Viral Entertainment as a Vehicle for Disseminating Core Development Services

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Abstract

Information and Communication Technologies for Development (ICT4D) can aid development where information and connectivity are the missing components. Several developing world problems like lack of natural resources, poverty, corruption, disease etc. could be helped through ICT based solutions. ICT4D techniques can lead to better management of available resources, improved monitoring & reporting of corruption and more connectivity among people. To achieve impact at a massive scale such solutions need to be robust enough to reach the target masses using available means with minimum resource expenditures. However, traditional means of communication prove ineffective in reaching low-literate, non-affluent masses. One viable option is speech over simple phones that are gaining an increasingly high penetration in most developing regions. Past research reveals another challenge that low-literate people have trouble using even simple telephone-based dialog systems and typically need explicit training. As a result such services are restricted to a moderate number of beneficiaries due to the non-scalability of user training.

The goal of my research is to enable dissemination of speech-based, development-related information and communication services to low-literate telephone users throughout the developing world; without the benefit of explicit user training. My work shows that speech-based simple entertainment services can be used as powerful motivators to induce self-training and viral spread among low-literate masses. Such services can further be used as vehicles for delivering core development services and as experimental test-beds for performing randomized controlled trials and demographic studies.

Acknowledgements

Table of Contents

Table of Figures

1. Motivation and Introduction

ICT4D

Information and Communication Technologies for Development (ICT4D) can aid development where information and connectivity are the missing components. Several developing world problems like lack of natural resources, poverty, corruption etc. can be helped through ICT based solutions if not completely alleviated. ICT4D techniques can lead to better management of available resources, improved monitoring & reporting of corruption and more connectivity among people. Based on a Web 2.0 like ideology, a problem is only big as long as the solutions are limited. Feeding a million hungry children is less of a problem if there are a million hands to feed them. To achieve impact at such a large scale the solutions should be robust enough to reach the target masses using available means with minimum resource expenditures.

Our Vision

The ultimate goal of our research is to be able to disseminate speech-based, development-related information and communication services to low-literate telephone users throughout the developing world. Such services may include:

- Facilitating an efficient marketplace (speech-based Craig's List)
- Finding and communicating with others who share a common interest and facilitating social and political activism (speech-based message boards and blogs)
- Expressing opinions and making them broadly accessible to others (speech-based blogging and tweeting)
- Sending/receiving group messages (speech-based mailing lists)
- Broadcasting and receiving announcements in emergencies
- Citizen journalism
- Access to all kinds of information that can aid socio-economic development of the poor and marginalized e.g. education/training/employment opportunities, health, agriculture etc.
- Automated surveys and polls to gather up-to-date information about health conditions, public sentiment, demands, needed facilities (health, social, infrastructure), grievances, available workforce and skilled labor (unemployed or looking for employment) etc.

All of these services are already available to the affluent people via the web, and some of them are also available to non-affluent but literate people via SMS. Very few such services are currently available to the low-literate.

Challenges

The conditions specific to low-literate, non-affluent users make them hard-to-reach using traditional means of communication. Television and radio are non-interactive; print-media is not suitable as it assumes literacy; computers are both unaffordable and unusable because the target users are often not skilled enough to operate them. In addition, stable electricity and internet connectivity could not be relied upon. Hence, mobile phones may be our only remaining option that fortunately has a high penetration in most of the developing countries. Even in case of mobile phones, we still cannot rely on the availability of smart phones (or the technical know-how of users to use them); SMS-based

interactions also require some literacy; hence we are left with speech over *simple* phones as a viable option. This option demands no more than the capability to make and receive a voice call from a user.

Most ICTD projects already use innovative techniques like speech-based or graphical interactions over mobile phones to reach the low-literate and tech-shy and try to come up with design interfaces suitable for such users. Despite all that, such projects still typically require explicit user training (e.g. Health Line ([68], [69]), Avaaj Otalo [57]) and as a result are restricted to a moderate number of users. To be able to provide a speech service to low-literate users they must first be taught how to use speech interfaces. And to reach the masses there should be a way to advertise and promote the intended services. Above all, this needs to be done without the benefit of explicit user training and traditional advertisement mechanisms.

One Possible Solution: Viral Entertainment

In 2010, Smyth et al. [70] described the remarkable ingenuity exhibited by low-literate users when they are motivated by the desire to be entertained, and concluded that such powerful motivation "turns UI (*user interface*) barriers into mere speed bumps" (ibid). Inspired by this powerful demonstration, we set out to systematically develop practices for entertainment-driven mass familiarization and training of low-literate users in the use of telephone-based services. We aim to introduce and popularize speech interfaces among low-literate users to serve as a delivery vehicle for core development services. We envision speech-based viral (defined as long, sustained chains of transmission to new users) entertainment as an ongoing component of a telephone-based offering, drawing people into the service, where they can periodically be introduced to the more core-development oriented services listed above. In addition, a speech-based entertainment service can have its own intrinsic development value by directly addressing the universal human need for entertainment. We need to balance various aspects of the entertainment to make it suitable for the target audience in line with our goals.

Research Questions

The following research questions have been driving our research:

1. **Viral Entertainment:** Are there simple-to-understand, non-controversial, quick-to-engage-and-spread forms of entertainment that are suitable for low-literate telephone users formerly inexperienced with automated dialog systems?

2. **Introduction and popularization of speech interfaces using viral entertainment:** Is it possible to virally spread awareness of speech-based services in a largely low-literate population, using entertainment as a motivation? Can people be educated to appreciate the need for such services in their lives and motivated to train themselves?

3. **Entertainment as a "hook" or delivery vehicle for core development services:** Is it possible to use entertainment as a viral conduit to disseminate core development related services to low-literate masses?

4. **An Experimental test-bed:** Can a virally spreading entertainment service be used as an experimental test-bed for performing randomized controlled trials and demographic studies?

5. **Reproducibility:** Can our setup and results be reproduced in the same or (geographically, culturally and linguistically) different locations?

Summary

Viral Entertainment to Introduce and Popularize Speech Services

To answer the first two research questions we started by developing a system called *SongLine* (describe in chapter: *Cultural Appropriateness*). Songline was a telephone-based, voice-based application that allowed users to listen to songs recorded by others, as well as to record their own songs and to forward them to friends. We developed it as part of our exploratory study in Pakistan and adapted it in response to user feedback. Soon, however, we learned through focus groups and informal discussions that a song and music based system was being considered controversial and its broadcast nature, a breach of privacy, by a large fraction of our target audience.

Our next step (as described in [63] and the chapter: *Pilot*) was to develop a simple telephone-based, voice-based entertainment service, called Polly, that allowed any caller to record a short message, choose from several entertaining voice manipulations, and forward the manipulated recording to their friends. The theme of light entertainment using funny modifications of a voice recording is both non-controversial and easy to understand (as we also confirmed later by analysis of user feedback). Recorded content in Polly is only available to the sender and intended recipients, in contrast to Songline where it was available to any caller.

In 2011, we introduced Polly among a handful of low-skilled office workers in Lahore, Pakistan. In 3 weeks Polly spread to 2,032 users and logged 10,629 interactions before we shut it down due to insufficient telephone capacity and unsustainable cellular airtime cost. From analyzing the traffic and its content, it was evident that Polly had been used extensively for entertainment and social contact, but it had also been put to an unintended use as a voicemail and group messaging facility. This demonstrated the potential for speech based services, and the pent-up demand for entertainment, among our target population. Also of note, Polly's viral spread crossed gender and age boundaries and even established itself in a female population. However, it appears to have not crossed socioeconomic boundaries.

Entertainment as a Delivery Vehicle and Experimental Test-Bed

Following the success of the pilot, we wanted to know if a system like Polly could scale to a larger audience and also spread other development related services. We set the following experimental goals to attempt to answer the next two research questions and the question of reproducibility in the same environment:

1. Determine whether a system like Polly can be employed to engage and support a large user base, for an extended period of time, while at the same time becoming cost efficient.
2. Attempt to add a development-focused service ('payload') to Polly's offering.
3. Use Polly as an experimental test bed to answer the following questions:
    a. How do usage patterns change with respect to gender, age, socio-economic status (SES), experience with the system, and cost to user?
    b. Spread vs. Cost: how to spread Polly as widely as possible at the smallest possible cost?

In [64] (and the chapter: *Large Scale Deployment*) we report the first large-scale sustained deployment of Polly. Re-launched in Pakistan in May 2012 with a 30 telephone line capacity, in five months Polly spread to 85,000 users, engaging them in 495,000 interactions, and was continuing its spread to 1,000 new people every day. One major addition to this re-launch was a voice based job search service for low-skilled workers. In its first five months, the job service attracted over 27,000 people, who in turn listened over 279,000 times to job ads and forwarded them over 22,000 times to their friends.

This version of Polly remained online for a whole year (see details in chapter: *Large Scale Deployment*) that allowed us enough time to conduct several experiments and randomized controlled trials regarding cost and spread. We also analyzed the traffic, demographics, geographical spread and message contents. The speech data gathered was used to study some of the demographics of the target users like gender and language. Follow-up surveys (manual) were conducted to gather information about the socio-economic status, age and educational background of selected users. We found that Polly was used mostly by uneducated young men (as well as some mid- and high-SES users). For most, interest declines within ~4 days however there are a non-negligible number of long-term users. We found most of the users to be very sensitive to airtime cost. We also collected a large dataset of social interactions consisting of detailed call logs and audio recordings. Some of it is already being analyzed by our collaborators.

Reproducibility in a Different Environment

To answer the question of reproducibility in a different environment and to track employment outcomes, we teamed up with *Babajob.com* in India to launch Polly from Bangalore. This version of Polly, deployed in July 2013, supports voice prompts in Hindi and Kannada. To our surprise, the system did not take off immediately as it did in Pakistan. Instead, it entered a six-month long *"sputtering" phase* of fluctuating, intermittent activity. A different form of seeding initiative transitioned it into a *viral phase*, with sustained transmission over five months but without (exponential) growth. Finally, some user interface adjustments caused the system to transition abruptly into a *viral-exponential phase* of very rapid growth amassing 10,349 phone calls by 1,613 users over a span of seven days. Analysis of the call graph, call logs, user feedback and surveys suggest the necessary conditions for each phase. We studied the interplay of user interface; language of the system; seeding mechanisms (how new users are introduced to Polly) and active response to user feedback towards the uptake of the service.

Our take home message from the Bangalore deployment is that exponential spread of speech based information services can be achieved in many countries and cultures, but must be accompanied by careful attention to the unique logistic and cultural aspects of each country, and that early attention to user feedback has a critical role to play in this process.

An Alternate Dissemination Model

We explored several possibilities when Polly did not take off immediately in Bangalore. One of our hypotheses regarding the lack of virality was the inability to effectively seed the service while not being physically present in India. We started exploring alternate seeding models. One such model was to use an existing voice-based, telephone service and to introduce some of its users to Polly. This may allow overcoming the trust and language barriers faced in remote seeding.

To test this model, we deployed Polly remotely in Jharkhand, India in collaboration with a popular local citizen-radio-over-phone platform, *Jharkhand Mobile Vaani* (JMV). Polly was launched in Jharkhand based on a "cross-selling" dissemination model where Polly advertised JMV and vice versa. As JMV is a utility-based service which is not inherently viral, our goal was to popularize it through Polly's exponentially growing users once it seeds Polly by advertising to its current user-base. Polly remained active for 54 days in which it received 19,042 calls from 4,428 users. Analysis of traffic reveals viral spread but no exponential growth. Polly was shut down due to high international calling costs and we are now deploying it locally in Jharkhand.

Polly's launch in Jharkhand shows that seeding via promos and advertisements has the potential to induce viral spread. The volume sustained itself even after the promo on JMV was turned off. Unfortunately, during the last few days our call-back request number remained down intermittently and

we cannot ascertain the potential volume that Polly could have acquired. Users' tendency to introduce new people to Polly in response to different types of promos shows that the content, mood and tone of the promo plays a vital role in influencing user's understanding of the service and its capabilities, and in turn effects user behavior.

Additional Features and Outcomes

Data Gathered through Polly
The launch of Polly is Pakistan resulted in a large and detailed dataset of user interactions. We have started analyzing this dataset ourselves (see chapter: *Behavior Analysis of Polly's Users*) and with the help of our research collaborators (see chapter: *Network Analysis of Polly (Collaborative Work)*). In addition, we have a huge (anonymized) database of recorded calls and voice messages in various languages and dialects from all over Pakistan that can be usefully studied.

Real-time Monitoring and Analysis (see Appendix A)
Various types of information are required on the go while Polly is in operation, to monitor its smooth operation and to analyze its spread and distribution. Some of the key pieces of information provided by the monitoring system are as follows:

- Real-time operational statistics to get the pulse of the system e.g. lengths of scheduler queues; available memory and telephone capacity; system responsiveness; call-back and delivery latency.
- Temporal (by date and time of day) and geographic distribution of Polly's traffic and system activity.
- Analysis and tracking of spread e.g. message delivery graphs; trees of who-introduced-whom to Polly (to link seeding to spread); user retention.
- Flow analysis of the dialog tree to find out the fraction of users who reach particular points in the tree. This helps in tracking user preferences and detecting interface hurdles.
- Analysis of user feedback, scheduled voice messages and access to complete call recordings.

In addition the monitoring & diagnostics system also:

- Raises real-time SMS and email-based alerts about operational problems and bugs,
- Automatically archives, backs up, summarizes and emails various types of data on regular basis,
- Auto-detects and recovers from certain problems by restarting the telephony and web servers,
- Helps is manual diagnostics of errors and allows quick-fixing several known problems.

Quick Launch in Developing Regions (see Appendix E)
Polly's initial Pilot was launched in Pakistan remotely from the US. Since then we have been using this technique as a quick way to do proof-of-concept in remote locations. As Polly is originally based on Voxeo's Tropo platform, it can be hosted directly from tropo's servers in US. In this case, Polly receives the call-me-back requests (via "missed calls") from the users through a local phone number in the target country. These phone numbers are forwarded to Polly via http requests. Polly then calls the users back directly from US. The main advantage of this mechanism is the ease of deployment. Only a phone number capable of receiving and forwarding call-me-back requests is needed on ground while everything else can be done remotely. The main disadvantage is airtime cost, which is generally much higher in this case as compared to a completely local deployment. In summary, all that is required to pilot launch Polly in a new region (using a new language) is:

1. Translate and record around 70 voice prompts into the target language.
2. Arrange a local phone number capable of receiving missed calls and forwarding these as web-requests to Polly.
3. A mechanism to send SMS to the users (if international SMS is not supported).

Multiplatform Support (see Appendix E)

As mentioned earlier, Polly was originally developed in PHP for the tropo platform. As tropo is not open-source and involves commercial licenses for telephony ports, we have also made Polly available over FreeSwitch, which is a popular open source telephony platform. This is enabled through a PHP-LUA (Freeswitch) translation library. Both versions of Polly share the same code-base.

Sustainability and Larger Impact

(See chapter 12. Future Plans: Impact and Long-Term Sustainability)

Skill-training and Job Opportunities in Pakistan

Polly has been funded by GIZ to act as a platform for connecting disabled people in Pakistan with employment and skill-training opportunities. Polly is required to act as an information dissemination and survey tool where it reaches the target audience through selective seeding and referrals; interviews people to gather their qualifications and interests; allows organizations to post job and skill-training openings with a special focus on jobs and training opportunities for the disabled; and connects people with opportunities appropriately.

Spreading Awareness about Ebola in West Africa

The recent outbreak of Ebola in several West African countries threatens to engulf an even larger population if effective measures are not taken to prevent its spread. Ebola spreads primarily through blood and bodily fluids of the infected person. Its rapid spread is largely being attributed to careless local practices that bring people in contact with Ebola patients and the deceased; lack of reliable information being conveyed to the public; corruption and mismanagement on part of the governments and a sheer absence of trust. In this situation an information dissemination service like Polly may prove useful.

We hope to lend a hand in quickly spreading reliable public health messages to the target audience. We are making efforts to quickly deploy Polly in Liberia, Sierra Leone and Guinea. Our plan is to use Polly to spread awareness messages pertaining to practices like washing hands and observing proper precautions in handling the sick and deceased. These messages would be generated by healthcare organizations that are intervening on the ground and will be recorded by influential public figures like religious leaders, celebrities etc.

2. Related Work

Viral Spread & Technological Solutions for Development

Several attempts to design user interfaces for low-literate users have been reported in the literature. Plauché et al [59] deployed information kiosks in community centers across six rural sites in Tamil Nadu, India to disseminate agricultural information to farmers. The kiosks allowed multimodal input (speech and touch screen) and output (speech and display). The reported study involved around 50 participants. Various forms of user training were employed, including short training sessions and group sessions. Low-literate users exhibited a mixed preference towards speech vs. touch screen input. The speech data gathered during spoken interactions was used to semi-automatically train acoustic models for each village for the ASR used in these kiosks [60]. In *Warana Unwired* [76], PC based kiosks used for distributing agricultural information to sugarcane farmers were replaced by mobile phones. The information was transferred to the farmers using SMS. Medhi et al [46] compare textual and non-textual interfaces for applications like digital maps and job search systems for low-literate users. The study was conducted in three slums of Bangalore, and highlighted the importance of consistent help options in the interface. It also confirmed that abstracted non-textual and voice based systems are preferred by low-literate users over textual one.

Most of the work done to date in providing speech-based communication services to low-literate users relied on explicit user training. In *Project HealthLine* ([68], [69]) the target audience was low-literate community health workers in rural Sindh province, Pakistan. The goal was to provide telephone-based access to reliable spoken health information, and the speech interface performed well once the health workers were trained to use it via human-guided tutorials. This project also highlighted the challenges in eliciting informative feedback from low-literate users.

Avaaj Otalo [57] is another successful example of a speech interface serving low literate users, in this case farmers. The 51 users of the system were shown how to use Avaaj Otalo before its launch. This telephone based system was pilot-launched in Gujarat, India and offered three services: an open forum where users could post and answer questions, a top down announcement board, and a radio archive that allowed users to listen to previously broadcast radio program episodes. The most popular service turned out to be the open forum, constituting 60% of the total traffic, and users found interesting unintended uses for it like business consulting and advertisement.

Patel et al. [55] recently identified three major factors enabling peer-to-peer services in the context of developing countries: access cost, subject matter or type of exchange and the influence of the administering institution. While subject matter builds the main perception about the service among users, moderation and encouragement can play a vital role in improving and refining the details of peer-to-peer interactions. In a follow up study, Patel et al. [58] compared the influence of peer-generated vs. institutional authority-generated content on farmers. In a two week trial, seven agricultural tips were disseminated to 305 farmers in Gujarat, India. Each tip was recorded in the voices of university scientists and farmers. Based on the number of follow up calls to listen to the remainder of the tip, it was concluded. The study showed that farmers preferred to hear agricultural tips in the voice of their peers; even though in interviews they maintained their more socially acceptable inclination towards scientists.

Voice-based media has also been shown to promote social inclusion among underserved communities. Mudliar et al. [50] examined participation via citizen journalism by rural communities in India using

CGNet Swara, an interactive voice forum. It enabled users to record and listen to messages of local interest and became popular among the target audience. Koradia et al. [36] involved listeners in voice content creation, feedback and station management via community radio, and showed that it can also be used to provide ICT solutions in the developing world. They highlighted the need to prioritize hardware stability over cost, diagnostic tools and remote technical assistance to solve most of the equipment related problems. Wyche et al, in their empirical study of professionals living in Nairobi, Kenya [78], highlight factors to guide ICT work in infrastructure poor settings with an emphasis on collective consideration: limited bandwidth; high access cost; varying perceptions of responsiveness and threats to physical and virtual security.

When dealing with a large user base, explicit training is not feasible. One alternative is to rely on learning from peers and on viral spread. To achieve virality, Baker [4] suggests (albeit in the context of literate users and web-based services) maximizing the product of (1) Install Rate (Percentage of invited users who install the applications); (2) Invite Sending Rate (percentage of users who invite at least one friend); and (3) Average Invites (average number of invites sent per user). A successful example of cellphone based (though not speech-based) viral spread is *SMS-all* [7], a group text-messaging service in Pakistan. Users can also create new access-controlled groups and join already existing ones. As of last report [7] the service has over 2 million users and four hundred thousand groups, and more than 3 billion messages have been sent out. People use this service to share information and discuss hobbies and other interests. However, the use of text assumes a level of literacy which is not common in our target population.

An important question in developing speech based telephone interfaces is the preferred input mode: speech vs. DTMF (push button). Project HealthLine ([67], [68] and [69]) found that speech input performed better than DTMF in terms of task completion, for both literate and low literate users. However, it provided no clear answer in terms of subjective user preference. In fact, [68] found that low literate users preferred DTMF input over speech input, although they performed better on average with the latter. User studies conducted in Botswana by Sharma et al [66] with HIV health information systems for the semi and low literate populations also suggest user preference towards touchtone over speech while both systems perform comparably. In contrast, [57] and [56] (which were conducted in a controlled environment) both report that DTMF and numerical input perform better than speech in terms of task completion and performance improvement. Patel et al [56] also report the problem of transitioning between DTMF and speaking as a major challenge. But overall, the study suggests that numerical input is more intuitive and reliable than speech. It seems from both of these reports that DTMF may be a better choice if user perception is vital for system adoption, especially in a situation where training and tutorials cannot be relied on.

Speech based input presents another major hurdle when dealing with the languages of the developing world: lack of local linguistic resources and expertise for training a speech recognizer. This is especially true in regions of great linguistic diversity as is the case in Pakistan, where even neighboring villages may speak different languages or dialects. However, for applications or services requiring only a small input vocabulary, the *Salaam* method [61] can be used, as it provides high recognition accuracy in any language for up to several dozen words.

Affordable smart phones are rapidly gaining popularity in the developing world. Several researchers are exploring the use of text-free graphical interfaces [48] and multimodal (spoken and graphical) interfaces [23] for the low-literate, however, user's literacy and experience using smart phones plays an important role in the usability of these interfaces. Chaudry et al. [22] report that chronically ill patients of varying literacies are able to use text-free graphical interfaces and prefer the ones with more prominent

buttons. A comparison of textual and text-free interfaces by Medhi et al. [47] shows that textual interfaces are problematic for novice low-literacy users; a live-operator is ten times more accurate than textual interfaces; task completion is the highest with graphical interfaces while spoken dialog improves user's efficiency, speed and comfort when system's language and dialect is understandable. In *Video Kheti*, Cuendet et al. [23] explored graphical interfaces used in conjunction with speech and touch-tone to allow low-literate farmers in rural India to find and watch agricultural videos in their own language and dialect. Their field study based on 20 farmers shows that although *Video Kheti* is usable and farmers are enthusiastic about it yet task success largely depends upon user's education level.

User Behavior Analysis

User behavior in IVR systems in the developing world was studied in Project Gurgaon Idol [37], a telephone-based singing competition. In this project, over 80 participants were trained to use the IVR system to record singing by four methods: training over radio, repeated calls, over the phone and in-person handholding. No significant differences were found between repeated calls and a single call in terms of task completion rate, while the in-person handholding, which costs more, significantly improved task completion rate. [51] studied the time-of-day periods when 51 users call a self-reporting system of tobacco and alcohol consumption. In project Avaaj Otalo [57], 51 small-scale farmers joined an interactive voice application. There was no evidence of error prevalence decreasing with user experience.

More broadly, behavior analysis has wide application in real life. User segmentation, for example, has been an area of research with applications such as behavioral targeting ([54], [47], [15]), and detecting social spammers [38]. Jeon et, al [30] performed cellphone user segmentation by analyzing smart phone logs. Three types of users were proposed: communicative-use type, entertainment-use type and restricted-use type. Ozer [54] proposed fuzzy clustering method to classify users with different goals in an online music service.

3. Cultural Appropriateness

Chapter Abstract

This chapter describes our initial efforts to find a simple-to-understand, non-controversial, quick-to-engage-and-spread form of entertainment that is suitable for low-literate telephone users formerly inexperienced with automated dialog systems. The goal was to use such an entertainment form to virally spread awareness of speech-based services in a largely low-literate population and to find out if it is possible to educate people to appreciate the need for such services in their lives and motivate them to get themselves trained. When we developed our first entertainment application called SongLine, a song recording and sharing system, we found it to be culturally inappropriate and unattractive for our target users. On the basis of user feedback and in consultation with a professor of psychology and human behavior in a Pakistani university, we developed Polly, a voice manipulation and forwarding system. Polly was appreciated by our target group.

Songline: A Song Recording and Forwarding Application

Songline is a telephone-based, voice-based application which allows users to listen to songs recorded by others, as well as to record their own songs and to forward them to friends.

We developed Songline as part of our exploratory study in Pakistan and adapted it in response to user feedback. We implemented it using the Tropo speech and telephony platform [5] due to its reliability, ease of development and free online hosting service. Songline employs spoken prompts (in Urdu and English) for output and DTMF (push button) for input.

To promote Songline to low-literate, low-income people, we kept it free to the user via a "missed call" mechanism: a user calls Songline, hears a busy tone, and hangs up. The system then immediately calls the user back (incoming calls are free in Pakistan). The "missed call" mechanism is already familiar to telephone users in Pakistan and most other developing countries.

User Interface

When Songline returns a user's missed call, it offers them to either record a new song or listen to already recorded ones. Songs can be browsed by *most-popular* or *most-recent,* and the user can skip, listen, and vote for them. To record a song, the user is given up to 30 seconds to sing, but they can end earlier by pressing a button. The user may also enter phone number(s) of explicit recipients -- friends to whom their recorded song will be actively forwarded. In this case they may also record a brief introduction. Songline then calls the explicit recipient on behalf of the sender and plays them the sender's introduction followed by their recorded song. The recipient may choose to reply with a song, record their own song, or browse all the songs in the system.

All actions in Songline require explicit user confirmation.

User Feedback and Lessons Learned

We conducted focus groups in Lahore to gather feedback on Songline. The 10 participants, in two focus groups, were office workers at a local university, with eight years of formal education. Participants were first given a brief explanation of what Songline can be used for, then were observed interacting with Songline. We made sure that the uses were not intimidated by a lab or an interview like setting and

observed them non-intrusively in a friendly conversational setting. Participants were also encouraged to continue using Songline on their own after the focus group and their activity was logged.

Mansoor and Samia (in the background) non-intrusively observe the real-time logs of a user's interaction with Songline while Ali observes his responses.

Mansoor conducting focus groups in a village near Lahore

Figure 3-1: User feedback and focus groups in friendly conversational settings

User Feedback on Songline as an Application
- It was not clear to some of the users how such an application would be beneficial to them
- Songs and music of certain types are considered culturally immoral in Pakistan and hence the very theme seemed controversial to eight participants
- All ten participants were concerned about the fact that anyone can listen to their recording, considering it a breach of privacy. They also seemed shy to sing in front of our team or even their fellow workers

Feedback on the Interface
- Entering phone numbers of friends (rather than selecting from a built-in phone directory or call history) was reported to be a big hurdle by three
- Busy tone confused one user who thought that the number is actually "busy"
- Interface was reported as being confusing to two users due to detailed call tree and numerous options
- Prompts were unclear due to low audio volume as was reported by five participants
- At least two participants had difficulty entering international style phone numbers with country code and "+"

This was enough to convince us that drastic changes in theme and interface were required to make an application acceptable and compelling to our target population. This led to the development of *Polly*, as described below.

Polly: A Voice Manipulation and Forwarding Application
Polly is a telephone-based, voice-based application which allows users to make a short recording of their voice, modify it and send the modified version to friends.

In Urdu, Polly is called "Miyan Mithu", which has a similar meaning to "Polly the Parrot". The theme of light entertainment using funny modifications of a voice recording is non-controversial and easy to

understand (as we also confirmed later by analysis of user feedback). Recorded content in Polly is only available to the sender and intended recipients, in contrast to Songline where it was available to any caller.

Polly's pilot was also based on the Tropo platform and employed pre-recorded prompts for output. Standard system prompts played in Urdu or English depending on whether the call was made from Pakistan or the US. DTMF (push button) is used for input. The "missed call" mechanism was used to keep the service free to the user.

User Interface

Following feedback from Songline, we designed Polly's interface to be particularly simple, significantly reducing the depth and breadth of the call tree. When a user calls the Polly local number, instead of busy tone they hear a "caller tune" informing them in a parrot-like voice that Polly will call them back momentarily (caller tunes are mobile operator supported services for which the caller is not charged). Polly calls back the user and prompts them to record a short phrase. The recording terminates if the user remains silent for more than 4 seconds or when 15 seconds have elapsed. Immediately afterwards, a funny modified version of the user's voice is played back. This is done to engage the user early on, before they encounter any menus or need to press any key. At this point, the user is given an option either to try the next voice manipulation effect or to forward their modified voice to friends. We offered the following voice modifications effects, all achieved with a standard audio processing utility:

1. An *I-have-to-run-to-the-bathroom* effect, achieved by a gradual increase of the pitch,
2. A *drunk chipmunk* effect, achieved with pitch and pace modification,
3. Converting the voice to a *whisper*, achieved by replacing the excitation source of user's voice with noise
4. Adding *background music*.
5. The original, *unmodified* voice of the user

Sample voice modifications and a detailed video demonstrating user interface are available online at [6].

If the user chooses to forward his recording to friends, he is prompted for the phone number and (optionally) name of his friend and also (optionally) his own name for introduction. Only the phone number is confirmed for correction. The user is not required to press any keys to terminate recordings of names, which are terminated by silence detection and/or time-out after 4 seconds. The user is allowed to forward his voice to multiple recipients with the same or different modifications applied.

Polly calls the intended recipients to deliver the recorded voice and the sender's phone number is sent as the caller ID. The sender's name (in his own unmodified voice) is immediately played to the listener to prevent any confusion regarding the identity of the caller. A recipient can choose to send a reply, forward the recording to others or create their own recordings.

As an additional mechanism for viral spread, text messages containing Polly's contact information are sent to all of Polly's recipients on their first two interactions with the system.

We also elicit **User Feedback,** in the form of an unconstrained recording (up to 60 seconds, with a silence timeout) from repeat users during their interactions with Polly. Feedback is requested only when a user actively initiates a call. Feedback is requested in two manners:

System Prompted Feedback – Every user is prompted for feedback on their fifth interaction with Polly, and on every 20th interaction thereafter.

User Initiated Feedback – Following the user's fifth interaction, the menu is augmented with an explicit option to give feedback.

Trial Launch

In a trial launch of Polly we gave Polly's phone number to two office workers at Lahore University of Management Sciences (LUMS) and asked them to call it, without explaining the details of the application. The test lasted two weeks during which the user base increased spontaneously to 32. We then stopped Polly and gathered feedback by interviewing the users. Most of the reported problems were minor software flaws which were fixed as we prepared for the pilot launch.

4. Pilot launch of Polly in Pakistan

Chapter Abstract

The goal of this pilot was to find a proof-of-concept that simple speech based entertainment services for mobile phones have the capability of becoming viral among low-literate telephone users in Pakistan. We also wanted to find out whether Polly's interface is simple enough for the target users and if they can be motivated to overcome the remaining interface hurdles by themselves. The pilot was seeded once by 32 low-skilled office workers in a Pakistani university. Within 3 weeks Polly amassed 2,032 users and logged 10,629 telephonic interactions. From analyzing the traffic and its content, it was evident that Polly had been used extensively for entertainment and social contact, but it had also been put to an unintended use as a voicemail and group messaging facility. This demonstrated the potential for speech based services, and the pent-up demand for entertainment, among our target population. Also of note, Polly's viral spread crossed gender and age boundaries and even established itself in a female population. However, it appears to have not crossed socioeconomic boundaries.

System Description

We used a distributed system setup for Polly. User initiated calls were received on a mobile phone in Pakistan which was attached to a PC, which in turn rejected the call and forwarded the caller ID to the Polly application running on Tropo servers in US. The return call was made directly from US to Pakistan as an international Tropo call charged to the research project. Voice modification and file storage were done in the US, where a logging database was also kept.
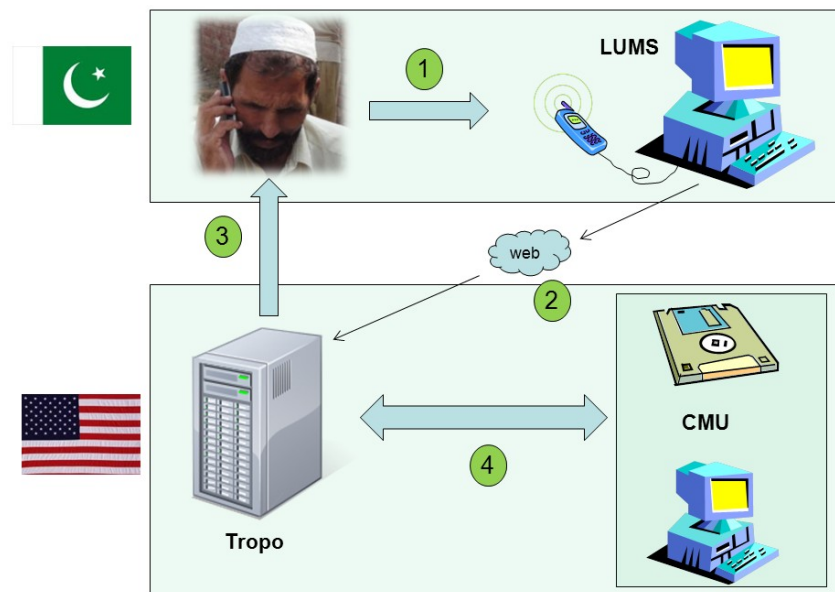
Figure 4-1: Distributed setup of Polly

Launch and Shutdown

We launched Polly by seeding it with the 32 users who had participated in the pilot launch. We had our system call these users up and announce via a voice recording that Polly is back up. We made no further attempts to solicit users. Figure 4-2 shows the growth in system usage over the 22 days it was active. In

what follows, we define "Polly Day" as a 24 hour period ending at 4am Pakistan time. "Polly Day 1" refers to the first day of Polly's launch, which was shorter than the other Polly Days since it started in midday.
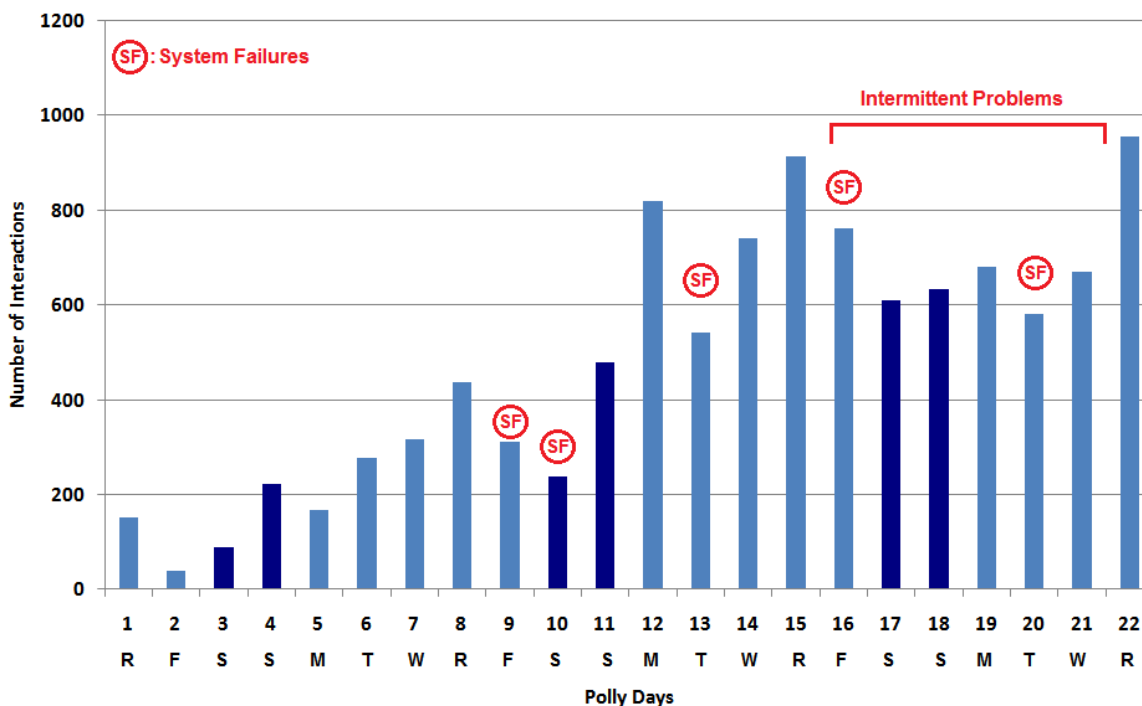
Figure 4-2: Polly Traffic Volume by day.

Unintended System Downtime

Polly experienced multiple down times due to power/ internet failures and other technical and administrative reasons. Major system failures occurred on Polly Days 9, 10, 13, 16 and 20, and repeated intermittent problems were experienced on Polly Days 16 –21.

Shutdown

We shut down Polly at the end of Polly Day 22, for two reasons:

1. During the peak evening hours (see Figure 4-6 below) the system was saturating, with many callers receiving a busy signal due to contention over the single incoming phone line (this was later confirmed in the analysis of user feedback). We also started experiencing intermittent system problems, further exacerbating user frustrations. We did not want users, especially new ones, to be frustrated in their interactions with our system.

2. The international call charges were becoming a significant financial burden for us.

It thus became clear that, to support the ever increasing incoming call volume, we need to reconfigure Polly for a multiline setup operating entirely within-country.

We shut Polly down gradually and gracefully, for the next 10 days, we continued to use the Missed Call mechanism but the returned call played a message stating that Polly is offline temporarily to make improvements on the basis of user feedback. We also solicited further feedback by inviting the caller to record any additional suggestions and comments. This **Post shutdown feedback** will be discussed later

on. After that period, we replaced Polly's caller tune with a brief message stating that Polly is temporarily offline and will return as soon as we are done improving it on the basis of user feedback.

Airtime Cost

We paid $0.12/minute to go from US to Pakistan over IP, with another $0.023/min for using a hosted solution. The total traffic for the 22 days amounted to 26,000 minutes (approx.) incurring a cost of around $4,000.

Annotations of Recordings and Feedback

Four student annotators (three male and one female) listened to the recordings and created detailed annotations based on their subjective assessments. All recordings were annotated in this manner, each by a single annotator. Each recording was first annotated as to the speaker's gender, estimated age; the language used, and net recording duration. Recordings were next categorized by their content (humor, information, romance, introduction, informational, profane, saying hello, meaningless, or other). Feedback recordings were similarly annotated, although with different content categories (request for continuation of service, appreciation for Polly, suggestion for improvement, specific feedback, complaint, suggestions for new services, or other). Annotators also noted the location or geographic origin of the caller, if it were expressed in, or could be inferred from, the recording. Finally, the annotators were also encouraged to note in unstructured comments any interesting subjective observations, such as the functions for which Polly appears to be used.

For the purpose of annotation, recordings were sorted by the phone number used (which often, but not always, corresponded to a single user), and then by increasing date and time. Each annotator listened to all the recordings of a subset of the users, and all recordings of any user were listened to by the same annotator. This aided in making demographic assessments and enforcing annotation consistency. It also allowed the annotators to observe changes over time in a user's interaction style and usage patterns.

Analysis of Viral Growth

During the 22 days that Polly was active, it handled a total of 10,629 calls (interactions). We distinguish calls initiated by the user (albeit via the *missed call* mechanism) from those which were initiated by Polly (to deliver a recording from another user). We also distinguish whether any new delivery requests were made during the call (see Table 4-1). We consider an **Active Interaction** any call which was either initiated by the user or during which a new delivery request was made (all but the bottom right cell). Note though that, as our annotation shows, even interactions we deemed Not Active often involved significant user engagement: voice recording, listening to various modifications, and sharing with others nearby (203 such *non-active* interactions were made). Note further that many users who received deliveries chose to hang up and then place a separate user-initiated call. Taken together, this analysis shows that Polly simultaneously provided entertainment and promulgated viral growth.

	User Initiated	System Initiated (delivery)
User made new delivery requests during interaction	4,340	699
User made no delivery request during interaction	2,444	3,146
Total	6,784	3,845

Table 4-1: Breakdown of Polly's 10,629 interactions

The dual entertainment and viral-spread properties of Polly are also demonstrated in the growth of its user base. Table 4-2 shows the number of users who took part in each of the four types of interactions

(the categories are not mutually exclusive). Note that 86% of Call Initiators and 17% of Call Receivers spread the service further to their contacts.

	Call Initiators	Call Receivers
New delivery requests made during call	525	313
No delivery request made during call	476	1,723
Total	613	1,843

Table 4-2: Breakdown of Polly's 2,145 Users by Interaction Type (not mutually exclusive)

Word-of-mouth spread

Of Polly's 613 Call Initiators, fully 291 (47.5%) placed their first call before receiving any calls from Polly. We conclude that a significant component of growth and adoption of a service like Polly can come from word of mouth or physical observation and emulation.

We define **Active User** as any user who participated in an Active Interaction

Rate of Adoption

Another important measure of the viability of a service like Polly in the developing-world is its rate of adoption. Namely, how quickly did users adopt Polly once they learned about it? Of the **322** users who became Call Initiators when called by Polly

- **25** immediately placed delivery requests *during* the first call that they received from Polly (Instant Conversion)
- Out of the remaining **297**, 166 users started using Polly (called back Polly) just after receiving a single call. However, on average it took 1.83 calls to each of these **297** users before their first in-bound call

Therefore, while a very small percentage of users become active users in their first interaction, most became active users after fewer than two reminders. This relatively small number, 1.83, highlights the potential of, and the pent up demand for, value added voice-based services in the developing world.

Usage growth pattern

Figure 4-3 shows the daily growth in Polly's usage. Even though viral growth is evident, the dampening effect of system down times (Days 9, 10, 13, 16 and 20) is clearly visible, as is the impact of the intermittent disruptions during the last 6 days. Note also the impact on the number of new users following system down time, as many users are introduced to Polly via Polly deliveries.
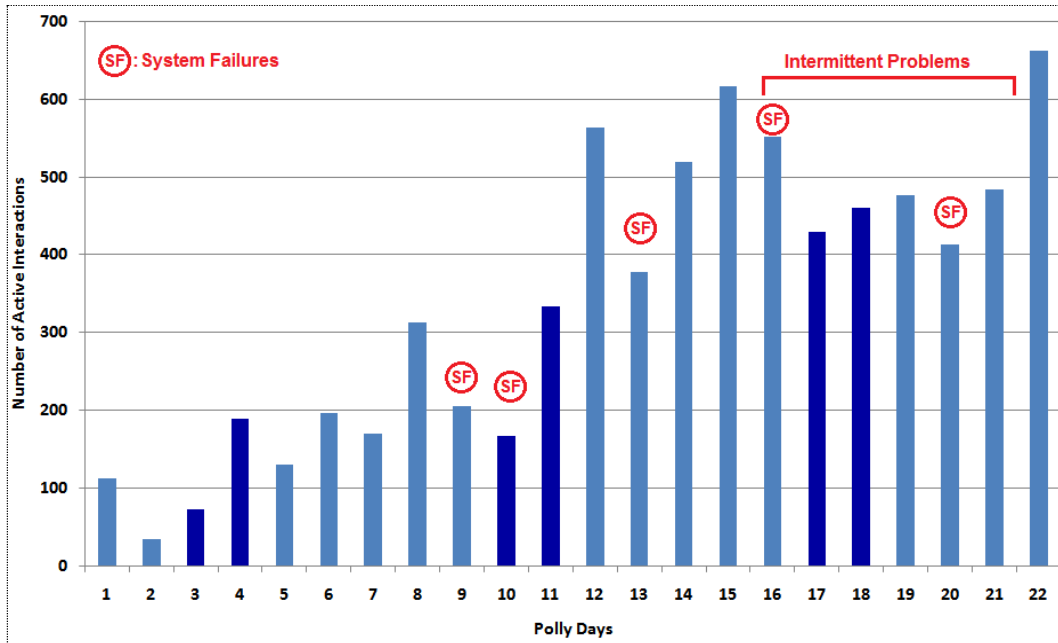
a.
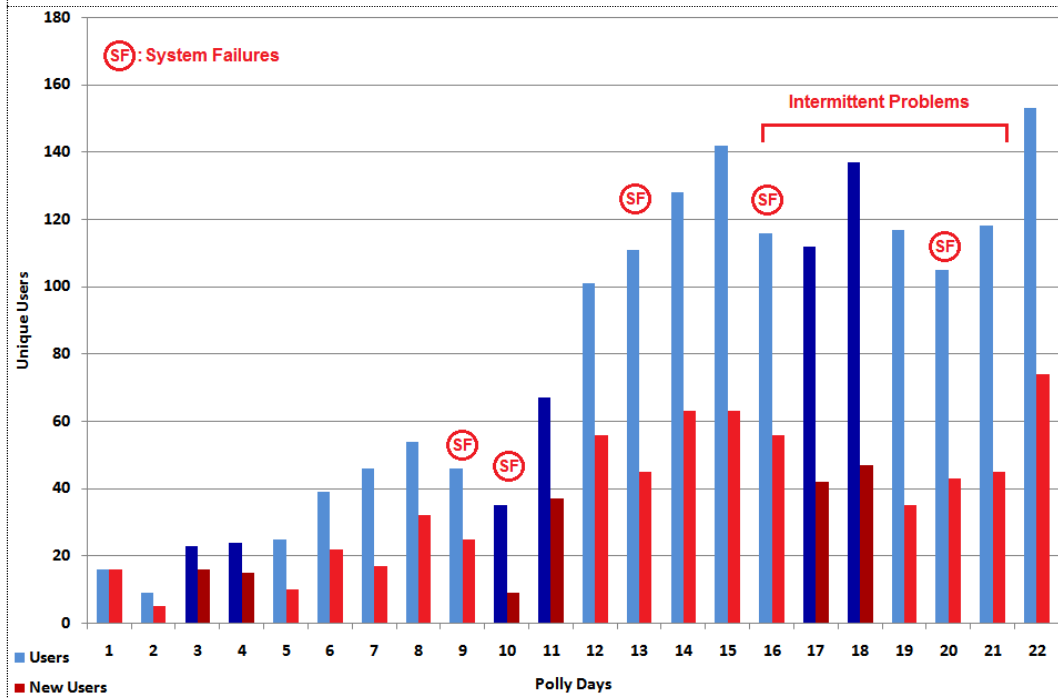
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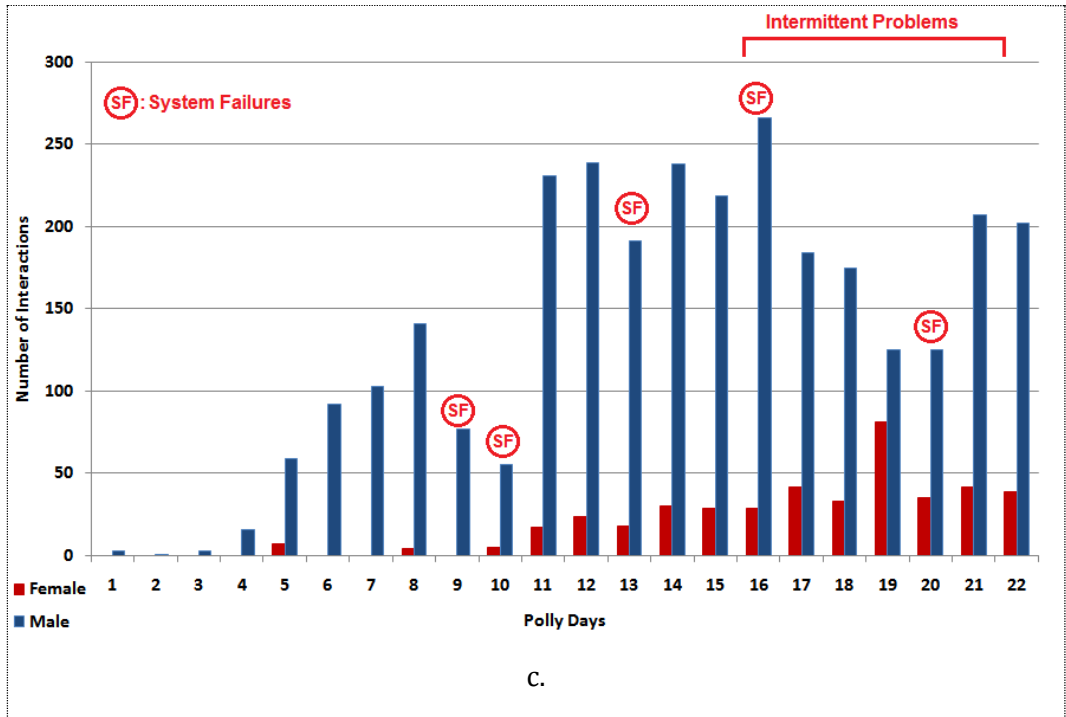
Figure 4-3 Polly's daily growth in terms of (a) interactions, (b) users, and (c) gender

Short-term vs. long-term users

Since the entertainment options provided by Polly did not vary over time, we expected that most users will tire of it within a short time. Figure 4-4 depicts user retention by means of sedimentation layers. Each layer represents the cohort of users who started using Polly on a given day. For example, on day 12 (yellow), there were 57 new users, out of a total of 99 users that day. The members of this cohort who remained active on subsequent days can be seen by following the shrinking color band. As expected, most users stayed with the system for only a few days. However, of note, a small but consistent fraction of users appeared to have settled into long-term usage. Figure 4-5 shows the percentage of active users who continue to use the system k days after their first interaction.
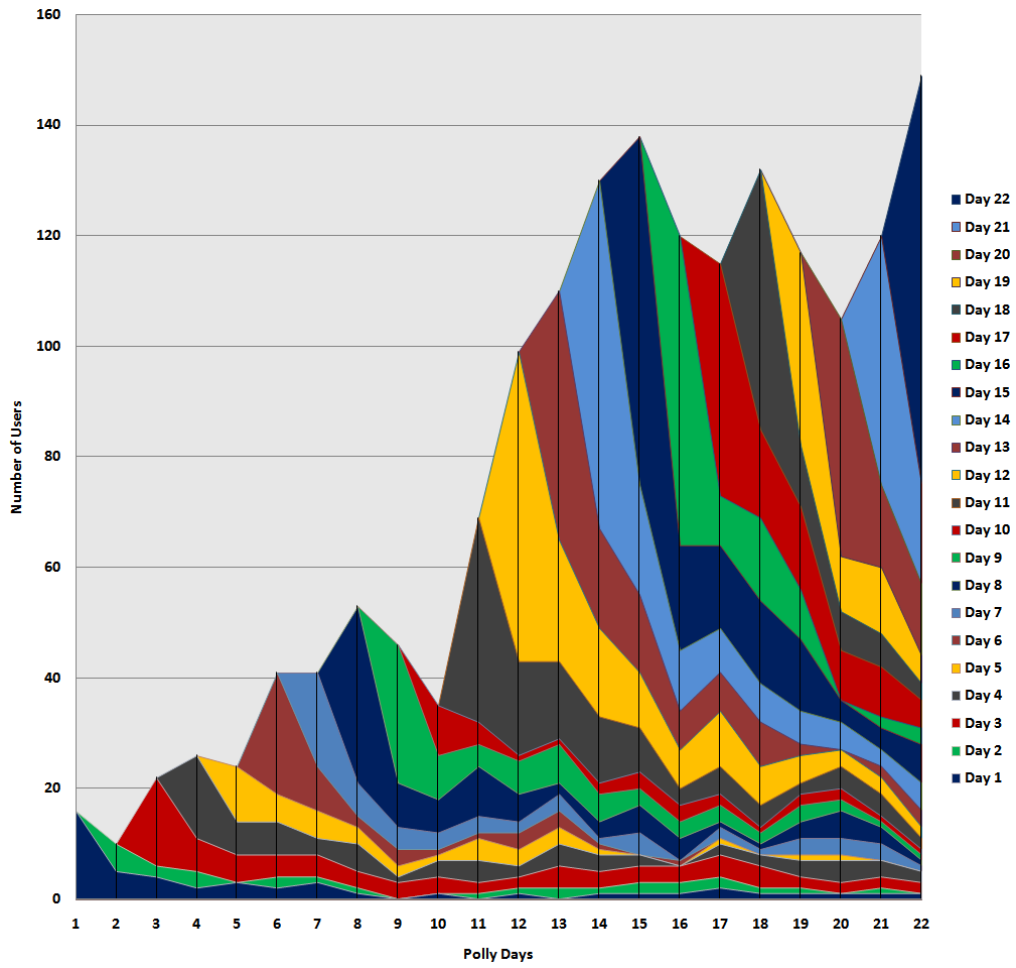
Figure 4-4: Number of Active Users each day. Each color corresponds to users who started using Polly on a given day. About 10% of users continue to use Polly long term.
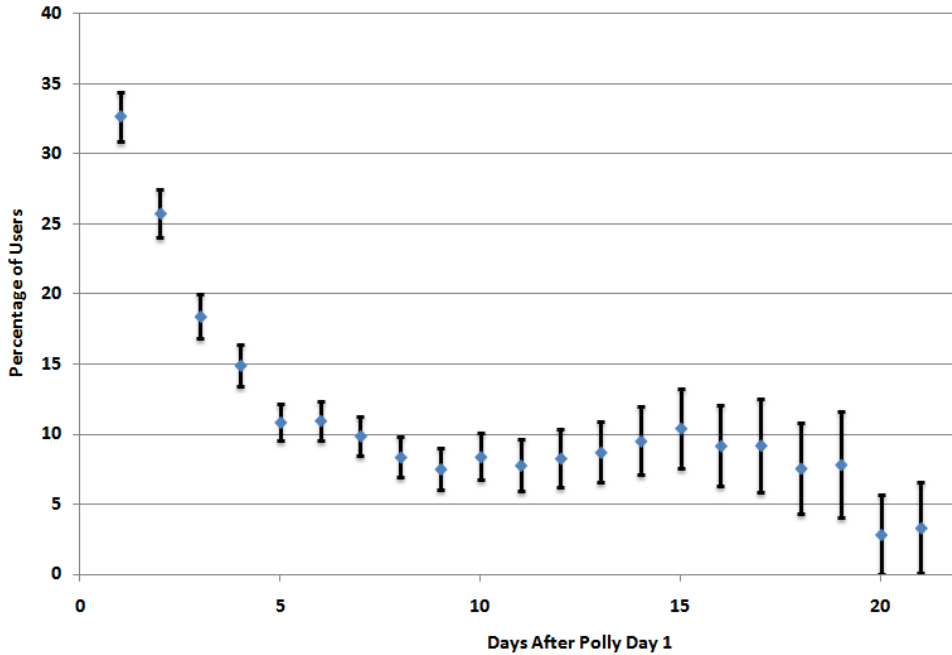
Figure 4-5: User retention in Polly

Activity by Time of Day

Figure 4-6 breaks down Polly's interactions by time of day. Although peak activity occurred in the evening hours, there was significant activity throughout the day, dropping down to a trickle only late at night.
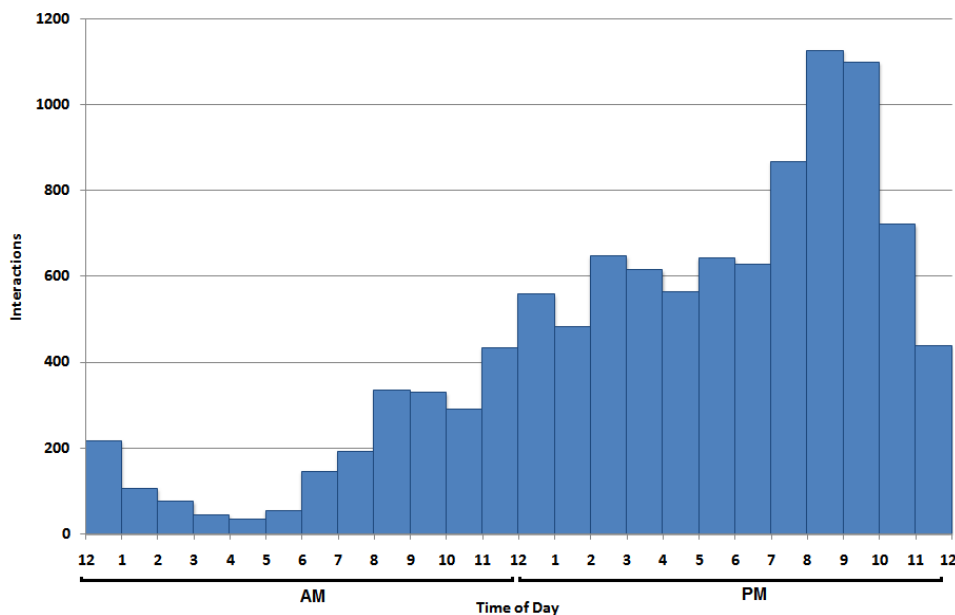
Figure 4-6: Polly activity by time of day

Post Shutdown Usage

Users were still calling Polly 40 days after its final shut down, when we finally stopped monitoring the calls. We received 1276 calls during this period made by 310 individuals. 117 out of these callers were

new users who had never called Polly during its active period. A significant number of users kept calling repeatedly, as many as 46 times. This is perhaps the most compelling evidence for the potential of, and pent-up demand for, this type of service in developing countries.

User Feedback

Feedback elicited during Polly calls

The feedback mechanism was implemented on Polly day 13. In the nine remaining days in which this option was available, 391 recordings of feedback were made by 264 unique users. Out of these, 189 recordings of user initiated feedback were made by 129 individuals. In addition, 202 system-prompted feedback recordings were provided by 169 users. 34 users recorded in both feedback categories. Out of the 391 recordings 118 were empty files.

Based on the remaining 273 files (191 distinct users) following is a brief summary of the main suggestions and complaints (the categories are not mutually exclusive):

Feedback Type	%
Interface/functionality related feedback and complaints: too long turn-around time of message delivery; poor call/sound quality; busy network; too short message recording time; increase/rearrange sound effects etc.	49
General appreciation including mentioned reasons such as: a way to connect to friends; a means of having fun; free service etc.	47
Confused users (pressing keys or saying "hello")	7
Irrelevant feedback including: songs; messages for friends; irrelevant messages for Polly etc.	5

In addition to these, several users recorded interesting and useful suggestions for the improvement of Polly as well as their ideas about other speech applications. A brief summary follows:

- Ideas for new voice modification effects in Polly including female/child voice modification, laughter and giggling, scary voice and background effects like sad music, rain drops, sound of a train, wind blowing etc.
- A application similar to Polly just for ladies
- Several suggestions to improve user interface including a rerecord option for messages, rapid access to effects of choice, options to go to the previous menu and to end the call etc.
- Suggestions to improve the wording of the prompts

Additional suggestions included:

- An accessibility software for the blind that could be used on less expensive mobile phones
- A software that could identify and filter out foul language in a message

Post Shutdown Feedback

As mentioned earlier, we continued to elicit feedback after shutdown. 565 post shut down recordings from the initial 11 post shutdown days were analyzed. 299 of these were empty files (noise, silence, button presses etc.). Out of the remaining 266 files 34% users asked to bring Polly back online as soon as possible. 8% were annoyed / angry because of Polly's shutdown and 8% explicitly expressed that this shutdown is creating problems for them and Polly was useful for them. 16% of the users simply stated that they want Polly to continue as it is a good service. Several files contained irrelevant feedback or recordings of users who were confused by the shutdown and were pressing keys or asking questions.

User Demographics and Usage Analysis

Gender

Among Polly's 773 Active Users, 74% were determined by the annotators to be male, 14% to be female, with the remaining 12% undetermined (young children, old people, too much background noise, etc.). As shown in Figure 2(c), sustained usage by female users coincided with an explosion in use by male users.
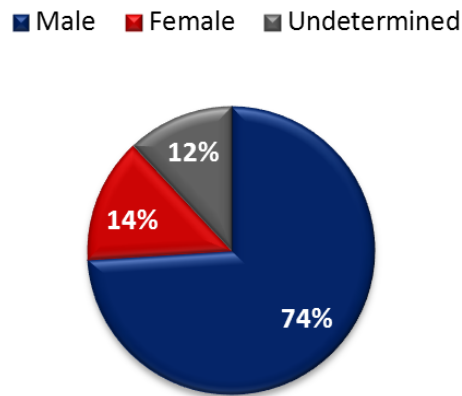
Figure 4-7: Gender distribution

Age

Figure 4-8 gives the approximate distribution of the Active Users' age, as guesstimated by the annotators. It is clear that most users are young men. This may partially reflect our seed population. Nonetheless, we were encouraged to observe participation by other demographic groups, especially women.
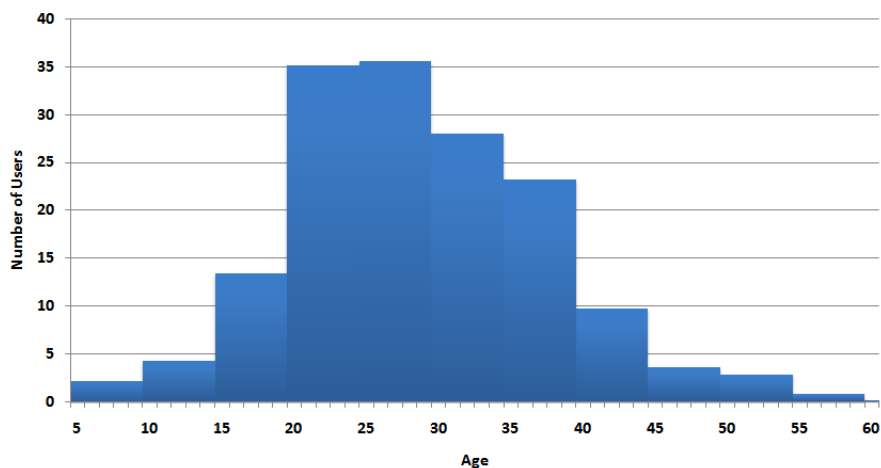
Figure 4-8: Age Distribution

Language of recordings

Some 46% of the user recordings were in Urdu, which is Pakistan's national language and the most widely spoken and understood language in Pakistan. This is also the language we used for Polly's prompts, effectively priming for the use of this language, and excluding those who don't understand it.

Of note, fully 38% of the recordings were in Punjabi, the regional language of Punjab province, where Polly was launched. Fewer than 3% of recordings were in mixed Urdu/Punjabi, in English, or in mixed Urdu/English. Interestingly, there was also a smattering of recordings in Potohari (17 recordings), Saraiki (6), Pashtu (2) and Arabic (2).

Geographic Spread

Polly was seeded with office workers in Lahore. Analysis of the traffic showed us that it received phone calls from several cities throughout Pakistan. Figure 4-9 shows the rough geographical spread of Polly.
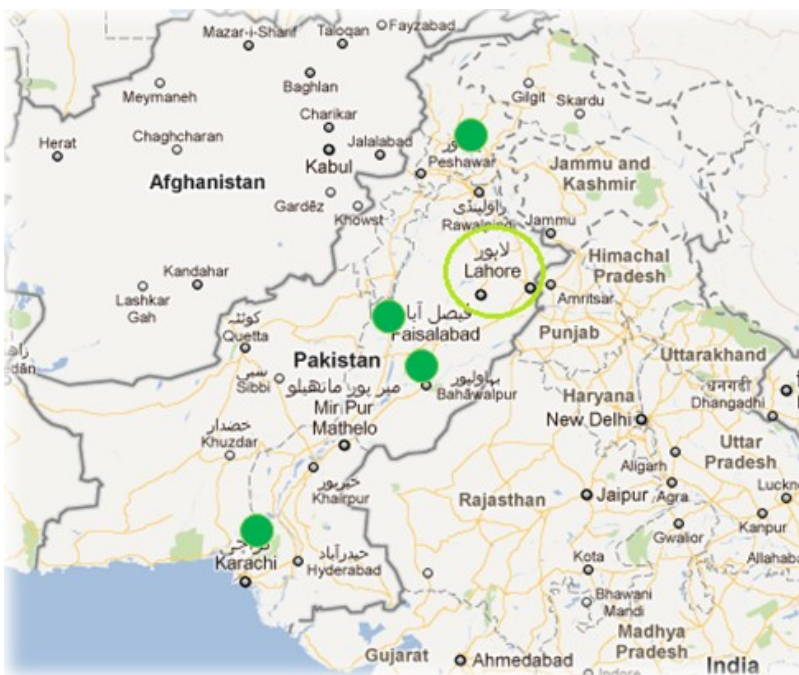
Figure 4-9: Geographic Spread

Socio-economic level and educational background

Although we have not rigorously verified this, the transcribers' best estimates of the socio-economic and educational level of the callers suggest that the vast majority come from a socio-economic class similar to that of the originally-seeded low-skilled office workers, and with an educational level that does not exceed theirs (approximately 5th grade and below). The fact that such users were able to successfully use and share the system with their friends is consistent with the finding by Smyth et al. [1] that low-literate users are able to learn potentially complicated user interfaces without any systematic training when the purpose of the system is entertainment.

Usage Analysis

Table 4-3 shows the distribution of voice recordings based on the type of content recorded. These message types are not mutually exclusive. In 2,138 interactions the users did not place any delivery requests and simply played with the system by recording their voice and listening to the modifications. 203 out of these were calls initiated by Polly to deliver messages. This brings forth two main uses of Polly: personal entertainment and free voice messages.

Content Type	% of Messages
Informational messages for friends	50.53
Hello/Hi and introductory recordings	13.01
Profane	6.26
Poetry/Songs/Whistling	2.60
Humorous recordings	2.07
Romantic	1.99
Political	0.02

Table 4-3: Distribution of recordings by content

Further analysis showed striking differences in usage by females and males. There were almost twice as many romantic recordings, four times fewer profanity-laced recordings, and four times more song recordings by women than men.

Additional Findings

As discussed earlier, a significant fraction of Polly's users started using it without ever receiving a call from it, presumably having been introduced to it by word of mouth or by observing others. In addition, a large portion of user recordings (including feedback files) contained interactions where one user is training another to use the system. All this points to the important role of direct human interaction in the spread of Polly. This is not unexpected in a rural setting where people routinely gather face to face in the evenings.

Another interesting finding was that people kept recording detailed messages and complaints about problems with everyday necessities such as electricity outages. Some explicitly requested that their voice should reach government, relevant officials and people who can solve their problems. Some users even identified Polly as someone who can solve their issues or raise their voice.

Conclusion

The pilot launch proved that entertainment and free voice messaging are both powerful motivators that attracted 2,032 users to Polly in a span of 22 days, compelling them to learn the interface and enabling them to find creative uses for Polly in their daily lives.

Although Polly was not designed to fan-out as much as SMS-all [7] (which was based on group messaging), it nonetheless became viral practically instantly. That this happened in spite of significant system failures and intermittent down times underscores the potential for speech-based services, as well as the pent up demand for entertainment, among our target audience.

Of particular note, Polly's viral spread crossed gender and age boundaries and even established itself in a female population. However, it appears to have not crossed socioeconomic boundaries. This could be due to the more insular nature of socioeconomic classes, or due to our service not being attractive to wealthier people, who may have other entertainment alternatives available via the Internet.

Stability and capacity

Much of the instability that Polly suffered from, and most of the airtime cost we incurred, can be attributed to the distributed and international setup we used. We next started working to set up Polly locally in Lahore, using robust multiline infrastructure. That would allow us to reliably support significantly larger call volume at the fraction of the cost.

Airtime charges

Even with our new setup, local airtime costs (about $0.02/minute) will still be incurred. Although we could try shifting most of this cost to the users by eliminating the missed-call mechanism, we were reluctant to do so at such an early stage because this may discourage the poorest users, who are the ones we are most interesting in reaching. One option we considered was to offer two versions of Polly: a free bare-bone version, and a premium one which requires the user to pay their own airtime charges.

Help facility

Our annotators noted that some users found it difficult to master Polly on their own, and could be heard asking their friends for assistance. We also noticed that some features of Polly, like group messaging, were rarely used. We considered incorporating an intelligent help facility in the future versions. Less frequently used features could be introduced after a user has had some success with the basic system (the callerID mechanism allows us to effectively retrieve at runtime the user's entire interaction history).

Speed dial

A frustrating bottleneck in requesting a forward was to have to manually enter the friend's phone number. Since Polly is designed to work with any cellphone, it only uses the voice communication channel, and thus has no access to the phone's internal directory or dialing history. Our pilot system already elicits friends' names from our users during Polly interactions. In our latest version, recipients could be specified by choosing from a short menu of names they previously recorded.

5. Large Scale Deployment

Chapter Abstract

Following the success of the pilot, we wanted to know if a system like Polly could scale to cater a larger audience and also spread other development related services. We decided on the following experimental goals to attempt to answer these research questions and the question of reproducibility in the same environment:

1. Determine whether a system like Polly can be employed to engage and support a large user base, for an extended period of time, while at the same time becoming cost efficient.
2. Attempt to add a development-focused service ('payload') to Polly's offering.(details in chapter: *Development-related Service: Job Opportunities*)
3. Use Polly as an experimental test bed to answer the following questions (details in chapter: *Polly as an Experimental Test-bed*):
   a. How do usage patterns change with respect to gender, age, socio-economic status (SES), experience with the system, and cost to user?
   b. Spread vs. Cost: how to spread Polly as widely as possible at the smallest possible cost?

In 24/7 operation in Pakistan from May 9, 2012, as of mid-September Polly spread to 85,000 users, engaging them in 495,000 interactions, and was continuing to spread to 1,000 new people daily. It had also attracted 27,000 people to a job search service, who in turn listened 279,000 times to job ads and forwarded them 22,000 times to their friends. Starting mid-September, we applied strict quota limits on the number of subsidized calls per user per day. We did this both to control our airtime expenses as well as to continue our series of randomized controlled trials (started as early as July 2012, discussed in chapter: *Polly as an Experimental Test-bed*) aimed towards answering the question of finding the optimal balance between cost and spread. Under the quota restrictions Polly continued to bring in significant number of new users every day, though the growth of its call volume slowed down. After a year from its launch Polly had gathered 165,000 users who had participated in 636,000 interactions. 34,000 people had used the job browser to listen 386,199 times to the 728 job ads available in the system. These ads were forwarded 34,000 times by 19,000 users to their friends. Polly was shut down again on May 07, 2013 because we had concluded our set of experiments and the airtime cost was becoming a burden again.

System Description

The system that we used in the large scale deployment represents a substantial extension of the pilot that we deployed in 2011. The most important changes are:

- Telephony capacity was increased from 1 to 30 channels (up to 30 concurrent phone calls, incoming and outgoing).
- Three different telephone numbers were assigned to a 'hunt group' consisting of these 30 channels, to support flexible, dynamic allocation for multiple application types.
- All the software resides on a single server hosted on location in Pakistan by a local telecom (in 2011, software was distributed and split across two continents). Consequently, outgoing call airtime costs were reduced from $0.126/minute to $0.023/minute.
- Most menus, prompts and recordings can now be skipped by the user by pressing any button on their phone.

- The number of voice manipulations offered was increased to six by adding male-to-female and female-to-male options.
- Extensive logging, real-time monitoring, automated error detection and recovery features were added.
- The most important addition in the current system is the introduction of a development-related application (what we call 'the payload') as part of the dialog menu: an audio-browsing of advertisements, collated from Pakistani newspapers, for jobs that are appropriate for low-skilled, low-literate workers.

User Interface

Polly's user interface for the large-scale deployment was an extension of the one described in [63]. For convenience and completion, we provide a full description here. For video and audio demonstrations, see [6].

Informed Consent: Before the start of interaction every caller is informed that the call is being recorded and may be analyzed, and is given the opportunity to hang up. All users must listen to this prompt as it cannot be skipped by any key press.

At the start of the call, the user is prompted to make a short recording of their voice (15 seconds, or shorter if the user presses # or remains silent for 4 seconds). A funny voice transformation of the recording is immediately played back to them. The user is then given an option to hear the recording again, rerecord, try another voice manipulation effect, forward their modified voice to friends, give feedback to Polly or listen to the latest job ads (explained in chapter: *Development-related Service: Job Opportunities*). We offer the following voice modifications effects, in the following order, all achieved with a standard audio processing utility:

1. A Male to female voice conversion, achieved by raising the pitch and increasing the pace,
2. A Female to male voice conversion, achieved by lowering the pitch and decreasing the pace,
3. A drunk chipmunk effect, achieved with pitch and pace modification,
4. An I-have-to-run-to-the-bathroom effect, achieved by a gradual pitch increase,
5. The original, unmodified voice of the user,
6. Converting the voice to a whisper, achieved by replacing the excitation source of user's voice with white noise,
7. Adding background music.

If the user chooses to forward their recording to a friend, they are prompted for the phone number, the name of their friend, and their own name for introduction. Only the phone number is confirmed for correction. Recordings of names are terminated by silence detection and a 4 second hard time-out. The user is allowed to forward their voice to multiple recipients with the same or different modifications applied. The message forwarding request is then added to the system queue, and will be executed as soon as a channel becomes available. When Polly calls the intended recipient to deliver the recorded message, the sender's name (in their own unmodified voice) is immediately played to the listener to prevent confusion regarding the identity of the caller, and the recipient can also choose to hear the phone number of the sender. After hearing the message, the recipient can then choose to replay the message, record a reply, forward the recording to others, create their own recordings, or listen to job ads.

As an additional mechanism for viral spread, text (sms) messages containing Polly's contact information are sent to all of Polly's recipients on their first two interactions with the system. Polly's phone number is also played during the phone call itself.

We also elicit User Feedback, in the form of an unconstrained recording (up to 60 seconds, with a silence timeout) from repeat users during their interactions with Polly. Feedback is requested only when a user actively initiates a call. Feedback is requested in two manners:

System Prompted Feedback – Every user is prompted for feedback on their fifth interaction with Polly, and on every 20th interaction thereafter.

User Initiated Feedback – Following the user's fifth interaction, the menu is augmented with an explicit option to give feedback.

The Job audio browser component of Polly is explained in detail in the next chapter: *Development-related Service: Job Opportunities*.

Software Setup

Polly's IVR code consists of PHP scripts that run on Voxeo's PRISM platform [8] using Voxeo's Tropo [5] as the interpreting engine. Speech prompts and audio files are hosted on an Apache server. The application server also maintains detailed textual and audio logs of all phone calls. The database is managed using MYSQL. Praat scripts are used for manipulating audio files.

Telephony setup

All the software is installed on a single 2U server that is hosted in the data center of Wateen [9], a local internet and telephone service provider. The first of our three phone numbers is used for toll-free calls to Polly by means of a "missed calls" mechanism: a call to that number is interpreted as a "call-me-back" request. It is rejected and a call-back request is added to the queue. As soon as a channel becomes available, Polly calls the user back. The second phone number is used as a caller-paid service which is answered immediately (see below). The third phone number is currently reserved for deployment of future services.

Real-Time Monitoring

To get the pulse of the system as well as an overall picture of activity, we built a real-time monitoring system that provides cumulative, daily, hourly and per minute statistics [6]. Our system calculates and reports statistics on overall traffic volume, answered calls, deliveries of messages and job ads, ads in the system, ads listened to by users, user feedback and other categories. Hourly and per minute statistics on queue lengths of the different request types, channel utilization, inbound and outbound calls and free hard disk space allow us to detect problems in real-time and to schedule maintenance. The system also sends sms and email alerts and recovery reports about server crashes, automatic server restarts, hard disk space crunch, etc.

Annotations of Recordings and Feedback

One graduate student and one undergraduate student listened to a uniformly selected sample of 5388 recordings and created detailed annotations based on their subjective assessments. Each selected recording was annotated by a single annotator. As in [63], each recording was annotated as to the speaker's gender, language(s) used, estimated age (child, young, middle aged, old), estimated Socio-Economic Status (SES) (low, middle, high), and whether the message appears to be recorded for entertainment or utility (not mutually exclusive). The inter-annotator agreement rates were later found

to be adequate for gender (97.8%) and language (81.5%) but poor for SES (40.4%), age (62.6%) and primary use (51.6%). We therefore decided not to use the last three in our further analyses. Instead, we conducted follow up surveys as described in the next section to get information on these variables. In addition, starting on August 4, 2012 feedback recordings were listened to daily, briefly paraphrased, and categorized as complaints, requests or suggestions. Finally, the annotators were also encouraged to note in unstructured comments any interesting subjective observations, such as unusual functions for which Polly appears to be used.

Follow up Surveys

We called 207 randomly chosen users of Polly to collect more reliable demographic information. Engaging the users in a friendly chat we asked them about their experience using Polly, literacy level, age, rough location (city, small city, village etc.), primary uses of Polly and their experience using Polly's job search (See "Demographics and Primary Use from Follow Up Survey").

Results and Analysis

Seeding

Polly was seeded on May 09, 2012 at 8:13pm Pakistan Time by placing automated calls to 5 of the most frequent callers from Polly's 2011 study. These calls briefly announced that Polly is back online and launched into Polly's main interaction. No attempt to further promote the system was ever made. Polly has been up continuously since then (as of this writing, January 2013), with minimal interruptions (see Table 5-1).

May 9 -Jun 27	Telcom bug reduced Polly's effective capacity to 10 channels and degraded voice quality during peak hours.
May 25-26	SF1: Disk space crunch reduced system responsiveness / availability
June 21	SF2: Application server remained down as new phone lines were being installed
Jul 12	SF3: A bug reduced the effective channel capacity to 0
Jul 31	SF4: Upgraded software platform severely reduced channel capacity
Aug 16	SF5: OS error crashed the server
Aug 25	SF6: Server ran out of disk space
Aug 29	SF6: Licensing problems reduced channel capacity to 2
Aug 28-30	SF6: SMS provider's glitch stopped all outgoing sms
Sep 11-12	SF7: SMS provider's glitch stopped all outgoing sms

Table 5-1: Major System Failures

System Activity Level

In Figure 5-1, "All call types" shows the overall volume of successful calls; out of these: "Message Deliveries" and "Job Ad Deliveries" depict the number the successful calls made by Polly to deliver messages and ads forwarded by users to their friends. "All Users" shows the total number of unique users of Polly (including those who just received messages without ever calling Polly). "Active Users" are the users who called Polly or used it to schedule deliveries.
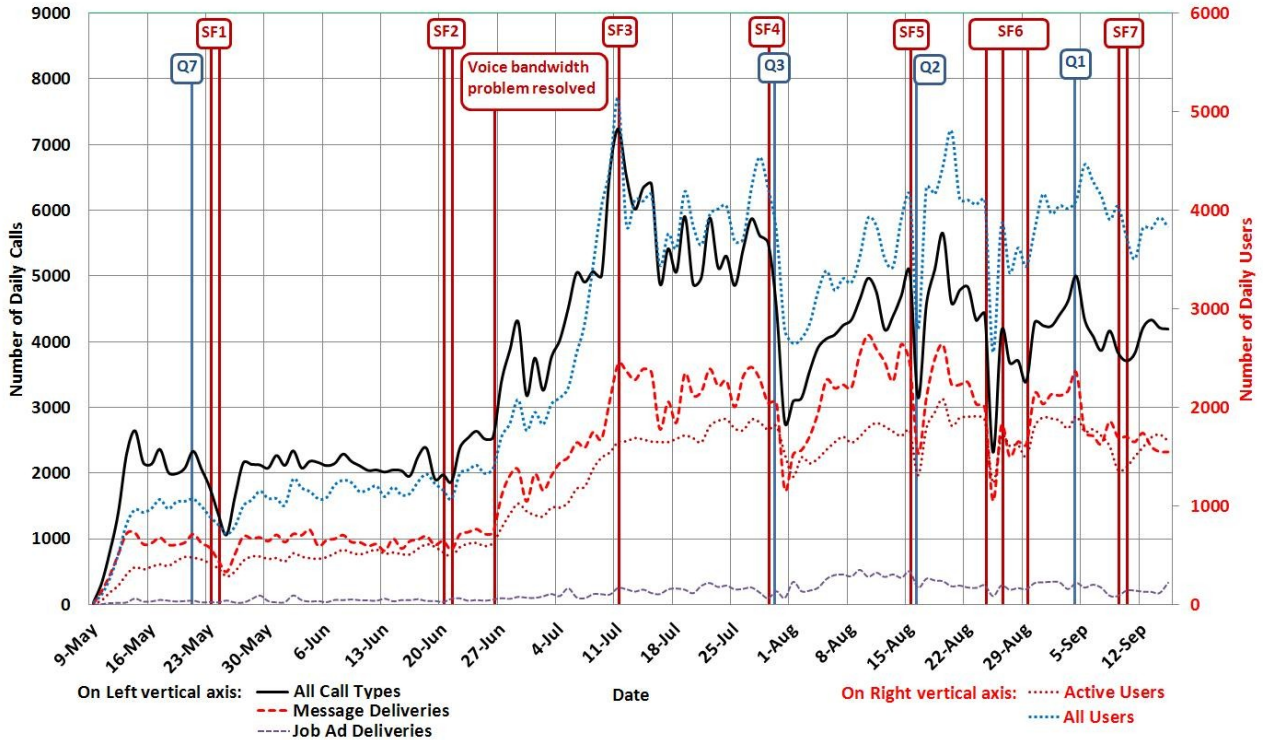
Figure 5-1: Polly's Activity Levels. "SF": system failures (Table 5-1). "Q": onset of quota experiments. For term definitions, see "Seeding".

Polly's activity level (Figure 5-1) rose exponentially and saturated our system's capacity within 7 days. On June 27, a telecom system bug was discovered that had been keeping our effective capacity at 10 channels and degrading voice quality during peak hours. Once the telecom company fixed this bug, activity level again climbed exponentially and stabilized within 10 days. Activity levels appear to be limited only by channel capacity. System failures (see Table 5-1) usually resulted in a commensurate drop in call volume, but the latter always recovered quickly once the problem was fixed. Another source of volume drop was our quota experiments, to be discussed later.

As of mid-September, 2012 Polly has had more than 495,000 telephone interactions with more than 85,000 users. There have been 103,250 failed calls (user busy, out of signal reach, phone switched off, incorrectly entered numbers etc.). The message forwarding feature (where a user forwards a received message) was used in 31,740 calls with the longest chain consisting of 40 forwards and an average chain length of 2.33. Among the most forwarded messages were funny voices (baby laughing, duck sound etc.), quiz-like questions ("what is x called in English?"), a guy whistling a tune.

Delivery requests were placed in 182,652 calls (1.6 delivery requests per call on average), including 55,543 delivery requests for multiple recipients. On average there were 1.7 delivery requests placed for every personal message and 61 delivery requests for every job ad.

Choice of Voice Modifications

On average, users listened to 1.83 voice modifications per interaction. The modifications chosen for delivery of the 291,504 messages were (in menu order): male-to female conversion 72%; female-to-male 9%; drunk-chipmunk 6%; I-have-to-run-to-the-bathroom 3.5%; unmodified 5.3%; whisper 0.7%; and background music 3.5%.

User Activity Profile

Figure 5-2 depicts user-initiated interactions as a function of the number of days since they were first introduced to Polly. Most users interact with Polly for only a few days. Only 31% of users returned to Polly on the second day, 19% on the third, 13% on the fourth, and 10% on the fifth. Participation continues to drop logarithmically, e.g. to 1% after 36 days and to 0.5% after 55 days. Among users who do continue to use Polly, average daily activity peaks at 3.2 calls on day 2, then drops gradually to around 1.5 calls.
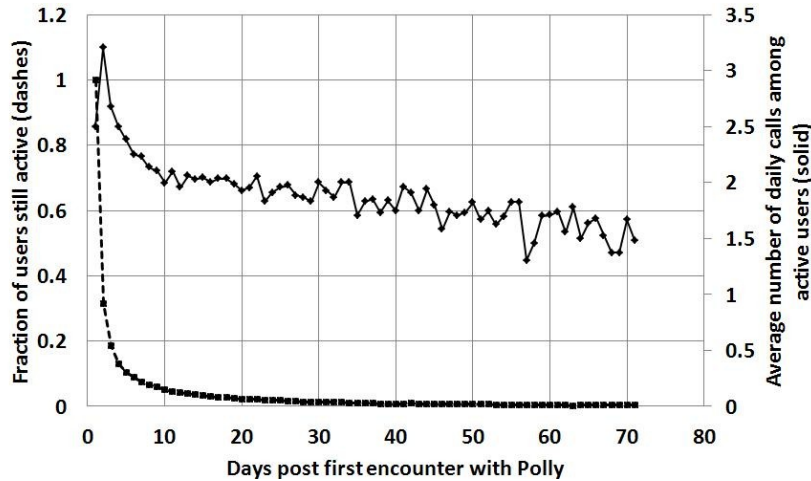
Figure 5-2: User Retention

Average call duration was 160 seconds. It takes no more than 40 seconds to start experiencing the first voice modification. Of the 495,000 Polly interactions: 87% lasted 40 seconds or more.

There were a total of 1,023,824 menu options selections (by key presses) during the 495,000 interactions, out of which 4.5% were invalid choices. Note that Polly's IVR tree was designed to require no key presses until after the first voice modification is played back. No keys were pressed in 36% of the interactions. Of the remaining interactions, 91% completed without any invalid key presses. A more detailed analysis of user behavior is presented in chapter: *Behavior Analysis of Polly's Users*.

Geographical Spread

Polly is hosted in Lahore and its seed users were mostly from Okara (a city in Punjab located near Lahore). After initial seeding we made no further effort to publicize Polly. Polly spread quickly via message forwarding and word-of-mouth. Within the first four months of its operation it has received calls from, and delivered messages to, all four provinces of Pakistan, as well as to Belgium (19), UAE (11), Saudi Arabia (4), Spain (4), Oman (3), India (1) and Luxembourg (1). Figure1 shows some snapshots of the domestic geographical spread of Polly.
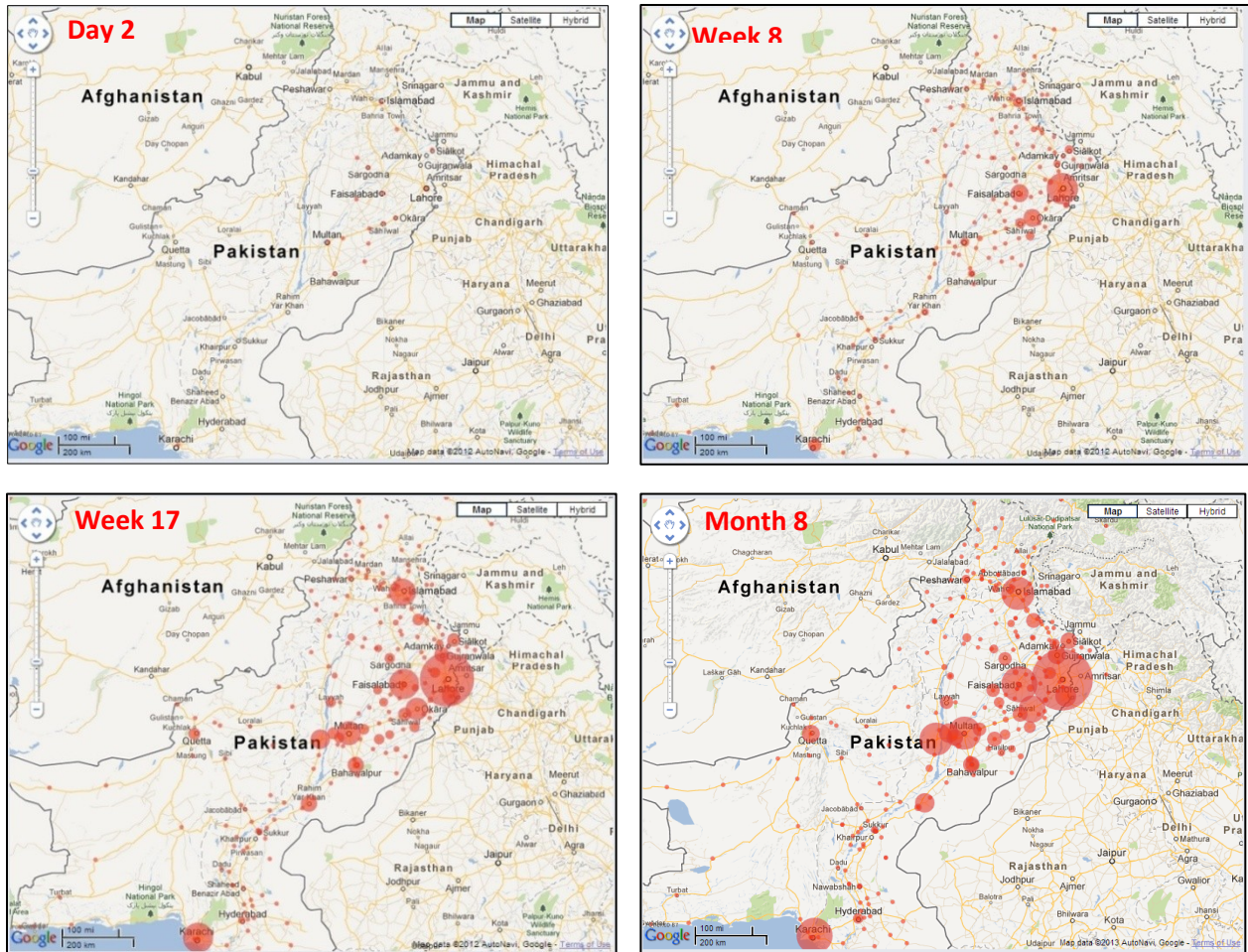
Figure 5-3: Geographical spread of Polly (only Pakistan shown)

Landline vs. Mobile phone usage

In Pakistan, telephone numbers readily reveal whether they belong to a landline or to a mobile phone. Polly's service is provided via a landline, making it cheaper to call it from a landline than from a mobile phone.

Only 0.32% of the more than 400,000 toll-free calls were made from landlines. In contrast, landlines accounted for almost 4% of the caller-paid calls. This demonstrates some cost sensitivity on the part of users when they need to pay for the call. But this is only a lower bound because, unfortunately, we do not know how many of the users who made called-paid calls had access to a landline.

User Feedback

Table 5-2 lists the main findings from our feedback annotation process. Several users gave suggestions to improve the user interface. Among these were frequent requests to increase message recording time, remove the voice modifications OR to bring the unchanged voice to the beginning, to display sender's name/number on screen, to keep messages for later listening and to be able to post ads on the job ad system. One guy suggested that Polly should send a text message to the recipient who should call Polly to listen to the message at his convenience (we added this feature).

Period of feedback recordings listened to:	Aug 4–Sep 9
Total number of feedback recordings in that period:	7770
Total number of feedback recordings listened to:	2567
Of those, containing thanks or praise to Polly	1797 (70%)
containing other feedback	272 (10%)
Of those containing other feedback:	
System-initiated	183 (67%)
User-initiated	89 (33%)
Complaints about:	189 (70%)
Delay in call-back time	140
Poor sound quality	28
Failure of system to send/receive message	14
Being disturbed by Polly	5
Requests/suggestions:	83 (30%)
Higher quota or more recording time	47
New services: News, Weather, Medical, Voice Chat, Job Ads, Songs.	22
More voice manipulations	8
No voice manipulation	6

Table 5-2: User Feedback Summary

Anecdotally, among the positive feedbacks, one person said (loosely translated) "after all that is going wrong with the country … well, at least we have Polly … God bless Polly and may the service continue forever".

Summary and Discussion

Our first goal was to determine whether a system like Polly can be scaled up to engage and support a much larger user base, for an extended period of time, while at the same time becoming cost efficient. With regard to scale and persistence, we believe that the numbers speak for themselves. The long queues for call-me-back and delivery requests, and the quick rebounding of traffic to a fixed level after each disruption, suggest that activity level is resource-bound and that the potential demand for these services is much higher than our current 30-channel capacity.

On the question of cost efficiency, we believe that the jury is still out. We have treaded lightly on limiting the toll-free service because we did not want to scare off poor users, and because we wanted to use the large volume to answer many other questions, some of which we are just now beginning to analyze. However, we clamped down more strongly starting mid-September, and have partially discussed the impact in [62]. As we mention above, cost efficiency can be achieved not only by getting the users to pay for airtime, but also by the use of ads, carrier revenue-sharing, and/or content sponsors (e.g. governments or NGOs). We are planning to explore all these options.

Our second goal was to add our first development-focused service ('payload') to Polly's offering. We found that users took to the new offering in large numbers, and that many of them started calling Polly specifically for the job information – exactly the result we had hoped for. This is discussed in detail in chapter: *Development-related Service: Job Opportunities*.

Our third goal was to use Polly as an experimental test bed to answer questions about demographics and about spread vs. cost. This discussed in detail in chapter: *Polly as an Experimental Test-bed*

Additional benefits: We collected detailed interaction data, which we believe have great potential value as a test bed for analyzing social network dynamics.

6. Development-related Service: Job Opportunities

Chapter Abstract

This chapter describes the job audio browser component of the large scale Lahore deployment of Polly in more detail. This component was added to meet the second experimental goal of this deployment, of attempting to add a development-focused service ('payload') to Polly's offering (as discussed in chapter: *Large Scale Deployment*). Between May 9, 2012 and mid-September the job browser was used by 27,000, who in turn listened 279,000 times to job ads and forwarded them 22,000 times to their friends. If we also include the quota limited period starting mid-September, we find that between May 09, 2012 and May 07, 2013, 34,000 people had used the job browser to listen 386,199 times to the 728 job ads available in the system. These ads were forwarded 34,000 times by 19,000 users to their friends.

System Description

User Interface

The job audio browser is available to the users of Polly right from their very first interaction with Polly and they could access it through the first (main) menu in all call-types (delivery calls and "call-me-back" calls), by pressing 5. Once inside the job-browser the ads are played latest-first. Each ad is recorded split in three portions: 1. Date and newspaper information, 2. Actual content of the ad (the vacancy being advertised, prerequisites, salary expectations etc.) and 3. Contact information (addresses, phone numbers etc.). Following each ad, users are given the options to repeat the complete ad or just the contact details; play the next or previous ad; or to forward the ad to a friend. If the user does not press any key, the next ad starts playing 5 seconds after the options menu stops playing.

If the user chooses to forward an ad to a friend, he is prompted for the phone number, the name of their friend, and their own name for introduction. Only the phone number is confirmed for correction. Recordings of names are terminated by silence detection and a 4 second hard time-out. The user is also allowed to forward the ad to multiple recipients. The ad forwarding request is then added to the system queue, and will be executed as soon as a channel becomes available. When Polly calls the intended recipient to deliver the ad, the sender's name (in their own unmodified voice) is immediately played to the listener to prevent confusion regarding the identity of the caller, and the recipient can also choose to hear the phone number of the sender. After hearing the forwarded ad recipients can also choose to browse the job ad list. Even during quota limitations on number of free Polly-paid deliveries per day, users could still send as many job ad deliveries as they desired.

As an additional mechanism for viral spread, text (sms) messages containing Polly's contact information are sent to all of Polly's job-ad recipients on their first two interactions with the system. Polly's phone number is also played during the phone call itself, between the job ads.

Job browser back-end

We daily scan Paperpk.com for advertisements that appeared in Pakistani newspapers for jobs that are appropriate for low-skilled, low-literate workers. An example of such an ad is in Figure 6-1. Although we focus on jobs not requiring any literacy, we also select some that require up to 10 years of education. We then record these ads in Urdu, and make them available for audio-browsing as part of Polly's menu.

Specifically, we record each ad in three separate parts: date and newspaper source; details and requirements; and contact information. These are then made available to the user via an interface option in the main menu of Polly.

Figure 6-1: Sample low skilled job ad from paperpk.com scanned from Daily Jang

Analysis of Spread and Uptake

Perhaps the most meaningful development in our large-scale deployment was the addition of a development-related service to our menu – the job ad browser. Since audio-browsing job ads was added as an option at the end of the Polly menu, and since this service was not advertised in any other way, the extent of its use is a direct test of our strategy to reach users via entertainment.

During the initial 130 days of Polly operations analyzed here (May 9 – September 15), we identified and recorded a total of 530 suitable job ads, an average of some 28 ads/week. These ads were listened to, all by user initiative, a total of some 279,000 times, This averages to over 525 playbacks per ad – possibly more than the number of people who read that ad in the newspaper. Some ads were listened to much more than others – the most popular ad was listened to more than 8,400 times, and 73 ads were listened to more than 1,000 times each.

A further indication of the usefulness of this service was the use of job ad deliveries – requesting that a particular job ad be delivered by Polly to a friend. During the period of this reporting, a total of 23,288 such requests were made, and job ads were delivered to 9,475 different users. Even more interestingly, out of all the calls during which job delivery was requested, more than half requested only job deliveries (i.e., no regular Polly message deliveries), most likely indicating that the user called Polly specifically to interact with the job ad service.

Summary

The second goal of the large-scale deployment in Lahore was to add our first development-focused service ('payload') to Polly's offering. We found that users took to the new offering in large numbers, and that many of them started calling Polly specifically for the job information – exactly the result we had hoped for. Our survey calls revealed that around 57% of the interviewed users had used job search but only a handful of them applied. This can be attributed to lack of trust or interest. The former may be by co-branding with familiar government organizations or newspapers. More job ad types can be explored (e.g. jobs for the handicapped) to serve all interest groups.

One limitation of this study was our inability to track employment outcomes. We do not have the stats of the number of people who actually applied for the various jobs that were advertised through Polly and if some of them actually got those jobs. We also do not know the degree by which Polly increased the number of applicants for these positions. Hence, the impact is not measurable.

For this reason, we reached out to Babajob in India. Babajob acts as a (primarily) web-based gateway between job-opportunities for low-skilled workers and potential applicants in Bangalore, India. The details of our collaboration are presented in chapter: *Reproducibility: Deployment in .*

7. Polly as an Experimental Test-bed

Chapter Abstract

In this chapter we discuss the various experiments that we performed using the large scale development of Polly in Lahore. We used Polly as an experimental test bed to answer the following main questions:

a. How do usage patterns change with respect to gender, age, socio-economic status (SES), experience with the system, and cost to user?
b. Spread vs. Cost: how to spread Polly as widely as possible at the smallest possible cost?

From May 09 till mid-September, we report users' activity over time and across demographics, analyze user behavior within several randomized controlled trials, and describe lessons learned regarding spread, scalability and sustainability of telephone-based speech-based services.

User Demographics and Primary Use from Recording Annotation

To understand our users' demographics and their use of Polly's message delivery capability, we selected a sample of user recordings uniformly across time and annotated them as described in chapter: *Large Scale Deployment*. Results are in Table 7-1.

	Toll Free	Caller Paid
	Count	Count
Annotated recordings	5388	399
By gender		
Male	4713(87.3%)	359 (90.0%)
Female	590(10.9%)	26 (6.5%)
Unclear	93(1.7%)	14 (3.5%)
By language		
Urdu	1135 (21.1%)	64 (16.0%)
Punjabi	3480 (64.6%)	194 (48.6%)
English	23 (0.4%)	4 (1.0%)
Pushto	703 (13.1%)	100 (25.1%)
other/mixed	45 (0.8%)	37 (9.3%)

Table 7-1: User Demographics from annotated recordings

Our annotators noted that the following interesting examples of the various things that people use Polly for. Some of these are clearly unintended (or at least unthought-of) uses:

1. As a "voice-SMS" to send hello-hi messages, greetings of birthday, New Year, Eid etc. to schedule casual meetings e.g. "meet me in 10 minutes in front of x shop", and for sending call-me-back requests to friends e.g. "please call me back as I am low on cell-phone credit".
2. To wake up others in the morning for prayers, work etc.
3. To send random and often obscene messages and playing pranks on close friends
4. To send romantic messages to the opposite gender (though we have mostly seen male users sending such messages)
5. To record songs, movie dialogues etc. from TV, radio and send them to friends with or without voice modification.
6. To record poetry, jokes, songs in their own voice for their friends

7. To play quiz-like games over Polly e.g. "what is x called in English?" and the friend responds with the answer.
8. To play with Polly in group settings. This where people record their voices and play with the voice mods while laughing away with a group of friends. Some parents also used to modify their voice and play it to entertain their young children.
9. To record messages reporting problems for government officials and even Polly (as if Polly can convey their problems to the government). E.g. power failures, lack of electricity, gas etc.
10. Some people also recorded messages for specific police officers. As some of these messages were full of curse words we were further motivated to quickly add the option of listening to the sender's phone number in all of Polly's message deliveries.
11. During the period when as part of an experiment Polly stopped delivering free voice messages but still continued to deliver job ads, a youngster started recording all his messages in the sender's name part of the job ad deliveries (allowed duration 4-5 seconds). This allowed him to keep sending free voice messages.
12. Someone scheduled a message delivery to Polly's own number. As we did not have a check to prevent this at that time and as all calls received by Polly are treated as call-me-back requests; this triggered a series of recursive call-backs. We were able to catch and fix it only after nearly 3000 such calls.
13. For making announcements. E.g. A user announced change of his phone number through Polly.
14. To search and send job ads appropriate from friends. We found some people who themselves were employed doing this.
15. Several blind users expressed a lot of interest and remained its loyal users. They liked Polly as a voice messaging system and as a way for them to listen to job ads. They even asked for making newspaper content available over Polly.
16. For teaching their friends the use of Polly. Such messages often included explicit instructions like "after recording your message, press 2 and enter my number to send it to me…", "keep pressing 3 and you'll get your clear voice too…".

Entertainment and Utility are not Mutually Exclusive

Our attempts to classify the messages as entertainment or utility turned out to be a challenging task for human annotators (one graduate and one undergraduate student). The annotators were asked to listen to 6,000 recordings, randomly chosen over the span of a year of Polly's Lahore deployment, and to tag each recording as utility, entertainment or both. In the end, the inter-annotator agreement came out to be 51.6% and we decided not use this data for any further analysis.

Apparently it was difficult in majority of the cases to clearly mark a recording as entertainment or utility. It is similar to asking the question: "do people post messages on Facebook for entertainment or utility". Surely there are cases where the user-intent is beyond doubt e.g. a person announcing a change in his phone number to several friends in unmodified voice is clearly looking for a utility, a user sending songs or jokes in unmodified voice is mostly doing so out of entertainment. But a back-and-forth conversation where a friend is quizzing another; a competition where friends are reciting poetry starting from the last letter of the previous persons verse; a romantic voice modified message "I love you!",… are examples of messages where the intention could be either or both.

We conclude from this experiment that the primary intent of a user of Polly while recording a message could range from (and be a mixture of) curiosity, exploration, fun, a desire for entertainment or just to be able to send a free voice message.

Demographics and Primary Use from Follow Up Survey

Table 7-2 summarizes our survey's results. Out of the 207 survey calls a 106 resulted in useful information of some type. Low to low-mid SES people having up to 10 years of education comprised 77% of the interviewed users: mostly shopkeepers, fruit sellers, farmers, laborers, carpenters, and craftsmen. Another 14% had 11-12 years of education and belonged to medium SES while the remaining 8% had more than 16 years of education. Majority of the users belonged to villages or small cities. For heuristic mapping of education level to SES, see [29].

		Fun	Utility	both
Total number of survey calls attempted				207
Number of calls resulting in any information				106
Number of calls that successfully gathered:				
a. Gender Information				106
b. Information about primary use				63
c. Information about use of Polly's Job Browser				65
d. Age Information				60
e. Literacy/SES information				70
Primary Use				
Among the 63 users		34	17	12
Gender				
Male	98	33	17	12
Female	8	1	Did not answer	
Age				
Less than 25 years	30	20	6	3
25-35 years	22	9	6	5
More than 35 years	8	2	2	1
Highest Education Level Attained, SES				
None, low SES	17	30	14	10
Primary (5 years), low SES	15			
Matric. (10 years), low-mid SES	23			
Intermediate (12 years) , mid SES	9			
University (16 years), high SES	6	3	3	0

Table 7-2: Results of Survey Calls

Although around 57% of the respondents had browsed Polly's Job ads, only a handful reported applying for those jobs. This was mostly because the ads were either not of interest to them or they did not trust them. Two users claimed that their friends got jobs through Polly, but we were unable to verify this.

The respondents who described their primary use of Polly as "fun" gave examples like making prank calls to friends, hello-hi/random messages, poetry and even browsing job ads as a pastime. More serious users defined Polly as a voice messaging system that they use to send occasion (holiday, birthday) greetings, to request a call-back, to know a friend's whereabouts or to browse and apply for jobs. Four blind users defined Polly as an "alternative to text messaging" and praised it profusely. Females were mostly reluctant/shy to talk.

Cost vs. Spread – RCTs and the Quota Experiments

With an outgoing call airtime cost of $0.023/min, and with each interaction lasting an average of 3 minutes, at its peak Polly was costing us some $400/day in airtime alone. A variety of mechanisms can eventually be used to offset this cost, including banner ads, carrier revenue sharing agreements, and content-providing sponsors. However, in the current experiment, one of our goals was to test how far we can reduce our airtime costs directly while maintaining the system's viral spread. We view our ongoing airtime expense as simply the cost of reaching new users, and are interested in strategies that

maximize the cost-effectiveness of that investment. We are also interested in understanding how the airtime cost structure affects our target users' behavior.

We did not want to eliminate the toll-free option because that would have biased the user base away from low socioeconomic users, who are our prime target. We also avoid a reliance on SMS messages, so as not to deter low-literate users. Instead, we experimented with imposing daily quotas on the number of toll-free calls for each user (based on their caller id).

One of the benefits of a large-volume, dynamically controlled system such as ours is the ability to run randomized controlled trials (RCTs). Our first goal was to avoid subsidizing high-volume users, and to nudge them towards a caller-paid model. The main research questions asked here were:

1. How much can we reduce our airtime charges (our main operating expense) while maintaining system activity and spread, and how? Sub-question: What partial subsidy scheme may induce people to contribute their own funds to the airtime cost?

2. Is Polly compelling enough for people to spend their own money on it, at least sometimes?
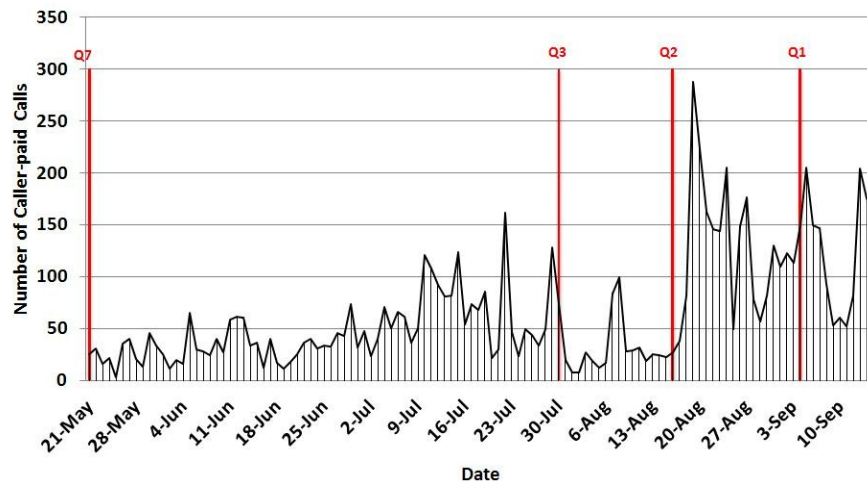
Figure 7-1: Daily caller-paid calls

In our first RCT ("Q7") we targeted users who called Polly more than 7 times a day. Once a user attempted to call Polly for the 8th time on the same day, they were alternately assigned to the quota-restricted group or to a control group (and retained that assignment indefinitely). A user in the quota-restricted group, on their 8th daily call to Polly, was told that they exhausted their subsidy for that day, and invited to call Polly on the caller-paid line, where their call would be picked up immediately and their scheduled deliveries would also receive absolute priority. This was a substantial "perk" because users often complained of delays in receiving call-backs and in delivery of messages, due to long queues, especially at the peak evening hours. Subsequent calls by this user on that day to the toll-free number were not answered. Users in the control group were not restricted. We ran this experiment from May 21 through July 30. Results (shown only for the 1,115 high-volume users who were new to Polly during this period) are in Figure 7-2. Activity on the caller-paid (namely, unsubsidized airtime) line is shown in Figure 7-1. We can see that the quota indeed reduced toll-free usage by the restricted group, and caused sporadic activity on the caller-paid line. However, the differences from the control group vanished after a week: it appears that most high-volume users reduced their activity substantially within a few days even without the quota.
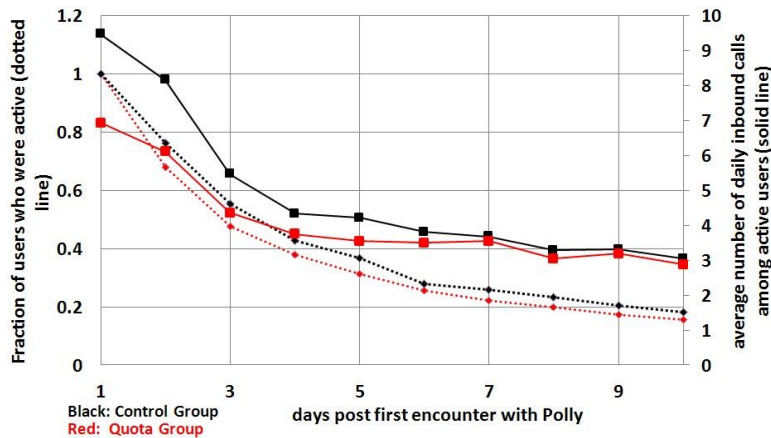
Figure 7-2: Experiment with a quota of 7 toll-free calls/day

Our next experiment was to more severely restrict toll-free usage, to a maximum of 3 calls/day, for everyone. We hypothesized that on the first few days of using Polly, a user is likely to send their messages mostly to new people, but that on subsequent days they are more likely to request deliveries to the same recipients. We therefore randomized users into three arms: those on whom the 3/day quota was imposed immediately ("Q3D0"), those on whom it was imposed starting on their second day ("Q3D1", having one day of unrestricted toll-free use of Polly), and those on whom the quota was imposed starting on their third day ("Q3D2", 2 unrestricted days). This experiment was run from July 31 through August 16. Results (shown only for the 486 users who were new to Polly during this period and who attempted to make a 4th daily call) are in Figure 7-3. The quota reduced activity during the first few days, as expected. Also of note, there was no significant difference among the behaviors of users from various quota arms once the grace period (in which the users are allowed unlimited daily toll-free calls) expired. (Note: "the number of calls per day" appear to exceed the quota because it also includes the one call during which the quota announcement was played).
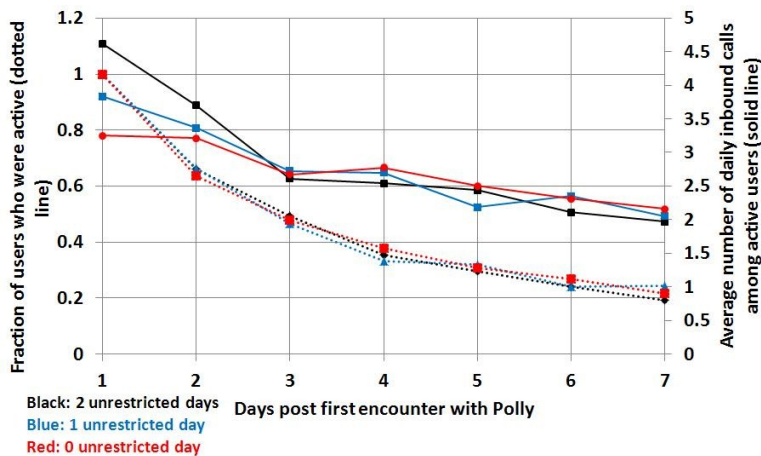
Figure 7-3: Experimenting with a quota of 3 toll-free calls/day

Regretfully, the introduction of Q3 required a software platform upgrade, resulting in frequent system crashes (and a sharp drop in all activity) from which we recovered gradually over the following 10 days ("SF4" in Table S1). We therefore cannot measure the short-term impact of the Q3 quota on overall activity level, but we observe that after 10 days activity fully recovered, thanks to a constant supply of new users, and supporting our hypothesis that activity is only limited by our channel capacity. In hindsight, the quick rebound is not surprising, because the few unrestricted days were enough to recruit

54

new users. Note from Figure 5-2 that 40% of calls to Polly took place during a user's first day of interaction, and fully 56% during their first two days.

Our next experiment, run from August 17 to September 4, was similar but tightened the quota to 2/day, with the same 3-arm randomized assignment (Q2D0, Q2D1, Q2D2). Results (shown only for the 1,029 who were new to Polly during this period and who attempted to make a 3rd daily call) are in Figure 7-4. Again, users seem to have quickly adjusted to the new quota regardless of whether it was introduced immediately or with delay. Caller-paid calls spiked (Figure 7-1). Thankfully, the system failure ("SF5" in Table 5-1) that coincided with this introduction lasted only a day, and overall activity remained high (Figure 6-1).
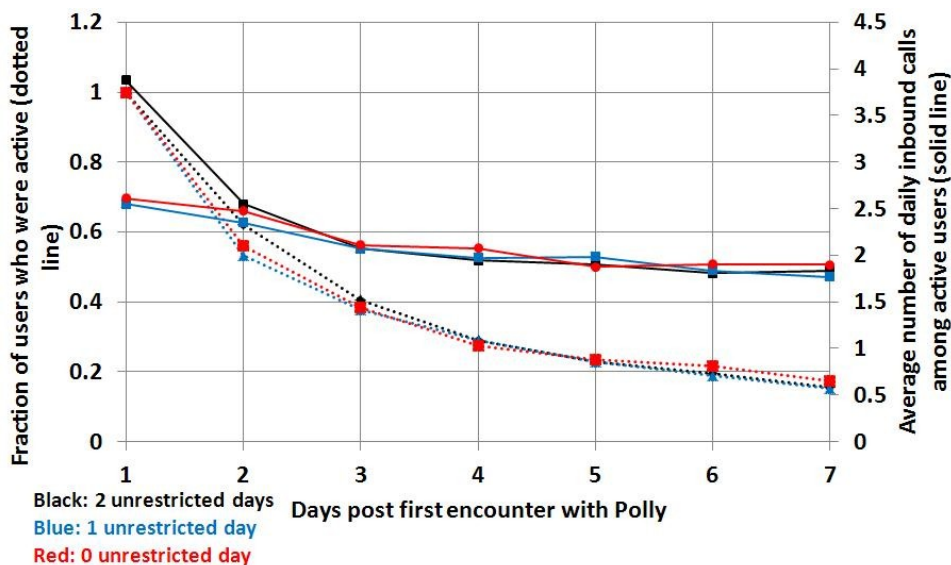
Figure 7-4: Experimenting with quota of 2 toll-free calls/day
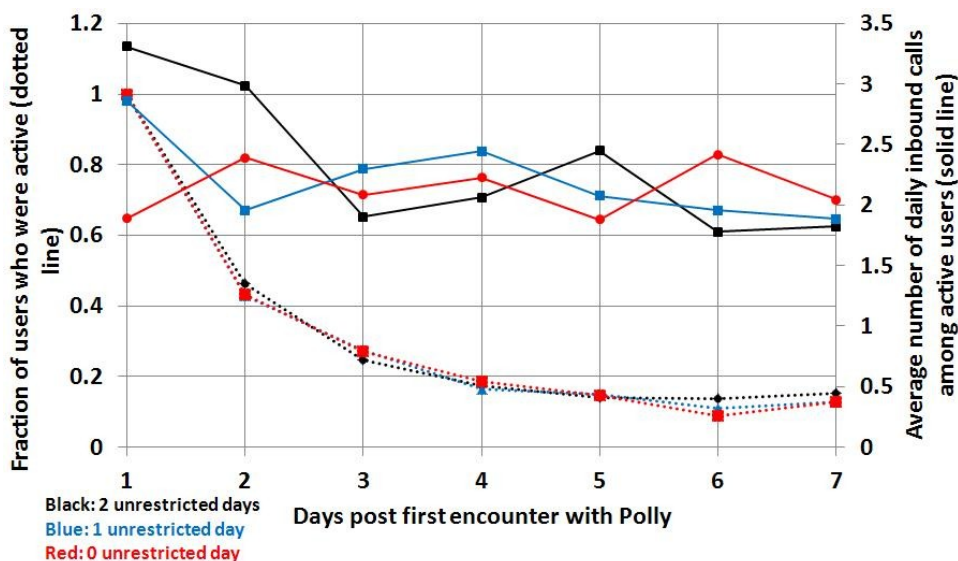
Figure 7-5: Experimenting with quota of 1 toll-free calls/day

Finally, from September 5 on we have been operating under a 3-arm Q1 experiment (Figure 7-5). This

time, overall activity level did go down somewhat, although the number of users and number of new users (Figure 7-6) did not, achieving the same spread with lower costs.
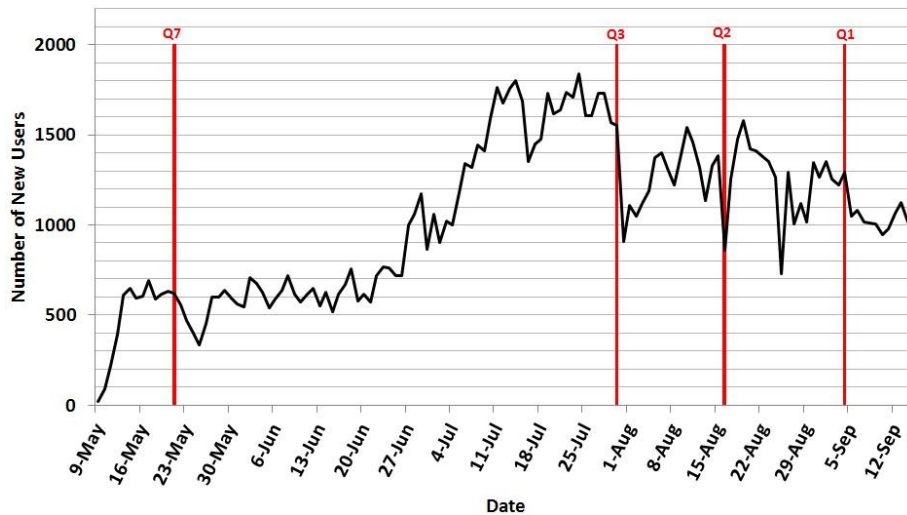
Figure 7-6: New users added daily

Cost and Sustainability – Limiting Free Message Deliveries

The previous section describes how the number of daily toll-free ("missed call" based) calls to Polly were gradually restricted for each user. Once users exceeded their daily quota, they were invited to a caller-paid phone number, which provided a similar (in fact, slightly enhanced) Polly experience. Although more than 4,500 users used the caller-paid line to make more than 12,000 calls, the majority of users chose to avoid the call charges by waiting until the following day.

After limiting toll-free calls to one per user per day, we were still paying for 4,000 calls/day, costing nearly $300/day in airtime alone. We did not want to eliminate toll-free calls altogether, because we did not want to lose the lower-SES users, who are our primary target. Upon further analysis, we found that of the 4,000 Polly-paid daily calls, some 60% were interactions initiated by users, and 40% were *message deliveries* – calls initiated by Polly to deliver previously scheduled messages to their recipients. To further reduce costs, we focused on message delivery calls. We wanted to test how willing people will be to pay call charges in order to retrieve messages sent to them by friends. We therefore replaced the original model with one where the recipient is just notified that a message has been recorded for him and that he may call our caller-paid line to listen to it. The caller-paid line was then modified to add the following functionality:

a. When an experienced user calls, if they have any messages waiting Polly informs them of their number and prompts them to choose between listening to them and going directly to interacting with Polly.
b. When an inexperienced user calls, if they have any messages waiting Polly informs them of their number and starts playing them one-by-one. After each message it prompts the user to choose between continuing to listen to messages and switching to normal interaction with Polly.

A user is considered experienced if he has interacted with Polly at least three times before. Messages that have been skipped are retained for future retrieval. Job-related calls were not affected and were always delivered at our expense.

56

We send message notifications using SMS and optionally short voice follow-up calls. We conducted this experiment in three phases:

SMS-only notification

Under this experiment, an SMS was sent to the intended recipient of a message immediately upon its scheduling, briefly informing him that a message has been recorded for him, listing the sender's phone number and Polly's caller-paid number for retrieval. A total of 7,893 such SMSs were sent during this stage of the experiment, which resulted in 514 (merely 6.5%) caller-paid retrieval calls. Of note, 57% of these calls were made within one hour of the SMS delivery, and 85% were made within 24 hours.

SMS notification with a 24-hour voice follow-up

We conducted this as a two arm randomized controlled trial. Out of all the SMS notifications that did not result in retrievals within 24 hours, half were randomly chosen for sending voice-call reminders. Polly called each of these intended recipients and briefly announced that a message is waiting for them, playing the sender's name in their own recorded voice, and explaining that, to listen to the messages, the receiver needs to call back the number from which they were just called (which was the caller-paid line). The main motivation for voice call reminders was to help recipients who may not have understood the SMS, perhaps due to lack of literacy. Also, with voice alerts the user was not required to type any numbers to access their messages, but could simply call back using their mobile phone's history.

During the period of this trial, 4.7% of the delivered SMS alerts triggered retrievals within 24 hours, and hence were not assigned to any arm. Of the remaining messages, 2,693 were randomly assigned to SMS only (the control arm), out of which 26 (0.96%) were eventually retrieved. We attempted voice reminders for the other 2,681 messages, resulting in 113 retrievals. So, the message pickup rate of the treatment group was 4.2% vs. 0.96% for the control group, with an estimated effect size of 4.2%-0.96% = 3.24%, a relative increase of 57% in the retrieval rate.

Of note, among those who responded to the voice calls by retrieving their message, new users were somewhat over-represented (40% vs. their 32% share of all recipients), suggesting that unfamiliarity and lack of reading/comprehension skills are a factor in failing to retrieve messages.

SMS notification with a 1 hour voice follow-up

This was also conducted as a two arm RCT, very similar to the previous one, except that voice call reminders were sent 1 hour after SMS delivery. During the period of this trial, 3.5% of the delivered SMS alerts triggered retrievals within one hour, and hence were not assigned to any arm. Of the remaining messages, 868 were randomly assigned to the SMS-only (control) arm, out of which 21 (2.4%) were subsequently retrieved. We attempted voice reminders for the other 880 messages, resulting in 61 retrievals. The message pickup rate of the treatment group was therefore 6.9% vs. 2.4% for the control group, with an estimated effect size of 6.9% - 2.4% = 4.5%, a relative increase of 63% in the retrieval rate.

Cost of Spread and Development Outcomes

In Pakistan we paid for Polly by 15 second pulses. Table 7-3 summarizes the airtime distribution of Polly's use in terms of various billing methods. It is clear that most of the airtime is spent in *Call-me-back* and *Delivery* type calls.

CallTypes	Sum of Seconds	Sum of 15SecPulses	Sum of 30SecPulses	Sum of 1MinPulses
Call-me-back	62,485,883	4,347,495	2,260,732	1,225,009
DelAlert	271,750	27,069	15,237	15,111
Delivery	22,620,738	1,600,680	848,340	470,678
JDelivery	3,179,257	222,124	116,530	63,878
SystemMessage	875	60	31	16
USDelivery	255,699	18,088	9,593	5,323
USJDelivery	3,977	280	147	83
Grand Total	88,818,179	6,215,796	3,250,610	1,780,098

Table 7-3: Airtime by call types

Table 7-4 summarizes various spread outcomes of Polly.

Number of Job ads in the System	**728**
Number of Phone Numbers who listened to a Job ad at least once	33,832
Number of times Job ads were listened to	386,199
Job ads were listened during	77,944 calls
Number of job ads that were forwarded	584
Job ads were forwarded	33,597 times
Job ads were forwarded by	8,715 users
Job ads were forwarded to	18,541 users
Each Job ad was listened on average	530.49 times
Each user of Job Ads service listened on average to	11.42 job ads
Number of Active Users	101,984
Number of Users	166,428

Table 7-4: Outcomes

On the basis of Table 7-3 and Table 7-4, Table 7-5 shows the cost in terms of airtime as well as PKR and (estimated) US dollars to achieve some of these outcomes. Table 7-5 should not be interpreted to mean that a separate cost is incurred for each of these outcomes. The fact is that once the system is operational, all of the stated outcomes are achieved simultaneously.

	15SecPulses	30SecPulses	1MinPulses	@ 2PKR/Minute	@100PKR = 1USD
Cost per user	37.35	19.53	10.7	PKR 21.4	$0.214
Cost per active (trained and interested) user of Polly	60.95	31.87	17.45	PKR 34.9	$0.349
Cost per user of job ad service (anyone who listens to at least one ad)	183.73	96.08	52.62	PKR 105.24	$1.0524
Cost of playing one ad to a user	16.09	8.42	4.61	PKR 9.22	$0.0922

Table 7-5: Cost of Various Outcomes

Summary and Discussion

Our third experimental goal of the large scale deployment in Lahore was to use Polly as an experimental test bed to answer questions about demographics and about spread vs. cost. Regarding demographics, we find that Polly is used predominantly but not entirely by men, who are predominantly young or middle-aged. This was also observed in Polly's 2011 test deployment, and is what led us to select job advertisements as our first development-focused service. Unlike in 2011, we find that Polly has spread significantly into the mid-SES and even high-SES populations.

Usage over time is marked by rapidly declining interest among most users. This was expected given the unchanging nature of the entertainment, although interestingly a still significant number of people continue to use Polly for many weeks and months. Usage grew exponentially because every user spread the system to more than one new user on average. Since the target population is measured in the tens or hundreds of millions, volume will grow exponentially for quite a long time, limited only by the system's carrying capacity. Nonetheless, without significant long-term use eventually activity will indeed decline. In the short term, we are working to increase repeat usage by varying the entertainment content. In the long term, we believe the utility components will draw the users back. We see the entertainment component mostly as a method to spread awareness of the system and train the users in speech-based services, not as a steady-state standalone service in its own right. Additionally, when a new service is added, Polly can call some of its past users and introduce them to it, re-starting a viral spread.

The large volume of users allowed us to use randomized controlled trials to answer some questions regarding users' cost-sensitivity. A high daily quota on toll-free calls did not reduce expenses much. When faced with a lower quota, most users chose not to use their own money to make calls that they would otherwise have made. This can be demonstrated by comparing the average call volume (user-paid and toll-free) of people in the quota-restricted arm to that of people in the control arm. Nonetheless, the total volume of user-paid calls is evidence that at least some people were willing to pay some of the time. During the last week of our reporting period, toll-free calls averaged 2,200/day, whereas caller-paid calls averaged a mere 160/day. It is possible that, once a service is introduced as toll-free, people would always be reluctant to pay for it. We are planning to test this hypothesis by deploying a pure caller-paid system in a new geographic location. We also found that restricting high-volume users does not stymie spread, as measured by the number of new users added (Figure 7-6).

Anecdotally, quite a few of the user-paid recordings contain strongly worded complaints and even curses regarding the quota. Apparently, people are willing to pay for the service in order to vent their anger at the need to pay for the service.

Limitations of the study: Randomized controlled trials are potentially confounded by offline communication among friends.

8. Behavior Analysis of Polly's Users

Chapter Abstract

This chapter describes a follow up study done with the help of Haohan Wang and Yibin Lin [77]. The interaction data gathered from the 165,000 users of Polly, who interacted with the system by telephone over 636,000 times, was studied to find behavior patterns. We discovered that, with experience, users respond faster to menus (using more barge-in) and make fewer mistakes and abortive attempts. We also studied how users' choice of activity evolved over time, and found that with experience users show an increasing interest in message sending, become more explorative of the system's capabilities, and better adapt themselves to its constraints. Many new users seem to arrive with some preexisting knowledge of Polly's functionality, presumably through some back-channel information from their friends. Long-term users engage in lengthier calls from the start, and take a more active interest in voice modification and forwarding features.

Revisiting the User Interface

Polly has two major features. It is a voice messaging service as well as a job market.

The most common way to contact Polly is via a "missed-call" mechanism which shifts the airtime cost to the system. A user calls Polly's phone number (a "Call-Me-Back" request), and Polly immediately hangs up the call. Shortly afterwards, Polly calls the user to start the interaction.

Once a user is connected with Polly, they are prompted to record a short voice message, limited to 15 seconds, and can opt to terminate the recordings before that by pressing the # button. Polly then applies its first voice modification to the recorded message (raising its pitch, thereby creating a male-to-female effect) and plays it back to the user. At this point the user arrives at the *Main Menu*, which gives him the following choices:

1. "To re-record, press 0" (re-record a voice message, and return to main menu). This option is removed from the main-menu after the user chooses to forward the recorded voice to a friend.
2. "To repeat, press 1" (replay the manipulated voice message, and return to main menu)
3. "To forward (the manipulated recording) to friends, press 2" (navigate to the forwarding menu)
4. "To try another effect, press 3" (play another voice modification effect, and return to main menu)
5. "To listen to job ads for free, press 5" (navigate to the job browsing menu, from which the main menu is no longer reachable)
6. "To provide feedback by recording comments and suggestions about the system, press 8" (only available from the user's 5th call onwards)

Note in particular that the user is prompted to record a short audio message, and then presented with a manipulated version of their recording -- all before he is presented with any action choices, including access to the job ads. This is because we view the entertainment aspect of Polly as crucial to achieving viral spread.

If the user chose to forward a message to friends, they are prompted to enter the phone number of their first friend, and then to confirm it. They are then prompted to record their name and their friend's

name. This is repeated for any number of friends desired, after which they are returned to the Main Menu.

Polly only allows one voice message to be forwarded in one call, although it can be forwarded to multiple friends. The "re-record" option goes away when the user navigates back to main menu after the forwarding menu.

In the Job Ads menu, users can browse, listen to and forward job information to their friends. However, they cannot return to the Main Menu.

In any of the Polly menus, if a user presses an *invalid button* (defined as a button that is not allowed in that menu), Polly will play the menu options again.

Barge-in (pressing a button before the menu finished being played out) is allowed in all Polly menus.
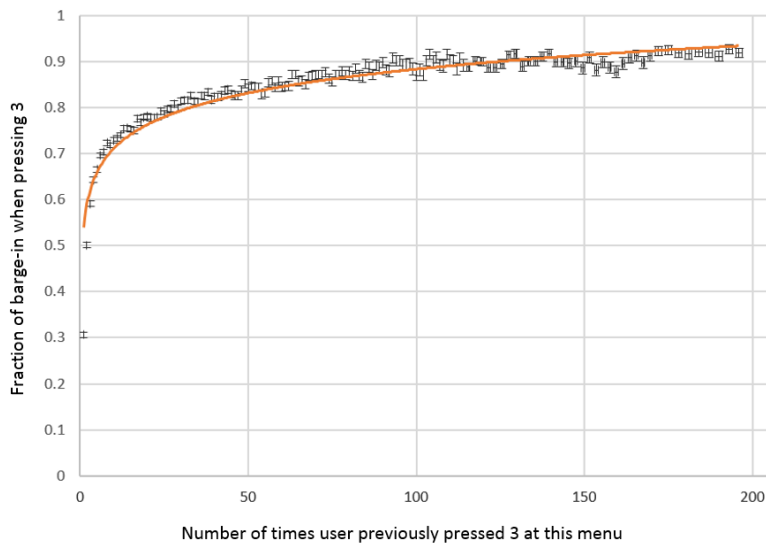
(a)
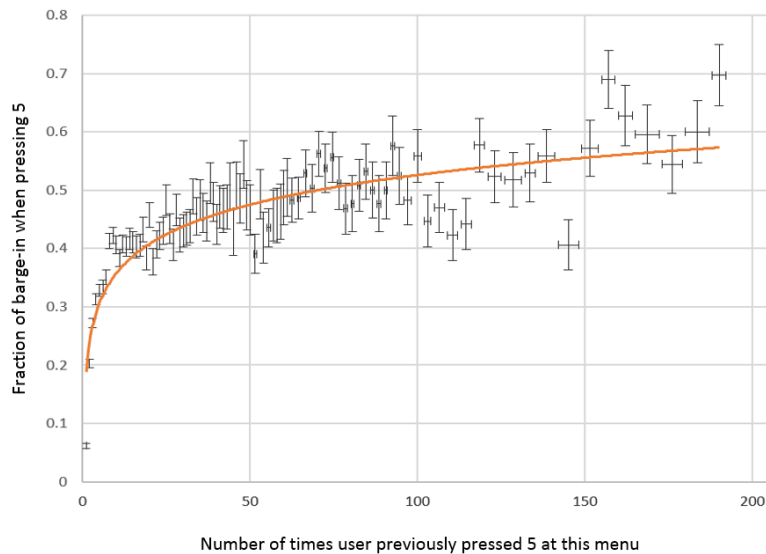
(b)
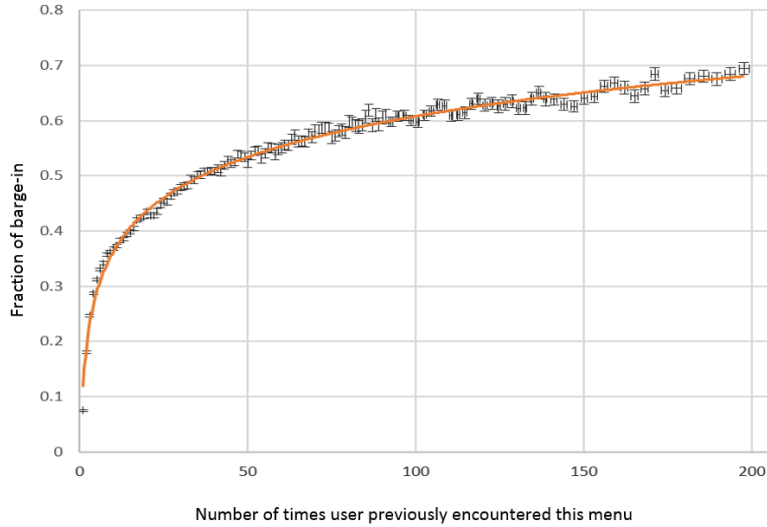
(c)

Figure 8-1: Prevalence of barge-in by user experience level. (a) for pressing 3 (next voice effect); (b) for pressing 5 (listen to job ads); (c) for any button. Horizontal bars correspond to binned values.

Improvement in Users' Interaction Skill

Since most of Polly's users were low literate, many of them may not have been familiar with speech interfaces prior to their interaction with Polly. In this section, we investigate if users' skill at interacting with our system improves as they gain experience with the dialog interface.

We focused on users' interactions with the first (main) menu of Polly. A user's menu-interaction is the process from hearing the menu options to pressing any button, hanging up, or a timeout (which only happens after the menu is played a second and then a third time). There may be none to several menu-interactions within one call. We analyzed 934,742 main-menu interactions from 292,951 calls during which there was at least one main-menu interaction. These calls were made by a total of 50,414 users, assuming that each phone number corresponds to a single, distinct user. We investigated users' interaction skill by tracking the prevalence of three phenomena: barge-in, invalid button presses, and unsuccessful forwarding attempts.

Barge-in Behavior

Barge-in, in speech interface terminology, occurs when a user interrupts a menu by pressing a button before the instructions end. It often happens when a user is familiar with the speech interface and needs fewer or no reminders.

We analyzed the changes in barge-in behavior as one indication of learning by the users. We tracked the prevalence of barge-in as users' experience level increases. Figure 8-1 shows the fraction of barge-in as a function of user experience level, separately for button 3 ("next voice effect"), button 5 ("go to job ads menu") and for any button. Here, user experience level is defined as the number of times that user encountered the same menu and made the same choice, before the current interaction. Whenever there were fewer than 100 such interactions at a particular experience level, we combined (binned) the data with the next higher experience level (horizontal bars). This tended to happen only at the higher experience levels.

We observe that barge-in prevalence increases with experience in all three categories, with a roughly logarithmic growth rate in the range studied. Fitting a logarithmic regression line results in *y = 0.075 logx+0.58* for (a); *y = 0.074 logx+0.19* for (b); and *y = 0.10 logx+0.11* or (c). Thus the "learning curve" appears to be steeper for pressing button 3 (next voice effect, which is often repeated multiple times in order to reach the desired voice effect) than for button 5 (going to the job ads menu, which never returns to the main menu and hence can only be done once per call).
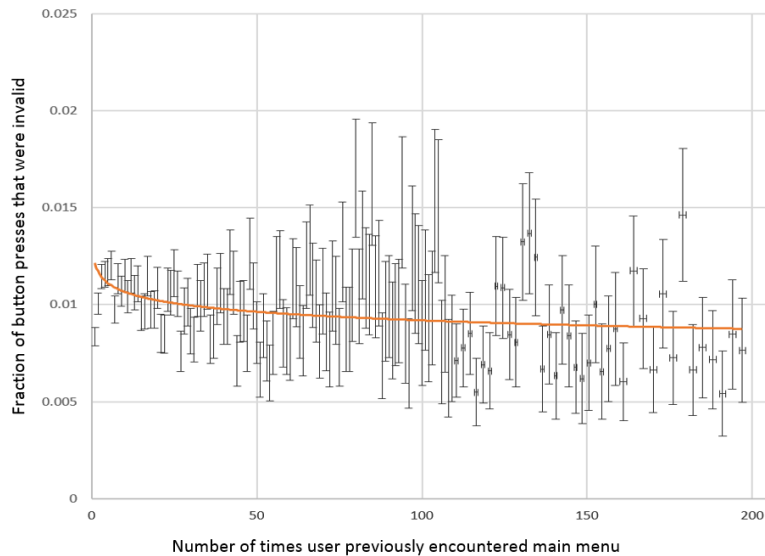
Figure 8-2: Prevalence of invalid buttons presses as function of user experience. Horizontal bars correspond to binned values.
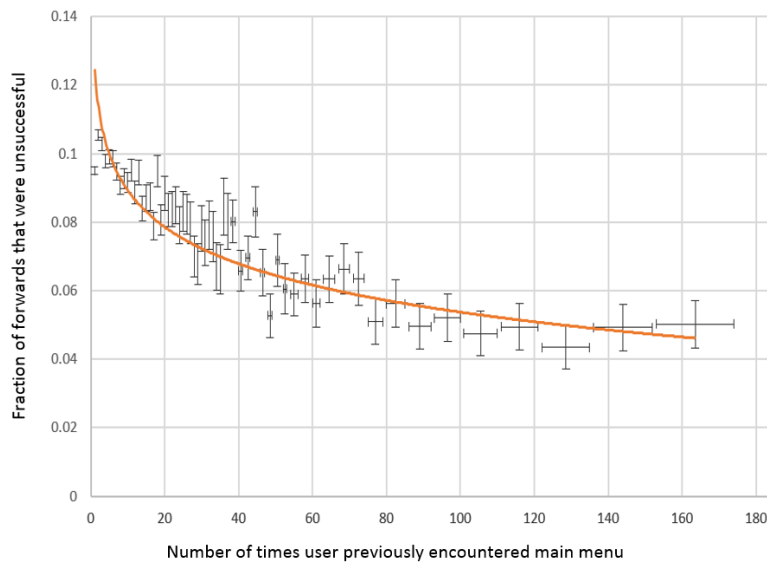
Figure 8-3: Prevalence of unsuccessful forwarding attempts as function of user experience. Horizontal bars correspond to binned values.

Invalid Selections

People can respond very quickly to voice instructions, but about 0.8% of all button presses in our data were invalid (not one of the offered choices). We studied how the frequency of these invalid selections changed as users' experience with the system increased. We continued to focus on the main menu of Polly. Figure 8-2 tracks the fraction of invalid selections as function of user experience. Whenever there were fewer than 1000 total button presses at a given experience level, we combined (binned) the data with the next larger experience level. The (negative) logarithmic regression line suggests a very mild improvement rate, contrary to our expectations.

Complex Functions

Perhaps the most complex function available from the main menu is "forward your recording to friends" (button 2). Forwarding requires a user to key in a receiver's phone number, to listen to the number being read back and press a button to confirm it (or else re-key the phone number), to record the sender name (for first recipient only), to record the receiver's name, and then to repeat the process for a an additional recipient or else indicate that there are no more recipients. This requires more interactions with the system than any other choices. As a result, there were numerous attempts to forward a message that failed.

Here, we focused on the interactions in which forwarding was requested. We binned the data as before to achieve a minimum of 1000 forward attempts per bin. Figure 8-3 shows how the fraction of unsuccessful forwarding attempts changes as user experience increases. The (negative) logarithmic regression line ($Y = -0.014\log x + 0.12$) shows good agreement with the data. There is significant improvement even after more than 20 successful interactions.

Caveat – Confounded User Types

The last three analyses were based on a very large number of interactions, which was made possible by combining the interaction data of many users, most of whom were short-term users, but many of whom were long-term users. Because of that, the analysis confounded true learning by any one user with differences between the different user types (short-term vs. long- term). It is reasonable to suspect that long-term users may tend to be more adept at using IVR system to start with. To isolate this effect we study the experience-dependent behavior of specific, controlled user groups in all the remaining analyses presented in this chapter.

Improvement In Users' Interaction Skill among Specific User Types

The next three subsections repeat the above analyses for three user groups:

Short-term Users: We define our *short-term* set as the users who stopped using Polly after exactly 5 or 6 calls (we chose 5-6 because we were hoping this is a large enough number to observe trends). The behavior of this set is analyzed till the 5th call. We lumped the two experience levels together to arrive at a large enough sample.

Intermediate-term Users: We define the intermediate-term set as the users who stops using Polly after exactly 10, 11 or 12 calls.

Long-term Users: Finally, we define the *long-term* set as the users who continued using Polly for 30 calls or more (we also studied separately the "very long-term users" with 50 calls or more (not shown), but did not find any significant changes in their behavior past the experience level of 30).

Improvement in Barge-in Behavior

Here we analyze two different types of barge-in behavior:

1. **Barge-in:** The user presses a key before the end of the voice prompt
2. **Barge-in w/o Instruction:** The user presses a key before the voice menu even instructs him about that option

For the *barge-in* we simply compare the interval between start of main menu and the key press with the total length of main menu prompt. As Polly's menus are adaptive and get changed based on several factors like past experience of the user, forwarding attempts etc. the length of the prompt could be different and this analysis caters for that variation. This measure reflects that the user is comfortable and confident enough with the menu to make the desired choice before listening to all available options. It also shows that he has learnt to expect the system to understand his response even when he interrupts its instructions. Polly never explicitly announces the barge-in facility.

For the *barge-in w/o instruction* we compare the interval between start of main menu and the key press with the interval between the start of main menu and the end of instruction regarding that choice. We believe that a choice barge-in captures users experience and knowledge of the system even better than simple *barge-in* (of which it is a subset). A barge-in w/o instruction reflects that the user was already familiar with the main menu options and also that the voice prompts can be interrupted reliably.

Further, we have separately analyzed the barge-ins in the following ways:

1. **First main menu interaction:** For this we just look at the first main-menu interaction for each user in each call (experience level).
2. **All main menu interactions:** For this we look at all main menu interactions in all the calls and then find out the average barge-ins per users at each experience level.

Figure 8-4 compares the prevalence of the two types of barge-in behavior as depicted by various user types. Perhaps the most notable thing is the use of barge-in by all user types right from their very first encounter with Polly (barge-in was utilized nearly 80% of times and 15% of time users barged-in without even hearing about the selected option). We can assume that even a new user can press the key of his choice soon after hearing about it with waiting for the prompt to finish, but the use of barge-in w/o instruction indicates one of two factors:

a. An old user called using a different SIM card. This is discussed in more detail in the chapter on Polly's large scale deployment in Lahore, and
b. A new user who was introduced to Polly by a friend either face-to-face through a demo or through a regular phone call (aka back-channel spread). As a result the user knew about the options of interest and did not need to wait for the prompt to mention these choices.

It is clear from the figure that the prevalence of barge-in increases with experience for all user types. This is especially notable for the barge-in w/o instruction, which continues to improve with experience till the very end, where the users start to remember the menu options of interest. For the prompt barge-ins the trend eventually tapers after an initial increase. It can also be concluded that users need little training (if any) do a simple barge-in after they hear the option of interest and even naïve, short-term, users expect the system to recognize their pressed key even if they press it before the instructions are complete. Hardly anyone continues to listen to the whole prompt after some initial experience using Polly.
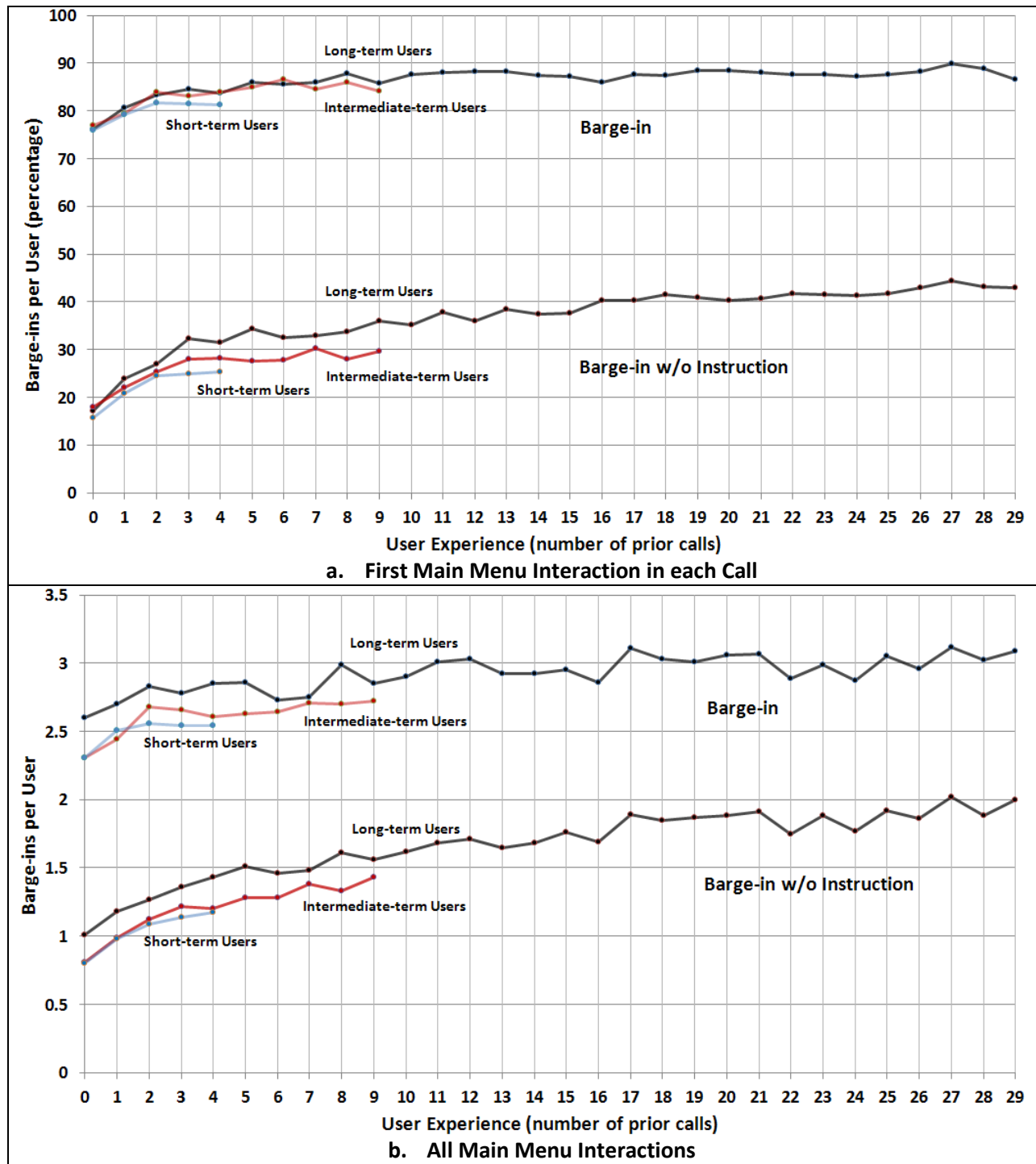
Figure 8-4: Prevalence of *barge-in* and *barge-in w/o instruction* with user experience based on 1,530 long-term, 2,585 Intermediate-term and 4,755 long-term users

Invalid Selections

These are analyzed in the next section along with prevalence of various key presses.

Complex Functions

As discussed before, one way to gauge a user's ability to manage complex functions is via improvement in his message forwarding skills. If a user presses 2 in the main menu to attempt forwarding the recorded message to a friend but is unable for any reason to complete this operation successfully, we count it as a failed forwarding attempt. Figure 8-5 shows (1) the percentage of unsuccessful forwarding attempt (out of all forwarding attempts at that experience level) and (2) the average per-user failed forwarding attempts at each experience level. These are analyzed for the same three user categories having 4,066 short-term users, 2,011 intermediate-term users and 1,111 long-term users.

Average per-user failed forwarding attempts

Percentage of failed forwarding attempts
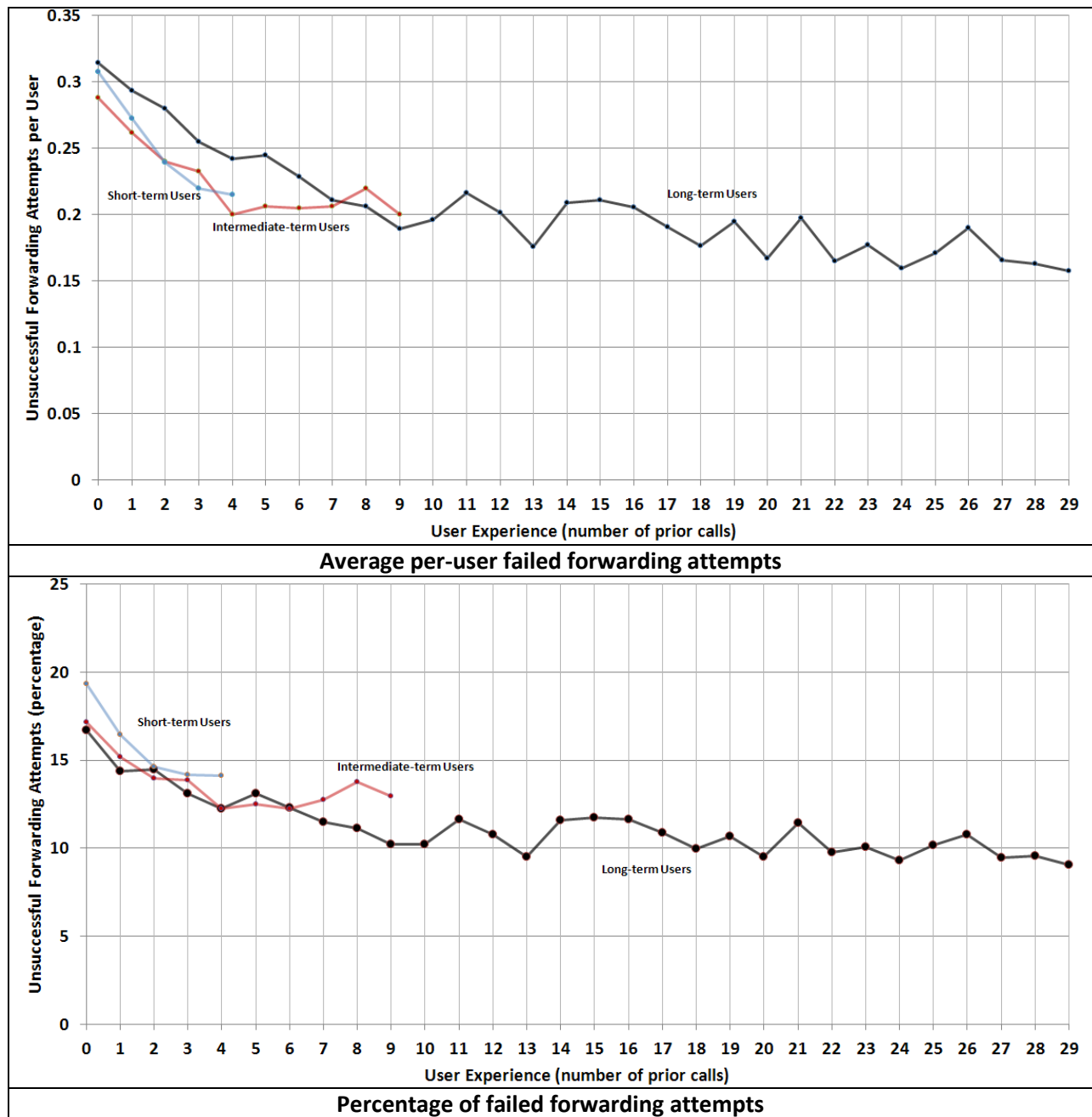
Figure 8-5: (1) Percentage of unsuccessful forwarding attempts (out of all forwarding attempts) and (2) Average per-user failed forwarding attempts, as functions of user experience. Based on 1,111 long-term, 2,011 Intermediate-term and 4,066 long-term users.

The figures show a clear improvement in users' forwarding abilities. By comparing the per-user failed attempts of all user types it is clear that all users are nearly equally matched in terms of forwarding abilities in the beginning but they keep improving with experience. It does not seem like shorter term users get frustrated and leave just because of failed forwarding attempts both because all groups seem to improve at very similar rates and also the overall number of failed attempts are not very high to start with.

Usage Change with Experience

In this section, we analyze specific sets of users and explore changes in their usage patterns as a function of their experience with Polly. To simplify things, we continue to concentrate on the main menu interactions only. We define an *interaction* with the main menu as the response of a user when faced with this menu: pressing any of the valid or invalid buttons, failing to press any button, or hanging up. We define *user experience* as the number of Polly calls this user experienced prior to the current call.

First Main Menu Interaction in a Call

For the analysis in this subsection, we focused on the first 30 calls of the 1,523 users who experienced at least that many calls. Our analysis is thus based on 45,690 calls. During these calls, these users interacted with the main menu on average 3.4 times per call, but here we look only at the first main menu interaction of each call.

Figure 8-6 depicts user responses when encountered with the main menu for the first time in a call, as a function of their experience (number of prior calls). The most striking finding is that, some 35%-50% of the time, users' very first chosen action in a call is to forward their recorded message (by pressing 2). Even on their very first interaction with Polly (their very first call), 35% of users jump straight to forwarding, without exploring any other options. We believe this may be indicative of preexisting knowledge of Polly's functionality among new users through a "back channel". This occurs when a new user of Polly gets informed about Polly and its use by a friend via means other than Polly itself (see discussion in section 4.1). In fact, we have anecdotal evidence in the recorded messages that some of Polly's users inform their friends about Polly and even give them basic usage tips before sending them a Polly message or giving them Polly's phone number. An early jump to delivery even by new users also suggests that Polly has a reputation as a "voice messaging system".

68

An increase in the use of forwarding indicates users' growing interest in this feature. This increase is accompanied by a corresponding decrease in the use of keys 0 (rerecord) and 1 (repeat). The repeat and rerecord functions are used a lot in the initial few calls. Our annotators were able to find two main reasons for this behavior: a) many users find it hard to compress their complete message in the 15 seconds allowed for recording, so they have to retry a few times; b) users play with the voice modifications by repeatedly recording themselves and listening to their modified voice, sometimes even playing out loud the modifications to family or friends around them. An increase in the use of key 3 (next voice modification) supports the latter hypothesis and also indicates users' increasing interest in exploring Polly's features. However, there can be a second reason behind this: some users prefer to send their voice using a particular voice modification, or even completely unmodified. As the unmodified voice is offered in the fourth place among other modifications, key 3 must be repeated pressed in order to reach it. The use of key 5 also gradually drops over the initial few calls. The frequent use of keys 2 and 5 may indicate that Polly is perceived by long-term users primarily as a "message sending" or "job ad browsing" system.

All Main Menu Interactions

In this section we compare the usage pattern of different types of users. The user types are defined in terms of the overall number of calls made by each user (feature 1 in Section 4). In the following subsections, we further define and analyze these user sets.

Short-term users

We define our *short-term* set as the 2,701 users who stopped using Polly after exactly 5 calls (we chose 5 because we were hoping this is a large enough number to observe trends). In this set, users encountered the main menu on average 3.09 times per call. Figure 8-7-a shows, at each experience level, the average per-user number of responses of each response type.

The most common user responses are keys 2 (forward) and 3 (next effect), both of which initially increase. The number of forwards starts decreasing slightly from the second call while the number of "next effect" choices decreases after the fourth call, before all these users stopped using the system altogether after 5 calls. Use of "rerecord" and "repeat" also show a decreasing trend. The prevalence of "switch to job ads" option is low and gently decreasing . Note that once a user chose to switch to the job ads menu, they cannot return to the main menu, so there can be at most one such response per call, and the average number of such responses corresponds to the fraction of calls that end up in the jobs menu.

Intermediate-term users

We define the intermediate-term set as the 1,862 users who stops using Polly after exactly 10 or exactly 11 calls. We lumped the two experience levels together to arrive at a large enough sample, comparable to the short-term set (while we do not show the error bars, the large samples guarantees that changes of 0.1 are statistically significant). These users had encountered the main menu on average 3.15 times per call. Figure 8-7-b shows, at each experience level, the average per-user number of responses of each response type.

We find that the most prominent of user responses are again keys 2 (forward) and 3 (next effect). However, as compared to the short-term users *over the same range of 5 initial calls*, activity not only begins at a higher level but also climbs higher. While the average number of 'next effect' choices continues to climb until the experience level of 7 calls, the number of forwards starts showing a decline much sooner. Finally, use of both these options declines during the last two calls. Use of rerecord and

repeat is very similar to that of the short-term users during the initial five calls. The option to switch to job ads declines gradually as in the short-term case, but here we can see the trend persisting through the users' 10th (and last) call.
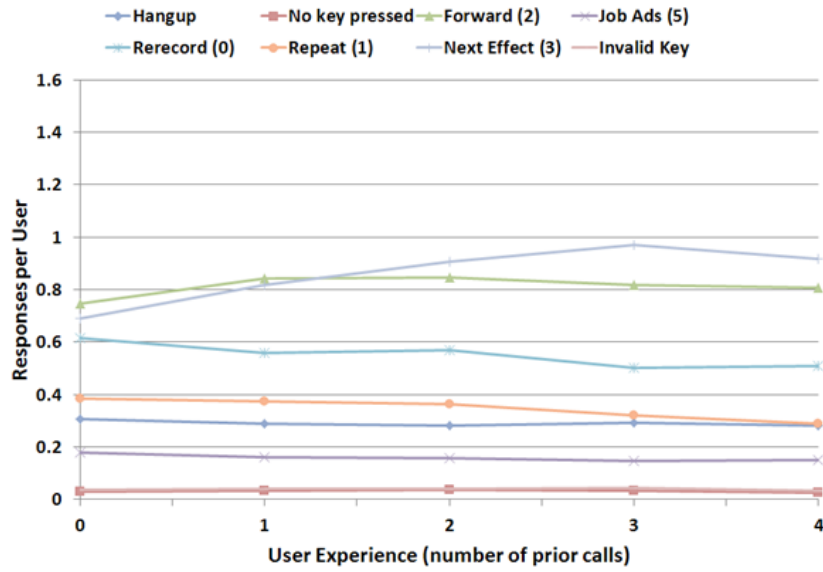
(a) Short-term users (2,701 users who stopped interacting with Polly after exactly 5 calls)
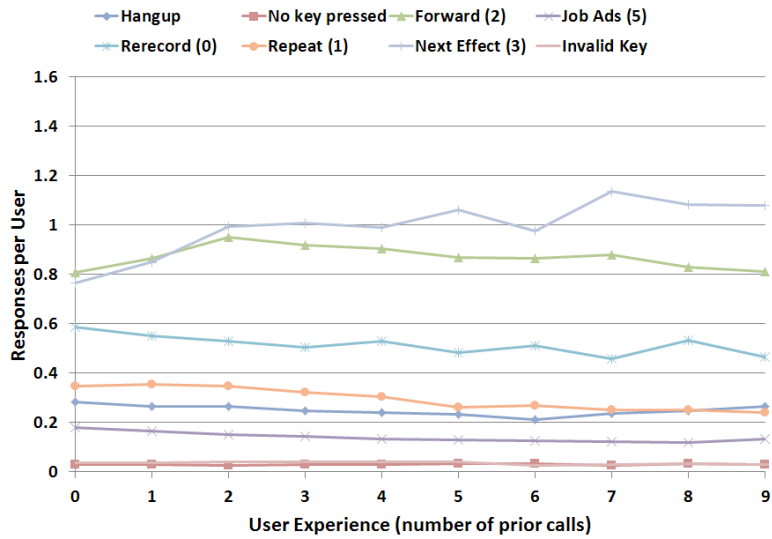
(b) Intermediate-term users (1,862 users who stopped interacting with Polly after exactly 10 or 11 calls)
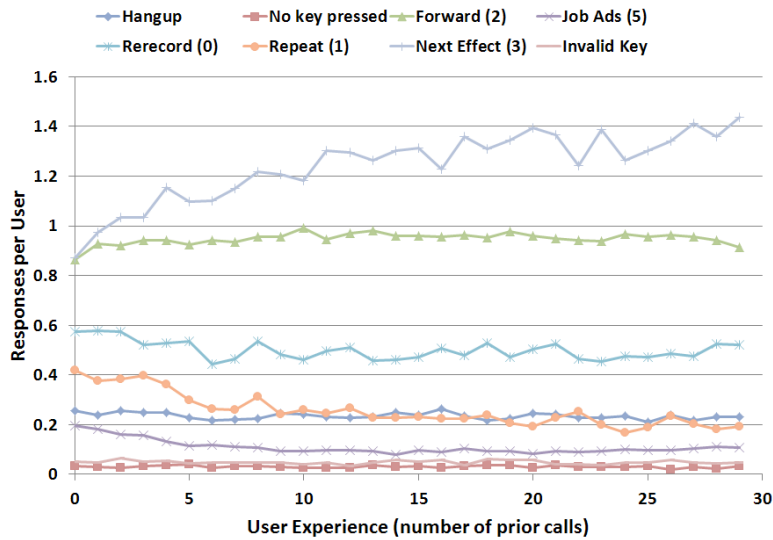
(c) Long-term users (1,523 users who continued interacting with Polly for 30 calls or more)

Figure 8-7: Average per-user number of responses of each response type in main menu, as function of user experience.

Long-term users

Finally, we define the *long-term* set as those 1,523 users who continued using Polly for 30 calls or more (we also studied separately the 508 "very long-term users" with 50 calls or more (not shown), but did not find any significant changes in their behavior past the experience level of 30). Users in the long-term set, during their first 30 calls, encountered the main menu on average 3.4 times per call. This is the same set of users that was studied in section 6.1. Figure 8-7-c shows, at each experience level, the average per-user number of responses of each response type.

Once again the most prominent of user responses are keys 2 (forward) and 3 (next effect). The prevalence of these two choices is higher than in the intermediate-term users *over the same range of 10 initial calls*. The prevalence of "next effect" climbs up more steeply during the first 10 calls, and then continues to climb till the end. It should be noted that not all users of this group stopped using Polly after 30 calls; therefore we don't see the usual tapering off of the number of "next effect" choices towards the end.

The increase in the use of "next effect" with experience may due to users who (1) are exploring different voice modifications; and/or (2) are looking for a particular voice modification. We have anecdotal evidence about this latter scenario, where we found people telling their friends in delivered messages to keep pressing 3 until the voice "clears up", and people complaining that by the time they cycle through all effects to reach the unmodified voice (fourth) the call sometimes disconnects, so they had to be content with the first modification (male-to-female). Also, a common feedback request was to bring the unmodified voice to the first position.

The prevalence of forwarding is more or less stable after the initial 10 calls. Use of "rerecord" and "repeat" shows no major differences from intermediate-term users during the first 10 calls, and continues its gradual decline afterwards. The prevalence of switching to job ads shows the same initial decline as in the intermediate set, but then stabilizes or even begins to rise.
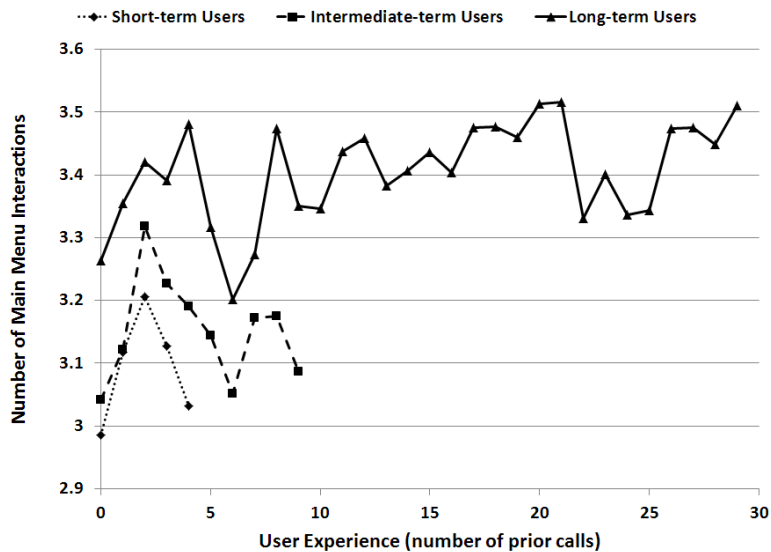
Figure 8-8: Average call complexity as function of user experience for short-term (N=2,701), intermediate-term (N=1,862) and long-term users (N=1,523).

Overall, we find that the most frequently used keys are 2 (forward) and 3 (next effect), and that long term users not only start out using these options more times, but also continue to increase their use of "next effect" over time. In all cases "rerecord" and "repeat" are used more in the beginning (presumably to calibrate to the 15 second limitation, and to share the fun with nearby friends, respectively) and their use declines as user experience increases.

Early Differences in Call Complexity

By aggregating the different response types in the graphs of Figure 8-7, we can compare the overall call complexity (number of menu interactions) of the different user sets at similar levels of experience (Figure 8-8).

We observe that short-term users tend to make the shortest, simplest calls (with fewest main menu interactions) throughout their entire "life span" (first five calls). Similarly, intermediate-term users make significantly simpler calls than long-term users throughout their own "life span" (first 10 calls). Put another way, users who make simpler calls are more likely to stop using the system sooner. Thus call complexity can be useful in predicting user dropout, which can then be acted upon in a variety of ways.

Another striking observation is the persistent pattern of steep rise in call complexity from the first to the third call, followed by an equally steep decline to the sixth call. Since the three user sets are large and mutually exclusive, we believe this represents a real and persistent phenomenon, although we are not sure how to explain it.

9. Network Analysis of Polly (Collaborative Work)

Team of collaborators and co-authors:

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Chapter Abstract

When a free, catchy application like Polly shows up, how quickly will people notify their friends about it? Will the enthusiasm drop exponentially with time, or oscillate? What other patterns emerge?

This chapter presents these questions using the large influence network of 72,000 people from Polly, with about 173,000 interactions, spanning 500MB of log data and 200 GB of audio data. The most striking findings are: (a) the FIZZLE pattern, i.e., excitement about Polly shows a power-law decay over time with exponent of -1.2; (b) the RENDEZVOUS pattern, that obeys a power law (we explain RENDEZVOUS in the text); (c) the DISPERSION pattern, we find that the more a person uses Polly, the fewer friends he will use it with, but in a reciprocal fashion. Finally, a generator of influence networks is proposed, which generates networks that mimic our discovered patterns

Introduction

How will a catchy phone application like Polly propagate among people? Will the excitement about it spike, oscillate, or decay with time? Information cascades, like the above one, appear in numerous settings, like blogs, trending topics in social networks, memes, to name a few. Social influence has been a topic of interest in the research community [73, 52, 28, 39, 34, 20, 14, 19, 24, 43] because of the rise of various on-line social media and social networks. In this work, by social influence we refer to the fact that "individuals adopt a new action because of others". Our current work tries to answer all these questions in a large dataset of hundreds of thousands of interactions obtained from Polly's large scale deployment in Lahore between May 2012 and May 2013. We focus on two main problems, described informally as follows:

Informal Problem 1 (Pattern Discovery) *Consider a real-world influence network: Given who influences whom, and when, **find** general influence patterns this network obeys.*

Informal Problem 2 (Generator) *Create a realistic influence-network-generator:*

– Given a friendship social network (who-likes-whom)

– Design a simple, local propagation mechanism

– so that we can generate realistic-looking influence networks. By "realistic" we mean that the resulting influence networks match our discovered patterns.

Figure 9-1 gives examples of a social network (who is friends with whom, in gray, directed edges), and a possible influence network (who sends messages to whom - in red; directed, time-stamped, multi-edges). For simplicity, only edges between 1 and 2 are shown with time-stamp and multi-edge structure.
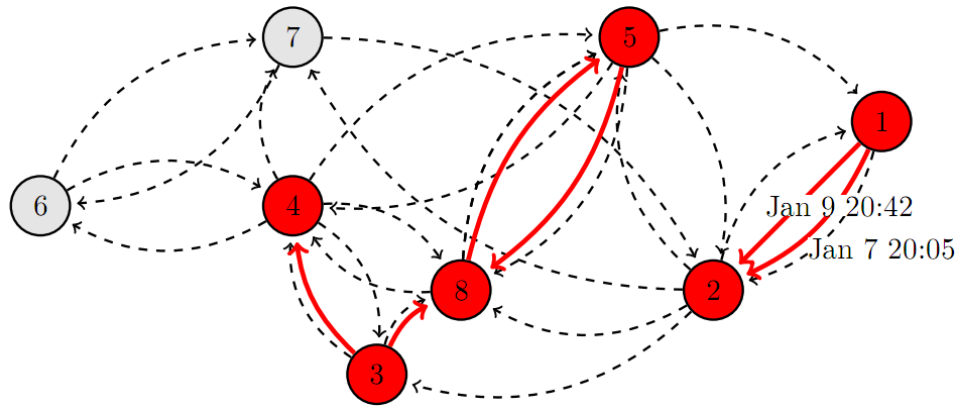
Figure 9-1: Illustration of a 'base network' (in gray) and a possible 'influence network' (= cascades; in red). Here, the initial nodes ('seeds') are nodes 1 and 3.

The contributions of this work are the following:

– **Discovery** of three new patterns (laws): the FIZZLE, RENDEZVOUS, and DISPERSION pattern;

– **Generator and Analysis:** We propose a local, efficient propagation mechanism that simulates an influence graph on top of existing social network datasets [12, 13] or synthetic social network datasets [11]. Figure 9-1 illustrates the process of simulating influence network. We also did analysis on the DISPERSION pattern.

The importance of the former contribution is that patterns can help marketers and sociologists understand how influence propagates in a social network; they can also help spot anomalies, like spammers, or faulty equipment. The importance of our second contribution is that a realistic generator is valuable for what-if scenarios, and reproducibility: publicly-available influence network datasets are notoriously difficult to obtain, due to privacy and corporate regulations; a good generator can serve as proxy.

Reproducibility

For privacy reasons, the Polly dataset is not public. Thus, for reproducibility, we present experiments on public data (such the Enron Email net-work [35, 12], and Facebook [13]) which exhibit similar behavior like our dataset. We also make our code open-source at: https://github.com/yibinlin/inflood_generator/.

Dataset Used

The dataset comes from the first large-scale deployment of Polly in Lahore, Pakistan. We use data from 72,341 users. It comprises 173,710 recorded interactions, spanning 500 MB of real-world message delivery logs and 200 GB of audio data. However, this analysis focuses only on the forwarding of user recorded messages. In what follows, we denote a user with a node and a forwarded message with a directed and dated edge. Hence we view our dataset as an influence network.

Discovered Pattern (P1): FIZZLE

Users may have been introduced to Polly by receiving a forwarded message from one of their friends, or simply by "word of mouth". Many such users may in turn call the system, experiment with it, and possibly send messages to their own friends. Most such users cease interacting with the system within a few days. Still, a significant number of users stay with the system for a long time. How does these users' activity change over time?

In the following analysis, we define a user's "system age" as the number of days elapsed after the user successfully sends out first message. Moreover, the active senders after n days are defined as the users who actively send out messages on the n-th day after they sent their first message. Figure 9-2 depicts the FIZZLE pattern: the number of active senders (that is, users that still send messages to their friends) vs. their system age. It also shows the count of messages they sent, as a function of their system age.
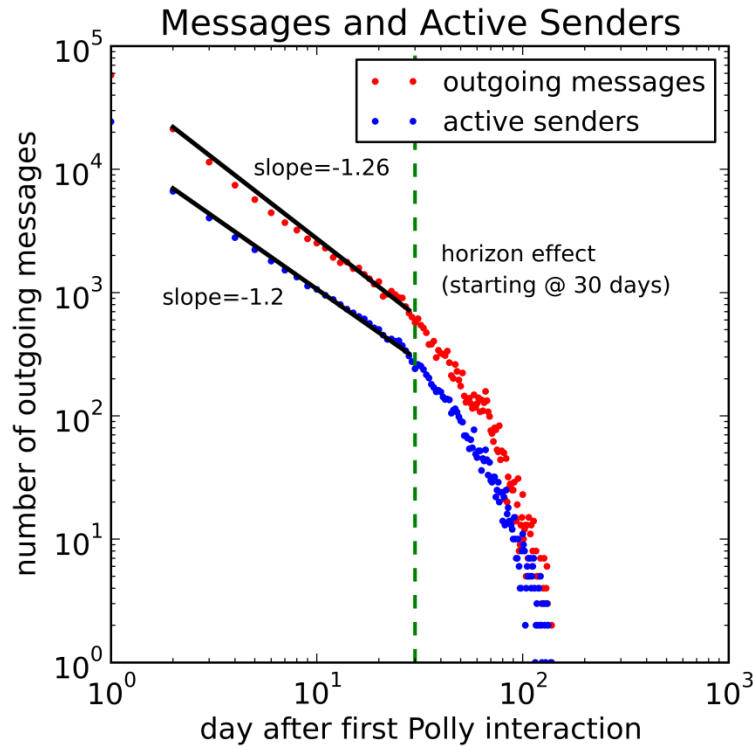
Figure 9-2: (Activity (number of messages (red), remaining users (blue)) vs system age) The FIZZLE pattern (P1) - best viewed in color: the number of messages sent (in red) and count of active senders (in blue), versus system age. In both cases, the excitement follows a power law with exponent ≈ -1.2. The horizon effect is explained in the text.

Both follow power-law distribution with exponents of -1.2 and -1.26, respectively. This observation agrees with earlier results of the behavior of elapsed time in communication patterns (see [52]): there, Oliveira et al reported shows similar power-law patterns in mail and e-mail correspondences, but with slightly different exponents (1:5 and 1).

Observation 1 (P1) *The number of active senders c(t) at system age t follows*

$$c(t) \propto t^{\alpha} \qquad (1)$$

where α ≈ - 1.2. Similarly for the count of messages m(t) at system age t.

Horizon effect: In order to get accurate information about the FIZZLE pattern, new users who are introduced to the system later than 110th day after it was launched were excluded. In this paper, messages delivered within the first 140 days are analyzed. In other words, all the users shown in Figure 9-2 have passed "system age" of 30 (no matter whether they are still active or not) because they

were introduced to the system at least 30 days before the end of our analysis scope. This is exactly the reason for the deviation from power-law, as "system ages" of 30 and above are unfairly handicapped.

The detailed power-law linear regression results for the FIZZLE pattern, as well as all our upcoming patterns, are listed in Table 9-1. Notice that they all have extremely high correlation coefficient (absolute value ≥ 0:95).

Pattern	Slope k	Correlation Coefficient r
P1 The FIZZLE pattern (number of remaining users) k_1	-1.2	-0.994
P1 The FIZZLE pattern (number of phone calls) k_3	-1.26	-0.996
P2 The RENDEZVOUS pattern k_2	-4.88	-0.992

Table 9-1: Summary of Power Laws Observed in Our Dataset

Discovered Pattern (P2): RENDEZVOUS

In a directed network, propagation from one source can take multiple paths to the same destination node. Of particular interest to us are two paths that diverge for a while (with no intermediate connections between them) before they re-converge – an event which we here call RENDEZVOUS. This event type corresponds to diffusion into different social circles (e.g. a-friend-of-a-friend... of-my-friend, whom I am unlikely to know), followed by convergence. The prevalence of such re-convergences can shed light on the effective population size. In a large country like Pakistan (180 million people), the effective population size for our system may vary widely and is unknown a priori. Thus, we are interested in the prevalence of RENDEZVOUS as a function of the shortest path to the most recent common ancestor of two parents of a node, where path length and recency are both measured in terms of number of edges, rather than time. A node with k parents gives rise to $k \cdot (k - 1) = 2$ different RENDEZVOUS. Taking into account the edge from the common child to its parents, we have the following definition:

Definition 1 (n-RENDEZVOUS:) An n-RENDEZVOUS is defined as a RENDEZVOUS where the shorter path from the two parents to their most recent ancestor is of length n - 1.

For example, Figure 9-3 (a) shows a RENDEZVOUS of length 2: the shortest leg from the final node Ω to the starting node A, is n=2 hops long.
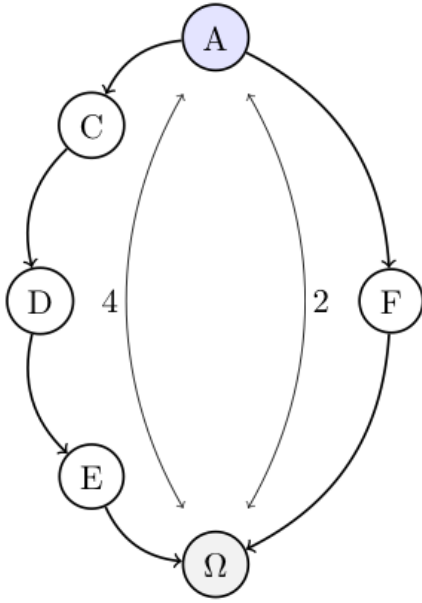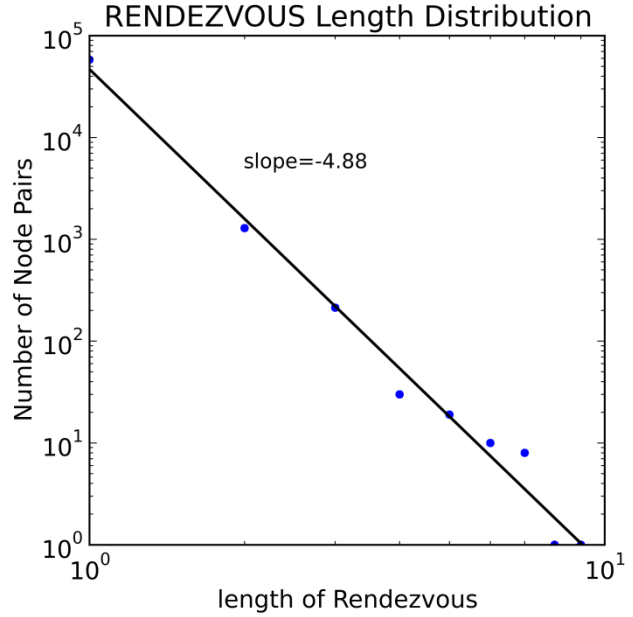
| (a) A 2-RENDEZVOUS. | (b) Distribution of RENDEZVOUS lengths |

Figure 9-3: (a) Example of a 2-RENDEZVOUS. (b) Distribution of RENDEZVOUS lengths follows a power law with exponent -4.88.

Figure 3(b) shows that the length distribution of RENDEZVOUS' in our dataset follows a power-law. Most of RENDEZVOUS have a length of 1, meaning that one of the parents is the most recent common ancestor, because it has a direct link to the other parent.

Observation 2 (P2) The number of RENDEZVOUS' $n(l)$ at RENDEZVOUS length l follows

$$n(l) \propto l^{\beta} \qquad (2)$$

where $\beta \approx -4{:}88$.

Discovered Pattern (P3): DISPERSION

Let the "reciprocal activity" between two users be the smaller of the number of messages sent between them in either direction. Let the "activity profile" of a user be $\{m_1, m_2, m_3, \dots, m_F\}$ ($m_1 > m_2 > m_3 > \cdots > m_F > 0$), where m_i is the reciprocal activity between a user and one of his recipients.

Definition 2 (DISPERSION) *The DISPERSION D of a user with activity profile $\{m_1, m_2, m_3, \dots, m_F\}$ is defined as the entropy H of the normalized count distribution:*

$$D(m_1, m_2, m_3, \dots, m_F) = -\sum_{r=1}^{F} P_r * ln(P_r)$$

where $P_r = \frac{m_r}{\sum_{k=1}^{F} m_k}$

Therefore, if a user has a high DISPERSION, she sends messages her friends more evenly than other users with the same number of friends, but lower DISPERSION.

Figure 4(a) shows that the real DISPERSION (entropy) is smaller than the "maximum dispersion" where a user sends messages each of her friends evenly. This means that long-term Polly users on average exhibit the DISPERSION pattern when they send messages to their friends.

(a) DISPERSION pattern in our dataset   (b) DISPERSION pattern in Experiment E1 (Enron)
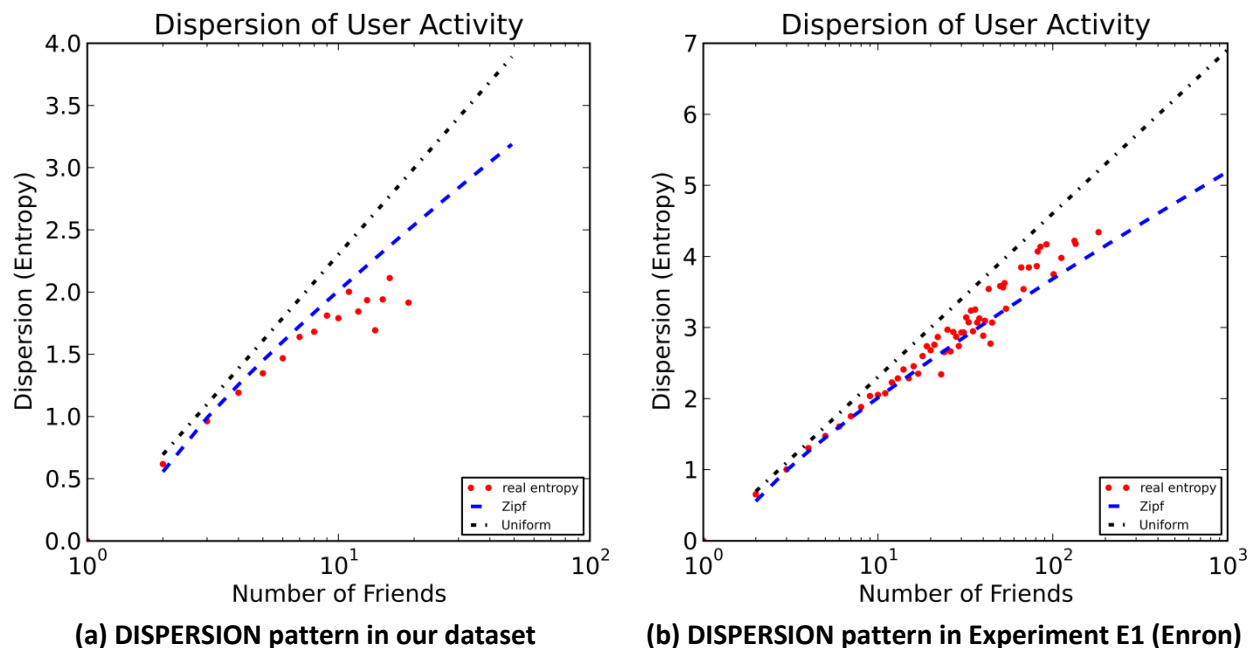
Figure 9-4: (a) DISPERSION pattern found in the influence network. (b) DISPERSION pattern found in simulated influence network in Experiment E1, see next section.

We can explain the DISPERSION behavior using a closed-form formula, under the assumption that people send messages to their friends following a Zipf's distribution, which implies $P_r \propto 1/r$, to be specific, $P_r \approx \frac{1}{r \times ln(1.78F)}$ [65]. Based on this, we can derive that if we use integral as an approximation of the sum part of the entropy calculation:

Lemma 1. *The entropy H of a Zipf 's distribution is given by:*

$$H \approx \left(C \times ln^2(F) + K \times l\,n(F)\,lnln(1.78F) \right), where\ F > 1. \tag{3}$$

The proof is omitted for brevity.

Observation 3 (P3) *Dispersion pattern can be modelled well by Zipf 's law in our dataset.*

The mathematical analysis shows that the "friend contact" distribution of a user with *F* reciprocal friends will follow an expected entropy value proportional to the square of logarithm of *F* ($ln^2(F)$) other than ($ln(F)$) when we assume the distribution follows uniform distribution. The predicted entropy of Eq (3) matches reality much better than the uniformity assumption. As shown in Figure 9-4 (a), the predicted entropy (the dashed blue curve) is a better match for the real data (red dots), while the uniformity assumption leads to the black-dotted line.

Inflood Generator: Algorithm and Evaluation
First, we formally define the *base* and *influence* network:

Definition 3 (Base Network) *A Base Network (V_{base}, E_{base}) is the underlying social network of all people who are related to social information cascades. V_{base} is a set of individuals. E_{base} is a set of directed, weighted edges. The weights represent the strength of connections.*

Definition 4 (Influence Network) *An Influence Network (V_{infl}, E_{infl}) shows which node sent a system message to which node, and when. V_{infl} is a set of individuals. E_{infl} is a set of directed, time-stamped edges of which the weight shows the number of times a node has been notified of the influence by another node.*

In our model, $V_{infl} \subseteq V_{base}$, $E_{infl} \subseteq E_{base}$, i.e., individuals can only be influenced by others they know.

We model all patterns by using INFLOOD GENERATOR. As mentioned above, Polly can be viewed as an influence network where people are notified of it from their base-network friends. After the notification, people may start forwarding messages.

Why we need a generator: The best way to verify all our three patterns (FIZZLE, RENDEZVOUS and DISPERSION) is to study other influence network datasets. However, they are difficult to obtain, and some of them lack time stamp information.

Details of INFLOOD GENERATOR: The pseudo code of our influence-network generator is given in Figure 9-5 (Algorithm 1). In more details, on day 0, s_0 seed nodes ($s_0 = 5$) in the social network G1 (e.g., Facebook or Enron) are notified of Polly. Then, each following day t, every person u who has been notified of Polly has a probability, $P_{u,t}$, of calling some of her friends via Polly. The friends are sampled from the outgoing edges from G1 *independent of* no matter whether they have been already notified.

```
Input: G1 = A base network, T = simulated days, α = power-law decay factor, P_{u,0}:
       first-day infection probability of user u, day = 0.
Output: An influence network G2 on top of G1
begin
    notifiedUsers ←—(5 randomly chosen people in G1 with notified day t_u = 0);
    day ←— 0;
    while day < T do
        for each user u in notifiedUsers do
            coin ←— TAIL;
            if random() < P_{u,t} in Equation 4 then
            |   coin ←— HEAD;
            while coin == HEAD do
                f = a friend sampled from G1;
                if f is not in notifiedUsers then
                |   add f into notifiedUsers with t_u = day
                else
                |   //User u has sent a message to user f, Record this interaction.
                |   //Details are omitted for simplicity.
                if random() >= P_{u,t} then
                |   coin ←— TAIL;
        day ←— day + 1;
```

Figure 9-5: (Algorithm 1) Pseudo Code of INFLOOD GENERATOR

The probability of a user *u* telling other people about Polly is given by:

$$P_{u,t} = P_{u,0} \times (day - t_u)^{-1.0 \times \alpha}, d > t_u \qquad (4)$$

,where α parameter affects the exponent of the power-law that governs the decay of infection activities, and $P_{u,0}$ is defined the *first-day infection probability*.

Estimating $P_{u,0}$: $P_{u,0}$ depends on the total weight (number of communication messages) a user (node) has in base network $G1$. In fact, $P_{u,0}$ is set so that, in expectation, the number of edges user u makes on the first day $msg_{u,0}$ is proportional to the user's total weight of out-going connection strength in base network $G1$, i.e.

$$msg_{u,0} = c \times \sum_{v \in V_{G1}} W_{u,v} \qquad (5)$$

Note that in Algorithm 1, the process of sending messages is a geometric distribution. Hence we can get $msg_{u,0} = 1/(1\ P_{u,0})$ in expectation.

Hence, we set the $P_{u,0}$ to be:

$$P_{u,0} = 1 - \frac{1}{c \times \sum_{v \in V_{G1}} w_{u,v}} \qquad (6)$$

This ensures that a high weight node has more simulated edges. It is also more realistic, because more social people may spread messages more easily. In our setting, $c = 1/4$, i.e. a user will contact a quarter of her $G1$ out-degrees in expectation on the first day. This formula is based on experimental observations.

Evaluation of INFLOOD GENERATOR

We tested INFLOOD GENERATOR in a number of networks. Here we use communication networks, such as Facebook, to be approximations of "real" base network. The results are presented in Table 9-2.

Experiment	Base Network $G1$	$G2\ |V|$	$G2\ |E|$	FIZZLE slope k_1	RENDEZVOUS slope k_2
Polly	N/A	$72,341$	$173,710$	-1.2	-4.88
E_1	Enron [22,1]	$19,829$	$227,659$	-1.16	-8.39
E_2	Slashdot [3,17]	$6,880$	$19,781$	-1.18	-6.11
E_3	Facebook [2]	$22,029$	$222,686$	-1.16	-7.65

Table 9-2: Results of INFLOOD Simulations

In all experiments, α= 1.17, and the number of simulated days is T = 140.

In all cases, the correlation coefficients |r| were high (|r| > 0:93). The FIZZLE slopes k_1 are calculated based only on the first 30 days of interactions of each user, exactly as we did for the real, Polly dataset. Recall that k_1 is the slope of the FIZZLE pattern, that is, the slope of the number of remaining active users, over time, in log-log scales. For the RENDEZVOUS pattern, the k_2 slope varies between experiments. This may be due to the small count of data points; see Figure 9-3 (b).We also tested the INFLOOD GENERATOR on synthetic datasets, such as Erdös-Rényi graphs of various parameter settings. Notice that the RENDEZVOUS pattern is violated: the Erdös-Rényi graphs do not follow a power-law in their RENDEZVOUS plots.

Because the INFLOOD GENERATOR graph is big, we observe the DISPERSION pattern in Experiment E1. Figure 9-4 (b) shows that the entropy footprint grows well with the Zipf's distribution curve for users who have less than 50 friends. When the number of friends goes beyond 50, the entropy footprints seem less regular as the number of samples decreases.

Related Work

Static graph patterns

These include the legendary 'six-degrees of separation' [49]; the skewed degree distribution [25], especially for telephone graphs [16]; the power law tails in connected components distributions; the power law PageRank distributions and bimodal radius plots [33]; the super-linearity rules [45], triangle patterns [74, 32]. This list is by no means exhaustive; see [21] for more patterns. Algorithms for detecting these patterns have been proposed by multiple research teams, such as [31].

Temporal and influence patterns

Work on this topic encompasses the shrinking diameter and densification [41]; the power law for the mail response times of Einstein and Darwin, [52]; analysis of blog dynamics [28, 42], and discovery of core-periphery patterns in blogs and news articles [27]; viral marketing [39, 34]; meme tracking [40]; reciprocity analysis [26, 17]; analysis of the role of weak and strong ties in information diffusion in mobile networks [53]; identification of important influencers [71]; prediction of service adoption in mobile communication networks [72]; information or cascade diffusion in social networks [20, 14, 19, 73]; linguistic change in online forums, and predicting the user's lifespan based on her linguistic patterns [24]; peer and authority pressure in information propagation [18].

However, none of the above works reports anything similar to our discoveries, the RENDEZVOUS and the DISPERSION patterns.

Chapter Summary

We study a large, real influence network induced by the Polly system, with over 70,000 users (nodes), 170,000 interactions (edges), distilled from500MB of log data and 200GB of audio data. Polly is a free, telephone-based, voice message application that has been employed and used in the real world. Our contributions are as follows:

Discovery of new patterns in Polly:

– P1: the 'enthusiasm' drops as a power law with time.

– P2: The RENDEZVOUS pattern shows a power-law distribution.

– P3: The DISPERSION pattern of users behaves like a Zipf distribution;

Generator and Analysis:

– We propose the INFLOOD GENERATOR algorithm, which matches the observed patterns (P1, P2 and P3) in various communication networks. The code is open-sourced at:

https://github.com/yibinlin/inflood_generator/.

– We give the derivation for the observed DISPERSION pattern

With respect to future work, a fascinating research direction is to estimate the underlying population size of our dataset, from the statistics of the RENDEZVOUS pattern.

Acknowledgements

The acknowledgements of this chapter can be found in [44].

10. Reproducibility: Deployment in a Second Country

Chapter Abstract

This chapter details Polly's first launch in India in collaboration with Babajob.com - a large informal and entry level job portal in India. The collaboration was built around the idea of using Polly to advertise Babajob's low-skill job opportunities among low-literate and unemployed users in Bangalore. To our surprise, Polly did not take off immediately as it did in Pakistan. Instead, it entered a six-month long "sputtering" phase of fluctuating, intermittent activity. A different form of seeding initiative transitioned it into a viral phase, with sustained transmission over five months but without (exponential) growth. Finally, some user interface adjustments caused the system to transition abruptly into a viral-exponential phase of very rapid growth amassing 10,349 phone calls by 1,613 users over a span of seven days. Over the year Polly accumulated 22,742 calls by 3,801 users. Analysis of the call graph, call logs, user feedback and surveys suggest the necessary conditions for each phase. We study the interplay of user interface; language of the system; seeding mechanisms and active response to user feedback towards the uptake of the service.

Introduction

This chapter reports Polly's first launch in India in collaboration with a commercial job portal that maintains an active listing of thousands of informal and entry level jobs. As explained in chapter: *Development-related Service: Job Opportunities*, one limitation of our study in Lahore was our inability to track employment outcomes. We did not have stats about the number of people who actually applied, got interviewed and eventually got selected for the various jobs that were advertised through Polly. We also did not know the degree by which Polly increased the number of applicants for these positions. Our follow-up surveys did give us evidence that people took a lot of interest in these job opportunities and (anecdotally) some of them did get positions by applying. But we could not verify those claims. Hence, the impact of the job-browser was not measurable.

For this reason, we reached out to Babajob [1] in India. Babajob.com is one of India's largest informal and entry level job portal. The portal connects registered job seekers and employers using their website (primarily), voice services as well as SMS-texting [10]. Our collaboration was built around the idea of using Polly to advertise Babajob among low-literate people in Bangalore (and possibly other places in India), and to allow people to access Babajob's IVR system through Polly. Babajob already has a mechanism to track employment outcomes of its registered users, hence giving us the opportunity to measure impact.

Based on the lessons learned during Polly's year-long deployment in India, and in comparison with its deployment in Pakistan, we derive necessary conditions for achieving virality (defined as long, sustained chains of transmission to new users) and exponential spread of telephone-based speech services among low-SES people.

To our surprise, unlike in Pakistan [64], our initial attempts at seeding Polly in India did not lead to viral spread, and activity dwindled within a few weeks to a mere handful of daily calls (a "sputtering" phase) that persisted for nearly six months. After several unsuccessful attempts, a modified form of seeding led

to viral spread, though the system still did not take off exponentially. This viral-non-exponential phase continued for another five months. Finally, adjusting the user interface in response to user feedback led to an abrupt exponential spread matching the growth and spread of Polly in Pakistan.

Research Questions

Our original research question was of reproducibility: *can Polly become viral in a second country?* In addition, we were interested in measuring the impact of the development related back-end service. However, as Polly did not immediately take off in India as it did in Pakistan, we became interested in the following questions:

- Why did Polly instantly take-off in Pakistan but not in India?

- During the non-exponential phase, how was a daily stream of new users sustained yet without achieving exponential growth?

- What are the factors necessary for achieving virality and exponential spread?

System Description and Improvements

Before doing a local deployment in India, we decided to do a remote Pilot, to find out if Polly can indeed become viral in India without extensively modifying its entertainment type. For this purpose we ported the latest version of Polly (that had been used in Lahore) back to tropo's cloud-based platform and setup the following mechanism for Polly's operation:

- A local phone number was setup in Bangalore to receive the missed calls (call-me-back requests) from users. The system (hosted through Exotel.com) does not support ring-back-tunes, so the caller just hears the phone ringing a couple of times and then the call gets rejected without charging the caller anything for the airtime. The phone number is then forwarded to Polly's database (deployed on our servers at CMU). Polly's scheduling scripts (also running on our servers at CMU) launch Polly (running on tropo's cloud) in response to the call request and the caller is called back from US (bearing international tropo call charges of approximately 8 cents per minute).
- Polly sends the local Bangalore number as its caller ID so that the receiver can call back later from the phone history.
- Our incoming (missed) call capacity is a single phone line but outgoing call capacity is around 512 simultaneous calls.
- Polly's voice prompts were translated and recorded in Kannada and Hindi (both female voices). The initial system supported Kannada only that was replaced by Hindi when we realized the Kannada prompts to be too formal and difficult to understand a few months after the initial launch.
- A voice-based phone directory feature was added:
  - After phone number entry, Polly prompts its users to (optionally) save the newly entered phone number. If users choose to do so, they are prompted to record their friend's name.
  - When users decide to forward something (voice message, job ad) to a friend, Polly allows them to choose from the saved numbers in reverse chronological order.by pressing a key e.g. to enter a new number, press 0; to send to "Roni", press 1; to send to "Ali", press 2,…
- Call transfer to Babajob IVR system was added. Users could transfer to Babajob from the main menu by pressing 5.
- Babajob's IVR system is based on voice prompts that get concatenated in real-time and hence do not lead to a nice user experience. We decided to ignore that initially till we get evidence of Polly's virality in India.

- Babajob's IVR allows a new user to register by entering the location (city, state) and demands (job categories, salary expectations). Afterwards jobs openings are played back to him every time he calls in. He can also record messages for the job advertisers.
- Babajob's IVR system has an internal mechanism that allows users to forward job ads to their friends via SMS. Whenever a user listens to a particular job ad or requests its forwarding to a friend, that information is passed on to Polly to allow tracking.
- Polly sends the delivery SMS by passing the SMS text on to Babajob. The text of the SMS needed to be preapproved by Indian telecomm regulators before we were allowed to send SMS. We decided on an English text based on the suggestions of our partners to maximally cover the target audience.
- Polly's DB was modified to add more user-centric information and tracking.
- The monitoring system was significantly enhanced (detailed in the Appendix on pg-120).
- In Kannada Polly was renamed from "Mian Mithu" (Mr. Polly or Polly – The Parrot) to "Gini Maathu" (A cute little parrot). The Hindi version retained the same name.

User Interface

Polly's user interface is described in detail in [64]. Here is a summary for the benefit of new readers:

Each call starts by prompting the user to make a short recording of their voice (10 seconds, or shorter if the user presses # or remains silent for 4 seconds). Immediately the recording is morphed and a funny version is played back. User is given the option to rerecord, replay, to forward the morphed recording to a friend, to listen to a different voice modification, to give feedback to Polly or to get transferred to the job service. Later, we also added an explicit menu option to send unmodified recordings because a significant number of users demanded it. Polly offers the following voice modifications, in the following order, all achieved with a standard audio processing utility:

1. A *Male to female* voice conversion, achieved by raising the pitch and increasing the pace.

2. A *Female to male* voice conversion, achieved by lowering the pitch and decreasing the pace.

3. A *drunk chipmunk* effect, achieved with pitch and pace modification,

4. An *I-have-to-run-to-the-bathroom* effect, achieved by a gradual pitch increase,

5. The original, *unmodified* voice of the user

6. Converting the voice to a *whisper*, achieved by replacing the excitation source of user's voice with white noise

7. Adding *background music*.

When the user chooses to forward their recording to a friend, they are prompted for the phone number, the name of their friend, and their own name for introduction. Only the phone number is confirmed for correction. Name recordings are terminated by silence detection and a 4 second hard time-out. We also added an optional audio speed-dial feature as surveys revealed that users find it difficult to enter long phone numbers repeatedly. The speed-dial remembers the last nine phone numbers entered and allows the user to choose a number by pressing a key (e.g. for John, press 1, for Tom, press 2…). The user is allowed to forward their voice to multiple recipients with the same or different modifications applied.

When Polly calls the intended recipient to deliver the recorded message, it plays the sender's name (in their own unmodified voice) immediately to the listener to prevent confusion regarding the identity of

the caller and establish trust. The recipient can also choose to hear the phone number of the sender; this effectively inhibits prank calls. After hearing the message, the recipient can choose to replay the message, record a reply, forward the recording to others, create their own recordings, or get transferred to the job service.

Polly's contact information is sent to all of Polly's recipients via text messages right after their first two interactions as an additional mechanism for viral spread. Polly's phone number is also played during the phone call itself. Additionally, call recipients can simply call Polly's number from their call history (a feature commonly used by low-literate mobile phone users).

Polly elicits **User Feedback**, in the form of an unconstrained recording (up to 60 seconds, with a silence timeout) from repeat users during their interactions. Feedback is requested only when a user actively initiates a call.

The job service allows the user to choose a job category of interest, browse openings available in that category, register or leave a message for the employer who advertised the opening. For now, the service only advertises jobs in Bangalore.

Polly in India initially supported voice prompts in Kannada since we aimed it at Bangalore. We later switched the prompts to Hindi as we found that Kannada was suitable for only a subset of our target population in Karnataka, and Hindi allowed it to spread to large parts of India.

Remote Pilot Launch

Polly was launched in India using our *remote pilot setup*. To be able to do quick launch in new countries we use a distributed setup (similar to [63]). In this setup, Polly receives the call-back requests from the users (via missed calls) on a local phone set up in the target country and then calls the user back directly from the US. Hence, the only on-ground hardware support that this setup needs is a phone capable of rejecting incoming calls and forwarding the caller's phone number to Polly's servers in the US via the internet. This allows us to test Polly before going for a large-scale local deployment (as described in [64]).

Annotations of recordings and feedback

The feedback files have been annotated by several members of CMU, MSRI and Babajob teams. Being in a variety of languages (Hindi, Kannada, Bangla...), the process of annotation has not been a very smooth one. Message recording have not been largely annotated yet.

Surveys

We have conducted several telephonic and face-to-face user surveys at various points to gather user feedback, demographics and understand system's dynamics. These have been done with the help of our partners and also team members.

Results and Analysis

Seeding Attempts

As shown in Figure 10-1, Polly was launched in Bangalore, India on July 03, 2013. Desirable methods of seeding in India have been one of our major challenges. Unlike Pakistan, where I was present on-ground, we had to rely heavily on our partners to do the seeding for us. As a result we have not been able to

replicate the form of seeding that we initially did in Pakistan ("manual-familiar" seeding[1]). Also, unlike our experience in Lahore, Polly did not immediately become viral after initial seeding attempts so we had to reseed frequently and using various techniques. Here are the details of our seeding attempts:
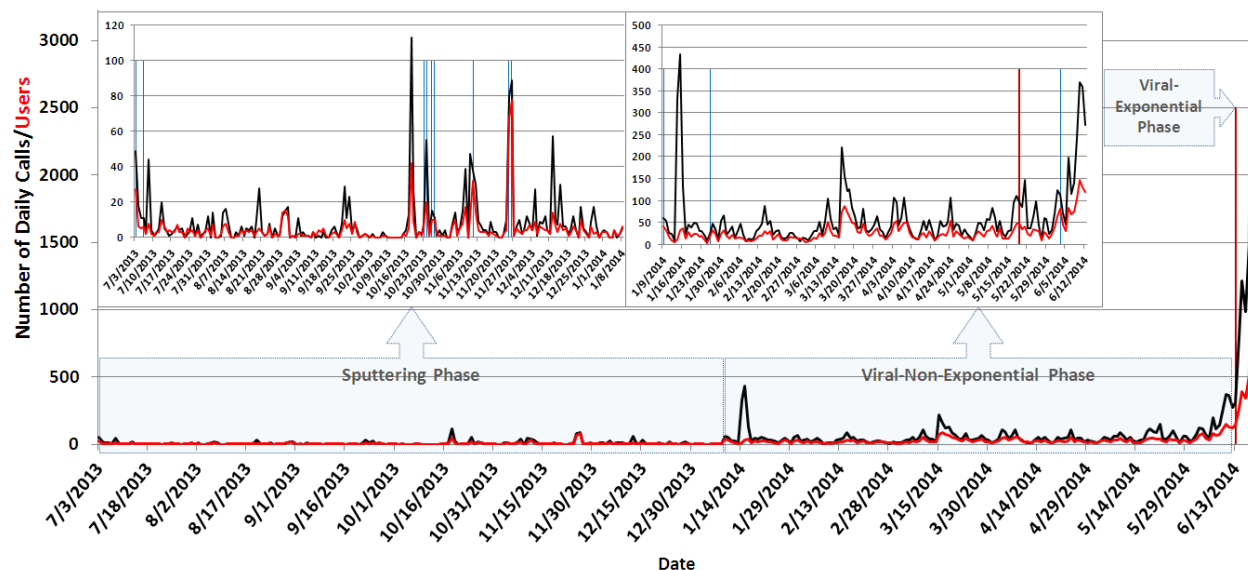
Figure 10-1: Polly's Activity Levels in India (Blue vertical lines: Seeding attempts; Dark red line: Major interface changes.)

Telephonic Seeding through BabaJob.com
Automated phone calls were made by Babajob to 100 of their active users in the Driver category. Each call was followed by an SMS 84 of which were successfully delivered.

The text message simply stated: "Hello from Gini Maathu. Give missed call to 0806-xxxxxx and play a fun voice game for free! Call now!"

And the automated voice call said: "Hello from Gini Maathu. Give a missed call to 0806-xxxxxx and play a fun voice game for free! Just call 0806-xxxxxx" (in Kannada)

Behavior: A handful of calls resulted from this initial seeding. The user behavior exhibited a striking peculiarity though: by the third day there were just 73 call-me-back type calls, 24 users but the 75 job ads had been listened to 133 times! The users did not show any interest in the voice modifications or the message sending features of Polly (only 10 deliveries were scheduled during the first three days).

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[1] **"Manual-Familiar" Seeding:** Provide as much handholding as needed to make the seeds understand the system, comfortable with it, and excited about it. For motivational reasons, the best seeds are those who know the seeders personally. The method involves meeting with the seeds, preferably as a group, and introducing Polly to them as a free and funny voice messaging service, without any hint of the development-related service (the jobs option). The seeder should explain Polly, and our goals, in any way that may motivate the seeds. Give a brief (pre-tested) demo: Record something in front of the group, play a few modifications out loud (so that the listeners laugh) and then forward the message to one or more of the audience members. Wait till they receive the call(s), and have them interact with the system. Ideally, the seeder can have them practice placing a missed call to Polly themselves. They may want to prepare a phone number to forward to. For everyone in the group to be able to understand what's happening the phones should be placed on speakerphone. Finally the seeder gives Polly's number to everyone, and encourages them to spread it to as many people as possible. He may even suggest a few forwarding scenarios (friends, family back home… jokes, pranks, etc.).

So it clearly showed that the users were biased towards considering the whole system a job ad browser. We hypothesized that if the users consider Polly a serious system (as opposed to entertainment) they are not likely to use it very often. This biased behavior may be a product of the facts that these were all active users of BJ system, looking for jobs and that they received the seed messages from the familiar Babajob's phone number.

Later we learnt that many professional job-brokers also frequently use Babajob's services; so many of our seeds (active users of Babajob's services) might have been job brokers. Hitherto they had to pay for these services; however, they could access the ads for free through Polly. So they naturally showed a tendency to listen to all available ads and refrain from spreading the system.

What we wanted was to seed the system with users who do not know about Babajob. However, doing such a seeding proved quite a challenge for us as none of our team members were on ground in Bangalore.

Manual seeding through Babajob.com
A second round of seeding was done through some staff members of Babajob.com. They volunteered to pass the Polly number on to 5 of their friends and family members. Sadly, it generated very little call traffic and the seeds did not call in more than once or twice each.

Aug 29-31, 2013: Cold Calling Old Users who experienced Major System Bugs: Due to a bug the main menu of Polly remained silent between July 30 and Aug 26 hence giving a bad experience to the users. Between Aug 29 and 31 all such users were called back after fixing the bugs. In all cases, a message was played to the users briefly explaining what is Polly (in English to some and in Urdu to others) followed by the Kannada prompt asking them to say something after the beep. A total of 35 numbers were called. 31 of these calls were answered. It led to 3 CMB calls and 1 forwarding attempt. Most of the recipients did not stay on for long, appeared confused and very few said anything during the recording period. Most of the calls were hung up during the recording interval. It was observed that the voice quality from the user's side was very bad and choppy in several calls. It was also observed that the Chipmunk voice mod does not sound so funny when the voice is recorded in a low voice, or half-heartedly. As a result we changed the arrangement of the voice mods hence forth and moved male-to-female mod to the beginning.

Cold Seeding
As is clear from the Figure 10-1, our initial seeding did not lead to sustained activity. We then tried "cold calling" random numbers in the Hindi speaking areas (avoiding *do-not-disturb* subscribers). These *cold-seeding* attempts were made between Oct 23 and Nov 26 (blue lines in Figure 10-1). Another such attempt was made on Jun 03, 2014. We tracked the activity of all seeds and found that none of these cold-seeding attempts generated any noticeable activity.

Oct 23 – Nov 26, 2013 – Cold-Seeding in the Hindi belt: In an attempt to find suitable seeds via cold calling Polly was seeded several times by calling random numbers in the Hindi belt. Hindi and Urdu, male and female system prompts were tried for this experiment. The numbers were selected to exclude user who had opted for the do-not-disturb registry. All numbers were further filtered to be "non-elegant" (fewer repetitions and not being very "series-like", for details see **Error! Reference source not found.Error! Reference source not found.**) so as to exclude premium and vanity numbers that are mostly used by the well-off and numbers reserved for government offices. All in all 600 were called over seven separate days. Calling day-time was varied between weekends and weekdays, early morning, afternoon, early and late evening. Other variations included male and female, Urdu and Hindi voice

prompts, with and without an explicit brief introduction of Polly at the beginning of each call. Only 181 out of the 600 numbers answered the seeding calls. It led to 39 call-me-back requests by 14 users out of whom only 1 scheduled a message delivery. Therefore, the cold calling experiments failed to generate any significant call traffic. Most of the recipients either ignored the calls or hung up after listening for a few seconds. The few who did continue beyond the initial few seconds mostly refrained from recording anything and pressing buttons and hence could not test out the functionality of the service. Some users called back later once or twice but did not record anything.
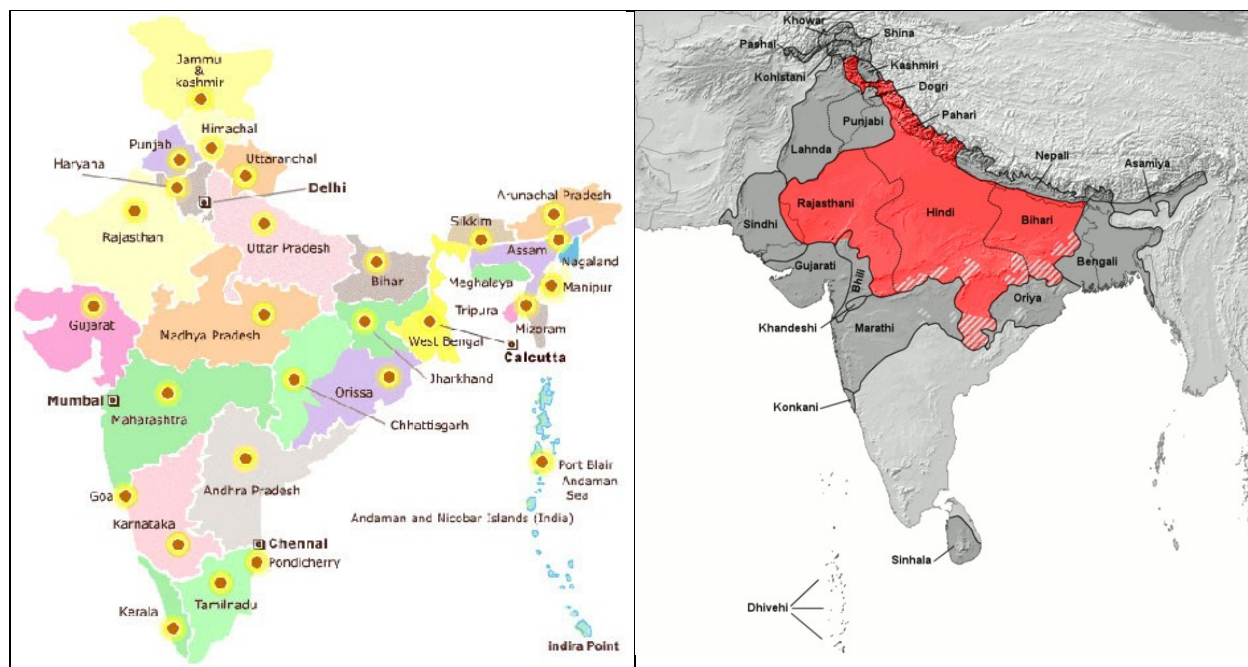
Selected Areas: Bihar, Uttar Pradesh, Madhya Pradesh, Haryana, Rajasthan, Himachal Pradesh, Uttarakhand, Chhattisgarh, Jharkhand, Madhya Pradesh
Corresponding Telecom Circles: BR: Bihar & Jharkhand, DL: Delhi, MP: Madhya Pradesh & Chhattisgarh, UE: Uttar Pradesh(East), UW: Uttar Pradesh(West) & Uttaranchal, HR: Haryana, RJ: Rajasthan, HP: Himachal Pradesh

Figure 10-2: Indian Telecom Circles [3] (left), Hindi Belt [2] (in red, right)

Jun 03, 2014 - Cold-seeding in Punjab Telecom Circle: A small set (100) of randomly generated numbers who were non-subscribers of Do-not-Disturb from Punjab telecom circle were cold seeded in an attempt to observe the response from the area that is geographically and culturally very similar to Lahore. The response was very similar to our previous cold-seeding attempts. Only 33 calls were answered. None of the recipients scheduled any delivery and very few recorded anything. None of them called back later.

Jan 09, 2014 - First Seeding through MSRI: On Jan 09, 2014 we tried a modified form of seeding where undergraduate students were informed of the service and posted about it afterwards on their Facebook pages, blogs etc. This led to the beginning of the viral-non-exponential phase.

Jan 26, 2014 - Second Seeding through MSRI: This was done with low-literate security guards mostly based out of Bangalore. Their education background was around 5-8 years. One seed was given a demo and others were approached by him. Although it was explained to him that it was free and cool app to send free voice messages the primary seed didn't show much interest. He said that other seeds also did it because he asked them to but they didn't show much interest either. Figure 10-3 shows the delivery

graph and user introduction tree among these users. It clearly shows that their activity was strictly contained to a handful of calls and forwarding attempts, most probably to oblige the seeder whom they knew personally.
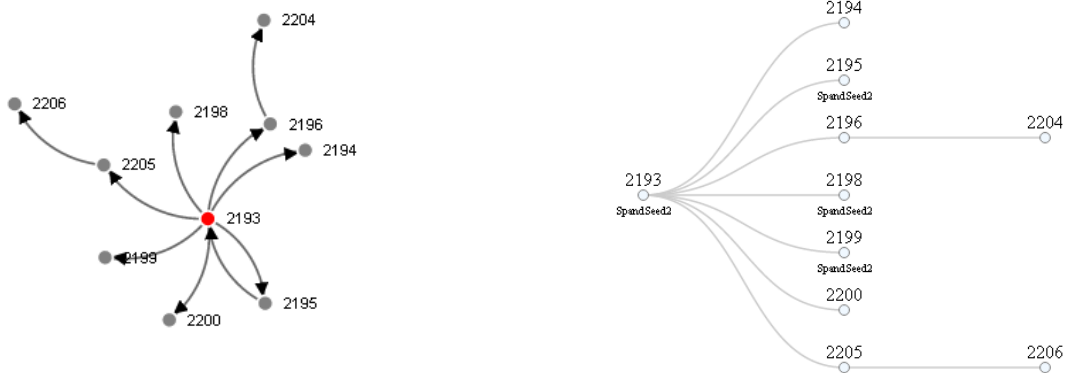
<p align="center">Figure 10-3: Response to Jan 26 Manual Seeding</p>

Major System Updates

Here are some of other major events along the timeline:

- **July 08, 2013:** Polly's outgoing caller ID was changed from the US number to the local BLR phone number.
- **July 30, 2013:** The onset of job-ads' option was delayed to the 6th user-initiated call in an attempt to allow the users to play with and spread Polly before seriously starting to use the Babajob IVR system (that is not viral in nature). Up to this point majority of the users who were calling in were mostly jumping directly to the job ads option and were not forwarding any messages. However, this software upgrade introduced a bug which made Polly's main menu silent. This bug was discovered and fixed on **Aug 26, 2013**. New users who called during this period were called back in bulk to allow them to experience the corrected interface.
- **Sep 17, 2013:** We also learnt that our Kannada prompts are too formal and use an "educated" language making them unsuitable for a low-literate audience. As we did not have Kannada speaking researchers in our team we decided to focus our efforts on the Hindi speaking areas in India where we can easily use Hindi prompts (well understood by myself). We got the prompts translated with the help of Rita Singh and Bhiksha Raj (Professors in Language Technologies Institute at CMU) and recorded them in Rita's voice. The language of system prompts was changed from Kannada (female voice) to Hindi (female voice).
- **Sep 18, 2013:** The voice directory option was enabled.
- **Dec 19, 2013:** Polly was updated to ignore multiple call-me-back requests from the same phone number to be ignored if previous requests are still to be tried.
- **12 Jan, 2014:** Voice mod order was changed to be the same as was in Lahore. Intentional call-back delay (following CMB requests) was reduced from 45 seconds to 15 seconds.
- **14 Jan, 2014**: Polly remained down for eight hours due to a power failure.
- **16-17 Jan, 2014:** Added confirmation of message forwarding following each scheduled delivery. We updated the scheduler to silently ignore multiple message delivery requests to the same recipient with the same voice mod in the same call. The activity peak around this time was mostly because a

single excited user started placing many calls in which he just scheduled numerous deliveries of the same message with the same voice mod to the same set of friends.

- **April 9, 2014:** Decreased the retry intervals of all call types in case the recipient does not answer.
- **April 27, 2014:** Onset of Jobs option was made available from age 0 again.
- **May 19, 2014:** In response to user feedback, introduced an explicit option in the menu to send message in unmodified voice by pressing 4. However, this option was never advertised up front to the users.
- **Jun 13, 2014:** In response to user feedback, increased recording interval to 25 sec from 10 sec.
- **Jun 20, 2014:** Graceful Shutdown. Every caller is called back only once to inform about the shut down and is allowed to record one last feedback message.

Interface Changes to Induce Spread

In addition to seeding attempts we also experimented with modifying several interface features: language and gender of the system prompts; cold seeding at varying times-of-day and days-of-week; cold-seeding with and without initial introduction of the service; an audio speed-dial feature; adding the job service only *after* a user gains some experience with Polly; changing the order of voice modifications; servicing the call-back requests more quickly. Some of these attempts resulted in minor fluctuations of call and user traffic but none led to sustained activity or spread.

Finally, in response to user suggestions gathered through survey calls and automated feedback feature in Polly, we made two further interface changes:

1. On May 19, 2014 we added a new option in Polly's menu that explicitly offered forwarding a message in an unmodified voice. This option was always implicitly available to the users via cycling to the fifth option among the voice modifications but Polly's menu or instructions did not announce it. It is also of note that we did not advertise this new menu option upfront and it took most of the users several days to discover it and start using it. Call traffic starting growing soon afterwards.

2. On Jun 13, 2014 we increased the recording duration from 10 seconds to 25 seconds and Polly's call and user volume abruptly started growing exponentially that very day. On June 19 we terminated the service after exhausting our telecommunication budget.

Comparison with Phases from Polly-Pakistan

In what follows we compare the three phases of Polly in India with the following phases of Polly's Pakistan deployment (see [64] for figures and details): *PK-Exp* is the first exponential growth phase in Pakistan that started from the initial seeding on May 09, 2012 and continued till May 15, 2012. *PK-Exp2* is the second growth phase in Pakistan that started on Jun 27, 2012 with the fixing of a telecom bug (that reduced capacity) and continued till July 11, 2012. The viral-non-exponential phase *PK-Viral* is defined as May 16, 2012 to Jun 26, 2012 [64]. We also define a *steady-state* phase from Pakistan that represents a six month period when we stopped subsidizing message deliveries and imposed a quota of one subsidized call per day for each user (publication pending).

Virality and Exponential Spread

Polly spreads mostly through forwarded voice messages that accounted for 72% of its new (*Polly-Introduced*) users in India. Another 6% were introduced through our seeding attempts. The remaining 22% were introduced by *word of mouth*, that is, informed about Polly by friends or family face-to-face or through a regular phone call or text message. Sometimes the introduction was also accompanied by a demo. We assigned 8% of these users to their putative introducers by tracing their message passing

activity. If a *Word-of-Mouth* (WoM) *introduced* user *Y* sends or receives a Polly message from a user *X* who started using Polly before *Y*; we assign *X* as the word-of-mouth introducer of *Y*.

Viral spread is characterized by long, sustained chains of transmission to new users. The **Basic Reproductive Rate** of spread, R_0, is defined as the expected number of new users introduced by a current user over its lifetime, in a fully susceptible population. Exponential spread occurs when $R_0 > 1$ while activity dies out quickly if $R_0 < 1$. We estimate R_0 for a given cohort of users by summing up introductions over a user's first 7 days of activity. This establishes a lower bound on R_0 because: (1) a small subset of Polly's users continues to introduce new users for several weeks and beyond; and (2) there remains a large group of unassigned, and therefore unaccounted for, Word-of-Mouth users.

Figure 10-4 shows R_0 estimates and chain lengths of new user introductions during the various phases. Only *PK-Exp* and *India-Exp* qualify as truly exponential as $R_0 > 1$. *PK-Exp-2* appears exponential based on call and user traffic but is more close to the viral-non-exponential phases because it was induced by an increase in traffic due to increased capacity and not because of true growth. All but the *India-Sputtering* phase are characterized by long chains of transmission and are clearly viral.

Period	6mo & 6d	5 mo & 4d	7 days	7 days	15 days	1mo&11 d	17 days
R0	0.2	0.7	1.2	1.3	0.8	0.7	0.7
Avg Chain	0.9	9.3	5	8.1	3	3.7	2.5
Max Chain	7	26	15	21	19	23	19
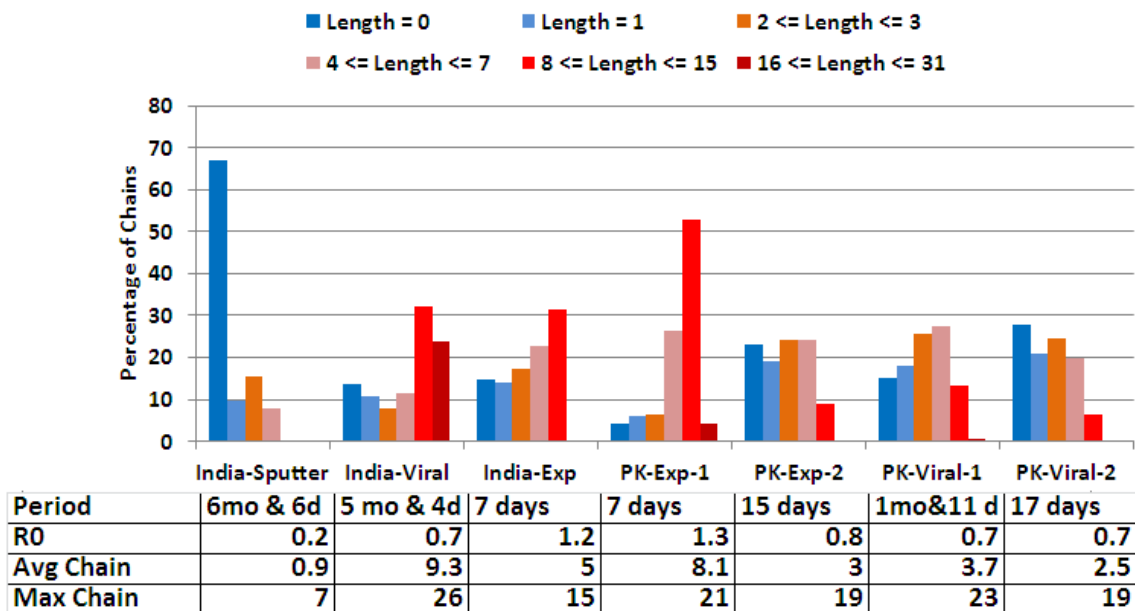
Figure 10-4: R₀ and Chain Lengths

User Retention and Fecundity

Figure 10-5 compares user retention across phases, based on users who initiate call-back requests to Polly. During *India-Exp* and *PK-Exp* phases a large number of users kept returning to Polly. Nearly half of the users called back on their second day, more than 30% on their third day and this trend continued for several days. All viral-non-exponential phases are also similar and are characterized by lesser retention as compared to exponential phases. Sputtering phase exhibits very little retention. All but the sputtering phase have a non-negligible fraction of long-term users (not shown).
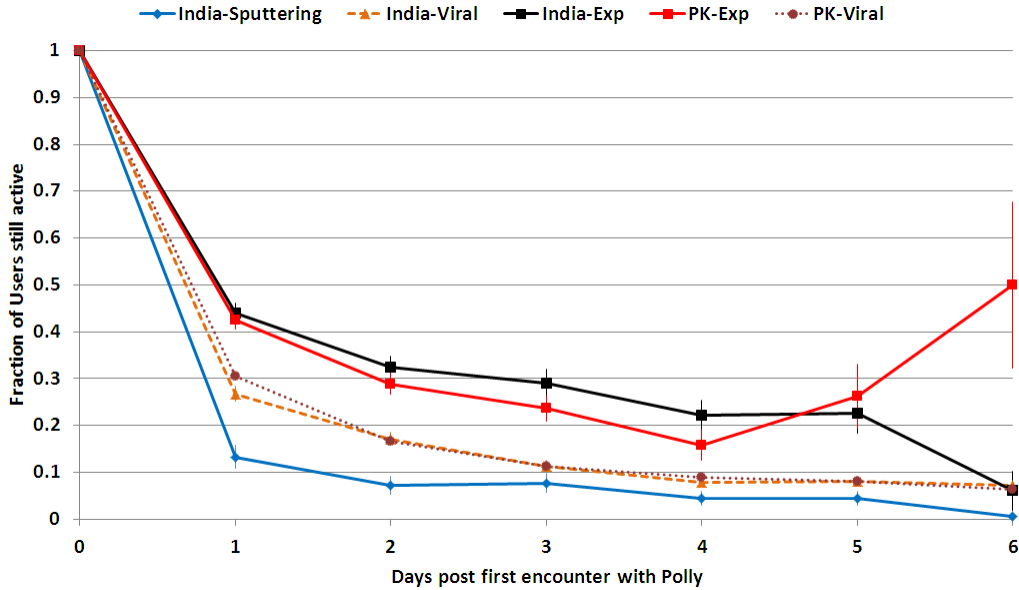
Figure 10-5: User Retention

Figure 10-6 shows *user fecundity* - the tendency of a user to introduce new users, as a function of days post first encounter with Polly. The cohort of potentially fecund users is composed of all users who take part in at least one successful call with Polly. We see that even on their first day, only 18%-20% of users spread Polly to new people during the exponential phases, and around 16% do so during the viral-non-exponential phases. These fractions drop quickly as the users 'age', but a small fraction of users continues bringing in new users several days after their first use of Polly. During the sputtering phase, only around 6% of users introduce new users on their first day, but even this phase has a small fraction of long-term fecund users.
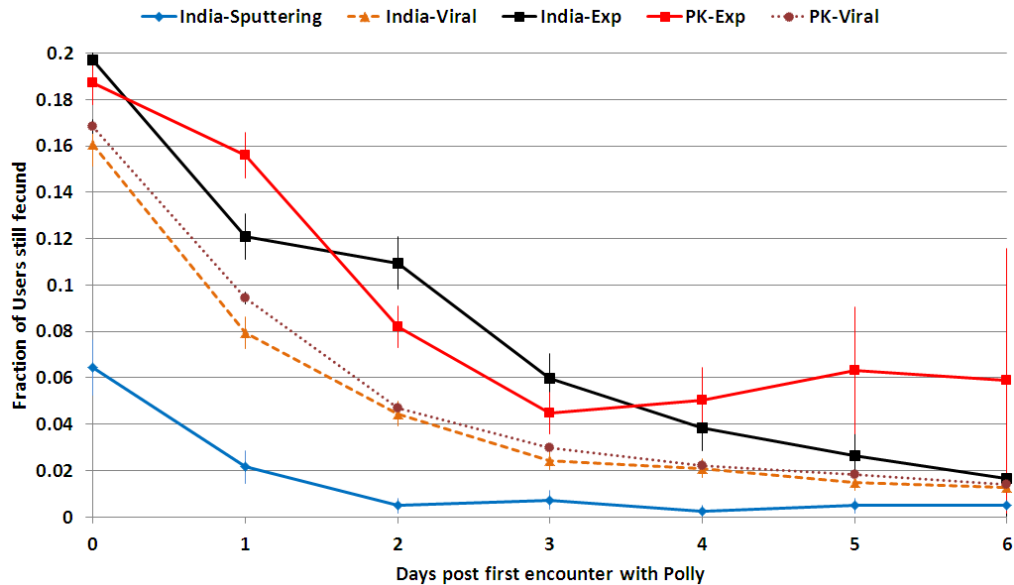
Figure 10-6: User Fecundity

Choice of Voice Modifications

Figure 10-7 shows the percentage of voice modifications chosen by users in their forwarded messages in the various phases. Here we have further divided the viral phase into two sub-phases: *Viral before unmodified voice menu option* and *Viral after unmodified voice menu option.* The first option (*male-to-female)* is very dominant across all systems and phases, presumably because (1) it is the first option; (2) it is funny; (3) some users do not know that other modifications exist; (4) it is clear enough to be used for serious message passing; or (5) frequent users prefer not to cycle through even for serious messages. There is significant increase in the use of the unmodified voice for message delivery after the explicit option to do so was introduced. In the exponential phase the percentage of such messages increases threefold, indicating a clear user preference.
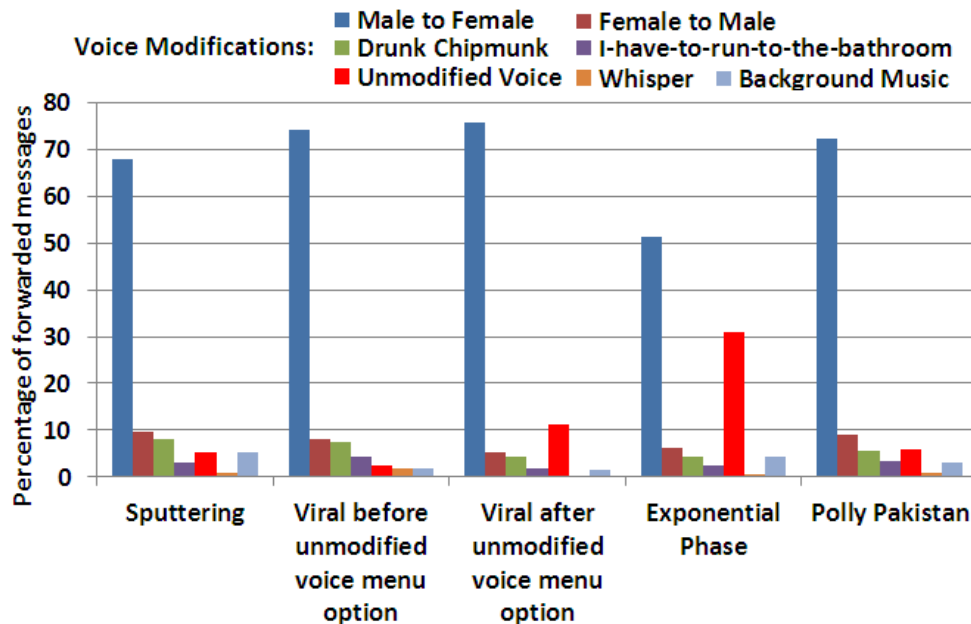
Figure 10-7: Choice of Voice Modifications

Choice of Menu Options

Figure 10-8 shows the prevalence of main menu selections during the various phases. The *transfer to job service* option is used a lot during the sputtering phase but not afterwards. One reason is that our jobs service only has a listing of jobs from Bangalore and after the sputtering phase Polly spread out to other areas of India. As a result, users did not remain as interested in this option. Another reason we discovered is that our initial seeding in Bangalore brought in some *job-brokers* who used to call in just to browse job ads, and presumably sell this information to others.

In the viral phases users showed much interest in forwarding messages and much less interest in exploring the voice modifications. With the introduction of explicit option to send unmodified messages users not only started using this option but also started cycling through the mods to hunt for the unmodified voice (as is evident from Figure 10-8). It is as if they got a hint from this menu option that it is possible to send unmodified messages using Polly. The use of rerecord key is reduced to half during the exponential phase as the recording interval was increased from 10 to 25 seconds and users no longer needed several attempts to fit their message in the recording interval.
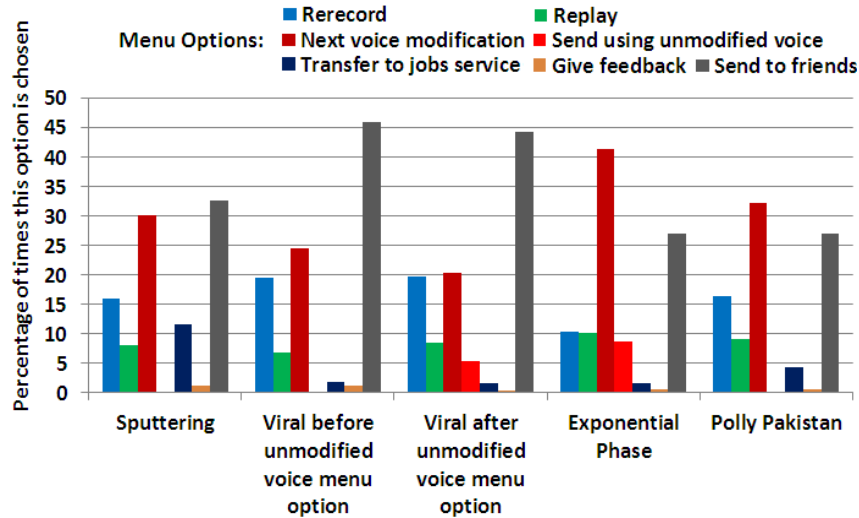
Figure 10-8: Choice of Menu Options

Distribution of Users by Experience

Figure 10-9 shows representative samples of distribution of users by their *Polly-Age* from each of the described phases. Here Polly-Age is defined as *days post first encounter of a user with Polly*. The height of each bar shows the number of users who used Polly on that date while the colors represent their Polly-ages.

During the exponential phases, user-traffic is almost exclusively composed of users who are new to Polly or have very recently started using it. During the viral-non-exponential phase in India we find nearly half of the daily users to be more than a week old with a significant number of 2weeks-, 1month-, and even more than 3month old users. The viral-non-exponential phases in Pakistan are not very Different, though there we find around 30% of the users to be more than a week old.
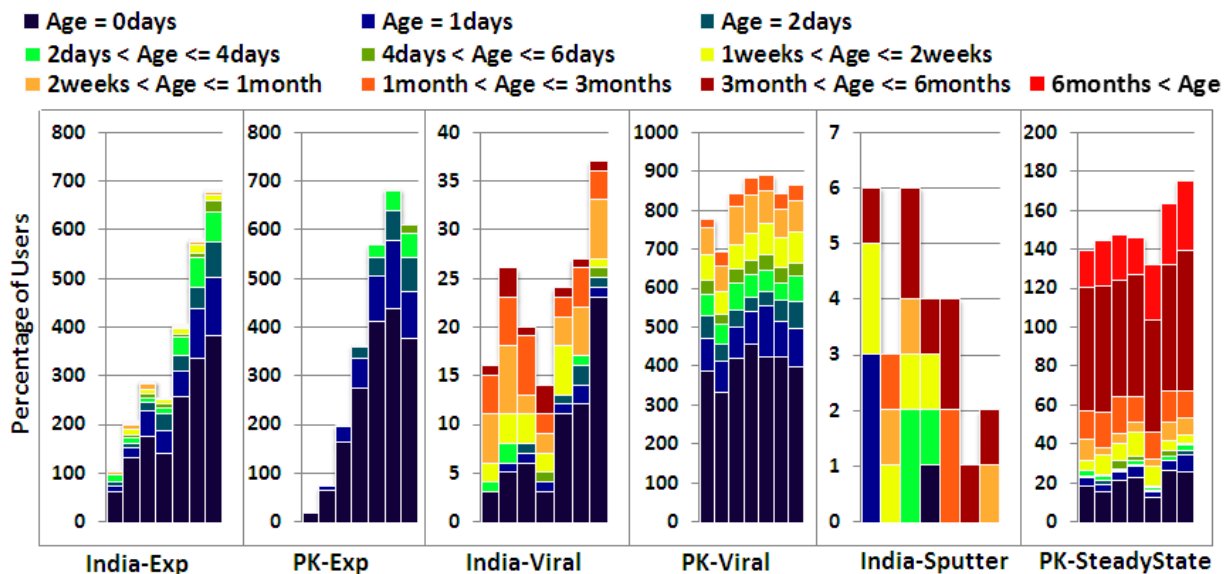
Figure 10-9: Distribution of Users by Polly Age (Days post first encounter with Polly)

The most interesting phases are India-sputter and PK-Steady State, where user traffic is dominated by long-term users. In India-sputtering phase, the few users who called back every day are mostly very old

94

users. In PK-Steady State more than 70% of the daily traffic comprised of users who were introduced more than a week before, nearly 50% were more than 3 months old, and around 10% of daily users were more than 6 months old! Thus, during these phases of low-activity, the service is kept alive mostly by very long-term, loyal users.
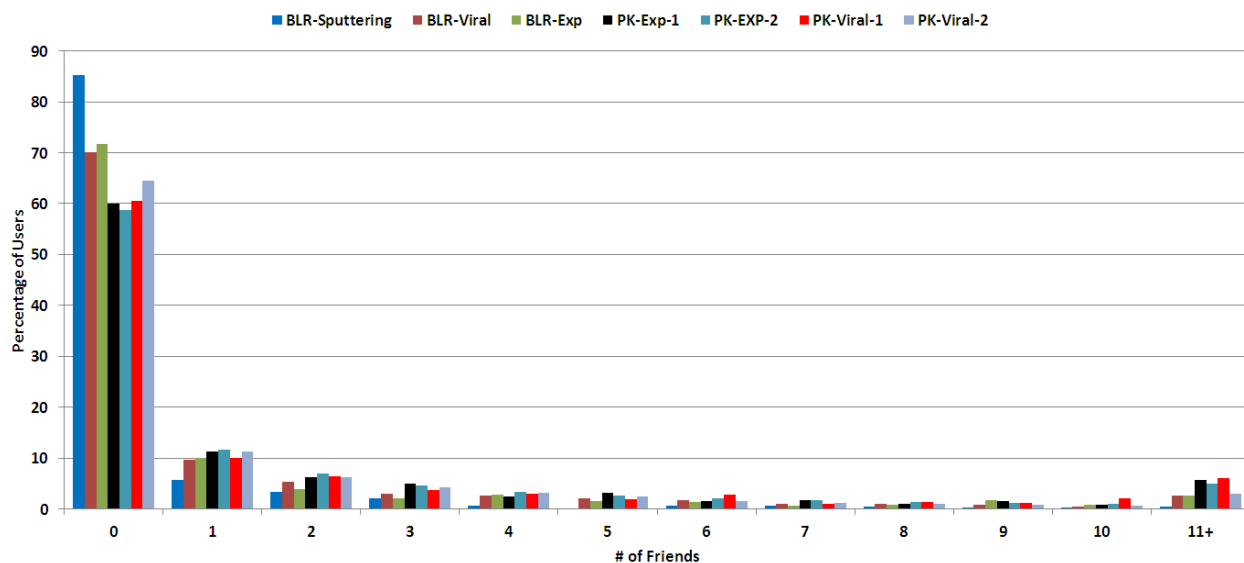
Figure 10-10: Message Passing Branch-out Distribution

Message-passing Brach-out Distribution

Figure 10-10 shows that the viral and exponential phases have a lower fraction of "non-spreaders" (as opposed to only having a handful of "super-spreaders"). In addition to that the two exponential phases are clearly much higher in terms of super-spreaders (11+) too (close to 5%). For all viral periods the fractions of users who forwarded to 2-9 friends are very similar to each other. Apparently the two major differences (in terms of branch-outs) between a viral non-exponential Polly and a viral-exponential Polly are the fractions of non-spreaders and super-spreaders.

The non-spreaders could be the people who:

a.   just called once and didn't like/couldn't use the system;
b.   called more than once, liked to play with the system, but never sent any messages.

We found in the survey calls to terminals that several did not continue the use because they could not understand any Hindi.

User Surveys

During the *viral* phase, we did two rounds of surveys, manually calling up several users of Polly to gather feedback and to find out the reasons for lack of exponential spread.

We conducted the first survey three months after the Jan 09 seeding (which was done through undergraduate students over Facebook, blogs etc.). We called 20 of our most active users, reaching 16 of them. To our surprise, all of them were young men (6), associated with skilled labor (10), low-SES (10), mostly low-literate (7) and living in Delhi (7), West Bengal (3), Mumbai (1) and Jaipur (1). None of the students who seeded the system were from any of these cities. Their professions were: carpenter (1) , marble polisher (1), tinsmith (1), goldsmith (1), tailor (1), embroider (3), diamond-assorter (1), self-

95

employed (1) and one unemployed person. Most of them had heard about Polly from friends (from other cities in two cases). They used Polly for free voice messaging (5) and fun (7) (without using voice modifications). They were cost conscious as some kept confirming if Polly is indeed free. Interestingly, 9 out of 20 interviewees initially denied ever using the service, claiming that their friend/brother/someone else might have used it. Following this "disclaimer", they nevertheless showed intimate familiarity with Polly and its various uses. The formal denial suggested to us a fear of being asked to pay for the service.

Most common suggestions included: Not to morph the voice as the modified voice is unclear, difficult to recognize and it confuses users into thinking that the service is not working properly; to increase the message recording interval and to make Polly available in local languages especially Bangla.

We conducted another set of 250 survey calls in mid-May 2014. Only 71 calls were answered as we tried calling several user types (super-spreaders, spreaders, non-spreaders etc.) including several who had not shown any interest in using Polly. We found that the best time to get a response from users in on weekend evenings and nights.

Category	# Responses	Outcome
Literacy	28	12+ Years: 16 Under 10 Years: 10 None: 2
Age	35	Under 20: 5 20-30: 26 30+: 3 80: 1
Locations	12	Delhi: 7, Calcutta: 2, West Bengal: 1, Mumbai: 1, Jaipur: 1
What do you use it for?	31	Messages: 23 Messages. Fun. Jobs: 6 Messages and Jobs: 3

Table 10-1: User Demographics of Survey Calls

A major reason for the lack of interest cited by non-spreaders is the language barrier. Polly currently supports Hindi prompts while the majority of our users come from West Bengal and Calcutta and understand little to no Hindi. More motivated users get instructions from Hindi speaking friends and then operate Polly accordingly.

Users complained about call audio quality (22%); requested the ability to send unmodified messages (55%); increased recording interval and better message sending abilities (32%); improved job ads service (32%) and availability of Polly in Bangla (19%). Almost all users were using Polly only to send and receive voice messages. Very few reported using Polly to access jobs, and around 40% had no idea that the job service even exists.

Table 10-1 summarizes the demographics of surveyed users. Among the contacted users we also encountered several school/college students and three blind men. Most of the blind men belonged to a blind institute in Calcutta and were all prolific users. They claimed that a lot of their blind friends are also using Polly. Some very long term users reported having used Polly for several months.

User Feedback

Table 10-2 summarizes automated user feedback collected through Polly. Users who provided the feedback were mostly Bangla-speaking men who could also speak some Hindi. Even the recordings marked as Hindi often contain several Bangla words.

Of the 1,029 recorded feedback files:
- 773 were empty, noise, messages by confused users.
Feedback and Suggestions

There were 256 files with real feedback.
Of those:
- 174 simply contained praise for Polly and its features
- 82 contained suggestions and requests. Of those (the following are not mutually exclusive):
  • Audio quality is bad: 21%
  • Key-presses are not recognized correctly sometimes: 10%
  • Allow sending unmodified voice messages: 22%
  • Increase message recording interval: 18%
  • Make Polly available in Bangla: 16%
  • Demanded/Suggested new voice modifications: 9%
  • Job service related feedback: 6%
  • Demanded other features, mostly making Polly more suitable for voice messaging: 21%

Gender

Of 419 recordings successfully annotated for gender:
  • Female: 13%
  • Male: 87%

Language

Of 376 recordings annotated for Language:
  • Bengali: 38%
  • Hindi: 47%
  • English: 7%
  • Mixture of Hindi, Bengali, English: 8%

Table 10-2: User Feedback

Most users like Polly a lot. Several low-SES blind users said that it was a much needed service for them as they cannot use regular SMS. They use it to stay connected with their friends. Bad audio quality has been the most common complaint. When testing Polly from India we observed that indeed, in contrast with the main deployment in Pakistan, audio quality is often poor which critically degrades the entertainment effect. The reasons are not clear to us, but we suspect the international call (over IP), bad signal reception, and a noisy environment. Some users also reported problems with key press (DTMF) recognition, a problem mentioned anecdotally by other researchers working with IVR in India.

The improvements suggested by users all attempt to tweak Polly into a better voice messaging service (several users even referred to it as "voice sms"). Among the most popular suggestions were increasing the recording interval; allowing unmodified messages; making unmodified voice the default option; providing a way for users to directly talk to their friends through Polly (like a conference call) etc. Bangla speakers complained that they do not understand Hindi; the service does not talk like "one of them" and most people around them cannot use Polly because of the language barrier. Some users complained that the job ads are not suitable for their location; are not available in Bangla and are not updated frequently enough.

Summary and Discussion

Why didn't Polly take-off immediately in India as it did in Pakistan?

Below are some of our hypothesized explanations.

Ineffective Seeding Attempts, i.e. not reaching the appropriate 'seeds' (people to initiate viral transmission).

Our initial seeds of July 03 were active users of the jobs service – a service for which they used to pay before finding out they can access it for free through Polly. Many of them called periodically and only listened to job ads. We suspect they were job brokers, who therefore hardly ever attempted to explore the voice modifications or to spread Polly to friends.

We believe several factors to be responsible for the failure of our *cold-seeding* attempts. Indian cellphone users are faced with a large number of daily spam calls and text messages. Frauds perpetrated through mobile services have also deteriorated users' trust. This explains the lack of interest and mistrust exhibited by the recipients of Polly's *cold-calls* – automated calls from an unknown phone number.

Deployment in Pakistan employed high-intensive seeding tactics: exciting demos were given to a handful of seeds by 'seeders', who were members of the research team; Polly was introduced as a fun, free service, and the seeders remained available for a few days to help the seeds with their questions and technical difficulties. In addition, the seeds felt obliged to spread the service to their friends out of their respect and relationship with the seeders, whom they personally knew and trusted. Regretfully, we were not able to use these tactics in India, and had to rely on less intensive, less personal introductions.

Inappropriate voice prompts: Polly's voice prompts were not suitable for the majority of its potential users.

In India, Polly was initially seeded in Bangalore, Karnataka where Kannada is the official state language. However, Bangalore is a metropolitan city with people from diverse linguistic backgrounds and Kannada is only appropriate for a modest subset of them. Additionally, we later found through user feedback that our Kannada system prompts were too formal-sounding and literary, and were therefore unsuitable for low-literate Kannada speakers. Our choice of language also prevented Polly's spread beyond the state of Karnataka until we changed it to Hindi.

Why didn't the traffic fizzle despite lack of virality and (exponential) growth?

During the *sputtering* phase, Polly was occasionally called by users of the job service (presumably professional job brokers) who wanted free access to the job ads. A handful of interested users were responsible for generating the rest of the fluctuating call traffic.

During the *viral-non-exponential* phase, activity was mostly due to long-term users (as shown in Figure 10-9) who had discovered some utility in the service, most likely free voice messaging. Surprisingly, a fraction of such utility-oriented users kept introducing new users for many months post their first introduction to Polly.

Why did Polly eventually attain exponentially spread?

Because we modified it to match users' needs.

Contrary to our expectations, Polly users in India were not as interested in the entertainment aspect of Polly (voice modifications) as were their Pakistani counterparts. This could have been the result of the poor call audio quality in India. Or it might have been due to some intrinsic difference between the people reached by Polly in the two countries. Clearly, Polly's users in India wanted a good voice messaging platform. User feedback kept reflecting that demand and as soon as we tweaked Polly accordingly by introducing a way to send unmodified messages and increasing the recording interval, Polly immediately achieved exponential spread.

Our take home message is therefore that exponential spread of speech based information services can be achieved in many countries and cultures, but must be accompanied by careful attention to the unique logistic and cultural aspects of each country, and that early attention to user feedback has a critical role to play in this process.

Lessons Learned

- Voice prompts should be recorded using a close speaking microphone. Telephone based prompt recording does not produce desirable quality as it passes through the noisy channel twice.
- Voice prompts should be translated in a simple to understand, friendly and informal way. If the prompts are too formal or too-educated-sounding then our target audience loses interest.
- Outgoing caller id could be faked by sending the caller id as +Country Code.
- User feedback and surveys should be carefully translated and attended to regularly.
- The silent voice prompt bug suggests that on-ground team members should call the service every few days to ascertain bug-free operation.
- On ground presence and understanding the local culture, norms, language etc. is a must.
- People previously exposed to voice spam and telephone based scams are averse to pressing keys in automated calls.
- Polly can penetrate back to low SES strata even if seeded with literate and high SES people.

11. Alternative Dissemination Models: A Collaboration with JMV

Chapter Abstract

This chapter reports Polly's remote deployment Jharkhand in collaboration with a popular local citizen-radio-over-phone platform, Jharkhand Mobile Vaani (JMV). Polly-Jharkhand was launched based on a "cross-selling" dissemination model where Polly advertised JMV and vice versa. As JMV is a utility-based service which is not inherently viral, our goal was to popularize it through Polly's exponentially growing users once it seeds Polly by advertising to its current user-base. Polly remained active for 54 days in which it received 19,042 calls from 4,428 users. Analysis of traffic reveals viral spread patterns but no exponential growth. Polly was shut down due to high international calling costs and is now being deployed locally in Jharkhand.

System Description

We used the remote deployment model described in Appendix-E. The call-back requests via missed calls are received on a local number in Jharkhand; the phone number is transferred to Polly's code deployed on tropo's cloud over the internet and Polly calls the user back internationally.

Dissemination model

JMV allows its users to browse a shuffled playlist of items (recorded radio programs, ads, user-generated content). Polly's 2.5 minute long promo[1] (including its phone number) was initially put up (on May 02, 2014) in this playlist where it used to be played to a subset of users. Following the promo, users were prompted to press a button to place a call-me-back request to Polly. If users choose this option, then JMV disconnects the call and Polly calls them back within 15-30 seconds depending on the availability of free phone lines. On May 28, 2014 the playlist promo was replaced by a shorter (28 sec) promo[2] that was played to all JMV callers at the beginning of each interaction.

In Polly, an option to get a call back from JMV was added to the main-menu. If users choose this option, then Polly disconnects the call and JMV calls them back soon.

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[1] (A girl's voice): Hey Deepak, have you heard about Mithoo Tota? (A boy replies): Nope. Have you got a new parrot as a pet (sounds of laughter in the back ground). Girl: No! This is actually a free service started by Jhakhand Mobile Vaani. Boy: Okay. So what's so special about this service? Girl: Using that service, whatever you say to Mithoo Tota, it will modify it in a fun way. Listen, here is my message: "Hi Deepak! What's up!" (plays in her original voice). Now listen how Mithoo Tota says it back: "Hi Deepak! What's up!" (plays in drunk-chipmunk voice). Boy: Wow! This is such a cool service. Girl: Not only that, you can even send your modified voice to friends and family. Boy: Wow! But you didn't tell me what do I need to do to access Mithoo Tota. Girl: It is very easy to use Mithoo Tota. There are two ways to do it. The first method is to go from JMV to Mithoo Tota by pressing 9 while this item is playing. As soon as you press 9, your call would be disconnected and Mithoo Tota will immediately call you back. Boy: And the other method…? Girl: The second method is to call Mithoo Tota directly by dialing xxxxyyyyzz. As soon as you dial, your call would be disconnected and you will get a call back. Boy: Could you please repeat the number for me? Girl: Here is Mithoo Tota's number again: xxxxyyyyzz. Hey, hey Deepak! Where are you off to??? Boy: I am off to call Mithoo Tota and to record all sorts of fun messages! Girl: He is gone! Why are you still here? Press 9 now! You will not regret it! That's my personal guarantee! … Hey! You still haven't pressed 9? You have last 3 seconds… Press 9 or you would regret it. I am leaving now. Give a missed call to: xxxxyyyyzz. Thanks!

[2] Now use Mithoo Tota (Polly-the parrot) to modify your voice in fun ways and send it to friends. Press 9 while this item is playing or dial xxxxyyyyzz.
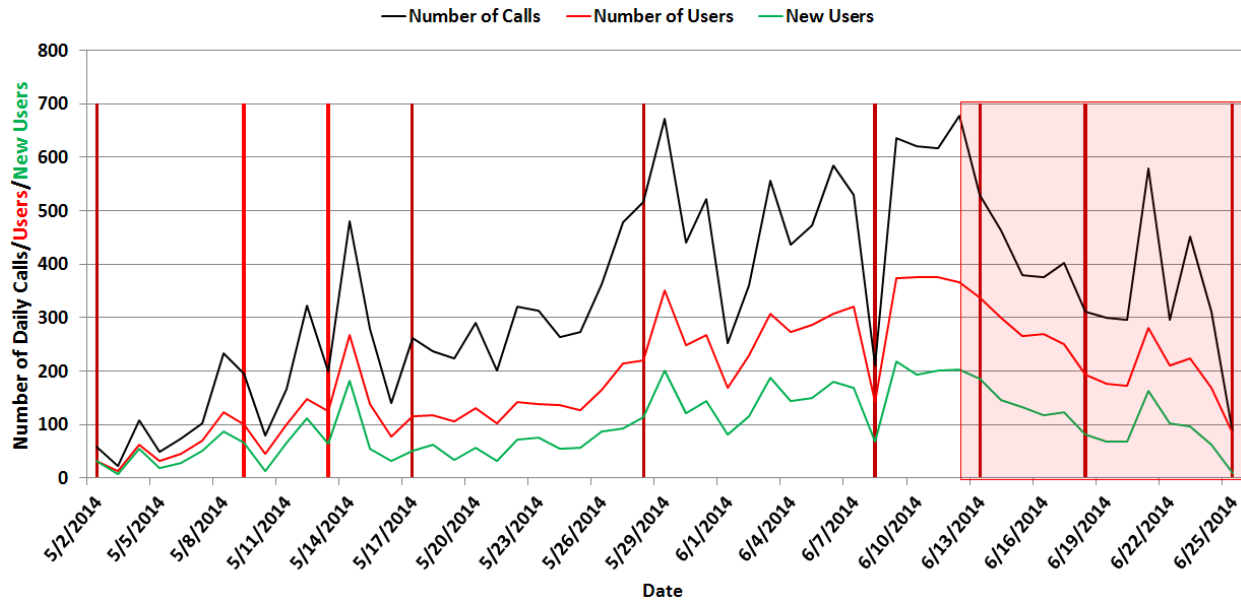
Figure 11-1: Polly's Call and User Volume. Bright Red Vertical Lines are System Failures. Dark Red Lines are Major System Updates. Beyond Jun 12, 2014, the service was only intermittently accessible.

Results and Analysis

Polly Became Self-Sustaining without Taking-off exponentially

As shown in Figure 11-1, Polly was launched on May 02, 2014 by adding the promo to JMV's playlist. As a result this promo was played occasionally to its users. On May 28, 2014 it was replaced by a shorter, always-on promo that was pinned to the start of JMV calls. On Jun 18, 2014, the promo was completely disabled hence stopping all further advertisement and seeding of Polly in Jharkhand. Finally, Polly was shut down on Jun 25, 2014 to analyze the data and prepare for a local deployment in Jharkhand. Polly's suffered a lot of down times in Jharkhand due to system failures (depicted by bright red lines in the figure). Mostly this happened when either the local call-back number was offline or the promo was not accessible in the playlist. In addition, due to some unexpected call load, JMV's system (including the missed call number) remained mostly inaccessible beyond June 12, 2014.

On May 18, 2014, an explicit option to send unmodified-voice messages was added to Polly's main menu. On Jun 13, 2014 the message recording interval was increased from 10 to 25 seconds.

In Figure 11-1 we see an initial increase in the volume which fluctuated a lot. Lengthy, system failures and downtime also contributed to the fluctuation. Polly continued to get a steady stream of users throughout the 54 days that increased after the shorter, always-on promo was introduced. Strong activity continued after the promo was turned off. It is clear that Polly succeeded in becoming self-sustaining in terms of users and calls but it did not take off exponentially.

A small fraction of daily calls were requested through JMV Promo

Figure 11-2 shows the distribution of daily calls by type. Users could request for a call-back from Polly either through JMV by pressing 9 during the promo, or directly by giving a missed-call to Polly's number. Rest of the traffic resulted from the messages scheduled by Polly's users for their friends. It is clear that call-back requests through JMV's promo only accounted from a small fraction of daily calls. Most of the

volume comprised calls requested via missed calls and delivery calls. As a result we do not see any major loss of volume after the promo was disabled on Jun 18.
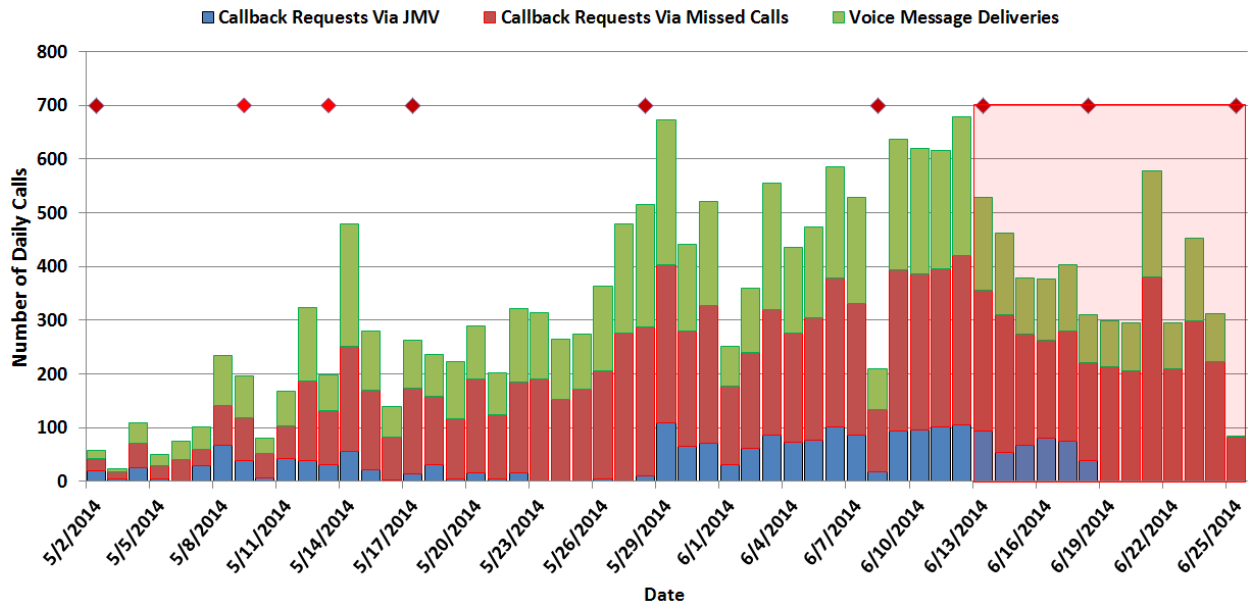
Figure 11-2: Daily Distribution of Calls by Type

A small fraction of Polly's users choose the JMV option

Figure 11-3 shows that around 10%-15% of daily callers of Polly choose the menu option to get a call back from JMV. A handful of users do so in multiple calls.
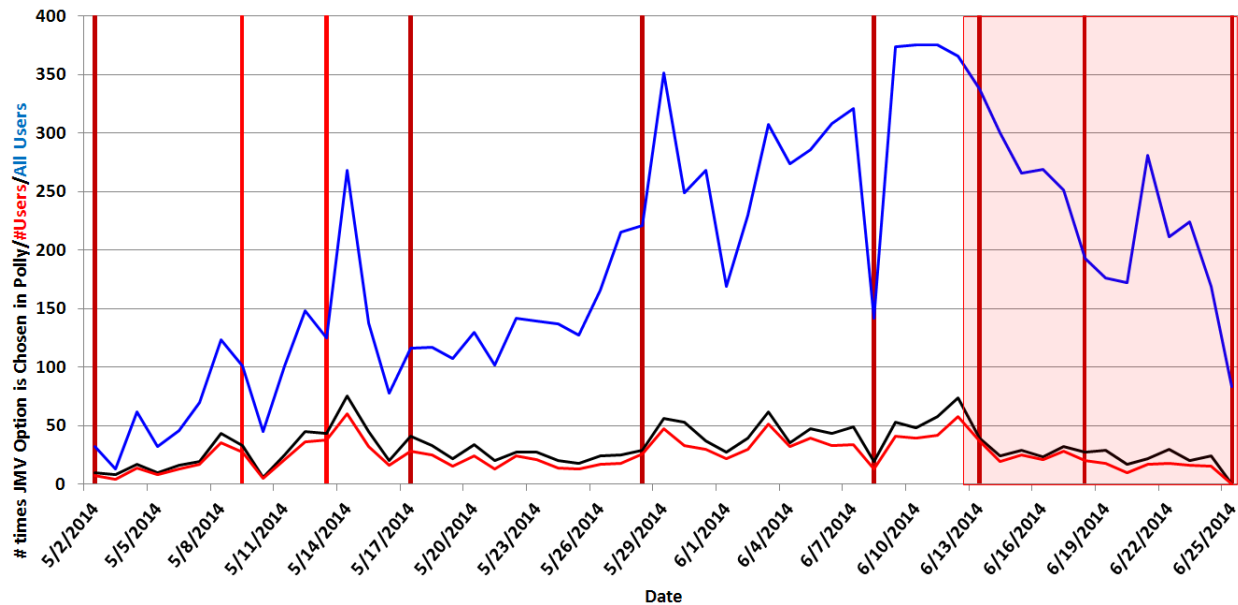
Figure 11-3:
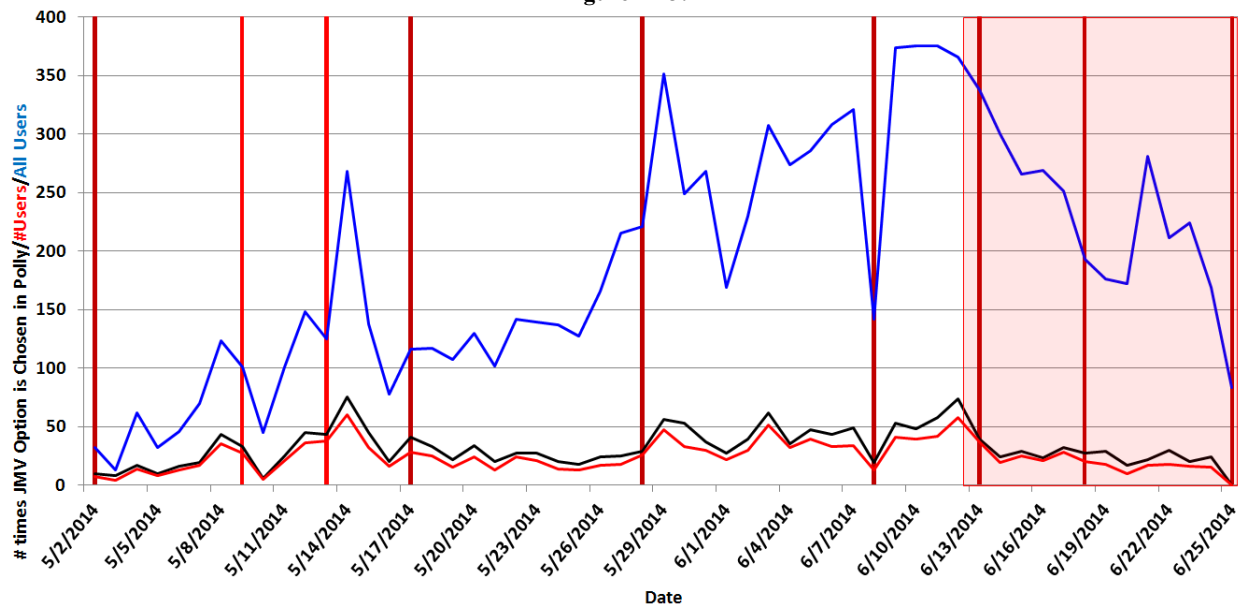
Figure 11-3: Prevalence of JMV option in Polly's menu

Choice of Voice Modifications

Comparing Polly-Jharkhand with data from other versions of Polly, we find it very similar to the "Viral after unmodified option" period in the Bangalore deployment (see Reproducibility: Deployment in a Second Country). Both of these phases are characterized by an increasing user interest in sending unmodified recordings as messages. The first modification is, as usual, used a lot. Users did not show a lot of interest in using other voice modifications in their scheduled messages though the "Drunk Chipmunk" is slightly preferred over "female-to-male" modification.
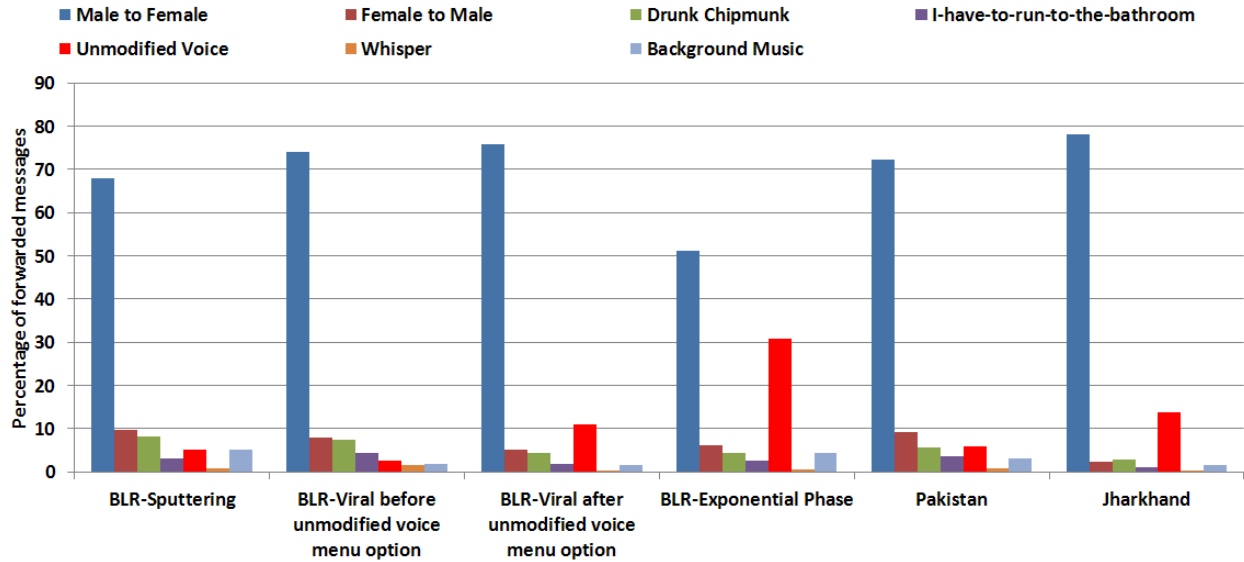
Figure 11-4: Choice of Voice Modifications in Sent Messages
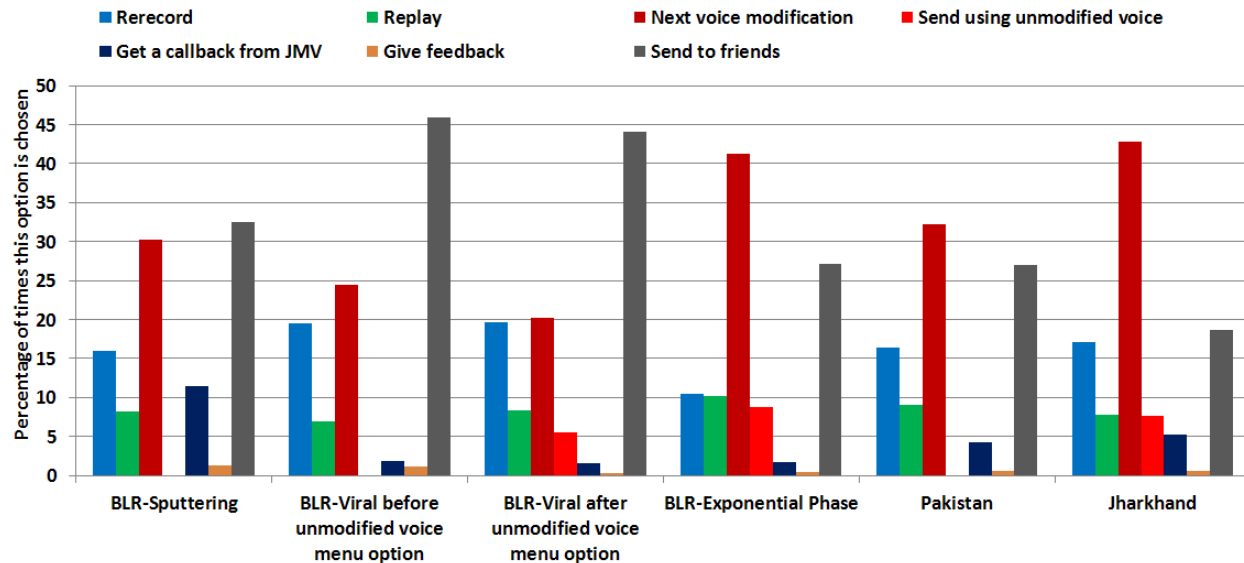
Figure 11-5: Prevalence of Main Menu Choices

Prevalence of Main-Menu Choices

The main-menu choices preferred by users of Polly-Jharkhand reveal very interesting patterns. Users seem a lot more interested in exploring the system, as they use the *Next Effect* option a lot to explore the voice modifications, but they seem less enthusiastic about forwarding messages. This could be the result of the fact that most of them have already been users of JMV, which does not feature a *forward to friends,* option. So they are not used to the concept of peer to peer forwarding. They use of *get a callback from JMV* option is also used a lot. This may suggest that they already knew about the service or were attracted by it because it is advertised as something local to Jharkhand (from where most of the users belonged). The *send unmodified voice* option, although introduced halfway through the 54 days, was still used very often.

104

If we look at the comparison of the phases of Polly-Jharkhand (Figure 11-6), before and after the introduction of explicit menu-option to send unmodified messages, we see an increase in the use of unmodified voice for sending messages. This is very similar to increase we saw in the Bangalore deployment. Looking at the prevalence of main –menu options, we see a higher uptake of this option in Jharkhand than in Bangalore. Interestingly it also corresponded with a decrease in the use of *callback from JMV option*, presumably indicating an increasing interest of users in Polly's own functionality.
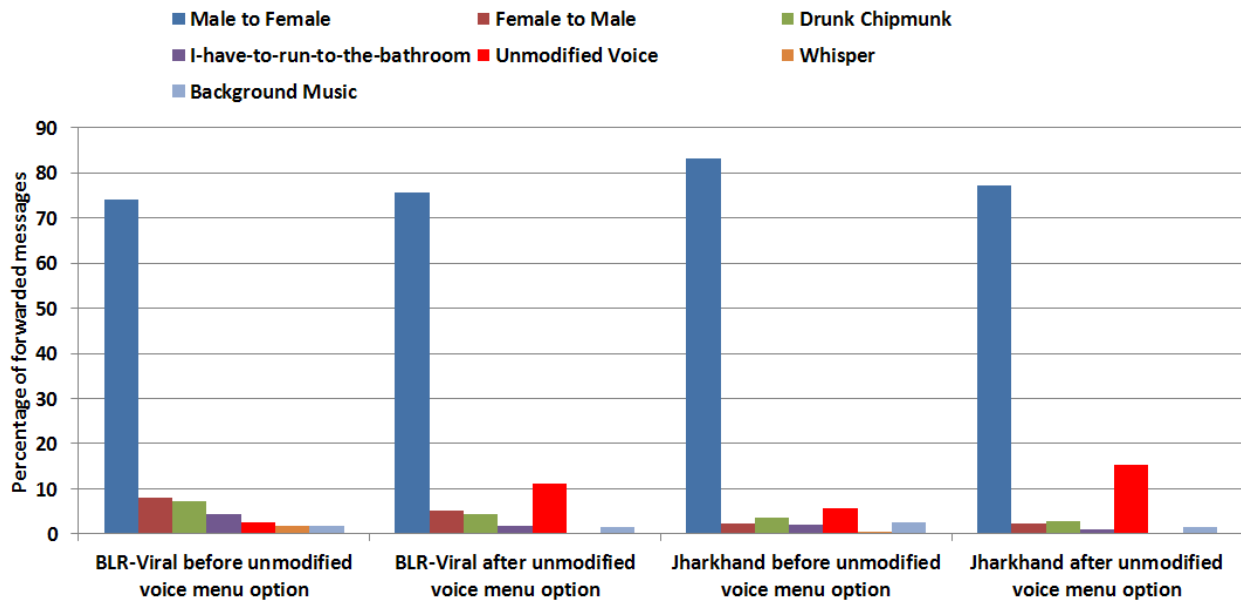
Figure 11-6: Comparing the choice of voice mods before and after the explicit menu option to send unmodified messages
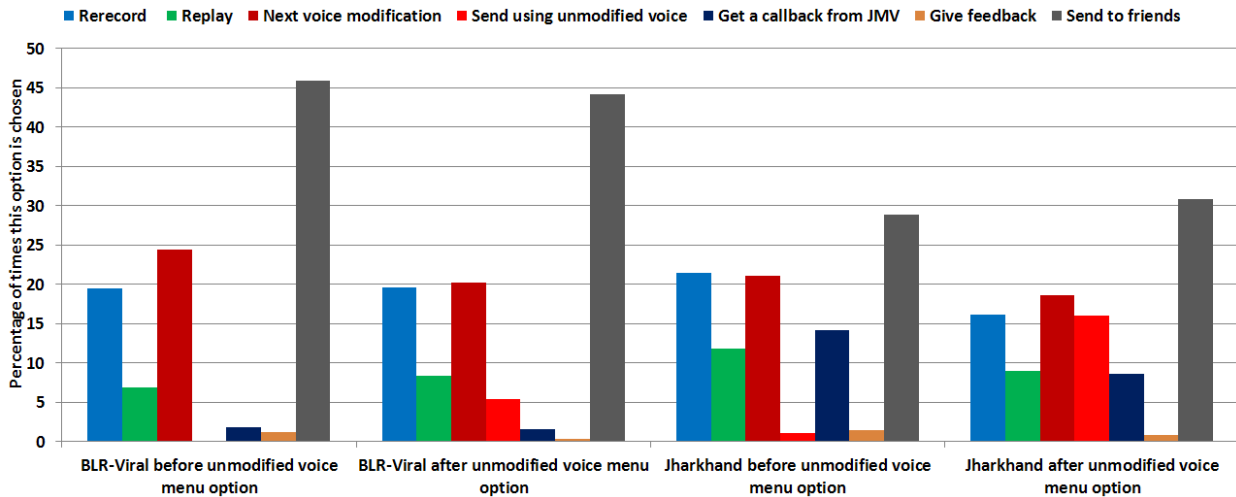
Figure 11-7: Comparing the prevalence of key presses before and after the explicit menu option to send unmodified messages

Spread and Virality

As shown in Figure 11-8 the R_0 calculation for Polly Jharkhand is not reliable as it operated under a very different dissemination model of continuous seeding. While it is true that Polly clearly did not become

exponential in Jharkhand, the calculation is influenced by the large number of new users who get introduced to Polly through JMV and get counted towards the denominator of R_0 but the not the numerator. The chain length distribution shows clear signs of virality where it is comparable with the viral periods in Pakistan.

	India-Sputter	India-Viral	India-Exp	PK-Exp-1	PK-Exp-2	PK-Viral-1	PK-Viral-2	Jharkhand-All
Period	6mo & 6d	5 mo & 4d	7 days	7 days	15 days	1mo&11 d	17 days	1mo&24d
R0	0.2	0.7	1.2	1.3	0.8	0.7	0.7	0.5
Avg Chain	0.9	9.3	5	8.1	3	3.7	2.5	2.9
Max Chain	7	26	15	21	19	23	19	13
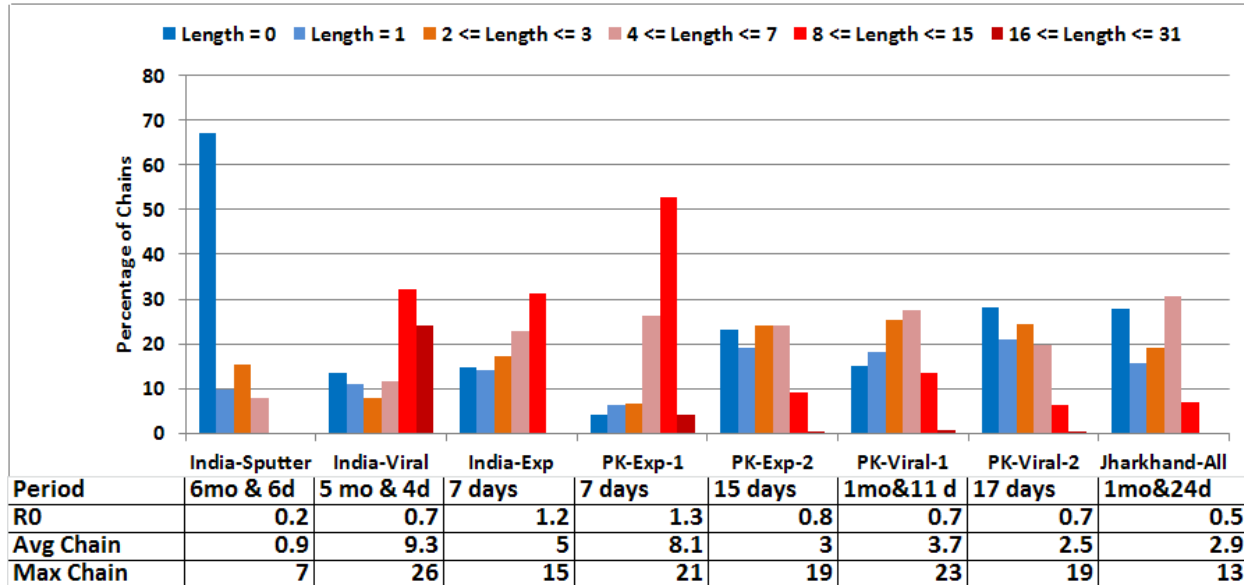
Figure 11-8: Distribution of transmission-to-new-user chain lengths and R_0

User Retention and Fecundity

Figure 11-9 shows that the user retention is all phases of Polly's deployment in Jharkhand remained low. In fact the retention during the "always-on-promo" phase is only slightly higher than the sputtering phase in Bangalore. The retention during the "occasionally-on" phase is greater than the "always-on" phase. During the "no-promo" phase, we the maximum retention which is comparable to the viral phases in Pakistan and India (Bangalore deployment). As expected, several users who give Polly a call out of curiosity after hearing the promo on JMV, do not get very excited about it and do not keep calling back for several days.

Figure 11-10 shows user fecundity (tendency to introduce new users to Polly) as a function of experience using Polly. It is interesting to note that the "no-promo" phase that retains more users than other Jharkhand phases corresponds with the least fecundity. The "occasionally-on" promo has the highest and "always-on-promo" falls in between. A plausible explanation could be the promo itself. During the "occasionally-on" phase, a two and a half minute promo explained the voice modification and forwarding clearly using an example and as a result several users understood how Polly works and what to expect. In the "always-on" phase, the promo was made much shorter (thirty seconds) and did not feature an example. In the "no-promo" phase, Polly was spreading by usual means (forwarding and word-of-mouth) and there was no example, instructions or demo regarding its capabilities.
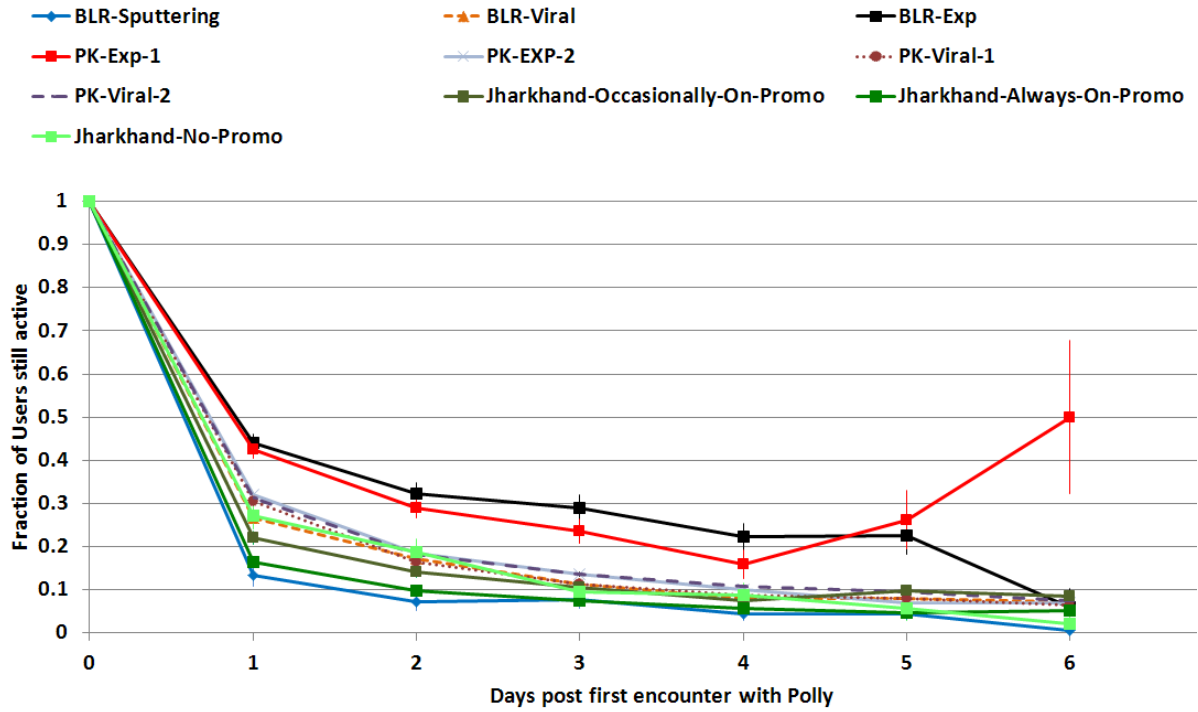
Figure 11-9: User Retention
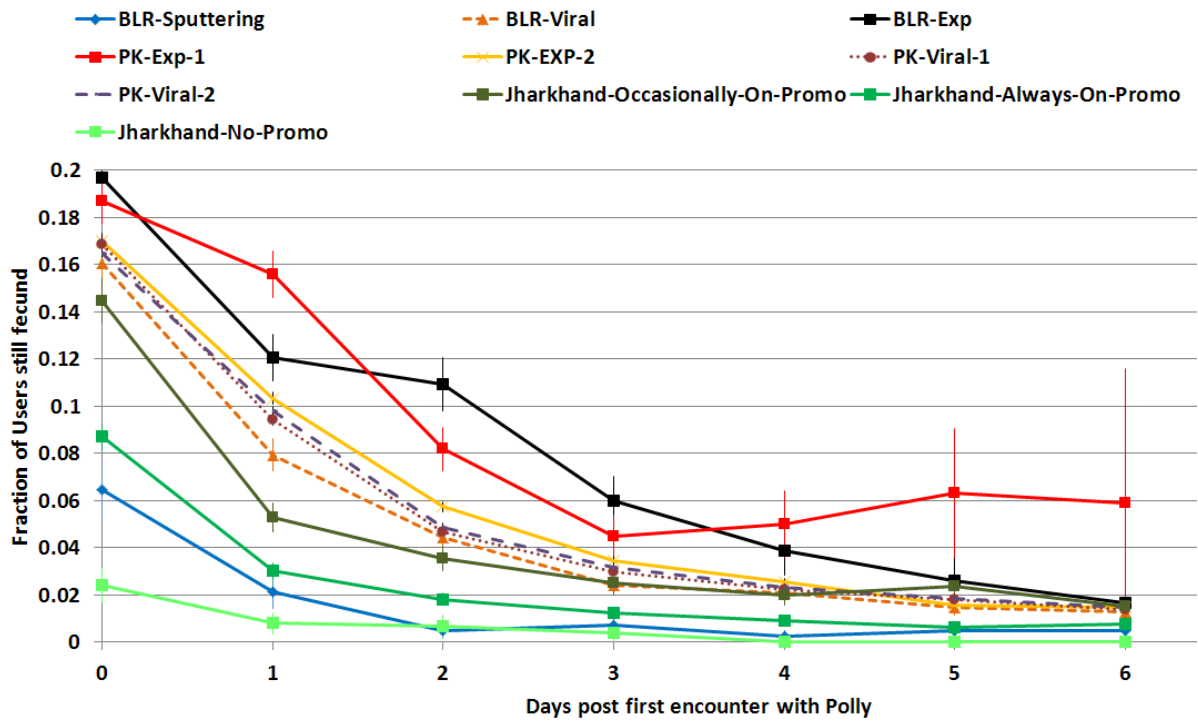
Figure 11-10: User Fecundity

Message-passing branch-out

As shown in Figure 11-11 the user branch-out distribution is lower than other viral phases. This is also influenced by the users who just interacted with Polly out of curiosity and were either not impressed by its functionality or did not understand how to use it. Despite all that we still see that a non-negligible number of users did interact with several friends.
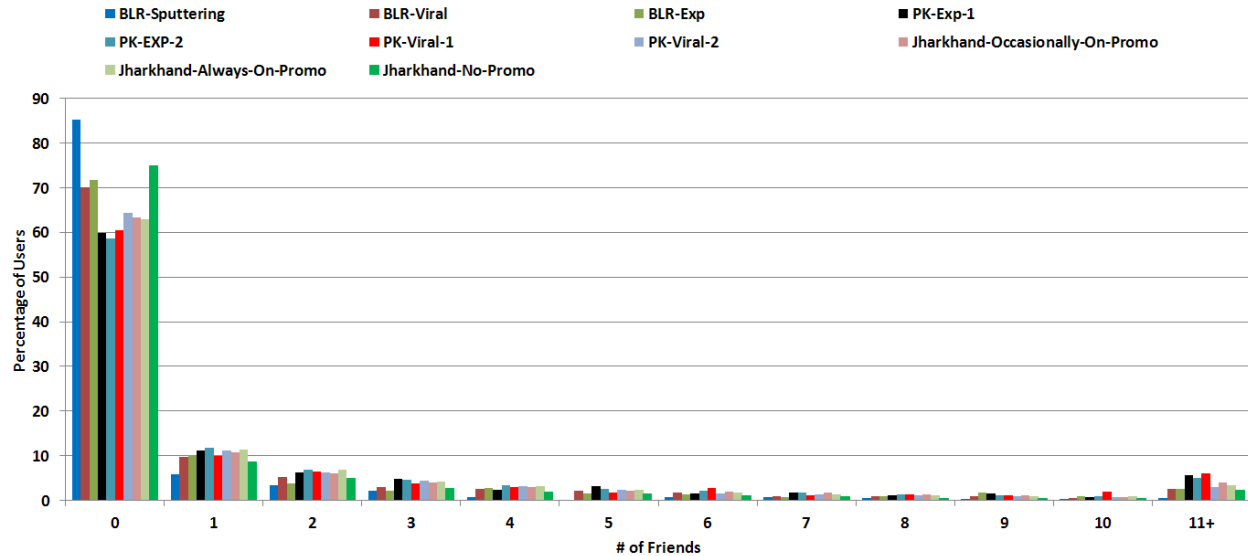
Figure 11-11: Message-passing-branch-out Distribution

Distribution of Users by Polly Age

Figure 11-12 compares the distribution users of Polly-Jharkhand by Polly Age with other versions of Polly. Jharkhand is similar to the viral phases however the number of new users is clearly higher and it accounts for more than half of the daily users. Presumably this is the effect of the dissemination model. We also see old users (more than a month old) calling Polly. As the Jharkhand pilot only lasted 54 days, there could be no users belonging to the categories of Polly age greater than 3 months.
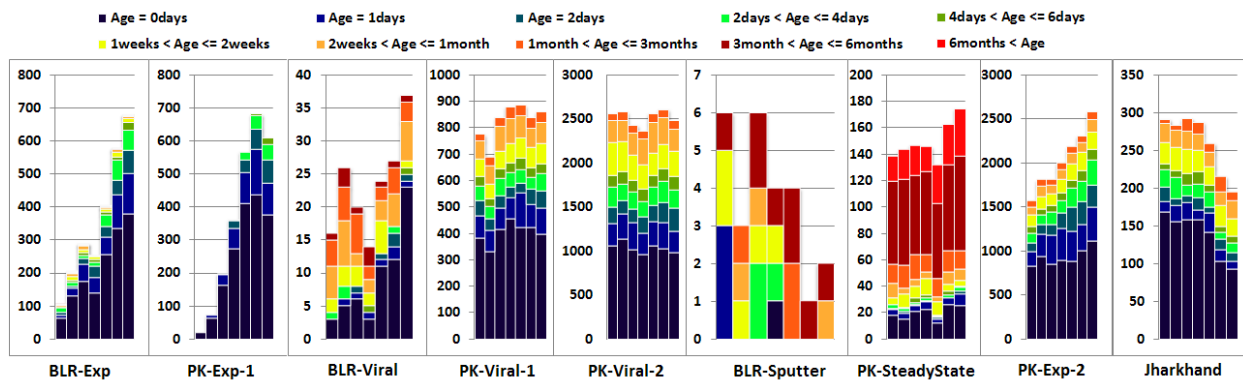
Figure 11-12: Distribution of Users by Polly Age (Days post first encounter with Polly)

Geographical Distribution

Polly was mostly used by people local to Jharkhand, Bihar and Gujrat (Table 4-1). This audience probably corresponds to the users of JMV and it was to be expected that the initial spread of Polly would be among them.

108

Location	Percentage of Users
Bihar & Jharkhand	76.10%
Unknown	8.90%
Gujarat	7.20%
Madhya Pradesh & Chhattisgarh	1.20%
Delhi	1.10%
Andhra Pradesh, Uttar Pradesh (East), West Bengal, Maharashtra, Mumbai, Kolkata, Orissa, Rajasthan, Uttar Pradesh, Tamil Nadu, Kerala, Punjab, Karnataka, Assam, Haryana, North East India, Himachal Pradesh, Chennai, Jammu & Kashmir	4.60%

Table 11-1: Geographical Distribution of Users

Summary and Discussion

Polly's launch in Jharkhand shows that seeding Polly through promos and advertisements has the potential to work. Polly became viral in Jharkhand with a small but non-negligible set of long-term users. The traffic also sustained itself even after the promo on JMV was turned off. During the last few days the missed call number remained down intermittently and we cannot ascertain the potential volume that Polly could have acquired. Users' tendency to introduce new people to Polly in response to different promos shows that the content, mood and tone of the promo play a vital role in influencing user's understanding of the service and its capabilities.

12. Future Plans: Impact and Long-Term Sustainability

1. Spreading Awareness about Ebola in West Africa

The recent outbreak of Ebola in several West African countries threatens to engulf an even larger population if effective measures are not taken to prevent its spread. Ebola spreads primarily through blood and bodily fluids of the infected person. Its rapid spread is largely being attributed to careless local practices that bring people in contact with Ebola patients and the deceased; lack of reliable information being conveyed to the public; corruption and mismanagement on part of the governments and a sheer absence of trust. In this situation an information dissemination service like Polly may prove effective.

We hope to lend a hand in quickly spreading reliable public health messages to the target audience. We are making efforts to quickly deploy Polly in Liberia, Sierra Leone and Guinea. Our plan is to use Polly to spread awareness messages pertaining to practices like washing hands and observing proper precautions in handling the sick and deceased. These messages would be generated by healthcare organizations that are intervening on ground and will be recorded by influential public figures like religious leaders, celebrities etc. Our technology for peer-to-peer spreading will supplement the existing and commonly used method of radio broadcasting. We believe it will have the advantage of carrying more trust because it is send from people known to the recipient.

Advantages of Polly over a Robocall service

Another possibility of spreading the message to a large number of people is to use "robocalling" – randomly place cold calls to phone numbers. However, following are some of the advantages of Polly over a robo-call service for Information Dissemination

Polly…

• Can know the language of the recipient via message sender

• Earns peer2peer trust that leads to stickiness of the message

• Enhances social communication networks

• Allows follow-up questions and feedback

• Enables recruitment into the network

• Spreads through backchannel/word-of-mouth communication

• Can control better timing of delivery

• Gives the feeling of ownership of the message to the sender

• Makes people get attached to it in a personal and emotional way

2. Skill-training and Job Opportunities in Pakistan

Polly's spread in Pakistan led to a lot of media attention that resulted in some interesting collaboration and funding opportunities. One such opportunity that promises sustainable impact is a collaborative project to improve access to skill training and employment opportunities for marginalized people using automated voice interaction systems in Punjab, Pakistan. Being funded by GIZ, this project is collaboration between Information Technology University and our team comprising Prof. Roni Rosenfeld (my advisor) and myself.

Polly will act as a platform for connecting marginalized (especially handicapped) people in Pakistan with employment and skill-training opportunities. Polly will act as an information dissemination and survey tool where it reaches the target audience through selective seeding and referrals; interviews people to gather their qualifications and interests; allows organizations to post job and skill-training openings with a special focus on jobs and training opportunities for the disabled; and connects people with opportunities appropriately.

Project Objectives

The Primary objective of the project is to develop an automated voice interaction system that would offer:

1. access to employment opportunities,

2. access to skill training opportunities,

3. and access to financing opportunities (through time-barred training voucher scheme)

for the socially, economically or geographically marginalized segments of the society (with special focus on the handicapped) who predominantly use featured / dumb phone.

The project will also bring together various key stakeholders of vocational training entities, industrial bodies, technology agencies and small businesses to create synergy between them in order to improve the efficacy of skill training and employment creation by creating linkages and providing data for effective policy development and implementation. Our concrete objective is to benefit, within the initial 18 month period, over 50,000 poor people from under-served populations (women, minorities, low-literate and/or remote), by registering and connecting them to skills training and employment opportunities; and to further benefit a subset of 3300 of them, who will additionally receive financial incentives in the form of vouchers for appropriate skill training programs.

Beneficiaries and Location of Project

The primary beneficiaries would be semi-illiterate or illiterate, socially, economically or geographically marginalized, physically disabled, unskilled and unemployed people who have access to at least a dumb / featured phone. The direct beneficiaries of the project will be the people who gain employment through the use of our system and those who will have access to training opportunities and skill development in their vicinity. The primary focus in on the province of Punjab and the pilot will be launched in Lahore. But later the project can be scaled up to cater for the entire Pakistan with relatively low investment, but that is beyond the scope of current proposal.

In Pakistan, like most of the developing countries, there has been a rapid increase in the popularity and usage of mobile phones and significant growth in the number of phone owners and thus the phone users. "The phone users have been defined as 'people who use a phone, without owning themselves

(Tomitsch)." The reason for this increase can be accounted for, by observing the increase in the number of GSM providers, and reduction of connection costs and mobile phone costs in Pakistan.

Pakistan has approximately 5.8 million land line telephones and over 125 million cellular connections which are amongst the highest in this region. This kind of coverage through technology provides an unprecedented opportunity to innovate new solutions to cater to those people who were traditionally inaccessible for such initiatives. A significant fraction of the user base represents people who are geographically, economically or socially marginalized. Given such an increase in the use of mobile phones, a service based upon using Interactive Voice Response (IVR) for the illiterate, semi-literate or illiterate, socially, economically or geographically marginalized people is a step in the right direction to empower the people. Since using this service would not require them to own personal computers, or be able to read or write text. Usage of this system will enfranchise even those who were not accessible through traditional routes. These beneficiaries would be identified through the poverty score card or other yardstick defined on the basis of such attributes. The initial focus of the project is Punjab and the districts with higher manufacturing and industrial concentration. Thereafter, in the next phase, the system will be deployed nation-wide.

Direct Beneficiaries

Direct beneficiaries would be the under-served populations who were engaged by our system, expressed interest in jobs or job skill training, and provided basic geographic and demographic information, including location, education, skills, and financial status. In our past experience with Polly, some 30% of Polly users engaged with the job opportunities. We conservatively assume that only 5% of the total will choose to register with our system and be connected with employment and skill training opportunities. Based on the projections of Polly's Pakistan spread (see section 5 below), this translated into 50,000 people. It is important to note that all users of Polly (even those who never choose to register) will benefit from it, as they will enjoy free speech-based access to job opportunities, vocational skill training opportunities and subsidized skill training opportunities over telephones and mobile phones. They can audio-browse these opportunities and opt to register with our system. Our pervious project in Pakistan cost us an average of $0.25 per user. Under our current airtime budget these numbers are expected to reach up to 1 million users and are only bounded by our systems telephone capacity and airtime charges. For these users our database will maintain a record of their phone numbers and geographical locations (as provided by our partner Telco).

Direct Financial Beneficiaries

Direct financial beneficiaries would be a subset of the registered users, who will be given training vouchers towards specific skill training appropriate for their location, circumstances and expected job prospects. They will be chosen from among the most under-served portions of the population (females, minorities, illiterate, rural), with exact criteria still to be worked out. The vouchers will be time limited: unused vouchers will expire, allowing us to offer new ones to other eligible applicants. Therefore, even though our budget supports only 3,300 vouchers, we expect to be able to offer them to 5,000—10,000 eligible under-served users.

Other Beneficiaries

Other beneficiaries of this proposal would be:

- Pakistani companies and SMEs (Small and Medium Enterprises) as they will have better access to relevance skilled manpower;
- Pakistani government as they will have better information about employment and skill-training needs and opportunities; and

- Pakistani technology base via transfer of the underlying technology from the US

Employment Opportunities for Beneficiaries

Unemployed and economically, socially or geographically marginalized people would be matched with job opportunities. At the same time, these same beneficiaries will also be connected with opportunities for training courses that would enhance their subsequent employment opportunities. A qualifying subset belonging to most underserved portions of the population will receive free training through the training voucher scheme. Registered users would be able to find out about job opportunities on a regular basis through their dumb / featured phone, increase their employment prospects. In a nutshell, this project will improve access to training and employment opportunities for disenfranchised Pakistanis.

Currently, for the people with formal education and access to the internet there are many web-based online job portals as well as newspapers and other resources to search for employment opportunities. But no formal system exists for those who do not have that access to internet or newspapers, and resources are extremely limited for them. Our system is trying to fill that gap by using an automated voice system for delivery and dissemination of such information to those who do not already have access to it. It will be accessible to anyone with a simple telephone anywhere in Pakistan.

Sustainability Strategy

Once the system development, testing and deployment are completed, the most significant expense to remain in steady-state operation is cellular airtime charges for our toll-free numbers. We anticipate steady-state traffic averaging 5,000 calls/day, at 3 minutes each, for a total of some 5,475,000 airtime minutes/year. These would be covered by a combination of the following sources:

- Revenue sharing by the cellular carriers (30% is the customary rate for for-profit enterprises that generate such high traffic. Non-profits may garner more, perhaps 40%).
- Cost sharing by the partner organizations, since they will receive significant marketing and communication services from the system.
- Some ongoing subsidy from national and/or provincial depts. of labor.
- Anticipated global drop in cellular communication costs.

As a fallback strategy, we can offer some of the services on standard (not toll-free) lines, effectively letting the callers bear the airtime charges. Our experience with Polly shows that this reduces activity significantly, so we will only do this if necessary. Another strategy we have used successfully is to put a quota on the number of toll-free calls available to each caller, and adjust the quota based on our budget.

In the longer run, we can also establish strategies to make this sustainable, by charging nominal fees from the employers once the system has gathered enough mass to create a significant value. A mechanism can be developed to offset the costs by using targeted advertisement and charging the advertisers to maintain the free accessibility of the system.

3. Closing the Loops

Information Generation-Dissemination Loop

The content shared over Polly's payload services has been hitherto populated by us (i.e. the job ads, although were published in newspapers by the general public and organizations, were converted to audio format by our team members). This does not have to be so and a Craigslist-like web 2.0 model

where people completely generate and consume the content can be adopted for a wide variety of services. An essential component of such offerings is content moderation. One issue with active moderation is that it limits the scale of the spread as a small team of moderators can only handle and screen a limited amount of data. An alternate approach could be to partially or completely rely on the users for content moderation as well [75]. How reliable is user-based content moderation for developing world, speech-telephone-based services where users' financial gains, health, development etc. may be at stake is an open research problem.

Direction of Information Flow

Until now our focus with Polly has been to disseminate information. We do gather data from the users but that has never been our main goal. Example of such data include recorded speech and phone calls, usage data and unstructured surveys done via user feedback and comments about Polly in the form of unconstrained speech. There is a lot of untapped potential in using Polly to:

- Conduct structured surveys to get a pulse of the population's needs and sentiment. This could result in a real-time platform for performing demand assessment.
- Assess skills and literacy through speech-based quizzes and games. This can be used to do prequalify users for certain offerings (appropriate job ads, courses, welfare schemes etc.) as well as to track the improvement in users' knowledge and proficiency of skills as they progress through classes and tutorials.

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Appendix A: Real-Time Monitoring & Analysis

The real-time monitoring and analysis system consists of a set of PHP scripts that support an online dashboard designed to provide various types of information that is required on the go while Polly is in operation. It also helps monitor Polly's smooth operation and to analyze its spread and distribution. It is critical for understanding where virality is hampered, how people choose to use the system, and to take a pulse of the running system.

Some of the key pieces of information provided by the monitoring system are as follows:

- Real-time operational statistics to get the pulse of the system e.g. lengths of scheduler queues; available memory and telephone capacity; system responsiveness; call-back and delivery latency.
- Temporal (by date and time of day) and geographic distribution of Polly's traffic and system activity.
- Analysis and tracking of spread e.g. message delivery graphs; trees of who-introduced-whom to Polly (to link seeding to spread); user retention.
- Flow analysis of the dialog tree to find out the fraction of users who reach particular points in the tree. This helps in tracking user preferences and detecting interface hurdles.
- Analysis of user feedback, scheduled voice messages and access to complete call recordings.

In addition the monitoring & diagnostics system also:

- Raises real-time SMS and email-based alerts about operational problems and bugs,
- Automatically archives, backs up, summarizes and emails various types of data on regular basis,
- Auto-detects and recovers from certain problems by restarting the telephony and web servers,
- Helps is manual diagnostics of errors and allows quick-fixing several known problems.

Following are some examples of the way this system can be used:

The Monitor Report

This provides a summary of the overall statistics till the current day and also the updated statistics for the current day. In addition it gives alerts about remaining hard drive space etc.

Polly-BabaJobs Real-Time Monitoring Report

Automatically generated on Tue 2014-08-26 03:03:11 IST (UTC+5:30)

(419 days since launch)

Free space left on hard drive: 63.46 GB

Call Statistics To-Date

	Overall		Today (Another Date?)	
	Calls	Users	Calls	Users
Call-me-back requests to the system	15,167	2,071	0	0
System's callbacks answered by users	14,029	2,049	0	0
Message delivery requests to the system (Draw Introduction Tree (who introduced whom to Polly), A more efficient version (beta))	10,532	3,688	0	0
Successful message deliveries (Draw Successful Message Delivery Graph)	8,370	2,710	0	0
Calls from Polly answered by users (message delivery, call-me-backs)	22,683	3,784	0	0
All Successful Calls (inbound and outbound)	22,742	3,801	0	0
Calls from Polly that remained unanswered	22,641	2,101	0	0
Calls w/ airtime paid by user	59	18	0	0
Overall call volume (message delivery, job ad delivery, call-me-backs, unanswered calls, retries, call-me-back requests)	89,691	4,773	0	0

Last successful callback was to 6373, 153.43 hours ago.
Last successful delivery was to 6099, 1604.05 hours ago.
0 new users were added to Polly today.

Request Statistics To-Date

	Overall	Today
Overall requests (Call-me-back, message delivery, Job ad delivery, SMS)	31,749	0
Fulfilled call requests	22,571	0
Failed call Requests	3,096	0
Fulfilled SMS Requests	5,749	0
Unfulfilled call requests (still to be retried)	0	0
Pending call requests	14	0
Pending SMS requests	0	0

Job Statistics To-Date

	Overall		Today	
	No.	Users	No.	Users
Number of times job ads were listened to	2,444	31	0	0
Distinct job ads accessed	1,076	31	0	0
Job ad delivery requests to the system	4	4	0	0

User Feedback Statistics To-Date

	Overall		Today	
	No.	Users	No.	Users
Total feedback collected	1,940	958	0	0
User initiated	175	116	0	0
System prompted	1,765	842	0	0

This report also provides access to various analysis scripts.

121

Note: The links below issue real-time DB queries, and may take up to 30 seconds to display.

Activity Level	
By Date	**By Time of Day**
Overall Call Volume (table) All Successful Subsidized Calls (Types) (table) All Unsuccessful Subsidized Calls (Types) (table) "Call-Me-Back" type Requests and Calls (table) Message deliveries (table) Job ad deliveries (table) Unsubsidized calls (table) Caller-Paid deliveries (table) All successful subsidized calls (table)	Overall call volume (table) Missed Calls (table) Call-me-backs: requested (table), fulfilled (table) Deliveries: requested (table), fulfilled (table)
Users	**Active Users**
Daily (table) Cumulative (table)	Daily (table) Cumulative (table)

System Responsiveness		
	By Date	**By Time of Day**
Following a CMB Request	Time to 1st attempt (table) #attempts (table) Time to success (table) Time to 1st attempt (truncated at 20 minutes) (table)	Time to 1st attempt (table)
Following a Delivery Request	Time to 1st attempt (table) #attempts (table) Time to success (table) Time to 1st attempt (truncated at 20 minutes) (table)	Time to 1st attempt (table)

Miscellaneous Scripts
Breakdown of Daily Call Volume by Call-type & Call-status (table) Frequency of Calls per User for any given date How many users sent messages to a particular user? User's active Polly age vs. the use of job audio-browser Geographic Distribution of Users Airtime Calculator User Retention Branch-out Distribution of message passing. Chain-length Distribution of New User Introduction. User fecundity (the tendency to introduce new users) as a function of time. Choice of Voice Mods by Date Flow Summary

Further details about any particular date can be obtained by clicking on *another date*.

Go to Polly's website.

<< Previous Date   Please enter the date (YYYY-MM-DD): 2014-06-19   Submit   Next Date>>

Polly-BabaJobs Monitoring Report

Automatically generated for 2014-06-19 IST (UTC+5:30)

(351 days after launch)

Call Statistics on 2014-06-19:
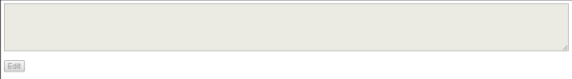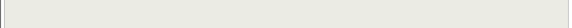
	Calls	Users
Call-me-back requests to the system	1,817	370
System's callbacks answered by users	1,788	367
Message delivery requests to the system	1,635	735
Successful message deliveries	1,357	551
Job ad delivery requests to the system	0	0
Calls from Polly answered by users (message delivery, call-me-backs)	3,146	700
All Successful Calls (inbound and outbound)	3,146	700
Calls from Polly that remained unanswered	2,195	354
Calls w/ airtime paid by user	0	0
Overall call volume (message delivery, job ad delivery, call-me-backs, unanswered calls, retries, call-me-back requests)	7,919	882

506 new users were added to Polly on this date.

The main page also gives access to an interface for accessing and transcribing feedback files.

User Feedback

Automatically generated on Tue 2014-08-26 00:37:15 IST (UTC+5:30)

Feedback Files	Date	Transcription
Feedback-1942-GBye ▶ ● 0:01 ◀)) ▬▬	2014-06-18 22:18:01	 Edit
Feedback-1940-GBye ▶ ● 0:43 ◀)) ▬▬	2014-06-18 19:23:26	 Edit
Feedback-1939-GBye ▶ ● 0:08 ◀)) ▬▬	2014-06-18 19:16:20	 Edit
Feedback-1937-GBye ▶ ● 0:31 ◀)) ▬▬	2014-06-18 19:02:49	 Edit
Feedback-1936-GBye		

New User Introduction Trees

123

First Polly Date: 2014-06-15 11:17:57
Type: P_Introd
11-digit phone number
All successful calls: 2 (CMBs: 1, DLVs: 1)
Location: West Bengal Telecom Circle (includes Andaman & Nicobar,Sikkim excludes Calcutta Telecom District)
Ads listened: 0
Distinct Ads: 0
Click node for more details.

First Polly Date: 2013-11-24 12:17:58
Type: P_Introd
11-digit phone number
All successful calls: 2 (CMBs: 0, DLVs: 2)
Location: West Bengal Telecom Circle (includes Andaman & Nicobar,Sikkim excludes Calcutta Telecom District)
Ads listened: 0
Distinct Ads: 0
Click node for more details.

5159
WoM

5160 — 5645 — 5652
5698

5162 — 5418 — 5793

5165 — 5167
5169
5175
5178
5193
5204
5208
5435

5170
5238
5320
5322
5765 — 5767 — 5770
5795 — 5810
5840
5848

4965
WoM

4966
4995 — 5005
4996 — 5002
5009
5012
5050 — 5079
5100

5007 — 5031 — 5040
5041
5063 — 5988 — 6000
6004
6025
6033
6040
6044

5629 — 5870
5872 — 5877
5887
5892
5916
5921
5854 — 5874
5880 — 6037
5905 — 6046

5082 — 5265 — 5337
5910

2434
WoM

2435 — 2436 — 2437
2441 — 2716
2442 — 2718 — 2740 — 2741
2807
2881
2506
2882
2520

Message Delivery Graphs

User Statistics

Now displaying details of UserID: 3418 [Submit]

Automatically generated on Tue 2014-08-26 03:48:23 IST (UTC+5:30)

Geographical location	Mumbai Metro Telecom Circle (includes Navi Mumbai & Kalyan)
Length of phone number	11 digits
User Type	P_Introd
Parent ID	3268
Root ID	3260
Root Type	BKCHL0D
Number of Children	10
Was added to Polly DB on	2014-05-28
Started answering Polly's calls on	2014-05-28
Most recent interaction took place on	2014-07-07
Number of times listened to job ads	0
Distinct job ads accessed	0
Missed Calls placed to the system	30
System's callbacks answered	28
Message delivery requests placed	21
Succesful message deliveries placed	14
Succesful messages delivered to this user	3
Calls w/ airtime paid by this user	0
Unsubsidized Delivery attempts made to this user	0
Unsubsidized Deliveries successfully made to this user	0
User-initiated feedback	0
System-prompted feedback	1

127

Interaction Summary for 3418

Date-Time	Details
Wednesday, May 28 2014, 8:47pm	User receives a "Delivery" call from Polly (Sender: 3268) - Call Duration: 2 minutes 2 seconds - Did not choose to go to the new recording part of the interaction. - Complete Recorded Call: Go to file. [More Details]
Wednesday, May 28 2014, 8:47pm	User receives a Delivery SMS from Polly.
Wednesday, May 28 2014, 9:07pm	"Missed Call" placed by user.
Wednesday, May 28 2014, 9:07pm	User receives a "Call-me-back" call from Polly. - Call Duration: 2 minutes 29 seconds - Recorded his voice (Go to file) - Placed a Delivery request for 3421 with effect no. 0 that was fulfilled. - Complete Recorded Call: Go to file. [More Details]
Thursday, May 29 2014, 1:25pm	"Missed Call" placed by user.
Thursday, May 29 2014, 1:26pm	User receives a "Call-me-back" call from Polly. - Call Duration: 2 minutes 19 seconds - Recorded his voice (Go to file) - Placed a Delivery request for 3421 with effect no. 0 that was fulfilled. - Complete Recorded Call: Go to file. [More Details]
Thursday, May 29 2014, 5:16pm	"Missed Call" placed by user.
Thursday, May 29 2014, 5:16pm	User receives a "Call-me-back" call from Polly. - Call Duration: 1 minutes 33 seconds - Recorded his voice (Go to file) - Complete Recorded Call: Go to file. [More Details]
Thursday, May 29 2014, 6:49pm	"Missed Call" placed by user.
Thursday, May 29 2014, 6:49pm	User receives a "Call-me-back" call from Polly. - Call Duration: 2 minutes 32 seconds - Recorded his voice (Go to file) - Placed a Delivery request for 3436 with effect no. 0 that was fulfilled. - Complete Recorded Call: Go to file. [More Details]
Saturday, May 31 2014, 2:26am	User receives a "Call-me-back" call from Polly. - Call Duration: 2 minutes 14 seconds - Recorded his voice (Go to file) - Placed a Delivery request for 3441 with effect no. 0 that was fulfilled. - Complete Recorded Call: Go to file. [More Details] Call Answered. Listened to Hi Listened to Greetings Listened to Informed Consent Has been prompted to record something Listened to the clock sound Listened to modification number 0 Listened to effect related options Pressed 2 to send to a friend Phone directory is enabled Number of Entries in the directory: 0 Now prompting for phone number Entered phone number User told that Polly will repeat the number back now Number repeated User asked to confirm the number Confirms the number (1) User's name recorded This is the first message to this phone num with this effect in this call User is given a choice to save number Presses 2 to not to save User is thanked and informed that the message would be sent soon User is offered a choice to enter more numbers Did not press any key Listened to the clock sound Hang up

Go to Polly's website.

Automatically generated on Tue 2014-08-26 04:05:25 IST (UTC+5:30)

<< Previous Date   List of users who called Polly on 2014-06-19   Next Date>>

#	User ID	Type	Location	Root	Root Type	Root Location
1	5592	WoM	West Bengal Telecom Circle (includes Andaman & Nicobar,Sikkim excludes Calcutta Telecom District)	5592	WoM	West Bengal Telecom Circle (includes Andaman & Nicobar,Sikkim excludes Calcutta Telecom District)
2	5593	P_Introd	unknown	5590	BKCHL0D	Kolkata Metro Telecom Circle (includes parts of Haora, Hooghly, North & South 24 Parganas and Nadia
3	5594	P_Introd	West Bengal Telecom Circle (includes Andaman & Nicobar,Sikkim excludes Calcutta Telecom District)	4200	BKCHL0D	Kolkata Metro Telecom Circle (includes parts of Haora, Hooghly, North & South 24 Parganas and Nadia
4	5595	P_Introd	Delhi Metro Telecom Circle (includes NCR, Faridabad, Ghaziabad, Gurgaon & Noida)	5373	WoM	unknown
5	5596	P_Introd	Bihar & Jharkhand Telecom Circle	4765	BKCHL0D	North East India Telecom Circle (includes Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Manipur a
6	5597	P_Introd	Bihar & Jharkhand Telecom Circle	4765	BKCHL0D	North East India Telecom Circle (includes Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Manipur a
7	5598	P_Introd	Tamil Nadu Telecom Circle (excludes CH Chennai, MEPZ, Mahabalipuram & Minjur and includes Pondicherr	4765	BKCHL0D	North East India Telecom Circle (includes Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Manipur a
8	5599	P_Introd	Bihar & Jharkhand Telecom Circle	4765	BKCHL0D	North East India Telecom Circle (includes Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Manipur a
9	5600	P_Introd	Uttar Pradesh (West) & Uttarakhand Telecom Circle (excludes Ghaziabad & Noida)	5217	BKCHL1D	Rajasthan Telecom Circle
10	5601	P_Introd	unknown	5217	BKCHL1D	Rajasthan Telecom Circle
11	5602	P_Introd	unknown	5217	BKCHL1D	Rajasthan Telecom Circle
12	5603	P_Introd	Rajasthan Telecom Circle	5217	BKCHL1D	Rajasthan Telecom Circle
13	5604	P_Introd	West Bengal Telecom Circle (includes Andaman & Nicobar,Sikkim excludes Calcutta Telecom District)	4832	BKCHL0D	West Bengal Telecom Circle (includes Andaman & Nicobar,Sikkim excludes Calcutta Telecom District)

All Successful Subsidized Calls as a Function of Date
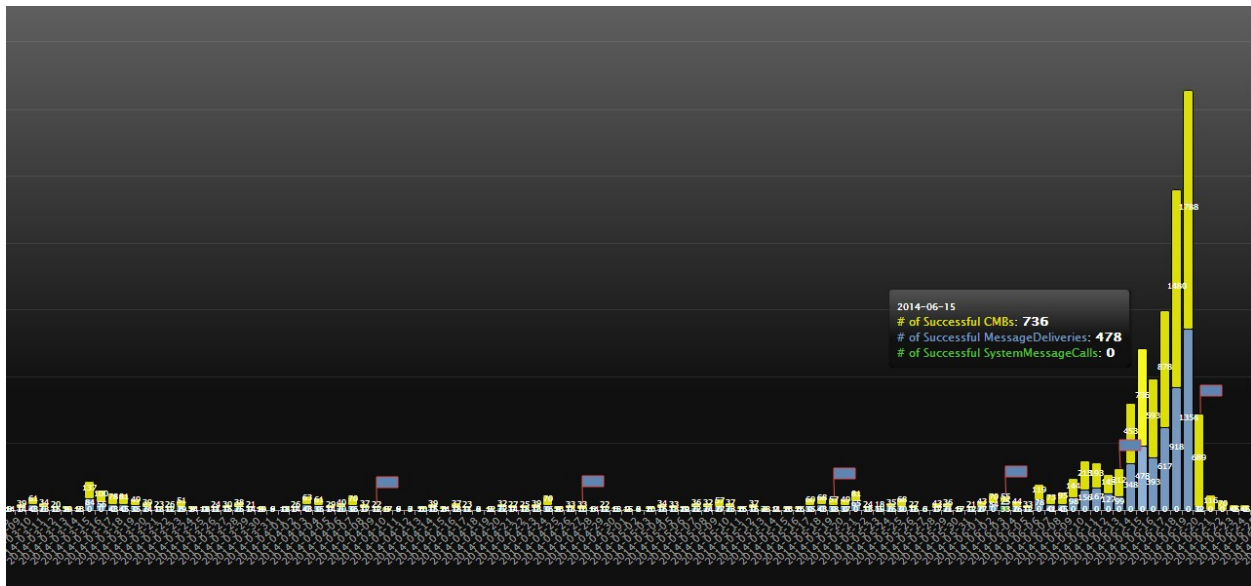
Users/New Users as a function of Date
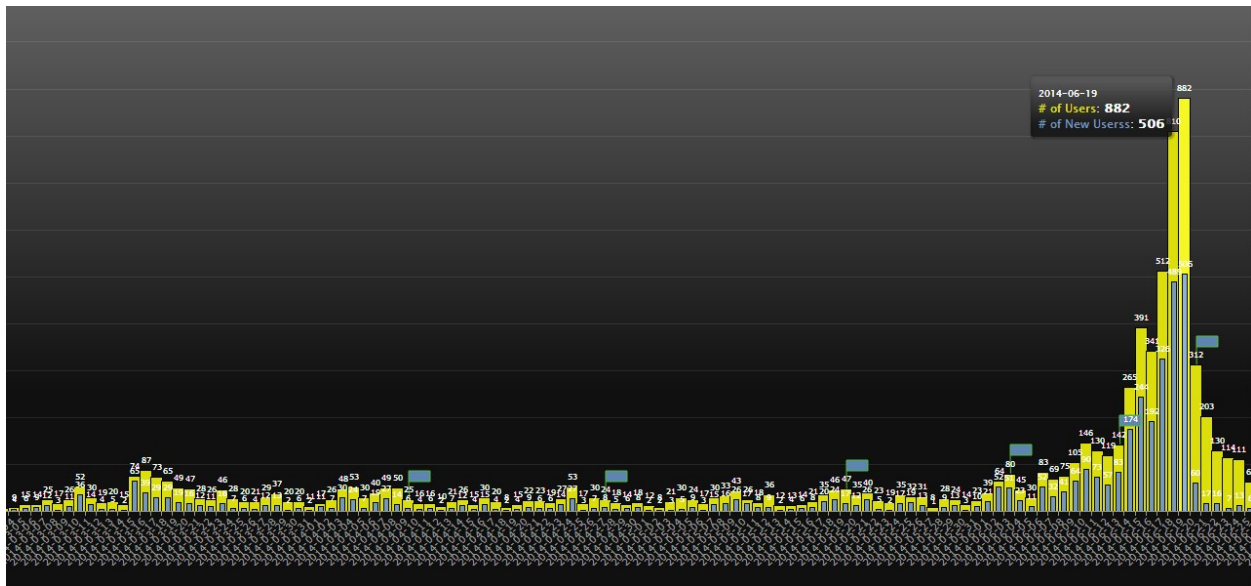
Airtime Minutes Consumed

Go to Polly's website.

Airtime minutes consumed on 2014-06-19

Automatically generated on Sun 2014-09-07 06:23:41 IST (UTC+5:30)

Over all **7552.92** minutes were consumed in **3141** calls.
Out of these, **5129.68** minutes were consumed in **1788** call-me-back calls and **2423.23** were consumed in **1353** message delivery calls.

Go to Polly's website.

Geographic Distribution of Polly's Users

Geographic distribution of users who have joined Polly since 2013-08-01

Automatically generated on Sun 2014-09-07 06:16:27 IST (UTC+5:30)

Distribution of all phone numbers who have been added to the system since 2013-08-01

#	Location	Number of Users	Percentage of Users
0	West Bengal Telecom Circle (includes Andaman & Nicobar,Sikkim excludes Calcutta Telecom District)	1714	38.3%
1	unknown	901	20.1%
2	Kolkata Metro Telecom Circle (includes parts of Haora, Hooghly, North & South 24 Parganas and Nadia	424	9.5%
3	Delhi Metro Telecom Circle (includes NCR, Faridabad, Ghaziabad, Gurgaon & Noida)	419	9.4%
4	Uttar Pradesh (East) Telecom Circle	168	3.8%
5	North East India Telecom Circle (includes Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Manipur a	111	2.5%
6	Karnataka Telecom Circle	98	2.2%
7	Bihar & Jharkhand Telecom Circle	89	2%
8	Rajasthan Telecom Circle	88	2%
9	Mumbai Metro Telecom Circle (includes Navi Mumbai & Kalyan)	71	1.6%
10	Madhya Pradesh & Chhattisgarh Telecom Circle	67	1.5%
11	Punjab Telecom Circle (includes Chandigarh & Panchkula)	56	1.3%
12	Uttar Pradesh (West) & Uttarakhand Telecom Circle (excludes Ghaziabad & Noida)	51	1.1%
13	Andhra Pradesh Telecom Circle	51	1.1%
14	Orissa Telecom Circle	37	0.8%
15	Haryana Telecom Circle (excludes Faridabad, Gurgaon & Panchkula)	29	0.6%
16	Tamil Nadu Telecom Circle (excludes CH Chennai, MEPZ, Mahabalipuram & Minjur and includes Pondicherr	25	0.6%
17	Maharashtra Telecom Circle (includes Goa but excludes Mumbai, Navi Mumbai & Kalyan)	25	0.6%
18	Gujarat Telecom Circle (includes Daman & Diu, Dadra & Nagar Haveli)	15	0.3%

User Retention

User Retention on the basis of User-Initiated Interaction Requests (CMB Requests) - Separate Cohorts of Users for Each Day

Automatically generated on Sun 2014-09-07 09:55:55 IST (UTC+5:30)

Notes
- Set stdate to the starting date for the analysis.
- (Optionally) Set endate to the ending date for the analysis (if not set, current date would be used).
- Set noofdays to the number of days that you want to analyse.
- includelastday is set to true and current analysis assumes that we have seen the endate completely and data from endate is included.
- samecohort is set to false. This means that the analysis chooses a separate cohort of users, X, for each day, n, who had a chance to use Polly for n days-post-their-first-encounter. Then we find the fraction of users who actually used Polly on the nth day out of X.

Days post First encounter with Polly	Cohort Size (all potential active users on this day)	Number of users still active	Fraction of users still active	Standard Error
0	718	718	1	0
1	539	237	0.4397	0.0214
2	374	121	0.3235	0.0242
3	238	69	0.2899	0.0294
4	171	38	0.2222	0.0318
5	93	21	0.2258	0.0434
6	33	2	0.0606	0.0415

The script took 5.52 seconds to execute.

User Fecundity as a function of Polly Age - Separate Cohorts of Users for Each Day

Automatically generated on Sun 2014-09-07 09:56:46 IST (UTC+5:30)

Notes
- The denominator includes all users of that Polly age who answered any call. The introduced friends include all who were newly added to Polly's user table on that date and answered at least one call in their life time.
- Set stdate to the starting date for the analysis.
- (Optionally) Set endate to the ending date for the analysis (if not set, current date would be used).
- Set noofdays to the number of days that you want to analyse.
- includelastday is set to true and current analysis assumes that we have seen the endate completely and data from endate is included.
- samecohort is set to false. This means that the analysis chooses a separate cohort of users, X, for each day, n, who had a chance to use Polly for n days-post-their-first-encounter. Then we find the fraction of users who actually used Polly on the nth day out of X.
- includebkch is set to true and current analysis includes all assigned WoMs (P_Introd, BKCHL0D, BKCHL1D, BKCHI1D).
- usersorfriends is set to friends and current analysis reports the fraction of newly introduced users (friends) to potential fecund users as a function of Polly age.

Days post First encounter with Polly	Cohort Size (all potential fecund users on this day)	Number of friends who were introduced on this day	Fraction of friends to fecund users	Standard Error
0	1473	710	0.482	0.013
1	1093	295	0.2699	0.0134
2	759	130	0.1713	0.0137
3	502	45	0.0896	0.0127
4	364	29	0.0797	0.0142
5	191	15	0.0785	0.0195
6	61	1	0.0164	0.0163

r0 = 1.19
Note: This only establishes a lower bound on the r0 because:
1. A small fraction of most cohorts can remain fecund for several weeks or even months.
2. There were 124 unassigned word-of-mouth users who were introduced to Polly within the given range of dates (and who answered calls as well).

The script took 1.76 seconds to execute.

R_0 – The Basic Reproductive Number

User Fecundity as a function of Polly Age - Separate Cohorts of Users for Each Day

Automatically generated on Mon 2014-09-15 13:24:43 IST (UTC+5:30)

Notes
- The denominator includes all users of that Polly age who answered any call. The introduced friends include all who were newly added to Polly's user table on that date and answered at least one call in their life time.
- Set stdate to the starting date for the analysis.
- (Optionally) Set endate to the ending date for the analysis (if not set, current date would be used).
- Set noofdays to the number of days that you want to analyse.
- includelastday is set to true and current analysis assumes that we have seen the endate completely and data from endate is included.
- samecohort is set to false. This means that the analysis chooses a separate cohort of users, X, for each day, n, who had a chance to use Polly for n days-post-their-first-encounter. Then we find the fraction of users who actually used Polly on the nth day out of X.
- includebkch is set to true and current analysis includes all assigned WoMs (P_Introd, BKCHL0D, BKCHL1D, BKCHI1D).
- usersorfriends is set to friends and current analysis reports the fraction of newly introduced users (friends) to potential fecund users as a function of Polly age.

Days post First encounter with Polly	Cohort Size (all potential fecund users on this day)	Number of friends who were introduced on this day	Fraction of friends to fecund users	Standard Error
0	1473	710	0.482	0.013
1	1093	295	0.2699	0.0134
2	759	130	0.1713	0.0137
3	502	45	0.0896	0.0127
4	364	29	0.0797	0.0142
5	191	15	0.0785	0.0195
6	61	1	0.0164	0.0163

r0 = 1.19
Note: This only establishes a lower bound on the r0 because:
1. A small fraction of most cohorts can remain fecund for several weeks or even months.
2. There were 124 unassigned word-of-mouth users who were introduced to Polly within the given range of dates (and who answered calls as well).

The script took 1.75 seconds to execute.

Message Passing Branch-out Distribution

Message Passing Branch-out Distribution

Automatically generated on Sun 2014-09-07 09:46:33 IST (UTC+5:30)

User who forwarded: 304, All users who could have forwarded: 759. Both these numbers deal with the users whose first interaction with Polly was on or after 2014-06-13 and no later than 2 days before 2014-06-19.
Notes
- Set stdate to the starting date for the analysis and endate to the ending date.

# of friends (for whom messages were scheduled)	Number of users	Percentage of users
0	455	59.9473
1	85	11.1989
2	47	6.1924
3	37	4.8748
5	24	3.1621
4	18	2.3715
7	13	1.7128
6	12	1.581
9	11	1.4493
15	8	1.054
8	8	1.054
13	6	0.7905
10	6	0.7905
16	4	0.527
18	4	0.527
11	4	0.527
12	3	0.3953
14	2	0.2635
20	2	0.2635
21	2	0.2635
30	2	0.2635
35	1	0.1318
26	1	0.1318
27	1	0.1318

Chain-Length of Transmission to New Users Distribution

Chain Length Distribution

Automatically generated on Sun 2014-09-07 09:46:34 IST (UTC+5:30)

Notes
- Set stdate to the starting date for the analysis and endate to the ending date.
- Pass bkch=false if you do not want assigned WoMs to be part of the chains.

Average Chain Length = 7.44, Max = 28

Chain Length	# of Chains	% of Chains
0	1040	21.33
1	351	7.2
2	196	4.02
3	250	5.13
4	184	3.77
5	220	4.51
6	246	5.05
7	173	3.55
8	169	3.47
9	202	4.14
10	223	4.57
11	190	3.9
12	232	4.76
13	229	4.7
14	186	3.82
15	154	3.16
16	151	3.1
17	123	2.52
18	54	1.11
19	79	1.62
20	62	1.27
21	42	0.86
22	14	0.29

132

Choice of Voice Mods by date

Choice of Voice Mods by Date

2014-05-22	94.12%	0.0%	5.88%	0.0%	0.0%	0.0%	0.0%	17
2014-05-23	76.19%	9.52%	0.0%	9.52%	4.76%	0.0%	0.0%	21
2014-05-24	96.43%	0.0%	0.0%	0.0%	3.57%	0.0%	0.0%	28
2014-05-25	47.06%	2.94%	0.0%	0.0%	50%	0.0%	0.0%	34
2014-05-26	91.3%	4.35%	0.0%	0.0%	4.35%	0.0%	0.0%	23
2014-05-27	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5
2014-05-28	68.42%	0.0%	0.0%	10.53%	21.05%	0.0%	0.0%	19
2014-05-29	84.62%	15.38%	0.0%	0.0%	0.0%	0.0%	0.0%	26
2014-05-30	63.64%	18.18%	9.09%	9.09%	0.0%	0.0%	0.0%	11
2014-05-31	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	18
2014-06-01	92.11%	5.26%	0.0%	0.0%	2.63%	0.0%	0.0%	38
2014-06-02	98.53%	1.47%	0.0%	0.0%	0.0%	0.0%	0.0%	68
2014-06-03	71.88%	9.38%	3.13%	0.0%	12.5%	0.0%	3.13%	32
2014-06-04	84.85%	0.0%	0.0%	0.0%	15.15%	0.0%	0.0%	33
2014-06-05	86.67%	0.0%	0.0%	0.0%	13.33%	0.0%	0.0%	15
2014-06-06	80.22%	10.99%	1.1%	0.0%	7.69%	0.0%	0.0%	91
2014-06-07	71.67%	21.67%	0.0%	0.0%	6.67%	0.0%	0.0%	60
2014-06-08	93.15%	2.74%	1.37%	0.0%	2.74%	0.0%	0.0%	73
2014-06-09	86.73%	6.19%	2.65%	1.77%	2.65%	0.0%	0.0%	113
2014-06-10	79.27%	1.55%	3.11%	3.11%	8.81%	0.0%	4.15%	193
2014-06-11	47.85%	2.87%	19.14%	1.44%	26.32%	0.0%	2.39%	209
2014-06-12	67.53%	3.9%	2.6%	3.25%	16.23%	1.3%	5.19%	154
2014-06-13	**73.91%**	**0.72%**	**2.9%**	**2.9%**	**15.22%**	**0.0%**	**4.35%**	**138**
2014-06-14	65.87%	6.73%	3.61%	2.4%	15.63%	0.0%	5.77%	416
2014-06-15	56.16%	8.32%	4.64%	4.64%	23.36%	0.48%	2.4%	625
2014-06-16	48.11%	7.92%	10.94%	2.08%	24.91%	0.75%	5.28%	530
2014-06-17	47.35%	7.2%	3.66%	2.9%	35.73%	0.51%	2.65%	792
2014-06-18	53.25%	4.95%	3.9%	1.46%	31.82%	0.24%	4.38%	1232
2014-06-19	47.03%	5.02%	3%	2.63%	36.27%	0.86%	5.2%	1635
2014-06-20	50%	5.26%	5.26%	7.89%	15.79%	0.0%	15.79%	38

Call Flow Summary: How many calls reached various points in the interaction.

Selection Criteria

Period: Now displaying flow summary for the period from `2013-10-01 00:00:00` to `2014-06-20 09:31:23`

User Types: Results would be contain these user types only (What's this?)

Select All | Select None

☑ WoM ☑ BJTester ☑ BJSeed1 ☑ BJSeeder2 ☑ BKCHL0D ☑ P_Introd ☑ BJSeed2 ☑ CMU-Tester ☑ ColdSeed1 ☑ ColdSeed2 ☑ ColdSeed3 ☑ ColdSeed4 ☑ ColdSeed5 ☑ ColdSeed6a ☑ ColdSeed6b ☑ ColdSeed7 ☑ ColdSeed8 ☑ BKCHL1D ☑ ColdSeedP1 ☑ ColdSeedP2

New or All: Please select if you want all users from the selected period or just the new users

● All users
○ New users only

Submit

Suggestion regarding the selected period:
4901 total users matched your 'user types' and 'new or all' criteria who interacted with Polly between 2013-07-01 00:00:00 and 2014-09-07 01:58:15. (Do you want to re-execute for this period?)

List of Users

Call-me-back Calls

1. 12386 total CMB requests (1650 users), as a result of which:
2. 99% (12206)calls (1633 users) were answered
3. 0% (9) calls became zombies.
4. 1% (171) calls failed.
File 39116.txt does not exist.

2. Out of the 12205 answered CMBs:
3. - 99% (12064) listened to Hi.
4. -- 96% (11764) listened to Greetings.
5. --- 96% (11764) listened to Informed Consent.
6. ---- 86% (10526) were prompted to record something.
7. ----- 86% (10523) passed through the time given for recording.
8. ------ 84% (10272) listened to the first modification.
9. ------- 74% (8979) listened to effect related options.
10. -------- In 71% (8716) calls users pressed at least one button.
10.1. --------- In 15% (1810) calls users pressed 0 (rerecord) at least once.
10.2. --------- In 12% (1425) calls users pressed 1 (replay) at least once.
10.3. --------- In 14% (1747) calls users pressed 3 (next effect) at least once.
10.4. --------- In 9% (1115) calls users pressed 4 (send using unmodified voice) at least once.
10.5. --------- In 3% (398) calls users pressed 5 (job ads) at least once.
10.6. --------- In 1% (143) calls users pressed 8 (feedback) at least once.
10.7. --------- In 55% (6658) calls users pressed 2 (forward) at least once.
10.7.1. ---------- In 63% (7630) calls phone directory was enabled.
10.7.2. ----------- In 42% (5178) calls users had one or more entries in the directory and were given a choice to enter a new number or choose one from the directory.
10.7.3. ------------ In 11% (1350) calls users choses an entry from the directory.
10.7.4. ------------- In 30% (3659) calls users chose to enter a number (manually).
10.7.4.1. -------------- In 56% (6869) calls users were prompted for phone number (either because they chose to enter a number manually or they did not have any entry in the directory).
10.7.4.2. -------------- In 54% (6579) calls users entered at least one phone number.
10.7.4.3. -------------- In 52% (6393) calls phone number was repeated to the user.
10.7.4.4. -------------- In 50% (6155) calls users was asked to confirm the number.
10.7.4.5. -------------- In 45% (5494) calls users confirmed the number (by pressing 1), at least once.
10.7.4.6. -------------- In 11% (1341) calls users wanted to reenter the number (by pressing 2), at least once.
10.7.4.7. -------------- In 51% (6215) calls user's name was recorded (this completes the basic forwarding process).
10.7.4.8. -------------- In 44% (5355) calls users were given a choice to save a number.
10.7.4.9. -------------- In 20% (2466) calls users pressed 1 to save.
10.7.4.10. -------------- In 20% (2410) calls user's friend's name was recorded for the directory.
10.7.4.11. -------------- In 18% (2151) calls users pressed 2 to not to save.

System Message Calls

1. 258 total System Message attempts (217 users), as a result of which:

2. 96% (248) calls (210 users) were answered

3. 0% (0) calls became zombies.

4. 4% (10) calls failed.

2. Out of the 248 answered System Message Calls:

3. - 68% (168) listened to Seed Greetings.

4. -- 31% (78) were prompted to record something.

5. --- 31% (78) passed through the time given for recording.

6. ---- 25% (63) listened to the first modification.

7. ----- 13% (31) listened to effect related options.

8. ------ In 5% (12) calls users pressed at least one button.

8.1. ------- In 2% (4) calls users pressed 0 (rerecord) at least once.

8.2. ------- In 2% (5) calls users pressed 1 (replay) at least once.

8.3. ------- In 2% (5) calls users pressed 3 (next effect) at least once.

8.4. ------- In 0% (0) calls users pressed 4 (send using unmodified voice) at least once.

8.5. ------- In 0% (0) calls users pressed 5 (job ads) at least once.

8.6. ------- In 0% (0) calls users pressed 8 (feedback) at least once.

8.7. ------- In 1% (2) calls users pressed 2 (forward) at least once.

8.7.1. -------- In 1% (2) calls phone directory was enabled.

8.7.2. --------- In 0% (0) calls users had one or more entries in the directory and were given a choice to enter a new number or choose one from the directory.

8.7.3. ---------- In 0% (0) calls users choses an entry from the directory.

8.6.4. ----------- In 0% (0) calls users chose to enter a number (manually).

8.7.4.1. ------------ In 1% (2) calls users were prompted for phone number (either because they chose to enter a number manually or they did not have any entry in the directory).

8.7.4.2. ------------ In 1% (2) calls users entered at least one phone number.

8.7.4.3. ------------ In 0% (1) calls phone number was repeated to the user.

8.7.4.4. ------------ In 0% (1) calls users was asked to confirm the number.

8.7.4.5. ------------ In 0% (1) calls users confirmed the number (by pressing 1), at least once.

8.7.4.6. ------------ In 0% (1) calls users wanted to reenter the number (by pressing 2), at least once.

8.7.4.7. ------------ In 0% (1) calls user's name was recorded (this completes the basic forwarding process).

8.7.4.8. ------------- In 0% (1) calls users were given a choice to save a number.

8.7.4.9. ------------- In 0% (0) calls users pressed 1 to save.

8.7.4.10. ------------- In 0% (0) calls user's friend's name was recorded for the directory.

8.7.4.11. ------------- In 0% (1) calls users pressed 2 to not to save.

Delivery Calls

1. 10437 total Delivery Call requests (to 3645 users), as a result of which:
2. 79% (8243) calls (to 2668 users) were answered
3. 0% (41) calls became zombies.
4. 21% (2153) calls failed.
File does not exist.

2. Out of the 8242 answered Delivery Calls:
3. - 94% (7769) listened to message delivery greetings.
4. -- 94% (7769) listened to sender's name.
5. --- 84% (6924) listened to the sent message.
6. ---- 44% (3656) listened to message related options.
7. ----- In 36% (2969) calls users pressed at least one button.
7.1. ------ In 18% (1496) calls users pressed 0 (play sender's ph no.) at least once.
7.2. ------ In 10% (864) calls users pressed 1 (repeat) at least once.
7.3. ------ In 6% (482) calls users pressed 2 (forward to friends) at least once.
7.4. ------ In 9% (773) calls users pressed 3 (reply) at least once.
7.5. ------ In 3% (257) calls users pressed 4 (record a new message) at least once.
7.6. ------ In 2% (131) calls users pressed 5 (jobs) at least once.
3. ------ 0% (0) listened to Hi.
4. ------- 0% (0) listened to Greetings.
5. -------- 12% (991) listened to Informed Consent.
6. --------- 11% (892) were prompted to record something.
7. ---------- 11% (892) passed through the time given for recording.
8. ----------- 11% (874) listened to the first modification.
9. ------------ 10% (797) listened to effect related options.
10. ------------- In 10% (791) calls users pressed at least one button.
10.1. -------------- In 2% (150) calls users pressed 0 (rerecord) at least once.
10.2. -------------- In 2% (128) calls users pressed 1 (replay) at least once.
10.3. -------------- In 2% (199) calls users pressed 3 (next effect) at least once.
10.4. -------------- In 3% (228) calls users pressed 4 (send using unmodified voice) at least once.
10.5. -------------- In 0% (20) calls users pressed 5 (job ads) at least once.
10.6. -------------- In 0% (4) calls users pressed 8 (feedback) at least once.
10.7. -------------- In 6% (520) calls users pressed 2 (forward) at least once.
10.7.1. --------------- In 8% (657) calls phone directory was enabled.
10.7.2. ---------------- In 4% (369) calls users had one or more entries in the directory and were given a choice to enter a new number or choose one from the directory.
10.7.3. ----------------- In 2% (172) calls users choses an entry from the directory.
10.7.4. ------------------ In 2% (203) calls users chose to enter a number (manually).
10.7.4.1. ------------------- In 7% (557) calls users were prompted for phone number (either because they chose to enter a number manually or they did not have any entry in the directory).
10.7.4.2. -------------------- In 6% (480) calls users entered at least one phone number.
10.7.4.3. -------------------- In 5% (451) calls phone number was repeated to the user.
10.7.4.4. -------------------- In 5% (431) calls users was asked to confirm the number.
10.7.4.5. -------------------- In 5% (375) calls users confirmed the number (by pressing 1), at least once.
10.7.4.6. -------------------- In 1% (121) calls users wanted to reenter the number (by pressing 2), at least once.
10.7.4.7. -------------------- In 12% (949) calls user's name was recorded (this completes the basic forwarding process).
10.7.4.8. -------------------- In 4% (359) calls users were given a choice to save a number.
10.7.4.9. -------------------- In 2% (201) calls users pressed 1 to save.
10.7.4.10. -------------------- In 9% (708) calls user's friend's name was recorded for the directory.
10.7.4.11. -------------------- In 2% (128) calls users pressed 2 to not to save.

Modules of the monitoring system also make sure of the following operations, which is not being discussed in detail here:

- Automatically backup DB, audio files and Log files (also produce a daily summary) on regular basis.
- Create all summaries and reports that are not needed in real-time e.g. finding user's geographic locations, expensive DB queries etc.
- Generate SMS/Call/Email-based alerts to the principle technical personnel if anything (predictable) goes wrong with Polly, e.g.:
  - Hard drive is nearly full (with automated ways to fix it)
  - Outgoing call capacity is running unusually low (server needs a restart). The monitor can even restart the server on its own if enabled.
  - Some applications are down and are not coming back online even after automated retries.

Appendix B: Technical & Functional Overview of Database and Log Files

Functional overview
There are two ways a user can access Polly:
1. via a "missed call" (i.e. a *Call-me-back* request)
2. via caller-paid call (i.e. an *Unsubsidized* call where user pays for the air time)

During the call a user may:
1. Record his voice, listen to various funny voice modifications, replay, re-record his recorded voice etc.
2. Forward his voice to a friend by entering his phone number, recording his own and his friend's name
3. Audio-browse newspaper job ads
4. Forward a particular ad of interest to a friend by entering his phone number, recording his own and his friend's name
5. Recording a feedback message for us. The option to provide feedback becomes available in the main menu starting from a user's 5th successful call. The system also periodically prompts every user for feedback.

Interaction with Polly may also begin when Polly calls a number to:
1. Deliver a voice message on someone's behalf. In this call Polly plays the name of the sender and also allows the user to optionally listen to the sender's phone number. This type of call allows the receiver to replay the message, reply, forward, to record a new message to to listen to job ads.
2. Deliver a job ad on someone's behalf. In this call Polly plays the name and phone number of the sender. This type of call allows the receiver to replay the job ad or to browse the complete job-ads listing.

Polly also sends text messages to new message recipients to give them the contact number.

Polly also implements usage quotas to limit the number of subsidized calls per user per day. Once the quota for a day is expired, the user is directed to call the call-paid number or wait till the next day.

Another feature of Polly is caller-paid deliveries. When enabled, Polly does not call out to deliver voice messages. It only informs the recipients via text messages, brief voice calls or both that they have a message from their friend and they can call the caller-paid line to retrieve it. The caller-paid line allows these users to browse the messages (like an inbox).

Technical overview
1. All call-requests and SMS-requests are stored in a "request table" in our DB.

2. A php script that we call the "master caller" continuously scans this request table and tries to make outbound calls whenever there are new requests. In order to create an outbound call the master caller invokes Polly.php (Polly's main code-base) which calls the user and allows him to interact using DTMF.

3. High level details of every call are stored in a "call table".

4. Details of all users are stored in a user table (user_table_new).
5. Details of all in-call activity are logged in text files.

Technical Details of the DB
Call Table
1. **Call_ID:** Primary key.
2. **Originating _Request_ID:** ID of the entry in the request table which led to this call. One request may lead to multiple calls as the system retries after set intervals until the call recipient picks up.
3. **Phone_Number:** Encoded phone number.
4. **Call_Type:**
    a. **SystemMessage:** A Polly-initiated cold-call to seed the system.
    b. **Missed_Call:** A user-initiated call-me-back request. This call is rejected by Polly without charging the user and a "Call-me-back" call is made in response as soon as some free telephone line is available.
    c. **Call-me-back:** A Polly-initiated call made in response to a "Missed_Call".
    d. **Delivery:** A Polly-initiated call made on behalf of a user to deliver a voice message.
    e. **JDelivery:** A Polly-initiated call made on behalf of a user to deliver a job ad.
    f. **Unsubsidized:** A user-initiated, caller-paid call.
    g. **USDelivery:** A Polly-initiated call made on behalf of a user to deliver a voice message. The request was placed in a caller-paid call.
    h. **USJDelivery:** A Polly-initiated call made on behalf of a user to deliver a job ad. The request was placed in a caller-paid call.
    i. **DelAlert:** A Polly-initiated brief call to inform a voice-message recipient that a Polly has a message for him sent by his friend. This only happens when caller-paid deliveries are enabled.
5. **Call_Start_Time:** Date-time when the system started attempting this call.
6. **Call_End_Time:** Date-time when the call was hungup. If the call became a zombie (terminated unusually) this entry would be marked half an hour after the call-start-time and the actual end time can be dug up from the log files.
7. **CallStatus:**
    a. **Answered:** The call was picked up by the user.
    b. **Failed:** The call was not answered.
    c. **Started: (ignore)** This marks the beginning of "missed_call" type calls but as these are user-initiated and only last a few seconds this status does not mean a lot.
    d. **Complete: (ignore)** This marks the end of "missed_call" type calls but as these are user-initiated and only last a few seconds this status does not mean a lot.
    e. **Complete_Zombie:** The call was answered by the user but terminated unusually at some point during the interaction.
    f. **unsub: (ignore)**
    g. **TimedOut:** The call was not picked up.
    h. **Error:** The call was not picked up.

Request Table
1. **Request_ID:** Primary key.
2. **Recording_ID:** Unique ID assigned to each recording. One recording ID per call. The rerecord function overwrites the previous recording. Once a user decides to forward a recording he cannot rerecord in that call anymore.

3. **Effect_Chosen:** Voice modification chosen for the forwarded voice message. (0: Male2Female, 1: Female2Male, 2: Chipmunk, 3: Bathroom, 4: Original, 5: Whisper, 6: Music)
4. **Requesting_Call_ID:** Call ID of the call in which this request was placed. Multiple requests may be placed in each call.
5. **Request_Type:** Type of request:
    a. **SystemMessage:** Request for a Polly-initiated cold-call to seed the system.
    b. **SMSDelivery:** Request for a text message to a recipient of a voice message (this sms is scheduled for users who have actively called Polly (via missed calls or unsubsidized calls) less than twice).
    c. **Call-me-back:** Request for a Polly-initiated call to be made in response to a "Missed_Call". Not every missed call leads to a Call-me-back request. Here are some scenarios:
        1. If a pending CMB request to the user is already in the system that was never tried before (and has a higher priority in the queue then "retry" type requests), the new missed call would be ignored and another CMB request would not be created.
        2. If a pending CMB request to the user is already in the system that was tried unsuccessfully before, a new CMB request would be created (with retry count set to 0) and the previous CMB request would be marked "upgraded" (and would not be tried again).
        3. If the daily quota of the user has already expired and he has been informed about this, all the subsequent missed calls on that date would be ignored.
    d. **Delivery:** Request for a Polly-initiated call made on behalf of a user to deliver a voice message.
    e. **JDelivery:** Request for a Polly-initiated call made on behalf of a user to deliver a job ad.
    f. **SMSJDelivery:** Request for a text message to a recipient of a forwarded job ad (this sms is scheduled for users who have actively called Polly (via missed calls or unsubsidized calls) less than twice).
    g. **USDelivery:** Request for a Polly-initiated call made on behalf of a user to deliver a voice message. The request was placed in a caller-paid call. This has the highest priority in the queue.
    h. **USJDelivery:** Request for a Polly-initiated call made on behalf of a user to deliver a job ad. The request was placed in a caller-paid call. This also has the highest priority in the queue (equal to USDelivery).
    i. **CallerPaidDLV:** When caller-paid deliveries are enabled all voice message deliveries are marked "CallerPaidDLV" instead of "Delivery". Polly does not call the recipient to deliver these messages but only sends them an SMS, or brief voice call or both (depending on configuration) to inform them about the phone number of the unsubsidized line and that a message from their friend is waiting for them.
    j. **DelAlert:** Request for a Polly-initiated brief call to inform a voice-message recipient that a Polly has a message for him sent by his friend. This only happens when caller-paid deliveries are enabled.
6. **From:** Encoded phone number of the sender.
7. **To_Whom:** Encoded phone number of the recipient.
8. **Originating_Call_Time :** When was this request created in the system.
9. **Request_Status**
    a. **fulfilled:** Request was successfully completed.
    b. **unfulfilled:** System attempted to fulfill the request unsuccessfully. It will be attempted again.
    c. **Done:** Only for SMS requests. This marks them fulfilled.

d. **Failed:** Polly tried to fulfill this request multiple times until the number of allowed retries expired and it was given up as failed.

e. **upgraded:** This request was tried (once or more than once) but all outbound calls failed. It was not given up on. The user placed another missed call and a new request with retry_count=0 was created and this request was marked upgraded. It will not be retried now.

f. **Pending1:** Requests were manually prevented from being tried (only 9 of these).

g. **CallinFulfilled:** Only for CallerPaidDLV type requests. For these requests the status is initially SMSPending, then when an SMS is sent to the recipient the status becomes CallinPending and when the intended recipient calls-in to retrieve the message, the status becomes CallinFulfilled.

h. **SMSPending:** Only for CallerPaidDLV type requests. Intended recipient has not been sent an alert SMS to call and retrieve the message yet.

i. **CallinPending:** Only for CallerPaidDLV type requests. Intended recipient has not called-in to retrieve the message.

10. **Number_of_Attempts:** How many times Polly has already attempted to fulfill this request (max is 1 try and 5 retries for Delivery, JDelivery, USDelivery and USJDelivery and 1 try and 2 retries for Call-me-back.)

11. **Time_of_Last_Attempt:** When did the system last try to fulfill this request.

12. **FollowupCall:** Only for CallerPaidDLV type requests. Was a followup delAlert call scheduled for this message? Possible values:

    a. U: No (default) followup calls were disabled;

    b. D: It was decided as part of an AB experiment not to make a delAlert call for this request (this user received delAlerts for other CPDLVs before).

    c. N: It was decided as part of an AB experiment not to make a delAlert call for this request (coin toss).

    d. YP: Yes a follow up delAlert call was scheduled for this caller paid delivery request and it will be tried.

    e. YD: Yes a follow up delAlert call was successfully made for this caller paid delivery request.

13. **FollowupReqID:** Only for CallerPaidDLV type requests. Request ID of the follow up delAlert call that was made for this request. Default: -1.

User Table (user_table_new)
1. **user_id:** Encoded phone number. Primary key.
2. **date_added:** Date-time when this phone number first appeared in the system and was encoded. This can be the result of a missed_call, unsubsidized call, or at the time of the scheduling of a delivery.
3. **parent_id:** Who introduced this user? If the number first appeared in a Missed_Call or Unsubsidized call then the parent ID is 0.
4. **root_id:** Who was the root of this tree? If this number first appeared in a Missed_Call or Unsubsidized call then the parent ID is 0 and root_id = user_id.
5. **AdjList:** A "-" separated list of all the children of this user.
6. **PhDir: (ignore for LHR data)** Phone numbers of all users who are in the speed dial list of this user.
7. **location:** Location (if known)
8. **type:** user type: WoM: Word-of-mouth (has no parent), ColdSeed (a cold seeded user), P_Introd (Polly introduced i.e. has a parent)

Important definitions:
- "Active Users" are the users who call Polly or use it to schedule deliveries.

Log File
- A single file contains all logs
- Format:
- **CallID%%SeqNo%%Day_Year-Month-date_Hour-Minute-Second** ~:::~ **Details**
  - CallID: Links the logs to the call table
  - Sequence number: Unique, increasing ID assigned to each log line. Some sequence numbers may be missing as some log lines were intentionally deleted (responses from SMSAll)
  - Hour: in 24 hour format. Date-Time is in PKST
  - Details: Details of the log line. Polly's code is available here: (https://docs.google.com/document/d/18pwQJcxecubbNKoxvYsb3hJ6_bU5vf8V-hukxVi11Oo/edit?usp=sharing) to follow each log line detail.

Appendix C: Hypotheses Regarding Initial Lack of Virality in India

This chapter lists all the hypotheses that we developed to explain the initial lack of virality in India. This act work as an initial reference in a similar situation:

Hypotheses Regarding non-Virality

- Problem was: Our initial seeds reached through the automated seeding via Babajob.com, were professional job brokers. For the first time they found this chance of accessing Babajob.com for free through Polly and hence they are not interested in anything else but jobs.
- Problem was with the choice of language (Kannada for Bangalore). It is not very widely understood beyond Bangalore and as Polly spreads quickly we should either switch to a more widely understood language or give a menu of languages:
    o Try Hindi, both in Bangalore and targeting the Hindi belt
    o Try Urdu, both in Bangalore and targeting Delhi
    o Is India more complicated linguistically? Start the interaction with a language-choice menu (against our original strategy, but we can check effect on dialog flow). The menu should makes an auto-choice in case the user hesitates.
- Problem was with the choice of system gender (currently female, that may deter male users from recording messages freely):
    o Try changing to Male voice
- Problem was with the way the system introduces itself
    o Re-design the initial experience & see if it affects dialog flow
        o From: "Now you can do all sorts of cool things with your voice. Check it out",
          To something like (maybe shortened):
          "Now you can do all sorts of cool things with your voice and forward it to your friends for free. Check it out"
          "Now you can send your friends funny messages for free."
        o Give examples of chipmunk effect: e.g. "We can make you sound like this"
        o Suggest specific prompts to repeat
        o For the cases where clearly no recording was made, say "had you recorded blab la, it would have sounded like this: …" now try it yourself."
    o Add a brief introductory prompt at the beginning of initial few interactions of each user
- Problem was with the style/prosody/enthusiasm of the system's prompts (esp. the very first)
    o Some CMU (non-native) Kannada speakers had difficulty following the main menu
        ▪ "The Kannada system should not sound too educated (wording & prosody)"
        ▪ "People in the South do not like the Northern accent of Kannada"
        ▪ "Tamil speakers don't like non-Tamil speakers"
- The Bangalore system had a different image than the Lahore one:
    o Because of system prompts
    o Because of the way it was introduced manually (seeded)
    o Because something is different in India: airtime cost, voice messaging, voice spam, bad experience

- Problematic access to phone numbers at forward time, esp. for first-time users:
  - We can test this hypothesis by comparing dialog flow between BLR and Lahore
    - In the initial cold-seeded calls, no one reached Forwarding stage.
  - Bill Thies: Prepend a hint to have your friend's number ready.
  - Upon forwarding request, give choice to provide it later (but this requires a suspended session)
  - Implemented audio speed-dial (but it doesn't help with 1st-time users)
- Lahore succeeded due to "manual-familiar seeding" / need proper motivation/incentive for seeds.
  - Reseed using a fresh sample of low-literate users who do not know about BabaJobs.com
- In Lahore seeds were motivated to please their superior (Mansoor)
  - Bill: Incentivizing (possibly only initial) spread through monetary gain (airtime/Polly-time). Small guaranteed pay seems to work better than chance of big pay.
  - Aadi: Try seeding with IIT/Delhi workers (and try to replicate the situation in LUMS)
- Lahore succeeded due to back channel introduction/pre-forwarding
- Lahore succeeded by depending critically on groups of young men
  - Seed groups of young men in cities and conduct campaigns in villages.
- Pakistan and India are different in some other way:
  - Run an identical Urdu system, no jobs, in both PK and India:
- There is some other difference between the two systems that we don't see
  - Re-import the BBJ cloud-based system to Lahore, and try it again (in case there is an invisible *dead-skunk* in the BBJ system)
  - How Polly should be pitched / portrayed to seeds? Entertainment (without any mention of jobs)? Free message service? Jobs?
- Babajobs backend doesn't always work (would only affect people when they choose the job menu).
- Cold-seeds/Message delivery recipients are caught off-guard and they do not respond as a result
  - Send an SMS before sending a Polly call (CMB or Delivery or Both?)
  - In cold-seed calls say: "This is a cool new free service. When you have a minute, give us a missed call and see".
- "Back channel" is essential:
  - Of the people who first received a delivery, how many had been tipped beforehand?
    - Test: Eliminate some instructions and see effect.
    - Check how many barged-in with a button before hearing about it ever.
    - Repeat these tests for people who call Polly without having been forwarded to (can signal the popular perception of Polly)
  - Provide a back channel to users to send a plain message in their own voice to friends telling them about Polly (use the sender's number as the caller ID). May be, place this call before the Polly message call, or even without it. Just "tell your friends about Polly! Record your message after the beep" or something like that.
    - Instead of placing this call before the Polly message call, maybe simply start the Polly call with this recording?
- Choice of Hours of cold-seeding: People were contacted when they were busy.
  - Possible Solution: Reseed a fresh sample after office hours or on weekends.
- Choice of Sample: Current users have shown little or no interest in forwarding voice messages or playing with the voice mods. However, they seem keen on listening to a lot of job ads. This may indicate that they do not consider Polly a fun service to play with and spread but a serious service only to listen to jobs ads

- o Possible Solution: Reseed using a fresh sample of low-literate users who do not know about BabaJobs. May be people who may know our team members in personal capacity (maids/gardeners/drivers etc.)
- Our seeds/users seem reluctant to explore Polly and to forward voice messages but often show an eagerness to listen to job ads. One possible reason can be that they already know of BBJ as a paid service and upon finding out that it is now free they become excited about it.
  - o Delay the onset of the jobs option for the initial 4-5 interactions of a user (in both call-me-back calls and delivery calls) to induce spread before utility.
- Most of the recordings indicate that users are not clear about what to record. They say things like "hello", "I don't know what to do" etc. during the recording option.
- Automatic Seeding: Automatic seeding may have led some users to ignore the message as common spam.
  - o Possible Solution: Manual reseeding.
- Biased Sample: As the automatic seeding was done using Babajobs' caller ID and SMS ID, users may have been led to expecting a serious service rather than a fun game.
  - o Possible Solution: Manual reseeding or seeding using other numbers.
- Entertainment/Utility confusion: Almost all of the users preferred utility (listening to jobs) over entertainment (play/spread). This may be the result of giving them the option to browse jobs even before they can be attracted by the entertainment appeal.
  - o Possible Solution: Start giving the option to browse jobs after initial few interactions.
- Possible System Flaws that we are unaware of (dead-skunks):
  - o a. Inability to contact Polly: Recipients of voice delivery messages are confused about how to call Polly.
    - ▪ Possible Solutions: Send SMS; Use BJ local phone number as caller ID in outgoing calls; Accept CMB requests from people who call Polly directly.
  - o b. Inability of the seeds to Call Polly: The seed SMS should be tested on several mobile phones to see if it works fine every time a user tries to calls by clicking the number within the SMS.
- People are expressing that the voice distortions are a reason for not liking the service. What if we add a parallel and simple option to send a voice sms (record -> enter friend number (or choose from voice directory))? We could compare the number of people opting for distortions vs. voice sms.
  - o There may be an interesting (possibly cultural) difference between the perception & preference of Pakistanis (fun & free messaging) and of Indians (primarily free messaging). It may explain why Polly spread virally in Pakistan but not so much so in india, i.e. that entertainment is inherently more viral than a service, even a somewhat useful service.
- Is there any reason why people may be reluctant to call BJ's (Exotel's) missed-call number for fear that their balance would be deducted anyway e.g. the number format may convey that additional taxes will be charged? (we have such numbers in Pakistan), it may be more expensive to call numbers in other telecom circles? (BJ's number must be a BLR number?), very unfamiliar looking number?
- Do people in our target group easily understand the term "missed call" and its meaning? We use this term in our sms and delivery voice calls. I have heard other terms like "flash my number" to refer to missed calls as well.
- What other services are available to these people? What do they use when they want to use cheap communication? SMS? Viber? Do they mostly have smart phones? Is there a reason they may fear such services? Are there many telephonic scams? Do they have other phone based entertainment options?

- Is the entertainment void situation among low-SES Indians similar to their Pakistani counterparts?
- Spandana reported that the security guards did not like the service though they used it easily enough. Why? Shall we do focus groups in India to see if people find Polly funny and engaging?
- Bill reported DTMF problems with GSM modems when calls originated from certain regions of India. Does this ever happen with Polly?
- Although this was tested by Maya on our request before, but still, how reliable is the missed call number? Do calls always ring it properly and successfully register missed calls?
- How many people stop using Polly just because they do not understand/like/prefer the language of the prompts?
- People may be flashing our BLR missed call number too briefly to get the call registered.
- The missed call number may not be working reliably.
- People in India are never sure of telecom calling rates, so they may be: 1. reluctant to give a missed call to a number in another telecom circle (BLR in this case) being unsure of how much money would get deducted if the other side picks up, or even the flashing may get charged. 2. reluctant to pick up the call coming from a BLR number, unsure if it may actually cost them money.
  - We can probably get over 2 by using the message sender's phone number as the caller ID in delivery calls? Even in the CMB calls, we can use the caller's own ID as our caller ID.
    - Question1: Would that be legal/moral?
    - Question2: This would not allow people to call Polly back from their call history. So, not sure how much the trade-off would be...
  - Add an announcement in our calls that Polly is completely free and make it explicit that neither the MIssed Call nor Call-back would charge anyone anything if s/he is anywhere in India. But first we somehow need to make sure if that is indeed the case. Who can confirm that?
- What if, unlike Pakistan, people in India are okay with using SMS in English or transliterated Hindi. As sms is generally cheaper and easier to use, people may prefer it over a free voice messaging service like Polly.
- Short Code. If we can easily get a short code through Exotel, we can just use that to make/receive calls. That will not reveal (hopefully) that it belongs to which telecom circle.
- May be the informed consent is scaring them? What do you think?
- Zahir Koradia: In the last few years, value added services had become quite prevalent where many people felt that service providers had started services on their numbers without their consent. In reality often service providers would send a USSD message to people's phones and require a single button press to enable the service. Many would accidentally press the button (often not being able to read or understand the text sent to them) and get charged money. Since then people have this phobia of pressing a button or calling a number. The exotel number is a standard mobile number. We have a similar number. People do have a fear of calling the number thinking that they will get charged for it. So in our offline introductions we explain that it is a free service and that the system will disconnect and call back.
- Existing attitude of the target group towards receiving IVR cold calls: Are they bothered a lot by telemarketing calls already?
- The entertainment we are offering is not appropriate/appealing for people in India or we have not yet reached the appropriate target audience to whom our form of entertainment will appeal.
- The order of Voice modifications is not attractive.
  - Pilot: Bathroom, chipmunk, original, whisper, music
  - Lahore: M2F, F2M, chipmunk, bathroom, original, whisper, music
  - BBJ: chipmunk, bathroom?, M2F, F2M, bathroom?, original, whisper, music

- "Manual-familiar seeding" methods:
  - "Seeders should be motivated about Polly, well-versed in its functionality, enthusiastic and talkative"
  - "The seeder should introduce Polly as a free and funny voice messaging service without any hint of the jobs option. He should give a brief (well-rehearsed) demo. May be record something in front of the group (or even record one of them), play a few modifications (so that the listeners laugh) and then forward the message to one or more of the audience (this will also help us gather the seeded phone numbers). If they are reluctant to provide their numbers, then just give them Polly's number after the demo. They will also receive the sms. The seeder can even suggest a few forwarding scenarios e.g. "send a funny message to prank a friend..."
    - "Manual-Unfamiliar" seeding, to groups of young men in street.
    - Focusing seeding on a small area (e.g. with village elders)
    - Goonj-like seeding (physical visit & demonstration)
- Group seeding
  - The Seeders should be motivated about Polly, well-versed in its functionality, enthusiastic and talkative. Probably BBJ office workers would be good options.
  - These seeders should target groups of idle young men who sit gossiping at street corners, market places, restaurants etc. as they often have plenty of time and may want to explore Polly just for fun on their own.
  - The seeder should introduce Polly as a free and funny voice messaging service without any hint of the jobs option. He should give a brief (well-rehearsed) demo. May be record something in front of the group (or even record one of them), play a few modifications (so that the listeners laugh) and then forward the message to one or more of the audience (this will also help us gather the seeded phone numbers). If they are reluctant to provide their numbers, then just give them Polly's number after the demo. They will also receive the sms. The seeder can even suggest a few forwarding scenarios e.g. "send a funny message to prank a friend..."
- Seeding-by-curiosity. e.g. a person using Polly on speaker phone in a crowded place. People around may get nosey and excited.

Appendix D: Audio Prompts

Following is a list of the audio prompts of Polly along with their current translations:

PromptName	Urdu	English	Kannada	Hindi
0.wav	Sifar	Zero	Sonne	shoonya
1.wav	Aik	One	Ondu	ek
2.wav	Do	Two	Eradu	do
3.wav	Teen	Three	Mooru	tiin
4.wav	Char	Four	Nalakku	chaar
5.wav	Paanch	Five	Aidhu	paanch
6.wav	Chai	Six	Aaru	che
7.wav	Saat	Seven	Elu	saat
8.wav	Aath	Eight	Entu	aaTh
9.wav	Nao	Nine	Ombattu	nau
Anotherfriend.wav	aur bhi kisi ko bhaijnay kay liyay aik dabain, warna do dabain.	To add another number, press one, or if you are done, press two.	Matthondu Sankhyeannu Serisalu Ondannu Otthi, Illavaadalli Yeradannu Otthi.	aur kisi ko bhejne ke liye ek dabayen, ya phir do dabayen
12.wav	Dobara record kernay kay liay, sifar dabain.	To rerecord, press zero.	Matte Record Maadalu Sonneyannu Otthi.	dobara record karne ke liye shoonya dabayen
13.wav	Dobara sunnay kay liay, aik dabain.	To repeat, press one.	Mattomme Kelalu onndannu Otthi.	is sandesh ko doabra sunne ke liye ek dabayen
14.wav	Ye awaz kisi ko bhaijnay kay liyay, do dabain.	To send to a friend, press two.	Snehitarige kaluhisalu yeradannu otthi	dostoon ko bhejne ke liye do dabayen
15.wav	Iss awaz say jawab bhaijnay kay liay, do dabain.	To reply using this effect, press two.	E effect balasi uttarisalu yeradannu otthi.	is awaz se jawab dene ke liye do dabayen
16.wav	Agli awaz sunnay kay liay, teen dabain.	To try the next effect, press three.	Bere effect annu prayathnisalu murannu otthi	agli awaz sunne kay liay teen dabayen
17.wav	Mulazmat kay ishtiharaat muft sunnay kay liay, panch dabain.	To listen to jobs on Babajob For free, Press 5	Babajob nalli Kelasada Maahithiyannu Uchithavaagi Kelalu Aidannu Otthi.	naukariyon ke baare mein muft jankaari ke liye paanch dabayen
18.wav	Apnay doston kay paighamat sunnay kay liay, chai dabain.	To listen to messages sent to you by your friends, press six.	NImma Snehitharinda Kaluhisalaada, Sandeshagalannu Kelalu Aarannu Otthi.	doston ke messajez sunne ke liye chhah dabayen
19.wav	Ya hamain koi mashwara dainay kay liay, aath dabain.	To tell us what you think about Polly, press eight.	Gini Maathina bagge, nimma anisikeyannu, namage thilisalu, entannu otthi	Miyaan Mitthu ke baare mein kuch kehne ke liye aath dabayen
20.wav	Iss paigham kay bhaijnay walay ka phone number sunnay ka liay, sifar dabain.	To listen to the sender's phone number, press zero.	Kaluhisidavara Dooravaani Sankhyeyannu Kelalu Sonneyannu Otti.	bhejne waale ka namber janne ke liye shoonya dabayen
21.wav	Paigham dobara sunnay kay liay, aik dabain.	To repeat, press one.	Punaha Kelalu, Ondannu Otthi.	dobara sunne ke liye ek dabayen
22.wav	Doston ko bhaijnay kay liay, do dabain.	To forward to friends, press two.	Snehitarige vargayisalu yeradannu otthi	doston ko bhejne ke liye do dabayen
23.wav	Jawab dainay kay liay, teen dabain.	To reply, press three.	Uttharisalu murannu otthi	jawaab dene ke liye teen dabayen
24.wav	Koi naya pagham record kernay kay liay, char dabain.	To record a new message, press four.	Hosa Sandeshavannu Record Maadalu Naalkannu Otti.	naya mesej record karne ke liye chaar dabayen
25.wav	Agala paigham sunnay kay liay, chay dabain.	To listen to the next message, press six.	Mundina Sandeshavannu Kelalu Aarannu Otti.	agla mesej sunne ke liye chhah dabyen
Bye.wav	Hamain call kernay ka shukria. Khuda Hafiz.	Thanks for calling. Good Bye.	kare maadidakke dhanyavaadagalu.	Call karne ke liye dhanyawaad.
ContactDetails.wav	Bas sifar aath sifar chai saath chai aath char char paanch paanch per aik missed call deejiyay aur mian mithoo khud aap ko call karay ga.	Just give us a missed call on 08067684455 and Polly will call you back.	08067684455 E Numbernalli, Kevala Missed Call Needi. Nanthara, Gini Maathu Nimage, Kare Maaduvudu.	bas zero-eight-zero-six-seven-six-eight-double-four-double-five per aik missed call dain aur mian mithoo khud aap ko call karay ga.

delAlertMsg.wav	... nay mian mithoo ko aap kay liay aik paigham dia hai. Iss paigham ko sunnay kay liay jis number say aap ko ye call aai hai, issi number per call keejiyay. Shukria. Khuda Hafiz.	... has asked Polly to deliver a message to you. To listen to the message, simply call back on the same number from which you received this call. Thanks. Good Bye!	sandeshavannu nimage thalupisalu Gini Maathu kelutthide. ee sandeshavannu kelalu, ide sankyeyinda namage thirugi kare maadi. dhanyavaadagalu. Good Bye!	ne miyan mitthu ke haath aapke liye sandesh bheja hai. Is nambar par call karke sunen. Dhanyawaad.
Forward_confirmation.wav	Shukria. Mian Mithoo jald hi aap ka paigham pohancha day ga. Ab aap apni baqi shararat bhari awaizain sunain.	Thanks. Your message will be sent soon... Now you can enjoy the remaining effects...	dhanyavaadagalu. nimma sandesha sheeghradalli kaluhisalaaguvudu... eega neevu ulidiruva effect galannu keli aanandisi...	Dhanyawaad. Aapka messej jald hi bheja jayega. Ab aap baaki aawazon ka aanand uthayen.
Forward_confirmation2.wav	Shukria. Aap ka paigham jald hi bhaij diya jaiy ga.	Thanks. Polly will send your message soon	dhanyavaadagalu. Gini Maathu nimma sandeshavannu sheeghradalli kaluhisuvudu	dhanyawaad. Miyan Mitthu apka mesej sheeghra hi bejega
Friendname.wav	Jinhein bhaijna chahtay hein, beep kay baad un ka naam bolain.	After the beep, please record your friend's name	beep shabdada nantara, dayavittu nimma snehitara hesarannu mudrisi	beep ke baad apne dost ka naam batayen
Friendnoprompt.wav	Jinhein bhaijna chahtay hein, un ka number milain aur aakhir mein hash ka button dabain.	Please enter the phone number of your friend, followed by the pound key	dayavittu nimma snehitara phone sankyeyannu serisi, nantara hash key yannu otthi	ab apne dost ka poora phone namber dabane kay baad hash dabayen
Friendnorepeat.wav	Aap nay jo number milaya hai, wo ye hai...	Here is the number you just entered	idu eegathaane neevu serisida sankye	aapka dabaya hua nambar hai ...
Greetings.wav	Ab aap apni awaz ko tarha tarha kay dilchasp andaz mein badal saktay hein.	Now you can do all sorts of cool things with your voice... Check it out!	eega neevu nimma dhwaniyinda impaada chatuvatikegalannu maadabahudu... parisheelisi nodi!	ab aap apni aawaj majedaar tareekon ke badal sakte hain.
Greetings2.wav	AssalamAlaikum. Mian Mithoo ko aap kay liay aik paigham diya gaya hai. Bhaijnay walay ne Mian Mithoo ko apna naam bataya hai...	Hi! Polly has been asked to deliver a message to you. The sender has stated his name as...	Namaskara! sandeshavannu nimage thalupisalu Gini Maathu kelutthide. kaluhisidavara hesaru heegide...	Miyaan Mitthu aapke liye ek message laye hain. Behjne waale ka naam hai ...
GreetingSingle.wav	AssalamAlaikum. Hamaray pass aap kay liay aik paigham hai. Paigham bhaijnay walay ka naam hai...	Hi. We have a message for you. The sender has stated his name as...	Namaskara! nimagaagi nammalli sandeshavide. kaluhisidavara hesaru heegide...	Namaskaar. Appake liye ek sandesh hai. Bhejne waale ka naam hai ...
Hereitis.wav	Aur wo paigham ye hai.	AndHereIsTheMessage	haagu sandesha heegide...	Sandesh hai ...
InformedConsent.wav	Mian Mithoo ko aap ki pasand kay mutabiq behtar bananay kay liay, ye call record ki ja rahi hai.	This call is being recorded in order to improve Polly.	Gini Maathannu utthamagolisuva saluvaagi ee kareyannu record madalaguvudu.	Miyan Mitthu ko aur behtar banane ke liye ye call record ki ja rahi hai
J_CallLater.wav	Baraiy Mehrbani kuch dair baad call keejiyay. Shukria.	Please call later. Thank you.	dayavittu nantara kare maadi. dhanyavaadagalu	Kripaya kuch der baad call karen. Dhanyawaad.
J_ConfirmSend.wav	Shukria. Ye ishtihar aap kay dost ko jald hi bhaij diya jaiy ga. Ab aap baqi Ishtiharaat suniyay.	Thanks. Polly will send this ad to your friends soon. Now listen to the remaining ads.		dhanyawaad. Miyan Mitthu is vigyaapan ko sheegra hi bhejega. Ab aap baaki vigyapanon ko suniye.
J_Greetings.wav	AssalamAlaikum. Ab aap ghar baithay akhbaraat kay taaza tareen ishtiharaat bilkul muft sun saktay hein. Ye service aap tak Punjab Information Technology Board kay Ta'awun say pohanchai ja rahi hai.	Hi. You can now listen to the latest newspaper job ads for free without leaving the comfort of your home. This service is being brought to you through by courtesy of the Punjab Information Technology Board.		Namaskaar. Babajobs ki taraf se ab aap nokrion kay vigyapan muft mein sun sakte hain.
J_Greetings2.wav	AssalamAlaikum. Aap kay liay mulazmat ka aik ishtihar bhaija gaya hai. Bhaijnay walay nay hamain apna naam bataya hai...	Hi. A newspaper job ad has been forwarded to you. The sender has stated his name as.		Namaskaar. Apke liye ek vigyapan hai. Bhejne waale ka naam hai ...
J_Hereitis.wav	Aur wo ishtihar ye hai...	And here is the ad.		ye hai wo vigyapan ...
J_Menu.wav	Sirf rabtay ki maloomat dobara sunnay kay liay, aik dabaiyay. Mukammal	To repeat the contact details, press one. To repeat the whole ad, press two. To send		nambar dobara sunne ke liye ek dabayen. Poora vigyapan dobara

	Ishtihaar dobara sunnay kay liay, do dabaiyay. Ye ishtihaar kisi ko bhaijnay kay liay, teen dabaiyay. Pichla ishtihar dobara sunnay kay liay, char dabaiyay. Agla ishtihaar sunnay kay liay panch dabaiyay, ya chand lamhay intizar farmaiyay.	this ad to a friend, press three. To listen to the previous ad, press four. To listen to the next ad, press five or simply wait for a few seconds.		sunne ke liye do dabayen. Kisi ko bhejne ke liye teen dabayen. Pichhla vigyapan sunne ke liye chaar dabayen. Agla vigyapan sunne ke liye paanch dabayen ya kucch der intezaar karen
J_Next.wav	Agla Ishtihar	Next ad.		agala vigyapan hai …
J_NoMoreAds.wav	Ham mazrat khua hein. Iss waqt system mein mazeed ishtiharaat mojud nahin hein.	We are sorry that there are no more ads in the system right now.		Maaf karen, is samay hamare paas aur vigyapan uplabdh nahin hain
J_PlayingFromBeg.wav	Ab istiharaat dobara shuru say chalai janay lagay hein…	Now the ads will be played from the beginning again.		Saare vigypan shuroo se suniye ..
J_Prev.wav	Pichla istihaar	Previous Ad.		Picchla vigyapan …
J_Skip.wav	Kisi bhi waqt agla ishtihar sunnay kay liay koi bhi button dabaiyay.	At any time, you can press any key to skip to the next ad.		agla vigyapan sunne ke liye kisi bhi samay koi bhi namabr dabayen
J_SolicitFeedback.wav	Aap ko mulazmat kay ishtiharat ka ye nizam kaisa laga? Beep ki awaz kay baad apnay mashwaray record kerwaiyay takay ham is nizam ko aur behtar bana sakain.	Do you like the newspaper job ad system? After the beep please record your suggestion so that we can improve Polly.		Kay aapko Miyan Mitthu accha laga? Beep ke baad apne vichaar hamen batayen
J_SPrompt.wav	Ab aap ghar baithay akhbaraat mein diyay gaiy mulazmat kay ishtiharaat bilkul muft sun saktay hein. Ishtiharaat sunnay kay liay, aik ka button dabain.	Now you can now listen to the latest newspaper job ads for free without leaving the comfort of your home. To listen to the latest ads now, press one.		Ab aap akhbaaron se naukriyon ke vigyapan ghar baithe baithe sun sakte hain. Nai vigyapan sunne kay liay aik dabaen.
J_YouCan.wav	Ab aap ghar baithay akhbaraat mein diyay gais mulazmat kay ishtiharaat bilkul muft sun saktay hein.	Now you can now listen to the latest newspaper job ads for free without leaving the comfort of your home.		Ab aap naukriyon ke vigyapan muft mein ghar baithe baithe sun sakte hain
msg1.wav	Mian Mithoo ko aap kay liay aik naya paigham diya gaya hai…	Polly has been given one new message for you.	Gini Maathu nimagaagi ondu hosa sandeshavannu needidhe	Miyan Mitthu appke liye ek naya message laya hai
msg2.wav	Mian Mithoo ko aap kay liay do nay paighamat diya gaiy hain…	Polly has been given two new messages for you.	Gini Maathu nimagaagi yeradu hosa sandeshagalannu needidhe	Miyan Mitthu appke liye do naye message laya hai
msg3.wav	Mian Mithoo ko aap kay liay teen nay paighamat diya gaiy hain…	Polly has been given three new messages for you.	Gini Maathu nimagaagi mooru hosa sandeshagalannu needidhe	Miyan Mitthu appke liye teen naye message laya hai
msg4.wav	Mian Mithoo ko aap kay liay char nay paighamat diya gaiy hain…	Polly has been given four new messages for you.	Gini Maathu nimagaagi nalku hosa sandeshagalannu needidhe	Miyan Mitthu appke liye chaar naye message laya hai
msg5.wav	Mian Mithoo ko aap kay liay panch nay paighamat diya gaiy hain…	Polly has been given five new messages for you.	Gini Maathu nimagaagi aidu hosa sandeshagalannu needidhe	Miyan Mitthu appke liye paanch naye message laya hai
msg5p.wav	Mian Mithoo ko aap kay liay panch say ziada nay paighamat diya gaiy hain…	Polly has been given more than five new messages for you.	Gini Maathu nimagaagi aidakkintalu hechchu hosa sandeshagalannu needidhe	Miyan Mitthu appke liye paanch se jyada naye message laya hai
msgFirst.wav	Pehla paigham	First message	modala sandesha	pehla message
msgNameIs.wav	Iss paigham kay bhaijnay walay ne Mian Mithoo ko apna naam bataya hai…	The sender of this message has stated his name as	ee sandeshavannu kaluhisidavara hesaru heegide	Sandesh bhejne waale ka naam hai …
msgNext.wav	Agla paigham	Next message	mundina sandesha	agla message ..
msgNoMore.wav	Mian Mithoo kay pass aap kay liay abhi koi aur paigham nahin hai…	Polly has no more messages for you right now.	Gini Maathalli nimage innu yavude sandeshagalu illa.	Miyan Mithhu ke paas aapke liye aur message nahin hain
msgNowOrLater.wav	Ye paighamat abhi sunnay kay liay aik dabain, warna do dabain.	To listen to these messages right now, press one. Otherwise, press two.	ee sandeshagalannu eegale kelalu ondannu otthi. illavadalli yeradannu otthi.	Messages sunne ke liye ek dabayen athwa do dabayen
Nobutton.wav	Ap nay koi button nahin dabaya	You did not press any button.	neevu yaavude sankheyannu aayke madilla.	aapne koi butoon nahin dabaya

Numberconfirm.wav	Agar ye sahi hai to, aik dabain, warna do dabain.	If this is correct, press one. Otherwise, press two.	idu sari iddalli ondannu otti, illavadalli yeradannu otti.	agar yah sahi hai to ek dabayen athwa do dabayen
Processingplzwait.wav	Chand lamhay intizar farmaiyay	Please wait for a few seconds.	Dayavittu Kelavu Kshanagalu Kaayiri.	Bas kuch second intazaar karen
Promptforspeaking.wav	Bas beep ki awaz kay baad kuch bhi kahain aur hash ka button dabain…	Just say something after the beep and press the pound key when done.	Beep na nanthara yenannadaru heli nanthara hash annu otti.	beep ke baad kuch bhi kahen aur phir hash dabayen
Quota2.wav	AssalamAlaikum. Mian Mithoo aur mulazmat kay ishtiharat ki service ko pasand kernay ka shukria. Funds mehdood honay ki waja say, aj Mian Mithoo aap ki itni hi missed caloun ka jawab day sakta tha. Mian Mithoo say fori rabtay kay liay, app kisi bhi waqt hamaray dosray number per, call ker saktay hein. Number note farmaiyay. sifar char do, teen aath, teen teen teen, aik aik do… Yaad rahay kay Mian Mithoo ki service pehlay ki tarha bilkul muft hai, laikin is number per ki janay wali calloun ki qeemat, aap ko khud ada kerni ho gi. Aap kal phir hamein mazeed missed callein ker saktay hein, jin ka jawad Mian Mithoo aap ko day ga. Shukria. Khuda Hafiz.	Hi. Thanks for your interest in Polly and the job ads service. Due to our limited budget, Polly cannot pay for any more calls to you today. Tomorrow Polly will again reply to your missed calls. To reach Polly immediately, you can always call our other phone number, 04238333112. Polly's service is always free, but you will have to pay for your own airtime when calling this new number. Thank you, and good bye.		Aaj aapke liye Miyan Mitthu ke paas itni hi call budget hai, aap kal phir muft mein vigyapan sun sakte hain. Agar sunne ke liye aap khud call ke paise dena chahte hain to zero-four-two-three-eight-triplethree-doubleone-two par call karen. Miyan mitthu se vigypan sunne ke liye dhanyawaad.
Readyforeffects.wav	Kya aap apni dilchasp andaaz mein badli hui awaz sunnay kay liay tayyar hein? Ye lejiyay…	Now get ready for the effects… Here goes!	eega effect galigagi tayari maadi kolli…igo illi!	Yeh hai aapki aawaz ke anokhe andaaj, taiyaar ho jaiye!
Recordyourfeedback.wav	Shukria. Aap ko Mian Mithoo kaisa laga? Beep ki awaz kay baad, apnay mashwaray record kerwain, takay ham Mian Mithoo mein aap ki pasand ki tabdeelian ker sakain.	Thanks. Do you like Polly? After the beep, please tell us what you like or don't like about Polly, and suggest improvements and additions.	Dhanyavadagalu, Nimage Gini Maathu Ishtavayithe? Dayavittu Beep na nanthara Gini Maathina Bagge Nimma Anisikeyannu Record Maadi Haagu Gini Maatannu Mattashtu Uttamagolisalu Nimma Salaheyannu Needi.	Dhanewad. Aap ko Mian Mithoo kaisa laga? Beep kay baad, apnay sujhao hamain batain, takay ham Mian Mithoo ko aap ki pasand kay anusaar sudhaar sakain.
Recordyourname.wav	Beep ki awaz kay baad apna naam bolain, kyunkay aap ki awaz kay saath aap ka naam bhi bhaija jaiy ga.	AfterTheBeepPleaseRecordYourNameSoThatYourFriendCanSendYouAMessageBack	Beep nantara nimma hesarannu record maadi, aaga nimma snehitha nimage punaha sandesha kaluhisabahudu	Beep ke baad apna naam batayen taaki aapke dost apko is naam se message bhej saken
Salaam.wav	AssalamAlaikum.	Hi.	Namaskara.	Namaskaar
SeedGreetings.wav	Aap kay liay khush khabri hai kay aap ki pasandeeda service Mian Mithoo ka dobara aghaz ho gaya hai. Mian Mithoo mein aap ki pasand ki bohat si tabdeelian ki gai hein. Yehi nahi, balkay ab aap Mian Mithoo kay zaryay akhbaraat mein diyay gay mulazmat kay ishtiharaat bilkul muft sun saktay hein. Mian Mithoo aur ishtiharaat ki service aap tak Punjab Information Technology Board kay ta'awun sa pohanchai jaiy gi…	Good news! Your favorite service, Polly, has been started again. Based on your feedback, we have made a lot of exciting changes in Polly. On top of that, you can now listen to the latest newspaper job ads through Polly completely for free. Polly and the job ads service are brought to you courtesy of the Punjab Information Technology Board.		Miyan Mitthu ab Punjab Information Technology Board ke saujanya se aur bhi nayi anokhi adaon ke saath wapas aa gaya hai. Aur ab aap akhbaaron ke vigyapan ekdam muft mein sun sakte hain.
senderPh.wav	Bhaijnay walay ka phone number hai…	The sender's phone number is:	Sandeshavannu Kaluhisidavara Dooravaani Sankhye.	Bhejne waale ka nambar hai
Thanksbye.wav	Shukria. Khuda Hafiz.	Thank You. Goodbye!	Dhanyavaadagalu.	Dhanyawaad.

ThanksforFeedback.wav	Apna Qeemti waqt dainay ka shukria. Ham jald hi aap kay mashwaron per amal kernay ki koshish kerain gay.	Thank you for your time and advice. We will try to incorporate your feedback as soon as possible.	NImma Samaya Haagu Salahege Dhanyavaadagalu. Aadashtu Bega Nimma Salaheyinda Namma Seveyannu Uttamagolisalu Prayathinisutteve.	Aapke sujhawon ke liye dhanyawaad. Ham aapke sujhawon par jald hi vichaar karenge.
Thanks_sendingSMS_bye.wav	Mian Mithoo abhi aap ko message ker kay hamara number bataiy ga, jahan se aap hamain muft call ker saktay hein.	Polly will soon send you an sms to allow you to send cool voice messages to your friends for FREE. Thanks. Goodbye!	Gini Maathu Nimage Ondu Sandeshavannu Kaluhisuttade Nanthara Neevu Nimma Imapada Dhwaniyinda Sandeshavannu Nimma Snehitharige Uchithavagi kaluhisabahudu. Dhanyavadagalu.	Miyan Mitthu ke sms ka intezar karen aur apni nayi aawajon mein doston ko muft mein message bhejne ki jankari haasil karen. Dhanyawaad.
Tryagain.wav	Dobara koshish keejiyay.	Please try again.	Dayavittu Punaha Prayathnisi.	kripaya fir se koshish karen
Wrongbutton.wav	Aap nay sahi button nahin dabaya.	You did not pressed a valid button.	Neevu Sariyaada Sankhye Aayke Maadilla	Aapne sahi button nahin dabaya
YouCan	Ab aap kisi bhi waqt Mian Mithoo ko call ker kay apni awaz ko dilchasp andaz mein badal saktay hein, aur phir is badli hui awaz ko apnay doston ko bilkul muft bhaij saktay hein.	You too can call Polly anytime to apply cool effects to your voice and to send it to your friends, completely for free.	Neevu Saha Yavude Samayadalli Gini Maathige Kare Maadi Nimma Impada Dhwanige Vividha Effectgalannu Serisi Nimma Snehitharige Kaluhisabahudu...... Adu Uchitavagi!	Ab aap bhi Miyan Mitthu ko call karke apni aawaz majedaar tareekon se badal sakte hain aur apne doston ko nayi aawaz mein message bhej sakte hain. Yah seva muft hai.
Name of Polly	Mian Mithoo	Polly	Gini Maathu	Miyan Mitthu
SMS	Abhi 04238333112 per call ker kay baghair kisi intizar kay Mian Mithoo say baat kerain (Iss call ki qemat aap ko ada kerni ho gi)	Call 080-67684455 For Free. Just Give Us Missed Call and Polly Will You Back	080-67684455 e Number ge Ondu Missed Call Needi Nanthara Gini Maathu Nimage Kare Maaduvudu.	zero-eight-zero-six-seven-six-eight-double-four-double-five par missed call den aur Miyan Mitthu se apna number call karwayen
SMS	04238333111 per muft call kerain. Bas missed call kerain aur Mian Mithoo khud aap ko call karay ga.	To reach Polly immediately, call 0423833112 right now (you will be responsible for airtime cost).	Polly ya jotte takshina maathaadalu 04238333112 kare needi. Ee karege tamage charge aaguthade	Miyan Mitthu se turant baat karne ke liye zero-four-two-three-eight-triplethree-doubleone-two dial karen. Dhyan rakhen is call ke charges aapko bharne honge.
SMS				
SMS	04238333111 per muft nokri kay ishtihar sunain. Bas missed call kerain aur Mian Mithoo khud aap ko call karay ga.	Listen to job ads for free on 04238333111. Just give us a missed call and Polly will call you back.		Naukriyon ke vigyapan ab muft mein sunen. Zero-four-two-three-eight-triplethree-doubleone-two par missed call den aur Miyan Mitthu se call paayen. Danyawaad.
SMS	Aap kay liay $ouserid nay Mian Mithoo ko aik paigham dia hai. Paigham sunnay kay liay 04238333112 per call kerain. Shukria.	$ouserid has given Polly a message for you. Please call 04238333112 to listen to it. Thanks.	$ouserid polly ya moolaka tamagondu sandeshavannu kaluhisalaagide. Adannu kelalu 04238333112 ige kare maadi. Dhanyavaada.	Miyan Mitthu ke paas $... Se apke liye message hai. Sunne ke liye zero-four-two-three-eight-triplethree-doubleone-two call karen. Dhanyawaad.
0.wav	zero	zero	zero	zero
SaveNumber.wav	Kya aap ye number save kerna chahein gay? Save kerne kay liye aik dabain, warna do dabain	Would like to save this phone number for future use? To save, press one, otherwise. press two.		Kya aap ye number save kerna chahein gay? Save kerne kay liye aik dabain, ya fir do dabain
NameOfNumber.wav	Jis naam say save kerna chahte hein Beep kay baad wo naam bolein!	Okay! After the beep please record your friend's name		Jis naam say aap save kerna chahte hein, usay beep kay baad bolain.
NewNumber.wav	Koi naya number dakhil kerne kay liye, sifar dabain.	To enter a new number, press zero.		Koi naya number dalne kay liay shunye dabain.
SendTo1.wav	... ko bhaijne kay liye, aik	For.." "...press one		... ko bhaijne kay liye,

	dabain			aik dabain
SendTo2.wav	... ko bhaijne kay liye, do dabain	For..." "...press two		... ko bhaijne kay liye, do dabain
SendTo3.wav	... ko bhaijne kay liye, teen dabain	For..." "...press three		... ko bhaijne kay liye, teen dabain
SendTo4.wav	... ko bhaijne kay liye, char dabain	For..." "...press four		... ko bhaijne kay liye, char dabain
SendTo5.wav	... ko bhaijne kay liye, panch dabain	For..." "...press five		... ko bhaijne kay liye, panch dabain
SendTo6.wav	... ko bhaijne kay liye, chai dabain	For..." "...press six		... ko bhaijne kay liye, chai dabain
SendTo7.wav	... ko bhaijne kay liye, saat dabain	For..." "...press seven		... ko bhaijne kay liye, saat dabain
SendTo8.wav	... ko bhaijne kay liye, aath dabain	For..." "...press eight		... ko bhaijne kay liye, aath dabain
SendTo9.wav	... ko bhaijne kay liye, nau dabain	For..." "...press nine		... ko bhaijne kay liye, nau dabain
26.wav	apni asli awaz mein paigham bhejne kay liye, char dabain	to send a message in your unmodified voice, press 4		Apni bina-badli hui awaz mein sandesh bhejne kay liye, char dabain.

Appendix E: How to Deploy Polly?

Polly supports several deployment mechanisms each suited to different needs. Polly's code-base is originally written in PHP for Tropo platform. However, I added FreeSwitch support to it afterwards maintaining the same code-base.

Rapid Cloud-based Deployment

In order to do a quick pilot deployment in a new country, we need a ways to minimize local partner's skills and effort. Using this mechanism reduces the barriers to Polly's entry. Here is a summary of this setup:

1. Polly's core code and audio files (for voice prompts) are deployed on tropo's cloud. Detailed call-logs are also maintained here.
2. A server at CMU hosts the following:
   - Database
   - Database-access scripts that are invoked from Polly's core code
   - Voice modulation scripts that use Praat scripting
   - Quicklogs (summary of user's interface related activities) are logged here at the end of each call (sent by Polly's core-code).
   - Master scripts that are responsible for all scheduling
     - Master Scheduler: Invoked by Window's Task Management once every 5 minutes, it makes sure that Master Caller and Master Reviver are running. It sends all SMS messages to users and also removes records of any zombie calls (calls that terminate abruptly without producing records in the DB)
     - Master Caller: Makes all outbound calls (CMBs, Deliveries, Job Deliveries etc.). Runs in a continuous loop. Also deals will all server load balancing and resource allocation in case of local deployment.
     - Master Reviver: Reschedules all failed call attempts. Runs is a continuous loop.
3. An on-ground phone setup receives missed-call based call-me-back requests. Rejects all incoming calls and forwards the phone-number to the server at CMU, where it is added to the queues of numbers to be called.
4. A method to send local SMS

This means that in terms of technical support from the partner we only need 3 and 4. In addition we also want their help in translating and recording Polly's (less than 100) voice prompts.

The shortcomings of this setup include higher calling costs (as all calls are made from the US), deteriorated (sometimes) audio quality and limited incoming call capacity (of the missed-call number). The following could be used to overcome the call costs but we have not tried it as SIP traffic is blocked both in India and Pakistan:

1. Initiate an outgoing SIP call from tropo's cloud to a local server (A) in the destination country (currently at $0.03/minute/leg)
2. Attach telephony hardware (PRI, GSM modems, VoIP modems etc.) to A

3. Use a VoIP gateway setup on A to bridge the incoming SIP call through to the local network at local calling costs.

Local Deployment

This is the large-scale deployment method that we used in Pakistan. Essentially it hosts all code and data in the destination country on a single (or several connected) server. This requires contracts with local telecoms or a personal setup using GSM modems or PRIs. This is much better in terms of voice quality and call costs however, suffers from technical difficulties on ground (e.g. power, internet etc.) and can potentially take a long time to setup.

Our last Pakistan-based deployment used a local version of Tropo (running over voxeo's Prism). We are also working on a FreeSwitch version of Polly that uses the same code-base.

Appendix F: Detailed Analyses & Graphs

Complete year of Lahore Large-Scale Deployment (to be published)
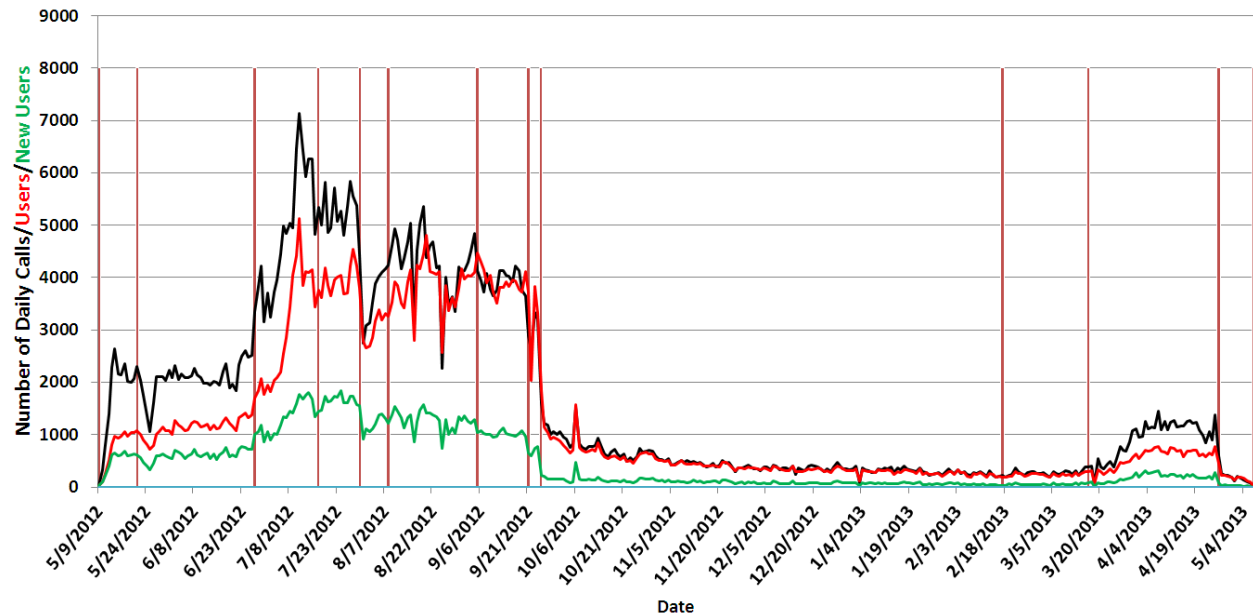

Timeline and Chronology

Major Phases

- **May 9, 2012 to May 15, 2012 - EXP-1:** The first exponential growth phase culminating in a plateau due to voice bandwidth capacity bound of 10 simultaneous calls.
- **Jun 27, 2012 to July 11, 2012 - EXP-2:** The second period of exponential growth when the voice bandwidth was increased to support 30 simultaneous calls.
- **May 16, 2012 to Jun 26, 2012 - Viral-1:** The first viral period when daily traffic volume remained nearly same.
- **Jul 13, 2012 to Jul 29, 2012 - Viral-2:** The second viral period when daily traffic volume did not vary a lot.
- **Sept 25, 2012 to Mar 20, 2013 – Steady State:** Subsidized message deliveries were disabled during this period and users were allowed one subsidized call per day.

Here are some of the major events on the Lahore timeline:

- **May 09, 2012 - Seeding:** Polly was seeded by cold-calling 5 of the most frequent callers of its 2011 Pilot.
- **May 21, 2012 – Daily quota of 7 toll-free calls:** Launched 2-arm Q7 experiment. Users exceeding 7 calls/day are placed into treatment group Q7R (calls beyond the 7th call each day are directly answered and thus not subsidized) or Q7F (no quota on call subsidy).
- **Jun 27, 2012 - Voice bandwidth bug fixed:** Telco fixed the bug that had been reducing voice bandwidth to allow supporting only 10 simultaneous calls (instead of 30).

- **July 17, 2012 – Added a caller-paid line:** Users can call this line directly to access Polly as many times per day as needed.
- **July 30, 2012 – Daily quota of 3 toll-free calls:** Q3 RCT was deployed. Users assigned at random to a grace period of 0, 1 or 2 days of unlimited subsidized calling.
- **Aug 08, 2012 – Daily quota of 2 toll-free calls:** Q2 RCT was deployed. Users assigned at random to a grace period of 0, 1 or 2 days of unlimited subsidized calling.
- **Sep 05, 2012 – Daily quota of 1 toll-free calls:** Q1 RCT was deployed. Users assigned at random to a grace period of 0, 1 or 2 days of unlimited subsidized calling.
- **Sep 21, 2012 – Daily quota of 1 toll-free calls:** The grace period was eliminated for all users.
- **Sep 25, 2012 – Caller-paid Deliveries:** All subsidized message deliveries were stopped. Users are only alerted via a short call or SMS to call in (and pay for the airtime) and retrieve their messages.
- **Feb 17, 2013 – Daily quota of 2 toll-free calls:** The daily quota was increased to 2 toll-free calls.
- **Mar 16, 2013 – Quota of 1 and subsidized deliveries:** Converted back to Q1 and enabled subsidized deliveries in toll-free calls.
- **Apr 26, 2013: Quota of 0 subsidized calls:** All subsidized calls' quota has been ended. Now the only way to reach Polly is through caller-paid calls.
- **May 07, 2013 - Shutdown:** Polly was shutdown
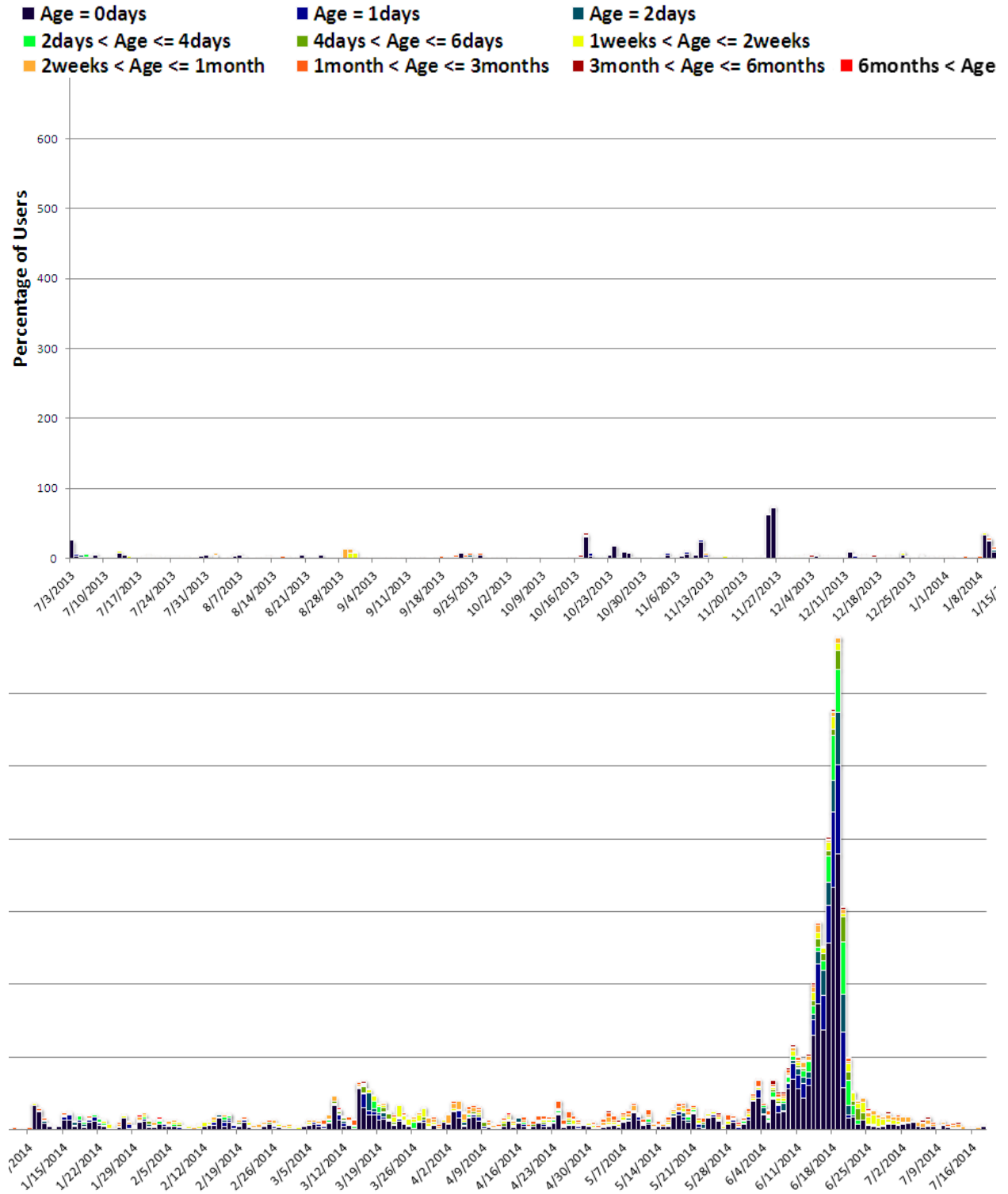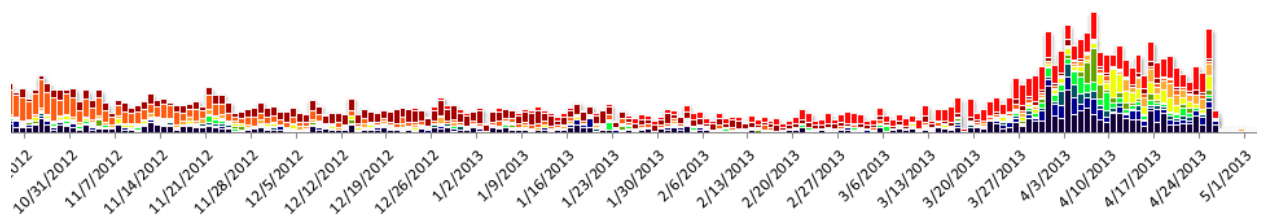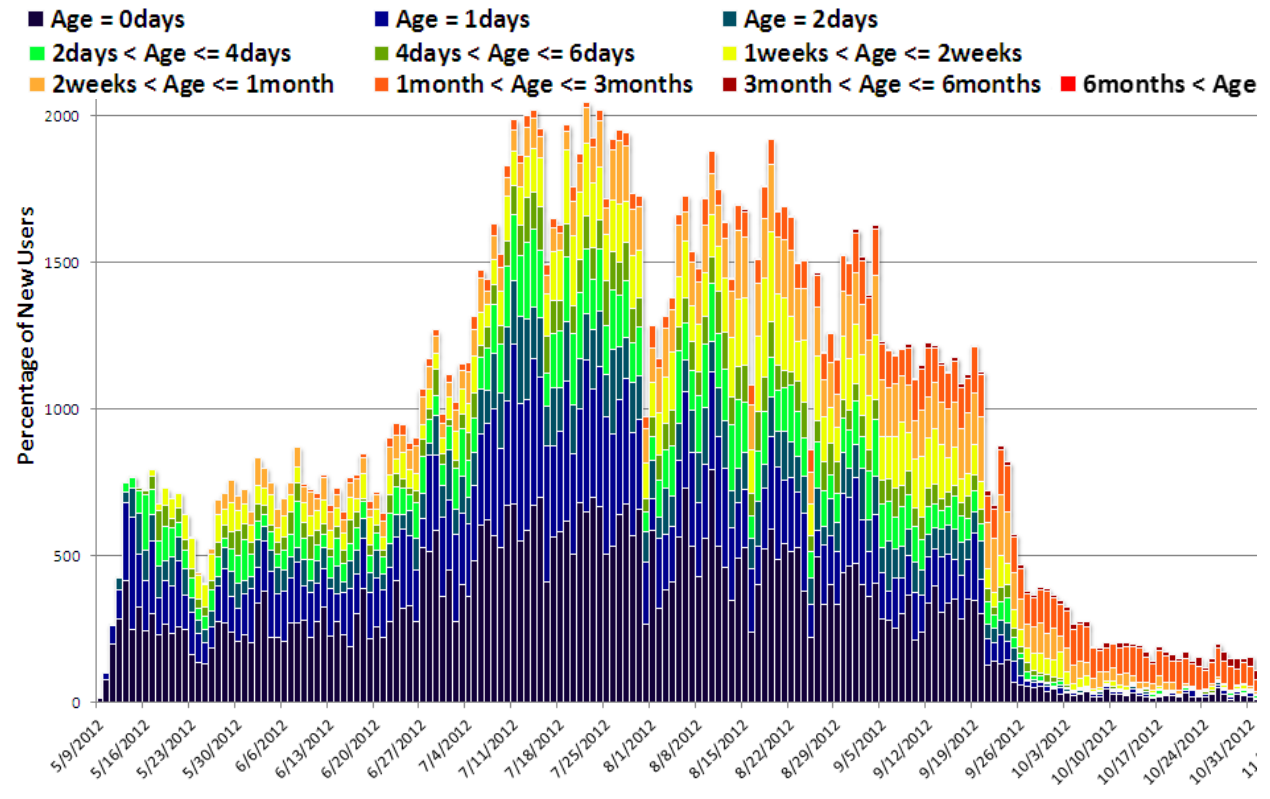
Daily User Volume Distribution by Polly Age (Jharkhand)
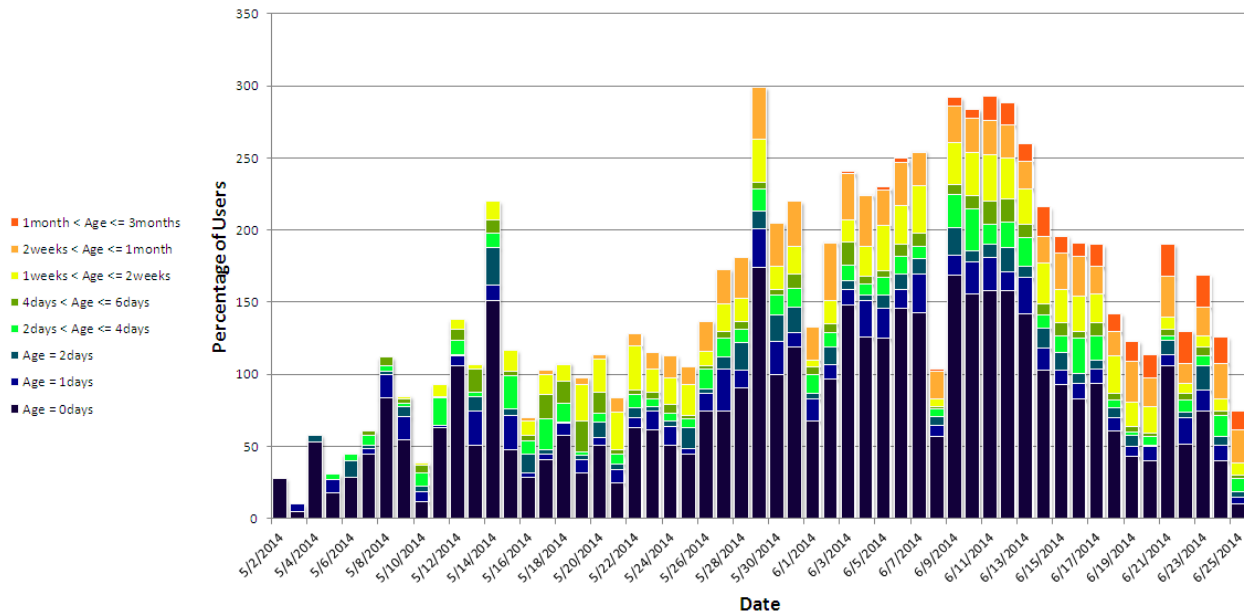
Daily User Volume Distribution by Polly Age (Lahore)
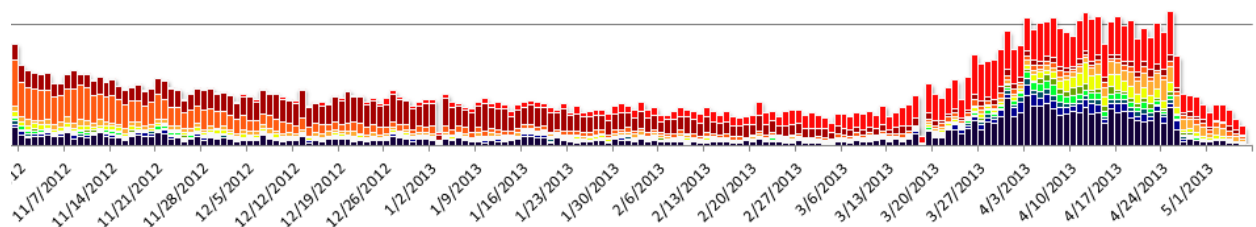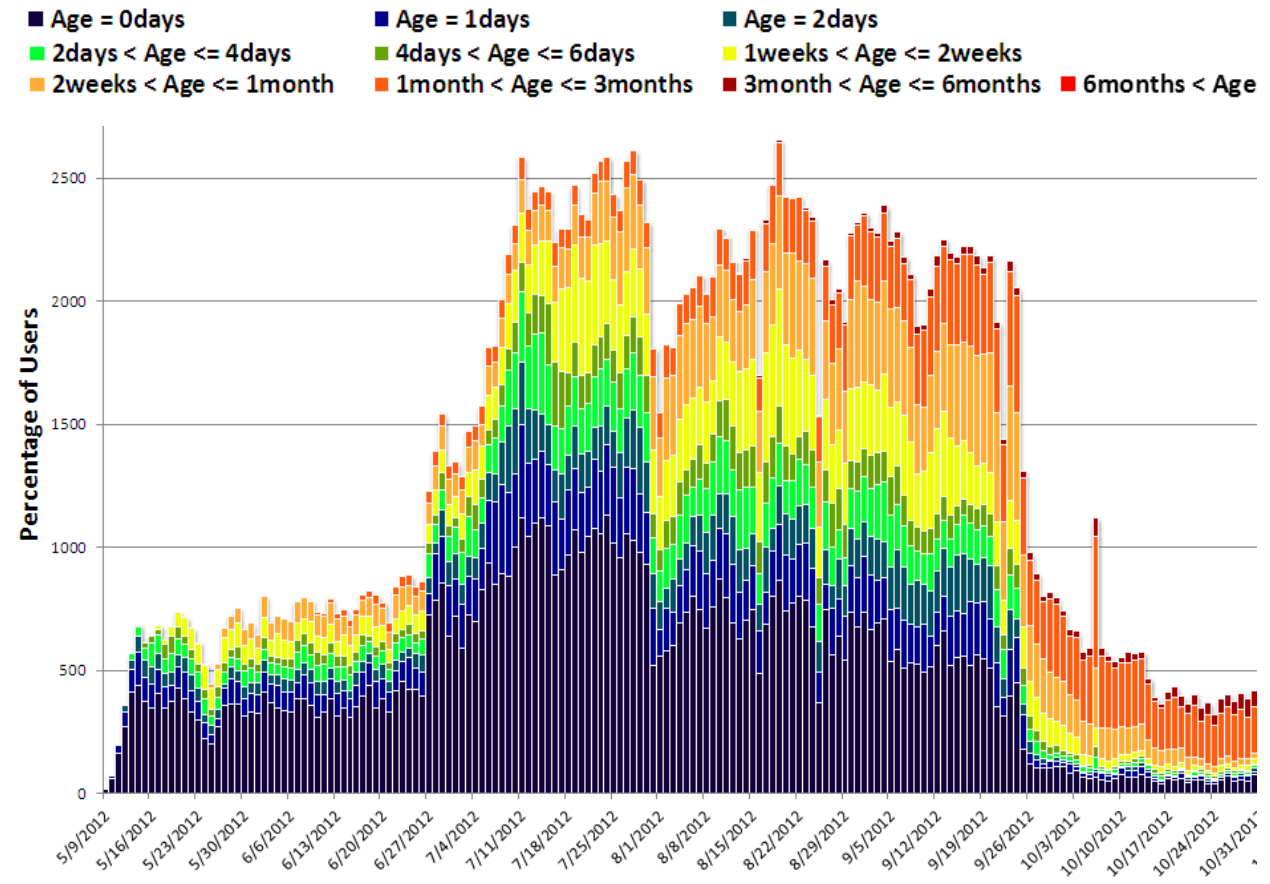
Daily User Volume Distribution by Polly Age (Bangalore)

158

Daily New User Distribution by Introducer's Polly Age (Lahore)

Legend:
- Age = 0days
- Age = 1days
- Age = 2days
- 2days < Age <= 4days
- 4days < Age <= 6days
- 1weeks < Age <= 2weeks
- 2weeks < Age <= 1month
- 1month < Age <= 3months
- 3month < Age <= 6months
- 6months < Age

Daily New User Distribution by Introducer's Polly Age (Bangalore)

■ Age = 0days   ■ Age = 1days   ■ Age = 2days
■ 2days < Age <= 4days   ■ 4days < Age <= 6days   ■ 1weeks < Age <= 2weeks
■ 2weeks < Age <= 1month   ■ 1month < Age <= 3months   ■ 3month < Age <= 6months   ■ 6months < Age