The Mali Milk Service 3.0

A voice-based milk selling and farmer networking platform for Tominian Mali

Aske Robenhagen, Bart Aubers

ICT4D
Victor de Boer, Anna Bon, Stefan Schlobach
Vrije Universiteit Amsterdam
The Netherlands
May 2016

1 Introduction

Information and Communications Technology(ICT) has been enormously influential in spurring economic development and the empowerment of people across the world in ways previously impossible. However these benefits have not historically been equally distributed across the world(Sadowsky et al., 2012). The term digital divide(Ho, Smyth, Kam, & Dearden, 2009; Sadowsky et al., 2012) is sometimes used to refer to this gap between a primarily rural and poor population in developing nations and the predominantly urban digitalized population. There have been many projects to help ameliorate this divide, some well-intended, but not successful projects including sending old computers to be used in conditions where they broke down[1] and ended up as landfill[2] to more successful extensions of local technologies in a bottom-up approach like RadioMarché(de Boer et al., 2012). This report outlines the third version of a system developed using a bottom-up approach based on a use case from Mali regarding the need for a local milk selling solution and expanded to help enable empowerment through dairy cooperatives. The use case was created by associates of the Web Alliance for Regreening in Africa (Bon et al., 2013) and extended based on further research outlined in the background and use case sections of this report.

2 Background

Electricity and internet access is sparse in many rural areas (Davis, 1998) across the developing world and particularly in many African nations, but despite of this lack of infrastructure mobile phone usage is high and increasing(Poushter & Oates, 2015). Large parts of Africa have leapfrogged to mobile phones, skipping the land line communication stage seen throughout Europe and North America(Poushter & Oates, 2015). Cell phone ownership has surged in recent years as shown by figure 1 and 2.

This means that despite low internet penetration, there are rich possibilities for mobile based systems in rural Africa. Across rural areas illiteracy remains a big issue(Ho et al., 2009; F. Dittoh, van Aart, & de Boer, 2013) which also precludes use of SMS based systems which in turn can also be prohibitively expensive for locals (Gyan et al., 2013). The multiplicity of local languages across Africa, often with few speakers and small or non-existing textual corpora, means that building systems easily used by locals, requires localization at the micro-level using audio recordings and not through text-to-speech software based on machine learning. Focusing on the local languages has also been argued by some as being a necessary part of sustainable development (Trudell, 2009). Both of these factors make text-based systems suboptimal, giving prominence to voice-based systems (Gyan et al., 2013). An example of a successful voice-based system is RadioMarché(de Boer et al., 2012; Gyan et al., 2013) which extended an existing solution for connecting rural farmers with potential buyers via a phone, web, and radio-based system. Evidence suggests that connecting, in particular women, to informal markets can have a positive impact on food safety by giving them a source of money than can be exchanged for other food stuffs thereby diversifying their food sources and decreasing reliance on a particular food source(Roesel & Grace, 2014). Furthermore, as mentioned during a lecture on the ICT4D course given by Victor de Boer, the lack of access to markets means that many farmers will downsize production to avoid spillage. In Mali, and other countries in the Sahel, this creates a big unused potential for growth in the dairy and associated industries(Kline & Gordon, 2012).

2.1 Gender Issues

Milk production in Mali and elsewhere in Western Africa includes a strong division of labour between the sexes (Roesel & Grace, 2014). In Mali cattle is largely tended and milked by men and male children, often Fulani herders hired by other ethnic groups to tend their cattle(Roesel & Grace, 2014). Women tend and milk

[1] Sandowksy gives the example of Dr. V.K Samaranayake, an important contributor to the standards and development of multilingual websites and the use of the Sinhalese characters in browsers, who described having lots of different hardware shipped to him with no manuals or infrastructure for repairs, leading to them just sitting around in his office in Sri Lanka gathering dust (Sadowsky et al., 2012).

[2] Example given by Stefan Schlobach during the ICT4D symposium on the 6th of April 2016 and restated during the first lecture of the ICT4D course at the VU.

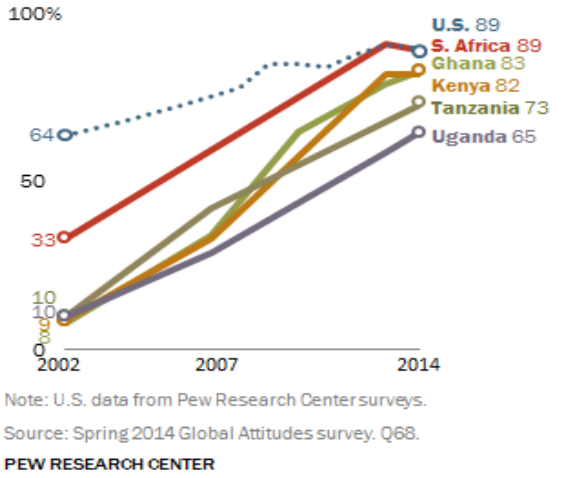

Figure 1: Cell phone ownership based on a sample of 7000 inhabitants based in 7 different African Countries

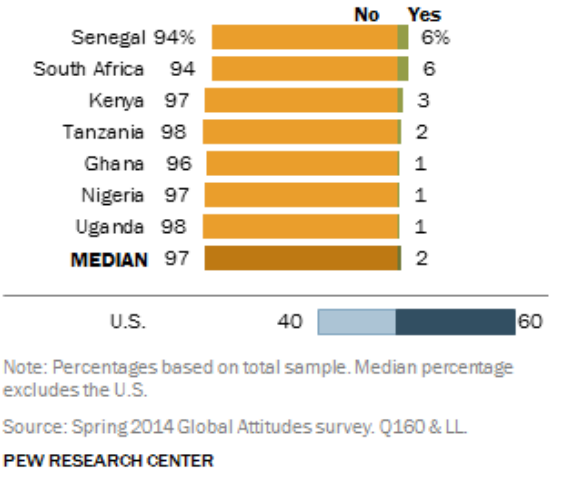

Figure 2: Landline ownership based on a sample of 7000 inhabitants based in 7 different African Countries

smaller ruminants like goats. However, once the cattle has been milked, processing the milk for consumption and sale is largely done by women (Roesel & Grace, 2014). This gender division, which we were unware of when developing the first versions of the Mali Milk Service, has an important impact on the evaluation of the system which will be outlined in the deployment and evaluation section of this paper. A concern about the potential impact of the service on women was also raised at the feedback session in Bamako in response to our submitted question about who could, potentially, be affected negatively by the service(de Boer, 2016). If at present women are responsible for selling the milk and handling the women from those sales, then that system could potentially by disturbed by a service centered around phones, if it is males in the family who own and use the phones. Male members of the family would then be the ones getting phone calls and potentially conducting the sales transactions. This poses a risk to the families, as some studies suggest that cashflows directed towards men and away from women can lead to increased alcohol consumption and associated problems(Obot, 2006). This concern is the reason the Grameen Bank focus their activities and microcredit on women (Yunus, 2016). The backdrop of these gender issues and the potential risk associated with them are an important dimension to consider during evaluation and decisions regarding deployment of any intervention that when plugged in(S. Dittoh, 2016) raises the risk of negatively interfering with an aspect of the existing system.

2.2 Problem

The W4RA use case describing the use for a milk ordering and delivery system for Tominian milk producers in Mali as well as (Chapon, Tourette Diop, & Minta, 2010; Craze, 2012) identified key problems faced by local consumers and milk producers. The key problems identified were:

- Lack of channels to facilitate buying and selling of milk between producers and buyers (Chapon et al., 2010; Craze, 2012)
- Irregular milk production, leading to overproduction in the rainy season and under supply in the dry season (Craze, 2012)

Figure 3: A malinese woman milking a goat (Roesel & Grace, 2014)

The first problem leads to inefficient practices like going door to door to sell milk, often at great effort and time as road conditions remain poor[3]. The second problem results in overproduction in the rainy season and under-supply in the dry season (Craze, 2012) This leads to spoiling of milk parts of the year and the need for expensive imported milk during the dry season. The system outlined in this report is designed for Tomininan Mali, but many of the issues and local factors dealt with also concern people elsewhere in the Sahel(Roesel & Grace, 2014; Gyan et al., 2013; F. Dittoh et al., 2013; Chapon et al., 2010). One of the ways these problems have been successfully overcome in parts of Mali are through cooperatives(Craze, 2012). During the field trip to Mali, participants visited the AB Mini Laterie dairy cooperative, which collects milk from farmers in the surrounding areas(de Boer, 2016). This particular coop cover 60 farmers in approximately 10 villages with a milk-collector per village who contacts farmers via phone. Their central distribution centre will pasteurise the milk which postpones spoiling by around 4 days. From the centre the milk is sold in 1/2 and 1 litre bags, or in bulk for the market(de Boer, 2016). The cooperative is popular and successful, but nevertheless some problems arise:

- Milk collectors are not always quick enough to retrieve the milk, leading it to spoil.
- The communication tends to be unreliable and occasionally cause issues between coops and farmers/collectors.

[3]The long duration of even short journeys was discussed during an informal conversation with Victor de Boer on the 26/05/2015

Figure 4: A Fulani man milking a cow near Mopti, Mali (Sultan, 2014).

The proposed system is called the Mali Milk service (m-Milk) and is a system designed to help with the problems outlines above, both where cooperatives exist and in areas where there are no cooperatives. The system is designed to help local milk producers connect with buyers and help farmers organize pooling of milk and transport to a dairy producer when there is excess production in areas with no cooperatives. In addition to this it is also intended as a service to help connect farmers and lay the groundwork for getting organized into cooperatives and support the work of existing cooperatives if they are already in place. Finally the system is intended as an aid to strengthen the networks between people in rural Mali to enable better knowledge sharing as stated in (Akkermans et al., 2011) and thereby use ICT as tool for empowerment. The use case and more information on the system will be presented below.

3 Use Case Description

3.0.1 Name

The use case name is m-Milk, which is a reference to the mobile usage of the milk buying and selling process in Mali.

3.0.2 Summary of the key idea

The business idea of the m-Milk application is creating a better and more efficient way for Malinese farmers to sell their milk to a broader target audience. If a farmer does not know where to sell, then travelling to the next village and going door to door is the only way to find buyers. Distances and poor road conditions make this strategy both time-consuming and potentially wasteful, if the milk spoils before a buyer has been

found. Instead the m-Milk service provides a mobile-based milk selling platform, where a farmer can call in and leave a message about available milk. Potential buyers can call in, hear messages left by farmers, and get the contact information of the farmer with milk for sale. To get a more financially durable service and potentially start a cooperative, the farmers can also leave messages expressing interest in cooperating with other farmers and potentially information that might be relevant to other farmers. If there is a cooperative in the area, like the AB Mini Laterie, then that coop can use the service to share information about their coop with farmers who have not joined yet. If the system is installed centrally at the coop and they have a computer, like the AB Mini Laterie (de Boer, 2016), then they can use a browser interface, that requires no internet, to get an overview of the messages received that day and estimate how much milk they can expect from the different villages and prepare and organize efficient transport if needed.

3.0.3 Actors and goals

The main actors are the farmers and potential buyers. Both of them need to get in touch when the milk is available. The goal of the farmers is to sell the milk, and the goal of the buyer is to buy the milk from the farmer. The goal for each is to make that transaction as efficient as possible. For a cooperative the goal is to reach more farmers and collect and sell the milk as efficiently as possible. The Kasadaka is also considered an actor, considering it is influencing the system. The goal of the Kasadaka is to connect the farmer and the buyers. In the deploymen section, a long-term plan for implementing the m-Milk service is presented which require the collaboration of one or more NGOs. The goal of these organizations will be measurably positive outcomes for farmers and locals relative to the NGO's investment and opportunity costs.

3.0.4 Context and scope

The interaction of the buyer and seller will be facilitated via the voice-based system, though the deal will be made between the two actors. The m-Milk application only facilitates in the connecting of both actors.
As mentioned in the background section, milk production from cattle in Mali has a strong gender dimension. Plugging in the m-Milk systems, in Dittoh's sense of plugging in interventions to an existing system (Dietz et al., 2013; S. Dittoh, 2016) could potentially upset the existing system in undesirable ways. Concerns were also raised at the feedback session in Mali that where women previously handled the sale and money from milk sales, a phone based system could make the man handle that now (de Boer, 2016). Potentially this increases risk that the men will spend the money on alcohol leading to diminished resources and food security for the the family as a whole (Obot, 2006). Being aware of this potential risk is a central part of evaluating the m-Milk service on the ground and one that should rapidly lead to changes to the system, if it turns out to be a problem.
The m-Milk system, like any system dealing with a perishable product like milk, also faces a practical boundary: spoiling of the milk. Farmers cannot travel very efficiently due to the poor infrastructure and therefore cannot transport milk to places far from their location.

3.0.5 Use case scenario script, interaction, and communication

The interaction model is visible in Table 1.

3.0.6 Information concepts

The following paragraphs will elaborate further on the information concepts of the m-Milk service.

3.0.7 Technology infrastructure

The infrastructure for the m-Milk project is already existant. In the first phase of the project to test if the service offers sufficient benefits to justify further deployment, the service will be free. In the next phase, subject to positive evaluation, the farmers will receive a micro loan for the KasaDaka and dongle. The m-Milk is compatible with the technology landscape of rural Mali, and only require users to have a basic

Buying/selling

Actor 1	**Interaction**	**Actor 2**
Farmer	Calls	KasaDaka
Potential buyer	Calls	KasaDaka
Potential buyer	Calls	Farmer

Co-op

Actor 1	**Interaction**	**Actor 2**
Farmer	Calls	KasaDaka
Other farmer	Calls	Kasadaka
Farmer	Calls	Other farmer

Table 1: Interaction model

mobile phone in order to call the KasaDaka. At existing cooperatives with a computer, i.g. AB Mini Laterie (de Boer, 2016), the existing hardware can be connected to the Kasadaka, with or without internet, allowing them to see all messages received with time and language codes. These messages can then be played as desired to get an overview of the available milk that day.

3.0.8 Cost considerations

The KasaDaka is a low-cost system, which does not require a lot of electricity. To reduce the buy-in price for locals, the KasaDakas are intented to be supplied via a microloan scheme from an NGO allowing the farmers to pay a little bit at a time. This aspect is outlined further in the deployment section of this paper. The operational costs include electricity costs and call costs for the farmers and buyers.

3.0.9 Feasibility and sustainability

The project, subjects to field studies, is potentially feasible as a stand-alone project, if issues like the system dropping calls are resolved(de Boer, 2016). Development of m-Milk beyond the current version should happen in an iterative, agile, process in close collaboration with local actors as far as it is feasible and the local conditions allow it[4]. This collaboration should be done to build for the local context and should include user studies to ensure that all aspects of the service is user friendly and acceptable in the local context (Dietz et al., 2013; S. Dittoh, 2016). As a prototype m-Milk should be rolled out and work as a standalone service, but for full deployment the intention is to package it is as part of a value bundle(Annor, 2016) to shift the balance of benefit vs cost and help realize what Stefan Schlobach at the ICT4D symposium referred to as the real value of the web - the suite of services built on top of that infrastructure(Schlobach, 2016). Feasibility will increase when the service is combined with other packages and services, such as for example a weather service. Over time, through repayments, the services and hardware will be wholly owned by farmers. The initial buy-in of making a commitment to a microloan and acquiring the system is intended to ensure uptake and motivate use with the secondary objective of making expansion more economically feasible. By creating a co-ownership with the farmers, it is also hoped that the equipment is maintained with care. In an ideal situation this project will break even over time.

3.0.10 Key requirements

The key requirements are described as a means of the MoSCoW model (van Vliet, 2008). These requirements show that the system benefits from stable conditions in the environment such as phone reception. The KasaDaka system has the advantage that it is cheap and therefore easy to deploy on several places. This means that the service will require servers far from the usage of the service.

[4]Hester Stubbe in her guest lecture on the ICT4D course explained the difficulties in access and time required to build relationship with local influencers during the TNO's serious game project in Sudan(Stubbe, 2016)

Must have

- A simple IVR/UX for the end users
- Good instruction on use of application for end users
- Local language settings for the end users
- Be easy to localize by adding new languages

Should have

- A clear IVR/UX for the users
- Low call drop rates
- An expansion with other products and services

Could have

- Web interface for co-operations
- A speech-to-text interpreter for the recorded messages

Won't have

- An internet portal
- Complicated and delicate hardware, which are hard to maintain in rural Africa

4 Financial model

The Kasadaka is a low cost piece of hardware, and should reduce the costs compared to expensive hardware setups in western societies. Nonetheless a starting budget is required, so public/private funding is necessary. To make the Mali Milk Service more (financially) sustainable, hardware purchases and maintenance beyond the trial phase is intended via a micro credit model. Having the farmers buy-in as a group via a micro loan helps ensuring cooperation from local farmers to develop the service provided and get uptake. The farmers will be provided the Kasadaka system as a loan and pay it off as a cooperative a little bit at a time. By creating a sense of ownership the farmers, they will be more cautious with the hardware and potentially might be more driven to develop the system further. This makes the farmer the end-user and end-customer. To prevent downtime, backups and spare Kasadakas are desirable, but subject to budget constraints. In order to provide a good service platform, a maintenance scheme with an NGO or a local university is necessary. The primary stakeholders of this project are:

- Farmers
- Potential buyers
- NGO or government
- Cell phone providers

The value exchange is shown in figure 5 and shows the relationships between stakeholders. The NGO provides a micro loan for the purchase of the technical infrastructure. Farmers can pay off the loan slowly, when profits are rising due to the m-Milk application. The farmers and potential buyers will need to pay small fees to cell phone providers for their calls made for the applications. Milk is exchanged for money by the farmer and buyer, and this completes the value exchanges.

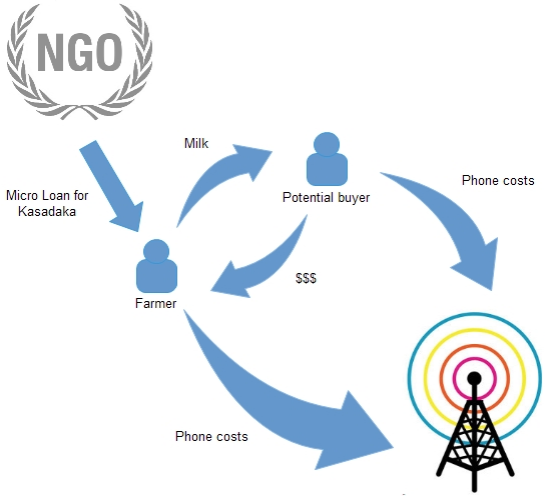

Figure 5: Value exchange model

5 System Overview

A call flow diagram can be seen in figure 11 in the appendix.

5.1 Design Choices

The W4RA use case suggested the need for a buyer-driven ordering system, but in order to help solve the problem of production fluctuations, the Mali Milk Service is designed as a seller-driven platform for milk producers to offer their products to potential buyers. This approach has been kept in version 3. By doing this, it is possible for either the farmers themselves, or potentially a local business, to get information about the local availability of excess milk and organize pooling and transport of the milk to a dairy processing facility or market in areas where there are no cooperatives. This could also include pooling the milk and having it turned into milk powder, which could offer an alternative to expensive imported milk powder in the dry season. A solution successfully implemented through co-ops elsewhere in Mali(Craze, 2012). The seller-driven platform also makes it easier to implement for existing cooperatives as it can help their activities and potentially be a sensible investment for them.

6 Prototype Fidelity

By creating a simple solution for the use case, the m-Milk service provides a low cost option for the milk farmers in rural Mali. By expanding the potential buying community, the farmers can sell their milk more effectively when the cows produce excess milk. To make sure that all farmers have equal opportunities, only one message per farmer is allowed. At the moment the system is not checking for this constraint. But this feature is recommended in order to create a system which is simple and easy to use for the buyers. To deal with language barriers the menus need to be translated and recorded in the local languages and not just French and English as in the current version, so that the users will be able to use the system regardless of mother tongue. If the service proves a success, m-Milk might be expanded to other regions as well as other products. To make sure that buyers only hear messages from farmers in their area a location menu could be added at the start of the call. Callers could then pick their region and then use the same call flow as depicted in Figure 4 in the appendix. The present version does not have this option. At present there remains an unresolved issue regarding recording messages on the Kasadaka. The issue is caused by Asterisk changing

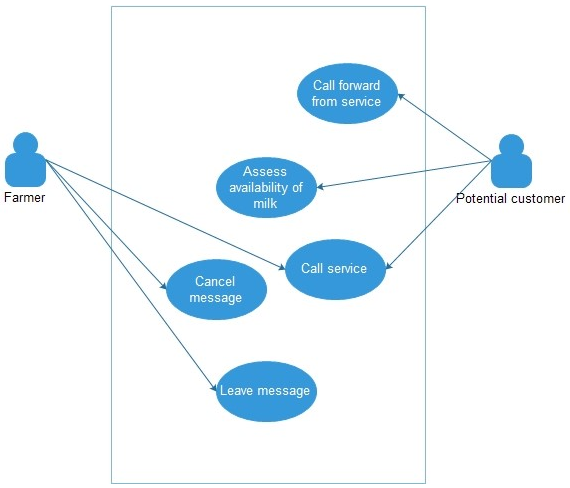

Figure 6: User interaction diagram

the format of GET and POST requests from the VXML record tag when using the submit next tag to send the request, resulting in a incorrect temporary file location being sent instead of the actual message. If it turns out that farmers quickly find a buyer and then receive a lot of phone calls they have to turn down, including an option for farmers to delete their messages as show in 6 could be a sensible addition to the system which it does not include in the present version.

6.0.1 UX Design

In response to feedback on version 1 and 2 of the m-Milk service and several phases of iteratively improving the Mali Milk Service UX design, following the guidelines set out in (Gottesdiener, 2003), several design choices were made. At each step of the call no more than three options are presented to the users, in line with the limits of human working memory(Cowan, 2005, 2001). Barge-in is allowed at each call step as the system is meant to be used often by the same people; who after a while will know their way around the system and might be interested in quickly leaving a message. This reduces the call time by skipping the instructions. This should help them save time and phone credit. The main menu, which is where the caller will first end up, will welcome the caller in all the available languages and then give options like "Press 1 for English", "Press 2 for French" where each option is given in that particular language. This is done to help the user find out how to get to their particular language path, where they will then only hear messages in the chosen language for the remainder of the call. This includes only hearing the messages recorded by callers who chose the same language as they chose. Milk offer messages are stored for 5 days, because milk is a perishable product and excess milk is likely to come in small amounts, so this helps prevent buyers calling farmers in vain. The message overview available if a coop has a computer is kept in very simple html to be backwards compatible with older hardware and software.

7 Stake Holders

The stakeholders of this use case are the farmers, buyers, and a facilitating organisation who can help cover the initial cost of setting up the system and plugging in the system. When the farmers see benefits from the system and are able, and want to, pay for the ongoing costs of the system between themselves, this financial support can be lowered. The system is intended to be implemented similar to micro loans, whereby seed money is given to a group of people, though here with the caveat that the organization will cover the costs if the farmers feel they see no benefit and do not wish to pursue the system further.

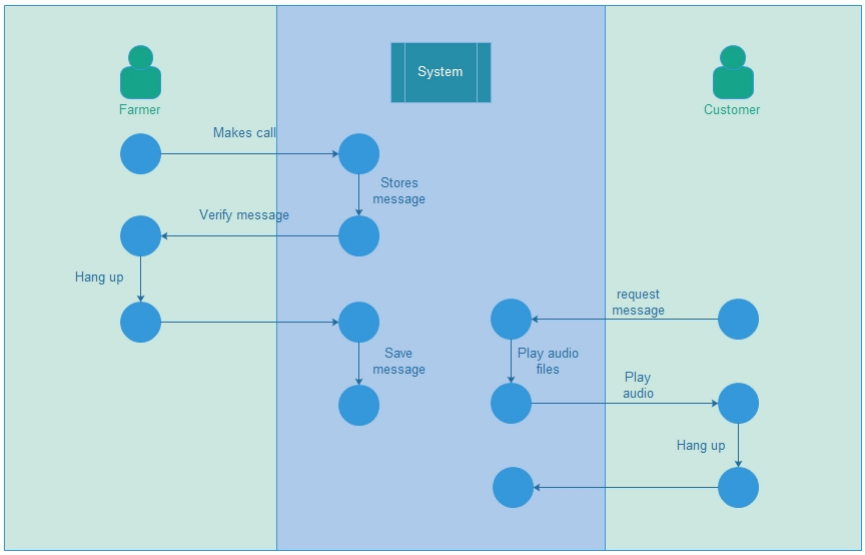

Figure 7: Activity diagram

8 System Architecture

The Mali Milk Serice will run on the Kasadaka system, which is a low-cost Raspberry pi based system(*Kasadaka Description*, 2016), which runs on the Debian Raspbian(*Debian raspbian*, 2016). In order to make the Raspberry accept phone calls, a dongle with a telephone SIM card is used. Using Asterisk, an open source framework (*Asterisk Description*, 2016) which turns the raspberry into a communication service, a communication hub for inbound and outbound calls is created.

9 Architecture

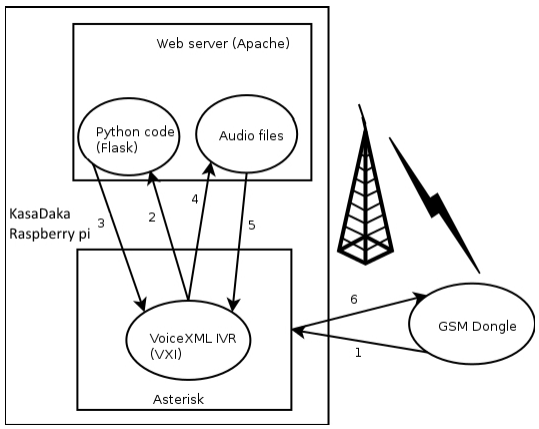

Figure 8: Architecture of the system

To connect the incoming call through the dongle with the VXML files an Asterisk service runs a VXML(*OpenVXI Description*, 2016) interpreter and a locally running Flask (`http://flask.pocoo.org/`) server will respond and render the Mali Milk Service VXML files and html for the computer interface with

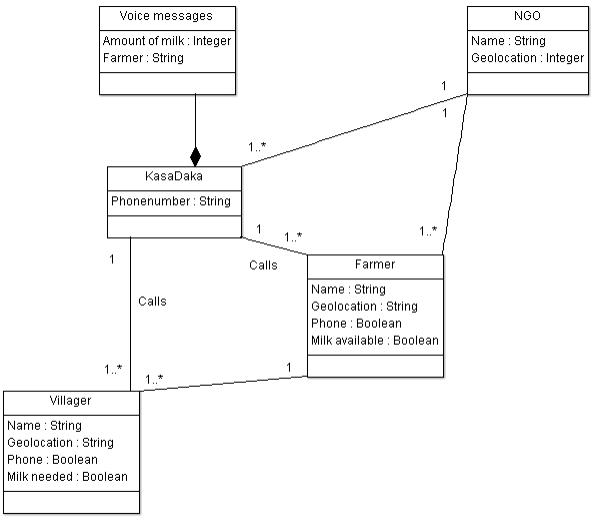

Figure 9: UML Class diagram of system

their corresponding audio files.

10 Data Model

The main actors of the system are

- Farmers
- Villagers
- KasaDaka

Figure 9 shows the Class diagram with all the classes and their interactions. The activity diagram is shown in Figure 7. These diagrams gives a visual representation of all the actors and the interaction they have. The voice messages are shown as a separate class, because they are saved entities on the KasaDaka system and store information which is used by farmers and villagers. The goal of the system is to inform the actors and increase connectivity in a local environment. The service is currently not collecting nor connecting to open data, but a connection with a geolocation database could be useful if caller locations could be accurately used. Then this information could be quickly rendered on a map using D3.js to have the computer interface at the coop include a visual representation of all farmers with available milk on a given day - potentially aiding in transport planning. In the future information about locations and amount of milk available could be extracted, saved in a SPRQL database and submitted to a central database via sms or collected and pooled ready for research into milk production in Mali. Local NGO's, entrepreneurs, and goverment agencies could benefit from this data, and get valuable information on where dairy processing facilities are most needed. The service is kept simple in terms of implementation, localization, and eventual system maintenance by people on the ground who might not have a background in computer science. If the service is successful on the ground in Mali, it can be expanded by structuring the incoming messages and storing the data in a database, using a Resource Description Framework (RDF). In order to use the data in the messages recorded, a speech-to-text interpreter needs to be installed. This enables the application to also get information on the quantities of milk produced and bought/sold. This requires more development of the application and was unfortunately not possible due to the limited timescale of the project. If such a

semantic network is deployed it will ensure a transparent data source which can be copied for other purposes. More information on this expansion is given in the future works section.

11 Installation Guide

The print-ready installation guide is found in Figure 14 of the Appendix.

12 Demonstration scenario

12.1 Individual farmer in a region without a cooperative

Adama, a farmer, has cows which sometimes produce enough milk for Adama to sell some of it. Walking to potential buyers is a time and energy consuming activity without a guarantee of selling any milk. This is where the m-Milk Service is useful. The service can help buyers contact Adama if he calls the service and leaves a message with his phone number and how much milk he has for sale. Now customers knows that Adama has milk and can call him to arrange delivery. Adama can go directly to the interested buyer knowing that he is not going in vain. The Mali Milk Service can also help Adama to collaborate with other farmers. Adama can call up and record his own message saying he is interested in getting in contact with other farmers or he can listen to the messages of other farmers. This way they can organize transport to a milk powder factory or the market in a bigger town when they have a lot of milk available. The milk messages of Adama will be deleted after 2 days, whilst messages for other farmers will be available for a month.

12.2 Existing Cooperative

The Mopti Laterie receives milk from several farmers from different villages. These farmers are contacted by collectors who bring the milk from several farmers to the pasteurizing factory. This process needs to be done within 4 hours. The communication with the collectors/farmers and the Laterie happens on a daily basis via phone, though this process is not always reliable. When the milk is pasteurised, it is prepacked in 1/2 and 1 liter bags and sold to villagers. The milk are also sold in bulk on a local or bigger market. The m-Milk service could benefit the Laterie, as having access to the recorded message either via phone or the interface makes it easier to get an overview of how much milk is available and can help coordinate milk collection. For the farmers connected with the Laterie, the efficiency improvements could lead to less errors around milk collection and less spillage.

13 Gender Issues and Actor Analysis

Evidence suggest that alcohol problems are a factor amongst Malinese men (Obot, 2006). This is an issue which must be taken into account. If the m-Milk application results in a shift of cash flows, resulting in money for the sale of milk previously went through the hands of women, are now flowing to the men this could exacerbate alcohol related problems and impact food stability(Obot, 2006; Roesel & Grace, 2014). At present, the application is an open platform and does not differentiate or restrict access between female and male users. As the transactions and exchange of money is done in person and not over the system, the m-Milk cannot control who receives money for the sold milk. This is a social issue that should be taken into account when evaluating the system, but as there is little evidence to date about whether or not women have access to the family phone nor on whether women would continue to handle the money if such a system is in place. It is an issue to be keenly aware of in evaluation, but should not preclude testing the system in the field.

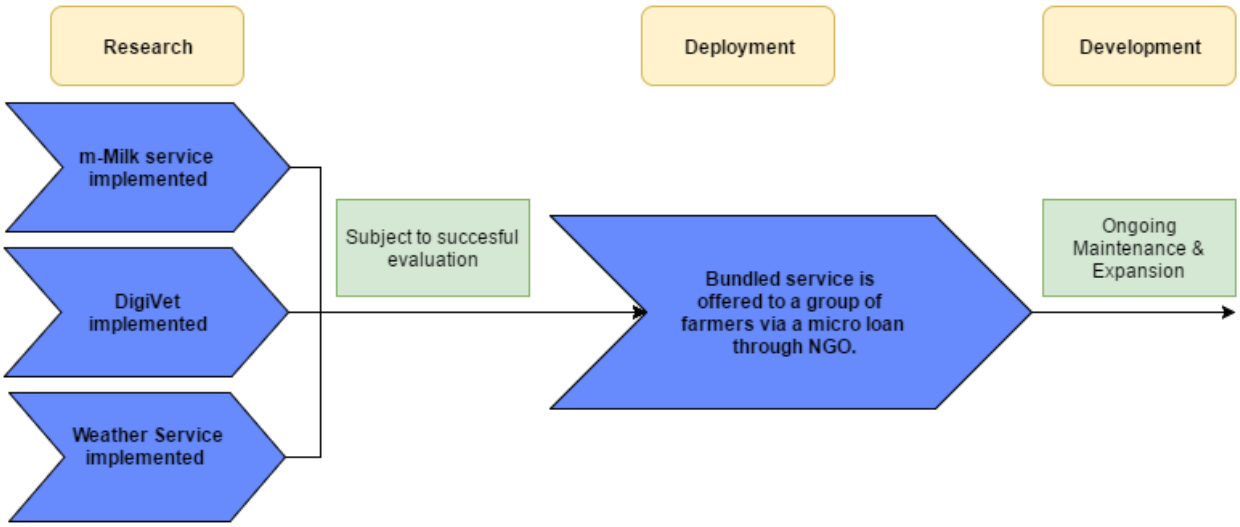

Figure 10: Deployment Model for the m-Milk service

14 Deployment

As (Ho et al., 2009) have argued one of the grand challenges in the field of HCI4D and more widely for ICT4D, is a system that proceeds beyond the prototype phase into a sustainable long term effort with provable development outcomes. The deployment plan of the m-Milk takes a long-term perspective with different actors involved at different stages, shown in figure 10. For the initial research focused phase, experts from universities and other research bodies work with local contacts in an agile iterative process to bring individual services to a stage where they can be tested and evaluated. If the testing and evaluation indicates that a given service has potential, then services that meet those criteria are bundled together and offered as a bundle with the necessary hardware via a micro loan. Microloans and ongoing support and evaluation will be supplied by a larger organization with the research and expertize in this area. Though funding for projects are often short term, it is hoped that the long-term view will help find partner organizations early in the process and setup a pipeline for long term development. Different actors with different expertize will be involved in each of the Research, Deployment, and Development stages of the process in line with the general consensus at the ICT4D symposium about the need for an interdisciplinary approach to development and the experience of long-term projects presented by (Stubbe, 2016).

15 Future Work

The MoSCoW model described under key requirements in section 3.0.11 recognized several additions to the Mali Milk Service. As outlined previous a simple visual interface using a computer has been implemented, which could be expanded further through data extraction. This could be done by implementing a more structured data collection, as RadioMarche(Gyan et al., 2013) does, where the amount available of the given product is stored in a more structured way than an audio file. Having this structured information would make displaying how much milk is available in a given area easy and aid organizing transport to collect the excess milk and bring it to a dairy. For users of the phone based system, implementing a way for users to navigate through the potentially many milk offer messages would be a useful function. At present no data is extracted from the phone calls aside from the voice messages. A simple way to get the information would be to use dtmf, but this would only be useful if farmers have less than 10 liters of milk for sale per day. This might be the case as Victor estimated 3-4 cows per farmer which will each produce around 4 liters of milk, yielding 12-16 liters of milk a portion of of which will be consumed by the farmer and extended family(de

Boer, 2016). If the amount of milk available per farmer is greater than 9 liters then a two phase system could be used where farmers first select if they have between 1-10 liters or 11-20 liters available and so forth as needed. Then we could extract first the tens of liters, then ask the farmer to key in the ones using dtmf, which we can combine and save as 21-30 = 2 tens and 7 ones as clicked by the farmer, saved as 27 liters of milk. The last enhancement to the KasaDaka is also shown in Figure 10. The m-Milk application alone should to be insignificant for a farmer to purchase because the KasaDaka could host more services at the same time. This proposed "package of services", needs to be evaluated as shown in the deployment phase. The limits depend on the workload of the KasaDaka, but a well designed package, with for example weather and digital vet services, could be delivered to the farmers.

16 Conclusion

The Mali Milk Service application is a simple, yet potentially effective way of dealing with some of the identified problems faced by farmers in Tominian Mali. The service help milk producers reach buyers in a more efficient way than going door to door and provides a means of organizing pooling and processing of milk in the rainy season when milk is relatively plentiful. By using the same service and telephone number for the farmer and the buyer, the service is kept simple and easy to use. This makes it easy to maintain, and aides expanding the system to other parts of the Sahel. To ensure that the application is financially sustainable, a deployment plan where several services are bundled onto a KasaDaka to increase the benefit relative to costs has been suggested. This bundle could then be offered by an NGO via a micro loan system, where the farmers can gradually pay off their KasaDaka and added value bundle. To ensure scalability local languages can easily be added, by recording and implementing new audio messages. The option to create a new cooperation creates a network where Tominian farmers can benefit by splitting transport costs or sharing information on farming. For existing cooperatives it offers a way to increase efficiency and reaching more farmers and buyers.

References

Akkermans, H., Gyan, N. B., Bon, A., Tuyp, W., Grewal, A., Boyera, S., & Allen, M. (2011). Is (web) science ready for empowerment? In *Proceedings of the 3rd international web science conference* (p. 27).

Annor, F. (2016). *Perspectives on ict4d symposium slides - 06/04/2016.*

Asterisk description. (2016). `http://www.asterisk.org/`. (Accessed: 2016-05-27)

Bon, A., de Boer, V., Akkermans, H., Gyan, N. B., Tuyp, W., Grewal, A., ... Froumentin, M. (2013). Use case and requirements analysis in a remote rural context in mali. *Requirements Engineering: Foundation for Software Quality*, 331-346.

Chapon, M., Tourette Diop, I., & Minta, O. (2010). Local milk sector in west africa, role of rpos, small and medium farmers in the full growth of its potential. In *Proceedings of workshop held in bamako on september 15 through 17, 2010.*

Cowan, N. (2001). Metatheory of storage capacity limits. *Behavioral and brain sciences*, *24*(01), 154–176.

Cowan, N. (2005). *The problem of capacity limits.*

Craze, J. (2012). Milk production is in business. (`http://www.theguardian.com/journalismcompetition/mali-milk-production`[Accessed: 17/04/2016])

Davis, M. (1998). Rural household energy consumption: The effects of access to electricity—evidence from south africa. *Energy Policy*, *26*(03), 207-217.

Debian raspbian. (2016). `https://www.raspberrypi.org/help/`. (Accessed: 2016-05-27)

de Boer, V. (2016). *Field trip report slides.*

de Boer, V., De Leenheer, P., Bon, A., Gyan, N. B., van Aart, C., Guéret, C., ... Akkermans, H. (2012). Radiomarché: Distributed voice-and web-interfaced market information systems under rural conditions. In *Caise* (pp. 518–532).

Dietz, T., Bymolt, R., Bélemvire, A., van der Geest, K., de Groot, D., Millar, D., ... Zaal, F. (2013). *Padev guidebook: participatory assessment of development* (Vol. 48). Amsterdam: KIT Publishers.

Dittoh, F., van Aart, C., & de Boer, V. (2013). Voice-based marketing for agricultural products: a case study in rural northern ghana. In *Proceedings of the sixth international conference on information and communications technologies and development: Notes-volume 2* (pp. 21–24).

Dittoh, S. (2016). *Perspectives on ict4d symposium slides - 06/04/2016.*

Gottesdiener, E. (2003). Use cases: best practices. *Rational Software white paper*.

Gyan, N. B., de Boer, V., Bon, A., van Aart, C., Akkermans, H., Boyera, S., ... Allen, M. (2013). Voice-based web access in rural africa. In *Proceedings of the 5th annual acm web science conference* (pp. 122–131).

Ho, M. R., Smyth, T. N., Kam, M., & Dearden, A. (2009). Human-computer interaction for development: The past, present, and future. *Information Technologies & International Development*, *5*(4), pp–1.

Kasadaka description. (2016). `http://kasadaka.com/`. (Accessed: 2016-05-27)

Kline, N., & Gordon, D. (2012). *Livestock in mali: The business enabling environment for livestock. report based on findings from the vcclir mali diagnostic published in march 2012, funded by usaid/mali.*

Obot, I. (2006). Alcohol use and related problems in sub-saharan africa. *African Journal of Drug Alcohol Studies*, *5*(01), 16-26.

Openvxi description. (2016). `http://www.speech.cs.cmu.edu/openvxi/OpenVXI_3.0/OSB_OpenVXI_3.0_Release_Notes.html`. (Accessed: 2016-05-27)

Poushter, J., & Oates, R. (2015). Cellphones in africa: communication lifeline. *Washingston DC: Pew Research Centre*.

Roesel, K., & Grace, D. (2014). *Food safety and informal markets: animal products in sub-saharan africa.* Routledge.

Sadowsky, G., Al-Shorbaji, N., Duncombe, R., Fredriksson, T., Greenberg, A., Hafkin, N., ... others (2012). Accelerating development using the web: empowering poor and marginalized populations. *Accelerating development using the web: empowering poor and marginalized populations*.

Schlobach, S. (2016). *Perspectives on ict4d symposium slides - 06/04/2016.*

Stubbe, H. (2016). *Successful game-design: Aiming for sustainability and scalability - slides.*

Sultan, Z. (2014). *Fulani (peul) man milking a cow among the herd in a crowd of children herder's encampment — near mopti mali, west africa.* Retrieved from `url{http://mylifetumbled.tumblr.com/post/81888937861/fulani-peul-man-milking-a-cow-among-the-herd-in}`

Trudell, B. (2009). Local-language literacy and sustainable development in africa. *International journal of educational development*, *29*(1), 73–79.

van Vliet, H. (2008). *Software engineering: Principles and practice.* Wiley.

Yunus, M. (2016). *Grameen bank focus.* Retrieved from `url{http://www.grameen-info.org/}`

Appendices

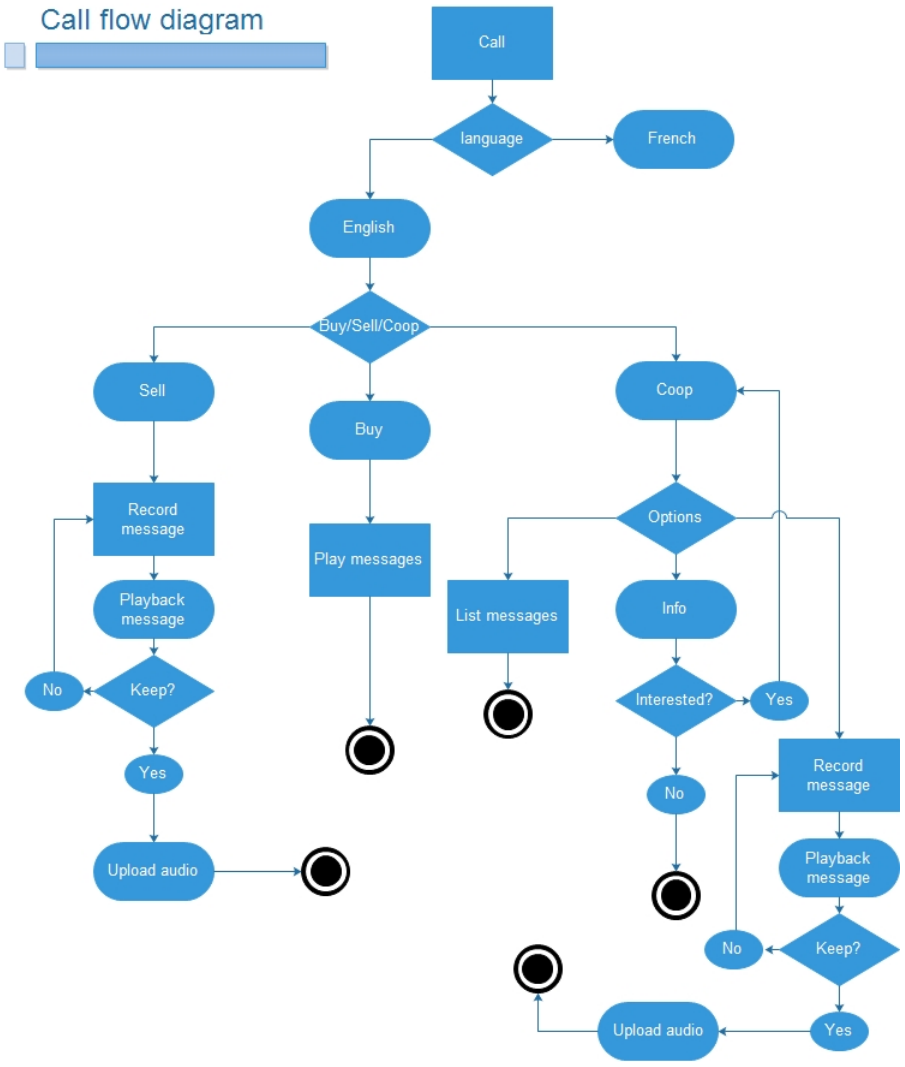

Figure 11: Call flow Diagram V3

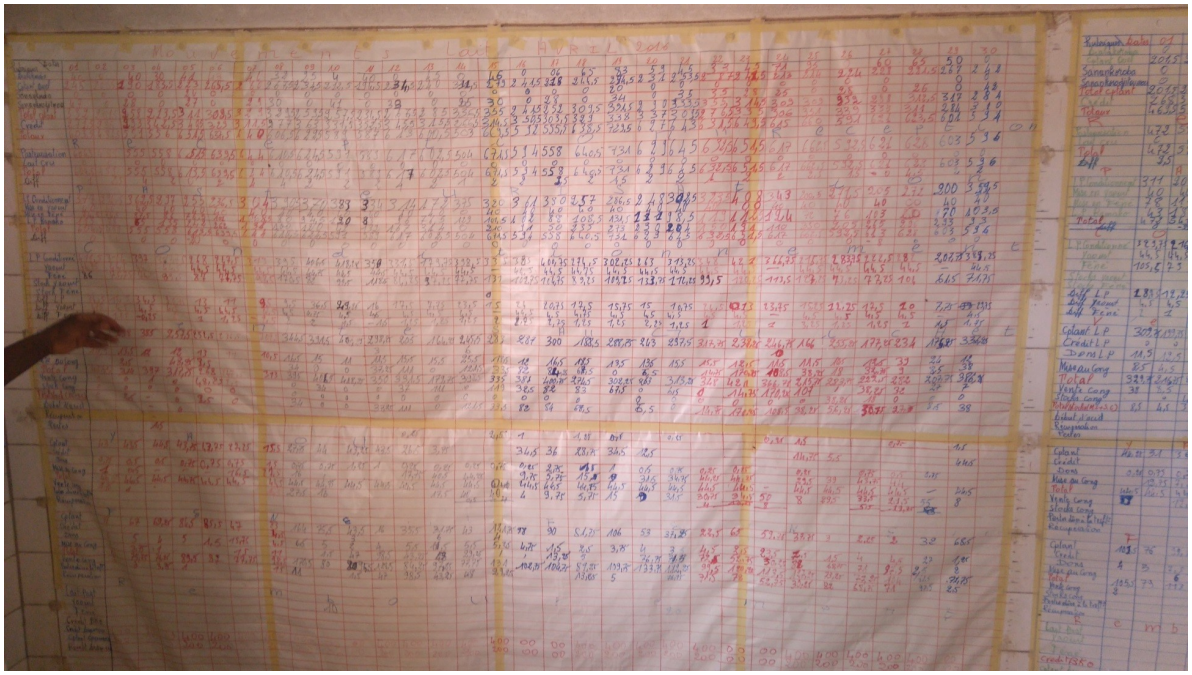

Figure 12: Picture of the offline data model

Main Menu	Welcome to the Mali Milk Service
Buy Route	For Language Press 1
Sell Route	To hear milk offers, press 1. To offer milk for sale, press 2. To hear about co-ops and express interest in joining, press 3.
Co-op Route	If at any point you want to return to the main menu, press 9.
Error Catching	Please listen to the following offers from farmers
	To hear messages again, press 1, else hang up. Thank you for using the Mali Milk service.
	There are no messages at present, please try again another time.
	Please leave a message after the beep, with name, phone number, location, and available milk. When you are done, press any key.
	Here is what you recorded
	To record a new message, please press 1. To keep your message, press 2.
	Thank you for leaving a message. Goodbye
	To hear information about co-operatives, press 1. To hear messages from people interested in starting a co-op, please press 2. To record your own message, please press 3.
	Setting up a cooperative is a way to get organized with other farmers to help each other. With a co-op you can organize transport to bring everyone's milk to the market or to bring sick animals to the vet.
	To listen again press 1. To hear messages left by other farmers interested in starting a co-op, press 2. To record your own message, press 3.
	Please leave a message with your name, phone number, and village so others can contact you. Press any key when you are done.
	Please listen to the following messages from other farmers
	To hear the messages again press 1. To return to the other options, press 2.
	I did not hear anything, please try again.
	I did not recognize that, please try again.
	Message not recorded, please try again.

Figure 13: Scripts for Audio Recording

THE MALI MILK SERVICE

GETTING IT UP AND RUNNING ON THE KASADAKA

Required:

- Kasadaka with power cable and setup according to instruction guide.
- Internet connection or SD card with project code.

Project Installation

Get code and audio files from either online repository or SD card:

- Cd to the /FlaskKasadaka/FlaskKasadaka directory.
- Clone the mali_milk repository from https://github.com/asroben/mali_milk
- Copy and paste the content of the /mali_milk folder into the FlaskKasdaka directory – replacing all files when prompted.
- Activate the virtual environment from a terminal in the FlaskKasadaka directory:

  source FlaskasadakaVenv/bin/activate
- **Pip install flask**
- **Pip install path.py**

Asterisk

Make the following changes as the root user:

- Change one or more of the extensions in the /etc/extensions.conf file to direct calls to: 0.0.0.0:5000/ voice so you can call the service.
- Copy and paste the updated vxml.conf content from: https://github.com/abaart/KasaDaka/blob/master/etc/asterisk/vxml.conf (to fix recording issue)
- Restart Openvxi: **sudo service openvxi restart**
- Restart Asterisk : **sudo service asterisk restart**

Running the Service

- From the FlaskKasadaVenv virtual environment use python __init__py to start Flask serving.
- Call the service to make sure it is running.

Trouble Shooting:

- Some issues, like linphone hanging up immediately on the virtual kasadaka can sometimes be solved with **apt-get update**.

Figure 14: Installation Guide for the Mali Milk Service