USSD: A COMMUNICATION TECHNOLOGY TO POTENTIALLY OUSTER SMS DEPENDENCY

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DISCLAIMERS

This white paper provides an overview of Unstructured Supplementary Service Data (USSD) technology as compared to Short Message Service (SMS). It presents information and guidance but does not support a specific plan of action, which would require additional information and insights into each situation. The vulnerabilities, analyses, and risks shown and analyzed in this paper are intended to be indicative of the risks an application vendor, third-party host, or network operator might face. The analysis given should not to be considered an exhaustive or fully objective list.

It is important that risks be assessed and validated based on the situation, the intended functionality to be offered, and the process controls that will be required or are already in place. Additional guidance should be sought wherever necessary before taking any action.

ABSTRACT

Value Added Services (VAS) have become an indispensable part of the products and services offered by mobile/telecom operators today. With growing competition in the telecom industry, operators must be diligent in how they price both new and existing services. They are therefore looking for faster and more economical technologies.

USSD technology is the key solution in all cases. It is a messaging service that is almost seven times faster than SMS and is highly cost effective. The operations involved in using USSD are simple and handset independent, which means the service can be accessed from almost any mobile device (from old cell phones to the latest smartphones).

From the core network to the internet, the reach of modern USSD services is rapidly transforming the telecom cloud into a services cloud. USSD is fast emerging as the communication protocol, which can ouster the dependency on SMS for quick messaging services.

SCOPE AND ASSUMPTIONS

This paper discusses the key features of USSD technology and its economic viability in providing VAS and other services. However, it does not cover:

1. Implementation details of any specific application
2. Generalized rules based on which USSD codes are derived (USSD codes are derived using a set of rules and are affixed to identify a specific service. Users must enter the defined code to access the service, but do not need to bother about its derivation.)
3. Detailed description of the Multi Media Interface (MMI) commands used in USSD

This technical paper assumes the reader has a fair knowledge of the GSM network.

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USSD: A COMMUNICATION TECHNOLOGY TO POTENTIALLY OUSTER SMS DEPENDENCY

Have you ever typed a code starting with an asterisk (*), number set, and hash (#) on your mobile? If yes, then, knowingly or unknowingly, you have already been using USSD service.

USSD is a communication protocol used to send text messages between a mobile phone and applications running on the network. It is a messaging service used in Global System for Mobile Communications (GSM) networks similar to SMS, where it sends data utilizing the signaling channel. However, unlike SMS which follows a store-and-forward oriented message transaction; USSD provides session-based connections. Because of its real-time and instant messaging service capability, USSD service is up to seven times faster and much cheaper than SMS for two-way transactions. It is a technology unique to GSM networks and is the standard for transmitting information over GSM Signaling Channels.

USSD is as similar to speaking to someone on a phone as SMS is to sending a letter.

EVOLUTION

As GSM networks have evolved over the years, several supplementary services have been introduced at various stages. But some of these newly introduced services are not recognized by older Mobile Stations (MSs). USSD was introduced to support these new services in old MSs.

The introduction was carried out in multiple phases. The first USSD service—Phase 1.0 (or Mobile Application Part [MAP] 1)—was only able to pass information from a mobile handset to the USSD application with a confirmation. There was no session held between the handset and the application; it was just like SMS service. Phase 1.0 was specified in the GSM 02.90 and only supported mobile-initiated operations (pull operations). In the core network, the message was delivered over MAP.

As GSM networks evolved, packet-oriented data transmission was introduced. Since then, USSD has undergone several revisions to become the current USSD Phase 2.0. As compared to a once-off transaction allowed in Phase 1.0, Phase 2.0 (or MAP 2) is capable of establishing a session. This means the handset and the USSD application can now have the technical equivalent of a dialogue. USSD Phase 2.0 is specified in the GSM 03.90 and supports both mobile-initiated as well as network-initiated operations (pull and push operations).

NEED FOR USSD

USSD is a highly cost effective and fast technology and is seven times faster in operating speed than SMS. USSD has several advantages as a bearer technology, such as:

1. USSD provides a cost-effective and flexible mechanism for offering various interactive and non-interactive mobile services to a wide subscriber base.
2. USSD supports menu-based applications facilitating more user interactions.
3. USSD is neither a phone-based nor a SIM-based feature. It works on almost all GSM mobile phones (from old handsets to new smartphones)
4. With USSD, messages can even be initiated during calls, allowing simultaneous voice and data communication.
5. USSD allows faster communication between users and network applications because messages are sent directly to the receiver allowing an instant response.
6. USSD services available on the home network are also accessible while roaming. Unlike SMS, there are no charges for this.

USSD is increasingly being adopted to develop interactive applications like mobile chatting, roaming with prepaid service, callback service, simultaneous software up-gradation of huge customer base, prepaid recharge, mobile banking, etc. Competitive pressure to deploy innovative services is driving the demand for USSD.

USSD is proving to be the ideal medium for quickly deploying a variety of new services and applications.

WHAT DOES THIS MEAN FOR OPERATORS?

USSD is a highly cost effective and fast technology and is seven times faster in operating speed than SMS. USSD has several advantages as a bearer technology, such as:

1. **Cost efficient** - Significantly less investment is required in the network as USSD uses existing SS7 protocols. Also, USSD-based self-care portal is cheaper than a live agent and IVR system. Hence, the capital expenditure (CAPEX) and operation expenditure (OPEX) are few.
2. **Fast and responsive** – Real-time and instant messaging service capability allows operators to provide easy to use, responsive and fast menu-driven content provision services.
3. **Interactive navigation** – USSD is increasingly being adopted to develop interactive applications like mobile chatting, roaming with prepaid service, callback service, prepaid recharge, mobile banking, etc.
4. **Reduced marketing cost** – Operators can use USSD as a cost-effective way to cross-and up-sell additional services.

1 USSD CODE FORMAT

USSD codes, also known as short codes, are simple to use. They comprise of asterisk (*) and hash (#) keys along with a combination of digits (0 to 9). Users can directly enter the USSD string and press the call key to send a message. The asterisk and hash codes are much like simple programming codes in that they signify the beginning and end of the request. Asterisks can also be used to separate the codes into multiple requests to access the different tiers of information. The intermediate set of digits, called the parameter, has variable lengths and is separated by the asterisk.

Short codes are standard messages pre-defined in the USSD platform. For example, if 159 is pre-defined/configured as a short code for call forwarding and 5288128 is the forwarded-to number, then the USSD code reads: *159*5288128#.

(There are some generalized rules based on which USSD codes are derived. Listing those rules and their derivations would be out of scope of this document.)

1.1 IN OPERATION

The handset recognizes the USSD code format and will invoke the use of USSD bearer and communicates with the USSD infrastructure, instead of invoking a voice call.

USSD is more like a "trigger" than an "application." It is used to invoke independent calling services that don't require the overhead and additional usage costs of a Short Message Service Center (SMSC) like a prepaid balance query, etc.

The USSD gateway has an interface with the Mobile Switching Center (MSC) over the Signaling System #7 (SS7). A real-time session is initiated between the mobile user and the USSD application platform when the service is invoked, allowing data to be sent back and forth. The session remains open over a radio connection until the USSD service is completed, the user terminates the application, an incorrect option is entered from the menu, or a time-out happens. Network operators often use USSD to query users about the network to receive a fast response.

2 USSD VERSUS SMS

The handset recognizes the USSD code format and will invoke the use of USSD bearer and communicates with the USSD infrastructure, instead of invoking a voice call.

FEATURES	USSD	SMS
Use of signaling channels	Yes	Yes
Type of functionality	USSD is real-time and session-oriented USSD information is sent directly from a sender's mobile to an application platform handling the USSD service USSD service can also involve a menu-based continuous session	SMS uses a store-and-forward technique to deliver text messages A text message is first sent to a sender's SMSC, which then tries to deliver the text message to the recipient SMS service is of a single instance type and can't involve a continuous session
Per message length (7 bit character)	182 alphanumeric characters	160 alphanumeric characters
Average duration for each transaction	2 sec	7 sec
Message storage in mobile	Incoming messages are of Flash type and cannot be stored	Incoming messages can be stored
Analogy	Web browsing, telnet	E-mail
Fast-dial keys in mobiles to operate the service	Yes	No

FEATURES	USSD	SMS
Operating costs involved	SMSC is not involved Messages are sent directly from mobile to the USSD platform without using SMSC, so USSD transactions are much cheaper	SMSC is involved SMSC and other related transit trunks are involved in transmitting SMS, making it costlier
Ease of use	Subscriber does not have to create a message. It is as simple as dialing a regular number Some applications will also allow menu shortcuts where the subscriber can add the menu item selection after an asterisk (*) separation character	Subscriber needs to type the message and then send it
Interface	SS7	SS7

The USSD Gateway uses the same application programming interface as the SMSC, making it easy to port services based on SMS to utilize USSD as the bearer. In practice, only USSD-specific modifications are needed for external applications.

3 USSD ARCHITECTURE

USSD transactions can be initiated by either the network or the subscriber. Figure 1 shows the USSD network architecture.

The USSD architecture basically comprises:

1. The network part that includes the Home Location Register (HLR), Visitor Location Register (VLR), and MSC
2. Complex logic to support multiple applications within a single USSD platform
3. Simple Messaging Peer-Peer (SMPP) interface for applications to enable services
4. USSD Gateway and all specific USSD application servers

USSD Gateway (USSD Center) is totally open and can be integrated with any telecom system/device and the internet. These features allow rapid deployment of new services and encourage existing messaging applications to leverage the USSD technology.

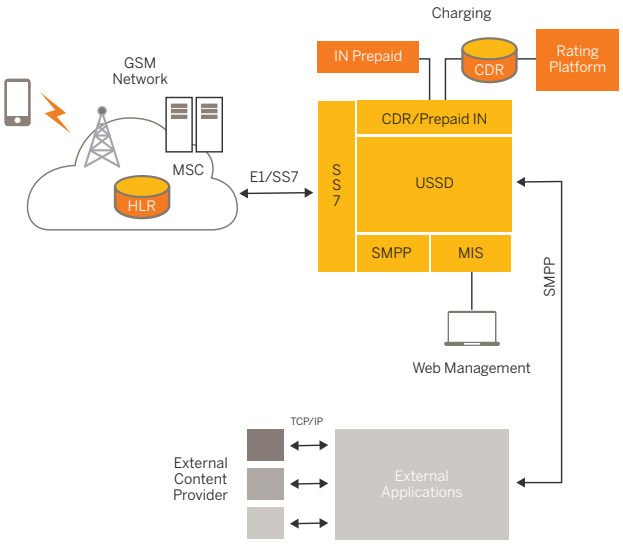

Figure 1: Architecture of USSD implementation

Other elements of the USSD architecture include:

- IN for pre-paid billing
- A rating platform/billing system to rate the post-paid Call Data Records (CDRs)
- Management Information Systems (MIS), Data Warehouse (DWH) systems for reporting and reconciliation. CDRs generated at USSD Gateway can also be used for these purposes
- May also be interconnected with SMSC, which can be used to send notification or special SMS to users

The MSC connects to the HLR in the home network via the SS7 network. GSM network (including HLR, VLR, MSC) is also connected to the USSD Gateway via the SS7 link. The USSD Gateway communicates with all its supporting external applications via SMPP.

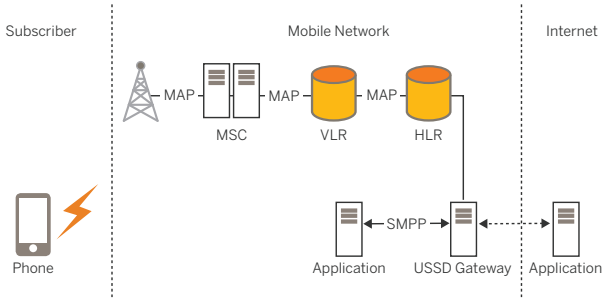

Figure 2: Elements of the USSD Mobile Network

3.1 ELEMENTS OF USSD MOBILE NETWORK

The mobile network comprises components that carry data messages between the handset and the corresponding USSD application. Figure 2 explains the elements of the mobile network and the communication protocols they use.

USSD services reside as applications in the mobile network. These applications can reside in MSC, VLR, HLR, or an independent application server that is connected through a USSD Gateway (using SMPP).

If a USSD message is not destined for an application in the MSC, VLR, or HLR, a USSD handler in these nodes routes the message to the USSD Gateway using the MAP protocol based on the service code. The gateway interprets the code and routes it to the specific USSD application server to fetch the necessary information requested by the user. In response, the application sends the relevant information to the USSD Gateway, which in turn converts the message to MAP format, and then sends to the mobile terminal.

Applications under the mobile operator's control will typically reside in the GSM network (MSC, VLR, HLR), while third-party applications may reside elsewhere such as on the internet. The application can also be a hyperlink to an internet site or information stored locally in the Service Application System. In a mobile-initiated service request, a session is created between the network and the mobile terminal. This session is used for all information transfers and must be released before another session can be started. Additionally, an application in the network (residing in the MSC, VLR, HLR, or external application server) may at any time send a message to a mobile terminal. This can be a request for information or a notification. Again, the session must be released upon completion.

3.2 BILLING OF USSD USAGE SERVICES

A billing mechanism for USSD services is not implemented in most cases. However, there are some rare cases where network operators implement a billing system. Depending on the sophistication of the rating platform, the subscriber will be billed according to one of the following criteria:

1. One-off cost
2. Number of menu transactions
3. Time spent browsing the menu/duration of the session

Generally, billing is based on the duration of the session. Duration-based charging permits users to search for information within a session-based service. It is charged on a per minute basis and is more economical than SMS. USSD is device independent and does not require specific activation.

4 USSD HANDLING

There are two modes of USSD implementation:

1. Push Service Mode: Network-initiated USSD service in which the network (MSC, VLR, or HLR) sends USSD message toward MS
2. Pull Service Mode: MS-initiated USSD service with user sending USSD message toward MSC

4.1 NETWORK-INITIATED USSD OPERATIONS

At any stage while the MS is registered with a network, the network (HLR, VLR, or MSC) can send a USSD string to the MS. This string contains operator-determined information that is relevant to the user.

This string/USSD command may be a request (asking the M to provide information) or a notification (requiring no information from the MS). If the information is unable to reach the MS, an error is returned to the network node that originated the operation.

4.2 INVOKING USSD OPERATION FROM THE MSC, VLR, AND HLR

When an application in the MSC needs to send a USSD request or notification to an MS, it sets up a transaction to the MS where the subscriber is currently registered and sends the operation to the MS. The MSC then awaits a response from the MS.

Because the MSC initiated the transaction, it is also responsible for controlling the transaction. The MSC normally releases the transaction after receiving a response from the MS, but in some cases may release the transaction before receiving a response (e.g., if an application timer expires).

If the application in the MSC needs to send further operations to the same MS, it will continue to use the same transaction until all operations are completed. If a different transaction is used for a subsequent operation, the MSC releases the first transaction before starting the next. If the MS releases the transaction at any time (e.g., due to the user clearing), MSC informs its application and terminates the USSD operation. (An MSC-invoked USSD request is likely to be used for call-related operations where the application is controlling a call to or from the MS.)

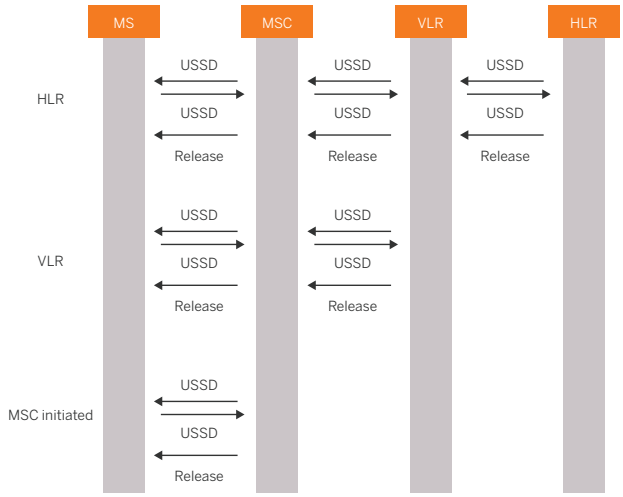

Figure 3: Information flow for a USSD request (single operation)

Figure 3 shows the message flow for a network-initiated (HLR, VLR, and MSC) USSD request for a single operation.

In another case, when an application in the VLR needs to send a USSD request or notification to an MS, it sets up a transaction to the MSC where the subscriber is currently registered and sends the operation to the MSC. The MSC further interacts with the MS as explained above. The VLR then awaits a response from the MSC. Because the VLR initiated the transaction, it is also responsible for controlling the transaction.

In a third case, when an application in the HLR needs to send a USSD request or notification to an MS, it sets up a transaction to the VLR where the subscriber is currently registered and sends the operation to the VLR. The VLR further interacts with the MSC which then interacts with the MS as stated above. The HLR then awaits a response from the VLR. Because the HLR initiated the transaction, it is also responsible for controlling the transaction. The HLR normally releases the transaction after receiving a response from the VLR.

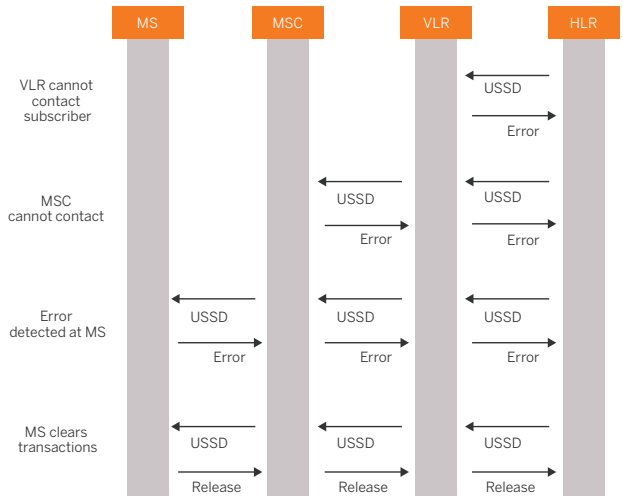

Figure 4: Information flow for a failed USSD request

Figure 4 shows the message flow for USSD requests failed at VLR, MSC, MS for a single operation.

ACTIONS AT MS

The MS may at any time receive a USSD operation request/notification from MSC. The MS processes the operation if it is in a state in which it can handle the operation. After sending the response to a USSD operation, the MS waits for the network to release the transaction. While awaiting this release, the MS will process any further USSD operation requests in the normal way.

At times, MS may not be able to process the network-initiated USSD because of the following reasons:

1. Feature not supported by the user (MS)
2. Alphabet indicated in USSD is not supported by MS
3. User is engaged in another USSD session (network- or mobile-initiated)
4. A non-call related supplementary service transaction is in progress. In all the above failure cases, an error indicator will be returned to the originator (MSC or VLR or HLR)

4.3 MOBILE-INITIATED USSD OPERATIONS

The MS may initiate a USSD operation either during a call or outside.

ACTIONS AT THE NETWORK

If the serving network (MSC) does not recognize the USSD code in a mobile-initiated USSD operation, it sends the operation to the next level (i.e., VLR). If VLR also does not recognize/decode the operation, it gets sent to HLR. If even HLR is unable to decode it, an error message gets passed downward and the session is terminated.

If MSC, VLR, or HLR (in the same hierarchical order) is able to decode the operation/service requested, and if either of the network nodes has the required data, then this information gets passed downward back to MS. However, if the network nodes are able to decode the operation/service request, but can't support the required application, then a check is made with the USSD platform. The decoded request is forwarded to USSD Gateway and then to USSD applications to fetch the required information.

If the mobile-initiated USSD transaction is found to be incompatible, the operation is rejected by a non-supporting network and the attempt fails. Figure 5 shows the flow diagram for a mobile-initiated USSD request. (The application at MSC/VLR may pass the request to another network element. That scenario is not shown here.)

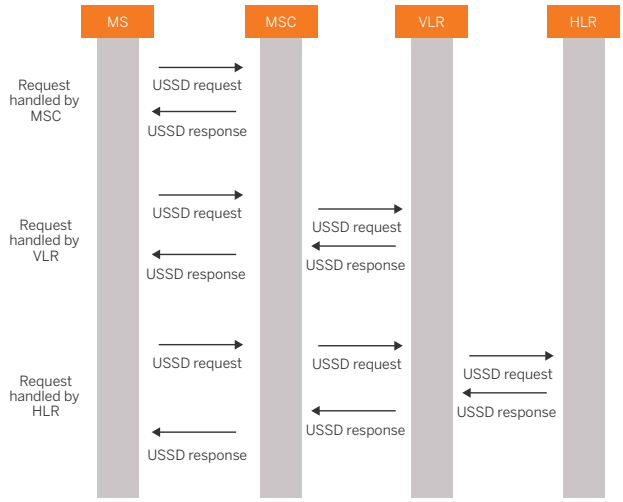

Figure 5: Information flow for a mobile-initiated USSD request

Figure 6 shows the message flow for a mobile-initiated USSD request that failed at MSC, VLR, and HLR. It also depicts a case where an MS clears the transaction before it receives a response to the initiated USSD request.

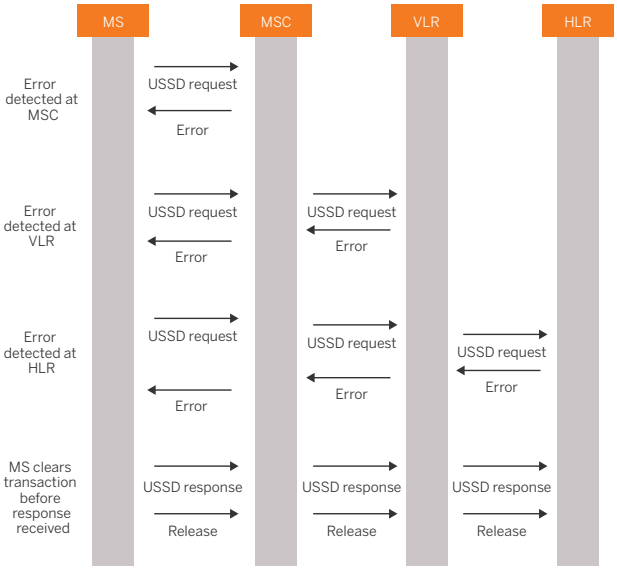

Figure 6: Information flow for a failed mobile-initiated USSD request

5 USSD USAGE AT HOME AND ROAM NETWORK

USSD can be accessed via two locations: Home Public Land Mobile Network (HPLMN) and Visited Public Land Mobile Network (VPLMN). USSD messages can be handled either from the VLR or the HLR, depending on the current location of the user. When accessing USSD at the home location (HPLMN), the user directly communicates with the HLR in case of a mobile-initiated USSD operation. And when accessing USSD at a visitor location (VPLMN), the user communicates to the HLR through the VLR.

USSD is an excellent choice for roaming with mobile prepaid service, which utilizes the USSD connection to originate a call while roaming. USSD messages from handsets always route to the home network. Thus, when roaming in another network, dialing a USSD string will always route the application on the home network. This feature allows for the virtual home environment concept.

The MSC connects to HLR of the home network via VLR using the SS7 network. The HLR sends the request to the USSD Gateway, which in turn passes the request to the prepaid application server. The application server ascertains the user's balance and provides instructions for handling the call via the same path to the serving MSC in the visited network.

Also, users accustomed to accessing a particular service in their home network are able to access that network from another country. The processing happens in the same way as explained above, but the supporting USSD application server may be different. Conversely, roaming subscribers from other networks cannot access USSD services on a host network.

6 IDEAL APPLICATIONS USING USSD

Services requiring menu-/session-based interaction between the user and the application are ideal for being offered via USSD. Some applications that are still in their naive stages of development, or that have yet to be developed, are discussed in detail below.

6.1 MOBILE BANKING VIA USSD

No other channels have the ability to reach the consumer as thoroughly as mobile phone. The coverage of cell phone networks in relation to fixed ATMs and branches helps reach more customers.

Architectural view of banking system

A bank's core banking system houses consumers' accounts, related transaction management, and history. It is necessary for translating banking instructions received from consumers through bank channels such as ATMs, the internet, and mobile devices into a format it can process.

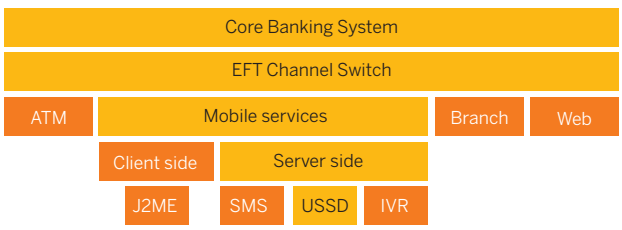

Figure 7: The Banking System Architecture

This translation is normally performed by an Exchange Traded Funds (EFT) channel switch that switches transactions from the channel to the appropriate area within the core banking system.

Client-side applications refer to those applications that reside on the customer's SIM card or mobile phone device. Client-side technologies include J2ME. On the other hand, server-side applications are developed on a server away from customers' mobile phone or SIM card. Server-side technologies include USSD, IVR, SMS, and WAP.

6.1.1 CRITICAL REVIEW OF SECURITY OPTIONS FOR MOBILE BANKING

Mobile banking brings new opportunities and new horizons, but also comes with implicit risks to financial providers, carriers, and the financial system. On the one hand, it holds out the prospect of adding convenience for accessing banking and payment services to customers. But the addition of a new channel also brings new operational risks to providers, just as the introduction of internet banking posed the risks a decade ago.

For this reason, mobile Financial Service Providers (mFSP) seeking to enter the market have to assess their risks and develop strategies to mitigate those risks on an ongoing basis. Security is a very sensitive issue for M-Banking, so this section compares the risks of using SMS and USSD messaging services.

Data carried across the mobile network is protected by the standard GSM security protocols at the communication layer. The subscriber identity is also protected across this chain. The risk in transporting data across the GSM channel is directly dependent on the number of stoppages the data must make before reaching the bank.

Data security with SMS banking

SMS service is deemed to be the least secured of the technologies suggested for mobile banking because of the number of points where the SMS data is available to others in a clear or unencrypted format.

The diagram below shows the entities involved across the GSM channel in SMS banking.

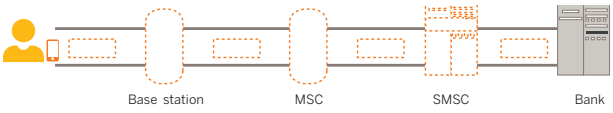

Figure 8: SMS Banking GSM Channel

A customer initiates a transaction by sending an SMS to the bank using the bank's SMS short code. The SMS is stored on the handset and is available to anyone who looks at the customer's phone; hence, making it unsecure at the very first step. The SMS then passes through the encrypted GSM communication channel through the base stations and terminates at the mobile network operator's SMSC. There, it is typically stored in an unencrypted form, making it unsecure at also the second step. The SMSC passes the message onto the bank's wireless application processor or mobile banking processor (which may be a third party), where it is stored either in encrypted or unencrypted form. The third party then passes the message to the bank across an encrypted fixed line to the bank, where it is typically stored in a secured environment.

In all, there are three highly susceptive points of exposure during the transaction where the data is stored, making the SMS service far less secure.

Data security with USSD banking

Unlike SMS, USSD message is not stored on customers' mobile, making it secure at the first level. USSD opens a single session between the device and the supporting application at the network operator/processor/bank.

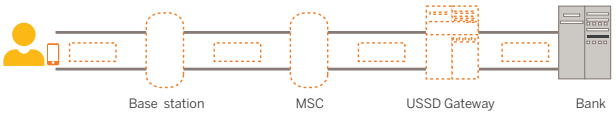

Figure 9: USSD Banking GSM Channel

The data is also encrypted at the USSD gateway sitting at the network operator/processor/bank, preventing any misuse of the data. This makes it secure at the second step. The end-to-end transaction flow occurs across the encrypted GSM communication layer while the subscriber identity is also hidden. Hence, USSD service is safer than to SMS and other GSM technologies.

However, there is one risk. If the GSM encryption (which is used to carry the data within the communication layer by secured means) is broken, the data can be accessed–which can actually happen with all GSM technologies (e.g., SMS, USSD, etc.). To avoid this, the GSM encryption needs to be made more robust, much like how internet banking has evolved over the years. Excluding this generic threat, USSD appears to be the most suited technology for mobile banking application.

6.1.2 MARKET PROJECTIONS FOR M-BANKING USERS

A recent report from Juniper Research gives a detailed forecast for mobile banking users by 2011 across eight regions of the world (Figure 10).

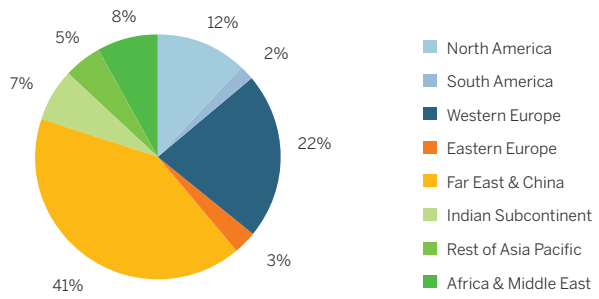

Figure 10: Mobile Banking Users – 2011 Regional Forecast (%)
Reference: Juniper Research

6.2 SPREADING AWARENESS ABOUT EPIDEMICS AND FATAL DISEASES

USSD service can be used innovatively to educate people and spread awareness about fatal, epidemic diseases such as AIDS.

For many of these diseases, prevention remains remains the only available cure. Taking early disease-prevention measures, educating people about their symptoms, providing anonymous counseling, gathering data, linking patients to services, and many other such acts can go a long way in improving the health of developing nations.

For millions of people affected by HIV and other diseases, there is an unmet need to circulate information regarding these diseases. Currently, this information is disseminated in numerous ways including print media, radio, television, newspapers, and the internet. However, not all of these channels are accessible to everyone; hence, using cell phones to reach the masses seems an obvious extension.

The information people require varies from basic knowledge like symptoms or prevention measures to a more detailed understanding of a particular disease's course and treatment. The menu implementation of USSD can be set in a single transaction, and the interested users can dig into the required information.

6.2.1 SMS VERSUS USSD FOR IMPLEMENTING THE SERVICE

Studies have indicated that reminding people to take their medicine on time can increase adherence to treatment. These messages need to be timed appropriately to suit each purpose. When patients regularly skip taking their medicine, or take it at the wrong time, the severity of their disease can increase, often necessitating costlier and more expensive second-line treatment.

Scalability and costs involved in using SMS

The size limit of 160 characters restricts the amount of content information that can be communicated through text. A detailed description of any disease/medicine therefore requires two or more messages, which means extra costs for an operator.

SMS delivery charges are costlier because they involve SMSC and other related transmission trunks. Also, scheduling costs of SMS are much higher because traffic at network and its availability versus traffic at SMSC must be taken into account.

Scalability and costs involved in using USSD

USSD's 180-character capacity per message increases the scope for content length. And because the USSD platform sends messages directly without using SMSC, it is less expensive than SMS.

In-depth information can be provided via a menu-based approach in which the interested users can drill down to the didactic content. Hence, an operator can provide handy tips in a common, free message while the cost of providing additional information can be charged to the user (only if the user uses an interactive USSD menu-based session). The messages can also be better timed by using USSD rather than SMS because there is no need to account for network congestion at SMSC.

Impact or Analysis

It can be concluded from this discussion that the USSD technology can go a long way in improving the living conditions of the poor.

Assuming that this innovative service is offered at no extra cost to customers, at least in developing and underdeveloped countries, the analysis is done only with respect to the operating costs for operators/service providers.

Although USSD is an efficient technology, it's too early to derive any conclusion on the impact and effectiveness of this service because data collection from the end user is an arduous job. Many people don't want to share information about their diseases, or register with the operator for fear it may lead to disclosure of their personal data.

This medical care application was just an example to demonstrate how USSD can be used in the health sector. There are many other areas where this service can prove beneficial such as in alerting fishermen about the rising tides and sea/weather conditions; teaching farmers about the best seasonal crops to grow in different regions and the new innovative tools available to improve agricultural productivity; and informing students on job trends and career opportunities.

6.3 UPDATING MOBILE SOFTWARE OVER-THE-AIR

As mobile phones are getting highly complicated, the demand for an effective firmware update service is increasing steadily. A proposed solution is to update and manage the software over- the-air (OTA).

Before these operations can be carried out, all OTA-capable mobile phones must be registered with a distributer/third party that has new software or an updated version of existing software. To update/install new software, information is required to uniquely identify devices, initiate a device management session, and determine if a firmware update is needed.

To get this information, the network operator can use USSD. The "Updation Service" is made available via a USSD menu option, wherein a user can select update options and communicate phone/model details. After receiving the model details at the operator end, the software version, features, IMEI manufacturer for that model, etc. are identified. If there are any latest updates applicable for that model from the mobile company, the updates are performed via OTA. Thus, phones no longer need to be taken to a service center, but rather can be updated at the user's leisure.

However, the cost of receiving the update may vary depending on location, with whom the operator has agreements, software used, etc. This kind of service can both generate a lot of revenue for the operator and help mobile manufacturers service their customers with updated software.

Although the three initiatives/innovative proposals discussed in this paper are still in their infancy stage, they have a real-time scope of becoming fully fledged applications in the near future.

6.4 POPULAR USSD APPLICATIONS ALREADY IN USE

Here is a list of some popular applications already being used extensively.

- Pull-based services like informational services
  - News, weather, movies, sports update
  - Currency update, stock market
  - Telephone directory, Yellow Pages
- Push services
  - Voting/polling
  - Flash emergency information
- Reservations (train/movies)
- Sponsored menu items/advertisements
  - Companies/shops/theaters can get listed on the menu and promote their services
- To indicate the account balance information from network to user after each call
- Direct balance inquiry by user without using IVR
- Prepaid recharge (even while roaming) through registered credit card
- Card validity time information
- Prepaid balance transfer: prepaid subscriber can transfer money to another prepaid user's account (e.g., press *short code*Security Code*other party number*Amount# and dial)

7 SERVICE PROVIDERS' PERSPECTIVE OF USSD

India has over 1 billion people and more than 180 million households. There are more than 90 million mobile phone users in the country today, with approximately 5 million new users being added every month.

As operators/service providers move into untapped rural areas to take advantage of the low penetration rate of mobile phone service, prepaid subscriptions from low-income, value-driven, and cost-sensitive customers will fuel future growth.

The usage and credit profile of first-time, entry-level users is certainly different from that of the more affluent, high-profile premium subscribers. To profitably grow in this segment, service providers need to embrace a business model that focuses on maximizing the use of existing network assets while reducing operational expenses via streamlined, cost-efficient processes.

A new operator can beat the entry barrier only by one of the following:

1. New service
2. New technology
3. Different business model (tariff and other plans)

Using the latest USSD technology, the operator can float new services and various applications at much cheaper rates while enhancing operational efficiency and generating incremental revenues by delivering practical value to the prepaid customer base.

COST EFFICIENCY

New subscribers in developing and underdeveloped countries are likely to generate in less Average Revenue Per User (ARPU) than existing subscribers. Prepaid distribution and customer care are key cost components that can escalate operational overhead. USSD-based solutions can help operators balance the trade-off involved in keeping service levels high and costs low.

Because the USSD technology uses the existing SS7 protocols, significantly less investment is needed in the the network. The USSD Gateway uses the same application programming interface as the SMSC, making it easier to port services based on SMS to utilize USSD as the bearer. In practice, only USSD specific modifications are needed for external applications. Hence, the capital expenditure (CAPEX) and operation expenditure (OPEX) are few.

REDUCED COST PER TRANSACTION FOR MENU-BASED IMPLEMENTATION

USSD-based prepaid reload enables operators to vend prepaid vouchers in electronic form over physical and virtual channels. Operators can distribute talk time to distributors and retailers via OTA using USSD. The retailer, in turn, credits airtime to the customer's account.

Operators can bypass the conventional dealer network and further extend outreach via an embedded and scalable peer-to-peer distribution network. Mobile users can use USSD to transfer airtime credits to another prepaid user's mobile account, effectively rendering each customer a potential service reseller.

LOWER CUSTOMER CARE COST

Operators can deploy a USSD-based self-care portal with a personalized, text-based menu to access a range of account-related tasks such as balance inquiry, refill account, or self-provisioning VAS. USSD's session-based architecture accelerates response time and ensures high-quality customer interactions.

On average, the ratio of expenses with "live agent calls" to "IVR system calls" to "customer served via text-driven self service" is 100:10:1. That means a customer served via self-driven USSD service is 100 times cheaper than a dedicated live agent answering customer queries and 10 times cheaper than the IVR system. Thus, the expenses for customer care services are inversely proportional to the number of services being rolled out via USSD.

LOWER MARKETING COST

Operators can also use USSD as a cost-effective way to maintain contact with prepaid subscribers, alerting them of new services with the "push" service. Operators can also use the unused character space in the balance inquiry response to deliver targeted marketing messages to prepaid customers in order to cross- and up-sell additional services.

8 CONSTRAINTS OF USSD

USSD keeps resources assigned, routing direct messages to the HLR, which means increased traffic on the channels between the MSCs and the HLR. Additionally, a USSD message can only be sent to a user's home network, where the connection is maintained for the entire duration of the USSD session. USSD can therefore be expensive in terms of its resources assigned.

Even though the resources (signaling channel, etc.) are assigned for the entire duration of the session, these resources are more efficiently utilized in USSD than to SMS. Clearly, the positives of USSD far outweigh the negatives.

9 FUTURE SCOPE

Modern interactive and real-time USSD services, combined with excellent compatibility with all mobile terminals (from old handsets to new smartphones), have played a significant role in enabling the telecom transformation. Mobile operators today are seen as lifestyle services providers. Deep integration of USSD center with various other platforms allows for a cost-effective and efficient utilization of resources.

Nowadays, VAS have become an indispensable part of the products offered by mobile service providers. Modern USSD service operators see their stature quickly changing from mobile service provider to innovation "super store," always wanting to provide new and easy network services and applications. From the core network to the internet, the reach of modern USSD services is expanding and rapidly transforming the telecom cloud into a services cloud. This is clearly valued by the users.

Today, USSD offers a competitive market for creating revolutionary network service. It binds the third-party interfaces (e.g., service providers, banks, enterprises, etc.), USSD sponsors, content providers, advertising and marketing crew, and many others. The new trends of services include location-based USSD services, USSD gaming and betting, user-managed USSD applications and content, mobile information and entertainment, and many more.

Although many of these USSD services are still in the nascent stage, this technology has a huge potential for growth. Still, many more innovative M-commerce applications can be thought of and serviced to make our communication easier.

CONCLUSION

To access USSD, subscribers require neither additional software for the handset nor a special Subscriber Identity Module (SIM) card.

The benefits of the USSD technology look promising. Recognizing the limits of SMS and IVR, USSD leverages subscriber-application dialog, offering a competitive edge, accentuating technological advantages, maintaining customer satisfaction, and significantly reducing the churn rate.

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ABBREVIATIONS

USSD	Unstructured Supplementary Service Data
USSDC	Unstructured Supplementary Service Data Center
MS	Mobile Station (mobile user)
SMS	Short Message Service
SMSC	Short Message Service Center
SMPP	Simple Messaging Peer-Peer
MAP	Mobile Application Part
TCAP	Transaction Capabilities Application Part
WAP	Wireless Application Protocol
MIS	Management Information Systems
DWH	Data Warehouse
VAS	Value Added Services
IVR	Interactive Voice Response
API	Application Programming Interface
HLR	Home Location Register
HPLMN	Home Public Land Mobile Network
VLR	Visitor Location Register
VPLMN	Visited Public Land Mobile Network
MSC	Mobile Switching Center
VMSC	Visited MSC
mFSP	Mobile Financial Service Provider
mFS	Mobile Financial Services
MNO	Mobile Network Operator
ARPU	Average Revenue per User
3GPP	3rd Generation Partnership Project
OPEX	Operation Expenditures
CAPEX	Capital Expenditures

REFERENCES

3GPP TS 22.030: "Man-Machine Interface (MMI) of the User Equipment (UE)".

3GPP TS 23.038: "Alphabets and language-specific information".

3GPP TS 22.004: "General on supplementary services"

3GPP TS 22.090: "Unstructured Supplementary Service Data (USSD) – Stage

3GPP TS 24.080: "Mobile radio interface layer 3 supplementary services specification; Formats and coding".

GSM 02.90 (ETSI TS 100 549) Specification (USSD) Phase 1 at 3Gpp.org

GSM 03.90 (ETSI TS 100 549) Specification (USSD) Phase 2 at 3Gpp.org

GSM 03.40 ETSI European Digital Cellular Telecommunication Systems – Technical realization of SMS

USSD Services for Interactive Mobile Users – A PDF doc

www.mobilein.com

www.mobitek.com

www.3g4g.co.uk

www.netfors.com

www.mobileUSSD.com

http://en.wikipedia.org/wiki/USSD

www.gsmworld.com

www.nfc-forum.org/

OMA, Device Management Working Group.

www.openmobilealliance.org

Mobile Payments Forum – Risks and Threats Analysis and Security Best Practices, Version 1