ABSTRACT

In East Africa and Africa in general, we have several innovations in the payments processing sector that are each aimed at solving a critical business function. Currently, we have payment systems such as mobile payment systems from Telco providers, instant remittance systems, card based payment systems from banks, Electronic Funds Transfer systems and Real Time Gross Settlement systems. Each type of payment systems has its own standards and protocols for integration to client facing applications. Mobile payment systems use telecommunication protocols such as: GSM, SMPP, CDMA, GPRS, and microwave. Card based systems use protocols meant for secure card payments such as: magnetic strip cards and smart/chip cards. Electronic Funds Transfer use interchange specification formats that are based on ISO 8583 standards. To tackle the issue of incompatibilities among the above diverse protocols, this paper explores an agent-based model for coordination and its impact in unifying payments from various industries. In this paper, an agent-based model for coordination is designed and an illustration on how to use open source tools such as: jPOS, Java and XML to implement such models.

Categories and Subject Descriptors: I.2. [ARTIFICIAL INTELLIGENCE]: Distributed Artificial Intelligence - Coherence and coordination; Intelligent agents; Multiagent systems; K.4.4 [Electronic Commerce]: Distributed commercial transactions

General Terms: Online payments, Real Time Gross Settlement, ISO 8583, Electronic
1. Introduction
In an effort to reach the unbanked people and financial institutions outreach on alternative banking channels, Africa has seen a revolution in the range of payment solutions. The unbanked now have access to micropayment services offered by the telkom providers through their mobile phones. The telkom providers setup virtual banks that serve the subscribers using their mobile phones by application of common telkom protocols such as: SMS and USSD. The best examples of such ground breaking services are the M-Pesa [MPESA 2010] from Safaricom Kenya and Zap [ZAP 2010] from the Zain mobile network in Kenya. With much progress that is happening in the payment industry, no efforts have been made to ensure existing and new innovations interoperate. This paper looks at existing payment systems and analyzes them based agent based models for coordination [Chavan et al, 2008]. The paper finally, illustrates an agent-based integration framework for integrating legacy and new payments systems in the African region.

2. Related work
Real Time Gross Settlement systems are EFT applications that enable cross bank transactions in real time. They provide a reliable bus for users to initiate payments into others accounts held with other banks. It has become the preferred means of payment of amounts exceeding certain limits in some countries. [Ruzbeh, 2010]

ATM/POS switching networks also provide a means of dispensing cash and purchasing goods or services. They are card based systems where users access services through secure terminals. The terminals which include POS and ATMs have special encryption and authentication mechanisms that have over time enabled automated and self service cash management. These networks rely on TCP/IP based protocols such as ISO 8583, XML, and HTTP.

Online payment gateways such as Google checkout, PayPal, and JamboPay are
payment services that integrate into the online merchants shopping carts to enable funds transfer from the buyer to the seller accounts. The accounts could be affected through credit/debit card transaction or a micropayment method where both parties’ online balances are affected. The payment gateways provide data interchange through their special APIs such as HTTP/HTTPS or web services.

To address the disparities in the above payment methods, Multi-Agent Systems (in Artificial Intelligence) can be used to model an integration framework that can promote interoperability and solve difficult coordination requirements. This paper explores an agent based coordination model aimed at unifying data interchange from various sources and its impact in revolutionizing payments in developing countries.

3. Research framework and methods
In this section, basic operation setup for targeted payment systems is illustrated. The payment setup analysis is based on the three basic components of an agent-based coordination model that is: coordination model, coordinables, coordination rules and security considerations. This approach is used in order to analyze the inherent agent-based aspects of payments systems and therefore, allow the agent-based approach to securely solve problems in the payments domain. The fundamental coordination media, coordinables, coordination rules, and security considerations are broken down for each payment system and their unique data interchange requirements exposed. The main systems analyzed are the ISO 8583 based such as ATM/POS, Real Time Gross Settlement, mobile payments, and the online payment systems.

3.1 ISO 8583: ATM/POS and other switching applications
ISO 8583 standard is a card originated transaction message that defines the data interchange specifications between financial entities such as banks, switching, bridging applications and devices. It guides the exchange of electronic transactions made by card holders using payment cards such as credit or debit cards. A sample ISO 8583 message for cash withdrawal is shown below.

```xml
<send><isomsg direction="outgoing"><field id="0" value="0200"/><field id="2" value="9000000000000001"/><field id="4" value="00000310000"/><field id="11" value="473593"/><field id="32" value="444111"/><field id="41" value="10000002"/><field id="43" value="agent test zone"/><field id="49" value="404"/><field id="102" value="2222222333333333"/></isomsg> </send>
```
3.2.1 Analysis

i) Coordination media
The main channel of data interchange is the TCP/IP networking where data is sent by client to the server and reverse as packets. In some cases GPRS networking is used for devices such as POS. In the case of GPRS the data services are provided through the telkom network.

ii) Coordinables
The main objects being coordinated are the ISO 8583 messages. They are TCP/IP data packets encapsulation of financial services requests such as: balance enquiry, cash withdrawal, funds deposits, funds transfer, and statements requests.

iii) Coordination rules
These are the rules guiding the interchange of data and interpretation of service requests. They are derived from the ISO 8583 standard where the request and responses are evaluated based on the message format such as: message types, processing codes, return codes, and data elements.

iv) Security considerations
To securely interchange data in this setup we need a trusted Virtual Private Network with a private-private key encryption. Further security can be enhanced by encrypting certain data fields like PIN blocks.

3.2 RTGS – Real Time Gross Settlement System
The Real Time Gross Settlement processing is a means of making payments by account holders of one bank to a different bank in real time while each transaction is settled independently. This standard forms a critical backbone on which payments exceeding certain amounts are settled. For banks to initiate and receive such transactions, they need an interface system that can interpret RTGS messages. The RTGS messages are ASCII formatted text sent over a TCP/IP network. The communication can be basic sockets that asynchronously process requests on given ports. A sample RTGS message format is given below.

Sample message for open notification
{A:CBSF24O00001000SBIN0001001200701081730}
3.2.1 Analysis

i) Coordination media
The RTGS message can be transmitted as TCP/IP packets. The interchange setup may be a simple client server communication, where, the server application binds on a network address and a port.

ii) Coordinables
The main objects of interchange are the RTGS messages. They consist of data elements and commands packaged as TCP/IP packets.

iii) Coordination rules
The RTGS interchange standards guide the communication. The RTGS interchange rules have certain control data elements that help to understand the message such as message identifiers.

iv) Security considerations
To securely interchange data in this setup we need a trusted Virtual Private Network with a private-private key encryption. Further security can be enhanced by encrypting certain data fields like PIN blocks.

3.3 Mobile payments
The mobile payment applications operate based on the telecommunication protocols. The protocols, though less developed are used to give users an interface on their cell phone mostly using the USSD interface or SIM card menu. The wire protocol is mainly SMS and SMPP. The SMS is basic text messages transmitted from one GSM device to another using the GSM network that is subscribed to and sometimes routed based on the roaming agreements. The SMPP protocol is used to overcome the SMS approach constraints by delivering the messages through TCP/IP packets. A generic message structure is shown below.

Message template: command#recipient#amount#sender
Message: transfer#0790999999999#20000#0719999999999

The submitted message is received at the SMSC and passed to the virtual banking system. On the bank’s side, a special SMS or SMPP interface has to be developed to parse the incoming messages and perform the right action on the accounts affected.
3.3.1 Analysis

i) Coordination media
The mobile payment setup allows information to flow on different channels before final delivery. In a typical case, the data is transmitted through the GSM network channels from source to destination and sometimes from GSM network channels to TCP/IP channels when SMPP transmission is involved.

ii) Coordinables
The objects involved in this setup are SMS messages that are transmitted using the GSM protocols and the TCP/IP message packets that are delivered through the SMPP protocol.

iii) Coordination rules
The user data and commands entered in the mobile interface are controlled by the SIM menu provided. The menu of the SIM application ensures the correct entry of data and then triggers the right action in the background. The same case applies for USSD menus, where the prompts the user is served helps to construct the meaning of the service requested. The command in the background could be a simple structured SMS that will be interpreted on reception at the SMSC.

iv) Security considerations
Mobile GSM technology security can be enhanced by introducing trusted Business to Business connections such as VPNs with 3DES encryption of the payload.

3.4 Online payment gateways
An online payment gateway is a secured web portal that enables users to pay for goods and services using the credit/debit cards, bank accounts or online balances. The online payment gateway such as PayPal or JamboPay provides a mechanism for online merchant websites to redirect their shopping carts to the gateways secure site for payment actualization.

Sample FORM for JamboPay merchant integration:
<form method="post" action="https://jambopay.com/WTCartProxy” target=”_blank”>
<input type=”hidden” name=”item_type” value=”cart”>
<input type=”hidden” name=”item_name” value=”general shopping description”>
<input type=”hidden” name=”business” value=”merchant email@yourdomain.com”>
<input type=”hidden” name=”amount_1” value=”4000”>
The web service approach involves the merchant web pages invoking a web service hosted at the payment gateway servers. The web service call is made through a SOAP message that carries same data as above HTML FORM only that in this case it is in XML format.

3.4.1 Analysis

i) Coordination media
The payment gateways data interchange is in the forms of TCP/IP channels, HTTP/HTTPS channels and RMI/RPC channels. The TCP/IP channels help in client server communications while HTTP/HTTPS are used in transmitting the FORM elements on the web interfaces. The RMI/RPC is used to transmit the SOAP messages in a setup that requires web services.

ii) Coordinables
In the payment gateway scenario, the communicating entities mainly manipulate HTTP GET and POST query strings. The query strings carry the data as name value pairs that can be processed by any server side running script. Sometimes, interchange objects may be the SOAP messages. The SOAP message is usually a XML formatted RPC/RMI message tunneled through a TCP/IP request. The SOAP messages are applicable when web services are being used.

iii) Coordination rules
The business activity intended for each data interchange is determined by the name-value pairs parsed in the HTTP query strings or the web methods and parameters invoked with the web service.

iv) Security considerations
Web based transactions security can be enhanced by deployment of public-private KEYs from Certificate Authorities like Verisign, Thawte, and COMODO. These security entities can help in managing the public and private KEYs/certificates for identity management and encryption.

4. Discussion
In the section above, simple analysis of various payment methods following the
agent based model’s three key components [Chavan et al, 2008] revealed that most payment systems can be analyzed easily using the framework. A summary of the findings above is shown in the diagram below.

The findings above show that payment systems are inherently agent-based models that depend on communication channels such as GSM, TCP/IP, SMPP, HTTP, RMI/RPC and other wire protocols. The results also show that each payment system exchanges data based on some standards or rules. These rules vary so much from one method of payment to another while the data exchanged is a simple ASCII or binary data encoded using the rules defined.

The above finding can be reorganized in a more generic way that can help to realize one main system that has customizable coordination media adaptors, flexible message packagers and easy coordination rules implementation through dynamic class loaders. One such framework is jPOS, a Java Professional Open Source library for development of card based payment systems.

**jPOS based solution**

jPOS is a Java® platform-based, mission-critical, ISO-8583 based financial transaction library/framework that can be customized and extended in order to implement financial interchanges [jPOS]. The framework has useful features that
makes it able to solve the problem of payments systems integration. Some of the key features are outlined below.

Q2 module: It contains adaptors which provide the Q2 lifecycle (init/start/stop/destroy) that are used to manage the services running on different ports and other jPOS components. Q2 provides an easy way of deploying each component as a QBean and provides one file per component for configurations. QBeans are Java JMX MBeans that are used to manage the frameworks life-cycle operations.

Message packagers: These are components that provide XML based message templates. They help the framework to pack and unpack messages when they arrive. How the message is packaged determines the data interchange formats between the communicating entities.

Channels: They implement the wire protocol. They are used to receive and send the messages. They deal with the channel communication protocols such as TCP/IP, directory polling, SMPP, GSM and others.

Space: This is a general purpose coordination component that helps in matching requests and responses. It is a Map like representation of objects lists in a name-value temporary storage.

Based on the jPOS architecture discussed above, a general purpose model can be realized that can help to integrate the payment systems discussed earlier. The model follows the agent based model design requirements of a coordination media, coordinables, and coordination rules. In this approach, all payment applications running in different institutions are treated as software agents since they run autonomously and run their tasks on the behalf of the hosting institution. The diagram below illustrates such a model designed for this paper.
The model consists of a coordination media, coordinables, and the coordination rules. The basic elements of the model are outlined below.

Coordination media: the layer is made up of message packagers, channels, channel multiplexers and space components that help in realizing the coordination media. In this layer, the RTGS messages, ISO 8583 messages, SMS, SMPP messages, HTTP Query strings and SOAP messages can be processed using customizable message packagers. The communication protocols such as sockets, GSM, GPRS, RMI, and RPC can be managed using the channel adopters that are associated to the message packagers in a peer pattern.

Coordinables: the key objects that are exchanged in this setup are the ISO 8583 messages. Each payment system message is adopted by its message packager to fit into an XML based ISO 8583 message. The main benefit of this arrangement is a standard set of operations that can be carried out on all the messages. In this layer, the RTGS messages, ISO 8583 messages, SMS, SMPP messages, HTTP Query strings and SOAP messages are all re-packaged as ISO 8583 messages before retransmission to destined institutions.

Coordination rules: from the coordinables layer, all messages are converted into ISO 8583 standard. Therefore, the governing rules for the data interchange are adopted from the ISO 8583 data interchange specifications. In this case, standardization has been achieved.
5. Conclusions
The work in this paper revealed that payment systems can be treated as an agent system acting on behalf of their hosting institutions. Some of the agents identified are: ISO 8583 Agents, RTGS Agents, GSM/SMPP Agents and HTTP/HTTPS Agents. This paper further shows that legacy payment systems in Africa can be analyzed using multi-agent systems methodologies where each payment system was analyzed based on basic elements of an agent based coordination model. The basic elements of such a model are: coordination media, coordinables, coordination rules, and the security layer. Based on the analyzed elements for each payment system, a generic coordination model that has customizable communication channel adopters, message packager, and coordination rules based on ISO 8583 interchange standard was illustrated. This paper has therefore, shown that legacy payment systems around Africa can be integrated using Artificial Intelligence Multi-Agent Systems models such as the one illustrated here.

6. Future work
From the finding in this paper, the key areas of concern for such a model proposed are data security and compliance standards. More research is required in establishment of data security and payment systems compliance standards that can protect users in the African region. The unique setup of the micropayment options in Africa requires special standards that fit into the African context.

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