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ABSTRACT

With the growth of international healthcare operations, methods to improve connectivity are sought, along with a reduction in major barriers of electronic connectivity between global trading partners. To address these barriers, a conceptual agent-based framework following a proposed methodology for the analysis and design stages is developed to allow for improved ease of connectivity and interpretability between international trading partners. This framework is comprised of agents and is applied to connectivity between healthcare entities such as payers and providers. While many healthcare entities exchange information electronically, few do so without some form of manual intervention. Information systems may be engaged to further enhance the healthcare industry. Given the increases in costs and international presence, it is vital to make use of electronic systems that improve overall quality and cost of healthcare.

Keywords

Multi-Agent System, MAS, Healthcare, Dynamic Connectivity, Collaboration.

INTRODUCTION

Healthcare businesses and operations are rapidly expanding internationally. This growth requires healthcare organizations to easily connect and interoperate with one another. Information technology can aid in the process of setting up dynamic relationships without the need for human intervention. This is applied in terms of setting up dynamic connections between healthcare entities, specifically providers and payers. Currently business and technical relationships exist between healthcare payers and providers on an individual basis or through conglomerates such as clearinghouses.

Currently the process for establishing connections between healthcare entities is time-consuming and costly, a major barrier to implementation. A conceptual model will be explored for improved use of healthcare connectivity through multi-agent systems (MAS) and other advanced technology that will allow for autonomous connectivity to occur. MAS are typically comprised of several autonomous agents acting and collaborating together. An agent is a software-based system with autonomous, interactive, reactive, and proactive capabilities. This allows agent communication by unique idenfier or name, without consideration for the underlying operating environment. These agents are used to reach goals that takes an individual longer to complete or with more difficulty. These techniques also include various forms of artificial intelligence which are applied to the self-formed network. Standards may also be developed to aid in the collaboration between entities. Some communication standards exist as a result of the legislature or industry bodies, however these do not reach the breadth or scope of all current operational aspects, and do not include autonomous system generation (Angeles, Corritoreb, Basuc, Nath 2001; Nikraz, Caire, Bahri 2006; Washington Publishing Company 2003).

The result of this process will lead to business value through improved quality and cost of healthcare for the individual organization and industry. This may also be applied to other industries depending on the applicability of business scenarios. This will create a competitive advantage for those entities willing to participate, as it will reduce setup costs and improve quality through decreased error rates.

LITERATURE REVIEW

Healthcare Globalization

Growth in overseas markets and changes in governmental coverage and control, are driving insurers to provide broader coverage internationally. In China, 90 percent of the population lack coverage, compared with 16 percent in the U.S. The market in China is expected to grow to an estimated $56 billion by 2020. While healthcare costs have increased, they are still far less than in developed markets, which is attractive to insurers. Latin America has also experienced a rapid influx of multi-national corporations providing healthcare coverage. During the period of 1996-1999, revenues of multinational healthcare

corporations increased faster in Latin American than the U.S. As the U.S market becomes saturated, companies are seeking new market locations for sustained growth (Lim 2006; Ran, Waitzkin, Merhy 2004).

Current State

In international studies, setup costs were identified as a major barrier to electronic system implementations. Healthcare services that occur outside the country of residence require a lengthy manual process in order to gain reimbursement. Trust factors such as information security, infrastructure, education, government, and culture influence adoption rates. Security issues include data theft, corruption, and personal or confidential data. Trusted authorities are also a key component to security and trust. Global certificate and intermediary services which improve security are being developed internationally. Cultures may also influence the communication language selected or willingness to engage in non-personal contracts between systems (Angeles, Corritoreb, et al. 2001; Hassan, Pans, Collins 2003; Hennick 2007).

To address these limitations, electronic marketplaces have been utilized in the past for B2B and e-commerce. This allows partners to identify one another, and in some cases setup contracts utilizing automated methods. Generally a business transaction follows three phases: search, negotiate, and fulfill. In the search phase, an entity looks for potential business associates. This would be equivalent to a provider seeking a payer for patient coverage, or a payer seeking another payer for coordination of benefits. Ontologies are utilized for standardization and international connectivity, which address language, terminology, and data differences. After identifying a business partner, the negotiation phase develops the contract and details of the transaction. This negotiation may involve a sequence of message exchanges, which allow for a final contract to be generated. In healthcare, the negotiation is typically around coverage or payment terms. For example, the payer may agree to cover only certain procedures, or only agree to pay a percentage of the provider's billed charges. The fulfill phase includes logistics, payment, etc. Transaction information is stored in order to determine payment, estimates, and fulfillment of contracts. Utilizing automation would improve the fufill phase and associated reimbursement turnaround times (Jeusfeld 2002, Quix, Schoop).

For trading partner agreements between healthcare entities, two components are typically included, but are not required for transaction acceptance. The first are the standard electronic implementation guidelines formed through the associated governing body. The second component involves the specific processing of the transaction, and may include information or manner by which the transaction is sent. The guidelines do not specify the method to link partners or to exchange data, they only provide the structure. This requires that each partner provides and agrees upon the linkage and exchange methods (Washington Publishing Company 2003).

Once the dynamic connection and agreement between Trading Partners is established, data would be exchanged electronically. This is typically done through Internet-based and traditional Electronic Data Interchange (EDI). Studies have been performed with regard to international EDI and the associated success factors. Among these are standards, communication infrastructure, security, legality and agreements. Standards provide the required definition for how entities transmit data between one another. Given the number of standards, many entities are waiting for emergence of a clear standard. Common messaging standards include ANSI X12 and EDIFACT for traditional EDI, and XML for Internet-based EDI. Communication infrastructure includes items such as VANs, network access, service levels, interconnectivity, protocols, and throughput. Security mechanisms are responsible for monitoring and ensuring the integrity of transactions. With human interaction removed, it is vital for the system security to be monitored. With the move towards Internet based standards, security must also be reviewed and continually updated. Legality poses an issue with regard to governmental rules surrounding data moving across borders. In order to transfer data to another country, some European nations require a contractual agreement. Other countries require handwritten signature or terms and conditions disclaimers. These laws and regulations are intended to ensure protection and security (Angeles, Corritoreb, et al. 2001).

Facilitating Technologies - Multi-Agent Systems

A MAS utilizes multiple systems that are geographically dispersed to form problem solutions, unable to be solved by an individual system. Given the nature of a MAS, it is vital for agents to be able to adapt to current and future environmental conditions. In a MAS, each agent has a unique role and objective. The agents combine and interoperate to increase efficiency and output of the system.

Three functions that describe the individual performance versus the system performance are competitive, additive, and cooperative synthesis. Competitive synthesis chooses the best problem solution from a set of agents working individually. Additive synthesis uses the individual agents to perform specific pieces and parts of the overall objective. Cooperative synthesis is when the objectives of the individual agents are in conflict, and must resolve.

In order to have an effective MAS, dependencies must be managed. Three types of interdependencies are temporal, resource, and sub-goal. Temporal interdependency requires the first agent to complete prior to the subsequent agent starting, and sequencing and synchronization issues arise. Resource interdependency requires resources such as time, money, space, processing, etc. to be shared amongst agents. Sub-goal interdependency necessitates the individual agents to transfer solution results to form a comprehensive problem solution. In an individual agent system, the agent seeks to maximize its payoff, whereas a MAS seeks to maximize the total system payoff (Pendharkar 2007).

Agents are capable of autonomy, reactivity, proactivity, as well as exhibiting human traits such as knowledge or emotion. Agents are used within a system to complete a task. Agents also permit interaction and interoperation between humans and machines. The four stages of agents in cooperative problem solving are recognition, team formation, plan formation, and team action. In order for the agents to be successful, agents must work together and coordinate resources, resolve conflicts, and achieve objects. Agents may also be placed in unfamiliar surroundings, and therefore must adapt to new circumstances or situations, while achieving the overall objective (Tweedale, Ichalkaranje, Sioutis, Jarvis, Consoli, Phillips-Wren 2007).

ANALYSIS AND DESIGN

Following the methodology outlined by Nikraz, Caire, and Bahri, an analysis and design is presented for the development of a multi-agent system within the healthcare connectivity context. The methodology is proposed for the Java Agent DEvelopment Framework (JADE), which is in compliance with the Foundation for Intelligent Physical Agents (FIPA) standards. The analysis and design are kept sufficiently generic to allow for alternative development platforms. The methodology allows for completion of planning, analysis, and design, thereby improvement of implementation on the development platform of choice (Nikraz, Caire, Bahri 2006).

The aim of the analysis component is to further clarify the area of interest. SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is utilized as part of the strategic management process to assist in decision making. SWOT analysis is used in this methodology for its simplicity to indicate important factors in the healthcare landscape, and can be used as part of the overall management activities, while at the same time providing requirements information for the final system implementation (Nikraz, Caire, Bahri 2006; Pickton, Wright 1998).

Strengths

Reduced administrative costs would take place through dynamic connections. The current time and cost of adding an additional partner can be replaced. The primary partner improvements include the provider and payer setup costs. This would also improve patient satisfaction through accurate payment and notification of patient financial responsibility at the time of service. The improved setup time allows a provider of service to accept multiple payment methods and does not limit the provider to large payers only. This also allows payer to payer reduction and does not necessitate a paper process or routing through the provider. Improved setup efficiency allows for payment to be made in a timely manner. This allows a seamless process, which does not penalize business partners through lengthy setup. Payment can be made in line with existing partners. Contract and confidentiality agreements are also reduced, as third party fees and rates are not included. The agreement is performed systematically, thereby reducing multiple draft and agreement timelines.

Weaknesses

System requirements and restrictions may limit adoption. As with other technologies, adoption is required by all parties to reach maximum benefit. This may include healthcare and non-healthcare entities such as government organizations or consumer groups. For some the cost-basis may not be justified, while others may choose not to implement. Today, many standards such as X12, HL7, NCPDP, NACHA, and DICOM exist. If new standards are created or mandated, this would require international collaboration and standards for integration. In addition to the potential obstacles for agreement and decision-making, there would also be timeline considerations. Standards would need to be universal as with XML-based or neutral syntax languages and created in a reasonable amount of time. There may also be differing enforcement requirements, which may lead to entities not following set standards or methods (Kazzaz 2005).

Opportunities

These capabilities allow for creation of international standards, which will benefit the industry. This may also lead to future collaboration and standards, which would benefit the global nature of healthcare. These applications may also be utilized in other industries such as retail, manufacturing, suppliers, etc. This will also permit a larger market and offering coverage due to the ability to dynamically setup new partners and conduct business in an effective and timely manner.

Threats

Health policy and associated laws relating to privacy or security may inhibit or limit international collaboration and standards. If local standards are mandated, entities may then be unwilling to support additional methods. Established organizations may already have implemented solutions, or purchased solutions from third-party vendors that provide some of the functionality. These entities may also be unwilling to adopt additional software or methods. Security and reliability of international partners may also limit capabilities. Security standards and methods must also be addressed when forming business relationships and conducting business. Third-party security monitoring, transmission encryption, and configurable system safeguards should be well-defined and implemented as part of a partner agreement.

Agent Identification

An initial agent listing of main responsibilities is presented in an informal manner. The resulting process output is the responsibility table shown in Table 1. Each agent is discussed in additional detail below. The formal model for dynamic connectivity and collaboration between entities is shown in Figure 1. The sender model contains the following components: discovery (finding partner), agreement, communication, and security. The transmit component occurs after such agents have completed. The diagram also contains a third party, which monitors and acts as the intermediary between the sender and receiver. The third party also maintains the appropriate registration information and allows querying. The receiver model contains the following components: agreement, communication, and security.

Agent type	Responsibilities
Sender	Initiates agent connections Allows providers to generate connections Allows payers to generate connections
Third Party	Maintins registration Monitors agent interaction
Receiver	Receives agent connections Allows providers to receive connections Allows payer to receive connections
Discovery	Locates trading partners
Agreement	Negotiation between partners
Communication	Identifies shared ontology Performs process mediation Determines data exchange methods
Security	Determines security parameters
Transmit	Exchange of information
Monitor	Monitors results Arbitration

Table 1. Responsibility table for healthcare case study.

Sender

The sender includes the initiator of the connection. Within e-commerce this would represent the consumer or business partner initiating the connection. Within healthcare this represents the provider or the payer. The provider would be the originator in cases where billing a covered service to a payer. The payer would be the originator in coordination of benefits situations, or where the payer is submitting to another payer for coverage. The sender is responsible for activating the agents which include finding an associated trading partner, agreement, communication, and security. The final stage involves transmission of information (Washington Publishing Company 2003).

Third party

The third party, which is a trusted entity, maintains the registration information, and monitors the interaction between agents. The registration information aids in location of trading partners in an efficient manner. The registration information consists of all industry associates. This trusted entity also monitors the interaction for auditing and legal purposes. The monitoring sits in between the sender and receiver, and acts as an observer to the activity. Electronic market places act as a third-party within e-commerce today, clearinghouses act as a third-party within healthcare. While some reciprocal arrangements exist, healthcare entities are limited to the partners currently under contract with the third-party clearinghouse. Through utilization of dynamic agent-based systems, global connectivity can occur without limiting capabilities to current partners only.

Receiver

The receiver is the recipient of the connection and information. Within e-commerce this represents the consumer or business partner receiving the connection. Within healthcare this represents the payer. The payer would receive a connection from a provider or payer, depending on the business scenario. The receiver is responsible for activating agents that are capable of agreement, communication, and security. The final stage involves receipt of information transmission.

Discovery

To form a link, agents must locate others capable of the meeting the given requirements. This link could be directly between agents, or may be through an intermediary or set of agents. In an open-ended system, such as the Internet, an agent is not capable of searching every possible agent. In these cases, an intermediary service would allow agents to easily locate the sought out capabilities. This search would be possible for registration information collected by the other agents. Typically such a service would be controlled by an industry group. For example, the healthcare service would standardize the communication language for the covered business transactions. Search services exist in the e-commerce domain through business directories or marketplaces, and in the healthcare domain through similar services. However due to maintenance and/or registration fees these are typically limited to large entities only. By utilizing an independent discovery service, all parties have equal access and integration of existing services (Burstein 2003).

The discovery agent, with a FindPartner() function, is responsible for locating the appropriate trading partner for the business transaction. This involves searching the appropriate trusted third party based on the business requirement. The agent function would contain information regarding the trading partner for location purposes, such as unique identifier, payer identifier, tax identifier, etc. If there is a case where the trading partner information is invalid or does not exist, the agent would terminate with a message and attempted information. Once the trading partner is found, control in transferred to the next agent.

Agreement

Negotiation may be performed between trading partners. This capability has been seen in some e-commerce auctions. In healthcare, this has largely been a manual process through business partner agreements and traditional legal contracts. Negotiation usually involves individual decision-making, resulting in shared benefit. In healthcare, benefits generally favor the larger entities, as they have greater negotiating power. Through utilization of an automated international system based on standardized parameters and readily available comparison metrics, healthcare entities can expect more equitable agreements to occur. Negotiations result in contracts, which are a legally binding agreements detailing the business requirements. The components of negotiation include bidding or response to requested services and bargaining or seeking to agree upon disparate preferences. Internet-based communication and negotiation can reduce the time and transaction costs involved, however most negotiations are still performed manually. The steps involved with e-Negotiation include generating a setup of policies and requirements, generating a contract template, matching those processes, and executing the processes. Those items not covered in the initial template, may be added during the process. Due to legal issues, negotiation data must be monitored by a trusted third party (TTP). This allows for independent third-party monitoring of the business transactions, and for resolution of conflicts between parties (Chiu, Cheung, Hung, Chiu, Chung 2004; Quix 2002).

The agreement agent consists of standard templates which are utilized for business agreements or contracts for conducting business. These may include fees, security, privacy components, service level agreements (SLAs), among other items. A pre-defined set of acceptance parameters will be built-in the agent. For healthcare transactions, direct connections typically involve no fees, and only include provisions for data usage and protection. If there is a case where agreement fails or is not acceptable to one or both of the entities, the agent would terminate with a message and attempted information. Once the agreement is accepted by both entities, as evidenced by the third-party monitor, control is transferred to the next agent.

Communication

The evolution of business information exchange began with fixed-length data, then moved to electronic transfer via the Internet, to WebEDI, to XML/EDI, and ebXML. The data description level describes the message syntax. In e-commerce and healthcare ANSI X12 is common within North America, UN/EDIFACT within Europe, and CII in Japan (Ichida 2003).

XML and associated standards XML Schema, XQuery allow for creation of data-exchange applications. XML does not allow for semantic data interpretation, but only syntactical interpretation. Other standards such as ebXML and EDIFACT exist, but also have issues regarding the support of varying standards. While attempts have been made to improve adoption in healthcare, e-commerce has seen improved usage and adoption of XML standards (Quix 2002).

The infrastructure may include the methods utilized to communicate or the physical infrastructure of the system. The communication infrastructure methods evolved from VANs to the Internet. The bottom level of information exchange is communication, which seeks to establish the protocol between partners. This type of business communication is currently performed through postal mail, telephone, fax, and computers. TCP/IP and HTTP are standard protocols used for electronic exchange (Ichida 2003).

With the expanding industry, challenges around service, quality assurance, and billing between organizations are encountered. Current B2B relationships are dynamic, and constantly evolving. Much of the operational support system cost is spent on integrating with external trading partners. Mediators are utilized to allow heterogeneous systems to interact. Data mediation is used when the naming or formatting conventions may be different between two systems. This may also be used for more complex mediation of datasets. Process mediation is used when the messages are different. This may involve generating specific message formats (Duke, Richardson, Watkins, Wahler, Schreder 2006).

A shared ontology and set of communication methods are required for agents to interface. XML, Java, and other languages have been used for developing prototype healthcare ontologies for Electronic Health Records (EHR) and biomedical information. Progress is still being made towards a universal ontology in development with open standards. One method to address communication is to generate agreed upon standards. Limiting factors include acceptance by all parties, rapid expansion of systems, and agents that must evolve and adapt to new scenarios. The alternative method is for agents to develop ontologies on their own, which improves the adaptability and openness of the system. A game may be modeled from the agent communication. The sending agent wants to request an event from another agent, which may include information about that agent, or a specific result. The sending agent must be able to identify a unique object that represents the request based on its ontology. The object is then transmitted by the sending agent to the receiving agent. The receiving agent would attempt to interpret the information, and determine applicability. Success of the game occurs if the receiving agent is able to interpret and validate the information. If an object is missing or the information sent is invalid, the agent must create or update an ontological term. The terms are weighted, such that commonly used terms arise as the preferred choice (Steels 1998).

The communication agent includes components that allow data exchange between partners. For example these components may include protocol, message syntax, transmission schedule, error handling, format requirements etc. The agents must find a common set amongst both entities. Typically each will have a pre-define set of capable methods. If no common set can be identified, the agent would terminate with a message and attempted information. Once the communication parameters are accepted by both entities and authenticated, as evidenced by the third-party monitor, control in transferred to the next agent.

Security

Within the United States, the Health Insurance Portability and Accountability Act of 1996 (HIPAA), set national privacy and fair information practices. The final act included separate provisions for transactions, security and privacy of data. Another requirement is that business associates must also abide by the act, and covered entities must guarantee that those associates have the necessary security. Some security protections include limiting access to information, blocking unauthorized users, only displaying the minimum amount of information necessary, securing workstations, and eliminating paper information which cannot be as easily protected or tracked. (Kibbe 2001).

Trust in e-commerce includes privacy, data confidentiality, authentication, integrity and non-repudiation. Privacy may be circumvented by governmental organizations, which have authority to tap data. Data confidentiality can be enforced through encryption, using a key and an algorithm, which converts data into a form only viewable by the authorized user holding the key. Authentication, involves verification of the entity communicating. Trusted third parties, or certificate authorities are used for user verification. Integrity permits the transmitted data to be accurate upon receipt, and be identical to the initial data that was sent. Non-repudiation is guarantee that the transaction or transmission was received, and cannot be denied at a

later time. Additional security safeguards include firewalls, which prevent external network attacks, intrusion detection systems, which identify intruders to the network, and internal system controls, such as passwords (McDermott 2000).

The security agent controls the physical and electronic protection of the systems. For the data exchange, this may include the cipher strength or encryption algorithm utilized. The public-key information may be transferred for encryption, or other agreed upon method. This agent ensures the data sent and received is protected and secure. If the encryption is incompatible, there are invalid keys, or other security failure, the agent would terminate with a message and attempted information. Once the security parameters are accepted by both entities, as evidenced by the third-party monitor, control in transferred to the next agent.
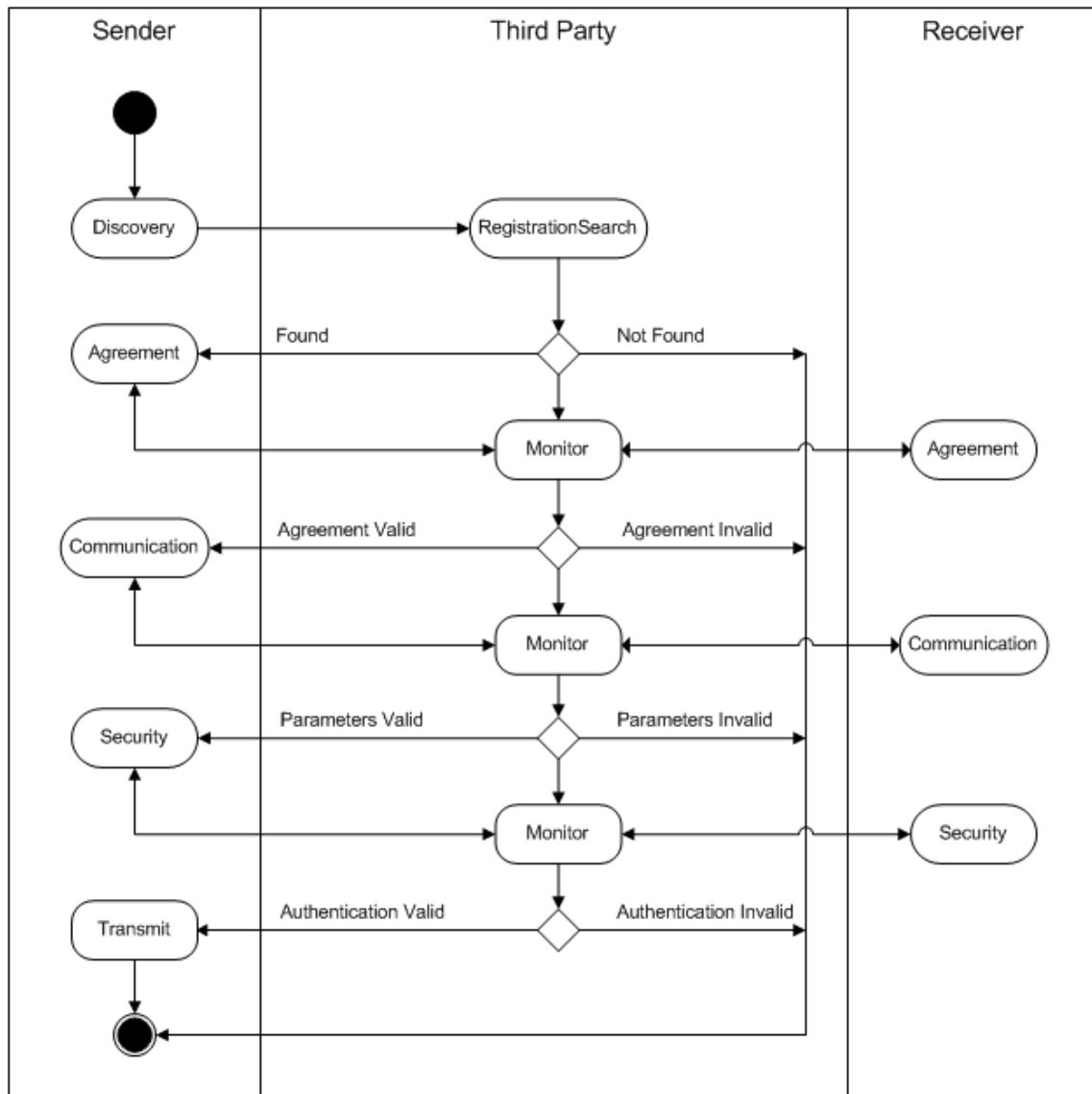

Figure 1: Agent activity diagram.

Transmit

The transmit agents controls the actual exchange of information once the prior agents have completed. In healthcare this commonly takes place through electronic data interchange (EDI), but may also occur through paper-based or image formats, as in the case of medical records or healthcare attachments. Ideally, full electronic transmission through an agent would occur to reduce costs and improve efficiency. This agent uses the established parameters of the prior agents to engage and generate the connection between entities and transfer information. As the prior agents collaborate in real-time, the

transmission follows in a real-time mode. This further expands the efficiencies of the system, and eliminates manual or batch mode delivery processes.

Monitor

The monitor agent, as part of the third party is responsible for reviewing all interactions performed between the sender and receiver. This includes monitoring the result of each of the agent components, as well as facilitating connectivity and collaboration through linkage services. The monitor agent acts as an audit and enforcement body, through tracking and record keeping. This information may be used at a later time to resolve disputes or for system troubleshooting. Centers for Medicare & Medicaid Services (CMS) currently act as the enforcement body within HIPAA, however currently rely on complain-based reporting or on-site auditing. The improved system would allow for real-time access and remote auditing capabilities to improve healthcare areas in a more efficient and cost-effective process.

CONCLUSION

As healthcare entities expand globally and seek real-time exchange, current manual processes must be removed to produce the expected efficiencies across systems. Given the increasing cost of providing care, technology may be employed to improve operational aspects of the system, and interaction between entities. Multi-agent systems can assist in the connectivity and collaboration of disparate and geographically-dispersed systems. The agents are capable of working together to maximize the value of the overall system. This study applied these technologies to healthcare connectivity between payers and providers. An overall framework through the planning, analysis and design phase is provided for agent components and roles, to allow for industry adoption and potential standard creation. This framework may be applied to other industries, or adapted to meet the particular application. Future work includes further defining the agent components, and generating standard or template datasets/forms. In addition to completing the implementation phase on a production system, to provide a proof of concept, and encourage adoption of agent-based methods to facilitate reductions in healthcare costs, through improved connectivity and collaboration on a global scale.

REFERENCES

1. Angeles, R., Corritoreb, C.L., Basuc, S.C., Nath, R. (2001). Success factors for domestic and international electronic data interchange (EDI) implementation for US firms. *International Journal of Information Management*, 330, 21, 329-347.

2. Burstein, M. (2003). Derivation of Glue Code for Agent Interoperation. *Autonomous Agents and Multi-Agent Systems*, 6, 3, 265-286.

3. Chiu, D.K.W. Cheung, S.C., Hung, P.C.K., Chiu, S.Y.Y., Chung, A.K.K. (2004). Developing e-Negotiation support with a meta-modeling approach in a Web services environment. *Decision Support Systems*, 40, 1, 51– 69.

4. Duke, A., Richardson, M., Watkins, S., Wahler, A., Schreder, B. (2006). Service assurance across organisational boundaries with semantic mediation. *BT Technology Journal*, 24, 1, 153-160.

5. Hassan, A. Pons., A., Collins, D. (2003). Global e-commerce: a framework for understanding and overcoming the trust barrier. Information Management & Computer Security, 11, 3, 130-138.

6. Hennick, C. (2007). Will your health plan cover you overseas?, in Budget Travel. <http://www.budgettravel.com/bt-dyn/content/article/2007/03/26/AR2007032600711.html>.

7. Ichida, Y. (2003). Development of B2B digital infrastructure. *The International Journal of Asian Management*, 2, 1, 81-91.

8. Kazzaz, D. (2005). Harmonizing Healthcare Standards: A Whitepaper. <http://www.radaint.com/Harmonizing_Healthcare_Standards.pdf>

9. Kibbe, D.C. (2001). HIPAA Privacy and Security Regulations. *E-Health*, March/April, 34-39.

10. Lim, L. (2006). Foreign health insurers seek clients in China, in Bloomberg News. <http://www.iht.com/articles/2006/03/29/bloomberg/bxchina.php>.

11. McDermott, P. (2000). Building Trust Into Online Business. *Network Security*, 10, 1, 10-12.

12. Nikraz, M., Caire, G., and Bahri, P.A. (2006). A Methodology for the Analysis and Design of Multi-Agent Systems using JADE. International Journal of Computer Systems Science & Engineering.

13. Pendharkar, P.C. (2007). The theory and experiments of designing cooperative intelligent systems. *Decision Support Systems*, 43, 3, 1014-1030.

14. Pickton, D.W., Wright, S. (1998). What's swot in strategic analysis? *Strategic Change*, 7, 2, 101-109.

15. Quix, C., Schoop, M., Jeusfeld, M. (2002). Business Data Management for Business-to-Business Electronic Commerce. *SIGMOD Record*, 31, 1, 49-54.

16. Ran, C., Waitzkin, H., Merhy, E. (2004). Managed Care Goes Global, in Multinational Monitor. <http://www.thirdworldtraveler.com/Health/Managed_Care_Global.html>.

17. Steels, L. (1998). The Origins of Ontologies and Communication. *Autonomous Agents and Multi-Agent Systems*, 1, 2, 169-194.

18. Tweedale, J., Ichalkaranje, N., Sioutis, C., Jarvis, B., Consoli, A., Phillips-Wren, G. (2007). Innovations in multi-agent systems. *Journal of Network and Computer Applications*, 30, 3, 1089-1115.

19. Washington Publishing Company (2003). National Electronic Data Interchange Transaction Set Implementation Guide. <http://www.wpc-edi.com/>.