Mahesh Madanamohanan. Systems integration in healthcare industry: A case study of one healthcare records management company. A Master's Paper for the M.S. in IS degree. April, 2005. 32 pages. Advisor: Deborah Barreau

A common challenge in designing and implementing information retrieval systems in the healthcare industry is the integration of systems supplied by different vendors. Vendors usually produce closed systems (systems without any electronic interfaces to share information with other systems) and this hinders free sharing of information among different medical systems.

Integrated health information systems that link the data from hospitals, health plan providers, and regulators would not only improve efficiency, but also would save money. Medical records that are digitally stored in servers need to be accessible from different applications. If products of different vendors were to communicate better and share medical data, it would significantly improve usefulness of information technology applications in healthcare industry. The purpose of this research is to explore system integration issues through a case study of Vegatip (Vegatip is an alias to protect the identity of the real company), a records management company that serves the healthcare industry.

This research will identify the problems faced while attempting to integrate Vegatip's servers that hold digitized images with the medical practice management systems that the hospitals and physicians' offices use. The research will define practice management systems and describe available commercial systems, will describe issues related to systems integration, and will describe the procedure used to recommend an integration method to connect a given practice management system to the server. Limitations associated with various options of systems integration will also be discussed.

Headings:

Systems Integration

Medical Records Management

Client-Server Communications

Electronic Medical records

Web Services

SYSTEMS INTEGRATION IN HEALTHCARE INDUSTRY: A CASE STUDY OF ONE HEALTHCARE RECORDS MANAGEMENT COMPANY.

by
Mahesh Madanamohanan

A Master's paper submitted to the faculty
of the School of Information and Library Science
of the University of North Carolina at Chapel Hill
in partial fulfillment of the requirements
for the degree of Master of Science in
Information Science.

Chapel Hill, North Carolina

April 2005

Approved by

_____

Deborah Barreau

Introduction

Hospitals, physicians' offices, and health plan providers store and retrieve electronic medical records. However, as information technology vendors in the healthcare industry often make closed systems (systems without electronic interfaces for transferring data), disparate medical systems are not always able to communicate and share medical records with each other.

Often, healthcare firms have to stick with a single vendor for seamless systems integration of all their medical systems. This leads to inefficiency and higher operating costs for healthcare firms.

This study will evaluate different systems integration options available to Vegatip, a records management company (Vegatip is an alias to protect the identity of the real company). The customers of Vegatip are hospitals and physicians' offices. Vegatip stores both paper based and electronic medical records but wants to build more capabilities for paperless storage and retrieval of documents. Vegatip manages medical records for its customers. Vegatip also provides document scanning, document storage and document retrieval services to hospitals and physicians' offices.

Hospitals and physicians' offices use different practice management systems to maintain information about patients, prescriptions, orders, and lab results. Mysis Healthcare Systems, Nextgen Healthcare Systems, a4 Health

Systems and Milbrook Corporation are examples of healthcare software vendors that produce commercial medical practice management systems. The practice management systems often have scheduling and reporting features. Some vendors also provide accounting and billing software as part of the medical practice management systems.

Vegatip stores medical records in its servers and retrieves them on demand by customers. Vegatip wants to electronically connect its servers (that hold digitized medical records) with the different practice management systems that its customers use. Using systems integration, Vegatip wants to share electronic medical records with hospitals and physicians' offices.

Hospitals and physicians' offices send medical records such as x-rays and charts to Vegatip to digitize and store. Vegatip collects medical records from its customers, scans the documents, and stores them digitally on its servers. Security and confidentiality of medical documents are very important for Vegatip's business.

The goal of this study is to find different systems integration options available to connect medical practice management systems to the servers that hold digitized medical records. Systems integration will allow hospitals and physicians' offices access to the servers that hold digitized medical records. The servers of Vegatip need to establish electronic communication with the clients (medical practice management systems in the context) to enable retrieval of patient records. This study will identify the problems faced while attempting to integrate servers that hold digitized images with the medical practice

management systems that the hospitals and physicians' offices use. The purpose of the study is to recommend a best practice for systems integration. Systems integration will enable downloading of electronic patient records from servers to medical practice management systems. This will involve implementation of electronic interfaces. The study will also determine the best method for systems integration for a given customer requirement.

Literature Review

Hospitals, physicians' offices, and health insurance companies store and retrieve digitized medical data in the healthcare industry but problems exist that hinder easy access and modification of medical data from disparate sources. Currently, systems integration in the healthcare industry is a challenge. Regulations do not require vendors to make interface-friendly systems and the standards for healthcare systems interfaces are currently evolving. The difficulty and expenses associated with developing and implementing efficient electronic interfaces often hinder easy access and modification of medical records. If disparate medical systems could communicate better, then efficiency of healthcare IT systems would improve.

Grimson, Grimson, and Hasselbring (2000) examine systems integration challenges faced while trying to share medical information across the healthcare organizations. The authors acknowledge that electronic medical records allow easy transfer of information compared to paper-based medical records and that electronic records allow different views of the records for different medical professionals (for example, physiotherapists, doctors, and nurses can get different views of the medical records). Medical data are often processed manually and it is a challenge to share electronic information across care organizations, the authors note. The authors feel that lack of political will in healthcare organizations, concern over security of medical documents, underinvestment in Information Technology, and slow adoption of standards are the major factors that pose challenges to sharing of electronic medical data.

Healthcare workers are often hesitant to embrace the idea of information sharing because they are concerned about the integrity, confidentiality, and security of patient data. The authors note the current trend of healthcare systems toward becoming web-enabled. The authors feel that the trend toward healthcare systems getting wrapped up and web-enabled may, in the future, lead to approaches that are generic and scalable.

Ragupathi and Tan (2002) have acknowledged that Information Technology spending in healthcare industry is increasing. They expect further exponential growth because of the trends towards electronic record keeping of medical records. They suggest that IT- based strategies for meeting competitive challenges such as using emerging web technologies to integrate healthcare systems are important for healthcare organizations. Computerized patient record systems, intranets, data warehouses and document management systems enhance information sharing. The authors feel that the web technologies bring the cost of information sharing down and help bridge the gap between consumers and health care organizations. Integrated decision support systems are capable of delivering real time histories of patients to healthcare professionals in distributed clinical settings, the authors note. For example, such a system would enable physicians located at remote locations to work collaboratively to cure a patient.

Moore (1996) examines integration of Information Technology solutions in the entire healthcare delivery system. The author suggests that a reason why healthcare workers are reluctant to accept IT is that the existing techniques work.

The author feels that healthcare professionals often do not have time to investigate the ins and outs of systems. The author feels that the institutional attitudes toward information technology are a hindrance to the acceptance of IT. In addition, the author points out that the IT systems face high performance demands in the healthcare industry. The author recommends training medical providers during their formative years of professional education to integrate Information Technology into the practice of medicine.

Cairo (1997) argues that technological connectivity enables healthcare organizations to fully benefit from cost savings and efficiency. The author describes the advantages brought about by systems integration in Spripps Clinic, located in La Jolla, California that she managed. The author finds that migration to a new integrated system helped cut operating costs of the clinic considerably. While comparing the cost of maintaining the old system with the cost of systems integration, the author finds that the cost of integration is less.

Schultz (1979) describes an approach called ‘build approach’ for software systems integration. The build approach for systems integration uses a series of successive system increments to integrate the system. Builds are the series of successive system increments. High-level control functions and the underlying low-level modules are integrated using the approach. The capabilities of the system are shown to the customer only after the integration of the high-level controls and the low-level underlying functions. The author describes a ‘build’ as a collection of related functions. A build forms a component of the system’s functional capabilities. Each additional build serves to add additional capability to

the system. This process continues until the last build produces the complete system. A ‘build’ consists of ‘constructs’ and ‘constructs’ consist of ‘modules’. In the systems integration process, functional modules are integrated into constructs and then constructs are integrated into builds.

Schultz (1979) explains big-bang integration, bottom-up integration, top-down integration and mixed integration, which are the traditional approaches to systems integration. While using the big-bang approach of systems integration, the individual modules of a system are debugged first. Then, the modules are locally integrated to complete the systems integration. In the bottom-up integration approach, the terminal routines are designed first. Terminal routines are the functions that do not call any other functions. Systems integration, while using the bottom-up approach, starts from the terminal routine and then proceeds incrementally one level up from the bottom until the systems integration is complete. In the top-down integration method, the system is merged and tested from the highest level first. Then the merging and testing proceeds to the lower levels until systems integration is complete. Another traditional systems integration approach, mixed integration, tries to retain the advantages of the bottom-up approach while retaining the desirable features of the top-down approach.

The author points out several advantages associated with the build approach. First, while using the build approach, interface problems can be detected and corrected early. This is because the systems integration activities start early. Second, the build approach allows the users to familiarize themselves

with partial system capabilities before the entire systems integration process is completed. Third, the build approach usually results in cost savings because the approach does not use test drivers as much as other system integration techniques. The author also suggests that the build approach serves to boost the morale of the development team because the approach usually provides an early operational system that is functional.

Although the build approach has several advantages associated with it, it does not come without shortcomings. The author notes that while implementing the build approach, engineers often find themselves without clues on errors at rarely executed logical paths in the system. According to the author, another disadvantage of the build approach is the issue of slowness in incrementing functionalities to the system. The author notes that the integration of higher-level functionalities is at times postponed to incorporate the lower level modules in early builds.

Weiner, Savitz, Bernard and Pucci (2004) find that policy makers do not have systemic data on how healthcare firms make decisions about information systems. They suggest involving users early while adopting the systems. They also suggest training, support, and maintenance to help transition form legacy systems to more advanced clinical information systems. The authors argue that healthcare leaders need to seamlessly integrate information technology components to derive the benefits of safety, quality, efficiency, and reduced costs.

The authors find that, for seamless systems integration, healthcare firms currently have to choose between selecting a single vendor for all their application needs and developing electronic components to tie all their disparate systems together. This problem exists because vendors usually do not provide open architecture and often they are unwilling to provide electronic interfaces that would enable their products to communicate with healthcare products of other vendors.

Coddongton and Pollard (1995) argue that all the stakeholders in the healthcare industry should be linked using information systems. They argue that physicians' offices, hospitals and health plan providers should be connected electronically. They feel that the integrated clinical information systems need to be more complex and functional than just the expansion of individual stakeholder's business and financial systems.

Bodorik and Riordon (1990) examine data sharing in heterogeneous databases in distributed computing environments. The authors report that the first step in the integration of databases is the identification of anticipated usage of data. A knowledge base keeps information on generic services needed in multiple databases. The authors find that the primary consideration in integrating heterogeneous databases is that of the autonomy at the local sites. Pernici and Mecella (2001) add on this subject and explain wrapper components in integrating heterogeneous systems. They report that, in most instances, the integration code of heterogeneous systems is reusable. In most occasions, the whole code for systems integration need not be re-written; another's code may

be used with minor modifications. The authors mention two types of integration wrappers, the access wrappers and integration wrappers. Access wrappers provide the access to view data in legacy applications while integration wrappers use new interfaces that facilitate integration of systems. The authors report that the integration wrappers provide high level of abstraction.

Capozzoli and True (2001) argue that integrated systems are necessary for business processes to operate in an optimum manner. According to the authors, better business processes and advanced technologies are required as an organization grows. Undoubtedly, success of systems integration plays a vital role in healthcare industry. Disparate systems should be able to communicate in real time and exchange medical records. The whole healthcare system will not be able to bring about the full power of IT without successful integration of systems. In the healthcare industry, the security and confidentiality of medical records is an important issue. Social security numbers and account numbers are confidential and the integrated systems need to maintain confidentiality and security of medical documents.

Also, better communication from the part of Information Technology workers would improve integration efforts. Better communication would allow information technology workers to identify what healthcare workers really want from Information Systems. Information Technology has the capability to produce decision support systems that could supplement the expertise of healthcare workers. Information Technology workers should identify what integrated Information Technology solutions healthcare industry would accept and would be

ready to use. Systems integration provides tools for transfer and sharing of data so that medical professionals would have relevant real time data available to make better decisions and improve patient care.

Procedures

Application of methods suggested by literature

Bodorik and Riordon (1990) point out the importance of identification of anticipated usage of data before systems integration. This is relevant in the context of Vegatip because before systems integration efforts start, Vegatip needs to know what all its customers want to do with the retrieved medical data. Also, Vegatip needs to know whether the customer wants to access medical data from different locations. It is important to know whether the medical professionals would need to rotate medical charts, zoom x-rays, etc. beforehand so that these functionalities could be designed and planned before the integration efforts start.

The 'build approach' described by Schults (1979) is relevant in Vegatip's case. The integration option that involves embedding ActiveX controls in customers' practice management systems forms a functional system first before adding additional system capabilities in increments. In this integration method, systems integration activities start early allowing detection of any interface problems. Using the method, client and server are made to communicate first. Then functionality is added to view the document. This makes a functional system. Then additional C++ methods may be used to further increment system capabilities.

The build approach is suitable in Vegatip's case because it allows gradual increments in the system's total functionalities. The approach gives an early prototype of a functional system. The vendor also makes knowledge base and discussion forums available to support system integration efforts.

Grimson, Grimson, and Hasselbring (2000) point out that electronic records allow different views of the records to different medical professionals. Web enabled solutions that the authors identify as a trend is a feasible approach for Vegatip. One of the systems integration options that Vegatip has is web services. Ragupathi and Tan (2002) note that Web technologies could bring the cost of information sharing down. In the case of Vegatip, customers could use internet browsers to connect and retrieve data from a shared server. Sharing of server space can bring the cost down.

Integration options

Various methods of connection to the server (to retrieve digitized files) in client-server framework could be employed for systems integration in Vegatip's context. The server could be placed locally (local machine) or placed remotely (in WAN). Client programs (programs that connect to the server) can connect to local servers or servers sitting in WAN. Client programs would communicate with the server to retrieve and display digitized documents stored in the server.

A client program in Vegatip's context would retrieve digitized documents for display. In a client-server setting, the server would store the digitized medical records.

In the context of Vegatip, a client program could be one of the following: (a) A medical practice management system with Digitech's Document Viewer ActiveX control embedded in it, (b) A simple custom client application (a client application may be developed in Microsoft Access or Microsoft Excel using Visual Basic programming), or (c) A standard client program supplied by the

vendor Digitech. One of these may be selected as the client that would interact with the server to retrieve or modify digitized patient records.

(A) Embed ActiveX controls at customer's practice management systems

For Vegatip, a direct method for systems integration is to embed ActiveX controls in its customer's medical practice management system. This way, the customer's practice management system can be made a 'client' in a client-server environment. The vendor Digitech provides custom Active X controls. The server would be Vegatip's server (supplied by vendor Digitech) that holds digitized medical records.

The ActiveX controls can be embedded into any application capable of working with ActiveX Ole Control Extensions (OCX's). When embedded, these controls look like buttons. Before choosing this method for systems integration, it should be verified that the customer's practice management system is capable of working with ActiveX controls.

Programming should be done in C++ in Visual Basic programming environment and then the code should be placed under the embedded ActiveX control in the client machine to establish connection with the server and display digitized medical documents. The vendor Digitech's ActiveX control named 'Document Viewing Control' facilitates viewing of digitized documents. The system would be an example of a solution that would display documents in a customer's practice management system on click of a button. Using Digitech's ActiveX/COM interface, digital medical records could be retrieved from a local document store or a remote server.

When embedded in a client application, the ActiveX controls can bring about functionalities such as document viewing, editing, zooming, rotation etc. Digitech supplies custom C++ libraries that may be put under ActiveX controls to bring about additional functionalities. This means that, for the medical practice management systems that are ActiveX enabled, a developer could embed ActiveX controls in them and program the ActiveX controls to achieve different functionalities supported by the available C++ classes.

(B) Create a simple custom client application

Alternatively, a developer could make use of Component Object Module Dynamic Link Library (COM DLL) and ActiveX technologies to develop a simple client program that would facilitate retrieval and editing of medical documents. Code may be written in Visual Basic programming language and embedded in applications such as Microsoft Access or Microsoft Excel to form simple client programs. This program would communicate with the server and retrieve the digital medical records for display. This may be supplied to the customer.

(C) Use the standard client provided by Digitech

The vendor Digitech provides a standard client that could communicate with server and retrieve documents for display. Vegatip has the option to use it as a client.

Web services

Another option is to use web services for retrieval and display of documents. This is a web-enabled solution. For this option, customers would need to use a browser such as Microsoft Internet Explorer to log onto a database-backed web site (secure site). The database will be the server that holds digitized medical records.

While using web services, customers can use a browser that would prompt the customer for some details of the patient and then relevant documents from the server could be displayed at the browser. In the retrieved document, additional functions such as annotations, rotations, zooming etc are possible with available C++ classes for these specific functions. In addition, in options that use browsers, various TIFF (Text Interchange File Format) file viewers may be used to substitute for Digitech's Document Viewer ActiveX Ole Control Extension (i.e. The type of the 'viewer' that couples with browser may be varied).

Security associated with this option (Web Services) is high. Microsoft's .NET is an example of a web services solution. Customers would go through a secure log in process in this solution.

Microsoft's Internet Information Server (IIS server), which serves .NET's Active Server Pages (ASP) provides extensive security options. In this solution, the client machines send requests to Internet Information Server (IIS). Microsoft Internet Information Server firewalls provide security through functions such as routing, IP address translation, traffic filtering, and session tracking. The .NET solution also uses SSL (Secure Socket Layers) which is an encapsulation

protocol. The protocol encrypts data before transmitting it between client and server. This also enhances security.

In this method, neither the client's browser nor the Active Server Pages directly interact with the document database as the server provides a low-level connectivity and uses temporary File Transfer Protocol (FTP) cache. When the customer's login session ends, the document will be removed from the cache. Digitech's ActiveX plug-ins could work with the web browser to bring about document retrieval as well as document manipulation (annotations, etc.) features.

If there are only few medical records to share and the customer's practice management system allows import of data and has imaging component, then memory devices such as flash drives or CD ROM's may be used to directly export digital records into the customers medical practice management system.

Procedures for embedding ActiveX controls in client programs.

For embedding ActiveX controls in a medical practice management system, first, ActiveX controls need to be installed in the computer that the medical practice management system resides. Once the ActiveX controls are put in the practice management system, the practice management system would become a client program capable of communicating with the server. In general, during the ActiveX control embedding process, client programs could be made to recognize the ActiveX controls by clicking 'Tools' -> 'References'-> (and then click the appropriate .ocx references for the ActiveX controls to be embedded). Once the client program recognizes the ActiveX controls, the controls may be

embedded in the practice management systems in Visual Basic programming environment. Component Object Model Dynamic Link Library (COM DLL) that Digitech provides enables communication between the client and the server both for local and remote connections. Component Object Model Dynamic Link Library (COM DLL) is a binary specification for re-using software code. It imposes a standard for interfaces through which client code talks to component classes. In Vegatip's case, as its digital document store (server) is provided by Digitech, the server is programmed to recognize Digitech's Component Object Model Dynamic Link Library (COM DLL). ActiveX/COM interface allows retrieval of documents from a local documents store or from a remote server (a server sitting in Wide Area Network). To retrieve the right document, the C++ code that is put under ActiveX control should refer to the digitized document's primary key (the unique identifier).

Comparison of the integration options available to Vegatip:

Option 1: Embed ActiveX controls in Active X enabled practice management systems and make the medical practice managements themselves the 'clients' in client-server environments to retrieve digitized medical records from the server.

Advantages: This is a direct method for the systems integration because the customer's medical practice management system itself is made the 'client' in a client- server environment.

Disadvantages: Some medical practice management systems do not have the capability to embed ActiveX controls.

Option 2: Develop a Simple Client Program that would communicate with the server and use the client to retrieve digitized medical records from the server.

Advantages: Simple client programs are easy to use and easy to customize. So, customer's special requests for look and feel of the interfaces could be easily accommodated by the developer of the client program. It is easy to administer and modify simple client programs.

Disadvantages: It is difficult to incorporate advanced security features although digital certificates can provide some authenticity in simple client programs.

Option 3: Use Web Services to connect to a database- backed website to retrieve digitized medical records.

Advantages: Security is very high. SSL (Secure Socket Layer) encryption of data, secure login, and FTP (File Transfer Protocol) caching enhances the security of documents in this option. This is an example of a web enabled solution which researchers identify as a future trend. Another advantage is that customers could login using a browser from any location from where a browser can be used.

Disadvantages: The option is not cost effective unless the project involved is large. Also, if internet connectivity is disrupted, documents could not be accessed.

Criteria for selecting an integration option:

1. Capabilities of the customer's practice management system.

If the customer's practice management system has the capability to work with ActiveX controls, then Active X controls may be embedded in the practice management system to form a client-server environment. Otherwise, for systems integration, a simple client should be made or web services option should be used.

2. Security and Confidentiality considerations.

If the customer demands very high security, then the selected option should provide high security. Web services using .NET technology is a feasible option for high security projects because SSL (Secure Socket Layer) encryption, secure login, and FTP (File Transfer Protocol) caching may be used to optimize security for this option. While using FTP caching, the retrieved documents are removed from the cache as soon as the customer's login session ends. Security and confidentiality are comparatively low for solutions involving simple client programs that use Visual Basic code in Microsoft Access or Microsoft Excel.

3. Amount of storage space needed to store medical documents.

If the project requires a lot of storage space (if there are a lot of medical records to be digitally stored or if the individual records are of large size), then it may be more economical to share space in a server sitting remotely rather than using a local connection in client-server settings.

If the storage space involved is large, then remote connection is usually preferable in client server settings. This applies both for the solution that uses ActiveX controls in customer's practice management systems and for the solutions that involves sample client programs that would communicate with the server.

Also, if the customer's practice management system has an imaging component and supports importing feature, then, for small projects that do not require large storage space or involve editing of documents, the digitized documents may be directly loaded into the medical practice management system for retrieval and display.

4. Geographic locations from which the digital medical document needs to be accessed.

If the documents are to be made available to different offices, then client machines at different offices need to communicate with a central server that stores the documents. Client-server communications using ActiveX controls may be used to make the access to server available to different locations. Server would be sitting in Wide area Network (WAN) in this option. Web services using browsers may also be used to serve different office locations.

5. Expense associated with the integration efforts.

If the customer is looking for inexpensive solutions for small projects, then web services option may not be feasible. Web service is not usually cost effective

unless the project involved is large. If the number of documents involved is very small and if the customer's practice management system supports imaging capabilities, then digitized files may be imported into the customer's practice management system as a quick solution. Or, an inexpensive simple client program may be made and supplied to the client.

6. Customer's preferences.

In some cases, customers may want to administer the whole system from office and may want the whole system to be physically located at the office. To meet such a request, local connections should be preferred. Also, some customers may have a preference for using web service option because of the enhanced security features available.

7. Availability of internet connection.

Web services option cannot be implemented without customer having access to internet.

8. Advanced functionalities that the customer requires.

Both the web services option and the solution that involves embedding of ActiveX controls in practice management systems would support advanced functionalities. But some customers would require only the retrieval of documents. Some others might require advanced functionalities such as the ability to annotate, rotate, or zoom documents. If customers do not need these

advanced features, then features for these need not be implemented in the solution. In other words, ‘builds’ that support these functionalities should not be made unless the customer requests the advanced functionalities.

Problems that could come up during systems integration processes at Vegatip.

Problem 1: The client and server do not communicate with each other in solutions that embed ActiveX controls in medical practice management systems.

The client machine needs to recognize relevant .ocx (related to ActiveX controls) and Component Object Model Dynamic Link Library (COM DLL) files before ActiveX/COM interface could work. These files should be installed at the client machine and recognized by the client program before client-server communications could start. Also, the coded connection line (code is placed under ActiveX controls) should have the right address of the target machine (server) for establishing proper client-server connection.

Problem 2: Wrong document comes up for display when the user clicks ActiveX control for viewing document.

The way to call the primary key (the unique identifier) of the document to be retrieved should be right in the code that is put under the ActiveX control.

The Case Study: Vegatip Medical Records Management Company.

Vegatip is a medical records management company. It stores both paper based medical records and digitized medical records. When hospitals and physicians' offices demand specific documents such as x-ray films and medical charts, Vegatip retrieves them for a fee. Currently, the trend is towards more and more digitization. Vegatip is getting more and more orders for document digitization and electronic retrieval of medical records. Therefore, Vegatip wants to invest in technologies that would make digital retrieval of documents more convenient, robust, and efficient.

Vegatip stores digitized medical records in its servers. These servers are provided by the vendor named Digitech. Vegatip wants to connect its servers to its customers' systems so that electronic medical records could be retrieved at the customers' systems.

Vegatip's customers, hospitals and physicians' offices use medical practice management systems manufactured by different vendors. Often the practice management systems are closed systems and are not interface friendly. Most of them do not have electronic interfaces that would enable communication with Vegatip's servers. Therefore, Vegatip wants to investigate available systems integration options.

Vegatip also uses servers provided by another vendor named Oniel. Oniels' servers handle the retrieval of paper-based records that Vegatip stores. Oniel provides Vegatip bar code tracking technology that assists Vegatip in

locating paper based medical records. Oniel's servers do not store digitized documents. Vegatip uses Digitech's servers for storage and retrieval of electronic medical records as Digitech's servers have the capability to store and retrieve electronic medical records.

Vegatip gets orders from customers to digitize paper-based records. Vegatip collects these paper-based records from its customers' sites, scans them to digitize them, index them and stores them in Digitech's servers.

Servers that Vegatip use:

Vegatip use servers provided by two vendors, Digitech and Oniel. Oniel's database supports paper-based document retrieval with bar code tracking facility. Digitech's server is used to store and retrieve digitalized medical documents. Both use MS SQL Server as the database engine.

To aid customizations of digitized solutions for its customers, Vegatip could control the location where the server resides in. The server could reside locally (in local machine) or the server could sit in Wide Area Network (WAN). It is also be possible for different customers to share a server sitting in the WAN thereby saving storage space at the server.

Digitech's system is suitable for systems integration because they have made a number of advances in that direction. The following factors support Digitech's preparedness for systems integration:

1. Digitech supports Visual Basic programming environment with Component Object Model Dynamic Link Library (COM DLL's) and ActiveX controls.
2. Digitech has developed their own custom ActiveX controls that could be embedded in other ActiveX enabled applications.
3. Digitech has developed custom C++ libraries that would support additional functionalities (such as the ability to annotate documents and to rotate images). These C++ libraries are to be put under ActiveX controls to bring about the functionalities.
4. Digitech makes knowledge bases and discussion forums available to support systems integration efforts.

The need for systems integration.

Vegatip's customers (hospitals and physicians' offices) use medical practice management systems produced by different vendors.

The size of the projects that Vegatip gets from its customers varies. Sometimes it gets small projects with a small number of documents to digitally store and retrieve. But mostly, its document digitization projects are large with thousands of medical records.

Currently, whenever hospitals and physicians' offices request copies of the stored digital files, Vegatip could deliver copies of the stored digital records only in storage devices such as flash drives. The customers would like to access the digital files from their offices directly from the servers that Vegatip uses to store the digitized documents. This requires the integration of Vegatip's systems with its customer's systems.

Recommendation

Different customers of Vegatip use different medical practice management systems. For system's integration, Vegatip should verify whether its customer's practice management system has the capability to work with ActiveX controls. If so, Vegatip should integrate its server's with the customer's system by embedding Digitech's ActiveX controls directly in customer's practice management system. This process makes the customer's practice management system a 'client' in client-server environment. On click of a button at the medical practice management system, the customer could retrieve and view the digitized medical record. This is a direct method of systems integration. In addition, for this option, Digitech's ActiveX/COM interface is capable of retrieving documents from a local document store or from a remote server sitting in WAN. If the customer so desires, this method can support advanced functionalities such as editing, zooming and rotations of retrieved medical documents.

On the other hand, if the customer's practice management system is not capable of working with ActiveX controls, Vegatip should strongly consider using Web services as the integration option. This is because Web services can employ good security features and because web services could serve all locations that have internet access. The Web services option, in Vegatip's context, also has the capability to support advanced functionalities such as editing, zooming and rotations of retrieved documents if the web browser used is ActiveX enabled. Researchers recognize that web enabled solutions such as this option can be generic and scalable.

The final option, the option of creating and supplying a simple client (simple client program developed in Visual Basic) should be employed when the other two methods described above are not feasible or when customer requests a simple client. The security associated with this option is low compared to the other methods although a digital certificate can provide some security for this option. This option can be a good choice when the project involves only a small number of medical records or when the customer appreciates the convenience of a small, easy to use client program.

Conclusion

The option to embed ActiceX controls in customers' practice management systems is a direct systems integration method. Vegatip should use this option if the customer's medical practice management system has the capability to work with ActiveX controls.

In a client-server environment, once the client machine is able to make connection with the server and is able to exchange data, the build method of systems integration could be employed to add additional functionalities. Each of these functionalities may be added as a 'build' to increment the total functionality of the system.

Users intended uses of the system need to be studied in detail before systems integration. Some users only want to retrieve and view the retrieved medical records while others may want to edit them or perform other advanced functions.

The choice of integration method depends on several factors. The main factors are the availability of interfaces at the customer's practice management system (ActiveX compatibility), cost, availability of internet connection, advanced functionalities that the customer requires, locations of access (from one geographic location only or from different office locations) and the security of documents.

Web-enabled systems integration solutions are gaining more acceptance as health care workers are able to access information from different geographic locations using the web. Security associated with the web enabled solutions can

be made high. Also, web enabled solutions have the potential to be scalable and generic. Web enabled solutions let users access data from the server from any location that has internet connection. The web services option for integration is an example of a web-enabled solution.

The emergence of standards in healthcare systems would facilitate better sharing of information between disparate medical systems. In ideal case, healthcare firms should be able to pick and choose products of different vendors and integrate them to make a unique solution that fits them. When more standards for electronic interfaces come into existence in future, different systems solutions for different medical industry segments would have standardized interfaces with them so that products of different vendors (different servers and different practice management systems) would be able to electronically exchange medical data.

References

Bodorik, P., & Riordon J.S. (1990). System integration in multidatabases. *Proceedings of the 1990 ACM SIGSMALL/PC symposium on Small systems, 160-163.*

Cairo, M. C., (1997). Integrated Vs. interfaces practice management systems. *Health Management Technology, 18(10), 47-49.*

Capozzoli, A. E., & True, L. S. (2001). An E-Commerce Systems Integration Framework.*Southern Business Review, 26(2), 27-32.*

Coddongton, D. C., & Pollard, J., (1995). Information systems and integrated healthcare: An essential partnership. *Health management Technology, 16(8), 38-39.*

Grimson, J.,Grimson. W., & Hasselbrig, W. (2000). The SI Challenge in Health Care. *Communications of the ACM,* 43(6), 49-55.

Moore, B .M., (1996). Acceptance of Information Technology by Health Care Professionals. *Proceedings of the symposium on Computers and the quality of life, 57-60.*

Ragupathi, W., & Tan, J. (2002). Strategic IT Applications in Health Care. *Communications of the ACM, 45 (12), 56-61.*

Schultz, J. D., (1979). A case study in system integration using the build approach. *ACM Proceedings of the 1979 annual conference 143-151.*

Weiner, J. B., Savitz, A. L., Bernard, S., & Pucci, G. L. (2004). How Do Integrated Delivery Systems Adopt and Implement Clinical Information Systems?. *Healthcare Manage Rev, 29 (1), 51-66.*

Pernici, B. & Mecella, M. (2001). Designing wrapper components for e-services in integrating heterogeneous systems. *The VLDB Journal, 10, 2-15.*