Why is IT important?

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Abstract

Healthcare organisations are under pressure to offer improved patient care while at the same time attempting to reduce or, at best, manage costs. Technology has always played an important role in medicine, helping with devices and improving investigations and treatments. In many cases, this technology has helped to boost revenues at the same time.

Information Technology (IT) has been applied traditionally within the administrative areas of the organisation. More recently, it is being used within the clinical area and is therefore confronting healthcare professionals with both opportunities and challenges in carrying out their tasks.

This paper attempts to cut through the jargon and hype surrounding trends in Information Technology and focus on aspects with which the organisation should be concerned.

IT in healthcare

The use of automation in healthcare began in the late 1960s with the introduction of Hospital Information Systems (HIS). Originally, information systems were mainframe based, and primarily supported billing and administrative functions such as patient registration, discharge and inventory management.

In the 1970s, the availability of low cost minicomputers helped to spread the use of IT to departmental information systems, such as Radiology, Pharmacy and Laboratory. These departmental systems provided quite specialised expertise, which was lacking in the main back-end HIS. However, this has introduced integration issues, where the systems need to communicate with each other, especially for the transmission of patient and financial information.

The 1980s saw the rise in relational database management systems and client-server computing, especially with personal computers acting as clients. Many businesses made major investments in converting to these technologies. However, healthcare has been slow to respond. It has been noted that healthcare institutions spend a very low percentage of their operating budgets on informatics than do other industries, such as banking, communications and transportation. Part of this is due to a strongly held belief on the part of clinicians that healthcare delivery is not a "business" and cannot be managed as such.

In any event, many healthcare organisations are just now in the process of converting from mainframe/minicomputer technologies with terminal displays to client-server models, where the displays are personal computers performing some of the business logic.

While informatics has long supported the financial and administrative sides of healthcare, it is only recently that it has looked toward supporting the clinician. Electronic patient monitoring and imaging equipment has been around since the 1960s but, until the 1990s, each piece of equipment was an island unto itself. Physicians typically never touched these machines; specially trained technologists operated them and produced hardcopy from which the physician might diagnose.

As the business landscape for healthcare institutions changed from individual units to a dispersed yet integrated enterprise, they have developed a strong need for portable interoperable information systems. These systems must operate seamlessly across a wide variety of industries such as pharmacies, laboratories, physician practices of all sizes, outpatient clinics, community hospitals, and tertiary and quaternary care regional medical centres.

Furthermore, in many cases the participating institutions need to interoperate by sharing their information; but as individual business entities, each institution in an Integrated Delivery System (IDS) must maintain ownership of its important patient-centred records. Centralised systems cannot meet these needs. Nor can client-server systems (which, themselves, are centralised data storage systems with local data analysis and presentation capabilities).

As will be explained below, the solution lies in distributed systems, which can scale to handle such enterprises and yet offer excellent price performance, availability and manageability.

Business imperatives

Before trying to make sense of the withering array of new technologies that suppliers are continually attempting to foist on a confused user base, it is important to step back and consider what are the most important imperatives for the healthcare organisations to assist in their operations. Only then, will we have a suitable reference set against which we can judge the benefits of particular technologies or product architectures. We would also have a basis for comparing different technological solutions that purport to address the same issues.

The use of IT is being extended from administrative to clinical functions of the organisation. The types of users encountering the technology are therefore expanding in a similar way to encompass the broad range of healthcare professionals from nurses to physiotherapist and to doctors at all levels.

Many of the healthcare IT products have been built upon technologies which are adequate for administrative users where the computer screen and its programs fit naturally into their daily operations. On the other hand, healthcare professionals are almost entirely focused on the softer skills of patient interaction such as consultation, carrying out investigative tests and performing treatment. At first, healthcare professionals find computer systems hinder their workload rather than enhance it.

Doctors, in particular, are wary of anything that interferes with their consultation process, especially their eye contact with patients. Computer systems that are not simple yet powerful to use, with instantaneous response to user input, are therefore doomed to failure.

Where possible, such systems should offer various input methods, such as voice recognition, handwriting, Optical Character Recognition, etc. Almost as important, is the ability to be available at any time and any place that the healthcare professional wants it. Thus mobile devices, especially Personal Digital Assistants (PDAs) are important. For similar reasons, being able to access patient information from outside the normal hospital campus, such as outlying clinics, at the Doctor's home or when travelling overseas, is desirable.

From the healthcare organisation's point of view, the IT systems should be flexible and configurable so that they can quickly adapt to the often rapidly changing business processes within such a demanding market. These changes must be able to be made by the organisation themselves, as much as possible, without redress to the software supplier for costly and time consuming program changes. Such changes should then be easily brought on-line without huge administrative overheads.

The systems should also be open and extensible so that they can communicate with products from other vendors using industry standards for such communications. This would also allow for enriched functionality such as user preferred report writers, executive information systems and so on.

Systems built with appropriate open and extensible architectures can also facilitate the integration of other healthcare facilities as hospitals undergo mergers and acquisitions. As the organisations grow either organically or by mergers and acquisitions, the system must be capable of scaling to meet such growth without an inordinate growth in the supporting hardware facilities.

Finally, hospitals need to manage and possibly reduce costs, and information systems must assist with this. They must not add to the problem by involving huge sums of money, especially by making large investments in hardware to solve problems inherent in badly designed software.

Moreover, care should be taken that the total cost of ownership (TCO) is considered and not just the up-front capital investment. The on-going maintenance charges, upgrades, etc, must be included in the equation. Thus, the business imperatives are for Information Technology to have the ability to:

- encompass the healthcare professionals to assist with the management of the longitudinal patient record
- allow the healthcare organisations to quickly change their business processes to meet market demands
- facilitate growth of the organisations
- be provided in a cost-effective manner.

Technology "Tower of Babel"

To address the business imperatives discussed above, we can break down the desired technology features into six areas. They are performance, ease of use, availability, configurability, scalability, and affordability. These become the essential focal points for any discussion on the merits of particular technology solutions.

It is also incumbent upon the healthcare organisation to ensure that these issues are adequately addressed in the choices of products, so that they are not disadvantaged in growing their business, and in particular, in gaining the acceptance of all their stakeholders.

As with medicine, information technology is enamoured with self-serving jargon and TLAs (three letter acronyms!). Thus, the poor user is continually bombarded with new and often competing technologies with names such as FTP, DNA (the IT not medical one!), XML, Soap, EJB, and .NET.

What is worse is that before one has a chance to learn about the latest technology, it is quickly superseded by an even later one and the pace of such change seems to be ever increasing. However, if one takes a step back and examines the different offerings in the light of "how can I improve my operations and business?" then it becomes a matter of evaluating against the set of features highlighted above.

Technology requirements

The following technology requirements are primarily the result of providing a technical solution to the previously stated Business Imperatives. Without the technology satisfying these requirements, we would not be able to achieve the main imperatives for the business markets.

Multi-tier environment

There must be a clear distinction between the three main functional components of the system: the user interface (the client tier), the business logic (the application tiers), and the databases (the database tier). This is necessary because the user interface layer needs to encompass both known workstations and casual users and to cover both PC desktops and portable devices such as Personal Digital Assistants and mobile telephones.

Moreover, the look, feel, and layout of these interfaces need to be able to be changed without affecting the business logic or the database. In particular, the layout of the WAP telephones or PDAs would be different to the fixed desktop. Similarly, the business layer should be loosely coupled with the database and the user interface. Changes in the business processes or new functionality can be made within these programs without having to disturb the user interface and the database unnecessarily.

This approach also simplifies development and management. Common logic is isolated into general business objects and can be managed more efficiently.

In a similar way within the database layer, modifying the structure or even changing to a different database system should be possible without affecting the rest of the applications.

Distributed architecture

To achieve high performance and scalability, it is necessary to deliver the system in a distributed environment. In other words, the system must be able to run across many computers, each of which may have several processors. Some of these computers may be running particular applications or modules and others may be running the database servers.

The basic system must be able to run completely self-contained in a laptop. In other words, the user interface, business and database layers must all be co-located on the one machine. For most organisations, it will be necessary to provide these different layers or tiers across different numbers of computers depending on the size of the user organisation. This architecture allows the system to scale easily by adding more computers or more processors or providing more powerful machines or any combination thereof.

Load balancing

The system must take advantage of this distributed environment to dynamically balance the load across the available processors. This will allow the number of users to increase quickly without any appreciable impact on performance.

Fault tolerance

The distributed architecture also provides capabilities to meet stringent service level agreements. The ability to redistribute processing immediately and transparently during failure of particular machines should be a mandatory feature.

This ability will enable the organisation to provide high level of fault tolerance and failover capability without necessarily having to invest in very expensive fault tolerant hardware environments.

Multiple platforms

To meet the criteria of high availability, high performance and scalability, the systems must be able to run on a range of machines and operating systems - from Windows NT/2000 systems up to large scale Unix platforms.

They must also be able to run from various client interfaces including normal PCs, portables such as Palm and Windows CE systems and WAP telephones.

Object-oriented

To effectively deliver the above technology requirements, a robust object oriented environment must be employed. This will give the ability to segment and distribute the development and to encapsulate the business logic in meaningful and manageable portions so that the system can be assembled in a predictable way.

Current technology requirements

The previous section has highlighted both the market imperatives and the requirements of the new technology to meet them. To address these demands, distributed computing environments have been developed. These solutions primarily fall into three main groups:

- Microsoft's COM+ and DNA, which has now been replaced by its new .NET strategy, and which is at least 12 months away from commercial release.
- CORBA (Common Object Request Broker Architecture) Application Server architecture.
- Sun Microsystem's J2EE (Java 2 Enterprise Edition) Application Server architecture.

Only CORBA and J2EE environments are completely open and cross platform. Even Microsoft's new. NET strategy is expected to run mainly on Windows type platforms or be at least primarily supported on them.

The CORBA approach is designed to work across a heterogeneous environment and is well suited to encompassing legacy systems. The J2EE Application Server is designed for a homogeneous environment using technology based on the Java language.

Apart from Microsoft, most of the industry players are moving strategically into J2EE Application Server environments. There are now over 40 suppliers of Application Servers of this type including Sun, IBM, Borland, BEA, Bull, Fujitsu, IONA, Netscape, Oracle, Progress, Sybase and Siemens.

IBM, for example, has re-arranged its whole enterprise strategy around WebSphere, which is based on J2EE. Oracle has now embedded a full J2EE Application Server within its latest release of Oracle 8i and 9i.

Other solutions which claim to be multi-tier and distributed, such as Citrix Metaframe or Windows Terminal Server, do not provide the same level of scalability and performance as the above. This is because these solutions do not address the distributed architecture approach at all. Rather, they take an existing client-server architecture and offer a thin client front-end for the presentation layer by simply running the previously fat client process in a middle-tier and sending the display commands to the presentation layer and accepting key strokes from this layer.

This solution still mandates one copy of the program running in the middle-tier for each connected user, as the underlying architecture is not changed to distribute the load or partition the business logic. Thus, such systems can only scale up by heavy investment in hardware for the middle-tier on top of similar investments in third-party user licenses. Moreover, these clusters of machines incur much higher administrative costs to ensure they are running at their best at all times.

Conclusion

While the range and complexity of technology architectures may seem quite daunting to healthcare enterprises considering new information systems, such choices can be simplified by focusing on the key business imperatives.

Within the rapidly changing environment of hospital amalgamations and increasing pressure from patients and governments for better healthcare management, information systems must quickly be implemented to meet these demands. To justify the investment in such information systems, they must be built from the ground up to provide flexible performance and scalability in a cost-effective way.

Truly distributed architectures are now available that capitalise on the Internet to meet these challenges. Healthcare organisations should ensure that their solutions are based on such technologies.

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