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Communication Standards for Health Care MIS

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INTRODUCTION

Standards in the data and telecommunications industry provide the basis of system development for all network operating systems, e-commerce and electronic data interchange. Without these standards, data from one system would not be interpreted correctly on another. Standards, like the IEEE 802 series, which allow communications from any operating system to others via network connections, are crucial to business. Publishing these standards insures that no matter what manufacturer of data communications equipment is chosen, the interoperability of the equipment is not a problem.

In health care, specifically hospitals, the different electronic systems that connect to real time information systems that provide doctors with timely information poses an almost overwhelming communications problem. Each piece of equipment that monitors a patient should be capable of electronic data interchange within the hospital's network. Standards have been developed for the equipment that allows electronic data interchange. These standards are capable of providing a software developer the necessary tools that could allow for a fully integrated health care system that deal with the real time information on a patient's status while in the hospital. Doctors could use this information to provide better medical care.

STANDARDS

Three standards are available for the system developer. The Health Level Seven (HL7), the Medical Information Bus (MIB or IEEE P1073), and Digital Imaging and Communications in Medicine (DICOM) all have had an enormous impact on health care information systems and patient care. Each of these standards impacts the data gathering and exchange of information within a health care information system. This paper will explain the three standards in terms of what is standard in each layer of the OSI layered model.

Health Level 7 (HL7)

The HL7 committee was founded in 1987 to develop standards for the storage and exchange of clinical, financial and administrative information generated by such hospital areas as laboratory, pharmacy, admissions, etc. It was designated as an accredited standards developer by ANSI (American National Standards Institute) in June of 1994. HL7 has grown from its modest beginnings to become "*the*" standard for vendors and most prominent hospitals the world over. It essentially is a protocol for electronic data exchange, defining transmission transactions for patient registration, insurance, billing, orders and results of laboratory and physiologic tests, imaging studies, observations, nurses notes, diet and pharmacy orders and inventory/supply orders. It is very flexible, being an "open system," which has led to some confusion and vendor "sales pitch stretch" as far as the issues of connectivity and "HL7 compliance" are concerned.

In relation to the layered OSI model, HL7 is a seventh layer, application standard. It defines the data to be exchanged, sets timing of such exchanges and manages error messages between applications. It assumes compatible protocols for layers 1-6 and herein lies one of the difficulties of "HL7 compatibility" because different technological routes may be taken in those layers to reach the application layer and the route chosen by one department in the hospital may not communicate with that chosen by another. The flexibility of the HL7 standard is important because the level of care, demographic patient base, payer mix, content of physician versus respiratory therapy orders, etc. differs from institution to institution. Data fields differ widely from hospital to outpatient surgical center to multi-speciality clinic office.

In its latest version (HL7 3.0), the issue of flexibility has received considerable attention and indeed is being scaled back as the problems of compatibility abound. ("The reduced optionality will greatly help HL7 to approach plug and play specificity. The slogan for Version 3 is, "optionality is a four-letter word."" HL7 Version 3 Statement of Principles - Revised 1/22/98.) Thus, an ongoing attempt to streamline the collection and retrieval of data promises even more in the way of "plug and play" which the medical community has come to expect. Indeed, HLV3 as it is known represents a complete "rethinking" of the delivery of clinical information built around the concept of a single object model, the HL7 Reference Information Model (RIM.) The HL 7 Board of Directors has proposed this as the solution:

"The most intractable barrier to the application of information technology in healthcare has been the lack of standards for exchanging fine-grained, highly heterogeneous, structured clinical data among information systems. The strength of Version 3 messaging is the exchange of fine-grained data without bilateral negotiations." [1]

It is felt that the adoption of HL7 V3 with its RIM which allows for the use of 96 hierarchical message descriptors (HMDs) that delineate specific message types which can be "implemented as a unique, but compatible XML schema." (Same above reference) will advance the cause of a single, integrated state of standards for health care informatics around the world.

Medical Information Bus (MIB)

MIB's scope: "To provide for open systems communications in health care applications, primarily between bedside medical devices and patient care information systems, optimized for the acute care setting."

MIB's purpose: "To allow hospitals and other health care providers to interface medical instrumentation to host computer systems in a manner that is compatible with the patient care environment." [2]

The critical care areas of a hospital represent a formidable challenge from an information systems standpoint. This is an area where the requirements for data generation, interpretation, status changes, alarms, safety and reliability, are far beyond those required of typical and "standard issue" computer hardware and software. The number of "device riders" on the "bus" can easily go from one to ten within a matter of moments as a patient's status changes rapidly. It is not uncommon for patient monitors to suddenly and quickly increase their displays from simple EKG and temperature to 5-6-7 lines of waveform data, accompanied by a profusion of IMED (intravenous) pumps, a ventilator and cardiac support pumps within minutes. This is the environment where "plug and play" is not a desired feature but a matter of life and death. And this was recognized very early on, in 1984, when the IEEE (Institute of Electrical and Electronic Engineers) founded the committee charged with writing the "Standard for Medical Device Communications." This committee, which produced the family of standards known as IEEE P1073 (MIB,) has continued working and has rewritten the standards several times in a continuing

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effort to reach a true plug and play environment where the manufacturer, model number, vintage (within reason) of a needed piece of equipment is of no consequence in the overall care/information picture except as it performs its clinically designated task.

MIB is a model that focuses on object orientation where entities like pumps, monitors, ventilators, etc. are defined as objects by the MIB model. Objects may also include patients, doctors, nurses, therapists- in short all the "Virtual Medical Objects" in play at and around the bedside, as defined by MIB, using the Medical Device Data Language (MDDL). Since the objects, information, access to the information and usage/display of the information all are addressed by MIB, it is a full seven-layer protocol stack in the OSI model.

The lower layers cover the equivalent of what in an office would be covered by Ethernet and TCP/IP being the physical connections, topology and transmission protocols. Considerable effort was expended in the area of connections, grounding and safety, given the sometimes less than ideal environment in which these devices must function. Star topology- specified by MIB- can also be viewed as a safety device in so far as it prevents a single cable failure from bringing down the entire local device network (i.e. attached to one patient). MIB also specifies a once per second device polling to ensure prompt failure recognition.

The upper layers of the MIB OSI protocol stack define content, format, structure and syntax of the message in question. This area is of crucial importance for MIB deals with micro controller and microprocessor based equipment with little processing power and little if any programmability. In addition, these devices are mobile, and must be connected and disconnected several times daily by non IT trained clinicians who neither know, nor care to learn, the finer points of network programming.

The upper layer protocol work has progressed slower than the lower. The IEEE has purposely attempted to standardize device classes, such as infusion pumps (the first to be standardized -IEEE 1073.1.3.1) in order to define parameters, attributes and services in a logical fashion. In addition, the Andover Working Group, a consortium of IT and healthcare companies under the direction of HP, has also continued work in this area and indeed has been one of the champions of standards based networks in this area. Finally, it cannot be ignored that MIB devices are by definition FDA regulated, which adds additional engineering, clinical and clerical hurdles and impacts the speed of this work.

Digital Imaging and Communications in Medicine (DICOM)

Soon after the advent of CT (computerized tomography) scanners in the late 1980's, it became apparent that a method of storage and transmission of radiographic and other images more efficient than the traditional X-ray file room was needed. The American College of Radiology and the National Electrical Manufacturers Association formed a joint committee in 1983 to develop interfaces and standards relating to imaging equipment and other medical electronic equipment. The first version of DICOM was published in 1985 and has undergone several revisions. [3]

In its present form, DICOM 3.0 is a full 7 layer OSI protocol stack. This is indeed necessary given the different pieces of equipment from an array of vendors that make up even a relatively unsophisticated radiological department. DICOM 3.0 addresses interoperability and such questions as: commands, information objects (CT scan, barium enema etc.) and their attributes, data element tagging, naming and semantics (interpretation), encoding rules for data stream construction, message exchange, all of which allow applications to establish sessions, transfer messages (data) and terminate sessions. DICOM 3 allows support of numerous OSI protocol stacks, to include Ethernet, FDDI, ISDN, X.25, TCP/IP and other LAN and WAN technologies. However, DICOM physical layer protocols specify a 50-pin cable to accommodate the large data transfer requirements inherent in medical imaging.

As in the previous discussion on MIB, the environment of DICOM devices can be less than ideal. More importantly, the crucial aspect of all information in the reconstruction of images cannot be overestimated. The presence of errors or the failure of transmission of only a few bytes out of millions can render an image unreadable as understood in the clinical sense of the word. Also, recognizing that digital radiological images vary from 0.064 Mbytes per exam image (nuclear medicine scan) to 32 Mb per exam image (computerized radiography) and that transmission rates via a DS-0 would vary from 59 sec to 76 minutes shows the magnitude of data accumulation, transmission and the extraordinarily low tolerance for error in this area of medical information technology.

Work continues on the DICOM standard, in particular on interfacing with HL7, crucial to enable demographic and other data needed for radiological examination to flow smoothly from the "static" to the "imaging" portions of hospital care. Once again, however, the term "DICOM compliant" doesn't necessarily mean fully complaint for the sheer complexity and size of DICOM standards is such that no products currently implement it totally. Thus, careful consideration of the "non compliant" areas is in order and adequate planning for interfacing at those points is mandatory.

CONCLUSION

This paper analyzed the standards that deal with data collection from various sources within a hospital. Each standard is still evolving. As they evolve, more information can be stored, displayed and available real time for medical assessments. These standards are present in many systems available from various vendors. Those systems are commercially available and being implemented in various hospitals. Most of the systems put together suites of intercommunicating equipment, all standards based. As technology evolves, doctors will be able to better serve the patients with real time data.

ENDNOTES

1 http://www.hl7.org/ Press Release Ann Arbor Michigan, August 16 2001

2 http://grouper.ieee.org/groups/mib/archives/1073gr.htm

3 http://medical.nema.org/dicom/geninfo/dicomstrategyv105/StrategyJuly0601.htm