IT Primer for Health Information Exchange

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When it comes to building data exchanges, an understanding of basic IT terminology helps HIM professionals serve as a bridge between technical and clinical professionals.

Clinical data exchange is poised to radically transform healthcare delivery. By connecting disparate healthcare providers, patients, payers, and other stakeholders, data exchange networks are expected to streamline and accelerate the flow of patient data from doctor offices to hospitals to outpatient clinics.

That exchange is expected to develop through regional health information organizations, or health information exchanges (HIEs). Most of these organizations are still very much in their infancy and are plagued by unresolved issues. They struggle with establishing effective governance and sustainable business models, privacy and security policies, and accurate patient-matching practices.

HIM professionals contribute information management expertise to HIEs, not technical input. However, with an understanding of basic IT terminology related to data exchange, HIM professionals can improve communication between technical and clinical professionals. Serving as a bridge between the professions, HIM can help drive the successful adoption and use of exchanged clinical information.

Network Basics

Ten years ago it was prevalent for healthcare providers to house computer networks and equipment in one IT data center utilizing a **local area network** (LAN) that provided communication between the various computers, or nodes, in the network. While centralized data centers and LANs are still common, **wide area networks** (WANs) that span an entire city or state are becoming more common. This ease and openness of sharing data across networks has been facilitated by the development of standardized communication protocols.

A computer **network** is made up of multiple connected computers that communicate over a wired or wireless medium, sharing data and other resources. An example is a home network consisting of two computers that share files and a printer.

The size and scalability of any computer network is determined both by the physical medium of communication and by the software controlling the communication. A network can refer to any interconnected group or system, including LANs, WANs, or MANs (metropolitan area networks designed for cities or towns).

Network topology is the arrangement of the nodes (typically the computers) in a network. It describes the physical and virtual (or logical) connections between the nodes. Common physical topologies include bus, star, and ring (see the diagram on the following page). The names describe the arrangement of the nodes on the network.

Network protocol defines the common set of signals and rules governing the syntax, semantics, and synchronization that networked computers use to communicate. One of the most popular protocols for LANs is Ethernet. Wi-Fi is the wireless LAN standard present in many home offices and small office networks. It augments many Ethernet-based LANs in larger institutions. Networks can be broadly classified as using one of two network architectures.

Peer-to-peer architecture is a model in which each user shares the same capabilities, such as query, add, and update, and any party can initiate a communication session. In a peer-to-peer network (often written P2P), each node is equal, and each functions simultaneously as a “client” and a “server” to other nodes on the network.

In an HIE, each "peer" node must provide the same type of user or computer authentication, but each participating organization must provide individual authentication for each of its users. The peer-to-peer network trusts any user coming from an authenticated source as long as the proper authentication message is sent with the user's access request. Peer-to-peer also has come to describe applications in which users can exchange files directly via the Internet or a mediating server.[1]

Client-server architecture is a versatile, message-based, and modular infrastructure intended to improve usability, flexibility, interoperability, and scalability when compared to centralized, mainframe, time-sharing computing. Client nodes on the network communicate through a centralized server. This is the architecture typically used by larger businesses that employ only two types of nodes, client and server. It is sometimes referred to as two-tier. Devices may share files and resources.

Planning for Quality Assurance

Close attention to data quality is critical as HIEs expand the exchange of data from within a single provider organization or enterprise to a regional network. Quality control is a vital prerequisite, and it should be addressed early in the planning stages.[1,2] The need for data quality and data validation is especially important when data are used by individuals or groups other than those who originated the data.

The terms **quality control** and **quality assurance** both refer to the structured pursuit of accuracy in natural science measurement programs. The methods are used to reduce errors, loss, redundancy, misidentification, misattribution, contamination, and incompleteness. The processes should be planned and managed during data collection.

With expertise in data integrity, HIM professionals are important participants in successful clinical data exchange, regardless of whether the exchange is within the walls of their own facilities or as part of a regional exchange network.

Notes

1. Loshin, David. "Issues and Opportunities in Data Quality Management Coordination." DM Review Magazine, April 2004. Available online at www.dmreview.com/article_sub.cfm?articleId=1000836.

2. AHIMA. "Data Quality Management Model." June 1998. Available online in the FORE Library: HIM Body of Knowledge at www.ahima.org.

File Transfer Fundamentals

With the Internet, file transfer became simpler, and organizations expanded their data sharing beyond local area networks. The expansion and widespread use of standardized communication protocols in turn fueled the Internet's expansion. A **communication protocol** is a set of standard rules for data representation, signaling, authentication, and error detection required to send information over a communications channel.[2]

A variety of "open" standards exist for communication protocols, including TCP/IP. Transmission Control Protocol implements error detection and correction; Internet Protocol implements addressing for a large set of protocols. One computer can send a file to another computer by just knowing the receiving computer's **IP address,** which can be viewed as a computer's street address or phone number.

TCP/IP was developed in the 1970s, and the structure of the Internet is still closely reflected by the TCP/IP model. Other open standards for communication protocols include OSI (Open Systems Interconnection) and UPnP (Universal Plug and Play). **Open source** software code is available to the general public with limited or no intellectual property restrictions. The term describes a collaboration of content source code using a set of principles and practices that promote access to the design and production of goods and knowledge.

File Transfer Protocol (FTP) is an open standards protocol for exchanging data over any network that supports TCP/IP. An FTP server uses FTP software to listen on the network for connection requests from other computers. The client computer, running FTP client software, initiates a connection to the server. Once connected, the client can perform a number of file operations such as uploading, downloading, renaming, and deleting files on the server.[3]

Nearly every computer platform supports the FTP protocol regardless of the operating system. An **operating system** is a program that allocates and manages the tasks and internal system resources of the computer such as controlling and allocating memory, prioritizing requests, and controlling input and output devices.

Nowadays, **distributed environments** typically provide efficient real-time data sharing among computers. Different parts of a software program may run on different computers communicating with each other across a network, and data are stored decentrally and are pulled together by the application when needed.

Rather than sending files of data in one message, individual communications are sent with just the data needed to communicate that one message. They are one-way, sometimes requiring a response from the receiving computer. This allows real-time communication, with little chance of the entire message not making it successfully to the receiving computer.

A common distributed environment current in healthcare today might be a multifacility organization using an electronic medical record viewer application that pulls data from different clinical and ancillary systems such as nursing documentation, laboratory, or radiology results. Various programs used in the electronic record system could be run on different computers, optimizing the response time of the programs. This would typically occur in a **client-server network architecture** setting. The server is the brains of the system, and the client computers are the workstations.

Messages or transactions between computers travel through a port on the computer. There are physical ports, such as a **serial port** or a **USB** (universal serial bus) port, and there are virtual ports that provide a virtual data connection between computer programs. All personal computers have physical ports. All application programs that send or receive data will have a virtual port.

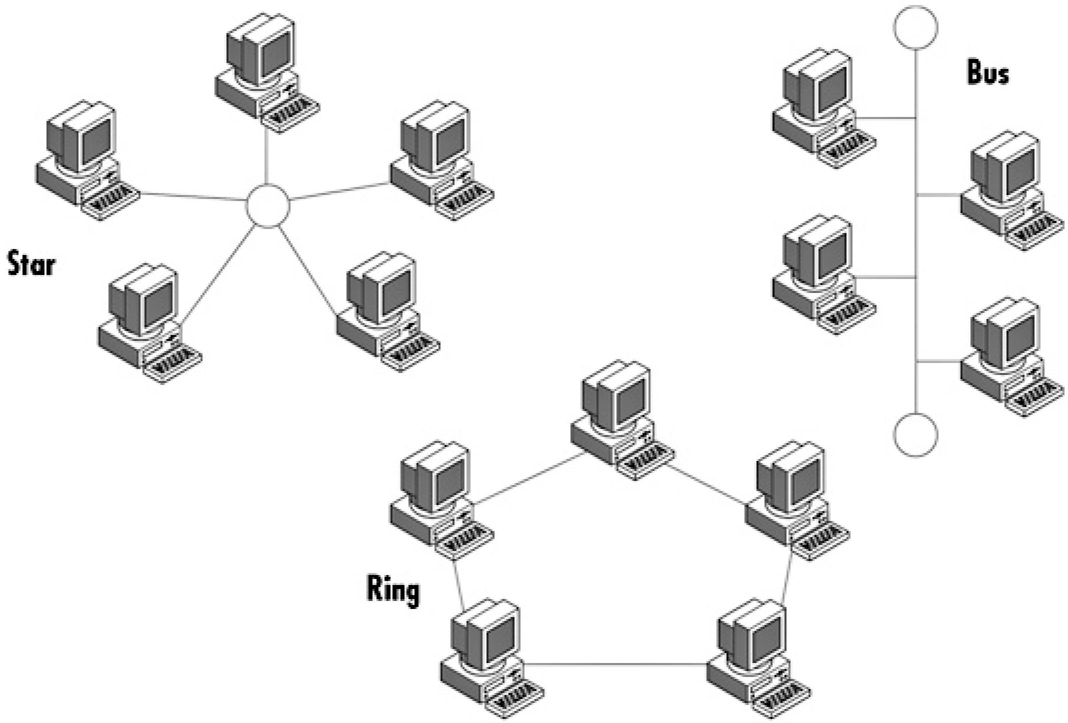
An **interface** defines the communication between two entities, such as a piece of software, a hardware device, or a user. A software program that provides an interface between a human and a computer is called a **user interface.** Interfaces between hardware components are physical or **device interfaces.** Interfaces between separate software components are **software interfaces** and allow for data mapping and any special coding or translating. They provide a mechanism by which databases and software applications can communicate.

Message communication between one database system and another are handled either via a point-to-point interface or through an interface engine. **Point-to-point interfaces** are programs that define the message content (or fields), format, and translation required to send data directly from one system to another. These are typically more expensive to maintain and manage, as they may have many customized fields and formats.

Changes to the sending system's application or the receiving system's application or database will often require an update to the point-to-point interface program. Most medium to large healthcare organizations now use an interface engine to help manage the interfaces between their various administrative, financial, and clinical applications.

An **interface engine** is a software application that manages the input, data mapping, data translation, and distribution of transactions from one computer system to another. Most provider organizations and healthcare IT products follow Health Level Seven (HL7), the industry standard for electronic data exchange in healthcare environments.

Common Network Topologies



Network topology is the arrangement of the nodes in a network (typically the computers). In **bus topology,** the nodes connect to a common backbone or trunk, called the bus. Data sent between the nodes travel along the bus and are received by all nodes at once. **Star topology** links all nodes of the network to a central node. Data transmitted between nodes are first sent to the central node, which then retransmits the data to the other nodes in the network. In **ring topology,** each node connects to another in a closed loop. Data travel from one node to the next, usually flowing through the network in a single direction.

An HL7 Overview

HL7 became an ANSI-accredited standards developing organization in 1994 for interchange of clinical, financial, and administrative information among healthcare computer systems. ANSI, the American National Standards Institute, is a private, not-for-profit organization that oversees the development of voluntary consensus standards used in the US.

HL7's name refers to the top layer (level 7) of the Open Systems Interconnection model of the International Standards Organization in the health environment. The standard ensures a common communication method between applications generally mapped through an interface. The organization's primary goal is to provide data exchange standards that eliminate or substantially reduce custom interface programming and program maintenance.

The HL7 message structure provides a delineation of the type of data being transmitted, the actual message description, a specification of each segment of the message and the actual fields and subfields contained in each segment.[4] An example of an HL7 message is shown in the sidebar "Inside an HL7 Message," above.

The HL7 standard has become the foundation for the electronic medical record, allowing the exchange of data between very diverse health services such as pharmacy formularies, radiological imaging, lab values, and transcribed reports.

Inside an HL7 Message

At first reading, a message conforming to the HL7 transmission standard is overwhelming. But breaking down the documentation of each message-its segments and fields-shows how straightforward the message standard really is. The standard establishes the following message elements:

1. Message Type: e.g., ADT (admission, discharge, transfer), ORM (order response message), MDM (medical document management), MFN (master file notification).

2. Message: e.g., A01 (admit/visit notification), A03 (discharge/end visit), A08 (update patient information), A34 (merge patient information).

3. Segments: e.g., MSH (message header), PID (patient ID), PV1 (patient visit), NK1 (next of kin).

4. Components ("field"): e.g., in the PID segment, patient name, internal identifier number, and date of birth.

5. Subcomponents: for example, identifier number (the medical record number itself), identifier type (such as MRN), last name, first name, middle name, and other subcomponents in the patient name field. Subcomponents are typically delimited by a caret (^) symbol.

Sample HL7 Message

```
MSH|^~&|EPIC|EPICADT|SMS|SMSADT|199912271408|CHARRIS|ADT^A04|1817457|
EVN|A04|199912271408|||CHARRIS
PID|||454721^^^St. Mary's^MRN||DOE^JOHN^^^^|DOE^JOHN^^^^|19480203|M|
NK1||CONROY^MARI^^^^|SPO||(216)731-4359||EC|||||||||||||||||||||||||||
PV1||O|168 ~219~C~PMA^^^^^^^^^^||||277^ALLEN FADZL^BONNIE^^^^||| |||||||
```

Components in each segment of the message are separated with a delimiter. The sample message above uses a pipe symbol (|).

Because message naming is standardized and each segment and component appears in a standard position within the message, the receiving computer is able to identify each individual piece of data the message contains and sort and store it automatically.

For instance, the above message is an A04—"register a patient," typically used for communicating outpatient registrations. In the patient identification (PID) segment, the third position contains the patient's medical record number (MRN)—454721, coming from St. Mary's.

Scalability and Life Cycle

As healthcare IT environments become larger and more interconnected, **scalability** becomes a major concern. Scalability is used in two different fashions in IT.

The first is the hardware or software's ability to continue to function well when it or its context changes in size or volume of record storage. Rescaling is typically to a larger size or volume; for example, when additional storage is added or a new database program is launched.

The second use for the term is an organization's attempt to improve performance and reduce response time. Rescaling often is needed because of an increase in users or high-volume periods, which drive the need for a more sophisticated operating system or database platform.

The useful life of an information system is referred to as the **system development life cycle.** The explosion of available clinical information and rapid pace of health information system development has shortened the cycle. Today software development requires teams of architects, analysts, programmers, testers, and users working together to create the millions of lines of custom-written code that drive enterprises. **Object-oriented technology** allows smaller sets of programming code that can be reused in one system multiple times for multiple applications. This reduces an application's development life cycle.

There are many life cycle models: waterfall, fountain, spiral, build and fix, rapid prototyping, incremental, and synchronize and stabilize.[5] Systems analysts use these models to develop an information system, including requirements, validation training, and user ownership through investigation, analysis, design, implementation, and maintenance.[6] (For a description of common models, see the appendix to the online version of this article, available in the FORE Library: HIM Body of Knowledge at www.ahima.org.)

Old Challenges, New Media

All that has been previously discussed—from networks to operating systems to communication protocols—makes up what is commonly referred to as the **system architecture**. This describes the set of relations between the system's structural properties. The representation of the system architecture sets forth the relationship between the elements and rules governing those relationships. These designs are critical to leveraging the investment in a way that meets the business needs and strategies of the organization.

Although system architectures are as unique as the organizations designing them, they share one constant need in achieving interoperability within healthcare organizations or HIEs. That constant is the need to deliver accurate clinical information to the user in a timely manner that supports patient safety.[7]

HIM professionals hold the key to delivering that transformation. They understand the patient's progression through the continuum of care and how that patient's data must be presented to the clinician while preserving the privacy of the patient and confidentiality of his or her data.
HIM professionals have always enabled continuity of care by ensuring a complete and accurate patient record. They have always maintained compliance to federal and state regulations and supported the organization's revenue cycle. Today's challenges are no different than the ones of the past. The only difference is the media by which health information is delivered.

Notes

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