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IP Enhanced Medical Networks

In the beginning...

Changes in the medical world are improving healthcare in ways that just a few short years ago seemed more like something out of a Jetsons cartoon or Star Trek than a reality. Patient care has benefited through new open standards within the medical community. In order to understand how far medical technology has progressed, it is important to understand first, where it all started.

Just a few short years ago, when a patient checked into a hospital his/her records were entered into a database. Forms were printed for every procedure, insurance filing, pharmacy order, patient billing, etc. Generally, these forms and information had to be re-keyed into each and every system involved with the patient's care. The systems were proprietary and as such, communicated poorly, if at all, with each other. Each insurance provider had their own form. In a move to simplify billing and standardize information, HL7 was developed.

HL7 (Health Level Seven) is one of several ANSI accredited standards development organizations dedicated to the healthcare industry. There are several others dedicated to pharmacy, insurance, medical devices, etc., which will be covered later. The Level Seven of HL7 refers to layer 7 of the OSI model, which is the application layer. It is an application standard which revolves around the communication of data to enable disparate healthcare applications to share key pieces of patient information. This level supports a variety of functions including security checks, exchange mechanism negotiations, identification, availability, and of course, the structure of data exchange. This standard applies not only to the United States but to several other countries as well.

The life cycle of the events that a message or group of messages contains is defined in the RIM (Reference Information Model). The Vocabulary Technical Committee of the HL7 defines unambiguous meanings for each component. Further developments of this standard are being addressed via the XML (eXtensible Markup Language) special interest group. This committee has also worked closely with HIPAA (Health Information Patient Accountability Act) participants to assure conformance to their standards.

The ability for these systems to communicate and share data means that networks are now an integral part of patient care. With the advancements in networking and widespread adoption of TCP/IP, communication is now easier, faster, and more reliable. The human factor can be taken out of the equation for many of the applications as the data does not need to be re-keyed into each system. HL7, however, does not deal with these communications. This is the responsibility of the network administrator, guided by several other boards and organizations within ANSI and the medical community that address the lower 6 layers of the OSI model stack.

Image Advancements

The network consists of the electrical components for connectivity, the communication protocols, and the physical media over which the signals travel. Included in the communication protocols and network applications are security validations and transmission validations. With secure networks in place, this opened the door for other advancements in the medical community. X-ray images of old were taken, printed on expensive film, viewed by the doctor, and then stored. The films contain mercury making their destruction after their useful life an environmental consideration. Medical device manufacturers took this to task and digital X-ray technologies were developed.

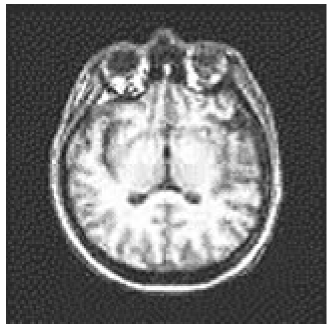


Figure 1

Figure 1 is an image of the human brain. One of the advantages of a "live" digital image is that it allows manipulation of the image. The image can be zoomed, panned, overlaid on another image and stored digitally. This image can also be viewed by computers anywhere on a connected network. With advances in streaming technology and compression algorithms, the images can actually be viewed by a physician in another part of the country or world. The greatest benefit, however, is the digital clarity of the image.

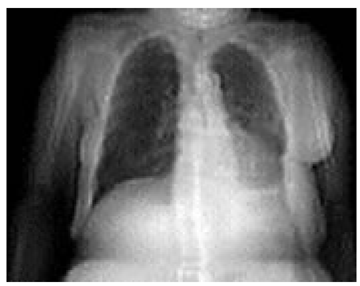


Figure 2

Figure 2 is a familiar image of a chest X-ray. Most of us have seen a chest X-ray at some point in our lives. As you can see from this picture, the quality is better than that of traditional film. The cameras that take the pictures have advanced along with the digital technology making these images a far more effective tool for diagnostics and patient treatment.

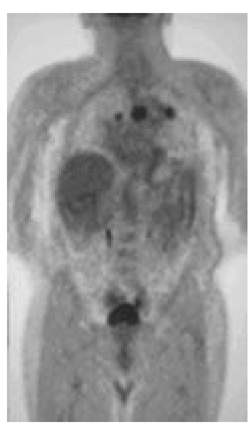


Figure 3

Figure 3 is a 3-D image that can be rotated a full 360°. This is a PET image (Positron Emission Tomography). The patient is given a radioactive isotope. The images are then gathered. The body reacts with chemical changes and the radiologist can see hot-spots or areas where activity is greater. PET imaging is unique in that it shows the chemical functioning of organs and tissues, while other imaging techniques - such as X-ray, CT and MRI (above) -

show structure. PET is particularly useful for the detection of cancer, coronary artery disease and brain disease. These images can be used alone as a diagnostic tool or with a new technique called fusion, where they can be overlaid on structure type images. They can also be fed into treatment planners allowing radiation treatments to target a specific area through the best bodily route to avoid damage to other tissues.

These imaging techniques are just a few simplified examples of new medical equipment that is gaining wide acceptance today. In order to facilitate effective use of this equipment and the images, a standard was developed. The Digital Imaging and Communications in Medicine (DICOM) standard was created by the National Electrical Manufacturers Association (NEMA) as a common denominator for the viewing of medical images. Part 10 of the standard specifies the actual file format for distribution of the images. This format is an extension of the previous NEMA standard. DICOM-compliant modalities (types of equipment) are those that adhere to this portion of the standard. This standard provides for TCP/IP transport of images between modalities and image storage systems typically called a PACS (Picture Archiving and Communications System). "The number of hospitals planning to purchase PACS has more than doubled in one year," said Sheldon Dorenfest, president of Sheldon I. Dorenfest and Associates, a Chicago healthcare management consulting service. Images are stored via a DICOM push, and retrieved via DICOM query and DICOM pull. These images can be literally viewed anywhere security and policies allow. Smaller hospitals and those in remote locations can utilize the services of radiologists that are in separate locations for a cost savings. These images can also be viewed in the patient's room, in the operating room, or in the physician's office.

Due to network constraints, DICOM images can be compressed via lossy or lossless compression. In a lossy compression scheme, parts of the image are lost when the image is uncompressed. The loss may be from redundant information or information that will not adversely effect the quality of the image to the human eye. In lossless compression, the entire image is restored with no loss of additional bits. These compression schemes are necessary due to slower networks and storage demands.

Integration Central

Hospital Information Systems (HIS), Radiologic Information Systems (RIS), and other systems within a hospital or medical center now have a means to communicate. HL7 communicates patient information and the PACS also stores patient information. HL7 to DICOM conversion devices are also commonplace. There are additional devices that communicate between the DICOM modalities and the Information Systems so that a single patient record can be used by all practitioners as well as the business office. This device, called a DICOM broker, takes the information stored in a HIS/RIS system and formulates the DICOM header which contains information about the patient, type of exam, date and time information, ordering physician identification, as well as information about the image(s). In an integrated healthcare environment, a patient can walk into a doctor's office or hospital and his/her information is gathered into the HIS system. This single record can follow every step of their treatment. Their images can be stored with the record. Pharmacy orders and items used in their care like band-aids have barcodes that are scanned and automatically uploaded to their master chart. New systems even allow vital signs to be automatically placed in the patient record. Driver's license information and other forms can be scanned into the network and these images are also linked or stored with the patient record. The additional overhead that this can place on the medical network grows exponentially with the number of input and retrieval methods.

Hospital information systems began as mainframe applications with dumb terminals. These systems were inherently secure, robust and required very little network resources. This is no longer true. The client/server evolution some years ago began changing this environment. PC applications became necessary for people to do their jobs, and dumb terminals were replace with PCs that communicated with the mainframe/midrange computer via terminal emulation. With the acceptance of TCP/IP, these communications evolved into IP terminal emulations, all of which create additional demands on the network.

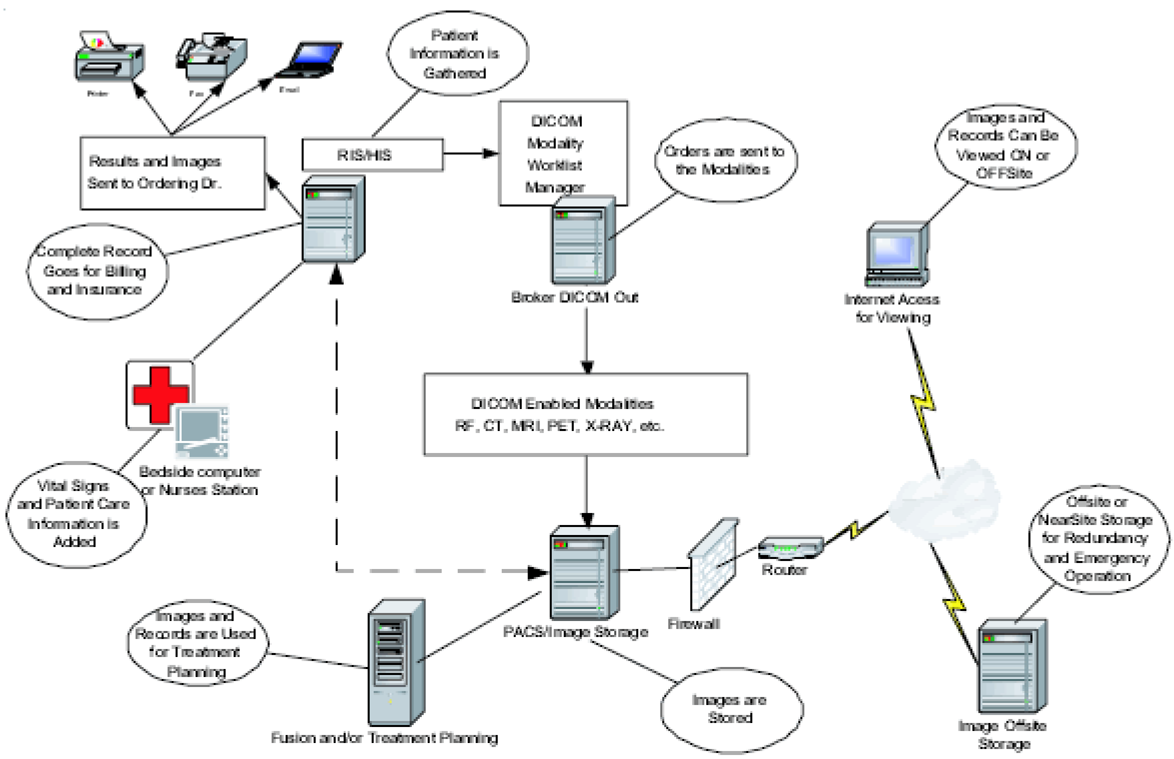
A Word About HIPAA

The HIPAA act addresses many issues. In short, it addresses information about any patient that is contained in any system, the systems themselves, and the transmission of this information. All patient information and resource usage must be added to the patient chart prior to their check-out at the hospital. There is a significant amount of information about patient care that is tracked, stored, and transmitted to insurance companies, other physicians, etc. Specifically related to this information, the act addresses data integrity, confidentiality and availability. The key points address administrative, audit and security procedures as well as disaster recovery and emergency operation should the systems go down.

Each and every node on the network must be fully documented as does each and every system. The disaster recovery and emergency operations cover not only local data, but any offsite storage. Compliance with this federal mandate has become an overwhelming task for hospitals, doctors' offices, dentists, pharmacies, other specialties and insurance companies. Consulting firms that specialize in HIPAA requirements are as common today as Y2Kfirms were at the turn of the century.

Data and Network Ramifications

The diagram on the next page represents a very simplified view of a hospital network. Even in this over-simplified form, it is easy to see that data and traffic requirements are far greater than they were in past years with paper-based systems. Add redundancy and additional security layers to the network and the need for bandwidth is again increased.



Enlarge this image

Bearing in mind the amount of information stored, retrieved and the number of times it is changed or retrieved makes infrastructure decisions paramount decisions. In the past, everything ran on category 5/class D cabling. In fact, many of the dumb terminals of the past actually ran on category 3 or Twinax. Today, fiber is the connectivity of choice for collapsed backbones in hospitals and treatment centers. In the MAN or CAN encompassing the hospital, singlemode and/or multimode fiber remains the solution of choice. New advances in fiber technology make laser-optimized fiber an even better solution. Augmented Cateogry 6 is the horizontal media of choice with category 7/class F expected to become a larger player. Category 7/class F has significant bandwidth availability and the shielding is of further benefit in environments where EMI (ElectroMagnetic Interference) is a consideration. Further, category 7/class F will provide exceptional performance in data center environments where throughput is a prime consideration and fiber may or may not be viable.

Older hospitals were not cabled or designed for these new technologies. The HIPAA requirements for documentation and security provisions are placing additional demands on networks over and above the requirements of the data alone. As a portion of compliance, many hospitals are seizing this as an opportunity to have their network infrastructures reworked or upgraded.

Conclusion

The medical center is one environment where a solid network infrastructure is critical not only to patient care, but also to Federal Compliance. As new systems and capabilities are added to the networks, new capacity planning must be taken into consideration. Compression and assistive technologies have provided some bandwidth relief, but it is fully expected that with greater bandwidth available, further bandwidth demands will become more of a reality than previously expected. Siemon's 10G *ip*™ offers an array of Augmented category 6, category 7 and fiber cabling solutions developed for such critical environments. 10G *ip*™ has been carefully engineered to assure that today's environments and tomorrow's enhancements will be enabled with exceptional bandwidth and throughput. Backed by a global network of certified installers and a warranty that covers products, labor, performance and applications assurance, this system is the system of choice for mission critical environments.

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