Considerations for Implementing IPTV in Healthcare

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Video transmissions over IP
There are many driving forces for implementing Internet Protocol-based Television (IPTV) in Healthcare today. In February 2009, the American Recovery and Reinvestment Act (“the Stimulus Bill”) was signed into law by the Federal Government providing $27 billion under the Health Information Technology for Economic and Clinical Health Act (HITECH Act) providing a catalyst for implementing many new technologies in the Healthcare enterprise. As we focus on meaningful use and patient outcomes, one area that is proven to improve patient satisfaction is better television services that engage, entertain and educate patients. Managing the patient experience with integrated patient applications through television qualifies for ARRA meaningful use. (David W. Wright, 2011) In parallel, consumer demand for improved access to information anytime, anywhere, through any device is transforming how individuals watch television and access information. New Internet-based video streaming services like AmazonPrime, HuluPlus, and NetFlix provide on-demand movies and video content. Individuals are also watching free internet video via YouTube, Facebook, Tweeter and other web sites causing a shift in how we are entertained and educated. For example, ~33 million more viewers watched the Internet broadcast of puppies in a window than the premier of a popular TV Drama Madmen supporting the theory that people are shifting the content they access from mainstream broadcasting to Internet-based content sources. (Marina Gorbis, 2012)

Healthcare organizations are challenged to meet the demands of consumers by providing hotel-like amenities as hospitality and comfort are key ingredients to patient and customer satisfaction. Internet Protocol-based Television is evolving as the standard and healthcare organizations will need to embrace the technology and develop video patient services at the bedside to remain competitive and meet the meaningful use criteria for patient engagement. The driving forces to improve healthcare through technology, meet consumer demands and standardize with the consumer video services industry, validate implementation of integrated IPTV solutions for the healthcare enterprise.
IPTV Evolution

Television is rapidly changing from digital broadcast services delivered by a carrier to Content Delivery Networks. In the next 3-5 years, most home consumers will move away from traditional cable, satellite and telephone company television services to accessing Internet based content. Sometimes referred to as over-the-top (OTT) video, it essentially uses the Internet as a transport pipe to deliver the content. This approach to video delivery has been extensively studied and is being standardized through the combined work of the International Telecommunication Union-Telecommunication Standardization Sector (ITU-T) and International Organization for Standards/International Electrotechnical Commission (ISO/IEC) Joint Technical Committee (JTC1/SC29/WG11, also called the Motion Picture Engineering Group [MPEG]). The MPEG standards for video transmission have evolved since their introduction in the late 1980s to today. The ability to compress video images and stream rich media content live or on demand over Internet to many devices, fixed or mobile, with the same reliably and quality is revolutionizing the industry. (Khalid Ahmad and Ali C. Begen, Cisco, December 2009)

The benefits for IPTV include lowering cable costs to install and distribute content over one common infrastructure, increasing flexibility to introduce applications with interactive content and providing ubiquitous access from any device and location. Today, the average homeowner pays about $2,000 annually for cable or satellite television services which are limited to only viewing content in their home. Accessing IPTV content, individuals can access free or purchased content separate from their Internet provider and access it anywhere from any Internet connected device. Applications and devices are being developed to allow the viewer to program content sources, rather than paying for hundreds of channels they never watch. Broadcast services like ABC, CBS, NBC, CNN, and local news stations stream their content from the Internet allowing devices like Warpia (warpia.com) or Roku (roku.com) to manage an Internet channel guide menu system independent of the cable/satellite provider. Eventually, the cable and satellite providers will no longer have a need to provide broadcast television. If you have access to the Internet, you can pick and choose your content and reduce subscription fees.
Application in Healthcare

As we consider the possibilities for home IPTV to replace the broadcast carrier, like Comcast or DirectTV, what does this mean for large organizations in the hospitality industry? Since the 1980s, hotels have been delivering on demand movies using Spectradyne like video content systems. The hotel industry was the first to push for more interactive capabilities and cost effective solutions for rich media distribution. As healthcare organizations strive to meet the needs of patients similar to the hospitality industry, they will need to rely on IPTV to entertain, educate and interact with patients and their families.

The value of IPTV to the healthcare organization goes beyond the cost effective method of distributing the content and the consumer desire to access any content on the Internet. The real power of IPTV is achieved by implementing a healthcare middleware application that will allow the patient to interact with a television display using the bedside Nurse Call system remote control. This provides the patient and their family access to healthcare information systems and customized video content. Services could include assessing their pain using an interactive chart, ordering discharge medication from the Pharmacy, displaying contact information of their care team including photos, watching physician prescribed educational videos, completing assessments regarding their understanding of the education, ordering food services or purchasing items from the gift shop. The list of possibilities is endless. These interactive systems are customizable by age or individual to personalize the content available. A child could see a cartoon like game interface to play a game, call the nurse or browse the Internet with parental controls to protect them from inappropriate content. Longer stay patients can access Cyber School or online class materials to continue their education. Conversely, for older patients, the interface can be customized to be less complex and basic to their needs. IPTV should provide a variety of broadcast-like channels, video on demand movies and education, and access to the Internet. (Optimal Solutions and eVideon, 2012)
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Anatomy of Healthcare IPTV System

At a high level, IPTV is processed in four major steps: (see Figure 1 below)

1) Acquire the content signals from the Content Delivery Network or cable/satellite provider
2) Encode the digital feed for IP transport
3) Distribute the IPTV streams or signals over the healthcare enterprise network
4) Decode the IPTV signal at the Set Top Box (STB) or an IPTV enabled TV (Smart TV)

(Optimal Solutions and eVideon, 2012)

[1] In the Healthcare environment, we are expanding the use of IPTV to include the capturing of live content on site and distribution of organizationally produced educational content available via Video on Demand. These video sources along with a content delivery subscription-to a broadcast, satellite, or cable service are accessible through a common infrastructure. Cable and satellite providers are focused on the home market, so a third party consultant or solution integrator is advisable to coordinate and interface their service into the enterprise IPTV Head End. Live TV streams using a camera and standalone encoder allow the organization to produce local content to stream live events occurring at the hospital enabling patients who are too ill access to view from their hospital room. Video content stored on the Video on Demand server including prerecorded events, education purchased from
professional sources or on demand movies from a provider like Swank Entertainment are accessible through the system.

[2] A major part of the IPTV infrastructure is the video encoder head end. A bank of encoders is required to convert the broadcast signal from base band RG6 to IP RJ45 for distribution on the enterprise network. A head end system distributing 150 to 300 channels may take up to 4 communications racks. Since hospitals are extremely regulated and to ensure consistency for a reliable system, it’s best to follow standards and use high quality components.

- All IPTV streaming devices should be H.264/MPEG-4 part 10 AVC compliant.
- Video streaming and reception devices shall be compliant to Alliance for Telecommunications Industry Solutions (ATIS) Standards
- All IPTV devices shall be HDCP compliant as applicable.
- All components must be UL-Listed. Underwriter Laboratories establishes safety standards for many industries.

Some manufacturers that provide encoder bank of tuners include Cisco Digital Media Encoder, Motorola, Haivision, Visionary Solutions, Envivio 4Caster, and V-Brick HPS/XPS series. An encoder like the one shown below is required for each digital channel to be converted to ip. To decode the ip channel, a Set Top Box (STB) or integrated SmartTV is required that matches the encoder. For example if you use Visionary Solutions AVN443 (H.264 MPEG-4 Port 10/AVC) you need to have a STB that matches it like the Amino A130.

![Visionary Solutions, Inc. AVN443 Channel encoder and Amino A130 Set Top Box](image)

**Figure 2: Visionary Solutions, Inc. AVN443 Channel encoder and Amino A130 Set Top Box**
Why standardize on H.264/MPEG-4/AVC?

H.264/AVC is an industry standard for video compression. The H.264 standard is also known as MPEG-4 Part 10 and is a successor to earlier standards such as MPEG-2 and MPEG-4. It's an ITU standard for compressing video based on MPEG-4 and is very popular, especially for high-definition video. AVC stands for Advanced Video Coding and it's identical to H.264. The compression achieved with MPEG-4 and H.264 has reduced the bandwidth needed by 50% for equivalent quality of video as MPEG-2. Some characteristics of H.264 Advanced Video Codec include multiple reference frames for each compressed frame, spatial prediction of a macroblock based on adjacent blocks, deblocking filter to smooth out sharp transitions, weighted prediction to simplify widespread change in brightness such as a fade to black, and improved techniques for compression including context adaptive variable length coding. These advancements collectively provide more flexibility for increased compression while retaining the image quality. One of the most exciting aspects of this codec is the introduction of scalable profiles which allows a decoder to process only a subset of the stream data to produce images that are scaled to a lower resolution, lower frame rates, or lower quality level then images in the original stream. This advancement allows applications to drop down to lower resolution as bandwidth is limited without interrupting the video flow. That is why this standard is considered the optimal for IPTV solutions available in today’s market. (Simpson, 2008)

IP Transport Considerations

[3] One cannot propose to implement an IPTV system without evaluating the impact that these technologies will have on the enterprise network. Decisions regarding the network topology, how to implement multicast flows, management of video quality and how to monitor and troubleshoot the end to end video path are necessary to implement IPTV transport of the enterprise network. Video transmission cannot be directly compared with voice or data traffic as it has much higher requirement for bandwidth and is less tolerant of disruption. Distributing video over IP requires an entirely new set of tools, staff skills, configuration and potentially increased bandwidth. For these reasons, the network design is a crucial element for a successful IPTV deployment. In many cases organization may approach the network design as a hybrid or segregated network model rather than attempting to converged voice, data and video over one common converged enterprise network.

Some of the considerations with transporting IPTV will require major configuration changes to your enterprise network. The assumption is that the IP video transport path will be converged over the enterprise network rather than separated in its own physical network. Segregating the IPTV system
traffic and maintaining an isolated local area network simplifies management, however limits the ability to interface the patient with hospital systems. If the organization wants to gain the benefits of patient engagement and interface with other enterprise systems, a converged medical grade network is required. A hybrid approach may be possible using the base band coaxial RG6 cable distribution for the broadcast/satellite TV distribution, while using the IP network to distribute the video on demand content and interface with hospital systems. This would eliminate the head end conversion for each broadcast channel but still require both coaxial RG6 and data RJ45 cable pulled to each STB-TV.

Focusing on the enterprise network configuration, a quality of service (QoS) policy is recommended. QoS will facilitate the prioritization of video and voice traffic across the network to reduce the likelihood of jitter, packet loss and full queues. Architecting and configuring queues for IPTV/IP flows may seem simple however packet behavior can be unpredictable. For example, take a consistent flow of 3.75mb/s coming from a broadcast stream. Sometimes packets will bunch up causing the queues to fill even though the offered load is limited. In this example under ideal conditions each packet carries a payload of 1316 bytes of video with a 2.8ms inter-packet gap. To further complicate the discussion, consider a moderate IPTV deployment has 150 to 300 digital broadcast IPTV flow carried over multicast IP. Add into that the video on demand flows transport as unicast IP. In order to ensure reliable performance of your IP network, you must be able to measure the burstiness of live flows, account for loss and establish a realistic test model for your video traffic with increasing network loads. If you have ample bandwidth you should not experience many problems, however it is better to evaluate before committing to the service. (Ineoquest Application Note)
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Bandwidth requirements for IPTV Standard Definition streams are generally 4Mb/s per video flow, however high definition streams are going to consume at least twice that amount of bandwidth. If 300 channels at ~4mbps = 1.2 Gb/s then one can expect that 300 High Definition channels at 15-20Mb/s will require 6 Gb/s. The minimum recommendation is 10G at the core and distribution levels of your network.

In addition to managing the quality of service over the enterprise network, there are several other network management challenges. IPTV systems are evolving in the enterprise however there are very few end to end single vendor solutions. With multiple vendors’ video components and element management systems such as the video head end, middleware, video on demand servers, security services like Certificate Authentication or Digital Rights Management equipment, ad splicers, multiplexers, etc., the complexity of troubleshooting an error or performance problem becomes very difficult. Tools to monitor video quality from different parts of the network may be hard to find. Video traffic requires a considerable amount of bandwidth demanding critical monitoring to avoid exceeding thresholds and mitigating network disruptions. It goes without saying that a robust, resilient and redundant enterprise network is needed to even consider this application. If the appropriate staff, network management tools, and rock solid network design are not available, video distribution over the enterprise network is not recommend. (Cisco Systems, Inc., October 2009)

Additionally, a prerequisite to distribute IPTV broadcast channels via the enterprise network is to understand and master multicast routing. For the sake of this discussion, CISCO’s network best practices are referenced as an example of how to implement multicast for IPTV. Multicast packets are replicated in the network by routers and switches using multicast protocols. Two categories of Multicast protocols are Internet Group Management Protocol (IGMP) and Protocol Independent Multicast (PIM).

- IGMP facilitates the User-to-Network requests with an IGMP join to request a multicast address. This industry-standard protocol manages IPv4 multicast group membership and dynamically registers individual hosts in a multicast group on a particular network segment. Each channel in our IPTV example is a single Multicast address. Every time a user changes the channel, the Set Top Box sends an IGMP leave and join to request the new channel. The access switches need to be configured for IGMP snooping or this feature will not work correctly.
Network-to-Network requests use PIM which is the de-facto industry standard for building multicast distribution trees. In most cases, the system uses the information learned from PIM to install shared-tree (\( *,G \)) and shortest-path tree (\( S,G \)) entries in the multicast routing table.

In an enterprise network design, it is best to segregate multicast devices either in a VLAN or MPLS zone to simplify the management and configuration. Within a Layer 2 zone, the Set Top Box requests a channel by issuing an IGMP join to the access switch in the network. If the Access switch is already broadcasting that channel to another device, the process is complete. If the channel is not available at the access switch, it issues a PIM join to the distribution switch or mrouter to request the channel. In this way, a network access switch only broadcasts channels that are in use by the STBs it hosts reducing the need to broadcast all channels across the network. Most access switches will have up to 48 ports so the maximum capacity needed at access switch for IP video is 192 Mb/s.
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**Set Top Box, In Room control devices and Healthcare Middleware**

[4] The Set Top Box or Smart TV decodes the H.264/MPEG-4/AVC ip transmission to display the channel and video content at the patient’s bedside. Hospital-grade TVs are required in healthcare for reliability, infection control and integration with other hospital systems. Whatever IPTV solution is selected, the in-room controls need to be compatible. Most Nurse Call systems include the pillow speaker that controls changing channels and volume for the TV. These systems must be integrated with the STB. Most of the healthcare focused IPTV installers understand this and are able to work with most popular systems.

Android TVs like HCI are available that have built in H.264 decoders and do not require the STB. This is a cleaner design, but reliability issues have been reported. It’s not clear whether these are resolved in the company’s latest product line. Whether using a STB or Smart TV, the codec needs to be consistent with the encoder technology used to convert the signal at the head end. IE: Visionary Solutions AVN443 recommend the Amino A310.

The IPTV transmission is complete however; there are some additional considerations for optimizing the use of an integrated IPTV system. The Office of the National Coordinator (ONC) for Healthcare and the Center for Medicare/Medicaid Services (CMS) are federal agencies that established the guidelines for ARRA Meaningful use. It has been identified that by 2015, the meaningful use standards are expecting organizations to offer:

- Patient-specific educational resources online in the common primary languages consistently for at least 20% of patients
- Access for all patients to a Personal Health Record (PHR) populated in real time with data from EHRs [Outpatient, Inpatient]
- Patient self-management tools [Outpatient]
- Electronic assessments and reporting on the patient’s perception of their experience of care
- Capability to upload and incorporate patient-generated data (e.g., electronically collected patient survey data, biometric home monitoring data, patient suggestions of corrections to errors in the record) into Electronic Health Records and clinician workflow

Today, our electronic medical record does not offer patient facing, interactive resources to enable the direct communication expected. The flexibility and innovation available in some middleware solutions will provide patients the ability interface from their hospital bed using applications like GetWellNetworks, Evidon and Magnet Health middleware applications. In addition to the patient services, organizations will to track access to healthcare content and provide reports for these criteria to
prove they have achieved these objectives. Healthcare system use HL7 – Health Level 7 standard interfaces to present, track and update the patients’ interactions from in-room device(s). Whether that’s a TV with a STB, a Smart TV with Android operating system or a zero client flat panel display, the time has come to move away from a traditional TV services limited to broadcasting digital TV services and establish video as an application over the enterprise network. This approach can become a major patient satisfier and help align our healthcare organization with the requirements for meaningful use in 2015. (David W. Wright, 2011)

It is clear that the movement towards IPTV that started over 30 years ago in the 1980s is finally taking hold of our consumer and corporate video services. IPTV solutions seem complex, but are not insurmountable. To support video transmission over IP, requires some adjustments, staff training, video resources and increased network requirements which aren’t trivial, but are manageable. If providing high quality rich media content is a priority in the healthcare organization and there is a commitment to invest in the development of these patient engagement services, than IPTV is a logical solution. Not only will this service help inpatients, but the content developed can be made accessible to patients at home or anywhere they have Internet connectivity. Mobile devices or home users can access these services which further improve our ability to meet the criteria for patient engagement and meaningful use.
**Works Cited**


