Convergence:
Hotel Technology for Today and Tomorrow

Hotel Technology Next Generation
In-Room Technology Workgroup
June 2005

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Table of Contents

I. The Business Case for Convergence

con·ver·gence (kən-vûrˈjəns) *n.*

1. The process of coming together or the state of having come together toward a common point.

Computer networks, the central nervous system of any modern enterprise, are rapidly evolving to meet the needs of the organizations they serve. This technical evolution focuses on *convergence,* the merging of many dissimilar networks into one. The evolution of network infrastructure in the hospitality industry is following this path. Today, the many different network architectures used for voice, video, data, and controls in hotels are moving towards a single network and a single protocol capable of supporting many applications. From the technical viewpoint, network convergence is a logical evolution. However, from the business perspective, it opens the door to a positive revolution. Quite simply, the converged network gives hoteliers much more for much less. It provides more flexibility, more applications, more reliability and more security, for less money.

As the hospitality industry recovers from the recent market slump and experiences rising revenues and occupancy rates, leading hoteliers are looking ahead and determining what role technology will play in furthering the recovery. In the late 90's, many enterprise businesses made the investments needed to converge their network infrastructures. Although some early adopters suffered as they worked through the technical challenges, they saw their investments produce solid returns in the form of reduced complexity and greater productivity. Today, now that the underlying elements that drive converged networks have matured, hoteliers are in a position to benefit. By building or migrating to a converged network infrastructure, hotels can provide the premium services the high-value guest desires and improve revenue per available room while deploying applications that increase staff efficiencies.

Hotel Technology Next Generation makes this white paper available to hospitality companies interested in creating converged networks to take advantage of today's guest service applications.   A commitment to open standards as a means to "future-proof" the hotel infrastructure is a driving philosophy behind this white paper. Although many hoteliers may never find it possible to combine all networks in all properties, the information presented here is a first step in building a strategy to meet the needs of and opportunities for current and future guests. This white paper addresses the business benefits of a converged network infrastructure to the hospitality industry. It provides detailed information on the various architectures that will help hoteliers determine how to build, or migrate to, a converged network.

A. The Current State of Hotel Technology

The general level of sophistication of technical infrastructure across the hotel industry ranges from low to entirely non-existent when compared to other businesses. While some innovators are challenging the status quo, these success stories are few. The unfortunate reality is that the vast majority of hotel technology typically takes the form of *islands of automation*, multiple, proprietary systems and networks, each performing a single task, built on costly, proprietary technology and largely incompatible with one another. Too often, pieces of the infrastructure are physically crumbling, unsupportable, improperly managed, or vulnerable to security attacks—and quite possibly face all of these threats at the same time.

Legacy technology products within the same hotel or hotel group frequently require infrastructures that are incompatible in critical ways, leading to expensive redundancy, performance degradation, and inability to achieve integration. At best, these factors represent a significant opportunity cost, in their failure to make a positive contribution to the quality of the guest experience despite the investments required to acquire and maintain these systems. At worst, the cost, complexity and inherent unreliability adversely affect guest service and the overall guest experience.

Converged infrastructure models that are the norm in other industries combine critical functions such as user authentication, data management, word processing, e-mail, and printer management seamlessly within a single system. Many current hospitality enterprises, however, implement these same functions inconsistently, spanning multiple applications within the same environment. Some systems even require their own unique, single-use workstations and networks, despite the fact that the intended users may have (or have the need for) standard PCs, connected to the hotel's local area network, to perform other job functions.

Modern technology systems require a consistent and reliable infrastructure, built on standard technology and ready to be shared by several applications. The key elements of infrastructure are:

- Wide and local area data networks (WANs and LANs)
- Network operating systems
- Server and workstation operating systems
- Data management platform

Secondary elements include general business tools like office automation software, security tools such as firewalls and virus scanners, and supporting applications like custom reporting packages. The business environment that supports the infrastructure needs to be prepared with robust process for technology selection and integration, and for system administration and user support throughout the products' useful lifecycle. These requirements are similar to those of enterprises in many other industries.

In recent years, demand has increased to extend networks into the guest room and public spaces, areas previously off limits to modern computer-based technologies. Today, these spaces require a variety of wired and wireless networks providing services such as high-speed Internet, cell phone coverage, pagers and messaging systems for rapid response, video-on-demand, digital television, digital CCTV, door locking, HVAC control, room occupancy detection and many other necessary services.

Many older hotels, and some newer ones, were not designed to allow cabling to reach needed areas, preventing the required services from being deployed easily. Adapting existing telephone cables, television Coax networks, or high-voltage electrical cables to carry necessary network signals may require heroic efforts. Wireless solutions widely adopted in residential and office buildings have proven difficult to provision reliably in hotels due to the unit (room) density, difficulty of propagating signals to the required areas, and sheer diversity of requirements placed upon the wireless networks.

Some of these problems are legacy-system related, but many result from absence of industry-wide infrastructure standards and ignorance of the impact at the hotel company level. As an industry, the information assets of hotels and hotel groups must be sharable as required across multiple organizations, such as management companies, franchisors, owning companies, suppliers, and distribution partners.

Investment in infrastructure needed for today's systems are easier to justify if they are built on robust, industry-wide standards, paving the way for continued interoperability even if the hotel is re-flagged or sold tomorrow. It therefore makes sense to define a common platform that guarantees a minimum level of interoperability. Yet, hotels have been reluctant to acknowledge the benefits or to make the required investments to date, and vendor interest in common platforms and interoperability, while growing, is far from sufficient.

B. The Benefits of the Converged Network

In today's competitive travel market, hotels around the world strive to differentiate themselves from others while increasing revenue to bring positive change to the bottom line. Hotels can use technology to gain advantage in two distinct areas – in the guest suite and everywhere else. Hotel companies look to highly intelligent, converged networks to increase occupancy by attracting high-value guests, creating new recurring streams of revenue and driving operational efficiencies.

1. Attracting and Maintaining Guests via Improved Services

The advanced communication and wireless capabilities provided by a converged network allow hotels to offer new or improved communication and entertainment services to their guests. A single network allows the distribution of guest information across many systems to improve and personalize guest services. This is well beyond the capabilities of today's non-converged telephony, Internet and video offerings.

Imagine a guest checking into the hotel and by the time she gets to her room, the temperature controls and room lighting are adjusted to her taste, the phone displays the speed dial for other guests in her party, as well as business and personal speed dial numbers she prefers when staying at that property. The television welcomes her with a personalized notice of an upcoming meeting in the hotel conference facility, while providing a link to headlines from her hometown newspaper. All this and more is possible with a converged network.

- Environmental Controls: Settings for HVAC controls, room lighting and other room features such as opening / closing draperies can be managed from the front desk. Where the guest's personal preferences are known, and available in a knowledge base linked to the PMS via the converged network, the customization of the room can be completed automatically, during the check-in process.
- Personalized Telephony Services: By replacing traditional TDM telephony systems with IP Telephony, hoteliers can offer their guests an expanded range of phone-based services.   New services, such as unified messaging, Internet data services and phone-based video conferencing add to the value perceived by the guest. High quality speakerphones, color display screens with web browsing capabilities and adaptable phone menus allow the hotel to personalize and improve services compared to standard analog or digital telephones.
- Next Generation Video Entertainment: A high-speed network infrastructure throughout the hotel enables advanced video services over a common network. This network transforms the standard television into an advanced entertainment center with offerings tailored to the individual guest. The television's value expands, as it becomes the means of delivering new options for Video-on-Demand, interactive services and unified messaging.
- High Speed Internet Access In-room: Just as televisions and hair dryers have become standard issue in a hotel guest room, so has High Speed Internet Access (HSIA). Hotels can offer this service via wired or wireless media, free to the guest or as a source of revenue. In addition, the welcome page or guest portal links the guest to other hotel services, while content management solutions present other information that is valuable to the guest.
- High Speed Internet Access Everywhere: Guests can access a ubiquitous wireless Internet service throughout the property, either as a paid service to increase revenue or as a complimentary service to attract guests. Hotels can use wireless Internet services to link guests to revenue generating hotel services (e.g., spa services) through the guest's own laptop computer or via guest service kiosks.

2. Creating and Improving Recurring Sources of Revenue

Hotel-wide wired and wireless Internet access coupled with IP Telephony and video services enable a hotel to create new, distinctive offerings that increase revenue. Current and future applications will allow hotels to expand convention services, push advertising to guests in strategic locations and link shops and facilities to a common network.

- Conferencing Services: Business conferences are an important revenue generating opportunity for many hotels. Converged hotel networks provide areas for differentiation by providing business travelers with High Speed Internet Access throughout the hotel. IP communication services, like IP Telephony systems, provide phones with excellent speakerphone capabilities, and conferencing services that include both scheduled and ad hoc voice and video conferencing. IP communications and the free flow of guest information between hotel systems allow the hotel to notify guests of upcoming sessions via a phone or television display and provide video viewing of meetings in the guest room via live or recorded broadcasts. In addition, wireless extensions of the converged network give the hotel an easy, dynamic means to offer Internet access to their convention / meeting customers making set-up and tear-down quick and responsive to customer needs.
- In-Hotel Advertising: Hotels can gain new sources of revenue by providing guest-specific advertising to increase guest awareness of hotel shops and services. A converged network allows hotels to deploy advertising through a variety of means: plasma screens in lobby and reception areas that display in-hotel announcements or advertising, networked kiosks located throughout the hotel, IP phone display screens in guest rooms and online guest service portals. Content management solutions tailor the message to the guest, so the message is considered useful information, not a blaring interruption.
- Voice and Data Connectivity for Shops and Facilities: In-hotel retailers require both voice and data connectivity to support their business and generate sales. A converged network enables hotels to lease their network and services to their tenants. Hotels become service providers offering telephony, wireless connectivity and broadband – all providing additional sources of revenue.

3. Building A More Productive and Responsive Staff

A courteous, knowledgeable staff is a key ingredient to winning and maintaining customer loyalty. Getting the right information to hotel employees is critical. With all hotel systems communicating and sharing guest preference information on the converged network, a staff member is always informed and up-to-date. In addition to the rapid sharing of this information, hoteliers can standardize the content and distribution of staff training materials by utilizing IP video and storage solutions.

- Workforce Mobility: Mobility solutions enable hotel staff and management to be more responsive to guest needs by breaking the chains that keep them bound to reservation desks, business centers and back offices. Staff can take advantage of an intelligent information network to gain secure access to the right people and information regardless of their location in the hotel. Wireless communication over the converged network provides operational efficiencies by allowing staff to communicate with each other via wireless IP phones or paging systems and allowing wireless remote access to guest information. Wireless networks enhance many applications like curbside check-in and stock control management via radio frequency identification (RFID) become options at the hotel staff's disposal.
- Advanced Telephone Services: With IP phones, hotels can utilize advanced phone-based services that provide integration with emergency communication systems and property management systems. In an emergency, the hotel can broadcast live messages in voice or text directly to the guest phones. Integration with the property management system allows phone-based requests (wake up calls, room service) to become automated, reducing operating costs.
- Automatic Room Security via Key Card Systems: Most leading hotel companies have implemented key card systems to control access to guest rooms. A converged network lets you amplify the impact of these systems to personalize guest services and improve guest security. For instance, a personalized key card could allow language and a temperature preference to be set once the guest enters his room. The key card system integrates with the hotel's entire security system to control building access and monitor guest location in emergencies.
- Video Conferencing and Content Networking for Staff Training: The large number of hotel employees and high staff turnover require that hotels devote much time and

money to effective and consistent staff training. Video training content can be stored centrally and provided to staff via individual video-on-demand systems or team video conference training. The IP video distribution system for staff training would also provide live or recorded conference sessions to the guest room.

4. Centralizing Services for Cost Reduction

The services discussed in this document are available through applications that are running over a converged network that is "speaking" a common language, the Internet Protocol (IP). This industry standard protocol allows remote configuration, operation and maintenance of various network devices and endpoints. Hoteliers can benefit from reduced expenditures by centralizing the physical equipment that provides multiple hotels with communication and entertainment services.

- IP Telephony Clustering: One of the many benefits of IP Telephony is that hotels do not need an individual, on-site PBX for each property. The distributed architecture of IP Telephony networks allows hotels to cluster IP Telephony servers and call processors in one centralized location. A hotel company with many properties in one area could provide telephone service to multiple properties from a single site. This reduces the hardware and service expense of owning and operating one PBX at each property.
- Remote Network Management: A remote base of highly skilled network administrators can improve customer satisfaction through the continual measurement of response times, quality of service and identification of network bottlenecks. Automated, centralized configuration and software management saves time and money. Automated fault diagnosis, problem management and improved change management procedures increases uptime. Remote network management allows on-site hotel staff to maximize the amount of time they can provide face-to-face guest service.
- IP Video Surveillance: IP video surveillance cameras are replacing traditional, analog closed-circuit television (CCTV) systems because IP video surveillance offers significant advantages when compared to analog CCTV. One such advantage is video portability. Leveraging network based digital video recorders eliminates the need for VHS tapes and management of these tapes. This provides for a more efficient and effective management of multiple facilities via a less expensive centralized security operations model while allowing for instant retrieval of security information.

- Building Automation and Control: Hotels can streamline maintenance processes and cut operating costs by using networked building automation systems. A converged network provides the foundation for a range of building automation and control technologies including energy management, lighting management, heating, ventilation and air conditioning.
- Centralized Reservation System: Hotels can hold guest information centrally for use across all the properties in a chain by connecting to a centralized reservation system. Staff can take advantage of integrated applications which link hotel operations and reservation systems to all guest "touch points" including curb side greeters, baggage handlers, guest check-in, concierge, housekeeping, food and beverage and conference services.
- IP Call Centers: Deploying IP Telephony across a network maximizes staff efficiency. A centralized call center provides an important resource for guests and staff, and sharing this resource among multiple properties reduces the costs for all.

5. Lowering the Cost of Network Ownership

A converged network eliminates the traditional barriers between voice, video and data departments, allowing overall costs to decrease. A converged network can lower a hotel's total cost of network ownership by eliminating multiple sets of infrastructures, simplifying system administration and maintenance and consolidating voice, video and data circuits.

- Reduction in Equipment Costs: Combining multiple network infrastructures into a single converged network, means that organizations no longer need to invest in dedicated devices (such as PBX's) or maintain separate networks for ISDN and in-room entertainment. This reduces wiring costs, especially for new construction. The hotel is no longer required to install multiple cables of different types in each guest room to provide voice, in-room entertainment and High Speed Internet Access.
- Reduction in Network Administration Costs: A converged network lets hotels reduce network administration costs by improving the productivity of the network support staff. No longer does the hotel need individualized, product-specific support teams. Hotels also gain the option of remotely managing multiple properties from a central location.
- Reduction in Network Carrier Costs: Using a data network to carry telephone calls reduces toll charges and voice circuit costs. This also causes a significant reduction in tariffs for international calls.

6. Technology Migration

Time affects different parts of a hotel in different ways. The structure itself, for example, grows old at a relatively slow rate compared to its technology infrastructure. While an office building may undergo a technical update once every three to five years, this is practically impossible to achieve in a hotel. The requirement to maintain pristine guest-accessible environments and the resulting reductions in rate and occupancy imposed by renovation projects, inevitably mean that what does not get done today is put off for tomorrow. The implications of this are profound; incremental, evolutionary upgrades to the technology infrastructure commonly made in the home or office environment are often impossible in hotels.

Instead, this infrastructure is generally bound to timelines associated with hard room renovation, which often may stretch up to fifteen years between cycles. The requirements placed on the infrastructure in hotels therefore are extreme – fifteen years is a long time and may encompass five or more generations of technology. Certainly, the need to get it right the first time has never been more important. Hotels need to install tomorrow's technology today, and to be accurate in their predictions and technology choices if the base infrastructure is to track the timeline of the floors, walls, bathroom fixtures and beds.

7. The Case for Convergence

It is possible to find coherent and effective fifteen-year-old network infrastructures in hotels, but it is all too rare. Typically, infrastructures are fragmented, unmanageable and unreliable, addressing only the needs of a single application. The lack of a common network, for instance, complicates facility upgrades such as adding CCTV cameras to elevator lobbies, installing network addressable door locks or adding fifty new television channels. The lack of investment in infrastructure may come from a lack of effective planning or foresight as well as a general unwillingness to spend money on assets hidden in the walls, where they cannot be seen (or marketed).

All components of a converged hotel network, including the hardware, software and services, should have feature-rich roadmaps designed to support constantly changing business requirements. Most organizations have made significant investments in their existing networks and they are concerned about their ability to protect these investments while migrating from separate networks to a converged networking model. A low-risk migration path is clearly required. Most converged networking vendors have created products to ease this transition and ensure that new equipment can integrate with the existing infrastructure.

A converged network based on open standards is the best bet to make additional technology purchases even more interoperable, each using the same network, as opposed to separate voice, video and data networks. All elements of the hotel's technical infrastructure contribute to the synergy of a standards-based multi-vendor environment that adapts swiftly to changing business and technical requirements while continuing to map cost to business benefit, providing true value to the hotel and its guests.

II. Comparing Network Media

At the base of all network architectures is the transport media, which is typically a combined view of the physical and media access layers, or more simply – the cabling and modulation. This section describes the characteristics, features, and benefits of four different transport media and discusses alternatives for existing buildings and new-builds.

A. Media Types

The alternative transport media are:

- Coaxial Cable (Coax)
- Unshielded Twisted Pair (UTP)
- Fiber Optic Cable
- Wireless

As more and more devices in hotel guest rooms require IP connections to central servers, it is necessary and critical to install the proper network to support these devices. The following are some key points to consider when selecting the transport media and equipment.

- Network Topology – A star topology between each device and a central location (such as a wiring closet) provides the most flexibility in terms addressing the differing requirements of each location and upgrading the network in the future. However, a star configuration can require significantly higher cabling costs than a bus configuration because of the necessary home runs.
- Bandwidth – Bandwidth requirements to a room are constantly increasing as the number and complexity of integrated applications increase. In fact, it is prudent to expect bandwidth requirements to double every few years. To "future-proof" a network, the wiring infrastructure should accommodate as much bandwidth as can be economically justified at the time, using media that can support future bandwidth increases.

- Distance – Preparing cabling plans requires careful attention to distance limitations. For example, it is necessary to place switches or amplifiers, which extend a network's reach, in locations with proper environmental conditions (such as wiring closets). Fiber optic cable may be required where very long runs of cable are needed, such as between buildings or to high floors.
- Cost – It is of course much easier to cable a building under construction, to support the "digital" guest room, than retrofit a hotel that is many years old. In an older property, there will typically be separate wiring for the analog phone systems (Category 3) and the analog television systems (Coax). The cost to add a separate IP network (Category 5, Category 6 or Wireless) can vary greatly from property to property. Fortunately, it is now possible to run IP protocols over an existing Category 3 or Coax infrastructure for certain applications.

Fiber optic cable is a very high bandwidth capacity medium suitable for long distance cable runs. The equipment used to support a fiber connection is more expensive than a typical Category 5 switch, for instance. Therefore, for short, low bandwidth needs, it may not be a cost-effective choice. However, fiber can often save a great deal of expense because a single fiber optic cable can be used in place of many copper cables, thereby reducing wiring costs. Fiber's ability to span long distances can eliminate the need for extra switching equipment.

- Application Support and Video Formats– Although all the media on the chart, referenced below, can support IP traffic, they cannot all support the various analog or IP requirements that can potentially be present in a guest room. It is important to match the media for a converged network to the expected usage.

Comparison of Transport Media for Converged Networks
Voice, Video, and Data on a Single Physical Network

	Twisted Pair Category 3	Twisted Pair Category 5	Twisted Pair Category 6	Coax RG 59	Coax RG 6	Coax RG 11	Single mode & Multimode Fiber	Wireless 802.11b	Wireless 802.11g	Wireless 802.11a
Network										
Technology	ADSL/2+	Fast Ethernet	Gigabit Ethernet	Digital Cable	Digital Cable	Digital Cable	Gigabit Ethernet or Wave Division Multiplex	802.11b DSSS	802.11g DSSS	802.11a DSSS
Modulation	DMT	N/A	N/A	VSB, 8VSB, QAM	VSB, 8VSB, QAM	VSB, 8VSB, QAM	DWDM	BPSK, QPSK, CCK, QAM	BPSK, QPSK, CCK, QAM	BPSK, QPSK, CCK, QAM
Physical	Star	Star	Star	Bus/Star	Bus/Star	Bus/Star	Bus/Star	Bus	Bus	Bus
Logical	Star	Star	Star	Bus	Bus	Bus	Bus/Star	Bus	Bus	Bus
Bandwidth										
Mbps	24	100	1000	4850	6467	12933	10,000	1-11	1-108	6-54
MHz	120	350	750	750	1000	2000	10,000	83	83	300
Shared / Dedicated	Dedicated	Dedicated	Dedicated	Shared	Shared	Shared	Either	Shared	Shared	Shared
Distance										
Without Amp	20,000'	328'	328'	900'	1200'	2400'	1800'	Indoor 100' Out 300'	Indoor 100' Out 300'	Indoor 75' Out 225'
With Amp/Repeater	N/A	1312'	1312'	1.5 miles	3 miles	6 miles	25 Miles	Indoor 600' Out 20+miles	Indoor 600' Out 20+miles	Indoor 450' Out 7+miles
Cost										
New Build	high	medium	med+30%	medium	medium	medium	higher equip cost	medium	medium	medium
Existing	low (in place)	high	high	low	low	low	higher equip cost	medium	medium	medium
Application Support										
IP	fair	good	excellent	good	good	good	excellent	fair	good	good
Analog Video	no	no	no	yes	yes	yes	yes	no	no	no
Digital Video	no	no	no	yes	yes	yes	yes	no	no	no
Video over IP	yes	yes	yes	yes	yes	yes	yes	limited	limited	limited
Analog Voice	yes	yes	yes	no	no	no	yes	no	no	no
Digital Voice	yes	yes	yes	no	no	no	yes	no	no	no
Voice over IP	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Video Formats										
SD (4:3, 480i)	yes	yes	yes	yes	yes	yes	yes	limited	limited	limited
ED (16:9 480p)	limited	yes	yes	yes	yes	yes	yes	no	limited	limited
HD (16:9 720p)	limited	yes	yes	yes	yes	yes	yes	no	limited	limited

III. Reference Architectures of Comparative Transport Media

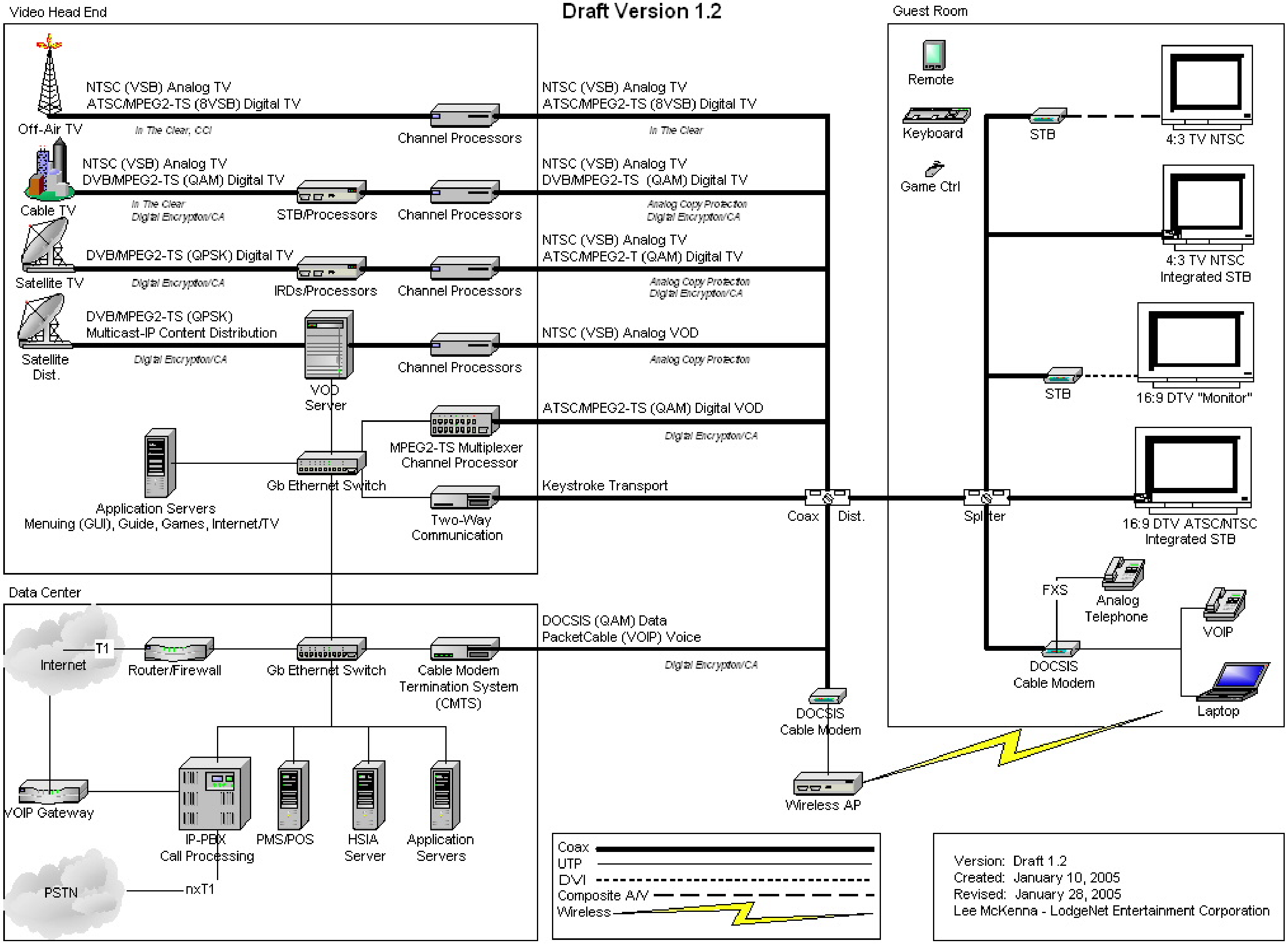
The following four reference architectures are representative of today's designs and technologies, and each of them represents a step forward in the convergence evolution of one network carrying any application. Some, to a lesser degree than others, show the natural migration of applications to an all-IP network protocol.

There are four distinct reference architectures:

- Coaxial Cable (Coax)
- Hybrid Coax and Unshielded Twisted Pair (UTP)
- Unshielded Twisted Pair (UTP)
- Fiber Optic to the Unit (Guest Room)

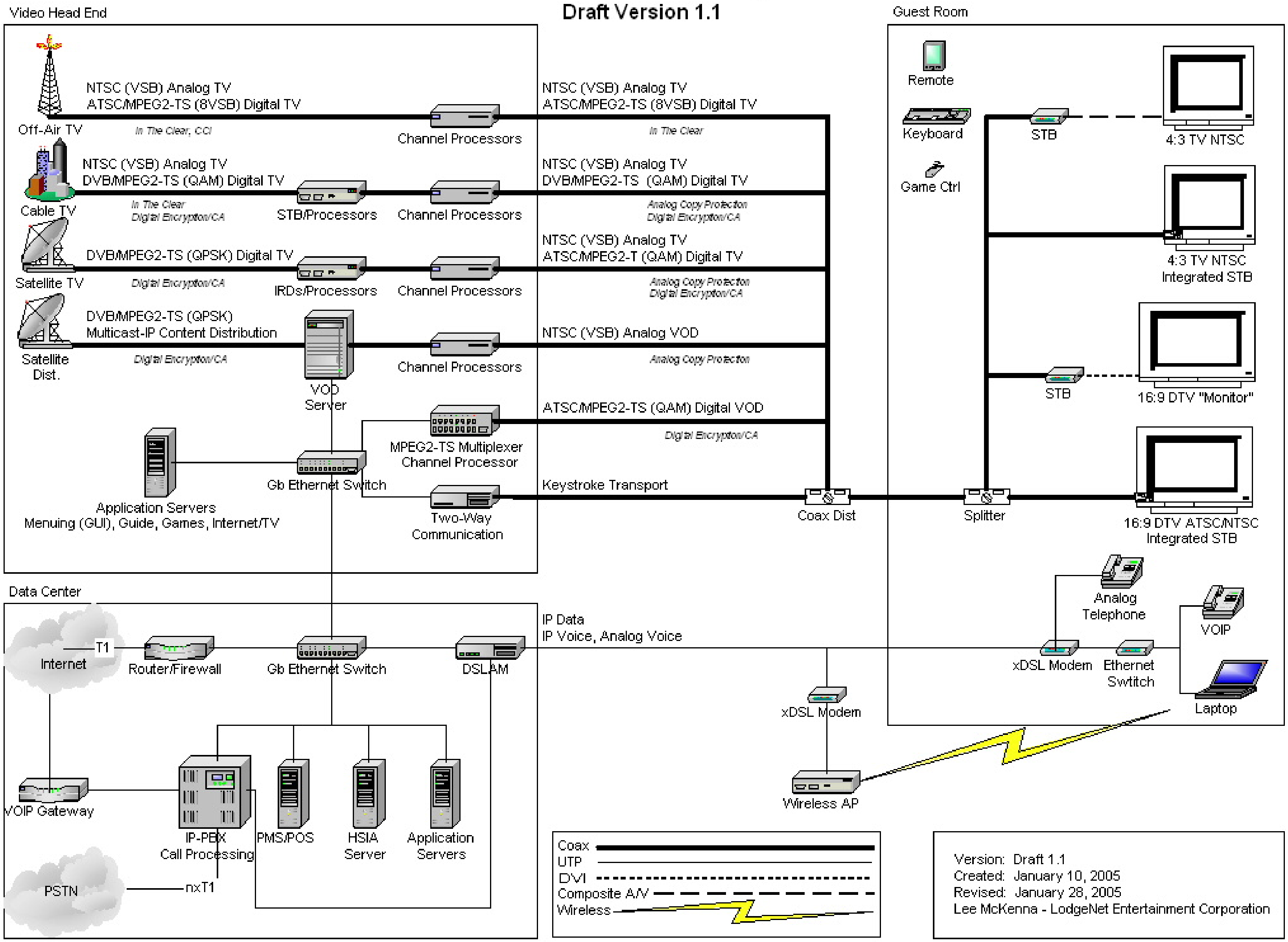
HTNG Reference Architecture - Coax

Draft Version 1.2



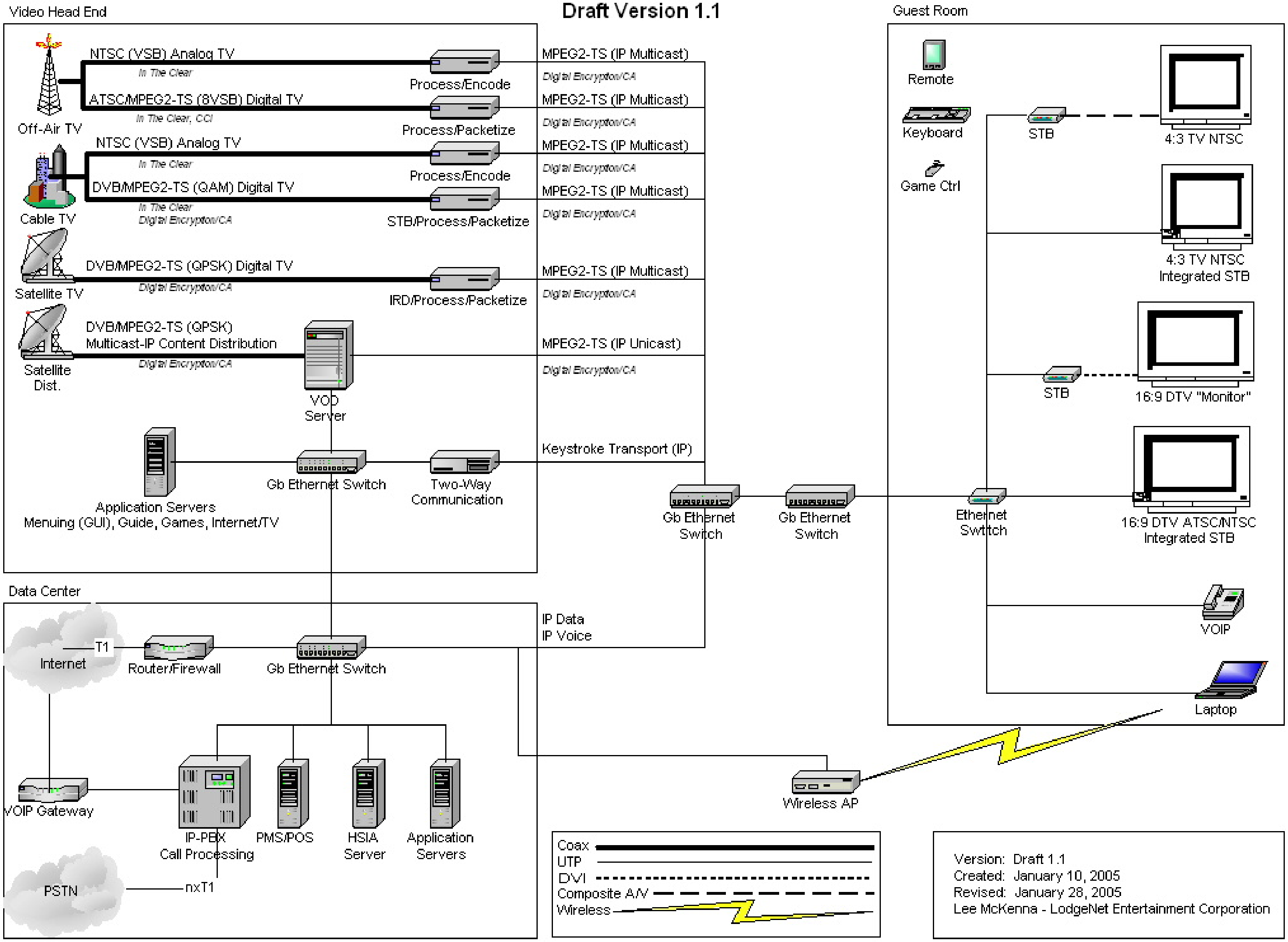
HTNG Reference Architecture - Hybrid Coax & UTP

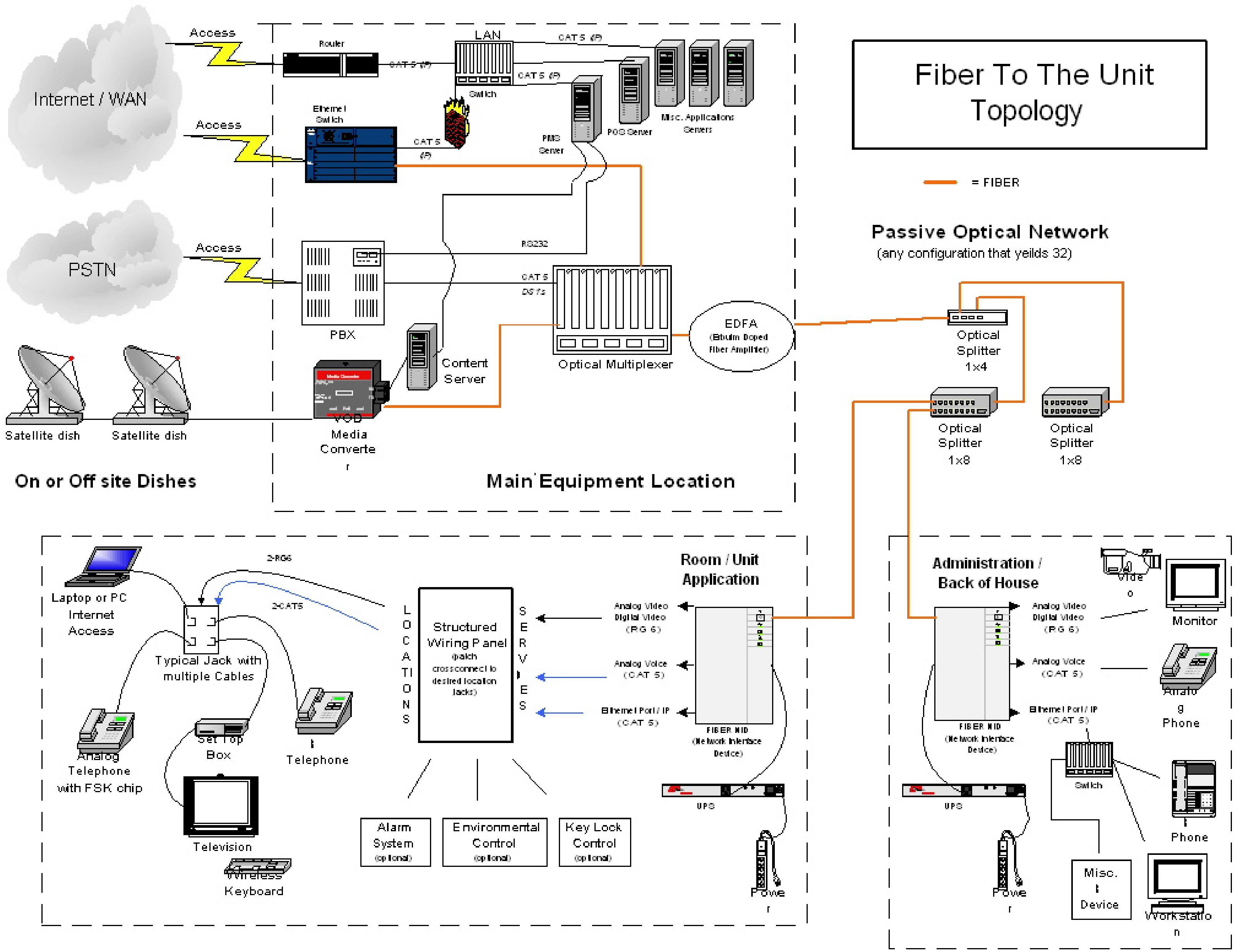
Draft Version 1.1



HTNG Reference Architecture - UTP

Draft Version 1.1




Fiber To The Unit Topology
= FIBER
Passive Optical Network
(any configuration that yeilds 32)
Internet / WAN
PSTN
Access
Access
Access
Router
LAN
Switch
Ethernet Switch
CAT 5
Misc. Applications Servers
POS Server
PMS Server
RS232
DS Ts
PBX
Content Server
Optical Multiplexer
EDFA
(Erbium Doped Fiber Amplifier)
Optical Splitter 1x4
Optical Splitter 1x8
Optical Splitter 1x8
Satellite dish
Satellite dish
VOD Media Converter
On or Off site Dishes
Main Equipment Location
Laptop or PC Internet Access
Typical Jack with multiple Cables
2-RG6
2-CAT5
Analog Telephone with FSK chip
Set Top Box
Telephone
Television
Wireless Keyboard
LOCATIONS
Structured Wiring Panel
(patch crossconnect to desired location jacks)
SERVICES
Room / Unit Application
Analog Video Digital Video (RG 6)
Analog Voice (CAT 5)
Ethernet Port / IP (CAT 5)
FIBER NID (Network Interface Device)
UPS
Power
Alarm System (optional)
Environmental Control (optional)
Key Lock Control (optional)
Administration / Back of House
Video
Monitor
Analog Phone
Switch
Phone
Misc. Device
Workstation

IV. In-Room Entertainment System

A. Application Overview

In-room entertainment systems provide guests access to audio-visual forms of entertainment and information including the products and services described below.

Free-To-Guest (FTG) – FTG typically gives the guest a fixed line-up of television programming at no cost to the guest. FTG includes programming delivered by various sources including off-air (local market stations), satellite (DirecTV, Dish Network, etc.), and cable (local market cable provider, e.g., Comcast, Cox, etc.). Each of these sources represents a different technical challenge because of different modulation, encoding, security, and conditional access mechanisms.

Video on Demand (VOD) – VOD provides the guest with a broad selection of pay-per-view content delivered on demand. VOD content provides access to video content from various sources including major Hollywood studios like Paramount, Universal, MGM, Sony, Pixar, etc., second-tier and independent content producers, as well as content creators like HBO and Showtime.

Promotional Video – Promotional video, typically delivered free of charge to the viewer, includes such programming as video welcome, hotel promotions, and promotion of local venues like restaurants, theaters, and other attractions.

Music – Music may include local and national radio stations, Internet-based radio, satellite-based radio (XM, Sirius, etc.), as well as large libraries of stored music and music videos presented to the viewer either as an amenity or for a fee. The Video services provider may deliver in-room music, or it may come from sources as simple as a clock radio in the guest room.

Games – Several types of games may be delivered to a guest, including consumer-based console-style high action "twitch" games (Nintendo, Sony, Sega, etc.), Internet delivered games (Doom, etc.) and non-console / non-Internet games (e.g., Solitaire).

Internet on TV – Internet on TV provides a guest with access to the Internet using the television as a display device and either a keyboard or remote control as input. Guests navigate the system with either a PC-like cursor using "point-and-click", or a "highlight and select" link-hopping process.

Content reformatting for analog displays has been a barrier for a truly successful delivery of web content, but newer digital displays may remove this barrier.

Guest Services – Guest services are typically value-added applications delivered to the guest through the television. This includes applications for activity booking, reservations, room service, maps of the property, weather forecasts, etc.

Guest Device Connectivity – Unlike yesterday's hotel entertainment systems, tomorrow's systems need to accommodate the entertainment and business devices that the guest carries with them, such as media players, digital cameras, personal computers, PDAs, and mobile phones. Guests who are accustomed to docking these systems into their home theater systems at home will expect the same capabilities in hotels.

B. System Components

1. Head-End Infrastructure

The Head-End Infrastructure is generally comprised of infrastructure that deals with different audio-visual sources, processes signals, provides a two-way communication mechanism to each room, and distributes the signals into the Distribution Infrastructure (described in further detail below). There are multiple sources of audio-visual content in a head-end. Traditional sources such as off-air, cable and satellite are joined by new sources such as:

- Application Servers – This type of server typically provides audio and video on demand (VOD). This includes motion pictures, music, music videos, and other pre-recorded content for playback on demand, which may also provide menuing, games and Internet access.
- Channel Processors – This component takes various incoming source signals and condition and process them for re-distribution on the internal network. This can include RF de-modulators, RF modulators, and IP-based real-time encoders or transcoders.
- Integrated Receiver Decode (IRD) – The Integrated Receiver Decoder takes an incoming satellite program source and strips conditional access and encryption, may optionally add a new form of encryption, before sending the resultant signal on to a channel processor.
- MPEG2 TS Multiplexer – The multiplexer packages individual digitally encoded programs into a packetized stream of multiple programs, and conditions and processes the signals for re-distribution on the internal network.

- Streaming IP Server – This server delivers digitally encoded programs in an IP packetized format, using either unicast or multicast IP addressing.

2. Distribution Infrastructure

There are generally two types of network architectures used for distribution of in-room entertainment and information systems – Coax and UTP (or a Hybrid of both). Refer to the HTNG Reference Architecture diagrams, above.

a. Coaxial Distribution Infrastructure

As of this writing, "channelized", RF-modulated, coaxial cable networks, also called Coax networks, are the predominant distribution infrastructure. The Coax is a logical bus topology (although physically it can take the form of either a bus or a star topology) that is divided into 6 MHz channels (8MHz in some parts of the world), with typical total capacity of 750MHz (or 125 x 6MHz channels).

Older "analog" cable systems use an RF modulation technique that consumes one 6 MHz channel per television program (e.g., NTSC, 4:3, SD program).

Modern "digital" cable systems use a newer modulation technique that provides up to 38.8Mbps per 6 MHz RF channel for carrying "packetized" digital video (usually in the form of an MPEG2 Transport Stream). Depending on the format of the digitized source video, a single 6MHz channel can carry, for example:

- 2 High Definition programs, using MPEG2 @ 19.4Mbps
- 4 Extended Definition programs, using MPEG2 @ 9Mbps
- 10 Standard Definition programs, using MPEG2 @ 3.75Mbps
- 25 Standard Definition programs, using MPEG4 @ 1.5Mbps

The total bandwidth capacity of a digital cable system is over 4.5 Gigabits per second. Using MPEG4, Coax could theoretically carry over 3,000 standard definition (SD) television programs.

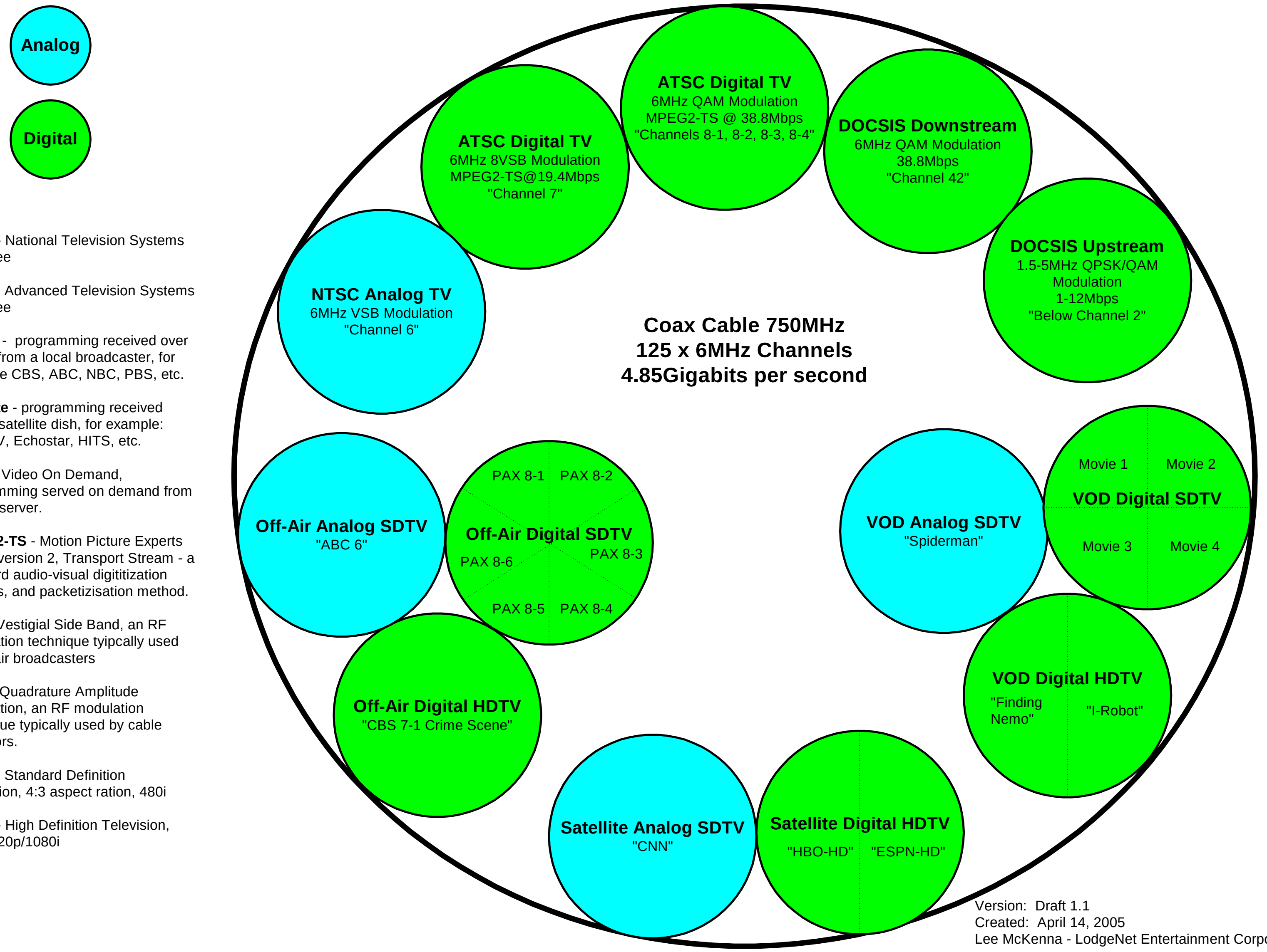
A Coax infrastructure carries IP packets by using the MPEG2 Transport Stream in a one-way "broadcast" system, or by using DOCSIS cable modem subsystems to support two-way communications.

The PacketCable standard from CableLabs in the US also specifies a system for carrying IP Telephony over a Coax infrastructure.

A common misconception is that Coax is an old and outdated analog-only infrastructure incapable of supporting modern IP-based communications and new applications. On the contrary, Coax is quite capable of supporting IP and carrying virtually any digitized and packetized information - including voice, data, and video, using a variety of techniques as described above.

The diagram below depicts the channelized nature of Coax.

Coax - Channelized Media



NTSC - National Television Systems Comittee

ATSC - Advanced Television Systems Comittee

Off-Air - programming received over the air from a local broadcaster, for example CBS, ABC, NBC, PBS, etc.

Satellite - programming received from a satellite dish, for example: DirecTV, Echostar, HITS, etc.

VOD - Video On Demand, programming served on demand from a local server.

MPEG2-TS - Motion Picture Experts Group version 2, Transport Stream - a standard audio-visual digititization process, and packetizisation method.

VSB - Vestigial Side Band, an RF modulation technique tyipcally used by off-air broadcasters

QAM - Quadrature Amplitude Modulation, an RF modulation technique typically used by cable operators.

SDTV - Standard Definition Television, 4:3 aspect ration, 480i

HDTV - High Definition Television, 16:9, 720p/1080i

Version: Draft 1.1
Created: April 14, 2005
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b. UTP Distribution Infrastructure

Packetized, switched, IP networks that use Unshielded Twisted Pair (UTP) cabling form the basis for new distribution infrastructures. The two most common types of UTP networks are switched Ethernet over Category 5 cabling; and one of the Digital Subscriber Line (DSL) technologies (such as ADSL, ADSL/2+, VDSL, etc.) over Category 3 cabling.

The following bandwidths are representative of each type of network technology that may be used:

ADSL	8Mbps (downstream) 1Mbps (upstream)
ADSL/2+	24Mbps (downstream) 3Mbps (upstream)
VDSL2	50Mbps (downstream) 26Mbps (upstream)
Fast-Ethernet	100Mbps
Gigabit-Ethernet	1000Mbps

UTP networks, configured in a star topology, generally provide dedicated bandwidth to each end point. Each end point is wired back to a concentrator (Ethernet switch, DSLAM, etc.). Concentrators typically have a Gigabit “uplink” that provides a connection back to centralized application servers and resources like streaming IP VOD servers, etc.

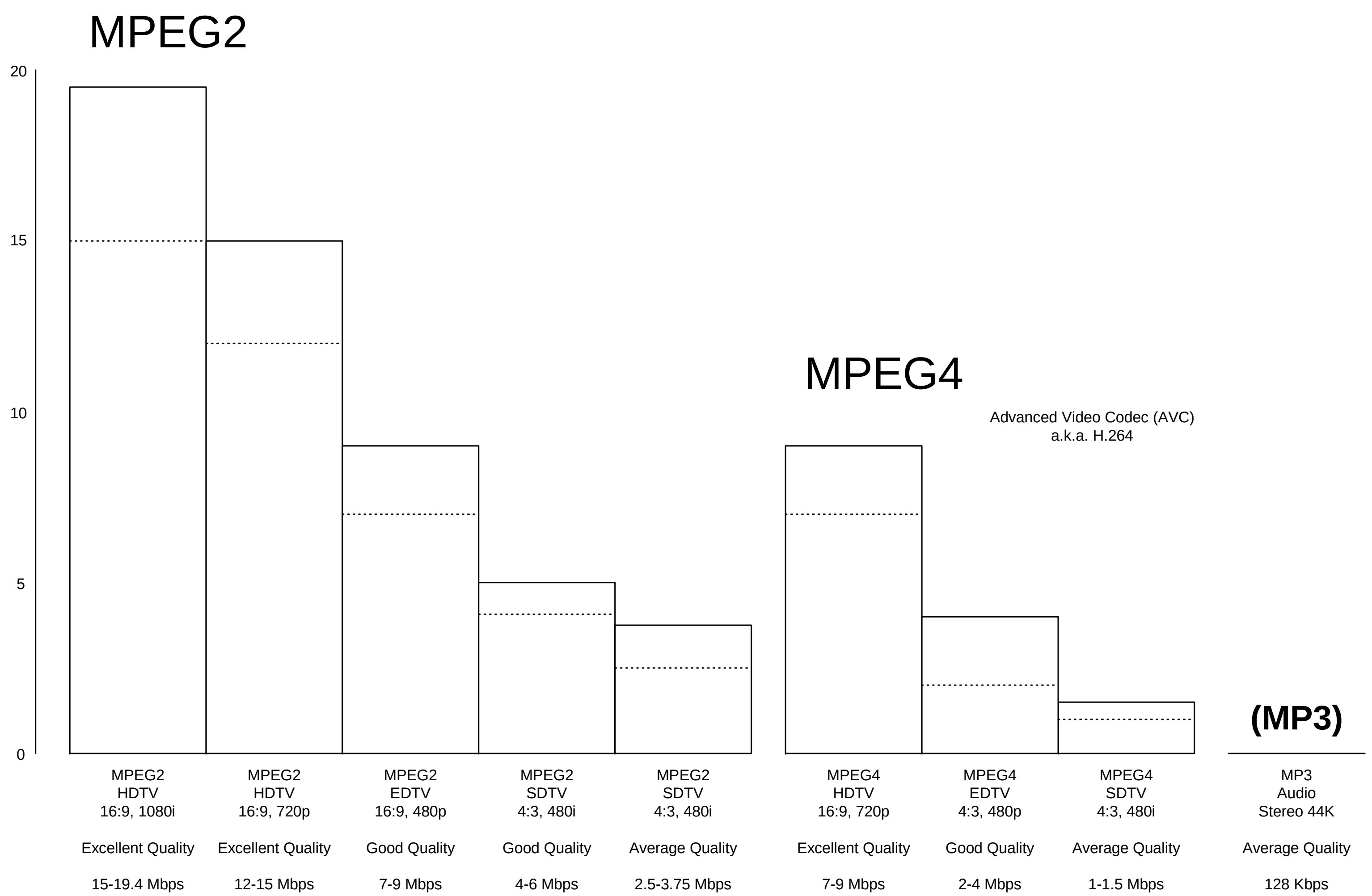
IP networks provide transport for digitized and packetized video using either a Multicast or a Unicast IP addressing method. Multicast allows multiple end points to “join” the transmission of a single multicast video stream, while a Unicast is destined for one and only one end point. Support for Multicast IP (and IGMP) is typically required in the network concentrator, and at the source server.

The charts below show the Bandwidth Requirements for Typical DTV Formats, and Bandwidth Capacities of IP Networks compared to the Bandwidth Requirements of DTV.

While most all of the common UTP network technologies can support VOD in virtually any CODEC format (MPEG2, MPEG4, WM9/VC-1), some of these networks may not support higher bit rate source content. For example, an ADSL network would not support an off-air HDTV program in MPEG2 format at 19.4Mbps.

Packetized video over IP is sensitive to network delays, called *jitter*. Therefore, the network infrastructure design must include proper attention to Quality of Service (QOS) factors. This is especially important when combining video with the transport of other voice and data applications using IP, for example, HSIA and IP Telephony.

Bandwidth Requirements for Typical DTV Formats



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Created: April 14, 2005
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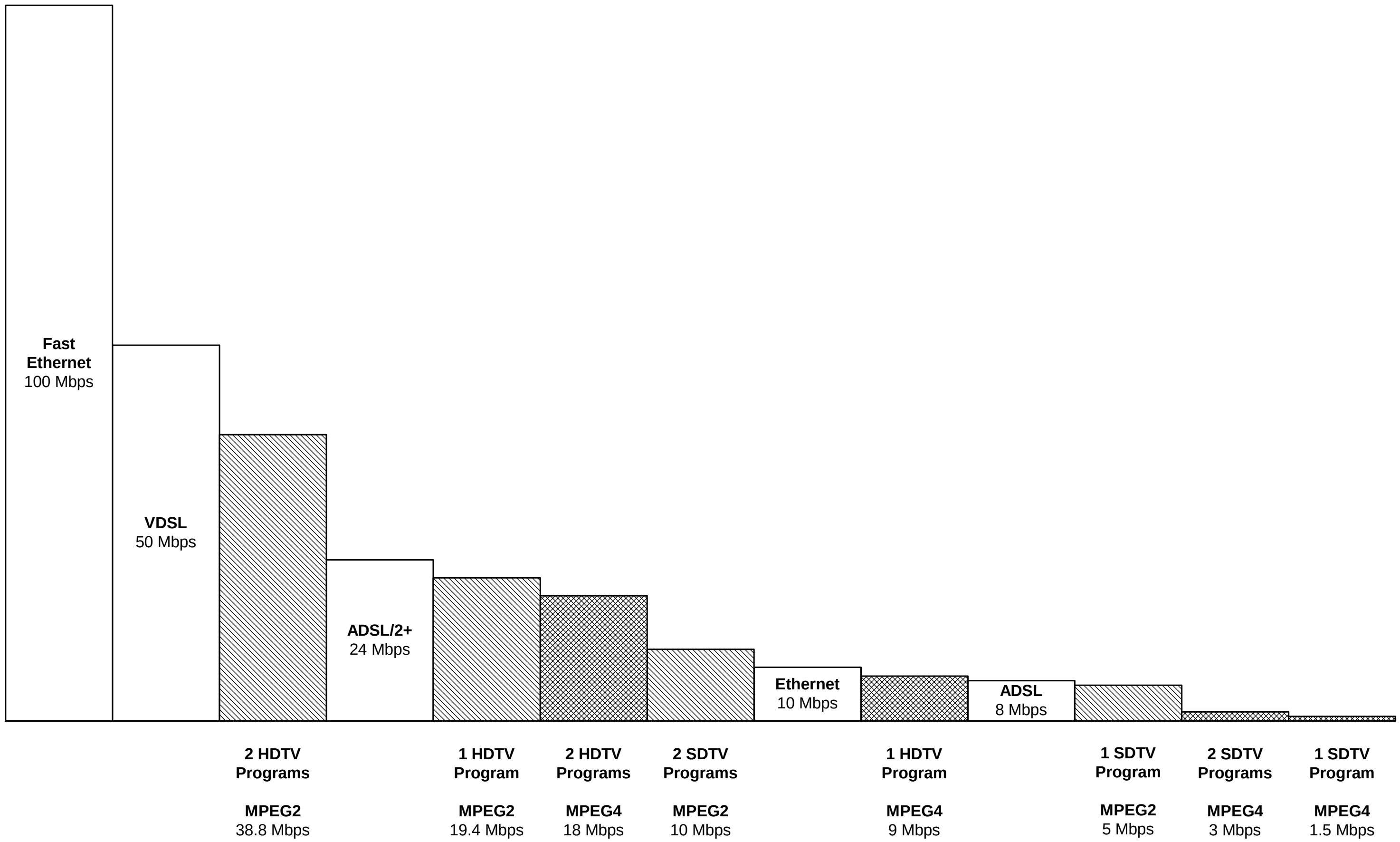
Bandwidth Capacity of IP Networks

Compared To

Bandwidth Requirements of DTV



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C. In-Room Infrastructure

In-room infrastructure for entertainment systems may include a television or other similar display device, remote control, keyboard, game controller, and Set Top Box (STB) that may be a stand-alone box or integrated within the television.

Televisions and display devices come in many shapes, styles, sizes, and types, but can generally be described by these key attributes:

- Aspect ratio – either 4:3 or 16:9 (the ratio of width to height)
- Display type – Traditional cathode-ray tube (CRT), Liquid Crystal Diode (LCD), Plasma, etc.
- Integrated electronics – tuner, decoder, or simply a display device.
- Analog or Digital – NTSC or ATSC

The Set Top Box is an important component of the in-room entertainment infrastructure. This device generally controls access to different applications presented by the entertainment system, and provides a means of two-way communication between the room and the head end. The STB may be an external stand-alone box – from the size of a mini-PC to the size of a book, or integrated inside the television, hidden from view for improved aesthetics.

D. Convergence Issues

There are several key issues to consider before the convergence of in-room entertainment systems can be fully realized, including bandwidth constraints, digital video formats, and security.

1. Bandwidth Constraints

As shown in the graphic above entitled “Bandwidth Capacity of IP Networks Compared to Bandwidth Requirements of DTV”, it takes a significant amount of dedicated bandwidth to carry most formats of digital television. As an example, it takes at least a VDSL network connection to carry two High Definition (HD) programs in MPEG2 format. If a hotel room has more than two televisions, it will take multiple VDSL network connections to service the room with digital video over an IP network.

2. Format Conversions

Many digital video source transmissions are not in an IP format when they arrive at the hotel. Therefore, these sources must be processed and translated. These processes are known as “transmodulation”, “transcoding”, or “real-time encoding”, and the devices that perform these processes can be very expensive. For example, in the case of terrestrial HDTV broadcasts in North America, the source format is MPEG2 at 19.4Mbps using 8VSB modulation. Depending on the type of IP network, this transmission must at the very least be “de-modulated” and “re-packetized” onto the network. Another example is a terrestrial analog broadcast in North America, where the source format is NTSC video using VSB modulation. This material must be run through a real-time encoder whose output is a digitized and packetized multicast IP transmission.

3. Security Issues

There are numerous issues related to security and content acquisition. Major Hollywood studios and other premium content providers demand their content be protected from theft. This adds to the overall cost of a converged system because it requires sophisticated conditional access and encryption techniques to ensure only those authorized to view material at a specific time and place are allowed.

The minimum requirements for these systems include physical security mechanism, like “security sleeves” on all connectors, Advanced Encryption Standard (AES-128), renewable and revocable keys and devices, and protected digital outputs like DVI with HDPC (or HDMI).

Finally, some content owners and broadcast rights owners have yet to give approval for the “retransmission” of their broadcasts or content into an IP format.

V. High Speed Internet Access

A. HSIA Overview

High Speed Internet Access (HSIA) systems provide guest access to the Internet through either wired or wireless connectivity, generally using the guest's laptop or other computer equipment.

B. System Components

1. Internet Subscriber Gateway Server

The Internet Subscriber Gateway Server is a system (which may be a hardware device or software application) that gives a hotel's guest access to the Internet without installing any software on their computer and without changing any of the existing settings. This true plug and play functionality permits the guest to connect to the hotel's guest network without reconfiguring their network or email settings.

From the hotelier's point of view, this system not only performs the plug and play magic, but also acts as the gateway to the Internet for their hotel guests. A robust system will handle hundreds of concurrent connections with ease. It will accommodate the various settings of customer computers without any changes to their system.

Some of the features to look for in a subscriber server system:

Authentication – Authentication is the process of validating an attempt to access the network, to ensure that only properly authorized (authenticated) people or systems are allowed access. Even if a property is planning to offer High Speed Internet Access service at no cost, it is still wise to require some method of authentication. By implementing some authentication mechanism, you can reserve your Internet services for your customers. Even simple authentication processes, such as handing out access code cards at the front desk during check-in, are very effective. Building authentication into the network from the start adds to network security and reliability, and simplifies the move to a fee-based network in the future.

Terms and Conditions – Any hotel offering Internet access should require users to accept a set of Terms and Conditions and Acceptable Use Policy before allowing access to the hotel's Internet connection. Otherwise, the property may be liable for any activities a client may perform while connected to the Internet.

Plug and Play – Guests should be able to connect their laptop computer to the local Internet connection without any changes to their system configuration. The Internet Gateway server should be capable of accommodating the guest laptop configuration without any changes. A true plug and play system will provide a better guest experience, increasing customer satisfaction while reducing calls to the hotel technical support team.

Walled Garden – A Walled Garden permits the local hotel to allow guests to use the service to connect to a limited selection of web sites without having to pay for the service. The hotel has complete control over which sites they will allow their guests to access without having to pay for service. The guest can try the service at no cost, and may in turn decide to pay to use the service to access other web sites not available within the Walled Garden. The hotel gains a potential source of revenue; the property may elect to charge local businesses to have their web sites included as part of the Walled Garden.

Billing – Some properties charge for access to the Internet. Hotels that charge for the Internet services may require direct posting to the guest folio. For example, the guest connects their computer to the network jack in their room. When he starts his web browser, the Internet server will display a web page that outlines the various service offerings and billing packages. Next, the guest selects the service offering, and gains Internet access while the Internet Subscriber Gateway Server posts the charges direct to his guest folio.

NOTE - Potential costs associated with billing to the guest folio: Some PMS vendors require that the hotel property purchase an additional interface from the PMS vendor before they can connect the Internet Server.

Billing (Credit Card) – In some hotel networks, there may be no easy method to determine the guest location when they attempt to access the Internet (for instance, when using a wireless Internet connection). In these cases, the hotel can opt to use a credit card authorization and billing service. The guest responds to prompts for their credit card credentials and once authorized, is allowed Internet access. This is a secure transaction, with only encrypted data sent between the client's computer and the credit card servers.

NOTE – Potential costs associated with billing to a credit card: All credit card authentication services will require that the hotel or property management company have an Internet Merchant Account. The Internet server may require a digitally signed certificate for enhanced security to protect guest credit card information.

2. Enhanced Services

Some Internet servers offer additional functionality and features not found in the basic systems. These features allow the property to offer greater security and flexibility to their guests using the service.

Bandwidth Control – Bandwidth Control presents each guest with various options on how much network bandwidth they would like to reserve. Guests that will be using the service for Internet applications requiring high bandwidth (e.g., file downloads) may opt to upgrade their service to a larger amount of bandwidth. This will enable them to download files at a faster rate.

VPNs – While traveling, many business travelers connect back to their enterprise networks using secure software called a Virtual Private Network (VPN). A VPN establishes a secure network path from the guest laptop to their corporate network over the Internet. There are a number of different VPN protocols. As a minimum, the Internet Server must be able to handle PPTP, IPSec and SSL VPN clients.

IP addresses – The Internet Server must be able to offer different types of IP address schemes to the guests. Most guests are unaware of the very existence of IP addresses. They merely want to be able to connect to the Internet and run their applications. In the case of VPN clients, the Internet server should be able to offer both public and private IP addresses.

Network Security and Intrusion Detection – The Internet server should offer a method to track and detect users that may be attempting to access or attack other computers within your network, or detect a computer attempting to spread a worm or virus on the local network or Internet. The Intrusion Detection System (IDS) should flag these user's computers and act accordingly. In some cases, blocking the user's computer from further network access protects the rest of your guests and further prevents the spread of a virus to other computers in the network.

3. In-Hotel Network

The in-hotel network can use various technologies to deliver the network services to the guest room, common areas and meeting rooms. The first thing to ensure is that the technology offers some means of securing the guest traffic from being viewed, collected, or modified by other network users.

a. Wired Solutions

There are several wired alternatives to provide High Speed Internet Access (HSIA) infrastructure. The most common ones are dedicated Category 5 or greater Unshielded Twisted Pair (UTP) cable, Digital Subscriber Line (DSL) modems over existing phone lines or using Category 3 or greater UTP cable, Cable modems over coaxial cable, and fiber optic cable.

Dedicated UTP – Providing Ethernet over dedicated UTP requires at least Category 5 cable with four pairs of wire in the cable. The wire standard is EIA/TIA 568A, which sets the minimum requirements for cable. Category 5 is the most prominent but only supports Ethernet speeds up to 100 Mbps. For new installations, it is recommended to use Category 5E (E for Enhanced) or Category 6, both which supports Ethernet speeds up to 1000 Mbps (or Gigabit Ethernet).

The guest plugs directly into a wall port or a cable provided on the desk. This is a dedicated connection back to an Intermediate Distribution Frame (IDR) or directly back to the Main Distribution Frame (MDF), where each cable plugs into an Ethernet switch. This switch must have an uplink connection to an upstream switch (also called the core switch) and ultimately to the Internet subscriber gateway server.

This access method can produce the most flexibility providing Ethernet services to the guest room but usually requires new, dedicated cable deployed throughout the property, resulting in a costly solution. The big advantage for this solution is the absence of any required equipment in the guest room. There is simply a wall outlet or an Ethernet cable provided for the guest to use.

DSL Modem – Providing Ethernet using DSL is a cost effective alternative. The big advantage to DSL is its ability to use the existing phone lines on the property as long as the cable is at least Category 3 UTP or greater. The components for a DSL solution require a DSL Access Multiplexer (DSLAM), usually located in the main equipment room, and a compatible DSL modem located in each guest room. Deploying DSL over the existing phone line infrastructure requires the installation of Plain Old Telephone System (POTS) splitters at the DSLAM, and the installation of POTS filters for each phone in every guest room. The installation of the DSL modem and filter requires some forethought since the access to the modem must be obvious, while maintaining a certain level of security of the equipment.

There are many different types of DSL service. The most commonly deployed in the hospitality industry and for business and residential applications is Asymmetrical Digital Subscriber Line (ADSL). Asymmetrical refers to the differing transmit and receive speeds on the line. Standards-based ADSL is capable of achieving 8 Mbps downstream (towards the guest room) and 1 Mbps upstream (towards the Internet). The newest ADSL standard as of this writing is ADSL2+ and it is capable of achieving speeds of 24 Mbps downstream and 3 Mbps upstream. There are several other types of standards-based and proprietary DSL services including VDSL, VDSK2, etc., but ADSL is the most prevalent.

Cable Modem – Providing Ethernet using Cable Modems is very similar to the DSL alternative described above. The cable modem network operates on the existing coax television wiring in the property and uses the CableLab's standard Data Over Cable Service Interface Specification (DOCSIS) to offer the network services. Use of cable modem technology eliminates the need to install new wiring to offer Internet service to the guest or meeting rooms and therefore can be a very cost effective solution.

The DOCSIS standard specifies downstream traffic transfer rates up to 36 Mbps, and upstream traffic transfer rates up to10 Mbps. Because data over cable travels on a shared loop, individuals will see transfer rates drop as more users access the network simultaneously.

Similar to the DSL solution, the cable modem requires a splitter, which is placed on the coaxial cable before the television. The cable modem must be located in an easy place for the guest to reach. A Cable Modem Termination System (CMTS) is usually located in the

MDF or cable head-end and connects directly to the Internet subscriber gateway server. The CMTS communicates to and manages all of the cable modems.

Coaxial Cable – Providing Ethernet over coaxial cabling is very similar to the cable modem solution. These are non-standard technologies offering similar functionality to DOCSIS cable modems. This emerging technology offers network services on a coaxial cable at a lower cost. They use small in-room devices that connect to the coaxial cable in the guest room and transmit network traffic using the Coax cable. A control unit in the MDF manages and communicates with the in-room units.

Fiber Cable – providing Ethernet over fiber optic cable requires dedicated fiber from the MDF or an IDF. The fiber multiplexer in the equipment room connects an upstream switch (sometimes called a core switch) to the Internet subscriber gateway server. There will be a media converter located in each guest room or conference room with the common RJ45 Ethernet interface connection. The guest connection for the media converter must provide easy guest access.

The advantage of fiber is the virtually unlimited bandwidth potential. Most fiber devices operate at 1 Gbps to 10 Gbps. Fiber cable is not susceptible to electrical interference like copper cable due to its optical nature. However, running fiber cable throughout a property can be very expensive.

b. Wireless Solutions

Wireless 802.11B at 11mbps and 802.11g at 54mbps, or Wi-Fi has become very popular among business and recreational travelers. Intel's Centrino advertising campaign is one of many reasons that wireless data communication has become so popular. Many hotels that installed a wired Internet access solution early on also found it practical to add wireless Internet access later. Travelers like the convenience of a wireless connection while using their laptop. Wireless connectivity eliminates the end user having to carry cables, or find the RJ45 jack that is often under desks. Instead, it allows them to use their laptop to access the Internet or corporate VPN anywhere in their room, in a restaurant, by the pool, or elsewhere in the hotel or resort.

4. Network Security

a. Required security features

User-to-user security feature – User-to-user security is required at several layers of the installation, beginning at the Wireless Access Point. The wireless user-to-user security features mean that one user cannot use the wireless connection as a media to access another user. Equipment vendors call this a variety of names, such as Public Secure Packet Forwarding, Intracell blocking, and disabled wireless bridging. All accomplish the same thing; a user's MAC address may enter the wireless port, but not exit the same wireless port to access another user. Filters on the port to allow the users to enter the wireless port and go upstream toward the Internet, but not enter and exit the same port. The user-to-user feature is required for Internet access but does not replace the need for a host-based software firewall on end users laptops.

Association status feature – Association status should be visible from a graphical web interface. This allows support personnel to access the wireless access point and help end users by viewing their association status and association process. The GUI interface should allow support staff to clear the end user.

b. Recommended security features

Multiple SSIDs allow the property to designate SSIDs for separate functionality. These SSIDs and their associated VLANs can serve as extensions of the hotels' network for various applications' connectivity to the hotels' network if properly designed. Each SSID should be capable of providing security levels independent of other SSIDs. For instance, SSID "Guest" may be broadcast to all users and not require any authentication, while SSID "hotel-private" may require 802.1 x authentications to a RADIUS server to access the media and require 128 or 256 bit encryption of all packets transmitted across the network.

Multiple VLANs are another feature of securely converged networks and should allow association of separate SSIDs and permit separate security levels. Each VLAN provides a broadcast domain for users within the VLAN, with access to other VLANs possible only through a router. The router may filter or permit interaction with other VLANs or networks as needed, providing another layer of security for users.

Quality of Service (QoS) – With separate SSIDs / VLANs providing separate logical networks on the same wireless LAN, QoS provides a guaranteed service level for each application associated to a SSID / VLAN. For example, a wireless 802.11b phone on a wireless LAN requires proper QoS settings to reserve needed bandwidth and provide proper prioritization to allow the phone to work properly. This guarantees that one user or application cannot monopolize bandwidth.

Applications such as voice require a priority status of sending data and a reserved bandwidth to operate on a network properly. Meeting minimum bandwidth requirements and staying within maximum delay thresholds allow some data types, such as WWW and FTP, to operate effectively with delay.

802.1q Trunking – This is another recommended feature. Although many different proprietary trunking systems exist, 802.1q is an open standard that interoperates with many vendors' 10/100 Ethernet switches. An open standard, 802.1q also supports QoS via the 802.1p specification.

Variable transmit power output – Wireless coverage may sometimes be covered by a single access point, but better results occur if the power is reduced on the access point and the cell is covered by two or more access points. This is the case where a large number of users will be using the wireless LAN. Evenly distributing a large number of users across several access points result in a better user experience for all users.

Auditing features – All access-points should have logging capabilities. This permits seeing users trying to abuse or attack the system. Alerts may be set to inform the administrator of the system that an intrusion might be taking place, such as a certain number of wrong passwords entered by someone trying to access the equipment. Auditing authentication to a private SSID / VLAN by reviewing logs on a RADIUS server or TACACS server used for authentication of private VLAN users.

c. Wireless Security requirements and audits

To reduce costs, some hotels install wireless networks for the guest network. Access points (WAPs) are installed in locations throughout the property. Guests of the property use a wireless network card on their laptop to access the Internet. The guests can work in their room or in the pubic areas with the same connection to the Internet.

The wireless network installed in a property provides multiple services throughout the property. Through the use of Virtual LANs (VLANs), and SSIDs on the access points, the guest network can be set as a public network. Other departments within the property infrastructure can use the same AP's, with their network traffic directed to a different segment of the network.

Although there is great flexibility in this network installation, there are security concerns. In a public wireless network, the network hardware configuration must minimize the possibility that another user can view another guest's network packets. Guests should be encouraged to install personal firewalls, ensure that all file sharing applications are disabled, and that they use a VPN to connect to their corporate network.

In a wireless network, the wireless network access is available wherever there is a network signal. This means that the network connectivity is not limited to the inside of the physical structure but is also accessible outside the building. It is extremely important to provide some means of authentication (access card) when implementing a wireless network solution.

C. Guest Room Needs

The guest room should include all equipment for a guest to connect to the Internet. In the case of a wired Internet server, the desk should have a clearly labeled Internet connection, which should provide simple instructions for connecting to the system, reaching the Internet, and getting additional support. Typically, the guest connects their network cable to a small desktop device resembling a brick or puck. Network cables should be available from the front desk or in the guest room. Additional power plugs must be available to connect the guest computer, and should also be conveniently located on the desktop.

D. Conference Room Needs

In properties that offer Internet service in the conference rooms, the Internet server must be able to differentiate that the connections are coming from the different meeting rooms and from guest rooms. Most hotel properties apply different business rules to the Internet connection in meeting rooms vs. guest rooms. The meeting rooms normally use a model where there is a flat fee charged for the room that gives all participants of the event access to the Internet by use of access codes.

There must be adequate network and power connections to address the number of participants in a meeting room. The meeting room Internet connection may require more bandwidth to handle a large number of users concurrently accessing the Internet.

E. Hotel Back Office Needs

The hotel back office and corporate network may run on the same physical network as the guest network, but this traffic should be segregated from guest network traffic to ensure security and reliability. Proper network configuration guarantees that the two networks are completely separate. This is accomplished with standard network hardware such as firewalls, and with the use of Virtual LANs (VLANs) to provide separation between guest and corporate network traffic.

Back Office network traffic needs to be considered when planning the network, in particular to assure that the Internet connection provides enough bandwidth to serve both back office users and applications, as well as guests.

F. Bandwidth Requirements

Most hotel properties offer the same level of bandwidth to all the rooms in the property. The challenge with implementing this form of network is that a single user or group of users can consume all of the available network bandwidth (downloading large files, movies, sharing music). This limits the amount of bandwidth available for other guests. One method of preventing users from consuming all the available bandwidth is to provide a means of bandwidth limiting. Some Internet Gateway systems can be configured to limit the amount of bandwidth that any single network user can consume.

Meeting rooms usually have multiple computers connected to the Internet. In the meeting rooms, network speeds between 512 Kbytes to 1 Megabyte per second are appropriate. These values can be adjusted based on the number of participants in a meeting and the applications they will be running. Video conferencing applications require higher and dedicated bandwidth.

G. Internet Connectivity

An Internet Service Provider (ISP) provides the wide area network connections that give the hotel access to the Internet. There are several physical and logical alternatives; the right choice depends on bandwidth requirements, available services, and cost.

The main physical access alternatives are Digital Subscriber Line (DSL), DOCSIS Cable Modem, Fractional T1 (FT1), Full T1, Satellite, Fixed Wireless, Fractional T3 (FT3), and Full T3. The logical access alternatives include Ethernet, Point-to-Point Protocol (PPP), Frame Relay, and Asynchronous Transfer Mode (ATM).

Ethernet is the dominant protocol used by local and wide area networks. Point-to-Point Protocol (PPP), Multilink PPP (MLPPP), Frame Relay, and ATM are protocols used to encapsulate Ethernet data and send it over a Time Division Multiplexer (TDM) access facility. All of these protocols arrive from the service provider and usually connect to a router, switch or other equipment within the hotel with the appropriate interface.

1. Digital Subscriber Line (DSL)

DSL service can provide Ethernet or Time Division Multiplexed (TDM) access to the property. Many different types of DSL services are available on the market today but selection will depend on the products offered by local service providers. Typically, businesses choose Symmetrical DSL (SDSL) service or Symmetrical High-bit-rate DSL (SHDSL or sometimes called G.SHDSL or G.991.2) service which can provide downstream and upstream speeds up to 2.3 Mbps (or 5.7 Mbps the proposed SHDSL.bis (G.994.1) standard). SDSL and SHDSL can provide Ethernet or TDM access depending on the vendor equipment.

If the property's Internet access requirements are limited to guest and office access then a high upstream speed will not be necessary and the more common Asymmetrical DSL (ADSL) service will meet their needs. Asymmetrical refers to the differing transmit and receive speeds on the line. Standards based ADSL is capable of achieving 8 Mbps downstream (towards the property) and about 1 Mbps upstream (towards the Internet). The newest ADSL standard as of this writing is ADSL2+ and it is capable of achieving speeds of 24 Mbps downstream and 3 Mbps upstream. Standard ADSL has the largest install base but ADSL2+ has started replacing this older service.

The DSL service is delivered over one or more pair of copper wires. It is very distance sensitive and the maximum attainable speeds depend on distance from the ISP's local facility and the type of DSL service. DSL services can be as low as 32 Kbps, or greater than 50 Mbps, when bonding several lines together. The ADSL technology can actually use an existing phone line that is providing Plain Old Telephone Service (POTS). All of the other DSL technologies require a separate cable pair for the service. The DSL service terminates into a DSL modem, typically located in the Main Distribution Frame (MDF) at the property. The DSL modem provides Ethernet connectivity using wired, wireless, or both types of access. The modem can operate as an Ethernet switch but some modems can include multiple Ethernet ports, wired and / or wireless access, and router functions. The most common application has the DSL modem functioning as a switch and connecting directly into a gateway server at the property.

2. Digital Cable

Cable television companies began offering Internet access over their coaxial cable infrastructure several years ago and this service has grown quickly. Coaxial cable has higher bandwidth over longer distances than DSL services. The Data over Cable Service Interface Specification (DOCSIS) standard specifies downstream traffic transfer rates between 5 and 36 Mbps, and upstream traffic transfer rates between 320 Kbps and 10 Mbps. Because data over cable travels on a shared loop, individuals will see transfer rates drop as more users access the network simultaneously.

Providing Ethernet using Cable Modems is very similar to the DSL alternative described above. The cable modem network operates on the existing cable television wiring to the property and terminates on a cable modem. The modem usually operates as an Ethernet switch and connects directly into the gateway server. Some cable modems can provide both wired and wireless connections as well as support router functions.

3. T1, FT1, T3 and FT3

Before the days of Cable and DSL Internet services, the main method for high-speed data access to another site or to the Internet was using T1 (also known as DS-1) or T3 (also known as DS-3) facilities. The full T1 bandwidth is about 1.5 Mbps while the full T3 bandwidth is about 45 Mbps. Service providers also offer Fractional T1 and Fractional T3 services for those properties not requiring the full bandwidth.

Traditional T-type services usually connect directly into a router or a switch. These services make logical connections to the service provider using PPP or ATM protocols between the equipment at the property and the equipment at the service provider. Properties requiring more bandwidth than a T1, but not enough to justify a FT3, can choose to bond two or more T1 lines. For the PPP protocol, it is Multilink PPP (MLPPP) and for ATM it is Inverse Multiplexing over ATM (IMA). MLPPP and IMA are both standards and should work in a multi-vendor environment. As the market moves away from ATM based services, PPP and MLPPP are becoming more common service types as compared to T1 and T3 facilities.

4. Satellite

Satellite technology presents another way to deliver Internet service to the hotel. It is an effective alternative; the question is no longer "Will it work?" but rather "How do I use it?" Effective use of the technology requires an understanding of the capabilities of satellite networks, as well as the satellites' themselves. This is a key design element since every link within a common footprint must pass through the satellite itself.

Satellite network solutions are available today at lower costs due to advances in VSAT DAMA (Very Small Aperture Terminal - Demand Assigned Multiple Access) combined with improved satellite network technology. Satellite terminal designs and digital signal processing provide an efficient medium to integrate multiple applications (voice, video and data). VSAT DAMA reduces operational costs by lowering satellite lease costs due to more efficient use of bandwidth. Only the required bandwidth is allocated leaving the unused bandwidth available for other users. BOD (Bandwidth on Demand) increases or decreases bandwidth allocated to a connection depending on network traffic load.

A typical DAMA network usually consists of a hub with a large antenna and several VSAT nodes (remote sites with small to medium antenna). Each hub has two major subsystems, a network management system and a system to manage user traffic. Topology configurations include mesh, star or possibly a hybrid combination of both. A mesh configuration allows the VSAT nodes to communicate with each other via a single relay link "single-hop" through the satellite.

This single hop reduces the time lag between the sending and receipt of traffic. In a star topology, all traffic is routed via the central hub station. This type of configuration is desired when a large amount of the traffic terminates at a designated earth station. Satellite network designers will consider connection requirements and anticipated applications when recommending the best topology for a particular application. One advantage of this technology is the scalability of this type of network. The network expands easily, by adding low cost remote terminals. In addition, wide geographic coverage areas still allow centralized control and management.

5. Fixed Wireless (WiMAX)

The term WiMAX (Worldwide Interoperability for Microwave Access) has become synonymous with the IEEE 802.16 Wireless Metropolitan Area Network (MAN) air interface standard. In its original release, the 802.16 standard addressed applications in licensed bands in the 10 to 66 GHz frequency range. Subsequent amendments have extended the 802.16 air interface standard to cover non-line of sight (NLOS) applications in licensed and unlicensed bands in the 2 to 11 GHz frequency range. Filling the gap between Wireless LANs and wide area networks, WiMAX-compliant systems will provide a cost-effective fixed wireless alternative to conventional wire-line DSL and cable in areas where those technologies are readily available. More importantly, WiMAX technology can provide a cost-effective broadband access solution in areas beyond the reach of DSL and cable. The ongoing evolution of IEEE 802.16 will expand the standard to address mobile applications thus enabling broadband access directly to WiMAX-enabled portable devices ranging from smart phones and PDAs to notebook and laptop computers. WiMAX is capable of attaining speeds around 250 Mbps but most services provide speeds of 1 Mbps to 10 Mbps.

VI. IP Telephony and Messaging Systems

A. Overview

The IP Telephony and Messaging system is a group of devices that utilize open, industry standard IP-based protocols to provide telephony and messaging capabilities for hotel guests and staff. The system supports IP-based signaling and media protocols between all system components allowing deployment in a wide range of cable plants. Other applications may share this physical network. These applications include wired and wireless HSIA, entertainment, building and property management systems, staff operations and so forth.

The system is comprised of a number of components that interoperate using IP-based protocols – call control, messaging platforms, application servers, telephones and gateways. Gateways interface to traditional devices such as analog and digital handsets, wired and wireless IP-based handsets, as well as the PSTN. Support for integrated voice and data communications provides for new and exciting means of integrated messaging. These include access to voicemail, email and fax from a single endpoint. Integrated support for IP and web based communications offers an open environment for development of new services such as access to hotel staff, group or event messaging, in-room dining, entertainment system control, wake-up services, environmental system control and more.

B. Features and Benefits

The IP Telephony and Messaging system offers a number of features and benefits to both hotel guests and hotel staff:

- The use of IP-based communications allows the system deployment over a converged infrastructure, a single in-house cable plant that supports data, voice and video communications. This results in significant capital and operational savings.
- The use of industry standard signaling and media protocols results in open interfaces between the components. This flexibility allows an integrated solution made of components from many possible vendors.

- The use of IP-based interfaces relaxes the needs to co-locate system components, which results in a wide range of possible deployment scenarios.
- Tight integration with traditional PBX systems results in a wide range of migration and / or coexistence possibilities.
- Support for enhanced IP and web based services improves guest and staff productivity, reduces the number of devices that need to be installed and maintained, and improves the overall guest and staff user experience.
- Support for wired and wireless handsets improves guest and staff productivity.
- Tight integration of numerous messaging capabilities (voicemail, email, fax, group / event messaging, targeted advertising, and instant messaging) creates new and far-reaching ways to communicate for guests and staff.

C. Use Cases

System capabilities offer a wide range of possible uses. The system certainly offers the capabilities to communicate in the same way as existing systems – calling guest-to-guest and guest-to-staff, inbound and outbound dialing to the PSTN, support for single-line and multi-line phones, as well as features like hold, conference and transfer functions. The real power of the system is in its potential to support new communication applications. The following are a few examples:

- Welcome messaging – The system can post a welcome message to IP-based phones instructing the guest to access key services. Upon checking in and entering the room, the guest would see the welcome message and select a soft key on the phone. The phone would present a series of customizable services, allowing flexible messages for each property, guest or event.
- Unified messaging – The system supports access to voicemail, email and faxes in an integrated inbox. Either the phone or the entertainment system provides access to the message repository. The phone's handset or speaker plays voicemail messages and emails and faxes can be reviewed on the screen. In addition, hard copies of emails or faxes can be requested from the phone or entertainment system.
- In-room dining – The phone supports the ability to review an online menu and select items to be delivered to the room. The restaurant staff receives guest selections

through an IP and / or web-based application server. The server is capable of forwarding the selections in any format supported by the staff – hardcopy, email, text messaging and so on.

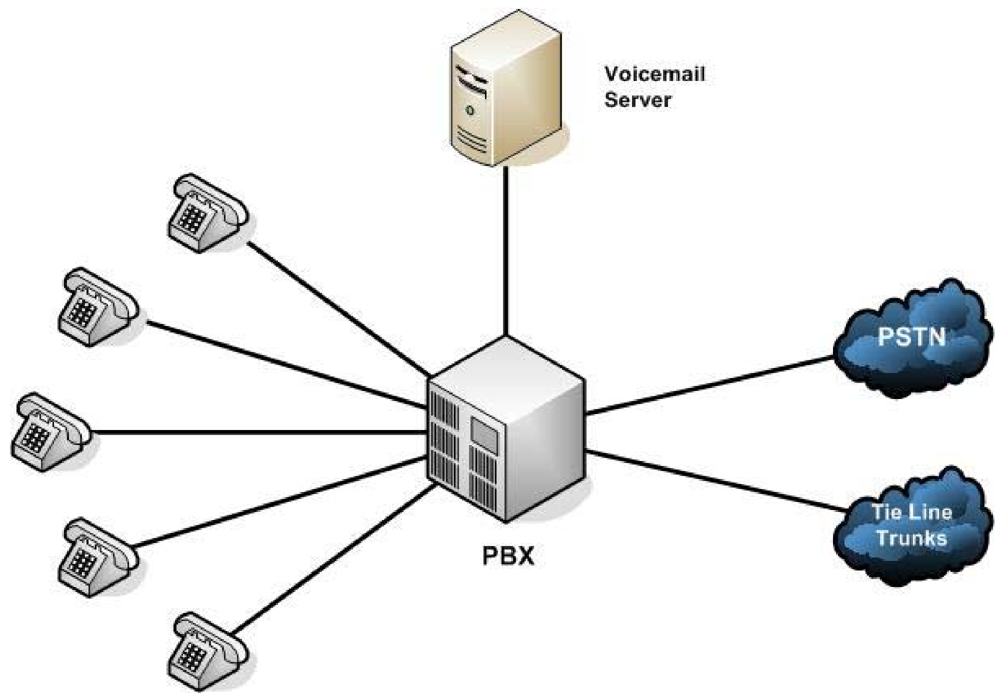
- Restaurant reservations – The phone supports the ability to review an online restaurant guide and place a call to a restaurant of choice. The phone can display key information on the restaurant such as theme, atmosphere, key menu selections, opening and closing hours and so forth.
- Group / event directory – The system supports the ability to provide a customized guest directory limited to the members of a group or event. The directory hides certain information such as specific extension and / or room number and provides one-touch dialing to fellow group members.
- Event, group and / or property messaging – The system supports the ability to push messaging to phones during idle activity. This information may include certain alerts, property advertising and / or group and event messaging.
- Automated wake-up service – The system supports the ability to arrange an automated wake-up event. From the phone, the guest can select a wake-up time and method (e.g., ring the bedside phone, bring up the lights to a certain level, tune the television or entertainment system to a certain station).
- Automated turn-down service – The system supports the ability to arrange turning-down the room from the phone. From the phone, the guest can select to dim the lights, close the drapes or enable a sleep timer on the entertainment system and the like.
- In-room controller – The system supports the ability to control in-room systems (entertainment, environmental systems, drapes, door locks, etc.) from the phone. Multiple preferences combined into a single profile allow setting multiple systems with a single selection.
- Guest alerts – The system supports the ability to post one-time or yes / no instant messages to wired or wireless phones. This capability can be integrated into paging and instant messaging services.

D. System Components

The IP Communications and Messaging subsystem includes a number of key components. Before exploring these components, an understanding of the basics of traditional telephony systems and IP Telephony systems must exist.

1. Traditional Telephony System

The figure below shows a traditional basic telephony system.



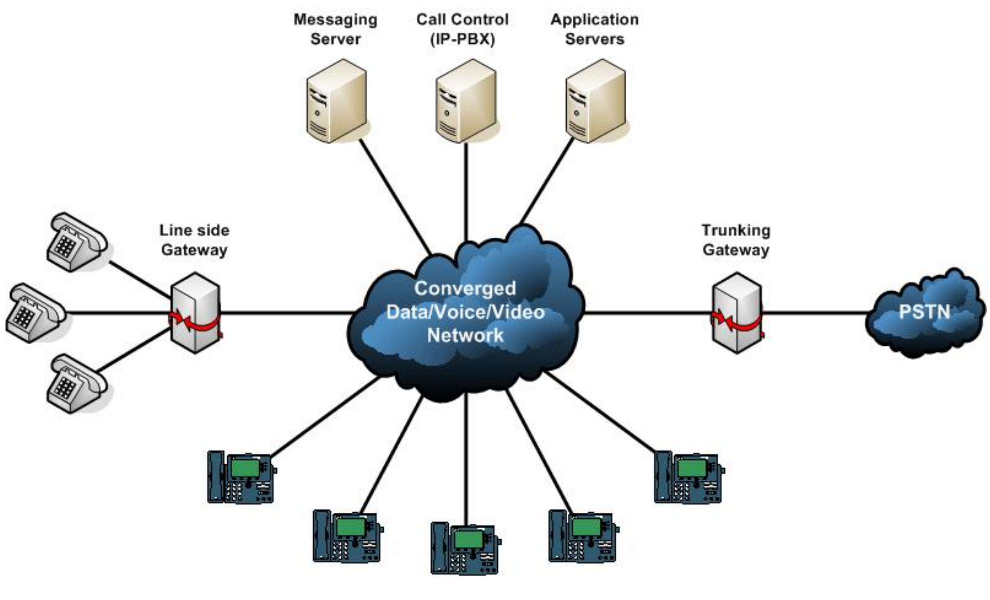
Traditional telephony systems include three basic components:

- Telephones – Guests use telephones to make phone calls as well as a number of other functions, such as hosting conference calls and retrieving voicemail.
- Private Branch Exchange (PBX) – This is the electronic heart of the system. The PBX is the device that connects, redirects and modifies telephone calls.
- Voicemail – Voicemail systems save and retrieve voicemail messages as well as system and user greetings.

The infrastructure used to implement a traditional telephony system is unique and dedicated to telephone functions. Cabling between the phones, PBX, voicemail system and the PSTN are not shared with any other system, subsystem or business function. In addition, the interfaces between the phones, PBX and voicemail systems are specific to a particular vendor. In brief, traditional telephony is often a closed, monolithic system.

2. IP Telephony System

The figure below shows a basic IP Telephony and Messaging system.



IP-based voice communications and messaging systems include the following components:

- IP-based telephones – Like traditional phones, guests use these devices to make phone calls and for a number of other functions, such as hosting conference calls and retrieving voicemail.
- Call manager – This is the electronic heart of the system and is analogous to the PBX. However, it differs from the PBX in two important ways. First, the call manager is a software application that runs on a standard server. Second, it utilizes IP to interface to the rest of the components.
- Messaging platform – This system is roughly analogous to the traditional voicemail system. In its simplest form, it is the device where voicemail messages are stored and retrieved. It also provides additional capabilities such as unified messaging (single repository and retrieval of voicemail, email and fax), auto-attendant functions and presence-based communications.

- Application servers – These devices provide enhanced services to users and their telephones. These devices are often where IP-based voice and IP-based data services are integrated.
- Trunking gateways – These devices link the system to the traditional PSTN.
- Line-side gateways – These devices interface traditional telephony devices, such as analog telephones, to the IP-based system.

While both approaches share a number of common components and capabilities, the IP-based system offers significant benefits. As the name would suggest, the IP-based system interfaces are implemented using IP-based communications mechanisms. This takes full advantage of a converged infrastructure – a single shared in-house wired / wireless cabling system that supports voice, video and data communications. The use of the converged network represents significant capital and operational cost savings, now and in the future.

In addition, the use of IP communications allows the powerful integration of voice, video and data functions into a single device. Examples of this include the following:

- Access to IP or web based information repositories such as stock quotes, flight status, weather and news headlines.
- New integrated messaging capabilities such as advertising, targeted group or event messaging, text messaging and instant messaging as well as voicemail, email and fax retrieval.
- Powerful communication capabilities including one-touch dial from group or event directories, wireless service integration, video calling and conferencing as well as presence-based communications.
- Next generation application integration capabilities such as personalized wake-up services, property and restaurant reservations, video room-service menus, video and audio system control and customization of in-room controls.

Both the traditional and IP-based systems are implemented using two types of communications – control traffic and media traffic. Control traffic is the signaling that used to connect, redirect and modify voice and video calls as well as access information repositories and services. Vendors of IP-based systems use a wide range of standard and non-standard signaling mechanisms. Today, the standard mechanisms include H.323 developed by the International Telecommunications Union (ITU), Session Initiation Protocol

(SIP) developed by the Internet Engineering Task Force (IETF) and Media Gateway Control Protocol (MGCP) also developed by the IETF. Non-standard methods involve encapsulation of proprietary signaling protocols inside IP.

Media traffic transports voice and / or video streams across the network. Protocols like H.323, SIP and MGCP based systems use Real-time Transport Protocol (RTP) developed by the IETF to transport voice and video streams. Some systems that support non-standard signaling mechanisms use RTP. Control and media traffic require a stringent service level from the infrastructure to guarantee the user experience.

E. Infrastructure Requirements

IP-based voice communications and messaging systems require a particular service level to guarantee optimal user experience. This is because IP-based voice, video and data communications use very different profiles. IP-based data communications are asynchronous in nature. They assume the use of a shared network and include no guarantees of access to the network. Each endpoint has statistically the same chance of accessing the network and is able to send as much data as is available at any time. This results in bursts of data transmission.

The nature of the human eye and ear requires a very different traffic profile. Voice and video must be delivered synchronously – an equal amount of voice and video information must be delivered at each interval in time. If this is not maintained, humans will detect artifacts affecting the user experience. Examples of these artifacts for voice include echo, static, noise as well as others.

A number of useful design considerations provide a positive user experience:

- Use a switched network infrastructure – Switched architectures provide a certain level of performance to each endpoint independently as opposed to shared infrastructures, which provide no guarantees. This approach prevents any one endpoint from "hogging" the network and reduces the potential interference between endpoints.
- Design the network for zero packet loss – Packet loss results when too much information is destined to a congested network link. Make sure the size of each network link appropriately reflects the total amount of traffic routed across that link. In

addition, configure the infrastructure devices to use queuing techniques that prioritize voice and video traffic over data traffic. This protects voice and video from data bursts and allows data packets to be dropped before voice and video during link congestion.

- Guarantee end-to-end network delay is within a certain budget – Assure that the packet delay end-to-end for voice and video is well within certain limits. For example, the maximum delay for voice media is 150 milliseconds one-way and 250 milliseconds round-trip.
- Minimize end-to-end jitter – Jitter is the variance in delay across the network. It measures how synchronous the communications path is. Too much jitter results in loss of packets in the voice and video endpoints. For voice, keep jitter below 40 milliseconds.
- Secure the voice network – Isolating the voice and video traffic from the data traffic further minimizes the effects data traffic can have on voice and video performance. Virtual LANs (VLANs) are a first line of defense. However, the nature of network hackers, snooping, viruses and worms makes further isolating the voice and video networks a reality. Access Control Lists (ACL's), firewalls and intrusion detection systems are all techniques used to further isolate and protect voice and video communications.
- Use a highly available design – Users expect much higher availability from voice systems than data systems. This reality forces a much more highly available infrastructure. To accomplish this, the infrastructure must provide redundancy and failover of critical network and server components.

F. Deployment Models

The nature of IP-based communications allows a wide range of different deployment models. IP removes dependency on the location of components in the system. This holds true only to the extent that the performance of the resulting infrastructure is within the proper profile as discussed above.

Given that the possibilities are so diverse, discussion of all possible models are outside the scope of this paper. However, a number of examples should be explored. The models generally differ in the placement of the call control, messaging platform and application servers.

- Single-site model – In this model, each property includes all the components included in the system. Typically, call control, messaging and application systems are deployed in some central location such as the computer room or the main building distribution frame. Trunking gateways are located closest to the PSTN circuit termination, again the computer room or main building distribution frame. Line-side gateways are placed closest to the traditional telephony devices. They are most likely located in the guest rooms or some intermediate building wiring closet. Telephones (analog, digital or IP-based) are deployed closest to the users – in the guest rooms or in staff workspaces. All systems connect with the in-house wired and / or wireless LAN.
- Distributed model – This model is typically reserved for large, multi-site campuses. In this model, the system is comprised of a number of distinct single-site deployments as discussed above. Voice and video services are provided locally. Sites are interconnected via a highly available LAN, MAN or WAN which is typically used to transport inter-site communications and services.
- Centralized model – This model is also typically reserved for large, multi-site campuses. It is also used to provide services to multiple geographically dispersed facilities. In this model, call control, messaging and application systems are deployed in central data centers. High availability is provided using redundant platforms. Trunking gateways at each location meet the requirements for emergency services. Telephones and line-side gateways are distributed locally.

Individual properties connect to the central data centers using a managed WAN service. In addition, the WAN can be used to route communications between properties. It is also possible to use the WAN to support a toll-bypass network for off-net communications.

- Managed service model – Properties have historically used managed services for access to the Internet and virtual private network services. Increasingly, service providers are providing managed IP-based voice services. In this model, call control, messaging and voice application services are within the administrative domain. The systems that provide these services are often deployed within the service provider's footprint.

Properties connect to the managed service using a managed router located on-site. Trunking gateways typically integrate into the managed router. Telephones and line-side gateways connect to the service over a managed LAN or are installed and maintained within the administrative domain of the property. The managed service also typically provides inter-site and toll-bypass voice services.

The IP communications system also interfaces with a number of back-office functions. The functions may include property management, guest billing, HSIA and building management based on the capabilities required. A voice application server that supports a gateway between the phones, line-side gateways and the particular back-end systems typically provides the interface.

All of the deployment models require interfaces to the IP-based and traditional phones. IP-based phones require LAN switch ports. For hotel staff, these ports are typically located on wall jacks within each workspace. In the guest room, the phones connect to a LAN switch located somewhere in the room or in the nearest wiring closet. IP-based phones connect to the network using Category 5, 6 or 7 unshielded twisted pair (UTP) cables. Traditional analog and digital phones connect to the line-side gateways located in the nearest wiring closet. Traditional phones connect to the gateways using four-pair Category 3 cabling.

G. Migration Guidelines

The transition from a traditional PBX-based communications system to an IP-based system typically follows one of two schemes – a phased migration or a flash cutover. Neither method is right or wrong; they depend on individual properties' circumstances and preferences to determine which scheme is most suitable.

Phased Migration – The phased migration approach entails connecting the IP-based system to the PBX using trunk interfaces on the PBX. A trunking gateway connected to the PBX forms the connection with the IP-based components. Evaluating the capabilities of the IP-based system and the PBX, required features and functionality, and implementation costs, leads to the best choice of signaling method for a particular application.

Extensions are migrated from the PBX to the IP-based system in phases, one group at a time. All extensions within the affected group are identified and deleted from the PBX. Entries added to the routing table in the PBX enable routing of inbound calls to these extensions across the trunks connected to the trunking gateway. New extensions are added to the IP-based system, new phones and / or line-side gateways are deployed and the process is repeated until all endpoints are migrated. At that point, the PSTN trunks can be moved to the trunking gateways and the PBX can be decommissioned.

Flash Cutover – The flash cutover approach involves complete deployment of the IP-based system along side of the existing system. All IP phones and line-side gateways are fully configured and deployed. Outbound PSTN trunks are connected to the trunking gateways for the purposes of calling externally and internally. All internal calls remain routed to the PBX. Subscribers will have both PBX-based and IP-based phones throughout the transition period.

With the full deployment of the IP-based system, the new system can be brought online by transferring the inbound PSTN trunks to the trunking gateways. The PBX remains in place until testing of the new IP-based system is complete. At that point, the PBX can be decommissioned.

The flash cutover approach offers the following advantages:

- Reversion to the PBX-based system requires only moving the inbound PSTN trunks from the trunking gateways and back to the PBX.
- Configuration and operation of the IP-based system can be accomplished without requiring it to carry live traffic.
- Training can be accomplished at a more leisurely pace. Users may explore the new phone capabilities at their own leisure prior to cutover of the inbound trunks.
- No special provisions are needed for “communities of interest”. The phased approach requires maintaining the integrity of certain functions such as call pickup groups, hunt lists, shared lines and so forth.

The requirement of a full IP-based system deployment is the main disadvantage of the flash cutover method. In the phased migration, components may be deployed incrementally, as required. This also allows migrating to a full system from a small pilot over time.

H. Future Directions

The future of IP Telephony and Messaging is quite bright. The technology has been proven reliable in many real-world production deployments. Many vendors offer useful new integrated messaging solutions based on the technology. IP Telephony systems offer a wide range of features and capabilities to users. Messaging platforms go well beyond simple voice mail capabilities to offer integration with other messaging systems such as Email, Fax, Paging, Text Messaging and Instant Messaging. In addition, the work continues to enhance the technology in ways that offer completely new ways to communicate and collaborate.

A survey of the current market shows three interesting trends:

- Businesses are increasingly turning to IP Telephony. The Synergy Research Group estimates that roughly one-third of PBX lines are now IP-based, up from less than 20% in 2003. This adoption rate is expected to increase to nearly 50% by the end of 2005. Industry analysts state that the transition to IP from TDM is akin to the transition from analog to digital. It is not a question of if, but when.
- Service providers are making the transition to IP Telephony. Early adopters sought the benefits of toll bypass, particularly for international calling. Some providers also offer hosted IP Telephony services such as hosted basic phone service and outsourced call center services.
- Recently, IP Telephony services began to reach into the home through traditional telephony providers such as Verizon or AT&T, independent providers such as Vonage and a wide range of cable operators.

Over the next few years, most of the activity may well center around the following:

- Standards – There have been a number of different protocols connected to IP Telephony and messaging – H.323, MGCP, SIP, TAPI, JTAPI, XML/VXML and others. Many users consider SIP the ultimate choice, given its lightweight nature and ease of integration with web-based technologies. As the capabilities of SIP continue to mature, it promises to become the de facto choice given the ease of development of next generation features and capabilities.
- Features – Traditional digital and analog PBX systems have been around for quite some time. Throughout the history of this technology, a wide range of features and

capabilities has been implemented. Over time, analysts expect IPT telephony systems to evolve to offer some of these capabilities in response to customer demand. However, the majority of development effort will focus on native features that give IP-based systems unique and new ways to communicate and collaborate that were not possible with traditional systems.

- Applications – The tight integration of IP Telephony and Messaging systems with other IP-based applications have changed the nature of how the IP phone is used. Increasingly, it is becoming more of a communications device. Phones integrated with web browser capabilities have created opportunities to interact with users in new ways – both in providing information to the user and collecting information from them. In addition, integration with backend systems such as Property Management, Building Management, Entertainment, the Internet and others offers guests, hoteliers and their staff a wide range of new capabilities. Some examples of this include enhanced check-in / check-out, new wake-up services, individual and group messaging, environmental and in-room systems control, entertainment system control, personalized alerts and many others.
- Mobility – Mobile full-feature handsets have proven to be the communication system of choice for businesses and individuals alike. The success of cordless and cellular phones has proven that. IP Telephony and Messaging systems are also working on mobility. Mobile IP Telephony has been available for some time through the use of IEEE 802.11 based IP phones and soft phones running on wireless laptops. However, IEEE 802.11 based systems have a limited coverage area – typically a building or a campus. To combat this, the industry is researching a number of alternatives. Principally, the two most frequently discussed are IP Telephony over an improved infrastructure such as WiMAX as well as multi-mode communications systems that can bridge communications between premise-based wireless environment and the cellular world. The latter offers the ability to roam seamlessly between cellular and IEEE 802.11 environments.

VII. In-Room Controls

Many industry experts consider In-Room Controls to be the next frontier, the next element to be integrated within the converged network. In-Room Controls consist of a group of devices that control various functions in the guest room ranging from environmental to entertainment. Until recently, these devices have been unable to communicate centrally or with each other. Recent advancements in technology allow communication, but this typically requires the use of proprietary architecture or protocol. As the evolution of technology continues, tools and methods for these devices and the underlying control systems to communicate over a standard network and with each other will deliver a new level of functionality that is beneficial to the property and, more importantly, to the guest.

Examples of in-room controls that are available for use today include:

- Thermostat – Control of room temperature
- Access Control – Door locks, Do-Not-Disturb control
- Presence Detection – Automatic status of room occupation
- Lighting – Remote control of room lighting
- Drapes – Open or closing of drapes
- Room Safe – Status of safe in use, Reset code
- Mini-bar – Status of mini-bar usage
- Entertainment Controls – Audio, video
- Misc. Devices – Coffee maker

A. Features and Benefits

By providing guests control of the in-room functions and integrating them, the guest has the ability to tailor the room to their preferences for greater comfort. Some ways this technology integration will enhance the guest experience are:

- Enhanced Wake-up through guest profile controlling drapes, room temperature, television or Radio station, and turning on the coffee maker.

- Guest control of temperature from thermostat, television, or phone with preferences set during check-in from a guest profile.
- Automatic setting and indication of Do-Not-Disturb when the guest is in the room to prevent the need for door placards or interruption by staff.
- Notification at check-out of items left in safe.
- Audio Visual Control – Mute television or Radio when telephone rings.
- Personalization - preferences can be saved through self-learning or a guest provided profile for future visits.

Property owners gain increased control of in-room systems by networking them together and centralizing their management. This provides cost-savings as well as a better guest experience. Property benefits include:

- Centralized energy management – Heating, lighting, television could all be turned-off at checkout.
- Consistency – Room setup can be controlled at check-in to meet standards and a guest profile.
- Monitoring – Maintenance can become proactive by including devices capable of reporting health status or problems to a monitoring service. Batteries reporting low before running out.
- Efficiency – Mini-bar status prevents unnecessary inventory, room presence automates room cleaning schedules.
- Security – Networked door locks make key management and building access control centralized and real-time.

B. System Components

The evolution of in-room control systems will be continue around of three main elements:

- Control Unit – This provides direct control and monitoring for the system element in the room. Examples include thermostats, smoke detectors, room locks, and so on.
- Bridge Device – This is the means of collecting the signals from the various control units within a single room, and putting this information on the converged network. This

device may include both hardware and software subsystems to acquire signal and convert it to an open standard format where other network applications can use it.

- Control Applications – These are the applications that use the information from the Control Units to make changes to the room condition (such as change HVAC settings to match a guest's pre-set preferences), or monitor for certain conditions (such as determining if a room is unoccupied and available for housekeeping access). Control applications may be standalone or may be integrated with other hotel systems such as the PMS.

C. Infrastructure Requirements

The emerging standard that will support the growth of in-room controls is a wireless networking standard called ZigBee. ZigBee is a reliable, low-cost, low-power solution developed as an open standard by the ZigBee Alliance. Initially intended for use in industrial control applications, ZigBee provides a benefit for hotel applications compared to other wireless solutions like Bluetooth or 802.11b/g. These protocols are widely available in consumer devices that guests might bring into the room causing interference with in-room controls (or vice versa).

Control Units that feature ZigBee wireless, and ZigBee Bridge Devices will provide a secure, reliable and robust communication infrastructure for a wide variety of in-room control applications. As of this writing, these devices are coming to market, with wide availability expected throughout 2005 and beyond. One side of the Bridge Device communicates with the other ZigBee units in the room, the other side provides a standard Ethernet connection for IP communication with the rest of the converged network.

D. Integration Models

The presence of signals from the Control Units on the converged network is only part of the solution, however. The work begun by other HTNG workgroups, focused on creating standard, XML-based messages that can be used by hotel systems from multiple vendors as a common language, will be expanded to include the in-room control applications as well. This is a required step on the path to developing open standards based control applications and for integrating control applications into other hotel systems, such as the PMS.

This integration will make the promise of in-room control technology a reality and a useful tool for controlling costs and increasing the quality of the guest experience. Because the evolution of this technology is expected to follow a path established by other technologies, the early creation of a modular set of standards supported by multiple hardware and software vendors, and demanded by hotel industry consumers, will lead to a robust, future-proof architecture. All participants will benefit from falling costs and rising capabilities, leading to wider use of the technology.

VIII. Implementation and Support Overview

As the old saying goes, "All things are made twice; first with the head and then with the hand." Put another way, the plan precedes the reality – or it should! The flower must bloom in the mind of the gardener long before the seed is planted, for successful gardens are not random things. Thoughtful planning combines with skillful execution to produce stunning results. So it is with technology projects. Without proper care in planning, the project will follow the all-too-familiar trajectory of false starts, cost overruns, missed milestones and ultimately, lost opportunity. Choosing the wrong technology, the wrong team members or even the wrong business goals can cause problems that cannot be made right during project implementation, any more than a dandelion seed can be made to produce a daisy.

Research shows that technology projects have a poor track record. A landmark study by the Standish Group revealed that more than half of the Information Technology projects surveyed were not meeting their objectives. These projects were, on average, 189% over budget, 222% behind schedule and providing only 61% of agreed functionality.[1] Further studies indicate that this low success rate is primarily caused by errors and omissions made during the project's first creation – when it is first conceptualized and planned. The Gartner Group suggests that three-quarters of new IT projects will fail due to fundamental flaws in project planning.[2] More specifically, some authors point to failure to follow a proven process that provides leadership, unambiguous goals and clear accountability,[3] while others see root causes in poor sponsorship, including poorly defined tasks, ineffective project managers and the lack of management support in the early stages of the project.[4]

Successful guestroom infrastructure projects require adequate time and attention to detail during planning, and careful management throughout all subsequent phases of the project lifecycle. In reality, project planning never ends; the best practices promoted by the Project Management Institute include specific planning processes in each of its twelve Knowledge

[1] Standish Group, The Chaos Report, 1995
[2] Gartner Group, CEO and CIO Alert: Five Mistakes That Will Derail an e-Business Project, 1999
[3] Taylor, Mark, The 5 Reasons Why Most Projects Fail, 2003
[4] Kerzner, Harold, A Systems Approach to Planning, Scheduling and Controlling, Wiley 2003

Areas.[1] The approach suggested in this paper supports these best practices, but simplifies the twelve Knowledge Areas into a single process, called PDIM, with four phases: Plan, Design, Implement and Manage (hence the name).

This simplification puts the project lifecycle – from the initial concept through on-going support - into four logical groups. Guestroom infrastructure projects involve people with diverse professional backgrounds, and this simple roadmap helps all members of the team understand some important project management concepts. In turn, the PDIM process helps ensure project success by guiding the project, and the project team, along a proven path that balances both aspects of creation: the planning and the doing.

A. PDIM Process Overview

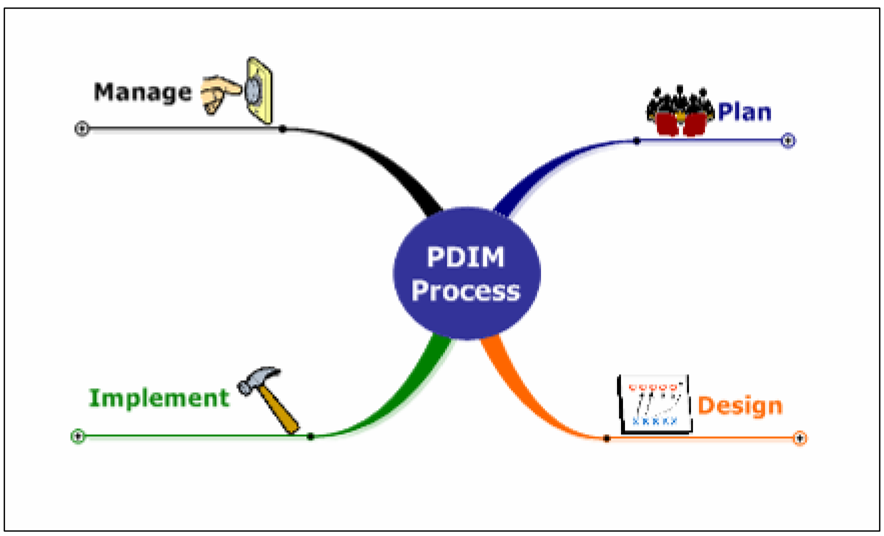


Figure 1: PDIM Process

The PDIM process (Figure 1) consists of four phases called Plan, Design, Implement and Manage. They are roughly chronological, that is, the processes in the Plan phase will be complete before Design phase activities begin. The primary objectives of each phase are:

- Plan – project goals and scope are established, project funding is obtained and the project team is formed.

[1] Project Management Institute, A Guide to the Project Management Body of Knowledge, 2000

- **Design** – technical architectures are created, a strategy for implementation is formed and a plan is built to ensure results conform to goals.
- **Implement** – system components are obtained, configured, installed and tested to ensure proper operation, training is provided.
- **Manage** – guestroom infrastructure is in full operation; support programs are in place, system growth planning and continuous improvement tasks are ongoing.

Underlying the PDIM process are several shared values that should be established early and encouraged throughout the project. In one sense, the PDIM process defines "what" is to be done; the shared values shape a project personality that shape "how" things will be done. Encouraging the continuous evolution of these shared values recognizes the important contribution they make in helping the team meet its objectives.

Common shared values that support the PDIM process include:

- **Focus** – The primary point of optimization for all project activities is the Project Goal (established in the Plan phase). All team members and all project activities should be focused on supporting the goal. The Project Goal should be the basis for decision-making and prioritization.
- **Teamwork** – The project team is likely a diverse group of managers, technicians and other professionals, probably from more than one firm. The performance demands of the project are great, and the smooth operation of the team is essential to reach the goal. Human factors associated with team building must be planned and coordinated to ensure an effective team.
- **Leadership** – There are two sides to the leadership coin: leading and following. Both are necessary for the team to reach its goal. Team members must be prepared to understand and respond to situational changes, ready to assume either role as required at a given point in the project.
- **Communication** – Even in highly technical projects, the challenge of the technology is not nearly as great as the human challenge of building and maintaining effective communication paths. These paths must be built and maintained to ensure appropriate flows of communication within the team, and between the team and its customers.
- **Process** – A single process (PDIM) must be understood and adhered to by all team members. There can only be one plan, and the plan must be followed, if the many different

aspects of the complex project are to be coordinated. There is little room for individual improvisation, although a fundamental aspect of the PDIM process is the ability to adjust rapidly to changing circumstances.

- Scalability – All of these shared values are expected to apply to all project activities, but to be effective; all must scale to meet the needs of each specific instance. There is not one right way to communicate, for instance. This or any of these values must be applied with common sense, keeping the Project Goal and the team's shared values foremost.

B. Plan Phase

As stated previously, the Plan phase of any project is the most important, and is the phase most likely to be neglected. Many factors contribute to this, and they should not be underestimated by those who assume that the common sense of the old carpenter's axiom, "measure twice and cut once" is enough to ensure thorough planning. Ironically, one of the most successful enemies of planning is the failure to plan itself; insufficient time is given to planning because the project is getting a late start due to someone's failure to properly plan the tasks! Planning takes time, but in the end, it also saves time. The old project manager's axiom, "to finish sooner, plan longer" has been proven true in countless successful projects.

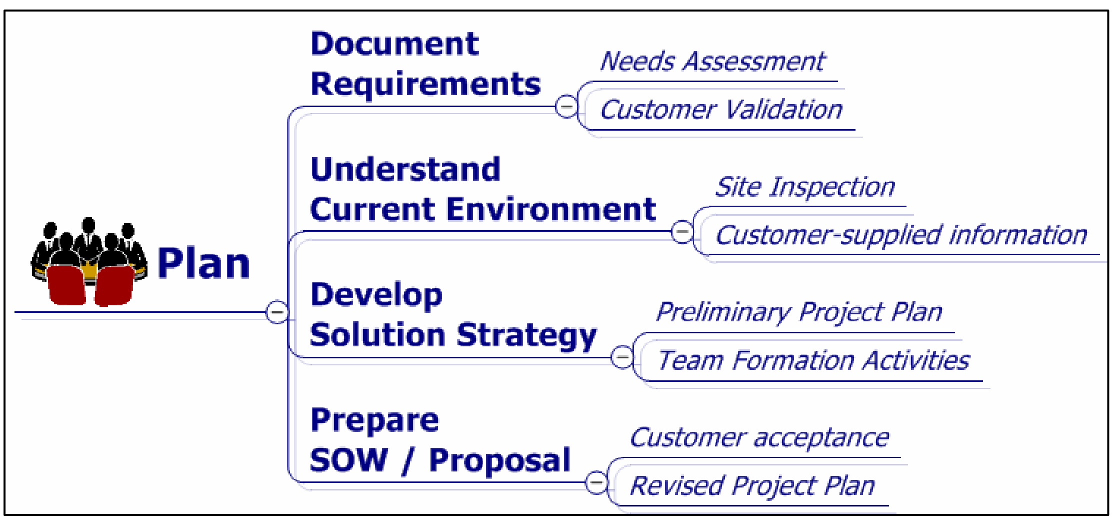


Figure 2: Plan Phase Activities

1. Plan: Document Requirements

The formation of the goal and scope of the project should begin with a widely accepted description of the project's required outcomes. All too often, especially in technology projects, the project starts with a directive from management that is the result of reading about a new product or service. This can produce a narrow, product-specific requirement, such as:

"Purchase and install the Omni-Tronic guest paging system for the lobby and pool areas."

Although clearly stated and easily measured, basing the project on this requirement could lead to the wrong product being selected, or implemented in such a way that it will never reach its full potential. It limits the team's thinking, and can prevent the consideration of other approaches that would bring the maximum benefit to the business.

Requirements should be stated in terms of the desired results, not the actions needed to produce the results. For instance, a more appropriate way of stating the same requirement might be:

"Enhance our guests' ability to contact each other, wherever they are on the property."

Using this type of outcome-based language will allow team members to evaluate multiple ways of meeting the goal, and select that alternative which best matches the need.

After preparing a list of requirements, validate them by sharing them with other people in the organization. Getting multiple perspectives will help refine the goals based on the knowledge and experience of several individuals. The revised goals should be reviewed and accepted by the project sponsor to complete the activity.

Note: One useful technique for those involved in documenting requirements is to follow the practice of "asking 'why?' five times." If the initial statement of need seems too narrow, ask why, and be prepared to ask it repeatedly to get to the core business motivators. Careful use of this technique typically results in a set of requirements that, if met, can produce powerful and positive change in the organization.

2. Plan: Understand Current Environment

The course of nearly all technology projects is constrained by the "as-is" situation. This is particularly true when an existing service is targeted for replacement or upgraded. Current networks, Property Management Systems (or other key business applications), telephone systems, floor plans and so on play a huge role in determining the way that new technology can be applied. Even when the project is focused on a new-build, the current environment, including franchise requirements and local building codes, must be considered.

The approach for documenting the current environment is two-fold. First, all existing documentation that defines the current environment (or describes limitations to the way that environment can be changed) should be assembled and organized. Second, a detailed physical inspection of the facility should be performed (or a structured walk-through of the plans for new-builds).

If the project will feature significant involvement of a third party, such as a technology vendor, the vendor should be given the existing documentation and invited to inspect the facility according to their need. Complete answers should be given to all vendor questions, and any documents provided by the vendor should be reviewed for accuracy to ensure their recommendations are based on fact. (Unless the vendor states otherwise, assume that the documentation they produce is proprietary information that should not be shared with competitive vendors.)

Following this course accomplishes three things:

- The vendor receives all the information needed to understand the requirements.
- A foundation of openness and mutual trust is established, which will be an important asset should the vendor be selected to participate in the project.
- The vendor's actions can be observed, providing valuable insight that will help later, when selecting vendors for the project. (For instance, the vendor who does not take the time to inspect the property might be a less reliable choice than the one who looks carefully and asks detailed questions.)

3. Plan: Develop Solution Strategy

Armed with a clear statement of requirements, and tempered by the realities of the current environment, the solution strategy can be formulated. Although preliminary in nature, the strategy should provide enough detail and reliability to form the basis for the important decisions that need to be made in the following step. These three components of the Solution Strategy are the:

- High-level Architecture
- Preliminary Project Plan
- Preliminary Cost Estimates

The High-level Architecture is the first formal attempt to specify all the parts and pieces that must be brought together to produce the desired outcome. Depending on the complexity of the project itself, this may be as simple as a product's technical specification or more complex, such as a conceptual diagram showing the function and relationship of all system components. Whatever the appropriate format is, the High-level Architecture should clearly list the primary components of the solution, and describe them without using overly technical terms or jargon. It should be an effective tool for communicating the solution to non-technical managers and key decision makers. (In projects involving vendors, it is typically the vendor's responsibility to provide this architecture, which describes their proposal.)

The second component, the Preliminary Project Plan, outlines the process that will be followed to deliver the required functionality. In very simple projects, this plan may only be a list of the steps needed to accomplish installation. In more complex projects, the Preliminary Project Plan should be more formal, and should include a statement of the project's goal and scope, a preliminary Work Breakdown Structure (WBS) that shows primary and secondary tasks, and a summary of resource requirements. The Preliminary Project Plan should also include the beginnings of a Risk Management and Quality Assurance Plan(s). In complex projects, particularly when vendors are involved, separate meetings may be required to gather the information needed to develop this plan. The Preliminary Project Plan should be prepared by the person (or firm) who will be the Project Manager during the subsequent project phases.

The third part of the Solution Strategy is the preparation of Preliminary Cost Estimates. This estimate should state all anticipated costs as accurately as possible. The length and complexity of the project will affect how precise these estimates can be. For simple projects, a fixed-price may be feasible at this point. For situations that are more complex or for activities that take place farther in the future, it is reasonable to expect that estimates will be provided.

Estimates are nothing more than forecasts, and like any other forecast, may or may not be accurate predictors of what the future holds. Assumptions that have been made when preparing estimates are listed, and an appropriate confidence interval is used to communicate clear expectations for any variation that may occur. The project sponsor may require all parties engaged in project planning to use a common set of confidence intervals, reflecting reasonable limits of variance of actual vs. forecast that might occur. This helps the decision making process, by simplifying the comparison of alternatives from different groups.

For instance, a project sponsor may establish the following three levels when the project is first being evaluated (plus an implied fourth level, that being a contractual, fixed-price offering):

Estimate Type	Actual costs may vary by:
Order of Magnitude	-50% to +100%
Budgetary	-25% to +50%
Preliminary	-15% to +30%

(Association for the Advancement of Cost Engineering – www.aacei.org)

In this example, the project sponsor may request a fixed-price commitment for Plan Phase activities, a Preliminary estimate for the next phase (Design), and a Budgetary estimate for the Implement Phase (that follows Design). As the Plan Phase completes, each subsequent phase estimate is revised and moved to the next level of accuracy. This "rolling wave" approach provides continuous refinement of estimates, based on solid knowledge, while maintaining a focus on overall cost expectations.

4. Plan: Obtain Approval

At this point in the Plan phase, the project's management sponsor has the data required to make an informed decision about the project. The requirements analysis can be expanded to include the financial impact of the project from increased revenue or reduced expense, including soft-costs such as guest satisfaction. These can be compared to the investment cost estimates, using any one of the many cost / benefit analysis tools such as ROI, payback, and so on. Further, the availability of the Preliminary Project Plan gives the management team an opportunity to evaluate the potential threats and opportunities inherent in the project when determining if the project will move forward.

5. Plan: Launch the Project

With the formal approval to move forward with the project, the immediate priority becomes the formation of the project team. The team's initial goals are the refinement of preliminary plans into the tools that will guide subsequent project activity, including the production of the project schedule. Before these goals can be completed, however, the team itself must be created. This requires careful consideration, particularly if the team is comprised of members from different locations or employers. One experienced project manager defines "project team" this way:

"The sudden group of well-intentioned strangers who work for multiple managers presenting mutually exclusive priorities, who have conflicting personal objectives, who are unsure of or not committed to project goals and who are expected to be transformed into a high-performance, self-directed workgroup while eating donuts before the start of the project kickoff meeting"

The investments made to this point, and those that will follow, are in great jeopardy if the project team cannot work together effectively. Team members may not know each other's strengths and weaknesses or optimum working styles. Requirements of individual team members "real jobs" may interfere with their project responsibilities. Communication may be made difficult by geographic separation and incompatible email, scheduling and conferencing tools. The pressures that will interfere with its effectiveness are great. The team must be strong enough to overcome the challenges they will face *before* the challenges arrive; there is no room for "just in time" team building.

For complex projects, or for any project where a team approach is essential to success, specific steps should be taken to help the team come together as individuals and form an effective unit. Facilitated team-building workshops can accomplish much in a short time, particularly if they are business-focused (so that the subject of the team building is the project itself). Other techniques, such as the temporary co-location of project team members and the use of group communication tools such as web-based project portals can speed the process and reduce the risks associated with new teams.

The project sponsor should expect to see team-related risks as part of the Risk Management Plan, and corresponding actions described in the Preliminary Project Plan. Not paying sufficient attention to this common source of risk is dangerous. The suggested practice is to plan specific project tasks that will accelerate the formation of a healthy team capable of dealing with the stress that lies ahead, rather than to pretend that the group of "well intentioned strangers" will somehow find themselves as a team with outside help or investment.

C. Design Phase

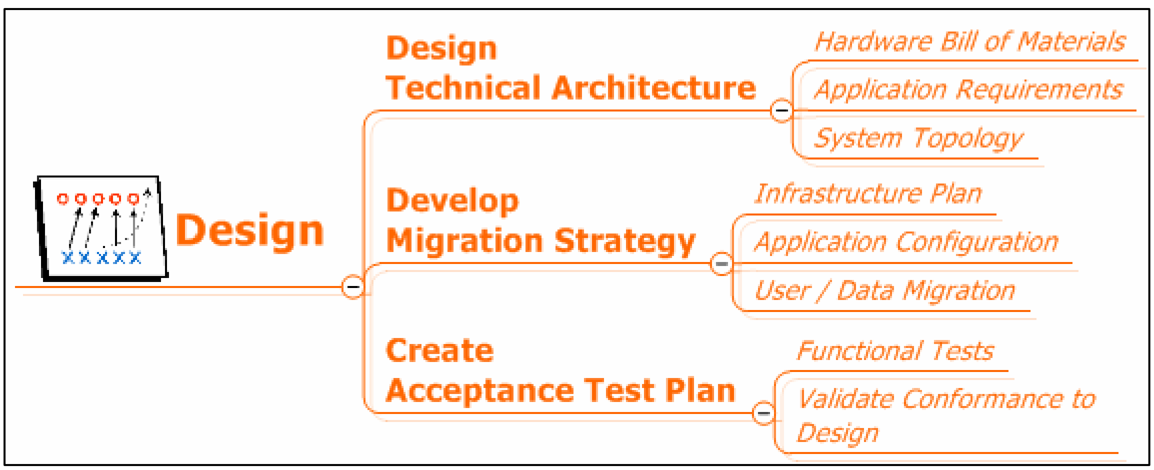


Figure 3: Design Phase Activities

In the Design Phase of the project, the detailed set of components of the solution (including hardware, software and services) will be established. This typically requires that the project team select from several alternative approaches, weighing the pros and cons of each to find the combination that best satisfies the requirements established in the Plan Phase. This is a good point to revisit the shared value of focus on the project goal, as a source of clarity in making these choices. In the PDIM process, the Design Phase includes more than the technical details. It also includes the preparation of a strategic plan to migrate from the current environment to the new one. This phase also includes agreement on the way the new infrastructure will be tested following implementation, to help ensure that the desired benefits will be obtained.

1. Design: Design Technical Architecture

The preparation of the technical architecture for the new guestroom infrastructure is analogous to creating a set of blue prints for a new house. Both render a view of the way the finished product is meant to look, provide the detailed specifications that must be met, and document the materials that must be used. The term “Design” is well chosen; this is necessarily a creative process where the quality of the output reflects not only the technical skill of the designer but the quality of the designer’s imagination, as well.

The requirements of the specific project will dictate the contents of the design deliverable, but in general, expect it to include:

- Bill of Materials – a listing of all hardware, software and other products that must be obtained to build the solution
- Application Requirements – for any new software that is to be created, or for modifications to existing software, the functional specifications must be defined
- System Topology – conceptual diagrams that show how the individual components are related, such as a network diagram that describes each physical location and the characteristics of links within and between each location

An important part of the preparation of the technical architecture is a series of reviews. This should include a peer review by others with specialized technical knowledge at least equal to the solution designer’s. For instance, a specialist from the maker of the selected hardware might be a good peer reviewer for the design prepared by the engineer from the system integration firm. As noted above, the design is a creative process where more than one right answer may exist. A peer review may (and usually does) identify “artistic differences” between the two peers; full agreement is not as important as a consensus that the proposed architecture will provide the expected benefits.

At least one other design review should occur, where the solution is presented to the project sponsor (in non-technical terms, if appropriate). The sponsor requires a clear understanding of the proposed solution, and must be satisfied that the solution will produce the desired results, as an important checkpoint that the project is on-track.

Note: A common human tendency is to avoid confrontation with others, often in the name of cooperation. The design review process is one place where this normal rule of social order should be suspended, in the best interests of the project. Calling on the shared value of focus on the project goal, all participants in the design review, including the designer, should agree beforehand that the common goal of creating the best possible design comes before all others. If everyone recognizes that a criticism of the design is not a criticism of the designer, there is no need to filter observations to avoid hard feelings. Depending on the characteristics of the team and the situation, this might best be achieved with independent facilitation of design review meetings.

2. Design: Develop Migration Strategy

Once the technical architecture is established, the team understands the desired future state of the guestroom environment. However, having the blue print and knowing how to build the house are two different things. Using the constraints identified when the current environment was evaluated, the Team must identify the migration strategy that will guide the implementation process.

The migration strategy should identify the techniques that will be used during the Implementation Phase. It should identify the high-level approaches to specific situations that will be used as a guide when the detailed Implementation Project Plan is prepared. For example, the migration strategy might include principles such as:

- "Power tools can be used in guest areas only between 9 AM and 3 PM."
- "Guest rooms will be blocked for installation activities in groups of X and all in-room installation activity must be complete in no more than X days (or hours)."
- "All areas served by wireless networks will be tested and certified before any guest use is allowed."
- "Technical support staff must complete required training and obtain X certification before the end of the implementation process."

Like the process of creating the technical architecture, there are multiple alterative approaches available for the project team. As was the case with the preceding step, more than one right answer may exist. The suggested steps needed to evaluate and agree on the elements of the migration strategy are the same as those followed with the preparation of the technical architecture. Reviews with peers and with the project sponsor should be held, focused on the goal of preparing the best possible plan. It is also very important that these reviews involve the many different constituencies at the property that might be impacted by the implementation process. Their input during the Design Phase can eliminate many problems during rollout, and their early involvement helps improve cooperation throughout the project.

3. Design: Create Acceptance Test Plan

An often overlooked, but very important part of the design is the preparation of a plan to test the functionality of the new infrastructure when it has been installed. The Acceptance Test Plan describes, in detail, the specific tests that will be used to validate the proper operation of the new system. These tests should be designed and formatted so that any competent system user can perform them, and when the tests are executed following installation, a system user (or someone not directly involved in the project) should perform the tests.

The Acceptance Test validation demonstrates that the new system has been properly installed. It establishes and documents a baseline, and is the milestone that marks the end of installation and the start of on-going use and support. If defects are found during Acceptance Testing, they are typically corrected by the implementation team. Problems that occur later, after successful testing, should be resolved through the support team.

While the test itself will not be used until implementation is complete, it should be created now, for several reasons. First, at this stage of the project there is clarity on the goals, and the way that technology is intended to meet them. These goals have formed the basis of the Technical Architecture and the Migration Strategy, and the flow into creating the Acceptance Tests that verifies conformance is logical at this point. Second, the time and resources needed to perform Acceptance Tests must be scheduled as part of the Implementation Plan (which will be prepared in the next phase of the project). To schedule this work accurately, it needs to be defined so sufficient time and the proper people and materials are available when needed. Finally, the Design Phase of many projects is a time of relative calm; often, due to unforeseen circumstances the actual rollout becomes hectic and time-challenged. In the rush to complete the project on time, the testing step is minimized or skipped altogether. While proper planning and control throughout the project should minimize the last minute frenzy, the risk remains that not enough time will remain for proper test development and validation. For these reasons, the Acceptance Test Plan should be considered an essential part of the Design Phase.

The Acceptance Tests should be designed to exercise the system so that proper functionality can be directly observed by the tester. For instance, if a new guestroom telephone system is to be installed, tests should include all the functions available to the guest: in-house and outside calls should be made and calls from other phones (in-house and outside) should be answered. Voicemail messages should be recorded and retrieved. Front desk procedures associated with the phone system, including integration with the Property Management System, should be tested. In short, the new system should be tested the way it will be used.

In vendor-driven projects, the technology vendor should be able to supply a set of standard Acceptance Tests that have been used during other, similar, installations. Each test should be examined to ensure it is appropriate for the project at hand. No two installations are exactly alike, so it is natural that the vendor’s standard plan may not align perfectly with the needs of every installation. Any needed modifications, including the addition of new tests to cover gaps in the vendor’s test suite, should be developed.

The tests themselves should be formatted for easy use by the testers. The recommended approach is to treat the tests as a worksheet, with one test per page. The tester’s name, date and the location of the test should be recorded. The worksheet should also include the systematic instructions needed to complete the test, and provide a space to record the outcome of the test. Typically, this will required a pass / fail checkbox, and a space to capture relevant notes or comments.

The number of individual tests, and the level of detail they cover, should be scaled to match the complexity of the system. Testing functionality of a newly installed wireless network access point may only require two or three tests. On the other hand, the installation of a new phone system may require more than one hundred tests. The number of tests performed can also vary within a product set. For instance, not all the tests needed to validate the set up of the new phone system need to be repeated for each room served by the same infrastructure. Once the core operation of the system has been proven, it may only be necessary to show that each phone gets dial tone and can place and receive calls, for example. This helps balance the time required to perform testing with the need to complete the installation.

D. Implement Phase

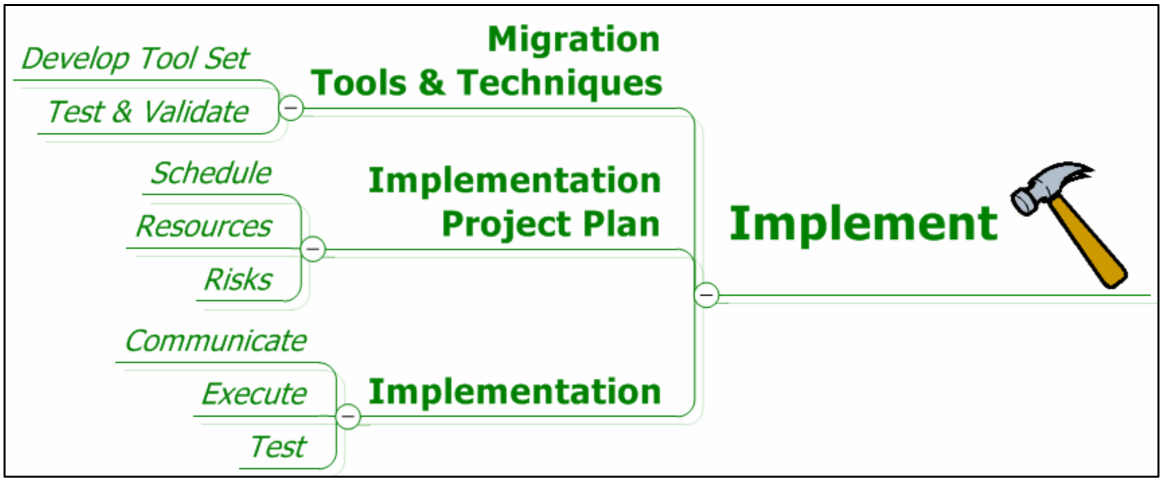


Figure 4: Implement Phase Activities

By the time the project begins the Implement Phase, assuming the PDIM process has been carefully applied, the major threats that contribute to the downfall of most projects have been eliminated. The project has gotten off to a good start, with well-defined objectives, management support and a healthy project team. The technical designs have been prepared and subjected to careful review, as have the techniques to be followed during rollout and the tests that will prove everything works as promised.

This is not to say that there are no risks facing the project at this point. Entering the Implement Phase, the project will move from being the subject of a relatively small group of people involved in Planning and Design to the larger stage of the whole enterprise. For the first time, the quality of the work done by the project team will be under the scrutiny of the most important audience of all, the customer's customer. The careful planning, the investment in building a strong team and dependable lines of communication will all be used to ensure the success of the rollout.

In the Implement Phase, obviously, the new infrastructure will be rolled-out. It will be supported by the development of a detailed Implementation Project Plan and possibly by the development of any specialized techniques or tools to be used to streamline deployment. It is also a time to revisit the project's foundation, examining the shared values and updating the Risk Management plan.

1. Implement: Create Migration Tools and Techniques

While highly dependent on the nature of the products being deployed, there is frequently an opportunity to reduce direct labor costs and improve team efficiency by developing specialized tools and / or techniques to automate all or part of the deployment. These tools may include sophisticated applications such as Microsoft System Management Server (SMS) or Novell's Zen Works to deploy software. Also to be considered are the useful practices such as building "franchise kits" that contain all the supporting materials needed to perform joint planning with multiple remote locations.

The process of developing these tools should mirror best practices followed throughout the project. The tool set should be developed in response to well-understood requirements, and should be built, tested, reviewed and refined, using techniques similar to those used to develop the Technical Architecture and Migration Plan, for instance. This includes the powerful technique of peer review. Most importantly, the development of the migration tools should be scaled to match the tasks they are meant to simplify. (A three-month effort to create an automated software deployment tool that will save three weeks of work is not a good idea, for example.)

Any tools developed or new techniques employed during the Implement Phase should be documented and archived as part of the project closeout process. These may be useful in similar future situations, or may be a helpful tool when it is time to perform a major version upgrade to the infrastructure.

2. Implement: Prepare Detailed Project Plan

To many people outside the project (including, frequently, the project sponsor), the timing of this activity seems out of place. Shouldn't the Project Plan be developed at the start of the project? While it may be surprising to some, a closer look shows the essential logic. Developing a detailed project plan for rollout requires knowledge of many items that did not exist until they were created in previous phases. In fact, the output of nearly every previous activity becomes an input to the implementation project plan.

Accuracy is always important when communicating key project milestones, and becomes even more important now, when the work of the project team will begin to interact with more people and other organizations to accomplish the physical installation of the new infrastructure. Simply by waiting until this point in the project to release the Detailed Implementation Plan, its accuracy is enhanced; the outcome of prerequisite steps are known and the activity described by the plan will be happening in the near future. Considering the impact of a missed schedule date on the customer's customer, this is a prudent technique for mitigating an important risk.

Depending on the nature and complexity of the project, the team may choose to perform a pilot rollout before committing the full schedule. This type of pilot, often called an Implementation Pilot, is meant to fine tune the deployment process, refine training, documentation and communication, and correct any defects found. This is very different from a Technology Pilot, often held in the Plan Phase, which helps identify the right technical solution. The Technology Pilot is typically short-term and will be de-installed after the pilot period. The Implementation Pilot is a production-quality deployment, which will remain in place.

The schedule for the rollout should be based on the specific requirements of the situation, with particular attention paid to the impact that deployment activities might have on guests and other staff members. This is a good point in the project to consider the original goals and shared values to help the prioritization and decision-making needed to build an effective construction plan. The best practice recommended in this area is to remember that the project is being done for the benefit of the guests, and implementation should be scheduled accordingly. It is not being done for the convenience of the installers. (Although, allowing efficient work patterns helps control costs and maintain productivity.) The best plan is a balance, with the project goals as the tipping point.

3. Implement: Complete Implementation

The actual implementation may seem anti-climactic after all of the planning and development that has preceded it, and for good reason. This is the point in the project when even small delays can be extremely expensive. In the Plan and Design phases, the project team consisted of a relatively small number of people. Their schedules could be easily coordinated and adjusted to meet unexpected turns and twists as the work unfolded.

Now, there may be a small army of electricians, installers, system engineers and so on. A lost day is not only costly, but its ripple effect can disrupt subsequent activities. The goal of PDIM, as stated previously, is to help projects "finish sooner by planning longer." Anti-climactic is exactly what we are looking for; an uneventful rollout is the hallmark of an effective project manager.

This white paper has emphasized the importance of planning and the techniques to make it effective. It is difficult to describe what will or should happen during the rollout because it is so dependant on the project itself and the decisions the project team has made in getting to this point. The greatest threats the project faces at this point are the unknown risks; the risks that the team could anticipate have been identified and appropriate strategies have been prepared. The shared values described earlier and (hopefully) built by the team throughout its work together are perhaps the most important risk mitigation strategy of all. The values such as Communication, Teamwork, Focus and Leadership give the team resiliency and the ability to change swiftly, together and effectively in the face of the unexpected. This is an asset of the project, perhaps its most valuable asset, which will only exist if the right investment in time and technique were made early in the project. Remember the reasons that most projects are not successful is due to a failure to follow best-practices during the planning and design activities; "doing it right" in the early phases of the project is the proven path to delivering all promised functionality, on-time and on-budget.

E. Manage Phase

The new infrastructure is installed and ready for use. The project team is ready to disband and get back to their "real" jobs. The project is nearly complete, but in one sense, it is just beginning. The Manage Phase of the project contains all of the activities needed to transition to the operation and maintenance of the new infrastructure for the rest of its useful life. These activities include the important transition from the project team to the new "owner", who will guide future refinement and enhancement in support of changing business needs and technical capability.

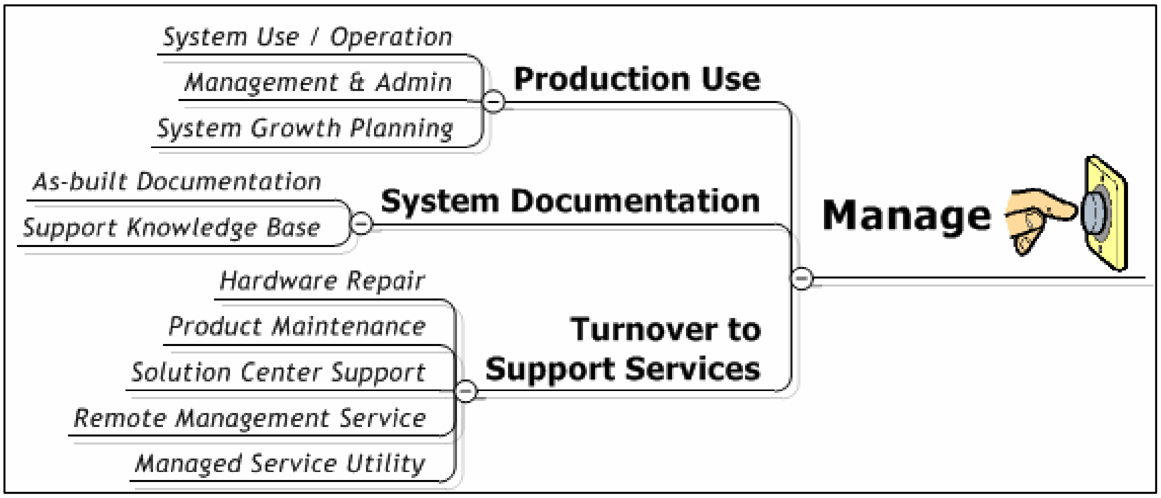


Figure 5: Manage Phase Activities

1. Manage: Production Use

When the new infrastructure is put into production, new processes must be ready to support both the users and the system itself. The system itself likely requires some sort of ongoing management and administration to ensure proper functionality. The people and processes needed to accomplish these tasks have been defined during the Design Phase. At this point, focus should shift to the details of these tasks, to ensure that they meet their intended purpose of supporting the infrastructure itself, and that they allow efficient work processes for the people who perform them.

Lifecycle processes such as continuous improvement efforts or system growth planning should be established at this time. For instance, a quarterly review of the infrastructure may be planned, following a predefined format. The review may include focus on support logs, user problems and other operational details. It may also be useful to schedule one major component for a closer review during each quarterly meeting, to discuss how effectively it is meeting the original goals and to review new options that may have emerged since installation. The pace of technological change is not expected to slow down anytime soon, and so an ongoing effort for improvement should be built into the standard operating processes.

2. Manage: System Documentation

System documentation should be organized and delivered to the people or organization responsible for providing support. This documentation includes many artifacts of the Plan and Design phases, and should be updated to reflect the infrastructure as it has been installed, since some changes from the original plan are inevitable. The planning documents should be retained, however, for future enhancements can be more effectively integrated if the support team, who may not have been a part of the original project team, has access to documents that reveal what options were considered and why they were or were not adopted. (This information is also a valuable asset that can greatly enhance similar projects in the future.)

The existence of this information is not enough to help the support team; however, it must be organized into an easily accessed, easily searched knowledge base so that the information is actually used.

3. Manage: Turnover to Support Services

Many organizations in the hospitality industry, and other industries, have chosen to follow a path of selectively outsourcing activities that are not part of their core mission or expertise. Information Technology is one area frequently outsourced in whole or in part. Some guestroom infrastructure projects are planned with the full expectation that ongoing support and maintenance will be provided by the vendor who performed the design and installation of the infrastructure. In some cases, the infrastructure itself will be purchased as a service, with the vendor responsible for all phases of management and administration.

The most frequently outsourced service is hardware repair. The specialized knowledge, tools and access to spare parts make this an ineffective service for an in-house organization to provide in nearly every circumstance. This extends to other “demand” services, which are used in response to a failure of the system, as well. Some vendors combine demand services that correct failures, with preventative maintenance services designed to reduce the incidence of failures. When analyzing the cost / benefit of this type of contract, consider not only the cost of repair, but also the cost of the outage that the pre-emptive work can prevent. These costs can be larger than expected when impact on factors such as guest satisfaction is considered.

A rapidly emerging area is the use of Solution Center Support services, as the next logical step in using vendors to augment in-house support groups. A Solution Center will typically provide telephone or on-line support to the in-house groups to help them operate and maintain the infrastructure. Some vendors are able to provide support directly to guests, although the capability of these organizations to meet the around-the-clock responsiveness needed should be carefully investigated. If a suitable Solution Center partner can be found, it can have a positive impact on the overall operation of the infrastructure; the highly specialized knowledge, high availability and sharing of unique expertise among organizations is proving to have a decidedly positive impact on customer satisfaction.[1]

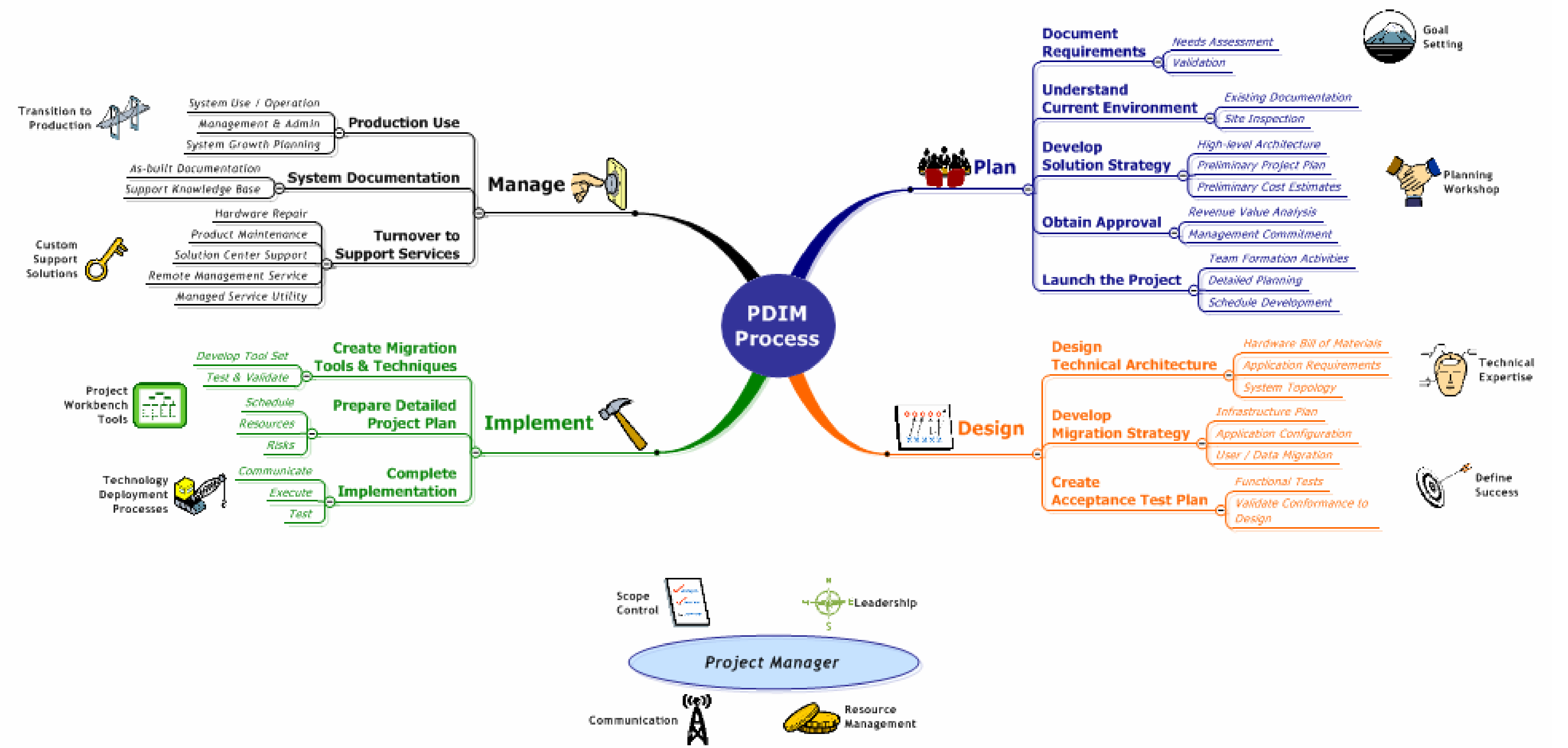
The use of third-party services can also provide options not feasible for in-house support. Remote management and administration can provide very sophisticated (and often very costly) tools for analyzing and controlling systems components. When shared by many organizations, the tools and the staff needed to operate them become cost-effective. Using a third-party firm to provide these types of managed services in support of the guestroom infrastructure takes advantage of their specialized knowledge, and provides the best possible reliability to the guest.

F. Summary

The purpose of this white paper has been to set forth a series of recommendations that will help ensure a successful deployment of a new, technologically advanced guestroom infrastructure. Much can be learned by the misfortune of a generation of failed technology projects, and this knowledge has been combined with proven project management techniques to produce the PDIM model. Empirical research, practical experience and common sense support its applicability. It emphasizes a flexible, scalable, team-based approach that is supported with solid communication and leadership practices. It offers no short-cuts to success, in fact, by emphasizing the reality “finish sooner by planning longer,” the PDIM process requires project sponsors to go slow in the early phases, when so much can be gained.

[1] Eckles, George, The Six Sigma Revolution, John Wiley & Sons 2000

PDIM Process Diagram



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Glossary of Terms

8VSB — 8 Vestigial Side Band

Aspect Ratio — A number representing a ratio of the number of horizontal pixels to vertical pixels, for example, 4:3 or 16:9. Older analog television's are 4:3, while newer digital widescreen televisions are 16:9. May also be shown in decimal representation, for example: 1.33 or 1.77 respectively.

ATSC — Advanced Television Systems Committee

Established in 1982, the Advanced Television Systems Committee, Inc., is an international, non-profit organization developing voluntary standards for digital television. The ATSC member organizations represent the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

ATSC Digital Television Standards include digital high definition television (HDTV), standard definition television (SDTV), data broadcasting, multichannel surround-sound audio, and satellite direct-to-home broadcasting.

On December 24, 1996, the United States Federal Communications Commission (FCC) adopted the major elements of the ATSC Digital Television (DTV) Standard (A/53). The ATSC DTV Standard has been adopted by the governments of Canada (November 8, 1997), South Korea (November 21,1997), Argentina (October 22, 1998) and Mexico (July 2, 2004).

In a nutshell:

6MHz RF channel
8-Vestigial Sideband Modulation (8VSB)
MPEG2 System
14 DTV formats

Digital Television picture formats (as defined by ATSC):

1080 lines, 1920 pixels, 16:9, 60i/30p/24p
720 lines x 1280 pixels, 16:9, 60p/30p/24p
480 lines x 704 pixels, 16:9 or 4:3, 60p/60i/30p,24p
480 lines x 640 pixels, 4:3, 60p/60i/30p/24p

Most commonly used Digital Television picture formats:

Standard Definition (SD): typically refers to 4:3, 480i or 480p
Enhanced Definition (ED): typically refers to 16:9, 480p
High Definition (HD): typically refers to 16:9, 720p or 16:9, 1080i
Nicknames: 480i or 480p, 720p, 1080i

CableLabs — Cable Television Laboratories, Inc., a nonprofit research and development consortium, is dedicated to helping its cable operator members integrate new cable telecommunications technologies into their business objectives.

Category 5	A commonly used type of cable for Ethernet communications, containing multiple pairs of copper wire with a modular connector. Multiple categories exist (e.g., Category 3, 5, 6, etc.) that refer to different specific properties. Sometimes abbreviated as Cat 5.
CMTS	Cable Modem Termination System
Coax	Coaxial Cable
CODEC	Acronym for Coder / Decoder, specifies a method of digitizing audiovisual information, for example: MPEG2, MPEG4, Windows Media 9, VC-1, etc.
Composite AV	Composite Audio and Video
Converged Network	A single, ubiquitous network that is used to carry data, voice and video information throughout the enterprise, which is medium for connecting all systems and applications used by the hotel, and which provides connection to external networks, such as the hotel group and the public Internet.
DOCSIS	Data Over Cable Systems Interface Specification
DTV	Digital Television
DVB	Digital Video Broadcast – European standards for the transmission and reception of digitized video. Uses MPEG2 System standards, includes specifications for Terrestrial, Cable, and Satellite (DVB-T, DVB-C, DVB-S)
DVI	Digital Video Interface
FCC	Federal Communications Commission
FPS	Frames Per Second – the number of still pictures displayed in one second that produce a moving picture
FSK	Frequency Shift Keying
FXS	Foreign Exchange Subscriber (or Station)
HDCP	High Definition Copy Protection
HDMI	High Definition Multimedia Interface
Head-end	The central infrastructure components of a communication system, which acquires signals from one or more sources, process the signals into a common format for distribution
HSIA	High Speed Internet Access
Interlace Scan	An image on the television produced by “drawing” every other line on the screen from top to bottom in 2 passes (producing 2 “fields”)
IP	Internet Protocol (sometimes called the Internetwork Protocol)
IP Telephony	A telephone system that built around the components of a standard data network, based on the Internet Protocol (IP).

IPTV	A term which refers to systems where television and / or video signals are distributed to subscribers using a broadband connection over Internet Protocol
IRD	Integrated Receiver Decoder
ISDN	Integrated Services Digital Network, the international communications standard for sending voice, video, and data over digital telephone lines or normal telephone wires
Islands of Automation	Multiple, often proprietary networks dedicated to single tasks and typically incompatible with one another and unable to meet modern system interoperability requirements.
MPEG	Motion Picture Experts Group, a standards setting body who established the various MPEG standards (see MPEG2, MPEG2-TS and MPEG4)
MPEG2	A digital audio and video CODEC and system used world wide and widely adopted by terrestrial, cable, and satellite service providers
MPEG2-TS	MPEG2 Transport Stream, better known as MPEG2 "Systems". Based on ATM's Adaptation Layer (AL5), specifies packetization and header information, ability to carry multiple MPEG2 programs and ancillary data packets, for example IP
MPEG4	A digital audio and video CODEC and system with performance improvements to MPEG2, and many additional features not available in MPEG2
Multicast IP	A IP addressing method for sending data to multiple recipients without replicating the data for each recipient.
NTSC	National Television Systems Committee Established in 1940 in the United States as a private sector organization sponsored by the Radio Manufacturers Association (RMA) in order to recommend a monochrome television standard to the FCC, which was adopted on April 30, 1941. NTSC was reactivated in 1950 to establish a color television standard and was approved by the FCC on December 17, 1953. In a nutshell: 6MHz RF channel Vestigial Sideband Modulation (VSB) Frequency Modulated (FM) sound carrier 525 scan lines, 30 frames (60 fields) per second (interlaced) 4:3 aspect ratio 59.94 Hz color vertical frequency
OFDM	Orthogonal Frequency Division Multiplexing
PacketCable	PacketCable is a CableLabs-led initiative that is aimed at developing interoperable interface specifications for delivering advanced, real-time multimedia services over two-way cable plant. Built on top of the industry's highly successful cable modem infrastructure, PacketCable networks use Internet protocol (IP) technology to enable a wide range of multimedia services, such as IP Telephony, multimedia conferencing, interactive gaming, and general multimedia applications.

PBX	Public Branch Exchange
Progressive Scan	An image on the television produced by "drawing" each line on the screen from top to bottom in 1 pass
PSTN	Public Switched Telephone Network, the international telephone system based on copper wires carrying analog voice data
QAM	Quadrature Amplitude Modulation
QOS	Quality of Service, a networking term that specifies a guaranteed level of throughput
QPSK	Quadrature Phase-Shift Keying
RFID	Radio Frequency Identification, a technology that allows identifying the location of people, material or other objects that carries an RFID tag
SSID	Service Set Identifier, a unique 32-character identifier attached to the header of packets sent over a wireless network that acts as a password when a mobile device tries to connect to the network
STB	Set Top Box
TDM	Time Division Multiplexing, a core technology related to traditional telephone systems
Unicast IP	an IP addressing method for sending data to a single recipient.
Unified Messaging	Providing the ability to send and receive messages from multiple sources within a common environment, for instance, to be able to retrieve voicemail messages in email, or to access email messages by telephone.
VC-1	SMPTE name given to Microsoft's Windows Media 9 CODEC, as of this writing it is not yet a ratified standard
VOD	Video On Demand
VOIP	Voice Over IP
VSB	Vestigial Side Band
Wi-Fi	A set of standards governing wireless Ethernet communications, also known as 802.11 standards (such as 802.11a, 802.11b or 802.11g).
WM9	A digital audio and video CODEC and system created by Microsoft with similar characteristics of MPEG4