STRATEGIC WHITE PAPER

How to Effectively Transition to VoIP and IMS – Big Bang or Phased Approach?

In order to bolster faltering revenue streams and fend off competition from both their traditional rivals and new entrants into the marketplace, service providers are investigating transitioning their existing infrastructure to a next generation network capable of offering converged services. One of the most viable evolutionary options is to transform their network using an IP Multimedia System (IMS).

This white paper describes the key drivers motivating service providers to migrate to IP-based networks as well as the most effective first steps, including the network topologies involved in the transformation. A number of design and implementation issues can have a major impact on the transition as the service provider prepares its network as a platform on which to build IMS-based services and grow revenues. The problems associated with taking a "big bang" approach – a one-time full migration – are compared to a phased approach that includes implementing partial VoIP and hybrid solutions on the road to full IMS.

Table of Contents

Introduction

Rapid globalization is dramatically changing the way companies do business, and the way people conduct their daily work, family, and social lives. People are constantly on the move across vast geographical regions for both business and personal reasons. Because they want to be able to communicate anytime, anyplace, over any network using a variety of media and end user equipments, consumers are demanding new and innovative user-centric, blended services to fit their mobile lifestyle. Traditional network-centric voice services are not sufficient to meet the communication demands of the coming decades. The continued decline in revenues from traditional voice services and consumer demand for converged services, combined with increased competition, is driving incumbent service providers to adopt IP Multimedia Subsystem (IMS) solutions.

Wireline, wireless, cable, and applications service providers are all looking to the standards-based IMS architecture as their choice to offer new converged services over next generation networks. The IMS architecture was initially developed by 3GPP (3^{rd} Generation Partnership Project) and 3GPP2 as an IP core network architecture for mobile operators. It allows interoperability among various provider networks, open standard interfaces between network elements, and interoperability between infrastructure and applications from different vendors across all access types.

Although service providers are aware of the numerous benefits they can realize from upgrading their network to IMS, they are faced with enormous practical challenges. They have an existing customer base to protect, existing services to be continued, and huge investments in their current infrastructure that need to be maximized. In many cases, it is more practical to make the network transformation in discrete, manageable steps. This allows the service provider to avoid massive changes to their network infrastructure that could result in service disruption.

The evolutionary path a service provider takes to transition to an IMS network depends on their current market space, the state of their existing network, short term needs, and long term goals. There may be a number of paths that lead to the desired results. This white paper discusses an approach that consists of one or more intermediate phases of partial VoIP and hybrid solutions on the road to realizing a full IMS network. It compares the topology and capabilities of partial and full service IMS solutions. The paper also explores the key design and implementation issues for service providers to consider while preparing to evolve to next generation networks.

Incumbent service providers need to offer new innovative services in order to stay competitive. These new services require major investments in upgrading network infrastructure and application areas.

Key Drivers

Some of the major drivers motivating service providers to plan network transformation include:

- Rapid adoption by consumers of a variety of mediums (voice, video, text) and networks (wireline, cellular, cable, WiFi) to meet their communication needs while they are at home, at work, or on the road. Often they need to use different reach numbers, logins, and operator networks without experiencing call and service continuity.
- Demand for ubiquitous services by increasingly mobile end-users. They want the ability to communicate any time, any place, on any network with any end-user device. Traditional network-centric voice services are unable to meet these new consumer requirements.
- Improvements in open, standards-based IP core and access technologies have brought new players into the market that are finding innovative ways to offer IP-based services at almost no cost to consumers. This extreme competitive pressure is forcing the incumbent service providers to protect and grow their revenue streams. The service providers need to act quickly or risk losing their customer base.
- Increased competition brought about by open standardization and the deregulation of the communication industry has also increased competition. An operator's ability to offer next generation networks that offer new, innovative blended services and quality of service with increased security will be a key competitive differentiator.
- Converged networks allow operators to consolidate their infrastructure, services, and operations to reduce CAPEX and OPEX.
- New and innovative blended services on top of converged networks open up new revenue streams for operators.
- Aging TDM networks with insufficient bandwidth are driving service providers to switch to flexible, high bandwidth IP networks. Continuing to invest in fixed bandwidth TDM transport networks is no longer a viable option.

Major Challenges

As operators plan to upgrade their networks to meet subscriber demands and competition, they face a number of practical and business challenges. Some of the major challenges are described below:

- The move to next generation networks demands major infrastructure modifications at the access, core and service layers. These modifications should be undertaken in carefully phased steps – providers cannot afford service disruptions and risk decline in customer satisfaction during this process.
- Although every incumbent service provider's situation is unique, they all have an existing customer base that needs to be protected and grown.
- Operators would like to maximize their investment on their legacy network infrastructure while upgrading it in order to offer new services.

- Service continuity and a positive customer experience are critical during the network upgrade. The end-customer should be least impacted by the underlying network changes.
- While the operator is migrating to the new network and offering new services, customers subscribed to legacy voice services should not have to upgrade their end-user devices.
- Subscribers using legacy voice services should experience the same level of QoS when they upgrade to converged services based on IMS.
- A full IMS architecture multiplies the number of network elements at the session and application layers that are involved in all calls. This results in increased network management and operations complexity.

Evolution Options

An operator's need to migrate to a next generation network architecture depends on its current market segment and future expansion plans.

- Mobile operators would like to expand their subscriber base by providing an alternative to fixed wireline services.
- The fixed wireline carriers are trying to add mobility to their broadband service through expansion of WiFi access points and offering IP-based services like video.
- Long distance carriers are investigating IP-based transport options to deal cost effectively with shrinking long haul TDM transport bandwidth.

Many operator networks are extremely complex. Availability, reliability and QoS are critical to their customers. In order to maximize the return on investment (ROI) and minimize impact on their customers and services, operators should consider implementing their next generation network solutions in phases. However, each partial implementation needs to be well thought out and should not be deployed as a non-standard, customer specific solution.

In the following section, we describe some possible partial solutions and discuss their pros and cons.

Pre-IMS, Partial VoIP Networks

Traditional network solutions are vertical in nature. Any new service introduction involves the implementation of overlapping and often duplicate functions like provisioning, charging, routing, and presence. On the other hand, the IMS architecture is horizontally layered and modular in nature to allow reuse of common network functions, enabling the quick and easy delivery of new services.

A typical strategy adopted by operators is to gradually evolve their legacy TDM network into several intermediate phases before deploying a fully capable IMS network offering truly converged service. We refer to these intermediate phases as pre-IMS or partial VoIP. Figure 1 illustrates a typical evolution path to IMS.

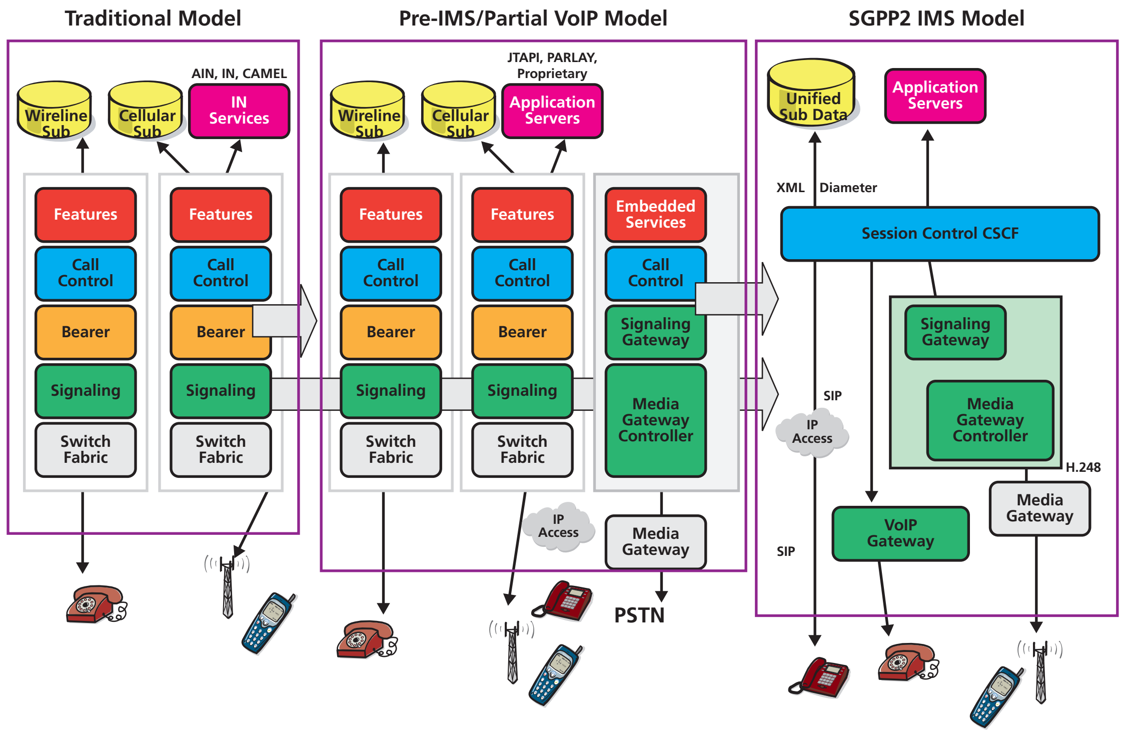

Figure 1. IMS Evolution Models

In a pre-IMS or partial-VoIP phase, one or more of the following changes is made to the network:

- Separate signaling and media by introducing signaling gateway and media gateway controllers in the control plane and media gateways at the edge;
- Addition or improvement of broadband IP access to the network;
- Introduction of standardized next generation protocols like SIP, MGCP, H323, MEGACO/H.248, and SOAP/XML as appropriate at various points in the network;
- Addition of feature servers to emulate and enhance traditional Class 4/5 services;
- Introduction of gateway MSC-based solution to simplify call flows and operations for wireless operators;
- Addition of application servers hosting IP-based services like instant messaging, unified messaging, video messaging and presence;
- Introduction of IP and SIP end points with access to traditional voice services and some new IP-based services as well;
- Introduction of IP Centrex to offer voice services to enterprise customers over existing IP infrastructure;
- Use of a SIP trunking mechanism to interconnect enterprise networks to PSTN networks – SIP trunking provides a pure IP pipeline to transmit enterprise voice, video and data through the carrier network.

IP Centrex and IP trunking are two of the common pre-IMS or partial VoIP network evolution strategies used by operators. They are discussed in more detail below.

IP CENTREX

IP Centrex is a set of IP telephony solutions for the business customers. It offers the entire feature set of legacy Centrex as well as IP-enabled features. As is the case with traditional Centrex, the service provider typically owns, operates and maintains the IP Centrex equipment, which provides the call control and service logic. There are two flavors to the IP Centrex architectures: One is a Class 5 switch-based solution and the other is softswitch-based.

In the Class 5-based architecture, the Class 5 switch is enhanced to support IP Centrex features in addition to existing POTS and ISDN lines. A new gateway network element at the operator's premises and one or more gateways at the customer premises are added between the legacy Class-5 switch and end user equipment. The two gateways in the network and customer site signal each other over a standard IP protocol like SIP or H.323. The network gateway connects to the switch as a DLC (digital loop carrier) system. It translates signals it receives from the customer gateway to a protocol that the switch understands, and converts any signal from the switch to IP while sending it to the customer gateway. The network gateway also mediates the bearer between the IP-enabled customer network and legacy Class-5 switch.

In the softswitch-based solution, the legacy Class-5 switch is replaced with a softswitch application. The softswitch provides call control and service logic functionality similar to a Class-5 switch. However, unlike a Class-5 based architecture, the bearer traffic will not flow through the switch. Once the call is set up between the two end points using IP protocols like SIP or H.323, the switch instructs the end points to send media packets between them. If one of the end points in the call happens to be a PSTN line, the switch instructs the other end point to transmit the voice packets to a PSTN gateway.

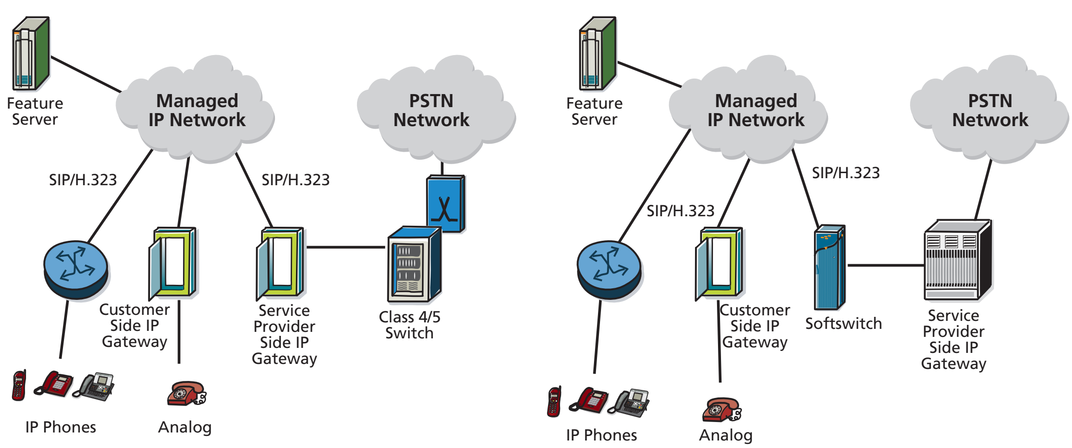

Figure 2. IP Centrex Solutions

Benefits of the IP Centrex based solution include:

- **Feature parity** - IP Centrex offers all the features and benefits of traditional Centrex.
- **Advanced features** - IP Centrex allows the service provider to offer advanced services like presence, location, unified messaging, and Instant Messaging (IM).
- **Consolidation** - Providers can group geographically distributed entities (e.g. main office, branch office, business partners, and employees with virtual offices) under a single IP Centrex.
- **Cost savings** - IP Centrex offers cost benefits by routing local and long distance inter-office communications over IP networks.

- **Simplification -** Businesses can combine voice and data traffic on their existing IP network – no need for dedicated copper lines for each user station.
- **Improved utilization** - Better bandwidth utilization with voice over IP. When phones are not active, the bandwidth can be used for other data related services. A single broadband pipe can carry many simultaneous calls. It is also easy to add new users and move existing ones without physical wiring changes.
- **Supports legacy user equipment -** With IP Centrex, businesses can continue to use their legacy POTS, ISDN phones by implementing Integrated Access Devices (IAD), or they can deploy IP-based end user devices to realize the full benefit of the features IP Centrex offers.

SIP TRUNKING

Corporations depend on their voice and data networks to meet their communication needs. Typically, corporate voice and data networks are disparate entities requiring redundant hardware, operations and maintenance costs. Although many enterprise voice networks are VoIP-based, their connectivity to PSTN usually goes through a gateway in the customer premises.

Enterprises that are already using VoIP and IP Centrex for internal communications can take advantage of a SIP trunking-based solution. With SIP trunking, businesses use a single pipe to connect their enterprise IP network to the service provider network to carry voice, video and data traffic. The SIP trunking eliminates the need for enterprises to operate and maintain separate connectivity to the PSTN and data networks. The SIP trunk also acts as a logical voice channel between service provider voice equipment and enterprise voice equipments that interoperates over an IP network.

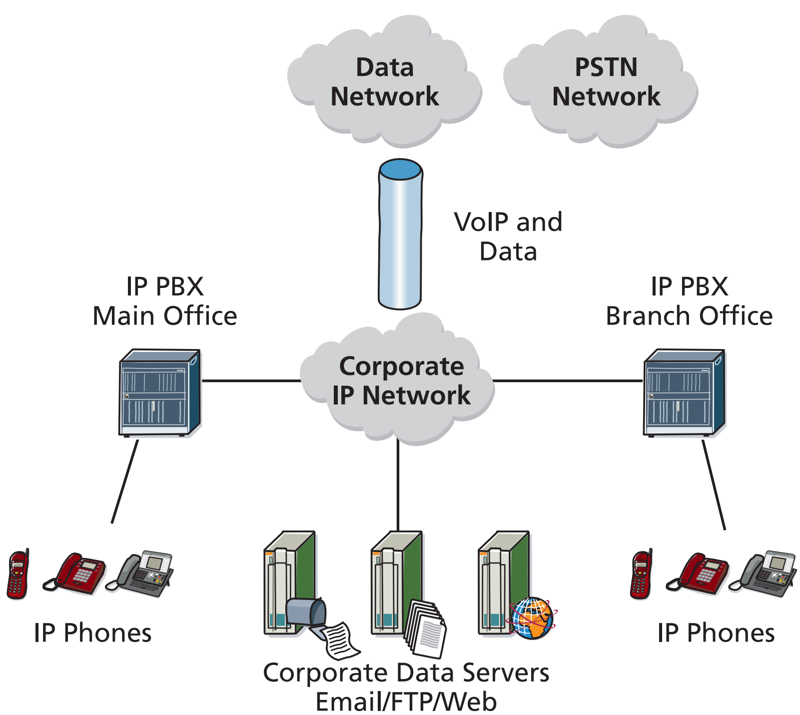

Figure 3 Corporate SIP Trunking

Corporate networks can avoid long distance charges by using their IP network for inter-office toll replacement. Large toll service providers not already providing VoIP services may choose to save on expensive growth of TDM network bandwidth by using flexible, high bandwidth IP networks to provide transport between their regional toll switches. Many service providers have already opted to use lower cost SIP-based IP trunking paths to make the long haul transport between national or international toll gateways that inter-connect various local PSTN networks.

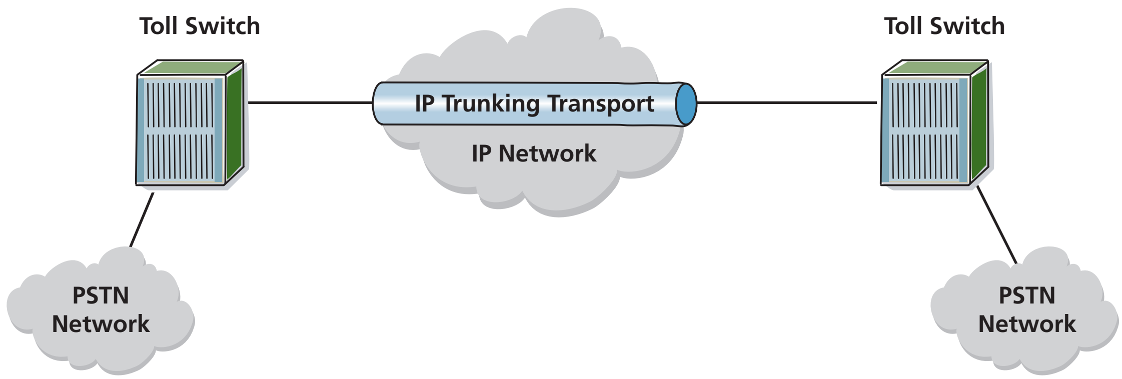

Figure 4. Toll Inter-connect IP Trunking

Some of the benefits derived from implementing a SIP trunking solution include:

- **Simplification** - The enterprise IP network can now carry voice traffic along with the standard corporate data traffic, including e-mail, instant messages, and Internet and intranet data. The voice traffic is simply an application overlay on top of the enterprise IP network.
- **Toll savings** - SIP trunks also enable enterprise locations to be connected through IP which eliminates toll charges for inter-office communication. For example, a corporate headquarters and its branches can be connected through a common SIP network and bypass the toll based PSTN network altogether. The enterprise long distance calls to PSTN will not be converted to PSTN until the very last mile. This drastically reduces the corporation's long distance expenses and eliminates the need to maintain and operate gateways on their premises for PSTN connectivity.
- **OPEX savings** - The SIP trunk can connect the enterprise network to the carriers PSTN gateways eliminating need for corporations to operate and maintain TDM circuit trunks. For large long distance service providers, SIP trunking allows aging, long haul, fixed bandwidth TDM transport networks to be replaced with flexible bandwidth IP transport networks that connect geographically remote gateway PSTN switches.
- **Advanced services** - By providing a pure IP link to the enterprise network, the service provider is now able to offer advanced blended services to its enterprise customers.

Full IMS Networks

IMS is an access agnostic, multimedia and telephony core network with standardized interfaces between applications, different layers, and back-office systems. Implementation of the various layers and interfaces per the 3GPP architecture model and a network's ability to offer true converged services is referred to as "full IMS". The term was coined to differentiate the full IMS deployment from the partial or phased implementation scenarios discussed in this document. We use the term interchangeably with "IMS" in this paper from this point forward.

Some of the key benefits of an IMS implementation are:

- **Standardization** - IMS architecture is layered and more modular, with open standards-based interfaces between the layers.
- **Convergence** - IMS brings together wireline, wireless, broadband, voice, video and data networks. IMS enables convergence of devices and services as well.
- **Common OSS** - IMS enables operators to move away from vertical, complex network infrastructure with overlapping functionalities for call control, billing, presence, directory services, OAM, etc. IMS facilitates reuse of the service enablement layer and common core and back office functions.
- **Blended services** - IMS enables operators to quickly and cost effectively deploy revenue generating, blended services across a wide range of access network and devices.
- **Security, QoS** - The layered architecture enables operators to provide end-to-end QoS and security for their users.

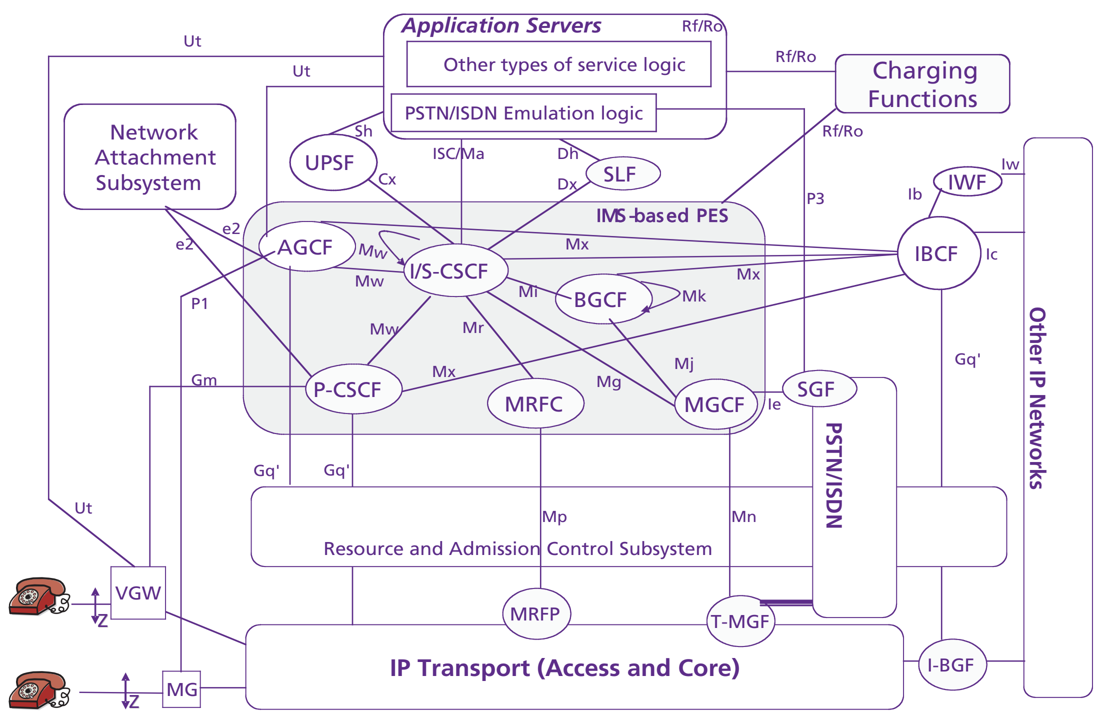

Figure 5. TISPAN TS 182 012 Full IMS Architecture

Transformation from Pre-IMS Partial VoIP to Full IMS Architecture

A great variety of VoIP network applications are available today. In many cases these are offered by small, single purpose providers – for example VoIP call centers with application servers, VoIP handsets, and MGC/SG/MG controlled access to other service provider PSTN networks. Companies providing these single purpose networks probably have no immediate motivation to expand to a full service IMS core network. However, larger, multi-purpose network service providers that deployed early pre-IMS VoIP or SIP trunking networks, may need to consider, either now or in the near future, whether or not they should transform their networks to a full IMS architecture.

For example, a large service provider with legacy wireless, Class 4 toll and Class 5 fixed line networks, may have implemented SIP trunking using NGN MGC, SG and MG network elements to provide low cost, flexible bandwidth transport within their toll network, while leaving legacy Class 5 and wireless networks in place. Although this architecture has worked well, the marketplace has changed and the service provider is starting to feel the pressure to upgrade its wireless service to full 3G UMTS and to add VoIP subscriber services to its existing network. If the service provider moves forward using legacy network growth procedures, they now implement two new, stand-alone networks that will interoperate with existing networks through gateway switches –probably MGC/SG/MG softswitch gateways.

While the benefits of VoIP and 3G services are realized in this scenario, the operational environment has become much more complex and no progress has been made towards improved interoperability and transparency across the various network topologies. This is precisely when a service provider must seriously begin to consider the benefits of convergence of their various networks under a single IMS services platform.

A converged network will provide common services, session and transport layers. Also, with IMS PSTN Emulation Service (PES), fixed line subscribers (POTS and ISDN) can be brought under the common IMS umbrella. All subscriber services can then be managed from the same application servers, making interoperation and transparency between a subscriber's various devices (wireless and fixed line) a real possibility. There are, however, a number of considerations that require careful study before a decision to undertake a complete transformation to an IMS based network can be made.

From an end user experience perspective these considerations include:

- At this time, 100% transparency between legacy Class 5 switch-based services and IMS PES application server-based services is not available. A high level of similarity may be achievable, but close attention must be paid to a thorough analysis of existing service implementations and the variants available on the proposed platform. The operator should prepare its end users up front to expect changes in their existing services, while at the same time emphasizing new services and capabilities that will result from the transition.
- Not all physical interfaces may be supported on the new access platforms required to implement the IMS PES architecture. Again, careful initial study of all the access interfaces on the legacy network and support for these interfaces on the proposed IMS platform should be undertaken. It may be prudent to upgrade dated CPE to enable use of supported interfaces.

Considerations from a network implementation perspective include:

- IMS architecture is based on SIP for call control signaling. Some legacy networks use H.323 for IP Centrex UE signaling. If the operator's network includes such equipment, careful consideration must be given to how it can be integrated into a SIP-based IMS network. Options include use of protocol converters at the edge or upgrading the existing equipment to SIP-based IMS ready application servers and UEs.
- The IMS transport layer is IP-based and the readiness of the existing IT infrastructure to support the increased traffic and complexity of a much enlarged IP transport demand must be examined. It may be necessary to redesign and expand the existing IP network to support the increased demand from the many IMS network elements such as CSCF, HSS, AS, DNS, and ENUM.
- While pre-IMS networks may have existed on stand-alone LANs with minimal security issues, implementing full IMS increases IP transport complexity, requiring a more robust and secured environment. Evolution to an MPLS/VPLS network, addition of fire walls and session border controllers, and implementation of Quality of Service policy are just a few of the IT infrastructure issues that must be studied and resolved before committing to a full transformation.
- Compared to a TDM network, operations within an IP infrastructure – such as provisioning procedures, alarms management, billing, voice quality problem isolation, performance metrics and lawful intercept – are very different. For example, these operations totally change when applied to IP voice networks. A careful study of operations readiness for such a large scale transition from TDM to IP should implemented in advance of committing to the transformation process. This will at least ensure a full awareness of the costs implied in preparing the operations staff to support the network.
- Keeping in mind the changes in capabilities that come with the new IMS architecture, the service provider will also need to review its business model and evaluate its business readiness to manage the expanded services environment.
- Once the decision is reached to evolve to a full IMS architecture, a thorough migration plan should be developed early in process.[1]

Additional Considerations Concerning a Phased Evolution to Full IMS

For those service providers who have not yet deployed IP-based voice platforms, the pressures to either replace overloaded TDM transport networks with SIP trunking or add new VoIP-based services to their portfolio, are becoming irresistible.

There are two primary options: Launch a "big bang" complete transformation of their legacy network to an IMS architecture; or start with a pre-IMS IP voice application and gradually evolve to full IMS over time. The second option can provide a viable, cost effective approach for many service providers.

With respect to partial VoIP to IMS evolution, there are a few considerations which, if addressed in the initial partial VoIP network design, will make the transition to full IMS easier. Included is the re-use of partial VoIP equipment in the evolved full IMS architecture. All IP voice networks have an IP transport network in common. While initial partial VoIP networks may not have the security, capacity and QoS capabilities comparable to a fully integrated IMS network, the design of the IP infrastructure should meet the requirement to evolve to a higher capacity, more robust architecture before transitioning to a full IMS

1 For detailed discussion on migration planning topics, see the Alcatel-Lucent papers "Migrating Millions to IP a Mission Impossible? - Not with a Migration Control Center" and "Minimizing Subscriber Migration Costs for Data Validation"

solution. Equipment should be selected that is modular and supports capacity growth with minimal expense and effort. The equipment should also support routing, security and QoS capabilities that will be required by the IMS network, even if the full capabilities are not used in the initial NGN network.

In general, the final IMS architecture should be thoroughly researched and high level designs completed before deploying the partial VoIP architecture. This approach allows the partial VoIP design to include design criteria that will facilitate the evolution to full IMS.

The partial VoIP design should take into account the use of equipment that is IMS ready – for example, select application servers and VoIP UE that work with SIP as the IMS base call control signaling protocol.

The service providers will want to analyze the legacy fixed line network services and interfaces with respect to their support on the IMS PES platform anticipated for the final architecture early in the transition. This allows them to develop a strategy to evolve unsupported or under supported services and interfaces to services and interfaces that can be more effectively migrated to the anticipated IMS PES platform.

They can also use the partial VoIP deployment to develop an operational IT infrastructure that can meet IMS's more complex support needs.

Conclusion

The IMS architecture provides a framework for developing large, converged service provider networks offering support of legacy fixed line and wireless access along with newer IP-based, 3G capabilities and blended services that span the different access devices. While not all service providers will benefit from the complex services portfolio IMS offers, many larger service providers are interested in evolving their networks to a full IMS architecture.

There are several approaches to moving a legacy network to full IMS architecture. A complete transition from a legacy TDM architecture is one option, which some service providers are selecting. For others, who have already implemented pre-IMS partial VoIP networks there may be the possibility of re-using the existing infrastructure to evolve to a full IMS network. Even for operators who have not yet ventured into IP voice networks it may be more effective to initially deploy a partial VoIP solution with a plan to evolve over time to full IMS.

For either of the partial VoIP paths there are several issues which most be addressed before proceeding. When starting with a earlier implementation of a partial VoIP network it is most important to evaluate the IMS readiness of equipment, infrastructure and operations processes. If planning a new partial VoIP network as a preliminary step to a full IMS transformation, it is important to work first through the details of the final IMS design so that the partial VoIP design can incorporate IMS network ready components and IT infrastructure that will facility re-use and ease of expansion during the transition to the final IMS network.

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During his career, Stern has also written three books as well as a variety of articles and white papers on IP network, network security, and directory services. Recent papers have focused on IMS Security and IMS peering. He was a contributor to the USTA IMS Implementation Guide, published in October 2006 and to the IEC publication "Business Models and Drivers for Next-Generation IMS Services", published in August 2007.

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During his tenure with Alcatel-Lucent, Jose has been assigned to several key international projects as technical lead and consultant.

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