



NAVIGATING THE
COMPLEXITIES OF
IMS FROM
DEVELOPMENT TO
REVENUE
GENERATION

A Stratecast Partners White Paper
Sponsored by Empirix, Inc.



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INTRODUCTION

IP Multimedia Subsystem (IMS) is moving the communications industry towards a new business model. No longer are proprietary solutions with long development cycles and network-centric applications the solution for the network equipment manufacturer or service provider community to enable feature-rich services.

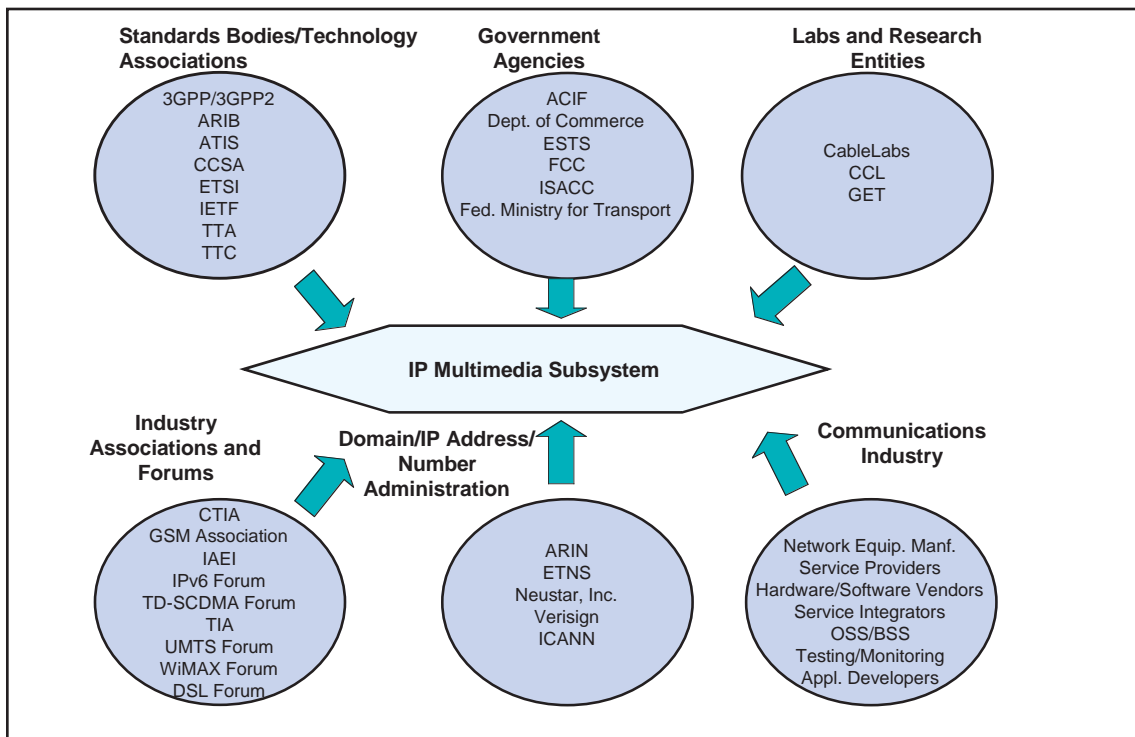
Traditionally, end user, network, testing/monitoring, and maintenance applications have been dictated by the access and network infrastructure equipment capabilities and feature sets. These applications have been integrated into the legacy equipment and the ability to customize has been extremely limited. However, these applications due to their proprietary and static nature and long development timeframes are very reliable and provide a high quality end user experience. This quality and reliability needs to be duplicated in the IMS environment and applied to real-time, next-generation applications but in a much quicker timeframe across diverse networks and devices.

The IMS reference-architecture has been developed and continues to evolve to enable any device, any access, voice, video, data, and multimedia applications. IMS is a reference-architecture that defines functions within a three-layer architecture consisting of (1) the access/transport/device layer, (2) the control layer and (3) the applications layer. Within each layer and between layers there are interoperability and interworking requirements for equipment, sessions, applications, and vendor variants. This extremely distributed and multi-vendor environment changes the landscape and requirements for applications development, deployment, testing/monitoring, and maintenance and support.

IMS incorporates a multitude of standards developed by numerous standards bodies, as well as incorporating input from industry forums and associations, equipment manufacturers, service providers, and other entities. It is important to note that Multimedia Domain (MMD) is sometimes used synonymously with IMS, for this whitepaper IMS includes MMD. MMD focuses predominantly on CDMA-based wireless radio access network architecture.

Figure 1 below illustrates the standards bodies, agencies, and overall IMS community that are involved in IMS development. While this ensures multi-vendor, best of breed solutions that will ultimately enable any access, any device, any service it also adds to the complexity of IMS; complexity from the development of IMS infrastructure to in-service operations. This is a radical concept when compared to legacy single vendor, single component, proprietary networks, and applications.

Figure 1: IMS Industry Participants



Source: *Stratecast Partners*

One of the primary drivers of IMS deployments are the applications that enable quick revenue generation and ARPU enhancement, as well as enabling service providers to utilize existing network assets while moving to an all-IP infrastructure. Migrating to an all-IP infrastructure and the benefits that IMS offers will take extensive planning, well thought out processes, and a change in strategy towards partnerships versus a build within strategy. This new strategy will require stringent deployment and testing processes at the NEM and service provider level but these processes will need to be repeatable as well as customizable and will need to be performed in quicker timeframes to meet quick time to market requirements.

The IMS open-architecture, underlying standards, and open-development environment change the entire communications industry by making multi-vendor solutions the norm versus an anomaly. This also adds complexity for the NEMs and service providers as the multitude of options for deployments, vendors, solutions, and applications is increased substantially. However, the high standards for service quality, reliability, and scalability will still be expected by the service providers and their customers. The need to offer more varied services in quicker timeframes will create new challenges for both the NEM and service provider community.

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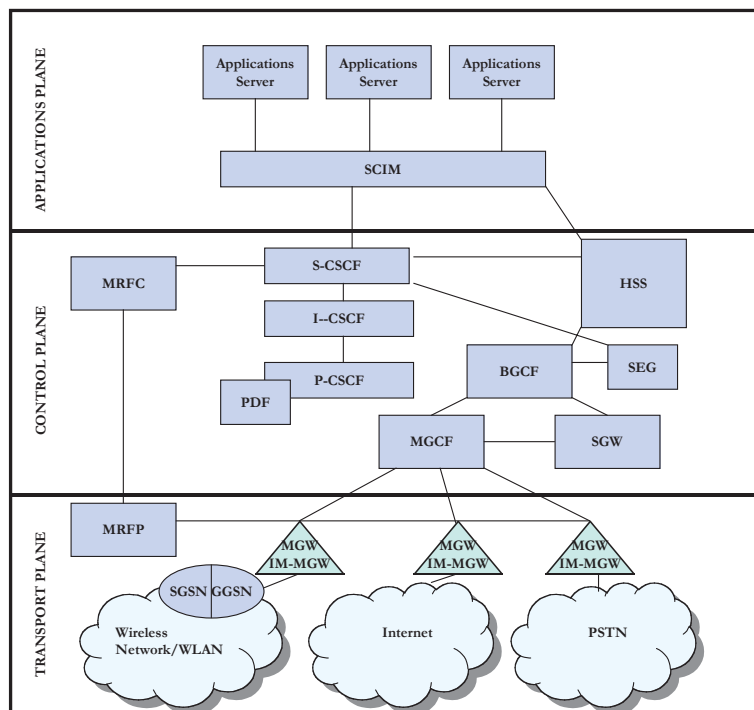
Service providers will take many approaches to enabling IMS in their networks and will continue to leverage the assets of their TDM networks. IP and legacy applications and infrastructure will co-exist. Whether the service provider starts at the applications layer, control layer, or access/transport layer, the new network elements must work seamlessly with legacy infrastructure elements and provide both legacy and next-generation applications and services. Additionally, service providers will rely on their vendors to provide them with pre-integrated, reliable solutions as well as bringing in other vendor solutions. This will necessitate a close partnership between the lead equipment manufacturer as well as service integrators and single solution vendors to ensure a smooth transition to a next generation network. Extremely well coordinated deployment practices that utilize best of breed processes and tools to ensure that the applications work and are seamlessly integrated will be a critical requirement.

HIGH LEVEL VIEW OF THE MAJOR IMS FUNCTIONS

IMS defines functionalities within each of the three-layers, is based on multiple standards and defines convergence of the wireline, wireless, and Internet domains. Figure 2 represents a high level view of the architecture and key elements and components that reside in each layer. Deploying and integrating all or a portion of these elements over existing legacy infrastructure and having them interoperate seamlessly is a large, complex undertaking.

“Extremely well coordinated deployment practices that utilize best of breed processes and tools to ensure that the applications work and are seamlessly integrated will be a critical requirement.”

Figure 2: IMS Architecture



Source: *Stratecast Partners*

IMS ARCHITECTURE INSIGHTS

The flexibility and complexity of the IMS architecture is exponentially greater than traditional legacy networks. As IMS is a standards-based architecture that describes functions, not devices or products, there are many options for deployments as well as vendors, services, integration scenarios as well as testing, operations, administration, and maintenance requirements. The key differentiators of the IMS architecture for fixed, mobile, and application convergence versus legacy architectures that add to the complexity gained by its inherent flexibility are:

- Multi-vendor, best of breed deployment options.
 - The IMS reference architecture defines functions within each layer. This promotes solutions that involve many vendors at each layer. The multi-vendor strategy will require the NEMs to work with more partners thus requiring them to perform more varied interoperability testing for their customers.
- Integration with existing network infrastructure versus a complete network forklift to utilize new technology.
 - The new architecture will need to interoperate with existing network infrastructure so the number of vendors within any network will grow significantly.
- Next-generation applications with different bandwidth, QoS, access and operations and maintenance requirements.
 - Voice, video and data all have different QoS requirements from a bandwidth, class of service and end user perspective. The ability to monitor and change requirements in a real-time environment will become increasingly important.
- Combinational applications deployed across diverse networks and multiple devices.
 - Both NEMs and service providers must be able to test and monitor these applications both separately and in conjunction with each other.
 - Real-time monitoring will become significantly more complex as customers use the same "pipe" to receive and use multiple services and applications.

Service providers will need to test, monitor, and gauge performance within their own network and end-to-end across other provider networks.

- Shorter timeframes for applications and services deployments.

Three-year development times for new applications and infrastructure features will no longer be acceptable due to increased competition in the industry. Additionally, applications for specific target markets will become more prevalent. Customizable applications will be required in order for service providers to increase their market-share.

- Standards that are not mature and continue to develop.
 - As IMS continues to develop and realize the goal of any access, any device, the standards will evolve to include all access, device, and applications types.

IMS ARCHITECTURE BENEFITS AND RISKS

As with all new technological developments and enhancements there are benefits and risks of deploying technology that is not mature; and IMS architecture and subsequent applications are not mature. Once the standards become mature there are still new requirements that IMS brings to the NEMs and service providers that traditional infrastructure does not. Over time the benefits of IMS will far outweigh the risks. However, NEMs and service providers need to be able to mitigate the risks now and deploy new applications now in order to leverage the benefits of a converged network, enhance their revenue stream by providing next-generation applications, and reduce the cost of deploying next-generation applications.

The processes and tools that the NEMs and service providers utilize will be a key element for successful implementations. IMS promises plug-and-play services but until the underlying deployment processes are developed, this plug and play environment will not be a reality. Both the underlying infrastructure as well as applications will need to have strict deployment, testing, and implementation guidelines in order to be successful. Internal, external, and joint deployment processes will also be required.

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Some of the main benefits and risks to deploying IMS architecture and related next-generation applications are outlined below:

Figure 3: IMS Benefits and Risks

<i>Benefits</i>	<i>Risks</i>
Utilization of existing network assets.	IMS standards are a work in progress.
Increase ARPU and reduce churn.	Due to the highly distributed nature of IMS, it is very complex with many network components/elements.
Open source development environment.	Open source applications create another level of complexity.
IMS solutions provide a clear migration path from legacy networks to all-IP networks.	As applications need to be available from multiple access types and networks, end-to-end QoS is hard to manage and enforce.
IMS reduces opex and capex costs due to network convergence.	Flexibility creates more opportunities for interoperability challenges.
IMS standards have incorporated existing standards (SIP, H.264, etc.) rather than re-inventing new ones and the 3GPP works with other standards bodies to incorporate legacy and next-generation compatibility.	Multiple CODECs, signaling types, SIP versions, equipment components, and vendor solutions will need to be operated, maintained, and managed.
IMS can be implemented incrementally versus a complete network overhaul.	IMS creates another layer of network infrastructure until the network is completely transformed into an all-IP infrastructure.

Source: *Stratecast Partners*

WHAT ARE SOME APPLICATIONS THAT ARE ENABLED BY THIS CONSOLIDATED IMS APPLICATION CORE NETWORK?

IMS applications exist in all three layers of the IMS architecture and will increase as the standards become more mature and as IMS infrastructure is implemented.

- Applications in the access/transport layer are those applications that enable the devices, regardless of access type (ADSL, UMTS, PON, cdma2000, PacketCable, WiFi, WiMAX, etc). As the type and number of devices increase and are not tied to the network operator, the ability to enable these devices in a real-time basis, not compromise network integrity and be able to push services to the device becomes a very critical function.
- In the access/transport and control layer the applications that converge the wireless and wireline networks will be critical as well as those applications that enable migration to an all-IP infrastructure. As there will be IMS and legacy elements within each layer for some time to come, interoperability becomes a much larger issue within the network infrastructure.

- Applications in the applications layer are many and varied. There are applications that enable a service provider to utilize existing legacy applications across disparate networks. An example of this type of application would be one voicemail box for your wired and wireless phone.
- Combinational applications are those applications that combine elements such as adding presence capabilities to conference calling so the moderator can set up a real-time call knowing in real-time where and if the participants are available.
- VoIP is a "foundation" application as it is being deployed now and needs to be added to existing infrastructure quickly to answer to competition pressures. End users have a very high expectation for voice that they do not have for some of the newer multimedia services so getting VoIP "right" is an added imperative. VoIP will often be the first step a service provider takes to offer next-generation services.
- Next-generation applications include multimedia (voice, video, and data) services such as real-time push or pull location services, sharing of data across disparate networks, and streaming IPTV over multiple devices, etc.

These varied applications add additional levels of testing and monitoring requirements for NEMs and service providers. The NEMs and service providers will need to work with companies and testing and monitoring tools that are able to support applications that are available today, as well as have the desire and potential to support next-generation applications.

What is the killer application, the second application? A service provider wants to lock in the subscriber (enterprise or residence) with high-speed data and video, data and voice, consolidate the services into a single account, and enable the services from common devices/set-top-boxes. The second application greatly increases the reluctance of the subscriber to change provider, and the service provider that retains their installed customer, expands the attraction to new customers and increases the revenue per user through new and on-demand applications, and utilizes a more cost-effective single application core network greatly increases their revenues, market-share, and success.

DEVELOPMENT AND PRE-DEPLOYMENT CONSIDERATIONS WITH IMS: BUILDING YOUR TEST PLAN

In order to implement IMS architecture, provide quick time-to-market applications, and be able to manage the complexities of the network there are key deployment, monitoring and maintenance functions and tools that can assist the NEMs and service providers in being successful.

Each component within the infrastructure must be tested for reliability, scalability, security/integrity, interoperability, and baseline performance to ensure it meets both the vendor requirements and subsequently the service provider requirements.

At the access/transport layer, control layer, and applications layer interoperability between network infrastructure components must be tested at the equipment, application, and underlying protocol level. Network equipment manufacturers will need to test their own equipment as well as other vendor equipment for interoperability and performance characteristics. Service providers will expect their vendors to provide pre-tested multi-vendor solutions as well as bring new equipment to the solution and expect their vendors to enable interoperability.

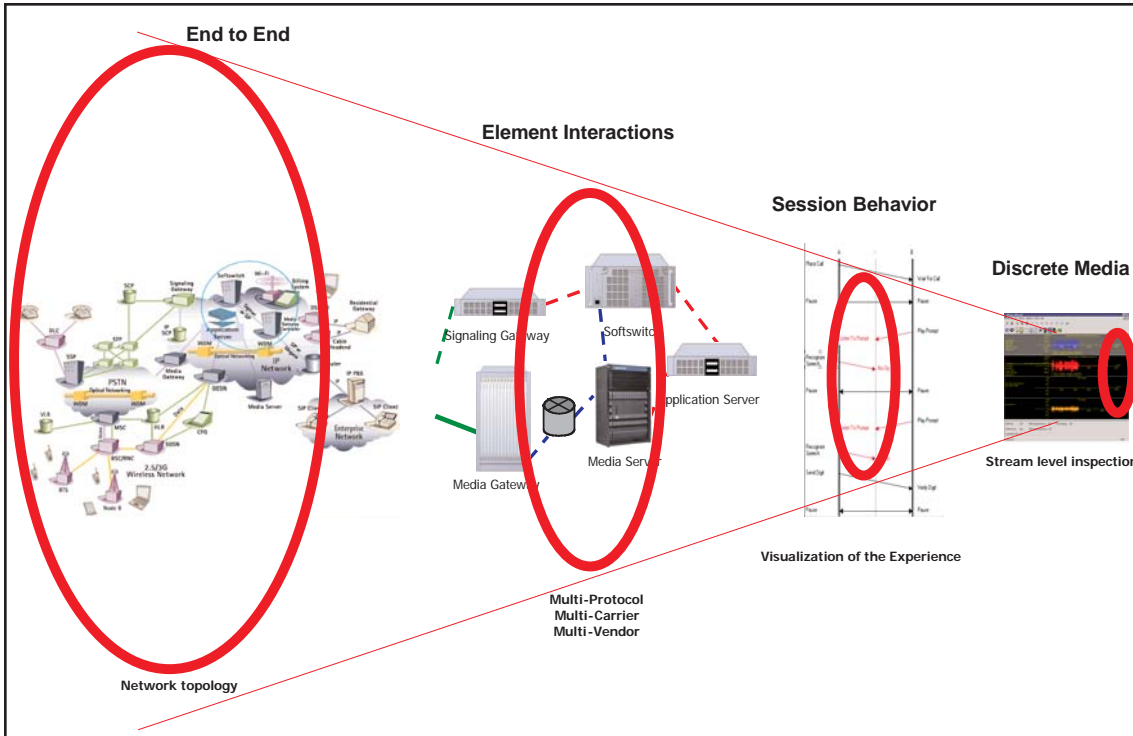
The service provider will need to be able to test across disparate internal networks as well as test across multiple external networks in order to provide the end user with a quality service and user experience. The end user will expect quality end-to-end performance regardless of device or network.

All applications will need to be tested both separately and in conjunction with the other applications on the network to ensure compatibility, interoperability, and bandwidth availability. Packet and session level testing and monitoring will be required to ensure the quality of each type of session. Specific applications such as VoIP and others will need to be monitored and tested for specific quality parameters such as delay, jitter, and latency, but more importantly will need to be tested for these parameters in conjunction with the other applications that are running simultaneously.

Different tools may be required for different tests for equipment interoperability, applications interoperability, network performance, network quality of service, network reliance, and individual applications performance as well as interaction testing. However, it is important for NEMs and service providers to be able to rely on as few vendors as possible for testing and monitoring in order to develop internal processes and guidelines to implement quick, reliable services and network components. These vendors will need to be able to support the diverse IMS protocols, equipment, and applications.

Testing, monitoring, operations, and maintenance become more complex and a critical element to success in the new open-standards IMS network at all levels and layers. The complexity of the interactions and multiple testing requirements is depicted in the following drawing. IMS adds complexity by just the sheer quantity of network components, functional elements, applications, architecture layers, and domains that need to interact with each other. Figure 4 below depicts the end-to-end performance and monitoring requirements required to successfully implement and maintain the IMS architecture.

Figure 4: End-to-End Performance and Monitoring Testing "Narrowing the Aperture"



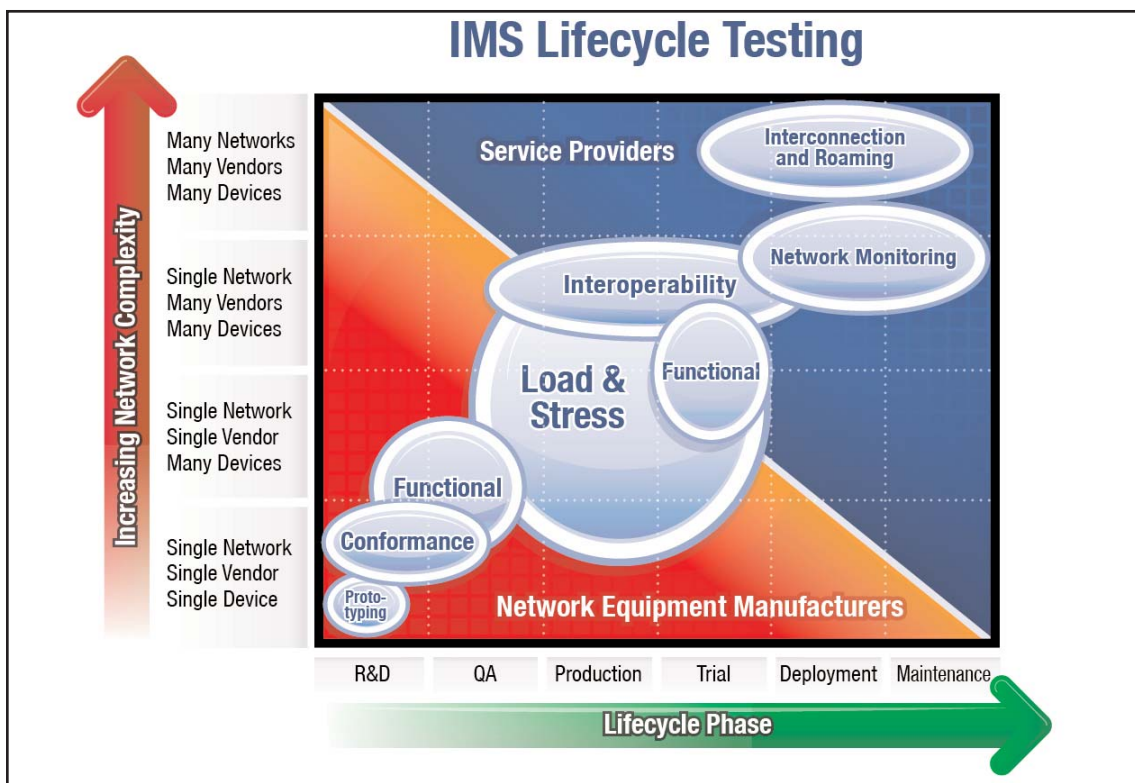
Source: Empirix

WHAT IS THE SOLUTION TO MITIGATE COMPLEXITY AND ENSURE SUCCESS?

It is well known that successful network deployments require a substantial amount of testing both in labs and real time environments. Due to IMS' inherent complexity and the need to test across layers, network equipment, devices and applications and the ability to test disparate signaling, media, protocols, transcoding, and end-to-end performance the testing and monitoring function becomes even more critical with the media-rich, stateful applications.

Both service providers and equipment manufacturers can reduce deployment costs and manage the complexity by choosing vendors and testing tools that can perform a wide variety of testing functions. By utilizing fewer vendors and tools, specific processes for testing, monitoring, and maintaining networks can be optimized as well as be customized when the situation warrants. Moreover, taking traces from live traces for offline analysis, detailed media, signaling diagnostics, and call trace regeneration. Figure 5 illustrates lifecycle-testing requirements.

Figure 5: Lifecycle Testing



Source: Empirix

THE EMPIRIX PORTFOLIO OF SOLUTIONS TO ENABLE THE TRANSITION FROM NGN TO IMS

Empirix, Inc. has a history of enabling next-generation testing, monitoring, and performance tools. They are focused on today's applications as well as the next-generation applications and convergence that IMS enables. To validate Empirix's recognition of the changing communications industry and their innovative products to support this fact, Empirix has a long list of product "firsts" that support new and legacy networks, applications, and devices.

- Empirix's product innovations include the first test system to recognize voice prompts and integrate voice and data test capabilities into one.
- Empirix has recognized the need to provide tools that enable uniform testing processes; this is evident by their standard scripting tool and standard voice quality assessment tools.
- Empirix has developed a highly scalable, blade-based testing solution that is capable of testing bearer traffic using both VoIP and TDM signaling.

- For load testing, Empirix developed the first call generator tool capable of supporting H.323, and SIP, and expanded the product to include MGCP, SCCP/skinny, SIGTRAN, SS7, CAS, ISDN, H.263., and H.264, etc.
- On the application level Empirix is the first vendor to enable a multimedia and VoIP specific test tool including network processors, emulating and correlating signaling, and media sessions.

Empirix has developed testing capabilities, measurements, and multi-faceted testing and monitoring solutions to ensure successful application development, deployment, and operations:

- **Verify core elements of the IMS architecture**
 - Positive and negative test solutions.
 - Solutions spanning signaling, media, applications, features, TDM, and IP.
 - SIP-centric functions and IP transport.
 - Vendor specific applications and protocol variants.
- **Verify interoperability and interworking**
 - Applications (i.e., video telephony, voice conferencing, push to talk, etc.).
 - Devices from multiple manufacturers to interoperate.
 - Legacy and new protocols to inter-work (i.e., SS7 to SIP, H323 to SIP, MGCP to SIP).
 - Layers of the IMS architecture to co-exist effectively (transport, control, applications).
 - Convergence across wireline and wireless network within a carrier network and across service providers (i.e., transcoding functions, end-to-end voice quality, etc.).
- **Faster pre-deployment assessments & smoother IMS network activation**
 - Feature test.
 - Load, Interworking test.
 - Regression and Quality Assurance with Automation.
 - Diagnostics and Service Monitoring.
 - Characterizing the end-to-end performance and experience through and between multiple networks, devices, manufacturers, hops, and topologies.

Empirix, Inc. is a test solution provider that offers test instrumentation, diagnostic, and services monitoring tools across the IMS layers, and is able to reduce the complexity of deploying IMS and IMS applications. Empirix provides testing, diagnostics, and services monitoring tools for existing TDM, NGN, and IMS network architectures.

Key elements of the Empirix solution that enhance the benefits and mitigate risks outlined in Figure 3 above are:

Figure 6: Empirix Solution Se Related to IMS Benefits and Risks

IMS Risk Mitigated	Empirix Solution	IMS Benefit Enabled
Multiple CODECs, signaling types, SIP versions, equipment components, and vendor solutions will need to be operated, maintained, and managed.	The ability to test and verify core network elements including signaling, media, applications, and features in both the legacy (TDM) and next-generation IP IMS infrastructure.	Utilization of existing network assets.
Multiple CODECs, signaling types, SIP versions, equipment components, and vendor solutions will need to be operated, maintained, and managed.	The ability to test standards protocols such as SIP, SS7, H.323, and MGCP as well as the interworking between the protocols.	Utilization of existing network assets.
IMS creates another layer of network infrastructure until the network is completely transformed into an all-IP infrastructure.	The ability to test the interoperability between wireline and wireless networks as well as verify interworking between multiple service provider networks including transcoding functions and end-to-end voice quality.	Increase ARPU and reduce churn.
Open source applications create another level of complexity.	The ability to test both standards-based and vendor specific applications and protocols.	Open source development environment.
Multiple CODECs, signaling types, SIP versions, equipment components, and vendor solutions will need to be operated, maintained, and managed.	The ability to verify interoperability between different manufacturer devices.	Utilization of existing network assets. Open source development environment.
IMS creates another layer of network infrastructure until the network is completely transformed into an all-IP infrastructure.	The ability to perform feature testing, load testing, regression, and diagnostic tests for multiple network infrastructure components both separately and interoperability between the components.	IMS reduces opex and capex costs due to network convergence.
Flexibility creates more opportunities for interoperability challenges.	The ability to test and visualize the actual session to see specific performance parameters within the session. This enables the service provider to see and the equipment vendor to see customized characteristics tailored for specific session types such as voice, video, and data.	IMS standards have incorporated existing standards (SIP, H.264, etc.) rather than re-inventing new ones and the 3GPP works with other standards bodies to incorporate legacy and next-generation compatibility.

Source: *Stratecast Partners*

Empirix provides tools for development, pre-deployment, and operations of IMS infrastructure and applications. Empirix testing and monitoring tools are solutions that span the industry from the user to the manufacturer. Empirix products and solutions include support for contact centers, VoIP equipment manufacturers, IMS equipment manufacturers, and service providers as well as web application developers, enterprises, and users. The products are designed to support extensive lab environments, real-time test and monitoring for service providers and their customers and self-service, web-based tools for enterprises. Empirix provides both public and private test services through their partner CT Labs. Empirix's IMS testing and monitoring solution portfolio includes:

- VoIP through IMS functional test (desktop test to rack-mount solutions)
 - Hammer FX
- VoIP and Fax troubleshooting
 - Hammer Call Analyzer (commonly known as the HCA www.callanalyzer.com)
- IP Network Emulation and Disaster Recovery for Enterprises and Carriers
 - Hammer NetEm
- Ultra-High Density end-point load and stress (TDM/IP)
 - Hammer NXT
- IMS Device Emulator (simulates NGN core infrastructure)
 - Hammer DEX
- NGN through IMS service and network monitoring
 - Hammer XMS

Empirix is active and leading in "shaking out" the IMS application core as they have evolved their product line to address new technology trends and have developed key products to support a diverse community of customers, technologies, solutions, and trends. Key technologies and trends include:

Signaling Trends

- Long duration, complex, SIP based, dynamic signaling protocols.
- End-to-end coverage from TDM to IP devices and applications.
- Multitudes of standards and vendor variants.

Media Trends

- The network is becoming more intelligent, so are the devices.
- Media servers, application servers, software delivery platforms are becoming leading infrastructure components.
- Bearer channel support, DSP voice quality, speech recognition technology.

Convergence Trends (wireless/wireline, transport/control/applications)

- TDM and IP support.
- IMS at the applications layer.
- Voice, Video, Data, and Security.

CONCLUSION

The promise of lower network costs, higher per subscriber revenues, a converged network, and access and device-agnostic applications that enable differentiation between service providers is the realization of 100 years of communications innovations. IMS is the architecture that will enable this to occur. Implementing IMS is complicated but utilizing tools, processes, and deployment guidelines that can be standardized and customized will help in reducing the risks that come along with the complexities.

Vendor testing and performance monitoring solutions that have demonstrated the ability to support multiple protocol, equipment, application, and technologies while continually providing new innovative products and solutions will enable the NEMs and service providers to deploy IMS and IMS applications by providing the tools, value, and peace of mind needed to move towards the next-generation architectures.

Although service providers will rely on their equipment manufacturers for pre-integrated multi-vendor, best of breed solutions they will also bring additional vendors to the table to share the responsibility of end-to-end interoperability and performance with the equipment manufacturers. End-to-end performance testing regardless of network, device, or application will become increasingly important for the service provider to keep customers on their network. End user demands to use devices not tied to specific networks will become increasingly important and service providers and their vendors will need to be able to support this requirement.

All of these non-proprietary, multi-vendor solutions and complexities that IMS brings to bear can be overcome by employing solutions that match the diversity of IMS itself and enable strong performance testing and monitoring capabilities across networks, devices, and applications.

Empirix has proven its ability to stay ahead of the technology curve, provide diverse solutions for testing and monitoring, and enabling the goal of quick, revenue generating application deployment.

ABOUT EMPIRIX, INC.

Empirix is an established test and measurement company with 16 years heritage in voice applications development.

Founded in September 2000, Empirix combines the award-winning Web test and monitoring solutions of RSW Software (est. 1997) with the industry-leading voice and network test solutions of Hammer Technologies (est. 1990). The result is a unique, comprehensive response to the testing, monitoring, and performance management needs created by the ubiquity and convergence of Web, voice, and network technologies. No other company offers this breadth of expertise and range of integrated solutions.

A Commitment to Innovation

Empirix has compiled an enviable record of firsts, including these breakthroughs:

- First to provide a full integrated development-through-deployment testing solution specifically designed for Web applications
- First to market with voice over IP testing solutions
- First to provide a comprehensive solution that synchronizes Web and voice performance testing for Web-enabled contact centers
- First to develop a test system that recognizes voice prompts
- First to provide a standards-based scripting language for voice system testing
- First to market with an automated testing solution specifically for testing Enterprise JavaBeans
- First to provide testing solutions for Web Services and COM components
- First in the Web testing industry to offer downloads of evaluation software via the Web
- First to offer an easy-to-use visual approach to Web application testing - thereby eliminating the need for programming
- First to develop a joint voice and fax testing system

The Empirix Advantage

- **The best insight into what customers' experience.** Empirix's patented Web and voice transaction engines emulate real customer behavior, providing the most accurate and deepest insight into what customers actually experience.
- **Proven as the worldwide leader in VoIP, Network Testing & Monitoring.** Empirix provides a broad range of award-winning Hammer™ testing and monitoring solutions designed to ensure the quality and performance of VoIP and IP Storage applications throughout their lifecycle. Our easy-to-use products will benefit your development teams, and provide rapid return on investment.
- **Correlation of customer experience with underlying system performance.** Empirix solutions can correlate the customer perspective with data on the performance of underlying systems, to pinpoint technology issues that could adversely impact customers.
- **A proactive approach to assuring technology performance.** Unlike reactive systems that only alert IT staff after something breaks, Empirix solutions are designed to identify emerging problems so they can be fixed before customers are affected. As the saying goes, "It slows down before it goes down."
- **Years of experience in Web and voice applications.** As inventor of Hammer®-known as the gold standard of testing for telecommunications equipment-Empirix has more than a decade of experience with contact center technology. It was also the first to introduce testing and management solutions designed specifically for Web applications and Web Services, and remains the only vendor able to simultaneously test the Web and voice components of applications such as Siebel.
- **Rapid return on investment for its customers.** Empirix solutions are known for their ease of use and fast time to implement. That means organizations can get up and running in hours or days instead of weeks or months.

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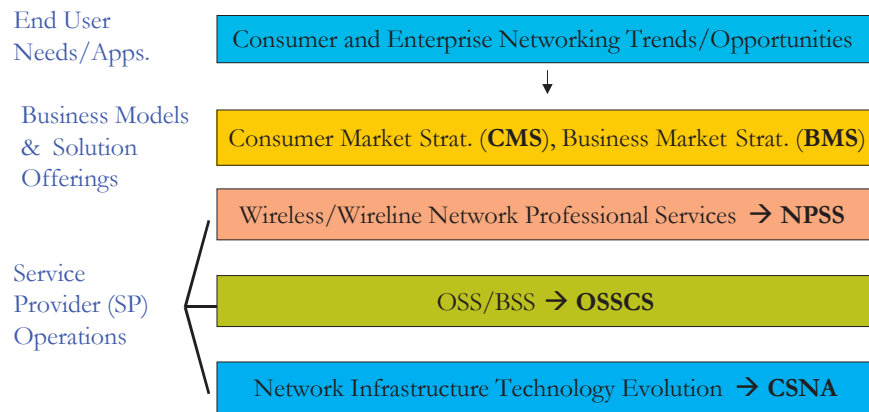
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