In Search of the Next Generation Network (NGN)

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Have you been up late at night pondering what the term NGN really means, what it includes, and when it will be available? Is it something being promoted by the network equipment vendors (e.g. Cisco), the standards bodies (ITU-T, TMF, etc), the network operators/ service providers, or all of the above?

Will the NGN provide multi-site grid interconnection as a managed service? Will grid technology be used internal to the NGN? Is the NGN a set of "spiffy" new services that are delivered via smart edge boxes and a "converged" IP-MPLS core network? If so, what is being converged? In particular, what is the difference between network convergence, service convergence, and applications convergence?

Could the NGN include seamless wireless/ mobile and wire-line integration? What about next generation Network Management (NMS), Operations Support Systems (NGOSS's), and new billing systems? **Will grid technology be used, internal to the NGN, to interface NMS and NOSS's? Will Web Services be used to expose network services to potential customers or for service level management?** Finally, what are the actual requirements, implementation scenarios, and deployment models for the NGN? Are the NGN goals so huge that they make take over a decade to realize?

In this article, we look at **three different views of the NGN**: from Cisco (as presented at their December 2004 Worldwide Analyst Conference), from the TMF (the NGOSS Release 4.5), and from ITU-T SG13 (output from their Dec 7-17, 2004 plenary meeting in Geneva). As both service providers, network equipment, and semiconductor vendors are participating in the **ITU-T NGN** effort, we will comprehensively cover that activity with emphasis on SG13 work- the lead study group for NGN standards development.

1. Cisco's vision of the IP NGN

A] Three areas of Convergence

The Cisco IP NGN architecture is focused around three primary areas of convergence which are evolving in service provider networks. Cisco is making advancements in its two focus areas of convergence - network and service:

- **Network convergence** - where disparate networks are converged over a more efficient and cost-effective common core based infrastructure. Providers are migrating from deploying, managing, and maintaining many service-specific (overlay) networks to delivering all services on a single IP/Multi-Protocol Label Switching (MPLS) based network. AT&T and BT have taken this approach.

- **Service convergence** - where increased application and subscriber-level service

control intelligence is needed to facilitate the efficient and profitable delivery of voice, video, data and mobility services for wire-line and wireless convergence. A good example of this is the much promoted, but yet to be delivered, "triple play" services – voice, video and data/Internet- over an IP platform. When you add wireless/mobile capabilities you get "triple play on the move" or "quadruple play."

To achieve true service convergence, providers must be able to operate, bill, and manage a service over a range of access mediums. Cisco and its partners are developing an open Service Exchange framework, which allows service providers to facilitate and control customer access and use IP services while placing no limit on the types of applications that can be deployed. The following activities and announcements from Cisco underscore the company's move to accelerate service convergence and integrate further intelligence within the network.

- **Application convergence** - where a profusion of new capabilities and end-user devices can provide a multitude of new service opportunities for carriers. ***This is where Web Services may play a prominent role in service level management and exposing the new services to customers. Managed grid site interconnection, already announced by BT as a new service on their 21st Century Network platform, is an example of application convergence.***

B] Why Network Convergence?

Network Convergence facilitates deployment of new, innovative services. The next wave of the Internet will be driven by end user demands for new and innovative applications and services. Cisco believes that only a global systems approach can work to handle the proliferation of new devices and resource-consuming applications that are being introduced every day. Network absorption of some of this functionality is what will make it possible for these applications to continue scaling and increasing in performance to meet the ever-changing demands. Network intelligence has never been more relevant and more advantageous to the entire system.

An IP-MPLS NGN architecture offers service providers a compelling model for revenue generation out of new services that are meaningful to customers. The services are aimed at delivering a network experience based on linking applications and networks in a seamless way that is independent of transport and switching technologies. This is the issue that is driving all of IP deployment and much of carrier capex, and it is one that Cisco is attempting to lead. *The assumption is that IP-MPLS can scale to accommodate multiple subscribers (e.g. each with their own VPN) and that it can provide the necessary bandwidth, transit delay and jitter needed for the new services. This remains to be proven.*

"For these IP Next-Generation networks to be built, customers require multiple layers of convergence and the technology innovation that delivers reduced operational costs,

expanded revenue opportunities and increased customer loyalty," said Carlos Dominguez, senior vice president of Worldwide Service Provider at Cisco Systems. "Cisco's continued commitment, leadership and technology innovation allows service providers to capitalize on the multitude of benefits of convergence, and ultimately achieve their strategic business objectives."

The goal is to help customers achieve their evolving business objectives and to underscore the exponential value realized when the network is implemented as a system. **Customers have clearly shown that a converged network is the direction they want to go.** In order for them to reap the full benefits of a converged network, convergence of services and applications will have to occur also.

C] What is the difference between a Cisco NGN/Intelligent Network and current/existing networks?

Charlie Giancarlo, SVP and CTO of Cisco: "Currently, networks are primarily focused on transporting bits. A Cisco Intelligent Information Network is focused on connecting people to the applications and services they want and need. An Intelligent Information Network is different from current networks because it is designed with the entire system in mind- including management and provisioning aspects- rather than designing each element in a silo. Increasing the intelligence of the network enables it to adapt to the ever changing needs of applications, rather than requiring the applications to change to meet the needs of the network." Cisco's "Integrated Services Routers" include full call control (e.g. SIP for VoIP), feature-rich IP routing, and wire speed security.

Cisco claims IP NGN leadership because of having more than 250 IP-MPLS networks in production, over 4M IP phones installed, 21.7M installed routers, over 14M VoIP gateway ports, over 10M cable VoIP subscribers using Cisco gear. Cisco is investing $1.5B annually on R&D for service provider networks.

D] When will Cisco's NGN/ Intelligent network be available?

John Chambers, CEO of Cisco: "The Intelligent Information Network is our three-to-five year technology vision for moving from basic connectivity products to a global systems architecture. This is our roadmap for the future and we will continue to make investments in the network foundation and develop more awareness of users needs at the application level. This will not only allow applications to scale to meet customer demand, but will make room for innovation of new advanced applications and services. We are now in phase one-the convergence of voice, data and video onto an IP-based network. In phase two, we will start to incorporate elements of applications and operating systems into the IP network allowing scalability and performance improvement. Phase three will see the virtualization of applications and services to enable faster time-to-market for these applications and services."

2. TMF NGOSS

An overview of NGOSS may be found at:

http://www.tmforum.org/browse.asp?catID=1913&linkID=30055

NGOSS Release 4.5 is the latest version of the **Telecommunications Management Forum's** (TMF's) core framework for developing, procuring and deploying operational and business support systems and software. OSS's are the back-end systems that take care of billing, inventory records, network performance and failure history, customer relationship management, etc. *Many service providers believe that a next generation OSS is needed to support new innovative services and that much improved integration between their own NMS's and OSS's is necessary.*

One of the most important developments within NGOSS 4.5 is the further refinement of the NGOSS 'contract' which in this version has been modeled in the Business View. This innovation enables business interactions to be contractually specified, which in turn provides a level of interoperability not previously possible.

To make NGOSS more accessible across the industry NGOSS 4.5 is being made available, for the first time, as a model, in several modeling tool formats: Rational (Rose and XDE), Case-wise Corporate Modeler and Popkin System Architect.

In addition, the NGOSS suite of documents has been expanded to include the Service Framework guidebook, GB924 version 2.0. This document discusses the problems associated with managing complex service delivery architectures and the need for interoperable OSS implementations to support these new demands. Key to this solution is the need for a common approach to modeling services and their components into an underlying NGOSS framework. The Service Framework outlines a methodology for mapping the 'user domain' terminology into the NGOSS SID and eTOM.

In addition, NGOSS Release 4.5 consists of the following new documents;

- GB921P, An eTOM Primer
- GB921T, eTOM – M3400 Mapping Application Note
- GB922 Addendum 1C, a SID model of the NGOSS Lifecycle Business View Contract

3. ITU-T SG13 Vision of the NGN

A. Background of FG-NGN

ITU-T established a Focus Group (FG) in May 2004 to co-ordinate development of global NGN standards. Four FG- NGN meetings were held in 2004. Please refer to: http://www.itu.int/newsarchive/press_releases/2004/05.html

The fundamental difference between NGN and today's network is the switch from current 'circuit-switched' networks to 'packet-based' systems such as those using Internet Protocol (IP). The need for global standards is critical as most operators expect to move to

an IP infrastructure. One area to be addressed is the concept dubbed ‘nomadicity’, which will provide fixed line and mobile users with seamless communication. Simply put this means the underlying technology will be invisible to the user regardless of a multi-service, multi-protocol, multi-vendor environment.

"Industry sought a quick solution on NGN and we responded," says Houlin Zhao, Director of the ITU Telecommunication Standardization Bureau. "In this case, the Focus Group concept has given us the means to act with the level of immediacy required. There is no faster and more efficient place for the development of this work."

Herb Bertine, Director of Standards, Lucent Technologies agrees. "Through this initiative ITU-T is bringing all players together in an environment where they can create truly global specifications for the service-aware network of the future, to deliver dynamic, customized services on a massive scale."

NGN will offer a richer set of applications to the end user. The work of the new group will build on existing fixed/mobile convergence architecture (eg 3GPP/3GPP2 IP multimedia subsystem (IMS)) to provide transparency between fixed and mobile networks. Keith Dickerson, Head of Standards, BT: "Service providers will benefit from specifications that will allow them to move quickly to a packet-based infrastructure. And, manufacturers will be able to offer NGN equipment to a global market, customized to user needs but interoperable."

Leading industry players have long sought an efficient body for the development of standards that will define services, network and systems architecture in the next generation of IP enabled communication systems. ITU was seen by all — operators and manufacturers alike — as the most flexible and efficient platform for the work.

The ITU-T Focus Group concept is a means to move quickly to meet urgent needs such as this, and consolidate work under the umbrella of one entity. In addition to allowing for ‘nomadicity’, other objectives of the Focus Group will be to develop specifications in the areas of Quality of Service in DSL, authentication, security and signaling.

B] ITU-T SG13 involvement with the NGN Project

ITU-T SG13 was designated the lead study group for NGN standards. At their December 2004 meeting, the following structure was adopted for SG13:

- **Working Party 1: (Project management and coordination) -** Questions 1/13, 11/13 and 13/13
- **Working Party 2: (Functional architecture and mobility)** - Questions 3/13, 6/13, 9/13 and 10/13. (Including also security matters)
- **Working Party 3: (Service requirements and scenarios) -** Questions 2/13, 7/13, 8/13, 12/13 and 14/13
- **Working Party 4: (QoS and OAM) -** Questions 4/13 and 5/13

According to the ITU-T Rec. A7, **all of the NGN Focus Group deliverables have to be presented to Study Group 13.** At the December 2004 meeting, SG13 plenary considered the one completed FG NGN deliverable (FG NGN-OD-00079 **Signaling Requirements for IP-QOS**) and after noting its content, passed the document to Study Group 11 (ITU-T Signaling lead SG) for their consideration. It was noted that Study Group 11 had appointed coordinators to work with the NGN Focus Group and with Study Group 13.

The relationship between the **NGN Focus Group and Study Group 13** was discussed at the December 2004 SG13 plenary meeting. It was agreed to be important to foster a good working relationship and to utilise the expertise efficiently. In order to get good early visibility in the Study Group of potential candidate draft Recommendation texts it was agreed that an iterative process should be adopted. It was therefore agreed that the meetings on Questions at the current meeting should look at the draft deliverables referenced in the Focus Group progress report with the aim to pass comments back to the Focus Group on them. The aim would be to provide feedback to the Focus Group but not to develop alternative texts which would lead to duplicate working and should be avoided.

The following NGN study items have been assigned to SG13, as noted in Table 1.

Table 1. Questions assigned to Study Group 13 on Next Generation Networks by WTSA

Question number	Question title	Status
1/13	Project coordination and release planning for NGN	Continuation of Q.12/13
2/13	Requirements and implementation scenarios for emerging services in NGN+	Continuation of Q.11/13
3/13	Principles and functional architecture for NGN+	Continuation of Q.1/13
4/13	Requirements and framework for QoS for NGN+	Continuation of Q.16/13
5/13	OAM and network management for NGN+	Continuation of part of Q.3/13
6/13	NGN mobility and fixed-mobile convergence+	New
7/13	Network and service inter-working in NGN environment+	Continuation of Q.5/13
8/13	Service scenarios and deployment models of NGN+	New
9/13	Impact of IPV6 to an NGN+	New
10/13	Interoperability of satellite with terrestrial and Next Generation Networks (NGNs)	Continuation of Q.13/13
11/13	General network terminology	Continuation of Q.15/13
12/13	Frame relay	Continuation of Question A/17

13/13	Public data networks	Continuation of Question B/17
14/13	Protocols and service mechanisms for multi-service data networks (MSDN)	Continuation of part of Question 7/17

+ marked questions are seen as most critical to NGN standards development.

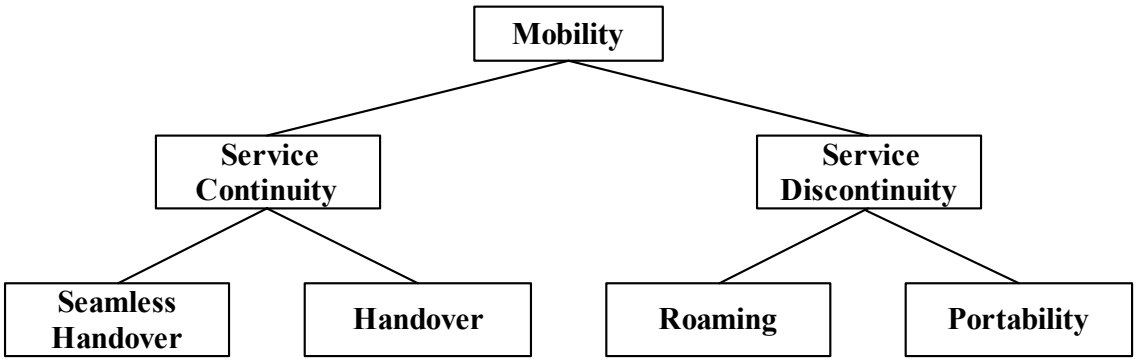
As you can see, the NGN scope is very broad and will involve liaisons with other ITU SGs and other standards bodies.

C] Formal Definition of NGN:

ITU-T revised recommendation **Y.2001 NGN-Overview** (contained in TD 21 PLEN).defines the Next Generation Network (NGN) as follows: **a packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different service providers. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.**

"Mobile Network Communications" will be included in the NGN work plan, as defined by the figure below.

Figure 1 Structured Model of Mobilities:



C. NGN Service Requirements and Scenarios (ITU-T WP3/13)

ITU-T SG13 WP 3 (WP3/13) seems top be the lead Working Party within SG13 for NGN study items. It has collective responsibility for: requirements and implementation scenarios for emerging services in NGN (Q2), Network and Service Interworking in NGN environment (Q7), Service Scenarios and Deployment Models (Q8) of NGN, and Protocols and Service Mechanisms for Mult-Service Data Networks (Q14).

The NGN work is focused around VPNs (including Layer 1 VPNs), MPLS, and inter-working functionality (including TDM-IP, and the new Y.1415 Ethernet – MPLS network inter-working- user plane).

The status of emerging WP 3/13 recommendations is depicted in Table 2. below:

Table 2. WP 3/13 Recommendation status and action plans

Rec No.	New/ Rev		Question	Priority	Target for 'Consent'		Rev/New / Text Doc	Short Title
Y.vpn-decomp	N		02/13	H	May 2005		TD 87 (GEN)	Generic VPN functional decomposition
Y.vpn-qos	N		02/13	M	2006		TD 86 (GEN)	QoS Support for network based VPN services – Framework and Characteristics
Y.ngn-account*	N		02/13	M	Late 2005		TD 88 (GEN)	Accounting, charging and billing Requirements and Framework for NGN Release 1
Y.1415 (formerly Y.ethmpls)	N		07/13	H	17.12.2004		TD 26 (PLEN) TD 27 (PLEN)	Ethernet – MPLS network interworking – user plane
Y.ppi	N		07/13	M	1Q2006		TD 100 (GEN)	Principles for peer partition interworking
Y.gina	N		07/13	H	09.09.2005		TD 101(GEN)	General interworking architecture
Y.tdmip	N		07/13	H	06.05.2005		TD 102 (GEN)	TDM - IP Interworking – user plane
Y.1401rev	R		07/13	H	09.09.2005		TD 103 (GEN)	General requirements for interworking with Internet Protocol (IP)-based networks
Y.vtoip	N		07/13	M	1Q2006		TD 104 (GEN)	voice trunking over IP networks
Y.tfo-ip	N		07/13	M	1Q2006		TD 105 (GEN)	Tandem Free Operation (TFO) - IP Network Interworking – User Plane
Y.ethatmfr	N		07/13	M	1Q2006		TD22 (WP2/13) at June 2004	Ethernet, ATM and Frame Relay Service Interworking – user plane
X.84 Amd.1	N		12/13	M	2006		TD 72(GEN)	Control protocol for PVC maintenance & status monitoring
X.iwfrmpls	N		12/13	M	2006		Not yet drafted	Performance of FR interworked with MPLS
X.iwo	N		12/13	L	2007		Not yet drafted	Performance objective: Frame Relay-ATM IWG
X.mplscpi	N		12/13	M	2006		TD 109(GEN)	MPLS control plane interworking

*** New Draft Recommendation Y.ngn-account: TD88(GEN)**

Many service providers, especially in Asia, are interested in new **recommendations for accounting and billing.**

As such, it was decided that mechanisms to support accounting, charging, and billing capabilities should be provided within Release 1 NGN services. These functions support the collection of data for later processing (offline charging) as well as near-real time interactions with applications such as for pre-paid services (online charging).

Requirements associated with Release 1 NGN accounting, charging and billing will be developed in coordination with Study Group 3 for implementation in NGN. It was agreed that the proposal is valuable to start development of technical tools in the areas of accounting, charging and billing capabilities for NGN. Consensus was reached on need to correctly position and coordinate this NGN work in respect of existing deliverables and related work groups: on one side, the FG-NGN deliverables (Rel.1 requirements, Functional Requirements and Architecture), on the other one, existing and planned SG3 deliverables (related to policy and regulatory aspects for these areas). In addition, other items proposed are new.

Some of the completed recommendations of ITU-T WP3/13 could be used within a NGN. That list is given in Table 3 below:

Table 3 List of IP/MPLS/VPN Recommendations under the responsibility of WP 3/13

Rec.	Title	Q.
Y.1261	Service requirements and architecture for voice services over Multi-Protocol Label Switching	2/13
Y.1281	Mobile IP over MPLS	2/13
Y.1310	Transport of IP over ATM in public networks	2/13
Y.1311	Network-based VPNs – Generic architecture and service requirements	2/13
Y.1311.1	Network-based IP VPN over MPLS architecture	2/13
Y.1312	Layer 1 Virtual Private Network Generic requirements and architectures	2/13
Y.1313	Layer 1 Virtual Private Network service and network architectures	2/13
Y.1401	General requirements for interworking with Internet protocol (IP)-based networks	7/13
Y.1411	ATM-MPLS network interworking - Cell mode user plane interworking	7/13
Y.1412	ATM-MPLS network interworking - Frame mode user plane interworking	7/13
Y.1413	TDM-MPLS network interworking - User plane interworking	7/13
Y.1414	Voice services - MPLS network interworking	7/13

The **Signaling Requirements for IP-QOS** document (from FG-NGN) provides the

requirements for signaling information regarding IP-based quality-of-service (QoS) at the interface between the user and the network (UNI), across interfaces between different networks (NNI), including access networks. These requirements and the signaling information elements identified will enable the development of a signaling protocol(s) capable of the request, negotiation and ultimately delivery of known IP QoS classes from UNI to UNI, spanning NNIs as required.

The signaling requirements also address signal information related to traffic priority and admission control, as these are also central to truly comprehensive QoS.

D] Proposed new Question X/13 on NGN Security

Motivation for NGN Security

While the public switched telephone networks (PSTNs) that use circuit based technology are relatively secure, threats on the evolving telecommunications infrastructure are on the increase – both in frequency and in complexity. Efforts over the years to secure packet infrastructures have been somewhat fragmented and reactionary and so far have failed to produce the desired level of protection against threats. This issue is complicated by the large number of organizations working on various aspects of security, making coordination and cooperation difficult and challenging.

Recognizing that security is one of the defining features of NGN, it is essential to put in place a set of standards that will guarantee, to the maximum degree possible, the security of the telecommunications infrastructure as PSTNs evolve to NGNs.

In addition, as NGNs evolve and new security vulnerabilities appear, for which there is no known immediate automatic remedy, such vulnerabilities must be properly documented so as to enable the network administrators and end users to mitigate them. The NGN Security studies must address and develop network architectures that:

- Provide for maximal network and end-user resource protection
- Allow for highly-distributed intelligence end-to-end
- Allow for co-existence of multiple networking technologies
- Provide for end-to-end security mechanisms
- Provide for security solutions that apply over multiple administrative domains

The complexity of the issue necessitates a systematic study of general security mechanisms and applications developed in ITU-T SG 17, the lead study group on security, ISO/IEC JTC 1 SC 27, 3G Partnerships, IETF, and other applicable SDOs as well as interface and protocol specific mechanisms developed in the relevant ITU-T Study Groups and the IETF working groups. To this end, the ITU-T Recommendation X.805 provides the framework

for network security studies in ITU-T, and this Recommendation must be systematically applied to the NGN work.

Another security aspect is that of spam. This has become a widespread problem causing loss of revenue to Internet service providers, telecommunication operators, mobile telecommunication operators and business users, as well as other problems to users in general. WTSA-2004 Resolution 52 on countering spam by technical means has requested Study Groups in cooperation with the Internet Engineering Task Force (IETF) and other relevant groups, to develop, as a matter of urgency, technical Recommendations, including required definitions, on countering spam, as appropriate, and to report regularly to the Telecommunication Standardization Advisory Group on their progress.

4. Summary and Conclusions

This article has examined the NGN from three perspectives: Cisco, TMF, and ITU-T. We can see that there is a tremendous amount of work to be done before the NGN vision translates into a converged network with seamless integration of transport technologies (e.g. wireless/mobile and wireline), Operations Support Systems, and Network Management Systems. We believe that this will take longer than most expect.

Look how long it has taken to get network convergence over an IP-MPLS core network! It has only been recently that IP-MPLS VPNs (RFC 2547bis) have been offered on a large scale. Service convergence is not here yet. After years of predictions, it will probably only emerge in 2005 with the delivery of IP-TV, broadband Internet access, and VoIP over a single IP based access line (VDSL-fiber to the node, FTTH, or cable). Yet, something like the NGN will be necessary for operators to profitably offer new, innovative services. We wish them and all concerned the best of luck. They may need it!