www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 1 January 2015, Page No. 9916-9928

Migration to Next Generation IP Network

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1- Introduction:

This white paper will help service providers understand the benefits and economics associated with implementing a Next Generation Network (NGN). Convergence is the process of interconnection of traditional switched circuit networks (the PSTN and mobile networks) and packet-switched networks based on the Internet Protocol (IP) for routing.

Network evaluation is the starting point for any network migration. Before planning for migration, design or implementation, the existing network should be evaluated. The evaluation could include operation support network, existing equipments and resources, services network, signaling network, bearer traffic network and synchronization network. According to the evaluation results a proper strategy, plan, and solution can be formed.

2- Convergence:

The NGN network "decouples" services from networks. The NGN links the various types of network elements into a unified network and provides users with access to every service wherever they may be, see figure 1.

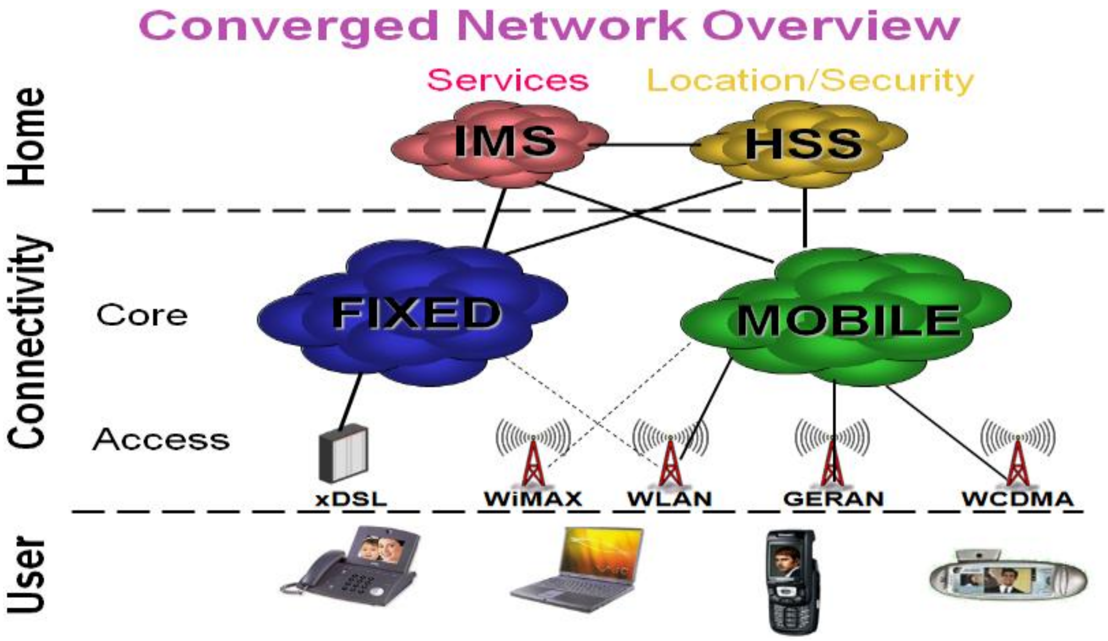

Figure 1 converged network overview

Within the NGN, convergence takes place on three levels:

2.1 Network Convergence:

The NGN is based upon a “many services, one network” model. The NGN combines all of the service-specific networks into a single converged network, eliminating duplication and reducing the number of layers in the network. The single NGN network can support all existing and new services: mobile and fixed; voice, data, and video. This will dramatically reduce the total cost of ownership for service providers.

2.2 Service Convergence:

The NGN makes all services available to the end users across all of the access networks. Thus, enterprise services available in the office can be available over a wireless LAN, a broadband connection, or a cellular network. Similarly, IP appliances in the home, such as an IP-enabled video recorder, can be accessed from the office or the car. Within the NGN, services can be transferred across access networks as the user roams – providing seamless connectivity. Service convergence provides a “stickiness” that increases customer loyalty and decreases churn.

2.3 Application Convergence:

More and more, carriers are finding that profitability depends upon applications, not just services. The NGN provides an application convergence that enables the carrier to provide advanced, all-media services. Such services integrate voice, video, and data into a unified application. Examples include IPTV, videoconferencing, voice-enabled gaming, and voice-enabled online commerce.

3- Migration to an NGN IP Network:

3.1 Transition from TDM Network:

Depending upon carrier size, range of services, and the diversity of the legacy network, the migration to an NGN IP Network typically should be implemented in several stages. These include:

- A field trial to select the suppliers,
- One or more pilot implementation to gain experience in the deployment and operation of an NGN network,
- A series of regional implementations, and
- The transition to a full NGN network for all services.

During the regional implementations, existing investments in the voice dominated PSTN can be integrated with the NGN in a way that is transparent to the carrier’s customers. This is made possible through the use of Media Gateways that function as intermediaries between the TDM-based PSTN and the IP-based NGN. Some of the Media Gateways function as trunking gateways to provide connectivity to local switches through standard SDH interfaces. Other Media Gateways function as access gateways to provide interfaces to customers over TDM links. A Signaling Gateway connects the SS7 signaling system from the PSTN switch to the soft switch.

The use of co-deployment prior to full NGN migration most often provides the optimal balance between the maximization of revenue from new NGN services, the minimization of capital investments, and the leveraging of the existing network, figure 2.

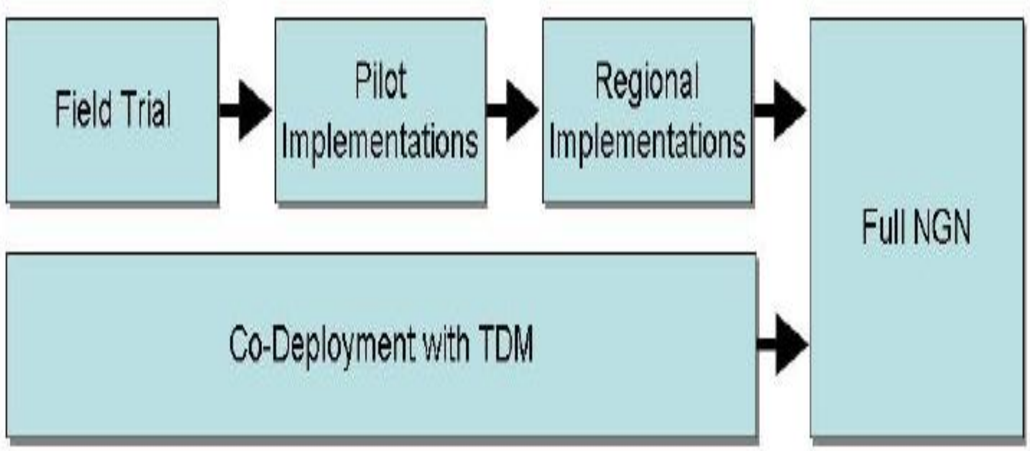

Figure 2 Transitions from TDM Network to Full NGN

3.2 Migrations within the Transition

The transition from a TDM to a NGN IP network actually requires six parallel migrations: transport migration, network database migration, signaling/IN migration, OSS migration, BSS migration, and traffic migration, figure 3.

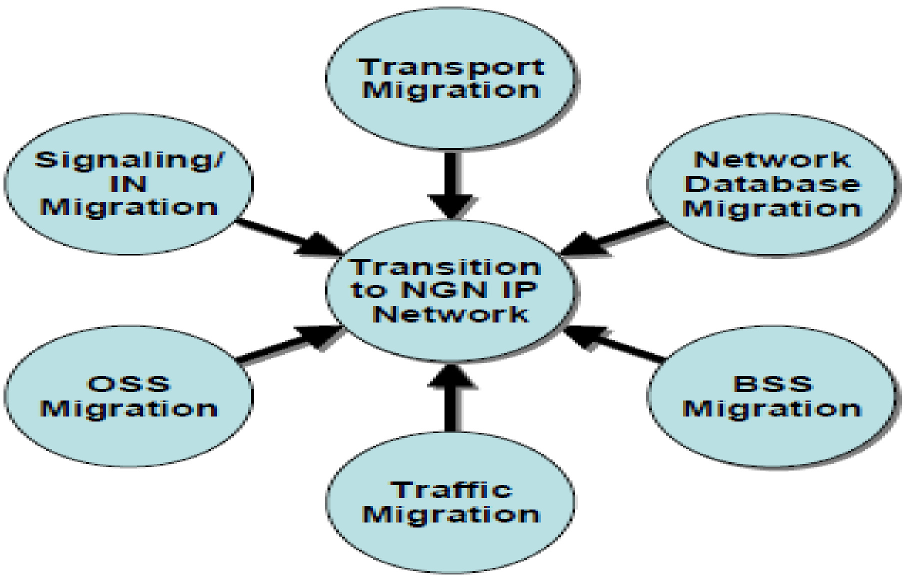

Figure 3 the six parallel Migration

While all six of these transitions are eventually required to gain the full benefits of NGN, some carriers can save initial capital costs by delaying full transport, OSS, and traffic migration for existing services until the NGN begins to generate significant revenue based upon media-rich applications.

3.3 Signaling / Intelligent Networking (IN) Migration

NGN offers the opportunity to both reduce expenses and expand the carriers offering to higher value-added services. However, one of the challenges in implementing an NGN is to insure that no interruption occurs to the carrier's existing services during the transition.

In the current TDM network, many services are provided over the signaling network or through additional intelligent network interfaces. A signaling / IN migration plan is required to evaluate the on-going need for these services. This plan must also identify the most effective way to deploy the existing services on the IP network.

3.4 Transport Migration

A detailed transport migration process is required to guide the NGN transition. Capacity requirements during migration may be greater than both the current requirements and the end-state network capacity requirements. As part of the transport migration, the network design should be evaluated for issues like physical footprints and floor space to minimize the overall effort to build the end-state IP network.

3.5 Database Migration

A detailed database migration plan is also required, since the current network contains large amounts of subscriber information that must be preserved during the transition to NGN. This plan must comprise the data in the multitude of PABX's, switches, and Intelligent Network databases. The rate of database migration will depend upon the overall transformation strategy. The use of a co-deployment approach for introducing the NGN will result in a more gradual database migration than an attempt to convert the whole network in parallel. The speed of migration will also be determined by constraints such as application availability and the current state of the BSS and OSS systems.

3.6 OSS Migration

The OSS migration plan focuses upon two critical issues:

- How will the management systems operate during the migration?
- How will the management systems operate in the end state when the carrier has an all-IP NGN network?

As any carrier knows, OSS systems are the heart of a carrier's provisioning and maintenance operations. Complete synchronization with the network is required to insure provisioning and repair times. OSS data needs to be transformed to support the IP infrastructure, and data from legacy systems may have to be transferred and transformed to a new OSS. The migrated data must be able to support the billing and customer management systems – both those retained from the existing network and those required to support the new generation of content rich services on the NGN.

3.7 BSS Migration

The BSS migration plan focuses upon how the business support systems will operate during the migration and during the operation of the new NGN IP network. These include the CRM and billing systems. Because the NGN IP network will be used to supply a wider range of services, new billing approaches are required. In addition, the transition to a NGN network can be used as an opportunity to simplify BSS systems to reflect the transition to fixed priced services and less complex rating plans.

3.8 Traffic Migration

Because most carriers implement the recommended strategy of co-deployment during the transition, a traffic migration plan is required. The carrier may want to offer certain customer segments the choice between several migration scenarios, depending upon the require applications. The traffic migration plan will also reflect the specific network design and migration priorities of the carrier.

3.9 Greenfield Implementation

The implementation of a Greenfield NGN network can be much faster than the transition discussed above. Nevertheless, field trials, pilot implementations, and regional implementations are still recommended for most service providers.

4- Evolution principles:

Evolution to NGN should allow continuation of the existing network capabilities and in addition facilitate implementation of new capabilities.

Evolution to NGN should respect the integrity of services provided by the existing networks and should facilitate introduction of new services.

4.1 Evolution of PSTN/ISDN to NGN:

NGN is believed to provide new opportunities for and capabilities to the network and service providers. PSTN/ISDN being one of the first networks is considered to be prime candidate for evolution.

4.1.1 Examples: Core Network evolution to NGN:

4.1.1.1 CS-based evolution to NGN:

The call server (CS) is the core element for PSTN/ISDN emulation. It is responsible for call control, gateway control, media resource control, routing, user profile and subscriber authentication, authorization and accounting. The Call Server may provide PSTN/ISDN basic service and supplementary services, and may provide value added services through service interaction with an external service control point (SCP) and/or application server (AS) in the service/application layer, figure 4.

Consolidation of local and remote exchanges preparing the evolution to NGN, in order to prepare the PSTN/ISDN for the evolution to a packet switched network (PSN) and as an initial step some of the local exchanges (LEs) are removed and all their functionalities such as control, accounting, etc. are transferred to those remaining LEs. Affected user access module (UAM), private automatic branch exchange (PABX), and access network (AN) are connected to the remaining LEs. Further consolidation occurs when user access modules (UAM) become remote user access modules (RUAM), which, are connected to the remaining LEs.

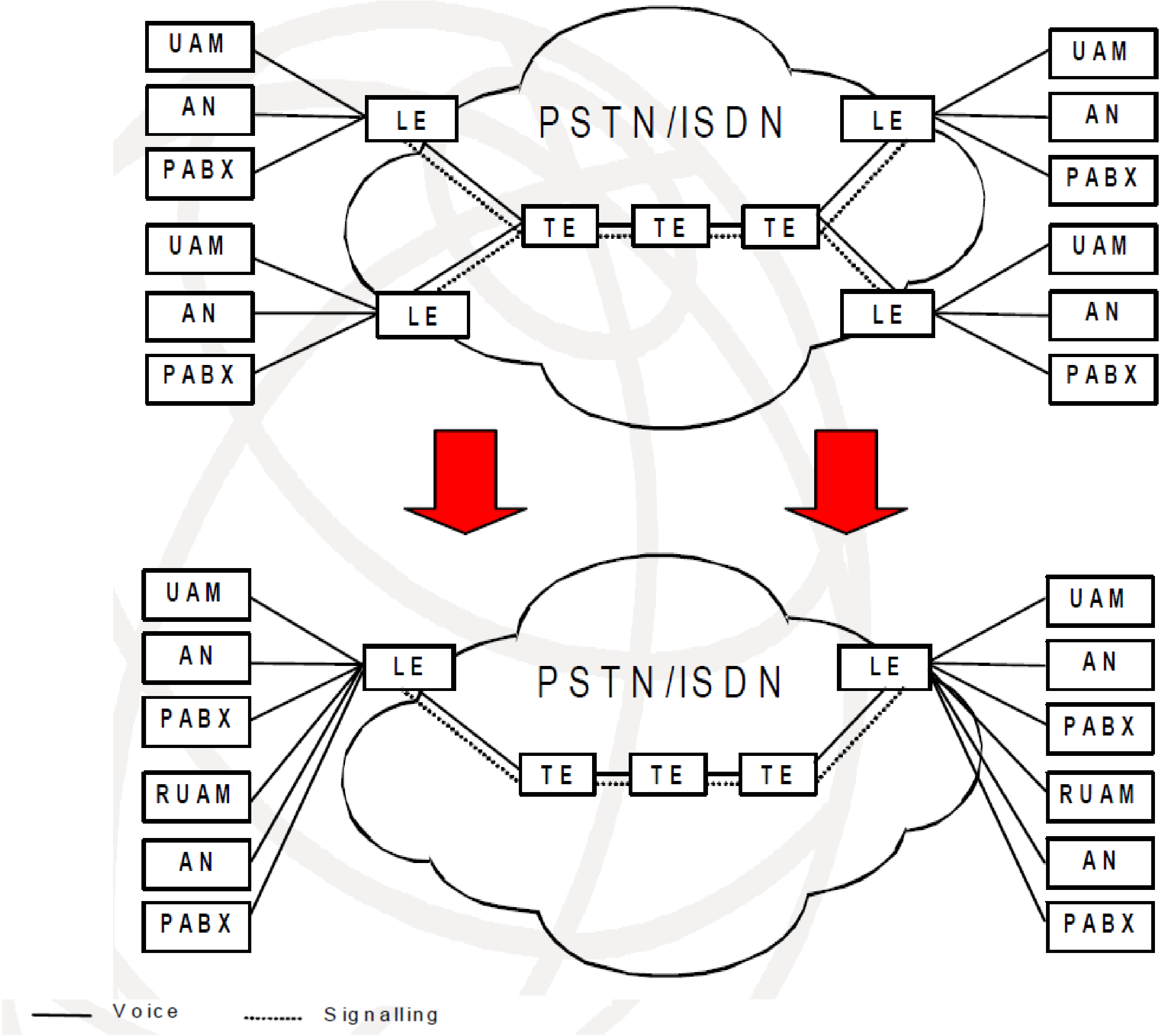

Figure 4 Preparation for evolution to NGN

Scenario 1:

PSTN/ISDN and PSN co-exist:

The most likely initial approach for evolution of PSTN/ISDN to PSN will involve a path that requires the PSTN/ISDN to co-exist with PSN during a transition period. This scenario follows that approach. There are two steps in this scenario, figure 5.

Step 1

In this step, some of the LEs are replaced by AGs. Functions originally provided by the removed LEs are now provided by the AGs and the CS. In addition, some of the access elements such as UAMs, RUAMs, and PBXs, which were originally connected to the removed LEs, are now directly connected to AGs. Additional AGs may also be deployed to support new subscribers that directly connect to them. The TMGs and SGs are deployed for interconnection between the PSN and the TEs of the legacy network as well as other operators' PSTNs/ISDNs. The AGs and TMGs are all controlled by the CS.

Step 2

In this step, the remaining LEs are replaced by the AGs, and the TEs are removed and their control functions are performed by CS. The TMGs and SGs are deployed for interconnection between PSN and other operators' PSTNs/ISDNs. The AGs and TMGs are all controlled by the CS.

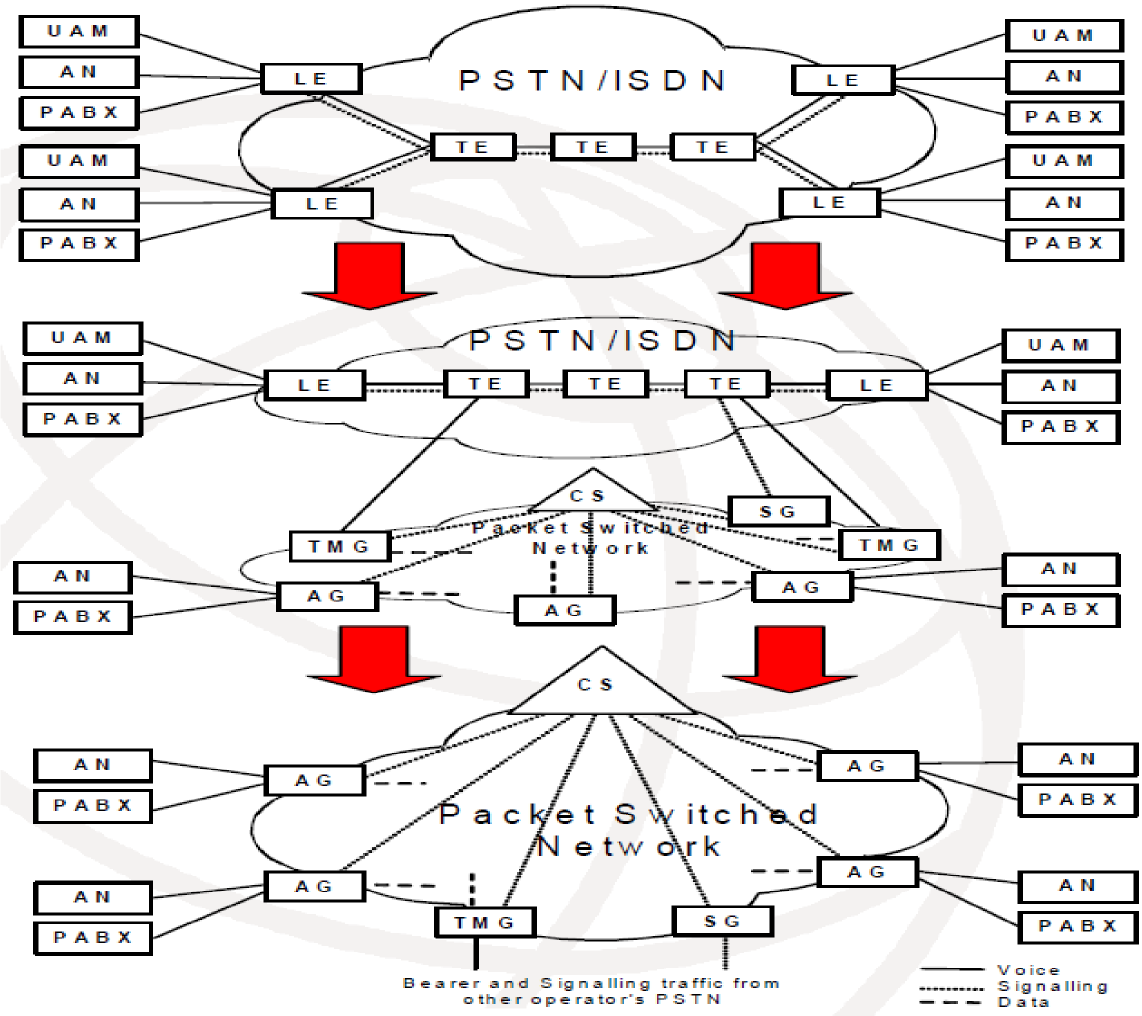

Figure 5 Co-existence of PSTN/ISDN and PSN

4.1.1.2 IMS-based evolution to NGN:

In this scenario PSTN/ISDN evolves directly to a PSN based on the IMS core network architecture. The end-users access the network using NGN user equipment or legacy user equipment connected via an AG. The transit and signaling gateways (TMGs & SGs) are deployed for interconnection between the NGN and other operators' PSTNs/ISDNs.

Concurrent CS-based and IMS-based evolution to NGN implementations can occur when an existing operator deploys a separate IMS based network for new services and supports the remainder of the services using a CS-based approach. These two types of network implementations need to interoperate. Interoperation is possible if SIP is used, but this is beyond the scope of this Recommendation.

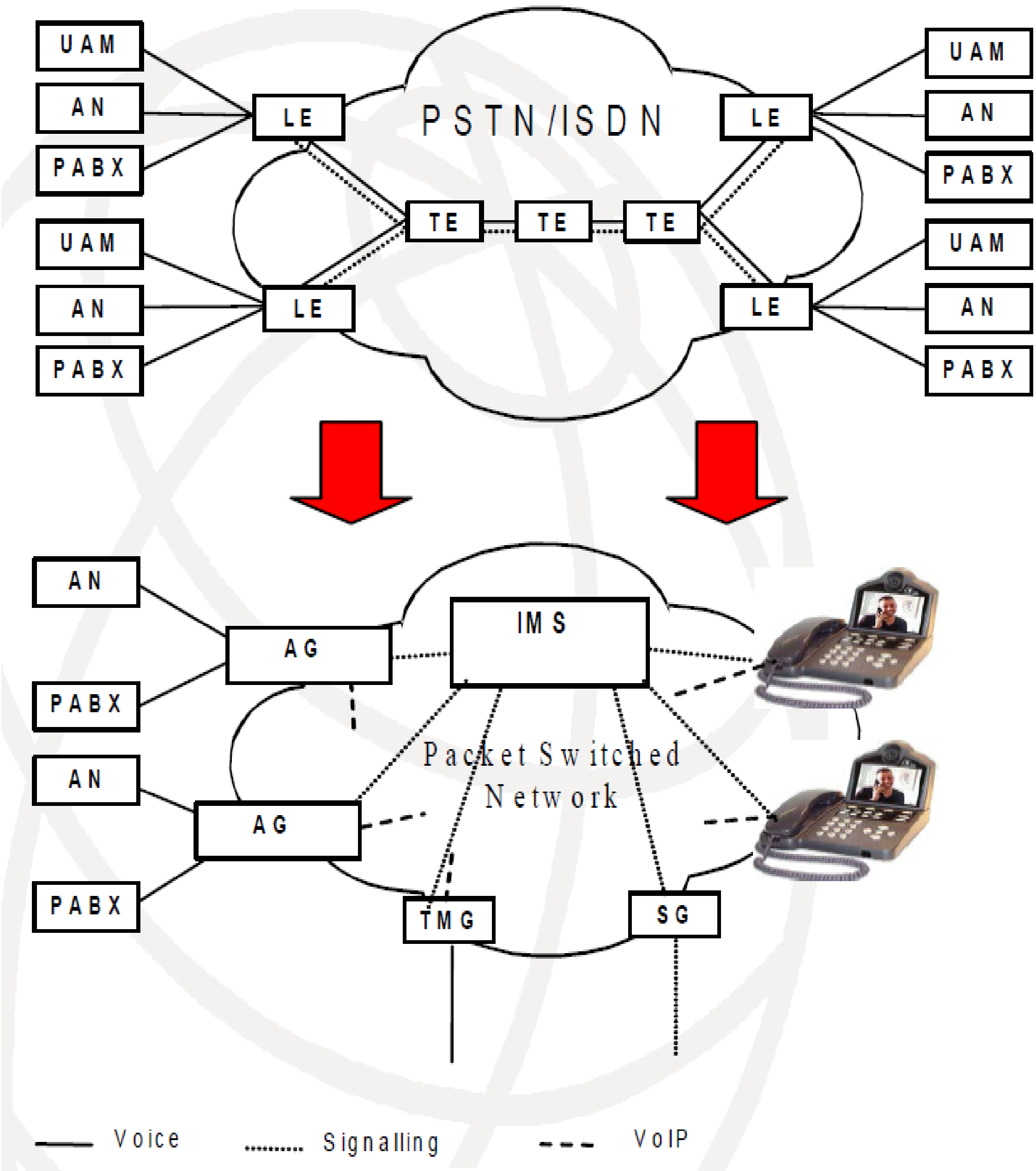

Figure 6 IMS-based PSTN/ISDN evolution to NGN

Scenario 2:
PSTN/ISDN Replaced by the PSN:
Immediate use of PSN, initially via SGs and TMGs
In this scenario PSTN/ISDN is immediately replaced by the PSN. LEs are connected to SGs and TMGs first, then they are eliminated, figure 7.

Step 1

In this step PSTN/ISDN is replaced by PSN and the TE functions are performed by the TMGs and the SGs under the control of the call server (CS). The local exchanges (LEs) are connected to the PSN via transit media gateways (TMGs) and Signaling Gateways (SGs). The Transit and Signaling Media Gateways (TMGs & SGs) are also deployed for interconnection between PSN and other operators' PSTNs/ISDNs.

Step 2

In this step the local exchanges (LEs) and some of the access elements such as user access modules (UAMs) and remote user access modules (RUAMs) are removed and their functions are provided by the access gateways (AGs) and call server (CS). The private automatic branch exchanges (PABXs) are directly connected to access gateways (AGs). The access networks (ANs) are either replaced by the access gateways (AGs) or are connected to the access gateways (AGs). The transit and signaling gateways (TMGs & SGs) are deployed for interconnection between PSN and other operators' PSTNs/ISDNs. The access and the transit (AGs & TMGs) are all controlled by call server (CS).

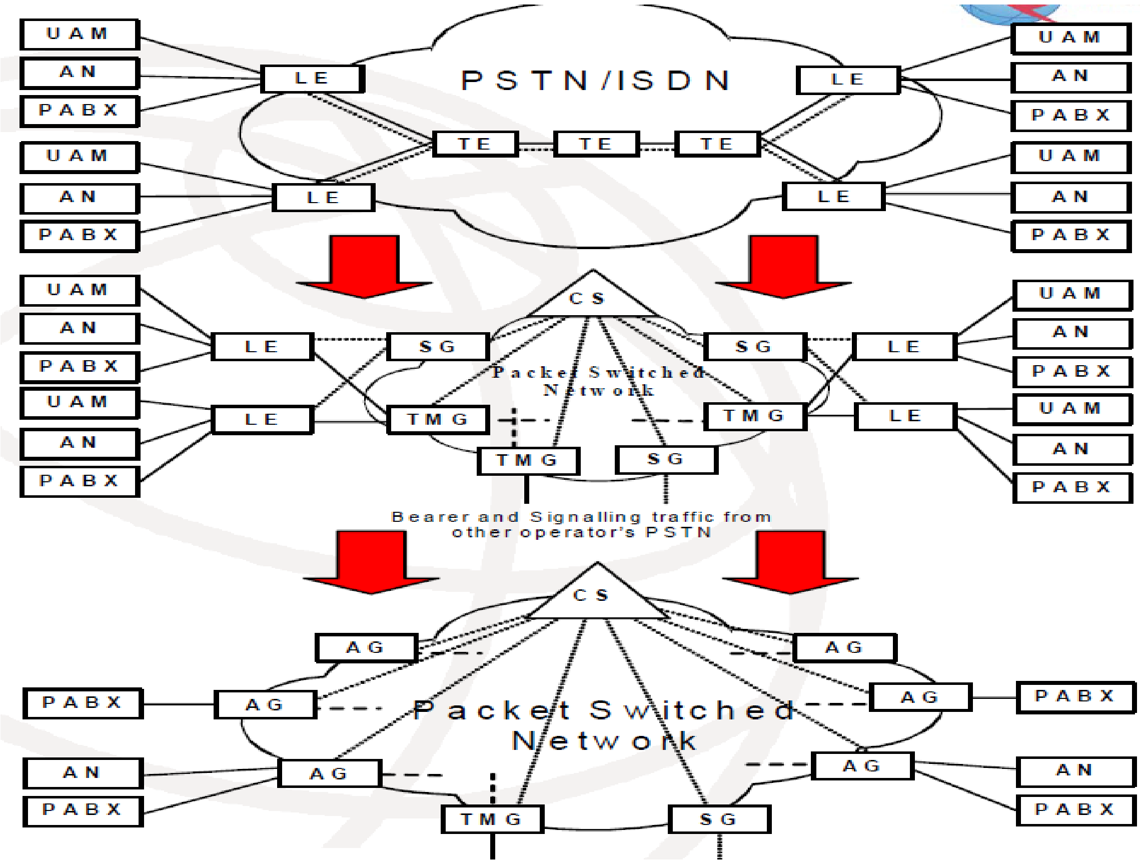

Figure 7 Scenario 2 immediate use of PSN

Scenario 3:
The one-step approach

In this scenario the PSTN/ISDN is replaced with packet switched network (PSN) in only one step. The local exchanges (LEs) are replaced by the access gateways (AGs) and their functions are divided between the AGs and the call server (CS). Specifically the call control and accounting functions are all transferred to the call server (CS).

All access elements such as user access modules (UAMs), remote user access modules (RUAMs), and private automatic branch exchanges (PABXs) are connected to access gateways (AGs). The access networks (ANs) are either replaced by the access gateways (AGs) or are connected to packet based network (PBN) through the AGs. The transit gateways (TMGs) under the control of the call server (CS), and the signaling gateways (SGs), are deployed to replace the TE functions and provide interconnection between PSN and other operators' PSTNs/ISDNs, figure 8.

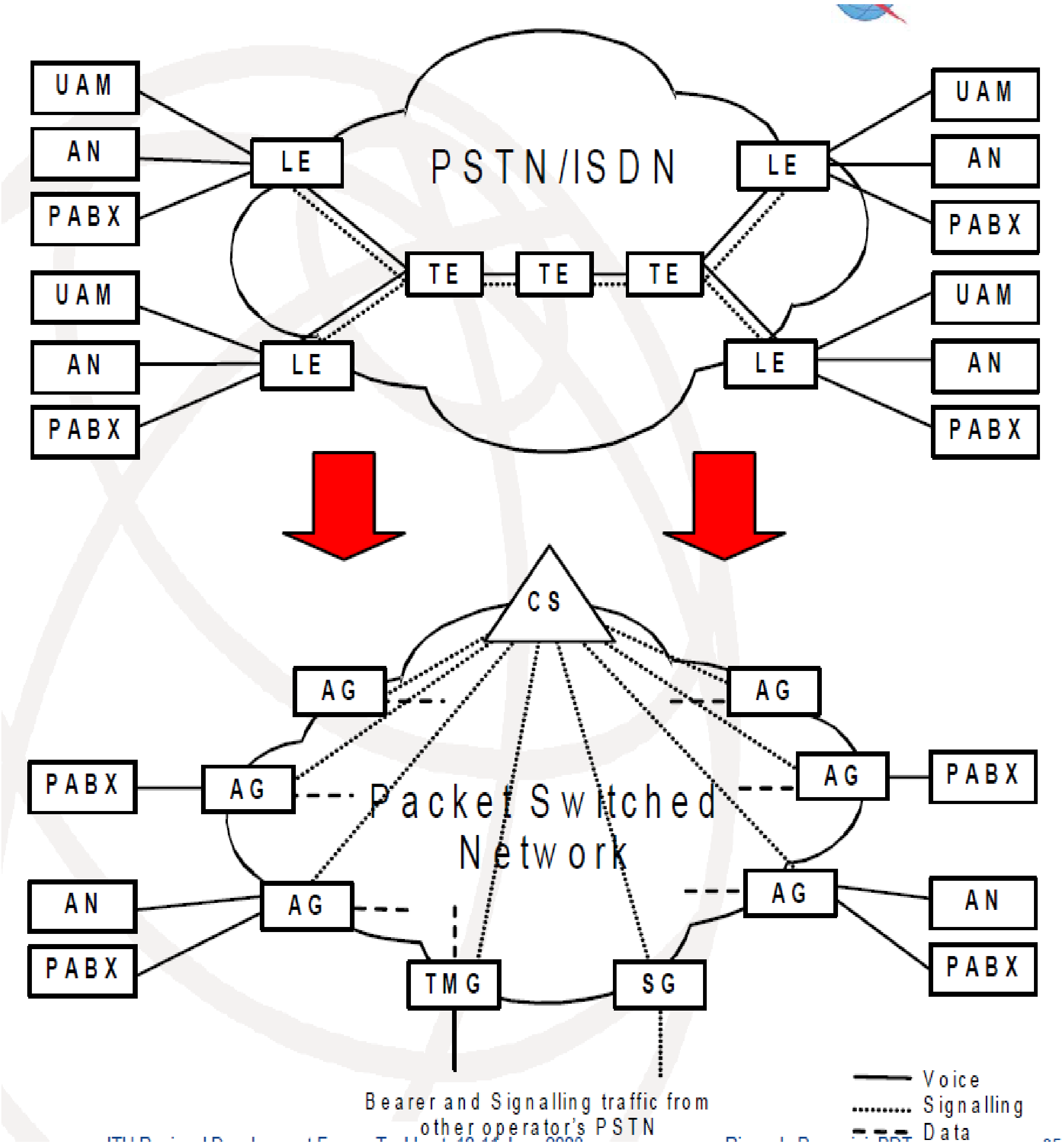

Figure 8 Scenario 3 one-step approach

4.1.2 Examples: Access Network evolution

Evolution of xDSL access to NGN

Evolution of Access Network is shown in three possible steps, figure 9.

Step 1

Traditional AN/UAM interfaces include: POTS, ISDN and V5.1/2 [G.964] and [G.965]. Such interfaces connect subscribers to the core PSTN/ISDN via LE.

Legacy voice users may also have access to broadband services for example via xDSL (see [G.995.1]). In this case, the customer-located equipment is an xDSL modem and the service provider equipment is a digital subscriber line access multiplexer (DSLAM). Since xDSL interfaces enable users to connect to the Internet, these interfaces may be utilized to connect such users to NGNs.

AN, for another user domain with V5.x [G.964] and [G.965] interface can be left as it is shown in Figure I.6 or it can be completely replaced by AG connected to NGN directly.

Step 2

The xDSL modem supports legacy subscribers and may enable them broadband access to NGN. An IP user may also use xDSL interface as the transport medium to an NGN. Protocol for xDSL interface may be Ethernet which enables broadband data flows and services, e.g., VoD, IPTV, VoIP and Internet.

Step 3

In this step, the legacy end systems are replaced by NGN end systems and twisted copper lines are replaced by optical fibre, either fibre-tothe- curb (FTTC) or fibre-to-the-home (FTTH) to increase transmission speed. Protocol for this transmission medium may be Ethernet.

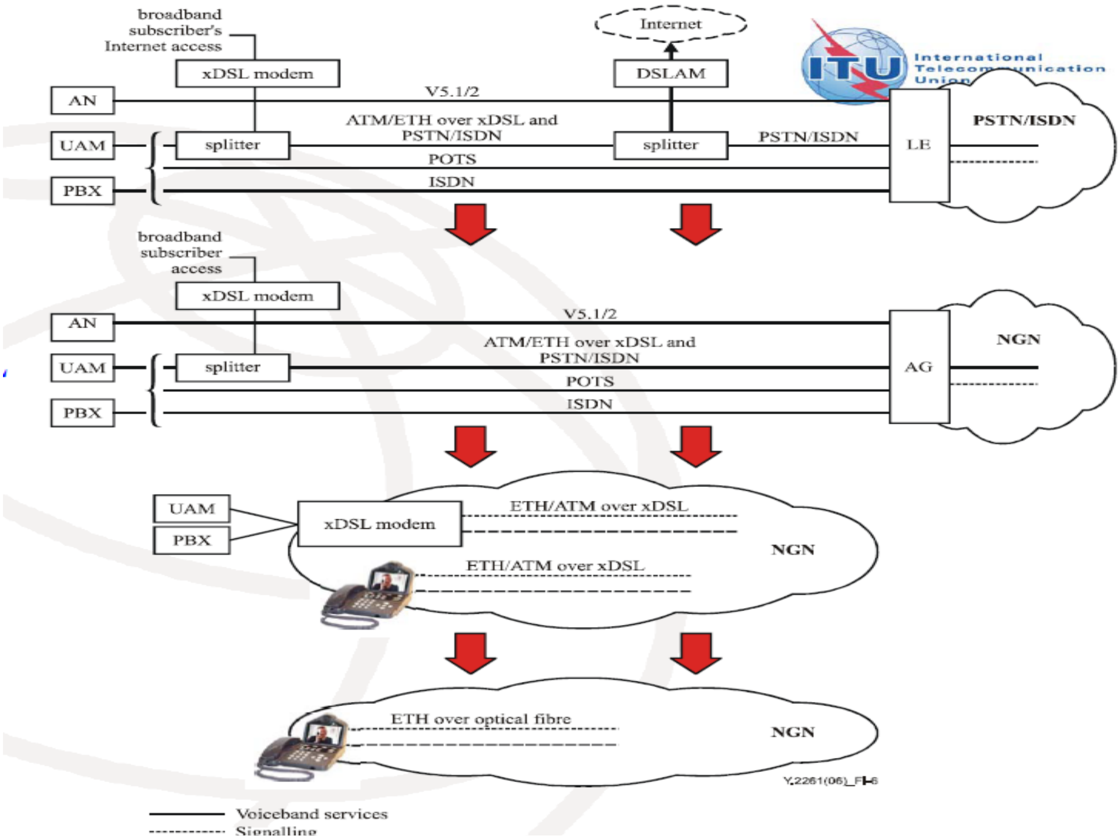

Figure 9 Evolution of xDSL access to NGN

4.2 Mobile Network Evolution to NGN:

The mobile telecom network, dominated by GSM, has evolved most rapidly from its original design for mobile voice service with lower speech quality, to GPRS and later EDGE, which enable the mobile data services of narrow band, to UMTS and recently HSDPA and HSUPA under the requirement for a broadband mobile data service like mobile television.

It is a well accepted fact that the capability of mobile networks is about 5 years behind that of fixed networks. Based on this fact, mobile network evolution is rather easier to define. In the radio access domain, the next moves will be:

- Introducing Mbps uplink capability with HSUPA, starting from 2007; · introducing tens of Mbps for both uplink and downlink with LTE (long-term evolution), starting from 2010;
- Introducing hundreds of Mbps for downlink with the next-generation mobile system or 4G or IMT-advanced, starting from 2015.

In the core network domain, the next moves will be:

- Introducing flat IP transport core for 10 ms user data latency from end to end with SAE (system evolution architecture), starting from 2010.

- Introducing interworking capability with roaming and handover support for service continuity among major co-existing mobile and wireless access systems like WiMAX and WLAN.

In backhaul network domain, the next moves will be:

- Introducing meshed multiple radio hops;
- Introducing EPON.

In the service domain, the next moves will be:

- Introducing IMS for mobile SIP-enabled peer-to-peer communication services;
- Taking over the fixed access and cable access to form a common IMS in the logic sense.

4.5 Cable Network Evolution:

The cable network is the last to evolve from its original design of analogue television and radio broadcasting services. The on-going moves are towards digital television and radio broadcasting services, and Internet services. The next move will be towards interactive television, HD television, large-screen digital imagery television and time-shifted narrowcast television. On the other hand, there are also moves to provide IP-based services like Internet services and VoIP service.

4.6 Internet Network Evolution:

The Internet, operated by an ISP, does not have its own physical network, instead sitting on the fixed telecom networks to provide basic Internet services of email, web-browsing, FTP and remote login, and also advanced IP applications like VoIP and IPTV.

Such an ISP does not have a direct customer base. However, this situation could change rapidly with various wireless access technologies that allow the rapid deployment of an end-to-end IP network or an IP access network at least.

Under such circumstances, the first wireless ISPs will come out very soon. For example, a WLAN-based wireless mesh network (IEEE802.11s) enabled ISP can provide its customers with broadband access and nomadic mobility.

5- Conclusion:

The network operators are attempting to provide a more efficient and cost-effective provision of services with the current conversion of the entire network infrastructure to IP technology. The aim is to unite fixed, mobile and data networks together and so to provide various services via a transparent network – the so-called Next Generation Network. The core of all communications services will then be a single platform, based on the Internet Protocol.

The table above summarizes some of the key differences between a traditional network and a new generation network. While few of these differences will seem strange to any carrier that has already operated a data network alongside the PSTN network, the shift nevertheless represents a fundamental change in the paradigm of a telecommunications network.

Table 1 the key Differences between a Traditional Network and NGN Network

#	Traditional Networks	NGN Networks
1	TDM	IP
2	Circuit switched	Packet/label switched

3	Hierarchical design	Flat network
4	Path reserved for the duration of the call	Resource not consumed when idle
5	Routes (trunk groups) pre-engineered	Routes dynamically determined
6	Poorly matched for bursty data transmission	Designed for bursty data transmission
7	Non-variable information transfer rates	Supports variable information transfer rates (voice, data, and video)
8	Monolithic switch will all function contained in one box	Switch functions distributed in different boxes with standard open interfaces
9	Choice of switch vendors based upon feature availability and overall performance	Allows choices of network elements from multiple vendors
10	Services and features depend on vendor implementation	Services and applications can be implemented and customized by vendors or third party developers
11	High initial deployment and expansion costs	Flexibility to add resources where and when needed, with more cost effective penetration of new markets

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