Empowered by Innovation NEC

White Paper

Mobile backhaul evolution

for deploying Mobile Next Generation Networks (Mobile NGN)

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Abstract

Next Generation Network (NGN) technologies are impacting the mobile operators as well. In the mobile NGN environment, new broadband services, such as mobile TV and mobile video, are being widely provided and are expected to increase their revenues, while voice revenues will increase at a slower pace. However, to accommodate these new bandwidth intensive services cost effectively, mobile backhaul networks need to evolve from current TDM/ATM-based to packet-based networks. Therefore, the mobile operators are now facing a drastic change of their backhauls and it is a big challenge to shift toward the all-packet backhauls. In the shift, there should be a defined migration strategy from the existing network.

This paper describes the steps for mobile backhaul architecture evolution toward the mobile NGN architecture and the associated requirements. It also introduces the NEC CX2600 Service Aggregation Switch as a solution to realize this evolution.

Introduction

Next Generation Network (NGN) technologies impact the mobile operators which intend to support new broadband services such as mobile TV and mobile video, as well as the fixed wireline operators. Currently most mobile operators provide 2G/3G-based voice-centric services. Although the voice services are still increasing steadily, voice revenues do not grow in the same proportion. Therefore, some operators are planning to shift their revenue growth toward data-centric services, while continuing to offer their base voice services. Industry and market forecasts anticipate that the data revenue will grow at an accelerating rate through a broader spread of current data services and future broadband services.

The deployment of such broadband services undoubtedly will impact the mobile backhauls as well. The current 2G and 3G services use TDM and ATM technologies respectively. The TDM traffic generated from 2G BTSs and ATM traffic from 3G Node-Bs are multiplexed and transported into TDM backhauls. That is, a TDM transport platform is being used as the multi-service platform for the voice-centric services. On the other hand, the data-centric services provided by IP-based 3G, WiMAX, 3GPP-LTE, and 3GPP2-UMB technologies, will be deployed on packet transport platforms using Ethernet, MPLS, and IP. This is because broadband services are based on the packet technology, which provides a solution to overcome issues of cost and scaling. This means that the installation of such broadband services requires new packet-based mobile backhauls. Thus, mobile backhauls require the new flexible platform to transport both TDM and packet for the future.

The backhaul architecture evolution gradually becomes essential for the growth, and it is quite important to address how to migrate from current TDM to packet backhauls in a cost-effective and efficient way, while continuing current 2G/3G services. Mobile operators are now facing a drastic change of their backhauls. Such changing will become a big challenge.

Mobile backhaul architecture evolution

As mentioned above, current mobile backhaul networks are deployed using a TDM transport platform. In the future these will need to be replaced with a packet transport platform to efficiently accommodate broadband services based on WiMAX, 3GPP-LTE, and 3GPP2-UMB technologies.

Figure 1 shows a roadmap of service availability based on mobile access technologies. The 2G services are already in customer use, but the number of the subscribers is forecasted to take a downward turn as the other services are made available. The 2G services, however, must continue to be supported for years until all of 2G subscribers shift to the 3G or later services.

The 3G services have already been available and gradually deployed on a steady basis. The WiMAX services are also available for the deployment. The 3GPP-LTE and 3GPP2-UMB services are expected to be deployed starting in 2010. The broadband services, such as IP-based 3G, WiMAX, 3GPP-LTE, and 3GPP2-UMB, will increase and become dominant in the near future.

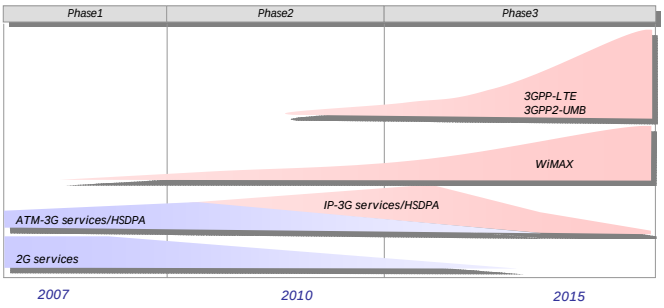


Figure 1. Roadmap of the service availability

From a service point of view, the roadmap is divided into Phase 1 to Phase 3. In Phase 1, current 2G/3G services are provided. In Phase 2, newly IP-based 3G/HSDPA services are available. In Phase 3, 3GPP-LTE and 3GPP2-UMB services are growing.

In line with the roadmap above, backhauls will evolve from TDM to packet networks. Figure 2 shows a backhaul architecture migration from Phase 1 to Phase 3.

In Phase 1, a TDM backhaul architecture is applied to provide current 2G/3G services as shown Fig. 2 (a). These TDM backhauls have been widely adopted to accommodate both TDM and ATM.

In Phase 2, the backhauls are shifted to TDM/packet hybrid backhauls as shown in Fig. 2 (b). This TDM/packet backhaul is a transition architecture toward all-packet backhaul. As the broadband services require larger bandwidth than those of the existing 2G/3G services, more effective packet backhauls will be deployed and partitioned from the existing TDM backhauls. In this phase, the current TDM-based 2G/ATM-based 3G service backhaul platform is gradually shifted to the new packet one. As a result, the TDM backhauls will be scaled down.

In Phase 3 when the packet-based broadband services become dominant, the backhaul evolves to an all-packet backhaul architecture as shown in Fig. 2(c). In this architecture, TDM/ATM-based services and packet-based services are converged onto a single packet-based platform.

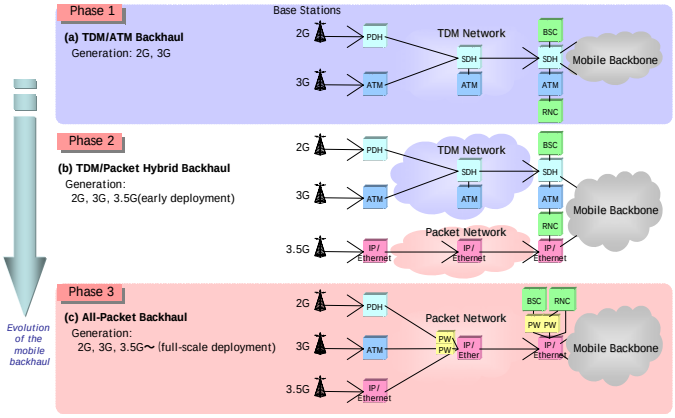


Figure 2. Backhaul architecture migration

In this way, the backhauls are gradually evolved toward the all-packet backhauls. This evolution is coming close to start.

Requirements for mobile NGN

A transition/migration to an all-packet backhaul has to be done in a cost-effective manner. The mobile backhauls are expected to be a multi-service platform which is capable of being applied to all of the backhaul architectures as shown in Fig. 2. The mobile backhauls must accommodate TDM, ATM, and other packet traffic, such as Ethernet, MPLS, and IP, simultaneously. The necessary functional requirements to support the mobile NGN are described as follows.

1) **Multi-service platform functionality required to support a wide range of the services from 2G/3G to public wireless LAN, WiMAX, 3GPP-LTE, and 3GPP2-UMB services**

In line with the backhaul architecture migration as shown in Fig. 2, the multi-service platform is expected to behave as a TDM platform, a TDM/packet hybrid platform, and an all-packet platform. Therefore, this platform is required to support both TDM and packet switching functionality. In addition, to achieve smooth and seamless migration, the platform should provide a capability to changeably assign the switching capacity to TDM and packet switching with fine grain, in proportion of the traffic volumes. The platform should also support both TDM-based and packet-based interfaces.

In Phase 3 where all-packet backhauls are deployed, to accommodate current 2G/3G services on the all-packet backhauls, 'TDM/ATM emulation over packet' functionality must be supported. In the TDM/ATM emulation, the precious clock recovery is known as a key technology. In addition, the packet-loss recover mechanism is also important to provide the stable quality equivalent to TDM networks. Such a TDM/ATM emulation functionality is one of the keys to efficient migration toward all-packet backhauls.

2) Support of per-flow Quality of Service (QoS) technology to ensure transmission quality and bandwidth flow by flow

The QoS in the packet networks is quite important for mobile operators to deploy Service Level Agreements (SLA) for broadband services in an over-subscribed environment for efficient use of bandwidth. SLA requirements for a flow in which the service traffic is transported are different from those of others. For example, voice services are delay-sensitive but not so sensitive to packet losses, while mobile TV and video services are bandwidth and packet-loss sensitive but not so delay-sensitive. The fact that each service has an associated QoS level dictates that per-flow tight QoS technology should be applied. Hence, the per-flow QoS functionality is also important to provide the stable quality for existing 2G/3G services over packet networks.

3) Support of carrier-grade management functionality equivalent to SDH/SONET

In both TDM/ATM-based and packet-based platforms, comprehensive management functionality is required in the transition/migration. Packet-based management functionality historically has been less satisfactory, while more capable TDM/ATM-based management functionality has already established and proven. Furthermore, performance measurement functionality such as transmission delay and jitter, is quite important to maintain and verify the quality for TDM/ATM emulation traffic on the packet networks. Therefore, an advanced OAM functionality must be deployed in the packet-based backhaul scenario.

From a network reliability point of view, packet-based backhauls also require the resiliency to be equivalent to or better than that of the TDM-based backhaul networks based on SDH/SONET technology.

NEC CX2600 Service Aggregation Switch

The NEC CX2600, as shown in Fig. 3, is a multi-service transport platform capable of supporting a mixture of TDM and packet traffic while providing a smooth migration at the same time with a minimum cost. The CX2600 offers the mobile operators the functionality and ability to accommodate both the current TDM/ATM-based 2G/3G services and the future packet-based WiMAX/3GPP-LTE/ 3GPP2-UMB services.

Figure 3. CX2600/200 Series

The CX2600 offers several functionality advantages:

1) A multi-service transport platform with TDM/packet hybrid switching capability and TDM/ATM emulation functionality for a seamless migration

The NEC CX2600's TDM/packet hybrid switching capability of a single switching card simultaneously provides both low-latency circuit switching for TDM traffic and effective packet switching for Ethernet, MPLS, and IP. Therefore, the CX2600 can apply to all of the architectures as shown in Fig. 2. Figure 4 shows CX2600 configuration examples. The CX2600 can act as a TDM/ATM backhaul node in Phase 1, a TDM/ATM and packet hybrid backhaul node in Phase 2, and a packet backhaul node in Phase 3. This flexibility provides a single platform solution with an ability to solve the above backhaul migration issues. In addition, the CX2600 supports a wide range of network interfaces, such as TDM, ATM, and Ethernet, for use in any backhaul architecture.

In addition, TDM/ATM emulation on the packet networks, known as a pseudo-wire Edge-to-Edge (PWE3), can be configured as another important technology for backhaul migration. NEC's PWE3 functionality realizes the packet-loss recovery mechanism as well as the basic clock recovery one, so that the CX2600 provides 'loss-tolerant' TDM/ATM emulation functionality.

2) Per-flow intelligent QoS and ultra low latency QoS processing functionality

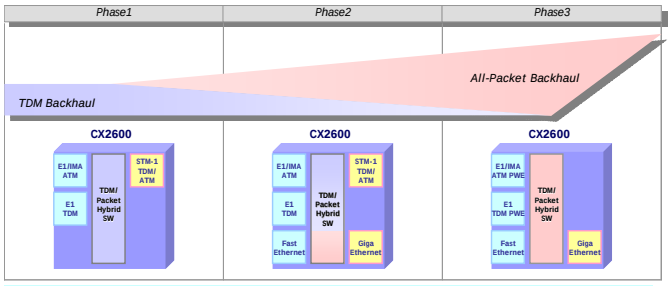
NEC's flow-based intelligent QoS engine provides the ability to ensure a certain delay, minimal jitter and specific bandwidth. This engine also realizes flexible and tight traffic control, such as maximum bandwidth limitation, minimum bandwidth guarantee, and fair rate sharing.

In general, the maximum number of controllable flow is seriously limited due to avid the degradation of packet-delay and jitter characteristics. However, NEC's original QoS mechanism does not affect any additional packet delay and jitter despite handling thousands of traffic flows. This advanced functionality enables the mobile operators to maintain the designated quality for each service and customer, regardless of the number of TDM/ATM emulation traffic and/or oversubscribed best-effort traffic.

3) Carrier-grade management functionality for packet-based backhaul requirements

The CX2600 supports Ethernet-based OAM functionality standardized in ITU-T Y.1731 and IEEE 802.1ag. Continuity Check function provides the ability to detect a failure and misconfiguration automatically. Loopback and Linktrace functions assist in the fault localization and verification operations processes. Performance Monitoring, which realizes traffic measurements such as delay, jitter and packet loss ratio for each flow, enables mobile operators to verify the transmission quality for TDM/ATM emulation traffic over packet networks. In addition, the CX2600 supports Ethernet Automatic Protection Switching to provide the reliability equivalent to TDM networks.

Thus, the CX2600's OAM functions bring proven management capabilities and existing TDM/ATM attributes to the packet-based backhaul networks.



CX2600 deploys multi-service / generation-free architecture and it has flexible capability to support all phases of TDM to All-Packet Backhauls, simply by installing suitable interface modules.

Figure 4. Seamless Migration with CX2600

Summary

Advancements of the mobile NGN providing packet-based broad broadband services will impact the mobile backhaul network architecture as well. To accommodate both new broadband services and current voice-centric services, the existing TDM-based backhaul networks must seamlessly transit and migrate to data-centric packet-based networks at minimum cost.

This paper defines key issues in migrating backhaul architectures toward packet-based backhauls, discussing the expected service evolution and necessary functional requirements. The backhauls will require a multi-service transport platform with TDM/ATM and packet switching capability, reliable TDM/ATM emulation functionality on the packet backhaul, and carrier-grade management functionality. The NEC CX2600 provides mobile operators with a minimum-cost single-platform multi-service solution capable of supporting a flexible mixture of TDM and packet traffic during and after migration, while also providing the QoS and OAM functionalities needed to guarantee carrier-grade service quality.