Backhaul Network for Beyond 3G Environment

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Abstract: Backhaul network will be the key issue to deploy services in beyond 3G environment. This paper provides some key factors to consider for deploying the future backhual network and also propose one scenerio of future backhaul network architecture.

1. Introduction

Mobile backhaul capacity demands and associated cost will increase exponentially in the immediate future. Mobile operators have relied to a large extent on fixed-line wholesale carrier services to backhaul mobile voice and data from the mobile base stations onto a backbone via leased lines and, where available, direct fiber. However, with the increasing demand from clients for converged services, including bandwidth-hungry rich media content on 3G networks to mobile handsets, mobile operators are beginning to see that their business models are simply not going to scale, especially with ARPU growth lower than backhaul expenditure growth. This problem is certainly not going to go away, as business and residential customers look for more mobile media and interactive communications, such as live TV streaming to a mobile device. Future wireless platforms, such as 4G, HSDPA, and LTE, will cause backhaul requirements to shoot up yet more.

At the same time, mobile operators cannot expect traditional mobile telephony charged per-minute to provide a way out of this problem, especially as more dual-mode handsets and services enter the market, allowing clients to conduct VoIP calls and other mobile data services (e.g., SMS and chat) from home WiFi areas or public hotspots. So the need of new backhaul architecture is obvious to support the 4G traffic. In this paper, we analysis the capacity requirement of 4G backhaul network and propose a new backhaul architecture for the future backhaul network.

The rest of the paper is organized as follows:

In the section two, we discussed about the need of new backhaul network architecture. In the section three, the key factors for the upcoming backhaul network is discussed. Section four provides the current backhaul network architecture where as in section five we proposed new backhaul network architecture. Finally we made the conclusion in the section six.

2. Why do we need new backhaul architecture?

According to ABI Research, the key motivators for capital expenditures in the past were focused on customer acquisition to increase market share. Today, however, it seems to be that the key motivator is to increase ARPU and reduce costs associated with operating the backhaul network.

The reason for the expected increase is mostly due to the fact that most GSM operators have started or committed to migrate towards 3G within the next few years. Similarly, service providers currently offering 3G services have also initiated the transition towards incorporating HSDPA/HSUPA, even though the transition from 2G is still underway.

It is reasonable to assume that in the next few years 3G (i.e. UMTS) will overlap with 2G services, including GSM, GPRS and EDGE. In practice, this means that most GSM BTS and BSC network elements will be co-located, for the most part, with UMTS Node B and RNC network elements, including UMTS Release 99 and UMTS Release 4, 5 and 6. Initially, the majority of the traffic from these co-location sites could be safely assumed to be dominated by GSM voice traffic, requiring an average of two to three E1 links to connect the BTS to the aggregation network. In subsequent years, however, it is expected that UMTS and HSDPA will eventually become the dominant traffic at these sites, initially requiring an expansion in terms of capacity from the co-location site equivalent to two to four E1 links per Node B.

3. Key factor for upcoming backhaul network

Mobile WiMax and 4G networks are starting to be rolled out. These emerging deployments are being driven by the requirement for higher capacity mobile applications, and will be used to deliver mobile video, gaming, and data

delivery, in addition to traditional voice. As these networks are being deployed, traditional T1/E1 backhaul solutions are no longer viable for the Ethernet based transport required for emerging services.

T1/E1 backhaul solutions not only have capacity limitations that are exceeded by 4G networks, they do not support the Ethernet transport requirements of 4G networks. This has caused many operators to consider wireless Ethernet backhaul for their 4G deployments. However, these new services are driving a completely new group of requirements on the wireless backhaul network. The key characteristics of the backhaul network which we will discuss and analyze how they can be delivered are:

- Network Availability
- Latency
- Backhaul cost
- Ethernet functionality

3.1 Network Availability

One of the primary requirements that all service providers have for existing and emerging services is high availability. Network availability requirements vary by operator from 99.9% to 99.999%. This wide range of availability levels must be delivered by the wireless network, with the 99.999% services being the hardest to deliver. In order to deliver this level of services, a new set of requirements is imposed on the wireless network. The wireless network must be in the licensed bands to avoid any potential interference which is unpredictable.

3.2 Latency

The next key performance characteristic that is required of the backhaul network is ultra-low latency. The emerging set of voice and video services being delivered by 4G networks typically has a metro latency budget of about 10ms. 5 ms of this is usually allocated to the fiber network. This leaves 5 ms of delay for the wireless backhaul network. About half of this is allocated to the Ethernet switch layer, leaving about 2.5 ms for the wireless links. In an 8 node ring, this leaves a maximum latency of .3ms per link. This drives the requirement for a very low latency Ethernet system, and will be a key factor in backhaul technology selection.

3.3 Backhaul Cost Factor

The 4G business case is very sensitive to the backhaul network cost. The wireless backhaul network cost in turn is dominated by the ongoing lease costs, rather than the upfront install and equipment cost. This makes it very important to minimize recurring antenna lease and indoor cabinet leasing costs. This can reduce the monthly recurring antenna lease costs by more than 50%. Ongoing lease costs can also be drastically reduced by using an all outdoor system. The first step towards this is to use an all outdoor modem and radio, eliminating the need for indoor rack space for the modem. Of course the outdoor equipment must be fully weather and temperature hardened.

3.4 Ethernet functionality

The last important requirement of the 4G backhaul network is enhanced Ethernet functionality. This encompasses a few key items. The first item is that it is important that the transport layer supports Jumbo frames, for protocols such as MPLS. The backhaul layer also needs to support flow control, with pause frames, to be able to provide back pressure to the Ethernet switching layer, when the link is being overloaded in capacity. The Ethernet backhaul network must also be fully layer 2 transparent in order to fully support 4G services and roaming capabilities Lastly, 802.1p and DSCP prioritization need to be supported in order to handle multiple traffic types.

4. Current backhaul network architecture

Currently, most service providers rely on a series of point to point TDM links to interconnect the 2G BTS and the BSC. However, this design cannot scale to satisfy the demands for 3G services or the introduction of new multimedia services (MMS) defined in Release 99 even when the migration from

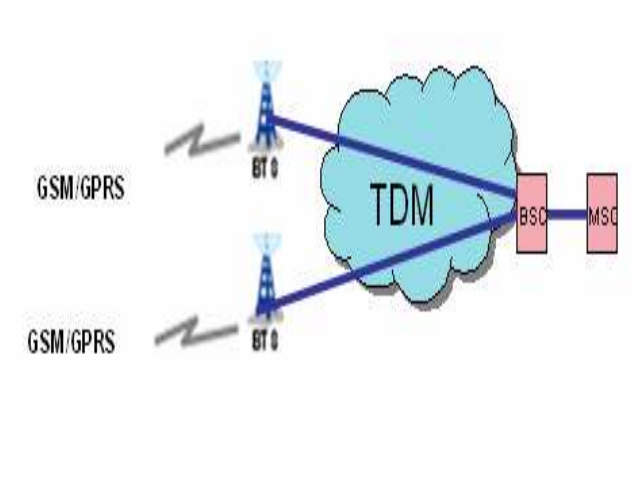

Figure 1 GSM/GPRS backhaul network

GSM/GPRS is not directly to UMTS, but executed gradually by introducing EDGE technology prior to UMTS. The RAN design for GSM and GPRS therefore assumes the vast majority of traffic to be compressed voice rather than

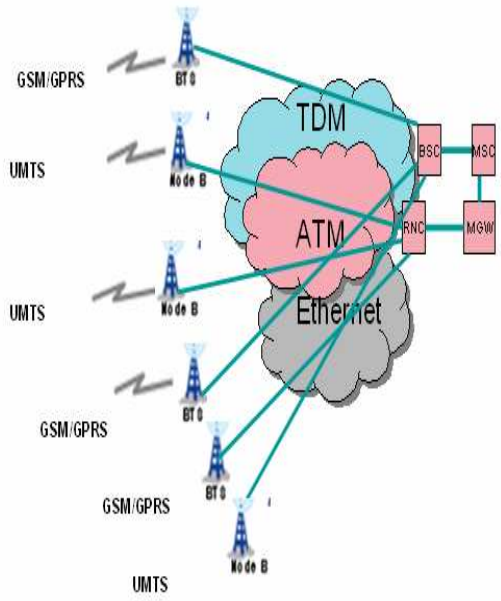

Figure 2 HSDPA, UMTS and GSM backhaul network overlap

derived from data services, which are assume to be limited and not having any impact on the capacity requirements for the RAN. Network engineering is therefore done based on the expected customer density and average voice usage, leading in most cases towards a network design in which a low capacity backhaul network, mostly based on a reduced number of point to point E1 links, is sufficient to satisfy the capacity requirements for the backhaul network.

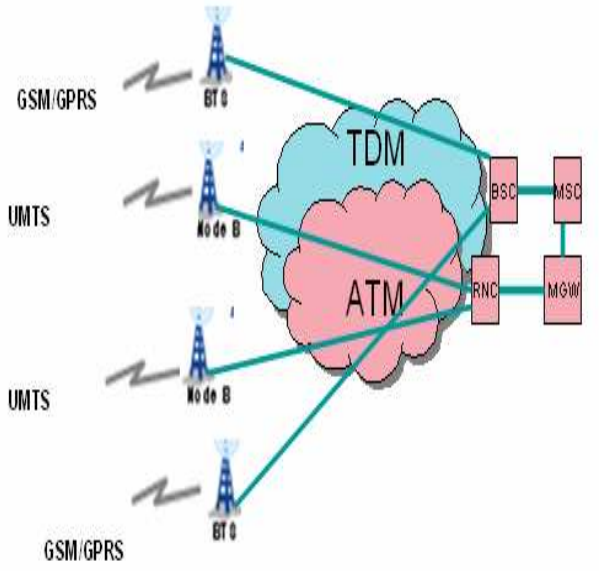

Figure 2 UMTS and GSM backhaul network overlap

5. Proposed network architecture

It is obvious that 4G will require a much higher data transfer in the backhaul. It also needs to support Ethernet based service. all the access points will be converged into single box which is the most challenging task to accomplish. In our proposed architecture we just showed the top level scenario of future backhaul network architecture. We haven't discussed how it will be implemented in the real world scenario. We proposed WDB fiber ring in the core network as shown in the Figure 4.This will be connected to the base station via 10GE-PON. We assumed one single box will provide the access capability of service like WiMax, UMTS etc. Each base station will be connected to each other via fast Ethernet line so that they can share the traffic load. Here overlay of 10GE-PON can utilize the bandwidth more efficiently. Bandwidth scheduling between different BS are also possible because of the overlay.

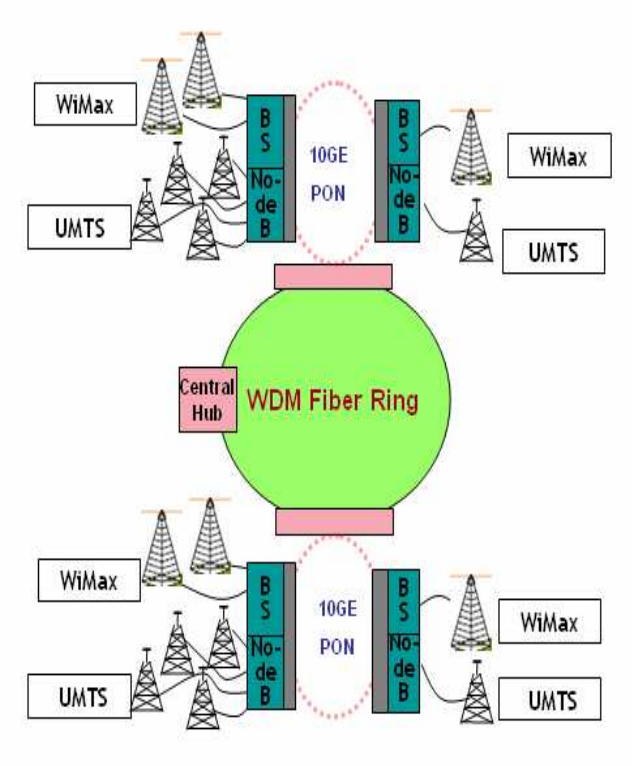

Figure 3 Proposed backhaul network architecture

6. Conclusion

In this paper, we discussed some key factors for future backhaul network. We showed current backhaul network which is very much independent for each service. But it is obvious that future backhaul network will be converged in the access part as well as in the backhaul part. So our proposed network architecture is just a top level view. We

haven’t discussed the implementation complexity, which can be done in the future.

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