Business White Paper

Nokia Siemens Networks

Optimize backhaul to increase mobile data profits

Abstract

Mobile backhaul challenges in the new mobile high-speed data world

With the increasing adoption of broadband data services, traffic loads in mobile networks are rising dramatically. Mobile operators face the challenge of providing much more capacity within their transport networks and doing it not only ahead of the wave of demand from data services, but at optimized cost to be able to maintain profitability.

Mobile backhaul encompasses the transport network between cell sites (base stations) and associated controller or gateway sites. Cell sites are numerous, often geographically remote and with limited bandwidth.

Conventionally, the BSC and RNC mark the border between the access network and the core network. However, this border is being blurred by new radio technologies, like I-HSPA, LTE, and WiMAX, which introduce flat architectures, in which cell sites are connected directly to the core network. Those elements handling the user plane might move closer to cell sites, but an access network must remain in place, because cell sites will remain widely dispersed.

This White Paper reviews the current situation that most operators face and outlines the different solutions available. The ultimate aim is to evolve existing backhaul to a simplified packet-based network that can carry all types of traffic.

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Executive Summary

Nokia Siemens Networks expects that by 2015, five billion people across the globe will be united by communications technology. Many will enjoy broadband connectivity, enabling them to use a wide range of services wherever they are and on whatever device they choose. Running in parallel with this boom in subscriber numbers, is the development of rich data services, from mobile TV to advanced interactivity.

Already, rising data revenues are helping to offset a decline in voice ARPU. According to Global Mobile, blended ARPU figures increased across the board in Q2 2007 for the 30 largest mobile operating groups, in both emerging markets and more-developed ones.

The upshot of these trends is a dramatically increasing volume of traffic traveling over mobile networks. The widespread take-up of bandwidth-hungry data services is driving up the need for operators to invest in their networks to provide the required capacity.

Operators face difficult cost pressures

However, high levels of competition are driving down data tariffs. Eventually, flat rate data tariffs, so familiar to fixed broadband users, will be adopted by the mobile world. Analysis carried out by Nokia Siemens Networks predicts a 10 % per year fall in overall tariffs in the coming years, with data tariffs set to decrease still further.

This places intense cost pressures on operators who need to ensure that the cost per bit of transporting data falls more quickly than the cost per bit that end users are paying.

With many of the world's established operators relying on transport networks using E1 leased lines or their own legacy infrastructure, the cost conundrum becomes even more difficult. Simply adding more leased lines to increase capacity is not economically viable because doubling the capacity means doubling the cost. A new architecture needs to be adopted to break this linear relationship between capacity and cost.

Smoothly evolving to all-Ethernet backhaul

Nokia Siemens Networks foresees an evolutionary path for most operators to migrate smoothly to all-Ethernet mobile backhaul via an intermediate hybrid backhaul network step. This is likely to be the most cost-effective evolutionary path for existing operators, although some greenfield operators may have the opportunity to build a full packet-based backhaul network from scratch.

The hybrid network optimizes existing assets. It transports high-value voice services over E1 lines, with packet transport being used for data services.

This evolutionary path makes it feasible for operators to provide the high capacity that bandwidth-hungry data services need, while simultaneously optimizing backhaul OPEX. The strategy calls for CAPEX investment now to reduce OPEX over the long term.

Operators also gain a simplified network structure that gives them the ability to respond rapidly to market demands and to launch new services more quickly and with lower costs.

Finally, many operators are considering the use of managed services to achieve the efficiency gains they need, to reduce the risks of investment, and to free up their resources to focus on differentiating themselves with excellent customer service. Outsourcing is a proven business model that provides full visibility and predictability of OPEX, simplifying budgeting and business planning.

Data use is going up, data tariffs are coming down

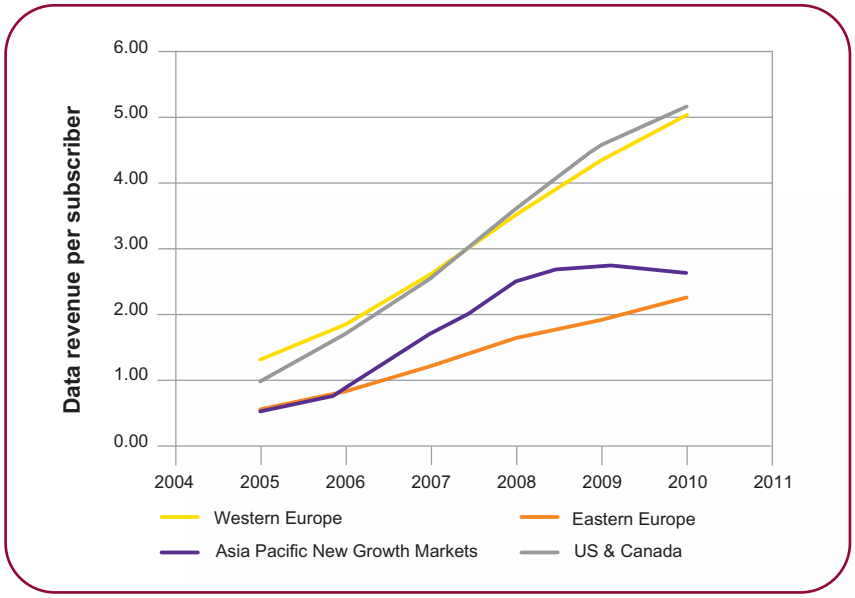

Figure 1: Revenue from non-messaging data services is rising, helping to offset falling voice revenues

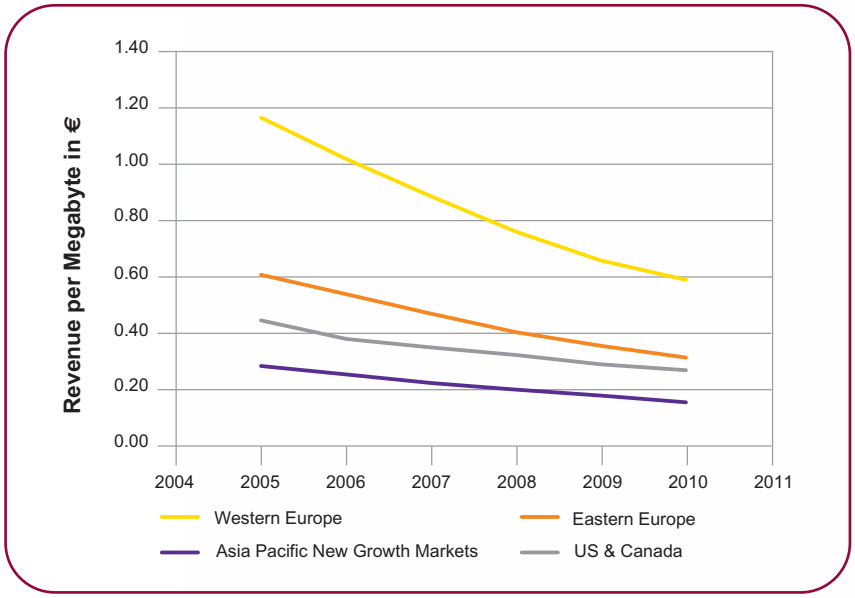

Figure 2: Average revenue per MB will decline by 10% annually

By 2015 it is expected that five billion people around the world will be united by communications. People will be able to use a vast array of content and services, where they want, when they want, using whichever device they want.

Today's highly competitive communications sector will intensify, demanding that service providers in both advanced and emerging markets focus on providing innovative services that match the changing lifestyles of end users. Advanced data services are already starting to offset the steady decline in voice revenues (Figure 1). There is great opportunity for service providers to bring innovative value-adding services to market to differentiate and take their share of the data boom.

The adoption of advanced data services is already rapidly driving up traffic over mobile networks. Data-hungry services like mobile TV and multimedia content streaming are complementing new and richer person-to-person communications, such as video sharing, advanced messaging and VoIP, further fueling the demand for high-speed data.

With the greater availability of mobile broadband, data tariffs are already falling. Further price pressure will come from subscribers who are familiar with the "all you can eat" pricing of fixed broadband. They will increasingly expect the same from mobile service providers. The introduction of flat-rate data tariffs over mobile networks is inevitable. Once one service provider launches such an offer, other operators in its market must follow to remain competitive.

According to the analysis by Nokia Siemens Networks, average revenues per MB will decrease by at least 10 % annually (Figure 2).

Falling data tariffs present service providers with a significant challenge as they strive to achieve a fast return on their investment in new services and infrastructure development.

Avoiding the backhaul bottleneck

Networks are being prepared to meet mushrooming mobile broadband demand. Many existing 3G radio access networks are being upgraded to HSPA capabilities. Further dramatic increases in radio site capacity will come with the implementation of new wireless technologies such as WiMAX, I-HSPA, and LTE.

All of which adds up to immense and growing pressure on the next link in the chain – the mobile backhaul network. In order to secure the promised new revenue from advanced data, service providers face an urgent need to build high-capacity transport networks.

It is thought that many operators currently spend more on their transport networks, mostly on leased line rental and maintenance, than they do on salaries for their entire organization. Optimizing the cost of backhaul is now a critical issue for most operators. Smart investment in transport now will bring much reduced operational costs long into the future.

Much existing backhaul infrastructure remains rooted in E1 leased-line technology and self-built networks, using only limited Layer 2 aggregation (typically ATM-based). This legacy architecture does not scale cost-effectively to provide higher capacity. Adding leased lines increases costs explosively. This is simply not economically viable. Instead, a way must be found to decouple cost and capacity.

The solution to the transport network challenge will be different for each service provider, depending on their existing technology and commercial position, geography of coverage area, their market, and strategic plans. However, all service providers need to address the following key issues:

- Reducing long-term OPEX
- Achieving the most efficient CAPEX
- Creating scalability in transport
- Adopting the right future-proof technologies

Evolving to packet-based networks

Matching the performance of fixed services

Traditionally, mobile and fixed operators have taken a different approach to the Quality of Service they offer. Fixed operators are able to generate profits from broadband services because they do not guarantee performance of data services to the end user. xDSL provides best-effort performance, with heavy over-subscription of lines. The performance of voice services is guaranteed but is offered separately to data services.

Mobile operators on the other hand have traditionally guaranteed performance of voice and data services delivered over the same network. This has led to broadband services being provided over HSPA with guaranteed performance. The high costs of the transport to achieve this are no longer viable.

To stay profitable, mobile service providers will need to adopt the cost structure of fixed operators by treating data traffic separately (Figure 3). A model based on voice services with guaranteed performance and broadband services delivered with best-effort performance will provide the right balance in protecting voice revenue, while reducing transport costs substantially.

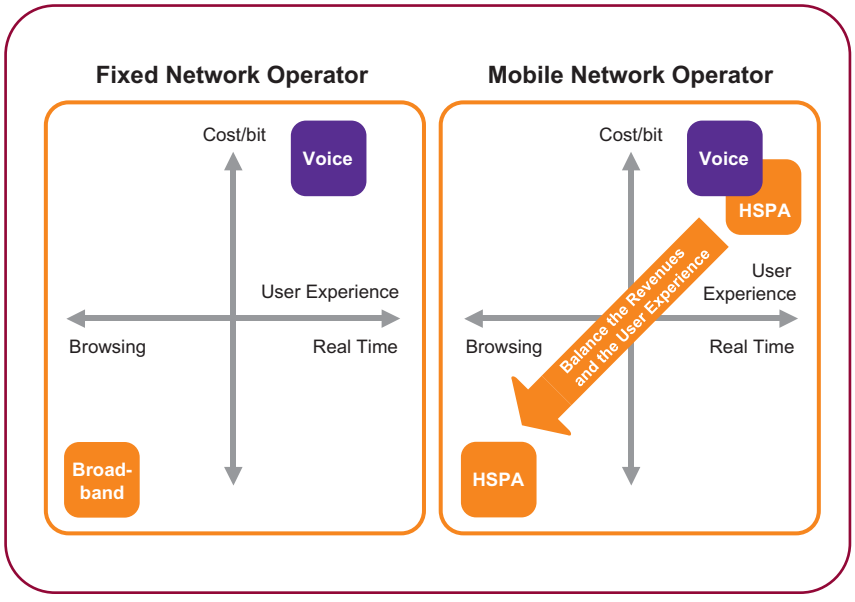

Figure 3: Mobile operators will need to match the QoS and cost structure of fixed operators to achieve profitability with advanced data services

The options for evolving the transport network

Backhaul networks have traditionally been built using a mix of E1 (2 Mb/s) leased lines, PDH/SDH microwave links, and SDH fiber systems. The use of PDH and SDH technologies caters for 2G and 3G base stations that typically have E1 interfaces (carrying TDM for 2G and connecting with an ATM overlay to concentrate 3G data traffic).

Traditionally, mobile operators have taken three different approaches to their backhaul network:

Self-built backhaul networks

Mobile operators have built up their transport network over many years by deploying PDH microwave radios to bridge the first and second mile, and using SDH microwave radios or SDH fiber rings for trunks. ATM aggregation was added with the introduction of 3G.

With the adoption of HSDPA, limits have been revealed with a growing need for more E1 lines, which quickly incurs unacceptably high costs. Also, the capacity of microwave radio links may be limited by spectrum unavailability.

Networks using leased lines

Mobile operators that have not built their own transport network typically rely on E1 leased lines. While E1 lines are suitable bearers for high-value services such as voice, adding more leased lines to provide higher capacity is uneconomical. With HSPA and future technologies, new backhaul services are needed that enable higher bandwidth with much lower costs.

Networks combining fixed and mobile traffic

Increasingly, mobile network operators are offering fixed broadband access, typically xDSL for residential users. When the mobile operator achieves this by acquiring a DSL provider, the mobile and the fixed networks are usually completely separate.

The complexity of merging mobile and fixed traffic on a common transport network will be driven largely by the availability of fixed lines and the extent to which microwave radios are already deployed.

Smooth evolution is vital

Achieving the separation of cost and capacity to enable flexible and cost-effective capacity growth ultimately requires traditional architectures to be evolved to a full packet-based network. Such a single, unified network also achieves the aim of network simplification, removing complexity from infrastructure and business processes to provide greater flexibility and agility for service providers to react quickly to changing market conditions.

However, it is critical that this evolution is performed smoothly to ensure uninterrupted service for end users.

For many existing service providers, the most cost-effective solution will be to evolve to a hybrid backhaul network as an intermediate step to the full packet-based network (Figure 4).

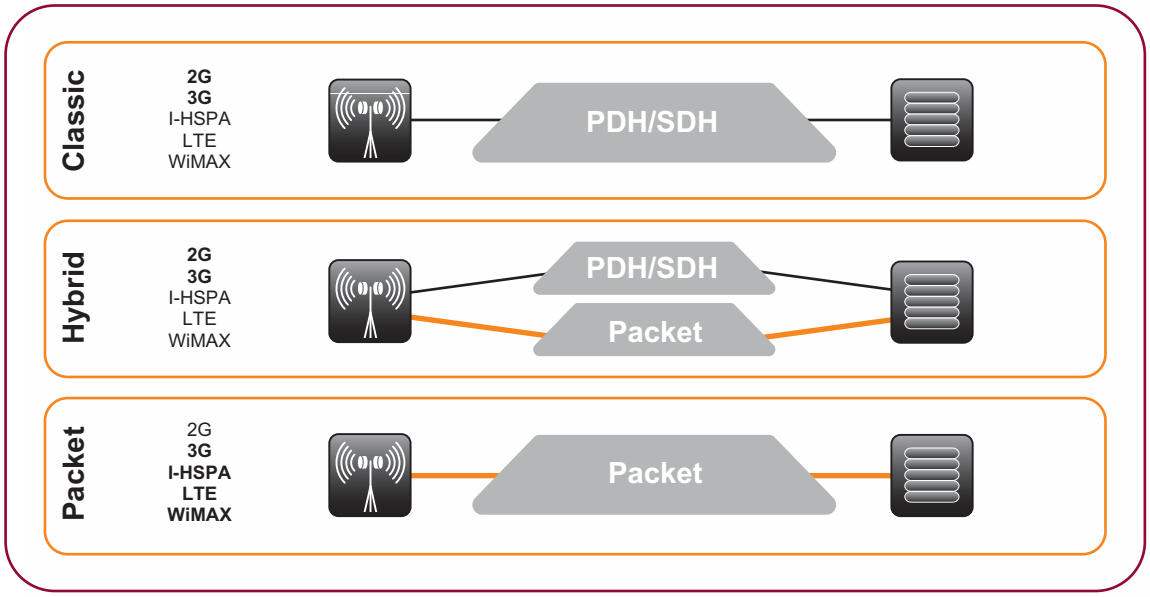

Figure 4: Evolving from today's classic TDM networks to the all-packet network will often require an intermediate step – the hybrid backhaul network

The converged packet-based 2G/3G transport network is typically seen as a longer-term evolution running in parallel with the adoption of IP/Ethernet interfaces on base stations. However, some service providers, such as greenfield entrants, may elect to invest directly in building a pure packet-based transport network using Ethernet throughout.

The aim is not only to optimize the costs within the transport network and provide capacity to meet current demands, but to provide a foundation for implementing future developments cost-effectively. It should also enable changing traffic requirements to be met rapidly and flexibly.

The hybrid backhaul network

The hybrid backhaul solution is based on packet transport for bandwidth-hungry data services (HSPA) to take advantage of statistical multiplexing gains and overbooking. Voice and other critical services are still transported over the existing TDM backhaul network.

This limits the use of costly E1 leased lines to one per site, offloading HSPA traffic to IP-based transport, such as xDSL lines. This saves significant costs when scaling up capacity, while still guaranteeing highest quality for voice services and synchronization of base stations over the PDH/SDH network. The hybrid backhaul solution achieves a good compromise of adopting alternative technologies, while optimizing the use of existing assets.

A variety of technologies can be used to build the network, such as extending the use of microwave radios, upgrading radios with Ethernet L2 functionalities and adaptive modulation, and introducing copperbased (IP DSLAM) and fiber-based (GPON) optical broadband access technology to cover the first mile.
A variety of aggregation technologies can also be adopted, including Next Generation SDH, Carrier Ethernet, ATM switching, Layer 3 MPLS, and IP.

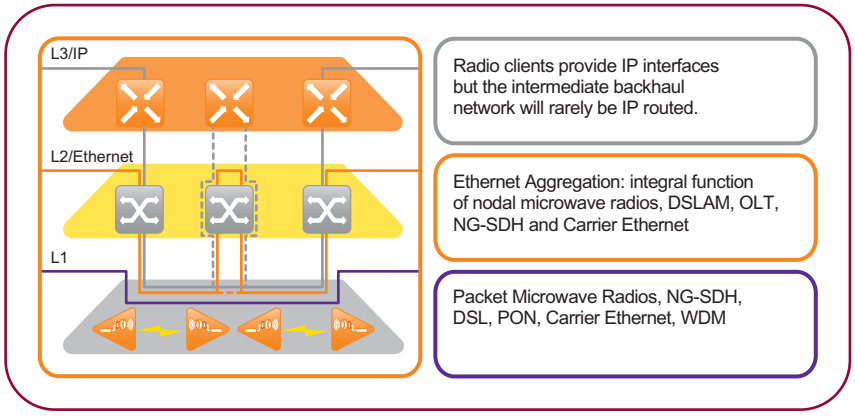

Figure 5: An optimized mix of technologies will be needed to meet the needs of service providers as they evolve their transport networks

The all-Ethernet backhaul network

Packet-based transport is the key technology for next generation mobile networks. Service providers with access to a high-quality packet transport network will want to consider using an all-Ethernet backhaul network. This network can be based on either a leased Metro-Ethernet network or a self-built packet network combining different technologies, including packet microwave radios, GPON, NG-SDH, or Carrier Ethernet. This approach enables a unified backhaul network for different services, simplifying the operation of this network and reducing the operational cost accordingly. The network handles the increasing packet traffic in a highly efficient fashion, but also allows the operator to enter SLAs that guarantee all necessary key performance indicators.
The most recent mobile radio network deployments do support native IP, and legacy equipment can be upgraded with pseudo wire technology, often integrated into the base station itself. While the radio clients provide native IP interfaces, there is, however, no need for sophisticated routing capabilities in the access network. Layer 2 Ethernet Aggregation will be sufficient for the needs of mobile backhaul networks. The result is a cost-optimized network, taking into account the network resources and the available topology.

Many factors affect the technologies used

There is no single solution for evolving legacy transport networks or rolling out new networks. The requirements for each operator are driven by a wide range of factors, including:

- **The radio access architectures to be served**
  A backhaul solution for a GSM/EDGE network will differ from that for a WiMAX network, both in terms of traffic type and volume. The network needs to encompass the range of co-existing radio access technologies and be optimized for one of them
- **The installed base needs to be considered**
  WCDMA often inherits the initial backhaul solution from an existing GSM/EDGE network. Several options exist for scaling this up to meet growing data traffic demand and with minimum disruption to end-user services
- **Sharing the transport infrastructure between mobile and other traffic**
  A decision must be made on how to optimize the network, particularly the aggregation architecture
- **Legal restrictions**
  Spectrum availability for microwave radios or the status of local loop unbundling, for example

Building the business case

Calculating the value of network development

The choice of transport network technology is driven by a range of variables, including CAPEX and OPEX, expected return on investment, services to be delivered, geographic spread, required rate of rollout, availability of microwave radio spectrum, migration or ramp-down of legacy systems, and, increasingly, environmental and cost implications.

Justifying the necessary investment in transport infrastructure entails a detailed analysis of all these factors to reveal the value of alternative technological solutions, such as leased lines, microwave radios, fiber optics, and Metro Ethernet. This value must then be considered against the capability that the revitalized transport networks provides the operator to offer services to build new revenue streams, to increase its operational efficiency, and address market trends such as convergence.

Business modeling reveals the best choices for the operator

Figure 6 illustrates an example analysis of the value of three different business cases based on 100 % Ethernet leased line, hybrid backhaul, and a self-built network using a combination of Carrier Ethernet switches and packet microwave. The reference network includes not only the “last mile,” but also the cost for the higher layers of the backhaul network. All cases include the cost of items to build and maintain the transport and assuming an increasing share of data traffic.

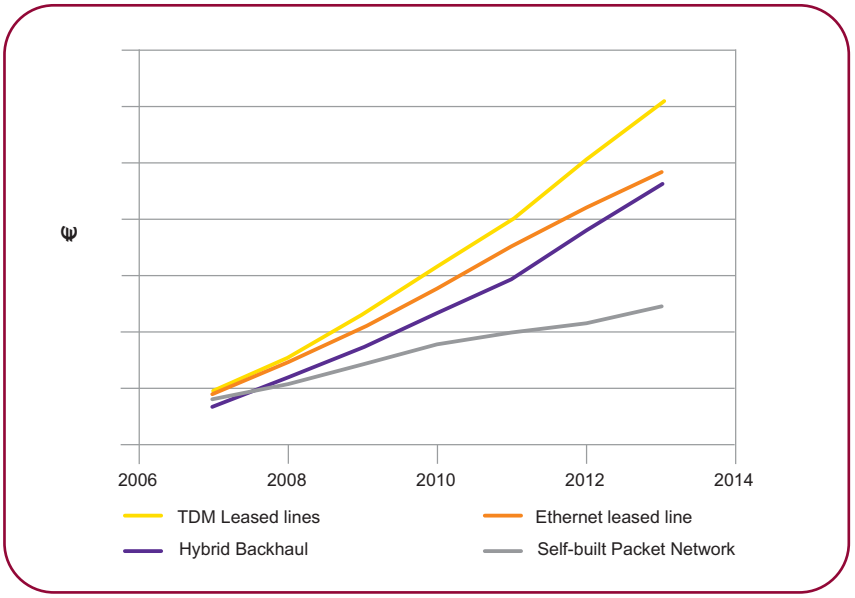

Figure 6: A typical business case analysis

The results of this example analysis lead to the following conclusions:

- An HSPA network with TDM leased line architecture is the most expensive option and does not make business sense
- For the given traffic scenario, the leased Ethernet achieves 25% cost savings, while the hybrid backhaul network achieves slightly greater savings. However, a more aggressive traffic scenario (not shown) would reveal that leased Ethernet can be more attractive than the hybrid solution, because costs per bit decrease with higher bandwidth
- More than 60% savings are achieved with the self-built network, making it the most attractive option. For operators with an existing network, adopting NG-SDH and packet microwave radio technologies to evolve their network will be attractive, while greenfield operators should consider Carrier Ethernet

Managed Services to support backhaul evolution

Being a successful operator used to depend largely on managing the network, but today it is increasingly about managing customer relationships.

Competition for these customer relationships is intensifying, forcing investment in new technologies and services to prevent churn and enable growth. But service differentiation comes at the price of greater network complexity and higher capital and operational costs, when operators must keep both under tight control and compete on value for money.

Faced with these challenges, operators are reviewing how outsourcing their networks and operations can not only help manage the operational and technological risks involved, but also reshape balance sheets and source the competences, skills, and resources they need to compete more efficiently.

No two operators are the same, so outsourcing solutions need to be tailored to individual requirements. Key components of what an outsourcing solution can deliver include technical operations such as field maintenance, network implementation, network operations, and optimization. An outsourcing solution can also include service management and development activities.

For many operators, relinquishing control of their network operations to a single supplier is not an easy decision. But with the proper agreements and measures of success in place, teaming up with the right trusted partner will ensure that the operator's current market size and position has very good possibilities to grow as the communications ecosystem evolves.

Conclusion

Moving ahead with optimized backhaul

As the mobile communications sector continues its relentless expansion with more subscribers and more advanced services generating ever-greater volumes of traffic, operators must invest in their infrastructure to provide the bandwidth to meet demand.

Nokia Siemens Networks takes an holistic and consultative approach to mobile backhaul evolution. Through close consultation with an operator, we help to identify shortcomings in the present network design, assessing alternatives, and finally deciding to introduce a certain solution. We then work with the operator to implement the solution and can provide total life cycle support with our portfolio of managed services.

The transport network represents one of the highest costs for mobile operators. It typically accounts for a higher proportion of total operational costs than any other area of the business. Optimizing these costs is a critical challenge for operators to be able to maintain profitability in the face of downward pressure on tariffs in a competitive market.

A change in the architecture of the mobile backhaul infrastructure is needed to be able to cost-effectively provide the huge rise in capacity that is needed as new, bandwidth-hungry data services grow in popularity. Evolving the transport network to a single, unified packet-based network is the ultimate aim, simplifying network and business processes to bring new flexibility for service providers.

Abbreviations

ARPU	Average Revenue Per User
ATM	Asynchronous Transfer Mode
BSC	Base Station Controller
CAPEX	Capital Expenditure
DSLAM	Digital Subscriber Line Access Multiplexer
EDGE	Enhanced Data rates for GSM Evolution
GPON	Gigabit Passive Optical Network
GSM	Global System for Mobile communications
HSPA	High-Speed Packet Access
I-HSPA	Internet High-Speed Packet Access
IP	Internet Protocol
LTE	Long-Term Evolution
MB	Megabytes
MPLS	Multi-Protocol Label Switching
NG-SDH	Next Generation Synchronous Digital Hierarchy
OPEX	Operating Expenditure
PDH	Plesiochronous Digital Hierarchy
QoS	Quality of Service
RNC	Radio Network Controller
SDH	Synchronous Digital Hierarchy
VoIP	Voice over IP
WiMAX	Worldwide Interoperability for Microwave Access
xDSL	Digital Subscriber Line, usually ADSL or SDSL

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