White Paper

Could Adaptive Backhaul close the Mobile Broadband Profitability Gap?

As users consume more and more data it's becoming clear that the profitability of Mobile Broadband services is falling short of traditional margins for Voice and Short Message Services. Attitudes to this problem vary amongst operators: there are the *optimists*, who still believe they can claim a share of revenues back from the content providers, the *pessimists* who are solely concerned with driving down costs and a group we will call the *realists*, who are urgently addressing their cost base but also looking at changing the way they deliver the new services their users are demanding. The *realists* are looking for partners with innovative solutions who can help drive down cost per Megabit and drive up service delivery. In this article we examine how an emerging "adaptive" backhaul transport network could provide a key part of the *realists*' answer to mobile broadband profitability.

The Mobile Broadband revolution…

The Mobile Internet has been around for more than 10 years, but it was not until the last couple of years that things really began to take off. It was a combination of factors, which together created 'Mobile Broadband'. Firstly, Mobile Network Operators quietly began to upgrade their radio networks. 3G networks became 3G+ networks through a software upgrade, which gave them High Speed Downlink Packet Access (HSDPA) speeds of 3.6Mbps, 7.2Mbps or even 14.4Mbps. Suddenly, the performance gap between fixed and mobile had been dramatically reduced and fixed network user experiences could be emulated on mobile networks.

The second ingredient was a revolution in user equipment.

The launch of the Apple iPhone created a phenomenon which suddenly transformed the Mobile Internet experience from a pain into a pleasure and has stimulated demand for mobile broadband access beyond any previous expectation.

Figure 1 USB modem: "Broadband anywhere"

Thirdly, at about the same time, mobile broadband HSDPA USB modems (or dongles) began to appear on the market. Whilst initially targeting business users for whom the laptop could now connect them to the office, the USB modem was quickly adopted by late teens and early twenty-somethings – students in rented or university accommodation who could not get credit-scored for a fixed broadband connection were buying mobile broadband instead. Mobile operators seized the opportunity to substitute fixed broadband and intense competition between mobile operators led to a price war and some incredible flat tariff plans. So suddenly, mobile broadband was here, it was attractive and it was affordable.

...and the Mobile Broadband Profitability Gap

Mobile operators have enjoyed very healthy revenue streams from voice and short message services (SMS) for more than a decade. Suddenly they have a new challenge: how to make a profitable margin from Mobile Broadband?

The fact is that - despite regulatory and competitive downward pressure on pricing - cost structures for handling voice calls are still able to maintain a healthy margin for operators and SMS is even more profitable than voice. In contrast, the outlook for Mobile Broadband margins looks decidedly gloomy. Even the most efficient operators are finding they can only break even.

The profitability gap is compounded by traffic growth predictions, with data already outstripping voice by a factor of 2.5 to 1 (Morgan Stanley, Mobile Internet Report, December 2009) and growing exponentially, whereas voice growth in developed markets has reached a plateau as market penetration has become saturated.

In fact, by the end of the first decade of the 21st century, market penetration in western markets had exceeded 100% - just about everyone who wanted a mobile phone already had one (or more!) and, as a user, what incentive could cause you to double

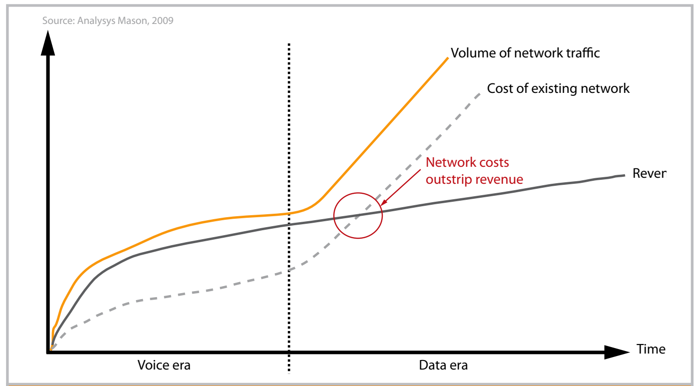

Figure 2 Mobile Broadband's profitability gap

your monthly voice minutes? In contrast, demands for data are soaring as device usability and network capability are at last coming together.

Mobile operators must take rapid and decisive action if they are to respond to these trends and protect their overall financial performance in an increasingly competitive, complex and difficult market.

Network *optimists* look to new revenue streams, Network *realists* look to control costs

Some mobile operators take an optimistic view, expecting their future margins for mobile broadband to improve as the appetite for Mobile Web 2.0 applications continues to grow.

These *optimists* are hopeful that they will be able to command a critical role within the Web 2.0 value chain. It is true the network operators have a very strong relationship with the user and as the access provider billing for airtime the operator holds many of the cards in a traditional telco business model. However, this business model is fundamentally changing with mobile broadband. Micro-payments for content and application downloads are often completely invisible to the mobile network operator, who is reduced to charging for 'dumb pipes' of connectivity, while application and content providers like Apple and Google make the incremental revenue from 'over the top' services. Users' expectations have already been set and they are unwilling to be restricted to content or applications offered by their operator.

Unlike the *optimists*, the realistic operator is highly focused on network cost optimisation as the remedy in the short term. However they are also concerned about the short/medium–term prospects for strong revenue growth from Mobile Broadband services.

Traditional self-build efficiency methods are insufficient for the Mobile Broadband era

When the going gets tough and operators look for savings, they have often turned to their internal transmission teams to come to the rescue. A successful strategy over the last 10 years has been the replacement of leased transmission capacity with self-built transmission using a mix of fibre (in the core network) and microwave radio (for backhaul in the access network). The self-build strategy has saved billions in OPEX over the last decade but in mature markets the incremental savings still to be expected from self-build are limited.

Wholesale transmission services have come down in price because the wholesale operators can benefit from greater economy of scale and specialisation than individual mobile operators. This is compounded by the Pareto principle which means that the most expensive 15% of sites are unlikely to become economically viable for any individual operator.

Upgrades in self-built capacity to meet the demands of Mobile Broadband are unlikely to meet stringent CAPEX over Revenue targets of typically <10% expected by investors.

Therefore, operators looking for incremental savings cannot simply turn up the run-rate for their self-build transmission rollout programmes. Instead they need to look for new ways to reduce the cost per Megabit.

Where next for incremental savings?

Operators must look to make a further step change in their transmission network cost structures. Achieving such a step change will not only require new technologies, but also new business models.

It's time for networks to become Adaptive

Fixed networks operate with a distinctly lower cost-base compared with mobile networks. The complexity of mobility management comes at a premium. However, the typical Mobile Broadband user does not need all of this complexity all of the time. In fact there is a *nomadic* pattern of behaviour emerging amongst smartphone and USB dongle users. These *nomadic* users still expect reliable access anywhere they happen to roam – and so the ubiquitous coverage offered by mobile operators remains a key differentiator compared with patchy WiFi coverage. However, the *nomadic* user is generally stationary while online so they don't need true mobility management all of the time. What if it were possible to detect these *nomadic* behaviour patterns and selectively offload the *nomadic* user's broadband traffic from the expensive mobile network onto a fixed network, able to handle the broadband traffic at a fraction of the cost of the mobile network?

Another key driver is the changing traffic mix. Video streaming is already the dominant traffic type and is also growing faster than any other service. This is especially true of the *nomadic* user, who is typically an especially heavy consumer of video content. What if the very same architecture which performs traffic offloading also enabled the possibility to cache, host and serve video content - such as this week's most popular on-demand TV shows - directly to those *nomadic* users from servers placed as close as possible to the user. This will create huge efficiencies in mobile operator's networks backhaul and backbone networks as opposed to today's model where all content is transmitted across operator's core backbones and backhaul networks each time it is requested. But it's not just video content. Laptop operating system upgrades for mobile workforces are also very bandwidth-hungry and could be cached and served closer to the network edge.

Figure 3 Backhaul from radio sites is the main bottleneck for mobile broadband

This is a vision requiring an architecture that is beyond the capability of today's networks and requires something we call Adaptive Backhaul.

Why Adaptive Backhaul?

With advances in RF technology such as HSPA, HSPA+ and LTE increasing available bandwidth on the air interface between mobile handset and base station, the bottleneck for data throughput is increasingly shifting onto the backhaul network - the transmission network which connects radio sites to the core switching network.

Today's backhaul networks are reliable, dumb pipes which treat all traffic the same, irrespective of its value to the customer or to the operator. Premium voice traffic, delay-sensitive video streaming content, web browsing traffic and even peer-to-peer file sharing are given equal access to network resources and consume scarce and valuable resources within the mobile operator's core, transport and radio networks. Adaptive backhaul consists of a set of key capabilities designed to alleviate bottlenecks while saving on backhaul and core network infrastructure budgets.

Building Blocks of Adaptive Backhaul

1) The first component of Adaptive Backhaul is Differentiated Quality of Experience. This is the ability to identify different types of traffic at the application level, classify and mark the traffic according to its relative priority and then respect this marking within the backhaul network in the way in which the traffic is queued and routed. A range of techniques are involved in differentiated QoE, including deep packet inspection to characterise traffic by type, policy interrogation to allow classification by class/type of user, together with heuristic techniques to characterise resource-heavy usage such as peer-to-peer traffic. Having classified data packets according to their priority, the next challenge is to treat them accordingly. This means that whenever congestion occurs at any point in the backhaul, high priority traffic is going to take precedence over low priority traffic. This fine-grain prioritisation on a per-packet basis works seamlessly with new techniques at the physical network layer. One great example is Adaptive Modulation within the microwave radio systems used in the backhaul network. Adaptive Modulation can turn up and turn down the aggregated capacity on a backhaul link, depending on the prevailing atmospheric conditions. When coupled with differentiated Quality of Experience, Adaptive modulation allows operators to ensure that packets transporting priority voice traffic survive in a rainstorm, whereas internet browsing may be throttled back. Previously, all traffic would have been affected.

2) Secondly, a new concept currently under development and undergoing standardisation is Selective Traffic Offloading: Upon detection/selection of *nomadic* user behaviour, the user's data traffic flow is broken out (see Figure 4) and 'selectively offloaded" from the mobile backhaul and core networks onto a fixed network, which (because it lacks the mobile network's complexity) can provide the necessary transport and switching for these *nomadic* usage patterns on a much more cost-effective and scalable network platform. It should however remain possible for a user to enjoy full mobility when necessary, for example when travelling on a high-speed train.

3) A third key technique which has been around for 10 years but which has gained a new lease of life with the advent of mobile broadband is Content Optimization. 10 years ago, optimisers were deployed to perform acceleration and compression of webpage content using GPRS over 2G networks. On today's high-speed 3G/HSPA networks, web page optimisation is no longer a big priority for MNOs. However, video streaming optimisation has become a hot topic, with vendors providing middleware devices which can optimise Youtube or BBC iPlayer content for a mobile device and dramatically save resources using techniques such as progressive download optimisation. This works by manipulating how streaming buffers operate in order to only download content as it is being viewed, saving unnecessary transmission of content that may never be watched.

4) Finally, Deep content caching and application hosting provides the ability to place devices closer to the mobile user which can distribute popular content (such as the top 20 TV shows of the week) and also serve applications locally, without requiring to "pull" the content across the entire backhaul and core network. This distributed approach brings a number of key benefits. Firstly, content hosting in the backhaul network can save hugely on core and backhaul capacity. Secondly it could reduce dramatically the latency (round-trip delay) for applications such as Pay for Play video gaming. This could open up a whole new market place for video games which are played on mobile devices, but hosted by and purchased through mobile network operators.

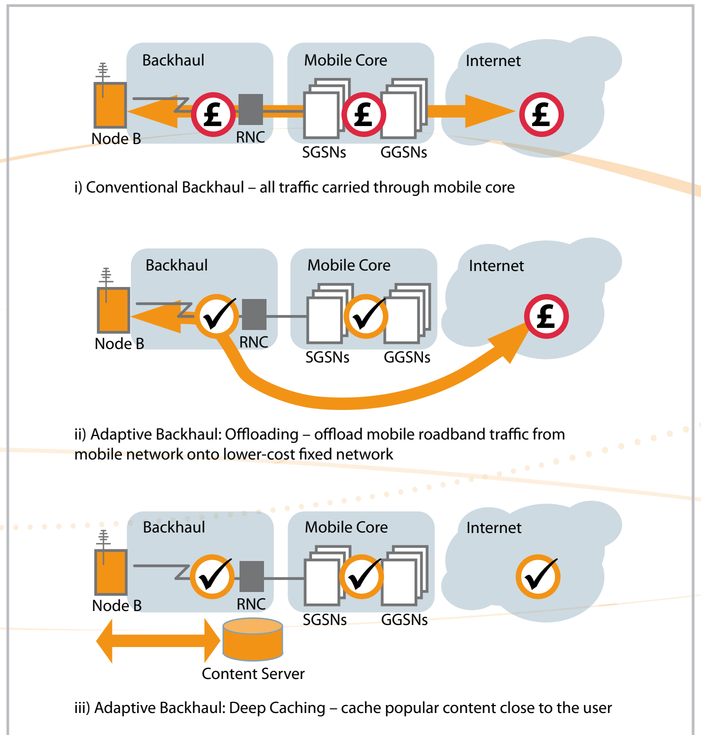

Figure 4 Adaptive Backhaul – traffic offloading and deep content caching can enable huge savings for Mobile Operators

Enabling the widest possible distribution of such caching and application serving devices will require some architectural changes within the backhaul network. Most importantly, it will rely on the adoption of the same traffic breakout capability already described under Selective Traffic Offloading.

Wholesale services must evolve to support Adaptive Backhaul

Adaptive Backhaul leverages Ethernet as the underlying transport technology. Ethernet has already been widely adopted by wholesale network operators offering managed backhaul solutions to mobile operators in order to drive down backhaul service costs.

But for mobile operators to take advantage of Adaptive Backhaul these services must evolve to offer the ability to offload mobile broadband traffic directly from within the wholesalers' managed backhaul network as well as offering the option to plug in caching, hosting and optimisation as additional value-added managed services. In this way, backhaul wholesalers can increase the value of their offer whilst taking advantage of their scale and specialisms to serve multiple MNO customers.

Meanwhile the wholesaler's customer, the mobile network operator will be able to cap and outsource network capacity growth, while, crucially, retaining control of user quality of experience and policy control.

Conclusion

The Adaptive Backhaul techniques described will add new levels of value to the backhaul network, transforming dumb pipes into smart ones, which are able to make intelligent allocations of network resource, host content and applications or select on-net versus offload traffic routing per application.

When applied in backhaul wholesale scenarios, Adaptive Backhaul will give mobile operators the best of both worlds; a low cost base driven by economies of scale and a customisable architecture to lower cost of service delivery.

So whilst the network *optimists* hope their users will change their ways, and the network *pessimists* wait for them to lower their service expectations, the network *realists* can enjoy lower costs per Megabit and deliver increasing value for their end users.

Glossary

CAPEX	Capital Expenditure
GPRS	General Packet Radio Service
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access – an enhancement to 3G networks providing broadband data rates
HSPA+	Evolved HSPA architecture enabling gateway offload points to be distributed much deeper within the backhaul – similar to the architectural direction LTE will follow. HSPA+ will not be supported by all equipment vendors
LTE	Long Term Evolution (3GPP's forth generation standards framework)
MNO	Mobile Network Operators.
OPEX	Operational Expenditure
QoE	Quality of Experience
SMS	Short Message Service
USB	Universal Serial Bus

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