WHITE PAPER

# UK mobile broadband measurements

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This white paper contains the findings of independent research and analysis carried out by Informa Telecoms & Media from June to August 2009. The research was sponsored Bytemobile

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## ABOUT INFORMA TELECOMS & MEDIA

Informa Telecoms & Media is the leading provider of business intelligence and strategic marketing solutions to global telecoms and media markets.

Driven by constant first-hand contact with the industry our 90 analysts and researchers produce a range of intelligence services including news and analytical products, in-depth market reports and datasets focused on technology, strategy and content.

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## ABOUT BYTEMOBILE

Bytemobile is a tier-one provider of integrated mobile internet solutions which enable wireless network operators to deliver value-added data services to consumers on all mobile devices. Bytemobile solutions are installed in the networks of 111 operators in 54 countries and 12 of the world's top 15 tier-one operators. Customers include AT&T, China Mobile, China Unicom, KDDI, KPN, Orange, Orascom, Sprint Nextel, T-Mobile, Telecom Italia Mobile, Telefónica, TeliaSonera, Vodafone, and WILLCOM. Bytemobile is a privately held company with regional sales and support offices in Wokingham, U.K.; Dubai, U.A.E.; Mumbai, India; Tokyo, Japan; Beijing, China; Seoul, Korea; Singapore; and Sydney, Australia; and research and development centers in Mountain View, California; Beijing, China; Patras, Greece; Champaign, Illinois; and Belfast, Northern Ireland. The company is committed to helping its customers and partners deploy green mobile internet solutions in a sustainable network environment.

For more information, visit http://www.bytemobile.com

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# Executive Summary

Informa Telecoms & Media conducted an extensive measurement campaign between June and August 2009 to assess the effect of mobile broadband optimisation when users access the Internet through notebook/netbook computers. Measurements were performed on all UK mobile networks that offer mobile broadband products and conducted so that the results were comparable, regardless of the surrounding environment and traffic in the measured cell. A series of tests were performed in and around London, measuring the download performance of several popular Internet destinations, including Amazon, Facebook, Lycos and Starbucks.

In all cases, measurement results for operators that optimise illustrated smaller webpage size compared with operators that did not. It was also concluded that file size is the dominant parameter in affecting webpage download duration. Thus operators that have an optimisation product installed are likely to offer faster downloads and a better overall user experience. However, propagation characteristics and user location also affect the webpage download duration.

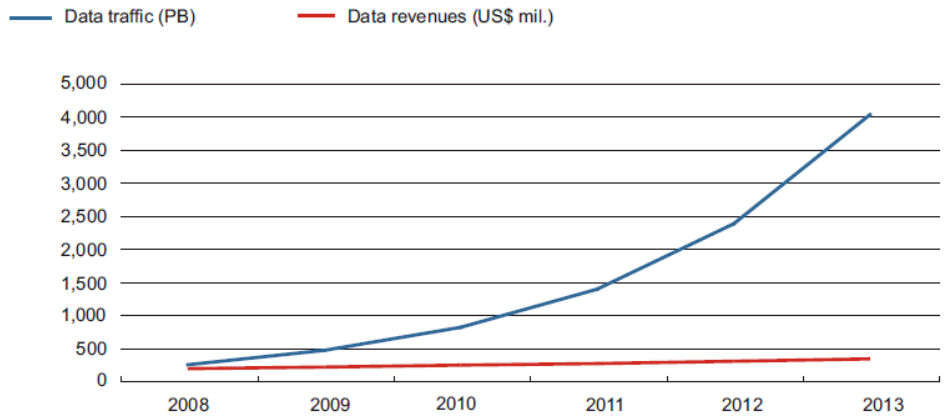
Informa's measurements illustrate that T-Mobile and O2 (which both use Bytemobile's solution), BT (which uses Vodafone's network) and Vodafone were consistently the smallest in webpage download size and in 80% of measurements were the fastest to complete the download. This illustrates that efficient optimisation improves the user experience dramatically while no loss of quality is perceived by the end user. Operators that do not optimise content were consistently among the slowest to complete downloads, implying an inferior user experience compared with operators that do.

Informa also performed similar measurements over fixed broadband, to compare mobile broadband operator performance with that of fixed, where no optimisation is used. Measurements illustrate that webpage size is greatly reduced and, in the case of T-Mobile, savings of up to 52% based on the content were recorded. Such reductions can obviously save a significant amount of radio capacity and provide operators with room for organic growth before expensive infrastructure upgrades are required.

# Section A – Introduction

Mobile data networks are increasingly becoming saturated while mobile operators are seeking new, cost effective ways of adding capacity without increasing their planned capital expenditure (CAPEX). Mobile broadband is thus putting a considerable and growing strain on radio infrastructure as several sites in developed markets are already saturated even though there is still much growth potential for mobile broadband and data services. Although mobile broadband is providing the much-needed stimulus to raise revenues for mobile operators, traffic growth is proving a serious challenge as it requires heavy expenditure to effectively resolve resulting capacity constraints. The following chart illustrates global revenue and traffic growth forecasts for mobile broadband networks.

***Figure 1: Mobile broadband traffic and revenue growth***




*Source: Informa Telecoms &Media Mobile Networks Forecast report, 2008*

The chart illustrates the strong trend currently taking place – the decoupling of data revenues and traffic volumes. This is being fuelled by the growing adoption of high-end smartphones (including the iPhone and Google Android handsets) as well as mobile broadband dongles. Following the advent of flat-rate tariffs and data bundles, operators are finding that revenues are not increasing proportionally to traffic but at a much lower rate. This creates a significant challenge for operators in the current economic climate, because they need to balance CAPEX, maintain organic growth in mobile broadband subscriptions and continue to offer a good user experience for their data subscribers.

Mobile broadband subscriber numbers are predicted to continue to soar, having already reached 186 million worldwide at the end of 2008, compared with 101 million at the end of 2007 and 50 million at the end of 2006. Revenues will also increase to reach US$187 billion by 2013, making mobile broadband the top revenue driver for mobile operators in coming years. In developed markets, mobile operators are starting to promote prepaid mobile broadband packages, similar to prepaid voice, where users can top up the mobile broadband package whenever they need to use it. These products are penetrating the lower cost market where users do not want to commit

to — or cannot afford — a monthly contract for data only. Prepaid mobile broadband is providing additional growth in developed markets where postpaid mobile broadband penetration is reaching saturation.

However, despite the healthy growth anticipated for mobile broadband, mobile operators are discovering that they need to consider alternative ways to enhance the end user experience while optimising existing infrastructure and traffic and maintaining their competitive position. Optimisation solutions work with existing infrastructure and generate significant benefits to both operator and end users.

## Section B – Optimising Mobile Broadband

Mobile broadband optimisation is widely used to enhance user experience and save infrastructure costs without users perceiving a difference in quality. The market is fragmented; vendors have different product lines and technologies that each offer unique advantages. For example, some vendors optimise through quality of service (QoS) and traffic management, while others compress content or cache frequently-used content.

One category of products aims to handle packets in order to slow, mark or even drop them completely. However, due to the nature of the transmission control protocol (TCP), these solutions tend to slow traffic rather than reduce the amount to save capacity, thus affecting the user experience by significantly slowing webpage loading. The products are very efficient when targeting selected users in favour of others. However, optimising through packet handling does not solve the fundamental problem of capacity constraints.

Some products operate at a higher level in the communications stack, handling objects instead of packets over a variety of protocols. Advanced functionality is possible in these products, including caching of frequently requested objects. Compression in this case does solve the problem of capacity since it actually reduces the traffic required to deliver a service rather than slowing it down. However, compression is not necessarily an efficient solution since Web content is currently rich and consists of animated images, Adobe Flash objects and other multimedia content. As this kind of content may already be compressed and content providers typically install their own compression devices, mobile broadband optimisation may provide only a small benefit for the operator.

Several vendors have released products that optimise multimedia content, including Adobe Flash video (which makes up the majority of today's' video content) without users perceiving a loss in quality. This is achieved by advanced optimisation and traffic management technologies — usually proprietary — that are most efficiently applied at the network level.

# Section C – Measurement Procedure

Informa Telecoms & Media planned a series of measurements to assess the effect of optimisation on the end-user experience, as well as data file size and download speeds.

The measurements were designed to benchmark the effects of optimisation applied by UK mobile broadband operators. File size reduction is the chosen metric in this set of measurements, quantifying the performance of each optimisation solution.

In order to assess the performance of optimisation, mobile broadband products from all major UK mobile operators were selected. The mobile operator broadband packages profiled in this measurement campaign are illustrated in the following table. All the offerings were obtained 'across the counter' at operator's usual consumer outlets. The majority of mobile broadband connections were made over HSPA (3.6Mbps) albeit this maximum speed was never reached. Some USB dongles actually supported higher speeds (7.2Mbps) but none of the networks measured connected over these faster speeds (theoretical speeds were logged during the actual measurements and were confirmed to be a maximum of 3.6Mbps). ITM also conducted the same measurements over fixed broadband in order to benchmark the mobile broadband measurements and compare an optimised with a completely unoptimised data set.

***Figure 2: Operator selection for measurement campaign***

| Operator | Mobile broadband package |
|---|---|
| 3UK | Prepaid |
| BT | Postpaid (bundled with fixed broadband) |
| O2 | Postpaid |
| O2 | Prepaid |
| Orange | Prepaid |
| T-Mobile | Prepaid |
| Virgin Mobile | Prepaid |
| Vodafone | Prepaid |

*Source: Informa Telecoms & Media*

Informa Telecoms & Media acquired two SIM cards from O2: one postpaid and one prepaid. With the postpaid SIM card and setup used there was a feature which gave ITM the ability to switch off optimisation and then enabled the comparison of optimised and unoptimised measurements for a single operator. Usually, both postpaid and prepaid O2 SIM cards are optimised, but in this case ITM were able to set up a special Access Point Name (APN) which was not optimised. This is not a standard customer arrangement.

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Informa's research indicates that O2 postpaid and prepaid subscriptions are treated similarly with regard to Web page optimisation.

A selection of sites around the urban area of Greater London were chosen, at busy times when the mobile broadband network was under strain. This included dense urban office locations during mid-morning hours and lunchtime, residential areas during evening hours and train stations during early morning hours, when commuters are arriving in London. The following table shows the measurement locations and approximate times when measurements took place.

***Figure 3: Measurement locations***

| Measurement Location | Time | Environment |
|---|---|---|
| Clapham Junction | Early morning, peak time | Train station, crowded. People using mobile handsets to access the web. |
| National Theatre | Morning | Open environment, low traffic |
| Oxford Circus | Noon | Dense urban environment, office locations |
| West Croydon | Afternoon | Suburban area, low traffic |
| Putney | Evening | Residential area |

*Source: Informa Telecoms & Media*

Two new netbooks were set up to perform the measurements in parallel, in order to ensure that measurements were performed in the same environment characteristics. Netbooks were chosen in favour of notebooks since mobile broadband operators are now bundling them with mobile broadband connections. Moving forward, it is expected that this set up will be one which most users are likely to be using outdoors with a mobile broadband connection.

Measurement software based on Internet Explorer 6 was installed in both computers, which allowed the measurement of the following:

- Total webpage size: The total traffic transferred to download a complete webpage
- Download time: The total time elapsed to download a complete webpage

A selection of webpages were chosen to reflect typical user behaviour including popular Internet destinations, such as Amazon, Facebook, Lycos, Orange and Starbucks. The homepage of Informa Telecoms & Media was also chosen, in order to include an information-rich webpage that did not change during the course of the measurements. The webpages were downloaded sequentially with 20 iterations in order to average out any instantaneous errors caused by the surrounding environment. Although the webpages selected did not rank highly in Internet top sites, they include multimedia-rich content that is usually consumed by mobile broadband users. Moreover, the Orange webpage was selected as typical of one that is frequently visited by subscribers that

use its network to top up, or check their prepaid balance. The remaining webpages were selected to reflect typical user behaviour with mobile broadband, including the page of the popular coffee shop chain Starbucks and other retail webpages.

The following diagram depicts a simplified illustration of the measurement procedure.

***Figure 4: Measurement procedure***


*Source: Informa Telecoms & Media*

Although the measurements were affected by the traffic, propagation characteristics, the number of HSPA carriers and the general environment around the transmitter and receiver, the results illustrated that webpage sizes were consistent. As expected, the webpage size differs only with different operators as each one may have implemented a different optimisation solution. On the other hand, webpage download duration was largely affected by all factors mentioned above.

Even though the propagation channel was quite different for each of the operators measured (since base stations were unlikely to be collocated and the receiving netbooks were different distances from each of the base stations), the most dominant parameter in measurement performance was expected to be the total file size of the webpage. This was followed by the propagation channel, allocated capacity, traffic, HSPA carriers and the rest of the parameters affecting the measurements.

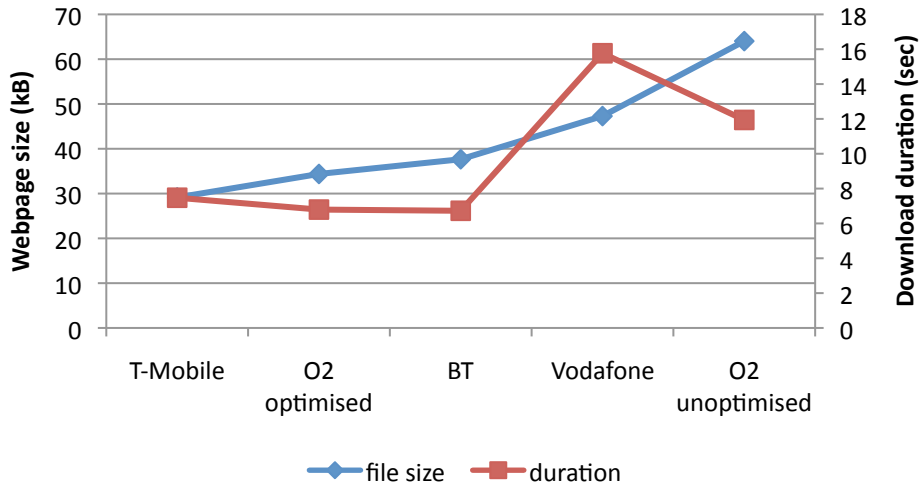
## Section D – Results

The measurement results were split into two groups: webpage size and download duration. Each measurement was performed 20 times in order to average out any instantaneous errors. A selection of results is set out overleaf.

The Lycos webpage illustrated that T-Mobile, O2 optimised (prepaid) and BT were the best-performing operators (see graph below). T-Mobile, O2 prepaid (optimised), BT and Vodafone use webpage optimisation, hence they demonstrate a lower file size. (Although BT uses the Vodafone network for mobile broadband, Informa Telecoms & Media believes that BT may have signed strict SLAs with the host network, causing its users to be given higher priority, hence explaining the better performance. However, BT may have also installed its own GGSNs and optimisation solutions which may be independent of Vodafone's).

The performance of Orange and 3UK was very slow on the Lycos webpage test; both networks timed out on the test software. Throughout the other tests Orange and 3UK also consistently recorded higher webpage sizes than other operators.

***Figure 5: Lycos webpage measurement results***



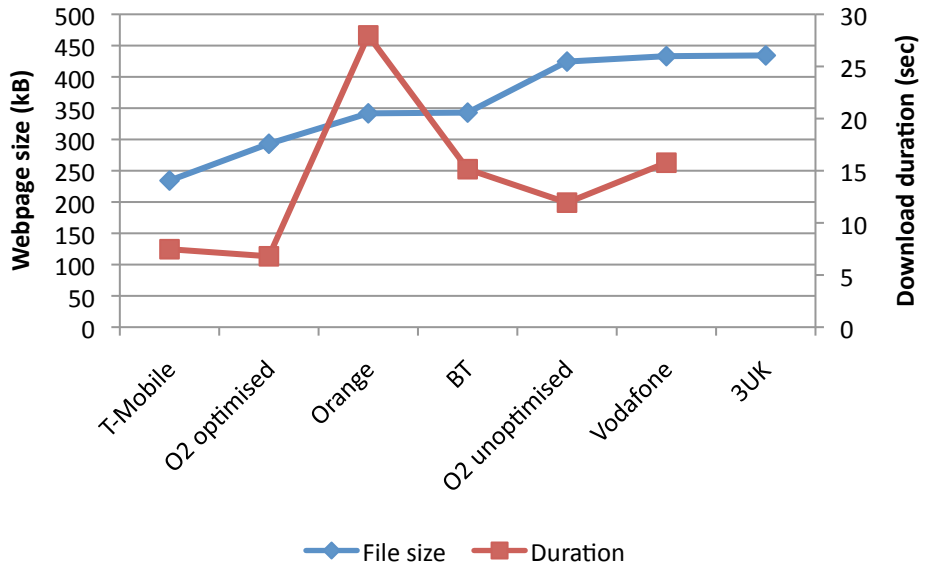

*Note: O2 unoptimised measurements were performed with the non-standard SIM and APN*

*Source: Informa Telecoms & Media*

The webpage content was inspected for all sessions and no major difference was recognized, as none of the mobile operators measured here use techniques that are so strong that they are readily visible to the user. In this case, as in the majority of measurements, webpage size was the dominant factor affecting download duration.

The Amazon.com measurements (shown in the graph below) illustrate consistent webpage size measurements: T-Mobile is followed by O2 optimised, Orange and BT. The Amazon webpage is dynamic and changes each time it is downloaded, explaining the inconsistency in file sizes for the operators following T-Mobile and O2 prepaid. Download duration in these measurements was inconsistent due to several factors, including traffic which seems to have been higher in the Orange network, hence the spike in the graph.

***Figure 6: Amazon.com measurement results***




*Note: O2 unoptimised measurements were performed with the non-standardl SIM and APN*

*Source: Informa Telecoms & Media*

The rest of the measured sites illustrated a similar trend, where the webpage size was consistently lower for T-Mobile and O2 prepaid, while webpage download duration was lower for these two operators in 80% of the cases, although this varied slightly according to the surrounding environment and traffic.

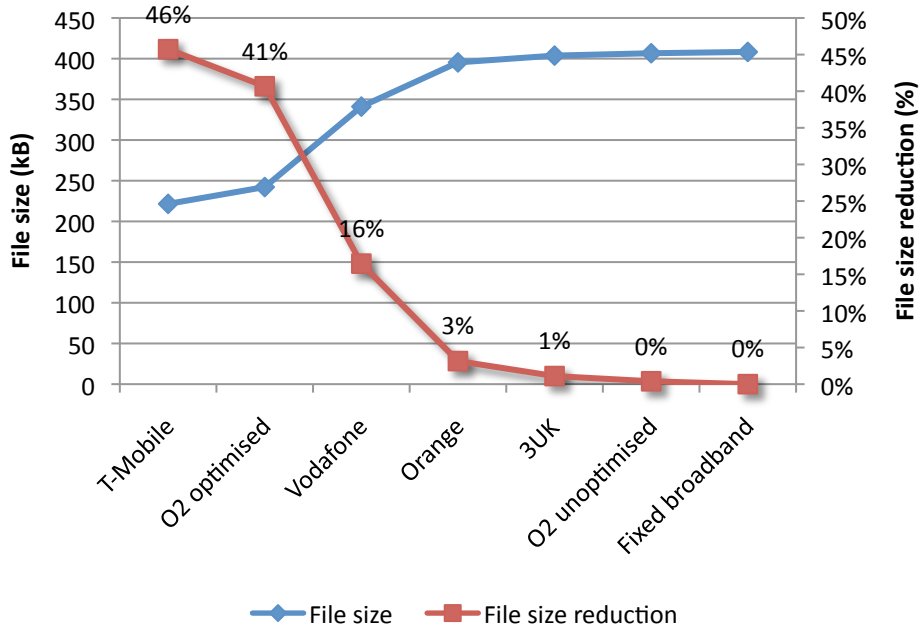
## File size reduction

Measurements indicate that file size is significantly reduced when optimisation is used, without any noticeable difference in image quality from a user perspective.

In several cases where static webpages were measured, file size reduction was as high as 45%, indicating that a significant reduction in transferred data can be achieved. This has an effect similar to that of increasing radio capacity.

The two charts on the next page give examples of webpages where file size reduction clearly affected download duration. In the first example, optimised connections offered a file size reduction of up to 46%, while the second illustrates an even stronger case for optimisation, reducing file size by up to 52%. Mobile operators that do not optimise, including Orange and 3UK, did not have a significant file size reduction compared with fixed broadband.

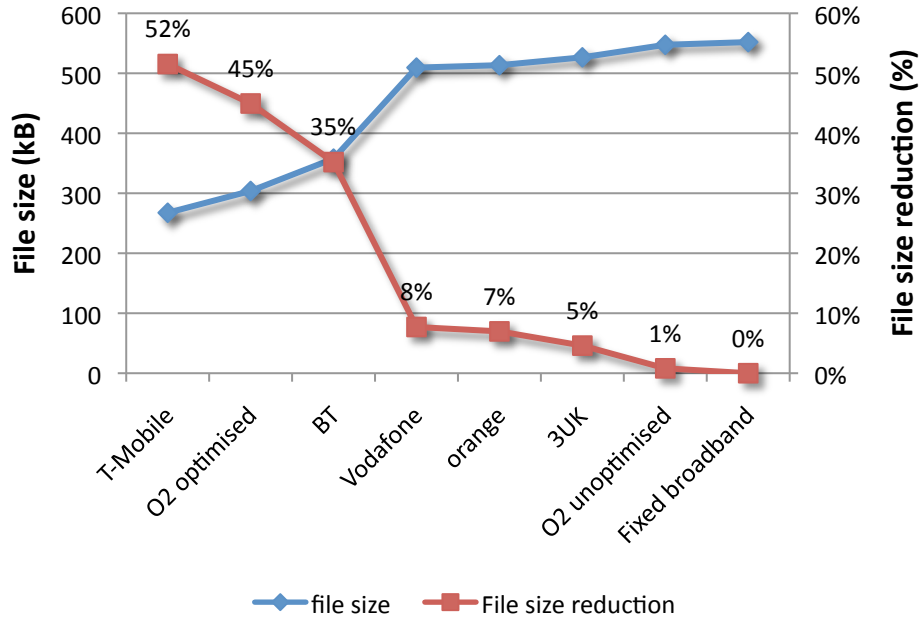
***Figure 7: File size reduction for informatm.com webpage***




*Note: O2 unoptimised measurements were performed with the non-standard SIM and APN*

*Source: Informa Telecoms & Media*

***Figure 8: File size reduction for Orange webpage***




*Note: O2 unoptimised measurements were performed with the non-standard SIM and APN*

*Source: Informa Telecoms & Media*

# Section E – Conclusion

All measurements were consistent in webpage size within each operator, but not in download duration. Although file size is the dominant factor affecting download speed, several other factors affect the speed of the connection, including propagation (distance from the base station), traffic in the cell in which the measurements are taking place, the surrounding environment, bottlenecks in the core network and several other parameters that are impossible to factor out of the measurement procedure. Nevertheless, Informa Telecoms & Media is confident that optimisation products offer significant benefits and improve the performance of operators that optimise compared with operators that do not.

T-Mobile, O2, BT and Vodafone consistently showed a better performance when compared with the rest of UK operators, illustrating that optimisation plays an important role in reducing traffic and indirectly increasing capacity.

File size reduction was up to 52% in several cases with T-Mobile, offering that operator the opportunity to extract additional value from existing radio networks and alleviate capacity bottlenecks without the need for hefty radio infrastructure upgrades. The expenditure required for installing an optimisation solution is an order of magnitude less than actual hardware upgrades – which include radio access and backhaul improvements. Moreover, installing an optimisation solution takes place at the core network instead of the radio access network, thus minimising installation locations and cost. Optimisation solutions can also be integrated without any service disruption.

Enhancing an existing network with an optimisation solution, whether via 2G, 3G or 3.5G technologies, produces results that are not achievable via any other form of network upgrades with a similar level of financial investment. As demonstrated above, webpage and file size reduction correlate with a notable reduction in both traffic and capacity. This makes optimisation an option worthy of serious consideration in the current economic climate since it might make sense to delay RAN infrastructure investment in favour or core software application investment.

If all mobile broadband users were subject to optimisation, this would translate to substantial capacity improvements in mobile operator radio and backhaul networks. The above measurements illustrate a performance benefit of up to 50%, so mobile operators have the potential to enjoy such significant benefits in the radio network without expensive and time-consuming infrastructure upgrades. In the short term, operators can breathe new life into WCDMA/HSPA networks with optimisation, before upgrading to HSPA+ and LTE.