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# 10 Ways to Deal with Mobile Data Capacity Crunch

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## 1. Executive Summary

Service providers around the world are feeling the strain as tremendous growth in mobile data traffic swamps their networks. American, European and Chinese providers have withdrawn some of their unlimited data plans because they are unprofitable.

AT&T's CEO Ralph de la Vega explains that around 2% of their users consume 41% of their bandwidth, leading the company to introduce tiered pricing for new customers. Other service providers validate these figures.

It's not just straightforward data usage that's the problem. Many smartphone applications actively perform frequent status checks, leading to congestion of the signaling channels and the core network. The result can be missed voice calls or poor coverage in many areas.

Mobile network service providers have a wide variety of different methods at their disposal to solve the problem of rapid data consumption. This paper explores ten different approaches which may be used in different combinations by providers to form a comprehensive strategy.

## 2. Introduction: The Mobile Data Capacity Crunch is Real

The reality of the data capacity crunch is putting unprecedented demand on the network in an increasingly more connected world. According to a Cisco research report, mobile broadband data traffic will increase by a factor of 39 times between 2009 and 2014, reaching 42 exabytes annually. Surging demand continues to exceed capacity as more bandwidth-hungry devices are scooped up and used by data-hungry users. The latest in smartphones, netbooks, laptop cards and tablets strain network capacity – including intensifying Web browsing and streaming music and video to these devices (one video can devour as much capacity as 500,000 text messages). The data capacity crunch is real and bearing down hard.

There are many ways of dealing with this issue, and we outline ten different methods that can be used in different measures by service providers in the next few years.

## 3. Ten Complementary Solutions

### 3.1 Expand Existing Cellsite Capacity

Cellsite capacity can be expanded in several ways:

- **Optimizing and tuning the radio network:** Comprehensive analysis tools can be used to assess the performance of the radio network and recalibrate the thousands of parameters in each cellsite for optimal performance.
- **Install extra baseband processors:** Adding hardware at each cellsite to achieve the full capacity from each radio carrier. Often initial deployments used less hardware to reduce cost. This is a relatively quick and simple upgrade.
- **Upgrade to HSPA+:** Each new release of the 3G standard increases its peak data rate and therefore the total capacity, using higher and more complex modulation techniques. Some of these upgrades can be installed through software alone. Peak rates of 21 Mbit/s are now live in several commercial networks, with higher rates forecast for future releases. Only the newest USB dongles and smartphones can make the best use of this new high speed, but it is backward compatible with all existing handsets and data dongles.
- **Sectorization:** Spatially separating the transmissions from each cellsite into three or even six sectors, each independently capable of the full capacity of a single cell. This can be further enhanced through Multiple Input, Multiple Output (MIMO) techniques which introduce spatial diversity, often requiring additional physical antennas at each cellsite.
- **Install additional carriers per cellsite:** Most 3G licenses provide enough frequencies to allow a service provider two or even three radio carriers. Initial 3G networks often used only a single carrier, and some still do today. Most have now started to roll out their second (or even third) across those areas with the most traffic demand.
- **Roll out additional macro cellsites:** The installation of new cellsites can be a long and tortuous process: zoning/planning permission, site acquisition, power and transmission can make for a complex logistical nightmare.

None of these measures should be confused with the various RAN (Radio Access Network) sharing activities in progress in many countries. RAN sharing cuts costs by reducing the duplication of cellsites by two or more service providers. It doesn't by itself increase capacity.

### 3.2 Roll Out LTE

The upcoming Fourth Generation (4G) radio technology, Long Term Evolution (LTE), promises greater spectral efficiency and higher data rates than its predecessors. In the long term, this should lead to lower costs because it requires fewer cellsites to deliver the same payload.

While there have been some high profile launch plans for the technology, and many service providers are committed to deployment, it isn't a quick fix.

In many countries, the spectrum to be used is not yet available and will have to be cleared. Spectrum may be expensive to buy (although probably not as highly priced as for 3G). A wide range of supported devices is unlikely to become available until 2013 at the earliest.

We have seen strong disparities in spectrum pricing for lower frequencies, such as the 800MHz bands released by switching off analog terrestrial television compared to 2.6GHz and higher bands. Service providers value the lower frequencies much more highly because of the increased range and inbuilding penetration they offer. Higher frequencies are most valuable in very high traffic areas with large numbers of small cellsites.

The additional spectrum combined with the superior performance of LTE will add further capacity to networks, but if it is installed only at existing cellsites this is unlikely to do more than double the capacity.

Other factors affecting this issue are regulatory and planning restrictions for individual cellsites. There are peak RF transmission power limits for individual cellsites, which could potentially be exceeded at combined 2G/3G/4G sites where all are used simultaneously. The use of new frequency bands may require additional antennas to be installed, with multiple antennas per sector required for MIMO operation. There may also be physical limits at cellsites preventing additional equipment or antennas from being installed. All

of these factors mean that analysis is required at a granular level before a full LTE rollout can be planned and costs estimated.

### 3.3 Buy More Spectrum

In many countries, buying more spectrum won't be an option, but some governments are continuing to make new spectrum available. India has only recently auctioned 3G spectrum for the first time. The digital TV spectrum freed up across the U.S. and Europe releases attractive new frequencies for this purpose.

Additional spectrum allows service providers to install extra equipment at each cellsite, increasing capacity without impacting the existing network.

This is one of the most expensive options, with spectrum being a finite resource and governments keen to extract as much as they can in license fees for it.

### 3.4 Offload Data to Wi-Fi and Femtocells

Dramatic capacity increases can be made by using a large number of very small cellsites, each of which can reuse the same frequencies. Wi-Fi is a very popular, common and low-cost radio technology that is present in many homes, businesses and indoor public areas.

By encouraging the use of Wi-Fi hotspots at home and suitable indoor areas, service providers can significantly remove a large proportion of data traffic from their networks. 3G signals at the common 2.1GHz frequency are poor at penetrating indoors, further enhancing the value of this approach.

Consumers may find higher data rates and improved response when using smartphones (and laptops) on Wi-Fi locally rather than transmitting to a 3G cellsite outdoors some miles away. Battery life is also likely to be much improved.

Downsides are that the handset now requires two radios (3G and Wi-Fi) to be active simultaneously and the service provider has no visibility or control over the data traffic. Battery life can be severely impacted, with smartphones lasting less than a day on a full charge.

Femtocells are miniature 3G cellsites, very similar to Wi-Fi hotspots, installed by consumers in their homes and connected using wireline broadband. They operate seamlessly as part of the 3G network and do not require any device configuration to enable their use. Many providers are trialing or launching Femtocell services with a view to solving both coverage and capacity problems.

This approach offers the highest potential capacity, with factors of 100 to 200 times the current capability of outdoor cellsites.

### 3.5 Deploy Metro-Femto

The Metro-Femto concept, first outlined by Kenny Graham, head of new technologies and innovation at Vodafone, follows on from the domestic Femtocell/Wi-Fi concept above. Large numbers of low-cost cellsites are installed in high data traffic areas, such as transport hubs, stadiums and city centers.

One approach involves hanging these from existing street wiring or they can be integrated with street furniture. Due to their small size, these unobtrusive devices do not attract the same ire of large cell towers bristling with antennas.

Backhaul connectivity is done through existing copper wires such as DSL, cable modems or fiber. A mesh arrangement can be used with high-speed fiber links only at each corner of the grid.

The estimated capacity of a mesh Metro-Femto network is around 3Gbit/s per square kilometer.

### 3.6 Sideload Content

Anyone familiar with Apple's iPod or iPhone is aware of how they download content to the PC or Mac and transfer it across without going through the mobile network. Podcasts, music and films can easily be bought and updated.

This sideload technique can be used for content bought on mobile devices, too – for example, the shopping transaction could still be carried out over the air, but larger data files transferred by computer or through your home Wi-Fi or Femtocell.

### 3.7 Introduce Traffic Shaping

There are two types of traffic shaping considered here:

- **Customer-Agnostic:** This is where the resources allocated to each user are shared based on their demands. An example is providing fast and high-speed response to initial requests, so that web pages show up quickly, but throttling back on continuous high data rate transfers such as file downloading or peer-to-peer file sharing. The most appropriate point in the network to do this is at the cellsite, using admission control.
- **Customer-Specific:** This is where the customer profile is known and can be used to prioritize traffic above or below others. A common example is tracking the monthly data usage of subscribers and throttling back or reducing data speeds when the usage cap has been exceeded. These are implemented using Deep Packet Inspection routers located next to (or integrated with) the GGSN at the edge of the core network.

Service providers such as T-Mobile USA, Mobilkom Austria and others have found more positive results from their customers by taking this approach. Individuals can choose to accept the reduced service for the remainder of their monthly cycle, or pay a fee to restore high-speed capacity immediately.

With extreme examples of unlimited data use being quoted by several network providers – figures of 40-50% of network capacity being consumed by 2-3% of users being commonly cited – this approach alone could dramatically increase available capacity.

### 3.8 Expand Range of Data Tariffs

Many networks today offer unlimited data usage and have suffered the consequences. Others have very high limits, such as Austria Mobilkom's 19GB for 19 Euro monthly tariff. We have been seeing many more networks introduce monthly caps on their data plans to address this.

When the Apple iPhone was first launched in the UK, O2 included unlimited data. When Orange launched a year later, they set a 750Mbyte/month cap; Vodafone and Tesco also set a limit.

An important factor here concerns education of the customer so that the meaning of data tariffs is fully understood.

Approaches which could be considered include charging premiums or blocking some types of data traffic, such as streaming video which places high demands on network resources. Such services may be restricted to offpeak times or only through Wi-Fi/Femtocells on some tariffs; premium tariffs could be charged for higher performance and/or priority.

### 3.9 Optimize, Compress Data Content

With video taking up a large proportion of mobile network data capacity, it makes sense to reduce the amount sent, especially where it is wasted. Studies of those viewing YouTube videos uncovered that most do not watch each complete scene. This means that downloading the full video in advance, a standard feature to avoid glitches when watching, wastes a lot of capacity. Additionally, the video may be sent in a format suitable for larger screen sizes, again wasting capacity.

There are several vendors offering solutions to this problem, identifying and actively buffering the streaming video, transcoding it into smaller and more efficient formats, and limiting the amount downloaded in advance. Such solutions need to work seamlessly with both the server and a wide range of smartphone devices to provide a good viewing experience.

### 3.10 Improve Application Design

A more subtle form of data optimization involves encouraging and persuading application developers to write better behaved software. Many free and commercial applications are not written with due consideration of their impact on network resources. A program of education and encouragement might be further enhanced by rating applications based on their behavior. There would also be knock-on effects of improved battery life and response time for the consumer.

Another large source of data traffic relates to software program updates, such as for Windows® and Apple Mac operating systems. There are two schools of thought here – these could be moved to download at offpeak times in the middle of the night, saving precious resources during peak times. However this might leave individuals with computers unprotected from the latest exploits, potentially opening up the network operator to legal claims. The issue is further complicated in that most laptops are switched off overnight, and so unable to process the update at that time of day.

## 4. Conclusion

We've outlined ten different ways in which service providers can deal with the growing mobile data capacity crunch. Providers are likely to use a combination of these techniques in the years ahead, basing their decisions on criteria such as:

- Cost/Benefit analysis.
- Time to deploy.
- Impact on customer satisfaction.
- Marketing strategy.

The industry is still at a very early stage in the evolution of broadband data services, and we can expect to see further options become available as the market matures. Those service providers who analyze the options correctly and invest appropriately will reap the rewards due to best business practice. Others may fall by the wayside due to competitive pressure. The winning providers will require good advice, back-office design tools and business processes to achieve their goals.



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