Why and When to deploy Metrocells

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Mobile data traffic is doubling annually. Future predictions are for total mobile data capacity demand of anywhere between 20 and 50 times within 5 years. The greatest demand both today and in the future is concentrated in the dense urban areas.

While operators have just about been able to keep up so far (some less so than others), there is wide recognition that something radical will have to change to deliver the capacity required.

And it's not just about more capacity per se, it's about the overall speed and quality of service each customer perceives.

Customers want to use the higher speeds possible with 3.5G and 4G for reliable use of video and other high speed services. These require robust, fast data connectivity everywhere we go – whether outside on the street, inside our offices, shops or transport hubs.

The capacity problem is most noticeably in the dense urban areas rather than sparsely populated rural areas, and is only going to get worse. Although the total network capacity might grow 50x overall, some peak traffic traffic hotspots are forecast to need 500x or even 1000x in extreme cases.

The laws of physics set some constraints

The laws of physics provide for three main ways to increase total throughput:

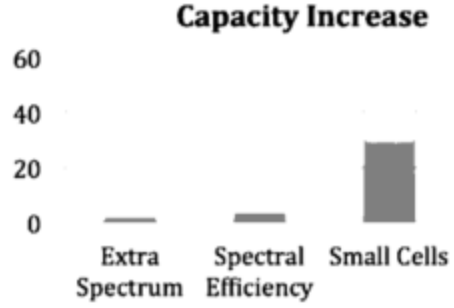
1. **Add extra spectrum.** If available, a simple capacity upgrade at high traffic basestations, by adding some extra cards, may be all that's required. Different spectrum bands may also need new antenna on the mast and/or new handsets/smartphones that can use the different frequencies. New spectrum is usually very limited, expensive and difficult to acquire.

2. **Improved spectral efficiency.** New versions of 3G, such as HSPA, encode the radio signal with higher orders of modulation to carry more traffic. The new 4G LTE standard uses a myriad of the latest techniques to carry the maximum possible throughput. However, these higher rates are only achievable in ideal conditions with limited interference and when very close to the transmitter. Further improvements are possible but may required additional antenna and could be quite expensive.

3. **Spectrum reuse through small cells.** Most of the vast growth in cellular traffic capacity has in the past been achieved by increasing the number of cells and this option easily offers the most promise. Thousands of small metrocells would be installed in each city, the maximum number limited by commercial viability rather than technical barriers.

A 3GPP workshop considered these options earlier this year and found that an increase of up to 1000 fold is possible (something that might be needed in the most demanding urban locations) through a combination of three dimensions, shown below both numerically and graphically:

Feature	Capacity Increase
Extra Spectrum	3x
Spectral Efficiency	6x
Small Cells	56x



Studies by several vendors, such as NSN and Qualcomm, have resulted in similar conclusions.

The main choices available to operators today are

1) LTE – The new 4G technology

A hot favourite at present because it's the latest, fastest and newest kid on the block. Network operators are full of technologists who love playing with the latest toys.

LTE is also important for brand marketing, ensuring a leadership position through the promise of high speed, low latency connections. However, it's irrelevant in the short term unless customers buy new smartphones (which are usually subsidised by the network operator). In many cases, it's not a "quick win" because of the time taken for the installed base of smartphones to be upgraded. This is why we are seeing some operators looking to provide initial LTE coverage through existing macrocells, but install substantial capacity on the ground using 3G small cells.

It's also worth noting that the peak achievable speeds of LTE are unlikely to be delivered (for sustained periods) using macrocells, due to lack of capacity. The short range of a radio link to the nearby metrocell (which could be 3G or LTE) will usually deliver better performance, allowing the highest order modulation to be used for maximum speed and efficiency.

Even if an operator could gain access to 3x the current spectrum and deploy LTE throughout (with a questionable 6x capacity gain), this would still fall short of the 20 fold or higher growth required – especially in the highest traffic hotspots.

2) Wi-Fi – A quick fix?

We've seen some great strides being made with Wi-Fi in recent years. Operators have accepted the technology as a complementary and essential component of the overall solution. Mass takeup has enabled it to be very low cost, easily understood (and becoming even easier to use), and compatible with all recent smartphones.

Today, many operators provide their customers with easy access to large numbers of Wi-Fi hotspots, either deploying their own or through wholesale arrangements with Wi-Fi aggregators (or both). This increases the total capacity of the network dramatically, and relieves the pressure in high traffic environments. AT&T and Verizon report that over half their mobile data traffic now passes through their public Wi-Fi network.

Customers, particularly "power users", will actively seek out Wi-Fi hotspots in order to find better throughput. Some apps and services are restricted to work only over Wi-Fi, rather than 3G.

But is this what customers really want? Surely we want simplicity and to be always connected. That means identifying and seamlessly connected to a Wi-Fi hotspot in the area when it makes sense, but being able to continue if not in range and/or when walking about.

The comparatively low RF power of a Wi-Fi hotspot (100mW maximum compared to perhaps 1 to 2W for a metrocell or 20W for a macrocell) is ideal for indoor environments but limits range when outdoors.

A mix of both Wi-Fi and cellular can be a winning combination, but the evidence from Korea and Japan suggests that relying solely on huge numbers of public access Wi-Fi hotspots (networks in those countries had 100,000's deployed) won't deliver the quality of service to large numbers of users at high throughput on its own.

3) Business as usual: More and higher capacity macrocells

The numbers of macrocells in urban areas isn't growing. Site acquisition is difficult and costly. That's partly because people are becoming more sensitive to highly visible masts on the skyline and also because landlords continue to be keen to exploit their monopoly.

Quite apart from the limitations due to the laws of physics, the commercial costs don't compare well with metrocell deployments. A recent Alcatel-Lucent study compared the two approaches for a typical Western European urban area found a 38% total cost saving. There is a traffic density threshold beyond where metrocells become the cheaper solution. Traffic levels in most developed urban cities have already crossed that point.

4) Deploy Metrocells

A dense underlay of metrocells can deliver unbelievable amounts of total capacity, which is exactly what's going to be needed in the not to distant future. But being closer to the user has other benefits. The short range provides a much better quality radio channel, which can achieve higher speeds and better throughput. There will be a lower battery drain on the handset device, increasing battery life. There are many more potential locations to install metrocells (although more are needed). An extra benefit is that each metrocell frees up capacity on the macrocell. Locations which are difficult to reach because they are deep indoors, behind buildings etc, consume a lot of the total macrocell resource to deliver a relatively slow throughput.

Planning push or customer pull?

Network planners have a tough job looking at how best they can meet traffic demand. They are likely to prioritise investments where they see the most serious capacity shortfalls, both current and predicted.

But equally, customers themselves will become more aware of which networks are more likely to meet their needs. As we become ever more reliant on remaining connected "on-grid", those networks who fail to keep pace with their competitors "Quality of Experience" risk losing subscribers and market share.

This leads to the question of how urgent it is to make a choice and start implementing it.

When to deploy metrocells?

Planning and deployment of metrocells isn't simply a scaled down equivalent of the same process used today for macrocells. A whole range of factors needs to be considered, including but not limited to:

- Are different network performance measurement and reporting tools required?
- How does radio planning need to evolve to determine ideal metrocell locations?
- What operational processes need to adapt to allow scaling up of the deployment process to handle 10x the number of cellsites?
- What backhaul technologies should be used to connect the metrocells (especially for the last mile)?
- What aspects of the operation are best outsourced?
- How does the commercial investment returns change for a metrocell network?

Operators need to understand how to evolve as their network includes large numbers of metrocells. They need to start this learning process now, rather than when under extreme pressure to build extra capacity quickly. Many are running trials, evaluating suppliers and considering outsourcing options. Now is the time to make progress, before it's too late.

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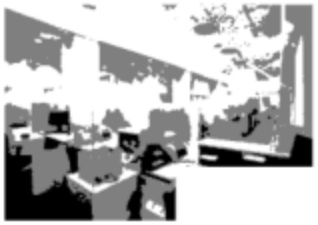

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