

HetNet Orchestration

The fourth dimension for
wireless capacity growth

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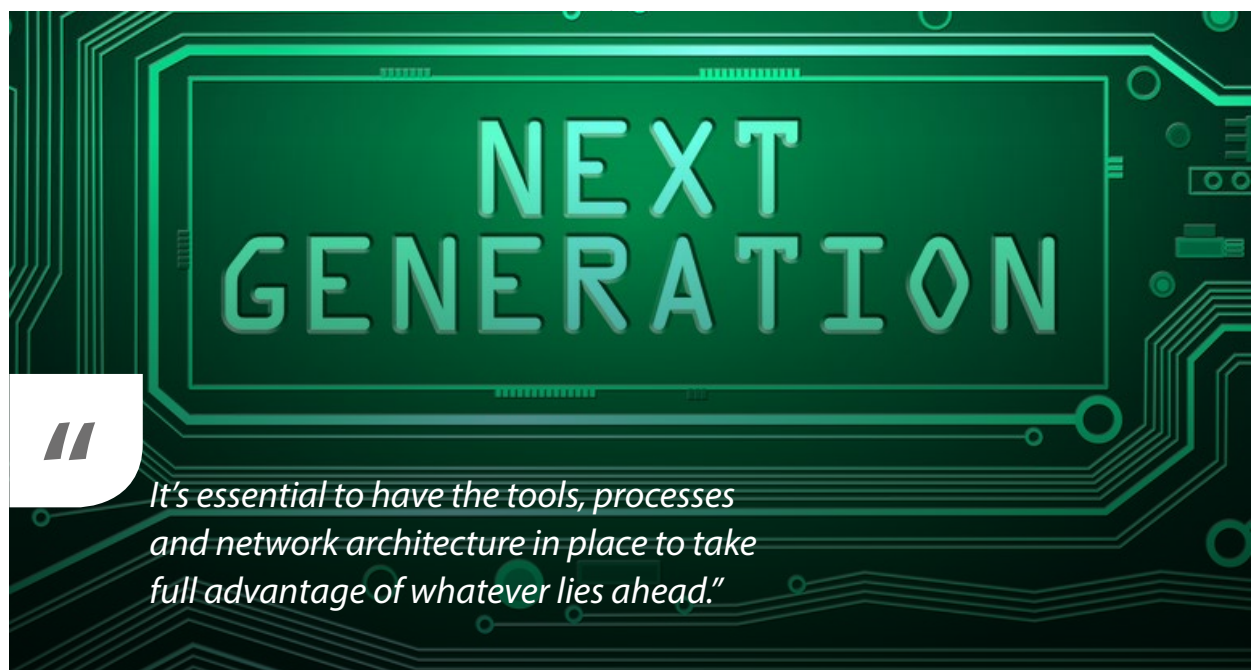


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Have we seen the end of the 10 year “Generation Gap”?

In the past, we’ve seen a regular 10 year technology refresh with 2G, 3G and 4G each being added incrementally. Some believe that 5G will follow in the same cycle, although at the moment it remains vague and unpredictable. Others point out that the benefits of each new generation – mainly increasing spectral efficiency and releasing new spectrum – are reaching their full potential. This has been a key argument for small cell deployment, which increases capacity through frequency reuse without the need for additional spectrum or spectral efficiencies.



This ten-year cycle hides many complex factors placing demands on network planners and managers, including but not limited to:

- Spectrum: Acquisition, trading and re-farming
- Radio interfaces: 2G/3G/4G/Wi-Fi
- Backhaul: Wired and many wireless alternatives
- RAN architecture: Integrated basestations vs C-RAN; Macro/Micro/Small
- Vendor selection: Single solution vs best of class ecosystem
- Ownership: Entirely owned vs RAN share/roaming

A sensible course of action is to enable the network to become agile, able to adapt and cope with forthcoming technical and commercial challenges. At any time, the network should be delivering the best performance from all available resources. Nirvana for an operator isn't deploying some radical new wireless interface, it's ensuring that the complex mix of spectrum, radio technologies, backhaul and other assets are operating coherently to best effect. It's essential to have the tools, processes and network architecture in place to take full advantage of whatever lies ahead.

The four methods of wireless densification

There are commonly thought to be three ways to densify wireless traffic capacity:

1. More spectrum (expensive, limited)
2. More spectrally efficiency (e.g. LTE rather than 2G)
3. More spatial reuse (i.e. small cells)

But there is also a fourth aspect which can deliver significant additional benefit

4. Orchestration and tighter control. (e.g. SON (Self Organising Networks), traffic steering/shaping across and between all available wireless resources)

Network operators have already invested heavily to prepare themselves for the onslaught of new spectrum and new radio generations.

This has been a key factor driving replacement of outdated macrocells with “Single RAN” basestation equipment that supports all generations of radio interface. These specifically address (1) and (2) above. What’s needed next is investment in tools and equipment that provides similar flexibility for (3) and (4), scaling to cope with an influx of small cells and introducing real-time management and co-ordination across all available wireless technologies, both cellular and Wi-Fi.

Co-ordination between radio technologies is important, perhaps even more so than C-RAN which tends to focus on a single technology, primarily LTE. Super-optimising a single RF technology isn’t enough, especially if that would rely on a major hardware upgrade to smartphones as required by more advanced LTE features such as CoMP (Co-ordinated Multi-Path) or LAA.

We have seen the industry adopt LTE quickly ([422 commercially LTE networks to date](#)), invest heavily in new spectrum (e.g. [\\$41 Billion in the US, \\$18 Billion in India](#)), and allocate substantial funds for small cell deployment (e.g. [Verizon allocates \\$500 million](#)). However, it’s less visibly obvious that operators are as well prepared for HetNet Orchestration as they should be.



Radio technology evolution?

5G, should it ever take form, can't just be about delivering yet another air interface and associated infrastructure. It must satisfy needs which are otherwise unmet. A not unreasonable medium term goal may be that ultimately almost everything cellular uses some form of LTE or Wi-Fi. This is likely to take very long time for many reasons:

- Both LTE and Wi-Fi standards continue to evolve and add new capabilities (e.g. LTE Direct, Wi-Gig etc.)
- The majority of wireless data sent today is and will remain Wi-Fi. Most Wi-Fi use will be through private networks (residential), which also needs to be integrated and evolve to provide seamless handoff to/from cellular. It's just not feasible for either cellular or Wi-Fi to dominate and replace the other.
- Profitable inbound roamers will continue to need to be supported, regardless of the technology and/or band plan of their devices
- Much of the world can't afford to adopt it very quickly. (LTE subscribers are [only 10% of global total](#). The majority of users remain 2G and will do until 3G takes over around 2019. Even by 2020 there will still be more 2G users than 4G worldwide.)
- Low power M2M devices can't support today's LTE, so will either need LTE-M variant or use one of many other competing wireless standards. It's not entirely clear how much will bypass or be integrated into cellular networks
- 5G is still vague and unknown. It's unlikely to be a single ubiquitous new radio interface and perhaps more about the synergy of interworking between newer versions of LTE and Wi-Fi to it all works in a simplified, seamless and efficient way.

So we will need to make best use of all existing channels need to support 3G, LTE and Wi-Fi for some years. This needs flexibility to adapt, deploy, refarm any and all of these radio technologies. It also requires the ability to manage and optimize across all resources to achieve the best system performance.



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Commercial evolution

Different parts of the world operate on different commercial basis. In some countries, RAN sharing is endemic – operators may own very little of the network equipment themselves. At the other extreme, even tower sharing is rare. We can expect increasing commercial pressure to reduce costs and encourage RAN share especially in areas of poor coverage.



Those networks that are technically better positioned and prepared for that eventuality will have an advantage. They will be ready to cope with MNVOs who may want the option to deploy some of their own in-building small cells and/or carrier grade Wi-Fi. They can accommodate whatever commercial arrangements for network sharing might arise, including support for Public Safety and private networks.

Some networks have chosen a single solution supplier, setting SLAs for service quality and outsourcing both equipment and field activities. Often contracts are awarded on a regional/geographic basis to different vendors in order to encourage competition. We have also seen different vendors being introduced as an underlay (urban microcell/small cell) or in-building (enterprise and/or residential).

This ability to be able to integrate and use other vendor RAN equipment adds enormous commercial advantage. Open standard interfaces rather than proprietary ones have proven to be very successful, with it being common to award contracts to different suppliers for core and RAN equipment. Using a multi-vendor HetNet gateway expands choice. It empowers procurement to be able to negotiate better pricing for equipment and allows flexibility to introduce new products tailored toward specific markets such as Enterprise buildings.

Adding each new vendor increases complexity and support costs, so typically a compelling case has to be made. Compliance with standards is hugely beneficial. Sometimes the subtleties of technical features/choice are not fully appreciated by procurement departments focused only on the cost of the box.

App evolution



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Traffic is growing exponentially in volume, diversity and numbers of connected devices. The headline growth figure relates to video, highlighted by [Netflix consuming 34.5% of all US fixed internet traffic](#) in the evening. But few people walk around with video running on their devices, although they might be on a call, streaming audio or downloading app/social media updates. Some think that augmented reality may change that; the honest answer is “we just don’t know”. Perhaps the more likely answer is high value paid traffic growth will come from something quite different, unrelated and unexpected.

The Internet of Things (IoT) is expected to dramatically increase the number of connected device, but it’s difficult to predict what percentage would be served by a cellular network operator. Usage would likely impact signalling load than traffic volume and about resilience rather than speed of connection. This includes avoiding heavy signalling loads on the core network, a lesson learnt early in LTE deployment by SK Telecom who [installed one of the first LTE gateways to offload and optimise that](#).

Cisco VNI and other reports predict that Wi-Fi offload will continue to grow, helped further by new high speed Wi-Gig launching in 2017. This technology should be ideal for fast data synchronisation if used well.

The main point is that predicting today’s traffic quantity and profile would have been difficult even 5 years ago, so we can’t be exactly sure of what’s coming next except it will be big. Agility, flexibility and scalability of the network architecture will be key to responding quickly to handle future demand.

Managing this wide variety of traffic types using techniques such as traffic shaping, steering and caching will grow in importance despite concerns about Internet neutrality.

Today RAN expansion activity

Undoubtedly, today's priority for network operators has been about maximising the return from existing macrocell sites. Relatively few new sites are being acquired but many are being expanded and upgraded. Many operators already have flexible basestations which can be remotely configured between 2G/3G/LTE to refarm frequency bands. Most can achieve that with equipment swaps.

Investment has switched to LTE, increasing the wide area coverage footprint by using the lower 700MHz frequency bands. This can be counter productive where there isn't matching 3G coverage or VoLTE. Europe has seen extensive refarming of the 900MHz band from 2G to 3G which should help, but that option isn't open to all operators.



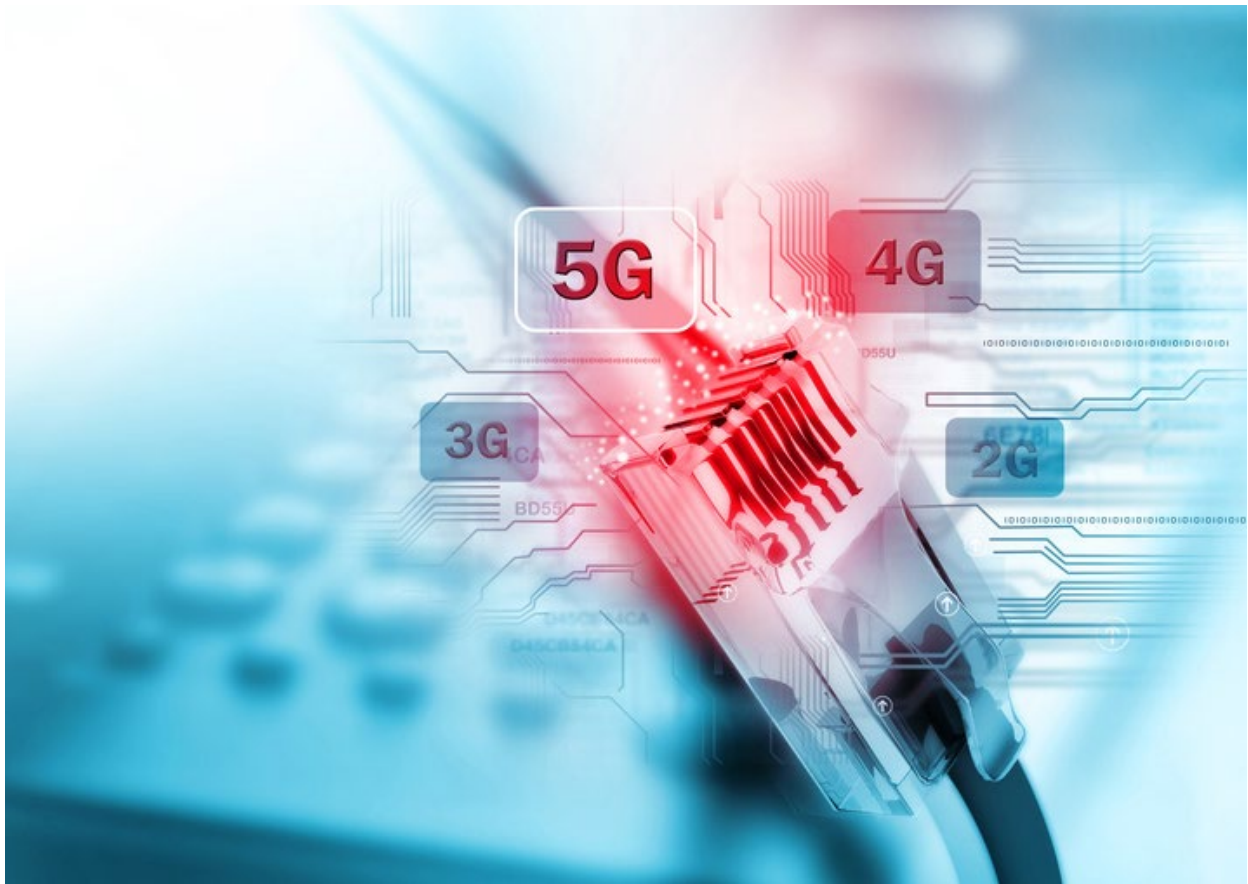
Capacity investment in LTE varies widely between countries. Developed countries where users have LTE smartphones would prioritise LTE, but may find that only the latest devices can access some frequency bands, delaying the benefit of the investment. Sri Lanka has 4G but continues to build up 3G capacity because that's what their customers are equipped to use. North America has moved quickly with 4G because Verizon/Sprint want to retire expensive/outdated CDMA systems, forcing competitors to keep up. Australia has been slower with 4G because it originally deployed 3G at 700MHz which has very good coverage range.

Sector splitting at high traffic sites remains popular where antenna can be mounted. Six sector sites are not uncommon in central business districts, with all available frequencies being deployed from 700MHz through 2.6GHz. Backhaul links have been upgraded to suit, with rates up to 1Gbps not unusual.

Additional spectrum and site expansion has its limits, and we can see many operators actively conducting small cell pilots, identifying the processes and methods for site acquisition, rapid configuration and suitable backhaul methods. The industry is positioning and preparing itself for the inevitable need to a small cell layer, even if it has been delayed longer than expected by the macrocell and spectrum expansion listed above.

We've also seen a wide variety in approach to Wi-Fi. Insisting that all smartphones are Wi-Fi capable has taken huge pressure off cellular networks, offloading the majority of wireless data to private, often residential, Wi-Fi access points. Some operators have taken a more proactive approach, setting up roaming agreements with public Wi-Fi networks and/or deploying their own Carrier Wi-Fi points. This is rarely co-ordinated with the RAN planning departments and more often dealt with as a commercial roaming transaction. Although many small cell products have Wi-Fi capabilities, these are often disabled for organisational or commercial rather than technical reasons.

Future RAN expansion strategy



With a mix of cellular and Wi-Fi radio technologies to manage, a co-ordinated HetNet approach is required. These can't be optimised or operated purely as separate silos. Tools will be needed to determine where, when and how best to invest in new capacity. Performance management reports can be used to identify hotspots/notspots, but wider consideration is needed to determine which frequency band and radio technology will provide the best return. This may include commercial options including RAN sharing and roaming, with tighter integration with both trusted (i.e. Carrier deployed) and untrusted (i.e. 3rd party) Wi-Fi.

An ability to expand the network efficiently and rapidly using any current or future radio technologies will be essential. This includes integrating new products and/or equipment vendors whether directly or indirectly connected.

Once installed, active management of traffic and usage across and between these different radio technologies becomes very important. It's not enough to optimise performance of any individual radio interface, traffic flow and steering in as close to real-time as practicable delivers great benefits. We can expect to see greater use of SON, data caching and other techniques.

Conclusion

Perhaps greatest challenge for today's CTO is not to predict exactly which RF interface, architecture, App or technology will make the greatest demands on their network in the future. Instead, it's about shaping their organisation and operation to be in the best position to move quickly and adapt efficiently when the industry does finally make its choice.

While we've seen new frequencies and capabilities enabled by LTE take up the majority of investment in recent years, we can expect to see more emphasis on network densification through small cells, C-RAN and Wi-Fi in the near future. Commercial disruption through increased RAN sharing, roaming and new vendor equipment is also likely if unpredictable.

The best-positioned organisations will be those who put in place the capabilities to be agile, adaptable to meet future unknown and unpredictable market demands. HetNet Orchestration provides the flexibility to make the most of all the technologies brought to bear. Capabilities to rapidly deploy, integrate, manage and optimise networks will be critical, and a holistic approach which deals with all technologies in a co-ordinated manner will have a tremendous advantage.

