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Private and Shared Access 5G:

Opportunities for enterprises based on practical deployment experience

Peira Consulting Limited

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Peira Consulting

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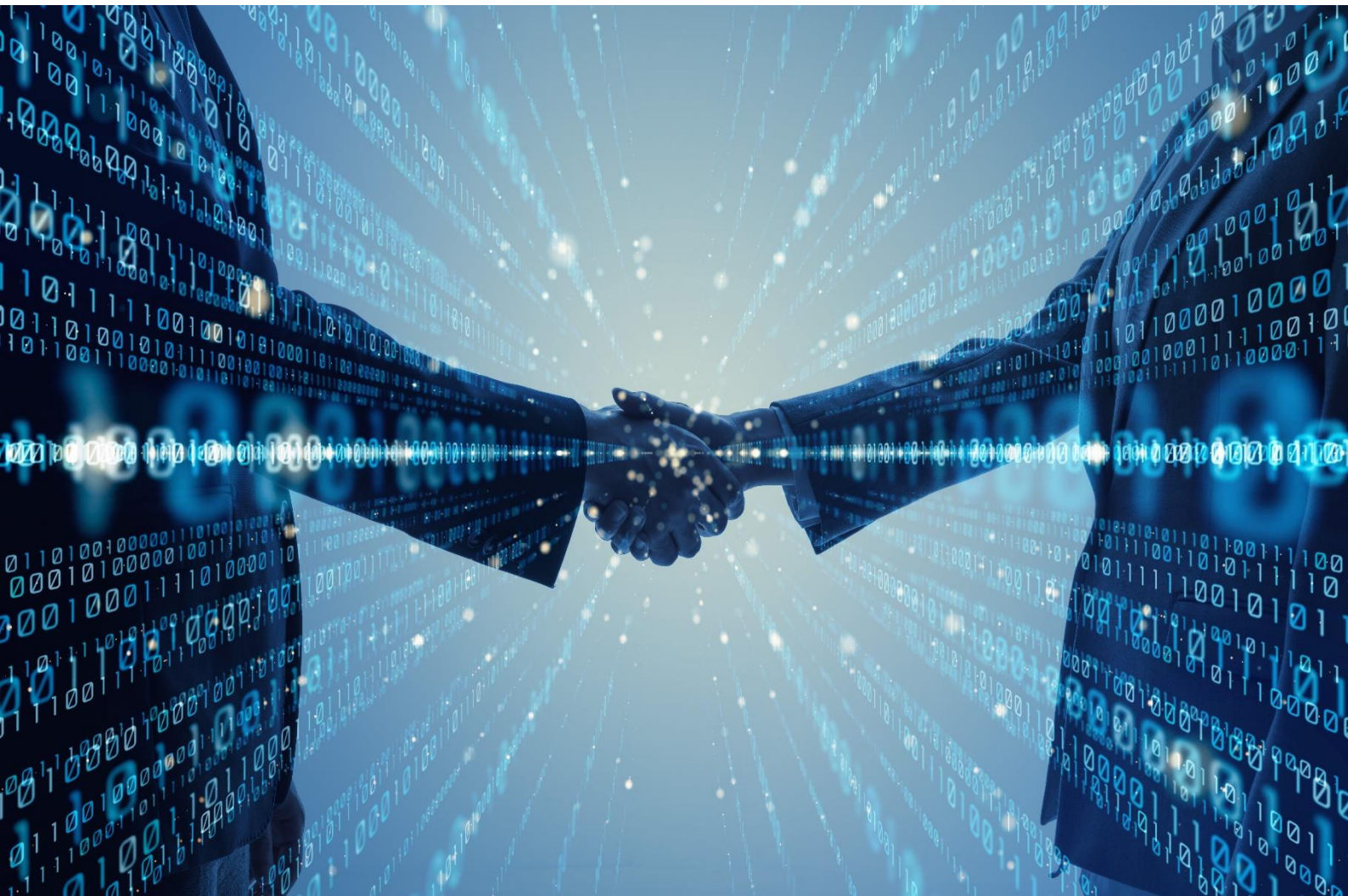
We support governments, regulators, industry bodies, telcos, vendors, enterprises, law firms, and investment / financial sector clients globally, across a range of capabilities including strategy and policy development, telecoms regulation, technical and commercial analysis and advisory, and complex technology programme delivery.



1 Wireless technologies and commercial models are changing...

Whereas 'traditional' mobile systems continue to evolve, and are now doing so with 5G technology, new private and shared access networks are being deployed by enterprises and public authorities, where demands are otherwise not being met with legacy 'one size fits all' mobile systems.

This article looks at some of the key issues driving change in the wireless sector, why new commercial models are attractive, and how these can be realised, drawing from practical experience.

2 5G: more of the same. Or is it?

Smartphones based on mobile wireless technology are now a familiar feature of daily life. Commercial deployment and use of mobile systems grew significantly in the 1990s with the launch of GSM (2G) which eventually became a global standard. GSM has since been followed by newer mobile technologies: 3G (UMTS or WCDMA), 4G (LTE), and now 5G (OFDM). 5G is where things start to get 'interesting', and potentially confusing. So a few points of clarification:

'5G' is, somewhat confusingly, used to refer to mobile and other wireless systems (e.g. FWA). It has also been used to refer to new radios which don't use 5G! Strictly, 5G is about those systems using 5G chipsets and/or system architectures.

5G technology has been designed to address, principally, three low level service requirements: sub-10ms latency (so-called Ultra-Reliable Low Latency Communication, URLCC), high speed data communications (Enhanced Mobile Broadband, EMBB), and machine to machine (M2M) (Massive Machine Type Communications, MMTC). The EMBB element of 5G is by far the most relevant in current markets, and 5G-based M2M (or Internet Of Things, IOT) is not yet commercially mature.

5G mobile technology is, in many respects, a straightforward evolution from previous mobile technologies such as 3G and 4G. Key technology differences brought with 5G include: the New Radio OFDM physical layer, which enables greater flexibility in radio bandwidths (100MHz or more, instead of 20MHz with 4G) and greater per-carrier data capacity, and enhanced use of advanced array antennas (i.e. Multi-User Multi-Input Multi-Output, MU-MIMO) – which can provide range and capacity extensions (at a cost). 5G is also often associated with software-defined networking (SDN), but the reality is that the SDN industry is now around 10 years old, and 4G networks employ SDNs as much as 5G ones do.

Hype, misinformation, and errors are widespread with media and industry reporting on 5G performance levels. In reality, 5G technology operating at the 700MHz and 3.5GHz (C-) bands will support higher data rates than possible with 4G, subject to radio link budget designs and available spectrum bandwidth. 5G has been designed to offer peak data rates up to 20Gbps, but these will rarely be attained in practical situations. With sub-6GHz band operation, typical data rates attained are around 100Mbps downlink, 20Mbps uplink, depending on cell loading. 5G capacity performance gains are more notable when millimetre wave (mmW) bands are used, as bandwidths of several

hundreds of MHz can be available, with peak data rates in commercial products running at around 5Gbps. (Gigabit performance is possible with 5G in sub-6GHz bands, depending on system designs).

5G does, however, bring some important flexibility, by virtue of greater use of digital technology across the system as a whole.

3 Traditional wireless models are becoming economically unsustainable

As wireless markets continue to evolve, there is emerging recognition that 'linear' evolution of mobile architectures, as from 3G to 4G, and now 4G to 5G, does not provide compelling new investment cases and commercial solutions. 'Linear' here means more data capacity, more spectrum, higher frequency carriers, less coverage, more cost, and weaker investment cases.

Catch 22. Unless, that is, new commercial models can be found with 5G. With private and shared access approaches, they can…

4 What are private and shared access 5G models?

Private networks are as the name suggests: 5G networks are assembled and operated by private operators, with no connection to public telecommunications networks. Private 5G services are provided to private users over private 5G infrastructure. But private operation is only possible if radio spectrum is available for use privately.

Shared access 5G solutions enable multiple commercial operators (e.g. MNOs, wireless operators, or enterprises) to run services over a single shared 5G network (i.e. neutral host architecture), with physical sharing on passive and active equipment, logical separation on data and control planes, and physical or logical separation on use of physical radio spectrum. This approach may include interconnection to the public telecoms networks, licences permitting, meaning that public and private enterprise services can be provided over one network.

These new models are possible with 5G technology, as the radio access network (RAN) is fully digital, and radio nodes are disaggregated from baseband units and switching networks. There is nothing new in the concept of network and asset sharing, but 5G technology takes it to a new level.

5 Why are private 5G and shared access solutions commercially valuable?

Private networking allows networks to be deployed exactly to private needs. Aside from coverage, service quality is another major driver; with privately designed and deployed networks, quality levels can be implemented exactly to requirements, rather than as 'off the shelf'. One size no longer fits all. But one size systems have previously provided cost efficiencies. 5G helps resolve this tension with greater use of software, which provides flexibility and slicing options.

Another major factor is the desire for operational control: in mission-critical situations, some enterprises prefer to have ownership of problems and solutions, rather than being dependent on others.

Use of shared infrastructure brings immediate benefits: network-related capital and operational costs can be shared across multiple entities, significantly cutting exposure and improving margins and valuations.

But there are challenges too. Shared access on infrastructure and spectrum brings a host of complexities at the operational level, and with regulation. Deployments can be complex, and bespoke regulatory agreements can be required.

Without disaggregation of network functions at the product level, practical architectures are limited. As a result, private networks have in the past been deployed using, essentially, a real estate model – where mobile operators install and operate network systems at private premises, with private entities offering little more than physical space and electrical power to the network operator, with some rental costs.

With the increased flexibility possible with 5G, enterprises are free to engage more directly in deployment and operation of 5G networks. Key benefits for enterprises then include:

Direct engagement in strategic planning and requirements setting for the design, operation, and services with the network (including radio coverage planning, service level agreements, and network operations).

Development of a neutral host architecture, with clear cost benefits and synergies for the enterprise (and other stakeholders), especially with shared access architectures.

Commercial flexibilities, including: joint investment models, shared services, asset reuse, cost recovery and profit-driven models, and risk mitigation.

Technical flexibilities, including: integration of cloud-native and premises-based private cores, staged investment plans, access to managed services suited to vertical segment applications, accurate radio planning, and deployment to meet private needs.

6 Market and technology factors drive the need for new commercial models

On the demand side, private 5G networking is being driven by a number of factors:

Public 5G networks are developing at modest pace, with valid concerns from operators and investors over investment cases and performance levels. Therefore, new attractive commercial models are being sought.

Enterprises need solutions that can be tailored to meet specific localised requirements, with acceptable system costs, and security levels.

Some enterprises want solutions where they can engage in operational management of solutions, thereby ensuring local control, and managing risks at the local level.

On the supply side, there are numerous driving factors also:

5G technology offers greater flexibility for system deployments, both in terms of overall architecture (with SDN, digital backhaul, and disaggregated network functions), and at the radio level (with variable bandwidths). This flexibility supports new commercial models, such as neutral host shared access systems and services slicing.

Private networks based on WiFi using unlicensed radio bands have limited performance levels, especially when networks become heavily loaded. 5G solutions, based on use of licensed radio bands are much more resilient, suffering much less from radio interference.

Many regulators have recognised the enhanced flexibility possible with 5G mobile networks, and many have introduced local and shared access licensing. This allows flexible radio band use across local areas, supporting neutral host network solutions with multiple commercial operators.

7 Which vertical segments can benefit most from private 5G solutions?

Fully private (i.e. 'black box') 5G systems, with no connection to public telecommunications networks can be valuable in many situations, and these can be viewed as alternatives to legacy wireless networks, such as WiFi, Tetra, and others.

5G technology can provide mobility, so roaming is possible in private systems, albeit only within on-net areas. There is strong interest in private 5G systems from enterprises and industry verticals which require wireless services in 'difficult' areas (e.g. off-shore rigs, mining complexes, chemical plants, and manufacturing plants).

Strong interest in 5G shared access solutions exists with governments, local authorities, airport operators, hospital authorities, travel and port operators, and in urban areas with requirements for high speed data access (e.g. with public safety and security camera uploads, smart cities, tourism centres, shared office facilities, and wide area enterprise facilities), and others where a mix of public and private services are needed.

8 Which use cases are attractive in the market?

Use cases are of course specific to particular enterprises and verticals. A good practical example with shared access 5G is in a hospital:

Multiple sites have installed shared access indoor neutral host 5G networks, which connect to all mobile operators active in the market, and thus provide public 5G services, on-net private 5G services, and off-net private 5G services with VPN access over the public telecommunications networks.

Private on-net two-way 4K resolution very low latency real-time video conferencing services can be established between the two hospital sites, potentially supporting real-time clinical activities (e.g. expert consultations, and even live patient operations).

Wireless operation with full mobility is beneficial, as clinical staff may be on the move, and require high quality digital services in mission-critical situations.

Some hospital staff may be outside hospital on-net coverage areas, perhaps at home and working, or in vehicles, but within coverage of public 5G networks. In this case, private services will still be possible, with connectivity across the whole private-public 5G network connection via VPN connections.

In addition, public 5G services are available to visitors and patients across all hospital areas.

Cost synergies start to become compelling: many services, one network.

Other use cases important for enterprises and regional authorities include:

Augmented / virtual reality (AR/VR), with video conferencing;

Portable security camera video links;

Autonomous / robotic mobile vehicles (V2X);

Wearable monitors and IOT devices (sensors and trackers); and

Wireless data-enabled mobile kiosks.

In developing 5G system designs, use cases must be considered with bearer level service requirements and user volume levels, together with coverage requirements.

In most cases, 100/20Mbps (downlink, uplink) data throughput is adequate to support use cases, though the importance of uplink capability should be noted in some particular situations: with security cameras, high quality bearer performance is required on the 5G uplink, and this may warrant specialised designs in some cases.

9 Regulation is a key part of the solution

Regulation can be complex, with the need for licensing on radio spectrum and with network operations. Private 5G network operation requires access to radio spectrum, as with all wireless technologies.

With C-band operations, practical solutions typically involve use of spectrum licensed to MNOs, with bands allocated to enterprise users on a regional basis. With physically shared spectrum, regional access requires appropriate radio planning to ensure that interference is not caused across systems which may be using the same band in different areas for different purposes. Practically, this can be accomplished with adherence to regulations, and careful system design, ensuring that 5G radio sectors are shielded and pointed in directions that do not cause interference. C-band spectrum can

be used to deploy 5G systems either indoors or outdoors, and in some cases, radio regulations may support use of particular bands for indoor areas only, or with limitations on transmit power levels.

Where 5G systems are deployed in the higher frequency 26-28GHz licensed bands, range per 5G site is typically only in the tens or hundreds of metres, rendering radio planning somewhat less complex. With these bands, licences are typically available for regional (i.e. shared spectrum) usage, and practical deployments are well-suited to indoor and urban applications.

Spectrum sharing can be accomplished using either physical allocation of radio bands, or virtually – where a single band is shared across multiple commercial operators using codes to allocate and authenticate data traffic to users by commercial operators. The former approach is referred to as multi-operator RAN (MORAN), and the latter multi-operator core network (MOCN) operation. MOCN solutions are more appropriate in cases where network mergers have taken place, and traffic congestion can occur unless designs are carefully dimensioned. Private 5G operation is better supported with MORAN network designs, where physical spectrum and data channels can be wholly allocated to private users, according to requirements.

With MORAN operation and neutral host networks, however, comes a degree of complexity at the regulatory level. If different commercial operators share physical infrastructure and radio equipment, legal questions can arise as to who is accountable for adherence to radio regulations.

Further regulatory issues arise with interconnection and class licenses. Interconnection may be regulated, and if so, complexity may arise (for example, it may not be obvious where points of interconnect lie in the network, and these may be physical and logical). Class licences may be required to authorise service operations in neutral host network designs.

10 5G technology enables attractive new architectures

Private and shared access 5G systems may involve development of local 5G RAN networks, which may be deployed across enterprise sites, or local areas - as with smart cities and public authorities. If interconnection to external networks is required, this is usually facilitated physically at layer 2 or 3 switching sites, though logical interconnections can be complex, with line card interconnections occurring within 5G equipment racks in RAN networks (typically at baseband traffic aggregation points).

Neutral hosting can be accomplished with logical separation of data and control planes and digital multiplexing over active and passive equipment across the RAN. Digital multiplexing of channels extends directly to 5G radio nodes and antennas, where MORAN operation allows channels to be demultiplexed for transmission over physical radio bands which may be physically separate and licensed to different commercial operators.

Physical installations at enterprise sites will typically involve: use of physical space and passive equipment, electric power supplies and cooling systems, optical fibre cabling and ducting, deployment of 5G RAN equipment and radio nodes, data switching equipment and routers, and interconnections to private networks.

Core networks, BSS/OSS systems, and application suites are more flexibly implemented via cloud-native solutions, which may be hosted on- or off- site. As 5G stand-alone (SA) products are now available in the market, there is no need for 4G network coverage to provide control plane support for 5G radio bearers.

11 Trusted advisors can help mitigate risk in getting to market

With neutral hosting and shared access comes the question as to which commercial model is most effective.

Turnkey solutions are highly valued in the market; a ‘packaged’ solution mitigates risk and can ensure optimised value.

Key stakeholders will typically include: network and IT systems vendors, mobile network operators, civil engineering contractors, enterprises, regulators, governments, local authorities, systems integrators, and lawyers.

With so many stakeholders, independent expert consultants can play a vital role as trusted advisors, ensuring that technical designs and commercial models are in clients’ best interests, and that programmes stay 'true' to objectives, rather than diverging - the main cause of failure with many large technology transformations.

Expert consultants can provide: board level investment cases, overall programme management, use case definitions, expert advice on regulations, development and brokerage of commercial deals, technical and commercial advisory services, commercial models, solution procurement, supplier management, and post-delivery programme assurance and diligence work.

Commercial deals with shared infrastructure may involve joint capital investments and joint operations. Care should be taken to design commercial models that provide value in key dimensions, as required by all stakeholders. For example, value may accrue to an enterprise with direct control over operations of parts of the system; value may also be seen as financial.

In practical cases, successful commercial models result where balanced objectives are met. Specifically, cost-based pricing models are attractive, as financial benefits accrue directly from cost synergies with shared access. This means that whilst cost recovery should be implemented with infrastructure programmes, models seeking unbalanced profits are unlikely to work well.

It is worth noting that co-investment is by no means necessary; private 5G systems can also be deployed successfully using a managed services model – where an MNO or systems integrator takes full ownership of system design, deployment, and operations, according to defined contractual requirements, preferably, again, with trusted advisors in place.

Fully managed (buy) solutions are likely to be attractive where enterprises have little desire or need to get involved in 5G systems design and operation.

Co-investment (make) models are likely to be attractive in cases where hands-on operational control and local security is needed by enterprises, and where direct engagement in financial models is preferred.

12 The future looks bright… (for those in the know)

Development of 5G and 6G wireless technology is continuing with clear recognition that the economics of radio networks are reaching a point of inflexion where new approaches are required. The old model of one size fits all is no longer sustainable, or acceptable.

As markets continue to develop, wireless solutions will be related to environments served, radio bands used, and market demands. Practically, evolution can be expected with network 'layers', with focus on indoor areas, urban regions, and wide area coverage, with high capacity wireless services increasingly carried over millimetre radio bands such as those at 26-28GHz and 60GHz.

In the longer term, to 2030 and beyond, 6G will provide advanced services through combinations of ultra-high definition comms, network edge processing for very low latency, and high accuracy timing and geolocation functions, with core processing taken to new levels of machine intelligence. Over the next decade, network architectures are likely to shift to a mix of FTTX, context-specific wireless links, and cloud-native networking – supported by edge and core datacentres.

The opportunity for enterprises, public authorities, investors, and network operators with wireless systems is increasing.

Winners are likely to be those able to develop new commercial models and partnership deals, with neutral hosts and carrier-neutral segment-focused datacentres, with services tailored, cost-efficiently, towards local and vertical requirements.

13 For further information …

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