WHITE PAPER

MicroTCA architectures for in-building wireless networks

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Introduction

Increasing data usage and the expectation of broadband access everywhere is driving new thinking in the design of in-building radio coverage. Building owners are also recognising an opportunity for new revenue streams through the services they can provide by installing private networks.

These two drivers lead to the combined requirements of the adoption of mobile edge computing (MEC) to improve local user experience, and in-building small cell architectures which support densification and improve coverage. This article discusses the current network challenges and shows how PICMG MicroTCA-based modular architectures can be well placed to take advantage of the new markets.

Private Networks

The release of unlicensed carrier space, such as the Citizen Broadband Radio Spectrum (CBRS), or use of techniques such as MulteFire, mean that in-building wireless solutions providers have new options to provide high performance, custom networks. LTE-based networks can be used in this spectrum to provide improved service quality, greater bandwidth, higher security, better load-balancing, and policy management than the ubiquitous Wi-Fi networks.

With an underlying technology built on LTE, these private networks have access to the building blocks and features developed for the national networks, with specifications defined by 3GPP and European Telecoms Standards Institute (ETSI). For example, this includes device-to-device communications, proximity based services, and mission critical push-to-talk – features that can only be implemented in a proprietary manner using Wi-Fi.

Mobile Edge Computing

MEC is defined by the European Telecommunications Standards Institute (ETSI) as supporting data processing close to the network user, removing the need for traffic to be processed by the network core. In the context of in-building services, this could support streaming of local video, accessing local venue content or services. For example, a fan at a sports venue may be offered a subscription to a live video feed, or spot betting opportunities for the game in progress.

A private network allows the MEC element to be co-located with the venue data centre, prior to the core network access. The venue operator can then control the content, own the big data, and generate additional revenue from the provision of network coverage. This is a completely different model to supporting network operator coverage inside the venue, where all access (and revenue) is diverted back to the operator's network.

Densification and Coverage

Provision of a private network within a building is challenging. Densification is the addition of local network capacity to support increased numbers of users in a coverage area. This is achieved by adding small cells.

However, adding small cells to provide coverage rather than capacity is expensive. It also leads to user equipment (UEs) having to hand-over between small cells too frequently, which impacts performance. A better solution is a hybrid of small cells which also have distributed passive network of antennas, similar to D-RAN.

A hybrid small cell D-RAN solution can be optimised for a measured and modelled number of users with a certain traffic within a building. However, typically this changes depending on the time of day. For example, at lunch times access demand would be expected to migrate from work space to cafeterias. If a meeting is held it might be reasonable to direct additional capacity to a meeting room. So, flexibility in the network is needed.

MicroTCA

Micro Telecommunication Computing Architecture (MicroTCA) is a chassis based, scalable architecture with open specifications developed by the PCI Industrial Computer Manufacturers Group (PICMG). First released in 2006, MicroTCA is geared towards small-scale solutions which also require the high performance and reliability versions of core telecoms network equipment. Later developments of ruggedized MicroTCA for harsh environments have increased the attractiveness of the platform for industrial deployments.

A MicroTCA chassis can accommodate up to 12 Advanced Mezzanine Cards (AMCs) in chassis sizes from 1U to 14U. These cards can provide a mix of functionality, such as network storage, general processing units (GPUs), baseband processors, and fabric switches, from an ecosystem of vendors. The backplane architectures offer a range of high-speed fabric interconnect including Gigabit Ethernet, PCIe Gen3, and RapidIO.

Because of its small size, the MicroTCA architecture allows solutions such as a MEC to be realised alongside the baseband processing in a single-box solution in space constrained environments. It also allows scalability while re-using common building blocks, for example adding baseband cards supports increased densification, while adding storage cards allows the caching of more local content to reduce the backhaul network load.

Baseband Processing AMCs

An example of a suitable AMC board for such applications is CommAgility's AMC-D24A4-RF4, Figure 1. This is a complete eNodeB solution capable of supporting up to two sectors of 2x2 MIMO. Each sector can be deployed as an LTE cell, supporting 120 connected users at data rates of 300Mbps downlink and 150Mbps uplink.

Figure 1: CommAgility AMC-D24A4-RF4 LTE eNodeB AdvancedMC

Since the AMC-D24A4-RF4 is a software-defined radio, the operating band and bandwidth can be centrally configured. This allows spectrum usage within a building to be configured and re-used according to availability and demand, increasing flexibility.

Private Network Architecture

A MicroTCA-based in-building private network can be supported using one or more AMC-D24A4-RF4 cards. The cards can be configured to support a traditional DAS architecture from a central location, or an AMC-D24A4 without an RF interface can be deployed as a baseband-only card supporting two remote radio heads (RRHs) over optical CPRI connections. This allows a hybrid D-RAN type architecture where the RRHs can be located as distant satellites stations to increase densification, for example a floor of a building, as shown in Figure 2. Alternatively, the RRHs can be deployed with a local network of DAS to improve coverage, for example stair wells or shielded areas on that floor.

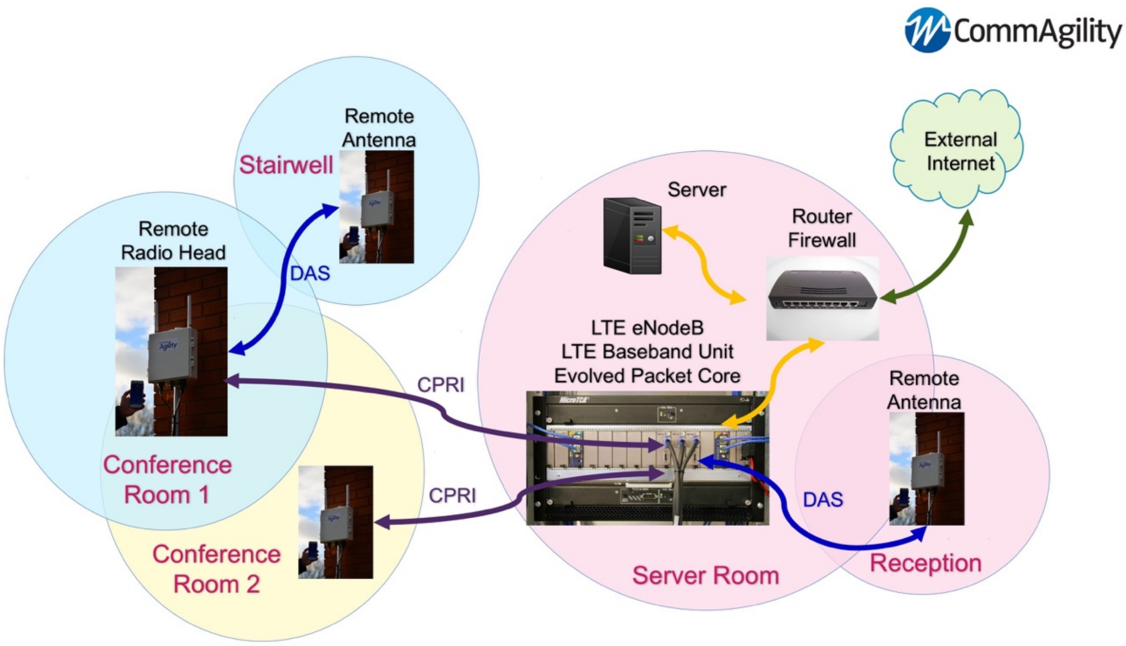

Figure 2: Hybrid D-RAN and DAS Based MicroTCA Architecture

User requirements for the deployment environment would influence the optimum topology of the network, but the architecture provides for this flexibility.

MEC support can be added by co-locating the server GPU and storage cards within the MicroTCA chassis for small solutions, essential where space is at a premium in the building server room. For example, a 3U 19" rack mounted MicroTCA chassis could be configured to support two AMC-D24A4-RF4 cards, supporting four sectors of LTE, two general processing cards, four hard disk carriers providing over 2.4TB storage and an integral network switch. A comparable PCI chassis may have a height of 4U and require external baseband processing units plus a top-of-rack Ethernet switch.

MicroTCA also offers a superior level of reliability and ruggedization compared to consumer equipment, which means it is more suitable for industrial deployment. Larger systems may choose to locate the MicroTCA base station in the data centre and make use of commercial servers to fulfil this role. Either way, scalability is offered.

Conclusion

A traditional in-building wireless coverage architecture using a DAS severely limits the user experience, network scalability and the building operator's opportunities for revenue generation.

These limitations can be overcome by taking a private network approach. Coupled with this, barriers for private network deployment are being removed by the government release of spectrum and innovative developments enabling the non-conflicting sharing of that valuable resource.

We have presented a MicroTCA-based architecture which offers a scalable pay-as-you-grow approach to providing an in-building service. The flexibility of the modular architecture also supports the ability to swap out LTE 4G technology for 5G technology as the standards evolve, keeping the network fresh and supporting the latest rapidly changing mobile phone features.

Other modular architectures are available, and it is possible to co-locate the baseband processing with server room equipment. However, the inherent size, reliability and available features of MicroTCA and the companion rugged MicroTCA for industrial environments make MicroTCA hard to ignore.

About the author

Paul Moakes PhD CEng MIET is Chief Technology Officer at CommAgility. He has previously held positions at Motorola and Blue Wave Systems. He is co-inventor of two patents in the field of MicroTCA and AdvancedMC. He holds a PhD in Electrical and Electronic Engineering from Sheffield University and a 1st Class Honours degree in Electronic Communications and Computer Systems Engineering from Bradford University.