Cisco Vision: 5G – THRIVING INDOORS

Whitepaper

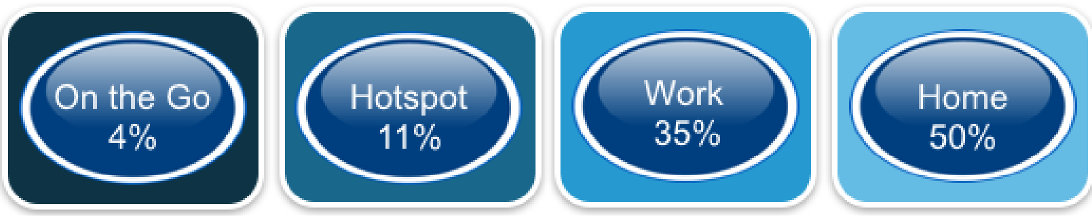
Summary

This short whitepaper describes the challenge in enabling 5G to thrive in an environment where an increasingly higher percentage of overall mobile data is being consumed from indoor environments, and where the businesses that are responsible for those indoor environments are increasingly requiring wireless service be offered to all employees, contractors, partners, visitors and guests, irrespective of their carrier affiliation. Hence, how 5G systems can facilitate multi-operator service will become a crucial capability for their overall success.

Introduction

5G needs to be designed to thrive in an environment where, even today, over 80% of mobile data is being consumed indoors and where Cisco's VNI is predicting that by the time 5G gets deployed, only 4% of mobile data will be consumed when "on the go". What is increasingly evident, is that a significant proportion of these indoor environments where the vast majority of data is being consumed, comprising retail properties, transportation hubs, healthcare environments and education establishments, want to be able to offer wireless connectivity to all their visitors, irrespective of carrier affiliation. These are the stark observations from a new paper on multi-operator challenges produced by 5G Americas and the Small Cell Forum [1].

Figure 1. Cisco VNI 2020 Estimates of Mobile Data Consumption



Having discussed small cell offerings with many of Cisco's enterprise customers, it is evident that they are indeed increasingly expecting the indoor network to be able to provide wireless service to all their employees, partners, contractors and visitors. So, if multi-operator, indoor shared networks are going to be essential for 5G's success, it is appropriate to review the adoption of such capabilities in today's 4G market and to understand whether we can take those learnings and apply them to ensure 5G is able to thrive indoors.

5G and DAS

It's true to say that, today, enterprises with a need for a multi-operator indoor network will first look to Distributed Antenna Systems (DAS) to meet their requirements. As it relates to a 5G environment, because the DAS systems effectively provide distributed in-building coverage from a single sector, issues related to capacity scaling will need to be addressed. Most likely, large buildings will need to be divided into sectors, by deploying multiple base stations (which will likely require more space and power) but reducing the number of users per sector and thereby increasing capacity.

However, with a recent report from IHS [2] predicting that the DAS market will only grow at a low single digit percentage CAGR over the next 5 years, then 5G should not rely on traditional DAS approaches to accelerate indoor adoption. Indeed, a recent Cisco enterprise customer recounted their experience with trying to engage with carriers to address their current indoor coverage issues. Despite having thousands of employees, the customer reported that carriers were unwilling to fund the installation of the necessary DAS systems. Moreover, they had already spent close to 12 months in planning the deployment, an indication of the lengthy times required for a DAS deployment, and more telling, had recently decided to switch strategies and were now expediting the support of Wi-Fi Calling across their IT network.

5G MOCN

If multi-operator DAS isn't going to scale to ensure 5G can thrive indoors, then its timely to look at the adoption of 3GPP's standardized technique for multi-operator support, so called Multi-Operator Core Network, or MOCN. As reported last year by Caroline Gabriel in Rethink's Wireless Watch [3], "*Mobile operators are concerned [if they deploy MOCN] about enabling competitors and losing control of infrastructure and network optimization*." Critically, whilst MOCN based LTE networks were defined in 3GPP Release 8, the issues related to management of a shared RAN were only studied as part of Release 12. Moving forward, as more of the RAN configuration and operations get automated, important aspects concerning the integration of SON capability between dedicated and shared equipment will need to be defined. Unfortunately, the SCF have concluded that multi-vendor interoperable SON deployments are being hampered by incomplete interface definition [4], providing a further barrier to automated MOCN adoption.

Importantly, the MOCN model requires the use of common spectrum that is shared between the multiple operators. Historically, spectrum sharing has not always found favor with regulators, since it has often been viewed as a potential threat to healthy competition between national operators. However, a recent report published by the SCF [5] indicates that several countries have already authorized the use of active network infrastructure sharing including RAN/spectrum sharing in certain circumstances. In particular, SCF report that spectrum sharing has been allowed in some countries where regulators have had strong policy objectives to extend mobile broadband coverage to areas of low population not likely to be served by multiple competing networks. Yet, the regulatory mechanisms by which this has been achieved are not always clear and vary from one country to another.

5G and new shared spectrum

The issues with sharing exclusive spectrum can be mitigated by new shared spectrum regimes. Significantly, the FCC's definition of the new Citizens Broadband Radio Service (CBRS) in the 3550-3700 MHz band is targeted at enabling small cell deployments where the small cells are able to easily share the frequency band. CBRS defines a 3-tier approach to sharing the band, with the incumbent federal users being protected from licensed "priority access" users, who in turn are protected from "generalized authorized access" users. However, from a 5G success perspective, it is not clear at this time whether broader spectrum sharing regimes will be adopted by other national regulators, in which case 5G's ability to address indoor demand may end up relying on a license-exempt version. An evolution of the recently defined MuLTEfire Alliance solution for operating LTE-based technology in unlicensed spectrum is an example of this.

5G Ready to thrive indoors?

With 5G's ability to thrive indoors being put at risk by:

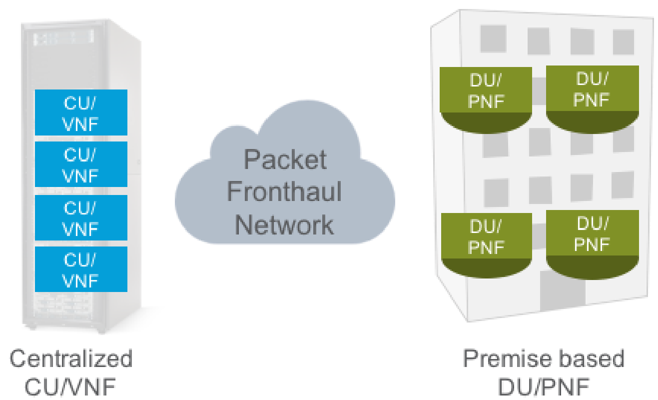
- DAS approaches that are unable to scale,
- MOCN approaches that have yet to demonstrate their ability to be smoothly integrated into the multi-operator Self Optimized RANs,
- National Regulatory Authorities with fragmented regulations associated with sharing exclusive spectrum,
- Still more ambiguity from the NRAs as it relates new shared spectrum regimes, and
- A yet to be proven ability for cellular operating in license exempt to be successful in the market

we think it is time to examine ALL options for enabling multi-operator 5G networks to effectively serve the 80-96% of mobile data traffic that will be generated indoors.

5G Virtualization – a new opportunity

Unlike previous generations of Radio Access Network, 5G will be the first time 3GPP has defined a split architecture, enabling the RAN "Distributed Unit" (DU) to be realized as a conventional Physical Network Function (PNF) and the RAN "Centralized Unit" (CU) to be realized as a Virtual Network Function (VNF). The issue of which functions are in the CU and which are in the DU has important implications on the latency budget of the transport network used to interconnect the two. However, what is apparent from recent progress at 3GPP, is that 3GPP will define a split with sufficient latency for the indoor DU/PNF to be supported by an off-premise CU/VNF, meaning virtualization will become a key capability in future 5G indoor deployments. There is the opportunity for 5G to enable re-use of the CD-DU split to support the necessary multi-operator deployments, enabling a common DU/PNF to be serviced by multiple CU/VNFs operated by different service providers.

Figure 2. Using virtualization splits to address 5G indoor deployments

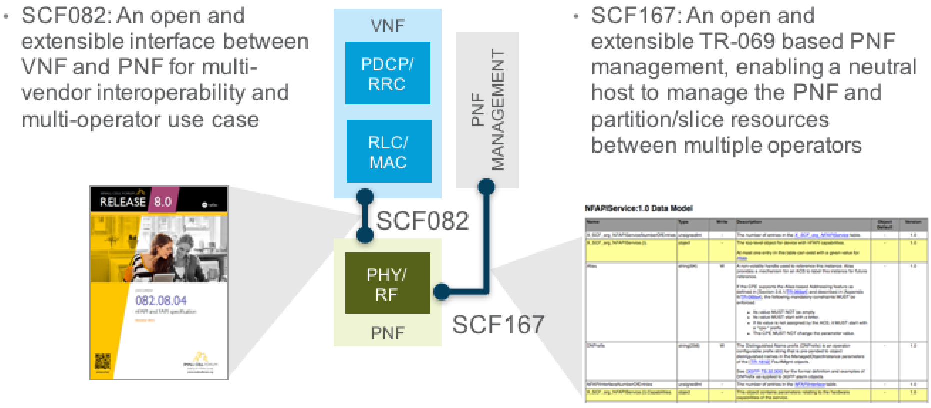


However, a recent report from nomor Research [6] indicates that infrastructure vendors are opposing standardization of any internal RAN interface to a level where multi-vendor(operator) deployments can be supported. Currently, it is unlikely that 3GPP will define a system which enables a common DU/PNF to be shared between multiple operators, meaning that multiple networks of DU/PNFs will need to get deployed to serve the businesses requirements.

5G Small Cells – a different perspective

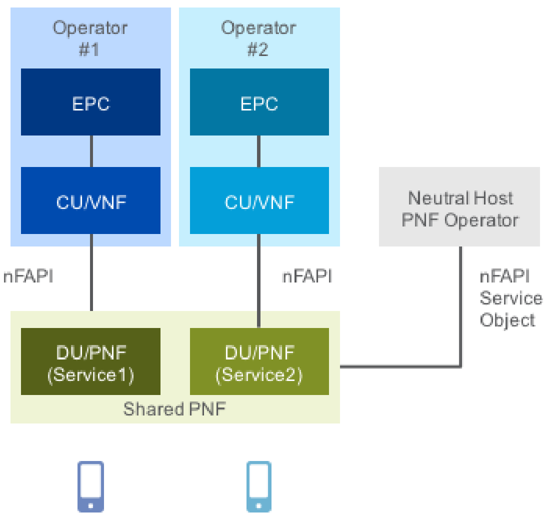
The Small Cell industry is focused on facilitating the densification of the radio access network, a foundation capability that is going to become table stakes in the 5G era. Furthermore, with 3GPP having a poor track record in enabling the deployment of systems that leverage multi-vendor internal RAN interfaces, it is perhaps natural to look to the Small Cell ecosystem to see their view on multi-vendor interoperable RANs that are able to meet the multi-operator requirements necessary for 5G to flourish in the indoor environment.

Figure 3. SCF's open and extensible, multi-vendor/multi-operator virtualized small cell



The small cell industry has successful track record in enabling multi-vendor capability, be that through the plugfests used to validate multi-vendor interoperability of RAN interfaces such as Iuh, S1 and X2, but also the internal equipment interfaces. Significantly, over the last three years, the SCF has been analysing the issue of splits between CU/VNF and DU/PNF within the small cell environment. As a result of this work, last year the SCF published their nFAPI specification [7], an open and extensible interface designed to support a multi-vendor MAC/PHY split between CU/VNF and DU/PNF. Importantly, nFAPI is an evolution of the Forum's Functional Application Platform Interface (FAPI), a MAC/PHY platform-based split that has been used to encourage competition and innovation between suppliers of small cell platform hardware, platform software and application software. Finally, at Mobile World Congress this week, the SCF has published the final piece of the jigsaw, the definition of an open and extensible TR-069 based PNF management [8]. This standardized management object enables an independent neutral host provider to manage the PNF and partition/slice resources between multiple operators.

Figure 3. Using multi-vendor nFAPI to support a multi-operator shared PNF deployment



Multi-vendor deployment challenges

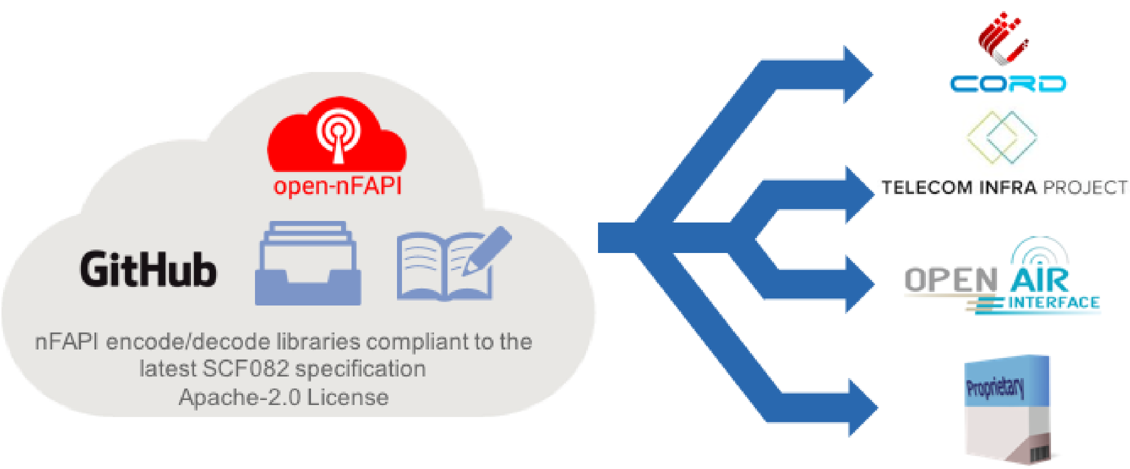
Irrespective of the fact the industry looks to have defined a multi-vendor CU/VNF to DU/PNF split, together with a management model that supports neutral host management of a common PNF that can be shared between multiple operators, we should not underestimate the real challenges ahead in getting such capabilities implemented. Despite the fact that particular attention was paid to enable vendors of the CU/VNF to continue to differentiate based on their own internal RAN algorithms, history has shown that, outside of the small cell ecosystem, deployment of multi-vendor internal RAN interfaces have been resisted within the industry.

Accelerating multi-vendor virtualization – some different thinking

Over the last nine months, Cisco, together with the Small Cell Forum, has been investigating different approaches to accelerate nFAPI adoption. One approach considered has been the use of the open source community to accelerate nFAPI adoption, an approach which has been supported by a number of operators, small cell vendors and open source ecosystems. In particular, open source ecosystems have already demonstrated the ability to address the issues related to compatibility, certification and interoperability that hamper multi-vendor ecosystems, characteristics that have a direct bearing on the success of a multi-vendor CU/VNF to DU/PNF split. As an example, a combination of a published specifications, open source libraries and code to execute interoperability testing is already been used by the Wireless Innovation Forum to accelerate multi-vendor interoperability for systems used to implement the Spectrum Access System necessary to support new CBRS-based small cells [9].

With this in mind, Cisco is pleased to announce the establishment of an "open-nFAPI" open source project; a set of nFAPI libraries, simulators and associated Wireshark dissectors that is aimed at accelerating adoption of the SCF's nFAPI interface. Open-nFAPI is maintained in the following publicly accessible opensource GitHub repository https://github.com/cisco/open-nfapi. Distributed under version 2 of the Apache Software License, the code in the open-nFAPI project is conducive to integration by the widest range of industry stakeholders, from other alternative open source ecosystems interested in RAN virtualization, e.g., including the Telecom Infrastructure Project (TIP), the Central Office Re-architected as a Datacenter (CORD) initiative and the Open Air Interface (OAI) project, through to integration into closed-source proprietary RAN products.

Figure 2. Thinking differently about multi-vendor indoor networks: open sourcing libraries for a MAC/PHY Split



Obviously nFAPI's MAC/PHY split is only one of the possible splits being studied by the likes of 3GPP TSG RAN3 working group and IEEE's Next Generation Fronthaul Initiative (NGFI). We do not presuppose that the MAC/PHY split will be the only split defined for 5G's New Radio, but we do think the combination of published specification that is designed for multi-vendor implementation together with an open source ecosystem can increase the chances of successful interoperable internal RAN interface, whichever split is used.

Summary

If 5G is to be a success, then it needs to thrive indoors where an ever increasingly percentage of mobile data is consumed. However, with the businesses that are responsible for those indoor environments increasingly wanting to deliver wireless service to all users, 5G's multi-operator capabilities are going to become essential.

We feel the current set of multi-operator solutions are ill equipped to enable 5G to thrive indoors. There are scalability challenges, incompletely defined multi-vendor interfaces, ambiguity from national regulators associated with sharing exclusive spectrum and adoption of new shared spectrum regimes, and yet to be proven ability of the cellular ecosystem to succeed in the license exempt environment. As a consequence, the industry needs to think more broadly about the issues of multi-vendor interoperability of internal RAN interfaces, a key requirement for successful multi-operator deployments.

With combinations of a published specifications, open source libraries and code to execute testing already being used by the CBRS ecosystem to accelerate multi-vendor interoperability, we think that the small cell industry has a great opportunity to drive the definition of multi-operator LTE and 5G systems using a similar approach. The establishment of the open-nFAPI open source project is the first step on this path, and Cisco welcomes other Small Cell Forum members, 3rd party developers, other open source ecosystems and researchers to contribute to the project.

References

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