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Neutral hosts on JOTS

SCF Neutral Hosts' Perspective on the new Joint Operator Technical Specifications for Neutral Host In-Building (JOTS NHIB)

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Small Cell Forum develops the technical and commercial enablers to accelerate small cell adoption and support the digital transformation of enterprises and communities.

Broad roll-out of small cells will make high-grade mobile connectivity accessible and affordable for industries, enterprises and for rural and urban communities. That, in turn, will drive new business opportunities for a widening ecosystem of service providers.

Our focus and work program reflects two key areas of diversification in the small cell ecosystem – the emergence of alternative deployment models such as neutral hosting and private networks, and Open RAN specifications enabling disaggregation of small cells at both component and network level.

We have driven the standardization of key elements of small cell technology including Iuh, FAPI, nFAPI, SON, services APIs, TR-069 evolution and the enhancement of the X2 interface. These specifications enable an open, multivendor platform and lower barriers to densification for all stakeholders.

Today our members are driving solutions that include:

- 5G components, products, networks
- Neutral host & multi-operator requirements
- Open RAN small cells & disaggregation
- Private networks & enterprise requirements
- Deployment and regulation
- Edge compute with small cell blueprint
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1 Introduction

As a strong advocate for emerging neutral hosting models, Small Cell Forum (SCF) is delighted to see the first release of the Joint Operator Technical Specifications for Neutral Host In-Building (JOTS NHIB), agreed by the four UK mobile network operators, Telefonica O2, EE, Vodafone and 3UK. The JOTS NHIB specifications set out technical requirements for shared in-building solutions using small-cell base stations.

SCF represents a growing group of neutral hosts and other alternative deployers [3] that have been closely following the development of the JOTS NHIB specifications since they were discussed at Small Cell World Summit 2019 [SCF237]. We see this pioneering operator agreement as a significant step forward in the cost-effective delivery of multi-operator services into small- to medium-sized business premises in the UK, as well as being a template for other regions.

We encourage everyone to download and read the JOTS NHIB specifications here. [1]

In this paper we provide a neutral host's perspective on these consensus UK MNO requirements – both for the UK indoor cellular market, but also how global neutral hosts view this model compared to established and emerging models in their own regions. We conclude by describing SCF's activities to support commercialization of JOTS in the UK, as well as encourage similar models which can be supported with common technology and policy frameworks.

2 Market trends identify need for JOTS NHIB

2.1 A growing market for neutrally hosted in building small cells

Figure 1 shows the numbers of small cells forecast to be installed by different deployers in indoor and urban outdoor environments. Urban small cells will continue to be predominantly deployed by mobile operators, with a small but growing percentage deployed by neutral hosts and others. For indoor small cells, the reverse is true – already more than half the annual deployments are by deployers other than MNOs. By 2026, more than 70% of indoor small cells will be deployed by these alternative deployers. The greatest growth over this period will be in the neutral host segment, and the JOTS NHIB specifications are evidence of growing industry recognition of the importance of shared networks to address the indoor enterprise market. It is likely that partnerships established during growth of the indoor enterprise market will also pave the way for similar models in outdoor urban scenarios.

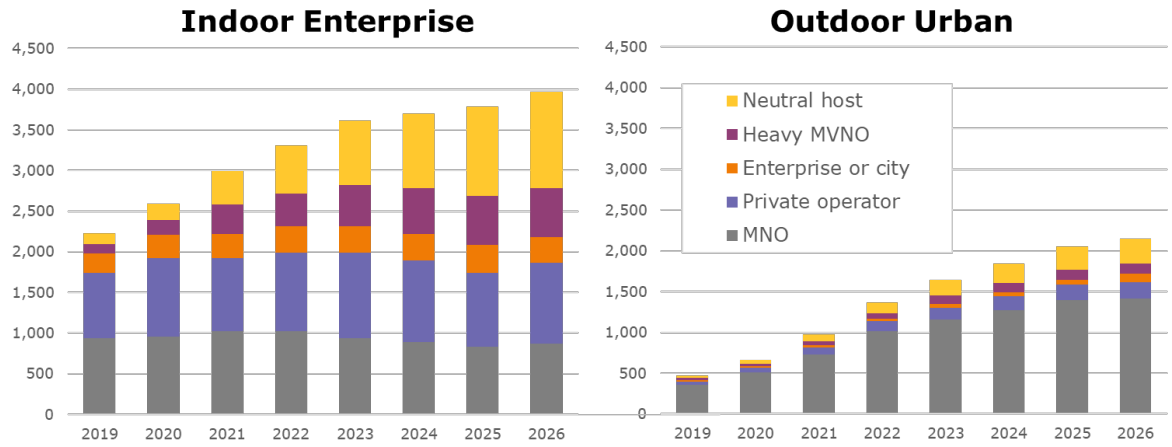

Figure 1 New deployments and upgrades of small cells globally, by operator type [SCF050]

2.2 Priorities for indoor and outdoor deployments

The shift in deployment models shown in Figure 1 has implications for the technology providers that will need to factor in new requirements emerging from the growing market for hosted small cells.

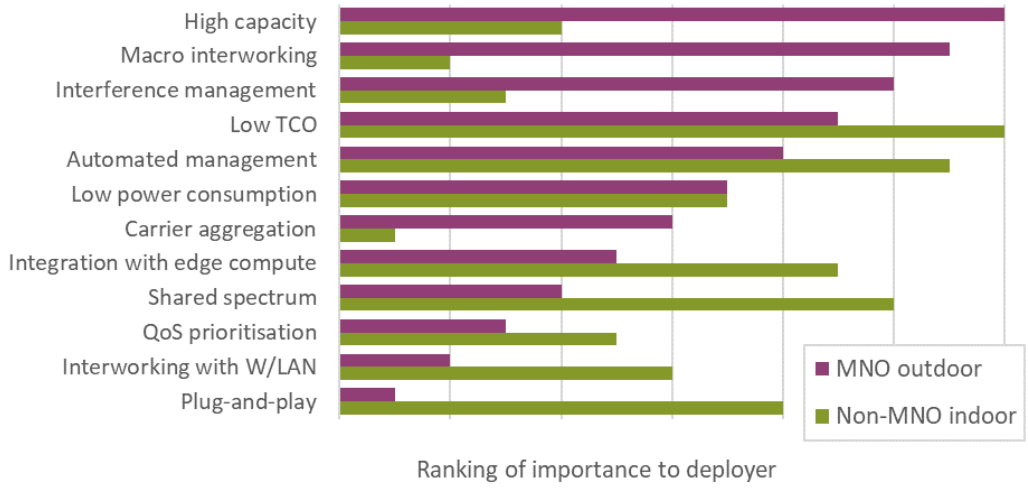

Figure 2 Comparing technology priorities for MNO's outdoor small cells versus non-MNO deployed indoor networks [SCF050]

Error! Reference source not found. reflects the priorities of MNOs deploying outdoors compared to neutral hosts and other deployers addressing indoor enterprise scenarios: MNO's top priorities of high capacity, macro interworking and interference management are relatively low down the list for indoor deployers. The reverse is true for shared spectrum, edge computing and plug and play deployment. Low total cost of ownership (TCO) and automated management remain high priorities for all deployers indoor and outdoor.

2.3 Neutral hosts 'moving up the stack' with small cells and JOTS

Neutral hosts act as an intermediary between building owners and mobile operators, particularly for in-building scenarios. Building owners require multi-operator coverage on their premises, and mobile operators wish to extend network coverage and capacity with minimal effort and cost. The value neutral hosts bring is in making the offer attractive to both sides, which requires a great deal of flexibility. As such, there are a wide range of hosting models used throughout the world that bridge the gap between the needs of building owners and what's operationally practical from an operator perspective.

Established models are site sharing and DAS, in both cases with MNOs bringing their own macro. And although such an approach maximizes network sovereignty for the MNOs, it's expensive and slow to deploy and has not proven affordable for the vast majority of SMEs within their digital transformation budgets.

The neutral hosting proposition is now being made more scalable and affordable with increased sharing of the mobile network – in effect, neutral hosts are 'moving up the stack' and including shared antennas, shared radios, shared base stations and even shared core network functions into the bargain – as will be shown.

In recent years, small cells have proven to be a scalable way for the MNO/neutral-host partnership to broaden the addressability of multi-operator systems [SCF218], and JOTS NHIB is first example of an MNO-driven standard for shared small cell networks.

3 JOTS NHIB in a global neutral hosting context

The JOTS NHIB specifications themselves [1] are the definitive description of the architecture, requirements and processes, and we refer readers to these documents for a complete and accurate description directly from the MNOs. Here, the SCF provides a global neutral host perspective on the UK MNOs' requirements set out in the JOTS NHIB specifications.

3.1 Commercial context for JOTS NHIB specifications

JOTS NHIB specifications are provided as a set of five annexes describing a common MNO-agreed baseline which form the basis of the multiple individual bilateral MNO-neutral host agreements. **Error! Reference source not found.** shows the commercial context in which the technical specifications are used. They represent the technical table-stakes required by MNOs for neutral host wholesalers to enter into commercial discussions. The annexes are well suited to appending to contracts, and individual bilateral agreements can augment the JOTS baseline to suit particular needs of individual MNOs.

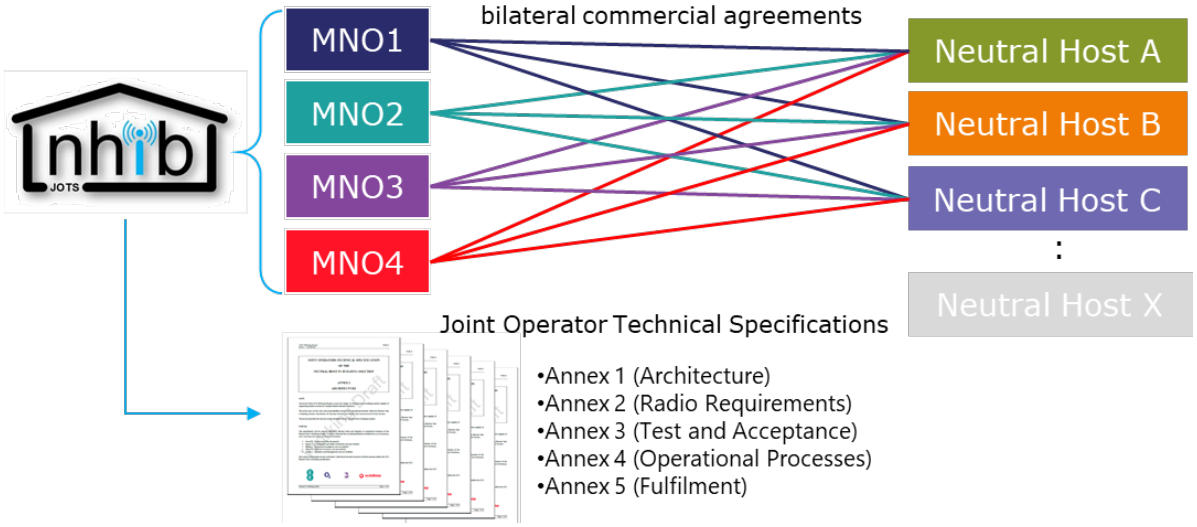

Figure 3 Commercial application of JOTS NHIB Specifications [1]

An MNO peace agreement for shared RAN – Neutral hosts welcome this MNO consensus on requirements because, from their perspective, it greatly reduces the technology permutations. Not only does network sharing itself reduce cost, but alignment around the *approach* to sharing reduces complexity too. These together improve both affordability and scalability, which means more UK businesses will benefit and the UK mobile networks will have better indoor coverage. Furthermore, offloading the inefficiently-served indoor users also improves outdoor network capacity.

A UK initiative with global implications – Neutral hosts operating beyond the UK report that the advanced drafts of these specifications have provided an excellent reference in progressing towards a standard approach to sharing of active 3GPP functions with their regional mobile carriers. Mobile technology requires global standards and economies of scale, so it will benefit everyone where elements UK agreement can be adopted globally.

Focused on security and trust – neutral hosts understand that mobile networks are critical national infrastructure, and that MNOs have strict security requirements that must be met and maintained. The heart of the JOTS NHIB specifications is a security architecture which provides multiple layers of protection for the MNOs with interconnects to trusted neutral host wholesalers.

Modular requirements – The structure of the specifications means certain aspects can be re-used in other contexts. For example, the security architecture is applied to an 3GPP S1 demarcation, but is equally applicable to S5/S6a demarcation proposed for neutral hosting with CBRS networks in the US.

Standard approaches – neutral hosts looking to leverage small cells to scale up deployments welcome JOTS as a standard approach to shared 3GPP functions on top of shared real-estate and passives. This helps build confidence in the neutral hosting offer for both MNOs and real estate perspectives.

3.2 NHIB architecture: Domains and security

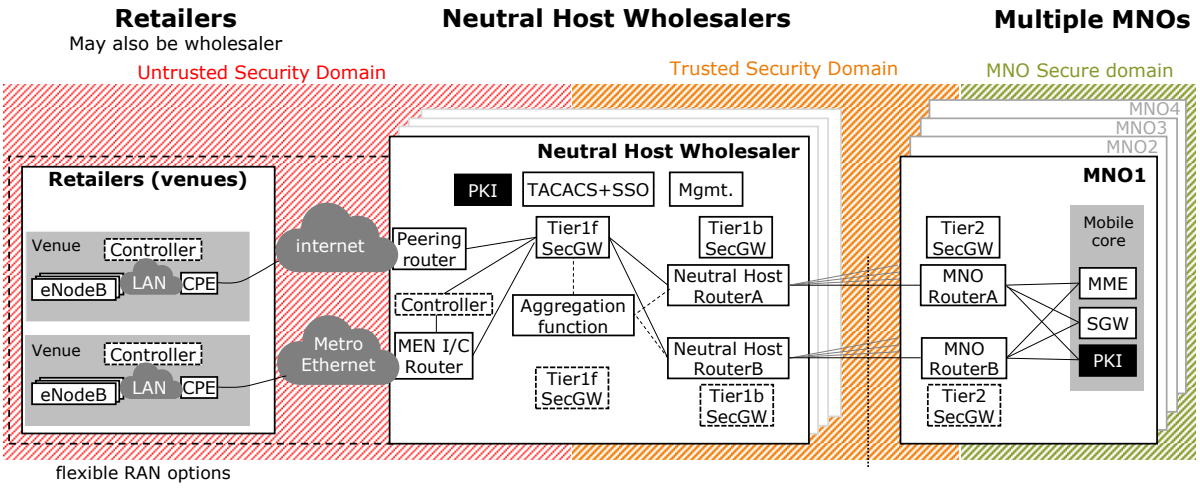

Figure 4 JOTS NHIB architecture

Figure 4 illustrates the main concepts described in Annex 1 – Architecture. The focus of the specification work is the security architecture. Mobile operators mandate several layers of protection for their mobile cores. Multiple independent configuration details are required to be correct for core connectivity to remain in place, and which can be shut down instantly if any one aspect is detected as being misconfigured.

The architecture is arranged into three domains – MNOs, neutral host wholesalers and retailers. The retailer and wholesaler may be the same company. The wholesaler hosts routers, security and management functions within a trusted security domain, with S1 'backhaul' interconnects to the MNOs.

The wholesaler is also accountable for the untrusted retailer domain, with 'fronthaul' interconnects to venues potentially over public internet transport. Note that in the NHIB context 'fronthaul' does not imply a functionally split base station. In many cases the NHIB fronthaul contain S1 interfaces prior to aggregation by the wholesaler onto the backhaul. In addition, the architecture permits – and has been demonstrated to support – disaggregated RANs.

The retailer manages the relationship with the venue, including small cell deployments and monetization. The term 'venue' here represents any type of building requiring multi-operator connectivity, including hotels, café's, offices and retail spaces.

3.3 Business models and commercial relationships

The domains described in the specifications imply the set of business models and relationships shown in Figure 5.

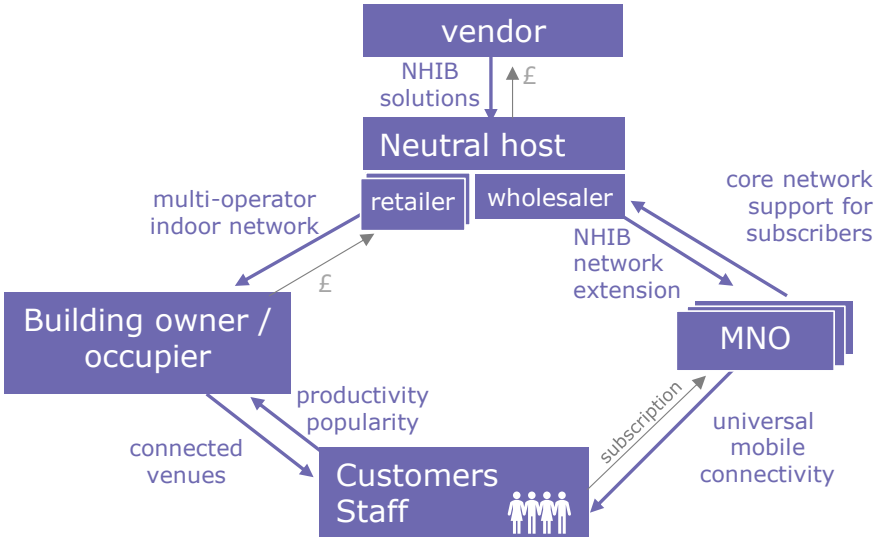

Figure 5 Business models implied by JOTS NHIB domains

Building owners or occupiers wish to make their venues more attractive for customers or more productive for staff and IoT with indoor mobile connectivity. These same staff and customers almost certainly use mobile devices and subscribe to one of the MNO's mobile connectivity services. All three parties want the venue to be connected; the venue is willing to pay for a multi-operator service, and neutral hosts can provide it.

The building owner engages a **neutral host retailer** that is in a position to purchase and deploy a NHIB compliant indoor network from a RAN vendor. This implies a new customer for RAN vendors, that may have different priorities to MNOs deploying outdoor networks – priorities which the SCF is capturing through its neutral host work requirements work.

Neutral host wholesalers manage the retailers and presents the MNO with aggregated feeds from the many NHIB compliant indoor networks. In return, the MNOs provide the core network support for their subscribers to connect over the NHIB networks.

Initially it is likely that many neutral hosts will perform both wholesale and retail functions. With time, the wholesalers will likely engage with a broader set of retailers to expand addressability into niches. Candidate NHIB retailers might be existing vertical-specific system integrators that already supply IT to specialized industries like healthcare or hospitality. Their existing customers may be interested in adding one or more MNO's network coverage on their premises, but the retailer could not justify the investment of becoming a NHIB wholesaler.

NHIB provides an opportunity for MNOs to harness commercial innovation via the trusted wholesaler's engagements with smaller agile retailer entrepreneurs. The NHIB framework provides a sandbox for retailers to innovate with cellular connectivity business models towards enterprise. The wholesaler is responsible for policing NHIB network quality and MNOs retain sovereignty over the national network experience for subscribers.

3.4 Hosted radio access networks

In JOTS NHIB, the 3GPP RAN is largely deployed within the retailer domain – possibly as integrated eNodeBs, or potentially as a disaggregated RAN, with DU and/or CU functions on-prem (e.g. for larger venues) or at a wholesalers' site (for smaller venues). A range of example RAN implementations are provided in the architecture annex, illustrating the extent to which MNOs can be agnostic to the RAN architecture. That said, JOTS NHIB mandates the radio performance requirements in Annex 2, as well as acceptance testing in Annex 3, to ensure mobile network quality is maintained.

NHIB specifications are based on MNO EPCs (evolved packet cores) connecting via S1 to a hosted LTE RAN, but 5GNR including NSA (non-standalone) are considered to be possible within this framework, as are open and disaggregated RAN. Not only is JOTS NHIB largely RAN agnostic, it is also spectrum agnostic and could support shared spectrum and potentially license exempt, or licensed shared access. SCF neutral hosts see the potential for other radio access technologies like Wi-Fi and LoRa to fit within framework.

One of the key differentiators between different neutral hosting models around the world is the point of demarcation between hosted shared assets and the dedicated MNO functionality, shown in Figure 6.

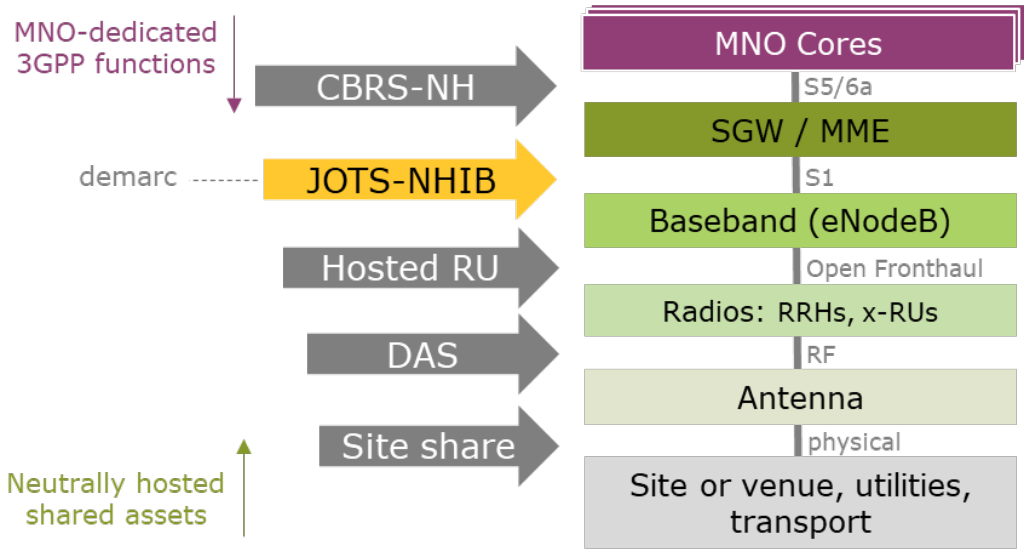

Figure 6 Neutral hosting models – 3GPP architecture demarcation point

Traditional site share and DAS are based on hosting of real estate, passive components and utilities like power and transport. More recent models like digital DAS host active components like radios and, increasingly, 3GPP-defined network functions such as the physical layer in an RU (remote unit). Such architectures having stringent fronthaul transport requirements requiring MNOs to install base station equipment at or near the venue, which has proven to have limited scalability in practice.

JOTS NHIB is based around the S1 demarcation – between a hosted shared LTE RAN and MNOs' EPC cores. This has the potential to reduce cost and improve scalability, as it does not require the MNO to install and manage new equipment each time a new venue requires coverage. Instead, the neutral host installs a shared small cell RAN configured with MNO provided parameters as described below.

The virtualized neutral-hosting approach provides another way to circumvent the need for MNOs to install hardware at or near the venues. Hosting of compute, memory and transport at and/or near venues enables MNOs to deploy instantiations of virtual network functions (VNFs) such as CUs and DUs. Physical network functions like RUs (remote units) must also be hosted and made accessible to the VNFs. Multi-tenant RUs are preferred for neutral hosting.

Figure 6 reveals that JOTS NHIB is not at one extreme end of network hosting – in the US, private CBRS networks have been proposed to support carrier services via the established public S5/S6a interfaces from shared S-GW and MME functions. Apart from this difference, other aspects of the JOTS NHIB specifications are applicable to this demarcation, including the security architecture.

3.5 Operations and maintenance

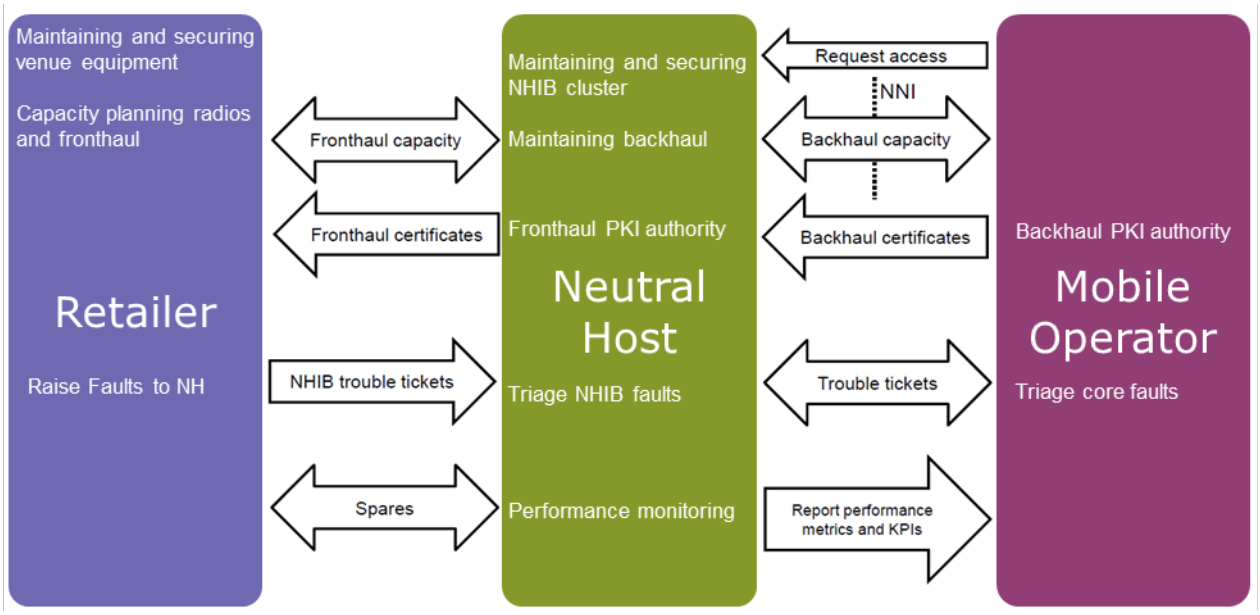

Figure 7 Operations and maintenance responsibility split

Figure 7 summarizes operational responsibilities between the three parties, including fault and performance management. The framework allows for the neutral host to manage some or all of the RAN, depending on individual MNO preferences. Pragmatically, the retailer and neutral host maintain equipment at the venue according to NHIB minimum requirements, and potentially enhanced SLAs required (and funded) by the venue.

In SCF discussions, the management plane presents one of the key barriers to scalability, but also provides the enablers for flexible sharing of responsibilities between MNO and NH. Figure 8 illustrates key features.

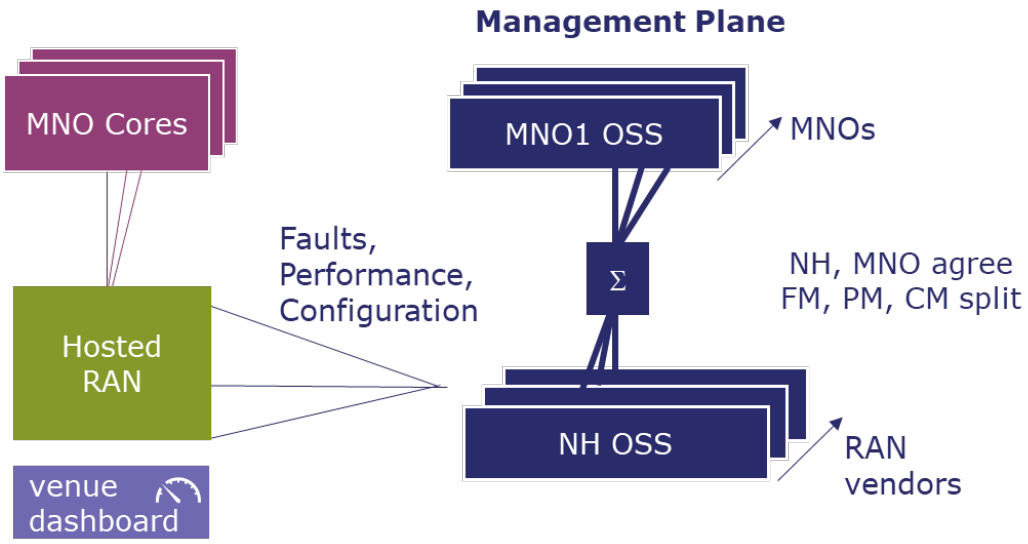

Figure 8 Management plane key features for neutral hosting

Today, most vendors' equipment requires its own management system for configuration and monitoring of faults and performance. A key barrier to the introduction of a new RAN vendor for an MNO is the onboarding of these management systems. This is yet another set of controls that the MNO needs to learn to use and integrated into their overall operational processes. JOTS NHIB proposes that the neutral host becomes responsible for RAN management and provides the MNO with KPIs to ensure compliance with SLAs. One emerging technology requirement from SCF discussions is for neutral hosts to be able to aggregate the management feeds across multiple RAN vendors and present them in a common format to the MNO. Similarly, multi-tenant management systems should enable multiple MNOs to have visibility of their share of the hosted RAN. Venue-visible dashboarding of relevant network KPIs is also a commonly requested feature from enterprise users, and will be necessary in some form for the retailer to demonstrate SLA compliance to the venue.

The management responsibility split is an important flexibility for neutral hosts working with different appetites for outsourcing from their partner MNOs.
Figure 9 illustrates how configuration, performance and fault management responsibilities might be split in three different hosting scenarios. For each aspect, one party is responsible for reacting to events, while the other remains informed. Initially, MNOs might want to closely monitor of NHIB rollout, but as trust is established this responsibility may want to increasingly outsourced.

	MNO			Neutral Host		
Management Model	Configuration Management	Fault Management	Performance Management	Configuration Management	Fault Management	Performance Management
MNO Managed						
Shared management						
Neutral Host Managed						

Figure 9 Flexibility in the management responsibility split between MNO and NH

3.6 Fulfilment

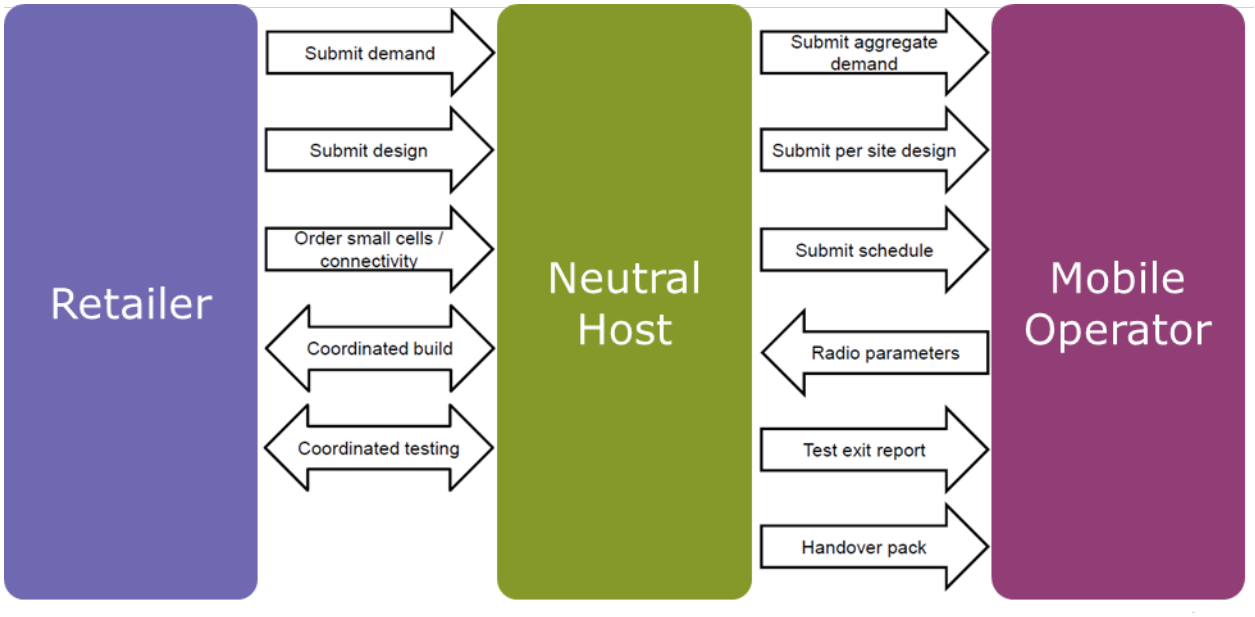

Figure 10 Fulfilment responsibility split

Figure 10 outlines the main processes described in the fulfilment Annex 5, whereby new NHIB site requests and designs are aggregated and forwarded by neutral hosts to mobile operators for approval and assignment of radio parameters. Network builds are tested to ensure MNOs' quality requirements are met before the NHIB site is approved to carry commercial traffic. It is expected that this specification will mature as experience of commercial deployments grows and trusted partnerships are established.

4 What next?

Although a significant milestone, the approval and publication of the JOTS NHIB specification is a means to the end of driving the proliferation of commercially deployed in-building networks delivering multi-operator services to UK businesses. SCF is working with neutral hosts and engaging with the commercial property industry to establish and accelerate growth of this market both in the UK where JOTS NHIB applies, and globally.

SCF's objectives for neutral hosting are

1. Support commercialization of JOTS Neutral Host In-Building in the UK
2. Continue to raise awareness of JOTS NHIB globally to drive adoption of similar models in other regions which can be served by common technologies and business processes.
3. Build on the market-facing [SCF231] *Options for indoor cellular* to raise awareness and confidence of offers from MNOs, neutral hosts, private networks and other deployers.
4. Capture neutral hosts' and other deployers' priorities for future small cell technologies.
    - [SCF244] "*Neutral hosts requirements: 1. Architectures*" is in progress at the time of writing.
    - Subsequent works will go on to detail radio technologies, management and operations, policy and regulatory support, etc.
5. Work with technology providers and policy makers to develop common frameworks which address requirement of all future deployers including MNOs and neutral hosts.

We welcome leading MNOs, neutral hosts and their technology suppliers to join our activities and strengthen our ecosystem to drive consensus and promote best practise globally.

5 Further reading

- [1] "*Joint Operators Technical Specification*", https://www.mobileuk.org/jots
- [2] "Small Cell Forum Work Program 2020-21", Jun 2020, https://workplan.smallcellforum.org/2021/program-2020-21/
- [3] "*Small Cell Forum announces new board, representing evolving mix of deployers and diversifying small cell eco-system*", 12 November 2020, https://www.smallcellforum.org/press-releases/small-cell-forum-announces-new-board-representing-evolving-mix-of-deployers-and-diversifying-small-cell-eco-system/
- [SCF050] "Small Cell Market Status Report, July 2020", www.scf.io/doc/050
- [SCF218] "*Multi-operator indoor coverage for your enterprise with neutral-hosted Small cells*", Nov 2018, www.scf.io/doc/218
- [SCF237] "*Small Cell World Summit 2019 – event report*", Jun 2020, www.scf.io/doc/237
- [SCF231] "*Options for indoor cellular*", Sep 2020, www.scf.io/doc/231