FREQUENTLY ASKED QUESTIONS

Celona Neutral Host Networking

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Contents

1. WHAT IS A NEUTRAL HOST NETWORK?

The emergence of small cells and new shared spectrum options, such as Citizen's Band Radio Services (CBRS) in the US, have paved the way for a new model that delivers mobile network operator (MNO) network coverage and capacity across private LTE/5G infrastructures in locations that are deemed to have weak signal strength.

This model is known as a neutral host network (NHN). It involves a third-party wholesale carrier offering its network to be transmitted and accessed from a certified private LTE/5G network. Basically, a private LTE/5G network deployed using a shared spectrum medium such as CBRS can provide service to mobile subscribers from one or more MNOs. This extends the MNO services across the private LTE/5G network coverage.

This architecture can create enhanced signal strength or capacity in locations where signal strength is low or at certain venues where it doesn't make sense for each MNO to deploy a separately owned radio network. NHNs are an ideal choice for extending the coverage of existing mobile networks, especially where coverage is limited or non-existent, such as inside a building (coverage extension). MNO's can also offload capacity in areas where networks are congested with too many users or high data traffic loads (capacity augmentation) in a scalable manner.

Neutral host networking is a relatively new concept that, unlike traditional models, allows multiple parties - both private and public - to securely share the same network infrastructure within an organization. Doing so provides wireless connectivity to a wide range of MNO subscribers with the goals of increasing public cellular coverage and capacity while dramatically reducing capital and operating expenses using a shared infrastructure approach.

For users of the network, an NHN operates seamlessly with their MNO and will be entirely transparent to them. Accessing the NHN doesn't take any user input or action to roam into and out of the network.

2. WHAT'S DRIVING THE USE OF NEUTRAL HOST NETWORKS?

The cost and complexity of extending cellular services indoors is the main driver for neutral host networks.

Poor cellular coverage and limited throughput inside buildings and large venues has driven organizations to deploy expensive and complex distributed antenna systems (DAS) that amplify cellular carrier signals over a passive cabling run throughout a given site. This disparate and discrete system requires specialized cabling, RF antennas and carrier infrastructure equipment to process signals, terminate and route connections.

The neutral host model is a new approach that radically reduces this cost and complexity by allowing private cellular access points operating in the private cellular spectrum (e.g., CBRS in the US) to be deployed and connected over an existing enterprise local area network (LAN). In this scenario, carrier traffic will be automatically offloaded and securely tunnelled over that site's broadband connection(s) to the respective mobile network operator (MNO).

3. WHAT VALUE DOES CBRS BRING NEUTRAL HOST NETWORKS?

Most smartphones and LTE devices manufactured in the last three years are natively compatible with networks that operate in the 3550 to 3700 MHz CBRS frequency range in the United States. Many if not all of these devices support international private spectrum options as well.

Not only can this frequency spectrum be used for private mobile network purposes, but a defined portion of the available bandwidth can also be used to advertise public MNO networks. This means that any CBRS-capable device with a public carrier SIM can connect to the private cellular wireless network and continue to access the MNO network services natively – as if it were connected to a public MNO cell tower. No other free-to-use spectrum can accomplish this feat.

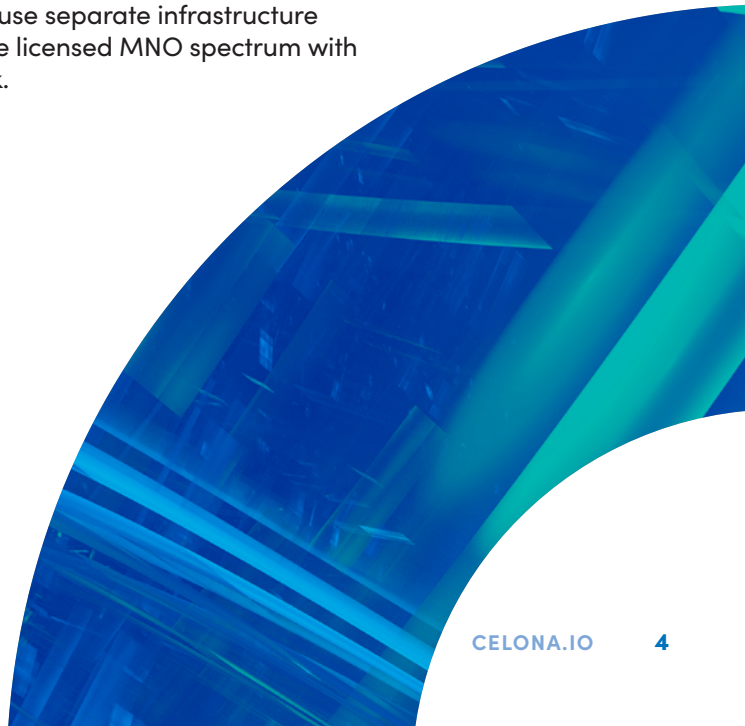
4. WHO OWNS AND OPERATES THE NEUTRAL HOST NETWORK?

With a full ownership of integrated core and radio networks, including private spectrum (e.g., via the CBRS band in the United States), an NHN operator essentially becomes the network operator of indoor venues.

NHNs may be managed by a third-party managed services provider (MSP) or the enterprise organizations themselves. This enables private mobile network devices and public mobile network operator (MNO) subscribers involved to maintain connectivity and ensure network coverage.

With NHNs, each MNO permits use of its own licensed spectrum for bandwidth. The MNO also is fully in control of their own wireless services as core network functions and services like IP multimedia subsystem (IMS) are derived and managed from the MNO's existing network. Connectivity between the private LTE/5G network and the MNO network is accomplished through an IPsec tunnel.

Also note that NHN provides all the critical KPIs to MNOs. By leveraging the CBRS band as a common shared spectrum for indoor access, a portion of the private cellular bandwidth can be allocated for MNO use. This eliminates the need to use separate infrastructure equipment, which would have been designed to propagate licensed MNO spectrum with careful (and expensive) customization of the radio network.



5. WHAT ARE THE BENEFITS OF NEUTRAL HOST NETWORKS?

Despite the significant enhancements with LTE, reliable indoor coverage has illuded many enterprises. This is primarily due to poor RF signal penetration inside large buildings using carrier macro cells deployed outdoors and often far away. This problem gets even worse inside new energy efficient buildings that use low-emissivity glass (Low-E glass) and other building materials that are known to cause wireless propagation interference. Furthermore, new 5G macro MNO network deployments largely use high frequency licensed bands that make outside-to-inside penetration from public cellular towers even harder.

There is growing need for a neutral host network that can be directly owned and operated by enterprise organizations to bridge the gap between very large projects with direct MNO involvement and large numbers of smaller projects that are too small for carriers to consider, but also too complex for enterprises to handle on their own.

This has created the need for a low-cost solution that removes complex and costly implementation models associated with multi-operator support.

As a result, NHNs offer a myriad of benefits to enterprises, MNOs and subscribers alike. These include but are not limited to:

- Providing added cellular coverage in low coverage areas,
- Increasing capacity in congested locations,
- Delivering reliable cellular connectivity to occupants within a building that, to users, is seamless and indistinguishable from public cell tower access,
- Enabling cellular coverage within venues with limited equipment space,
- Increasing wireless coverage at lower infrastructure costs,
- Simplifying the deployment and ongoing operation of indoor MNO signal propagation compared to DAS alternatives, and
- Servicing multiple cellular networks using a single shared and common IT infrastructure along with private LTE network use, if desired.

6. HOW DO NEUTRAL HOST NETWORKS WORK?

The fundamental concept of a neutral host is the sharing of private cellular network infrastructure components deployed within public venues, enterprises, and other organizations. Network sharing is enabled through methods such as sharing the campus, tower, rooftop, power, cabinets, lighting, and air conditioning. Active sharing of the network involves dynamic real time sharing of antennas, access networks, transmission, spectrum, RF design, planning, and core network functions.

Neutral host networks add the ability to easily integrate CBRS cellular access points to an existing Mobile Network Operator (MNO) footprint to broadcast multiple signatures of different private and MNO networks, securely tunneling traffic directly to each requisite network operator's mobile core.

Roaming onto a Neutral Host Network (NHN) leverages the same cellular roaming principles and procedures as roaming onto another RF band of a given operator's network.

A user device first discovers a NHN by automatically scanning the CBRS frequency band for a network broadcasting one or more network identifiers. The device reads the list of public land mobile network (PLMN) IDs from the broadcasted signature. (Note: If the mobile network operator has a commercial roaming agreement with the NHN operator, then the NHN would be broadcasting the participating MNO's network identifier PLMN-ID.)

The device is provisioned with the PLMN information of the participating SP. Once this device attaches to the NHN, it is authenticated by the MNO's core network with the provisioned SIM credentials provided by the MNO.

Once a user device roams onto an NHN, the data connection subscribed to the device is supported on the secure tunnel established between NHN and MNO.

7. WHAT'S REQUIRED TO BUILD A NEUTRAL HOST NETWORK?

Celona provides all the necessary network components (radio and core network) required to enable NHNs leveraging the existing enterprise network infrastructures within a fully integrated, simple to deploy solution architecture. They include:

Access Points - Citizens Broadband radio Service Devices (CBSD):

These are small form-factor base stations or access points, that operate within the 3.55 to 3.7 GHz band (also known as the Citizens Broadband Radio Service or CBRS) supported by 4G LTE and 5G standard. These small cells provide Neutral Host (NH) shared RAN access for participating MNOs UE devices at select indoor venues where NH radio networks are deployed.

Mobile edge core neutral host gateway:

This core software suite that can be deployed within a virtualized compute environment supports a variety of centralized functions such as spectrum and radio infrastructure management, access control and security. Celona Edge software provides this essential capability and multi operator core network (MOCN) gateway functions used to aggregate tunnelled traffic from cellular access points and directly establish secure IPsec tunnel to supported MNO core network services.

Orchestration and management:

Celona's cloud-based Orchestrator provides all the requisite remote infrastructure management, zero-touch provisioning of Celona access points and KPI-based monitoring of application quality. In a Celona network acting as NHN, granular QoS enforcement can be applied on a per application or device group basis.

8. WHAT CHANGES ARE NEEDED ON MNO NETWORK TO SUPPORT NEUTRAL HOST?

Besides establishing a secure control and data plane connectivity from the Celona network to the MNO core, the organization needs to have an high performance enterprise LAN and internet infrastructure with sufficient bandwidth to support voice and data traffic traversing it.

9. ARE THERE ANY USER DEVICE REQUIREMENTS?

Yes, user devices must support the CBRS band 48 in the United States. Other countries have similar allocation of private cellular spectrum option, for which the end user device will need to offer support for.

There is now a large ecosystem of CBRS-supported devices and most new smartphones and SIM-capable tablets come with native support for the CBRS spectrum.

When using CBRS with a SIM card that only supports private network credentials, the device uses the SHNI (Shared Home Network Identifier) for camping, authentication and supporting data connectivity with the private network.

When the private 5G LAN has NHN services enabled and established, the device uses the MNO's credentials and PLMN-ID's to camp. The authentication and data connectivity for these devices is handled by the MNO's core network that resides on the other side of the secure IPsec tunnel.

When the device supports both private network and MNO credentials with a dual SIM without a Neutral Host Network configuration in place, internet data traffic is offloaded to the private network while the other services like IP Multimedia Services (IMS) (e.g., VoLTE) will still be supported on the MNO network.

10. DO NEUTRAL HOST NETWORKS REPLACE DAS DEPLOYMENTS?

While neutral host networks are a viable new option for "greenfield" deployments where there is no existing distributed antenna system (DAS) in place – or the existing DAS is end-of-life.

They can also be designed and deployed to complement existing DAS environments by providing additional cellular capacity and coverage using the CBRS band and the existing enterprise network infrastructure to connect to MNO networks.

Here are the top 5 benefits of the solution compared to DAS installations:

1. Ability to support multiple MNO subscribers on the same wireless network,
2. Lower cost to design, acquire and operate enabling deployments at scale,
3. Full control over the network configuration and devices that connect,
4. Guaranteed QoS per application across a myriad of private use cases, and
5. Higher degrees of privacy and security for critical infrastructure connectivity.

11. HOW MANY DIFFERENT MNO NETWORKS ARE SUPPORTED?

This strictly depends on the different certifications that each 5G RAN equipment vendor has with particular MNOs. Celona is currently engaged in the certification process with several of the world's top MNOs. We have not yet announced this certification.

The 3GPP standard allows for up to 6 network identifiers to be broadcasted on the NHN, including the private 5G LAN services. If SHNI is used for private network operations, it allows for up to 5 MNO's to be supported on the NHN. Otherwise, up to 6 MNO's can be simultaneously supported.

12. WHAT INFORMATION DOES AN ENTERPRISE NEED TO PROVIDE TO MNOS TO SETUP A NEUTRAL HOST NETWORK?

Once the private LTE/5G infrastructure is deployed, enterprises simply need to work with the MNO to establish a secure IPsec tunnel between the MNO's network and Celona's neutral host MOCN gateway.

The MNO will also require that the private LTE/5G network owner exposes API access to key performance indicators (KPI) such as throughput rates, signal strength, packet loss, attached failures, etc. This will be used by the MNO for monitoring and troubleshooting purposes. Celona offers a rich API structure that allows any MNO to easily integrate this data into their existing systems to monitor the user experience.

13. HOW DOES TROUBLESHOOTING WORK BETWEEN ENTERPRISE IT AND AN MNO?

Both the private LTE/5G network owner and MNO will have monitoring access to the 5G LAN. When problems occur on the NHN, alerting tools will notify both parties of the issue.

If the problem detected is within the Celona radio infrastructure or backhaul across the enterprise LAN and out to the neutral host gateway within Celona Edge, the local administrator will be responsible for resolving any issues.

All other issues that occur within the MNO's core network on the opposite side of the IPsec tunnel will be the responsibility of the carrier to resolve.

14. HOW CAN I CALCULATE HOW MUCH BANDWIDTH (INTERNET AND LAN) THAT A NEUTRAL HOST NETWORK WILL CONSUME?

When a private LTE/5G network is first designed, architects take into account the total throughput capacity of the new radio network and ensure that this throughput can be supported by the existing LAN infrastructure.

If not, upgrades will need to be made to support the added throughput capacity. Bandwidth calculations for all traffic sent between the private 5G LAN and MNO(s) across the established VPN tunnel(s) will need to be calculated and internet bandwidth need to be adjusted to handle the additional traffic load.

15. HOW IS NEUTRAL HOST NETWORK TRAFFIC SEGMENTED/SECURED FROM MY PRIVATE LAN DATA?

Within a Celona Neutral Host Environment, distinct and separate IPsec tunnels are established-one for enterprise private cellular traffic and another for public MNO traffic.

With the neutral host gateway function within Celona Edge, MNO traffic is then securely tunneled to the respective MNO's evolved packet core (EPC).

For neutral host and the private use cases, Celona's patent pending MicroSlicing™ technology appropriately secures and assigns specific service levels for latency and throughput. Each of the Participating Service Providers with a unique Neutral Host profile would then be applied a unique MicroSlicing policy within a Celona 5G LAN. This will ensure that each participating entity will be applied with strict Quality of Services (QoS) guarantees and service level agreements (SLA) for voice and data traffic flows.

Enterprise apps such as critical IoT infrastructure connectivity, public safety voice and staff push-to-talk communications or video surveillance apps can be supported within the same Celona 5G LAN. With a growing list of digital initiatives for many years to come, it further improves return on investment and reducing its overall TCO.

16. WILL NEUTRAL HOST NETWORKS FUNCTION DIFFERENTLY COMPARED TO MNO NETWORKS?

No. The experience is effectively identical. This includes MNO location/emergency services (emergency calling, Wireless Emergency Alerts (WEA), and Wireless Priority Services (WPS) that do not function when using Wi-Fi calling.

17. WILL NEUTRAL HOST NETWORKS FUNCTION DIFFERENTLY COMPARED TO DAS FROM AN END USER PERSPECTIVE?

No. The end user will not experience any difference when connecting to MNO's using an NHN over CBRS frequencies compared to natively connecting to MNO bands that are distributed via a DAS.

18. WILL FREQUENCY PENETRATION OF CBRS BE ANY DIFFERENT VERSUS NATIVE MNO ON A DAS?

It depends on the cellular band being used. However, the design phase of a private 5G LAN rollout will account for the frequency penetration of CBRS band 48 which will ensure that access point placement and signal strength will be adjusted appropriately so that complete coverage in buildings/campuses is achieved.

19. DOES CELONA OFFER A NEUTRAL HOST SOLUTION?

Yes. Celona is offering a fully integrated solution that combines private cellular wireless services with neutral host networking. With Celona's 5G LAN solution, enterprises will be able to easily add, via software, neutral host capabilities to their existing CBRS 5G LAN for seamless roaming with voice and data. Celona's neutral host solution leverages a multi-operator core network (MOCN) gateway within its edge software suite that securely tunnels traffic to the requisite MNO core EPC while providing support for VoLTE with prioritized QoS, E911 wireless emergency capability, remote certificate management on the celona edge and in-campus mobility.