White Paper

Private 5G

Casa Systems' Framework Provides Private 5G Network Functionality

Casa Systems' Axyom™ Software Framework provides private 5G network functionality utilizing Red Hat OpenShift and 3rd generation Intel® Xeon® Scalable processor-based servers

Interest in private 5G networks is growing as enterprises understand better how they can make a significant impact on their businesses, as spectrum becomes available and as private 5G network technology becomes more affordable and appropriate for enterprise environments.

5G offers an unprecedented combination of throughput, connectivity, and low latency for enterprise networks. Using network slices to create separate networks with their own unique performance characteristics, a private 5G network can support high-bandwidth enterprise applications as well as internet of things (IoT) applications that need connectivity for large numbers of low bandwidth sensors.

The availability of spectrum has been a significant gating factor for private 5G, but that challenge is falling away as mobile network operators (MNOs) increasingly offer services utilizing their licensed spectrum and as more unlicensed spectrum is available for enterprises that want to build and operate their own networks. New licensing rules for the Citizens Band Radio Services (CBRS - 3550 MHz to 3700 MHz) and the opening up of a portion of the high-frequency C-band (4 to 8 GHz) in the U.S. and similar spectrum regulatory actions across Europe are providing the shared or lightly licensed spectrum to enterprises to make private 5G networks possible.

The development of private 5G networks is coinciding with the emergence of edge cloud networks. These cloud servers are placed on the customer premises to offer both the compute performance and agility of a cloud data center with much less transport latency. For applications where real-time decisions need to be made or where low latency impacts the user experience, the combination of private 5G and edge cloud is a significant advance.

One of the issues that held back private 4G is a lack of cellular technology skill set within enterprises. The technology used in cellular networks has always been significantly different from enterprise information technology (IT). In addition, proprietary radio access network (RAN) systems meant limited availability of trained technicians for this critical portion of the cellular system. This technology hurdle has been overcome with private 5G networks that utilize IP data packets, open source protocols, virtualization and software running on Intel® architecture based commercial off-the-shelf (COTS) servers. 5G networking projects better resemble standard IT projects and have a larger ecosystem of vendors to choose from, which increases the access to technical resources.

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Private 5G Use Cases

With this technology evolution, private 5G has become a cost-effective solution for enterprises. Several use cases are emerging that can leverage this technology. These include:

Owned Enterprise Network: This "fire and forget" model can augment or replace Wi-Fi in an organization that needs comprehensive wireless coverage and capacity so that new applications can be deployed without the need for expensive site surveys and incremental radio planning and installation. This is ideal for a manufacturing or health care location that anticipates new RF applications to be deployed and wants the flexible infrastructure that can accommodate these applications. It's also suitable for high-security environments like financial services or where radio communication is unsuitable, like underground mining. The enterprise owns this deployment and thus can use CBRS or other unlicensed/lightly licensed spectrum.

Neutral Host: This model is a fit for a building owner, large venue operator, or venue-based service provider (VSP) that wants to deploy wireless access as a tenant or guest improvement. Office buildings, airports, and sports venues are examples of this use case. The VSP works with the property owner, who pays to have better coverage in a high-traffic consumer location, or who charges back customers in a business office location.

Industrial IoT/Industry 4.0: 5G IoT connectivity has the potential to make industry much more efficient and responsive to changes in machines on a factory floor. By placing sensors on all of the machinery, factory managers can optimize production cycles and detect machine maintenance issues before they become problems. In sensor-only applications, the network must provide connectivity of many devices each with very low data volumes. However, these sensor networks are often supported by artificial intelligence (AI) and video monitoring, which means the network must add support for high bandwidth to the high connectivity requirement. 5G networks have the capacity to serve this application while also supporting other enterprise IT connectivity needs. This convergence of IT and operational technology (OT) increases the need for timing, and 5G supports the Time-Sensitive Networking function that was introduced in the 3GPP Release 16 standard.

To demonstrate how far private 5G systems have come and how much can be done in an edge server, Casa Systems and Red Hat have built a complete private 5G demonstration system that runs on a single Intel architecture-based server. This "private 5G network in a box" further breaks down the technology barriers for MNOs to provide, or enterprises to build, private 5G solutions.

Casa Systems Private 5G Radio Access Network

Casa offers a private 5G network solution that includes a lightweight 5G multi-access network core and disaggregated O-RAN-compliant radio access network (RAN) components. The different elements of the system include:

High Efficiency DU and Gateway (HEDG): This appliance provides distributed unit (DU) and fronthaul multiplexing gateway functions that meet the criteria for O-RAN Split 7.2 fronthaul and Split 2 midhaul designs. The gateway supports up to 16 100 MHz RUs, 4T4R massive MIMO and capacity to support up to eight 200 MHz 4T4R MIMO antennas. The HEDG is connected to the central unit (CU) for processing of non-real-time layer 2 data. For the demo, the CU functionality is provided from the cloud.

5G Core: Casa System's Axyom 5G Core provides services to mobile subscribers through the RAN and is a gateway to other networks such as public clouds or the voice telephony network. Some of the features in the 5G demo system include:

- User plane function (UPF)
- Core access and mobility management function (AMF)
- Authentication server function (AUSF)
- Session management function (SMF)
- Network slice selection function (NSSF)
- Policy control function (PCF)
- Unified data management (UDM)
- User data repository (UDR)
- Network repository function (NRF)

Remote Radio Unit: The RU for the demo was Casa Systems' Apex 5G EVO Radio which is an open RAN-compatible radio that supports industry standard 5G frequency bands. These include 5G FR1, which operates in the sub- 6 GHz frequency range (including CBRS and C-Band), and FR2 (also known as millimeter wave), which operates in the 28 GHz frequency range. Casa's Apex 5G EVO radio offers a dual-band CBRS and C-Band radio with the capacity to offer up to 280 MHz of occupied bandwidth and 100 MHz of instantaneous bandwidth via support for simultaneously running CBRS and C-Band carriers.

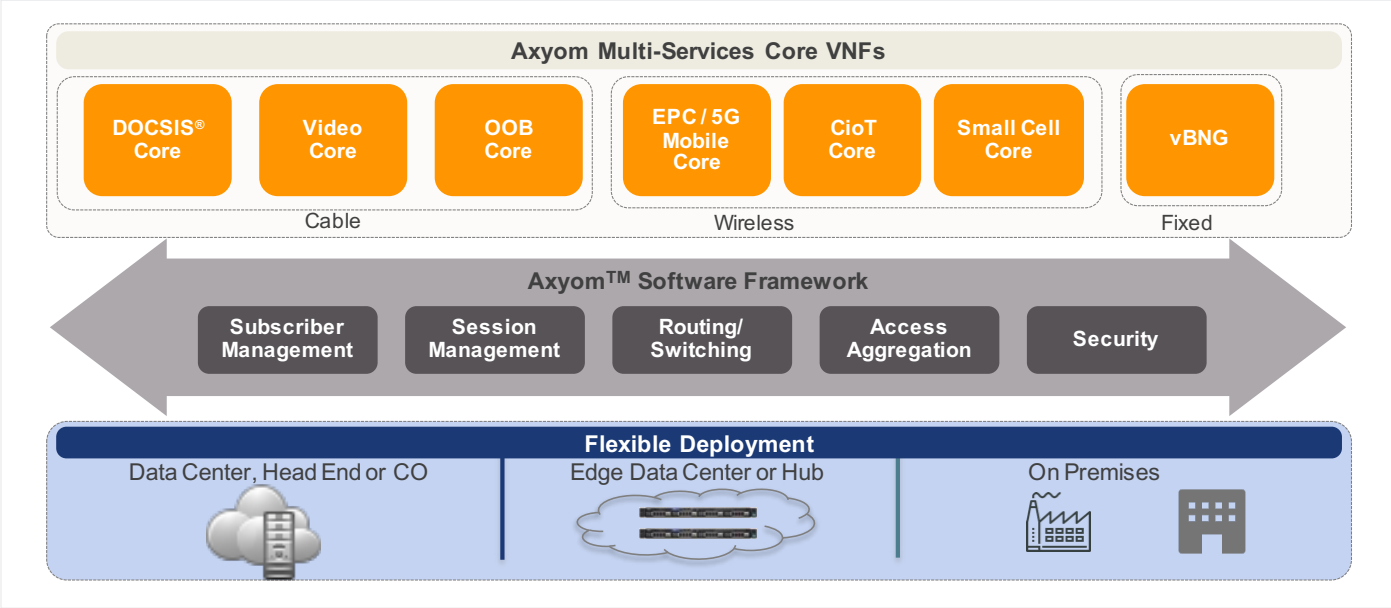

Figure 1. Casa Axyom 5G software framework.

Casa Systems Axyom Software Framework

The Axyom Software Framework is a web-scale collection of cloud native network functions that are designed to transform broadband networks into ultra-broadband networks. The framework architecture is composed of essential services and multi-service core virtual container network functions (CNFs) as shown in Figure 1.

Managing these CNFs is the Axyom Network Manager (ANM), which provides a Kubernetes-native resource model supporting day 0/1/2 operations, element management system (EMS) functions and northbound interfaces to domain-specific slice orchestrators.

The ANM can support multiple application and slice-specific KPIs providing control and visibility when used to orchestrate large numbers of CNF instances running simultaneously and to manage them through their life cycle. The CNFs that make up the 5G functions support stateless processing, work with third-party orchestrators and are composed of microservices for scalability.

Overall, Axyom microservices are designed to be self-contained so that they can be individually upgraded and also chained/clustered into one or more logical services. This cloud native approach provides optimal flexibility and operational efficiency.

The Complete Demo System

For the demo, Casa has combined all of this technology into a complete solution for private 5G core and RAN running on a single server that is seen in Figure 2.

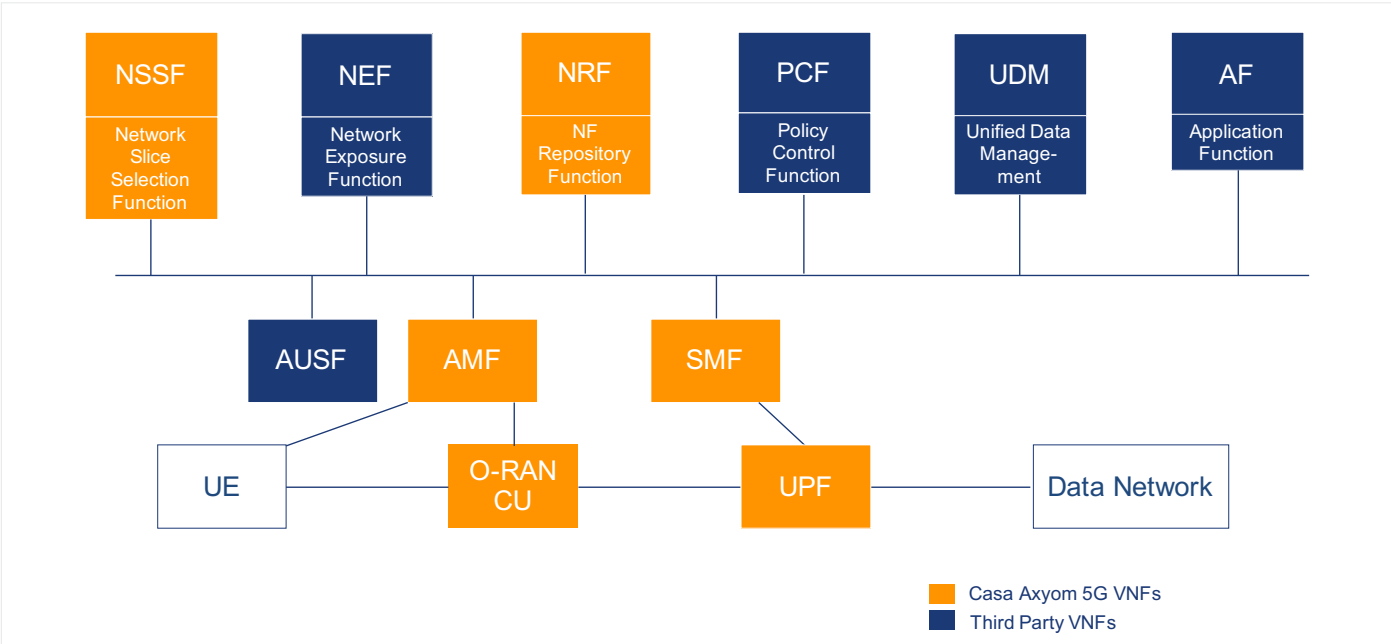

Figure 2. Casa Axyom 5G core components.

Running Cloud Native Workloads on Red Hat OpenShift

To provide an open, hybrid container/virtual machine infrastructure for the Axyom Software Framework, Casa is using Red Hat OpenShift in the private 5G demo system.

Red Hat OpenShift is a container platform for Kubernetes that can automate the provisioning, management, and scaling of CNF and VNF applications for 5G. Red Hat OpenShift includes an enterprise-grade Linux operating system with real-time capabilities, container runtime, networking, monitoring, registry, and authentication and authorization solutions (see Figure 3). These features combine to automate life-cycle management for increased security, tailored operations, easy-to-manage cluster operations, and application portability.

Hybrid Workloads on Red Hat OpenShift

The ability to run VMs inside of a container is called OpenShift Virtualization. It packages each VM inside a special container, in order to modernize legacy apps and at the same time deploy new cloud native and serverless workloads. The hybrid environment can be managed through a single Kubernetes-native architecture.

Red Hat OpenShift can be scaled for use in many deployment sizes ranging from core data center to edge and far edge servers.

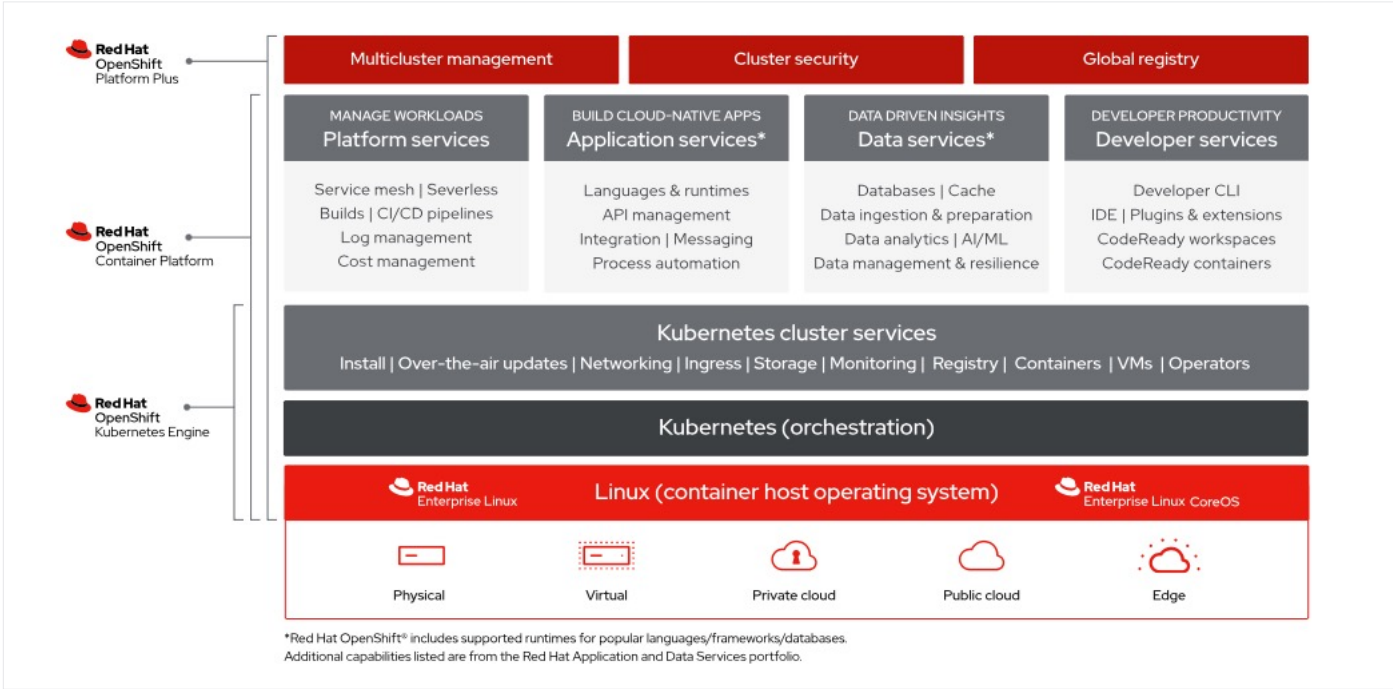

Figure 3. Red Hat OpenShift functionality.

5G Powered by 3rd Gen Intel Xeon Scalable Processors

3rd generation Intel® Xeon® Scalable processors offer a balanced architecture that delivers performance along with built-in advanced security capabilities that allow enterprises to place workloads where they perform best—from edge to cloud.

The latest 3rd Gen Intel Xeon Scalable processors are optimized for modern network workloads and performance levels. They are perfectly paired with 100 GbE Intel® Ethernet Network Adapter E810 for high-throughput network applications.

The CPUs are architected for deterministic performance and high performance per watt. For organizations ready to drive 5G networking to the next level, these CPUs offer increased 5G user plane function (UPF) performance vs. the prior generation.[1]

5G use cases come in all shapes and sizes and 3rd Gen Intel Xeon Scalable processors have from 8 to 40 cores that enable a scalable infrastructure.

Red Hat OpenShift uses an open-source development model, leveraging the collected talent of communities of collaborators, contributors, and partners to take advantage of the latest innovations to reduce costs, bring new solutions to market faster, and help transform their businesses. Red Hat OpenShift is part of the company's Open Hybrid Cloud vision for delivering a develop once, deploy anywhere application development and life-cycle management model across private or public clouds, or across hybrid environments.

Conclusion

Seeing is believing, and the private 5G demonstration system created by Casa Systems and Red Hat with technology from Intel, provides a hands-on demonstration of how the full range of 5G capabilities can be delivered from a single Intel architecture-based server. The small form factor and high performance makes it ideal for IoT, high-traffic venue, enterprise, and other applications.

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