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Manufacturing, Energy Sector, Logistics, Education

Blue Arcus, ASUS and Intel Deliver 5G Core in Small Compute Footprint

Blue Arcus demonstrates¹ private 5G core functionality using ASUS NUC mini computer based on Intel® Core™ Ultra processors



With a virtualized and software-defined architecture, the 5G core is evolving to a smaller footprint server that can be deployed at the network edge. This offers a solution for broader network reach and better support of challenging applications. An edge-deployed 5G core reduces transportation latency benefitting real-time applications and reduces backhaul network traffic improving overall network efficiency.



Essential 5G Core Functions

The 5G core network is the intelligent engine driving the next generation of mobile communication. It orchestrates a complex dance of functionalities to ensure seamless mobile connectivity. Here's a breakdown of the essential functionality delivered by the 5G core:

- **Connectivity and Mobility Management:** The 5G core manages device registration, connection setup, and handover between cell towers, ensuring that users stay connected as they move through the network.
- **Authentication and Authorization:** 5G core software verifies user identities and controls access to network resources.
- **Subscriber Data Management:** The 5G core stores and manages user profiles, including subscriptions, service plans, and preferences.
- **Policy Management:** Enforces network policies that dictate how data is prioritized and routed, ensuring quality of service (QoS) for different applications.
- **Security:** The 5G core safeguards network integrity through encryption, access control, and intrusion detection mechanisms.
- **Service Management:** It facilitates the exposure of network capabilities through APIs, enabling the creation and deployment of innovative 5G services.

5G core functions can be implemented using cloud-native container network functions (CNFs) that increase service lifecycle management agility, reduce costs and allow operators to create tailored networks to meet customer requirements.

Blue Arcus is an Intel® Industry Solution Builders' Network Builders Community Gold Tier member and has tested¹ its 5G core software on one of the smallest form factor computers available--the ASUS Next Unit of Computing (NUC) mini PC that is powered by Intel® Core™ Ultra processors.

Arcus 5G Core is 3GPP Compliant

The Arcus 5G Core from Blue Arcus utilizes a converged architecture with 3GPP-compliant interfaces and can be used in either 5G standalone or 5G non-standalone networks.

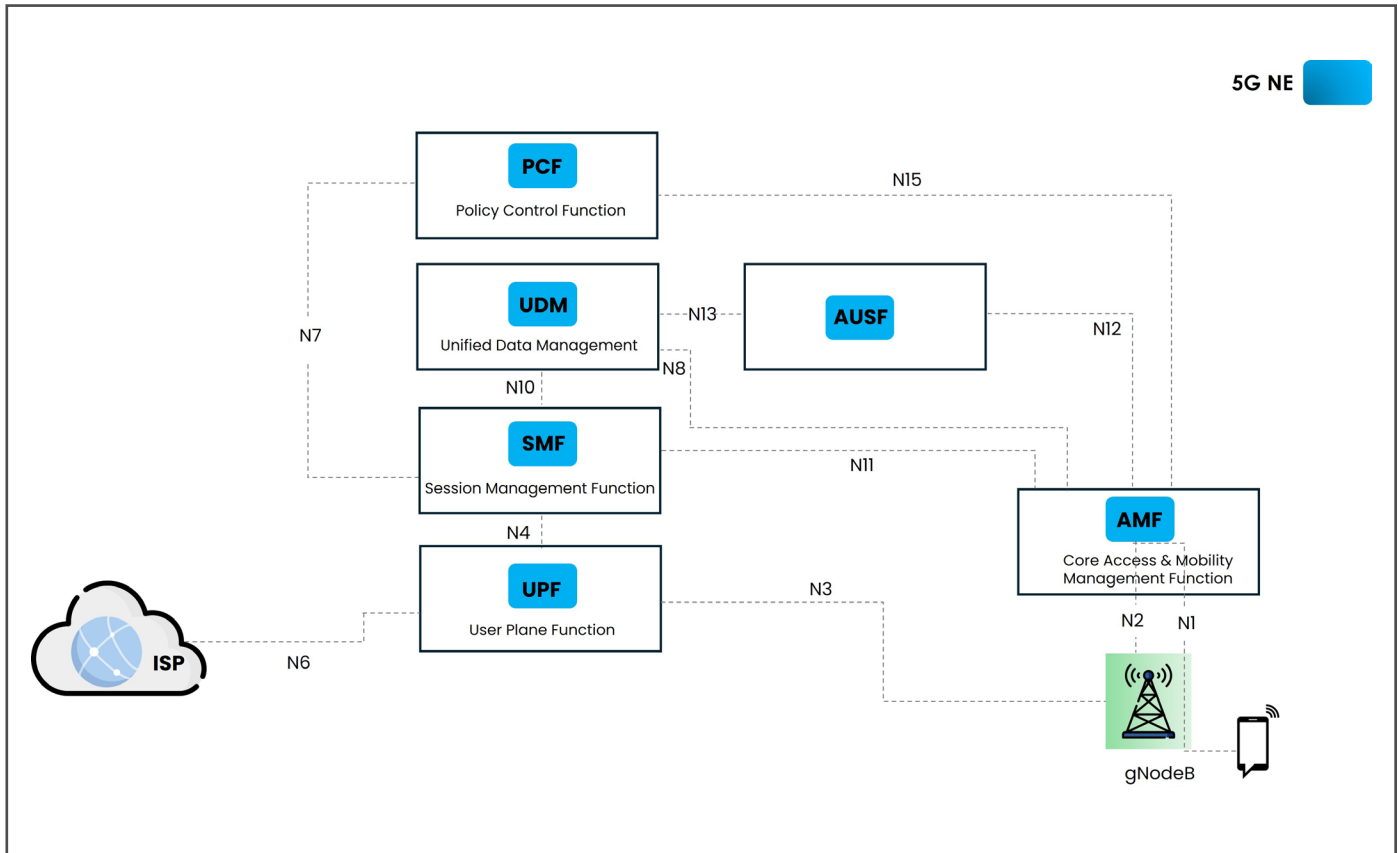


Figure 1. Blue Arcus 5G Core architecture.

This solution is designed for deployment on customer premises or service provider edge locations where the following requirements are needed:

- Low cost
- Low power draw and heat dissipation
- Easy installation

Figure 1 shows a block diagram of the functionality provided by the Arcus 5G Core. Data from the user equipment (UE) enters the system (lower right hand corner) and is processed by the access and mobility management function (AMF) which sends the packet for processing by other 5G core functions including the session management function (SMF), policy control function (PCF), unified data management (UDM) and the authentication server function (AUSF). After packet processing, there is establishment of PDU session for traffic exchange between user equipment and UPF connected to the internet or to application services.

Arcus 5G Core Supports CUPS for Flexibility

The Arcus 5G Core supports control and user plane separation (CUPS) to enable hybrid cloud-edge deployment scenarios. In addition to running as a standalone core solution, CUPS enables the Arcus 5G Core to work in other deployments such as the user plane function (UPF) edge host, or for local breakout in commercial / private deployments with remaining control plane functions hosted on cloud.

The hybrid architecture allows the UPF to be configured to meet the requirements of 5G network use cases including Enhanced Mobile Broadband (eMBB), Ultra-Reliable Low Latency Communication (uRLLC), and Massive Machine-Type Communications (mMTC).

CUPS also enables network slicing, which allows customers to configure bandwidth, connectivity, reliability and other network functionality to support different 5G features for different network traffic types all on the same transport network. For example, a slice can support high-bandwidth video with another network slice configured for IoT applications that feature large numbers of connected devices that transmit smaller-sized data flows.

The Arcus 5G Core is designed to be a cost-effective and high-performance system supporting hundreds of subscribers¹. The software is deployed as a CNF on a wide range of CPUs to achieve this scalability. These range from mini PCs to rack servers to compute clusters composed of multiple servers. Customers can accommodate growing demands by adding additional subscriber licenses or through the distributed architecture deployment for the capacity expansion.

While the system supports this extensive scalability, one thing that sets it apart is its ability to be used in applications that utilize cost-effective, low core-count and mini PC servers such as the ASUS NUC mini PC. This small, cost-effective solution meets emerging needs for private wireless and IoT applications.

¹Intel does not control or audit third-party data. You should consult other sources to evaluate accuracy.

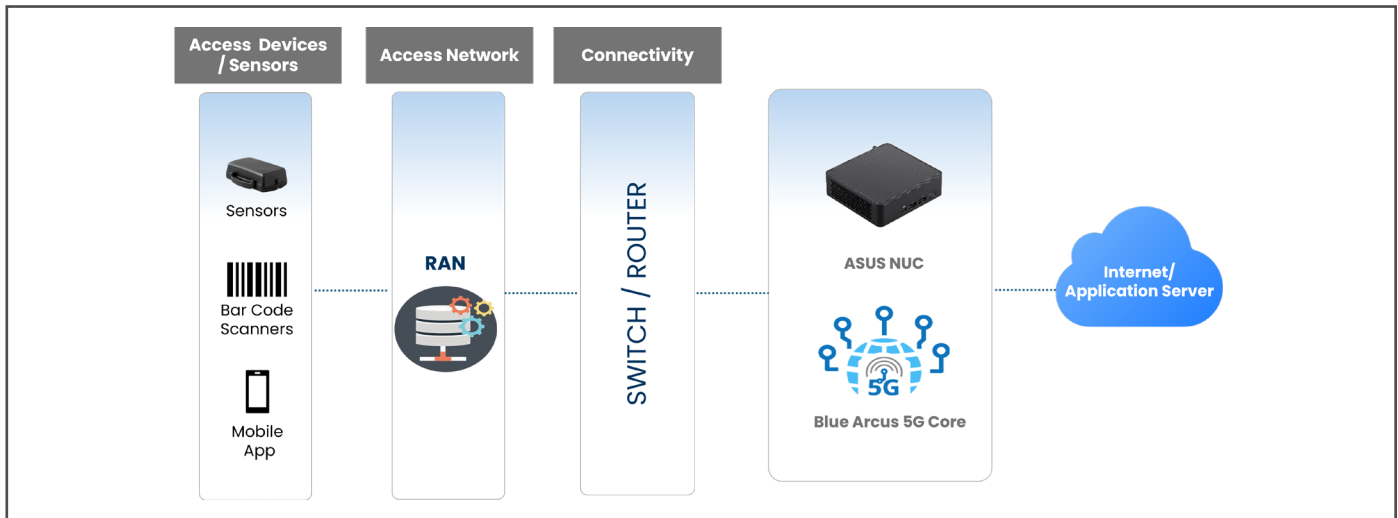


Figure 2. Network functions used in test of Arcus 5G Core on ASUS NUC mini PC.

Small ASUS NUC based on Intel® Core™ Ultra Processors

The ASUS NUC product family is built on a small footprint and user-friendly product design. Known for its ultracompact 4"x4" system size, NUC products are developed through a partnership between ASUS and Intel. Even with this small form factor, the ASUS NUC integrates the power of a full-sized computer with quality, reliability, modular design, extended lifespan, smart cooling solutions, and advanced AI capabilities.

The ASUS NUC is powered by recent generations of Intel® Core™ Ultra 7, Intel® Core™ Ultra 5, or Intel® Core™ 3 processor. SoCs in this product family have between eight and 16 CPU cores and operate at up to 5GHz. This flexibility allows ASUS to meet a wide range of cost and performance requirements. Intel Core Ultra SoCs feature integrated graphics processor units (GPU) based on Intel® Arc™ or Intel® Iris Xe Graphics. These GPUs have up to 16 vector engines that allow a high degree of parallelization.

Functionality Test Set Up

To test the functionality of the 5G core on a small server, a system under test (SUT) utilizing an ASUS NUC computer was configured to run the Arcus 5G Core software (see end note for full configuration). Other aspects of the test system (see Figure 2) included a 5G gNodeB radio, subscriber identity module (SIM) cards with a known authentication key (Ki) value, 5G-capable UEs and the networking equipment needed to connect the 5G core to the gNodeB.

Full Functionality

Table 1 shows the tests that were successfully run on the SUT demonstrating complete 5G functionality on a small form factor PC.

Test Case Num	Title
System Tests	
5G_IOT-001	Bring up N2 interface
5G_IOT-002	Bring up N3 interface
5G_IOT-003	Restart AMF load and verify services
5G_IOT-004	Reboot gNodeB and verify services
User Experience Tests	
5G_IOT-005	Register 5G UE
5G_IOT-006	Power down (detach) registered 5G UE
5G_IOT-007	Place a data call from 5G UE (download test)
5G_IOT-008	Place a data call from 5G UE (upload test)
5G_IOT-009	Perform data calls with multiple 5G UEs
5G_IOT-010	Perform a long-duration data call
5G_IOT-011	Put registered 5G UE in airplane mode (on/off)
5G_IOT-012	Periodic registration area update for 5G UE
5G_IOT-013	N2 handover for 5G UE
5G_IOT-014	Xn handover for 5G UE
5G_IOT-015	Restart UPF load and verify services
Load Tests	
5G_IOT-016	Registration of multiple UEs
5G_IOT-017	Multiple data calls (UL and DL)
NGAP Procedure Tests	
5G_IOT-018	Next-generation application protocol (NGAP) set-up procedure
5G_IOT-019	AMF-initiated NG reset procedure
5G_IOT-020	Service-extended power-saving paging procedure over NGAP interface
5G_IOT-021	Initial context set up procedure over NGAP interface
5G_IOT-022	Security mode command process over NGAP interface
5G_IOT-023	Uplink and downlink NAS transport packet analysis over NGAP interface
5G_IOT-024	RAN /AMF configuration update procedures
5G_IOT-025	PDU session initiation over NGAP interface
5G_IOT-026	PDU session modification over NGAP interface
5G_IOT-027	PDU session release over NGAP interface
5G_IOT-028	Location report procedure over NGAP interface

Table 1. Test case outcomes.

Conclusion

5G core solutions need scalability to accommodate hundreds of thousands of users, but it's also important for the systems to cost-effectively scale down to a mini PC-based system that can serve hundreds of users from the network edge. This size PC can deliver the core services needed for new private 5G networks or low-latency hybrid edge-public cloud networks.

The Arcus 5G Core is a complete, 3GPP-compliant core software solution. The company worked with Intel to test the system on an ASUS NUC mini PC running on Intel Core Ultra processors. The test results show how the system carried out all tests thus demonstrating its ability to deliver a cost-effective 5G core for these small applications.

Learn More

[Arcus 5G Core](#)

[ASUS NUC Product Overview](#)

[Intel® Core™ Ultra Processors Family](#)

[Intel® Network Builders](#)



SUT: ASUS NUC14 Pro micro server powered by eight-core Intel® Core™ Ultra 7 Processor 165H @ 5.00GHz. Total DDR5 memory was 32 GB (2x16 GB); HT on; Turbo on. BIOS version: RVMTLV57.0043. NIC: 1X Intel i226-v10/100/1000/2500 Mbps RJ45 Ethernet network adapters. OS: Ubuntu 22.04.4 LTS (Jammy Jellyfish); kernel Linux 5.15.0-94-generic; 256 GB SSD. Compiler: native compiler. Benchmark/workload version: 5G core modules, AMF, SMF, PCF, UDM, AUSF and UPF IMS software on NUC. Libraries: libsctp1, libconfig9, gdb, system-coredump, liblz4-tool, libconfig-dev lrzsz gdb libsctp-dev libconfig9 libsctp1 libmnl libmnl-dev libidn11 libidn11-dev. Test by Blue Arcus on May 10, 2024.

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