

WHITEPAPER

Enabling The 5G Intelligent Edge:

How White Box Network Solutions Help Drive

AIoT Innovation in the 5G Era

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Executive Overview

The world is at a technology inflection point that hasn't been seen since the rise of the Internet, and 5G is paving the path. Recent advancements in machine learning and the internet of things (IoT), paired with new network technologies, 5G New Radio (5G NR), disaggregation, edge computing, and open industry standards, are all coming together – leading to a new era that will be driven by the AIoT, or the Artificial Intelligence of Things. Ripples of this transformation will be felt across many industries, impacting business models and operations. Industry 4.0, what is expected to be the next industrial revolution, is one outcome.

AI-enabled private 5G networks will shepherd in an era of connected machines and robotic processes working autonomously to deliver system-wide automated processing control. These systems will have the capacity to 'learn' to optimize productivity – **allowing businesses to become more efficient and agile**. This is expected to significantly improve productivity and output. In fact, it is estimated that by 2030, the manufacturing sector could add \$400 billion to \$650 billion to the global GDP by leveraging the benefits of 5G, and private networks are quickly becoming a new avenue for growth for service providers around the globe. Private LTE and 5G networks generated \$4.7 billion in revenue in 2020. That number is expected to be \$8 billion by the end of 2023. (source: [SNS Telecom and IT](#))

The factory of the future will be more automated and efficient than today, and white box hardware is an important component in achieving this goal. The concept of white-box hardware has been around for nearly a decade but has really taken off in the networking space in the recent years due to the broader adoption of network functions virtualization (NFV). A white-box infrastructure is based on interoperable, programmable, off-the-shelf equipment designed to provide support for web-scale, cloud-native, virtualized network architectures - delivering greater flexibility and agility from the core to the edge. This paper addresses the reasons, challenges, and benefits of service providers and enterprises adopting a white box edge approach to optimize operations and generate new revenue.

5G – A Key Enabler for Industry 4.0 and AIoT

Industry 4.0 brings together various advances in technology – but there remains an issue with connectivity. Even the most advanced factories still rely upon traditional fiber-based or Wi-Fi networks. In a fiber-based environment, there is no flexibility for supporting an increasing number of mobile devices and sensors, and in a traditional wi-fi environment, the growing number of business-critical connections contributes to interference, congestion and security concerns that are difficult to manage in advanced industrial environments.

When paired with 5G, AIoT has the potential to transform businesses across industries, creating a new economy that will power the fourth industrial revolution. One that is driven by machine learning and automated decision making, connectivity, and the exchange of data. This opens the door to a new generation of smart factories, smart logistics, smart transportation, smart energy grids, smart cities, and more.

5G New Radio

In contrast to previous generations, 5G New Radio (5G NR) is built for business. It is a transformative technology that enables greater bandwidth and lower latency. Plus, the added security and reliability benefits meet the needs of mission-critical applications. Previous mobile communication technologies were designed primarily for mobile handsets. But as millions of new IoT 5G enabled chipsets, modules and other connected devices come into the market, the focus will go far beyond these personal devices and into a world of connected 'things' made smarter through artificial intelligence. A world of AIoT fueled by 5G.

3GPP has defined three initial 5G use cases, which will help power an AIoT enabled Industry 4.0:

- **Ultra-reliable low latency communication (URLLC)** - for real-time communications between machines
- **Enhanced mobile broadband (eMBB)** - greater bandwidth and support for a higher number of connected devices and sensors that generate more data traffic
- **Massive machine-type communications (mMTC)** - low power connections for longer battery life, enabling support for massive numbers of IoT sensors and devices.

Private 5G Networks

Private 5G networks have been designed to deliver businesses with ultra-reliable, low-latency mobile connections that will power new capabilities - from predictive maintenance, autonomous machines, and factory robotics to ultra-high definition video analytics that will enable many different use cases across industry verticals.

Today, there are different deployment options and business models for private 5G networks, each with their own level of mobile network operator (MNO) engagement:

Option A: An enterprise builds its own 5G network with spectrum that they have purchased outright or leased from a mobile service provider. Some countries have reserved unlicensed or lightly licensed bands, such as the Citizens Broadband Radio Service (CBRS), to support this capability.

Option B: A MNO builds and operates an on-premises private 5G network for the enterprise and provides integration with its public network if required.

Option C: A MNO builds a public 5G network and provides a dedicated network slice that meets the enterprise's specific SLA requirements.



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White Box Hardware and 5G

With these new business models in mind, service providers are investing in virtualizing their mobile networks, creating the agile, automated, cloud-native environment that 5G needs to succeed. An open architecture that utilizes common industry standards, supported by the O-RAN ALLIANCE, the Telecom Infra Project (TIP), and others, to fully realize the 5G vision.

Since its foundation in 2018, the O-RAN ALLIANCE has promoted the use of white-box hardware to reduce the cost of 5G deployments. Up until now, mobile networks have been relatively closed ecosystems. By opening the Radio Access Network (RAN) to new cloud and IoT players through a standardized, interoperable, multi-vendor environment, innovative services and applications can be deployed at the edge that generate new revenue streams. Adopting a white-box strategy reinforces this approach – building an open and agile foundation that will allow operators to take advantage of economies of scale and encourage the creation of an innovative and competitive ecosystem that is ready to adopt next-generation cloud-native architectures.

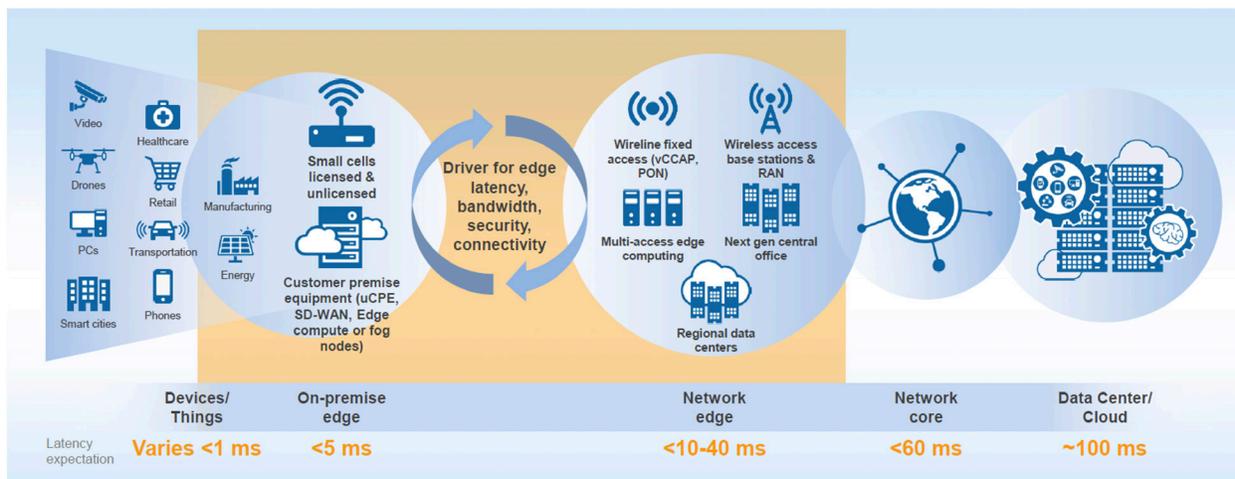


Figure 1 -The 5G Edge

Source: Advantech

The white box transformation is also happening at the enterprise edge (figure 1) with virtual functions such as SD-WAN being deployed on commercial-off-the-shelf appliances or universal Customer Premises Equipment (uCPE), setting the scene to deliver a broader range of premium 5G enterprise services. As introduced before, 5G technology enhancements have put the spotlight on private 5G networks as key smart manufacturing and AIoT enablers, providing a secure wireless connectivity solution for AI, VR and AR that heavily rely on 4K/8K UHD video as a main source of information. NFV and software-defined networking (SDN), along with the definition of O-RAN standards and the use of white box infrastructure, are democratizing mobile network technology, enabling 5G Stand Alone (5G SA), low-footprint solutions that are viable for enterprise deployment.

Still, while building this new open and intelligent 5G edge, a gap needs to be addressed so that the benefits of Industrial 5G and AIoT can be fully realized. This is where the operational technology (OT) layer, which is defined as the equipment and industrial systems within a production environment, needs to “talk” to the information technology (IT) and communication technology (CT) layers. The operational technology layer needs to integrate seamlessly with the IT and CT layers to deliver on the promise of the intelligent, autonomous, AI-driven factory of the future. Again, white-box solutions can play a key role to accelerate digital transformation and mend this gap by enabling an open architecture that extends network intelligence all the way to the factory floor, over a consistent white-box infrastructure that can reliably execute mission-critical applications anywhere in the network. Private 5G solutions deployed following this approach allow for a lighter, more flexible and future-proof communications infrastructure that can be managed as another enterprise IT system.



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White Box Benefits

Overall, virtual, and open infrastructure solutions based on white box hardware opens the network to innovation, optimizes infrastructure costs and lowers barriers to entry. The disaggregation of software and hardware is at the foundation of these capabilities. Below are the benefits that can be achieved when a carefully considered, strategic approach is taken:



Figure 2 – White Box Benefits

Source: Advantech

Greater Economies-of-Scale

The right white box approach can advance the standardization of telco infrastructure, making private 5G networks more efficient, flexible, and easier to implement with commercial, off-the-shelf solutions.

A More Agile Infrastructure

An intelligent, virtualized network edge infrastructure based on white box hardware can ensure greater network agility by supporting a cloud-native architecture that enables web-scale open compute, networking, and storage.

Hardware Interoperability

The interoperability of white box hardware can provide second-sourcing protection, reducing supply chain risks, and enabling a more competitive ecosystem that benefits both vendors and operators.

Challenges at the Edge

Today, there is widespread agreement amongst operators that edge computing and core 5G network functions will need to be tightly integrated with and powered by public and private clouds, which is especially true for Industrial AIoT. As mentioned previously, the O-RAN ALLIANCE, 3GPP, and many operators worldwide understand the advantages and are committed to driving these efforts forward.

But implementing a scale-out white-box strategy across the network is a challenging task as there is no one-size-fits-all option when it comes to the edge. White box hardware is not all created equally. At its best, it can deliver high availability, redundancy, and remote management; supporting intelligent manufacturing by bridging the critical operational technology gap mentioned earlier. With the arrival of edge computing, the right hardware platform must be chosen based not just on what function it will perform, but also on where and under what conditions, to guarantee sustained operations and avoid costly downtime.

Key Challenges to Consider:

- **Reliability** – Reliability and sustained operations is a top priority when deploying network equipment that supports mission and business critical applications. Painsstakingly designed hardware that has built in redundancy and high availability reduces costly downtime and service interventions. Advanced remote management, such as fail-safe upgrades, is another key consideration that can greatly reduce operational expenses.
- **Performance** – The data tsunami brought by 5G and AIoT will require higher computing power to be moved closer to subscribers at the edge of the network. In addition, vRAN brings the challenge of deploying baseband virtual Distributed Unit (vDU) functions at the edge on white-box base station infrastructure that will also require higher performance to support 5G NR.
- **Energy Efficiency** – Edge computing moves computing resources outside of the datacenter to remote locations with strict energy and space constraints. To ensure maximum energy savings at the edge, performance-per-watt should be a primary consideration of any white box strategy, along with hardware acceleration and the ability to maximize density. Hardware consolidation to optimize resources usage will also be critical.
- **Environmental** – Certain environments, such as heat, cold or dust, can result in poor performance, or even failure. As mentioned before, bringing high performance hardware to remote locations means having to deal with harsh environments far from datacenter-controlled conditions. Maintainability is also a consideration. Can the system be easily accessed, maintained, and serviced - or are there limitations? It is important to select hardware that is designed to meet these specific edge needs to assure continued high-performance operations.



Overall, virtual, and open infrastructure solutions based on white box hardware opens the network to innovation, optimizes infrastructure costs and lowers barriers to entry.

- **Integration** – Network disaggregation and virtualization opens the market and optimizes infrastructure costs. However, this new multi-vendor scenario creates new risks in having to integrate pieces from different sources without jeopardizing performance, security or reliability. An open, programmable, off-the-shelf white box approach requires strong eco-system collaboration and pre-validated configurations to achieve streamlined deployments. In the end, this saves time and money, while enabling more agile, future-proof, open solutions.

The Advantech Advantage

Selecting the right 5G white box approach is critical to avoid unpleasant surprises when the rubber meets the road. Advantech's 5G Edge Servers and Appliances provide a solid and open foundation for service providers and enterprises to deploy agile, reliable, and secure network edge solutions that break away from monolithic architectures. These scalable white boxes integrate the latest computing and networking technologies into optimized edge platforms that are widely deployed, running popular on-premises, access network and edge cloud software from industry-leading ecosystem partners. This flexible approach helps minimize supply chain risks. It protects network investments, building an open and virtual infrastructure ready to adopt next-generation converged and cloud-native models.

Advantech 5G Edge Solutions integrate lessons learnt from over 20 years of experience designing carrier-grade hardware for leading service providers and telecom equipment manufacturers globally. Some of these include:

- **High performance and density:** unlike IT servers, Advantech 5G Edge Servers are designed from the ground up to optimize throughput and offload required by communication workloads. The systems not only combine powerful CPUs with support for high thermal design power (TDP) PCIe cards, but also carefully balance I/O between multiple processor sockets (NUMA balanced).
- **Built-in reliability and security at the edge:** Advantech's advanced designs yield higher margins and lower component

The Right White Box Strategy Requires Careful Consideration

Opportunities

- Reduces CAPEX and OPEX
- Provides web-scale agile compute and storage - enabling a cloud-native architecture
- Eliminates vendor lock-in - minimizes supply chain risks
- Protects investment – deploying a software agnostic infrastructure
- Opens the edge – to new Cloud and IoT partners

Challenges

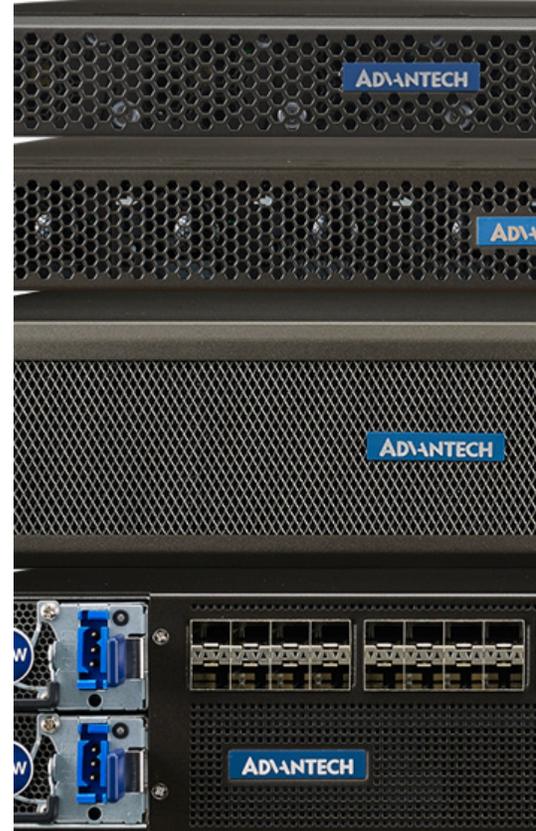
- Reliability – redundancy, availability, remote management requirements
- Performance requirements – including AI edge computing, hardware consolidation and baseband functions
- Energy needs – performance per watt, density, hardware acceleration
- Environmental considerations – built to withstand harsh conditions
- Integration challenges – industry standards, software validation

stress for improved platform reliability. The servers support single failures of critical components such as power supply modules and fans. They have been designed for the telecom edge, including NEBS Level 3 compliant and ultra-short depth (11") configurations that pay special attention to maintainability and serviceability. In addition, redundant BIOS and firmware images not only provide a safe way to recover from component failures but also offer remote fail-safe update capabilities via Advantech's IPMI which reduces MTTR and costly on-site services.

- **Flexible integration, customization & design:** solution providers can also leverage Advantech's Customized COTS framework for semi-custom electronic or mechanical design as well as product branding including artwork, packaging and BIOS firmware strings or IDs. As Advantech designs and manufactures all its sub-assemblies they can modify and optimize any element in the system to suit a specific market need.
- **Full ecosystem collaboration:** Advantech works closely with leading silicon, OS, ISV, system integration and service provider partners to jointly address the challenges of open and disaggregated networks, bringing to market optimized solutions that have been verified to perform well together.

Advantech White Box Edge Solutions: Building the Backbone of the new AIoT Economy

5G Edge Servers for the Open RAN: Advantech SKY-8000 Servers are high performance, high density platforms optimized to run virtualized communication workloads at the network edge. Deployed globally in telecom and industrial business and mission-critical applications, they provide a wide choice of white-box hardware platforms that scale from pole-mount, ultra-short-depth, extended operating temperature range, outdoor configurations all the way up to high-performance designs that can be deployed as micro data centers at the edge or in virtual Central Offices.



Advantech
SKY-8000
Servers are high performance, high density platforms optimized to run virtualized communication workloads at the network edge.

Universal Edge Appliances for SD-WAN, uCPE and SASE:

Advantech FWA Network Appliances streamline enterprise network transformation with universal platforms that can scale secure connectivity services from small and medium branches to large campuses and headquarters. Rugged configurations such as the FWA-1112VC supporting extending operating temperature range and 5G bridge the gap between enterprise and industrial connectivity.

4K/8K Video & AI Acceleration: Advantech provides commercial-off-the-shelf access to live video acceleration technology in platforms that have been designed for edge deployment.

Advantech VEGA Video Solutions enable highly efficient, real-time 4K/8K compression and streaming in compact modules and appliances.

Private 5G Network Small Cell Demonstrator: Advantech wants to streamline solution evaluation and validation by providing enterprises with a fully integrated small cell demonstrator that can be easily deployed on premises delivering all required elements to run private 5G NR networks in a ruggedized rack. The demonstrator can be configured to meet different performance and functionality needs in indoor or outdoor scenario. Coupled with Advantech solutions for network security, SD-WAN, 4K/8K and AI, this demonstrator can help enterprises accelerate their digital transformation toward true OT, IT and CT integration to achieve operational excellence.



Rugged configurations such as the FWA-1112VC supporting extending operating temperature range and 5G bridge the gap between enterprise and industrial connectivity.

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About Advantech

Advantech's corporate vision is to enable an intelligent planet. The company is a global leader in the fields of IoT intelligent systems and embedded platforms. To embrace the trends of IoT, big data, and artificial intelligence, Advantech promotes IoT hardware and software solutions with the Edge Intelligence WISE-PaaS core to assist business partners and clients in connecting their industrial chains. Advantech is also working with business partners to co-create business ecosystems that accelerate the goal of industrial intelligence.

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