Truminds optimizes the energy efficiency of private wireless networks via Kontron edge servers that leverage Napatech SmartNICs to offload the User Plane Function (UPF).

Enterprises serving markets as diverse as manufacturing, broadcasting, mining and healthcare are increasingly adopting private wireless networks in preference to public cellular or WiFi alternatives, due to the increased reliability and guaranteed coverage that they offer. In order for these networks to be cost-effective and energy-efficient, it's important for them to maximize the number of client devices that can be supported in a small-footprint server.

Truminds Software Systems, a specialized engineering solutions provider for 5G private networks, has optimized the cost-performance and energy efficiency of its **TruCore** (5G Core Network Technology) solution by deploying it on servers from **Kontron** that are designed for edge deployments, configured with Smart Network Interface cards (SmartNICs) from **Napatech** that offload and accelerate the compute-intensive User Plane Function (UPF), freeing up the server's CPU for running applications and services.

This solution brief summarizes the details of this solution for private network infrastructure.

Delivering private cellular networks for business-critical applications

TruCore (Truminds' 5G Packet Core Solution) is an industry-proven 5G packet core licensable technology solution that offers cloud-native 5G packet core functions as part of the portfolio. This solution has been adopted by multiple clients globally and is being deployed in tier-1 operator networks and by tier-1 Network Equipment Providers (NEPs).
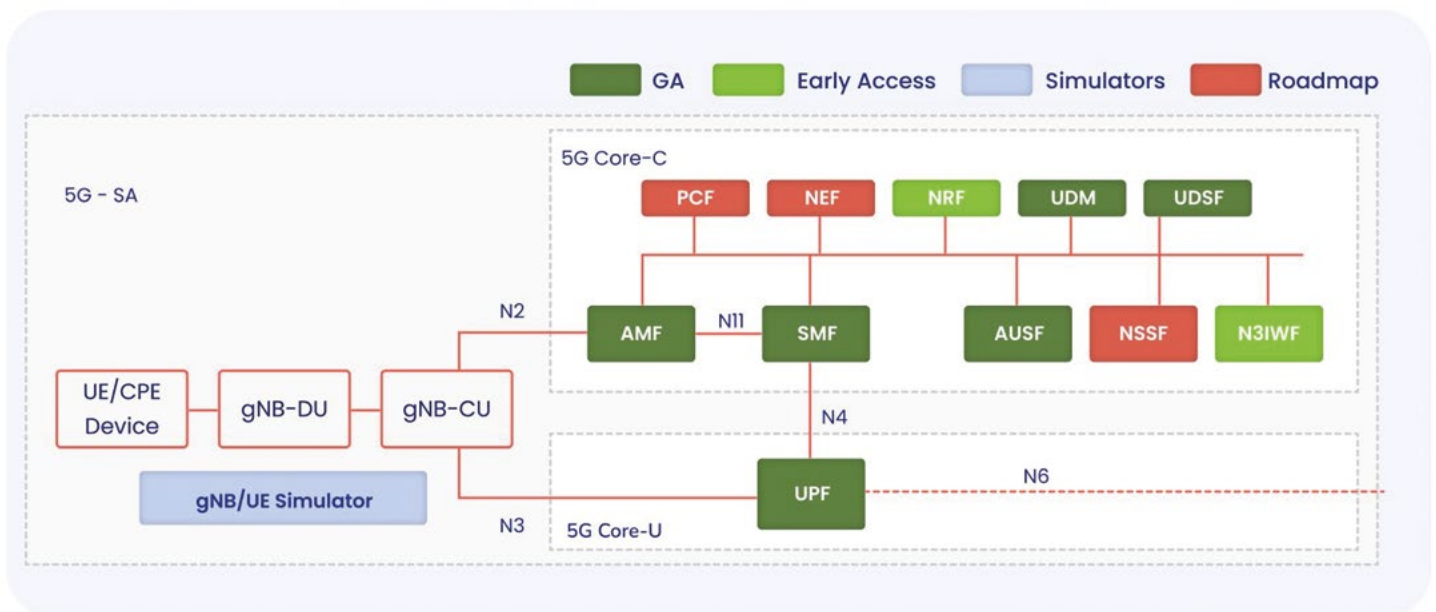
TruCore highlights include:
• UPF, SMF, AMF, AUSF, UDM, UDSF and N3IWF/TNGF, all available as GA.
• NRF, available as Early Access.
• PCF, NEF and NSSF, under roadmap development.
• High performance for user traffic handling and forwarding engine for multi-Gbps, with support for Napatech SmartNIC offload (see below for details of the throughput improvements enabled by this solution).
• CUPS-based architecture for flexible and scalable network deployments.

Private networks face different challenges to telecom infrastructure. To ensure that their on-premise deployments are as cost-effective and energy-efficient as possible, Truminds runs its TruCore software on servers that are optimized for edge use cases and Kontron edge servers meet these requirements.

Kontron edge servers address the needs of private networks

The Kontron high-performance ME1310 multi-access edge server is a rugged, long-life, power-efficient, and multi-purpose system designed to decrease network congestion and improve the performance of applications by getting task processing closer to the user. Powered by Intel Xeon D-2700 family processors, the ME1310 enables applications such as virtual RAN (v-RAN), Artificial Intelligence (AI), data caching, and other ultra-low latency and high-bandwidth edge applications.

With support for wide temperature range (-40°C to +65°C), the ME1310 solves restricted space and power challenges by condensing multiple functions and devices into one rack unit (RU), saving space, cabling, and costs. The ME1310 is also available in a hardened passively cooled, IP-65 sealed enclosure (named RS1310) to support deployments directly into an outdoor setting (including pole mount).

The Kontron ME1310 has a built in 12-port, 200 Gbps switch for fiber optic front haul connections. The switch features four SFP28 and eight SFP+ ports to support fiber-optic connections at 25 GbE or 10 GbE.

The ME1310 server supports up to 512GB of DDR4 memory at 3200MHz. For storage, the server supports four M.2 low profile

memory banks supporting up to 2TB of RAID storage. Kontron has built independent management into the server that includes support for the Redfish application programming interface (API) and Intelligent Platform Management Interface (IPMI) v2.0 Secure Remote Management Capabilities (encrypted firmware, boot, storage, secure boot and failsafe boot).

Implementing Kontron's common design in both fan-cooled / rack mount and IP65 / passively cooled enclosures enables a single software image and development effort to be applied to different operating environments.

To maximize the performance of the User Plane Function (UPF) subsystem within their private network packet core, Truminds and Kontron leverage the UPF offload solution from Napatech that comprises a high-performance SmartNIC together with an optimized software stack.

Napatech's SmartNIC solution delivers industry-leading UPF performance in an industry-standard environment

Napatech addresses the business imperative of minimizing the cost-per-device or cost-per-user for 5G packet core deployments by providing an integrated hardware/software solution that delivers industry-leading UPF performance. This solution comprises a fully-offloaded UPF fast path implemented within the Link-Inline™ software stack, running on an NT200 PCI-Express (PCIe) SmartNIC that supports a total bandwidth of 200Gbps.

Napatech's UPF offload solution enables Truminds to support significantly more users or devices per server than with either a pure software solution or competing offload solutions, while at the same minimizing the overall cost per user and improving energy efficiency.

Using a single NT200 SmartNIC to sustain 100Gbps of full duplex traffic, the Napatech UPF offload solution processes 140 million concurrent flows, with a flow learning rate greater than 1.5 million flows per second, achieving a total throughput of 85 million packets per second with stateful operation.

Napatech's UPF offload solution is fully compatible with the industry-standard DPDK RTE_FLOWS API for flow configuration. This ensures that 5G packet core software vendors like Truminds can readily leverage the performance benefits of the Napatech solution without having to rewrite their software to use a proprietary API. Kubernetes support enables the solution to be deployed within a cloud-native environment using a standard orchestration platform.

5G UPF SLOW PATH
ON SERVER CPU

5G UPF FAST PATH
with Link-Inline™ Software
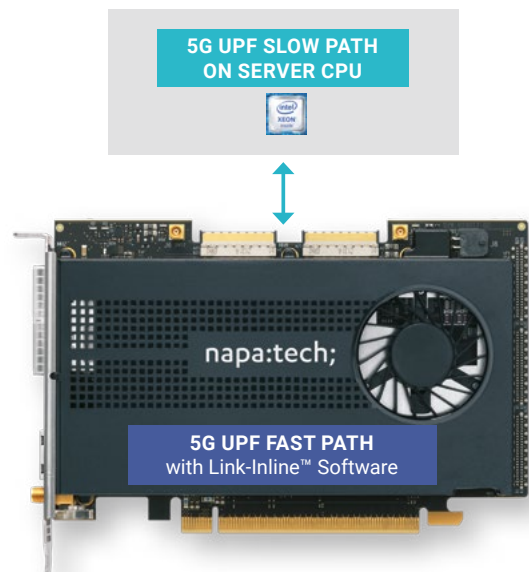
From a hardware perspective, the NT200 SmartNIC is a full-height, half-length PCIe Gen3 card, available in both active and passive (NEBS) cooling variants, with standard QSFP28 network ports. The SmartNIC fits into industry-standard servers like the Kontron ME1210 as an alternative to standard or "foundational" NICs that provide no offload features.

End-to-end packet core solution maximizes system performance while minimizing server CPU utilization

The combined packet core solution from Truminds, Kontron and Napatech implements the UPF data path as a port-to-port "hair-pinned" architecture, which ensures that following initial setup all flows are processed on the SmartNIC with no need for traffic to flow to and from the server CPU. This maximizes the overall performance of the system while minimizing the utilization of the server CPU, freeing up its resources for running control plane functions as well as edge applications and services.
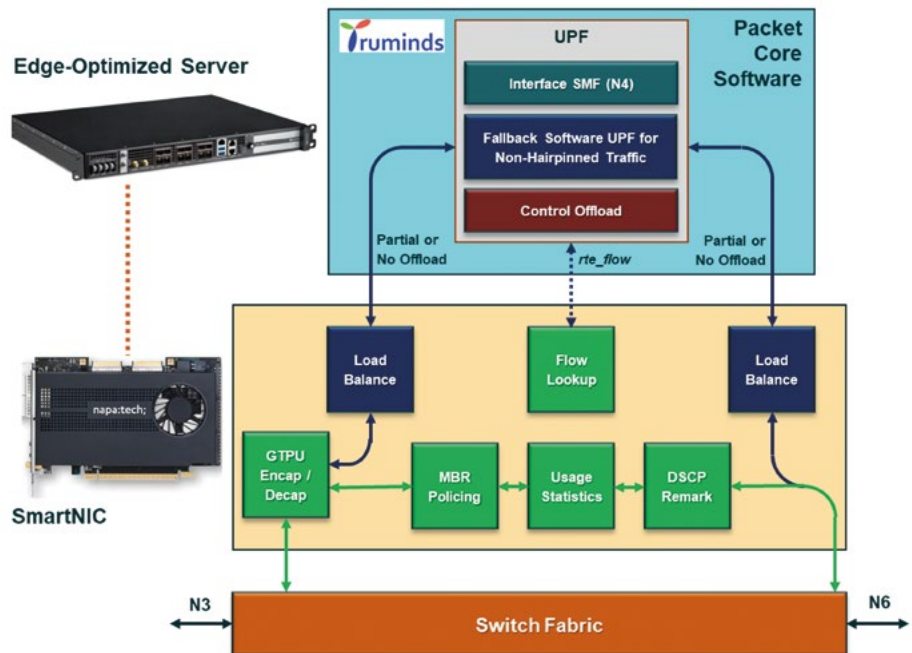
Compelling business benefits for private wireless networks

As a critical 5G packet core element between the RAN and Data Network, the UPF is responsible for processing the massive amount of data traffic originating from various applications. The UPF represents a significant compute workload performing packet detection, enforcement of QoS policies and application of forwarding rules, in order to meet real-time packet processing requirements for latency-sensitive applications. It's essential for packet core vendors like Truminds to deploy solutions that enable private network operators to deliver these functions while optimizing the CAPEX, OPEX and energy efficiency of their infrastructure.

Truminds analyzed the performance of the TruCore packet core running on the Kontron ME1210 server, comparing the throughput in a pure software implementation to that achieved using the Napatech SmartNIC-based offload solution.

In a pure software implementation, TruCore delivers a throughput of **14Gbps** with 650 byte packets, or **16Gbps** with 1400 byte packets, while requiring the allocation of seven CPU cores to run the UPF data plane and one core to run the UPF control plane.

When using the Napatech SmartNIC-based offload solution, TruCore is able to sustain full, bidirectional **2x 100Gbps** throughput without any CPU cores being consumed by the UPF data plane, freeing up those seven cores to run revenue-generating applications and/or services.

- This performance improvement delivers several compelling benefits for operators of private networks:
- Maximum subscriber density in terms of the number of users or devices supported in each edge server;
- Maximum energy efficiency in terms of the server power consumer per user;
- Minimum CAPEX and OPEX calculated on a per-subscriber or per-device basis;
- Guaranteed availability of server compute resources to run revenue-generating applications and/or services, for example in a Multi-access Edge Compute (MEC) use case or in a scenario where the vRAN Centralized Unit (CU) is co-located with the packet core.

Summary

Enterprises with a need for highly-reliable, business-critical mobile communications are increasingly adopting private cellular networks in preference to public cellular or WiFi alternatives. In order for these networks to be cost-effective, it's important for them to maximize the number of client devices that can be supported in a small-footprint server.

Thus, by leveraging Napatech's SmartNIC-based UPF offload solution running on an edge server from Kontron, Truminds has optimized the cost-performance of their private cellular network infrastructure for markets like healthcare, government offices, utilities, universities and airports.

Truminds is a global engineering services and licensable technology solutions company in the digital and connected space offering expertise in next generation technologies including 5G, Internet of Things (IoT), Automation, Cloud/ Virtualization, Artificial Intelligence/Machine Learning Big Data/Analytics, Cybersecurity to name a few. We offer capabilities across the product/solution lifecycle from Design, Development, Testing, Support to Deployment and Maintenance. Truminds has offices in San Diego, Greater Boston, Gurgaon, Bangalore and Hyderabad.

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Kontron is a global leader in IoT/Embedded Computing Technology (ECT) and offers individual solutions in the areas of Internet of Things (IoT) and Industry 4.0 through a combined portfolio of hardware, software and services. With its standard and customized products based on highly reliable state-of-the-art technologies, Kontron provides secure and innovative applications for a wide variety of industries. As a result, customers benefit from accelerated time-to-market, lower total cost of ownership, extended product lifecycles and the best fully integrated applications.

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Napatech is the leading supplier of programmable SmartNIC solutions used in telecom, cloud, enterprise, cybersecurity and financial applications worldwide. Through commercial-grade software suites integrated with robust, high-performance hardware, Napatech accelerates telecom, networking and security workloads to deliver best-in-class system-level performance while maximizing the availability of server compute resources for running applications and services.

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