‹kaloom™›

UNIFIED EDGE FOR SUPERIOR PRIVATE 5G NETWORK AS A SERVICE

Introduction

Enterprises are starting to prefer private 5G networks over public cellular networks for the customized design of heterogeneous networks and deterministic quality of service. According to Global Mobile Supplier Association (GSA)[1], the number of private cellular networks is growing rapidly, from 656 in February 2022 to 889 in September, a 36% increase in seven months. Analysis Mason[2], a research firm, forecasts private network installations reaching 39,000 by 2027.

As the adoption of industrial automation and business-critical applications increases with 5G, the enterprise collaborates with network operators and cloud computing partners for converged IT solutions at the edge. Enterprises are also increasingly collaborating with system integrators and managed service providers for assistance to spell out the business case and craft the solution design for private 5G networks. According to a 2021 survey by Omdia and Bearing Point[3], system integrators led 27 percent of the projects, compared to 16 percent by communication service providers (CSPs).

Concurrently, CSPs are positioning their connectivity services for higher-margin emerging end-to-end software solutions that interconnect the enterprise, and its ecosystem partners and technology vendors. The end-to-end networks allow the ecosystem partners to collaborate with the enterprise and technology vendors to co-create solutions. According to TM Forum's Telecoms Revenue Growth Survey 2022[4], 60% of operators see end-to-end connectivity as a significant opportunity for revenue growth.

Private 5G network services are increasingly in vogue for the management of hybrid networking needs with a single point of execution for all of them. They need programmable network fabrics that create an open rubric to consolidate, share and reuse network resources and intelligence for multiple uses.

> 5G Private cellular networks and programmable network fabrics have a symbiotic relationship—together they create consolidated and shareable networks able to serve multiple customized application needs.

New Needs of Managed Service Providers

A prerequisite for adopting 5G networks and edge technologies in the enterprise is that its execution should not disproportionately increase risk. In the past, turnkey network projects were the preferred choice for the enterprise. They relied on experienced incumbents to take complete responsibility for the design and execution of projects. Unfortunately, such an approach leaves little room for the enterprise to achieve flexible network solutions with the favorable attributes of 5G. Managed Service Providers must leverage network solutions that dynamically adapt to application needs but do not lose control or increase costs.

MSPs want to combine software, hardware, and operating platforms to achieve predetermined business outcomes for their enterprise customers. They want to pick and choose from a widening choice of hardware, software, and operating platforms to achieve the desired results. Moreover, network operators want granular visibility and flexibility to dynamically configure the network functions and services faster with intelligence and automation.

End-to-end distributed networks compound complexity with the interlinking of several sub-networks operating multiple applications and navigating several streams of packet flows. The enterprise is burdened with inefficiencies at several levels as follows:

- ▸ Multiple networks for the growing variety of applications.
- ▸ Forwarding of packets across multiple networks with a diversity of operating environments with different methods of synchrozing network functions and service chaining.
- ▸ The flow of traffic could encounter varying states of health of intermediate networks and does not flow smoothly.

Furthermore, packet forwarding needs a pathway for moving packets end-to-end. The orchestration of the network and IT functions and services across several networks cannot be done manually. Network operators face several challenges:

▸ Packet forwarding does not involve a single straight path from one end to another. Instead, the enterprise wants to program multiple hops depending on the chosen departure and destination point for packets.
▸ Service chaining with current methods like VxLAN are not scalable as packets have to flow through multiple boxes even if they don't need all the services.

Serving demanding levels of service quality

MSPs must meet more rigorous service quality standards without increasing costs as mission-critical applications are widely adopted. They must learn to calibrate the virtual and the physical network layers to meet the precise metrics desired by the enterprise. Instead of fixed function switching and routing, MSPs want to intelligent means to embed policy-based attributes into packet headers to achieve the network parameters, such as low-latency, their enterprise customers' desire. MSPs want visibility into the network at a granular level to monitor and control network performance to achieve deterministic quality of service.

Unfortunately, existing networking solutions involve laborious engineering, inflexible protocols, and sub-optimal hardware resources to scale managed services. They are unable to use intelligence to identify packets at the physical and virtual layer and their associated policies and services hop-to-hop to achieve the desired standards without disproportional increase costs. They fall short in:

▸ Coordination of the IP layer and the physical layer
▸ The intelligence required to optimize packet movement hop-to-hop in real-time
▸ Flexibility to adapt to unexpected failures in individual elements in the network
▸ Programmable network fabric to make quick adjustments
▸ Flexibility to use a diversity of hardware acceleration options to meet performance requirements
▸ A single point of execution for containerized network and IT services.

Kaloom's Unified Edge Provides Programmable Cloud-Native Networking Fabric for Bespoke Private 5G

Kaloom Unified Edge is a highly automated and virtualized network fabric with integrated switching, routing, 5G UPF, and RedHat OpenShift container platform for accelerated application deployment at the private 5G edge.

Kaloom's network architecture is uniquely suited to meet the needs of system integrators and managed service providers.

▸ Lean infrastructure with the consolidation of multiple network functions to operate far more applications with much less network equipment.
▸ Containerized networking architecture with common operating environment for networking, storage, and compute.
▸ Flexible traffic engineering that intelligently adapts to network availability and utilization levels.
▸ P4 programmable network operations for an agile and future proof network.
▸ Built-in 5G UPF for large amount of data processing, with lowest latency at the edge.
▸ Unique fabric virtualization for fully-isolated network slices.

It speeds up the process of customizing 5G networks and achieving deterministic service quality in the following ways:

▸ Customizability for application-level service quality needs using P4 programming for network configuration.
▸ SRv6 based micro-programmability for service chaining and optimization of packet routing.
▸ Heterogeneous hardware acceleration for needs of agility and data processing performance.
▸ Intelligent automated routing and service chaining for achieving the desired service quality.
▸ Granular monitoring and control of complex end-to-end networks.
▸ Telemetry for hop-to-hop network visibility.

Kaloom provides a variety of means for MSPs to design and manage networks to adapt dynamically, make adjustments with automated methods, optimize the network and recalibrate it in fluid situations. It uses programmable fabric for customized configuration of private networks tailored to enterprise needs. Its segmented routing of packets provides policy-based customization of packet forwarding for their navigation hop to hop as well as attaches the correspding services and quality attributes.

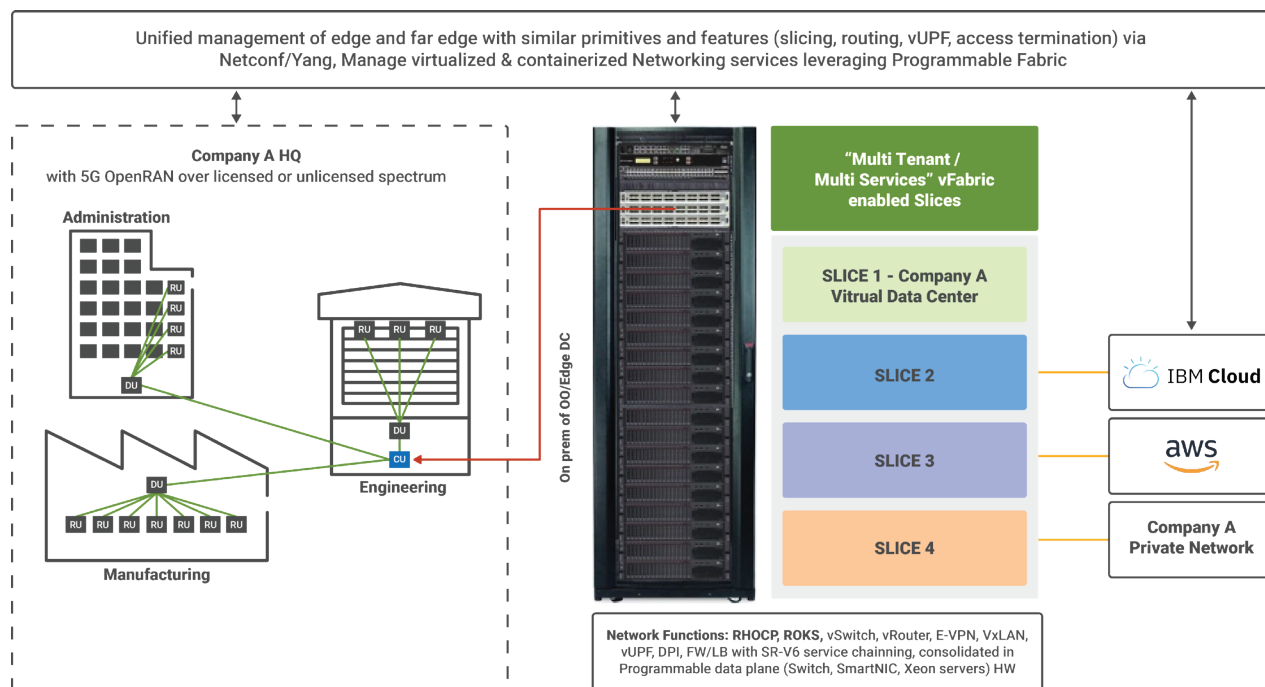## Adapting to dynamic application demands with programmable flexibility

Traditional network switches operate with embedded software with little scope for programming to increase their data processing capacity,adapt to the changing traffic mix or evolving standards and protocls like 3GPP. Current Software-Defined Network (SDN) methods, with tools like OpenFlow, are limited in adjusting forwarding rules for directing data traffic to conform to desired outcomes.

The forwarding of packets across diverse IT environments in fluid traffic conditions with fixed protocols is fraught with the risk of misalignments in traffic flow. Kaloom provides new methods for higher-level data plane programming, such as P4, to adapt to the expanding heterogeneity of network applications and flexibility in forwarding of packets. By taking a software-centric and programmable approach that leverages different hardware options (P4 programmable ASIC based switches, FPGA, Smart NICs, IPUs, CPUs), Kaloom Unified Edge easily adapts to dynamic application needs, including new requirements of 5G (and evolving wireline) networks.

Supporting unique application needs with secure 5G network slicing

The expanded heterogeneity of enterprise digital applications with distinct performance requirements for latency, throughput, jitter, and security, increases the risk of network sprawl to serve diverse application needs.

The Kaloom network fabric is the first product with full support for network slicing. The Kaloom Unified Edge is designed for multi-tenant operations, providing isolated network slices, including a 5G network. Once instantiated, the Unified Edge creates a self-forming virtualized fabric (vFabric), ensuring the complete separation of the services down to the hardware level for better security and quality of experience fitting the diverse application needs of the enterprises, yielding additional cost savings. Within each slice, it is possible to deploy several instances of virtual network functions such as virtual routers, virtual firewalls, or virtual 5G UPFs. Further, these slices can be created dynamically via automation and orchestration through API calls, supporting rapid and flexible 5G slice deployment.

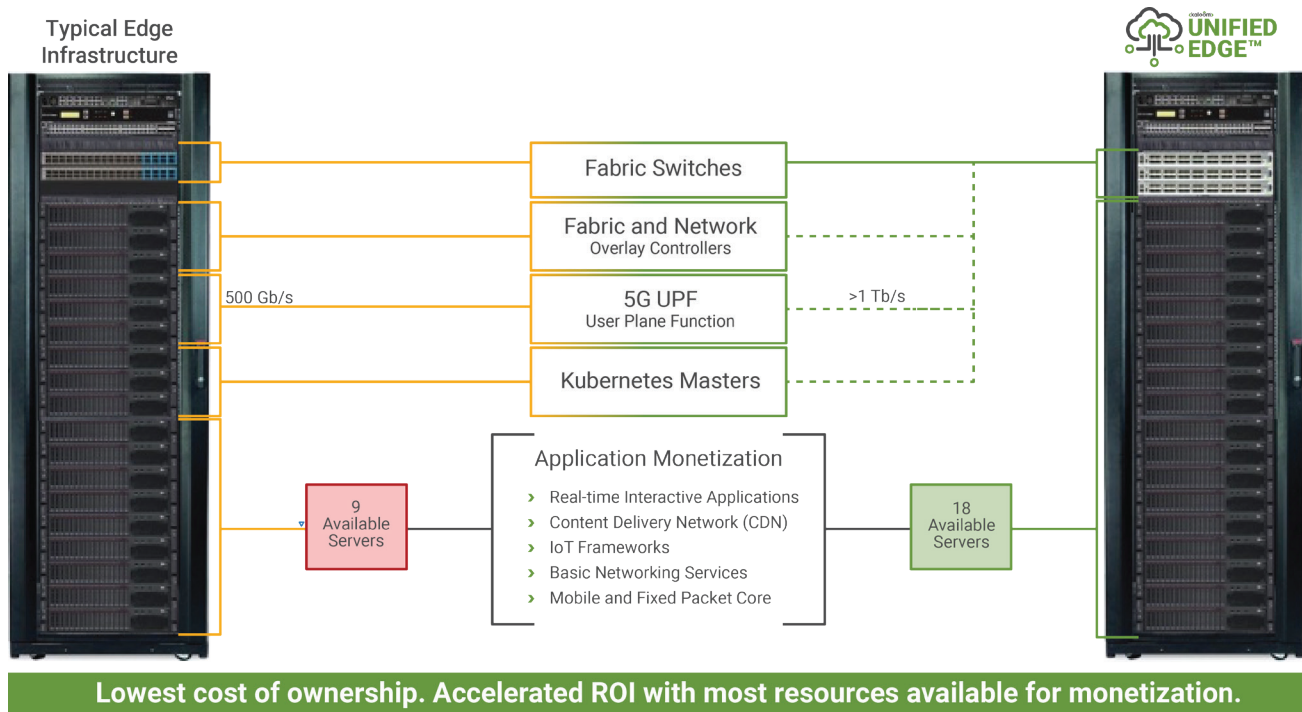**Adapting to dynamic application demands with programmable flexibility**

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Adapting to dynamic application demands with programmable flexibility

The network edge is potentially a choke point as data processing needs tend to spike and grow in volumes over time. The rack space for deploying network equipment is limited and power and cooling costs are prohibitive. Therefore, a recalibration of data processing network functions is warranted to get higher throughput and lower latencies.

Kaloom economizes on rack space, power, and cooling costs by optimizing on the use of shared pool of network resources. It uses only three OCP-compliant white box switches equipped with Intel XEON processors (used for control and management plane functions) and fully programmable high-performance packet processors (such as Intel Tofino/Tofino2) for compute-intensive data plane applications thereby significantly reducing capital and operating costs for edge deployments. Its integrated virtual router and 5G UPF can sustain multi-terabytes of data and sub-4 micro-second latency that server-optimized networking infrastructure cannot achieve.

Typical Edge Infrastructure — UNIFIED EDGE™

Fabric Switches
Fabric and Network Overlay Controllers
5G UPF User Plane Function
Kubernetes Masters
500 Gb/s — >1 Tb/s

Application Monetization
› Real-time Interactive Applications
› Content Delivery Network (CDN)
› IoT Frameworks
› Basic Networking Services
› Mobile and Fixed Packet Core

9 Available Servers — 18 Available Servers

Lowest cost of ownership. Accelerated ROI with most resources available for monetization.

Additionally, Kaloom uses containerized networking architecture with common operating environment for networking, storage, compute. Kaloom's cloud-native network fabric software increases the efficiency of space utilization at the edge by using containers to replace virtual machines. As Kubernetes has become the standard for the orchestration of containers on computing, Kaloom has applied the same technology to the network component by integrating Red Hat OpenShift into its Unified Edge soluiton. This approach allows enterprises to use the same Kubernetes platform and the underlying Linux distribution over servers and switches.

Using the same orchestration layer for these components makes resources at the distributed edge and hybrid cloud better streamlined and optimized, significantly lowering the friction for rapid deployment of network resources for edge applications.

Ensuring quality with real-time intelligence

Kaloom brings the benefits of Segmented Routing over IPv6 (SRv6), in-band telemetry, and granular policy-based packet forwarding to manage service quality and costs. Packet routes are segmented by automatically associating their attributes of policy and service chains hop-to-hop with their identities. The policies such as desired latencies or services such as load balancing are linked to the identifies of packets.

MSPs can monitor the outcomes with telemetry which provides means to make adjustments should the actual reality diverge from the expected outcomes. Kaloom provides means to make automated adjustments to maintain the quality of services. The benefits of Kaloom's methods are:

- ▸ The navigation of the flow of packets is mediated by headers with embedded intelligence to forward packets end-to-end.
- ▸ In the event the network is impaired accidentally or suffers damage, the headers are recalibrated automatically to find alternative paths for the packets.
- ▸ The flow of packets is unimpeded because telemetry brings network awareness and identifies functioning alternatives for continuous flow of traffic.

Kaloom saves costs with its programmable network fabric with shared pool of resources reusable for multiple applications. Load balancing, packet filtering, service chaining, network slicing, and telemetry are built into the network fabric in a scalable way at a fraction of the cost of monolithic network solutions. MSPs can pick and choose the functions and services they want to invoke to program a pathway that suits the preferences of their enterprise customers.

Conclusion

Managed Service Providers are coping with pervasive hetereogeniety of hardware equipment, applications and choices in network operations with rising adoption of 5G mission-critical applications. The choices help them meet the increasing diversity of demands made by the enterprise. However, old style methods of network management are a drag as they are not flexible enough to adapt quickly at a reasonable cost. Much greater automation is needed and intelligence to support it. At the edge, the enterprise needs higher reliability, security, and performance levels with less space, assets, and resources. Kaloom meets these seemingly conflicting demands by using programmable networks and intelligence, to raise performance while reducing costs.

Kaloom's programmable and unified edge contributes to the elasticity of networks by dynamically configuring its components to serve the evolving demand of applications. The accent is on the consolidation and unification of networks to remove the friction and redundancies that lead to sub-optimal utilization of networks.

References

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