

EXECUTIVE SUMMARY

Liberty Global RFI

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DriveNets' Approach

DriveNets is a fast-growing software company that has created a radical new way for communication service, transit, and cloud providers to build network infrastructure. It disaggregates the network in the same way hyperscalers built their cloud infrastructure. While the world has moved to software and cloud-native architectures, most networks have remained hardware-centric, based on complex monolithic architecture and proprietary hardware. Those do not leverage modern software technologies that enable better resource utilization, service scaling and faster innovation. DriveNets Network Cloud is changing this paradigm. DriveNets' cloud-native, software-centric networking solution supports the highest capacity and scale in the market today, with an innovative business model.

Market Background

The huge growth in demand for network capacity and scale is driving providers to rethink their network architecture. This growth is only expected to accelerate with the explosion of FTTP, OTT services, IoT devices, 5G rollouts, and the standardisation of 10G and 100G access. Providers look for innovations to handle increased network traffic while keeping costs under control.

The growing demand for higher network capacity and scale creates two primary challenges for service and cloud providers: increased cost of capacity invest and increased operational complexity, with multiple router, hardware, software versions and complex maintenance procedures, slowing innovation and reducing flexibility.

While other parts of the networking world have moved to software-centric and cloud-native architectures, most IP networks remain hardware-centric, based on a complex monolithic architecture.

Building Networks Like Clouds

Hyperscalers solved these challenges in the data center by advancing the cloud model with a pool of shared resources over virtual machines on a disaggregated architecture across low-cost white box servers.

Given today's emerging competitive threats, many providers are looking to adopt an architectural model like the hyperscalers' – radically simplifying their network's operational model and enabling optimal scaling and ease of innovation. Deploying newer software technologies that enable better resource utilisation, service scaling and revenue acceleration, and adopt cloud-centric architectural models adapted to their unique networks and requirements.

Building networks like cloud is about adapting cloud architecture principles to network design. Some of these principles include disaggregation of software and hardware, use of standard white boxes, virtualization, and the ability to run multiple applications over a shared pool of resources. All of which aim to lower infrastructure and in-life costs and accelerate service innovation and revenue streams.

Introducing DriveNets Network Cloud

DriveNets Network Cloud is a new network architecture built for massive growth, rapid service innovation, and economic profitability.

Inspired by hyperscalers' cloud architecture and network virtualization, Network Cloud supports disaggregation at multiple levels, disconnecting network cost from capacity growth and radically simplifying the network's operational model, leading to lower expenses and increasing profit.

First level disaggregation: Hardware and software. DriveNets sells only the Network Cloud software that runs over commercial off-the-shelf white boxes, which are sold directly to CSPs by their manufacturer at cost+ model. This new economic model allows CSPs to increase their profitability as service demand grows.

Second disaggregation: Router architecture. Network Cloud disaggregates the traditional monolithic router to a cluster built from just two types of white boxes. Routing functions run on top of the cluster as software instances in containers, with a cloud-native architecture. This architecture can scale from small routers to edge, aggregation, and large core routers using the same hardware solution. This approach of only two building blocks for all routing needs eliminates maintenance of tens of router models, and hundreds of inventory parts and maintenance procedures, simplifying operations and reducing OpEx.

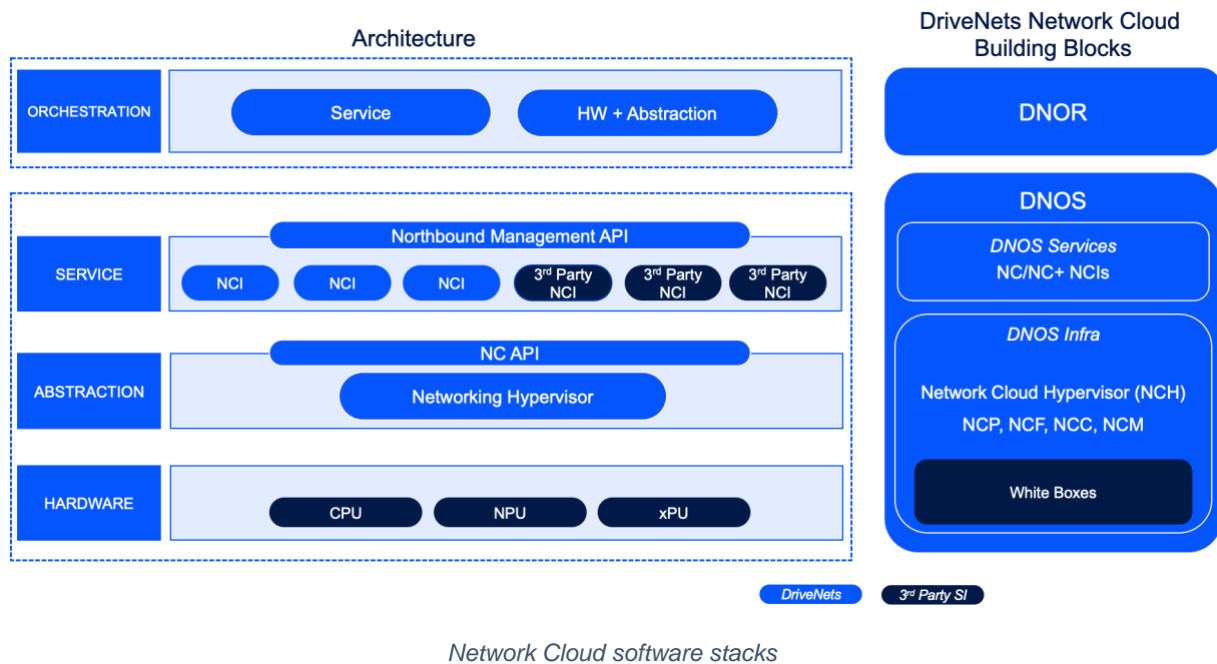
Third disaggregation: Data plane and control plane. Network Cloud's data plane runs on white-boxes and is designed to scale granularly from 4 to 691Tbps by simply adding more white boxes. The control-plane is based on containerized microservices that run different routing services for different network functions (core, edge, aggregation, etc.) Once they are colocated, service chaining allows sharing of the same infrastructure for all router services.

This disaggregation is supported by Network Cloud's orchestration capabilities, including zero-touch provisioning, full lifecycle management and automation, as well as superior diagnostics with unmatched transparency.

Software Architecture

Our modern software is built on docker containers. Every element is a collection of resources treated in the same way regardless of its function. A control card, fabric card, or line card becomes a logical function that can be easily stacked. DriveNets Network Operating System (DNOS) connects to the hardware via a hypervisor layer, allowing the solution to be hardware agnostic. DriveNets Network Orchestrator (DNOR) is responsible for full lifecycle management of all router elements.

The Network Cloud architecture is depicted in the diagram below:



Software Building Blocks

DriveNets Network Cloud comprises the following software building blocks:

DriveNets Network Operating System (DNOS) transforms lifeless boxes into live network elements. It scales from supporting a single standalone white box to hundreds of them. DNOS handles hardware abstraction and hardware resource allocation to upper-layer network functions, as well as creates large routing nodes that are automatically installed and provisioned, creating a true cloud environment in the service provider's network.

DriveNets Network Orchestrator (DNOR) is purposely designed to address the unique challenges of deploying, integrating and managing a disaggregated network. By centrally orchestrating the smooth operation of every Network Cloud element, DNOR delivers carrier-grade, scalable manageability while laying the foundation of a modern network control apparatus, complete with end-to-end automation and enabling data-driven decision making.

DNOR has three key roles:

Lifecycle management: DNOR deploys a fully automatic process to turn the discrete and disaggregated software and hardware elements of Network Cloud into complete and coherent routing entities. From zero-touch installation to hitless decommissioning, DNOR manages the full lifecycle of every Network Cloud element, both separately and as a whole.

Network intelligence & analytics: with complete network visibility, DNOR collects and analyzes data on all levels of running the network. Future releases will turn this network information into actionable insights that will unlock data-driven operation.

Service creation & provisioning: coupling network intelligence with complete software-centric gear control, future releases of DNOR will take a central position in the service orchestration stack. DNOR will allow rapid service innovation and execution from a central point, including support for self-service models.

DriveNets' Solution

Solution Components

DriveNets' solution is based on white boxes, which are built with the Open Compute Project's (OCP) Distributed Disaggregated Chassis (DDC) design and can be purchased from several ODMs.

Each of the required node types can be built using some of the basic hardware elements below:

Network Cloud Processor (NCP- 36CD-S) – 2RU:

2x Broadcom Jericho2c+ (deep buffer)

Scaled – Broadcom OP2 chip (high network scale)

32x400G + 40x400G fabric ports



Network Cloud Processor (NCP- 10CD) – 2RU:

Broadcom Jericho2 (deep buffer)

Broadcom OP2 chip (high network scale)

10x400G + 13x400G fabric ports



Network Cloud Fabric (NCF-48CD) – 2RU

Broadcom Ramon (fabric cell switch)

19.2Tbps switch capacity (48x400G)



Network Cloud Management (NCM) – 1RU

Internal control and management switch

Broadcom Qumran MX 48x10GE + 6x100GE



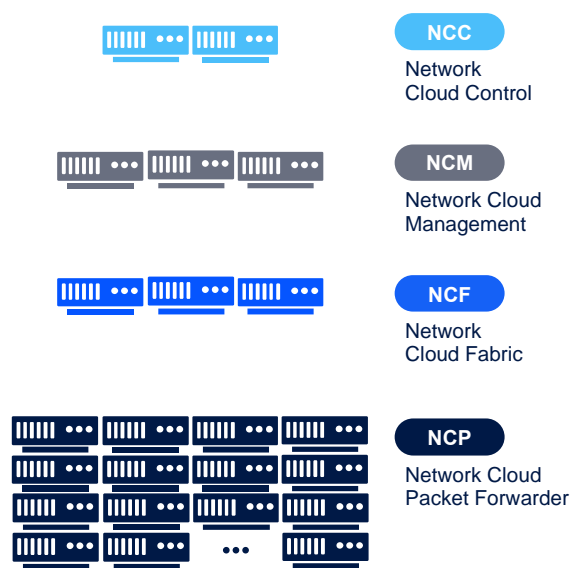
Network Cloud Controller (NCC) – 1RU

X.86 COTS cluster controller server

At least 32 core CPU, memory 96G



The DDC architecture is depicted in the figure below:



The entire DDC operates like a regular router. The main difference is that it is built of disaggregated white box elements rather than customized building blocks integrated in a chassis.

The NCC represents the route engine/processor and runs the Network Operating Systems and hosts the control plane of the system.

The NCM establishes a out-of-band network to interconnect all system elements.

The NCF represents the switching fabric. All user traffic between network ports of different NCPs is cell-switched via the NCFs.

The NCPs represent line card elements. NCPs host the network ports. The combination of NCPs and NCFs represent the data plane.

A Cluster configuration will allow Liberty Global to add newer white boxes with higher rate Ethernet interfaces as required. Clusters can be scaled horizontally as needed. The Cluster configuration meets most high-availability and redundancy criteria.

Disaggregation of hardware and software allows DriveNets to provide a transparent business model which helps Liberty Global achieve best-in-class pricing, knowing that it is not locked into a specific hardware vendor indefinitely. By breaking the linkage between hardware, software, and the services offered, Liberty Global may decide that deploying new and improved hardware options mid-project is more beneficial and cost-effective than providing ongoing support for an aging hardware platform, with increasing associated support costs.

Paying for software once and not having this linked to the underlying hardware also provides a massive benefit - when the physical network needs to be upgraded Liberty Global does not have to purchase software again.

Summary

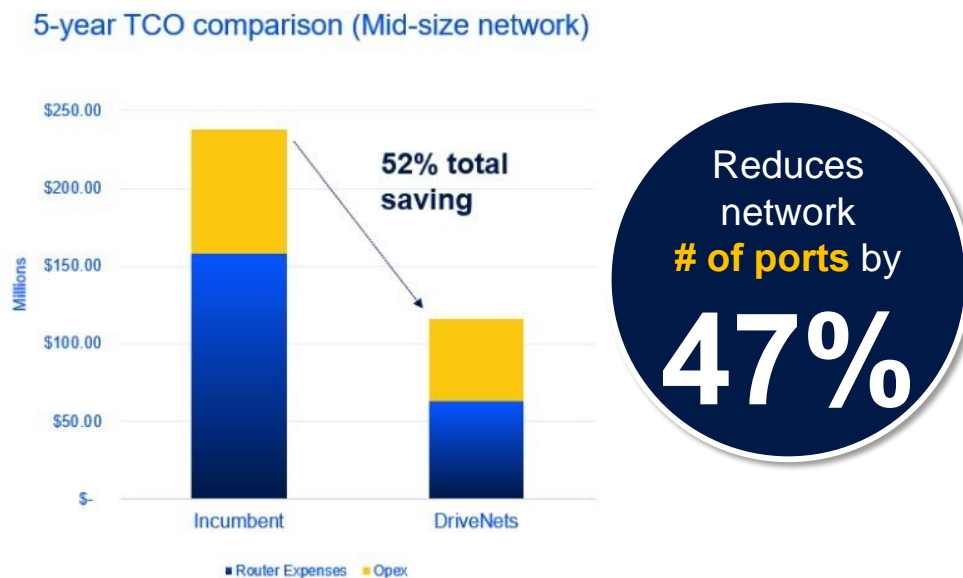
DriveNets approach to building networks like cloud provides Liberty Global with the flexibility it requires when refreshing its IP routing and switching layer, ensuring capacity and service demands continue to be met. DriveNets' solution can scale from 4Tb to 691Tb, with the ability to scale horizontally as new capacity is required in any geographic location.

By adopting cloud-native principles, Liberty Global will radically transform its cost base and improve the services offered. A truly cloud-native software stack allows the agile and cost effective delivery of new services and features to Liberty Global, whilst ensuring the highest levels of availability.

De-coupling the software and service layer from the underlying physical network will allow Liberty Global to avoid being trapped with expensive long-term extended support costs as white boxes can be swapped out easily to take advantage of the network economics that next-generation chipsets provide in both price and speed. Enhancing the underlying transport network while maintaining the services (with software stability) provides Liberty Global with a supportable and flexible setup allowing for growth and reliable future support of new requirements, in addition to providing Liberty Global with investment protection.

The DriveNets Network Cloud solution can help reduce OpEx by providing significant savings in power, rack-space and cooling, which should always be a key consideration.

Running multiple applications over a shared pool of resources, can produce significant savings in port utilisation and TCO. Combined with the principle of disaggregation of software and hardware and the use of standard white boxes, should lead to lower infrastructure and in-life costs.



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