DRIVENETS
Network Rising

SOLUTION
BROCHURE

HIGH-SCALE, CLOUD-NATIVE, NETWORK-CENTRIC, OPEN SOLUTION

DRIVENETS: BUILDING NETWORKS LIKE CLOUDS

DriveNets Network Cloud is a software-based, high-scale, open networking solution based on cloud-native architecture and standard networking white boxes that provides a shared compute and networking infrastructure to run any service, on any port, at any scale. With built-in routing and automation services, DriveNets Network Cloud simplifies the network architecture from core to edge and reduces costs while optimizing scaling and accelerating new revenue opportunities with third-party service hosting.

DriveNets Network Cloud allows service and cloud operators to build their network like clouds and to leverage the cost, flexibility and innovation benefits of this new architecture. It takes inspirations from cloud-native, virtualized architecture of hyperscale clouds and adapts it to high-scale networks.

Separating hardware from software, the data plane is disaggregated from the control plane, running cloud-native software on standard networking white boxes from multiple ODM vendors. Relying on a simplified, distributed architecture and a fully virtualized hardware infrastructure, it can easily scale from 4 Tbps to 768 Tbps, supporting routing services – from core to edge – and any hosted third-party network-centric service – with maximum efficiency and at the lowest cost.

DriveNets Network Cloud brings an efficient operational model that's as simple to operate as traditional networks, advancing cloud benefits in the network.

DriveNets Network Cloud main benefits are:

- ***Lowest Cost:*** *Unified, cost optimized hardware building blocks, optimal resource utilization and multiservice over shared PoD*
- ***Optimal Scaling:*** *Any size distributed router with separate capacity and service scaling paths.*
- ***Ease of Innovation:*** *Software-paced innovation for faster time to market*

The Network Cloud platform comprises:

DRIVENETS NETWORK OPERATING SYSTEM (DNOS)

A distributed cloud-base infrastructure and NOS that create a unified shared compute and networking platform, supporting integral routing and third-party services instances from core to edge.

DriveNets Network Operating System (DNOS) is a cloud-native, distributed networking software, built on containerized microservices, which creates a unified, shared infrastructure over a distributed architecture. DNOS supports multiple service offerings at scale, including routing - from core to access- and hosting for third-party network-centric services.

- **Hardware Agnostic:** Creates a shared resource pool by abstracting any hardware resources for multiple OCP-standard ODM
- **High Availability, Carrier Grade:** Inherently provides support for high availability and resiliency through containers, microservices, and smart cluster management
- **Rich Set of Network Solutions:** Includes core, aggregation/peering, edge, 5G, access routing and hosted third-party network-centric services

DRIVENETS

Introducing DriveNets Network Cloud

From Traditional Chassis to Disaggregated Software-Based Networking

WHITE PAPER

The huge growth in demand for network capacity and scale is driving service providers to rethink their network architecture. That growth is only expected to accelerate with the explosion of OTT services, IoT devices, and 5G rollouts. While the networking infrastructure necessary to support this traffic growth requires a sizable investment, service providers are currently operating on thin margins. As such, they are eagerly looking for innovations that can handle the increased network traffic while keeping costs under control.

While other parts of the networking world have moved to software and cloud-native architectures, most networks still remain hardware-centric, based on complex monolithic architecture. They are not taking advantage of newer software technologies that enable better resource utilization, service scaling and more valuable economic models.

Building Networks Like Clouds

Hyperscalers solved these challenges in the datacenter 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 service providers are looking to adopt an architectural model similar to the hyperscalers – radically simplifying their network's operational model, and enabling optimal scaling and ease of innovation.

Building networks like cloud is about adapting cloud architecture principles to network design. Some of these principles include separation (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 costs and to accelerate innovation.

Market Needs

The growing demand for higher network capacity and scale creates two primary challenges for service and cloud providers:

- **Declining profitability** – Costs increase with capacity growth, requiring heavy network investments while revenue remains stagnant.
- **Increasing operational complexity** – Multiple routers and a variety of physical infrastructure increase operational complexity due to the wide range of hardware and software versions and maintenance procedures. This complexity is costly and slows network evolution and upgrades.

Network service providers are looking to adopt the cloud resource pooling approach and architectural model, adapted to their unique networks and requirements.

Networking Challenges and Trends

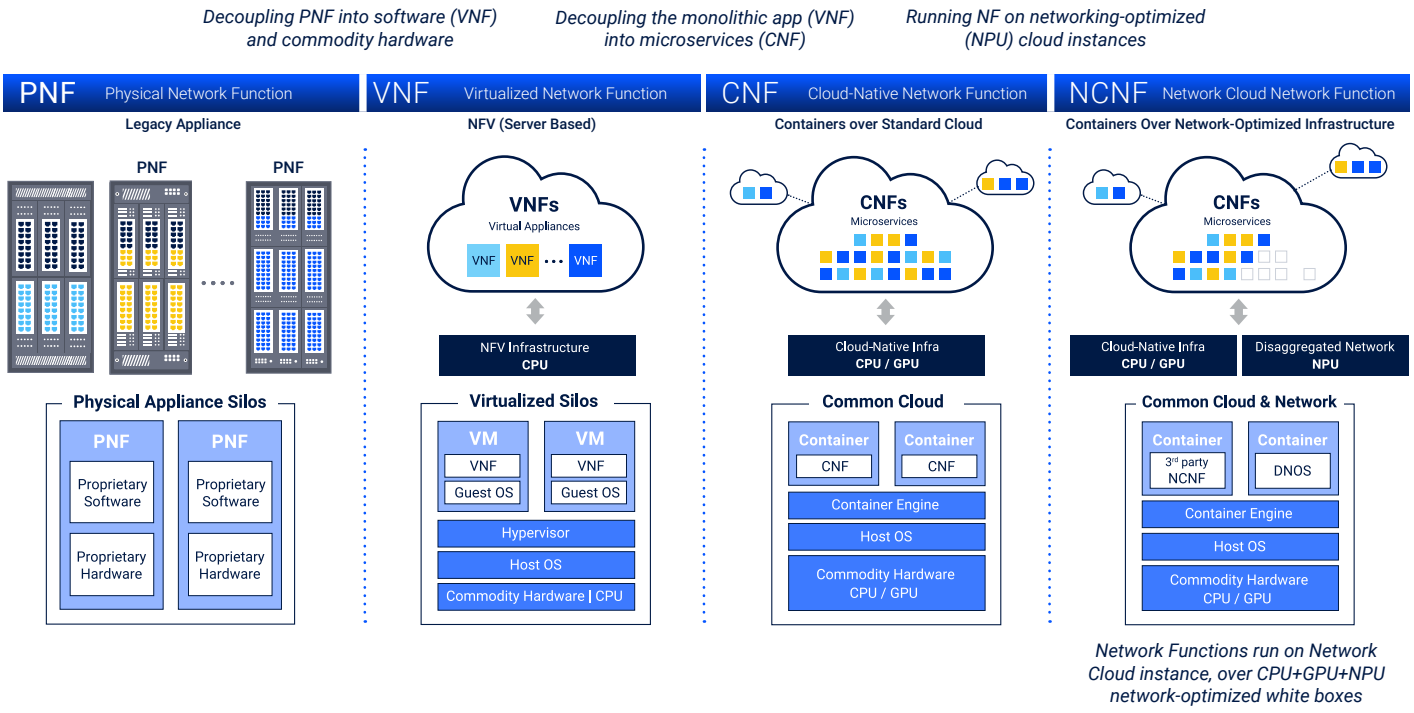
Today's networks are based on proprietary hardware-centric router infrastructure. Due to the monolithic design of the router, these networks are service-oriented, meaning that even in networks that are colocated, each service (whether a mobile backhaul, internet edge, business service or core network) runs on its own batch of dedicated chassis-based routers.

Since these dedicated resources cannot be shared as a pool of network resources, it results in an inefficient and costly physical infrastructure. Networks are designed for peak usage, leaving them severely underutilized most of the time. Concurrently, since router vendor revenue is tied to the number of ports sold, vendors are not motivated to change their "single-service" routing model to make networks more efficient.

The hardware-centric infrastructure imposes key challenges on service providers:

- **Profitability** – A strained cost structure where expenses are tightly linked to capacity
- **Scale** – Having to add services with monolithic software while avoiding upfront investments
- **Agility** – A slowed pace of development/innovation for hardware-based, purpose-built networks

When looking for a new network architecture that is software-based, high-scale, open, and simple to operate, we found that the hyperscalers have already solved these challenges for datacenters by radically changing their architecture. They disaggregated the software from the hardware and introduced a virtualization layer that allows multiple applications to share the hardware resources and consume them only when needed. With the new virtual machine (VM) resource sharing model, the high-end servers could be replaced with many low-cost white boxes.



Network Functions run on Network Cloud instance, over CPU+GPU+NPU network-optimized white boxes

DriveNets Network Cloud Solution

To solve the same challenges for service and cloud providers, DriveNets has adapted and enhanced cloud approaches and applied the following principles to the DriveNets Network Cloud solution:

- **Software-based network** – The network operating system and services are based on microservices and containers
- **Disaggregation of hardware and software** – The software-based network can run over standard white boxes, and can scale to support a single white box router or a large router based on a cluster of 10s and even 100s of white boxes
- **Network resource pooling** – Fully virtualized network supporting any service on any port sharing a pool of networking resources, CPU processing power and more

Network Operator Benefits

Open, software-based architecture is more efficient with network hardware resources and therefore more relevant to the traffic growth and demand changes impacting operators today. DriveNets Network Cloud solution supports a variety of network-function sizes with the same white box building blocks and can scale from a single-box based router to the largest router size available in the market, with the same software. This architecture offers the most efficient way to build networks while significantly reducing the amount of hardware resources required in the network, leading to significant benefits:

- **Lowest cost** – Unified, cost-optimized hardware building blocks, optimal resource utilization and multiservice over shared Point-of-Delivery (PoD)
- **Optimal scaling** – Any size distributed router with separate scaling paths for capacity and services, using he same building blocks for any use case
- **Ease of innovation** – Software-paced innovation for faster time to market

DriveNets Network Cloud solution simplifies the network's operations and offers carrier-grade, telco-scale performance at a much lower cost. A comparison of white box and traditional routers shows the clear value of DriveNets Network Cloud:

Traditional Routers	White Box Routers
Monolithic, chassis-based	Based on low-cost white boxes
Different chassis models and sizes are used in different locations in the network	Same white box building blocks (data plane) are used for any size router in any location
Vendor lock – same vendor software and hardware, low probability of mix-and-match vendors	Mix-and-match vendors - hardware and software sold independently from different/multiple vendors
Separate infrastructure for different networks and services, with minimal resource sharing	Cloud-native software enables different networks and services to run in separate containers over a shared physical infrastructure, maximizing resource utilization with virtualization
High cost	Low-cost standard networking white boxes from a choice of vendors, and cost-effective software licensing model
Complex and costly NFVs designed to scale services	Low-cost, cloud-native software and containers designed to scale services

DriveNets Network Cloud Solution Highlights

DriveNets Network Cloud introduces a radical, innovative, and cost-effective way to build networks. It applies cloud approaches to service providers' networks, significantly simplifying the network's operational model, and enabling substantial growth, rapid service innovation and greater service profitability.

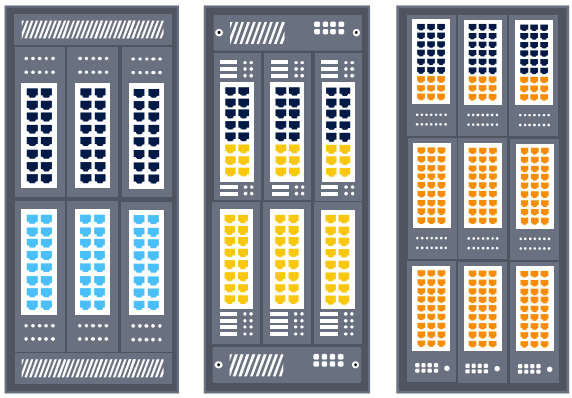
- **Cloud-native software** – Built with containerized microservices, creating a unified shared infrastructure, and enabling any service, on any port, at any scale

- **Flexibility** – From a 4Tbps single-box router to a cluster of white boxes that operate as a single carrier-grade router of up to 691.2Tbps
- **Same building blocks, any use case** – Rich service offering including core, aggregation/peering, edge, access, data center interconnect (DCI), 5G, and more, using the same hardware building blocks and running on open standard white boxes (built on networking merchant silicon and COTS x86 servers)
- **Carrier grade ecosystem** – Full ecosystem including software, hardware, cabling, and professional services, meeting the demands of Tier-1 carrier-grade service providers
- **Software-based license model** – Independent from hardware constraints
- **Open, standard and field-proven** – Deployed in AT&T's core network, supporting the distributed disaggregated chassis (DDC) submitted to the Open Compute Project (OCP)

DriveNets Network Cloud Solution Architecture

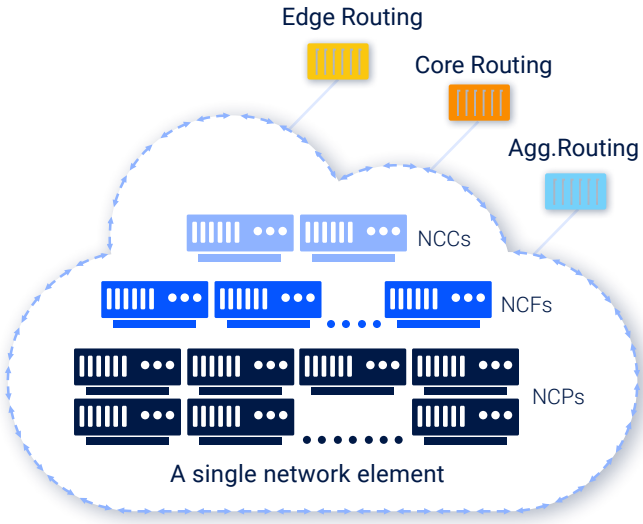
DriveNets Network Cloud architecture is flexible and modular, enabling a variety of deployment models. It can run within a single white box (standalone mode) or in a cluster mode over multiple white boxes interconnected using Clos topology and operating as a single router.

Monolithic Chassis



Agg. Router Edge Router Core Router

DriveNets Network Cloud



DriveNets Network Cloud takes the big router and breaks it down into white box building blocks, running cloud-based software on top of it. It disaggregates the control and data planes, allowing each to scale independently. The control-plane runs on x86 servers and the data plane is implemented with a cluster of white boxes. The data plane is built from just two building blocks: **Network Cloud Packet Forwarder** (NCP) and **Network Cloud Fabric** (NCF), and it scales from a single standalone solution of 4-12.8Tbps to a large cluster of 691.2Tbps made of dozens of white boxes operating as a single routing entity.

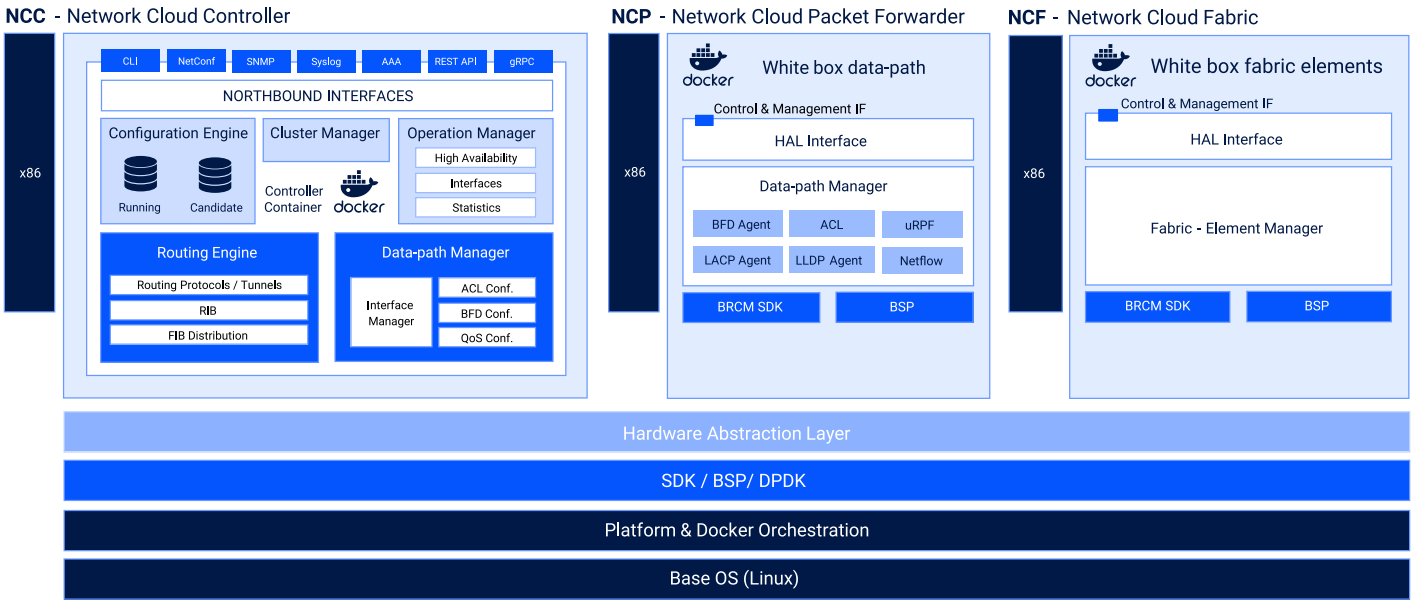
DriveNets Network Cloud cloud-native software also allows for additional services that run in separate software containers. Each networking function, which runs a **Service Instance** (SI) microservice in a cloud container, can be allocated with any hardware resources (physical interfaces, NPU, CPU, TCAM, QoS etc.) of the underlying hardware-shared infrastructure.

Unlike a typical Clos cluster, where every hardware/software router instance must be managed separately and looks like a separate router to other routers, the DriveNets Network Cloud makes a disaggregated "cluster'

router look like a a single router in all respects. No matter how large or complex is the configuration, or how many white boxes are used, the cluster is connected and managed like a single network element. The same way cloud orchestration is turning a series of connected servers into a resource pool of unified virtual host, DriveNets Network Orchestrator (DNOR) enables disaggregated networks with cloud-computing-like shared infrastructure.

While DNOR provides all the elements for orchestration and automation of the solution lifecycle management from the top down, DriveNets Network Operating System (DNOS) delivers the actual functionality from the bottom up. DNOS operating system is a cloud-native, distributed networking software, built on containerized microservices, which creates a unified, shared infrastructure over a distributed architecture.

To ensure open architecture, the DriveNets Network Cloud solution is ready to run on any network cloud-certified hardware platform, and is the first to support AT&T's Distributed Disaggregated Chassis (DDC) architecture, submitted to the Open Compute Project (OCP).



Conclusion

The network is a key asset and differentiator for both service and cloud providers. Facing business and technical challenges, the traditional network model based on proprietary, chassis-based devices has become irrelevant. Service and cloud providers are now looking for alternative software-based solutions that are open, highly scalable, simple to operate, and low-cost.

DriveNets Network Cloud solution offers a single disaggregated networking solution for building core, edge, peering, and access network, as well as an open, scalable, simple, and cost-effective approach.

The time for transforming to software-based networks has arrived. DriveNets Network Cloud makes it possible and real, today.

DRIVENETS

NCNF: From “Network on a Cloud” to “Network Cloud”

The Evolution of Network Virtualization

WHITE PAPER

Introduction

DriveNets Network Cloud allows communications service providers (CSPs) and cloud providers to evolve their infrastructure and enable the implementation of an efficient edge cloud architecture that also supports latency-sensitive applications. Moreover, Network Cloud delivers performance improvements and significantly reduces total cost of ownership (TCO) by using telco assets in an optimal way.

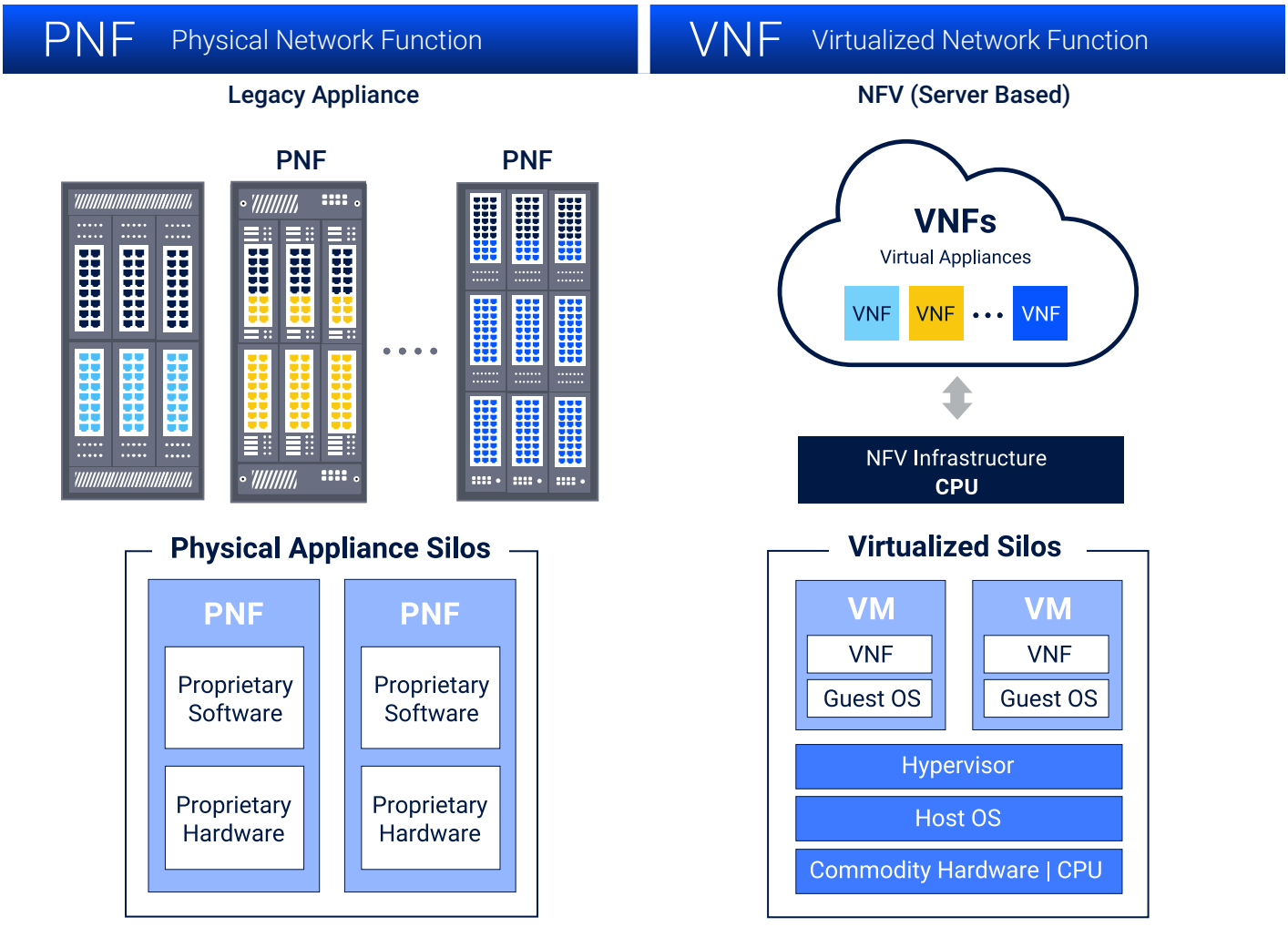
The DriveNets Network Cloud model addresses the same network, service-scaling and time-to-market challenges that network function virtualization (NFV) has tried to solve. It completes the journey from physical network functions (PNFs) and virtualized network functions (VNFs) through cloud-native network functions (CNFs) and now to Network Cloud network functions (NCNFs).

This journey started with VNFs that eliminated some limitations of PNFs, but were not geographically scalable. It continued with the introduction of CNFs that addressed geo-scalability but were not networking optimized. It now has reached ultimate optimization by "building networks like clouds" with the creation of NCNFs.

Virtualized Network Functions (VNFs)

Building networks is complex. The notion of simplifying it by disaggregating network functions from the hardware they run on is not new. Network function virtualization (NFV) introduced the concept of the virtualized network function (VNF) that enables replacing a monolithic solution with a software implementation of a network function over an x86-based server.

Decoupling PNF into software (VNF) and commodity hardware



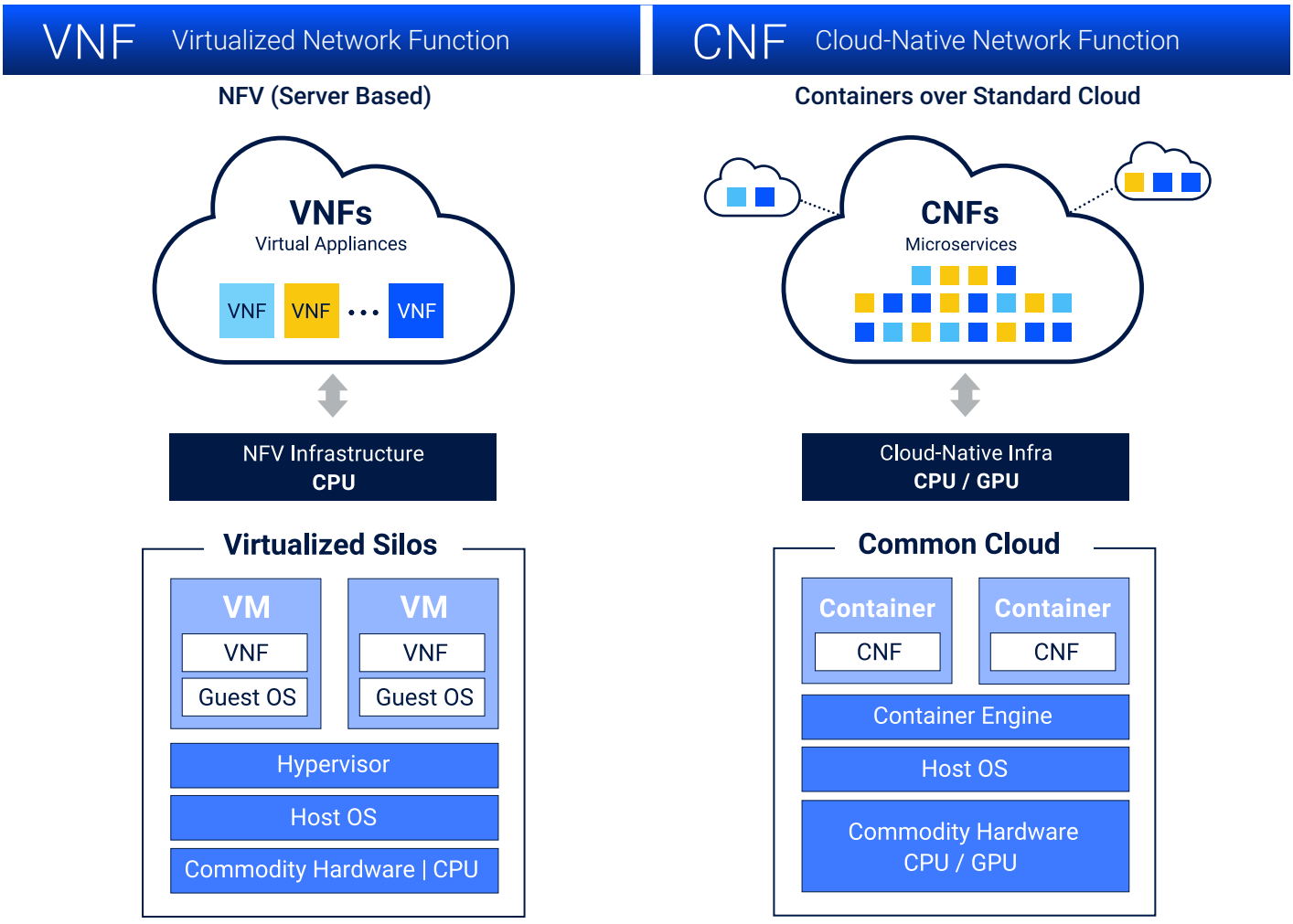
The previous physical network function (PNF) architecture is based on monolithic network elements, purpose-built to implement a single network function such as a router (e.g. core, edge or access), a firewall, or deep packet inspection (DPI). This architecture is extremely non-cost-efficient as it requires multiplication of hardware elements across the network. VNFs eliminate the limitations of the monolithic chassis by implementing the network function over a standard, scalable, unified hardware infrastructure, i.e. x86 servers.

While providing some value to service providers, VNFs lack the ability of easily deploying and scaling network functions (NFs) across multiple sites. With VNFs, adding a networking site requires significant investment in IT infrastructure, which blocks VNFs from being utilized and scaled on a global scale.

Cloud-Native Network Functions (CNFs)

The next step, therefore, was the move to cloud-native network functions (CNFs). This architecture allows an elastic implementation model for NFs, including dynamic resource allocation and even porting of these functions according to service needs. Developed using microservice architecture, CNFs can run, essentially, in containers over any cloud infrastructure. This gives operators a truly elastic network in which they can implement functions over a public, private or hybrid cloud.

Decoupling the monolithic app (VNF) into microservices (CNF)



CNF Limitations

While running network functions over cloud instances increases service scale and flexibility, it also introduces great inefficiencies and high costs. A server-based cloud architecture utilizes CPU (central processing unit)

and GPU (graphic processing unit) resources, which are optimized for wide-ranging applications but not for networking functions. This means that when running a CNF over a CPU/GPU infrastructure, performance falls short (e.g. in terms of forwarding capacity, queueing and buffering, and access list scalability), and service quality can be degraded. This substantially limits the introduction of new services, especially latency-sensitive ones that are classified as ultra-reliable low-latency communications (URLLC) in the 5G arena.

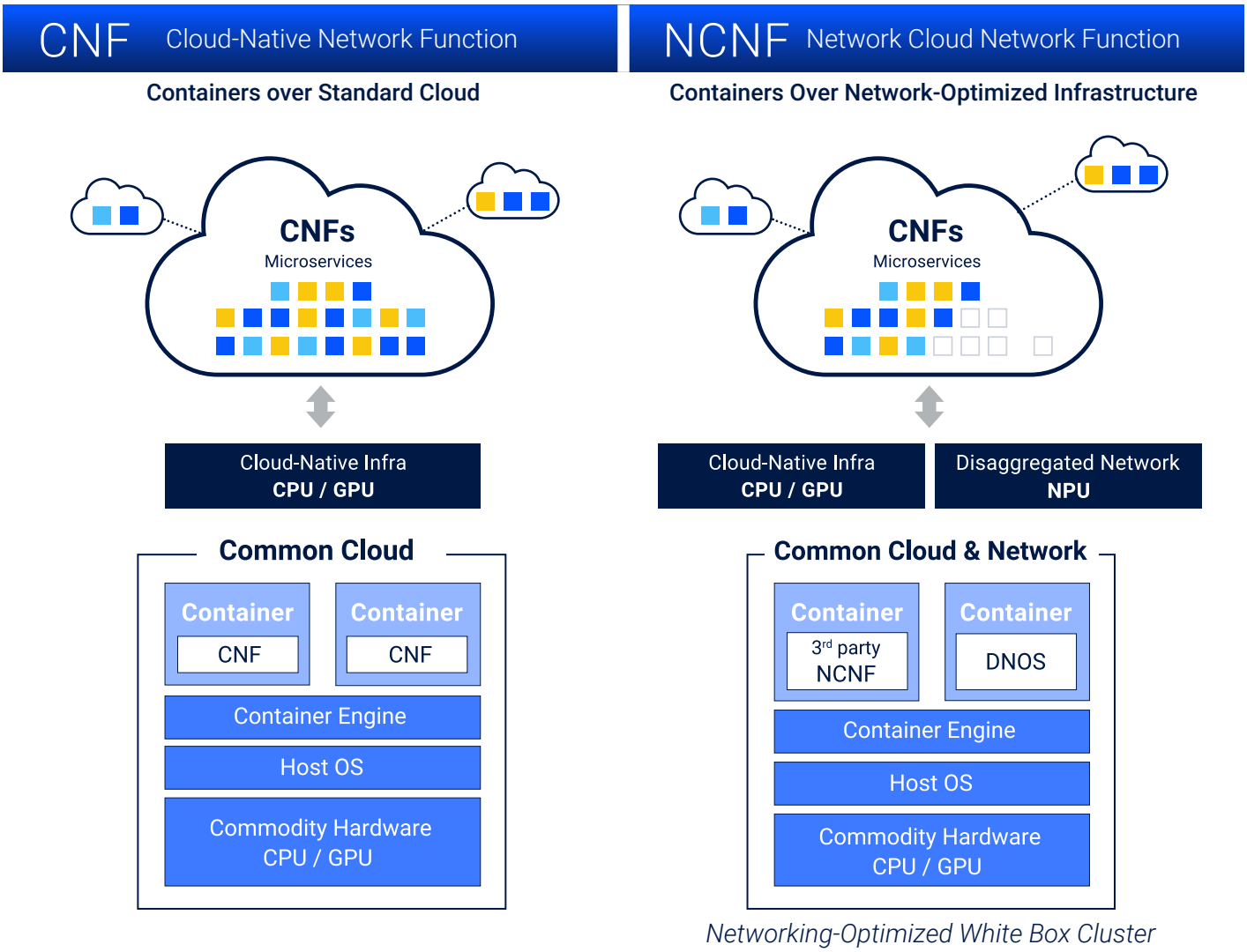
These limitations are extremely hard to resolve. Gathering enough processing power to perform network functionality means stacking a large number of servers; this is inefficient in terms of power and floor space, and is not feasible in the network edge where real-estate is limited.

Harnessing networking-optimized network processing units (NPUs) to perform these network functions can efficiently address scaling of network-aware services. Unfortunately, the platforms supporting them, mainly routers, are proprietary and closed, and do not offer the APIs and abstraction layer needed to run NF microservices as containers efficiently at scale.

Network Cloud Network Functions (NCNFs)

DriveNets Network Cloud enables the long-awaited solution to this scaling limitation. Network Cloud is a cloud-native architecture based on a cluster of networking white boxes, which incorporate CPUs and NPUs to address the networking-specific requirements of network functions. These NFs are implemented over the networking-optimized cloud in an architecture called Network Cloud network function, or NCNF, which utilizes a combined CPU and NPU resource pool.

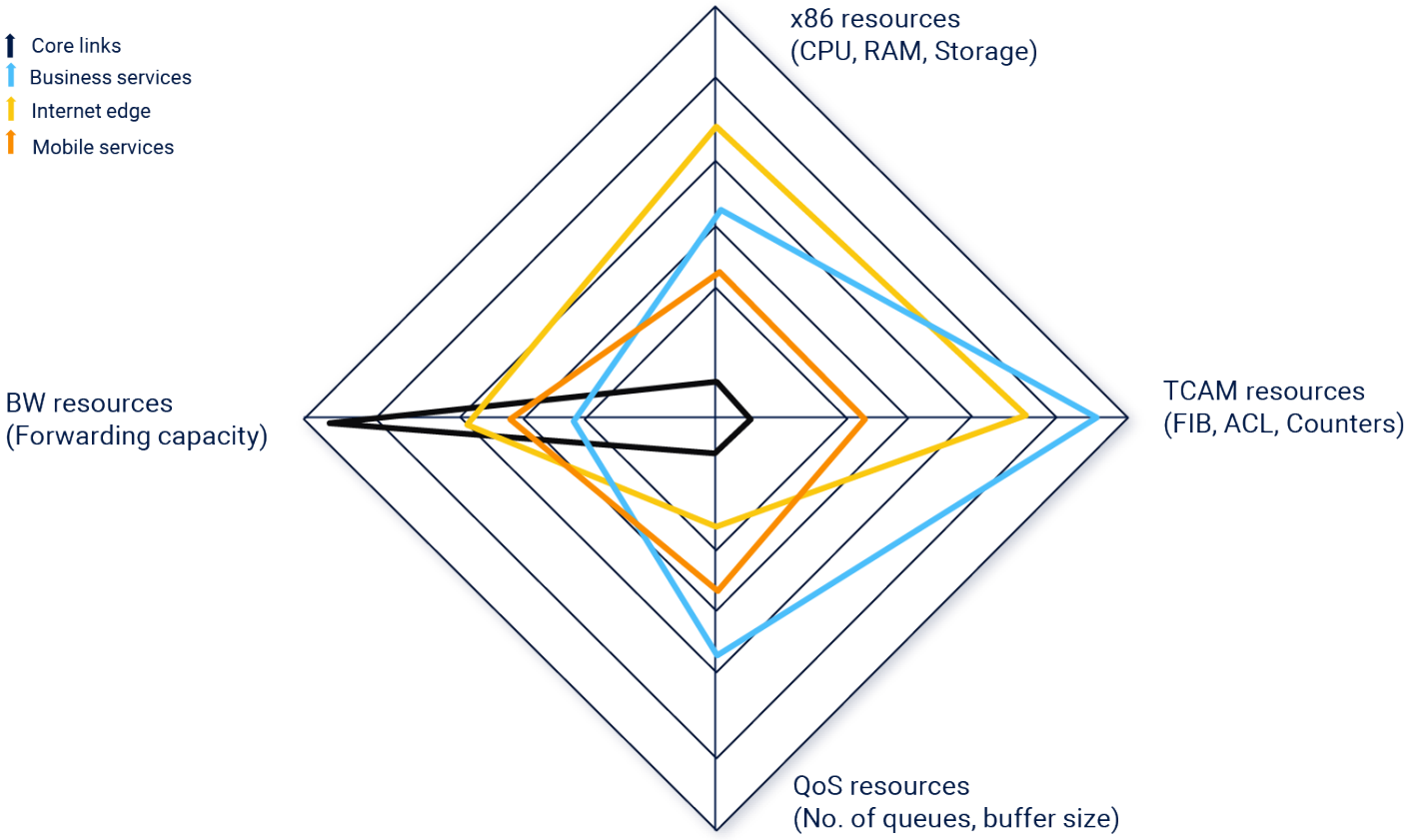
Running NF on networking-optimized (NPU) cloud instances



Networking-Optimized White Box Cluster

The NCNF architecture allows operators to efficiently implement functions that require intense networking resources over a lean infrastructure of CPUs and NPUs. This is achieved by sharing resources across different instances of the hardware infrastructure, thus allowing optimal utilization of bandwidth resources, x86 resources, QoS resources and TCAM resources, which are typically not balanced by a single service.

The following diagram illustrates the different resource requirements for different network services:



Resource sharing allows full utilization of infrastructure resources. For example, infrastructure can be shared between core and business services networking functions, which represent a highly complementary requirement map for BW and TCAM resources.

This implementation of NFs over the NCNF infrastructure not only improves resource utilization but also enhances service quality, by using optimized NPUs for networking functions. It also allows the tight integration of additional NFs with the networking infrastructure. These NFs can include firewall, DDoS prevention, DPI, content delivery network (CDN), and Evolved Packet Core/5G Core (EPC/5GC), among others.

This tight integration leads to another major benefit – the ability to dynamically adjust and optimize NFs based on a wide array of traffic and performance metrics collected, in real time, by the NCNF infrastructure. For instance, this could enable a significant reduction in remedy time and an increase in scale of a DDoS prevention platform, or change how a CDN distributes streaming content according to specific performance parameters in every network edge zone.

NCNF architecture offers the following key advantages:

- Efficient sharing and optimal utilization of network resources
- Enhanced service quality via optimized NPUs for networking functions
- Tight integration of NFs with networking infrastructure
- Dynamic optimization of NFs via real-time collection of traffic/performance metrics

The Edge Cloud – the New Edge

All of the forementioned advantages of the NCNF architecture become essential when it comes to time/latency-sensitive applications. Such applications are gaining momentum with the introduction of the 5G URLLC use case and the ongoing development of Industry 4.0 remote operations applications, as well as gaming, augmented reality (AR) and virtual reality (VR) apps.

These applications do not yet represent a major portion of traffic running through the CSP network, though this may change with the massive introduction of AR/VR devices and the maturing of level-5 autonomous vehicle technology. However, these apps represent a fast-growing portion of operators' revenues. Moreover, they require end-to-end time-sensitive networking (TSN) performance, which is changing the way the network edge is planned and built.

The new network edge is no longer only about compute and storage resources; it is, more than ever, about networking resources. As such, the advantages of NCNF architecture become a must in any edge implementation, making the concept of the "edge cloud" the networking-aware successor of the edge-computing function.

Conclusion

There is a new way of building networks for communication service providers, hyperscalers and other network operators. The DriveNets Network Cloud architecture is essential in any modern network as is it the only one that can integrate compute and networking resources while addressing service providers' cost, scaling and innovation challenges.

DRIVENETS

ABOUT DRIVENETS

DriveNets is a fast-growing software company that builds networks like clouds. It offers communications service providers and cloud providers a radical new way to build networks, detaching network growth from network cost and increasing network profitability. Founded by Ido Susan and Hillel Kobrinsky, two successful telco entrepreneurs, DriveNets Network Cloud is the leading open disaggregated networking solution based on cloud-native software running over standard white boxes. DriveNets was awarded the Leading Lights award 2020 for Company of the Year (Private) and 'Innovation Award – Vendor' at the 21st Annual World Communications Awards. To find out more, visit **www.drivenets.com**

DRIVENETS
Network Rising

COMPANY OVERVIEW

DRIVENETS: BUILDING NETWORKS LIKE CLOUDS

DriveNets is a fast growing software company that has created a radical new way for communications service providers and cloud providers to build networks. 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 software. They are not taking advantage of newer software technologies that enable better resource utilization, service scaling and innovative economic models.

DriveNets Network Cloud is changing the game. The software-based networking solution supports the highest capacity and scale in the market today, with an innovative economic model.

- **Disrupting the networking market –** moving it 20 years forward to cloud-native software
- **Customer-proven –** providing AT&T's core network and in various phases of engagement with 18 tier-1 providers
- **New economic model –** offering network services in an Infrastructure-as-a Services (IaaS) model, running over a shared infrastructure of white box clusters
- **Highest scale –** uniquely scales from a single-box router (4 Tbps) to clusters of 100s of white boxes (768 Tbps router)
- **Tier-1 ecosystem –** supported by leading chip manufacturers, white box ODMs, optical equipment, and software apps providers

THE DRIVENETS STORY

DriveNets was founded by Ido Susan and Hillel Kobrinsky, two successful telco entrepreneurs. Previously, DriveNets' CEO Ido Susan founded Intucell, the company that invented the Self Optimizing Network (SON). In 2013, when he was just 26 years old, it was acquired by Cisco for $475 million. After the acquisition, Ido held a leading role in the global mobility solutions business unit at Cisco. He worked there until co-founding DriveNets in 2015.

DriveNets' co-founder and now Chief Strategy Officer, Hillel Kobrinsky, had previously founded Interwise, a Web Conferencing software company. In 2007 it was acquired by AT&T for $121M.

DriveNets raised $117M in its Round A funding from Bessemer Venture Partners, Pitango Venture Capital and several private investors.

DriveNets at-a-glance

- *Founded: 12/2015*
- *Headquarters: Israel*
- *Mission: build networks like clouds - software-based, disaggregated and fully virtualized, running over standard white boxes*

Funding

- *Round A in 2019, $117 million*
- *Round B in 2021, $208 million*

Industry Recognition

- *Fierce Innovation Award*
- *Leading Lights Award – company of the year*
- *Broadband Awards*
- *CRN Emerging Vendor*
- *Gartner Cool Vendor*
- *Business Insider bet your career*
- *Globes Most Promising Startup*
- *World Communication Award – vendor of the year*

Learn More

- *Visit us at: www.drivenets.com*
- *Call: +972-9-744-4726*

> *Having a much more software-centric network allows us to respond much more rapidly to any new demand on the network, even those caused by worldwide pandemics…*
>
> *We chose DriveNets, a disruptive supplier, to provide the Network Operating System (NOS) software for this core use case.*

Andre Fuetsch
CTO of Network Services
AT&T

FROM TRADITIONAL CHASSIS TO DISAGGREGATED SOFTWARE-BASED NETWORKING: NETWORK CLOUD

DriveNets Network Cloud is a high-scale solution based on cloud-native software running on standard networking white boxes available from a selection of manufacturers. It simplifies the network's physical and operational model, automates its life-cycle management, and avoids monolithic feature sets, all of which overcome the limitations of traditional hardware-centric routers.

DriveNets Network Cloud uniquely supports the complete virtualization of network and compute resources, enabling communication service providers and cloud providers to meet increasing service demands much more efficiently than with today's monolithic routers. Its unique design also allows faster service innovation at the Network Edge, supporting multiple service payloads, including latency-sensitive ones, over a single physical network edge infrastructure.

DriveNets Network Cloud comprises:

- **DNOS –** DriveNets Network Operating System (NOS) – a distributed NOS, creating a unified shared infrastructure over a distributed architecture, supporting multiple service offerings, including core, aggregation, peering, edge and access routing
- **DNOR –** DriveNets Network Orchestrator – automates the deployment, scaling and management of DriveNets Network Cloud solution, removing the complexity of provisioning and managing a distributed multi-vendor disaggregated network
- **White Boxes –** standard networking white boxes, based on merchant silicon (OCP DDC compliant) – one for packet forwarding (NCP) and one for fabric (NCF)

OUR CUSTOMERS

AT&T recently announced that DriveNets Network Cloud is deployed across its core network - the largest backbone in the US. DriveNets is engaged with 18 Tier-1 operators and cloud-providers in North America, Asia and Europe, on large projects, including core backbone, aggregation, edge, peering, and 5G.

Headquarters:

4 Hasheizaf Street

Raanana, 4366411, Israel

P: 972-9-774-4726

www.drivenets.com

Romania R&D

Maria Rosetti 6

Bucharest, 020481, Romania

United States Customer Support

125 Half Mile Road, Suite #200

Red Bank, New Jersey, 07701 USA

Press Inquiries

+972 52-351-7698

judith@siliconvpr.com

Sales Inquiries

info@drivenets.com

DriveNets won several industry awards and recognitions throughout 2019-2020

Company of the Year (private)

Next-Gen Deployment Wireline

Research: Whitebox routing – a transformative disruption

Gamechanger Innovation Award