NetNumber
5G 101
Things We Need To Know

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Version 1.7

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NetNumber

NetNumber is changing the future of **telecom** services by enabling an **InterGENerational** network transformation, lowering the cost and complexity of essential **routing**, **signaling**, **security**, and **data management** solutions

InterGENerational Signaling, Routing, Security and Subscriber Data Management solutions for 2G, 3G, 4G and 5G

One platform delivering operational efficiency with unified provisioning and management functions

Integrated, customizable, network data and analytics tools

Highly experienced team, responsive customer-focused culture with deep subject matter expertise

NetNumber by the Numbers

Founded 1999
Boston, MA

290 Employees
Located in
22 Countries

20 Years
of Telecom Experience:
Routing, Security,
Subscriber Data
Management

>25%
Customer Growth
Cross Tiers and
Market Segments

Global Offices:
Boston
Munich
Toronto
Warsaw
Prague

280+ Customers / 60+ Countries

Deployed in all of the top 10 Carriers and Major IPXs

Mobile | Fixed | Interconnect | MVNO | MSO | Wholesale
Enterprise | CPaaS | FinTech | Government

Operators Top Concerns

Introduction
New technologies that will enable 5G

5G Migration
InterGENerational Converge Platforms

Infrastructure Modernization
Multiple Deployment Models, Migration, Cloud-Native

NetNumber *TITAN.IUM*
InterGENerational Platform

Key 5G Technologies

- 5G is designed to enable entire new industries
- There is no easy way to enable these new markets
- There is an order of magnitude of new protocols
- The infrastructure model that 5G is built upon is completely different than those of the past
- Automation will be a key factor to a rapid and operationally viable 5G solution

Why 5G At All?

Opening new markets and opportunities…not just new phones

Enhanced Mobile Broadband

Extreme Throughput
Ultra-Low Latency
Uniform Experience

3D Tactile Telepresence
Tactile Internet
Fixed Wireless Access to the home and business
Virtual reality streaming

Mission Critical Services

High Reliability
Ultra-Low Latency
High Availability

Autonomous Vehicles
Aviation
Robotics
Medical
Smart Grid

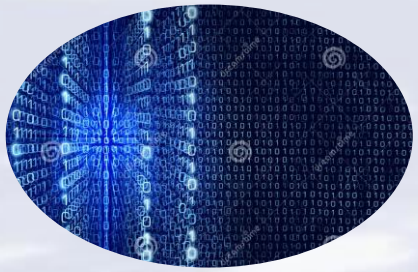
Massive Internet Of things (IoT)

Power Efficient
Low Complexity
Long Range

Factories
Shipment Staging
Home Devices
Office Devices

How Do We Get There

Distributed edge computing: Move services and intelligence closer to the user, reducing latency increasing availability - higher node density, smaller cells: orders of magnitude increaser in shorter distances, with higher frequencies and faster speeds

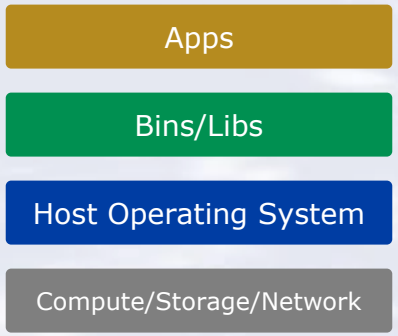


New infrastructure and protocols: network slicing, distributed architectures, virtualization, containers, automation/orchestration, cloud-native, service-based interface design, control plane – user plane separation (CUPS)

Better transmission strategies: Massive MIMO antennas, Beam Forming, more spectrum (licensed, unlicensed, shared spectrum) & denser wireline, standalone and non-standalone radio/core

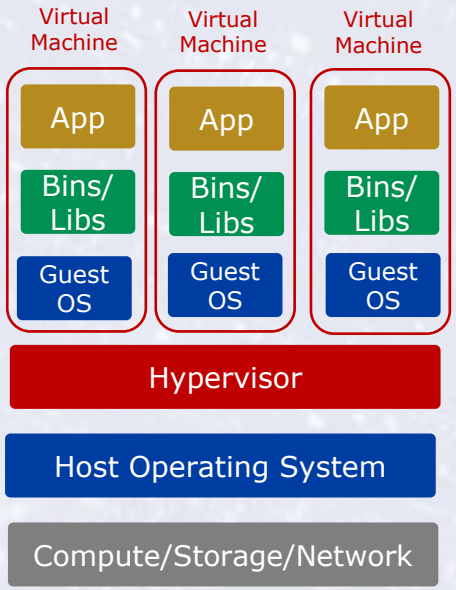
How Applications Are Deployed

Bare Metal



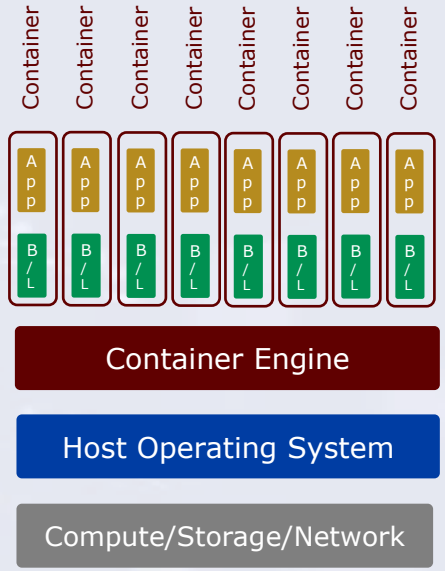
Does Not Scale
No overhead
High speed
Large blocks of code
No resource/user separation
Low user security
OTS SW

Virtual Machines



Allows Scale, boots new OS
High overhead – wastes resources
Slower speed
Large blocks of code
Virtual resource/user separation
Good user security
Flexible application control
Off The Shelf SW
Higher Complexity

Containers



Ultra-high Web Scale, boots in seconds
Less overhead – better resource utilization
High speed
Miro-service code design
Virtual resource/user separation
Good user security
Most flexible application control
Containerized SW
Higher Complexity

Cloud Ready Vs. Cloud Native Network Functions (NF)

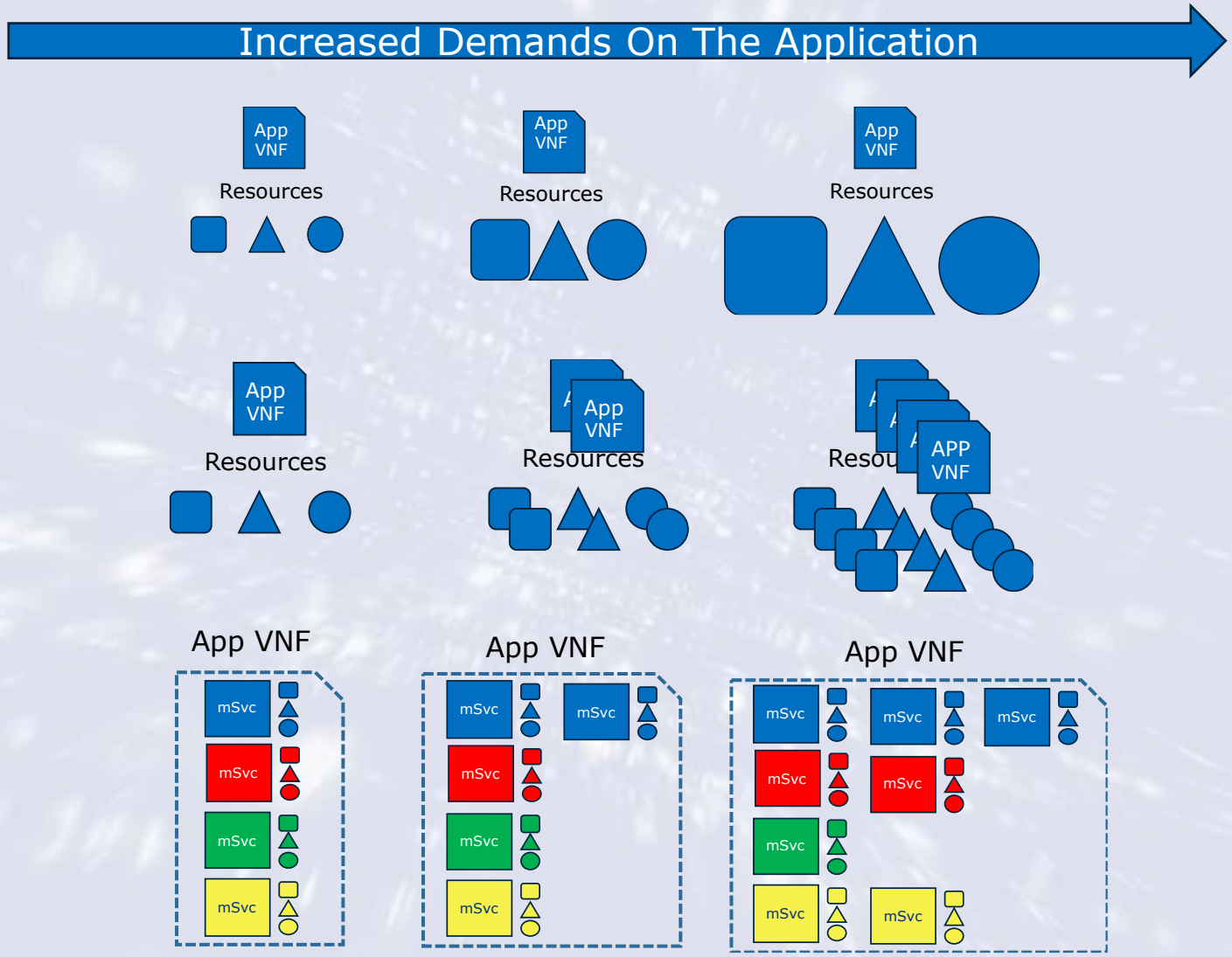
Cloud Ready – think Virtual Network Functions (VNF)

- Cloud-ready applications were once local-only programs
- Their features are built for static environments instead of the dynamic abilities of the cloud, but they have been tweaked and modified enough so that they can run in the cloud
- However, they do not have the innate flexibility that comes with programs designed to take advantage of operating in a cloud environment
- A good example of Cloud Ready is a legacy application that has been shoehorned onto a VMware

Cloud Native - think Containers and Cloud Network Functions (CNF)

- Cloud-native applications use a distributed design with, containers, microservices, multitenancy, and elastic scale baked into the recipe
- There's no shoehorning necessary to make them work in the cloud - they were born to be there and function smoothly and cleanly in that environment

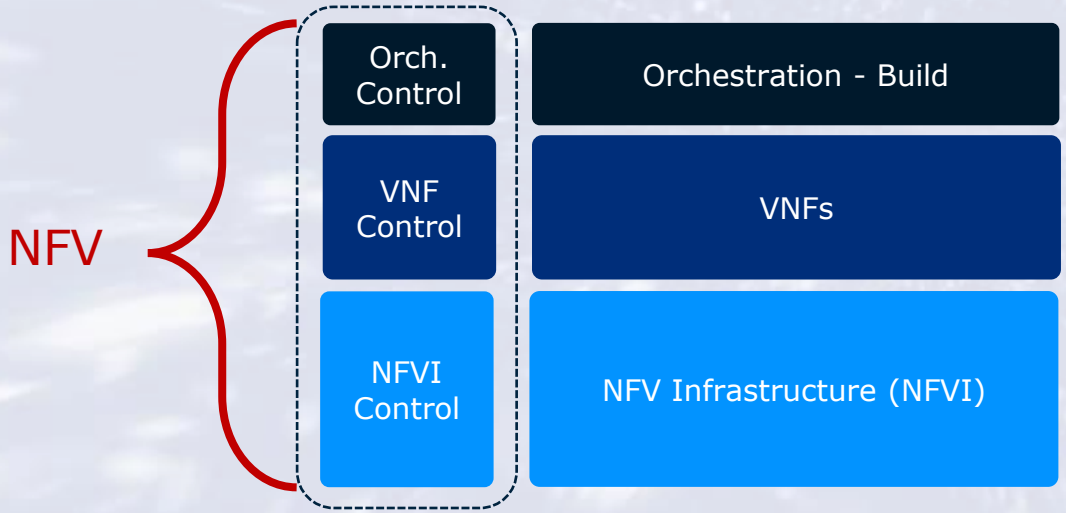
Scaling Applications



“Simple” Network Function Virtualization

With virtualization, new challenges arise…
“NFV is a framework for deploying Services in a virtualized world”

Control that manage other resources in the stack



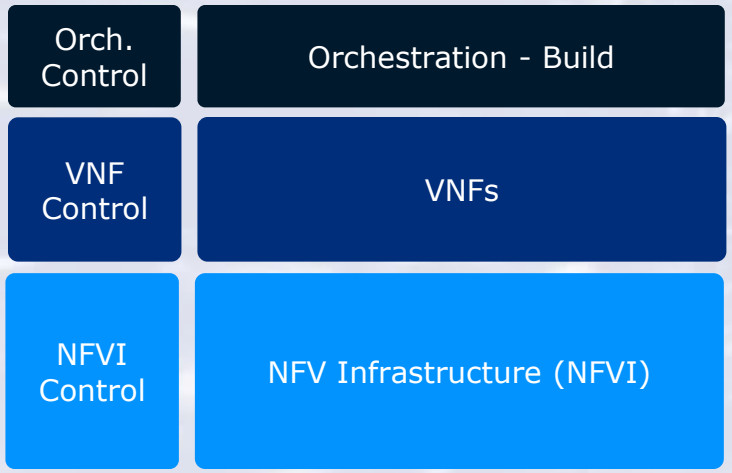
Tools that build and deploy the services (service Layer)

The VNFs that make up the services

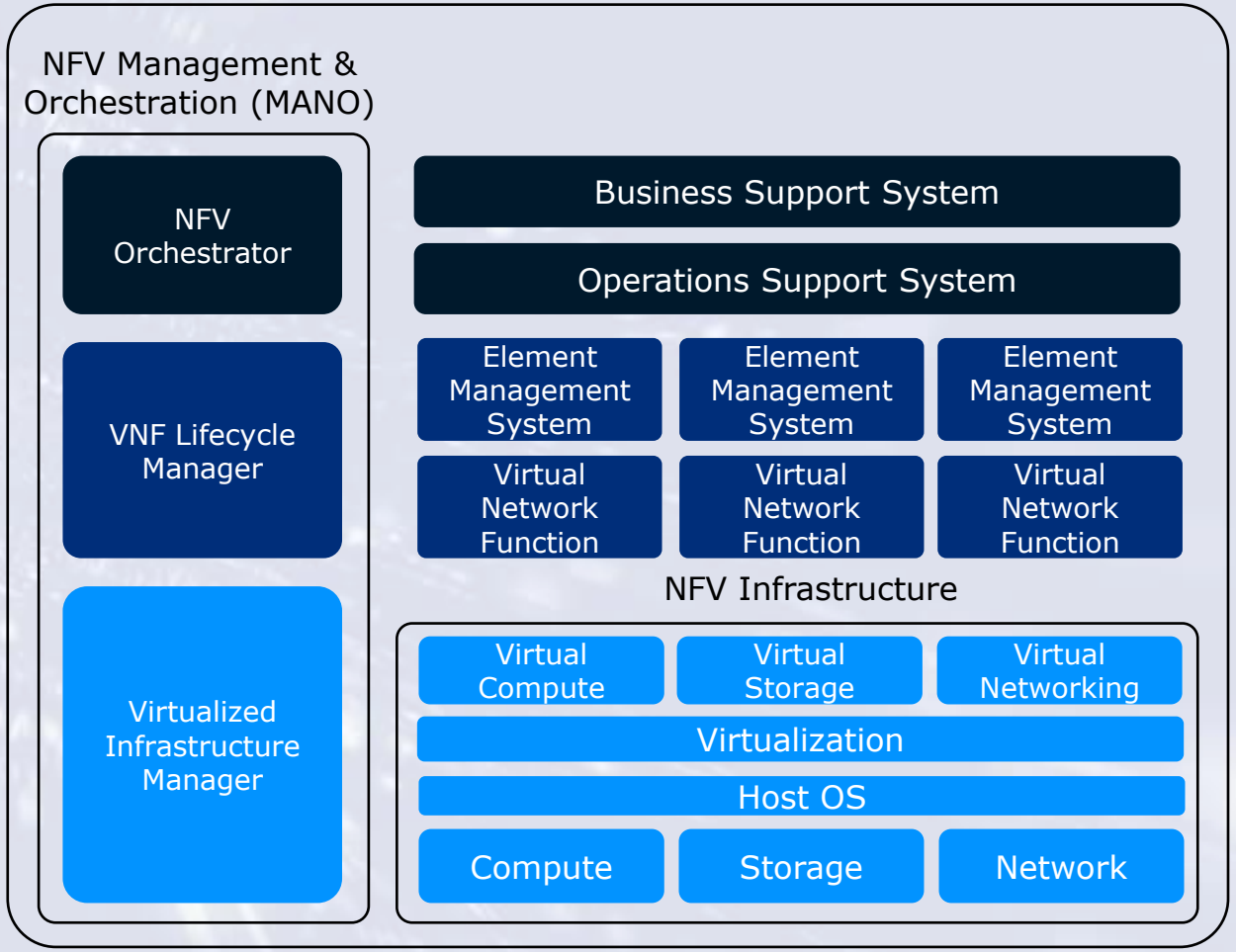
HW/SW resources that feed the VNFs

What It Really Looks Like*

Simple NFV Stack



NFV Stack – ETSI Model



Note: these are functional blocks not products. Some products can encompass multiple blocks at a time

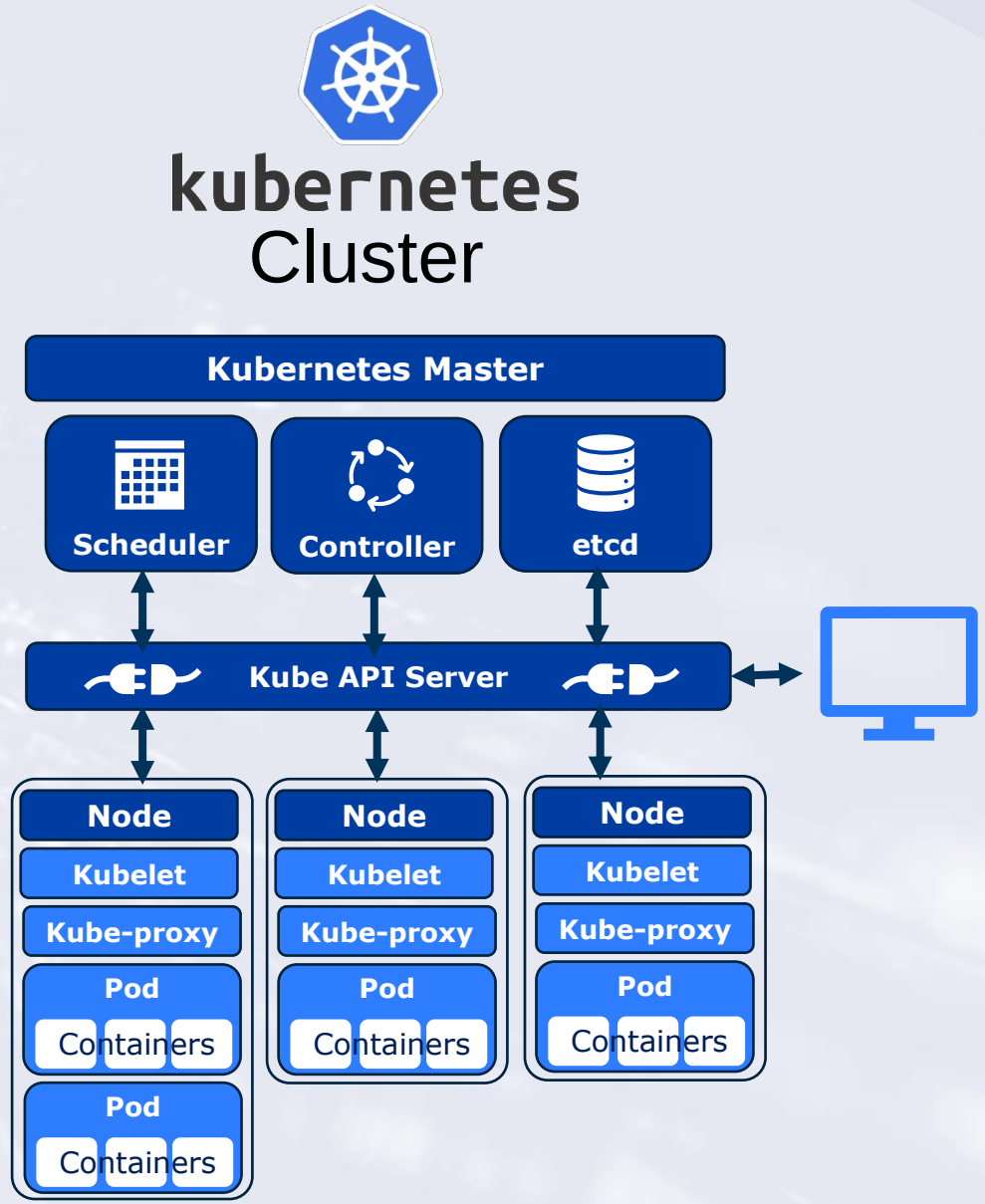
* Lots of detailed definition slides in backup – contact hsears@netnumber.com

Kubernetes (K8S) - High Level Component View*

- **Kubernetes** is an open-source platform, created by Google, for **managing containerized workloads** and services, supporting automation and orchestration
- This is not a 1 for 1 mapping of ETSI-NFV to containers

- **Master** manages the Kubernetes Cluster
  - **Etcd** maintains database that maintains state information pertaining to the entire cluster, when and where things are loaded, node states, metadata
  - **Kube Scheduler** identifies the right kind of node placement for containers, depending on container needs, node capabilities and configured policies
  - **Controller manager** maintains "container" life cycle management, onboarding, fault, availability and replication/scaling
  - **Kube API Server** – primary management interface that coordinates all communication between the master, worker nodes and the rest of the world

- Each **Worker Node** (sometimes just called nodes) help to segregate working containers
  - They have **Pods** that house groups of **containers**
  - A **Kubelet** maintains the pods and functions as a local agent that manages pod conditions
  - The **Kube-proxy** is responsible for routing traffic between containers, pods and nodes



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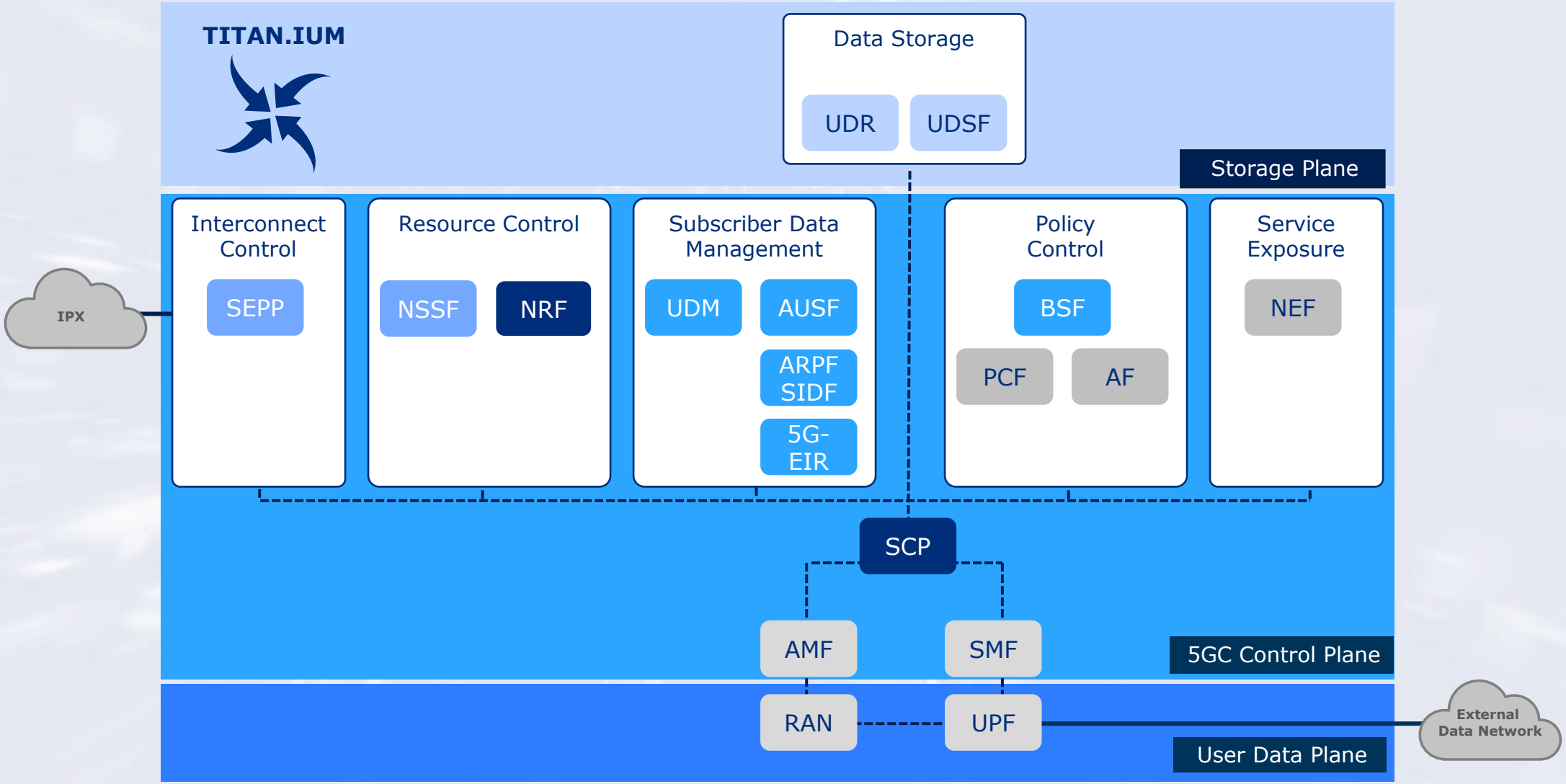
5G Migration – Market Needs

Unified Platform, InterGENerational

- Domain-based applications and multiple generations of functions must coexist using a non-siloed resource pool
- A “bundled” approach - security, routing, subscriber data management, core 5G under a unified operations mode
- Cloud native requirements span a large spectrum from simple to fully blown
- Solutions must support multiple deployment models, older and newer
- Suppliers must have a firm grasp on customer’s integration needs

5G Architecture*



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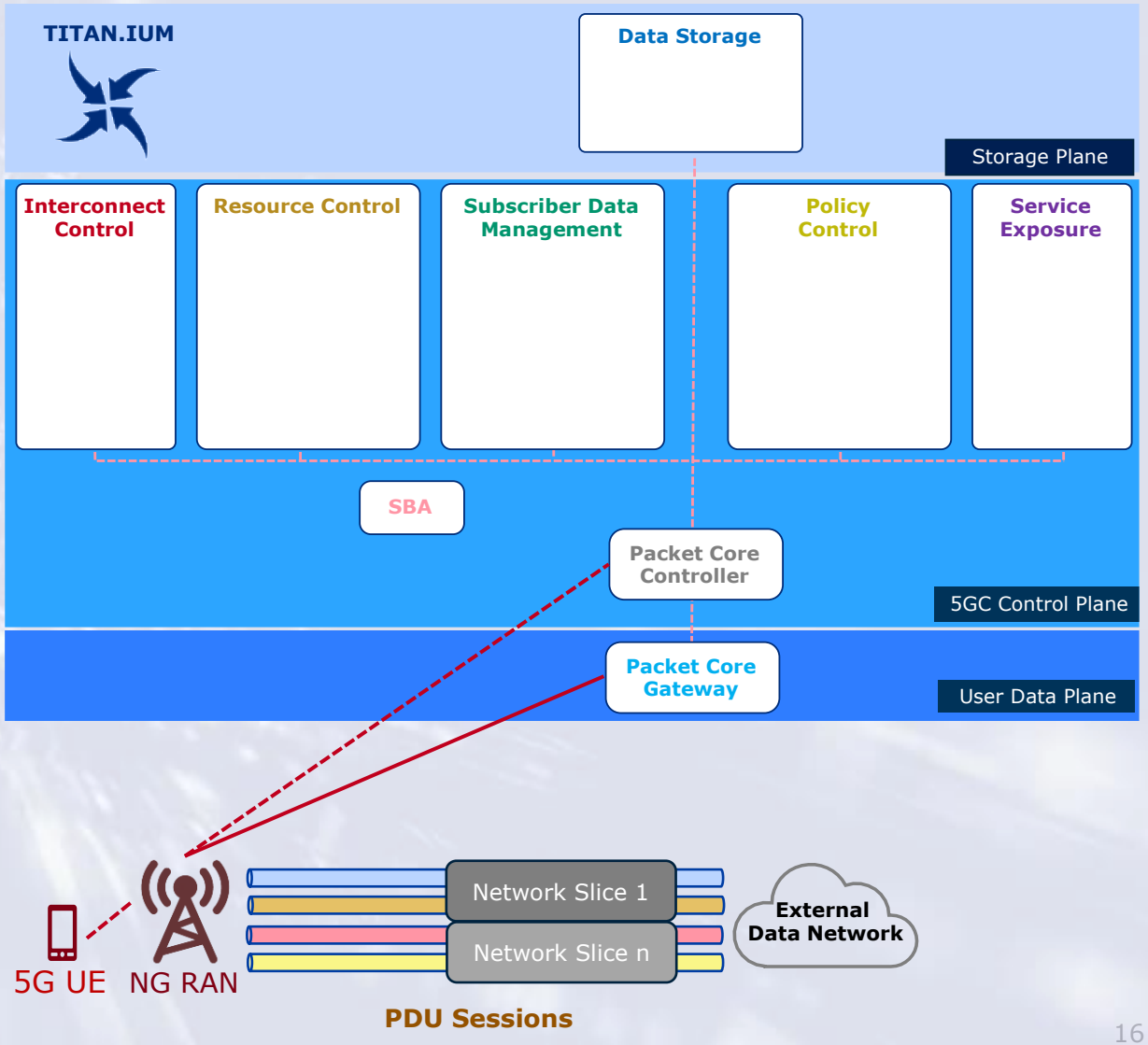
RAN Connected Functions

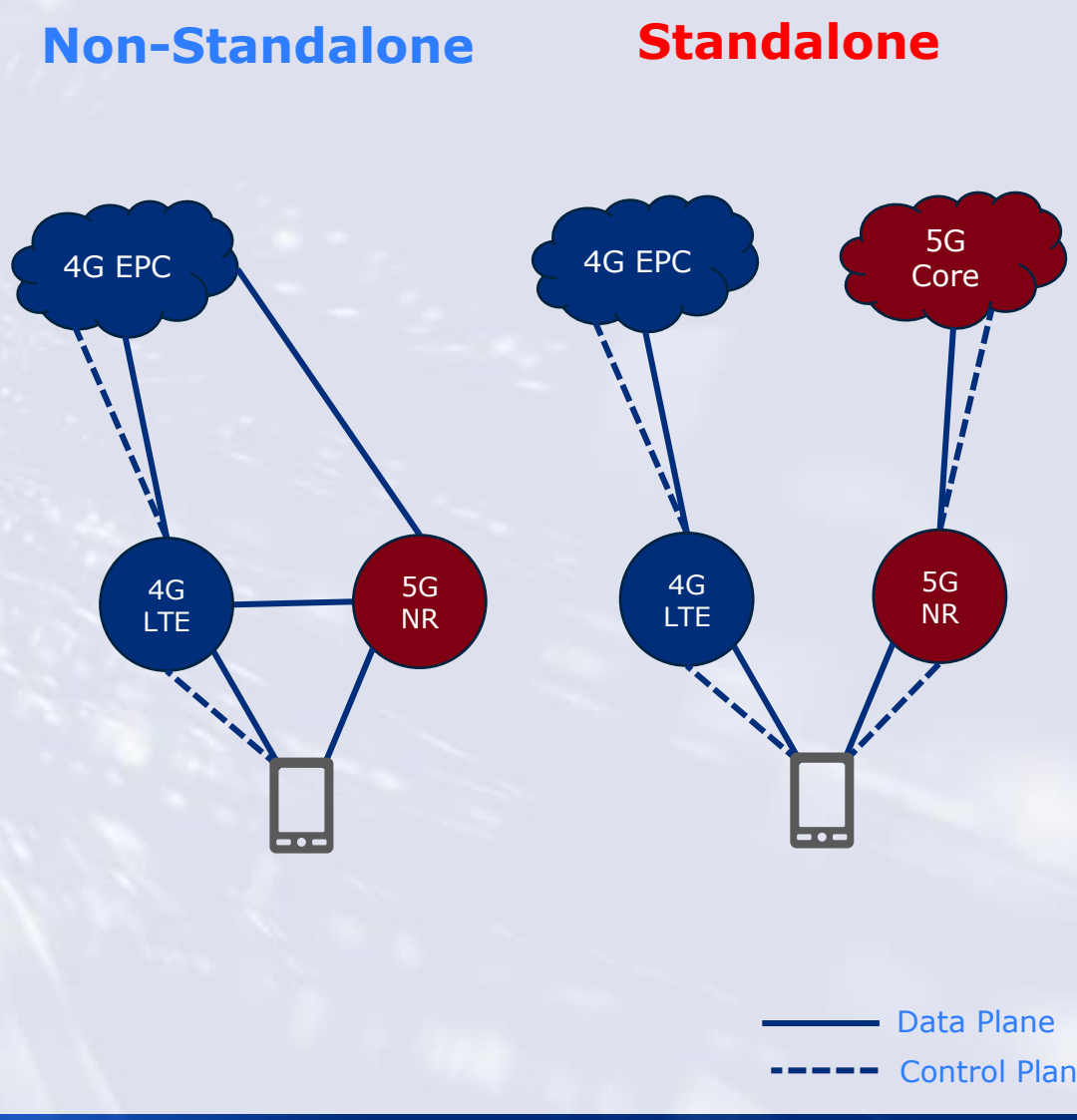
- Components are separated into separate entities following CUPS principles
- Packets flow across the packet core data path to many different **Data Networks** including
  - Internet Protocol Media Subsystem (IMS)
  - Internet
  - 5G providers' network
  - Public clouds
- All user traffic flows are called **Packed Data Unit (PDU) sessions**
  - There can be multiple flows with different qualities of service (QoS) used in different network slices
  - PDU flows will be typically be IP flows, but the specification allows for non IP-based dataflows and refers to them as unstructured data flows
- The **Packet Core Gateway** receives packets and forwards them based on rules asserted by the control plane
- The **Packet Core Controller** makes the key forwarding decision and programs the Packet Core Gateway accordingly
- NetNumber does not make Packet Core Controller/Gateway products



Radio Deployment Modes

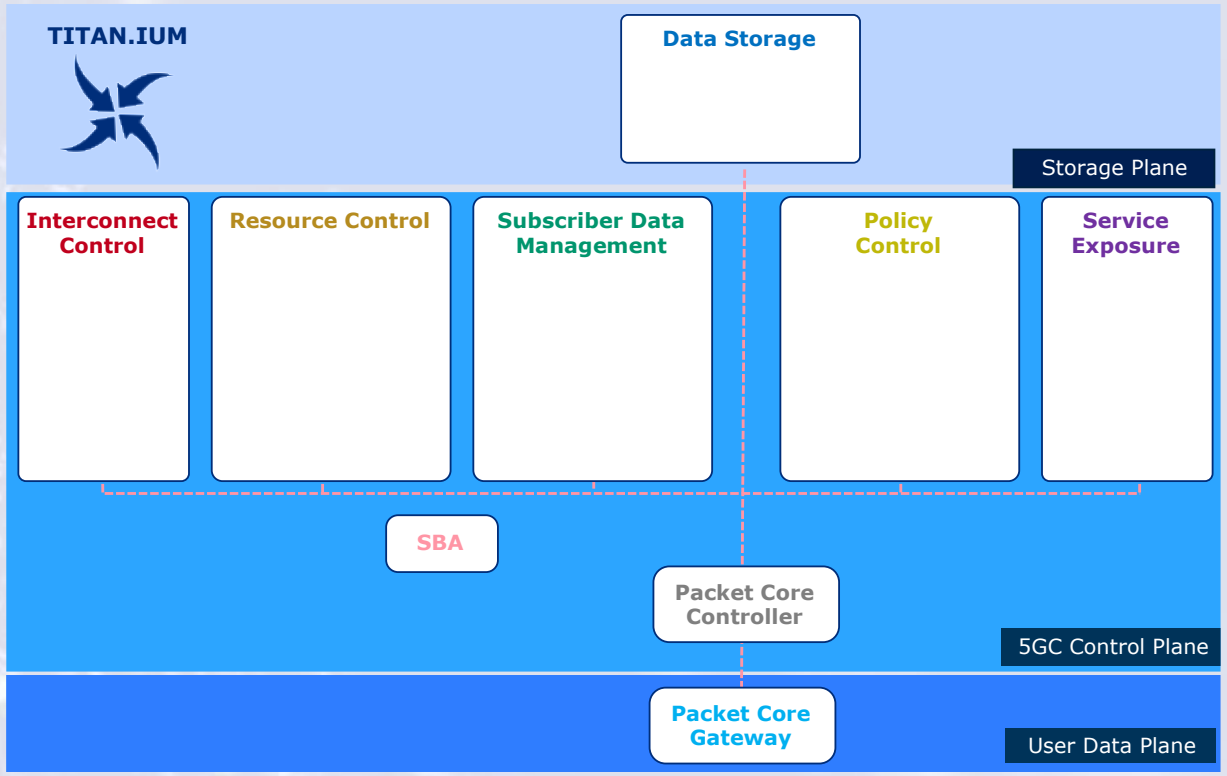
- The **Non-Standalone** (NSA) mode of 5G New Radio (NR) refers to an option of 5G NR deployment that depends on the control plane of an existing LTE network for control functions, while 5G NR is exclusively focused on the user plane

- **Standalone** (SA) mode of 5G NR refers to using 5G cells for both signaling and information transfer.
- It includes the new 5G Packet Core architecture instead of relying on the 4G Evolved Packet Core



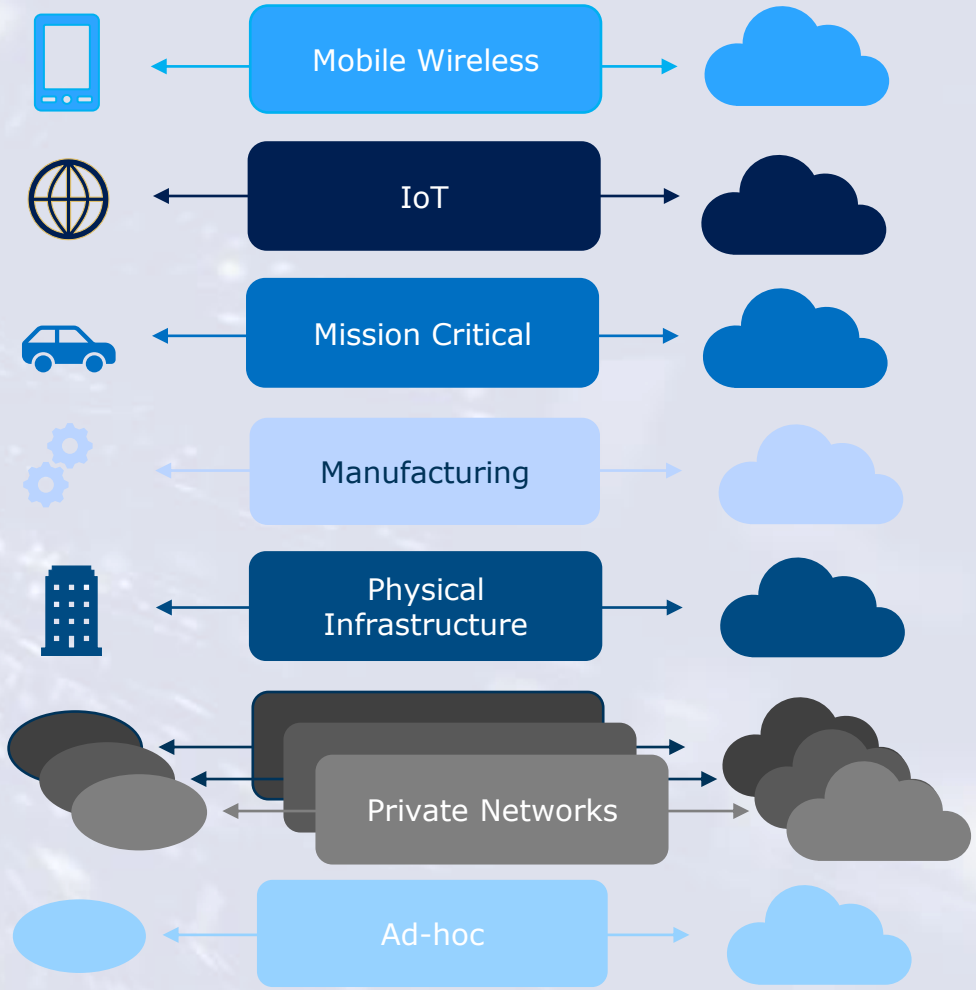
Services Make Up The Core Control Plane

- Before we start user there is a steady state of service connections on the **Service Based Architecture (SBA)** bus using the HTTP/2 protocol
- All VNFs, for which there may be *multiple instances* of each, will *register* with Network Repository Function (NRF) that is part of the **Resource Control** Block
- The *User Data* Management (UDM) function, part of the **Subscriber Data Management** block, maintains user data which is stored in the **Data Storage** block, functions along with any Authentication functions and credentials
- Policy Control Functions, found in the **Policy Control** Block, will map user sessions to policy control mechanisms
- Inter-provider communication will be secured via the Cloud **Interconnect Control**
- Non-SBA-connected functions, for example OSSs, can communicate policy control via the **Service Exposure**
- Each of these functional blocks have multiple components defined in the 5G specification



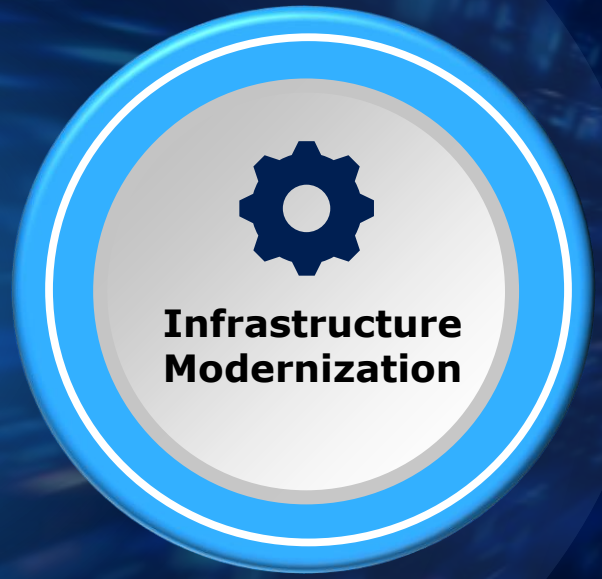
Network Slicing – Network Creativity

- Used to differentiate characteristics and resources for different broad classes of services
- Can create separate virtual networks on shared or separate network resources
- Can be offered as shared slices for common traffic types or dedicated to a particular customer
- Network slicing can allow for "traffic splitting" across networks (5G, 4G, and WiFi-fixed wireless) and is very flexible



Infrastructure Modernization – Market Requirements

Cloud Native With Multiple Deployment Models



- Cloud Native architecture and services are in most RFPs, but time frames to deploy are well into 2H 2021
- Significant increase in requests for legacy services moving to a new architecture
- Looking for an integrated InterGENerational approach
- Focus on reducing resources and operational siloes
- Operators accelerating plans for integrating their CI/CD pipelines with multiple suppliers

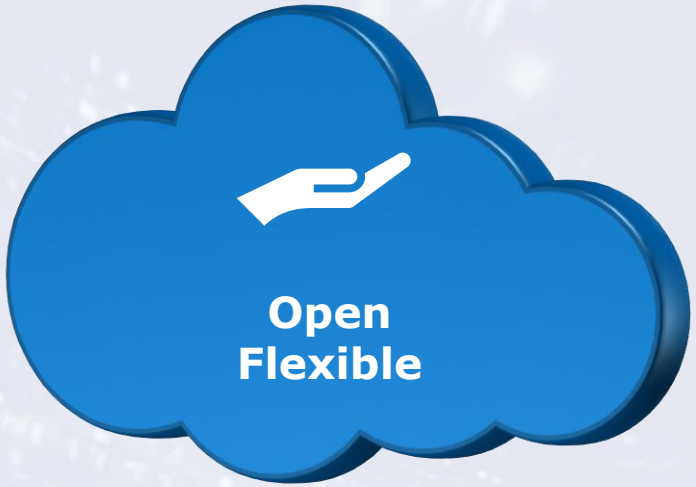
Orchestration & Automation

- **Automation** replaces a human action for a single task (a task may have more than one step)
  - Deploying an application
  - Adding a new customer to a service
  - Stopping, turning down, a service
  - Upgrading

- **Orchestration** is a type of automation that performs a workflow, automating multiple tasks – *this is a massively overloaded term*
  - Not only deploying an application, but also connecting it to the network so it can communicate with users and other apps
  - Building a service chain and deploying an entire service
  - Pulling multiple SW applications from a repository, packaging them and loading them on multiple devices

Cloud Native Capabilities – The Right Way

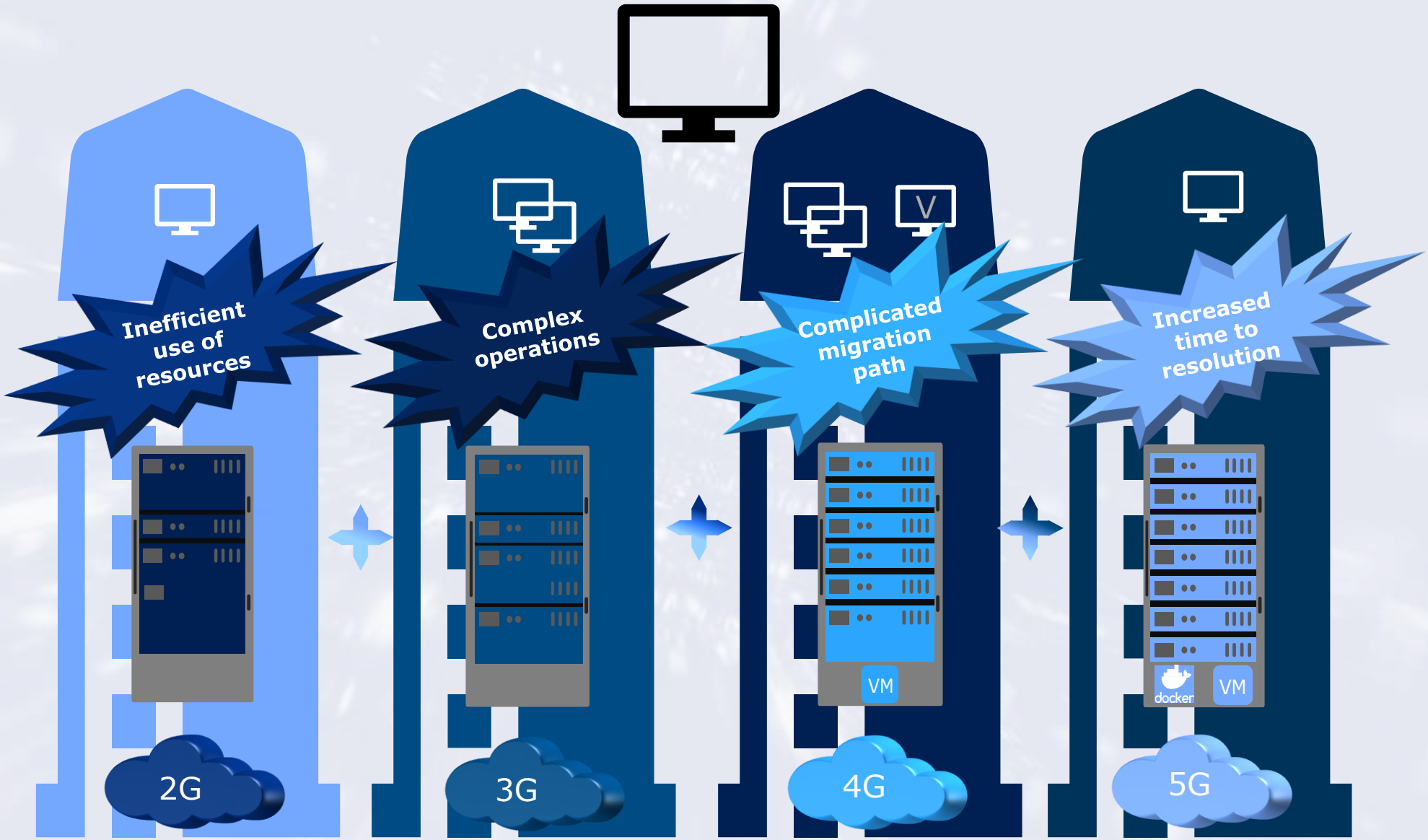
- One platform, with auto-scaling, multi-container micro-services
- Data pipelines and databases for distributed multiregional scale
- Low-latency, data replication/synchronization
- Declarative APIs



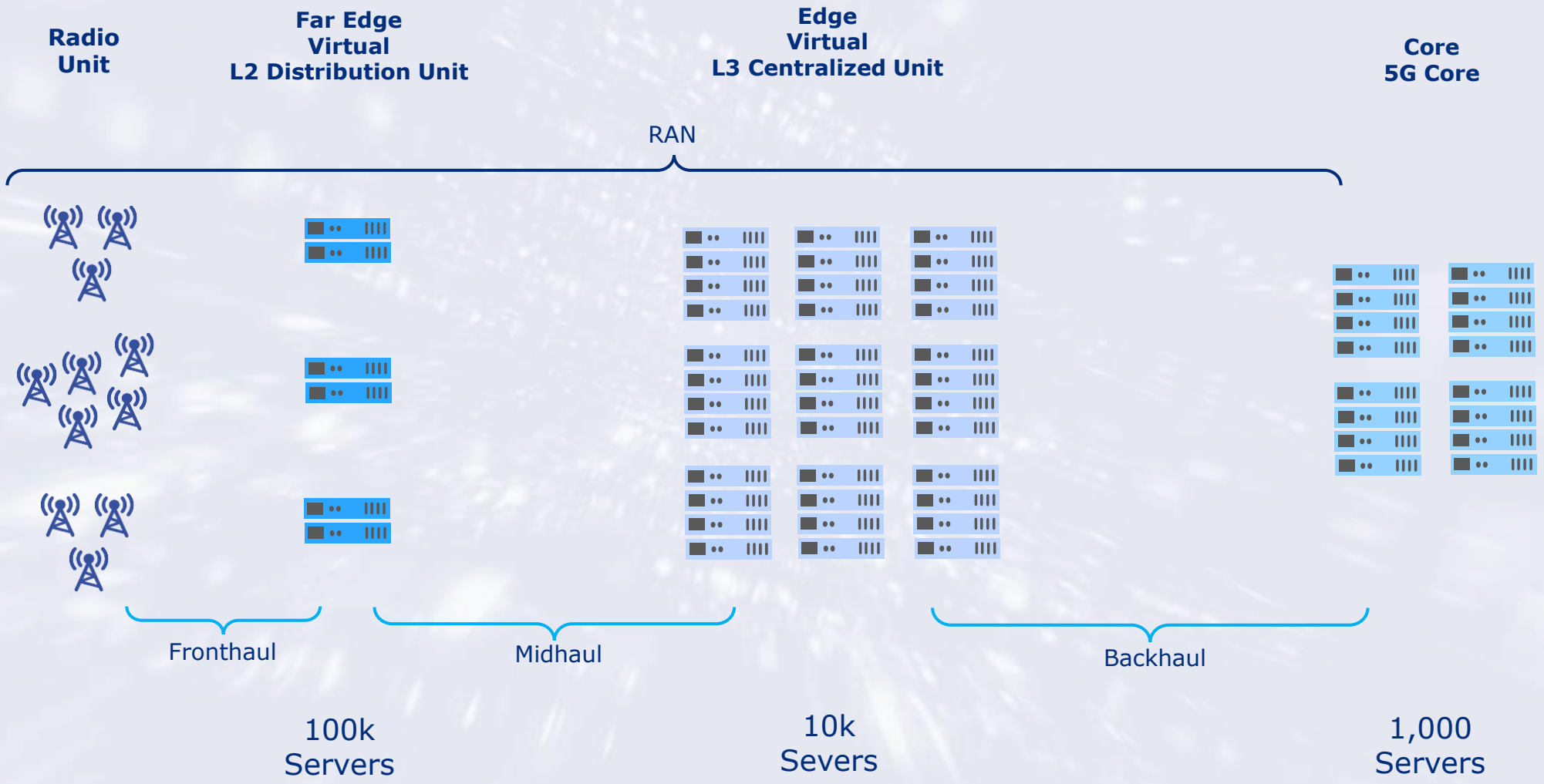
- Open source design components
- Built in analytics
- Flexible and adaptive Dev-Ops CI/CD model
- Wide range of container, OS and tools support

- Deploy in any cloud
  - Containers
  - Virtual Machines
  - Pre-integrated HW-SW bundle
- Fully automated deployments

Hiding Siloes Under A Management Platform

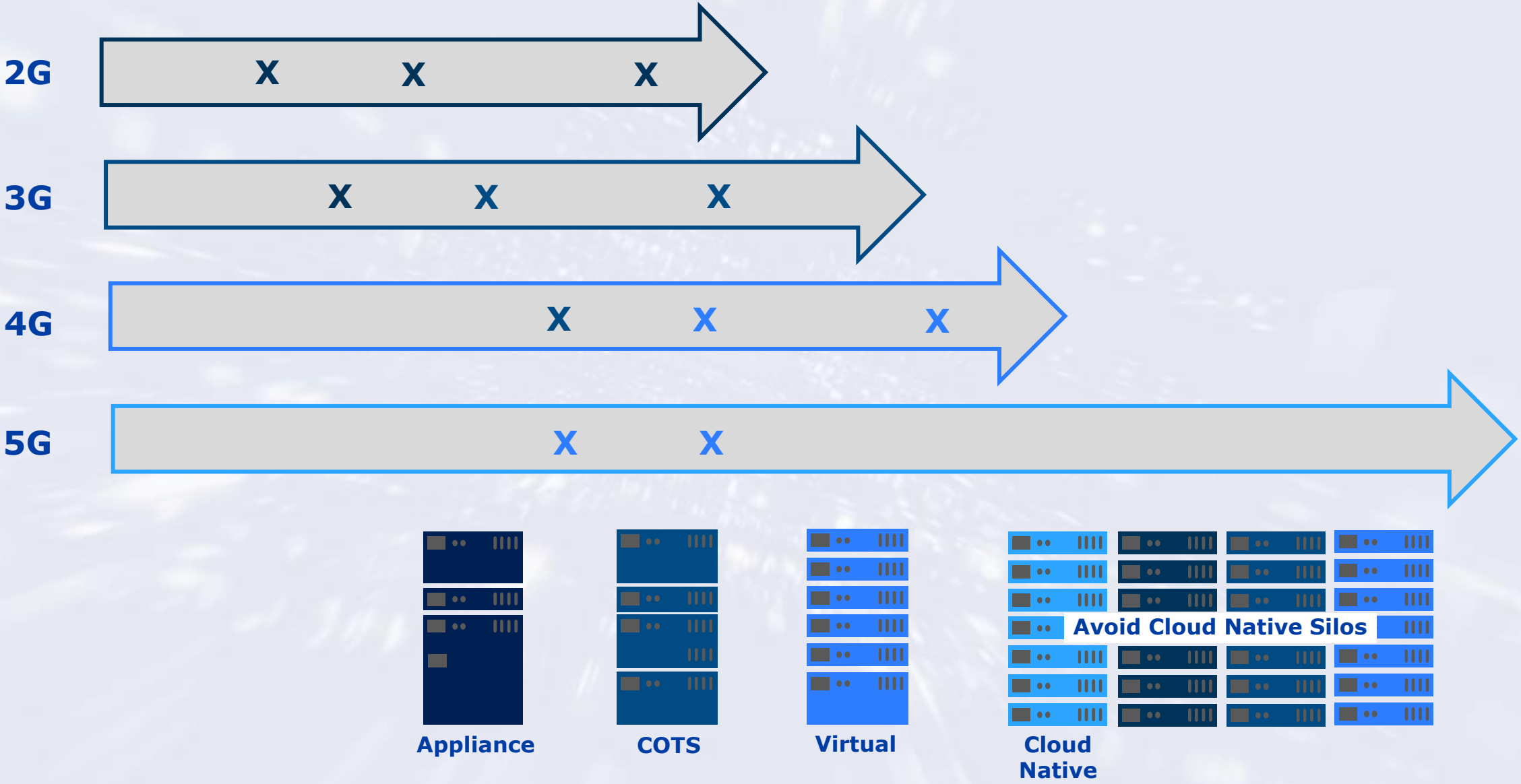


Containerization To the Edge With vRAN

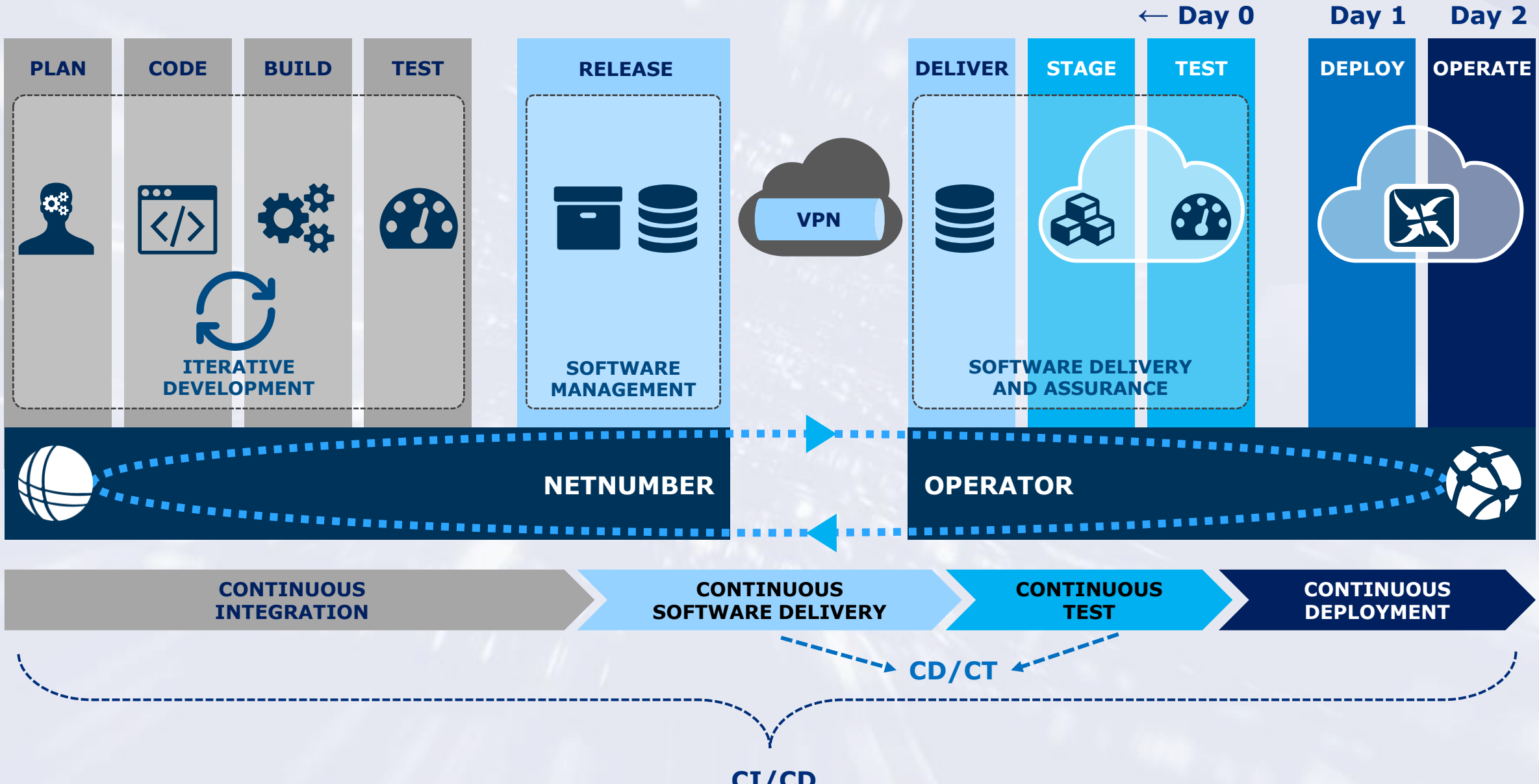


Not A Rip And Replace

New Networks Come And Old Networks Stay



CI/CD Service Pipeline



NetNumber *TITAN.IUM*

TITAN.IUM
The Bridge Between Generations, Protocols, Data And Security

Built from the ground up, harmonizing together

Rapid Deployment - Simplified Operations
Flexible

TITAN.IUM Solution Portfolio

Solution Domains

- Signaling Security & Routing
- Subscriber Data Management
- Access & Session Management
- Private Networks
- Customer Defined Solutions

Global Data Services

3G, 4G, 5G Applications

STP, DSC, Sig FW, SEPP, 5G-SCP, 5G-NRF, 5G-BSF, NSSF

HSS, HLR, EIR, UDM, UDR, AUSF, UDSF, 5G EIR

NP, ENUM DNS, Ut-Proxy, IMS, PCRF

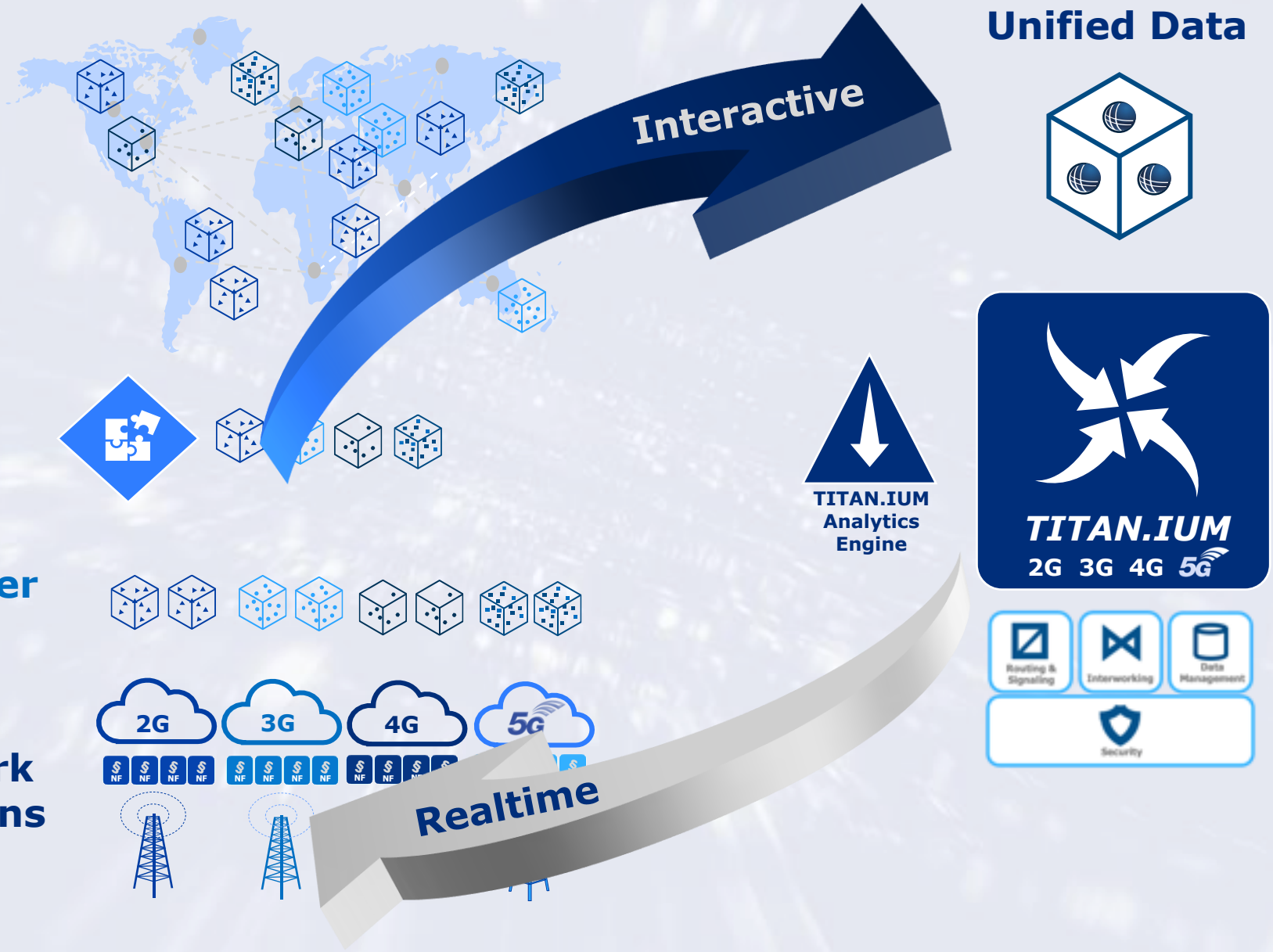
CRE, IWF, IN-SCP, LRF

TITAN.IUM, Integrated Management System, Reporting & Analytics

amazon web services, vmware, KVM, kubernetes, openstack.

Unified Data And Services

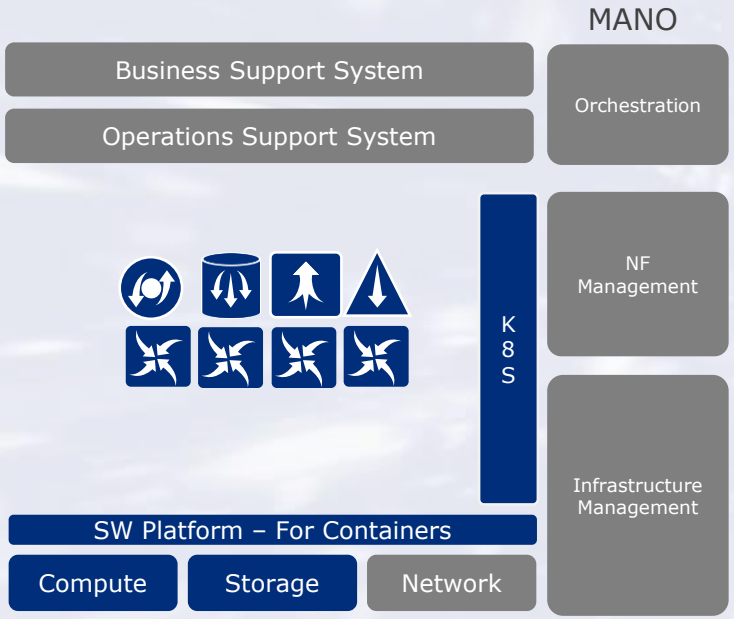
Enabling Streamlined CI/CD And An Easy Cloud Native Migration And Solution Evolution



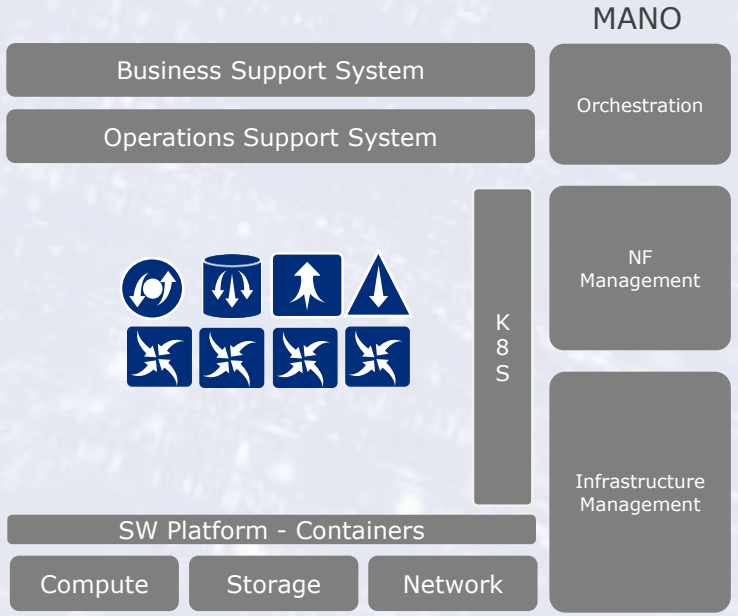
TITAN.IUM Consumption Models

These are not architecture reference models

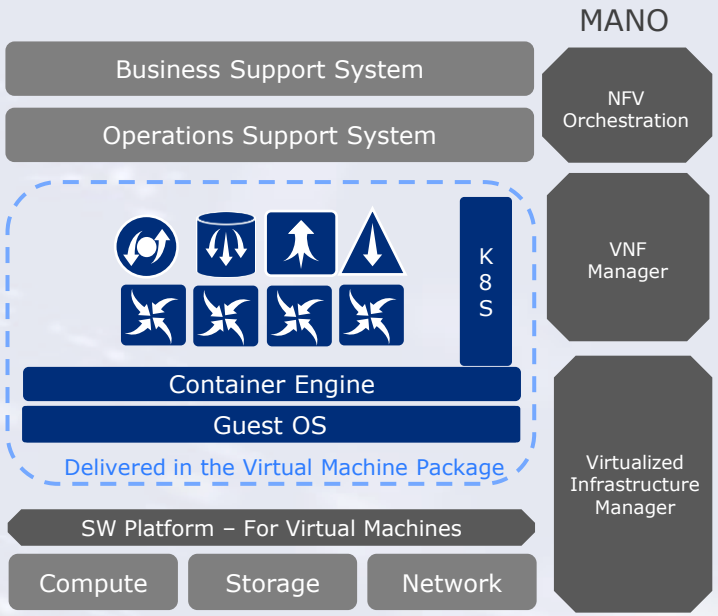
Containers
Turnkey
Pre-integrated HW/SW Appliance



Containers
Cloud Infrastructure



Virtual Machine
NFV Infrastructure



All blue indicates NetNumber made products
All gray indicates customer or partner infrastructure

The Company Is The Platform

People

Processes

- Deep subject matter expertise
- Custom features, applications & data
- Adaptive culture

- Full Agile Operations
- Requirements, Validation & Delivery
- Organizational Change

- Turning your DevOps methodologies into Automated, Customized, CI/CD solutions
- Support for multiple deployment models

- Built from the ground up to enable InterGENerational, Kubernetes-based cloud-native, continuous solution delivery

Collaborative Tooling

TITAN.IUM

TITAN.IUM Benefits

- Enables both new 5G & legacy markets on a single platform, built from the ground up
- Simplifies InterGENerational migration to a single Cloud-Native architecture
- Deploy and Upgrade "Anywhere"– Fully Automated Workflows – Containers, VMs, Appliance
- Multiple, flexible, CI/CD options
- Engineered for high Performance and Scale – Analytics, Data replication toolbox, Container based, Kubernetes orchestration

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