Network Slicing & related work in IETF

Dhruv Dhody, Chief Architect Standards, Huawei India
President, IIESoc

SANOG 36

Dhruv Dhody

Dhruv has been working in the networking domain for the last 16 years with **Huawei Technologies**. Over the years he has worked on MPLS VPNs, OSPF, NTP, ALTO, CSPF, etc for Huawei's Routing Platform. He is currently working on **research & standards** for various emerging technologies as **PCE, Segment Routing (SR), and Network Slicing**. He is an active IETF contributor in the area of Path Computation and Traffic Engineering with **15 RFCs as the main editor and 12 as a contributor.** He has filled 21 patents. He is also serving as the **PCE WG co-chair** at IETF. He is also part of the **Routing Directorate and sergeant-at-arms** for the IETF mailing list. He is a **founding member and president of India Internet Engineering Society (IIESoc) & secretary for Industry Network Technology Council (INTC)**.
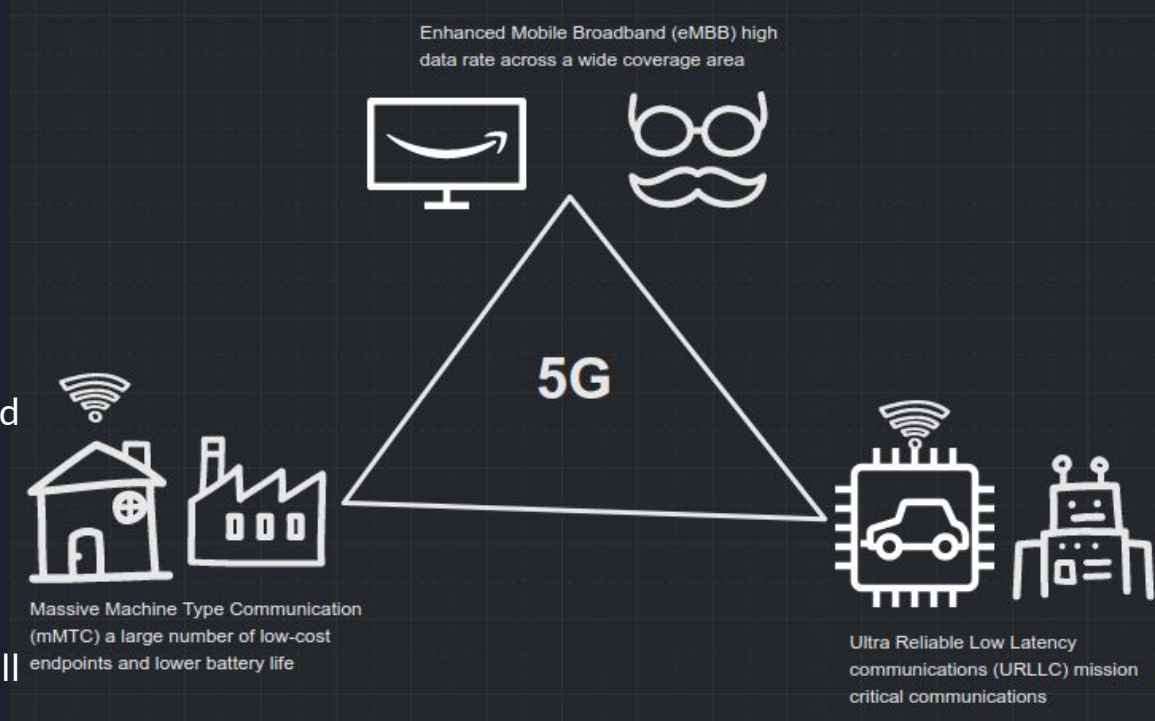
Let's talk about 5G

- 5G is the fifth generation of cellular networks, bringing new capabilities.
- 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices.
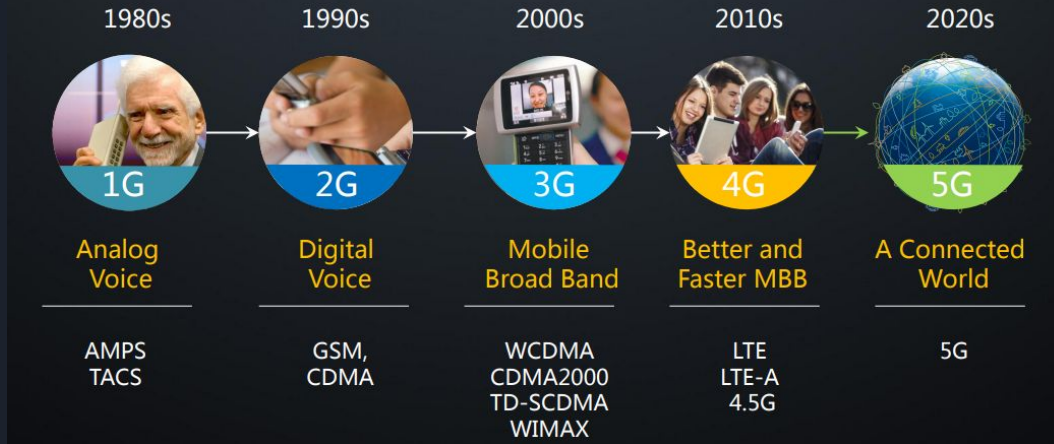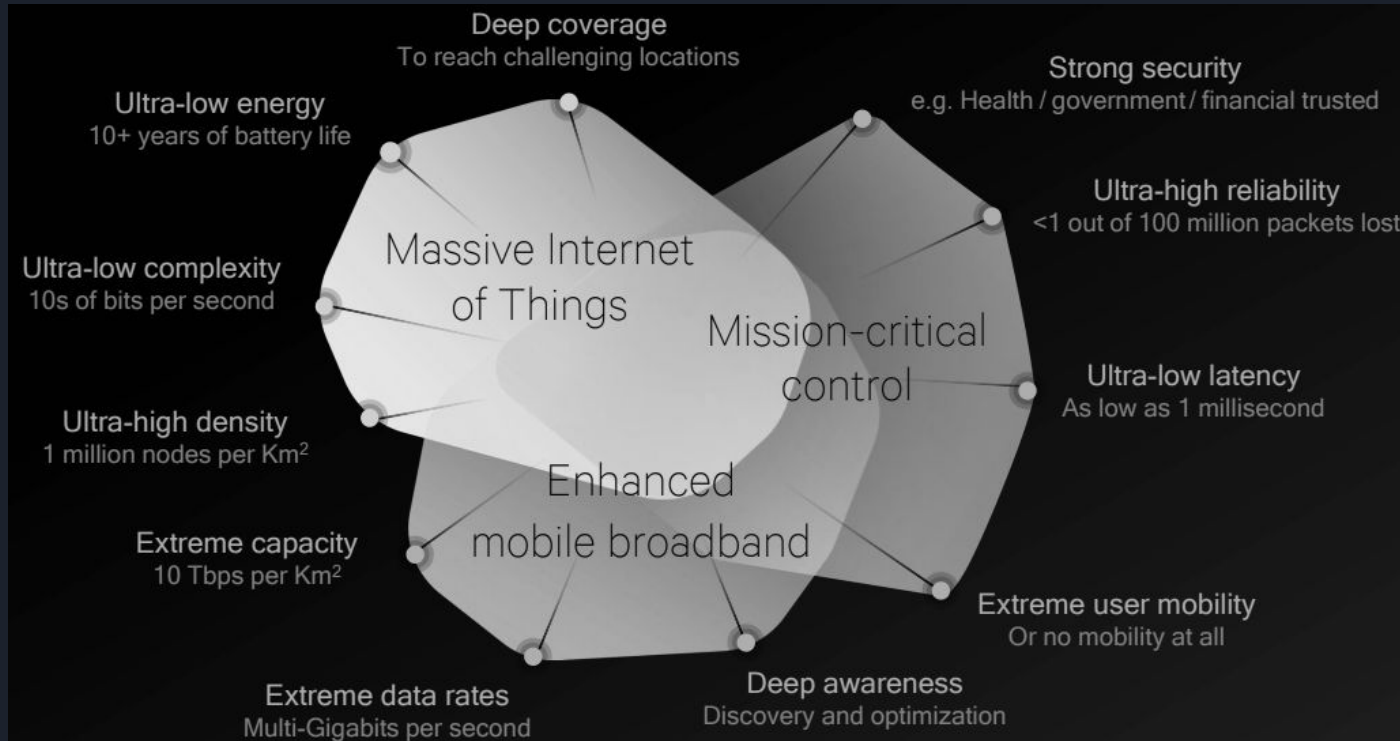
Key 5G Use-cases

- Enhanced Mobile Broadband (**eMBB**)
  - High data rates across a wide coverage area.
- Ultra Reliable Low Latency Communications (**URLLC**)
  - Target latency of 1 ms and requirements for end-to-end security and 99.999 % reliability.
- Massive Machine Type Communications (**mMTC**)
  - large no. of devices that intermittently transmit small amounts of traffic

Enhanced Mobile Broadband (eMBB) high data rate across a wide coverage area

5G

Massive Machine Type Communication (mMTC) a large number of low-cost endpoints and lower battery life

Ultra Reliable Low Latency communications (URLLC) mission critical communications

Different Requirements!

Deep coverage
To reach challenging locations

Strong security
e.g. Health / government/ financial trusted

Ultra-low energy
10+ years of battery life

Ultra-high reliability
<1 out of 100 million packets lost

Ultra-low complexity
10s of bits per second

Massive Internet of Things

Mission-critical control

Ultra-low latency
As low as 1 millisecond

Ultra-high density
1 million nodes per Km^2

Enhanced mobile broadband

Extreme capacity
10 Tbps per Km^2

Extreme user mobility
Or no mobility at all

Extreme data rates
Multi-Gigabits per second

Deep awareness
Discovery and optimization

Network Slicing is the key enabler

- Different virtualized and independent logical networks on the same physical network infrastructure, in order to meet diversified service requirements.
- Each network slice is an isolated end-to-end network tailored to fulfil diverse requirements requested by a particular application.
- Network slicing enables the most economical model to provide service differentiation and meeting end user SLAs.
- Builds on SDN, NFV, service orchestration, telemetry and closed loop automation etc

# Some "Networking" Background

- Started with simple service asking for connectivity - VPNs (L2 or L3)
- In traffic engineering
  - topology abstraction (summary)
  - virtualization (VN - virtual network) - edge to edge connectivity with certain qualities
    - Just connectivity
    - Enhanced connectivity (VPN with different per-site bandwidth)
    - Customer managed connectivity
    - Customer operated connectivity (multi-layer)
      - Carrier's carrier
      - IP over Optical
- We have been doing this for a while….

Network Slicing - the concept

- Multiple **virtualized and independent** logical networks on the same **shared** physical infrastructure with each **slice tailored to fulfil diverse requirement**
- **Partitioning** of network resources
  - We know this - VPN, Overlays, RSVP-TE, SDN etc
- **Service guarantee** making sure no impact from other services
  - Throughput, latency, jitter...
- **Reserving resources** for service
  - Bandwidth, compute...
- **Isolation**: multiple slices over shared infrastructure
  - Performance, Traffic separation, Security, Privacy, Management
- **Control & Orchestration**
  - E2E and multi-domain

E2E Network Slice
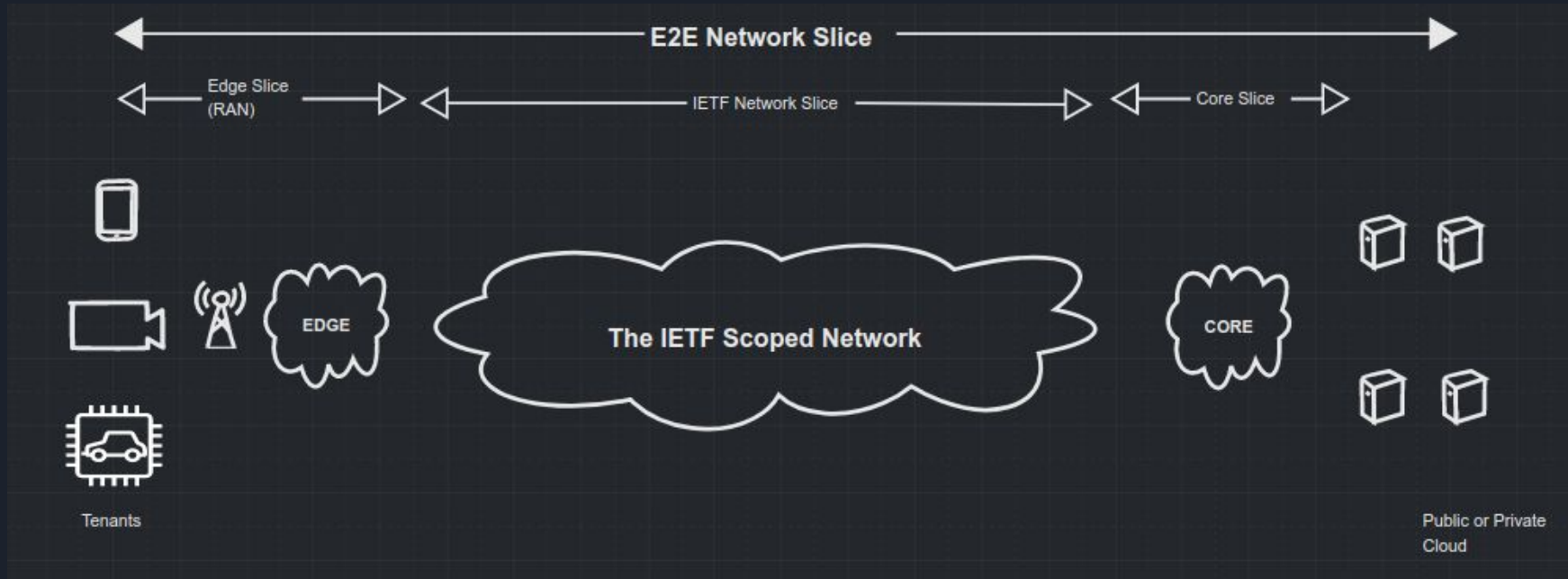
E2E Network Slice
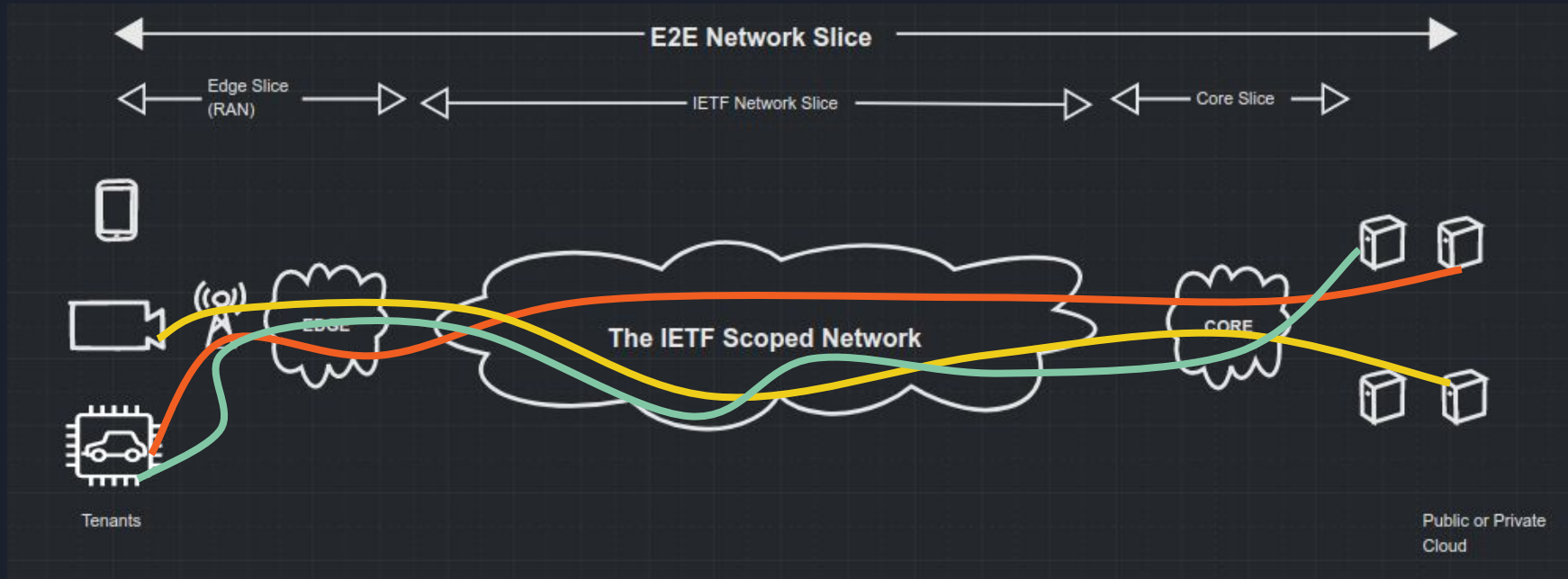
IETF Network Slice

- **An IETF Network Slice is a logical network topology connecting a number of endpoints with a set of shared or dedicated network resources, that are used to satisfy specific Service Level Objectives (SLOs)**
  - Use of 'IETF' to limit the scope
  - There was a long debate on the name, it was called Transport Network Slice before!
- IETF Network Slicing has **multiple use cases**
  - 5G (enhanced mobile broadband (eMBB), ultra reliable low latency (URLLC), massive machine type (mMTC))
  - NFV & DCI
  - Sharing of Network infrastructure among multiple operators
  - Network wholesale service
- IETF Network Slicing is **technology-agnostic and independent of underlying infrastructure** connectivity
- **Enable a diverse set of applications** that have different requirements to **coexist** on the same network infrastructure.
- *Slice refers to a set of characteristics & behaviours that separates one type of user-traffic from another!*

Service Characteristics

- **'quantifiable'** is key
- **SLI - Service Level Indicator** is a quantifiable measure of network performance (throughput, latency)
- **SLO - Service Level Objective** is a target value/range for the measurement of SLI
  - slice = set of SLOs
  - not 'how, but 'what' (remember **intent**)
  - **direct or indirect** measurable objectives
- **SLA - Service Level Agreement** is the contract between consumer & provider
- A debate on how to characterize **isolation** - SLO or NOT!
  - negative impact of other slices
  - traffic separation / interference avoidance / service assurance
 - **pragmatic** isolation

Endpoints & Connectivity Types

- An IETF Network Slice is a well-defined composite of
  - a set of **endpoints**
    - Conceptual point of connection of customer network, network function, device, application
  - the **connectivity requirements** between subsets of these endpoints
    - P2P / P2MP / MP2MP
    - Hub & Spoke
    - Full Mesh
  - associated service requirements
    - SLOs

Proposed Framework

- **Lifecycle** management (creation, modification, monitoring, deletion…) of IETF network slice.
- NSC takes request from higher system via NBI, request is then **realized** (or translated) to the underlying infrastructure and a **mapping** maintained
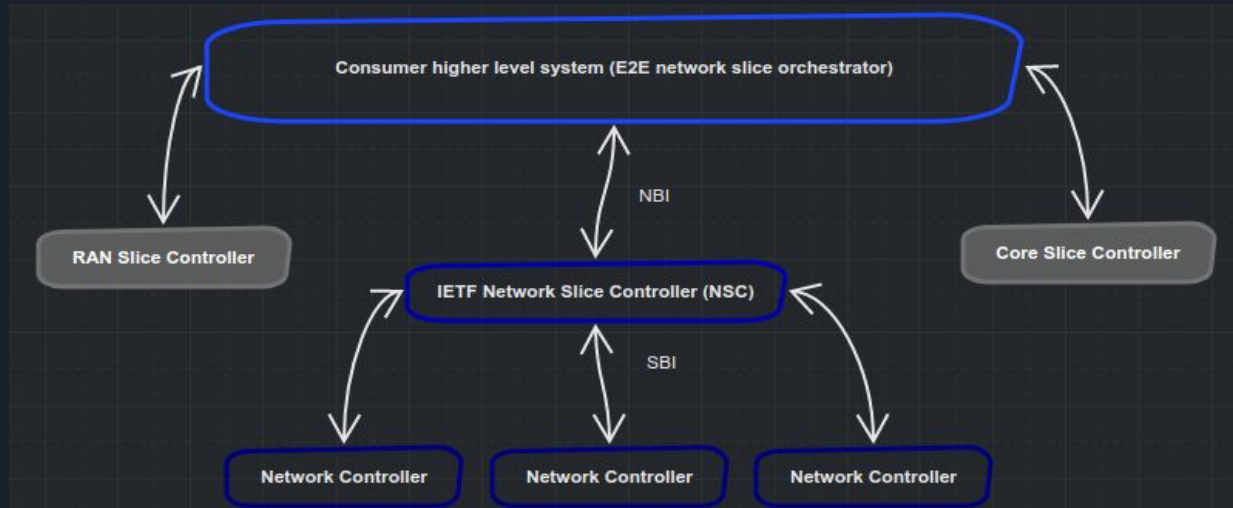
Proposed NBI

- A **technology-agnostic** NBI for creation/deletion/modification/monitoring of slice.
- **Endpoints**
- **Connectivity** between network slice endpoints
  - **Slice Members**
  - Allow grouping of connections with same SLO
  - Connection type
- Service requirements (**SLO**)
  - Well known and custom templates
- Status & **Monitoring**
- *Need to also maintain a **mapping** between consumer view (NBI) and the network slice realization (provider view)*

Building Blocks
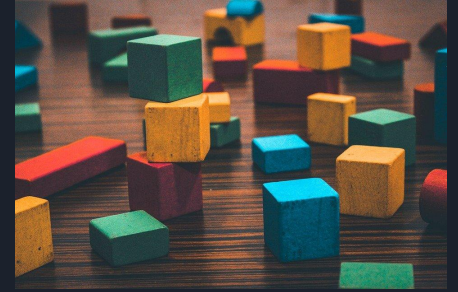
- **Frameworks**
  - ACTN, Enhanced VPN
- **YANG** Models
  - Slice NBI model
  - Service - L3SM, L2SM etc
  - TE - Topology, tunnel, VN, TE-Mapping, etc
  - …

- **Techniques**
  - SDN
  - L3VPN, L2VPN, EVPN
  - MPLS-TE, Detnet
  - SR / SRv6
  - Telemetry, OAM
- **Protocols**
 - BGP, BGP-LS, PCEP, IGP, RSVP-TE, Netconf, Restconf…

ACTN - Abstraction & Control of the TE networks

- ACTN facilitates **virtual network operations** by
  - abstracting underlying **heterogeneous** network domains
  - Coordinating between **multi-domain, multi-layer** network in a recursive hierarchical fashion
  - Providing a **customer view** of the network
  - **Mapping** customer request into network provisioning request
- ACTN (RFC 8453) maps well with Network Slice framework
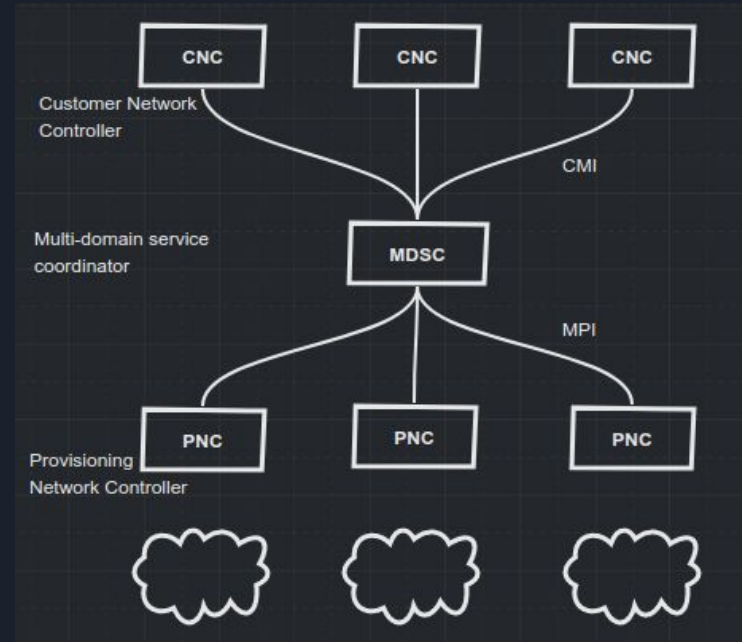
Enhanced VPN (VPN+)

- Builds on VPN service with **guaranteed network resources & predictable performance**
- A **tighter coordination & integration between underlay & overlay**
  - VPN - Overlay
  - **Virtual Transport Network (VTN)** - underlay customized network topology
  - **Enhanced VPN is the integration of the two!**
- Centralized Control & management - builds on ACTN & service model
- Customized virtual networks - overlay & underlay
- Enhanced dataplane - TSN, FlexE
- Pragmatic Isolation

Service Request

Network Controller

18
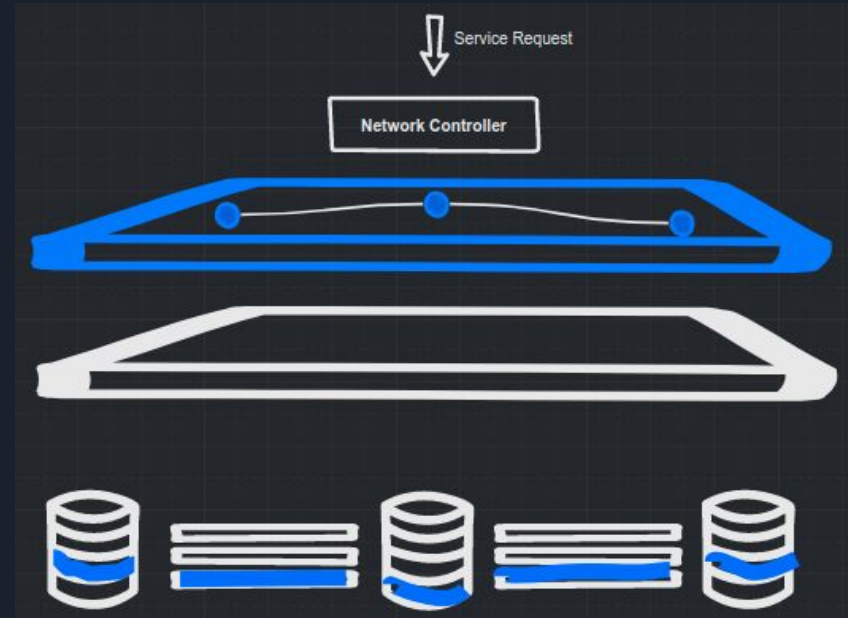
Some of the Realization Techniques...

- Using **SR for Enhanced VPN**
  - **Resource Awareness** to SR segments
  - Embedding Slice-ID in SRv6 SID
  - IGP extension - use MT / Flex-Algo
  - BGP SR Policy/BGP-LS extension
  - IPv6 Extension Header (HBH)
- Packet Network Slicing using SR
  - New slice based identifier - Administrative Instance Identifier (AII)
- Realizing slice in IP/MPLS

Lot of work ongoing in this area! Join TEAS WG mailing list...

Thank You!