Network Slicing Problem Statement

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Why network slicing in 5G?

- Diversified services, unique & extreme requirements
  - Enhanced Mobile Broadband: *VR, AR, Tactile Internet,etc.*
  - Mission-Critical services: *autonomous driving, remote surgery, etc.*
  - Massive IoT: *sensor networks, smart wearable, etc.*

- New ecosystem for rapid innovation
  - Operator services
  - Third-party and industrial applications

- Network slicing is necessary to meet these requirements in a common network infrastructure
  - Flexibility, scalability, low Capex & Opex

Network slicing definitions

- NGMN

  - Network Slice Instance: a set of network functions, and resources to run these network functions, forming a complete instantiated logical network to meet certain network characteristics required by the Service Instance(s).

- 3GPP (TR 23.799)

  - Network Slice Template (NST): a logical representation of the Network Function(s) and corresponding resource requirements necessary to provide the required telecommunication services and network capabilities.

  - Network Slice Instance (NSI): is an instance created from a Network Slice Template (NST).

- ITU-T (FG IMT-2020)

  - Slicing allows logically isolated network partitions (LINP) with a slice being considered as a unit of programmable resources such as network, computation and storage.

- IETF ?

Requirements of network slicing

- Isolation and separation

- Customization of topology

- Flexibility of topology

- Guaranteed Quality of Service

- Management considerations

Isolation and separation

- Service in one network slice should be impervious to anything happening on any other slices

- Data Plane
  - Dedicated data plane resources are required to meet the strict performance requirements in some slices
  - Mechanisms to provide data plane isolation is necessary

Isolation and separation (Cont.)

- Control plane
  - Network may need to provide different level of control plane isolation for different services
    - Dedicated control plane can provide guaranteed performance and allow flexible customization of control functions
    - Shared control plane is more efficient while may not meet performance requirements of some critical services
    - Hybrid control plane provides a trade-off between performance and efficiency

Isolation and Separation (Cont.)

- **Network operation**
  - Third-party or vertical industries have different requirements on the operation and management of their network slices
    - Some may simply delegate the operation to network operator
    - Some may be deeply involved in the operation of network slices

- **Security**
  - Security requirements of network slices may be markedly different
    - a balance between performance, confidentiality, complexity and resources
  - Different security mechanisms may be deployed for different network slices
  - One network slice must be impervious to an attack on any or all of the other network slices

Customization of topology

- **Customization of topology**

  - Each network slice can have customized topology

    - Independent of the underlying physical network topology

    - May include not only edge nodes, but also transit nodes

  - Existing mechanisms have problems in meeting the topology customization requirements

    - Multi-topology Routing

    - Virtual Private Network

    - Overlay Network

    - Segment Routing

Flexibility of topology

- Flexibility of topology

  - Network slice consists of a set of Network Functions (NFs).

  - NFV and MEC allow NFs to be dynamically created at any location, and can migrate from one place to another dynamically.

  - Flexible and dynamic positioning of NFs requires dynamic provisioning of network slice topology with on demand connectivity

Guaranteed Quality of Service

- Network slices for mission-critical services must ensure end-to-end guaranteed performance

  – Latency, jitter, bandwidth, availability, reliability, etc.

- Network slices for some eMBB services (e.g. Virtual Reality) require ultra-low latency and large bandwidth

- Even with underlying MPLS-TE LSPs, existing VPN technologies cannot provide guaranteed latency and jitter performance

- Ongoing works in Detnet WG may be used to meet the performance requirement in these network slices

Management Considerations

- The provisioning or modification of one network slice must not have any impact on other slices

    - Disruption or performance degradation

- Sometimes a new slice cannot be provisioned without modifying existing slices

- Some network resource management mechanism is needed to avoid transient damage to any network slices

Discussion

- What should be the definition of network slice from IETF's perspective?

  - Beyond connectivity

- What is the scope of network slicing in IETF?

- How much can existing/ongoing technologies meet the requirement?

- What are the remaining gaps?