Network Slicing - open issues

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Seoul, September 29, 2017
Introduction

- Slicing is a hot topic and will be a big revolution in the telco industry
  - Slicing is typically linked with software-based solutions (clouds, NFV, SDN)
  - It is an important feature of 5G
  - There are many research projects and standardization activities
  - There are still many open issues related to slicing and it seems we still need to work on:
    - business models
    - architecture (including the management one)
    - implementation issues
Introduction
NS definition by NGMN (5G P1 01/2016): 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)**
- A network slice instance **may be fully or partly, logically and/or physically, isolated from another network slice instance**
- The resources comprises of **physical and logical resources**

**Network Slice Blueprint:** A complete description of the structure, configuration and the plans/work flows for how to instantiate and control the Network Slice Instance during its life cycle. It enables the instantiation of a Network Slice with certain network characteristics (e.g. ultra-low latency, …)
Slicing according to NGMN (5G P1 01/2016)

The network slicing concept consists of 3 layers:

• **Service Instance Layer** represents the services (provided by the network operator or by 3rd parties)

• **Network Slice Instance Layer** that is created using **Network Slice Blueprint**
  • The Network Slice Instance **may be composed by none, one or more** **Sub-network Instances**, which may be shared by another Network Slice Instance

• **Resource Layer**
  • **Physical Resource**: A physical asset for computation, storage or transport including radio access (C/S/C)
  • **Logical Resource**: Partition of a physical resource, or grouping of multiple physical resources dedicated to a Network Function or shared between a set of Network Functions
VPN, MOCN, MGWN, RAN sharing: are they examples of Network Slicing?
What is the difference between the Network Slice based EPC and the 'classical EPC'?
Technical motivation for slicing: 5G use case (1)

Many other requirements already formulated by NGMN, ITU-R, 5G PPP

- Low latency
- High reliability for MTC
- Energy efficiency
- High connection density
- Spectral efficiency
- High traffic capacity
- One click service deployment

Cost of 5G can be very high
- in order to cope with reliability requirements a redundant solution is required
- in order to cope with high traffic capacity we have to use high frequencies and dense radio network
Technical motivation for slicing: 5G use case (2)

For a specific use case not all parameters are of equal importance!

- Can we use multiple RATs of different performance instead of designing an omnipotential RAT?
- Multiple RATs should be logically separable and combined with (in some cases) multiple Core Networks to provide E2E connectivity.
- Such approach may lead to multiple parallel networks having their architectures tailored to service specificity and requirements.
- The differences concern not the Data Plane only, but also the Control Plane (it is much more than VPN/QoS).

ITU-R M.2083

M.2083-04
Business motivation for slicing

• (Especially) in the IoT case many verticals are expected to need services tailored for them, the verticals know well their needs

• Some virtual operators want to have stronger impact on their service management
  • Deployment
  • Configuration
  • Security

• Network slicing enables almost full control over slice by slice operator (if properly designed)

• Network slice can be created on demand (cf. every day early in the morning)

• The end-user can have its own Network Slice (if process is automated)

• Shared C/S/C resources provide short TTM, low TCO, aggregation gain, NFV/Clouds benefits (dynamic VNF placement, scaling)
Open issues
Split of network slicing open issues

- Business related issues
- Generic open issues
- Operations related open issues
- Management and orchestration related open issues
NS business-related open issues

• (B1) Who can deploy a slice
  • Orchestrator operator?
  • 3rd party?
  • End-users?

• (B2) Who will provide a slice Blueprint
  • Orchestrator operator, 3rd party, others, mix, ....

• (B3) Who will take the responsibility concerning slice operations
  • Some of them may have import business value (SLA is a must)

• (B4) Do we need some regulations related to network slicing
  • Is legal intercept a must for all slices – who will do that?
  • Priorities should be defined for slices (for emergency situations, etc.)

• (B5) Do we have a business model for network slicing
  • Slice providers, Blueprint providers, slice brokers, ...
  • Do we know how to design a win-win model for network slicing?

• (B6) Should we include the ‘legacy’ equipment in the overall slicing picture?
NS-related generic open issues

- (G1) A single service per slice (VoD) or multiple services (MVNO)? Both?
  - Do we need separate service orchestration?
- (G2) How many slices do we expect (10 or 10k)?
  - Impact on slice orchestration, orchestration scalability issue, resource allocation
- (G3) Slice lifetime
  - 1 day?
  - 1 year?
- (G4) Is slice deployment time a critical one?
  - YES: in case of slice-on-demand (VPN-like)
  - NO: in case of MVNO
NS operations-related open issues

- (O1) Slice discovery, matching, attachment
  - do we need unification (standardization) of slice types?
  - sometimes slicing selection can be explicit (the IoT case)
  - Do we need a „default” slice?
- (O2) Multi-slice attachment
  - Is it a problem? Yes, it is
- (O3) Multi-domain operations
  - Can we chain multiple slices – what should be exposed to other slices?
  - Should we slice all domains of a multi-domain slice?
- (O4) Slice coverage (mobility in mind): local, regional, country-wide, global
- (O5) Should the terminal be
  - slice-aware
  - slice-agnostic
  - part of a slice
NS management and orchestration related open issues

- (M1) How to split management between
  - orchestrator
  - orchestrator operator (PBM, slice triggering?)
  - slice operator, including the end-users (SLA monitoring, PBM, accounting?)

- (M2) How to orchestrate multi-domain slices
  - Single, global orchestrator
  - Local orchestrators (local or global Blueprints)

- (M3) Orchestration scalability
  - Can single orchestrator cope with 1000’s of slices?
  - Do we need a decomposition into sub-slices and sub-slice chaining?

- (M4) How to provide slices that are end-users triggered and operated
  - Embedded, autonomic management?

- (M5) How to provide quickly deployed slices on-demand
Selected approaches to network slicing
A slice is a set of network functions and corresponding resources necessary to provide the required telecommunication services and network capabilities.

- The network slicing primarily targets a partition of the core network, but it is not excluded that RAN may need specific functionality to support multiple slices or even partitioning of resources for different network slices.
Prehistory of slicing in 3GPP: MOCN, DÉCOR, eDÉCOR

- **MOCN (TS 23.251)** – sharing of RAN among many CN operators; one CN per operator; PLMN-ID-based attachment

- **GWCN (TS 23.251)** – sharing of RAN and a part of CN nodes among many CN operators; one CN per operator; PLMN-ID-based attachment

- **DÉCOR (TR 23.707)** – multiple CN per operator sharing the same RAN and separately serving devices and/or customers with very different characteristics; HSS profile-based CN selection (‘UE Usage Type’)

- **eDÉCOR (TR 23.711)** – extension of DÉCOR with involvement of UE in CN selection

No UE attachment to multiple slices is possible

*Source: 3GPP*
Slicing in 3GPP NextGen

- Focused on CN only (without RAN)
- DP/CP separated slicing
- Common and Dedicated NFs
- Common Control Plane
  - Slice Selection Function (SSF)
  - Access & mobility control (AMC)
  - Network capability exposure
- Dedicated Control Plane
  - Session control

UE can be attached to multiple slices

It is hard to slice the RAN

Source: 3GPP
Slicing in 3GPP 5GS

- **Selected 5G services requirements** (TS 22.261)
  - Network slice lifecycle management
  - Configurable set of services supported by a network slice and policy control
  - Configurable association of UE or service to a network slice
  - Traffic and services of slices isolation
  - Definable minimum/maximum capacity of slice
  - Configurable priority for resource allocation

- **Slices support by 5GS architecture** (TS 23.501)
  - Subscription/registration: S-NSSAI = SST { eMBB, uRLLC, MIoT} +SD, NSI, policies

S-NSSAI = Single NS Selection Assistance Info
SST = Slice Service Type
SD = Slice Descriptor
NSI = NS instance ID
5G Americas

- RAN Slicing definition: RAN-specific configuration rules (at resource level) that fulfills service requirements (latency, bandwidth, etc.)
5G Exchange (5GEx)

- **5GEx focus:** E2E cross-domain (covering technological & administrative domains) orchestration of services in multi-vendor environments
- Multi-Domain Path Computation Element (MD-PCE) defined by IETF
- ETSI MANO extensions:
  - Inter-provider NFVO
  - Multi-domain VNF Manager
  - SLA Manager
  - Service Catalogue
  - Topology Distribution

*Source: 5G-PPP 5GEx*
ITU-T IMT-2020 Network Slicing (SG13/21 draft 07/17)
ITU-T IMT-2020 Network Slicing (SG13/21 draft 07/17)
Network Functions Virtualisation (NFV); Evolution and Ecosystem; Report on Network Slicing Support with ETSI NFV Architecture Framework (9/2017)
5G! Pagoda single-domain slice and orchestration architecture
5G!Pagoda management architecture
Conclusions

Network Slicing is a big revolution in the telco industry, but

- Still lack of a complete vision
- Many business and technical issues to be solved yet to obtain carrier grade solutions
- There is a need of standardization that goes beyond 3GPP (having in mind e2e slicing)
  - So far the cooperation between different SDOs takes place but is not effective
- We should accept different ways of slice implementation (including legacy systems)
- Probably killer applications will be IoT (different verticals) and NSaaS (slice-on-demand)
- Slice is an object that has to be managed and orchestrated – a lot of work for the management community
  - Split of management functions
  - Orchestration scalability
  - ...
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