TM Forum 5G Work Focus

• Learning from related Catalyst (Proof of Concept) Projects since 2016
  - With SP deployment scenarios to inform the APIs and modelling development (see supporting slides)

• Intent Based Management
  - Intent against OLA/SLA targets for each tenant instance is required for managing the volume and velocity of 5G services & resources

• Closed Control Loop (CCL)
  - Intent based management needs to support by layered orchestration and closed control loops (which does not imply multiple orchestrator implementations)

• Hybrid Infrastructure Management
  - PNF and VNF operations use platform based approach with CCL and policy mgmt.
5G Essentials: Separation of Concerns

• Horizontal Management Operations:
  Intent based management and cloud native implementation (IaaS PaaS and SaaS) moves operations towards horizontal management of
  - Service, Resource, Infrastructure /VIM Functions - linked by intent based abstraction using exposed service APIs and agreed SLAs for individual tenants.
  - 5G Domains – Access/ Backhaul/ Core network 5G ‘Sub Slices’ all modelled using intent based management to support multiple and changing 5G business models i.e. no static relationships between domains but defined exposed services
  - Intent-based approach allows for easier migration among generations of radio technologies and also support non-radio transport, i.e., the technology-specifics are not embedded in the exposed Service API.

• For agility, change management and model driven approaches:
  Platforms like ONAP should explicitly separate / decouple individual actors’ needs:
  - The Service View exposed at NBI ExtAPI (Service User actor)
  - The virtualization and onboarding of Software Assets including NFV (Operational Management actors e.g. SDC)
  - Management of policies including Security (Enterprise management actors e.g. SDC)
  - Example anti patterns:
    Exposing deployment flavors in the NBI ExtAPI Service views – couples implementation to the exposed Service definition making onward change management challenging

• Open APIs need to support change by rendering payload dynamically from catalog /repository
  - 5G slicing needs flexibility to support new features without re-coding API
  - Early APIs statically bind Payload /DM to API implementation requiring re-coding rather than configuration to accommodate change

• TOSCA metadata needs to support full commercial and operational onboarding (e.g., testing, metrics, licensing) not solely instantiation of Software Images i.e. multiple actors in a lifecycle from supplier to deployed images.
  - Affects structure and actor usage of ONAP TOSCA templates
5G Essentials: Slicing Model Considerations

- Expose technology neutral connectivity models for e2e Service (CFS) and exposed Resource Services (RFS)
  - Decouple exposed service from internal technical implementation (vendor and technology specific aspects)
  - Achieved by use of Connectivity Model using exposed (simple) service topology, flows and features
  - Allows hybrid 5G legacy for 5G slicing capabilities (decouples connectivity models from technology evolution)
  - TM Forum solution defined in TR 255 Connectivity Model (requirement and use case) covering:
    - Features constraints and topology models linked to GB 922 Logical Resource Models (Eases integration with Information framework based OSS /BSS e.g. SDC)
    - The connectivity model is also supported in an intent-based API.
    - Mapping/integration with detailed resource models and topology e.g. 5G (managed independently by Operational Management e.g. SDC recipes and templates)

- End point modelling for aggregation and concatenation of subnetworks using different internal technologies (multi-SDO discussion)
<table>
<thead>
<tr>
<th>TM Forum Work Activities</th>
<th>Relevance to ONAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements/ Use Cases</td>
<td></td>
</tr>
<tr>
<td><strong>IG1152 Dynamic Network Slices Management and Business Models R17.0.1</strong></td>
<td>• Network slice consists of multiple domains (i.e. Access/Backhaul/Core)</td>
</tr>
<tr>
<td></td>
<td>• Network slice provided by multiple service providers through APIs</td>
</tr>
<tr>
<td></td>
<td>• Definitions of actors for 5G e2e management</td>
</tr>
<tr>
<td></td>
<td>• SDO alignment achieved with Use Case w/ NGMN E2e Arch., Virtualization w/ ETSI-NFV, 3GPP 23.799</td>
</tr>
<tr>
<td><strong>TR229 ZOOM/NFV User Stories Suite R17.0.0 Part A section 4</strong></td>
<td>• Defines actor for Slice Orchestration Policy and Governance</td>
</tr>
<tr>
<td></td>
<td>• Network Slicing User Stories: Slice Orchestration in Multi-Service Provider with a single Slice Partner; Multi-Service Provider in B2B2C Model; Federated Orchestration</td>
</tr>
<tr>
<td><strong>Catalyst</strong></td>
<td></td>
</tr>
<tr>
<td><strong>5G Intelligent Service Planning and Optimization</strong></td>
<td>• Specifically looked at opportunities for integration with VES, DCAE, to achieve E2E Service Assurance</td>
</tr>
<tr>
<td><strong>5G Intelligent Service Operations (WIP)</strong></td>
<td>• Using ONAP Policy Manager to control Service Orchestration run time behavior</td>
</tr>
<tr>
<td><strong>Blade Runner (WIP)</strong></td>
<td>• 5G enabled AR scenario</td>
</tr>
<tr>
<td></td>
<td>• Service Assurance/SLA flow through ONAP modules: SDC, SO, SDNC, AAI, External API and VID</td>
</tr>
<tr>
<td></td>
<td>• TOSCA template for service assurance across CFS and RFS layers</td>
</tr>
<tr>
<td>TM Forum Work Activities</td>
<td>Relevance to ONAP</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Intent Based Management</strong></td>
<td>• ONAP 5G architecture, SO, Closed control loop, Separation of management concerns amongst different actors</td>
</tr>
<tr>
<td>• IG1128 Dynamic Control Architecture for Managing a Virtualized Eco-System R16.0.1</td>
<td></td>
</tr>
<tr>
<td>• IG1139 Business Rationale and Technical Overview for Orchestration and Autonomic Control Loops R16.0.1</td>
<td></td>
</tr>
<tr>
<td>• TR262 Management Platform Blueprint and Application to Hybrid Infrastructure R17.5.1</td>
<td></td>
</tr>
<tr>
<td>• IG1161 Overview: Agile Intent-based Resource Management in Hybrid Environments R17.5.1</td>
<td></td>
</tr>
<tr>
<td><strong>Modeling</strong></td>
<td>• SDC, Intent based Modelling of run time configurable and programmable network slicing.</td>
</tr>
<tr>
<td>• TR255 Connectivity Patterns for Virtualization Management R17.5.1</td>
<td>• Provides connectivity model with features to abstract /hide internal network detail needs for intent based management.</td>
</tr>
<tr>
<td>• GB922 Logical and Compound Resource Computing and Software R17.5.1 supports digital services, multi-tenancy offerings and virtualization/cloudification by the introduction of the Resource Function concept.</td>
<td></td>
</tr>
<tr>
<td>• TR275 Core Networking Resources Business Entities R17.5.1 Proposal on federation of parts of the TM Forum Information Framework R17.5 and ONF CIM v1.3 Describes federation between the two models and specific interconnections. This allows Information framework to incorporate transport network models.</td>
<td></td>
</tr>
</tbody>
</table>
Next Steps

• Identify key areas where ONAP can leverage 5G modeling and API experiences from the TM Forum
  - Coordinate deeper dive discussions

• Identify & prioritize concrete joint Casablanca deliverables
  - May require multi-SDO coordination
Supporting Materials
IG1152 Dynamic Network Slices Management and Business Models
This TM Forum 5G slice approach is **Business Scenario and User Story/Use Case-driven** with the objective to derive **Top 13 slice requirements** to pave the way for identifying and demonstrating the value creation for the players interacting in the 5G ecosystem.

Targeting relevant technical drivers and overcoming main challenges are key to drive the standardization phases and Products & Solutions maturity and sustainability.

**Operational 5G System** (or Network Slice Platform) as a playground is major piece to be built by the Catalyst partners to assess identified Technical and Business scenarios.

**The Catalyst cover a small scope and small size** then grows as 5G standard matures.

3GPP Architecture options considered: **Standalone (SA) and Non-Standalone (NSA)**.

Business scenarios are limited to only two use cases with extreme requirements (e**MBB** and **URLCC**). **The 5G Catalysts cover (URLCC, eMBB, m IoT, V2X)**.

Network Slices for those 2 selected use cases could be supported under 2 Deployment Scenarios:

- **A single Slice Provider model** where E2E Network Slice spans the Slice Provider’s 3 domains (Access, Backhaul, Core Network) under non-roaming model.

- **Multi-Slice Provider model** where E2E Network Slice spans Multi-Slice Provider according to governance, agreement and commercial arrangement among those partners (Roaming model could be an example).
E2E Network Life Cycle Management: Architecture and Processes (Holistic view: Customer & SP)

Customer’s perspective

5G BSS

- Customer Onboarding
- Subscription
- Network Slice (Self)
- Ordering
- Agile Delivery
- Dynamic change request
- Charging
- Billing
- Settlement

Network Slice Dynamic Design Tool-Chain

- Editors for Network Slice (NFs)
- Policy Generators (from Network Objectives / Goals)
- Validators against conflicts (Goals conflict resolution, Policy conflict resolution, Bad NFs chaining resolution)

Processes

Slice Provider’s perspective

5G OSS
EM, VNFM, VIM, SDN Controller empowered by Autonomic & Cognitive capabilities with Data Analytics

- Dynamic Creation
- Slice Registration
- Operations
- Orchestration
- Autonomic & Cognitive Assurance
- Modification
- Termination
- Retirement

E2E IoT Network Slice Instance
E2E eMBB Network Slice Instance

5G Access + LTE (SON)

Backhaul (SON-like / Autonomics)

5G Core + EPC (SON-like / Autonomics)

© 2018 TM Forum | 11
Network Slice Deployment Scenario 1: in Single Slice Provider (Multi-Domain model)
Network Slice Deployment Scenario: 2: in Multi-Slice Provider model
Network Slice structure options:
Network Functions composing a Network Slice instance

• Network Slice is designed as composition of NFs at CP and UP according to 3GPP SA2 TR 23 79
  – Control Plane NFs
  – User Plane NFs

• Each of the those Resources Capabilities (RFs) are stored in a catalog. We are using TM Forum terminology with those resource capabilities (RF: Resource Function)
Catalyst:
5G Service Operations – Real Time Service Assurance
5G Challenges

5G Service Management and Orchestration

- Many POCs and research on 5G radio aspects but very little on operations and management.
- No clear agreement on what needs to be managed or how the management should be organised.
- Expectation of radical change in how 5G operations is organised and the OSS IT systems to support them.
- Impact of 5G on service orchestration for slices not fully explored.
- Create, manage and automate end-to-end service-specific network slices that cross legacy, SDN, mobile and fixed networks.
- SDN/NFV operations platforms need enhancement to deliver new services.
- Full automation from fulfilment to assurance processes to support billions of IoT connections.

New 5G services

- Assigning specific network characteristics for each type of service across the network.
- Defining services with specific attributes such as latency, bandwidth etc by creation of network slices.
- Assuring and guaranteeing service performance and SLAs per network slice.

5G Network Slicing

- Currently on a service class basis with services mapped into 3-4 network slices manually.
- 5G based IoT services (with different attributes) need to be treated individually for better network utilization.
- Tens of thousands of slices require the entire process to be automated.
Catalyst Scope

- Focus on two 5G based IoT use cases with the goal of:
  - Composing repeatable services for industry verticals in hours
  - Zero friction integration into OSS /BSS Operations Center of the Future
  - Dynamically and autonomously fulfilling and assuring numerous concurrent slice instances (in parallel) with total isolation and security to meet carrier-grade standards.

- Explore the impact of 5G networks and network slicing on operations in creating and automating many parallel end-to-end network slices that cross multiple network types to:
  - Explore technology readiness and close potential gaps in 5G operations
  - Enable CSP to automate the creation and modification of specific network slices for new IoT services with specific SLAs and characteristics
  - Leverage open source to address the needs of IoT and to accelerate innovation

Connected Factories
- Equipment field sensors
- IMU sensors
  - uRLLC (Ultra-reliable and low latency communication)

Connected Cars
- uMTC (Ultra-reliable machine-type communication)
5G Operation – Management platforms and flow

1. Slices creation and fulfillment

2. Network Slice On-boarding

3. Network Slice Inventory/Lifecycle

4. Performance Collection and Thresholding TMF 628

5. Slice Scaling request (Scaling API evolving towards Entity Provisioning API)

Closed-loop Assurance

Service Assurance

5. uRLLC Slice Type SLA Operations

5. uMTC Slice Type Operations

Service Orchestrator

Netcracker

5G Network Slice

Netcom

5G Radio Simulation

VNF Event Stream (ONAP) Metrics Simulation

AT&T

mycomosi

TECO
Connected Factory – uRLLC slice operations

<table>
<thead>
<tr>
<th></th>
<th>uRLLC-Slice-Sensors</th>
<th>uRLLC-Slice-RobotCams</th>
<th>uMBB-Slice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency</td>
<td>&lt;10ms</td>
<td>SLA &lt;10ms</td>
<td>SLA &lt;50ms</td>
</tr>
<tr>
<td>DataRate-uplink per Device</td>
<td>200 Kbps CBR per Device</td>
<td>50 Mbps CBR per Device</td>
<td>5 Mbps VBR</td>
</tr>
<tr>
<td>DataRate-downlink per Device</td>
<td>100 Kbps CBR per Device</td>
<td>200 Kbps CBR per Device</td>
<td>5 Mbps VBR</td>
</tr>
<tr>
<td>Reliability</td>
<td>&lt; 0.3%</td>
<td>&lt; 0.3%</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

Dynamic Scaling (vnfcScalingMetric, Slice allocated bandwidth (MHz))

Pro-active SLA and Demand Monitoring
Connected Car- uMTC slice operations

**5G RAN Node**

- **5G RAN Slice**
- **5G Cell**

**uMTC (V2N, V2V)**

**mBB** (Car as a Mobile Hotspot)

**uMTC Sensor Slice**

**Core Network**

- **5G Common CPNF**
- **5G Slice UPNF**

**Data Network**

- Car Companies
- Connected Car Platforms & apps
- Proactive Network Monitoring

**Network Slice Flows (NG2/NG3/NG6)**

**Dynamic Scaling**

- (vnfcScalingMetric, Slice allocated bandwidth (MHz))

**Proactive Alarming, Correlation**

**Closed Loop Automation**

---

**Table: 5G slice Performance Metrics**

<table>
<thead>
<tr>
<th>Metric</th>
<th>uMTC for V2X Communications</th>
<th>mBB-Slice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency (ms)</td>
<td>SLA &lt; 10ms</td>
<td>SLA &lt; 50ms</td>
</tr>
<tr>
<td>Availability (%)</td>
<td>SLA &gt; 99%</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>Reliability (%)</td>
<td>SLA &gt; 99.99%</td>
<td>&gt; 98%</td>
</tr>
<tr>
<td>Slice Utilization (%)</td>
<td>&lt; 75%</td>
<td>&lt; 85%</td>
</tr>
<tr>
<td>User Experienced Data Rate (UL/DL) (Mbps)</td>
<td>DL &gt; 5, UL &gt; 1</td>
<td>DL &gt; 30, UL &gt; 5</td>
</tr>
</tbody>
</table>
Devised an efficient system to operationalize 5G slices using:

- Closed loop assurance
- Policy-based automation
- Domain/service Orchestration

Tested the system for dynamic and autonomous Fulfillment and Assurance for concurrent 5G Slices

Gained clarity on QoS requirements for 5G service categories: uRLLC and uMTC

Established the role of APIs in the 5G ecosystem: how to leverage open source to address the needs of IoT

Demonstrated how 5G ecosystem integration can be carried out through TM Forum concepts and API operations in:

- TM 628 Performance Management API,
- TR 255 Entity Provisioning API, (aka Resources Function Configuration and Activation API)
- Service Assurance using intent based SLA/OLA approach

Validated the ZOOM TR 262 Hybrid Infrastructure Platform principles and requirements
5G Connected Factory uRLLC Use Case

- **uRLLC slice type Assuance On-boarding**
- **uRLLC slice type Assurance SLA Conformance Alarming**
- **uRLLC slice type SLA Conformance Alarming**
- **uRLLC slice type Scaling request**
- **uRLLC slice type Assurance Policy-based automation (Demand and Congestion)**
- **Resource (re)allocation**
- **uRLLC slice-type scaling orchestration**
- **Closed Loop Assurance**
- **uRLLC slice-type on-boarding / instantiation**
- **Data Rate**
- **Latency**

© 2018 TM Forum | 22
5G Connected Cars uMTC Use Case

Closed Loop Assurance

- Rule-based Automated activation of scale-out and scale-in commands per monitored slice(s)
- Application of smart thresholds and correlation to proactively monitor SLA conformance
- uMTC (V2X) Integrated monitoring of contextual car data
Consumer, operational and Network scenarios

- **Consumer Scenario**
  - SmartDevices - uRLL
    - Robots + IMU sensors
  - Vehicle monitoring and Assistance - MMTC

- **Operations Scenario**
  - uRLL Ops
  - Resource Utilisation Ops
  - MMTC Ops

- **Network Scenario**
  - Closed Control Loop

- **Applications**
  - RAN
  - Core Network
  - Data Network

© 2018 TM Forum | 24
The 5G Intelligent Service Operations is demonstrating the usage of ONAP Policy management integrated with external OSS/BSS systems as part of an operational closed-loop use case.

- Business-Service Orchestration policies
- Service-slice policies
- Centralized and distributed policy management
ONAP Solution for Blade Runner Catalyst
Blade Runner Catalyst – ONAP Solution Overview

- Onboarding VNFs on ONAP
- Instantiating VNFs on Openstack Via ONAP
- Scale out Network Service

RIFT.io

Service Designer / Orchestrator/Inventory

CFS: Internet Reference to RFS

External API Plug In

Service Catalog (633)

Service Order (641)

Service Inventory (638)

REST/JSON

ONAP Portal

ONAP SDC

VID

ONAP SO

SDNC

ONAP AAI

GET

CSAR

POST

GET

Domain Orchestrator

RESTconf (YANG)

Domain Orchestrator

REST (Heat)

VIM (OpenStack - Ocata)

Riverbed SD WAN

EXFO Probe (vVerifier)

Fortinet Firewall

Video Server

VNFs /RFS: EXFO vVerifier, Riverbed SDWAN, Video App, Fortinet