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E2E Network Slicing use case : Overview, Roadmap & Honolulu Demo

Participants: CMCC, Wipro, Huawei, AT&T, IBM, LTTS, DT, TIM, QCT, Amdocs, Tech Mahindra, Reliance Jio, Tencent, China Telecom, highstreet technologies

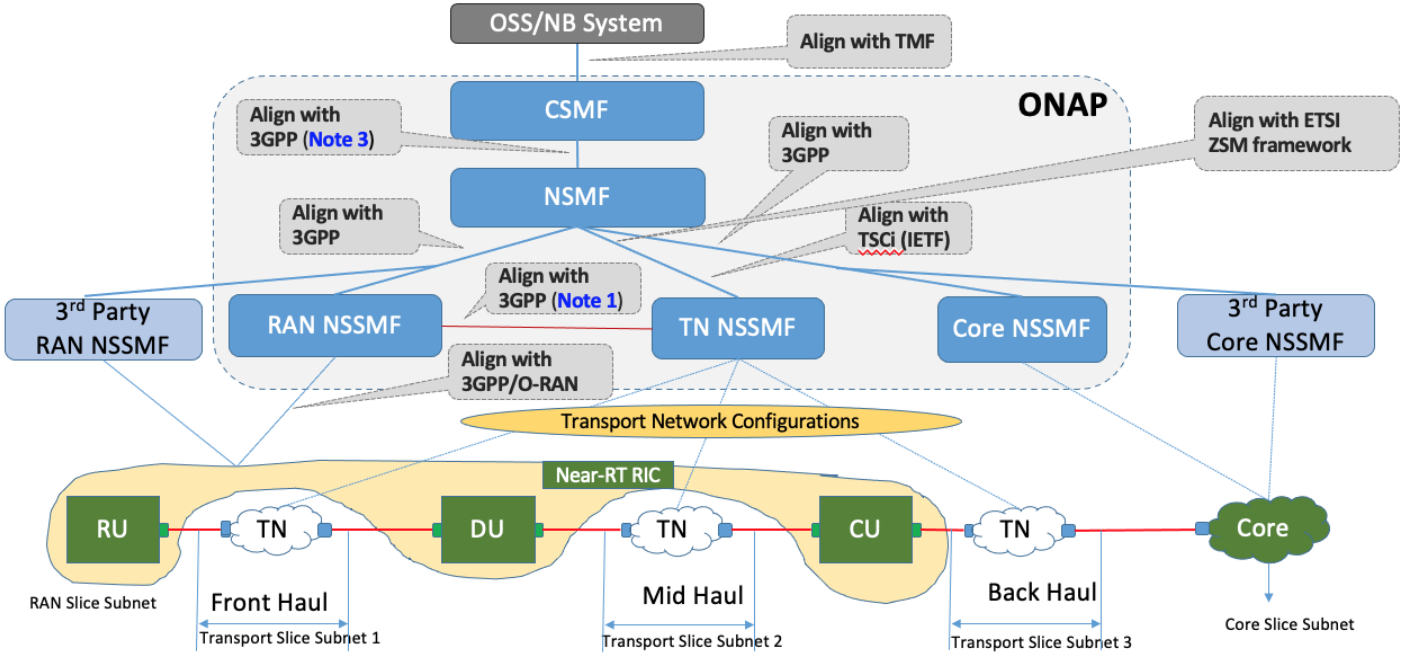
Presenters: Lin Meng (CMCC), Ahila P (Wipro), Henry Yu (Huawei), Milind Jalwadi (Tech Mahindra)

Slice Management Functions (3GPP-defined)

Management Function	Key tasks
Communication Service Management Function (CSMF)	• Responsible for translating the communication service related requirement to network slice related requirements. • Communicate with Network Slice Management Function (NSMF).
Network Slice Management Function (NSMF)	• Responsible for management and orchestration of NSI. • Derive network slice subnet related requirements from network slice related requirements. • Communicate with the Network Slice Subnet Management Function (NSSMF) and Communication Service Management Function.
Network Slice Sub-net Management Function (NSSMF)	• Responsible for management and orchestration of NSSI. • Communicate with the NSMF.

Ref.: 3GPP 28 series

Overall objectives



Objectives:

1. **Implement ONAP- based slice management functions defined by 3GPP (CSMF + NSMF + NSSMF)**
2. **Demonstrate e2e slice design, instantiation and operation, including RAN, core and transport slice sub-nets**
3. **Provide Operators flexible architecture choices for deployment scenarios (ONAP based xMF or 3rd party xMF)**

Current Status of E2E Network Slicing Use Case

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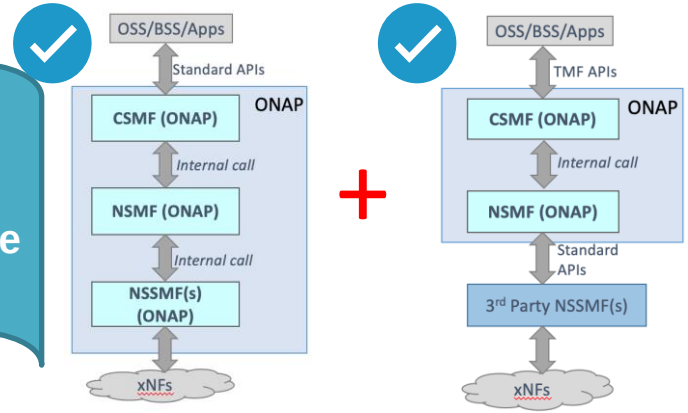
From **Architecture** View :



- **Frankurt release (2019.09 - 2020.06)**

CSMF within OANP + NSMF within ONAP + connect external Core NSSMF

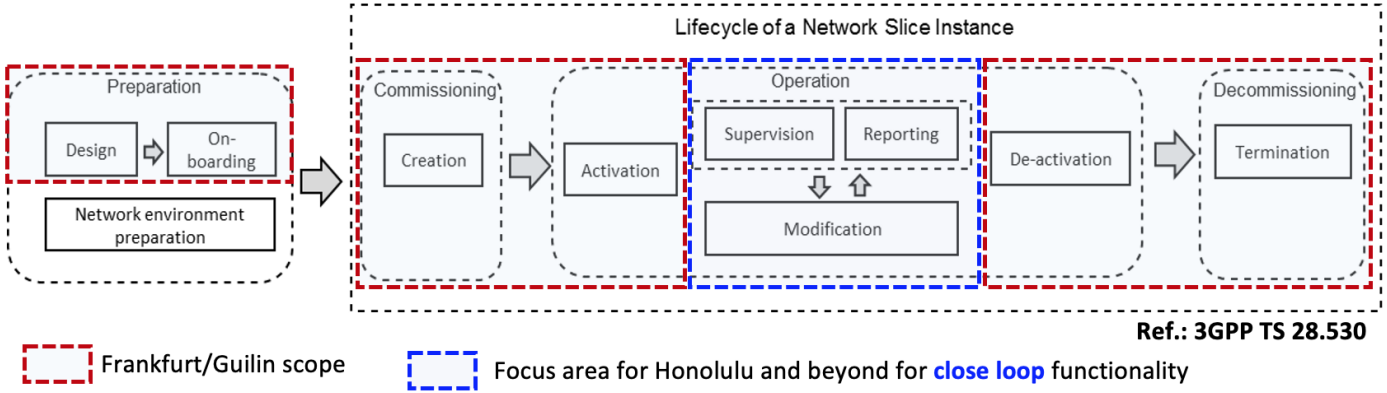
- **Guilin release (2020.06-2020.12)**

Frankfurt deliveries + extenal RAN NSSMF + RAN NSSMF within ONAP + TN NSSMF within ONAP + Core NSSMF within ONAP

- **Honolulu release and beyond (2021 ~)**

Enhancement of existing functions and extension of close loop scenarios (**WIP**)

From **NSI LCM** View:



RAN & Transport Slicing: Scenario 1

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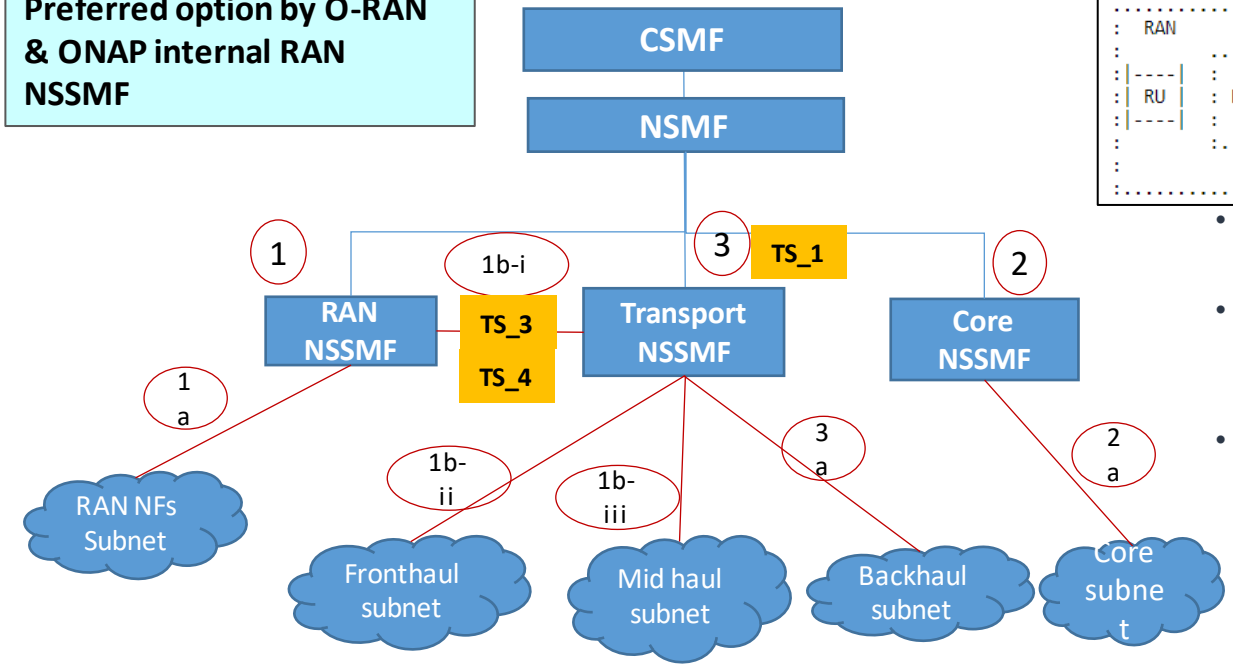
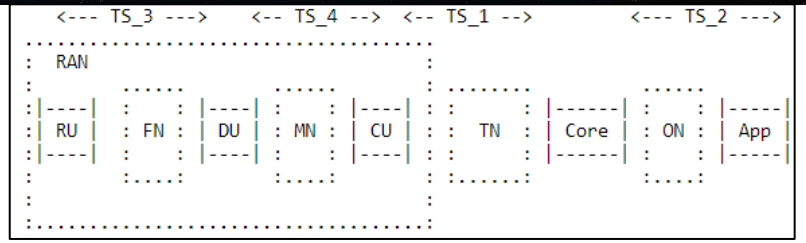
Preferred option by O-RAN & ONAP internal RAN NSSMF





- TS_1 is backhaul transport slice; TS_3, fronthaul; TS_4, midhaul.
- TN MD (T-NSSMF) receives TS_1 from NSMF (step 3), and TS_3 and TS_4 from RAN NSSMF (step 1b-i).
- TN MD then configures backhaul (3a), fronthaul (1b-ii), and midhaul (1b-iii), respectively.

- **RAN NSSMF shall be responsible for determination of Slice Profile of FH, MH and RAN NFs.**
- **RAN NSSMF shall be responsible for entire RAN subnet comprising FH and MH (stitching together, CL actions, etc.)**

RAN & Transport Slicing: Scenario 2

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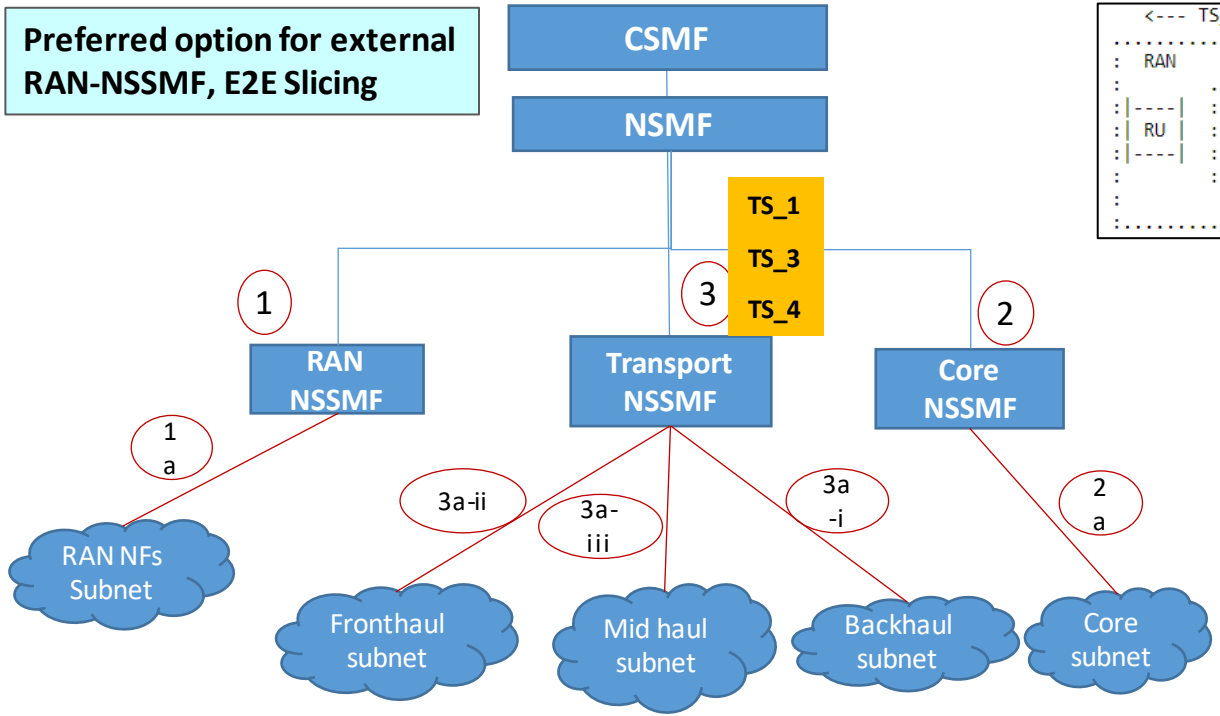
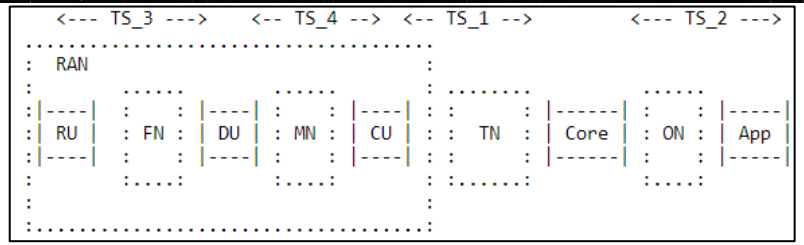
Preferred option for external RAN-NSSMF, E2E Slicing





- TS_1 is backhaul transport slice; TS_3, fronthaul; TS_4, midhaul.
- TN MD (T-NSSMF) receives TS_1, TS_3 and TS_4 from NSMF (step 3).
- TN MD then configures backhaul (3a-i), fronthaul (3a-ii), and midhaul (3a-iii), respectively.

- **NSMF shall be responsible for determination of Slice Profile of FH, MH and RAN NFs.**
- **NSMF shall be responsible for stitching together e2e slice including FH and MH.**

Current Status of Intelligent Slicing

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DONE:
- NST Selection
- NSI/ NSSI Selection

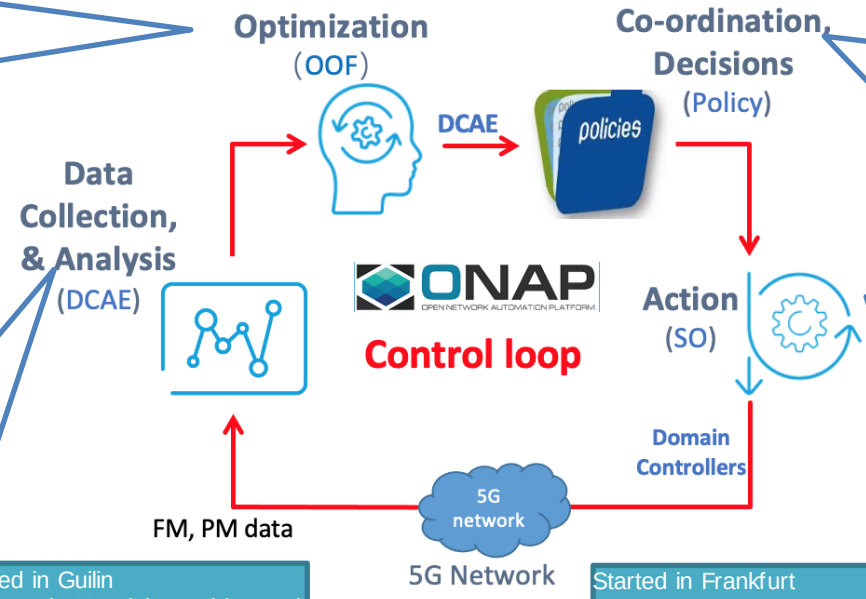
TBA:
- resource re-allocation optimization

Started in Frankfurt
Enhance in Guilin and beyond

Started in Frankfurt
Enhance in Guilin and beyond

WIP:
- NSI/NSSI Selection
- NSSI Resource reconfiguration

TBA:
- Initial resource assignment & resource reallocation
- Slice KPI Guarantee
- Slice SLA Guarantee
- Intent based decision



DONE:
- PM/FM Data Collection

WIP:
- Slice Analysis Micro Service
- KPI Calculation Micro Service
- Network Capability report (from NSSMF to NSMF)

TBA:
- Data collection configuration
- NRM Data storage
- Matured ML algorithms for prediction
- Intent triggered analysis

Started in Guilin
Enhance in Honolulu and beyond

Started in Frankfurt
Enhance in Guilin and beyond

DONE:
- Design
- Creation
- Activation
- Deactivation
- Termination

WIP:
- Modification triggered by supervision

TBA:
- Modification triggered by Requirement change
- Modification during the time of slice allocation
- Intent based actions

Integration Test Status

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CSMF +NSMF:

- Communication Service creation for both shared and non-shared NSI scenarios;
- Service termination testing is deferred

RAN NSSMF:

- Test cases related to terminating RAN NSSI
- Testcases related to interactions with TN NSSMF for FH/BH NSSI reuse
- A couple of minor aspects related to SDN-R and its interaction with RAN are also deferred to Istanbul

TN NSSMF:

- The tests are completed except for checking some minor aspects in SO related to modifying an existing TN NSSI. This will be covered in Istanbul including any issues

CORE NSSMF:

- Testcases associated with modifying (adding/removing slice profile) and deallocating a core NSSI are deferred to Istanbul.
- The test case for reuse of existing Core NSSI is also deferred to Istanbul due to an issue which will be solved in Honolulu_MNT and Istanbul release.

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E2E Network Slicing - Demo

E2E Network Slicing Option1 – New E2ESlice

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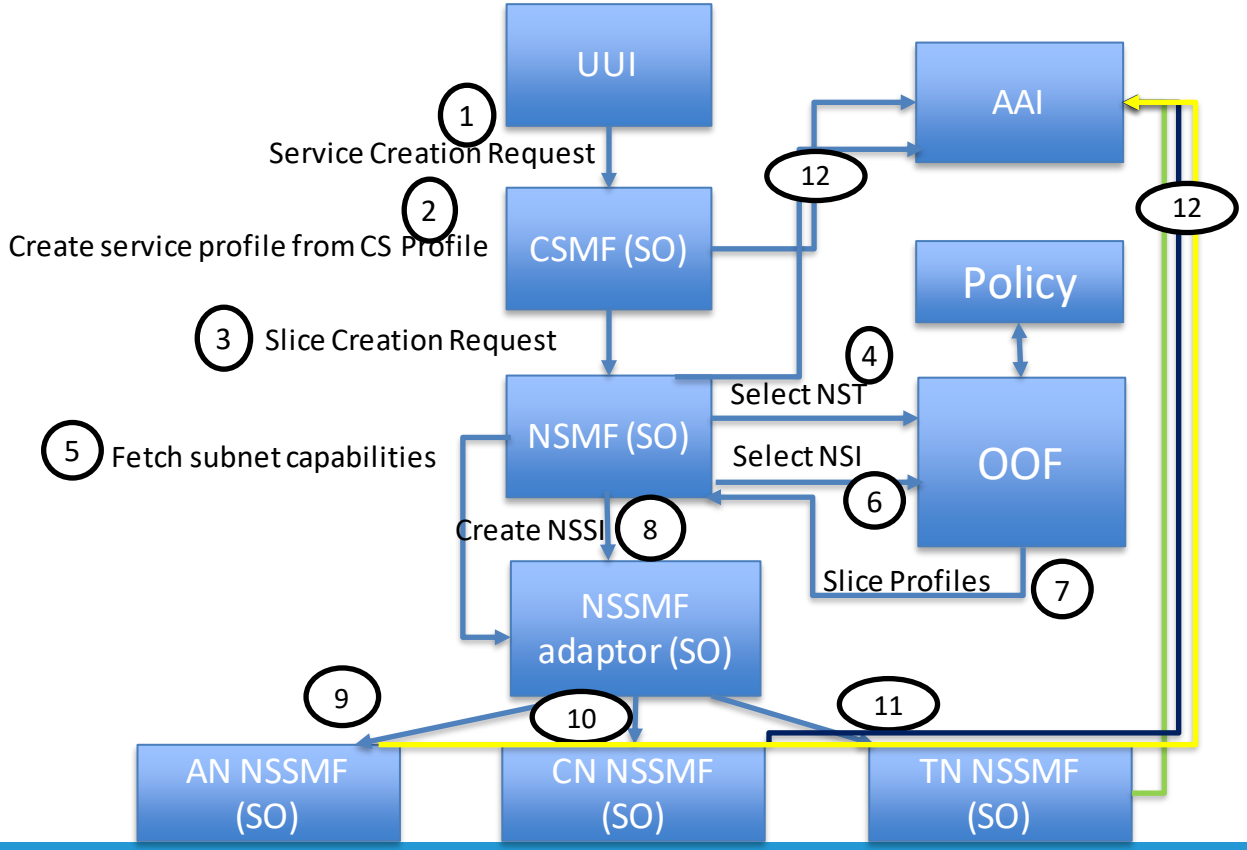

1. Request to create a 5G service is sent to CSMF
2. CSMF makes service profile from CS profile
3. CSMF sends request to NSMF for slice creation
4. NSMF requests OOF for the suitable NST
5. NSMF fetches the subnet capabilities from all the NSSMF via NSSMF adaptor
6. NSMF requests OOF for suitable and shareable existing NSI
7. OOF returns subnet slice profiles as there are not matching slices are found
8. NSMF requests NSSMFs to create the subnets with the slice profile returned at (7)
9. Request sent to AN NSSMF to create RAN NSSI which comprises RAN NF NSSI, TN-FH NSSI, TN-MH NSSI
10. Request sent to CN NSSMF to create Core NSSI
11. Request sent to TN NSSMF to create TN-BH NSSI
12. AAI updates are taken care at relevant stages

E2E Network Slicing Option1 – Shared E2ESlice

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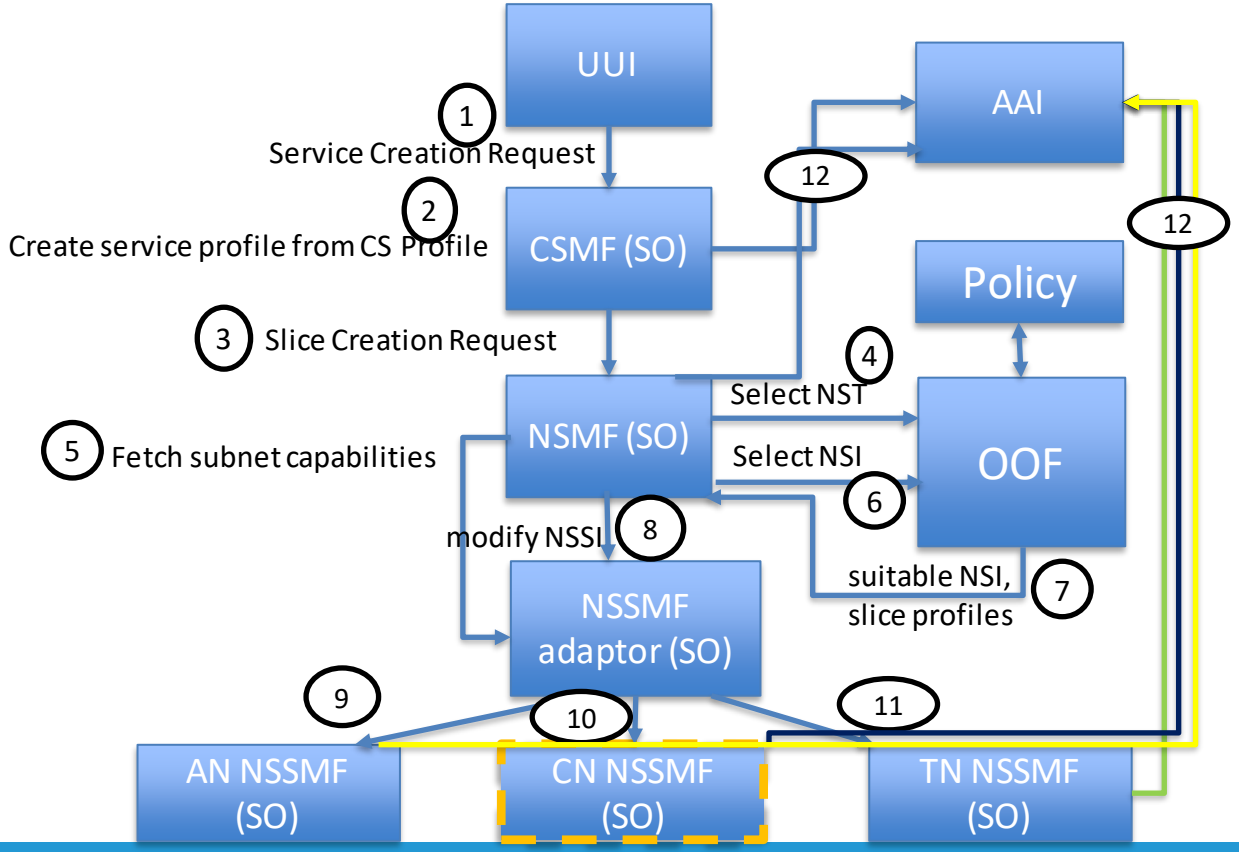
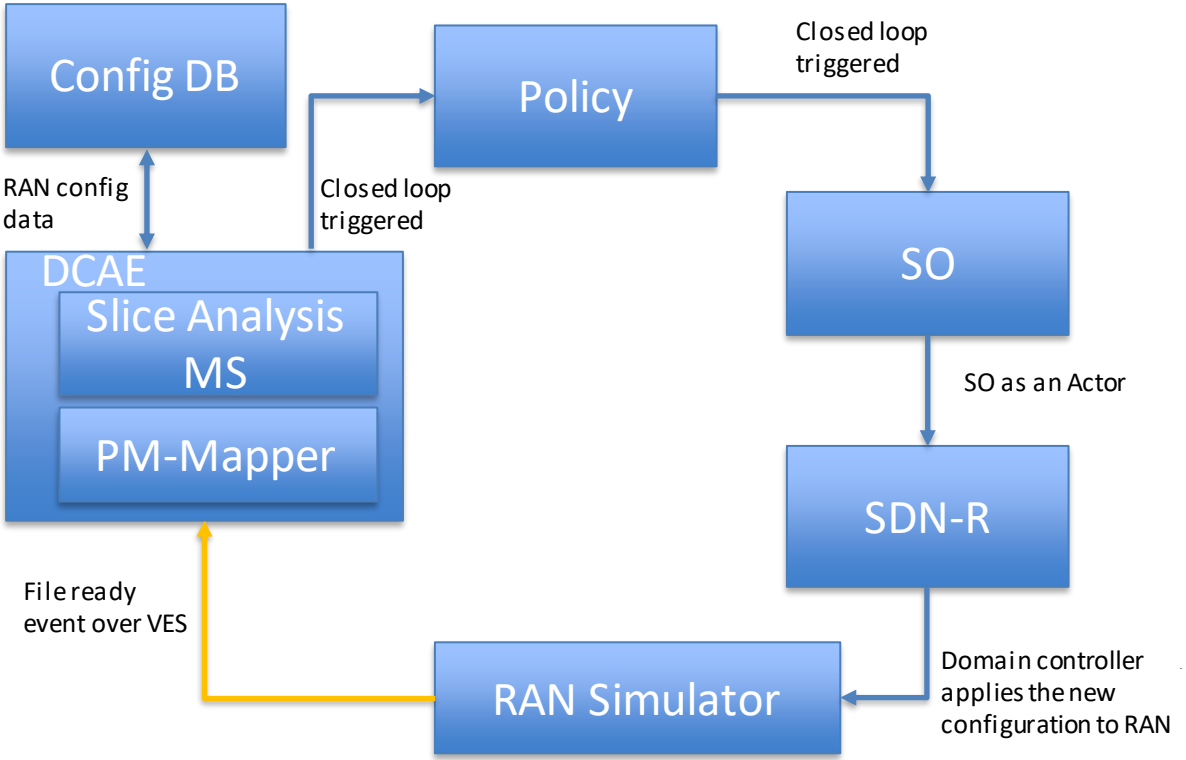
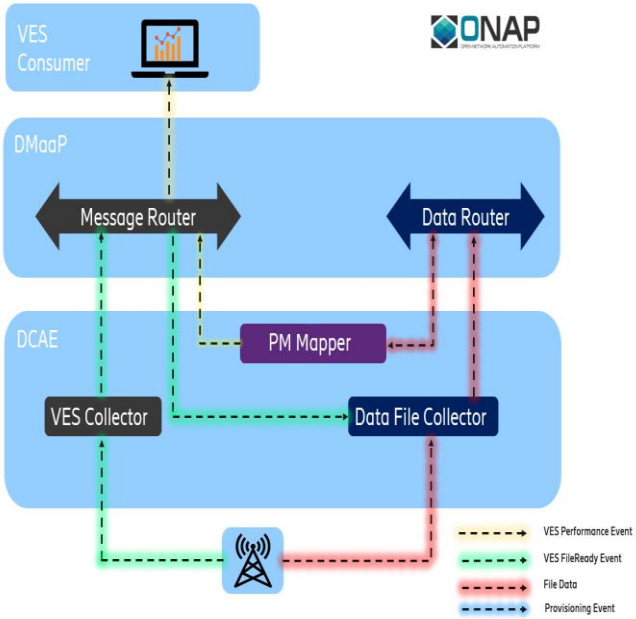


1. Request to create a 5G service is sent to CSMF
2. CSMF makes service profile from CS profile
3. CSMF sends request to NSMF for slice creation
4. NSMF requests OOF for the suitable NST
5. NSMF fetches the subnet capabilities from all the NSSMF via NSSMF adaptor
6. NSMF requests OOF for suitable and shareable existing NSI
7. OOF returns suitable NSI which can be shared.
8. NSMF requests NSSMFs to modify the existing NSSIs vi NSSMF adaptor
9. Request sent to AN NSSMF to modify RAN NSSI which comprises RAN NF NSSI, TN-FH NSSI, TN-MH NSSI for reuse
10. **Request sent to CN NSSMF to modify Core NSSI for reuse – reuse of CN NSSI is not supported for the demo**
11. Request sent to TN NSSMF to modify TN-BH NSSI for reuse
12. AAI updates are taken care at relevant stages

E2E Network Slicing – Closed Loop



Data flow from RAN n/w to DCAE-Slice Analysis MS



Ref. ONAP wiki

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Istanbul Release Roadmap

ONAP-based Slice Management: NSI Life Cycle view

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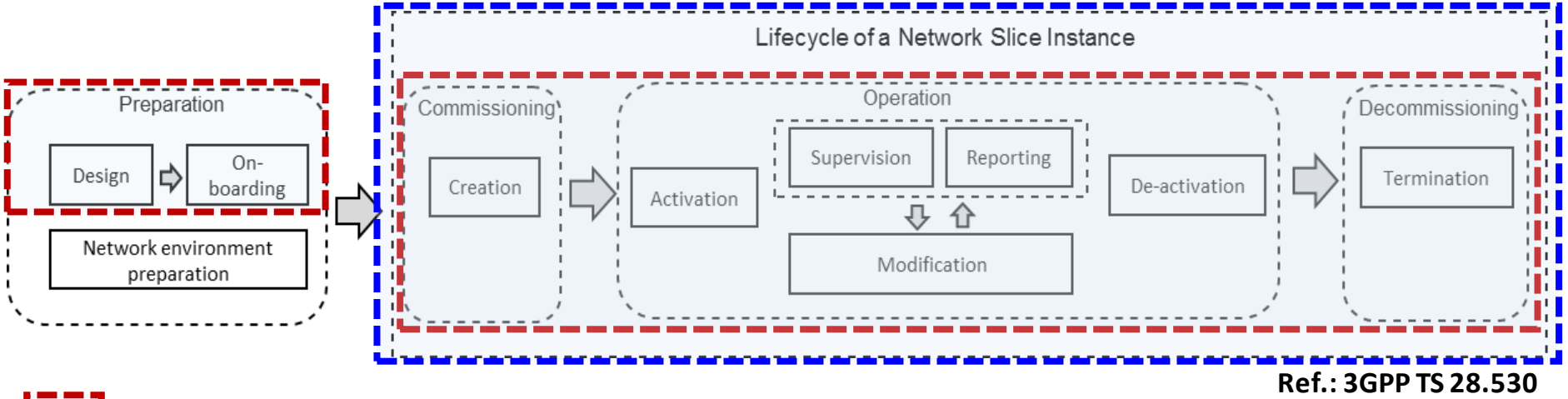
Objective: Demonstrate e2e slice design, instantiation and operation, including RAN, core and transport slice sub-nets.



Ref.: 3GPP TS 28.530

Delivered till H-release

Stabilization & Testing – Istanbul release

- **Design and pre-provision**: Creation of necessary slice/slice sub-net templates.
- **Instantiation/Configuration, Activation/Deactivation and deallocation/termination** of NSIs, including its constituent NSSIs (RAN, Core and Transport).

Istanbul proposal for E2E Slicing solution involving Core, RAN & Transport

- **REQ-1a: E2E Integration testing**
  - Integration testing of various scenarios for E2E network Slicing
  - Carry over test cases from Honolulu release
- **REQ-1b: Use case test automation**
  - Carry out Test automation for slicing use case in phases
  - Target to accomplish test automation for Non-shared slice creation
- **REQ-1c: Slice selection taking into account capacity, resource occupancy levels, etc. (stretch goal)**
  - Capacity definition for various sub-nets
  - NSI selection and NSSI selection based on capacity, resource occupancy levels
  - NSMF to support monitoring and update of resource levels at NSI level
  - NSSMF to support monitoring and update of resource levels at NSSI level (*dynamic capabilities is a stretch goal*)
- **REQ-1d: Consistency between Service Profile and Slice Profile (stretch goal)**
  - Resolving the inconsistency by proper mapping between service profile and slice profile attributes
- **REQ-1e: Support of Option 2 for RAN Slicing (stretch goal)**
  - Implement the call to RAN NSSMF for RAN NF NSSI actions in a model-driven way.

E2E Network Slicing: Impacts for CSMF/NSMF enhancements

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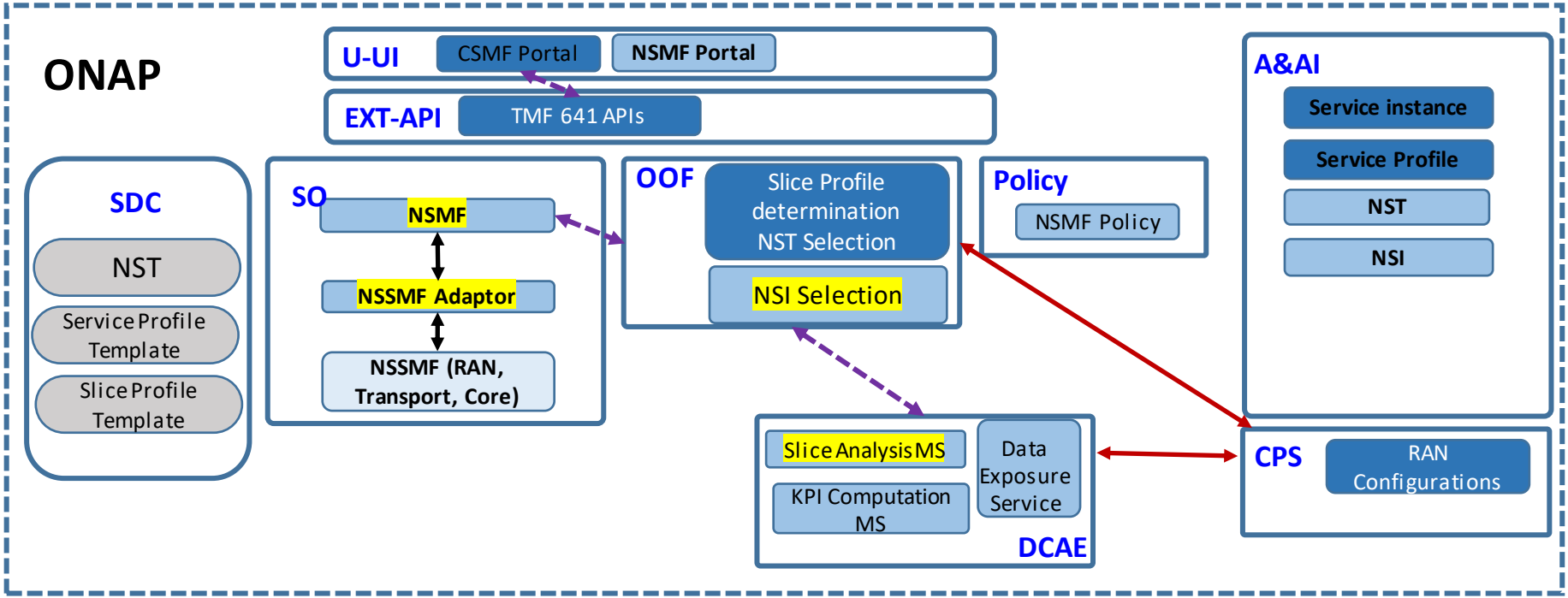

Enhanced interface

New interface

Stretch goal

Stretch goal

Istanbul proposal for RAN Slicing

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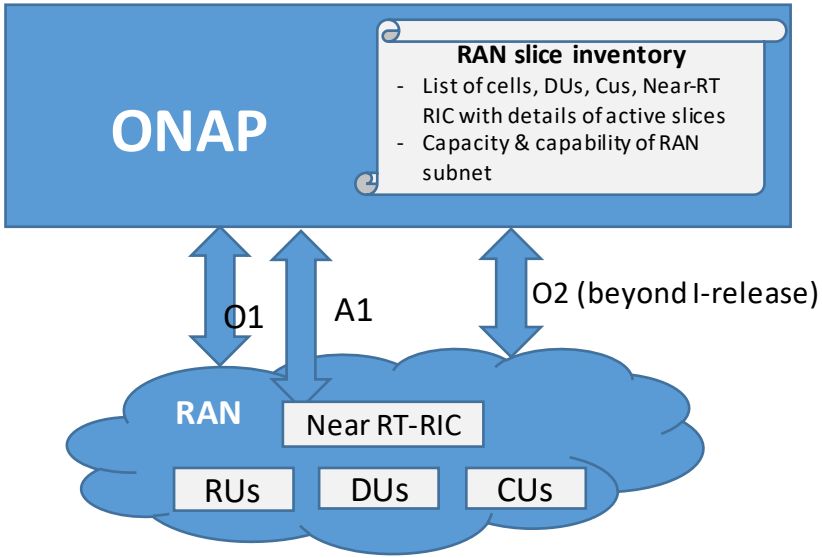
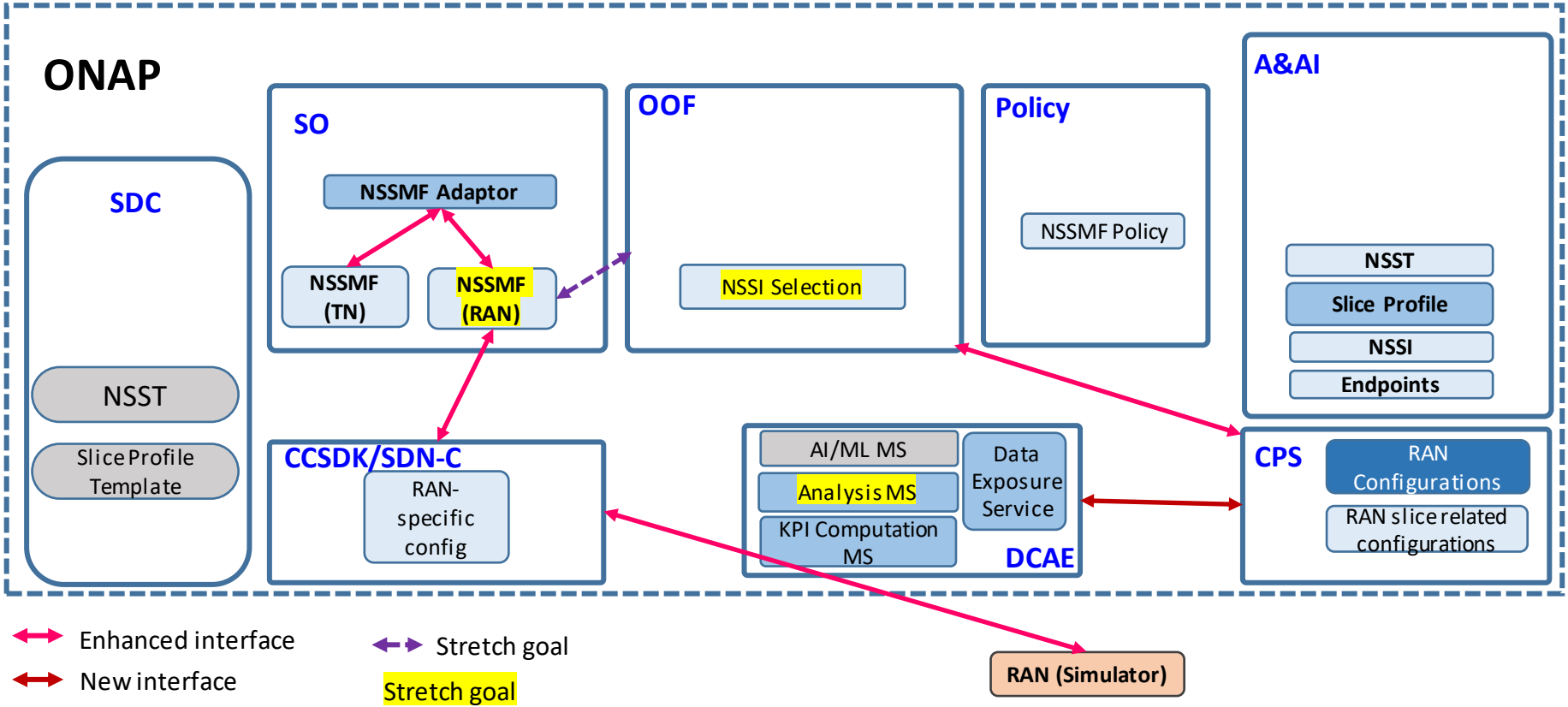
1. **REQ-2a**: RAN-Configuration enhancements including:
   - Mapping (decomposition of) Slice Profile to each Near-RT RIC
   - Sending initial slice config info to Near-RT RIC
   - Sending AI/ML based config updates to Near-RT RIC
   - Sending Closed Loop updates over A1
2. **REQ-2b**: Complete integration with CPS for Network Slicing related config.
3. **REQ-2c**: Integration testing of different scenario combinations with TN (FH and MH)
4. **REQ-2d**: Support of Option 2 (*stretch goal*)
5. **REQ-2e**: Capacity based NSSI selection (*stretch goal*)



Notes

1. Alignment with O-RAN information models to be considered in scope.
2. TA <-> Cell mapping inventory to reside in CPS
3. O2 interface shall be considered beyond I-release

RAN Slicing: Istanbul impacts



Istanbul proposal for Core Slicing

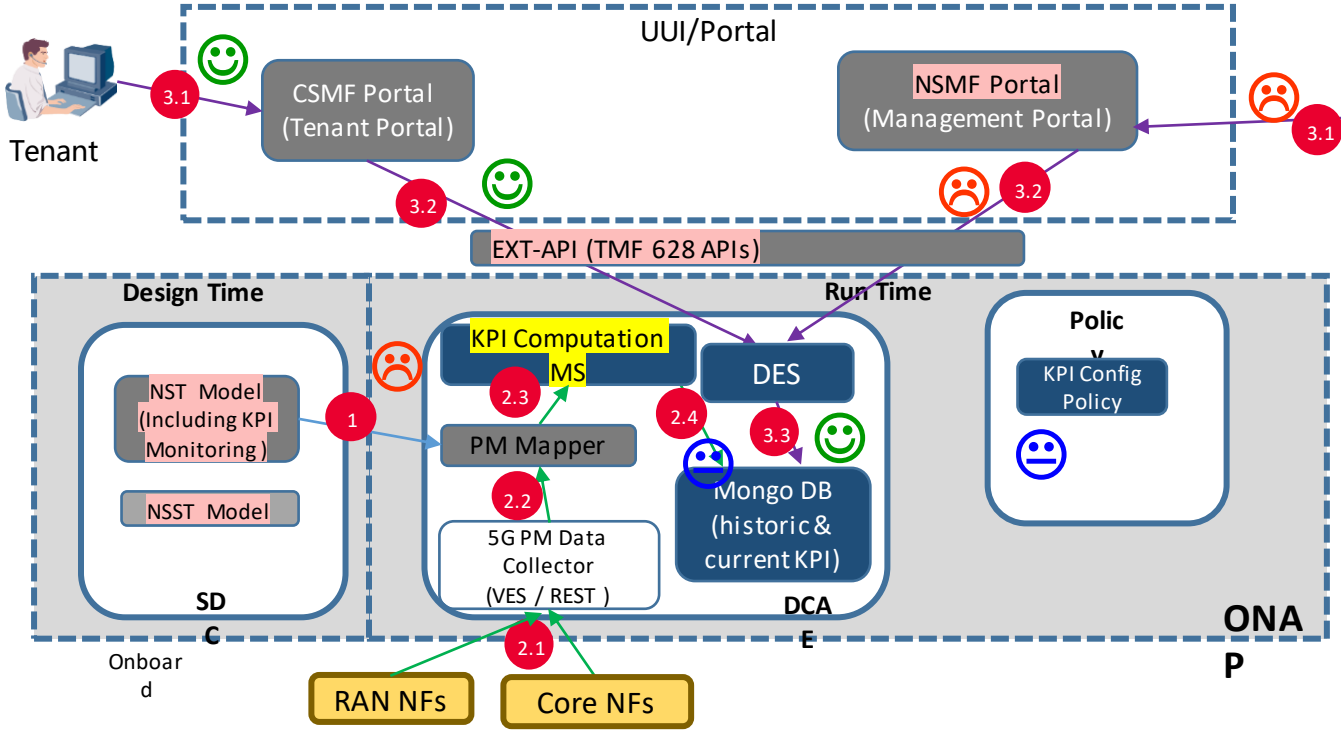
- **REQ-3a: Use of SOL005 interface by Core NSSMF (deferred to beyond I-release)**
  - Alignment with SOL005 interface for Core NFs creation
- **REQ-3b: Reuse of part of core sub-net (covered as separate requirement, integration beyond I-release)**
  - Using Allotted Resources (SO-3471)
- **REQ-3c: Integration testing of different scenario combinations**
  - Completion of carry-over test cases from Honolulu release.
  - Integration testing for different possible combinations with TN NSSMF & RAN NSSMF

Istanbul proposal for Transport Slicing

- **REQ-4a**: Honolulu carryover items for NSSI allocation (deferred)
- **REQ-4b**: Introduction of Intent framework (covered in CCVPN use case)
- **REQ-4c**: Introduction of E-tree service (covered in CCVPN use case)

Transport Slicing enhancements is being covered as part of REQ-456 along with CCVPN use case. The architecture for Transport Slicing, its interfaces and TN NSSMF design principles shall align with the E2E Network Slicing use case. While the next few slides provide an overview of Transport Slicing enhancements done in Honolulu release, refer to REQ-456 for more details about the Transport Slicing aspects.

KPI Monitoring: Istanbul proposal



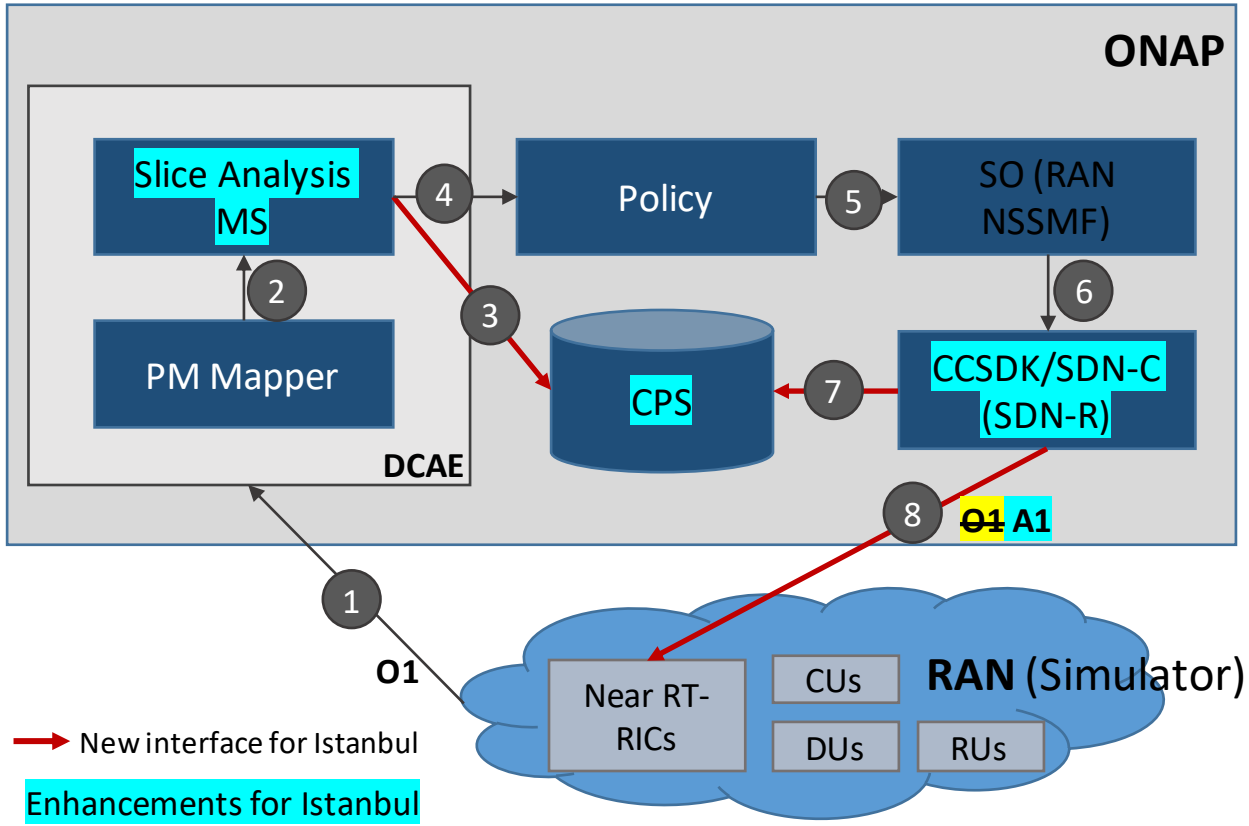
- Enhancements to the computation done in KPI Computation MS (stretch goal).
- **Assumption**: Data from NFs is already aggregated and then presented to ONAP.

Stretch Goal in Istanbul

Out of scope in Istanbul

Done | Partially done | Not done | New as part of Network Slicing

Closed Loop: Istanbul Release Impacts



- The PM data collected from RAN in Step 1 is DL/UL PRB used for data traffic.
- The configuration update determined by Slice Analysis MS and triggering Policy in Step 4 is slice specific throughput guidance for Near-RT coverage area (i.e., at Near-RT RIC level).
- Step 8 is over O1 in Guilin, it will be over A1 in Honolulu (using A1 adaptor).
- Additional PM data to be used is under discussion.

Notes:

1. DFC and VES Collector are not shown in the flow but are used.
2. Initial configuration may also be over A1 (based on Slice Profile decomposition) – this is under discussion with O-RAN.

Intelligent Slicing: Istanbul Release Impacts

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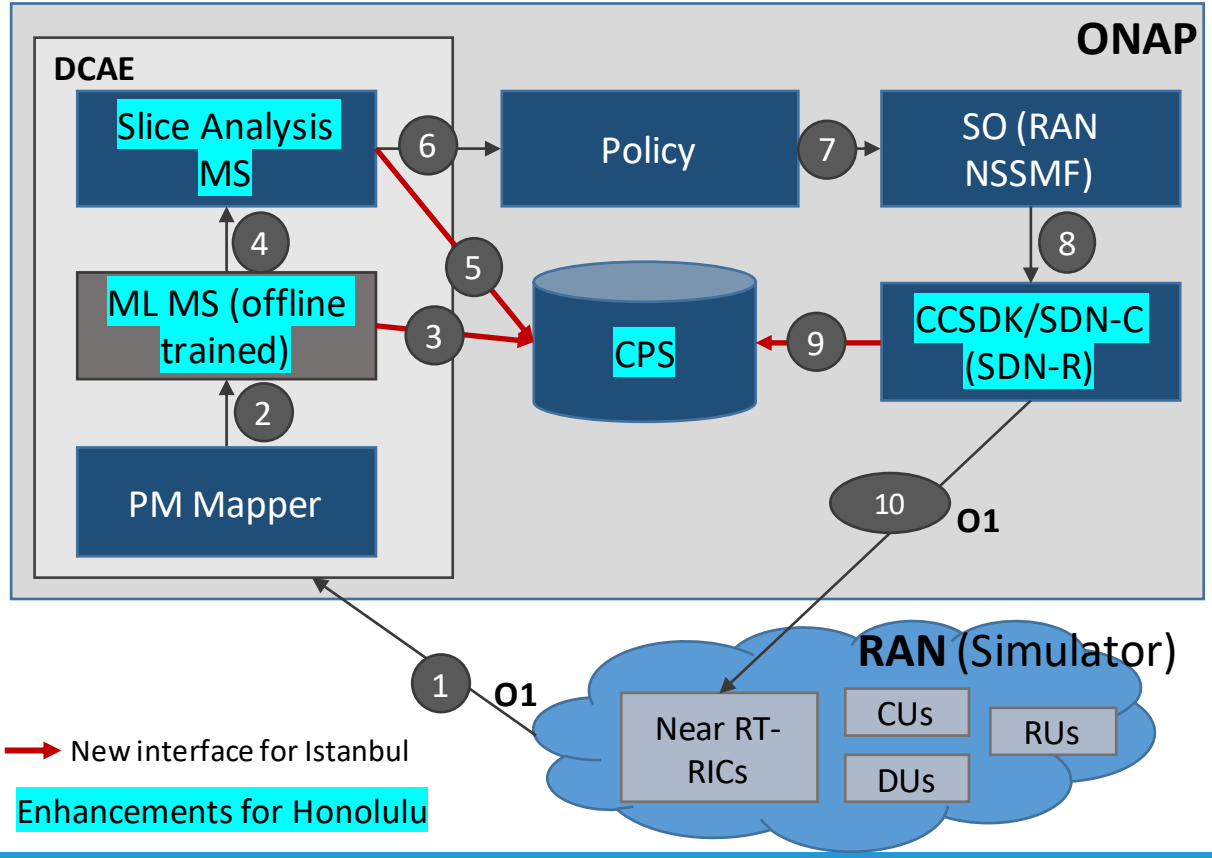

- The PM data collected from RAN in Step 1 is PDU sessions requested, setup successfully & failures.
- The configuration update determined by ML MS and triggering Slice Analysis MS in Step 3 is slice specific maxNumberof Conns for each cell (i.e., cell level for each S-NSSAI).
- Step 10 is over O1 now, it will continue to be in O1 based on latest discussions with O-RAN community.

Notes

1. DFC and VES Collector are not shown in the flow but are used.
2. ML MS is onboarded to DCAE, but not an official ONAP component. Later we will consider onboarding via Acumos DCAE adaptor.
3. Initial configuration may also be over A1 (based on Slice Profile decomposition) –this is under discussion with O-RAN.

To Do

1. Replace the external Core NSSMF simulator by internal Core NSSMF
    - Internal Core NSSMF is tested for non-shared slice, shared slice scenario need to be tested and yet to do the integration
2. Change the display name (Service Instance Name) for RAN NF NSSI, TN-FH NSSI & TN-MH NSSI
3. Closed Loop flow is shown from PM Mapper to RAN Simulator due to an issue at Data Router. To show the data generation part along with closed loop.
4. Alignment/collaboration with CPS
    - for RAN configuration
    - Coverage Area to Tracking Area mapping
5. AN & CN Endpoints, TN Connection Links Selection enhancements
    - Endpoints should be prepopulated for selection. This enhancement will be taken beyond Istanbul Release
    - TN Connection Links – Connection links fetched from AAI should be populated in UUI.

Pending Commits or JIRAs

Below are the commits to consider for trying out the demo. These commits will be available as part of Honolulu maintenance release/ Istanbul release.

SO:

https://jira.onap.org/browse/SO-3629

https://jira.onap.org/browse/SO-3624

SDN-R:

https://jira.onap.org/browse/CCSDK-3314

DCAE:

https://jira.onap.org/browse/DCAEGEN2-2826

Policy:

https://jira.onap.org/browse/POLICY-3369

OOF:

https://jira.onap.org/browse/OPTFRA-967

https://jira.onap.org/browse/OPTFRA-968

E2E Network Slicing Alignment with SDOs

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Standards Body	Alignment Reference(s)
3GPP (Rel. 16)	○ TS 28.530 (Concepts, requirements) ○ TS 28.531 (Slice and Slice sub-net LCM) ○ TS 28.541 (Network Resource Models) ○ TS 23.501 (Procedures in Control Plane) ○ TS 28.552 and TS 28.554 (PM and KPIs)
TMF	○ TMF 641 (Service Order – CSMF NB) ○ TMF 628 (PM and KPI monitoring – just started)
ETSI	○ ZSM 002 ZSM Framework ○ ZSM 003 E2E Network Slicing Architecture ○ ZSM 009 Closed-loop Automation
IETF	○ draft-rokui-5g-ietf-network-slice-00 ○ draft-ietf-teas-actn-vn-yang ○ RFC 8795: YANG models for TE topologies
O-RAN	○ O1 (RAN Configuration, notifications, PM data) – in progress ○ O2 (not started yet) ○ A1 – just started ○ RAN architecture and functional split (Non-RT RIC, Near-RT RIC, SMO) – in progress