Admission and Congestion Control for 5G Network Slicing

IEEE Conference on Standards for Communications and Networking 2018

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30. October 2018

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Introduction
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5G Inter-slice M&O
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Proposed Solutions
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Conclusion
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Outline

Introduction
Slice as a Service (SlaaS)

Network Slicing

- Logically isolated slices of radio/infrastructural/virtual resources
- Can be leased to tenants such as MNVOs & service providers
- Tenant issuing request ⇒ inter-slice M&O decides:
  - denial: tenant reissues / MNO reconsiders after a delay
  - admission: slice created ⇒ maintained ⇒ terminated

Challenges for cross-slice M&O in SlaaS

- Heterogeneous & flexible QoS requirement
- Cross-slice optimization
- Non-stationary dynamics of service demand
- Integration with the (pre-)standardized 5G network architecture(s)

Introduction
State of the Art

- Intelligent slice admission control:
    - Q-learning (Bega, 2017)
    - big data analytics (Raza, 2018)
    - neural networks (Raza, 2018)
    - heuristic optimization (Jiang, 2016)
    - game theory (Caballer, 2018)
- Hardware testbed demonstrations (Zanzi, 2018)
- Initial architectural frameworks (Samdanis, 2016; Nikaein, 2017)

The 5G MoNArch Network M&O Layer

- ETSI/3GPP/Non-3GPP compatible
- E2E Service M&O sublayer
- Service requirements $\xrightarrow{CSMF}$ network requirements $\xrightarrow{CDMO}$ slice template $\xrightarrow{CDMO}$ slice blueprint (with NFs, connectivity, topology, config., etc.) $\xrightarrow{CSMO}$ slice admission decision
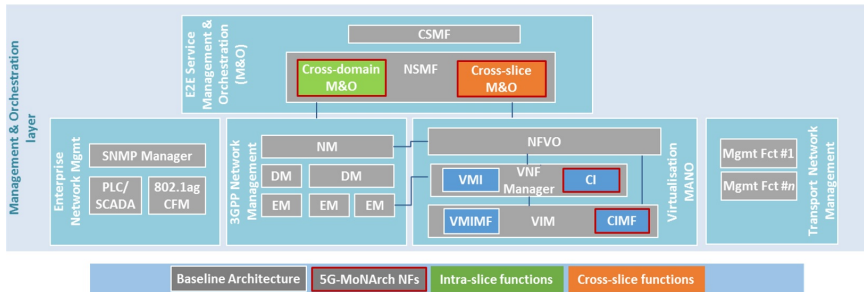
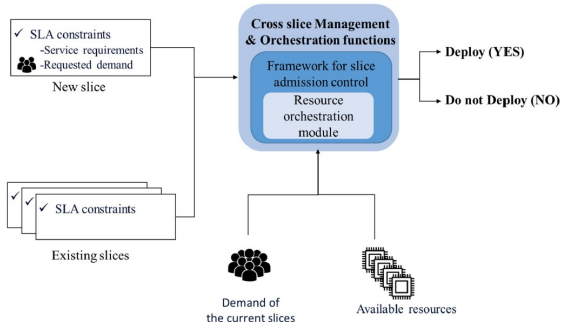# Cross-Slice Orchestration with Shared NF
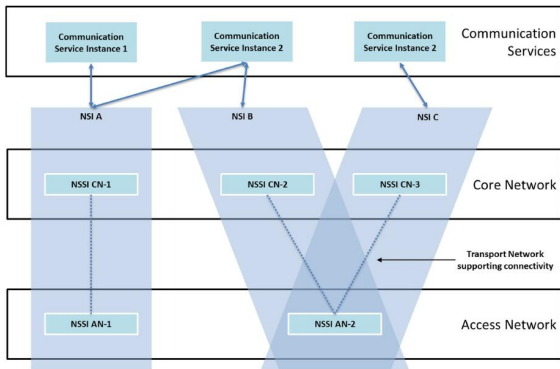
NS sharing scenarios

- NSI sharing among CSs
- NSSI sharing among NSIs

Use cases

- NS allocation reusing NSI
- NS creation reusing NSSI
- Req. update when NSI is shared among CSs
- Req. update when NSSI shared among NSIs
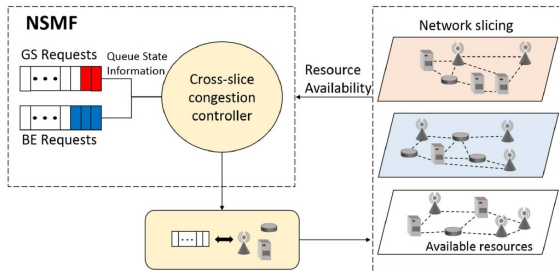
Frameworks

Slice Admission Control Framework

- Available physical and virtual resources
- Remaining capability
- Constrained by SLAs
- Multiple (adversarial) KPIs
- MOO methods to produce a set of Pareto-optimums
- MNO selects from several trade-offs
- Optimize resource utilization
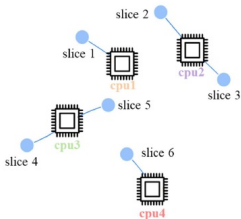- Running in cross-slice M&O

Frameworks

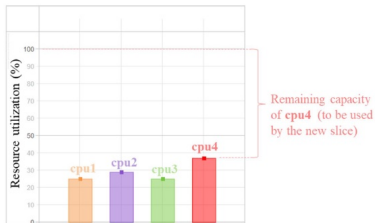## Slice Congestion Control Framework

- Slices may have different priorities and elasticity levels
- Downscaling Best Effort slices to admit more Guaranteed Service slices
- Predict the impact from resource availability, slice requirements & queue state
- Running as an additional function on the top of admission control framework at the orchestrator level

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○○

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Conclusion
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Implementations
Slice Admission Control
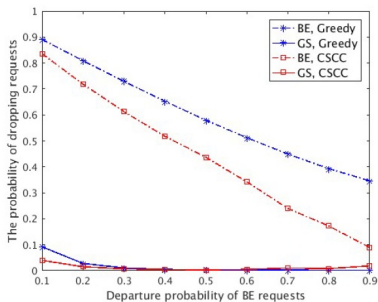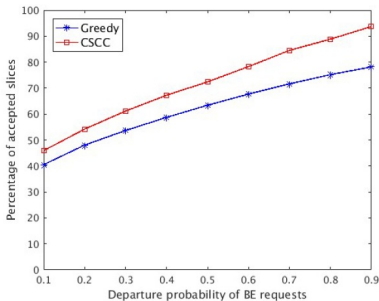

(a) Slice/resource mapping

(c) Resource utilization

(b) Resource orchestration results

Implementations

## Q-Learning Assisted Cross-Slice Congestion Control

See "Optimal Cross Slice Orchestration for 5G Mobile Services", **IEEE VTC 2018 Fall**, Chicago, USA, August 2018.

Implementations
Genetic Slice Admission Strategy Optimizer

Reinforced learning methods need...

- Good training dataset for better initialization
- Robustness against non-stationary service requirements
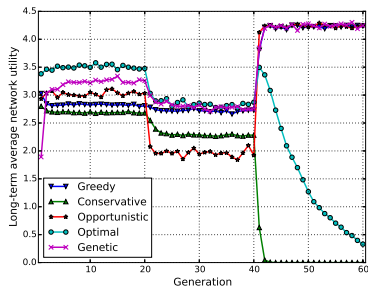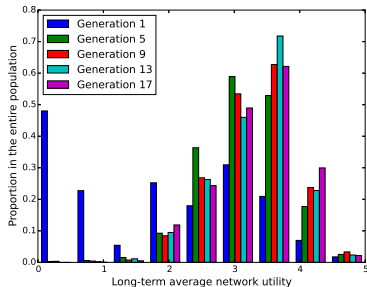
See "Slice as an Evolutionary Service: Genetic Optimization for Inter-Slice Resource Management in 5G Networks", in **IEEE Access**, vol. 6, pp. 33137-33147, 2018.

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○○

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○○

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Conclusion
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Conclusion

- 5G MoNArch defines a new M&O layer
  - ETSI/3GPP7Non-3GPP compatible
  - with a novel E2E Service M&O sublayer
- Cross-slice management with admission & congestion control for efficient utilization and high utility
- For more details about...
  - cross-slice orchestration
  - slice admission control
  - slice congestion control
  - genetic slice admission

  please contact...
  - TIM
  - CERTH
  - CEA LETI
  - TUKL

Acknowledgment

H2020-ICT-2016-2
5G Mobile Network Architechture
for diverse services, use cases, and applications in 5G and beyond

Thank you!