Admission and Congestion Control for 5G Network Slicing
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Outline

1. Introduction

2. 5G Inter-slice Management & Orchestration

3. Proposed Solutions

4. Conclusion
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 $\Rightarrow$ inter-slice M&O decides:
  - denial: tenant reissues / MNO reconsiders after a delay
  - admission: slice created $\Rightarrow$ maintained $\Rightarrow$ 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
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

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...

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5G Mobile Network Architecture
for diverse services, use cases, and applications in 5G and beyond
Thank you!