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Towards Assessing Effects of Isolation on Determinism in Multi-Application Scenarios

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FIRA Workshop Amsterdam – August 22nd 2022

TeraFlow

SIGCOMM 2022 Amsterdam

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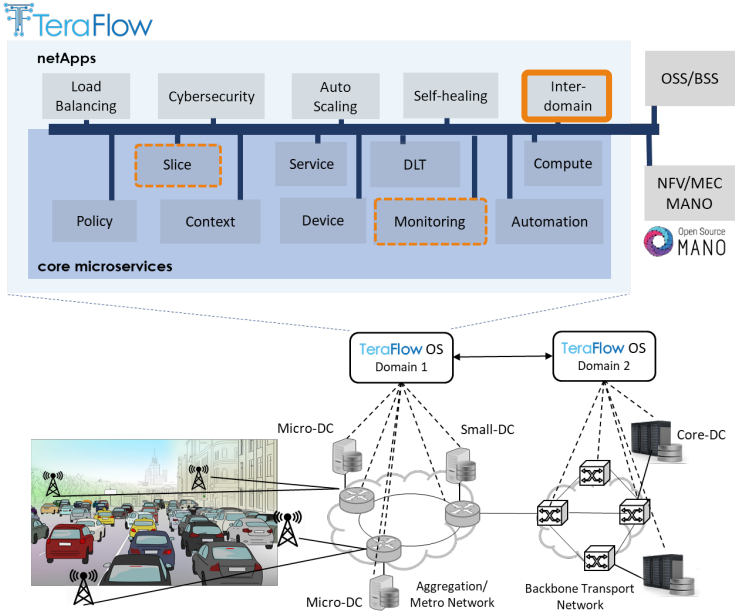
Context: TeraFlow H2020

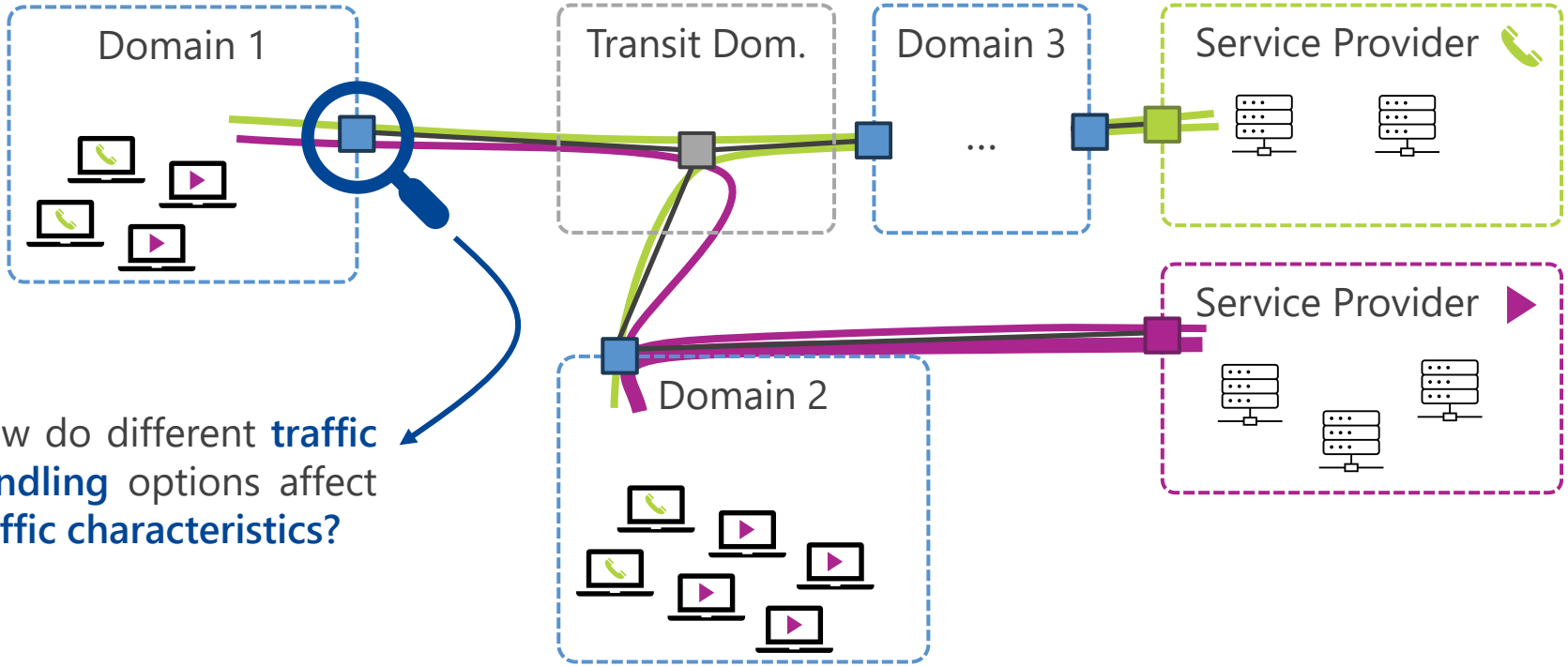
- Research areas
  - Secure autonomic **traffic management**
  - Smart **connectivity**
  - Business **agility**
  - **Automation in B5G** networks
- Contribution: **open-source cloud-native** SDN controller ›**teraflow-h2020.eu/teraflow-os**
- Use cases
  - Autonomous networks beyond 5G
  - Automotive
  - Cybersecurity



Focus of the paper

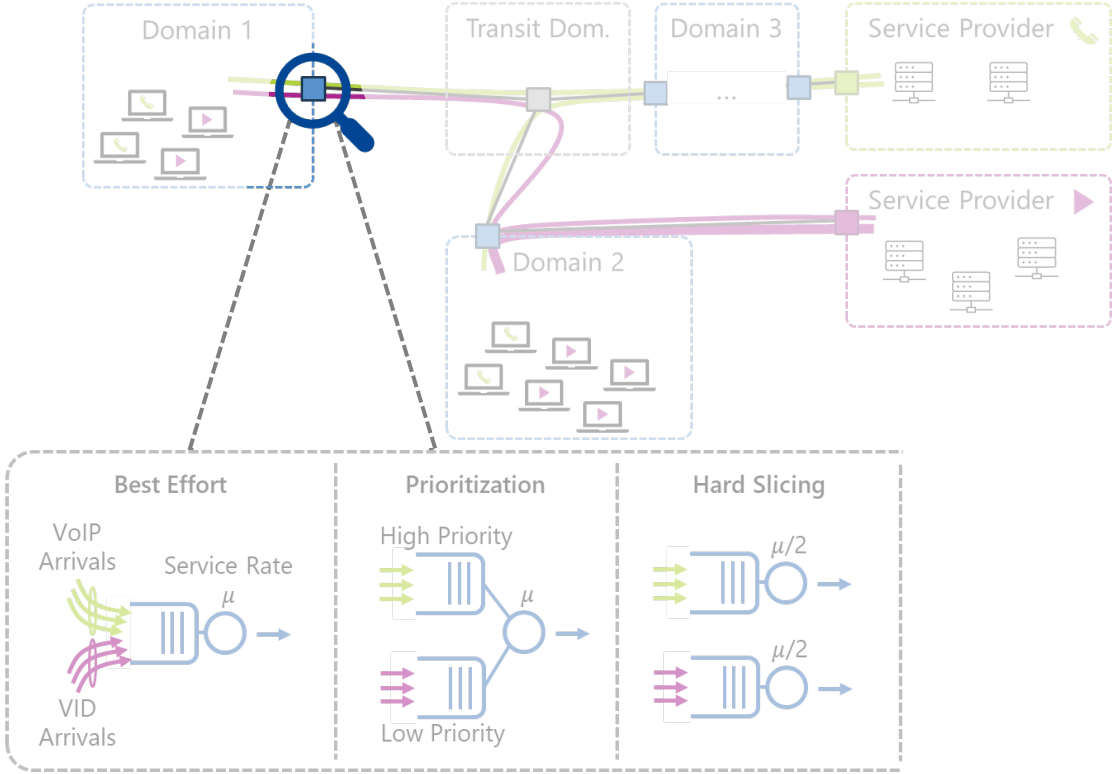
- Towards **E2E** connectivity with **QoS**
  - **Soft isolation** for multiplexing gains
  - **Determinism** of delay performance

Inter-domain Traffic Aggregation



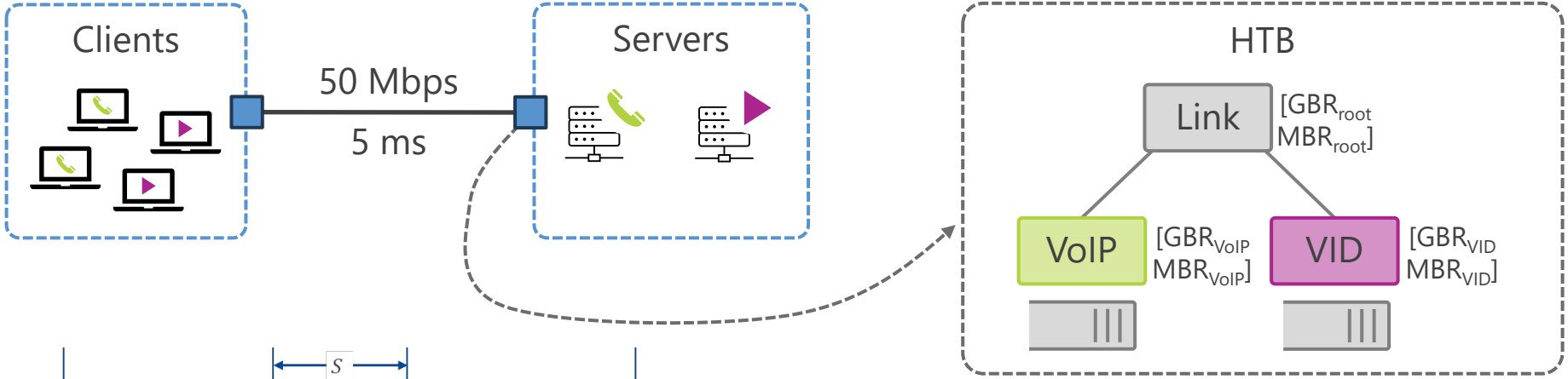
How do different **traffic handling** options affect **traffic characteristics?**

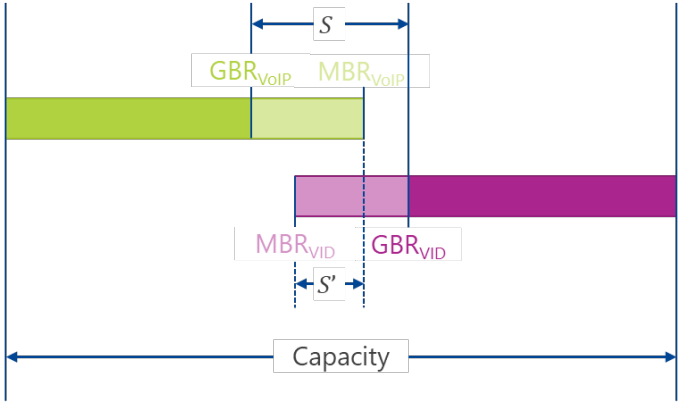
Inter-domain Traffic Aggregation



- Per-hop results as **building block for E2E** analysis
- **Trade-offs** between mechanisms w.r.t. complexity, scalability, differentiation, QoS, …
  - ➔ Focus on **soft slicing** and **isolation vs determinism**

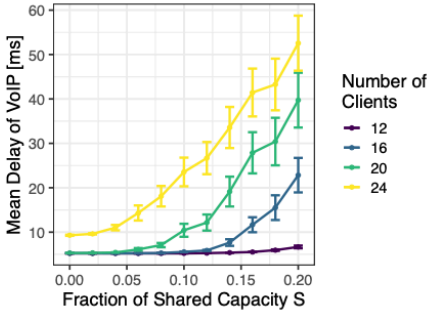
OMNeT++ Simulation



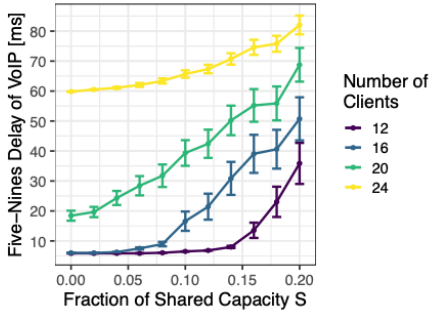


- GBR, MBR combinations affect **isolation indicators** S and S'
- KPIs: **delay** (mean, five-nines, max, var), **MOS**, and link **utilization**
- Varied number of clients, GBR, and MBR for a total of 2,420 simulation runs

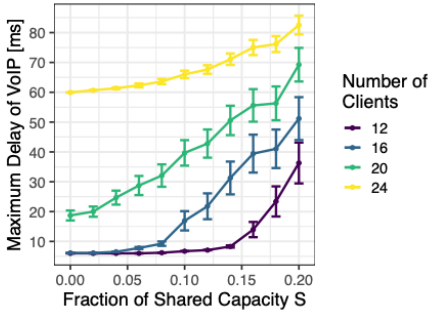
Evaluation Results



(a) Mean delay of VoIP.



(b) Five-nines delay of VoIP.



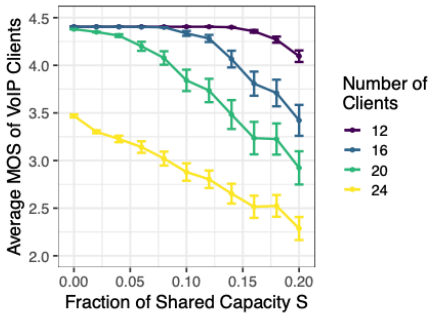
(c) Maximum delay of VoIP.

- Stricter delay metrics are impacted earlier by capacity sharing
- Shape and intensity of degradation depend on chosen metric
  - ➔ Need to know **applications' sensitivities**

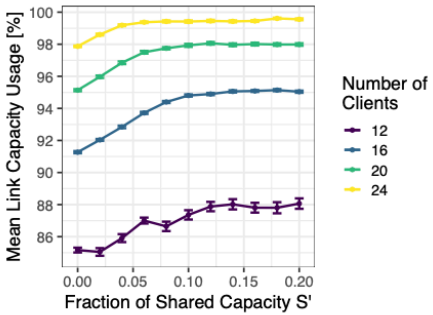
Evaluation Results

- Larger fraction of shared capacity leads to
  - Degradation of application quality
  - Higher link utilization

➔ Allows **identifying and quantifying** trade-offs

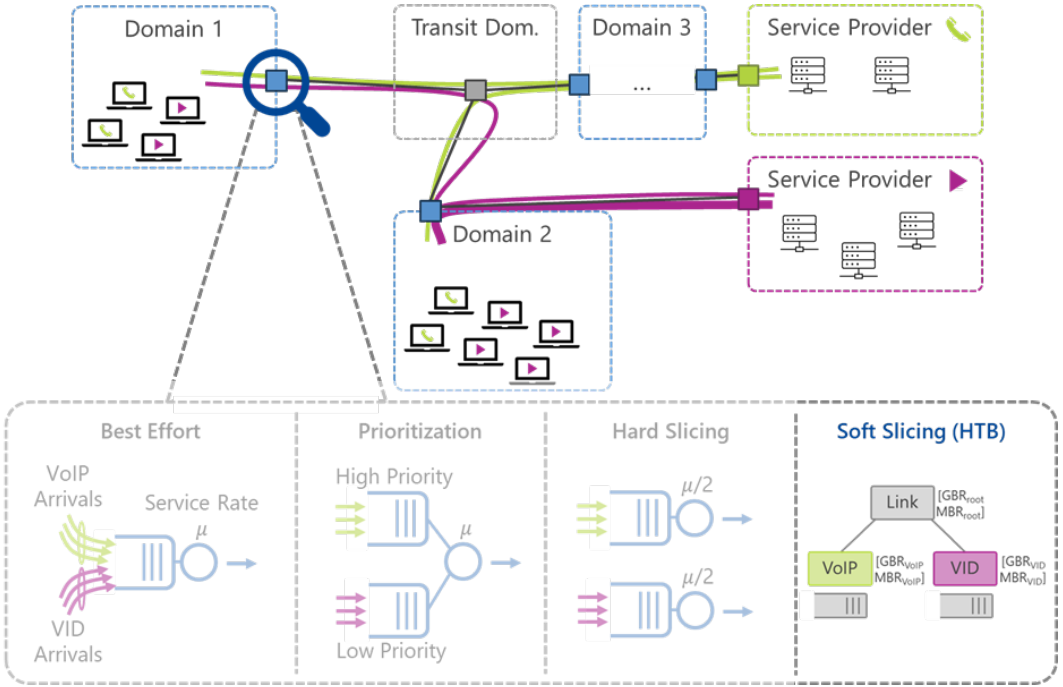


(e) Average MOS of VoIP clients.



(f) Mean link capacity usage.

Conclusion



- **Heterogeneous** environment with numerous control knobs
  - Single-hop analysis as step towards **understanding and quantifying trade-offs**
- Future work
  - E2E analysis with dynamics
  - General isolation models
  - Validation in testbed

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›teraflow-h2020.eu
›gitlab.com/teraflow-h2020

BACKUP

ANOVA & Correlation

Table 2: Correlation- and ANOVA-based analysis of isolation-related parameters and their effect on delay performance and link capacity usage. While r_s denotes Spearman's coefficient of correlation, F and p represent the value of the ANOVA test statistic and the corresponding p-value, respectively.

Parameter / Metric	GBR_{VoIP}			MBR_{VoIP}		
	r_s	F	p	r_s	F	p
Mean delay of VoIP traffic	−0.48	367.84	**< 0.001**	0.08	12.86	**< 0.001**
Five-nines delay of VoIP traffic	−0.43	316.20	**< 0.001**	−0.07	22.71	**< 0.001**
Maximum delay of VoIP traffic	−0.43	320.79	**< 0.001**	−0.07	22.38	**< 0.001**
Variance of delay of VoIP traffic	−0.43	257.54	**< 0.001**	−0.01	36.87	**< 0.001**
MOS of VoIP clients	0.42	350.94	**< 0.001**	−0.04	11.34	**< 0.001**
Mean link capacity usage	−0.00	0.08	0.78	0.20	73.01	**< 0.001**

- Delay / QoE metrics mostly affected by GBR / S
- Link capacity usage mostly affected by MBR / S'

Simulation Parameters

Parameter	Value(s)
Link capacity	50 Mbps
Link delay	5 ms
Simulation time	400 s
Video duration	Uniform(280, 320) s
Number of clients per application	$\{12, 16, 20, 24\}$
(p, q)	$\{0, 1, 2, \ldots, 10\}^2$
GBR for VoIP traffic	$(5.5 - 0.5 \cdot q)$ Mbps
MBR for VoIP traffic	$(5.5 + 0.5 \cdot p)$ Mbps
GBR for video traffic	$(44.5 - 0.5 \cdot q)$ Mbps
MBR for video traffic	$(44.5 + 0.5 \cdot p)$ Mbps
Number of repetitions per configuration	5
Total number of simulation runs	2,420