Ferdinando Marrone

Enhancing wireless technologies to support Time Sensitive Networking

Tutor: Prof. Stefano Avallone

Cycle: XXXIX Year: 2024/2025

Candidate's information

- MSc degree: Telecommunications Engineering
- DIETI Research group: Architectures and Computer Networks Laboratory (ARCLAB)
- PhD start date: 01/11/2023
- Scholarship type: no scholarship (ISTAT employee)

Summary of study activities

- Ad hoc PhD courses
  - Conversazioni su Etica e Intelligenza Artificiale
  - How to boost your PhD
  - IoT Data Analysis
- PhD school
  - 2025 Course Spring School on Transferable Skills
- Conferences attended
  - Security Summit Napoli 2025, Napoli, Città della Scienza, 23/09/2025
  - IEEE International Mediterranean Conference on Communications and Networking (IEEE ICC 2026) Nice, France, 7-10 July 2025. I presented a paper, “Smart Resource Allocation to Enable Network Slicing”

Research area

- My research activity focuses on enhancing wireless technologies to support Time-Sensitive Networking (TSN).

- The previously developed *SlicingScheduler* was refined and extended to improve slicing performance and resource utilization:
  - A comparative analysis was performed with state-of-the-art mechanisms (e.g., ATERR [1])
  - The framework was extended to the uplink direction, a largely unexplored area in Wi-Fi slicing research

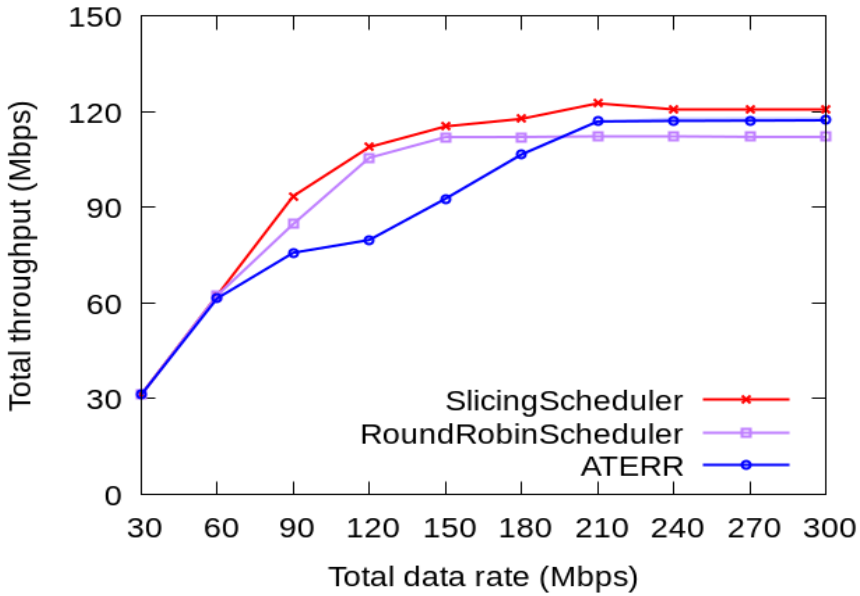
- Explored emerging IEEE 802.11be features, such as Multi-Link Operation (MLO), to reduce latency and improve reliability

[1] M. Richart, J. Baliosian, J. Serrat, J.-L. Gorricho, and R. Aguero, "Slicing in wifi networks through airtime-based resource allocation," Journal of Network and Systems Management, vol. 27, no. 3, pp. 784–814, 2019

Research results

- Simulation Setup (IEEE 802.11ax, ns-3)
  - Three slices with ratios {0.1, 0.3, 0.6}
  - 1 Access Point and 5 stations
  - BW 40Mhz, MCS 7

Slice 0	Slice 1	Slice 2
STA1	STA1	STA2
STA4	STA3	STA5



Research results

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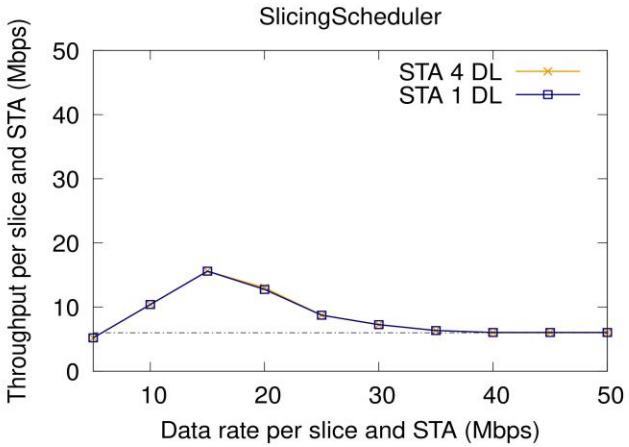

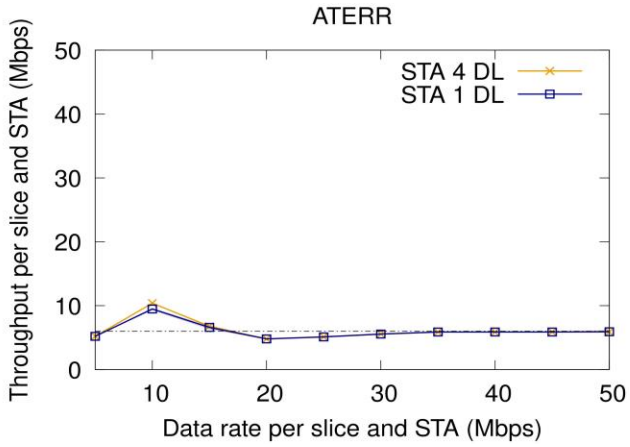

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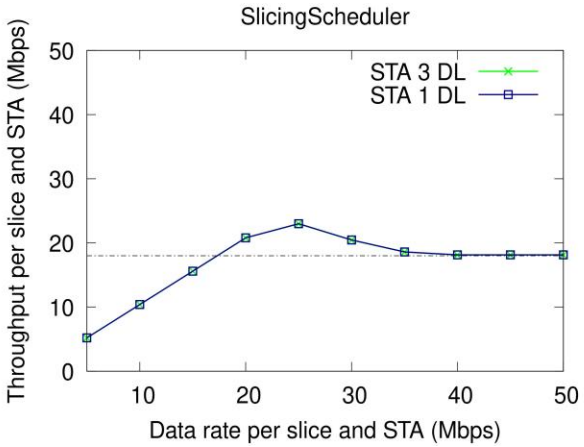

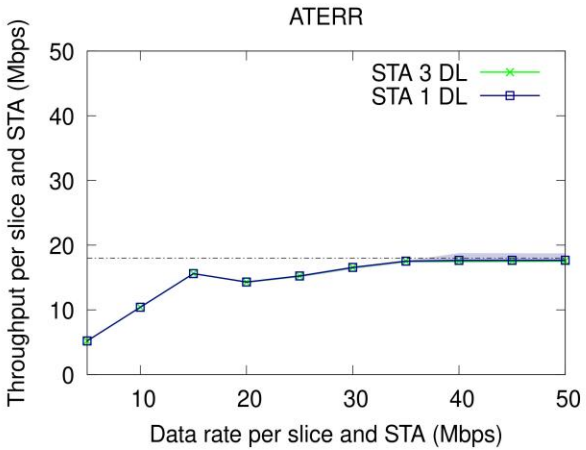

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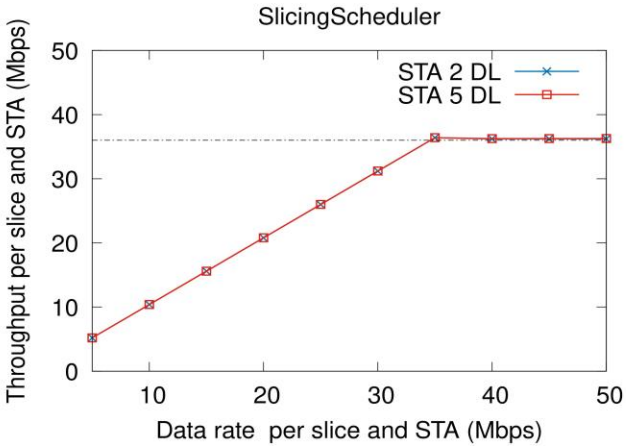

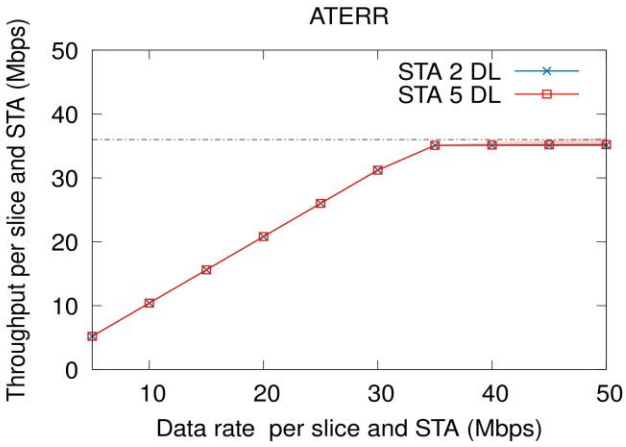

Research results

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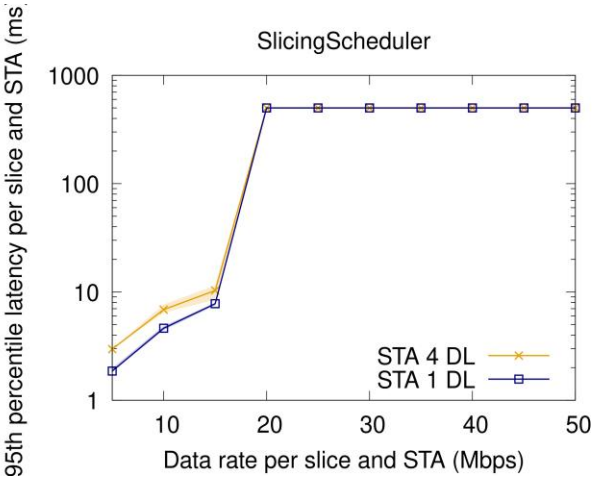

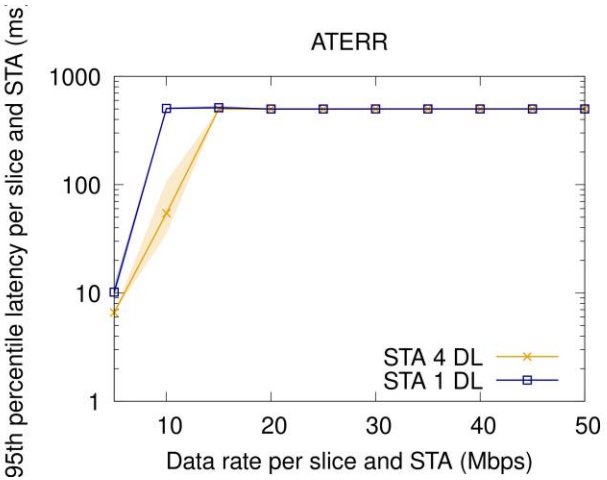

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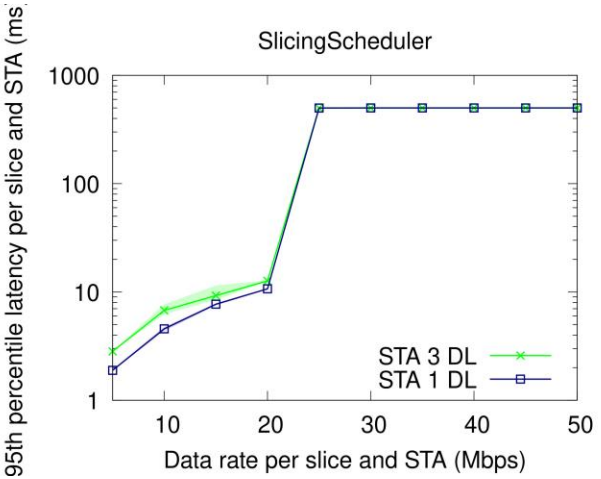

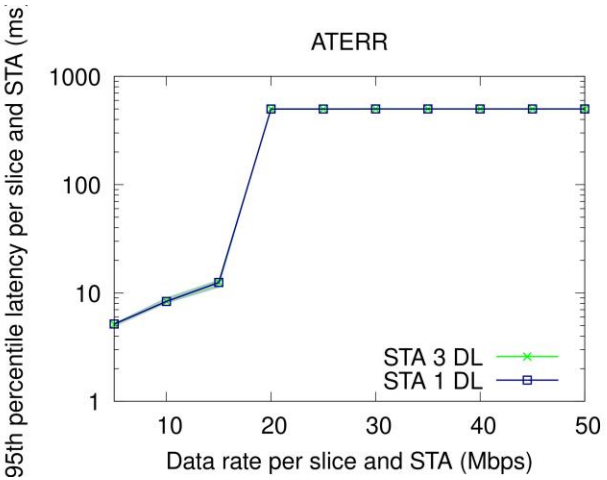

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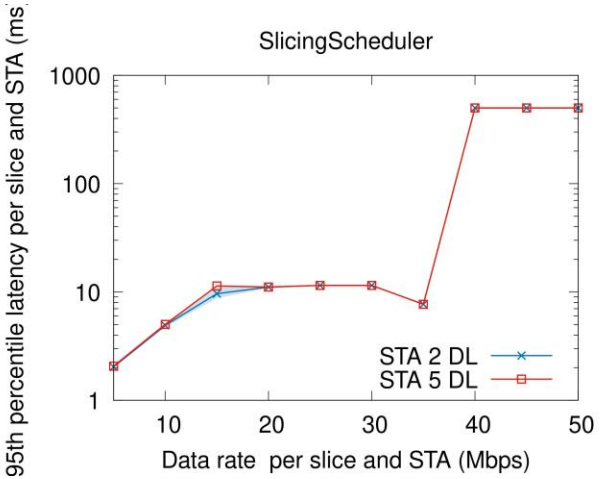
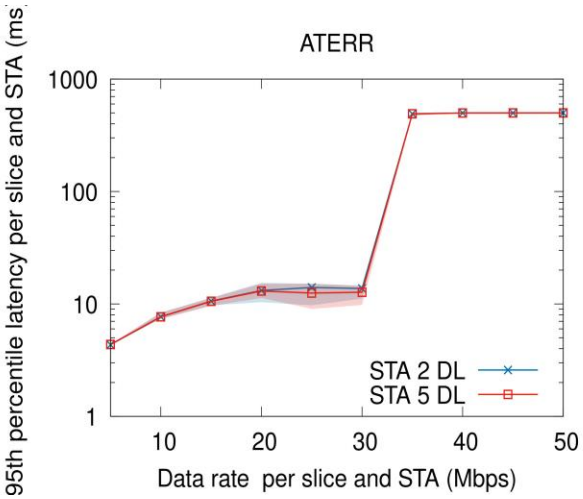




Research results

- Extension of slicing framework to the uplink direction
  - Standard-compliant
    - uses Buffer Status Reports (BSR)
  - Works with contention-based access
    - EDCA tuning reduces single-user transmissions
    - QoS Control field (*Queue Size* subfield) used for accurate buffer estimation
  - First solution supporting slicing in both downlink (DL) and uplink (UL)

- Simulation scenario with joint DL and UL
  - Data rate of the flows UL = DL

Slice 0	Slice 1	Slice 2
STA1	STA1	STA2
STA4	STA3	STA5

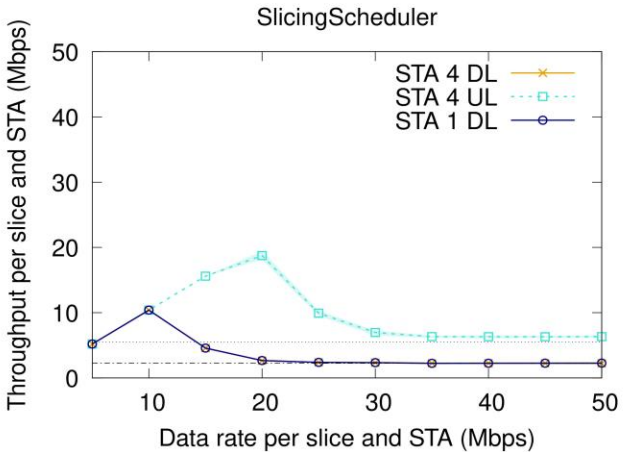
Downlink

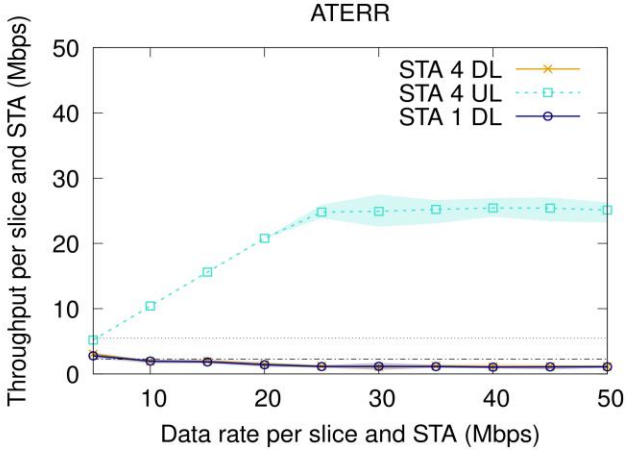
Slice 0	Slice 1	Slice 2
STA4	STA3	STA2

Uplink

Research results

Slice 0





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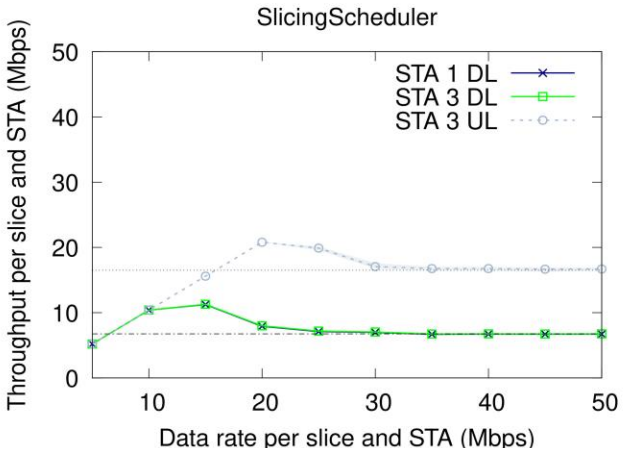

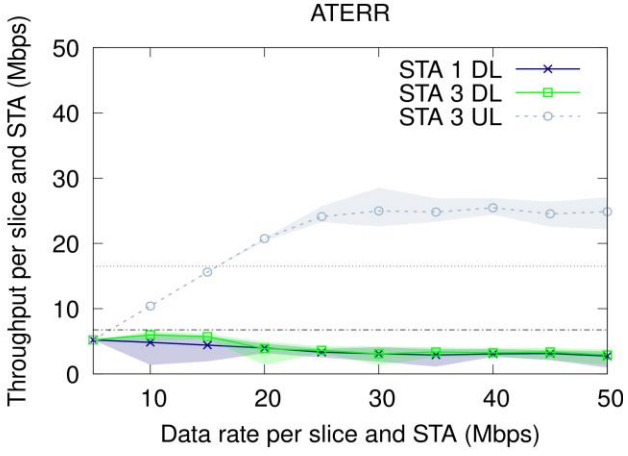

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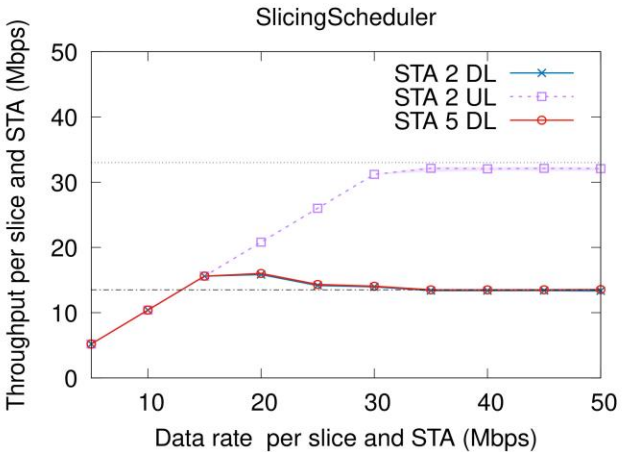

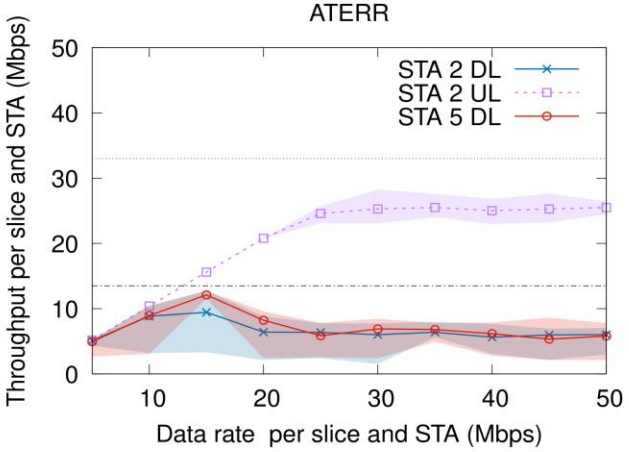

Research results

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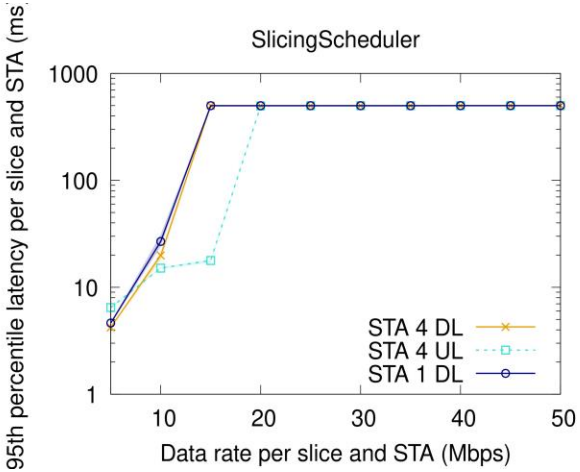

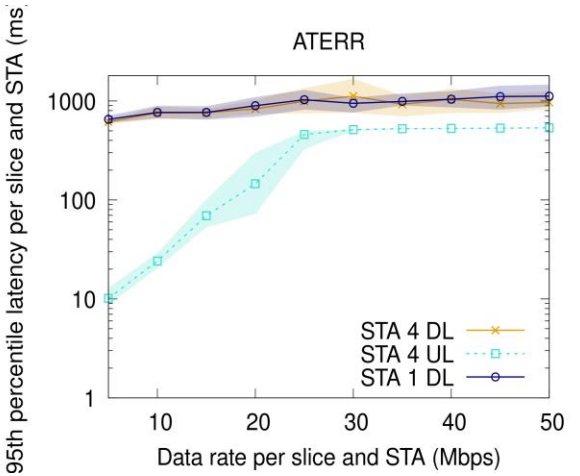

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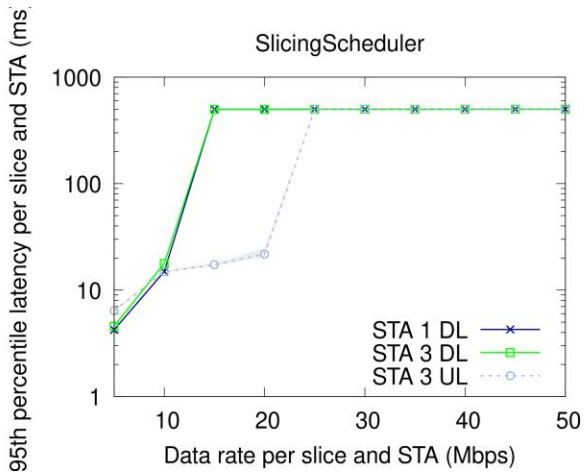

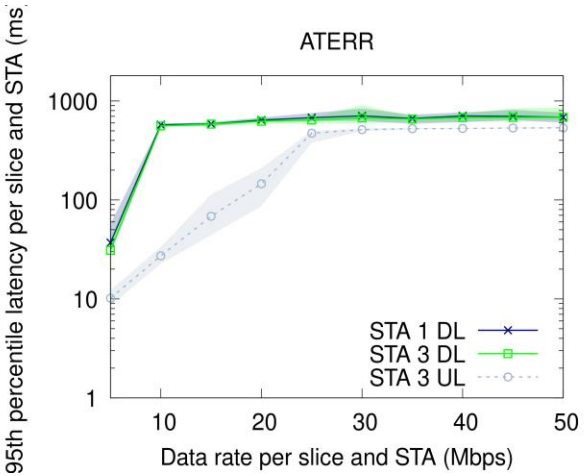

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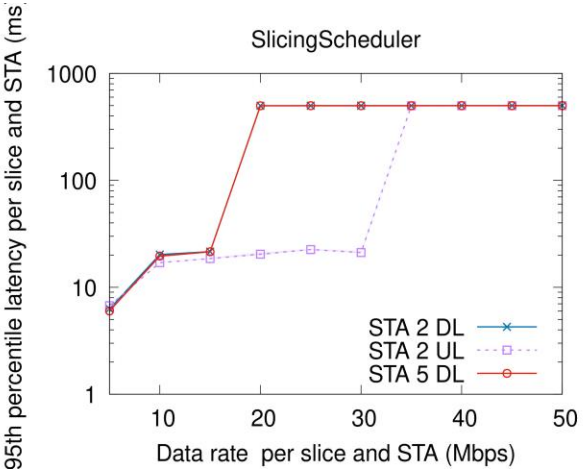

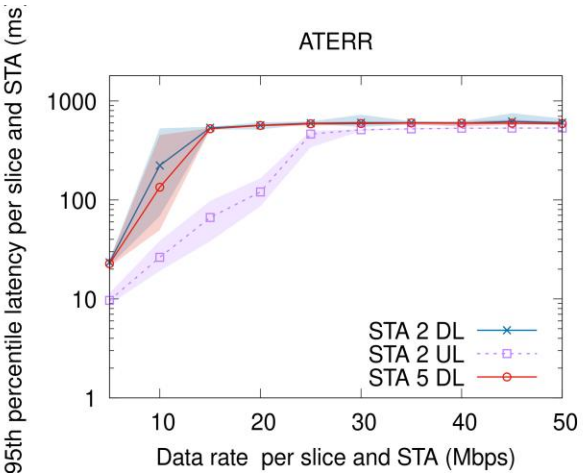

Research products

[P1]	F. Marrone, P. Imputato, S. Avallone, *Smart Resource Allocation to Enable Network Slicing,* **International Mediterranean Conference on Communications and Networking** Nice, France, July 2025, pp. 1-7, IEEE, doi: 10.1109/MeditCom64437.2025.11104443.
[P2]	F. Marrone, P. Imputato, S. Avallone, *Network Slicing Through Buffer Aware Multi-User Transmissions,* **Computer Networks** vol. 272, 2025, 111717, doi: 10.1016/j.comnet.2025.111717.
[P3]	S. Avallone, P. Imputato, F. Marrone, *Exploiting multiple links with a single interface: A performance study,* **Ad Hoc Networks** vol. 180, 2025, 104029, doi: 10.1016/j.adhoc.2025.104029
[P4]	F. Marrone, P. Imputato, S. Avallone, M. R. Kanagarathinam, J. M. Ppallan, *Flexible Network Slicing to Meet Latency and Reliability Requirements,* **International Conference on Communications,** 24 - 28 May 2026, Glasgow, Scotland (submitted)
[P5]	N. D'Ambra, F. Marrone, P. Imputato, S. Avallone, *Reinforcement Learning for Efficient Link Scheduling in Multi-Link Networks,* **International Conference on Communications,** 24 - 28 May 2026, Glasgow, Scotland (submitted)