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Is Mobile Networking Ready for the Serverless Revolution?

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uc3m | Universidad Carlos III de Madrid

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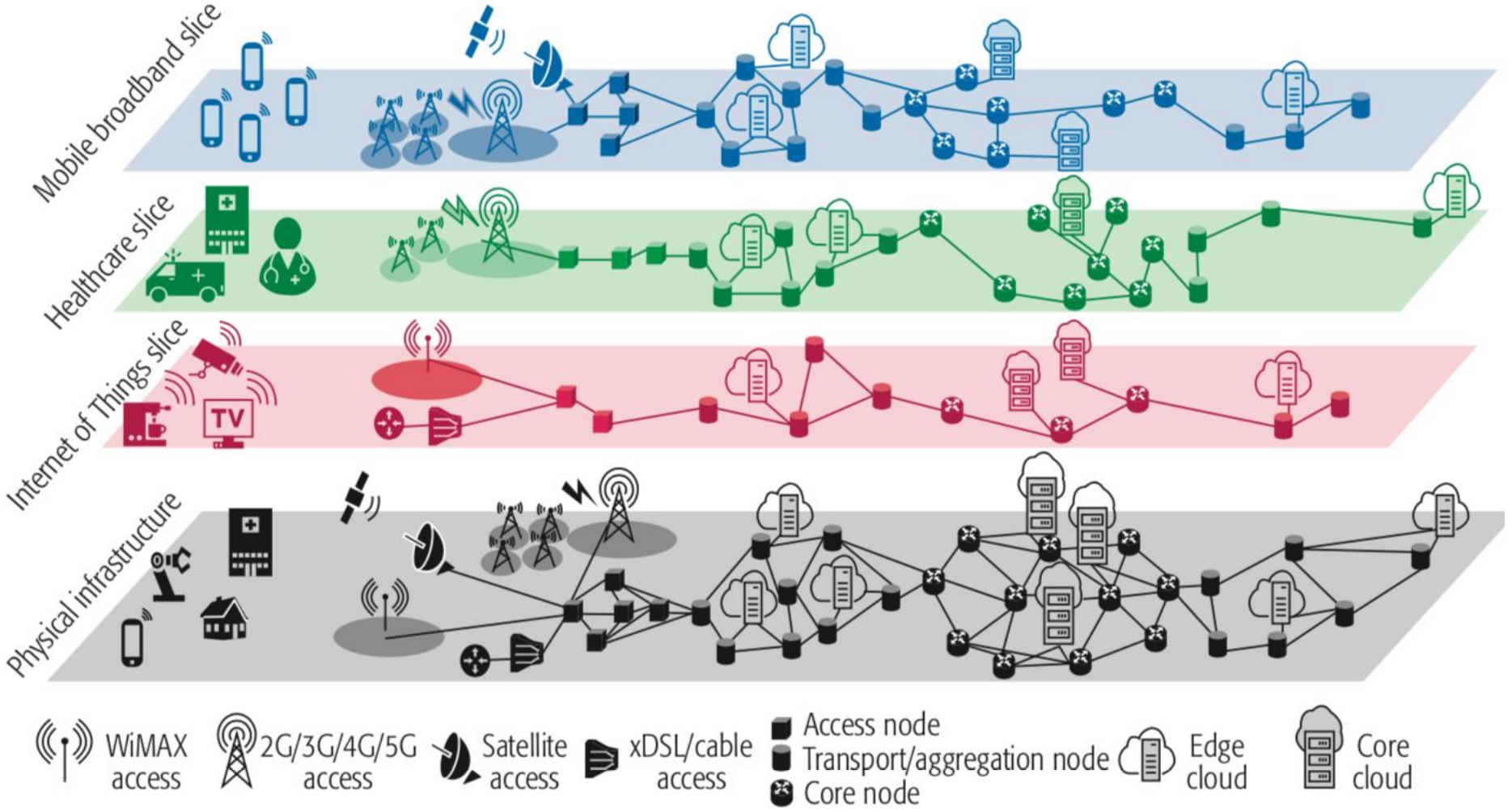
Background

- Mobile Networking is adopting two key technologies from Computer Science
  - Softwarization
  - Modularization
- This supports several benefits
  - General-purpose hardware
  - More agility, more efficiency
- From telco engineers to software engineers

Plethora of SW projects (and papers)

- I. Gomez-Miguelez et al., “SrsLTE: An Open-Source Platform for LTE Evolution and Experimentation,” in ACM WiNTECH 2016
- F. Gringoli et al., “Performance Assessment of Open Software Platforms for 5G Prototyping”, IEEE Wir. Comm. Magazine, 2018
- N. Apostolakis et al. “Design and Validation of an Open Source Cloud Native Mobile Network”, IEEE Comm. Magazine, 2022

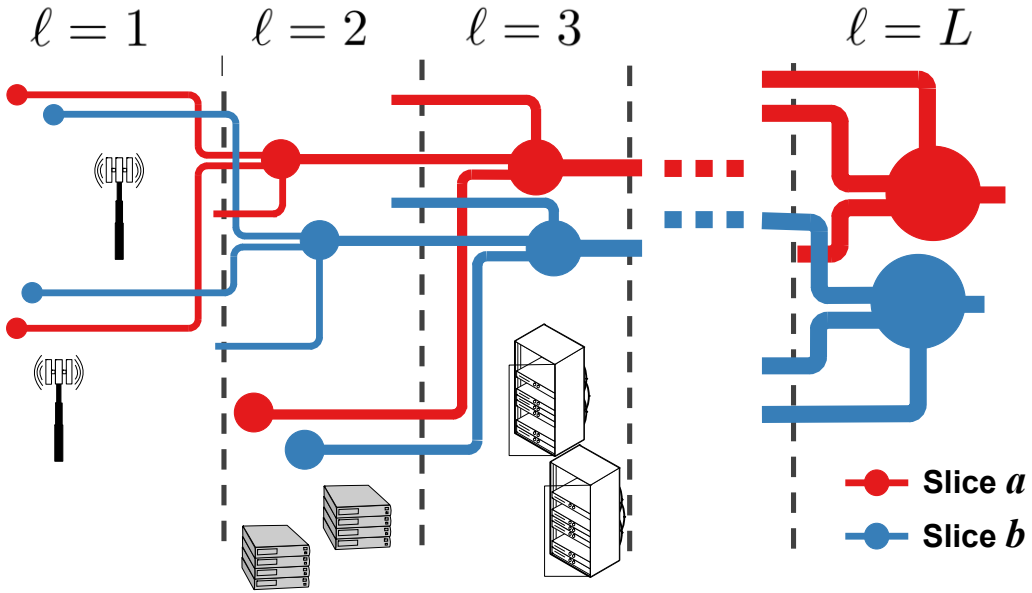
Network Slicing

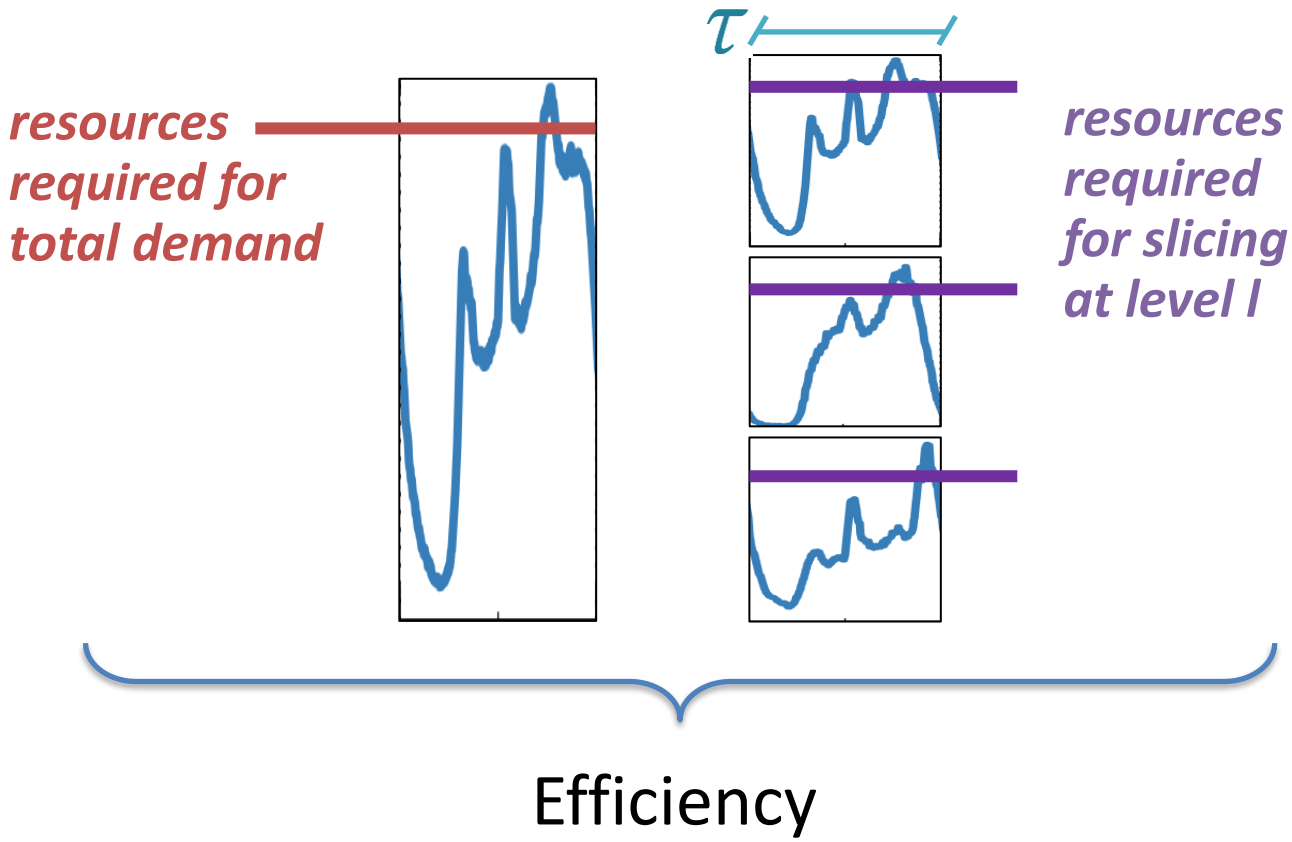


From: J. Ordonez-Lucena et al. "Network Slicing for 5G with SDN/NFV: Concepts, Architectures, and Challenges," in *IEEE Communications Magazine*, May 2017.

The orchestration needs to be agile

- Impact of aggregation level and reconfiguration time





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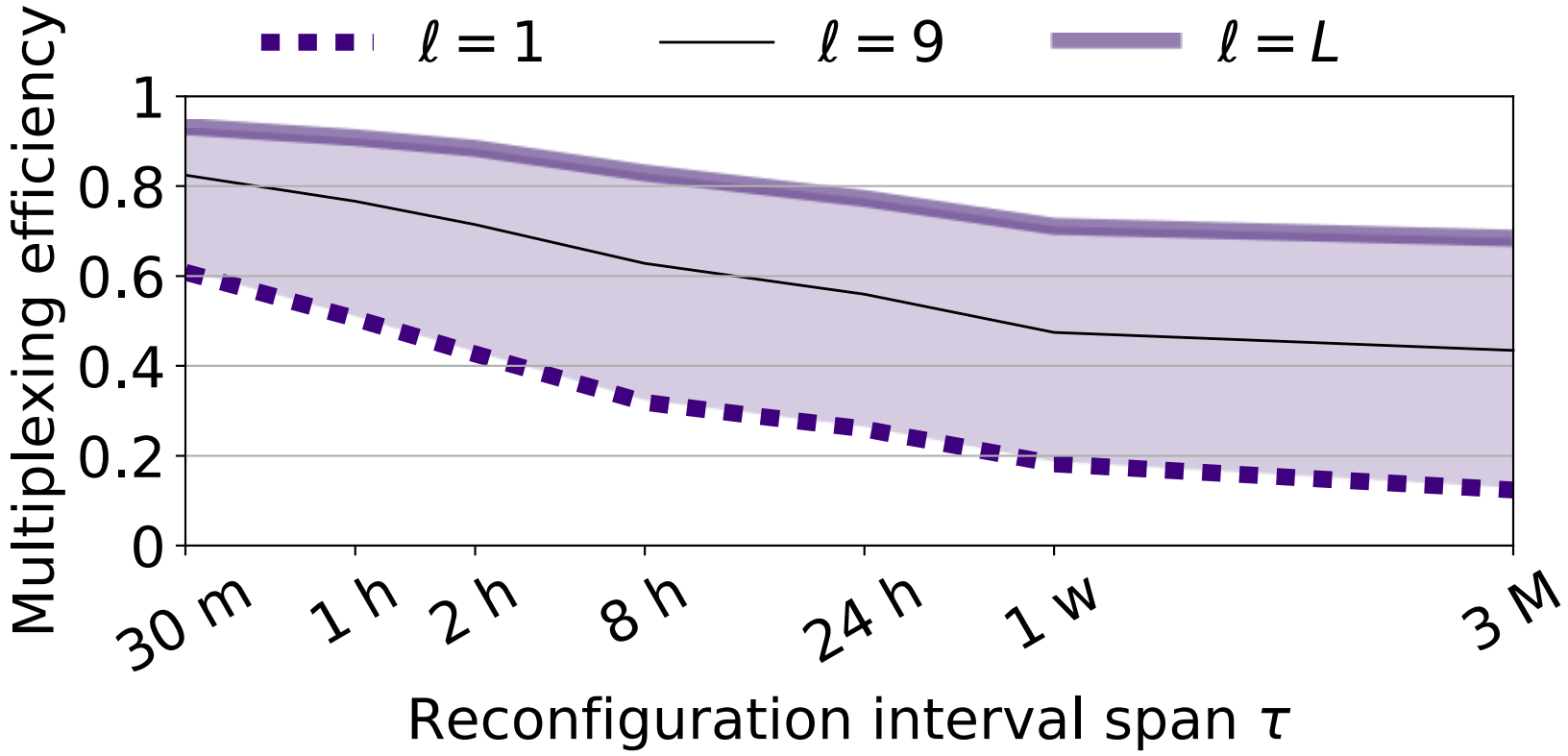
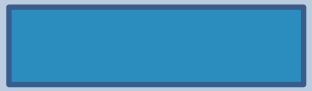


C. Marquez et al., "How should I slice my network? A multi-service empirical evaluation of resource sharing efficiency," ACM MobiCom 2018, New Delhi, India

Evolution of softwarization

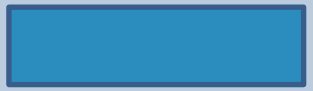
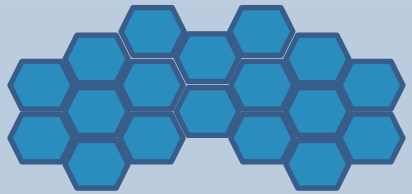
	Single Server PNF
Architecture	
Re-Configuration Re-Orchestration Frequency	Years
Orchestration Complexity	Low

From PNF to VNF

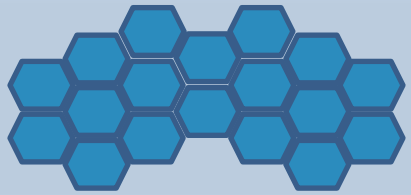
	Single Server PNF	Multi-tier VNF
Architecture		
Re-Configuration Re-Orchestration Frequency	Years	Months
Orchestration Complexity	Low	Moderate

VM / NFV

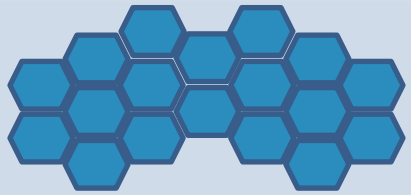
Cloud Native

	Single Server PNF	Multi-tier VNF	Microservices H. Modular VNFs
Architecture			
Re-Configuration Re-Orchestration Frequency	Years	Months	Cloud Native → Many times per day
Orchestration Complexity	Low	Moderate	High

Function as a Service (Faas)

	Single Server PNF	Multi-tier VNF	Microservices H. Modular VNFs	Serverless
Architecture				
Re-Configuration Re-Orchestration Frequency	Years	Months	Many times per day	Continuous
Orchestration Complexity	Low	Moderate	High	Very High

Mobile Networking

	Single Server PNF	Multi-tier VNF	Microservices H. Modular VNFs	Serverless
Architecture				
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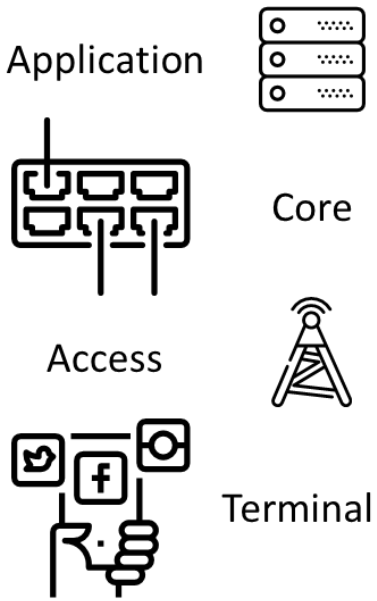
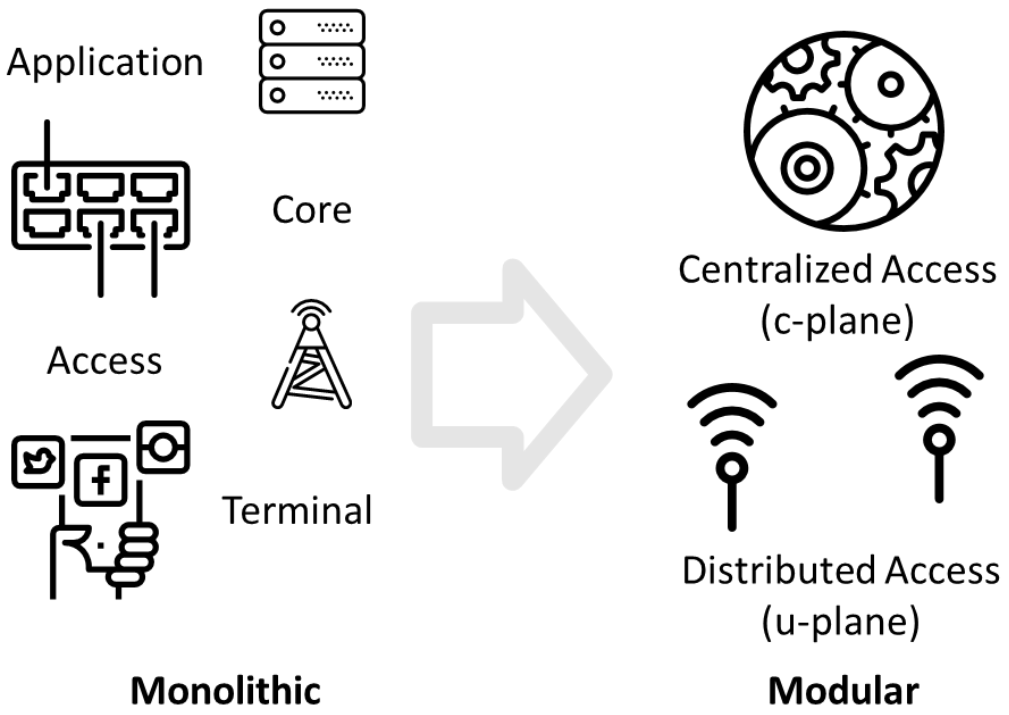
Serverless Radio Access Network



Monolithic

Serverless Radio Access Network



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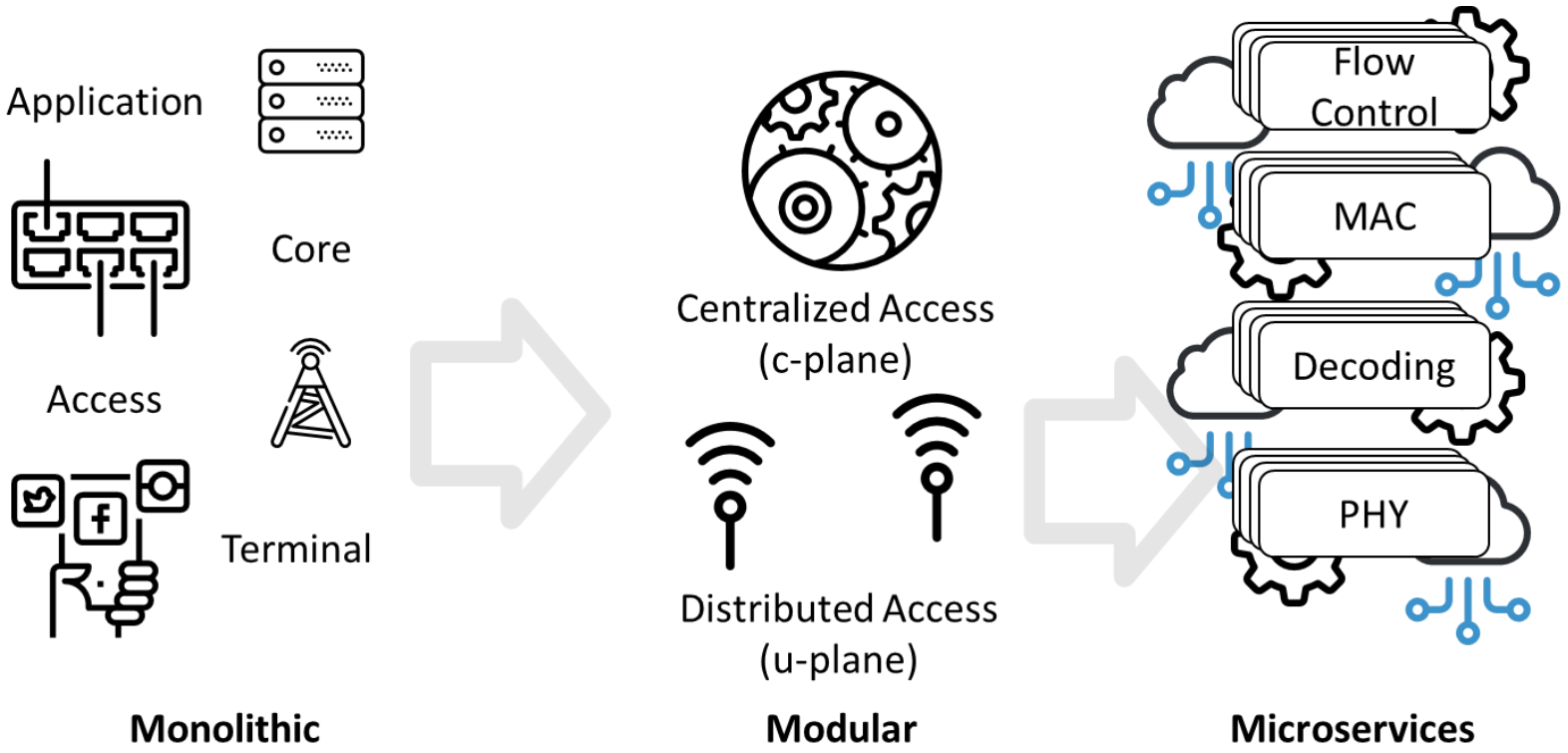

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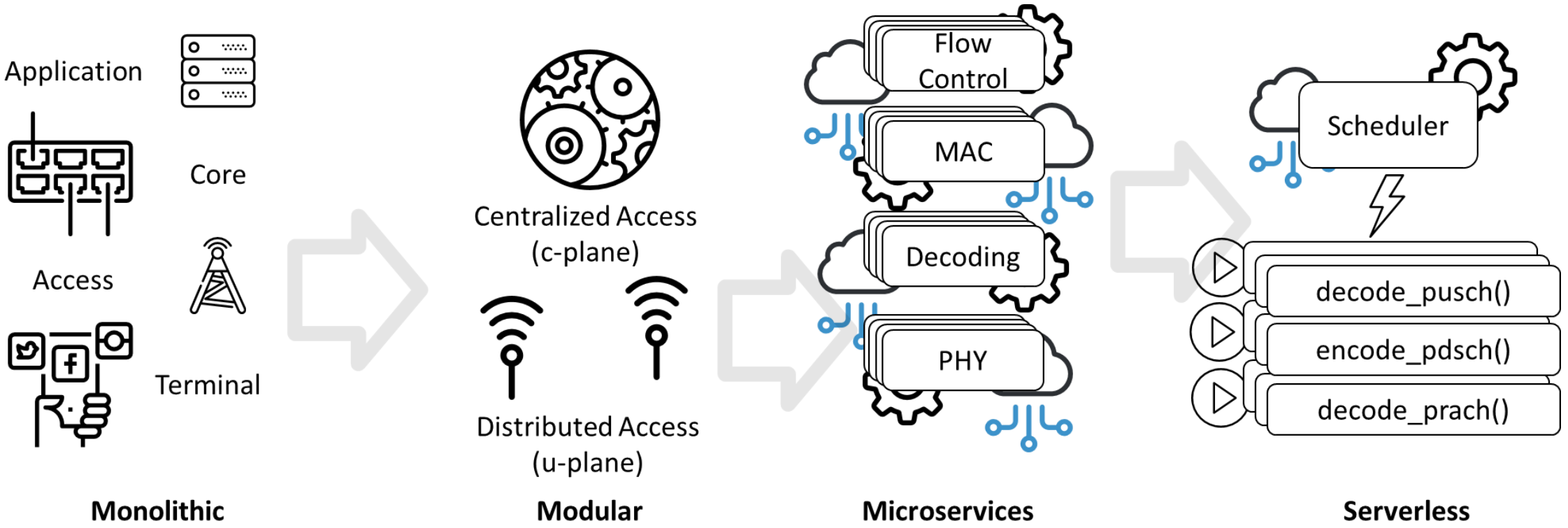
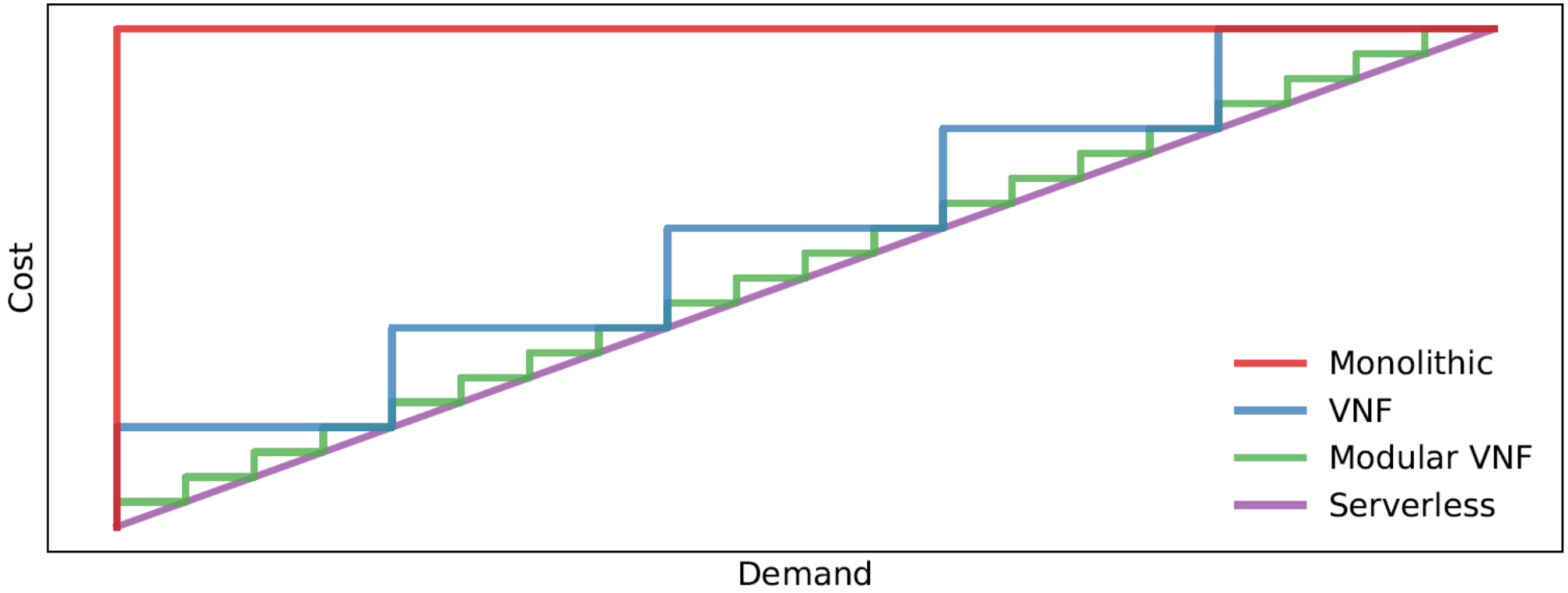


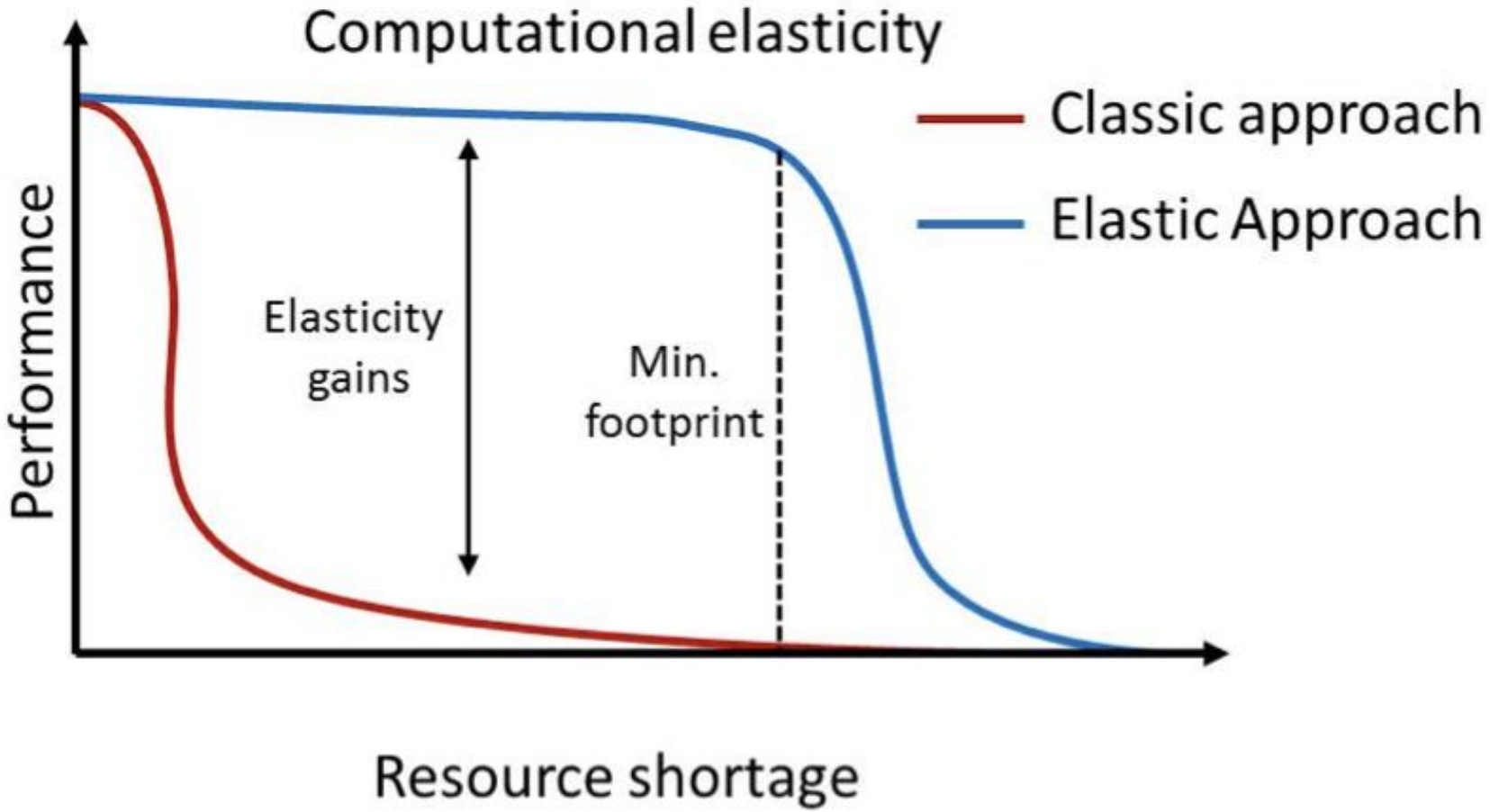
Advantages

- Scalability



Advantages

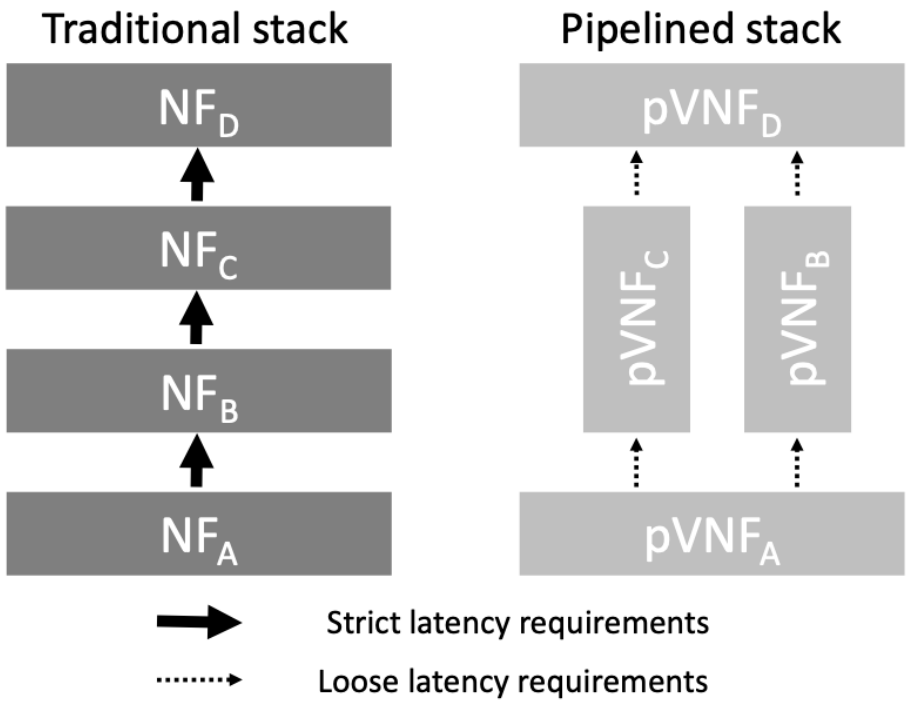
- Elasticity



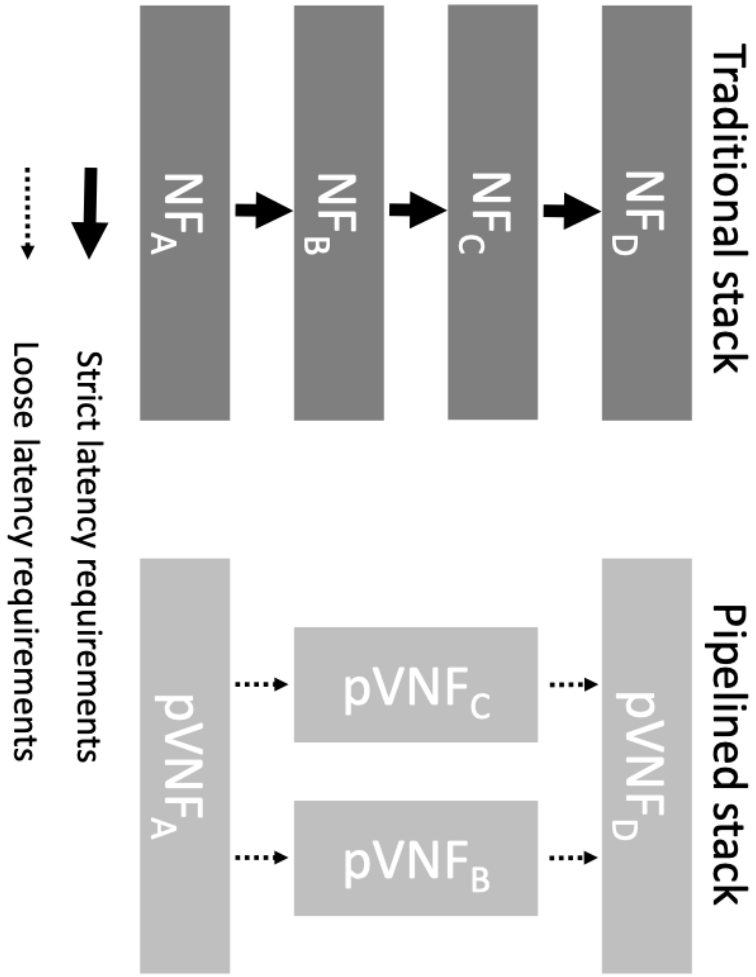
P. Serrano, "The path towards a cloud-aware mobile network protocol stack," Transactions on Emerging Telecom. Tech. Technologies, 2018

Challenges (1/3)

- Need to re-desing VNFs
- Current RAN functions
  - High load on the CPU
  - Stringent timing requirements
- New functions
  - Lessen requirements
  - Resource-aware execution



Addressing Challenge 1: Nuberu



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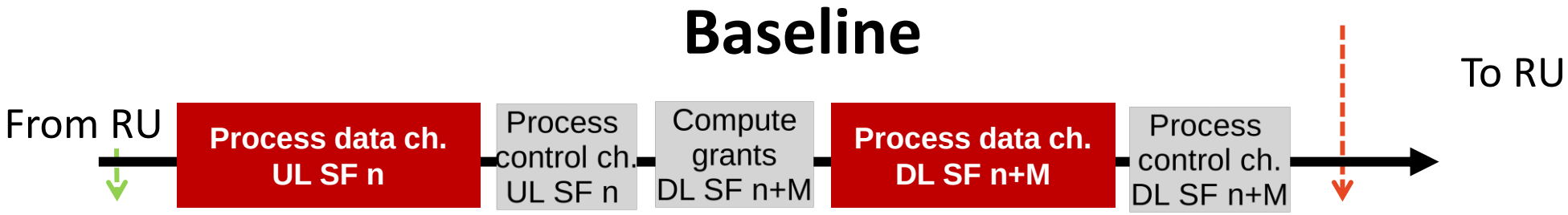

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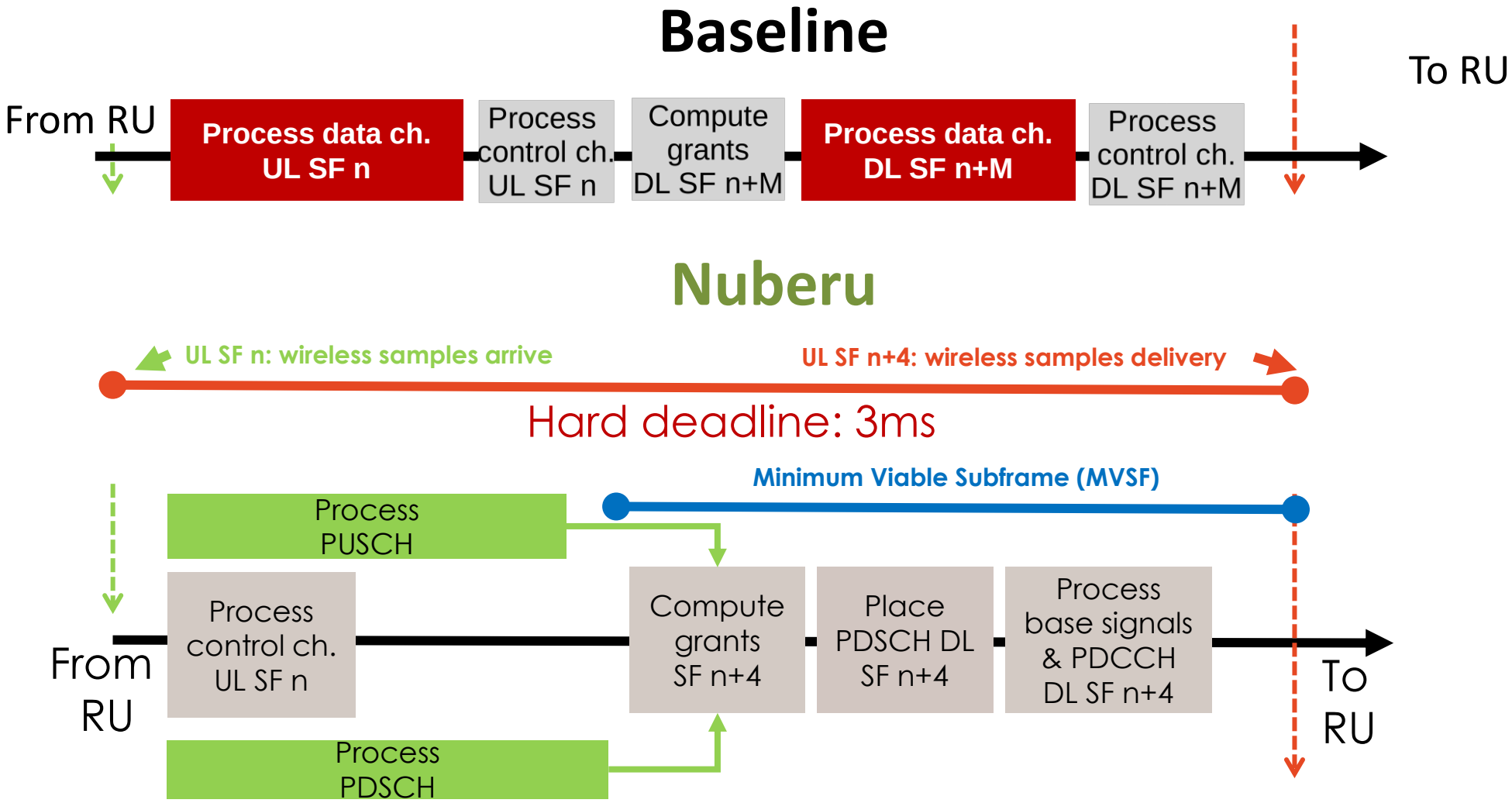

A. Garcia-Saavedra et al. "Nuberu: Reliable RAN Virtualization," ACM MobiCom '21,

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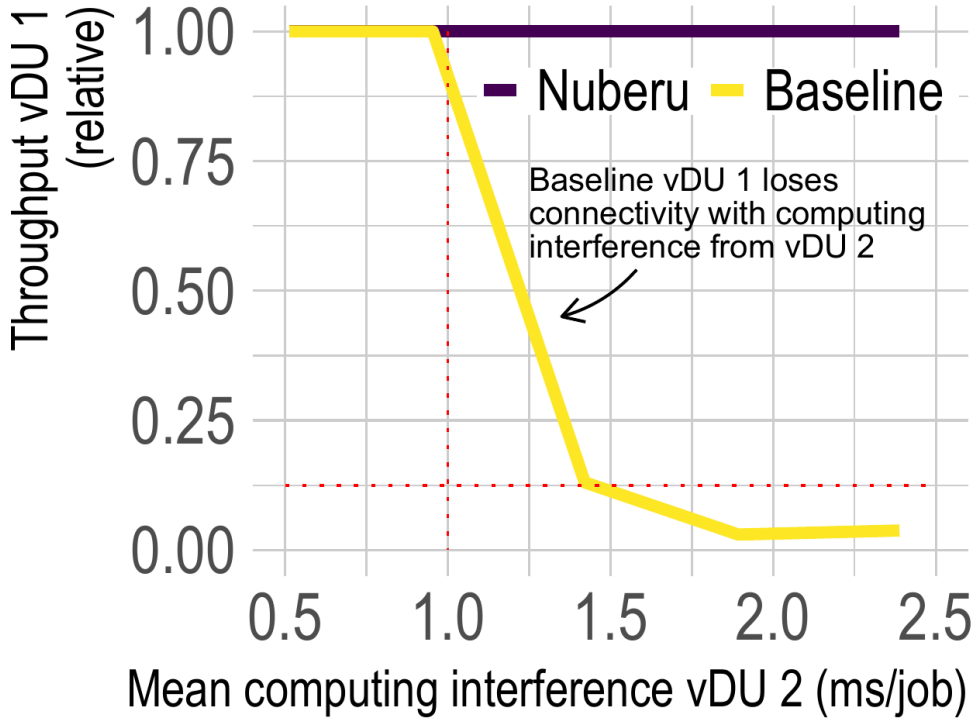
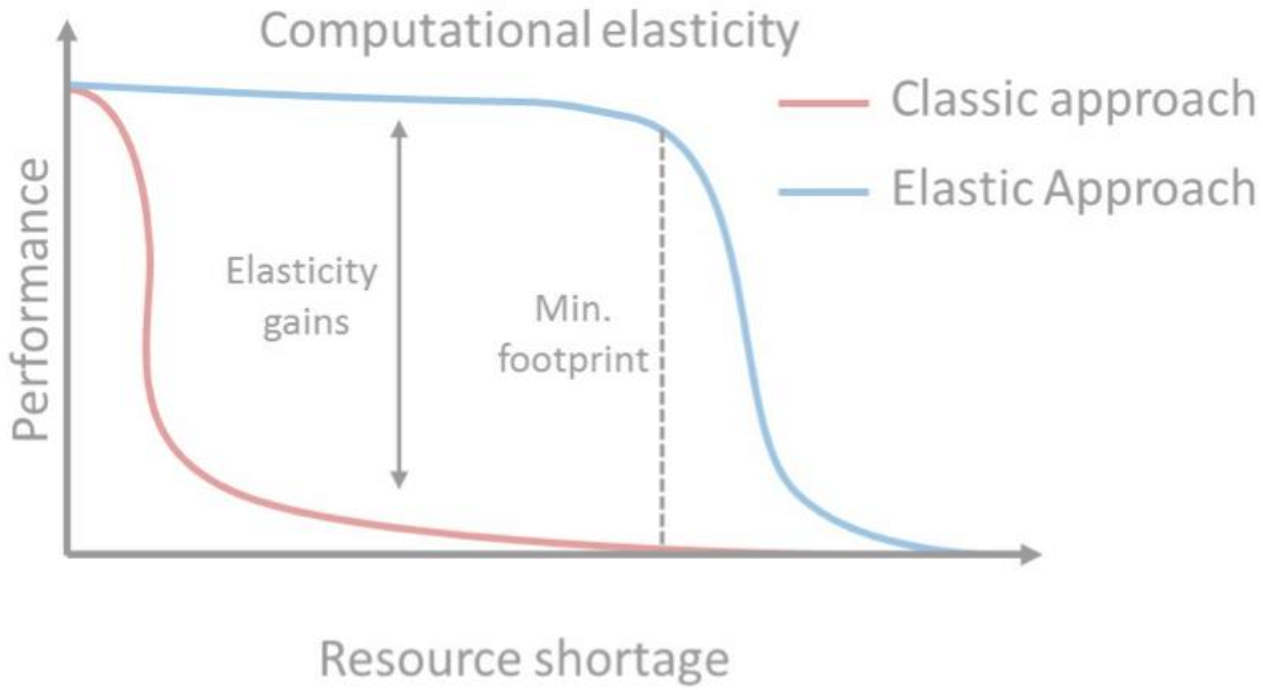
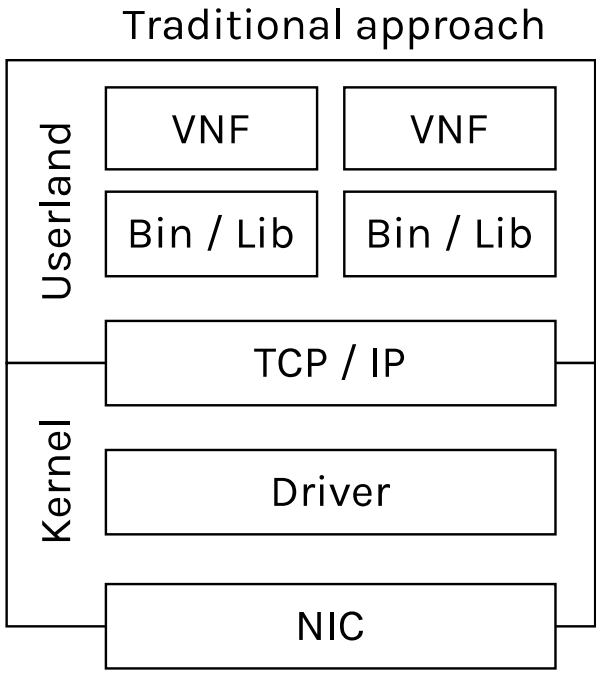


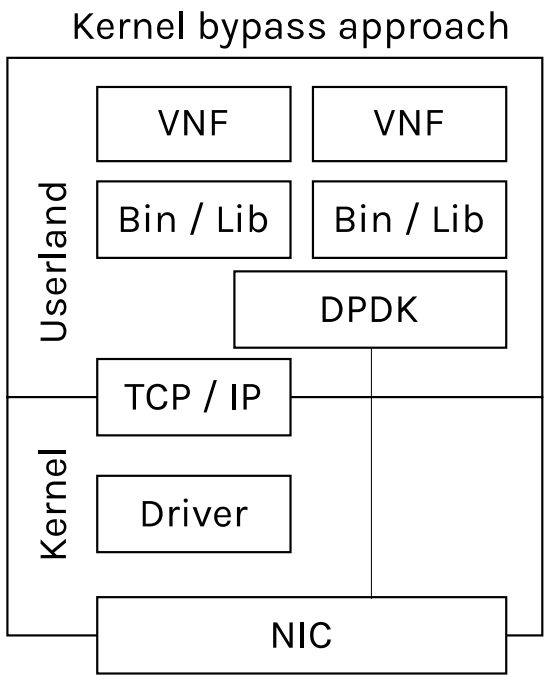


A. Garcia-Saavedra et al. “Nuberu: Reliable RAN Virtualization,” ACM MobiCom ‘21,

Challenges (2/3)

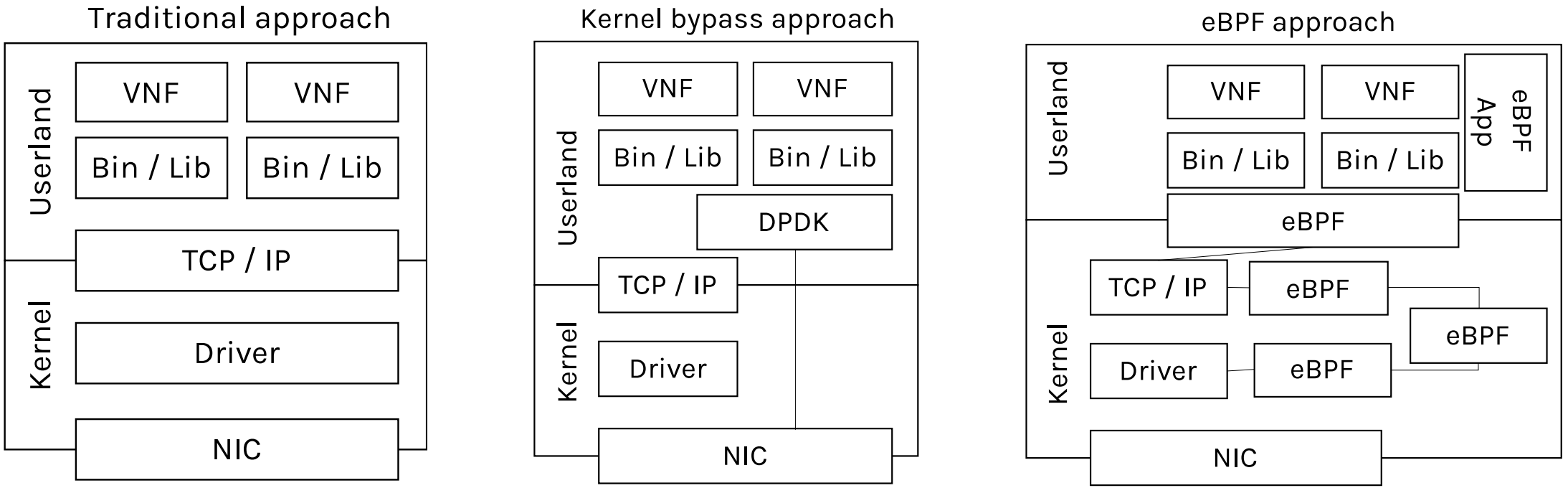
- Scalable interconnections
  - Traditional approach: slow
  - Kernel bypass: machine-dependent





Challenges (2/3)

- Scalable interconnections
  - From iptables to eBPFs



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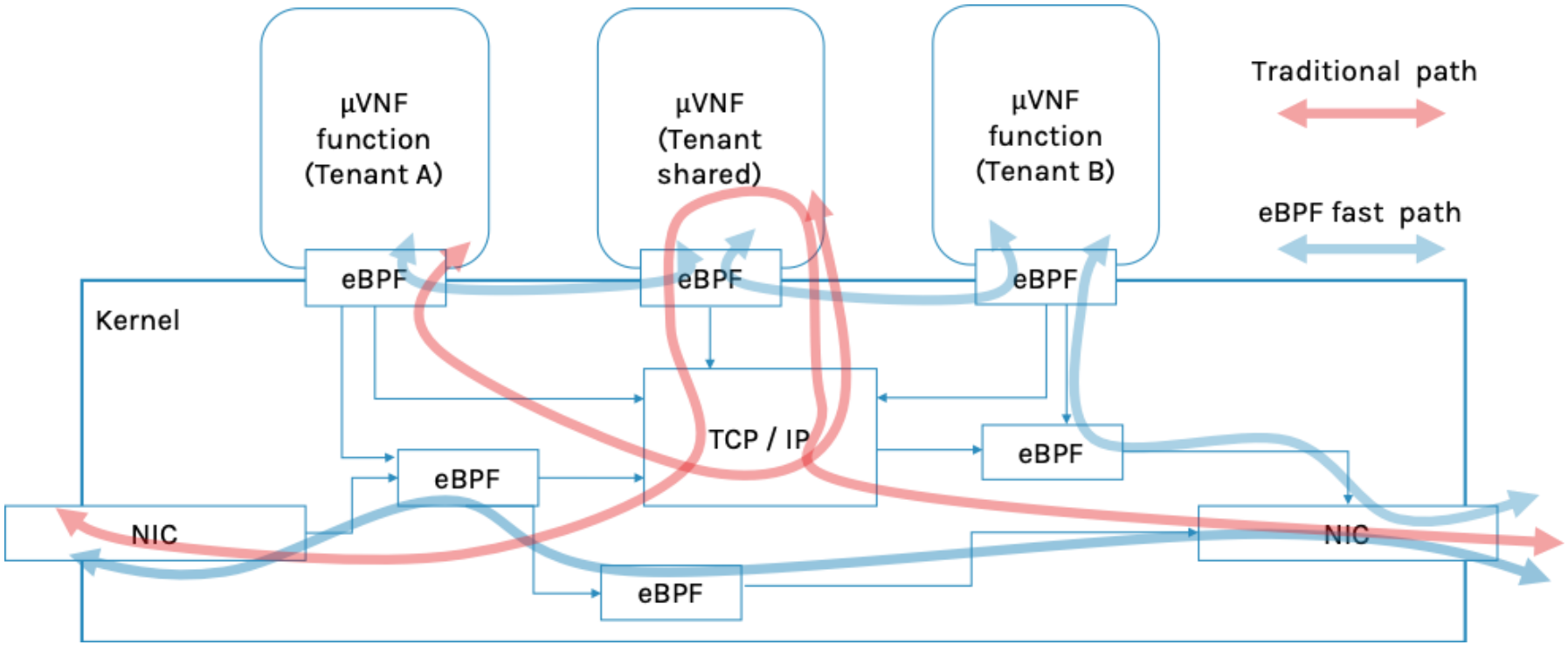
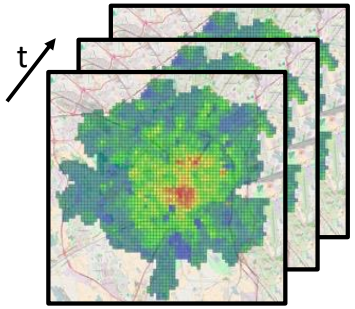


F. Monaco et al. "Enabling Scalable SFCs in Kubernetes with eBPF-based Cross-Connections," IEEE NFV-SDN, 2022

Challenges (3/3)

- Precise orchestration algorithms for functions
  - Anticipate demand in time and space



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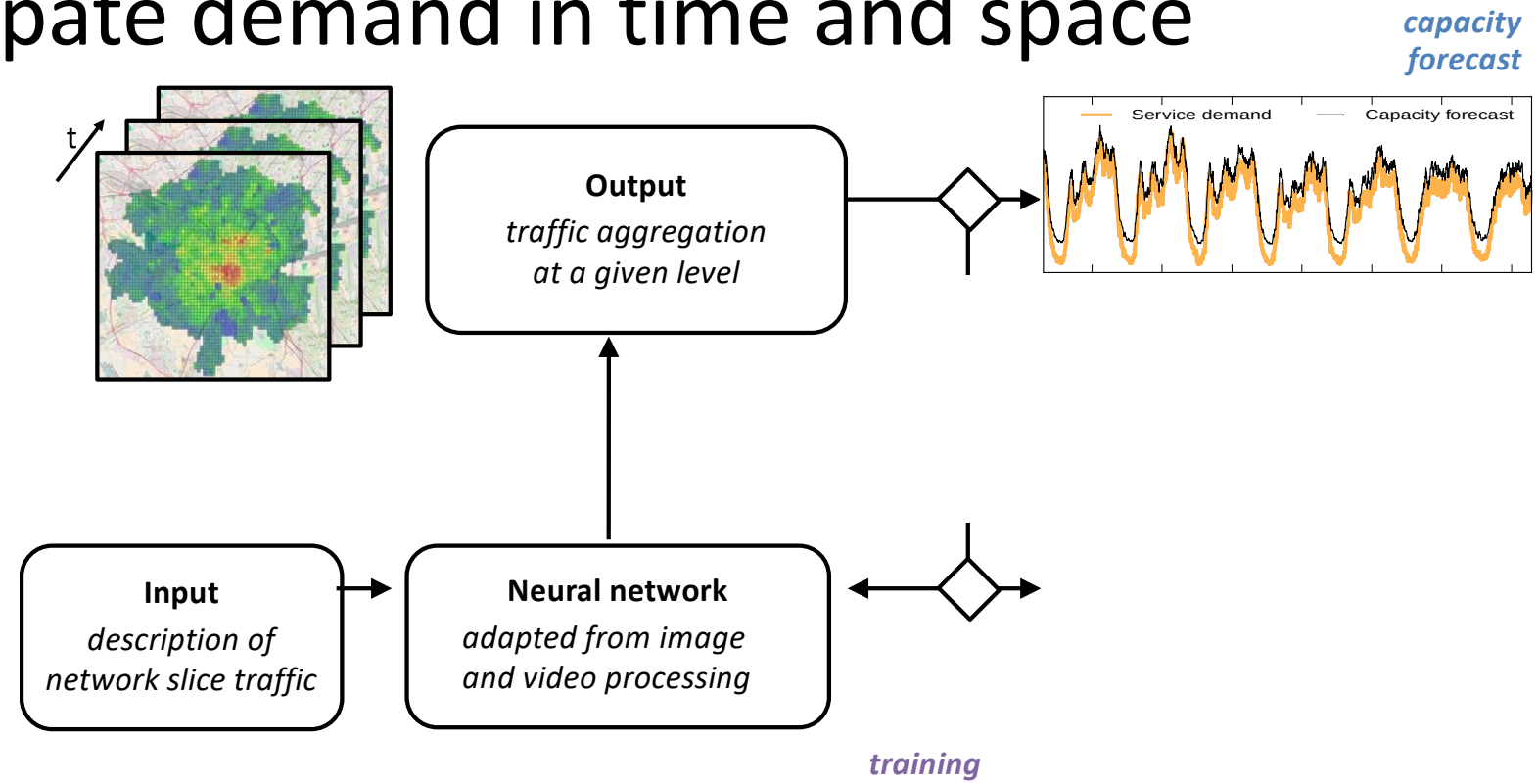

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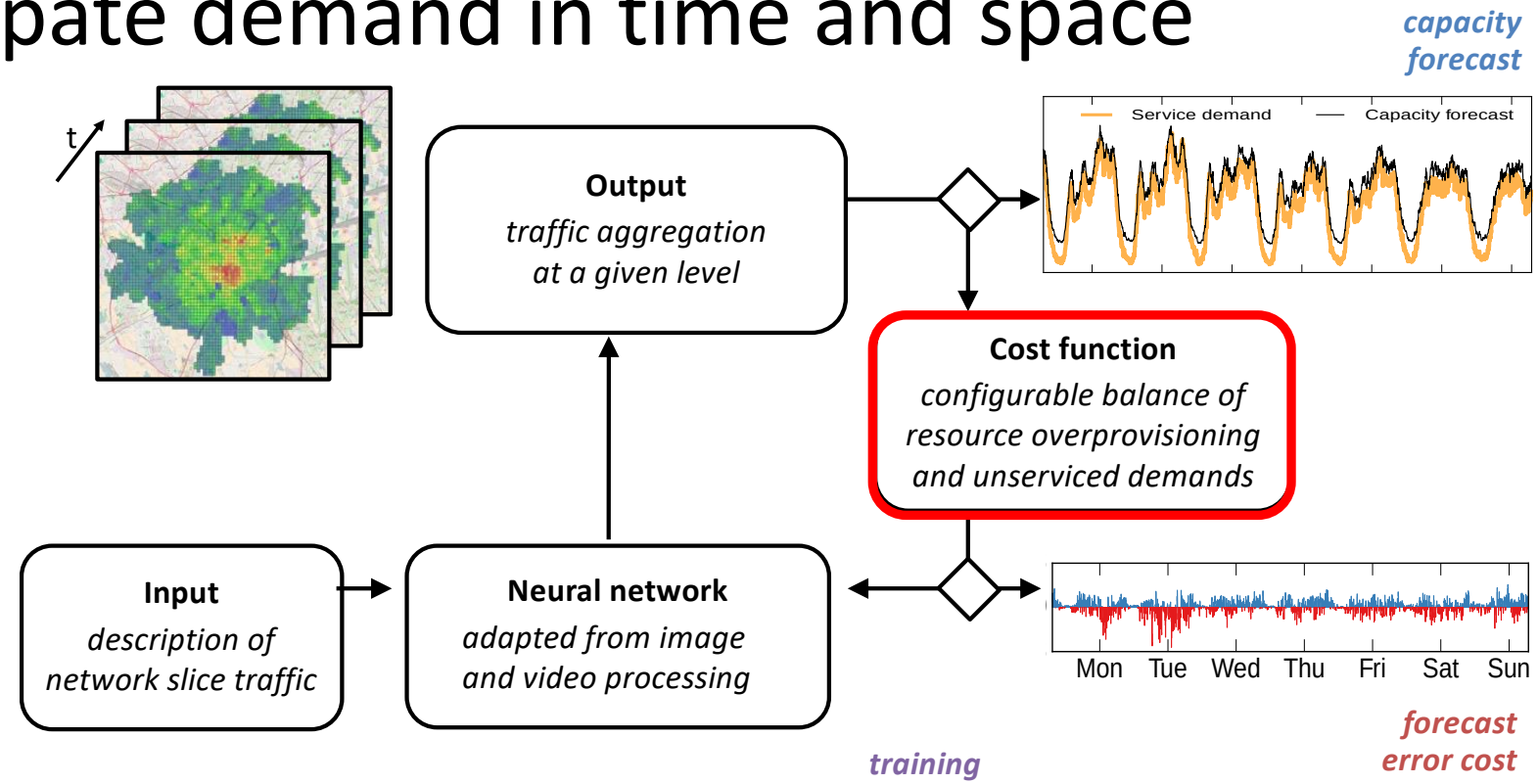

D. Bega et al., "DeepCog: Cognitive Network Management in Sliced 5G Networks with Deep Learning," IEEE INFOCOM, April 2019

Wrap up

- Cloud computing is already embracing microservices and serverless, while mobile networking is lagging
  - There are reasons for this
- Three main challenges
  - Re design of VNFs
  - Efficient and scalable interconnections
  - Novel orchestration approaches

Acknowledgements

- All my great co-authors
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CfP

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