OTTER:

Efficient Multi-WAN Transport for 5G

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Ryan Beckett, Rachee Singh, Paramvir Bahl

Two transformations enabling next-gen apps

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5G New Radio

- New frequency bands
- Flexible radio multiplexing
- New RAN protocols

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>10 Gbps throughput

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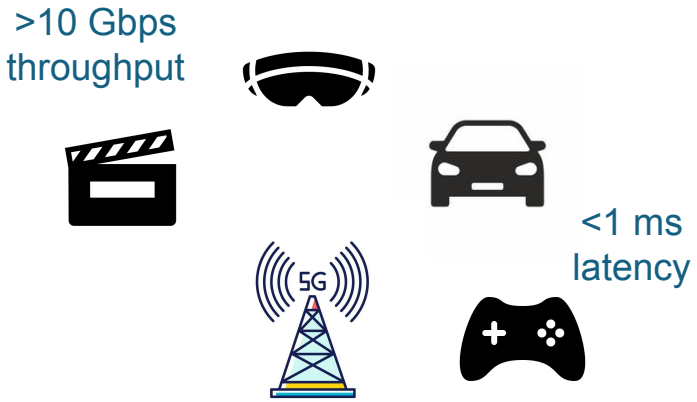

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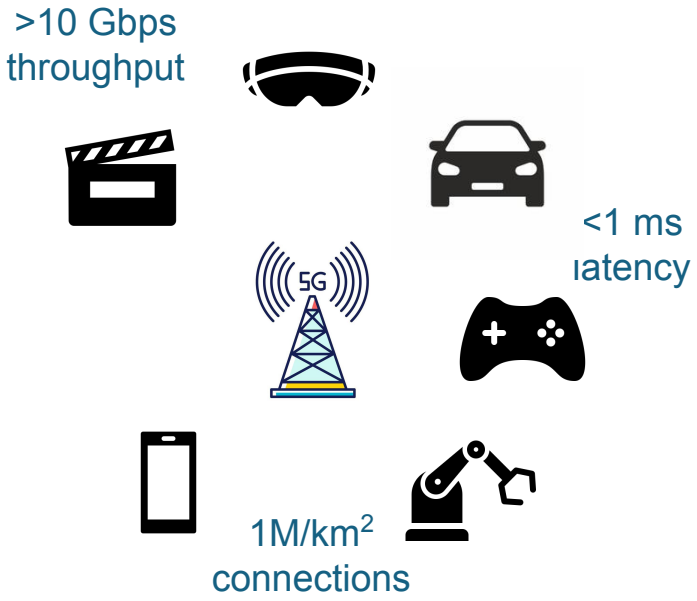

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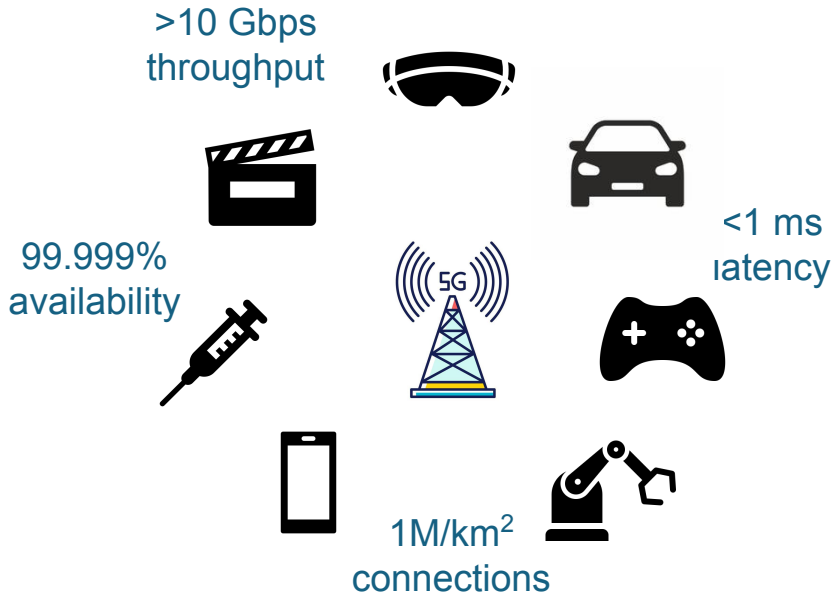

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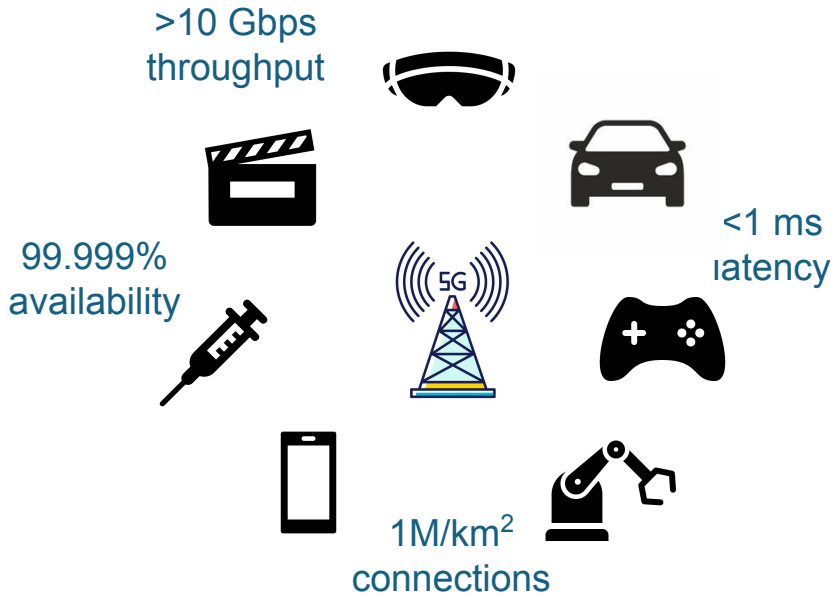

Cloudification

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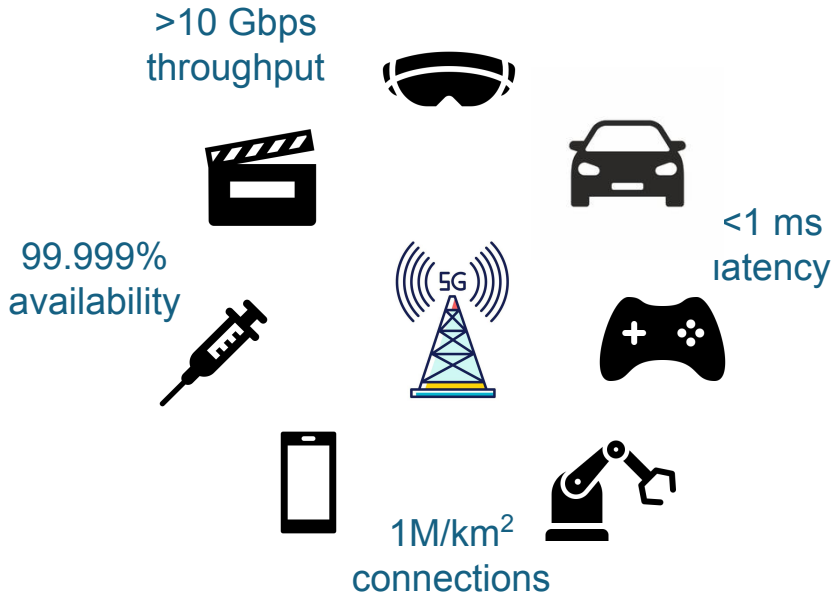

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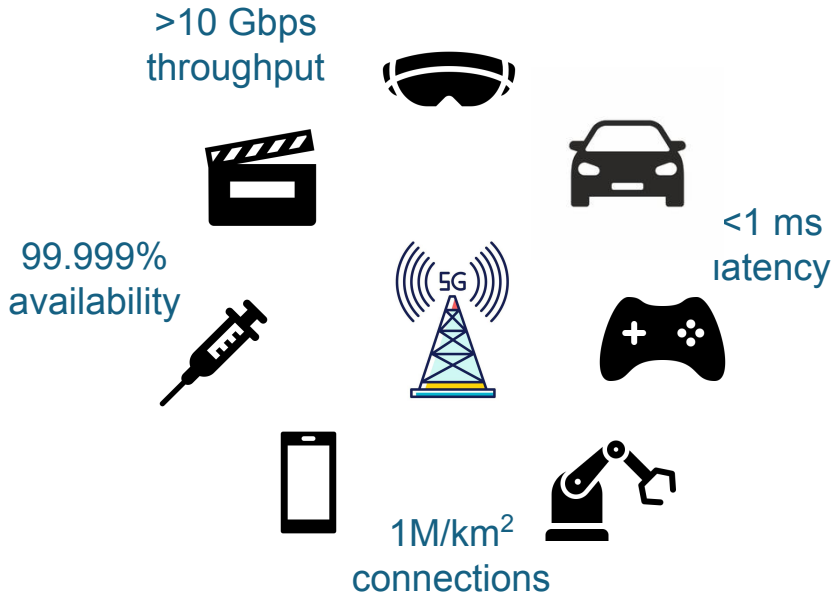
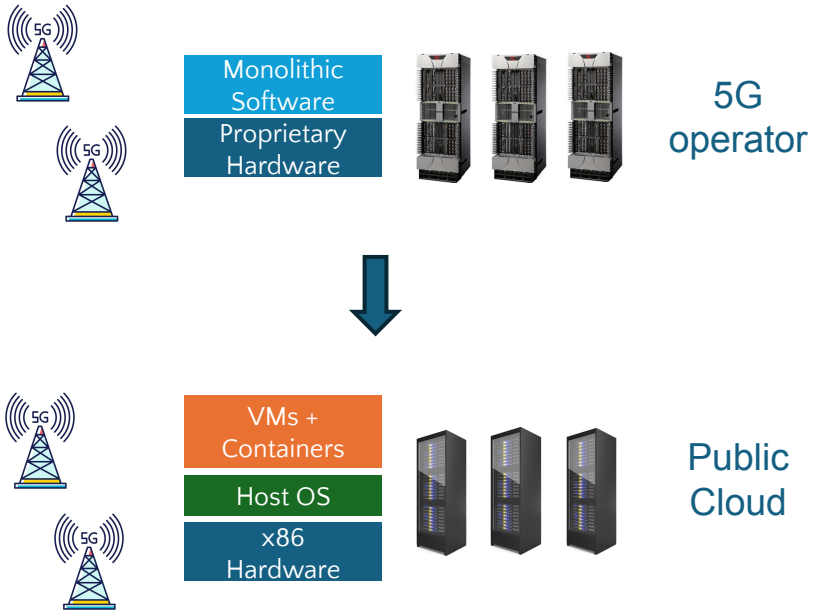


Cloudification

- Network function virtualization
- Flexible deployment
- Statistical multiplexing



5G NR and cloudification are already underway

Sign in USA

Home > Press releases > Ericsson and du reach 16.7 Gbps download speed on 5G Standalone with 10 aggregated carriers

Ericsson and du reach 16.7 Gbps download speed on 5G Standalone with 10 aggregated carriers

Available in English 日本語 简体中文 繁體中文 العربية

- Ericsson and du tested 10 carriers per sector on a live 5G network, achieving up to 16.7 Gbps aggregated downlink speed.
- Implementation is based on 5G standalone (SA) New Radio-Dual Connectivity (NR-DC) and carrier

Telecommunications

Rethinking 5G: The cloud imperative

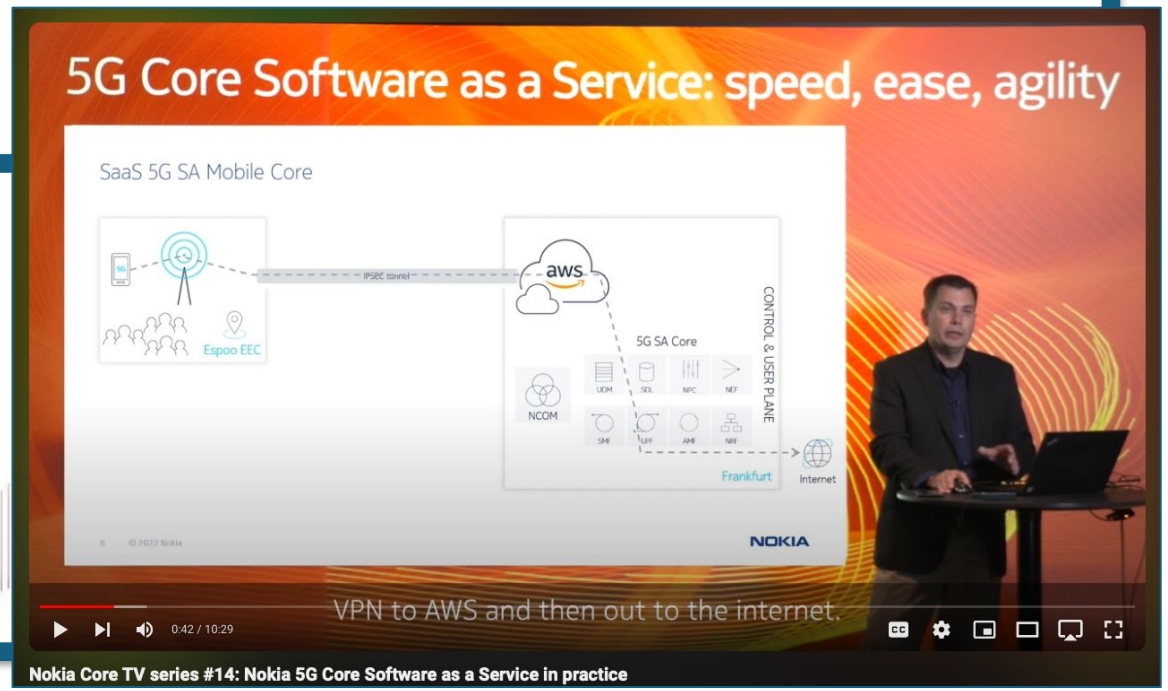
February 19, 2025

Eric Parsons
Head of Emerging Segments, Business Area Cloud Software and Services, Ericsson

Muninder Sambi
VP, Cloud Networking

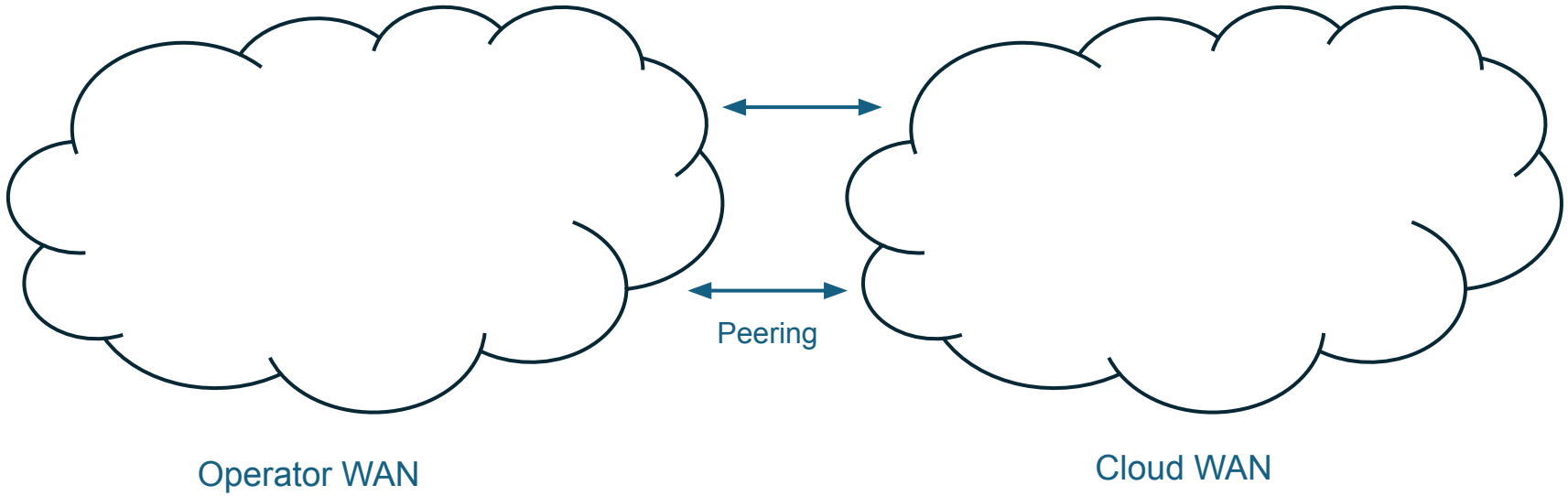
Verizon launches the world's first MEC platform with AWS Wavelength.

For the first time, developers can innovate and build new applications at the edge of the Verizon 5G Ultra Wideband network by accessing AWS Wavelength compute and storage services.



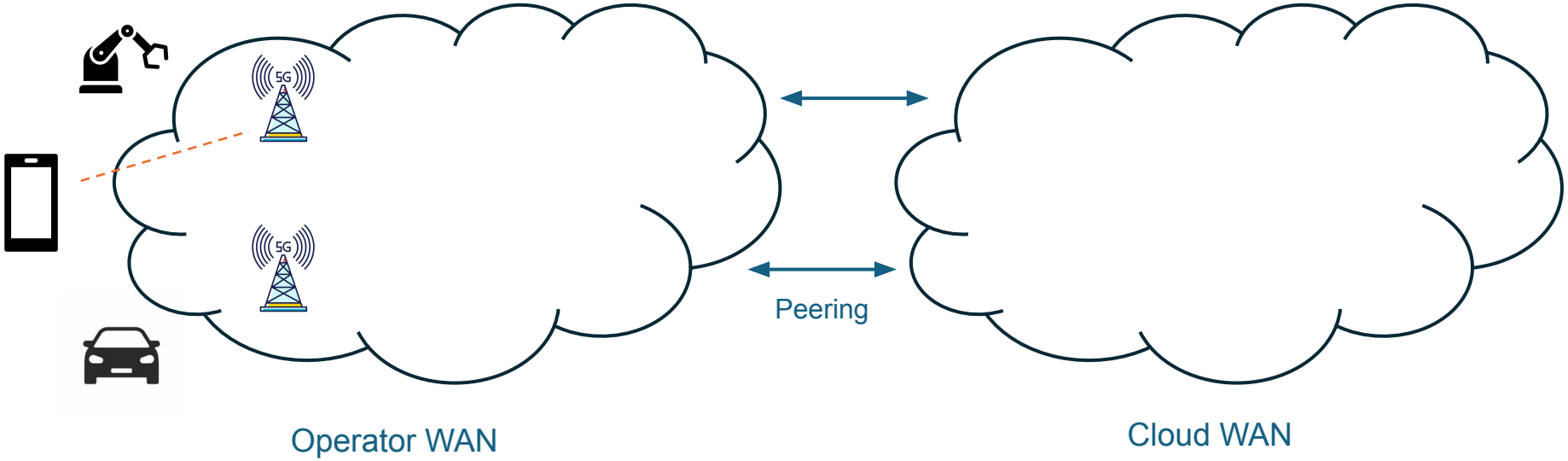
Nokia Core TV series #14: Nokia 5G Core Software as a Service in practice

The cloudification of 5G



5G Traffic can now traverse two WANs

The cloudification of 5G



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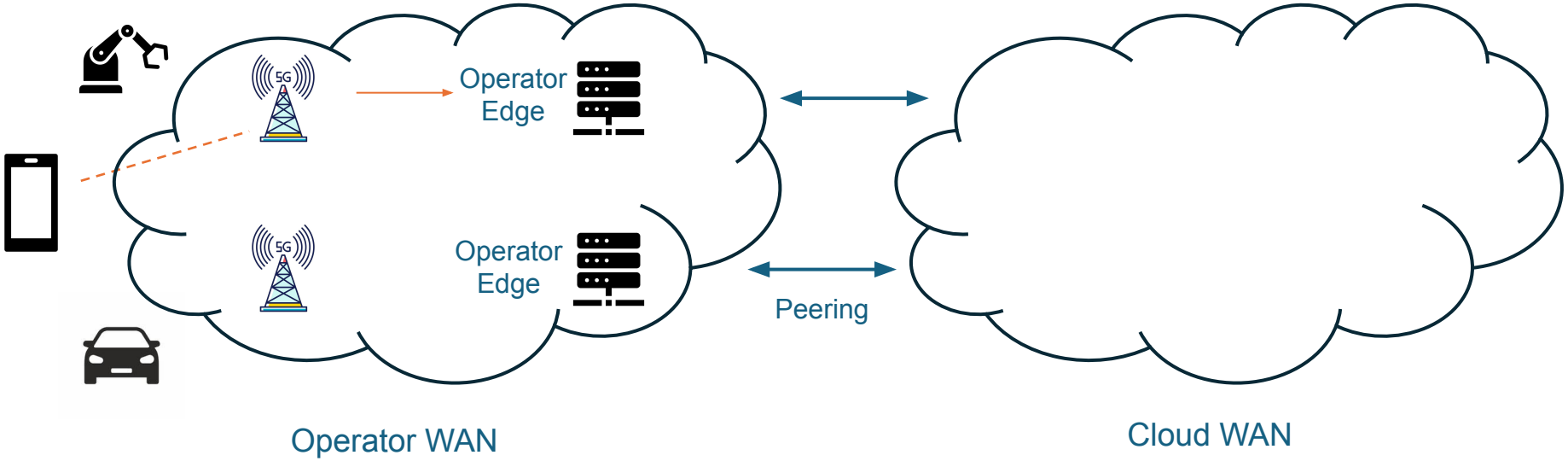

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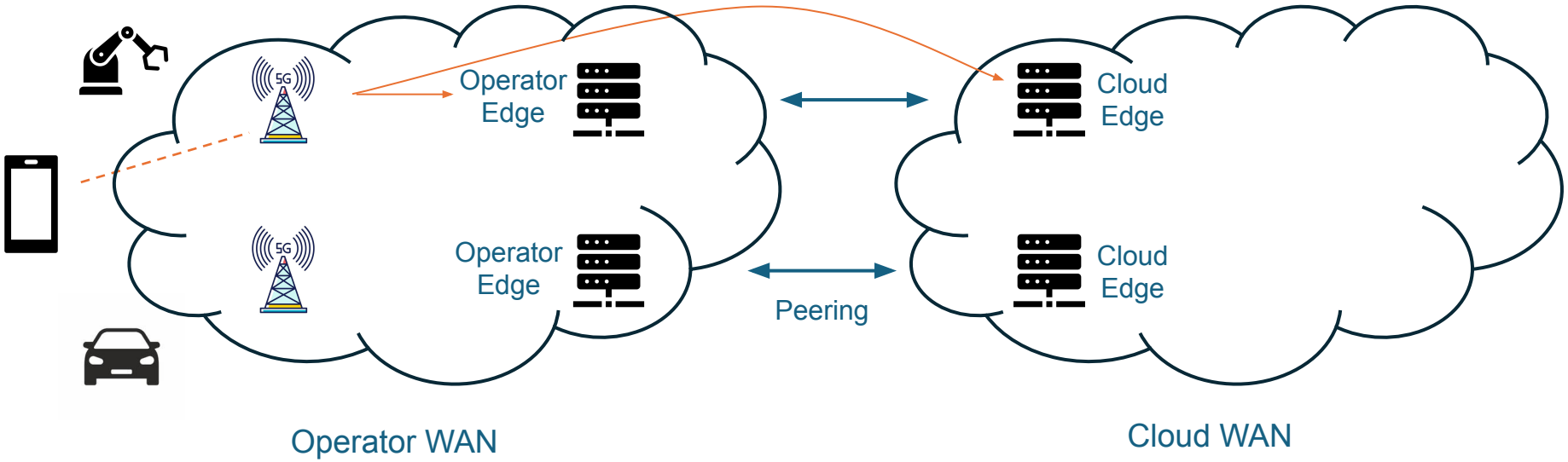

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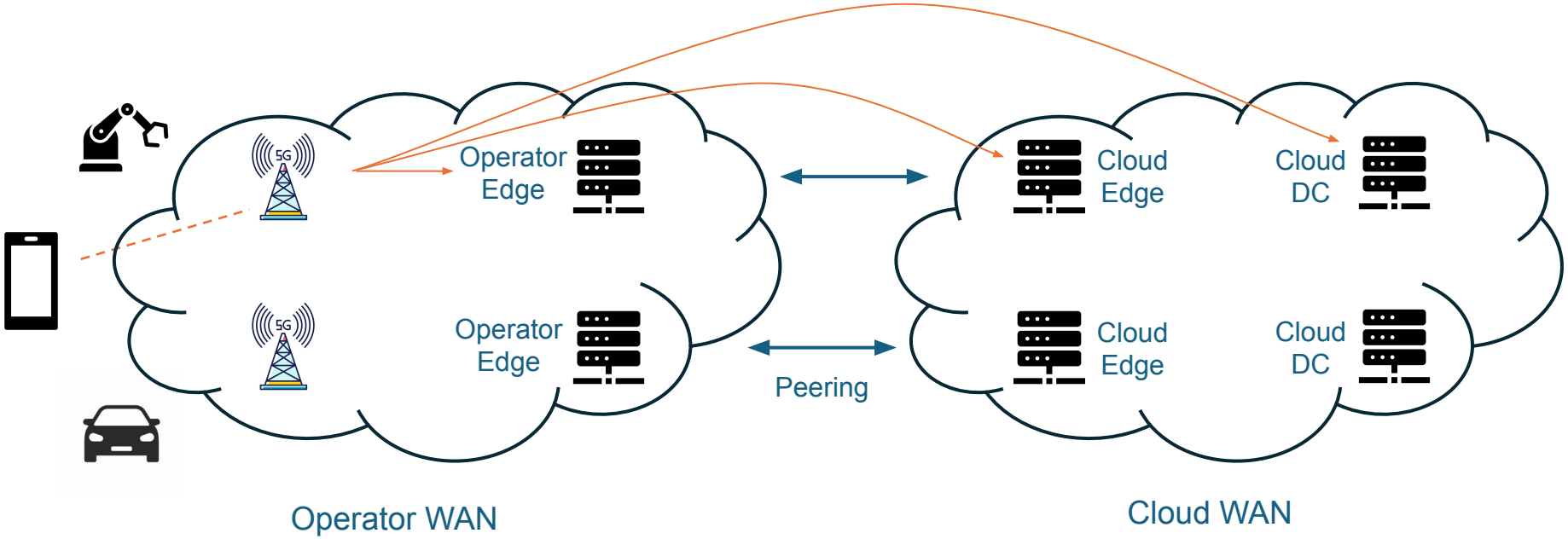
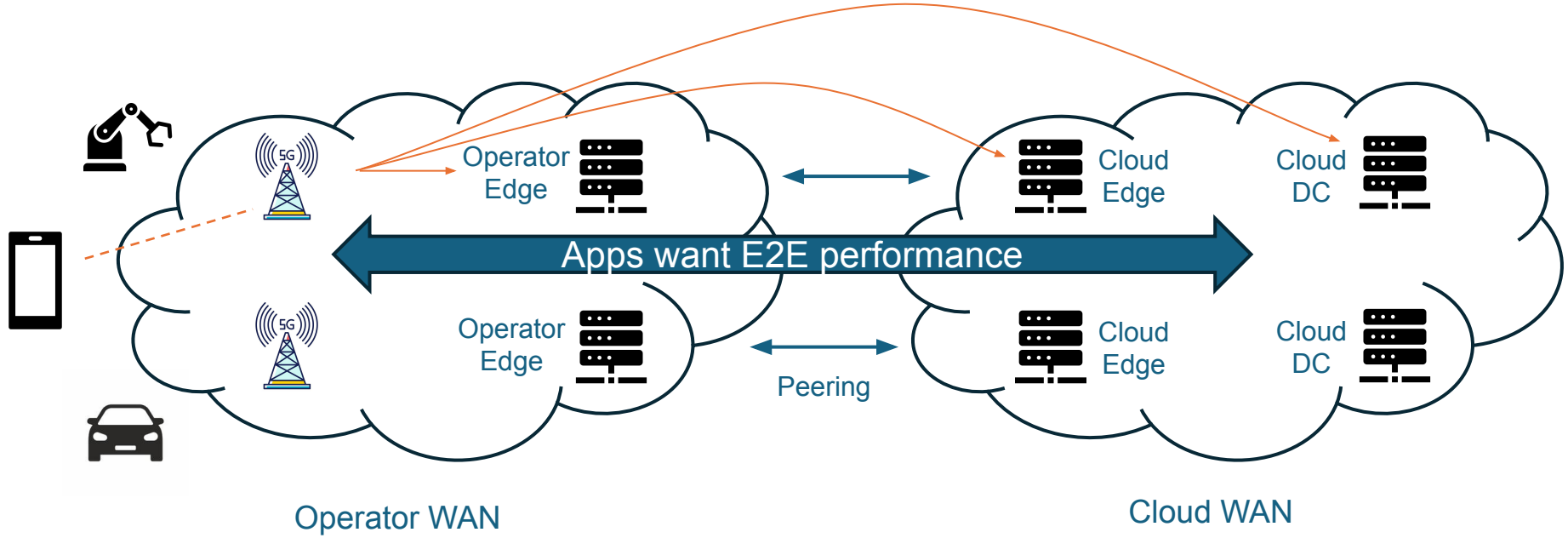


5G Traffic can now traverse two WANs

NR introduces significant pressure on the WANs



- Bandwidth: O(10Gbps/user) hitting cloud services
- Latency: O(1ms) over-the-air compared to WAN latencies & routing inefficiency
- Reliability: going from 99.5 enterprise grade → 99.999 carrier grade availability

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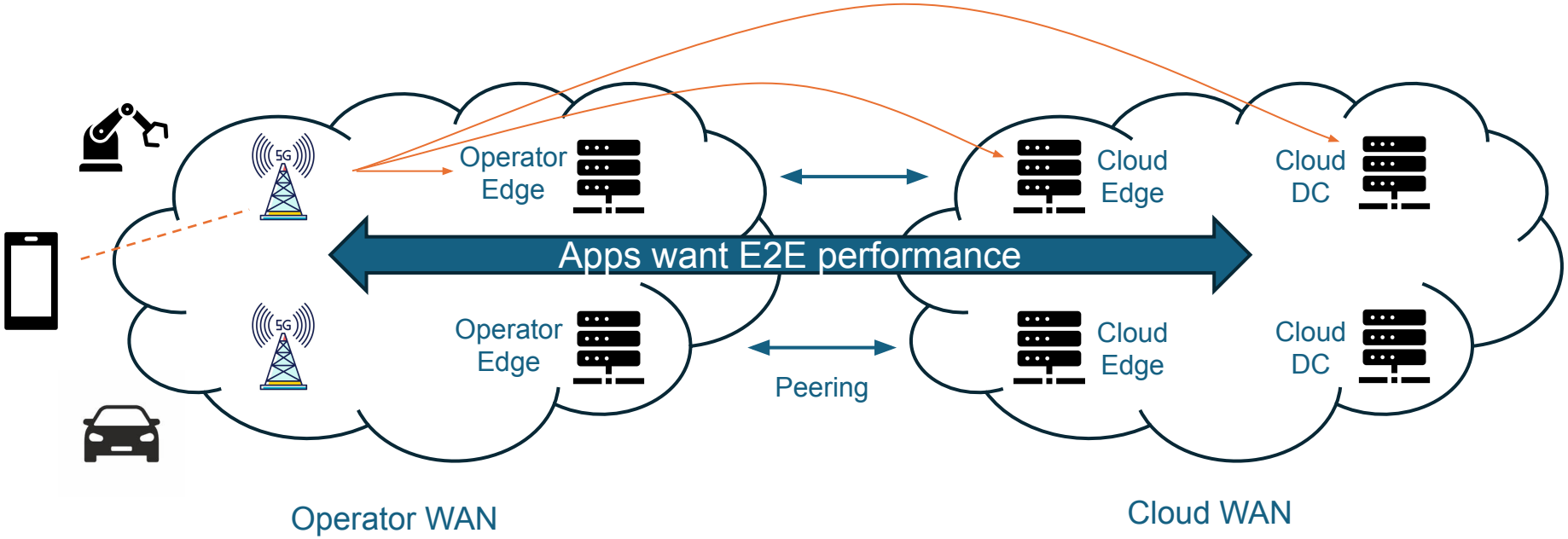
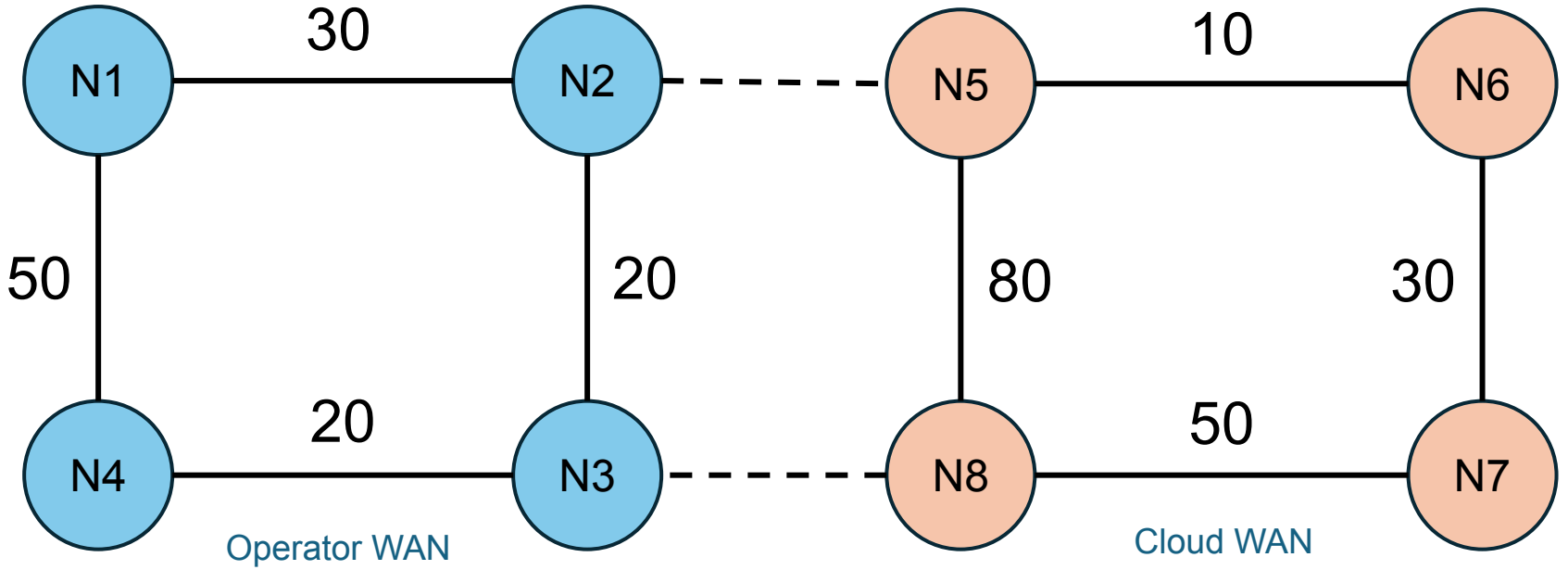


- Shared business incentive: unique opportunity to optimize across two WANs
- Path diversity and differing QoS demands of 5G apps opens door to more intelligent transport decisions

Example: multi-WAN coordination for E2E performance



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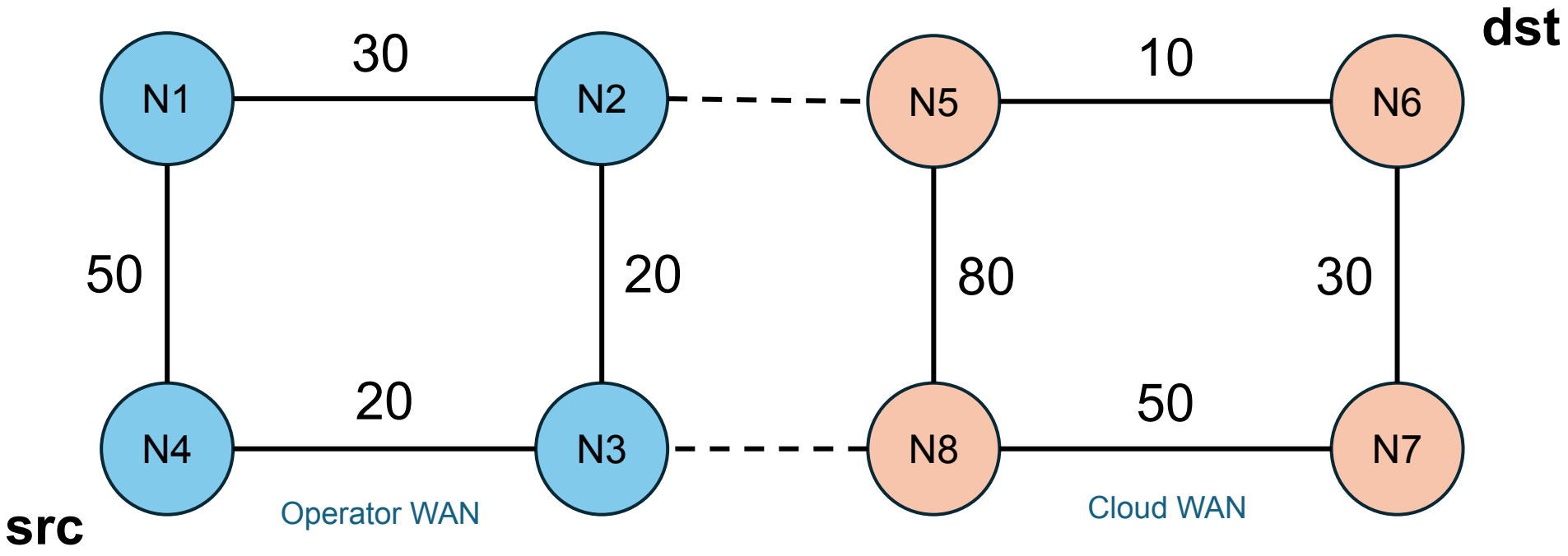

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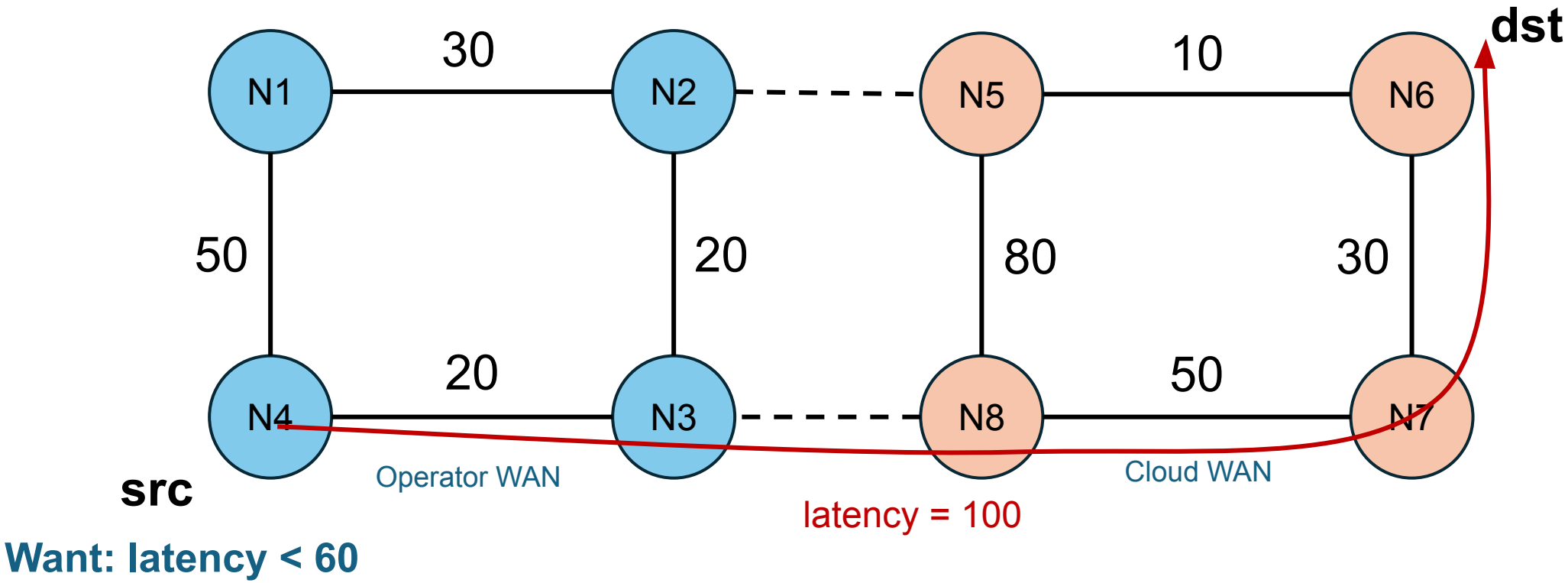

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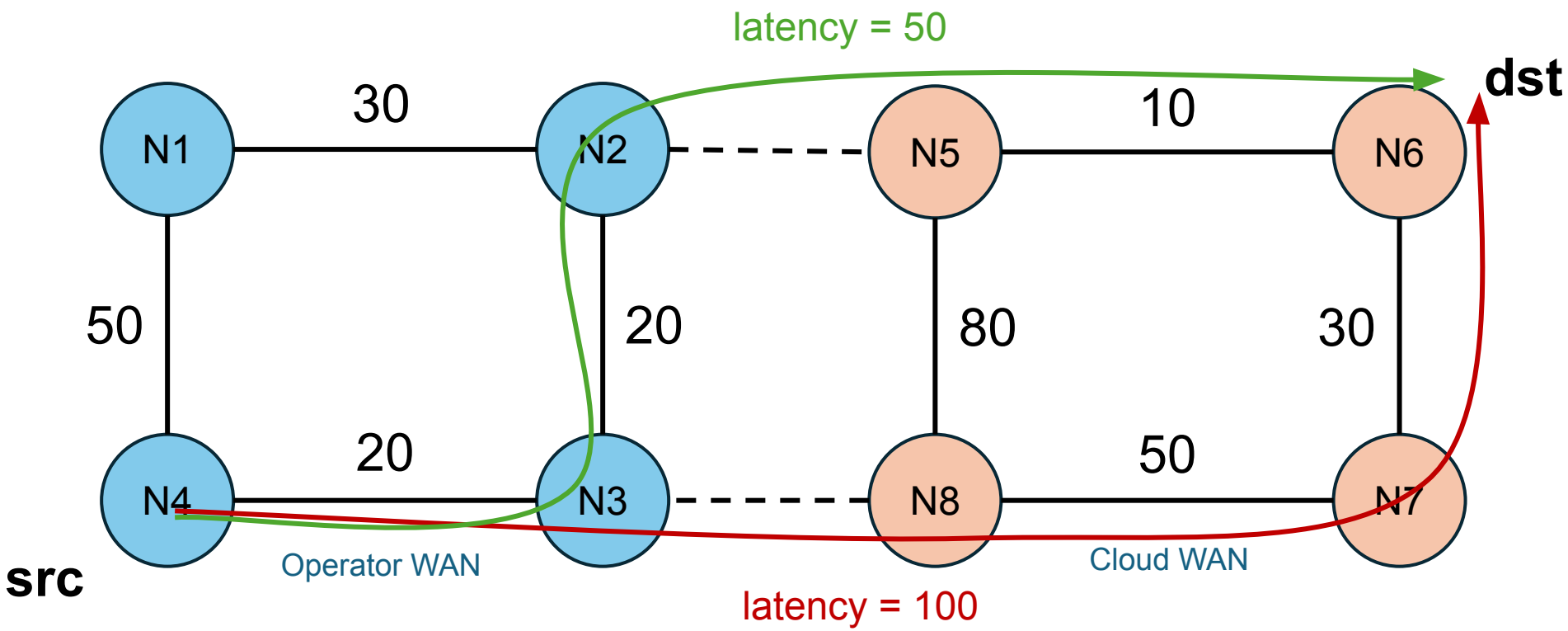

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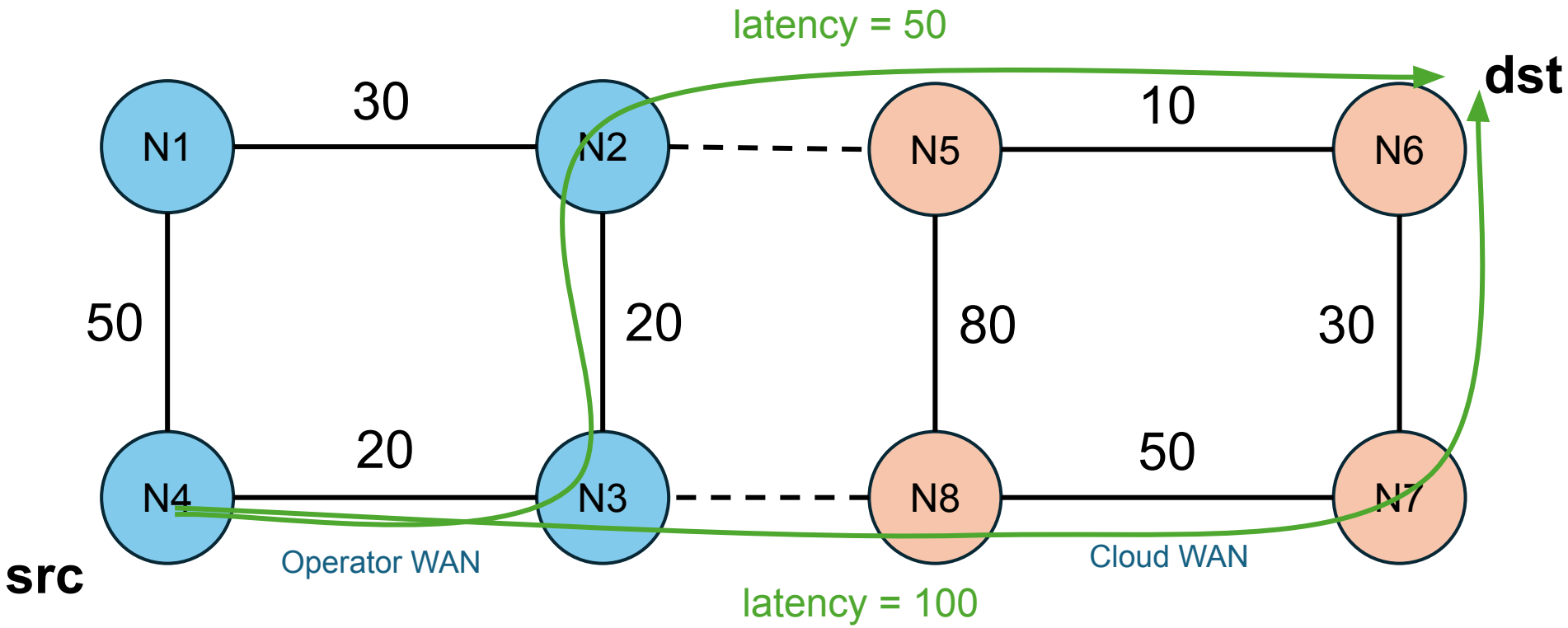
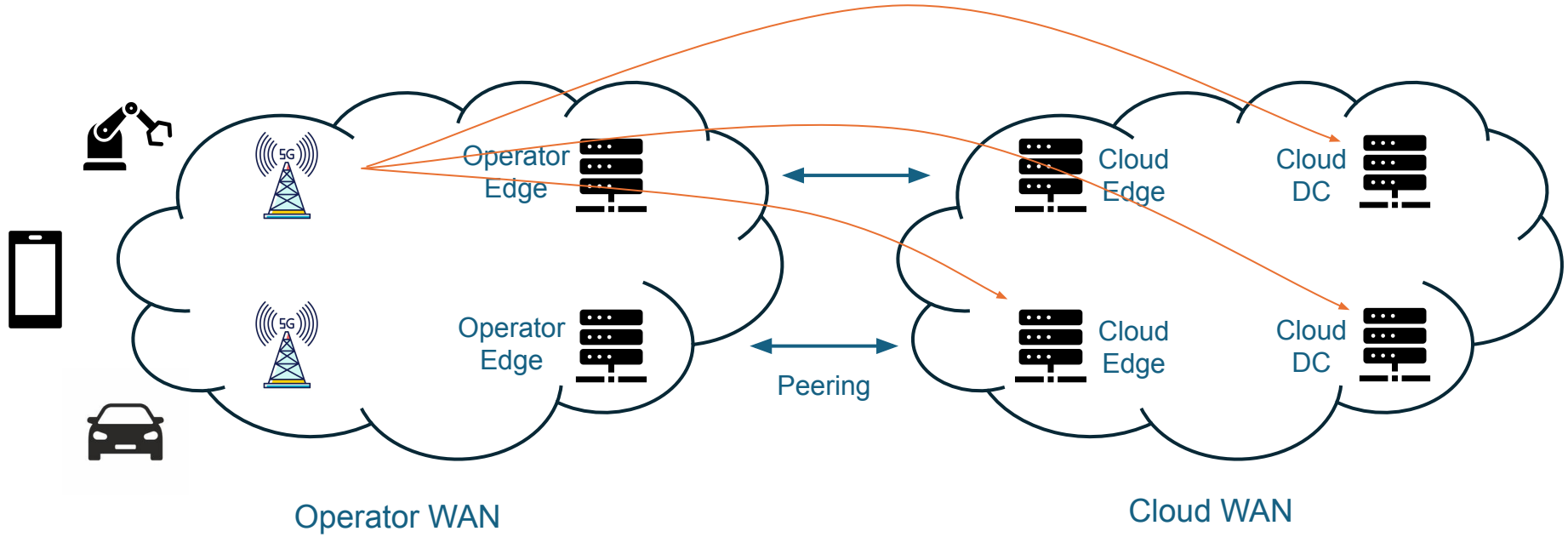


Want: latency < 1000

Not just paths, but destinations too



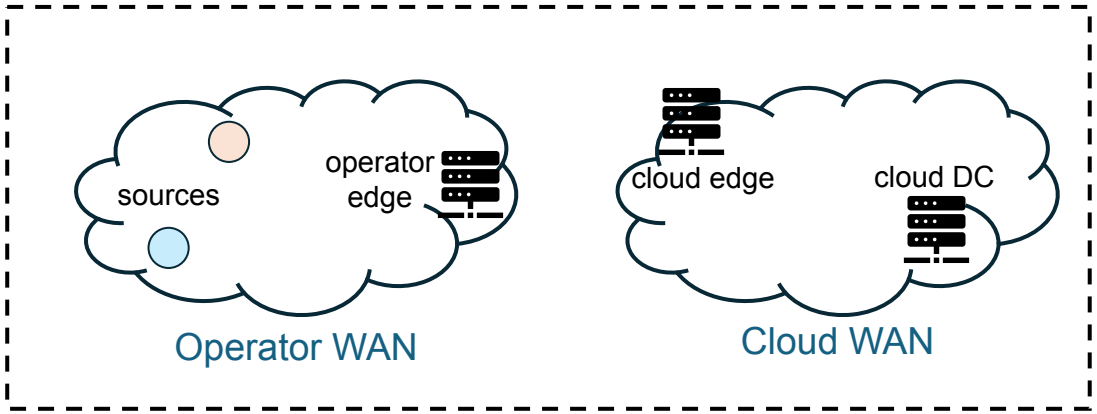
- Which edge site?
- Which cloud DC?
- Differentiated performance can come from both choice of path and destination

Problem summary

- Next-gen apps enabled by 5G NR and cloudification need E2E QoS
- Transport may include two WANs – operator & cloud
- WAN inefficiencies can negate benefits of NR
- Default routing doesn’t support diverse, fine-grained service objectives

OTTER: Overlay Traffic Transport and Efficient Resource allocation

- System for efficient, on-demand transport across both operator and cloud WANs for 5G flows with diverse QoS needs



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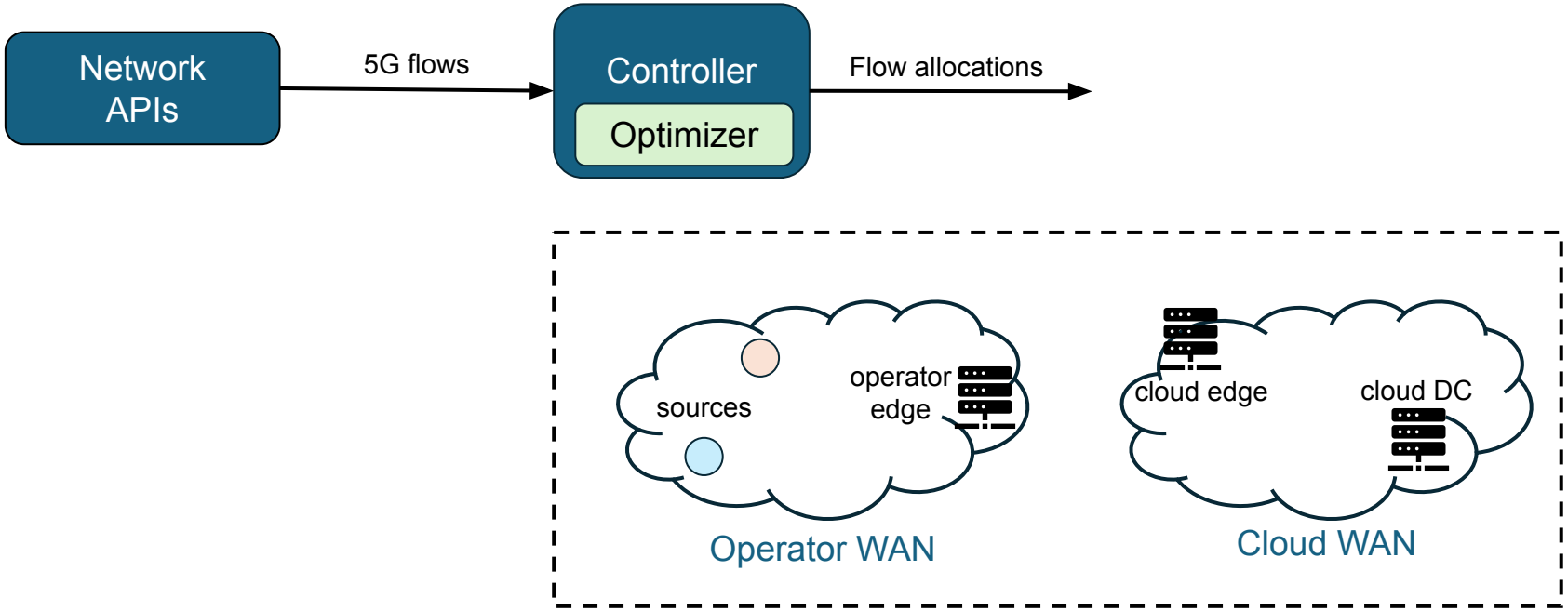

Three main technical components:

- **Controller** to place 5G flows w/ QoS demands on paths
- Scalable multi-WAN overlay that supports path **orchestration**
- **Measurements** on overlay to identify performance of paths and dsts

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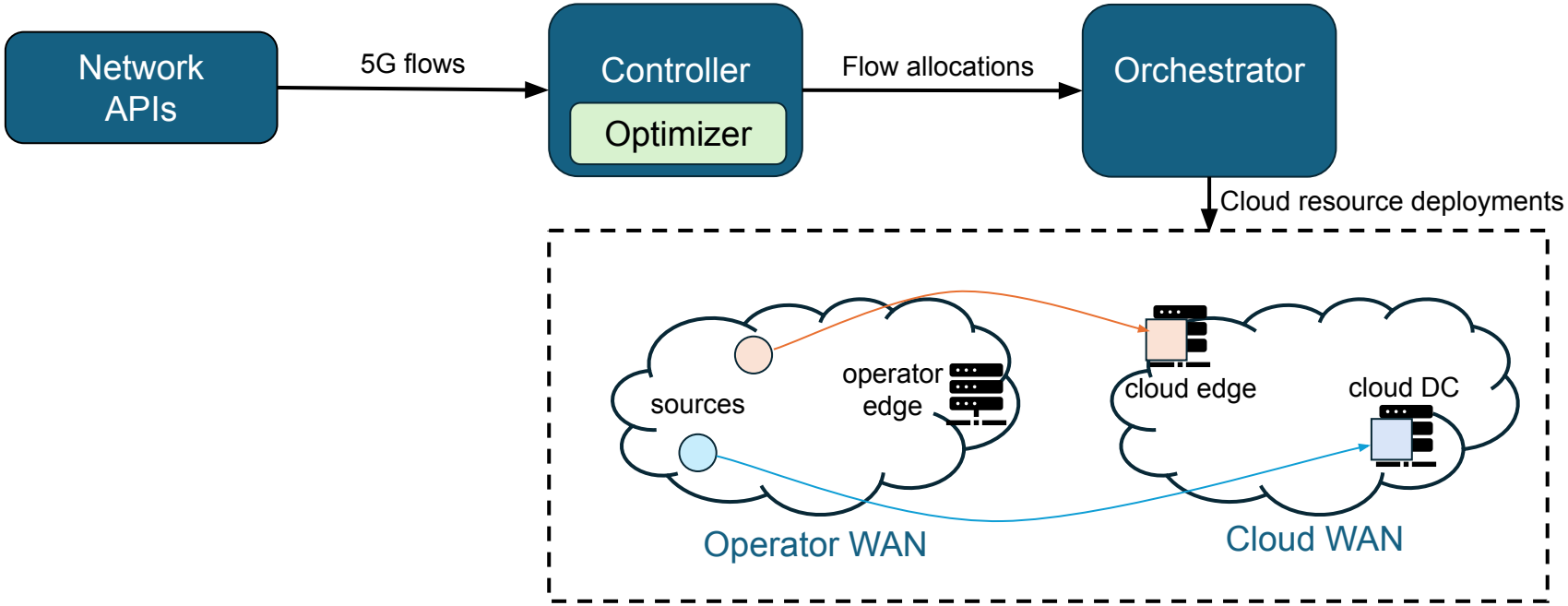

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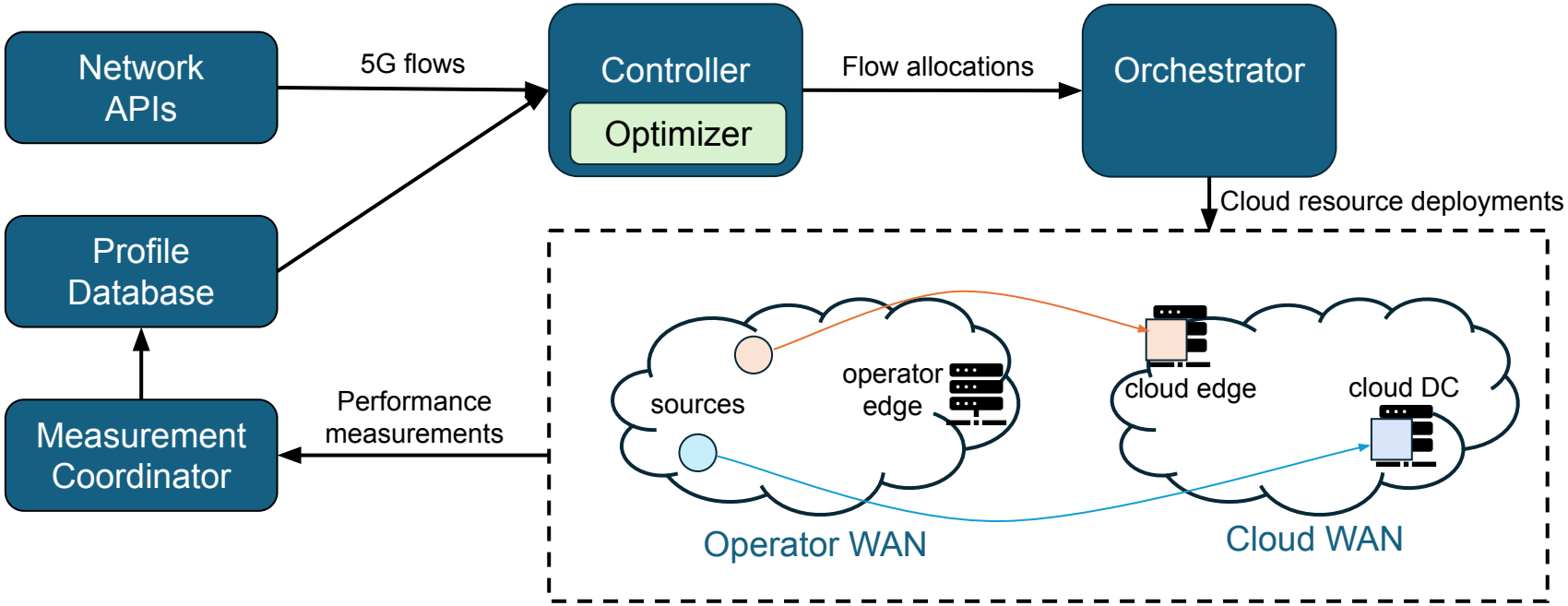

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- `(s, D, bw, demand fns, resource req)`
- `(s, d, links, path metrics)`

Standard multi-commodity flow problem

OTTER multi-WAN flow placement

Objective Function

$$\operatorname{argmax} \sum_{f,p} \left(x_{f,p} \cdot \sum_{m \in \{rtt, jit, loss, bw\}} \mathcal{D}_f^m(\sigma_p^m) \right) / bw_f$$

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Amount of bandwidth of flow **f** assigned to path **p**

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Degree of service
demand satisfaction

Objective Function

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Bandwidth demand

Objective Function

$$\operatorname{argmax} \sum_{f,p} \left(x_{f,p} \cdot \sum_{m \in \{rtt, jit, loss, bw\}} \mathcal{D}_f^m(\sigma_p^m) \right) / bw_f$$

subject to destination resource constraints

Objective Function

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subject to destination resource constraints

- Allocate as much bandwidth as possible while satisfying QoS demands

On-Demand Flow Placement

- 5G traffic is more dynamic compared to typical WAN workloads
- For scalability:
  - Greedily allocate new flows to paths with best demand satisfaction
  - Periodically run global optimization

OTTER Orchestrator

How to steer traffic along the routes computed by the Controller?

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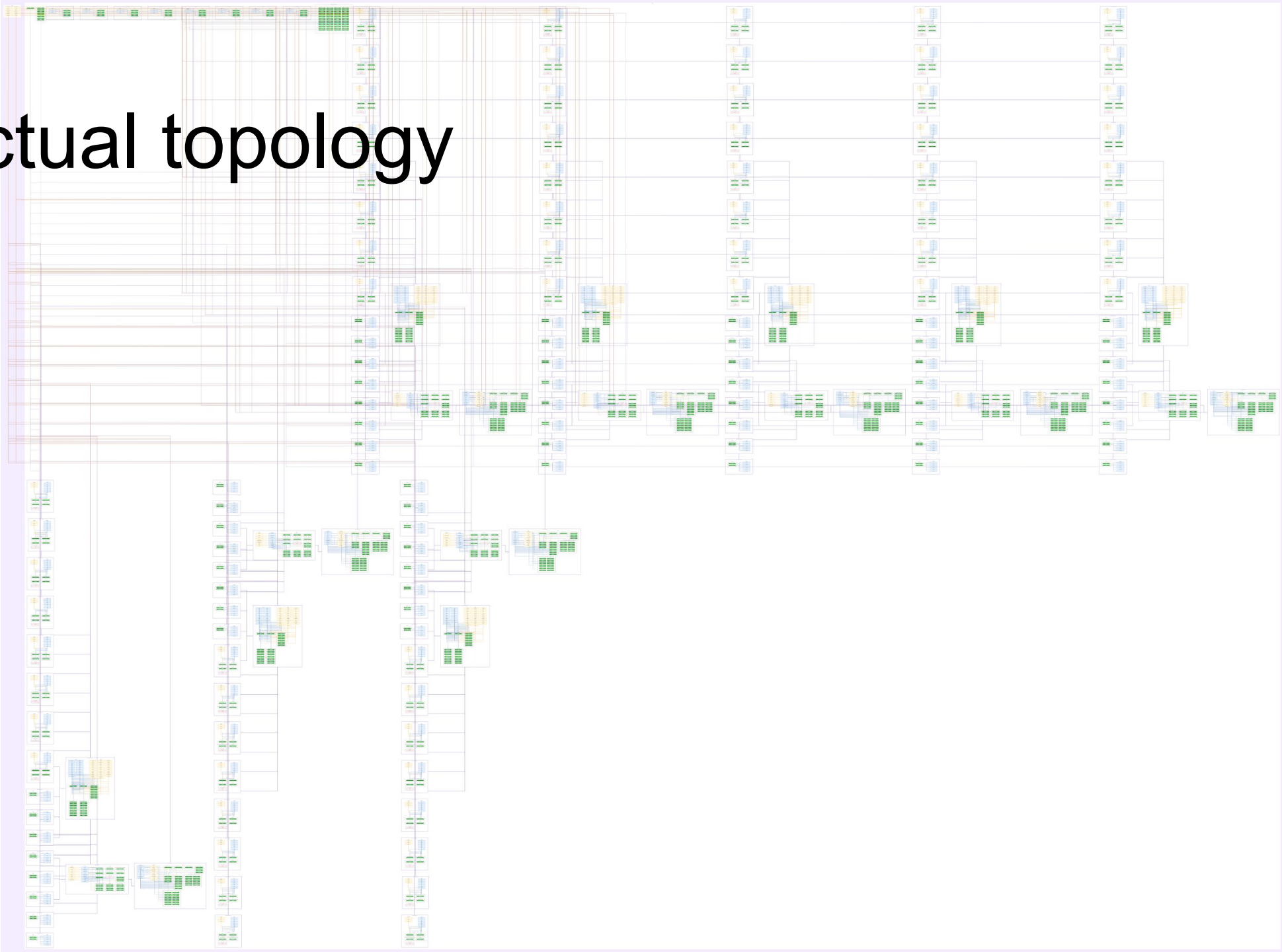
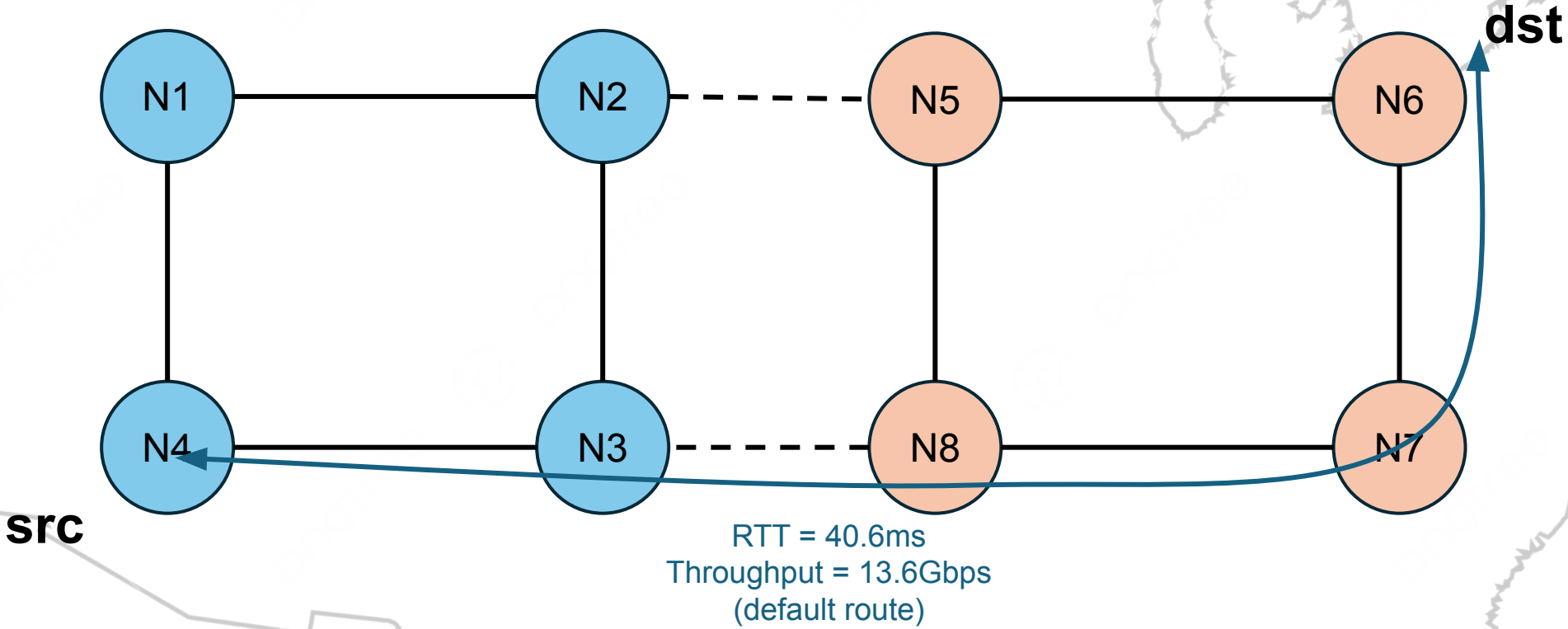
- Solution: a multi-WAN overlay using native cloud functionality
  - No need for explicit cooperation between WANs
  - No need for significant engineering effort to exploit path diversity
  - Can easily scale-up and scale-out

Actual topology



Example QoS choices



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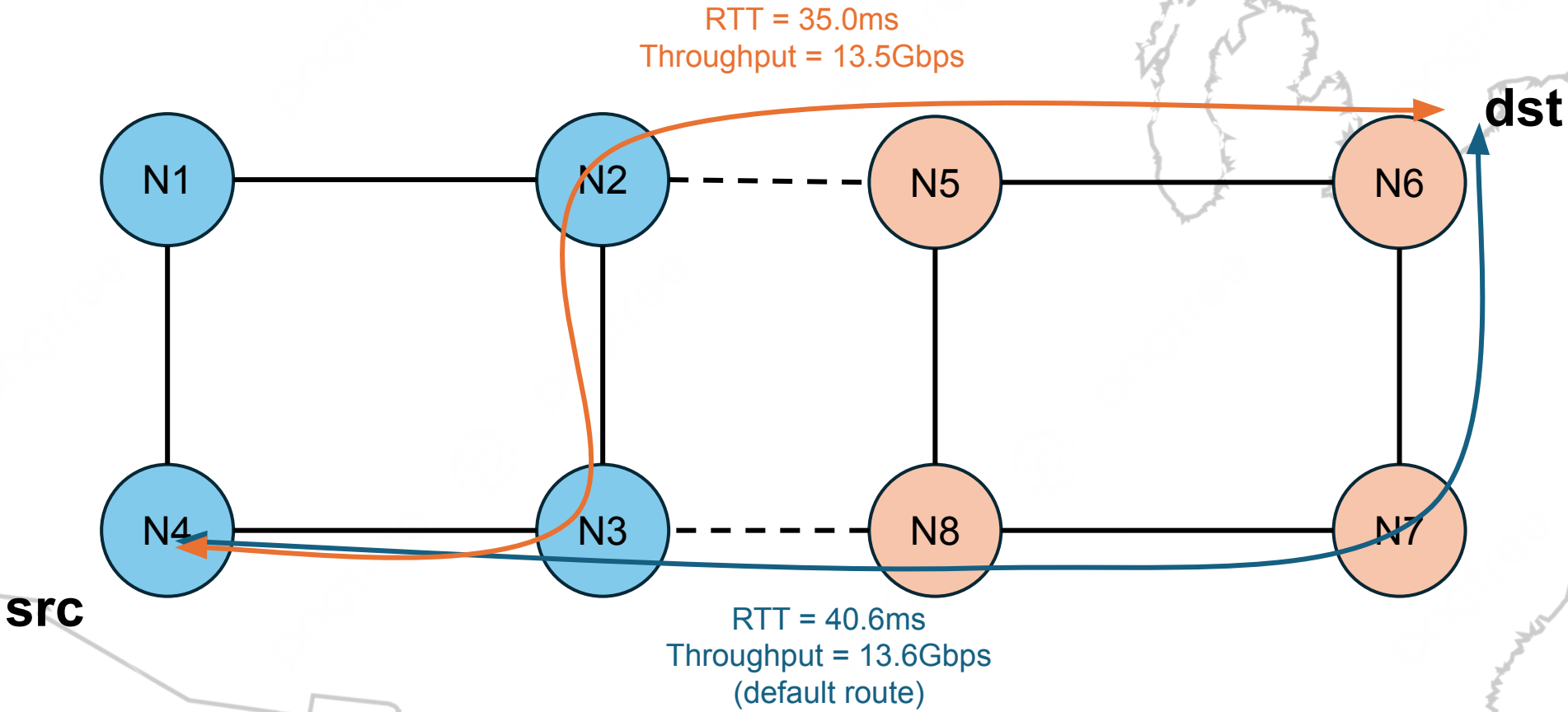

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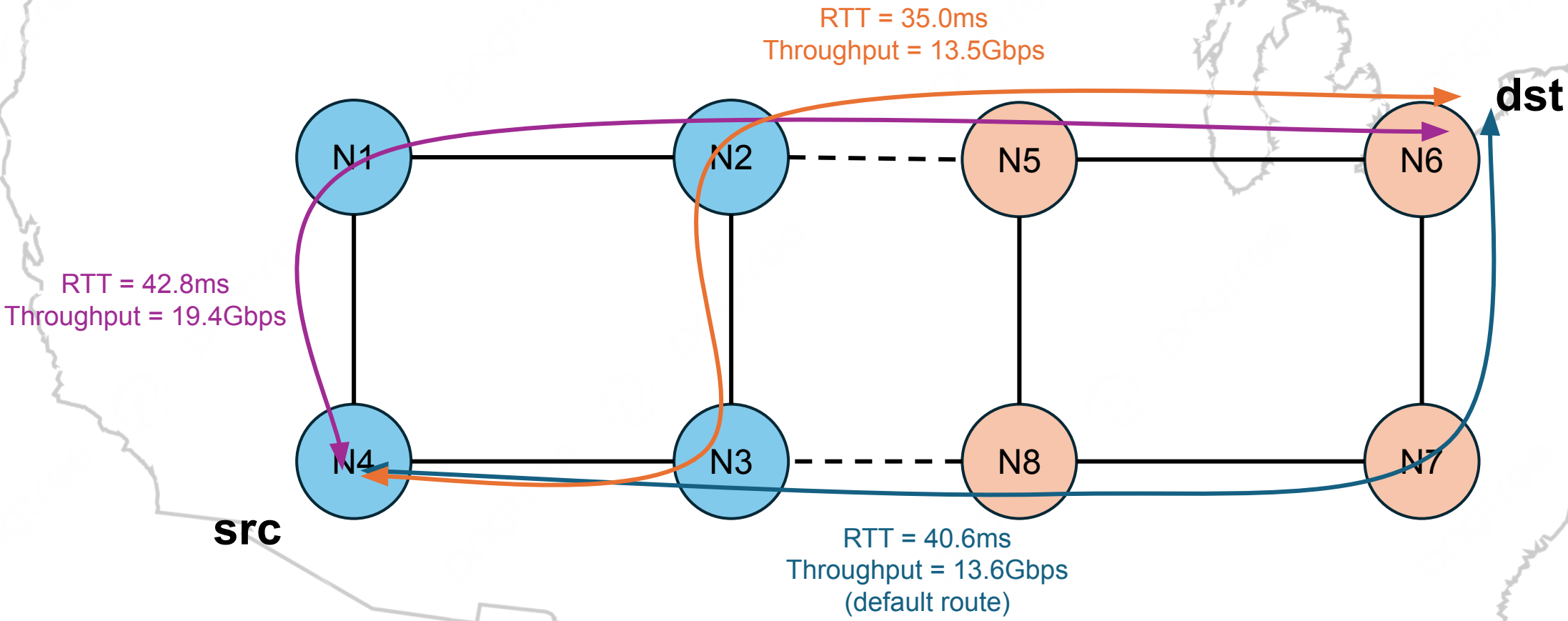
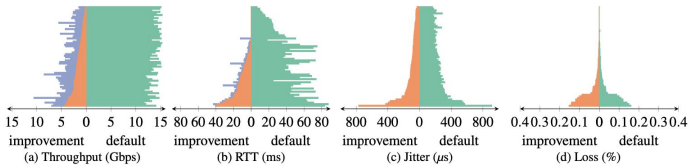
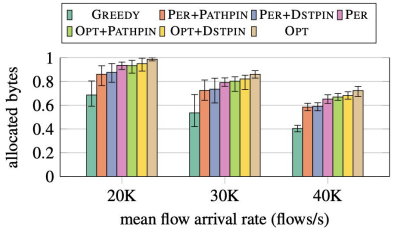


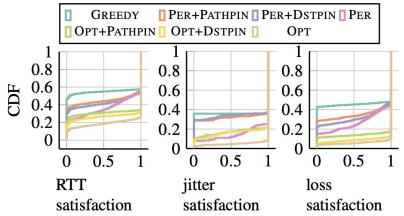
- OTTER offers a choice among paths with different performance characteristics to satisfy QoS demands

QoS Improvement Results

- Throughput: +13% average, +136% best case (6-10Gbps higher)
- Latency: -15% average, -56% best case (21ms lower each way)
- Jitter: -45% average, -99% best case (5ms lower)
- Loss: -0.06% average, -0.4% best case (after removing outliers)
- 25-46% more bytes allocated with higher service demand satisfaction vs. greedy baselines







Summary

- 5G NR and cloudification are already here
- E2E performance is being bottlenecked on WAN paths
- **OTTER**
  - Co-optimizes paths and destinations for flows with diverse QoS demands
  - Deploys a scalable, multi-WAN overlay that unlocks inter-domain routing flexibility