End-to-End Service Chains in a Multi-Cloud
– A Key Enabler for the Edge Cloud –

Larry Peterson

The Edge… Where the Hype Is

"The Edge Will Eat the Cloud"

Gartner Maverick Research Report

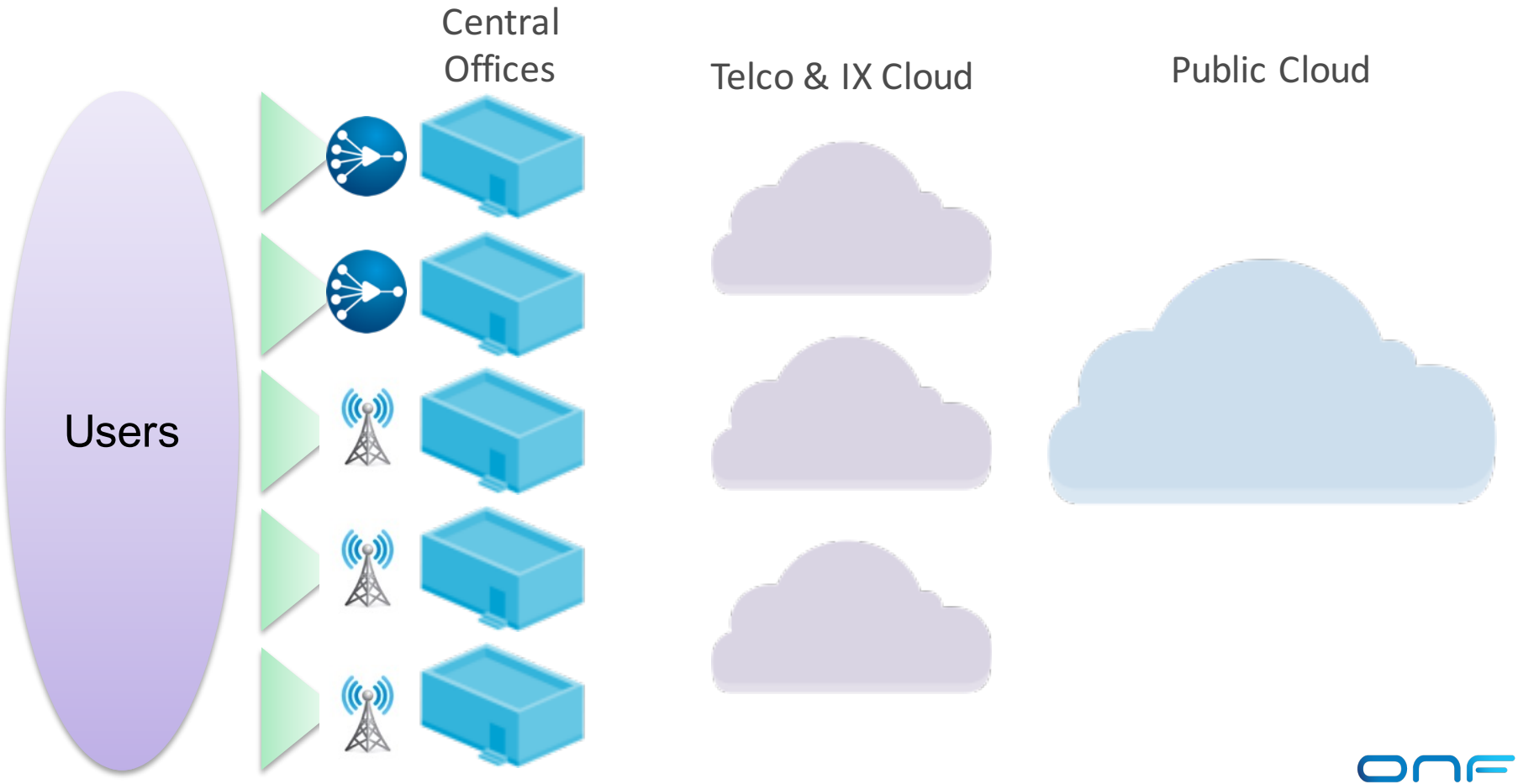
https://www.gartner.com/doc/reprints?id=1-4GH0FTL&ct=171004&st=sb

"Return to the Edge and the End of Cloud Computing"

Peter Levine, A16z

https://a16z.com/2016/12/16/the-end-of-cloud-computing/

An Untapped Opportunity



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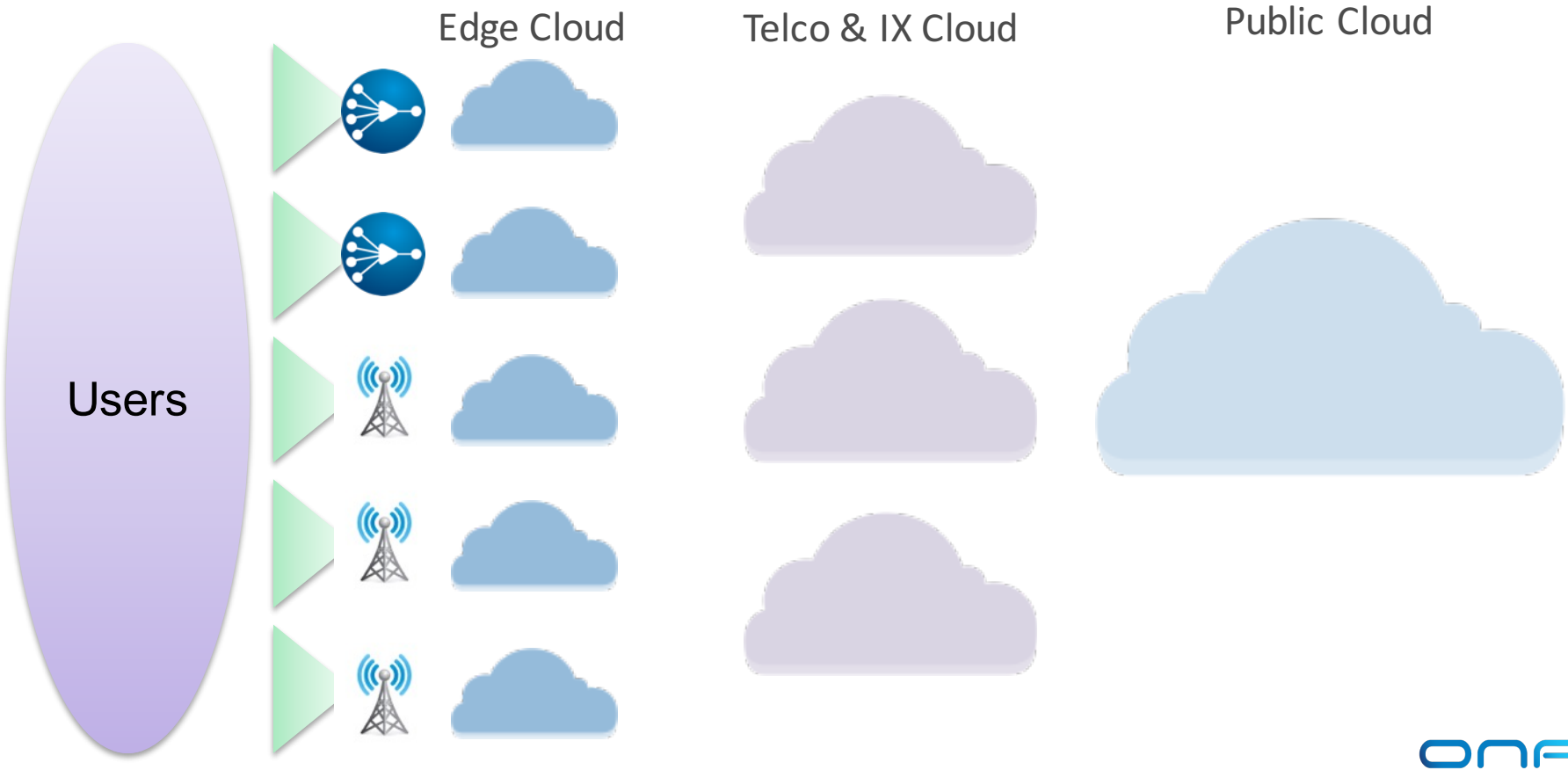

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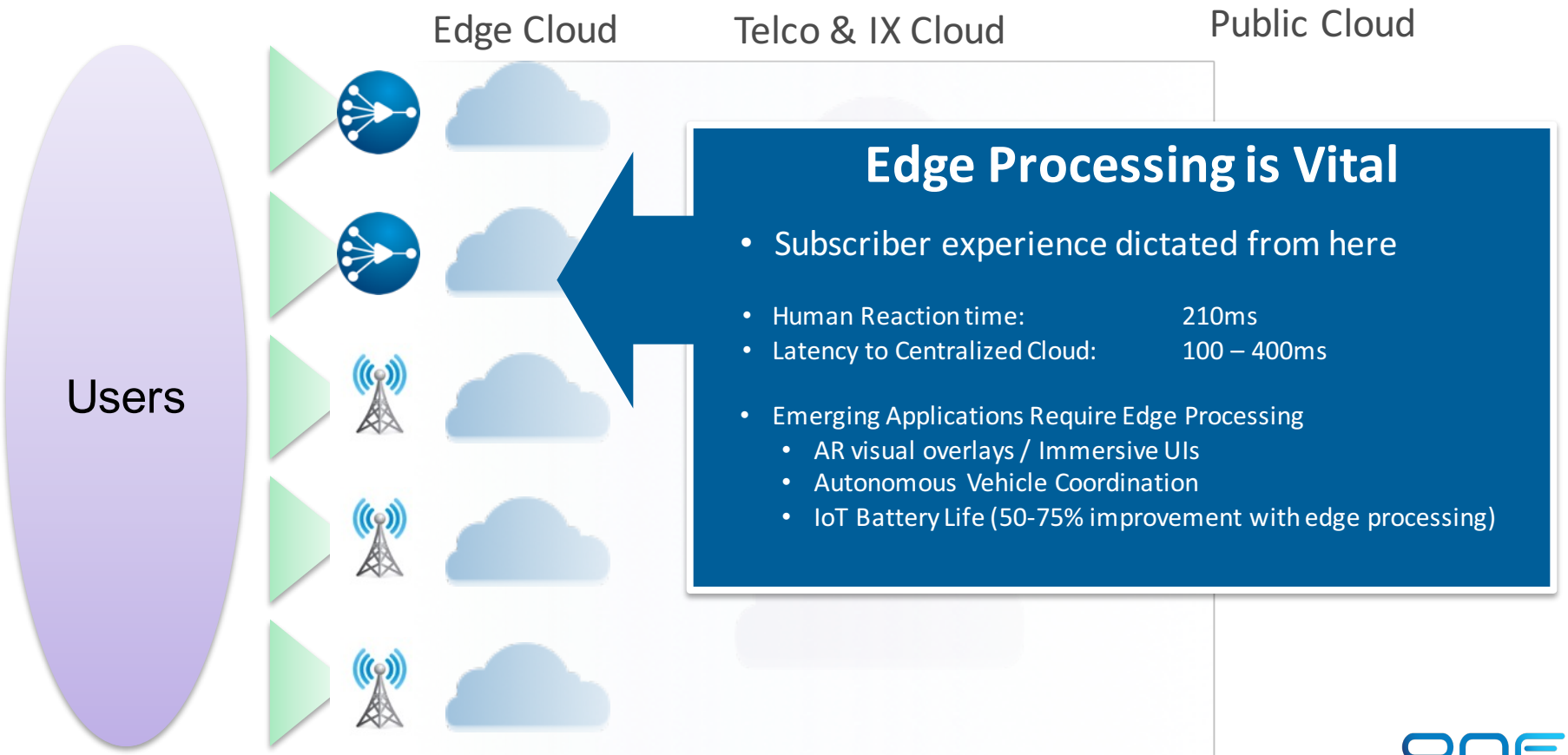


Edge Processing is Vital

- Subscriber experience dictated from here

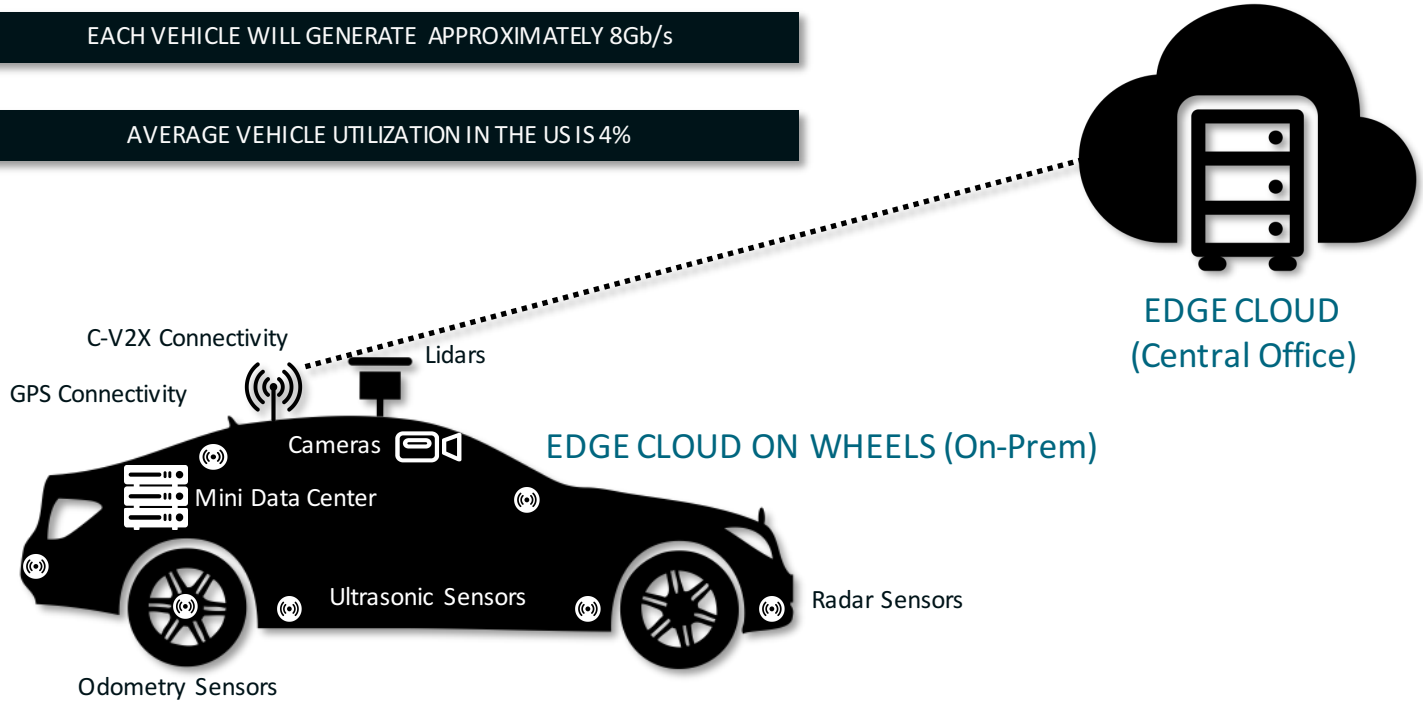
- Human Reaction time: 210ms
- Latency to Centralized Cloud: 100 – 400ms

- Emerging Applications Require Edge Processing
  - AR visual overlays / Immersive UIs
  - Autonomous Vehicle Coordination
  - IoT Battery Life (50-75% improvement with edge processing)

Example: Autonomous Vehicles

EACH VEHICLE WILL GENERATE APPROXIMATELY 8Gb/s

AVERAGE VEHICLE UTILIZATION IN THE US IS 4%



What's Different?

Access* x *Cloud → Edge Platform will host multiple types of services

- Access Services (e.g., vRAN, vOLT)
- Converged Network Services (e.g,. vEPC, vBNG)
- Edge Cloud Services (e.g. Immersive UIs, Internet-of-Things)

Multi-Cloud → End-to-End Functionality will span multiple clouds

- On-premise
- Central Offices
- Internet Exchanges
- Public Clouds

Role of 5G

Earlier generations were about improving broadband technology

5G is fundamentally about supporting new services

- Internet-of-Things
- Immersive UIs
- Public Safety

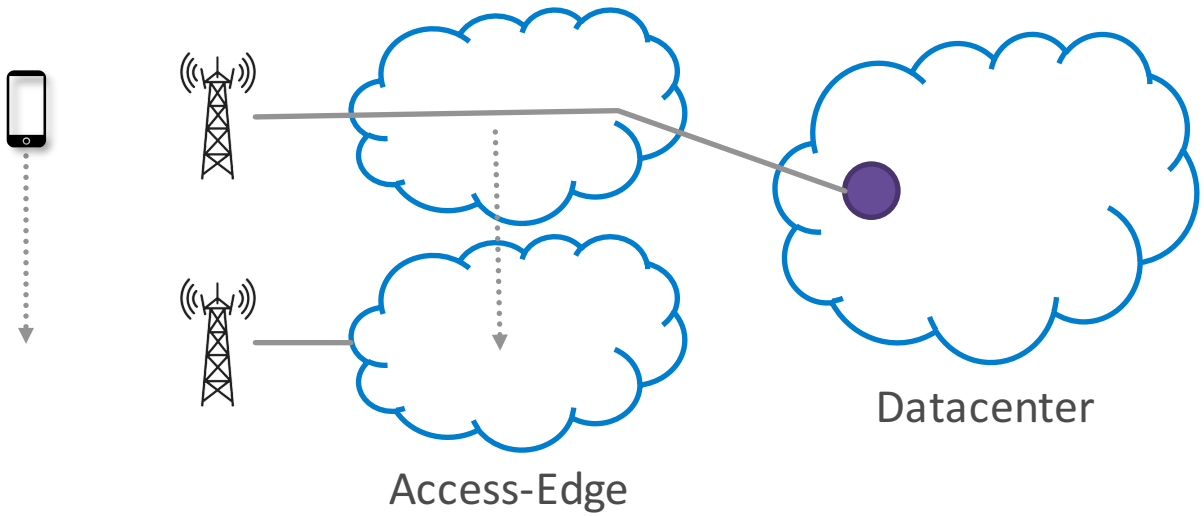
What unique capability does the mobile access network offer?

- Low-latency proximity to end-users
- Intrinsic support for mobility

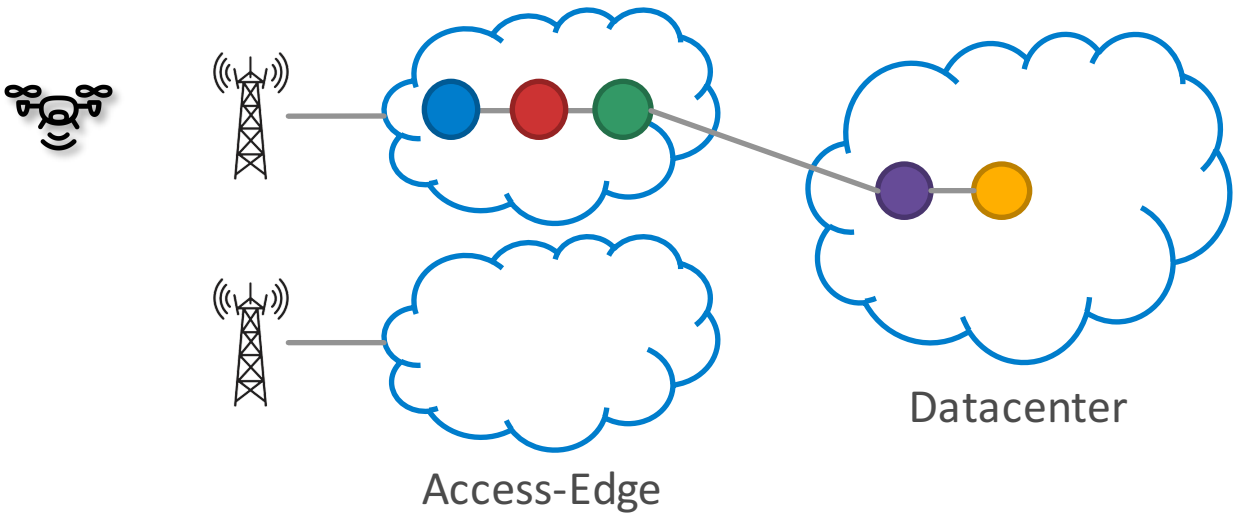
Challenge of 5G is to Simultaneously Support…

- Low Latency – Moving functionality to the edge, closer to devices
- Mobility – Accessing that edge functionality while continuing to be mobile

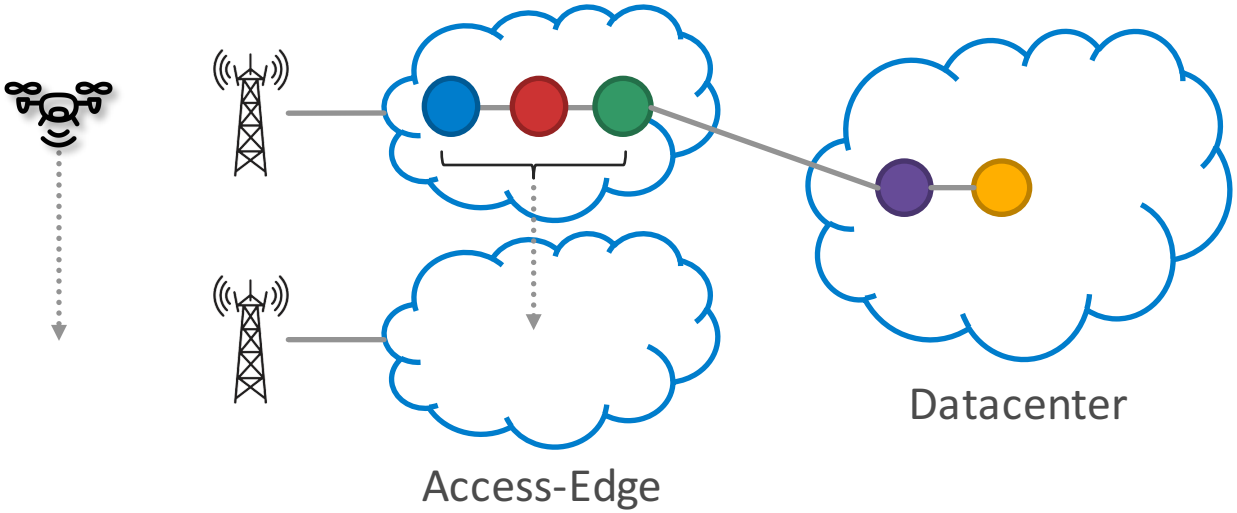
Mobile Broadband (2G – 4G)



Move Functionality to the Edge



Mobile Cloud (5G)



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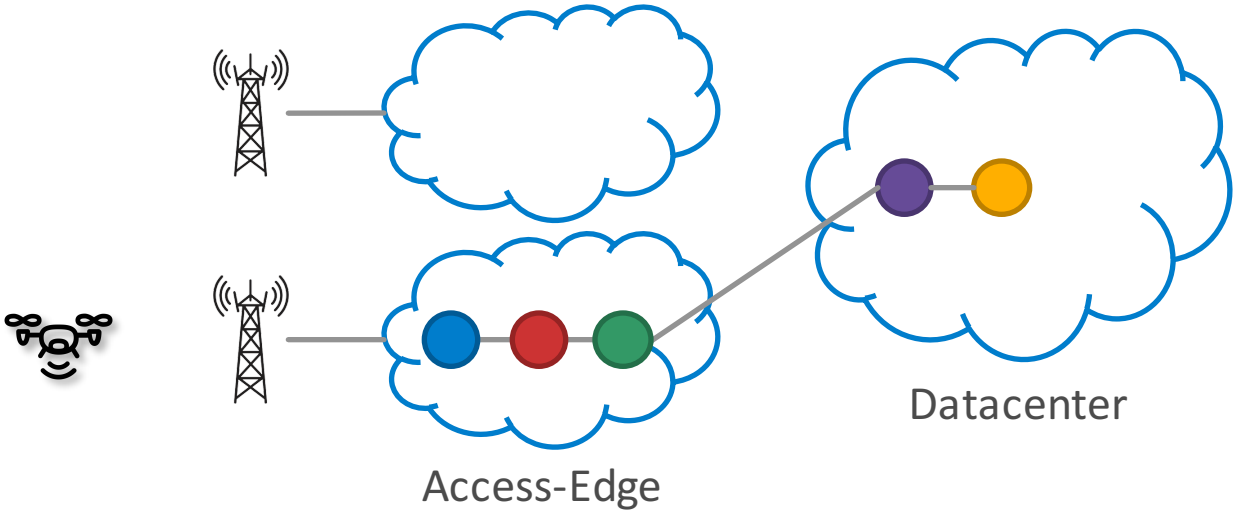
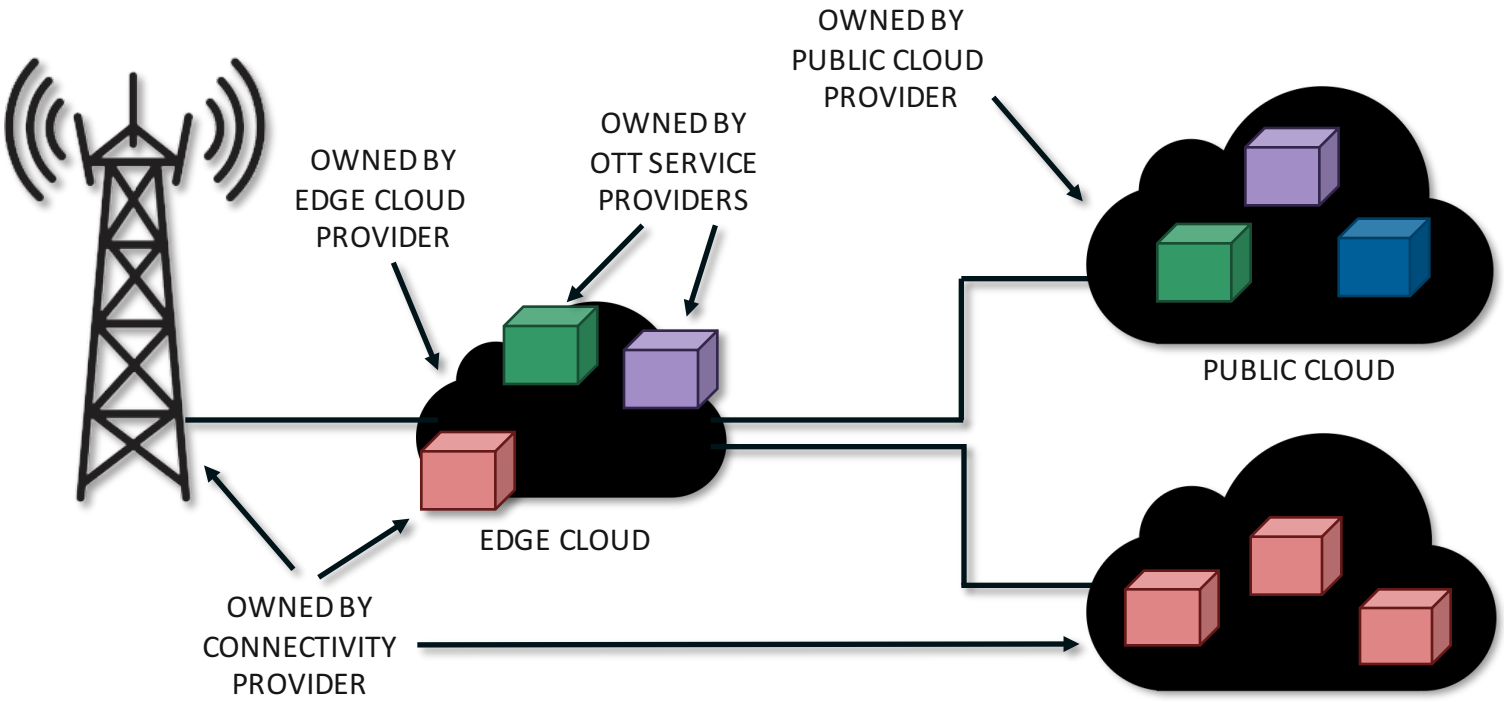


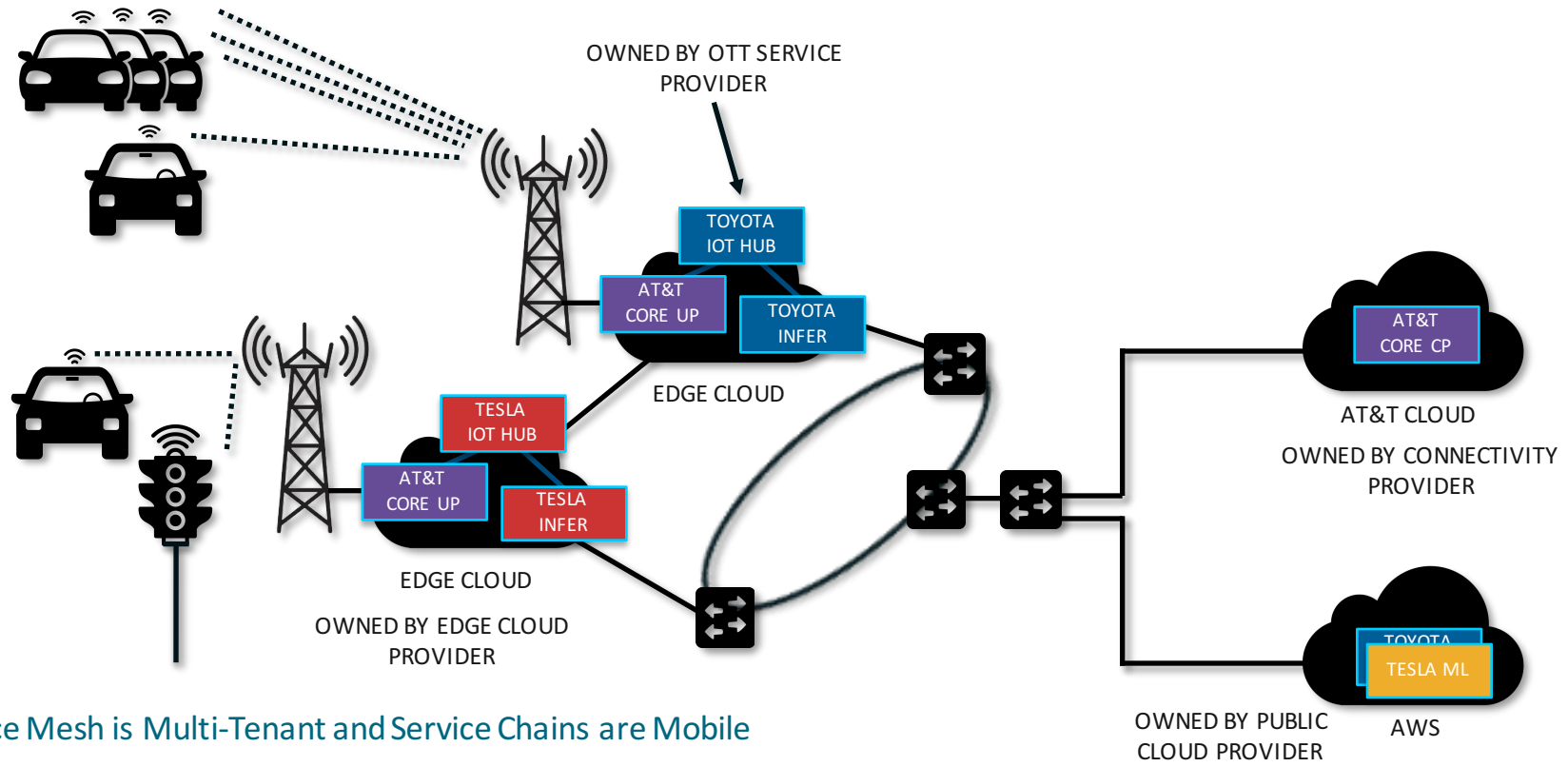
Edge Cloud Ecosystem



Multi-Tenant Edge

One Company (e.g. AT&T, AMAZON, CROWN CASTLE, GOOGLE) May Play Multiple Roles

Edge Cloud Ecosystem



Service Mesh is Multi-Tenant and Service Chains are Mobile

Factors

Performance dictates that functionality be implemented in the most appropriate hardware (e.g., GPUs, Switching Fabric).

Autonomy dictates that different stakeholders will be responsible for controlling and managing different components.

Monetization dictates the need to offer differentiated services to different classes of subscribers/applications.

Cost dictates a distributed solution, with some functions running in the datacenters and some running in a scalable number of edge sites.

Dynamicity dictates local (edge) control with tight control loops.

Requirements

Heterogeneous – Range of functional element implementations

Multi-Tenant – Multiple stakeholders managing functional elements

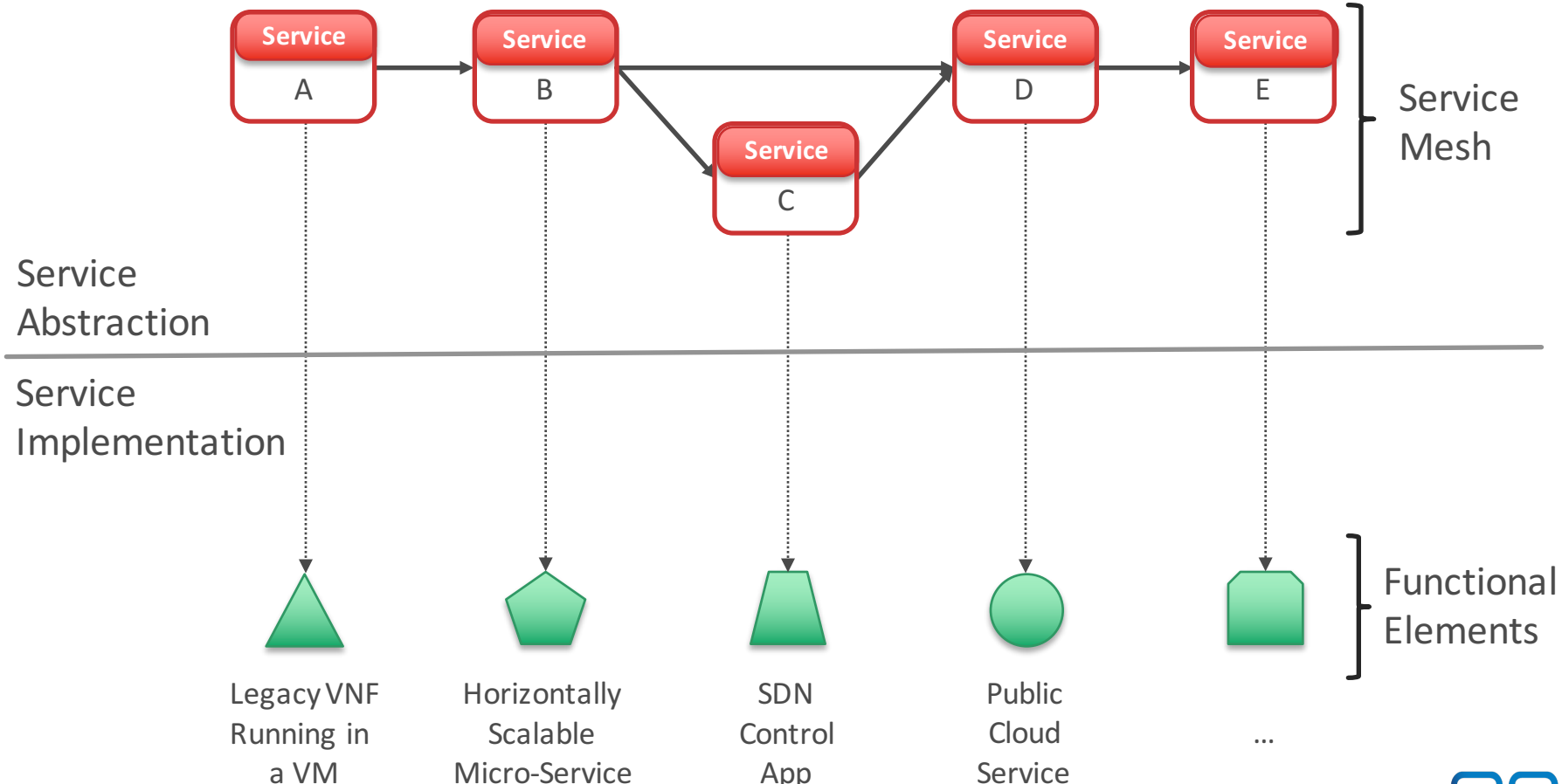
Isolation – Differentiated resource allocation between service chains

Dynamicity – Local control loops with minimal global dependencies

Distributed – Functional elements span multiple clouds

Mobility – Move service chains from one edge cloud to another

Service Mesh and Service Chains



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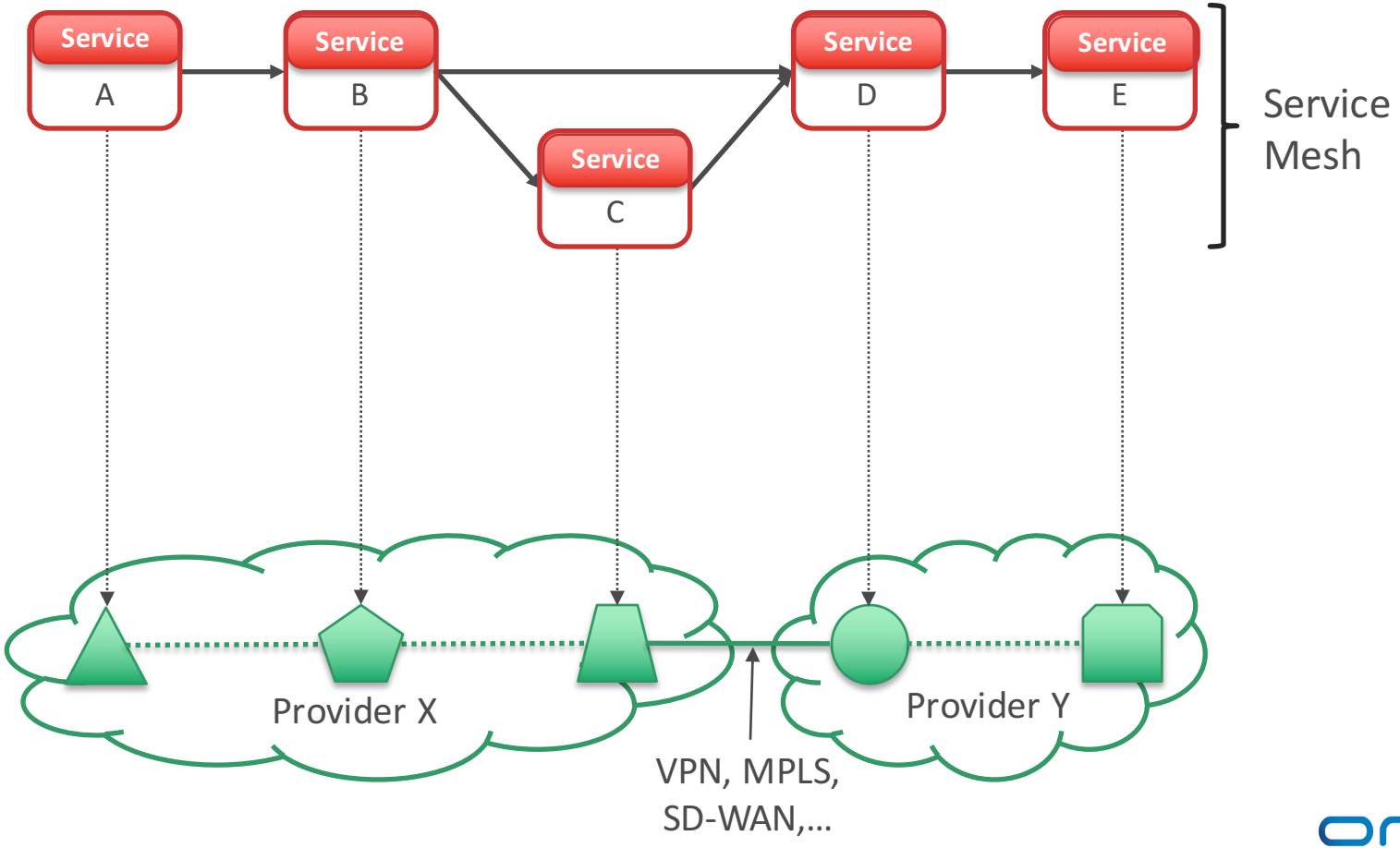

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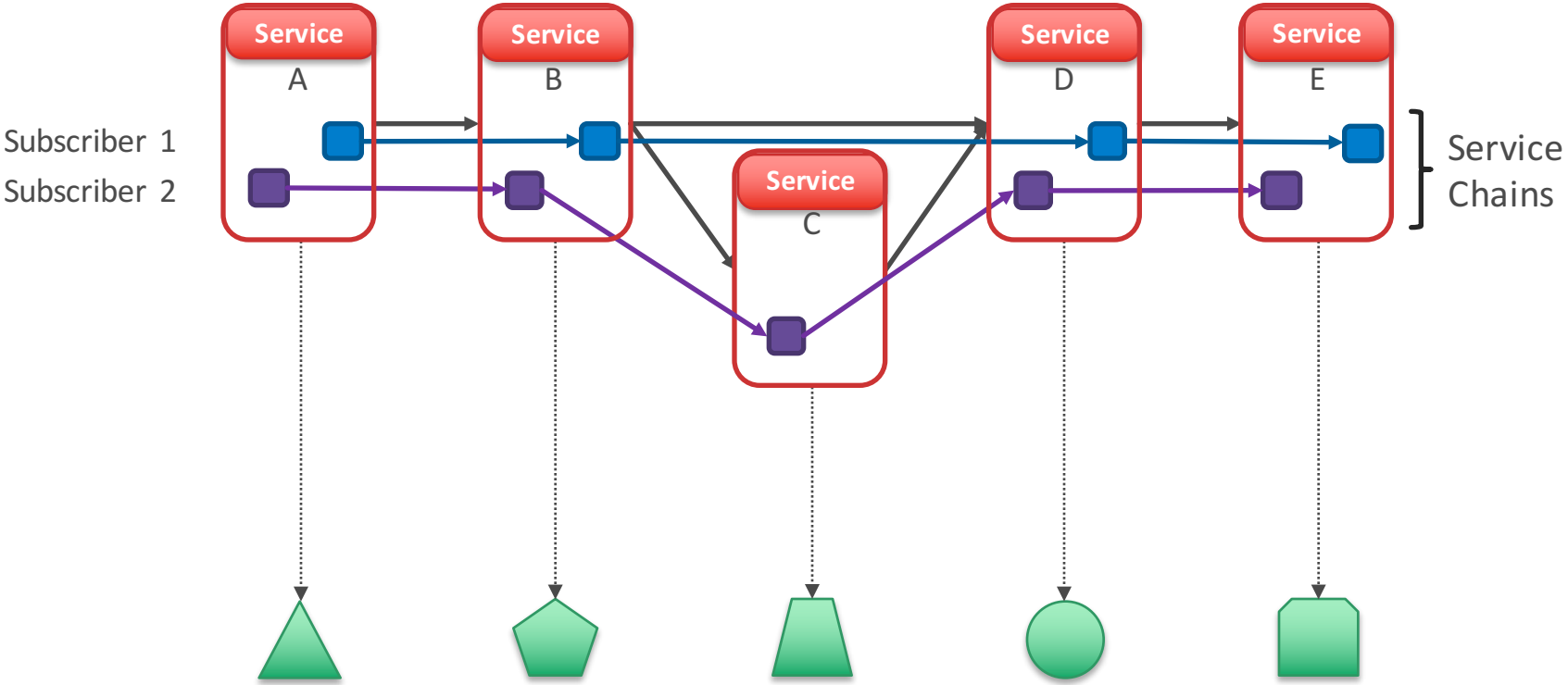
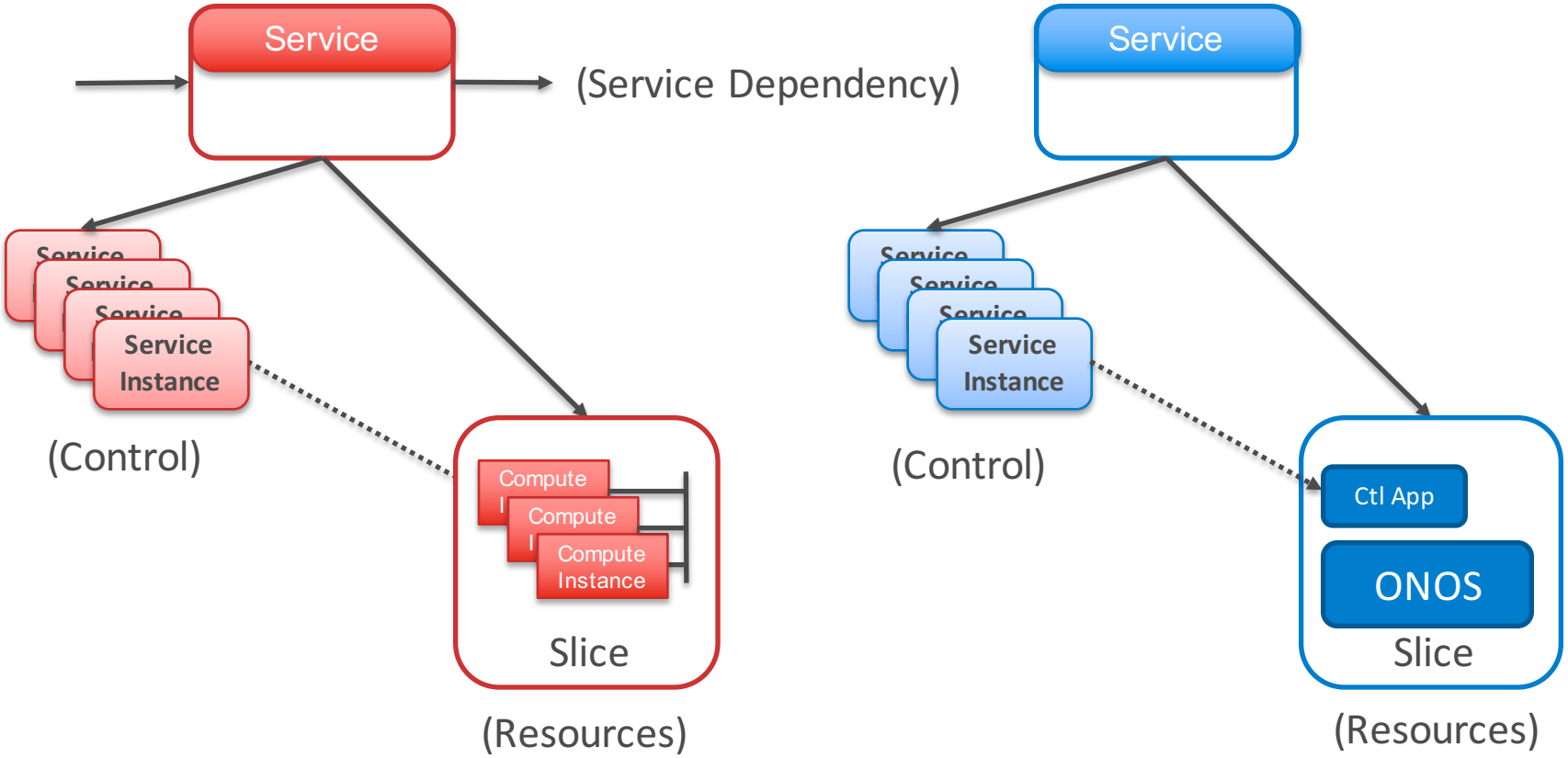


Base Service Model



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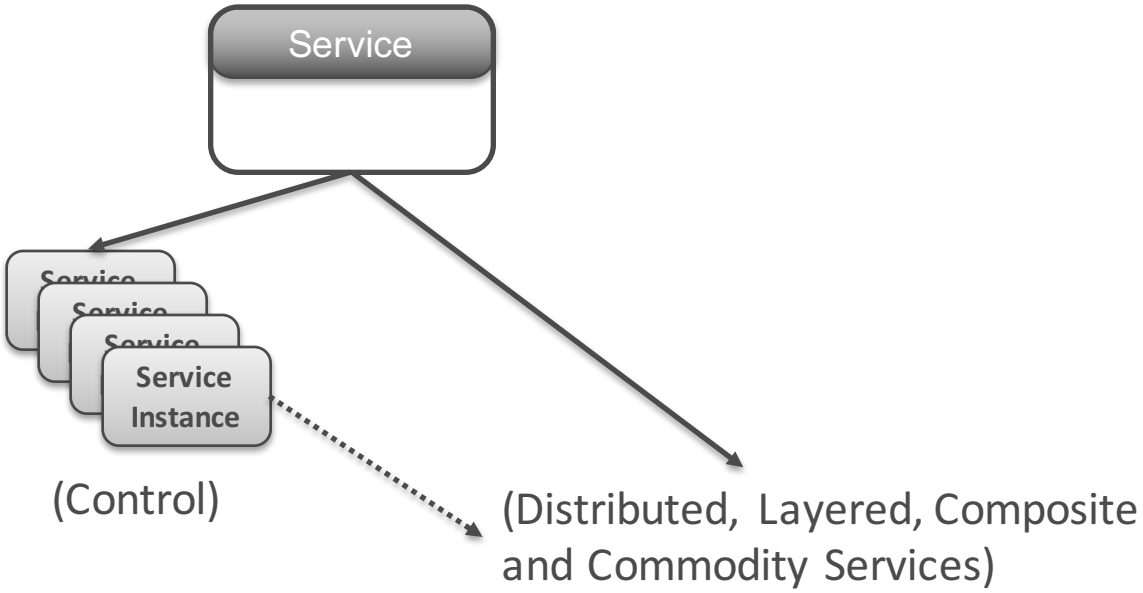

Requirements Revisited

Heterogeneous – Range of functional element implementations

- *Demonstrated in CORD (VMs, Containers, SDN Control Apps, Public SaaS)*

Multi-Tenant – Multiple stakeholders managing functional elements

- *Demonstrated in CORD (XOS defines policy language for access control)*

Isolation – Differentiated resource allocation between service chains

- *Demonstrated in M-CORD (network slicing) & R-CORD (subscriber provisioning)*

Requirements Revisited

Dynamicity – Local control loops with minimal global dependencies

- *Demonstrated in SEBA by Network Edge Mediator (NEM)*

Distributed – Functional elements span multiple clouds

- *Proof-of-Concept in progress (CORD as Edge / Google Cloud Platform)*

Mobility – Move service chains from one edge cloud to another

- *Paper Design (migrate control state, re-instantiate data plane)*