# Resilient Baseband Processing in vRAN with Slingshot

by

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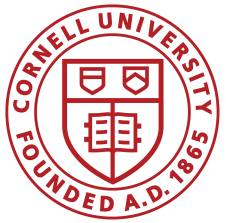
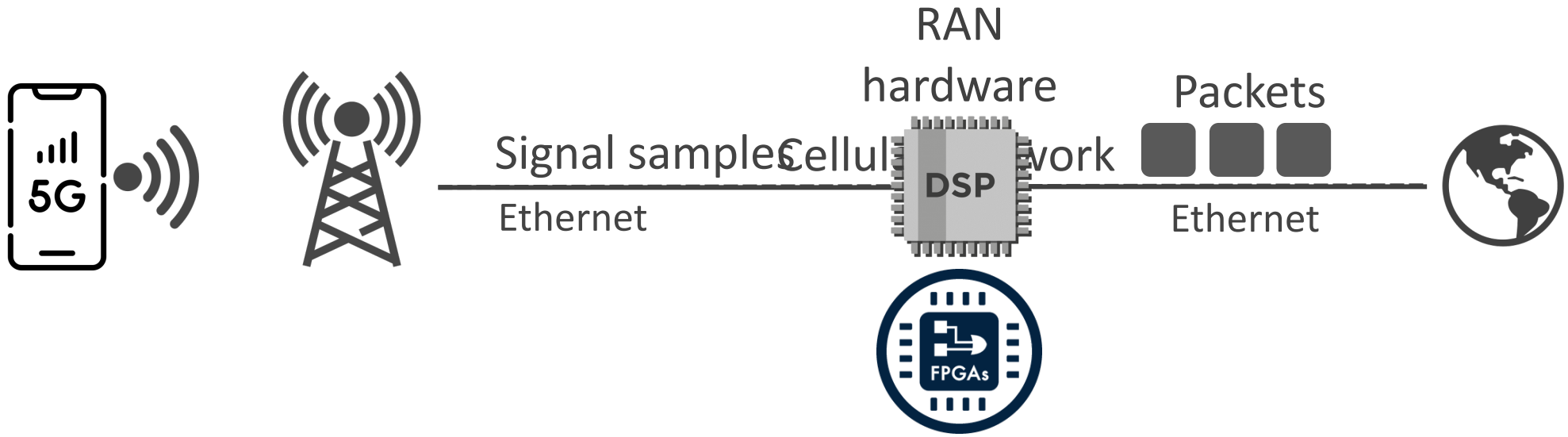
* Equal contribution





# Context: Softwarization (“Virtualization”) of the RAN



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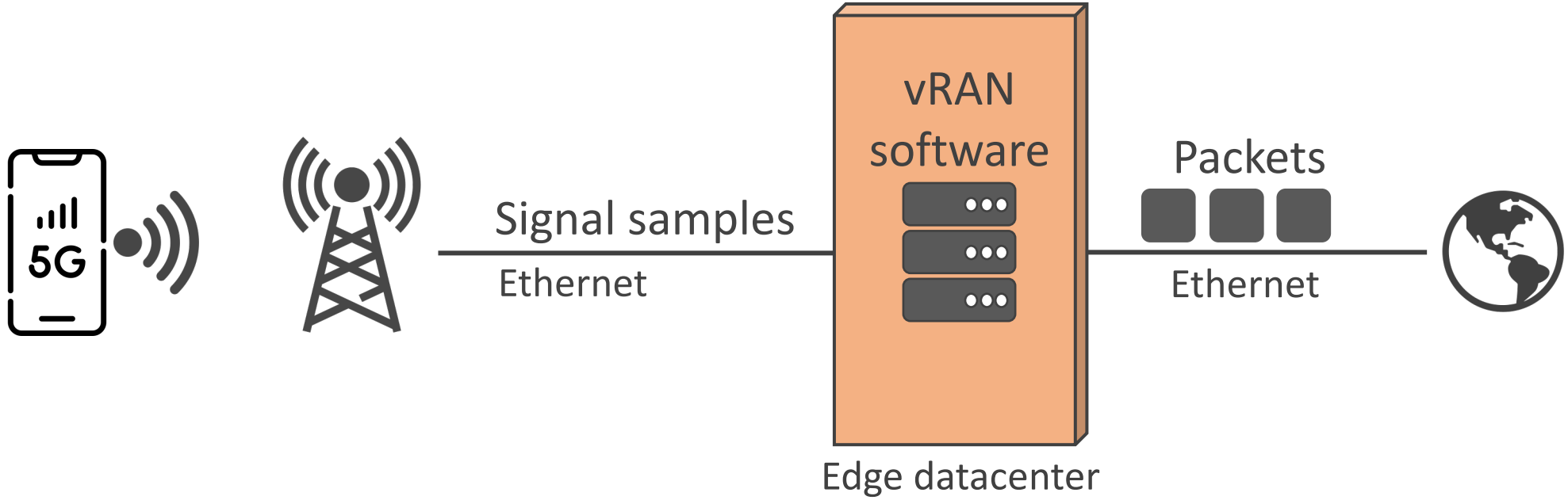
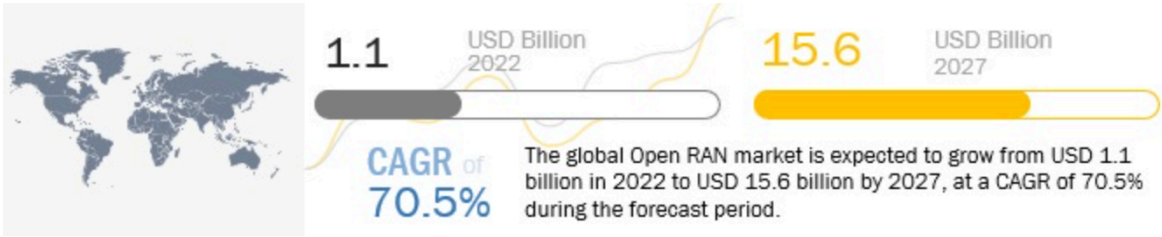


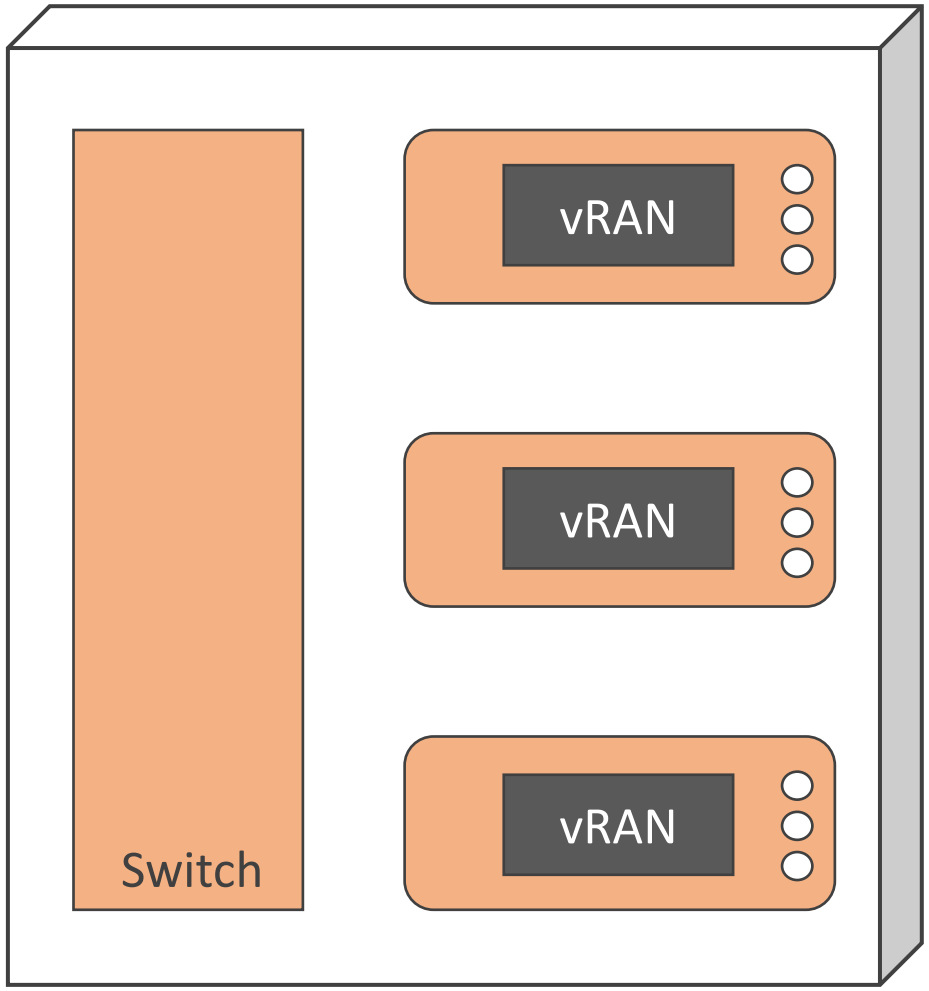

**vRAN offers:**

- reduced vendor lock-in
- rapid feature development & upgrades
- easier maintenance




30 000 units to be deployed by Rakuten

# Today’s vRANs Lack Resilience




Edge datacenter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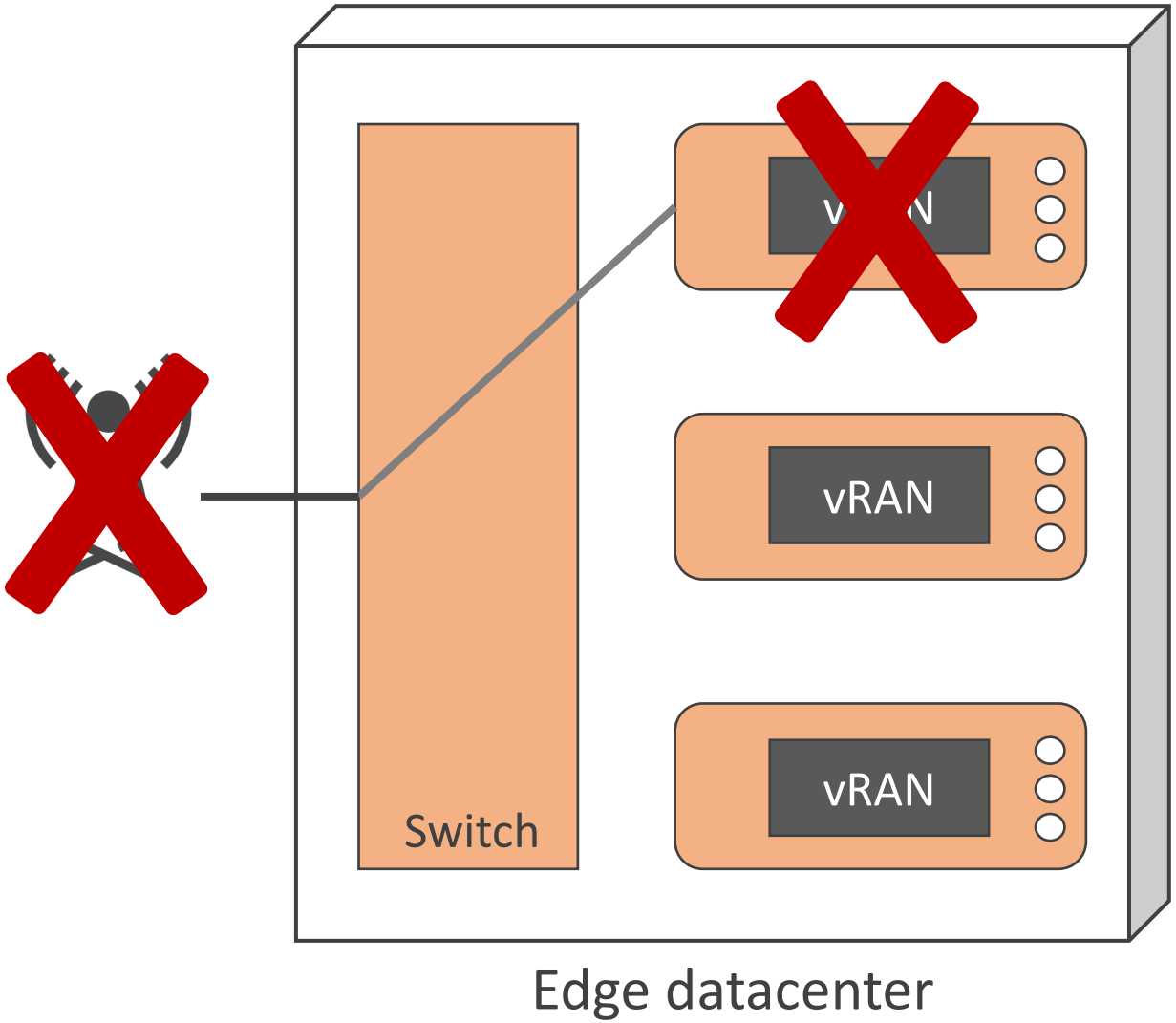


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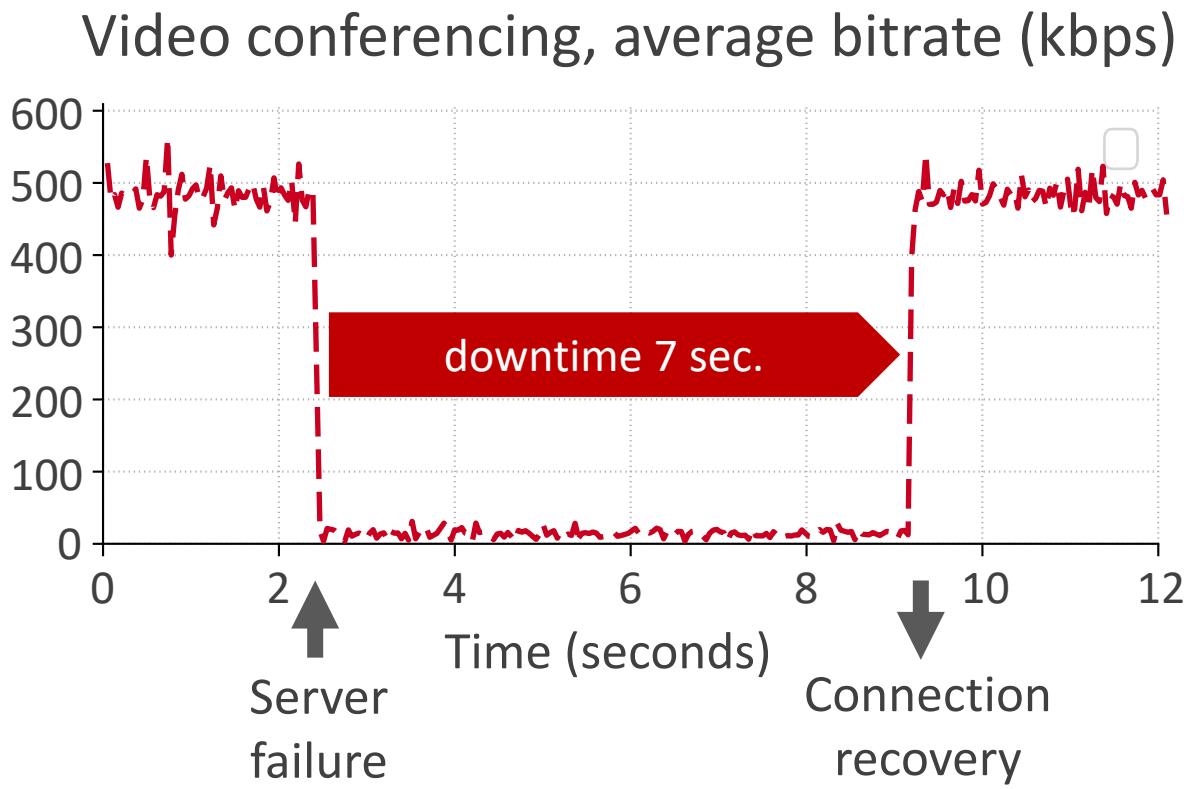

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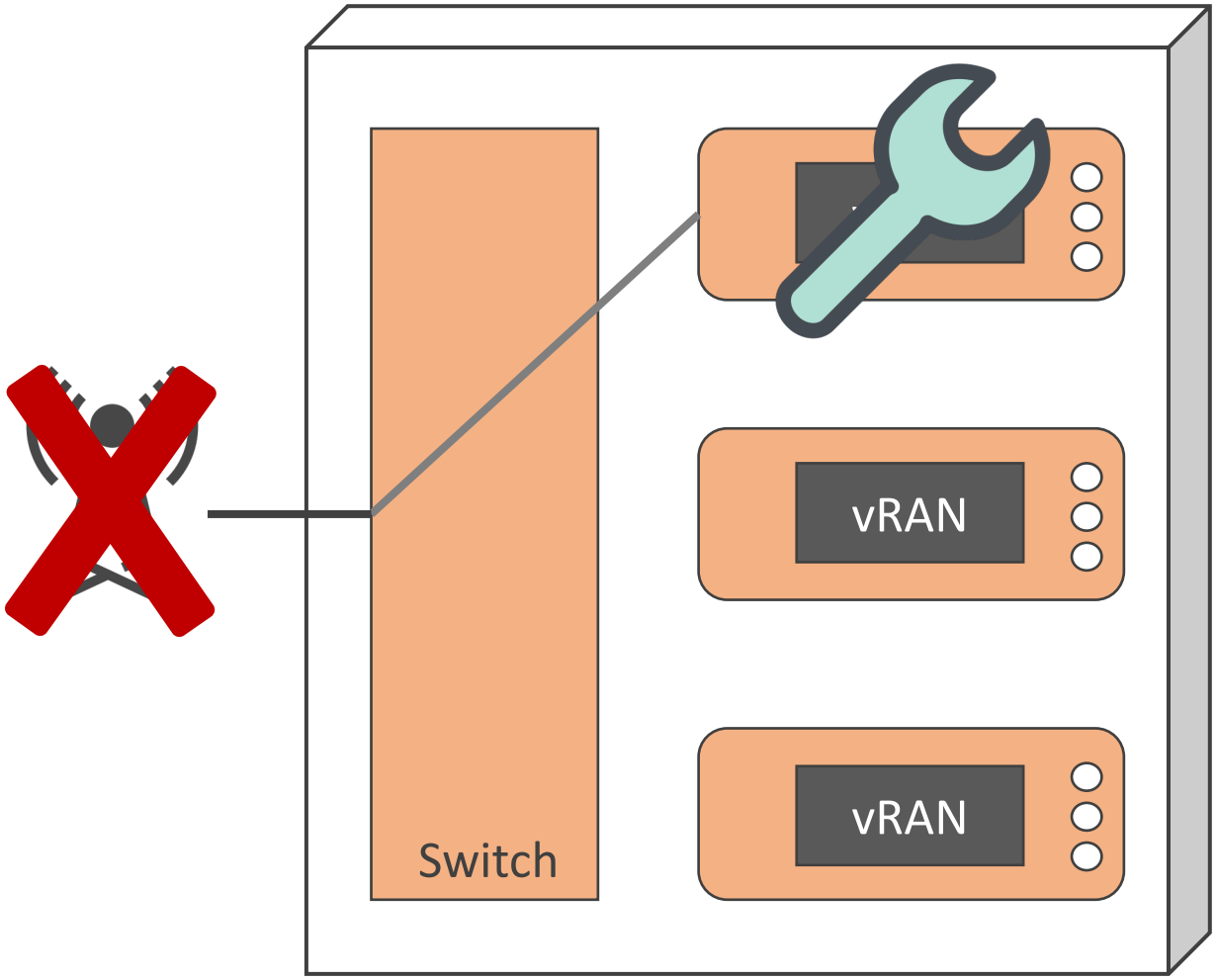


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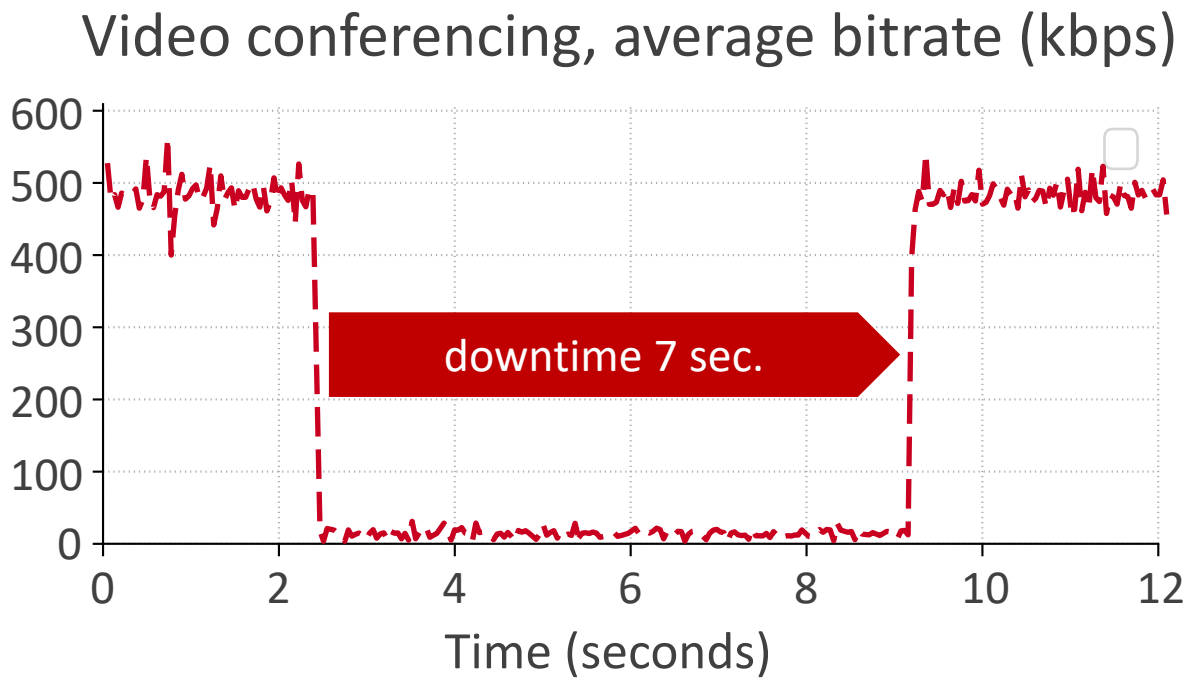
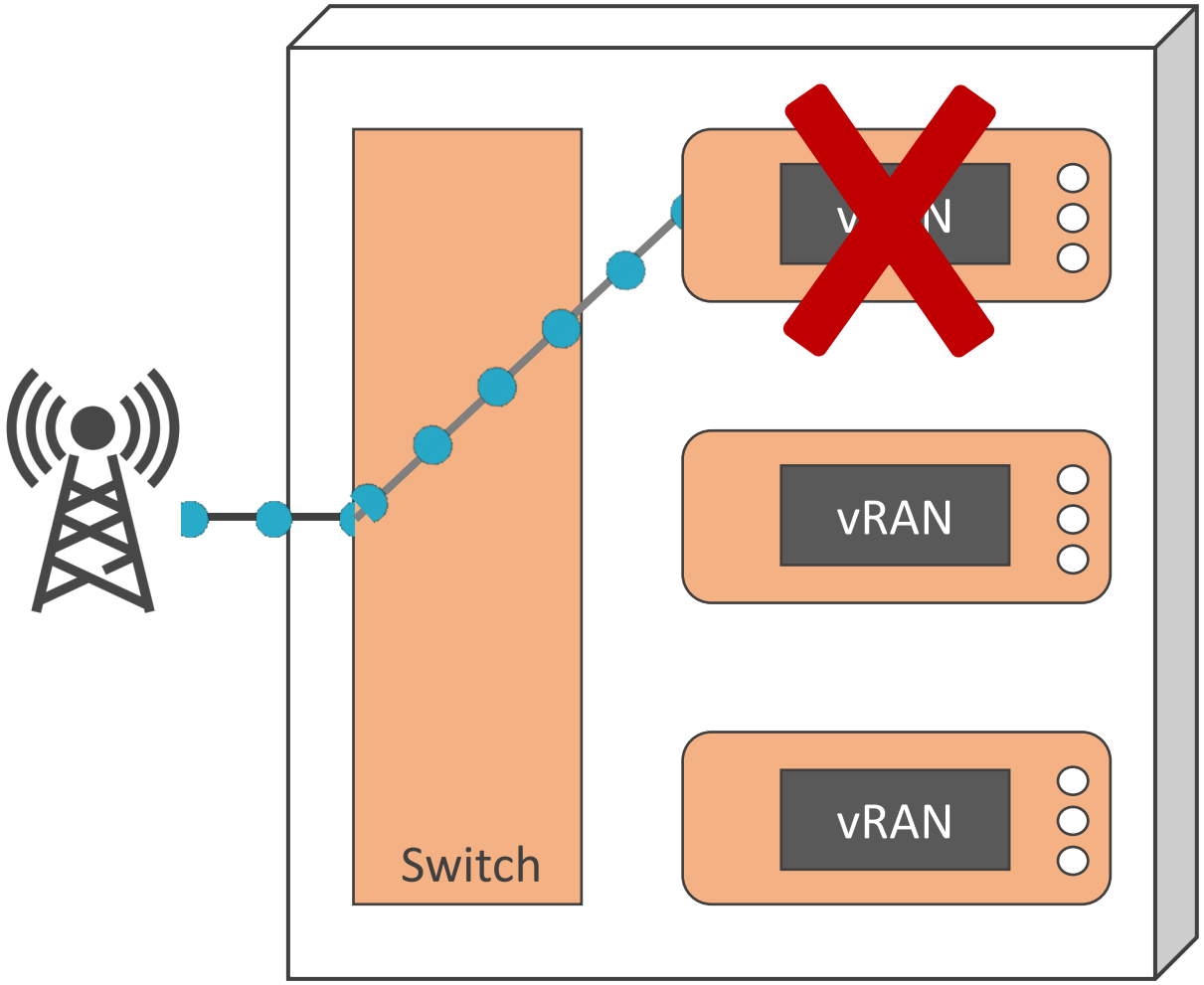


# Resilience with Slingshot: the Logical View

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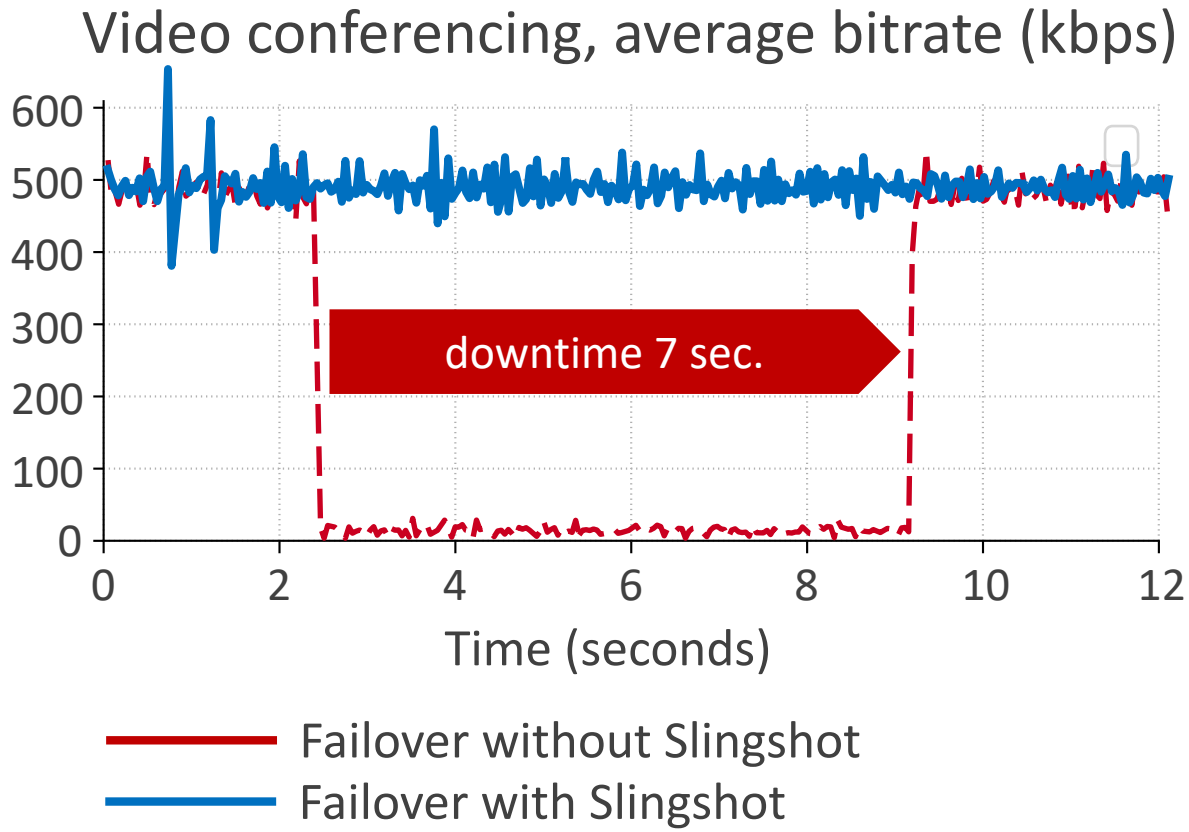
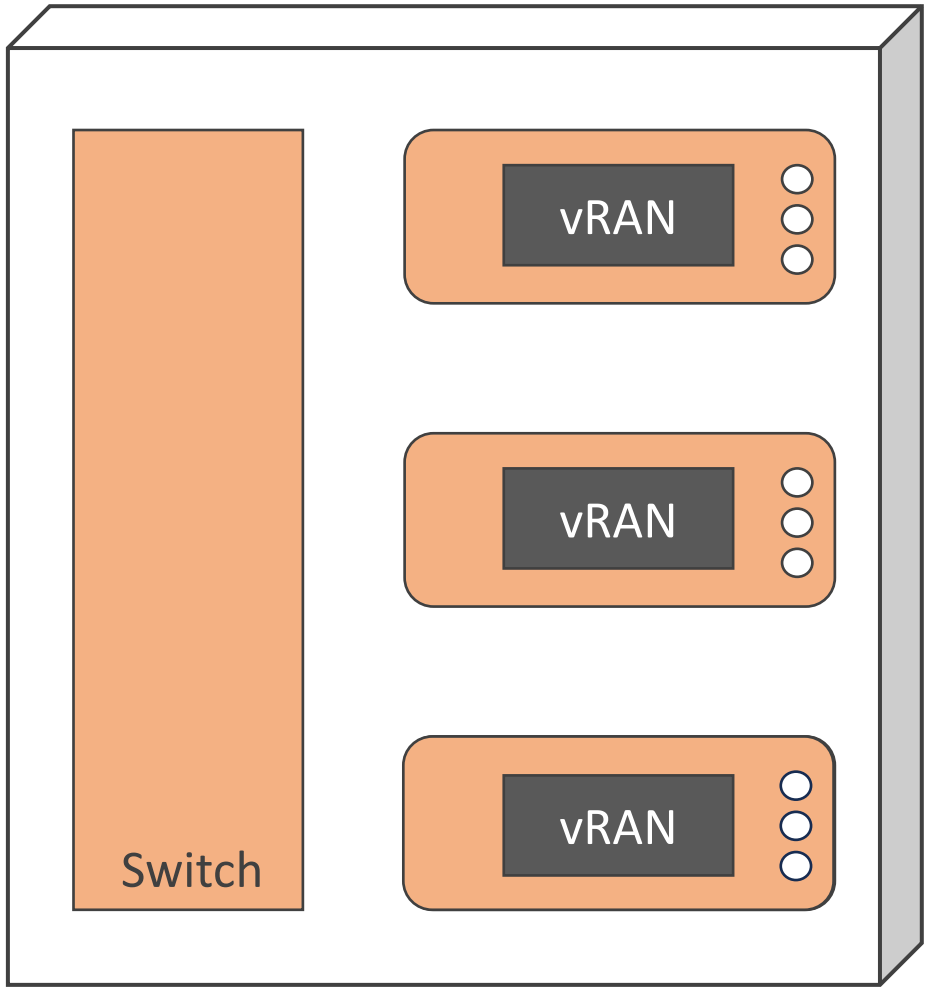


# Focus of This Work

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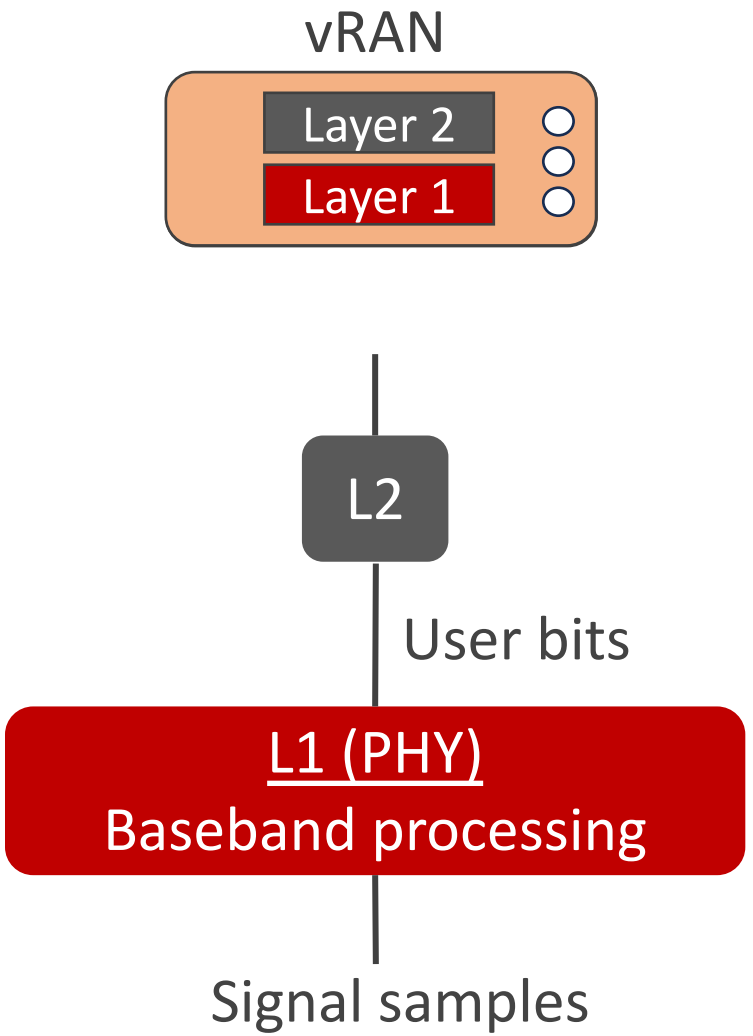



**Runs signal processing**:

- Fourier transform
- Error correction

# Existing Resilience Techniques Don't Work

**#1 Real-time requirements**

Hard sub-millisecond deadlines for signal processing tasks

✘ **VM live migration:**

takes at least 100 ms

**#2 Transparency and Interoperability**

Co-existence with standard vRAN infrastructure and protocols

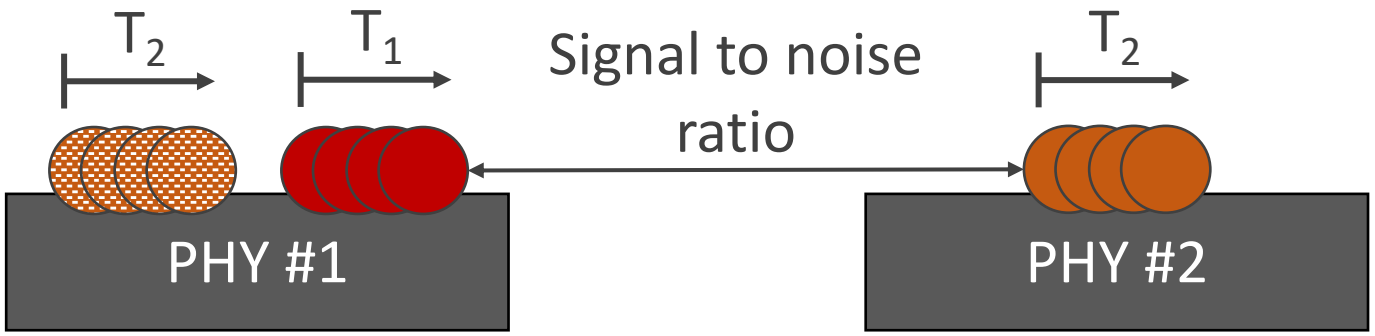
✘ **Reliable state store:**

too much state + transparency

# Challenge 1: Migration under Real Time Requirements

Insights:

(1) view baseband processing unit as a stateless functional executor




(2) treat little state inconsistency as regular wireless impairment

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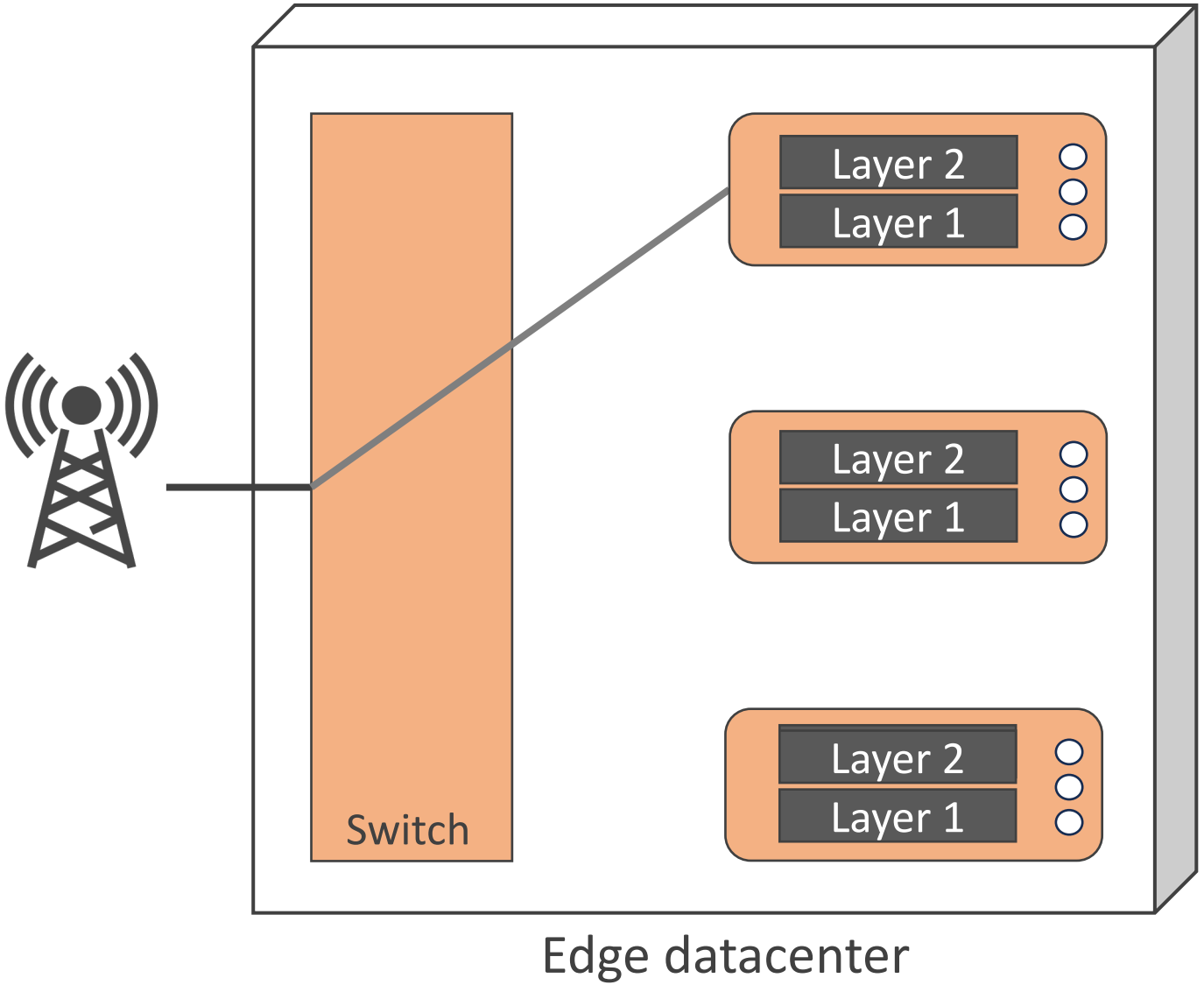
Performance impact of discarding PHY state ~ impact of normal wireless impairments

# Challenge 2: Transparency with New Middleboxes




**Issues**:

- fixed mapping of cell sites
- 1-on-1 mapping of layers

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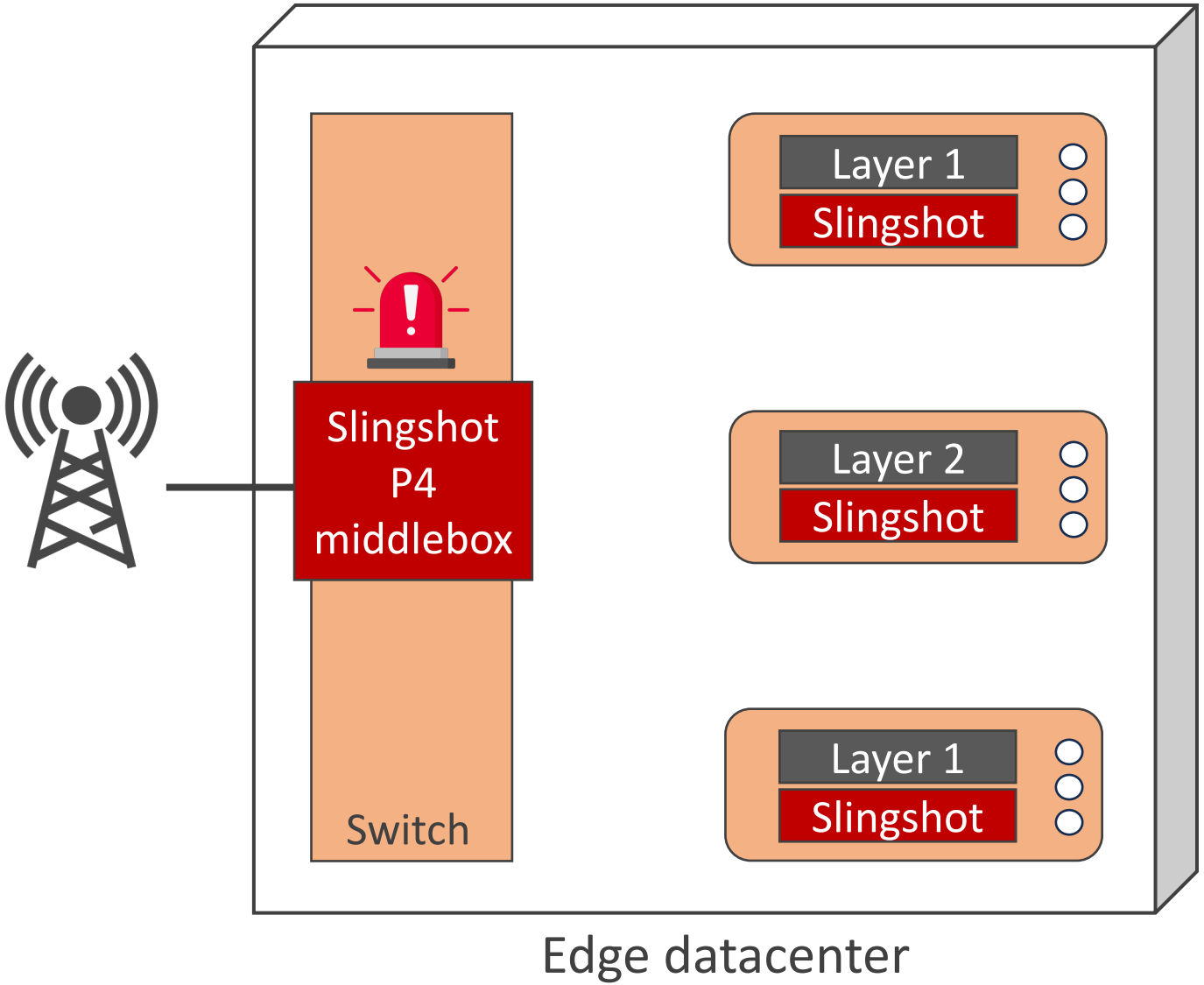


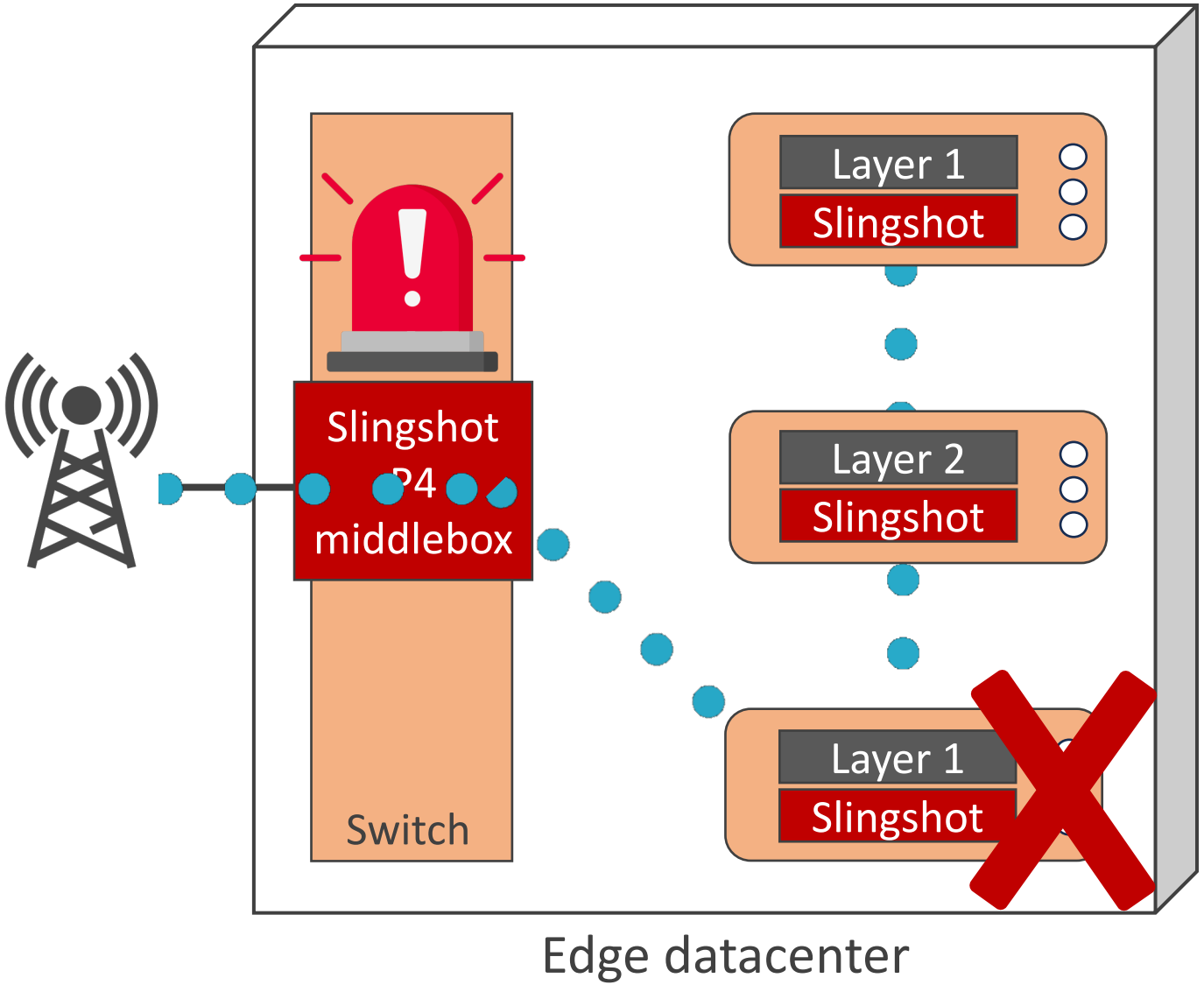

**Layer 1/Layer 2 middlebox:**

- disaggregate MAC and PHY
- reroute MAC-to-PHY messages

**Fronthaul middlebox:**

- reroute connections with cell sites
- runs PHY failure detection in dataplane

# Putting All Together

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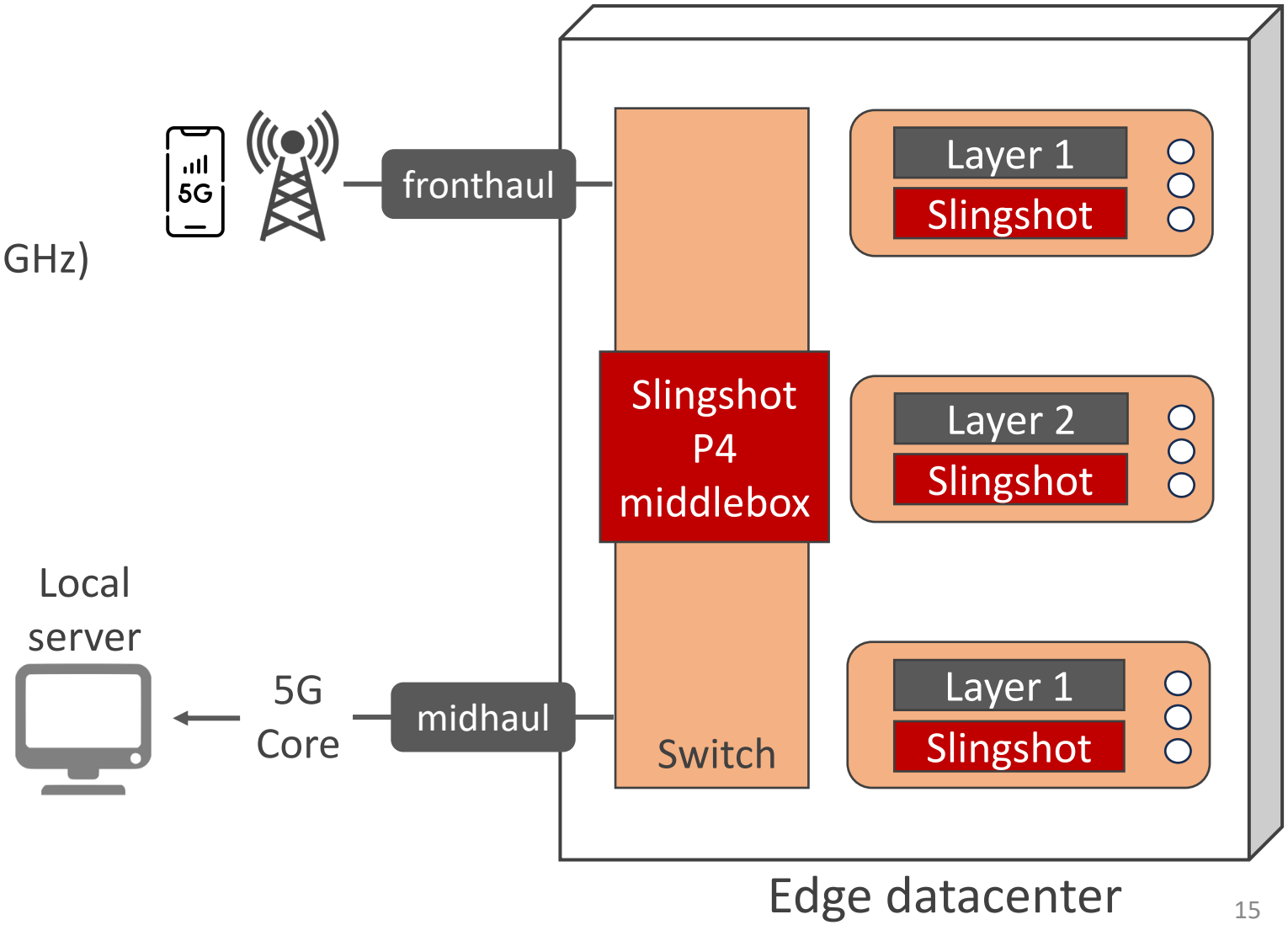
# System Deployment: Production-Grade 5G vRAN Testbed

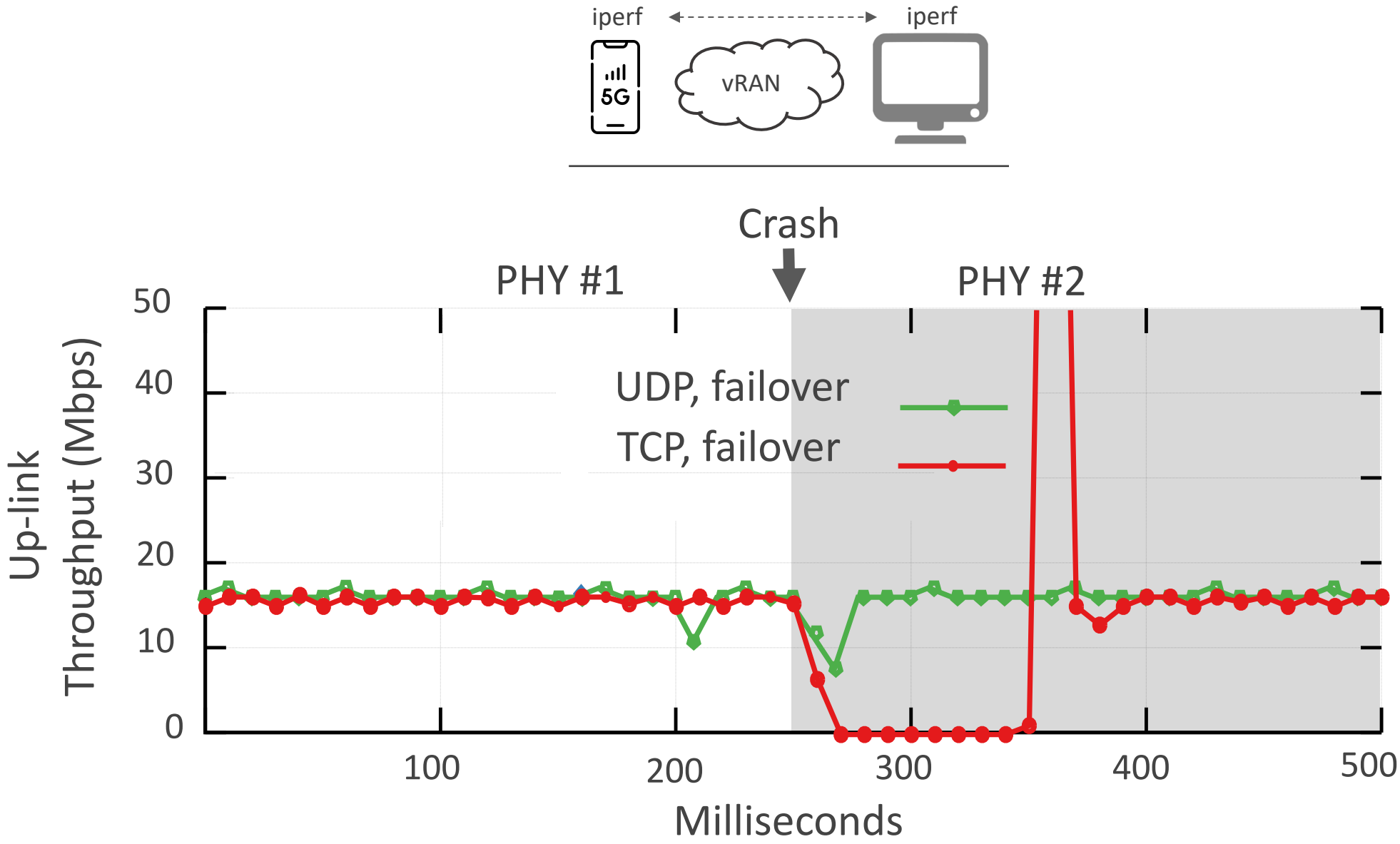
**Hardware:**
- x86 servers
- 100G NICs
- Tofino-based Arista P4 switch
- Foxconn 4x4; 100 MHz (3.3 – 3.4 GHz)

**Software:**
- Intel FlexRAN
- Capgemini Altran
- Metaswitch's Fusion Core

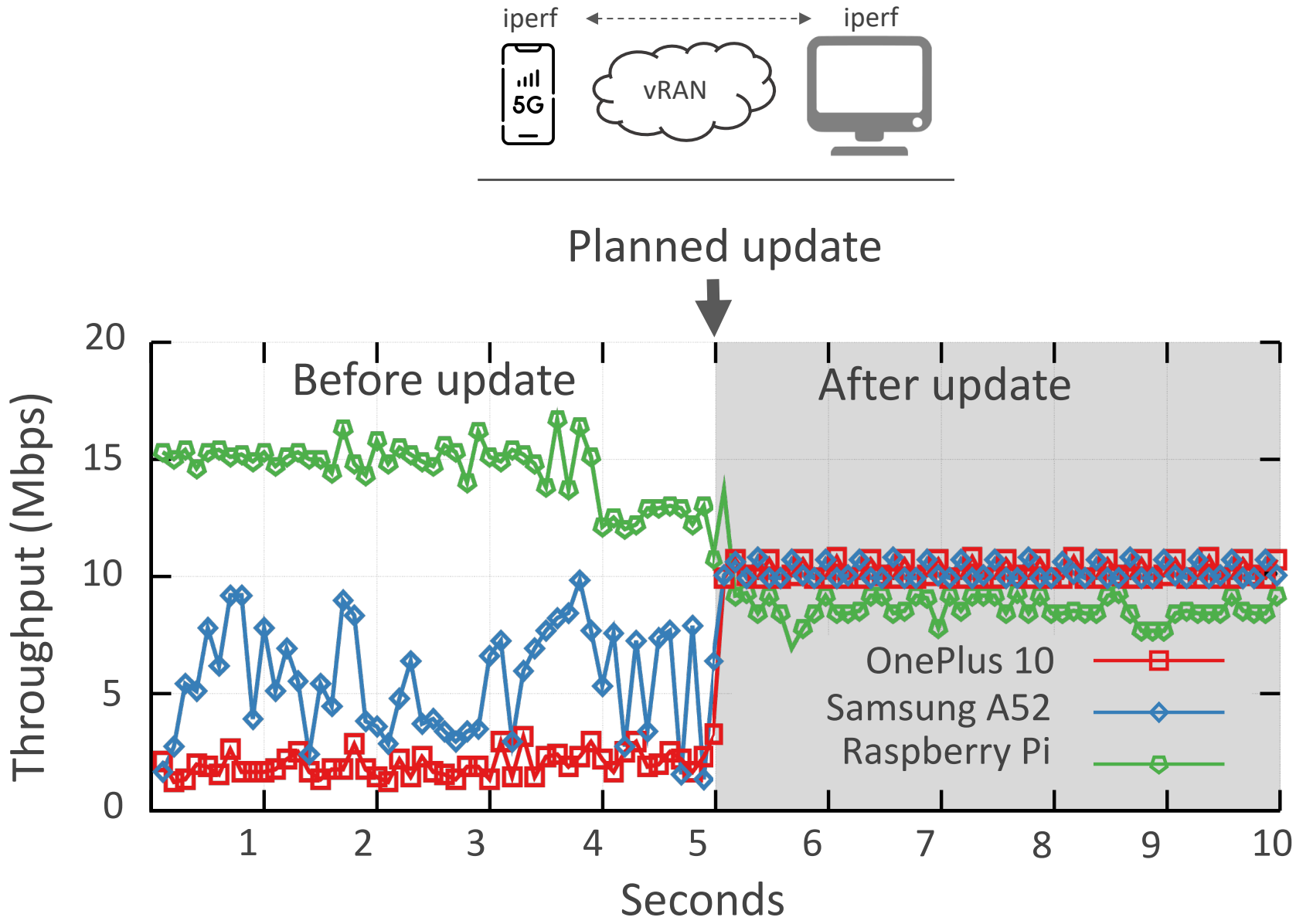
**User devices:**
- Samsung A52
- OnePlus 10
- Rasberry Pi



# Evaluation: PHY Failure Recovery in < 100 ms



# Evaluation: PHY Live Migration with Zero Downtime



# Conclusion

- vRAN is missing resilience – a must have feature of cloud applications.
- Slingshot is the first attempt to enable resilience in vRAN's baseband processing.
- Observation: PHY's state inconsistency ~ wireless impairment.
- Slingshot implements stateless failover to satisfy PHY's realtime requirements.
- Slingshot works transparently through the two new vRAN middleboxes.