Microsoft

Enabling Resilience in Virtualized RANs with Atlas

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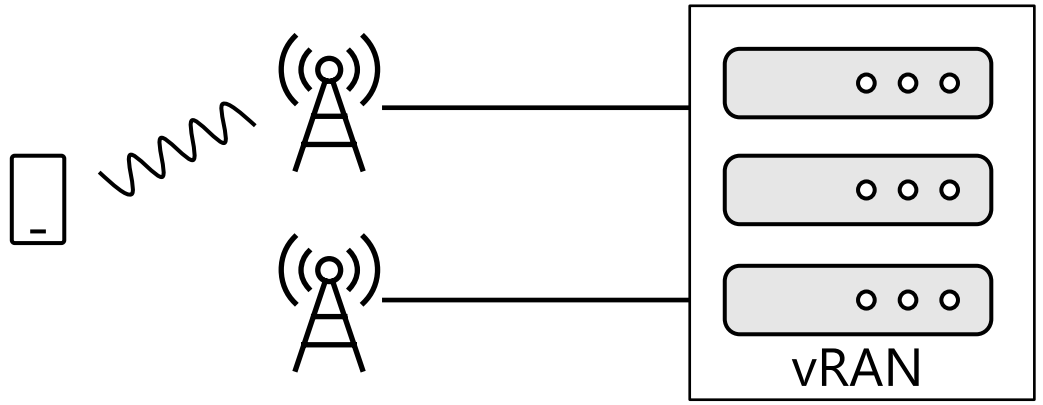
Context: Virtualization of Radio Access Networks (vRANs)



Virtualization = RAN as a normal software application instead of special box

Press Release

Rakuten Symphony Symware™ Phase Two Begins with Plans to Commercially Deploy 30,000 Units in Japan

September 27, 2022

Vodafone UK begins large-scale open RAN deployment

This marks the first phase of Vodafone's commitment to use open RAN in at least 2,500 sites by the end of 2027.

Monica Alleven • Aug 31, 2023 08:43am

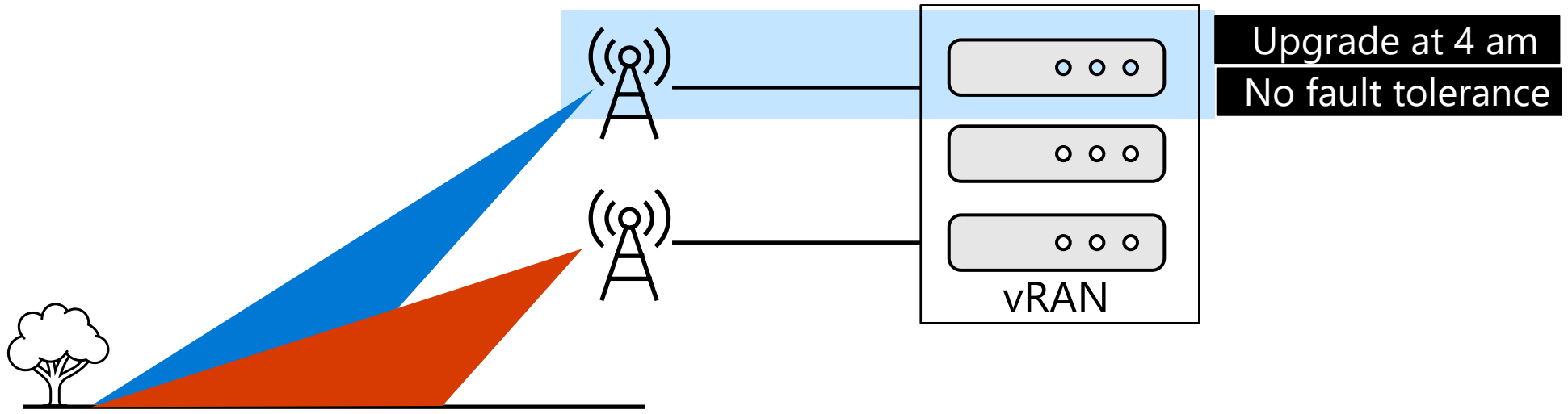
Verizon expands VRAN leadership position with addition of first Ericsson VRAN cell site

Verizon announced today it has extended its network virtualization efforts with the addition of the first Ericsson virtualized cell site (also referred to as Ericsson Cloud RAN), with support from Intel and RedHat providing the processing and cloud-native orchestration functions.

For **cloudification**, we need resilience in the vRAN to avoid downtime during

- Software updates for new RAN features
- Maintenance for hardware
- OS security patches
- Tolerance to hardware and software failures

Resilience in today's RANs is difficult and costly



Doesn't work in areas with sparse coverage, or if both cells map to same server

DU upgrades (once/week)*: maintenance window, plus antenna power/tilt adjustment

DU failures (once every few months): long downtime, reduced user performance

*Magus: Minimizing Cellular Service Disruption during Network Upgrades [CoNEXT 2015]

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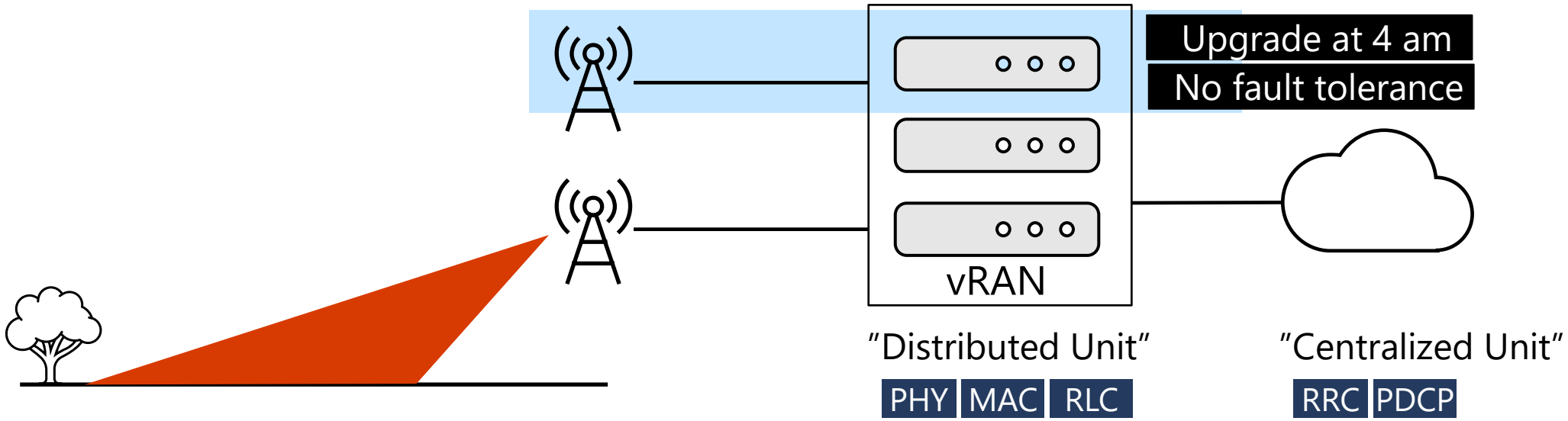


DU upgrades (once/week)*: maintenance window, plus antenna power/tilt adjustment

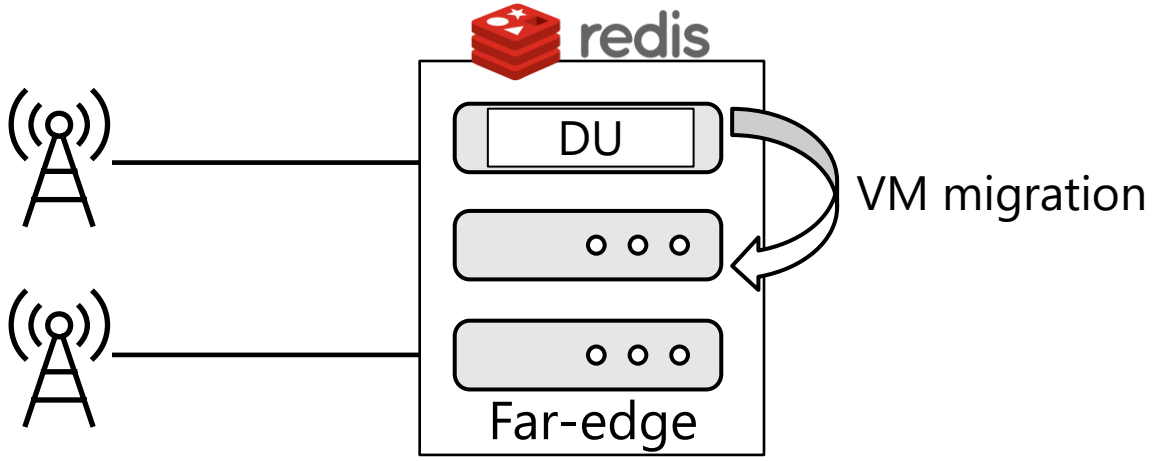
DU failures (once every few months): long downtime, reduced user performance

Atlas focuses on the Distributed Unit (DU)

- Geographically "distributed"
- Runs signal processing, MAC scheduling, …
- Strict real-time requirements (500 us)

*Magus: Minimizing Cellular Service Disruption during Network Upgrades [CoNEXT 2015]

DU's realtime, black-box nature precludes existing approaches



Why standard software resilience approaches do not work

VM migration for live upgrades ✗

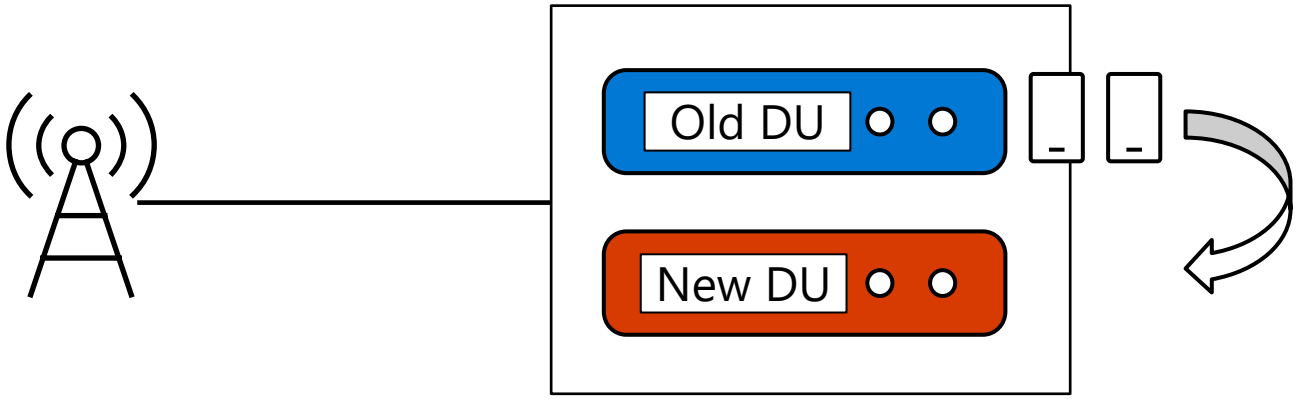
VM pause time (100 milliseconds) >>
DU task deadlines (sub-ms)

State replication for fault tolerance ✗

- Extremely complex + high overhead
- Not vendor-agnostic

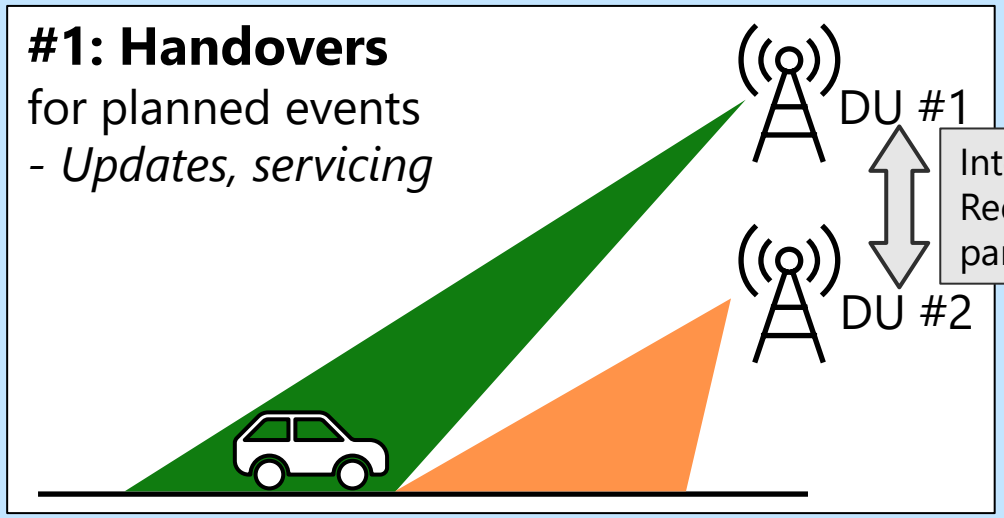
We need an cellular network--specific approach that exploits special properties of the DU

Can we use *wireless* resilience for *software* resilience?

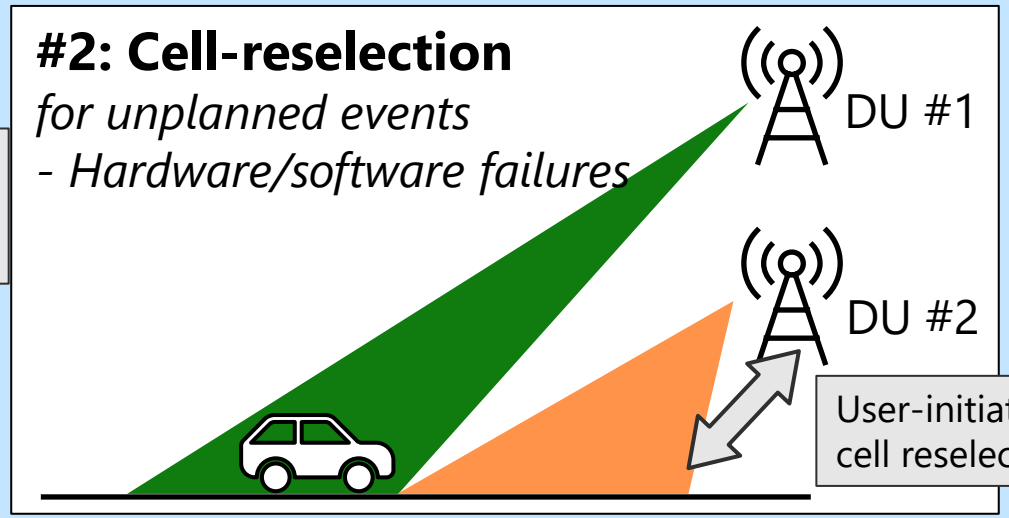


How can we migrate users during
1. Planned events (e.g., updates, servicing)
2. Unplanned events (e.g., failures)

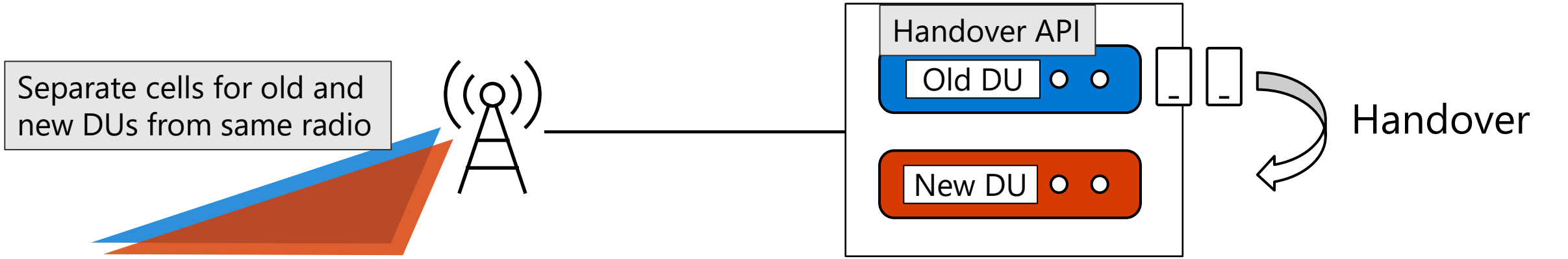
Two wireless analogues for planned & unplanned migration of UEs between DUs



Inter-DU handover. Requires both DUs' participation



#1: Atlas uses handovers for planned events (e.g., updates)



Challenge: We have only one radio. To do a handover, we need to simultaneously serve two (old and new DU) via the same radio => We need to split radio resources.

Wireless resources available for sharing

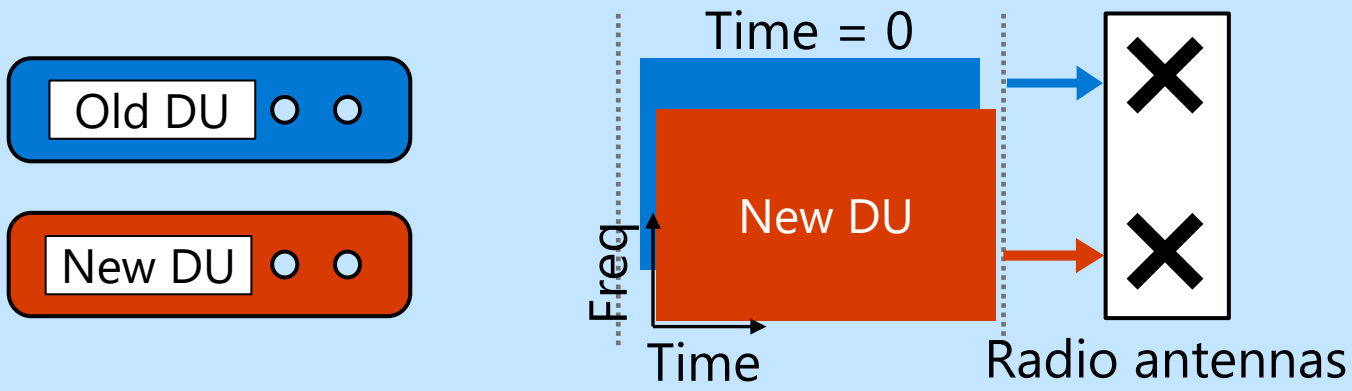
Frequency ✗
- Both old & new DU use full spectrum
- We could split with "Bandwidth Parts", but not all UEs support this

Time ✓
- We configure both DUs' MAC scheduler
- Old DU uses even slots, new DU uses odd

Sharing wireless resources between the old & new DUs

Problem: Time-domain multiplexing cannot handle some control signals (e.g., UL power control)

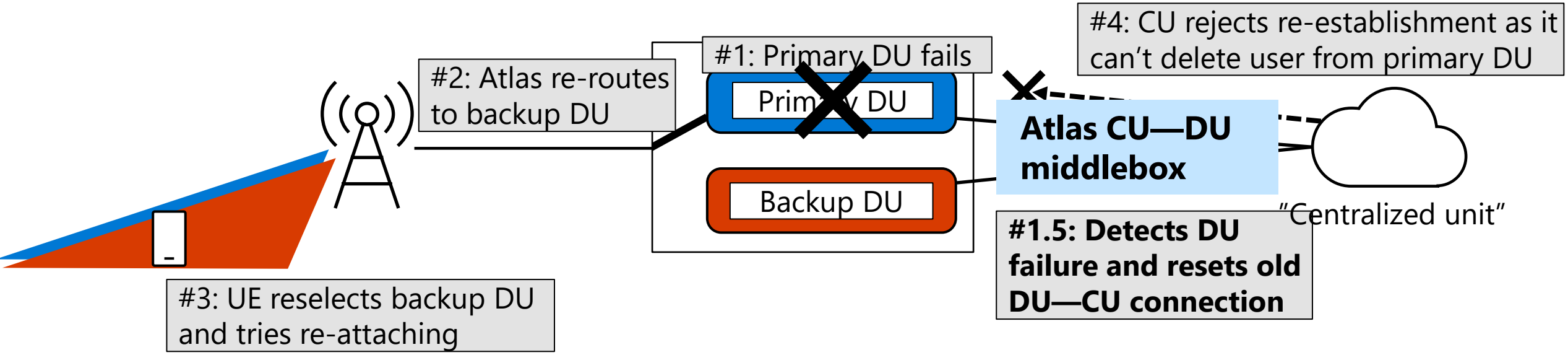
Spatial multiplexing over antennas for non time-multiplexable signals



Why it works despite interference

These signals are transmitted with a robust (QPSK modulation, high code rate) and conservative coding scheme

#2: Atlas uses cell-reselection for unplanned failures



Re-selection fails because today's 5G protocol specs for DU failures are incomplete

3GPP TS 38.473, Release 16, F1 Application Protocol (F1AP)

> In the event of a failure at the gNB-DU, which has resulted in the loss of some or all transaction reference information, a RESET message shall be sent to the gNB-CU.

Atlas implementation and evaluation testbed

Commercial-grade 5G vRAN testbed, with no software modifications

- vRAN software: Intel FlexRAN PHY; CapGemini DU, CU; Metaswitch 5G core
- 3x HPE DL110 “telco” servers
- 2x FoxConn 4x4 100 MHz RUs
- 5x 5G UEs (Raspberry Pi)

More testbed details in poster session

Accelerating Open RAN Research Through an Enterprise-scale 5G Testbed

Paramvir Bahl, Matthew Balkwill, Xenofon Foukas, Anuj Kalia, Daehyeok Kim, Manikanta Kotaru, Zhihua Lai, Sanjeev Mehrotra, Bozidar Radunovic, Stefan Saroiu, Connor Settle, Ankit Verma, Alec Wolman, Francis Y. Yan, Yongguang Zhang*

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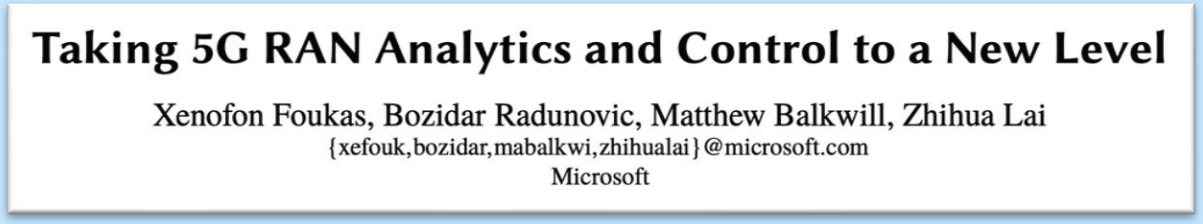
Realtime RAN control and telemetry via Janus [MobiCom 23]

- Even/odd slot MAC scheduling
- Routing packets to antennas for spatial multiplexing
- Handover scheduling



Taking 5G RAN Analytics and Control to a New Level

Xenofon Foukas, Bozidar Radunovic, Matthew Balkwill, Zhihua Lai

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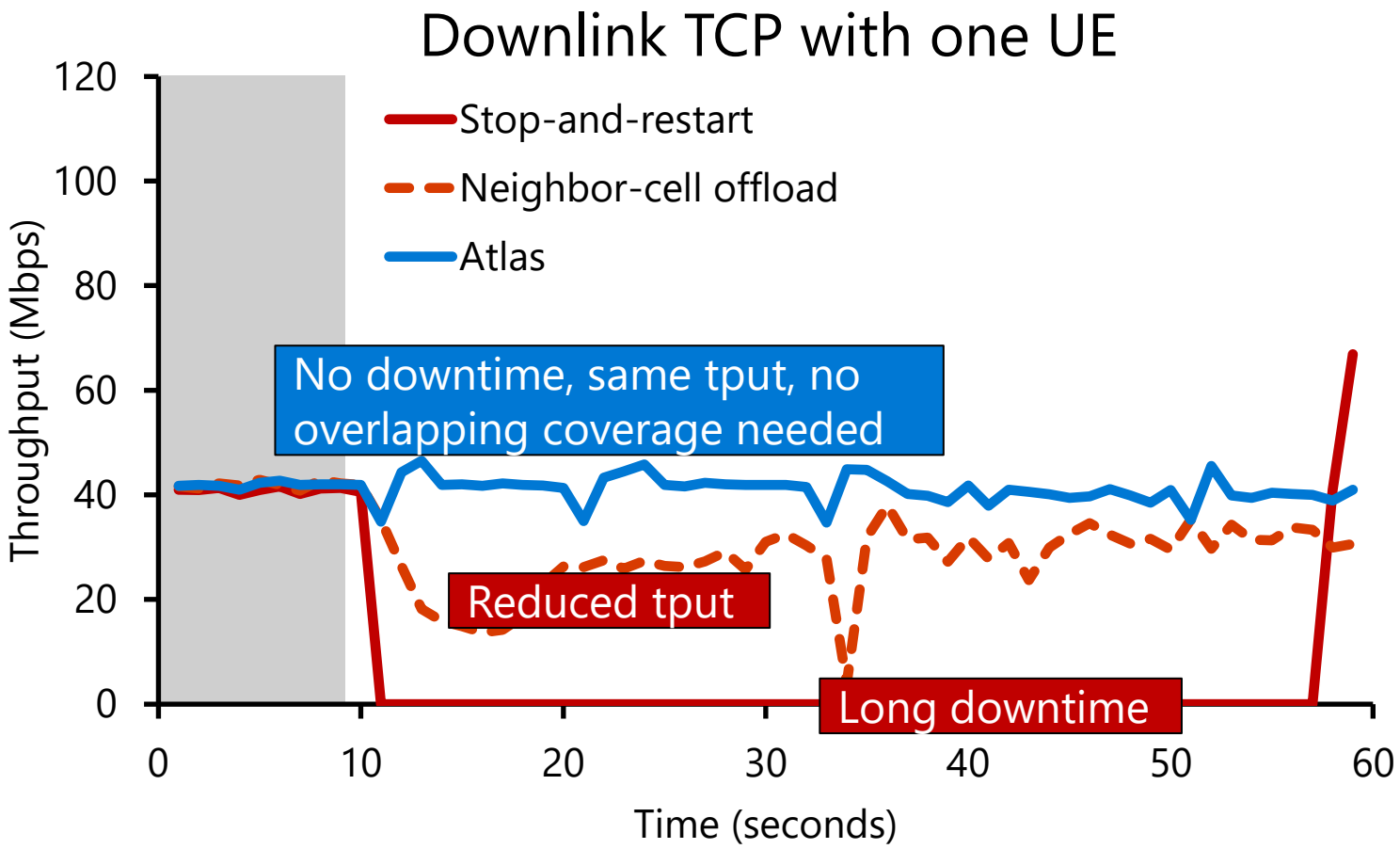
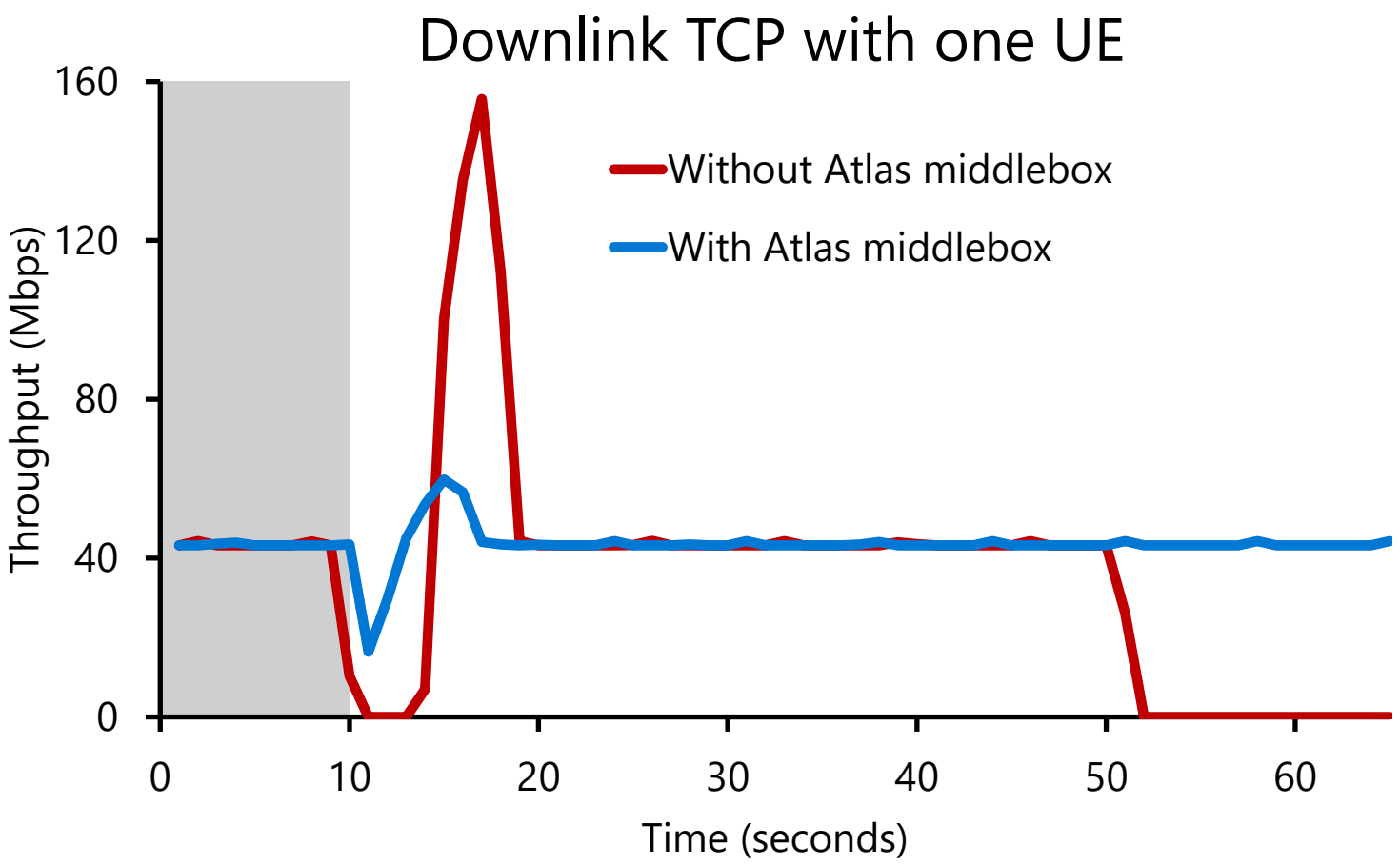
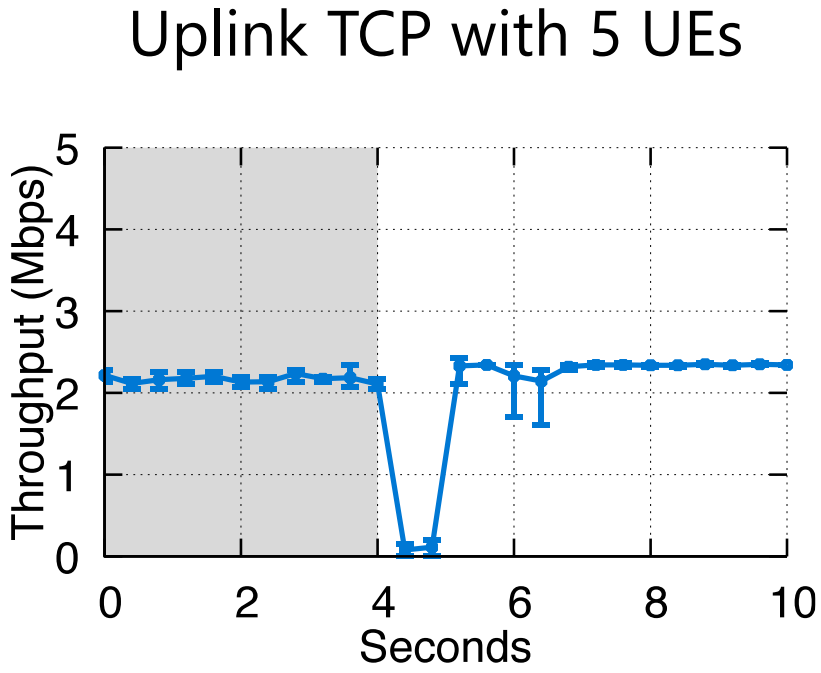
Atlas provides zero downtime for planned migration



Atlas provides ~1 sec downtime during failovers





Conclusion

Atlas uses existing cellular resilience for to build a resilient vRAN service

- Handovers for live upgrades, enabled by time + spatial multiplexing
- Cell re-selection for failovers, enabled by a CU—DU middlebox to work around 3GPP limitations

Works without RAN software or hardware modifications

Thank you!