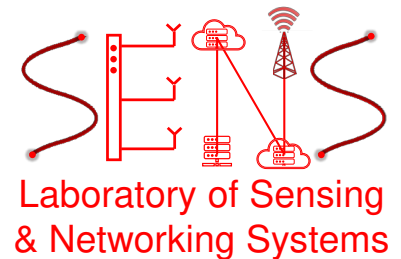


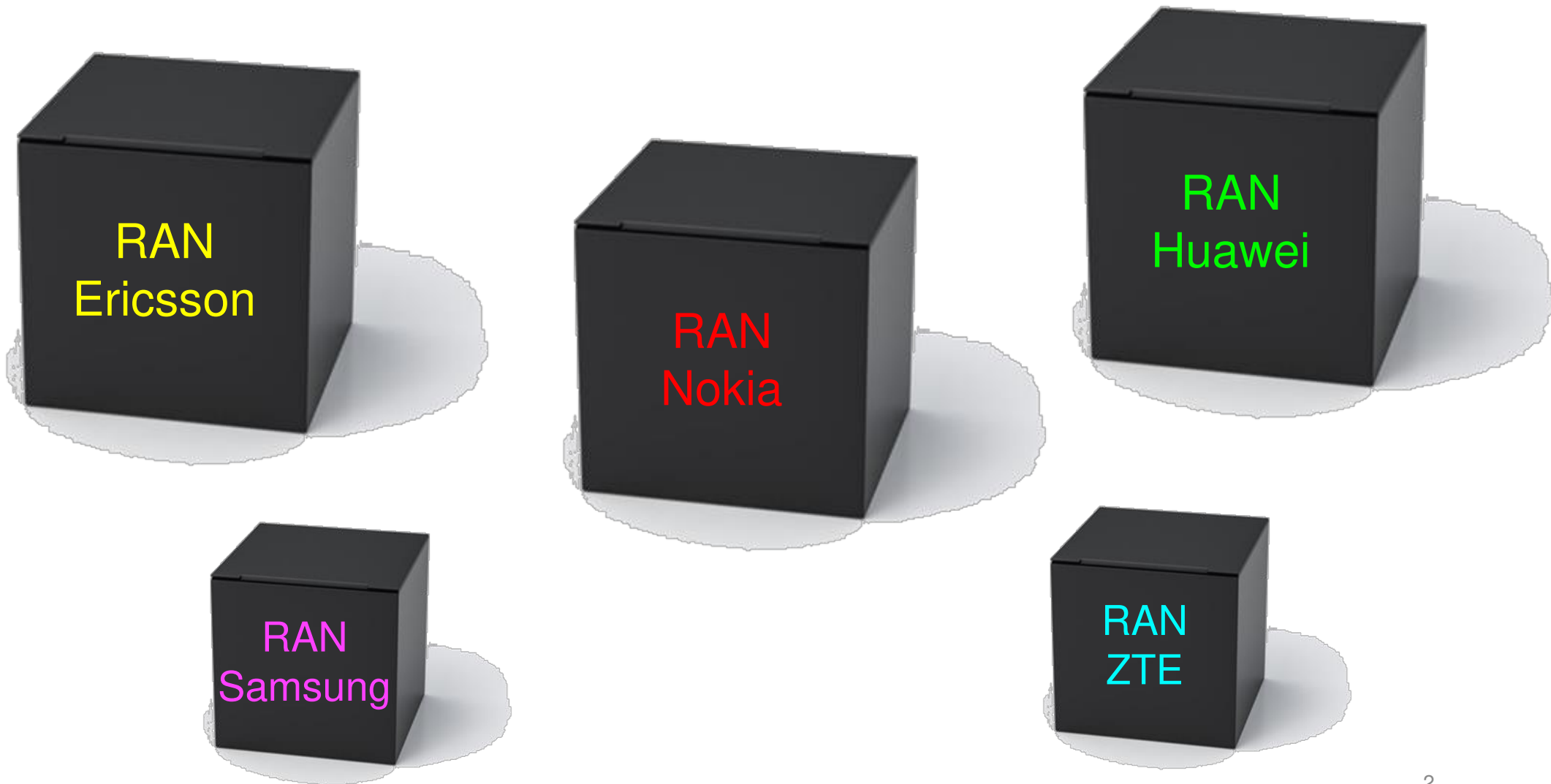
Towards Seamless 5G Open-RAN Integration with WebAssembly

Raphael Cannatà, Haoxin Sun, Dan Mihai Dumitriu,
Haitham Hassanieh

EPFL



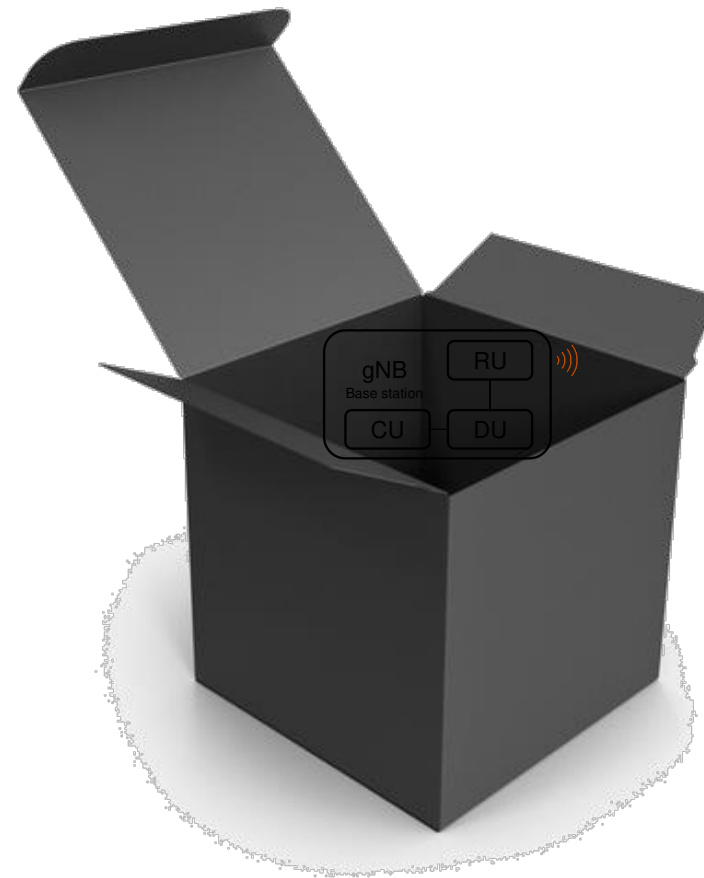
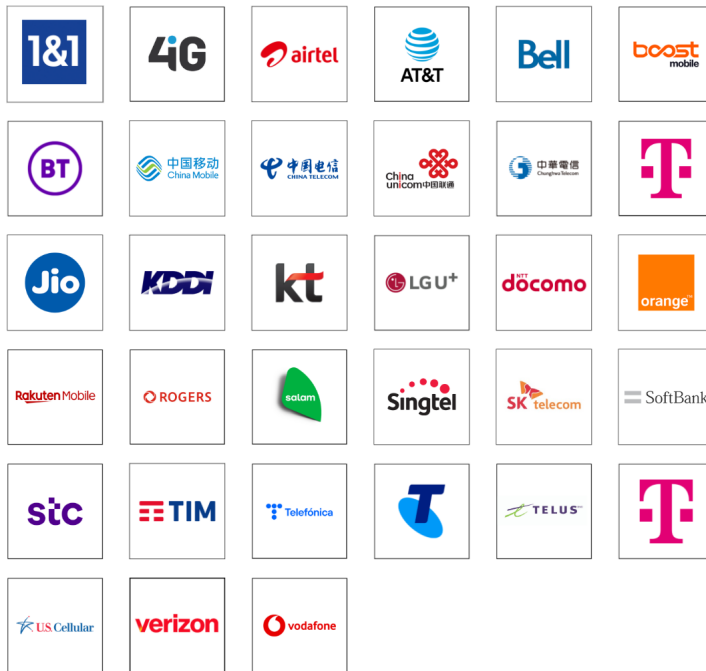
RAN: Radio Access Network



O-RAN: Open Radio Access Network



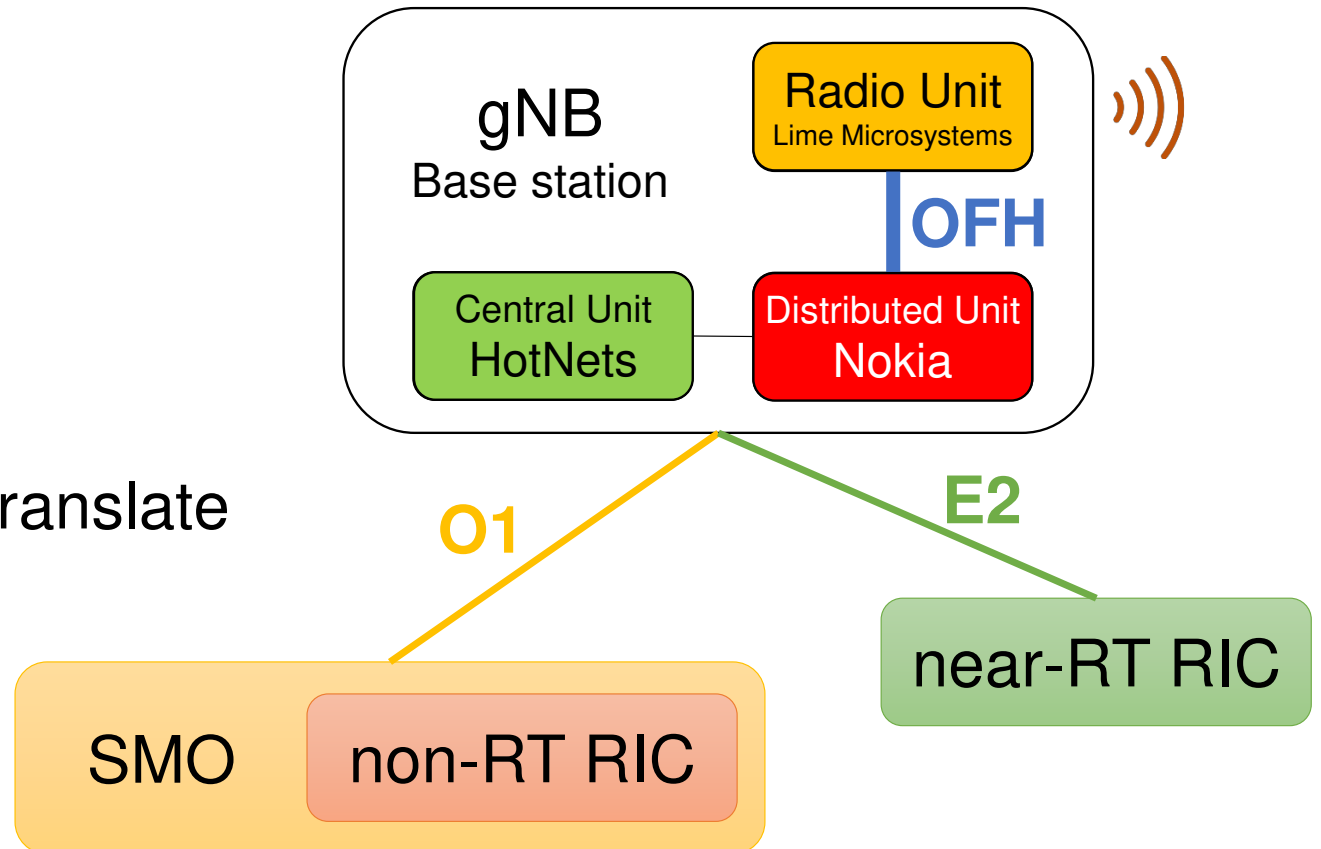
Operator Members



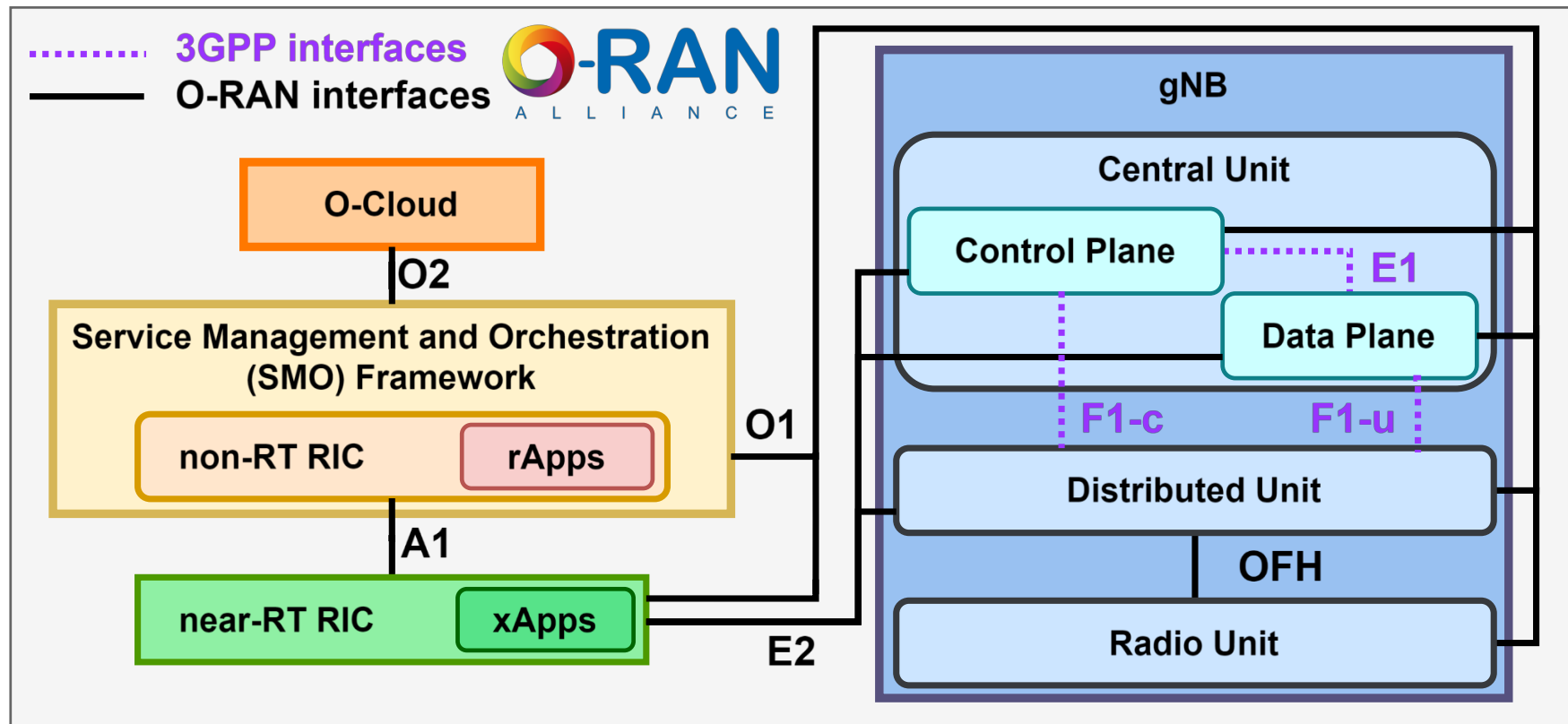
O-RAN: Open Radio Access Network



- More Competition
- More Innovation
- More Opportunities to translate research into practice



O-RAN: Open Radio Access Network



Different Vendors



Different interpretations
of the standards



Extensions to support
more features



Interoperability Issues

Huge integration burden on operators to deploy multi-vendor O-RAN

Single-vendor O-RAN



Single-vendor open RAN is spreading like a virus

⚡ LightReading

Boasting open RAN moves, some of the world's biggest operators have continued to buy the key products from a single vendor – and that's a problem for the concept.

Let's stop pretending open RAN is in good health

⚡ LightReading

Six years since the founding of the O-RAN Alliance, the original concept has barely made an impression on the global market.

Huge integration burden on operators to deploy multi-vendor O-RAN

Single-vendor O-RAN



US



Switzerland



Italy



UK



Single-vendor open RAN is spreading like a virus

 LightReading

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Let's stop pretending open RAN is in good health

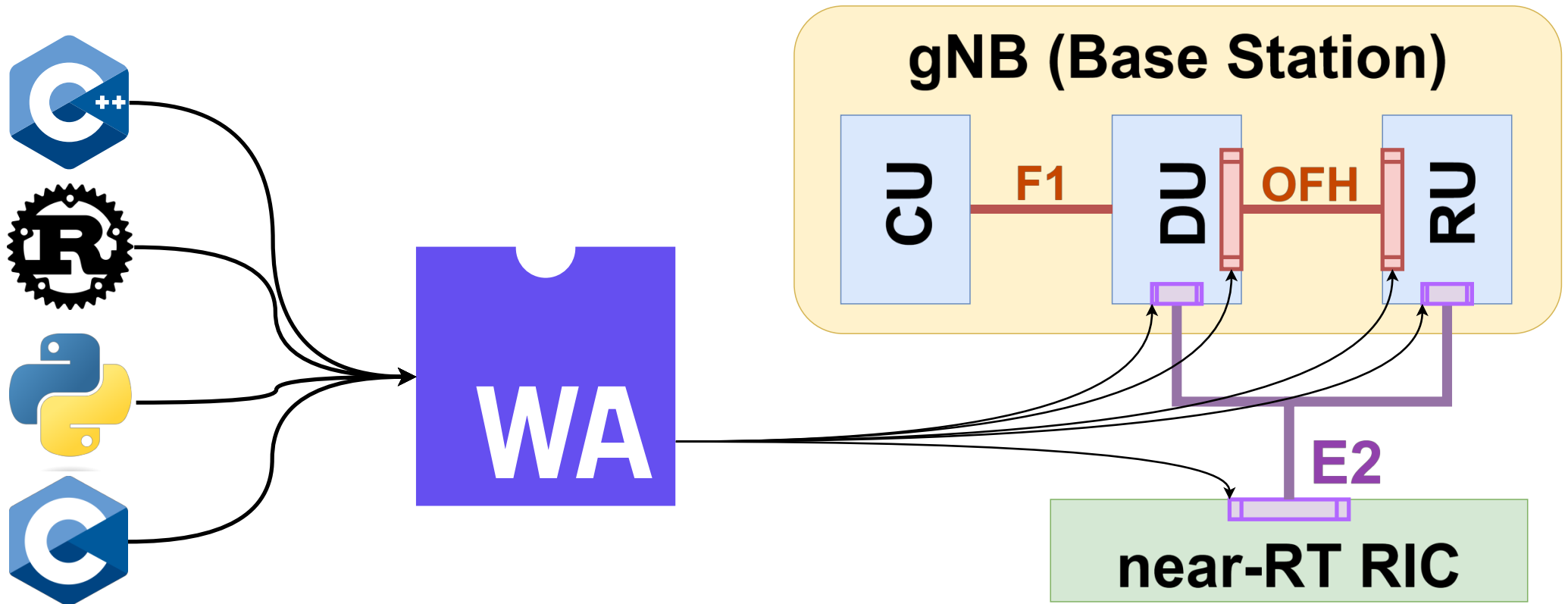
 LightReading

Six years since the founding of the O-RAN Alliance, the original concept has barely made an impression on the global market.

By 2028, at most 10% of the RAN market will be multi-vendor O-RAN

[Dell'Oro Group, 2023]

Web-Assembly RAN



Web-Assembly RAN

Universality:

- Plugins written in C, C++, Rust, etc.
- Support for different instruction sets (x86 and ARM)
- OS independent

Flexibility

- Streamline updates rollout
- On-the-fly integration of new components

Security

- Wasm sandboxes provide security and memory safety

Web-Assembly RAN Use Cases

Open Interfaces and Near-RT RIC

- Open interfaces with WebAssembly
 - Bypass standardized protocols
 - Wrap around low-level communications
- RIC development with WebAssembly
 - New metrics easily added
 - Easier development in any language
 - Will run on any hardware/software
 - Enhanced security

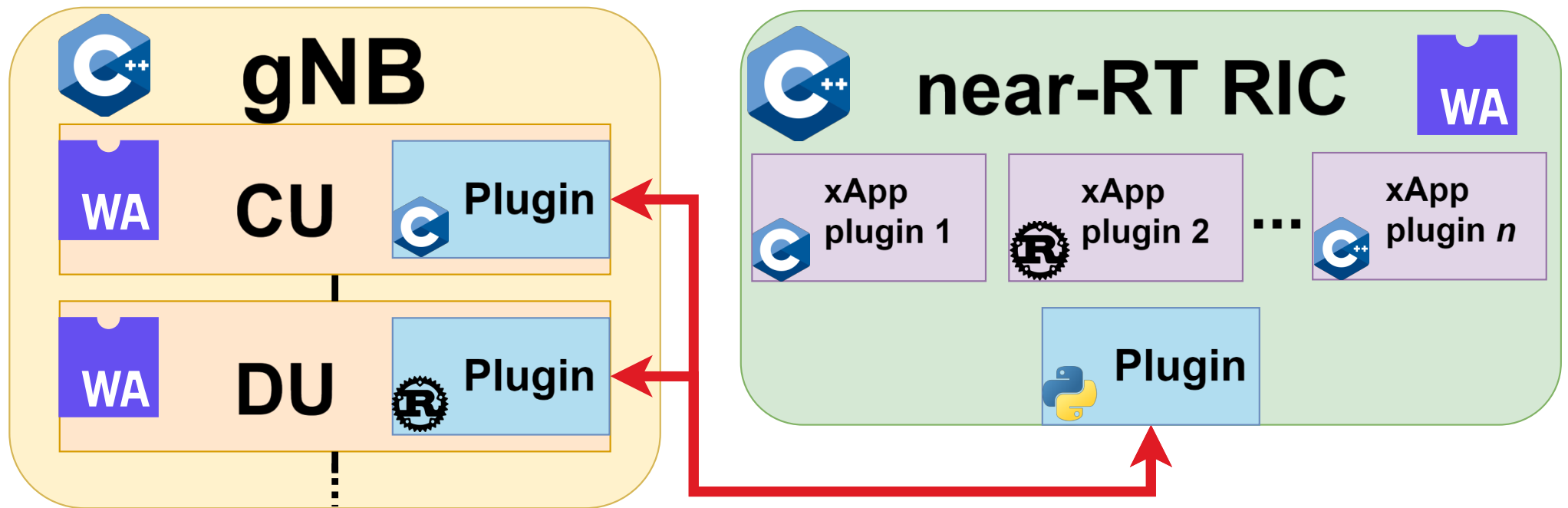
Commercial RAN components cannot be modified

Even open-source components are complex

Sharing new metrics requires standardizing a new protocol

Web-Assembly RAN Use Cases

Open Interfaces and Near-RT RIC



Web-Assembly RAN Use Cases

External Slice Scheduler

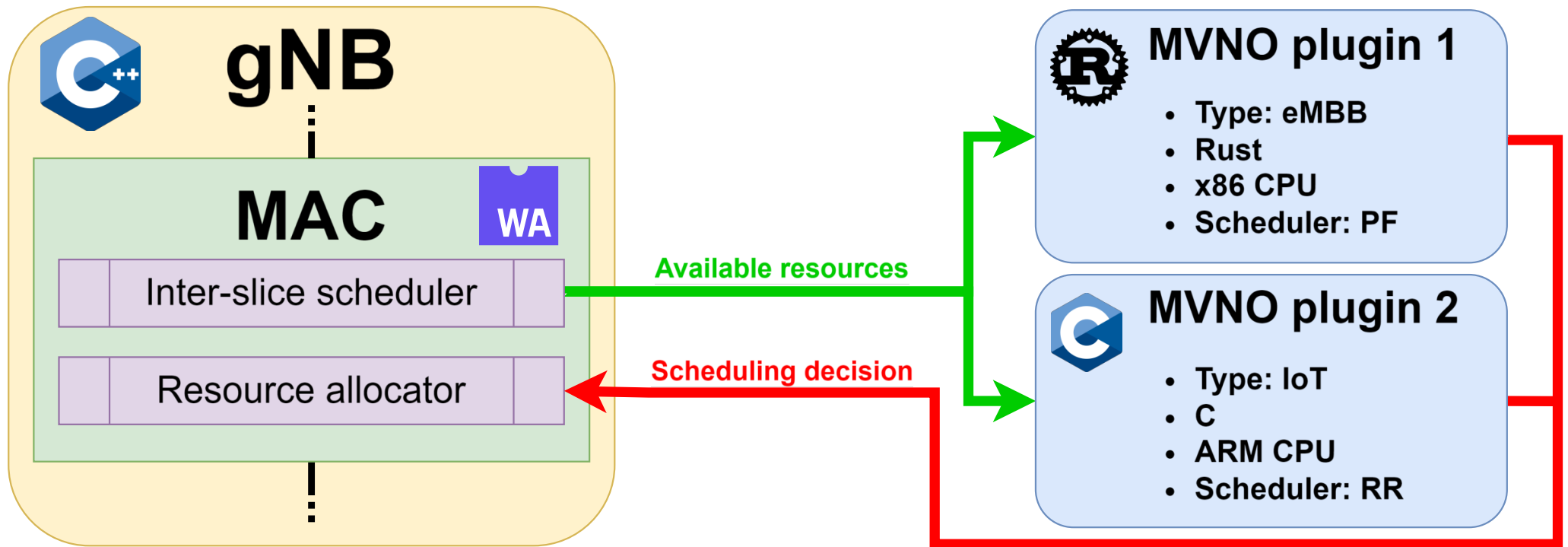
- Network Slicing (Virtual RANs)
 - Slice owners $\neq$ Operator (RAN Owner)
 - Customize and update
- MVNOs
 - Some 140 MVNOs in the USA
 - Target different applications
 - Differentiate in a competitive market

**Need to customize and update
the scheduling algorithm**

**No trust between host and
guest**

Web-Assembly RAN Use Cases

External Slice Scheduler



Preliminary Results

Core:

- open5gs
- Dell Precision Workstation 5820

RAN:

- srsRAN
- Intel NUC i7-1260P

Radio:

- Band n3 (FDD)
- 15 kHz SCS
- 10 MHz bandwidth



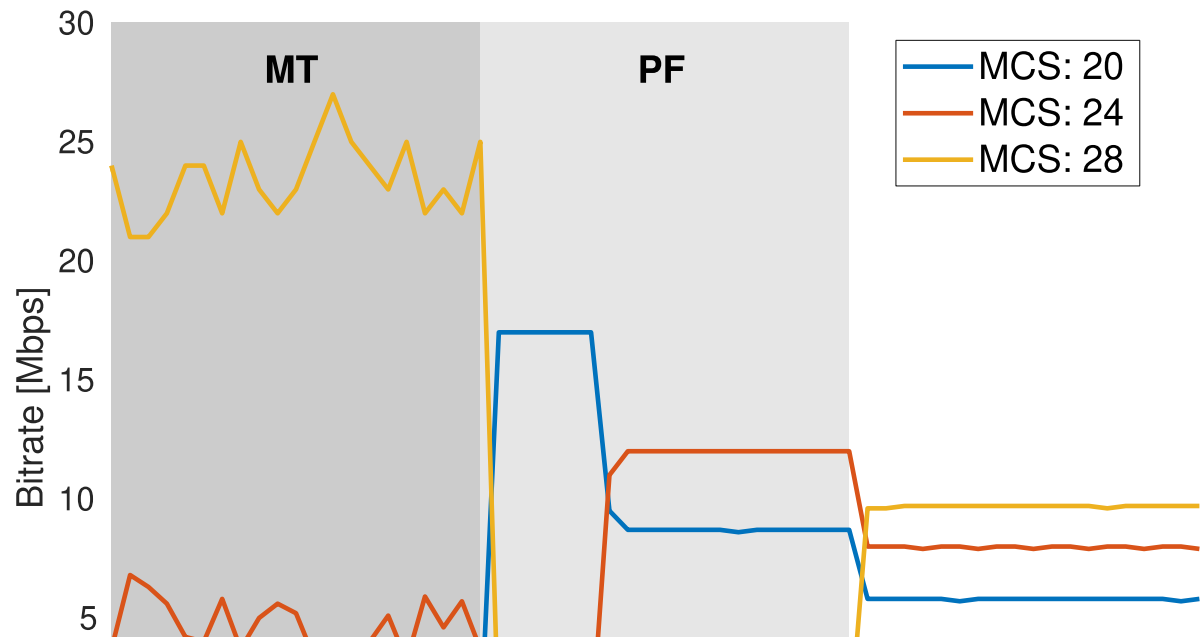
Preliminary Results

Three UEs:

- Mediocre channel
- Decent channel
- Good channel

Three phases:

- Maximum Throughput
- Proportional Fair
- R



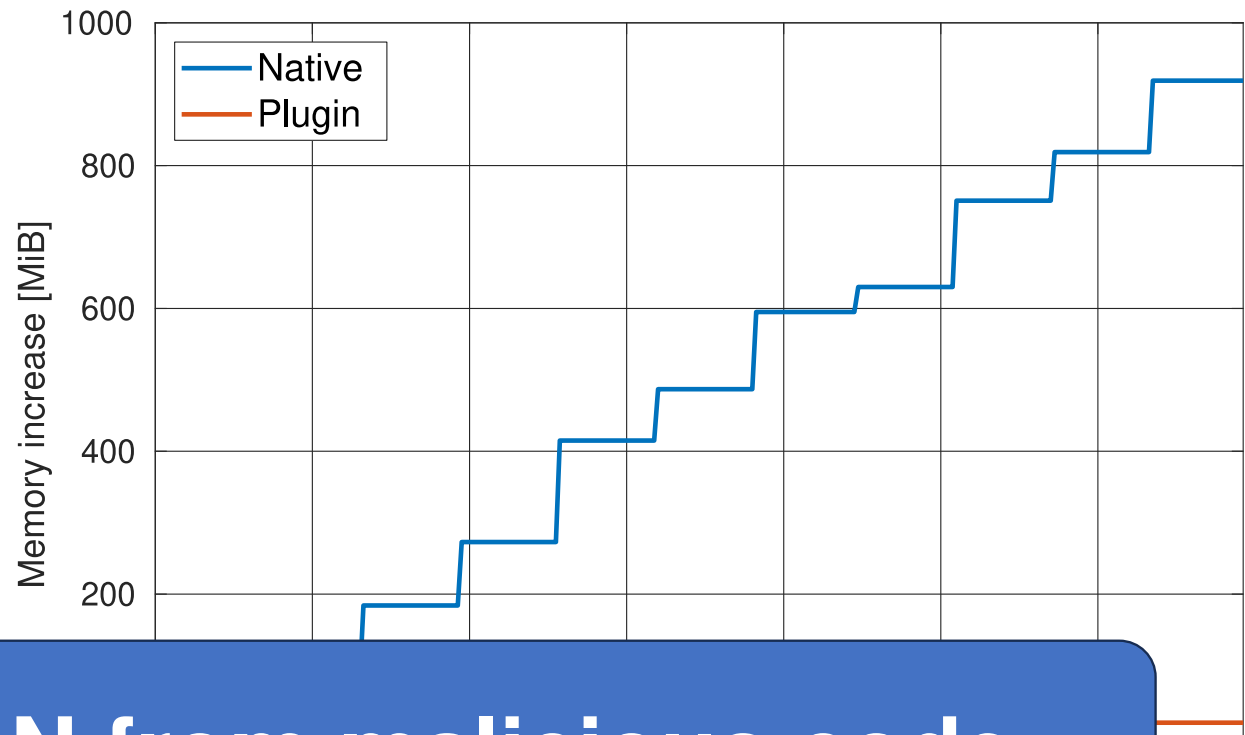
On-the-fly update of plugins

Preliminary Results

Continuous malloc

Unsafe instructions

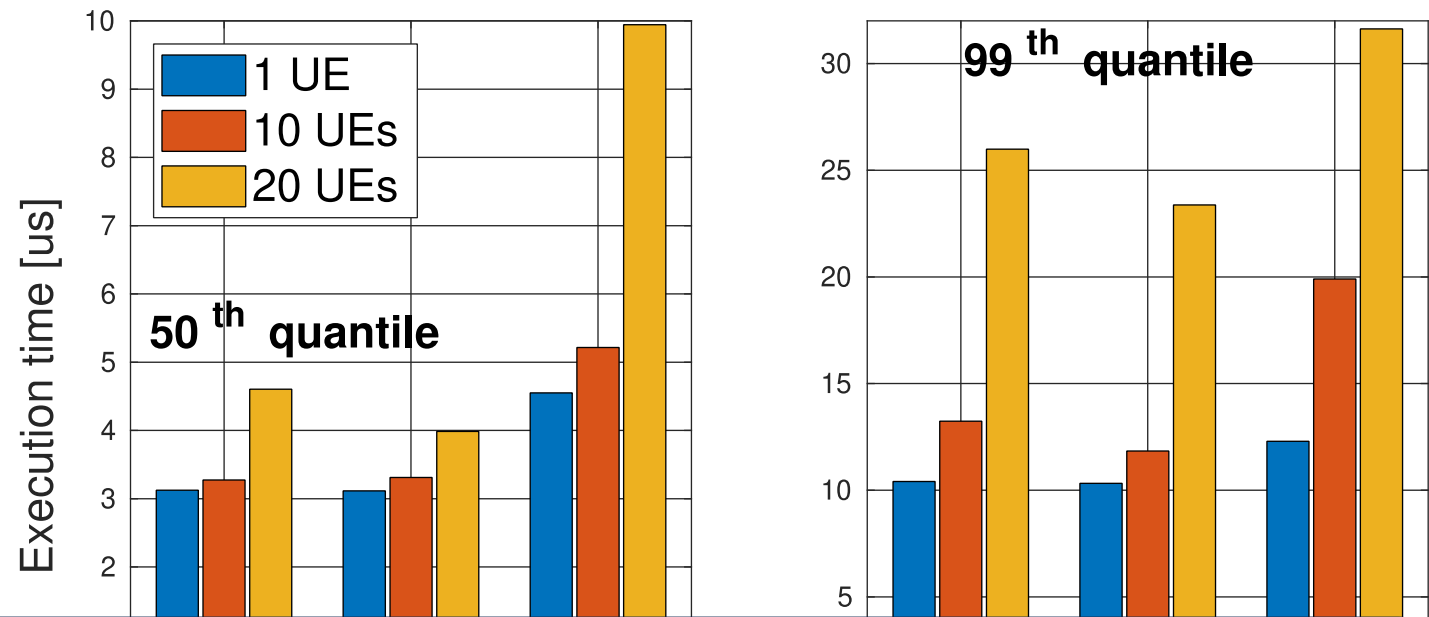
- Null pointer dereference
- Out-of-bound memory access
- Double free



Protect the RAN from malicious code

Preliminary Results

- Slot time: 1 ms



Execute within 5G time requirements

Discussion & Open Problems

- **Several Issues need addressing:**
 - **Resource management:** WA-RAN runs at the edge, where computational resources are scarce
 - **Running Speed:** AoT compilation, code optimization, and caching method lookups
 - **Toolchain Development:** compilers, sanitizers, runtime tailored to 5G RAN deployments
- **Community:** large community and big company support (Google, Microsoft, Apple, Mozilla)

Open RAN is at risk unless we as a community do something about it.