MagmaML

Automated Management for Low-resource 5G Cellular Network Deployments

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Challenge: Cellular Network Management

- Add Billions to MNOs' OPEX
  - Often requires field tests
  - Fix may take 100s of man-hours
- Exacerbated by more complex networks:
  - Denser deployments
  - More complex 5G technologies, e.g. massive MIMO
- More pronounced in low-resource networks
  - Lack of experienced technicians
  - Hard-to-reach areas

Can research community help?

- Why not use machine learning to proactively probe network KPIs & states and find and diagnose problems?
  - Labeled datasets required to train models
  - Private to MNOs and often limited to only the KPIs exposed by the hardware vendors.

New possibilities!

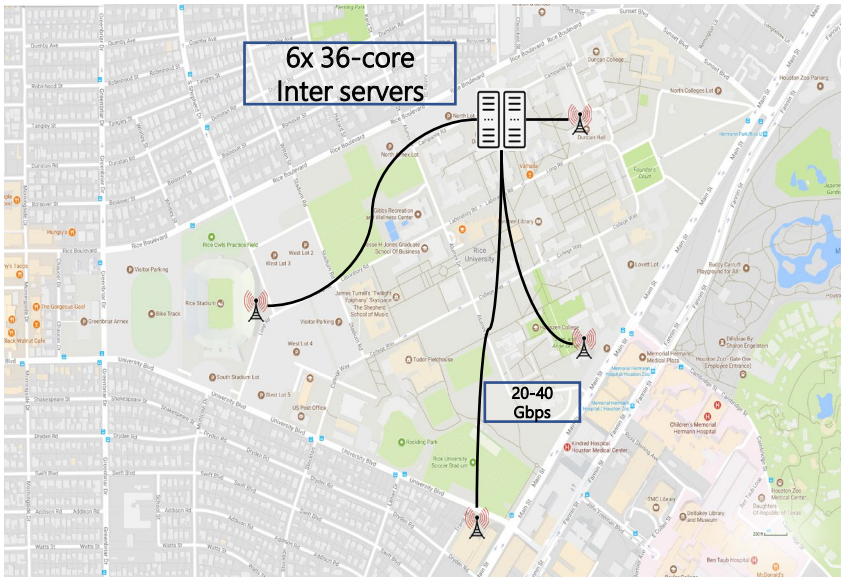
- Proliferation of city-scale wireless testbeds powered by SDRs,
  - POWDER-RENEW, COSMOS by NSF in the US
  - Other ones by US DoD
  - Several in Europe and Asia
- Open-source software, e.g. Magma Core, OAI RAN.

Possibility to "learn" to diagnose by observing the network in states that cause common bad performance

City-scale Testbeds

- RENEW @Rice
- POWDER @University of Utah

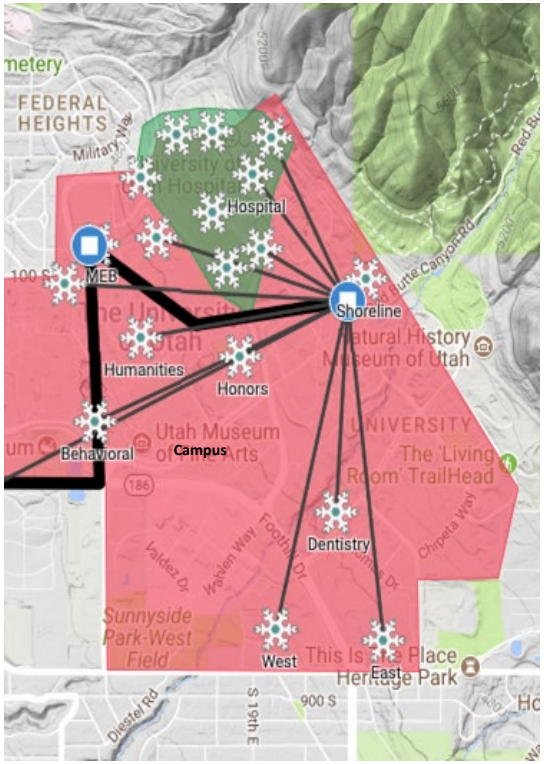
Rice RENEW

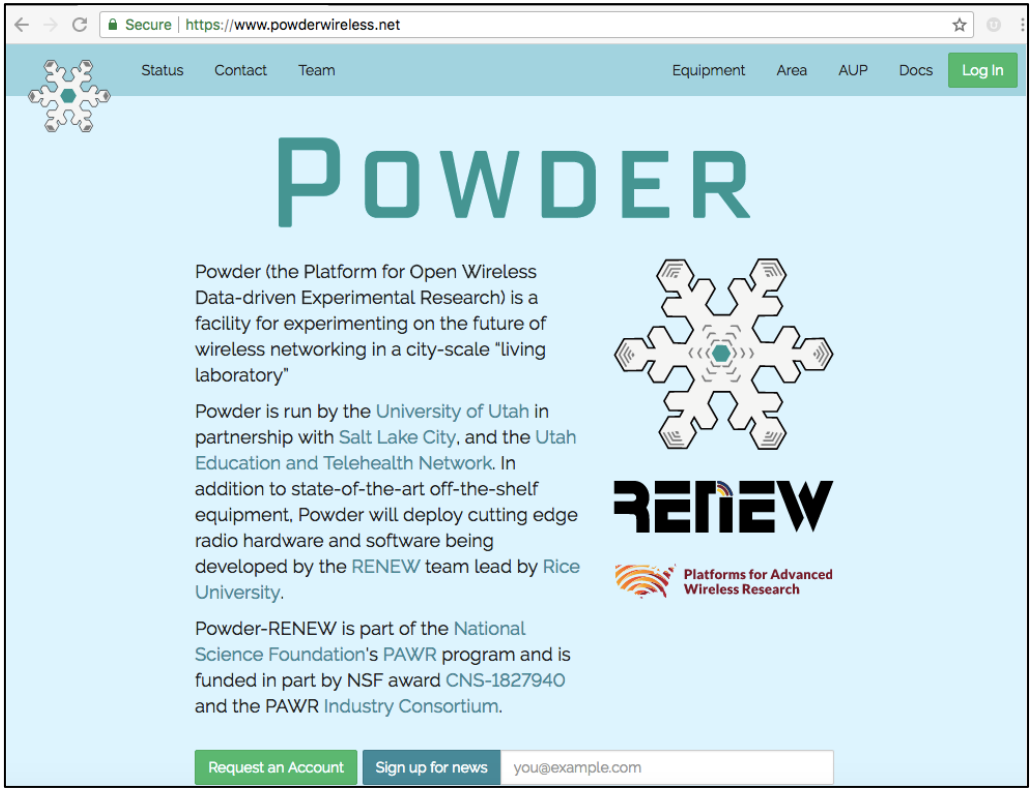


RENEW

- World's first multi-cell testbed for massive MU-MIMO
- World's first base-station class 3.5GHz SDR testbed

POWDER





- Deployment of 2.5GHz variant of RENEW hardware
- Lots of other 2-4 antenna SDR base stations and clients

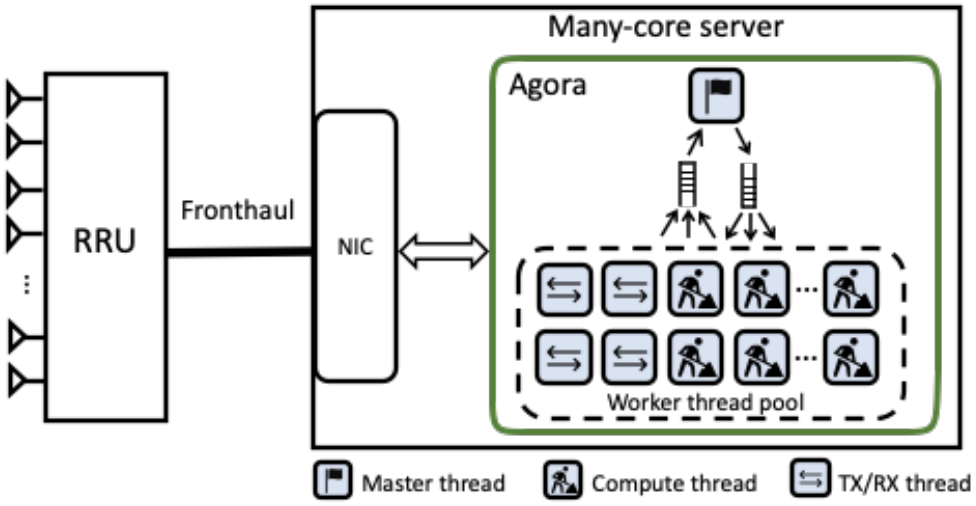
Open-source RAN Software

- OAI and srsLTE
  - Not well-tested in the field
  - No massive MIMO support
- RENEW-RAN
  - Currently include PHY Layer (Agora)
  - Development of L2 and L3 are underway
  - Coupled to fully observable RENEW hardware

Agora: L1-processing in Software

- Addresses the open problem in the O-RAN community on the possibility of virtualized massive MIMO

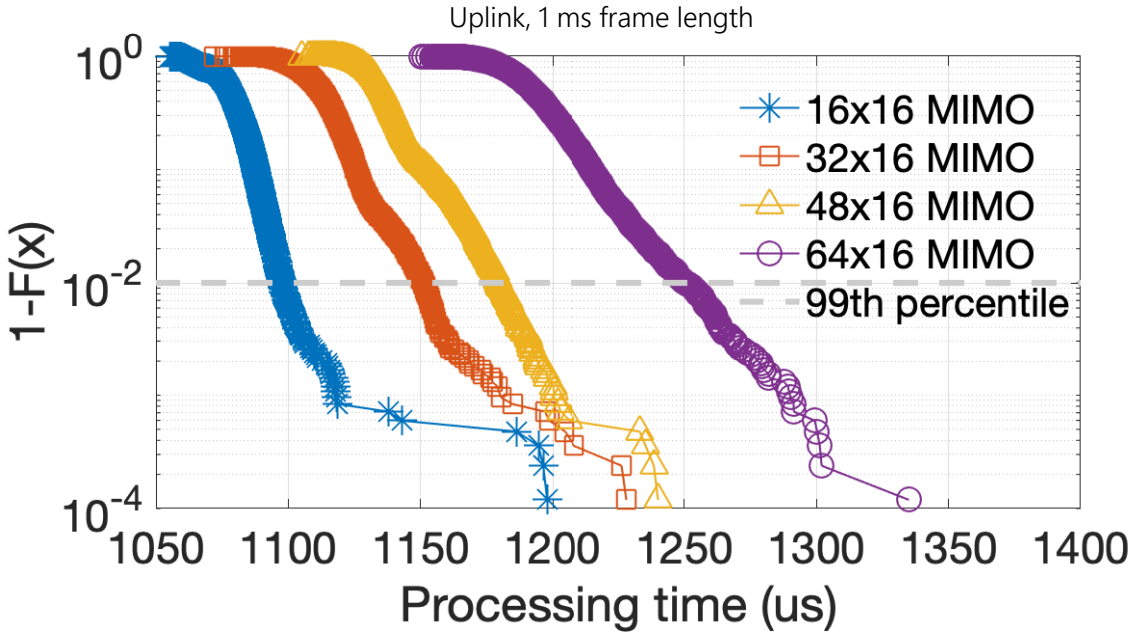
- Real-time PHY processing in C++
  - 64x16 MU-MIMO on 36-core intel server



J. Ding, R. Doost-Mohammady, A. Kalia, L. Zhong, "Agora: Software-based Real-time Massive MIMO Baseband Processing", in Proc. ACM CoNEXT 2020.

Agora: Latency Results

- Meet 5G's latency requirement for ehanced mobile broadband (eMBB) use-case, i.e., 4 ms



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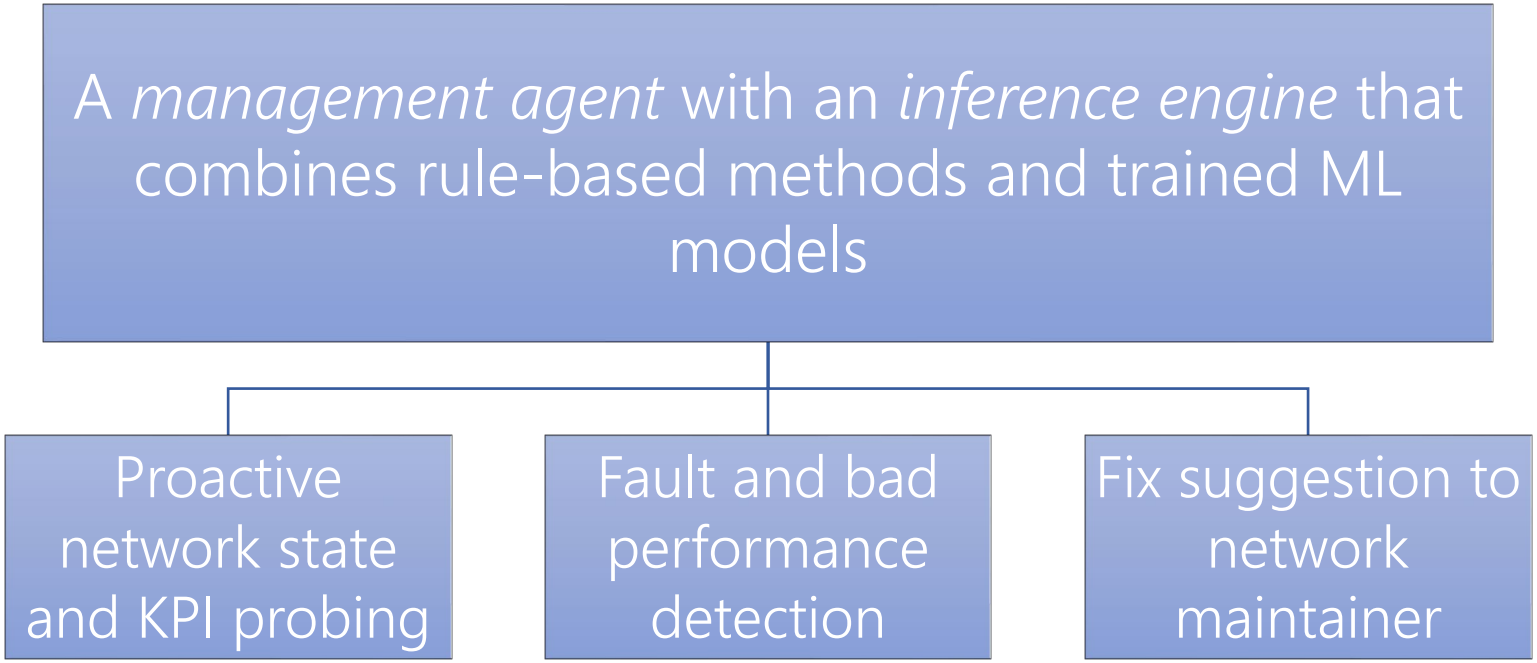
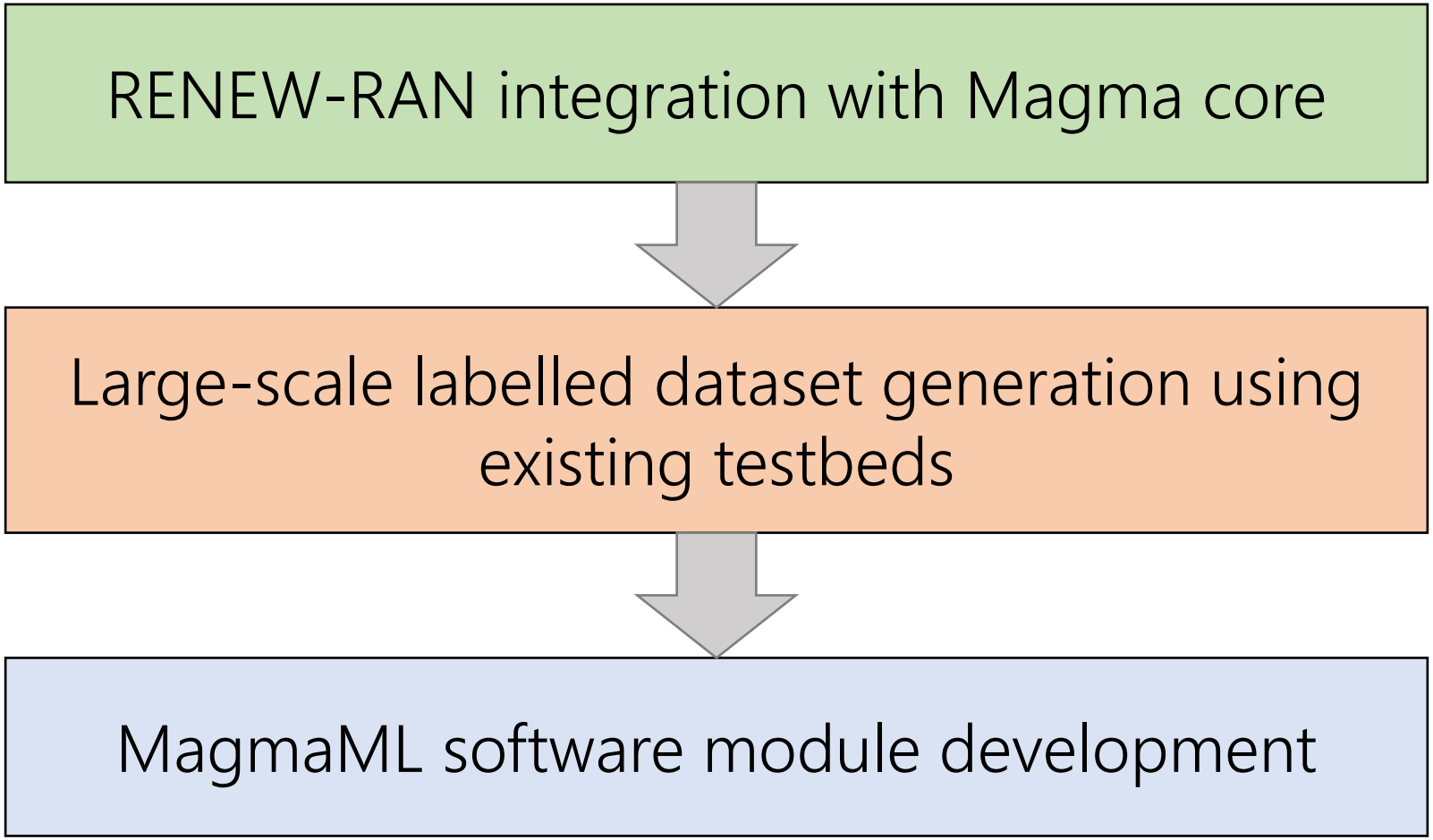
MagmaML Goals

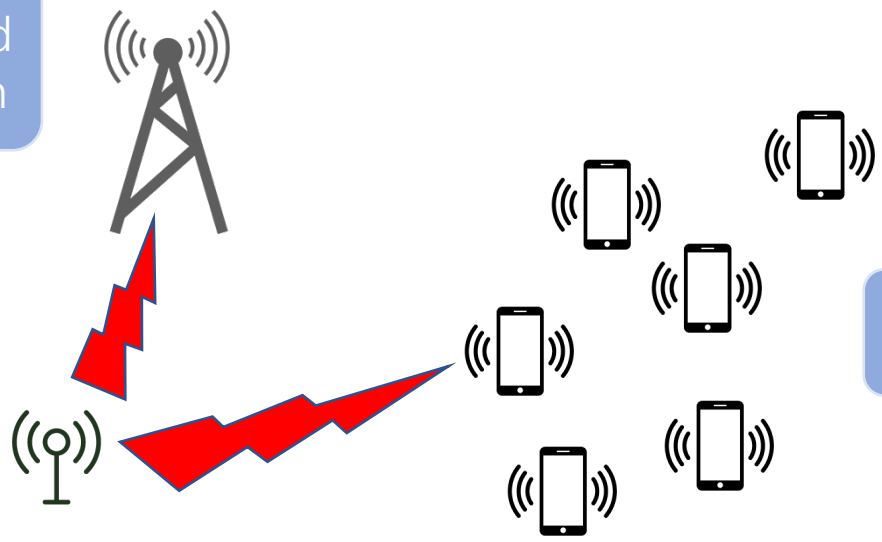


Project Tasks



Dataset Examples

eNB/gNB bad configuration



High user load

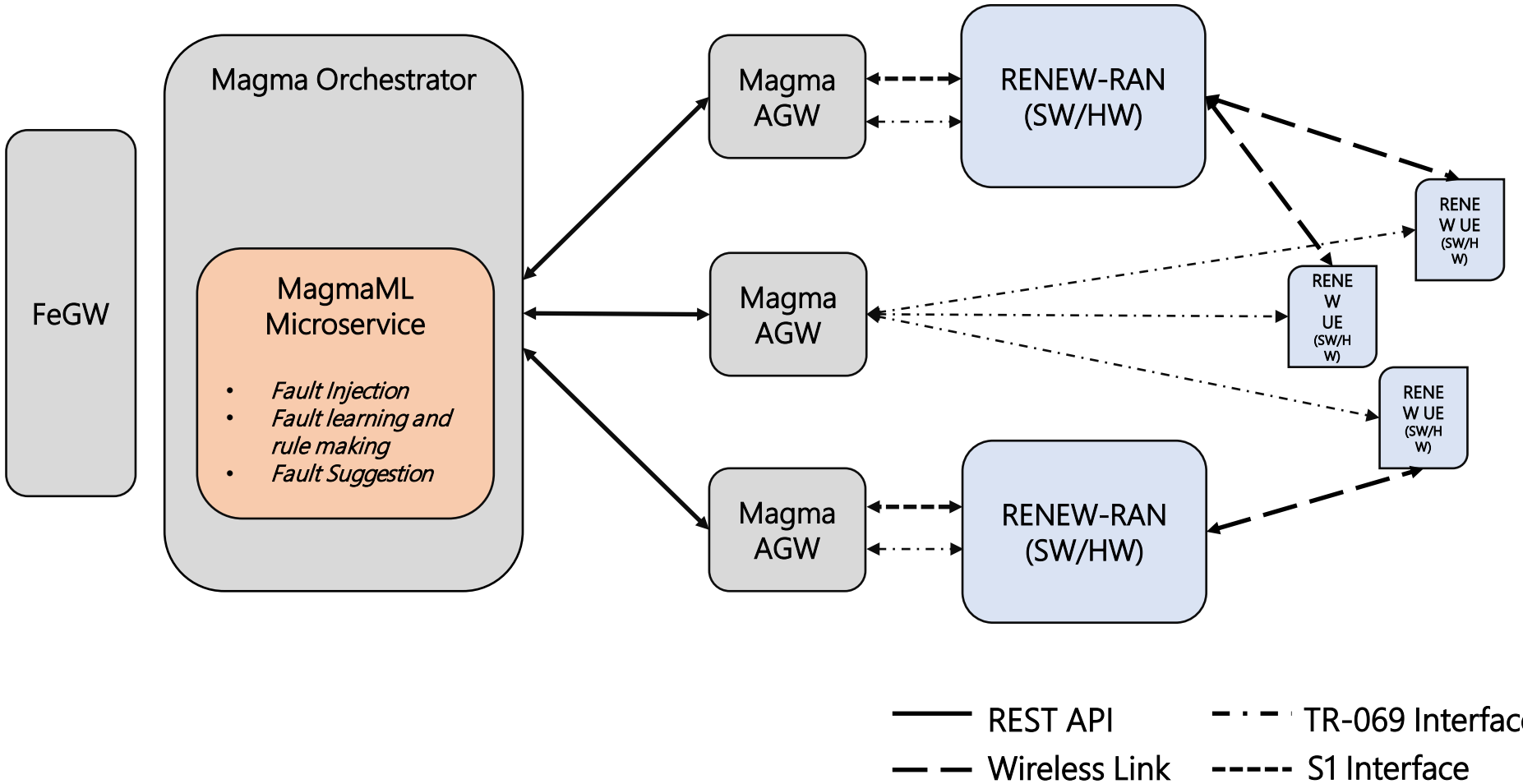
Interfering node at uplink/downlink

Malfunctioning UE

Measured KPIs:

- bearer data rate, HARQ re-transmission rate, BLER, CSI-SINR, CQI, …

System Architecture



Summary

- Automating cellular network management is highly needed especially for low-resource networks
- Open-source software and open-access testbeds provide a path to such goal
- MagmaML will equip Magma with an engine for automated fault discovery and recovery.

Thank you!