

# MagmaML

Automated Management for Low-resource 5G Cellular  
Network Deployments

*Ashutosh Sabharwal, Rahman Doost-Mohammady*  
*Rice University*



Magma Summit, Feb 3<sup>rd</sup> 2021

# 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!

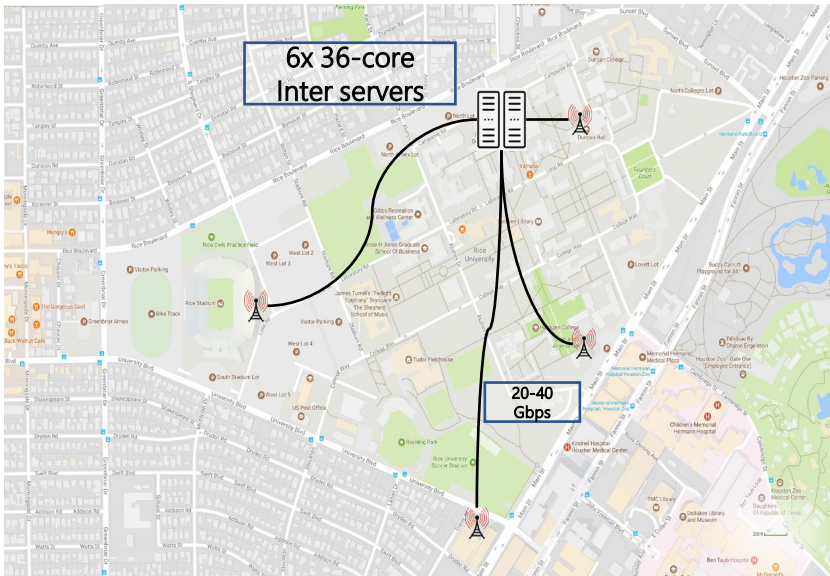
- Proliferation of city-scale wireless testbeds powered by SDRs,
  - POWDER-RENEW, COSMOS by NSF in the US
  - Other ones by US DoD
  - Several in Europe and Asia
- Open-source software, e.g. Magma Core, OAI RAN.

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

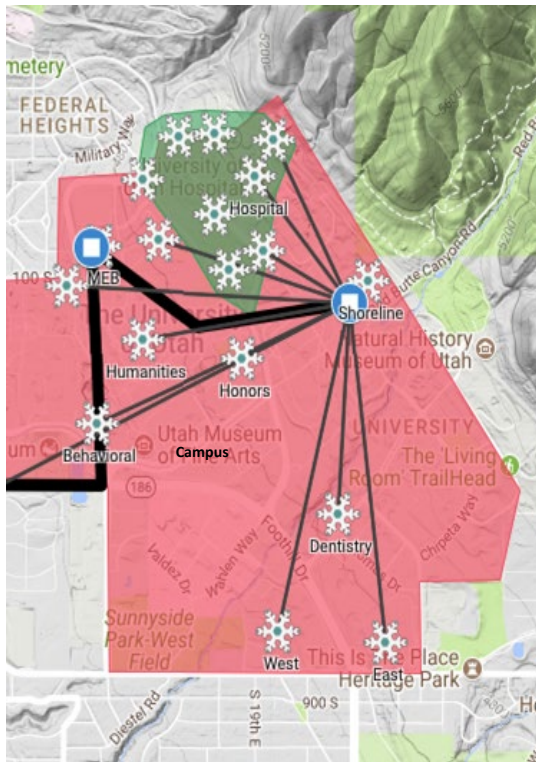
# Rice RENEW



## RENEW

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

# POWDER



Secure | <https://www.powderwireless.net>

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# POWDER

Powder (the Platform for Open Wireless Data-driven Experimental Research) is a facility for experimenting on the future of wireless networking in a city-scale "living laboratory"

Powder is run by the University of Utah in partnership with Salt Lake City, and the Utah Education and Telehealth Network. In addition to state-of-the-art off-the-shelf equipment, Powder will deploy cutting edge radio hardware and software being developed by the RENEW team lead by Rice University.

Powder-RENEW is part of the National Science Foundation's PAWR program and is funded in part by NSF award [CNS-1827940](#) and the PAWR Industry Consortium.

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

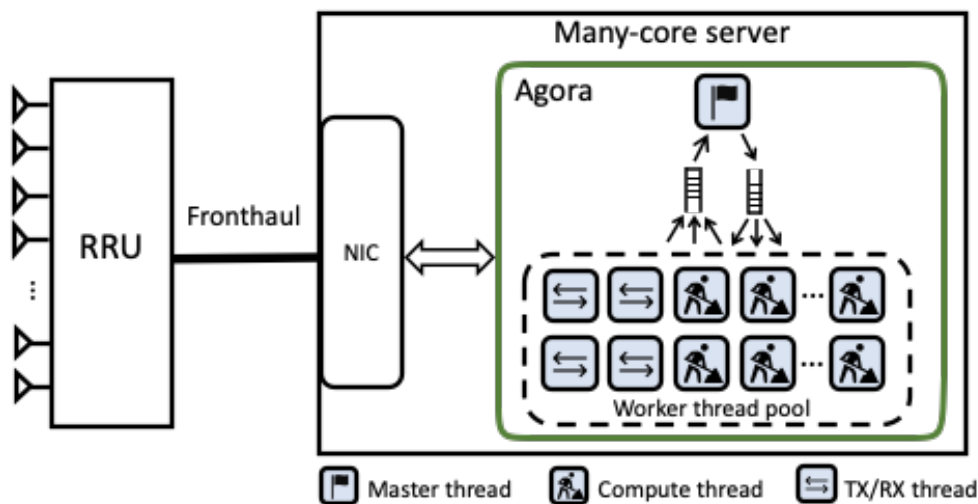
# Open-source RAN Software

- 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



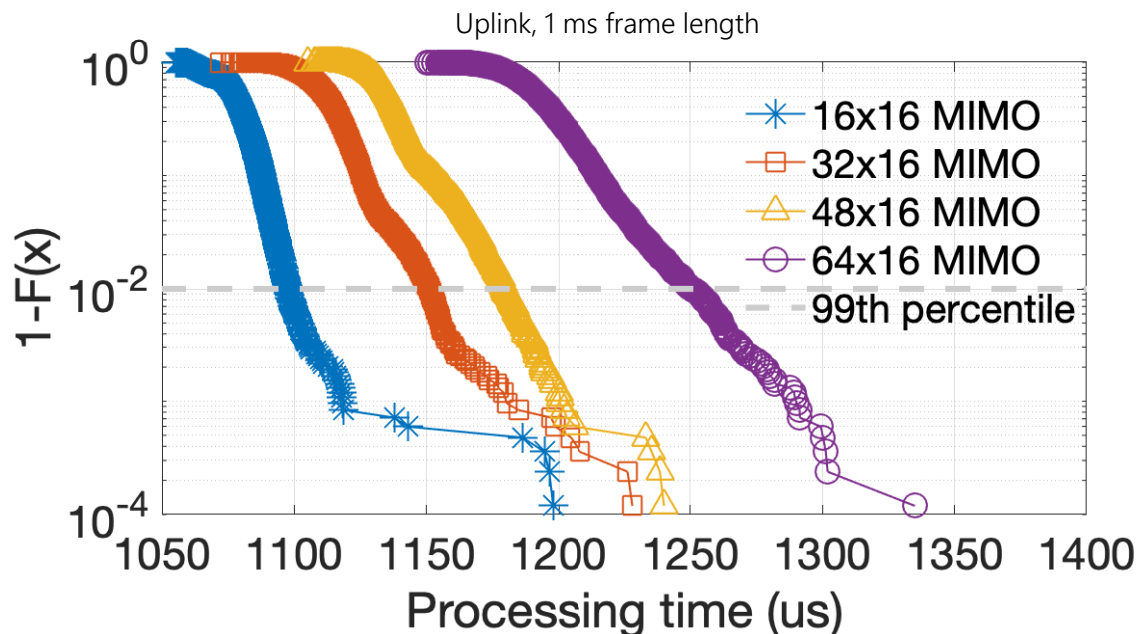
# Agora: L1-processing in Software

- 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



# Agora: Latency Results

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



# MagmaML Goals

*A management agent with an inference engine that combines rule-based methods and trained ML models*

Proactive  
network state  
and KPI probing

Fault and bad  
performance  
detection

Fix suggestion to  
network  
maintainer

# Project Tasks

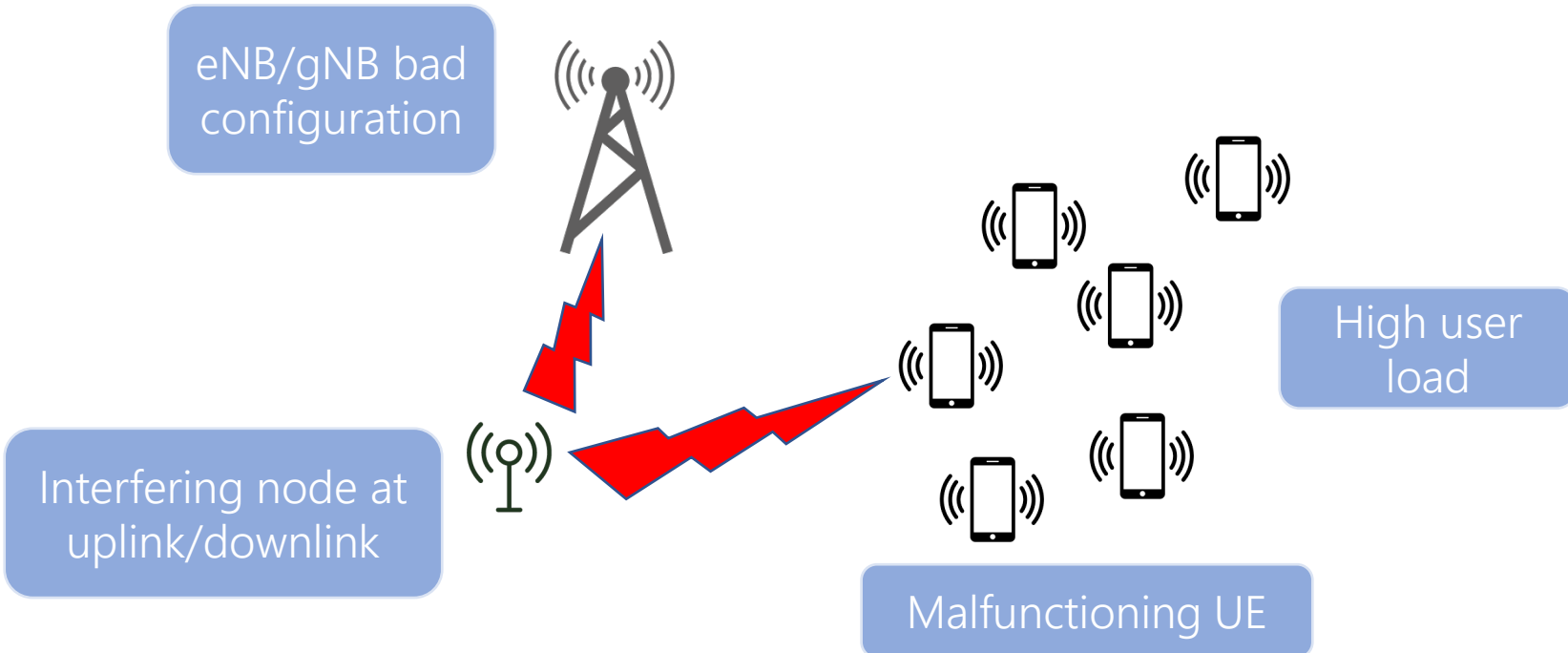
RENEW-RAN integration with Magma core

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graph TD; A[RENEW-RAN integration with Magma core] --> B[Large-scale labelled dataset generation using existing testbeds]; B --> C[MagmaML software module development];
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Large-scale labelled dataset generation using existing testbeds

MagmaML software module development

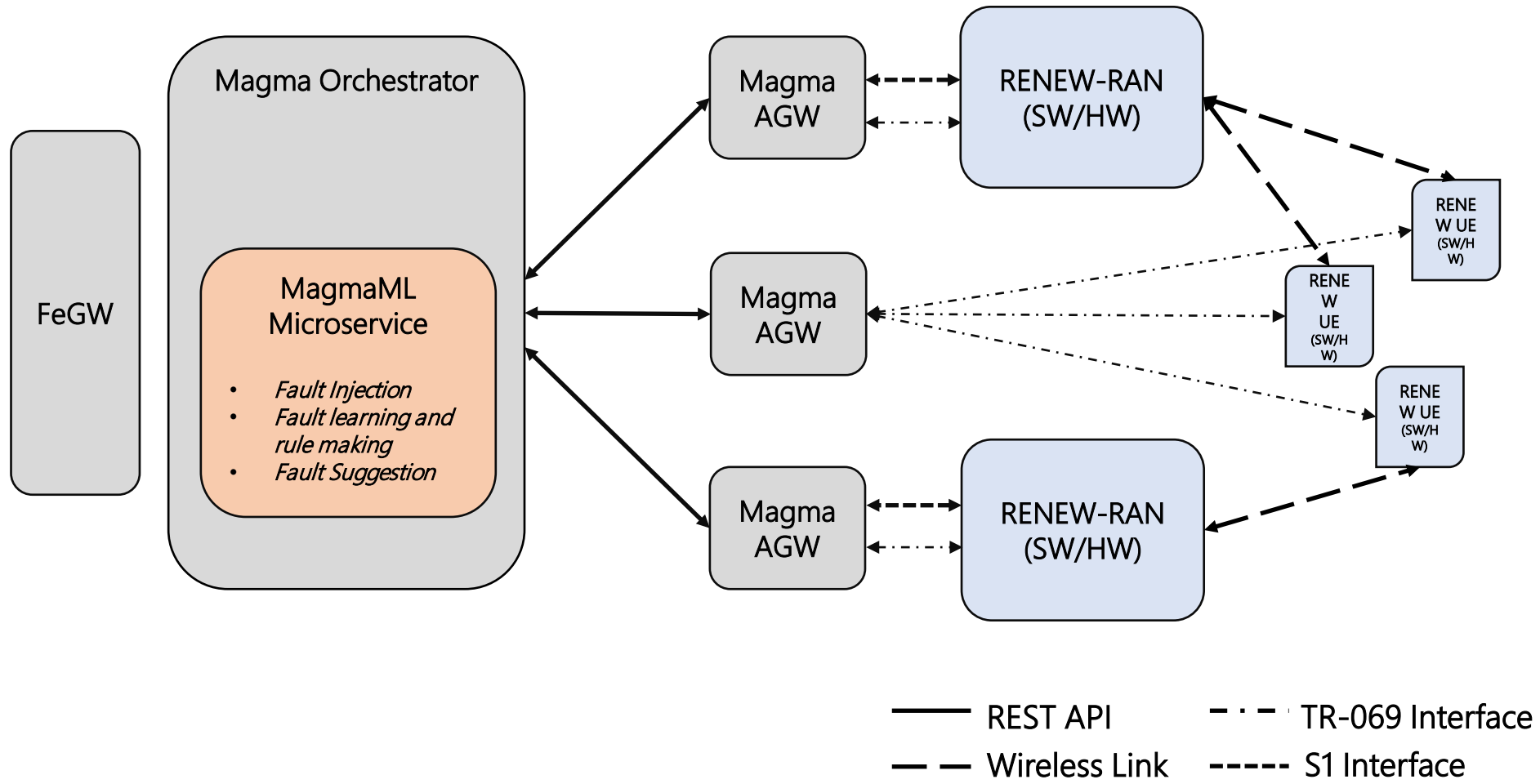
# Dataset Examples



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!