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

- 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

Agora: Latency Results

- Meet 5G’s latency requirement for enhanced mobile broadband (eMBB) use-case, i.e., 4 ms uplink, 1 ms frame length.

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
- 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, ...

- Interfering node at uplink/downlink
- eNB/gNB bad configuration
- High user load
- Malfunctioning UE
System Architecture

Magma Orchestrator

MagmaML Microservice
- Fault Injection
- Fault learning and rule making
- Fault Suggestion

FeGW

Magma AGW

RENEW-RAN (SW/HW)

REST API

Wireless Link

TR-069 Interface

S1 Interface
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!