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AIMM Low: A simulation study for energy efficiency in 5G RAN

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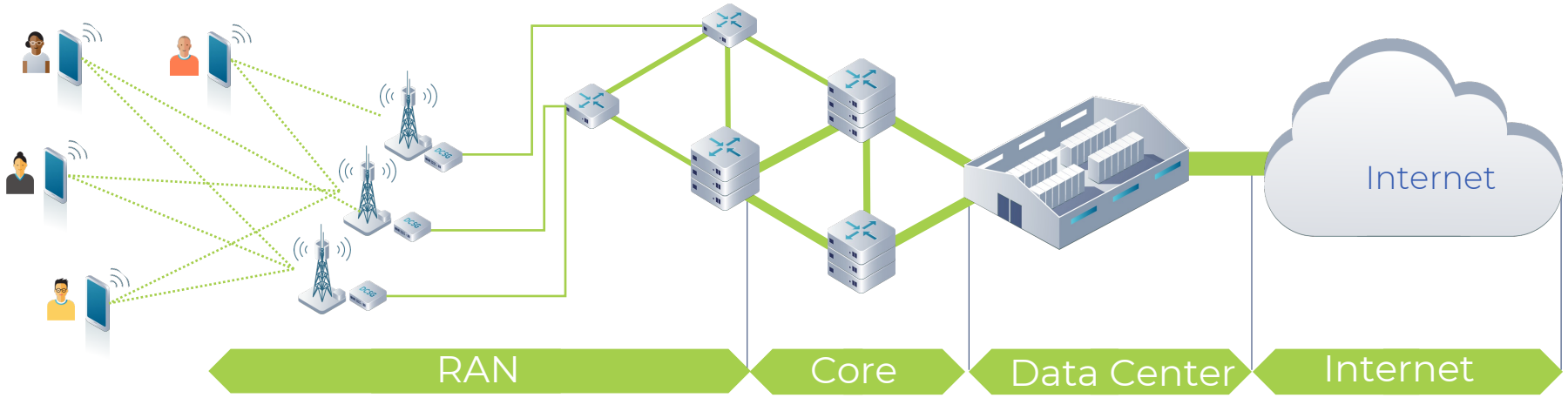
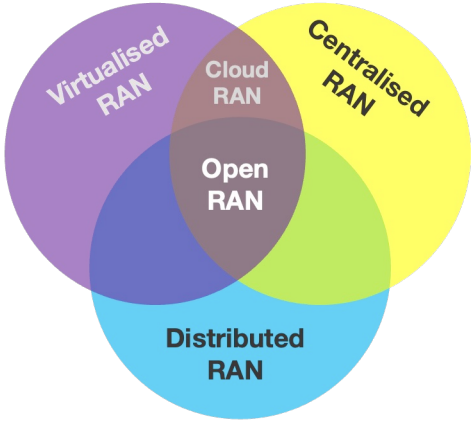
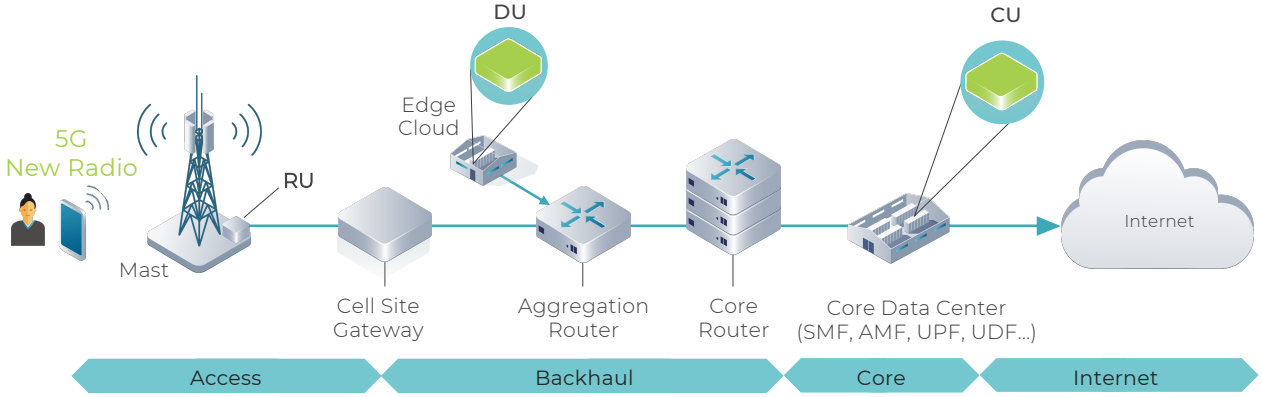


Radio Access Network

Infrastructure that enables wireless communication between user devices and the network core.

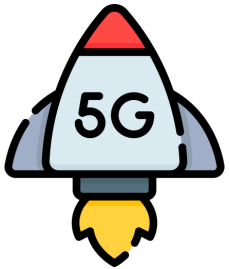




Open RAN

The concept of flexible, disaggregated and interoperable radio access networks.

Motivation



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BUT,

PERFORMANCE

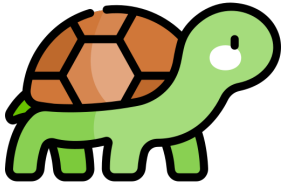
- ✓ mMIMO
- ✓ mmWave
- ✓ Carrier aggregation

EFFICIENCY

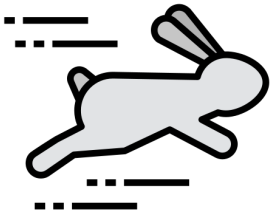
- ✓ Beamforming
- ✓ Advanced sleep
- ✓ Virtualisation
- ✓ Lean carriers

CONSUMPTION?

- 😓 More dense
- 😓 More devices
- 😓 More traffic
- 😓 More problems



Non-realtime RIC
>1s
Trains models
rApp optimisation

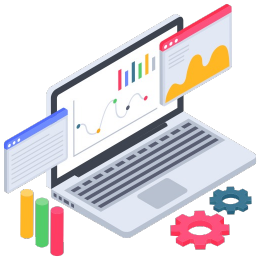


Near-realtime RIC
10 ms < 1s
Manages radio
xApp optimisation

RAN Intelligence Controllers

- Models untested in operational networks.
- Need explainable, reproducible & realistic results.
- Existing software simulators do not satisfy requirements.

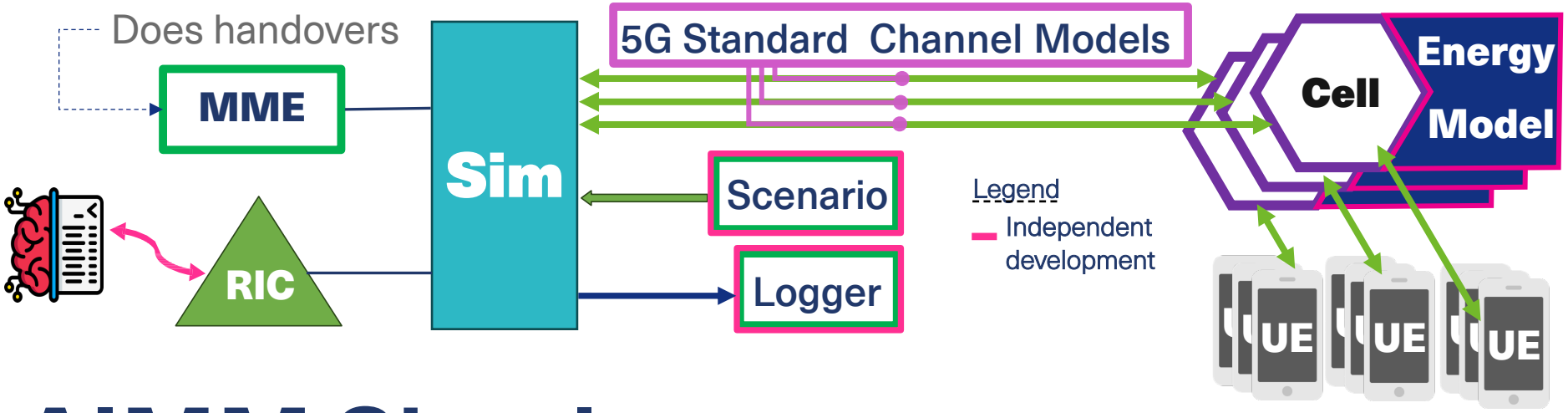
Objectives



Develop energy modelling simulation.

Performance compatible with RICs.

Vary base station transmit power and assess the impact of different strategies on mobile network performance.

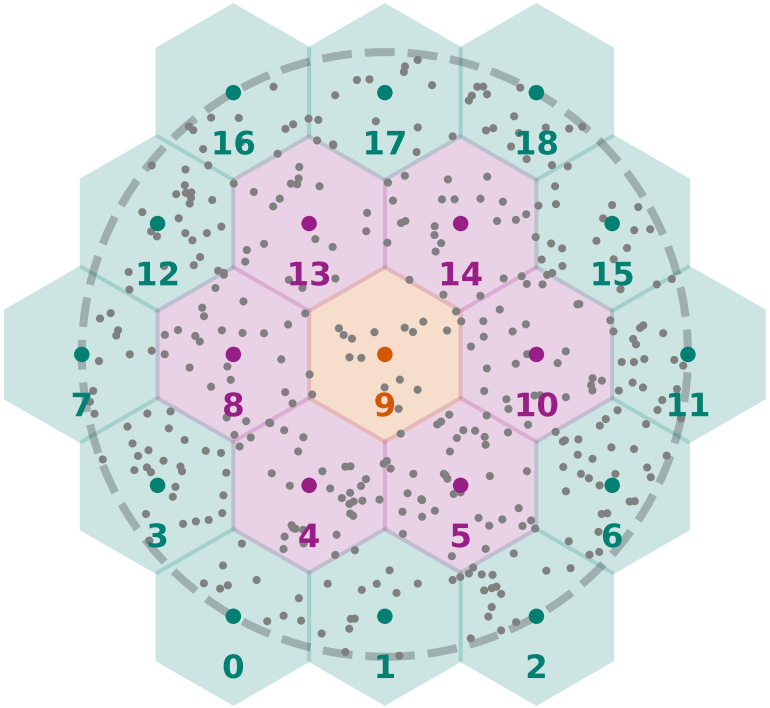


AIMM Simulator

Figure: Adapted AIMM simulator block structure (Credit: Keith Briggs)

- Python based; discrete event. System-level with 5G standardised channel models.
- Fast, flexible and extensible.
- Open-source and available: github.com/keithbriggs/AIMM-simulator
- Contributing developer for the AIMM Simulator.

Setup



Centre Cell

Inner Ring Cells

Outer Ring Cells

UEs

Base Stations

Simulation Radius

400 user's,
static,
distributed 2D plane,
uniform PPP,
max load,
best SINR,
non-LOS pathloss

19 macro hexgrid,
10 MHz,
link only
model [ ],
basic mode.

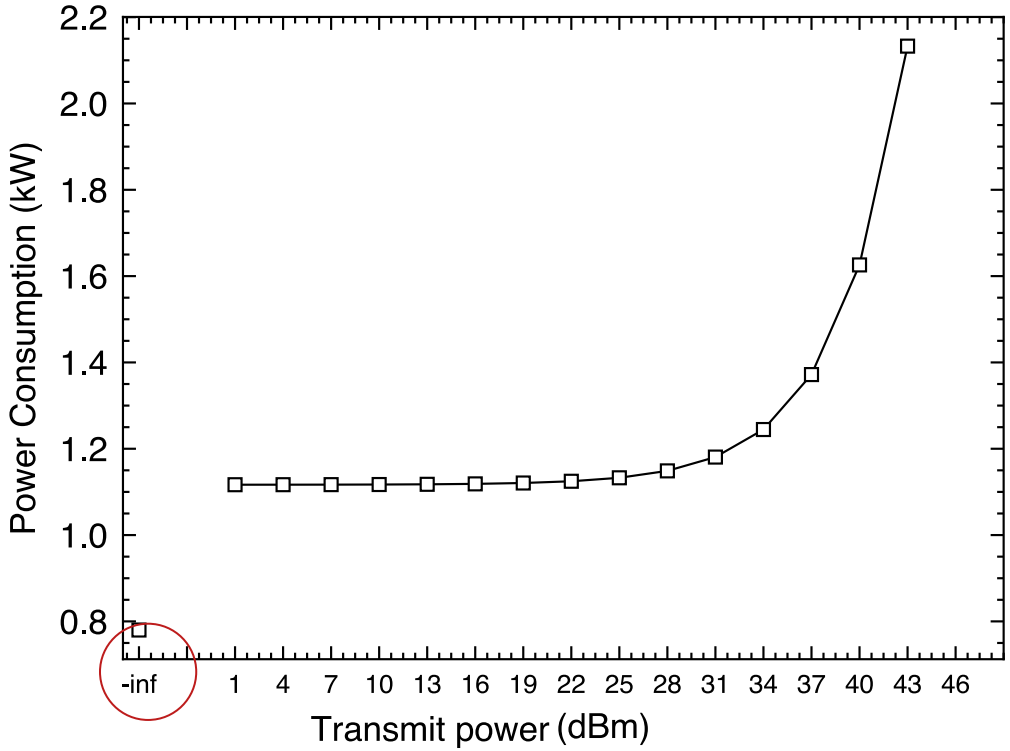
Experimental Design

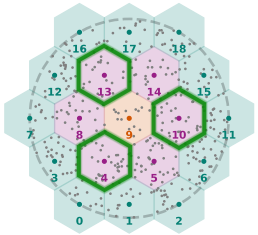
transmit power

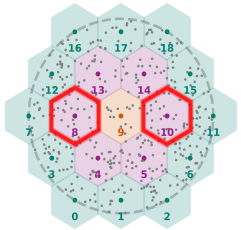
cell combinations

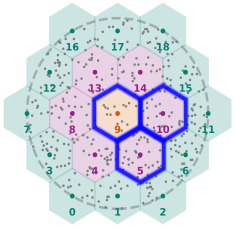
- Centre cell
- Sleep mode = symbol shutdown
- Some circuitry still ON
  ∴ non-zero power consumption

Power Consumption

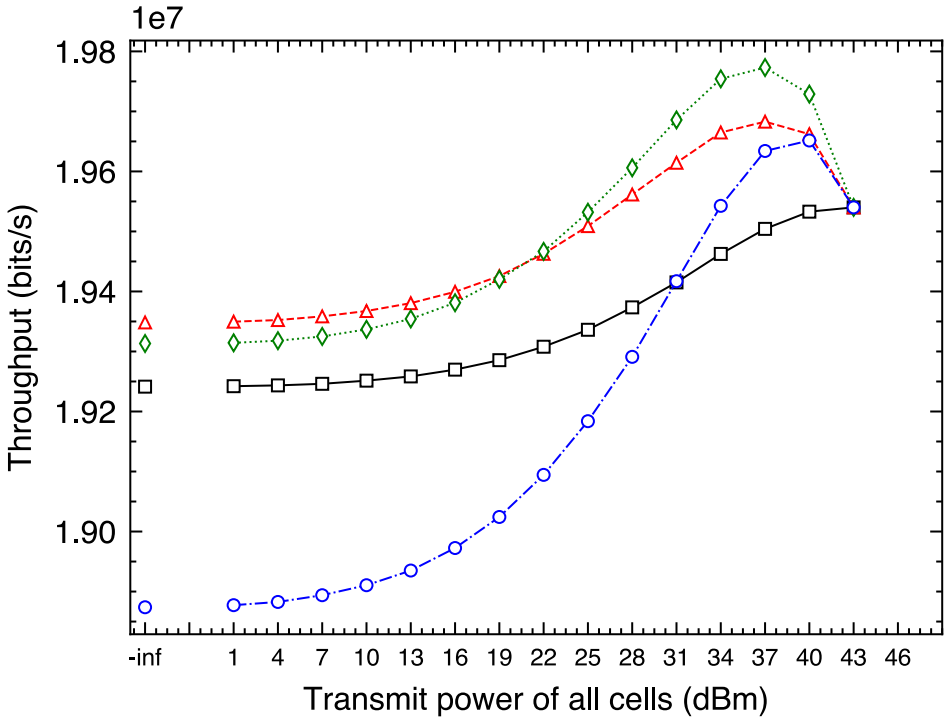




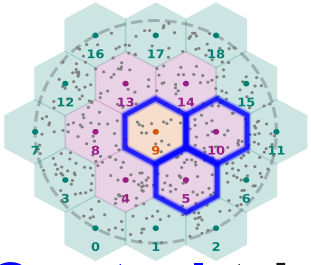




- Backing off the max. yields better network throughput.
- Largest drop ≈ 0.6 Mb/s
- Remember! MACRO cells.

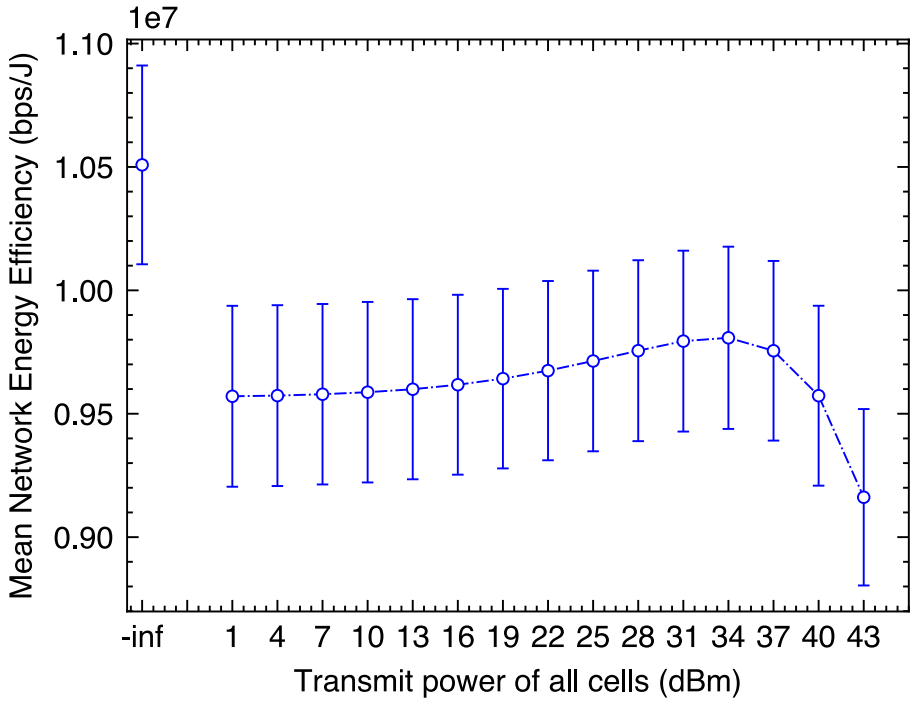


Mean Network Throughput



Central trio

- Transmit power reduction
  -> better efficiency?
- Similar for other combinations



Energy Efficiency: Central Trio

Conclusions

- Extended the AIMM Simulator with energy modelling.
- Determined suitability for non-realtime RIC optimisation.
- Found optimum points for transmission rate in various scenarios.
- Backing off max transmit power without significant loss in throughput.
- Next steps: more scenarios, wider range of strategies, optimise with RIC rApps.