ITUEvents

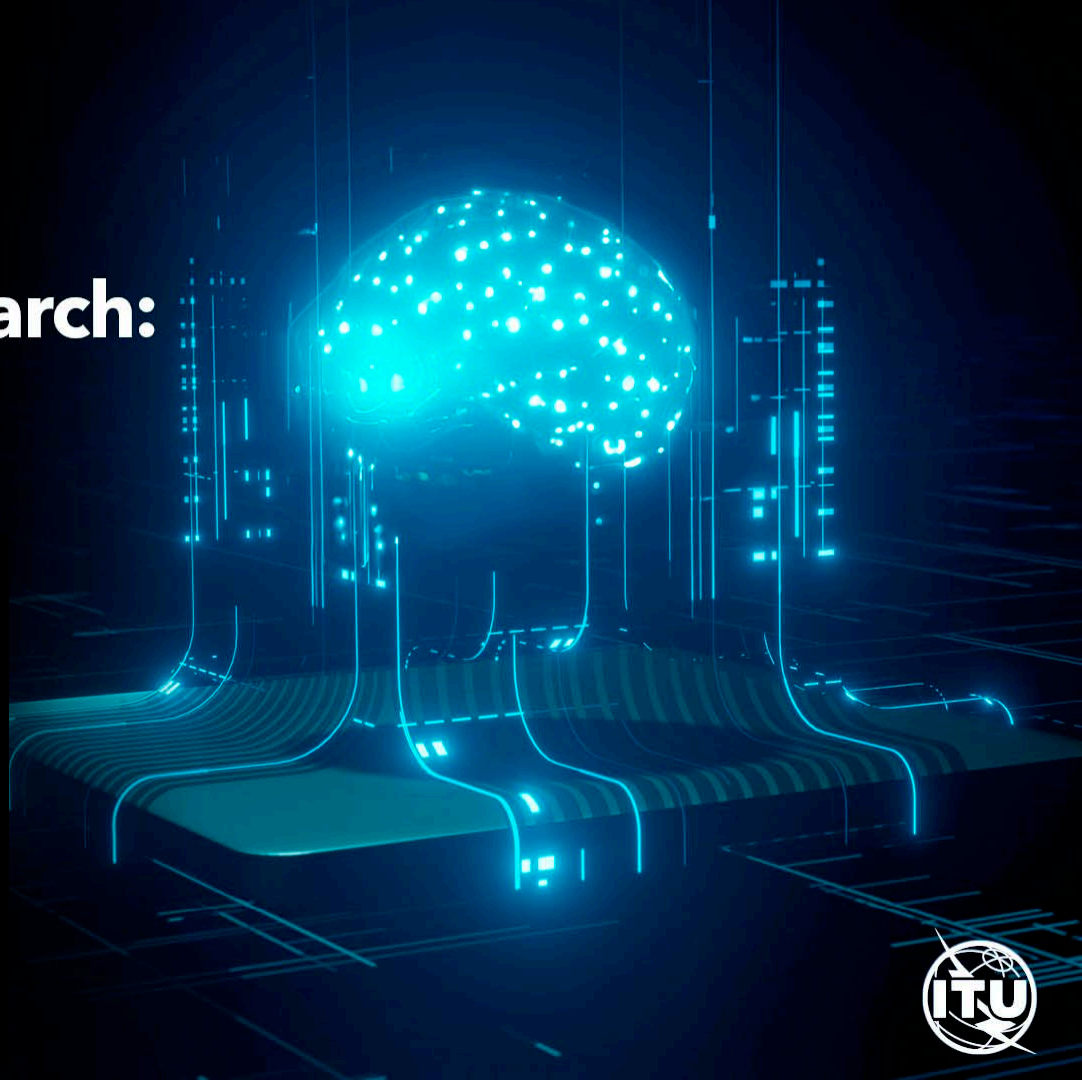
Workshop

At the crossroads of standards and research: AI/ML datasets for future networks

Simulated reality of communication networks (SRCON)

Dr. David López-Pérez
Universitat Politècnica de València

Feb 16th 2024



David López Pérez

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

About me

- Distinguished Researcher, Universitat Politècnica de València (since 2023)
- Technical Leader/Expert at Huawei Technologies (3 years)
- Distinguished Member of Technical Staff at Nokia Bell Labs (8 years)
- Post-doc at King´s College London (18 months)

Join me!

- Research on Wireless Communications (Cellular & Wi-Fi)

Contact

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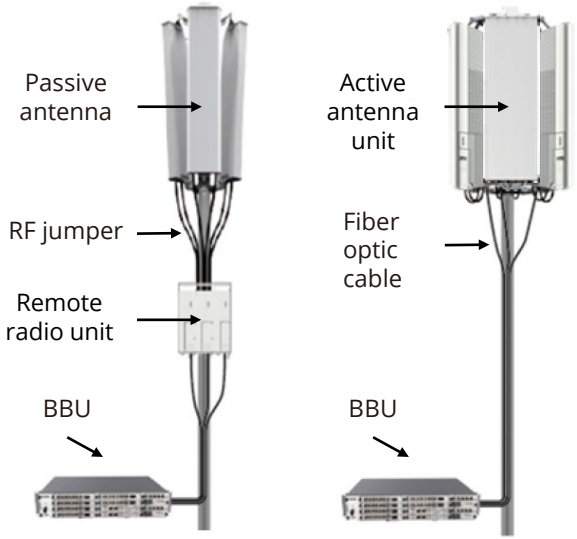
Network energy consumption

- **Energy cost**
  - Constitutes 20 to 40% of an operator's operational expenditure (OPEX) [1]
- **Network energy usage**
  - Represents 90% of the energy used by a mobile network operator [2]
    - The access network uses 80% of the network's energy
    - Its radio units use 66 to 82% of the access network's energy
- **6G challenge**
  - Potential for increased 6G radio consumption due to higher frequencies, wider bandwidths, more beams

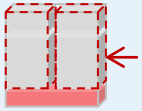


The radios are the major energy consumers in the telecom business

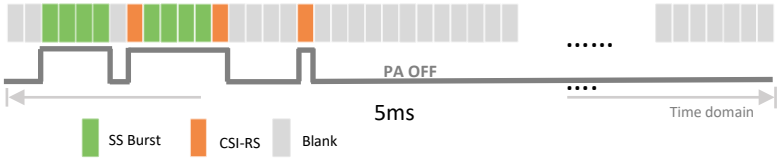
[1] GSMA, "Mobile Net Zero State of the Industry on Climate Action 2023," 2023.
[2] NGMN, Network Energy Efficiency Phase 2, Oct. 2023 https://www.ngmn.org/wp-content/uploads/NGMN_Network_Engergy_Efficiency_Phase2.pdf

Prime energy saving solutions

Time-domain Shutdown

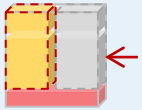


Instantaneous OFDM symbol shutdown when no data is transmitted



- Instantaneous symbol-level operation
- No UE performance degradation expected
- Around 15% energy savings reported

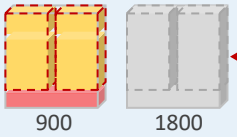
Spatial-domain Shutdown



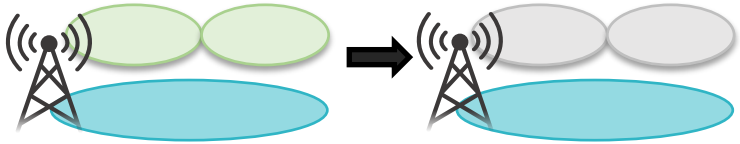
MIMO transceiver / channel shutdown when demand is low

- Operating in the time frame of seconds to minutes
- It can adjust common channel TX power of cell to ensure coverage
- Capacity loss may occur

Frequency-domain Shutdown



Carrier shutdown when demand is low



- Operating in the order of minutes
- Multi-carrier power amplifier can be shutdown if all its carrier are OFF
- Coverage & capacity loss may occur

[3] 3GPP TR 38.864 , “Study on network energy savings for NR (Release 18)”, v.18.1.0, 2023

[4] D. Lopez et al. “A Survey on 5G Radio Access Network Energy Efficiency: Massive MIMO, Lean Carrier Design, Sleep Modes, and Machine Learning”, IEEE Surveys and Tutorials, 2022

Network optimization challenge

Cost

Huawei's annual drive testing expenditure approximates 1 billion USD

Drive test measurement campaign

image by R&S

Complexity

No 5G networks were ranked as '*outstanding*' by Umlaut in 2023 [5]

- Networks are large-scale, stochastic, non-convex, and non-linear

5G crowd scores (2022)

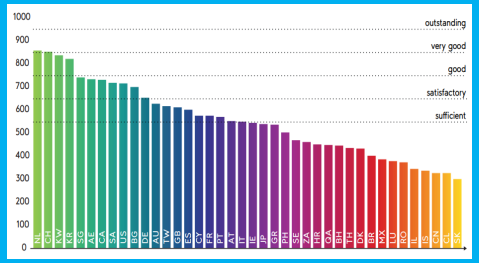


image by Umlaut

Expertise

Networks are typically optimized for coverage and capacity

- There is lack of expertise in optimizing for network energy efficiency

Coverage optimization

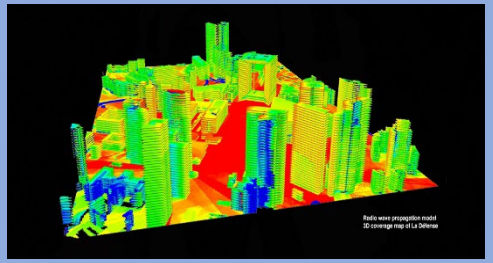
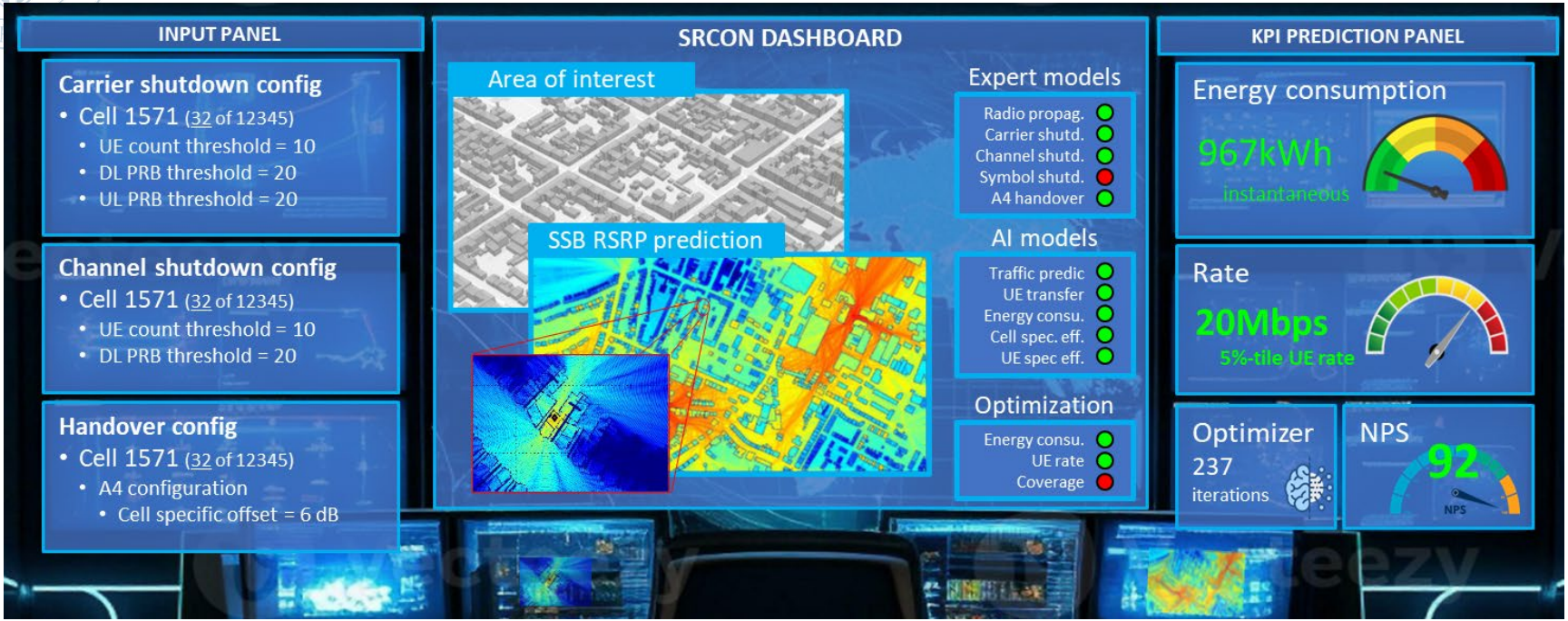


image by Orange

[5] Umlaut, "Benchmarking 2022. New Framework 5G Crowd Scores Preview, " 2022

SRCON statistical digital twin

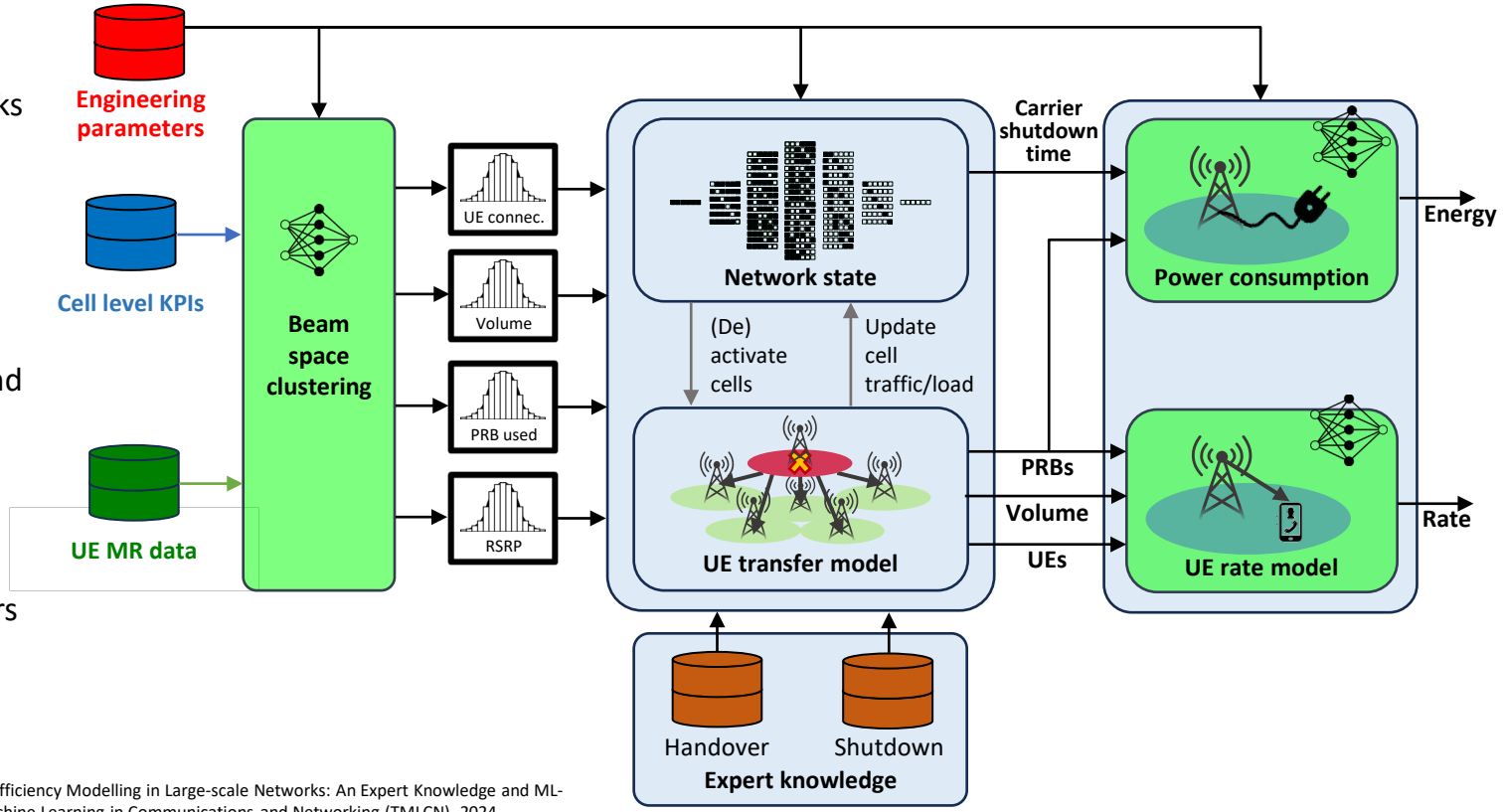


More accurate predictions → Better parameter optimizations → Improved user satisfaction

SRCON hybrid expert- & ML-based engine

Capabilities

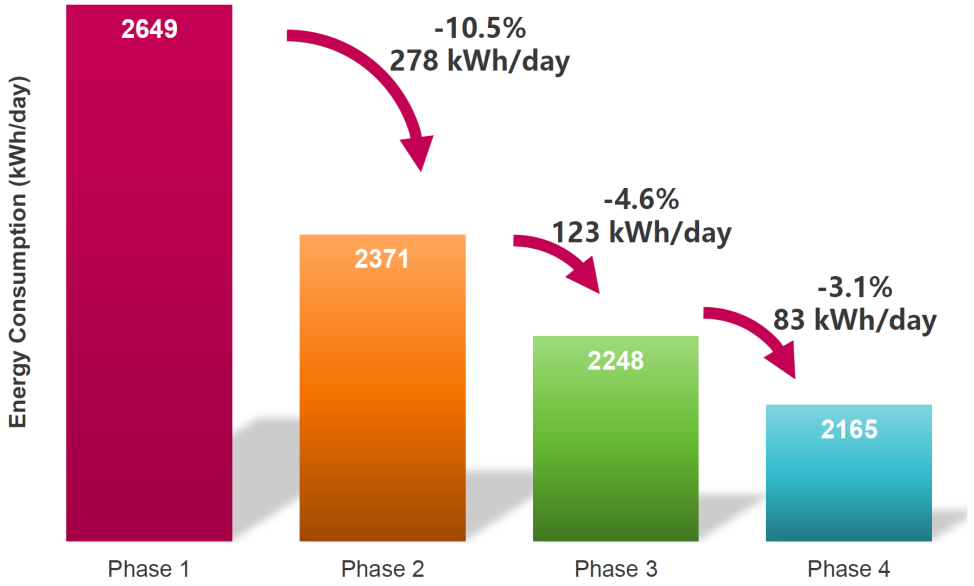
- Large-scale networks
- Heterogeneous network devices
- Massive cell-level and MR datasets
- Stochastic traffic and channel
- No need for GPS
- Expert knowledge
- ML-based predictors
- Generalization



[5] D. López-Pérez, et al,"Data-driven Energy Efficiency Modelling in Large-scale Networks: An Expert Knowledge and ML-based Approach," in IEEE Transactions on Machine Learning in Communications and Networking (TMLCN), 2024.

4G/5G Energy Efficiency Optimization

- Framework applied to a **real network comprising 134 sites**
  - 400 **4G LTE cells**
  - 155 **5G NR cells**
- **Phase 1**: No energy saving
- **Phase 2**: Energy saving based on expert configuration
- **Phase 3**: Data-driven optimization of energy saving parameters
- **Phase 4**: Hierarchical energy efficiency optimization [1]



[6] NGMN, Network Energy Efficiency Phase 3, to be published in 2024

IEEE COMSOC EMERGING TECH INITIATIVE

Large Generative AI Models in Telecom (GenAINet)

Objectives

- Create a dynamic platform of research and innovation on generative AI
- Foster collaboration and data exchange among academics, researchers, and industry leaders
- Drive standardization in the application of LLMs in telecommunications

Establish the **TelecomGPT Alliance**

JOIN US

@GenAINet_ETI

GenAINet_ETI

genainet.committees.comsoc.org/

GenAINet

- **Chairs**
  - General Chair: Merouane Debbah
  - Academic Chair: Tingting Yang
  - Industry Chair: Lina Bariah
- **Working groups**
  - WG1: Workshops, Special Sessions, and Conferences
    - Samson Lasaulce, David López-Pérez
  - WG2: Special Issues in Top-Tier Journals
    - Abdelmalik Bachir, Carlo Fischione, Emilio Calvanese Strinati
  - WG3: Tutorials, Invited Talks, and Industry Panels
    - Christina Chaccour, Xingqin Lin, Juan Deng
  - WG4: Dataset and Competitions
    - Qiyang Zhao, Igor Carron, Antonio De Domenico
  - WG5: Industry Activities and Standardization
    - Chenghui Peng, Fathi Abdeldayem, Markus Mueck
  - WG6: Online Content
    - Li Sun, Ali Maatouk, Abdelghani KABOT

TelecomGPT Alliance

Perspective 1: TelecomGPT for Wireless Communications & Networking

Perspective 2: Implementation Aspects of TelecomGPT

Perspective 3: TelecomGPT for Network Operation & Management

Perspective 4: *Connecting the LLMs*

Perspective 5: *Telecom AI Agent*

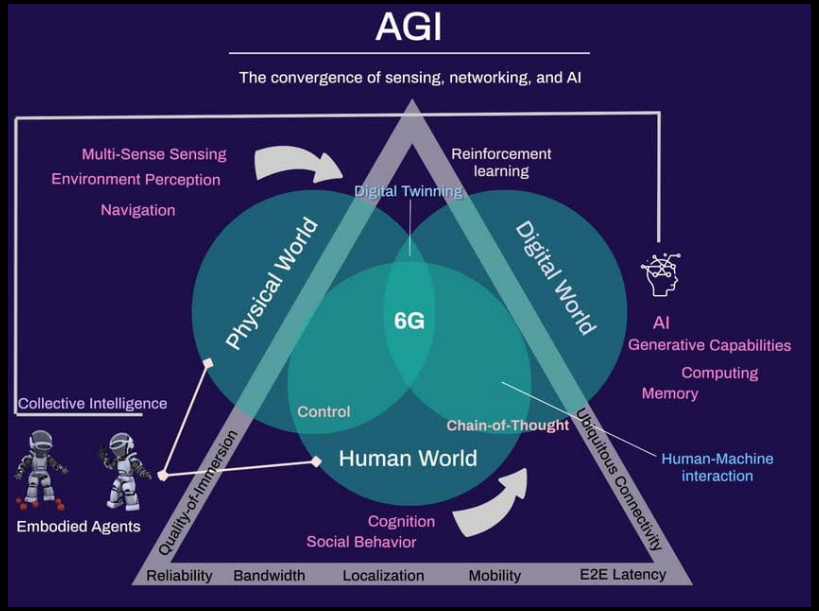
Perspective 6: *Reinforcement Learning with Human Feedback for TelecomGPT*

WHITE PAPER

Large-Scale AI in Telecoms: Charting the Roadmap for Innovation, Scalability, and Enhanced Digital Experiences

Topics:

- Overview of Large-Scale AI
- Large-Scale AI in Telecom: SotA
- AI Theory of Large Telecom Models
- Models Architectures & Deployment
- Datasets
- Evaluation & Benchmarking
- Hardware Advancement & Requirements
- Applications and Use-Cases
- Regulatory Perspectives
- Standardization Activities and Roadmap
- Industry Insights
- Practical challenges & opportunities



First draft targeted in Sep. 2024

ITU Challenge

AI for Good
Machine Learning in 5G Challenge

Specializing Large Language Models for Telecom Networks

aiforgood.itu.int