aspire Perfecting Networks

TELFOR

Mobile networks evolution & Road to 6G
The role of Artificial Intelligence

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November 2025

Agenda

Aspire introduction

AI in Mobile Networks

Aspire work in AI domain

Agentic AI Demo

Q&A

About Aspire

- Aspire, a subsidiary of NEC Corporation, provides specialized network services and software solutions
- Clients are fixed and mobile operators, large enterprises, vendors, system integrators, and other technology partners
- Expertise spans all network domains and technologies, including Telco and IT Cloud
- Offers end-to-end, multi-vendor solutions across the entire networks' lifecycle
- Delivers projects globally with an international team of network and software engineers
- Utilizes an Open Lab in Europe with over 30 vendors across Cloud and NFV, along with NEC Labs globally

Perfecting fixed, mobile, and private networks with Aspire Automation Platform and AI-powered applications

- Research & Development
- Strategy
- Design
- Rollout
- Optimization
- Operations & Support
- Customer Care

Our differentiators

Network performance experts

We are network experts, from R&D to Customer Care, we support operators across the whole network lifecycle, and in all network domains. We are committed to dedicate our senior experts.

Vendor independent

Unbiased and expert-led consulting, solely focused on minimizing network investment to achieve the best possible end-user experience, without any conflict of interest

Multi-technology & multi-vendor

Recognized by the industry and our clients as truly end-to-end, across large and niche suppliers for mobile, fixed and private networks.

AI-enabled automation

Bespoke AI-enabled software solutions for Operator specific needs, fully integrated with Operator’s systems, leveraging their existing landscape of tools.

A NEC Group company

Strong presence, with a Global talent pool and the highest industry standards on compliance, quality, cyber security, data management, and financial performance.

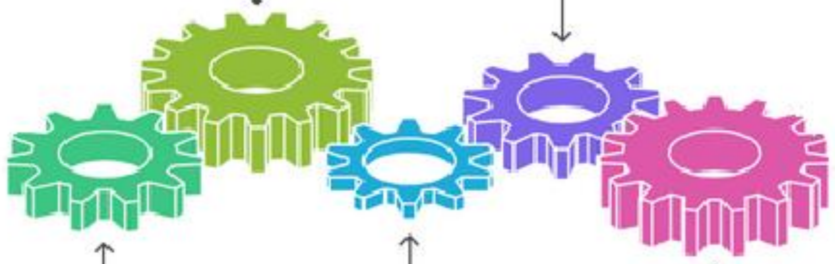
AI in mobile communications
Overview

- Many users **do not perceive a meaningful difference** between 4G and 5G.
- Operators are still working to **unlock Returns from Investments** in 5G
- Networks transformation and evolution towards 6G is **all about AI**

Only AI-powered mobile networks can realize the next wave of capabilities:

Zero-touch operations & self-healing

Automated troubleshooting across multi-vendor, multi-layer networks



Predictive Energy savings

Predictive capacity planning

Foundation for 6G intelligent, autonomous networks

“The next leap in telecom isn’t just from 5G to 6G — it’s a fundamental redesign of the network to deliver AI-powered connectivity, capable of processing intelligence from the data centre all the way to the edge.” — Justin Hotard, President and CEO of Nokia

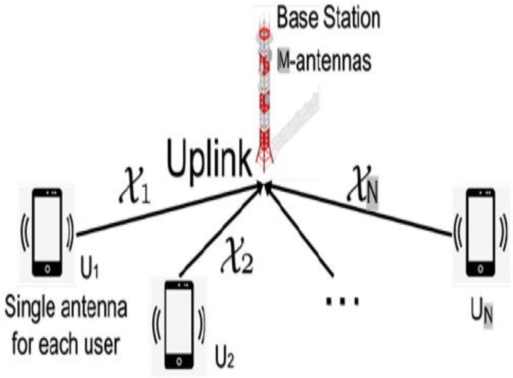
“Together with Nokia, and America’s telecom ecosystem, we’re igniting this revolution, equipping operators to build intelligent, adaptive networks that will define the next generation of global connectivity.“— Jensen Huang, Founder and CEO, NVIDIA

How AI impacts design of Physical Radio Interface

Example: User detection in MU-MIMO systems

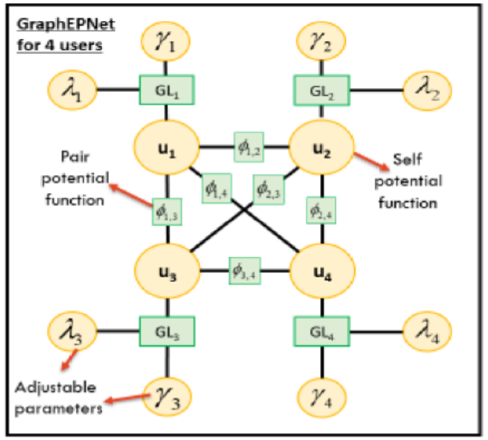
PROBLEM STATEMENT

- **Detection of users in Multi-User MIMO scenario**

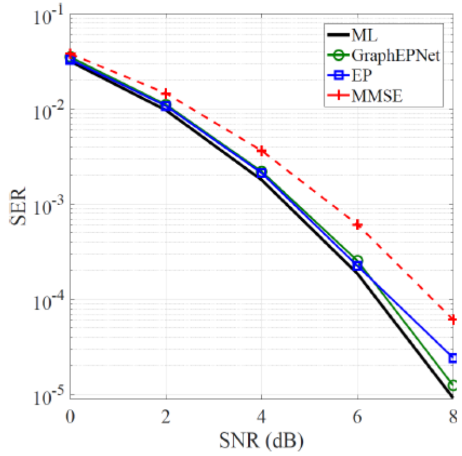


SOLUTION

- **Neural Network Based User Detection – Solution proposal:**



Graph Neural Network-based Detector



Symbol Error Rate

System configurations:
Quadrature Phase Shift Keying (QPSK),
Number of Rx: 32, Tx :8
Total samples : 100000, Batch size : 64
Number of training iterations : 500
Number of layers for each MLP : 3
Hidden layer neurons in each MLP : 128
Optimizer : Adam

BENEFITS

AI can reduce the complexity of physical layer algorithms and resource allocation protocols

Detector	Complexity	Complexity Values
Maximum likelihood	$O(A^N)$	4294967296
Minimum mean square error	$O(M^3)$	430080
Expectation propagation	$O((M^3+M^2N+MN^2)T)$	124288
GraphEPNet	$O((N^2+MN+L)T)$	32768 (26% of EP)

A. Kosasih, V. Onasis, V. Miloslavskaya, W. Hardjawana, V. Andrean, and B. Vucetic, Graph neural network aided MU-MIMO detectors, IEEE Journal on Selected Areas in Commun., Vol. 40, No. 9, July 2022, pp. 2540-2555.

AI-Native RAN: The Next Evolution of Mobile Networks

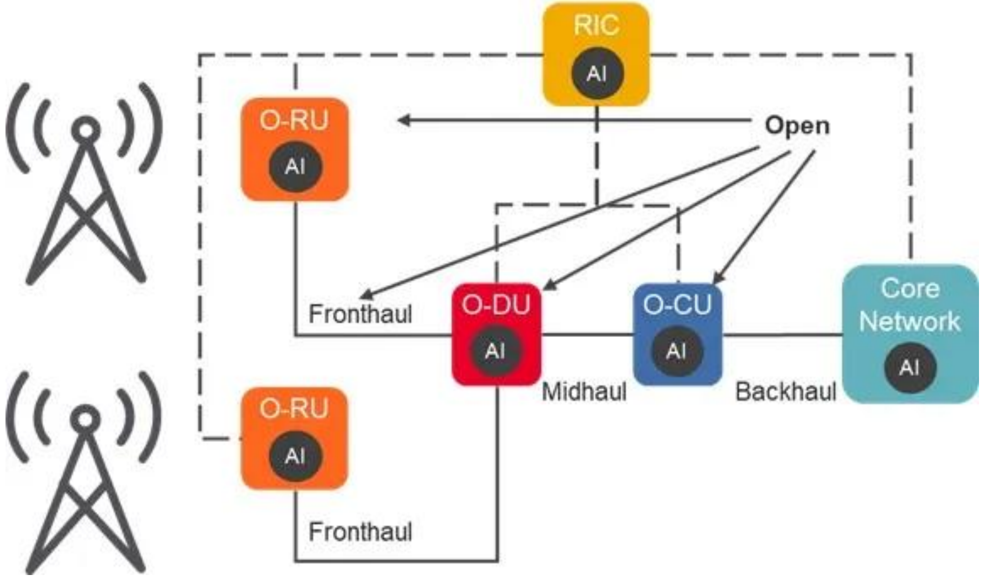
- **From static rules to adaptive learning** → RAN observes, learns, and self-optimizes in real time.

- **AI & automation redefine RAN economics** → Lower OpEx, energy use, CO_2 footprint, deferred CapEx, optimizing performance, improving user experience and enabling new services.

- **AI modernizes legacy RANs** → Adds intelligence and automation to existing, closed systems.

- <u>Two Paths Toward AI-Driven RAN Evolution</u>:
  - **O-RAN:** open innovation via SMO, Non-RT / Near-RT RIC, xApps & rApps.
  - **Legacy Vendors (Ericsson, Nokia, Huawei):** AI embedded internally; limited 3rd-party access.

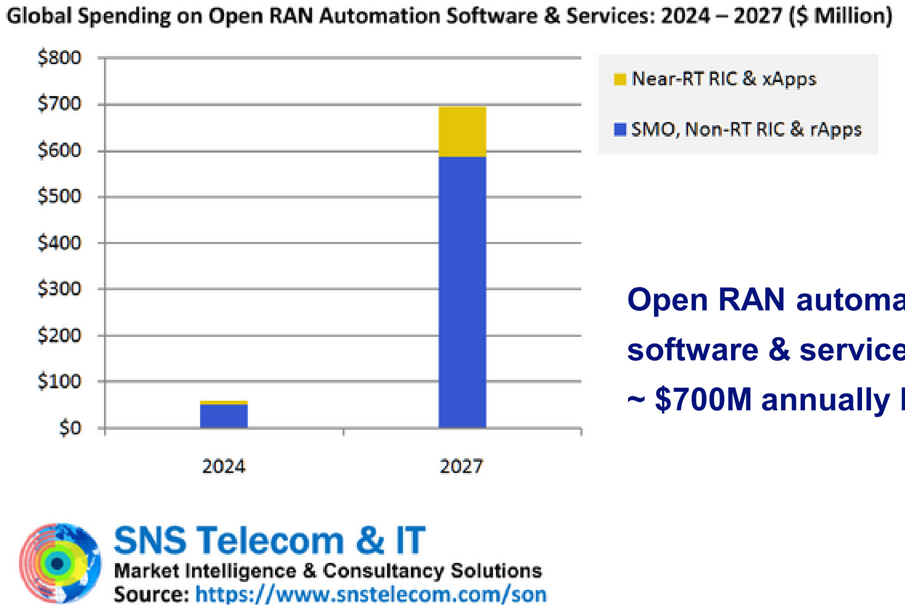
- **Leading adopters:** Rakuten, NTT DoCoMo, AT&T, Swisscom, Deutsche Telekom.



AI-Native RAN & Automation in Mobile Networks

Market & Deployment Data

- Rakuten Mobile: 17% cell-level energy savings via RIC-hosted RAN automation applications (target 25%), performed between mid-2022 and early-2023.
- Japanese operator NTT DoCoMo expectations: Up to 30% TCO reduction (validated in field trials and internal studies conducted from 2021 to 2023), 50% BS power reduction through Open RAN.
- AT&T is adopting Ericsson's SMO and Non-RT RIC as part of a $14 B, five-year Open RAN contract, replacing two legacy C-SON systems
- Telus in Canada plans to transform up to 50 % of its RAN using a multi-vendor SMO/RIC platform.
- In Europe, Swisscom and Deutsche Telekom are developing SMO/Non-RT RIC frameworks to automate legacy networks, and Vodafone Group aims to include Open RAN automation in its 170 000-site global modernization program



Open RAN automation software & services to reach ~ $700M annually by 2027.

Industry outlook/Vendor direction

- Global RIC / SMO / xApp / rApp spending projected to grow
  ->125 % CAGR (2024 – 2027) — *SNS Telecom & IT*.
- As a counterbalance to this approach, Ericsson, Nokia, Huawei and other Established RAN vendors are evolving toward AI-native architectures, integrating AI/ML intelligence deeper into DU/CU layers in preparation for 6G's intelligent air interface.

Key Challenges

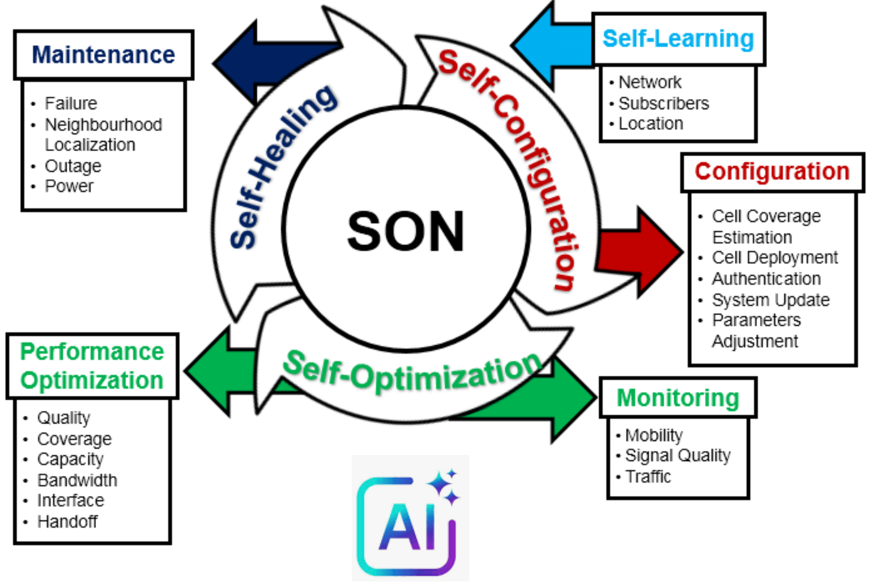
- Standardization and interoperability gaps.
- Conflict resolution between xApps/rApps.
- Operator trust, latency & reliability barriers.
- Integration into brownfield (legacy vendor) networks

AI Driven SON

AI-SON

- AI-SON enhances classical SON by integrating AI and ML directly into the decision-making loop.
- ML models enable proactive **detection**, **prediction** and **optimization** based on real-time KPI data
- These models enable the network to **detect** issues before impact, **learn** from experience, and **self-adjust** in real time.
- The intelligence resides in the **AI/ML processing layer**, where data is transformed into actionable insight.

AI models enhance each SON function — self-optimization, healing, configuration, and learning



AI-SON Architecture:

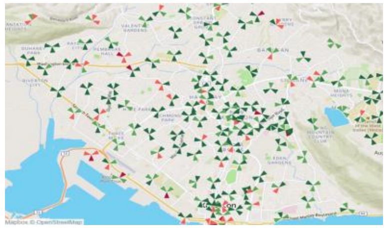
1. Data Collection Layer → Gathers KPIs, alarms, configuration, topology.
2. AI/ML Processing Layer → Learns, predicts, and diagnoses (core intelligence).
3. Decision & Policy Layer → Selects optimal corrective actions.
4. Execution Layer → Implements optimization via SON or OSS.

Different ML techniques enable various AI-SON capabilities

Learning Type	Typical ML Methods	Key Use in RAN / AI-SON
🧭 **Supervised**	Random Forest, XGBoost, SVM	KPI prediction, coverage classification
🔍 **Unsupervised**	K-Means, GMM, Autoencoders	Anomaly detection, interference grouping
🌗 **Semi-Supervised**	Self-training, Semi-supervised DL	Sparse data fault detection
🔁 **Reinforcement (RL)**	DQN, PPO, A3C	Load balancing, mobility, power control
🧠 **Deep Learning**	CNN, DNN, LSTM, Transformers	Beam management, QoE prediction

ML Based Traffic Forecasting

Building with precision, site level traffic prediction

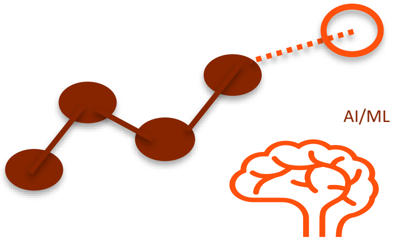


What?

- Each site/sector has its own traffic pattern
- NW/area-based traffic forecasting do not provide satisfying results
- For building with precision site/sector level traffic prediction recommended

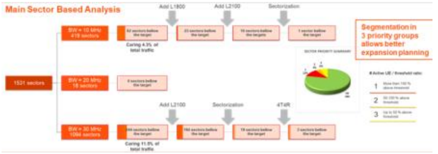
How?

- Advanced state of art ML models (ARIMA, Holt-Winters, xGBoost, Prophet, Deep learning…)
- Vast modelling experience
- Customized models for MNO's use cases



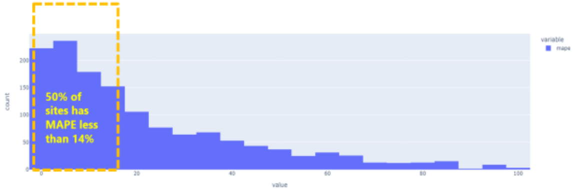
Value!

- Automated predictive expansions planning
- Site based RAN expansion
- TN capacity expansion (known topology + aggregation)
- Core NW Licenses expansion (payload -> Active #UEs)



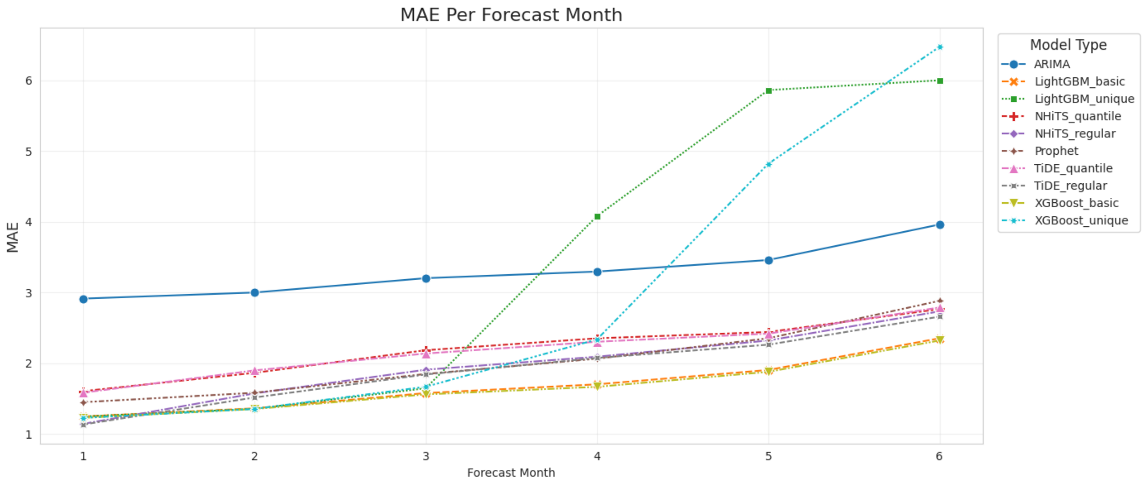
Result

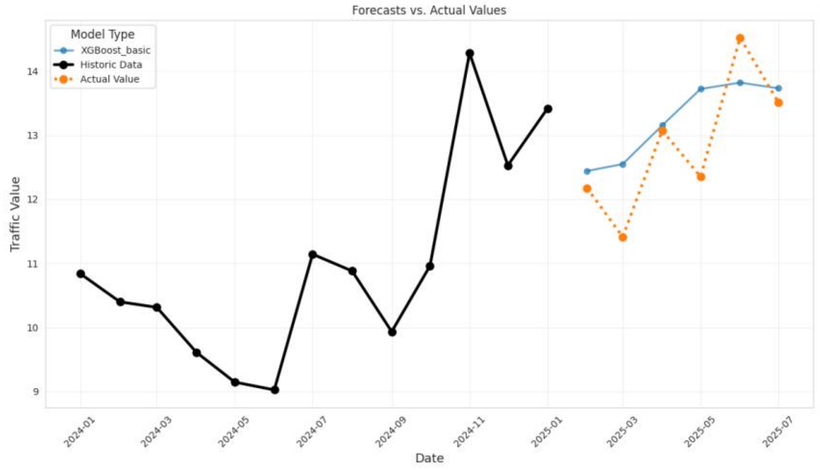
- Good accuracy achieved (50% of base station with MAPE<14%)
- Ability to predict with good accuracy in complex traffic mix & deployment scenario

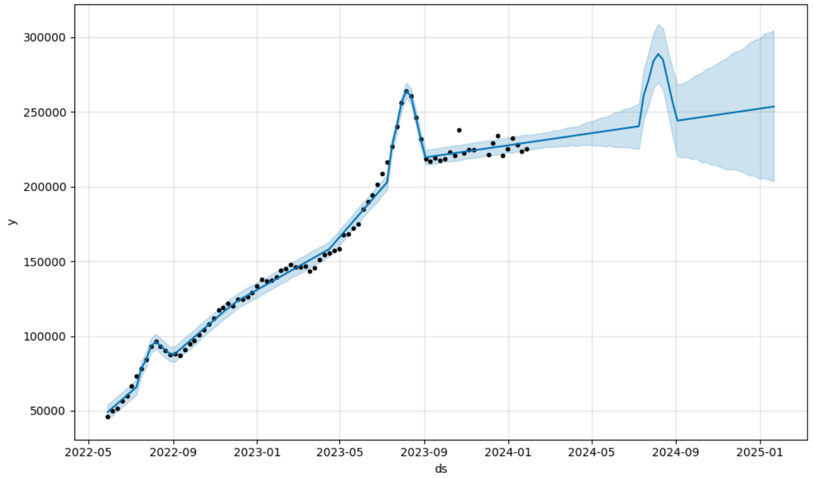


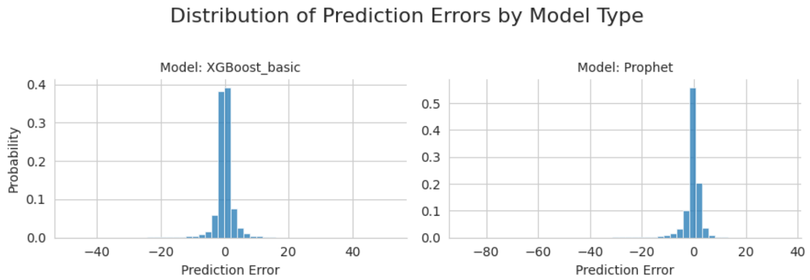
ML Based Traffic Forecasting

- Dilemma: To use one global model or multiple smaller ones?
- Monthly Traffic is calculated as mean of top 150 BHs for a site in that month
  - Problem: Customer data retention policies meant that not too many data was available
- Models considered: **ARIMA** (baseline), **Prophet**, **XGBoost/LightGBM** (among others)
  - Deep Learning: LSTMs, N-HiTS, TiDE
  - Each model has it's own complexities (e.g., XGBoost)
- Global models generally outperformed smaller ones by at least 10%
- Proper modelling can lead to very accurate predictions of holiday impacts
- Per-customer approach: one model may prove to be better for a given network topology



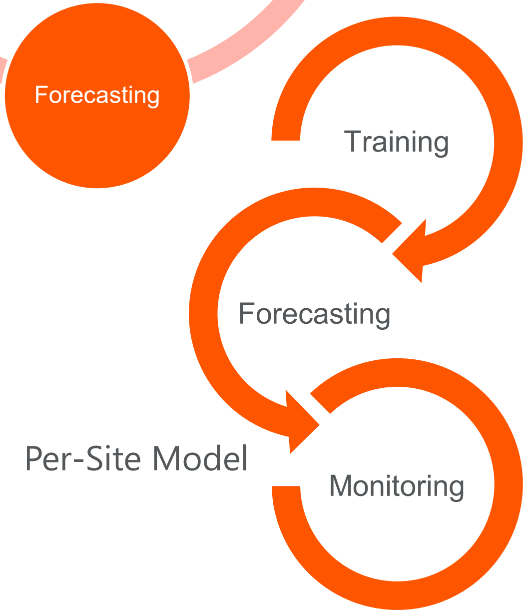


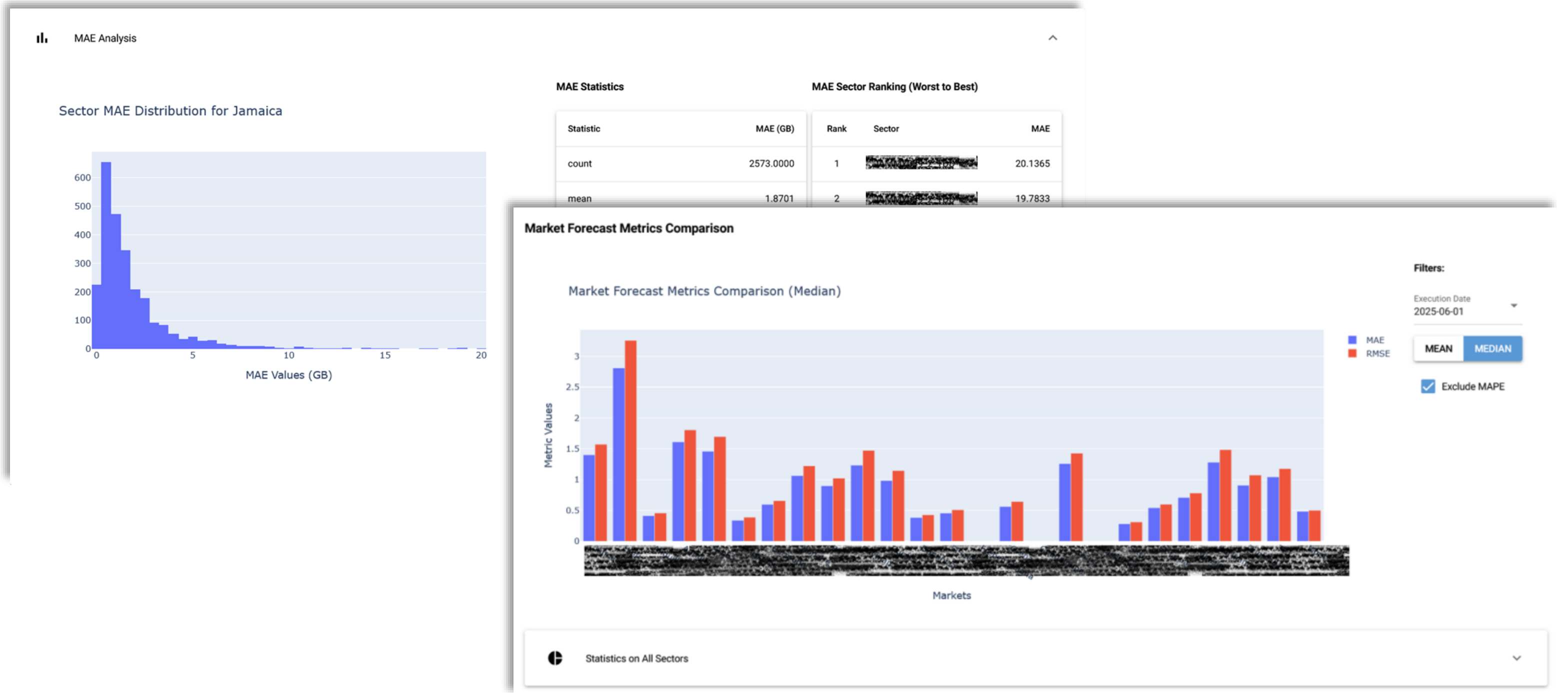




ML Based Traffic Forecasting

- The Traffic Forecasting Methodology for site level expansion has been deployed for multiple customers so far
- The solution constantly monitors the performance of the model(s) to provide more accurate feedback on the performance
  - Tracked metrics: **MAE**, **RMSE** and **MAPE**
- Constant re-evaluation of the models in real-world scenario, so that we have up to date reports on the performance of the models





ML Supported Sector Clusterization/Segmentation

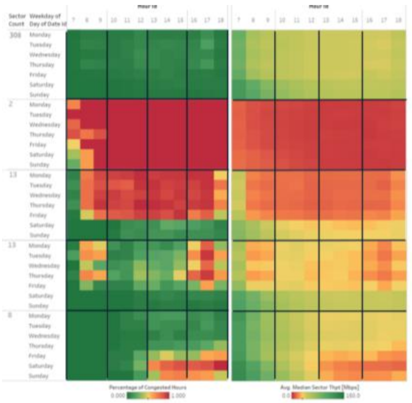
Problem/Solution/Benefits

PROBLEM STATEMENT

- Different traffic/performance pattern require different RF design and optimization measures.
- When CAPEX is limited, prioritization of expansions is a must.
- Sector segmentation/clusterization is a prerequisite for automation.

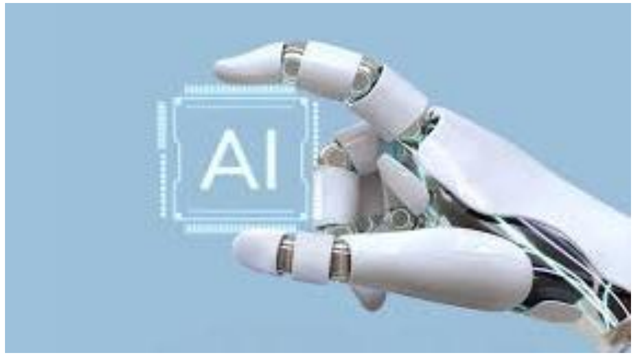
SOLUTION

- Optimized ML (K-Means) based methodology for sector segmentation and clusterization.
- Expert system to replace ML analytics for memory & processing power optimization.
- Integration with NetPlanner, NetConfig and improved engineering capabilities.



BENEFITS

- Reliable, automated patterns recognition and sectors segmentation.
- Valuable inputs for automated engineering actions and road towards Agentic AI solutions.

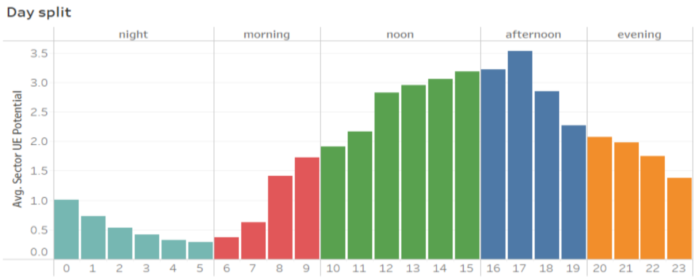


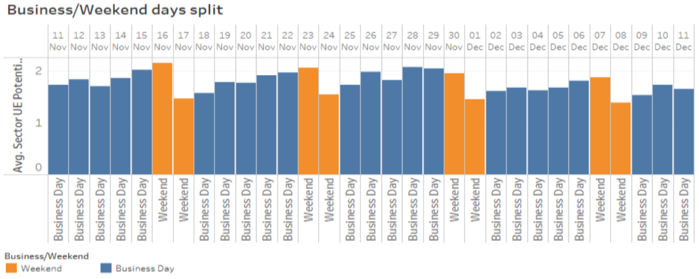
Winning strategy, CAPEX optimization, design with precision and end to end seamless rollouts.

ML Supported Sector Clusterization/Segmentation

Feature Selection

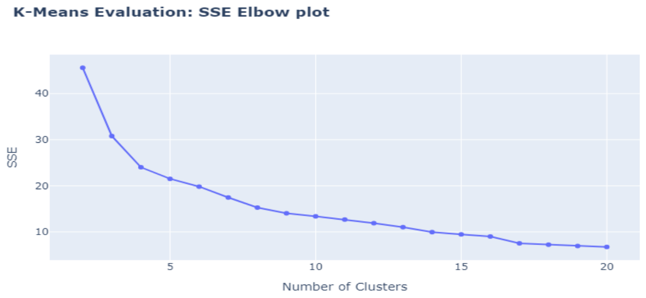
- User experience is driven by load/congestion, which depends on the time of the day
  - Aspire Cell Performance Signature Methodology was used to determine congestion
  - Features had to be time-based
- **Features:** Median number of congested hours in selected time window in different times of the day
  - Day splits determined by observing the Cell edge User Throughput for various sectors.
  - Business/Weekend split was introduced after noticing the clear difference in some of the sectors

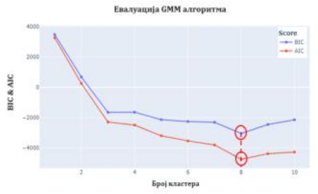




Clustering Model Selection

- Different clustering methodologies considered: **K-Means, BIRCH, DBSCAN and Gaussian Mixture Models**
- Determined optimal values for hyperparameters for each of them using appropriate methods
- **Results**: Algorithms converged to same optimal number of clusters obtained for K-Means
  - DBSCAN would just flag the problematic sectors as outliers
- Optimal *k* for clusters was determined using the SSE Elbow Plot
- **Evaluation** done both using metrics and manually
  - **Metrics used:** Silhouette Score, Davinski-Bouldin Index, Calinski-Harabasz Score
  - **Manual evaluation** done by confirming the grouped sectors had Throughput issues in the expected time-frames

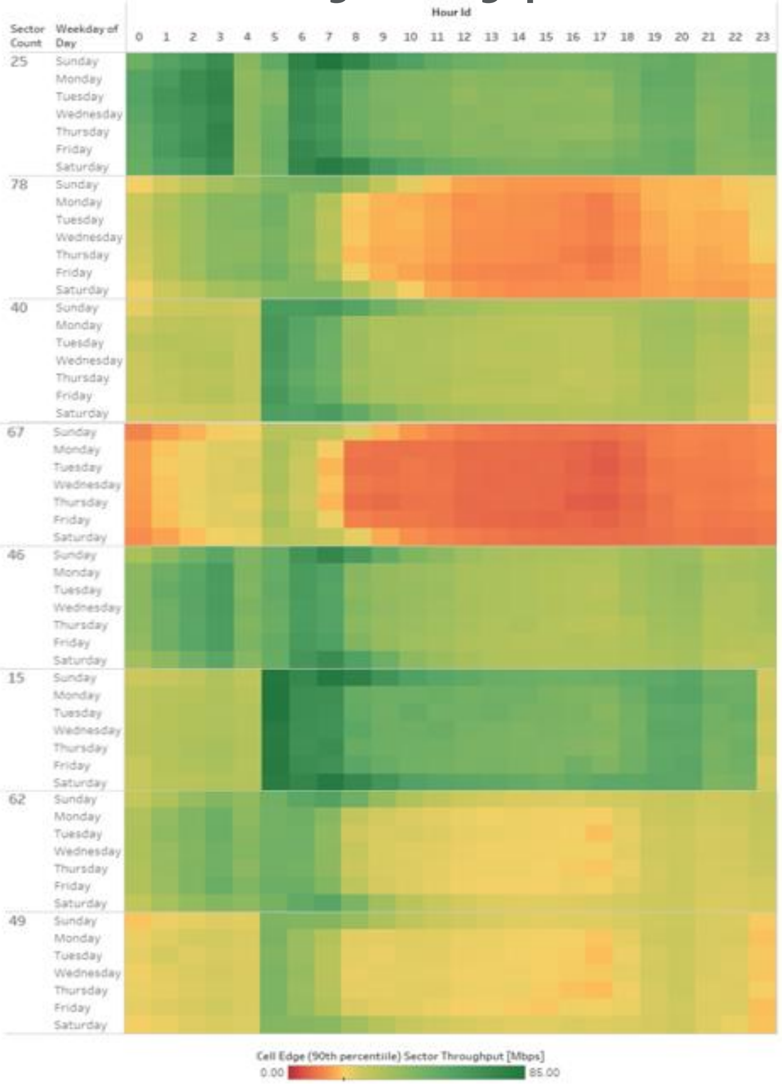




ML Supported Sector Clusterization/Segmentation

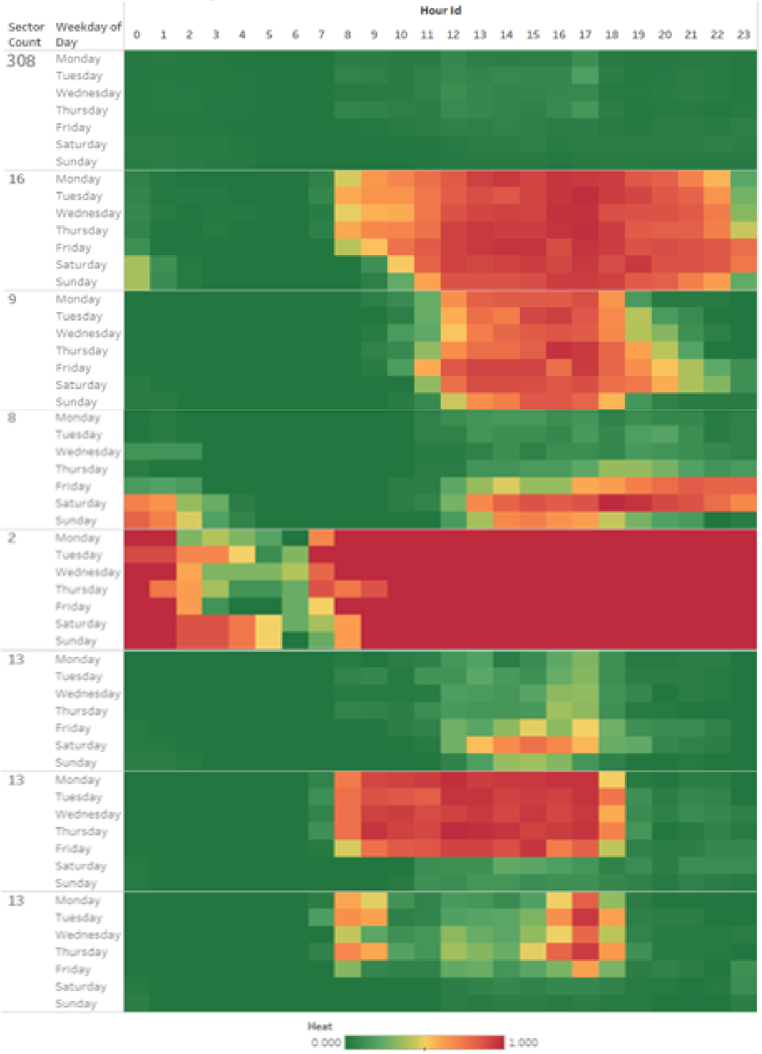
Aspire Innovation

Cell edge throughput criteria



Scheduler load status
relative to EDT threshold

Congestion level indicator criteria



- **Cell-edge throughput clustering is weak.** It doesn't reveal clear spatial or behavioural patterns, so it's less useful for decisions.
- **Congestion-based clustering is actionable.** It clearly groups sectors by overload, giving usable segments for planning & optimization.
- **Even split ≠ useful split.** Cell-edge throughput yields a more even cluster size distribution, but with lower relevance for network actions.
- **Sharper focus, better accuracy.** Congestion clustering narrows analysis to crowded sectors, improving grouping accuracy; well-performing sectors fall into one large, low-priority cluster.

Aspire Agentic NOC

Demo