AI-Driven vRAN Planning for 4G/5G Networks

CASE STUDY: Machine Learning for Group Center and Unit Optimization in 4G/5G Networks

At A Glance:

Efficient Virtual RAN Planning for Group Center (GC), Virtual Centralized Unit (vCU), and Virtual Distributed Unit (vDU) Mapping: A Real Project Case.

Locations:

- Tokyo, Japan
- Turkey, İstanbul
- Dubai, UAE

Sector:

Mobile Network Infrastructure, Virtual RAN

Services Provided:

Automated Virtual RAN planning tool developed by using K-means clustering machine learning algorithm to plan and optimize Group Center (GC), Virtual Central Unit (vCU), and Virtual Distributed Unit (vDU) mapping.

PROJECT OVERVIEW

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Project Background & Challenges

We supported a greenfield operator facing the complex challenge of rapidly evolving geolocation-based 4G/5G Group Center (GC) planning during an advanced virtual network rollout.

The manual planning process was time-consuming, inefficient, and difficult to scale, especially under aggressive deployment timelines.

Our Solution / Approach

We implemented an end-to-end machine learning-powered planning pipeline, combining K-Means clustering with a modular, scalable software architecture tailored for vRAN node mapping.

Our machine learning expert—leveraging a strong background in scientific research—solved a long-standing planning bottleneck in just a few weeks. The algorithm enabled automated Group Center optimization, reducing planning time from hours to just a few minutes, drastically improving scalability and operational efficiency.

By the end of the project, over 5,000 sites and 15,000 cells were successfully planned and integrated to vRAN automatically using our algorithms and dedicated tools. This module integrates multiple databases and ensures error-free PCI/RSI/PRACH/PUSCH planning using an SQLite database for secure storage and backup.

To enhance usability, a GUI-based multi-module software platform was developed, enabling efficient and user-friendly operations.

Key steps Included

Problem definition information provided from the vendor planning team. The desired solution outputs and planning criteria definition defined with corresponding parties.

An algorithm created with our AI/ML team for solution in 2 weeks. The viability of output planning results checked with corresponding team by using data analysis and performance analysis metrics extensively. It is validated.

A several layer custom tools created in python and its ML/AI libraries for performing specific functions, each software node working independently to secure the operation and performing individual updates to each tool. By this design approach operator can easily control and manipulate the software by own. This is crucial for future development and independency form software providers. Also a GUI-based multi-module software developed for efficient and user-friendly operations

A suite of software tools and automation nodes was developed to support the full lifecycle of the project. This included data cleaning, algorithm execution, consistency checks, backup of live network data, application of planning results, and immediate post-application performance validation. The system also featured rollback capabilities and automated reporting for live network monitoring and results analysis.

TECHNICAL OVERVIEW

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Technical Highlights

Pipeline Architecture: The system follows a robust pipeline-based design, where each software module sequentially processes and validates outputs from the previous stage, ensuring high reliability and modularity.

Open-Source Flexibility: All tools are built entirely on open-source technologies, eliminating dependency on third-party software—ideal for operators with limited budgets or access restrictions.

AI-Driven Automation: Integrated data science and AI tools drastically reduce manual effort while maintaining high accuracy across planning and validation stages.

Secure Deployment: Auto-check mechanisms and rollback capabilities are built in to ensure safe, real-world application in live network environments.

Specialist Skills & Team Approach

Our engineers possess strong expertise in data science, statistics, software development, RF engineering, algorithm design, and 4G/5G system architecture, all supported by solid scientific backgrounds. Accurate predictions and optimizations were achieved thanks to deep knowledge of electromagnetics, RF planning, and mobile networks spanning 2G through 5G.

Proficiency in scripting and data analysis enabled efficient processing of large datasets and automation of complex tasks, while scientific rigor ensured robust statistical analysis and model tuning.

Projects are consistently delivered ahead of schedule through smart resource allocation, strategic AI-assisted workflows, and close collaboration with contracted partners. The last project was successfully completed with minimal manpower, thanks to these automated and optimized processes.

Deliverables include three highly detailed and clear reports: An executive summary focused on key results and insights. A two-part technical report for the engineering team, comprising visual presentation materials and comprehensive statistical test results with data analysis.

The expert core team combines RF engineering and data science skills and is supported by backup engineers to ensure scalability and project continuity.

CHALLENGES & RESULTS

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CHALLENGES

Managing Complexity and Speed in Massive virtual RAN Deployments. Rapid scaling, accuracy under live conditions, and eliminating manual planning inefficiencies

Delivered a complete, modular, and upgradeable in-house solution to meet all virtual network planning needs.

Optimized network cluster planning using real-world data to enhance accuracy and performance.

Significantly reduced planning time and increased efficiency by orders of magnitude through automation.

RESULTS

400+ Engineering Hours Saved in 3 Months. Planning Time Cut from hours to minutes — up to 15,000 Cells planned with High Accuracy

Applied a tailored, scientific approach to deliver faster, more accurate results. Automated tools efficiently cleaned, corrected, and validated large datasets.

Engineers were able to inspect and refine planning data using custom-built tools. Internal models and workflows provided flexibility and independence from generic software.

Combined technical expertise with bespoke processes to reduce turnaround times, decrease manpower requirements, and deliver improved models.
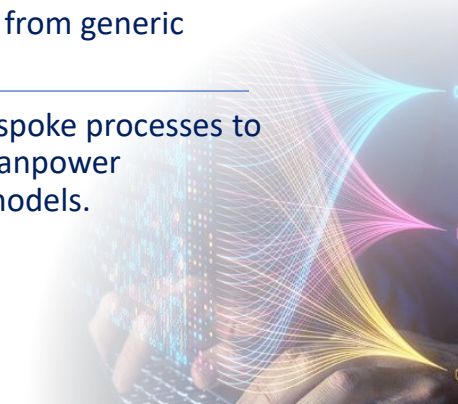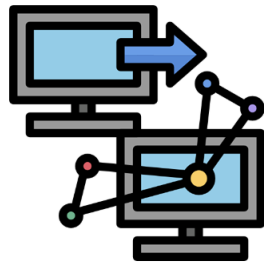
IDEAL SCENARIOS

Greenfield network deployments at all scales

New technology rollouts and developments

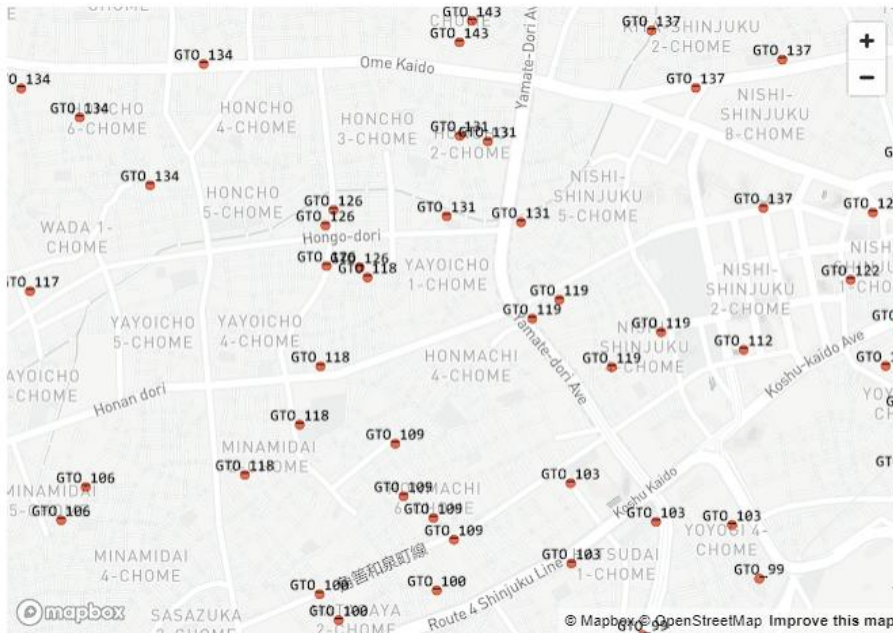Network topology changes and upgrades

Periodic updates to keep pace with evolving network conditions

REPORT DATA

Figure 1: Planning Result Screen Output. This view illustrates how nearby sites are grouped based on a defined algorithm. As the network expands—through the addition of new sites or relocation of existing ones—the virtual planning logic dynamically updates to reflect the most optimal configuration.
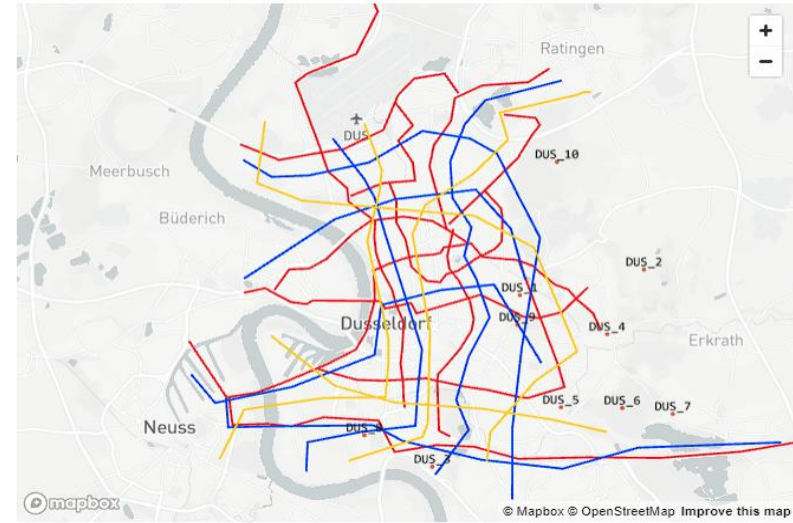
	Point		Min_Distance	Site Name	Min_Distance_Own	Min_Distance_V1	Min_
0	51.23278787	6.828896869	287.121	DUS_1	307.0427	287.121	
1	51.23949687	6.877493537	1,615.5493	DUS_2	1,615.5493	2,952.3421	
2	51.18787059	6.794628688	199.3762	DUS_3	597.7035	199.3762	

Figure 2: Fiber Optic Path Evaluation Module. This module of the planning tool evaluates and compares fiber optic line distances for each site. It automatically identifies the most suitable alternatives based on cost, distance, and feasibility analyses.

REPORT DATA

Figure 3: Sample output from the planning tool interface.The tool is optimized for simplicity and efficiency—users only need to push a few essential buttons and provide input via an online database or CSV files. Results are generated automatically and can be directly applied to the live network through integrated features.

TESTIMONIALS

This project stands out as a benchmark in innovation and execution. The team delivered a highly intelligent, fully automated virtual RAN planning solution that significantly exceeded expectations in both speed and precision. By integrating advanced machine learning with a modular software design, they not only solved a long-standing challenge but also set a new standard for scalable, real-world RF planning. The outcome was measurable—thousands of sites optimized in record time, with minimal manual effort. This is the kind of forward-thinking engineering that transforms operator capabilities.

Global Key Account Director, Infovista Japan

From day one, the project demonstrated exceptional technical depth and execution discipline. The automated vRAN planning solution developed by the team drastically improved our planning efficiency, saving hundreds of man-hours and delivering unmatched accuracy. Their ability to merge data science, RF engineering, and real-world operational needs into a single robust pipeline was a key success factor. This level of delivery, especially in a high-pressure greenfield rollout, is rare and commendable.

Head of Delivery (Operations Director), LCC Turkey

This project showcased exactly the kind of innovation and delivery excellence we value at Tangent International. The team's ability to develop a cutting-edge, AI-driven virtual RAN planning tool—while staying aligned with aggressive timelines and operational realities—was impressive. Their work not only solved a complex technical challenge but also delivered scalable, future-proof solutions that set a new benchmark for greenfield network rollouts. We're proud to be associated with such forward-thinking engineering talent.

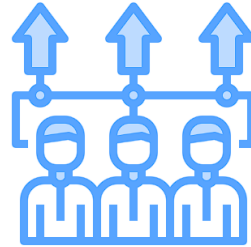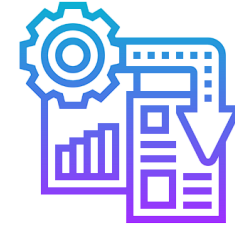**Divisional Director, Tangent International. UK**

WHY SBYSOFT ?

Access to highly specialized consultants with hands-on delivery experience.

The ability to scale up teams quickly for regional or multi-country projects.
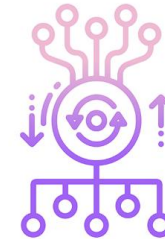
A practical, data led approach grounded in real-world network behaviors.

Fast, fully remote delivery with deep expertise and consistency

Smart, cost-effective RF solutions tailored to each project's goals.

A data-driven approach that reduces costs, shortens timelines, and improves accuracy.

CONTACT

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