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The new frontier: AI-based backhaul management

In today's modern 5G networks, true network reliability means treating the Radio Access Network (RAN) and its transport network as one cohesive entity.

Strategic reliability is no longer about reacting to failures, but proactively preventing them. O2 Telefónica Germany has been looking into how to incorporate artificial intelligence (AI) in microwave network management to complement and further enhance its current backhaul management tools suite.

Red Cells versus Red Sites

O2 Telefónica Germany is leading the way in proactive network management by systematically identifying and optimizing "Red Cells", defined as RAN cells with potential for enhanced performance, to help set a new standard for reliable network connectivity.

Red Cells may be impacted by factors such as fluctuating traffic demands, hardware malfunctions, or signal propagation challenges due to local geography. All of this can influence calls, data throughput, service quality and other key performance indicators (KPIs). Although Red Cells are specific to the RAN, their performance is inherently connected to the underlying transport network. To differentiate transport-related concerns from Red Cells, O2 Telefónica Germany uses the term "Red Site", which refers to a location experiencing backhaul capacity constraints or microwave link limitations.

O2 Telefónica Germany's approach to resolving Red Sites

To ensure optimal network performance and deliver a superior customer experience, O2 Telefónica Germany uses efficient and systematic methods to monitor the holistic health of its mobile network. Building on its established strategy, the company has a long history of utilizing microwave technology to complement its fiber backhaul network. By using advanced customized tools to transition from reactive fixes to a predictive maintenance model, O2 Telefónica Germany has reduced the occurrence of Red Sites in its transport network by 98 percent.

Transport network performance is continuously monitored end-to-end using a comprehensive range of KPIs that differentiate between data types and actual data throughput. The system converts the data into an intuitive 1–6 scoring scale that includes color codes and generates tasks automatically, making it easy for engineers to identify areas that may require attention. This multi-faceted analysis helps quickly distinguish between capacity-related bottlenecks and physical defects, which are the primary causes for Red Sites as shown in Figure 4.

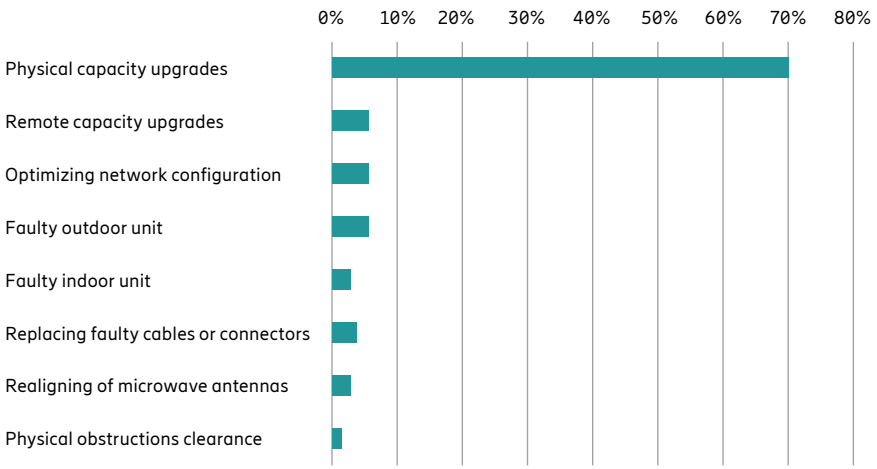
O2 Telefónica Germany is one of the leading integrated telecommunications providers in Germany, with 34.4 million mobile telephone lines and 2.4 million broadband lines. The company offers mobile and fixed network services for private and business customers as well as innovative digital solutions based on its infrastructure and the analysis of mobile data. It is part of Telefónica, one of the largest telecommunications service providers in the world. The company offers fixed and mobile connectivity, as well as a wide range of digital services for residential and business customers.

Red Cells and Red Sites

Red Cell
A RAN cell with lower performance than expected.

Red Site
A site with reduced backhaul availability or throughput.

Figure 4: Main remedial actions for resolving Red Sites



Beyond monitoring: The use of AI for smarter network management

A key objective for today's network operations is to use AI and automation to move from costly, reactive fixes to smarter, preventive maintenance and proactive, cost-efficient network management. Acknowledging this, O2 Telefónica Germany and Ericsson have collaborated to explore the transformative potential of AI in enhancing traditional monitoring systems, making early and automated predictions of Red Sites a crucial capability.

The foundation for efficient AI-based preventive maintenance

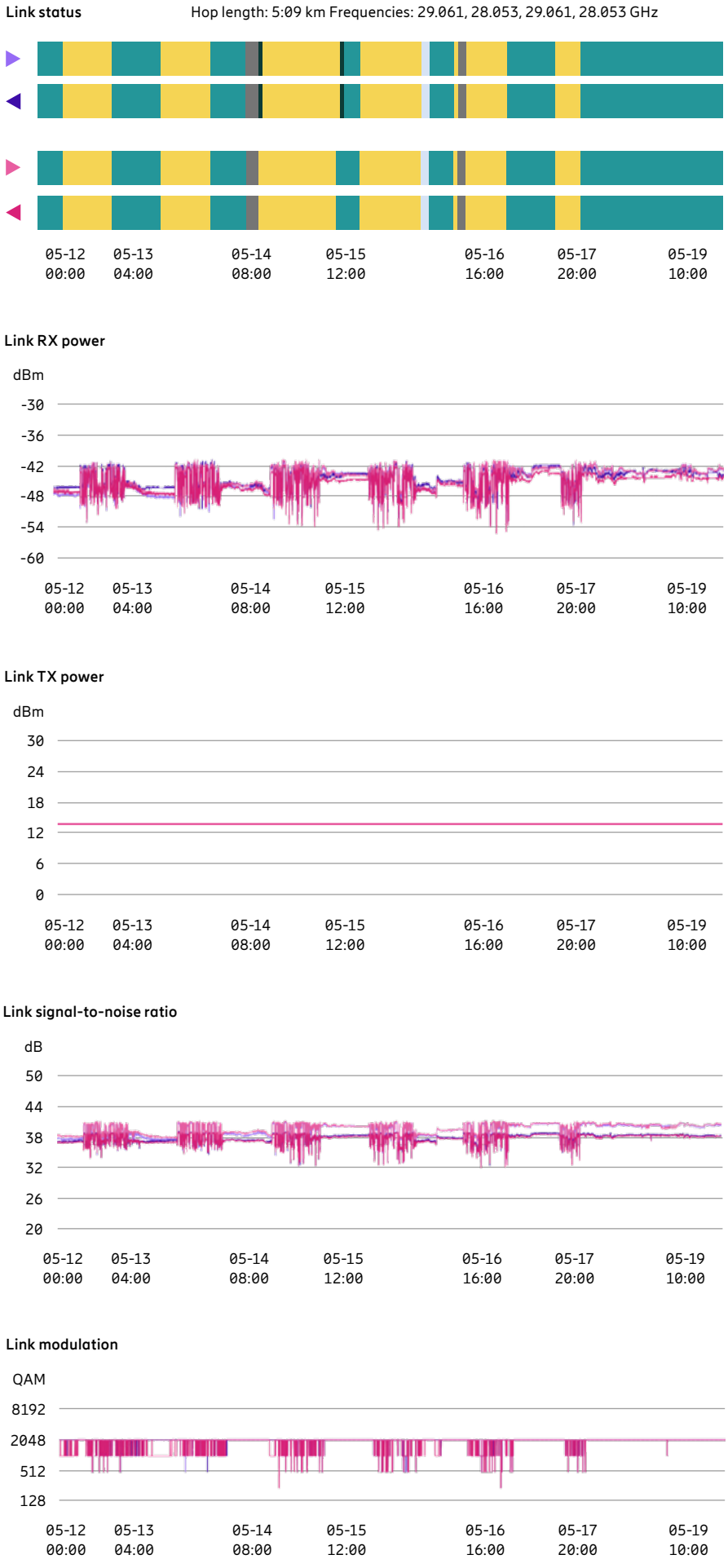
Building effective preventive maintenance with AI and automation starts with several key requirements. First, high-quality, granular network data must be available in real time. This data should also be stored for later analysis to identify and visualize performance trends over time. Traditional methods that use 15-minute performance counters are insufficient as they no longer provide enough detail. Today, modern data-centric architectures are used to deliver both the required data granularity and real-time availability. It's also becoming crucial to combine live performance data with network planning information to make the right correlations and detect outliers early and quickly.

For instance, AI-based management systems can easily identify slight antenna misalignments caused by storms or pinpoint developing cable faults. They can also distinguish between different types of signal degradation, such as the erratic signature of multipath fading versus the predictable pattern of rain fading, and can even predict equipment failures like an optical transceiver approaching its end-of-life.

Using AI to detect noise floor degradations

AI may also identify low-level interference events that degrade the system's noise floor, causing "erroneous seconds" in transmitted data. This invisible phenomenon, often brief and sporadic, reduces the available system margin but is often not severe enough to cause an immediate service outage, making it difficult to discover through manual monitoring. Consequently, the affected link operates with less resilience than planned, amplifying the impact of subsequent events such as rain or multipath fading. An AI system can detect such noise floor degradations and highlight the hidden risks, allowing network operations centers (NOCs) to address vulnerabilities and schedule maintenance activities efficiently before they impact service availability.

Figure 5: Visualization of an obstruction in the line of sight



Harsh environments present significant maintenance challenges.

The AI advantage in action: Uncovering hidden link issues

While a skilled microwave engineer could, in theory, analyze massive volumes of performance data to find hidden issues, the sheer scale of modern networks makes such manual checks unfeasible. A network with thousands of microwave links generates millions of data points each month, creating volumes that are impossible to review effectively by hand. AI-based tools play a crucial role in continuously analyzing large datasets and effectively detecting complex patterns and anomalies at an early stage. This includes subtle issues that traditional monitoring may overlook – issues that AI technology is particularly well-suited to addressing. O2 Telefónica Germany could see these benefits as a result of its hands-on experience, gained through an AI-driven transport network management solution.

Figure 5 shows a real-life example from the O2 Telefónica Germany network, where timely and proactive action was important to prevent a site from becoming a Red Site. By combining fine-granularity data and AI algorithms, the tool detected a recurring line-of-sight obstruction. The top of Figure 5 shows detected issues versus time, where yellow shows detected line-of-sight obstruction and green indicates stable operation. The following four plots show received signal power, transmitted power, signal-to-noise ratio and the modulation used to support the engineer in confirming the root cause detected by the AI algorithms. The root cause in this case was a nearby construction site with cranes that temporarily blocked the signal at similar time intervals during workdays. When the cranes stopped at night, their changing positions led to different signal levels being received each night.

Maintaining network reliability in harsh environments with challenging access, such as the high-altitude location shown in the image above, presents significant operational challenges.

Delivering consistent backhaul for RAN connectivity is vital in such areas, making the shift to intelligent remote management more important than ever. This detailed visibility enables accurate remote issue diagnosis, allowing the planning of site visits only when necessary and ensuring that field teams arrive with appropriate equipment for required tasks when a site visit is unavoidable. Additionally, it enables a proactive approach by allowing preventive maintenance to be scheduled well in advance, which helps to uphold consistent and reliable services even for remote communities.

Finally, having access to historical data on weather-related fading patterns in certain geographical areas helps engineers to plan new links more effectively. With real-world fading data, they can choose parameters with greater confidence, reducing the risk of future Red Sites and drops in RAN network performance. By converting high-granularity data into actionable insights, AI provides a crucial advantage. It empowers O2 Telefónica Germany's transport optimization teams to distinguish root causes with greater precision, enabling more accurate and proactive maintenance decisions. This capability allows engineers to resolve complex network issues more effectively, improving field force allocation and expediting the resolution of transport bottlenecks, which in turn increases maintenance efficiency and reduces operational costs.

Outlook for a smart future with AI-driven operations

Ultimately, the primary objective of a robust transport network is to support the services running on top of it seamlessly. This directly contributes to improved RAN performance and tangible gains in end-user satisfaction, thereby strengthening the network's reliability and readiness for future requirements. Through targeted analysis leveraging purpose-built tools, O2 Telefónica Germany has achieved a 98 percent reduction in Red Sites within its network. Moving forward, the integration of AI and automation-driven proactive maintenance and operations is anticipated to drive further efficiency and greater operational cost savings for the company.

About Ericsson

Ericsson's high-performing networks provide connectivity for billions of people every day. For nearly 150 years, we've been pioneers in creating technology for communication. We offer mobile communication and connectivity solutions for service providers and enterprises. Together with our customers and partners, we make the digital world of tomorrow a reality.

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