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TECHNICAL ARTICLE

AI/ML-driven applications for 5G-backhaul behaviour predictions

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5G backhaul composition and role of microwave radio

To successfully run high performance 5G services, a mobile network requires an outstanding transport infrastructure, capable of satisfying the different service's needs, from capacity, latency to synch and more. The network has to run with the highest reliability.

Nonetheless unexpected impacting events may occur and a fast and efficient supervision and operative response makes the difference between seamless network behaviour and a traffic effecting disruption.

Today, according to GSMA and ABI research, microwave radio technology accounts for over 65% of the mobile backhaul connections globally. The use of microwave radio as preferred backhaul technology is expected to remain in the foreseeable future (forecasted to be over 60% in 2027) *[ref 1].

A European mobile operator in average has over 25'000 microwave radio links nationwide, generating over 1M event records per day, plus several performance measurement points, generating a bulk data that can easily reach the 1 to 2 billion records yearly.

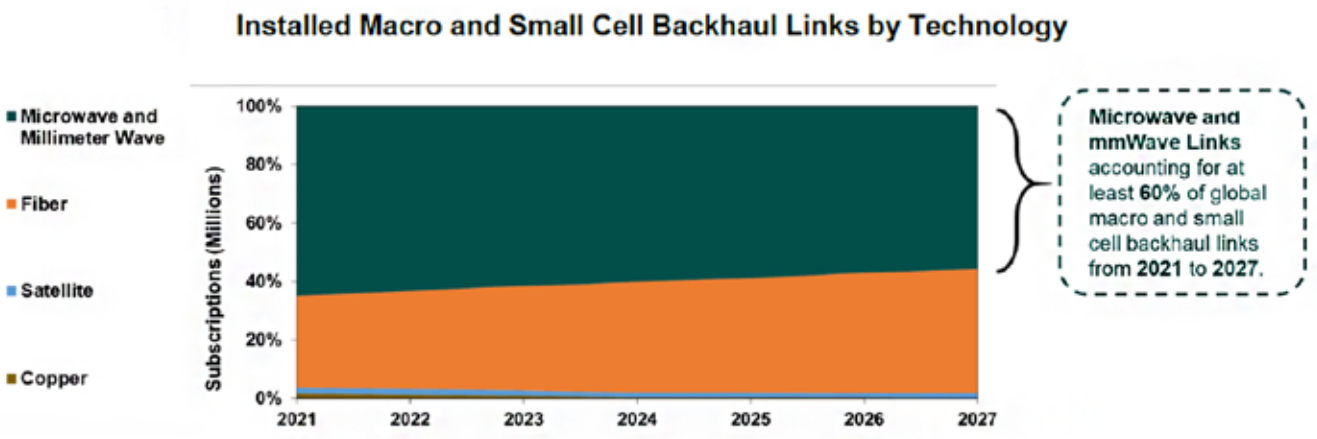
impairment happens. In case of an unexpected event, a timely manner reaction can be put in place, avoiding critical escalations, maximizing the network uptime.

In the past years an evolution toward a new network management model named SDN, Software Defined Networking, has started. SDN introduces a software module, named Domain Controller that acts as the Network Operating System. This Software Module collects all the data from the network elements and abstracts the interfaces to manage them to higher management levels, allowing applications to easily interact with the network.

Why the complexity of a multivendor proprietary OSS based solution has a high toll in the operational management and reaction time when an event occurs

In most cases an operator uses two or three vendors to build the backhaul network.

In the pre-SDN world, representing the current model, each vendor supplies the microwave radio links as well as its own OSS solution to manage, supervise and



<Nessun dato dal collegamento>

The analysis of such an amount of data is a task of titanic proportions and that's why it is generally done by operators in a reactive manner. Once an event occurs, data is examined for troubleshooting, to fix the outage and restore network operations.

Thanks to the use of AI/ML empowered applications, raw big-data can be analysed by an Artificial Neural Network (ANN), moving to an automated and reasoned approach; to predict network behaviour, to recognize known network patterns, and to intervene before an

collect performance data of the equipment, based on a proprietary protocol implementation.

This creates a layer of complexity as in a three vendor backhaul network scenario, one would find three different OSS with different ways to address equipment, to manage alarms and retrieve, store and access performance indicators data, leading operators to invest high amount of CAPEX to reconcile the data across the network.

With the implementation of SDN we will face a new paradigm. The industry is putting great effort in standardizing the domain controller's South Bound (SBI) and North Bound Interfaces (NBI). Harmonizing how the controller interacts with network elements (SBI) and on the way network data are exported and presented on higher order systems (NBI), allowing easy queries and management of the whole or portions of the network, as needed.

This opens the market for software applications that through NBI can interact with the whole network, regardless of the equipment or controller provider, offering operators data analysis and services at a fraction of the time and costs, with an accuracy and reliability before unattainable.

How an AI/ML based process can revolutionize the approach from reaction to an event, to preventing the event.

Thanks to the developments done in Big Data Analytics and to the availability of scalable computational power it has become possible to manage, process and extract information from the billions of records available in each network.

Previously, due to the complexity of the task, the KPI information database was analysed only after an impairment occurred, and if this caused loss of traffic, was related to propagation issues or network related problems.

In those cases, an investigation activity started aiming to understand the root cause and put in place corrective actions. Reacting after the event occurred, under pressure and with hard time constraints, pushed for broad non-cost-effective corrections.

With the use of Artificial Intelligence, the big-data database can be proactively analysed to identify and highlight any network issue and present them in an aggregated format so that the operation team can plan maintenance in advance, based on the priority.

The AI algorithms identifies multiple network issues including those whose effects are minimal and did not yet triggered any network alarm. This insight is brought to the attention of the expert network engineer that can proactively assess the identified network elements and/or network portion. Should it be necessary, the issue can be corrected before it escalates, without any time pressure, leading to an aimed and cost-effective response.

The AI algorithm can be retrained periodically to learn how the network has changed or has been expanded, improving its ability to recognize new network scenarios, increasing its added value. Furthermore, with the introduction of reinforced learning the AI algorithm can autonomously discover and learn new ways to autonomously solve upcoming network issues, maintaining its status continuously up to date.

Looking deeper into the AI/ML processes - how it works

The resulting benefit of using an AI application with machine learning algorithms are substantial. To achieve these results the designing and training of the Artificial Neural Network is key, and even more so is the quality of the big-data the application is trained on. In fact missing data, disorganized formatting and uneven reading will drive to uncoherent results.

Consequently, data mining and data preparation are fundamental steps. Today in a multivendor installed

base environment, organizing data is an onerous aspect to carry out as each vendor reads, saves and presents data in its own proprietary formatting. Tomorrow, with the adoption of SDN standard models, all collected data will already be presented in a homogeneous format with reliable quality across any vendor solution.

Once data is available, clustering takes place. The algorithm assigns the observed data patterns to one of the possible clusters, each associated to a possible network behaviour *[ref 2]. At this stage, where data gets labelled and classified, the design intervention of a microwave subject matter expert becomes paramount to ensure the network training isn't biased, compromising any future result.

Furthermore, data can be gathered externally to the network and correlated with the mined performance data to create a deeper understanding of the network

behaviour, especially if we consider the propagation aspects. And in the same way some network data can be offered externally to fulfil other applications outside the telco world.

The undeniable benefit a mobile operator gains with an AI-driven application at his disposal

The future of network management and especially the operation's teams is about to change for the better thanks to SDN and to the introduction of new tools like AI/ML applications. These will gradually help the shift towards a proactive and preventive management of the network as the AI application will relentlessly monitor the network performances. This change will offer mobile operators the means to see through the mist of the big-data, turning it into an asset to be capitalized on, ensuring the network is operating at his best.

The relationship between network engineer and supervision tools will become even more important as the AI will be able to bring to light a series of activities, upgrades and maintenance that needs to be validated, planned and executed to maximize network uptime and flawless service delivery. Furthermore, knowing where to invest on and what to invest on, calls for a better spending lifecycle with a better ROI value.

A real case scenario based on a live network deployment

Looking into the benefit of SDN and automation can bring to an operator, we can mention two different applications; one targeting a repetitive process that may appear tedious to carry out but of critical impact, and one impossible to carry out manually. Both applications are aiming to simplify operational activities and speed up time of intervention resulting in great monetary savings.

The first application targets network elements software upgrades. This is usually carried out manually, during off-peak time, with a rigid sequential process. An application can map the entire network topology, optimizes the software download policy, plan the activity and execute it autonomously, reducing the upgrade activity time five folds. Furthermore, the application can include in its planning any operator specific constrains or policy guideline. The estimated benefit to an operator of 25000 links, (average number of microwave radios in a European operator) is of 1000k€/year.

The second application matches the traffic requirements with the available physical resources, by monitors the network traffic in real-time and optimizing hardware resources accordingly. When the network is running off-peak time, e.g., during night time, traffic needs are much less compared to the day peak time or even day average needs. In this scenario the application can switch off the extra capacity when it isn't needed, with relative power consumption and CO2 savings. In this case the estimation in energy efficiency saving is estimated to amount to 100k€/year every 5000 nodes.

References articles:
[Ref 1] Wireless Backhaul Evolution – February 2021 – GSMA & ABI research
[Ref2] IEEE-supervised and semi-supervised learning for failure identification in microwave networks

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