Orchestrating a brighter world NEC

White Paper

# AI-powered Smart Facilitation Solution
## for Network Planning and Operations

## Introduction

Next-generation transport network providing 5G services must be responsive to assure that services can be spun up and taken down as needed. As the mobile network evolved, the management system has also advanced but not enough to cope with the complex task of provisioning paths and optimizations, especially with massive connectivity and under a multi-vendor environment.

Figure 1 below represents the evolution of transport network that NEC envisions within the next few years. It is not feasible to support the volume and pace of change that happens after 5G is introduced, with billions of devices running tons of applications. It is best to redirect effort from time-consuming and costly manual operations to creation of automated, self-aware environment. Financial benefits in CAPEX and OPEX savings and increasing revenue opportunities can be immediately realized.

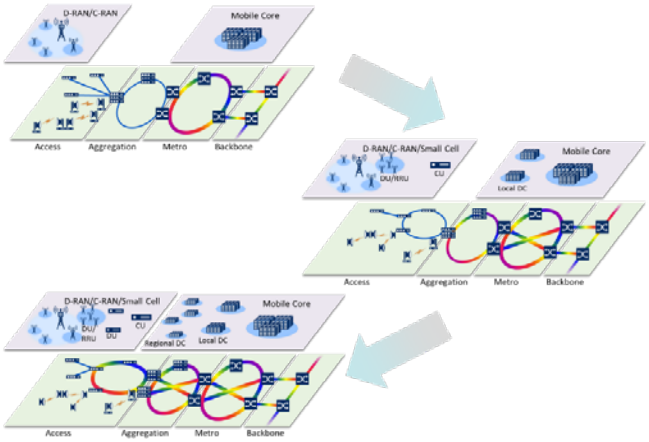


Figure 1 Transport Network Evolution

The question is, “How do we realize a flexible and automated network?” The answer, naturally, is Artificial Intelligence (AI). AI can scale, operate automatically, and adapt to new requirements and changes in the network quickly and efficiently. An automated response can be triggered that mitigates the problem, for example, when latency or anomalous packet flow is detected.

## Challenges

Various issues can pop up the network, ranging from a seemingly innocuous packet loss to a huge network outage that cripples services. Even minor incidents can add up and impact the network, harming the credibility of the operator to deliver reliable services. Potential financial loss can ensue.

Designing a perfect network from the ground up with so many variables involved would be a formidable, if not impossible, task. It is imperative to design the network with intelligence that can detect and react to changes on the fly, make predictions based on accumulated data, visualize every aspect of the network, and suggest prescriptions that best deliver performance and experience, ensuring that all available resources are utilized to the fullest.

The MNOs are still struggling to justify the massive 5G investments with ongoing LTE/LTE-A investments that are yet to yield substantial revenues. Apart from networks of some forward-thinking operators and early adopters of SDN, most networks are continually modified largely by hand for a huge number of changes, but with the network becoming ever more complex, the risk of outages and vulnerabilities rises. Moreover, these changes undergo planning procedures and checks that may take days or even weeks to be authorized. The agility of the network is seriously compromised.

The OTTs, on the other hand, piggybacking telecom operators' network infrastructure, yet are disinclined to share their revenues with the latter. They can spend the bulk of their revenues on developing new, capacity-hungry services that place even greater demand on operator resources. Some have gone so far as to build their own network infrastructure, mainly for data centers, to cope with burgeoning processing requests.

Preparations must also be made for as-yet-unknown use cases in addition to the three major ones (eMBB, URLLC, mMTC), each with its own set of performance requirements and running on a dedicated slice. Similarly, cloud-based applications

may not be able to process data fast enough to provide real-time response due to the distance between the client and the cloud. It is foreseen that some computing functionalities will be provided in a virtualized environment and instantiated closer to the edge, for example, at central offices (a la CORD) or micro data centers, taken down when the demand wanes or migrated to other parts of the edge network where they can provide the necessary computational tasks. Configuring such a dynamic network with intricate parameters is just too formidable a task for a human operator to handle.

A future-proof solution is highly sought after, that can accurately and efficiently get a grip on capacity, latency, reliability, and optimize the network - a fusion of hardware and software that makes the right decisions in capacity planning, network optimization, service assurance, and simplification of operations

This leads to an elevated level of customer experience, as well as peace of mind for the operators who can maximize current investments and optimize future ones, at the same time reduce risks and failures and provide the highest level of performance under any circumstances.

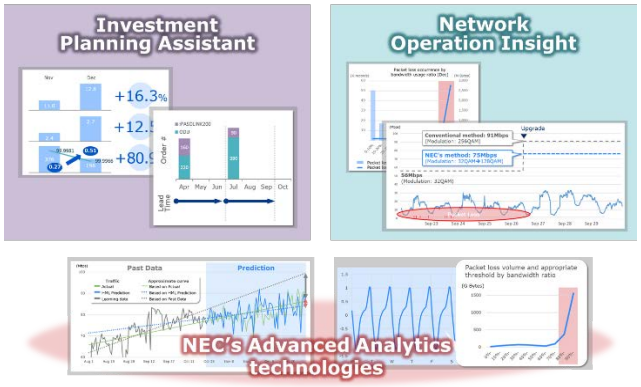


Figure 2 NEC Advanced Analytics services

And NEC can deliver, with our technology assets in transport network, network management, and AI.

## Solutions

At the core will be the NEC the WISE advanced AI technology that is highly acclaimed for its innovative social solutions. The following services have been specifically developed for operation and maintenance of transport network, built upon AI feature sets:

- Network Operation Assessment
- Network Operation Insight
- Investment Planning Assistant

As network complexity grows, it is necessary to simplify control and troubleshooting. For this, the Cause Analysis and Prescription features of AI will be utilized to provide

- Trouble Cause Analysis/ Troubleshooting support
- Dynamic Network Control with domain orchestrator (e.g. Backhaul Resource Manager for iPASOLINK)
- Deployment support

With future evolution of AI, Machine Learning, and Analytics, the ultimate goal of Automated Network Management and Automatic Updates are realized.

Needless to say, a grand view of the network is important in understanding and identifying what is currently happening in the network. Topology, paths, performance metrics are just a few of the aspects that need to be visualized. Just as important is the visualization of AI prediction and analytic results for prescription and recommendation of industry best practice.

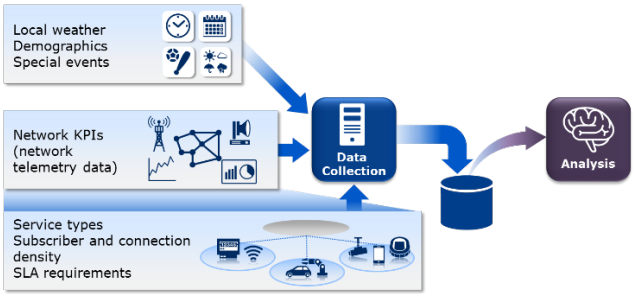


Figure 3 Data Collection for Big Data Analysis
Grasp the Present and the Future events "In and Out"

**Collection** of network data can be executed through legacy means such as CLI, syslog, and SNMP. But for 5G systems, a more scalable and efficient standard conforming to common data models is sought after, in order to reduce bandwidth requirement and to obtain end-to-end perspective across multiple vendors without spending time and effort on translation. The idea is to provide engineering and troubleshooting in minutes, not hours or days.

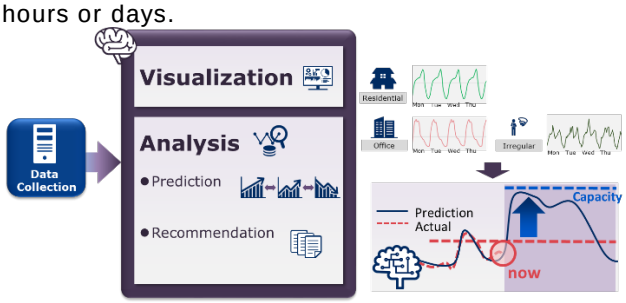


Figure 4 Analytics with the Most Advanced AI Solution
The Omniscience with Visualization, Analysis & Prediction

Once the data are collected, they are sent to an **analytics** engine that applies filtering and correlation to derive various network insights to drive better operational decisions and visualize the findings. The analytics engine, due to resource requirements, are usually housed in a cloud environment, whose data center may possibly be located on foregin shores. Some operators, on their own concern or under direction from the local authorities, are relunctant to deliver customer and network data across the border. In such a case, the analytics engine can be located in an on-premise data center, performing preliminary analytics. For events that require immediate actions, this approach could prove beneficial in terms of response time, as data travels shorter distances. For a thorough analysis with more accurate prediction and recommendation, the data, with explicit consent of the operator, can be sent abroad to the main data center with more advanced analytics capabilities.

**Analytics** plays a big part in constructing closed-control loops, which should handle automatic configurations and remediations. The analytics engine can look for certain triggers in the incoming telemetry data such as latency or utitization threshold, that prompts a quick response for mitigation. Similarly, through Heterogeneous Mixture Learning (HML), an advanced form of analysis technology, traffic patterns that are suspected to have caused interruptions in services in the past can be detected and mitigated before any harm is done.

Clustering of data is also an important function of analytics. Clustering is a method to classify data set into subsets or clusters. Ideally, data in each cluster have similar patterns and characteristics based on events, applications, locale, etc., thereby more likely to behave similarly in the future. This finding of natural grouping within the collected data greatly enhances discovery of underlying rules and reoccuring patterns, simplifies AI processes by eliminating noises from unrelated data that may contaminate the outcome.

The **visualization** phase involves both historical data and predictions based on analytics. Visualized historical data can help engineers at the network operation center to be aware of past and prevailing conditions. Predictions, similarly, can help the engineers make educated decisions for configuration changes or scheduled maintenances. But this is not the end.

Analytics data and recommendations must be presented in ways that are clear and unabigous for the **controlling** entity to understand the intent and asseemble instructions to execute the recommended actions. Changes to the network and its control are dictated by the desired business outcome, and optimizations, automation policies, etc, are defined accordingly.

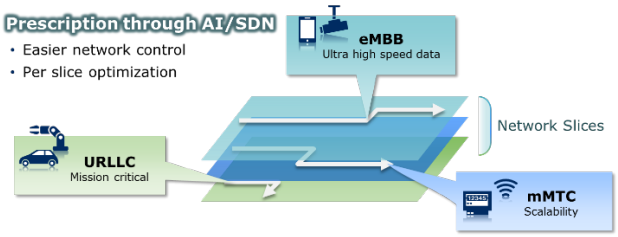


Figure 5 Network Optimization & Automation
Slicing and Optimizing every Use Case with Zero-touch

Futhermore, APIs can be developed for other software to access the information through REST or other standard interfaces, allowing productive data sharing across multiple divisions and with other BSS/OSS applications.

Initially, the microwave mobile nework will reap the benefits of the automation solution. It shall be expanded to include the overall transport network, inlcuding IP and optical layers, based on the full Transport SDN intiative after relevant standards go into effect. Moreover, it should not be limited to NEC products or to the transport network. Operator network is a mixed bag of products from multiple vendors, and for a sound end-to-end automation, all of these equipment must be supported. And for the network to take care of itself with minimal interaction from the administrators, vendor agnosticity and compliance to common standards and data models are needed.

## NEC Activities

In the past year, NEC has been engaged in projects with several of our customers to optimize their wireless transport network with AI, with the following goals:

- Self-monitoring, learning, and taking corrective actions in real-time
- Mitigate any financial or security risk to business
- Free up time to work on more strategic business initiatives

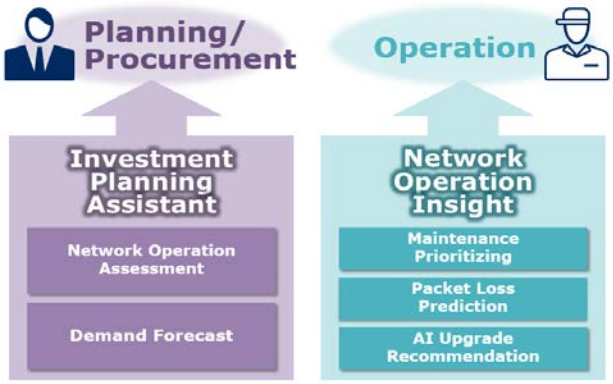


Figure 6 Added Value Available by NEC's AI Technologies

NEC has already completed the initial round of verifications for the AI-powered solution. During the three month trial, we have collected past traffic statistics of iPASOLINK mobile backhaul as a baseline, correlated them with fresh data from the live network, and made predictions based on analytics of traffic patterns and other attributes such as demographics and time of day. Significant ability was established in the following two areas:

1. Realization of inventory optimization through enhanced prediction of network traffic (Demand Forecast)
   Equipment orders schedules are planned by forecasting demands several months into the future. With "Advanced Performance Analytics for Transport Network" service boasting an accuracy of over 97% for traffic prediction, NEC delivered a sound demand forecast with which network carriers based their ordering schedules, thereby enabling inventory optimization.
2. Fulfilment of optimal maintenance schedules withe packet loss prediction (Preventive Maintenance)
   Carriers usually perform maintenance work after events such as packet losses are detected, but this incurs unanticipated cost as well as potential disruption of services. The program predicted and identified network equipment that may cause packet losses within 2-3 months and prioritized them. Carriers optimized their maintenance tasks according to this data, with efficiency of up to 15 times that of conventional practices.

SDN will play a pivotal role in this endeavour for network optimization. It is no longer possible to statically configure devices with increasing complexity and number of devices in the network. One of the main function of the SDN controllers is to manage network-wide resources and set up slices and end-to-end paths. Thus, a holistic approach to optimization, and eventually automation, can be introduced within this framework, by understanding the unique requirements to support the multitude of services and applications that run over the network. AI can provide this intelligence to discover and identify the requirements, and compose instructions that can be fed to the SDN controller to manage the network optimally.

This solution in tandem with AI, will bring operators significant CAPEX and OPEX savings with higher link utilization, maximized resource utilization, simplified network planning and reduced manual effort. It will also vastly improve customer experience that impact the bottom line.

## Next Steps

Introduced in 2017, the Smart Wireless Transport Network concept already mentioned the importance of closed-loop control for intelligent network optimization. As the name implies, microwave and millimetre wave transport was covered in this iteration. It allows traffic to traverse the optimal wireless path and provision capacity depending on use case and weather conditions,

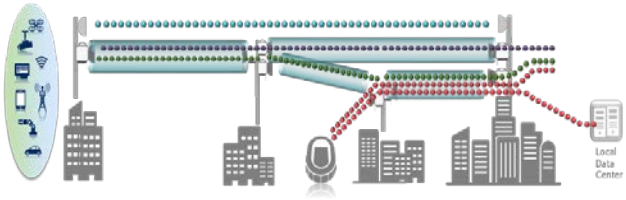

Figure 7 Smart Wireless Transport Network with Advanced Analytics for 5G

We take this concept further with tighter integration of AI and extensive use of virtualization technologies, network slicing and edge computing, to automatically configure and assure services, target customers with personalized experiences and improve customer experience.

Today the backhaul is still more than 70% Microwave based. Major telecommunications markets analysts keep projection for a MBH that will keep up to 65% by 2022 when 5G will find its first customers worldwide. Microwave deployment remains a TCO driven choice with a technology still fighting to remain competitive on the capacity as well as latency and reliability performances. MNOs are keeping the backhaul areas fully wireless with microwave in order to cope with LTE/LTE-A coverage densification which are part of their high competitive

deployment program that governments and shareholders are encouraging them to realize.

However as 5G matures, it is necessary to take into account multiple domains and layers, as well as computing and server nodes. The transport network must be able to efficiently transport traffic end-to-end across this complex web of devices. Not only should path rerouting and load balancing be executed on microwave and millimetre waves, but also on any heterogeneous transmission links, including copper and fiber, in order to optimize resource utilization and capacity and fulfil service requirements.

High Quality Reporting with clear visualization in network performances, trends analysis and recommendations can be created with the following NEC assets:

- Solid Installed base of iPASOLINKs with its Performance data collection with Service KPIs Analytics
- Advanced Analytics environment provided by AI to realize data mining and compute KPIs
- NEC Data Scientists and Engineers and Business Analysts for a more comprehensive report with recommendations adapted to customer challenges and requirements.

NEC now has access to a powerful tool for the iPASOLINK deployment areas with professional services based on the virtuous cyle encompassing deployment, maintenance, and performance of MBH to obtain the most accurate predictions and recommendations for the operators, enabling risk rating and faster decision making.. With further advances in computing power and refinements in AI algorithms and programmable networking, full automation can be realized with near real-time raction to faults, attacks, and changing environment to provide uninterrupted services at maximum performance and efficiency.

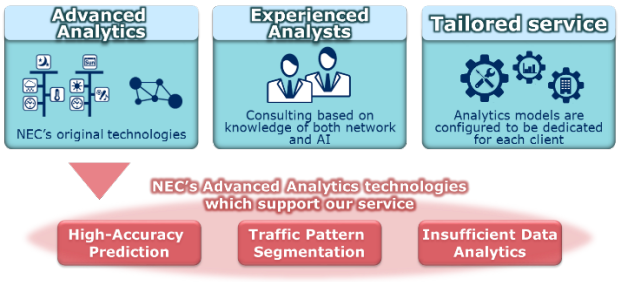


Figure 8 NEC Analytics Service Overview

Interested operators can inquire for a customized trial to get an early taste of the efficiency and accuracy of the advanced NEC services based on our progressive NEC the WISE AI technologies.

NEC and Netcracker have partnered with Infinera and Juniper Networks to deliver a full-stack, pre-integrated SDN solution for end-to-end, multilayer control and management across packet, optical, and microwave networks. The partnership enables a compelling new multilayer network management solution that provides full visibility across all IP, optical, and microwave domains.

NEC delivers solutions and technologies that help address the needs of both telecom carriers and businesses alike through the "5G. A Future Beyond Imagination," concept, which positions NEC and telecom carriers as service enablers for the co-creation of new business models for a wide variety of vertical industries, including the security, agriculture and transportation fields, that maximize resources and reinforce earnings.

## About NEC

NEC Corporation is a leader in the integration of IT and network technologies that benefit businesses and people around the world. By providing a combination of products and solutions that cross utilize the company's experience and global resources, NEC's advanced technologies meet the complex and ever-changing needs of its customers. NEC brings more than 100 years of expertise in technological innovation to empower people, businesses and society. For more information, visit NEC at http://www.nec.com.

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