White Paper

# Smart Wireless Transport Network

NEC's new Wireless Transport Network concept to empower transport networks with the Vision for 5G

## Challenges

5G New Radio, the wireless standard that would become the foundation for next generation mobile networks, will define requirements that are orders of magnitude more demanding than LTE and LTE Advanced, in capacity, latency, efficiency, etc. It will connect not only mobile phones but all kinds of IoT (Internet of Things) devices, such as cars, home electronics, utility meters, and much more.

Towards 5G, transport technology, especially in the wireless area, is evolving at a quick pace. Microwave (MW) has become fast and reliable enough to supplant fibre for transporting fronthaul and backhaul traffic, with lower cost of ownership, and introduction of high capacity millimetre wave (mmW) devices will spur even more adoption. New opportunities and applications beyond FH/BH, such as FWA and FTTx are also being commercialized. However, providing more capacity alone will not be enough for 5G.

Different spectrums have different propagation characteristics and mmW, although offering higher capacity and density than MW, is more sensitive to variations in the environment such as weather. Such shortcomings must be taken into account when designing the FH/BH network of the future. The FH/BH needs to be managed intelligently and efficiently such that these bottlenecks that are inherent to the network are alleviated.

It is clear that massive connectivity and traffic load will burden the transport network. The increased number of devices raise power consumption and also bring complexity in operation and maintenance. With traditional operational and managerial practices, revenue-per-bit will not be able to keep up with increasing cost-per-bit, affecting the bottom line. This is driving the aggressive transformation efforts of the operators.

As 5G becomes more and more integrated in the society, the importance of maintaining a fast, reliable, and stable transport network increases. To remain competitive in this high demand market, a paradigm shift in network engineering and management is needed to precisely coordinate and manoeuvre all transport devices as the network requirement are driven by the nature of the various services. A totally new approach for combining radio technology, spectrum usage, advances in networking and computing architectures must be taken to meet the challenging performance targets for 5G.

## Building Transport Network for 5G

Transport network for 5G is a complex mesh of macro cells, small cells and last mile accesses served by MW and mmW links and also optical links, especially in dense urban environments. High capacity, low latency, high reliability and availability, densification, etc. are notable KPIs that must be fulfilled. In order to build a transport network that can handle these KPIs and simplify operation and management, we focus on the following three aspects:

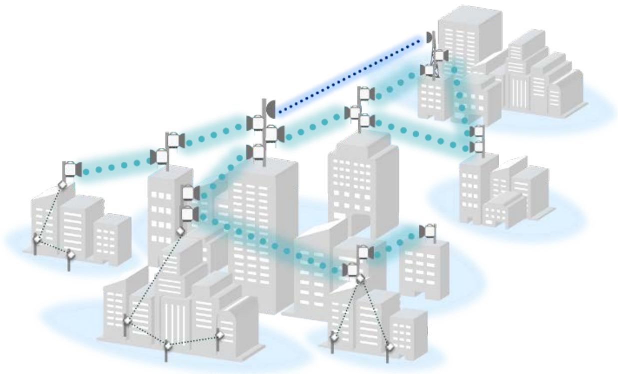

Figure 1: Transport network for 5G

- Automated network optimization
- Network planning and prescription
- High capacity transport

QoE (Quality of Experience) can be enriched through efficient network, service operations and management, based on various insights into the network.

Continuing developments in SDN and NFV and new emerging technologies are drastically changing the way transport networks must be designed. These products and solutions will help customers to build a flexible and agile network that can easily adapt to the rapid changing circumstances.

Distribution of processing capabilities closer to the edge provides an extra level of flexibility. The so-called MEC (Mobile Edge Computing) is considered to be another technology enabler for 5G. By deploying services and caching at the network edges, congestion on the backhaul can be alleviated and round trip latency for services can be reduced significantly. With this approach, single point of failure is naturally avoided as applications are distributed in the edge of the network.

AI (Artificial Intelligence) and Big Data are other technologies that can also change the telecom industry landscape. They are quickly becoming essential tools for prescribing solutions that facilitate decision making processes for operations and management. Algorithms are getting better by the day and computing architecture has evolved considerably to run multiple applications and handle Big Data promptly.

The wide bandwidth available in the higher frequency bands is the primary reason for the huge interest in mmW. They can be mobilised in high density areas due to their pencil beam nature and provide opportunity for spatial reuse. Dual-band solution which aggregates multiple frequency bands is another interesting method to enable enhanced data rates. However, in order to utilize mmW to its fullest, improved techniques for interference coordination and mitigation and sustained availability will also be important. Addressing these using data analytics and prediction is critical in elevating mmW to a viable 5G technology.

These solutions are expected to create new value chains and an energised ecosystem that will allow all players to benefit.

## NEC's Proposition

Enormous increase in mobile traffic will be a major driver for transport network upgrades and overhauls. Speeds as high as 1 gigabit/sec are expected to be supported at some heavy-duty cell sites. But reliability is an equally important aspect that should not be taken lightly. Continuous monitoring and evaluation, logical feedback and execution drawn from intelligent analysis are crucial.

NEC's approach for continuously optimised network modifications is illustrated in Figure 2 above. The cycle is broken down in three stages: Collection, Analysis, and Control.

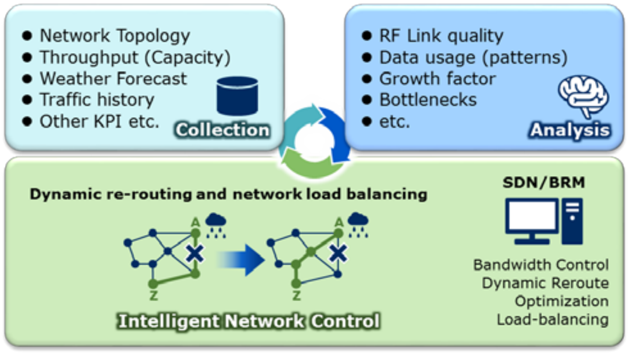


Figure 2: Engineering cycle for optimizing network

The Collection phase is where relevant information such as network topology and statistics are collected.

In the Analysis phase, collected data are organised and analysed according to specific criteria to deduce usage patterns and forecasts, and formulate solutions.

In the Control phase, changes to the network and devices such as iPASOLINK EX Advanced and iPASOLINK VR that support 10Gbps transmission are controlled in real-time or scheduled as suggested by the solution drawn in the Analysis phase. They will always be maintained in an optimal state delivering end-to-end the highest capacity.

This iterative three-stage model will be implemented to improve the quality and efficiency of transport network and its management.

In the following sections, we present NEC's advanced technologies serving the blocks of this cycle.

**NEC the WISE**

"NEC the WISE" is a portfolio of AI technologies developed by NEC for enriching human intellect and creativity. This portfolio represents our strong determination to harness the wisdom of humans and AI working together to resolve the increasingly complex and intertwined issues society is facing today.

AI coordinates and makes suggestions from different perspectives, thus it is possible to reduce risk of latent failures from emerging. Filtering across multiple dimensions is such a tool. Traffic usage, historic trends, incidents can all be analysed to help reach desired solutions quickly and effectively.

Figure 3: NEC the WISE Solution Logo

Predictive analytics provide answers to what is likely to happen, after combining historical data with rules, algorithms, etc., to determine the probable outcome or likelihood of certain situation occurring, such as network failures.

Prescriptive analytics anticipates what will happen and when and why it will happen, offering suggestive options on how to cope with such future events. It prescribes recipes on how, when, and where to change network configurations in advance to avoid risks such as failures from materializing or take advantage of favourable opportunities.

**SDN / NFV**

Since the first deployment of SDN solutions back in 2011, NEC has been involved with multiple global carriers for SDN/NFV commercialization. Through this effort, we have identified multiple challenges that the carriers face and devised solutions that cater to unique requirement and circumstance.

The goal of SDN is to provide open interfaces to develop software that can control the connectivity of network resources and the traffic flow through the resources. The architecture consists of an SDN application in the application plane, an SDN controller in the control plane, and an SDN-enabled network element in the data plane.

The service orchestrator and T-SDN controller being developed by NEC enable network-wide optimization, even in hybrid (mix of virtual and physical components), multi-domain, or multi-vendor environments. They conform to modern virtualised network requirements, including ETSI MANO and are based on industry standard and open source software. As a result, devices supported under this framework can all be controlled and configured precisely to deliver the desired network performance, reliability and flexibility.

**Integration of AI and SDN**

In SDN, the control plane is logically centralised and decoupled from the data plane. This was a necessary step to ensure visibility, programmability, and flexibility of the entire network. However, actions by the central intelligence can mostly be attributed to reactions to events that happened at that moment, such as resource conflicts and outages, in the network. There is no faculty to proactively modify network parameters to cope with anticipated events automatically.

AI can complement the SDN controller and/or orchestrator by providing relevant information processed from the vast accumulation of data. It can help SDN systems make optimal decisions automatically based on accurate analysis of what is happening in the network. Moreover, Big Data Analytics, which is a core part of AI, can help predict user and network behaviours (in the mid- to long term) by correlating weather patterns and demographics (daily commutes, popular events, etc.), which is of immense value to operators for network planning and engineering. IP engineers no longer take the helm in network control. It is the responsibility of the IT software teams to operate and manage the network in the 5G era.

However, for something that requires near-instant response, a completely centralised approach may not fit the bill. A delicate and optimal balance must be kept in the distribution of functionality and processing between clouds and edges in order to cope with real-world problems in real-time.

## Value Creation

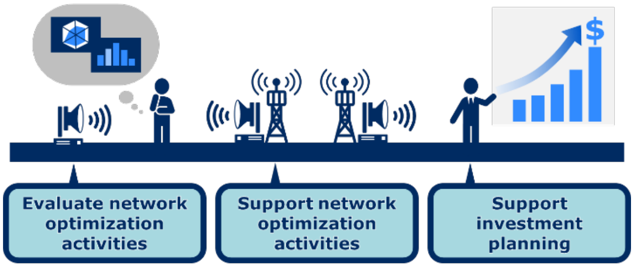


Figure 4: Values created with Big Data/AI

The integration of flexible communication assets such as SDN with AI technologies will enable Visualization, Analysis, and Prescription, which is essential in maintaining a stable and reliable communications infrastructure that is becoming increasingly complex. This forms the foundation for the continuous cycle for improving and optimizing the network.

NEC introduces a new concept solution called Smart Wireless Transport Network (Smart WTN) that combines leading AI, SDN/NFV, and wireless transport technologies to provide a smarter, more robust, more reliable transport network suitable for 5G. Smart WTN can provide customers with real-time provisions for network optimization and also mid- to long-term guidance and strategy combining historic data and predictive AI. What's more, it keeps improving on its decisions and predictions.

An interesting opportunity exists for maximizing over-the-air network capacity. There is a huge database maintained by ITU-R for propagation modelling according to precipitation characteristics, which can be analysed along with Big Data and forecast provided by local meteorological agencies.

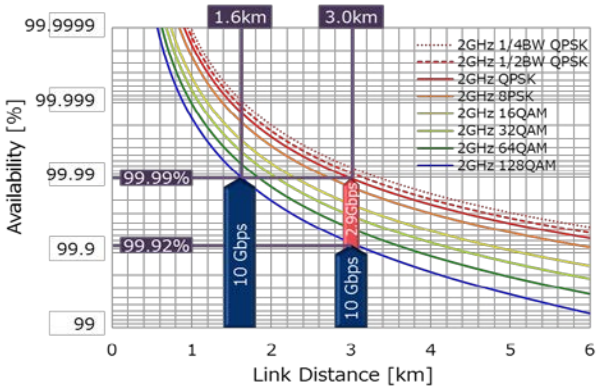


Figure 5: E-band availability vs distance

Figure 5 represents the relationship between availability and range of the iPASOLINK EX Advanced@2GHz channel spacing according to modulation. Such data can be utilised to deliver the highest transport capacity at the desired availability under a given precipitation rate for the dual band solution, which bundles together mmW and traditional MW links to realize high capacity over a reasonable distance.

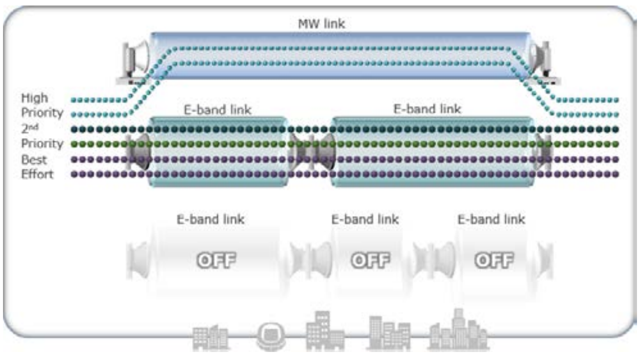


Figure 6: Case 1 Normal Condition

Case 1 illustrates multi-carrier aggregation during normal conditions. E-band links do not experience atmospheric attenuation and is providing high capacity links over relatively long distances.

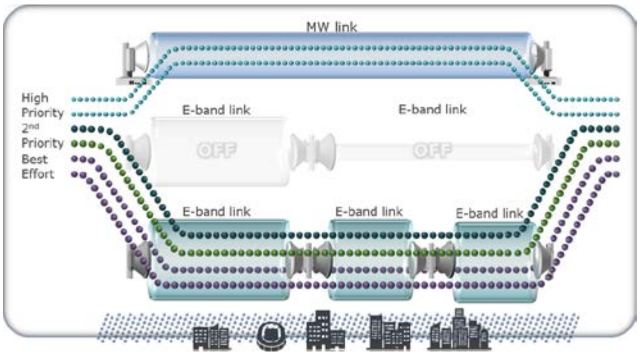


Figure 7: Case 2 Heavy Rain

For Case 2, rain affects the longer E-band link, but Smart WTN will anticipate this and activate the mmW links with more hops, that is, with shorter distance, where the links are less impacted by the rain. The switch will be triggered seamlessly with minimal traffic loss and the nodes in the original path will be powered off for energy savings.

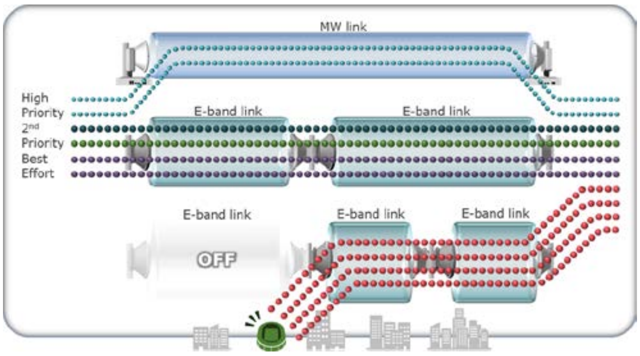


Figure 8: Case 3 Temporary capacity expansion

Case 3 depicts a situation where extra capacity is needed to cope with events that attract large crowds. Smart WTN will schedule the activation of dormant links so that capacity demands connected to the events are fulfilled.

Smart WTN enables to maintain capacity with comparable range by activating multiple mmW hops in succession without resorting to massive antenna arrays which provide large beamforming gains to counter large propagation loss in this spectrum.

Similarly, the following functions can be realised by collecting various KPIs and information such as type, size, and time of transmission at individual sites, past weather and event at particular locations.

**AMBR* correlation**, where adjustment can be made to the central frequency to make way for available spectrum to be utilised when bandwidth decreases due to weather related attenuations.

**Dynamic directional adjustment**, where beam forming and directional adjustments can be made to connect to different remote sites depending on forecasted weather or usage patterns.

**Dynamic capacity allocation**, where capacity usually kept in reserves and effectively wasted by the planning tool because it cannot adjust to changes in real-time, can be allocated to links where traffic is expected to grow, or reduce capacity where links are expected to shrink

Information is processed through AI and fed into a software based controller, which will then modify link capacities, traffic routes, or QoS parameters on the fly or make sugestions for capacity expansion according to analysed results.

The benefit of Smart WTN is not limited to radio links. Wired links, including fibres, can be included as paths for optimization and utilised to take advantage of its deterministic capacity.

*Adaptive Modulation and Bandwidth Radio, an exclusive feature on PASOLINK EX Advanced

## Conclusion

With Smart WTN, it is possible to:

- Know what is going on in the network
- Prevent incidents and crises before they happen
- Shorten feedback times through automated responses

It allows real-time monitoring of huge amounts of information that exist in the network and unravels them in a way that is easily understood and meaningful to the user. The ability to fix problems as they are beginning to happen instead of after they have surfaced and done some harm, will have a positive impact on both credibility and bottom line.

Smart WTN, the combination of NEC the WISE family of AI technologies, SDN/NFV, and iPASOLINK series radio communication equipment, will usher in a new era of mobile backhaul that will greatly enhance efficiency, flexibility, reliability, and value.

## About NEC

NEC is a global leader in the integration of cutting-edge technologies in computing, networks and software, building solutions that benefit governments, businesses and people worldwide. NEC brings more than 100 years of expertise in innovation, providing solutions for society that promote the safety, security, efficiency and equality of society. As embodied in our corporate brand statement "Orchestrating a brighter world," NEC aims to help solve a wide range of challenging issues and to create new social value through driving digital transformation for the changing world of tomorrow.

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