

Preparing microwave transport network for the 5G world

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Microwave technology

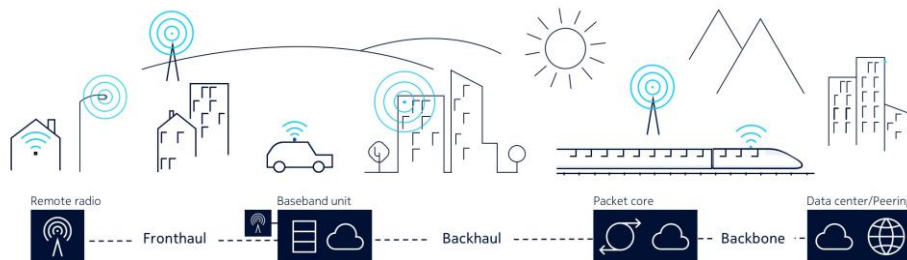
Transmitting information

- Microwave transmission is the transmission of information or energy by microwave radio waves



**Wikipedia*

- Microwave technology has been used widely to support backhaul mobile network providing the required capacity, latency and reliability for the 4.x networks

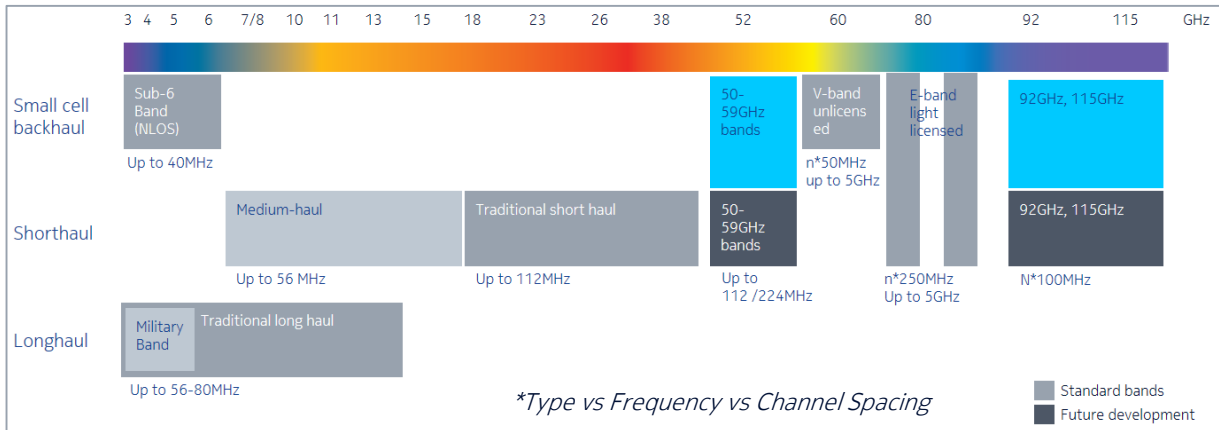
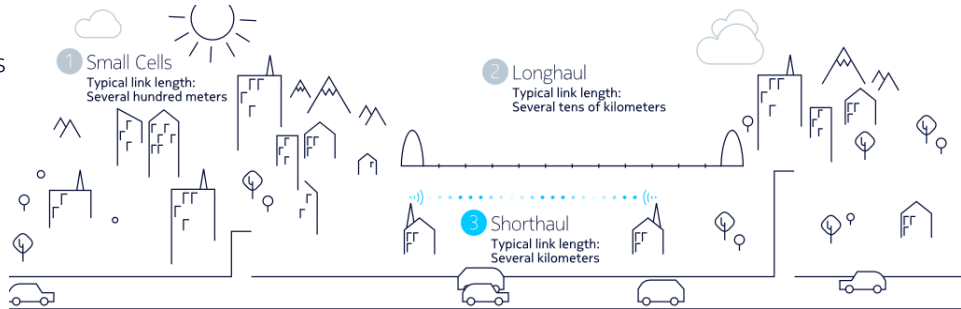


Mobile backhaul network

Types, frequencies and channel spacing

o Three types of backhaul networks

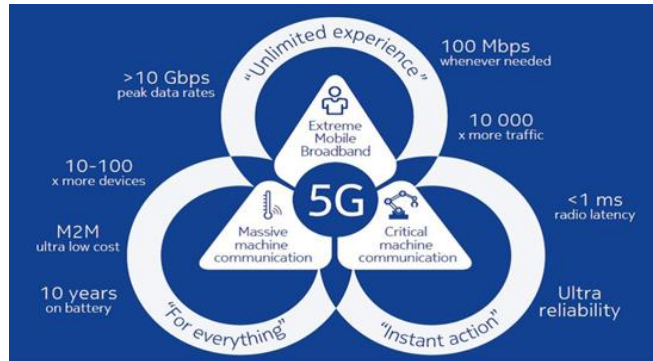
1. Smart cells
2. Long-haul
3. Short-haul



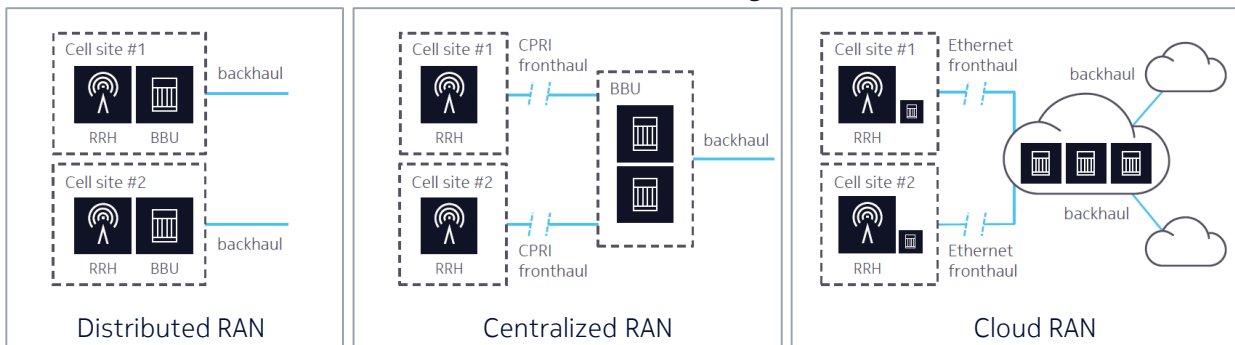
Microwave transport network

Challenges towards 5G era

- 5G requires fast broadband, massive machine-to-machine communications and critical machine communication
- Stringent demands on the transport network's capacity, reliability, energy efficiency and latency
- NFV and SDN drive also changes



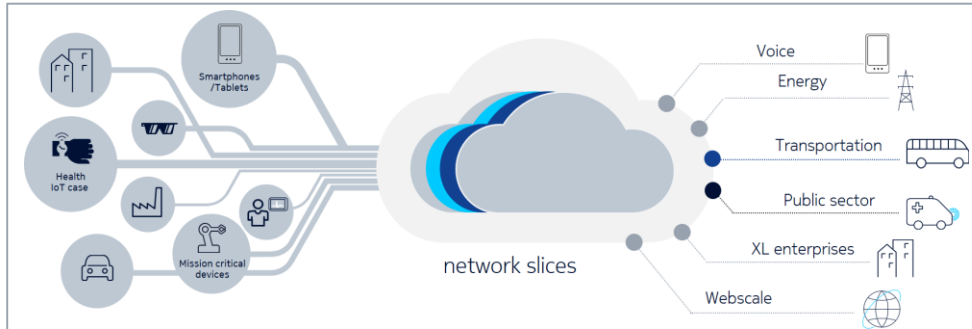
- Another factor is the new Radio Access Network (RAN) architectures, adding centralized RAN and cloud RAN to the well-known distributed RAN and introducing new fronthaul interfaces



Increased demands on transport

Enabling “network slicing”

- o Different kind of services require a more dynamic transport network
 - mobile broadband will require huge capacity and video caching capabilities
 - massive IoT will need high density but without mobility
 - mission-critical applications will be more about low latency and high reliability



- o 5G network is “sliced” into parallel and independent logical end-to-end networks
 - each slice is dedicated to a specific set of requirements
 - efficient deliver of simultaneous services

Building high-capacity responsive microwave transport

Spectrum Considerations

- Critical asset for microwave transport. Frequency bands used for wireless transport range today from 4 to 86 GHz. Traditional microwave frequencies range from 4 to 42 GHz and millimeter-wave frequencies are considered above 42 GHz
- Today, only V-band (60 GHz) and E-band (70-80 GHz) are used for millimeter-wave wireless backhaul. Higher frequency bands such as the W-band (90 GHz) and D-band (140-170 GHz) are being studied for future standardization
- A microwave channel is also characterized by its channel size. The higher the frequency, the wider the channels options: from 3.5 MHz to 112 MHz for traditional frequencies, from 250 MHz to 2 GHz for millimeter-wave frequencies

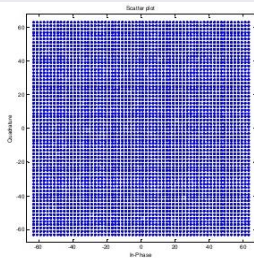
	Traditional frequencies			Millimeter-wave frequencies		Future bands	
	unlicensed (Sub-6GHz)	Low 4-13GHz	Medium 13-42GHz	V-band (unlicensed 60GHz)	E-band (80GHz)	W-band (90GHz)	D-band (140GHz)
Channel separation	10-40MHz	28-56MHz	3.5-112MHz	250-500MHz	250-2000MHz	250-2000MHz	250-2000MHz
typical max capacity	500Mbs	5Gbps	1-2Gbs	1Gbs	10Gbs	Up to 10Gbs	Up to 40Gbs
Typical min latency	< 5ms	< 200µs	< 200µs	< 500µs	< 50µs	< 50µs	< 50µs
Typical link length	Few 100 meters	Up to 150km	Up to 30km	Few 100 meters	< 5km	Few 100 meters	Few 100 meters

Smart spectrum usage

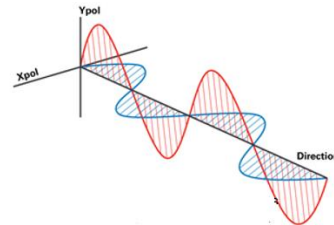
Useful techniques

- o There are several techniques to increase capacity of a given radio channel:

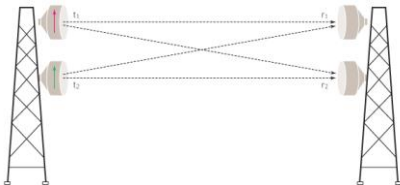
- **high order modulation schemes** allow for better spectral efficiency and **adaptive modulation** techniques dynamically adapt throughput during radio fading events. State of the art radios reach 4096 QAM,



- **Dual polarization** allows data transmission on both horizontal and vertical planes with cross-polar cancellation algorithms at the receiver side. This is a widely used mechanism which doubles the throughput using the same channel,



- **4x4 MIMO** is theoretically further multiplying the throughput by a factor of two, although it is subject to operational constraints and performance limitations.



- **Packet compression**, exploits the repetition of some packet fields (like Ethernet or IP addresses for instance) in order to avoid transmitting the same information several times. Thanks to such methods, it is possible to achieve a practical gain of around 30 percent capacity and more.

Carrier aggregation

A powerful technology

- Ability to combine two or more physical radio channels, operating in the same or different bands, into a single logical channel
- A smart way to exploit the specific characteristics and advantages of different frequency bands to support different services with different requirements in one logical channel by grooming several physical channels with different characteristics



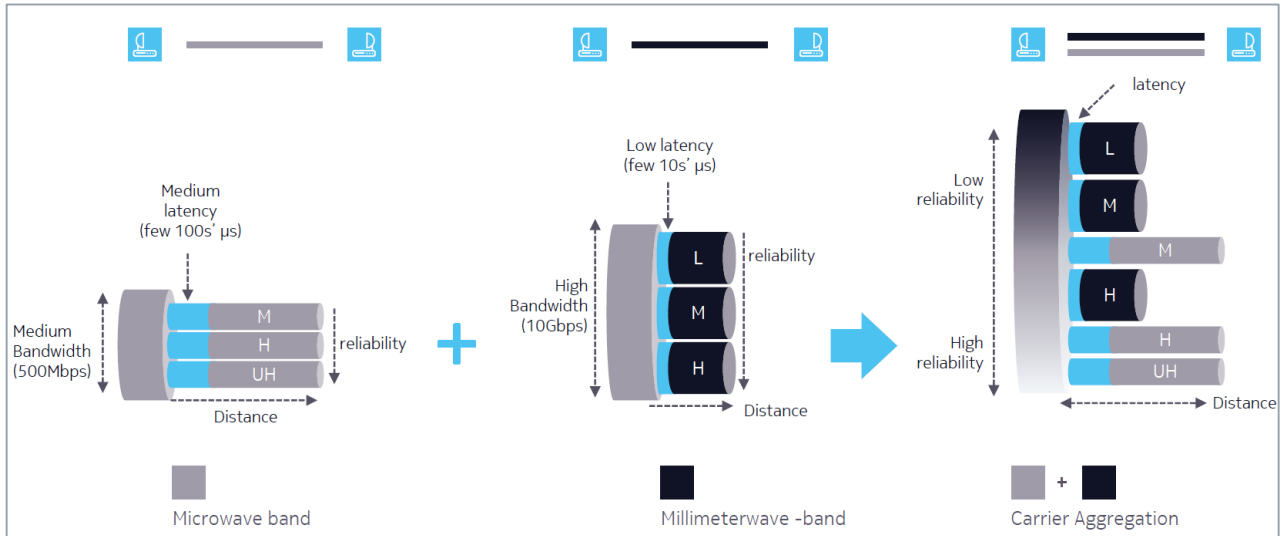
Traditional frequencies		Millimeter-wave frequencies		Benefits
unlicensed (Sub-6GHz)	Low 4-13GHz	Medium 13-42GHz	V-band (unlicensed 60GHz) / E-band (80GHz)	
		● + ●		➤ Additional capacity with regulated frequencies
●	+ ●			➤ Cost effective additional capacity
		●	+ ●	➤ Massive Capacity best effort + reliability for critical traffic

* Possible combinations and benefits

Carrier aggregation

Combining traditional and new bands




- Combination of a traditional frequency band with a millimeter-wave band to address evolving capacity needs
- Standard microwave band provides the reliability while the millimeterwave addresses the capacity need, thanks to larger channel sizes. In addition, the millimeter-wave ensures low latency due to wider channels

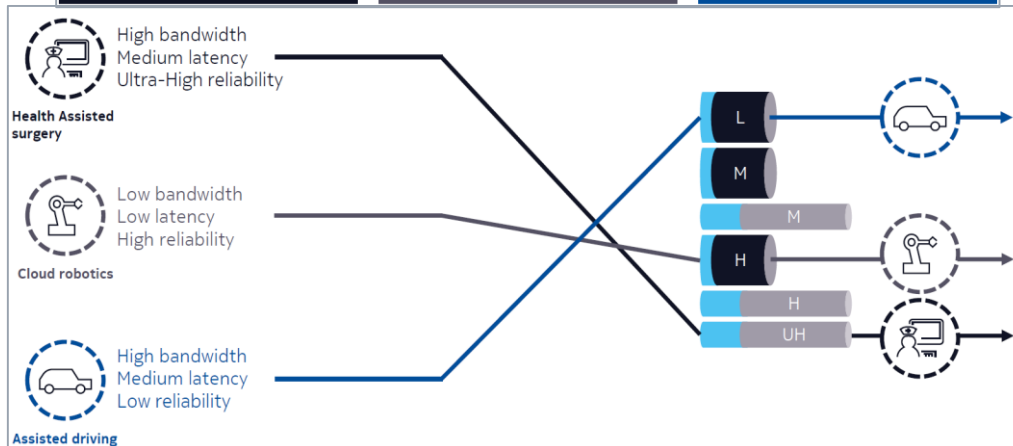


Carrier aggregation

Implementation of dynamic end-to-end network slicing

- o Three services with three different requirements as an example

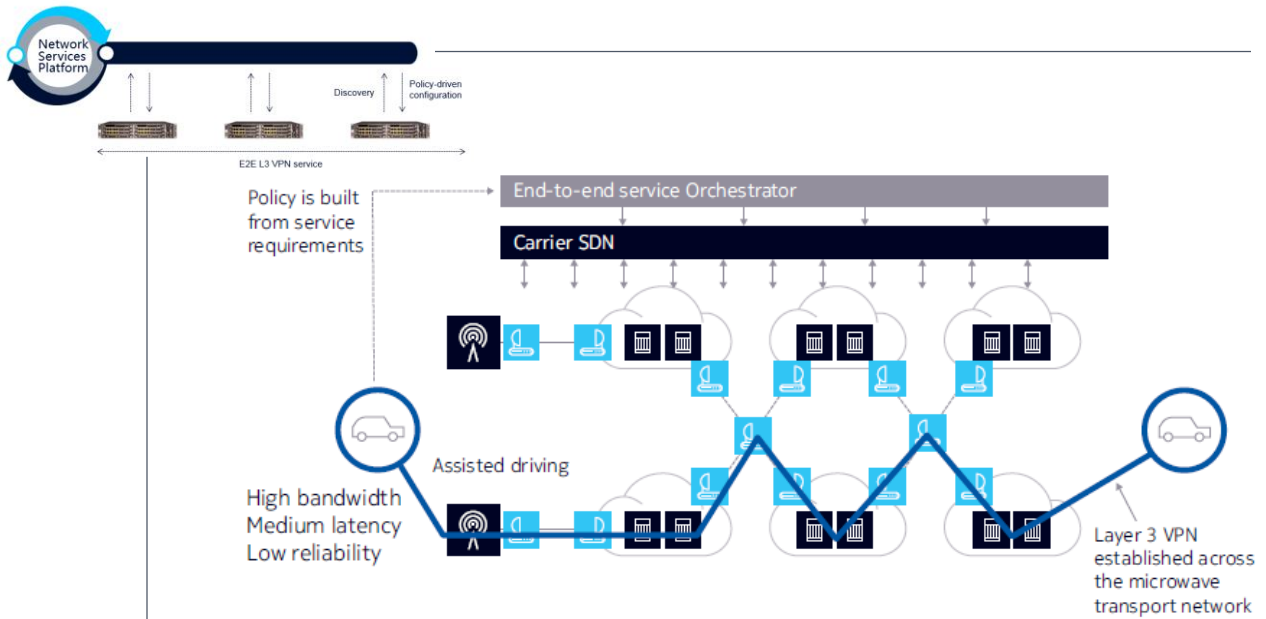
Health - Assisted surgery	Cloud robotics	Assisted driving
 High bandwidth Medium latency Ultra-High reliability	 Low bandwidth Low latency High reliability	 High bandwidth Medium latency Low reliability
<ul style="list-style-type: none">• Real-time video/ telepresence/ augmented reality for remote healthcare and assisted surgery• Ultra-High reliability	<ul style="list-style-type: none">• Coordinated robot control for industrial applications• Time critical sensing and feedback	<ul style="list-style-type: none">• Upload of sensed data to servers for dynamic digital map update / Download of latest digital map information• High video throughput



Carrier SDN

Bringing programmability and responsiveness

- SDN will enable the rapid creation, optimization and termination of services
- Microwave transport networks will have to become more flexible and responsive. Carrier SDN is the best option to optimize microwave transport resources across the network



Nokia Wavence

The microwave solution for 5G transport

- Wavence solution introduces innovative, high-capacity ultra-broadband transceivers to support operators as they transition to 4.5G, 4.9G and eventually 5G networks
- Ultra-broadband transceiver (UBT) twin, and the UBT 80, a compact E-band radio, support carrier aggregation to deliver multi-gigabit, low latency microwave transport.
- Exploitation traditional microwave frequency ranges (up to 42 GHz), as well as millimeter-wave frequencies (up to 86 GHz) utilizing the full range of frequency bands used for wireless transport today
- High output power, advanced modulation schemes and carrier aggregation are some of the supported technologies of the dual carrier (Twin) and E-band radio (80) UBTs ready to provide high-capacity, low-cost and ultra-responsive connectivity
- Nokia SDN carrier solution is supported to provide programmability for telco cloud and 5G network slicing



More Information

In our web sites

- Latest Launches

<https://networks.nokia.com/latest-launches>

- Nokia Microwave Transport

[https://onestore.nokia.com/asset/200985/Nokia Microwave Transport in 4G and 5G Networks White Paper EN.pdf](https://onestore.nokia.com/asset/200985/Nokia%20Microwave%20Transport%20in%204G%20and%205G%20Networks%20White%20Paper%20EN.pdf)

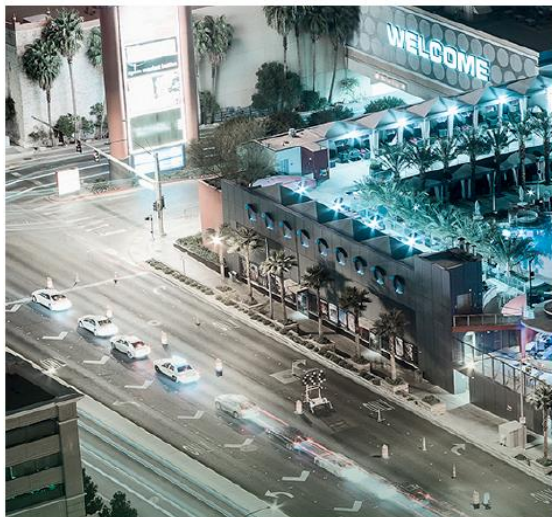
- Nokia UBT

[https://onestore.nokia.com/asset/200991/Nokia UBT Brochure EN.pdf](https://onestore.nokia.com/asset/200991/Nokia%20UBT%20Brochure%20EN.pdf)

- Wavence

<https://networks.nokia.com/products/wavence>

Thank you - Connect with us - Any Questions?



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