

5G AS A CONNECTIVITY ENABLER OVER THE NORTH SEA



KIVI webinar: "Connectivity on the North Sea"
March 12, 2024
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Content

- 1) TNO introduction
- 2) North Sea use-cases and service requirements
- 3) 5G features for coastal/maritime coverage
- 4) Integration of terrestrial and non-terrestrial networks
- 5) Conclusions and possible way forward

TNO: Networks department

› Excellence in telecommunications:

- › Radio access network
- › System Architecture

› Influencing 3GPP standardization

› Developing 6G through national Future Network Services (FNS) program

› Experimentation using TNO's mobile network platform (Hi5):

- › **Novel concepts** (radio and core network)
- › **New applications** (e.g. AR/VR, smart factories, automotive services, IoT)

*"Unmanned Valley" -
Leiden*



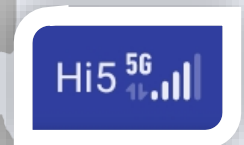
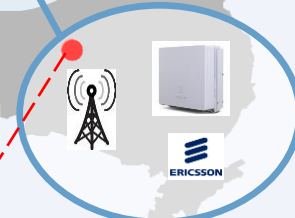
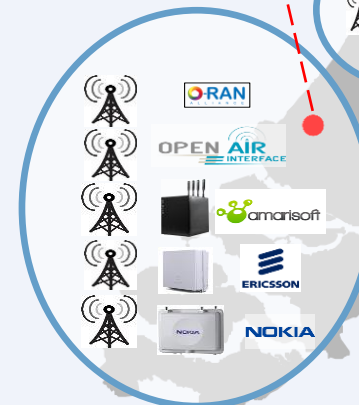
Rural Trial – Groningen



Main Lab - The Hague



Railcenter



Smart Road Trial - Helmond

North Sea use cases



Coast guard



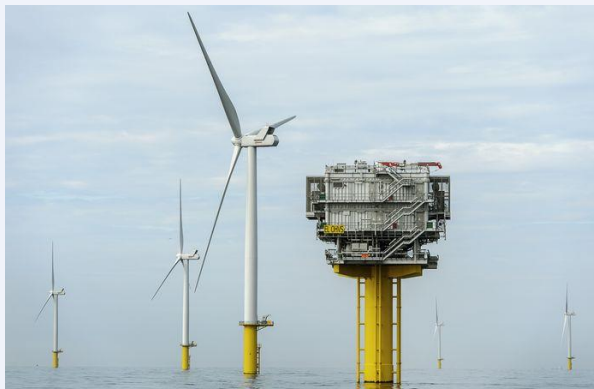
Shipping



Oil/gas rigs



Fishing



Wind parks, offshore stations



Smart buoys



Sea farming



UxV operations

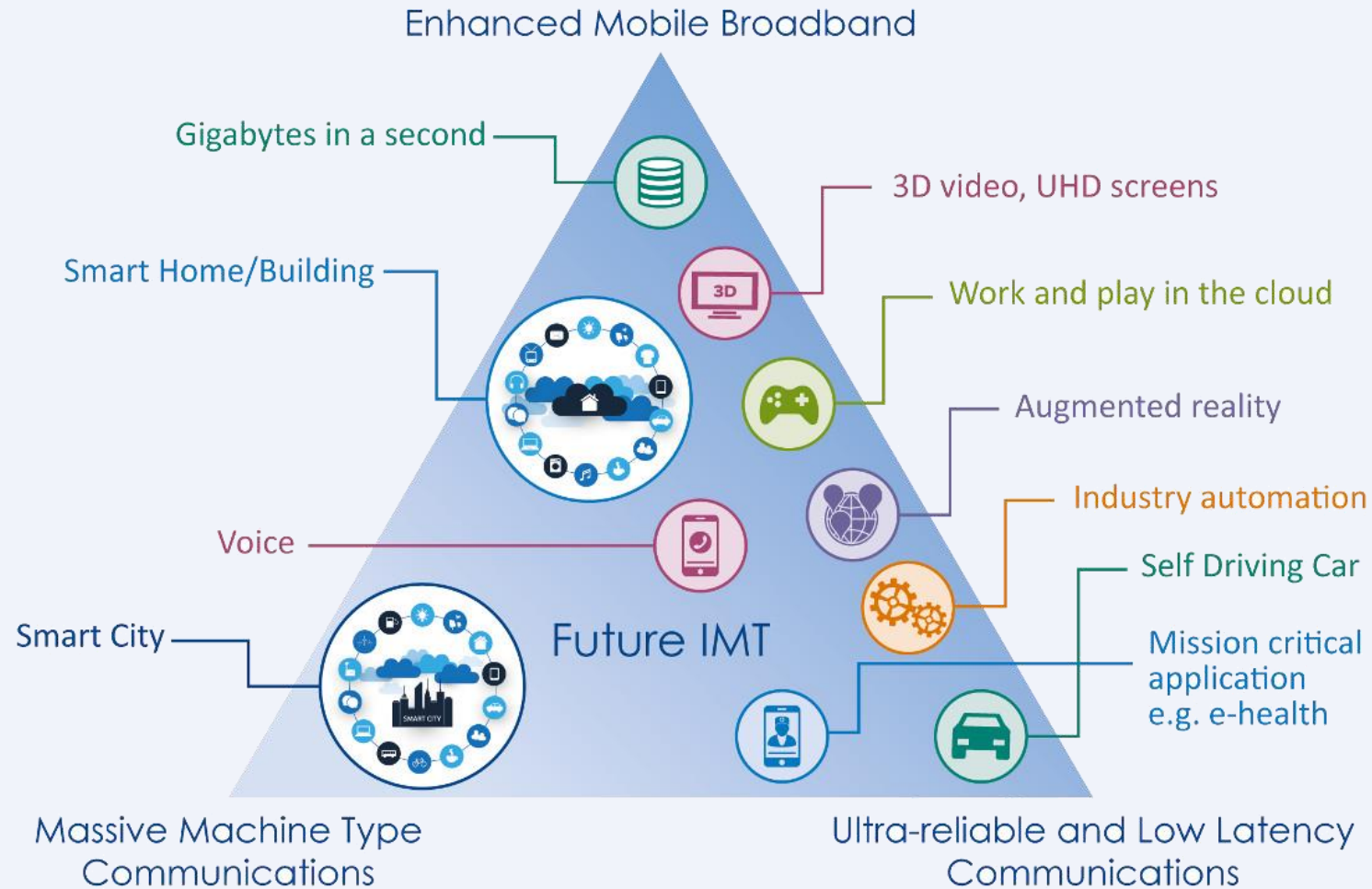
Communication types over the North Sea

- 1) **Maritime radio (voice):** inter-ship; ship-coast
- 2) **Mission critical push to talk (MCPTT) - C2000/Tetra:** First responders
- 3) **Delay tolerant, low-data rate (IoT) communications:** Monitoring or sensing data
- 4) **High speed – microwave links:** data transfer
- 5) **Legacy satellite communications:** video broadcast/multicast
- 6) **High speed, low latency proprietary links:** AR/VR applications, command and control of UxVs

5G

5th GENERATION OF MOBILE COMMUNICATION SYSTEMS

5G development pillars



5G architecture

1) Software defined networking (SDN)

- Fully programmable (SW) network in line with requirements
- Highly adaptable, scalable, agile network

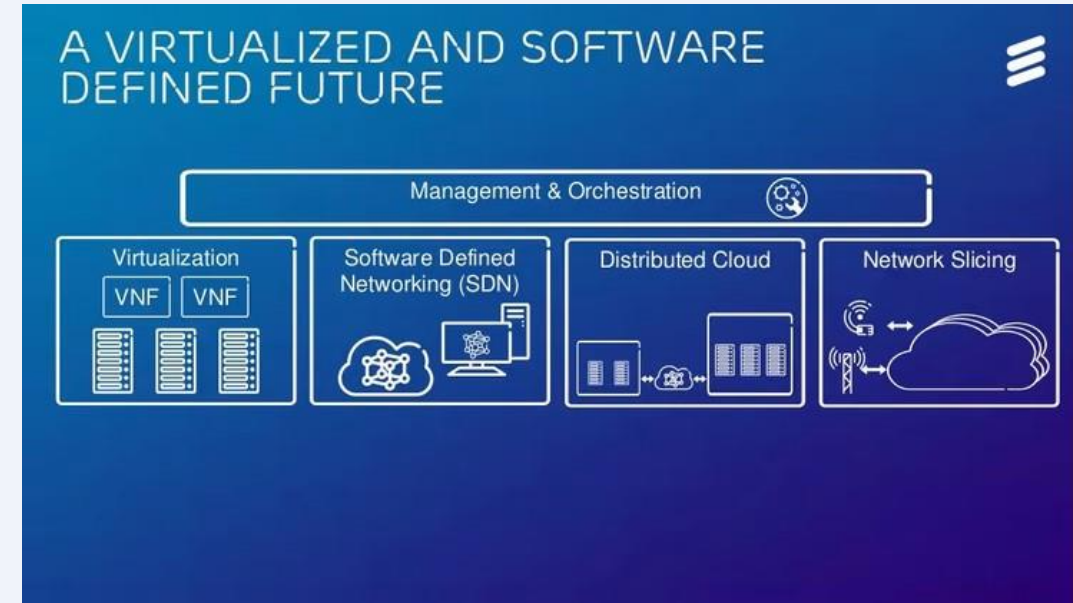
2) Network Function Virtualization (NFV):

- Decoupled network functions from proprietary hardware
- Virtual Network Functions (VNF) run on servers/cloud/edge

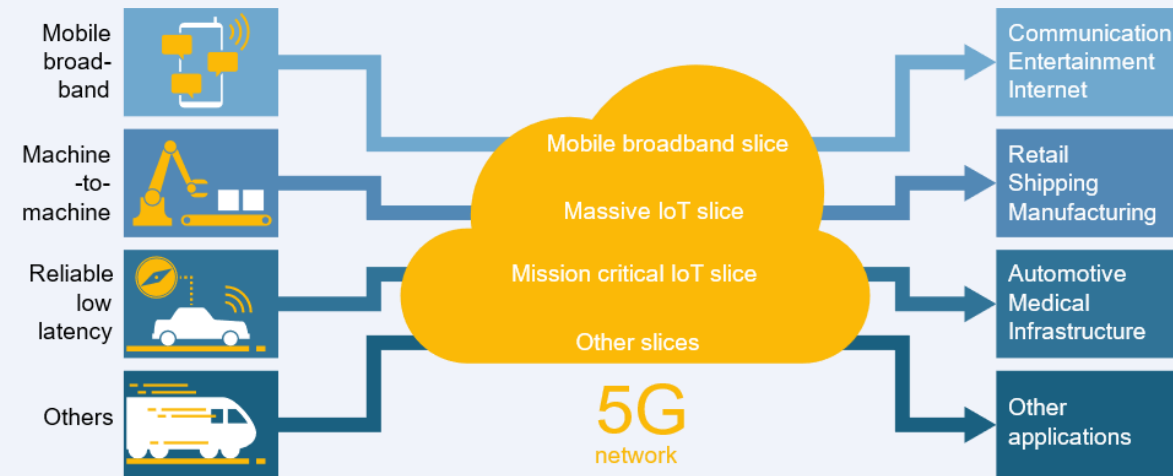
3) Control and User plane decoupling

4) Multi-access Edge Computing

5) Network Slicing - E2E virtual network tailored to specific reqs.



Source: Ericsson



5G Network slicing capabilities. (Source: ITUNews)

5G OPEN RAN concept

1) 4G: Dominance of the big vendors

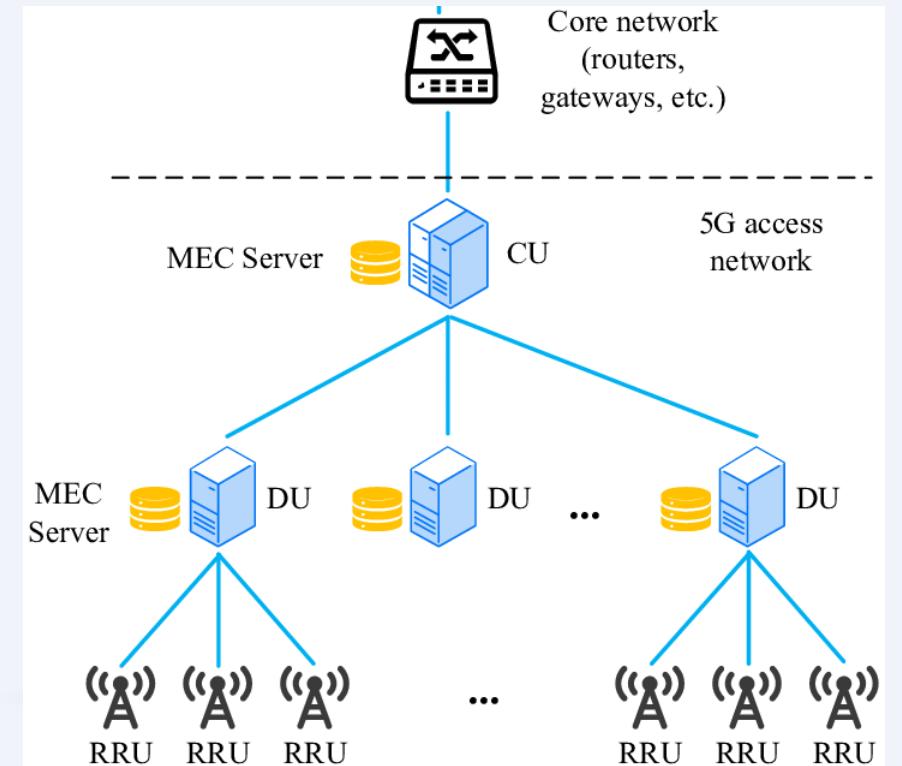
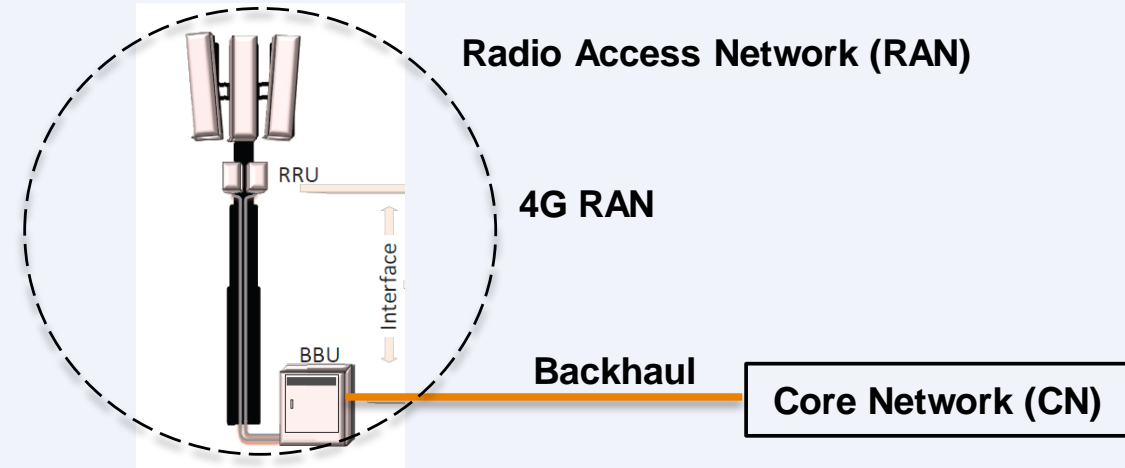
- Proprietary RAN solutions/interfaces
- BBU and RU vendor lock

2) 5G :

- Operators/governments ask for more flexibility in RAN
- Demand for a more diverse/open ecosystem of vendors
- New RAN architectures/solutions

3) 5G OPEN RAN disaggregates RAN into:

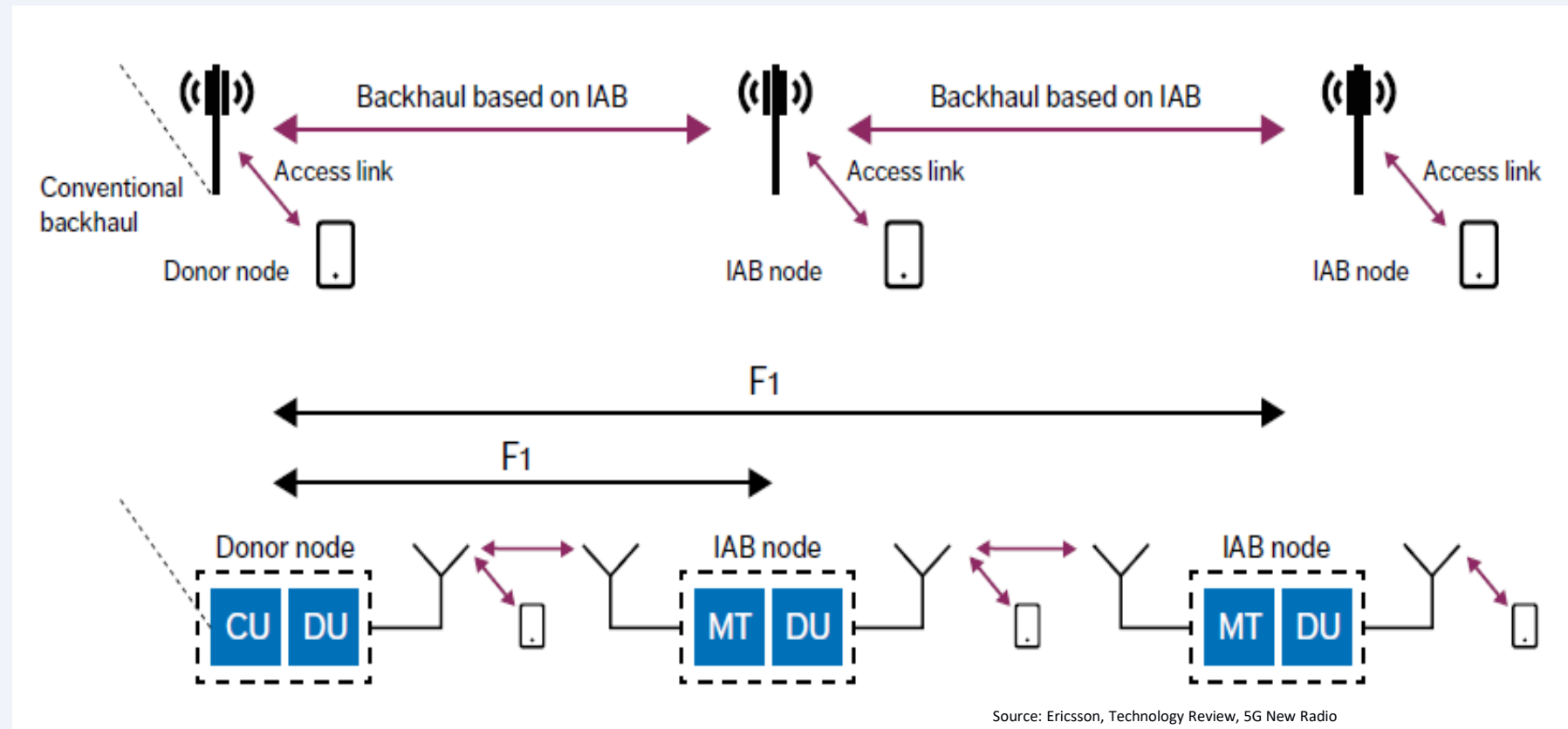
- The Radio Unit (RU)
- The Distributed Unit (DU)
- The Centralized Unit (CU)
- Standardized CU-DU-RU interfaces



5G Integrated Access and Backhaul (IAB)

1) IAB – a type of wireless backhaul

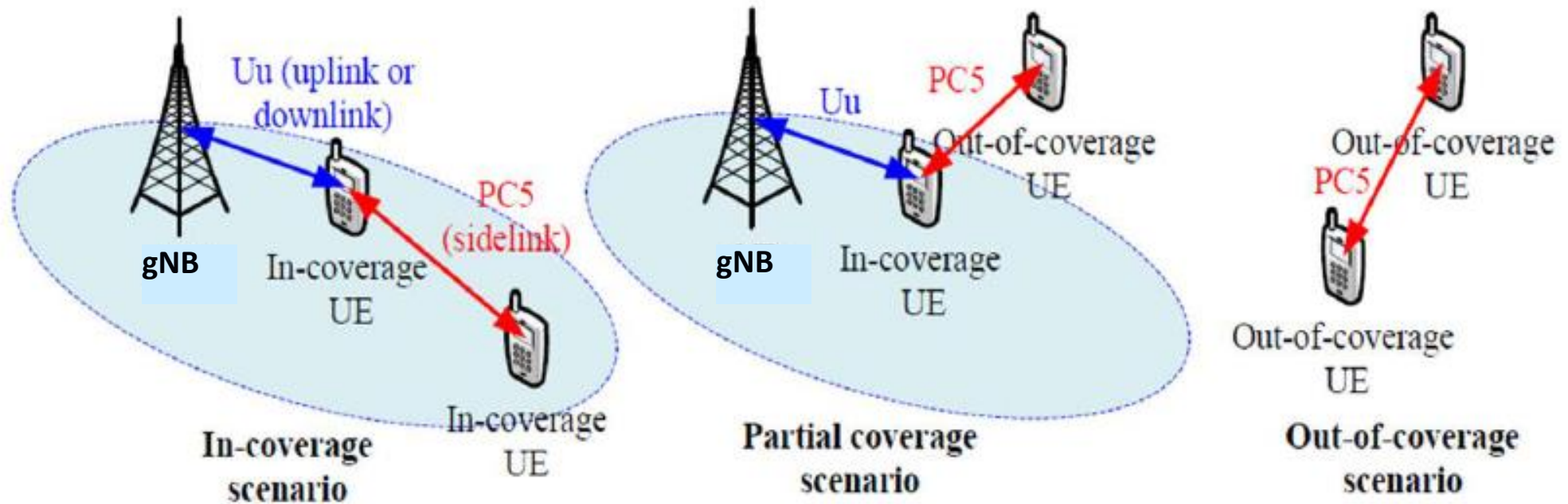
- Same radio technique used for access and backhaul
- High flexibility; Increasing reach by multihopping
- In-band or out-of-band backhauling (same or different freqs for A&B)



5G Integrated Access and Backhaul (IAB)

1) Sidelink – D2D/peer-to-peer communication

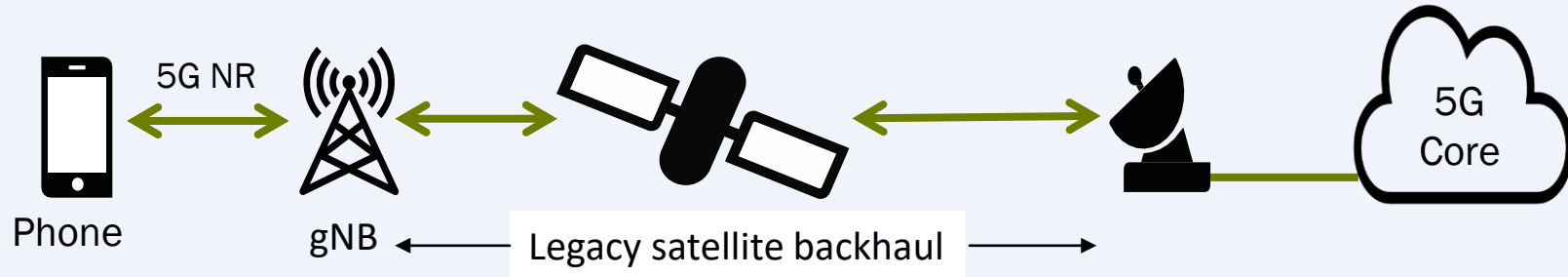
- Allows communication between UEs
- Allows reach/coverage extension
- Use cases: First responders, public safety, V2X



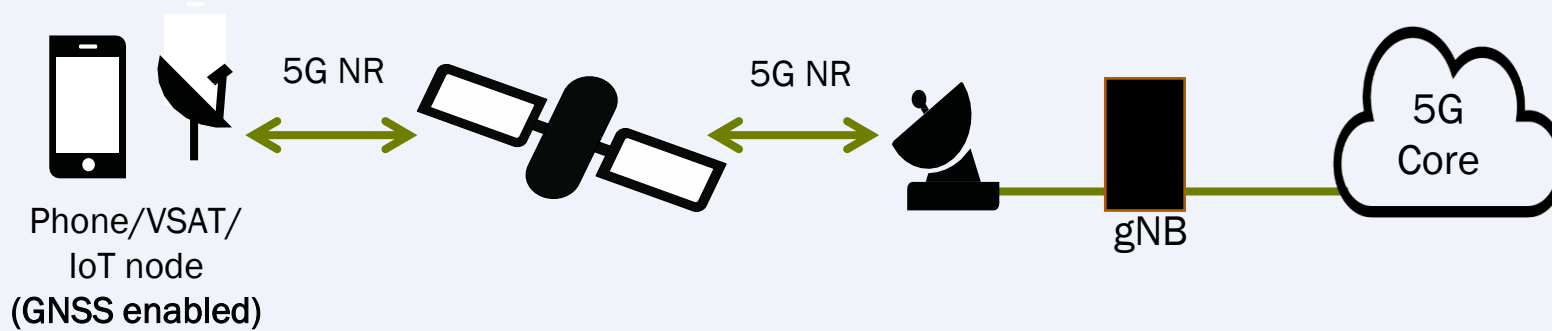
5G Non-Terrestrial Networks (NTN)

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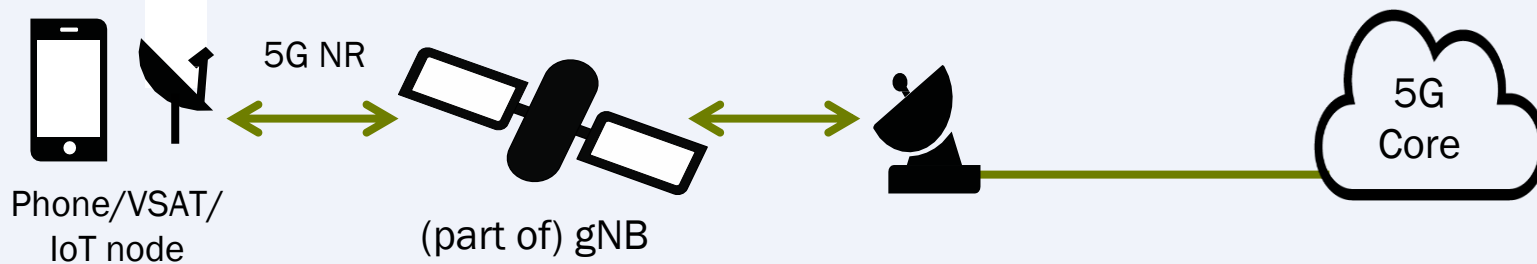
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Satellite backhaul to a remote 5G base station (gNB).



Transparent satellite (direct access)



Regenerative satellite (direct access)

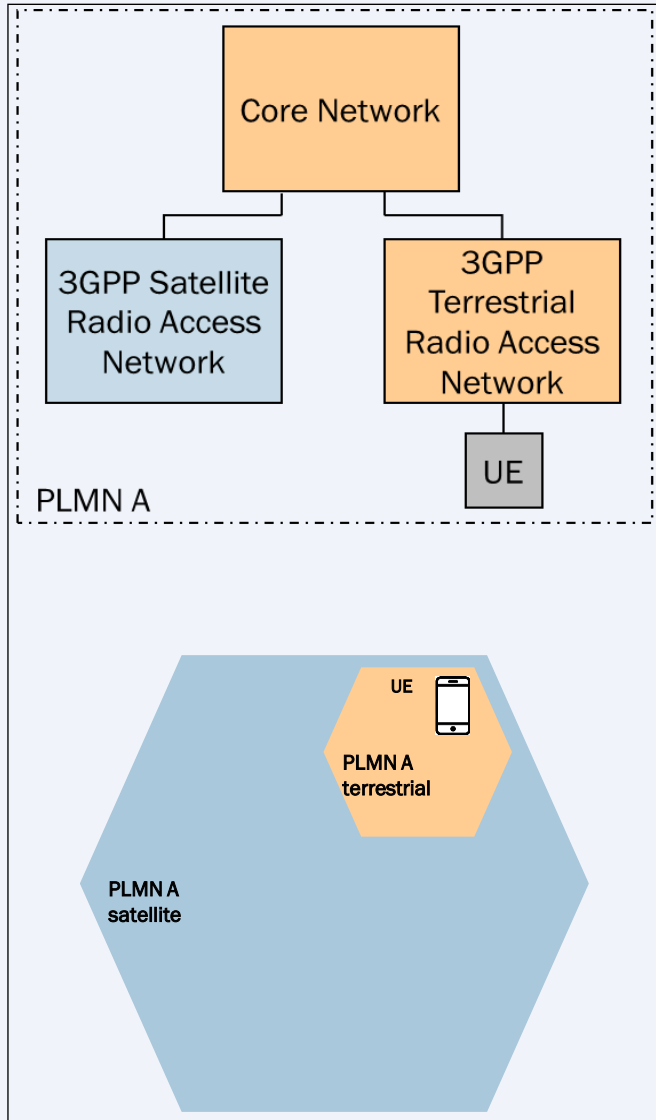
5G NTN performances

Usage scenarios	Experience data rate		Max UE speed	Environment	UE categories
	DL	UL			
IoT connectivity	2 kbps	10 kbps	0 km/h	Extreme coverage	IoT
Pedestrian	2 Mbps	250 kbps	3 km/h	Extreme coverage	Handheld
Public safety	3.5 Mbps	3.5 Mbps	100 km/h 250km/h	Open area	Handheld Vehicle mounted
Stationary	50 Mbps	25 Mbps	0 km/h	Extreme coverage	Building mounted
Vehicular connectivity	50 Mbps	25 Mbps	250 km/h	Along roads in low population density areas	Vehicle mounted
Airplanes connectivity	360 Mbps	180 Mbps	1000 km/h	Open area	Airplane mounted

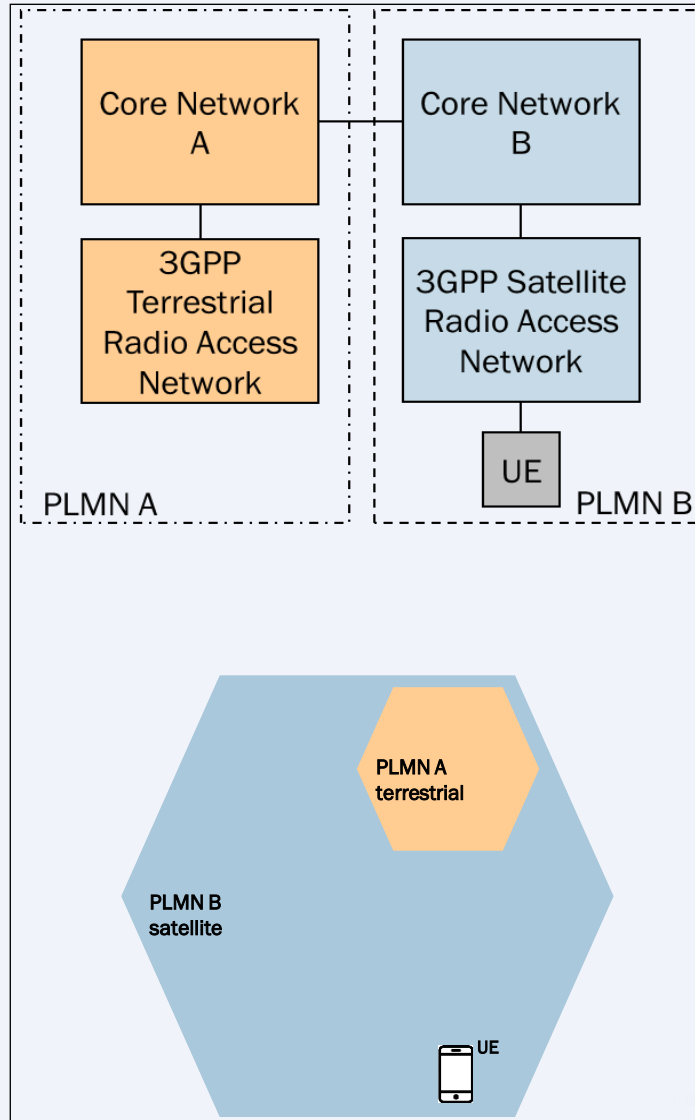
Source: 3GPP TR 22.261 and 38.821

5G TN-NTN Integration Scenarios

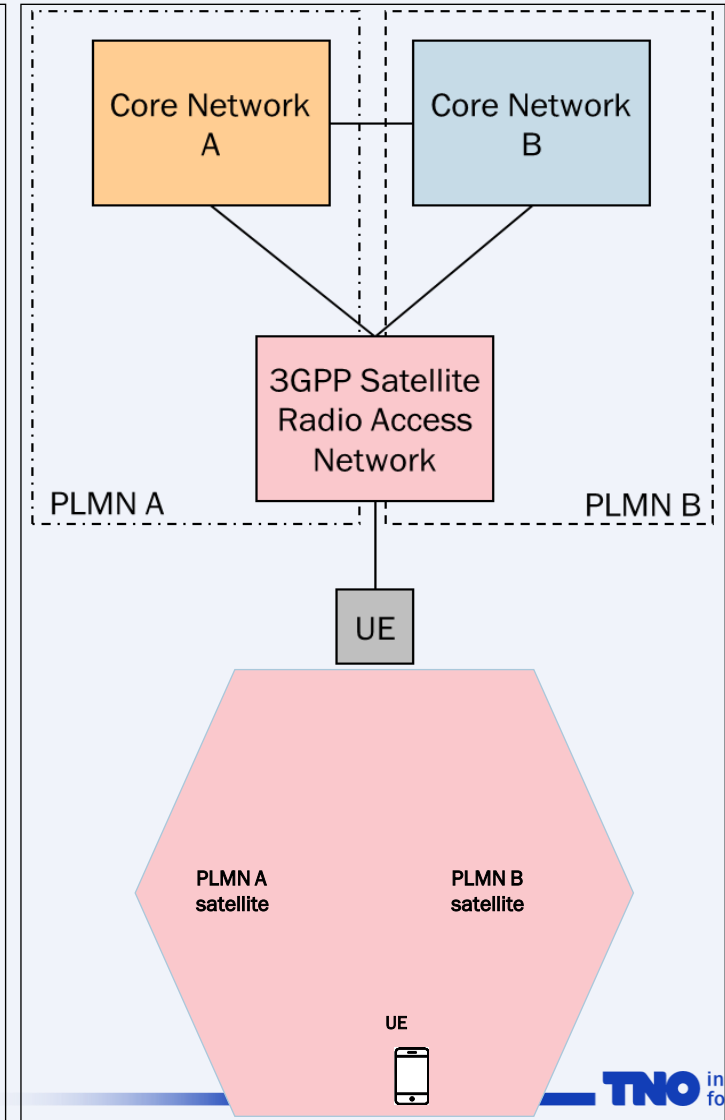
NTN access within a PLMN



Roaming between TN and NTN

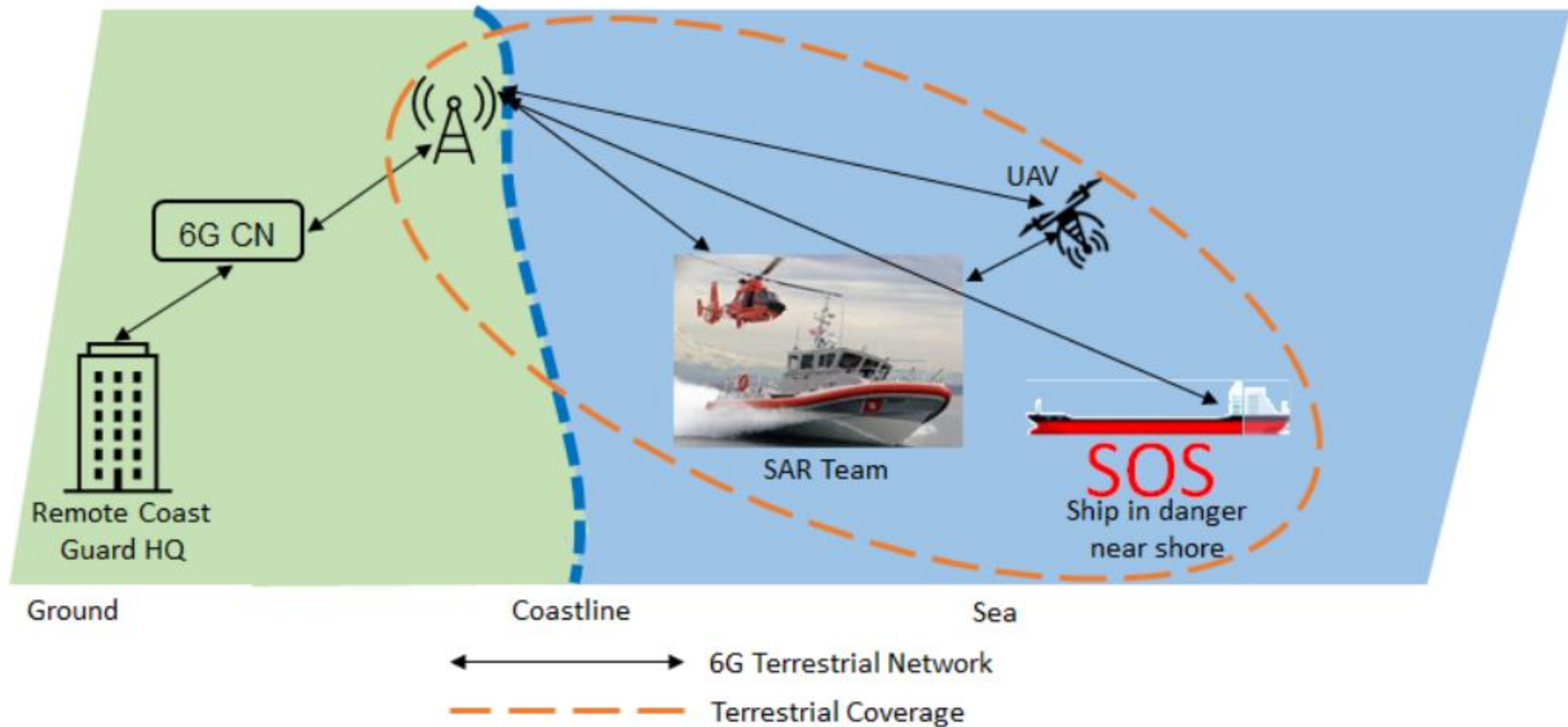


Shared NTN access

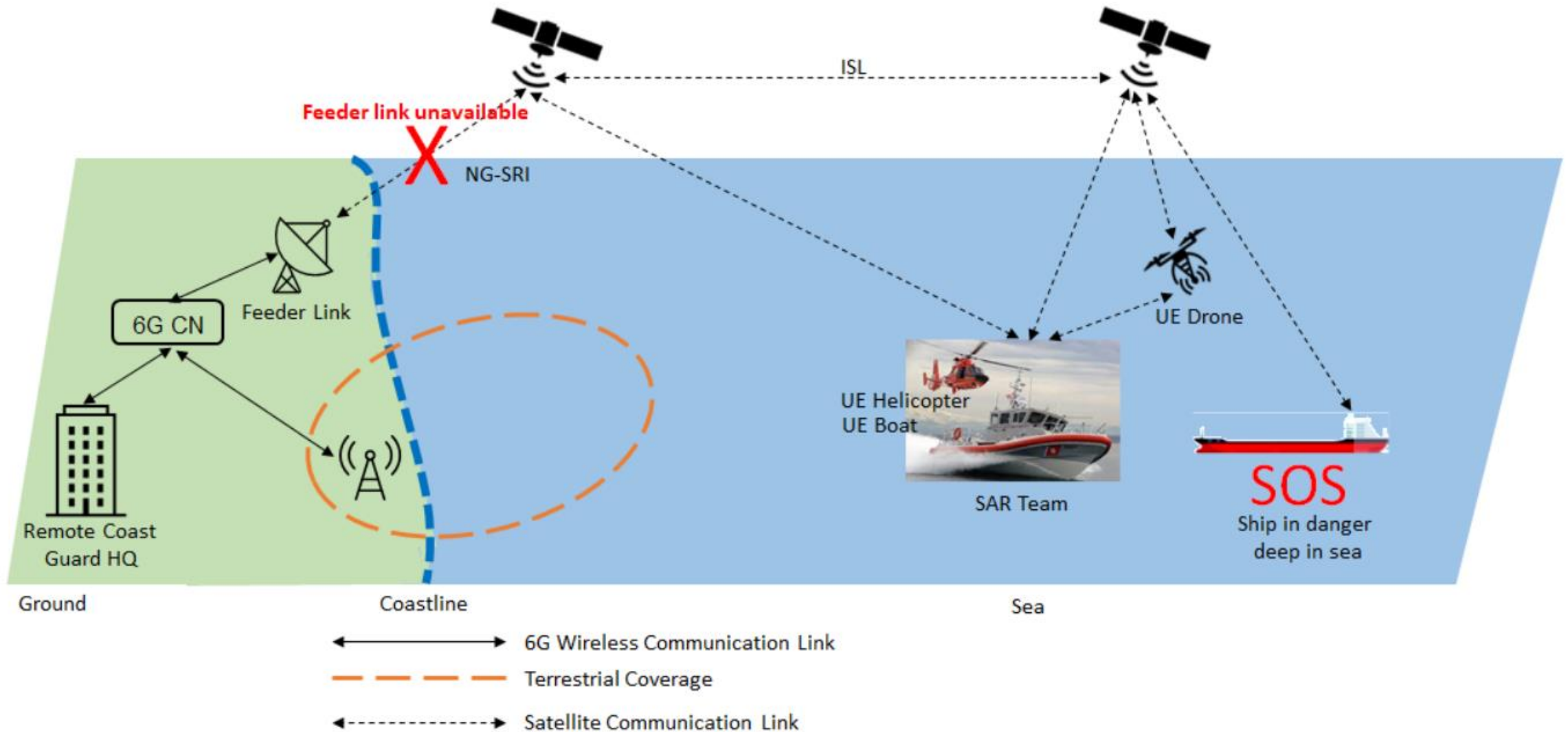


PLMN - public land mobile network is a combination of wireless communication services offered by a specific operator in a specific country (area).

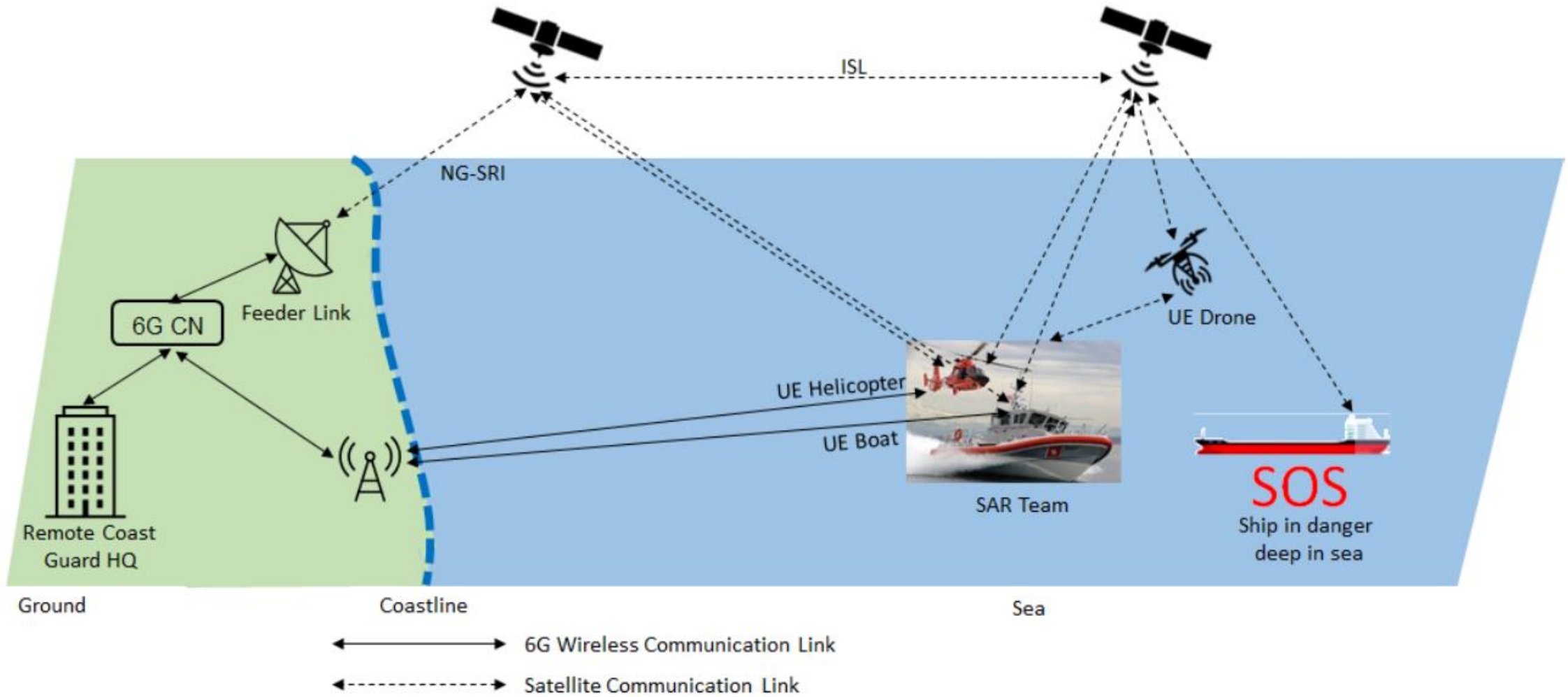
Connectivity at sea using terrestrial network



Connectivity at sea using TN and NTN



Connectivity at sea using TN and NTN



Source: 6G NTN: Use case definition
www.6g-ntn.eu

Trials (China telecom and Huawei)

(DL 100 Mbps, UL 5 Mbps) @ 95% RSRP > -105 dBm	(DL 100 Mbps, UL 3 Mbps) @ 95% RSRP > -110 dBm	(UL 1 Mbps @ 85%) RSRP > -115 dBm	Best Effort
5GtoC/5GtoH: coverage of densely populated areas such as floating fish farms and fishing villages Good network quality assurance for law enforcement ships	5GtoC: linear coverage of sea routes, partial network quality assurance for law enforcement ships	5GtoC: continuous coverage, basic call functions	5GtoC: best-effort, no standard requirements



Source: GSMA - 5G Promises to Transform Marine Industries

https://www.gsma.com/5GHub/images/5G-Case-Study-Smart-Ocean_2022-12-09-164936_iiki.pdf

Conclusions and discussion

1) 5G is a promising technology to enable connectivity over North Sea through

- Numerous 5G features to serve different type of the North Sea users and communication types
- Combining terrestrial and non-terrestrial 5G components to enhance coverage
- Cost efficient network deployment through economies of scale
- Diversity of the ecosystem (e.g. OPEN RAN)
- Software based design allows for flexibility, scalability
- Smooth transition towards 6G

2) Challenges

- Commercial deployment of some 5G features often years behind the 3GPP standard
- Frequency allocation and frequency sharing (national vs international waters)

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