Activity of Scalability Working Group Aiming for Deployment of Non-Terrestrial Networks

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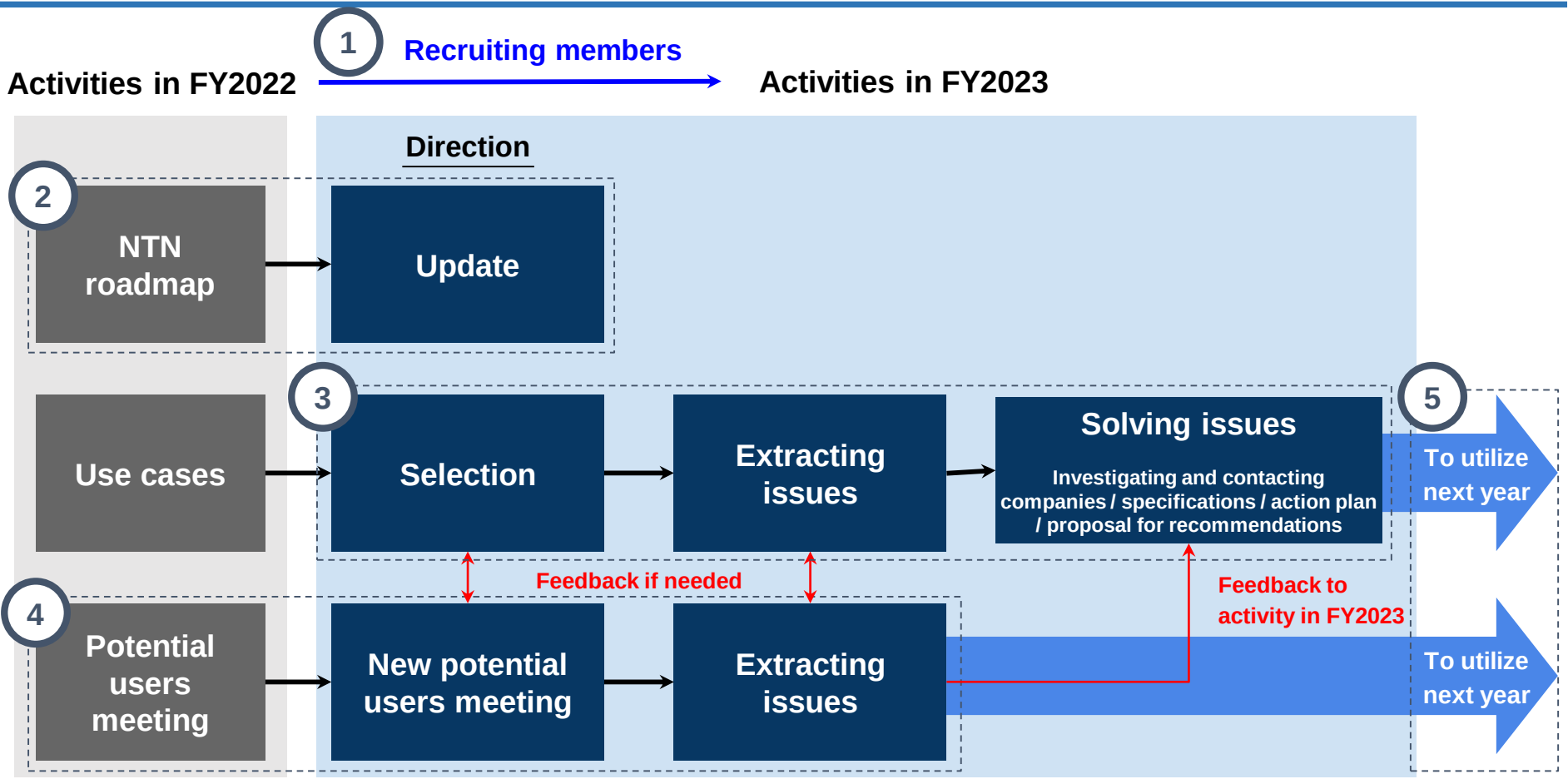
Overview of Scalability WG

- Objectives
  - Landscape mapping on Non-Terrestrial Network (NTN)
  - Identification of potential domestic companies contributing NTN technologies
  - Activation of NTN area with international collaborations
  - Aiming for a role of NTN global consortium
- Past activities
  - FY2021
    - First trial of the landscape mapping on four areas (HAPS, HTS, Satellite IoT, and Maritime domain)
  - FY2022
    - Continuous discussion on NTN area
    - Exchanging the opinions among WG members
    - New use case study through cross-industrial association

Scalability WG Activities in FY2023



Schedule in Scalability WG

Working items / meeting dates		2023					2024	
		No.1 Aug. 30	No. 2 Sept. 19	No. 3 Oct. 31	No. 4 Nov. 21	No. 5 Dec. 19	No. 6 Jan. 30	No. 7 Feb. 20
1 Recruiting members		K/O	X	X	X	X	X	X
2 Trends, standardization and dissemination	Information exchange	K/O	X	X	X	X	X	X
	NTN roadmap						X	X
	Report						X	X
	Website							X
3 Solving issues and making specifications	Use case selection	K/O	X	X			X	X
	Extracting issues			X	X			
	Investigating companies				X	X		
	Contacting companies							
	Specifications / action plan					X	X	X
4 Opinion exchange among industries	Studying agenda	K/O	X	X	X			
	Potential Users Meeting					X	Jan. 23	
	Extracting issues / summary						X	X
5 Proposal	Recommendations for institution / standardization							

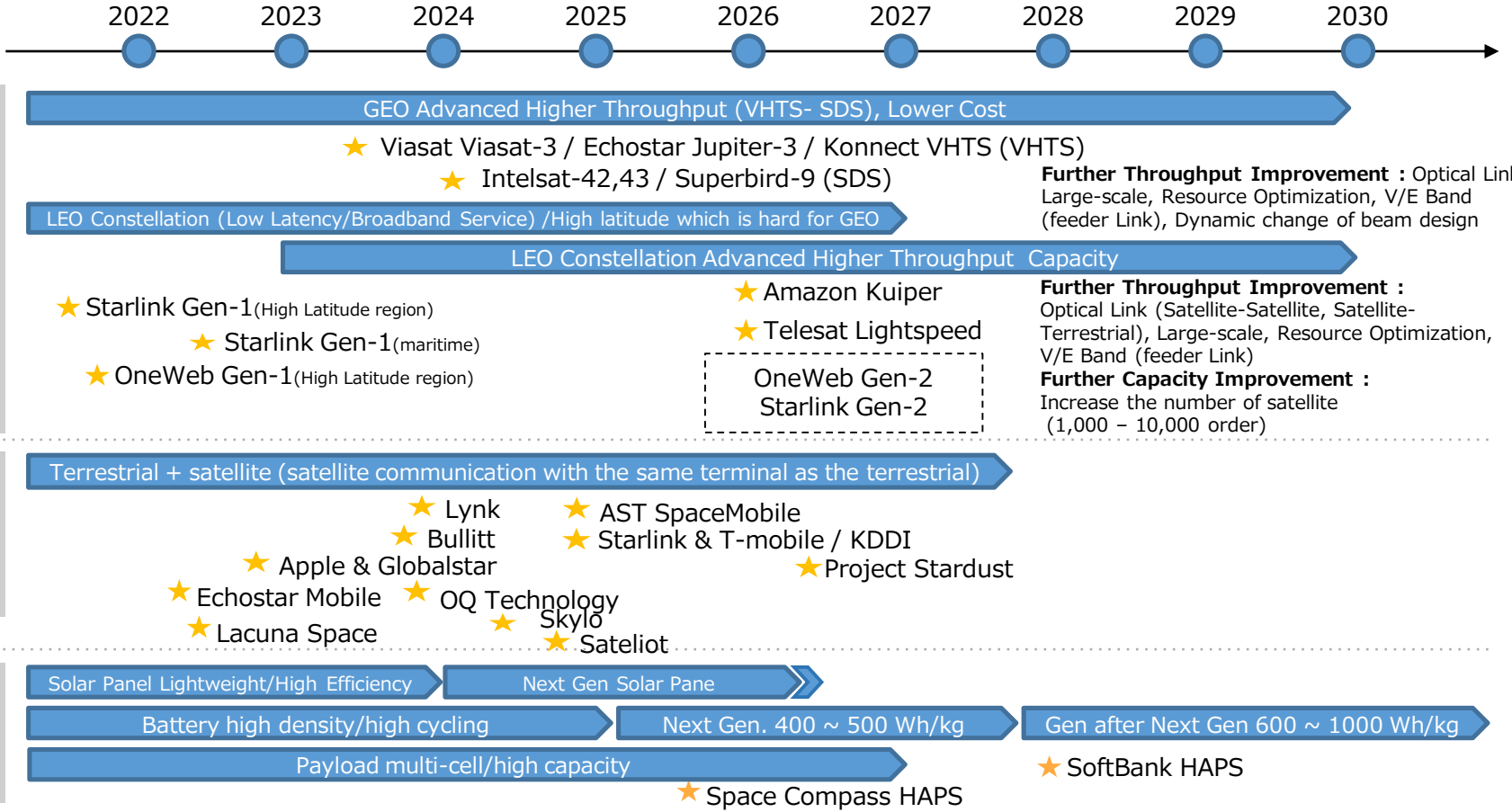
K/O: Kick Off Meeting

Assigned Working items in Scalability WG

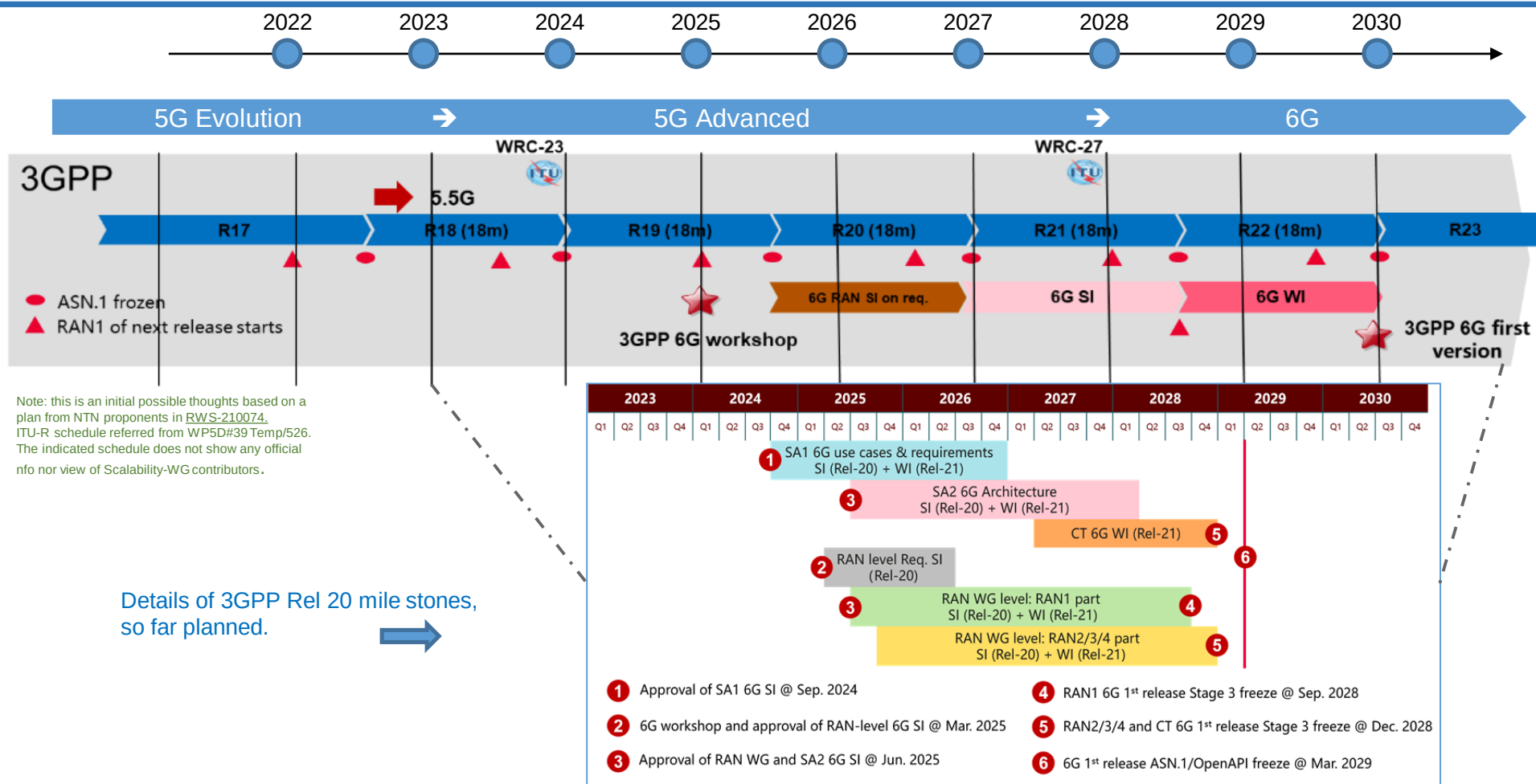
	Working items		Coordinator	Participation members	Contents
1	Recruiting members		Secretary	Rakuten Mobile VIAVI Solutions SoftBank Huawei Japan Ericsson Japan Space Compass KDDI	
2	Trends, standardization and dissemination	Information exchange	Secretary		- Information exchange in WG
		NTN roadmap	Rakuten Mobile		- Update on NTN technologies
		Report	VIAVI Solutions		- Making the activity report
		Website	Secretary		- Publication on the website
3	Solving issues and making specifications	Use case selection	SoftBank		- Study on NTN use cases
		Extracting issues	SoftBank		- Extracting the important use cases for NTN
		Investigating companies	VIAVI Solutions		- Investigating potential companies
		Contacting companies	-		- Contacting potential companies
		Specifications / action plan	Huawei Japan		- Investigating the challenges and difficulties for NTN
4	Opinion exchange among industries	Studying agenda	Ericsson Japan		- Study on the agenda
		Potential Users Meeting	Ericsson Japan		- Holding the meeting - Hearing the opinions among potential users
		Extracting issues / summary	Space Compass (HAPS) KDDI (Satellite)		- Extracting the issues for NTN - Summarizing the issues
5	Proposal	Recommendations for institution / standardization	-		- Proposing the recommendations

Observer	Tokyo Metropolitan University (Prof. Ishii), NTT DOCOMO

NTN Technology Roadmap: Landscape Map



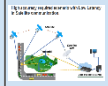
NTN Technology Roadmap: 3GPP/Standardization



NTN Technology Roadmap: 3GPP Comparison

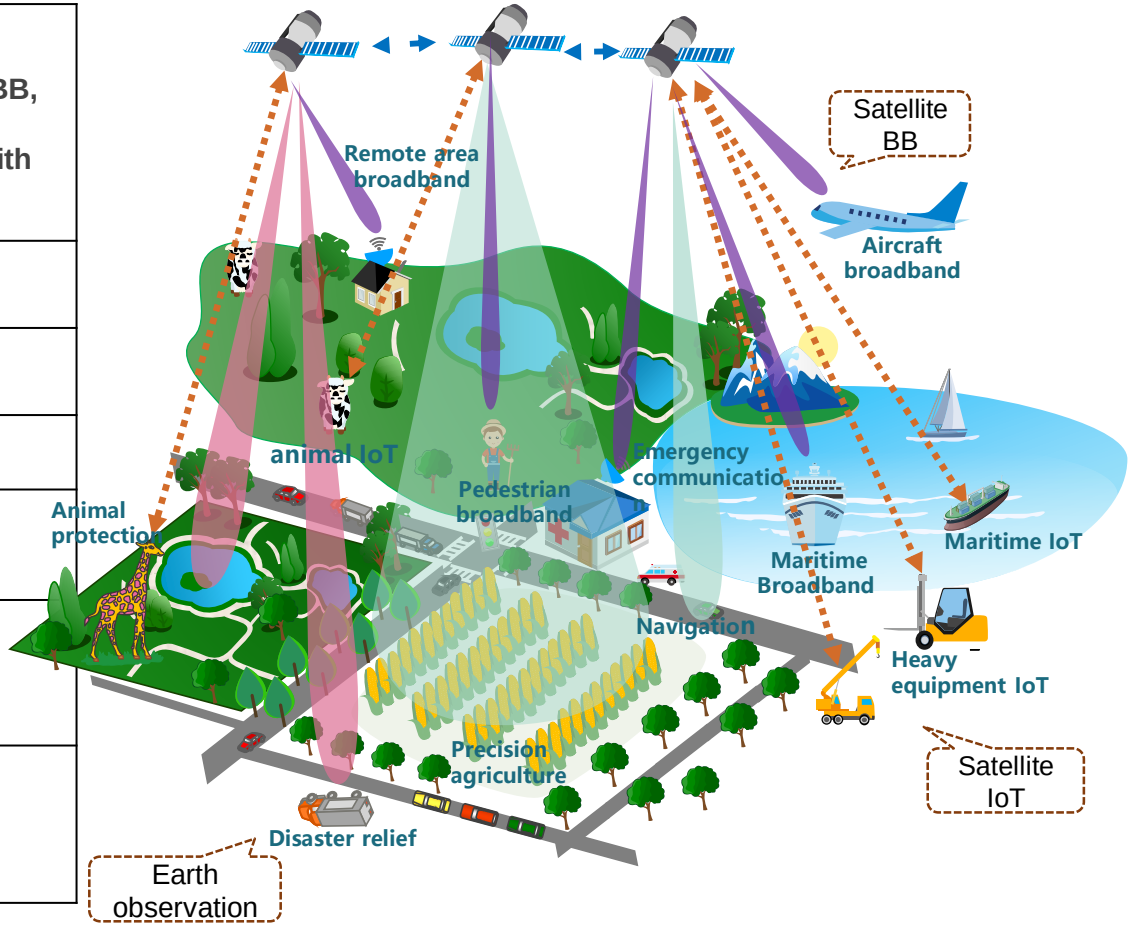
		3GPP NTN(Rel-17) incompatible before Rel16	3GPP NR NTN (Rel-17)	3GPP NB-IoT/eMTC NTN(Rel-17)	Beyond 5G/6G
Satellite		N/A	HAPS/LEO/GEO/MEO	HAPS/LEO/GEO/MEO	Undefined (HAPS/LEO/GEO /MEO)
Service Link Frequency		3GPP frequency Utilize the frequencies of partner MNOs			
Terminal		Existing portable phone terminal (3GPP)	5G NR terminal (3GPP Rel17)	5G IoT terminal (3GPP Rel17)	Undefined
Service		Text, voice, and broadband	Text, voice, and broadband	Text, voice, and broadband	Undefined
Coverage		Global, but within the range of partner MNOs' frequencies			
Features of each technology					
Related Systems	**Radio Regulations**	- Additional distribution of MSS is required for the frequency to be used. - Article 4.4 applies to the use of unallocated frequencies for mobile satellite services	Utilization Possibility of Existing MSS Allocation Frequencies (S-band)	Utilization Possibility of Existing MSS Allocation Frequencies (S-band)	-
	Domestic Installation	It is necessary to develop a system after resolving the institutional issues (type of radio station, license, etc.) caused by the direct communication of mobile phone terminals with satellites	In principle, regulations are established for each system, so it is necessary to develop a system.	In principle, regulations are established for each system, so it is necessary to develop a system.	-
	Standards	After 3GPP Rel-8 (LTE)	3GPP Rel 17 NTN	3GPP Rel 17 NTN	- (After 3GPP Rel 19)
Use Cases		Significant expansion of mobile network coverage Restoration of mobile networks in the event of a large-scale disaster, etc.	Significant expansion of mobile network coverage Restoration of mobile networks in the event of a large-scale disaster, etc.	Significant expansion of mobile network coverage Restoration of mobile networks in the event of a large-scale disaster, etc.	Undefined

Studied Use Cases for NTN

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Title	NTN-TN Interworking	Broadband Wireless Access for the Unconnected Scenario	Wide-Ranging IoT Services Extended to Unconnected Scenario	High-Precision Positioning and Navigation Scenario	Real-Time Earth Observation and Protection Scenario	River Water Level and Snow Cover Positioning	Cattle Count Management	Collaboration between Disaster Sites and Hospitals	Electricity / Communications under Disaster	Mobility	Communication Means in Mountainous Areas	Unmanned Delivery	Enhancement of Air Traffic Control	Detection of Signs of Disasters in Mountainous Areas	Public Safety LTE	Sensing	Complementary Service by NTN
Image																	
Broad-band	X	X	-	-	-	-	-	X	X	X	-	-	-	-	-	-	-
Mobile direct	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X
IoT	X	-	X	-	-	X	X	-	-	X	-	X	-	X	-	-	-
HAPS	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	-	-
Sensing/ Navigation	X	-	-	X	X	-	-	-	-	X	-	X	X	-	-	X	-
Mobility	-	-	-	X	-	-	-	X	X	X	-	-	-	-	-	-	-
NTN-TN integration	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X

Overall Vision of 6G NTN and TN convergence/integration

Use case overview		This shows an overall NTN-TN convergence image. Satellite BB, Satellite IoT, Satellite Observations are integrated with TN communication.
KPI	Throughput	>100Mbps
	Latency	<20ms
	Coverage	Rural areas, ocean, etc.
Terminal type		Dish terminal(fixed) Mobile phone
Frequency		Ku Ka sub-6G
Expected Service Provided Timing		Year 2025~30



Extracted Use Case: 1. NTN-TN Interworking (1/3)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
1	Identify the requirements for the expected use case	Standardization/Industry Association Trends	- Industry Associations (5GAA, etc)	Standardization in line with user needs	Common to all cases
		Trends of Business Operators	- Potential User Operators (Automotive OEMs, etc.)	Standardization in line with user needs	
2	TN (Terrestrial NW)/NTN NW integration architecture	[SD(Software Defined)-WAN method] - Switching of communication bearers between UT (User Terminal) and the network side, unification of specifications for traffic bonding/blending	- SD-WAN Vendor		Currently, each vendor's own implementation ->UT side - NW side must be the same vendor
		[TN-NTN operator Network-to-network connection method] -Standardization of inter-network interfaces and protocols - Authentication method - Handover - Converter in case of inconsistencies	- NTN operators - TN operators - Global MVNO - Manufacturer of telecommunications network equipment	Definition of network-to-network connection methods of TN/NTN operators and standardization of specifications of each vendor	Roaming and Shared RAN methods available
3	TN/NTN dual mode terminal	- Unification of chipsets, SIMs, antennas, etc.	- UT Vendor	Unification of chipsets, SIMs, antennas, etc.	Since the UT vendor takes the initiative in selecting each component, it is better to involve the UT vendor rather than the component manufacturer first.
		- Development of antennas with shapes tailored to the use case	- UT Vendor	Miniaturization of antennas	
4	Development of customer platform	- Billing system integration for TN/NTN integration	- NTN business - TN business - SIer	Assumed to be technically feasible	
		- Design and development of a system for visualizing usage status, etc.	- NTN business - TN business - SIer	Assumed to be technically feasible	
		- Design and development of link management systems	- NTN business - TN business - SIer	Assumed to be technically feasible	
		- Design and development of communication optimization systems	- NTN operators - TN operators - Manufacturer of communications network equipment	Assumed to be technically feasible	

Extracted Use Case: 1. NTN-TN Interworking (2/3)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
5	Technical Considerations Toward Institutionalization	- Definition of the ideal interwork mechanism for each NW (TN/NTN)	- NTN operators - TN operators - Global MVNO - Manufacturer of telecommunications network equipment	Definition of interwork mechanisms that meet user needs	It is necessary to understand customer needs as a precursor to defining the architecture. e.g. - Mobility autonomous driving - Communication can be used outside EEZ
		- Consideration of the best means of NW integration(Possible proposals) - SD-WAN - Inter-carrier roaming - Other	- NTN operators - TN operators - Global MVNO - Manufacturer of telecommunications network equipment	Definition of interwork mechanisms that meet user needs	Handover times must be achieved to meet customer requirements.
6	Examination of the scope of application of existing systems	According to the system linkage (interwork) to implement in society, Consideration of whether or not TN standards can be followed - decision (Authentication method, frequency, communication device)	- Each standard machine - Ministry of Privacy	Definition of interwork mechanisms that meet user needs	
7	Collaborative Coverage	Coverage enhancement	- Vendor& Operator	Enhancing coverages & interworking to support direct connection between cellphones and satellites	In-discussion (RP-232669) 3GPP RAN1-Rel18
		Dual coverage/multi connections	- Vendor& Operator	Extending dual connection coverages of satellite and terrestrial networks	Not discussed yet In 3GPP
8	Mobility Management	Cell Management	- Vendor& Operator	Interworking enhancement to support seamless roaming between different networks	Discussed in 3GPP RAN2 (RP-232669)
		Handover	- Vendor& Operator	Improve link stability while during handover process	

Extracted Use Case: 1. NTN-TN Interworking (3/3)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
9	Routing management	Dynamic Topology	- Vendor& Operator	Introduce new mechanisms to obtain or update the network topology in real time	More difficult than terrestrial, because the satellites moves, the topology changes by time
		Routing Protocols	- Vendor& Operator	Improved protocols such as TCP/IP to catch up moving satellite target	
10	Inter satellite communication	High capacity & stable link	- Optical communication	Up to support 100Gbps (per-link) inter-satellites	Inter-satellites bandwidth allocation
		On Board exchange	- Data processing (Chip speed)	Technical challenge based on the evolution of optical switches and processors on boarded.	
11	Spectrum coordination	Spectrum management	- Regulators and Operators	Regulations on Frequency Allocation and Multiplexing for Multiple Systems	Spectrum isolation or Spectrum sharing (ITU-R and 3GPP RP-232669)
		Interference detection	- Operators	Intelligent Interference Detection and Evaluation mechanism	
12	Operation & Maintenance (O&M)	Unified resource management	- Operators	Coordinates resources between different networks to meet user connection requirements.	Operators improved O&M features are expected
		Unified user management	- Operators	One charging mode, one terminal, and unified settlement	
13	Antennas	Satellite antennas	- Antenna manufactures	Digital phase array to support flexible beam steering and resource allocation	Expected improved Radio technology on Satellite Antennas
		Terminal antennas	- Antenna manufactures	Low cost electrical steering antenna / compact size terminal antenna for cell phones	

Potential Companies to Solve Issues for Use Case 1

Use case	No.	Subject	Detail	Industrial area to solve issues	Potential industries	Remarks
NTN-TN interworking	1	Identification of the requirements for expected use cases	Standardization/Industry Association Trends	Industry Associations (5GAA, etc.)	3GPP, 5GAA	
			Trends of Business Operators	Potential User Operators (Automotive OEMs, etc.)	HONDA, NISSAN	
	2	TN/NTN NW integration architecture	[SD-WAN method] - Switching of communication bearers on the UT and network side, traffic - Unification of Specifications for Bonding/Blending	- SD-WAN vendor	VMware, Fortinet, Versa Networks, Palo Alto Networks, Cisco Systems, Inc.	
			[TN-NTN operator: Network-to-network connection method] - Standardization of inter-network interfaces and protocols - Authentication method - Handover - Converter in case of inconsistencies	- NTN operator - TN operators - Global MVNO - Manufacturer of telecommunications network equipment	SKY Perfect JSAT, SpaceX	
	3	TN/NTN dual mode terminal	- Unification of chipsets, SIMs, antennas, etc.	- UT Vendor	Qualcomm, Kymeta, Intellian, SHARP	
			- Development of antennas with shapes tailored to the use case	- UT Vendor		

Potential Users Meeting (January 23, 2024)

Scalability WG is working to identify the issues for Non-Terrestrial Networks (NTNs) including HAPS and satellites technologies. In order to hear the problems, the potential users meeting was held on January 23, 2024.

Topic: **Potential Users Meeting for Deployment of NTN**

Organizer: **Scalability WG**

Program:

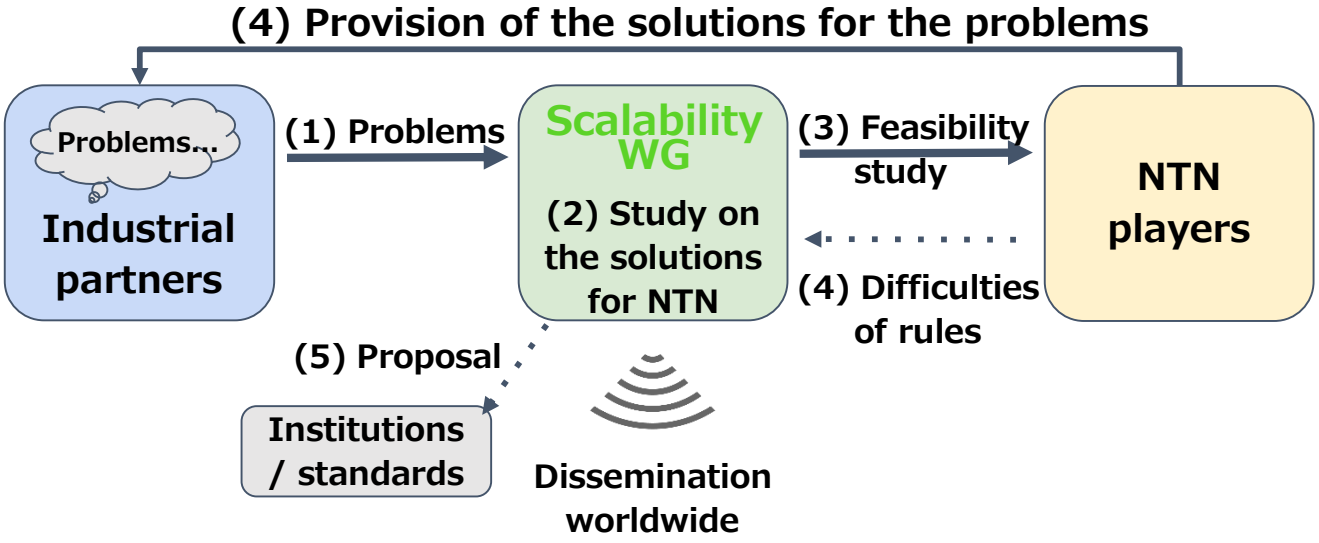
- **Introduction of NTN** (*Scalability WG*)
- **Maritime and Land Mobile Communications** (*Nippon Yusen Kabushiki Kaisha*)
- **Creating 21st Century Growth Industry from "Ocean" X "Communications"** (*Marindows*)
- **Infostellar Ground Station Services** (*Infostellar*)
- **Obayashi Corporation's Space Initiatives** (*Obayashi Corporation*)
- **Future Smart Forestry using Space ICT** (*Plum System Inc,*)
- Panel Discussion:
  - Q&A with presenters and observers
  - Observer: *Japan Airlines Co., Ltd.*

Potential Users Meeting (January 23, 2024)

Future Smart Forestry using Space ICT

Role of Scalability WG for NTN Global Consortium

- Provision of the discussion forum among the members aiming for the deployment of NTN including HAPS and satellites technologies
- Establishment of the common solution and value with the domestic and international partners by forming the co-creation system for NTN issues in Scalability WG



Concluding Remarks

- Current activities of Scalability WG were introduced:
  - Activities in FY2023,
  - Schedule,
  - Assigned Working Items,
  - Updating NTN Technology Roadmap, and
  - Examples of Studied Use Cases for NTN.
- It is important to discuss Japanese way to proceed NTN including HAPS and satellites technologies through the inter-company collaboration.
- Scalability WG is the place to form the discussion forum for NTN technologies in Japan and aims for collaboration with international partners as a role of NTN global consortium.
- Shall we discuss possible collaborations in Scalability WG together?

Welcome to join Scalability WG anytime!

Backup slides

2. NTN-Broadband(Broadband Wireless Access for the Unconnected Scenario)(1/2)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
1	Mobile Direct Data Rate Acceleration	- Is it possible to achieve a downlink speed of >10 Mbps with satellite-smartphone communication? On the other hand, the uplink speed may be less than 1 Mbps. - There are also concerns about capacity due to the large cell range.	- LEO Operators	Larger antennas (but trade-offs with convenience)	Based on the requirement [Throughput: >10Mbps for cellphone], it is judged to be a case of mobile direct. As a preliminary step, it is necessary to refine the requirements.
2	Air interface	Synchronization	- Vendor& Operator	To over come the Impact of Transmission Delay and Doppler Effect in satellite communication, common TA (Timing Advance) and GNSS positioning may mitigate the issue.	3GPP RAN1 38.213-4.2 ; 38.211-4.3.1
		Random access	- Vendor& Operator	New preamble sequence, Simplified random access procedure	Not discussed in 3GPP yet
		MU(Multi User)-MIMO	- Vendor& Operator	Improve the spectrum efficiency, the difficulty is how to synchronize multiple satellites	Not discussed in 3GPP yet
3	MAC protocols	Beam hopping	- Vendor& Operator	Beam resource allocation mechanism to make sure match the coverage demands	Already used in GEO satellite communication systems
		Resource allocation	- Vendor& Operator	Power, carrier resource allocation and bandwidth assignment to meet requirement of high throughputs	Similar to terrestrial networks

2. NTN-Broadband(Broadband Wireless Access for the Unconnected Scenario)(2/2)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
4	User terminal	Power consumption	- Chip manufacturer & protocol standard	Low power consumption devices, low transmit power than 5G	EIRP of user terminal discussed in 3GPP RAN1
		Antenna miniaturization	- Antenna manufacturer	Beam steering antenna in mobile phone for broadband	Antenna parameter of user terminal discussed in 3GPP RAN1 Rel16 (TR38.821)
		Device miniaturization	- Device manufacturer	Support direct connection to handset-UE or portable devices	Miniaturization may depends device manufacturers and usage scenarios.
5	Satellite payload	Onboard processor	- Chip manufacturer	Digital payloads, reduce time delay and provide more flexible service	Discussed in 3GPP RAN1
		Power supply	- Satellite manufacturer	Low cost Equipment	High capacity power supply is one of the technical limitations so far.

3. NTN-IoT (Wide-Ranging IoT Services Extended to Unconnected Scenario) (1/2)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
1	Definition of TN/NTN Integration	- NTN IoT technology has already been realized. -> If integration with TN is required, it is necessary to define the integration based on the expected use case. -> Discussion on "Target case name: NTN-TN interworking"		Understanding use cases that meet user needs	
2	Air interface	Synchronization	- Vendor& Operator	To over come the Impact of Transmission Delay and Doppler Effect in satellite communication, common TA (Timing Advance) and GNSS positioning may mitigate the issue.	3GPP RAN1 38.213-4.2 ; 38.211-4.3.1
		Random access	- Vendor& Operator	New preamble sequence, Simplified random access procedure	Discussed in 3GPP RAN1
		Redcap (Expansion to make it easier to connect small, low-power IoT devices with 5G)	- Vendor& Operator	Low power consumption, low modulation rank, low complexity	Discussed in 3GPP RAN1
		IoT protocols	- Vendor& Operator	Diversified three different protocols, such as NB-IoT, LoRa and Sigfox are exist, how should they are accommodated?	NB-IoT is discussed in 3GPP RAN1, LoRa and Sigfox are private protocols.

3. NTN-IoT(Wide-Ranging IoT Services Extended to Unconnected Scenario)(2/2)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
3	MAC protocols	Fixed resource assignment	- Vendor & Operator	Allocating fixed time-frequency resources to users may contribute to avoid collisions(NB-IoT)	Discussed in 3GPP RAN1
		Random resource assignment	- Vendor & Operator	Allocating different (time & frequency) domain resource mechanism may improve spectral and energy efficiency (LoRa and SigFox)	Private protocols
4	User terminal	Power consumption	- Chip manufacturing & protocol standard	Low power consumption devices, low transmit power than 5G	EIRP of user terminal discussed in 3GPP RAN1
		Device miniaturization	- Device manufacturing	Support direct connection to UE or portable devices	miniaturization may depends device manufacturers and usage scenarios.
5	Satellite payload	Onboard processor	- Chip manufacturing	Digital payloads, reduce time delay and provide more flexible service	Discussed in 3GPP RAN1
		Power supply	- Satellite manufacturing	Low cost Equipment	High capacity power supply is one of the technical limitations so far.

4. NTN-Sensing/Positioning(High-Precision Positioning and Navigation Scenario)(1/2)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
1	High Accuracy Location Positioning	- Clarification of positioning accuracy to enable autonomous driving of Mobility	- Automobile Manufacturers - Agricultural Machinery Manufacturers - Drone Manufacturers	Understanding use cases that meet user needs	
		- Development of high-precision positioning technology	- Telecommunications Equipment Manufacturers	Understanding use cases that meet user needs	- There exists SoL(Safety of Life Service) with cm-positioning (RTK positioning)
2	Definition of Low Latency (Latency : <20ms)	1) Examination of feasibility of placing processing capacity on the satellite side	- Satellite Communications Carriers	Understanding use cases that meet user needs	Refinement of requirements is required as a preliminary step
		2) Consideration of feasibility when using HAPS	- HAPS Operator		
3	Impact of Line of Sight	- When satellite communication is used, there are situations where LOS (line of sight) cannot be obtained, but is the autonomous driving scenario based on that?	- Automobile Manufacturers - Agricultural Machinery Manufacturers - Drone Manufacturers	Understanding use cases that meet user needs	Assuming a situation where you are out of cellular range and cannot take LOS
4	Air interface	Synchronization	- Vendor& Operator	To over come the Impact of Transmission Delay and Doppler Effect in satellite communication, common TA (Timing Advance) and GNSS positioning may mitigate the issue.	3GPP RAN1 38.213-4.2 ; 38.211-4.3.1
		Random access	- Vendor& Operator	New preamble sequence, Simplified random access procedure	Discussed in 3GPP RAN1
		Positioning	- Vendor& Operator	Single satellite positioning, Positioning enhancement based on GNSS	Discussed in 3GPP RAN1
		Sensing	- Vendor& Operator	Waveform support sensing and communication at the same time	Not discussed in 3GPP, similar to ISAC, need to consider the same waveform to support two functions

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
5	MAC protocols	Beam hopping	- Vendor& Operator	Power, carrier resource allocation and bandwidth assignment to meet requirement of high throughputs	Already used in GEO satellite communication systems
		Resource allocation	- Vendor& Operator		Similar to terrestrial networks
6	User terminal	Power consumption	- Chip manufacturer & protocol standard	Low power consumption devices, low transmit power than 5G	EIRP of user terminal discussed in 3GPP RAN1
		Antenna miniaturization	- Antenna manufacturer	Beam steering antenna in mobile phone for broadband	Antenna parameter of user terminal discussed in 3GPP RAN1 Rel16 (TR38.821)
		Device miniaturization	- Device manufacturer	Support direct connection to mobile phone or portable devices	Depend on device manufacturer and usage scenarios
7	Satellite payload	Onboard processor	Chip manufacturer	Digital payloads, reduce time delay and provide more flexible service	Discussed in 3GPP RAN1
		Power supply	Satellite manufacturer	Low cost Equipment	High capacity power supply is one of the technical limitations so far.

8. Collaboration between Disaster Sites and Hospitals (1/1)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
1	Ensure Availability	Rainfall attenuation measures	- LEO Operators	1) It is necessary to operate in consideration of the characteristics of the frequency band (Ku, Ka, etc.). In some cases, it is necessary to have redundancy with the S/L band GEO.	There are already use cases in the US and other countries. To what extent do you want to improve usability? Discussion needed.
			- LEO Operators	2) UT (Antenna) - Improving the satellite communication capability (receiving/transmitting)	
			- LEO Operators	3) Redundancy of ground GW stations (areas) based on ISL (Inter Satellite Link)	
2	Ensure Availability	Alternatives at the site of a disaster with non line of sight	- LEO Operators + TN/NTN Integration Discussion	Consideration of collaboration with other networks	
3	Ensure Availability (Connectivity)	Cooperate with other NTN systems	- LEO/MEO/GEO/(HAPS)Operator	Minimize Latency increase due to collaboration	
		Maritime (use outside Japanese territory)	- LEO operator, (MIC=government)	Currently, some LEO services may not be available outside the Japanese territory.	
4	Securing Capacity	1) Provision of bandwidth guarantee services	- LEO Operators	Technically feasible	There are already use cases in the US and other countries. To what extent do you want to improve usability? Discussion needed.
		2) Increased Satellite Capacity - Increase the number of satellite cardinals - Use high frequencies (e.g. V-band)	- LEO Operators	The use of high frequencies is further affected by rainfall attenuation.	
5	Ensure Reliability	Provide bandwidth guarantee services	- LEO operator		
		Retransmission control, high performance FEC, coordination with other NTNs, increase number of antennas	- Standardization, NW and UE vendor		
6	Reduce Latency		- TN/NTN operator	Edge servers, etc. NTNs, where Latency is more pronounced, need to be more aware than TNs.	

11. Communication Means in Mountainous Areas (1/1)

No.	Subject	Details	Potential companies to solve issues	Technical challenges and difficulties / Problem solving proposals	Remarks
1	Ensure Availability	To be used for rescue contact, it must be available at all times.	- HAPS Alliance Participating Companies - Aircraft manufacturer - HAPS Operator	1) Establishment of operational operations including autonomous driving	
			- HAPS Alliance Participating Companies - Aircraft manufacturer - Various manufacturers	2) Development of elemental technologies to realize long-term flight (Charging/storage, etc.)	
2	Ensure Availability	In mountainous areas, it may be difficult to install a ground station.	- HAPS Alliance Participating Companies - HAPS Operator - Telecommunications Equipment Manufacturers	1) Realization of InterHAPS communication	
			- HAPS Alliance Participating Companies - HAPS Operator - Telecommunications Equipment Manufacturers - Satellite Communications Carriers	2) Backhaul use of satellite communications	
3	Symbiosis with Cellular NW	Interference countermeasures with cellular network radio waves	- Government	1) Securing Dedicated Frequencies	The same problem is expected with anti-satellite.
			- Telecommunications Equipment Manufacturers	2) Beamforming	
			- Telecommunications Equipment Manufacturers - MNO	3) Canceller technology, etc.	