STANDARDS AND REGULATIONS: The backbone of secure and reliable NTN Networks

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Make ideas real

OUTLINE

- Motivation for Standardization and Regulations
- From proprietary solutions towards standardized solutions:
  - IRIS2 supports 3GPP 5G standards.
  - Direct-to-cell communications
  - Mission critical communications: Future-G
- Conclusions

Motivation for Standardization and Regulations

Challenges

- Proprietary solutions
- Fragmented systems
- Inefficient spectrum use

Motivation & Needs

- Ubiquitous coverage: Integration of terrestrial & non-terrestrial networks
- Convergence & Co-existence
- Regulations ensure efficient spectrum usage.

Benefits

- Interoperability & seamless connectivity
- Strong ecosystems & sustainable infrastructure
- Universal, affordable network design
- Reliable, compliant services without disruption

IRIS² – RELIABLE, SECURE And COST-EFFECTIVE

Space segment	Constellation	18 MEO	264 LEO-H 10+ LEO-L
	Payload	Regenerative + Transparent	Regenerative + Transparent
	Multiband	Ka-Mil/Ka virtual. +UHF(tbd) + SDR	Ka-Mil/Ka virtual. + Ku + SDR
	Network	5G Mesh	
Ground segment		5G Core network	
User terminals		Multi-purpose FPA | Multi-waveform | Phase array	

- Secure & cost-effective: Public-private partnership
- Dual Purpose: Secure government use + EU citizens
- 5G compatible
- Unified terminal compliance
- Standardized maintenance

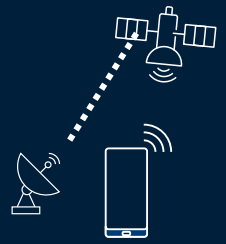
Satellite Communications from Proprietary to Standardized

Proprietary | Standardized

Legacy LEO/MEO Satellite + new 5G phone

- Dedicated spectrum
- Dedicated ecosystem
- Limited use case

(e.g. Apple-Globalstar)



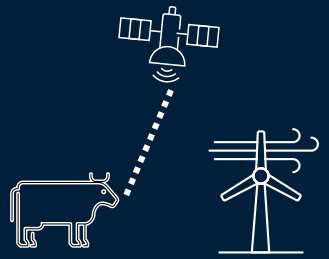
Advanced LEO Satellite + **unmodified** 4G phone

- Spectrum sharing
- Intelligent satellite
- Existing ecosystem: early service

(e.g. AST, Lynk, SpaceX)

Advanced GEO/LEO Satellite + **NB-IoT**

- Modified IoT devices
- Dedicated <6GHz spectrum
- Lim. Capacity, low data rate, delay tolerant



Advanced Satellite + **NTN-NR**

- Modified UE, various categories CPE, TCU, VSAT
- Dedicated spectrum >6GHz, Ku, Ka band
- Higher capacity, multiple use cases

DIRECT-TO-CELL: TWO DIFFERENT APPROACHES

D2C: Direct to Cell , D2D-IMT: Direct to IMT Device

D2C using Mobile Satellite Spectrum (MSS)

- Spectrum allocated to MSS use regionally/globally to provide D2C services by SNO
- Unmodified or modified smartphones
- Partnerships with phone manufacturers
- Players: Globalstar, Viasat, ~~EchoStar~~, Space42, Omnispace and Iridium, Starlink D2C **new**

D2C using Terrestrial Mobile Spectrum (TMS)

- Use of mobile spectrum assigned to the MNO
- Unmodified smartphone
- SNO – MNO agreement
- Players using MS: AST Space Mobile, Lynk, Starlink D2C

New: AST + Ligado (C/S-band), Viasat + Space42 = Equatys, Lynk + Omnispace + SES

Satellite D2D-IMT Deployment Considerations

MOBILE TEST SUMMIT 2025
Virtual conference connecting the World

Regulatory Context

– **Non-EU Operator Deployments**
Operate under **Article 4.4 of ITU Radio Regulations:**
⇨ *Non-protection and non-interference basis*

Spectrum & Device Requirements

– **Limited MSS Spectrum harmonisation:** *Special smartphones*

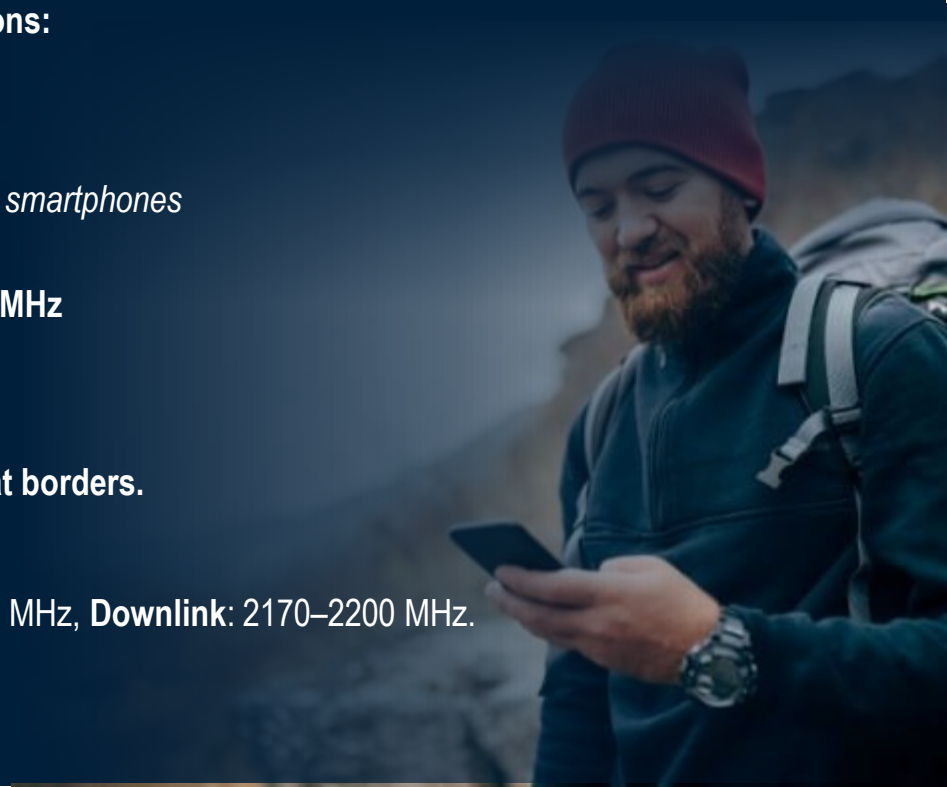
– **Greater Bandwidth in IMT Spectrum**
⇨ *Example*: One NZ expanded from **5 MHz to 15 MHz**

Regional Constraints

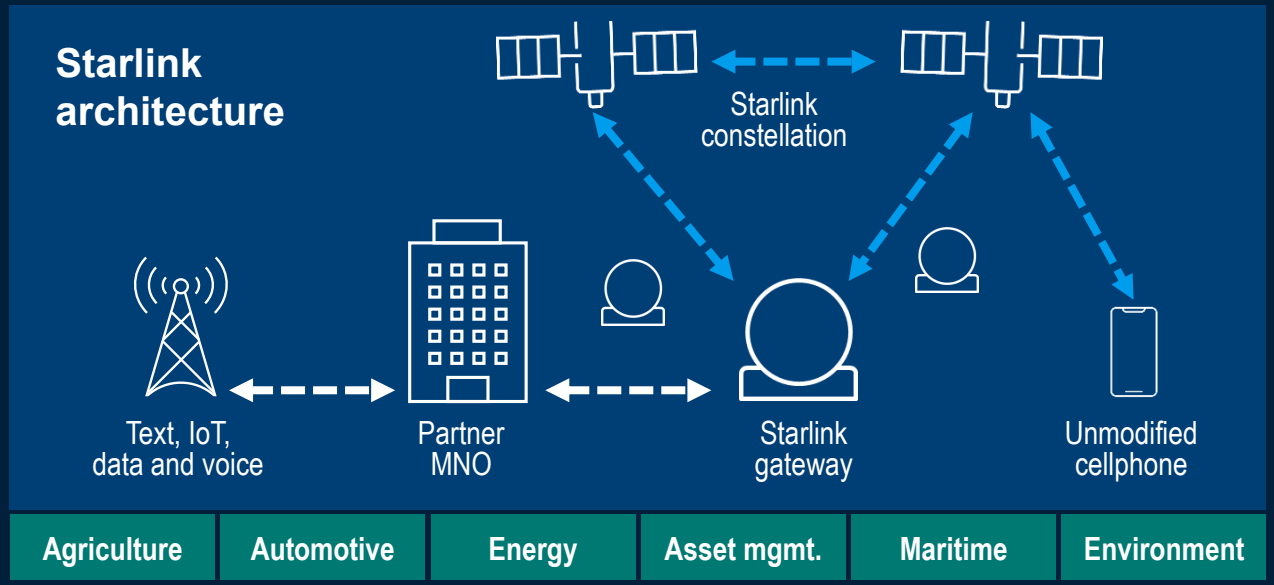
– **Europe, Central America, West Africa:**
⇨ Small countries necessitate **power reduction at borders.**

Alternative Path Forward:

– **Re-open 2 GHz MSS Bands: Uplink**: 1980–2010 MHz, **Downlink**: 2170–2200 MHz.



Starlink: Empowering mobile and IoT connectivity



Direct-to-cell possible without a partner:

Sept. 9, 2025: SpaceX buys a mix of MSS spectrum and S-band spectrum from EchoStar.

Partner MNOs worldwide

- T-MOBILE (USA)
- OPTUS (AUSTRALIA)
- TELSTRA (AUSTRALIA)
- ROGERS (CANADA)
- ONE NZ (NEW ZEALAND)
- KDDI (JAPAN)
- SALT (SWITZERLAND)
- ENTEL (CHILE)
- ENTEL (PERU)
- KYIVSTAR (UKRAINE)
- German Telekom (GERMANY)

new! Sept. 2025

DIRECT TO CELL (DTC) CHALLENGES

Spectrum sharing between terrestrial and non-terrestrial.

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Advantages

Signals are standard LTE/5G NR radio.

Unmodified UE

Validate initial use cases at early stage.

Disadvantages

Spectrum sharing causes coexistence issues

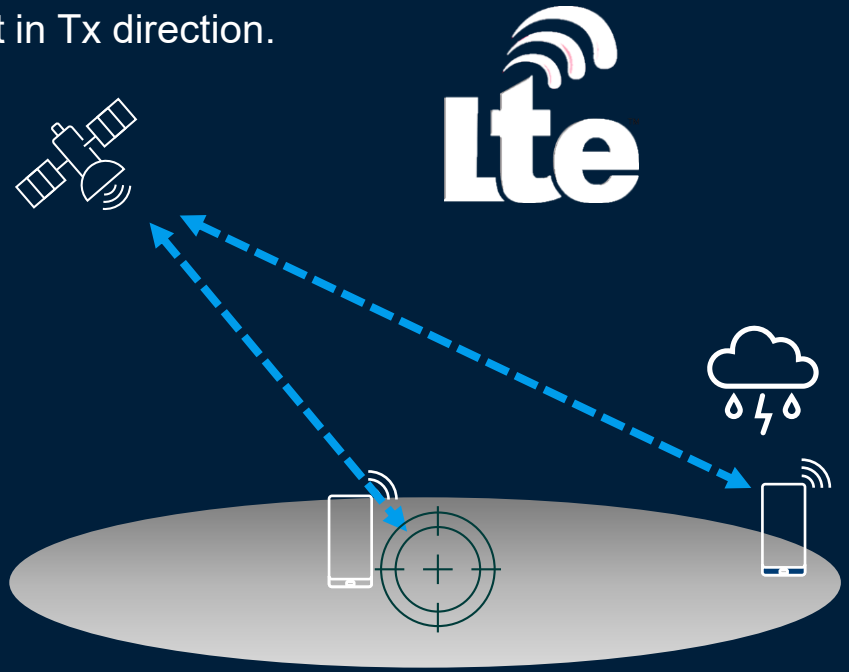
No treatment of irregularities like time, doppler, protocol.

Limited efficiency

Limited scalability, especially at large scale.

DIRECT TO CELL (DTC) CHALLENGES

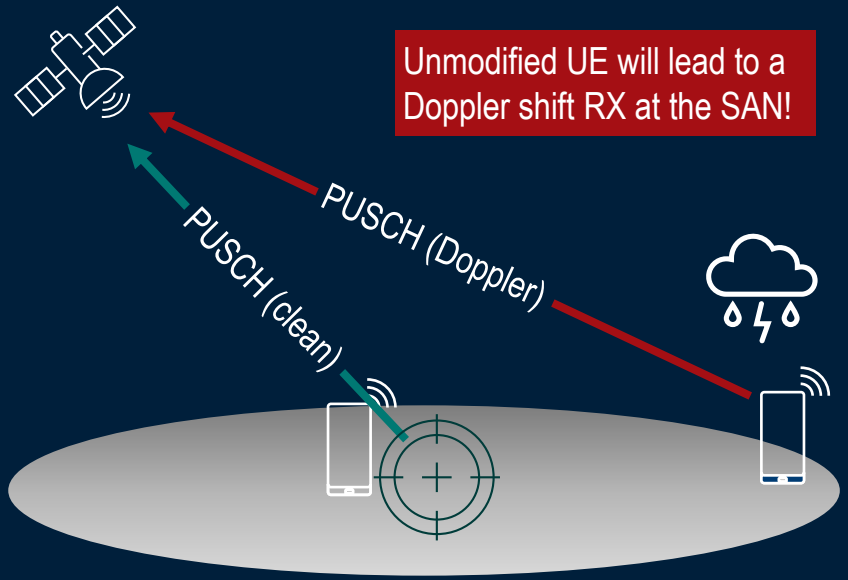
DTC: Satellite pre-compensates the Doppler shift in Tx direction.

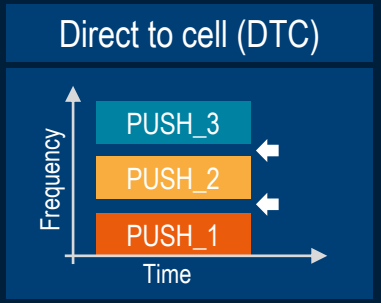


UE at beam center: ✓

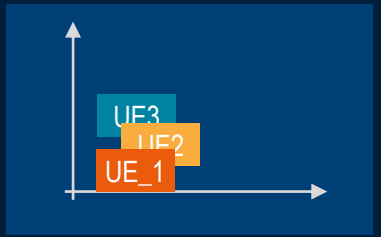
UE at beam / cell edge:
DL signal with Doppler shift > subcarrier/2
⇒ Degraded EVM and risk of connection loss
⇒ Only works for small cells

DIRECT TO CELL (DTC) CHALLENGES

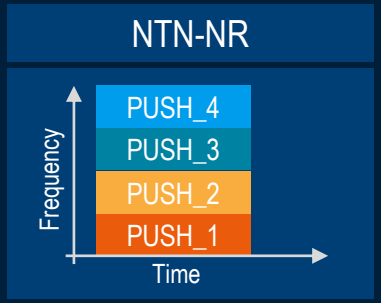




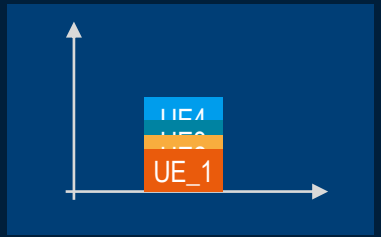
Frequency gap between PUSCH from various UE!



PUCCH uses orthogonal cover code (OCC) to stay orthogonal. DTC does not achieve this,



Release 18, location of UE.



5G NR supports up to 84 UE sharing same resource for PUCCH with OCC coding

ITU, FCC AND EU REGULATORY LANDSCAPE

Policy + consultancy
+ national regulatory

Directorate-General: Connect
Communications Networks, Content and Technology

Radio Spectrum Policy Group:
Advisory on spectrum policy

National Regulatory Authorities:
BNetzA, ANFR, Ofcom,..
→execution

Bundesnetzagentur — Ofcom

CEPT: 46 EU countries,
Technical studies

Electronic Communications Committee
of CEPT, decision-maker

CEPT ECC
Electronic Communications Committee

ETSI
Technical standards in EU

EUROPEAN REGULATORY ROADMAP FOR D2C

- **Aim:**
  Complement coverage in rural, remote, maritime regions → boost **resilience** during crises.

European Commission
Directorate-General: Connect Communications Networks, Content and Technology

CEPT:
- Feasibility study + harmonized technical conditions for satellite D2D-IMT in EU bands: 700 MHz to 42 GHz
- Co-existence with terrestrial ECS + protection of incumbent services

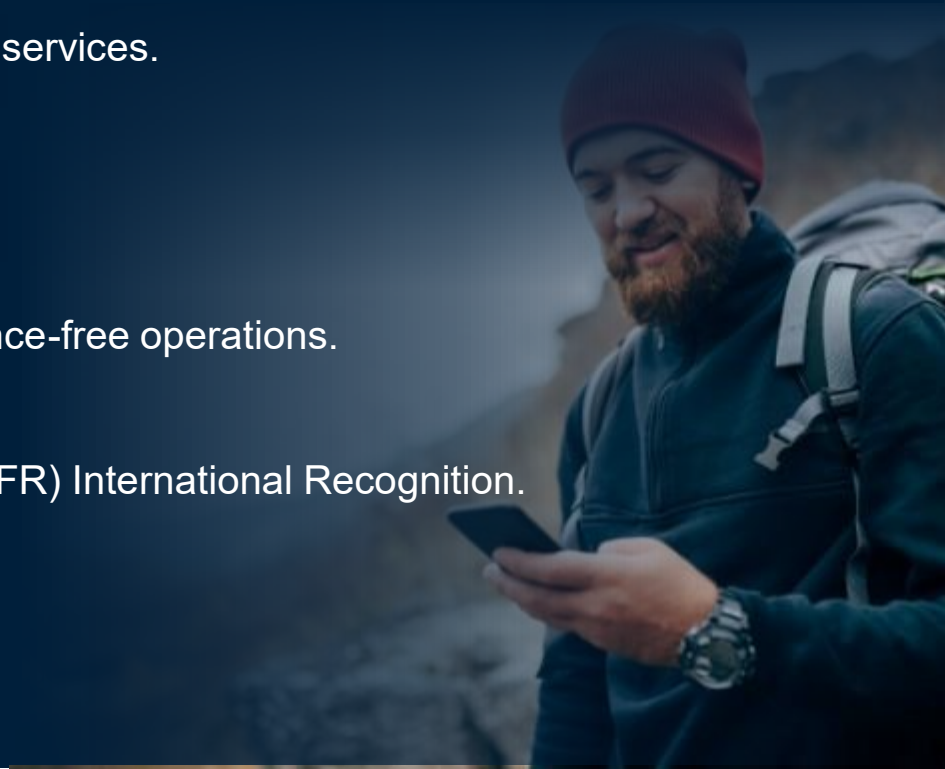
- **EU Policy priorities:**
  - **Digital Decade 2030** goals for gigabit and next-gen wireless coverage.
  - Promote innovation, competitiveness, and technological sovereignty.
  - Enable convergence of terrestrial and non-terrestrial networks: Path towards 6G.

WRC-27 AGENDA – A SATELLITE CONFERENCE?

FSS	MSS	Science	Others
1.1 Aeronautical/ Maritime 50 GHz ESIM	1.11 Inter-Ssatellite links	1.15 Lunar communication	1.7 IMT 4.4-4.8 GHz, 7.125-8.4 GHz, 14.8-15.35 GHz
1.2 14 GHz Small antennas	1.12 Mobile satellite IoT 1.4 – 2 GHz	1.16 Radio quiet zones – NGSO interference	1.8 Radio location 231.5-275 GHz
1.3 50 GHz NGSO gateways	1.5 Unauthorised access	1.17 Space weather sensors	1.10 Protection FS/MS 70/80 GHz (Satellite PFD/EIRP limits)
1.4 17 GHz Primary FSS	1.13 Satellite D2D	1.18 Astronomy protection 76 GHz	1.9 AMS modernisation
1.5 Unauthorised Access	1.14 New allocations mobile satellite	1.19 Sea surface temperature	
1.6 40/50 GHz FSS Equitable Access			

Mechanisms to control interference and ensure equitable access

- **ALLOCATION**
  Frequency separation of stations of different services.
- **POWER LIMITS**
  (pfd, epfd, eirp)
- **COORDINATION**
  between Administrations to ensure interference-free operations.
- **RECORDING**
  Master International Frequency Register (MIFR) International Recognition.
- **SPECTRUM MONITORING**

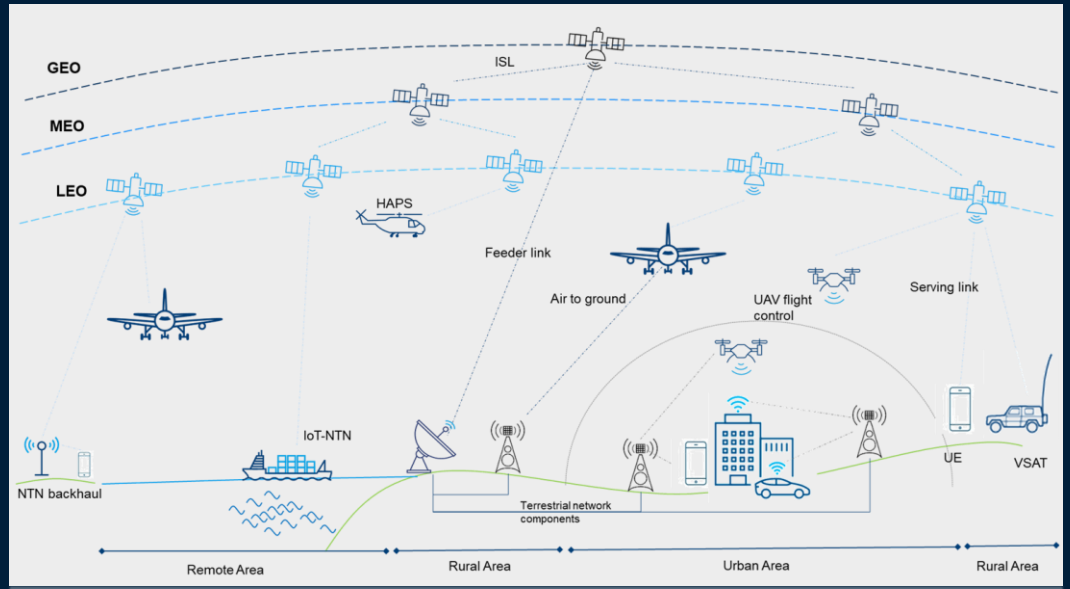


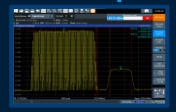
Satellite spectrum monitoring & interference capture

- Autonomous satellite signal monitoring
- Detection of undercarrier signals
- DVB-CID demodulation and multichannel signal quality measurements
- Paired-carrier signal processing

GSACSM communications system monitoring

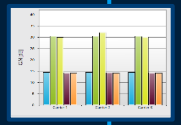
CO-EXISTENCE AND CONVERGENCE





Co-existence of technologies
- Spectrum monitoring

Signal quality
- BER, EVM
- Signal analysis



Channel simulation
- RF Link
- Fading, atmospheric effects, Doppler shift, Doppler delay

Conformance testing, RF/protocol
- RF, protocol dev.t & RRM
- E2E communications

Terminal testing
- GNSS receiver simulation
- Antenna, UE testing

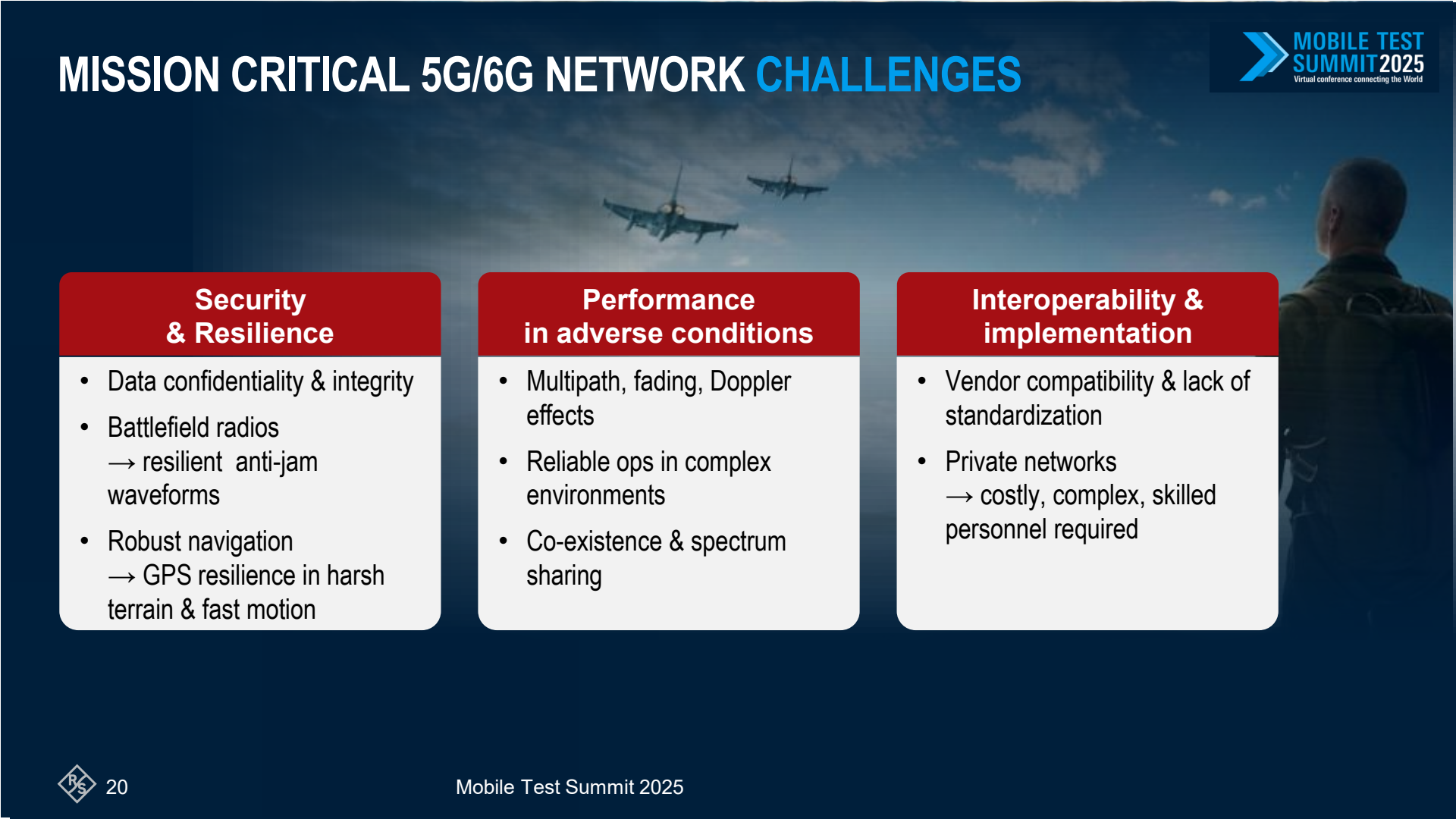
Future-G for Mission Critical Operations

Mission Critical Standardization Solution (June 2024):

- "This standard provides the ability to utilize 3GPP specifications and technologies to enable **federation of communications between Allies.**

- It will become the foundation and enabler of … e.g. exchange of tactical voice, position-location information, battle space objects and chat messages."

MISSION CRITICAL 5G/6G NETWORK CHALLENGES



Security & Resilience

- Data confidentiality & integrity
- Battlefield radios
  → resilient anti-jam waveforms
- Robust navigation
  → GPS resilience in harsh terrain & fast motion

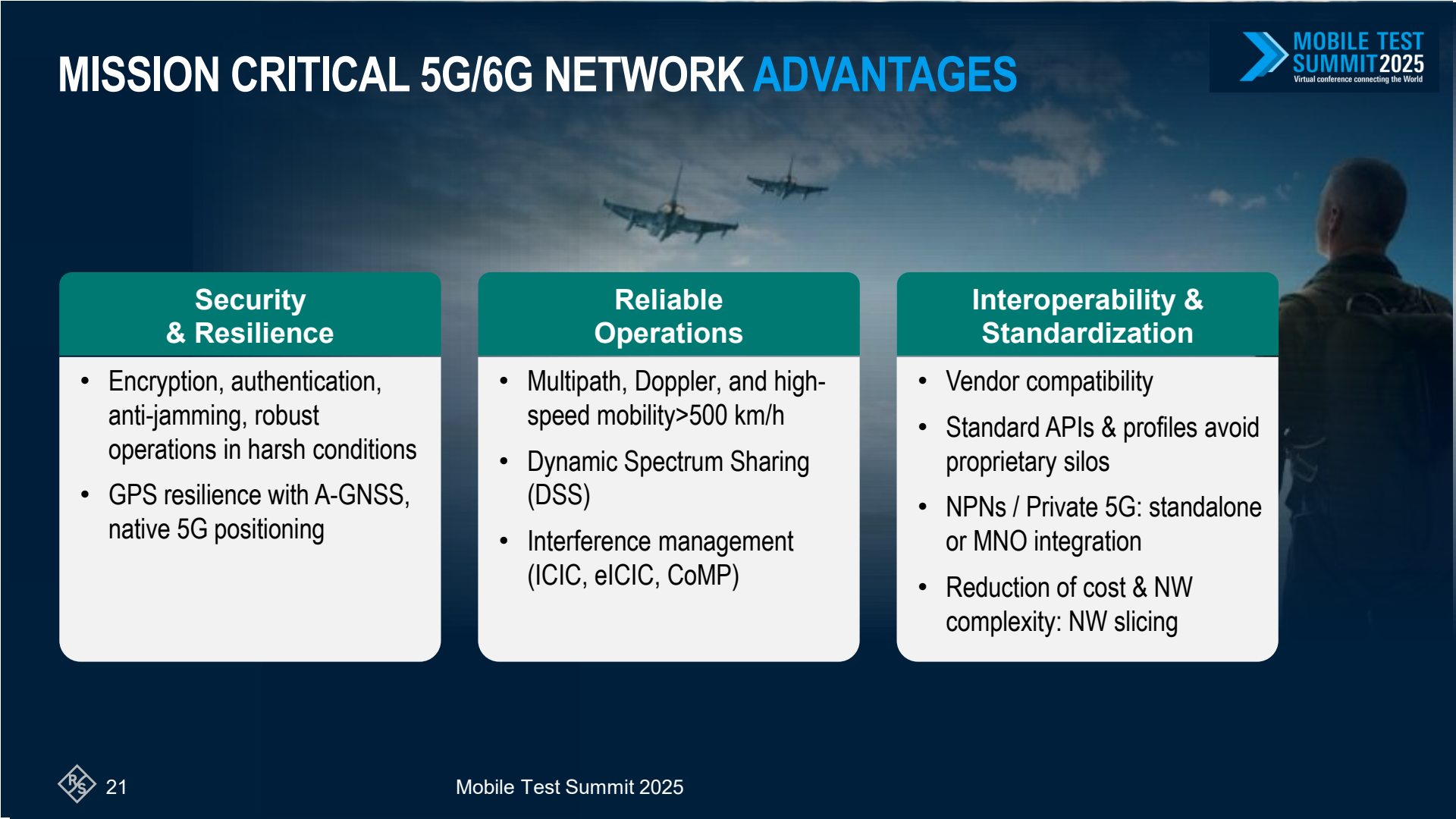
Performance in adverse conditions

- Multipath, fading, Doppler effects
- Reliable ops in complex environments
- Co-existence & spectrum sharing

Interoperability & implementation

- Vendor compatibility & lack of standardization
- Private networks
  → costly, complex, skilled personnel required

MISSION CRITICAL 5G/6G NETWORK ADVANTAGES



Security & Resilience

- Encryption, authentication, anti-jamming, robust operations in harsh conditions
- GPS resilience with A-GNSS, native 5G positioning

Reliable Operations

- Multipath, Doppler, and high-speed mobility>500 km/h
- Dynamic Spectrum Sharing (DSS)
- Interference management (ICIC, eICIC, CoMP)

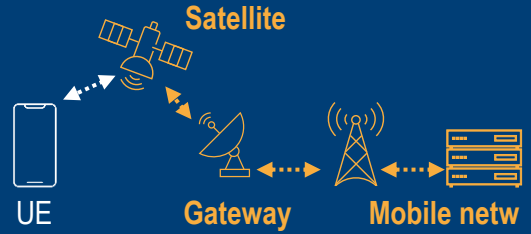
Interoperability & Standardization

- Vendor compatibility
- Standard APIs & profiles avoid proprietary silos
- NPNs / Private 5G: standalone or MNO integration
- Reduction of cost & NW complexity: NW slicing

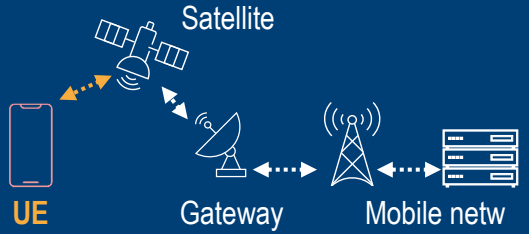
FUTURE-G TESTING ACROSS THE ENTIRE VALUE CHAIN

Radio Access Network (RAN/O-RAN) Test

Radio Access Network (RAN/O-RAN) Test



User Equipment (UE) Test



Field Test

End-to-End System Emulation

Energy Efficiency

Rohde & Schwarz is member of standardization organizations and active in key committees

ITUWRC · DVB · DIFI · WTA · esa · ECSS

ITU · 3GPP A GLOBAL INITIATIVE · ETSI · IEC International Electrotechnical Commission · DeSK · ◆◆◆

CONCLUSION

Standardization

- Shift from proprietary → standardized solutions
- Mass market, proven ecosystem, affordable & sustainable

Regulations

- Efficient spectrum use
- Prevent interference
- Enable terrestrial–satellite co-usage

Standards

- Drive universal, interoperable, seamless, converged networks
- Enable ubiquitous coverage

T&M Solutions

- Verification & compliance
- Ensure reliable services


TEST ◆ MEASURE ◆ INNOVATE
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