# TETRA and beyond

**Implementation of LTE and 5G broadband in critical communications**

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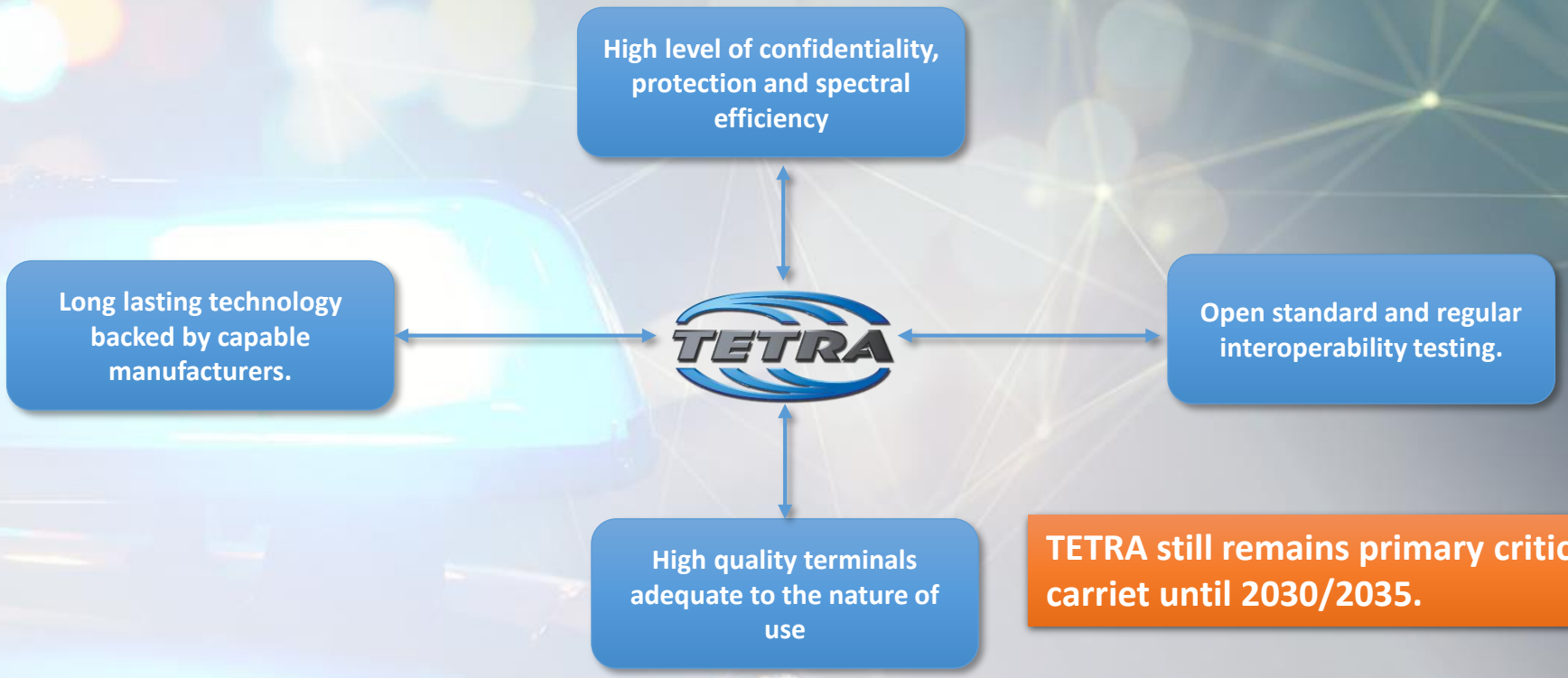
# TErrestrial Trunking RAdio

- Digital technology which allows secured robust private communication services for public safety and first responders.
- A concept developed in ’90 within Schengen Agreement framework as an interoperable communication frame for European Public safety sector
- Cellular communications technology based on following principles
  - Interoperability and roaming between ЕУ public safety structures
  - UHF frequency range wit robust digital modulation for increased coverage
  - RF path encryption protection
- Common users:
  - Safety sector
  - Professional sector

# TErrestrial Trunking RAdio

TETRA sucess is thanks to:




**TETRA still remains primary critical voice carriet until 2030/2035.**

# TErrestrial Trunking RAdio


- TETRA standard development end with TETRA Release 2
- TETRA Release 2
  - Increased TMO range
  - Implementation of robust  voice codecs
    - MELPe and AMR
  - TETRA Enhanced Data Services (TEDS)
    - 25KHz channel maximum downlink 66 kbps
- Virtualization
- Implementation of new encryption algorithms
  - Longer keys for lasting threats mitigation.

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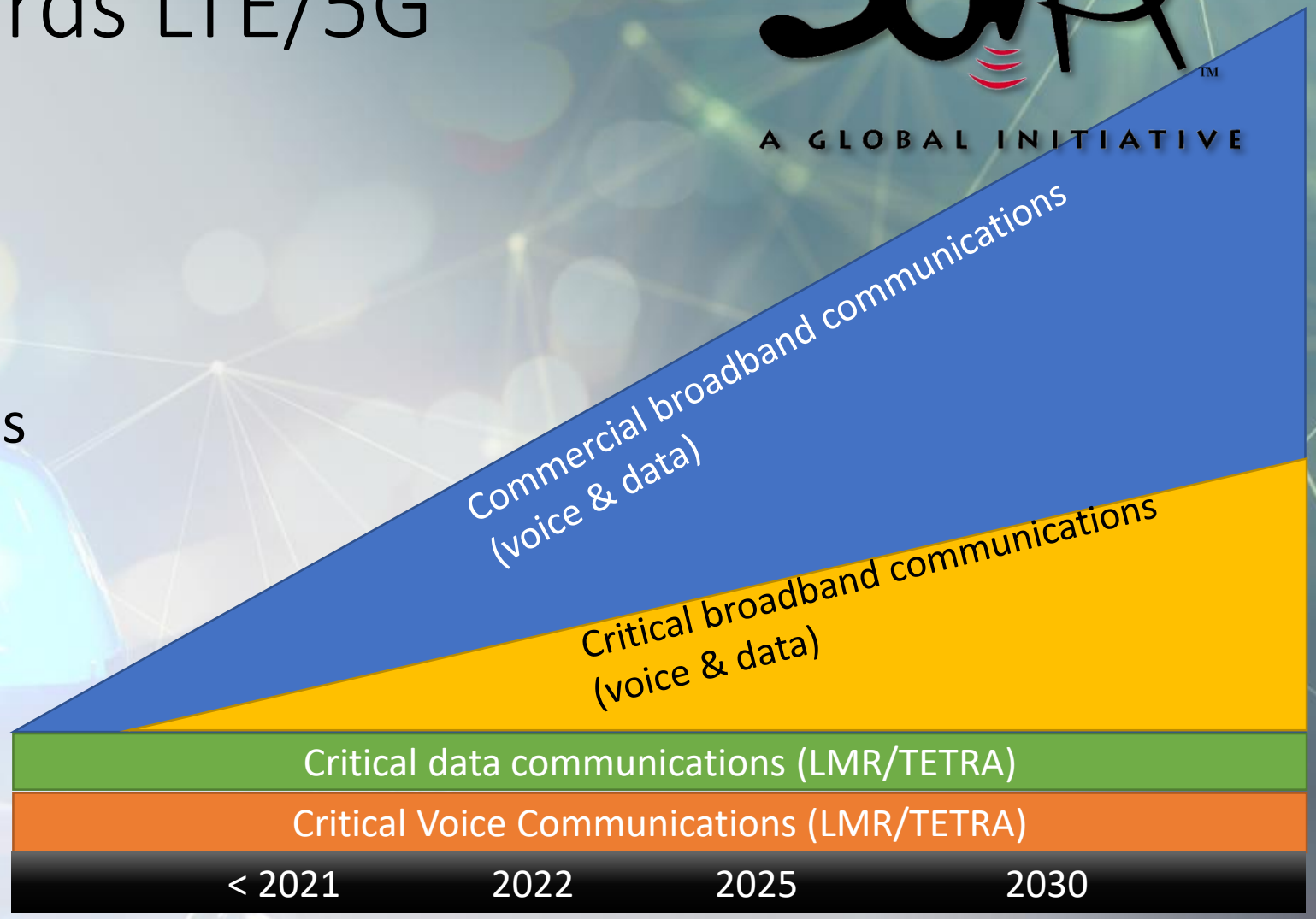
# Broadband critical communications- **why**

- LMR/TETRA has limited capability of creating true common operational picture
  - Enhanced group communications and PUSH-TO-VIDEO
  - Real time monitoring of various sensors
  - Drones and real time video
  - Enhanced geolocation (3D and Indoor)
- Reducing of OPEX

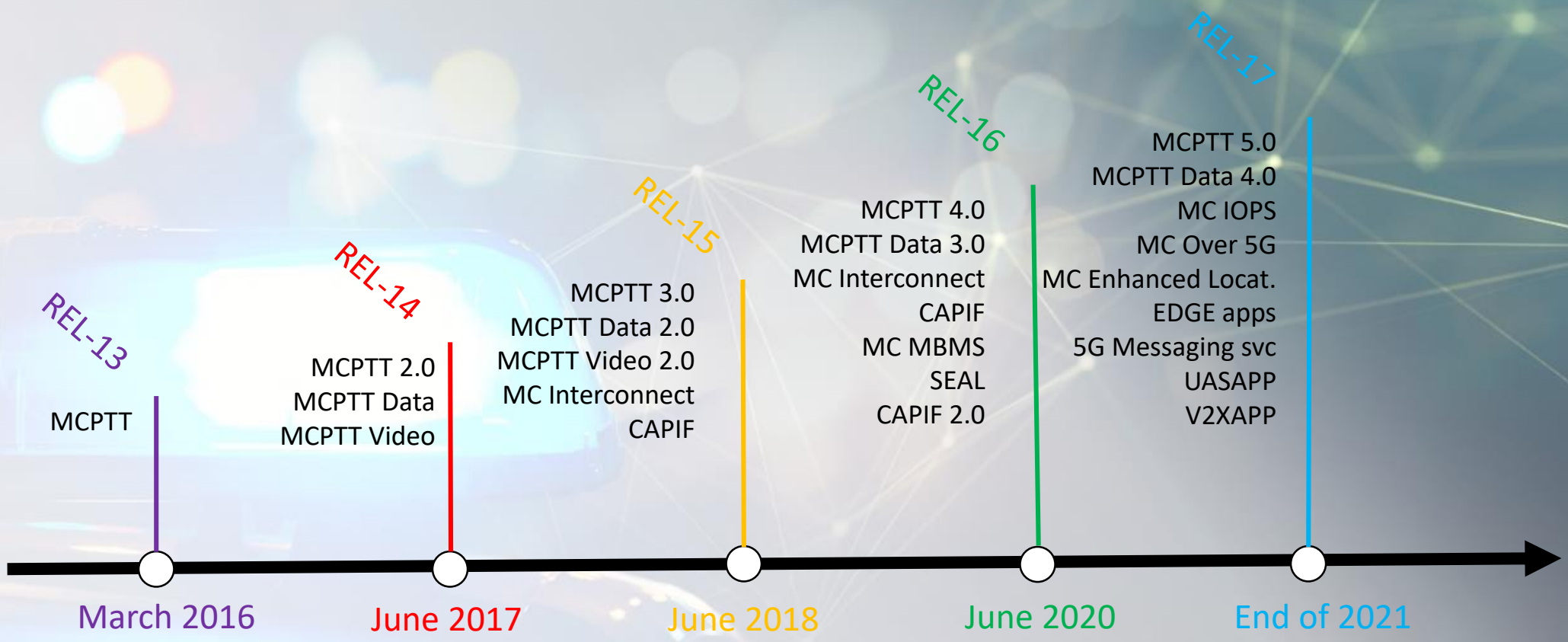
# From LMR towards LTE/5G

- Evolution of TETRA towards **reliable** broadband services
- Standardization process lead by 3G Partnership Project



# From LMR towards LTE/5G

- Standardization process timeframe



# From LMR towards LTE/5G - approach

- Over-The-Top apps
  - Fastest way to implement broadband services
  - No RF spectrum utilization
  - No cost for maintaining the infrastructure
  - No control over user database, QoS, security aspects of the network and RF coverage.
- Secured Mobile Virutal Network Operator
  - Control over user database.
  - Integration with security elements of the mobile operator core network.
  - QoS control by using special SIM cards allowing for priority in accessing the resources of the radio access network.
- Hybrid network
  - S-MVNO + additional use of RF spectrum and own RAN infrastructure.
    - Owned segments of the RAN network in critical areas (Critical Hot-Spots).
- Own infrastructure
  - Most reliable but most expensive concept

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# From LMR towards LTE/5G- Regulatory challenges

**Implementation of public safety broadband networks using the infrastructure of Mobile operators could initiate change of the existing regulative**

- Harmonization safety requirements with the business model of the Mobile operators
- Assignment of necessary frequency resources to the public safety sector in case of hybrid solutions
- Net Neutrality
  - The concept of equality in access to network resources is violated with implementation of prioritization of safety oriented traffic.
- National Roaming
  - Public safety networks benefit from use of national roaming through increased network resilience and RAN radio coverage.
  - Still national roaming can affect the competitiveness of some Mobile operators and therefore this service is limited in many countries.

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# From LMR towards LTE/5G- Technical challenges

**Are Mobile operators  ready for the challenge**

- Technical capabilities to implement Security-MVNO within their network
  - Implementation of 3GPP PTT Interworking standard
  - Implementation of packet prioritization and QoS
  - E2E
- Additional investments in RAN Network
  - Increased radio coverage
  - Base station hardening
  - Increase of redundant links
  - Capability of making local calls while base station transmission link is down (Isolated Operation for Public Safety – IOPS)


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# From LMR towards LTE/5G - Packet priorities

- TETRA recognizes packet priorities (voice calls)
  - 16 levels of call priorities
  - Preemptive Priority Call
  - Call retention
  - Busy queying
- 3GPP has standardized 3 packet prioritization mechanism
  - Access Class Bearing (class stored in USIM)
    - 0-9 Regular mobile operator users
    - 10-15 Public safety structures
  - Allocation & Retention Priority
    - Stops congestion at EPS bearer
    - Levels from 1 to15 (1 highest)
    - Valid for GPR and Non-GPR bearers


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# From LMR towards LTE/5G - Packet priorities

- Traffic Scheduling
  - EPS QoS class Indentifier (QCI)
    - 3GPP Release 8
      - QCI 1-4 GBR
      - QCI 5-9 non-GBR
    - 3GPP Release12
      - QCI 65 McPTT
      - QCI 66 non-McPTT
      - QCI 69 non-GBR Mission Critical signaling
      - QCI 70 non-GBR Mission Critical data
    - 3GPP Release 15
      - QCI 70 Mission Critical Video


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# 5G Change of the paradigm

- 2G focused on voice
- 3G evolution towards implementation of data
- 4G focused on data
- 5G should fuse all services into single packet oriented network
  - The technology is flexible enough to insure coexistence of critical services and critical voice


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# Migration towards 5G

| | Applied technology | Use case |
|---|---|---|
| LTE | - eNodeB Mobile Edge Computing<br>- Partially virtualized ePC<br>- SDN transport network<br>- Virtual Network Functions | - Surveillance (video, drones, body worn cameras)<br>- Telemetry/Biometry<br>- Remote diagnostics<br>- Autonomous vehicles |
| 5G Phase 1 | - New Radio Generation Node B<br>- Enhanced Massive Broadband<br>- 5G Control & User Plane over LTE | - HF , 4K video<br>- HD mapping<br>- Advanced tools in medicine (high res pictures) |
| 5G Phase 2 | - Ultra Reliable Low Latency<br>- Enhanced Massive Broadband<br>- EDGE Cloud<br>- Software Defined Networking (self healing functions)<br>- **Network Slicing** | - Isolated Operation for Public Safety<br>- Ultra fast coordination (drone swarms, massive vehicular coordination)<br>- Haptic technologies (remote medicine)<br>- Advanced augmented reality (AR, VR) in real time<br>- Massive IoT |

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# Additional 5G benefits

**Relevant to Public safety**

- Increased network resilience
  - Advanced MIMO and Beamforming
  - Integrated Access & Backhaul (IAB)
- Device-to-Device (D2D) connectivity
  - Increase interest for vehicular connectivity technologies can be applied to critical communications
- Increased accuracy of geolocation services
  - Indoor geolocation with high accuracy
  - Enhancement of the existing Position Reference Signaling concept
- Increased security
  - Implementation of Subscription Concealed  Identifier (SUCI) for OTA interface

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# Conclusion

- TETRA is here to stay
  - Built for public safety
  - Remains critical voice carrier until 2030/35
  - Exceptional spectral efficiency and security
- Improvement of critical operations procedures demands increased data exchange
- LTE and 3GPP work in standardization constitutes a good foundation for implementing mission critical applications
- Time period in which TETRA can be still exploited is sufficient to overcome legal and technical chalenges.

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