



TETRA to 2035 and beyond

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Critical communications for all professional users



Agenda

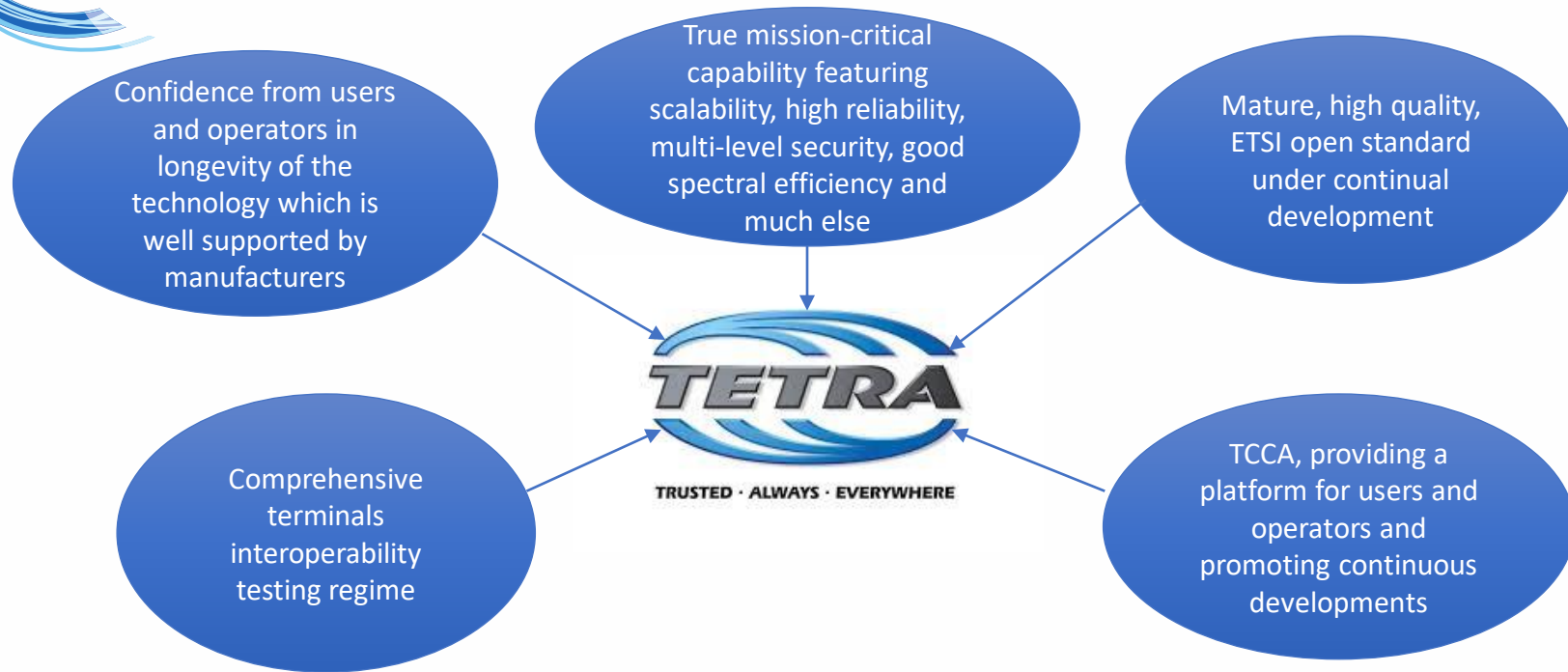
- Introduction to TETRA success
- Marketing overview
- Interoperability testing
- TETRA standard overview
- Ongoing development of the TETRA standard
- TETRA packet data enhancements
- Security enhancements
- Interworking with critical communications broadband systems
- Conclusions and the future





Introduction to the TETRA story

Why has TETRA been so successful and why does it have a long term future?





TETRA Market

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TETRA market overview

- **Worldwide installed base of more than 4 million users**
- **Europe has more than 50% of the installed base; growth expected to be 2.4%**
- **Asia Pacific is second largest region, followed by Middle East and Africa**
- **Latin America forecast to account for 75% of the Americas market**
- **North America is forecast to grow by nearly 14.9%**

All figures CAGR to 2023

Source: IHS Markit TETRA Terminals Report–2019 published 11 October 2019



Interoperability testing

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The Critical Communications Association



- **Standards leads to multi-vendor supply**
 - Fundamental user requirement
 - Vendor equipment must work together
- **Inter Operability is a commitment from TETRA vendors**
- **TETRA IOP – Inter Operability Profile**
- **Testing and Certifications is done by ISCOM.** Istituto Superiore delle Comunicazioni e delle Tecnologie dell'Informazione – laboratory of the Italian Communications Department of the Ministero dello Sviluppo Economico.
- **18 companies participate in TETRA IOP**
- **179 certificates have been issued as a result of 20+ years of testing**




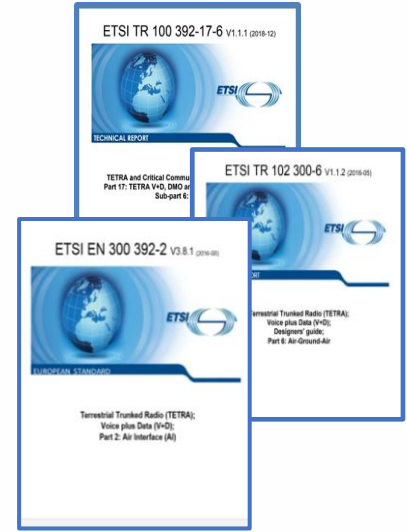
Overview of the TETRA standard

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What is the TETRA standard?

- An **ETSI**  standard, TETRA consists of 19 parts and defines:
- **Three TETRA interfaces**
 - Air Interface
 - Peripheral Equipment Interface
 - Inter-Systems Interface
- **Services and functions**
 - Security, Interoperability between TETRA and critical comms broadband, Harmonized radio conformance specifications, Direct Mode Operation, Codec, short data service, pre-emptive priority, DGNA, SIM)
- The standard consists of 142 current specifications and 37 technical reports, all of which are available freely on the ETSI website <https://www.etsi.org/standards-search#page=1&search=tetra>





Ongoing development of the TETRA standard

TETRA has been enhanced many times and continuously developed over the 25 years since the first specifications were released including:

- **Multi-slot packet data**
- **A location information protocol (LiP) for the efficient transmission of GPS positioning data carried over TETRA.**
- **An extension of TETRA frequency bands down to 138 MHz.**
- **A complete re-write of the Inter-Systems Interface which now provides a choice of either IP based or circuit switched bearer systems.**
- **A new harmonized standard for radio parameters complying with the European Radio Equipment Directive (2014/53/EU RED)**
- **Base station range extension from 58km to enhance air/ground/air services and rural cells**



Performance enhancements to TETRA packet data

Group addressed packet data

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Group addressed packet data

- TETRA packet data supports transmission of IP packets between an individual MS and a fixed host, or between two MSs
- SDS supports group addressed transmission
- Group addressed packet data intended to be more efficient where multiple MSs are served by the same BS

CONCEPT:

- Data packet encoded with additional forward error correction, spread across a number of 'repair segments'
- MSs can reconstruct missing segments, and can also request more repair segments (which are also sent to all MSs, so the first request can serve multiple MSs)
- TETRA group addresses mapped to IP multicast addresses
- Finer details of the protocol still work in progress

TOO LATE?

- If TETRA continues to provide mission critical speech and secure low bandwidth data in areas that 3GPP systems do not cover, this can be part of the solution to make data transfer more effective



Security enhancements to the TETRA standard

Additional Air Interface Encryption algorithms

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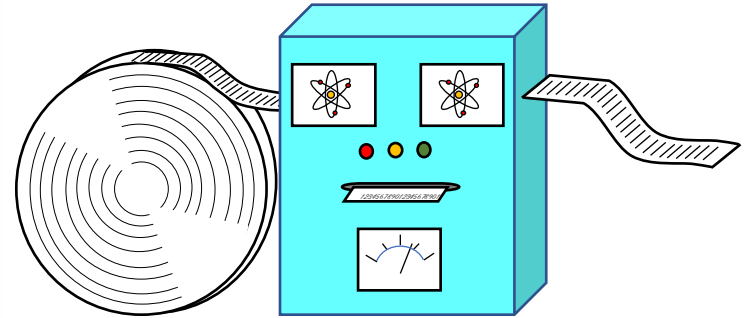
Additional TETRA air interface encryption algorithms

- **Work is underway to add additional air interface encryption algorithms to TETRA, which have:**
 - Longer keys, to mitigate the threats to at least 2040
 - Over the air rekeying updates to manage these keys
 - Backward compatibility to ensure transition within a system, and mutual co-operation with migration between systems
- **Completion of standards: 2022**
- **Much of the analysis work is currently ongoing in TCCA SFPG**



Air interface encryption

- The purpose of air interface encryption is to make the radio link between BS and MS harder to attack than the fixed network (or other means, e.g. subversion of operatives etc)
- Key length is assessed according to the difficulty of a brute force attack – trying every possible key in turn
- Computing power and memory gets cheaper every year, so it gets faster/cheaper to try a large number of keys
- Longer key lengths provide mitigation, to push the cost of attack back up again
 - The existing 80 bit keys have been adequate so far, but the length should be increased to give TETRA another 20 years of life
- Quantum computing, a developing science, may provide a way of speeding up the attack, and so longer key lengths are also prudent with this in mind
 - NOTE: Quantum computing may only speed up a key search – TETRA algorithms are not vulnerable to prime number resolution solutions that quantum computers could perform against public key algorithms





Interworking between TETRA and 3GPP MC systems

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3GPP MC Systems

- **3GPP developed Mission Critical applications for operation on LTE (4G) and later technologies (5G on)**
- **First release of MCPTT providing speech services in 3GPP Rel-13 (2016), enhanced with MCVideo and MCDData (Rel-14, 2017, onwards)**
- **Interworking with Land Mobile Radio (primarily for TETRA and P25) added in Rel-16 (June 2020)**
- **Interworking specifications provided for speech services (MCPTT) and Short Data Service (MCDData)**



Interworking facilities

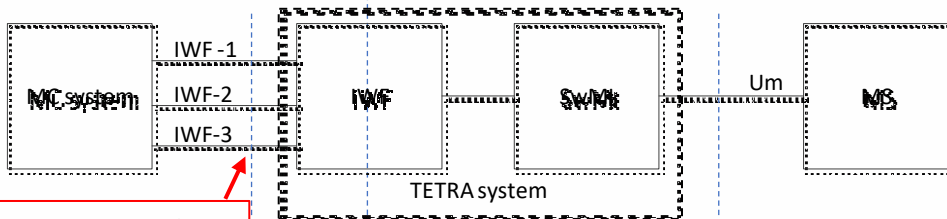
- **Group attachment**
 - Group controlled by MCPTT system
- **Group call**
 - Groups controlled by either TETRA or MCPTT system
- **Individual/private call**
 - Originated or terminated in TETRA system
- **Emergency call**
 - Group or individual
- **Short data messages**
 - Originated or terminated in TETRA system
 - Individual or group destination
- **Encrypted communications**



Interworking reference model

3GPP defined reference points

Out of 3GPP scope
Specified in ETSI TCCE

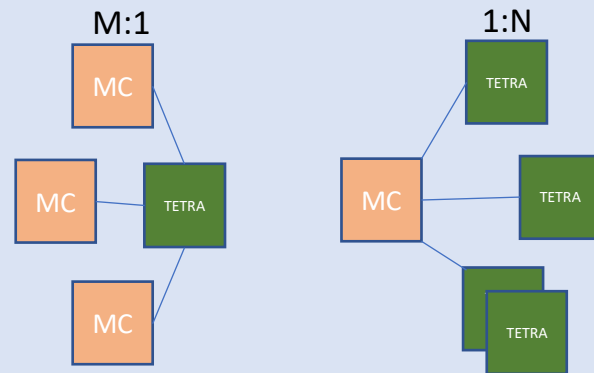


Interworking interface for TETRA systems

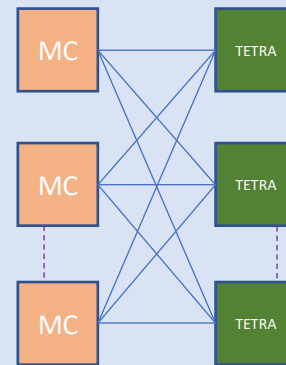
TS 100 392-19-1

- TETRA interworking interface = 3GPP specified interface
- Specification will define interaction between information exchanged on 3GPP defined reference points, and TETRA MS
- TETRA MS will consider the MC system to be another TETRA system connected by ISI
- IWF will manage how identities are represented in each system
- Speech transcoding by the IWF, or end to end use of TETRA ACELP (with or without encryption)

Deployment scenarios



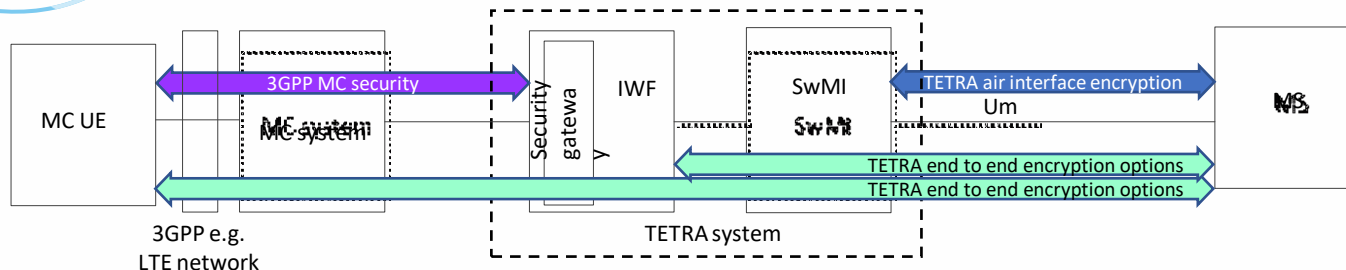
M:N



Note: MC to MC and TETRA to TETRA ISI also possible in model, but out of our scope!



Interworking security



- Authentication is carried out independently in each system
- 3GPP security applied as far as a security gateway function in the IWF
- TETRA air interface encryption applies to air interface in TETRA system
- TETRA end to end encryption can be terminated at the IWF, or can operate fully end to end to the MC UE
 - In this case, the TETRA ACELP vocoder is used for the audio



Interworking specifications

- **ETSI Technical Reports on interworking:**
 - TR 103 565-1 ‘Study into interworking between TETRA and 3GPP mission critical services’, published October 2017
 - TR 103 565-2 ‘Security of interworking between TETRA and Broadband applications’, by TCCE WG6 published May 2018
- **TS 100 392-19-1 Protocol specification is work in progress**
 - Scheduled WG4 complete end 2020 – but dependent on available voluntary contributions
 - Publication 2021
 - Dependent on 3GPP Release 16 completion – stage 3 and release complete June 2020, although CRs usually follow release completion
- **TS 100 392-19-2 Format for the transport of TETRA speech over mission critical broadband systems, published March 2019**
 - Format for speech transport formally registered with IANA https://www.iana.org/assignments/media-types/audio/TETRA_ACELP_BB



Conclusions

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Conclusions

- TETRA has proved itself to be the “GoTo” technology for critical communications users over the past 25 years and has an extensive range of well tried and trusted functionalities which are required just as much today.
- Because it has been continually developed and enjoys strong industry support TETRA is future proofed and enjoys the users’ confidence in its longevity and relevance.
- Interworking solutions between TETRA and MC Broadband systems will be very important over the medium term and will give users the maximum choice in future migration plans, whether temporary or on a long-term basis.
- Many users have no requirements for MC broadband services so TETRA remains their choice of technology for Critical Communications.



The Future

- Work is ongoing within ETSI TC TCCE, 3GPP, TCCA working groups TF, SFPG, CCBG and others to ensure that users have the most relevant mission critical solutions available to them.
- TETRA is still showing very good sales growth in many different verticals and so its future seems as bright as ever.
- TETRA shows every sign of being in use and still under development well towards the end of the next decade.