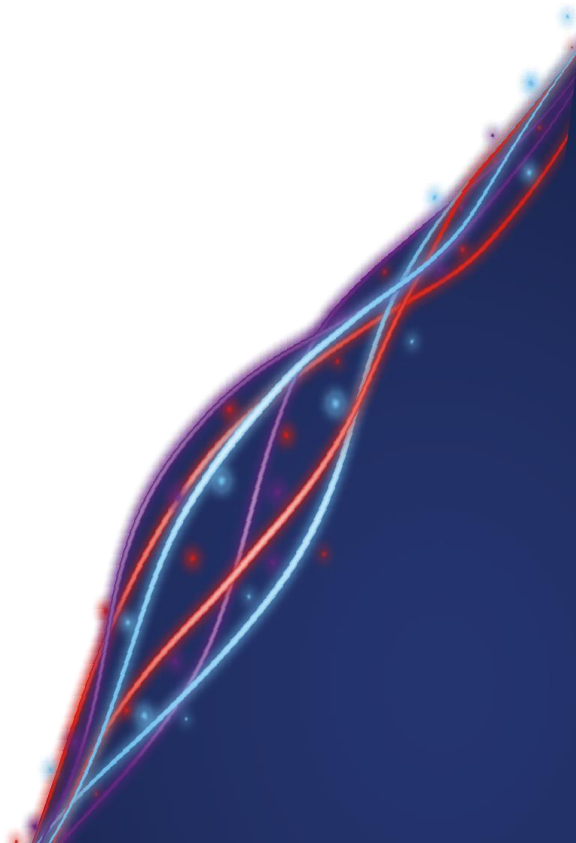
The strength of TEDS in mission-critical communication

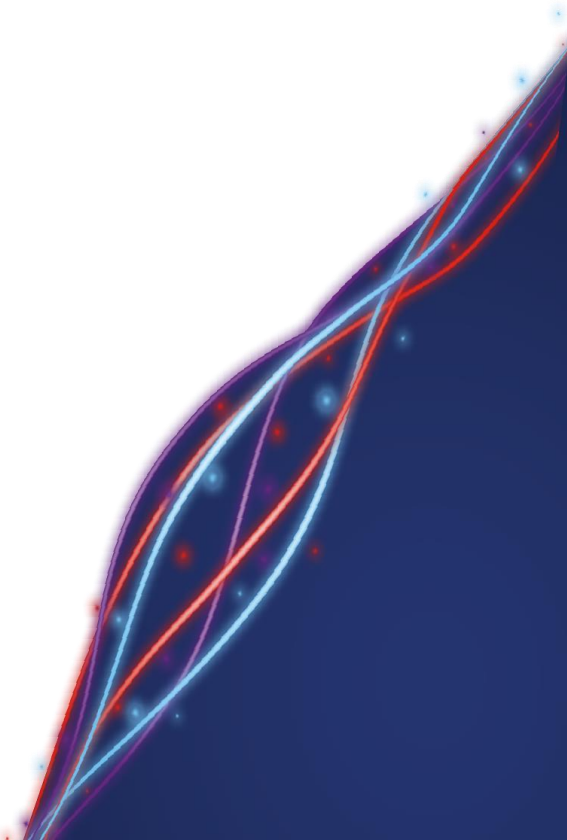
TETRA
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Jochen Bösch – DAMM Cellular Systems A/S
Michael Piciorgros – Funk-Electronic Piciorgros GmbH



Agenda

- Technology comparison
  - Standard, coverage, frequency availability
- Technology facts
  - Data rate, modulation types, device availability
- Use cases
  - From real life demands



Technology comparison (1)

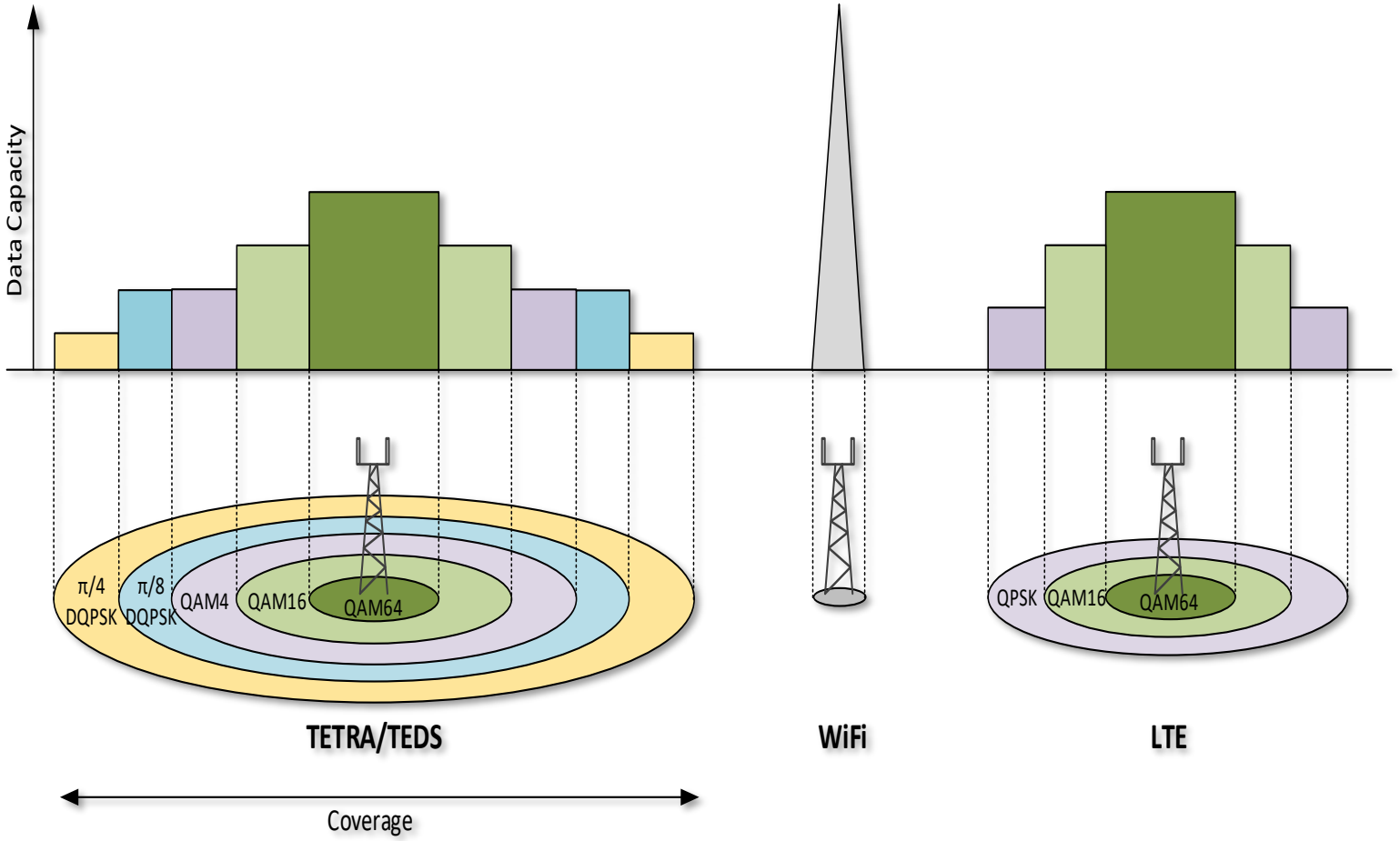
- Data only:
  - Several proprietary data solutions on the market
  - WiMax as a standard solution
- Voice and limited data:
  - DMR weak standard
  - P25 expensive limited solution
  - TETRA limited mission-critical data throughput
- Voice and data:
  - LTE
  - TEDS as part of TETRA



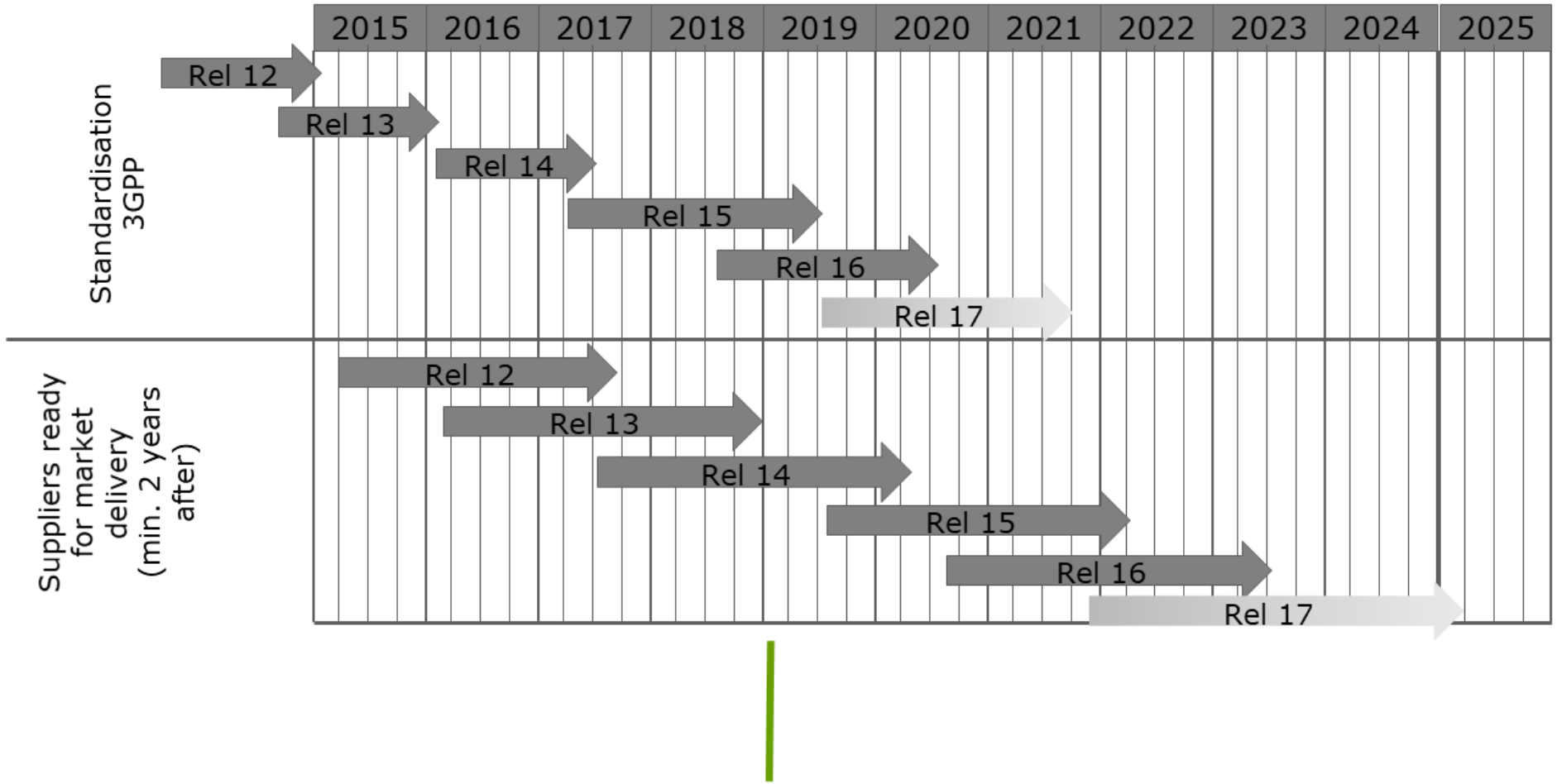
Technology comparison (2)

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- Coverage



LTE release status (1)



LTE release status (2)

Rel 13:	Rel 14:	Rel 15	Rel 16:	Rel 17:
- MC-PTT 1st version	- MC-PTT enhancement - Addressing, identification	- MC data - MC video - MC PTT enhancement - Multicast broadband - Start interworking LMR systems	- MC interwork LMR systems - Migration / interconnection - Security enhancement - MC data / video as multicast - Discreet listening - MC PTT enhancement	- MC over 5G
Q1/2019	Q3/2020	Q2/2022	Q3/2023	Q2/2025

User classification

Public safety nationwide networks

- Nation wide
- LTE frequencies / spectrum „easy“ to get
- Use one single device and technology
- Goal: Mission-critical voice & data
- Main challenge: MC-PTT & MC-Video
- Future: Replace TETRA installation with MC-LTE for voice and data

Transportation, utilities, industry networks

- Local installation, perhaps across a border
- Mostly shared LTE networks, as frequencies hard to get
- Intelligent integration of technologies
- Goal: Mission-critical voice & mostly business-critical data
- Main challenge: Frequency / spectrum & costs
- Future: Co-exist with TETRA installation for voice and use public safety LTE or commercial LTE for data, narrowband data like SCADA or ETCS over TETRA/TEDS

Mind the difference!

TEDS facts (1)

- The BS422 supports following bandwidths for TEDS:
  - 25kHz
  - 50kHz
  - 100kHz
  - 150kHz
- 25kHz and 50kHz devices are available on the market
- 100kHz and 150kHz units can be easily produced on demand
- Usable for CCTV video or SCADA at utilities
- Support of single and multi-slot TEDS
- Modulation type is dynamically adjusted depending on SNR
- Very similar spectral efficiency as LTE, same modulation as in LTE
- Greater coverage than LTE
- Only mission-critical standard solution on the market today



TEDS facts (2)

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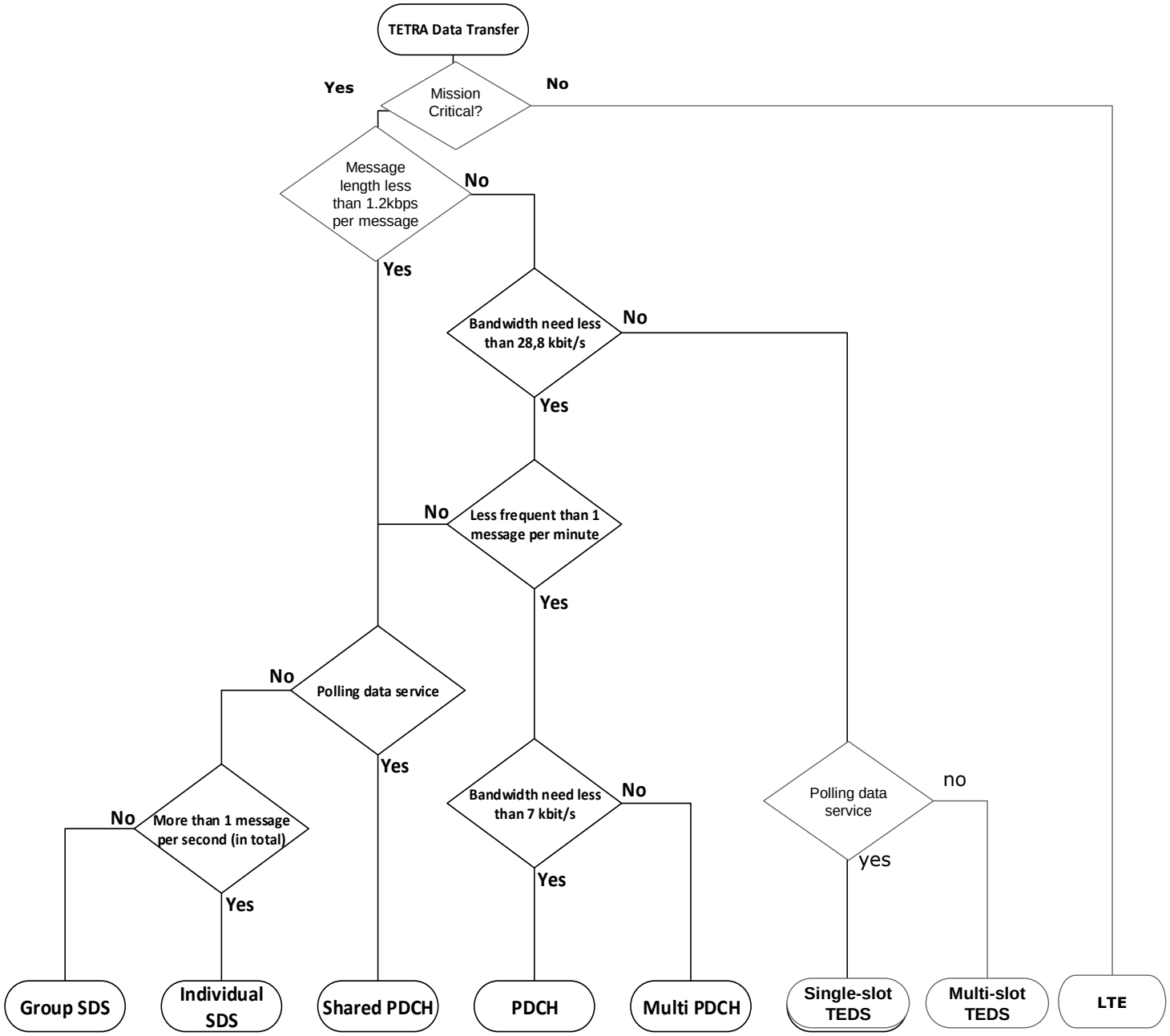
	Single Slot - Downlink							
	25kHz		50kHz		100kHz		150kHz	
	brut	net	brut	net	brut	net	brut	net
π/4-DQPSK	7.2	3.3	-	-	-	-	-	-
QAM - 4	7.2	2.5	15.5	6.5	32.1	14	48.7	22.1
QAM - 16H	14.3	5	30.9	13.1	64.1	27.9	97.3	44.2
QAM - 16U		9.4		25.6		54.7		87.3
QAM - 64H	21.5	7.4	46.4	19.6	96.2	41.9	146	66.3
QAM - 64M		9.9		26.2		55.8		88.4
QAM - 64U		14.9		39.3		83.8		132.6

	Single Slot - Uplink							
	25kHz		50kHz		100kHz		150kHz	
	brut	net	brut	net	brut	net	brut	net
π/4-DQPSK	7.2	3.5	-	-	-	-	-	-
QAM - 4	7	2.4	14.3	6	29	12.4	43.6	19.6
QAM - 16H	14.3	4.8	30.9	12	64.1	24.8	97.3	39.2
QAM - 16U		9.6		23.9		49.6		78.3
QAM - 64H	21.5	7.2	46.4	17.9	96.2	37.2	146	58.7
QAM - 64M		9.6		23.9		49.6		78.3
QAM - 64U		14.4		35.9		74.4		117.5

	Multi Slot - Downlink							
	25kHz		50kHz		100kHz		150kHz	
	brut	net	brut	net	brut	net	brut	net
π/4-DQPSK	29	13.9	-	-	-	-	-	-
QAM - 4	28.7	9.9	61.9	26.2	128.3	55.8	194.6	88.4
QAM - 16H	57.4	19.9	123.8	52.4	256.5	37.5	389.3	176.7
QAM - 16U		39.7		104.8		223.3		353.5
QAM - 64H	86.1	29.8	185.6	78.6	384.8	167.5	583.9	265.1
QAM - 64M		39.7		104.8		223.3		353.5
QAM - 64U		59.6		157.2		335		530.2

	Multi Slot - Uplink							
	25kHz		50kHz		100kHz		150kHz	
	brut	net	brut	net	brut	net	brut	net
π/4-DQPSK	30	14.5	-	-	-	-	-	-
QAM - 4	27.7	9.4	56.6	23.6	114	48.9	172	77.2
QAM - 16H	56.6	18.9	122	47.2	253	97.9	384	154.4
QAM - 16U		37.8		94.4		195.8		308.9
QAM - 64H	84.9	28.3	183	70.8	379	146.8	576	231.7
QAM - 64M		37.8		94.4		195.8		308.9
QAM - 64U		56.7		141.5		293.7		463.3

Data Decision Tree



Use cases (1)

- Requirement: Mission-critical data solution
  - Is safety critical
  - Is instantly available
  - Has guaranteed availability (battery backup, redundancy, etc.)
  - Has guaranteed quality of service (QoS)
  - Has a clear communication pattern with full control of priorities
- Market segment:
  - Transportation
  - Utilities
  - Industries
  - (local public safety)

Use cases (2)







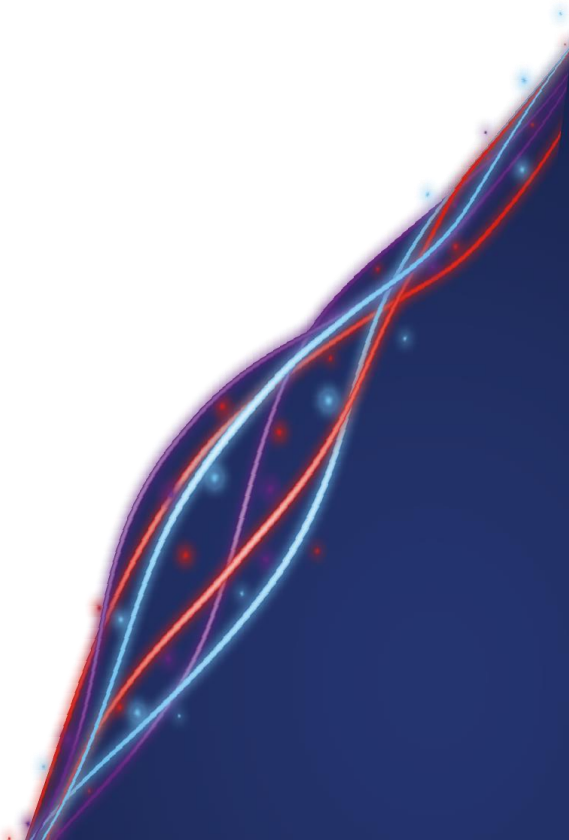




Use cases (3)

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- Emergency services
  - Patient data and diagnostics within ambulance under all conditions
- Power grids
  - SCADA systems with highest data throughput minimising outages and impacts thereof
- Smart metre data from private homes
  - Highest encryptions and certificate demands (BSI-certification in Europe)
- Fire fighting
  - Thermal cameras for bushfire surveillance or flying on drones to spot remaining heat areas
- Waterworks and wastewater treatment plants
  - Protect water supply also in flooding situation
- ETCS in heavy & light rail, metro
  - Level 3, high density areas and CCTV



Video over TEDS



- Video:
  - Thermal camera
  - H.264 codec
  - 10 frames per second
  - 352x288px
  - Approx. 30kbit/s data stream
- TEDS settings:
  - 50kHz
  - Multi-slot
  - QAM-64

Live demonstration available at CCW Stand F60

TETRA

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Thank You!

Visit us at our booths to discuss in more detail

Jochen Bösch

Senior Director Engineering

DAMM

&

Michael D. Piciorgros

CEO

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