CONCEPT PAPER

DAMM® TEDS – delivering mission-critical data and video when it counts

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TEDS – delivering mission-critical data and video when it counts

TETRA is well-established as a technology that supports not only voice calls but also transfer of packet data and pictures. It does so with the reliability and security that is characteristic of TETRA, but does have limited data throughput, making it fall short when it comes to transfer of video and large amounts of data. In comparison, the LTE technology has the data capacity to support large amounts of data and video. However, a truly mission-critical standard has yet to be fully developed.

To deliver this "mission criticalness" for data and video while retaining the high security and reliability, the TETRA standard was expanded to include TETRA Enhanced Data Service (TEDS). TEDS has a much higher data throughput enabling more detailed pictures and documents as well as live streaming.

Both TETRA and TEDS (part of TETRA II) deliver truly mission-critical communication.

What is mission-critical communication?

While mission-critical communication has traditionally been limited to voice communication, data communication has been gaining an increasing role. Mission-critical communication is communication that guarantees availability when lives are in danger, i.e. communication that:

- Is safety critical
- Is instantly available
- Has guaranteed availability
- Has guaranteed quality of service (QoS)
- Has a clear communication pattern with full control of priorities

Benefits of a TETRA/TEDS-based solution

Data transmitted via TETRA are secure, available, accessible and fully controllable with a guaranteed service. Furthermore, TETRA supports all of the advanced group communication functionalities required by mission-critical operators. For TETRA users and manufacturers alike, it is therefore logical to try to get the maximum out of this communication technology.

This includes deploying the mission-critical TEDS solution with an increased wideband bandwidth, which enables support of applications and functions that have otherwise required broadband. Not only can it support such applications, it can also do so with the added "mission criticalness", which is lacking in broadband and public LTE.

Such a TEDS solution could even take the shape of an integrated modem, which does not require an external PC or other device. For instance, Germany-based Piciorgros has developed a TEDS modem which connects directly to the communication network through a built-in Ethernet connection and can thus transmit data and video directly without an intermediary device.

Benefits of a TEDS solution

Key advantages of TEDS compared to LTE:

- Mission-critical
- Wider coverage
- Same spectral efficiency
- No frequency scarcity
- Guaranteed bandwidth and full QoS control
- Integrated voice and data service in one system
- Decentralized architecture: TEDS is available where you need it
- Can be easily integrated into an existing TETRA system.

DAMM's BS422 MultiTech Base Station enables single- and multi-slot TEDS and supports the following bandwidths for TEDS:

- 25kHz
- 50kHz
- 100kHz
- 150kHz

The modulation type is dynamically adjusted depending on the signal-to-noise ratio (SNR). Depending on the modulation, the following uplink data throughput rates can be achieved:

	Single Slot – Uplink: Packet data throughput (kbit/s)							
	25kHz		50kHz		100kHz		150kHz	
	brut	net	brut	net	brut	net	brut	net
π/4-DQPSK	30	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 – Uplink: Packet data throughput (kbit/s)							
	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	114.3	48.9	172	77.2
QAM - 16H	56.6	18.9	122	47.2	252.9	97.9	383.8	154.4
QAM - 16U		37.8		94.4		195.8		308.9
QAM - 64H	84.9	28.3	183	70.8	379.4	146.8	575.8	231.7
QAM - 64M		37.8		94.4		195.8		308.9
QAM - 64U		56.7		141,5		293.7		463.3

TEDS benefits from a spectral efficiency on a par with that delivered by LTE, with a highly efficient data throughput per 25kHz. Meanwhile, with frequencies in the 400MHz band being available, TEDS secures better coverage than LTE and will thus require fewer base stations to cover the same area as would be required with LTE.

UTILIZATION OF TEDS FOR VIDEO/DATA

Continued video streaming and data throughput in critical situations

In disaster situations both pictures and data are vital in order to take the appropriate measures and minimize damages to equipment and personnel. A TEDS solution can deliver both, with the possibility to choose whether to concentrate all capacity in one timeslot or utilizing all four timeslots.

Using all four timeslots, the solution is ideal for CCTV/thermal camera surveillance using a high continuous data rate. This solution is hugely advantageous to public safety organisations, internal emergency response teams and fire brigades, who will be able to get instant access to footage from any disaster or accident areas and thereby provide a much more targeted response. This in turn will minimise damage to persons and property.

Using only one timeslot it becomes possible to increase the data throughput. Thanks to the polling principle you can load the packet data channel by 100% instead of 30-50% only in random access. When sharing a packet data channel, there is no need for terminals to set up their IP connection each time. Instead, the connection is kept in idle for a certain hangtime, with the terminals resting quietly on the traffic channel while this is being used by another terminal.

This increased throughput solution is ideal for utilities who rely heavily on real-time data to monitor and control their plant or equipment through SCADA. In the rail industry, the high data throughput makes TEDS ideal for ETCS levels 2 and 3.

USE-CASE SCENARIOS

Activation of TEDS carriers on a fixed network for public safety

In October/November 2018, the Veneto region in Italy experienced a hurricane of exceptional intensity. The hurricane was accompanied by strong winds, causing the power grid to be shut down for several days. As a result, no telecommunications providers worked in the northern part of the region.

The only communication network in operation was a DAMM TetraFlex® network run by DAMM's Systems Partner in Italy, GEG Telecomunicazioni. This network was fundamental in supporting civil protection during this natural disaster.

While the traditional TETRA technology thus once again proved to be truly mission-critical, having a TEDS solution incorporated into the network in a situation like this would enhance data communication considerably by:

- Enabling transmission of pictures and video in real time
- Enabling local or remote control rooms to get a better overview of the disaster/accident area
- Allowing control rooms to see rescuers during their job and give them proper support
- Giving rescuers the security of being supported by real-time video

Such a TEDS solution could even be a mobile solution, which could be quickly deployed wherever and whenever needed, for instance at a key location in a critical area.

In the end, such targeted response would help reduce fatalities by providing support and transmission possibilities to rescuers in case of prolonged downtime of telecommunications networks. Such downtime is always a risk in communication setups that depend on commercial LTE systems, especially in case of natural disasters. The system architecture of commercial LTE networks includes one master only, with the remaining base stations being slaves. This means that there is no redundancy, so if the master fails, the whole network fails.

In a private mobile radio network based on TETRA, there is no single point of failure because of the decentralized architecture with full redundancy as well as backup power and excellent battery time.

Emergency services

The same properties that make TEDS ideal for disaster areas as described in the above scenario also make it ideal for emergency services.

When an ambulance is rushing a critically ill patient to the hospital, correct and immediate treatment is of the essence in order to ensure the patient's survival and complete recovery. Having a system on board with TEDS capabilities means that any medical equipment connected to the patient will be able to transmit findings directly to the hospital. This will save precious time upon arrival at the hospital as the medical team can skip lengthy examinations and start treatment right away.

Power grids

Power grid operators are highly dependent on reliable communication and data transmission. Data amounts are growing day by day, placing increasing demands on the communication system supporting the SCADA system.

SCADA systems are used to track any disturbances in the grid in real time and to respond automatically to isolate problems before they escalate and cause major issues. In a worst-case scenario overheating somewhere could cause a power outage.

Power outages affect thousands of users – businesses as well as private homes. Therefore, it is essential that any power outage is kept to a minimum. Power grid operators face regulatory penalties if they do not restore electricity within a reasonable amount of time. On top of that, repairs and replacements following faults and breakdowns are a costly affair. Key to keeping all of these costs down is swift identification of what has caused the outage.

TEDS has the data throughput capacity to cover both the increasing day-to-day data demand, for instance for smart meter reading, and to quickly pull the large amounts of data necessary to carry out swift tracing of the root cause of an incident.

Utilities

Utilities are facing increasingly high data security requirements in relation to their use of smart meters delivering readings from private homes. In Europe at least such data must be transferred using a BSI-certified device with a quite sophisticated encryption and certificate management – making TEDS, with its closed and secure infrastructure, the ideal solution for such data transfer.

Connecting a smart meter on the public network is out of the question because of the lack of encryption.

Public safety – fire fighting

When a forest fire breaks out in a remote location in hot and dry conditions, the fire can spread extremely fast. The main objective is to get the fire under control as quickly as possible to limit destructions and prevent fatalities. However, accessing the area to make a proper assessment of the fire is extremely challenging, making it difficult to attack the fire in the most efficient manner.

Similarly, in case of a building on fire, it is critical to identify any areas with residual fire to prevent the fire flaring up again, causing additional damage or even fatalities.

In these situations, using a drone-mounted thermal camera operating on a TEDS network would enable transfer of thermal images directly to a fire brigade dispatcher, who would be able to direct personnel and/or fire-fighting equipment to the critical locations to efficiently bring the fire under control.

Furthermore, a TEDS base station could either be rapidly deployed at the scene or even be permanently installed in known danger areas.

Not only does the TEDS network have the sufficient data capability for such operations, it also has the mission-critical reliability that is vital to ensure 100% communication availability. This availability cannot be guaranteed by other technologies such as commercial LTE, which in disaster situations carry a high risk of network overload leading to the network being blocked.

Waterworks and wastewater treatment plants

Water is one of the most important resources today. When a power failure happens at a water treatment plant, e.g. because of flooding, the water is put at risk of contamination from bacteria developing. This can have serious implications for people who drink it, as it can lead to personal injury or in the worst case be fatal. It can also have huge economic consequences for waterworks, who may be sued for negligence and be required to pay out damages.

Similarly, wastewater spills into rivers and oceans can have a detrimental impact on the local ecosystem and require a huge and costly clean-up.

To avoid these scenarios, wastewater treatment plants and waterworks rely heavily on reliable SCADA systems to monitor and regulate the water flow as well as track reservoir levels and pipe pressure. In the day-to-day running of SCADA systems, TETRA is an excellent choice as it provides a reliable and secure solution. However, in situations of crisis like the above, the data demand increases to a point where TETRA can fall short.

A TEDS solution would protect against this as it delivers a reliable communication solution with sufficient data capacity to support such SCADA applications – both to prevent contaminations before they happen and to quickly perform repairs when they do – saving lives and money.

Rail: ETCS level 2

Rail projects worldwide are relying on increasingly detailed and frequent data to be sent back and forth between the train and the operational control centre (OCC). Such data, classified as ETCS level 2, can be satisfactorily handled by TETRA:

- Data from the train to the OCC: Alarms, train log-on information, Communications-Based Train Control (CBTC) and Automatic Vehicle Location Systems (AVLS).
- Data from the OCC to the train: Train information from the signalling system, time synchronization, pre-defined announcements for PA and Public Information Systems (PIS).

However, while TETRA's limited data capacity is sufficient to handle the above ETCS level 2 data requirements, demands for data capacity for these functions increase drastically in at least two scenarios:

- High-density areas where multiple trains need to share a single data channel
- Regional level crossings where video (CCTV) and telemetry would share a data channel

With a lack of data capacity, important signalling and alarms could fail. In the worst-case scenario this would result in fatal train collisions.
Simply put, TEDS is a TETRA packet data channel with increased efficiency, which can cater for the above areas without needing to change technologies, while keeping the mission-critical aspect of all data transmissions.

Rail: ETCS level 3

While ETCS level 2 is widely used in rail, ETCS level 3 is gaining ground for other more data-demanding functions.

ETCS level 3 is a fully radio-based system without any track-side equipment. In an ETCS level 3 system each train continuously sends positioning data, enabling the Radio Block Centre (RBC) to always calculate the smallest possible distance between trains.

Employing ETCS level 3 with its inherent precision means that it becomes possible to increase passenger capacity without investing in extra tracks or extra carriages. Instead, the existing tracks can be utilized more fully because trains can run more frequently because of the increased accuracy of the positioning data. This makes it a cost-efficient system to deploy – even more so when it is deployed over a TEDS solution, which can be easily integrated into the existing TETRA system used for ETCS level 2 functions.

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