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User Requirement Specification;
Mission Critical Broadband Communication Requirements

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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Terrestrial Trunked Radio (TETRA).

The present document is a potential forerunner to a multi-part deliverable covering the User Requirement Specification (URSs) TETRA Release 3.

The user requirements contained in the present document are described in non-technical terms and are based on discussions in TC TETRA (WG1 and WG4), LEWP, Project MESA and the TETRA and Critical Communications Association.

1 Scope

The present document provides the User Requirement Specifications for Mission Critical Broadband Communications.

The present document describes the functionalities which are most needed by users and the requirements they make on the technology The present document is applicable to the specification of Mission Critical Broadband equipment.

The URS will support TC TETRA to guide the introduction of broadband features.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 170 001: "Project MESA; Service Specification Group - Services and Applications; Statement of Requirements (SoR)".

[i.2] ETSI TR 102 021-2 (V1.3.1): "Terrestrial Trunked Radio (TETRA); User Requirement Specification TETRA Release 2.1; Part 2: High Speed Data".

[i.3] Report for the TETRA Association-Public safety mobile broadband and spectrum needs. Final Report 8th March 2010, Analysys Masons.

[i.4] ETSI TR 102 628: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System reference document; Land Mobile Service; Additional spectrum requirements for future Public Safety and Security (PSS) wireless communication systems in the UHF frequency range".

[i.5] Connecting America: "The National Broadband Plan", Chpt. 16 Public Safety, FCC March 2010.

[i.6] The FCC Plan for a Public Safety Broadband Wireless Network, Jennifer A. Manner, Stagg Newman, Jon M. Peha, 2010, Telecommunications Policy Research Conference.

[i.7] U.S. Department of Homeland Security Public Safety Communications Evolution.

[i.8] U.S. Department of Homeland Security Interoperability Planning for Wireless Broadband.

[i.9] Public Safety Mobile Broadband communications network -Operational requirements, Govt. Of Canada.

[i.10] Evolution of TETRA To a 4G All-IP Broadband Mission Critical Voice Plus Data Professional Mobile Radio Technology - Martin Steppler.

[i.11] LEWP and RECG Matrix.

[i.12] User Requirements -Rail, TCCA Rail Forum, Trans 12-01-01.

[i.13] ETSI TR 102 580: "Terrestrial Trunked Radio (TETRA); Release 2; Designer's Guide; TETRA High-Speed Data (HSD); TETRA Enhanced Data Service (TEDS)".

[i.14] ETSI TR 102 021-10: "Terrestrial Trunked Radio (TETRA); User Requirement Specification TETRA Release 2.1; Part 10: Local Mode Broadband".

[i.15] Public Safety 700MHz Broadband Statement of Requirements Version 0.6 Nov. 8th 2007.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

mission critical broadband: work programme within ETSI Project TETRA to enhance the services and facilities of TETRA, Tetrapol and P25 in order to meet new user requirements, utilize new technology and meet user needs into the future within the traditional market domains of PMR and PAMR

P25, Project 25 or APCO -25: suite of standards for digital radio communications mandated for Public Safety in the US

TETRAPOL: FDMA, professional mobile radio system developed by MATRA/EADS

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ANPR	Automatic Number Plate Recognition
API	Application Programming Interface
APL	Automatic Person Location
AVL	Automatic Vehicle Location
AVLS	Automatic Vehicle Location System
BB	Broad Band solution for PMR
CCC	Command & Control Centre
COM	COMmunication
CSD	Circuit Switched Data
DMO	Direct Mode Operation
DQPSK	Differential Quadrature Phase Shift Keying
ECG	ElectroCardioGram
ERO	European Radiocommunications Office
ETSI	European Telecommunications Standards Institute
GIS	Geo Information Service
GPRS	General Packet Radio Services
GSM-R	Global system for Mobile Communications-Rail
GTSI	Group TETRA Subscriber Identity
HSD	High Speed Data
IMSI	International Mobile Subscriber Identity
IMT	International Mobile Telecommunications
IP	Internet Protocol
ITSI	Individual TETRA Subscriber Identity
LEWP	Law Enforcement Working Party
LTE	3GPP Long Term Evolution (4G)
LTE-Advanced	LTE meeting the IMT Advanced Requirements
MCCH	Main Control CHannel
MS	Mobile Station

PABX	Private Automatic Branch eXchange
PD	Packet Data
PDA	Personal Digital Assistant
PEI	Peripheral Equipment Interface
PIM	Personal Information Management
PMR	Private Mobile Radio
PPDR	Public Protection and Disaster Relief
PSS	Public Security and Safety
PTT	Push To Talk
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
RCEG	Radio Committee Expert Group part of the Law Endforcement Working Party
RF	Radio Frequency
SAT	SATellite
SCADA	Supervisory Control And Data Acquisition
SDR	Software Defined Radio
SDS	Short Data Service
TEDS	TETRA Enhanced Data Services
TETRA	TErrestrial Trunked RAdio
TR	Technical Report
UIC	International Union of Railways
URS	User Requirement Specification
WAP	Wireless Application Protocol

4 Mission Critical Broadband Requirements

4.1 General

With increasing use of data in PPDR, capacity issues for voice and data on existing TETRA 1,TETRAPOL and P25 networks together with the user experience of 3G terminals and applications there has been an increasing demand for more data throughput on PPDR systems. TEDS goes some way in this direction and requirements for High Speed Data were captured in [i.2] but with an eye to the long term future users are expecting that they will want a higher data rate than TEDS offers to support applications such as streaming video. This and more was anticipated in the MESA project and the requirements in [i.1] are informative about the issues to be addressed as well as detailing operational scenarios where such applications would be needed.

The wish is to have the benefits of TETRA,TETRAPOL or P25 functionality, robustness and security supported on a broadband bearer in order to fulfil the operational tasks of the future. In some cases the driver is the capacity to support applications such as video in others it is to create more capacity for voice traffic alongside data applications that in themselves do not require particularly high data rates, To give a multi-media capability to PPDR or just to give narrow band data capability to many users in the same area will both most efficiently be satisfied with broadband.

One way that users can and have responded to the need to provide extra capacity for data is to buy data services from public operators. These services whilst useful for back office applications are not suitable for PPDR in mission critical situations as in such situations the service cannot be relied on. To counteract this some arrangements have been made with operators to give PPDR priority in times of crisis. This can on a temporary basis improve accessibility but does not guarantee a service.

In the USA it has been mandated that the technology for PPDR data will be LTE (2x5 MHz of dedicated spectrum was initially allocated for PPDR and a further 2x5 MHz has recently been granted). Originally this was thought to come to PPDR on a priority call basis from a 10 MHz allocation to public operators. This latter approach for providing capacity for emergencies had not been shown to work yet. The principle though that PPDR does not need all of its spectrum capacity all of the time is however recognised. There is a definite need to plan for surge capacity in times of crisis. This means either overproviding spectrum resource for "normal" usage or having further spectrum needed in particular locations at time of crisis in a seamless way and with the same priority and access as the dedicated spectrum resource.

One assumption in Connecting America-The National Broadband Plan and further detailed in The FCC Plan for a Public Safety Broadband Wireless Network [i.5] and [i.6] is that the LTE terminals for PPDR will be low cost as they are the same technology as the general public will use but the requirements for functionality and robustness amongst others that PPDR users have for their terminals will impact this. Nonetheless there is an economic benefit from re-use of technology and users in Europe might well be interested in using technology that is also use in North America and elsewhere. The Public Safety Requirements for Broadband in the US are detailed in [i.15] (these were formulated prior to the D Block auction that failed and are being re-considered. They are nonetheless a good reference).

The way in which data use evolves in PPDR is likely to depend upon investment in infrastructure and Analysis Masons in their report for the TETRA Association [i.3] identified four possible growth scenarios ranging from steady growth with limited data services purchased from public operators for non-critical applications to full multi-media reliance for operations with either dedicated networks or highly upgraded commercial networks. In the current economic climate investment in infrastructure is likely to be delayed or constrained favouring where possible the use of services from public operators. Depending on the degree of criticality of the data used on these there will need to be improvements in the security, access, priority management and resilience of such services even when used as an overlay.

Spectrum availability will impact both the timing and nature of the solution. Clearly any solution has to efficiently use spectrum but in Europe it may be that large amount of harmonised spectrum cannot be found and therefore small and different blocks of non-contiguous spectrum may have to be worked with. The amount of spectrum required for PPDR broadband was estimated in [i.4]. This may need to be re-visited once WG4 has sized the throughput requirements outlined here and in the LEWP document [i.11].

Other users such as utilities and transport also see a need for more capacity for voice and data with the type of functionality and security that TETRA,TETRAPOL or P25 offers [i.12]. In particular UIC will need a replacement in place for GSM-R by 2025 and the replacement process in itself takes 5 years.

Most current users of TETRA,TETRAPOL or P25 would want a seamless migration to such improved capacity. There is therefore a need to look at emerging requirements, understand which can be met with TETRA (TETRA1 &2) and which go beyond that. Those that do need detailing sufficiently so that a technical solution can be found for them. This bottom up approach assists in defining the minimum to be achieved from a solution and helps justify why broadband is needed. There is also merit in a top down approach that sets out to ensure that any solution adopts the same goals as those for the public domain so that professional users are offered no less a service. The current IMT targets are 1 Gbps for stationary elements and 100 Mbps for mobile users. These are adopted in LTE-Advanced.

4.2 Systems Requirements for Professional Users

Analysis Masons concluded in their report for the TETRA Association, now the TETRA and Critical Communications Association [i.3] that the requirements that PPDR and other users have of their systems today to support their way of working will be needed for BB too. These are:

- Availability - in time (often) specified as three or four nines of availability (e.g. 99,98 % or better at all times). Others specify different requirements for different times such as 99,9 %/year, 99,7 %/month and 99 %/24 hours.
- Control (Dedicated)- network control to allow prioritised access, reserved capacity to be guaranteed, queing of traffic and the dynamic management of queues.
- Low Latency - very short call set up times (< 200 ms) and very limited end to end voice/data transmission delay (< 1 s)
- Interoperability - between users (e.g. police, fire, ambulance) and across borders
- Coverage (national) - defined by geography rather than population e.g. 99 % of landmass. Also see 99,5 % (outdoor mobile), 65 % or better (indoor mobile), 99,9 % (air to ground).
- Resilience/Robust Networks - need layers of redundancy. Central network switching to be fully redundant with geographically distributed switching. Interconnection between bases to be resilient and include back-ups between key base sites. Need for fallback sites if the primary fails. Backup power supplies required at different levels depending on criticality.
- Layered Security - authentication, air to air encryption, end to end encryption.

- Ability to support mixed traffic (voice and data) - integrated network solution supporting transmission of mixed traffic types to enable the use of the same technology in different environments/operations/missions

- Seamless handover - not in the Masons summary but a general need. For rail use there should be seamless handover while transmitting in a call; at speeds up to 300 km/h (500 km/h in the future). Seamless is defined as less than a 300 milliseconds break in connection. Full functionality also has to be supported at these speeds.

In addition TETRA, TETRAPOL and P25 standardisation has only applied to the air interface. Users [i.10] see are interested in the broadband solution including reference points within the SwIMI so that there can be more competition for the elements of the system. This is desirable but not critical.

For mobile users it is expected that broadband capability and the applications defined below can be powered by batteries that have sufficient capacity to support a 10 hour shift.

With increasing pressure on resources it is expected that new technology will bring with it reduced power operating requirements and increased environmental sustainability. There are a number of opportunities to reduce power using sleep mode on terminals or base stations during inactive periods and opportunities to extend the life of products and increase the amount of re-cycle able material in them.

4.3 Operational Requirements

The services required should be built upon that offered in the TETRA, TETRAPOL and P25 standards. These include for voice:- Group calls, encrypted individual and group calls with authentication, individual calls to command centre PABX and /or public telephone networks, direct mode operation between terminals, emergency calls and air to ground calls .For data it includes SDS, packet data, status messaging and WAP support. There are further services that will be needed for BB and these include the following (clauses 4.3.1 to 4.3.7).

4.3.1 Roaming compatibility

TETRA, TETRAPOL or P25 services in use on a present TETRA, TETRAPOL or P25 cell should continue to work with minimal interruption and without loss of pre-arranged information (e.g. QoS information) when an MS roams to a BB cell and vice versa. Voice calls, packet data connections and security should work without significant interruption or loss of partially-transferred data . We should expect roaming between present TETRA, TETRAPOL or P25 and BB to be a common occurrence, both during the roll-out of BB and because BB cells will most probably have a shorter range than present TETRA, TETRAPOL, P25 cells. Authentication, air-interface encryption and end-to-end encryption should continue to work without interruption.

4.3.2 Interoperability between present TETRA, Tetrapol or P25,BB MSs and present dispatchers

An MS using a present TETRA, TETRAPOL or P25 cell should be able to communicate (without any special measures by present MSs) with an MS using a BB cell, and vice versa. MSs using a BB cell should be able to communicate with present dispatchers. End-to-end encrypted voice calls (individual and group), packet data, SDSs, etc., should work without intermediate decyphering and re-encyphering).

4.3.3 Priority

There should be a priority mechanism that determines order of access and once access is granted the relative degree of degradation of services if the system becomes congested.

Data priority in the present TETRA standard is complex and does not work perfectly. A simpler and more effective data priority mechanism is required for BB. In this it is envisaged that the MS would be able to indicate the data priority of every reservation requirement.

4.3.4 QoS

The BB solution should be capable of managing applications which have different requirements for QoS such that in a congested network applications with a low QoS requirement can be slowed to permit those with a higher QoS to be passed. The solution should support parameters for setting QoS and managing them dynamically.

4.3.5 Data throttling

It would be useful to provide a means of rapid end-to-end throttling of prolific data sources (e.g. video) when the link quality drops at the receiving end, to avoid the build up of undeliverable packets in the SwMI or the sending MS; e.g. when the data recipient moves out of a BB cell into a present QAM cell. This is partly a PEI and application issue, but the SwMI may have to initiate flow control messages directed at a sending application. Possibly there is already a protocol for this in the IP domain.

4.3.6 Video rate

It is recognised that some operational situations require high resolution, real time video whilst others do not. The solution should be able to support restricting the number of high resolution channels to reduce congestion.

4.3.7 Maintenance

There needs to be a way of assuring that the chosen solution can be kept up to date and benefit from economies of scale wherever possible and on a sustained basis. There will need to be a network management interface and a protocol for this. It should be possible to manage the end user devices over the air.

There are common elements here with the operational requirements for Public Safety in the US and in Canada [i.8] and [i.9].

4.4 Application requirements of PPDR

In the Analysis Masons study [i.3] they summarised all of the findings of the TETRA Association, now called the TETRA and Critical Communications Association and presented case studies and possible scenarios for the evolution of data that included as an option full multi-media reliance. This is the scenario that is most relevant to broadband. For this they saw, "A diverse range of mobile broadband applications including high quality imaging and real-time video take off, with widespread use across the public safety sector. Widespread information sharing improves the establishment of common operating pictures at incidents, facilitates real time decisions at incidents and enables the introduction of new video services such as remote medical applications, and personal characteristics recognition."

One of the inputs they used was the ERO summary of current public safety applications to CEPT, FM PT38.

More recently the LEWP and RECG [i.11] met to create a matrix of needs for mobile data. This has considerable overlap with the Masons report The result is appended. The needs are categorised as:

- Location data
- Multi-media
- Office Applications
- Download operational information
- Upload operational information
- Online database enquiry
- Miscellaneous

4.4.1 Location data

This covers automatic person or vehicle location data being fed back from terminals to the command and control centre as well as positioning information or directions being fed back to terminals. These applications are available today. Whilst the package size for such information is small (SDS) the use of high reporting rates can dominate the use of the MCCH and impact system capacity. As the use of location information increases this will put system capacity under pressure.

4.4.2 Multi-media

Included in this is:

- video to and from the command and control centre during pursuit so that other units may be informed and intervene;
- video for fixed observation of people or other assets (stakeout);
- video at the scene of a disaster or event to inform command and control;
- video conferencing;
- the broadcast of photographs and the sending of photographs to specified groups.

The data rate needed to stream video has been assessed as being about 2 Mb/s whereas the sending of photographs is a current application that is supported but one that will test capacity/speed of download if it becomes commonplace.

4.4.3 Office applications

The anticipated needs are PDA/PIM synchronisation and mobile workspace including public internet access. These functions are being satisfied currently by devices such as smartphone but there is a desire to have this functionality in the same terminal as other communications and within the same secure system.

4.4.4 Download operational information

This envisages:

- the supply of text and image data from the command and control centre to terminals in the field and net centric working;
- ANPR update hit list;
- the downloading of maps with annotations to field units and the downloading of command and control information such as task management and briefings.

4.4.5 Upload operational information

This mirrors the category above and includes:

- the sending of incident information to the command and control centre;
- status information tied with location (currently supported), for ANPR/speed control an automatic upload to the database including picture evidence from temporary fixed cameras and from vehicles;
- the forwarding of scanned documents such as licences, proof of identity;
- the sending of reports with pictures;
- the uploading of maps and schemes with included information;
- patient monitoring data such as ECG and monitoring the status of security workers using data from sensors such as biometrics, man down, etc.

4.4.6 Online database enquiry

There is a need to make operational searches of own and external databases. Particular cases are:

- remote medical databases;
- number plate checking;

- biometrics such as fingerprints, cargo data;
- crash recovery (enquiry and updates).

4.4.7 Miscellaneous

This set of requirements include:

- the ability to update firmware, software and device & application settings over the air;
- GIS map updates over the air; automatic telemetry such as remote control and the presentation of information from static sensors;
- capacity to be able to manage a large amount of communications in and out of a "hot spot" event including that for a mobile communications centre; front office to back office application support;
- underwater communications to, for example, a scuba diver; alarming or paging (already supported); traffic information and management systems support;
- radio bearing or tracking of special agent's operations;
- IMSI Catcher information to units and connection of units overseas to their home command and control centre.

4.5 Ranking of the Criticality of Applications.

In the LEWP/RCEG matrix of 40 applications the urgency of availability was rated as "now", "short" (<2 yr), "medium"(2 yr to 5 yr) and "long"(>5 yr).Not surprisingly of the 12 in the "now" category 11 are reported as partly used already although the one excluded (AVL) is definitely operational.

4.5.1 Highest Priority, "Now" Group

- Video on location
- Photo broadcast
- Photo to a selected group
- Status Information and location
- Reporting including pictures
- Operational database search
- ANPR-number plate check
- Biometric e.g. fingerprint check
- Alarming/paging
- Tracking
- IMSI Catcher information
- Plus AVL and APL information to command and control centre

4.5.2 Second Priority, "Short" Group

- AVLS data return (data to field units)
- Command and Control information including task management and briefings
- Patient Monitoring

- Crash Recovery System (download of data)
- Crash Recovery System (uploads of information)
- Connection from units aboard to their home command and control centre

4.5.3 Third Priority, "Medium" Group

- Video from field to command and control centre for following and intervention
- Video for fixed observation
- PDA PIM synchronisation
- Mobile workspace
- Incident information - download to field and Netcentric operation
- ANPR update list
- Download maps with annotation
- Incident information upload to command and control centre
- ANPR/speed control and "fixed" speed cameras
- Forward scanned documents
- Upload of maps with information
- Monitoring status of security worker
- Remote medical database services
- Cargo data
- Software update over the air
- GIS map updates
- Auto telemetry and remote control of devices
- Hot spot on disasters
- Front office/back office applications
- Traffic management systems

4.5.4 Fourth Priority "Long and Future" Group

- Video conferencing of operations
- Under water communications

4.6 Expected Capability of TEDS

The packet data throughput rate (table 1) that is achieved for TEDS is based on the level of QAM modulation and the bandwidth. The initial bandwidth being offered by manufacturers is 50 kHz. The maximum rate therefore is with the highest level of 64QAM (coefficient of 1) i.e. about 150 kbit/s. This is not likely to be practicable and 64QAM (2/3) is more likely giving a data rate of about 100 kbits/s.

Table 1: Estimated throughput (kbit/s) for different TETRA HSD channels [i.13]

Modulation type and coding rate	Channel bandwidth (kHz)							
	25		50		100		150	
	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink
π/4-DQPSK, r = 2/3	15	15						
π/8-D8PSK, r = 2/3	24	24						
4-QAM, r = 1/2	10	10	24	26	49	55	77	86
16-QAM, r = 1/2	19	20	47	51	98	110	153	173
64-QAM, r = 1/2	29	30	71	77	146	164	230	259
64-QAM, r = 2/3	39	40	94	103	195	219	306	345
64-QAM, r = 1	58	60	141	154	293	329	459	518

One of the reasons for selecting 50 kHz initially is the coverage that can be achieved and recognition that TETRA users are looking for wide area coverage. This is illustrated in the figures 1 and 2.

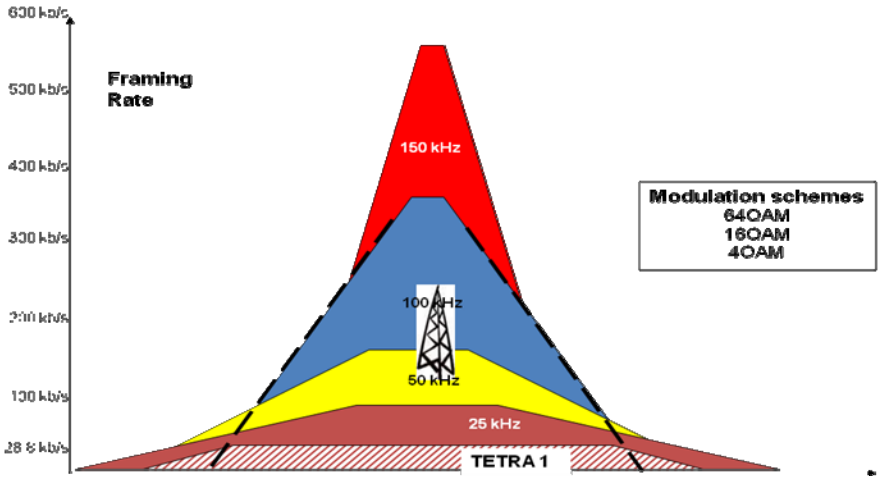

Figure 1: Coverage footprint

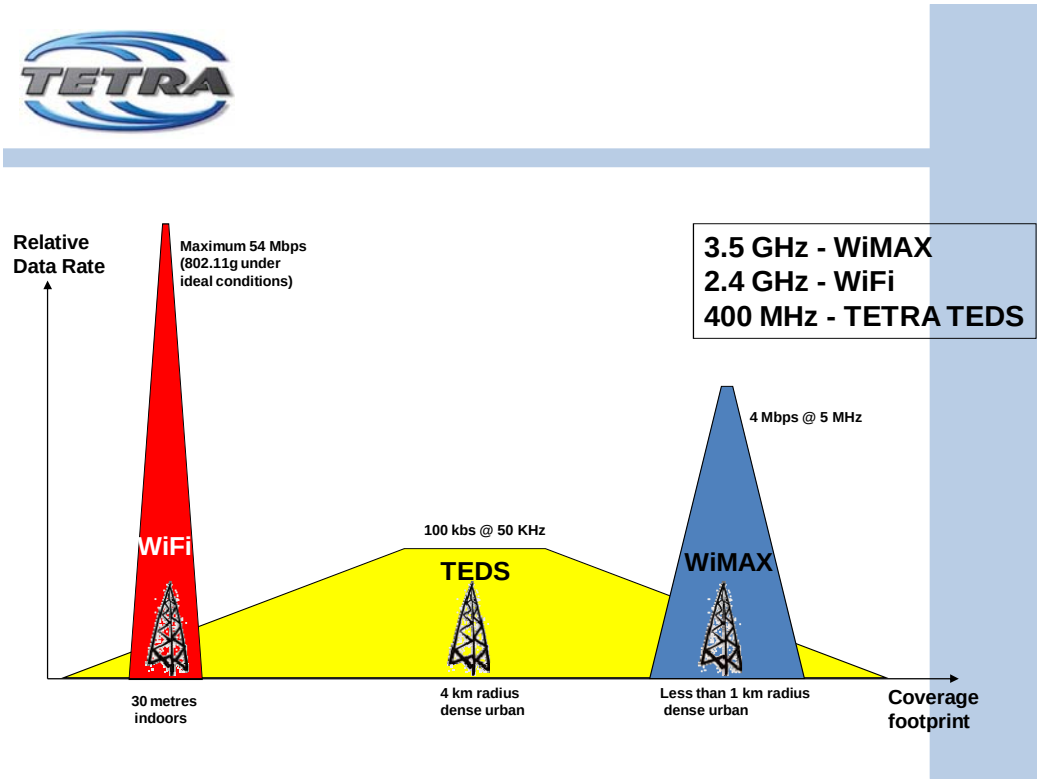

Figure 2: Data rates vs coverage footprints of different radio applications

Analysis Masons have grouped a number of applications and mapped them against data rates.

4.7 Applications identified today that cannot be met by TEDS

Table 2 has been used to look at how data requirements may be met with TETRA. This is very general though and does not consider the use case or the competing requirement for voice. For example if the receiving device for a photograph is a handheld terminal with a small display then high resolution images may not be very critical and single slot transfer may be acceptable. If the receiving terminal is a tablet pc then this will not be acceptable as higher resolution images will be necessary in the same time period and the throughput requirement is increased significantly. Similar cases can be made elsewhere.

Where voice capacity is already an issue then TEDS or broadband data offers a solution for data.

Table 2: Mapping of data services against TETRA variants

	TETRA 1				TEDS
	Circuit Data	**SDS**	**Single Slot PD**	**Multislot PD**	
Database Search					
AVL					
E-Mail					
File Transfer e.g Still images			Small files		
Slow Scan video					
Streaming video					
Legend: Not suitable		Possible		Appropriate	

When this table was put together originally it did not include SCADA/Telemetry.

CSD - works for SCADA, Image transfer and Slow scan video. So at least "possible".

SDS - works for SCADA, email and image transfer . So at least "possible".

Furthermore there are now some working examples of e-mail by SDS so this should also be regarded as possible.

Of the requirements listed for applications the ones that show high throughput and high operational use are video back to the command and control centre during chases, video at disasters and mobile communication centres at hotspots re). Whilst TEDS has been demonstrated streaming video it has been only low resolution and on an unloaded cell. It is certain that this need will only be satisfied with broadband. The need for broadband elsewhere is not driven by a particular application but by the total loading of the system which will impact response times and therefore ease of use. It is multi-media support that defines the need for broadband.

4.8 Ranking of those Applications by Customer Need

Of the three applications identified the priorities for the LEWP group based on their urgency of requirement are:

- Video at disasters to inform co-ordinators, managers, etc.
- Video back to the command and control centre during chases to allow intervention.
- Hotspot mobile communication centres.

These examples of urgent communications needs are all likely to be provided by video/imaging devices with access to PPDR BB, commercial BB, satellite services etc. to cover any eventuality.

4.9 Requirements during Migration to a New Technology Solution

In a similar way to the migration to TEDS it is desirable to be able to seamlessly move from TETRA, TETRAPOL or P25 voice and data services into broadband data services initially and then voice. If voice is supported on the broadband service then the feel and functionality of the services should be the same as for TETRA, TETRAPOL or P25 so that operational practices do not need to change. The security of the broadband service should be at least the same as that for TETRA, TETRAPOL or P25 and use the same algorithms and key lengths albeit that preferably these will be an evolution on those used today with longer key lengths to give sustained protection from interception. The broadband service should have roaming and compatibility with TETRA, Tetrapol and P25 networks, perhaps not all in one device (although with a SDR and multiple RF this might be possible).

If the solution to broadband is evolutionary then interfaces need to be developed to the intermediate technologies. For example GPRS is used for many PPDR data applications today. If the migration strategy uses public services such as these then multi-bearer terminals will be needed with appropriate protocols to use the correct bearer for any given application. This protocol will need to select the bearer based on security, priority, size of data package and quality of service available.

For TETRA users wishing to keep to dedicated networks and the same broad technology it is seen that the first step of the migration is to TEDS. This can offer capacity to meet a number of the user requirements identified and is deliverable in the short term. Due to the time taken to agree and clear broadband spectrum for PPDR and other PMR users it is not expected that dedicated PPDR/PMR broadband will be available before 2021.

There are likely to be significant changes to operational procedures to benefit from broadband and these will need development. For this reason an evolutionary approach is desired. This is recognised in the US plan [i.7].

5 If LTE is chosen

LTE defines a high speed radio access for IP, but 3GPP LTE standardisation scope does not define any PMR specific services (no TETRA like Group or PTT services covered). TETRA voice services may therefore have to be provided outside of the 3GPP LTE standard and LTE radio access network scope. The most obvious solution to fulfil TETRA users need would be from a TETRA server; an independent ´TETRA PTT call processing server´ or more favourably expanding the existing TETRA core network, providing today's TETRA services to the current TETRA1 radios to support also LTE terminal users. This latter scenario would be best fit for an existing TETRA user/operator, as it would most easily enable smooth expansion of TETRA services to LTE or other high speed IP radio terminals. Such a joint core would provide TETRA services simultaneously and interoperably with the existing TETRA users, using their existing TETRA terminals.

Anticipating that the long term solution for a PPDR/PMR bearer will be LTE (or more probably LTE-A), as defined in 3GPP standard releases 9 and 10 and fortcoming further 3GPP LTE Advanced 3GPP releases 11, then there is standards work to do to ensure that LTE is able to meet the needs of PMR. In particular the following:

1) Development of air interface and end to end encryption algorithms that will be secure for the next 20 years.

2) Development of the standard for group communications including multi-cast voice and data.

3) Development of the standard for voice to achieve a common way of delivering good quality audio that is compatible with TETRA, TETRAPOL and P25 for point to point and point to multi-point communications (assumes voice over BB data standard agreed for LTE). The standard would need to address how background noise would be cancelled (as it is in the TETRA CODEC).

4) Standardisation of access control and priority management.

5) Standardisation of interworking with and providing TETRA1, TEDS, P25 and TETRAPOL PMR voice and data services over LTE.

6) Standardisation of the method by which an MS roams between TETRA1 1 and TETRA 2 cells and a BB TETRA cell (and vice versa).

7) Standardisation of a protocol for working outside the coverage provided by the infrastructure. This to cover voice and data with a range at least comparable to that of TETRA DMO. Data throughput to be sufficient to support slow scan video, say 50 kbps across a DMO link of at least 1 km at 400 MHz. Gateways and Repeaters should be supported. Fuller details of the requirements can be found in [i.14].

8) Standards work aimed at facilitating cross border exchanges of data through standard intersystem's interfaces.

In addition there will need to be development of a PMR standard for operating with broadband that will include the adoption of LTE reference points for the infrastructure, support of interworking, and possibly standardisation of an API for control rooms.

5.1 Some Blue Sky Applications for the Future.

Some Blue Sky Applications for the Future (source: Analysis Masons Report [i.3]):

- 3-D video forensics
- Tele -health
- High quality, evidential facial recognition applications

Annex A:
LEWP Matrix of Requirements

The following is an extract from the matrix showing all the applications but not all the detail of their usage. That can be found in [i.11].

Type of application + services	throughput p/s per session	use per month per user	Number of users	mobility (using while moving)	quality of experience (can there be a hiccup in the connection)	Availability/start-up time	timeliness/delay in delivering the data (high=no delay)	continuous operational availability (mission critical level)	peripherals for field units	necessary screen for field units	security (confidential + integrity)	group calls + broadcast	urgentie to introduce
LOCATION DATA													
A(V) LS data to CCC (persons + vehicles positions)	low	high	high	high	medium	ready	high	high	modem/gps receiver/router	none	medium	no	now
A(V)LS data return	medium	high	medium	high	medium	ready	high	high	modem/gps receiver	graphic	high	yes, small + big groups	short (partly already in use)
MULTI MEDIA													
Video from/to CCC for following + intervention	high	low	medium (emergency vehicles)	high	low	ready when vehicle is ready	medium (has to be in line with speech; max. 1 or 2 seconds)	high	modem/router	none by sending; graphics when receiving	low	yes, medium number	medium
Low quality additional feeds	low-medium (depending on quality)	low (but more than above)	medium (emergency vehicles)	high	low	ready when vehicle is ready	medium (has to be in line with speech; max. 1 or 2 seconds)	high	modem/router	none by sending; graphics when receiving	medium	yes, medium number	medium
Video for fixed observation	medium (high on hdd)	high	low	low	low	low (mostly enough time to switch on)	medium (has to be in line with speech; max. 1 or 2 seconds)	medium	modem/router	none	high	yes, small number	medium (partly already in use)
Low quality additional feeds	low-medium (depending on quality)	high	low (but more than above)	low	low	low (mostly enough time to switch on)	medium (has to be in line with speech; max. 1 or 2 seconds)	medium	modem/router	none	high	yes, small number	medium
Video on location (disaster or event area) to and from control room - high quality	high	low	low	low	medium	Take along on ad hoc basis	medium	high; availability at Golden Hour essential	modem/router	graphic (if receiving also)	low	yes, low number	now (partly already in use)
Video on location (disaster or event area) to and from control room - low quality	medium	low	low	low	medium	Take along on ad hoc basis	medium	high; availability at Golden Hour essential	modem/router	graphic (if receiving also)	low	yes, medium number	now (partly already in use)
Video on location (disaster or event area) for local use	medium - high	low	low	low	medium	Take along on ad hoc basis	medium	high; availability at Golden Hour essential	modem/router	graphic (if receiving also)	low	yes, medium number	now (partly already in use)

Type of application + services	throughput p/s per session	use per month per user	Number of users	mobility (using while moving)	quality of experience (can there be a hiccup in the connection)	Availability/start-up time	timeliness/delay in delivering the data (high=no delay)	continuous operational availability (mission critical level)	peripherals for field units	necessary screen for field units	security (confidential + integrity)	group calls + broadcast	urgentie to introduce
Video conferencing operations	medium (high on hdd)/priority needed	low	low	low	low	low	medium (has to be in line with speech; max. 1 or 2 seconds)	low (but medium/high if used in crisises)	special equipment	graphic	medium	yes, small number	long
Non real time recorded video transmission	high	low	low	low (but high when using in cars)	medium	low (mostly enough time to switch on)	medium (has to be in line with speech; max. 1 or 2 seconds)	medium	modem/router	none	medium	no	medium
Photo broadcast	medium	low	medium	high	low	ready	low	medium	PDA/Smartphone	graphic	medium	yes, big groups	now (partly already in use)
Photo to selected group (e.g. based on location)	medium	low	low	high	low	ready	low	medium	PDA/Smartphone	graphic	medium	yes, medium number	now (partly already in use)
OFFICE APPLICATIONS													
PDA PIMsync	medium	high	low	high	low	ready	low	low	PDA/Smartphone	graphic	high	no	medium (partly already in use)
Mobile workspace + (incl. public internet)	medium	medium	low	high	low	ready	low	low	laptop or tablet	graphic	high	no	medium (partly already in use)
DOWNLOAD OPERATIONAL INFORMATION													
Incident information download (text + images) from CCC to fieldunits + Netcentric working	medium	low	medium	low	high	ready	medium	high	PDA	graphic	medium	yes, medium number	medium (partly already in use for small messages)
ANPR update hit list	medium	medium	medium	medium	low	low (mostly enough time to switch on)	low	low	PDA/laptop	text	medium	yes, big groups	medium (partly already in use)
Download maps with included information to field units	medium	low	low	high	medium	medium	medium	high	PDA/laptop	graphic (if receiving also)	medium / high at confidential applications	yes	medium
Command & control information incl. task management + briefings	medium	medium (high when also operational task information)	high	high	medium	ready	high	high	PDA/laptop	text/graphic	medium	yes, medium number	short (partly already in use)
UPLOAD OPERATIONAL INFORMATION													

Type of application + services	throughput p/s per session	use per month per user	Number of users	mobility (using while moving)	quality of experience (can there be a hiccup in the connection)	Availability/start-up time	timeliness/delay in delivering the data (high=no delay)	continuous operational availability (mission critical level)	peripherals for field units	necessary screen for field units	security (confidential + integrity)	group calls + broadcast	urgentie to introduce
Incident information upload (text + images) to CCC + Netcentric working	medium	low	medium	low	high	ready	medium	high	PDA	graphic	medium	yes, small number	medium (partly already in use for small messages)
Status information + location	low	high	high	high	medium	ready	medium	medium (during incidents high)	radio/PDA/laptop	text	medium	no	now (partly already in use)
ANPR or speed control automatic upload to data base incl. pictures (temporally 'fixed' camera's + from vehicles)	medium (high on busy roads)	high (fixed equipment is constantly on)	low, but growing	Fixed + high when using driving	low	ready	medium	fixed camera's low. If operational in cars medium	special equipment	graphic in cars	low	no	medium (partly already in use)
Forward scanned documents	medium	low	low	medium	low	low (mostly enough time to switch on)	low	medium	modem/router	graphic (if receiving also)	medium	no	medium
Reporting incl. pictures etc.	medium	medium	medium	low	low	low (mostly enough time to switch on)	low	low	PDA/laptop	graphic	high	yes, small number	now (partly already in use)
Upload maps + schemes with included information	medium	low	low	high	medium	medium	medium	high	modem/router	graphic (if receiving also)	medium / high at confidential applications	yes, small number	medium
Patient monitoring (ECC) snapshot to hospital	medium	medium	low	high	high	ready	medium	high	special equipment	not applicable	medium	no	short (partly already in use)
Patient monitoring (ECC) real time monitoring to hospital													
Monitoring status of security worker (drop detection, stress level, carbon monoxide etc.)	low	low	Probably partially fire department	high	high	ready	high	ready	special equipment	not applicable	medium	no	medium
ONLINE DATA BASE ENQUIRY													
Operational data base search (own + external)	medium	high	high	high	high	ready	high	high	PDA	graphic	high	no	now (partly already in use)
Remote medical database services	medium	medium	low (mainly ambulance cars)	high	high	ready	high	high	modem/router	special equipment	high	no	medium (partly already in use)

Type of application + services	throughput p/s per session	use per month per user	Number of users	mobility (using while moving)	quality of experience (can there be a hiccup in the connection)	Availability/start-up time	timeliness/delay in delivering the data (high=no delay)	continuous operational availability (mission critical level)	peripherals for field units	necessary screen for field units	security (confidential + integrity)	group calls + broadcast	urgentie to introduce
ANPR checking number plate live on demand	low	medium	medium	medium	low	low (mostly enough time to switch on)	medium	medium	PDA	text	medium	no	now (partly already in use)
Biometric (e.g. fingerprint) check	low	low	low	low; high on the train	low	ready	low	medium	PDA-like device	hit/no hit	low	no	now (partly already in use)
Cargo data	low	low	medium	high	high	ready	medium	high	PDA	text	medium	no	medium
Crash Recovery System (asking information on the spot)	medium	low	low (mainly fire trucks)	high	high	ready	medium	high	PDA	graphic	low	no	short (partly already in use)
Crash Recovery System (update to vehicles from data base)	medium	low	low (mainly fire trucks)	medium (fire truck in use can receive a little later)	high	ready	low	high	PDA	graphic	low	no	short
MISCELLANEOUS													
Software update online	medium	low	high	medium (it has to be certain everyone receives, but a bit later is acceptable)	low	low: it has to be certain everyone receives, but a bit later is acceptable	low	low	not applicable	not applicable	high	yes, big groups	medium
GIS maps updates	medium	low	medium	medium (it has to be certain everyone receives, but a bit later is acceptable)	low	low: it has to be certain everyone receives, but a bit later is acceptable	low	low	not applicable	not applicable	medium	yes, big groups	medium
Automatic telemetrics incl. remote controlled devices + information from static sensors	low	low	medium	none at permanent static sensors; high with applications in/on cars	medium	ready	medium for control processes; low while gathering information; high at time-critical applications	high	modem	none	depends on kind of sensor application	no	medium (partly already in use)
Hotspot on disaster or event area (e.g in mobile communication centre)	extreme high	low	medium	low	high	have to be installed	high	high	special equipment	not applicable	medium	yes	medium
Front office - back office applicaties - form filling online with backoffice system etc.	low (medium if graphics is included)	high	high	high	low	ready	low	medium	PDA	graphic	medium	no	medium
Alarming / paging	low	medium	medium	medium	medium	ready	high	high	pager	text	medium	yes, medium number	now (partly already in use)

Type of application + services	throughput p/s per session	use per month per user	Number of users	mobility (using while moving)	quality of experience (can there be a hiccup in the connection)	Availability/start-up time	timeliness/delay in delivering the data (high=no delay)	continuous operational availability (mission critical level)	peripherals for field units	necessary screen for field units	security (confidential + integrity)	group calls + broadcast	urgentie to introduce
Traffic management system: information on road situations to units	low	low	low	high	medium	ready	high	high	PDA/Smartphone	graphic	medium	no	medium
Connectivity of abroad assigned force to local ccc	medium	low	low	medium	medium	ready	high	high	SAT COM	graphic	high	no	short
		low:<10x	low:< 20 %										short: <2 years
		medium:10-30x	medium: 20-70 %										medium: 2-5 years
		high:>30x	high:>70 %										long: >5 years
Most important parameter for this application		BxCxD= network capacity indication											
Second important parameter for this application													
Third important parameter for this application													

Type of application + services	Short explanation
LOCATION DATA	
A(V)LS data to CCC (persons + vehicles positions)	Sending (automatically) location information from units to the control centre
A(V)LS data return	Sending (automatically) location information from the control centre (or software applications) to units (individual + groups)
MULTI MEDIA	
Video from/to CCC for following + intervention	Video information from and to special police units on suspects (hot persuit etc.)
Low quality additional feeds	Extra camera's for observation with lower quality, which can be switched to higher quality when relevant
Video for fixed observation	Video information to controlroom or special observation room from a fixed location (most time building under observation)
Low quality additional feeds	Extra camera's for observation with lower quality, which can be switched to higher quality when relevant
Video on location (disaster or event area) to and from control room - high quality	Video information to controlroom or special crisis centre from units on the location and to the units on what is happening; only a few high quality video links
Video on location (disaster or event area) to and from control room - low quality	Video information to controlroom or special crisis centre from units on the location and to the units on what is happening; some more low quality video links
Video on location (disaster or event area) for local use	Video information between the commandunit on the location and the units on what is happening; some medium quality video links which are only local
Video conferencing operations	Video conferences between management, specialists etc. (like in other businesses) + for coordination on the field
Non real time recorded video transmission	Sending a selected part from a recorded video in a later stage to controlroom or coordination centre
Photo broadcast	Picture (e.g. from wanted person) to a big group of officers
Photo to selected group (e.g. based on location)	Picture (e.g. from missed child) to those officers which are in the relevant search area
OFFICE APPLICATIONS	
PDA PIMsync	The 'normal' applications like mail, agenda search of the public internet etc.
Mobile workspace + (incl. public internet)	The facility to do with a laptop 'on the street' the same as in the office (also the backoffice applications e.g. to fill in a file
DOWNLOAD OPERATIONAL INFORMATION	
Incident information download (text + images) from CCC to fieldunits + Netcentric working	Information regarding an incident from the controlroom to the fieldunits. Can be text, pictures, images, maps etc.
ANPR update hit list	Automatic update from the wanted cars (hit list) for the automatic numberplate recognition application
Download maps with included information to field units	Sending maps with additional information (extra info on buildings, location of officers, routes etc.) from the controlroom to the field units
Command & control information incl. task management + briefings	Sending all kind of briefing information from the controlroom to the relevant units
UPLOAD OPERATIONAL INFORMATION	
Incident information upload (text + images) to CCC + Netcentric working	Information regarding an incident from the fieldunits to the controlroom. Can be text, pictures, images, maps etc.
Status information + location	(automatic) sending of status information (on route, arrived, incident closed etc.) + location from field units to controlroom
ANPR / speed control automatic upload to data base incl. pictures (temporally 'fixed' camera's + from vehicles)	ANPR / speed control application: automatic upload to data base incl. pictures from relevant cars. Info is coming from temporally 'fixed' camera's + from vehicles equipped with ANPR or speed measurement equipment
Forward scanned documents	Making a scan from document(s) by field units and send that to controlroom or colleaques Includes medical health care information
Reporting incl. pictures etc.	Making a report (can be pictures, images or map info included) by field units and send that to controlroom or colleaques
Upload maps + schemes with included information	Sending maps with additional information (extra info on buildings, location of officers, routes etc.) from the fieldunits to the controlroom or other field units
Patient monitoring (ECC) snapshot to hospital	Sending patient information (e.g.ECC) from ambulance or from the field to hospital: only a limited snapshot
Patient monitoring (ECC) real time monitoring to hospital	Sending patient information (e.g.ECC) from ambulance or from the field to hospital on real time basis
Monitoring status of security worker (drop detection, stress level, carbon monoxide etc.)	Specific Fire application: Fireman are equipped with safety measurement equipment which will send out a warning when there is a risk for the fireman; Usually, Fire Brigades will send the information locally to a commander at the scene Rescue services need to send the data back to a supervisor over the main network

ONLINE DATA BASE ENQUIRY	
Operational data base search (own + external)	Data base enquiry by field units from all the backoffice data bases + relevant external data bases
Remote medical database services	Data base enquiry by medical field units from the relevant (external) medical data bases
ANPR checking number plate live	On the spot numberplate control by field units via connection to the car registration data base
Biometric (e.g. fingerprint) check	With special equipment checking biometrics and sending this info to the relevant database to check (hit-check)
Cargo data	Data base enquiry by field units from the relevant external data bases with cargo information (by logic cargo numbers)
Crash Recovery System (asking information on the spot)	On the spot control by fire units where to use the hydraulic scissor for cutting a car open to rescue people (via the car registration data base)
Crash Recovery System (update to vehicles from data base)	From the most common cars the car drawings are stored in the firetruck to save datacommunication. Updates are then needed.
MISCELLANEOUS	
Software update online	Online software updates for the terminals in use
GIS maps updates	Updates from geographical maps which are stored on the terminals
Automatic telemetrics incl. remote controlled devices + information from (static) sensors	All kind of telemetric information: from and to remote control devices + information from (static) sensors (e.g. observation)
Hotspot on disaster or event area (e.g in mobile communication centre)	A temporally hotspot for local broadband data on a crisis/disaster/investigation area or at a big planned event
Front office - back office applicaties	The possibility to work 'on the street' with the normal 'in the office' front and backoffice applications
Alarming / paging	Paging function to alarm PSS people (e.g. fire people to go to the fire centre)
Traffic management system: information on road situations to units	Information to the field units on which roads to used, blockages etc.
Connectivity of abroad assigned force to local ccc	Availability for forces from other countries to get in contact with the local controlroom via data communication
Legend	
Most important parameter for this application	Some parameters are more relevant for an application than others. This differs per application. The colours indicates the 3 most relevant parameters for a certain application
Second important parameter for this application	
Third important parameter for this application	

Annex B:
Transport Requirements

B.1 Rail user requirements

The document "User Requirements Specification - Rail by TETRA and Critical Communications Association" describes requirements of rail users. The document is contained in an Adobe Portable Document Format™ file (Trans12-01-01r2.PDF contained in archive tr_10202201v010101p0.zip) which accompanies the present document.

B.2 Transport for London

Basis for requirements:

- Driver communications for information and safety (currently 35 000 calls /day)
- Emergency calls (Code Red). Currently 230 calls/day.
- Location services 915k messages /minute)
- Bus location updates to bus stop countdown signs (50 Mbytes/h)
- Communication on bus location to web and to phone app
- Blue light interoperability
- Communications to manage events and incidents

Annex C:
Utilities Requirements

C.1 Electricity

Basis for requirements:

- Restricting outage extent by rapid communication of fault location and switch action (10ms);Teleprotection
- Work scheduling and communications to field engineers/utility vehicles
- Emergency calls
- SCADA
- Voltage, current, open switch, temperature etc.
- Smart Grid related communications
- High resilience of network for voice and data
- Highly available communications
- Low latency
- Wide area
- Cyber security
- Distributed systems architecture
- Mains power independence for infrastructure

History

Document history		
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