AUTOMOTIVE INFOCOM TRANSPORT & ENVIRONMENT AERONAUTICS SPACE DEFENCE & SECURITY

Procedure for gathering capacity requirements for German PPDR agencies

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Goal of study

- **Scope of study:**
  - For fulfilling the PPDR requirements concerning narrow band data and specifically voice TETRA is in Europe the recognized platform
  - The study looked at the PPDR communication demand beyond this. Consequently this is a supplement to narrow band, not a replacement.

- **Main goal: demand driven frequency planning for PPDR**
  - Derivation from expected communication demand of PPDR
  - Implementation starting from 2015

- **Agreed and harmonized implementation of frequency assignment in Europe**
  - Efficient utilisation of spectrum
  - Minimisation of problems for international collaboration of PPDR agencies
  - Cost efficiency due to broad deployment of common technologies

Questionnaire

Requirements of service or application				
Detailed description of service:				
Question	**Normal operation**	**Demonstration and mass event**	**Natural or other major disaster**	**Other remarks**
• When will this service /application become relevant?				
• Who communicates with whom? (communication scenarios, communication paths, paths of information exchange) o from emergency site to control centre o from control centre to emergency site o between vehicles at emergency site o between persons at emergency site o at locations outside the coverage area (tunnels, buildings, …) o with non-PPDR agencies				
• How large is typically the operation area?				
• Which data rate has to be transmitted over the various communication paths? • Alternatively, which amount of information (Bytes) need to be transmitted in which time?				
• How many simultaneous communication paths are required in the operation area?				

Questionnaire

	Normal Operations	Demonstration & Mass Events	Natural or major desaster	Other remarks
• Do the communication partners require full-duplex or semi-duplex communication?				
• Are the communication partners mobile or stationary? • If mobile, what is their typical speed?				
• Are the communication partners outside or inside buildings?				
• Which service availability is required throughout the operation area? • At which time and which location does the service has to be available?				
• Is the service mission critical, that is, is life in danger in case the service isn't available? • Is the service important or nice to have?				
• Which are the key service quality properties (call setup time, MOS value, delay, jitter …)				
• Is the transmitted information sensitive? • Which are the respective security requirements (confidentiality, integrity, authentication …)				

Procedure for demand gathering (1)

- Chosen approach for demand gathering: performance of „guided“ interviews with end users from representative PPDR agencies

- Rationale for this approach
  - End users don’t think in terms of “frequency requirements” but in terms of “operational scenarios” and “required applications”
    - Interviews started exactly on this level, talking to interview partners in “their language”
  - Goal of study was explained personally and interactively
    - Ensures that interview partners really understand study goal and are able to provide the correct information
    - Ensures that replies from different interview partners are comparable
  - Provided information from interview partners has been scrutinized
    - Ensures that user replies are well thought out
    - Ensures that given user requirements are realistic (no wish lists)
  - Gathering of extensive background information during interviews
    - Ensures correct understanding of the operational requirements
    - Important for subsequent post-processing of gathered information
  - Allows first discussion of suitable technologies together with the users
    - The users could feed-in operational or other restrictions

Procedure for demand gathering (2)

- Careful selection of 20 key interview partners / PPDR agencies, which are representative for the German PPDR sector
  - Police
    - Federal police and federal criminal police office
    - 3 State polices
    - 1 SWAT team and 1 mobile observation team
    - 2 Special agencies
  - Fire brigades
    - 2 professional fire brigades
    - 2 factory fire brigades
    - German association for fire brigades representing the volunteer fire brigades
    - County staff for disaster control
  - Rescue services
    - German Red Cross
    - Mountain rescue
  - Federal Agency for Technical Relief
  - Toll
  - Federal Office for Goods Transport
- Interviewed partners of each PPDR agency have been selected to represent operational experience and expertise in communication technologies
  - Ensures competence for study

Procedure for demand gathering (3)

- Distinction of 3 relevant operation categories
  - Rationale: Depending on the operation category there are differences concerning
    - the kind applications required during operation
    - the amount of information required to be transmitted
    - the collaboration taking place between multiple PPDR agencies
    - the availability and reliability of infrastructure-based communication networks
    - …

- Operation category 1: Normal operation
  - Typically no strong collaboration between different PPDR agencies
  - Infrastructure-based communication networks are in operation where available
  - Normal network load by PPDR traffic

Procedure for demand gathering (4)

- Operation category 2: Demonstration and mass events
  - Intensive collaboration between different PPDR agencies
  - Infrastructure-based communication networks are often overloaded by commercial and private users
  - Operation can be planned ahead
    - e.g. possibility to install additional communication resources
  - High network load by PPDR traffic

- Operation category 3: Natural and other major disaster
  - Intensive collaboration between different PPDR agencies
  - Infrastructure-based communication networks are often overloaded by commercial and private users
  - Infrastructure-based communication networks can be destroyed by disaster
  - Operation can't be planned ahead
  - High network load by PPDR traffic

Procedure for demand gathering (5)

- For all 3 operational categories the respective “operational scenarios” and “required applications” have been discussed with the interview partners, e.g.
  - Performing observation of suspicious persons (mobile observation teams, toll)
  - Distributed operation management (fire, rescue and police services)
  - Transmission of thermal images from emergency site to mobile and central control units (fire services)
  - Transmission of body sensor information to mobile control units (police and fire services)
  - Access from the emergency site to all kind of data bases stored in contol centers or the Internet (most PPDR agencies)
  - Connection of the police car to the control center for database access, video transmission from operation, … (police services)
  - Transmitting patient data from ambulance to hospital (rescue services)
  - Connection of mobile controllers (e.g. at highway control places) to the control center (Federal Office for Goods Transport)
  - Transmission of data collected by CBRN measurement vehicles (fire and police services)
  - Control and monitoring of drones and robots equipped with sensors (police, fire and rescue services)
  - Transmission of additional operation information from control center to mobile units during alarming phase (fire and rescue services)
  - …

Procedure for demand gathering (6)

- For all required applications the communication demand has been identified and discussed together with the interview partners
  - Identification of required communication paths
    - from emergency site to control centre
    - from control centre to emergency site
    - between vehicles at emergency site
    - between persons at emergency site
    - at locations outside the coverage area (tunnels, buildings, …)
    - with non-PPDR agencies
  - Identification and discussion of number of users / vehicles
  - Identification of size operation area
  - Identification of requirement to collaborate with other PPDR agencies
  - Identification of criticality of application
  - Identification and discussion of bandwidth demand
  - Identification and discussion of availability and security requirements
  - Identification and discussion of suitable communication technologies
  - …
- During this process given replies have been scrutinized and alternatives have been discussed
  - Are alternative video-codices more bandwidth-friendly and acceptable?
  - Is immediate transmission of information required?
  - …

Determination of overall bandwidth requirements (1/2)

- **Step 1: Selection of suitable technologies**
  - **Approach: Usage of commercial technologies operated by PPDR with exclusive spectrum**
    - **Economical while ensuring availability and reliability**
  - **Consideration of current and future communication technologies (ad hoc networks, LTE, satellite, WLAN, indoor radio, 802.11p, …)**
  - **Identification of most suitable technology based on discussions with interview partners**
    - **Bandwidth requirement, size of operation area to be covered, user mobility, requirement of indoor coverage, …**

- **Step 2: Calculation of theoretical maximum bandwidth requirements per operation category**
  - **Consideration of tactical and operational aspects discussed during interviews**
    - **Per operation category only bandwidth requirements for those scenarios and applications have been added up, which take place at the same time and at the same location**

Determination of overall bandwidth requirements (2/2)

- Step 3: determination of theoretical maximum bandwidth requirements for all operation categories

- Step 4: Reduction of overall bandwidth requirement based on tactical and operational aspects gained from interviews
  - Focusing on mission critical applications
    - Dimensioning of the required bandwidth for only those applications, which are mission critical
  - Focusing on real-time applications (video, real-time data, …)
    - Dimensioning of the required bandwidth for only those applications, which required real-time transmission
    - Other applications will be handled in „best effort“ mode
  - Neglecting applications for bandwidth dimensioning, which required bandwidth just for redundancy reasons

Final bandwidth requirements per technology

technology	Final requirements (Bandwidth)
ad hoc 5 GHz (in Mbit/s)	178
WLAN 802.11 (in Mbit/s)	0
LTE downlink (in Mbit/s)	187
LTE uplink (in Mbit/s)	255
satellite (bidirect., in Mbit/s)	0,5
indoor radio (in Mbit/s)	9,6
802.11p (in Mbit/s)	0

Derivation of required spectrum

- Generally: the relation between bandwidth (in bit/s) and required spectrum (in Hz) for a certain technology depends on many different factors
  - modulation
  - channel access
  - overhead of different layers
  - transmission power

- Step 1: relation first is derived from operational experience or pilot tests of respective communication technologies
  - Ensures realistic approach

- Step 2: consideration of new trends in development and standardisation of technologies (e.g. LTE release 10, 802.11n ad-hoc)
  - consideration of possible influence of emerging technologies until 2015
  - Ensures optimal Mbit/s per Hz

Required spectrum

technology	Final requirements
Ad hoc 5 GHz (in MHz) 802.11a (802.11n)	400 (160)
WLAN 802.11 (in MHz)	0
LTE downlink (in MHz)	20
LTE uplink (in MHz)	40
satellite (in MHz)	0,4
indoor radio (in MHz)	14
802.11p (in MHz)	0

(Consideration of new trends)

Conclusion (1/2)

- **Bandwidth requirements have been gathered for whole German PPDR**
  - not only for specific agencies

- **Strong effort has been made to minimize these requirements while still addressing the operational needs**
  - Representative PPDR agencies / interview partners have been carefully selected
  - Study goal has been explained in detail in order to ensure correct answers
  - Replies of interview partners have been scrutinized
  - Bandwidth-friendly alternatives have been discussed with interview partners
  - Bandwidth requirements only have been added up if the respective scenarios take place at the same time and at the same location
  - Bandwidth dimensioning focused on mission critical and real-time applications
  - Bandwidth requirements collected for redundancy reasons have been neglected
  - Emerging technologies have been considered in order to get more Mbit/s per Hz

Conclusion (2/2)

- **The highest bandwidth requirements result from operation categories „demonstration and mass events“ and „natural and other major disaster“**
  - **Probability (in time) for scenarios in these categories is small**
  - **Nevertheless appropriate spectrum needs to be reserved for these operations**
    - **Short-term spectrum reservation in case scenario takes place is unrealistic**

IABG Key recommendations

- **Focusing on reservation of PPDR spectrum suitable for LTE**
  - **If possible 60 MHz (20 MHz downlink, 40 MHz uplink)**
- **Reservation of PPDR spectrum suitable for broadband ad hoc networks**
  - **Approach: Extension of existing PPDR spectrum 5,15 – 5,25 GHz by additional 60 MHz**
- **Reservation of PPDR spectrum suitable for indoor radio**
  - **If possible14 MHz**