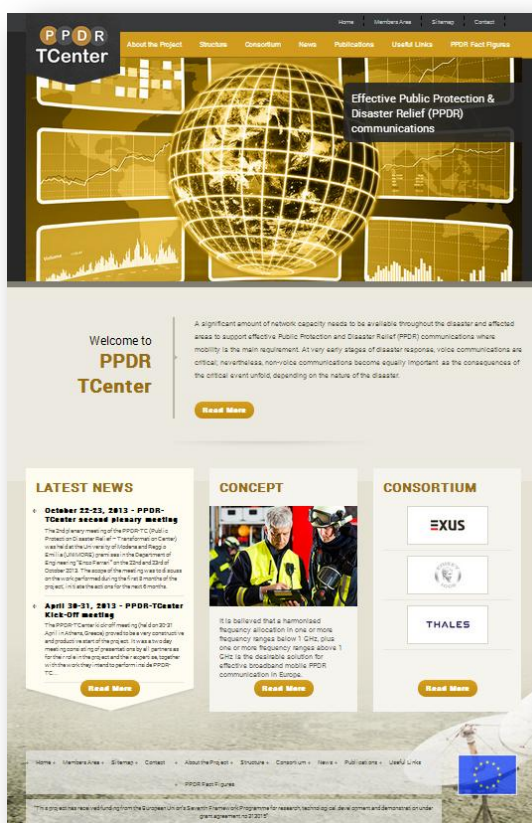


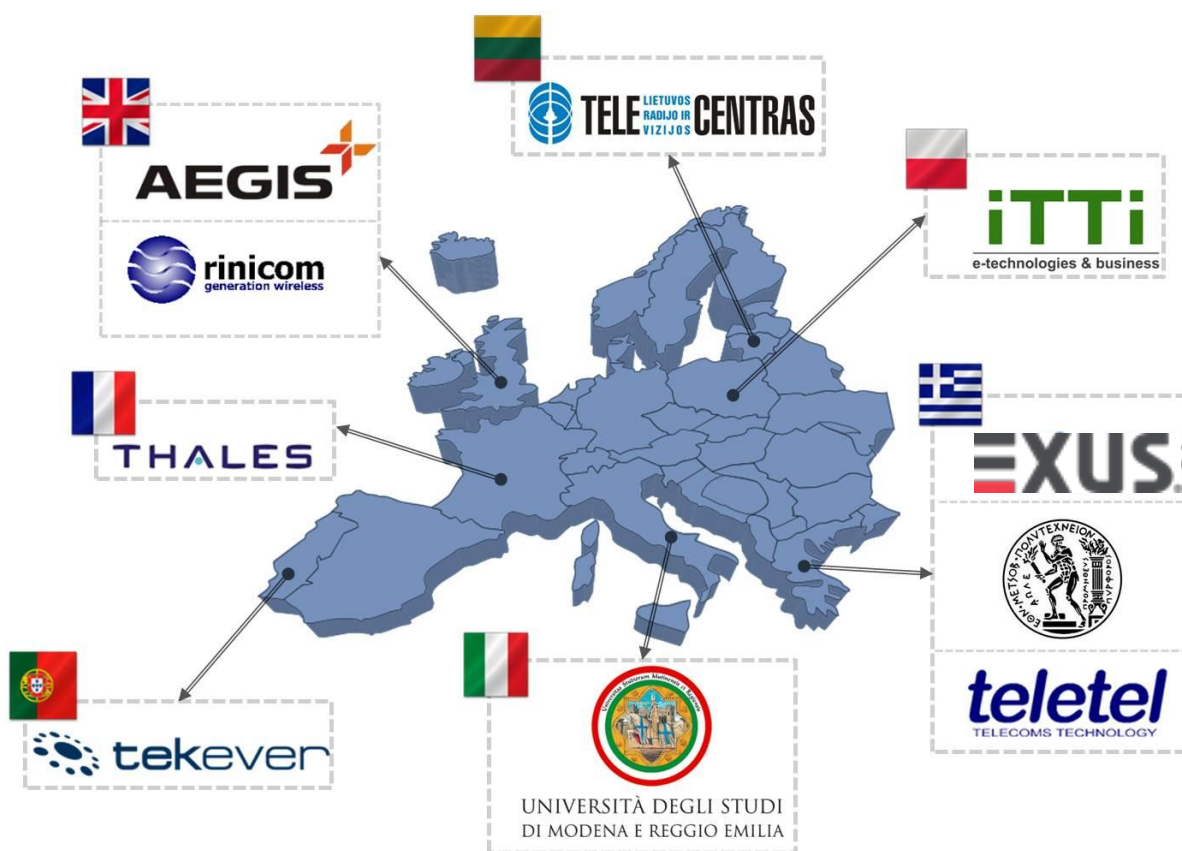


PPDR–TRANSFORMATION CENTER:
*“BUILDING THE ROADMAP FOR FUTURE
PPDR COMMUNICATION SYSTEMS
EVOLUTION”*

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Project full title:	Public Protection and Disaster Relief - Transformation Center
Call identifier:	FP7-SEC-2012.5.2-1
Programme Objective:	SEC-2012.5.2-1: Preparation of the next generation of PPDR communication network
Grant agreement no:	313015
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Start date:	April 1 st , 2013
Duration:	30 months
Coordinator:	EXUS S.A.



- To gather European PPDR facts and figures data.
- To define PPDR reference usage scenarios and identify service requirements and future needs in the European context.
- To implement a detailed study of the reference scenarios with a view to establishing service classification and identifying key technical issues.
- To identify candidate PPDR technologies and architectures.
- To develop validation tools for future PPDR.
- To derive technical recommendations on candidate technologies and architectures.
- To provide economical recommendations on candidate technologies and architectures.
- To provide a roadmap towards full satisfaction of future PPDR requirements and to develop recommendations for PPDR standards for decisions-makers.

- **PPDR-TC foresees to elaborate a holistic approach recommending future systems applied in critical events as well as normal work depending on end-users' requirements.**
- **The proposed solution will have few dimensions so it can be tuned by decision-makers to the size of each critical incident taking technical, financial, organisational and business constraints into account.**
- **The future PPDR systems will be designed in order to handle sensitive information and increase the level of citizen's security by strengthening cooperation among first responders in emergency situations.**

- Identification of current **PPDR status** and **requirements** for future PPDR users
- **Data synthesis** and **usage scenarios** development
- **Assessment** of current and emerging **Telecommunication Technologies**
- **Economical** and **political** implications of future PPDR development.



Recommendations for PPDR Roadmap

@M20 of the project we have:

- **Gathered** European PPDR facts and figures and established relevant DB
- **Defined** PPDR reference usage scenarios
- **Established** PPDR service classification
- **Analysed** the radio spectrum currently utilized by PPDR agencies around the world and the projected future needs for radio spectrum
- **Identified** several business models (with sub-models) presenting different approaches to set a PPDR system up and developed a tool for Technical, financial, economical and organizational analysis

- **Analysis of collected questionnaires from 24 PPDR organizations around Europe**
- **Analysis of major incidents and events** (eg. 2012 Emilia earthquake, Northern Italy, 2011 Great East Japan Earthquake and Tsunami, 2005 London Underground Bombings, 2012 London Olympics)
- **2011 studies for German government by BMWI, WIK and Aegis**
- **ECC Report 199, prepared by CEPT Project Team 49**
- **Hypothetical major incident scenario submitted to the US Federal Communications Commission by the New York City PPDR Authorities**
- **2011 Canadian Centre for Security Science study to identify 700 MHz spectrum requirements for PPDR Mobile Broadband Communications**
- **Other EU Framework Studies:**
 - HIT GATE (FP7-284940) - Heterogeneous Interoperable Transportable Gateway For First Responders
 - E-SPONDER (FP7-242411) - A Holistic Approach Towards The Development Of The First Responder Of The Future”
 - eVACUATE (FP7-313161) - A Holistic, Scenario-independent, Situation-awareness And Guidance System For Sustaining The Active Evacuation Route For Large Crowds

- **5 distinct communication requirements identified:**
 - Voice
 - Narrow Band Data (e.g. for messaging)
 - Broad Band Data (e.g. images or large files)
 - Video
 - Use of repeater stations to extend coverage or provide air-to-ground communication
- **Video and Image transmission identified as important in various scenarios**
 - Surveillance
 - Maintaining public order / safety at large events
 - Assisting treatment of casualties
 - Identification of suspects or vehicles
 - Situational awareness (e.g. during rioting or high speed pursuits)

MAIN OUTCOMES - HIGH LEVEL COMMUNICATION SCENARIOS

- **A:** Between a Central **Control Station** and **Field Personnel** at an Incident
- **B:** Between PPDR **Vehicles** and an Incident Location or Control Station
- **C:** Between Individuals **at an Incident**
- **D:** Between **Different PPDR Entities** (e.g. Police, Fire, Ambulance, Volunteers)
- **E:** Accessing **External Data** Sources (e.g. Internet)
- **F:** Communication in **Enclosed Spaces** (e.g. Tunnels Or Basements)
- **G:** Communication With **Remote Locations** (e.g. Mountains or at Sea)
- **H:** Communication with or between **Machines** (e.g. Remotely Controlled Vehicles)

- **Coverage**
 - Incomplete with significant black spots, especially indoors, underground or in remote areas.
 - Worse for data services
- **Lack of Interoperability**
 - At the technology and working protocol level
- **Resilience:**
 - At the network level (uninterruptable power supplies etc.) and terminals (e.g. need to be rugged and waterproof)
- **Reliance on public networks:**
 - Often unusable after major incidents due to congestion. Especially a problem for data transmission as not supported by most existing PPDR networks.

- **Video**
 - Applications include automatic number plate recognition, body worn cameras, portable CCTV deployments, surveillance, suspect identification, telemedicine and thermal imaging
- **Other data applications**
 - Breathing apparatus telemetry, vital signs monitoring, access to on-line forms and databases
- **Location services:**
 - Tracking of personnel, vehicles and other assets. Also electronic mapping services are increasingly used
- **Resilience and Backup:**
 - Multiple networks preferred (e.g. voice and data) to provide fall back if one fails.
- **Flexibility:**
 - Rapid provision of extra coverage or capacity when needed
- **Better interoperability** between different agencies and ICT systems

MAIN OUTCOMES - PPDR REQUIREMENTS MATRIX

Communication scenario	Application / Service																																																	
	1. A(V)LS data to CCC	2. A(V)LS data return	3. Video from/to CCC for following + intervention	4. Low quality additional feeds to APP3	5. Video for fixed observation	6. Low quality additional feeds to APP5	7. Video on location to and from control room - HQ	8. Video on location to and from control room - LQ	9. Video on location for local use	10. Video conferencing operations	11. Non real time recorded video transmission	12. Photo broadcast	13. Photo to selected group	14. PDA PIMsync	15. Mobile workspace (incl. public internet)	16. Incident information download from CCC to field	17. ANPR update hit list	18. Download maps with incl. information to field	19. Comm. & control incl. task manag. + briefings	20. Incident information upload to CCC	21. Status information + location	22. ANPR/speed control automatic upload to database	23. Forward scanned documents	24. Reporting incl. pictures, etc.	25. Upload maps + schemes with incl. information	26. Patient monitoring (ECC) snapshot to hospital	27. Patient real-time monitoring (ECC) to hospital	28. Monitoring status of security worker	29. Operational data base search (own + external)	30. Remote medical database services	31. ANPR checking number plate live on demand	32. Biometric (e.g., fingerprint) check	33. Cargo data	34. Crash Recovery System (asking info. on the spot)	35. Crash Recovery (update vehicles from database)	36. Software update online	37. GIS maps updates	38. Automatic telemetrics (remote devices + sensors)	39. Hotspot on disaster or event area	40. Front-office and back-office applications	41. Alarming / paging	42. Traffic management system	43. Connectivity of abroad assigned force to local CCC	44. UAS control applications	45. Sensors on site					
A: Between the CCC and PPDR personnel at the incident	✓	✓	✓	✓			✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
B: Between PPDR vehicles and the incident or the CCC	✓	✓	✓	✓			✓				✓	✓	✓	✓	✓	✓		✓	✓	✓			✓		✓					✓	✓	✓		✓	✓					✓	✓	✓	✓			✓	✓			
C: Between PPDR individuals at the incident	✓	✓							✓	✓	✓	✓	✓	✓	✓	✓			✓	✓			✓						✓												✓	✓	✓	✓						
D: Between different PPDR entities	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓														✓	✓	✓	✓	✓					
E: Accessing external data sources	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓		✓	✓	✓	✓							✓	✓													✓	✓	✓	✓	✓			
F: Communications in enclosed spaces	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓												✓	✓	✓	✓	✓	✓	✓	
G: Communications with remote locations	✓	✓					✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓				✓	✓												✓	✓	✓	✓	✓	✓	✓	
H: Communications with or between machines	✓	✓			✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓													✓	✓	✓	✓	✓	✓	✓

- **18 PPDR network solutions were analysed according to:**
 - Relevant players in the development and adoption
 - Standards development
 - Technical details
 - Requirements
 - Strengths and weaknesses for PPDR applications

Category	Network solution
Current PPDR technologies	TETRA Release 1
	TETRA Release 2
	TETRAPOL
	Analogue PMR
	Digital PMR
	DMR
	SATCOM
Public networks	CDMA2000
	GSM
	GPRS/EDGE
	UMTS
	HSPA/HSPA+
Candidate technologies for future PPDR applications	LTE (public/dedicated)
	Wi-Fi (public/dedicated)
	WiMAX
	MANETs
Transversal communication concepts	Software-Defined Radio
	Cognitive Radio

MAIN OUTCOMES - TECHNOLOGY GAPS

PPDR-TC Network Requirements	TETRA Release 1	TETRA Release 2	TETRAPOL	Analog-PMR	Digital PMR	DMR	SATCOM	CDMA 2000	GSM	GPRS/EDGE	UMTS	HSPA/HSPA+	LTE	Wi-Fi	WiMAX	MANETs
Users	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant
Coverage area	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Partially Compliant	Partially Compliant
Required network topology	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Fully Compliant
Node connectivity models	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Fully Compliant
Capacity in terms of type of data and required bandwidth	Partially Compliant	Partially Compliant	Partially Compliant	Not Compliant	Not Compliant	Not Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant
Mobility requirements	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Fully Compliant	Fully Compliant
Interoperability requirements	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant
Service availability, reliability and resilience	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Fully Compliant
Performance requirements	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Partially Compliant	Partially Compliant
Security	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Fully Compliant	Partially Compliant	Fully Compliant	Fully Compliant
Specific voice communication requirements	Fully Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant
Specific data communication requirements	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Partially Compliant	Fully Compliant	Fully Compliant	Partially Compliant	Fully Compliant	Fully Compliant

MAIN OUTCOMES - INTEROPERABILITY

	TETRA 1	TETRA 2	TETRAPOL	Analogue PMR	Digital PMR	DMR	SATCOM	CDMA2000	GSM	GPRS/EDGE	UMTS	HSPA/HSPA+	LTE	Wi-Fi	WiMAX	MANETs
TETRA 1	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
TETRA 2	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
TETRAPOL	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Analogue PMR	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Digital PMR	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
DMR	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
SATCOM	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
CDMA2000	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
GSM	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗
GPRS/EDGE	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗
UMTS	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗
HSPA	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗
LTE	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗
Wi-Fi	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗
WiMAX	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
MANETs	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Interoperability
in terms of
roaming

Interoperability
in terms of data
exchange

	TETRA 1	TETRA 2	TETRAPOL	Analogue PMR	Digital PMR	DMR	SATCOM	CDMA2000	GSM	GPRS/EDGE	UMTS	HSPA/HSPA+	LTE	Wi-Fi	WiMAX	MANETs
TETRA 1	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
TETRA 2	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
TETRAPOL	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Analogue PMR	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Digital PMR	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
DMR	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
SATCOM	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
CDMA2000	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
GSM	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗
GPRS/EDGE	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗
UMTS	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗
HSPA	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗
LTE	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗
Wi-Fi	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗
WiMAX	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗
MANETs	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

MAIN OUTCOMES – PPDR REFERENCE

SERVICE CLASSIFICATION

Service	Classification
Push-to-talk	Near-term evolution
Private call	Near-term evolution
Emergency/priority call	Near-term evolution
Call retention/busyqueuing	Near-term evolution
Direct mode operation	Near-term evolution
Ambience listening	Near-term evolution
Voice over the public switched telephone network	Near-term evolution
Area selection/dynamic group number assignment	Near-term evolution
Messaging and notifications	Near-term evolution
Low resolution photos	Near-term evolution
Location-based information	Near-term evolution
Extension of coverage	Near-term evolution
Extension of availability	Near-term evolution
Security tools	Near-term evolution
Group call	Mid-term evolution
Automatic telemetrics	Mid-term evolution
Mobile workspace applications (narrowband)	Mid-term evolution
Access to internal databases (narrowband)	Mid-term evolution
Access to external sources (narrowband)	Mid-term evolution
Rapid file transfer	Mid-term evolution
High resolution photos	Mid-term evolution
Mapping with geographic information system layers	Mid-term evolution
Mobile workspace applications (broadband)	Mid-term evolution
Access to internal databases (broadband)	Mid-term evolution
Access to external sources (broadband)	Mid-term evolution
Video transmission	Mid-term evolution
Video file transfer	Mid-term evolution
Video call	Mid-term evolution
Proximity services	Mid-term evolution
Augmented reality	Mid-term evolution
Remote operations	Long-term evolution

WHAT SPECTRUM IS REQUIRED FOR PPDR?

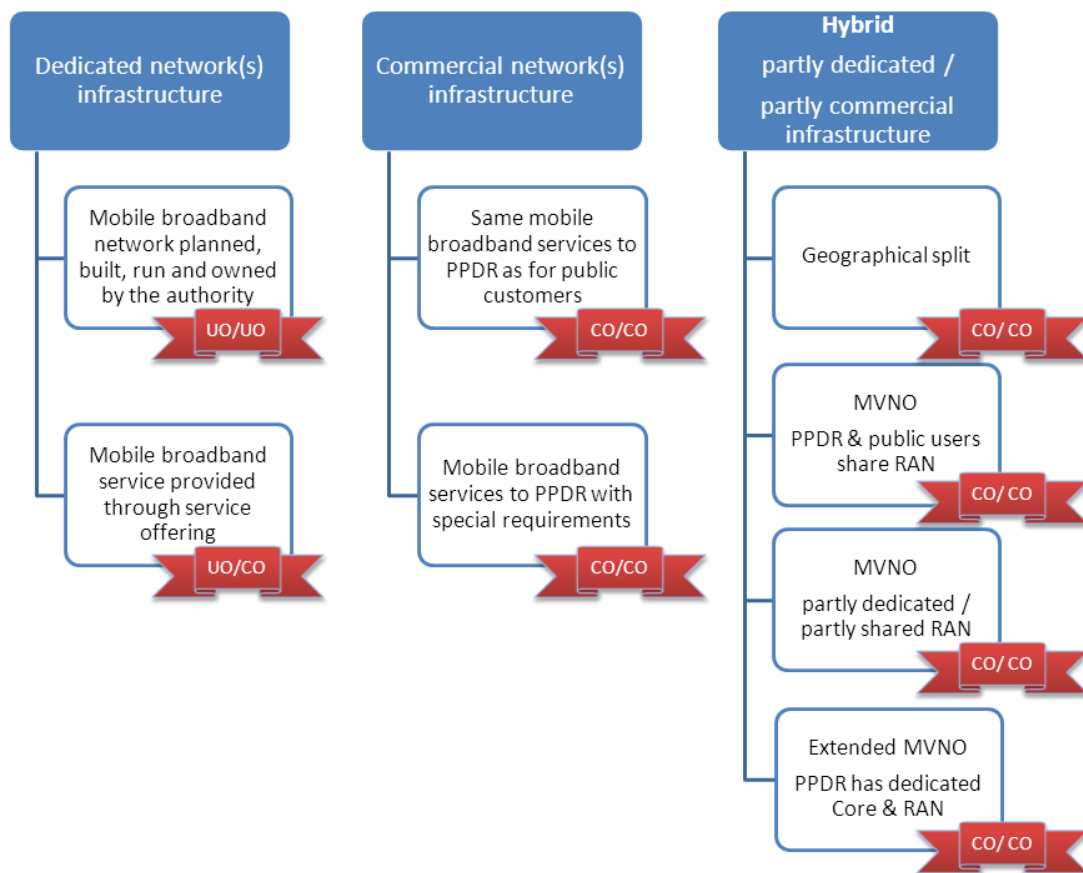
- **Wide area voice and messaging**, e.g. TETRA
- **Wide area broadband**, e.g. video
- **Local area communication**, including:
 - Extending coverage of wide area networks
 - Direct communication between terminals (DMO)
 - Ad-hoc local area networks
- **Air to ground communications (A2G)**, e.g. helicopters
- **Satellite communications**, e.g. for remote areas and disaster recovery
- **Fixed links**, e.g. network backhaul or temporary links

- Only fully **harmonised** band is **380-400 MHz** – only half of this is available (2x5 MHz) and is used mainly by **TETRA/TETRAPOL**
- Some specific frequencies in this band set aside for **DMO** and **A2G**
- Many countries still have **analogue** systems operating in a variety of VHF and UHF bands (68 – 470 MHz)
- Some countries already have specific bands identified for **broadband PPDR** (e.g. video links) – main bands are **2.3 GHz** and **3.5 GHz** but precise frequencies vary
- CEPT has attempted to harmonise spectrum around 5 GHz (**4940-4990 MHz** and **5150-5250 MHz**) for **local area broadband PPDR**, but few countries have taken this up
- Existing international bands used for **satellite** and **fixed links** (generally shared with other users)

CONCLUSIONS IN SPECTRUM REQUIREMENTS

- Growing global consensus that additional spectrum is required for BB PPDR (already implemented in some countries outside EU)
- Should comprise low frequency (<1 GHz) for WAN and higher (e.g. 4940-4990 MHz) for WLANs
- 700 MHz strongly favoured for BB WAN – ECC PT49 has proposed 2x5 MHz dedicated band plus additional from adjacent mobile band where needed
- Also need spectrum for specialist apps like DMO and A2G
 - 700 MHz centre gap / 2.3 GHz / 3.5 GHz?
- BB LANs should use existing allocations around 5 GHz
- Other potential bands of interest include
 - 3G unpaired bands (1900-1920/2010-2025 MHz)
 - 3G satellite bands (1980-2010/2170-2200 MHz)
- Will still need 400 MHz for narrow band for some time

BUSINESS MODELS



a) User Owned – User Operated (UO-UO): Building, ownership & operation of the network(s) by the end-user agency (or agencies) themselves.

b) User Owned – Commercial Operated (UO-CO): Build & ownership of the network(s) by the end-user agency (or agencies). Operation of the network(s) by a commercial provider of outsourced managed network services.

c) Commercial Owner – Commercial Operated (CO-CO): User agencies subscribe for services provided by a commercial network owner / operator.

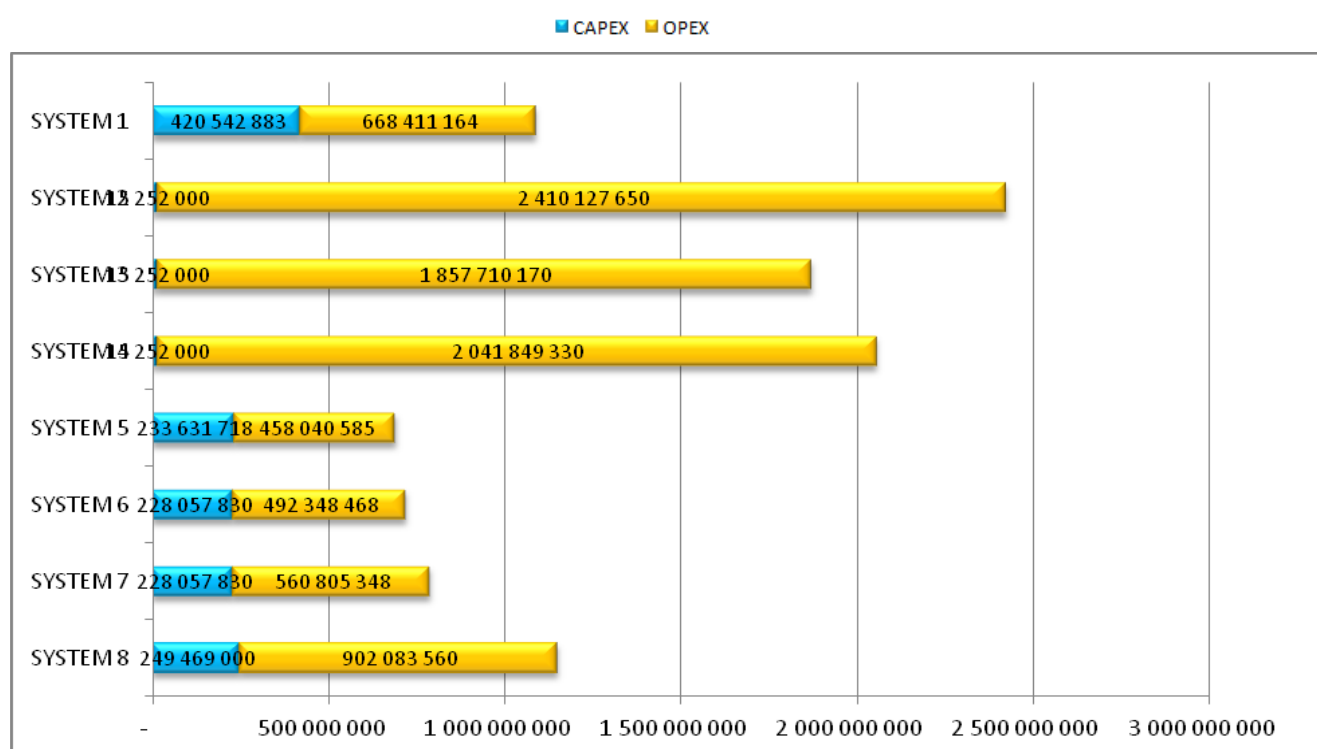
MODEL BENCHMARKING – ASSUMPTIONS (1)

	Scenario 1.1 Mobile broadband network planned, built, run and owned by the authority	Scenario 1.2 Mobile broadband service provided through service offering	Scenario 2.1 Same mobile broadband services to PPDR as for public customers	Scenario 2.2 Mobile broadband services to PPDR with special requirements	Scenario 3.1 Geographical split between dedicated and commercial network infrastructure	Scenario 3.2 MVNO where PPDR share RAN with the public users	Scenario 3.3 MVNO with partly dedicated / partly shared RAN network	Scenario 3.4 Extended MVNO
1st technology	TETRA	TETRA	TETRA	TETRA	TETRA	TETRA	TETRA	TETRA
financing model	own	leased	leased	leased	own	own	own	own
operation model	own	outsourcing	outsourcing	outsourcing	own	own	own	own
2nd technology	LTE	LTE	LTE	LTE	LTE	LTE	LTE	LTE
financing model	own	leased	leased	leased	leased	leased	leased	leased
operation model	own	outsourcing	outsourcing	outsourcing	outsourcing	outsourcing	outsourcing	outsourcing
3rd technology	WiMAX	WiMAX	WiMAX	WiMAX	WiMAX	WiMAX	WiMAX	WiMAX
financing model	own	leased	leased	leased	own	leased	leased	leased
operation model	own	outsourcing	outsourcing	outsourcing	own	outsourcing	outsourcing	outsourcing
area	312 000	312 000	312 000	312 000	312 000	312 000	312 000	312 000
number handheld terminals								
1st technology	100000	100000	100000	100000	100000	100000	100000	60000
2nd technology	0	0	0	0	0	0	0	60000
3rd technology	0	0	0	0	0	0	0	
number of other terminals								
1st technology	1000	1000	1000	1000	1000	1000	1000	1000
2nd technology	6000	6000	6000	8000	6000	6000	6000	6000
3rd technology	4000	4000	4000	2000	4000	4000	4000	4000
number of base station								
1st technology	533	533	533	533	533	533	533	533
2nd technology	4803	4803	2882	4 803	2882	2882	2882	2882
3rd technology	533	533	320	533	213	213	213	213

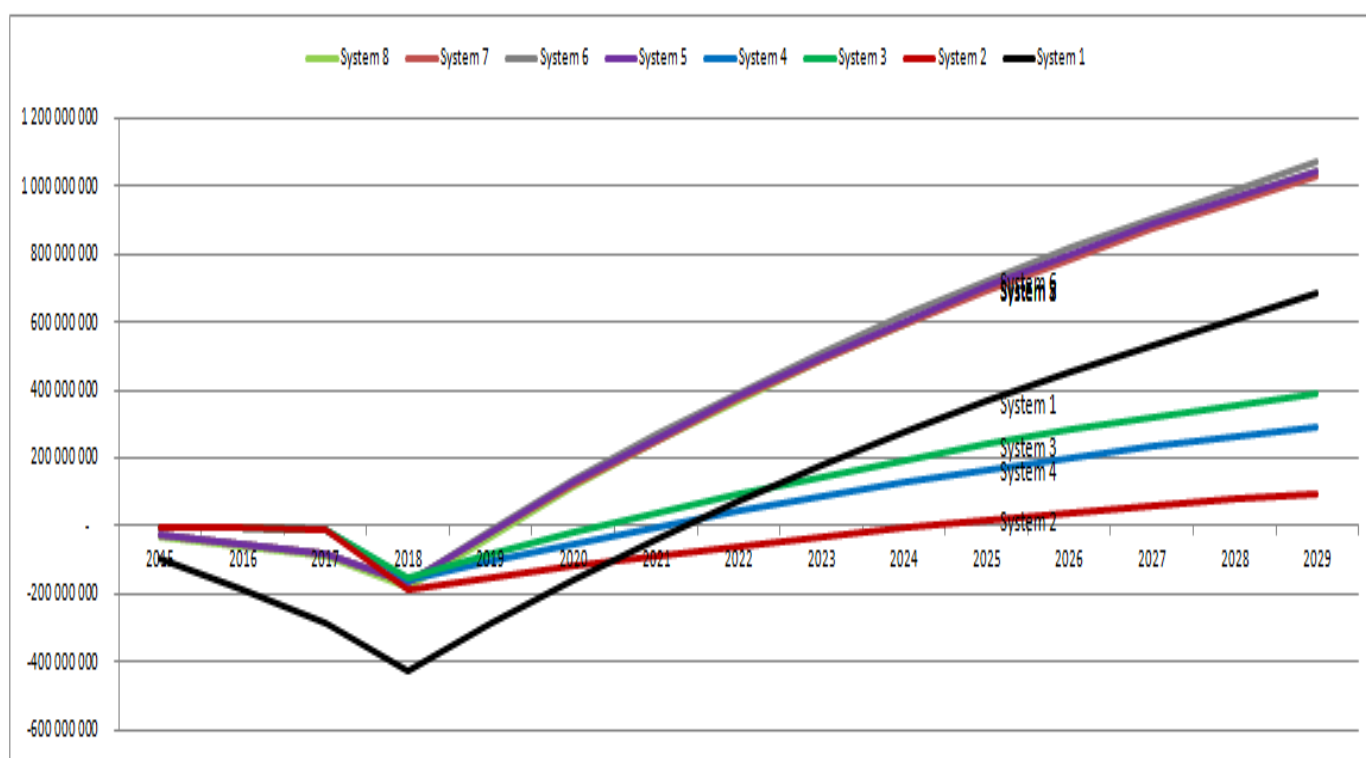
MODEL BENCHMARKING – ASSUMPTIONS (2)

	Scenario 1.1 Mobile broadband network planned, built, run and owned by the authority	Scenario 1.2 Mobile broadband service provided through service offering	Scenario 2.1 Same mobile broadband services to PPDR as for public customers	Scenario 2.2 Mobile broadband services to PPDR with special requirements	Scenario 3.1 Geographical split between dedicated and commercial network infrastructure	Scenario 3.2 MVNO where PPDR share RAN with the public users	Scenario 3.3 MVNO with partly dedicated / partly shared RAN network	Scenario 3.4 Extended MVNO
number of national NOCs	1	1	1	1	1	1	1	2
number of regional NOCs	16	16	16	16	16	16	16	16
number of dispatchers centers	380	380	380	380	380	380	380	380
number of mobile switches	17	17	17	17	17	17	17	18
percentage of existing masts	20%	20%	20%	20%	20%	20%	20%	20%
percentage of masts to be built	50%	50%	50%	50%	50%	50%	50%	50%
percentage of masts to lease	30%	30%	30%	30%	30%	30%	30%	30%
number of external systems cooperation	2	2	2	2	2	2	2	2
number of gateways	4	4	4	4	4	4	4	4
number of radio links in WAN network	1814	1814	1814	1814	1814	1814	1814	1814
length of leased backbone network	39700	39700	39700	39700	39700	39700	39700	39700
changes assumption	no changes	no changes	leased cost: TETRA: 50/75 LTE: 50/75 WiMAX: 75 outsourcing cost: 45/45/45	leased cost: TETRA: 50/75 LTE: 50/75 WiMAX: -/75 outsourcing cost: 55/55/55	leased cost: LTE: 50/75 outsourcing cost: LTE: 45	leased cost: LTE: 50/75 WiMAX: -/75 outsourcing cost: LTE: 45 WiMAX: 45	leased cost: LTE: 50/120 WiMAX: 120 outsourcing cost: LTE: 45 WiMAX: 45	leased cost: LTE: 50/80 WiMAX: -/80 discount for 1st, 2nd, 3rd technologies: 0%

MODEL BENCHMARKING – CAPEX/OPEX



MODEL BENCHMARKING – ENPV



- **Simulate, validate and optimize** the reference PPDR system architectures in terms of performance, resilience, interoperability and spectrum flexibility
- **Provide** technical recommendations
- **Provide** economical recommendations
- **Propose** a migration path towards full compliance to PPDR requirements

THANK YOU FOR YOUR ATTENTION

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