Spectrum Management Issues in Emergency Telecommunications

Srdjan Mihaljevic
CTO TAS

Emergency Spectrum bands

Band	Sub-band	Frequency	Wavelength
HF		3-30 MHz	decametric waves
VHF		30-300 MHz	metric waves
	Low Band VHF	30-50 MHz	
	Mid band VHF	72-75 MHz	
	High Band VHF	138-174 MHz	
	220 MHz	216-220 MHz	
UHF		300-3000 MHz	decimetric waves
	450 MHz	420-470 MHz	
	700 MHz	758-768, 788-798 MHz IMT 769-775 , 799-805 MHz NB 806-824 MHz	
	800 MHz	851-869 MHz	
SHF		3-30 GHz	centimetric waves
	4.9 GHz	4 940-4 990 MHz	

HF Propagation

- Ground-Wave Propagation
- Sky-Wave Propagation

HF Ground-Wave Propagation

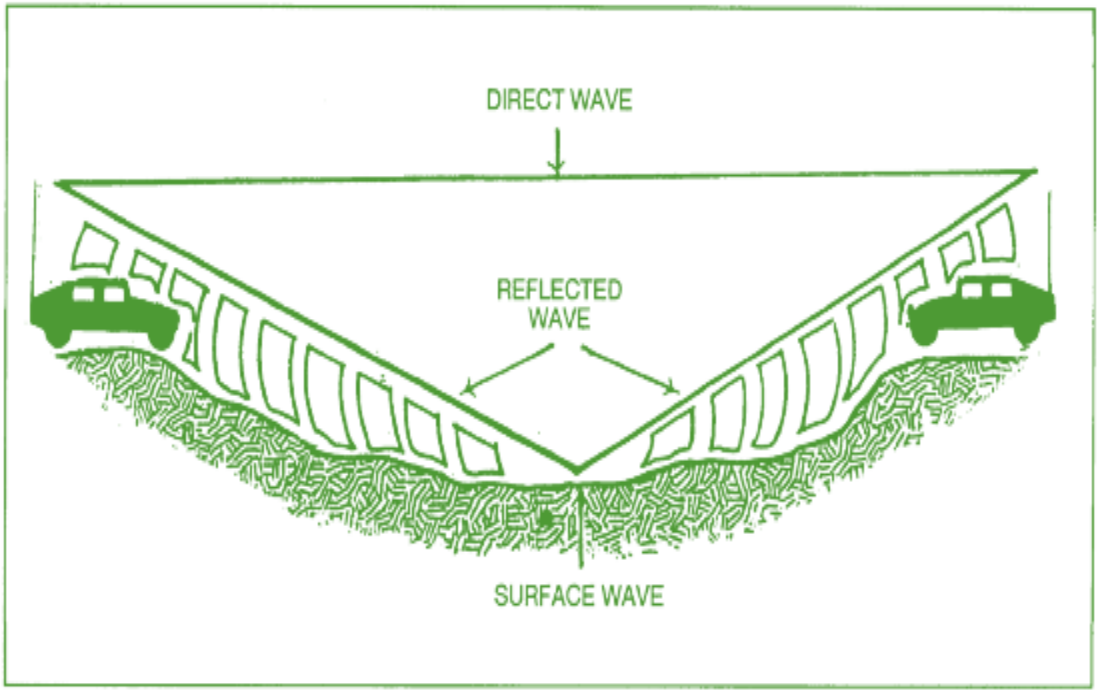


Figure D-2. Components of ground wave.

HF Sky-Wave Propagation

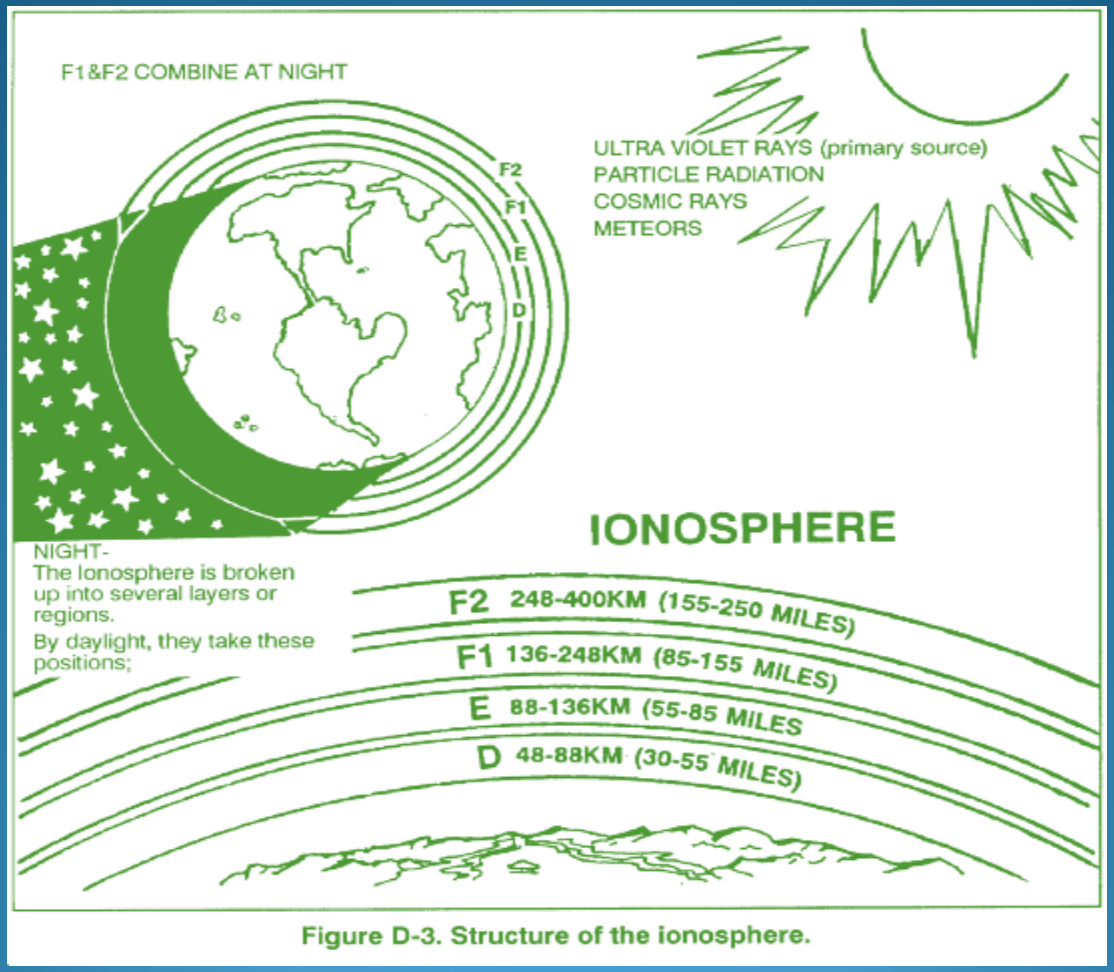


Figure D-3. Structure of the ionosphere.

HF NEAR-VERTICAL INCIDENCE SKY-WAVE EFFECT

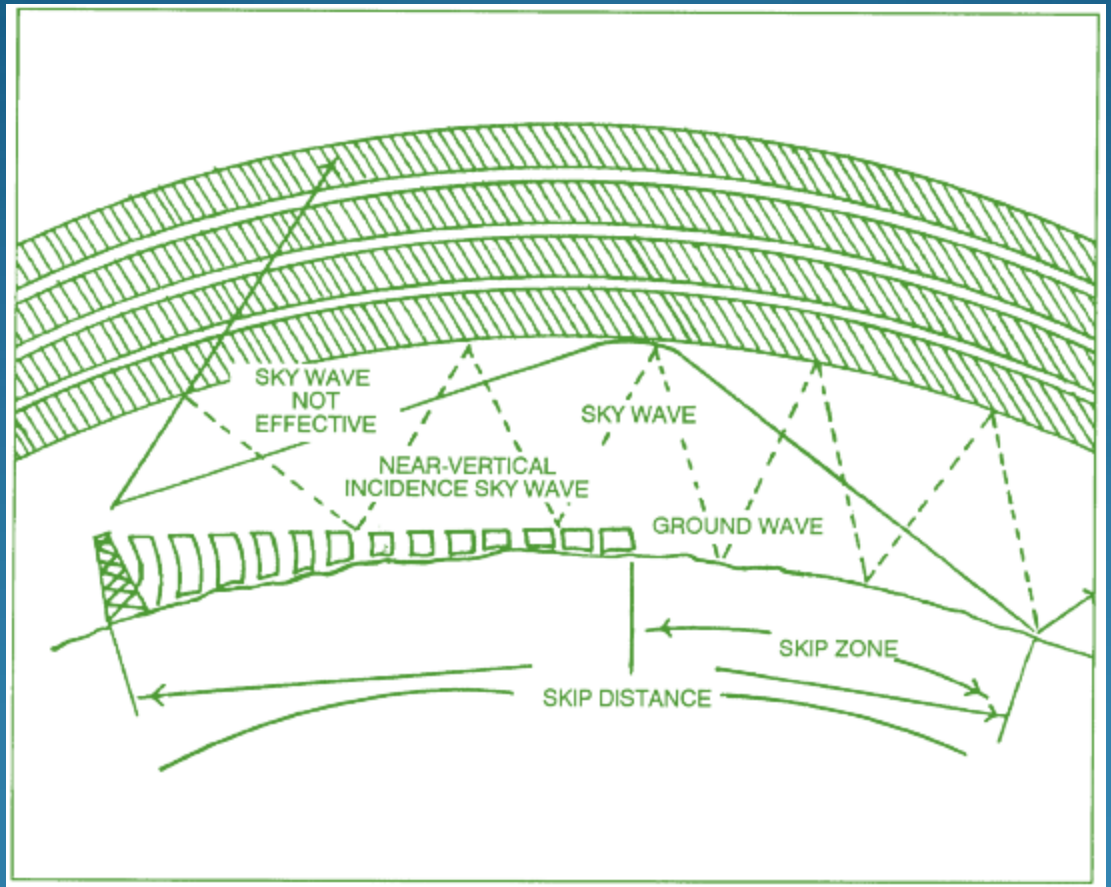


Figure D-4. HF skip zone and use of NVIS.

ANTENNA

- Wavelength and Frequency
- Resonance
- Polarization
- Classification

POLARIZATION

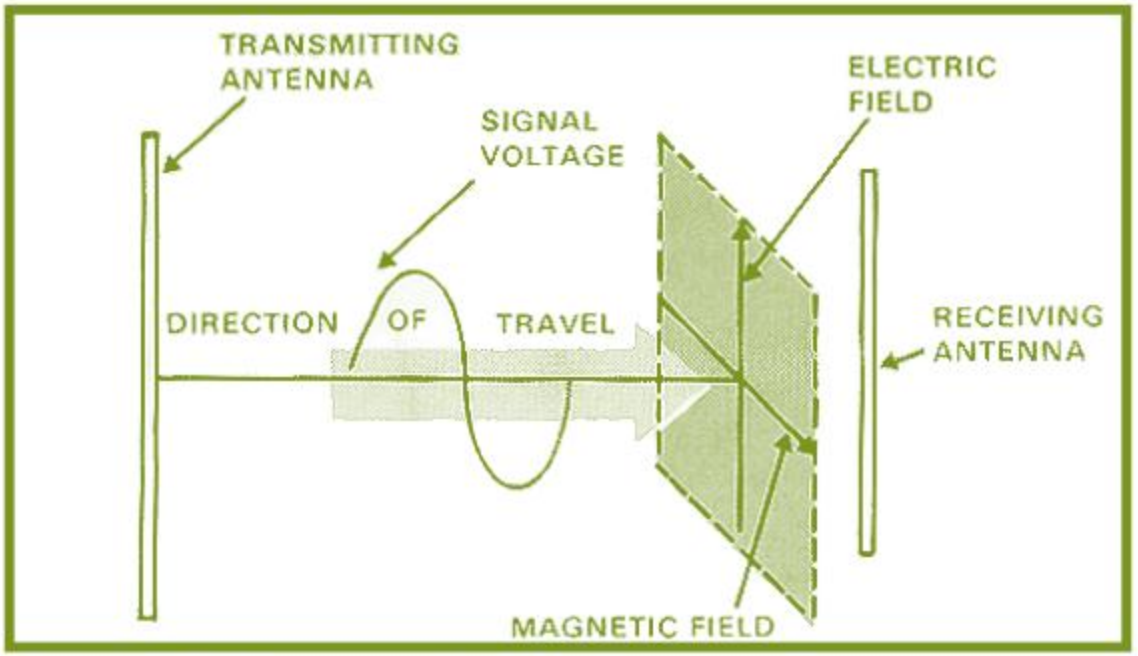


Figure 3-2. Components of electromagnetic waves.

V,H & C POLARIZATION

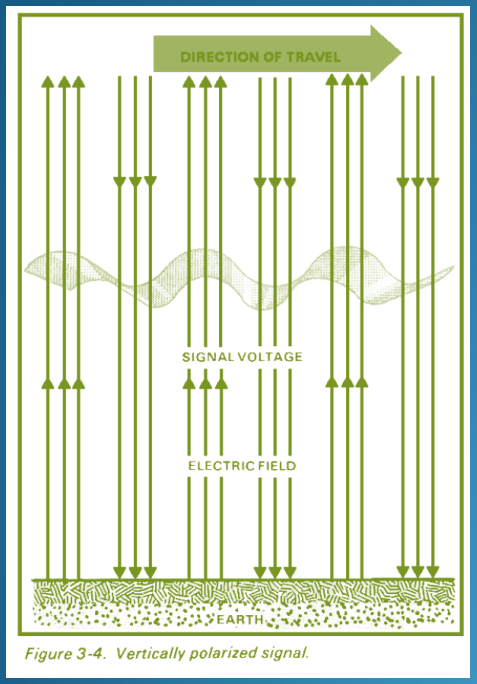


Figure 3-4. Vertically polarized signal.

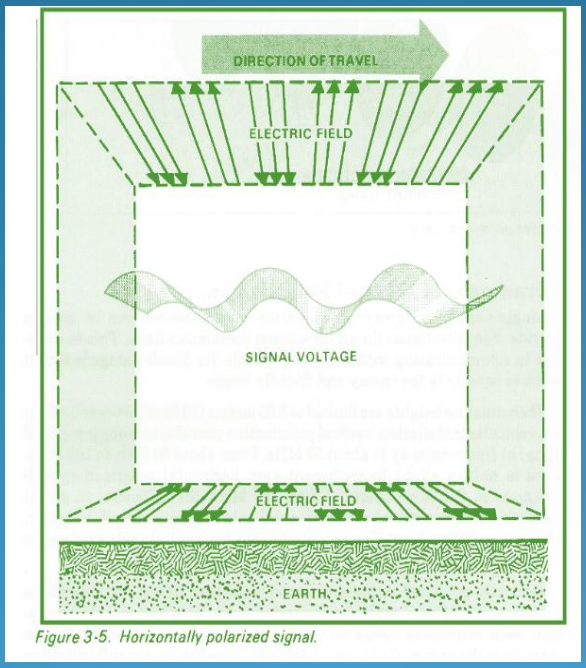


Figure 3-5. Horizontally polarized signal.

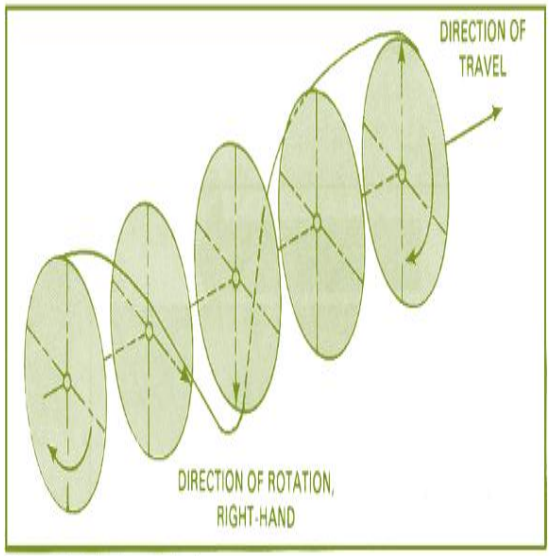


Figure 3-6. Circular polarized wave.

ANTENNA CLASSIFICATION

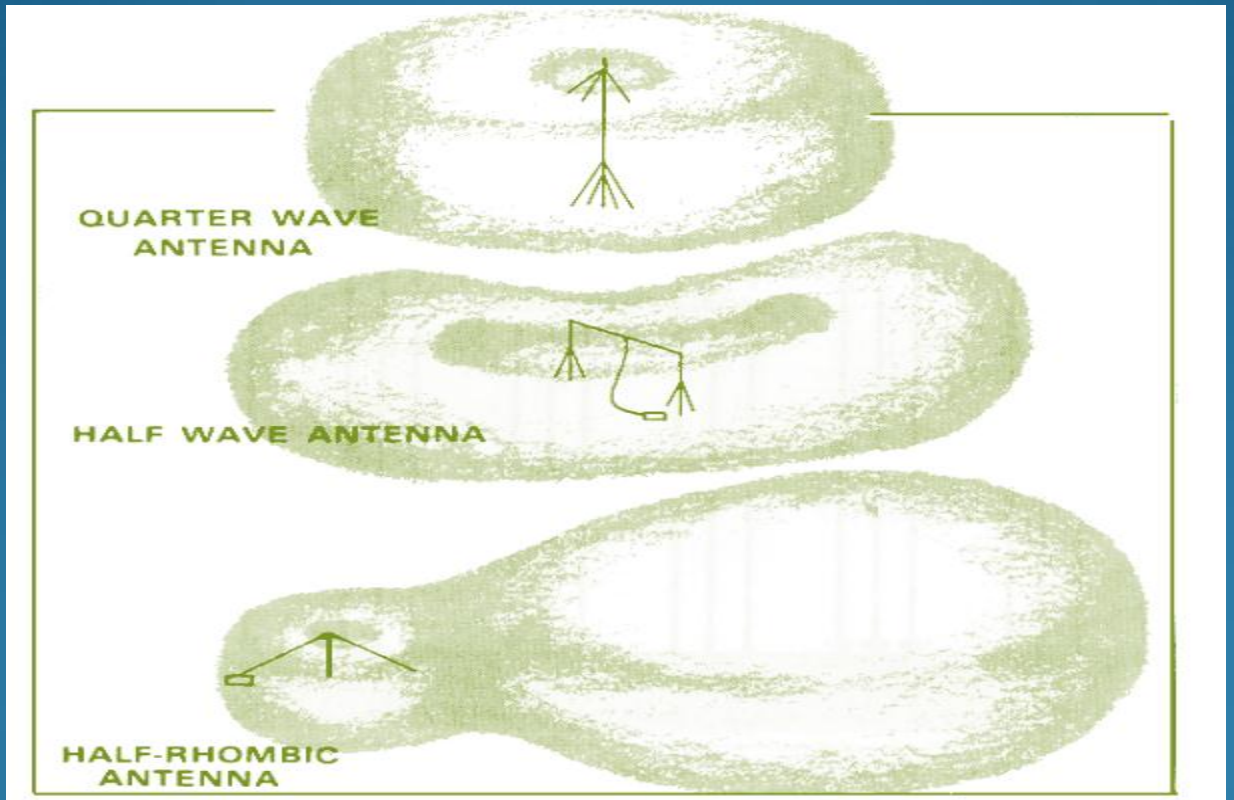


Figure 3-3. Solid radiation patterns from quarter-wave, half-wave, and vertical half-rhombic antennas.

ANTENNA GROUND EFFECTS

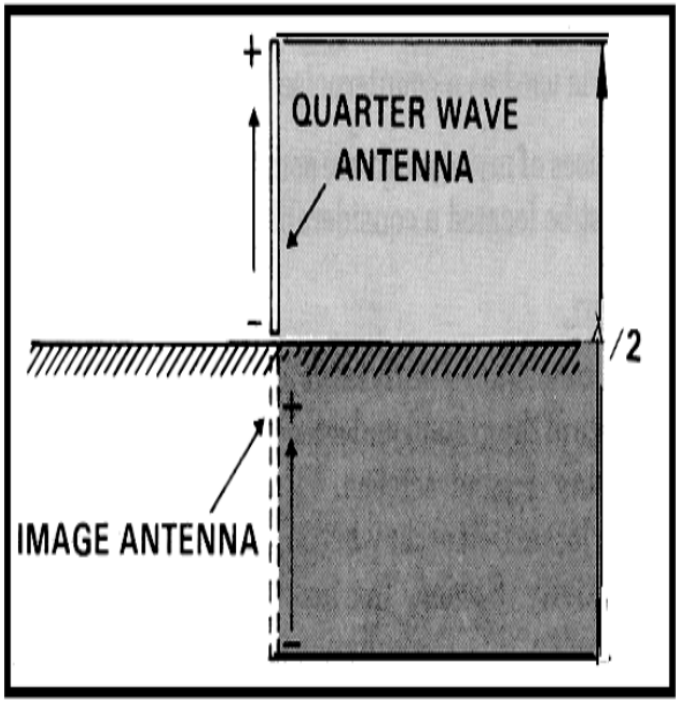


Figure 3-7. Quarter-wave antenna connected to ground.

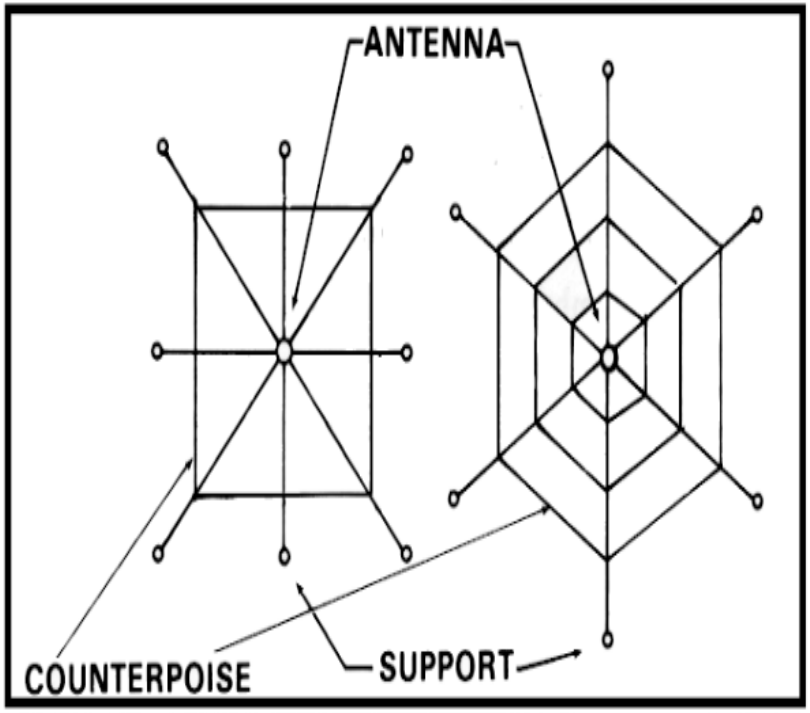


Figure 3-8. Wire counterpoise.

HF band (3 155 kHz -30.01 MHz)

- Short Wave – SW (100 m – 10 m)
- oil pipeline, public safety, airlines
- 30 km – low-powered, man-pack
- 100 km – high-powered vehicle
- thousands in cases of skip
- one day may work and not the next

HF band

- 11- year sunspot cycle
- peak year 2012 – interference high
- limited number of manufacturers
- cost premiums
- similar equipment on both sides
- minimum power to maintain comm.

HF band - antenna

- antenna systems are large
- ¼ wavelength radiator – 50 m
- Marconi antenna – very tall
- Hertz antenna – extend many m
- not easy to move
- 250,000 $ multi-frequency rotatable

HF band - concerns

- Low loss of transmission lines
- Power-handling capability of line
- RFI can travel over very great distances
- link budget – no prediction
- No formula for propagation – daily
- Coverage is spotty – day-to-day basis
- Noise floor will and can be heard 1000

HF band - conclusion

- Licensing – few restrictions
- No data and non-voice comm.
- Only available medium for tragedies
- Predominant among first responders
- Price are now decreasing
- Size of equipment limitations
- Best range – few sites – backup for all

Low band VHF (30-50 MHz)

- Coverage of very large geographic area
- A minimum use of tower sites
- Limited equipment availability
- Signal can travel up to 200 km and still be useful
- Skip => 1000 km stronger signal than 20 km away
- Power range 100-watt
- No walkie-talkie radios
- Antennas ~3 m long or loading coil to shorten
- Little loss in transmission lines => smaller lines

Low band VHF concerns

- RF interference → impulse-type noise
- Electrical contacts making or breaking - arcing
- Automotive distributors and spark plugs
- Thunderstorms within 200 km from a system
- Radio planning without problems except intrf.
- Very few new low-band systems
- Data and non-voice comm. are limited
- Licensing is usually very easy

Mid band VHF 72-75MHz

- Generally used to connect fixed up to 200 km
- only base stations allowed – no subscribers
- Restricted - TV channels 4 and 5 are neighbors
- The ERP levels from 25 - 100 W
- The antennas are Omni directional or directional
- Large antenna but slightly shorter than LB VHF
- Little loss in transmission lines => smaller lines
- Backhaul link between stations and other FX

Mid band VHF concerns

- Limited number of users - protection TV
- RF interference little except skip
- Link budget predictable
- It is intended for distance 120-200 km
- Noise floor is low
- Licensing is relatively easy – low demand
- Data and non-voice comm. are allowed
- Mainly use for voice traffic

High Band VHF (148-172 MHz)

- The most popular band for LMR use
- Excellent range, propagation characteristics
- Availability of low cost equipment
- Ideal for urban and rural environments
- Predominant band for public safety
- Trunking, data and other non-voice traffic
- All power levels
- All types of antenna configurations and rather large
- The signal loss in the transmission lines is acceptable

High Band VHF Concerns

- The potential for RF interference is big problem
- Lightning, static discharge, and man-made issues
- The very large number of VHF stations – high NF
- Almost every electrical device -> interference
- The electrical noise found on many building tops
- The licensing of VHF systems is difficult
- Long coverage range and crowding
- Narowbanding 25 kHz to 12.5 kHz and 6.25 kHz.

220 MHz (216-220 MHz)

- Unpopular for most users
- There are power, height, and other restrictions
- The lack of low-priced equipment
- Similar to HF band
- No base antennas above 150 m
- Marketplace's reluctance - peripheral equipment
- Antennas are large
- Mobile & portable not available
- Primarily for telemetry by the utility
- Also for transportation industries.

UHF band (380-470 MHz)

- Represent best of both world
- Absolutely perfect for use in urban environments,
- Conventional, trunking and networked systems
- Very large areas of communication coverage
- The variety of equipment and the good range
- Well-suited for almost every application
- very broad range of choices for antennas
- range of transmission lines and other design

UHF band - concerns

- RFI from other systems
- Link budget and coverage are very accurate
- building penetration exceptional
- Signal is mostly LOS but also more
- The narrowbanding is requirement
- Intermodulation is concern
- Trunked system – intermodulation pairings
- Mitigation by proper filtering

UHF band trunking

- South America - for European TETRA (TDMA)
- 380-385 MHz and 390-395 MHz – emergency sys.
- 385-390 MHz and 395-400 MHz – civil systems
- 410-430 MHz and 450-460 MHz - civil systems
- GOTA systems which is based on CDMA 450

700 MHz

- 15 years for public safety
- Digital dividend
- RF coverage in this band is excellent
- There are two separate types of channels for 700
- Broadband allocation of 20 MHz for IMT
- Narrowband allocation of 12 MHz (6.25kHz)
- 769- 775 and 799-805 MHz
- Abundance of equipment with advanced features

800 MHz & 900 MHz

- Line of sight – urban and suburban areas
- Rural rarely – many towers
- Wideband conventional and trunking systems
- 900 MHz extension of 800 MHz
- all band can be mixed to accommodate fleet

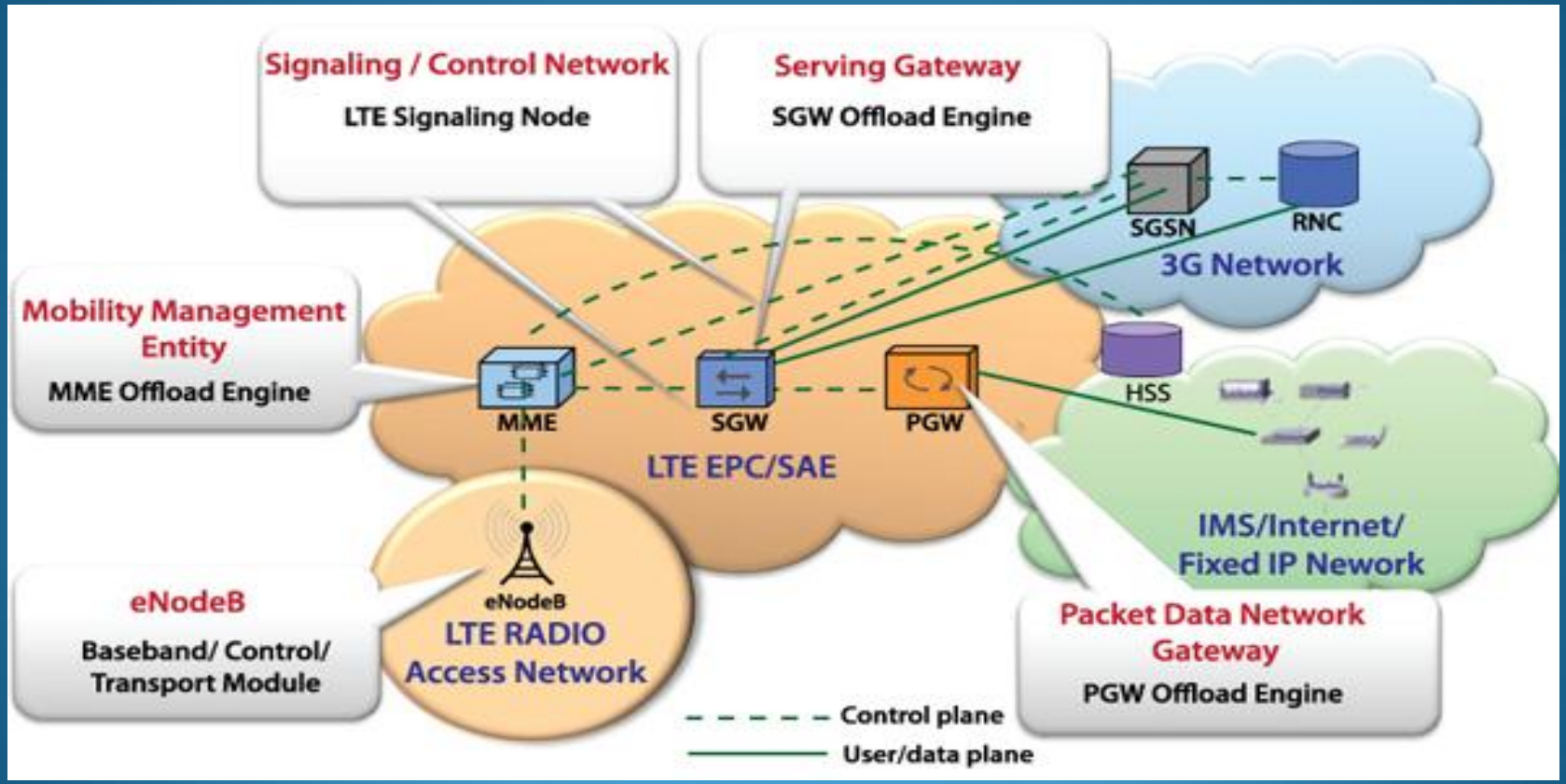
4.9 GHz

- public safety
- Base, mobile or portable operations anywhere
- there are no regulated individual channels
- co-ordination obligatory between users
- video and high-bandwidth data
- backhaul
- Utilities

IMT
A TRANSITION IS UNDERWAY IN EMEREGENCY COMMUNICATIONS

- Emergency responders
- Enhanced awarenes
- PPDR industry

IMT STANDARD NETWORK COMPONENTS



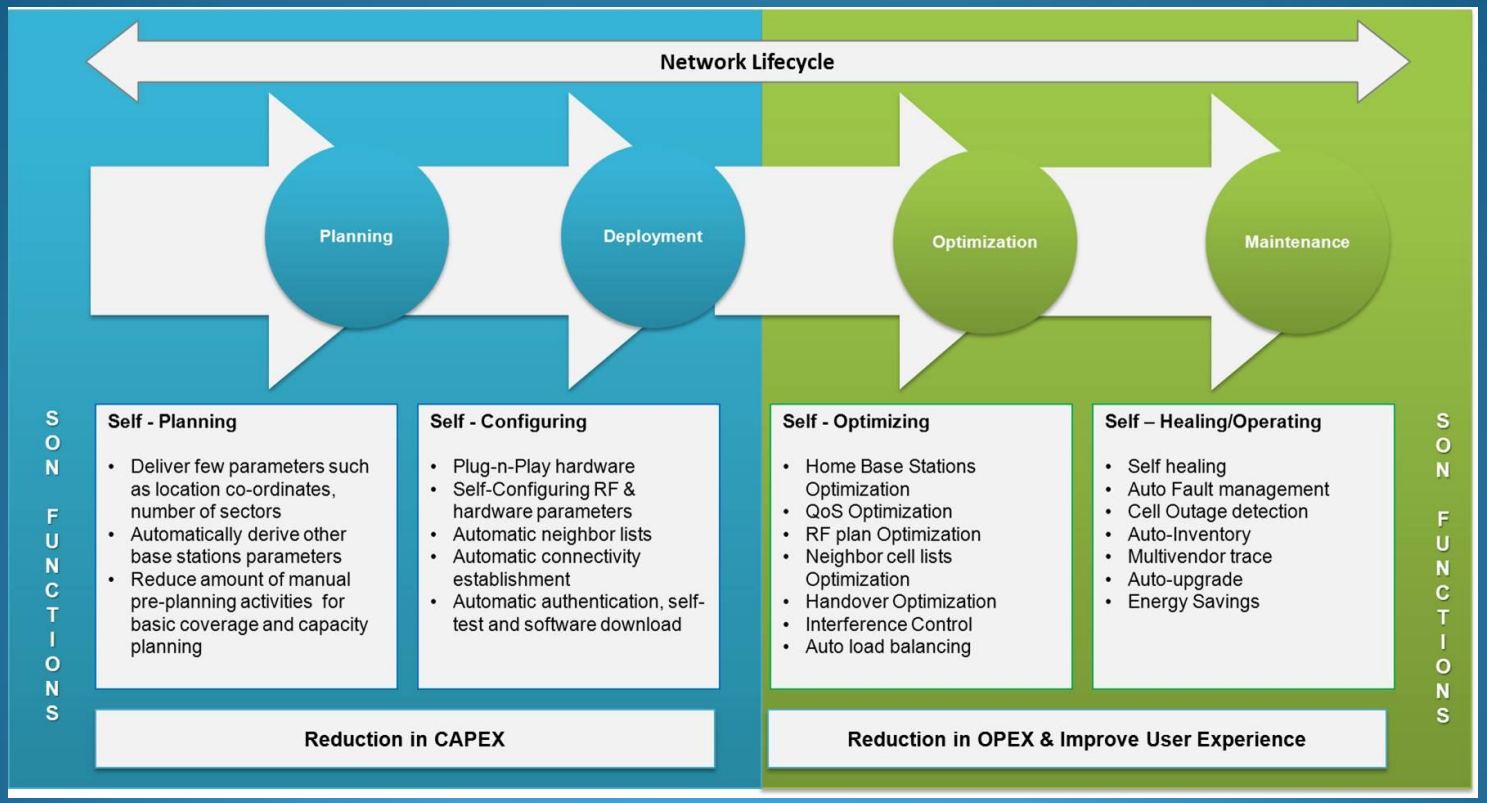
IMT TERMINALS

Car
modem

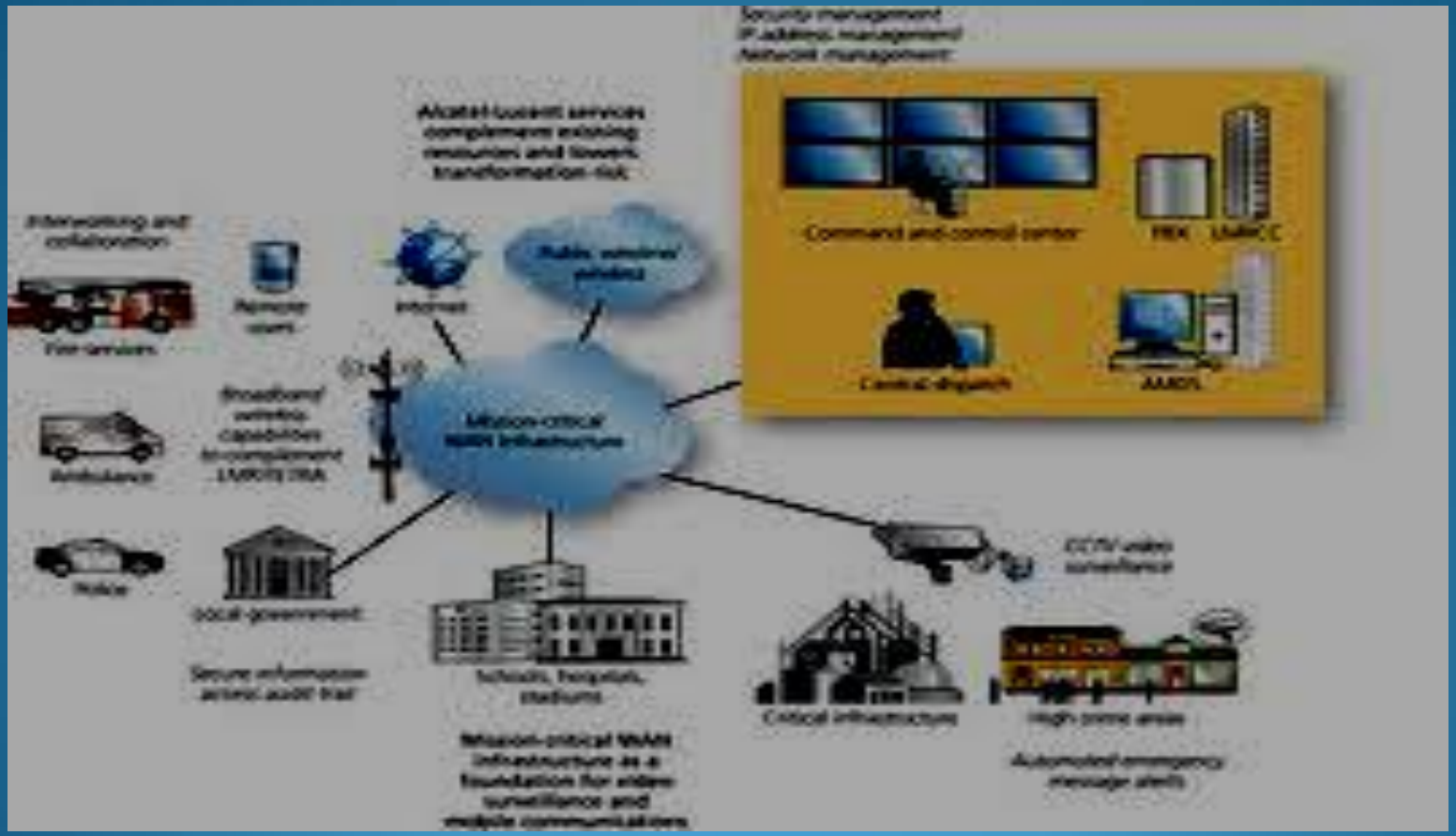
Embedded modules

Handheld computers

IMT NETWORK AVAILABILITY AND MONITORING



IMT SOLUTION IN PRACTICE



IMT APPLICATIONS

IMT SERVICES

IMT for PPDR questions:

- Application range
- Role of video in UL and DL
- Type of terminals
- Profile of users
- Sharing of network
- QoS

Resolution 646 (Rev. WRC-12)

Public protection and disaster relief

ITU								
Region 1	380-385	390 -395						
Region 2					746-806	806-869	4940-4990	
Region 3			406.1-430	440-470		806-824	4940-4990	5850-5925

BAND FOR IMT APPLICATION

Rec. ITU-R M.1036-4 (03/12)

Band (MHz)	Footnotes identifying the band for IMT
450-470	5.286AA
698-960	**5.313A, 5.317A**
1 710-2 025	5.384A, 5.388
2 110-2 200	5.388
2 300-2 400	5.384A
2 500-2 690	5.384A
3 400-3 600	5.430A, 5.432A, 5.432B, 5.433A

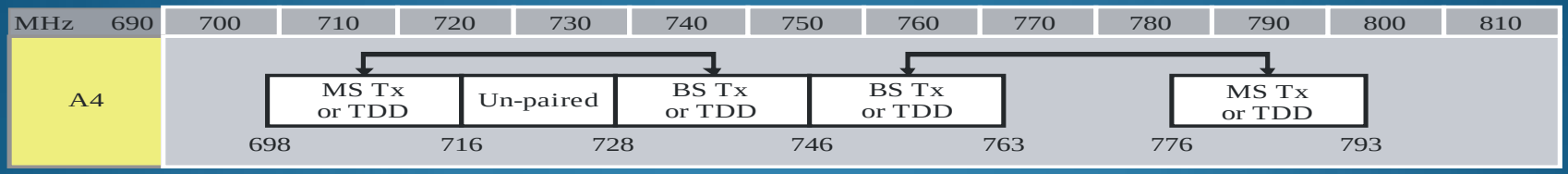
Frequency arrangement for PPDR using IMT

- PPDR Systems are outside of scope of Rec. ITU-R M.1036-4
- Large coverage area and possible interoperabilities 700/800

Frequency arrangements in the band 698-960 MHz

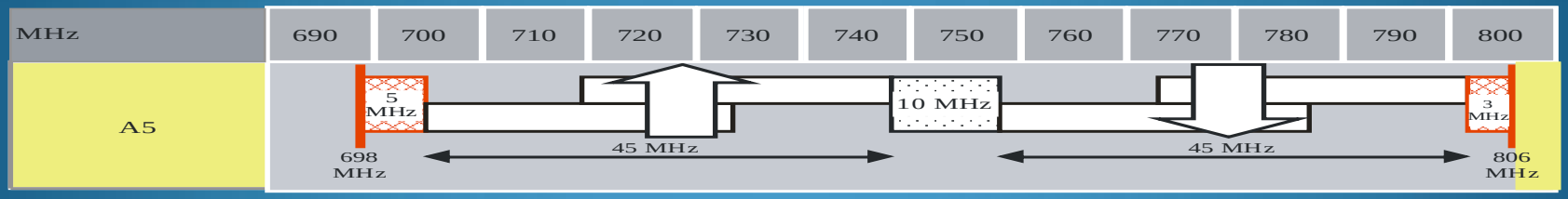
Frequency arrangements	Paired arrangements				Un-paired arrangements (e.g. for TDD) (MHz)
	Mobile station transmitter (MHz)	Centre gap (MHz)	Base station transmitter (MHz)	Duplex separation (MHz)	
A4	**698-716** **776-793**	**12** **13**	**728-746** **746-763**	**30** **30**	**716-728**
A5	703-748	10	758-803	55	None
A6	None	None	None		698-806

IMT Arrangement in Region 2



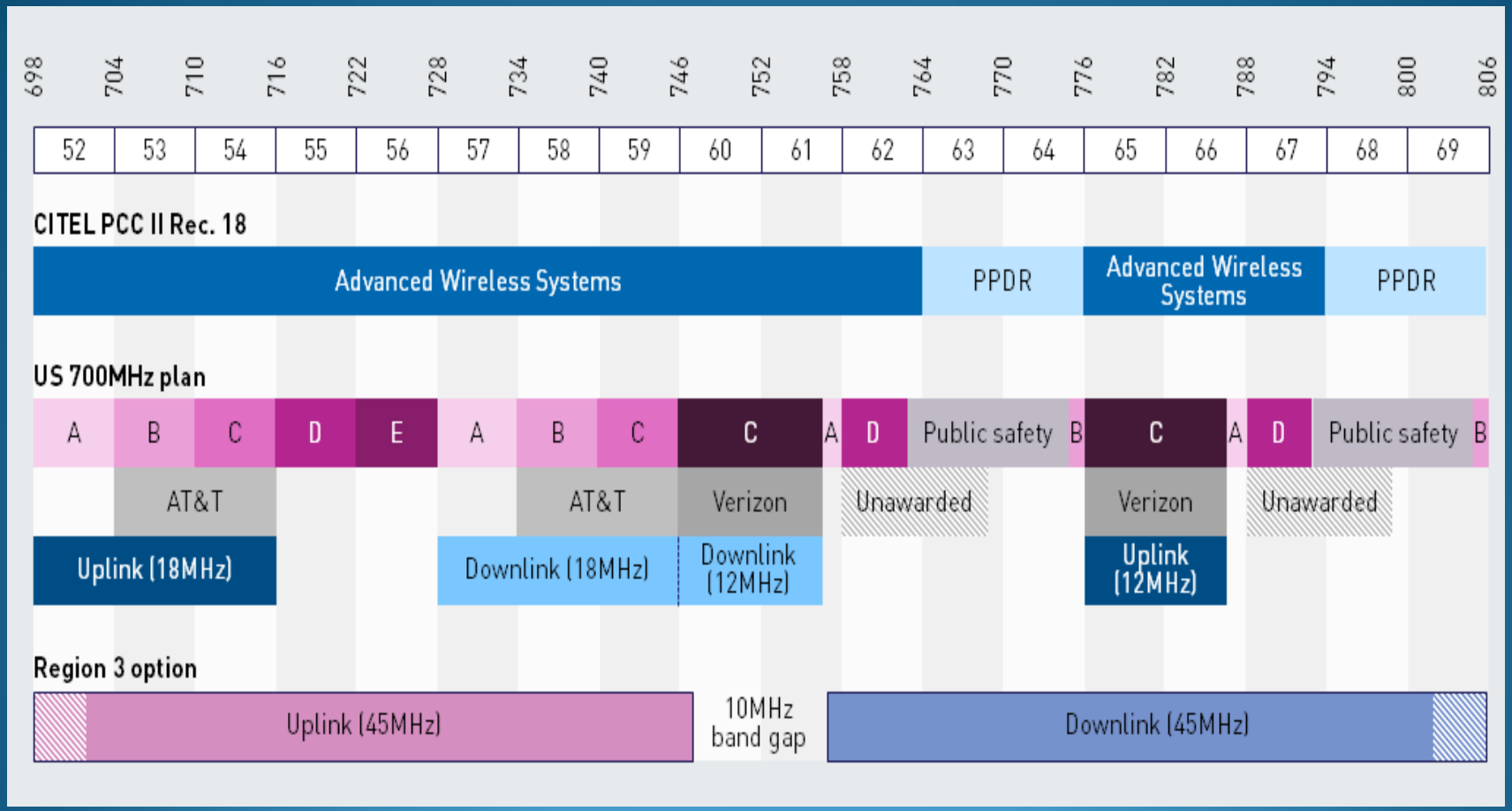
M.1036-03-A4

Mexico – No any reservation for Public Safety

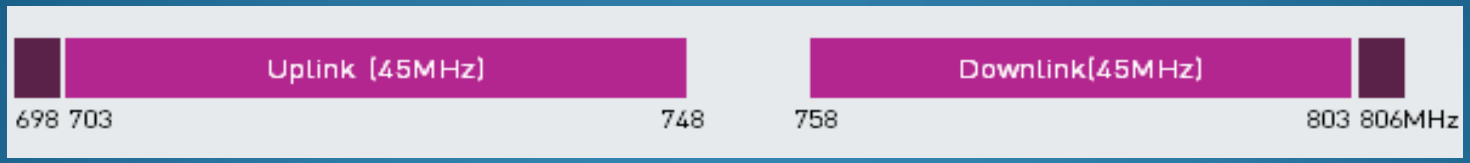


M.1036-03-A5

IMT Arrangement in USA & Region 2



IMT Arrangement in Mexico and Ecuador



Worldwide Research Programs

Public Safety Communications Research – PSCR – US Department of Commerce & Boulder Laboratories
Public Safety Communication Europe Forum – PSCE – EU funded

Gracias

Srdjan Mihaljevic
CTO TAS