PRIDA Track 1 (T1)
Online training in English

On-line English workshop. 20th April to 1st May 2020

Spectrum Harmonization: how the regional organisations and industry associations can complement the ITU harmonisation efforts

Dr. Haim Mazar; ITU Expert
Vice Chair ITU-R Study Group5 (terrestrial Services)

About the Author

- Ex Spectrum Manager of Israel
- Engineer & Economist
- PhD thesis on how culture & geography influence wireless regulation
- Wiley book on spectrum-management
- 49 years of RF experience
- Acquainted with all wireless communications: cellular, broadcasting, point to point, radars, satellites…
- Very active in Cameroon, Zambia, Togo communications' market
- What Is worth-knowing if you don't share it (based on 1973 David R. Olson

Sources of the presentations

- 49 years of RF experience at all radio communications services
- 29 years of RF Spectrum Licensing and Monitoring
- Development of two Computer Aided Techniques for National Spectrum Management
  - Spectrum Management 'Shraga'
  - Spectrum Management System 'Iris' and ICS Telecom
- ITU Spectrum Monitoring Handbook 1995, 2002, 2011
- Contributed to
  - ITU Computer-aided Techniques for Spectrum Management (CAT) 2015
  - Recommendation ITU-R SM.1370 Design guidelines for developing automated spectrum management systems
  - ITU Handbook on National Spectrum Management 2015

Main ITU-D activities of the Author

Contributes and participates actively at the two ITU-D Study Groups:, specific to this training

Resolution 9: Participation of countries, particularly developing countries, in spectrum management

Question 1/1	Strategies and policies for the deployment of broadband in developing countries
Question 2/1	Strategies, policies, regulations and methods of migration and adoption of digital broadcasting and implementation of new services
Question 4/1	Economic policies and methods of determining the costs of services related to national telecommunication/ICT networks
Question 5/1	Telecommunications/ICTs for rural and remote areas
Question 6/1	Consumer information, protection and rights: laws, regulation, economic bases, consumer networks
Question 7/1	Access to telecommunication/ICT services by persons with disabilities and other persons with specific needs
Question 1/2	Creating smart cities and society: Employing information and communication technologies for sustainable social and economic development
Question 2/2	Telecommunications/ICTs for eHealth
Question 5/2	Utilizing telecommunications/ICTs for disaster risk reduction and management
Question 6/2	ICTs and the environment
Question 7/2	Strategies and policies concerning human exposure to electromagnetic fields

Main ITU-R activities of the Author

- Since 1991, around **250** technical contributions to all ITU-R WPs
- VC ITU-Radio SG 9 - Fixed service 2000-2007; ITU-T (standardization) Workshop "All Star Network Access" 2004, Chair of Regulatory session; co-chaired ITU-R JRG 8A-9B. VC of ITU-R SG 1- Spectrum Management since October 2007 (elected by 92 countries at Radio Assembly 2007), re-elected by 102 countries at the RA 2012
- Since October 2015, VC of ITU-R SG 5- Terrestrial Services (elected by 88 countries at RA 2015). VC since May 2016 of ITU-R WP 5C - Fixed wireless systems; HF systems in the fixed and land mobile services
- Chair ITU-R Working Group 5C-3 'Systems above 86 GHz & interdisciplinary topics'
- Contributed two training modules- 'Fixed Service' and 'Short Range Devices'- to 'Wireless Telecommunications Technologies', for the ITU Academy, Spectrum Management Training Program (SMTP); now the advanced EMF module

ITU-T activities of the Author

1. ITU-T (standardization) Workshop "All Star Network Access" 2004
2. Rapporteur to the World Health Organisation (WHO) and International Commission on Non-Ionizing Radiation Protection (ICNIRP) of ITU-T Study Group 05 (ICT and climate change), to assess exposure from Electro Magnetic Fields, Question 3/5
3. Prepared the ITU intersectoral response to the public consultation of the Draft ICNIRP 'Guidelines on limiting exposure (100 kHz to 300 GHz)'.
4. Nominated by ITU R SG1 (spectrum management), SG5 (terrestrial services) and SG6 (broadcasting) on June and November 2014 and ITU RAG, to represent them on EMF
5. ITU Workshop on "5G, EMF & Health" (Warsaw, Poland, 5 December 2017), Warsaw EMF Dec 2019 IEEE95.1 ICNIRP guidelines 3 Dec2019
6. 'ATDI Coverage & EMF contours, around 5G base stations' see also.
7. More details on Author http://mazar.atwebpages.com/CVMazarEN.pdf

Theories and Policies

1. So begins Leo Tolstoy's Anna Karenina : ‘All happy families are alike; each unhappy family is unhappy in its own way’
2. Between two points in planar geometry there is only one simple line, but indefinite curves
3. 'Great minds think alike' (Michaelian)
4. ‘Stand on the shoulders of giants‘ (also I. Newton)
5. 'Okham’s Razor': ‘if you have to choose between competing theories, choose the simplest theory- it is most likely to be true’

Demand the duty with each one can perform

Antoine de Saint-Exupéry ‘Little Prince’

- “One must require from each one the duty with each one can perform," said the king
- "Accepted authority rests first of all on reason. If you ordered your people to go and throw themselves into the sea, they would rise up in revolution. I have the right to require obedience because my orders are reasonable”

Strategies

1. Follow RR Allocations
2. To reduce interference: lower-power, lower-altitude Above Sea Level, lower-altitude Above Ground Level
3. No discrimination; Fairness, transparency & efficiency
4. Unused RF is a waste to economy
5. For cellular efficient usage consider to oblige active RF sharing
6. There is available RF: never say I have no time, I have no money I have no RF
7. Penetration is relatively high and technologies improve b/Hz/second
8. Market-Dynamics: Intervene only when market-failure: lack of competition
9. Efficient use of spectrum: assign spectrum to those that will generate the greatest socio-economic benefit from its use
10. Promote investment & innovation in the sector
11. Does not undermine effective competition
12. Convergence of mobile, fixed & broadcasting services ; Internet Service Providers mainly use fixed stations
13. Try not to allocate RF when the Transmitter & the receiver are fixed
14. Put most attention on Short Range Devices
15. Focus on long term policy objectives rather than short term gains (not *Carpe Diem*, seize the day)

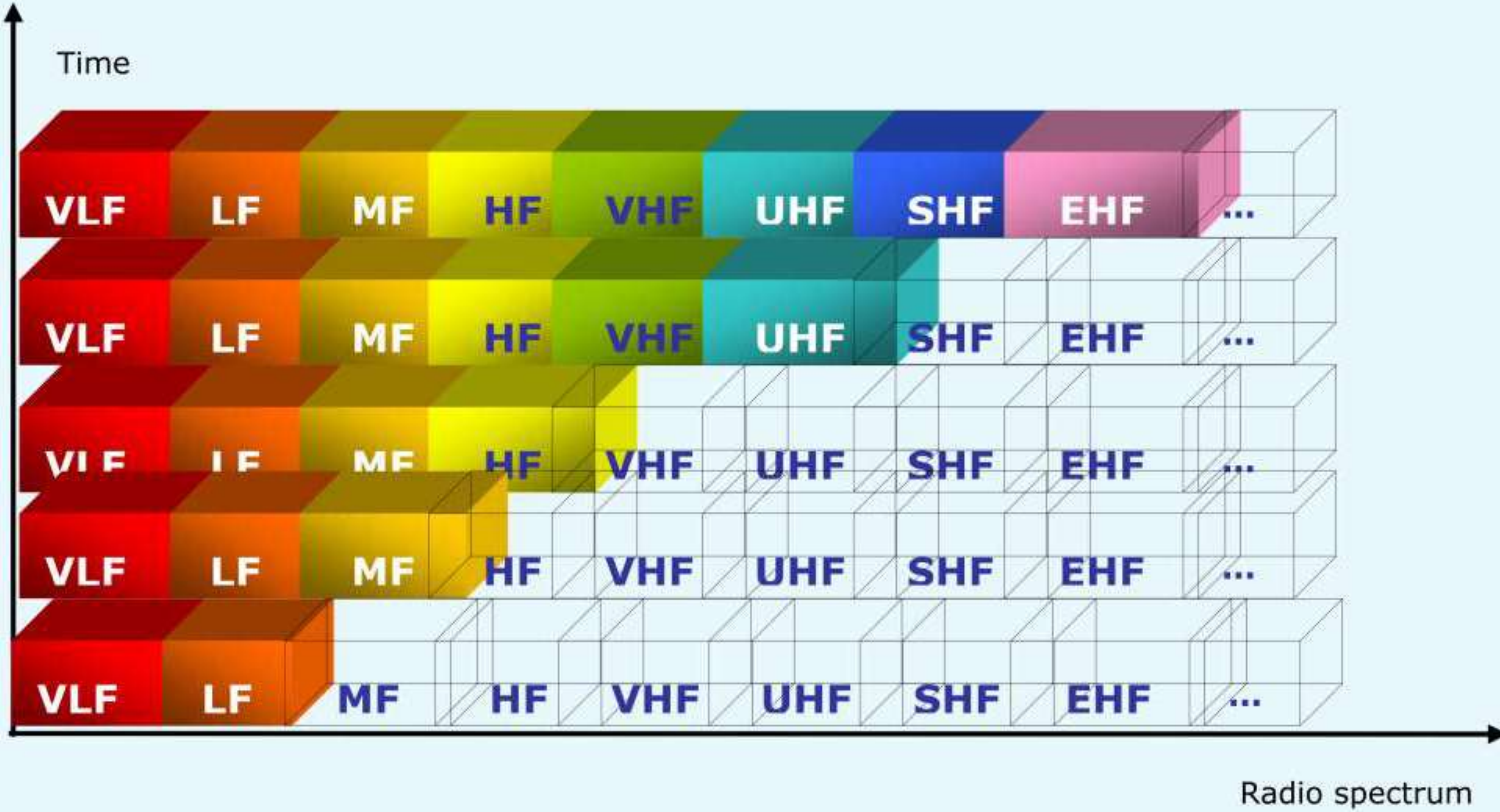
Where you sit is where you stand; auctions as example

1. Ministry: QoS, remote areas coverage, investments & better infrastructure
2. Ministry of Finance max revenue
3. Incumbent Operators may pay for more Spectrum
4. Public interest: min. prices, max. coverage & capacity, including rural and remote areas, Public Protection and Disaster Relief (PPDR)
5. Other players?
6. Administration should integrate all interests

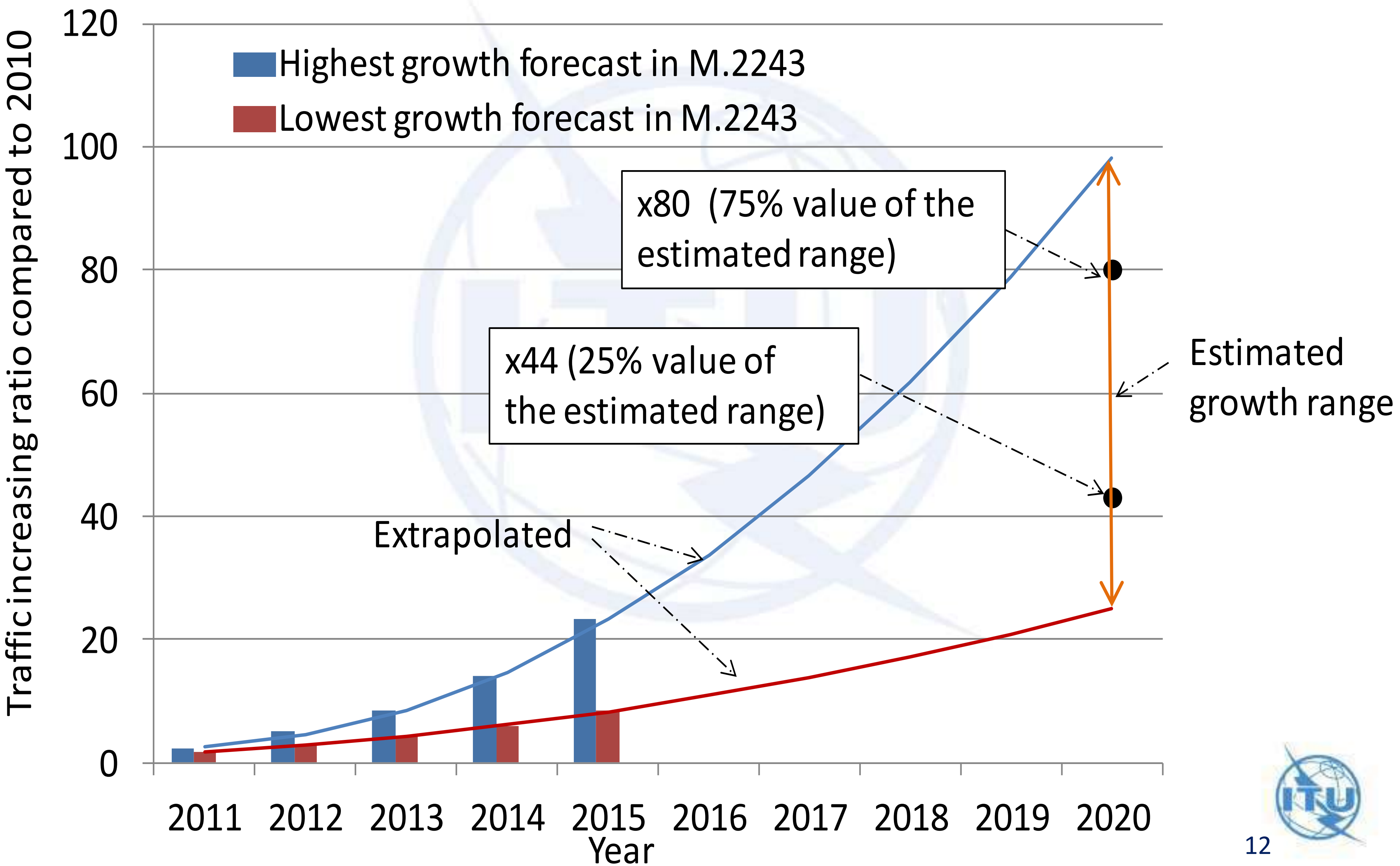
Figure 1: Scarcity of radio frequencies

Scarcity of Radio Frequencies

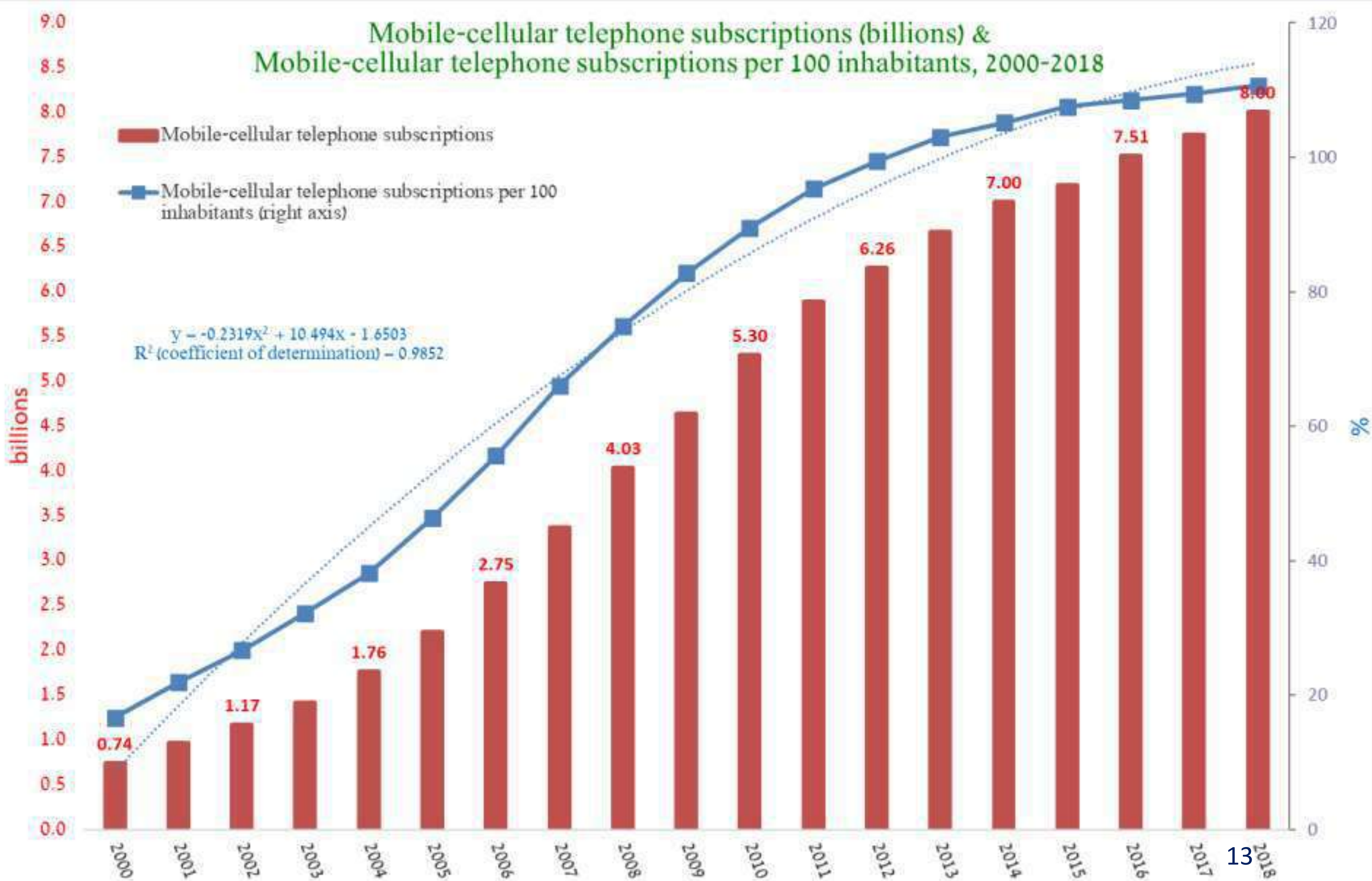
ITU-D Resolution 9 Final Report; 2014 Fig. 1



Mobile traffic forecasts toward 2020 by extrapolation ITU-R Working Party 5D



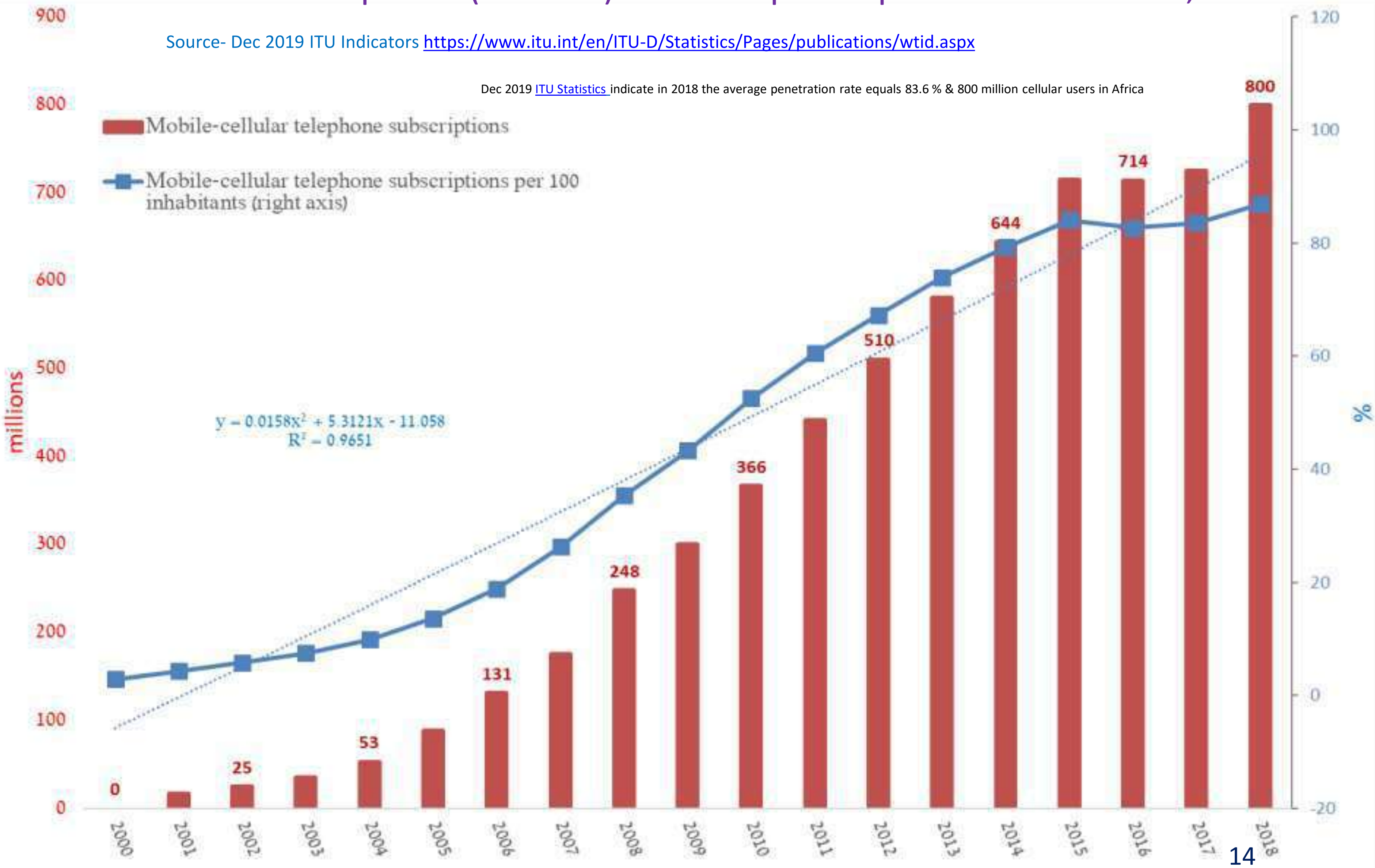
Global mobile-cellular and telephone subscription rate

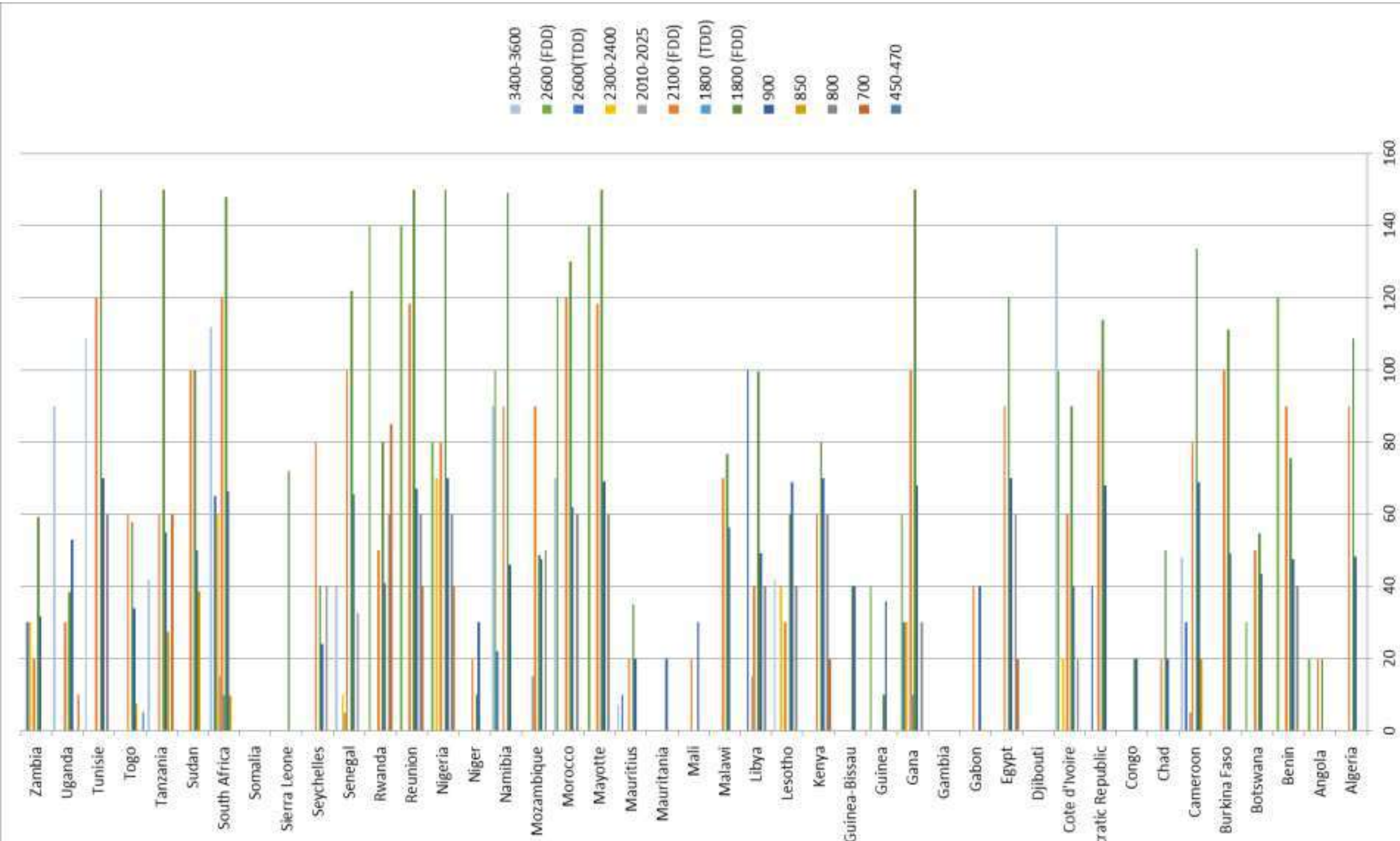


African cellular subscriptions (millions) & subscriptions per 100 inhabitants, 2000-2018

Source- Dec 2019 ITU Indicators https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

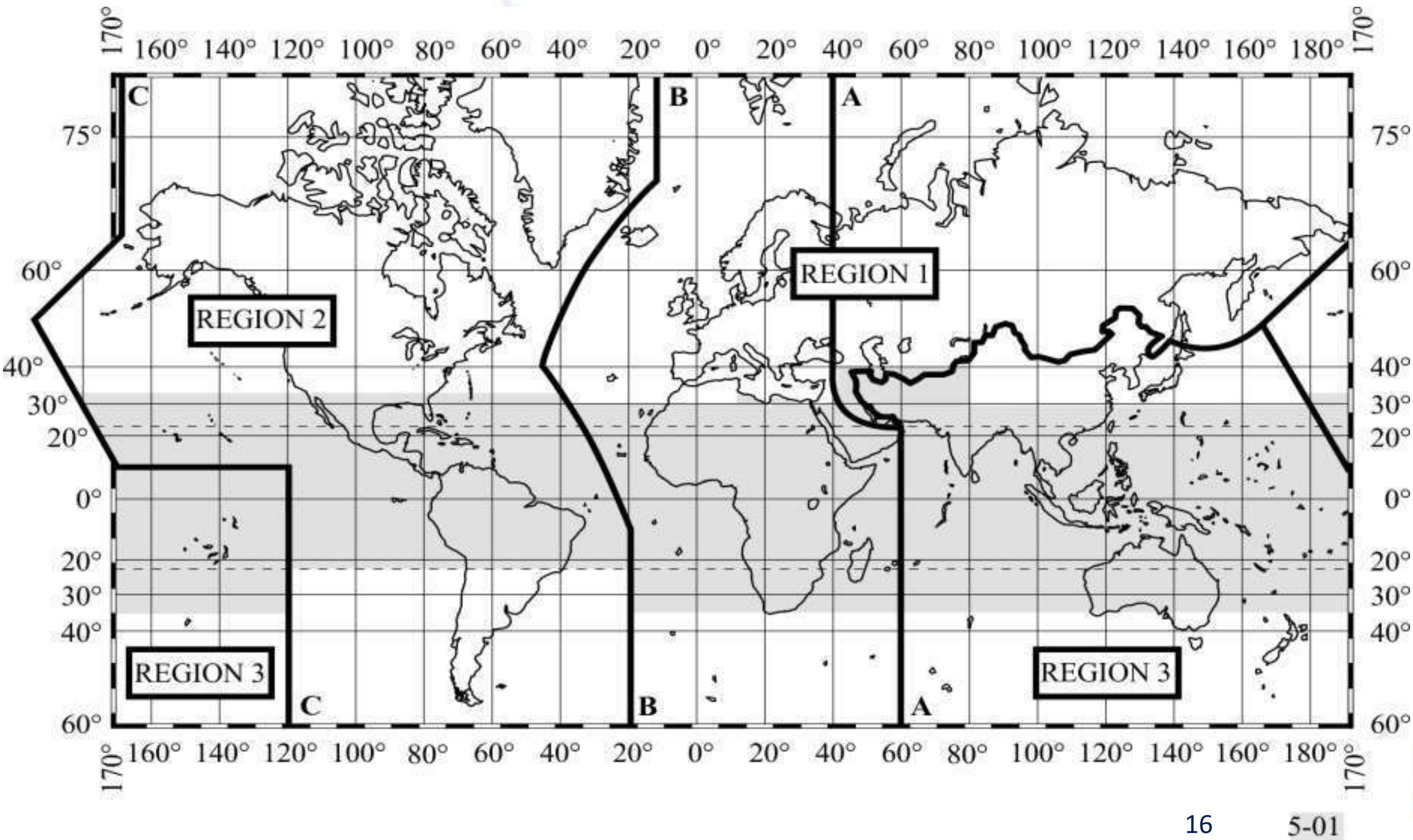
Dec 2019 ITU Statistics indicate in 2018 the average penetration rate equals 83.6 % & 800 million cellular users in Africa





Spectrum assignments in Africa in MHz (source GSMA)

International Harmonization: Three ITU RF Allocation Regions



Radio Frequency Co-ordination; Europe experience

1. Avoiding RF interference
2. ITU RR do not meet all practical requirements
3. Each country obliged to take account of other stations before putting own into operation
4. Procedures agreed in the Agreement
5. Bilateral preferential frequency agreements for frontier zones: who can operate what and with which interference ranges

Radio Frequency Co-ordination

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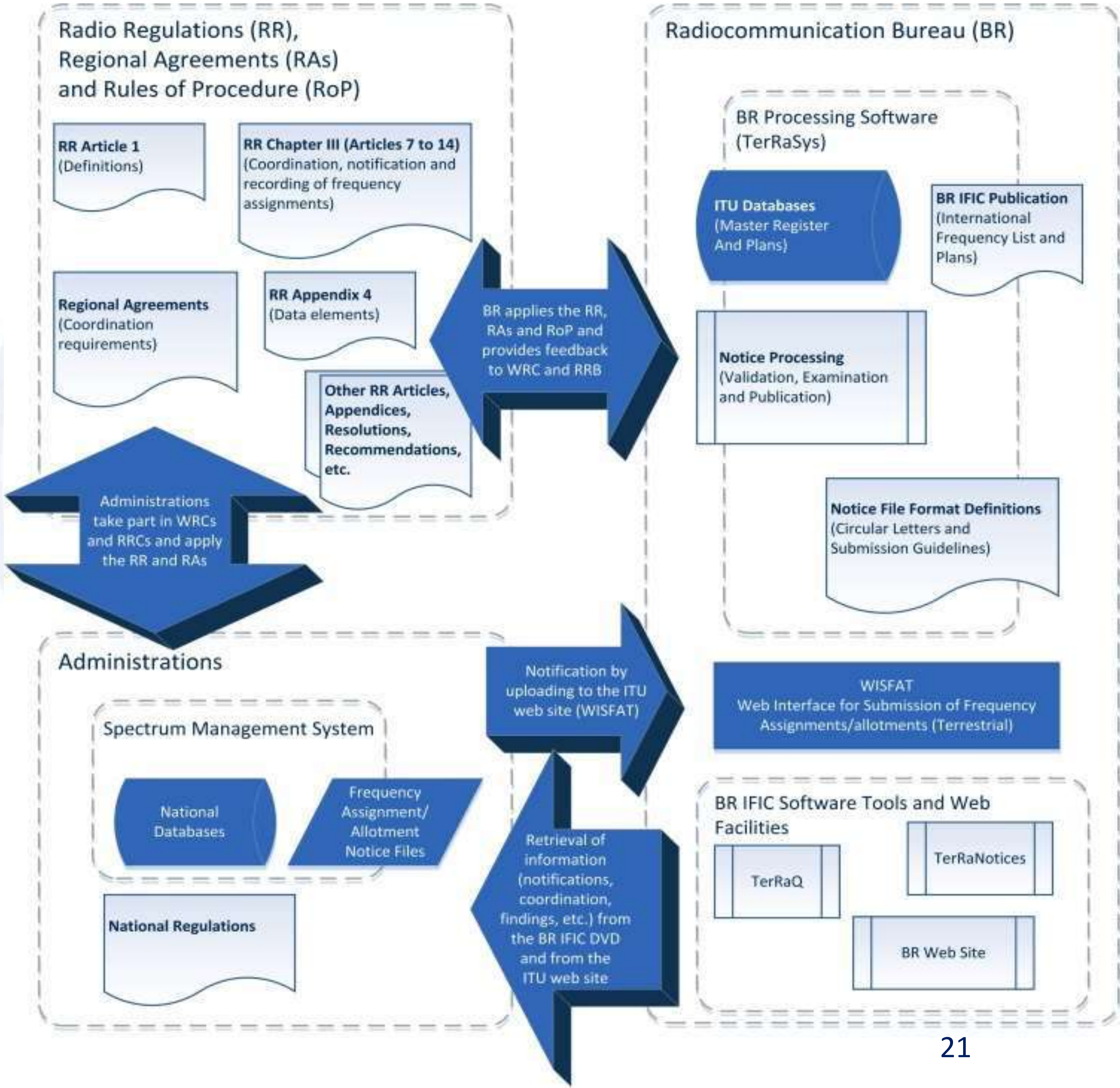
Radio Frequency Co-ordination; Advantages

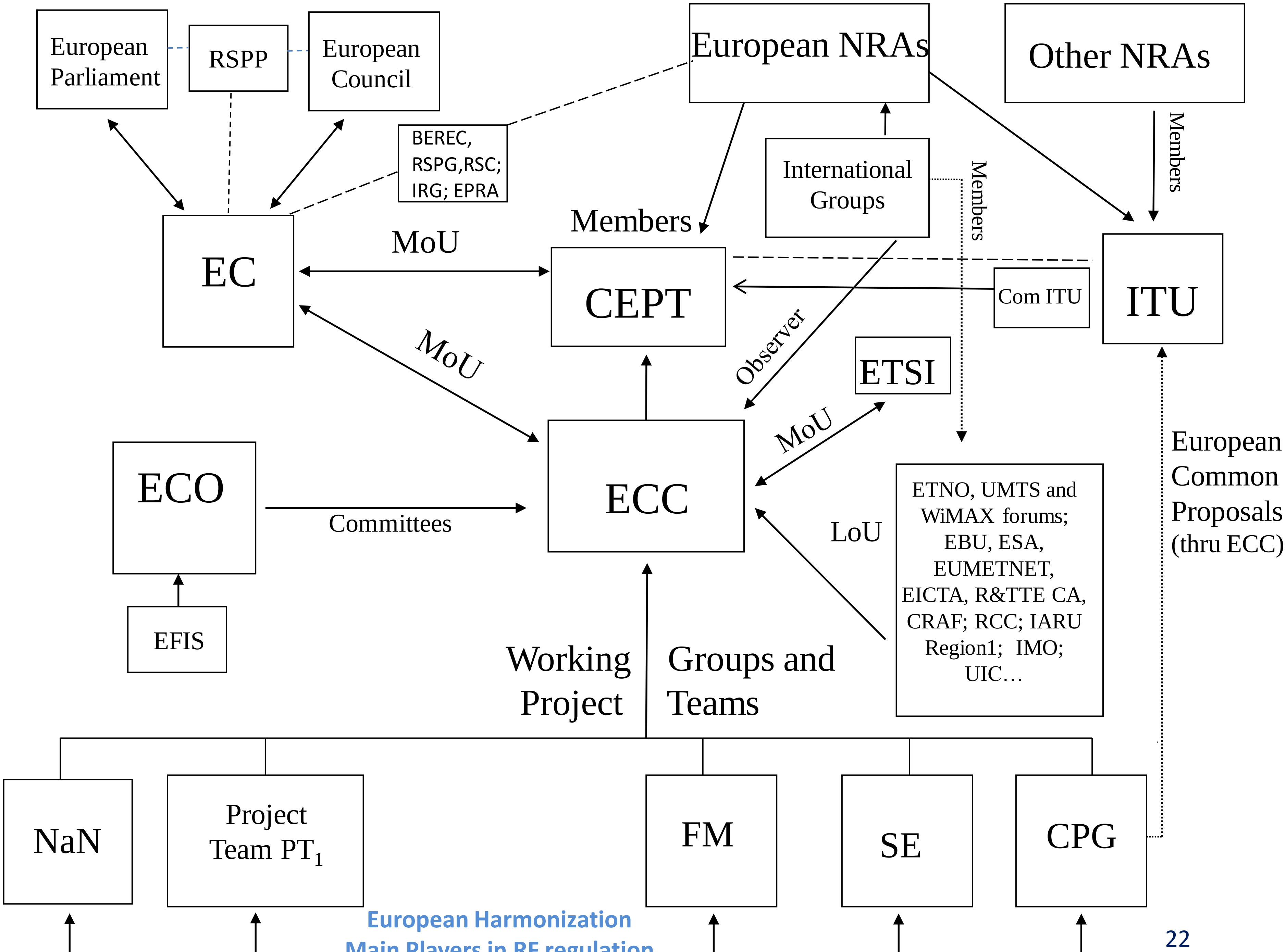
1. Aim: Optimise spectrum usage
2. Administrations obliged to co-ordinate frequencies before assigning them
3. Administrations obliged to ensure harmonised application of technical provisions
4. Quick assignment of preferential frequencies
5. Transparent decisions through agreed assessment procedures
6. Quick assessment of interference through data exchange

Radio Frequency Co-ordination; disadvantages

1. Hurt sovereignty
2. Increase in administrative work and costs (complex procedures, longer turnaround times, topographical database)
3. Detailed input data required from operators (geographical data, antenna parameters)
4. Complex operational conditions, assignments subject to diverging conditions
5. Customers affected by changes in usage rights: Various consequences
6. Limits also to preferential frequencies, limits may vary from case to case
7. Restrictions in frequency assignment
8. More work in application processing

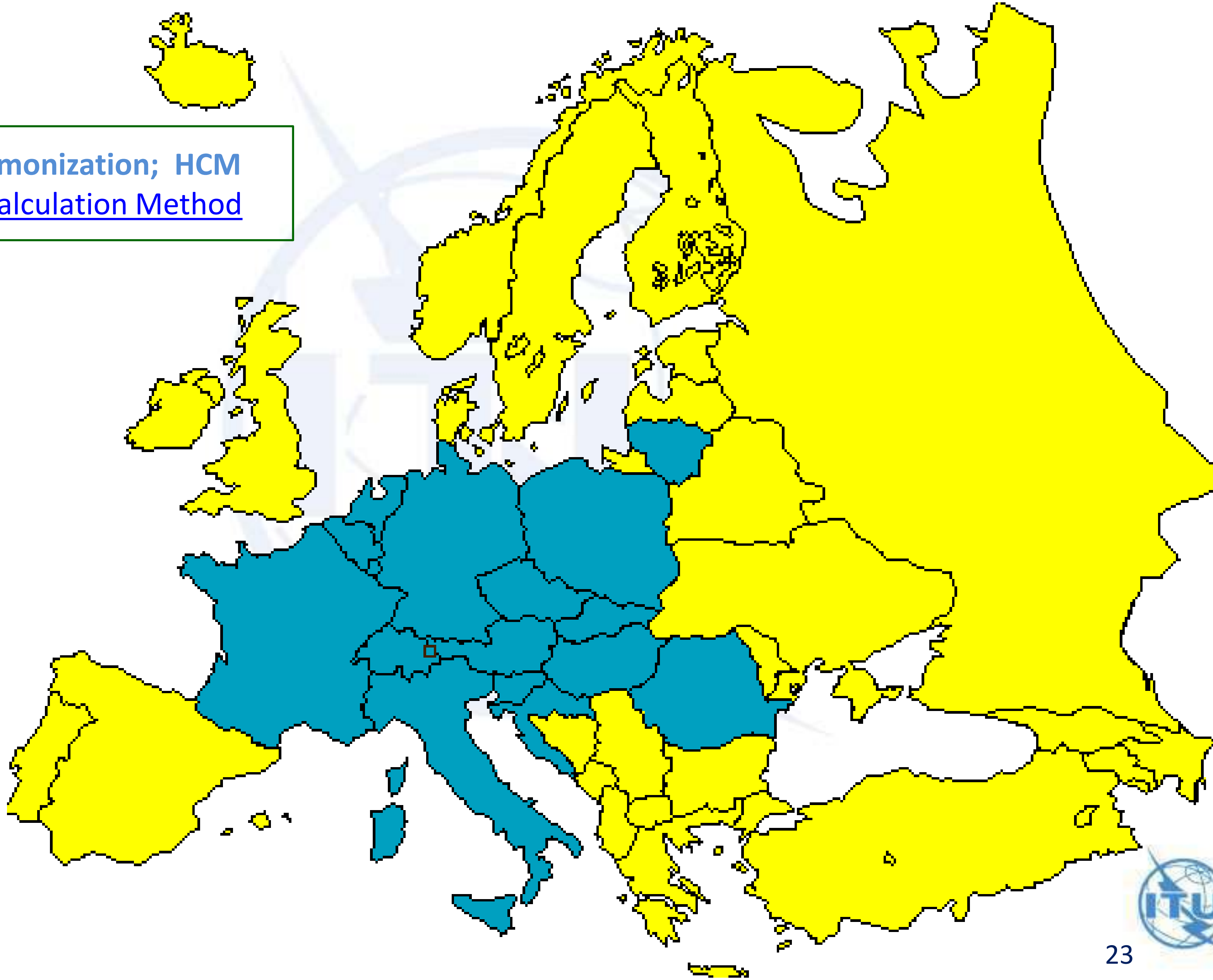
Terrestrial data exchange





European Harmonization
Main Players in RF regulation

European Harmonization; HCM
Harmonised Calculation Method



European Harmonization; HCM (Harmonised Calculation Method)

1. *HCM Agreement is the official designation of the Agreement between the Administrations of Austria, Belgium, the Czech Republic, Germany, France, Hungary, the Netherlands, Croatia, Italy, Liechtenstein, Lithuania, Luxembourg, Poland, Romania, the Slovak Republic, Slovenia and Switzerland on the Coordination of frequencies between 29.7 MHz and 43.5 GHz for fixed service and land mobile service*
2. Agreement 2019
3. The **European rulings**, such as the European table of frequency allocations and applications in the frequency range 8.3 kHz to 3000 GHz (ECA TABLE), are first-rate guidelines

RF Regulation in Africa

The African Telecommunications Union (ATU); ATU is a continental partnership between public and private stakeholders in the ICT sector to foster the development of ICT technologies, infrastructure and services. ATU formulates policies and strategies, represents the interests of its members at global decision-making conferences, promotes integration of regional markets, advances universal access and inter-country connectivity, attracts investment, builds institutional and human capacity and supports active participation in the global information and knowledge society. ATU has 44 Member States and 16 Associate Members (comprising fixed and mobile telecom operators). Figure 7.7 depicts the ATU Members.

West African States

The Economic Community of West African States (ECOWAS) is a regional group of fifteen countries, founded in 1975. Similar to the EU model, ECOWAS promotes economic integration including telecommunications matters, and fosters cooperation and integration of West African telecommunications and information technology activities. The West African Economic and Monetary Union (UEMOA) undertook telecommunications regulation harmonization project, aimed at designing a strategy for the harmonization of telecommunications policies in ECOWAS. The West Africa Telecommunications Regulators Assembly (WATRA) was established in November 2004. WATRA consists of the 15 independent National Regulatory Authorities (NRAs) and departments for regulation of telecommunications services established by governments of ECOWAS and Mauritania. Benin, Burkina Faso, Cabo Verde, Cote D'ivoire, Gambia, Ghana, Guinee, Guinee Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo.

East African Community: EAC and EACO

The East African Community (EAC) and East Africa Communications Organization (EACO) are the regional intergovernmental organization of the Burundi, Kenya, Rwanda, Tanzania and Uganda to widen and deepen also economic integration, in order to increase competitiveness in East Africa. EACO was established by ICT regulators of East Africa and licensed communications operators within the East Africa region, to co-ordinate all the ICT activities and initiatives in the region. EAC also does have an arm dealing with development of ICT sector within the region which is not member of EACO.On 30 December 2014 EACO is not yet part of EAC.

South-African Region: Regulatory Framework

Two main Southern-African regulatory groups: the Southern African Development Community (SADC) and Communication Regulators' Association of Southern Africa (CRASA); CRASA is the renamed TRASA. SADC is the regional economic community comprising fifteen Member States, established in 1992. SADC is committed to regional integration within Southern Africa through economic development. The focus of the thirteen countries forming the CRASA is the harmonization of ICT and Postal regulatory environment, in order to improve the business environment and investment climate in SADC. Telecommunications Regulators' Association of Southern Africa (TRASA) was established in 1997. TRASA co-ordinates regulatory matters, promotes operation of efficient telecommunications networks and services, and maximises the utilisation of scarce resources.

ITU RR 460-890 MHz

Region 1	Region 2	Region 3
470-694 **BROADCASTING** 5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.311A 5.312	470-512 BROADCASTING Fixed Mobile 5.292 5.293 5.295	470-585 FIXED MOBILE 5.296A BROADCASTING 5.291 5.298
	512-608 BROADCASTING 5.295 5.297	585-610 FIXED MOBILE 5.296A BROADCASTING RADIONAVIGATION 5.149 5.305 5.306 5.307
	608-614 RADIO ASTRONOMY Mobile-satellite except aeronautical mobile-satellite (Earth-to-space)	610-890 FIXED MOBILE 5.296A 5.313A 5.317A BROADCASTING
	614-698 BROADCASTING Fixed Mobile 5.293 5.308 5.308A 5.309 5.311A	
694-790 **MOBILE except aeronautical mobile** 5.312A 5.317A **BROADCASTING** 5.300 5.311A 5.312	**698-806** **MOBILE** 5.317A BROADCASTING Fixed 5.293 5.309 5.311A	
790-862 **FIXED** **MOBILE except aeronautical mobile 5.316B 5.317A** **BROADCASTING** 5.312 5.319	806-890 FIXED **MOBILE** 5.317A BROADCASTING	
862-890 **FIXED**		

Importance of Frequency Allocation Tables; 694-862 MHz; Ref.[1]

Frequency band	Allocations	Applications
694 MHz - 790 MHz (5.300) (5.311A) (5.312)	•BROADCASTING •MOBILE EXCEPT AERONAUTICAL MOBILE (5.312A) (5.317A)	•PMSE Programme-making and special events (PMSE)) •Radio microphones and ALD •MFCN •PPDR •Broadcasting (terrestrial)
790 MHz - 862 MHz (5.312) (5.316B) (5.317A) (ECA13)	•MOBILE EXCEPT AERONAUTICAL MOBILE	•Radio microphones and ALD •MFCN
862 MHz - 870 MHz (5.323) (ECA13) (ECA36)	•MOBILE (5.317A)	•Radio microphones and ALD •- •RFID •Tracking, tracing and data acquisition •Wideband data transmission systems •Land military systems •Maritime military systems •Alarms •Non-specific SRDs

African telecommunications union draft zero African Spectrum Allocation Plan (AfriSAP) 8.3kHz to 3000 GHz

ITU Region 1 allocations and FNs	Africa Common Allocation	Africa Common Main Utilization	Additional information
460-470 MHz **FIXED** **MOBILE 5.286AA** **Meteorological-satellite (space-to-Earth)** **MOD 5.287 5.288 5.289 5.290**	**460-470 MHz** **FIXED** **MOBILE 5.286AA** **Meteorological-satellite (space-to-Earth)** **MOD 5.287 5.289**		
470-694 MHz **BROADCASTING** **5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.312**	470-694 MHz BROADCASTING 5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.312	DTT broadcasting (470-694 MHz)	Band IV/V Analogue television to migrate to digital television in line with SADC time lines
694-790 MHz **MOBILE except aeronautical mobile 5.312A 5.317A** **BROADCASTING** **5.300 5.312**	694-790 MHz MOBILE except aeronautical mobile 5.312A 5.317A 5.300 5.312	IMT	
790-862 MHz **FIXED** **MOBILE except aeronautical mobile 5.316B 5.317A** **BROADCASTING** **5.312 5.319**	790-862 MHz MOBILE except aeronautical mobile 5.316B 5.317A SADC13	IMT	Res. 224 (REV. WRC-19) applies

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations / utilisation	Additional information
790-862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.312 5.319	**790-862 MHz** MOBILE except aeronautical mobile 5.316B 5.317A SADC13	IMT	Res. 224 (REV. WRC-19) applies
862-890 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.319 5.323	**862-890 MHz** MOBILE except aeronautical mobile 5.317A 5.322 SADC14	862-876 MHz IMT	This band is paired with 824-849 MHz
		876-880 MHz IMT PMR and/or PAMR	This band is paired with 921-925 MHz.
		880-915 MHz IMT	Paired with 925-960 MHz.
890-942 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 Radiolocation 5.323	**890-942 MHz** MOBILE except aeronautical mobile 5.317A	915-921 MHz PMR and/or PMR	
		921-925 MHz IMT PMR and/or PAMR	Paired with 876-880 MHz.
		925-960 MHz IMT	Paired with 880-915 MHz
942-960 MHz FIXED	**942-960 MHz** MOBILE except aeronautical		

Importance of Frequency Allocation Tables; 2900-3400 MHz,Reference[1]

Query in the EFIS database (ECO Frequency Information System; See Reference[1] Fig. 14

Frequency Range: 2900 to 3400 MHz Frequency Table: France Search

Results from the ERO Frequency Database:

FREQUENCY BAND	ALLOCATIONS	APPLICATIONS
2900.0 - 3100.0 MHz	RADIOLOCATION RADIONAVIGATION	Maritime navigation Primary radar
3100.0 - 3300.0 MHz	EARTH EXPLORATION-SATELLITE RADIO ASTRONOMY RADIOLOCATION SPACE RESEARCH (active)	Maritime radar
3300.0 - 3400.0 MHz	RADIO ASTRONOMY RADIOLOCATION	Defence systems

Factors contributing to the scarcity of RF & increased spectrum access costs; Reference[1] ITU-D Resolution 9, 2014

- Deregulation & liberalization of communication markets
- Privatization & "merchandizing" of the public domain
- Awareness of the value of the spectrum
- Worldwide competition between multinational operators

Interrelation of national spectrum management & monitoring functions

MONITORING

- Predicted data
- Reference data base: users, sites, equipment
- Missions & priorities according to importance (safety of life), decision makers policy & interference complaints

- Measurements, including drive tests
- Eyes & Ears: frequency, occupancy, field strength, power, bandwidth, direction, polarization, modulation
- Infringements: discrepancies, illegal stations, comparison to licenses

- Common display: maps, visualisation of monitoring results and licence data
- Records, reports, statistical data & analysis
- Broadcast video, audio & data; fixed; mobile; other services
- Coverage capacity & quality of service
- Interference : complaints, investigation, identification,
- Enforcement and clearance
- Monitoring from other international & regional sources

MANAGEMENT

Roles of RF monitoring

1. Ensuring operation of transmitters in conformity with national and international regulations and licence conditions
2. Verification of proper technical and operational characteristics of authorized transmitters
3. Detection and location of unauthorized transmitters and interference
4. identification and resolution of interference problems
5. Measuring spectrum occupancy
6. Validation of propagation and sharing models

Items which need to be regulated

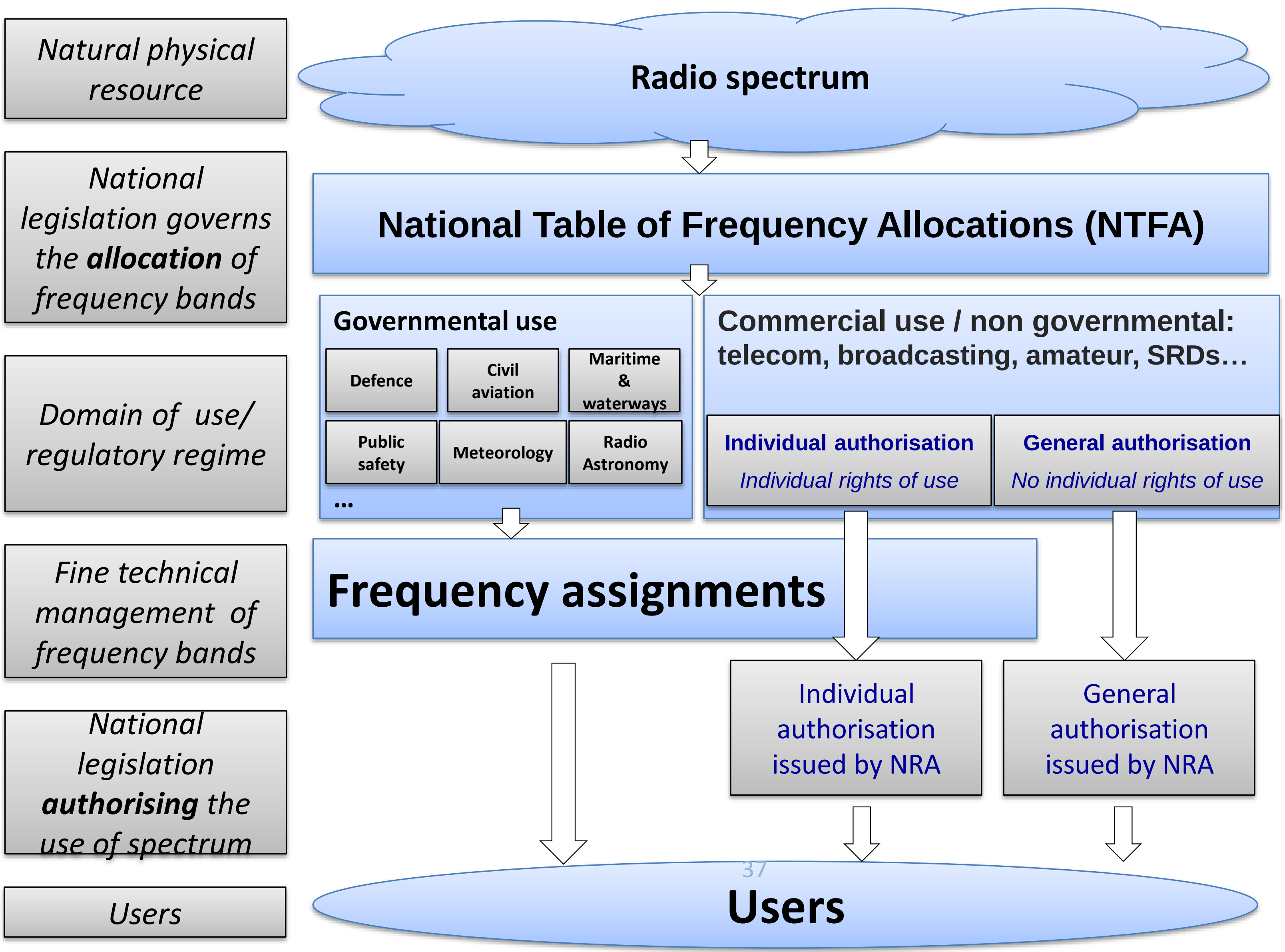
1. RF allocations to radio services; follow ITU Radio Regulations
2. Assignment of licence and RF to Tx Stations
3. Fee collection: RF License & annual fees
4. Equipment Type approval; 2014/53/EU (RED) is liberal
5. Coordination with neighbour countries (no borders to the ElectroMagnetic waves)
6. Notifying ITU to the Master International Frequency Register (MIFR) e.g. http://www.itu.int/ITU-R/eBCD/ePub.aspx
7. External relations: toward ITU, International & Regional orgs see http://eprints.mdx.ac.uk/133/2/MazarAug08.pdf p. 179

Main Roles of National Spectrum Management

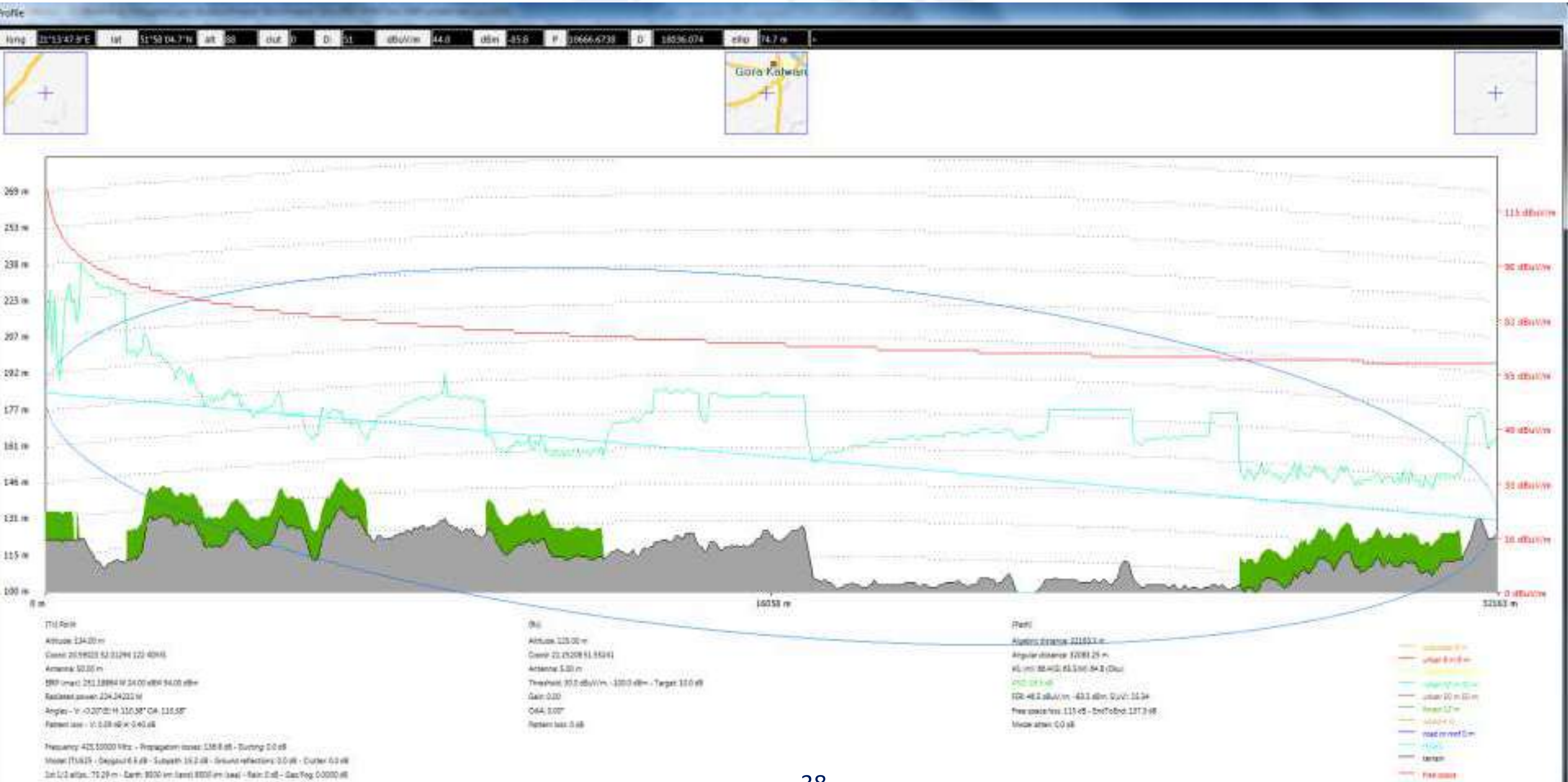
1. Avoid and solve interference
2. Design long and short range RF spectrum
3. Support Engineering: propagation, coverage…
4. Coordinate with military wireless services
5. Advance new wireless technologies (such as cognitive radios; digital audio and video)
6. Coordinate with other Administrations
7. Advance new technologies & efficient import
8. Serve your clients, the public: be transparent
9. Reduce RF human hazards

36

National legislation in Europe from the radio spectrum to users ECC Report 205



profile analysis window
the basics of all engineering work



Coverage of Lusaka TV UHF channel the basics of all engineering work

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Thank you!

Thank you!

PRIDA Track 1 (T1)
Online training in English

On-line English workshop 20th April to 1st May 2020

Mobile Infrastructure Sharing

Dr. Haim Mazar; ITU Expert
Vice Chair ITU-R Study Group5 (terrestrial Services)

Sources of this presentation

1. Promoting site-sharing in Ministry of Communications, Israel
2. Engineering analysis in ATDI for site-sharing in Singapore
3. Owner of a site shared by 2 operators in one mast

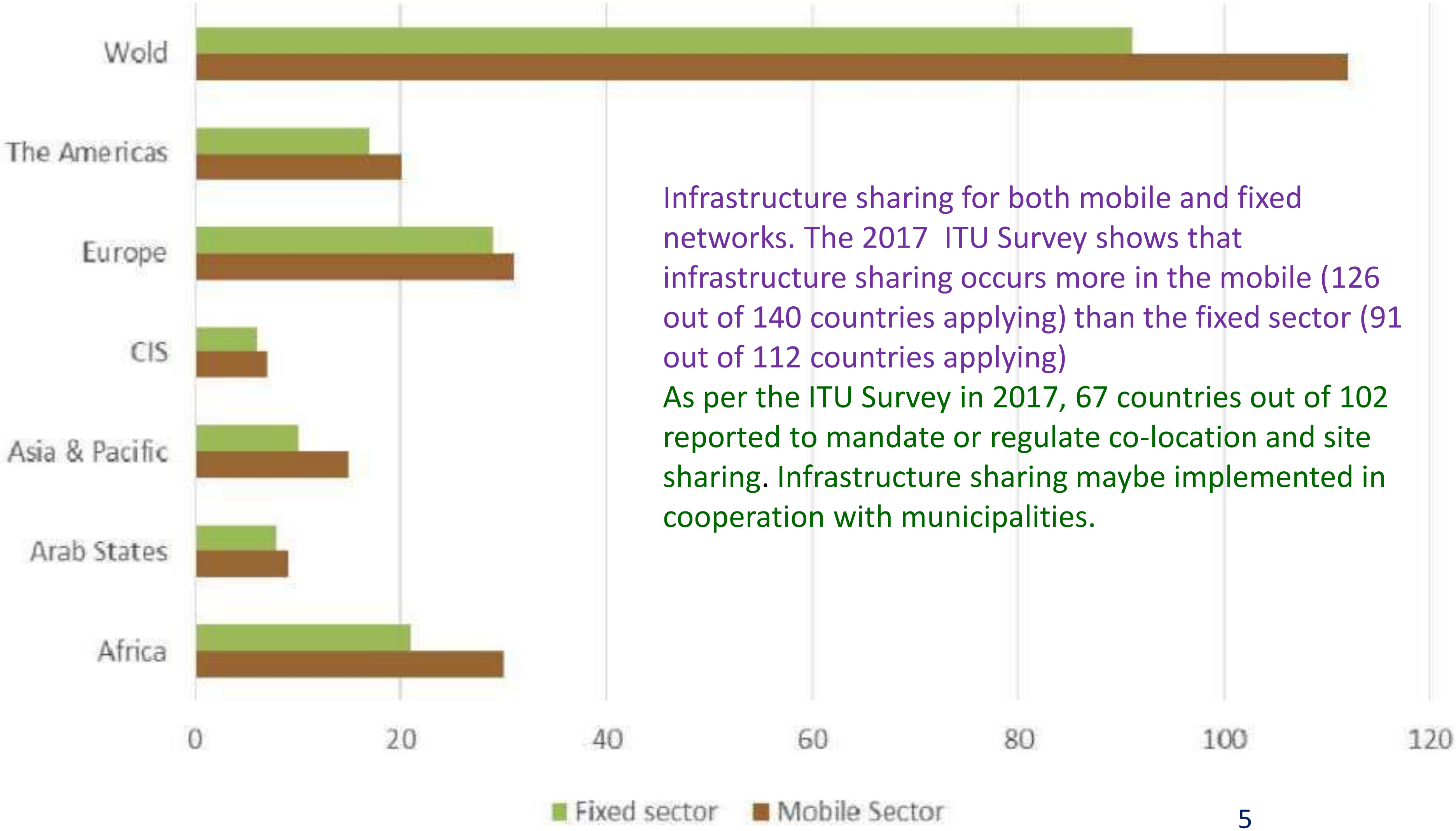
1. Definitions of infrastructure
2. Passive sharing: site and mast sharing
3. Active sharing: RAN and core sharing
4. Implementing nation-wide Mission Critical Communications networks, competition concerns

ITU Sharing Infrastructure
ITU news magazine

Possible methods of sharing guided for high capacity networks

1. Passive infrastructure sharing (PIS)
2. Active infrastructure sharing (AIS)
3. Spectrum sharing in the AIS model

All about Infrastructure Sharing ITU-D 2018



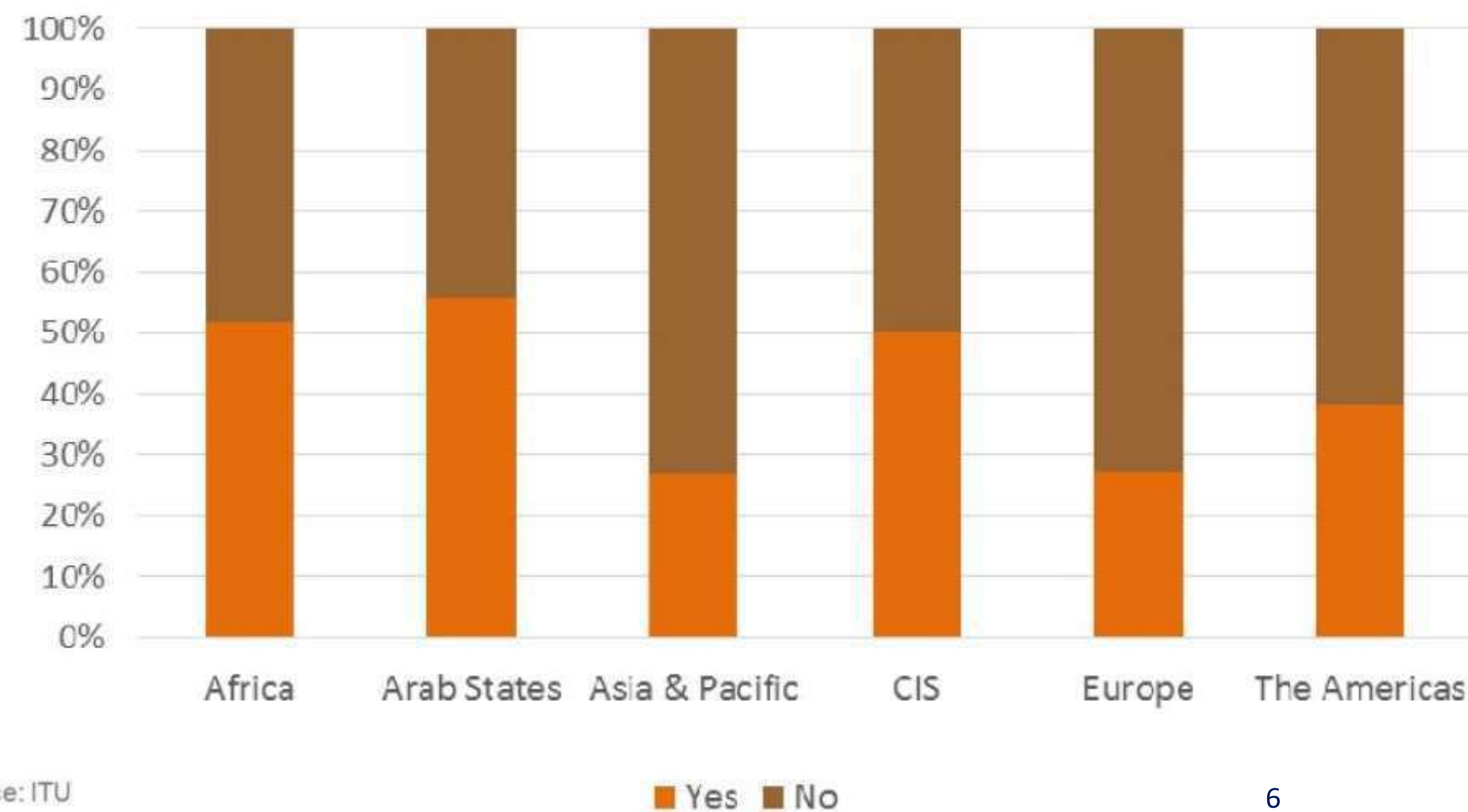
Infrastructure sharing for both mobile and fixed networks. The 2017 ITU Survey shows that infrastructure sharing occurs more in the mobile (126 out of 140 countries applying) than the fixed sector (91 out of 112 countries applying)

As per the ITU Survey in 2017, 67 countries out of 102 reported to mandate or regulate co-location and site sharing. Infrastructure sharing maybe implemented in cooperation with municipalities.

National Roaming and co-location? Infrastructure Sharing 2018

National roaming, which refers to the ability to connect from one mobile operator to another in the same country, continue to be implemented in all regions.

Countries mandating sharing for national-roaming



Source: ITU

Definitions; see Mazar 2016 –Radio Spectrum Management: Policies, Regulations and Techniques

1. Proliferation of sites overgrows the environmental footprint, increases operators’ expenses and delays the time-to-revenue.
2. Convergence of wireless infrastructure (like intra-country roaming agreements among operators and roaming between neighbor countries) decreases the number of antenna masts and human exposure
3. Sharing and co-location may include network, planning, base stations and RF spectrum
4. Passive sharing comprises common site, generator, air-conditioning, mast and antenna
5. Active sharing, operators may share equipment and RF. The problem is that more sharing may decrease competition. The deals of radio access network (RAN) sharing always face challenges in terms of ensuring differentiation and **competition** between different carriers' services

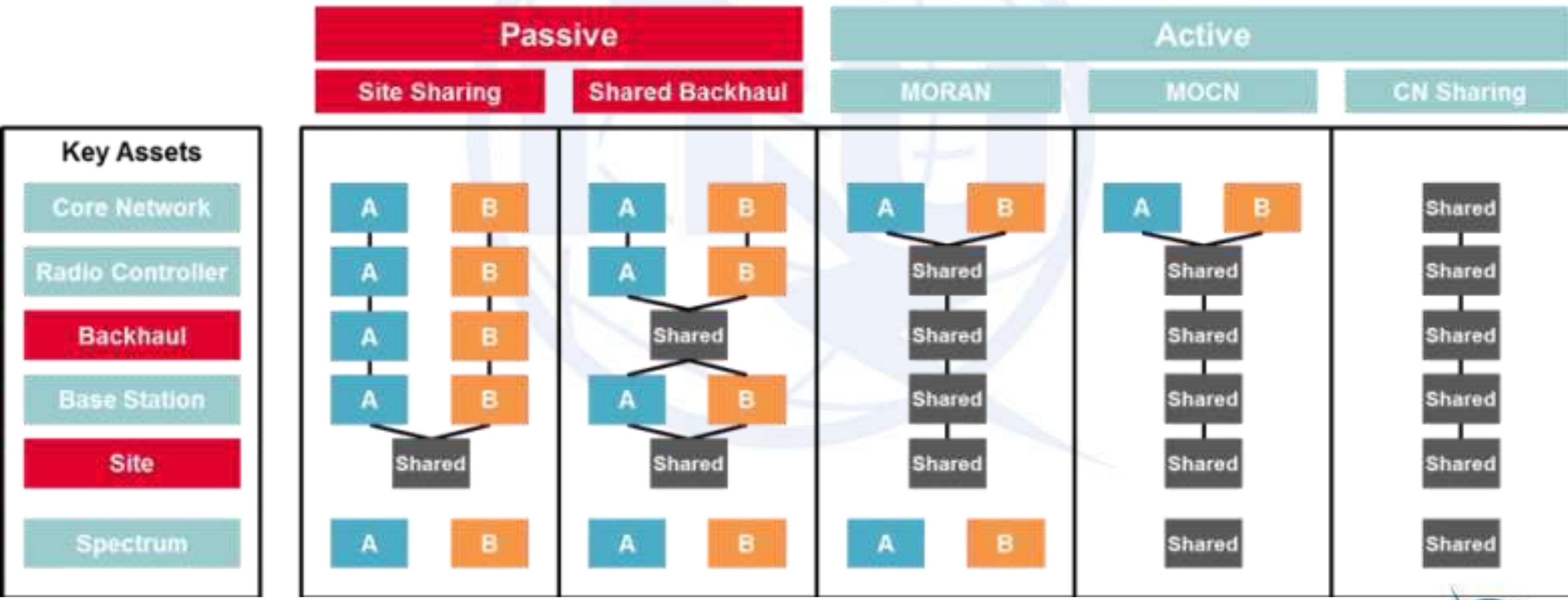
Definitions; see Mazar 2016 –Radio Spectrum Management: Policies, Regulations and Techniques

1. Infrastructure sharing leads to faster and wider roll-out of coverage into new and currently underserved geographical areas
2. Active sharing of the frequencies optimizes the use of the RF spectrum; active hardware: Tx, Ant, RF, switching, BTS, routers and the like)
3. Debate between many small cells and mast sharing, and its impact on radiation hazards.
4. If regulators increase the channel bandwidth of operators , the number of urban sites may decrease; thus, additional RF versus fewer antennas; see Mazar' *9.6.3 Test to Quantify RF Versus Sites; Shannon*
5. Infrastructure sharing is usually part of the telecommunicatons regulatory environment

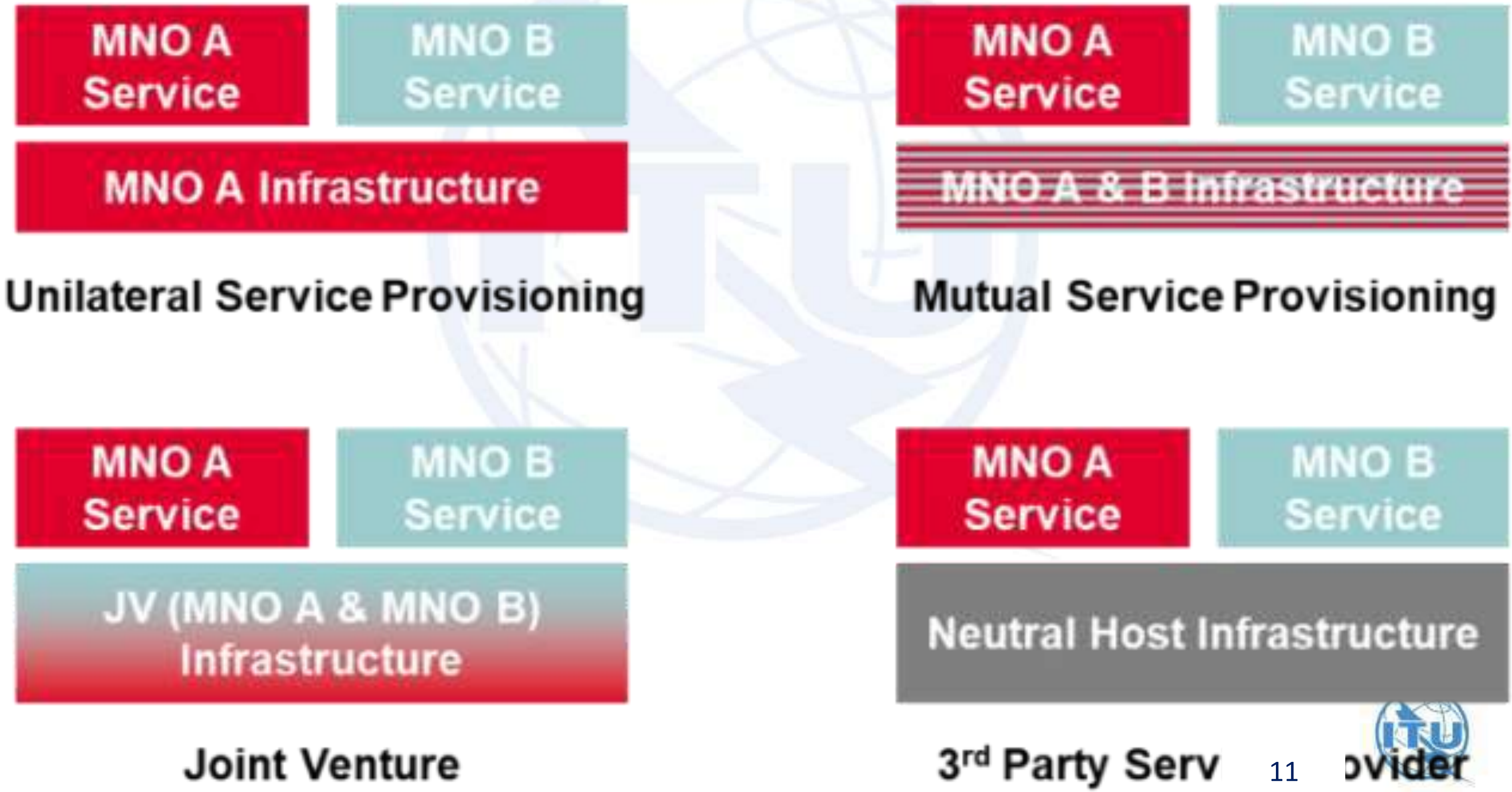
Definitions; see Mazar 2016 –Radio Spectrum Management: Policies, Regulations and Techniques

1. Sharing avoids duplication of long-term investment
2. Sharing shouldn’t harm competition
3. Infrastructure sharing is usually part of the telecommunicatons regulatory environment
4. Countries (Canada, UK, Israel…) oblige infrastructure sharing
5. Sharing shouldn’t harm competition

Technical classification of infrastructure sharing; GSMA



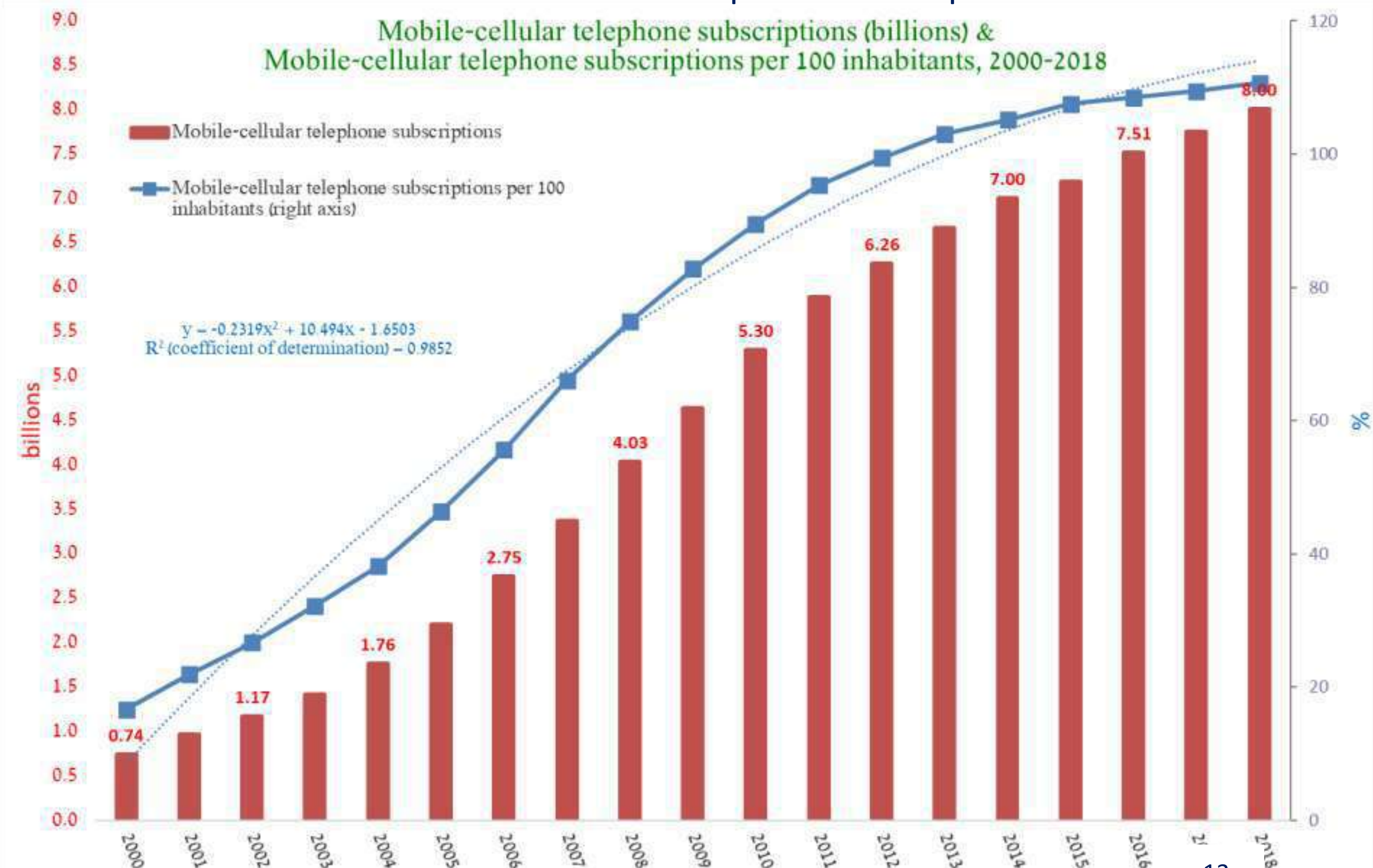
Business/ownership classification of infrastructure sharing, GSMA



ITU-D Indicators

1. The 24rd Edition, Dec 2019 indicates that in 2018 there were 8 billion subscribers
2. Based on China and India data (millions of base stations), in average, roughly every 1,000 subscribers need one cellular mast,; see See H. Mazar, *Radio Spectrum Management: Policies, Regulations, Standards and Techniques*, Chichester, West Sussex: John Wiley & Sons, Ltd., 2016; Chapter 9 Section 9.6.2
3. So, there are more than 8 million base stations around the world

Global mobile-cellular telephone subscription rate

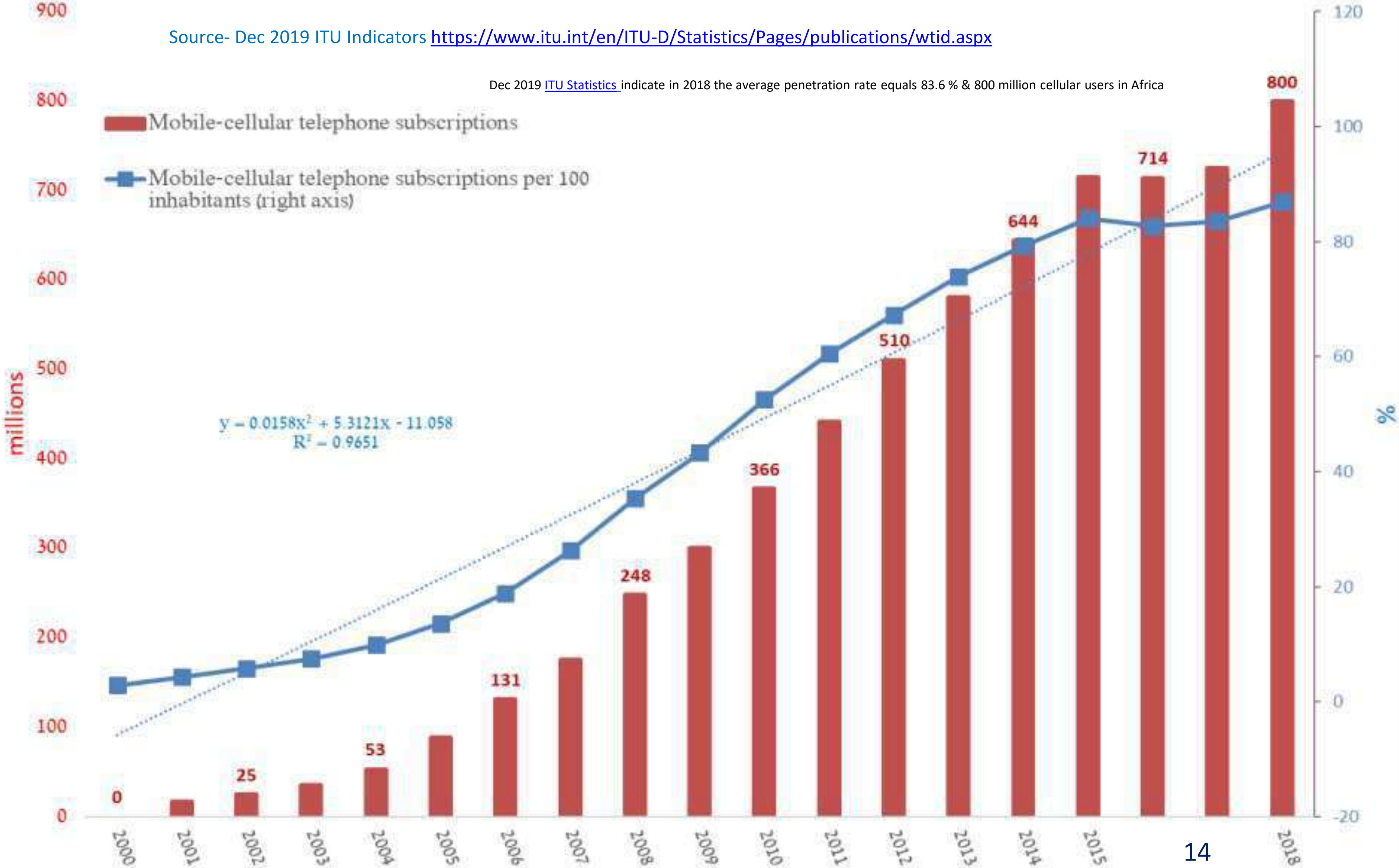


Source- Dec 2019 ITU Indicators https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

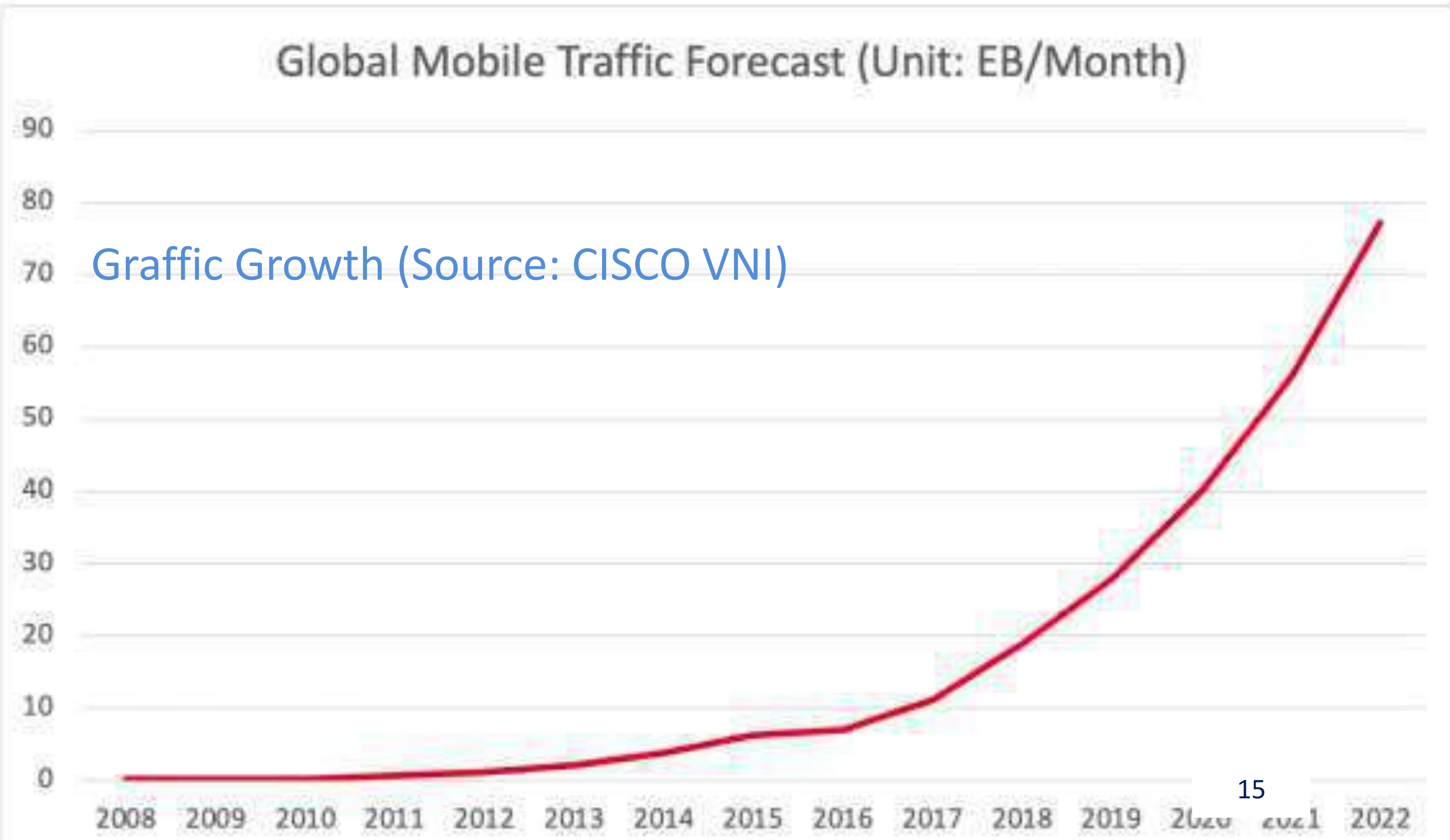
African cellular subscriptions (millions) & subscriptions per 100 inhabitants, 2000-2018

Source- Dec 2019 ITU Indicators https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

Dec 2019 ITU Statistics indicate in 2018 the average penetration rate equals 83.6 % & 800 million cellular users in Africa



Graffic Growth (Source: CISCO VNI)



Benefits of infrastructure sharing- economic benefits

1. No duplication of hardware
2. Economies of scale for providers and users
3. Reduced investment costs for operators and expected lower prices paid by consumers
4. Easier access to costly resources for new or small-operators
5. Reduced cost and risk of deployment

Model of shared use	Savings of operators
PIS	Up to 30%
AIS	Up to 50%
Spectrum sharing in AIS	Up to 10%

Benefits of infrastructure sharing- better service & competition

1. Faster rollout and wider reach, especially in less densely populated areas
2. Fewer interconnection disputes between operators because they are forced to cooperate
3. Access to scarce resources for new or small operators
4. Improved services
5. Lower barriers to competition
6. Also disadvantages: may harm competition; operators may match prices and services

Benefits of infrastructure sharing- environnemental

1. Preservation of open spaces
2. Green impact of mobile infrastructure on landscape
3. Less proliferation of base-stations; people dislike cellular masts near them; sharing infrastructure reduces the number of sites
4. Saves energy and carbon; footprint of mobile networks
5. Reduction in nuisance factors associated with civil engineering work (noise, degradation of public roads, obstacles to road traffic, accidents, etc.)
6. Urban planning and Aesthetics
7. Reduced RF hazards: not near the shared base station, but in general

Disadvantages of site-sharing

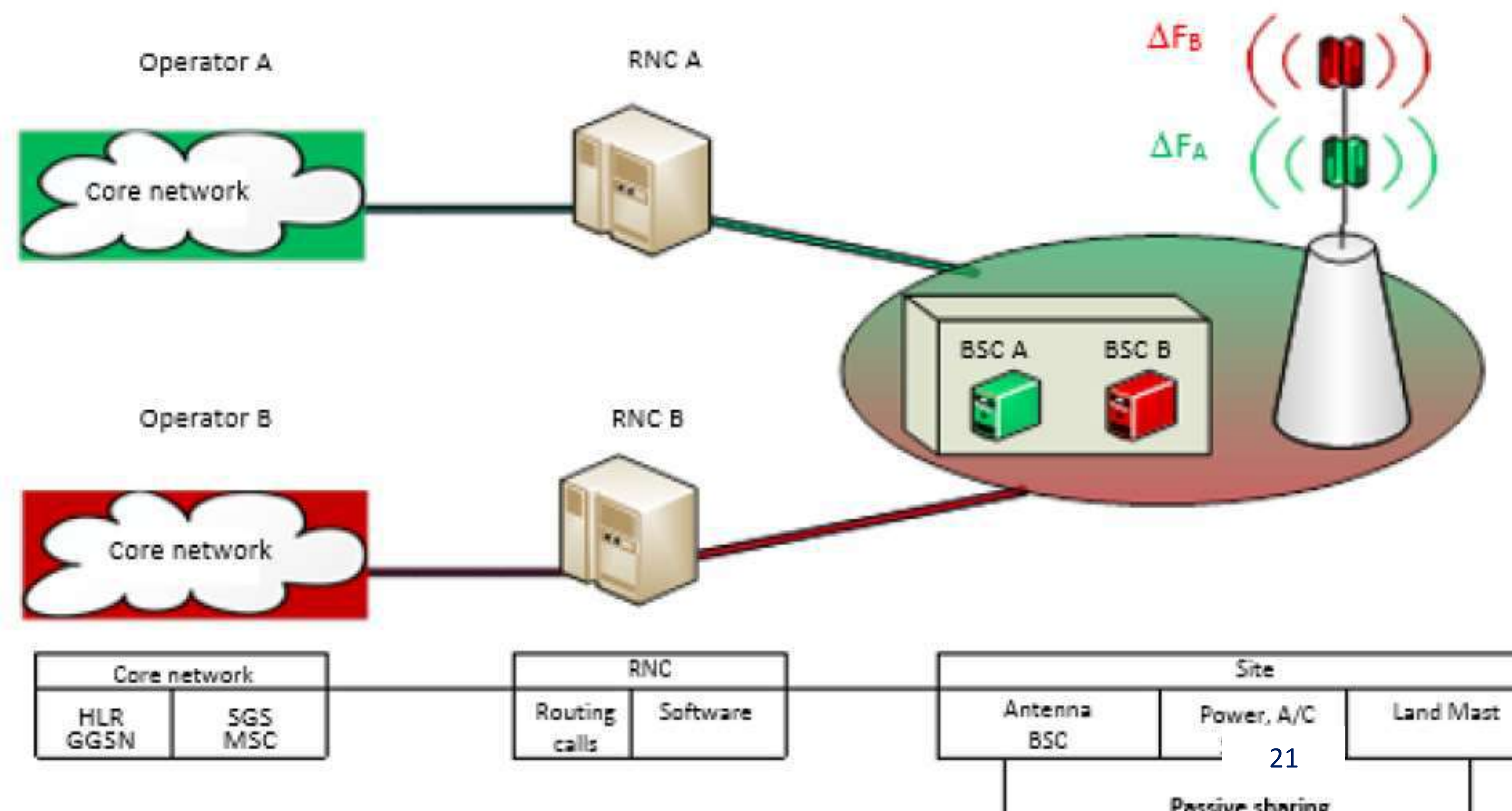
1. Increased EMF around the shared site
2. EMC problems among RF Transmitters & receivers
3. May affect negatively competition

Passive infrastructure

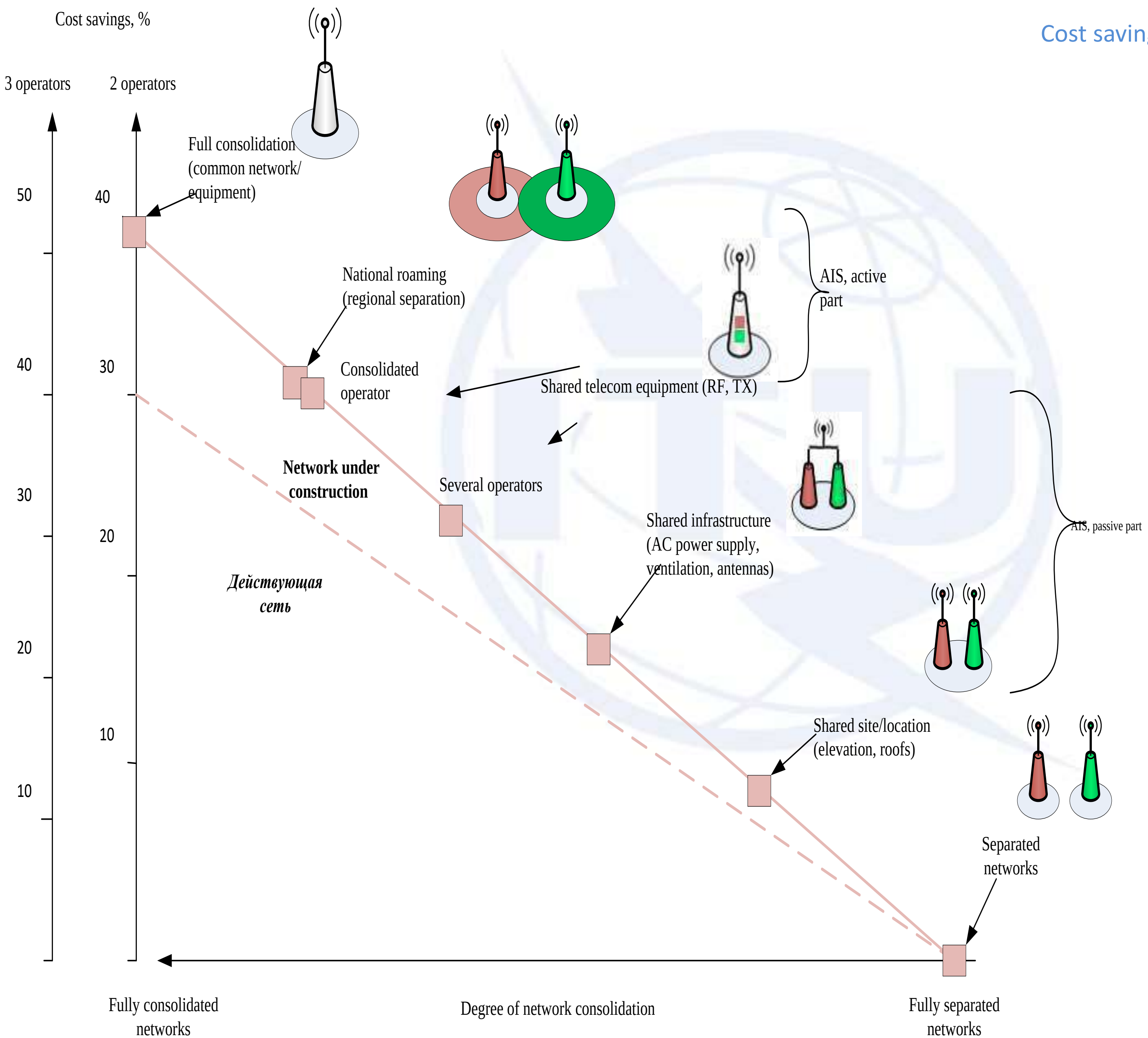
1. Not only with other Operators, with TV
2. sharing the non-electrical, civil engineering elements of base stations
3. (i) rights of way or easements, (ii) ducts, (iii) pylons, (iv) masts, (v) trenches, (vi) towers and poles, (vii) equipment rooms and associated power supplies, air conditioning and security systems
4. Passive elements are the physical network components that are not necessarily owned or managed by every operator
5. The passive infrastructure in a mobile network is composed mainly of: electrical or fibre-optc cables, masts and pylons, plots of land, towers, roof tops and other premises, shelter and support cabinets, electrical power supply, air conditoning, alarm systems
6. The regulator will need to (i) recommend the deployment of an open architecture, as opposed to an integrated vertical architecture; (ii) have a geographical informaton system (GIS) to determine the location and ownership of equipment to be shared; (iii) define certain infrastructure elements as essental; (iv) where appropriate, enforce operational separation of the body responsible for commercializing any sharing arrangements
7. Some countries, such as DRC and Côte d'Ivoire, provide for infrastructure sharing between operators in the sector, but also the possibility for a non-operator to make infrastructure available to operators, as is the case with TowerCo
8. Administrations follow has yet to be made clear in most of the regulations

Typical Passive model; Figure 10, Resolution 9

Figure 10: Typical PIS model



Cost savings depending network sharing, ITU-T Study Group 3 – Report 17



///Active infrastructure; sharing active electronic network elements

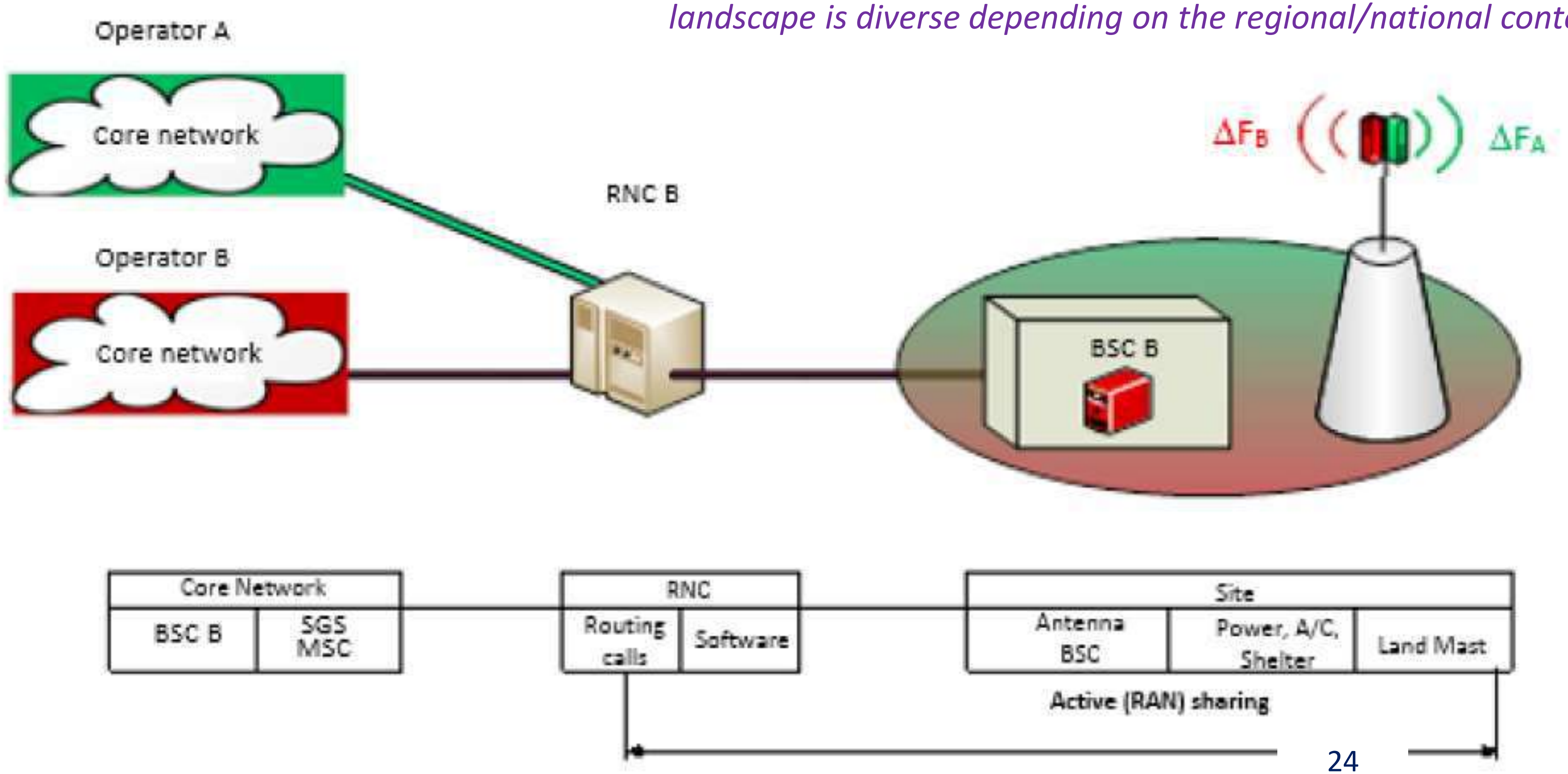
Efficient use of spectrum and network assets

1. Base stations and other equipment for mobile networks
2. Access node switches
3. Fibre-optic networks
4. Hardware active: Tx, Rx, Ant. Equipment of cellular and fixed wireless access
5. RF spectrum of cellular and fixed wireless access
6. Active infrastructure may affect competition
7. Some countries, like the Democratc Republic of the Congo (DRC), adopt the precautionary approach, and active infrastructure sharing is introduced gradually

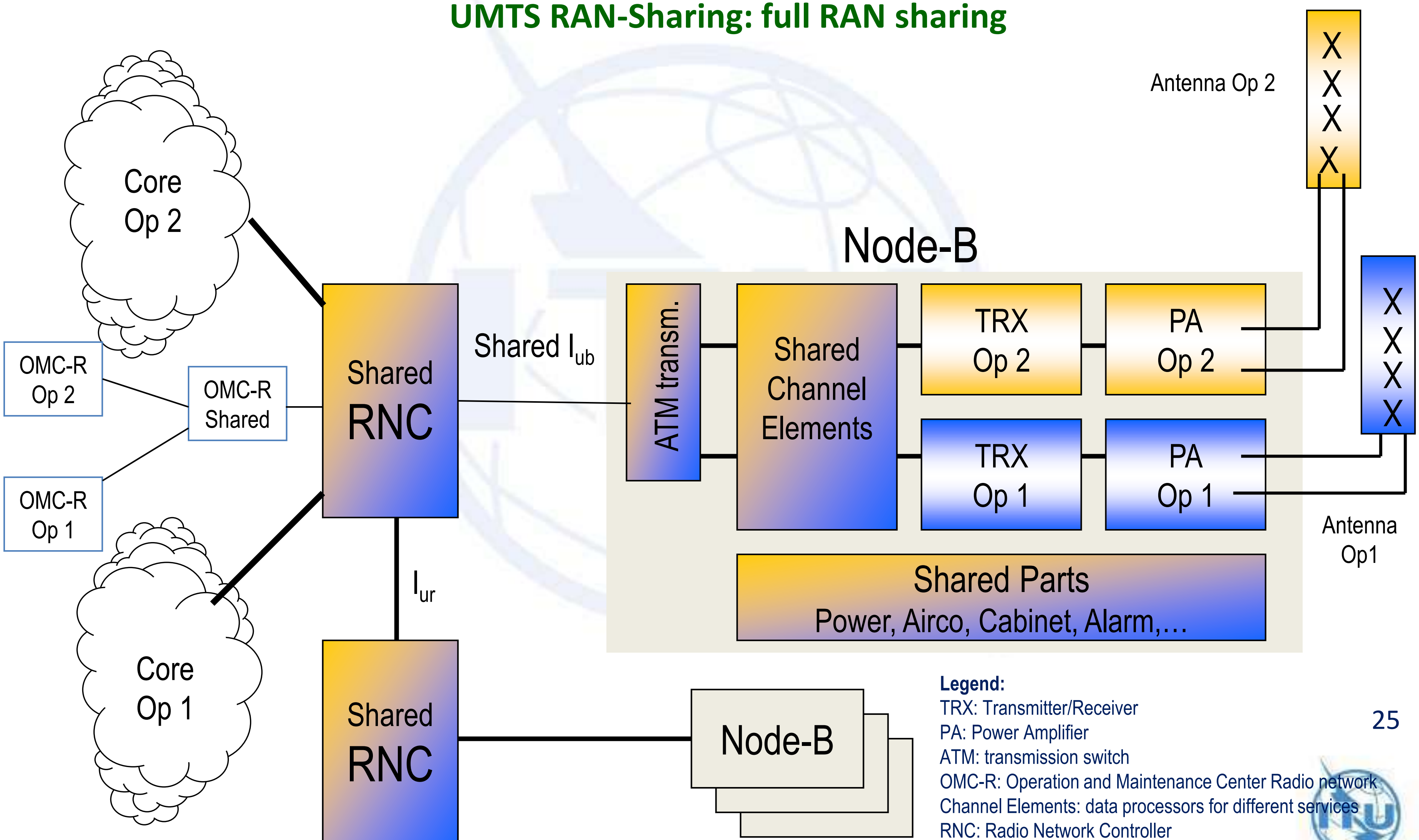
Typical Active Model; Figure 11, ITU-T Study Group 3 – Report 17

Figure 11: Typical AIS model

spectrum sharing or use of unlicensed spectrum as the regulator landscape is diverse depending on the regional/national contex



UMTS RAN-Sharing: full RAN sharing



Legend:
TRX: Transmitter/Receiver
PA: Power Amplifier
ATM: transmission switch
OMC-R: Operation and Maintenance Center Radio network
Channel Elements: data processors for different services
RNC: Radio Network Controller
Iub: logical connection (or interface) between RNC and Node-B

Regional Initiatives- Africa

1. The West African ICT Common Market set guidelines adopted by WATRA (the West Africa Telecommunicatons Regulators' Association) Accra, September 2005
2. The eighth Forum on Telecommunicatons/ICT Regulaton in Africa (FTRA-2007), Nairobi 6/7 June 2007, highlighted the Optical Power Ground Wire (OPGW), implemented jointly by the incumbent operators of Mali, Mauritania and Senegal in partnership with the Société de Geston de l'Énergie de Manantali (SOGEM), as a good example of sharing

Network sharing can lower costs and risks for operators & **bring significant benefits** in terms of rollout speed, network coverage & service quality

1. In the European regulatory framework, **obligations to share infrastructure can be imposed only under strict conditions**, in order to address specific market failures or public interest objectives
2. **Voluntary sharing agreements**, both in fixed and mobile networks are **promoted and incentivised**, while providing for appropriate pro-competitive safeguards
3. All agreements continue to be subject to **ex-post competition law** – but there is significant scope for pro-competitive sharing

Better connectivity; BEREC Common Position on Mobile Infrastructure Sharing Mission Critical Communications networks

1. Service improvements in terms of coverage (digital land development) or quality of service (throughput, service continuity or other **mission-critical performance parameters** such as low latency and reliability, e.g. needed for connected and automated driving along highways)
2. Facilitate the development of IoT, machine type communication, network slicing for the next generation networks, management of legacy technology or services with a long lifecycle (such as GSM-based machine-type communications, including access to e-Call for cars), etc.
3. Reduction of cost of deployment for passive infrastructure of high speed electronic communications network (also in line with the broadband cost reduction directive)

Main Findings

1. Development of telecommunications network infrastructure and increasing penetration of broadband to bridge the digital divide
2. Infrastructure and spectrum sharing contribute to attain these objectives by providing opportunities to decrease operators' costs and increasing efficiencies
3. Getting sustainable investment, increasing network deployment, facilitating new services, increasing the competition and reducing telecommunication services tariffs for end users

Promotion of infrastructure and spectrum sharing

1. In mobile networks, infrastructure sharing is mostly based on Commercial agreements rather than on a specific regulatory mandate.
2. Member States may promote infrastructure, enabling regulatory framework tailored to market requirements , to :

I. Establish the basic commercial, technical, legal and economic forms and procedures for infrastructure and spectrum sharing along with the obligations and rights of operators

II. Foster sharing negotiations between operators

III. Apply appropriate dispute resolution mechanis

Guidelines on Infrastructure Sharing

1. PRIDA may recommend that the guidelines, already proposed at the level of sub regional regulatory authorities and international forums (such as GSR) maybe implemented to take full advantage of the benefits of infrastructure sharing.
2. Governments and regulators may guide operators, through regulation or public investment, encouraging infrastructure sharing to optimize costs and accelerate network deployment, above all with regard to broadband.

Abbreviations

1. AIS Active infrastructure sharing
2. BTS Base transceiver station
3. CAPEX Capital expenditures
4. LTE Long-Term Evolution; 5G; IMT
5. OPEX Operating expenditures
6. PIS Passive infrastructure sharing
7. RAN Radio Access Network
8. RNC Radio Network Controller
9. UMTS Universal Mobile Telecommunications System

Thank you!

PRIDA Track 1 (T1)
Online training in English

On-line English workshop 20th April to 1st May 2020

Spectrum sharing and Dynamic Spectrum Access

Dr. Haim Mazar; ITU Expert
Vice Chair ITU-R Study Group5 (terrestrial Services)

Cognitive Radio Systems Report M.2225

CRS may modify these **operational parameters**, not limited to the following parameters:

Output power; Operating frequency; Modulation type; Radio access technology

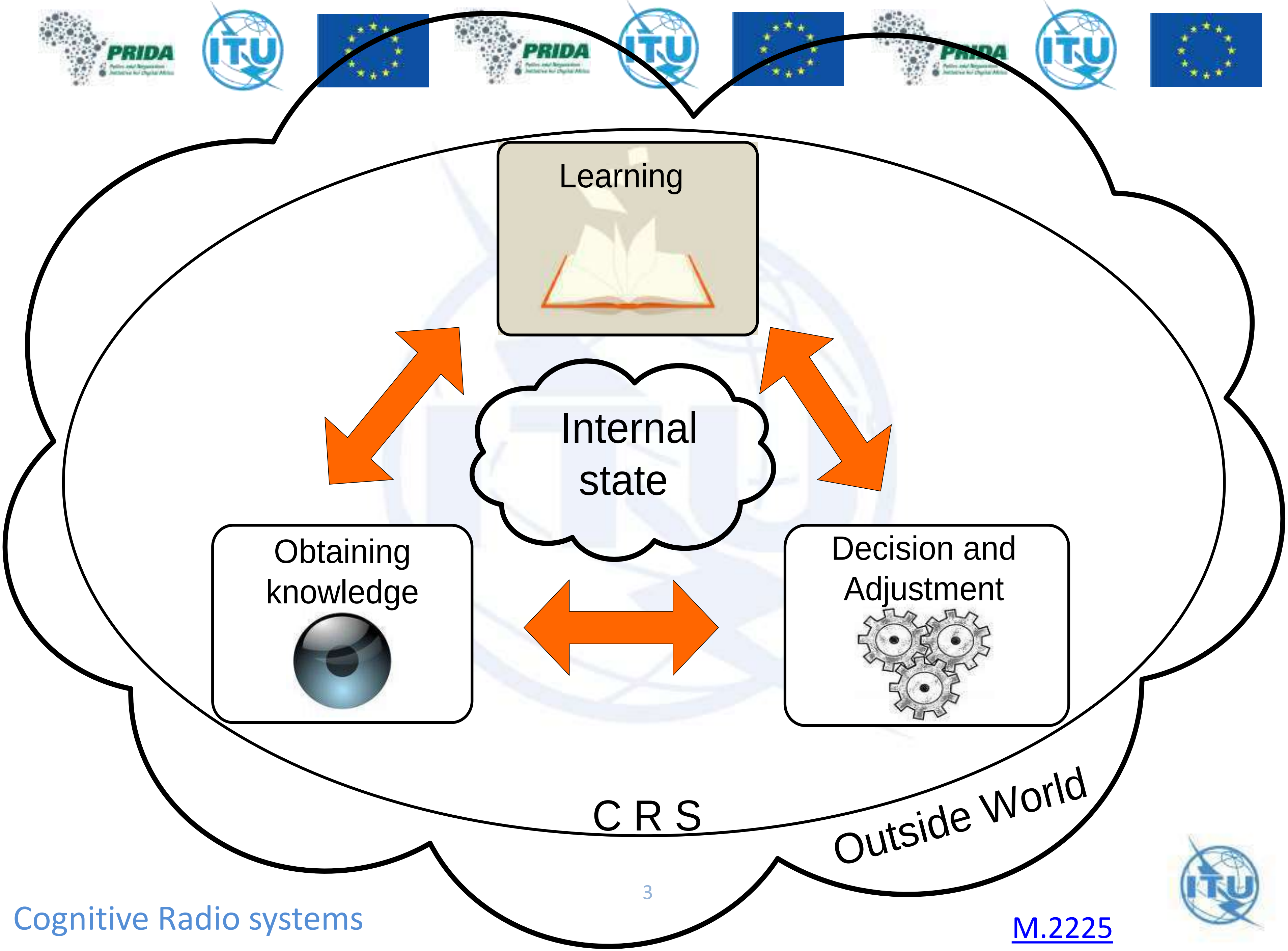
Potential benefits to system operators and end users

adding flexibility to assign RF

improving the efficiency of spectrum-use

improving the efficiency of power-use

benefits and the suitability of applications depend on the frequency band


Learning
Internal state
Obtaining knowledge
Decision and Adjustment
C R S
Outside World

M.2225

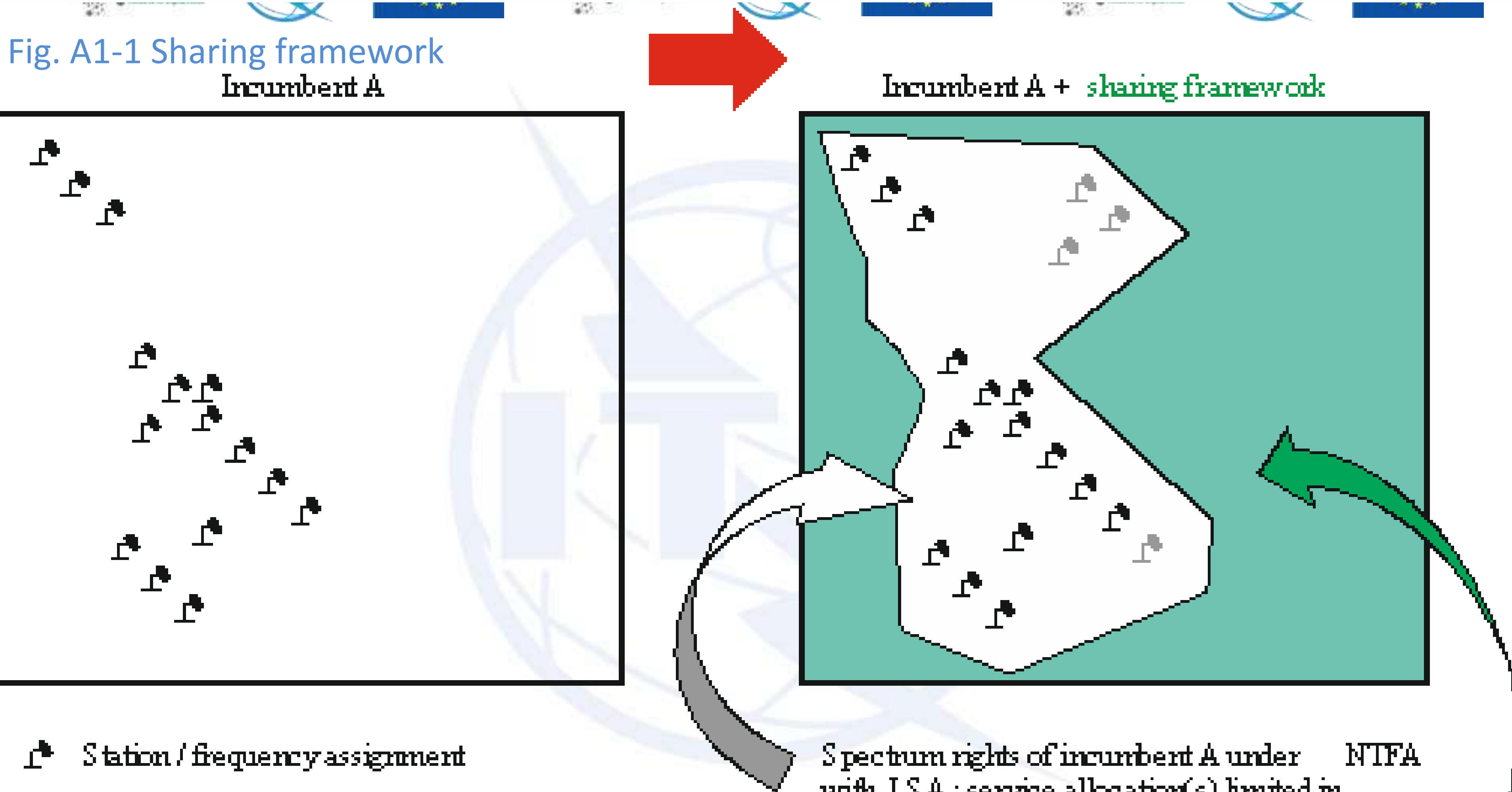
LSA as a complementary tool for spectrum management SM.2404

Licence Shared Access (LSA) is "A regulatory approach aiming to facilitate the introduction of radiocommunication systems operated by a limited number of licensees under an individual licensing regime in a frequency band already assigned or expected to be assigned to one or more incumbent users.

Under the LSA, additional users are authorised to use RF (or part of it) in accordance with sharing rules included in their rights of use of spectrum, thereby allowing all the authorised users, including incumbents, to provide a certain QoS.

In LSA the sharing can be done in the three dimensions, namely, time, frequency and area.

Fig. A1-1 Sharing framework



Station / frequency assignment

Spectrum rights of incumbent A under NTFA : service allocation(s) not restricted

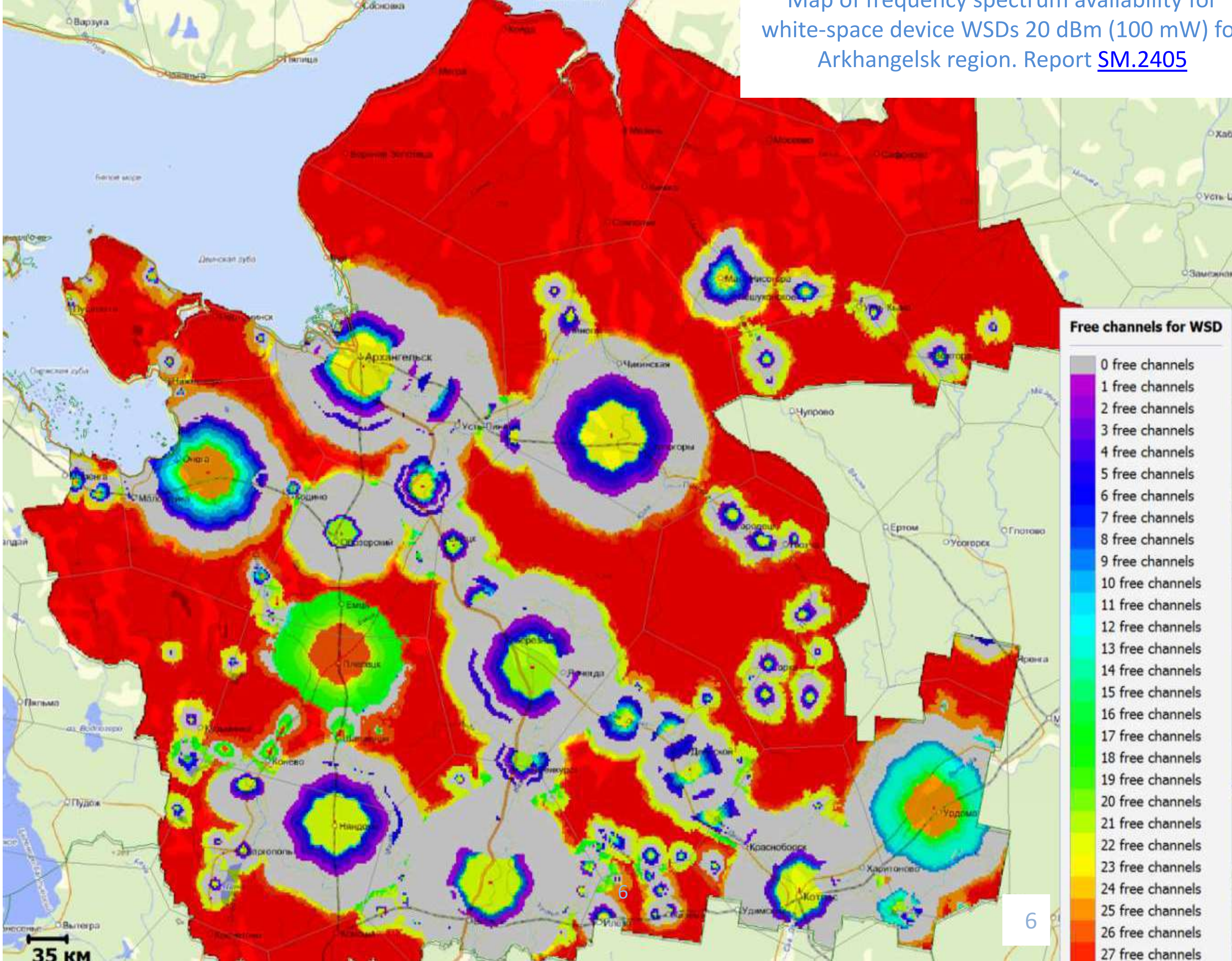
Spectrum rights of incumbent A under NTFA with LSA : service allocation(s) limited in accordance with the terms of the "sharing framework"

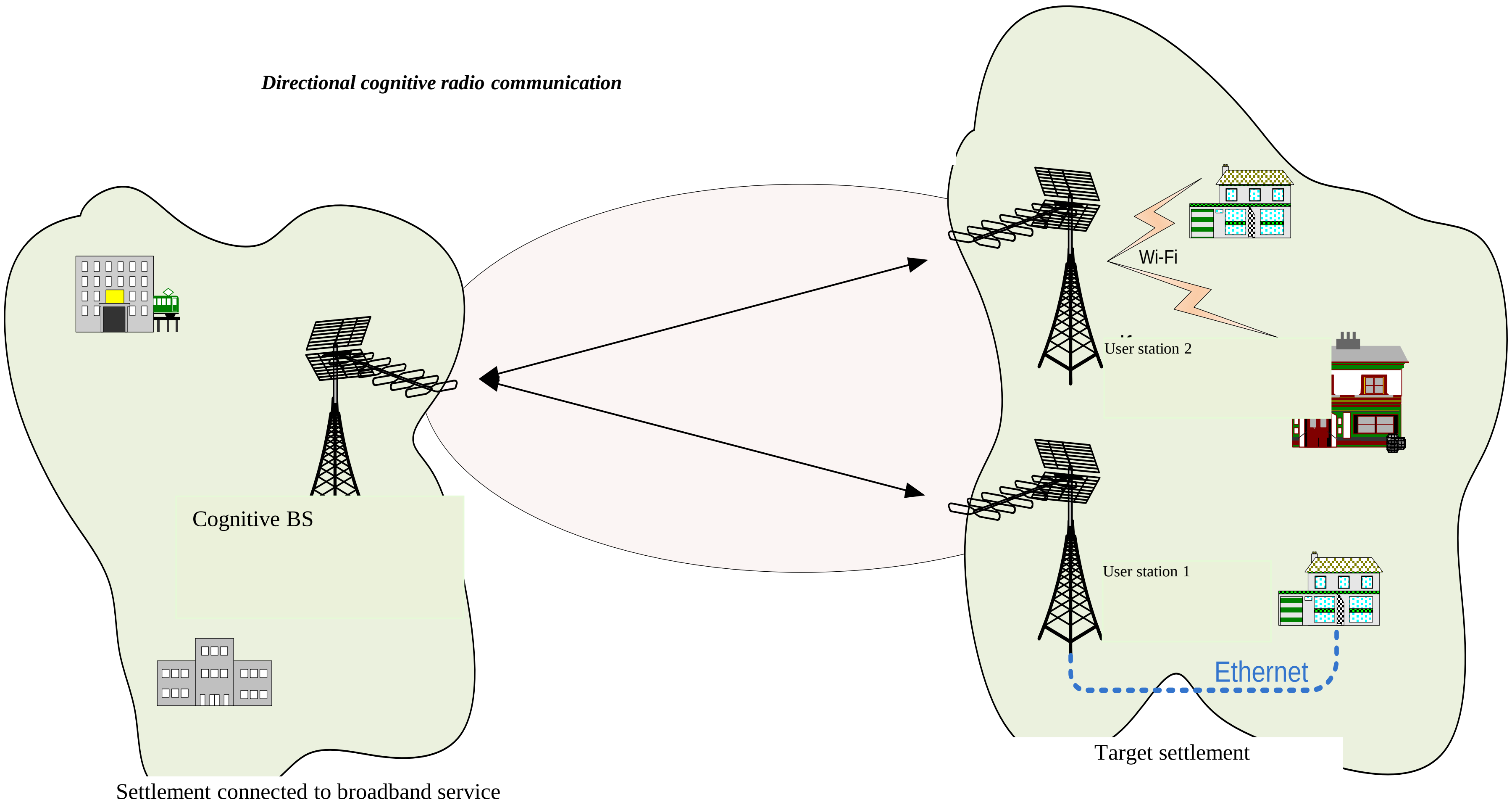
The "sharing framework" also defines the spectrum that can be made available for alternative usage under LSA.

RF availability is based on geographical separation. In the area marked green, the "sharing framework" defines availability to LSA users

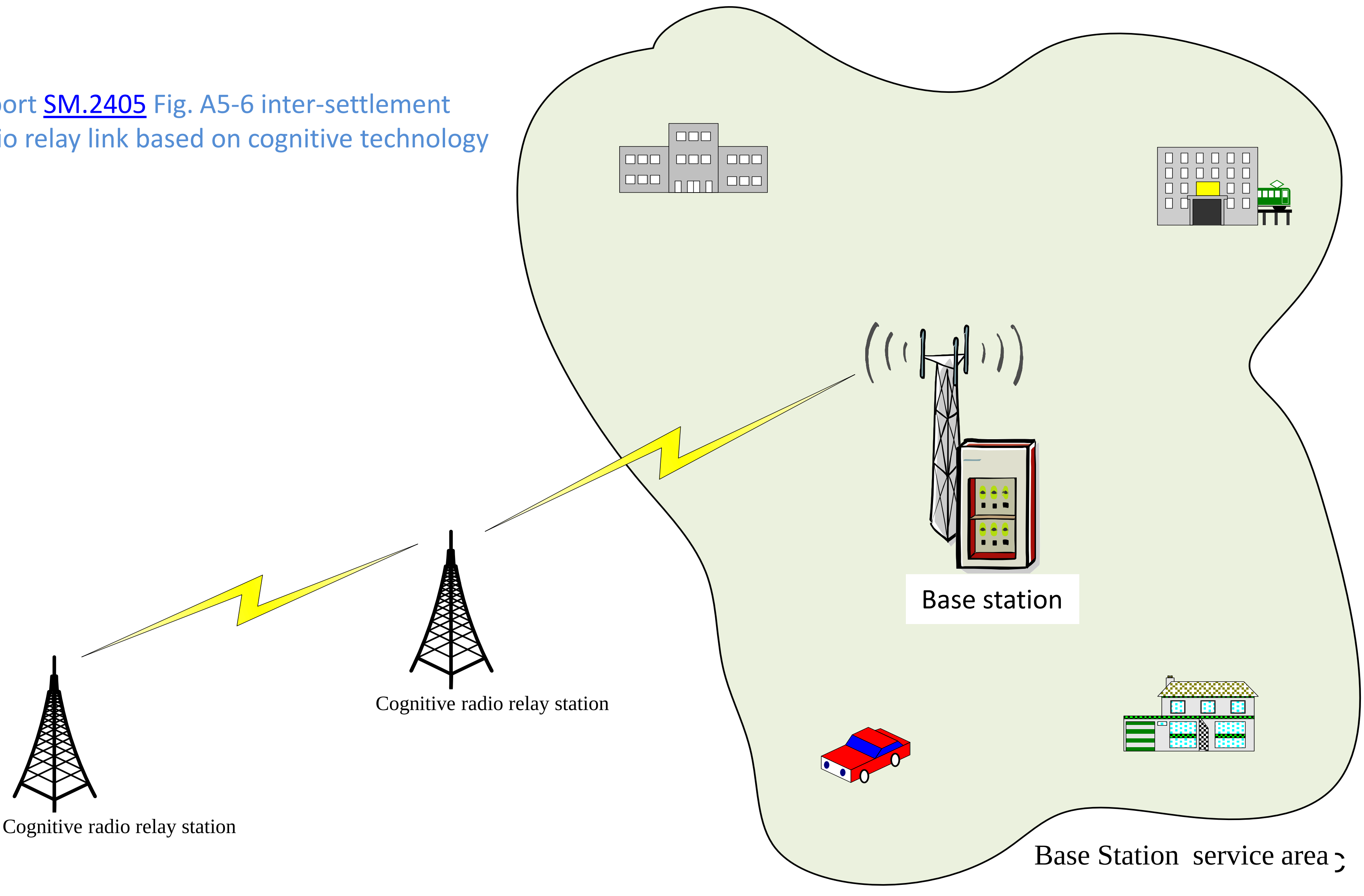
LSA takes into account for future needs of an incumbent, as depicted with grey stations in the Figure

Map of frequency spectrum availability for white-space device WSDs 20 dBm (100 mW) for Arkhangelsk region. Report SM.2405

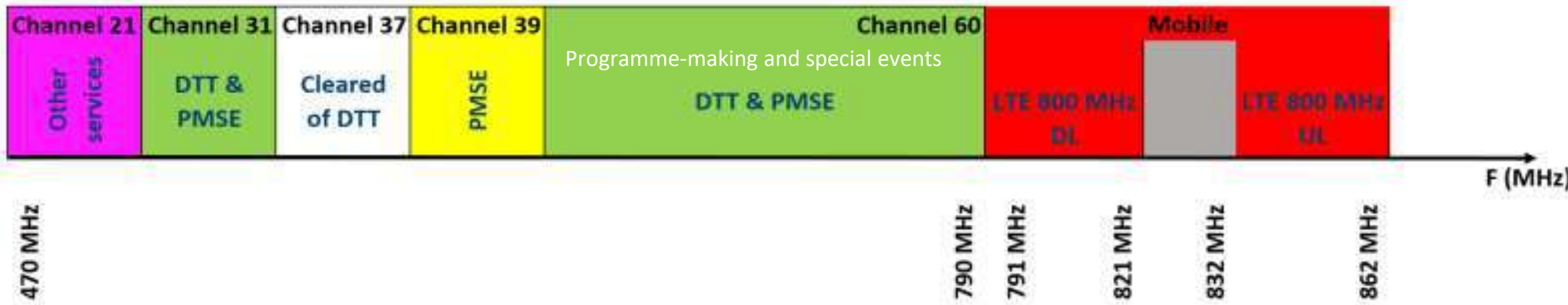



Directional cognitive radio communication
Wi-Fi
User station 2
Cognitive BS
User station 1
Ethernet
Target settlement
Settlement connected to broadband service

Report SM.2405 Fig. A5-6 inter-settlement radio relay link based on cognitive technology



SM.2405 Fig. A7-1 Illustrative UHF TV band (470-790 MHz) and its European users



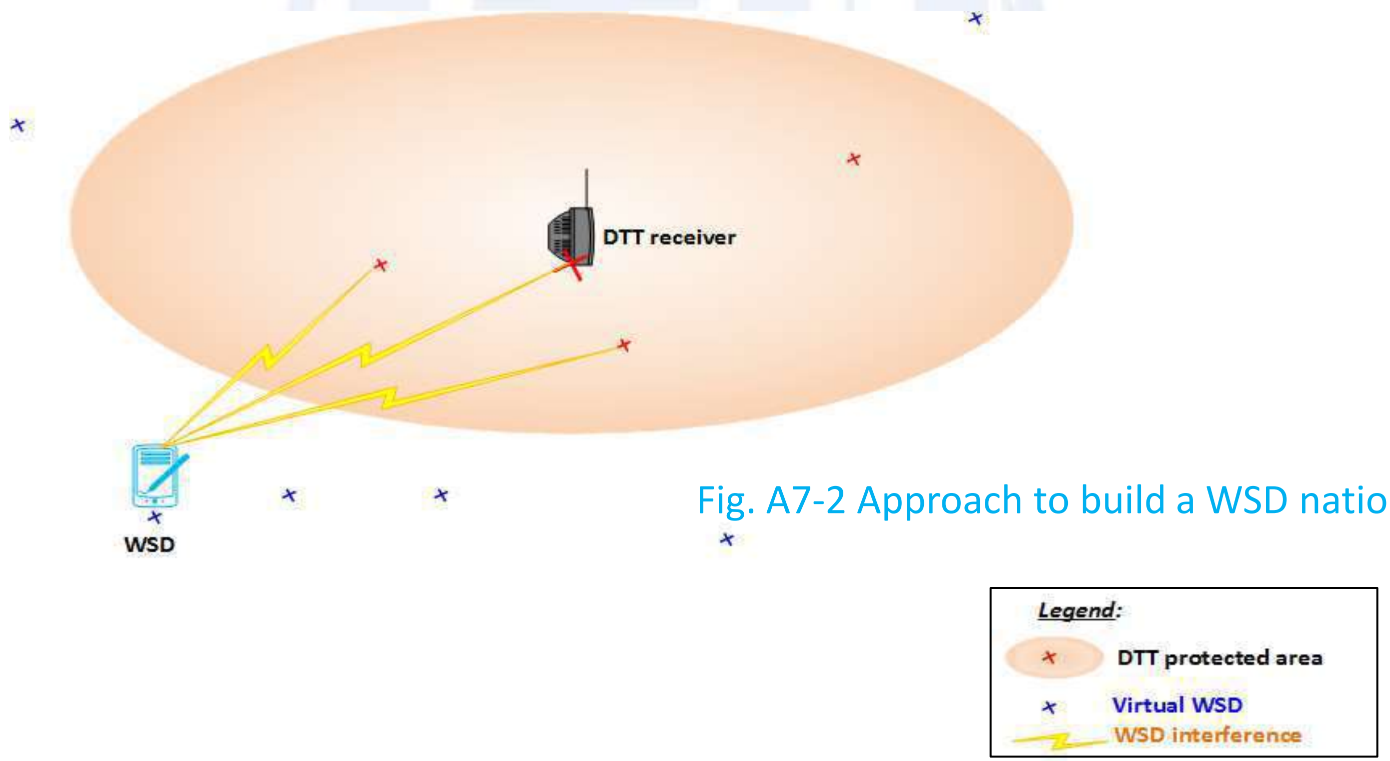
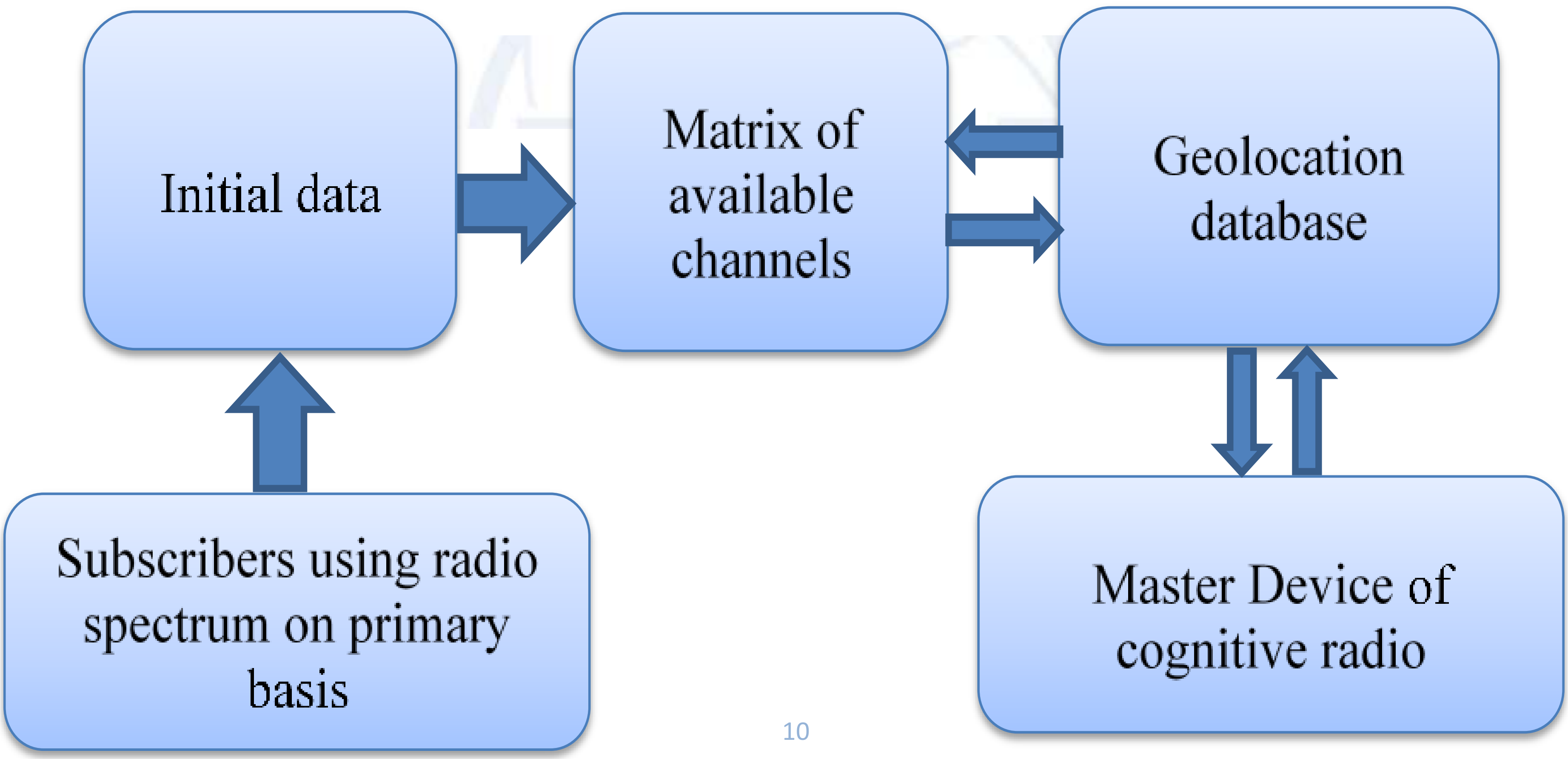


Fig. A7-2 Approach to build a WSD national database

9

Cognitive system using geolocation database Report SM.2405

The matrix of available channels is generated from the database on radio electronic devices with valid authorizations, and their specifications



RF to Operators Versus number of Sites, based on Shannon

Based on Shannon Hartley monumental paper (Shannon 1948 p. 43, theorem 17)

see Mazar 2016 –Radio Spectrum Management: Policies, Regulations and Techniques; 9.6.3

$$c = b \times log_2(1 + s/n)$$

1. Higher data rates oblige more RF spectrum and reduce the range achievable by the base station (WHO 2007 p.25-6 and155)
2. However, around the world, the RF Spectrum of cellular systems is the scarcest among wireless services, only comparable to the 87.5–108 MHz, FM radio broadcasting, known as Band II internationally.
3. As additional spectrum and active RF network-sharing (including RF spectrum) reduce the number of sites and human-hazards
4. Biglieri E., **Proakis** J. and **Shamai** (Shitz) S. October 1998 emphasize capacity, as the most important performance measure of cellular.

Thank you!

PRIDA Track 1 (T1)
Online training in English

On-line English workshop 20th April to 1st May 2020

Spectrum sharing:
Spectrum commons (unlicensed spectrum)
Short Range Devices (SRDs)

Dr. Haim Mazar; ITU Expert
Vice Chair ITU-R Study Group5 (terrestrial Services)

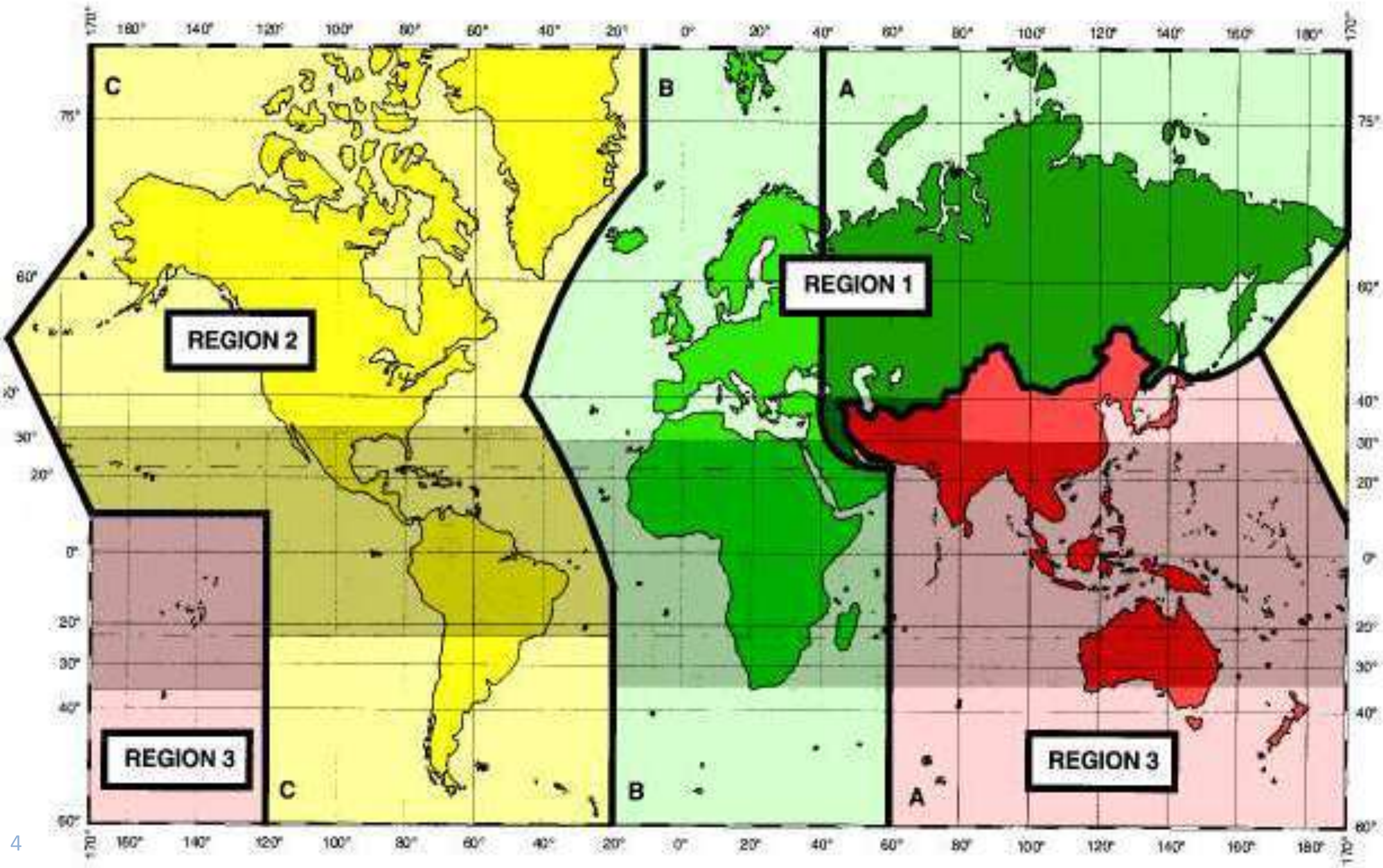
Definitions

1. The regulatory framework for SRDs is a national matter
2. SRDs are not a “Radio Service” under ITU Radio Regulations RR; thus they cannot get primary or secondary allocation
3. SRDs are emissions without a corresponding frequency allocation in the RR
4. SRDs are not ISM applications, as defined in No. 1.15 of RR
5. SRD covers radio transmitters, providing either unidirectional or bi-directional communication, with low capability of causing interference to other radio equipment
6. For SRDs, individual licenses are normally not required
7. SRDs are permitted to operate on a *non-interference* and non-protected basis
8. In general SRDs cannot claim protection from radio services, intentional or unintentional radiator, by ISM equipment, or by an incidental radiator
9. SRDs are deployed in both bands designated for ISM applications and bands not designated for ISM applications
10. SRDs are deployed in both bands designated for **ISM** applications and bands not designated for ISM applications. ISM band is **sufficient condition but not obligatory**; SRD band is different than ISM band

ISM Bands: ITU 2016 Radio Regulations RR

6 765-6 795 kHz	(centre frequency 6 780 kHz)	FN 5.138
13 553-13 567 kHz	(centre frequency 13 560 kHz)	FN 5.150
26 957-27 283 kHz	(centre frequency 27 120 kHz)	FN 5.150
40.66-40.70 MHz	(centre frequency 40.68 MHz)	FN 5.150
433.05-434.79 MHz	(centre frequency 433.92 MHz) in Region 1*	FN 5.138
902-928 MHz	(centre frequency 915 MHz) Region 2	FN 5.150
2 400-2 500 MHz	(centre frequency 2 450 MHz)	FN 5.150
5 725-5 875 MHz	(centre frequency 5 800 MHz)	FN 5.150
24-24.25 GHz	(centre frequency 24.125 GHz)	FN 5.150
61-61.5 GHz	(centre frequency 61.25 GHz)	FN 5.138
122-123 GHz	(centre frequency 122.5 GHz)	FN 5.138
244-246 GHz	(centre frequency 245 GHz)	FN 5.138

ITU RF Allocation; three Regions



Frequency Bands for SRDs

Global
Only in Europe
Only in Americas

ISM bands for SRDs

6,780 kHz; 13,560 kHz
27,120 kHz; 40.68 MHz
433.92 MHz
915 MHz
2,450 MHz; 5,800 MHz
24.125 GHz;61.25 GHz
122.5 GHz ;245 GHz

non-ISM candidate bands for SRDs

9-148.5 kHz; 3,155-3,400 kHz
9 kHz- 47 MHz (specific SRDs)
7,400-8,800 kHz
138.20-138.45 MHz
169.4-216 MHz
312-315MHz (non Europe)
402-405 MHz medical devices
470-489 MHz (normally individually licensed)
823-832 MHz and 1,785-1,805 MHz
862-875 MHz in some Asian counties
862-876MHz Non-Specific SRDs
915-921 MHz (in some countries)
5,150-5,350 & 5,470-5,725 MHz
57-64GHz, 76-77GHz, 77-81GHz

Mazar 2016 –Radio Spectrum Management: Fig. 3.1

5

SRDs regulation & standardisation are divided into 3 major camps: Europe, N. America & Asia

Europe constrains wideband data transmission in 5150–5350 MHz, to only indoor use (some changes at WRC-19)

The Radio Equipment Directive 2014/53/EU (RED) is more liberal: self-conformity not FCC *ex-ante* certification; *laissez passer;* tests *ex-post* . Different processes to update the 70-03 and Part 15

Part 15 American *Licence-Exempt Devices vs. European Short Range Devices.* Europe permits lower emissions: e.g., e.i.r.p. 0.1W versus 4W at 2.4 GHz

FCC Part 15 originated in 1938, inspired the European SRD concept (~1990) and ERC/REC 70-03. In US and Canada most of the RF is available to SRD

Placing on the market in the US. Any Part 15 must be tested and authorized before it may be marketed. There are two ways to obtain authorization: Certification & Verification

Rec. SM.1896 Ann.1: SRDs global harmonization

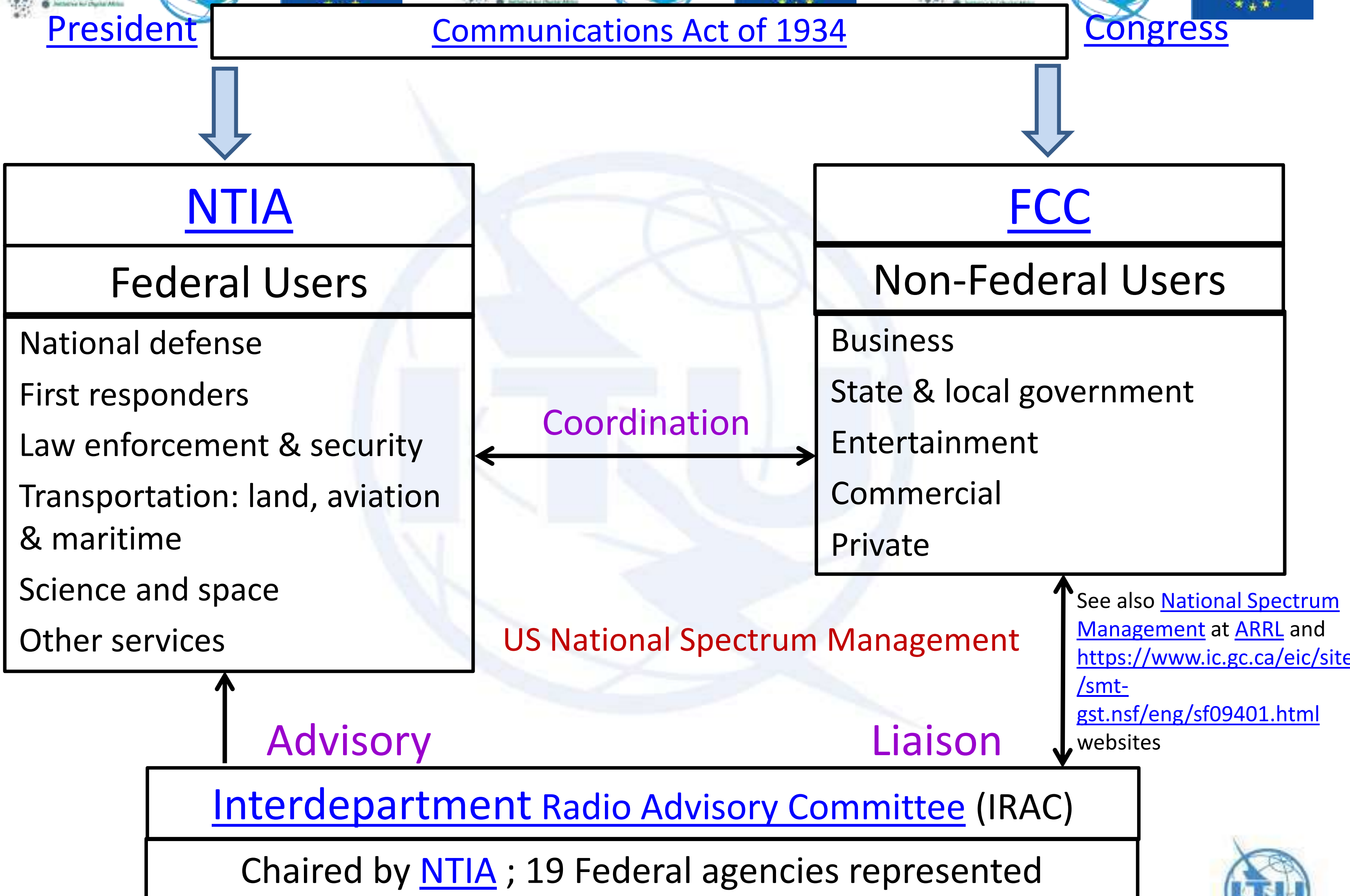
RF Range	Remarks
9-148.5 kHz	Inductive SRD applications
3 155-3 400 kHz	Inductive SRD applications RR No. 5.116
6 765-6 795 kHz	Inductive SRD applications ISM band (RR No. 5.138) Centre frequency 6 780 kHz
13.553-13.567 MHz	Inductive SRD applications; ISM band (RR No. 5.150); Centre frequency 13.560 MHz; Level of side band suppression is dependent on national regulations
26.957-27.283 MHz	Inductive SRD applications/non-specific SRDs; ISM band (RR No. 5.150); Centre frequency 27 120 kHz
40.66-40.7 MHz	ISM band (RR No. 5.150); Centre frequency 40.68 MHz
2 400-2 500 MHz	ISM band (RR No. 5.150); Centre frequency 2 450 MHz
5 725-5 875 MHz	ISM band (RR No. 5.150); Centre frequency 5 800 MHz
24.00-24.25 GHz	ISM band (RR No. 5.150); Centre frequency 24.125 GHz
61.0-61.5 GHz	ISM band (RR No. 5.138); Centre frequency 61.25 GHz
122-123 GHz	ISM band (RR No. 5.138); Centre frequency 122.5 GHz
244-246 GHz	ISM band (RR No. 5.138); Centre frequency 245 GHz

Frequency ranges for regional harmonization of SRDs (SM.1896 Annex 2)

Frequency range	Remarks	Region 1	Region 2	Region 3
7 400-8 800 kHz		Available	Available	Available in some countries
312-315 MHz	These bands are exchangeable in terms of applications but not always available at the same time in one country.	Available in some countries	Available	Available in some countries
433.050-434.790 MHz	433.050-434.790 MHz is an ISM band (RR No. **5.138** in Region 1) except for countries mentioned in RR No. **5.280**. Centre frequency 433.92 MHz. The whole of these bands can be considered as a tuning range. However, they may not be completely available in some countries. See national regulations.	Available	Available in some countries	Available in some countries
862-875 MHz	The whole of this band can be considered as a tuning range. Only parts of this tuning range are operationally available in each country due to the use by commercial mobile systems. See national regulations.	Available	Not available	Available in some countries
875-960 MHz	902-928 MHz is an ISM band in Region 2 (RR No. **5.150**). Centre frequency 915 MHz. The whole band can be considered as a tuning range. Only parts of this tuning range are operationally available in some countries. The band 880-960 MHz is not available for SRDs in a number of countries due to the use by commercial mobile systems.	Available in some countries	Available. See remarks	Available in some countries
3.1-4.8 GHz 6-9 GHz	UWB application for communication, location tracking, radio determination(1)	Available in some countries	–	Available in some countries

Technical requirements applicable in certain administrations or regions

General band	Adm. or region	Specific RF band (MHz)	Tx output power (mW) (except as noted)	Antenna gain (dBi)
2.4 GHz band	USA	2,400-2,483.5	1,000	0-6 dBi (Omni)
	Canada		**4 W e.i.r.p.**	N/A
	Europe		**100 mW (e.i.r.p.)**	N/A
	Japan	2,471-2,497 2,400-2,483.5	10 mW/MHz 10 mW/MHz	0-6 dBi (Omni) 0-6 dBi (Omni)
5 GHz band	USA	5,150-5,250 5,250-5,350 5,470-5,725 5,725-5,850	50mW; 2.5 mW/MHz 250mW; 12.5mW/MHz 250mW; 12.5mW/MHz 1,000mW; 50.1mW/MHz	0-6 dBi (Omni) 0-6 dBi (Omni) 0-6 dBi (Omni) 0-6 dBi (Omni)
	Canada	5,150-5,250 5,250-5,350 5,470-5 725 5,725-5,850	200 mW e.i.r.p.; 10 dBm/MHz e.i.r.p. 250 mW; 12.5 mW/MHz; (11 dBm/MHz) 1,000 mW e.i.r.p. 250 mW; 12.5 mW/MHz (11 dBm/MHz) 1,000 mW e.i.r.p. 1,000 mW; 50.1 mW/MHz	https://www.itu.int/pub/R-REP-SM.2153-7-2019
	Europe	5,150-5,250 5,250-5,350 5,470-5,725	200 mW (e.i.r.p.); 10 mW/MHz (e.i.r.p.) 200 mW (e.i.r.p.); 10 mW/MHz (e.i.r.p.) 1,000 mW (e.i.r.p.); 50 mW/MHz (e.i.r.p.)	
	Japan	4,900-5,000 5,150-5,250 5,250-5,350 5,470-5,725	250 mW 50 mW/MHz 10 mW/MHz (e.i.r.p.) 10 mW/MHz (e.i.r.p.)	13 N/A N/A N/A



19 federal agencies in IRAC; + FCC as Observer

ISM applications in & outside ISM bands

Frequency	Applications
Below 1,000 kHz	Induction heating; ultrasonic cleaning and medical diagnostics; Domestic induction cookers; metal melting; billet heating; tube welding; soldering and brazing; component heating; spot welding; selective surface heat; treating of metal parts; semiconductor crystal growing and refining; seam bonding of autobody surfaces; package sealing; heating strip steel for galvanizing, annealing and paint drying; electrical surgical units (ESU); hyperthermia equipment
1-10 MHz	Surgical diathermy (dampened wave oscillator); wood gluing and wood curing (3.2 and 6.5 MHz); valve induction generators production of semi-conductor material; RF arc stabilized welding; ESU
10-100 MHz	Dielectric heating and material preheating. The majority operate in the ISM RF bands at 13.56, 27.12 and 40.68 MHz, but many also operate on frequencies outside the ISM bands): drying (textile, fiberglass, paper and paper coating, veneer and lumber, foundry core, glue, film, solvent, food), ceramics, business products (books, paper, gluing and drying), food (post baking, meat and fish thawing), wood gluing, plastic heating (welding and moulding, die sealing and plastic embossing), adhesive curing. Medical applications: medical diathermy and hyperthermia equipment (27 MHz), MRI (10-100 MHz in large shielded rooms)
100-915 MHz	Medical applications (433 MHz), hyperthermia equipment (433 MHz and 915); food processing (915 MHz); RF plasma generators; Rubber vulcanization (915 MHz); MRI
Above 915 MHz	**Microwave ovens** domestic and commercial (915 MHz and 2,450 MHz), food tempering, thawing and cooking; RF excited ultra-violet paint and coating curing; pharmaceutical processing; RF plasma generators; rubber vulcanization (magnetrons at 915 and 2450 MHz)

Typical SRDs Applications

1. Wideband data trans`mission: RLAN/Wi-Fi, UWB, White Space Devices (in the USA, white space devices operate on a non-protected, non-interference basis), Wideband Low Activity Mode (WLAM), short range video
2. RF IDentification (RFID), active medical implants, health monitoring, personal identification, inductive systems, proximity sensors
3. Car door openers, Transport and Traffic Telematics (TTT), road tolling, Automatic Meter Reading (AMR), Street Lamp Monitoring and Control, railway applications, car immobilisers
4. Logistics, livestock, Electronic Article Surveillance (EAS)
5. Radiodetermination: Automotive Short Range Radar (SRR), RF level gauges, radar sensor, Level Probing Radar (LPR)
6. Near Field Communication (NFC) & voice like: walkie-talkie, baby monitoring, remote control, radio microphone, cordless loudspeakers and telephones, aids for the hearing impaired, voice enabled data collection
7. Telemetry, tracking, tracing and data acquisition, model control, home automation, automotive industry, sensor monitoring
8. Alarm, social alarms, anti-theft
9. Internet of Things (IoT); IoT may also operate as a cellular application

RFID technology, as a typical SRD

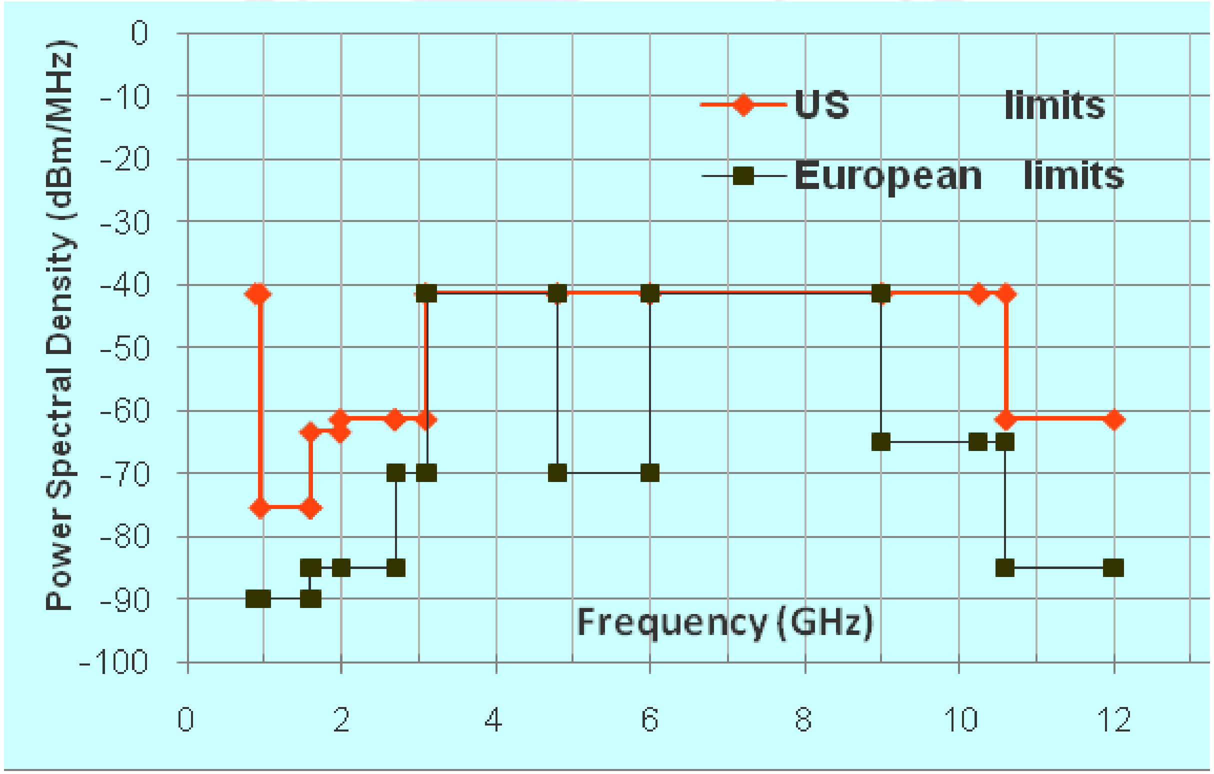
1. RFID was developed by the British Air Force during World War II to identify enemy aircrafts: identification, friend or foe (IFF)
2. RFIDs consist of transponders or tags, in objects to be identified
3. Many kinds of RFIDs, depending on power source , RF & functionality
4. 3 types: passive, semi active and active
   1) Passive: no internal power, inductive coupling or backscattering short range, unlimited life
   2) Semi-passive: like passive but uses battery for electronic components
   3) Active: battery powered incl. active transmitter; larger size, longer range, shorter life
5. Technological advances in RFID in recent years:
   1) RTLS (Real Time Location Systems): addition of location functionality to identification and data transfer, utilizing triangulation and other techniques
   2) 5.9GHz DSRC : "Wi-Fi for cars" for high data rate low latency V2V (vehicle to vehicle) and V2I (vehicle to infrastructure) communication

Wireless Power Transfer (WPT) as SRD, CISPR's and China's views

1. ITU RR No. 1.15 *ISM applications:* operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, **excluding applications in the field of *telecommunications***
2. WPT with no data communication (e.g. Blue Tooth or ZigBee) is ISM, and may operate in all ISM bands
3. 'equipment with a WPT function may be regarded as another type of SRD' (CISPR/1302/INF; 2015-03-20)
4. WPT is SRD only if there are telecommunications
5. USA separates between FCC Part 15 for 'Radio Frequency Devices' and FCC Part 18 for ISM

UHF RFID: Americas versus Europe, UWB emission

	RF band (MHz)	Max e.i.r.p. power (Watts)	Channels (kHz)	Total RF BW(MHz)	Approval process
Europe	865-868	up to 2 (e.r.p.) x 1.64=3.28	15 x 200	3	*R&TTE*
Americas	902-928	4*	52 x 500	26	US tests every RFID



Differences up to 49 dB@900-960MHz; Europe allowed UWB in 2005, US in 2001

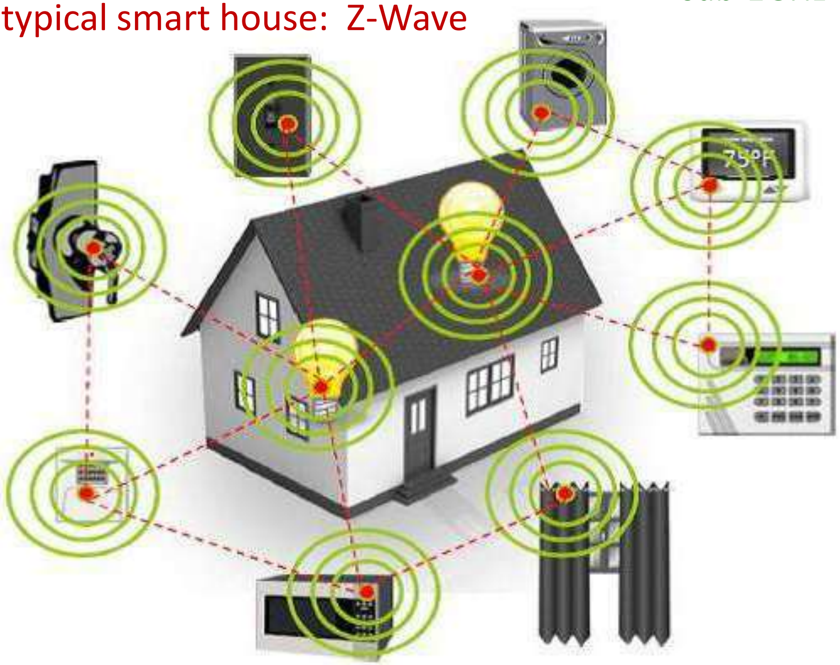
SRDs & smart sustainable world, cities, houses, cars

SRDs provide ICT's vital infrastructure & connection for Smart Sustainable Cities

Source: ITU-T Report 2014 *EMF Considerations in Smart Sustainable Cities*

Current sub-1GHz

typical smart house: Z-Wave

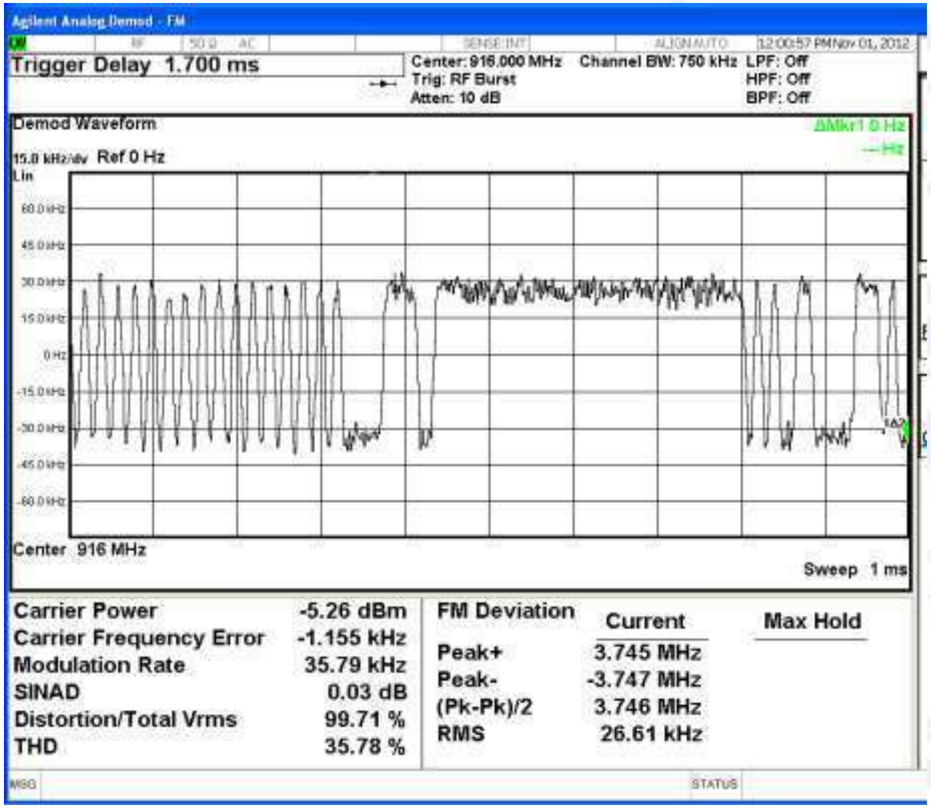


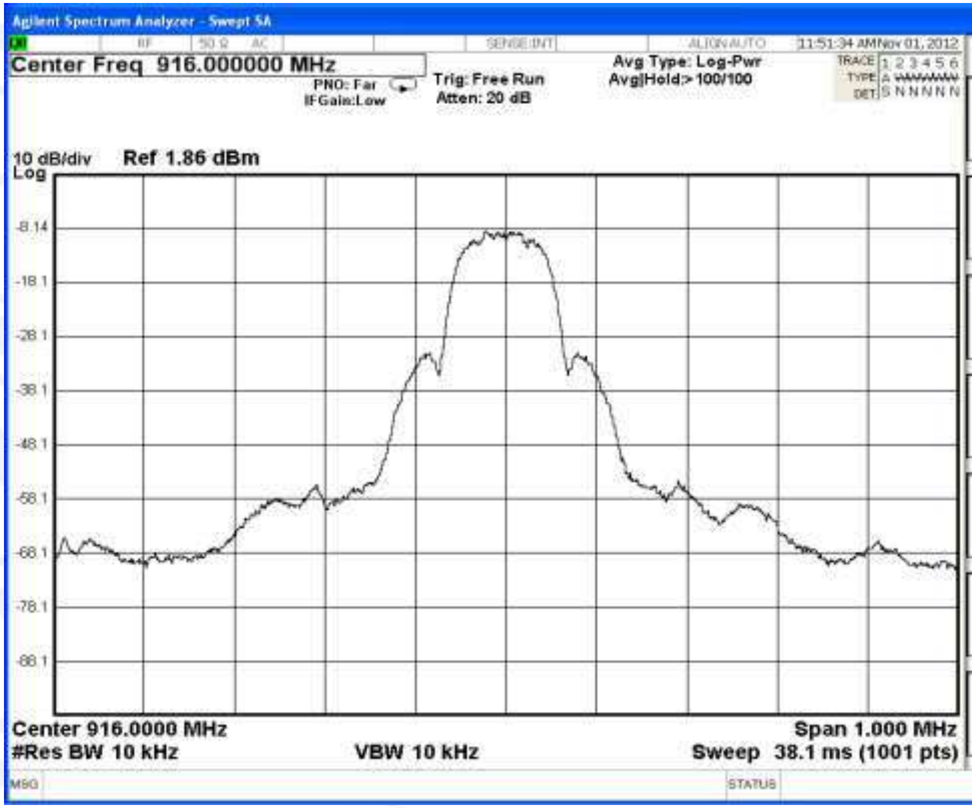
designed mainly for remote controls, smoke alarms and security sensors

1. Z-Wave uses a single frequency FSK
2. Data rate up to 100 Kbps; unlike IEEE 802.11, designed primarily for high-bandwidth data flow
3. Range between controllers & slave devices up to 100 ft

Country/Region	Standard	Z-Wave RF
Australia	AS/NZS 4268	921.4 MHz
Brazil	ANATEL Resolution 506	921.4 MHz
CEPT	EN 300 220	868.4 MHz
Chile	FCC CFR47 Part 15.249	908.4 MHz
China	CNAS/EN 300 220	868.4 MHz
Hong Kong	HKTA 1035	919.8 MHz
India	CSR 564 (E)	865.2 MHz
Israel	MoC Wireless Act	915-917 MHz
Japan 950 (obsolete by end of 2015)	ARIB T96	951-956 MHz
Japan 920 (since Feb 2012)	ARIB STD-T108	922-926 MHz
Malaysia	SKMM WTS SRD/EN 300 220	868.1 MHz
Mexico	FCC CFR47 Part 15.249	908.4 MHz
New Zealand	AS/NZS 4268	921.4 MHz
Russia	GKRCh/EN 300 220	869.0 MHz
Singapore	TS SRD/EN 300 220	868.4 MHz
South Africa	ICASA/EN 300 220	868.4 MHz
Taiwan	NCC/LP0002	922-926 MHz
UAE	EN 300 220	868.4 MHz
USA/Canada	FCC CFR47 Part 15.249	908.4 MHz

New Technologies, Time and Frequency Domains





Preserving Vultures

SRD to track (& preserve) short-toed snake-eagle

Calculating Electric and Magnetic fields

- For RF lower than 30 MHz, power limits are usually converted to magnetic fields at 10 m; see Rec. 70-03. The magnetic field strength (*h*) unit is the A/m. The magnetic field strength may be expressed in µA/m or dB(µA/m). Below 1,000 MHz, ERP is used. 70-03 uses logarithmic dB µA/m magnetic-fields at 10 m. Use of dB µA/m unit globally reveals 70-03 influence; e.g. first 2 rows at Table 2 APT Report APT/AWG/REP-07
- Most of Part 15 of the American FCC Regulation 47 CFR emission limits are specified in field strength; numeric units V/m, mV/m and µV/m; and not the logarithmic dB V/m, dB mV/m or dB µV/m; mainly at 3 m distance; 30 m (at 490 to 30,000 kHz) and 300 m (at 9 to 490 kHz) are also used. Japan, Korea, some Latin Americas and many other countries follow this procedure for SRDs; it reveals the Part 15 influence
- 70-03 dB(µA/m) @ 10 m:

$$|\vec{h}| = \sqrt{\frac{erp \times 1.64}{480\pi^2 d^2}} = \frac{\sqrt{erp}}{53.75 \times d}$$

$$H\left(\text{dB µA/m}\right) = ERP\left(\text{dBm}\right) - 20\ log\ d\left(\text{m}\right) + 55.38$$

- Part 15 @ *d*= 3 m equals

$$ERP\left(\text{dBm}\right) = H\left(\text{dB µA/m}\right) - 35.38$$

$$e = \frac{\sqrt{30 \times eirp}}{d} = \frac{\sqrt{30 \times eirp}}{3} = \sqrt{\frac{eirp}{0.3}}$$

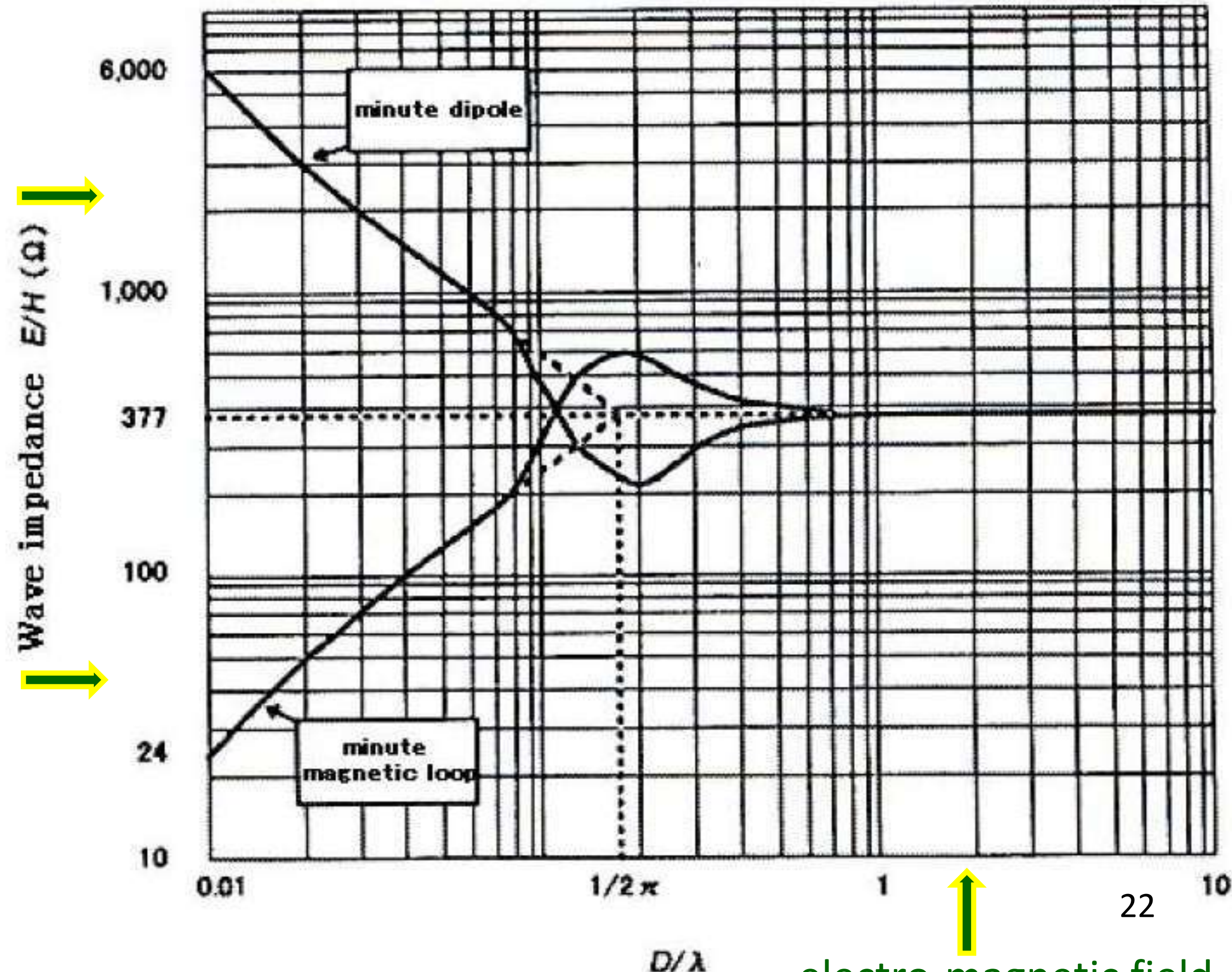
$$eirp(\text{W}) = 0.3 \times e^2 (\text{v/ m})$$

Wave Impedance (z) of minute dipole & minute magnetic dipole

$$PoyntingVector = \frac{p_t g_t}{4\pi d^2} = (\vec{e} \times \vec{h}) = \frac{e_o^2}{z} = h^2 z$$ Most relevant to near field

Wire-
electric field is
dominant

Loop-
magnetic field is
dominant



electro-magnetic field

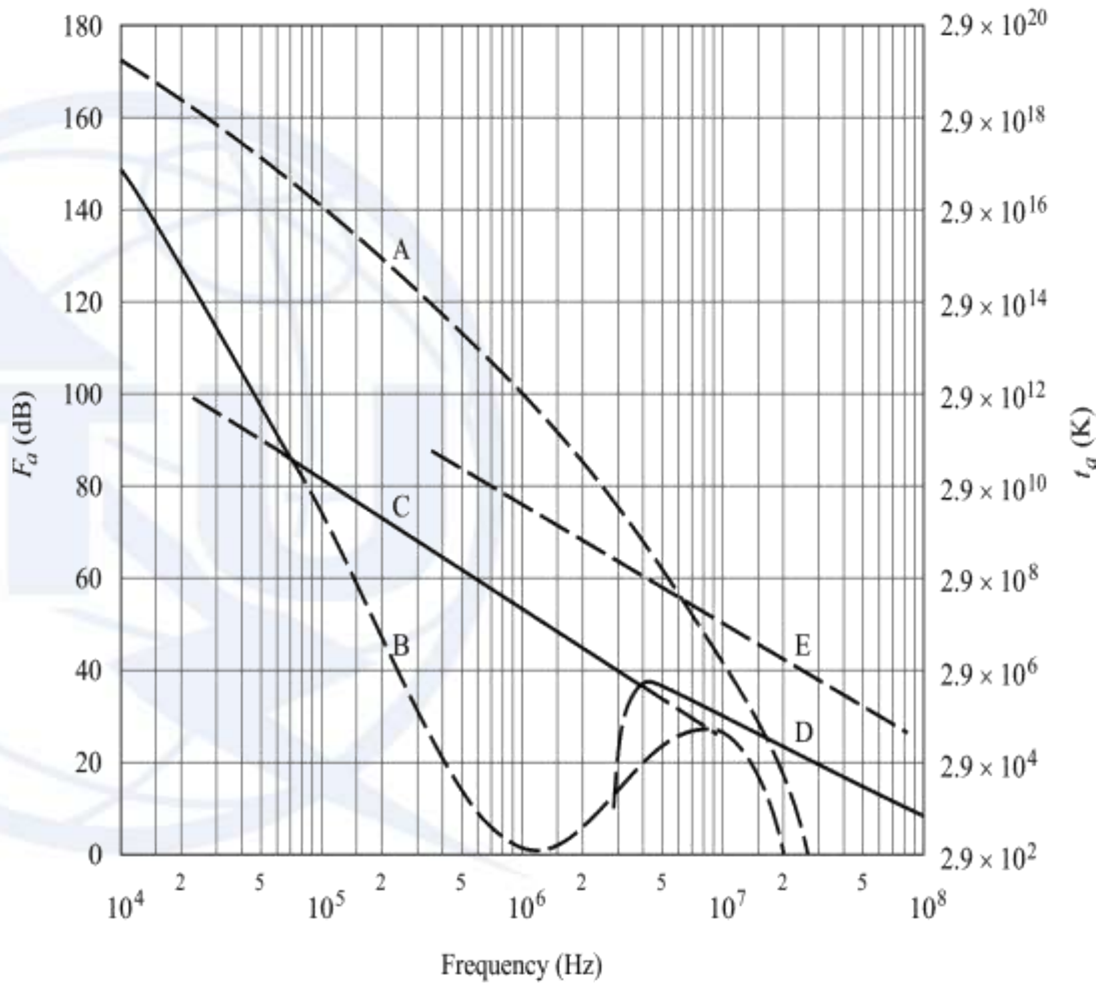
Interference of SRDs to Radio services.
At low RF **no significant degradation**

Atmospheric and man-made noise,
10 kHz to 100 MHz (P.372 Fig. 2)

Below 30 MHz, external noise is most influential at victim receiver. Thus, as atmospheric, man-made, galactic noises and emissions from atmospheric gases and hydrometeors are dominant: they are stronger than the KTBF power. Therefore, SRDs operating below 30 MHz, interfere less than SRDs at higher frequencies

FIGURE 2

F_a versus frequency (10^4 to 10^8 Hz)



A: atmospheric noise, value exceeded 0.5% of time
B: atmospheric noise, value exceeded 99.5% of time
C: man-made noise, quiet receiving site
D: galactic noise
E: median city area man-made noise
—— minimum noise level expected

0372-02

Regulating SRDs

1. Administrations define: RF bands, power, channel spacing & mitigation requirements
2. Reducing interference: Indoor, Internal antenna, Duty Cycle and Activity Factor, Dynamic Frequency Selection (DFS), Adaptive Frequency Agility (AFA), Listen Before Talk (LBT), Aloha: Carrier Sensing (CS) and Collision Detection (CD), Transmitter Power Control (TPC), One-Time Programmable (OTP), Spread-spectrum technique: Frequency-Hopping Spread Spectrum (FHSS)
3. Risk vs. Risk: reducing RF power & BW of SRD or UWB may preclude the entry of new technology. Benefit vs. Benefit: more RF resources available to the citizen & more RF power & BW for SRDs advance rapid growth of new technologies & services. More RF, less congestion & less 'tragedy of commons' in the RF 'public park'
4. Will first responders use 'unprotected' RF bands?
5. SRDs are unprotected! *Caveat Emptor*: 'let the buyer beware'
6. No need to regulate non-active RFID: *de minimis non curat lex*

Wi-Fi: greatest triumph after GSM

Wi-Fi, RLAN, WLAN, U-NII (Unlicensed-National Information Infrastructure) operating in 5.15-5.35 GHz & 5.470-5.85 GHz)- including Recs ITU-R M.1454 & RS.1632

For me personally, **when abroad**, connected to RLAN is **more important** than cellular connection, to offer **free** internet connection and audio/ **video** calls

Wireless Access Systems (WAS) Radio Local Area Networks (RLANs)

WRC-19 agenda items 1.16 and 9.1 (issue 9.1.5) BR file

– Change regulatory conditions, in the band **5 150-5 250 MHz**

1. Wi-Fi devices in trains and cars, indoor usage, including inside trains, with maximum mean e.i.r.p. of 200 mW, and usage **inside automobiles** with **maximum e.i.r.p.** of **40 mW**
2. **limited deployment of outdoor WAS/RLANs**, with due protection of space services
   1) Controlled outdoor usage with a maximum mean e.i.r.p. of 200 mW
   2) Up to 1 W could be allowed, with e.i.r.p. mask for protection of space receivers
   3) The number of higher power outdoor RLANs shall not exceed 2% of total

– No changes for other 4 bands under consideration due to sharing constraints: **5 250-5 350 MHz**; **5 350-5 470 MHz**; **5 725-5 850 MHz**, **5 850-5 925 MHz**

– For the bands **5 250-5 350 MHz & 5 470-5 725 MHz**, clarifications in respective RR No. 5.447F by which RLS, EESS (active) and SRS (active), and in RR 5.450A by which RDS, shall not impose more stringent conditions upon the MS than those in Res. 229 (Rev. WRC-19)

Wi-Fi Global: derived from revised Rec M.1450

Characteristics	IEEE Std 802.11-2012 (Clause 17, commonly known as 802.11b)	IEEE Std 802.11-2012 (Clause 18, commonly known as 802.11a)	IEEE Std 802.11-2012 (Clause 19, commonly known as 802.11g)	IEEE Std 802.11-2012 (Clause 18, Annex D and Annex E, commonly known as 802.11j)	IEEE Std 802.11-2012 (Clause 20, commonly known as 802.11n)	IEEE P802.11ac	IEEE Std 802.11ad-2012	ETSI EN 300 328	ETSI EN 301 893	ARIB HiSWANa,	ETSI EN 302 567
Frequency band	2 400-2 483.5 MHz	5 150-5 250 MHz 5 250-5 350 MHz[(4)] 5 470-5 725 MHz 5 725-5 825 MHz	2 400-2 483.5 MHz	4 940-4 990 MHz 5 030-5 091 MHz 5 150-5 250 MHz 5 250-5 350 MHz 5 470-5 725 MHz 5 725-5 825 MHz	2 400-2 483,5 MHz 5 150-5 250 MHz 5 250-5 350 MHz 5 470-5 725 MHz 5 725-5 825 MHz	5 150-5 250 MHz 5 250-5 350 MHz 5 470-5 725 MHz 5 725-5 825 MHz	57-66 GHz	2 400-2 483.5 MHz	5 150-5 350 and 5 470-5 725 MHz	4 900 to 5 000 MHz 5 150 to 5 250 MHz	57-66 GHz
Interference mitigation	LBT	LBT/DFS/TPC	LBT	LBT	LBT/DFS/TPC	LBT/DFS/TPC	LBT	DAA/LBT, DAA/non-LBT, MU	LBT/DFS/TPC	LBT	
Channel indexing	5 MHz				5 MHz in 2.4 GHz 20 MHz in 5 GHz	20 MHz	2 160 MHz		20 MHz	20 MHz channel spacing 4 channels in 100 MHz	

Summary of major 802.11 Wi-Fi Standards

WLAN: IEEE 802.11 Network bearer standards

Source: also Radio-Electronics.com

	802.11a	802.11b	802.11g	802.11n	802.11ad^	802.11ac*	802.11af**
Date of standard approval (release)	Sept. 1999	Sept. 1999	June 2003	Oct. 2009	Dec. 2012	Dec. 2013	February 2014
Maximum data rate (Mbps)	54	11	54	< 600	<7 Gbps		< 600***
Modulation	OFDM	CCK or DSSS	CCK, DSSS, or OFDM		SC and OFDM	OFDM	
RF Band (GHz)	5	2.4		2.4 or 5	60	5	TV bands below 1 GHz
Number of spatial streams	1			1 to 4	5 to 8	1,2,3,4 or 8	up to four streams
Channel width (MHz) nominal	20			20 or 40	80 or 160	20, 40, 80, 160	8 in Europe; 6 in N. America

^ known also as µwave Wi-Fi; brand name WiGig operating in the 2.4, 5 and 60 GHz bands

* known also as Gigabit Wi-Fi, 5G Wi-Fi and 5G very high throughput (VHT)

** known also as White-Fi and Super Wi-Fi

*** max data rate is 426.7 Mbit/s in 6 & 7 MHz channels, & 568.9 Mbit/s for 8 MHz channels.

Wi-Fi offload to improve cellular capacity

(Sources: KDDI May 2013 and Alvarion October 2013)

1. In congested areas (outdoors & indoors), the growing need of mobile data exceeds the available cellular capacity
2. Main usage: city centers, big malls, airports, train station, stadiums
3. WiFi is the most cost effective solution for data offloading
    1) RF Spectrum free of charge (at 2.4 GHz and 5 GHz)
    2) Embedded in all smartphones and tablets

~150 access points (APs) & more than 1800 stations (STAs) were observed in Ch1 in 2.4GHz band, in Shibuya Metro

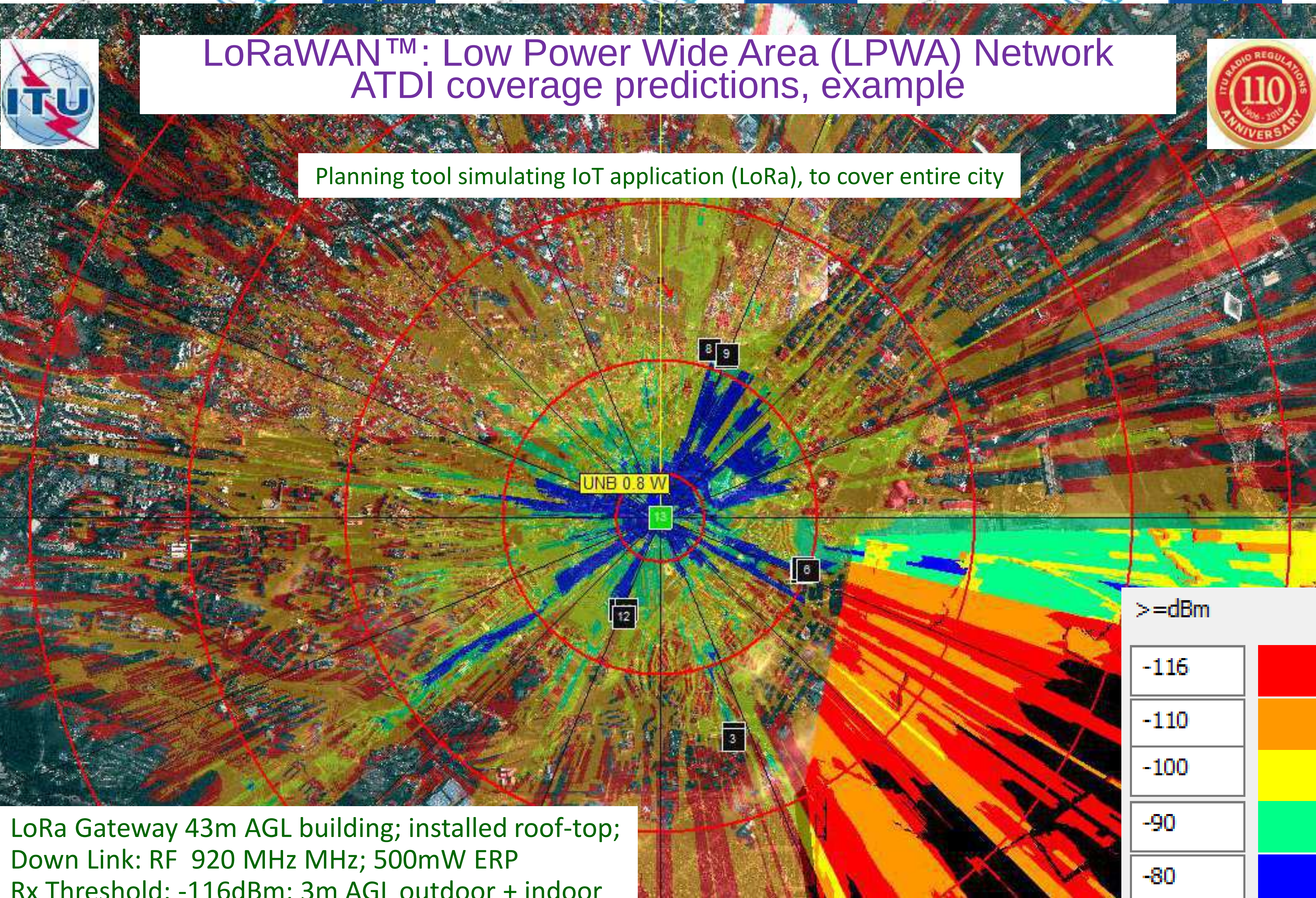
In Seoul KTX train station, 351 APs and 1101 STAs were observed in 2.4 GHz band. In underground COEX mall, 277 APs and 917 STAs were observed in 2.4 GHz band

Shibuya station of Tokyo Metro; 15 April 2013

Shenzheng: RFI to 2.4 GHz train comms, due to 2.4 GHz Wi-Fi

LoRaWAN™: Low Power Wide Area (LPWA) Network
ATDI coverage predictions, example

Planning tool simulating IoT application (LoRa), to cover entire city



LoRa Gateway 43m AGL building; installed roof-top;
Down Link: RF 920 MHz MHz; 500mW ERP
Rx Threshold: -116dBm; 3m AGL outdoor + indoor

SRDs and Internet of Things (IoTs)

SRDs may connect IoT to wireless networking

M2M via cellular or WiFi infrastructure, & other SRDs means

Smart grids, homes, and cities; intelligent transportation & smart energy management

Examples for M2M/IoT applications include: RFID; Home automation and Smart meters

Additional author's presentations on SRDs

1. UHF Global And Regional Ruling and Standardization - The Case Of Different Allocations To Short Range Devices (SRDs) & Electronic Devices , Go Global Compliance Academy TM **Webinar**, 19 Feb. 2013
2. International, Regional & National Regulation of SRDs **ITU Workshop** on SRDs, Geneva 3 June 2014
3. Telecommunication Certification Body, Council; 15 April 2015, Baltimore MD; USA **TCB is accredited by FCC** to approve electronic devices
4. http://mazar.atwebpages.com/Downloads/China_**Beijing**_SRMC%209July15_SRD.pdf
5. http://mazar.atwebpages.com/Downloads/January%202016_SRD_Mazar_**SNG**&SRTC&XHY&GDRTC.pdf
6. ITU Workshop on **IoT** IoT deployment in SRD networks Geneva 22 Nov. 2016; video includes Author's my 16 minutes presentation 2:36:13 till 2:53:10

Thank you!

PRIDA Track 1 (T1)
Online training in English

On-line English workshop 20th April to 1st May 2020

Spectrum use efficiency, economic value and refarming

Dr. Haim Mazar; ITU Expert
Vice Chair ITU-R Study Group5 (terrestrial Services)

Re-Deployment/ Re-Farming

Spectrum Engineering

Spectrum Use

RF spectrum re-deployment and re-farming : Ref. Mazar 2016

1. ITU-R Recommendation SM.1603 *recommends1* defines spectrum redeployment (spectrum refarming) as 'a combination of administrative, financial and technical measures aimed at removing users or equipment of the existing frequency assignments either completely or partially from a particular frequency band. The frequency band may then be allocated to the same or different service(s). These measures may be implemented in short, medium or long time-scales'. Redeployment of spectrum, like frequency management, is a national responsibility. Spectrum redeployment is included in the administration's national spectrum strategy together with the mechanism identified to assist implementation of redeployment.
2. The U.S. was one of the refarming pioneers; 'refarming' is the informal name of a notice and comment rule-making proceeding (PR Docket No. 92-235) opened in 1992 to develop an overall strategy for using the spectrum in the private land mobile radio (PLMR) allocations more efficiently to meet future communications requirements.
3. There are two basic types: voluntary spectrum redeployment and regulatory spectrum redeployment.

FIGURE 1

Consolidated flow chart for the algorithm method

1 Data input

↓

2 Determination of distances between geographical sampling points and existing stations

↓

3 Determination of variants for the reciprocal orientation of reference and existing station ADD for each geographical point

↓

4 Determination of the permissible frequency separations for the reference station in relation to existing stations at each geographical point

↓

5 Calculation of spectrum utilization factor

1599-01

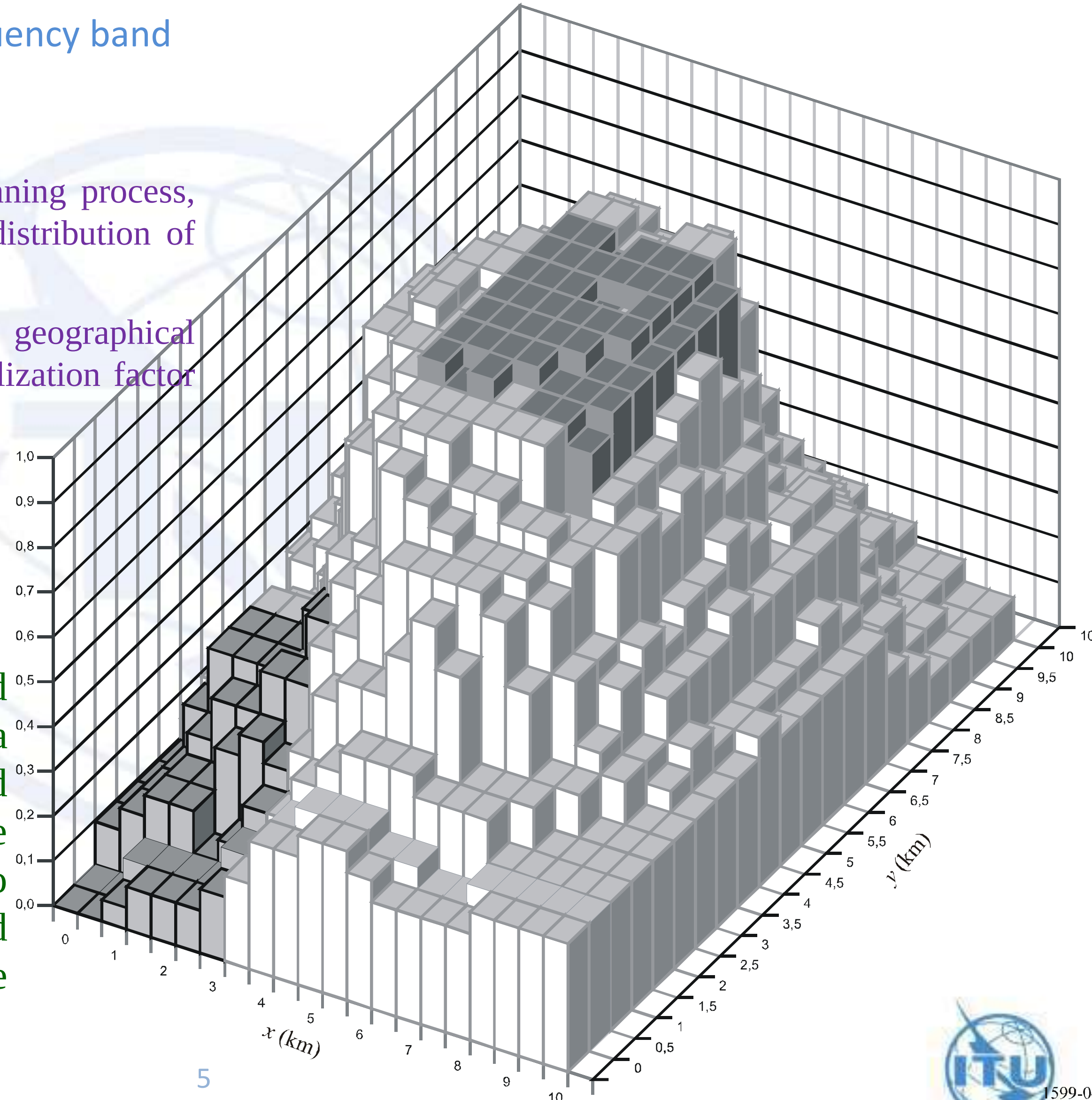
Rec ITU-R SM.1599-1 Variation of spectrum utilization factor in area 10 X 10 km^2 and in the frequency band 169-170 MHz

recommends

1 that administrations should, in the planning process, use data on the geographical and frequency distribution of the spectrum utilization factor;

2 that the methods used to determine the geographical and frequency distribution of the spectrum utilization factor should be those given in Annex 1.

Fig. shows how to identify the congested and available ranges of the spectrum and a territory in the given RF band and geographical area. This facilitates the selection of frequencies for new radio stations being brought into operation and helps to increase the efficiency of the frequency planning process as a whole.



1599-04

Re-Farming & Some Practices; Reference Mazar 2016 –Radio Spectrum Management pp.146-8

- Refarming is a process to govern the repurposing of spectrum bands to more efficient technologies and/or new services
- Service continuity and investment are critical for successful Refarming

1. Set out the approach to **refarming** & **renewal** in advance (some 3–4 years prior to expiry) to avoid network investment being postponed
2. In the case of **renewal**, incumbent licensees may have the rights of first-refusal
3. Provide stability, certainty & transparency through long-term planning, i.e. develop spectrum roadmaps
4. Progressively technology restrictions in existing mobile spectrum usage rights
5. Introduce flexible regulatory tools; consider sharing and spectrum trading , to facilitate better spectrum utilisation
6. Evaluate spectrum value in a holistic approach; focus on long-term socio-economic impact

Yaoundé
Cameroon

3 Nov. 16

Chris Woolford
OFCOM

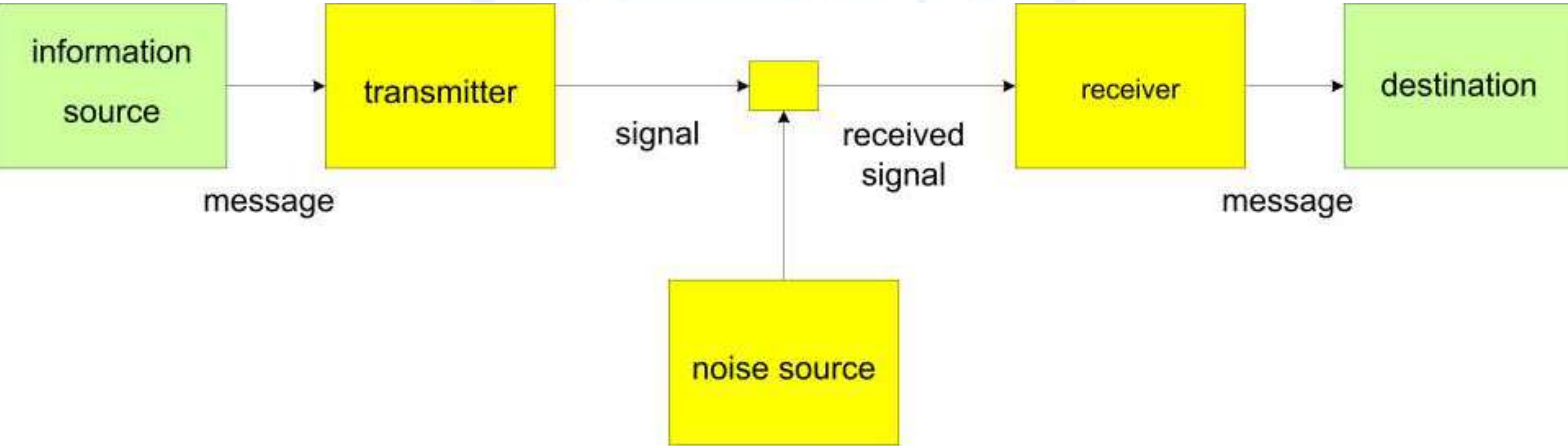
Dr. Haim Mazar
ATDI

[Common Wealth event]

Mazar chairing panel on Spectrum Auction

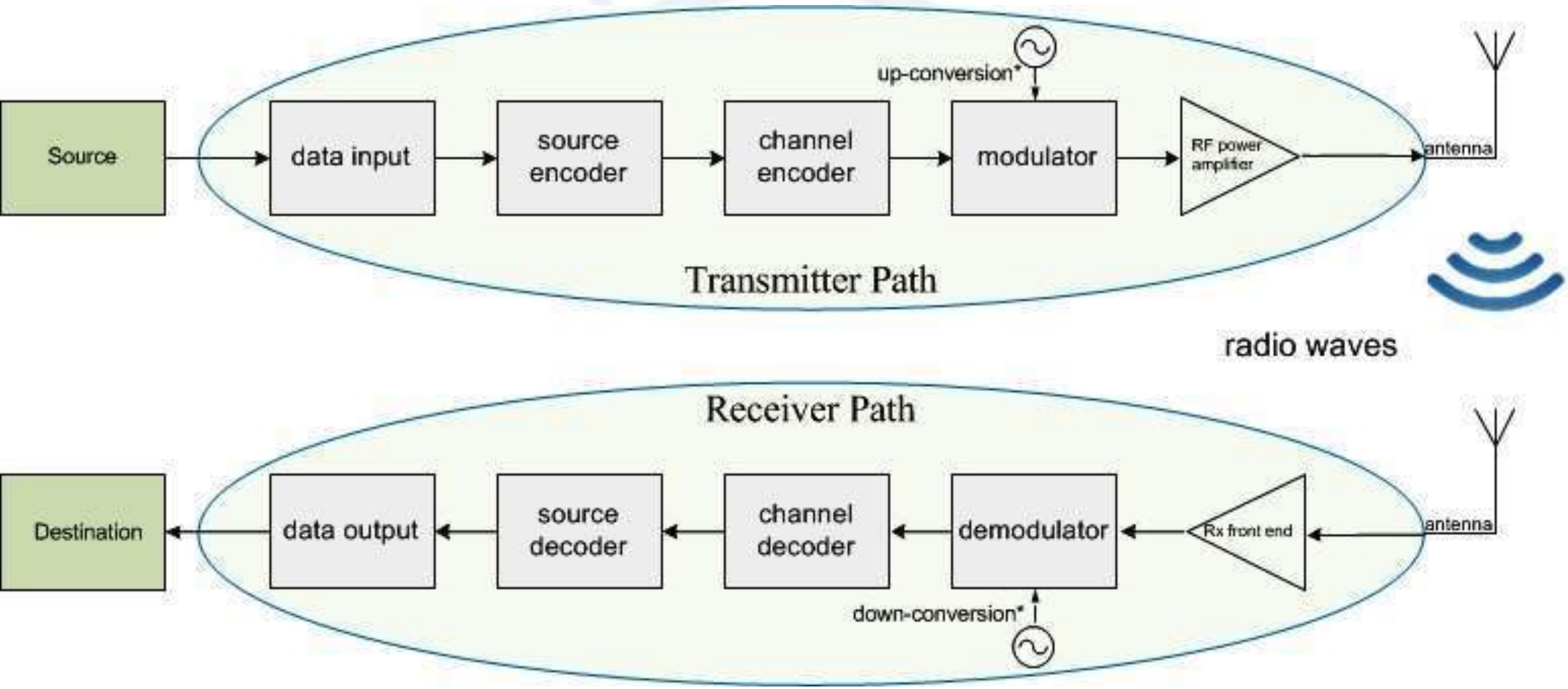
End-to-end wireless communication

Engineering



Shannon's 1949 schematic diagram of a general communication

Schematic diagram of wireless communication; duality



Friis transmission equation and Free-space propagation loss- power

Using the international system of units (SI):

p_t = transmitter output power	(Watts)
g_t = transmitter antenna gain	(dimensionless, with no units)
d =observation distance from transmitter to receiver	(m)
p_d = incident power density at the receiver	(W/m^2)
A_e = effective area of receiver's antenna	(m^2)
λ = wave length	(m)
g_r = receiver antenna gain	(dimensionless)
p_r = received power	(Watts)
p_l = propagation loss	(dimensionless)

$$p_d = \frac{p_t g_t}{4\pi d^2} \qquad A_e = \frac{g_r \lambda^2}{4\pi} \qquad p_r = \frac{p_t g_t}{4\pi d^2} \times A_e = \frac{p_t g_t}{4\pi d^2} \times \frac{g_r \lambda^2}{4\pi}$$

Free-space propagation loss- power (cont.)

Friis transmission equation relates the power delivered to the receiver antenna p_r to the input power of the transmitting antenna p_t. Expressing p_r and p_t in the same units, the *Friis transmission equation* expressed numerically looks

$$\frac{p_r}{p_t} = \frac{\dfrac{p_t g_t}{4\pi d^2} \times \dfrac{g_r \lambda^2}{4\pi}}{p_t} = g_t \times g_r \left(\frac{\lambda}{4\pi d}\right)^2$$

$\left(\frac{4\pi d}{\lambda}\right)^2$ is independent of antenna gains; it is called the *free-space loss factor*. Where d (distance) and λ (wave length) are expressed in the same unit,

$$p_l = \left(\frac{4\pi d}{\lambda}\right)^2 = \left(\frac{4\pi df}{c_0}\right)^2$$

The free-space path loss expressed logarithmically by wavelength or frequency, where c_o(velocity of light)≡λxf:

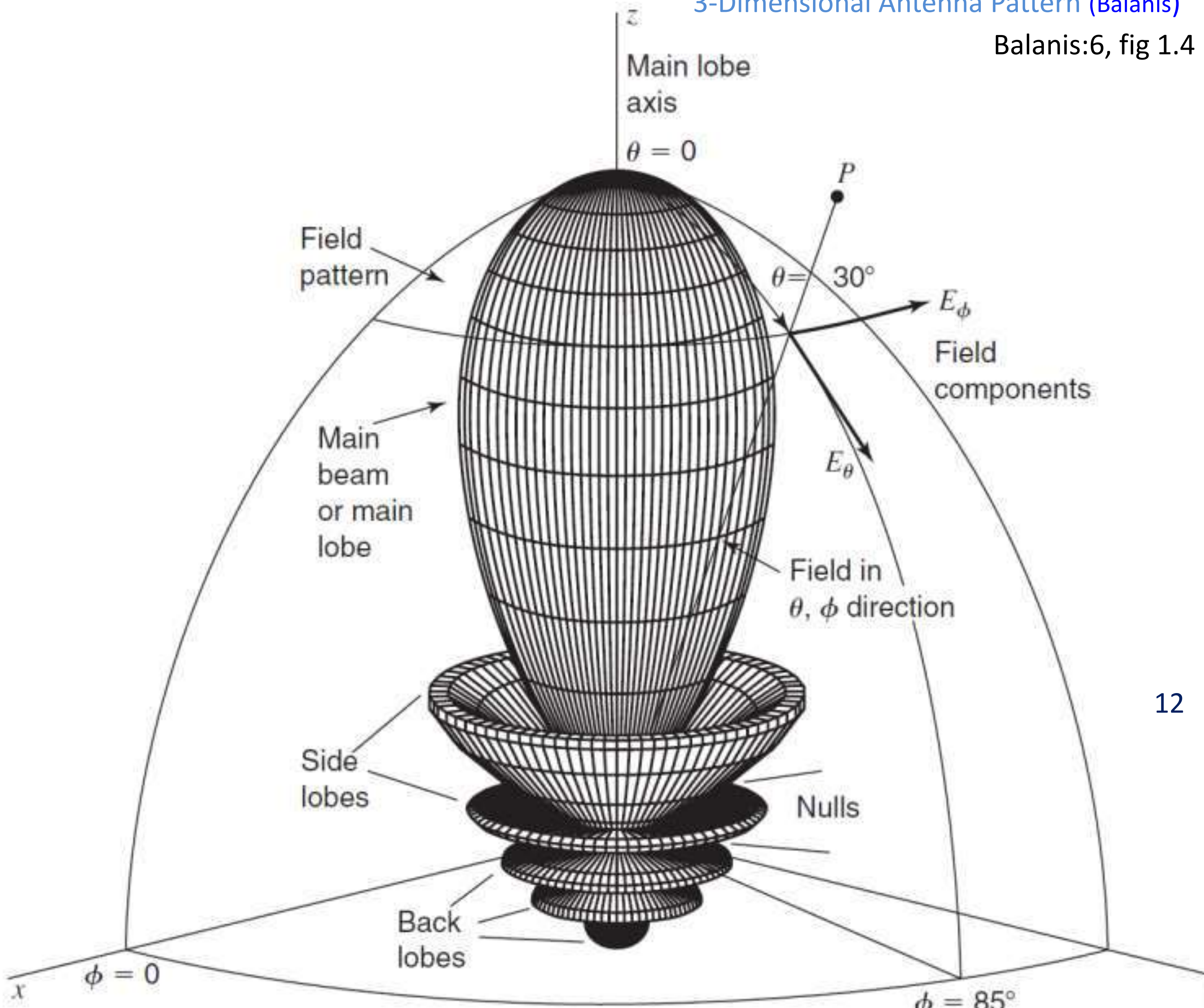
$$P_l(\mathrm{dB}) = 20\ log(4\pi d / \lambda) = 20\ log(4\pi df / c_0) = 20\ log(4\pi df) - 20\ log c_0$$

$$P_l(\mathrm{dB}) = 32.45 + 20\ log\ d\ (\mathrm{km}) + 20\ log\ f\ (\mathrm{MHz})$$

3-Dimensional Antenna Pattern (Balanis)

Balanis:6, fig 1.4

Azimuth Cut: $E(\phi)$
Elevation Cut: $E(\theta)$



Antenna Directivity and Gain

For η = Aperture efficiency; *A* = Physical aperture area, A_e = Effective aperture area;
d_0= max directivity; g_0= max Ant Gain , G= Ant Gain (dBi), Gd =Gi-2.15;
λ= wavelength, BW= Ant beamwidth, θ= BW_{elv} φ= $Bw_{az;}$

Balanis (2008:18, formula1.12) defines the maximum directivity d_0:

$$d_0 = \frac{4\pi}{\Omega_A(steradians)}$$

$$d_0 = \frac{4\pi}{\Omega_A(steradians)} \approx \frac{4\pi}{\phi(\text{radian})\theta(\text{radian})}$$

$$d_0 = \frac{4\pi}{\Omega_A\,(\text{steradian})} \approx \frac{4\pi}{\phi(\text{radian})\theta(\text{radian})} \approx \frac{4\pi}{\phi^0\theta^0}\left(\frac{180}{\pi}\times\frac{180}{\pi}\right) = \frac{41,253}{\phi^0\theta^0}$$

$$g_0 = \eta d_0 = \eta\frac{4\pi}{\Omega_A\,(\text{steradian})} \approx \eta\frac{4\pi}{\phi(\text{radian})\theta(\text{radian})} \approx \eta\frac{4\pi}{\phi^0\theta^0}\left(\frac{180}{\pi}\times\frac{180}{\pi}\right) \approx \eta\frac{41,253}{\phi^0\theta^0}$$

For typical antenna efficiency of η=0.73 the max g_0 for many practical antennas

$$g_0 \approx \eta\frac{41,253}{\phi^0\theta^0} \approx 0.73\frac{41,253}{\phi^0\theta^0} \approx \frac{30,000}{\phi^0\theta^0}$$

Practical Formulas, for ant. gain

For η=0.7

$$g = \eta \frac{4\pi}{\varphi\theta(radians)} = \eta \frac{4\pi}{\varphi\theta(^0)}\left(\frac{360}{2\pi}\frac{360}{2\pi}\right) = \eta \frac{41{,}253}{\varphi\theta(^0)} = \eta \frac{41{,}253}{\varphi\theta(^0)} \approx \frac{28{,}800}{\varphi\theta(^0)}$$

G=44.6 dBi -10logθ^0 –10logφ^0; for circular Ant, G=44.6 dBi -20log θ

$$\varphi_e(\text{radian}) = \sqrt{\frac{1}{\eta}}(\lambda / a) \qquad \theta_e(\text{radian}) = \sqrt{\frac{1}{\eta}}(\lambda / b)$$

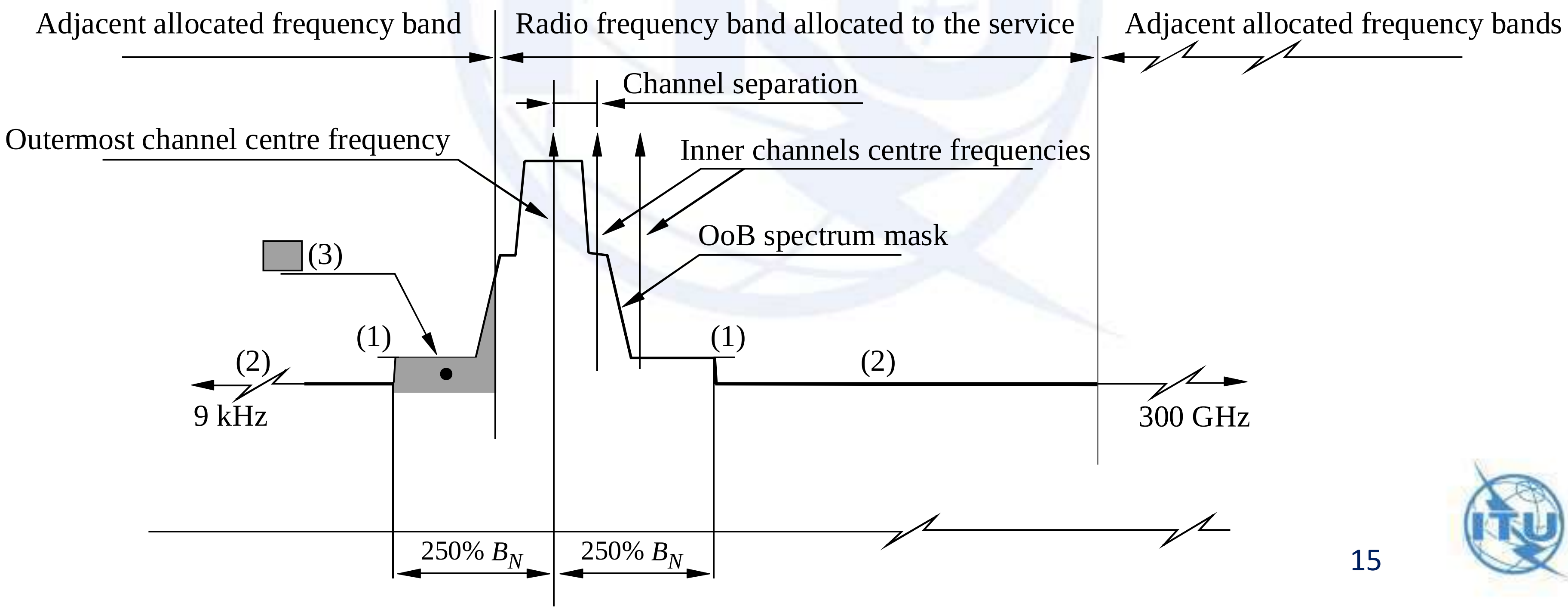
For circular antennas, where *λ/l* is not given, this ratio may be estimated; inserting

$\theta(\text{degrees}) \approx 70\frac{\lambda}{l}$ G=44.6 dBi -20log $(70\frac{\lambda}{l})$ *G*= 7.7 - 20log $(70\frac{\lambda}{l})$

Transmitters: Unwanted Emissions (Rec SM.1540, fig 1)

crucial to avoid interference from Tx OoB and spurious-emissions

1. the frequency, output power, the bandwidth and unwanted emissions, consisting of spurious emissions and out-of-band Emissions; see ITU Radio Regulations RR 1.146, are the important parameters of Tx
2. The ITU RR Article 1 defines *spurious emission* (RR 1.145), *out-of-band emission* (RR 1.144), *occupied bandwidth* (RR 1.153), *necessary bandwidth* (RR 1.152), *assigned frequency band (*RR 1.147) and *assigned frequency* (RR 1.148).



Receiver Sensitivity (Watts)

crucial to define coverage obligations & vulnerability to interference

s_{min} : sensitivity (W)

k : Boltzmann's constant = 1.38×10^{-23} J/K

t_0 : reference temperature (K) (absolute degrees, ^{0}Celsius + 273.15), taken as 290 K

b : power bandwidth of the receiving system (Hz)

The nominal receiver bandwidth equals the channel spacing, such as 12.5 kHz for simplex, 100 kHz for FM, 6-8 MHz for TV

nf : noise factor of the receiver

s/n: required signal to noise ratio;

s/n is interchanged with c/n: carrier to noise ratio

$$s_{min} = k \cdot t_0 \cdot b \cdot nf \cdot (s/n)$$

Receiver Sensitivity Expressed logarithmically

S_{min}: sensitivity (dBW)

K : Boltzmann's constant = $10\log(1.38 \times 10^{-23})$=-228.6 dB J/K

T_0 : reference temperature (K) taken as 10 log (290) dB K

B : RF bandwidth of the receiving system 10log b(Hz) dB Hz

NF : noise figure of the receiver 10 log nf dB

SNR, S/N: signal to noise ratio 10 log (s/n) dB

CNR, C/N: carrier to noise ratio 10 log (c/n) dB

SNR, S/N, CNR and *C/N* are interchanged

$$S_{min}=K+T_0+B+NF+SNR$$

Thermal noise power density @ 290 K (16.85 °C)= -204 dBW/Hz= -174 dBm/Hz =-144 dBm/kHz=-144 dBW/MHz=**-114dBm/MHz**

GSM Reference Sensitivity (REFSENS)

REFSENS is the minimum mean power received at the Base Tx Station (BTS) or User Equipment (UE) antenna port at which the Bit Error Ratio (BER) shall not exceed a specific value

- GSM 3GPP TS 05.05 (2005) 6.2 for UE & BTS BER 0.001

GSM 900Mhz -104dbm; GSM 1800Mhz UE -102dbm

GSM900 & GSM1800 (DCS 1 800) the normal REFSENS BTS is - 104 dBm.

- For B=0.2 MHz, F (Noise Figure) 8 & 10 dB respectively and co-channel interference C/Ic 9dB the UE, KTBF(C/N) equals:
- for GSM 900 MHz equals -114+10*Log10(0.2)+ 8+9= -104dBm
- for DCS 1800 MHz equals -114+10*Log10(0.2)+10 +9 = -102dBm

UMTS Reference Sensitivity (REFSENS)

REFSENS is the minimum mean power received at the Base Tx Station (BTS) or User Equipment (UE) antenna port at which the Bit Error Ratio (BER) shall not exceed a specific value

UMTS ETSI TS 134 121-1 (2014) 6.2 UE Table 7.3.5-1: Reference sensitivity QPSK REFSENS for BER 0.001 Down Link (DL), for REFSENS as the minimum mean power of DPCH_Ec received at the UE at which the BER shall not exceed 0.1%

Band I (2,100 MHz) dBm/3.84 MHz -117 dBm

Band VIII (900 MHz) dBm/3.84 MHz -115 dBm

For NF 10 dB (9-12dB), the thermal noise floor in the WCDMA channel (3.84MHz) is: $-114+10*Log_{10}(3.840)+10$ =-98 dBm adding Eb/No (7dB) we get -91 dBm; the DPCH_Ec processing gain (25dB) improves REFSENS to -91 dBm. See also next slide

Regards the difference in REFSENS :In bands where the duplex distance places tougher design constraints on the duplexer: in band I (UL band 1920-1980, DL band 2110-2170 and duplex separation 190 MHz vs Band VIII only 45 MHz separation. May be REFSENS is relaxed due to higher insertion losses; therefore, higher NF is tolerated; this is not the case GSM 900Mhz -104dbm; GSM 1800Mhz -102dbm.

Reference sensitivity & coverage range; efficiency versus excessive power

Table 22.7 Reference sensitivity.

System	Modulation	Channel BW (MHz)	*kTB* (dBm)	NF (dB)	SINR (dB)	IM (dB)	REFSENS (dBm)
LTE UE	QPSK 1/3	5	–107.5	9	–1	2.5	–100
	QPSK 1/3	20	–101.4	9	–1	2.5	–94
	64QAM 3/4	5	–107.5	9	17.5	4	–80
	64QAM 3/4	20	–101.4	9	17.5	4	–74
LTE BS	QPSK 1/3	5	–107.5	5	1.5	2.5	–101.5
UMTS UE	QPSK 1/3	3.84	–108.2	9	1.2–21.1 (21.1 dB spreading gain)	2.5	–117

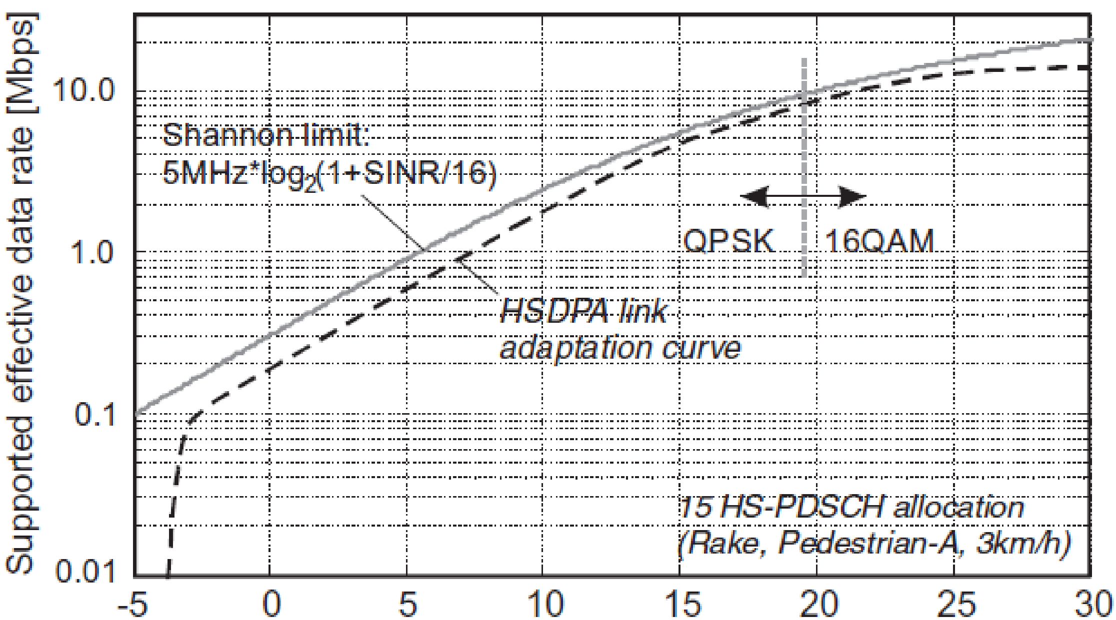
Table 22.8 Downlink range.

Modulation	QPSK 1/3	64QAM 3/4
Reference sensitivity (dB)	–100.0	–80.0
Maximum path loss (dB)	146.0	126.0
Maximum range urban (km)	4.7	1.4
Maximum range rural (km)	30.3	7.8

Sesia S., Toufik I. and Baker M. 2009 (2011 2[th] edition) LTE, the UMTS Long Term Evolution: from Theory to Practice, John Wiley & Sons

LTE Downlink peak bit rates; Wiley 2009; LTE Technology

Modulation coding		Peak bit rate per sub-carrier/bandwidth combination				
		72/1.4 MHz	180/3.0 MHz	300/5.0 MHz	600/10 MHz	1200/20 MHz
QPSK 1/2	Single stream	0.9	2.2	3.6	7.2	14.4
16QAM 1/2	Single stream	1.7	4.3	7.2	14.4	28.8
16QAM 3/4	Single stream	2.6	6.5	10.8	21.6	43.2
64QAM 3/4	Single stream	3.9	9.7	16.2	32.4	64.8
64QAM 4/4	Single stream	5.2	13.0	21.6	43.2	86.4
64QAM 3/4	2 × 2 MIMO	7.8	19.4	32.4	64.8	129.6
64QAM 4/4	2 × 2 MIMO	10.4	25.9	43.2	86.4	172.8



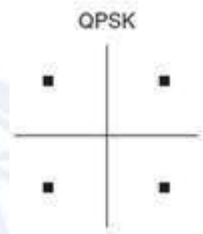
Throughput (Mbit/s) as function of SINR (dB)

Remark: true Shannon limit is:

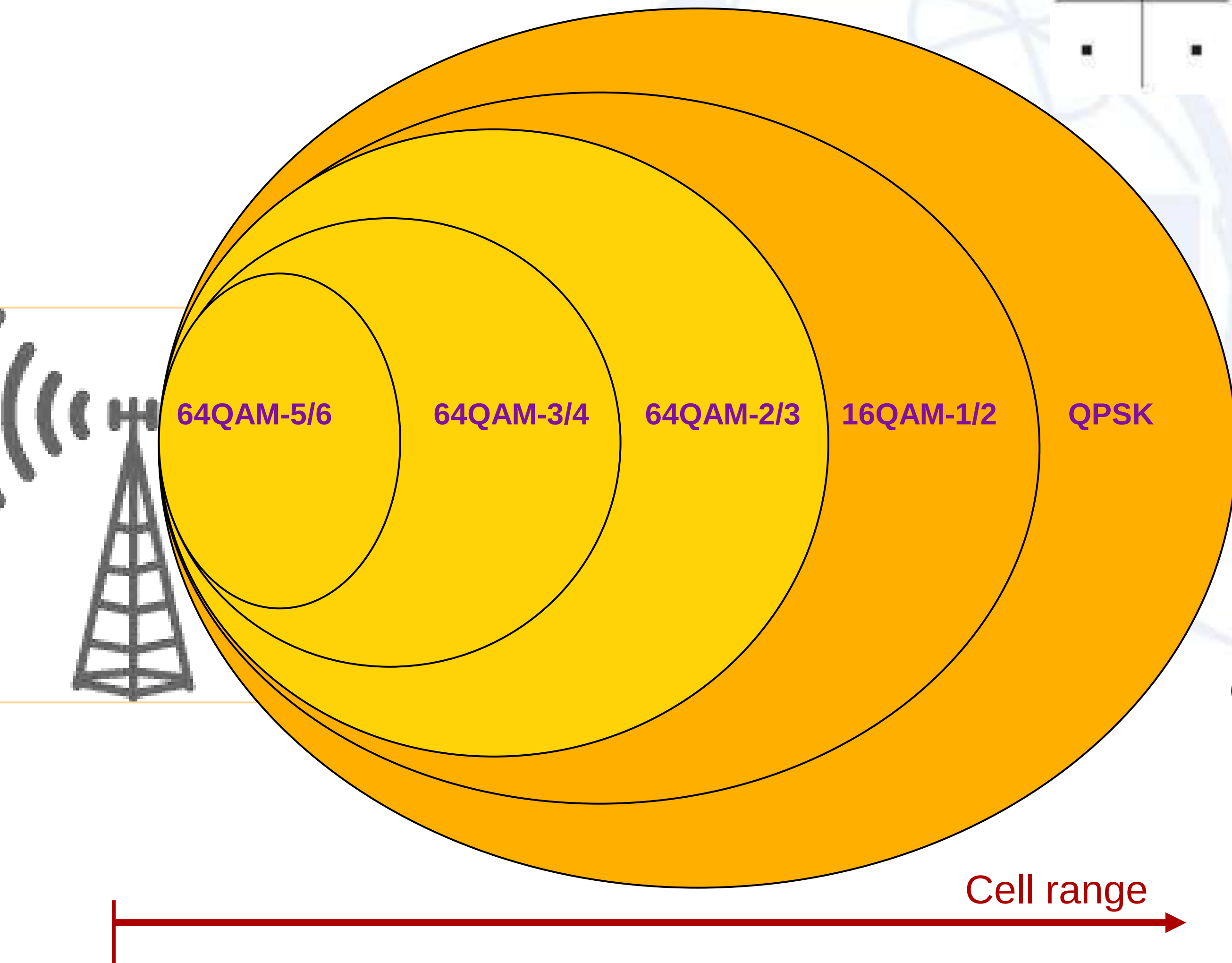
$$c = b \times log_2 (1 + s/n)$$

Trade off between Coverage and Capacity

The MCS (Modulation and Coding Scheme) defines the cell coverage & capacity



OFDM *PR*s, *C/N* and *C/I* are similar. Intra-protection ratios for co-channel interference are identical to the respective C/N values. The 64-QAM imposes higher *PR*s relative to 16-QAM: circa 6 dB; 4 times higher *PR* (for the same CR)is a consequence of 4 times more vector signal density at the I-Q plane. Balance: for the same range higher capacity 64QAM or 16QAM, vs higher Tx power. Min distance between points in the constellation indicates the power efficiency, number of points indicates the bandwidth efficiency.



Coding rates (1/2, 2/3, ¾ and 5/6) reduces the system sensitivity

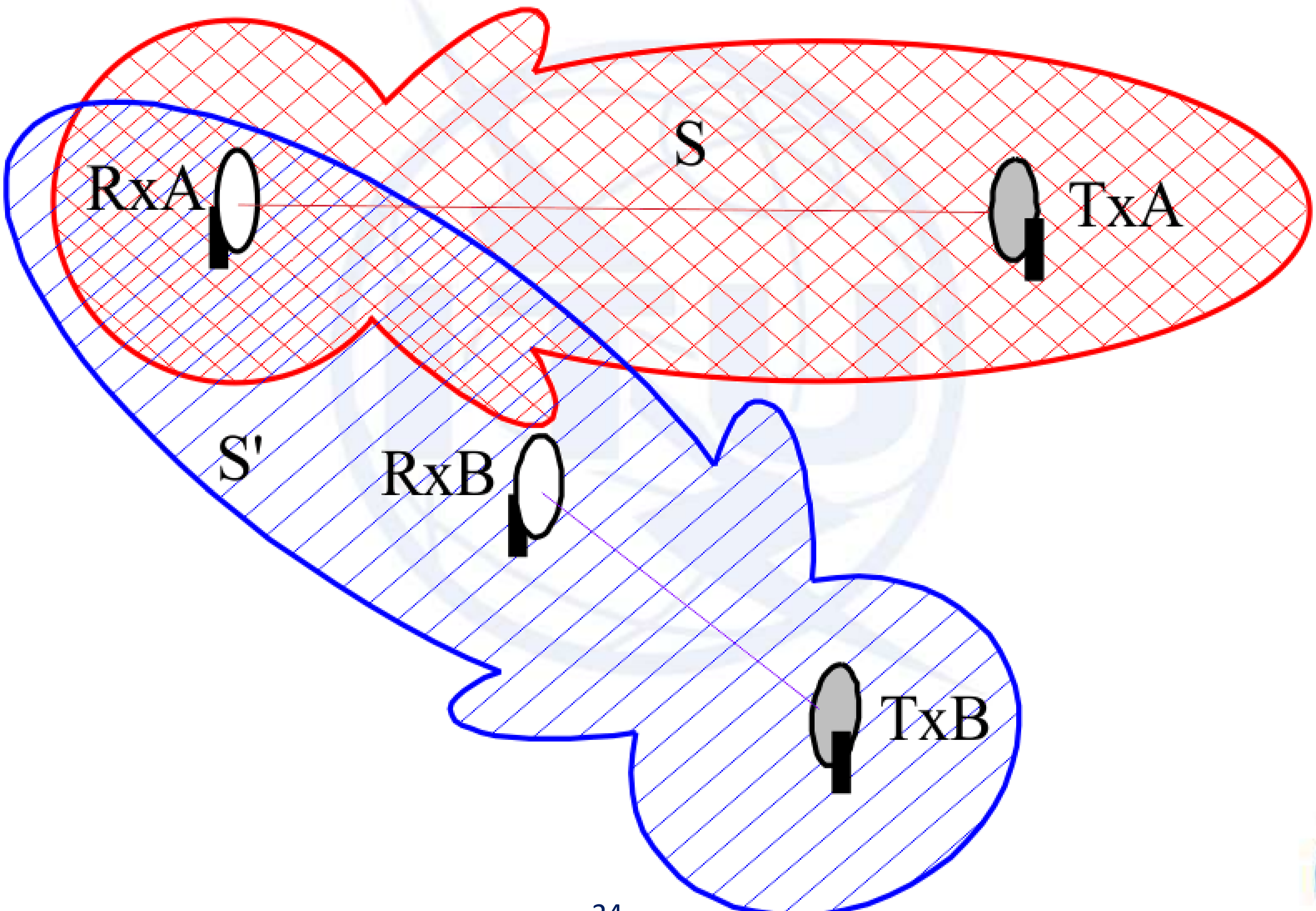
Source: Shalev

LTE [TS 136 521-1](#) Table 7.3.3-1: UE Reference sensitivity QPSK REFSENS (dBm)

Down Link DL FDD RF bands retrieved from Table 5.5-1 of [3GPP TS 36.104 V12.3.0 (2014-03)](#)

	Channel Bandwidth BW (MHz)						
Band	DL RF (MHz)	BW 1.4 MHz	BW 3 MHz	BW 5 MHz	BW 10 MHz	BW 15MHz	BW 20MHz
1	2,110-2,170	------		-100	-97	-95.2	-94
2	1,930-1,990	-102.7	-99.7	-98	-95	-93.2	-92
3	1,805-1,880	-101.7	-98.7	-97	-94	-92.2	-91
5	869 -894	-103.2	-100.2	-98	-95	------	
7	2,620-2,690	------		-98	-95	-93.2	-92
8	925-960	-102.2	-99.2	-97	-94	------	
20	791-821	------		-97	-94	-91.2	-90

General interference scenario; RF area (F.2059 2005)



Rap 2059-01

Linear Carrier-to- Interference Ratio (CIR)

where:

ϕ_1 : interferer off-boresight angle, relative to the victim

ϕ_2 : victim off-boresight angle, relative to the interferer

P_l: propagation losses

G: antenna gains

$bw_{unwanted}$: bandwidth of the un-wanted signal

bw_{wanted}: bandwidth of the wanted signal

XPD: cross-polarization discrimination

P_l differs as the distance from the wanted and unwanted emitters to the victim is different

The attenuation 10 log bw_{wanted} /$bw_{unwanted}$ is considered only for bw_{wanted} <$bw_{unwanted}$

Disregarding line losses at the transmitter and receiver, according to the logarithmic wanted carrier received signal *C* equals at standard units:

$$C = P_t + G_t - P_{l\_want} + G_r = EIRP_{wanted} - P_{l\_want} + G_r$$

The interference *I* from the interferer *INT* equals:

$$I = INT + G_{\text{int}}(\varphi_1) - P_{l\_\text{int}} + G_r(\varphi_2) - 10\log\frac{bw_{unwanted}}{bw_{wanted}} - XPD$$

The carrier-to- interference ratio *CIR* is 10 log *c/i* = *C* - *I* and equals:

$$C - I = EIRP_{wanted} - P_{l\_want} + G_r - (INT + G_{\text{int}}(\varphi_1) - P_{l\_\text{int}} + G_r(\varphi_2) - 10\log\frac{bw_{unwanted}}{bw_{wanted}} - XPD)$$

Thresholds power & field-strength for cellular & BWA (1)

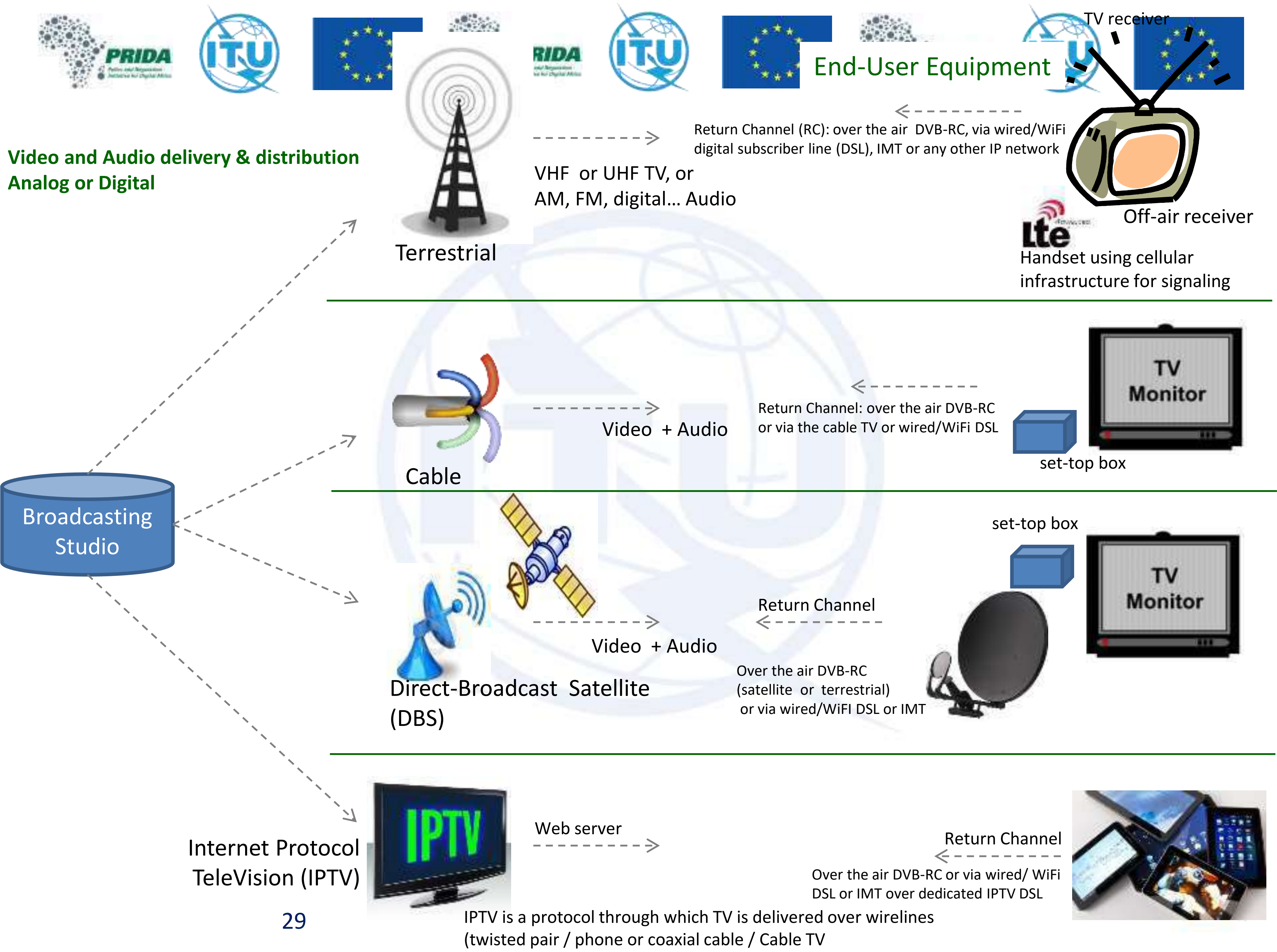
Technology (MHz)	CS (kHz) Channel Separation	SENS (dBm)	FS (dBµV/m)
GSM 900	200	-104	30
GSM 1,800	200	-104	36
UMTS 2,100	5,000	-80	61
LTE 700/800	5,000	-80	53
LTE 1,800–2,000	5,000	-80	61
	10,000	-77	64
	20,000	-74	67
LTE-TDD 2,300/2,600	5,000	-80	63
	10,000	-77	66
	20,000	-74	69

Thresholds power & field-strength for cellular & BWA (2)

Technology (MHz)	CS (kHz)	SENS (dBm)	FS (dBµV/m)
WiMAX 2,300/2,600	5,000	-80	63
	10,000	-77	66
	20,000	-74	69
WiMAX 3,500	5,000	-80	66
	10,000	-77	69
	20,000	-74	72
WiMAX5400	5,000	-80	70
	10,000	-77	73
	20,000	-74	76
WiMAX10500	5,000	-80	76
	10,000	-77	79
	20,000	-74	82

Spectrum Use Efficiency

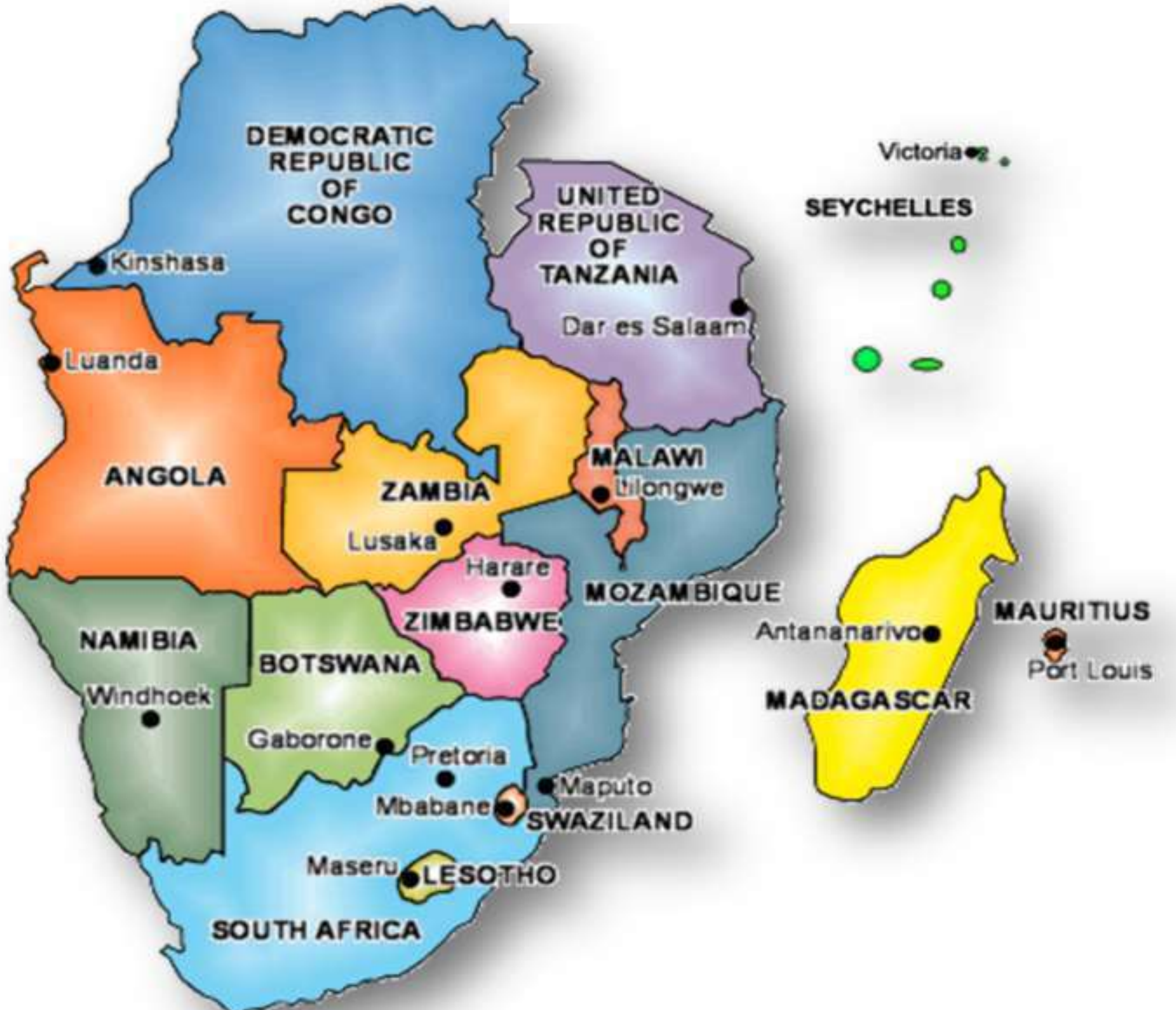
1. Spectral efficiency, spectrum efficiency or bandwidth efficiency refers to the information rate that can be transmitted over a given bandwidth in a specific communication system. It measures how efficiently a limited frequency spectrum is utilized
2. The spectral efficiency of a digital communication system is measured in bit/s/Hz
3. The upper bound for the spectral efficiency possible without bit errors in a channel with a certain SNR, if ideal error coding and modulation is assumed, is given by the Shannon-Hartley theorem


End-User Equipment
TV receiver
Video and Audio delivery & distribution
Analog or Digital
Terrestrial
VHF or UHF TV, or
AM, FM, digital… Audio
Return Channel (RC): over the air DVB-RC, via wired/WiFi
digital subscriber line (DSL), IMT or any other IP network
Off-air receiver
Handset using cellular
infrastructure for signaling
Cable
Video + Audio
Return Channel: over the air DVB-RC
or via the cable TV or wired/WiFi DSL
TV Monitor
set-top box
Broadcasting Studio
set-top box
TV Monitor
Return Channel
Video + Audio
Over the air DVB-RC
(satellite or terrestrial)
or via wired/WiFI DSL or IMT
Direct-Broadcast Satellite
(DBS)
IPTV
Web server
Return Channel
Over the air DVB-RC or via wired/ WiFi
DSL or IMT over dedicated IPTV DSL
Internet Protocol
TeleVision (IPTV)
IPTV is a protocol through which TV is delivered over wirelines
(twisted pair / phone or coaxial cable / Cable TV

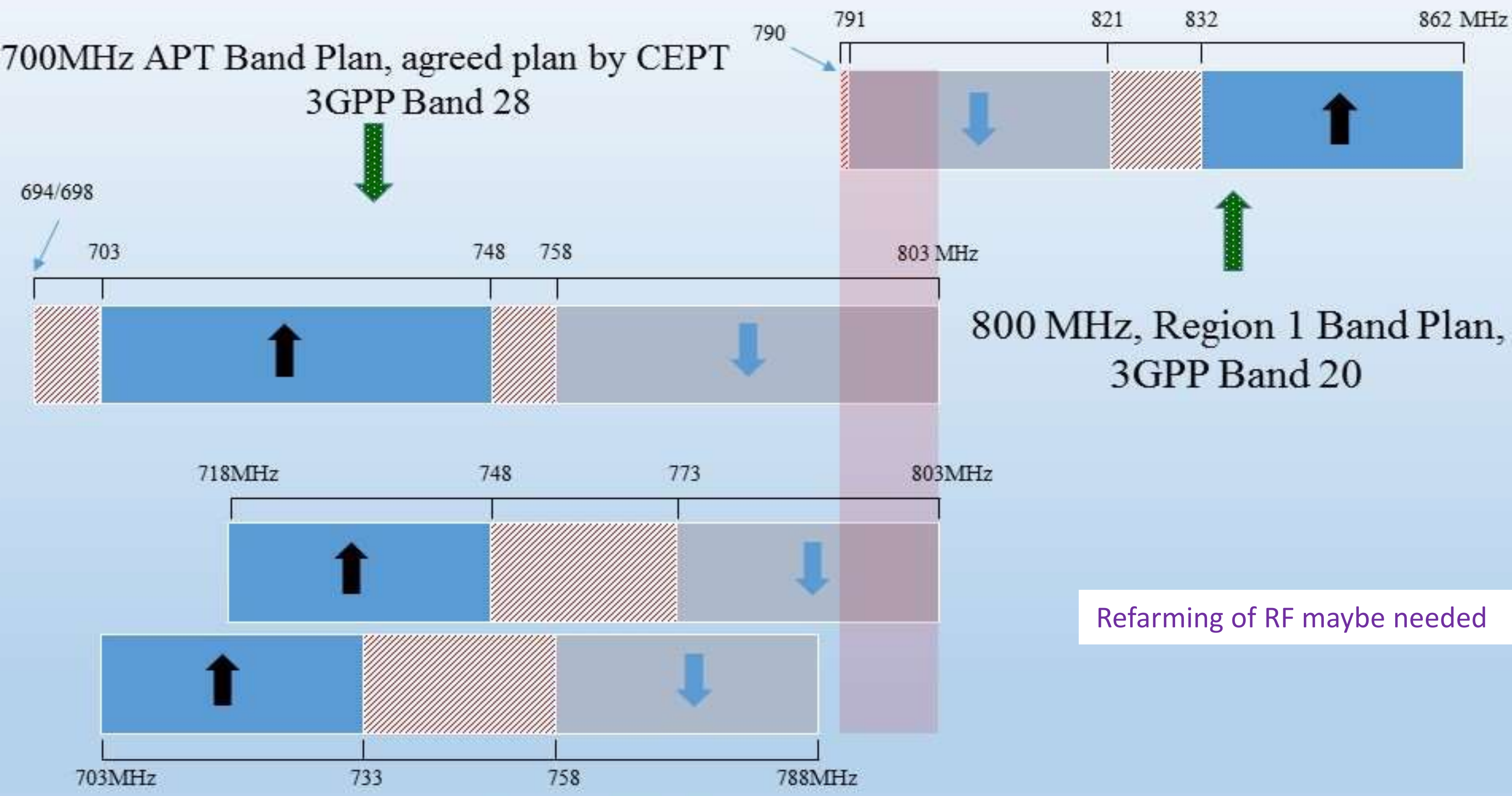
Public protection and disaster relief (PPDR)
CEPT harmonization measure on PPDR 698 to 791 MHz

698-703	703-708	708-713	713-718	718-723	723-728	728-733	733-736	736-752	753-758	758-763	763-768	768-773	773-778	778-783	783-788	788-791
PPDR a) up-link	PPDR b) uplink (MFCN)						PPDR c) up-link	...	PPDR a) down-link	PPDR b) downlink (MFCN)						PPDR c) down-link
5 MHz	30 MHz (6 blocks of 5 MHz)						3 MHz		5 MHz	30 MHz (6 blocks of 5 MHz)						3 MHz

Member States of the Southern African Development Community (SADC)



Digital Dividends: 700/800MHz band plan (source GSMA)



Refarming of RF maybe needed

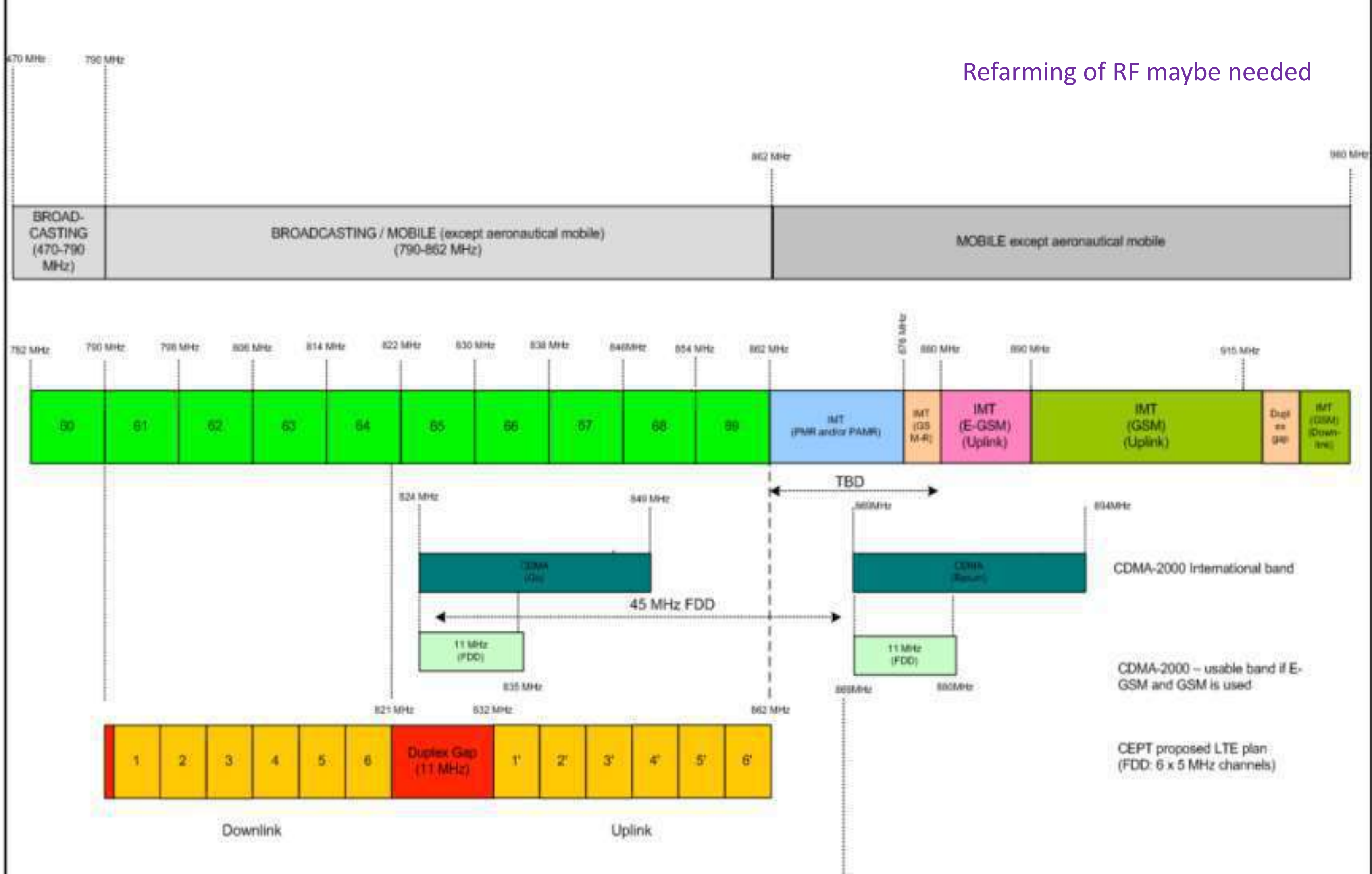
harmonised plan: 2x30MHz

Digital Dividends at 694-862 MHz according to SADC 2015 Frequency Allocation Plan

ITU Region 1 allocations and footnotes	ZICTA allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations / utilisation	Additional information
694-790 MHz MOBILE except aeronautical mobile MOD 5.312A 5.317A BROADCASTING MOD 5.300 5.311A 5.312	694-790 MHz MOBILE except aeronautical mobile MOD 5.312A 5.317A BROADCASTING MOD 5.300 5.311A MOD 5.312	IMT	
790–862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.312 5.319	790–862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.319 SADC13	IMT	Band IV/V analogue television to migrate to digital television according to SADC time lines. WRC-07, WRC-12 and WRC-15 allocated this band to Mobile service except aeronautical mobile and identified it for IMT. This band should be made available for IMT as soon as possible after the migration of analogue television to digital. Fixed links operating in this band will have to be migrated in order to accommodate IMT

ITU Region 1 allocations and footnotes	SADC common allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations / utilisation	Additional information
790-862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.312 5.319	**790-862 MHz** MOBILE except aeronautical mobile 5.316B 5.317A SADC13	IMT	Res. 224 (REV. WRC-19) applies
862-890 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 5.319 5.323	**862-890 MHz** MOBILE except aeronautical mobile 5.317A 5.322 SADC14	862-876 MHz IMT	This band is paired with 824-849 MHz
		876-880 MHz IMT PMR and/or PAMR	This band is paired with 921-925 MHz.
		880-915 MHz IMT	Paired with 925-960 MHz.
890-942 MHz FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING 5.322 Radiolocation 5.323	**890-942 MHz** MOBILE except aeronautical mobile 5.317A	915-921 MHz PMR and/or PMR	
		921-925 MHz IMT PMR and/or PAMR	Paired with 876-880 MHz.
		925-960 MHz IMT	Paired with 880-915 MHz
942-960 MHz FIXED	**942-960 MHz** MOBILE except aeronautical		

Spectrum allocations 790 MHz to 915 MHz



Zambia Allocations (source, ZICTA, Sep. 2019)

ITU Region 1 allocations and footnotes	ZICTA allocation/s and relevant ITU footnotes	SADC proposed common sub-allocations / utilisation	Additional information
470-694 MHz **BROADCASTING** **5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.311A 5.312**	470-694 MHz BROADCASTING 5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.311A 5.312	DTT broadcasting (470-694 MHz)	Band IV/V Analogue television to migrate to digital television in line with SADC time lines
694-790 MHz **MOBILE except aeronautical mobile MOD 5.312A 5.317A** **BROADCASTING** **MOD 5.300 5.311A 5.312**	694-790 MHz MOBILE except aeronautical mobile MOD 5.312A 5.317A BROADCASTING MOD 5.300 5.311A MOD 5.312	IMT	
790-862 MHz **FIXED** **MOBILE except aeronautical mobile 5.316B 5.317A** **BROADCASTING** **5.312 5.319**	790-862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.319 SADC13	IMT	Band IV/V analogue television to migrate to digital television according to SADC time lines. WRC-07, WRC-12 and WRC-15 allocated this band to Mobile service except aeronautical mobile and identified it for IMT. This band should be made available for IMT as soon as possible after the migration of analogue television to digital. Fixed links operating in this band will have to be migrated in order to accommodate IMT.

Zambia Assignments for 900 MHz countrywide (source, ZICTA, Sep. 2019)

Mobile Operator	900 MHz Band	Comment
MTN Zambia	16	
Airtel Zambia	20	
Zamtel	16	
Uzi Zambia	-	16 MHz reserved at Tender

[1] Uzi Zambia has not commenced operations in Zambia and the indicated spectrum holding is based on Authority’s offer to the MNO subject to payment of fees.

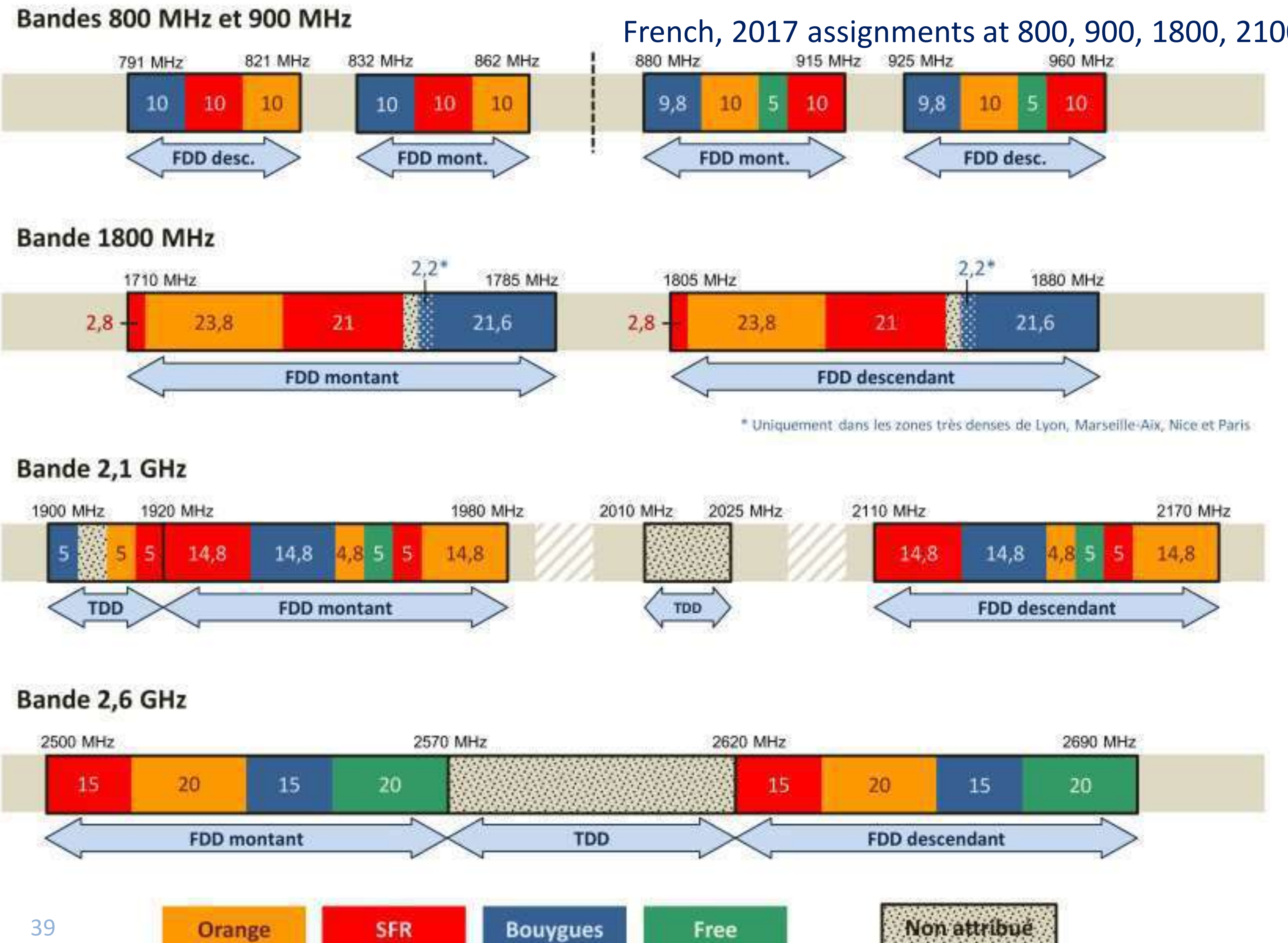
Zambia Assignments for 900 MHz countrywide (source, ZICTA, Sep. 2019)

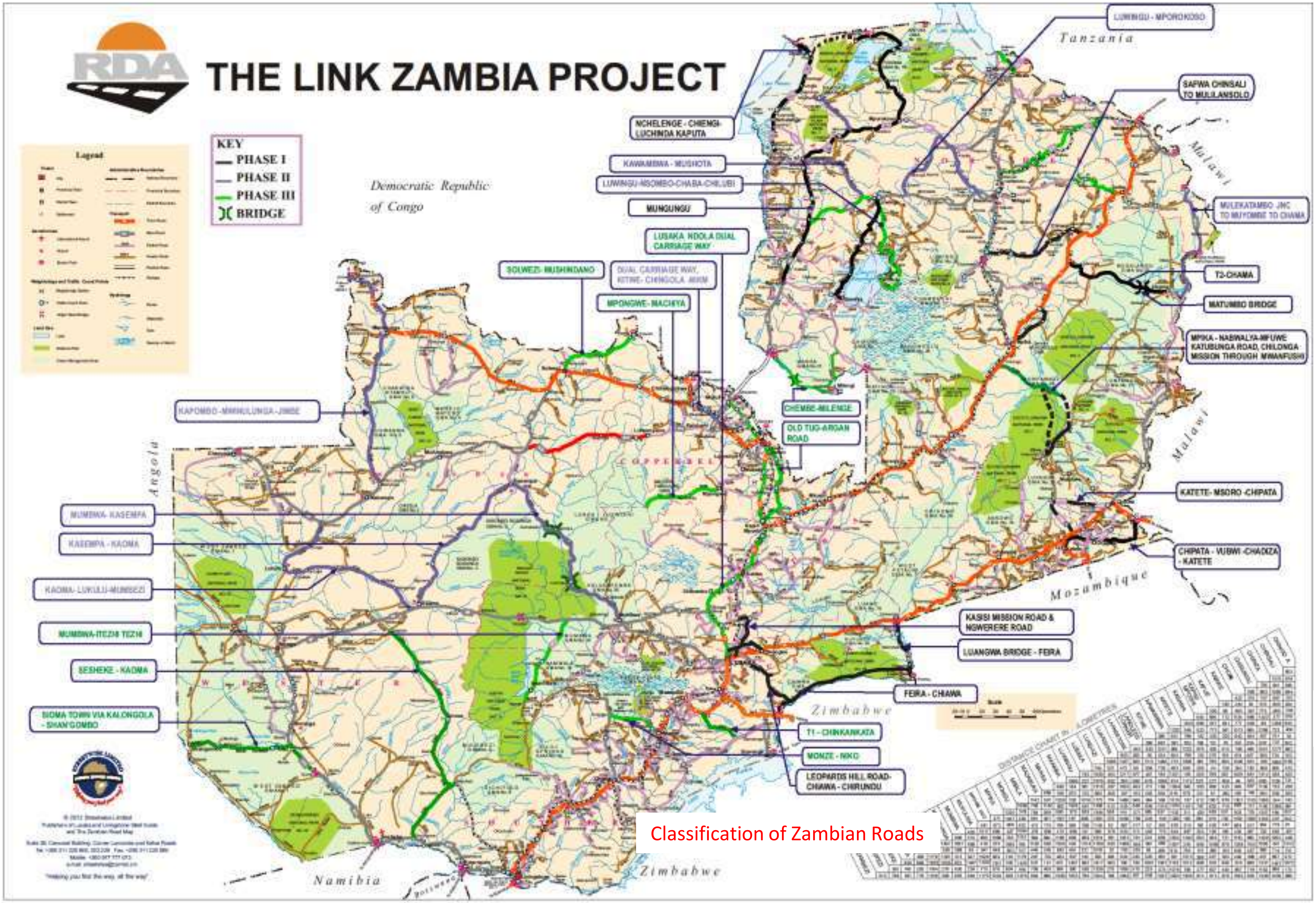
Airtel:
900 MHz Assignment (10 FDD)
885-890 MHz/ 907-912 MHz
930-935 MHz / 952 – 957 MHz

Zamtel:
900 MHz (8 MHz FDD)
890.20-898.20 MHz
935.20-943.20 MHz

MTN:
900 MHz (8 MHz FDD)
898.40-906.40
943.40-951.40

French, 2017 assignments at 800, 900, 1800, 2100 & 2600 MHz





Classification of Zambian Roads

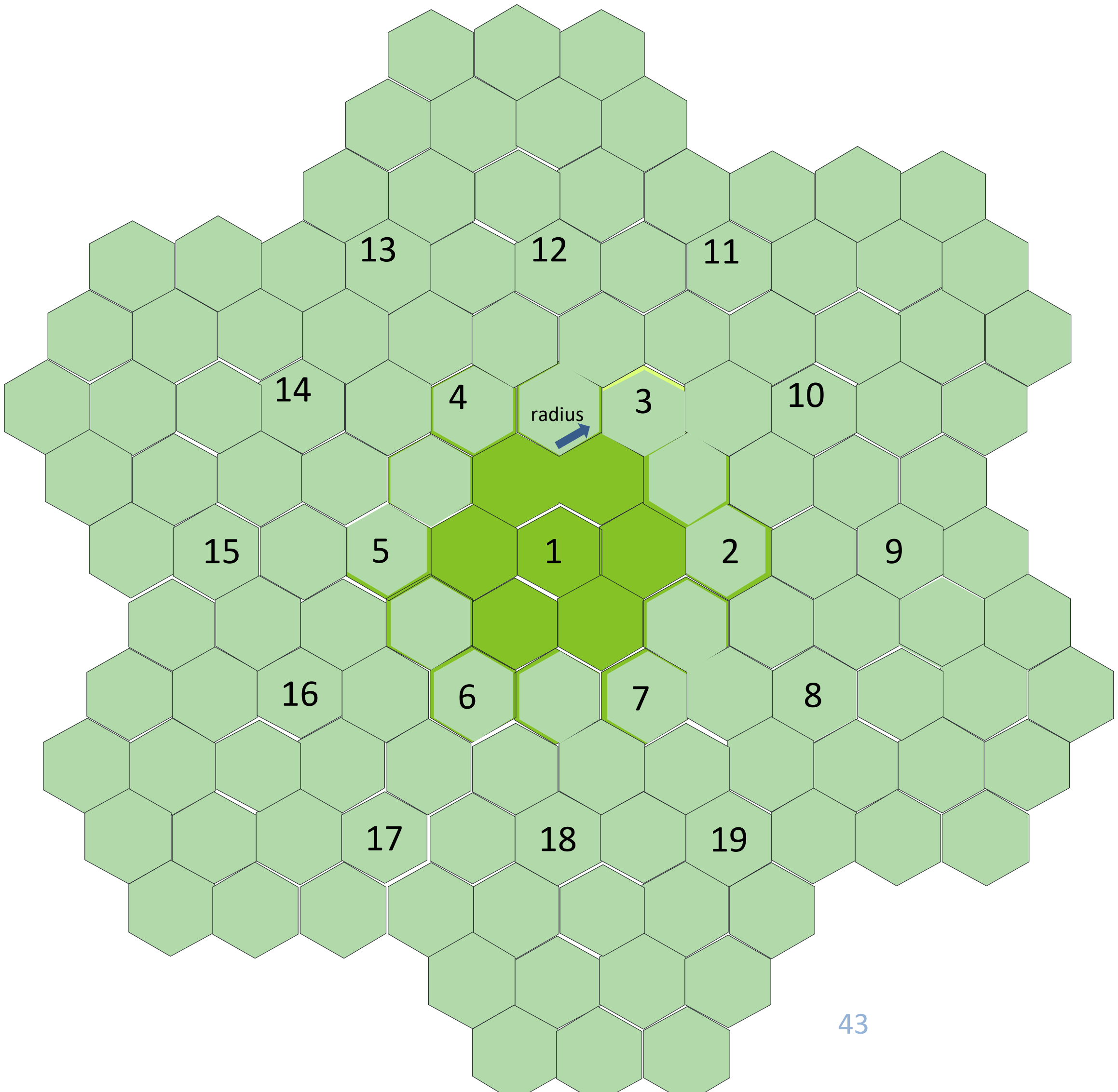
Parameters influencing the min. RF required

- Technology: spectral-efficiency, RF aggregation, MIMO
- Number of BTS per cellular users
- Population density
- Propagation scenarios
- Center Frequency
- Network topology: heterogeneous network reduces needed RF
- Is Internet provided by fixed lines (ADSL), by cellular by hot-spots
- Traffic forecast
- Licence obligations:
  - QoS
  - coverage
  - capacity requirements
  - indoor requirements
  - Offloading by RLANs- unlicensed RF bands ease the coverage and capacity;
  - human-hazards limits- restricted thresholds force more BTS, therefore more

Spectral efficiency of common communication systems

Wiki

Typical cellular network based on the 19 cell reference network unit



Spectral efficiency of common communication systems

Service	Standard	Launched year	Max. net bitrate *R* per carrier per 1 spatial stream (Mbit/s)	Bandwidth *B* per carrier (MHz)	Max. link spectral efficiency *R/B* ((bit/s)/Hz)		Typical reuse factor *1/K*	System spectral efficiency ((bit/s)/Hz per site)
					SISO	MIMO		
2.75G cellular	CDMA2000 1× voice	2000	0.0096 per phone call × 22 calls	1.2288	0.0078 per call	N/A	1	0.172 (fully loaded)
2.75G cellular	GSM + EDGE	2003	0.384 (typ. 0.20)	0.2	1.92 (typ. 1.00)	N/A	⅓	0.33
2G cellular	GSM	1991	0.013 × 8 timeslots =0.104	0.2	0.52	N/A	⅑ (⅓ in 1999)	0.17 (in 1999)
3.5G cellular	HSDPA	2007	21.1	5	4.22		1	4.22
3G cellular	WCDMA FDD	2001	0.384	5	0.077	N/A	1	0.51
3G cellular	CDMA2000 1x PD	2002	0.153	1.2288	0.125	N/A	1	0.1720 (fully loaded)
3G cellular	CDMA2000 1×EV-DO Rev.A	2002	3.072	1.2288	2.5	N/A	1	1.3
4G cellular	LTE	2009	81.6	20	4.08	16.32(4x4)	1	16.32
4G cellular	LTE-Advanced	2013	75	20	3.75	30.00(8x8)	1	30
4G MBWA	iBurst HC-SDMA	2005	3.9	0.625	7.23		1	7.23
Broadband modem	ADSL2 downlink		12	0.962	12.47	N/A	N/A	N/A
Broadband modem	ADSL2+ downlink		28	2.109	13.59	N/A	N/A	N/A
Digital cable TV	DVB-C 256-QAM mode		38	6	6.33	N/A	N/A	N/A
Digital radio	DAB	1995	0.576 to 1.152	1.712	0.34 to 0.67	N/A	⅕	0.08 to 0.17
Digital radio	DAB with SFN	1995	0.576 to 1.152	1.712	0.34 to 0.67	N/A	1	0.34 to 0.67
Fixed WiMAX	IEEE 802.16d	2004	96	20	4.8		¼	1.2
Wi-Fi	IEEE 802.11a/g	2003	54	20	2.7		⅓	0.900
Wi-Fi	IEEE 802.11n	2007	72.2 (short GI)	20	3.61		⅓	1.2
Wi-Fi	IEEE 802.11ac	2012	433.3 (short GI)	80	5.42			
WiGig	IEEE 802.11ad	2013	6756	2160	3	3	⅓	1

Thank you!

PRIDA Track 1 (T1)
Online training in English

On-line English workshop 20th April to 1st May 2020

Wireless broadband spectrum awards

Dr. Haim Mazar; ITU Expert
Vice Chair ITU-R Study Group5 (terrestrial Services)

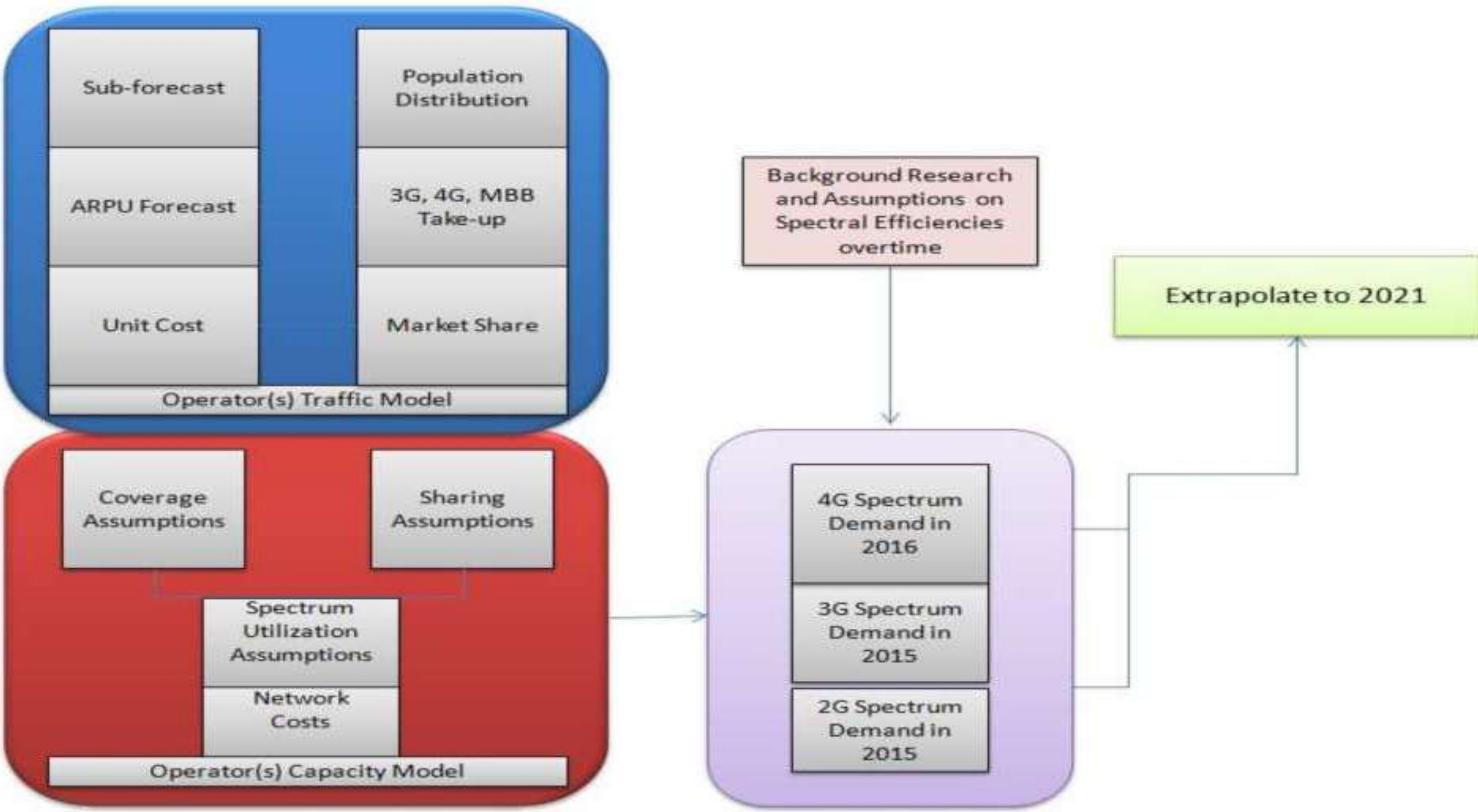
Concerns about Auctions

1. Following digital dividends (DD) 1 & 2, is the demand higher than supply?
2. **Mozambique** attempted to auction the 800, 1800z & 2600 MHz 2018. Only the 800 MHz was sold due to the relatively higher reserve prices set for the other two bands
3. In 2016 **Nigeria** attempted to auction the 2.6 GHz band. Only one operator acquired spectrum at the **reserve** price. For the others, the reserve price was deemed too high
4. 2018 **Tanzania** successfully auctioned the 700 MHz band, with a particular focus on placing coverage obligations
5. **Ghana**, between November and January 2018, also auctioned the 800 MHz
6. **South Africa** is currently actively preparing to host a spectrum auction

Main References of the Auctioning

1. Reference[1] ITU-D Resolution 9 Final Report; 2014
2. Reference[2] ITU-D Guidelines for the Review of spectrum pricing methodologies and the preparation of spectrum fees schedules; 2016
3. Reference [3] ITU-D ITU Statistics; December 2019
4. Reference [4] ITU-R Report SM.2012-6 (06/2018) Economic aspects of spectrum management
5. Reference [5] ITU-D Economic contribution of broadband, digitization and ICT regulation, econometric modelling for Africa; 2019
6. Additional reference Guidelines for the establishment of a coherent system of RF usage fees (separate publication to Resolution 9 report); 2010
7. Reference [7] ITU-D Exploring the value and Economic Valuation of spectrum; April 2012
8. Reference [8] Ofcom, Annual Licence Fees for 900 MHz and 1800 MHz frequency bands; 2018
9. Reference [9] Ofcom Statement on the making of certain regulations in connection with the award of 700 MHz and 3.6-3.8 GHz spectrum; 21 May 2019
10. Reference [10] Mazar H., Wiley book Radio Spectrum Management: Policies, Regulations and Techniques; sub-chapter 4.3 Economic Environment; 2016
11. Reference [11] GSMA Effective Spectrum Pricing: Supporting better quality and more affordable mobile services February 2017
12. Reference [12] GSMA Spectrum pricing in developing countries, Evidence to support better and more affordable mobile services; July 2018
13. Reference [13] GSMA Auction Best Practice GSMA Public Policy Position May 2019
14. Reference [14] Plum Insight, Vorsprung durch Econometrics: what drives spectrum value?; April 2016
15. Reference [15] Mazar H., Common Wealth Workshop, Spectrum Re-Farming: Framework and Methodology; Yaoundé; 2 Nov. 2016
16. Reference [16] Mazar H. Broadband RF Spectrum Audit, Lusaka; 19 April 2017
17. Reference [17] Mazar H. Broadband Pricing Model, Lusaka; 19 April 2017
18. Reference [18] Coleago Consulting Ltd Increasing mobile broadband coverage through spectrum awards; Sept. 2019

Forecast of spectrum demand for cellular services; Reference ITU-D Guidelines [2] fig. 8



Assignment Methods:

Lotteries, Secondary Trading & Auctions

Different frequency assignment methods; ReferenceRes 9 2014 [1] pp. 33, 34

	Lottery	Auction	Secondary spectrum trading
Applicability	Rapid dissemination of new technologies and services	Efficient dissemination of new technologies and services	– Transactions in accordance with established procedures – Prior agreement of competent authority is required
Advantages	Speed Transparency	– Price competition alone used to select licensees – Transparency and fairness – Avoids corruption and collusion – Maximization of revenues	– Spectrum efficiency: existence of secondary spectrum trading market may encourage operators to use frequencies intensively & efficiently to sell off part of their allotments on the market – Flexibility of frequency allocations, by establishing a direct re-allocation mechanism
Disadvantages	Large number of applicants	– May involve high license costs, preventing rapid exploitation of spectrum, deployment of new networks & services, & inhibiting competition – Success of auction depends largely on its design	– New administrative arrangements required for resale of RF – Distortions in competition due to price differences between frequencies for competing services – Lack of coordination at borders
Risks	– Random selection of operators – Arbitrary prices obtained for frequencies if no **reserve price** set	Non-simultaneity of auctions may result in non negligible distortions and in cross-subsidies	Speculation by licensees

Lotteries; Reference ITU-R SM.2012 [4]

1. Lotteries represent a fast, relatively inexpensive & transparent means of choosing between candidates with very similar or equivalent qualification
2. Lotteries should be preceded by an official qualification process to select candidates to participate in it, otherwise recourse to such a method could act as a brake on development of the sector. For example, participants in lotteries may not always intend to operate the telecommunication services, but may wish simply to resell the frequency licenses obtained for a profit
3. Some lottery winners may not have the financial resources to bring a service into operation

Secondary Spectrum Trading; Reference SM.2012 [4]

1. Spectrum trading was firstly proposed in 1959 by Ronald Coase where he suggested that spectrum assignments should be treated in a way similar to property rights.
2. Secondary spectrum trading is a market-based mechanism whereby the purchase and sale of equipment
3. Licenses or spectrum utilization (with associated rights and obligations) previously allocated by the spectrum manager can take place between different parties for a given fee
4. Operation may be effected directly between parties or via an intermediary
5. Regulatory issue, when RF belongs to the State

Auctions; Reference SM.2012 [4]

1. In auctions, it is ultimately the market that determines the spectrum license holder
2. In many auctions, bidders pre-qualify based on criteria similar to those applied in the comparative evaluation methods. Thus, participation in some auctions is restricted to those bidders with proven technical and financial resources
3. Auctions organized to allocate frequencies show that it is important to apply strict criteria at the technical, financial and commercial levels in order to determine the eligibility of bidders
4. Some successful bidders may subsequently find themselves unable to finance their overly ambitious bids. Other bidders may have neither the technical means nor the intention to operate the telecommunication services using RF for which they made a bid which was ultimately successful

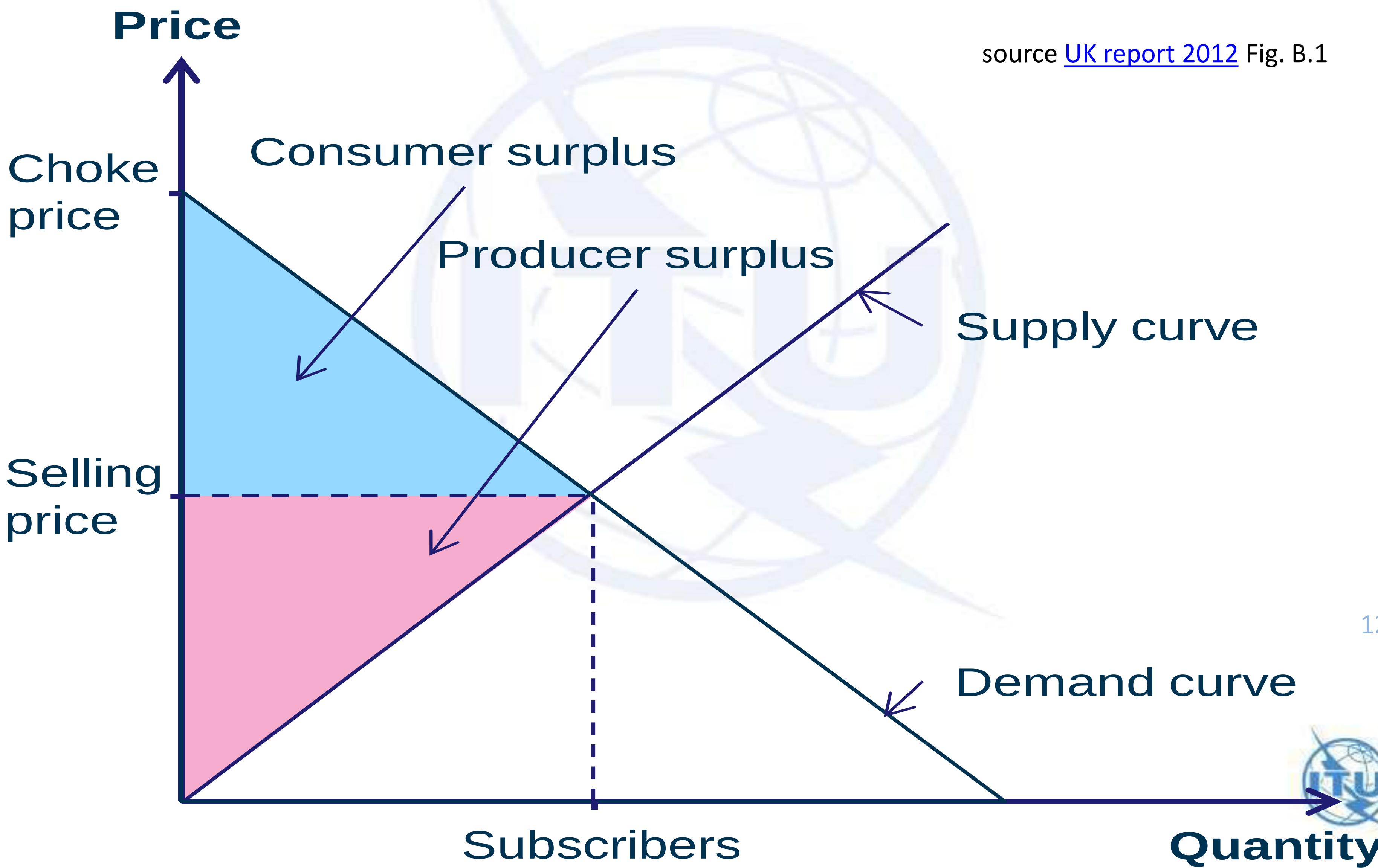
Economic Theories of **Auctions**: Econometrics & Benchmarks

Vision of Ronald Coase : see Mazar 2016 4.1.2.2 p. 117 [10]

1. Auctions are applicable only when the demand for spectrum exceeds the available supply.
2. Ronald Coase famously noted the inflexibility of spectrum allocation and the near-certainty of suboptimal allocation; 'the allocation of resources should be determined by the **forces of the market** rather than as a result of government decisions' Ronald Coase, 1959; Nobel Laureate 1991.
3. Coase's solution was not to move away from exclusive-use licensing, but to extend it further and treat these licences as **property rights** that could be **bought and sold**. Coase claimed that no matter how these rights were initially allocated, mutually beneficial trades would lead to an **economically efficient allocation**.
4. Auctions have become the most common way in which spectrum rights have been assigned in the developed world and many countries have permitted the **trading** of spectrum licences

Illustration of consumer and producer surplus

source UK report 2012 Fig. B.1



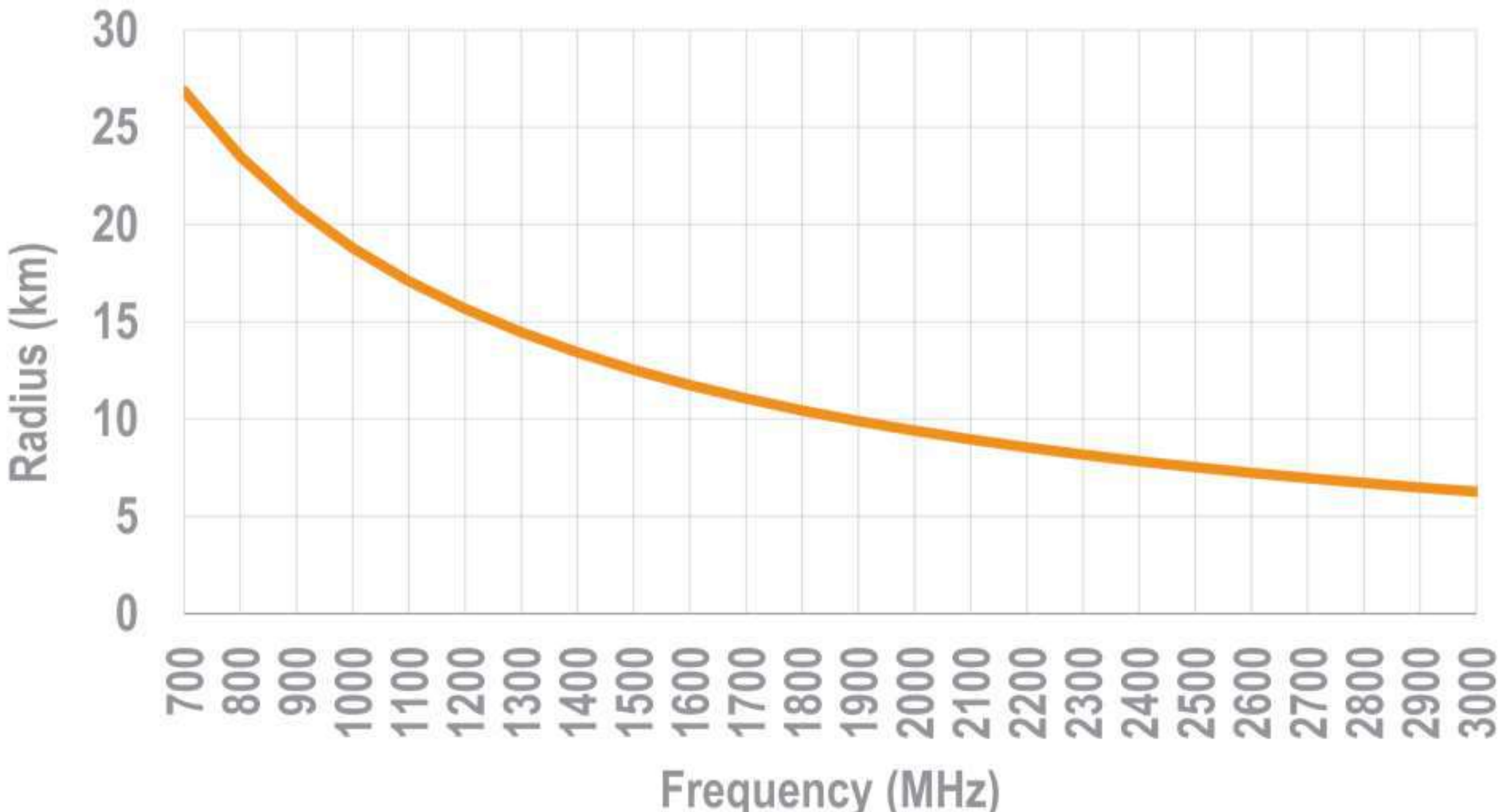
Three different methodologies to estimate the relative value of spectrum bands

1. Benchmarking indicates the mean or median value of the observations
2. Econometric analysis uses statistical methods for pure comparison between bands
3. ITU Indicators

Econometric variables; Reference [11]

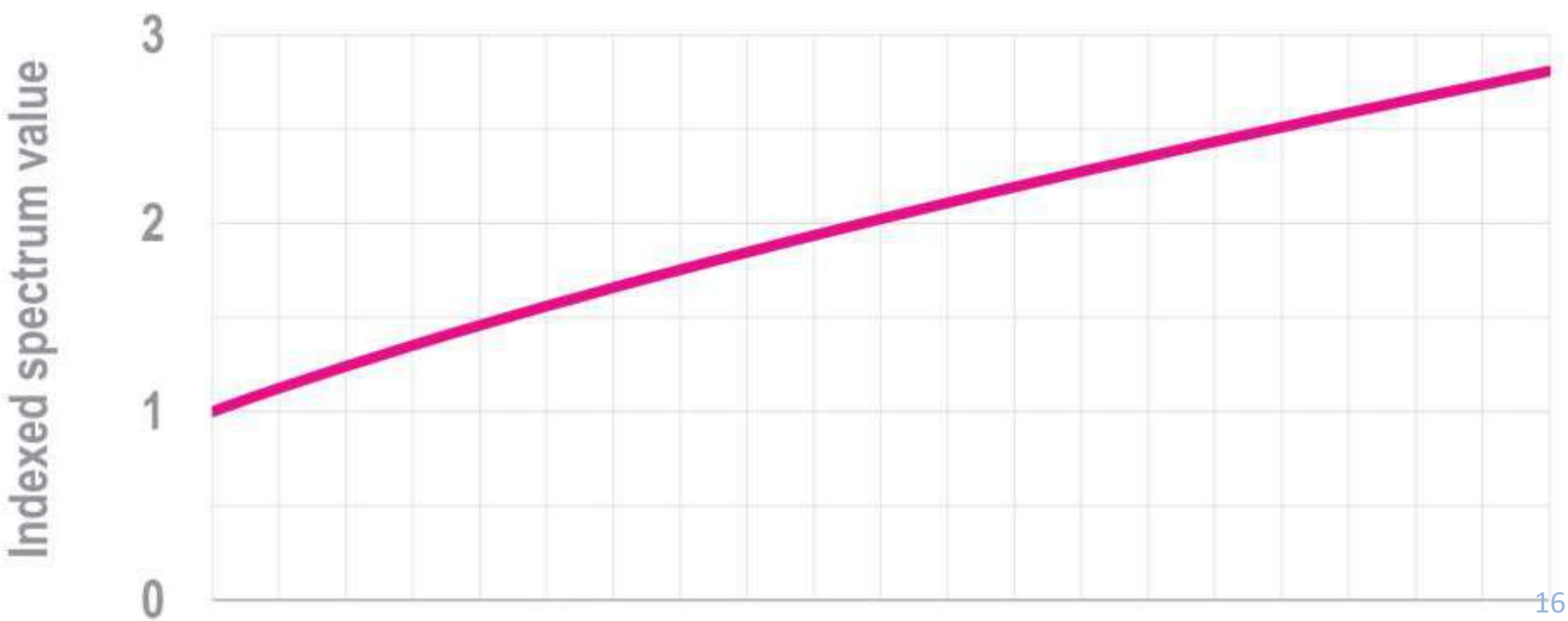
Variable	Description
Constant	Constant term (included as standard in regression analysis)
Bandwidth sold	Quantity of spectrum being auctioned. More contiguous bandwidth is expected to be more valuable.
Licence duration	Length of the licence
GDP per capita	Measure of the country's wealth
TDD spectrum	Dummy variable for time-duplexed spectrum
Region	Dummy variables for regions
Year	Dummy variables for years
BW	Bandwidth sold per operator (can indicate auction competitiveness)
>3 GHz spectrum	Dummy variable to indicate spectrum above 3 GHz
Population density	Country's population divided by its land area
Spectrum stock	Quantity of spectrum already released or mobile broadband
Cell radius	Maximum cell radius a frequency can support
Supported devices	Number of distinct mobile devices supported by a spectrum band
Auction format	Dummy variables for the auction's format
Mobile market HHI	Herfindahl-Hirschman Index (HHI) measures market concentration

Maximum cell radii, by frequency band; Reference Plum [11]



Value of spectrum vs. years in licence; Reference Plum [14]

- the longer the licence the more valuable it is
- Subject to diminishing returns: doubling the licence duration adds only 56% to the licence value diminishing returns
- Reflects uncertainty about the future: improvements in spectral efficiency (the amount of information that can be carried by the spectrum) make additional spectrum less vital in meeting future demand for data
- The fig is indexed to a 10-year licence



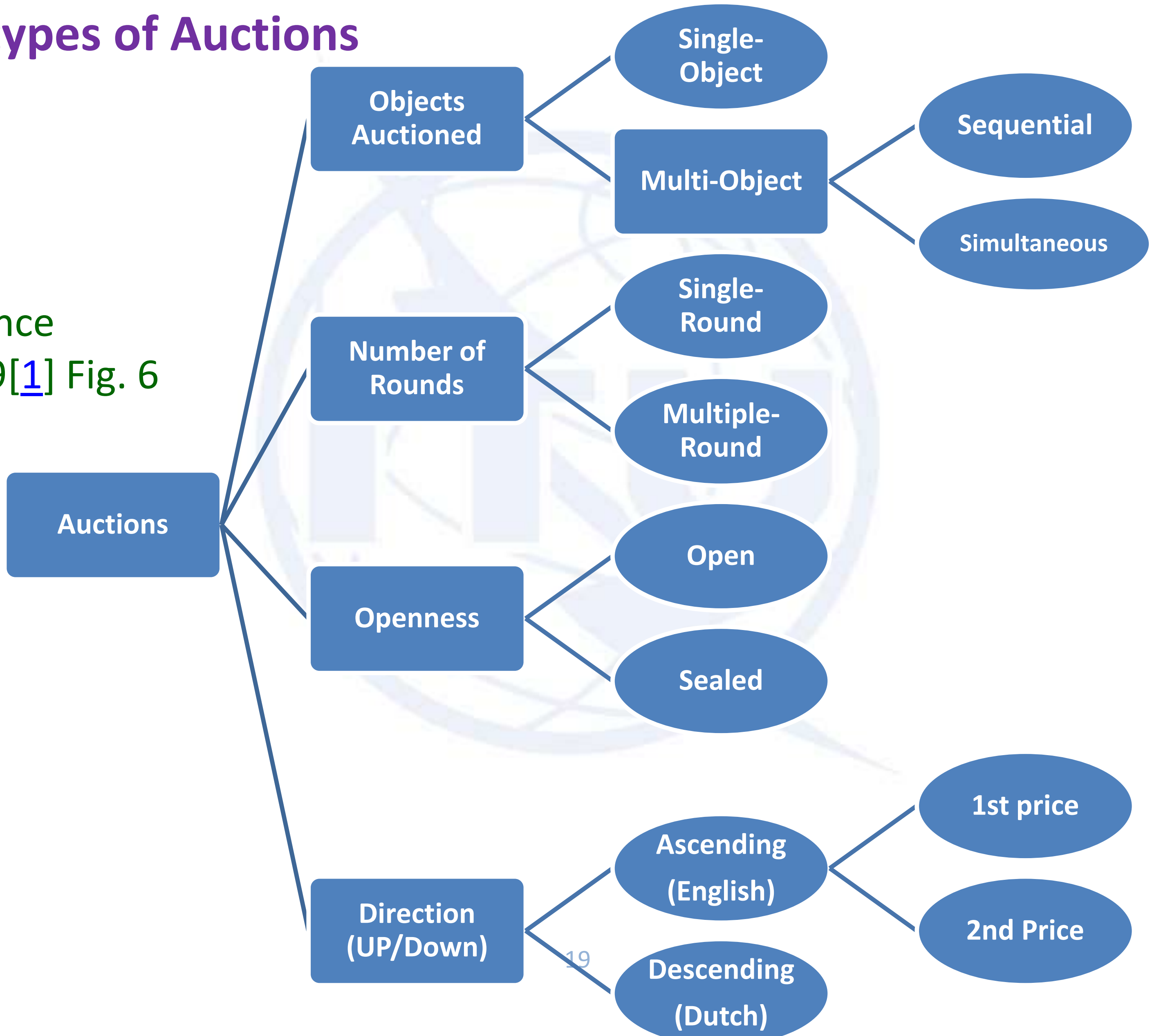
Market-based economic value; Reference ITU-D BC [2] p. 4

1. Auctions and spectrum trading: participants in a competitive auction or engaged in a spectrum trade determine the price
2. Auction: economic value is reflected in the price paid by the successful bidder, which will meet or exceed the **reserve price** established for the auction. It will be composed of **bidding deposits** paid at the outset and the applicable winning price
3. Spectrum trading reflects the economic value
4. Spectrum fee includes transaction costs imposed on the participants in trade
5. Spectrum prices are determined through market mechanisms, price levels at a given time influenced by a number of factors such as geography, competition amongst potential users, advances in technology, the present value of cash flows

Types of Auctions

Different types of Auctions

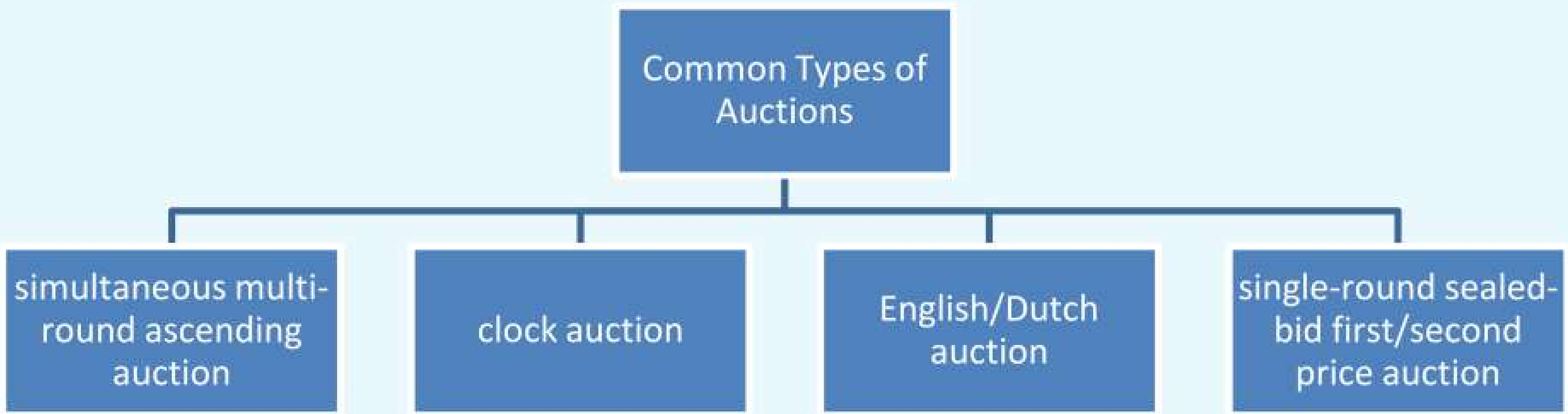
See Reference
ITU-D Res 9[1] Fig. 6



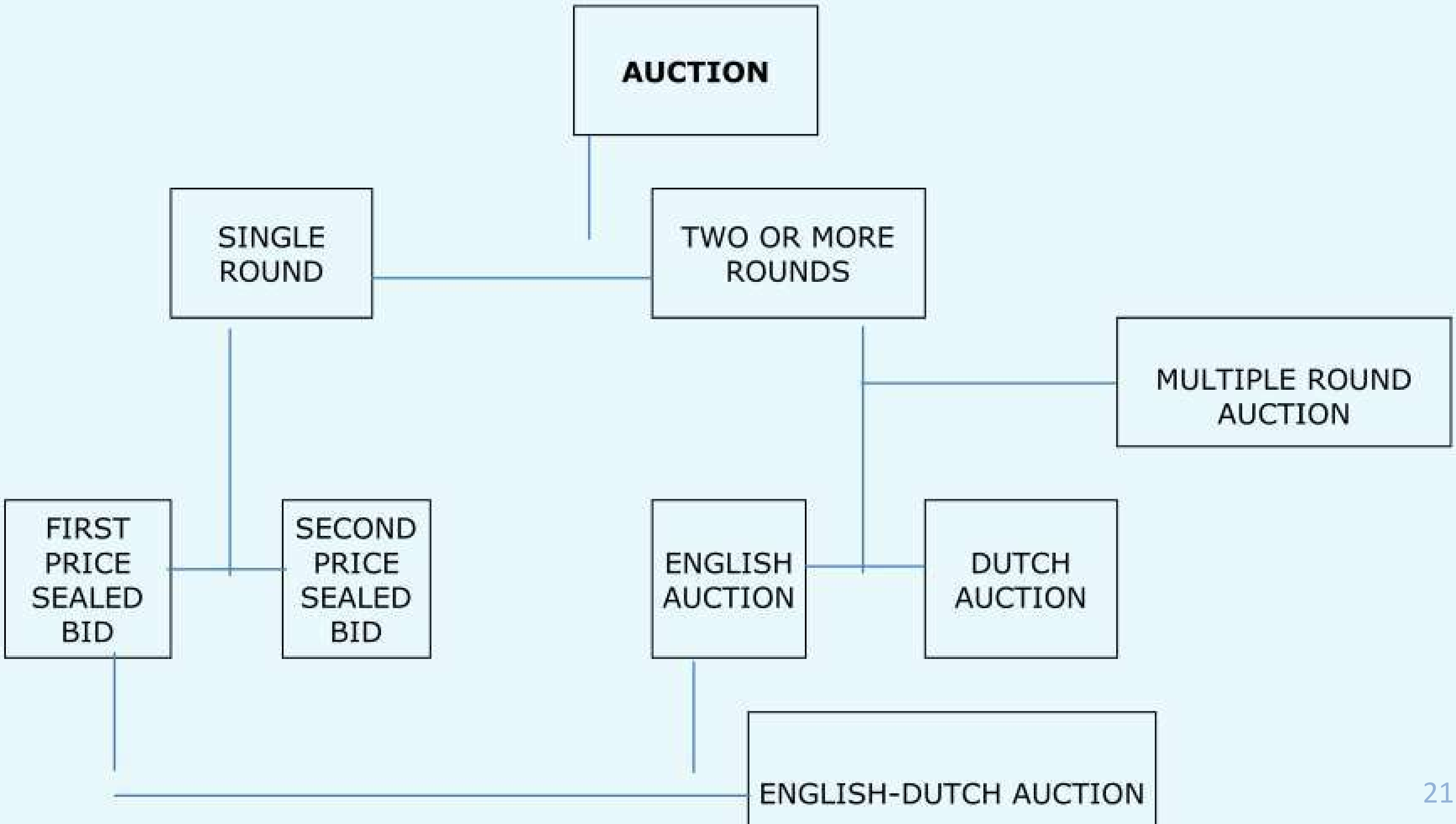
Common types of auction; Reference[1]

Figure 7: Common types of auction

See Reference[1] Fig. 7/1



Most widely-used Auctions; Reference ITU-D D Res 9[1]



Reverse auctions; USA Doc ITU-D SG1RGQ/209 Sep. 2019

1. Promote last mile connectivity for its Rural Digital Opportunity Fund in the future
2. Last mile, the final stretch of connectivity between broadband providers & individual consumers i.e., the physical links directly to homes and businesses. Geographic barriers pose an added challenge to connectivity, especially for low-income and rural consumers
3. FCC used a reverse auction to efficiently & effectively allocate limited government funds to providers for last mile broadband (BB) deployment & connectivity in hard to reach places. Reverse auction serves as one example that aims to promote affordable access to broadband for all
4. Providers compete to build out BB to a specific number of locations in an unserved area for the smallest government subsidy. Bids represent amount of government support that a BB provider would accept in order to commit to providing BB coverage, while still making a profit
5. The BB provider that bids the lowest, after adjusting for quality, is awarded the funding and is required to cover 100% of the locations identified by the FCC in the areas it won within a specified number of years

Reverse auctions; USA Doc ITU-D SG1RGQ/209 Sep. 2019

1. FCC promotes last mile connectivity by using rural broadband "reverse auctions."
2. FCC has successfully used multiple approaches/techniques to fund broadband infrastructure projects in order to enhance nationwide broadband connectivity and close the digital divide.
3. FCC) used a reverse auction to efficiently and effectively allocate limited government funds to broadband providers for last mile broadband **deployment** and connectivity in hard to reach places.
4. The Auction encouraged fixed broadband deployment in high cost and rural areas by giving broadband providers subsidies to offset infrastructure and service costs.
5. Winning bidders must cover **40% of the locations** for which they were awarded funding within **three years** of the auction at the performance tier and latency they agreed to during bidding. The broadband providers must then increase broadband coverage by **20% each following year**, meeting full coverage by the **sixth year**

Reverse auctions advantages; USA Doc ITU-D SG1RGQ/209

1. Adjusting bids based on the QoS (speed, usage allowance, latency, etc.), a reverse auction can encompass many types of services at the same time (satellite, fixed wireless, fiber, etc.) and find the service that is the best fit for each area
2. Considering many unserved and hard to serve areas at once, a reverse auction can efficiently distribute government funds to those areas where government support will make the greatest impact.
3. The FCC's Connect America Fund Phase II Auction (CAF II Auction) successfully used a reverse auction solution to help bridge the digital divide between urban and rural FCC Staff Paper, *Maximum Impact for Minimum Subsidy: Reverse Auctions for Universal Access in Chile and India*, (2010)

The Author doesn't find that reverse-auction is advantageous to the German way, obligating Bidders to firstly cover rural and remote areas

Increasing mobile broadband coverage through spectrum awards; Coleago Consulting Ltd; Ref [18]; Sep. 2019

1. Germany has used "reverse roll-out requirements". In the 2010 German 800 MHz auction, four classes of locations were identified with each assigned a different level of priority. The first priority class involved providing coverage to the smallest towns, the second priority class involved slightly larger towns and so on
2. Roll-out could not commence in a lower priority class until the previous priority class has been covered by 90%
3. The obligation could be met through jointly providing coverage with another operator based on "economic cooperation"
4. Five years later the obligation had to be met entirely by the individual operator

Auctions Principles:
Legal, Economic & Engineering

Legal principles; Reference SM.2012 [4]

1. Radio Frequency (RF) spectrum is the property of the State. Thus, any spectrum occupancy relating to non-governmental activities is considered to be private occupancy
2. Belonging to the State's public domain, spectrum is managed in the interests of the national community
3. As the owner of the spectrum, the State has the right to require private occupants thereof to pay *spectrum fees* (known also as *spectrum occupancy fees*, *frequency availability fees* or *spectrum usage fees*, annual licensing fees or simply as *fees* where there is no ambiguity)
4. Planning, management &monitoring of the spectrum are carried out by the State or by entities to which the State has delegated such responsibilities
5. Lawful to require, that private spectrum occupants also pay *administrative fees* (known also as *frequency management fees* or *service fees*, as well as *administrative charges* to cover all of the costs arising out of spectrum planning, management & monitoring activities
6. Spectrum & administrative fees should respect the rules of **transparency**, objectivity, proportionality and non-discrimination. Where transparency is concerned, it is particularly important that the rules governing the establishment of fees be **simple** and readily understandable by all concerned
7. The rules governing the establishment of fees must be relatively stable over time in order to provide spectrum occupants with the necessary visibility and legal security
8. In return for the fees they pay, users enjoy **protection** under the relevant provisions of the regulations in force.
9. By contrast, users of freely accessible frequencies (Short Range Devices used, for example, for Wi-Fi, Bluetooth, amateur radio and radio-controlled models) are **not protected** & should therefore **not be required to pay fees**. A reality principle unites with this legal principle to dictate that fees should not be applied to freely accessible frequencies

Economic principles; Reference [4]

1. RF is a limited &, in some cases, scarce resource. The main objectives of the manager are to secure both optimum spectrum occupancy and effective
2. frequency utilization
3. The reasons & aims for spectrum & administrative fees are different. That difference should thus be reflected in two distinct approaches for establishing each kind of fee
4. Purpose of administrative fees is to pay for the service rendered by authorities
5. Purpose of spectrum fees is:
   I. enable achievement of the budgetary objective set by the authorities
   II. not clash with the economic objectives of the authorities in regard to national development and the development of new services
   III. take account of all the benefits that occupants derive from the spectrum
6. **Constitute a tool for spectrum management**
7. Fees constitute financial resources for the State & for the spectrum manager. The level at which they are set reflect inflation & the evolving status of the spectrum manager's budget

Advancing Auctions

Design of a Competitive Auction or Tender; Source Common Wealth 2016 Mazar

1. Draft rules for use of the spectrum: licence parameters; coverage and QoS obligations, bilateral and multilateral agreements; obligations relating to the mutual interference caused to/by other services in the band or in adjacent bands; **technology neutrality**
2. Technology neutrality allows for license holders to evolve their technology and the services delivered as markets develop
3. Clarification of the international situation: interference that may be caused to the notified licensed network in border areas, what are the commitments taken by the government to protect the services of other countries and those taken by other governments to protect the licensed network
4. Obligations to protect the public human hazards, against electromagnetic waves
5. Setting licence terms and conditions (e.g. fees, term limits, renewal criteria)
6. Setting auction rules
7. Publication: transparency, openness and responsiveness
8. Check for potential bidders' qualifications in terms of financing, operational experience in other countries, and management capabilities

30

Auctions' mechanisms: Reference [2] p. 3

1. ***Administratve*** mechanisms include administratve incentve pricing (AIP) and spectrum fee formulas that recover regulator costs of spectrum management
2. ***Market-based*** mechanisms for setting spectrum prices typically involve a market exchange such as spectrum auctions and (in the secondary market) spectrum trading

Operating principle of an Auction; Reference[1]

1. In a world of perfect information, the higher the number of participants, the higher the sales price
2. Sale price is equal to the expectation of the highest private valuation
3. During the auction, participants indicate the amount they commit to pay to acquire the object for which the auction is organized. The amount may be indicated in a sealed envelope, orally in public, by Internet, etc.
4. In cases where spectrum is auctioned, its value is revealed in the market clearing prices

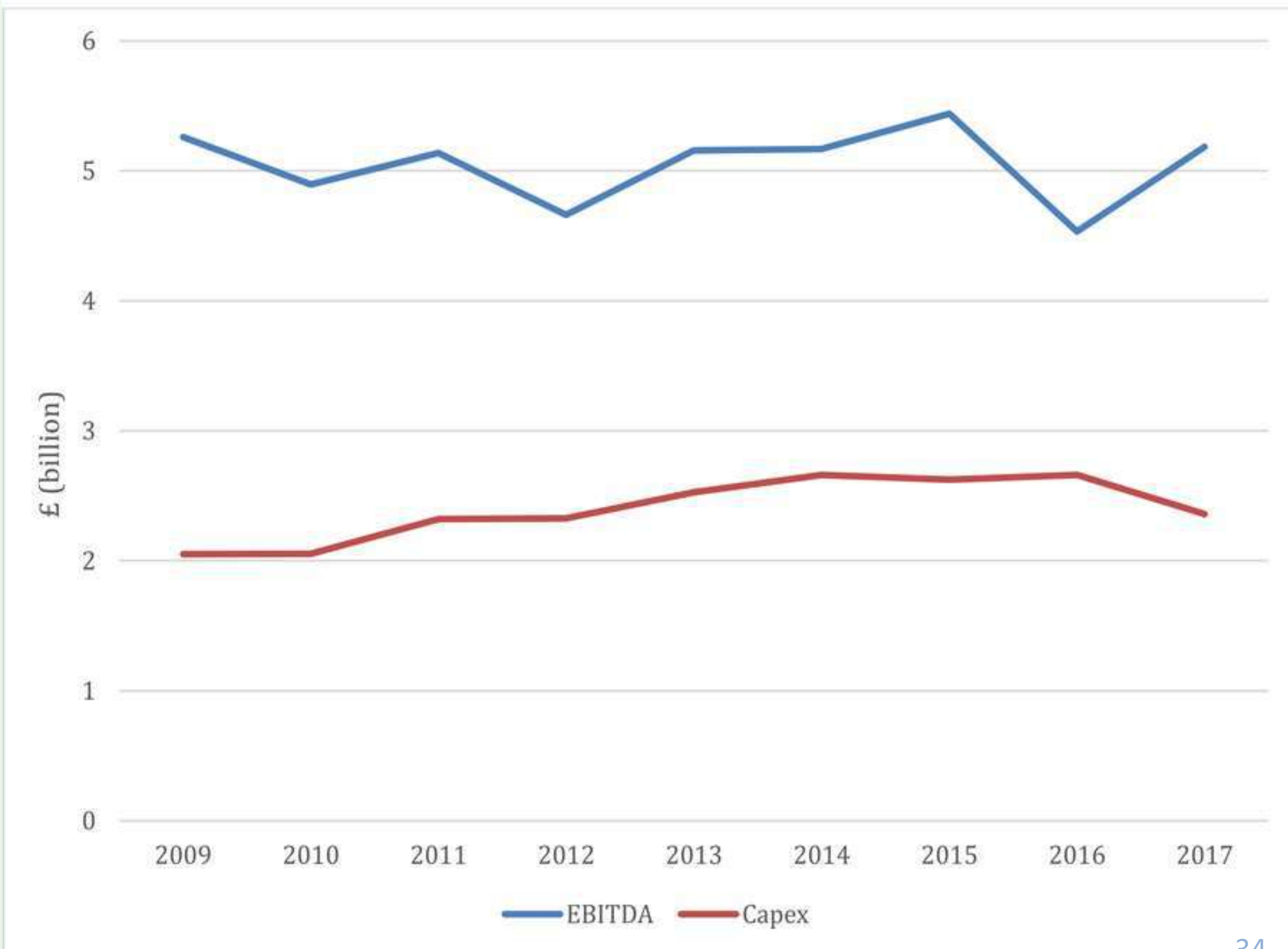
Figure 5: Operating principle of an auction

Reference[1] Fig. 5

Economic Impact & Spectrum Price

Aggregate capex & EBIDTA for the 4 UK MNOs, 2009 to 2017 (April 2018 prices) Ofcom Ref. [8] p. 54

CAPEX (capital expenditures) & EBITDA (earnings before interest, taxes, depreciation, and amortization) accumulated 2009 to 2017 (price April 2018)



Regulators may distinguish fees among: Reference [10]

1. RF services: broadcasting (audio and video), mobile, fixed links, satellites…
2. Categories of terminal equipment & radio transmitters, licences examinations, inspection certificates & certifications (conformity assessment), human-hazards measurements,
3. Issue of type approvals, not for European Directive 1999/5/EC (R&TTE) signatories

Economic Valuation of Spectrum; Ref. ITU-D BB [7]

1. *Spectrum assignment* – Valuation is often instrumental in determining threshold or reserve prices in spectrum auctions or tender processes, and bidders can be expected to estimate spectrum value in designing their bidding strategies
2. *Spectrum trading* – Secondary markets involve both suppliers and customers, and both seek to determine valuation in order to arrive at an optimal price point for their businesses
3. *Spectrum fees* – Regulators need to estimate spectrum value in order to set recurring fees (or even up-front fees) that go beyond their regulatory costs (i.e., fees set based on *administered incentive pricing* (AIP)
4. Unlicensed equipment- importer doesn't pay

Factors affecting the RF value; Ref. [7]

1. Factors are detailed at Table 2 ITU-D 2012, Alden J., *Exploring the Value and Economic Valuation of Spectrum*.
2. Intrinsic factors are propagation characteristics, sharing capacity, profusion of uses, global and regional harmonization and international constraints. All other factors are extrinsic.
3. Physical factors are geography and climate
4. Socioeconomic factors are demographics, population density, income distribution, economic level and growth rate, political stability, absence of corruption and rule of law
5. Policy & regulation factors include the existence of an independent regulatory agency, favourable investment & customs laws, competition policy, infrastructure sharing, rules of protection of the public against electromagnetic waves, open access rules, technology neutrality, protection against interference, coverage obligations, spectrum caps, auction rules and bidding credits/set-asides, transparency, licensing framework and dispute-resolution mechanisms

Tariff has two components: Reference [10]

1. **One-off licence charge** is the authorization to execute the telecommunication service. It reflects the **costs** that occur once in connection with issuing the licence (e.g. for frequency planning & management, international co-ordination, administrative costs & investment in equipment); the indirect costs of staff departments such as the communications department and legal department are also part of that tariff. Often, these indirect costs are covered by the general budget. The one-off licence-fee is cost-oriented and is not to be confused with the amount to be paid in case of an auction. The licence-fee can reflect the benefits of exploitation of the licence, such as a percentage of turnover or the profits, as a result of implementing the licence; this component is useful for cellular communications and digital TV; and
2. **Annual costs** are paid every year by licence holder for enforcement and monitoring costs. These are activities which contribute to safeguard the use of the frequencies, ensuring compliance with the rules, relating to the use of the airwaves and of equipment. The Minister or the Parliament approves the tariffs. Tariffs should be published.

Principles for Licence fees; Reference SM.2012 [4]

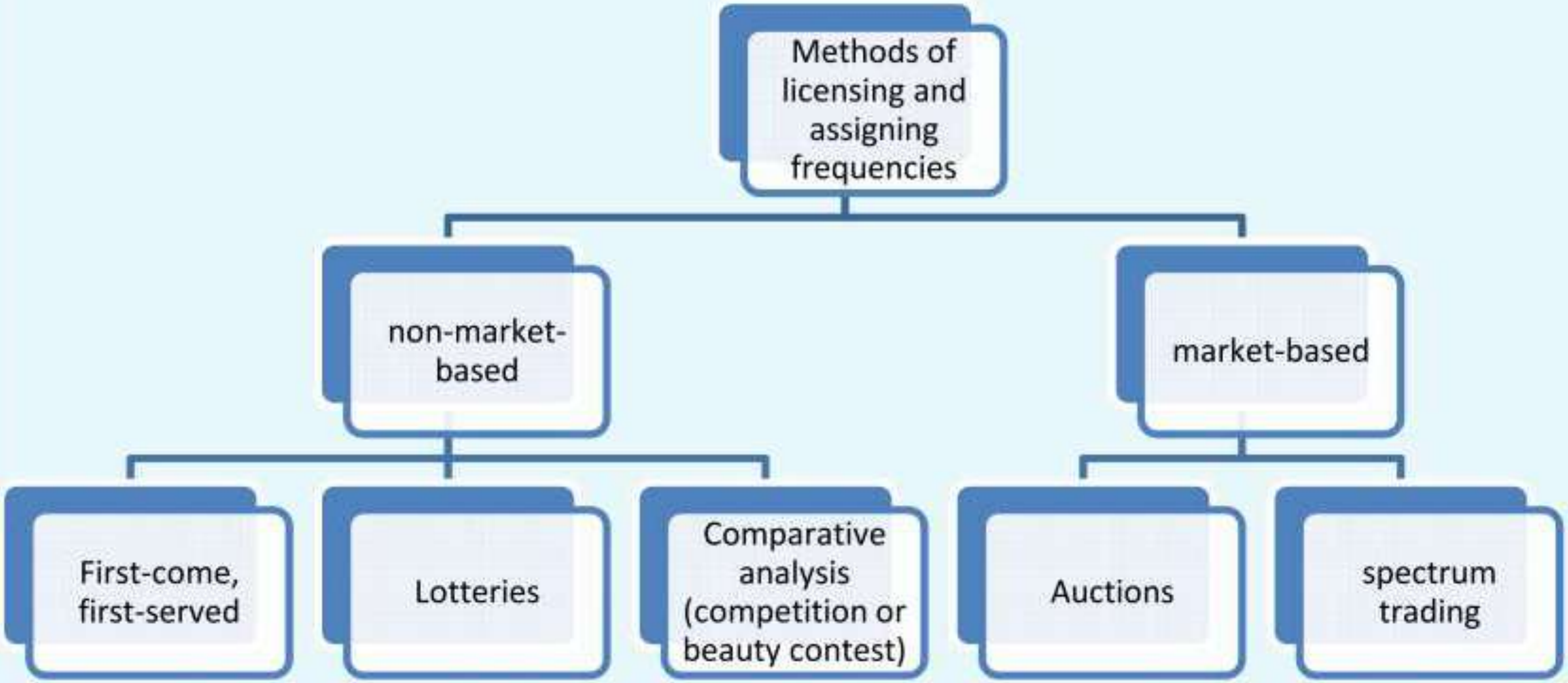
1. Decisions & changes related to fee collection should be undertaken transparently thru consultation with users & industry
2. Fees should consider the value of the spectrum
3. Fee mechanisms should be easy to understand & implement
4. Fees should not be an impediment to innovation & use of new radio technologies, or to competition.
5. Fees should support the attainment of the spectrum manager’s national goals and objectives

Fees based on spectrum management costs;
Reference R SM.2012 [4]

1. Direct & indirect spectrum management costs
2. Fees based on user’s gross income
3. Incentive fees
4. Opportunity cost fees

Methods of licensing & assigning frequencies

See Reference[1] Fig. 4



Auctions Advantages & Disadvantages; Reference[1]

Advantages	Disadvantages
• Relative maximization of revenue for the government • Optimization of spectrum (economic efficiency) • Opening up to competition • Relative speed of process • Transparency	• Limited technical requirements • Does not necessarily achieve the highest social value • A poorly qualified candidate may win the license • Successful candidate may overbid ("Winner's curse"): uncertainty regarding the demand, tariffs, etc. • Possible collusion during the bidding

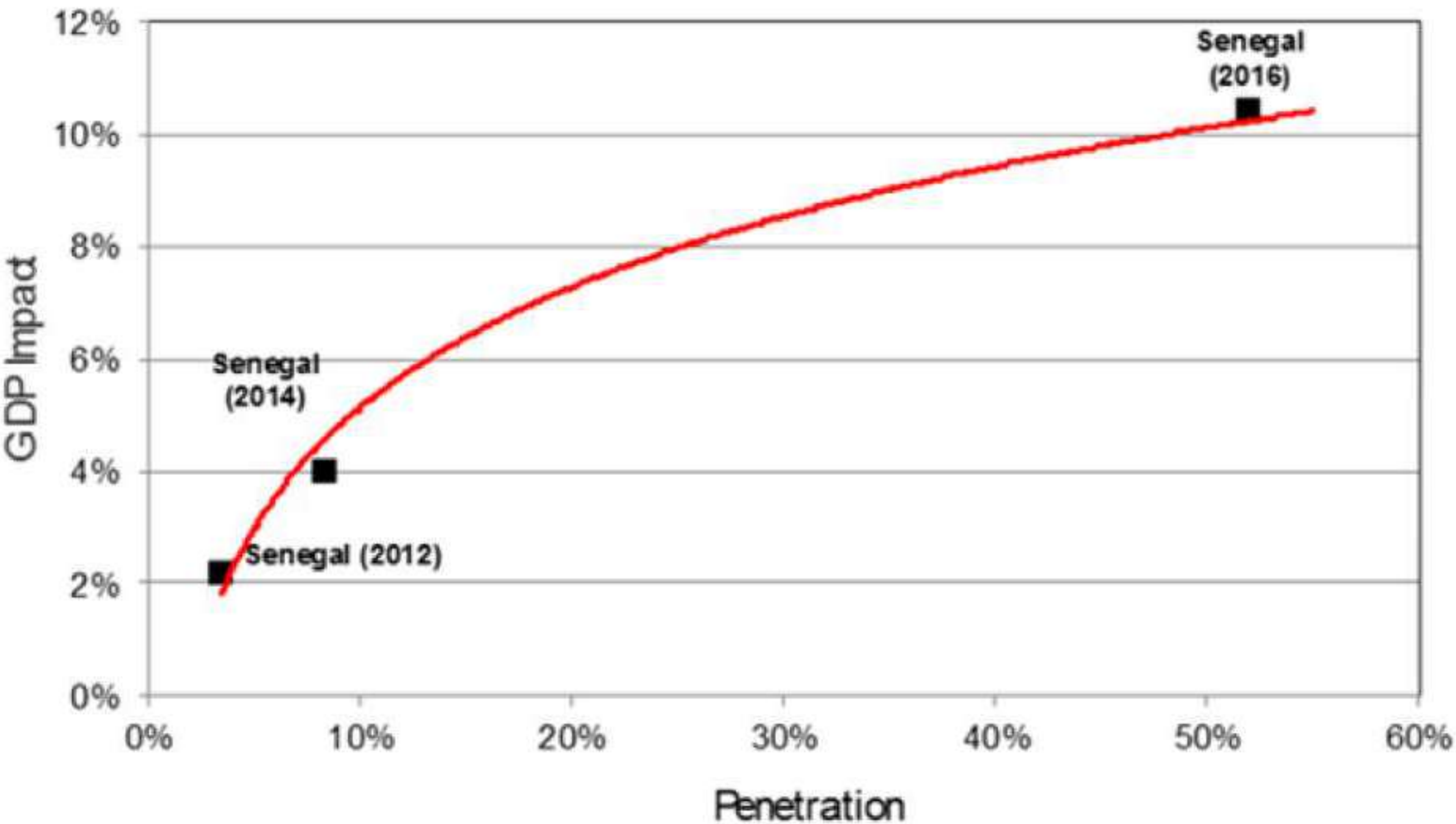
ITU Radio Regulations footnote 5.340 all emissions are prohibited ; Reference [10]

1. … bands serve for meteorological services, space research or radio astronomy. The value of these RF bands is inestimable, as they cannot serve any other wireless application
2. In general, fees are paid for terrestrial & earth stations (Earth-to-space); those stations are located in a specific country; this is not the case of satellites. Coverage area is significant for terrestrial cellular, broadcasting and point to multipoint (P-MP) fixed wireless. For point to point links, the range of the application is more meaningful than the surface
3. EC **Directive** 1997/13/EC **(Licensing) Article 11 (**fees and charges for individual licences) **permits** the collection of fees for the use of frequencies, to enhance efficient use of the frequencies:

Different methods to evaluate the Licence-Fee; Ref. [10]

1. Advantages of auctions are: more efficient use of frequencies through revelation of the private valuation of its price, optimization of spectrum access, competition, transparency, accountability, speed and offering the public with the highest value for use of the public resource. However, incompetent bidders may win, and auctions facilitate anti-competitive outcomes; for example: large operators acquiring a disproportionally large part of the available RF spectrum. So, safeguards are needed, such as restrictions on the amount of spectrum a bidder may win and by obliging the winning bidder to use the frequency awarded. The sale price is equal to the expectation of the highest private valuation. Higher levels of communication infrastructure, fewer barriers to shareholdings and greater demand for RF spectrum access will boost the state's revenue. There are additional methods to evaluate the licence-fee. In some cases extra market-based fees apply in case of beauty contests (possibility of a voluntary bid), and occasionally 'usage fees'.
2. Combined with complementary policies (such as administrative incentive pricing) spectrum trading and liberalisation play an important part, in securing the optimal use of the radio spectrum. They can help to promote innovation, investment and competition in the supply of wireless services, economic growth; they can open up new opportunities for businesses to innovate and grow, giving consumers faster access to new services and lower prices (see Ofcom website and chapter 8, the UK case study 8.3.3).

Senegal: Mobile broadband economic impact Reference [5] fig. 1



Determining economic value of spectrum;

Reference ITU-D BB [2] p. 3

In an auction, the economic value is reflected in the price paid by the successful bidder, which will meet or exceed the reserve price established for the auction. It will be composed of bidding deposits paid at the outset and the applicable winning price

Setting the price of spectrum; Reference[1] Annex 6

Methods	Subjects
Simple fees	Simple fee to have the right to use the spectrum
Fees based on costs	Based on all the kinds of cost systems
Incitative prices of spectrum (Spectrum « Value »)	– "Economical Variables" to calculate the fees (Formulae) – Bandwidth – exclusivity – geographic location – coverage… – Fees based on brut income – Fees on cost opportunity
Auctions	– Sealed bid (first price) auction – Single round sealed (second price) auction – English or ascending auction – Dutch (descending) auction – English/Dutch auction – Clock auction – Simultaneous multiple-round auction – Sequential/simultaneous open auction
Secondary Market	"Rights to Frequencies Uses"

Spectrum auctions in Africa. see SRG Spectrum HB 2018 Fig 23-1

No.	Country	Spectrum Sold	Amount
1	Nigeria	30 MHz of 2.3 GHz &80MHz of 2.6GHz	$119 million USD
2	Ghana	20MHz of 800MHz	$67.5 million USD
3	Kenya	60MHz of 800MHz	$75 million USD
4	Senegal	20MHz of 800MHz & 20MHz of 1800MHz	$53 million USD
5	Egypt	40MHz of 900/1800 MHz	$1.9 billion USD
6	Rwanda	10MHz of 800MZ	PPP to cover 95% of the pop. with LTE in three years
Mozambique attempted to auction off spectrum 800MHz band			
South Africa attempted to auction spectrum but is currently in a standstill			

Source: Public data sources and Summit Ridge Group, LLC analysis

Bidder deposits; Ref. [11]

1. In an auction, the economic value is reflected in the price paid by the successful bidder, which will meet or exceed the **reserve price** established for the auction.
2. It will be composed of bidding deposits paid at the outset and the applicable winning price
3. Concludes agreements on deposits before Auction

Opportunity Cost & Administrative Incentive Pricing (AIP)

Simple, functional & linear equations; proposed by author Apr 2019 Reference [4]

- For all services, fee formula, only transmitters: **Cost /MHz: *α x F x ρ x σ x l x Mpub***
- Except Cost unit in the national currency (cur) k α, (cur/MHz) and *B* (MHz), all parameters serve as modifiers (relative indexes).
- Model determines the fees only for transmitters; i.e. VSAT earth stations operators pay only for their transmitters' bandwidth; FM and TV receivers don't pay Spectrum Utilization Fee (SUF). Unlicensed Short Range Devices don't pay license or annual fees; maybe type-approval
- Modifier to the fee reflects the particular circumstances of the spectrum being priced

α (fee /MHz): basic price unit. Based on the market dynamics, the country's vision of the ICT sector and international best practice. *α* = value of 1 MHz for cellular service below 6 000 MHz

F: depends solely on centre frequency; *F* equals 1 below 6 000 MHz and 6 000/*f* for higher frequencies. *F* is uncorrelated to the service

ρ: regional factor; equals 1 for national license, & proportional (less than 1) to the number of administrative areas (regions, provinces) covered by non-national license

σ: regional factor; equals 1 for national license, & proportional (less than 1) to the number of administrative areas (regions, provinces) covered by non-national license

l: site location: urban or rural (site outside the urban area) areas. Defines the socio-economic development within different districts and classifies different fees. *l* may get two values, e.g. full price in urban; 25% full price in rural areas. Administrations may decide other value, or provide additional classes like remote, etc.

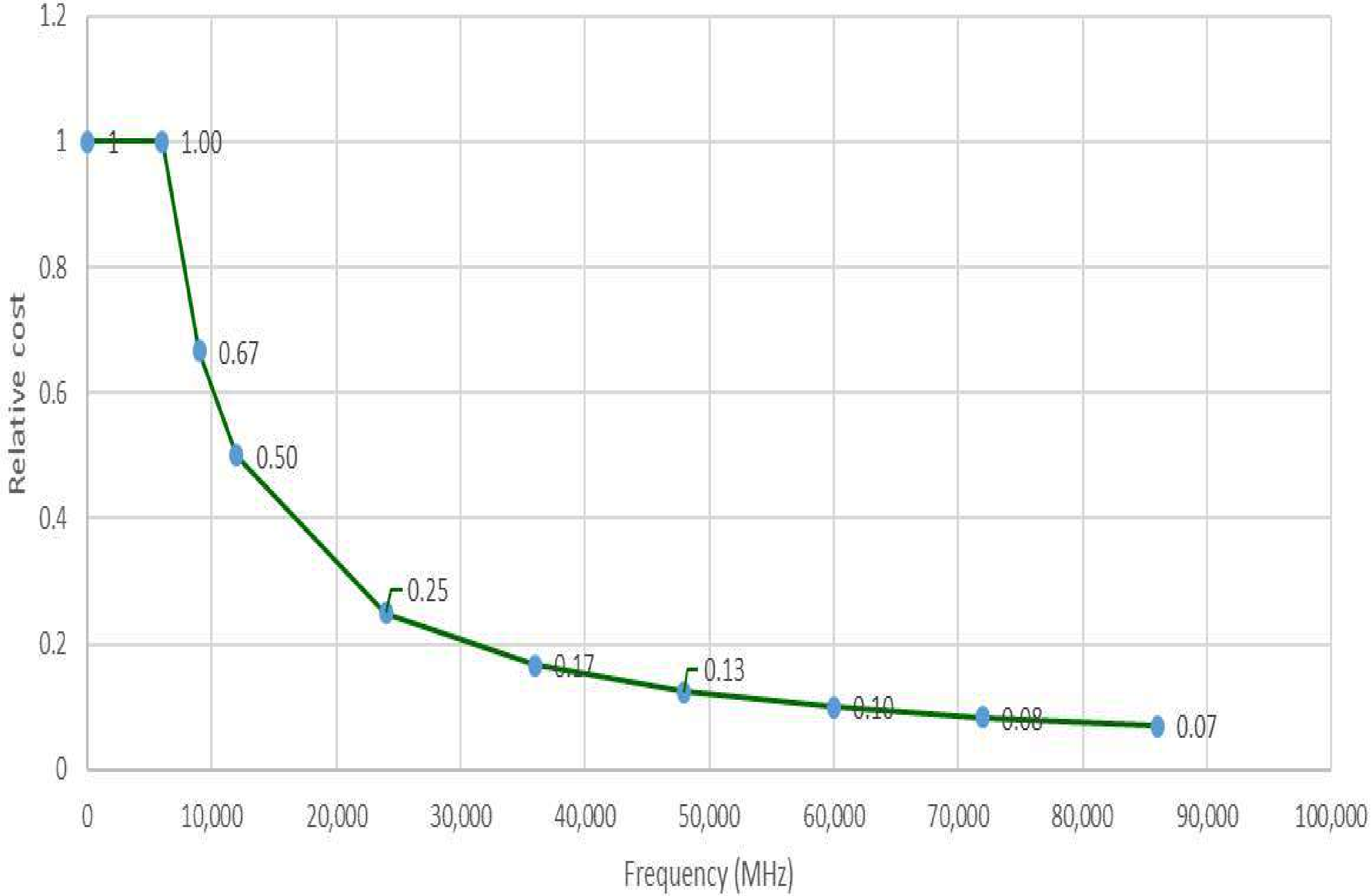
M_{pub}: public moderator to differentiate among services. M_{pub} actually defines the fees. M_{pub} equals 1 for the cellular service. For other services, M_{pub} numbers are arbitrary & predetermine the annual cost of the service. For example, for free-to-air television M_{pub} may be significantly lower than 1. M_{pub} serves as framework for holding the values of different services

Higher RF – lower fees Reference [4] section 4.8

1. Rec. ITU-R P.2040 – Effects of building materials and structures on radiowave propagation above about 100 MHz, Rec. ITU-R P.2109 – Prediction of building entry loss, and Report ITU-R P.2346 – Compilation of measurement data relating to building entry loss, explain why above 6 000 MHz the building materials attenuate the signal and may obligate a line of sight between the transmitter & receiver. Reference [10], section 5.6.8 specifies that practically before fifth generation, cellular networks operate below 6 000 MHz
2. < 6 000 MHz, propagation properties provide better coverage & penetration
3. < 6 000 MHz, there are less frequencies available, relative to higher frequencies. These bands are considered subject to excess demand
4. Model does not distinguishamong different cellular bands< 6 000 MHz: the advantage at lower RF is compensated by the provision of more bandwidth (& capacity) & availability of terminal equipment (e.g. 1800 vs 900 MHz)
5. Encourage efficient choices about frequency requirements. Lower frequency bands may serve greater distances and ‘bypass’ topographical obstacles. Relatively short distances can be facilitated in higher RF. To ensure the availability of lower frequency bands, operators are encouraged, through the factor *F* in the fee formula, to select the highest RF available, relative to the physical distance to cover
6. Factor *F* provides incentives for potential users to use higher RF, when contemplating new licenses, to optimize the use of spectrum

Relative fees (coefficient *F*) depend on frequency:

F=1 for f <6 000 MHz F=1/f for f ≥ 6 000 MHz Reference [4] Fig. 11



Example to calculate fees per MHz Reference [4]

- PtP annual fees per 1 MHz, operating nationwide, at 15 GHz, sharing with 3 other operators (σ = 1/4), given for PtP (M_{Pub}= 0.1)
- Cost /MHz: $\alpha \text{ x } F \text{ x } \rho \text{ x } \sigma \text{ x } l \text{ x } Mpub$ =
  $\alpha \text{ x } 6/15 \text{ x } \rho \text{ x } \sigma \text{ x } l \text{ x } Mpub$=
  α x 6/15 x 1 x 1/4 x 0.1= 0.01 α

Factors **non-included** in the formulae Reference [4]

1. Equation Cost /MHz: $\alpha \times F \times \rho \times \sigma \times l \times Mpub$ includes straightforward parameters that are directly connected to the use of the RF, & the 'shadow price', of denying other operators to use the same RF spectrum
2. Equation disregards others parameters, such as
    1. Number of base stations, to promote installation of more stations to improve QoS, & to achieve better coverage & capacity
    2. Surface of coverage or radius cell, as it is difficult to define; moreover, public & regulators may prefer higher coverage (surfaces and radii). Surface of coverage has no meaning for µ wave links. The surface is included in the moderator *ρ,* representing the number of districts
    3. Power, as it is difficult to monitor power or e.i.r.p.; total e.i.r.p. of cellular stations change continuously (due to power control)
    4. Effective altitude, as it complicates the method, and there is a need of digital terrain map (DTM)
    5. Temporal scope and duty cycle, as most emissions (cellular and µwave links) are all day long. To remind that a **non-used frequency is a waste to the economy**

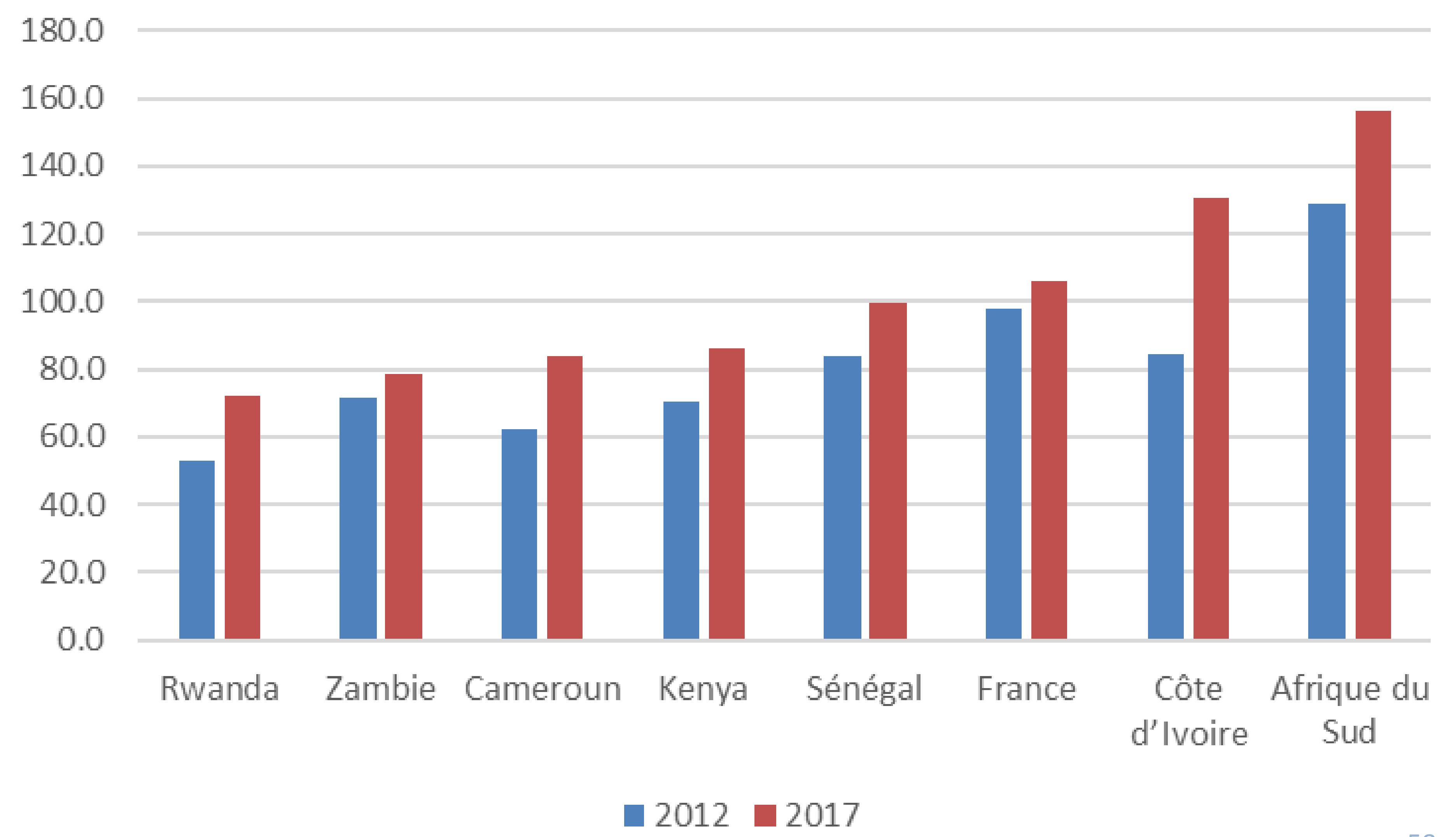
Sub-Sahara 800/700 MHz Case Study

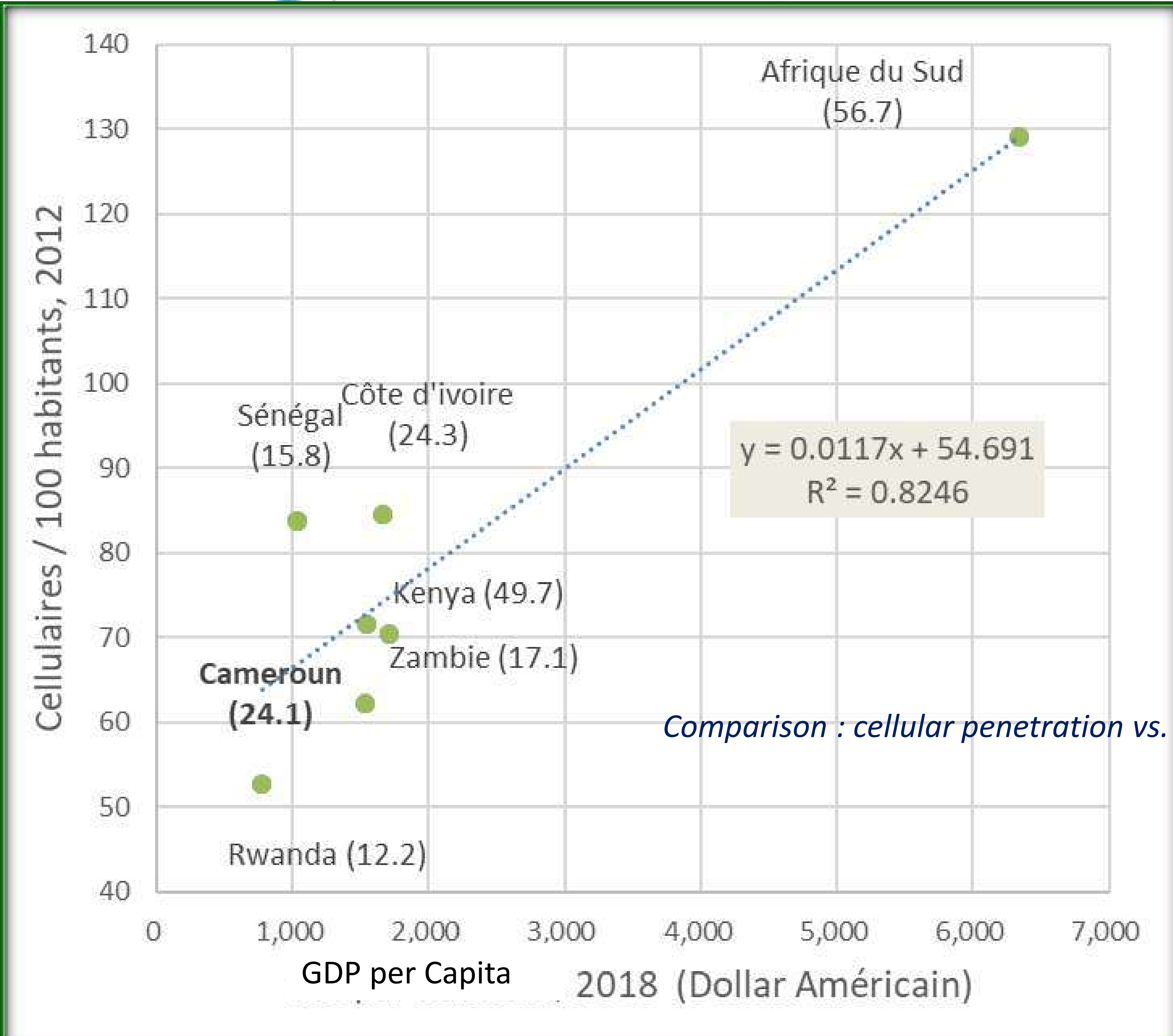
Comparison among some African countries: population, GDP, cellular penetration; Source based on ITU indicators

Countries	Population (millions)	GDP per habitant (USD)	cellulars/100 habitants		
			2012	2017	2017/2012
Rwanda	12,2	773,0	52,7	72,2	1,4
Sénégal	15,8	1,033.07	83,7	99,4	3,5
Zambie	17,1	1539,9	71,6	78,6	1,1
Cameroun	24,1	1526,9	62,2	83,7	1,3
Côte d'Ivoire	24,3	1,662.44	84,5	130,68	9,1
Kenya	49,7	1710,5	70,4	86,1	1,2
Afrique Sud	56,7	6339,6	129,0	156,0	1,2
France	65,0	41463,6	97,8	106,2	1,1

Comparison among some African countries: cellular penetration;

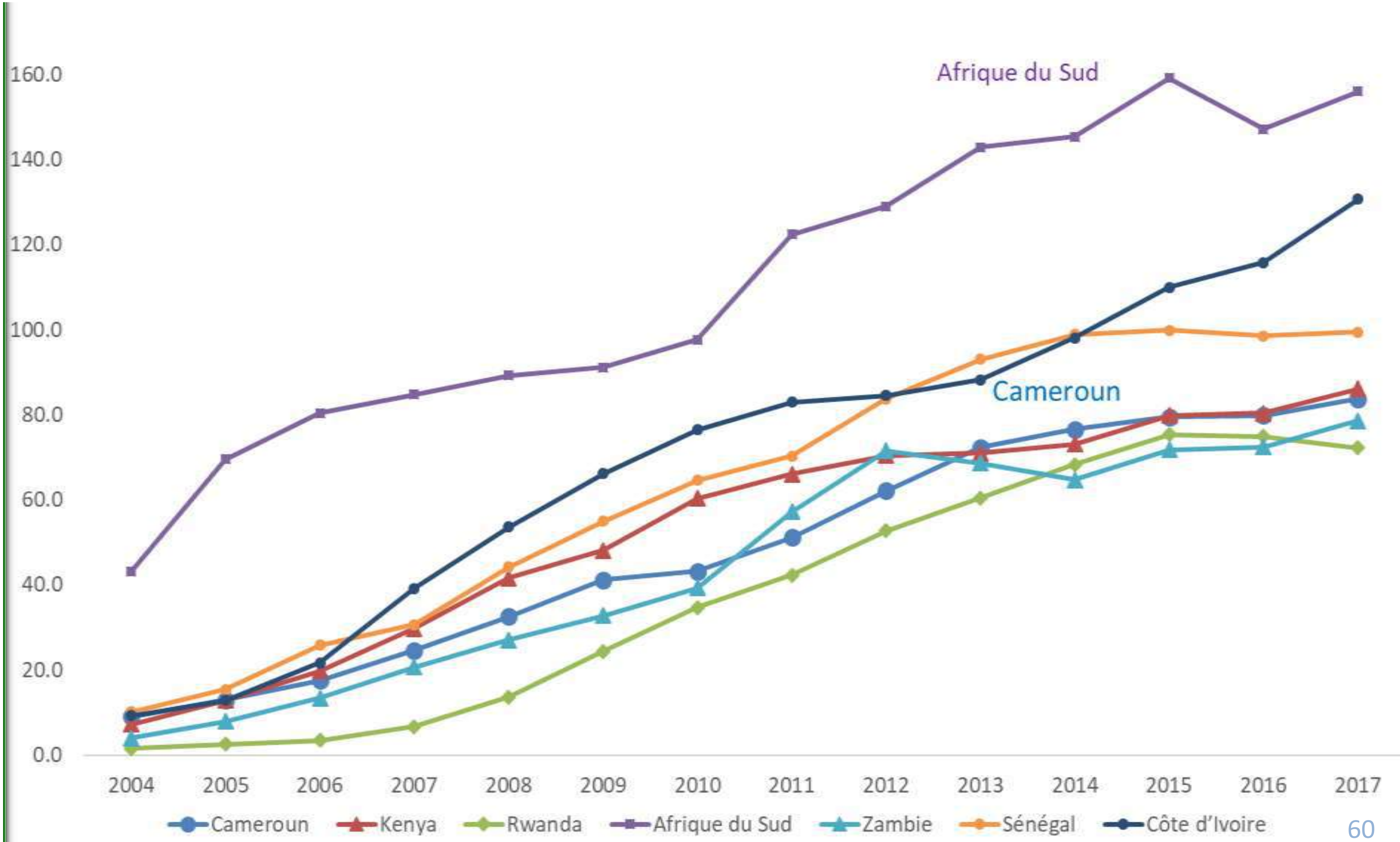
Source based on ITU indicators





Comparison : cellular penetration vs. GDP/capita ; R^2= *0.8246*

Comparison: Cellular Penetration 2004-2017; Ref. [3]



Mozambique Auction; press release of *Nacional de Comunicacoes de Mocambique* (INCM)

1. **800 MHz**
    1. 5 slots of 5 MHz bandwidth
    2. Reserve-price 15 M. USD
2. 1800 MHz
    1. 6 slots of 5 MHz bandwidth
    2. Reserve-price 30 M. USD
3. 2600 MHz
    1. 9 slots of 5 MHz bandwidth
    2. Reserve-price is 15 M. USD

- At 1800MHz & 2.6GHz no bids. The only lot auctioned was 800MHz
- Revenue equals the sum of 3 highest bid amounts
- Revenues about 83.4 million USD dollars
- 34% paid upon the assignment of RF. 33% in 2019 & 33% in 2020

Ghana Case

NCA Announces Winner for One Lot of 2x5MHz Spectrum in the 800MHZ Band

- The National Communications Authority (NCA) announces that Ghana Telecommunications Company Limited (Vodafone Ghana) has won one (1) lot of 2x5MHz
- Process started Sept 2018 when the NCA published a Request for Applications (RFA) & made available 3 lots of **2x5** MHz & **800 MHz**
- Two companies submitted applications, with Vodafone emerged the only successful applicant
- **30 M.USD** for 3 lots of 2x5 MHz equivalent to **20 M.USD** for 2 lots
- September this year, the Authority's public-call for a 'Request for Applications' resulted in the submission of 2 applications
- The sale of the Spectrum is in line with Section 58 of Electronic Communications Act 2008, Act 775 on Spectrum Management which highlights the NCA's mandate and the options for Frequency Assignment

Possible Benefits from Auctions

1. Advancement of the country's mobile broadband **infrastructure and capability** which will serve as a catalyst for the nation's economic development
2. Facilitation of social **provision of services** economic benefits to consumer as mobile broadband will widespread high quality services, and will be key to promote education, health and PPDR
3. Lowering mobile communications costs as a result deploying **fewer base stations** for wider coverage and therefore potential lower consumer prices
4. Extending mobile broadband services to a wider population especially those in **rural areas**
5. Promotion, enhancement and facilitation of **innovation for new ICT services & technologies**
6. Source of **national revenue** by obtaining optimal return for a scarce resource

Objectives of Assigning 800/700 MHz

1. Increase QoS: data and voice services
2. Increase mobile broadband coverage & capacity for both urban & rural areas
3. Maintain & enhance competition

Normalized results in Ghana & Tanzania can define reserve-price

Normalised revenues from mobile networks (RMN) & GDP

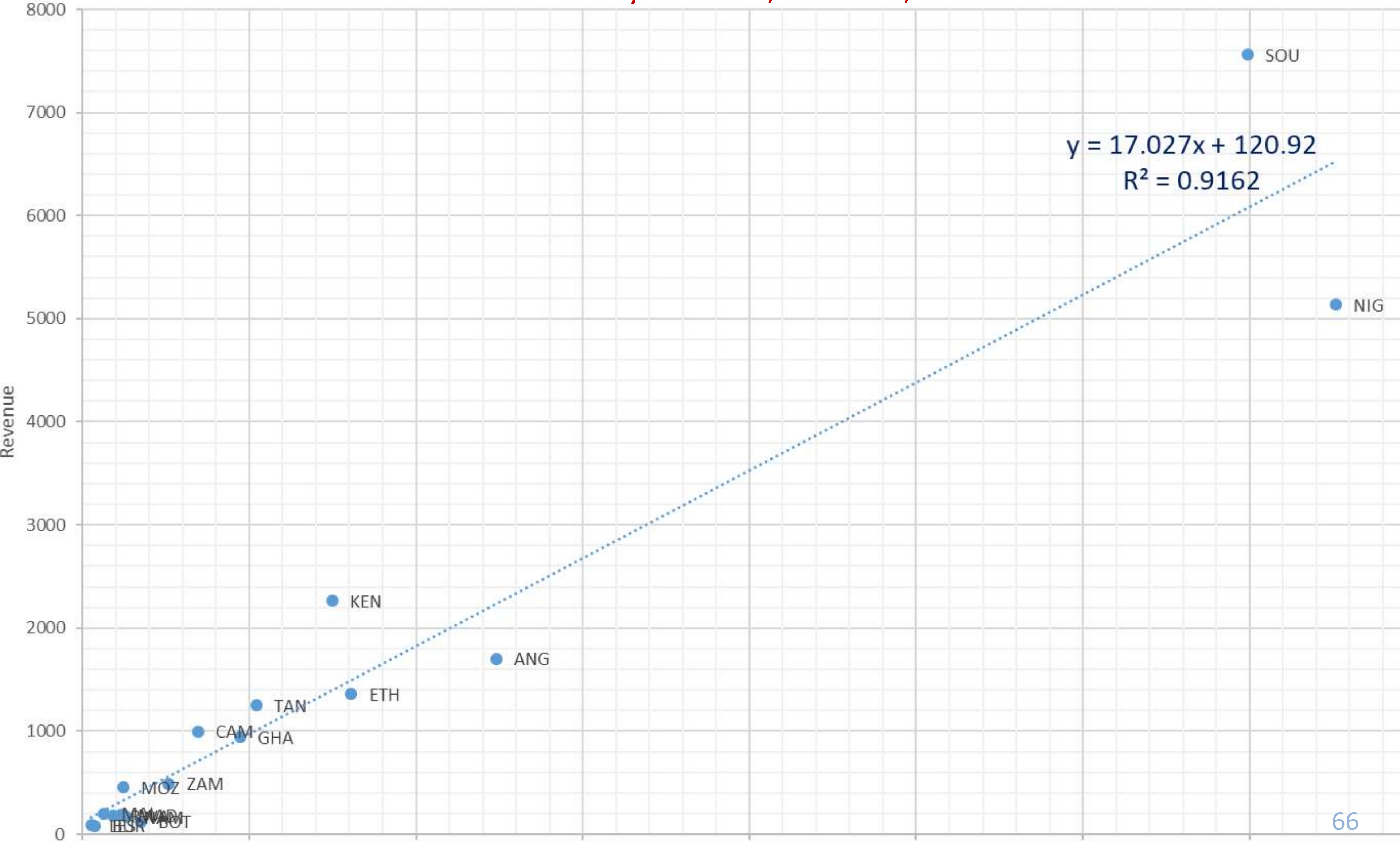
Reference year 2017 for **2 x 10 MHz**

Reference for Revenues is ITU statistical database, while GDP is based on world-bank statistical database; but, ITU Indicator Revenues of Mozambique are 6,412,559.753 M and not 458 M!

	RMN (US$ MN)	GDP (US$ BN)	Price (US$ MN)
Ghana	945.00	47.33	**20.00**
Mozambique	458.00	12.33	**33.00**
Tanzania	1,250.00	52.11	**10.00**
Zambia	490.00	25.81	
Any other Country Normalised 2 x 10 MHz	GHA: **10.4**	GHA: **10.9**	
	MOZ: **35**	MOZ: **69.1**	
	TZA: **3.9**	TZA: **5.0**	

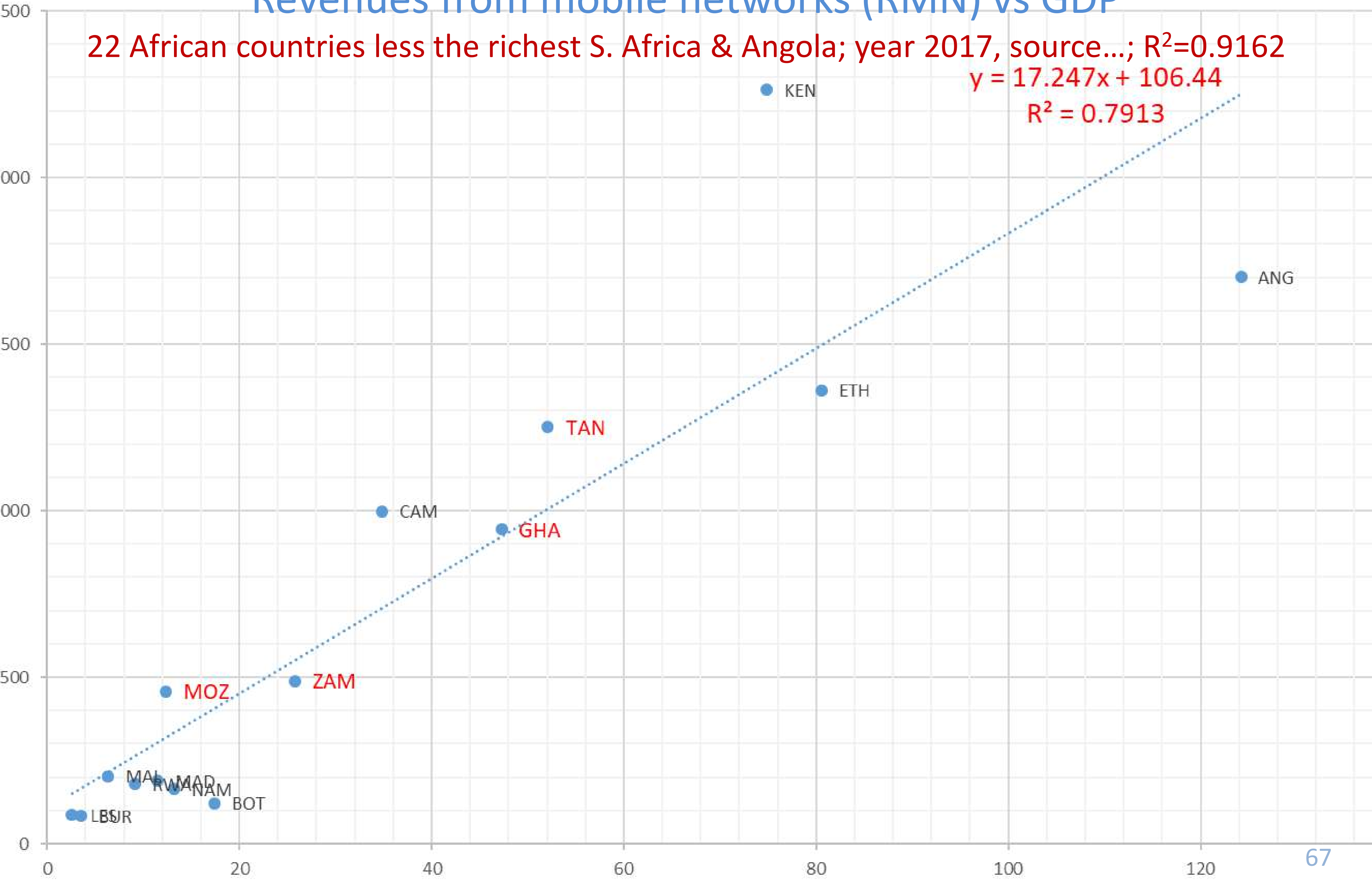
Revenue from Mobile Networks (RMN) vs GDP, Million US$

22 African countries year 2017, source…; R^2=0.9162



Revenues from mobile networks (RMN) vs GDP

22 African countries less the richest S. Africa & Angola; year 2017, source…; R^2=0.9162



Recommendations

1. Restrictive granting procedure of assignment of scarce- resource 800/700 MHz in high-demand
2. Set appropriate initial reserve-prices & save time & money
3. Draft Information Memorandum
4. Start Consultation Process
5. RF validity will be similar to business-license
6. Assign 800/700 MHz, only for existing MNOs or ISPs
   (Fixed applications only in 800 MHz)
7. Follow RR Allocations
8. Assignment based on technology-neutrality
9. Follow ITU Rec. M.1036/ 3GPP channel-arrangements, European standards
10. Where the assignment shall be thru a competitive process, the bid should include a clause *Caveat Emptor*- check & monitor before participating in a bid
11. In case of competitive bidding, make reference to similar countries in Africa, that have successfully conducted a bidding process

FDD 700/800 MHz bands frequency-arrangements; see Rec ITU-R M.1036 band-plan A3 (3GPP band-plan 20) at 800 MHz and M.1036 band-plan A7 (3GPP band-plan 28) at 700 MHz; ETSI TS 136 101 V14.7.0 (2018-04) Table 5.5-1 :

ITU/GPP	UpLink, Base station receives	DownLink, Base Station transmits
A3/20	832 MHz–862 MHz	791 MHz–821 MHz
A7/28	703 MHz–748 MHz	758 MHz–803 MHz

Administrative Uncertainties

1. Administrative Auction: only initial price without Auction?
2. Auctions? Beauty Contest?
3. More or less competitors than lots?
4. Auctions to some Operators?
5. Low or high reserve-price?
6. Type of market auction?
7. Open/ Close?
8. How to perform the industry stakeholder consultation?
9. Slots of 2x5 MHz or 2x10 MHz
10. 2x5 MHz at least for Public Protection and Disaster Relief (PPDR)?
11. Spectrum-caps and set-asides?
12. Spectrum hoarding and collusion prevention?
13. Auction design, format and methodology, rules?
14. Licensing mechanisms?
15. Auction software tools?
16. Bidder training & mock auctions?

Decisions are needed: mainly technical uncertainties

1. Proper technical planning to achieve optimal assignments
2. Allocations only at 800 or also at 700 MHz?
3. Is there enough RF to all RF users?
4. Spectrum packaging (size and number of lots)?
5. Lots of 2x5 MHz or 2 x10 MHz?
6. 5 x2 MHz or even 10x2 to PPDR?
7. Aggregate, adjacent RF?
8. Oblige active RF sharing?
9. Rollout time? 18 months for existing Operators?

Thank you!

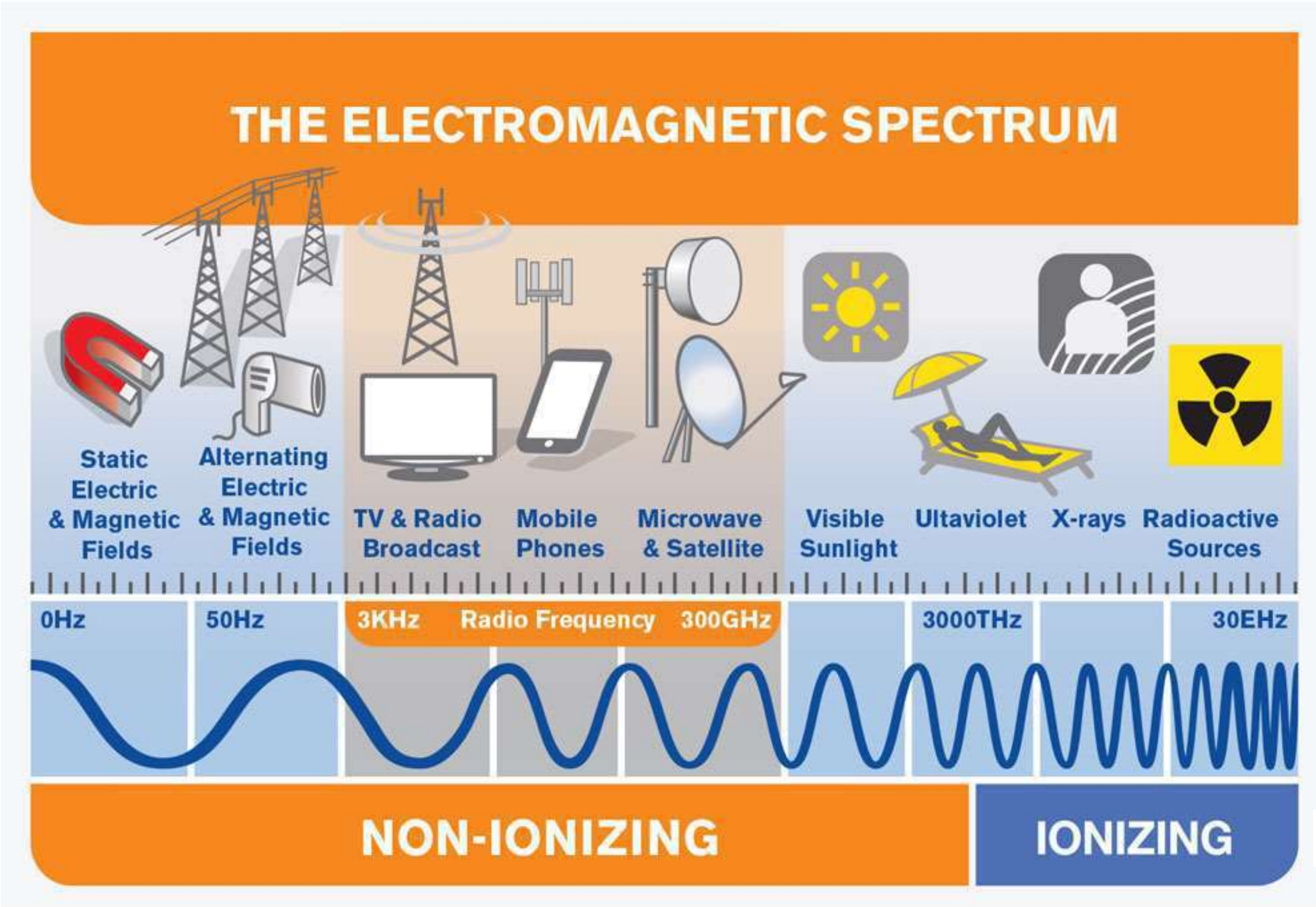
PRIDA Track 1 (T1)
Online training in English

On-line English workshop 20th April to 1st May 2020

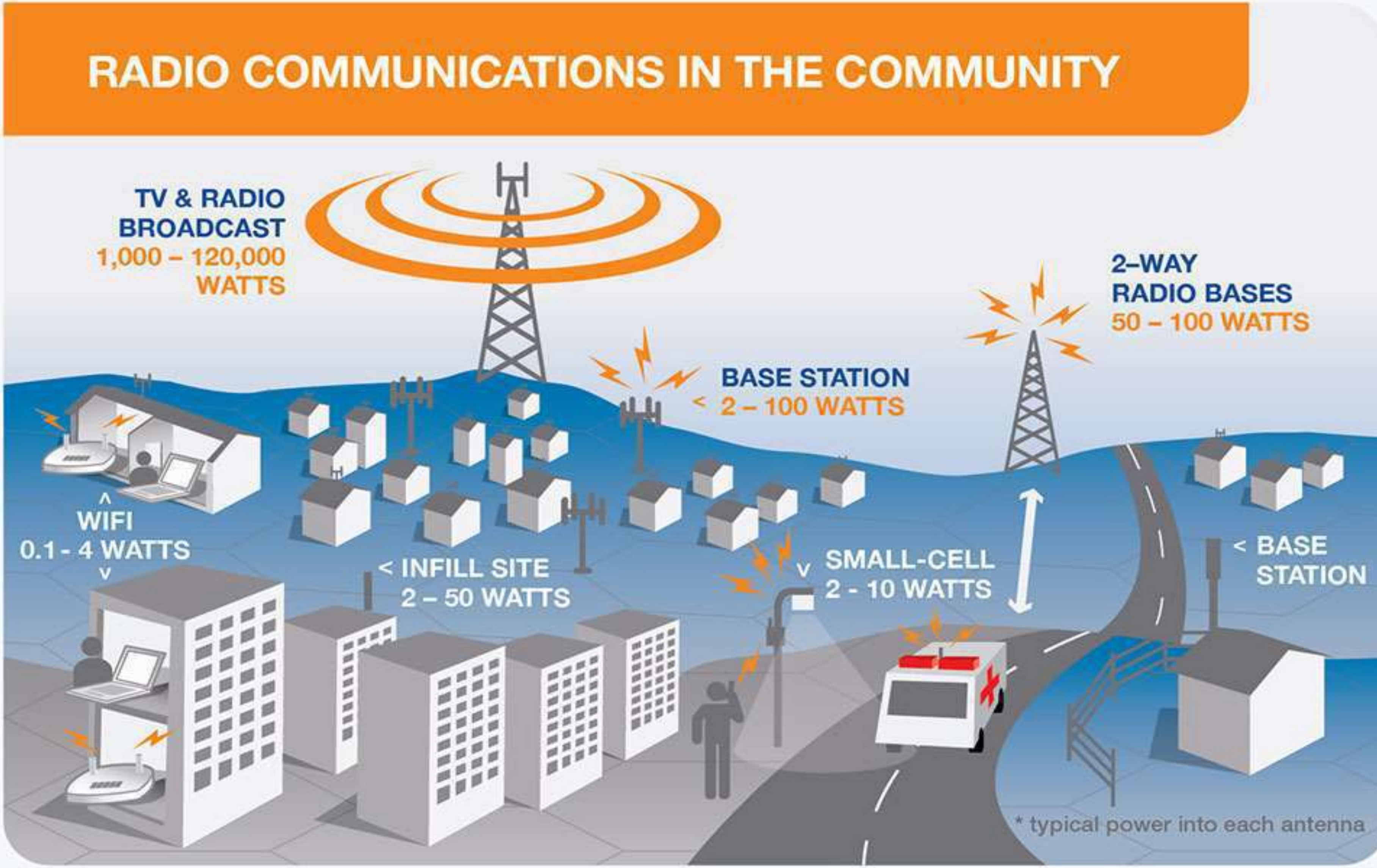
ElectroMagneticFields (EMF)
RF Human Hazards

24 April 2020

Dr. Haim Mazar; ITU Expert
Vice Chair ITU-R Study Group5 (terrestrial Services)



THE ELECTROMAGNETIC SPECTRUM
Static Electric & Magnetic Fields
Alternating Electric & Magnetic Fields
TV & Radio Broadcast
Mobile Phones
Microwave & Satellite
Visible Sunlight
Ultaviolet
X-rays
Radioactive Sources
0Hz
50Hz
3KHz
Radio Frequency
300GHz
3000THz
30EHz
NON-IONIZING
IONIZING



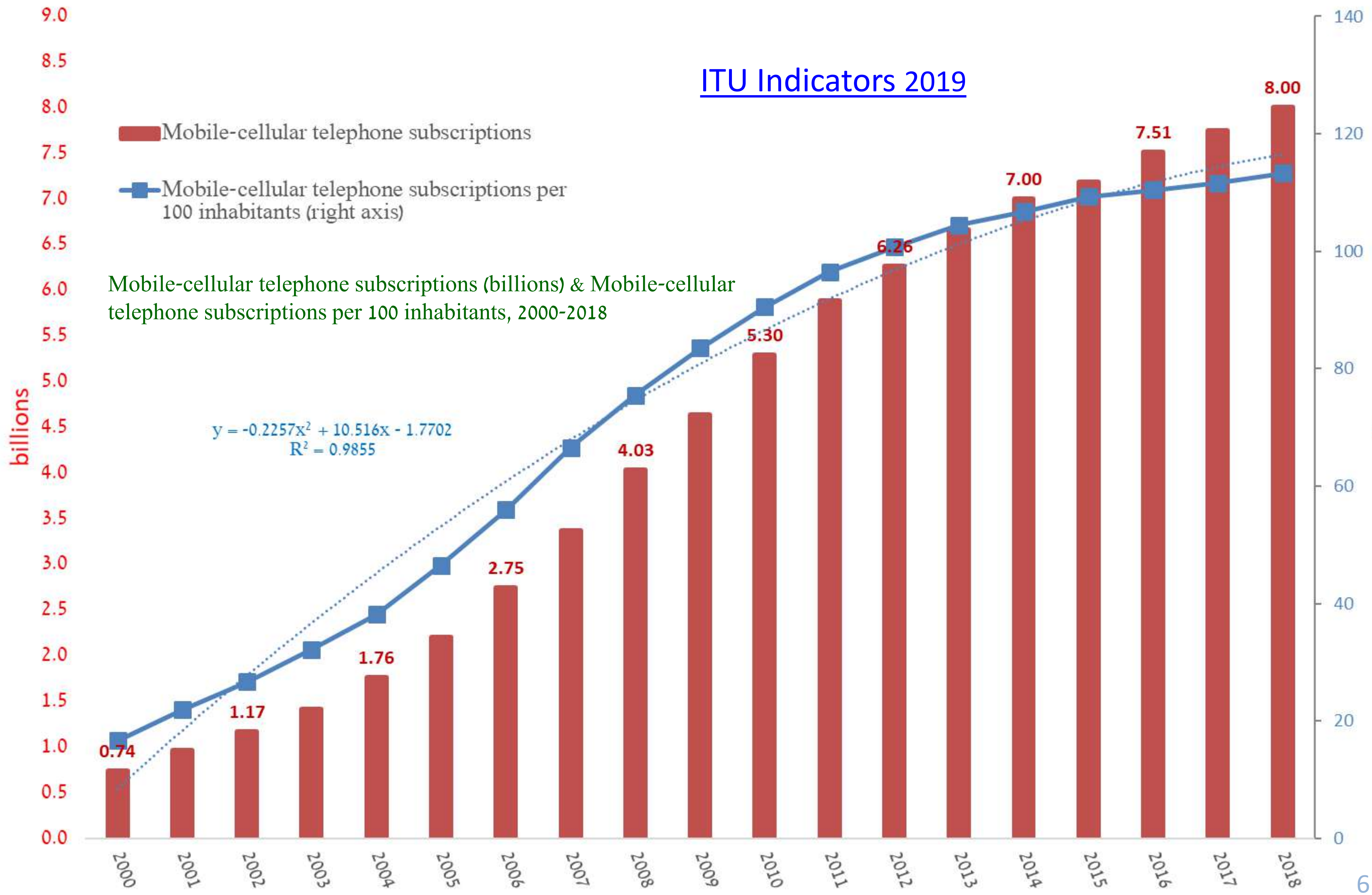
Source: ITU-T Report 2014 *EMF Considerations in Smart Sustainable Cities*

Ionizing and non-ionizing radiations

1. Ionizing radiation (ionizing radiation) carries sufficient energy to detach electrons from atoms or molecules, thereby ionizing them
2. Gamma rays, X-rays, and the higher ultraviolet part of the electromagnetic spectrum are ionizing, whereas the lower frequencies- ultraviolet, visible light (including nearly all types of laser light), infrared, microwaves, and radio waves are non-ionizing radiation

RF adverse effects: low-level effects

1. No adverse effects have been established from low-level exposures despite 70 years of research
2. No known interaction mechanisms
3. No meaningful dose-response relationship
4. Speculative
5. Inappropriate for standard setting


ITU Indicators 2019
Mobile-cellular telephone subscriptions
Mobile-cellular telephone subscriptions per 100 inhabitants (right axis)
Mobile-cellular telephone subscriptions (billions) & Mobile-cellular telephone subscriptions per 100 inhabitants, 2000-2018
y = -0.2257x² + 10.516x - 1.7702
R² = 0.9855
billions
0.74
1.17
1.76
2.75
4.03
5.30
6.26
7.00
7.51
8.00
2000
2001
2002
2003
2004
2005
2006
2007
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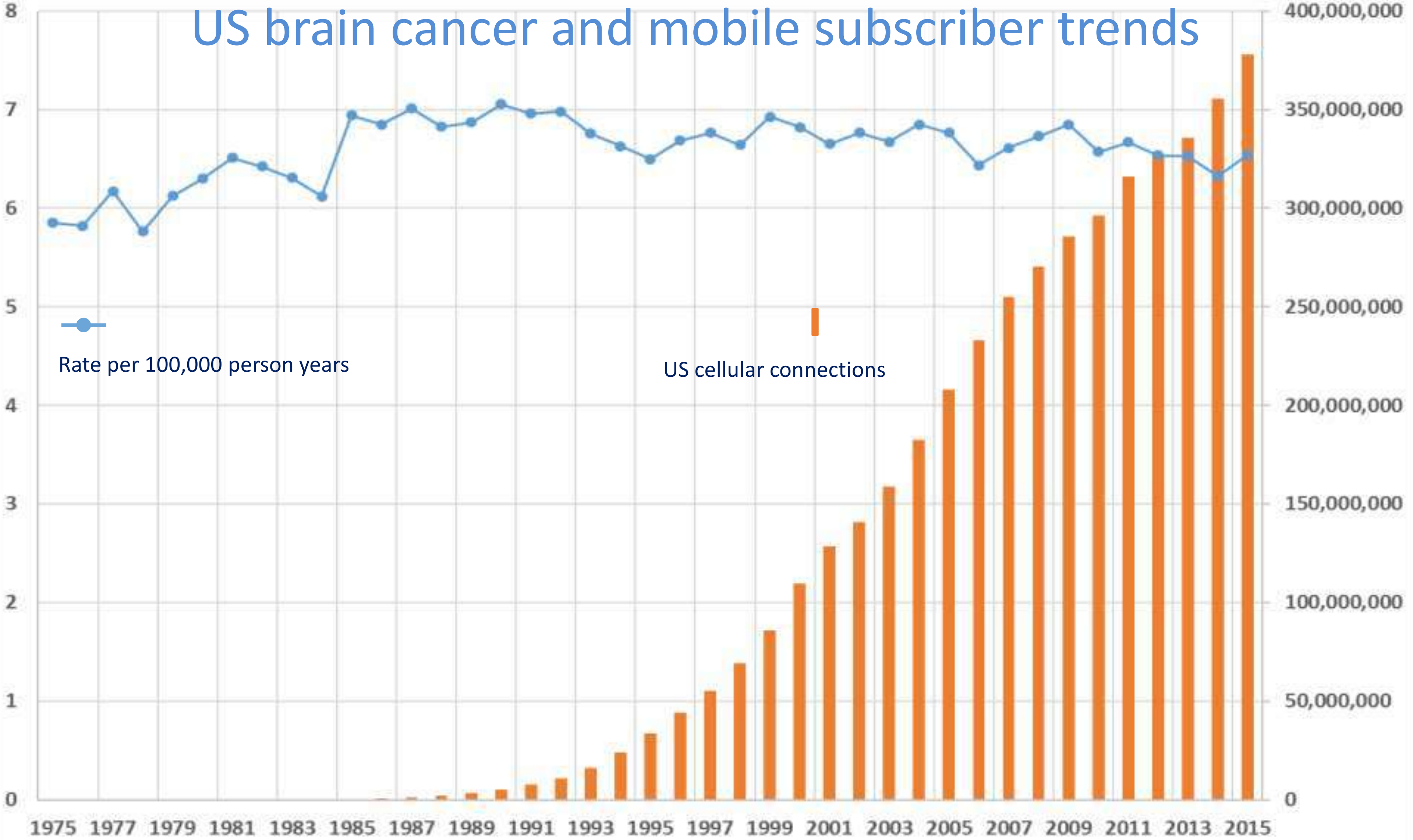
2018

African cellular subscriptions (millions) & subscriptions per 100 inhabitants, 2000-2018

US brain cancer and mobile subscriber trends



Overall, incidence data of the Surveillance, Epidemiology, and End Results (SEER) do not support the view that cellular phone use causes brain cancer

Based on CTIA and SEER data, and Inskip et al., 2010

Electromagnetic Hyper-Sensitivity; electro-phobia

Subjective phobia, phantom risk (?!)

Precautionary Principle: billions of cellular users phones and millions of base-stations worldwide

Type I error imposes regulatory restrictions on factors that turn out to be harmless.

Type II error : acceptance of a null hypothesis that turns out to be false

There is no evidence of causality between pains and RF exposure

World Health Organization (1948) definition of “health”: a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Monitoring of human exposure around the world: levels are very low, relative to ICNIRP reference levels

1. 2001 to 2004 (WHO 2007:30), UK conducted radio surveys at 289 schools with base stations on or near them. The highest compliance factor measured anywhere was 3.5×10^{-3} (= 12.2×10^{-6} of the power density), with the 90% of the schools having a highest compliance factor below 2.9×10^{-4} (**8.4×10^{-8}** power density) – which are very low values indeed. See also IARC 2013:58, fig. 1.11 specifies a cumulative distribution of exposure quotients corresponding to 3321 spot measurements made by OFCOM at 499 sites where public concern had been expressed about nearby base stations; the quotient values are median 8.1×10^{-6} of ICNIRP power density, ranging from the **5th percentile 3.0×10^{-8} to 95th percentile 2.5×10^{-4}**.
2. Two hundred randomly selected people in urban, sub-urban, and rural subgroups have measured on 2005–2006 in France (Viel et al. 2009; see also IARC 2013:114) for 24 hours a day, 184 daily measurements. At the GSM 900/1800 bands most of the time, the recorded field strength was below detection level (**0.05 V/m); 0.05 V/m is 3.63%** of the ICNIRP level at 900 MHz. 12.3% of measurements at the FM band indicate field strength above the detection threshold; the mean field strength was 0.17 V/m (Viel et al. 2009:552), the maximum field strength was always lower than 1.5 V/m. ANFR 2007 reveals that at 2004-2007, the average measurements are less than 2% of the field strength limit (less than 0.04 % of power density); more than 75% of the measurements were less than 2% of the field strength limit, regardless of the frequency band considered.
3. Ofcom published on February 2020 the results of recent measurements of EMF emissions close to sixteen 5G-enabled mobile phone base stations showing EMF levels at a total of 22 5G sites in 10 UK cities:
4. in 10 cities across the UK ; base stations support technologies in addition to 5G, including 2G, 3G and 4G:
    1. EMF emission levels from 5G-enabled base stations remain at small fractions of the reference levels for 1998 general public exposure in ICNIRP Guidelines (400–2,000 MHz) f (MHz)/200 (W/m^2), & 2– 300 GHz 10 (W/m^2)
    2. the highest level recorded being approximately 1.5% of the **power density** reference level.
    3. In all locations, the largest contribution to the measured levels comes from previous generations of mobile technology (2G, 3G, 4G).
    4. The highest level observed in the band used for 5G was just 0.039% of the reference level.

ANFR, RF-EMF 2018 annual survey of over 2,500 public exposure measurements

	Mesurements nº	50% (median values)	90 %	99 %	Max
Rural	425; 16 %	0,25* V/m	0,95 V/m	2,8 V/m	3,95 V/m
Urban	2166; 84 %	0,4 V/m	1,67 V/m	5,6 V/m	11,25 V/m
Indoor	1666; 64%	0,31* V/m	1,34 V/m	4,1 V/m	10,54 V/m
Outdoor	914: 36%	0,52 V/m	1,93 V/m	6,3 V/m	11,25 V/m
Total	**2591**	**0,36* V/m**	**1,57 V/m**	**5,5 V/m**	**11,25 V/m**

Summerised results 2017: 90% of exposure levels measured in 2017 in rural areas are below 0.95 V/m.

* Values below the typical sensitivity threshold of the measuring devices, which equals 0.38 V/m

See ANFR Sept. 2018 abstract

Questions to be raised

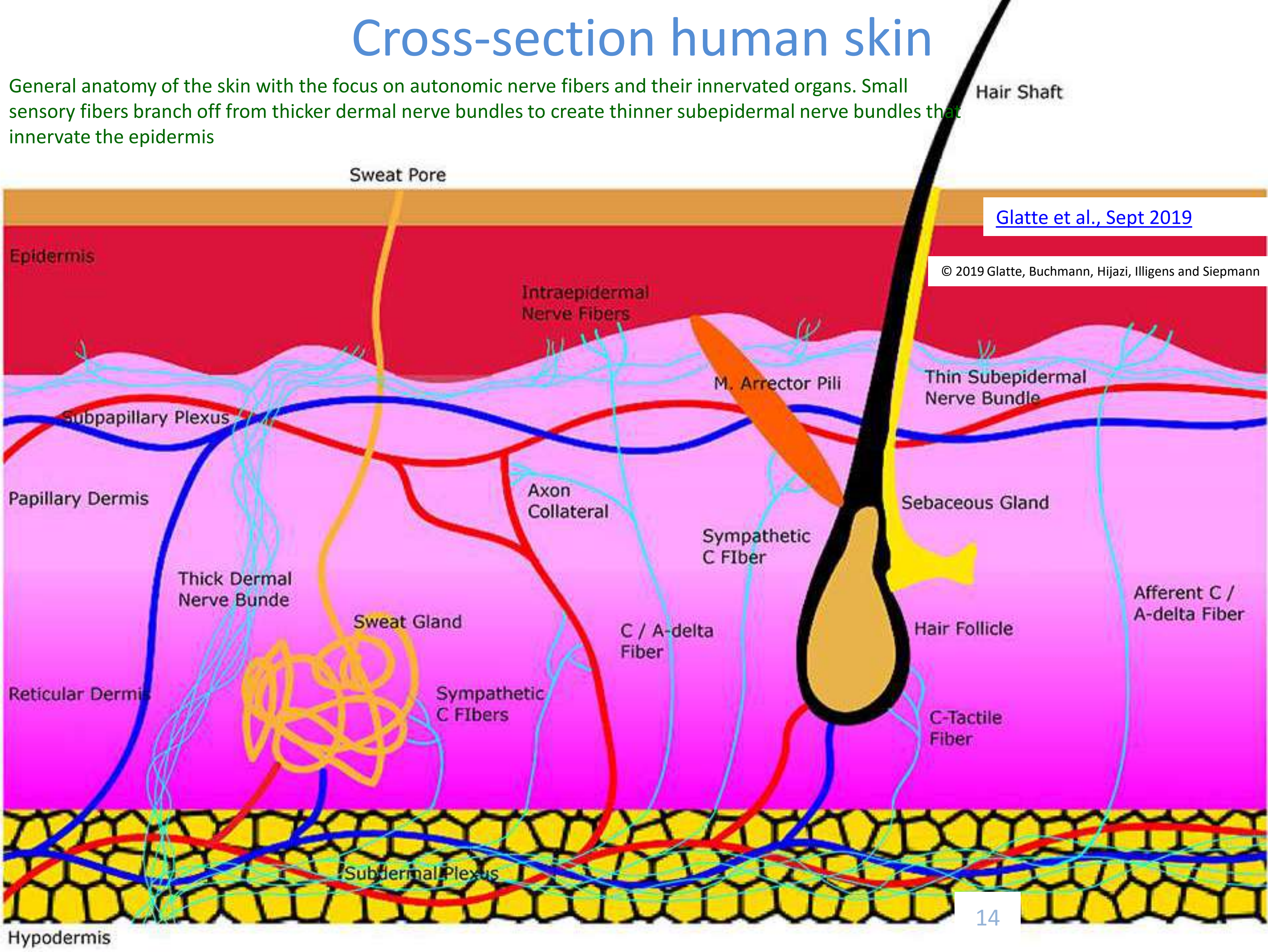
Compliance calculations and some periodic measurements are essential; however:

Why do we need to make so many nation-wide measurements?

May be ICNIRP reference levels are too liberal?

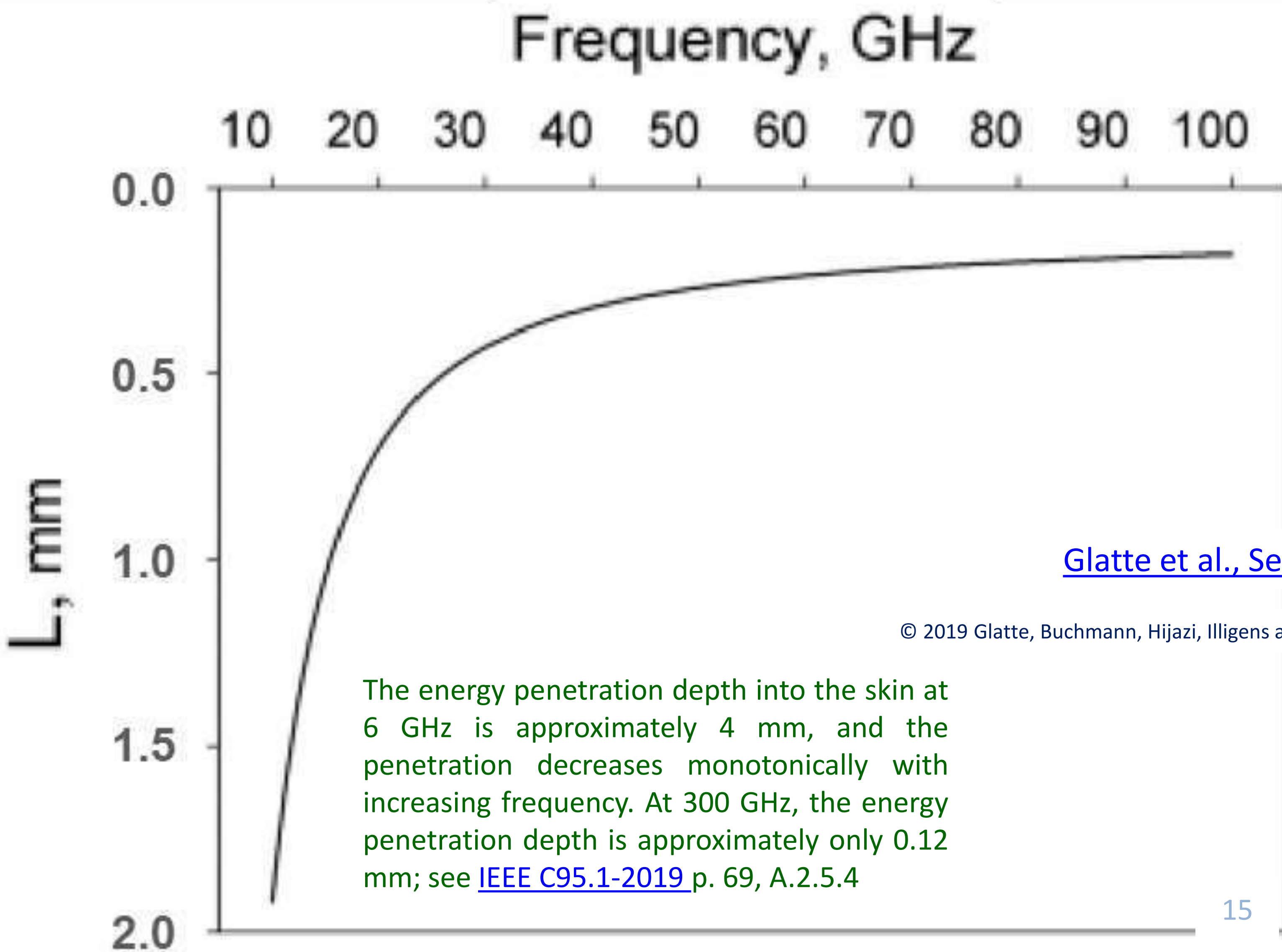
Cross-section human skin

General anatomy of the skin with the focus on autonomic nerve fibers and their innervated organs. Small sensory fibers branch off from thicker dermal nerve bundles to create thinner subepidermal nerve bundles that innervate the epidermis



[Glatte et al., Sept 2019]

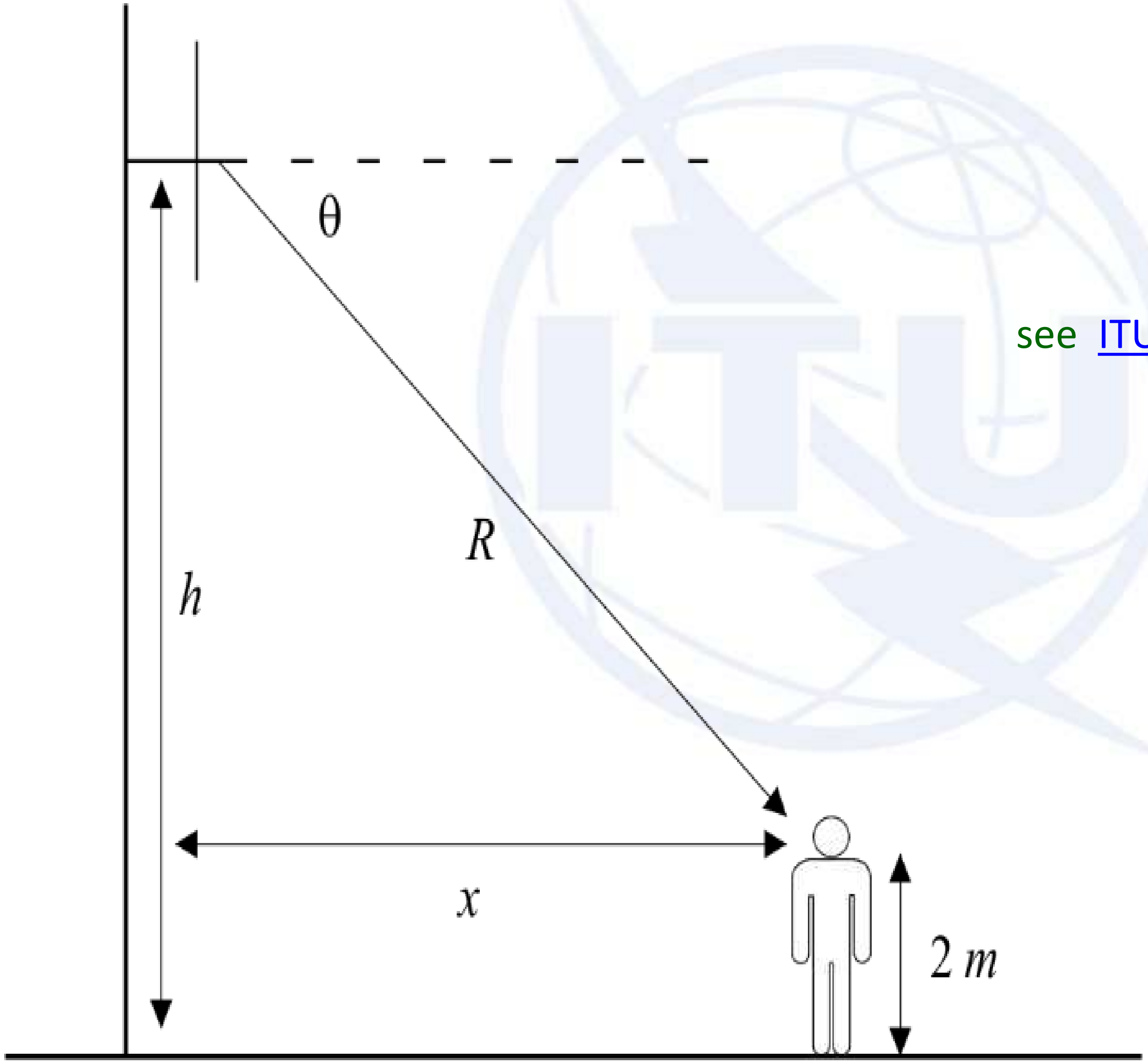
mmWaves mostly absorbed in outer skin layers



Glatte et al., Sept 2019

The energy penetration depth into the skin at 6 GHz is approximately 4 mm, and the penetration decreases monotonically with increasing frequency. At 300 GHz, the energy penetration depth is approximately only 0.12 mm; see IEEE C95.1-2019 p. 69, A.2.5.4

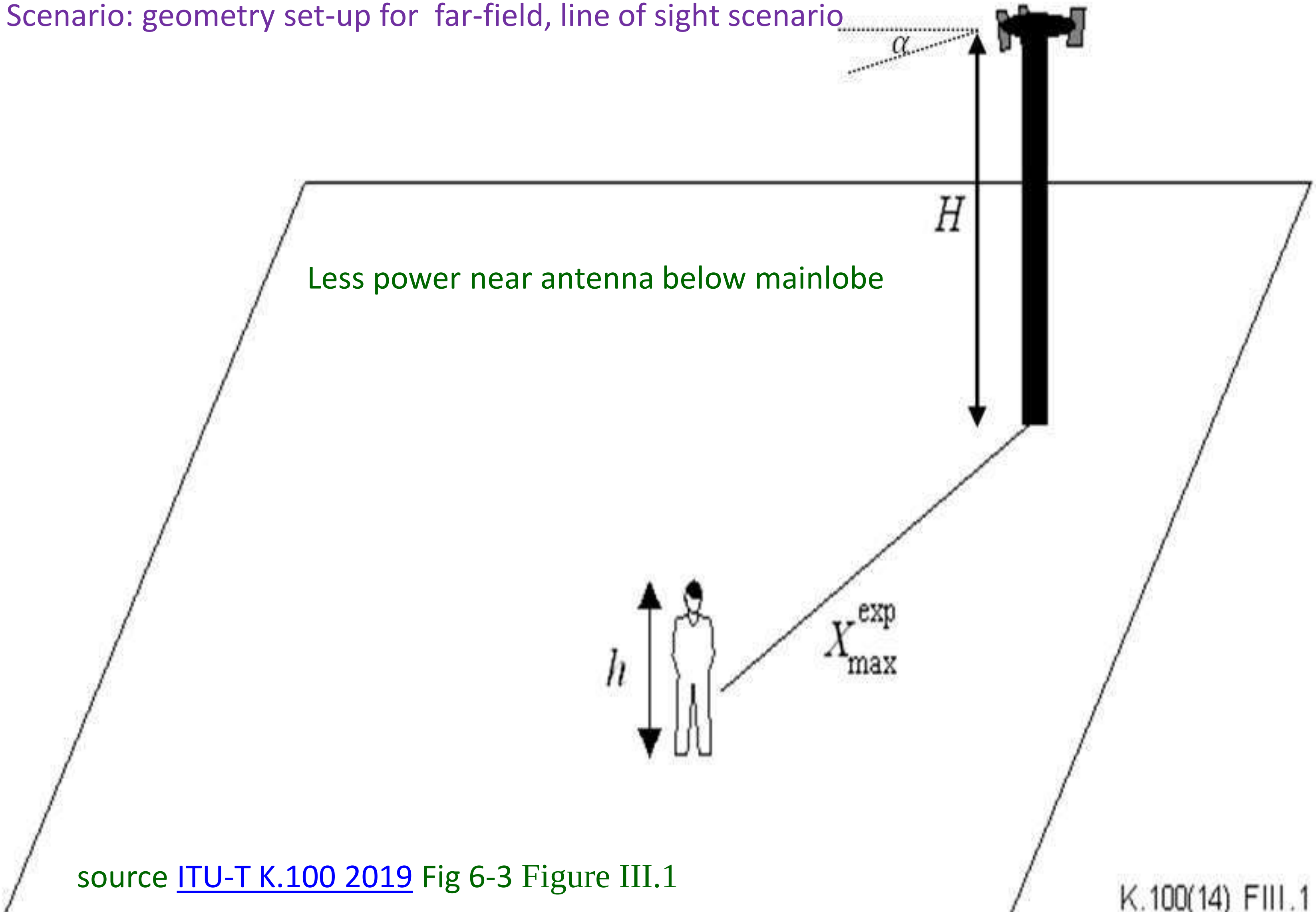
Configuration to calculate exposure at ground level for compliancy



see ITU-T 2018 K.52 Fig II.1

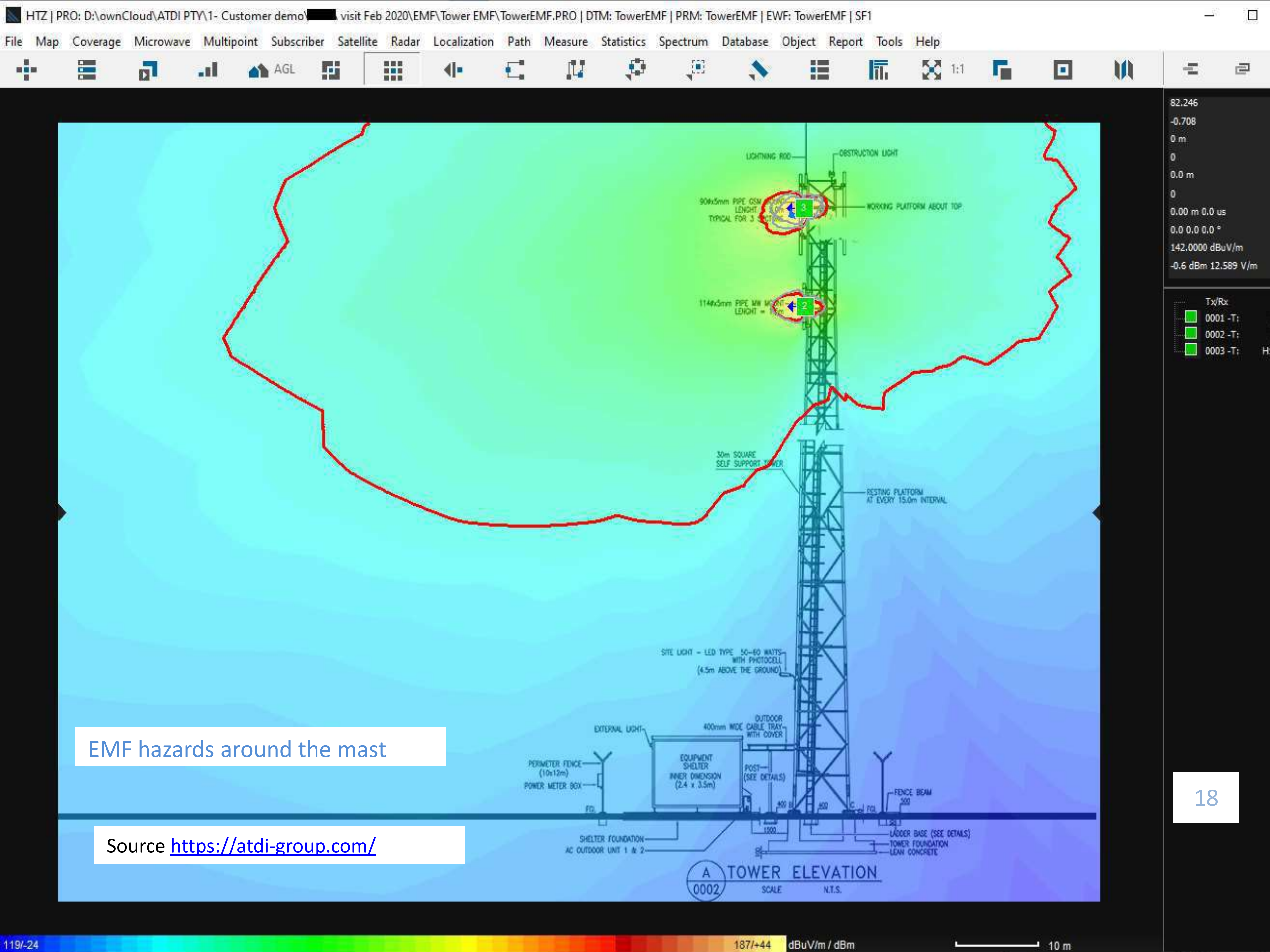
Configuration to calculate exposure at ground level for compliancy

Scenario: geometry set-up for far-field, line of sight scenario



Less power near antenna below mainlobe

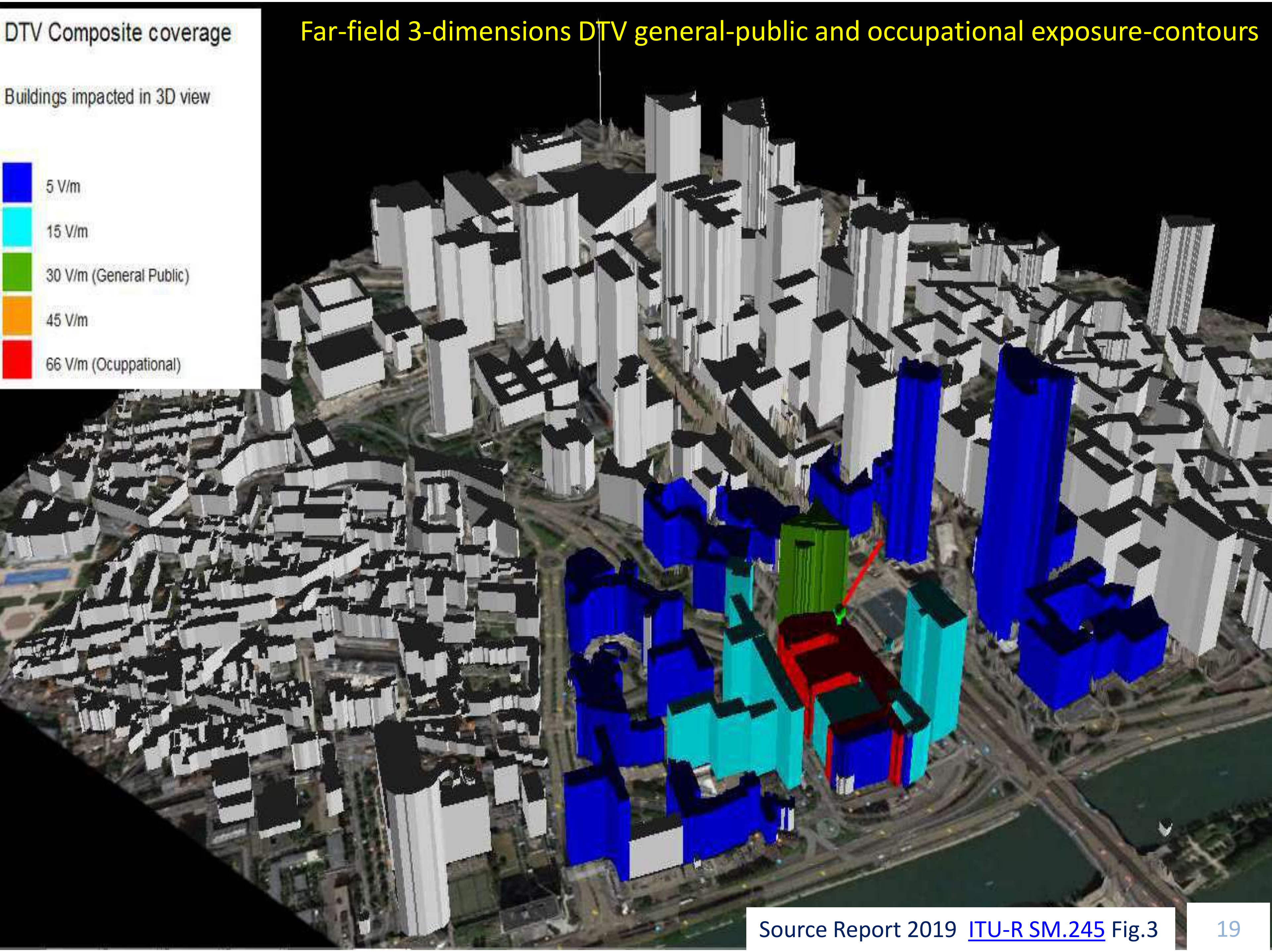
source ITU-T K.100 2019 Fig 6-3 Figure III.1



EMF hazards around the mast

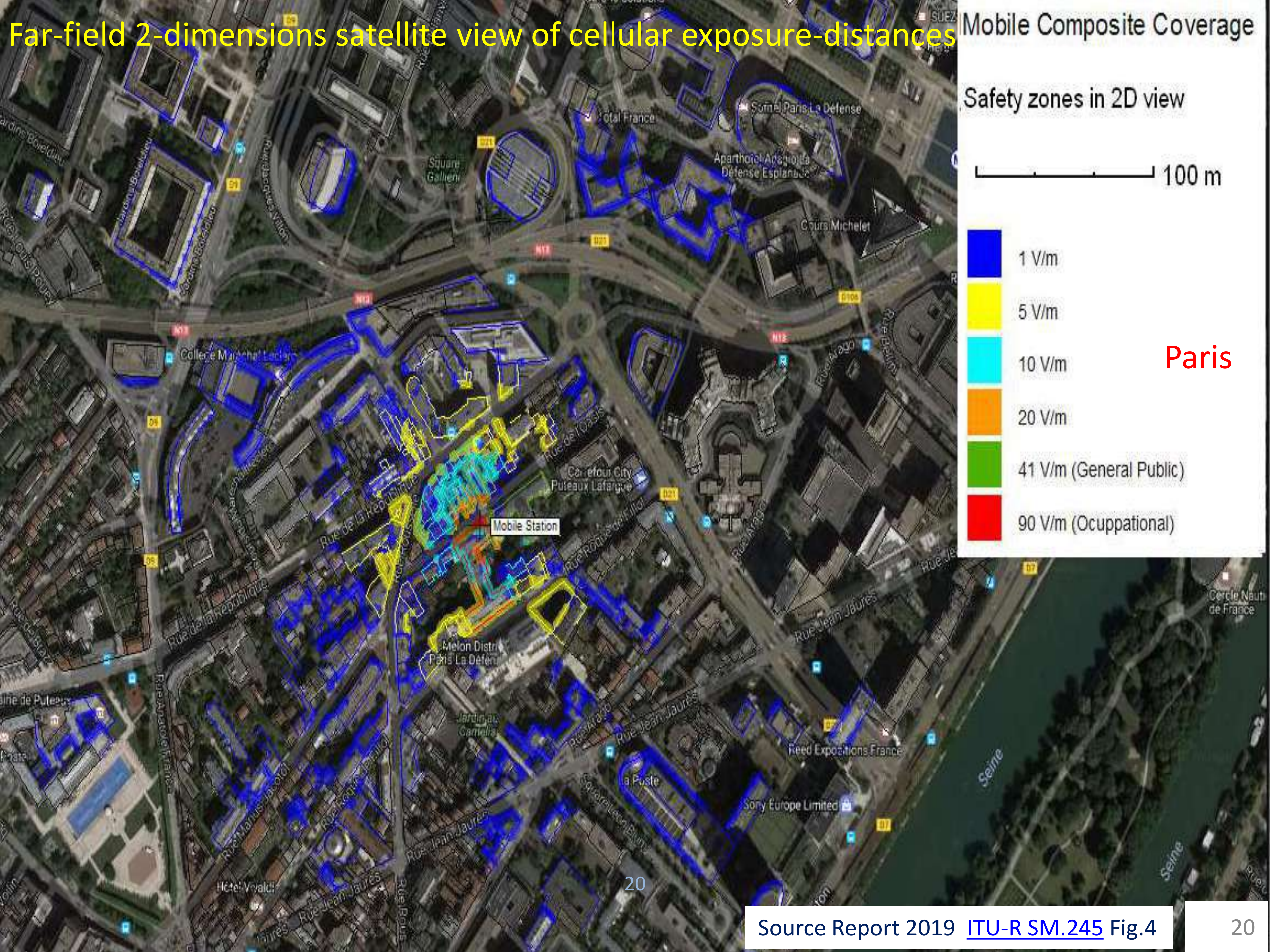
Source https://atdi-group.com/

Far-field 3-dimensions DTV general-public and occupational exposure-contours



Source Report 2019 ITU-R SM.245 Fig.3

Far-field 2-dimensions satellite view of cellular exposure-distances



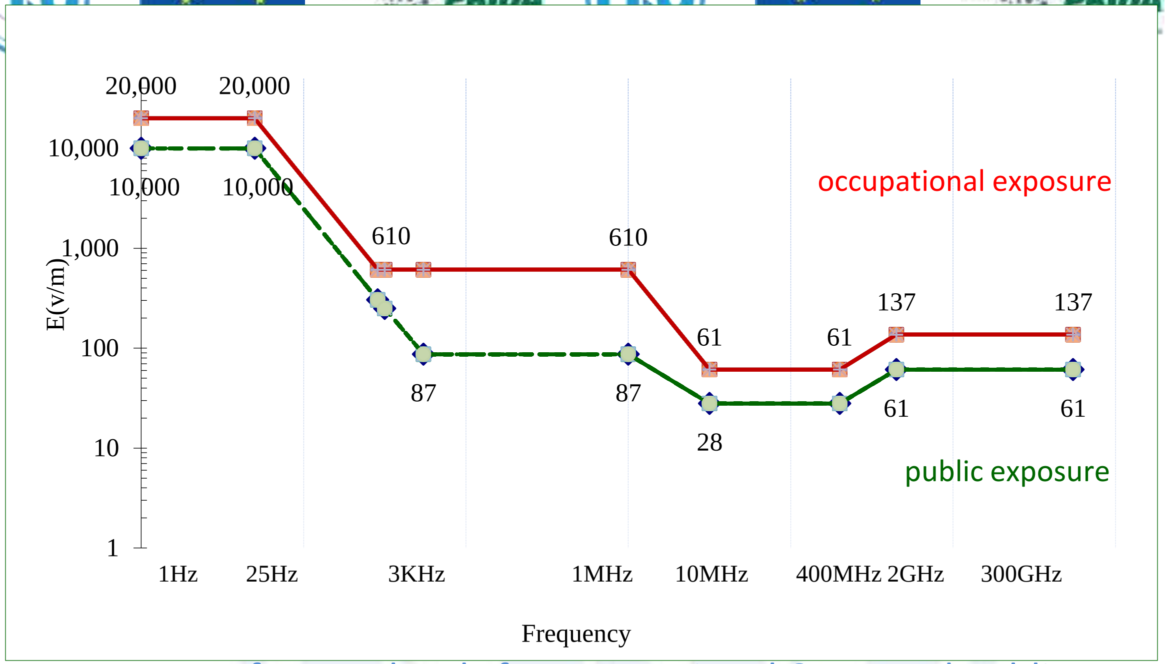
Source Report 2019 ITU-R SM.245 Fig.4

Example: Human Hazards- thresholds

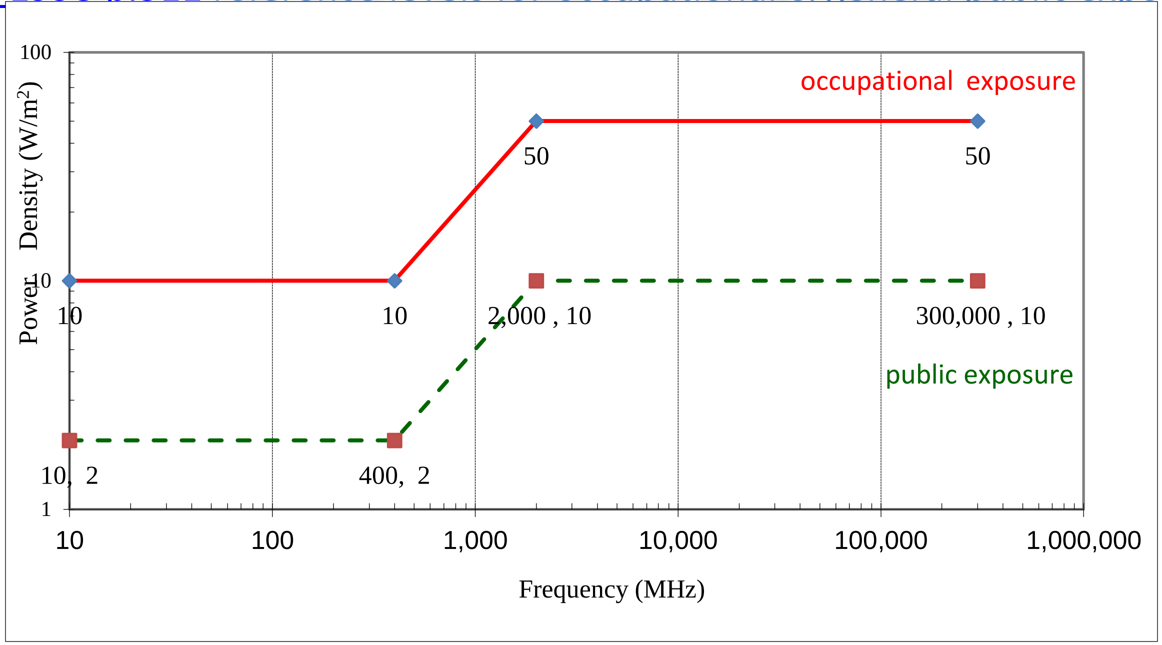
1. On April 2020 at 400-1500 MHz, the allowed ICNIRP 1998 (is revised in April 2020, see ICNIRP 2020) and EU Power Density for the general public is: ***f* (MHz)/200 [W/m²]**
2. Europe follows ICNIRP 1998 levels; but: SUI (0.01 ICNIRP for BTS), Italy (0.03 ICNIRP) and Slovenia (0.1 ICNIRP)
3. US & Canada limit is 4/3 higher: ***f*(MHz)/150 [W/m²]**
4. US & Canada threshold on terminal's SAR is **1.6 W/kg** (5/4 more risk averse). ICNIRP & EU limit is **2.0 W/kg**

Representative general population/ uncontrolled exposure reference levels April 2020

<table>
<tr><th></th><th>PD 1,000 MHz (W/m^2)</th><th>SAR (W/kg)</th></tr>
<tr><td>USA</td><td rowspan="2">$f/150$ =6.67; 133/%</td><td>1.6, averaged over 1g tissue</td></tr>
<tr><td>Japan</td><td rowspan="2">2.0 , over 10 g</td></tr>
<tr><td>ICNIRP1998; IEEE 2005; AUS; NZL; EC Directive 004/40/EC</td><td rowspan="2">$f/200$ =5; 100%</td></tr>
<tr><td>Korea</td><td rowspan="2">1.6, averaged over 1g tissue</td></tr>
<tr><td>Canada</td><td>$0.02619f^{0.6834}$ =2.94; 59%</td></tr>
<tr><td>China</td><td>0.4; 8%</td><td>2.0 , over 10 g</td></tr>
</table>

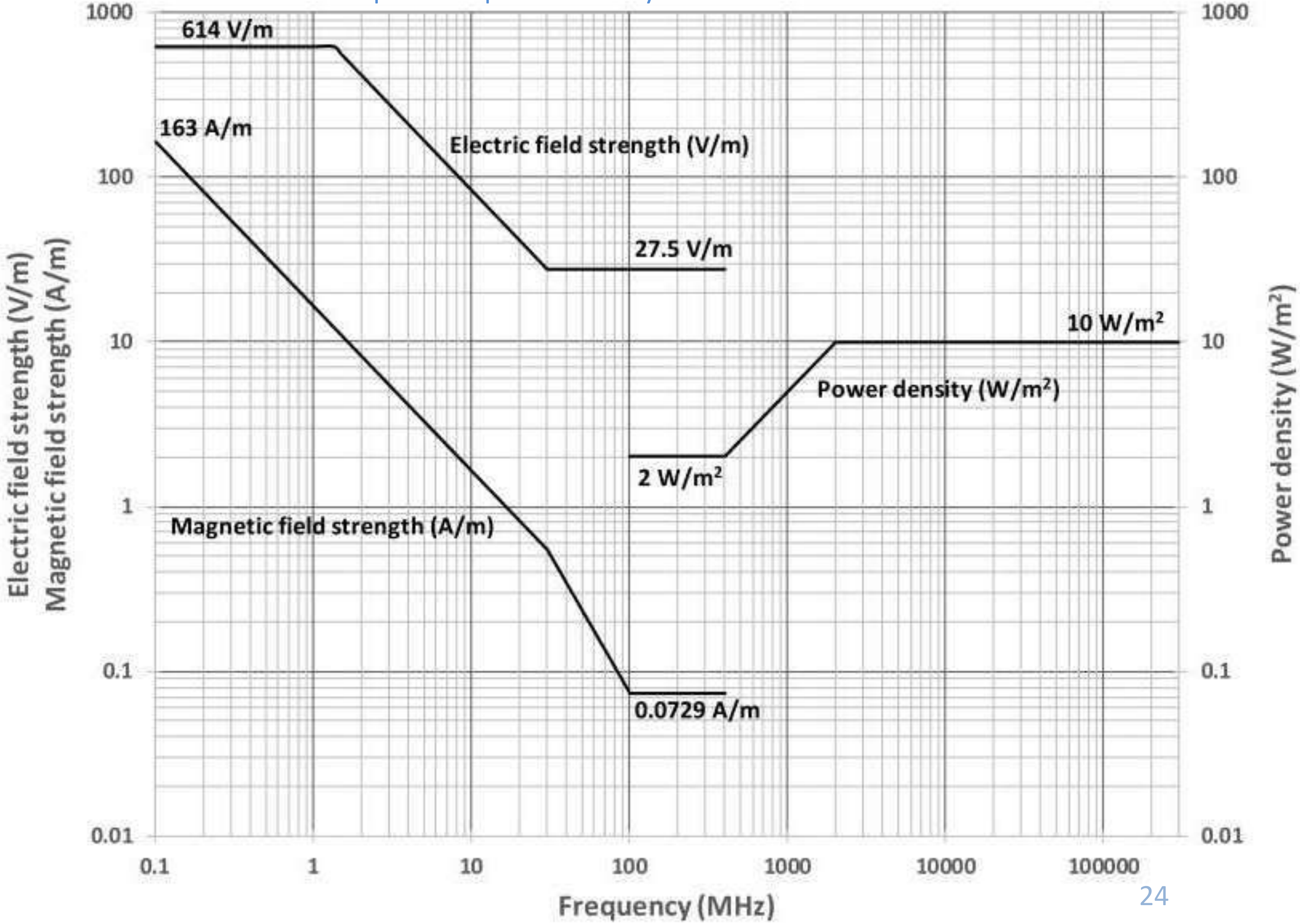


ICNIRP 1998 p.511 reference levels for occupational & general public exposure- graphs

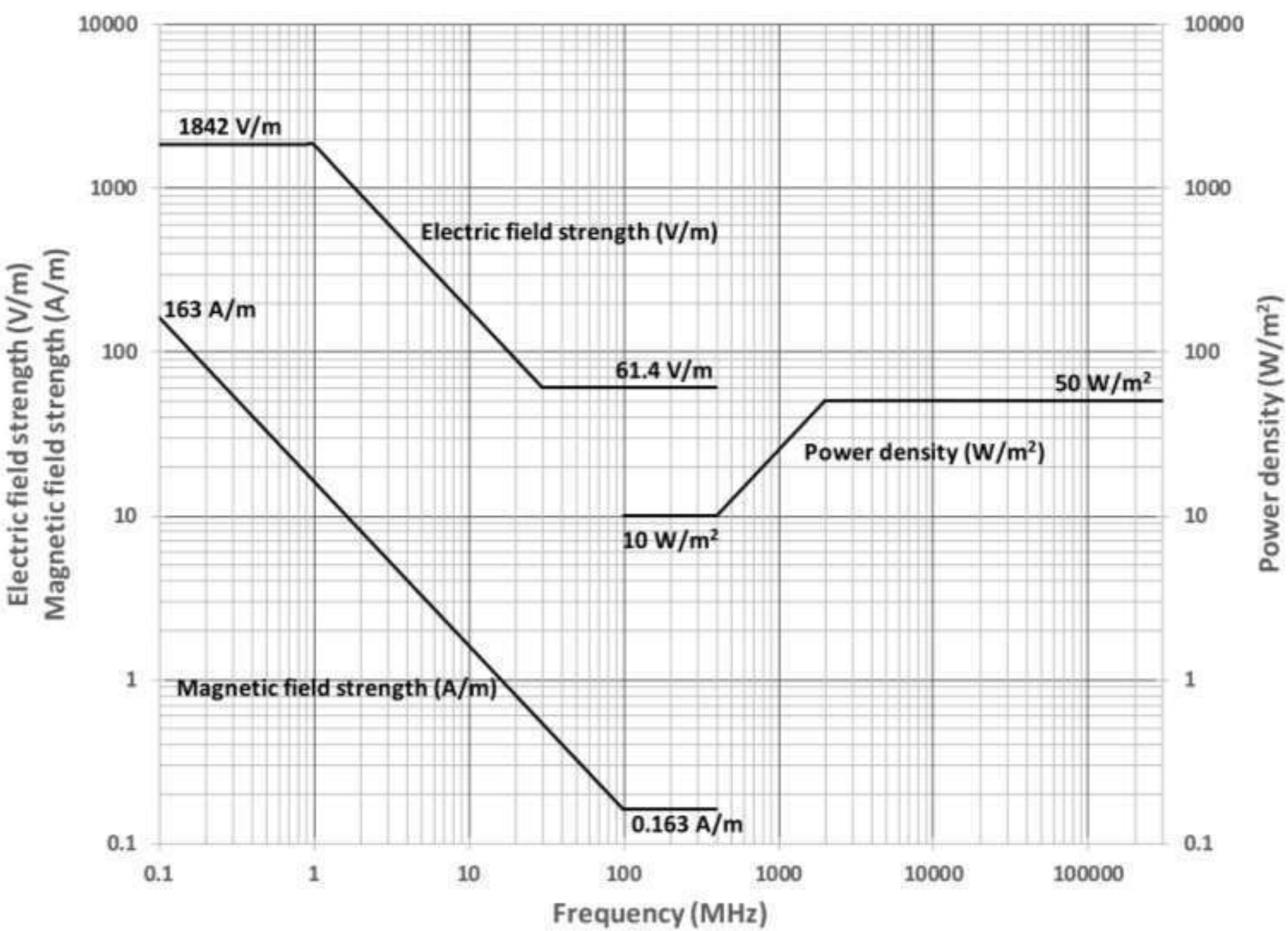


See Mazar H. 2016 Figs 9.1&9.2

IEEE C95.1-2019 Fig. 3: Graphical representations of the ERLs in Table 7 for electric and magnetic fields and plane-wave-equivalent power density—Persons in unrestricted environments



IEEE C95.1-2019 Fig. 4: Graphical representations of the ERLs in Table 8 for electric and magnetic fields and power density—Persons permitted in restricted environments

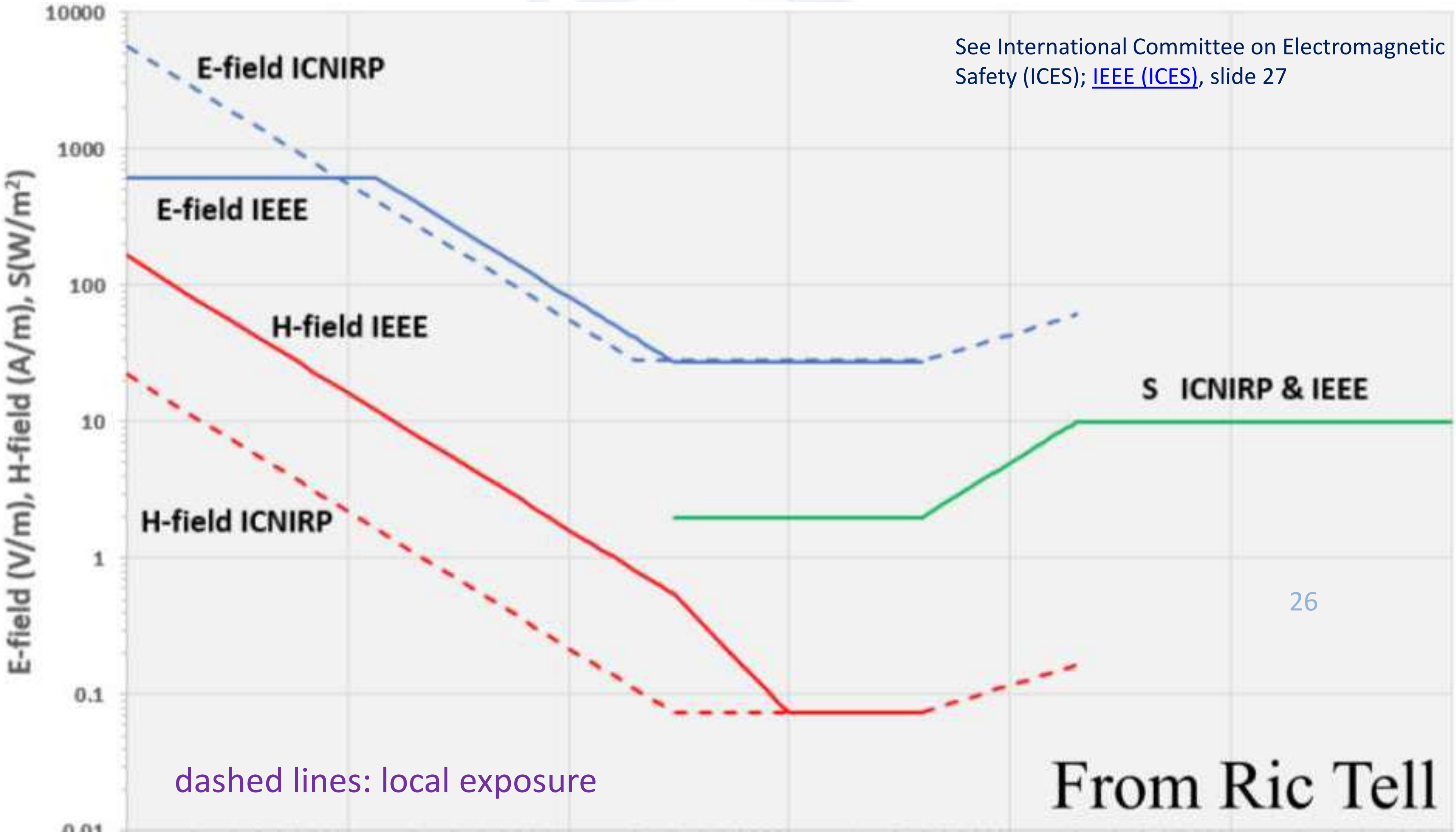


25

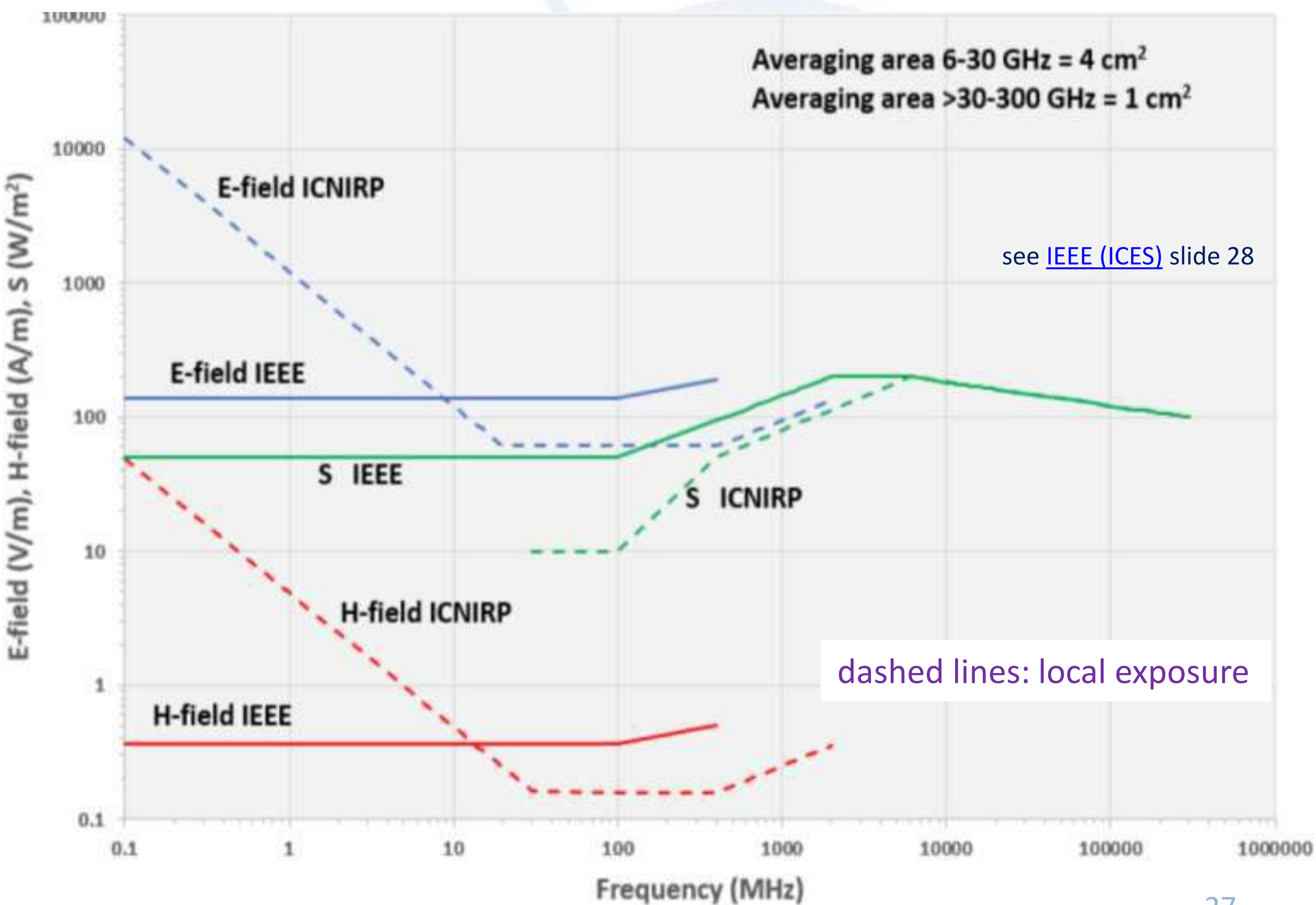
IEEE 2019/ICNIRP2020 differences in limits **general public**/ unrestricted environment

power-densities **above 30 MHz are identical** IEEE2019/ICNIRP2020

See International Committee on Electromagnetic Safety (ICES); IEEE (ICES), slide 27



IEEE-2019/ICNIRP 2020 differences in limits **Local exposure** Limits (assuming **6-minute exposure**) power-densities **below 6 GHz are different**



see IEEE (ICES) slide 28

27

ICNIRP GUIDELINES FOR LIMITING EXPOSURE TO ELECTROMAGNETIC FIELDS (100 KHZ TO 300 GHZ)

Published in: Health Phys 118(5): 483–524; 2020; DOI: 10.1097/HP.0000000000001210

ICNIRP reference levels are critical for compliance assessment

Tables 5 and 6 detail reference levels for exposure, averaged, to electromagnetic fields (EMF) from 100 kHz to 300 GHz (unperturbed rms values). The four ICNIRP figures appear in the additional material from the ICNIRP website, which are clearer, but could not be included in the Health Phys publication. Note that the units of the two y-axes (i.e. electric field and power density) are independent of each other. Figure and Figure disregard ICNIRP 2010.

ICNIRP 2020: Table 1. Quantities and corresponding SI units used in these guidelines

Quantity	Symbol	Unit
Absorbed energy density	U_{ab}	joule per square meter ($J\ m^{-2}$)
Incident energy density	U_{inc}	joule per square meter ($J\ m^{-2}$)
Plane-wave equivalent incident energy density	U_{eq}	joule per square meter ($J\ m^{-2}$)
Absorbed power density	S_{ab}	watt per square meter ($W\ m^{-2}$)
Incident power density	S_{inc}	watt per square meter ($W\ m^{-2}$)
Plane-wave equivalent incident power density	S_{eq}	watt per square meter ($W\ m^{-2}$)
Induced electric field strength	E_{ind}	volt per meter ($V\ m^{-1}$)
Incident electric field strength	E_{inc}	volt per meter ($V\ m^{-1}$)
Incident magnetic field strength	H_{inc}	ampere per meter ($A\ m^{-1}$)
Specific energy absorption	SA	joule per kilogram ($J\ kg^{-1}$)
Specific energy absorption rate	SAR	watt per kilogram ($W\ kg^{-1}$)
Electric current	I	ampere (A)
Frequency	f	hertz (Hz)
Time	t	second (s)

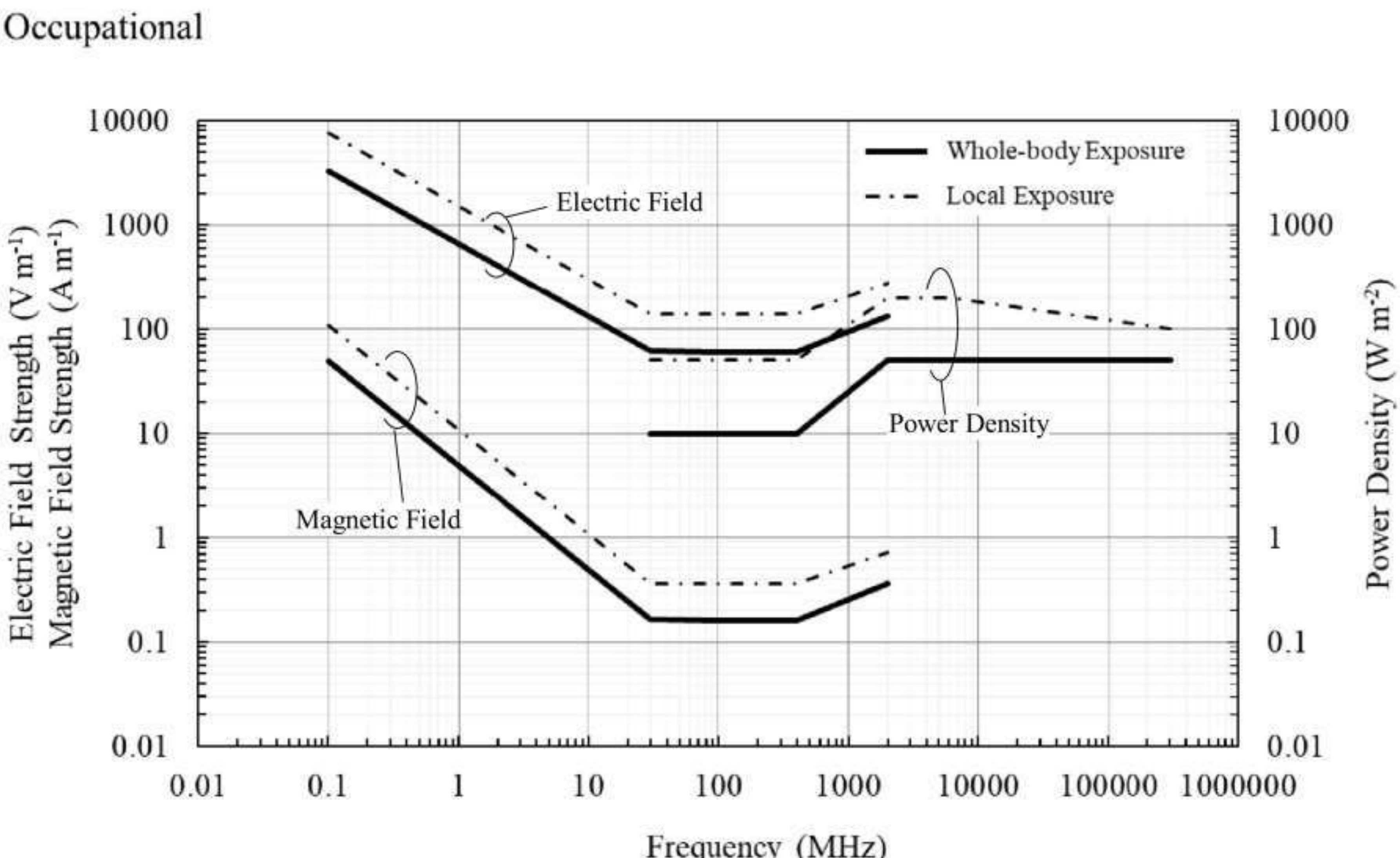
ICNIRP 2020 EMF for occupational & general public exposure, based on Table 5, p. 495: averaged over **30 minutes** and the **whole body**

Exposure scenario	Frequency range	Incident E-field strength (V/m)	Incident power-density (W m^{-2})
Occupational	0.1 – 30 MHz	$660/f_M^{0.7}$	NA
	>30 – 400 MHz	61	10
	>400 – 2000 MHz	$3f_M^{0.5}$	$f_M/40$
	>2 – 300 GHz	NA	50
General Public	0.1 – 30 MHz	$300/f_M^{0.7}$	NA
	>30 – 400 MHz	27.7	2
	>400 – 2000 MHz	$1.375f_M^{0.5}$	$f_M/200$
	>2 – 300 GHz	NA	10

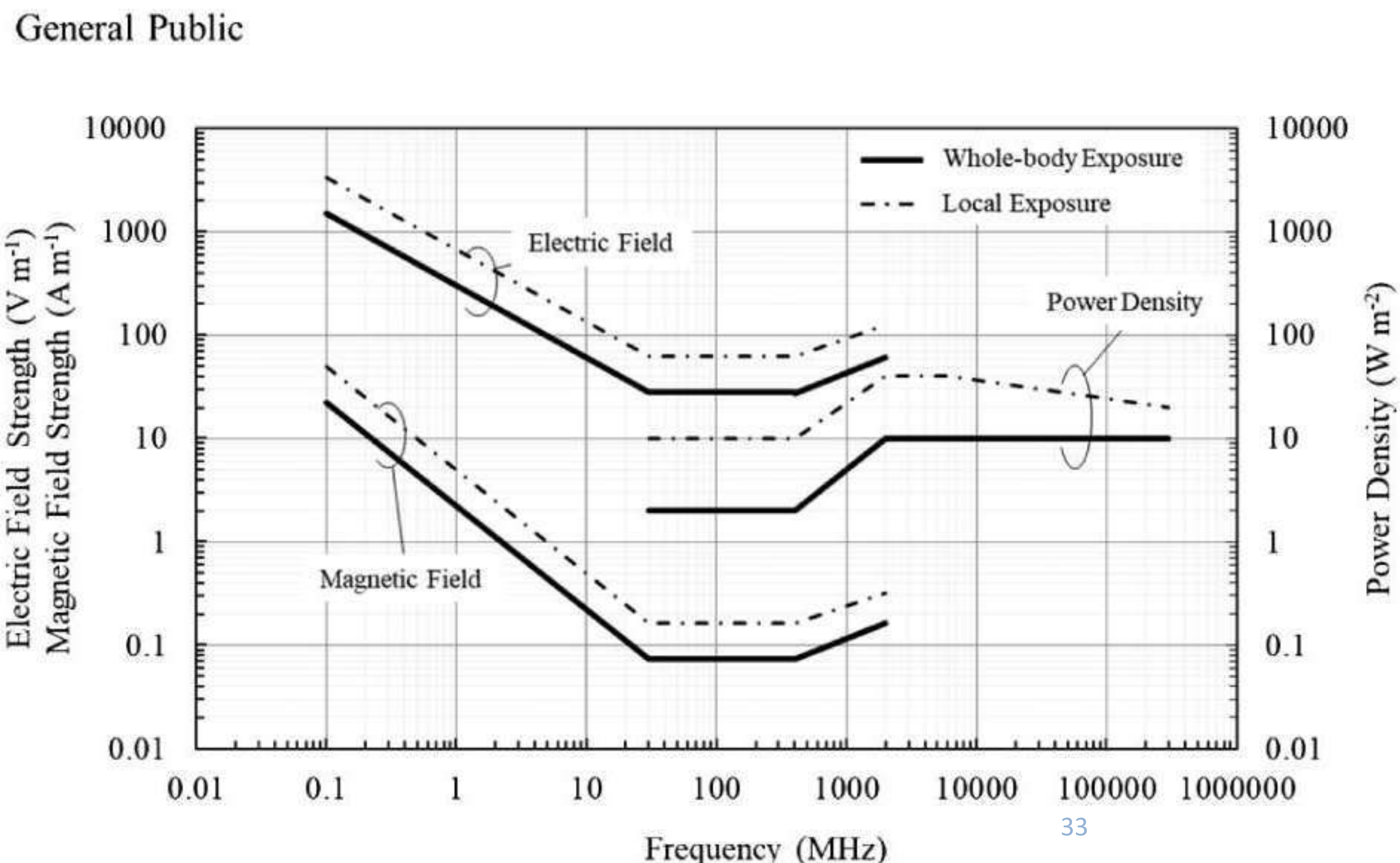
ICNIRP 2020 EMF for occupational & general public exposure, based on Table 6, p. 496: **local exposure**, averaged over **6 minutes**

Exposure scenario	Frequency range	Incident E-field strength; E_{inc} ($V\ m^{-1}$)	Incident power density; S_{inc} ($W\ m^{-2}$)
Occupational	0.1 – 30 MHz	$1504/f_M^{0.7}$	NA
	>30 – 400 MHz	139	50
	>400 – 2000 MHz	$10.58 f_M^{0.43}$	$0.29 f_M^{0.86}$
	>2 – 6 GHz	NA	200
	>6 – <300 GHz	NA	$275/f_G^{0.177}$
	300 GHz	NA	100
General Public	0.1 – 30 MHz	$671/f_M^{0.7}$	NA
	>30 – 400 MHz	62	10
	>400 – 2000 MHz	$4.72 f_M^{0.43}$	$0.058 f_M^{0.86}$
	>2 – 6 GHz	NA	40
	>6 – 300 GHz	NA	$55/f_G^{0.177}$
	300 GHz	NA	20

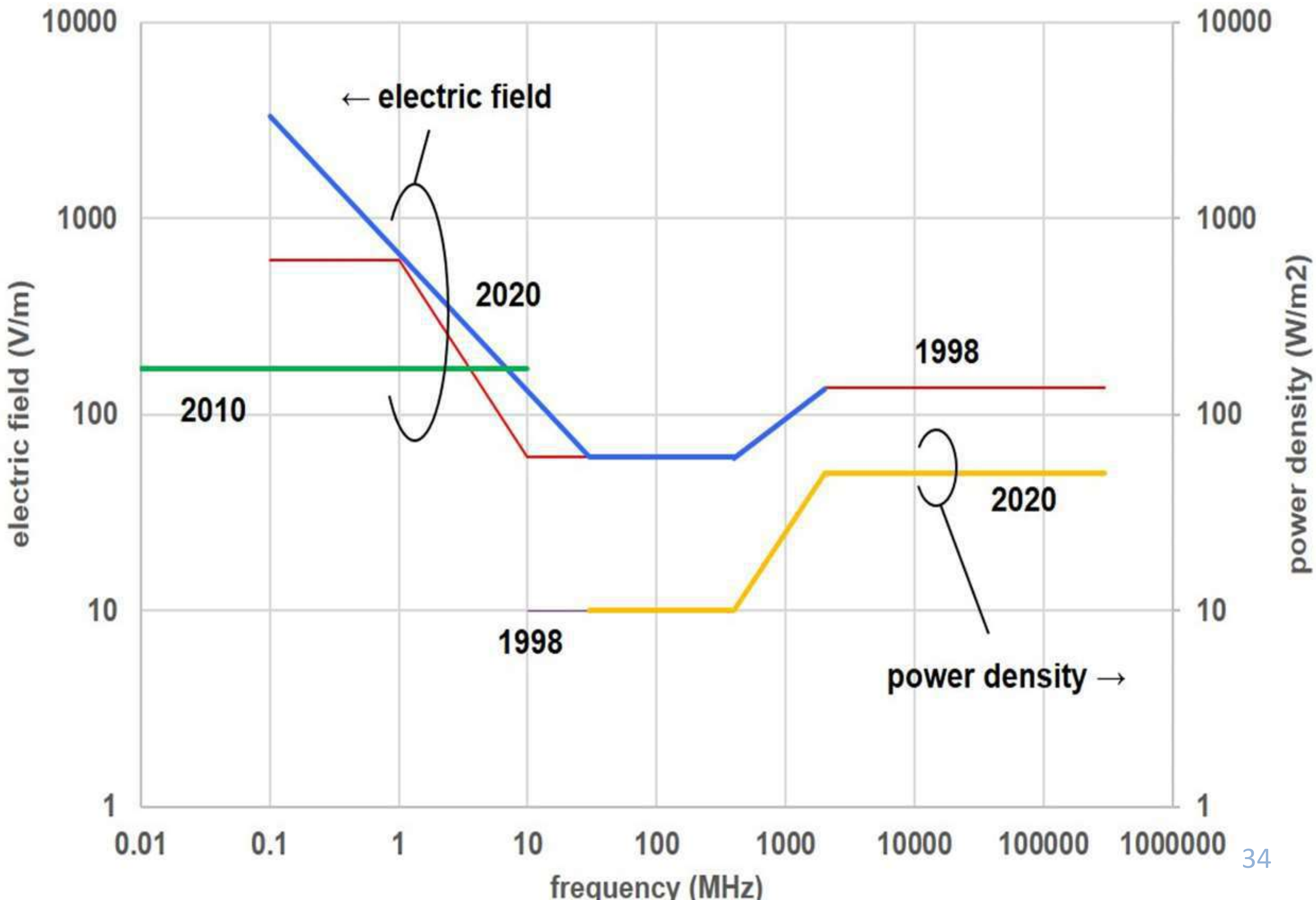
ICNIRP 2020 based on Tables 5 & 6, Figure 1 ***Occupational*** *exposures ≥ 6 min*



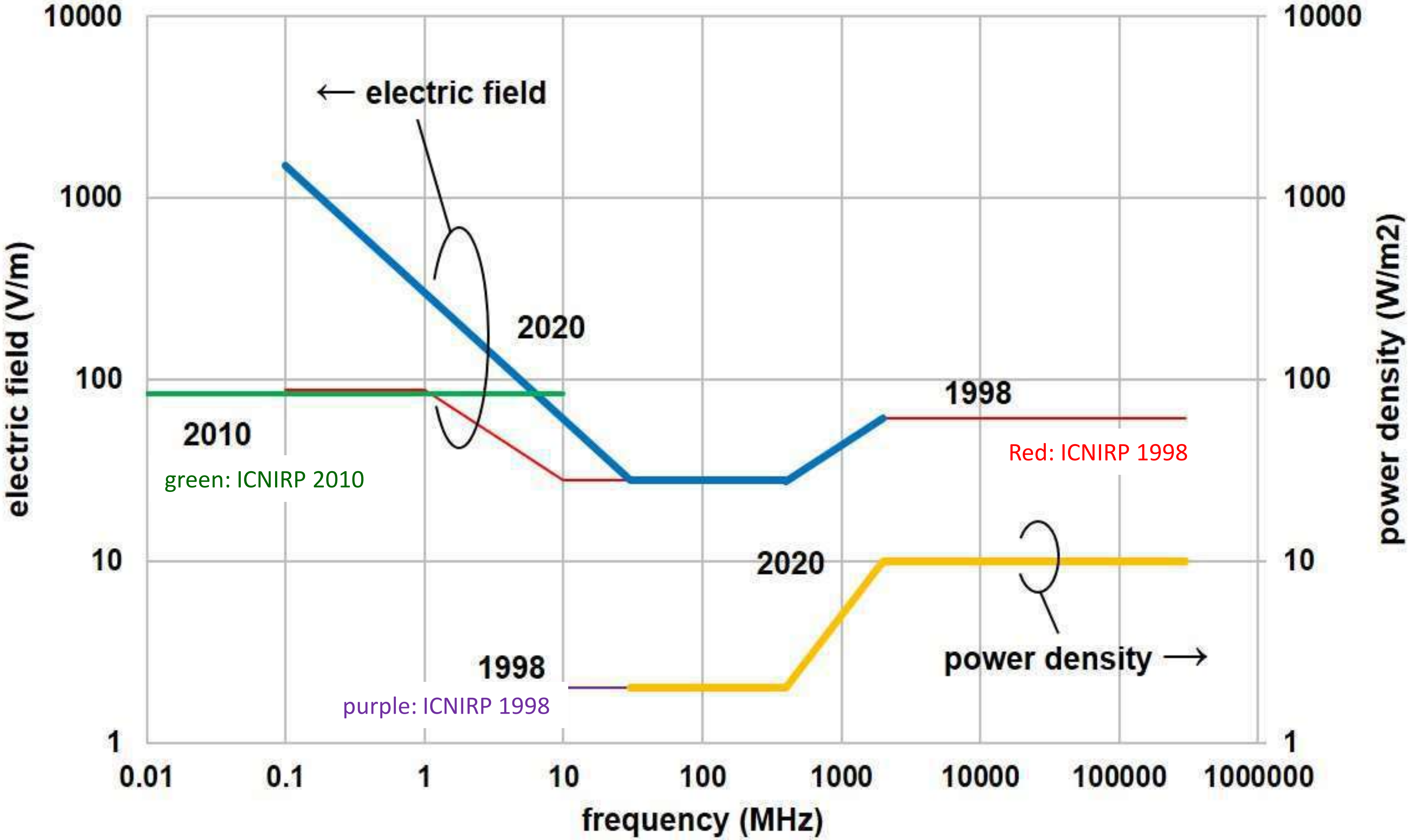
ICNIRP 2020 based on Tables 5 & 6, Figure 2, ***general public*** *exposures ≥6 min*



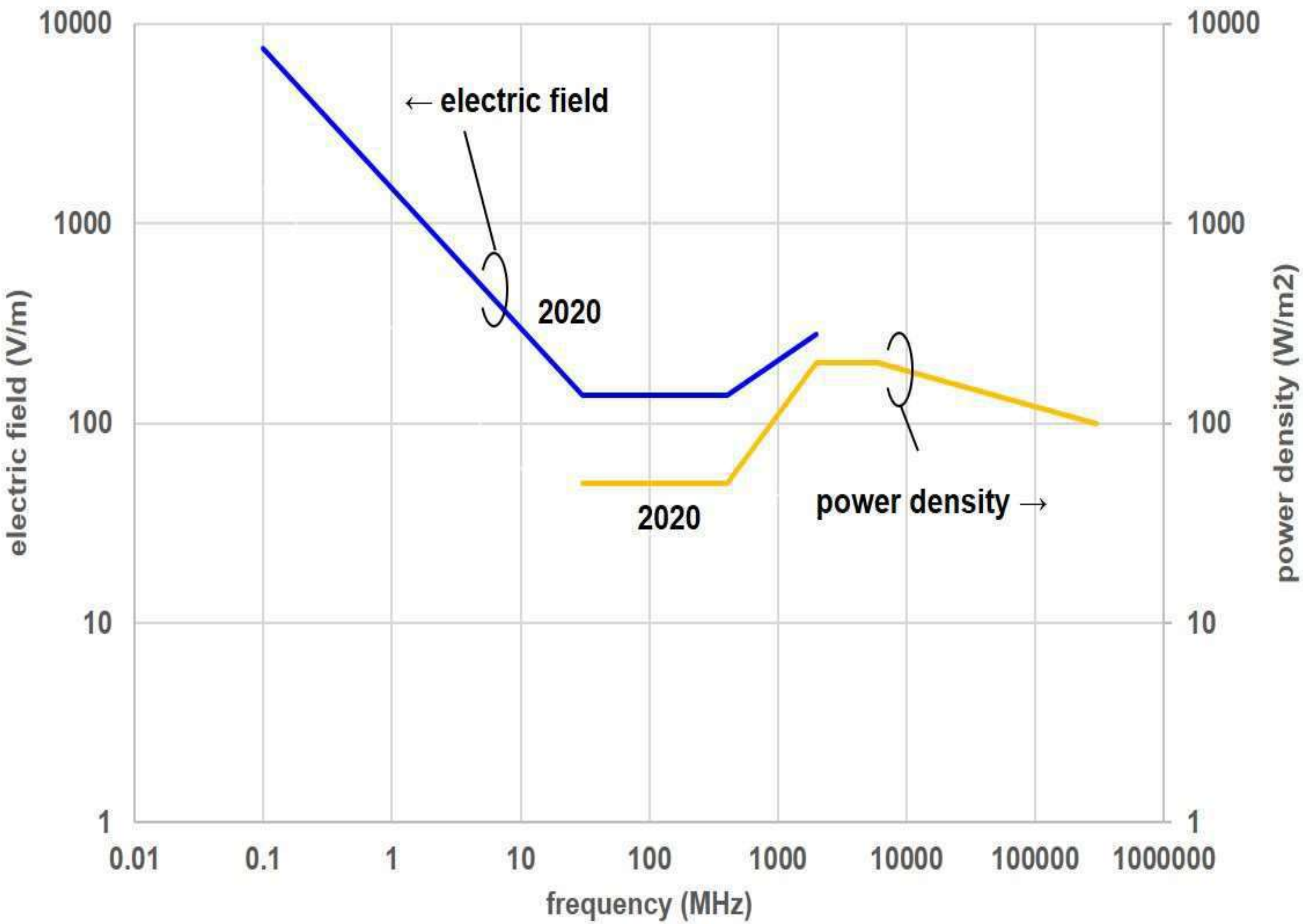
ICNIRP 2020 Web (not Guidelines) Figure 1, **Whole body** the **general public** for the **ICNIRP 1998**, **ICNIRP 2010** and **ICNIRP 2020**



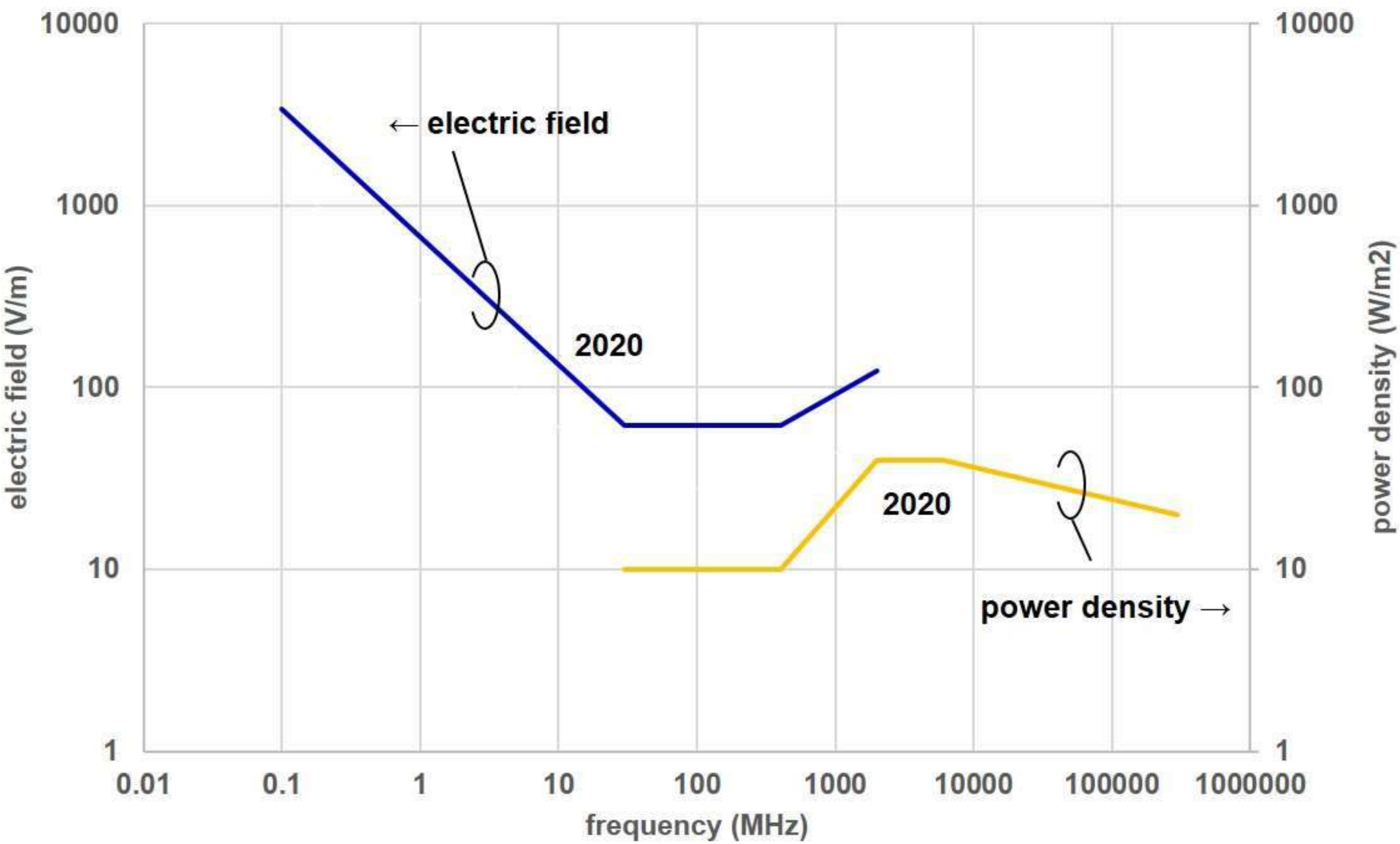
ICNIRP 2020 Web Figure 2, based on Table 6 the **general public** applying to l**ocal exposures ≥6 min** for the ICNIRP 2020 guidelines only

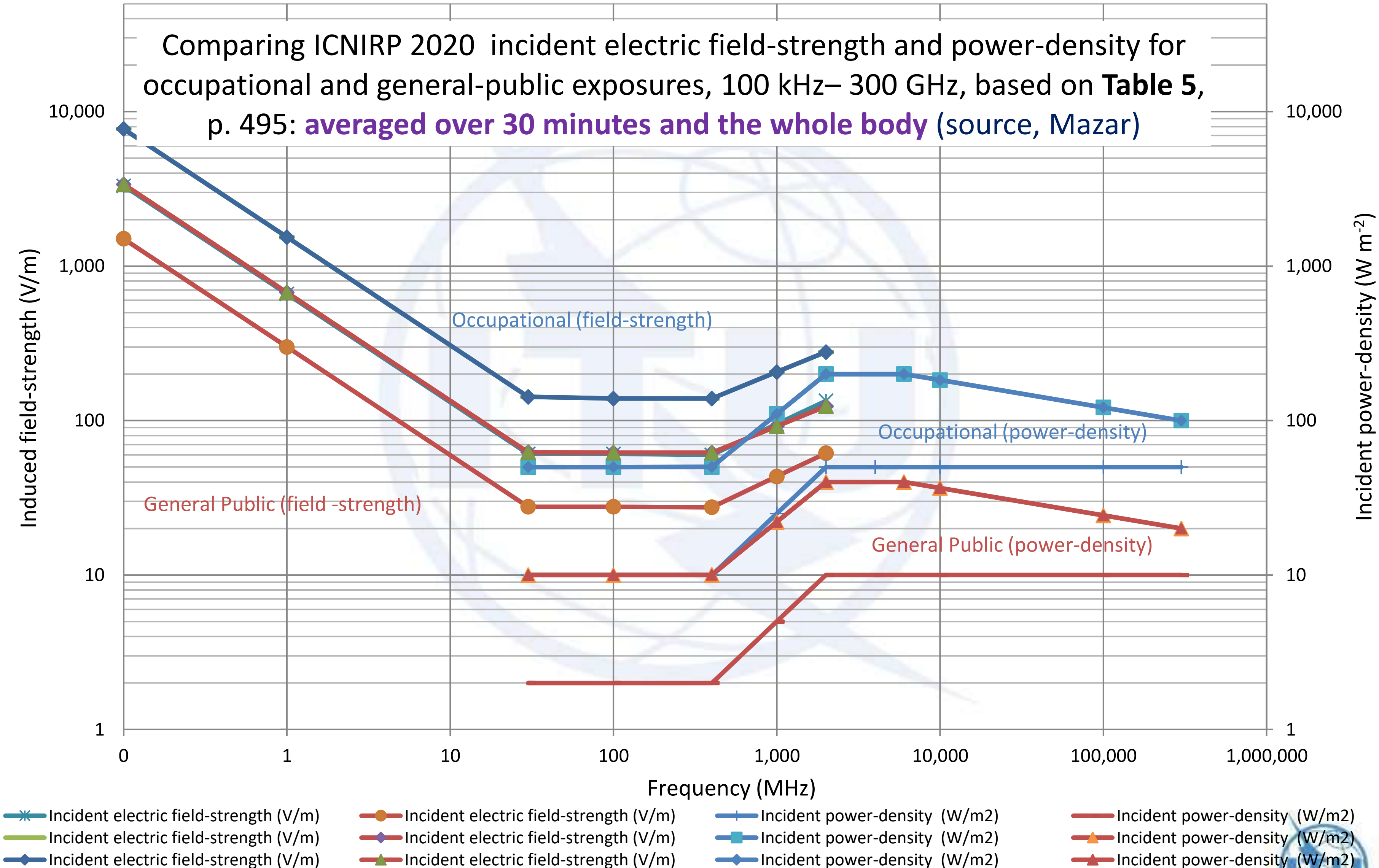


ICNIRP 2020 Web Figure 3 **occupational** (workers), **whole body** average for workers for the ICNIRP 1998, ICNIRP 2010 and ICNIRP 2020



ICNIRP 2020 Web Figure 4 workers (**occupational**)applying to **local exposures ≥6 min** for the ICNIRP (2020)




Comparing ICNIRP 2020 incident electric field-strength and power-density for occupational and general-public exposures, 100 kHz– 300 GHz, based on **Table 5**, p. 495: **averaged over 30 minutes and the whole body** (source, Mazar)
Induced field-strength (V/m)
Incident power-density (W m-2)
Frequency (MHz)
Occupational (field-strength)
Occupational (power-density)
General Public (field -strength)
General Public (power-density)
10,000
1,000
100
10
1
0
1
10
100
1,000
10,000
100,000
1,000,000
Incident electric field-strength (V/m)
Incident electric field-strength (V/m)
Incident electric field-strength (V/m)
Incident electric field-strength (V/m)
Incident electric field-strength (V/m)
Incident electric field-strength (V/m)
Incident power-density (W/m2)
Incident power-density (W/m2)
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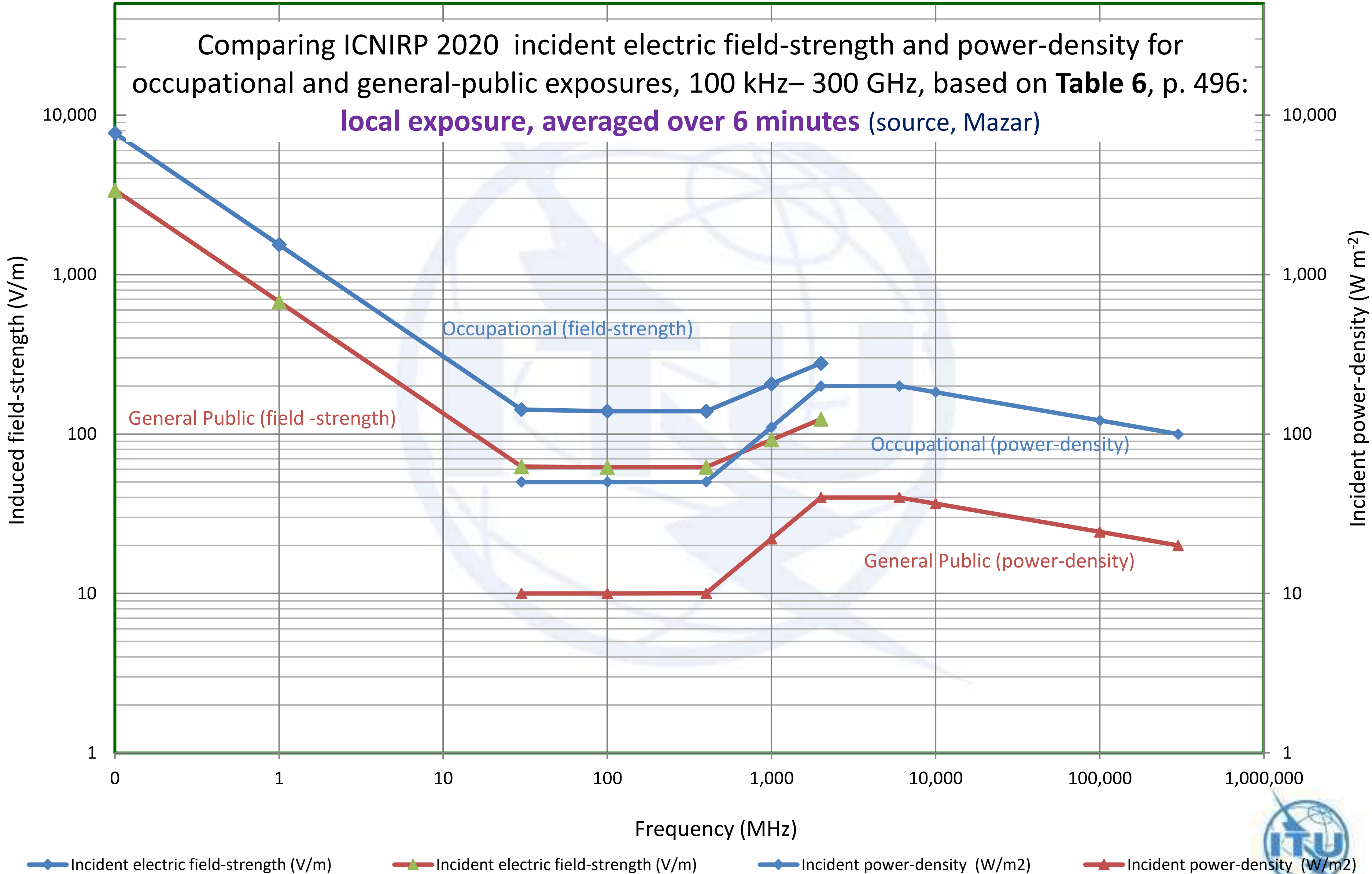
Incident power-density (W/m2)



Comparing ICNIRP 2020 incident electric field-strength and power-density for occupational and general-public exposures, 100 kHz– 300 GHz, based on **Table 6**, p. 496:
local exposure, averaged over 6 minutes (source, Mazar)
Induced field-strength (V/m)
Incident power-density (W m-2)
10,000
1,000
100
10
1
Occupational (field-strength)
General Public (field -strength)
Occupational (power-density)
General Public (power-density)
0
1
10
100
1,000
10,000
100,000
1,000,000
Frequency (MHz)
Incident electric field-strength (V/m)
Incident electric field-strength (V/m)
Incident power-density (W/m2)
Incident power-density (W/m2)

SAR is “the time derivative of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given mass density (ρ_m)”
(ITU-T 2012 K.91:9) in W/kg

$$SAR = \frac{d}{dt}\left(\frac{dw}{dm}\right) = \frac{d}{dt}\left(\frac{dw}{\rho_m dv}\right)$$

SAR can be ascertained in three ways as indicated by the following equations:

E : value of the internal electric field strength in the body tissue (V/m)

σ : conductivity of body tissue (S/m) (siemens per meter, or mho per meter)

$$\text{SAR} = \frac{\sigma e^2}{\rho} = C_i \frac{dT}{dt} = \frac{J^2}{\sigma\rho}$$

ρ : mass density of body tissue (kg/m³)

C_i : heat capacity of body tissue (J/kg °C)

dT/dt : time derivative of temperature in body tissue (°C/s)

J : value of the induced current density in the body tissue (A/m²).

Maximal power from handsets, April 2020: Specific Absorption Rate, SAR (W/kg), compared to ICNIRP 1998

ICNIRP 1998	European Community	USA and Canada
From 10 MHz to 10 GHz; Localized SAR (Head and Trunk)		Portable Devices; General Population/ Uncontrolled
2.0; averaged over 10 g tissue (also IEEE 2005 level)		1.6; averaged over 1g tissue

ICNIRP 2020 Table 3, basic restrictions for EMF Specific Absorption 100 kHz – 300 GHz, for integrating intervals >0 to <6 min

Exposure Scenario	Frequency Range	Local Head/Torso SA (kJ kg^{-1})	Local Limb SA (kJ kg^{-1})	Local U_{ab} (kJ m^{-2})
Occupational	100 kHz to 400 MHz	NA	NA	NA
	>400 MHz to 6 GHz	$3.6[0.05+0.95(t/360)^{0.5}]$	$7.2[0.025+0.975(t/360)^{0.5}]$	NA
	>6 to 300 GHz	NA	NA	$36[0.05+0.95(t/360)^{0.5}]$
General Public	100 kHz to 400 MHz	NA	NA	NA
	>400 MHz to 6 GHz	$0.72[0.05+0.95(t/360)^{0.5}]$	$1.44[0.025+0.975(t/360)^{0.5}]$	NA
	>6 to 300 GHz	NA	NA	$7.2[0.05+0.95(t/360)^{0.5}]$

Mitigation techniques to decrease the radiation level (1)

1. Maximize RF to operators in order to decrease number of sites
2. Maximize sharing, including active frequencies sharing among cellular operators
3. Close the WI-FI access point when not in use

Mitigation techniques to decrease the radiation level (2)

Restrict access to areas where the exposure limits are exceeded. Physical barriers, lockout procedures and adequate signs are essential; workers can use protective clothing (ITU-T 2004 K.52 p.19)

Increase the antenna height. The distances to all points of investigation are increased and the radiation level is reduced. Moreover, additional attenuation to the radiation is achieved due to the increase of elevation angle and decrease of transmitting antenna sidelobe (ITU-T 2007 K.70 p.22)

Increase the antenna gain (mainly by reducing the elevation beam width), and consequently decrease the radiation in the direction accessible to people. The vertical beam width may be used to reduce the radiation level in close proximity to the antenna. Moreover, the same value of the EIRP can be achieved by a low power transmitter feeding high gain antenna or by high power transmitter feeding low gain antenna. As far as the protection against radiation is concerned, a much better choice is to use the low power transmitter feeding the high gain antenna. (ITU-T 2007 K.70 p.22)

Minimize exposure to the min. needed to maintain the quality of the service, as quality criterion. Decrease the Tx power & consequently decrease linearly the power density in all the observation points. As it reduces the coverage area, it is used only if other methods cannot be applied (2007 K.70 p.22)

ITU Activities on EMF

- Intersector
- ITU-D
- ITU-R
- ITU-T

Intersector Activities

1. In response to the 2018 public-consultation, 32 comments to develop the ICNIRP 2020 guidelines
2. Mapping ITU-D/R/T EMF activities to avoid overlap, mainly:
   1) ITU-D : **Strategies** & **Policies** concerning human exposure to EMF
   2) R: EMF **measurements** from **base stations** to assess human exposure
   3) T: **Simulation**, assessment, **5G**
3. The most updated ITU inter-Sector coordination on mapping appears in the mapping tables, maintained by the Inter-Sector Coordination Group (ISCG).

ITU-D activities on EMF

- WTDC-17 Resolution 62 (Rev. Buenos Aires, 2017)
- Report for WTDC 2021 titled : Policies, Guidelines, Regulations and Assessments of Human Exposure to RF-EMF

Final Report of Q7/2, WTDC-2017

Strategies & policies concerning human exposure to EMF

This report collects and disseminates information concerning exposure to RF, to assist national Administrations, particularly in developing countries, to develop appropriate national regulations. It is useful for Administrations, in order to listen and respond to the concerns of the public related to radiating antennas. **https://www.itu.int/pub/D-STG-SG02.07.1-2017**

WTDC-17 9-20 Oct 2017, Buenos Aires, relevant results on EMF

1. ITU-D Resolution 62 (Rev. WTDC-17) on "Measurement concerns related to human exposure to EMF"
2. ITU-D Question 7/2 (Continuation of Q 23/1 and Q7/2) *Strategies and Policies Concerning Human Exposure To Electromagnetic Fields*

ITU-R activities on EMF

The June 2019 ITU-R Report SM.2452 “Electromagnetic field measurements to assess human exposure” provides significant measurements’ information

ITU's worldwide recognized reference on Spectrum Monitoring and related issues

- Chapter 5.6 on **Non-Ionizing Radiation (NIR) measurements**

- Explains **NIR limits & exposure quotient**
- **Instruments** for **NIR measurements**
  - Broadband isotropic probes and meters
  - Tri-axis antennas and field strength meters
  - Transportable station
  - standard field strength measurement equipment
- **Measurement procedures** for different radio services (incl. mobile, broadcasting, etc.)
- **Reporting methods**

ITU-T activities on EMF

- ITU-T WTSA-16 Resolution 72, K. series Recommendations and deliveries of Question 3/5
  - The World Telecommunications Standardisation Assembly 2016 (WTSA-16), held in Hammamet, Tunisia, agreed on the following Resolution 72 (Rev. Hammamet, 2016), "Measurement and assessment concerns related to human exposure to electromagnetic fields".
  - ITU-T EMF studies are advanced in Study Group 5 Question 3/5: "Human exposure to electromagnetic fields (EMFs) from information and communication technologies (ICTs)". The EMF recommendations appear as ITU-T K. series and are available at https://www.itu.int/itu-t/recommendations/index.aspx?ser=K.
- WTDC-17 Resolution 62 (Rev. Buenos Aires, 2017)

ITU-T Recommendations on EMF assessment

ITU-T SG5 (Environment, climate change and circular economy) has been particularly active in developing recommendations for the protection from and measurement/computation of RF fields. Enclosed the EMF ITU-T Recommendations (Standards). All of them include “related supplements”:

1. K.52: Guidance on complying with limits for human exposure to electromagnetic fields
2. K.61: Guidance on measurement and numerical prediction of EMF for compliance with human exposure limits for telecommunication installations
3. K.70: Mitigation techniques to limit human exposure to EMFs in the vicinity of radio stations
4. K.83: Monitoring of electromagnetic field levels
5. K.90: Evaluation techniques and working procedures for compliance with exposure limits of network operator personnel to power-frequency EMF
6. K.91: Guidance for assessment, evaluation and monitoring of human exposure to RF-EMF
7. K.100: Measurement of RF-EMF to determine compliance with human exposure limits when a base station is put into service
8. K.113: Generation of RF-EMF level maps
9. K.121: Guidance on the environmental management for compliance with RF-EMF limits for radiocommunication base stations
10. K.122: Exposure levels in close proximity of radiocommunication antennas

New Supplements ITU-T K on EMF

1. Suppl. 9: 5G technology and human exposure to RF EMF
2. Suppl.10: Analysis of EMF compatibility aspects and definition of requirements for 5G mobile systems
3. K.Suppl.13: RF-EMF exposure levels from mobile and portable devices during different conditions of use
4. K.Suppl.14: Impact of RF-EMF exposure limits stricter than the ICNIRP or IEEE guidelines on 4G and 5G mobile network deployment
5. K. Suppl. 16: EMF compliance assessments for 5G wireless networks
6. K. Suppl. 19: EMF strength inside underground railway trains
7. K.70 Appendix I – Software: EMF-estimator

Recent EMF material from Author

- ITU Conferences on EMF
  1) A Comparison Between European and North American Wireless Regulations, presentation at the 'Technical Symposium at ITU Telecom World 2011' www.itu.int/worl2011; the slides presentation, 27 October 2011
  2) 2016 ITU R-D-T 'Intersectoral activities on human exposure to EMF'; Bangkok, 26 April 2016
  3) 2017 ITU Workshop '5G, EMF & Health'; Warsaw, Poland, 5 December 017
  4) 2018 ITU workshop 'modern policies, guidelines, regulations and assessments of human exposure to RF-EMF'; Geneva, Switzerland, 10 October 2018
- Papers and Presentations
  1) Updated Chapter 9 on EMF exposure of my Wiley book on Spectrum Management
  2) Human RF Exposure Limits: Reference Levels in Europe, USA, Canada, China, Japan and Korea EMC Europe 2016; Wroclaw, Poland, 9 Sept. 2016
  3) Regulation of RF Human Hazards Lusaka, Zambia; 13 January 2017
  4) EMF Concerns and Perceptions Modiin, Israel; 25 March 2019
  5) EMF, New ICNIRP Guidelines and IEEE C95.1-2019 Standard: Differences and Similarities; Warsaw, Poland; 3 Dec 2019
  6) Module on EMF to the ITU Spectrum Training; Feb. 2020

ITU workshop on modern policies, guidelines, regulations and assessments of human exposure to RF-EMF

ITU, Geneva 10 Oct. 18

See workshop presentations at
https://www.itu.int/en/ITU-D/Study-Groups/2018-2021/Pages/meetings/session-Q7-2-oct18.aspx

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1. ANFR 2018 'Étude de l'exposition du public aux ondes radioélectriques'
2. Gati et al., 2009 'Exposure induced by WCDMA mobiles phones in operating networks'
3. Glatte et al., 2019 'Architecture of the Cutaneous Autonomic Nervous System'
4. ICNIRP 1998 ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHZ)
5. ICNIRP 2010 ICNIRP Guidelines for limiting exposure to time-varying electric and magnetic fields (1HZ – 100 kHz)
6. ICNIRP 2020 ICNIRP Guidelines for limiting exposure to electromagnetic fields (100 KHz to 300 GHz)
7. IEC 62232 2017 'Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure'
8. IEC 62669 Case studies supporting IEC 62232 - Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure …
9. IEEE Std C95.6- 2002 IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0-3 kHz
10. IEEE Std C95.1-2005 IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
11. IEEE C95.1-2019 Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz
12. Inskip et al., 2010 Brain cancer incidence trends in relation to cellular telephone use in the United States; Neuro-Oncology, Oxford University Press, ITU-R HB 2011 ITU Handbook on Spectrum Monitoring, Chapter 5.6
13. ITU-T K.52, 2018 Guidance on complying with limits for human exposure to electromagnetic fields; Recommendation **ITU-T K.52**
14. ITU-T K.100, 2019 Measurement of RF EMF to determine compliance with human exposure limits when a base station is put into service; Rec. **ITU-T K.100**
15. ITU-T K.122, 2016 Exposure levels in close proximity of radiocommunication antennas; Rec. **ITU-T K.122**
16. ITU-T FGTR, 2014 EMF considerations in smart sustainable cities; Focus Group Technical Report
17. ITU-R SM.2452, 2019 Report SM.2452 'Electromagnetic field measurements to assess human exposure
18. Mazar H. 2009 An analysis of regulatory frameworks for wireless communications, societal concerns and risk: the case of radio frequency (RF) allocation and licensing
19. Mazar H. 2016 Radio Spectrum Management: Policies, Regulations and Techniques; Chapter 4, 2019 on EMF is public-domain
20. Rowley & Joyner 2012 Comparative international analysis of radiofrequency exposure surveys of mobile communication radio base stations; *Journal of Exposure Science & Environmental Epidemiology* **volume 22**, pages304–315(2012)
21. Rowley J. 2019 RF-EMF presentation at WRC-19, 8 Nov. 2019
22. Sagar et al. 2017 Radiofrequency electromagnetic field exposure in everyday microenvironments in Europe: A systematic literature review Journal of Exposure Science and Environmental Epidemiology

3D	Three Dimensional
3G	3rd Generation mobile technology
4G	4th Generation mobile technology
5G	5th Generation mobile
BR	Basic Restriction
BS	Base Station
CENELEC	European Committee for Electrotechnical Standardization
DRL	Dosimetry Reference Limit
DVB-T	Digital Video Broadcasting - Terrestrial
EHS	Electromagnetic HyperSensitivity
EIRP	Equivalent Isotropic Radiated Power
EMC	ElectroMagnetic Compatibility
EMF	ElectroMagnetic Field
EMR	ElectroMagnetic Radiation
ERL	Exposure Reference Level
ERP	Effective Radiated Power
FCC	Federal Communications Commission
Gbit/s	Giga bits per second
GPS	Global Positioning System
HF	High Frequency
IARC	International Agency for Research on Cancer
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICT	Information and Communication Technology
ICES	International Committee on Electromagnetic Safety (IEEE/ICES)
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
ITU	International Telecommunication Union
LAN	Local Area Network
LTE	Long-Term Evolution
M2M	Machine-to-Machine
Mbit/s	Megabits per second
MPE	Maximum Permissible Exposure
NCD	Non-Communicable Diseases
NIR	Non-ionizing Radiation (NIR)
PFD	Power Flux Density
RAN	Radio Access Network
RF	Radio Frequency
SASB	Standards Association Standards Board (IEEE-SASB)
SAR	Specific Absorption Rate
SI	International System of Units
SRD	Short Range Devices
TTT	Transport and Traffic Telematics
UHF	Ultra High Frequency
VHF	Very High Frequency
WAN	Wide Area Network
WHO	World Health Organization
WiMAX	Worldwide Interoperability for Microwave Access
Wi-Fi	Wireless Fidelity
WLAN	Wireless Local Area Network
xDSL	x-type Digital Subscriber Line

Thank you!

PRIDA Track 1 (T1)

ITU-D Telecommunications Network and Spectrum Management Division (TNS)

On-line training 23 April 2020

Output 2.1 (WTDC-17)

The Objective of this Output is to assist ITU Member States and ITU-D Sector Members and Associates in maximizing the use of the of appropriate new technologies for the development of their information and communication infrastructures and services.

Specific areas of work include

- Spectrum management and radio monitoring
- Broadcasting
- Next generation networks
- Broadband networks: wired and wireless including IMT
- Rural communication
- International connectivity
- Conformance and interoperability (C&I)

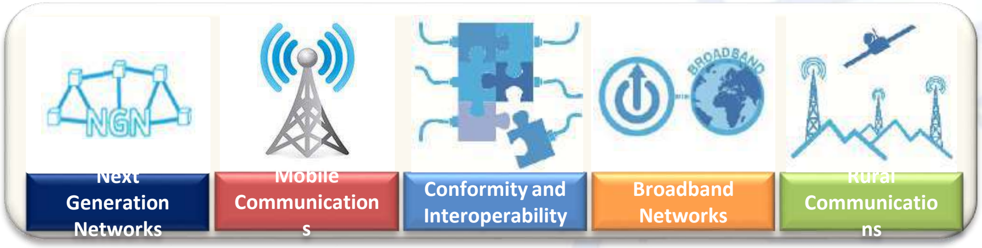
TNS Major Outputs

- Key Areas
  - Spectrum Management
  - Broadcasting
  - NGN
  - Broadband N/W
  - C & I
  - Bridging S-Gap
  - Rural communications

- Main Activities
  - Training
  - Providing Tools & Guidelines
  - Publications
  - Direct assistance to members
  - Partnerships & collaboration with various org.

Telecommunication Networks

Our work is carried out by various means, including symposia, workshops, conferences, seminars and expert advice as well as information sharing, creation of tools and training material, direct assistance, partnership, publications and events. Our priority areas are as follows:



- **Next-Generation Networks:** assistance on planning, deployment, migration, interoperatbility, digitization and evolution of networks, network elements and applications
- **Broadband Networks (wired and wireless technologies):** assitance with planning, implementation and development of national ICT broadband networks, including promoting IXPs
- **Rural communications:** provision of information on access and backhaul technologies and source of power supply, latest technologies and best practice, implementation of projects on public community broadband access points
- **Conformance and interoperability (C&I):** assistance on the establishment of national, regional or subregional C&I programmes, assessment and feasibility studies, providing information and training to technicians, policy-makers and businesses on C&I, providing guidelines on C&I
- **ITU Broadband, IPv6 and Internet Exchange Implementations:** to provide broadband connectivity free or low cost digital access for schools, hospitals, underserved populations; IXPs to reduce transmission costs, optimize Internet traffic, improve QoS
- **ITU Interactive Transmission Maps:** cutting-edge ICT-data mapping platform to take stock of national backbone connectivity and other key ICT metrics.
- **Bridging the Standardization Gap**: Increasing the knowledge and capacity of developing countries for the effective application/implementation of standards
- **WSIS** ALC2 (Infrastucture)

For more information please visit: http://www.itu.int/en/ITU-D/Technology/Pages/default.aspx

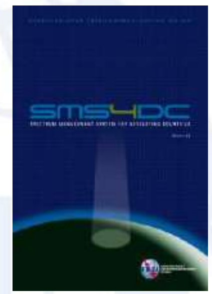
Spectrum management and digital broadcasting

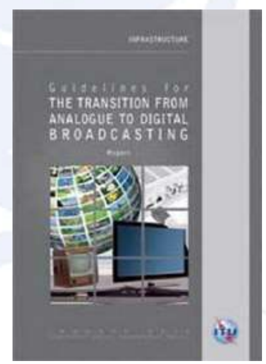
Spectrum Management Software (SMS4DC) has helped developing countries manage radio frequency and around 50 countries adopted it since 2007. The International Meeting of Users of the Spectrum Management System for Developing Countries took place from 8 to 9 December 2016 in Geneva.

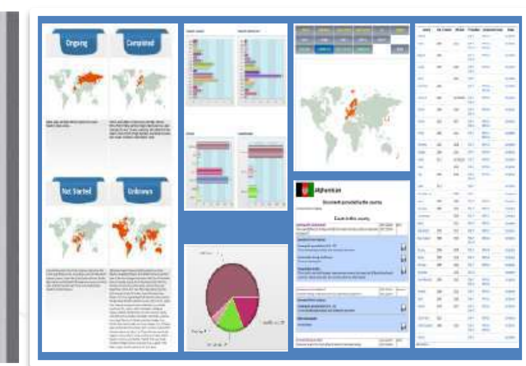
- Guidelines:
- ✓ Spectrum Management Assessment,
- ✓ National Table of Frequency Allocations (NTFA) preparation,
- ✓ Spectrum monitoring
- ✓ Spectrum pricing.
- ▪ Assistance to more than 30 countries on NTFA preparation, SM assessment and cross-border frequency coordination.

Transition to digital terrestrial television broadcasting

- More than 40 countries have been assisted for transition
- Projects funded by Republic of Korea, Japan, Australia, CAF (Latin-American Development Bank)
- Digital broadcasting transition (DSO) database







Other Activities

- **Spectrum Management**
  - ITU-D Study Group 1 Q2/1, Q7/2
  - Offering information through publications
    - "Guidelines for radio-frequency usage fees", etc.
  - Presentation at training seminars and workshops / assisting development of training program for spectrum management (SMTP)
  - EMF related cooperation and activities ITU-D SG2 Question 7/2
- **Broadcasting**
  - ITU-D Study Group 1 Question 2/1
  - Offering information to Member countries
    - "Digital Dividend", "Trends in Broadcasting", "The Guidelines for Transition to Digital Broadcasting", etc.
  - Presentation at training seminars and workshops
  - Cooperation with broadcasting organizations (WBU, EBU, ABU/AIBD etc.)

Conformance and Interoperability

C&I Programme:

- Assistance to Regions and countries on C&I Regimes, practices and testing
- Regional Assessment Studies for promoting MRAs and Direct Assistance
- Capacity Building on C&I programmes and testing
- Combating counterfeit and mobile theft

Competitors

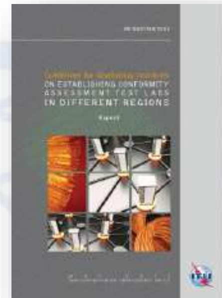
- SDOs targeting Developing Countries

Where we Want to be

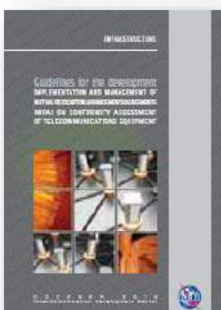
- Leadership in providing assistance on conformance assessment of ICT equipment for sustainability of infrastructure by innovation and mutual collaboration
- Reference on the global C&I status to facilitate network compliance, sustainability and installation for future networks and IoT readiness

ITU C&I Guidelines

Establishing Conformity and Interoperability Regimes – Basic Guidelines; and Complete Guidelines
These Guidelines address challenges faced by developing countries as they plan and review their own C&I regimes. Aspects covered by this publication include, inter alia, conformity assessment procedures; legislation to promote an orderly equipment marketplace; surveillance; coordination across regulatory agencies; and relevant international standards.



Guidelines for developing countries on Establishing Conformity assessment Test Labs in Different Regions This set of guidelines is the first publication on C&I, its valuable content includes information concerning: The process required for building testing labs; A site analysis (e.g. existing testing labs, know-how);Collaboration mechanisms; Best practices; Reference standards and ITU Recommendations



Guidelines for the Development, Implementation and Management of Mutual Recognition Arrangements/Agreements on Conformity Assessment
These guidelines promote the understanding and establishment of Mutual Recognition Agreements (MRAs)
on conformity assessment that are intended to promote efficiency and resource sharing as well as to streamline the flow of products among participating Parties such as ITU Member States and private sector organizations, such as testing laboratories

Feasibility Study for the establishment of a Conformance Testing Centre

This feasibility study describes environments, procedures and methodologies to be adopted to establish, manage and maintain a testing center covering different kinds of conformance and interoperability testing areas

http://itu.int/go/CI_Guidelines

Coming C&I Activities on Training and Assistance - 2019

Assessment Studies

- Follow-up Regional C&I Assessment
  - ECOWAS
  - The Caribbean

Direct country assistance

- Revision of national C&I procedures and specific training on demand

Training on C&I

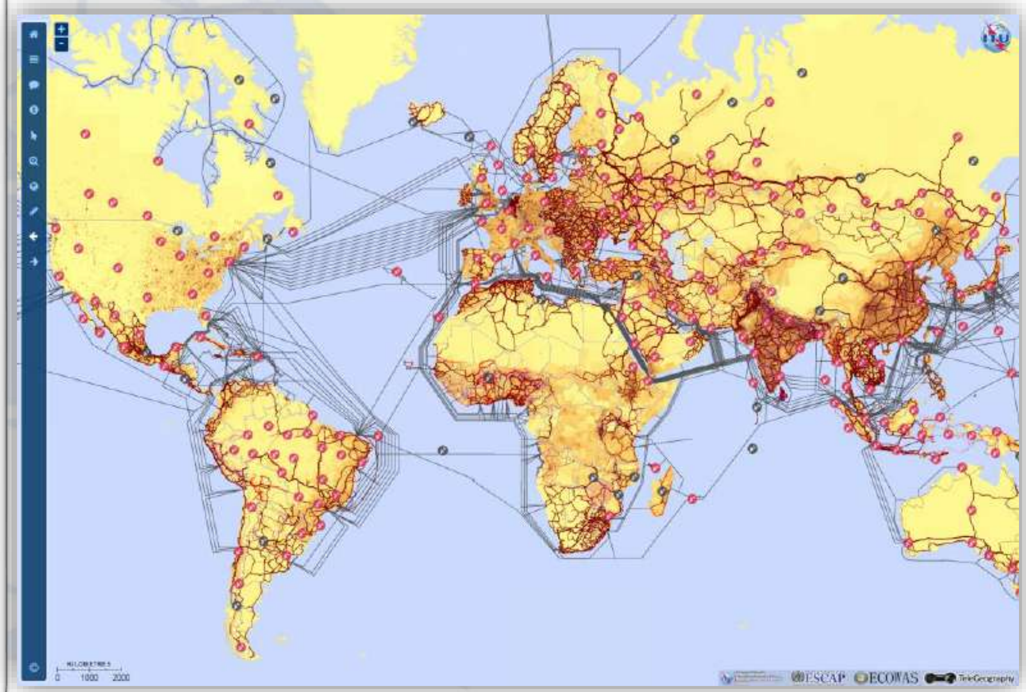
- AFR, September
- AMS, modules for the CITP: Proxies and Pre-compliance for start-ups
- ASP, 15 April to 26 April, 2019, CAICT Center of Excellence: Conformity and Interoperability and 5G

https://itu.int/go/CI_Events

ITU Broadband Maps

The ITU Broadband Maps (Interactive Transmission Maps) are a cutting-edge ICT-data mapping platform to take stock of national backbone connectivity (Optical Fibres, Microwaves and Satellite Earth Stations, IXPs) as well as of other key metrics of the ICT sector. Data concerning submarine cables are also included as provided by TeleGeography

- **The Scope** of this ITU project is to research, process and create maps of core transmission networks worldwide
- **The Objectives** of this ITU project are:
  - to assess the status of national connectivity and to identify gaps enabling the design of targeted strategies and implementation programs for increasing the use of broadband.
  - to assess market opportunities, thus serving as a management tool for making investment decisions, promoting broadband and achieving universal connectivity.
  - to be used as a source of abundant and current data on global ICT connectivity.



http://itu.int/go/Maps

video

Broadband Wireless Projects

Djibouti - Mobile WiMax standard IEEE802.16e

Burundi Training & Network Installation

Swaziland Project Implementation - field Missions

Burundi - Connecting Hospitals for E-Health

ITU Last Mile Connectivity Project: Objectives

Objective: Provide guidelines, toolkits and solutions to support ITU Members in setting last miles connectivity infrastructure and applications in order to close the connectivity gap

- Increased access to broadband
  - Increased last mile networks
  - Interconnection of (local, national and regional) networks
- Reduced cost of access
- Increased development of digital Skills
- Enhanced development and use of local solutions, applications, content & data

ITU Last Mile Connectivity Project: Deliverables

- Compilation of case studies, from different regions of the world, on last mile connectivity solutions
- Analysis of the use of different technologies, policies, regulations and business models to provide citizens with affordable and accessible last mile connectivity solutions
- Guidelines and/or toolkits for setting, maintaining and using last mile connectivity solutions
- Capacity building for local applications development as well as innovations
- Local data and content production, storage and processing
- Implementation of last mile connectivity solutions

ITU Last Mile Connectivity Project: Implementation

- The project will be implemented by the ITU and various partners
  - The project will be under the umbrella of the ITU
  - Potential partners are invited to provide contributions in any part of the study
    - Case studies
    - Last mile connectivity technologies
    - Sustainable business solutions for last mile connectivity
    - Regulations and Policies
    - Applications
    - Implementation of the last mile connectivity solutions
    - Financing the project implementation
- The contributors and their organizations will be recognized (as contributors or authors)

Last Mile Connectivity Technologies

- **Diverse technologies are used**
  - **Wireless technologies**
    - Mobile Cellular
    - Satellite
    - Wi-Fi
    - LAN and IoT technologies
    - HAPS
    - UAV
    - Etc.
  - **Wired technologies**
    - Fiber optic
    - Coaxial Cable
    - Asymmetric digital subscriber line (ADSL)

- **Diverse application requirements**
  – Energy consumption
  – Range
  – Bandwidth
  – Mobility
  – Cost

- **Technologies have different**
  – Signal penetration
  – Frequency use
  – Cost
  – Market size
  – Age, integration

Relevant ITU-D Study Group Questions

Question 1/1: Strategies and policies for the deployment of broadband in developing countries

Question 2/1: Strategies, policies, regulations and methods of migration and adoption of digital broadcasting and implementation of new services

Question 5/1: Telecommunications/ICTs for rural and remote areas

Question 4/2: Assistance to developing countries for implementing conformance and interoperability (C&I) programmes and combating counterfeit ICT equipment and theft of mobile devices

Question 7/2: Strategies and policies concerning human exposure to electromagnetic fields

Cross Border Frequency Coordination

- Harmonized Coordination Method for Africa (HCM4A)
  - Set a standard on a mutually beneficial approach by consensus
  - Provide a solid basis for bilateral and mutual agreements
  - Oblige each country to take account of other stations
- Implementation of HCM4A in four phases
  1. Assessment of existing administrative and technical procedures
  2. Multilateral agreement proposal by technical working group
  3. Validation workshop to adopt draft agreement
  4. Development of HCM4A software
- HCM4A involves 4 sub regions
  - Central, East, Southern and West Africa

http://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Pages/DSO/Default.aspx

International Telecommunication Union

Addressed problem

- Today there are no formal holistic SM education programs, except some ad hoc commercial or public courses such as ITU BR seminars, USTTI
- Large administrations train SM staff by seconding them to experienced workers, but this offers narrowed vision and no formal quality check
- Many smaller administrations, especially in developing countries, do not have even such option, but must rely solely on ad hoc courses

Solution

- ITU established Spectrum Management Training Program:
  - Unified course, offering students across the globe access to state-of-the-art holistic SM training and forward-looking professional vision
  - Formalised assessment ensuring minimal quality of professional education
  - Certification to give international recognition, with possible option of university credits/diploma

https://academy.itu.int

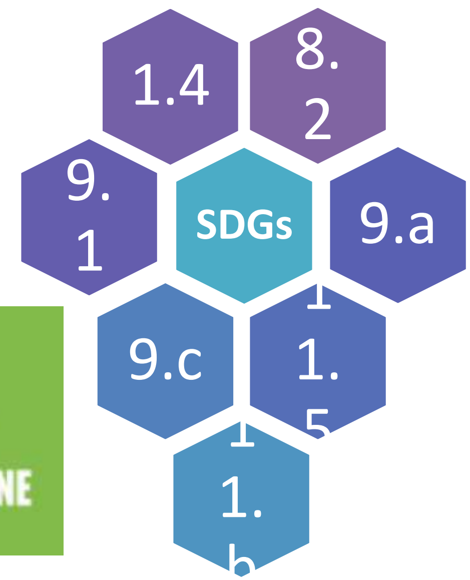
World Summit on the Information Society

- ITU is the sole Facilitator of Action Lines C2 (Information and communication infrastructure)
- WSIS Forum 2019

1. **Monday Session, April 8th, 2019, 11h – 12h30**
   - Title: **Hybrid infrastructure and technologies for affordable broadband access**, will be held on

2. **Thursday Session, April 11th 2019, 2h30 – 4PM**

   Title: Thematic workshop, **5G technology for developing countries**



Thank you!

PRIDA Track 1 (T1)

ITU-D Study Groups
ITU-D's platform for knowledge exchange and capacity development

Online training 23 April 2020

About ITU-D Study Groups

ITU-D study groups provide an opportunity for the membership to share experiences, present ideas, exchange views, and achieve consensus on strategies to address telecommunication/ICT priorities.

Key deliverables:

Reports, Guidelines, Best Practices and Recommendations based on inputs through contributions, case studies and surveys, which are made available to the membership through content management systems and web tools.

ITU-D study group outputs serve as guidance for implementation in Member States.

Main services:

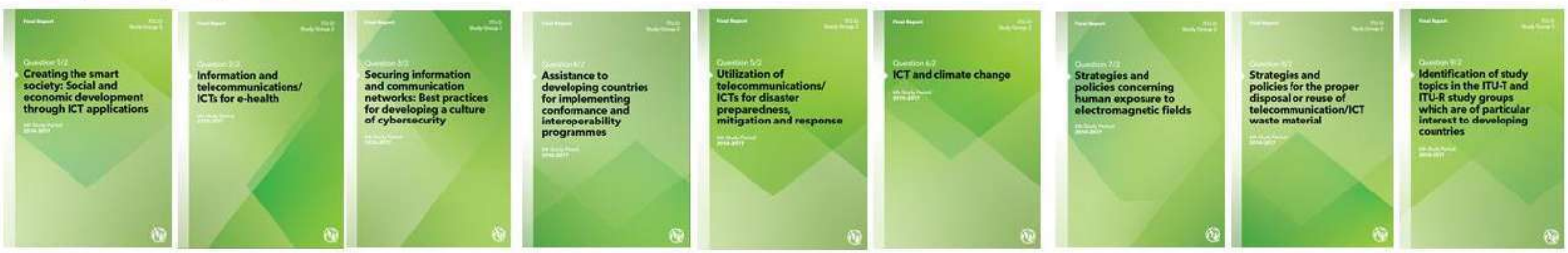
- ***Information exchange*** (contribution-driven and multi-stakeholder – for members by members);
- ***Capacity building mechanism*** (the topical expert meetings, workshops and training opportunities in headquarters and in the regions);
- ***Knowledge platform*** (repository of case studies, lessons learned, best practices and reports)
- ***Expert exchange*** (engaging communities of experts on topics of interest for implementation and for facilitating partnerships and collaboration).

The ITU-D study groups work under the leadership of appointed chairmen, vice-chairmen, rapporteurs and vice-rapporteurs, and are supported by BDT focal points and the Study Group Secretariat.

ITU-D Study Group 1 and 2 topical reports for the 2014-2017 study period

Study Group 1 Questions

Study Group 2 Questions



www.itu.int/pub/D-STG-SG01
www.itu.int/pub/D-STG-SG02

ITU-D SG1 and SG2 Questions under study (2018-2021)

SG1: Enabling environment for the development of telecommunications/ICTs

Study Question	Relevant SDG WSIS Action Line
Q1/1: Strategies and policies for the deployment of broadband in developing countries	8, 9, 11; ACTION LINE C2, ACTION LINE C6
Q2/1: Strategies, policies, regulations and methods of migration and adoption of digital broadcasting and implementation of new services	8, 9; ACTION LINE C2
Q3/1: Emerging technologies, including cloud computing, m-services, and OTTs: Challenges and opportunities, economic and policy impact for developing countries	4, 8, 9, 12; ACTION LINE C2, ACTION LINE C6, ACTION LINE C7
Q4/1: Economic policies and methods of determining the costs of services related to national telecommunication/ICT networks	4, 9, 11; ACTION LINE C6
Q5/1: Telecommunications/ICTs for rural and remote area	4, 9, 11; ACTION LINE C2, ACTION LINE C6
Q6/1: Consumer information, protection and rights: Laws, regulation, economic bases, consumer networks	4, 9, 12; ACTION LINE C5, ACTION LINE C6
Q7/1: Access to telecommunication/ICT services by persons with disabilities and other persons with specific needs	8, 10; ACTION LINE C3, ACTION LINE C4, ACTION LINE C7

SG2: ICT services and applications for the promotion of sustainable development

Study Question	Relevant SDG WSIS Action Line
Q1/2: Creating smart cities and society: Employing ICTs for sustainable social and economic development	2, 4, 7, 11; ACTION LINE C7
Q2/2: Telecommunications/ICTs for e-health	3, 6; ACTION LINE C2, ACTION LINE C7
Q3/2: Securing information and communication networks: Best practices for developing a culture of cybersecurity	4, 9, 11; ACTION LINE C5
Q4/2: Assistance to developing countries for implementing conformance and interoperability (C&I) programmes and combating counterfeit ICT equipment and theft of mobile devices	8, 9, 11; ACTION LINE C2
Q5/2: Utilizing telecommunications/ICTs for disaster risk reduction and management	11, 13; ACTION LINE C2, ACTION LINE C7
Q6/2: ICT and the environment	11; ACTION LINE C7
Q7/2: Strategies and policies concerning human exposure to electromagnetic fields	3, 11; ACTION LINE C2

www.itu.int/ITU-D/study-groups/

ITU-D study groups assist Member States in achieving their SDG targets and development goals

Relations of ITU-D SG1 Questions with radiocommunication

www.itu.int/ITU-D/study-groups

ITU-D SG1 Questions	Relations with radiocommunication
Q1/1: Strategies and policies for the deployment of broadband in developing countries	• Assess socio-economic benefits and raise awareness of the importance between efficient spectrum management and the broadband penetration • Study policies enabling spectrum sharing to make more spectrum available for broadband access • Consider the ITU-R studies and the WRC decisions related to the spectrum allocated (or to be allocated) to IMT-2020, HAPS, WAS/RLAN, etc.
Q2/1: Strategies, policies, regulations and methods of migration and adoption of digital broadcasting and implementation of new services	• Assist developing countries to complete transition from analog to digital broadcasting, especially in terms of the frequency plans during the simulcast and upon completion of transition
Q4/1: Economic policies and methods of determining the costs of services related to national telecommunication/ICT networks	• Spectrum sharing framework within infrastructure sharing: analyze the use of spectrum sharing within the model of active infrastructure.
Q5/1: Telecommunications/ICTs for rural and remote areas	• Assess socio-economic impacts of spectrum to remote areas • Consider available satellite systems and frequency bands for remote areas • Consider available technologies and spectrum issues related to connect IoT devices in remote areas for environmental monitoring and business monitoring/control
Q7/1: Access to telecommunication/ICT services by persons with disabilities and other persons with specific needs	• Discuss on short-range devices (SRD) and relevant ITU-R studies to make sure that persons with disabilities (PwDs) can have robust access and utilization to SRD that can operate in less crowded and less interfered frequency bands.

Relations of ITU-D SG2 Questions with radiocommunication

ITU-D SG2 Questions	Relations with radiocommunication
Q1/2: Creating the smart cities and society: Employing ICTs for sustainable social and economic development	• Study and present different scenarios for connectivity and monitoring purposes, based on e.g. IoT and short range devices (SRDs) • Consider new generations of cellular and wireless systems while planning for a smart city/community.
Q4/2: Assistance to developing countries for implementing conformance and interoperability (C&I) programs and combating counterfeit ICT equipment and theft of mobile devices	• Implement conformance programs of devices, especially those of short range (SRD), to make sure that they operate in accordance to the Radio Regulations, national regulations and the Table of Frequency Allocations, in order to avoid interference with other services and devices
Q7/2: Strategies and policies concerning human exposure to electromagnetic fields	• Analyze regulatory policies concerning human exposure to EMF that are being considered or implemented for authorizing the installation of radiocommunication sites • Propose guidelines and best practices as well as studying the challenges and opportunities of developing technical regulations on the limits for maximum exposure to non-ionizing electromagnetic radiation from radio base stations and specific absorption rate levels in wireless devices

Major milestones for the 2018-21 study period

Main meetings		Main deliverables and progress reports
First SG1 and SG2 meetings	30 April – 11 May 2018	Appoint management team members, identify experts, distribute tasks, agree on work plans and methods of action, review initial contributions, reply to liaison statements received. Ensure that the team has a good understanding of tools and working methods to conduct the work.
Rapporteur Group meetings	17 September- 12 October 2018	Review tables of content for Question deliverables, call for and review of detailed contributions, draft surveys. Case studies on the topics under study are appreciated. Prepare output reports to be put forward for approval at the annual meetings.
Second SG1 and SG2 meetings	**18 – 29 March 2019**	Present progress reports, advanced tables of content, outline of report, approve and launch of surveys (if applicable). Presentation of annual progress reports, holding of panel sessions and **approval of annual deliverables**.
Rapporteur Group meetings	23 September – 18 October 2019	Review contributions and input received through surveys, etc., chapter specific drafting/brainstorming groups. Case studies on the topics under study are appreciated. Prepare output reports to be put forward for approval at the annual meetings.
Third SG1 and SG2 meetings	17 – 28 February 2020	Present progress reports, review draft reports, guidelines, Recommendations, identify/ discuss next steps to complete work on time and how to overcome challenges encountered. Initial discussion on future study Questions. Annual progress reports and **approval of annual deliverables and reports**.
Rapporteur Group meetings	21 September – 16 October 2020	Finalize reports, finalize draft guidelines and Recommendations, propose/discuss possible study topics for the next period.
Fourth SG1 and SG2 meetings	15 – 26 March 2021	Fine-tune and approve reports, guidelines and Recommendations. Propose/discuss possible study topics for the next period. **Agreement on deliverables to WTDC-21.**
WTDC	Q4 2021	Study Group 1 and 2 Chairmen present results and deliverables to WTDC.

Next meetings

- The SG1/SG2 Chairmen report annual to TDAG on progress made.
- Thematic workshops, courses and seminars are to be held throughout the study period in Geneva and **the regions based on proposals received**.

ITU-D Study Groups:
More information and contact details

More information on the ITU-D Study Groups:
www.itu.int/ITU-D/study-groups/

You can contact us at:
E-mail: devsg@itu.int
Tel.:+41 22 730 5999

Thank you!

PRIDA Track 1 (T1)

Assessing National Spectrum Management Practices and NTFA

Online training, 23 April 2020

Introduction

- It is a government responsibility to develop spectrum management policies that conform to the international treaty obligations of the Radio Regulations while meeting national spectrum needs
- Within the national legal framework for telecommunications a spectrum management organisation has the delegated authority to prepare spectrum plans that meet government policies
- One of the most important tools for effective spectrum management is the National Table of Frequency Allocation (NTFA). This shows how the spectrum can be used in the country

ITU assistance

Guidelines

- **Creation of National Table of Frequency Allocation**
- **A Standard Approach for Assessing the Spectrum Management Needs Of Developing Countries**

Spectrum Management Master Plans

Spectrum Management Assessment

1 (1) Key elements of national spectrum management for review and assessment

1 Country background
2 Legal Framework for Spectrum Management
3 Organisational Structure of Spectrum Management
4 Current Spectrum Allocation & Usage as well as Future Trends
5 Spectrum & Apparatus Assignment/Licensing Processes/Mechanisms
6 Financing of Spectrum Management and Spectrum Pricing Mechanisms
7 Spectrum Quality Control, Interference Management & Enforcement
8 Spectrum Management Data Bases and Computer Assisted Assignment
9 Application of spectrum engineering in spectrum management and assignment
10 Radio Equipment Standardization, Type Approval & Related Certification
11 Participation in International Spectrum Planning and Co-ordination activities
12 Participation of Stakeholders in the Spectrum Management Process
13 Research Collaboration with Institutions of Higher Learning and Industry
14 Public Information; Websites; licensing

1(2) Terminologies

The radio frequency spectrum:

- a limited and valuable ***(re-usable)*** resource
- used for all forms of wireless communication
- its use must be managed or coordinated to prevent interference between signals
- growth in telecom services and radio technologies creates increasing demand

Strategic spectrum planning

- pressure on the regulatory system to manage rapidly rising/shifting demand
- becoming increasingly complicated
- must take account of: technical developments, market forces, social trends, international developments (radio waves cross national frontiers)

1(3) Terminologies

Spectrum management framework

- international framework set out in the ITU's Radio Regulations
- considerable flexibility for the establishment of national policies within this framework

Guidelines for assessment of National Spectrum Management practices

- no single standard model for spectrum management but a set of general requirements can be identified (follow the framework of the ITU Radio Regulations)
- intended to provide a standard approach for assessing national spectrum management development needs.

2(1) Country background: Influences on radio spectrum management

Political

Economic

Topographic Geomorphologic

Radiocommunications development requirements

Geographic

Demographic

2(2) Country background: Influences on radio spectrum management

Political

Indication of organizational and legal structure; policies for liberalization and market approach. Regional administrative centres may require spectrum management on a regional basis. Different ethnic regions are likely to have regional broadcasting requirements.

Economic

Information on the role of radiocommunications in supporting major sources of Gross Domestic Product (GDP).

Demographic

Distribution of population, main cities and towns indicate areas of (future) high spectrum demand. Large, sparsely populated, rural areas indicate requirement for radio links to support infrastructure development and/or backhauling.

2(3) Country background: Influences on radio spectrum management

Geographic

Country size: radio coverage requirements; coastal areas: maritime requirements; number of neighbouring countries: cross-border frequency co-ordination requirements.

Topographic/Geomorphologic

Mountainous regions, flat plains, deserts, large inland water areas, large forests or jungle areas etc: different influences on radio use and planning requirements.

Assessment objectives

Pre-mission assessment and report on the key factors listed above. Information from publicly available sources (including ITU development reports). To be discussed and agreed with the administration while on-mission.

3 Legal Framework for Spectrum Management

Primary Legislation

- Establish the legal right of the State to manage radio spectrum
- Identify and define "The Administration"
- Legal right to charge for spectrum use and management
- National Table of Frequency Allocations

Secondary legislation:

- Regulatory codes of procedure
- Statutory instruments etc.

Assessment Objectives *(to check whether the legal framework establishes):*

✓Legal certainty (e.g. spectrum availability) to spectrum stakeholders and investors
✓Efficient and equitable spectrum management procedures
✓Fair and transparent procedures (for licensing, fees, dispute resolution)
✓Consultative procedures (stakeholders, operators, users, industry)
✓Monitoring for control of spectrum quality (compliance, interference, efficient use)
✓Equipment standards and certification, putting on the market, import
✓International negotiations – frequency co-ordination, ITU representation
✓Support/fund spectrum efficiency research
✓Pro-active spectrum efficiency improvement by facilitating (e.g.) re-farming

4(1) Organisational Structure of Spectrum Management

The *Telecommunications* or *Radiocommunications Act* should identify and establish the ***Administration***, the legal entity with overall responsibility for national spectrum management and interface with the ITU. The Administration could be a government Ministry or one of its departments, a state institution (still not independent but not quite a ministry) or an independent regulator.

The Administration (or the Act) may also ***delegate*** some spectrum management responsibilities in nationally allocated bands for specific purposes to other government agencies, telecommunications operators (e.g. of public fixed and mobile services) or similar large organisations that make extensive use radio in their operations.

Delegation arrangements are frequently used because there are considerable benefits for the Administration (e.g. reduction of administration and technical resources) and for the delegated organisation (e.g. faster decisions to meet operational requirements, direct involvement by specialist practioners). A typical example is to have separate organisations for civil and military radio use.

However, these arrangements should ensure the Administration retains overall responsibility for national spectrum management and representing the country at ITU level.

4(2) Organisational Structure of Spectrum Management

Assessment objectives

❖Provide a clear description of the organisational structure of spectrum management, in particular to determine whether there is more than one organisation responsible for spectrum management.

❖The Administration should be identified and a description should be provided of the functional structure of the Administration together with staff numbers and responsibilities.

❖The legal relationship with other main spectrum users (government ministries, agencies or operators) should be described; especially if they have delegated powers for spectrum management.

❖The effectiveness of the co-ordination arrangements between Administration and other main spectrum users should be examined (described later).

5 Current Spectrum Allocation & Usage as well as Future Trends

An examination of national spectrum allocations and use can provide a measure of the effectiveness of spectrum management planning policies and day-to-day frequency assignment procedures.

Assessment objectives

❖Obtain and examine the ***National Frequency Allocation Table;***

❖Determine the amount of spectrum allocated to government and non-government services;

❖Is there a rationale for this division;

❖Determine the sub-division of spectrum for various non-government applications;

❖Obtain from licensing records/statistics a measure of the actual use (i.e. number of assignments) for each user category;

❖Identify systems, services or bands that have congestion or other spectrum availability difficulties.

6(1) Spectrum & Apparatus Assignment/Licensing Processes/Mechanisms

The international licensing requirement

- Article 18 of the Radio Regulations requires that: "No transmitting station may be established or operated by a private person or by any enterprise without a licence issued in an appropriate form and in conformity with the provisions of these Regulations by or on behalf of the government of the country to which the station in question is subject…".
- ITU Constitution Article 45 requires each Member State to ensure that stations established and operated by its operating agencies do not cause harmful interference to stations of other Member States or of recognized operating agencies operating in accordance with the Radio Regulations.
- The administration must therefore have some form of licensing process to meet this requirement.

6(2) Spectrum & Apparatus Assignment/Licensing Processes/Mechanisms

National licensing arrangements – the flexibility

Individual licensing

Usually required for "international" stations (e.g. aeronautical and maritime mobile) and for those transmitters which required individual frequency planning (e.g. interference analysis) including international co-ordination.

A general licensing regime

May be used for personal transmitters operating under the control of public mobile telephone networks designed to meet international standards. Various short range devices, including computer terminals in wireless local area networks, can operate under a general "licence exempt" basis, provided that the equipment conforms to an accepted standard on agreed frequencies.

6(3) Spectrum & Apparatus Assignment/Licensing Processes/Mechanisms

Assessment objectives

To describe the licensing system in operation, including what types of system require a licence and whether there is a licence exemption arrangement or general licence for certain systems e.g. SRD, WiFi etc.

The following procedures are especially important:

- ❖Is the application procedure easy to understand and published?
- ❖Are all application registered (to track progress through the system)
- ❖Are there qualified staff for technical analysis?
- ❖Is decision-making fast and efficient
- ❖What options are there for payment of licensing fees and charges
- ❖How is the licence issued (in person, by post, electronically etc.)
- ❖Licence renewal (period of validity)
- ❖Is there any computerisation of the licensing process (any planned)

7(1) Financing of Spectrum Management and Spectrum Pricing Mechanisms

Financing Spectrum Management

Spectrum users benefit from the planning, management and monitoring of the spectrum carried out by the State or by other organizations delegated by the State. It is therefore reasonable and lawful for the State or spectrum management organizations to require users to pay *administrative fees* (known also as *frequency management fees* or *service fees)*, as well as *administrative charges* to cover all costs arising out of spectrum planning, management and monitoring activities *(cost recovery).*

Market Approaches to Spectrum Management

Market approaches go beyond simple cost recovery (described above) and become spectrum tools in themselves by placing a value on the spectrum. These tools (including opportunity costs and auctions) can:

- be designed to promote spectrum efficiency;
- assist when spectrum demand exceeds supply;
- determine the most cost beneficial spectrum use;
- encourage innovation and adoption of newer/more efficient technologies.

7(2) Financing of Spectrum Management and Spectrum Pricing Mechanisms

Assessment objectives

- Is there a well defined financial strategy for meeting the total costs of managing the spectrum?
- Does the spectrum management authority publish its annual operational budget?
- Are budgets well-balanced, costs fairly distributed between licence groups, with those requiring the most spectrum management resources paying higher fees?
- Is there a simplified fee structure and collection mechanism with a simplified licensing scheme?
- Are licensees are able to easily choose a licence “product” that meets their needs and see how much it will cost, both for any initial fee and the annual renewal fees?
- Are auctions run in accordance with established good practice?

8 Spectrum Quality Control, Interference Management & Enforcement

In order to guarantee that spectrum use conforms to existing regulations and the authorizations granted, there should be some form of spectrum monitoring capability.

The main purposes of spectrum monitoring are:

❖To measure spectrum occupancy (to evaluate effectiveness of spectrum planning and identify geographical areas and bands having congestion)

❖To verify administrative (licensing) database records

❖To check technical compliance

❖For interference resolution

❖To trace unlicensed/illegal use

Assessment objectives *(to determine)*

➢The type of monitoring facilities available and the extent to which they are used (e.g. regular monitoring programmes to target particular issues)

➢The experience of the staff and how monitoring is integrated into general spectrum management activities

➢If the national regulations contain enforcement measures (e.g. financial penalties) intended to deter interference from unauthorized use, non-compliance with the allocation, assignment or authorization etc.

9 Spectrum Management Data Bases and Computer Assisted Assignment

Record keeping of administrative and technical data is an essential requirement of spectrum management. The data may be stored on a paper-based system but computerized systems are more efficient. Whichever format is chosen, the key elements are: accuracy; sufficiency; security and control; data entry validation; ability to search and analyse; ability to interface with other systems (especially national monitoring)

Assessment objectives

- The assessment should identify all databases used in the country; in particular the database used by the administration/regulator but also those used by delegated agencies and operators;
- The design of the database(s) should be noted (e.g. MS Access), data fields used (e.g. conform to ITU recommendations), ease of transfer;
- Examine the procedures used to validate application data (in particular the accuracy of transmitter location);
- Networking capability;
- Security and backup arrangements .

10(1) Application of spectrum engineering in spectrum management and assignment

Spectrum engineering is one of the key elements of spectrum management. It is the application of engineering practice and principles to ensure that spectrum plans are designed to make effective and efficient use of the spectrum and maximise the number of different radio systems that are able to operate as intended in any given frequency band.

Spectrum engineering analyses used as technical input to spectrum planning in two ways:

- to plan the spectrum to enable systems with defined technical and operational characteristics to operate as intended; or
- to determine the technical and operational characteristics necessary to enable systems to work in a specified frequency plan.

Spectrum engineering must also take into account design and equipment costs to ensure the economical viability of engineering solutions to spectrum management problems.

10(2) Application of spectrum engineering in spectrum management and assignment

Assessment objectives

- To what extent is spectrum engineering used
  - EMC and interference analysis for new frequency assignments
  - National allocation system planning

- What services (e.g. fixed, mobile, broadcasting) benefit from application of spectrum engineering

- What spectrum engineering tools and models are used. In particular, are ITU tools and models used for international frequency co-ordination and allocation plans

- Is propagation modelling used and is high resolution terrain data available

- Are computer tools available for spectrum engineering

11(1) Radio Equipment Standardization, Type Approval & Related Certification

Equipment requirements of the Radio Regulations

➢Article **3** of the Radio Regulations concerns the requirements associated with the technical characteristics of stations with the objective to avoid interference.

➢ Appendices **2** and **3,** respectively, of the Radio Regulations give maximum values for frequency tolerance and spurious emissions and other technical standards.

➢

➢Administrations have the responsibility to ensure that equipment authorised for use in their territory conforms to these Regulations.

11(2) Radio Equipment Standardization, Type Approval & Related Certification

Equipment standards

Documents which specify the minimum performance requirements for radio transmitters and receivers (or other equipment) and the associated procedures to ensure conformity with these requirements are commonly referred to as “equipment standards”. Standards can be developed by national, regional or international organisations such as ITU.

Compliance testing , placing on the market, import restrictions

- Obsolete procedures

▪Nationally developed standards

▪*Every* country required a sample of each equipment to be submitted to its own government-run laboratory for “type-approval” to the relevant national standard before market.

- New procedures

✓A combination of: manufacturers’ declaration of compliance, compliance testing by commercial test-houses, market surveillance,

✓Global standards , mutual recognition agreements (MRAs) of standards and approvals between countries or groups of countries.

11(3) Radio Equipment Standardization, Type Approval & Related Certification

Assessment objectives

To examine and describe the radio equipment standardization certification and import procedures and determine whether these:

✓***Are efficient:*** quickly enable users to implement their new radio systems by ensuring suitable and approved equipment may be obtained from a variety of legal sources (manufacturers/dealers) at reasonable cost;

✓***Are open and flexible:*** where possible, authorizing compatible standards from a wide range of regional standards bodies and accepting equipment certification from internationally recognised test-houses;

✓***Are transparent:*** publishing the equipment specifications required for each frequency band and service so that users know what to purchase;

✓***Are "import-friendly":*** publishing the import requirements that have been notified and agreed with the customs authorities to ensure properly certificated equipment may be imported easily.

12(1) Participation in International Spectrum Planning and Co-ordination activities

The international dimension of national spectrum management

National radiocommunications exist within an international (global, regional or bi-lateral) framework of regulation, legal commitments , operational and commercial realities (e.g.):

- Radio wave propagation traverses political boundaries,
- Navigation equipment is standardized to allow safe movement throughout the world,
- Satellite system transmissions facilitate worldwide communications,
- Maritime, aeronautical, broadcasting, satellite services are subject to international plans,
- Personal mobile-phones and wi-fi operate on globally common frequencies,
- Communications system manufacturers produce common equipment for many markets,
- Market-commonality results in simpler and less expensive production processes.

12(2) Participation in International Spectrum Planning and Co-ordination activities

The need to participate in international fora and influence outcomes

The national spectrum manager's ability to participate in international fora (and influence outcomes) becomes significant because all the international (global, regional or bilateral) spectrum management decisions will have an eventual impact on national legislation, regulations and spectrum use.

Assessment objectives

❖Is there a requirement for cross-border co-ordination, if so is this given some priority;

❖Does the administration carry out it's obligations of notification and co-ordination in accordance with ITU procedures;

❖Are there bi-lateral or multilateral co-ordination arrangements (and meetings);

❖Does the administration organise co-ordination or is there informal border co-ordination between operators;

❖Does the administration participate in international or regional preparations for World or Regional Radio Conferences;

❖Are there national preparations for WRC

13(1) Participation of Stakeholders in the Spectrum Management Process

Spectrum stakeholders:

Spectrum stakeholders are the government and non-government spectrum users that depend on radiocommunications to function efficiently. Consultation with these stakeholders is essential in virtually every aspect of spectrum management, including the development of national legislation and regulations, spectrum policies, technical standards, etc.

The type and extent of consultation

➢depends on government policy and how the institutional authority for spectrum management has been organised;

- detailed and regular consultation
- less regular but major changes

13(2) Participation of Stakeholders in the Spectrum Management Process

For detailed and regular consultation:

✓establish working groups or committees with membership drawn from relevant government departments and other agencies,;

✓include: major non-government spectrum stakeholders (e.g. service providers, telecom industry, broadcasting organisations);

✓allow associations or bodies representing groups of users to contribute (not practical to consult with each individual spectrum user).

For less regular but major changes

✓Advance publication of proposals with invitation to comment

✓Publish responses

✓Publish decisions and reasons

13(3) Participation of Stakeholders in the Spectrum Management Process

Assessment objectives

❖Examine and describe the procedures in place for consultation with spectrum stakeholders;

❖In particular determine which stakeholders are invited to participate and

❖Is there transparency and fairness;

❖Is there a "national strategic spectrum planning committee" of major stakeholders

❖Are there working groups of stakeholders to advise the administration on specific spectrum management issues

14 Research Collaboration with Institutions of Higher Learning and Industry

Research Collaboration – objectives and benefits

- research projects to improve spectrum management and efficient utilisation
- for administration with limited staff and resources, provides external source of academic knowledge and facilities
- academic institutions and students may be provided with the challenge of real spectrum management issues
- method of interesting and attracting a future generation of engineers and related professions into careers in spectrum management
- collaboration with telecom industry (including secondments) ensures the administration develops a practical understanding and industry understands the benefits of good regulation.

Assessment objectives

- Determine the extent to which the administration collaborates with colleges, universities, industry
- Provide examples of collaboration activities and benefits achieved

15(1) Public Information; Websites; licensing

The need for easily accessible, up-to-date and comprehensive spectrum information

All those involved in radiocommunications and telecommunications (users, potential users, operators, equipment suppliers etc.) need to be able to access, quickly and easily, timely an information about (e.g.):

- how spectrum is used (NTFA)
- what spectrum is available for particular purposes (NTFA),
- equipment specifications and standards (for each band/purpose),
- licensing processes and types,
- regulations and fees,
- proposed changes to regulations and spectrum use,
- opportunities and procedures to participate in the consultative process.

Information distribution through the internet and the administration's web-site is replacing the traditional official government gazette or journal.

15(2) Public Information; Websites; licensing

On-line licensing procedures

Ideally, the following licensing facilities should be available on-line:

- applications (in particular for “simple” licences)
- renewals
- electronic payments

Assessment objectives

An overall description of the administration’s public information facilities should be given, noting:

- Does the administration have a web-site
- Is it well maintained and up-to-date
- Does it contain key items (e.g.):
  - ✓Is the Radiocommunications legislation publicly available
  - ✓Is the National Table of Frequency Allocations (NTFA) available
  - ✓Is there a schedule of services and applications and available frequencies
  - ✓Is there a schedule of fees and charges
  - ✓etc.

16(1) The full ITU Guideline

More detailed information available

This presentation provides a brief review and introduction to the full ITU Guideline: "A Standard Approach for Assessing the Spectrum Management Needs Of Developing Countries". The Guiodeline contains detailed look-up tables for assessing spectrum management needs. In addition, it contains references and links to other relevant information from the ITU and other organizations.

Opportunities for improvement

As the Guideline is also intended as a template for preparing an assessment report (e.g. as part of an ITU mission), there is an example ***"Opportunities for Improvement"*** section for each key element of spectrum management. In a report, these can easily be prepared by comparing the actual situation in an administration with the look-up assessment tables and highlighting any activities that are not being done or are inadequate. Proposals on how to introduce these activities into national spectrum management may be given, preferably with a "route-map" and "milestones" relevant to the circumstances of that administration.

16(2) The full ITU Guideline: Sample Assessment Table

Current Spectrum Allocation & Usage as well as Future Trends

Aspects of spectrum use	Points to check and report
National Table of Frequency Allocations and if exists, associated Table of Frequency Use	Has an NTFA and Table of Frequency Use been developed? Are they separate or combined? What is the level of detail? How well has it been implemented?
Rational division of spectrum between major uses	How is spectrum divided between government and non-government use and how is spectrum provided for major uses such as aeronautical, maritime, public telecommunications, broadcasting?
Orderly use of frequency bands	Are channelling arrangements in use? Are "spectrum management parameters" of equipment specified (by applicable standards or other methods of specifying minimum performance requirements)?
Availability of statistical information on existing spectrum (actual) use.	Statistics should be available from assignment records. Information can be obtained from stakeholder interviews. Are there spectrum congestion problems (services, bands, areas)?
Strategic policies for future spectrum use	What plans are in place to deal with congestion or the introduction of new technology?
Availability and regular update of Spectrum Management Masterplan.	Is Spectrum Management Masterplan available and when was it last updated
Defence use	Approx amount of spectrum
Broadcasting	Approx amount of spectrum
Public mobile systems (cellular radio)	Approx amount of spectrum
Point-to-point links (microwave networks)	Approx amount of spectrum
HF radio	Approx amount of spectrum

National Table of Frequency Allocations (NTFA) preparation

Contents

1 (1) Introduction

The Radio Spectrum	➢ **A major national asset** ➢ **Competing demands** ➢ **International obligations** ➢ **Harmonization**
National Spectrum Policies	➢ Conform to ITU Radio Regulations ➢ Meet national objectives
NTFA	➢ Outcome of national spectrum plan ➢ High level approval (government) ➢ Several levels of detail

1 (2) Introduction

- With changes in regulatory and technical approaches to spectrum management

  i.e. Administrative control >>>>> Market freedom

- Do we still need an NTFA? >>>>> YES!!

  - Regulators, Industry, Operators, General Users etc. need a publicly available, clear plan of the current and proposed national use of the spectrum

2 (1) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

RR General Scope

- Legal instrument for international coordination of spectrum use
- Provisions binding on ITU Member States
- Frequency sharing between services
- Use of satellite orbits
- Recognition of spectrum use and protection from harmful interference
- Revised by World Radio Conferences (WRC-15)

2 (2) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

- RR are compiled in 4 Volumes (and a Set of Maps), as follows:
  - VOLUME 1: Articles (59)
  - VOLUME 2: Appendices (22)
  - VOLUME 3: Resolutions (151) and Recommendations (24)
  - VOLUME 4: ITU-R Recommendations incorporated by reference (39)
  - MAPS: Set of Maps for App. 27 (Aeronautical mobile (R))
- Rules of Procedure (RoPs): explain or clarify the way in which the provisions of the RR are to be applied. RoPs are adopted by the Radio Regulations Board (RRB)

2 (3) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

- **Key Definitions (Services and Stations)**
- ***1.3 Telecommunication:*** Any transmission, emission or reception of signs, signals, writings, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems
- ***1.5 Radio waves (or hertzian waves):*** Electromagnetic waves of frequencies arbitrarily lower than 3000 GHz, propagated in space without artificial guide
- ***1.19 Radiocommunication service:*** A service involving the transmission, emission and/or reception of radio waves for specific telecommunication purposes
- ***1.61 Station:*** One or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunication service, or the radio astronomy service

2 (4) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

- RR classifies services that use radio communications, according to several parameters, namely:
  - Link type: Terrestrial (earth to earth) or satellite (earth-satellite, satellite-earth, satellite-satellite)
  - Type of coverage: land, maritime, aeronautical
  - Station type: fixed, mobile
  - Type of use: communications, broadcasting, navigation and associated, meteorological, scientific, earth observation, time standard, astronomy, security, special.
- It also defines the different types of radio stations, classified as:
  - Terrestrial space
  - Land, sea, air
  - Fixed, mobile
  - Broadcasting, amateur radio, radio-astronomy, etc
- 41 types of services and 53 types of stations (more stations than services, as some stations simultaneously involve several services)

2 (5) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

Key Definitions (Frequency Management)

- ***1.16 allocation (of a frequency band):*** Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned
- ***1.17 allotment*** (of a radio frequency or radio frequency channel): Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radiocommunication service in one or more identified countries or geographical areas and under specified conditions.
- ***1.18 assignment*** (of a radio frequency or radio frequency channel): Authorization given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions

2 (6) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

Key Definitions (Frequency Management)

Other concepts related to Spectrum Management :

- Although not explicitly defined, in the RR when dealing with band allocations (Art. 5), the use in footnotes of expressions: "*identified*" and "*designated*" express the interest/intention of some administrations on a future use of that band for a specific application; that in benefit of a mid and long term harmonization of the use of that band.
- such designations/identifications in the international Table do *not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations*. However, they are a key element of worldwide or regional spectrum harmonization.

2 (7) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

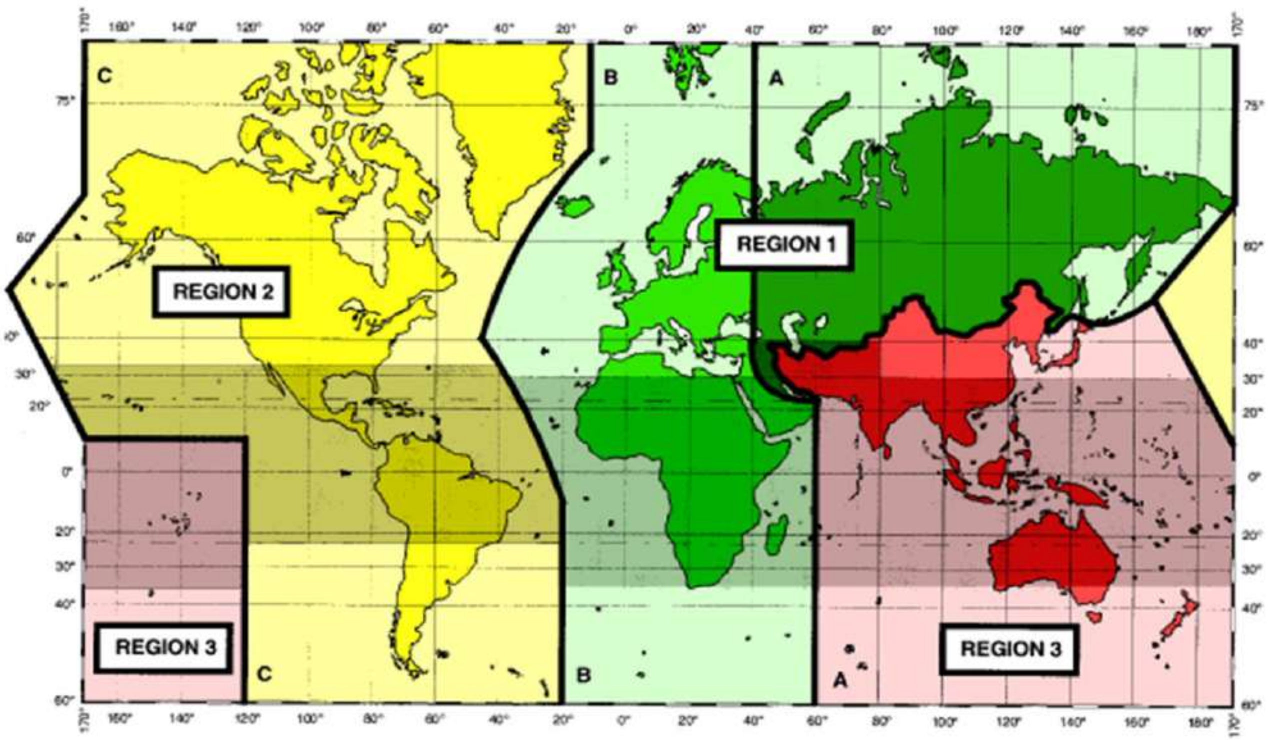
Key Definitions (Categories of Services and allocations)

- When the same band is shared between several services, categories are established, as:
- **PRIMARY** (with capital letters): *Primary Basis* means that in accordance with the nature of a right granted to the assignee of a particular spectrum (band or spot frequency), the assignee is the only entity to use the identified spectrum and is entitled to protection from:
  - harmful interference caused by any other spectrum user who may be authorized to use same spectrum on secondary basis; and
  - claims of harmful interference by any such spectrum user
- **Secondary** (with lower case): *Secondary basis* means the nature of a right granted to the assignee of a particular spectrum (band or spot frequency), is subject to the condition that the entity does not cause any harmful interference to, or claim protection from any harmful interference caused by, other licensees who have been granted the right to use same frequency bands on primary or co primary basis.
- Primary services protection considers both present and future stations

2 (8) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

Key Definitions (RR Regions)

- Frequency bands are allocated to different services either worldwide (worldwide allocation) or regionally (regional allocation). The world is divided into th



2 (9) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

Key Definitions (Table of Frequency Allocations)

- an excerpt of Table allocations in the RR, illustrating the different features of the Table (Frequency range, Worldwide & Regional allocations, Services (PRIMARY & Secondary), Footnotes.

Allocation to services		
Region 1	Region 2	Region 3
495-505 MARITIME MOBILE		
505-526.5 MARITIME MOBILE 5.79 5.79A 5.84 AERONAUTICAL RADIONAVIGATION	505-510 MARITIME MOBILE 5.79	505-526.5 MARITIME MOBILE 5.79 5.79A 5.84 AERONAUTICAL RADIONAVIGATION Aeronautical mobile Land mobile
	510-525 MARITIME MOBILE 5.79A 5.84 AERONAUTICAL RADIONAVIGATION	

Region Column

Frequency range

footnote

Harmonized (common for 3 regions)

PRIMARY

Secondary

2 (10) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

RR and NTFA

The RR is an international Treaty, applicable to all ITU Member States, therefore the NTFA must be consistent with the RR. However, it also has to respond to national interests and needs in relation to spectrum usage. Some relevant considerations in this regard are as follows:

- ***Inclusion of Footnotes of the RR:*** NTFA might contain a different allocation than those in the RR Allocations table (Art. 5) basically: a) additional allocation (adding more services); b) different (alternative) allocations (allocating to other different services instead); c) change categories to allocated services (different categories).

  As these differences were accepted by the competent WRCs and included in the RR, they enjoy international recognition (with the limitations contained in the respective footnote).

2 (11) The ITU Radio Regulations Article 5: Definition of Terms and Table of Frequency Allocations

RR and NTFA

- ***Choice of allocations***: In most frequency bands, the RR leaves the flexibility to each country to exercise a choice between several allocations. Often, this choice has to be exercised because the corresponding services would be incompatible over the same territory (e.g. broadcasting and mobile IMT). Alternatively, the NFTA may split the band into sub-bands, each allocated to one or more of those services already allocated in the RR.
- ***Worldwide and regional harmonization****:* In order to benefit from economies of scale, interoperability and facilitate equipment compliance, worldwide and regional harmonization needs to be followed, wherever possible. In this regard, the NTFA should also include details on which particular standard or detailed "Band Plan" (or channel Plan) is applicable in the country for a given allocation, consistent with this harmonization. This information may be included in Annexes to the NTFA
- ***Technology neutrality***: In order to keep flexibility in adopting new and more efficient technologies, it is preferable to avoid mandating specific technologies for the use of a specific allocation.

3 (1) International and National spectrum management frameworks

- **Spectrum management: levels of authority**

International (worldwide level)

- The international framework for the use of the radio frequency spectrum is set out in a treaty – *the Radio Regulations* - ratified by the Member States of the International Telecommunication Union (ITU), a specialized UN agency.

International (regional level) (*Note: not ITU region*)

- Regional Telecommunication Organizations have been established (usually) by administrations to develop harmonization measures intended to facilitate free movement of telecommunication equipment and services within the region and to offer industry and operators the economies of scale through a larger market with common requirements.

3 (2) International and National spectrum management frameworks

Spectrum management levels of authority

- **National (allocation level)** by an *administration* established by a national legislative framework. Recognised by the ITU as responsible for ITU obligations (CS, CV & AR). These obligations include management of the radio spectrum. The administration may be a Government ministry, or an independent regulator operating under a legislative mandate or policy guidelines. The administration establishes: a National Table of Frequency Allocations which sets out what radio services can use which frequency bands and under what conditions; national consultative procedures to prepare national requirements and positions for WRCs and harmonization by regional organizations.
- **National (assignment level)** Assigning a particular frequency (or groups of frequencies) to users (stations) is the detailed level of national spectrum management. The methods used may be administrative, market-based or some spectrum may be reserved for licence-exempt systems. Technical conditions for frequency use may vary widely, from reserving particular frequencies for specific uses with detailed technical requirements (for example: channel plans, equipment standards and assignment criteria), to allowing considerable flexibility in spectrum use for particular bands or services with light technical requirements (e.g. a simple spectrum mask).

4 (1) The Essential Requirements for effective National Spectrum Management

Legal Basis for Spectrum Management

- The legal basis for the regulation of the spectrum is set out in *Primary* legislation with associated detailed regulations. Legislation should set out such things as definitions, powers of the Minister or head of the spectrum regulatory authority, the powers of others involved in spectrum regulation, offences and penalties and the organizational structure and framework for regulation of the spectrum.
- *Secondary* legislation can be used to allow the regulatory authority to issue or revise regulations without changing primary legislation.
- The primary telecommunications legislation should require and authorise the administration to establish a National Table of Frequency Allocations. However, some countries do not include the NTFA itself in the primary legislation.

4 (2) The Essential Requirements for effective National Spectrum Management

Institutional Organisation of Spectrum Management

- The choice of national authority for spectrum management will depend on overall government policy on national regulatory arrangements. For example, the authority might be a government ministry or an independent regulator; the ministry might be responsible for policy decisions and the regulator for executive matters; often, there are separate authorities for government and non-government radio use.
- Whichever organisational option is used, there should be a single organisation with the overall authority to represent the country as the *administration* at the ITU.
- A *senior level* spectrum policy & strategy committee should be established to consider and agree major national spectrum allocation strategy and policy issues with the aim of ensuring spectrum use supports overall national objectives and achieves a rational balance between government and non-government use.
- Government spectrum users, major telecommunication operators, telecom manufacturing industry, broadcasters, spectrum user groups etc should be represented, at least in working groups of the policy and strategy committee.

4 (3) The Essential Requirements for effective National Spectrum Management

Consultation with major spectrum stakeholders

- Consultation with stakeholders is essential in virtually every aspect of spectrum management, including the development of national legislation and regulations, spectrum policies, technical standards, etc.
- effective consultations can take place by also allowing associations or bodies representing groups of users to contribute.
- it is important that the spectrum regulator's proposals be made public.
- meetings are held between the spectrum regulator and relevant stakeholders. The Internet has increasingly become a standard tool to maximise the effectiveness of consultations.
- minimal guidelines should be set, such as allowing for a given period of time, with a deadline by which comments must be submitted.
- transparency and fairness are paramount.

4 (4) The Essential Requirements for effective National Spectrum Management

National Spectrum Control and Enforcement

- National laws and regulations are useless unless the administration has the legal power and practical means to monitor whether actual spectrum use is in accordance with those laws and regulations and to take effective action against violations.
- national spectrum monitoring capability to obtain information on spectrum use and gather evidence of illegal activity to support subsequent legal action against offenders.
- unlicensed transmissions or operation that does not conform to the conditions of a licence.
- obligation to ensure all emissions from the country conform to the Radio Regulations and do not cause harmful interference to the services of other countries

5 (1) National Spectrum Planning and the National Table of Frequency Allocations (NTFA)

Principles and objectives

- The NTFA is the published outcome of national spectrum planning.
- National spectrum planning should be one of the duties of the spectrum policy and strategy committee, including setting up regular reviews, in particular as part of the preparations for ITU radio conferences.
- Direct relationship between effective planning of the spectrum resource through the continuous review of NTFAs and the economic impact of national spectrum use through an effective and efficient spectrum allocation, consistent with international spectrum harmonization.
- Ensure technical compatibility but also *provide the legal/regulatory basis for maximizing economic output from the utilization of the spectrum resource in the particular context of the corresponding country.*

5 (2) National Spectrum Planning and the National Table of Frequency Allocations (NTFA)

National choices

- Using the international Table of Frequency Allocations as the source document, work through each frequency band to decide which service allocations are required nationally and, in the case where there is more than one organisation responsible for frequency assignments (for example government and non-government use), decide how frequency bands (or parts of frequency bands) should be shared between the organisations concerned.
- Flexibility is possible with national allocations while maintaining conformity with the Radio Regulations. For example, only those international footnotes relevant to the country need to be applied as national footnotes. Also, in cases where, in the RR, a frequency band is allocated to several services, an administration may select which of those services may operate in its territory (choosing one or several) or may decide to split the band into sub-bands, each allocated to one or more services allocated in the RR.

6 (1) National Spectrum Planning and the National Table of Frequency Allocations (NTFA)

National Table of Frequency Allocations – structure

- NTFA is a method for presenting the national spectrum plan in an easily understandable (tabular) format.
- NTFA is derived from the international table of frequency allocations (Art. 5 of RR), the same tabular structure is used as it may easily be adapted to show national allocations, simply by inserting additional columns.

The following generic example of a simple NTFA demonstrates the basic structure >>

6 (2) National Spectrum Planning and the National Table of Frequency Allocations (NTFA)

Generic example of a simple NTFA

kHz

Allocation to Services			National Allocation	
Region 1	**Region 2**	**Region 3**	**Frequency and Service**	**Use**
4 063-4 438 MARITIME MOBILE 5.79A 5.109 5.110 5.130 5.131 5.132 *5.128*			4063-4438 Maritime Mobile 5.79A 5.109 5.110 5.130 5.131 5.132	G
4 438-4 488 FIXED MOBILE except aeronautical mobile (R) Radiolocation 5.132A	4 438-4 488 FIXED MOBILE except aeronautical mobile (R) RADIOLOCATION 5.132A	4 438-4 488 FIXED MOBILE except aeronautical mobile Radiolocation 5.132A	4 438-4 450 FIXED	G
			4 450-4 460 MOBILE except aeronautical Mobile	NG
			4 460-4 488 Mobile except aeronautical Mobile RADIOLOCATION 5.132A	S (Mobile NG) (Radiolocation G)

G=Government; NG=Non-Government; S=Shared

7 National Frequency Use Information

- Considerably more detailed planning is required at the national assignment level and this can be provided by a National Table of Frequency Use as a separate companion to, or as part of, the NTFA. For example:
- Detailed information about the assignment of frequencies or blocks of frequencies to different types of system (channelling plans)
- Technical conditions for frequency access (e.g. power, bandwidth)
- Licensing conditions for frequency access (individual licence, licence exempt etc)
- Future re-allocations (repurposing) as a result of long term planning: *Assignment freezing; Reallocation roadmap*

8 (1) Practical steps to develop a country's first NTFA

- Countries that are in the preliminary stages of introducing spectrum management may have to start with no spectrum plan. In this case, an outline NTFA can provide a helpful map to enable a logical approach to deciding how to allocate spectrum to services to meet national requirements.

- An example procedure is described in the next slides:

8 (2) Practical steps to develop a country's first NTFA

- Using the international allocation table, construct a draft NTFA by selecting the allocation "column" for the Region concerned as the base
- Identify and add all footnotes relevant for the Region and country concerned
- Identify and "reserve" in the draft NTFA the frequency bands used by all major "international" services, systems or applications which are already in use or are likely to be used in the country
- Identify and "reserve" in the draft NTFA all allocations which would be difficult to use without causing interference to (or receiving interference from) services in other countries operating in accordance with the Radio Regulations, even though such services might not be used in the country concerned
- Collect information on existing national frequency use.

8 (3) Practical steps to develop a country's first NTFA

❖ **Examples of major "international" services, systems or applications:**

- International services for maritime and aeronautical
- Public mobile communications systems
- Broadcasting (especially if there is an ITU Regional Allotment Plan)
- Fixed services – use ITU-R recommended frequency arrangements
- Non-public mobile systems. Unfortunately there are no ITU recommended channel arrangements, so it will be necessary to consider examples from other countries in the Region concerned and adopt the most common and comprehensive plans
- Fixed and mobile satellite bands, (especially if there is an Allotment Plan)
- Public protection and disaster relief radiocommunication systems (see Recommendation ITU-R M.2015)
- Radionavigation and Radiolocation

8 (4) Practical steps to develop a country's first NTFA

❖ **Examples of allocations or frequencies which would be difficult to use without causing interference to (or receiving interference from) services or systems in other countries operating in accordance with the Radio Regulations, even though such services might not be used in the country concerned:**

- Primary Amateur Radio allocations
- Radio astronomy (especially frequency bands where all emissions are prohibited)
- Frequencies used for Industrial Scientific and Medical applications
- Frequencies used for Short Range Devices. See ITU-R Recommendation SM.1896: Frequency ranges for global or regional harmonization of short-range devices (SRDs)

8 (5) Practical steps to develop a country’s first NTFA

❖ Identification of existing national use

- Potential sources of information on existing national use: existing licensing and assignment records; request users to provide information from their own records.
- If some form of monitoring capability is available, especially mobile monitoring, it may be used to verify existing records of spectrum use. Where records are poor or non-existent, monitoring can be used to determine actual frequency use, including finding transmitter locations and control points by direction finding.
- When existing national use is added to the draft NTFA, it is most likely that some will not conform to the Radio Regulations or will be using frequencies within frequency bands identified for the “international” services and applications identified in the previous slides. A transition plan should be prepared for the migration of non-conforming use to the new plan.

8 (6) Practical steps to develop a country's first NTFA

- Once the draft NTFA has been "populated" with the allocations and frequencies identified, the spectrum policy and strategy group can decide on a rational distribution of the spectrum between government and non-government uses.
- The spectrum for government use may be further sub-divided for particular departments: Defence; Transport (Maritime, Aeronautical) etc.
- The spectrum for non-government use may be considered for channelling arrangements, technical use conditions and licensing regimes

9 Publishing the NTFA and National Frequency Use Tables

- With increasing global telecommunications and liberalization of telecommunications markets, it has become a necessity to publish the NTFA as an aid to investment and market planning.
- An on-line NTFA can provide:
  - a public electronic record which is readily available and with timely updating;
  - a tool for identifying and flagging future modifications to the NTFA, for newly-planned bands and/or services;
  - clear information about the actual use versus allocation of any particular band (in cases of public safety, defence and other restricted government use, these can be simply labelled as “government use” for example);
  - a source of online information that can be used to generate important statistics/analytics on spectrum use.

10 Regional co-operation in presenting National Frequency Allocation Tables

❖ There is considerable regional co-operation and harmonization in spectrum management. This has resulted in regional telecommunications organizations providing “one-stop-shop” frequency allocation and use information systems.

Examples:

- The Inter-American Telecommunication Commission (CITEL) provides a Spectrum Allocation Database and a Mobile Services Database
- Southern African Development Community (SADC) countries have a Frequency Allocation Plan (SADC FAP)
- The Asia-Pacific Telecommunity (APT) has a Frequency Information System (AFIS)
- European Conference of Postal and Telecommunications Administrations (CEPT) has the ECO Frequency Information System (EFIS)

Generic contents list for NTFA document

FAT		RR REFERENCE
Chapter 1	Meaning of abbreviations	
	Terms and definition	
	General terms	RR 1.2 – 1.15
	Frequency management	RR 1.16-1.18
	Radiocommunication services	RR 1.19-1.60
	Radio stations and systems	RR 1.61- 1.115
	Operational terms	RR 1.116-1.136
	Characteristics of emissions and radio equipment	RR 1.137-1.165
	Frequency sharing	RR 1.166-1.176
	Technical terms relating to space	RR 1.177-1.191
Chapter 2	Frequency bands	RR 2.1-2.2
Chapter 3	Technical characteristics of stations	RR 3.1-3.14
Chapter 4	Assignment and use of frequencies	
	General rules for assignment and use of frequencies	RR 4.1-4.9
Chapter 5	Frequency allocations	RR 5.1-
	Regions and areas	RR 5.2-5.9
	Categories of services and allocations	RR 5.23-5.44
	Footnotes of RR	RR 5.53-5.565
	Plan of Frequency Bands Allocations in the [*Country*] (National Frequency Table)	National footnotes and general information

Example 1: Moldova

- A simple table showing direct alignment with ITU and simple categorisation of usage (P=shared)

Region 1	National allocation		
Frequency band – services - footnotes	Frequency band - services	Footnotes	Usage
143.65 - 144 MHz AERONAUTICAL MOBILE (OR) 5.210, 5.211, 5.212, 5.214	143.65 - 144 MHz AERONAUTICAL MOBILE (OR)	RN018, RN035	G
144 - 146 MHz AMATEUR AMATEUR-SATELLITE 5.216	144 - 146 MHz AMATEUR AMATEUR-SATELLITE	RN018, RN035	NG
146 - 148 MHz FIXED MOBILE except aeronautical mobile (R)	146 - 148 MHz FIXED MOBILE except aeronautical mobile (R)	RN018, RN018A, RN018B, RN035	G
148 – 149.9 MHz FIXED MOBILE except aeronautical mobile (R) MOBILE-SATELLITE (Earth-to-space) 5.209 5.218, 5.219, 5.221	148 - 149.9 MHz FIXED MOBILE except aeronautical mobile (R) MOBILE-SATELLITE (Earth-to-space)	5.209, 5.218, 5.219, 5.221 RN018, RN018A, RN035	G
149.9 – 150.05 MHz RADIONAVIGATION-SATELLITE 5.224B MOBILE-SATELLITE (Earth-to-space) 5.209, 5.224A 5.220, 5.222, 5.223	149.9 - 150.05 MHz RADIONAVIGATION-SATELLITE MOBILE-SATELLITE (Earth-to-space)	5.209, 5.220, 5.222, 5.223, 5.224A, 5.224B RN018, RN018A, RN035	P
150.05 - 153 MHz FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY 5.149	150.05 - 153 MHz FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY	5.149 RN018, RN018A, RN019, RN035	P
153 - 154 MHz FIXED MOBILE except aeronautical mobile (R) Meteorological Aids	153 - 154 MHz FIXED MOBILE except aeronautical mobile (R) Meteorological Aids	RN018, RN018A, RN019, RN035	P
154 - 156.4875 MHz	154 - 156.4875 MHz	5.226,	P

Example 2: Bahrain

- Somewhat more comprehensive providing more details of utilisation and some additional information

Frequency Allocation	ITU RR allocations for Region 1	National Allocations for Kingdom of Bahrain	Major utilization in Kingdom of Bahrain	Additional Information
1 710- 2 025 MHz	1 710-1 930 FIXED MOBILE 5.384A 5.388A 5.388B 5.149 5.341 5.385 5.386 5.387 5.388	1 710-1 930 FIXED MOBILE 5.384A 5.388A 5.388B 5.149 5.341 5.385 5.388	Public fixed and mobile GSM1800 IMT candidate band (1710-1885 MHz) Op1 1735-1760 / 1830-1855 MHz, Op2 1780-1785 / 1875-1880 MHz GSM Guard band 1790 - 1795 MHz DECT 1880-1900 MHz IMT2000	1710-1785 MHz paired with 1805-1880 MHz 3rd mobile licence incl GSM1800 – 2x15 MHz IMT2000 TDD 1900-1920 MHz FDD 1920-1930 / 2110-2120 MHz
	1 930-1 970 FIXED MOBILE 5.388A 5.388	1 930-1 970 FIXED MOBILE 5.388A 5.388	Public fixed and mobile IMT2000 (FDD) 3 operators each with 2x15 MHz FDD & 5 MHz TDD	IMT2000 FDD 1930 – 1970 / 2120 – 2160 MHz
	1 970-1 980 FIXED MOBILE 5.388A 5.388	1 970-1 980 FIXED MOBILE 5.388A 5.388	IMT2000 (FDD)	IMT2000 FDD 1970 – 1980 / 2160 – 2170 MHz
	1 980-2 010 FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) 5.351A 5.388 5.389A 5.389B 5.389F	1 980-2 010 FIXED MOBILE MOBILE-SATELLITE (Earth-to-space) 5.351A 5.388 5.389A 5.389B 5.389F	IMT2000 space segment	
	2 010-2 025 FIXED MOBILE 5.388A 5.388B 5.388	2 010-2 025 FIXED MOBILE 5.388A 5.388B 5.388	IMT2000 (TDD)	
2 025- 2 200 MHz	2 025-2 110 SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION-SATELLITE (Earth-to-space) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (Earth-to-space) (space-to-space) 5.392	2 025-2 110 SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION-SATELLITE (Earth-to-space) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (Earth-to-space) (space-to-space) 5.392	Government mobile	

Example 3: USA

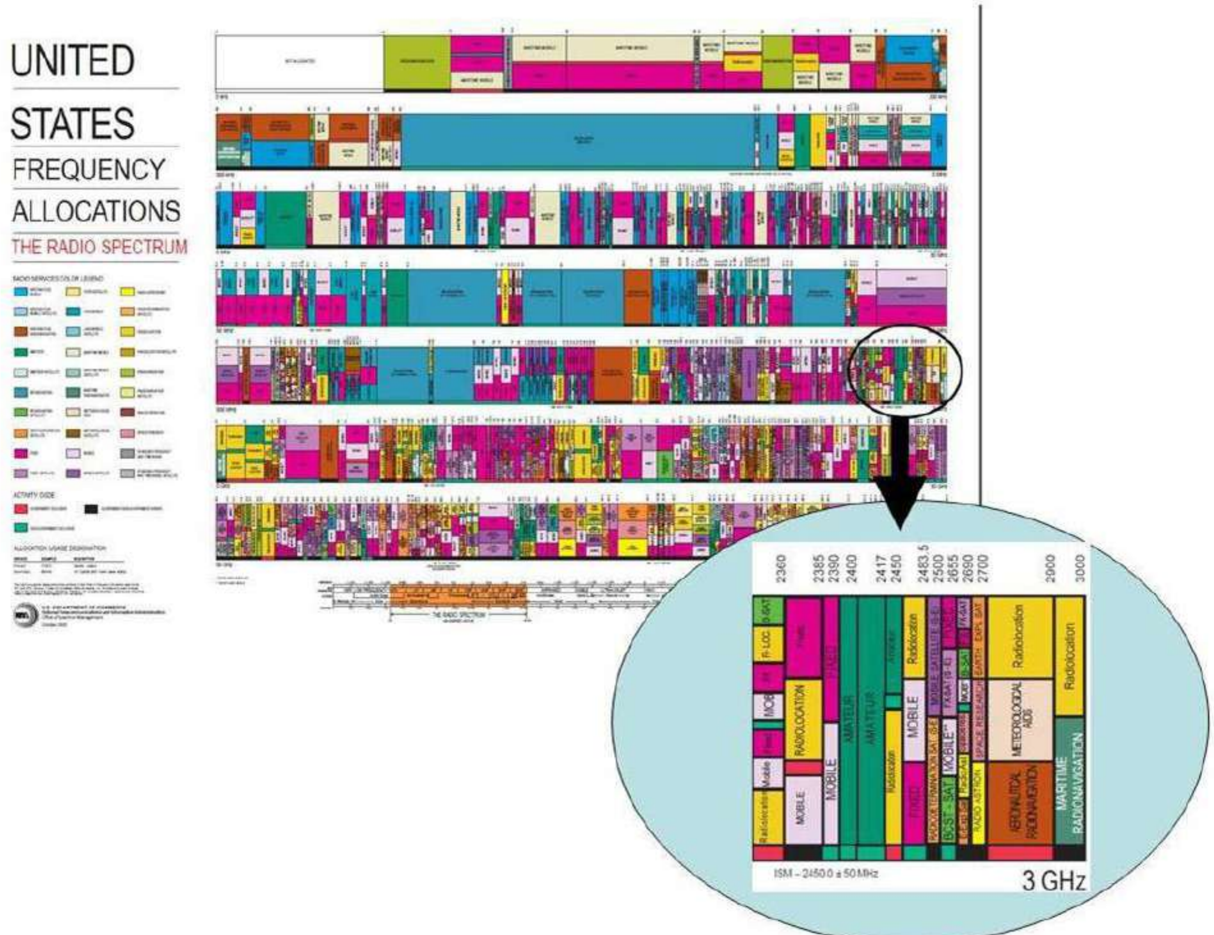
- A slightly different arrangement split between Federal (Government) and non-Federal. Helpful identification of any FCC rules that apply to the band

Table of Frequency Allocations — 2200-2655 MHz (UHF) — Page 37

International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
2200-2290 SPACE OPERATION (space-to-Earth) (space-to-space) EARTH EXPLORATION-SATELLITE (space-to-Earth) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (space-to-Earth) (space-to-space) 5.392			2200-2290 SPACE OPERATION (space-to-Earth) (space-to-space) EARTH EXPLORATION-SATELLITE (space-to-Earth) (space-to-space) FIXED (line-of-sight only) MOBILE (line-of-sight only including aeronautical telemetry, but excluding flight testing of manned aircraft) 5.391 SPACE RESEARCH (space-to-Earth) (space-to-space) 5.392 US303	2200-2290 US303	
2290-2300 FIXED MOBILE except aeronautical mobile SPACE RESEARCH (deep space) (space-to-Earth)			2290-2300 FIXED MOBILE except aeronautical mobile SPACE RESEARCH (deep space) (space-to-Earth)	2290-2300 SPACE RESEARCH (deep space) (space-to-Earth)	
2300-2450 FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.395	2300-2450 FIXED MOBILE 5.384A RADIOLOCATION Amateur 5.150 5.282 5.393 5.394 5.396		2300-2305 G122	2300-2305 Amateur	Amateur Radio (97)
			2305-2310 US97 G122	2305-2310 FIXED MOBILE except aeronautical mobile RADIOLOCATION Amateur US97	Wireless Communications (27) Amateur Radio (97)
			2310-2320 Fixed Mobile US339 Radiolocation G2 US97 US327	2310-2320 FIXED MOBILE US339 BROADCASTING-SATELLITE RADIOLOCATION 5.396 US97 US327	Wireless Communications (27) Aviation (87)
			2320-2345 Fixed Radiolocation G2 US327	2320-2345 BROADCASTING-SATELLITE 5.396 US327	Satellite Communications (25)
			2345-2360 Fixed Mobile US339 Radiolocation G2 US327	2345-2360 FIXED MOBILE US339 BROADCASTING-SATELLITE RADIOLOCATION 5.396 US327	Wireless Communications (27) Aviation (87)
			2360-2390 MOBILE US276 RADIOLOCATION G2 G120 Fixed US101	2360-2390 MOBILE US276 US101	Aviation (87) Personal Radio (95)
			2390-2395 MOBILE US276 US101	2390-2395 AMATEUR MOBILE US276 US101	Aviation (87) Personal Radio (95) Amateur Radio (97)

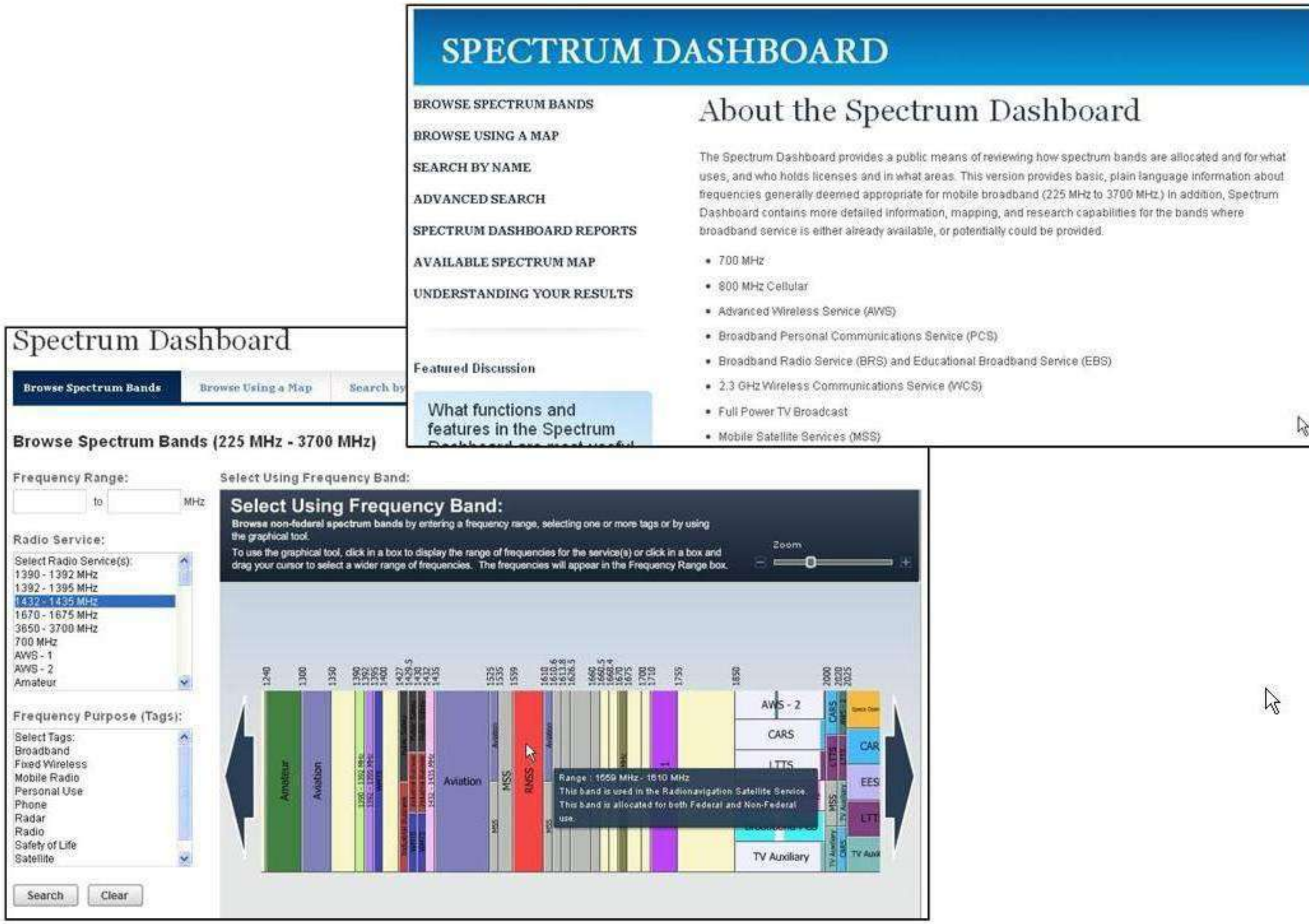
Example 4: Graphical Representation

Useful for public consumption and a quick overview of the use of the radio spectrum



Online system - US

The US spectrum dashboard is a recent initiative to make much more information publicly available and searchable



UK FAT

- Like other NRAs Ofcom publish a FAT. Here we look into a part of it in detail to understand some of the issues

UNITED KINGDOM

FREQUENCY ALLOCATION TABLE

2013

Issue No. 17

Including
The International Telecommunication Union Table of Frequency Allocations contained in the current Radio Regulations

Issued by the National Frequency Planning Group on behalf of the Committee on UK Spectrum Strategy

Summary

- The NTFA is a core element of the national use of radio spectrum and will be one of the most important documents for the NRA
- Most countries adopt a similar format, using the RRs as a template and then showing the national use alongside this
- It can be helpful to provide informative notes, cross-references and footnotes so that most of the activities of the NRA can be “hung from” the NTFA
- Developing the NTFA is a large undertaking and once produced it will need regular updates
- Most NRAs now make the NTFA available on-line both as a published document and sometimes as a searchable database

Spectrum Management Master Plan

SM Master Plan Project

- **Increasing need of efficient spectrum management**
  - Many countries adopted new approaches: unified licensing, market based spectrum allocation, technical neutrality, cognitive radio systems
  - Requires resources and skills to update national spectrum management frameworks
- **ITU-D Global Objective**
  - ***WTDC-14 Dubai Action Plan Objective 2:*** To foster an enabling environment for ICT development and foster the development of telecommunications/ICT networks, including enhancing awareness and capability of countries in the fields of spectrum planning and assignment, spectrum management and radio monitoring
- **MSIP Korea project** for ASP and Caribbean on developing SM Masterplan
- **ITU and MSIP formulated the scope** of activities and conducted a Spectrum Management profiling survey of the countries from ASP and Caribbean)

Thank you!

PRIDA Track 1 (T1)

Spectrum Management Master Plans in ASP and Caribbean

Online training, 23 April 2020

SPECTRUM MANAGEMENT IN THE COUNTRIES OF ITU-BDT/KOREAN PROJECT

1. **Initiators:** Partnership of ITU and Ministry of Science, ICT and Future Planning of the Republic of Korea
2. **Period:** 2014 – 2016
3. **Background:**
   - ❑ WTDC-2014 Objective 2 – ICT Infrastructure Development; priority areas of the Program 1 – Spectrum Management.
   - ❑ Asia-Pacific Regional Initiative 5 – Telecommunication/ICT policy and regulation in the Asia-Pacific region.

4. **Scope:**
   - ❑ Assistance to regulators in assessing, reviewing and developing new spectrum management (SM) framework.
   - ❑ Building human capacity and competency in spectrum management.
   - ❑ Development of Spectrum Management Master Plans.

Asia-Pacific Region Countries

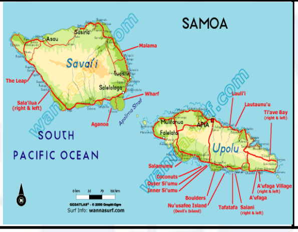
Bangladesh

Thailand

Brunei Darussalam

Pakistan

Samoa

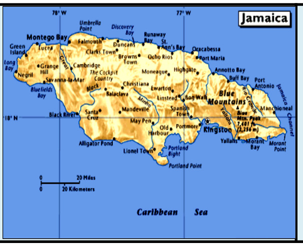


Vietnam

Fiji

Caribbean Islands Countries

Jamaica



Grenada

St. Vincent And Grenadines

Criteria for Assessing Current Situation in Spectrum Management

1. Establishing and maintaining SM entity responsible for administering the radio spectrum in the public interest.	**6.** Adopting decisions that are technologically neutral and allow for evolution to new radio applications.
2. Promulgation of mature primary legislation in SM.	**7.** Imposing spectrum charges ensuring the optimal use of scarce resources to foster the development of innovative services and competition.
3. Promulgation of mature secondary legislation (statutory instruments) in SM.	**8.** Encouraging radio communications policies leading to flexible spectrum use, including transfer of spectrum usage rights.
4. Making national frequency allocation plans and frequency assignment data public to encourage openness and to facilitate development of new radio technologies.	**9.** Adopting sustainable regulation with regard to spectrum reallocation and re-farming.
5. Harmonizing, as far as practicable, effective domestic and international spectrum policies.	**10.** Adopting sustainable regulation with regard to spectrum sharing.

Establishing and maintaining SM entity responsible for administering the radio spectrum in the public interest	**Regulatory Entity in Charge of Spectrum Management**
	SM entity either separate or as a part of telecommunication authority should be created. Independence of spectrum regulator should be provided in two ways: 1) Independence from any operator, service provider, and investors. 2) Independence from the Government. It must be able to adopt independent decisions based on technical, economic, social, financial, rather than political considerations and should manage its own staff without excessive interference from the Government.

Countries Under Consideration

Achieved	Grenada, St. Vincent and Grenadines, Pakistan	No particular actions required
Largely Achieved	Vietnam, Thailand, Brunei Darussalam, Samoa	There are still outstanding issues to align after transition to independent/converged model
Partly Achieved	Fiji, Jamaica, Bangladesh	Actions to establish standalone/converged regulator should be further undertaken
Not Achieved	–	–

Promulgation of mature primary legislation in SM

Primary Legislation in Spectrum Management Area

Primary legislation is a basic set of provisions establishing legal basis to govern spectrum usage, coordinating it among parties involved and providing relevant national policy together with specific regulations.

In some countries, the provisions related to SM are included in general telecommunications legal act. Usually it is the dedicated spectrum related chapter in national Telecommunications Law. It is more astute to proceed with the separate piece of legislation by adopting a Radiocommunications Act encompassing the full scope of SM aspects.

Countries Under Consideration

Achieved	Vietnam, Thailand, Pakistan	No particular actions required
Largely Achieved	Brunei, Grenada, St. Vincent and Grenadines, Bangladesh, Samoa	Some outstanding issues regarding rights and obligations of regulatory entities to be clarified.
Partly Achieved	Fiji, Jamaica	Current primary legislation complicates SM or not complies with the existing institutional structure of regulation.
Not Achieved	–	–

Promulgation of mature secondary legislation (statutory instruments) in SM

Subsidiary Legislation in Spectrum Management Area

Secondary legislation should embrace statutory instruments dealing with broad area of regulations and procedures such as radiocommunications regulations, regulations on operation of radio stations, or spectrum licensing regulations. A number of practical rules should also exist, including codes of practice, standards of performance, advisory guidelines, etc.

Countries Under Consideration

Achieved	Pakistan, Grenada, St. Vincent and Grenadines	No particular actions required
Largely Achieved	Vietnam, Fiji, Brunei Darussalam, Jamaica, Samoa	The detailed analysis of the required subsidiary legal instruments arising from new primary laws or innovations in institutionary structures should be performed.
Partly Achieved	Thailand, Bangladesh	Comprehensive secondary legislation should be adopted as a matter of urgency to improve current operational and regulatory practice.
Not Achieved	–	–

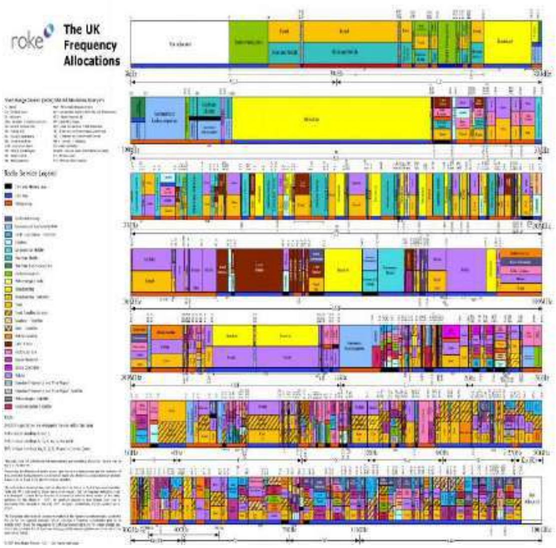
Making national frequency allocation plans and frequency assignment data public

Spectrum Allocation and Utilization Plans

National Frequency Allocations Table (NFAT) is a principal legal planning instrument in SM. Pursuant to primary legislation, SM authority should produce national frequency allocation plan and spectrum utilization plan legally binding on a regulator.

NFAT and spectrum utilization plan should be publically available in order to deliver essential information on the existing spectrum usage, as well as some future oriented information for specific frequency bands.

Countries Under Consideration



Achieved	Vietnam, Thailand, Pakistan	No particular actions required
Largely Achieved	Brunei Darussalam, Jamaica, Grenada, St. Vincent and Grenadines, Bangladesh, Samoa	Primary legislation need to include details on NFAT periodic modification.
Partly Achieved	Fiji	As the matter of urgency to update NFAT and provide spectrum utilization plan with the standard ITU format.
Not Achieved	–	–

Harmonizing, as far as practicable, effective domestic and international spectrum policies	Spectrum Management Harmonization Practices
	National SM practice should correlate with the requirements of international obligations primarily based on ITU Radio Regulations (RR). Regulators may also be bound by other obligations in its commitments to regional organizations or under bilateral or multilateral agreements. Preferably, specific international and national standards should be included in the national primary and secondary legislation in order to guarantee coordinated regulatory practices.

Countries Under Consideration

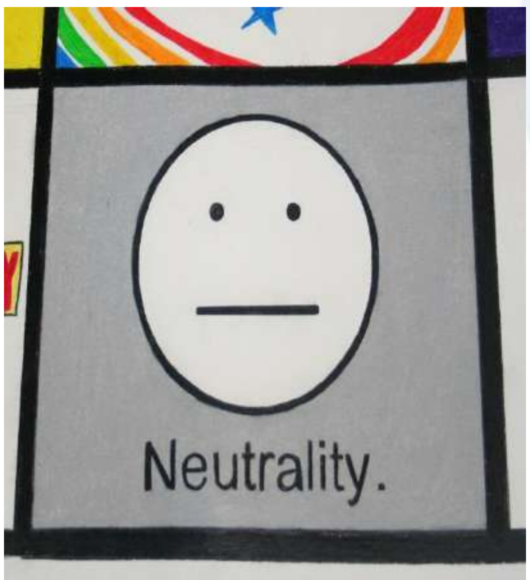
Achieved	Vietnam, Brunei, Grenada, St. Vincent and Grenadines, Jamaica, Pakistan	No particular actions required
Largely Achieved	Thailand, Fiji	Lack of regional efforts to establish structured approach to border coordination in some APT countries.
Partly Achieved	Bangladesh, Samoa	ITU notification and Regional coordination agreements should be developed as the matter of urgency
Not Achieved	–	–

Adopting decisions that are technologically neutral and allow for evolution to new radio applications

Technologically Neutral Regulation

Technological neutrality is the essential component in liberalization of SM regime. It allows licensees more discretion in the way they use spectrum that has been awarded to them. The licensee has the choice of technology to use in providing the specified type of services without seeking for permission from regulator. From its ideology, technological neutrality provides quicker adaptation of service supply to customers following the evolution of demand for these services. It also results in decreasing the costs of services supplied at the market.

Countries Under Consideration



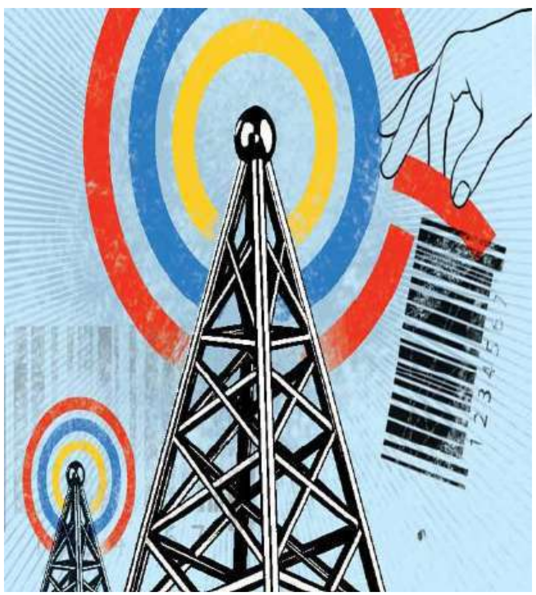
Achieved	–	–
Largely Achieved	Pakistan	Neutrality is stipulated by policy documents and is in implementation phase
Partly Achieved	Vietnam, Thailand, Brunei Darussalam, Jamaica, Samoa	The need to identify the licensing policy/subsidiary instruments that require amendments in view of technology neutral regulation
Not Achieved	Fiji, Grenada, St. Vincent and Grenadines, Bangladesh	Technology neutrality should be included in SM practice

Imposing spectrum charges ensuring the optimal use of scarce resources

Spectrum Pricing

Spectrum pricing should seek only to cover the administrative costs incurred in issuing, managing, control and enforcement of the individual licences. With scarce bands SM authorities should impose charges reflecting the need to ensure the optimal use of these resources.
Those charges should be non-discriminatory and take into account the need to foster the development of innovative services and competition.
Under no circumstances should SM entities consider spectrum charges to be the additional source of incomes to a Federal Budget.

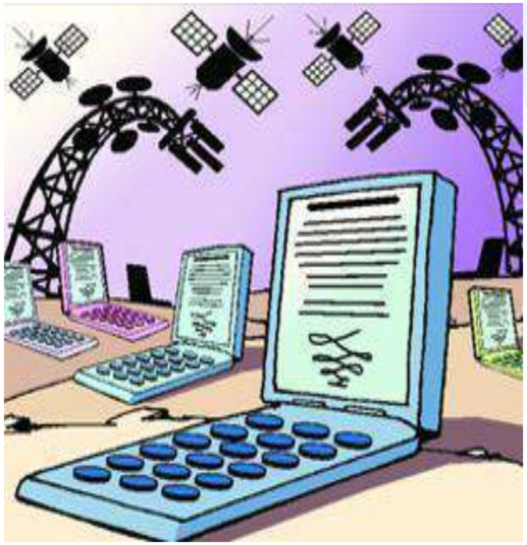
Countries Under Consideration



Achieved	–	–
Largely Achieved	Vietnam, Pakistan, Brunei Darussalam, Bangladesh, Samoa	Spectrum pricing framework established and can be updated based on implementation results.
Partly Achieved	Jamaica, Grenada, St. Vincent and Grenadines,	The economic methods should be introduced including the use of administrative incentive pricing.
Not Achieved	Thailand, Fiji	The review is urgent since the fee structure was adopted many years ago and it does not reflect the cost of managing the spectrum resources.

SM policy leading to flexible spectrum use, including transfer of spectrum usage rights.	Features
	Implementation of secondary trading provides greater flexibility, spectral efficiency, competition and an incentive to innovate and invest. It offers potential benefits to spectrum users in many ways, enabling them to buy, sell, lease, aggregate spectrum that would not be used. Trading enables operators to enter wireless market in those instances where they have not participated in a procedure for primary spectrum assignment. In order to provide efficient trading, spectrum rights of the users should be duly defined.

Countries Under Consideration



Achieved	–	–
Largely Achieved	Vietnam	Basic principles of transferring spectrum rights are included in legislation.
Partly Achieved	Fiji, Jamaica, Brunei Darussalam	Spectrum trading and rights are subjects of current legislation but not actively introduced.
Not Achieved	Thailand, Grenada, St. Vincent and Grenadines, Bangladesh, Pakistan, Samoa	Spectrum trading is out of the scope of legal basis and SM practices.

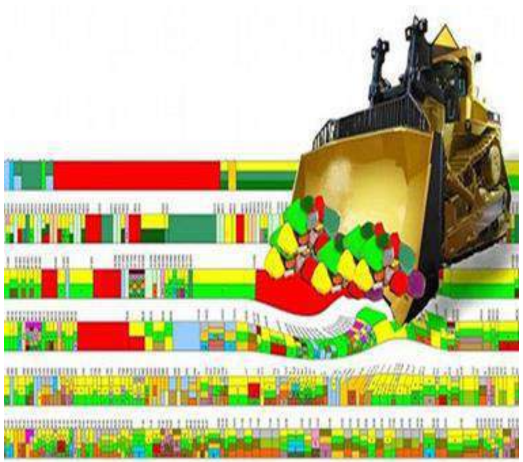
Adopting sustainable regulation with regard to spectrum reallocation and re-farming

Spectrum Reallocation and Re-farming

Modern SM should provide legal and procedural instruments to deal with spectrum reallocation and re-farming. The best cases demonstrate that regulators are including those aspects directly into the primary legislation. Sometimes the details of redeployment are defined through subsidiary legal instruments.

Reallocation is achieved typically by providing incumbents with alternative bands or incentivizing them with switching to wired technologies. The mechanism of compensations to incumbent users being subject to redeployment should be established.

Countries Under Consideration



Achieved	–	–
Largely Achieved	Pakistan	Basic principles of spectrum reallocation are included in legislation being in the implementation stage.
Partly Achieved	Vietnam, Thailand, Samoa	Although having some references current legislation does not provide the prescribed mechanism of spectrum re-allocation
Not Achieved	Fiji, Brunei Darussalam, Jamaica, Grenada, St. Vincent and Grenadines, Bangladesh	Spectrum reallocation is out of the scope of legal basis and SM practices. Need to be developed.

Adopting sustainable regulation with regard to spectrum sharing

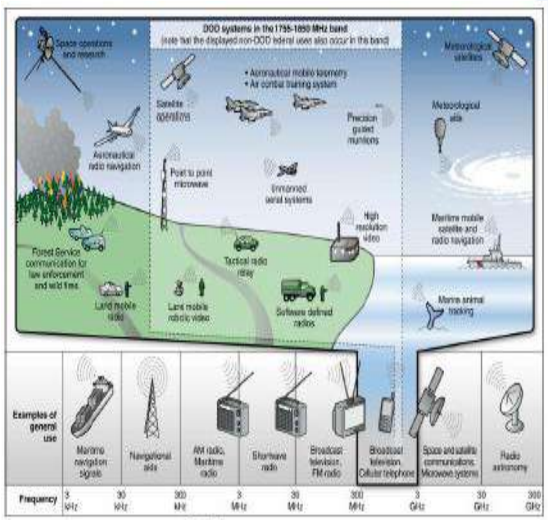
Spectrum Sharing

Spectrum sharing is the consequence of the combination of the increased demand for spectrum in key bands, and the recognition that much spectrum is heavily underused. New real-time technologies for sharing are now available which enable different users to respond dynamically to changing conditions of congestion.

Regulation should react on technological innovations making special arrangements for overlays and underlays, TVWS, dynamic spectrum access, licenced shared access etc.

Public-sector spectrum is the most amenable to change in this regard.

Countries Under Consideration



Achieved	–	–
Largely Achieved	Pakistan	Spectrum sharing is stipulated by policy documents and is in implementation phase
Partly Achieved	Vietnam, Samoa	The need to identify the primary/subsidiary legislation requiring amendments in view of spectrum sharing issues
Not Achieved	Thailand, Fiji, Brunei Darussalam, Jamaica, Grenada, St. Vincent and Grenadines, Bangladesh	Provisions on spectrum sharing should be included in SM legislation and practices

Conclusions and Recommendations

1. The countries covered by the Project have been analyzed on the subject of current SM regulatory framework. Achievements were classified in three categories following SM criteria chosen. Special attention of the majority of regulators under analysis should be drawn to Category 3.

Category 1. Largely Achieved	**Category 2. Partly Achieved**	**Category 3. Not Achieved**
Independent/converged SM regulator	Subsidiary SM legislation	Spectrum sharing
Primary SM regulation	Spectrum pricing	Spectrum reallocation and re-farming
Frequency allocation tables and utilization plans		Spectrum trading ands spectrum rights
Harmonization in SM regulation		Technologically neutral regulation in SM

2. Spectrum Management Master Plans (SMMP) have been developed, agreed and delivered to the National Radiocommunications Administrations of the countries covered by the Project. SMMP were supplemented with the recommendations on actions to be taken and vision on future utilization of the most valuable spectrum bands.

3. In defining future regulatory framework, national administrations should consider a set of factors influencing spectrum management:

- ❑ Further spectrum harmonization
- ❑ Flexible advanced radio technologies
- ❑ Further technological and service neutrality
- ❑ Enhanced licence-exempt usage
- ❑ Broad spectrum sharing
- ❑ Vital spectrum reallocation and re-farming
- ❑ Agile spectrum usage data bases
- ❑ Advanced spectrum engineering tools

Thank you!

PRIDA Track 1 (T1)

Cross-border frequency coordination

Online training, 23 April 2020

Why is coordination important? 1

- A major factor influencing the legal approach to spectrum management is the country's physical and human geography. The priorities and consequent investments and the management structure will vary depending on whether or not the country has neighbours (border coordination), is landlocked (the risk of radio link interference from ships at sea), covers a large or small area, has a high or low population density (saturation, organization of spectrum monitoring), is mountainous or covered in vegetation.
- The greater the level of radio usage then the more likely it will be that the spectrum management authority will require dialogue with neighbouring countries and the international radio community.

Why is coordination important? 2

- A small country at the heart of Europe (e.g. Luxembourg) cannot have a spectrum policy that is independent of those of its neighbours. That is not the case of island countries (Australia, New Zealand) or countries covering a large area, whose border areas may be sparsely populated and have reduced economic activity and hence low frequency use.
- Independence can limit the potential benefits of economies of scale and the capacity for interoperability associated with regional or global harmonization of frequencies.
- developing effective bilateral or multilateral agreements on frequency use in border areas will aid long-term strategic planning, promote efficient spectrum utilisation and help avoid interference

Why to coordinate

- Avoiding radio interference
- RR do not meet all practical requirements
  - It should be noted that according to the decision of WARC-79, cross border coordination of frequency assignments between stations by interested Administrations is excluded from the Radio Regulations. (but see also Article 6!)
- All administrations have sovereign right to use the spectrum on the whole territory of their countries. However radiowaves do not stop at the border of the country
- Possible harmful interference from the stations of different services of one administration into the territory and stations of neighbour (affected) administration.

Why to coordinate 2

- Each country obliged to take account of
  other stations before putting own into operation
- Even with technically similar systems from different sides of the border there could be different deployments goals in which one administration may pursue more flexibility in system roll-out in the border area and other one would seek interference protection of existing stations
- Procedures agreed in agreements
- Bilateral preferential frequency agreements for frontier zones: who can operate what
  and with which interference ranges

Why agreements are useful 1

- Coordinating frequencies among administrations before assigning them
- Optimizing spectrum usage by accurate interference field strength calculations.
- Establishment of models for computer-aided interference range calculations

Why agreements are useful 2

- Harmonized parameters: Objectively predictable and transparent decisions
- Quick assessment of interference through data exchange
- Quick assignment of preferential frequencies
- Optimizing turnaround times

Spectrum management policy and NTFA

- It is a government responsibility to develop spectrum management policies that conform to the international treaty obligations of the Radio Regulations while meeting national spectrum needs.
- Within the national legal framework for telecommunications a spectrum management organisation has the delegated authority to prepare spectrum plans that meet government policies.
  - National spectrum plans should be reviewed regularly and, when necessary, be updated to keep pace with technology and changing demands.
- One of the most important tools for effective spectrum management is the National Table of Frequency Allocation (NTFA). This shows how the spectrum can be used in the country.

Why coordination agreement

- The most efficient method for resolving interference of stations in a border region is frequency assignment planning, when neighboring administrations possess entire information regarding parameters of planned and operated stations of the affected administrations.
- In such a case the impact of harmful interference can be calculated during bilateral/multilateral discussions of the planned station.
- And although the situation described above is not typical in cross-border discussions between administrations , such approach shows the idealized course of action process providing maximum efficiency at minimum probability of neglected harmful interference.
- This approach has no difference between determination of technical conditions and the calculation to determine the mutual impact of a new or modified frequency assignment of requesting administration to stations of the affected administrations.

Why coordination agreement 2

- To calculate the effect of harmful interference during bilateral/multilateral discussions of a planned station, a parameter for permissible harmful interference needs to be determined.
- When defining the parameter for permissible impact of harmful interference on receiving station, it is recommended to use condition of protection of the receiving station from “long-term” harmful interference at a minimum (threshold) signal level.
- “Long-term” interference is defined as harmful interference with permissible level exceeded more than 1% of time. During bilateral/multilateral discussions on harmonization of planned frequency assignments to stations, it is recommended to use the requirement for protection from “long-term” interference not exceeded more than 20% of time.

Why coordination agreement 3

- In majority of cases the complete information on station parameters of neighbour administrations is not available and calculation of harmful interference during bilateral/multilateral discussions of planned station is challenging.
- In this case for determination of exceedance conditions for stations, some assumptions on possible station parameters at neighbour administrations are required.
- Actually, replacing parameters of unknown stations by system parameters of stations, it is possible to pass on to determination of harmful interference on border and rest territory of the affected neighbour administration using parameters of a conditional area around a station of requesting administration with a new or modified frequency assignment.

Example: European HCM-Agreement

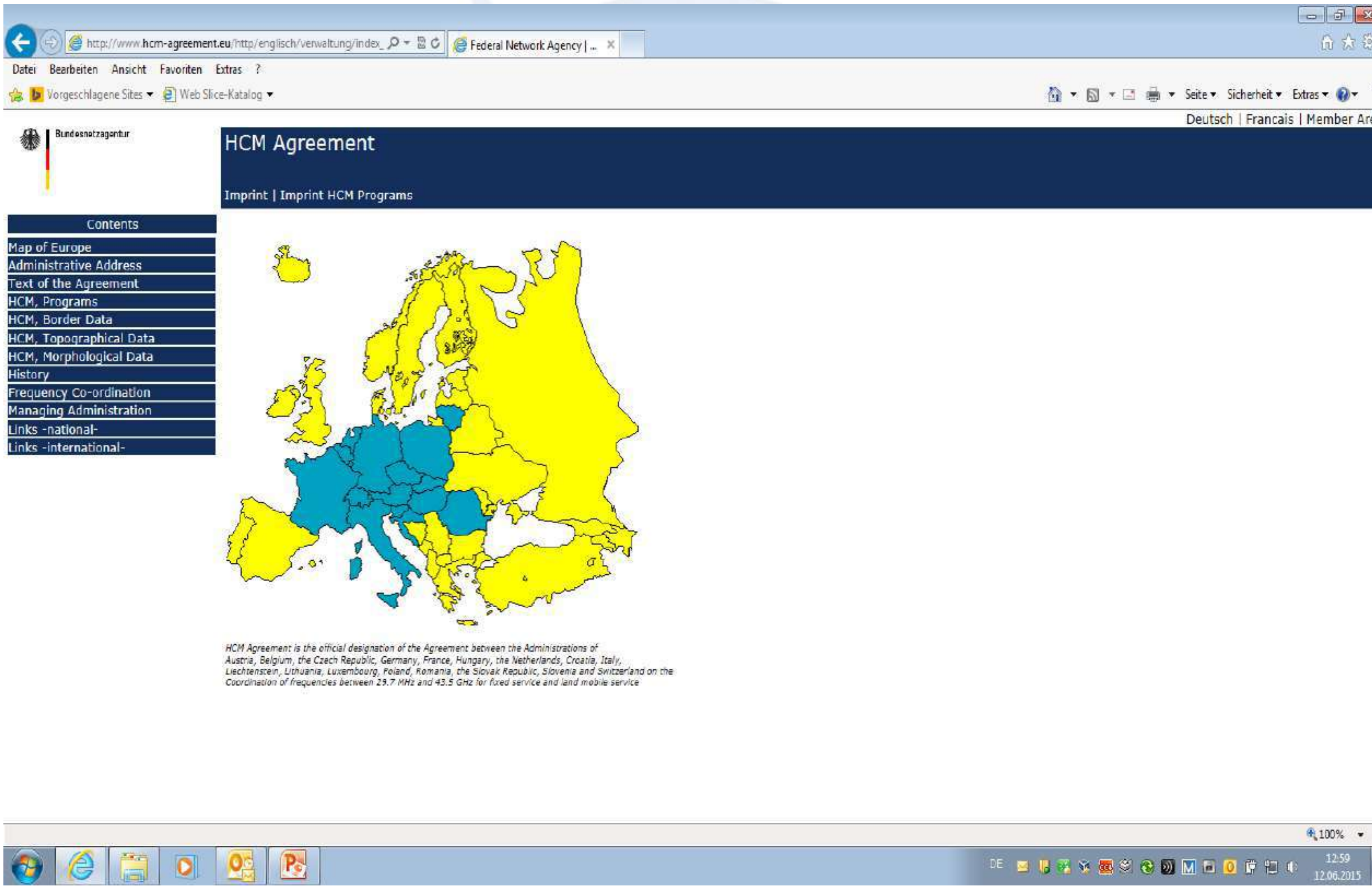
The web-site of the European Frequency Co-ordination Agreement.

The HCM-Agreement (Harmonized Calculation Method) can be accessed via the following link:

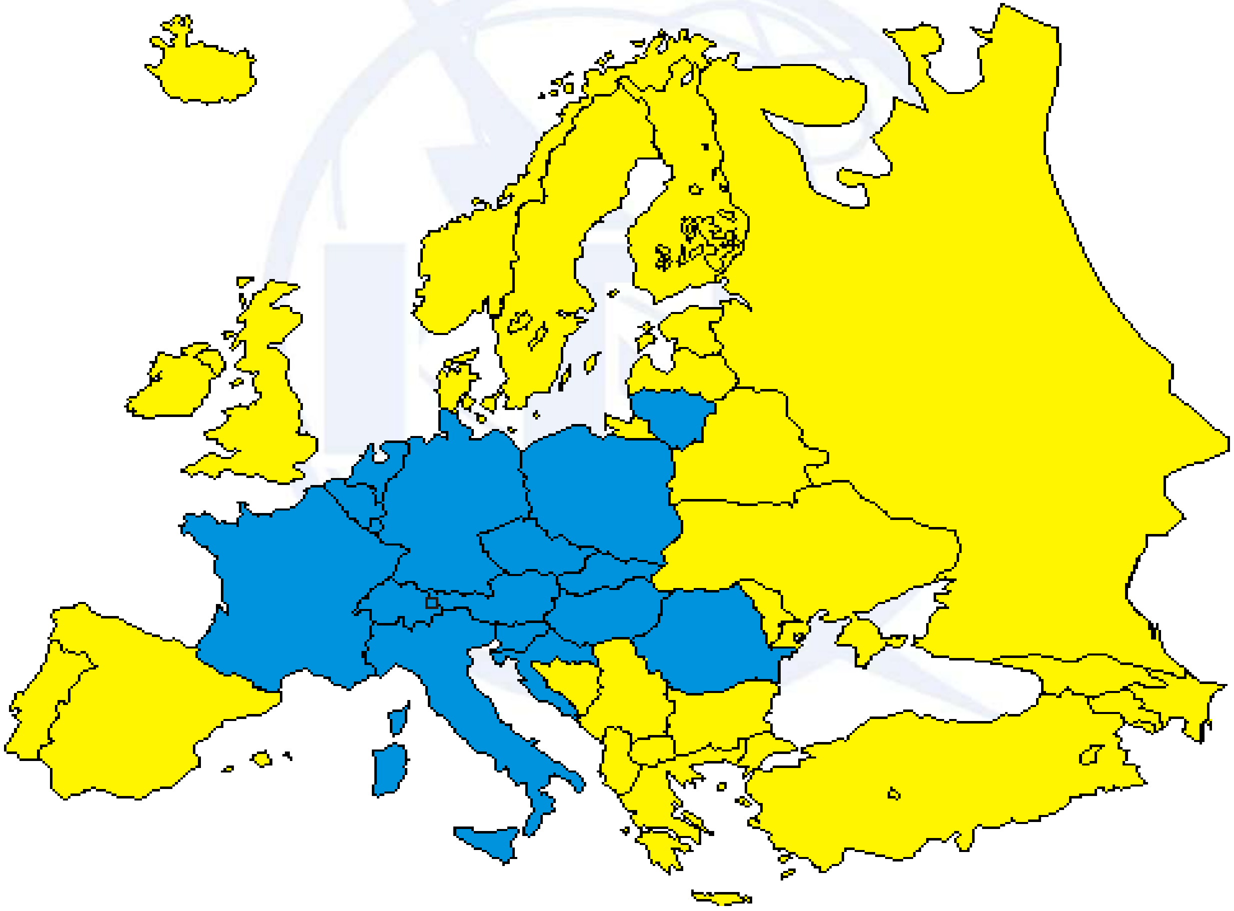
Federal Network Agency | Managing Administration of the "HCM Agreement" | Map of Europe

http://www.hcm-agreement.eu/http/englisch/verwaltung/index_europakarte.htm

European HCM-Agreement

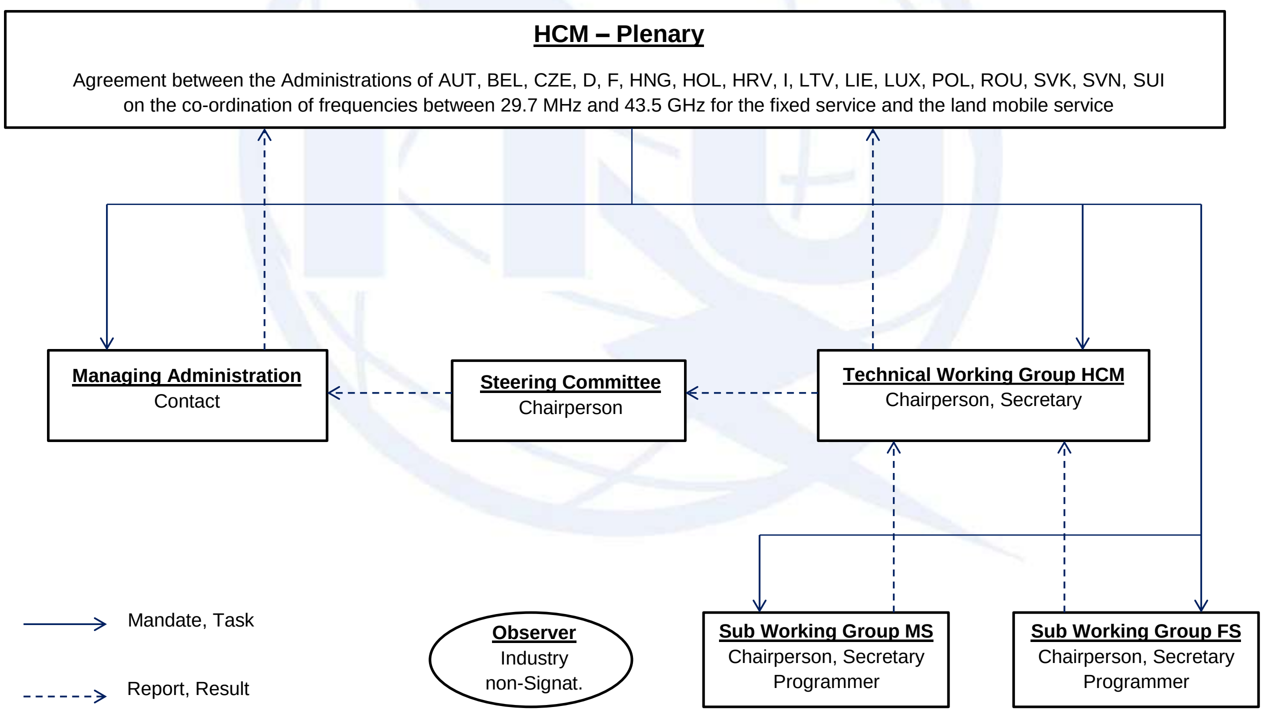


The Members



European HCM-Agreement

Organisational structure of the HCM-Agreement



European HCM-Agreement

Information on the HCM web-site:

HCM programs

Legacy, test and official versions for fixed and mobile service

.EXE executable test program

.DLL calculation kernel accessible from surrounding programs

Source code, Documentation, User Guide and further tools

HCM Border data

Border data of various regions, border program, manuals

HCM Topo data

Height data of various regions, topo-viewer, manuals

HCM Morpho data

Morpho data of various regions, morpho-viewer, manuals

European HCM-Agreement

Structure and main features of the HCM-Agreement:

Main Text and fixed/mobile service specific Annexes

Main Text

17 Member Administrations (Signatories)
Frequency Range 29.7 MHz – 43.5 GHz
Fixed Service and Land Mobile Service
Definition of Frequency Ranges for fixed and mobile service
Definition of Frequency Categories
Establishment of Frequency Register and Exchange of Lists
Description of Technical Provisions
Description of Co-ordination Procedure
Status of co-ordinations prior to Agreement

European HCM-Agreement

Annexes:

Annex 1

Maximum permissible interference field strengths and maximum cross-border ranges of harmful interference for frequencies requiring co-ordination in the Land Mobile Service

Annex 2A

Data exchange in the Land Mobile Service

Annex 2B

Data exchange in the Fixed Service

European HCM-Agreement

Annex 3A

Determination of the correction factor for the permissible interference field strength at different nominal frequencies in the Land Mobile Service

Annex 3B

Determination of the Masks Discrimination and the Net Filter Discrimination in the Fixed Service

Annex 4

Propagation curves in the Land Mobile Service

Annex 5

Determination of the interference field strength in the Land Mobile Service

European HCM-Agreement

Annex 6

Coding instructions for antenna diagrams in the Land Mobile Service

Annex 7

Provisions on measurement procedures in the Fixed Service and the Land Mobile Service

Annex 8A

Method for combining the horizontal and vertical antenna patterns
in the land mobile service

Annex 8B

Method for combining the horizontal and vertical antenna patterns in the Fixed Service

European HCM-Agreement

Annex 9

Threshold Degradation in the Fixed Service

Annex 10

Determination of the basic transmission loss in the Fixed Service

Annex 11

Trigger for co-ordination in the Fixed Service

European HCM-Agreement

<u>Experience with the HCM-Agreement:</u>

- Application of harmonized calculation method leads to reproducible results on both sides of the border
- In case of inconsistencies the HCM-Agreement provides guidance on resolution
- HCM-Agreement solid basis for a multitude of bi- or multilateral Agreements among Administrations
- Very low interference cases experienced in recent years
- Investigation showed that most cases were caused by deviating data between co-ordination database and real transmit parameters
- Permissible levels are rather conservative, therefore some tolerance in co-ordination triggers and status assignment based on calculations
- All Signatories contribute to the further development of the HCM-Agreement

Cross-border frequency coordination example: *Africa (HCM4A)*

ITU Workshop on Spectrum Management
13 October 2016
Mexico City

HCM4A implementation
by
ITU-EC HIPSSA project

- ITU and European Commission launched a global project to provide "*Support for the establishment of harmonized policies for the ICT market in the ACP states*" end 2008
- Component of "ACP-Information and Communication Technologies" programme (ACP-ICT) within the framework of the 9th European Development Fund
- 3 regional sub-projects addressing specific needs of each region

HIPCAR
Enhancing competitiveness in the Caribbean through the harmonization of ICT Policies, Legislation and Regulatory Procedures

HIPSSA
Support for Harmonization of the ICT Policies in Sub-Saharan Africa

ICB4PIS
Capacity Building and ICT Policy, Regulatory and Legislative Frameworks Support for Pacific Island States

Reflect sub-regional heterogeneity in terms of ICT market development and status of harmonization initiatives in four AU geographical regions

Global

- **Comparison of regional harmonization initiatives**
- **Monitoring and evaluation / Regulatory benchmarking**
- **Cross-border frequency coordination: harmonized calculation method for Africa (HCM4A)**
- **Input to African Union's Open Access guidelines**

Regional

West Africa | *Central Africa* | *East Africa* | *Southern Africa*

National

Advantages of a harmonized calculation method (HCM4A)

- **Based on HCM Agreement used in Europe**
- **Optimize** spectrum usage;
- **Prevent** harmful interferences;
- Confer an adequate **protection for stations**;
- Define **technical** provisions and **administrative** procedures;
- **Quick assignment** of preferential frequencies;
- **Transparent decisions** through agreed assessment procedures;
- Quick assessment of interference through **data exchange**.

HCM4A involves all for 4 sub regions

This project included performing a **survey** and a **comparative analysis** of existing administrative and technical procedures related to bilateral and multilateral cross-border frequency coordination agreements in 4 geographical sub-regions as defined by the AU **(Sub-Saharan Africa only!)**

- **Central Africa** [Burundi, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome and Principe];
- **East Africa** [Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, Seychelles, Somalia, Sudan, Tanzania, Uganda];
- **Southern Africa** [Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe];
- **West Africa** [Benin, Burkina-Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Sierra-Leone, Senegal, Togo].

Team of ITU experts for HCM4A

- Under the management of the HIPSSA Project Team (Project manager and Project Coordinator)
- In close collaboration with the ITU regional Office for Africa and the ITU Division at HQ dealing with the matter (TND)
- Team of 5 experts

  4 Regional Experts (West, Central, East and Southern Africa)

  1 Senior Coordinator
- http://www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPSSA/Pages/default.aspx

Implementation of HCM4A in four phases

1. **Assessment phase - Done**

   Review existing bilateral and multilateral cross-border frequency coordination agreements in Sub-Sahara Africa;

2. **Multilateral agreement proposal - Done**

   Technical working group review the results of the assessment and propose a multilateral agreement

3. **Validation workshop - Done**

   Adopt the draft agreement in line with the conclusion of the assessment

4. **Signature – Interests**

5. **Development of HCM4A software**

   Develop and release software (.dll) based on HCM4A agreement and organize training workshops on the procedure. Insertion into the SMS4DC

Tasks in Phase 1 of HCM4A for the sub-regions

Request

- *Contact* details of the person, dealing with spectrum management matters, and who will be the HCM4A Focal Point (FP) in the relevant country for this project.

Tasks from the HCM4A Focal Point

- Fill in a questionnaire;
- Provide info on any bilateral/multilateral agreement;
- Provide current frequency register database format;
- Provide protection requirements for the different radio-communication services;
- Provide clarifications on the subject whenever the need arises.

Cross-border frequency coordination in Africa
Assessment Phase - Key questions (1/3)

- Does your country have a framework (administrative procedures and technical provisions) for cross-border frequency coordination? If so, please provide us an electronic copy.
- Does your country have one or more cross border frequency coordination agreements? If so, how many? Please provide us a sample electronic copy of each one.
- Please indicate in a tabular form the bands, the services, the neighboring country/countries involved and the periodicity how often your country experience interference problems or conduct frequency coordination across borders.

Cross-border frequency coordination in Africa
Assessment Phase - Key questions (2/3)

- Can you provide in a tabular form those bands, services, neighboring countries involved and priorities, that you consider requires frequency coordination across the different borders with neighboring countries?
- Does your country have a frequency register for storing the co-ordination results? If yes, please provide us an example on an electronic copy where all the fields considered are indicated.
- Indicate what type of ITU tools including databases you use and in which cases you use them for coordination or registration

Cross-border frequency coordination in Africa
Assessment Phase - Key questions (3/3)

- Indicate with certain detail any other tool used for coordination or interference resolution, whether self developed or purchased.
- Indicate in a tabular form the propagation models and/or methods used per bands and services.
- In cases where you use digital terrain data for interference calculations indicate:
  - the use of elevation and/or morphological data,
  - the type of geographical projection system do you use,
  - the level of the resolutions of the terrain data that you use close to the different borders
  - the point or line whereof the calculation is made

HCM4A implementation studies

- During the first phase of the project, ITU experts contacted various administrations in subSaharan Africa and compiled information related to cross border frequency coordination through a questionnaire.
- Based on the results of the first phase of the project, the ITU team prepared a draft HCM for Africa Agreement with relevant Annexes (HCM4A). The draft Agreement for Africa is an adapted version of the existing HCM for Europe. The Agreement deals with co-ordination of frequencies between 29.7 MHz and 43.5 GHz for the purposes of preventing mutual harmful interference to the Fixed and Land Mobile Services and optimising the use of the frequency spectrum on the basis of mutual agreements.
- The Draft HCM4A Agreement has a number of Annexes relating to Land Mobile and Fixed Service respectively.

The Agreement

- The Draft Agreement comprises of a Preamble and the following Articles :

Art 1 Definitions
Art 2 General
Art 3 Technical Provisions
Art 4 Procedures
Art 5 Report of harmful interference
Art 6 Revision of the Agreement
Art 7 Accession to the Agreement
Art 8 Withdrawal from the Agreement
Art 9 Status of coordinations prior to the Agreement
Art 10 Languages of the Agreement
Art 11 Entry into force of the Agreement

The Annexes related to the Land Mobile Service

Annex 1: Maximum permissible interference field strengths and maximum cross-border ranges of harmful interference for frequencies requiring co-ordination in the Land Mobile Service

Annex 2A: Data exchange in the Land Mobile Service

Annex 3A: Determination of the correction factor for the permissible interference field strength at different nominal frequencies in the Land Mobile Service

Annex 4 Propagation curves in the Land Mobile Service

Annex 5 Determination of the interference field strength in the Land Mobile Service

Annex 6 Coding instructions for antenna diagrams in the Land Mobile Service

Annex 7 Provisions on measurement procedures in the Fixed Service and the Land Mobile Service

Annex 8A Method for combining the horizontal and vertical antenna patterns for the Land Mobile Service

The Annexes related to the Fixed Service

Annex 2B Data exchange in the Fixed Service

Annex 3B Determination of the Masks Discrimination and the Net Filter Discrimination in the Fixed Service

Annex 7 Provisions on measurement procedures in the Fixed Service and the Land Mobile Service

Annex 8B Method for combining the horizontal and vertical antenna patterns for the Fixed Service

Annex 9 Threshold Degradation in the Fixed Service

Annex 10 Determination of the basic transmission loss in the Fixed Service

Annex 11 Trigger for co-ordination in the Fixed Service

Software tool for HCM4A

- Optimise spectrum usage by **accurate interference field strength calculations**;
- Establish **general parameters**, improvement and supplementation of technical provisions, individual restrictions;
- Establish **models** for computer-aided **interference range calculations**
- **Harmonise parameters**: objectively predictable towards transparent decisions

Draft Framework Agreement on HCM4A (comments consolidated in Nairobi Meeting with ATU and AUC)

- Comments
  - All comments have now been incorporated in the draft agreement.
  - The English and French texts of the Agreements have been reconciled by ITU.
  - Agreement dispatched by BDT Director to Sub-Saharan Africa for signature
  - 20 Indication of intention to sign the agreement received
- Issue of hosting Body for Secretariat of HCM4A
  - To be discussed

HIPSSA website

www.itu.int/en/ITU-D/Projects/ITU-EC-ACP/HIPSSA/Pages/default.aspx

REGIONAL OUTCOMES

3. Cross-border frequency coordination

HCM4A Sub-Saharan assessment report [EN] [FR]
HCM4A Central Africa assessment report [EN]
HCM4A East Africa assessment report [EN]
HCM4A Southern Africa assessment report [EN]
HCM4A West Africa assessment report [EN]
HCM4A Agreement [EN] [FR]
HCM4A Annexes to Agreement [Annex 1] [Annex 2A] [Annex 2B] [Annex 3A]
[Annex 3B] [Annex 4] [Annex 5] [Annex 6] [Annex 6 App.1] [Annex 6 App.2] [Annex 6 App.3] [Annex 6 App.4] [Annex 6 App.5] [Annex 7] [Annex 8A] [Annex 8B] [Annex 9] [Annex 10] [Annex 11]

Indication of intention (20) to sign the agreement

- No Seychelles
- Yes

Benin	Ivory Coast
Burkina Faso	Kenya
Burundi	Mali
Cameroun	Niger
Congo	Rwanda
Gabon	Senegal
Gambia	South Sudan
Ghana	Togo
Guinee Bissau	United Republic of Tanzania
Guinee Equatorial	*Lesotho*

Thank you!

PRIDA Track 1 (T1)

Guidelines for setting up a new or updating an existing spectrum monitoring network

Online training, 23 April 2020

Outline

- Role of monitoring in spectrum management;
- Setting up a new or updating an existing spectrum monitoring network;
  - Considerations leading to the design;
  - Type of equipment and type of stations;
  - Where to locate the various stations;
- Financing the system;
- Development of a tender document;
- Release of the tender;
  - Questions by manufacturers;
  - Site survey;
- Evaluation of the bids;
- Award of the project;
- Contract negotiations and signing the contract;
- Implementation of the new system;
- Training of the staff;
- Testing of the new/updated system;
- Putting into use of the new/updated system

Spectrum Management process

Key elements in Spectrum Management:

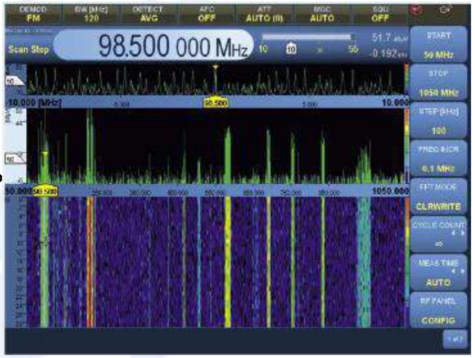
- Frequency Management (PLANS)
- Licensing (PERMITS)
- Enforcement (VERIFIES)

Role of Monitoring :

To support these key-elements in order to realise a usable and interference free spectrum

Definition of monitoring

Monitoring can be defined as a process of observing the radio frequency spectrum and report on the use of it.



Setting up or updating an existing network

- Monitoring has to serve the whole spectrum management organisation;
- It is essential that **before** decisions are taken on the type of monitoring equipment is needed, a fundamental discussion between the stakeholders of the spectrum management organisation is a '**must'** to identify the need for monitoring support on a national level;
- Once this is agreed, a **system design** can be identified. Based on this system design the **technical specifications** can be developed.

Considerations leading to the design

a) Need for monitoring based on the responsibility of the spectrum management organisation;
b) Need for monitoring based on the functional elements of the spectrum management organisation;
c) Need for monitoring based on the future use of the spectrum;
d) Need for monitoring based on monitoring needs;
e) Need for monitoring based on practical considerations

Development of Technical Specifications

After having decided on the design, the technical specifications will be developed.

Important elements are:

- Antenna system - What type of antennas are needed?
- Receiver - What is the quality of the receiver?
- Measurements - What type of measurements are to be done?
- Processing results - How do the results look like?
  - They should be user friendly
- Communication - How is the network configuration connected?

Technical Specifications – Antenna system

What type of antennas are needed?

Task	Type of antenna
Measurements	Omnidirectional
Interference handling	DF and/or directional
Illegal use	Horizontal/vertical polarisation

Technical Specifications – Receivers

What quality of receivers is required (ITU-R WP1C)?

Monitoring equipment test measurement procedures	
Selectivity of monitoring receivers	Recommendation ITU-R SM.1836 Report ITU-R SM.2125
IP3 of monitoring receivers	Recommendation ITU-R SM.1837 Report ITU-R SM.2125
Noise figure of monitoring receivers	Recommendation ITU-R SM.1838 Report ITU-R SM.2125
Scanning speed of monitoring receivers	Recommendation ITU-R SM.1839 Report ITU-R SM.2125
Sensitivity of monitoring receivers	Recommendation ITU-R SM.1840 Report ITU-R SM.2125
Other parameters	Report ITU-R SM.2125

Technical Specifications – Measurements

What measurements are to be done?

Signal parameter measurements:	
Frequency	Recommendation ITU-R SM.377 ITU Spectrum Monitoring Handbook, 2011, Section 4.2
Field strength (see also Radio Regulations Art. 21)	Recommendation ITU-R P.845 Recommendation ITU-R SM.378 Recommendation ITU-R SM.1447 Recommendation ITU-R SM.1708 ITU Spectrum Monitoring Handbook, 2011, Section 4.10
Modulation	Recommendation ITU-R SM. 1268 ITU Spectrum Monitoring Handbook, 2011, Sections 4.6 and 4.8
Bandwidth	Recommendation ITU-R SM.443 ITU Spectrum Monitoring Handbook, 2011, Section 4.5
Identification	Recommendation ITU-R SM.1052 Recommendation ITU-R SM.1600 ITU Spectrum Monitoring Handbook, 2011, Section 4.8
Signal analysis	ITU Spectrum Monitoring Handbook, 2011, Section 4.8
Measurements related to inspection of radio installations	Report ITU-R SM.2130

Technical Specifications - Connection

Based on the design, the various stations are to be connected to a control room for:

- Direct control;
- Uploading measurements tasks;
- Downloading results.

Questions to be answered:

- Is there a need for remote control via internet?
- Is a fixed communication network available?
- How to connect the mobile monitoring stations to the control room?

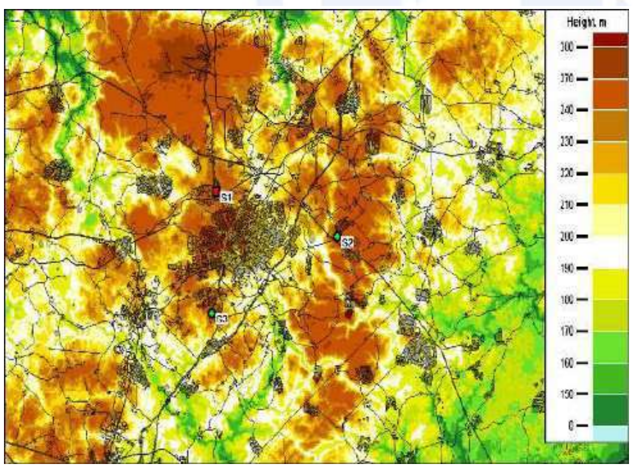
Type of stations needed

- Based on the size of the country;
  - Where to locate manned monitoring stations;
  - Where to locate automated remote fixed monitoring stations;
- What are the bands to be covered and how;
- What type of equipment is needed;
- How many mobile monitoring vehicles are needed;
- How many transportable stations are needed;
- Monitoring principles

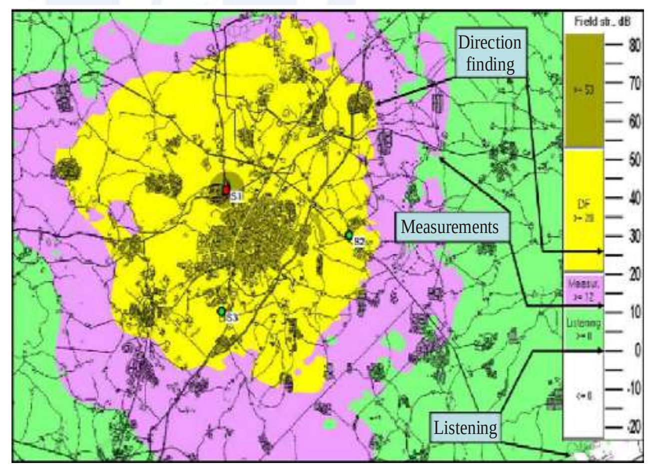
Where to locate the (remote) fixed stations?

ITU Handbook on Spectrum Monitoring in Chapter 6, section 6.8 information is included how to calculate the coverage of a monitoring station in a geographical area.

Based on this calculation one can define how many stations are needed to cover a geographical area



Spectrum-6.8-02



Spectrum-6.8-03

Available budget?

With the wanted design and quality of the network, does this still fit into the available budget?

If not, the following is to be considered:

- Consider most important areas to be covered;
- Consider number of transportable stations
- Consider number of mobile stations

Financing the system

The following possibilities are available for financing the system:

- Resources nationally available;
- Financing via the World Bank;
- Other funding e.g. European Commission if applicable

Tender documents

Once decisions are taken on the design and technical specifications, the tender documents needs to be developed in the format of a Request for Proposals (RFP).

The following documents are suggested:

- Master document;
- Technical and Service specifications;
- Commercial and Legal Conditions;
- Compliancy Matrix

Tender documents - Master

In the Master document the following is included:

1. Introduction – information on the customer;
2. Structure of the RFP;
3. RFP process;
4. Response instructions;
5. Overview of the design of the system;
6. Statement of requirements

Tender documents – Technical and Services

In the Technical Specifications and Services document the following is included:

1. Introduction – type of documents;
2. Terminology;
3. Overview of the design;
4. Statement of Technical requirements, including:
    - Specifications for hardware;
    - Specifications for control software;
    - Specifications on screen lay-outs
    - Specifications for the interface to a spectrum management system e.g. SMS4DC
5. Statement of Services requirements, including
    - Maintenance (hard-software, warranty);
    - Training on the new system

Tender documents – Commercial and Legal

In the Commercial and Legal document the following is included:

- Bidding structure;
- Terms and Conditions including:
  - E.g. conditions for financial proposal
- Project Administration;

Tender documents – Compliancy Matrix

In the Compliancy Matrix document the following is included:

- Response information on compliancy;
- Compliancy to the Master document;
- Compliancy to the Technical and Services document;

Req. ID			Description of Requirement	Compliancy	Supplier's remark, ref.
Doc. ID	Section ref.	Req. No.			

Tender documents – after the release

Once the tender documents are released, the manufacturers has to indicate:

- (normally) within one week their willingness to send in a proposal to the RFP;
- After that week to send questions they have to the RFP documents;

The customer has to:

- respond to these questions within one week and forwarded to all bidders;
- Organise a site survey to allow bidders to see the local situation.

Tender documents – Evaluation and awarding

All proposals as received within the deadline for sending in proposals, will be evaluated based on:

- Criteria as set and included in the Commercial and Legal document;
- For every technical requirement the compliance type result will be included;
- At the end of the technical evaluation, the total score will be determined;
- Only those bids having a score above a predefined percentage will be taken into account for the financial offer;
- The technical and fiancial score will lead to the winning bidder;
- The intention is to award the project to this bidder and contract discussions will follow.

Contract discussions and signing the contract

After having awarded the project to the winning bidder, contract discussions are needed:

- To find solutions where the bidder was not fully in compliance with the requirements;
- Date of start of the implementation;
- Any other item for discussion.

After having concluded and agreed on all aspects of the project the project documents and contract may be signed.

Implementation of the new system

During the contract discussions the implementation date is agreed.

During the implementation phase attention is needed for:

- Detailed design review as result of the modifications agreed;
- The design is in accordance with the reqired design;
- All elements are described properly;
- Project plan and milestones;
- Civil work if needed;
- Import of goods in the country;
- Complete system is delivered

Training of staff

The winning manufacturer will take care on training BEFORE the system is handed over in order to:

- Allow the staff to control the systems with all features;

Training will include:

- Monitoring fundamentals;
- Equipment features;
- System control;
- How to handle/interpret the output of the system

Testing the system

During the implementation phase the manufacturer will organise:

- Factory Acceptance Test (FAT)
  - On pre agreed parameters for the system;
  - Witnessed by representatives of the customer;
  - On all sub parts of the system, including vehicles and equipment which is not of the origin of the manufacturer e.g. spectrum analysers, portable receivers;

- Site Acceptance Test (SAT)
  - After installation in the customers country;
  - Total system test on pre agreed parameters
    - Remote controll of the system;
    - Performing required measurements;
    - Interconnection of the system

Handing over of the system

After a succesful SAT, the system will run for a predefined period to have any problem solved which hamper the proper functioning of the system.

After that period the handing over of the system may take place by signing the handing over protocol.

As from that moment the system is under control of the customer!!!

Thank you!

PRIDA Track 1 (T1)

ITU Spectrum Management Training Programme (SMTP)

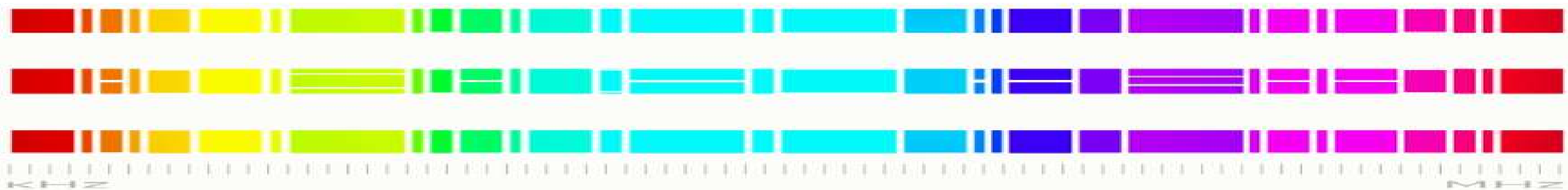
Online training, 23 April 2020


SMTP
SPECTRUM
MANAGEMENT
TRAINING
PROGRAMME
AN ITU ACADEMY INITIATIVE
http://academy.itu.int
ITU

PRESENTATION OUTLINE

- Addressed Problem, Solution and Development Process
- SMTP Structure, Composition and Certification Routes
- Delivery Options
- Pilot Test
- Partners(Development and Delivery)

Addressed problem



- No formal holistic SM education programmes;
- Current training in SM achieved through secondments in large administrations;
- Small administrations who cannot use secondments are not able to train.

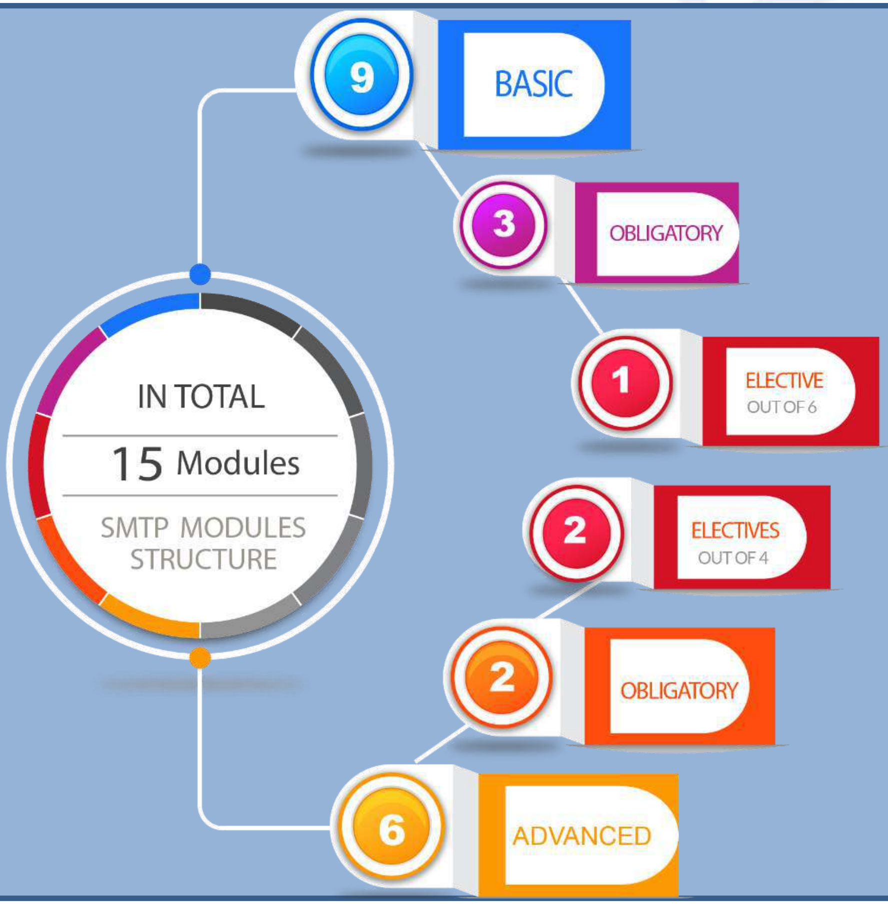
The Solution

- The ITU establishes the SMTP:
- Access to state-of-the-art holistic SM training and forward-looking professional vision;
- Formalized assessment;
- The SMTP programme was first developed in 2014
- All the materials of the programme were revisited and updated in 2018
- Certification to give international recognition, with possible option of university credits/diploma.

Development Process

- In-depth review of subject area and development of a scope
- Development of individual modules by subject matter experts
- Peer-review of materials
- Editing of the training modules
- Delivery of the training programme

SMTP Modules Structure



- **15 Modules in total**
- 9 Modules at Basic level
- 6 Modules at Advanced level
- **Basic Level:**
  - 3 are Obligatory modules
  - 1 Elective out of the 6 Electives
- **Advanced Level**
  - Two obligatory
  - Two elective out of 4.

Composition of the programme-Basic Level

- Obligatory Modules (OM):
  - OM1 “Legal Basis and Regulatory Framework of SM”
  - OM2 “Spectrum Engineering Fundamentals”
  - OM3 “Wireless Telecommunications Technologies”
- Elective Module 1 (EM 1)includes 6 options:
  - EM1-1 “Spectrum Monitoring”
  - EM1-2 “Enforcement and Type Approval of Equipment”
  - EM1-3 “SM for Satellite Systems”
  - EM1-4“SM for HF Systems, Science, Maritime and Amateur Services”
  - EM1-5“SM for Aeronautical and Radio Determination Services and Military Systems”
  - EM1-6“Computer-aided Spectrum Management”

Composition of the programme-Advanced Level

- Obligatory Modules (OM):
  - OM4 “Economic and Market Tools of Spectrum Management”
  - OM5 “Strategic Planning and Policies for Wireless Innovation”
- Elective Module 2 (EM2). Legal Specialization:
  - EM 2-1“Advanced Spectrum Authorization Regimes”
  - EM 2-2“Socio-Economic Impact of Spectrum Regulation; Competition and Consumer Protection”
- Technical Specialization:
  - EM 2-3“Terrestrial TV Broadcasting Planning and Digital Transition”
  - EM 2-4“Opportunistic Spectrum Access and Cognitive Radio”

SMTP Modules:

OM1 - Legal basis and regulatory framework of spectrum management
OM2 - Spectrum engineering fundamentals
OM3 - Wireless telecommunication technologies
OM4 - Economic and market tools of spectrum management
OM5 - Strategic planning and policies for wireless innovation.

SMTP Modules:

EM1.1: Spectrum monitoring
EM1.2: Enforcement and type approval of equipment
EM1.3: SM for satellite systems
EM1.4: SM for HF systems, science, maritime and amateur services
EM1.5: SM for aeronautical and radio determination services and military systems
EM1.6: Computer-aided spectrum management
EM2.1: (Legal Specialization): Advanced spectrum authorization regimes
EM2.2: (Legal Specialization): Socio-economic impact of spectrum regulation; competition and consumer protection
EM2.3: (Technical Specialization): Terrestrial TV broadcasting planning and digital transition
EM2.4: (Technical Specialization): Opportunistic spectrum access and cognitive radio.

SMTP Structure – Entry Levels

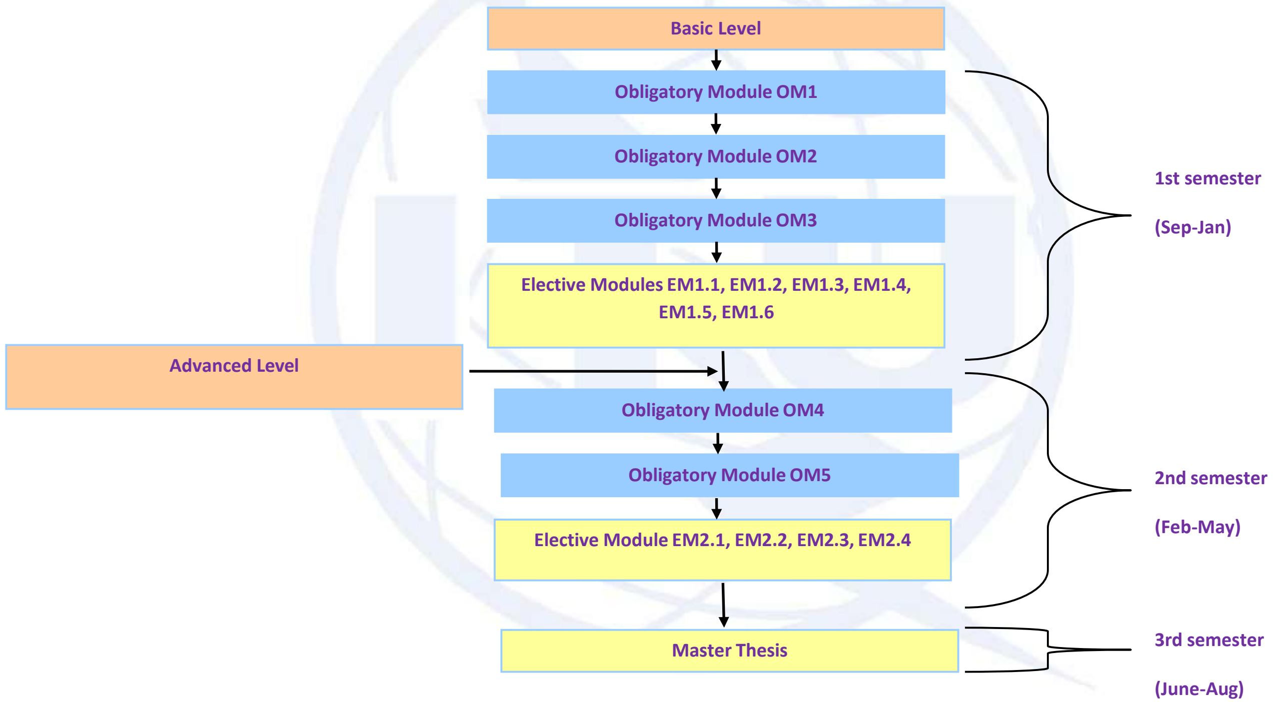


Figure 1. Proposed composition and duration of the SMTP

Certification Routes

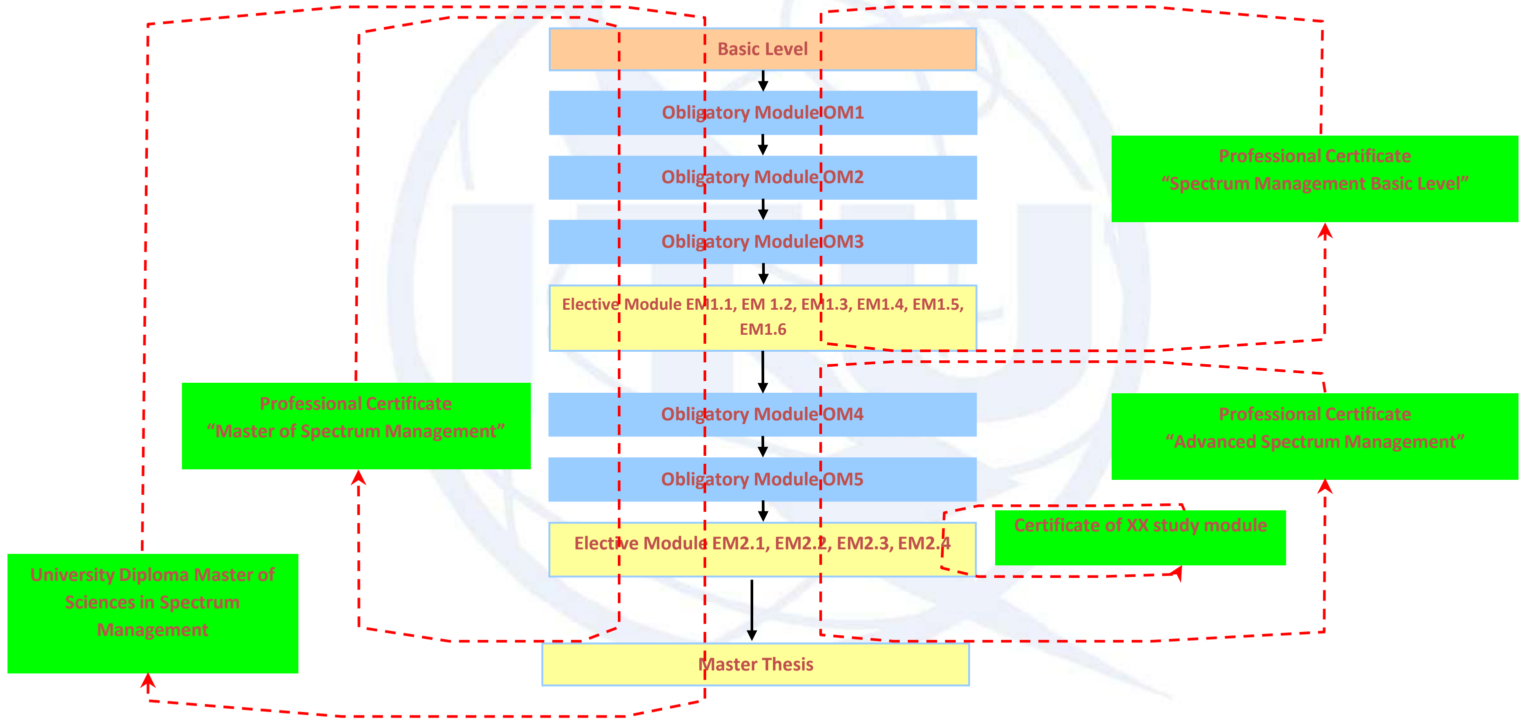


Figure 2. Possible derivative options for university or professional, full or partial certification levels

Programme Duration

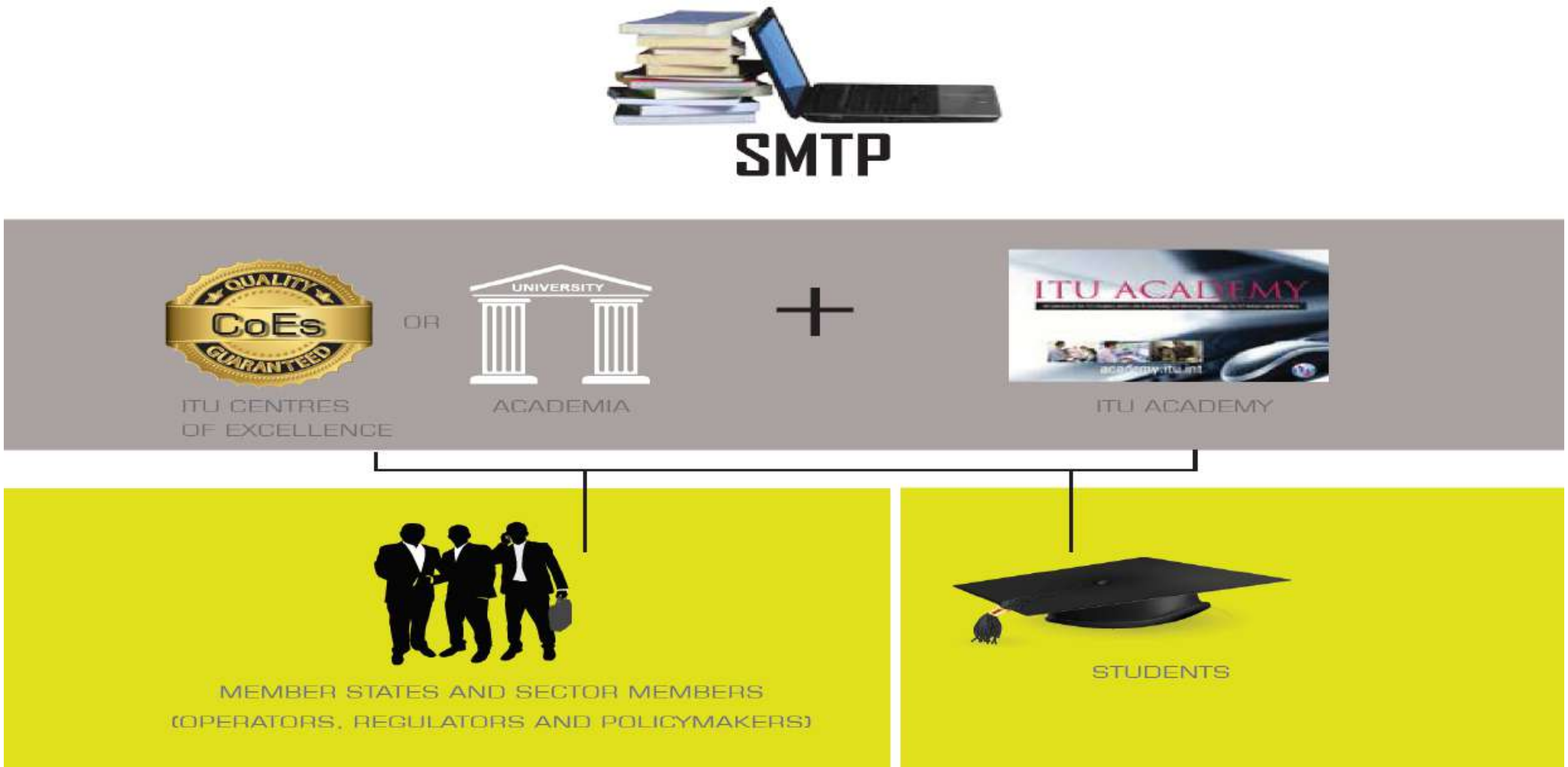
GUIDELINES FOR TEACHERS:

- Power Point slides to fill 30 hours of lecturing per module
- 20 slides per lecture with a total of 600 slides per module
- 10 hours of tasks for practical exercises / lab (where applicable) per module
- Exam questions for testing (50-100 questions)

GUIDELINES FOR STUDENTS:

- 125 hours per module, 40 hours of classroom training
- 4-5 weeks – module duration
- All modules can be completed in no more than 1 year
- 60-90 European Credit Transfer and accumulation System (ECTS) credits for the whole SMTP
- Combination of face-to-face sessions, remote teaching and self-studies
- Formal assessment at the end of each module

Delivery Options



Development process: partners

- Funding partners

Government of Canada Gouvernement du Canada

Canada

Liberté • Égalité • Fraternité

RÉPUBLIQUE FRANÇAISE

MINISTÈRE DES AFFAIRES ÉTRANGÈRES ET DU DÉVELOPPEMENT INTERNATIONAL

- Content development partners

ANE Agencia Nacional del Espectro

GSMA

IARU

ITSO

ROHDE&SCHWARZ

Delivery partners

- Czech Technical University
- AFRALTI
- Expression of Interest from Universities
- Strathmore University in partnership with AFRALTI in Kenya
- ICESI University in Colombia
- COMTELCA (regional body of regulators, Central America)
- TRC Jordan

Success Story: certification

- Awarded by the Central Evaluation and Accreditation Agency (ZEvA), a member of the European Association for Quality Assurance in Higher Education.
- SMTP can be aligned to Master's degree programmes internationally, making it easier for Universities to adopt the programme.
- The ZEvA panel of experts concluded that all SMTP modules correspond to Level 7 of the European Qualification Framework for lifelong learning.
- This will promote flexible study options and provide students with an opportunity to acquire an academic qualification in the specialized field of spectrum management.

Zentrale Evaluations- und Akkreditierungsagentur Hannover
ZEvA

Certificate

Upon application by the

International Telecommunication Union (ITU)

the **Central Evaluation and Accreditation Agency Hannover (ZEvA)** has awarded its quality label to the:

Spectrum Management Training Programme (SMTP)

The quality label certifies that the modules of the SMTP are equivalent in level and content to educational units in Master's programmes at higher education institutions, and that the ECTS key features are correctly implemented.

Expert Group:

- Prof. Dr.-Ing. Wolfgang Frohberg, AKAD University Stuttgart
- Prof. Dr.-Ing. Thomas Kürner, Technische Universität Braunschweig
- Günter Grüell, Consultant Engineer, Stuttgart

The certification of the Spectrum Management Training Programme is valid until 28 February 2023.

Prof. Dr. Wolfgang Lücke
Academic Director ZEvA

Hermann Reuke
Managing Director ZEvA

DELIVERY STORIES

- Since 2016, 150 participants trained at Afralti.
- Training is online through ITU academy platform
- Modules covered to date are:
  - SMTP OM1
  - SMTP OM2
  - SMTP OM3
  - SMTP EM1.3

PROMOTIONAL VIDEO

https://academy.itu.int/index.php?option=com_content&view=article&id=102&Itemid=641&lang=en

Spectrum Management Training Programme (SMTP)

SMTP is a programme developed under the auspices of the ITU Academy. It comprises a set of high-level training materials in all areas of spectrum management, which were developed by experts drawn from within and outside ITU. In 2018, SMTP received international accreditation from the Central Evaluation and Accreditation Agency (ZEvA).

ABOUT SMTP

SMTP comprises two levels: basic and advanced. Each level includes a number of obligatory modules (OM) and elective modules (EM) which are the following:

BASIC

OM1: Legal Basis and Regulatory Framework of Spectrum Management
OM2: Spectrum Engineering Fundamentals
OM3: Wireless Telecommunications Technologies
EM1-1: Spectrum Monitoring
EM1-2: Enforcement and Type Approval of Equipment
EM1-3: SM for Satellite Systems
EM1-4: SM for HF Systems, Science, Maritime and Amateur Services
EM1-5: SM for Aeronautical and Radio Determination Services and Military Systems
EM1-6: Computer-aided Spectrum Management

ADVANCED

OM4: Economic and Market Tools of Spectrum Management
OM5: Strategic Planning and Policies for Wireless Innovation
EM2-1: (Legal Specialization): Advanced Spectrum Authorization Regimes
EM2-2: (Legal Specialization): Socio-Economic Impact of Spectrum Regulation: Competition and Consumer Protection
EM2-3: (Technical Specialization): Terrestrial TV Broadcasting Planning and Digital Transition
EM2-4: (Technical Specialization): Opportunistic Spectrum Access and Cognitive Radio

DELIVERY

SMTP is being delivered through our partner universities and Centres of Excellence. For upcoming deliveries of SMTP, please visit the ITU Academy training catalogue.

DOWNLOAD THE SMTP REPORT

Next Steps

- Translation of the SMTP to other UN languages
- Partner contributions welcome
- Continuing discussions with private sector and academic institutions for SMTP delivery options
- Tailoring modules to specific needs of the regions
- Discussions with Comtelca on this is ongoing
- Simplifying legal access to program by users

Next Steps

- EMF module for the Advanced training - DONE
- Development of OM Zero (for those who are not experts)
- Regular revision of the training materials

For more information please contact
Human Capacity Building division

hcbmail@itu.int

or visit

https://academy.itu.int/

Thank you!

PRIDA Track 1 (T1)

Digital Terrestrial Television Broadcasting (DTTB)

DSO database

Online training, 23 April 2020

Digital Terrestrial Television Broadcasting (DTTB)

DSO database

Background

- Council 2014, 7 May, request from Kenya:

  ITU to provide an analogue to digital switchover stocktaking for assisting the Member States in their migration process.

- Information from relevant surveys, questionnaires of the ITU-D and ITU-R and other sources
  - ITU-D Question 11-3/2 Questionnaire, 2012;
  - ITU-D Question 11-3/2 Final report, 2014;
  - ITU-D Questionnaire to European countries, 2013 and a follow-up in 2014;
  - ITU-D Questionnaire to Arab Countries, 2013;
  - ITU-D and ITU-R meetings, workshop, seminars, frequency coordination meetings;
  - ITU-R SG6 Questionnaire, 2014, results published in Report ITU-R BT.2302-0;
  - African Union Commission Survey, 2013;
  - DIGITAG, 2014.
- Entered to the database

Website

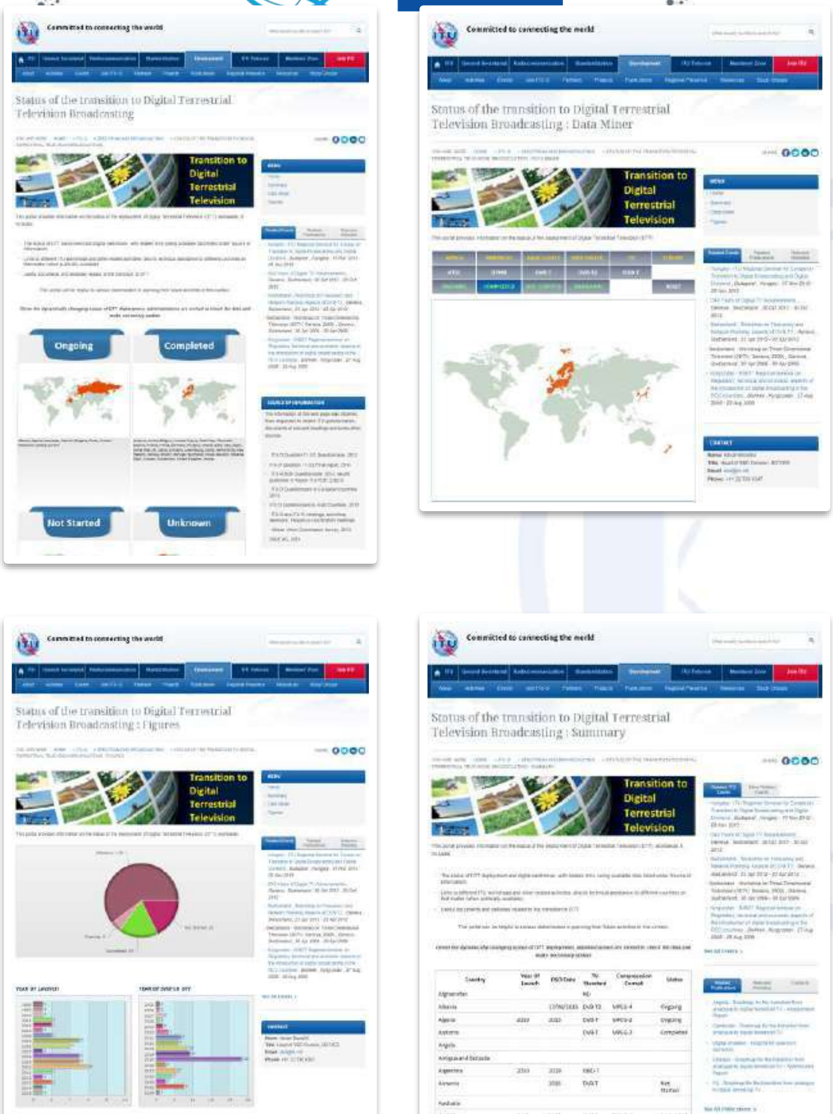
- Summary of the basic information from countries
- Relevant events (e.g. workshops, frequency coordination meetings, seminars)
- Relevant publications (e.g. ITU-R and ITU-D documents, roadmaps, workshop presentations)
- Relevant websites (e.g. ITU-R and ITU-D, broadcasting organizations, GE-06)
- Contacts
- Information sources (list of relevant surveys, questionnaires of the ITU-D and ITU-R and other sources)
- Accessible both form BDT and BR web pages

Circular Letter BDT/IEE/SBD/DM/014 from the BDT Director (23 February 2015)

- Given the dynamically changing status of the Digital Terrestrial Television (DTT) deployment and in order to enable all administrations to benefit from the latest status and information concerning the Digital migration, Administrations are invited to make the necessary update to ensure that their actual status and data are correctly reflected on the portal.

Circular Letter BDT/IEE/TND/016 from the BDT Director (12 February 2019)

- After the deadline set by the GE-06 conference, and in order to enable all administrations to benefit from the latest status and information, ITU is updating the database on the digital Terrestrial Television broadcasting transition. For this reason, Administrations are asked to provide and update their information using the web portal



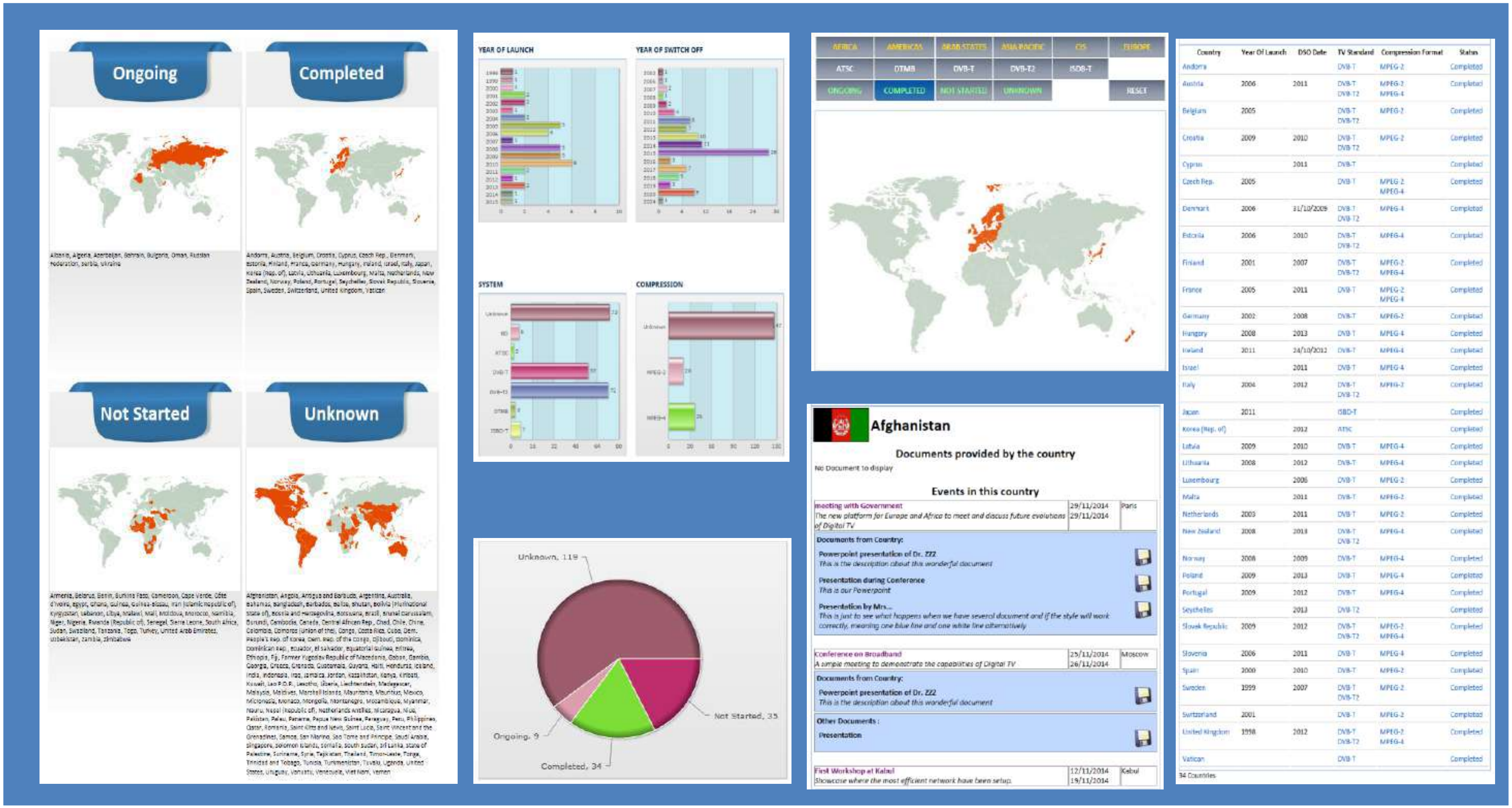
Data Miner

Figures

Summary

Country Profiles

Website features



Features

- Filtering on the different items (e.g. by region, date, technology)
- Detailed displaying of the available information (e.g. for a country, relevant events, documents, websites)
- Displaying information on a map
- Date entry/update possibility for the administrations

Website demonstration

http://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Pages/DSO/Default.aspx

ASO status for EUR Countries (46)

Country	Year of Launch	ASO Date	TV Standard	Compression Format	Status
Albania		17/06/2015	DVB-T2	MPEG-4	Ongoing
Andorra	2006	25/09/2007	DVB-T	MPEG-2	Completed
Austria	2006	2011	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
Belgium	2002	2010	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
Bosnia and Herzegovina	2009	17/06/2015	DVB-T	MPEG-4	Ongoing
Bulgaria	2013	30/09/2013	DVB-T	MPEG-4	Completed
Croatia	2009	2010	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
Cyprus	2010	01/07/2011	DVB-T	MPEG-4	Completed
Czech Rep.	2005	30/06/2012	DVB-T	MPEG-2 MPEG-4	Completed
Denmark	2006	31/10/2009	DVB-T DVB-T2	MPEG-4	Completed
Estonia	2006	2010	DVB-T DVB-T2	MPEG-4	Completed
Finland	2001	2007	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
France	2005	2011	DVB-T	MPEG-2 MPEG-4	Completed
Georgia	2015	01/07/2015	DVB-T2	MPEG-4	Completed
Germany	2002	2012	DVB-T	MPEG-2	Completed
Greece	2008	29/12/2014	DVB-T	MPEG-4	Completed
Hungary	2008	31/10/2013	DVB-T	MPEG-4	Completed
Iceland	2010	2015	DVB-T	MPEG-4	Completed
Ireland	2011	24/10/2012	DVB-T	MPEG-4	Completed
Israel	2008	2011	DVB-T	MPEG-4	Completed
Italy	2008	2012	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
Latvia	2009	01/06/2010	DVB-T	MPEG-4	Completed
Liechtenstein					No Information
Lithuania	2006	29/09/2012	DVB-T	MPEG-4	Completed
Luxembourg	2006	2006	DVB-T	MPEG-2	Completed
Malta	2005	2011	DVB-T	MPEG-2	Completed
Moldova		15/06/2015	DVB-T2	MPEG-4	Ongoing
Monaco	2005	2011	DVB-T2		Completed
Montenegro	2014	17/06/2015	DVB-T2	MPEG-2	Completed
Netherlands	2003	2011	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
Norway	2007	01/12/2009	DVB-T	MPEG-4	Completed
Poland	2009	2013	DVB-T	MPEG-4	Completed
Portugal	2009	2012	DVB-T	MPEG-4	Completed
Republic of North Macedonia	2008	31/05/2013	DVB-T	MPEG-4	Completed
Romania	2015	17/06/2015	DVB-T2	MPEG-4	Ongoing
San Marino					Completed
Serbia	2012	07/06/2015	DVB-T2	MPEG-4	Completed
Slovak Republic	2009	2012	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
Slovenia	2006	2011	DVB-T	MPEG-4	Completed
Spain	2000	2010	DVB-T	MPEG-2 MPEG-4	Completed
Sweden	1999	2007	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
Switzerland	2001	2008	DVB-T	MPEG-2	Completed
Turkey		2015	DVB-T2	MPEG-4	Not Started
Ukraine	2008	31/12/2019	DVB-T2	MPEG-4	Ongoing
United Kingdom	1998	2012	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed
Vatican	2012	2012	DVB-T DVB-T2	MPEG-2 MPEG-4	Completed

Thank you!

Radiocommunication Assembly 2019 and ITU-R Study Groups

ITURA
SHARM EL-SHEIKH2019
21 - 25 October
Sharm El-Sheikh, Egypt

International spectrum management framework

ITU Constitution, Convention	Plenipoten-tiary Conf.	High level principles
Radio Regulations Bi/multilateral Agreements	WRC RRC RRB	Rights and Obligations Table of Frequency Allocations Satellite orbit/terrestrial Plans Frequency coordination Frequency registration Interference Rules of Procedure…
ITU-R Recommendations	RA	
ITU-R Reports, Handbooks, software tools	Study Groups WPs, TGs	Technical characteristics Sharing criteria/assessment Spectrum management Operational aspects …

RRB: Radio Regulations Board
RRC: Regional Radiocommunication Conference
WRC: World Radiocommunication Conference

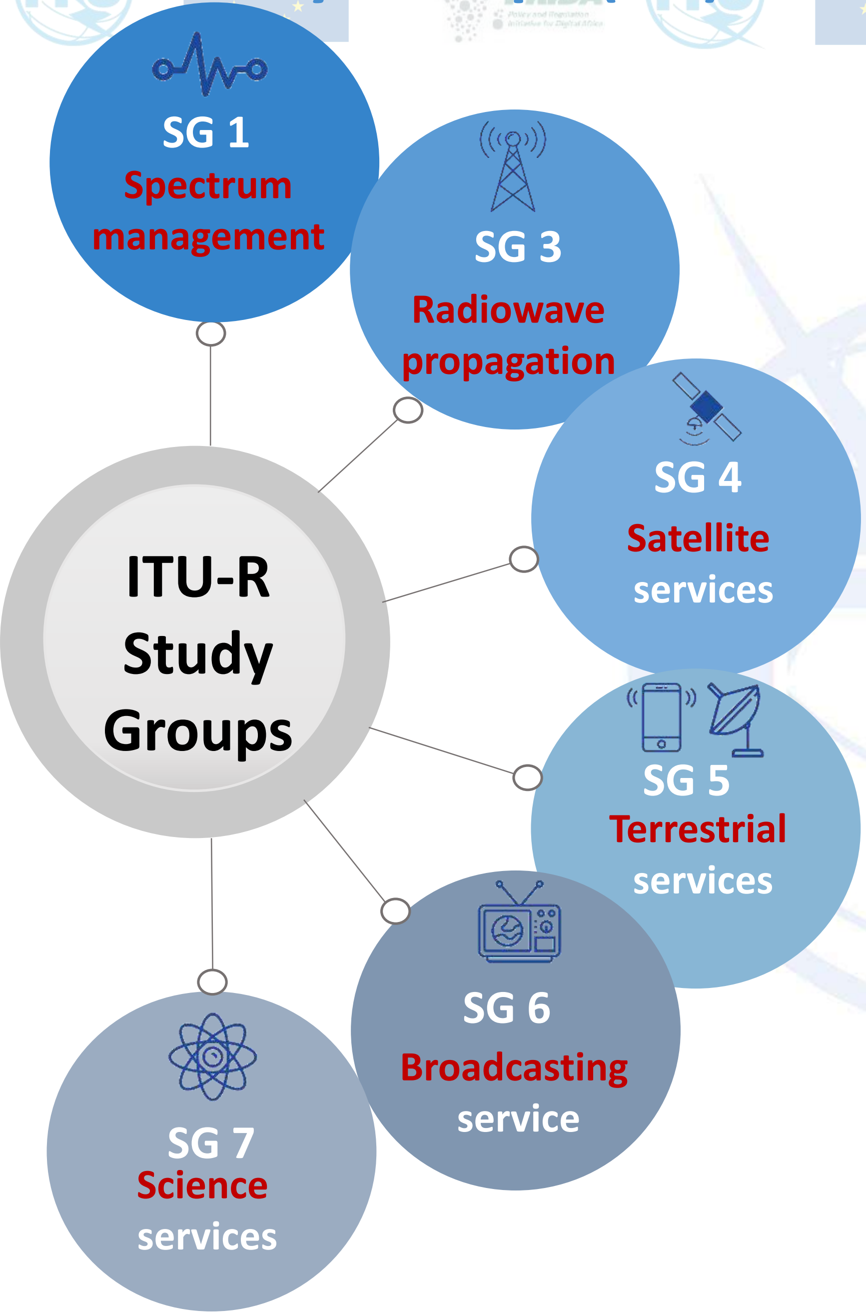
RA: Radiocommunication Assembly
WPs: Working Parties
TG: Task Groups

Radiocommunication Assembly 2019

ITURA
SHARM EL-SHEIKH2019
21 - 25 October
Sharm El-Sheikh, Egypt

- Held on 21 – 25 October 2019, in Sharm El-Sheikh, Egypt
- 521 participants, 91 ITU Member States, 48 ITU-R Sector members
- Maintained the ITU-R structure with **6** **ITU-R Study Groups**, **CCV**, **RAG** and **CPM**,
  Appointed **Chairmen and Vice-Chairmen** of these groups (see Res. ITU-R 4-8 & Doc. 84)
  Approved **programme of work/Questions** (Res. ITU-R 5-8) & **working methods** (Res. ITU-R 1-8 & 2-8)
- Approved **23 revised** **ITU-R Resolutions** and **2 new** **ITU-R Resolutions** (on broadcasting)
- Approved **5 ITU-R Recommendation** (including one on frequency arrangements for terrestrial IMT)

ITU-R Study Groups (SG)



SG 1

- WP 1A – Spectrum **engineering techniques**
- WP 1B – Spectrum **management methodologies** and **economic strategies**
- WP 1C – Spectrum **monitoring**

SG 3

- WP 3J – Propagation **fundamentals**
- WP 3K – **Point-to-point** propagation
- WP 3L – **Ionospheric** propagation and **radio noise**
- WP 3M – **Point-to-point** and **Earth-space** propagation

SG 4

- WP 4A – **Efficient orbit/satellite utilization** for **FSS and BSS**
- WP 4B – **Systems, air interfaces, performance** and **availability objectives** for **FSS, BSS and MSS** (incl. IP-based applications and SNG)
- WP 4C – **Efficient orbit/satellite utilization** for **MSS and RDSS**

SG 5

- WP 5A – **Land mobile > 30 MHz**, **fixed WAS**, **amateur** & **amateur-satellite**
- WP 5B – **Maritime** and **aeronautical** mobile services and **radiodetermination**
- WP 5C – **HF and other systems < 30 MHz** in the **fixed and land mobile services**
- WP 5D – **IMT systems**

SG 6

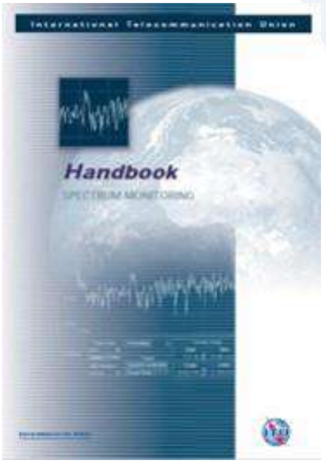
- WP 6A – Terrestrial broadcasting **delivery**
- WP 6B – Broadcast service **assembly and access**
- WP 6C – **Programme production** and **quality assessment**
- TG 6/1 – **WRC-23 agenda item 1.5** (use of the band 470-960 MHz) **New**

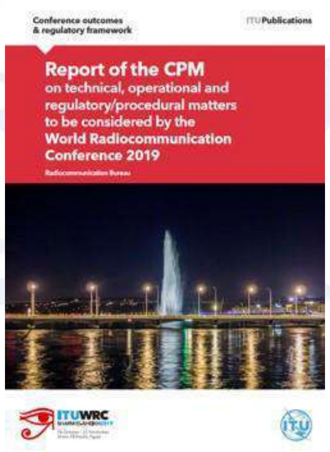
SG 7

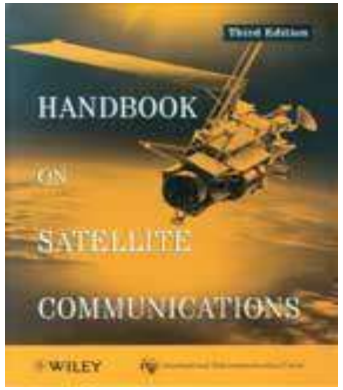
- WP 7A – **Time signals** and **frequency standard emissions**
- WP 7B – Space radiocommunication applications: **space operation, space research, Earth exploration**, **meteorological** satellite services
- WP 7C – **Remote sensing** systems (active and passive): **Earth exploration-satellite, MetAids, space research services**
- WP 7D – **Radio astronomy**

ITU-R Study Groups Products

- ITU-R Recommendations
- ITU-R Reports and Handbooks
- Technical bases for radio conferences







ITU-R Recommendations/Report series

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

SG 1 → **SM**

SG 3 → **P**

SG 4 → **M, S, SF, SNG**

SG 5 → **M, F, SF**

SG 6 → **BO, BR, BS, BT**

SG 7 → **RA, RS, SA, TF**

CCV → **V**

BR Publication Search Tool

Economic aspects of SM* (incl. redeployment/refarming)

* Spectrum Management

✓Report ITU-R SM.2012-6 at www.itu.int/pub/R-REP-SM.2012 (approved in June 2018)

- ➢Includes lists of legal, economic and reality principles for financing and promoting efficient NSM* (rights, auctions, fees) (Chapter 2)
- ➢Describes methods to assess spectrum's economic benefits and factors affecting benefits (incl. for international comparison of fee levels) (Chapter 3)
- ➢Provides guidelines on methodologies for establishment of spectrum fees formula and system (incl. for applying a new fees system) (Chapter 4)
- ➢Includes Administrations' experiences with fees (Chapter 5) from AUS, CAN, CHN, CLM, D, INS, ISR, KGZ, RUS, UK, USA, B, KOR

✓Rec. ITU-R SM.1603-2 (approved in August 2014) on spectrum redeployment (or refarming)

- ➢Includes examples on Redeployment cost & fund, etc., with ADMs' experiences from F, UAE, BEN, UKR, USA

* National SM

➢Regular updates of this information may be provided to every WP 1B meetings!

On-going work on Economic aspects of SM

✓On-going studies in response to Question ITU-R 240/1 (approved in September 2017) on Assessment of **spectrum efficiency and economic value**

- ✓ **Quantification of coverage & capacity** assists to ensure quality of service
- ✓ **Spectrum fees may assist to optimize the use of spectrum**
- ✓ To go **beyond info.** in Rep. ITU-R SM.2012 and **def.** of **spectrum use & efficiency of a radio system** (Rec. ITU-R SM.1046), e.g. **provide assessment of capacity** (bit/s/Hz)

- ➢ **Method** to **quantify spectrum efficiency**?
- ➢ **Factors** that **define the economic value of spectrum**?
- ➢ **General model** to **assess the economic value of spectrum**?

➢ The working document towards a draft new Report on these subjects will be further developed at the next WP 1B meeting.

➢Opportunities to contribute to the next WP 1B meeting (24 Nov. – 2 Dec. 2020)

Digital dividend and Dynamic access to spectrum

✓Report ITU-R SM.2353-0 at www.itu.int/pub/R-REP-SM.2353 (approved in June 2015)

Challenges and opportunities for SM resulting from the transition to digital terrestrial television in the UHF bands

- Provide a definition; some SM aspects relevant to the digital dividend (Planning principles, International & regional harmonization; Cross-border coordination; others (technical, socio-economic, societal, consumer demand, etc.)

✓Report ITU-R SM.2405-0 at www.itu.int/pub/R-REP-SM.2405 (approved in June 2017)

SM principles, challenges & issues related to dynamic access to frequency bands by means of radio systems employing Cognitive[1] capabilities

- Describes possible Techniques, Challenges and related Issues: Protection of **incumbent services**; **Cross-border coordination**; **Geolocation issue**; **Sensing technology**; **NRA responsibility** and **Database complexity; etc..**
- Includes Study cases from CEPT, RUS, CHN, BOT, PHL, KOR
- On-going revision of this Report to add a new study case of CLM

➢Opportunities to contribute to the next WP 1B meeting (24 Nov. – 2 Dec. 2020)

[1] Rep. ITU-R SM.2152 Def. of CRS & SRD

Evolving Spectrum Management Tools

✓Report ITU-R SM.2404-0 at www.itu.int/pub/R-REP-SM.2404 (approved in June 2017)

Regulatory tools to support enhanced shared use of the spectrum

➢Describes following approaches (with experiences of use):
- Licensed Shared Access (LSA)
- Shared Spectrum Access for Similar Technologies(SSA-ST)

✓WTDC-17 Report at www.itu.int/pub/D-STG-SG01.RES09.2-2017 (jointly approved by R-SG 1 in June 2017)

Evolving spectrum management tools to support development needs

- ➢ Summarizes **technical solutions** (IMT, WAS/RLAN, HAPS, Satellites, etc.) to provide wireless broadband (BB) coverage in wide-areas (incl. unserved & underserved areas)
- ➢ Indicates SM solutions for the spectrum use and sharing: **Licensed** (mobile BB, DTT, etc.); **License-exempt** (e.g. SRDs); **Dynamic spectrum access** techniques/ mechanisms (e.g. DFS, geolocation DB, LSA, TVWS, etc.) and **associated challenges**
- ➢ Assess some **economic aspects** of these solutions
- ➢ Describes some SM activities & resources (NTFA, spectrum monitoring, international activities such as WRCs).

On-going work on Spectrum Management Methodologies

✓On-going study on Question ITU-R 241/1 (approved in August 2019) on
Methodologies for **assessing or predicting spectrum availability**

- ✓ **Larger and more complex SM data** in the viewpoint of data science
- ✓ May **require advanced data analysis methods** including **machine learning**

- ➢ **Criteria and information?**
- ➢ **Methodologies**?
- ➢ **Technical approaches**, such as **data-driven management**, etc., that may **improve overall spectrum utilization**?

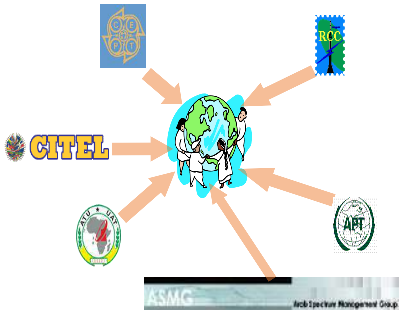
➢Opportunities to contribute to the next WP 1B meeting (24 Nov. – 2 Dec. 2020)

Guidance on the regulatory framework for NSM*

✓Report ITU-R SM.2093-3 at www.itu.int/pub/R-REP-SM.2093 (approved in June 2018)

- ✓ **Based on international principles** to **govern the spectrum use** and on **bi/multi-lateral agreements using ITU instruments** (CS, CV, RR, ITU-R Recommendations, etc)
- ✓ Need for **regional harmonization and standardization** (APT, ASMG, ATU, CEPT, CITEL, RCC)
- ✓ **Linkage between international and national regulations** (allocations, assignments, licensing, monitoring, interference) **preserving States' rights and obligations**
- ✓ Need for **national legal framework/regulation** to **take account of national specificities** (geographical, geopolitical, cultural, social, economical, etc.)
- ✓ Describes also **examples of National SM organizations** (F, UK, USA, CAN, NZL, CME, KOR, SUI, JOR, B, IND, CHN, UAE)
- ✓ See also the ITU Guidelines for the preparation of NTFA (2015) and A Standard Approach for Assessing the SM needs of Developing Countries (2016)

* National Spectrum Management



ITU-R Harmonization for Short-Range Devices

✓Report ITU-R SM.2153-7 at www.itu.int/pub/R-REP-SM.2153 (approved in June 2019)

Technical and operating parameters and **spectrum use** for SRDs

- ➢Definition of SRD (operating on a non-interference & non-protected basis)
- ➢Describes some SRD Applications (e.g. Telecommand, RFID[1], Alarms, etc.) [2]
- ➢Provides radiated power or magnetic/electric field-strength limits
- ➢Describes Administrative requirements (Certification and verification; Mutual agreements between countries/regions)
- ➢Provides information on national/regional rules (CEPT, USA, CHN, J, KOR (and some other APT countries), B, UAE, RCC)

[1] Rep. ITU-R SM.2255

[2] LPWAN in Rep. ITU-R SM.2423

✓Rec. ITU-R SM.2103-0 (approved in September 2017) on **SRD categories**

✓Rec. ITU-R SM.1896-1 (approved in September 2018) on **Frequency ranges** for **global or regional harmonization** of SRD

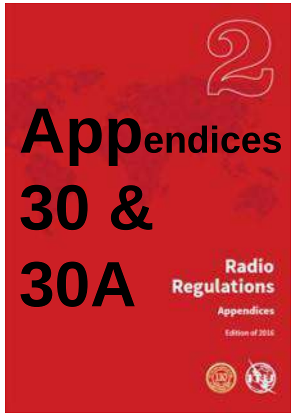
- ➢ Considering new range around 1.6 GHz for Assistive Listening Systems

➢Opportunities to contribute to the next WP 1B meeting (24 Nov. – 2 Dec. 2020)

Example of Space Plans – App. 30/30A BSS Plans

✓ITU CV Art. 44 (No. 196) & RR No. **0.3** includes provisions for **equitable access to radio frequencies and associated orbits resources**

✓Res. **507 (Rev.WRC-19)** – Establishment of agreements and associated plans for the broadcasting-satellite service (BSS, does not apply to the band 21.4-22 GHz)



✓**BSS & FL Plans established by WRCs** in Ku-bands

✓In Region 1 downlink, the **11.7-12.5 GHz band** is **divided into 40 channels of 27 MHz each**

✓**Each country** is **provided with** following **main features**:

- One **orbital position** in the GSO (several for large territories)
- Satellite **beam characteristics** to **cover the national territory**
- A **given number of channel/assignments per beam** (~10 in R1)

✓App. 30 & 30A contain also **regulatory procedures**, including provisions to **bring into use the assignments** and to **protect them before & after the bringing into use**

- 11.7-12.2 GHz (Region 3)
- 11.7-12.5 GHz (Region 1)
- 12.2-12.7 GHz (Region 2)

- 17.3-18.1 GHz (Region 1&3)
- 17.3-17.8 GHz (Region 2)
- 14.5-14.8 GHz (Region 1&3 except Europe)

✓ Additional information in the BR presentation No.18 at WRS-18

ITU-R Spectrum Harmonization for PPDR*

* Public Protection and Disaster Relief

- Relevant parts of the **WRC-15 decisions** were to:
  - ✓ **Encourage the use of harmonized bands**, especially for broadband: **694-894 MHz (globally); 380-470 MHz (in Reg. 1); 406.1-430 MHz, 440-470 MHz & 4 940-4 990 MHz (in Reg. 3)**
  - ✓ Invite ADMs to **use Rec. ITU-R M.2015 for national planning**

- **Rec. ITU-R M.2015** was revised in 2018 to provide **Frequency arrangements for PPDR radiocommunication systems – for use as guidance by ADMs when making spectrum available for PPDR applications (App.)**
- **Rec. ITU-R M.1826** was also revised in 2019 to provide **Harmonized frequency channel plans A & B for BB PPDR operations at 4 940-4 990 MHz in Reg. 2 & 3, for consideration by ADMs**
- See also Rec. ITU-R M.1637 (rev. Jan. 2019) – **Global cross-border circulation** of radio-communication **equipment for use in emergency and DR situations**

  Rec. ITU-R M.2009 (rev. Jan. 2019) – **Radio interface standards** for **PPDR** operations

ITU-R Spectrum Harmonization for PPDR (cont'd)

Frequency range (MHz)	Reg. 1 CEPT	Reg. 1 Arab States	Reg. 1 ATU	Some Reg. 1 countries	Some Reg. 1 countries	Some Reg. 1 countries	Region 2 CITEL	Some Reg. 2 countries	Reg. 3 APT	Some Reg. 3 countries
694 to 698		BB	BB						BB	NB and/or BB
698 to 703	BB	BB	BB						BB	NB and/or BB
703 to 723	BB	BB	BB	BB			BB		BB	NB and/or BB
723 to 764	BB	BB	BB	BB	BB		BB		BB	NB and/or BB
764 to 768	BB	BB	BB	BB	BB		BB & App.		BB	NB and/or BB
768 to 788	BB	BB	BB		BB		BB & App.		BB	NB and/or BB
788 to 791	BB	BB	BB				BB & App.		BB	NB and/or BB
791 to 806			BB			BB	BB & App.		BB	NB and/or BB
806 to 862			BB			BB	BB	NB	BB	NB and/or BB
862 to 869			BB				BB	NB	BB	NB and/or BB
869 to 894			BB						BB	NB and/or BB

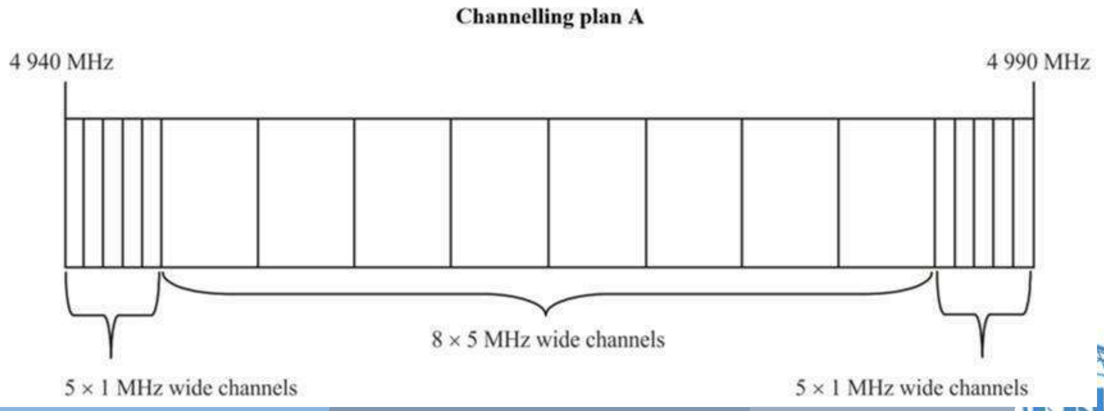
- **Frequency arrangements for PPDR in parts of frequency range 694-894 MHz (global basis)**

  (BB=broadband PPDR, NB=narrowband PPDR)

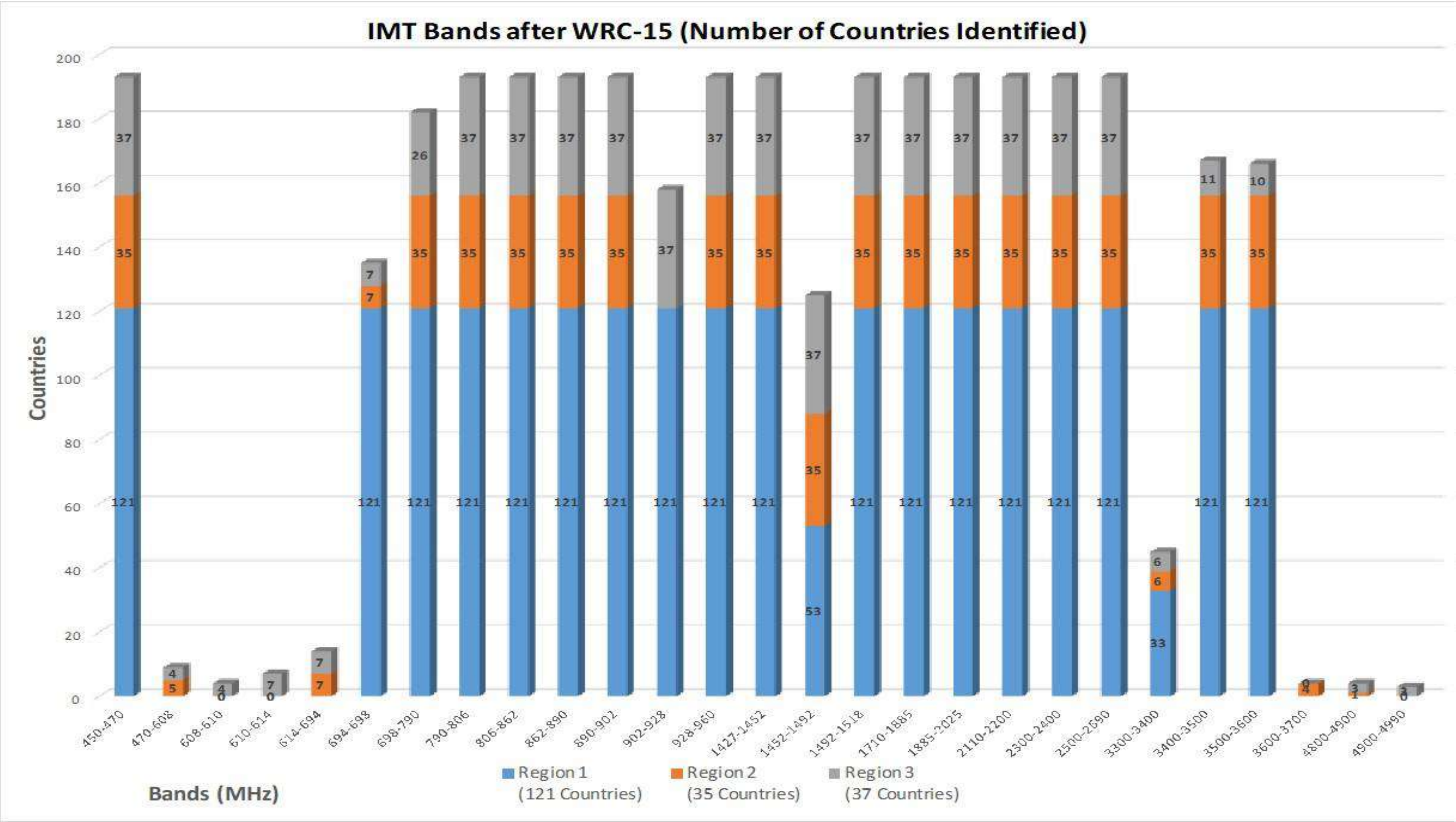
  Source: Recommendation ITU-R M.2015-2 (January 2018, www.itu.int/rec/R-REC-M.2015)

- **Harmonized frequency channel plans A & B for BB PPDR operations at 4 940-4 990 MHz in Regions 2 and 3**

  Source: Recommendation ITU-R M.1826-2 (November 2019, www.itu.int/rec/R-REC-M.1826)

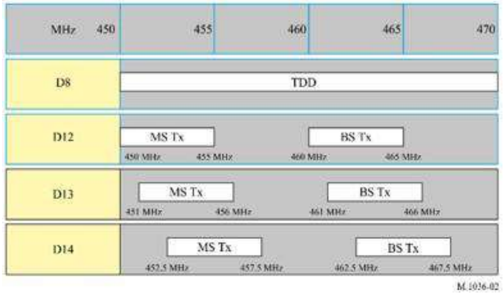


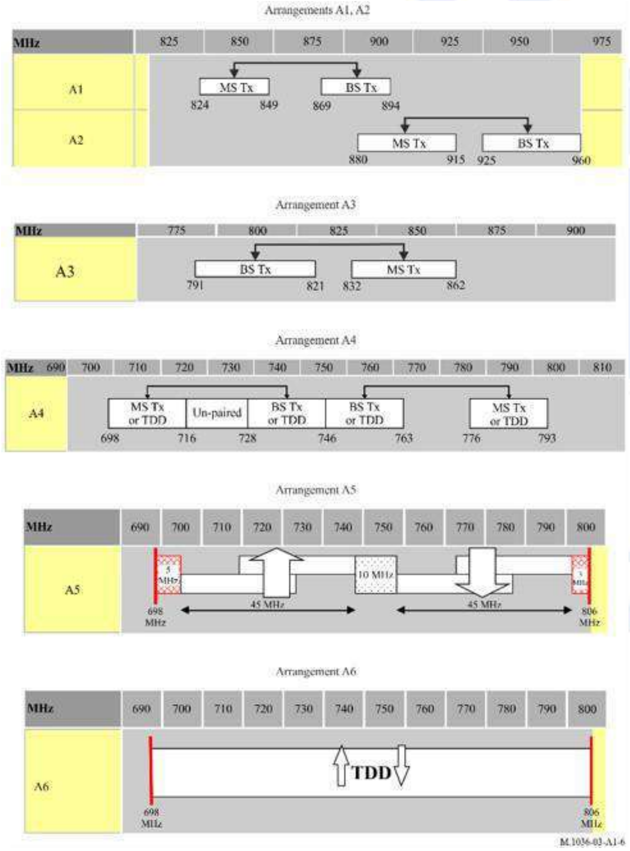
Frequency bands identified for IMT prior to WRC-19

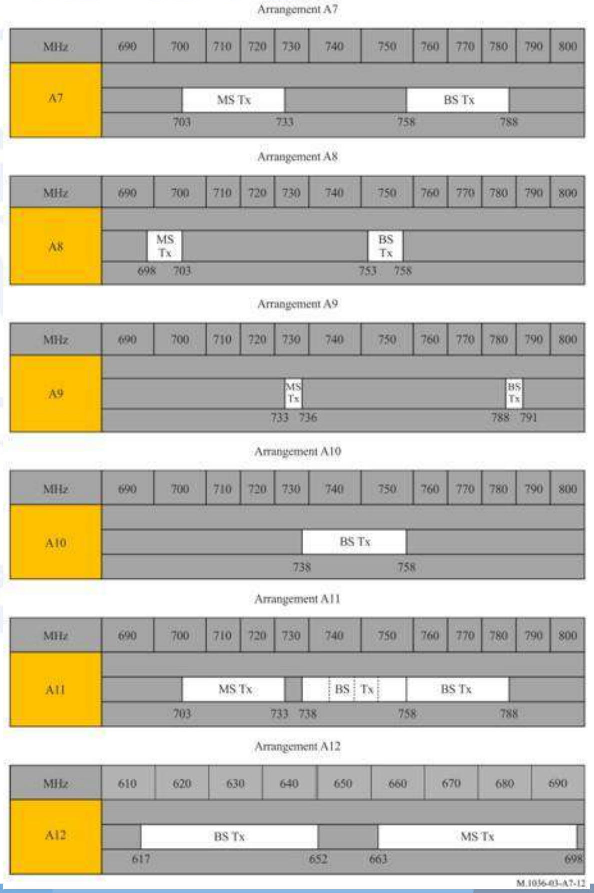


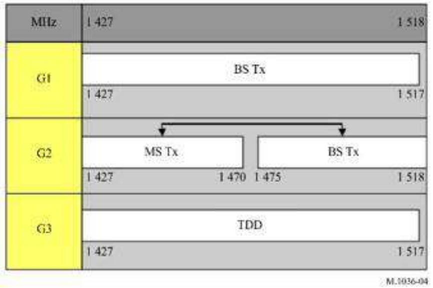
Frequency arrangements for IMT

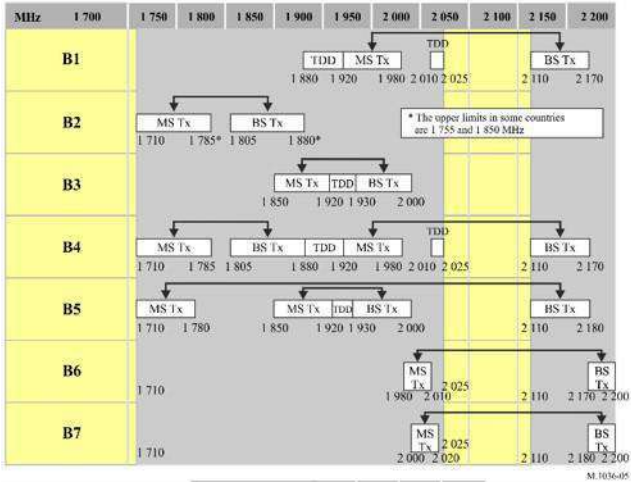
- **[Rec. ITU-R M.1036-6](www.itu.int/rec/R-REC-M.1036)** at www.itu.int/rec/R-REC-M.1036 (most recent revision at RA-19)
  Frequency arrangements for implementation of the terrestrial component of **International Mobile Telecommunications** in the bands identified for IMT in RR

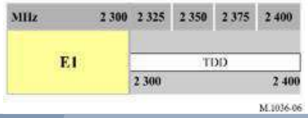










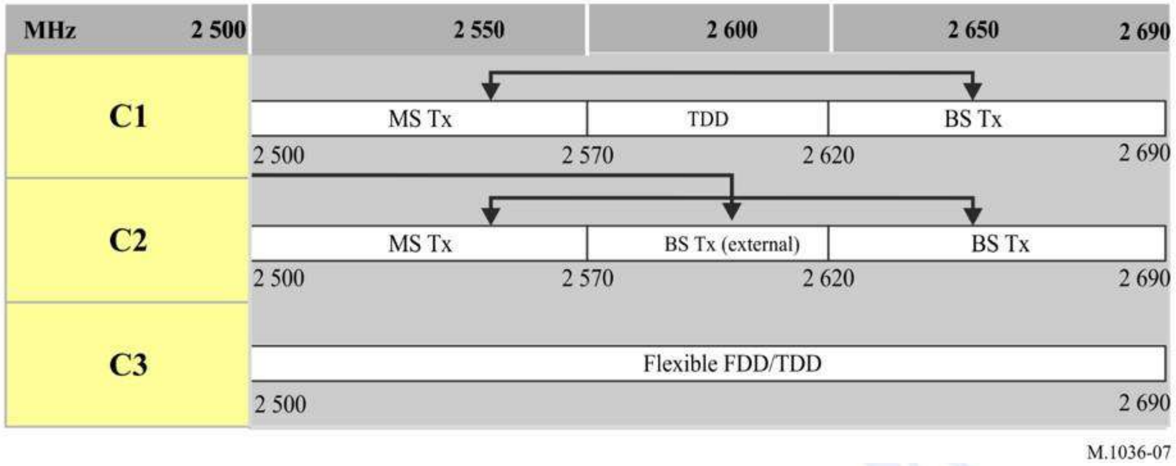


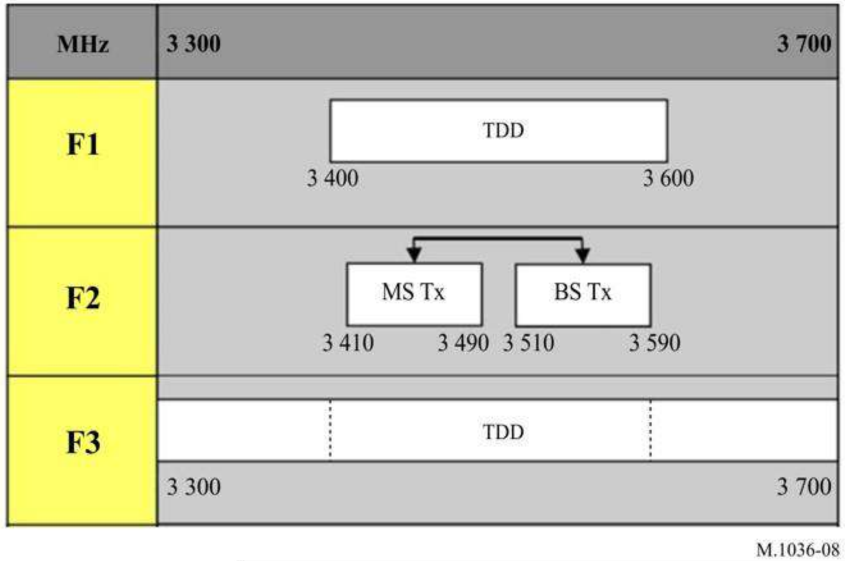
FDD: frequency division duplex
TDD: time division duplex

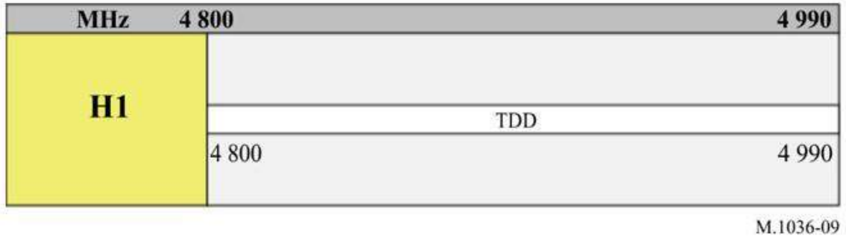
Frequency arrangements for IMT (Cont'd)

➢ **Rec. ITU-R M.1036** at www.itu.int/rec/R-REC-M.1036 (most recent revision at RA-19)

Frequency arrangements for implementation of the terrestrial component of **International Mobile Telecommunications** in the bands identified for IMT in RR

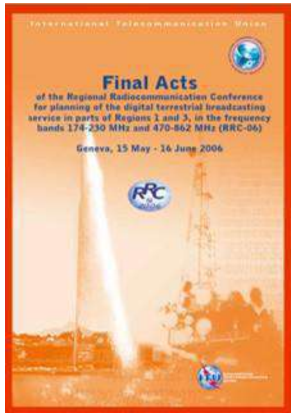






FDD: frequency division duplex
TDD: time division duplex

Example of Broadcasting Regional Plan: GE06



- **2 plans: Analogue and digital in**
  - Analogue plan: Assignments (television) - will cease to exist on 17 June 2020
  - Digital plan: Assignments and allotments (sound and television)
  - List of frequency assignments for other primary services
- **Region:** Region 1 (except the territories of MNG) and IRN
- **Bands** **(incl. channel numbering & channel boundaries)**

Band III: 174-230 MHz*
(*for Morocco 170-230 MHz)

Band IV: 470-582 MHz
Band V: 582-862 MHz

- **Channels:**

Band III: **7/8 DVB-T channles of 8/7 MHz badwidth** respect.
32 T-DAB blocks of 1.75 MHz bandwidth
Bands IV and V: **49 channels of 8 MHz bandwidth each**

- **Services:**
  - Broadcasting: *Digital sound & Analogue and digital television*
  - Other primary services

✓ Additional information in the BR presentation No. 7 at WRS-18

✓ See also latest SG 6 Recs in BT series, e.g. **BT.2020** (UHDTV); **BT.2033** (2nd generation DTTB); **BT.2052** (mobile reception); **BT.1667** (return channel / interactive BS)

Importance of EESS and remote sensing spectrum

✓Report ITU-R RS.2178 at www.itu.int/pub/R-REP-RS.2178 (approved in 2010)

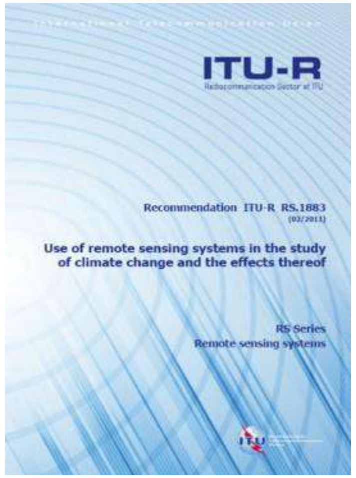
The essential role & global importance of radio spectrum use for Earth observations and for related applications

- Extensive overview of the use of the spectrum for this purpose
- Considerable societal weight & economic benefits of the spectrum use for Earth observation
- Economic benefits of solar monitoring and radio astronomy

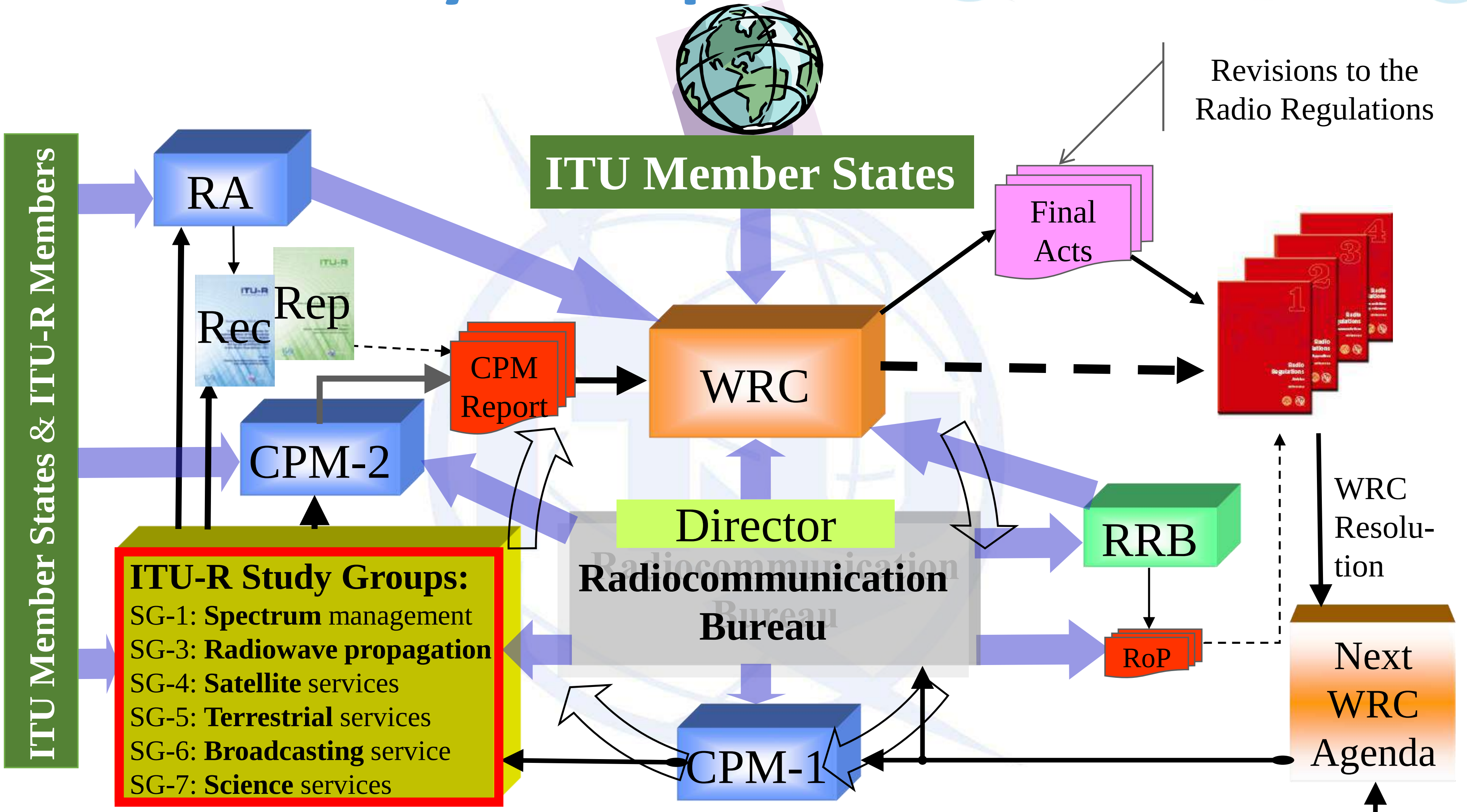
✓Rec. ITU-R RS.2178 at www.itu.int/rec/R-REC-RS.1883 (approved in 2011)

Use of remote sensing systems in the study of climate change and the effects thereof

- Guidelines on the provision of satellite-provided remote sensing data for the purpose of studying climate change
- Summary of status of major climate variables and forcing factors
- Protection of science service spectrum



ITU-R Study Groups in WRC Process



RRB: Radio Regulations Board
SGs: Radiocommunication Study Groups
RA: Radiocommunication Assembly
WRC: World Radiocommunication Conference

CPM: Conference Preparatory Meeting
Rec: ITU-R Recommendation
RoP: Rules of Procedure
RR: Radio Regulations (treaty status)

Thank you!

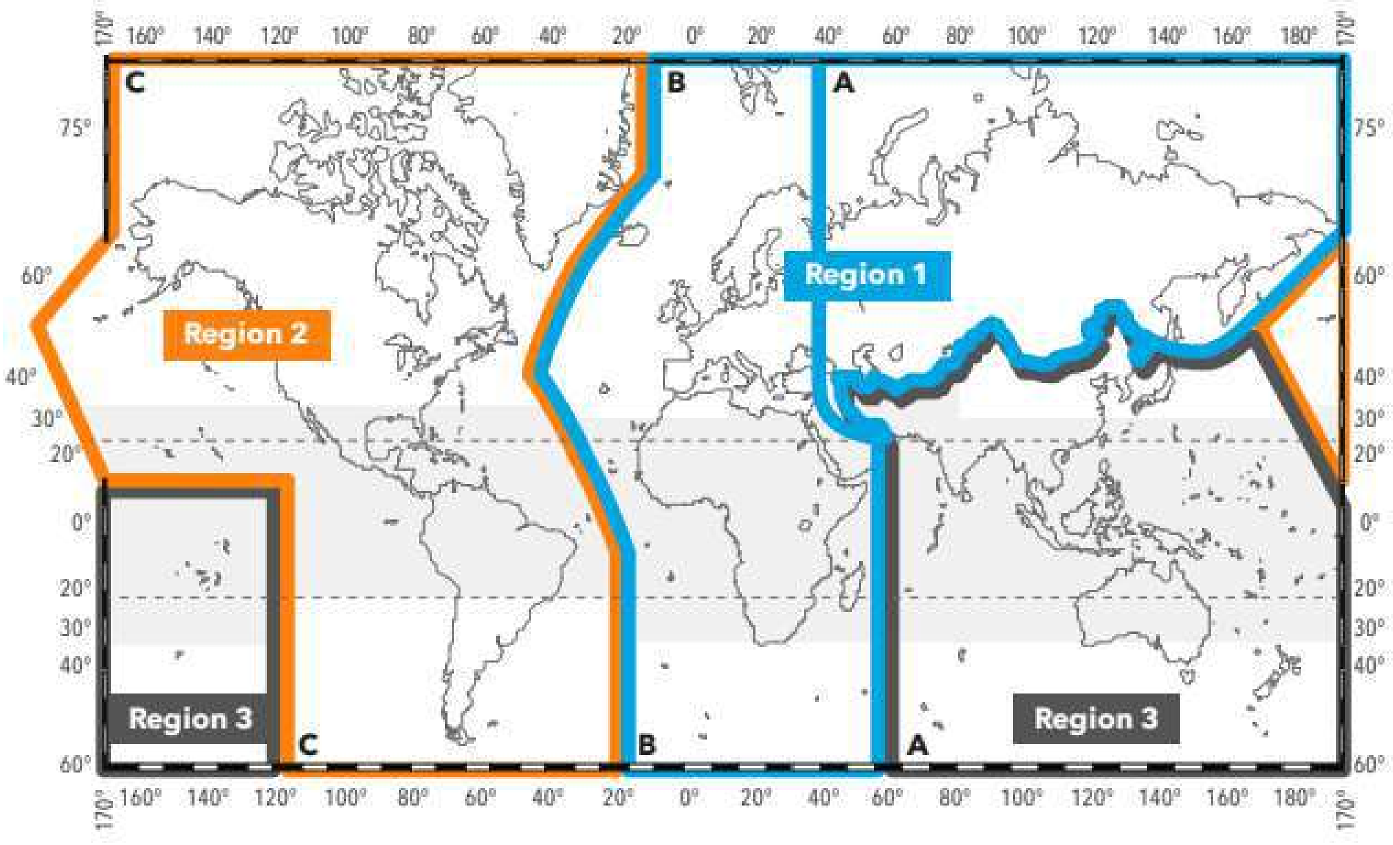
ITU-R Study Groups

Key Outcomes of WRC-19 and Preparation for WRC-23

World Radiocommunication Conferences (WRCs)

- **Updated the Radio Regulations,**
  the **international treaty** on the **use of radio spectrum and satellite orbits**
- **Brought together all stakeholders** in a process that is aimed at **building consensus**
- Provided a **stable** and **predictable regulatory environment** needed **for future investments**
- Enabled **new radiocommunication systems** and **applications** to **access the radio spectrum**
- Protected the operation of **existing radiocommunication services**
- Ensured the **rational, equitable, efficient and economical use** of the **radio-frequency spectrum and satellite-orbit resources**

Worldwide or Regional Spectrum Harmonization



Benefits :

- Reduces the potential for **harmful interference**
- Enables interoperability and **international roaming**, allowing citizens to use the same device in different countries
- Increases economies of scale, thereby enabling **affordable devices and services**
- Supports **emergency communications**

WRC-19 in numbers

- 4 week discussions, 28 October - 22 November 2019 , Sharm El-Sheikh, Egypt
- 3 420 participants ,163 administrations, 129 other entities, including industry
- 38 agenda items and issues, 568 documents, 5811 proposals
- Spectrum and regulations for most radiocommunication services

Topics considered at WRC-19

1.13
1.14
1.15
1.16

Fix. & Mob. BB Apps
(24.25 < IMT < 86 GHz, HAPS, Apps.Id>275 GHz, WAS/RLAN @ 5 GHz)

Maritime (GMDSS modernization (+Sat.), use of radio devices, VDES Sat component)

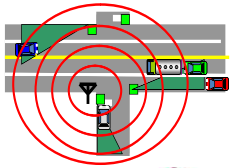
1.8
1.9.1
1.9.2

1.1

Amateur in R1 @ 50-54 MHz
(4WW allocation)

Aeronautical
(GADSS needs)

1.10



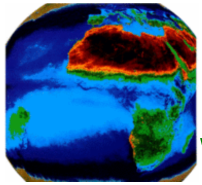
1.11
1.12

New Transport systems
(harmonized bands for railways, ITS)

Satellite issues
(BSS/FSS @12 GHz, ESIM, regul. for N-GSO FSS @ 37.5 to 51.4 GHz)

1.4, 1.5, 1.6

1.2
1.3
1.7



Earth resources & Climate monitoring Weather forecast, DCS improvement, TT&C for N-GSO Sat. of short duration

Regulatory issues
(Sat. regulations, harmonization of spectrum use, etc.)

7 (incl. 11 issues)
8

Plus other standing agenda items:
2, 4, 9.1 (incl. 10 issues), 9.2, 9.3 and 10

Note: *WRC-19 agenda item numbers indicated in italic*

Access to WRC-19 outcomes

www.itu.int/go/wrc-19

WRC-19 Provisional Final Acts

Minutes of the Plenary Meetings

WRC-19 Documents (Proposals, White, White Series, Blue, Pink)

Proposal (+ Doc.) Management System

Access to all other documents, incl. TD, Blue and Pink series

Special ITU News Magazine WRC-19 Key Outcomes

Other outcomes and follow-up

WRC-19 Final Acts
[not yet available]

ITU Council 2020 documents on
WRC-19 and WRC-23
[not yet available]

See relevant new and future BR Circular Letters at:
www.itu.int/md/R00-CR-CIR/en

Circulars		
	Number	Title
☐	[456]	WRC-19 decisions included in the Minutes of Plenary meetings
☐	[455]	Implementation of Resolution 559 [COM5/3] (WRC-19)

WRC-19 Proposal (+Doc.) Management System

www.itu.int/net4/Proposals/WRC19/Main

WRC-19 | See Report of the CPM

Full Text Search

Filtering

May also be used to display CPM Report regulatory examples

Export content(s) | Export results

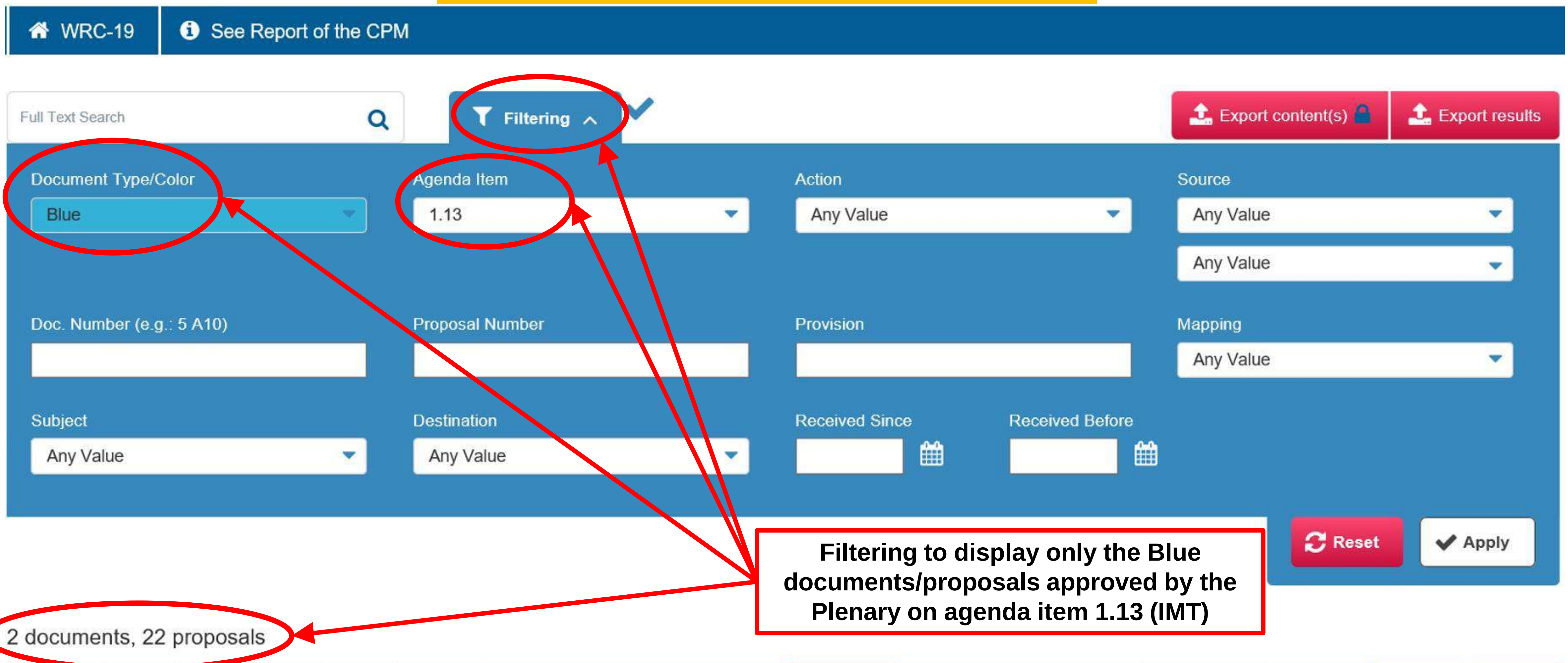
Overall numbers of issued documents with proposals* (*incl. typically ADD/MOD/SUP/NOC on RR provisions)

970 documents, 5811 proposals

English		Agenda Item	Action	Source	Doc. Number	Proposal	Provision/Reference	Mapping	Destination	Received	Properties
		1.13	MOD	AHGPL4A	544	4	5.338A	Vol.1/Chp. II	COM7	11/21/2019	
		1.13	MOD	B61	556	1	5.338A	Vol.1/Chp. II	PLEN	11/21/2019	
		1.6	MOD	B60	555	1	5.338A	Vol.1/Chp. II	PLEN	11/21/2019	
		1.8	MOD	AHGPL4C	529 R1	1	1 610-1 660 MHz	Vol.1/Chp. II	PLEN	11/21/2019	
		1.8	ADD	AHGPL4C	529 R1	2	5.ADJBAND	Vol.1/Chp. II	PLEN	11/21/2019	
		1.8	ADD	AHGPL4C	529 R1	3	5.INBAND	Vol.1/Chp. II	PLEN	11/21/2019	
		1.8	MOD	B61	556	2	1 610-1 660 MHz	Vol.1/Chp. II	PLEN	11/21/2019	
		1.8	ADD	B61	556	3	5.ADJBAND	Vol.1/Chp. II	PLEN	11/21/2019	
		1.8	ADD	B61	556	4	5.INBAND	Vol.1/Chp. II	PLEN	11/21/2019	

WRC-19 PMS filtering (ex. for AI 1.13)

www.itu.int/net4/Proposals/WRC19/Main



English	Agenda Item	Action	Source	Doc. Number	Proposal	Provision/Reference	Mapping	Destination	Received	Properties
	1.13	MOD	B61	556	1	5.338A	Vol.1/Chp. II	PLEN	11/21/2019	
	1.13	MOD	B61	556	7	22-24.75 GHz	Vol.1/Chp. II	PLEN	11/21/2019	

Additional spectrum for IMT

WRC-19 agenda item 1.13

- A total of **17.25 GHz** of additional spectrum was **identified for IMT**, in **5 bands, out of which**:
  - **14.75 GHz (86%) are harmonized on a global basis**, in bands:

    24.25-27.5 GHz, **37-43.5 GHz** and **66-71 GHz**
  - 2.5 GHz are harmonized on a regional basis or for some countries, in bands:

    45.5-47 GHz and 47.2-48.2 GHz
- For the IMT systems in **24.25-27.5 GHz**, **Res. 750 (Rev. WRC-19)** specified the **limits of unwanted emission power levels** to **protect** systems in the **Earth exploration-Satellite Service (passive)** in **23.6-24.0 GHz**, in a two-step approach:

  - Before 1 September 2027: -33/-29 dBW/200 MHz for base/mobile station
  - After 1 September 2027: -39/-35 dBW/200 MHz for base/mobile station
- In band **66-71 GHz**, balanced approach between IMT and other WAS applications: ADMs may **implement IMT** or **consider coexistence** between IMT & these applications
- NOC in other 6 bands which were under consideration: 31.8-33.4 GHz, 47-47.2 GHz, 48.2-50.2 GHz, 50.4-52.6 GHz, 71-76 GHz, 81-86 GHz.

► **WRC-19 new Res. 241, 242, 243 and 244** (ex. COM4/7, COM4/8, COM4/9 and COM4/10 resp.)

Number of countries in Additional spectrum for IMT

WRC-19 agenda item 1.13

Bands identified for IMT GHz (BW)	Region 1 (adm)	Region 2 (adm)	Region 3 (adm)
24.25-27.5 (3.25)	All	All	All
37-43.5 (6.5)	All	All	All
45.5-47 (1.5)	50	1	2
47.2-48.2 (1.0)	64	All	7
66-71 (5.0)	All	All	All

NOC GHz
31.8-33.4
47-47.2
48.2-50.2
50.4-52.6
71-76
81-86

(adm: number of countries)

Harmonization of IMT bands below 5 GHz at WRC-15 and at WRC-19

WRC-19 agenda item 8

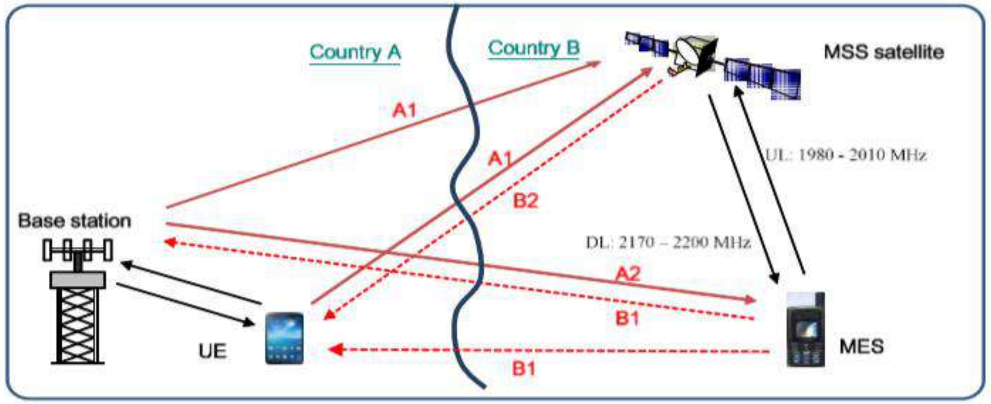
Freq_fm (MHz)	Freq_to (MHz)	BW (MHz)	At WRC-19 adm XR1	At WRC-19 adm XR2	At WRC-19 adm XR3	At WRC-19 adm XAA	At WRC-15 adm XR1	At WRC-15 adm XR2	At WRC-15 adm XR3	At WRC-15 adm XAA
614	694	80	0	8	7	15	0	7	7	14
694	698	4	121	8	7	136	121	7	7	135
698	790	92	121	35	27	183	121	35	26	182
3300	3400	100	33	13	7	53	33	6	6	45
3400	3500	100	121	35	16	172	121	35	11	167
3500	3600	100	121	35	13	169	121	35	10	166
3600	3700	100	0	7	0	7	0	4	0	4
4800	4900	100	33	4	6	43	0	1	3	4
4900	4990	90	33	1	6	40	0	0	3	3

(adm: number of countries in Reg. 1, 2, 3 (XR1, XR2, XR3 resp.) and in total (XAA))

Sharing of terrestrial IMT with satellite component and BSS

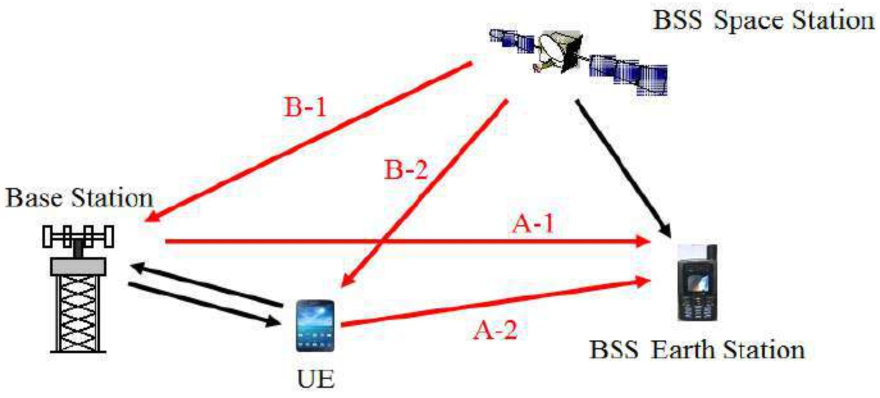
WRC-19 agenda item 9.1, issues 9.1.1 and 9.1.2

Issue 9.1.1



- **New technical and operational conditions** for operation of IMT terrestrial & satellite components in **1 980-2 010 MHz** and **2 170-2 200 MHz**. Include an **e.i.r.p. limit for terrestrial stations** and **pfd limit for space transmitters**
  - ► **Res. 212 (Rev. WRC-19)**

Issue 9.1.2



- **New technical conditions & coordination guidelines** for **sharing between IMT and BSS (sound)** in **1 452-1 492 MHz**, with **pfd limits on BSS satellite and IMT stations**
  - ► **Res. 761 (Rev. WRC-19)**

Wireless Access System (WAS/RLANS)

WRC-19 agenda items 1.16 and 9.1 (issue 9.1.5)

- Change of regulatory conditions for **WAS/RLANs in the band 5 150-5 250 MHz**
  - Allowing the **use of Wi-Fi devices in trains and cars**, which was very much sought by the automotive and railway industries
    - **Indoor usage**, **including inside trains**, with **maximum mean e.i.r.p.** of **200 mW**, and
    - usage **inside automobiles** with **maximum e.i.r.p.** of **40 mW**
  - Permits also a **limited deployment of outdoor WAS/RLANs**, **with due protection of space services**
    - **Controlled/limited outdoor usage** with a **maximum mean e.i.r.p.** of **200 mW**
    - Up to 1 W could be allowed, with e.i.r.p. mask for protection of space receivers
    - The number of higher power outdoor RLANs shall not exceed 2% of total

► Res. 229 (Rev. WRC-19)

- **No changes for other 4 bands** under consideration **due to sharing constraints**: **5 250-5 350 MHz; 5 350-5 470 MHz; 5 725-5 850 MHz, 5 850-5 925 MHz**
- For the **bands 5 250-5 350 MHz & 5 470-5 725 MHz,** clarifications in respective RR No. **5.447F** by which **RLS, EESS (active) and SRS (active)**, and in RR **5.450A** by which **RDS, shall not impose more stringent conditions upon the MS than those in Res. 229 (Rev. WRC-19)**

High Altitude Platforms (HAPS)

WRC-19 agenda item 1.14

- A total of **5.25 GHz** of spectrum in **5 bands are identified for HAPS, out of which**:
  - **2.4 GHz are now harmonized on a global basis**, in bands:

    31-31.3 GHz, **38-39.5 GHz** (at WRC-19), **47.2-47.5 GHz*/47.9-48.2 GHz***

    * With modified operational conditions
  - 2.85 GHz are now harmonized for Region 2, in bands:

    21.4-22 GHz and 24.25-27.5 GHz (both at WRC-19)
- **NOC for 6 GHz** (still 5 countries using the bands 6 440-6 520 MHz / 6 560-6 640 MHz)
- **1 country** added to the many others using the band **27.9-28.2 GHz**
- **Conditions were imposed on HAPS to protect the existing services** (RR footnotes, Res.): **limitations on link direction** (uplink/downlink), **category of service** (primary/secondary) and various **technical restrictions** (RR Art. 11, App. 4 and App. 7 have been modified accordingly)
- WRC-19 decisions will
  - **facilitate the development and implementation of HAPS**
  - **enable affordable broadband connectivity and telecommunication services** in **underserved communities and in rural and remote areas** (incl. mountainous and desert zones), noting that HAPS can also be used for **disaster recovery communications**

High Altitude Platforms (HAPS) (Cont'd)

WRC-19 agenda item 1.14

	21.4-22 GHz	24.25-27.5 GHz	27.9-28.2 GHz	31.0-31.3 GHz	38-39.5 GHz	47.2-47.5 GHz and 47.9-48.2 GHz
	Resolution **165** (WRC-19)	Resolution **166** (WRC-19)	Resolution **145** (Rev.WRC-19)	Resolution **167** (WRC-19)	Resolution **168** (WRC-19)	Resolution **122** (Rev.WRC-19)
Region 1				↓:↑	↓:↑	↓:↑
Region 2	↓	24.25-25.25 GHz ↓ 25.25-27.0 GHz ↑ 27.0-27.5 GHz ↓		↓:↑	↓:↑	↓:↑
Region 3				↓:↑	↓:↑	↓:↑
Countries			↓			

HAPS-to-ground: ↓
ground-to HAPS: ↑

- ► **Res. 122** (Rev.WRC-19)**, Res. 145** (Rev.WRC-19) **and**
- ► **WRC-19 new Res. 165, 166, 167 and 168** (ex. COM4/3, COM4/4, COM4/5 and COM4/6 resp.)

Transport communications

FS & MS applications in 275-450 GHz

WRC-19 agenda items 1.11, 1.12 and 1.15

1.11 Railway radiocommunications between train and trackside (**RSTT**)

► **WRC-19 new Resolution 240** (ex. COM4/2) **inviting** the **ITU-R** to **continue** the **development of spectrum harmonization** of RSTT in existing mobile service allocations via ITU-R Recommendations and Reports

1.12 Spectrum harmonization for Intelligent Transport Systems (**ITS**)

► **WRC-19 new Recommendation 208** (ex. COM4/1) **encouraging** the **use of globally or regionally harmonized frequency bands for evolving ITS**
Will contribute to connection of vehicles, improvement of traffic management and safe driving

1.15 **Identification of bands** 275-296 GHz, 306-313 GHz, 318-333 GHz & 356-450 GHz for **land mobile and fixed services applications**. Other bands within 275-450 GHz may only be used subject to **specific conditions to protect EESS (passive)**. **Protection of radio astronomy** ensured by specific conditions (e.g. minimum separation distances and/or avoidance angles) in **Res. 731** (rev.WRC-19)

Enabling future **high data rate wireless systems (>100 Gbit/s)**

Amateur, Maritime and Aeronautical issues

WRC-19 agenda items 1.1, 1.8, 1.9.1, 1.9.2, 1.10 and 9.1 (issue 9.1.4)

1.1 Allocated 50-52 MHz band in **Reg. 1** to **amateur service** on a **secondary basis**

► completed partial **spectrum harmonization** throughout the 3 Regions

GMDSS

1.8 a) **Authorized usage of NAVDAT*** in bands **415-495 kHz** and **505-526.5 kHz** and **6 HF channels** in RR App. **17 for NAVDAT in maritime mobile service**

* Navigational data

b) Allocation to **maritime MSS** was **upgraded** (**1621.35-1626.5 MHz**) to **expand the provision of a truly global maritime distress and safety system**

1.9.1 **Limitation** of Autonomous Maritime Radio Devices (**AMRD**) frequencies to **specific channels**

► Operation of two groups* of AMRDs is regulated, thus **enhancing safety at sea**

* *Group A*: those enhancing safety of navigation; *Group B*: others

1.9.2 ► Secondary allocations to **NGSO MMSS** (↓&↑links) enabling **VDES sat. component** and the **implementation of complete VHF Data Exchange System concept**

1.10 **No RR changes** for **GADSS**. WRC-23 will review outdated aeronautical RR provisions.

► **New WRC-19 Res. 427** (ex.COM4/1)

9.1.4 **No RR change** for **sub-orbital vehicles**. Studies continue for WRC-23 agenda item 1.6

Non-GSO satellites systems

WRC-19 agenda items 1.6 and 7 (issue A)

1.6 **Clarifications** of the **regulatory framework** for **non-GSO satellite systems** in bands between **37.5 GHz** and **51.4 GHz**

► **WRC-19 new Res. 769, 770 & 771** (ex. COM5/10, COM5/11 & COM5/12 resp.)

7(A) **New regulatory framework**, including the **bringing into use** and a **milestone-based approach** for the **deployment of non-GSO satellite constellations** in specific frequency bands and services

- non-GSO systems will **have to deploy 10% of their constellation within 2 years after the end of the current regulatory period for bringing into use**, **50% within 5 years**, and **complete the deployment within 7 years**.

This approach will help **ensure that the MIFR is aligned** with the actual deployment of non-GSO satellite systems and

- will **enable mega constellations of satellites** (hundreds to thousands of spacecraft) to rapidly come to fruition, ensuring operation of as many systems as possible
- will **ensure more affordable means of connectivity** to **rural and remote areas**, providing innovative solutions to **bridging the digital divide** as well as providing **broadband for all**

► **WRC-19 new Res. 35** (ex. COM5/7)

BSS & FSS Plans and ESIM

WRC-19 agenda items 1.4, 1.5 and 7 (issue E)

1.4 **New GSO orbital slots opened up in the Reg. 1&3 BSS Plan** with a "**special procedure**" including temporary regulatory measures (**as of 23 March and until 21 May 2020**) and which **can only be applied once**, in order to provide **priority to countries** that:

- **have no assignments in the List or submitted under Article 4 of RR Appendix 30;**
- **have assignments in the Plan with degraded reference situation.**

► **WRC-19 new Res. 558, 559 & 768** (ex. COM5/2, COM5/3 & COM5/4 resp.)

7(E) New "**Special Procedure**", applicable only once, to **facilitate entry** into the **Appendix 30B FSS List**, for **countries** that have **no assignments in the List or submitted under App. 30B Art. 6**.

► **WRC-19 new Res. 170** (ex. COM5/8)

► Ensure **equitable access** to the **spectrum & orbit resources** by providing **protection of assignments** and a **priority mechanism for countries to regain access to these resources**

1.5 **New regulatory, operational and technical conditions** under which the frequency bands **17.7-19.7 GHz & 27.5-29.5 GHz can be used by ESIM* communicating with GSO FSS**

* Earth Station In Motion

► For the use & further development of ESIMs, enabling **connection of people on ships, aircraft and land vehicles** and ensuring their safety, security and comfort while in motion

► **WRC-19 new Res. 169** (ex. COM5/6)

Other satellite issues

WRC-19 agenda items 1.2, 1.7, 7 (issue I) and 9.1 (issues 9.1.7 & 9.1.9)

1.2 Establishment of **maximum e.i.r.p. for any emissions of**

- **MSS earth stations** in the band **399.9-400.05 MHz** (with some restrictions of application until 22 Nov. 2022), except for telecommand uplinks within the MSS in the band **400.02-400.05 MHz**
- **MetSat & EESS earth stations** in the band **401-403 MHz** (with some restrictions of application until 22 November 2029)

7(I) New **WRC-19 Res. 32** (ex.COM5/5) on **Regulatory procedures for frequency assignments to non-GSO satellite** networks or systems identified as **short-duration mission** not subject to the application of Section II of Article 9

1.7 New **WRC-19 Res. 660** (ex.COM5/9) on the **Use of** the frequency band **137-138 MHz by non-GSO satellites with short-duration missions in the space operation service**

9.1.7 New **WRC-19 Res. 22** (ex.COM5/1) on Measures to limit **unauthorized uplink transmissions from earth stations**

9.1.9 Allocate the band **51.4-52.4 GHz to the FSS (Earth-to-space) limited to**

- gateway earth stations larger than 2.4 meters and

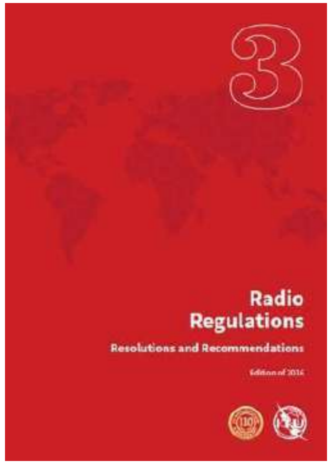
- communicating with GSO satellites.

► **New WRC-19 Res. 427** (ex.COM4/1)

► **One GHz extension of the current allocation in the 50.4-51.4 GHz band**

Review of W(A)RC Res. & Rec.

WRC-19 agenda item 4



- Modification of 30 Resolutions and 7 Recommendations to take into account results of requested activities and outdated references, including updating of **Res. 155** (UAS CNPC links), **Res. 647** (emergencies and disasters) and clarifications on **Res. 750** (protection of EESS)
- Modification of **Res. 95** to **clarify the procedure for implementing this agenda item (including at CPM)**

Review of Country footnotes in RR Article 5

WRC-19 agenda item 8

- SUP of several country names ► **higher harmonization of the spectrum use**
- ADD of country names to some footnotes to recognize specific national uses
- Modification of **Res. 26** to **include guidance on the approach taken at previous WRCs for implementing this agenda item,** in particular with respect to proposals to add country names to existing footnote, while recognizing that it is **not the intention of WRCs to encourage the addition of country names to existing footnotes**

Topics on the WRC-23 Agenda

WRC-19 agenda item 10

WRC-23 agenda

1.1
1.2
1.3
1.4
1.5

Mobile

Broadcasting

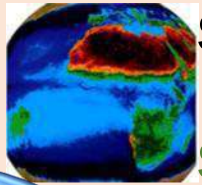
3.3 ≤ MS & IMT ≤ 10.5 GHz

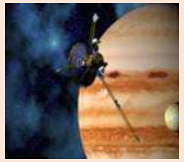
0.694 ≤ HIBS ≤ 2.7 GHz

470 ≤ BS, MS ≤ 960 MHz

Spaceborne radar sounders (2ndary)
EESS (active) @ 45 MHz *1.12*
SRS @ 14.8-15.35 GHz *1.13*
Remote-sensing observation requirements - EESS (passive) @ 231.5-252 GHz *1.14*

Science





1.6 **Sub-orbital vehicles**
1.7 **New AMS(R)S) VHF alloc.**
1.8 **UAS CNPC links via FSS**
1.9 **Dig. techno. for aviation safety-of-life applications (App.27)**
1.10 **New AMS alloc. (around 15.5 & 22 GHz) for non-safety applications**
1.11 **GMDSS modernization and e-navigation**

Aviation

Maritime

A-ESIM & M-ESIM (GSO Ku-FSS) *1.15*
ESIM (NGSO Ka-FSS) *1.16*
ISS / Sat.-to-Sat. links *1.17*
NB MSS for IoT (L/S-bands) *1.18*
Ka-FSS (s-E) (R2) *1.19*

Satellite

Regulatory issues *7*
(Sat. regulations, harmonization of spectrum use, etc.)

Note: *WRC-23 agenda item numbers indicated in italic*

► 19 specific and 11 standing items, see Res. 811 (WRC-19)

Fixed, Mobile and Broadcasting issues

WRC-23 agenda items 1.1 to 1.5

1.1 ➢ In the band **4 800-4 990 MHz** (identified for IMT in about 40 countries), consider the pfd criteria in No. **5.441B** for the **protection of stations** of the **aeronautical and maritime mobile services** located in international airspace and waters from **other stations located within national territories** ► **Res. 223 (Rev.WRC-19)**

1.2 ➢ Consider the **identification for IMT of** the following frequency **bands:**
3 300-3 400 MHz (sub-Reg.1 & Reg.2), **3 600-3 800 MHz (Reg.2)**, **6 425-7 025 MHz (Reg.1)**, **7 025-7 125 MHz (globally)** and **10.0-10.5 GHz (Reg.2)** ► **Res. 245 (WRC-19)**

1.3 ➢ Consider a **primary allocation** of the band **3 600-3 800 MHz** to the **mobile service** within **Region 1** ► **Res. 246 (WRC-19)**

1.4 ➢ Consider use of **high-altitude platform stations as IMT base stations (HIBS)** in the **mobile service** in certain frequency bands **below 2.7 GHz*** **already identified for IMT**, on a global or regional level ► **Res. 247 (WRC-19)**

* studies of bands **694-960 MHz**, **1 710-1 885 MHz** (1 710-1 815 MHz for ↑ only in Reg. 3), **2 500-2 690 MHz** (2 500-2 535 MHz for ↑ only in Reg. 3, except 2 655-2 690 MHz in Reg. 3)

1.5 ➢ Review the **spectrum use** and **spectrum needs** of **existing services in 470-960 MHz in Region 1** and
Consider **regulatory actions in 470-694 MHz in Region 1** ► **Res. 235 (WRC-15)**

Aeronautical and Maritime issues

WRC-23 agenda items 1.6 to 1.11

1.6 ➢ Consider regulatory provisions to facilitate **radiocommunications for sub-orbital vehicles** ► **Res. 772 (WRC-19)**

1.7 ➢ Consider **AMS(R)S) allocation** for both the E-s & s-E directions of **aeronautical VHF communications** in **all or part of the frequency band 117.975-137 MHz** ► **Res. 428 (WRC-19)**

1.8 ➢ Review and, if necessary, revise **Res. 155 (Rev.WRC-19)** & No. **5.484B** to accommodate the **use of FSS networks** by **control and non-payload communications** of **unmanned aircraft systems** ► **Res. 171 (WRC-19)**

1.9 ➢ Review Appendix **27**, to **accommodate digital technologies for commercial aviation safety-of-life applications** in existing HF bands allocated to the **AM(R)S** and ensure coexistence of current and modernized HF systems ► **Res. 429 (WRC-19)**

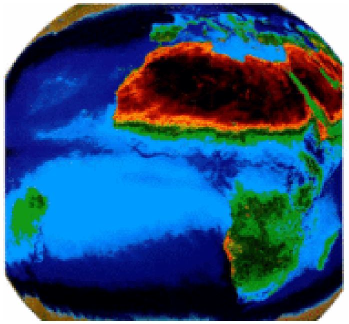
1.10 ➢ Consider **spectrum needs**, for possible **new AMS allocations** for **non-safety aeronautical mobile applications** ► **Res. 430 (WRC-19)**

1.11 ➢ Consider possible **regulatory actions** to **support** the **modernization of the GMDSS** and **implementation of e navigation** ► **Res. 361 (Rev.WRC-19)**

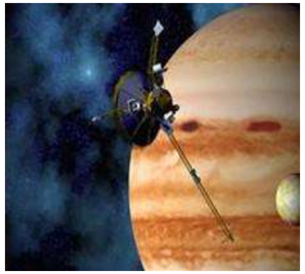
Science issues

WRC-23 agenda items 1.12 to 1.14

1.12 ➢ Consider new **secondary allocation** to the **EESS (active) service** for **spaceborne radar sounders** within the range of frequencies **around 45 MHz** ► **Res. 656 (Rev.WRC-19)**



1.13 ➢ Consider to **upgrade of the allocation** of the frequency band **14.8-15.35 GHz** to the **space research service** ► **Res. 661 (WRC-19)**



1.14 ➢ Consider possible adjustments of the existing or possible new primary **frequency allocations to EESS (passive)** in the frequency range **231.5-252 GHz**, to ensure alignment with more up-to-date **remote-sensing observation requirements** ► **Res. 662 (WRC-19)**

Satellite issues

WRC-23 agenda items 1.15 to 1.19

1.15 ➢ Consider the use of the band **12.75-13.25 GHz** (E-s) by **earth stations on aircraft and vessels** communicating with **GSO** space stations in the **FSS globally** ► **Res. 172 (Rev.WRC-19)**

1.16 ➢ Consider the use of the bands **17.7-18.6 GHz** and **18.8-19.3 GHz** and **19.7-20.2 GHz** (s-E) and **27.5-29.1 GHz** and **29.5-30 GHz** (E-s) by **non-GSO FSS** earth stations in motion (**ESIM**) ► **Res. 173 (WRC-19)**

1.17 ➢ Consider **inter-satellite links** in specific frequency bands*, or portions thereof, by adding an inter-satellite service allocation where appropriate ► **Res. 773 (WRC-19)**
* (ISS/s-s) **11.7-12.7 GHz**, **18.1-18.6 GHz**, **18.8-20.2 GHz** and **27.5-30 GHz**

1.18 ➢ Consider **spectrum needs** and potential **new MSS allocations*** for future development of **narrowband MSS systems** ► **Res. 248 (WRC-19)**
* in the bands **1 695-1 710 MHz** (R2), **2 010-2 025 MHz** (R1), **3 300-3 315 MHz** and **3 385-3 400 MHz** (R2)

1.19 ➢ Consider new **primary allocation** to the FSS (s-E) direction in the frequency band **17.3-17.7 GHz in Region 2** ► **Res. 174 (WRC-19)**

Other topics to be studied

WRC-23 agenda item 9.1

- Consider technical and operational characteristics, spectrum requirements and appropriate radio service designations for **space weather sensors** with a view to describing **appropriate recognition and protection in the Radio Regulations** without placing additional constraints on incumbent services

- Consider **amateur service and the amateur-satellite service** allocations in the frequency band **1 240 1 300 MHz** to determine if **additional measures** are required to **ensure protection of the RNSS (s-E)** operating in the same band

- Study the **use of IMT system** for **fixed wireless broadband** in the frequency **bands allocated to the fixed services** on primary basis

Additional topic identified at CPM23-1

- **Protection of EESS (passive)** in the frequency band **36-37 GHz** from **non-GSO FSS space stations**

WRC-27 Preliminary Agenda

WRC-23 agenda item 10

► see Res. 812 (WRC-19)

2.1 ➢ Consider **additional RLS spectrum allocations** on a co-primary basis in the band **231.5-275 GHz** and **identification for RLS applications** in bands in the range **275-700 GHz** for millimetre and sub-millimetre wave **imaging systems** ► Res. 663 (WRC-19)

2.2 ➢ Consider the technical, operational and regulatory measures, as appropriate, to facilitate the **use of the bands 37.5-39.5 GHz (s-E)**, **40.5-42.5 GHz (s-E)**, **47.2-50.2 GHz (E-s)** and **50.4-51.4 GHz (E-s)** by **aeronautical** and **maritime** earth stations in motion (**ESIM**) communicating with **GSO FSS** space stations ► Res. 176 (WRC-19)

2.3 ➢ Consider the allocation of all or part of the frequency band **[43.5-45.5 GHz]** to the **fixed-satellite service** ► Res. 177 (WRC-19)

2.4 ➢ Consider the introduction of **pfd and e.i.r.p. limits in Article 21** for the frequency bands **71-76 GHz** and **81-86 GHz** ► Res. 775 (WRC-19)

2.5 ➢ Consider conditions for the use of the **71-76 GHz** and **81-86 GHz** bands by stations in the **satellite services** to ensure **compatibility with passive services** ► Res. 776 (WRC-19)

2.6 ➢ Consider regulatory provisions for recognition of **space weather sensors** and their protection in the RR, taking into account the results of ITU R studies reported to **WRC-23 under agenda item 9.1** ► Res. 657 (Rev.WRC-19)

WRC-27 Preliminary Agenda (cont'd)

WRC-23 agenda item 10

► see Res. 812 (WRC-19)

2.7 ➢ Consider **NGSO FSS system feeder links** in the bands 71-76 GHz **(space-to-Earth and proposed new Earth-to-space)** and 81-86 GHz **(Earth-to-space)** ► Res. 178 (WRC-19)

2.8 ➢ Consider **space-to-space links** in the bands [1 525-1 544 MHz], [1 545-1 559 MHz], [1 610-1 645.5 MHz], [1 646.5 1 660.5 MHz] and [2 483.5-2 500 MHz] **among NGSO and GSO satellites** operating in the **MSS** ► Res. 249 (WRC-19)

2.9 ➢ Consider spectrum allocations to the **MS** in the band 1 300-1 350 MHz to facilitate the **future development of mobile-service applications** ► Res. 250 (WRC-19)

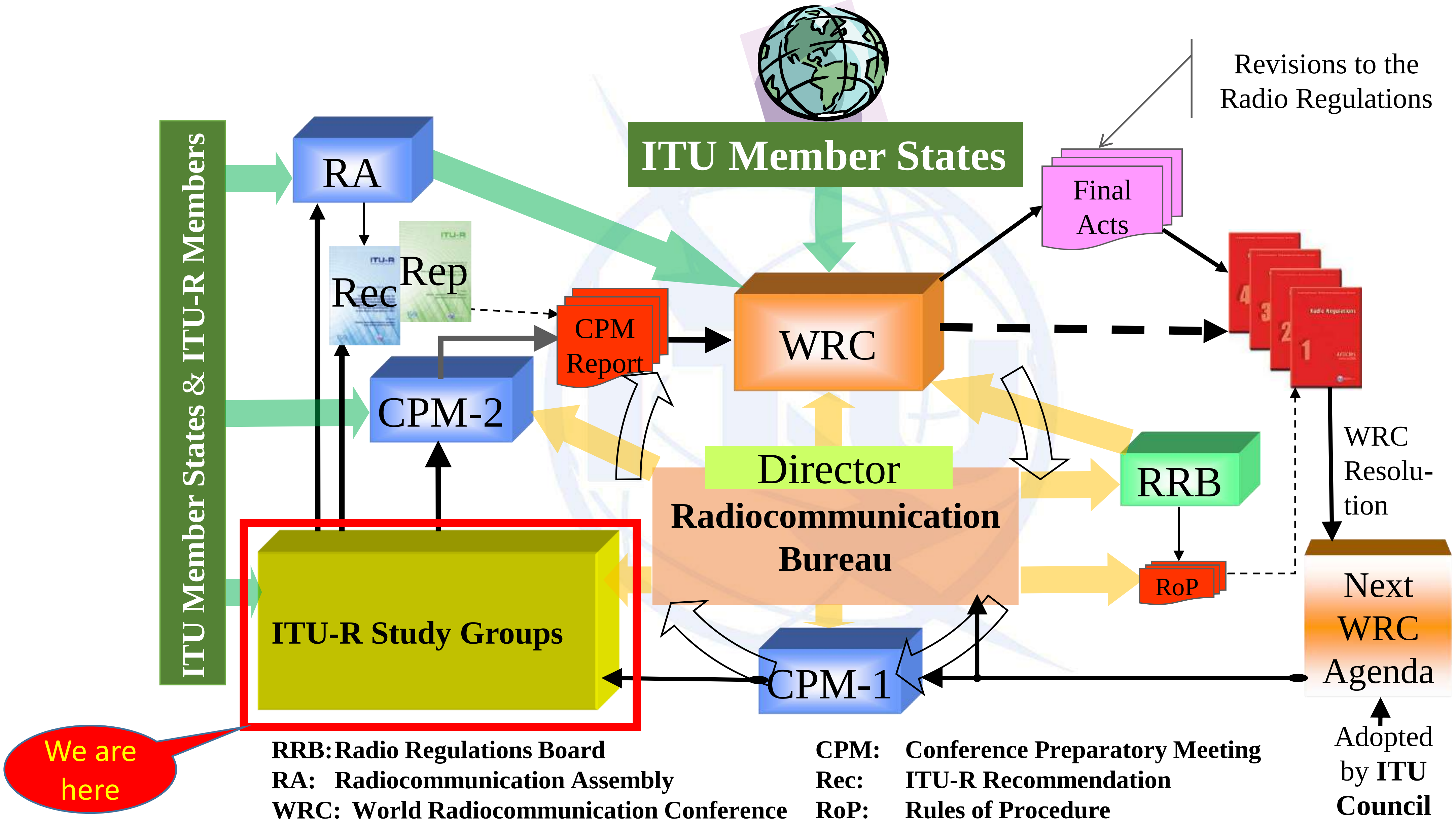
2.10 ➢ Consider **improving** the **utilization** of the VHF **maritime frequencies** in Appendix **18** ► Res. 363 (WRC-19)

2.11 ➢ Consider **new EESS (Earth-to-space) allocation** in the band 22.55-23.15 GHz ► Res. 664 (WRC-19)

2.12 ➢ Consider **use of existing IMT identifications** in the frequency range 694-960 MHz by consideration of the possible **removal of the limitation regarding aeronautical mobile** in the IMT for the **use of IMT user equipment by non-safety applications**, where appropriate ► Res. 251 (WRC-19)

2.13 ➢ Consider a possible **worldwide allocation** to the **MSS** for the **future development** of **narrowband mobile-satellite systems** in the range [1.5-5 GHz] ► Res. 248 (WRC-19)

The WRC Cycle



RRB: Radio Regulations Board
RA: Radiocommunication Assembly
WRC: World Radiocommunication Conference
CPM: Conference Preparatory Meeting
Rec: ITU-R Recommendation
RoP: Rules of Procedure

The WRC Process

(WRC-19 Docs)

Agenda: draft in WRC Res & final in Council Res

APT (Doc. 24)

ASMG (Doc. 29)

ATU (Doc. 46)

CEPT (Doc. 16)

CITEL (Doc. 11)

RCC (Doc. 12)

Regional preparation
Resolution 72 (Rev.WRC-07)

Proposals

Coordinated common proposals

Informal Group
(Structure & Chairmanship)

Proposals

Member States

RA
RA Report
(Doc. 129)

CPM Report
(Doc. 3)

Director's Report
(Doc. 4)

WRC

Conference Secretariat (BR & GS)

World Radiocommunication Conference 2019 (WRC-19)
Provisional Final Acts

Final Acts

Radio Regulations (CS89)

Main Steps towards WRC-23

WRC-19: WRC-23 Agenda - **Resolution 811 (WRC-19)**

1st Session of Conference Preparatory Meeting: CPM23-1
25-26 November 2019; **Results @CA/251 of 19 Dec. 2019**

Council: Finalize WRC-23 agenda with dates, venue

Meetings of ITU-R Study Groups, WPs / TG responsible/contributing on AIs

2nd Session of Conference Preparatory Meeting: CPM23-2
[Dates t.b.d. for the final CPM Report to be available five months prior to WRC-23]

Final regional group meetings & national preparations
Member States' proposals to WRC-23

RA-23; WRC-23

CPM-23

www.itu.int/ITU-R/go/rcpm

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(see details at www.itu.int/go/ITU-R/cvc/CPM**)**

First Session of CPM-23

Scope defined in Resolution ITU-R 2-8

- ✓ **Geneva, 25-26 November 2019** (330 participants, 73 MS, 11 SM, 11 contributions)
  ⇒ **results published in CA/251, of 19Dec. 2019**
  (see at www.itu.int/md/R00-CA-CIR-0251/en)
- ➢ **Define framework of preparatory studies:**
  Structure of the draft CPM Report **(see the proposed detailed structure at: https://www.itu.int/oth/R0A0A000014/en) with**
  five (5) Chapter, one Annex and eight (8) (co-)Rapporteurs
- ➢ **Identify responsible ITU-R Groups for each WRC-23 agenda item (AI) & topics**
  ⇒ **8 existing Working Parties and**
  ⇒ **Proposed new TG 6/1 for AI 1.5 (ToR in Annex 9 of CA/251)**
  + 4 existing SGs for the WRC-27 preliminary agenda items
  and contributing ITU-R groups
  (see Annexes 7 and 8 to CA/251)
- ➢ For sharing and compatibility studies, service/application **characteristics & parameters** from contributing WPs are **required by 15 June 2021 at the latest and unless otherwise specified** (e.g. case of TG 6/1 with 15 May 2021)

Overlapping frequency bands between some WRC-23 agenda items

1.2 (IMT) WP 5D	1.16 (non-GSO FSS ESIMs) WP 4A	1.17 (ISL) WP 4A	1.18 (narrowband MSS) WP 4C
3 300-3 400 MHz (Regions 1 & 2)			3 300-3 400 MHz (Region 2)
	27.5-29.1 GHz (E-s) 29.5-30 GHz (E-s)	27.5-30 GHz (s-s)	
* E-s: Earth-to-space; s-s: space-to-space.			

- The responsible groups are invited to **exchange the necessary characteristics, parameters and protection criteria** to **complete studies** addressing **mutual compatibility and sharing feasibility** among the applicable services/applications.
- They should **coordinate their work** and **review**, as appropriate, the **progress of studies so that any potential difficulties can be addressed**.

Draft CPM Report – ToC

(see Annex 6 to CA/251)

Chapters of the draft CPM Report	WRC-23 Agenda items
1. Fixed, Mobile and Broadcasting issues	1.1, 1.2, 1.3, 1.4, 1.5
2. Aeronautical and maritime issues	1.6, 1.7, 1.8, 1.9, 1.10, 1.11
3. Science issues	1.12, 1.13, 1.14
4. Satellite issues	1.15, 1.16, 1.17, 1.18, 1.19, 7
5. General issues	2, 4, 9.1 topics a), b), c), d)
Annex 1	Information on WRC-23 agenda item 10

CPM Chapter Rapporteurs

Chapters	(Co-)Rapporteurs
1. Fixed, Mobile and Broadcasting issues	**Dr. H. ATARASHI (J)** for AIs 1.1, 1.2 and 1.4 **Mr. U.A. MAHMUD (NIG)** for AIs 1.3 and 1.5
2. Aeronautical and maritime issues	**Mr. Mohammed ALHASSANI (UAE)**
3. Science issues	**Mr. T. A. BAKAUS (B)**
4. Satellite issues	**Ms. F. Magnier (F)** for AIs 1.15, 1.16, 1.17, 1.18, 1.19 **Mr. G. KWIZERA (RRW)** for AI 7
5. General issues	**Mr. J. HUANG (CHN)** **Dr. J. in PARK (KOR)**

(see details at www.itu.int/en/ITU-R/study-groups/rcpm/Pages/cpm-23-chp-rapporteurs.aspx)

Structure of the draft CPM texts for an agenda item in a given chapter

(see Annexes 6 and 11 to CA/251)

Chapter N

Agenda Item 1.XY

[Relevant WRC Resolutions if any]

N/1.XY/1 Executive Summary*

N/1.XY/2 Background*

N/1.XY/3 Summary and Analysis of the results of ITU-R studies, including a list of relevant ITU-R Recommendations

N/1.XY/4 Method(s) to satisfy the Agenda Item

N/1.XY/5 Regulatory and procedural considerations

* Not more than half a page of text

Chapter 5

Agenda Item 9.1(9.1-[x])

5/9.1-[x] [Title of the topic]

Summary of the results of ITU-R studies

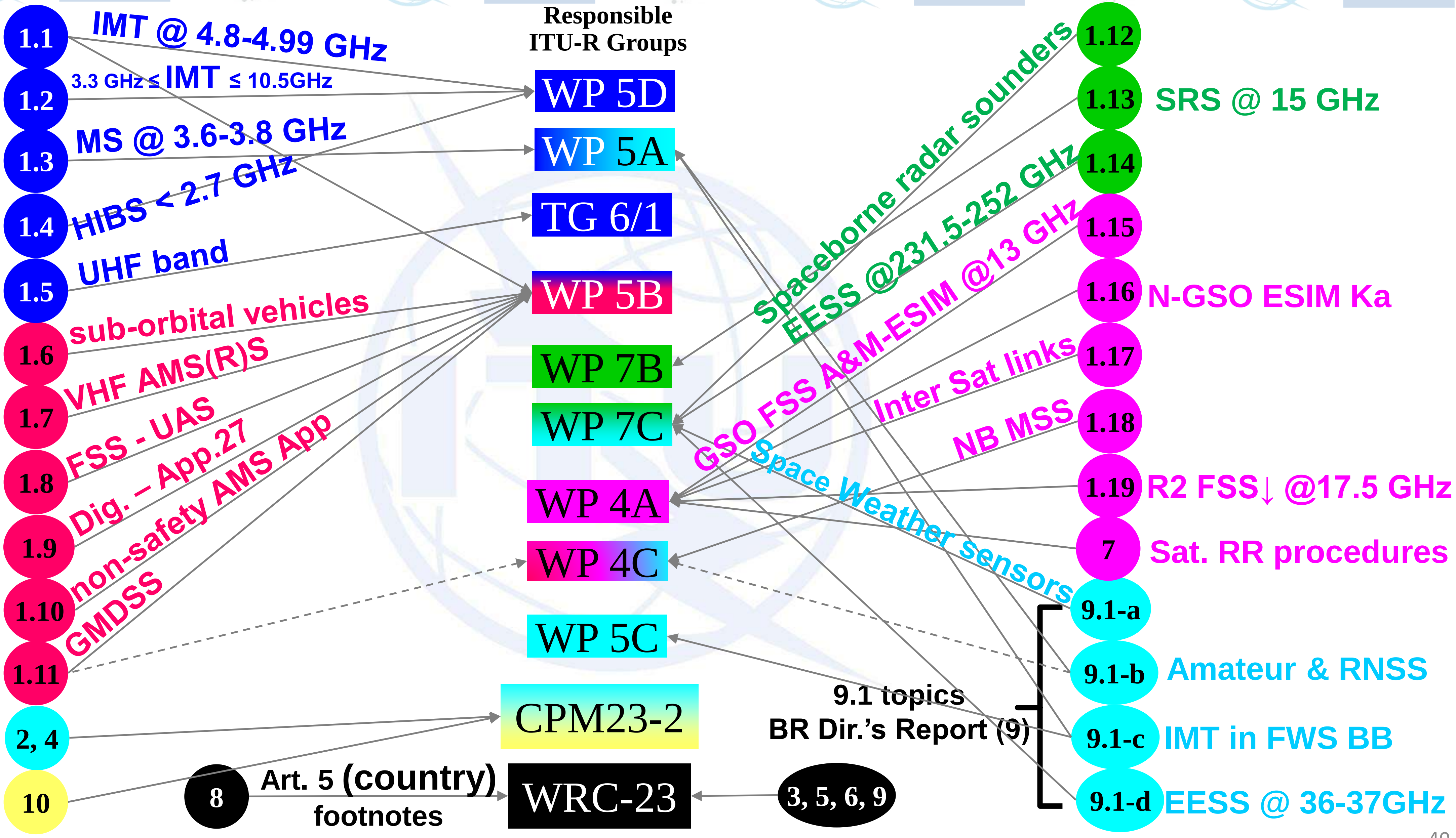
Annex 1 – Information on WRC-23 AI 10

2.[x] [label of the agenda item]

[Text of a short summary of ITU-R studies completed under the preliminary agenda item]

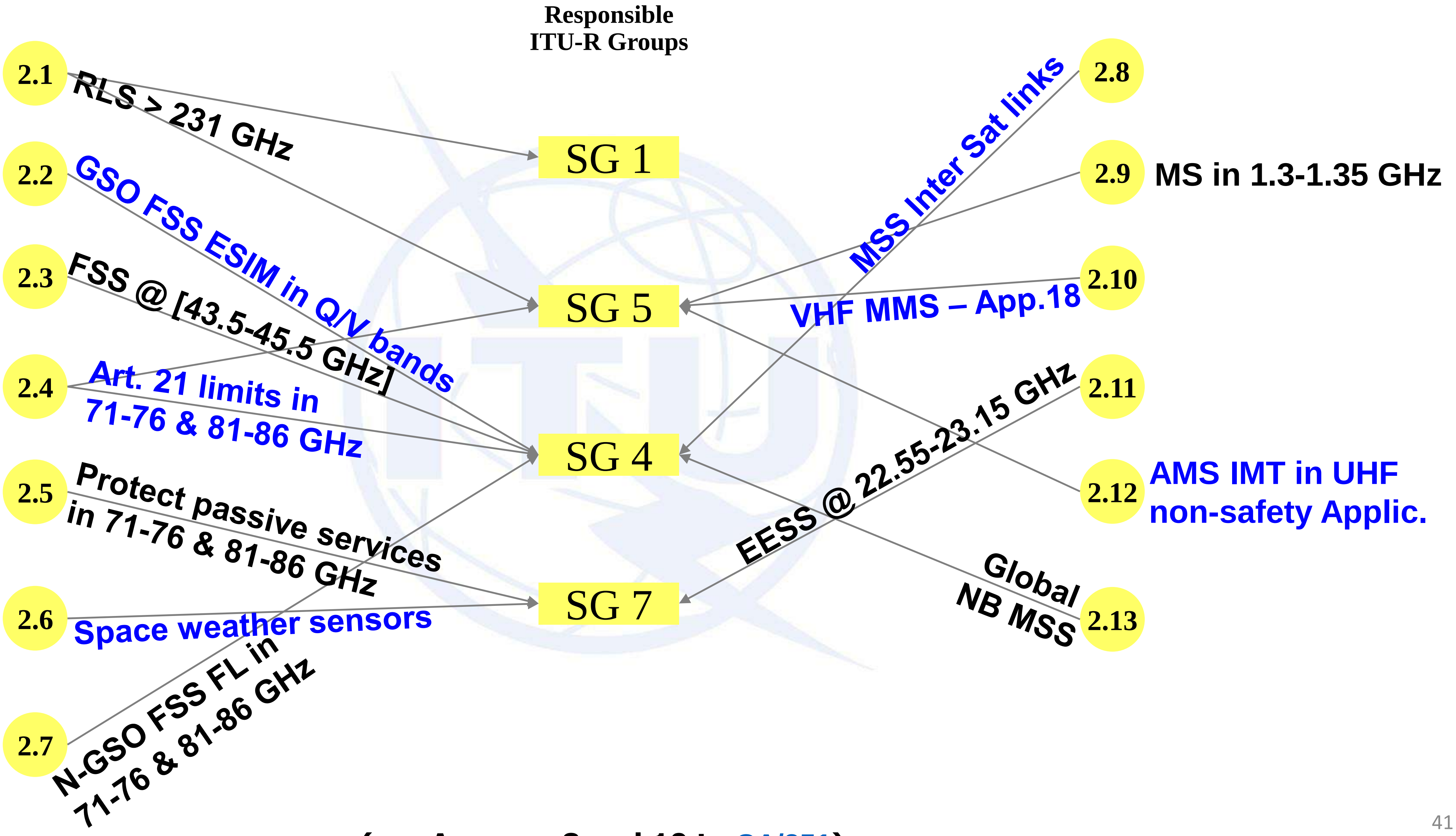
(see the Proposed detailed Structure for the Draft CPM Report to WRC-23 at: www.itu.int/oth/R0A0A000014/en)

WRC-23 agenda items & Resp. Groups



(see Annexes 7 and 10 to CA/251)

WRC-27 preliminary items & Resp. Groups

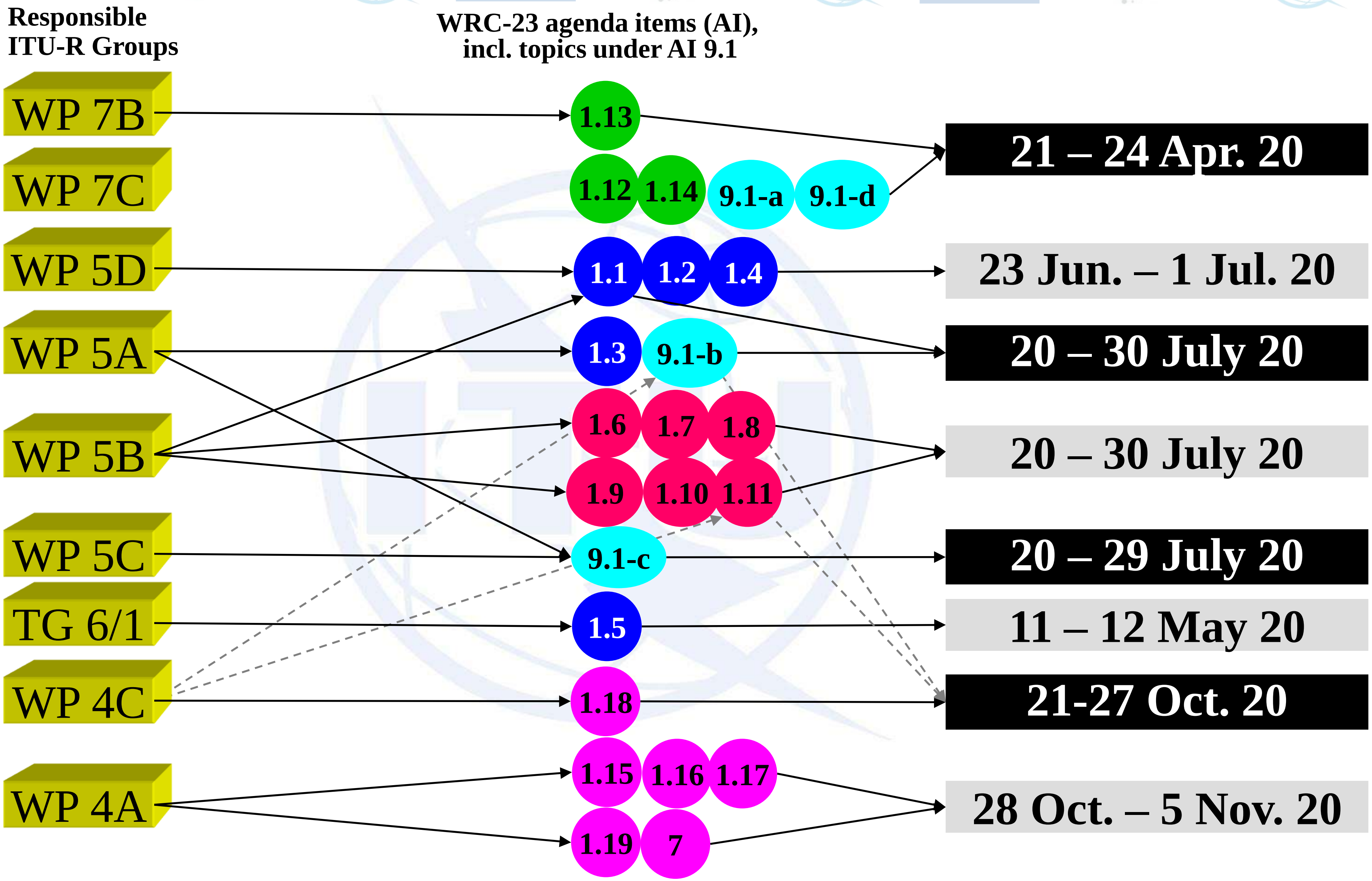


(see Annexes 8 and 10 to CA/251)

New TG 6/1 on WRC-23 AI 1.5

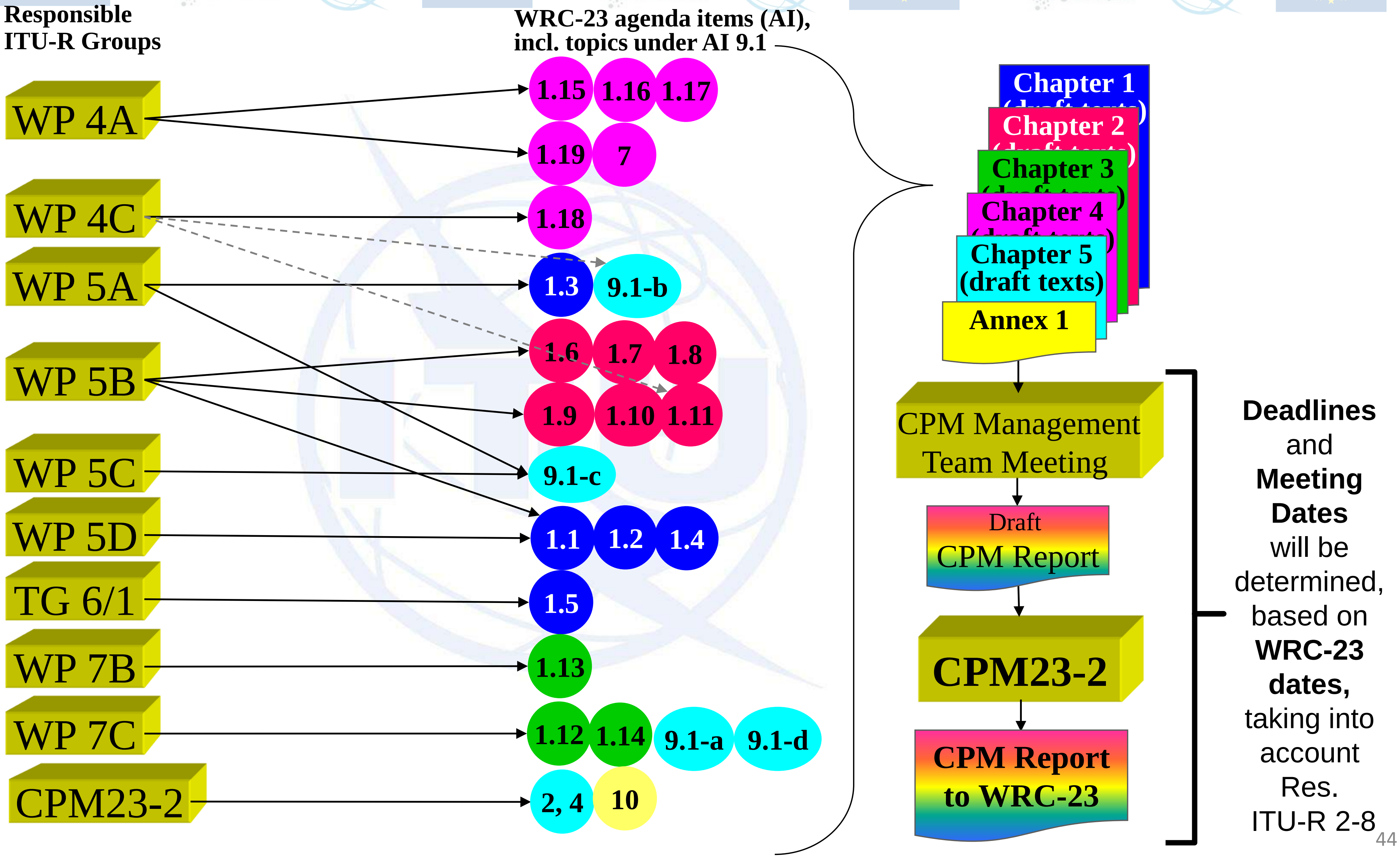
- ✓ Taking into account **CPM23-1 Decision** (see CA/226 Annex 9), SG 6 established **new TG 6/1** (www.itu.int/en/ITU-R/study-groups/rsg6/tg6-1)
- ✓ **SG 6 appointed Mr. Sergey PASTUKH as the Chairman**
- ✓ **SG 5 is invited to appoint the Vice-Chairman, who will coordinate the development of the draft CPM text**
- ➢ **By 15 May 2021**, in accordance with *resolves to invite ITU-R* 1 of Res. 235 (WRC-19), **results of studies on spectrum use and spectrum needs within the band 470-960 MHz should be reported by**:
  - **Working Party (WP) 6A regarding the Broadcasting Service (including the needs of the countries party to the GE06 Agreement)**
  - **SG 5 relevant WPs regarding the Mobile (except aeronautical mobile) Service**
- ➢ **By 15 May 2021, study assumptions (incl. propagation model, system parameters) and technical characteristics including protection criteria of the services allocated in the band 470-694 MHz should be provided by the WPs***
  (* Contributing Working Parties: **3K, 3M, 5A, 5B, 5C, 5D, 6A**)
- ➢ **TG 6/1 is responsible for conducting the sharing and compatibility studies** *(resolves to invite ITU-R 2 & 3)* **and developing the draft CPM text**
- ➢ **CPM23-1 provided also elements for the scheduling of the 5 or 6 meetings of TG 6/1**

Next Meetings of Resp. Groups



Up-to-date information and other ITU-R meetings online at: http://www.itu.int/en/events/Pages/Calendar-Events.aspx?sector=ITU-R

Summary of CPM Report Preparation



ITU-R Preparatory Studies for WRC-23

www.itu.int/go/rcpm-wrc-23-studies

Resolution **811 (WRC-19)** contains the WRC-23 agenda.

WRC-23 agenda Item (Chapter)	Issue	WRC Resolution (*)	Responsible Group(s)	Information from Responsible Group(s) TIES
1		-	-	-
1.1 (1)		Res.223 (Rev.WRC-19)	WP 5B (1) WP 5D (1)	See Administrative Circular CA/251 Doc. 5D/134, Chapter 2 Attachments 2.8 (a) (b) & 2.9 (a) (b), 2.11 (a) & 2.17 (a) & Chapter 4 Sections 2, 3.3, 5, Annex 2 & Attachments 4.4 (a), 4.13, 4.14, 4.15, 4.16 (b)
1.2 (1)		Res.245 (WRC-19)	WP 5D	Doc. 5D/134, Chapter 2 Attachments 2.8 (a) (b) & 2.9 (a) (b), 2.11 (a) & 2.17 (a) & Chapter 4 Sections 2, 3.3, 5, Annex 2 & Attachments 4.4 (a), 4.13, 4.14, 4.17, 4.18 (b)
1.3 (1)		Res.246 (WRC-19)	WP 5A	See Administrative Circular CA/251
1.4 (1)		Res.247 (WRC-19)	WP 5D	Doc. 5D/134, Chapter 2 Attachments 2.8 (a) (b) & 2.9 (a) (b), 2.11 (a) & 2.17 (a) & Chapter 4 Sections 2, 3.3, 5, Annex 2 & Attachments 4.4 (a), 4.13, 4.14, 4.19, 4.20 (b), 4.21 (c) & 4.22
1.5 (1)		Res.235 (WRC-15)	TG 6/1 (2)	See Administrative Circular CA/251
1.6 (2)		Res.772 (WRC-19)	WP 5B (3)	See Administrative Circular CA/251
1.7 (2)		Res.428 (WRC-19)	WP 5B (3)	See Administrative Circular CA/251
1.8 (2)		Res.171 (WRC-19) - Res.155 (Rev.WRC-19)	WP 5B (3)	See Administrative Circular CA/251
1.9 (2)		Res.429 (WRC-19)	WP 5B	See Administrative Circular CA/251
1.10 (2)		Res.430 (WRC-19)	WP 5B	See Administrative Circular CA/251
1.11 (2)		Res.361 (Rev.WRC-19)	WP 5B (4)	See Administrative Circular CA/251
1.12 (3)		Res.656 (Rev.WRC-19)	WP 7C	See Administrative Circular CA/251
1.13 (3)		Res.661 (WRC-19)	WP 7B	See Administrative Circular CA/251
1.14 (3)		Res.662 (WRC-19)	WP 7C	See Administrative Circular CA/251
1.15 (4)		Res.172 (WRC-19)	WP 4A	See Administrative Circular CA/251
1.16 (4)		Res.173 (WRC-19)	WP 4A	See Administrative Circular CA/251
1.17 (4)		Res.773 (WRC-19)	WP 4A	See Administrative Circular CA/251
1.18 (4)		Res.248 (WRC-19)	WP 4C	See Administrative Circular CA/251
1.19 (4)		Res.174 (WRC-19)	WP 4A	See Administrative Circular CA/251

➢ **Webpage to be updated on a regular basis after meetings of the responsible groups**

Thank You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ITU WRC
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