International, Regional & National regulation of electronic devices & SRD's

TCBC

Telecommunication Certification Body, Council; 15 April 2015
Holiday Inn, Baltimore MD; US

Dr. Haim Mazar; Vice Chair ITU-R Study Group 1 (Spectrum Management)

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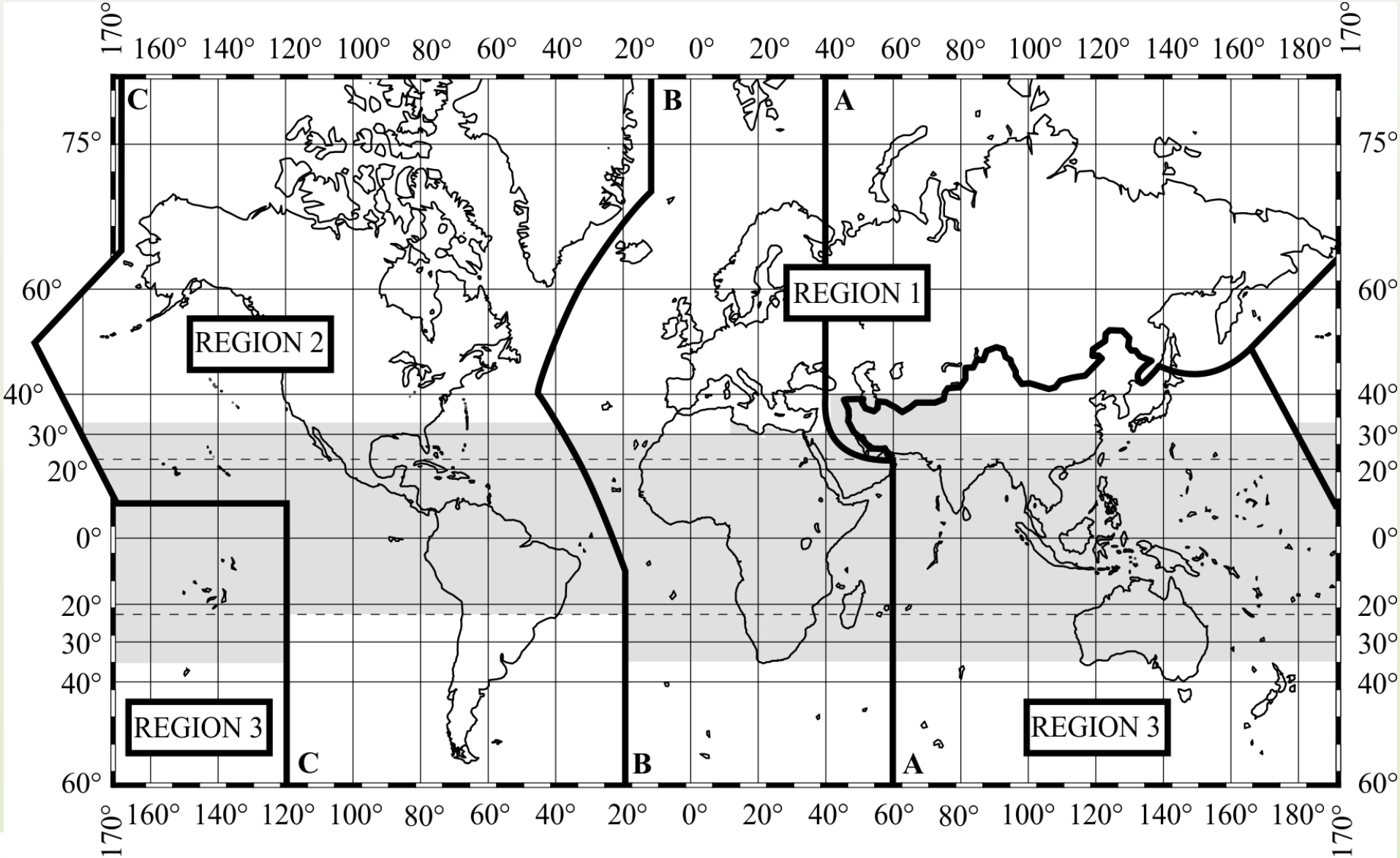
The Three ITU RF Allocation Regions



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Regional Intergovernmental Telecoms Regulators

APT	Asia Pacific Telecommunity, 38 countries
ASMG	Arab States Spectrum Management Group, 23 countries (22, without suspended Syria)
ATU	African Telecommunications Union, 44 countries
CEPT	European Conference of Postal and Telecoms Administrations, 48 countries
CITEL	Inter-American Commission of Telecoms, 36 countries
EACO	East African Communications Organization Burundi, Kenya, Rwanda, Tanzania, Uganda (like EAC)
FACSMAB	Frequency Assignment Committee Singapore, Malaysia and Brunei
RCC	Regional Commonwealth in the Field of Communication, 12 countries
REGULATEL	Latin American Forum of Telecom Regulator, 20 Regulators
SADC	Southern African Development Community, 15 countries
WATRA	West Africa Telecommunications Regulators Assembly ,15 countries

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Standards Development Organizations influencing wireless standardization

Name	Organization (Country)
3GPP (red- 3GPP member)	Third Generation Partnership Project
3GPP2	Third Generation Partnership Project 2
ANSI	American National Standards Institute (U.S.A.)
ARIB	Association of Radio Industries and Businesses (Japan)
ATIS	Alliance for Telecommunications Industry Solutions
CCSA	China Communications Standards Association (China)
ETSI	European Telecommunications Standards Institute (Europe)
GS1	Global Standards One
IEC	International Electrotechnical Commission
IEEE- SA	Institute of Electrical and Electronics Engineer- Standards Association
ISO	International Organization for Standardization
PASC	Pacific Area Standards Congress
TIA	Telecommunications Industry Association (U.S.)
TSDSI	Telecommunications Standards Development Society, India
TTA	Telecommunications Technology Association (Korea)
TTC	Telecommunications Technology Committee (Japan)
Wi-Fi Alliance	Wi-Fi Alliance

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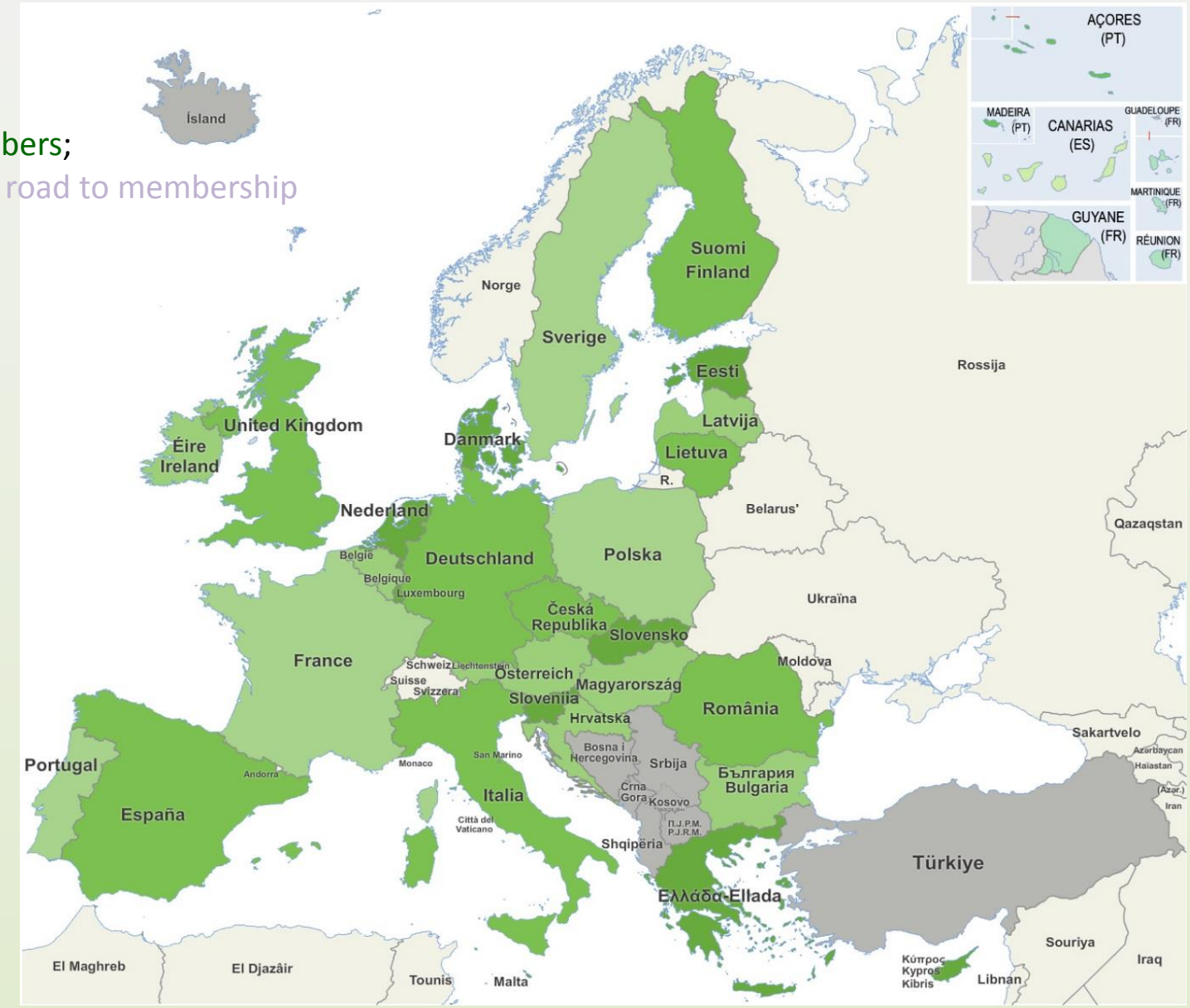
Map of EU Member States europa.eu

greens members;

grey- on the road to membership



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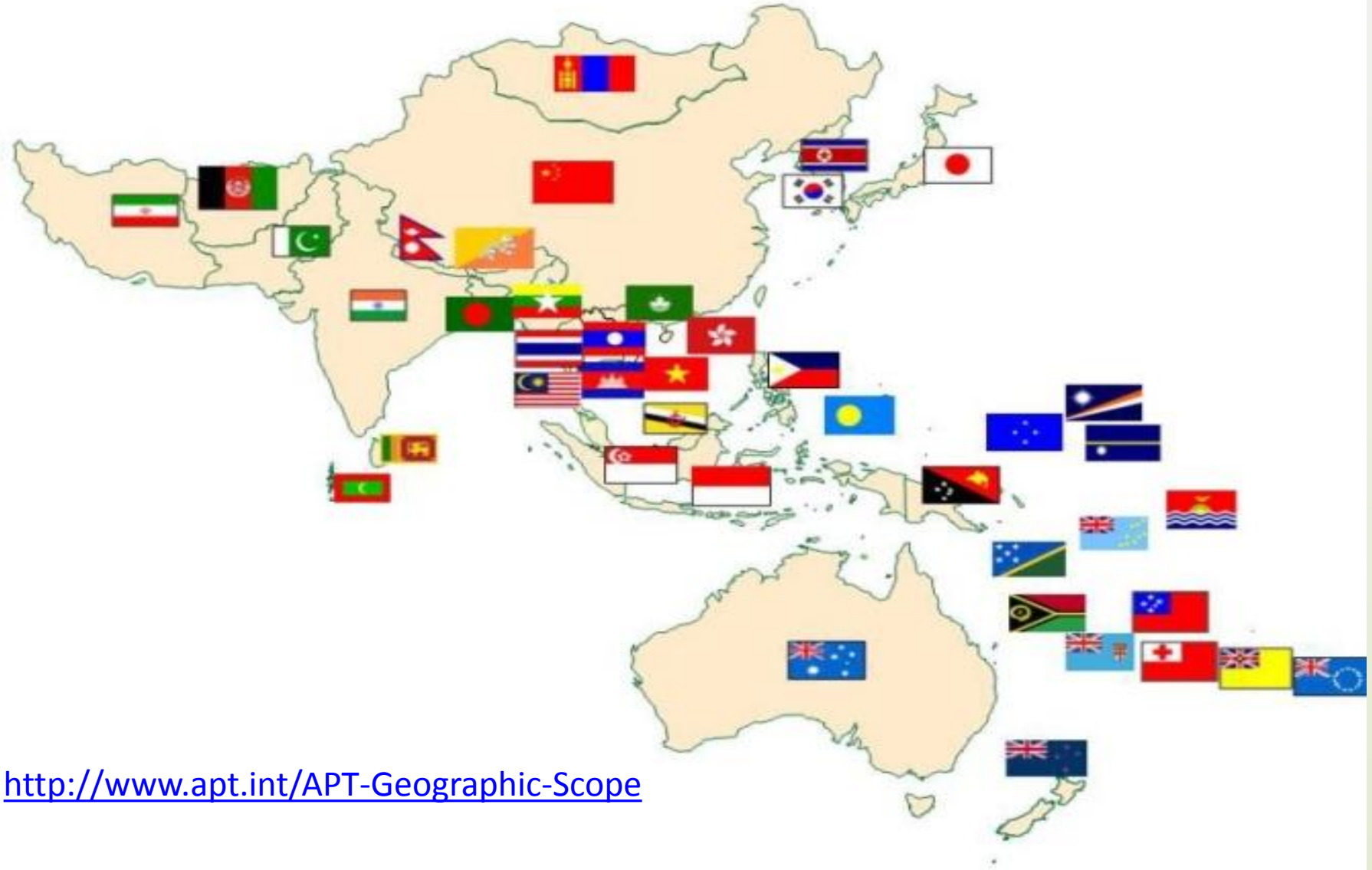
Geographic Scope of APT (Asia Pacific Telecommunity)



see http://www.apt.int/APT-Geographic-Scope

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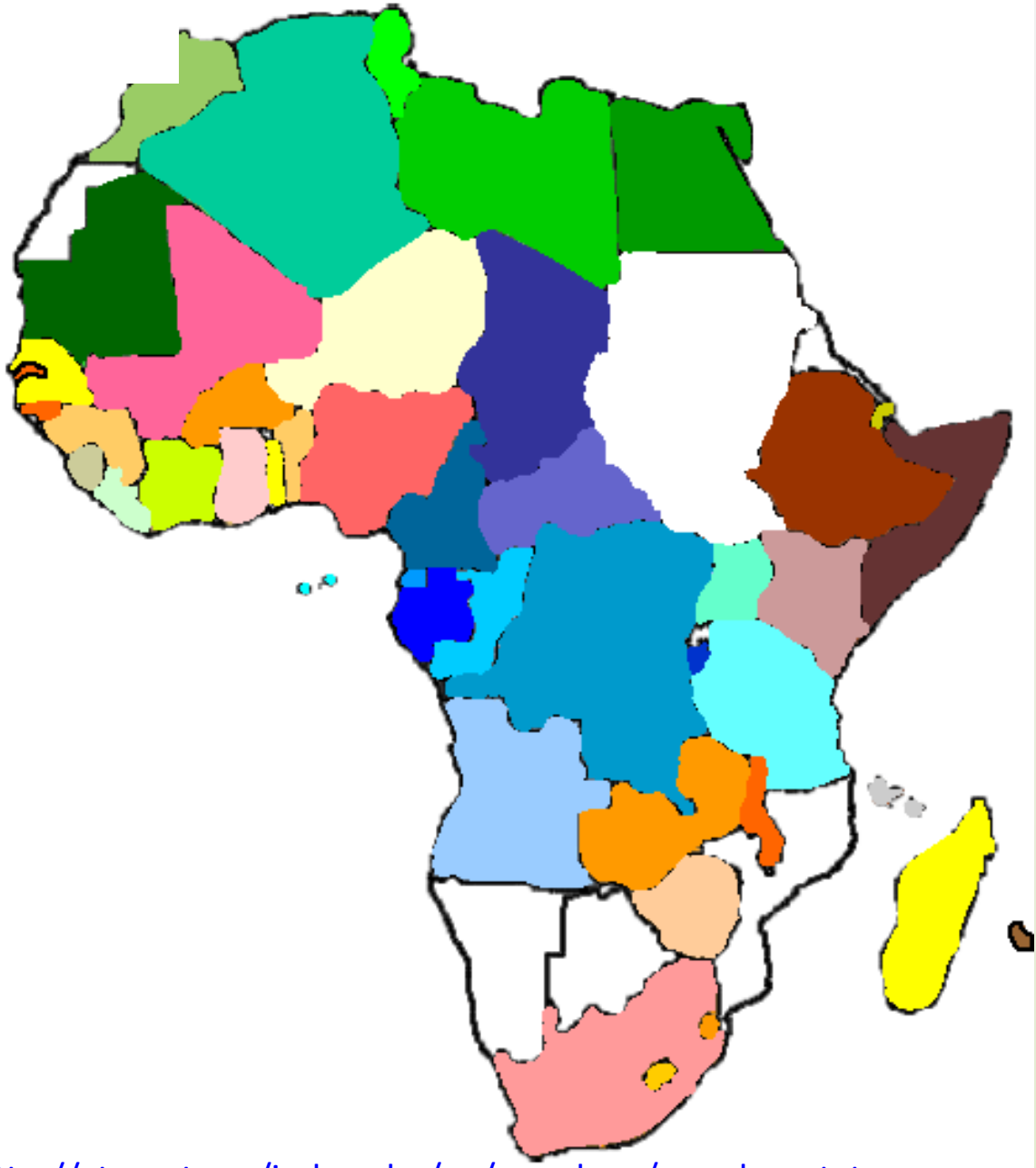
ATU Member States

African Telecom Union



http://atu-uat.org/index.php/en/members/member-states

US National Spectrum Management

The President — Communications Act of 1934 — The Congress

NTIA

Federal Users

- National defence
- First responders
- Law enforcement & security
- Transportation: land, aviation & maritime
- Science and space
- Other services

Coordination

FCC

Non-Federal Users

- Business
- State & local government
- Entertainment
- Commercial
- Private

See also National Spectrum Management at ARRL and https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09401.html websites

Advisory

Liaison

Interdepartment Radio Advisory Committee (IRAC)

Chaired by NTIA ; 19 Federal agencies represented

19 federal agencies in IRAC; +FCC as Observer

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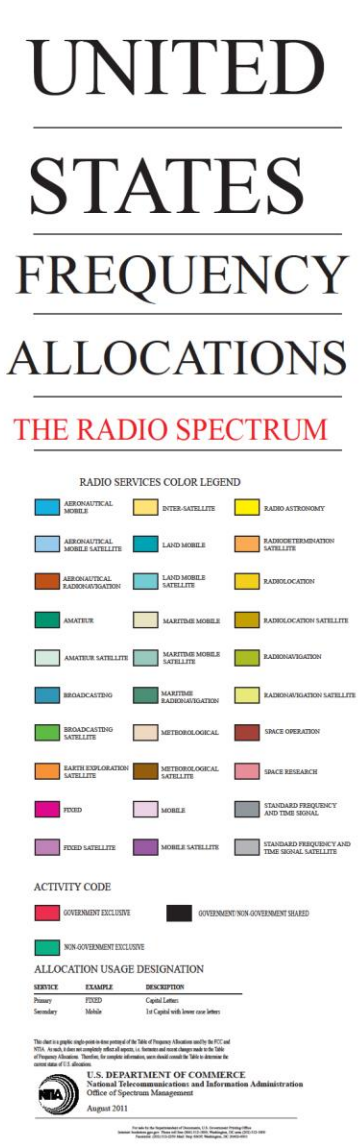
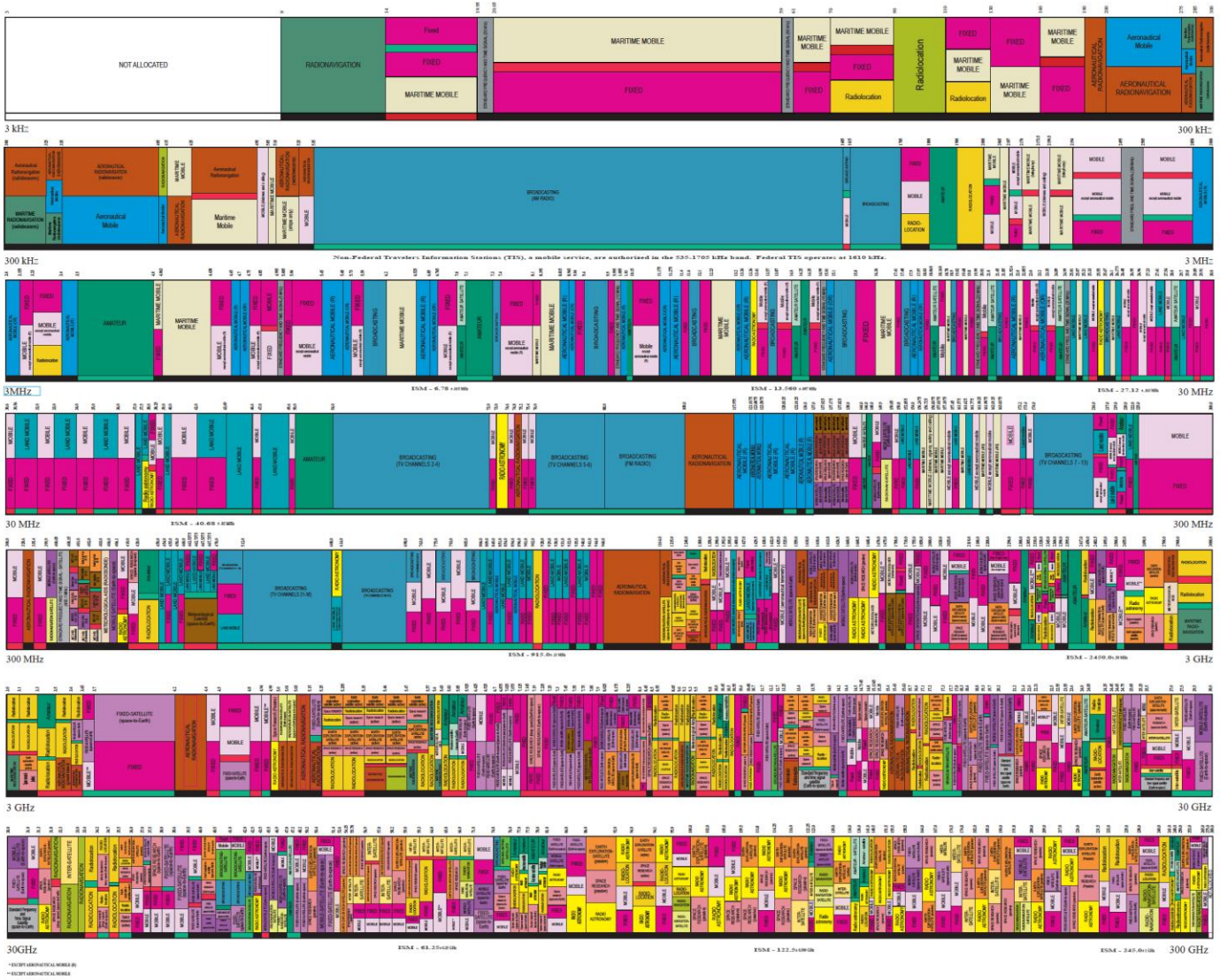
US RF Allocations 2011





http://www.ntia.doc.gov/files/ntia/publications/spectrum_wall_chart_aug2011.pdf
http://www.radioworld.com/uploads/NTIA%20spectrum_wall_chart_aug2011.pdf

Norbert Schroeder, NTIA

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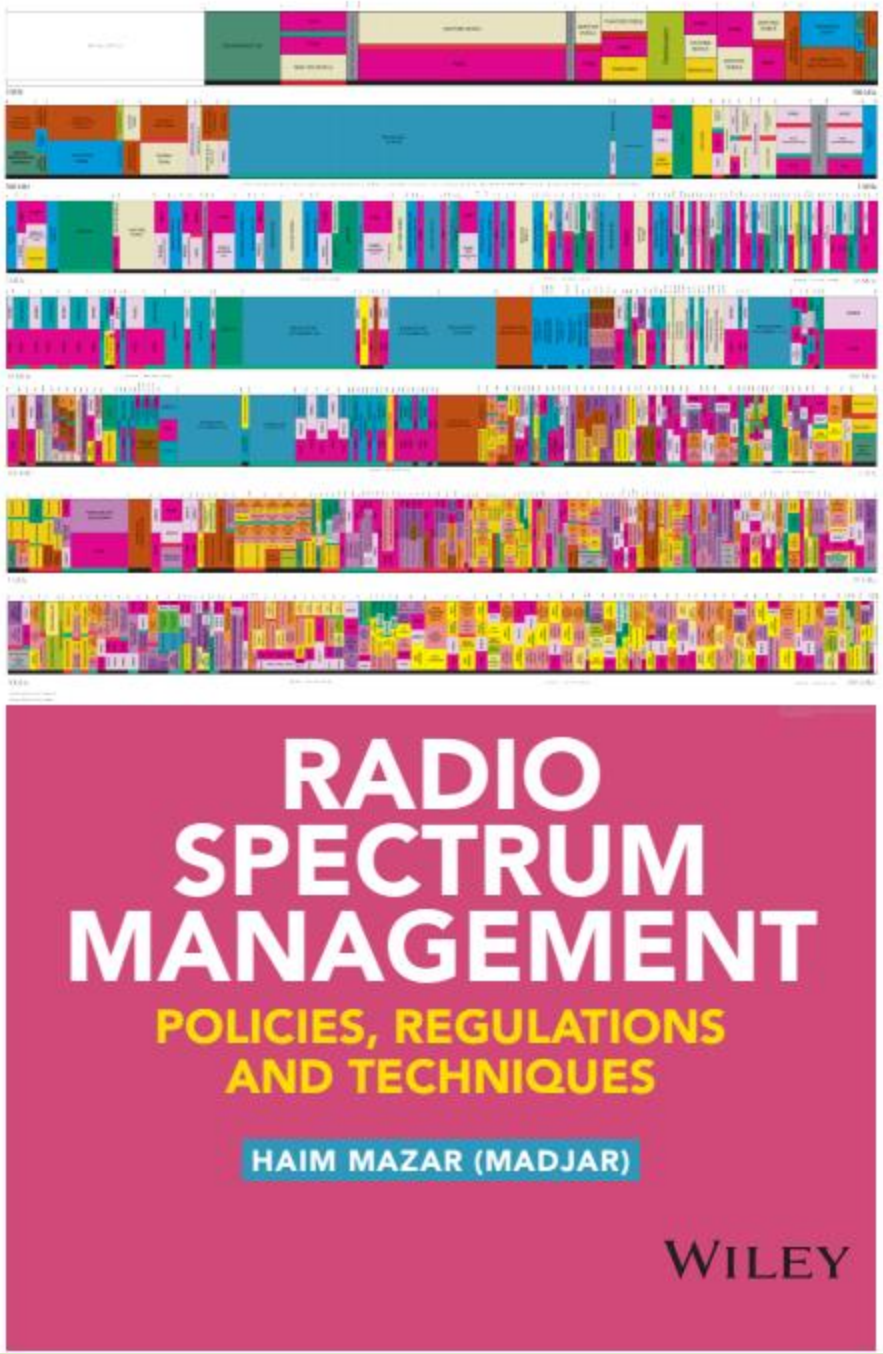
Cover of my book



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Definitions

- The regulatory framework for SRDs, such as the decision on frequency bands for use by SRDs, is a **national matter**
- **SRDs are not a "Radio Service"** under ITU Radio Regulations (RR); thus they cannot get primary or secondary allocation. SRDs are emissions without a corresponding frequency allocation in the RR
- **SRDs are not ISM applications**, as defined in No. 1.15 of RR
- For SRDs individual **licenses are normally not required**
- SRDs are permitted to operate on ***non-interference*** **& non-protected basis**
- In general SRDs **cannot claim protection** from radio services, intentional or unintentional radiator, by ISM equipment, or by an incidental radiator
- 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: 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 Region1	FN 5.138
902-928 MHz	(centre frequency 915 MHz) in 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

Note: 6.780MHzx2=13.560MHz; 6.780MHz x4=27.120MHz; 6.780x6=40.680MHz; 6.780MHzx32=433,920MHz 61.25 GHz x2= 122.5 GHz; 61.25 GHz x4=234 GHz

Only in Europe (Italic)

Only in Americas (Bolded)

ISM bands

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

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 & 1,785-1,805 MHz

862-875 MHz in some Asian counties

862-876MHz Non-Specific SRDs

915-921 MHz

5,150-5,350 & 5,470-5,725 MHz

57-64, 76-77 & *77-81* GHz

Potential global non-ISM bands for SRDs

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Applications of ISM equipment, in and 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)

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Typical SRD Applications

1. Wideband data transmission: RLAN/**Wi-Fi**, UWB, White Space Devices (in the USA, white space devices are to operate on a non-protected, non-interference basis), Wideband Low Activity Mode (WLAM), short range video. The WiFi achievement can be only compared to the GSM triumph
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, Intelligent transportation systems (ITS), Automatic Meter Reading (AMR), Street Lamp Monitoring and Control, railway applications, car immobilisers; devices for Smart Sustainable Cities (SSC): profitable use of our resources
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, machine-to-machine (**m2m**) model control, home automation, automotive industry, sensor monitoring
8. Alarm, social alarms, anti-theft (in houses and shops)
9. **…**

Wireless Power Transfer (WPT) as SRD

- 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***
- WPT with no data communication (e.g. Blue Tooth or ZigBee) is ISM, and may operate in all ISM bands
- 'equipment with a WPT function may be regarded as another type of SRD' (CISPR/1302/INF; 2015-03-20)
- WPT is SRD only if there are telecommunications
- USA separates between FCC Part 15 for 'Radio Frequency Devices' and FCC Part 18 for ISM.

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Typical Emerging technology: Z-Wave

Current sub-1GHz

designed mainly for remote controls, smoke alarms and security sensors

- Z-Wave uses a single frequency FSK
- Data rate up to 100 Kbps; unlike IEEE 802.11, designed primarily for high-bandwidth data flow
- 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

SRDs & smart sustainable world, cities, houses, cars; Internet of Things

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

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

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Rec. ITU-R SM.1896– RF ranges for global or regional harmonization

SRD applications are increasing, which result in increasing spectrum demands

Water meter with built-in AMR radio module

Solar-powered wireless relay for AMR

Wireless wastewater & sewage level monitoring unit with tilt sensors

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Need of SRD Harmonization

- Globalization & harmonization create a “connected world, offering free circulation of SRDs & worldwide roaming
- However, the risk in adopting regional harmonisation is contrasted with the harm caused to the independence of decision-making, and to the optimisation of the RF spectrum to local needs; see Recommendations 4.1 to 4.5 Martin Cave Report (2002:35) about the risks of harmonisation
- Administrations may learn from Europe & compromise their sovereignty to achieve regional RF harmonisation
- Don’t invent your national ruling
- Harmonized RF eases scale production, coordination, roaming/ nomadic devices. How non-harmonized RF will enable roaming of Wi-Fi or ITS devices?

Regulating SRDs

Regulators pay most attention to the RF bands of **cellular & SRD**

Administrations define: **RF bands**, **power**, channel spacing & mitigation requirements

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 techniques such as Frequency-Hopping Spread Spectrum (FHSS)

Risk vs. Risk: delays in allocation, reducing RF power & BW of SRD or UWB may preclude the entry of innovative technologies. Benefit vs. Benefit: more RF resources available to the citizen & more RF power & BW for SRDs advance rapid growth of new technologies and services. More RF, less congestion and less '**tragedy of commons**' in the RF 'public park'

Will first responders use 'unprotected' RF bands?

Don't repeat measurements from professional test houses

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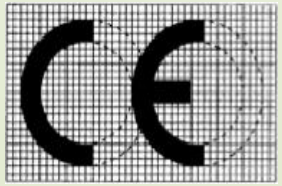
Placing on the market, approvals & labeling

- SRDs move thru borders. Administrations should regulate how to place the SRD and label it
- Marking of SRDs indicates its conformance to relevant international, regional and national regulations
- Most administrations require at least that the logo or name of the approval authority is labeled, along with the approval number
- Administrations may establish mutual agreements between countries/regions for the recognition by one country/region of the conformity test results of a recognized/accredited test laboratory in the other country/region
- To use SRDs on board aircraft, regulators may allow usage under conditions; however, for aviation safety aspects, the right bodies to address this matter remains the responsibility of aircraft manufacturers or aircraft owners who should consult with ICAO International Civil Aviation Organization, the relevant regional and national bodies, before installing SRDs on A/C
- Use regulation to ease simple penetration of SRDs to the market

Labeling SRD in Europe

- R&TTE Directive, Article 12 (CE-marking) states that “any other marking may be affixed to the equipment provided that the visibility and legibility of the CE-marking is not hereby reduced”
- The CE-marking has to be placed on the product or affixed to the packaging and the accompanying document. The CE marking shall consist of the initials 'CE' taking the following form



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Labeling SRD in Europe (Cont.)

- The CE marking indicates compliance with EU legislation and so enables the free movement of products within Europe. By CE marking a manufacturer declares, that the product meets all the legal requirements for the CE marking, & product can be sold throughout the European Economic Area (EEA, 28 Member States of the EU & European Free Trade Association (EFTA) countries Iceland, Norway, Liechtenstein
- The SRD labelling indicates that the equipment operates according to specific requirements

Placing on the market: Europe

- ETSI has developed harmonized European standards for the majority of SRDs. Other standards or technical specifications are applicable within the framework of the R&TTE Directive for placing on the market.
- R&TTE Article 4.1 defines the equipment two classes; EC Commission Decision 2000/299/EC identifies in Article 1 two classes (see next slide)
- On 16 April 14, EU adopted a new set of rules for placing radio equipment and putting them into service. There is a two-year time period for EU Member States to adapt their National laws to this new Radio Equipment Directive (RED) (2014/53/EU), published on 22 May 2014), which they will apply from 13 June 2016. The existing Radio & Telecommunications Terminal Equipment Directive (1999/5/EC) will be repealed on that date.

Placing on the market: USA

- Any Part 15 ‘Radio Frequency Devices’ ’transmitter must be tested and authorized before it may be marketed
- There are two ways to obtain authorization: Certification & Verification.
- Certification and Verification procedures require that tests be performed to measure the levels of RF radiated. After these tests have been performed, a report must be produced

SRDs regulation & standardisation are divided into 2-3 major camps: Europe, N. America & Asia

Licensing: Part 15 'Radio Frequency Devices'; influence of the European 70-03 and R&TTE on Africa and West Asia is compared to the influence of the US on Canada, Mexico (NAFTA), Brazil and Latin America

Part 15 *Licence-Exempt Devices vs. Short Range Devices*

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 Europe permits lower emissions: e.g., e.i.r.p. 0.1W versus 4W at 2.4 GHz Europe constrains Wideband Data Transmission in 5150–5350 MHz, to only indoor use; EU R&TTE 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; e.g. periodic updates of 70-03 and First Report and Order (First R&O) Released: April 1, 2014, adding over 100 MHz to the U-NII at 5.725-5.85 GHz

Neutrality (?): 70-03 specifies 13 annexes detailing different applications; Part 15 normally doesn't specify application (except Unlicensed-National Information Infrastructure U-NII); technology is enforced, such as 75 frequency hopping systems employing at least 75 non-overlapping hopping channels'. Neutrality will advance the SRD use and harmonization

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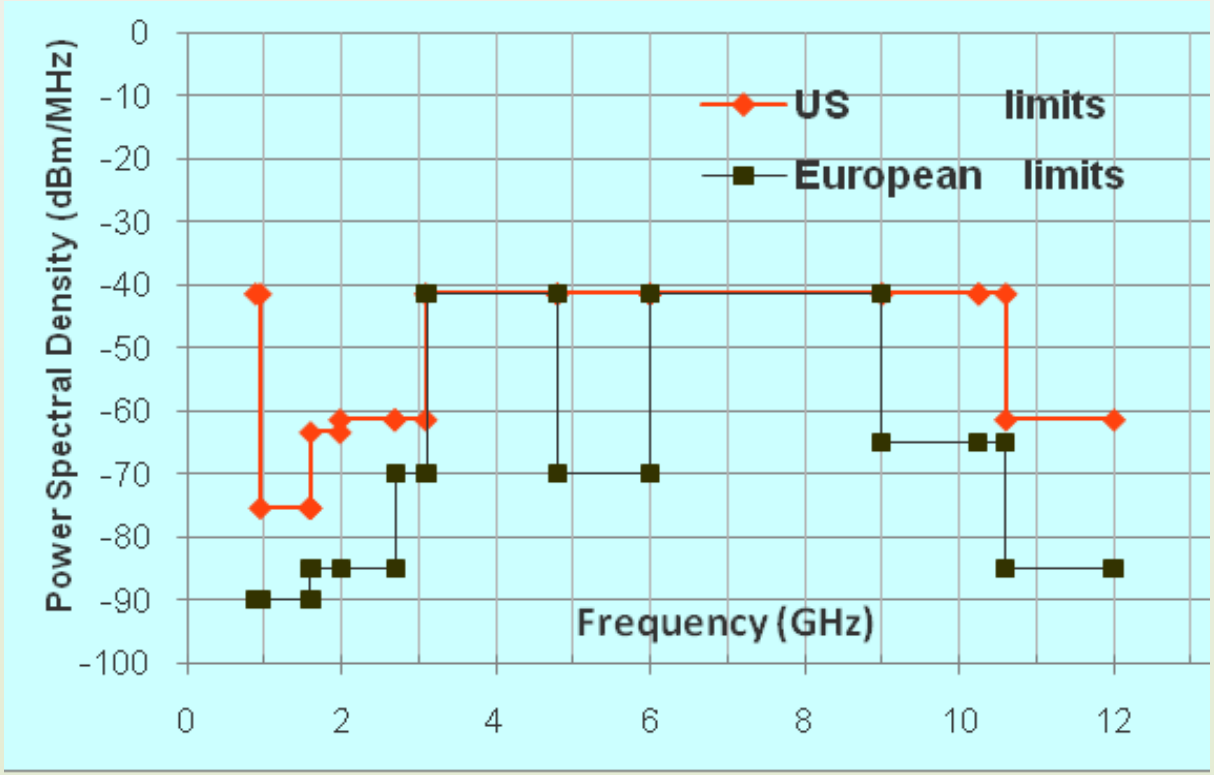
UHF RFID: Americas versus Europe

	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



UWB emission masks in Europe and the US

Differences up to 49 dB@900-960MHz;

Europe allowed UWB in 2005, US in 2001

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Foreign influence revealed via units of electric & magnetic fields, thresholds and technology

- 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)
- 70-03 uses logarithmic dB µA/m magnetic-fields at 10 m. Use of dB µA/m unit globally reveals European 70-03 influence. Examples: first 2 rows at Table 2 APT Report APT/AWG/REP-07 and Chinese SRD equipment A, 10 to 190 KHz 72 dB(µA/m) at 10 m
- Below 1,000 MHz, ERP is used; see as example Table 1 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 influence into Chinese ruling: 'automotive radars' (collision avoidance radars) RF 76 to 77 GHz, limit 55 dBm (peak e.i.r.p.); see RF and limit at 70-03 Annex 5- Transport and Traffic Telematics (TTT)
- Chinese 'Digital cordless telephone 2,400-2,483.5 MHz band should use at least 75 hopping frequencies' is influenced by FCC 47CFR§15.247

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RF for global harmonization of SRDs (See also Rec. SM.1896 annex1:)

Frequency range	ISM band; RR footnote	Centre frequency; remarks
9-148.5 kHz	Not ISM band	78.75 kHz; inductive applications
3,155-3,400 kHz		3,277.5; RR No. 5.116; inductive applications
6,765-6,795 kHz	RR No. 5.138	6,780 kHz; Inductive applications
13.553-13.567 MHz	RR No. 5.150	13.560 MHz; also Inductive applications
26.957-27.283 MHz	RR No. 5.150	27,120 kHz; also Inductive applications
40.66-40.7 MHz	RR No. 5.150	40.68 MHz
433.050-434.790 MHz	RR No. 5.138	ISM only in Region 1; see also RR No. 5.280; harmonized globally; 433.920 MHz
2,400-2,500 MHz	RR No. 5.150	2,450 MHz
5,725-5,875 MHz		5,800 MHz
24.00-24.25 GHz		24.125 GHz
61.0-61.5 GHz	RR No. 5.138	61.25 GHz
122-123 GHz		122.5 GHz
244-246 GHz		245 GHz

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Frequency ranges for regional harmonization of SRDs

Frequency range	Region 1	Region 2	Remarks
7,400-8,800 kHz	Available		
312-315 MHz		Available	Available only in some countries in Region 1, as a tuning range
862-875 MHz	Available	Not available	In Americas the band is used by trunking and cellular downlink systems. See national regulations
875-960 MHz	915-921 MHz is available	902-928 MHz is Available	902-928 MHz is an ISM band only in Region 2 (RR No. 5.150). Only parts of this range are operationally available for SRDs in Latin America. Europe operates GSM family at 873-915 MHz uplink and 918-960 MHz downlink

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Possible RF bands to harmonize SRD within Asia-Pacific, based on APT/AWG/REP-35 table 2

Frequency band	Typical Application	Remarks
402-405 MHz	Medical Implant	APT REC-05
433.05-434.79 MHz	RFID	APT REP-07
862-960 MHz	RFID	APT REC-03
5,150-5,350 MHz	WLAN	APT REC-06
5,470-5,725 MHz	WLAN	
76-77 GHz	Vehicle Radar	APT REP-07

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Harmonised RF bands in 7 Asia Pacific countries

Typical Applications	Frequencies / Frequency band (MHz)	Range of the maximum power level
Cordless Phones / Telemetry	315	25uW to 10mW e.r.p
Medical Implant	402-405	25uW e.r.p
RFID	433.92	1mW to 25m W e.r.p
WLAN	2,400-2,483.5	10mW to 1,000mW e.i.r.p
Vehicle Radar	76,000-77,000	10mW to 100W e.i.r.p

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Harmonised RF bands in five* Asia Pacific countries, based on Table 2 APT Report APT/AWG/REP-07

Typical Applications	RF band (MHz)	Range of maximum power level
RFID	13.553-13.567	100 mW* (e.i.r.p.) / 42 dBµA/m @10m
	26.96-27.28	0.5W to 3W e.r.p./42 dBµA/m @ 10m
Model Control	40.66-40.70	100 mW to 1,000mW e.r.p.
	72-72.25	10 mW to 750 mW e.r.p.
Cordless Phones	864.8-865	10 mW to 1,000 mW e.r.p.
WLAN	5725-5850	10 mW to 4W e.i.r.p.

Strange! assuming far-field free-space magnetic field is independent on RF, for 42 dBµA/m at 10 m,

$$|\vec{s}| = |\vec{e}| * |\vec{h}| = \frac{e^2}{120\pi} = 120\pi h^2 = pd = \frac{eirp}{4\pi d^2}$$

ERP = 42-35.38= 6.62 dBm; circa 5 mW; not 100 mW nor 0.5W to 3W

* Hong Kong, Korea, Philippines, New Zealand and Singapore

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Japan & Korea maximum electric field-strength 3 m distant from transmitter

Frequency band	Electric field-strength (μV/m)
$f \leq 322$ MHz	500
322 MHz < $f \leq 10$ GHz	35
10 GHz < $f \leq 150$ GHz	3.5 × f(GHz)*

*the maximal field-strength is 500 μV/m; therefore, above 143 GHz the field-strength is steady 500 μV/m.

Japan & Korea regulate as FCC not like Europe, determining specific bands for SRDs

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Wi-Fi Global: derived from revised Rec. ITU-R M.1450
Characteristics associated with broadband RLAN standards

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	

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General 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**	
	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.) 50 mW/MHz (e.i.r.p.)	13 N/A N/A N/A
57-66 GHz	Europe	57-66 GHz	40 dBm (e.i.r.p.)(12) 13 dBm/MHz (e.i.r.p)	N/A

Case Study:
ISM & Citizen Band (CB) 26.96-27.28 MHz

- Used around the world also as Citizen Band
- Applications: voice like walkie-talkie, baby monitoring, remote control, model control (in the air, on land or over or under the water surface), telecommand, anti-theft and car alarms

Global technical parameters of SRDs at 26.957-27.283 MHz; See also Report ITU-R SM.2153

Region/Country	Type of use		Specific Frequencies (MHz)	Emission limit	Reference
CEPT and many other countries	annex 1: non-specific SRD		26.957-27.283	42 dB(µA/m) at 10 m; 10 mW e.r.p.	ERC Recommendation 70-03
			26.995, 27.045, 27.095, 27.145, 27.195	100 mW e.r.p. < 0.1 % duty cycle	
	annex 8: model control			100 mW e.r.p.	
	annex 9: inductive applications		26.957-27.283 (as in annex 1)	42 dB(µA/m) at 10 m	
Americas	any		26.965, 26.975, 26.985, 27.005, 27.015, 27.025, 27.035, 27.055, 27.065, 27.075, 27.085, 27.105, 27.115, 27.125, 27.135, 27.155, 27.165, 27.175, 27.185, 27.205, 27.215, 27.225, 27.255, 27.235, 27.245, 27.265, 27.275, 27.285, 27.295, 27.305, 27.315, 27.325, 27.335, 27.345, 27.355, 27.365, 27.375, 27.385, 27.395, 27.405 : 40 channels	10 mV/m at 3 m equiv. to 30 µW (e.i.r.p.)	15.227 Operation 26.96-27.28 MHz § 95.407 channels to operate?
China	model & toy remote-control devices		26.975, 26.995, 27.025, 27.045, 27.075, 27.095, 27.125, 27.145, 27.175, 27.195, 27.225, 27.255 max bandwidth: 8 kHz	750 mW (e.r.p.)	Report ITU-R SM.2153
	other SRDs		26.957 to 27.283	42 dB(µA/m) at 10 m	
Korea	simplex		See Americas	3 W	Report ITU-R SM.2153
	Radio controller for	model automobile and ship craft	26.995, …, 27.195 MHz (5 channels, 50 kHz space	10 mV/m @10 m Equiv to 333 µW (e.i.r.p.)	
		toy, security alarm or telecommand	26.958-27.282 MHz		
Russia	car alarm		26.939-26.951 MHz	2 W. Duty cycle < 10%. Max ant gain 3 dB	
	security alarm		26.954-26.966 MHz		
Belarus, Kazakhstan, Russia	anti-theft alarm		26.945	2 W	SM.2153
	alarm & distress		26.960		

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Thank You for Listening

Any Qs?

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http://mazar.atwebpages.com/

international, regional and national regulation of SRDs is found at
http://www.itu.int/en/ITU-R/study-groups/workshops/RWP1B-SRD-UWB-14/Presentations/International,%20regional%20and%20national%20regulation%20of%20SRDs.pdf