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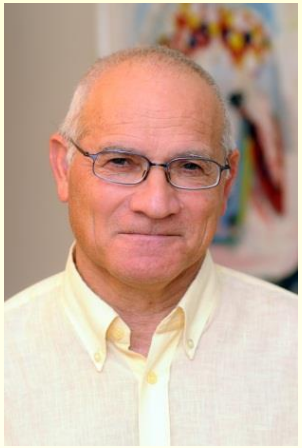

UHF RFID's global & regional ruling- the case of different allocations to Short Range Devices (SRDs) & electronic devices

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RF Spectrum Management of Short Range Devices

UHF 300 to 3 000 MHz Decimetric waves

In principle, SRDs have **no requirement for an individual licence** as they generally use the radio spectrum on a **non-interference and non-protected basis**. However, in specific cases licensing or registration may be required.

ITU Radio Regulations 1.15 ***industrial, scientific and medical (ISM)*** *applications* (of radio frequency energy)*:* 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***.

5.150 The following bands:

13 553-13 567 kHz	(centre frequency 13 560 kHz),
26 957-27 283 kHz	(centre frequency 27 120 kHz),
40.66-40.70 MHz	(centre frequency 40.68 MHz),
902-928 MHz	in Region 2 (centre frequency 915 MHz),
2 400-2 500 MHz	(centre frequency 2 450 MHz),
5 725-5 875 MHz	(centre frequency 5 800 MHz), and
24-24.25 GHz	(centre frequency 24.125 GHz)

are also designated for ISM applications. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications.

5.280 In Germany, Austria, Bosnia and Herzegovina, Croatia, The Former Yugoslav Republic of Macedonia, Liechtenstein, Montenegro, Portugal, Serbia, Slovenia and Switzerland, the band **433.05-434.79 MHz (centre frequency 433.92 MHz) is designated for ISM applications**. Radiocommunication services of these countries operating within this band **must accept harmful interference** which may be caused by these applications.

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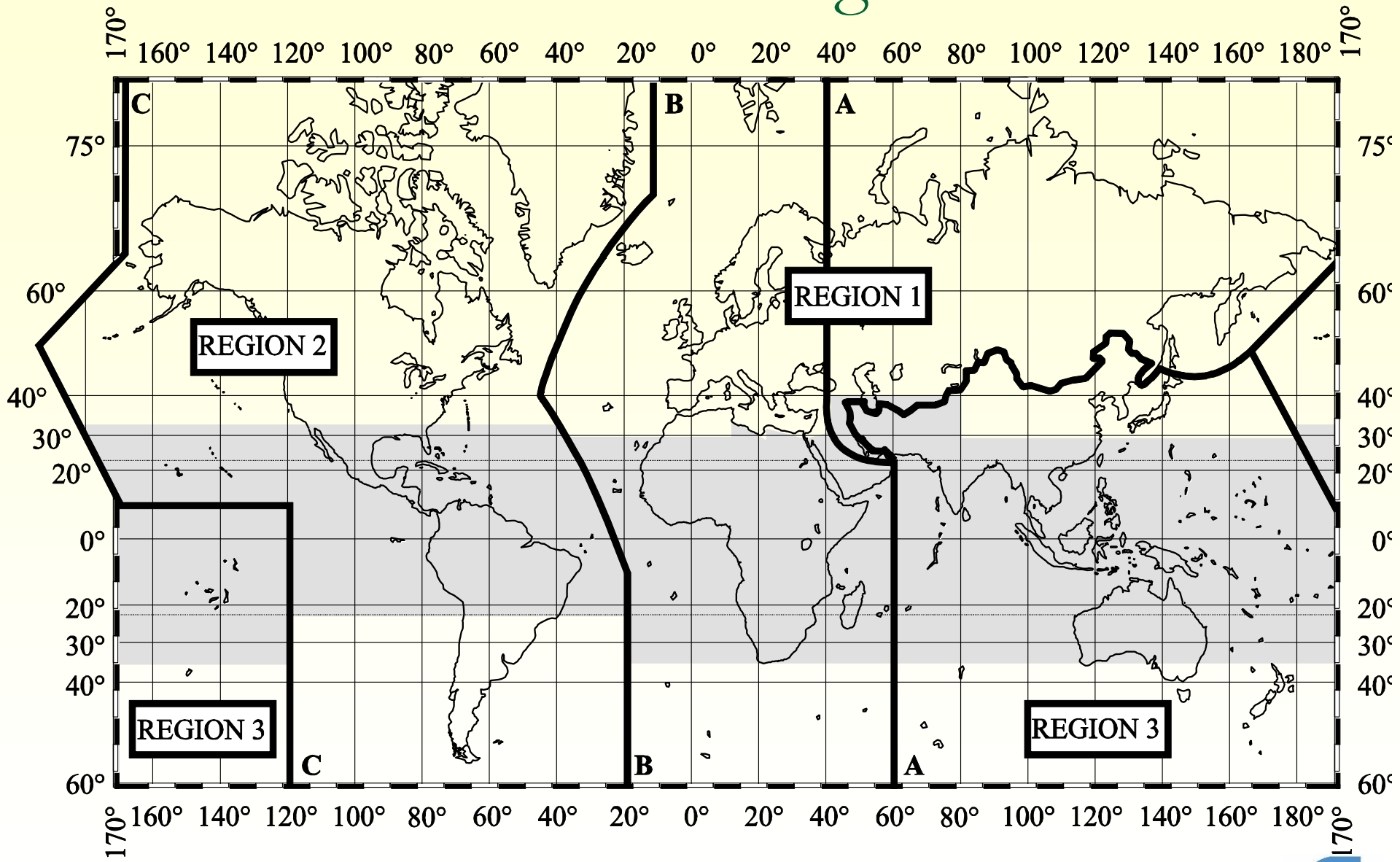
Regional & Intergovernmental Telecoms Regulators

Name	Regional and 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
TRASA	Telecom Regulators' Association of Southern Africa, 14 countries www.trasa.org.bw/
WATRA	West Africa Telecommunications Regulators Assembly,15 countries

Standards Development Organizations influencing wireless standardization

Name	Organization (Country)
3GPP	3rd Generation Partnership Project
3GPP2	Third Generation Partnership Project 2
ARIB	Association of Radio Industries and Businesses (Japan)
ATIS	Alliance for Telecommunications Industry Solutions
CCSA	China Communications Standards Association (China)
FCC	*Federal Communications Commission* (US)
IEC	International Electrotechnical Commission
IEEE- SA	Institute of Electrical and Electronics Engineer - Standards Association
GISFI	Global ICT Standardization Forum for India (India)
GS1	Global Standards One (responsible for EPC global RFID & global supply chain standards)
ISO	International Organization for Standardization
TIA	Telecommunications Industry Association (US)
TTA	Telecommunications Technology Association (Korea)

Three ITU Regions



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ITU-R Radio Regulations article 5: 470-890 MHz allocations

Allocation to services		
Region 1	Region 2	Region 3
470-790 BROADCASTING 5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.311A 5.312 5.312A	470-512 BROADCASTING Fixed Mobile 5.292 5.293	470-585 FIXED MOBILE BROADCASTING 5.291 5.298
	512-608 BROADCASTING 5.297	585-610 FIXED MOBILE BROADCASTING RADIONAVIGATION 5.149 5.305 5.306 5.307
	608-614 RADIO ASTRONOMY Mobile-satellite except aeronautical mobile-satellite (Earth-to-space)	
	614-698 BROADCASTING Fixed Mobile 5.293 5.309 5.311A	610-890 FIXED MOBILE 5.313A 5.317A BROADCASTING
	698-806 MOBILE 5.313B 5.317A BROADCASTING Fixed 5.293 5.309 5.311A	
790-862 FIXED MOBILE except aeronautical mobile 5.316B 5.317A **BROADCASTING** 5.312 5.314 5.315 5.316 5.316A 5.319	**806-890** FIXED **MOBILE** 5.317A BROADCASTING	
862-890 FIXED MOBILE except aeronautical mobile 5.317A BROADCASTING **5.322**		
5.319 5.323	5.317 5.318	5.149 5.305 5.306 5.307 5.311A 5.320

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ITU RR article 5: 890- 960 MHz allocations

Allocation to services		
Region 1	Region 2	Region 3
890-942 **FIXED** **MOBILE except aeronautical mobile 5.317A** **BROADCASTING 5.322** **Radiolocation** **5.323**	890-902 FIXED MOBILE except aeronautical mobile 5.317A Radiolocation 5.318 5.325 **902-928** FIXED Amateur Mobile except aeronautical mobile 5.325A Radiolocation **5.150** 5.325 5.326 928-942 FIXED MOBILE except aeronautical mobile 5.317A Radiolocation 5.325	890-942 FIXED MOBILE 5.317A BROADCASTING Radiolocation 5.327
942-960 **FIXED** **MOBILE except aeronautical mobile 5.317A** **BROADCASTING 5.322** **5.323**	942-960 FIXED MOBILE 5.317A	942-960 FIXED MOBILE 5.317A BROADCASTING 5.320

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ITU-R Rec 1896 Frequency ranges for global or regional harmonization of short-range devices (SRDs)

Frequency ranges for global harmonization of SRDs

Frequency range	Remarks
2 400-2 500 MHz	ISM band (RR No. 5.150) Centre frequency 2 450 MHz

Frequency ranges for regional harmonization of SRDs

Frequency range	Remarks	Region 1	Region 2	Region 3
312-315 MHz	These bands are exchangeable in terms of applications but not always available at the same time in one country. 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 in some countries	Available	Available in some countries
433.050-434.790 MHz		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

ITU-R Report SM 2255 Technical characteristics, standards, and frequency bands of operation for RFID

Table 2: ISO 18000 standard

ISO/IEC standard	Overview of standard	Frequency band
18000-4:2008	Air interface for radio-frequency identification (RFID) devices used in item management applications	**2.45 GHz (ISM)**
18000-6:2004	Air interface for radio-frequency identification (RFID) used in item management applications	**860-960 MHz (including sub-band 902-928 MHz of ISM in Region 2)**
18000-7:2009	**Air interface for radio-frequency identification (RFID) devices operating as an active RF tag used in item management applications**	**433 MHz (ISM in Region 1)**

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ITU Report SM 2255 TABLE 5 **Bands and technical rules for RFID**

Country	433.05-434.79 MHz (ISM Region 1)	860-960 MHz (902-928 MHz ISM Region 2)	2 400-2 500 MHz (ISM)
United States	11 000 µV/m **at 3 m** (RFID: for use in identifying the contents of shipping containers)	**4 W** e.i.r.p., digital modulation	4 W e.i.r.p. digital modulation
Canada	11 000 µV/m at 3 m (RFID: for use in identifying the contents of shipping containers)	**4 W** e.i.r.p., digital modulation	2 400-2 483.5 MHz:. 4 W e.i.r.p. digital modulation
Australia	**433.05-434.79 MHz**: 25 mW e.i.r.p. (All transmitters, RFID may use)	**918-926 MHz: 1 W e.i.r.p. 920-926 MHz: 4 W e.i.r.p.** **915-928 MHz: 1W** e.i.r.p. (Frequency hopping and Digital modulation transmitters, RFID may use where they comply)	2 400-2 483.5 MHz: 10 mW e.i.r.p. (All transmitters, RFID may use) 2 400-2 450 MHz: 1 W e.i.r.p. 2 400-2 483.5 MHz: 4 W e.i.r.p. (Frequency hopping and Digital modulation transmitters, RFID may use where they comply)
New Zealand		**918-926 MHz: 1 W e.i.r.p.**	2 400-2 450 MHz: 1 W e.i.r.p.
Countries Members of **CEPT**	Included in Annex 1 of ERC Recommendation 70-03 (see Annex 4 of the present document) Up to 10 mW e.r.p. Non-specific SRDs (RFID may use this band as long as they meet the technical parameters) 433.05-434.79 MHz: 10 mW e.r.p., duty cycle £ 10% 433.05-434.79 MHz: 1 mW e.r.p. 434.04-434.79 MHz: 10 mW e.r.p., channel BW £ 25 kHz	Included in Annex 11 of ERC Rec 70-03 (see Annex 4 of the present document). Up to 2 W e.r.p. in **865-868** MHz. Channel size: 200 kHz. 865-865.6 MHz: 100 mW e.r.p. 865.6-867.6 MHz: 2 W e.r.p. 867.6-868 MHz: 500 mW e.r.p.	Included in Annex 11 of ERC Recommendation 70-03 (see Annex 4 of the present document). Up to 4 W e.i.r.p. in 2446-2454 MHz 500 mW e.i.r.p. Indoor use only: 4 W e.i.r.p. and duty cycle 15%
	1 mW e.r.p. and −13 dBm/10 kHz power density for bandwidth modulation larger than 250 kHz 10 mW e.r.p. and duty cycle 10% 434.04-434.79 MHz 1 mW e.r.p. and −13 dBm/10 kHz power density for bandwidth modulation larger than 250 kHz 10 mW e.r.p. and duty cycle 10% or duty cycle 100% subject to channel spacing up to 25 kHz		
China	10mW e.r.p. Occupied bandwidth: 400 kHz	840.5-844.5 MHz 2 W e.r.p. FHSS 920.5-924.5 MHz 2 W e.r.p. FHSS Channel space :250 kHz	2 400-2 483.5 MHz: 10 mW e.i.r.p
Republic of Korea	433.67-434.17 MHz: 3.6 mW e.i.r.p. (RFID: for use in identifying the contents of shipping containers)	**917-923.5 MHz;** 4 W e.i.r.p. Passive RFID with the exception of the output RF power is 10 mW	2 400-2 483.5 MHz: 3 mW/MHz (for FHSS); 10 mW/MHz (for other spread spectrum type); 10 mW (other type)
Israel (see specific slide)	Up to 1 mW e.r.p. ; 10 mW e.r.p can be considered for approval	**915-916.8 MHz**, only; In average out of band below 915 MHz, -74 dBm per 100 kHz.. Above 917 MHz, -46 dBm per 30 kHz (already changes HM)	Up to 4 W e.i.r.p. in 2446-2454 MHz . 100 mW (eirp) at 2,400-2,483.5 MHz

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Frequency Band		Power / Magnetic Field	Spectrum access and mitigation requirements
f	433.050-434.790 MHz	10 mW e.r.p.	< 10 % duty cycle (note 1)
f1	433.050-434.790 MHz	1 mW e.r.p. -13 dBm/10 kHz	No requirement except for (note 4bis)
f2	434.040-434.790 MHz	10 mW e.r.p.	No requirement except for B(note 4bis)
g	863-870 MHz (note 3 and 4)	≤ 25 mW e.r.p.	≤ 0.1% duty cycle or LBT (note 1 and 5)
		≤ 25 mW e.r.p. Power density : - 4.5 dBm/100 kHz (note 7)	≤ 0.1% duty cycle or LBT+AFA (note 1, 5 and 6)
		≤ 25 mW e.r.p.	≤ 0.1% duty cycle or LBT+AFA (note 1 and 5)
g1	868.000-868.600 MHz (note 4)	≤ 25 mW e.r.p.	≤ 1% duty cycle or LBT+AFA (note 1)
g2	868.700-869.200 MHz (note 4)	≤ 25 mW e.r.p.	≤ 0.1% duty cycle or LBT+AFA (note 1)
g3	869.400-869.650 MHz	≤ 500 mW e.r.p.	≤ 10% duty cycle or LBT+AFA (note 1)
g4	869.700-870.000 MHz (note 4bis)	≤ 5 mW e.r.p. ≤ 25 mW e.r.p.	No requirement up to 1% duty cycle or LBT+AFA (note 1)
h	2400.0-2483.5 MHz	10 mW e.i.r.p.	No requirement

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Rec 70-03 annex 11: Radio Frequency Identification Applications

	Frequency Band	Power / Magnetic Field	Spectrum access and mitigation requirements	Channel spacing
a1	**2446-2454 MHz**	≤500 mW e.i.r.p.	No requirement	**No spacing**
a2	**2446-2454 MHz**	>500 mW-4 W e.i.r.p	≤ 15% duty cycle FHSS techniques should be used	**No spacing**
b1	**865.0-865.6 MHz**	100 mW e.r.p.	No requirement	**200 kHz**
b2	**865.6-867.6 MHz**	**2 W e.r.p.**	No requirement	**200 kHz**
b3	**867.6-868.0 MHz**	**500 mW e.r.p.**	**No requirement**	**200 kHz**

ETSI EN 302 208-2 V1.4.1 (2011-11)

RFID operating in **865-868** MHz up to **2 W**

15 channels of x200 KHz=3 Mhz

spectrum efficiency & system performance

- LbT is no longer requirement, still an option

FCC CFR47 CFR 47 FCC Part 15—*Radio Frequency Devices* in general followed in Americas

15.245 Operation within the bands 902–928 MHz, 2435–2465 MHz, 5785– 5815 MHz, 10500–10550 MHz, and 24075–24175 MHz.

902-928 MHz 500 mV/m @ 3 m

§ **15.247** Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

(i)For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

(iii) Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Tags operate 902 - 928 MHz; Frequency Hopping–52 channels×500kHz@4W EIRP

see also http://www.semtech.com/images/promo/FCC_Part15_regulations_Semtech.pdf

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Comparison North America vs. Europe

- **Frequency**: US 902-928; Europe 865-868 MHz;
- **Channels** : US 52 x 500 kHz; Europe 15x200
- **Bandwidth:** 26 MHz , Europe 15 x 200 kHz 3 MHz
- However, the approval process in the US is less tolerable -testing and approving every RFID- than the European R&TTE (EC Directive 1999/5 "*Radio Equipment & Telecommunications Terminal Equipment*" : simple declaration of the supplier is satisfactory, without any prior intervention of the regulator.
- The FCC still has a prior *ex-ante* certification regime (noting FCC number on the equipment), which does not exist anymore in the EU (in the case of RFID and GSM equipment, for instance).

EPC global UHF operating frequencies worldwide (extract)

48 CEPT countries	865.6 - 867.6	2 W ERP	ETSI
Americas (most)	902 - 928	4 W EIRP	FHSS
Australia	920 - 926	4 W EIRP	
	918 - 926	1 W EIRP	
Brazil	902 - 907.5	4 W EIRP	FHSS
	915 - 928	4 W EIRP	FHSS
China	840.5 - 844.5	2 W ERP	FHSS
	920.5 - 924.5	2 W ERP	FHSS
Hong Kong, China	865 - 868	2 W ERP	
	920 - 925	4 W EIRP	
India	865 - 867	4 W EIRP	
Israel	915 - 917	2 W EIRP	ETSI
Japan (effective until March 31, 2018)	952 - 956.4	4 W EIRP	Either LBT free with 4 x 200KHz channels for readers or LBT
	952 - 956.4	0.5 W EIRP	LBT
	952 - 957.6	20 mW EIRP	LBT
Japan (effective as of July 25, 2012)	916.7 - 920.9	4 W EIRP	Either LBT free or LBT
	916.7 - 923.5	0.5 W EIRP	LBT
Jordan	865 - 868	2.0 W ERP	
Korea, Rep.	917 - 920.8	4 W EIRP	FHSS or LBT
	917 - 923.5	200 mW EIRP	FHSS or LBT
Malaysia	866 - 869		
	919 - 923	2 W ERP	
New Zealand	864 - 868	4 W EIRP	FHSS
	921.5 - 928	4 W EIRP	FHSS
Oman	865.6 - 867.6	2 W ERP	ETSI
Saudi Arabia	865.6 - 867.6	2 W ERP	ETSI
Singapore	866 - 869	0.5 W ERP	
	920 - 925	2 W ERP	
South Africa	865.6 - 867.6	2 W ERP	ETSI
	915.4 - 919	4 W EIRP	FHSS
	919.2 - 921	4 W EIRP	Non-modulating
Taiwan	922 - 928	1 W ERP	FHSS
	922 - 928	0.5 W ERP	FHSS
Thailand	920 - 925	4 W EIRP	FHSS
Vietnam	866 - 869	0.5 W ERP	
	920 - 925	2 W ERP	

Israeli RFID UHF regulation

- RF 915 -917 MHz
- Spectrum mask of interrogators :
  - EiRP: 2 Watts
  - Out Of Band (OoB) below 915 MHz, -74 dBm per 100 KHz; above 917 MHz -63.6 dBm per 25 KHz;
  - the duty cycle (DC) provides a linear release only at 915 MHz; e.g. for DC 1 % (- 20 dB) OoB below 915 MHz is -54 dBm per 100 KHz, and not -74 dBm per 100 KHz
- The manufacturer should mark the product (model not type) by suffix in order to emphasize the specific ISR RF band and Out of Bands. ISR requests a unique identifier; “IL” is convenient; any other ISR unique identifier is accepted.

Lower RF is better due to Free Space loss

PL=PropagationLoss; P_t=T_xPower, P_r=R_xPower; d=distance, λ=wavelength, A_e =Effective ant. area

$$PL(dB) = 10\log\left(\frac{4\pi d}{\lambda}\right)^2 = 20\log\left(\frac{4\pi d}{\lambda}\right)$$

$$PL(dB) = 20\log(d/\lambda) + 22 = 22 + 20\log d_m - 20\log\lambda_m$$

$$PL(dB) = 20\log d_{kM}\, xf_{MHz} + 32.44 = 20\log d_m + 20\log f_{MHz} - 27.56$$

Explained by the free space propagation loss: the 433 MHz (lower RF) suits the higher distances; 2400 MHz seems too high.

readers for active tags need less power: as they don't initiate tags.
433 MHz active RFIDs; for example by SAVI for DoD

RFIDs - general

In general, passive and active tags can be differentiated by the existence of the battery in the tag. Active tags use battery as power source to broadcast and communicate with the reader. The power and effective range of active tags are significantly higher than passive tags and therefore may interfere farther.

EPC - Electronic Product Code is one of the standards for Global RFID developed by GS1; it's an eventual successor to the bar code, using RFID technology. EPC is a string of numbers & letters ,consisting of a header and three sets of data: the first partition identifies the manufacturer; the second identifies the Product type and the third the serial number unique to the item (source : RFID Journal)

Better Visibility: getting more in less time with reduce costs. RFID reduces manual and error-prone activity, by automating product visibility (Source: Motorola)

The **pharmaceutical** industry distributes regular pharmaceuticals through a complex supply chain involving thousands of trading partners through multiple transaction levels. RFID assists to stem the influx of counterfeit drugs. RFIDs "track and trace" a precision drug from the time pharmaceutical product leaves the factory to the moment a patient receives it. Histories and authenticity are established. (Source : ALIEN)

RFID in the **DOD supply chain**: RFID allows military logisticians to synthesize and integrate end-to-end information about assets . On July 2004 the DOD issued a policy requiring the implementation of RFID across DOD (Source :Army Logistician)

Advantages over Barcode:

- Legible without visibility; enables reading of several labels simultaneously
- Legible from great distance -active RFID up to 300 feet and more
- Can add data, can identify individual items
- Resistant to humidity and temperature

Some RFIDs Applications

1. **Asset Management:** RFID marked assets combined with mobile scanners provide a way to identify and manage them
2. **Inventory Systems:** RFIDs enable control of movement and constant monitoring of stored items (such as spare parts) and their inventory level
3. **Product Tracking:** Products are tracked through the manufacturing process from start to finished product ,finished product store and further through supply chain to end customer
4. **Transportation** and **Logistics:** Yard management ,shipping ,freight control at distribution centers use RFID tracking
5. **Animal Tracking and Identification:** implantable tag is used for wild animals, pets and ear tags for cattle and sheep
6. **Hospitals** and **Healthcare:** RFID wristbands are used to identify patients and active tags are used to mark medical equipment ,especially essential ,to locate them in the hospital area
7. **Timing Races:** racers wear tags and antennas in mats across the track
8. **Toll Road Management:** instead of toll boxes or gates ,transponders are mounted on the windshield and readers installed above the road. As the vehicle passes the reader its transponder is read and data sent to be processed
9. **Cutting Tools:** modern machining produce expensive parts; RFIDs guarantee that a part is processed with the correct tool. RFID tag is mounted on the tool carrier; tag is read by a reader on the machine CNC program can be verified
10. **Waste Management:** waste disposal trucks equipped with RFID readers pick up bins equipped with RFID tags. Tags are read: bin number, collection place and time are recorded and sent (e.g. via cellular modem) for further processing

Conclusion:

1. RFID's Regulation reveals the influence of national ruling.
2. UHF RFID's ruling advanced many applications that effect our daily life: better, more efficient and safer

Haim Mazar's book may interest you: An analysis of regulatory frameworks for wireless communications, societal concerns and risk: the case of Radio Frequency (RF) allocation and licensing

Future Wiley book: Radio Spectrum Management: Policies, Regulations, Standards and Techniques

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Craig Alan Repec Senior Manager EPCglobal Technology GS1

Contribution to Center for Biological Diversity

We may connect:
http://www.linkedin.com/profile/view?id=68463654&locale=en_US&trk=tyah

Any Qs?

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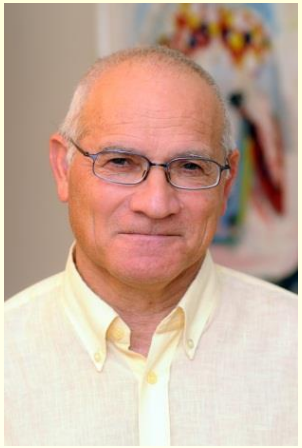

UHF RFID's global & regional ruling- the case of different allocations to Short Range Devices (SRDs) & electronic devices

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