International, Regional and National RF Spectrum Management

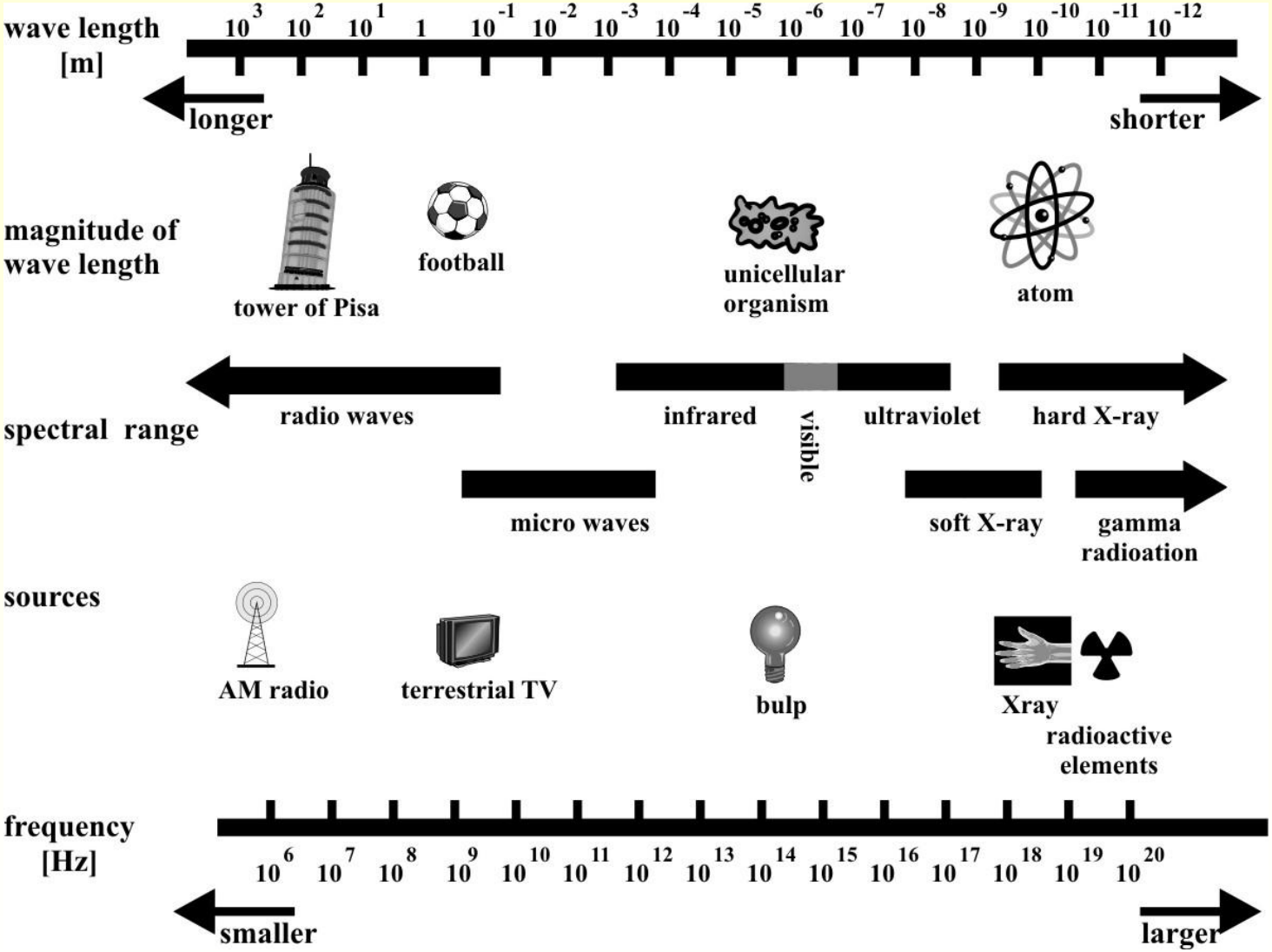
Dr. Haim Mazar (Madjar)

Vice Director, Ministry of Communications (MoC) RF Spectrum, Licensing and Monitoring Division
Vice Chairman, International Telecommunication Union Radio (ITU-R) Study Group 1 (Spectrum Management)

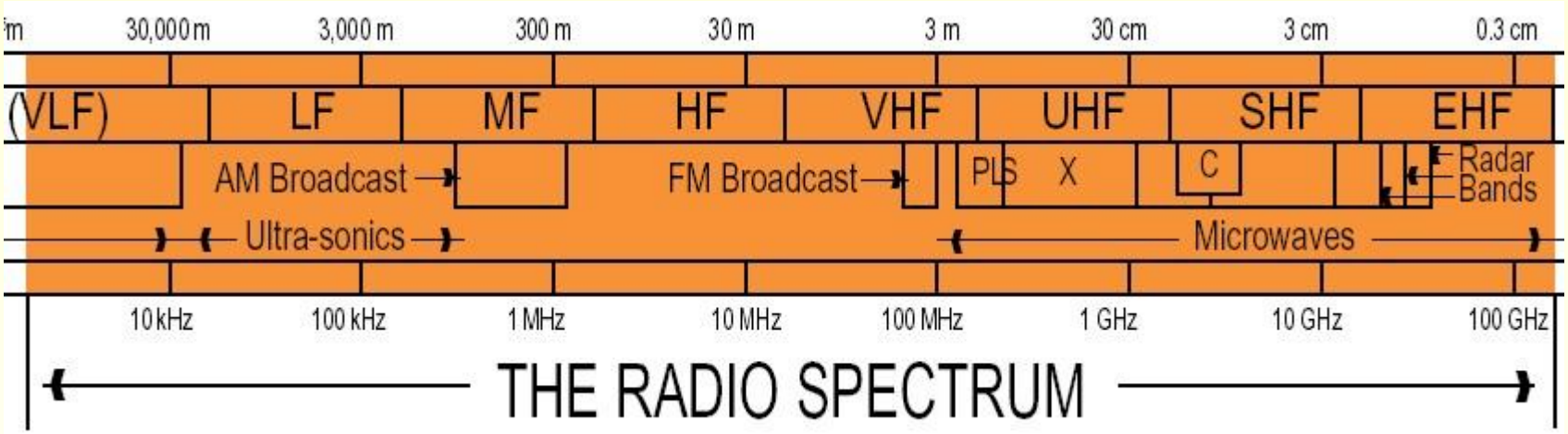
AFEKA Tel Aviv Academic College of Engineering

13 December 2011

The RF Spectrum



The RF Spectrum and nomenclature



Nomenclature of the frequency and wavelength bands used in telecommunications

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 (?!); EU R&TTE 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 and Regional orgs see my PhD thesis http://eprints.mdx.ac.uk/133/2/MazarAug08.pdf p. 179

Roles of the National Spectrum Management

1. Avoid and solve interference
2. Design long and short range RF spectrum
3. Support Engineering: Propagation, DTM
4. Coordinate with Military Wireless Services
5. Advance new wireless technologies (such as digital audio and video)
6. Coordinate with other Administrations
7. Advance new technologies and efficient import of equipment

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 2 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’

How to manage the RF Spectrum

1. Follow Regional Allocations and Assignments; try to ease circulation of equipment
2. Coordinate (bi-lateral and multi-lateral) with your neighbours
3. Don't invent specific allocations; with whom do you want to be identified? Follow its rules and standards
4. Transparency; Light Touch (?); central-based or market-oriented?
5. Try **not** to allocate to fixed transmitters and receivers (e.g. TV from air), if there is an alternative (cable or satellite)
6. Allocate RF spectrum with a vision towards implementing in many cases markets
7. Ensure the effective (reuse) and efficient (bits/hertz) use of the RF Spectrum
8. Decrease Interference by assigning: min power, min bandwidth, max RF


Structure
ITU
Plenipotentiary Conferences
Council
World Conferences on International Telecommunications
World/Regional Radiocommunication Conferences
Radiocommunication Assemblies
Radio Regulations Board
Advisory Group
Study Groups
World Telecommunication Standardization Assemblies
Advisory Group
Study Groups
World/Regional Telecommunication Development Conferences
Advisory Group
Study Groups
General Secretariat
Secretary-General
Deputy Secretary-General
Director
Radiocommunication Bureau
Director
Telecommunication Standardization Bureau
Director
Telecommunication Development Bureau
Radiocommunication Sector
Telecommunication Standardization Sector
Telecommunication Development Sector

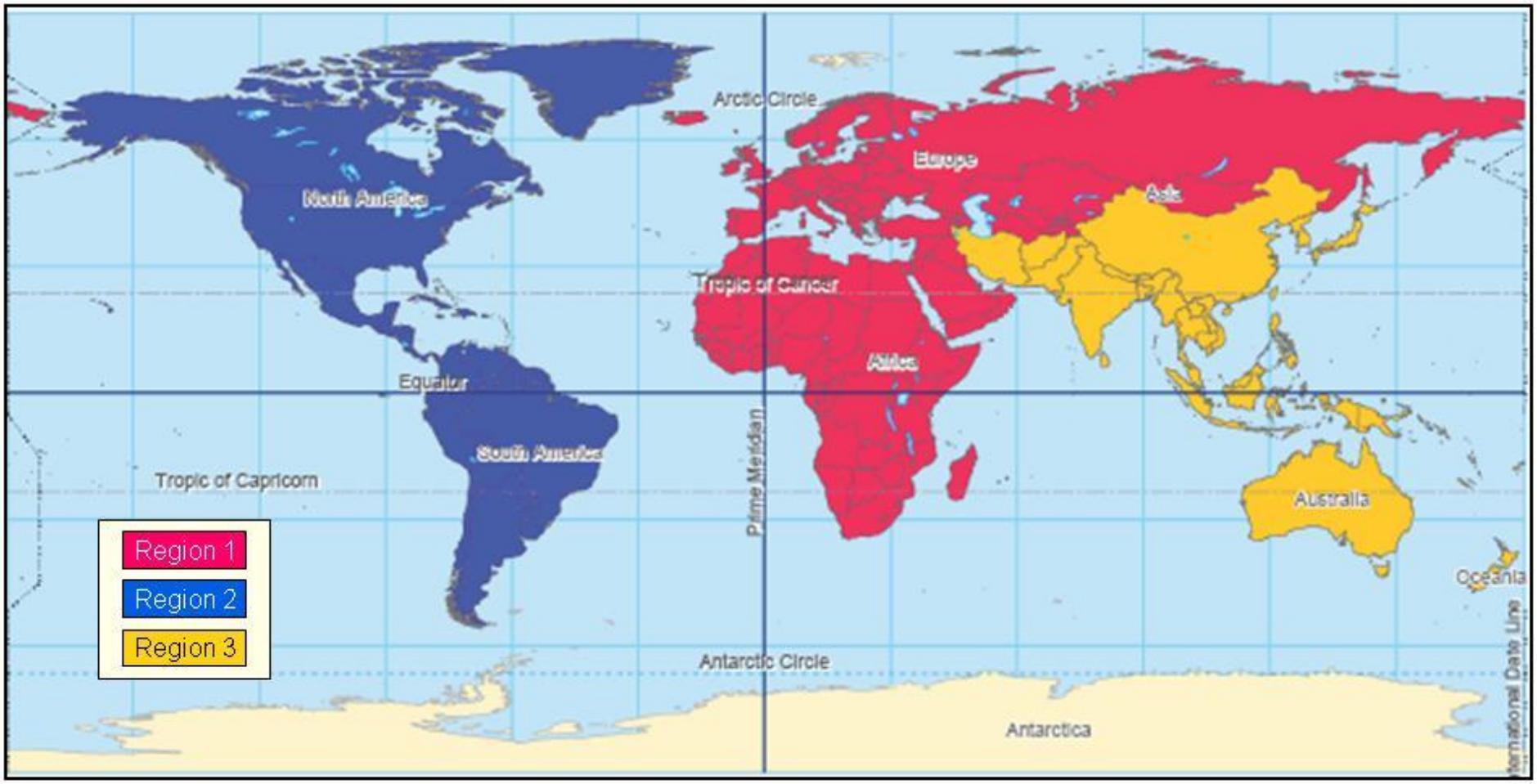
World Radio Conference 2012

ITU-R Radio Communications Assembly

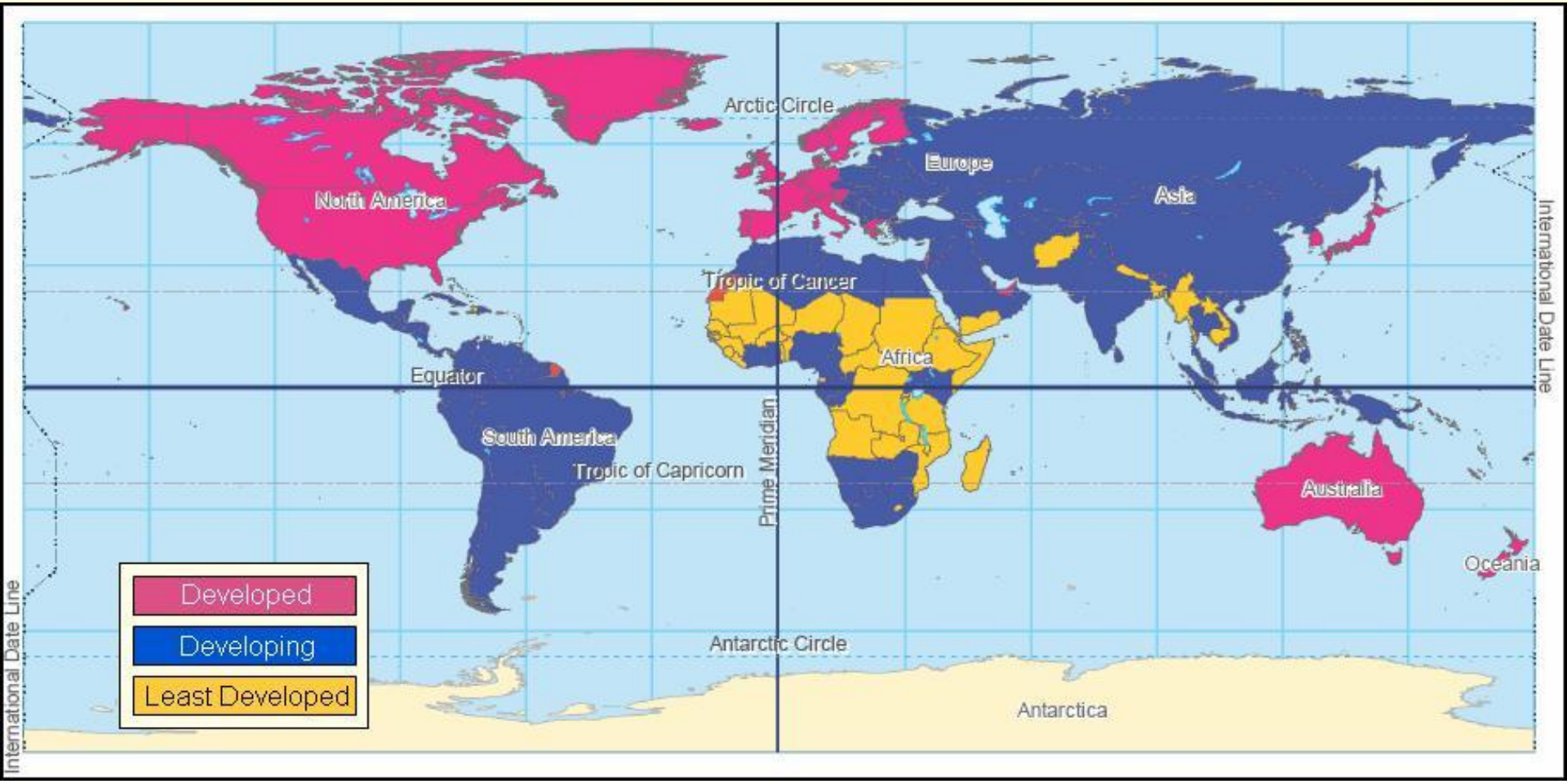
ITU-R Study Group Structure

Study Group 1 (SG 1) - Spectrum management
Study Group 3 (SG 3) - Radiowave propagation
Study Group 4 (SG 4) - Satellite services
Study Group 5 (SG 5) - Terrestrial services
Study Group 6 (SG 6) - Broadcasting service
Study Group 7 (SG 7) - Science services
Coordination Committee for Vocabulary (CCV)
Conference Preparatory Meeting (CPM)
Special Committee (SC)

ITU Regions

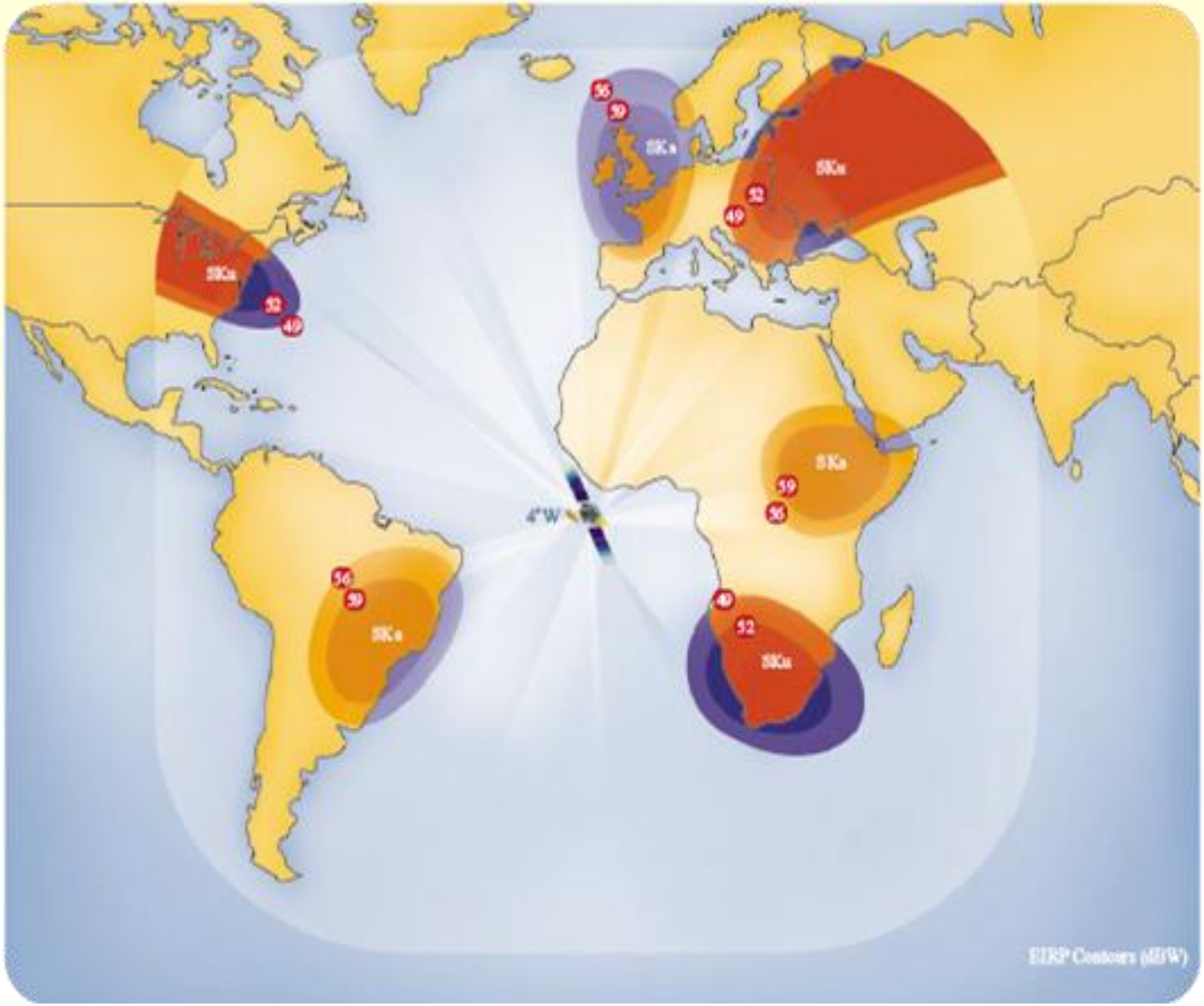

Arctic Circle
Europe
Asia
Tropic of Cancer
Africa
Equator
South America
Prime Meridian
Tropic of Capricorn
Australia
Oceania
Region 1
Region 2
Region 3
Antarctic Circle
Antarctica

Developed, Developing and LDCs



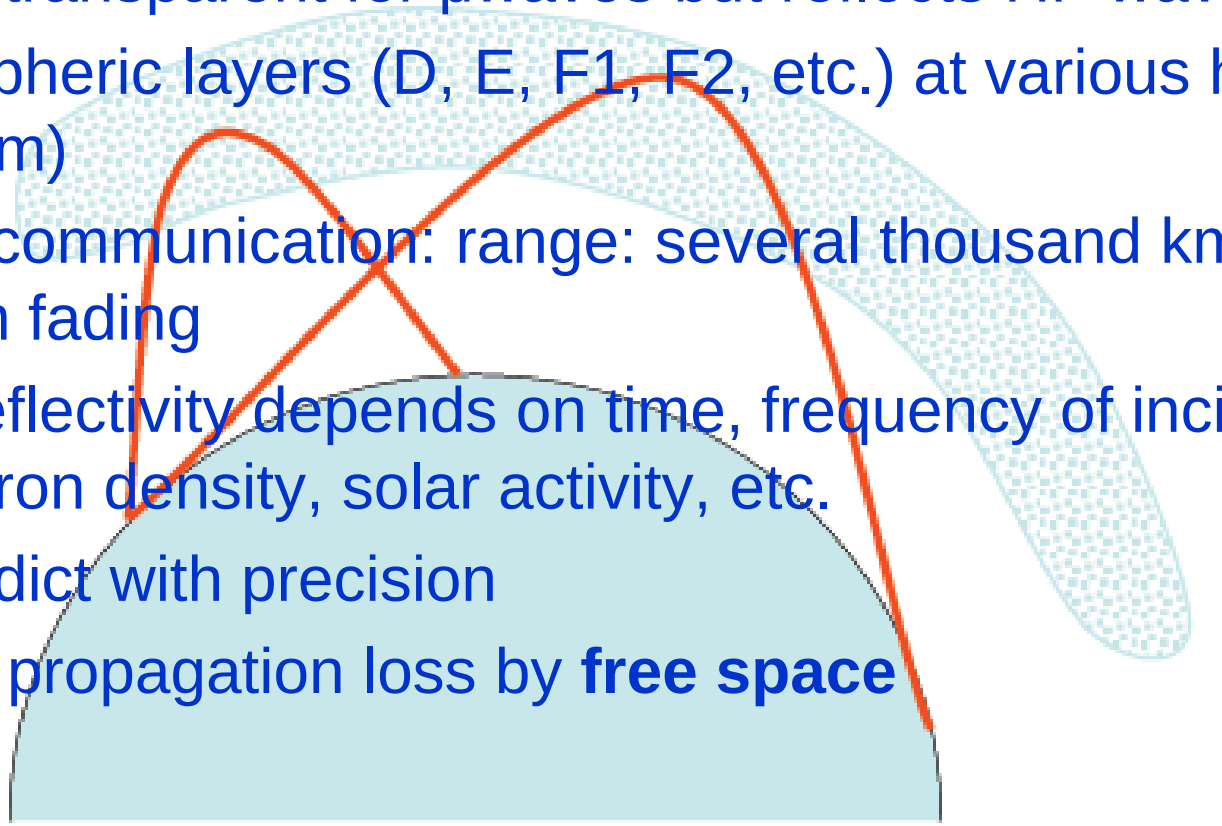
See http://eprints.mdx.ac.uk/133/2/MazarAug08.pdf pp 164

Why coordination is needed; Amos-3 Global changeable Ku & Ka footprints, Rami Neuderfer



Why coordination is needed, HF Propagation

- Ionospheric “reflections”
- Ionosphere is transparent for μwaves but reflects HF waves
- Various ionospheric layers (D, E, F1, F2, etc.) at various heights (50 – 300 km)
- Over-horizon communication: range: several thousand km; suffers from fading
- Ionospheric reflectivity depends on time, frequency of incident wave, electron density, solar activity, etc.
- Difficult to predict with precision
- Calculation of propagation loss by **free space**



Free space Loss

PL=PropagationLoss; P_t=T_xPower, P_r=R_xPower; d=distance, λ=wavelength; E_{rms}=field strength

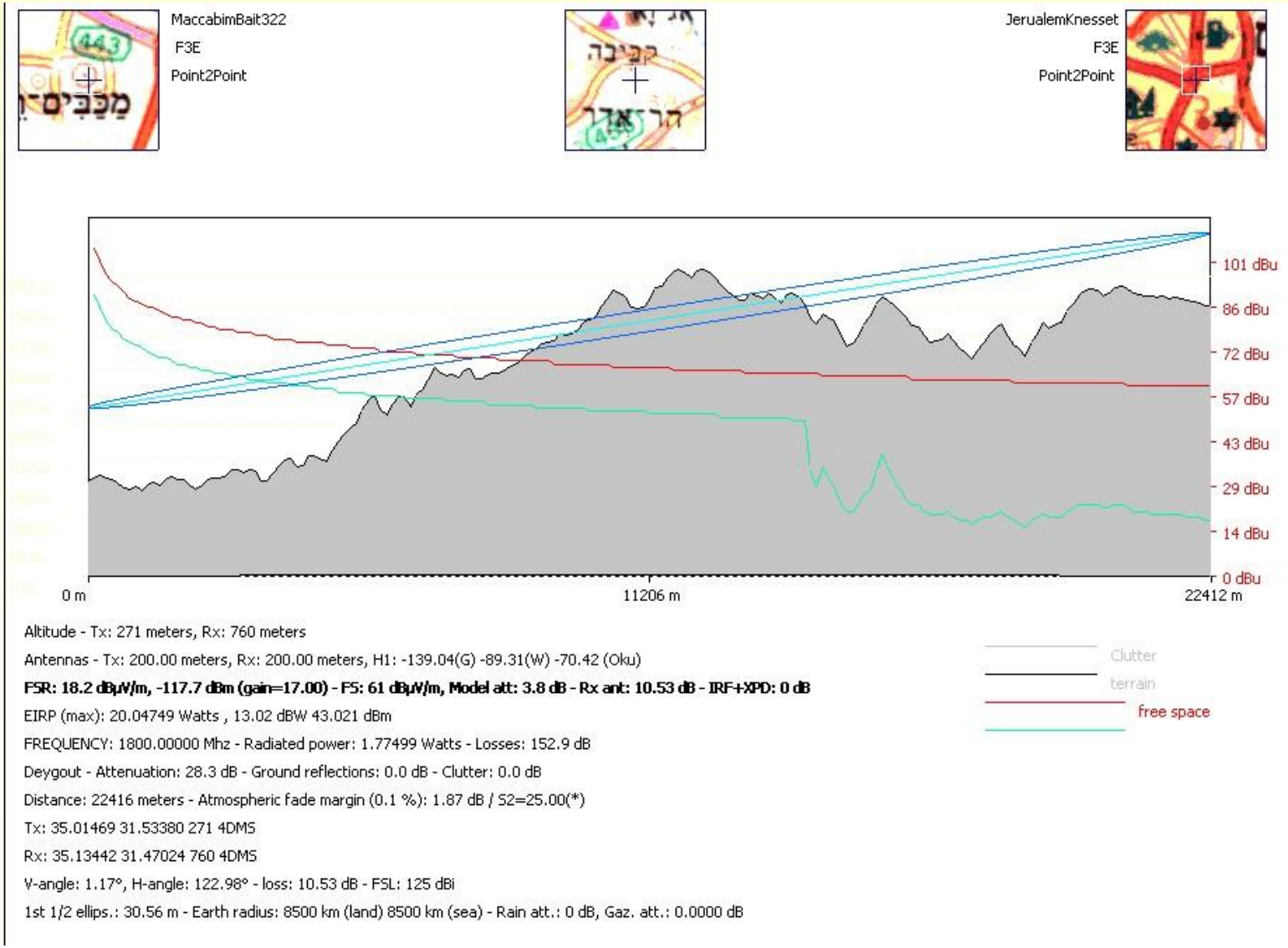
$$A_e = \frac{g\lambda^2}{4\pi}$$

$$PL = \frac{P_t}{P_r} = \frac{P_t}{\left[(P_t \div 4\pi d^2) \bullet \frac{\lambda^2}{4\pi}\right]} = \left(\frac{4\pi d}{\lambda}\right)^2$$

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

$$PoyntingVector = \frac{P_t}{4\pi d^2} = \frac{P_r \bullet 4\pi}{\lambda^2} = \frac{1}{\mu_0}(\vec{E} \times \vec{B}) = \frac{E_0{}^2}{120\pi} \qquad E_0 = \frac{\sqrt{30 \cdot P_t}}{d}$$

Engineering tool optimises RF usage; propagation model with DTM uses topographic obstacles to re-use assignments- Profile Maccabim-Jerusalem



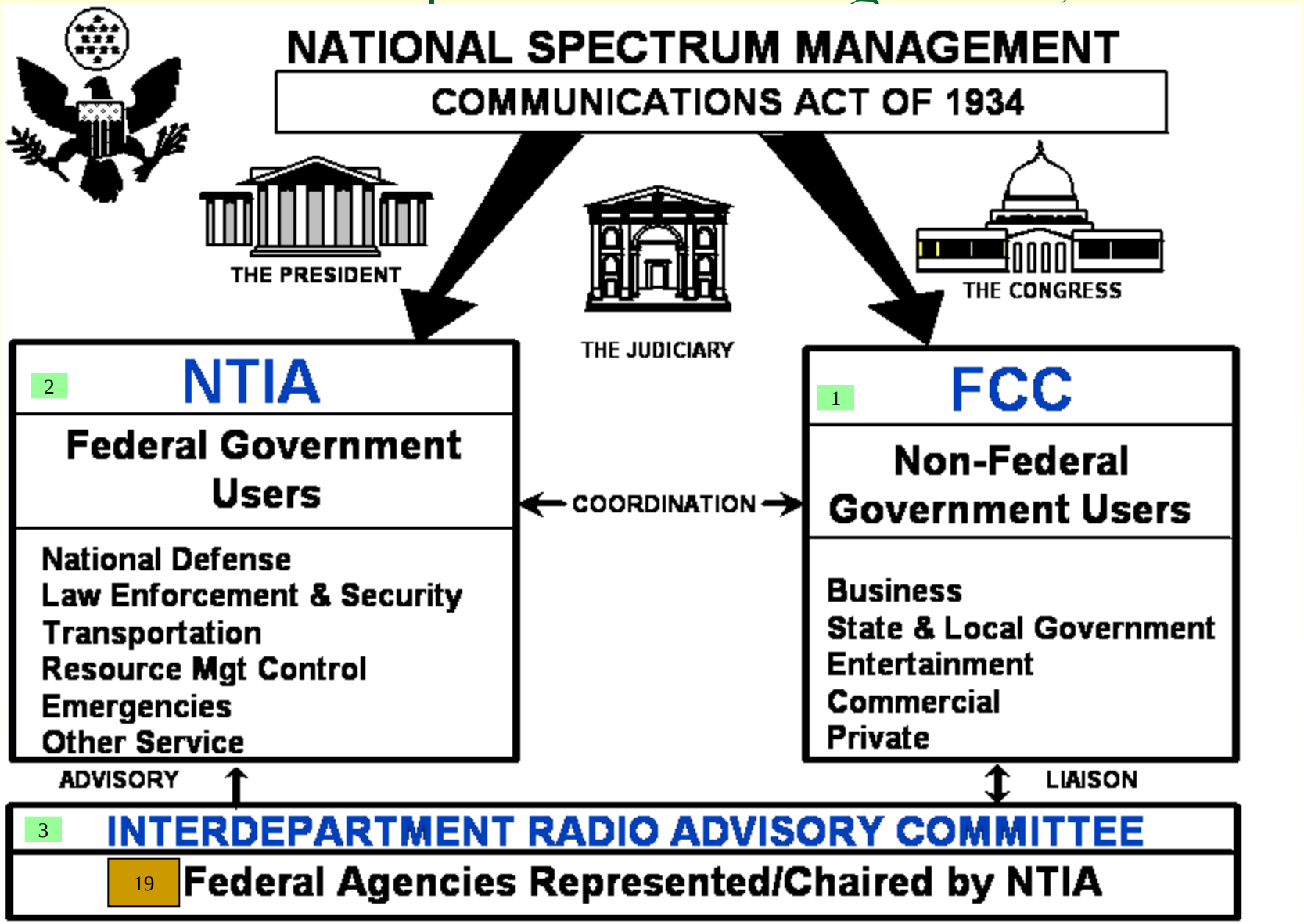
Spectrum Control (Mgmt and Monitoring)

1. Wireless regulation & standardisation are divided into two major camps: Europe and N. America
   - Different approach to top-down mandated standards: collectivism and intervention vs. *individualism* and '*light touch'*
   - Licensing: Part 15 and R&TTE; influence of EU on the rest Europe (& Region 1) is parallel to the influence of the US on Canada
   - Harmonisation: *E Pluribus Unum*, probability of interference
   - Europe: 50 Hertz, 9 KHz audio MW AM BW, GSM, 7-8MHz PAL&SECAM TV into DVB-T
   - N. America: 60 Hertz, 10 KHz audio MW AM BW, CDMA, 6 MHz NTSC TV switched to ATSC
2. Diverse cellular penetration and digital TV standards are derived from dissimilar coverage zones and population densities

Human Hazards- thresholds

1. At 400-1500 MHz, the allowed ICNIRP and Eur. Power Density for the general public is:
   f (MHz)/200 [W/m^2]
2. Europe follows ICNIRP 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/m^2]
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.

US National Spectrum Management; Bill Luther



NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (Redbook)

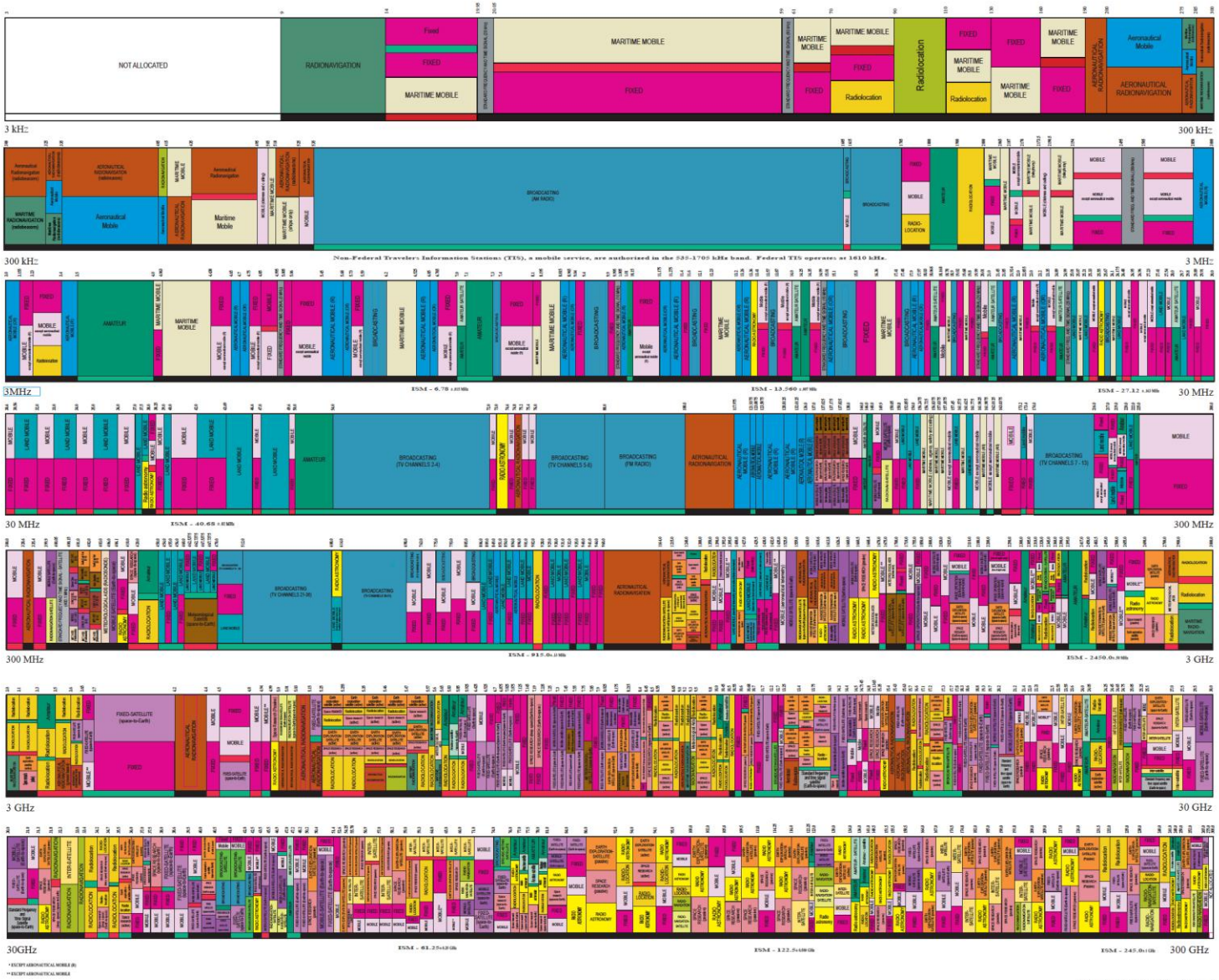
National Telecommunications & Information Administration (NTIA)

http://www.ntia.doc.gov/osmhome/redbook/redbook.html

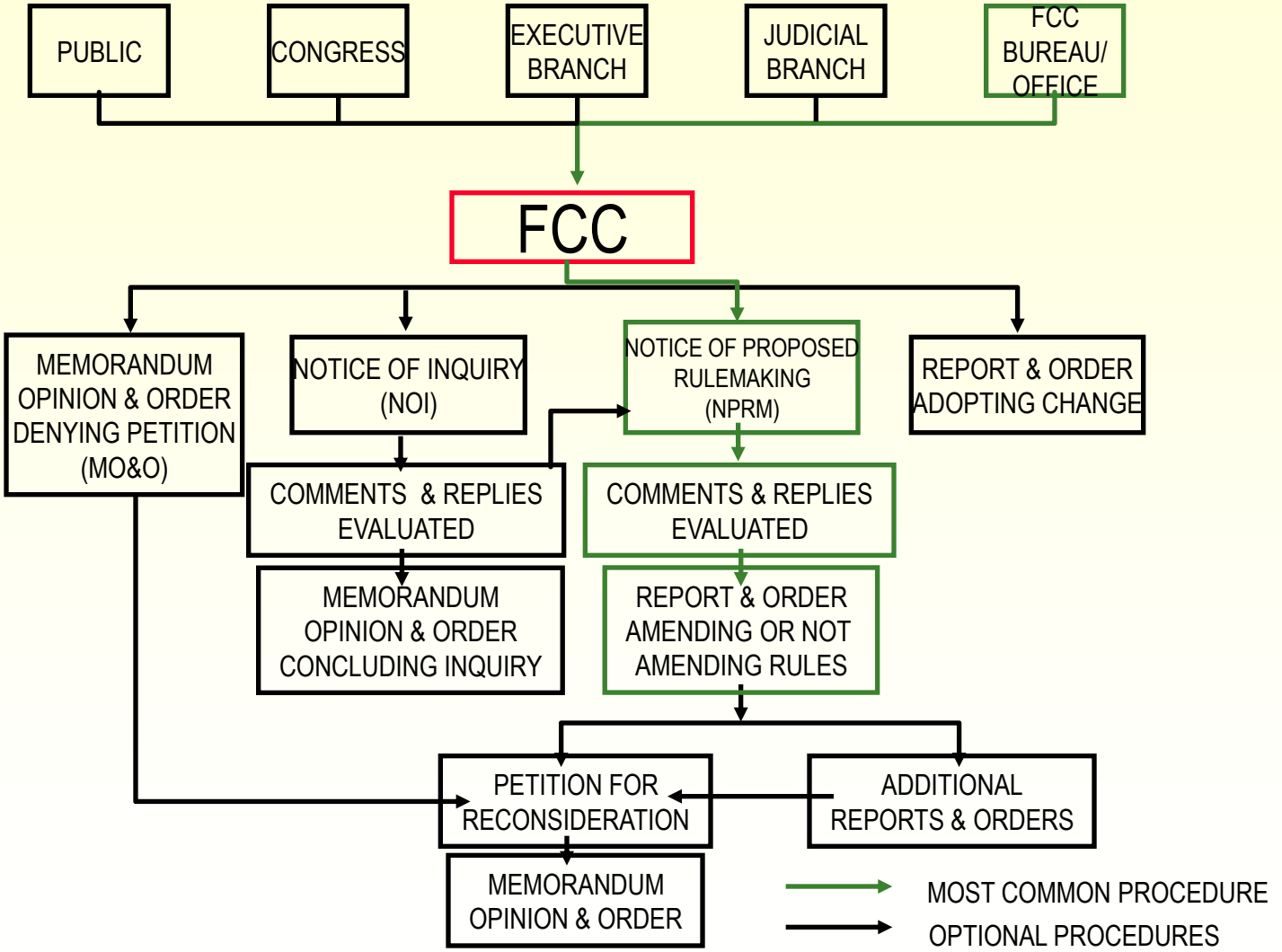
http://www.ntia.doc.gov/files/ntia/publications/spectrum_wall_chart_aug2011.pdf

UNITED STATES FREQUENCY ALLOCATIONS

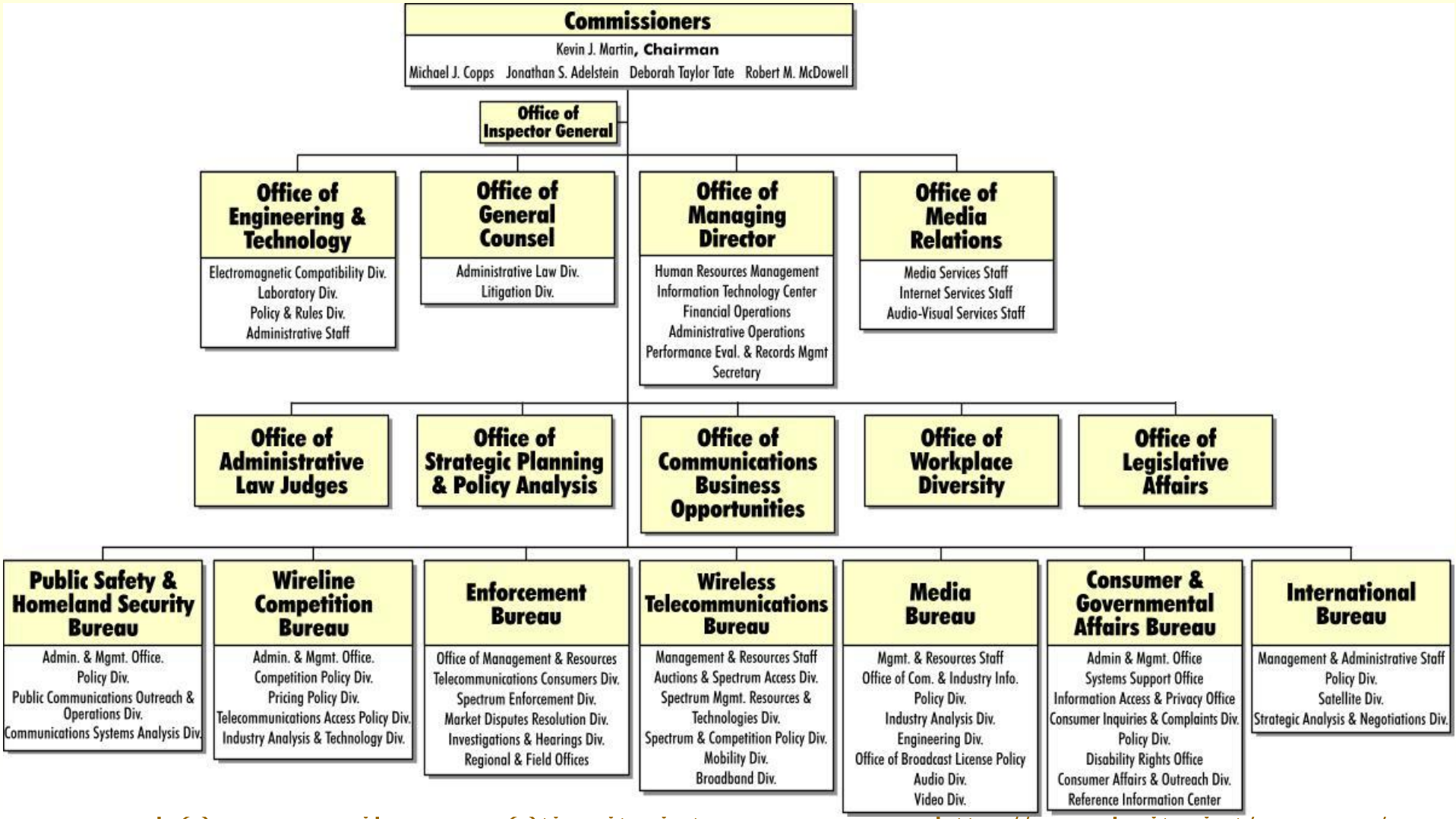
THE RADIO SPECTRUM



How FCC rules are made; Bill Luther



FCC Organizational Chart
All spectrum users except federal government

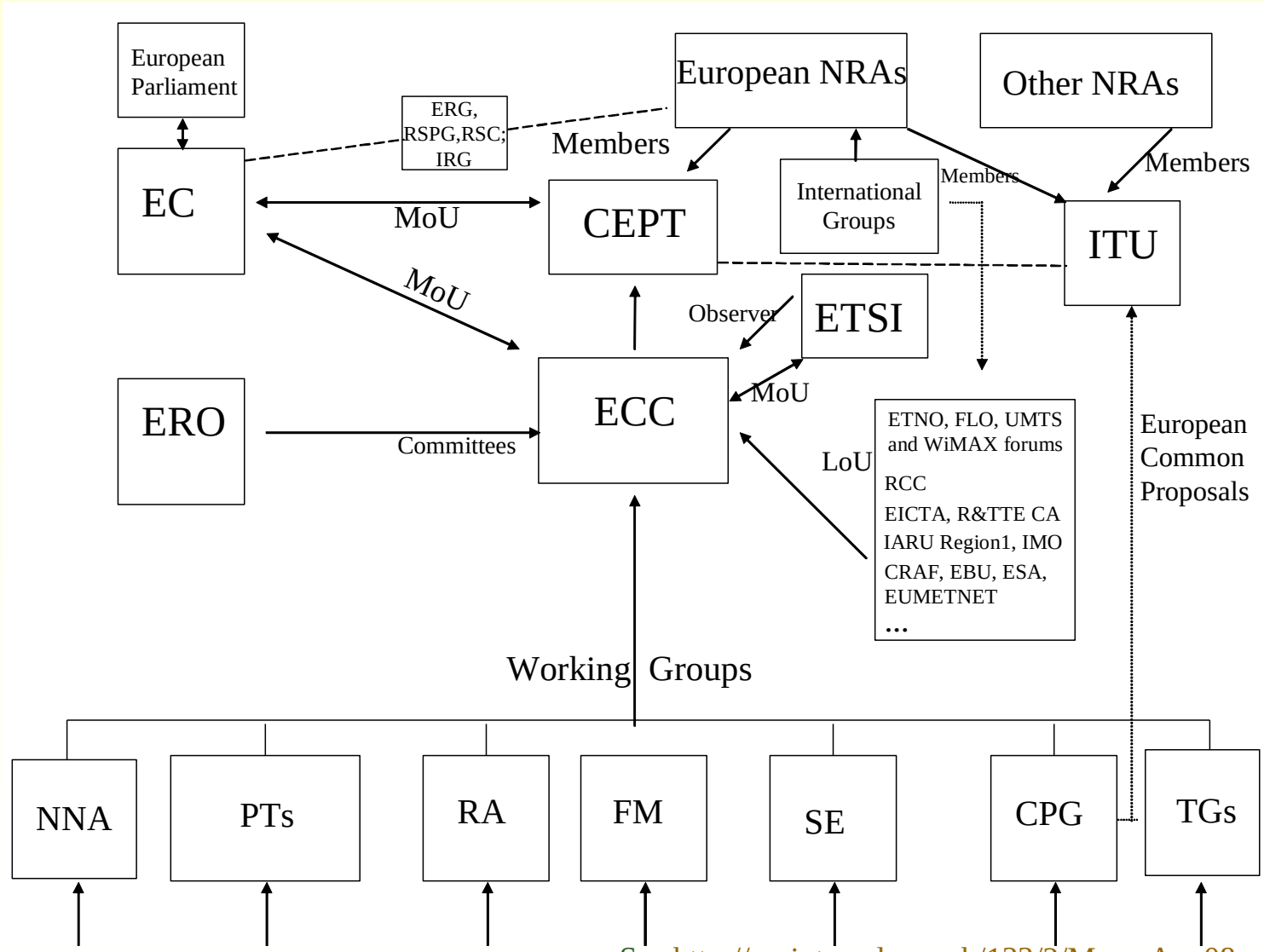


CFR 47, the Code of Federal Regulations

National Archives and Records Administration

1. http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=199847
2. http://www.access.gpo.gov/nara/cfr/waisidx_98/47cfr22_98.html
3. http://frwebgate.access.gpo.gov/cgi-bin/get-cfr.cgi?TITLE=47&PART=22&SECTION=905&YEAR=1998&TYPE=PDF
4. PP10Tables/get-cfr22_905Cellular.pdf

The Main Players in European RF regulation

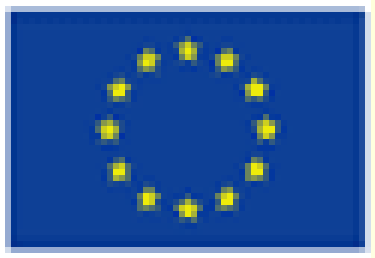


See http://eprints.mdx.ac.uk/133/2/MazarAug08.pdf p. 74

Key of Abbreviations

CPG: Conference Preparatory Group (preparations for ITU Conferences); CRAF: Committee on Radio Astronomy Frequencies; EBU: European Broadcasting Union; EC: European Commission; ECC: Electronic Communications Committee (formerly European Radiocommunications Committee ERC); EICTA: European Information and Communications Technology Industry Association; ERG: European Regulators Group (EC body); ERO: European Radiocommunications Office; ESA: European Space Agency; ESOA: European Satellite Operators Association; ETNO: European Telecommunications Network Operators; EUMETNET: European National Meteorological Services; FLO Forward Link Only; FM: Frequency Management; IARU: International Amateur Radio Union; IMO International Maritime Organisation; IRG: Independent Regulators Group (pan-European body); NRA: National Regulatory Authority; NNA: Numbering, Naming and Addressing (non RF); Project Teams PT PT_1: IMT2000, PT_2: TRIS Technical Regulation and Interconnection Standards, PT_9: Maritime issues; Task Groups TG: UWB (TG3) and Digital Dividend (TG4). RA: Radio Affairs (Radio and e-Communications); RRC: Regional Commonwealth in Communications; R&TTE CA: The Radio and Telecommunications Terminal Equipment Compliance Association; RSPG: Radio Spectrum Policy Group (EC body); RSC: Radio Spectrum Committee (EC body); SE: Spectrum Engineering. Industry Stakeholders, namely companies, consultants, industry groups and international agencies, contribute to the ECC Working Groups.

European tables that can assist the optimisation of RF spectrum in Africa



- **THE EUROPEAN TABLE OF FREQUENCY ALLOCATIONS AND UTILISATIONS IN THE FREQUENCY RANGE 9 kHz to 3000 GHz**

- **ERC RECOMMENDATION 70-03 RELATING TO THE USE OF SHORT RANGE DEVICES (SRD)**

LTE parameters in 800 MHz

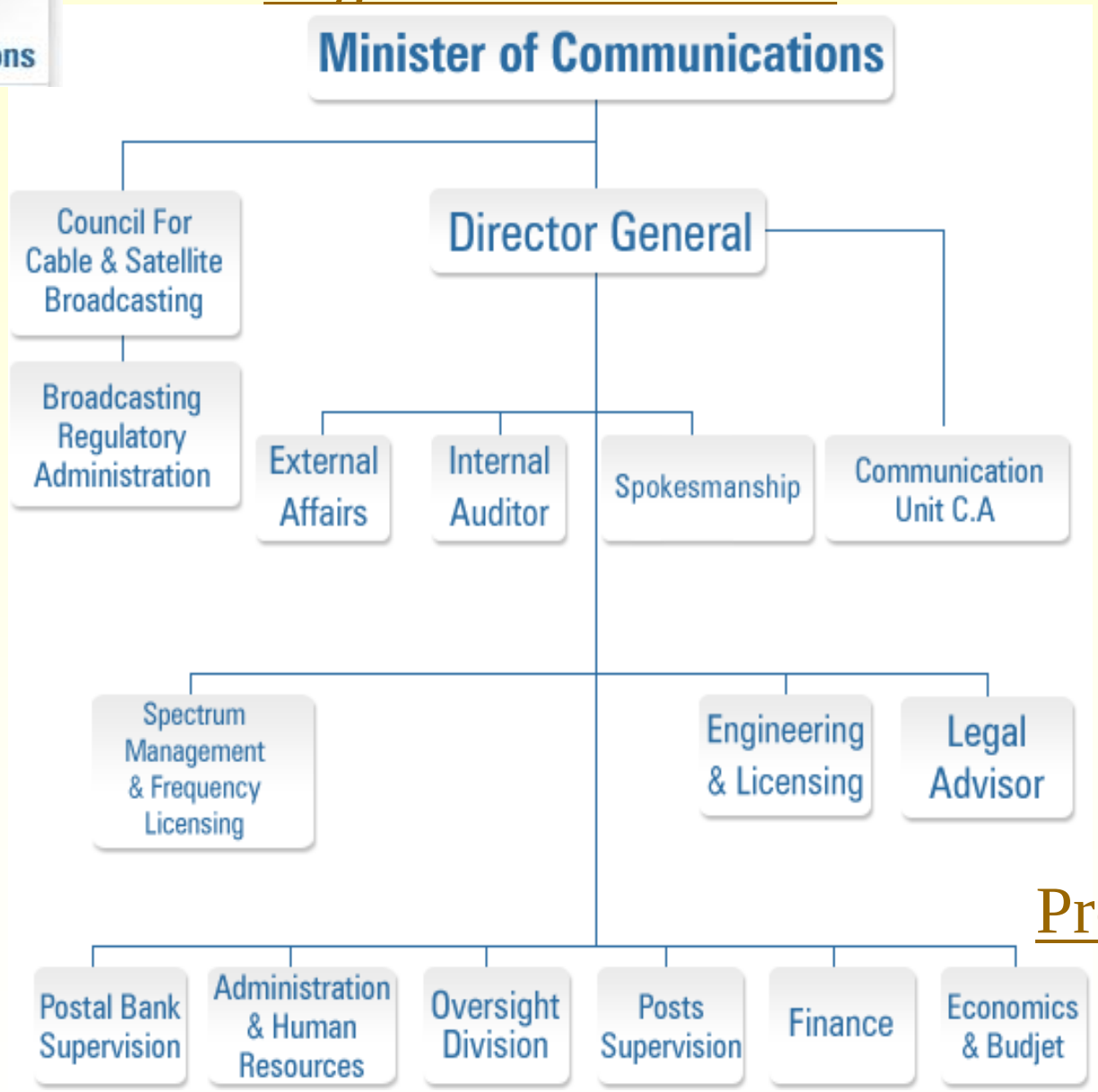
ETSI 3GPP bandplan for Band Class 20

3GPP bandplan for class 20	Downlink (DL) operating band BS transmit UE receive			Uplink (UL) operating band BS receive UE transmit			Duplex Mode
	F_{DL_low} – F_{DL_high}			F_{UL_low} – F_{UL_high}			
20	791 MHz	–	821 MHz	832 MHz	–	862 MHz	FDD

3GPP bandplan for class 20	TX - RX carrier centre frequency separation
20	41 MHz

State of Israel
Ministry of Communications

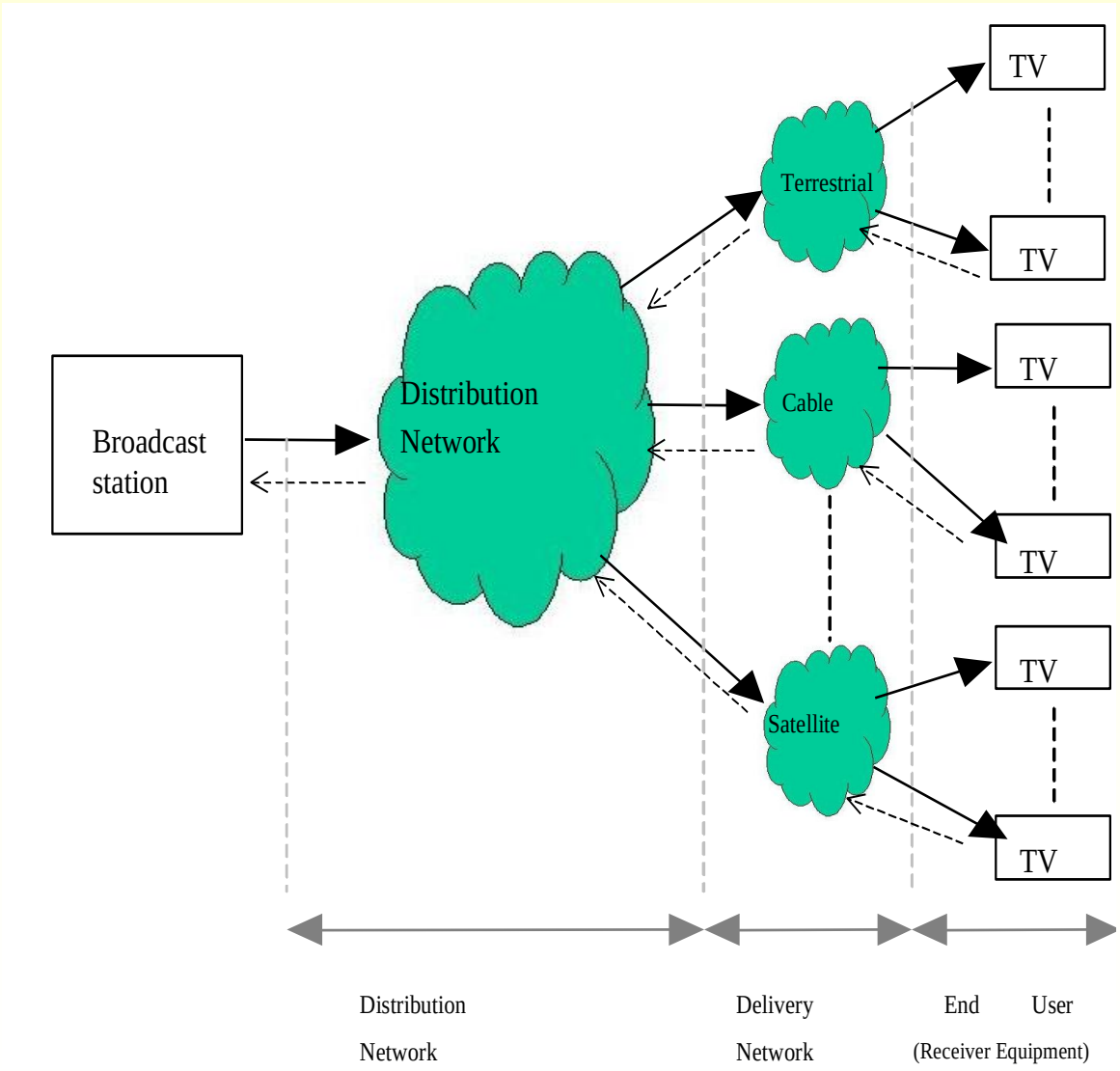
Organization Structure



Presentations

Broadcasting Network Henten A., Samarajiva R., Melody WH. 2003

Cable and Satellite communications are also good alternatives



Technical Parameters of the TV systems

The three Analogue (or Analog) TV standards

	Lines per frame (visible lines)	Fields per second	Line Frequency (Hz)	Video Bandwidth (MHz)	Colour subcarrier (MHz)	Subcarrier Modulation	Year implemented
NTSC	525 (480)	59.94	15,734.264	4.2	3.58	Quadrature Amplitude (QAM)	1954
PAL	625 (576)	50	15,625. Only for PAL-M 15,734.264	5; 5.5; 6	4.43; PAL-M 3.58, PAL-N 3.58	Quadrature Amplitude (QAM)	1967
SECAM						Frequency (FM)	

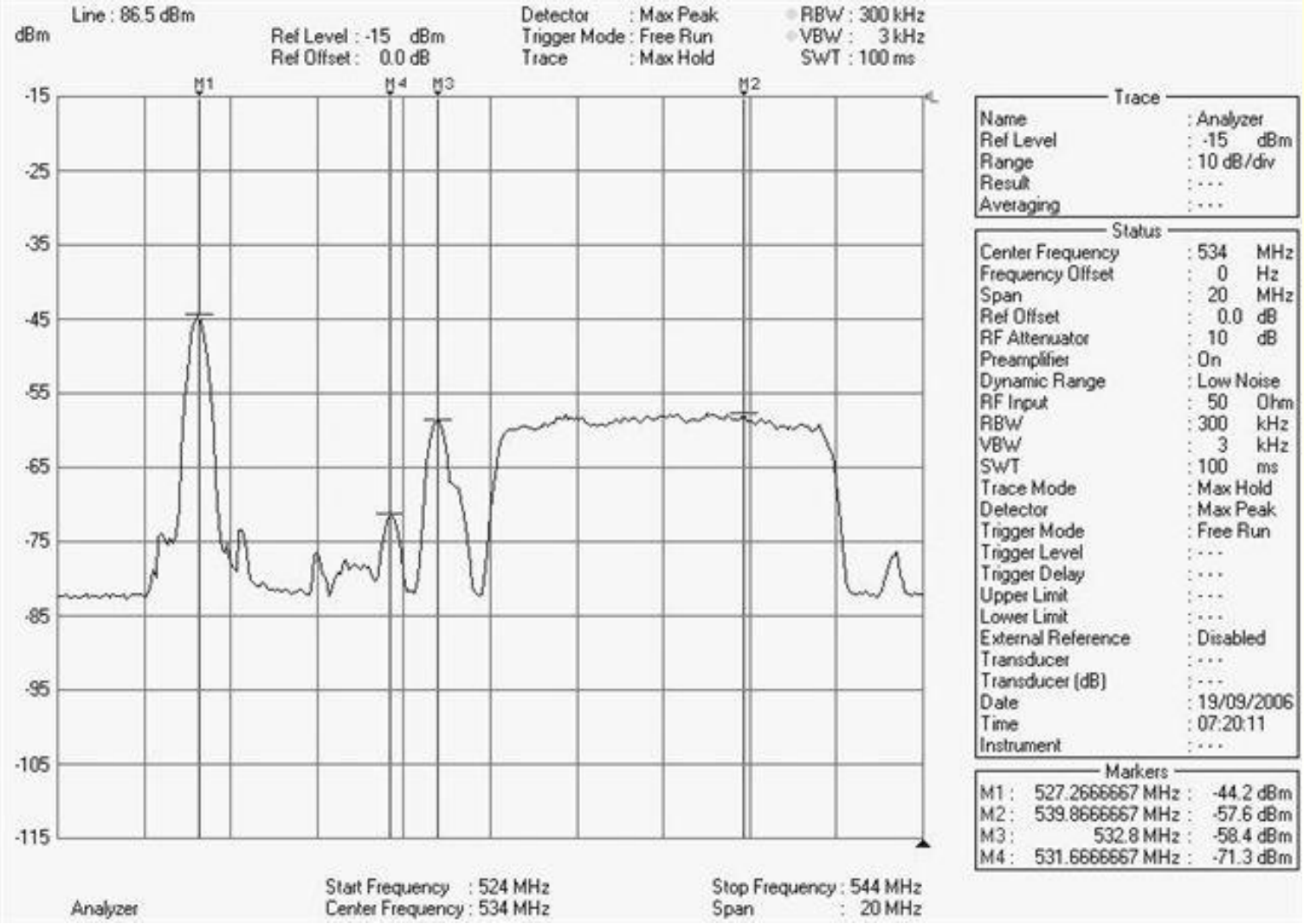
The Three Digital TV Standards (Aware Channel Separation)

	Reception speed	Scanning Lines	Image size Pixels	Modulation
ATSC	Portable	1125	1920x1080	Single 8-VSB carrier codes
DVB-T	< 90 km/h, for 8k carriers; <180 km/h, 2k	Flexible		OFDM
ISDB-T				

See author's PhD thesis at http://eprints.mdx.ac.uk/133/2/MazarAug08.pdf p. 20

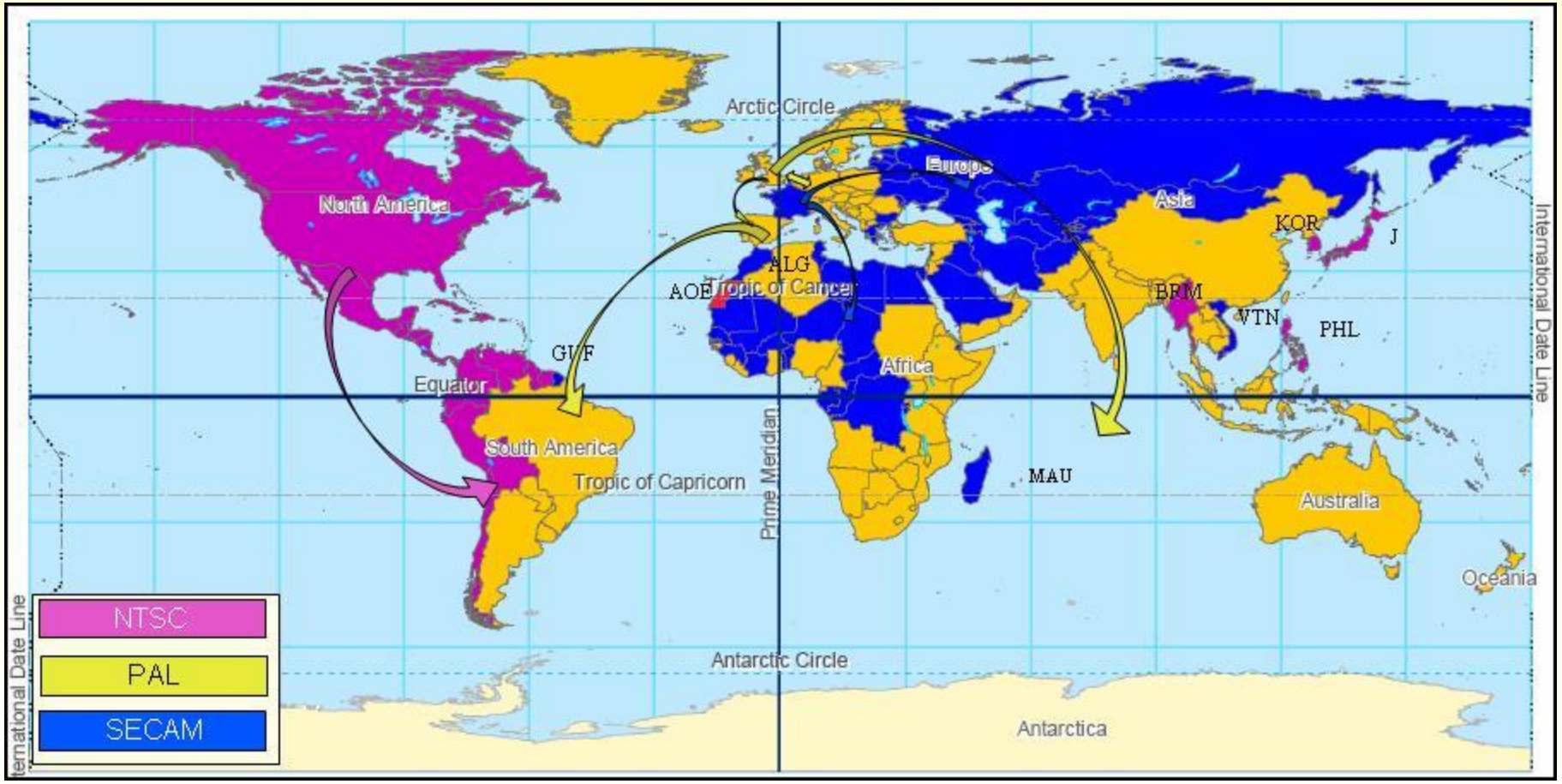
TV Analog ch. 28 (526-534 MHz) adjacent to Digital ch. 29 (534-542 MHz)

19/09/06; measured by author; M1-an.Video,M4-an.synch,M3-an.sound, M2- dig.



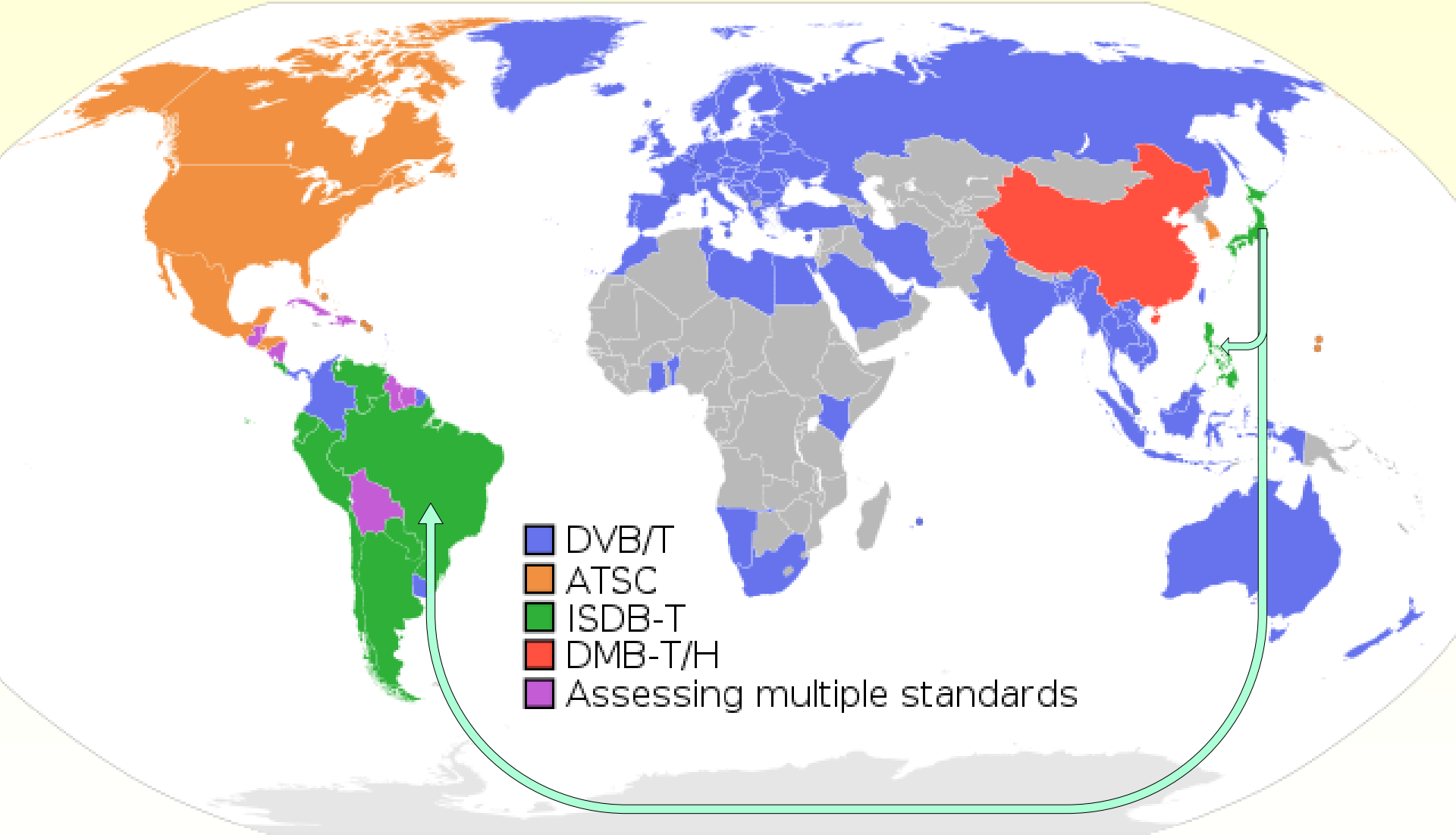
TV colours; analogue TV around the world

Influence of language (English or French) and colonialism



See http://eprints.mdx.ac.uk/133/2/MazarAug08.pdf p. 184

Digital Terrestrial Television (DTT) broadcasting systems by country



See http://en.wikipedia.org/wiki/File:Digital_broadcast_standards.svg 2 July 2010

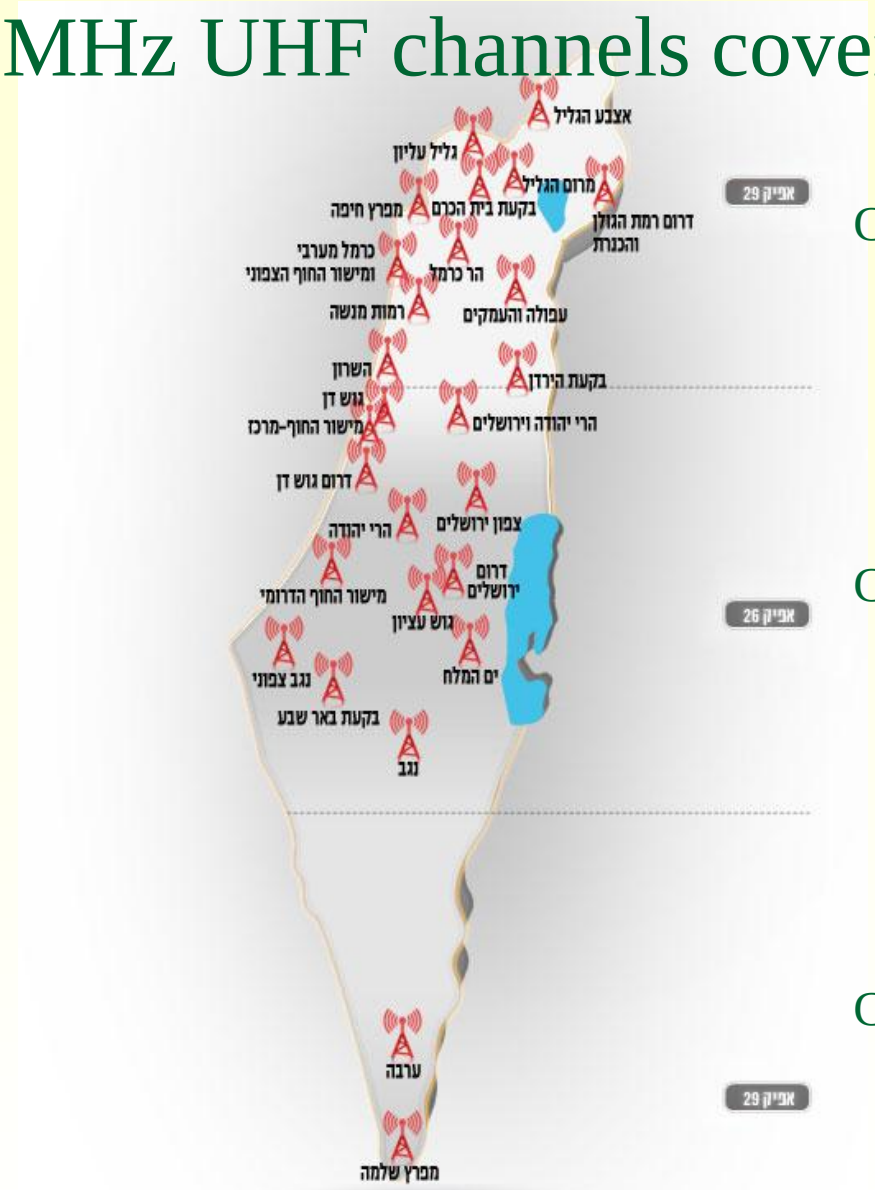
RF Digital Dividend in Israel

- ~20 digital Transmitters, with two 8 UHF MHz channels cover all Israel with 5 programs (1, 2, 10, 33, 99)

Thus instead of

- 45 analog UHF and additional VHF Transmitters covering only one program - ch.1; and 15 analog Transmitters at UHF covering only one program- ch. 2.

2 digital 8 MHz UHF channels cover all Israel



Channel 29

Channel 26

Channel 29

See http://www.rashut2.org.il/idan_map.asp 14 Dec 11

Digital Switchover and Dividend

1. Digital switchover saves RF spectrum
2. Digital TV multiplexes don't need all the VHF and UHF bands allocated today to the analog TV, for the same transmissions
3. Switchover requires homes to upgrade their aerials and their direction
4. The free RF spectrum is very useful for the land-mobile service
5. International http://www.itu.int/dms_pub/itu-d/opb/hdb/D-HDB-GUIDELINES.01-2010-R1-PDF-E.pdf and Regional activities

Questions to be Asked

1. Except competition to satellites and cable, do we really need over-the-air terrestrial TV?
2. Which Standard: DVB-T, ISDB-T? ATSC? DMB-T? (check Channel Separation)
3. Free view or paid? Will HD be free also? HD or Ultra HD, 3D?
4. How many programs to transmit? Subsidise set-top box?
5. Business model of DVB-H? Cellular Operators or Broadcasters transmit the DVB-H? Which Regulator?

Any additional Qs?

Between others, additional files are found at

http://people.itu.int/~mazar/Downloads

http://www.moc.gov.il/138-en/MOC.aspx

Hyperlink to **PhD Thesis**

Hyperlink to the **Book**

You are welcome to visit at my website

http://people.itu.int/~mazar/

Dr. Haim Mazar (Madjar)

Thanks for All