Ministry of Information and Communications Government of Nepal

International Telecommunication Union

Ministry of Communications Government of Israel

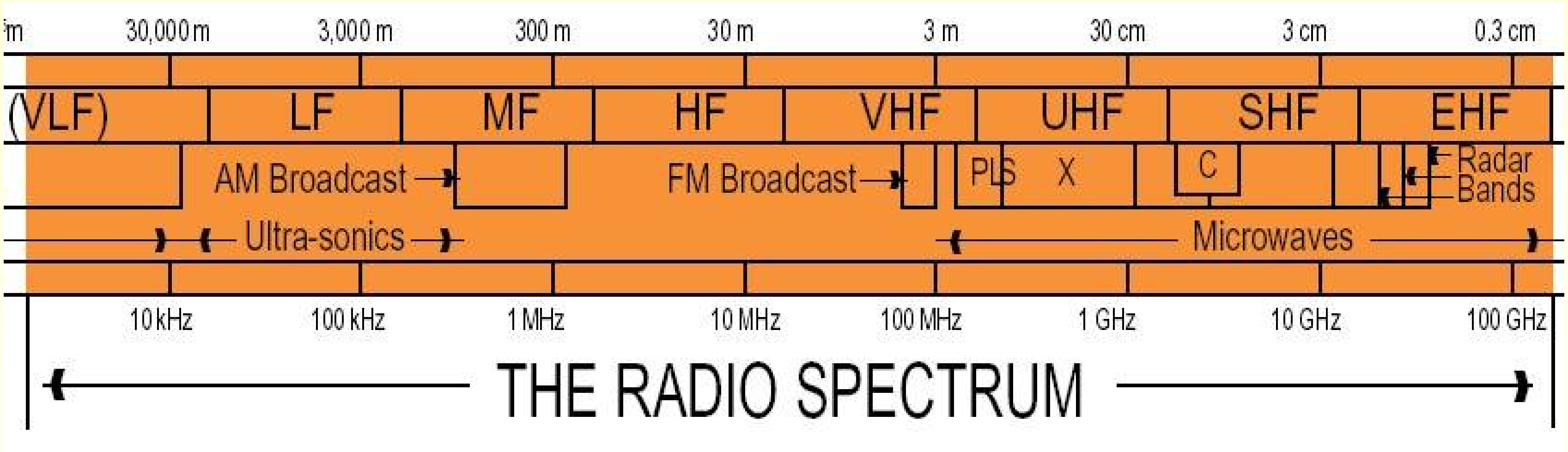
Ministry of Foreign Affairs MASHAV-Center for International Cooperation Government of Israel

Namaste and Shalom

Dr. Haim Mazar

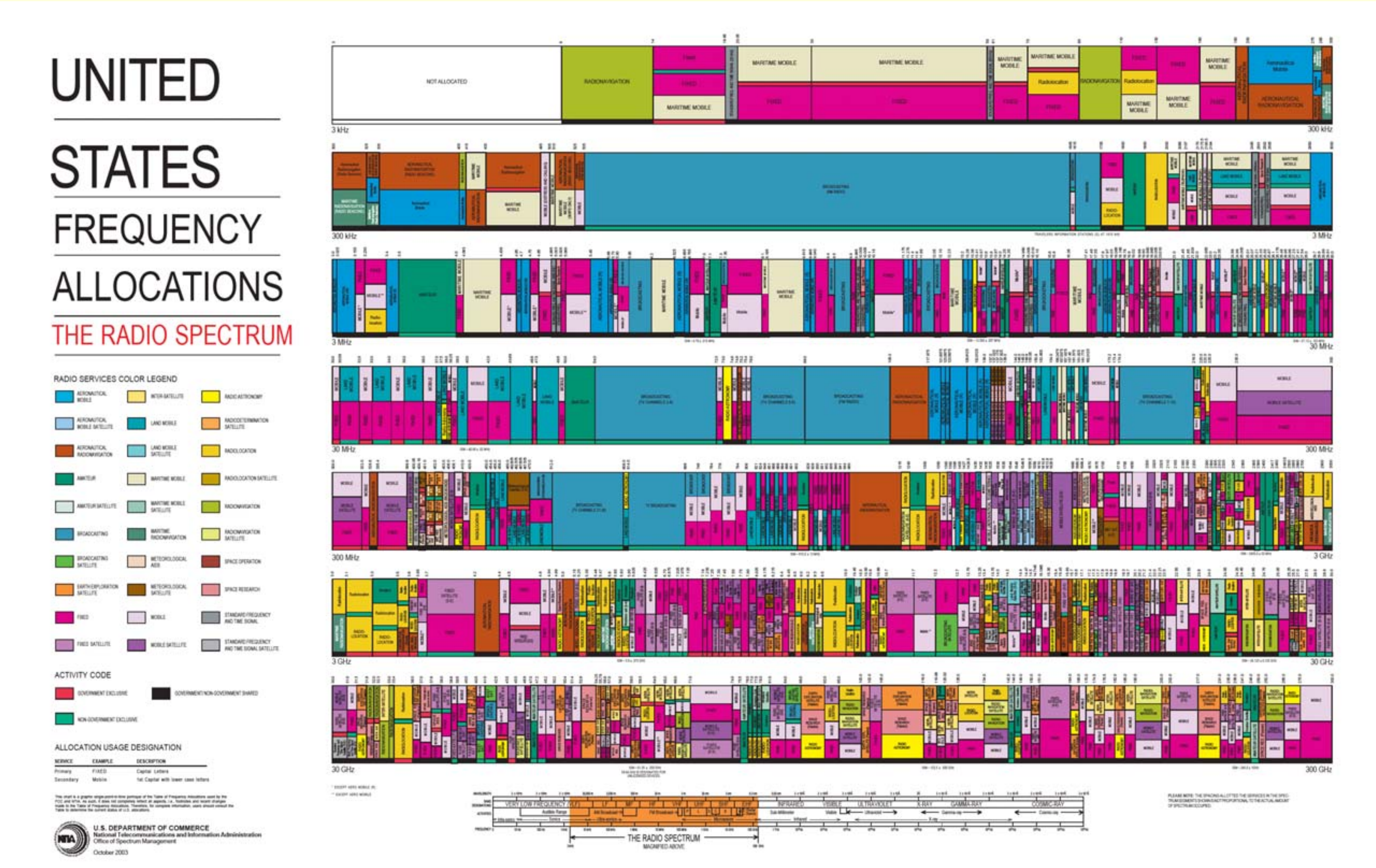
RF Spectrum and ITU

The RF Spectrum



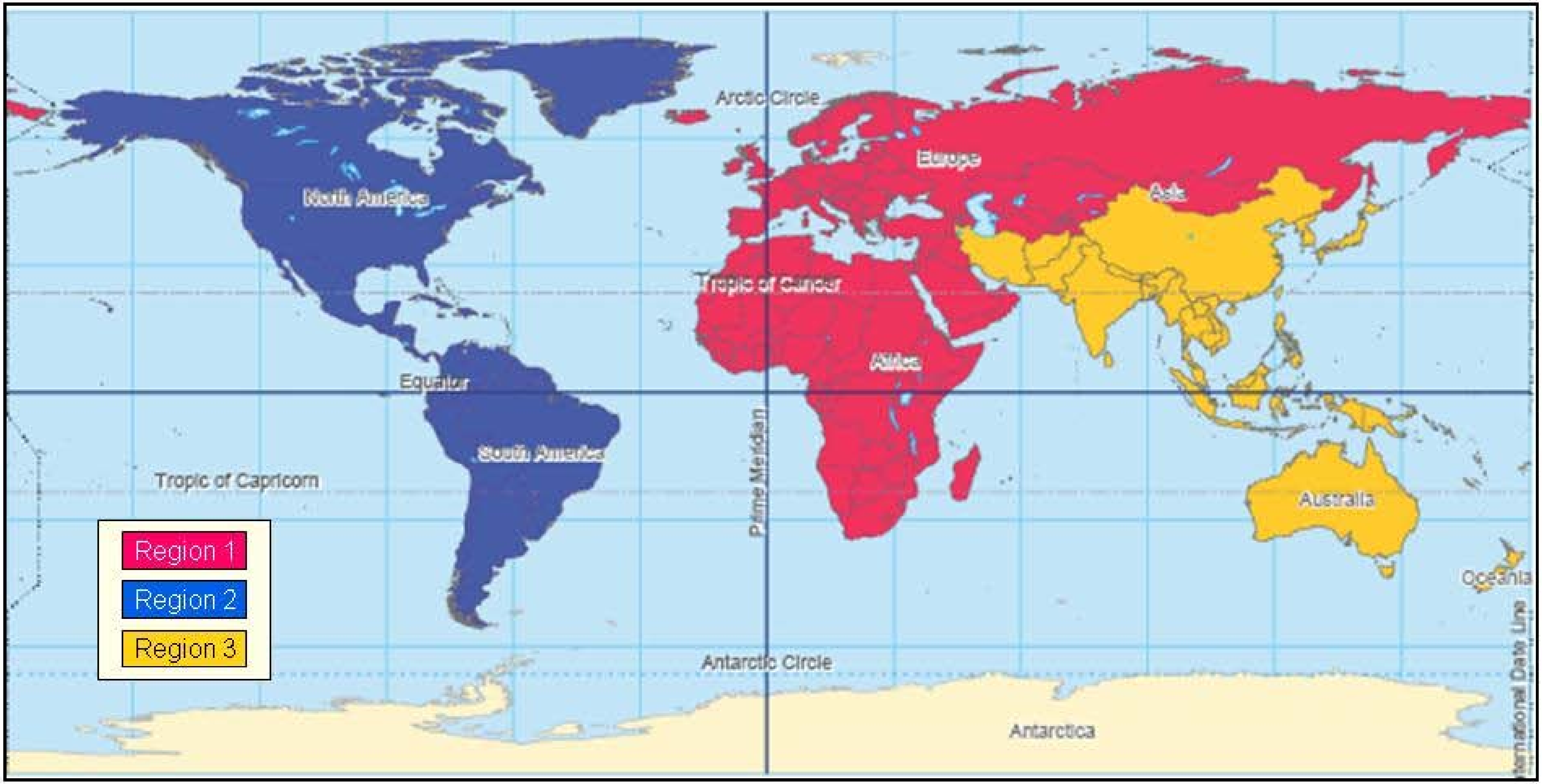
PP1 Tables/REC-V431-7-reqNomenclature.doc

US Chart, 2003



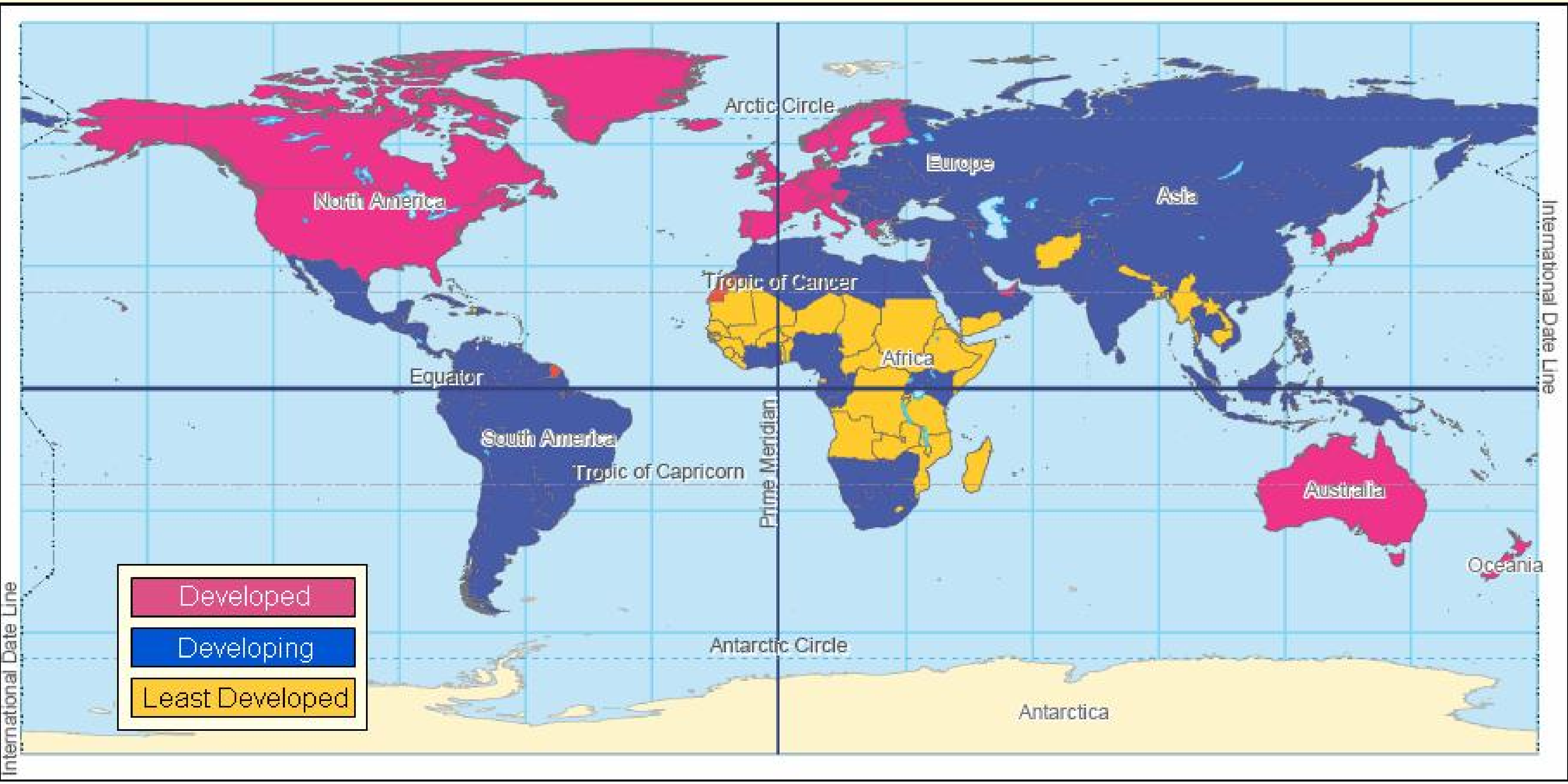

Structure
ITU
Plenipotentiary Conferences
Council
World Conferences on International Telecommunications
World/Regional Radiocommunication Conferences
Radiocommunication Assemblies
Radio Regulations Board
Advisory Group
Study Groups
World Telecommunication Standardization Assemblies
Advisory Group
Study 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

ITU Regions



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

Developed, Developing and LDCs



Allocation, Allotment and Assignment

RR 5.1

Frequency distribution to:	**English**
Services	Allocation (to allocate)
Areas or countries	Allotment (to allot)
Stations	Assignment (to assign)

Radio Regulation PP1 Tables\ITU RR04edv1Articles.pdf

Radio Services PP1 Tables\Radiocommunication services.doc

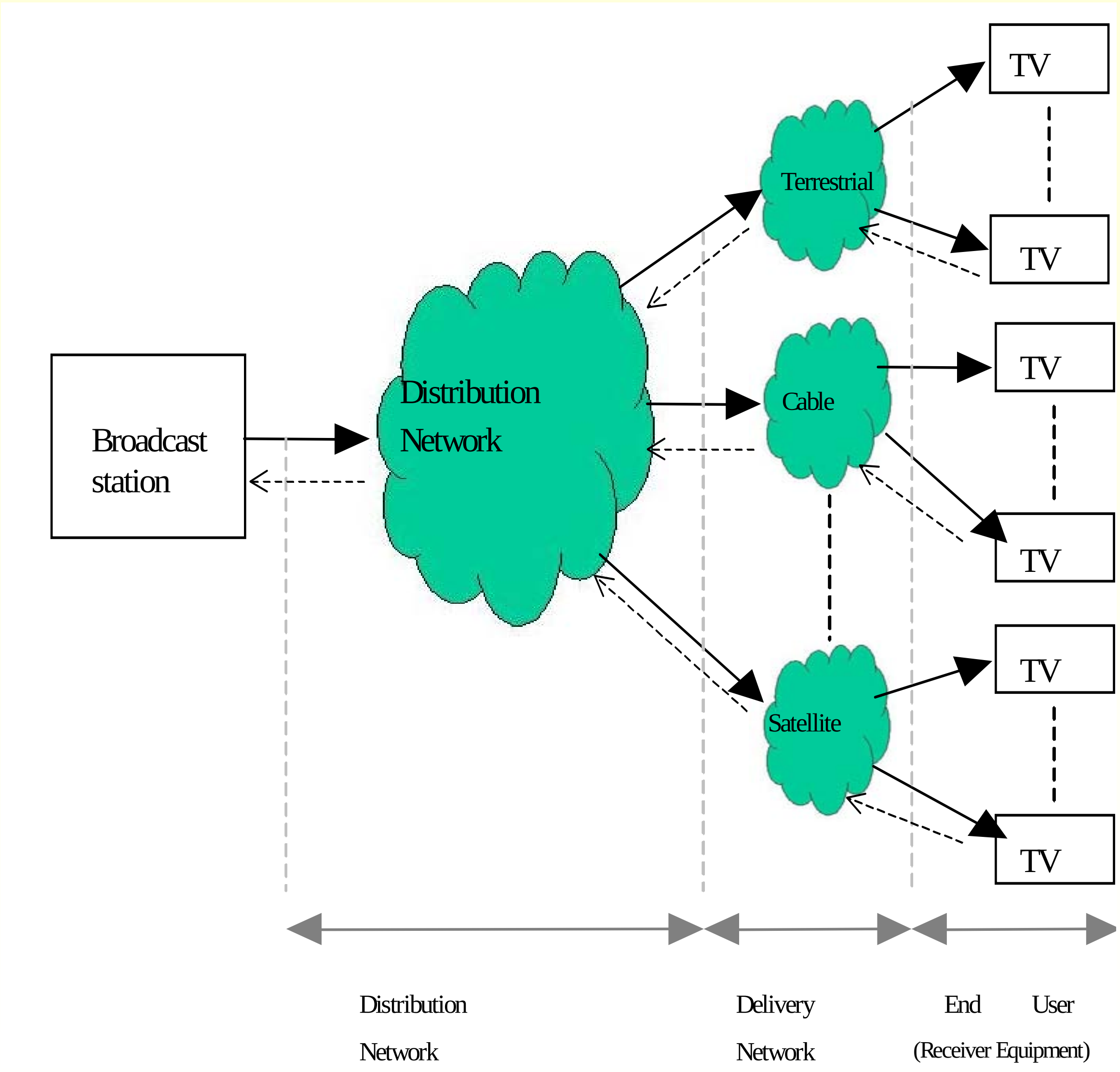
Mr. Suresh Pudasaini

Terraq.lnk

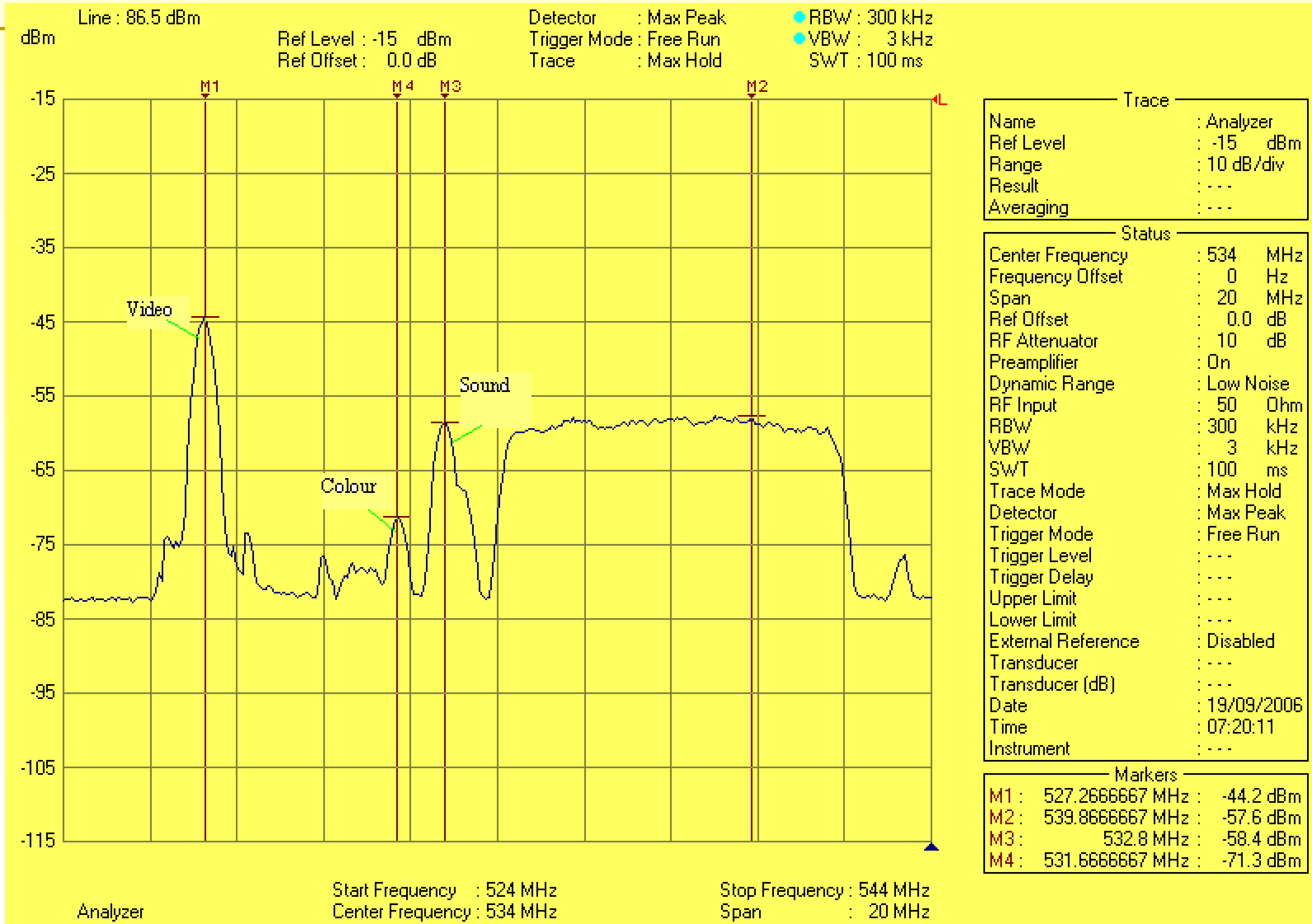
Broadcasting Services TV

1 Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il 1 Wireless Telecomms Seminar, Nepal, Kathmandu 24-28 Nov. 08

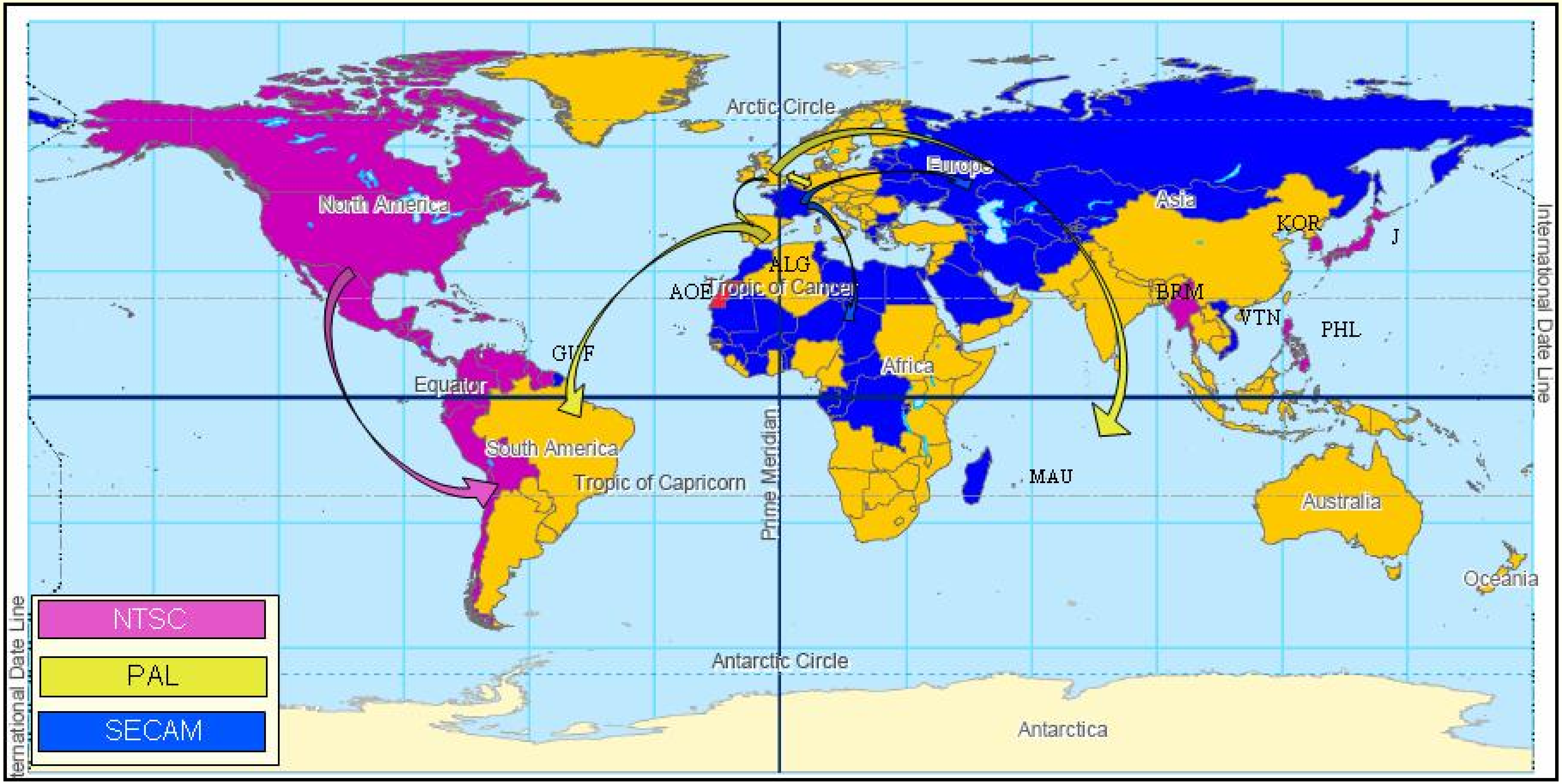
Broadcasting Network Henten A., Samarajiva R., Melody WH. 2003



Analogue and Digital TV figures

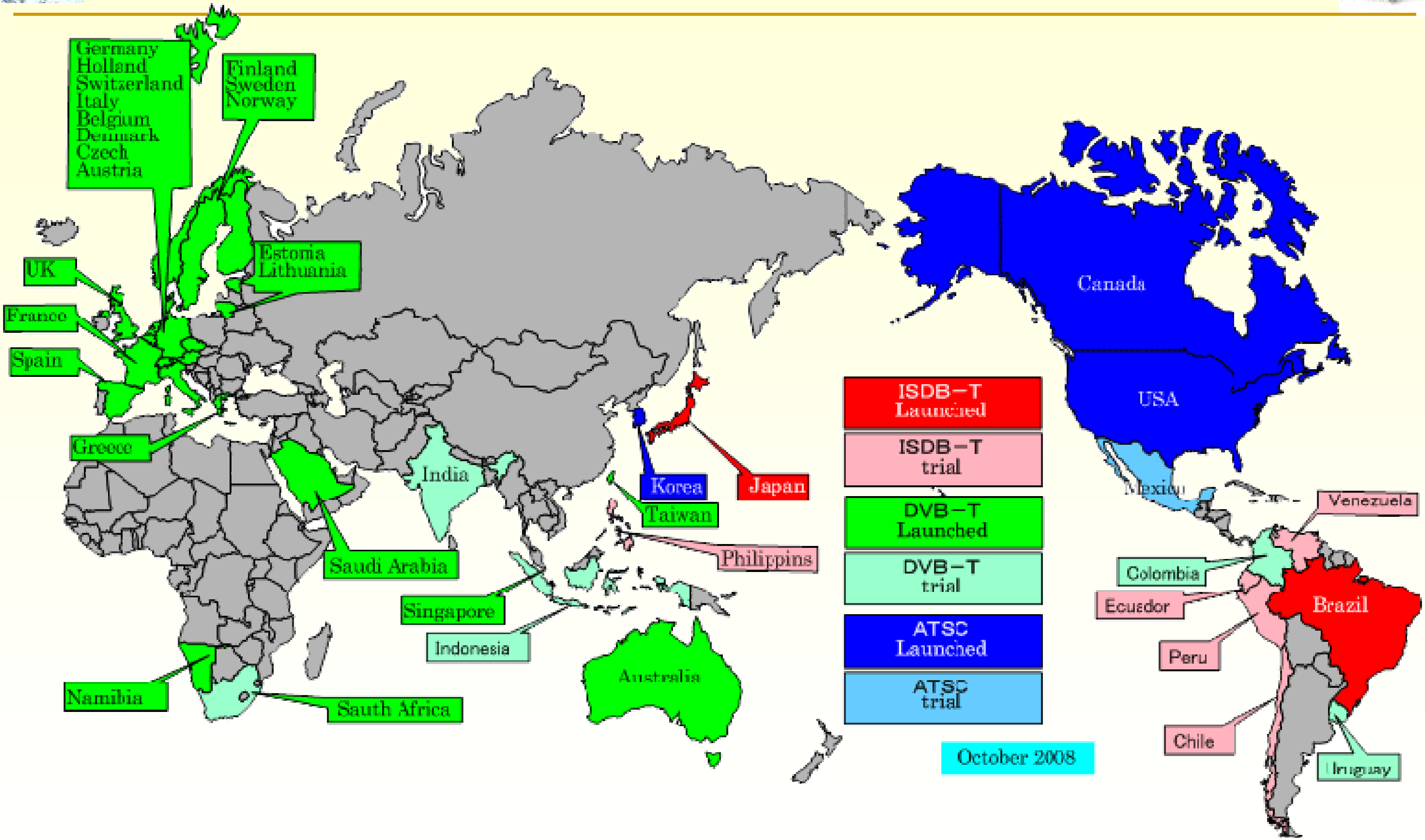


TV colours; Exceptional Countries



 Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il Wireless Telecomms Seminar, Nepal, Kathmandu 24-28 Nov. 08

Digital TV Spread Oct 2008



Technical Parameters of the TV systems

The three analogue 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		1967
SECAM						Frequency (FM)	

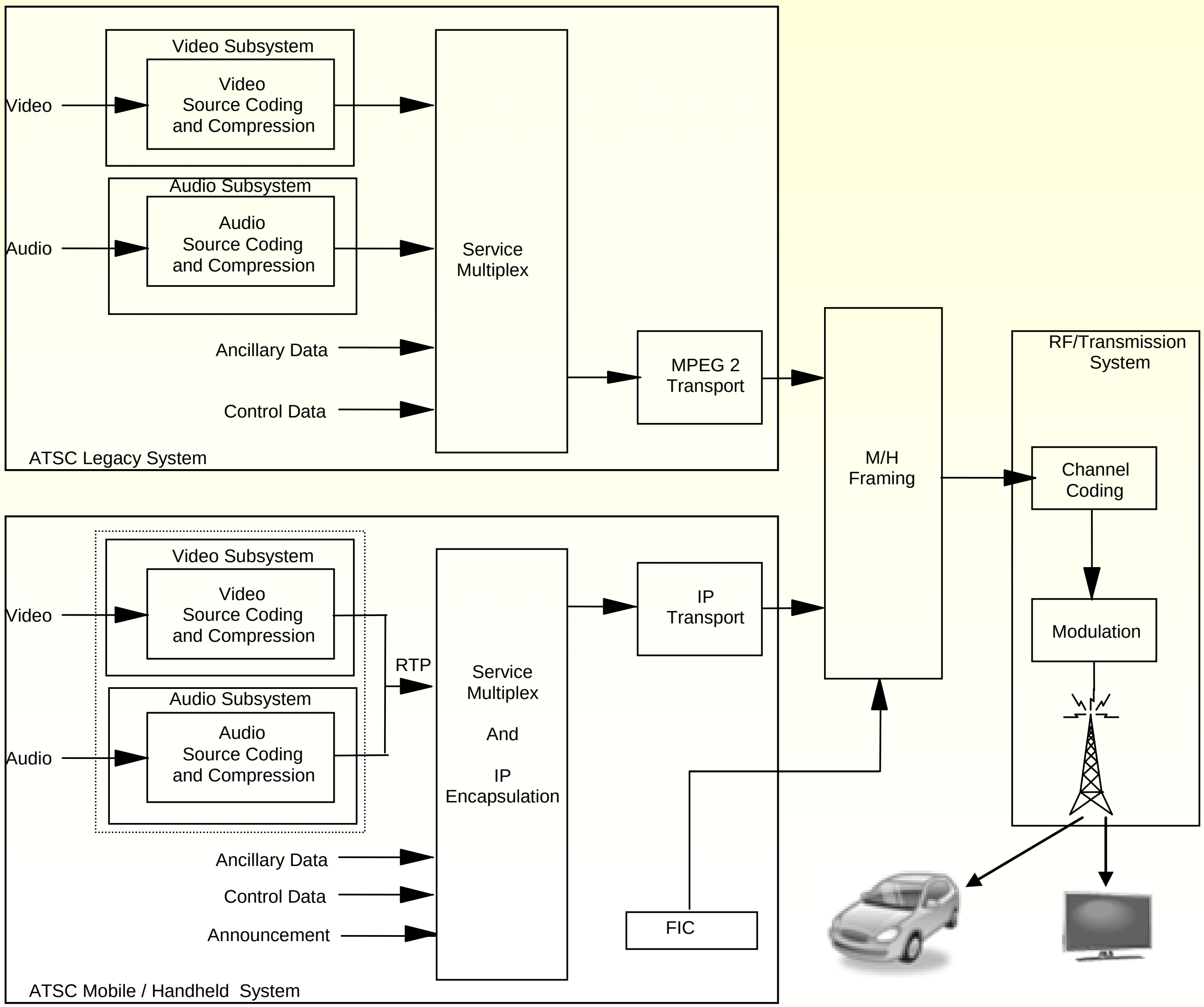
The Three digital TV Standards

	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

TV Standards; ITU report AN-Dig

Standard	Channels	Band	Modulation	Applicable standards
ATSC	6 MHz	UHF/VHF	8-VSB	A/52,A/53, A/65, A/153
ChinaDTV	8 MHz	UHF/VHF	OFDM	GB 20600-2006
DVB-T	6, 7 and 8 MHz	UHF/VHF	OFDM	EN 300 744
DVB-H	5, 6, 7 and 8 MHz	UHF/VHF	OFDM	EN 302 304
ISDB-T	6, 7 and 8 MHz	UHF/VHF	Segmented OFDM	ARIB STD-B31
T-DMB	1.75 MHz	VHF/1.5GHz	OFDM	ETSI TS 102 427 and ETSI TS 102 428
FLO	5, 6, 7 and 8 MHz	UHF/VHF	OFDM	TIA 1099
ISDB-T_{SB}	0.43, 0.50, 0.57 MHz 1.29, 1.50, 1.71 MHz	UHF/VHF	Segmented OFDM	ARIB STD-B29

ATSC Configuration



Ministry of Information and Communications Government of Nepal

International Telecommunication Union

Ministry of Communications Government of Israel

Ministry of Foreign Affairs MASHAV-Center for International Cooperation Government of Israel

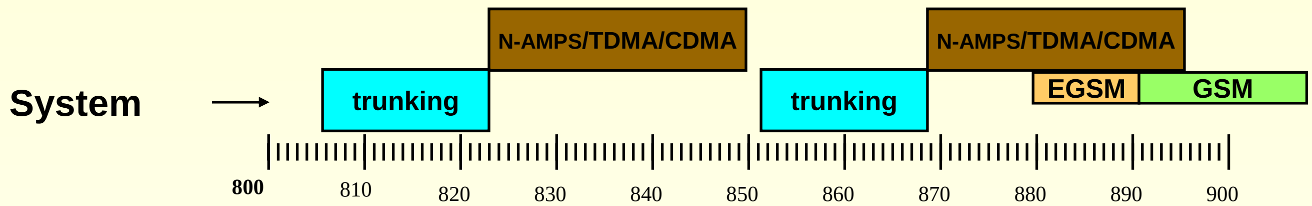
Land Mobile and Fixed Services

Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il Wireless Telecomms, Nepal, Kathmandu Seminar 24-28 Nov. 08
1 Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il 1 Wireless Telecomms Seminar, Nepal, Kathmandu 24-28 Nov. 08

800/900 MHz Cellular, Trunking & TV allocations

Israel allocation

US standard

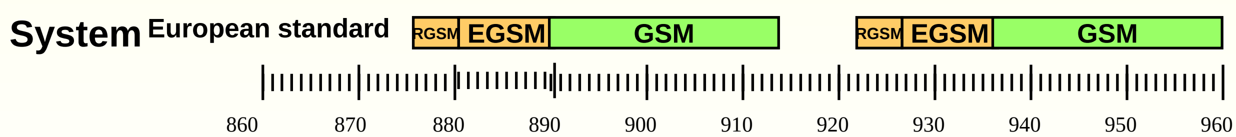


EUROPEEN

TV standard

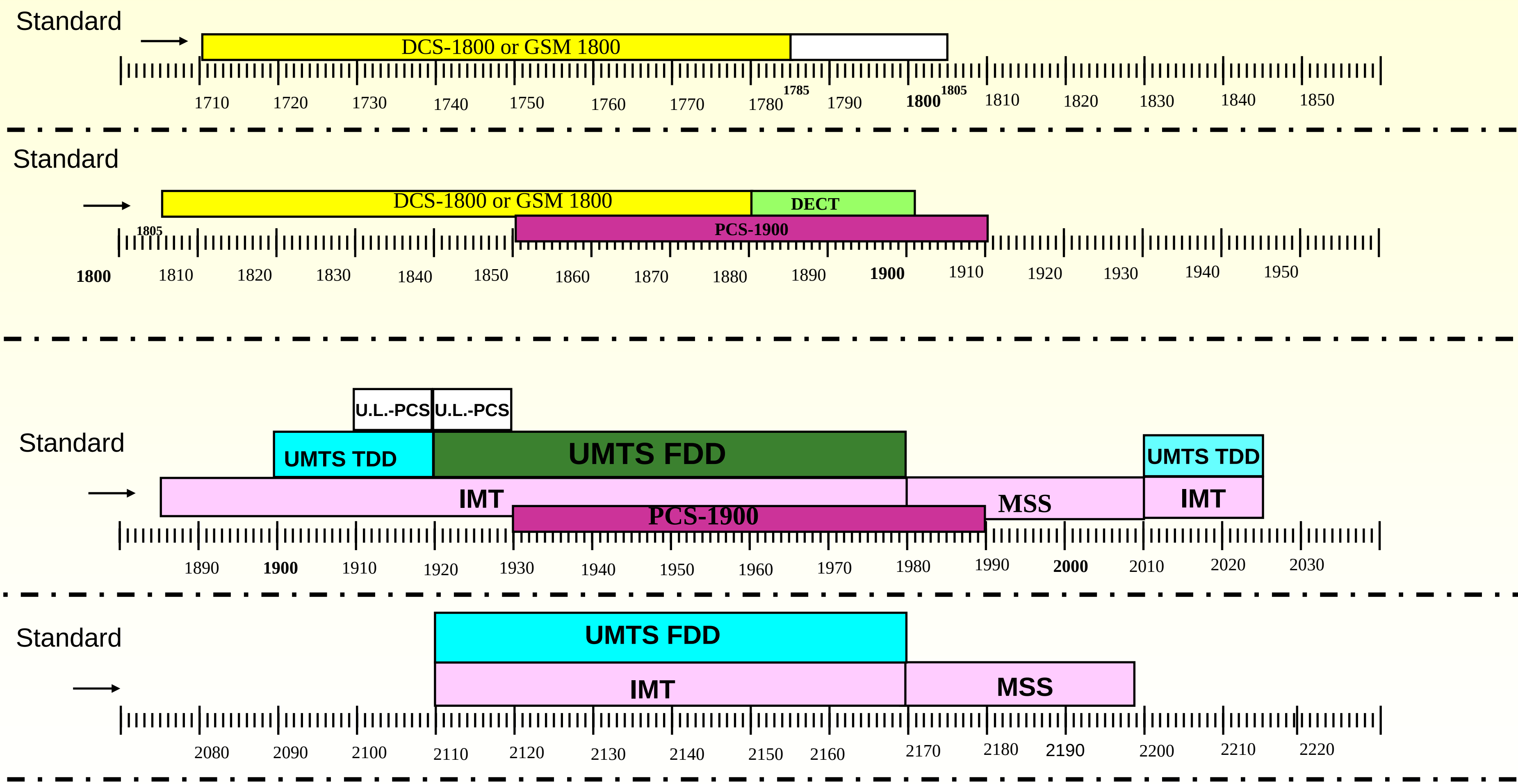
CH63	CH64	CH65	CH66	CH67	CH68	CH69

European standard

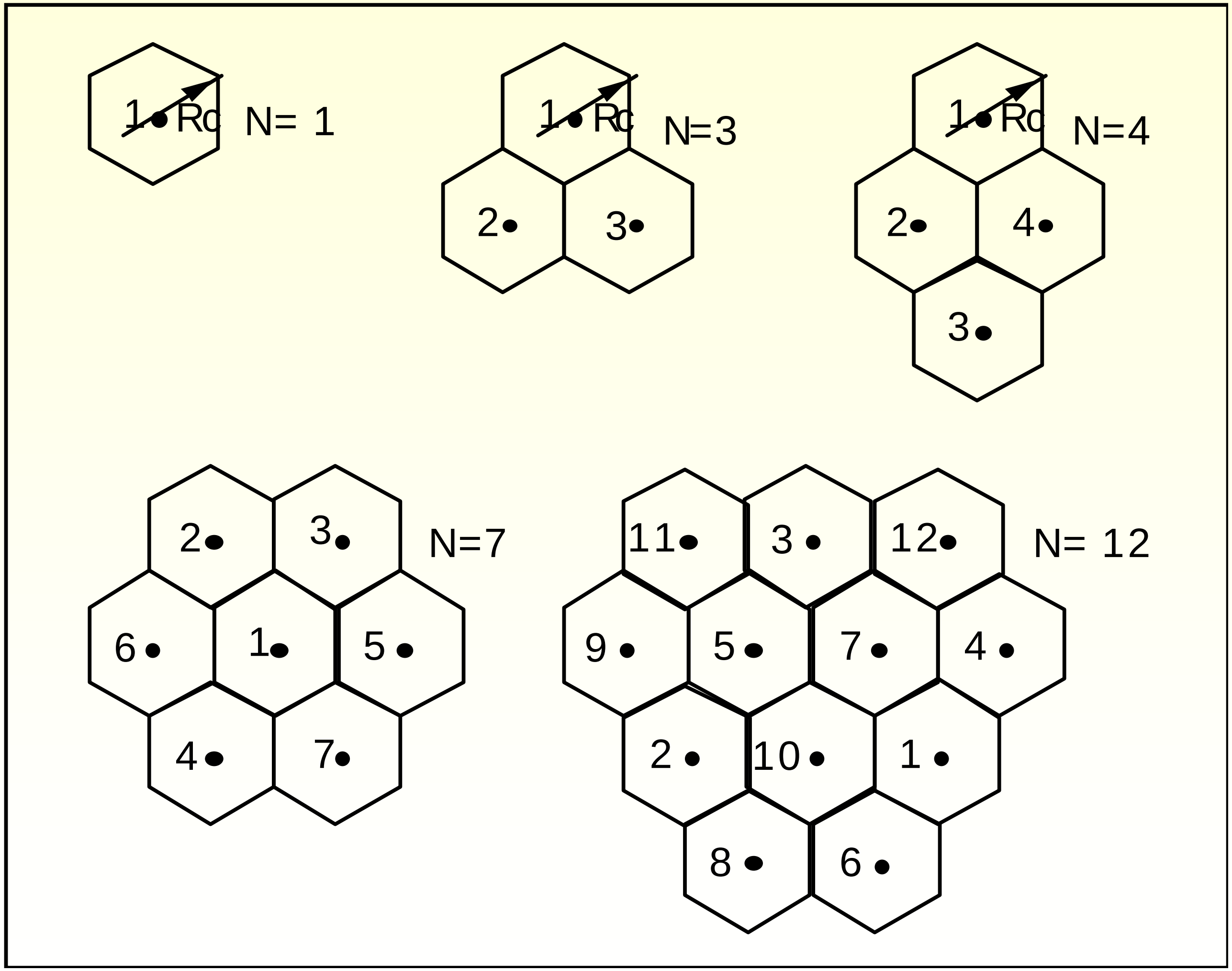


LAND Mobile Standards 1700-2200 MHz

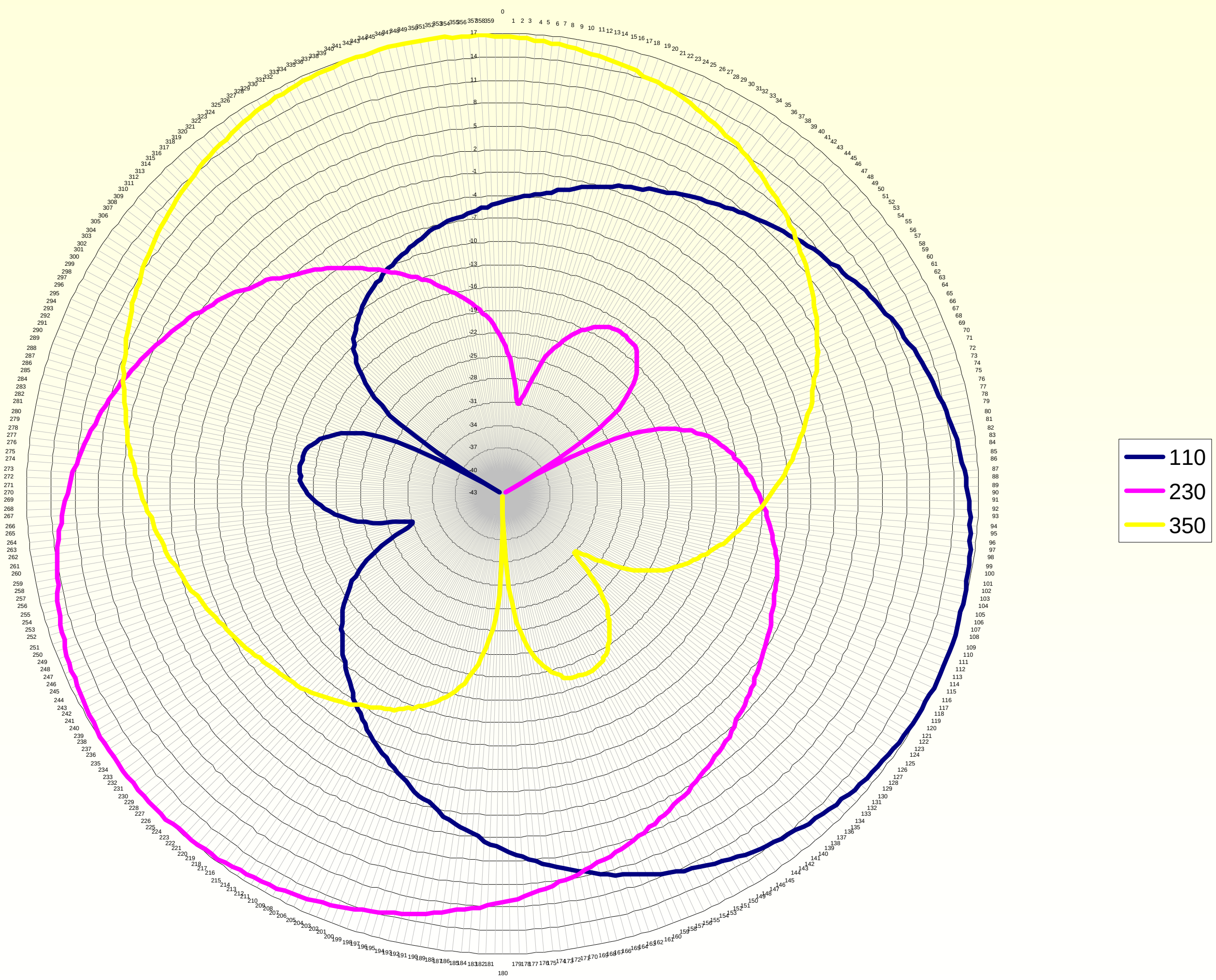
15 October 2008



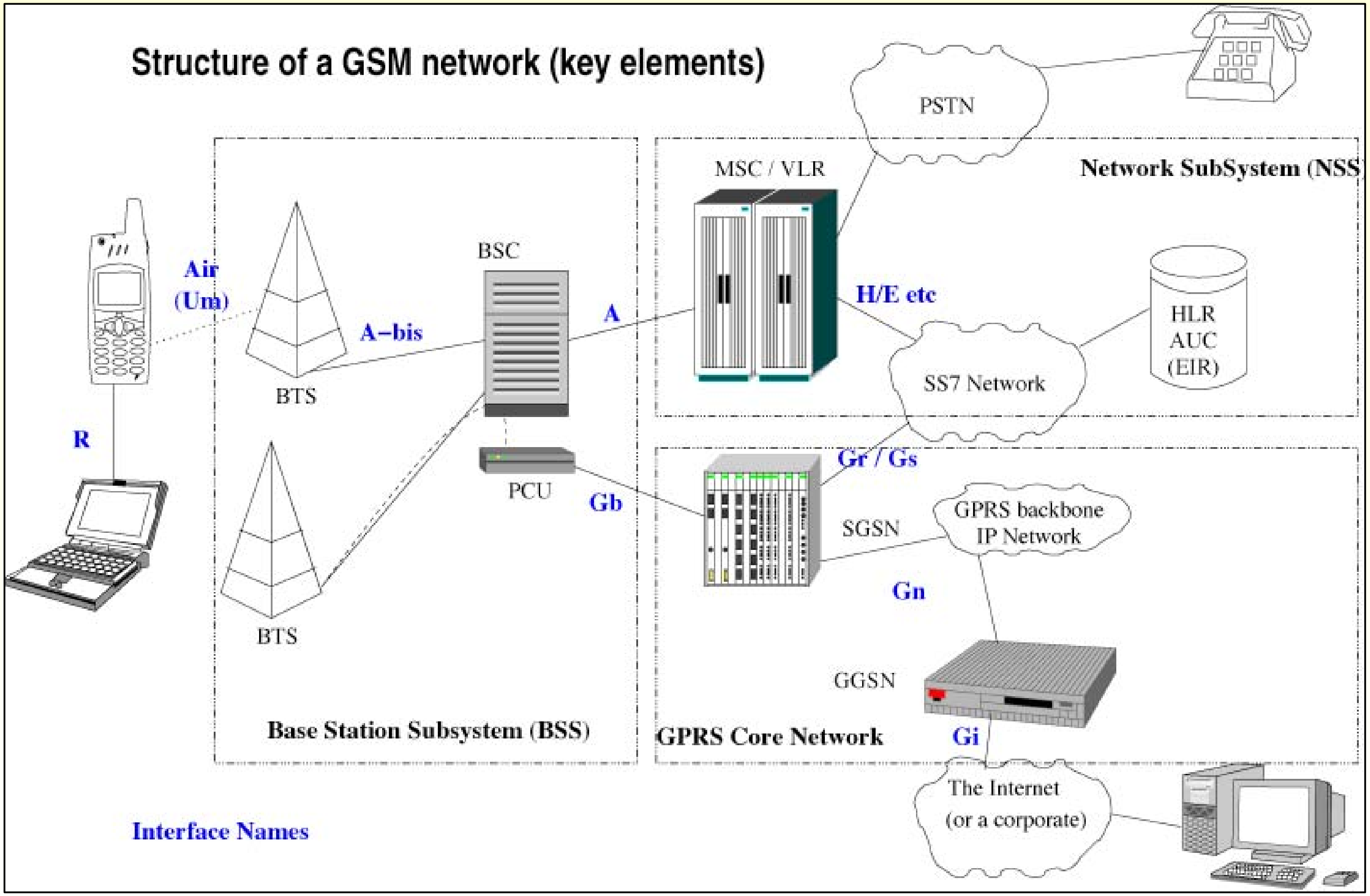
Land Mobile- Typical cell clusters



Land Mobile- Cellular typical BS pattern

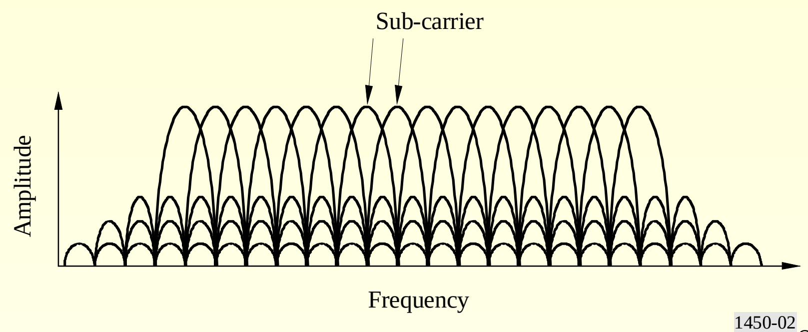


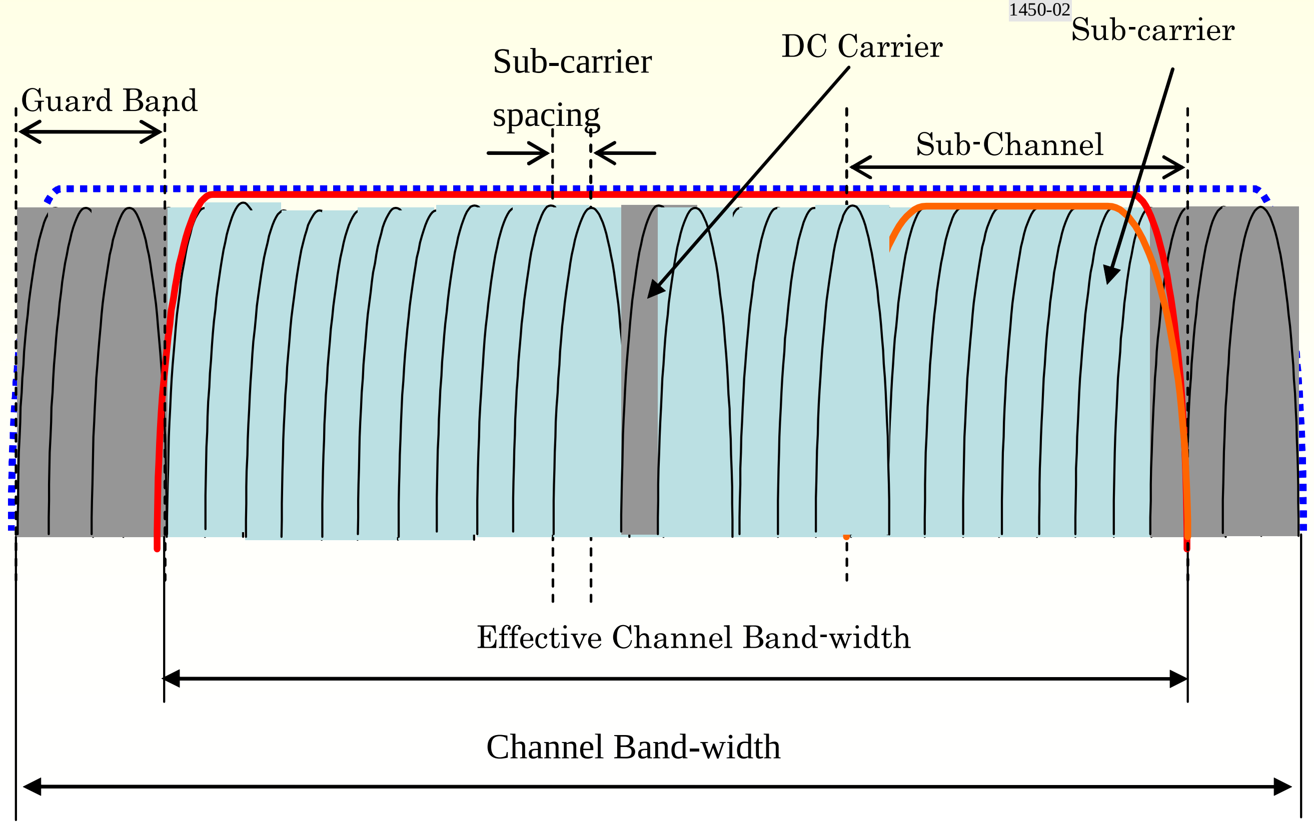
Structure of a GSM Network (key elements), LMHB



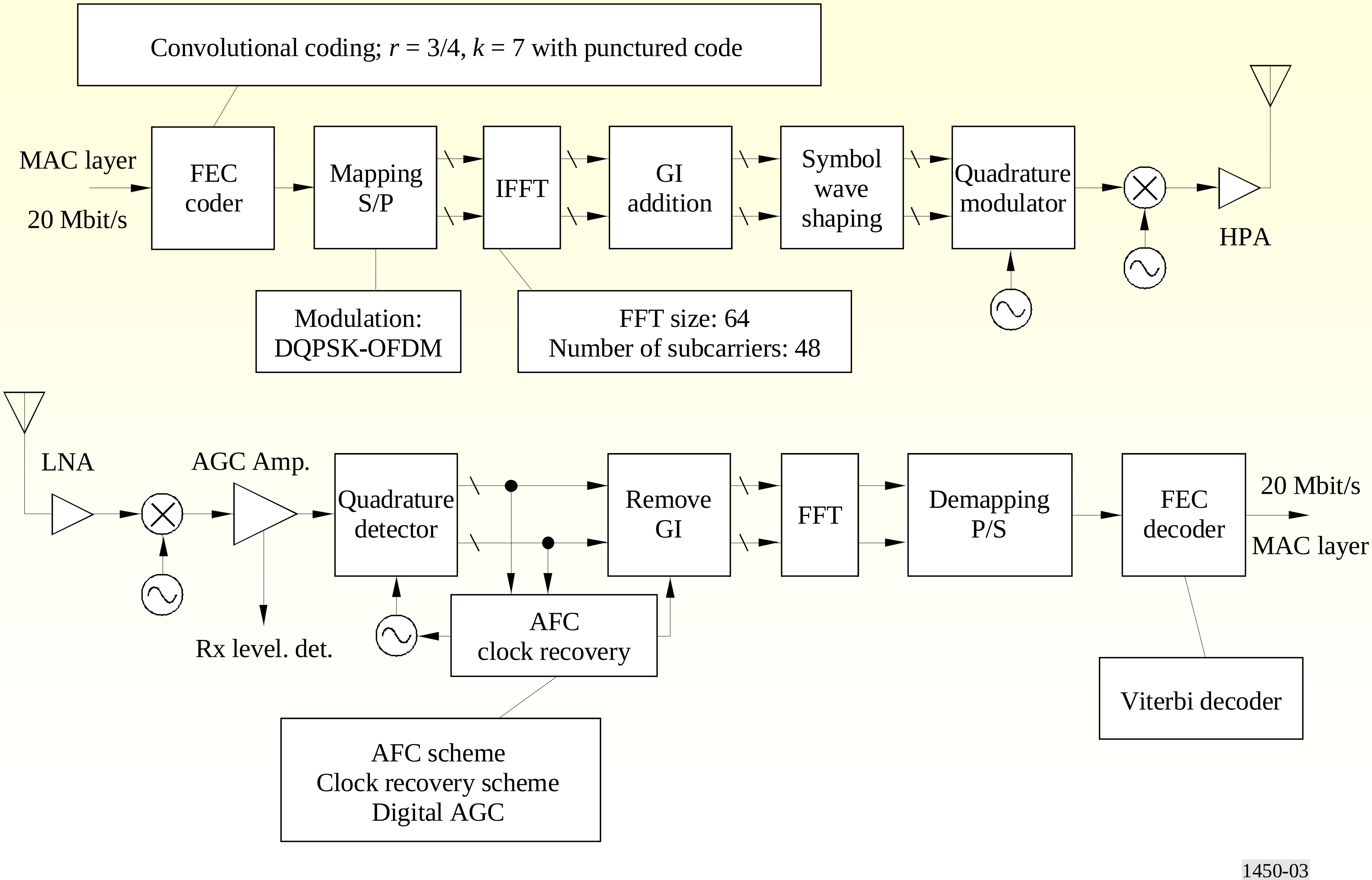
BTS;	Base transmitter station;	BSC	Base station controller
PCU	Packet control unit;	MSC	Mobile switching centre
HLR	Home location register;	VLR	Visitor location register
SGSN	Serving GPRS support node; Um, A-bis, A, Gb, Gr, Gs, Gn, Gi various interface protocols		

Spectrum AND Structure of OFDM, LMHB_M1450

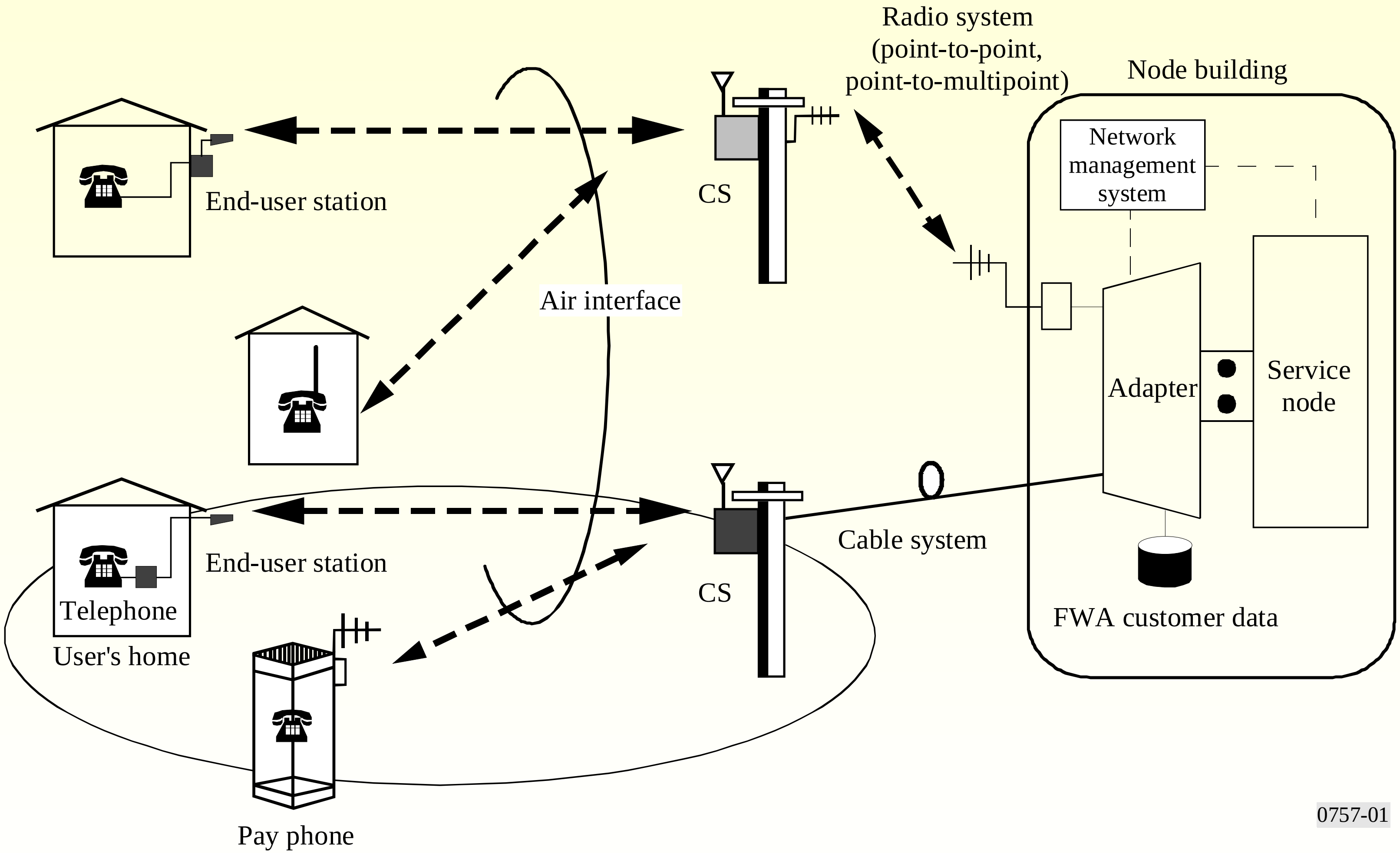




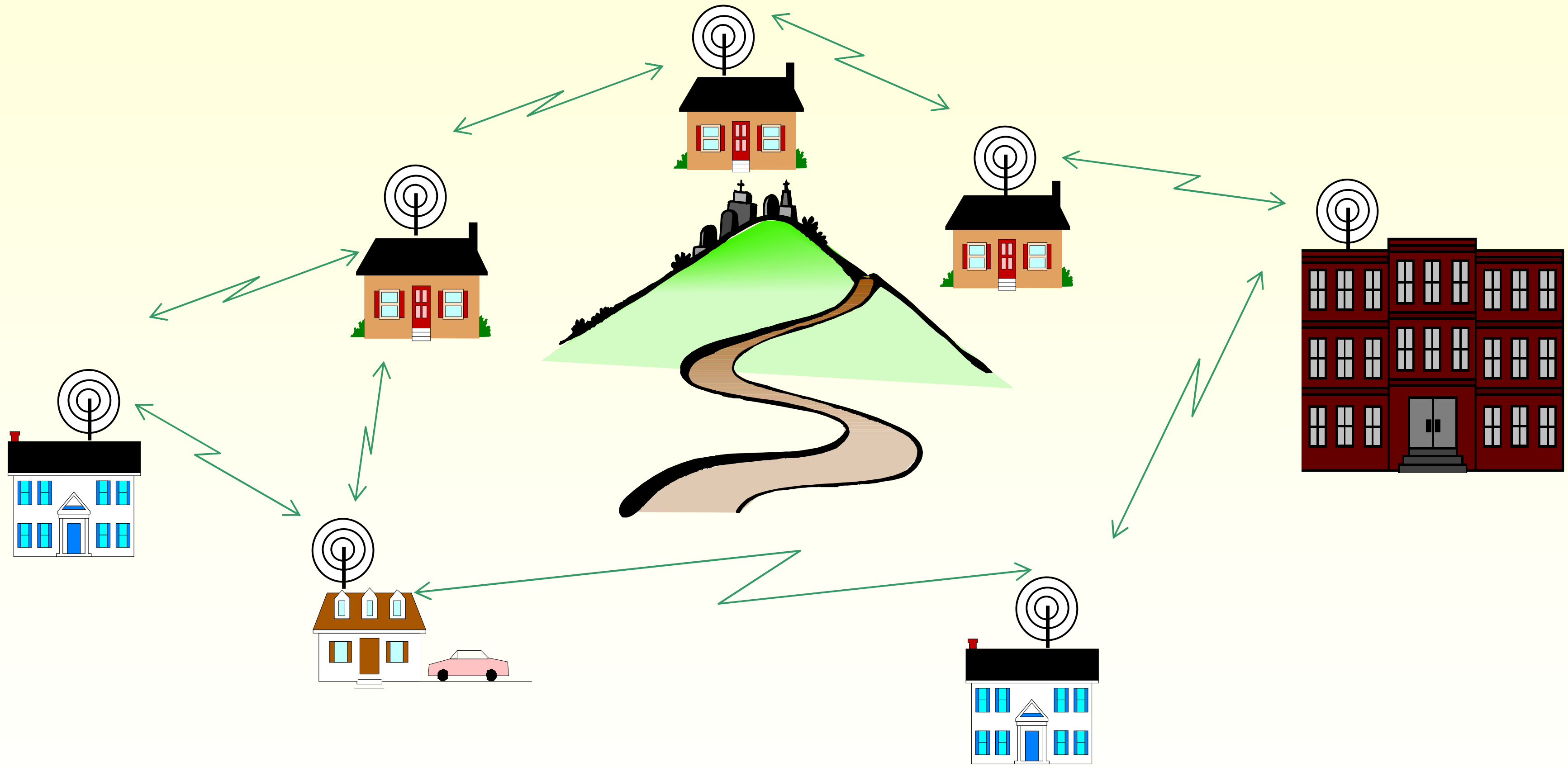
Configuration of DQPSK-OFDM, with conventional Coding, M1450



FWA using mobile technologies; F. 757



Mesh Network; Mobile & RLAN, ITU-R LMHB



Ministry of Information and Communications Government of Nepal

International Telecommunication Union

Ministry of Communications Government of Israel

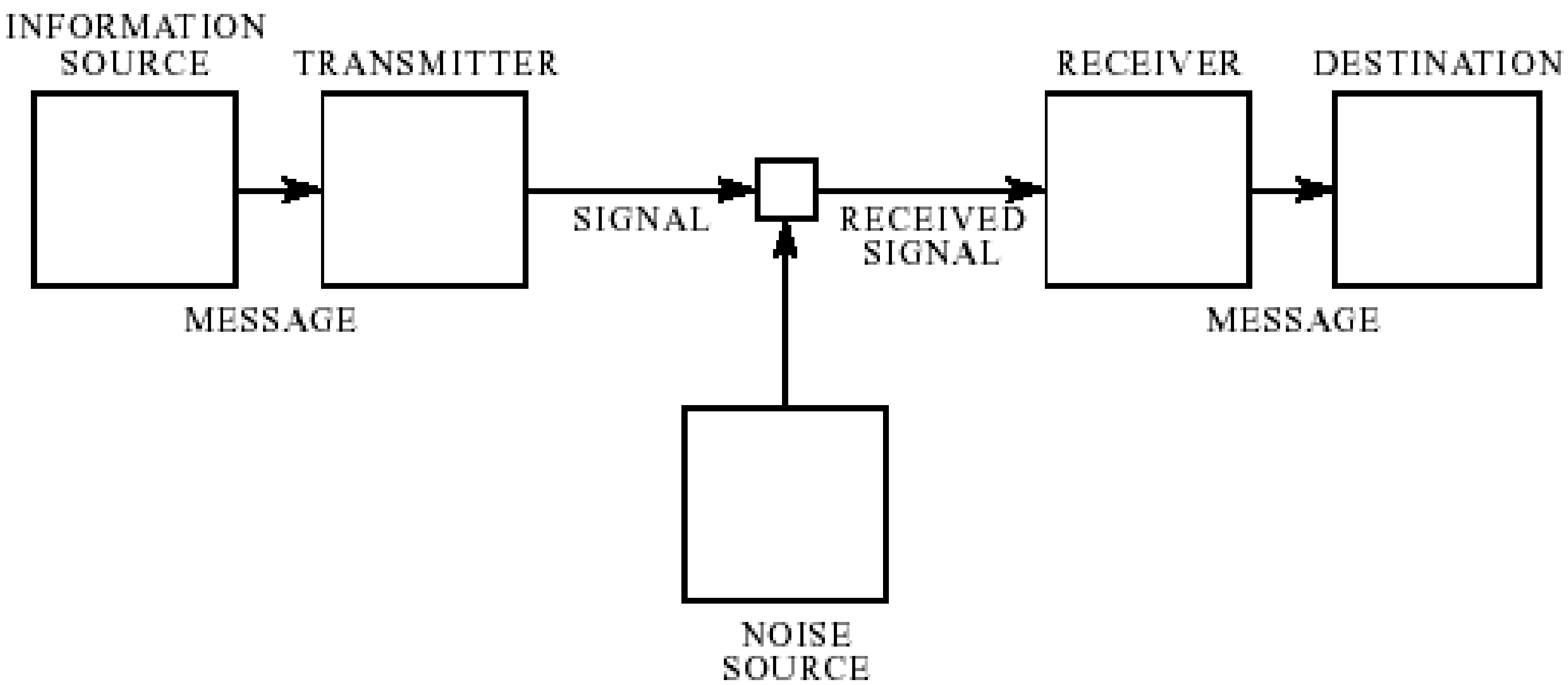
Ministry of Foreign Affairs MASHAV-Center for International Cooperation Government of Israel

RF Engineering Transmitters Receivers

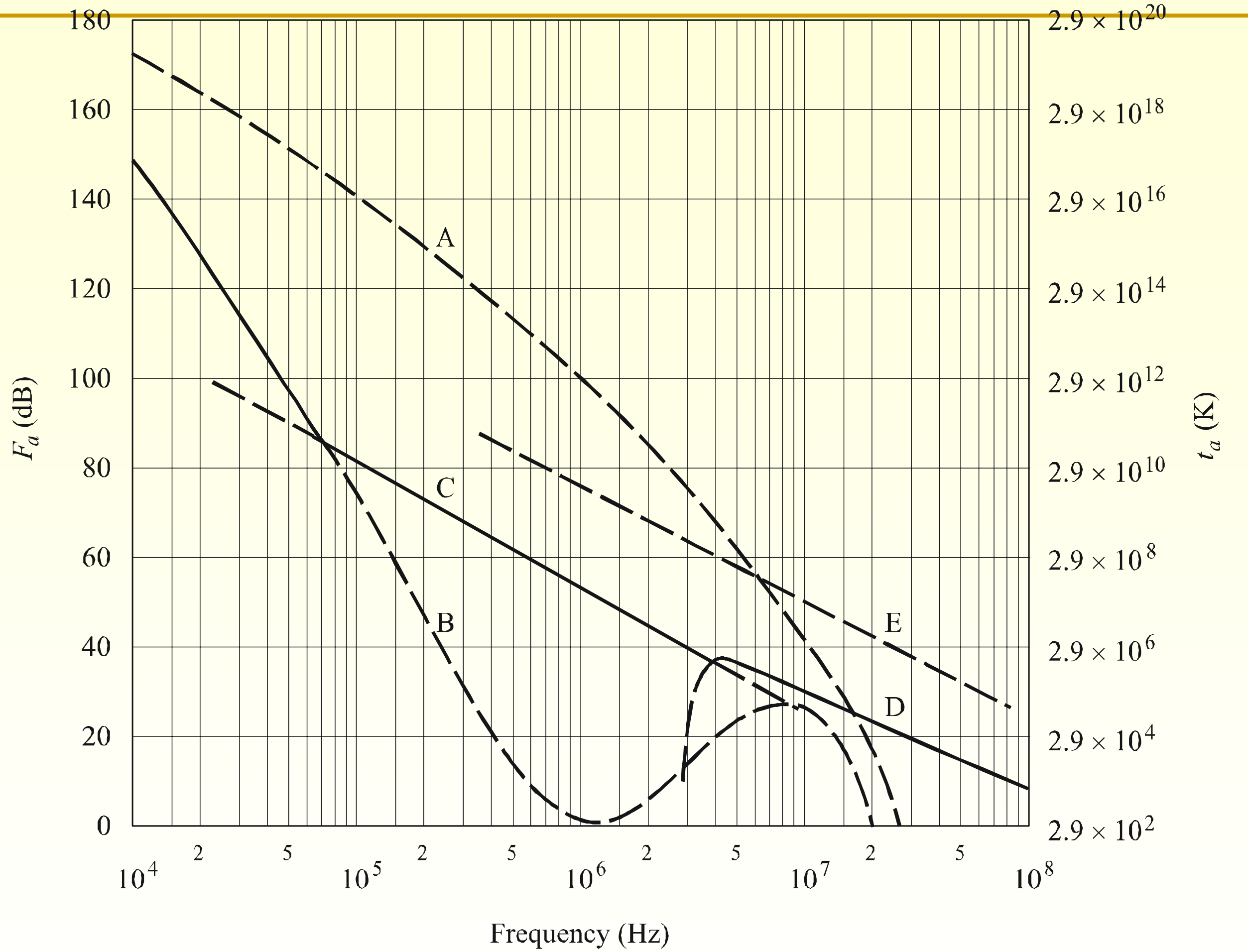
Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il

Wireless Telecomms, Nepal, Kathmandu Seminar 24-28 Nov. 08

Schematic diagram of a general communication; Shannon & Weaver (1949)



Radio Noise: F_a vs frequency, ITU-R P. 372



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

Receiver Sensitivity, M.1767

$$P_r\,(\text{dBm}) = -114 + F + I/N + 10 \log B_v + P_o$$

F: noise figure of the base station or mobile station receivers (dB)

I/N: criterion of interference to receiver system noise ratio (dB)

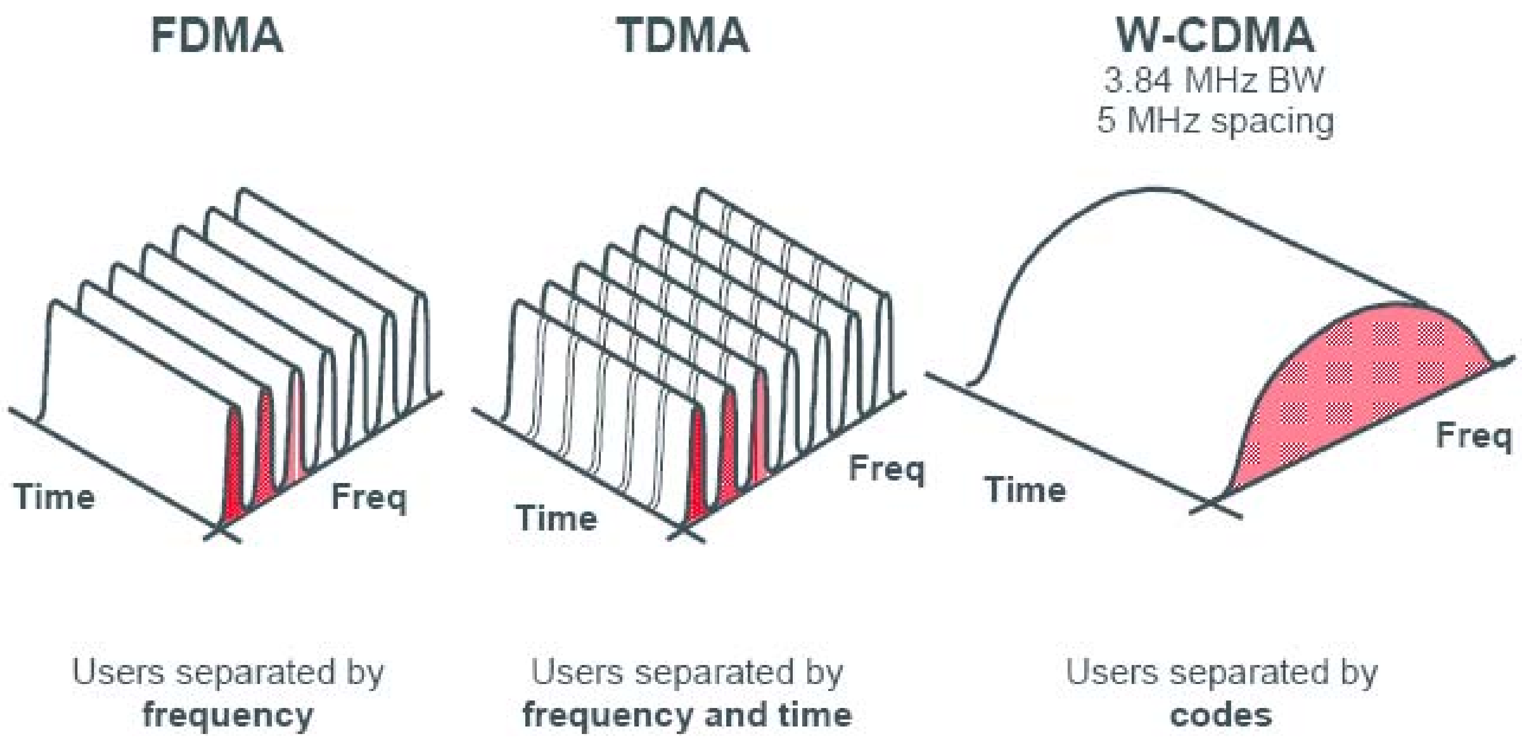
B_v: equivalent noise bandwidth of the receiver (MHz)

P_o: noise increase due to man-made noise and other interference (dB);

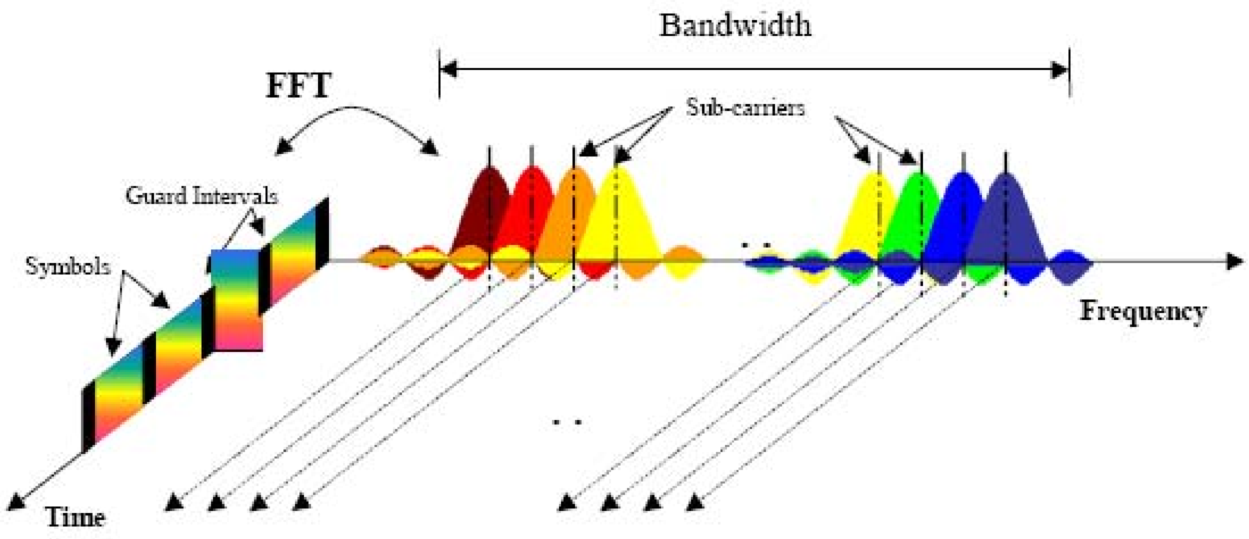
Relationship between field strength, *E*, power, *Pr*, in frees

$$P_r = \frac{E^2 G\lambda^2}{Z_0 4\pi} = \frac{E^2 G c^2}{480\pi^2 f^2}$$

Code Division Multiple Access

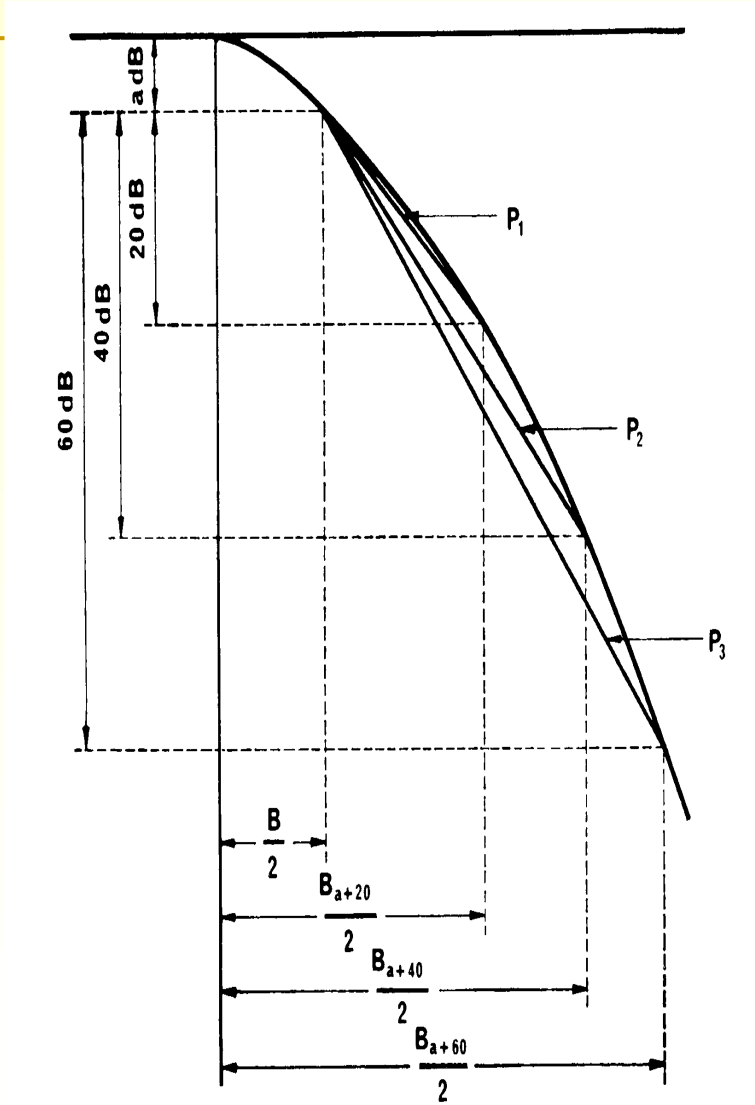


OFDM / OFDMA



- Each sub-carrier (frequency channel) carries a separate low-rate stream of data
- Frequencies are chosen so that the modulated data streams are orthogonal to each other
- Each sub-carrier is independently modulated
- A guard time is added to each symbol (cyclic prefix)
- Symbol duration is relatively long compared to channel delay spread -> less intersymbol interference

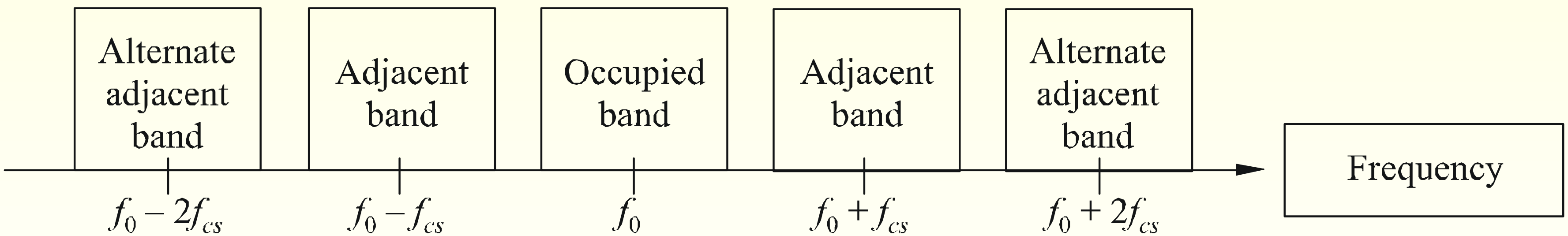
Single Signal Selectivity Rec SM 332-4



Unwanted Masks, Rec SM 1541

FIGURE 3

Power measurement bands

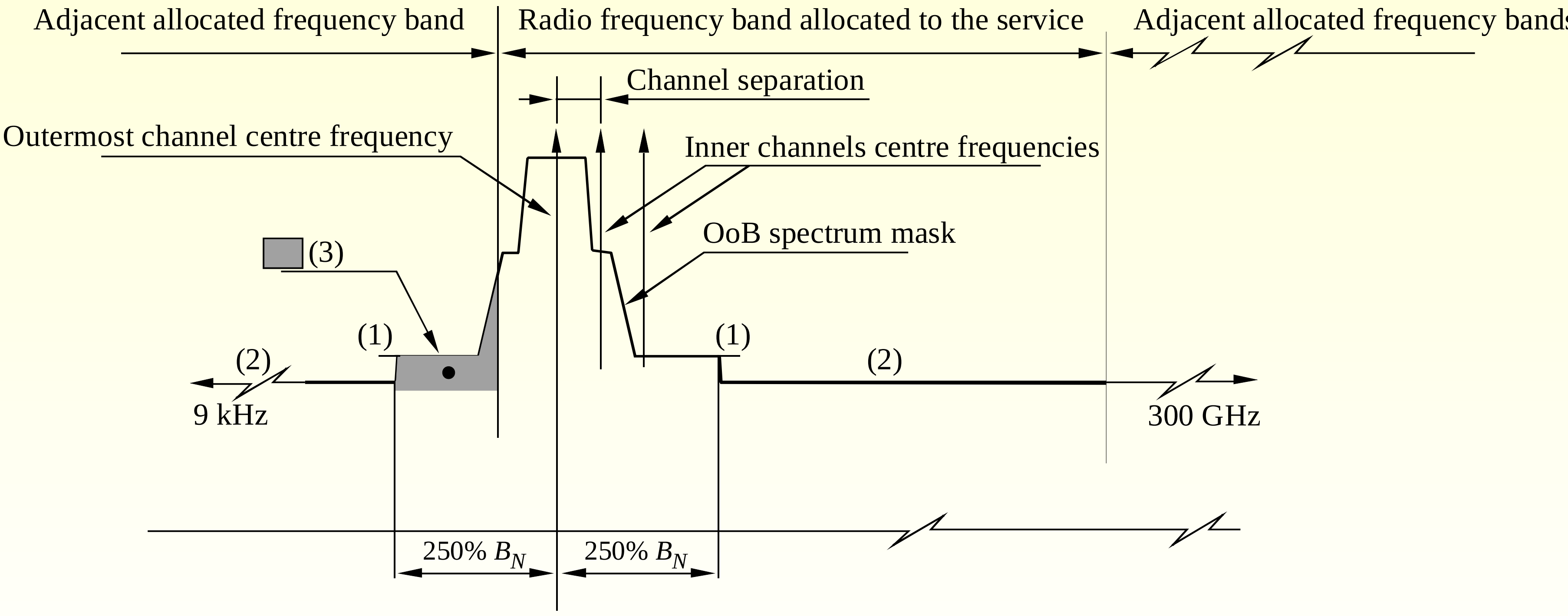


f_{cs}: spacing between assigned frequencies

1541-03

Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il

Unwanted Emissions, Rec SM 1540



(1) Actual OoB mask for the system under consideration
(2) Spurious limit defined by RR Appendix 3 or Recommendation ITU-R SM.329
(3) Unwanted emissions in the OoB domain falling in the adjacent allocated frequency band

1540-01

Categories of *spurious emissions* limits

Category A	The attenuation values used to calculate maximum permitted spurious domain emission power levels. **RR Appendix 3** is derived from Category A limits.
Category B	Limits are defined and adopted in **Europe** (all Europe not only EU) and used by some other countries.
Category C	Limits are defined and adopted in the **US and Canada** and used by some other countries.
Category D	Limits are defined and adopted in **Japan** and used by some other countries.

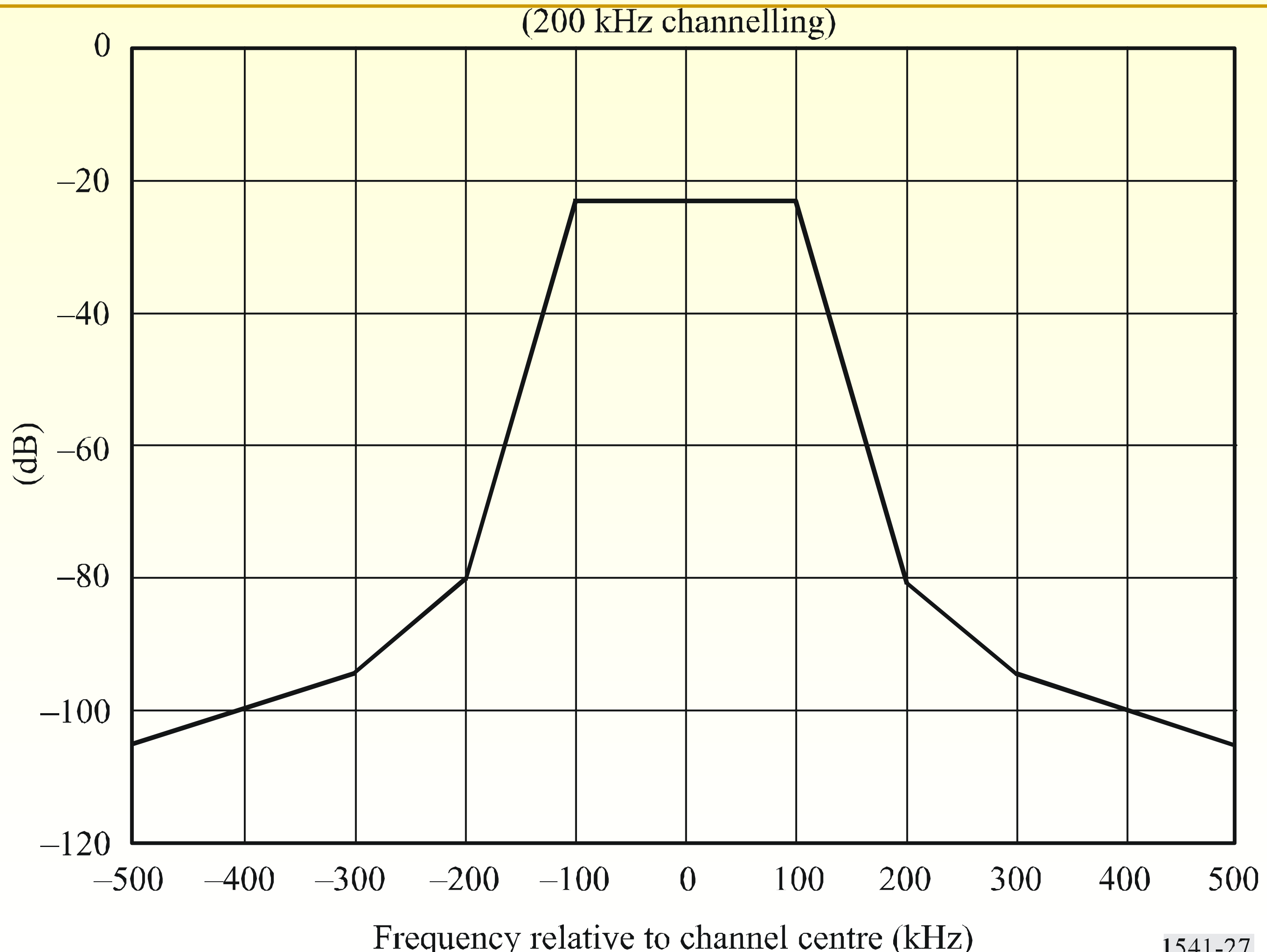
Spurious Emissions Rec SM 329

PP4 TablesTxRx\REC-SM329-10Spurious.pdf

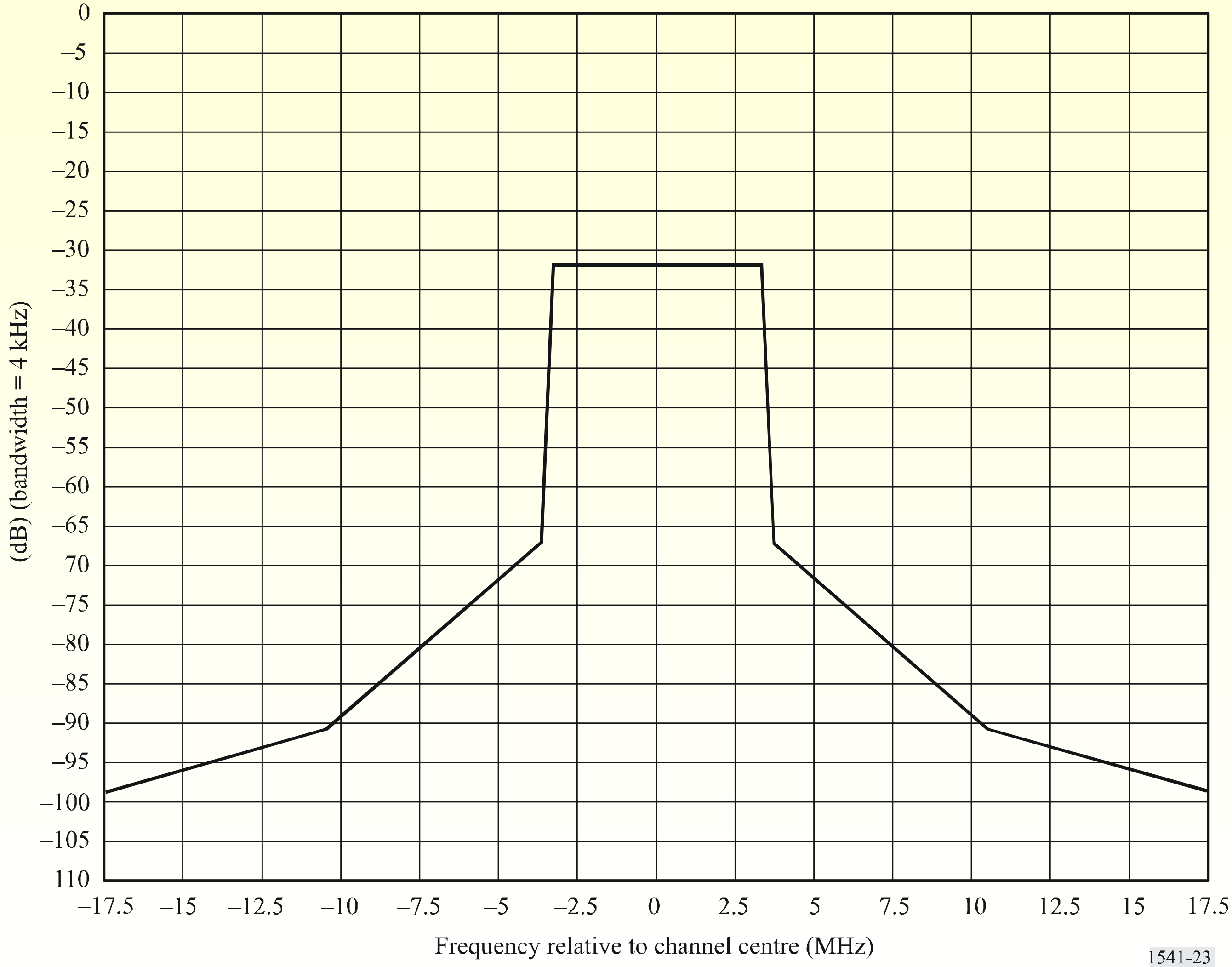
Comparative *spurious emissions* values (dBm)

Type of equipment	Category A: All Countries	Category B: Europe	Category C: USA, Canada	Category D: Japan
Portable, 465 MHz, 1 W, 12.5 kHz channels	-13	-36	-20	-30
Fixed Service, 325 MHz, 10 W	-13	-50	-13	-20
HF Broadcasting, 100 kW	17	17	0	17
FM Broadcast, 100 MHz, 10 kW	0	-15	-10	0

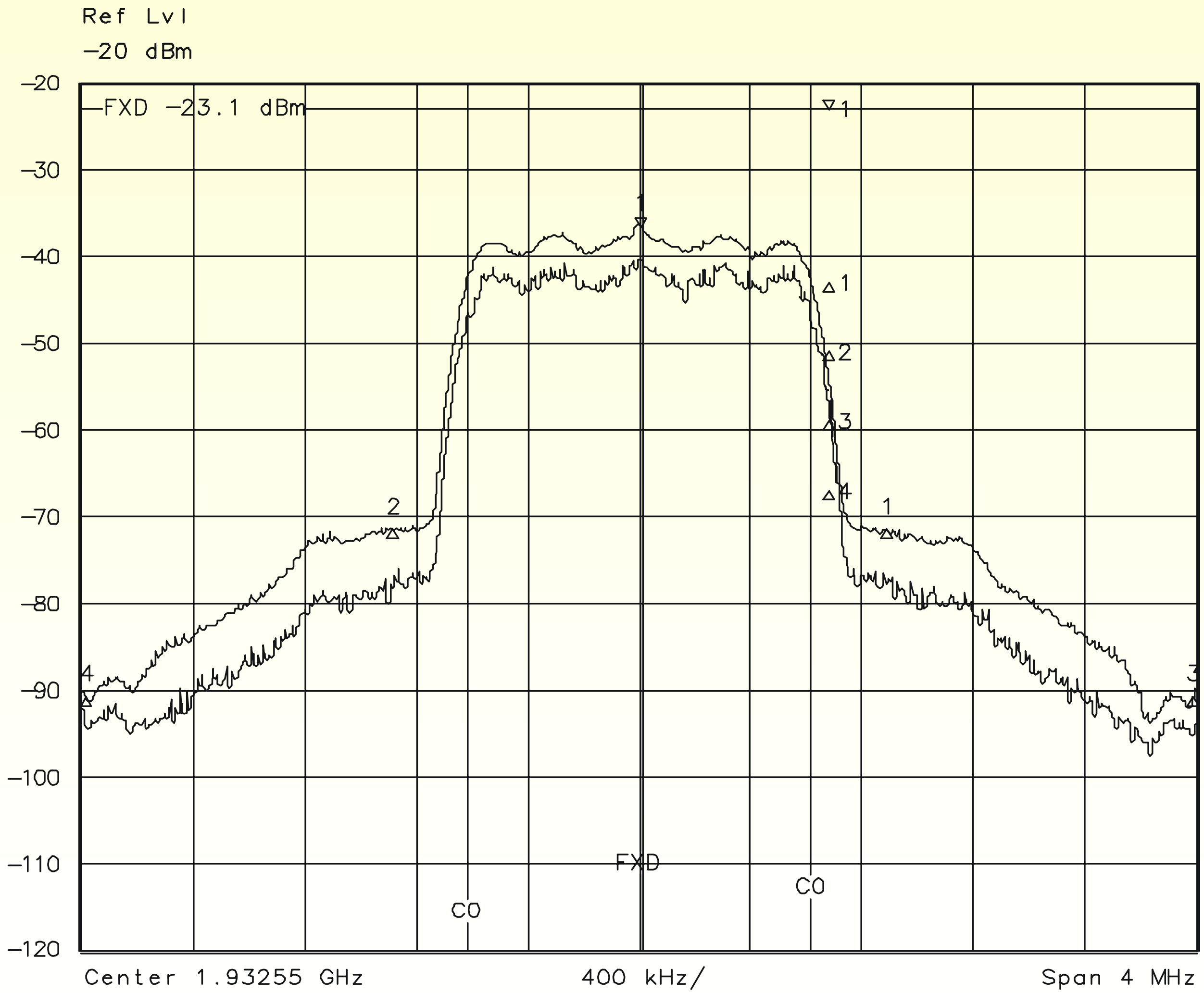
Spectrum Limit VHF FM sound, Rec 1541



Spectrum for 7 MHz DVB-T, Rec SM. 1541



CDMA IS95 1,932.55 MHz Ch. Spacing 1.25 MHz



Ministry of Information and Communications Government of Nepal

International Telecommunication Union

Ministry of Communications Government of Israel

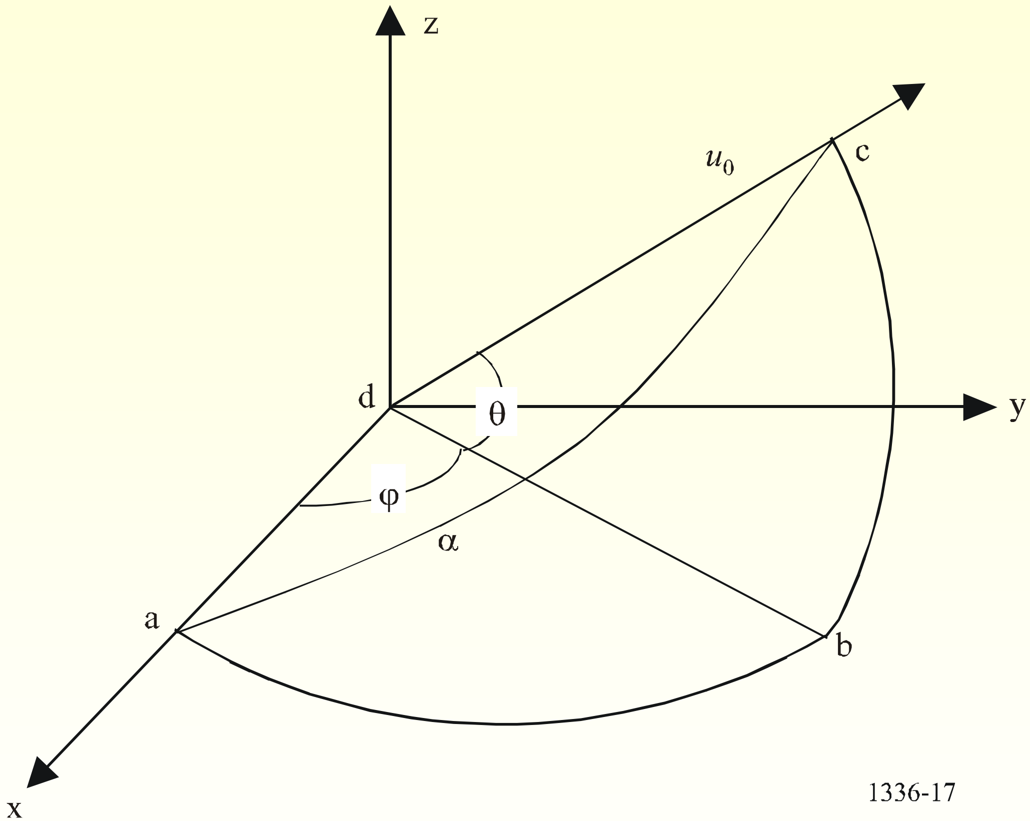
Ministry of Foreign Affairs MASHAV-Center for International Cooperation Government of Israel

Antenna Basics

Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il

Wireless Telecomms, Nepal, Kathmandu Seminar 24-28 Nov. 08

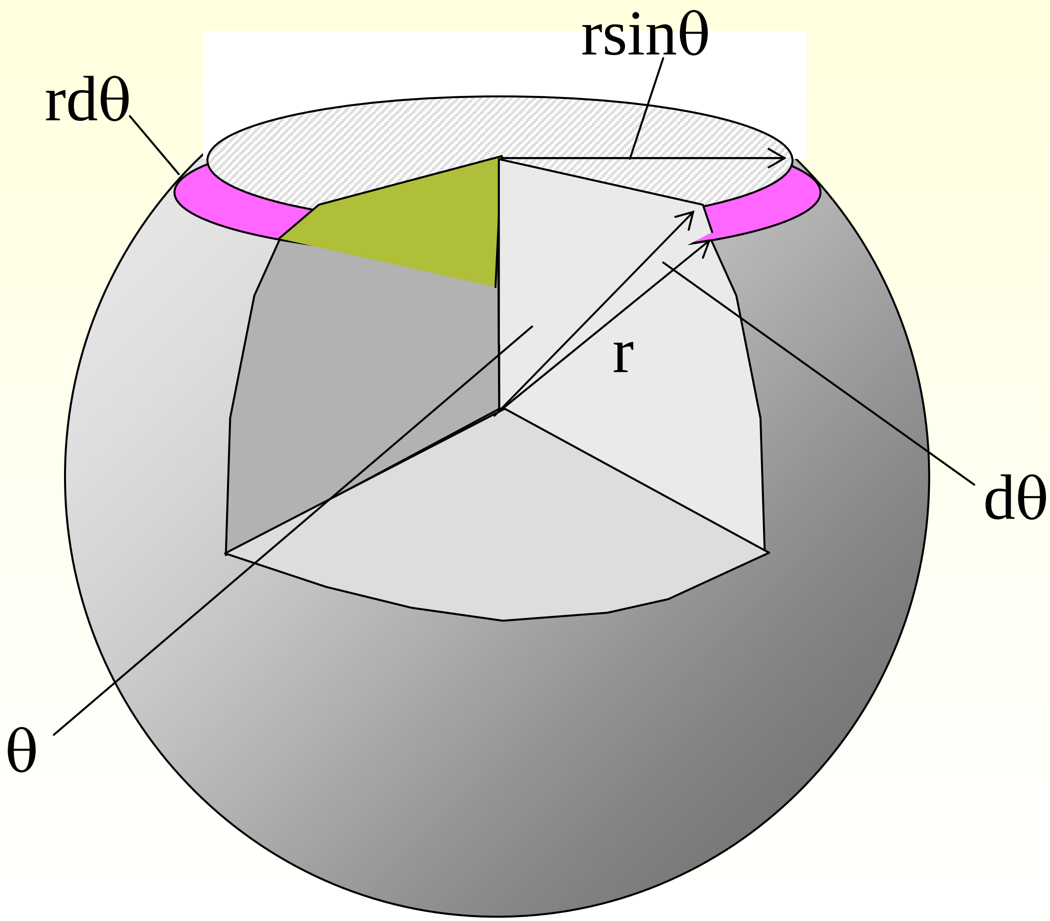
Off-boresight given azimuth and elevation angles (F1336)



$$g = \frac{4\pi \left|E(\theta,\varphi)\right|^2_{max}}{\int_0^{2\pi} \int_{-\pi/2}^{\pi/2} \left|E(\theta,\varphi)\right|^2 \cos\theta \, d\theta \, d\varphi}$$

Integration Surface

$dS = 2\pi r^2 \sin(\theta) d\theta$



Effective Capture Area

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

$$\eta = \frac{P_{rad}}{P_{input}} = \frac{A_e}{A}$$

$$g = \frac{4\pi}{\varphi\theta(radians)} = \frac{4\pi a_{az} b_{el}}{\lambda^2} = \frac{4\pi A_e}{\lambda^2} = \frac{4\pi\eta A}{\lambda^2}$$

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

Practical Formulas, for gain

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

$G = 44.6$ dBi $-10 \mathrm{Log}\,\theta^0 - 10 \mathrm{Log}\,\varphi^0$; for circular Ant, $G = 44.6$ dBi $-20 \mathrm{Log}\,\theta$

Rec F699 Patterns for 1 GHz to about 70 GHz, where D/λ <100

D= Ant length or diameter; these formulas apply for circular reflectors

$$G(\varphi) = G_{max} - 2.5\times10^{-3}\left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{for} \quad 0^\circ < \varphi < \varphi_m$$

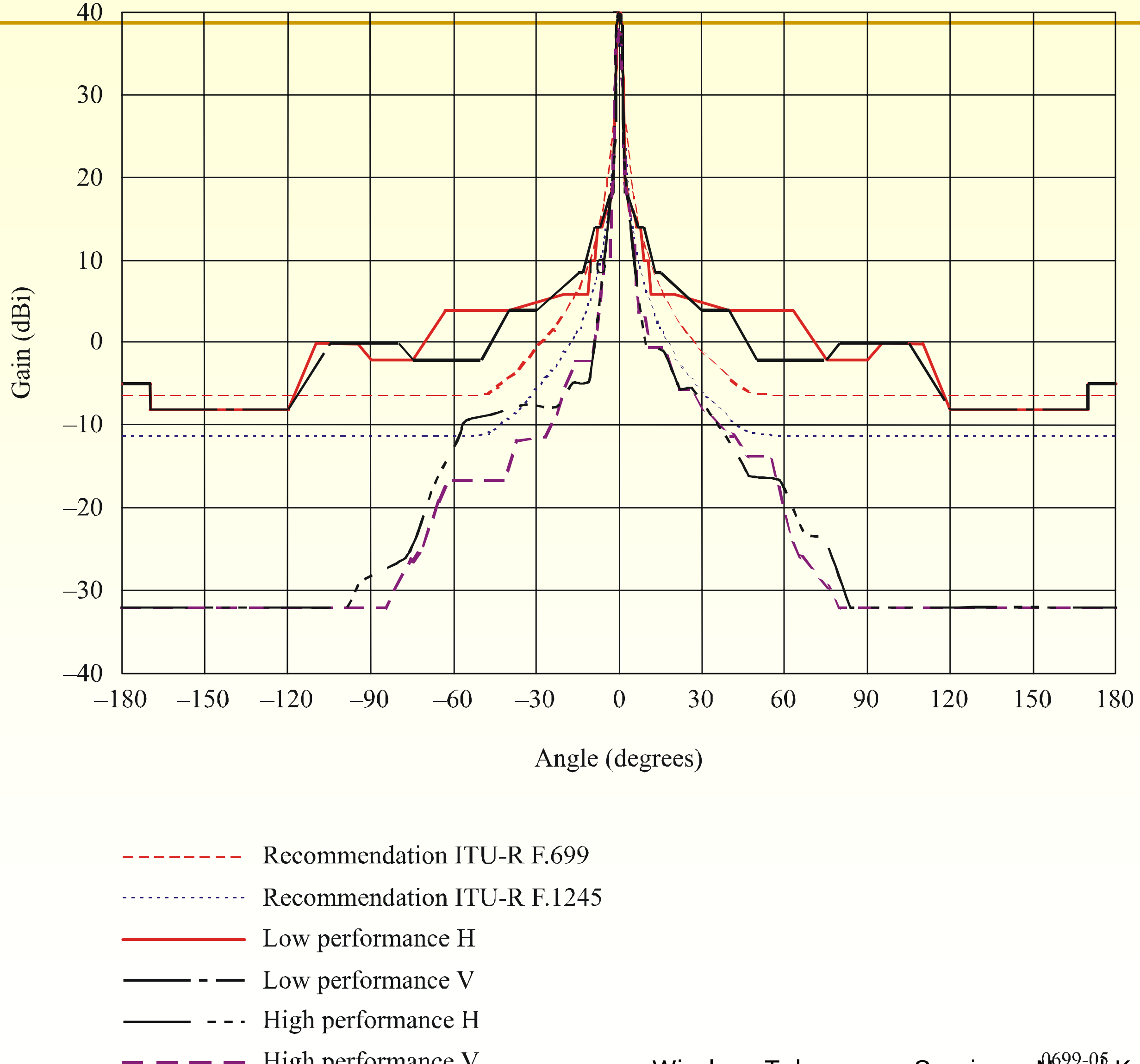
$$G(\varphi) = G_1 \quad \text{for} \quad \varphi_m \le \varphi < 100\,\frac{\lambda}{D}$$

$$G(\varphi) = 52 - 10\log\frac{D}{\lambda} - 25\log\varphi \quad \text{for} \quad 100\,\frac{\lambda}{D} \le \varphi < 48^\circ$$

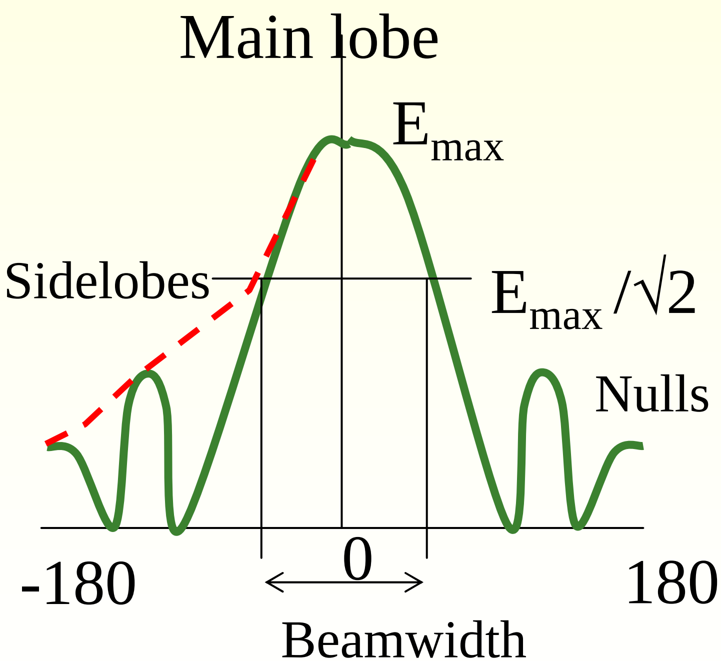
$$G(\varphi) = 10 - 10\log\frac{D}{\lambda} \quad \text{for} \quad 48^\circ \le \varphi \le 180^\circ$$

$$20\log\frac{D}{\lambda} \approx G_{max} - 7.7 \qquad D/\lambda \approx 70/\theta \qquad G_{max}\,(\text{dBi}) \approx 44.5 - 20\log\theta$$

10.5 GHz P2P 1.2 m D/λ=43 39.9 dBi; H:hor, V:vert



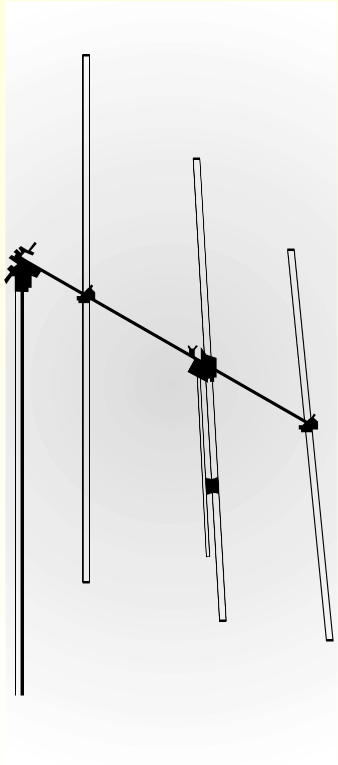
Elements of Radiation Pattern (Struzak)



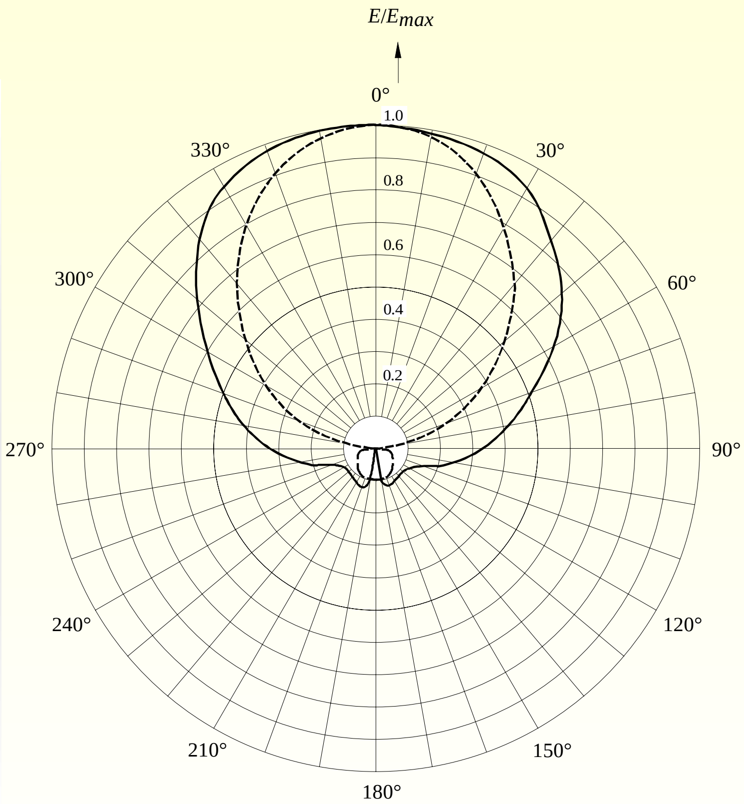
- Gain
- Beam width
- Nulls (positions)
- Side-lobe levels (envelope)
- Front-to-back ratio

Typical TV ant

FIGURE 18



a) Typical Yagi antenna for full Band II coverage



b) Typical radiation pattern

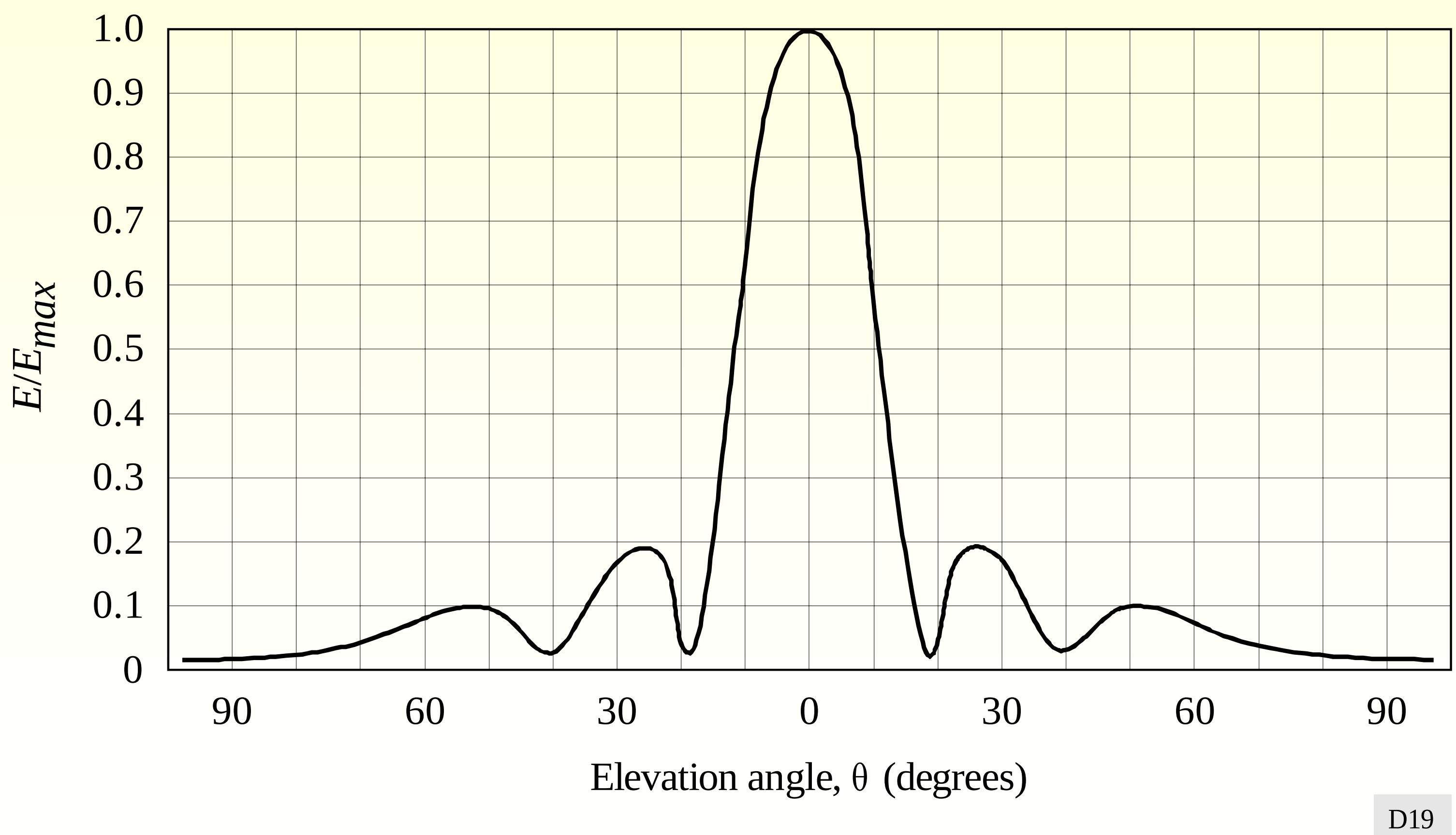
——— Pattern in the plane orthogonal to dipoles

- - - - Pattern in the plane of dipoles

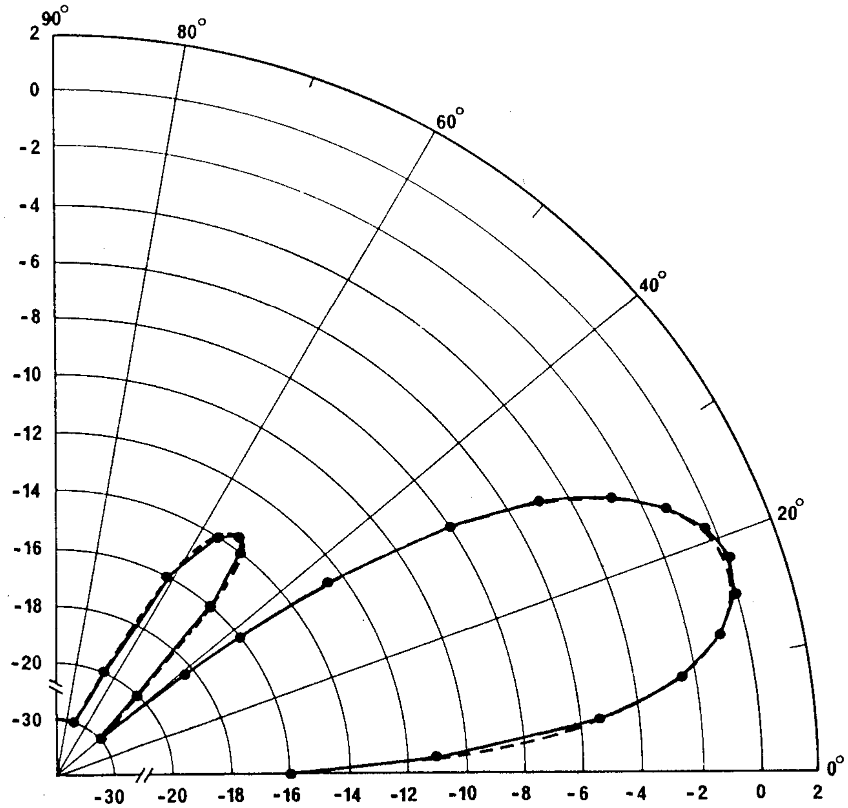
D18

TV elev. Pattern (BS 1195)

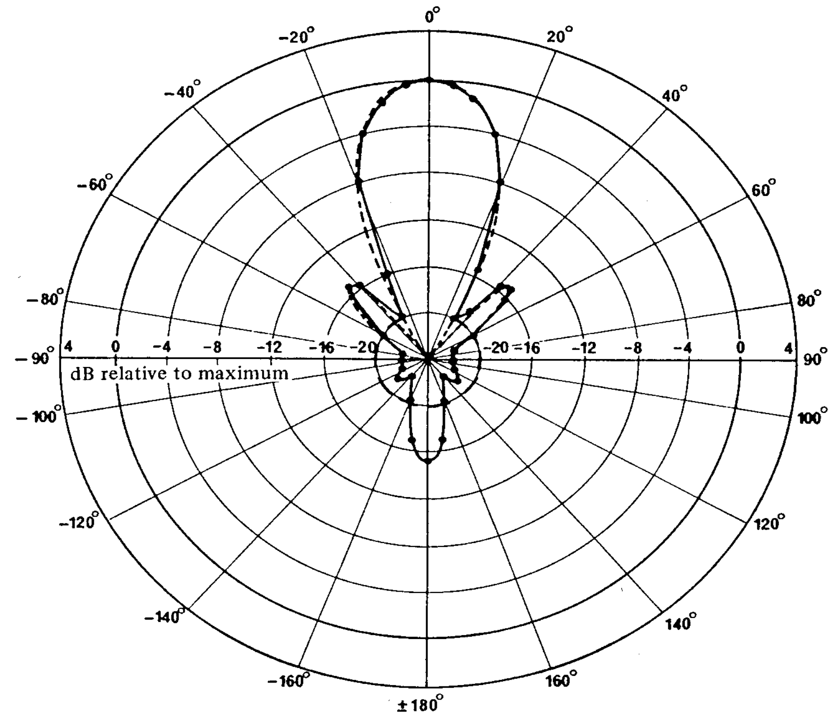
Vertical radiation pattern for an array of 5 vertical 0.5 λ spaced radiating elements having equal current and phase



Az. and Elev. Patterns of Tx HF Ant.BS. 80



a) Vertical pattern HR *m*/2/0.5



b) Azimuthal pattern HR 4/4/1, maximum gain 22 dBi

FIGURE 2 – *Azimuthal patterns*

Representative data

ITU-R data

Recommendation ITU-R BS.80

0080-02

Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il

Ministry of Information and Communications
Government of Nepal

International Telecommunication Union

Ministry of Communications
Government of Israel

Ministry of Foreign Affairs
MASHAV-Center for International Cooperation
Government of Israel

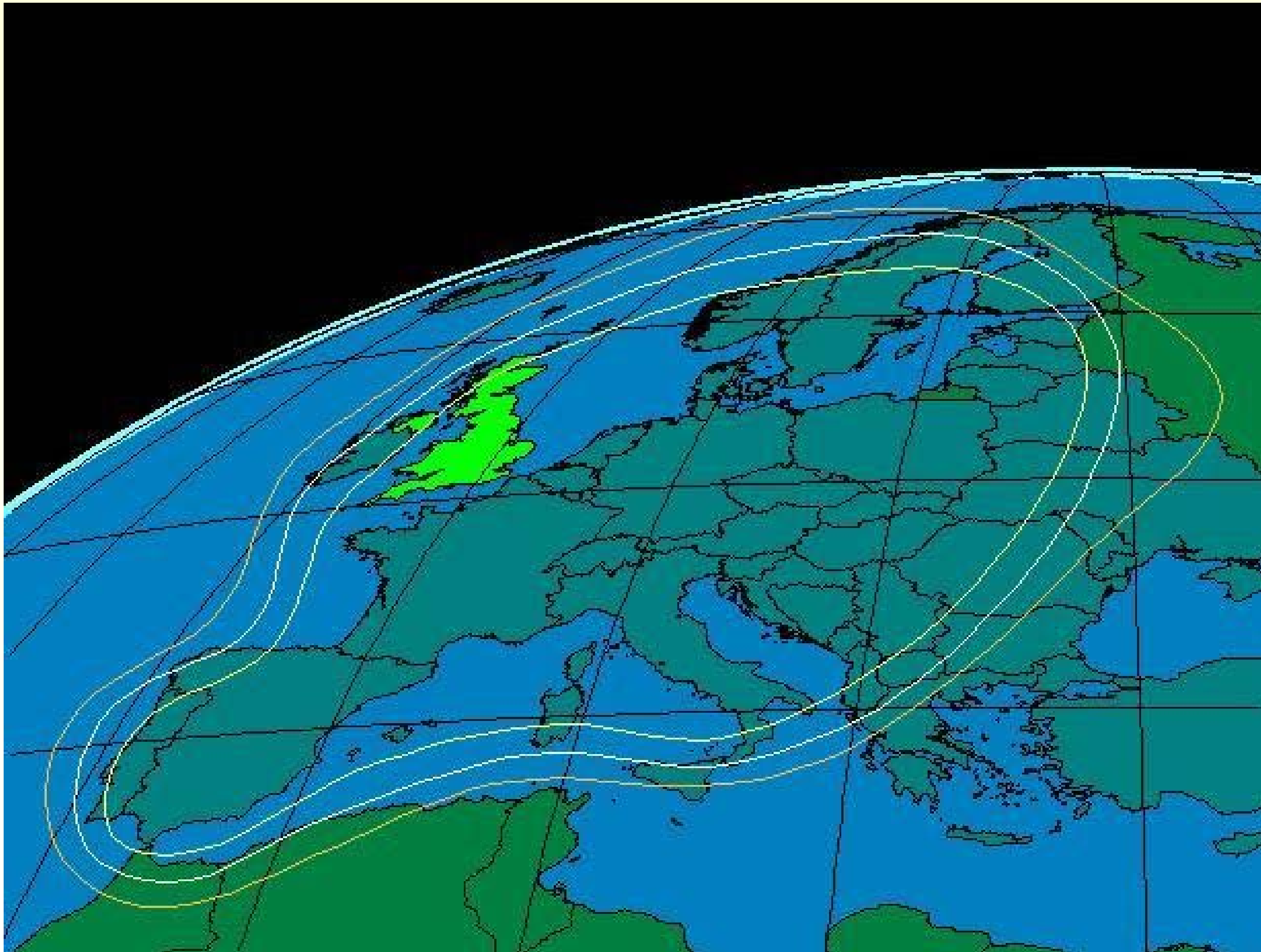
Satellite Communications,

Main Source, Rami Neudefer ramineu@netvision.net.il

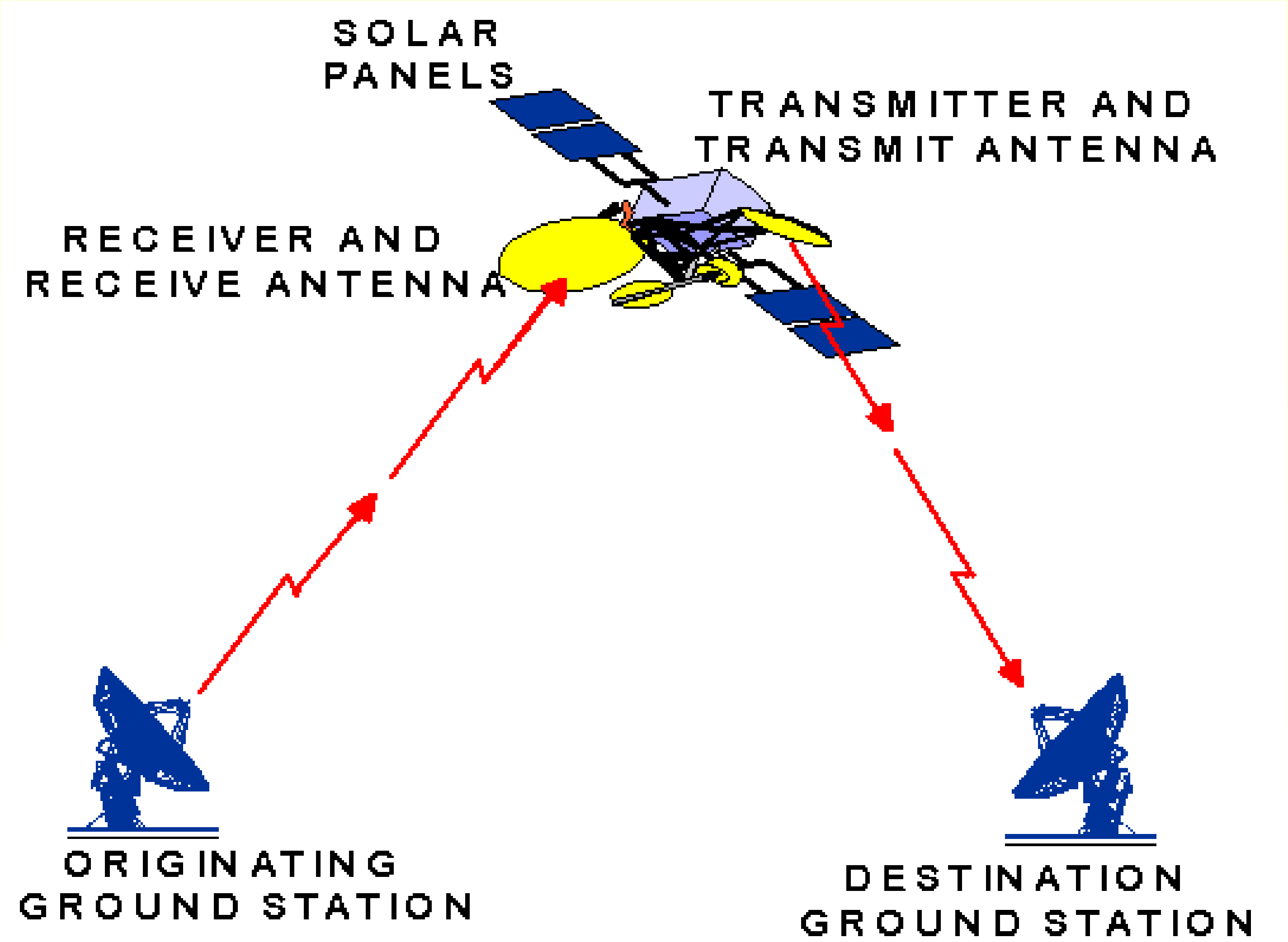
GEO (Rami)

- Circular orbits above the equator
- Angular separation about 1 degrees - allows 360 satellites
- Orbital height above the earth, about 23,000 miles/35,000km
- Round trip time to satellite about 0.24 seconds
- GEO satellites require more power for communications
- The signal to noise ratio for GEOs is worse due to distances
- 1 GEO covers about 40% of the world תוספת שלי
- Polar regions cannot be “seen” by GEOs
- As they appear stationary, GEOs do not require dynamic tracking
- GEOs are good for broadcasting to wide areas

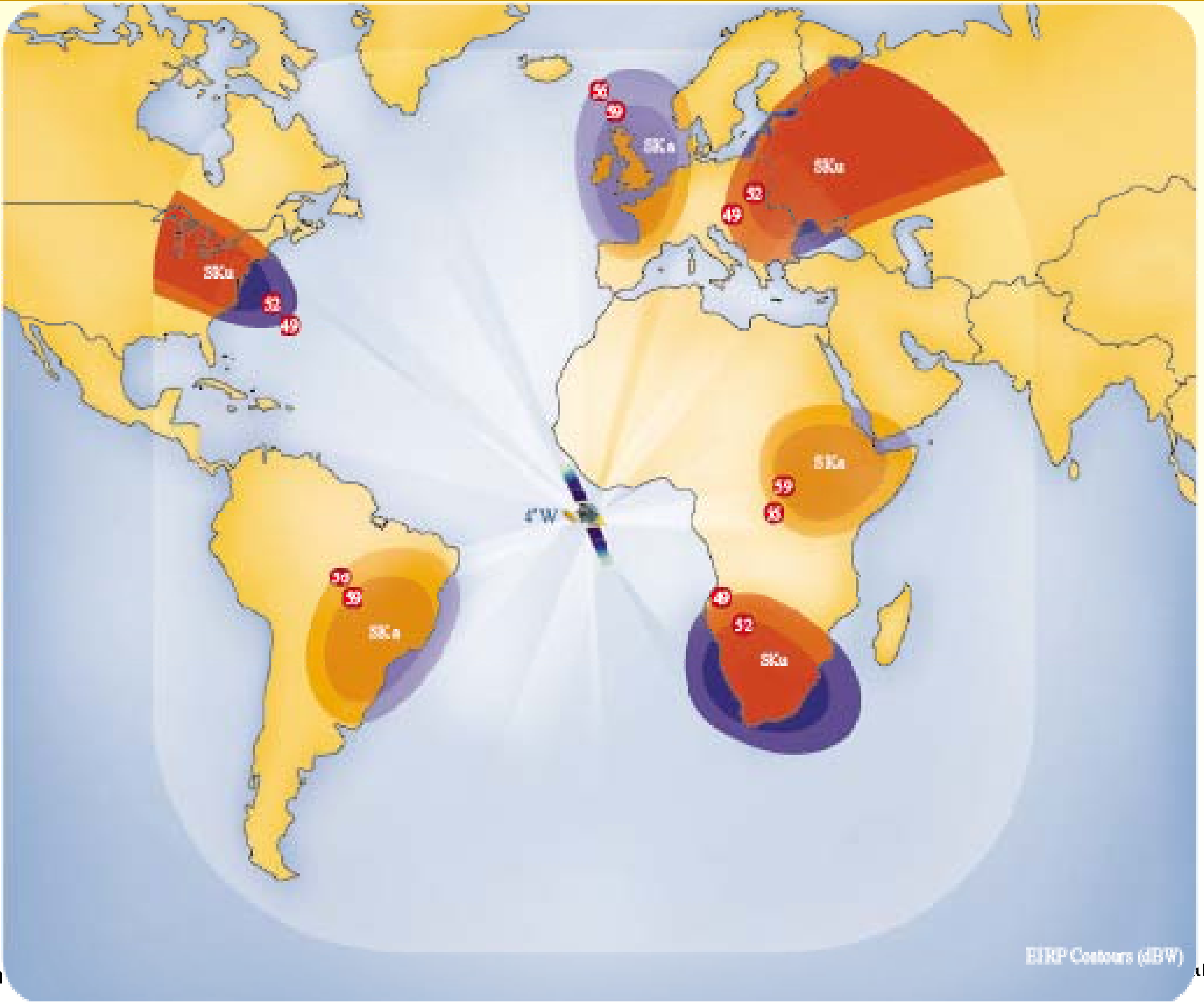
ASTRA Coverage, Transfinite Visualise7



Fixed Satellite Service, Rami



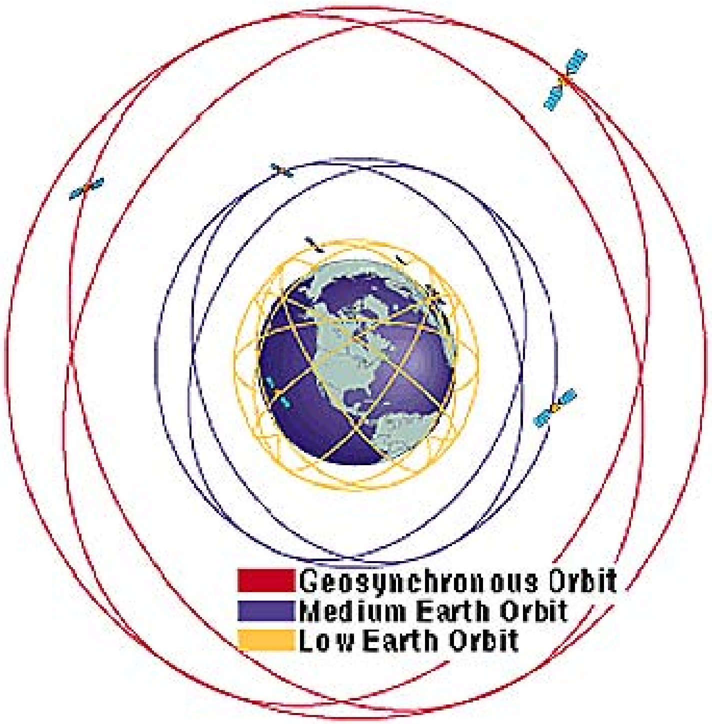
Amos-3 Global changeable Ku & Ka footprints, Rami



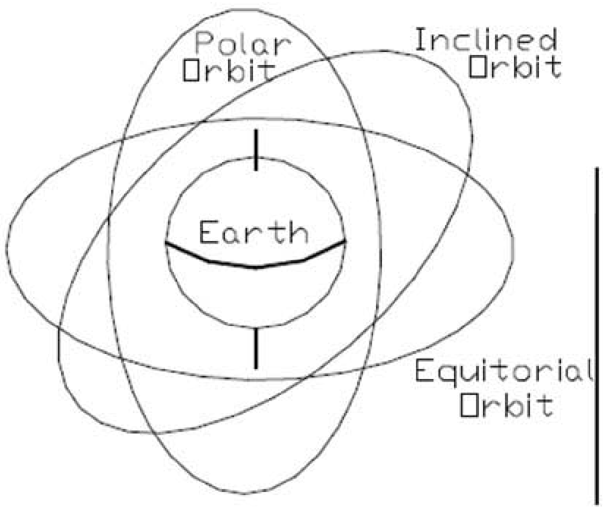
GEO Main Problems, Rami

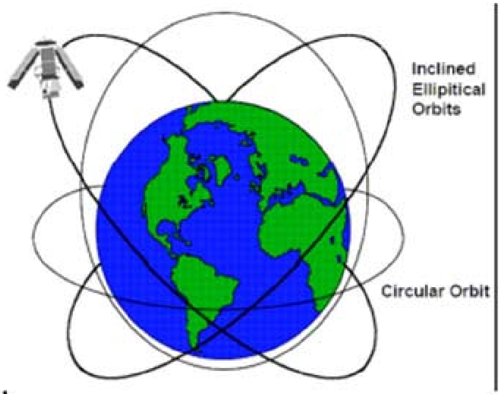
- Positioning in orbit: small rockets; fuel up to 10-15 Years
- Stability: solar panels and antennas
- Power: solar power is used to generate electricity; Batteries are needed as about half the time the LEOs are behind the earth
- Communications: satellite to satellite communication microwave or by optical laser
- Harsh environment: components need to be specially “hardened’’, not only for temperature

Satellites Orbits & Inclinations, Rami



- Polar
- Equatorial
- Inclined





LEO and Orbits, Rami

- Low earth orbit satellites - between 100 - 1500 miles
- Signal to noise should be better with LEOs
- Shorter delays, between 1 - 10 ms typical
- LEOs move relative to the earth; they require dynamic tracking or non directive antennas תוספת שלי
- Circular orbits are simplest
- Inclined orbits are useful for coverage of equatorial regions
- Elliptical orbits can be used to give quasi stationary behaviour viewed from earth using 3 or 4 satellites
- Orbit changes extend the life of satellites

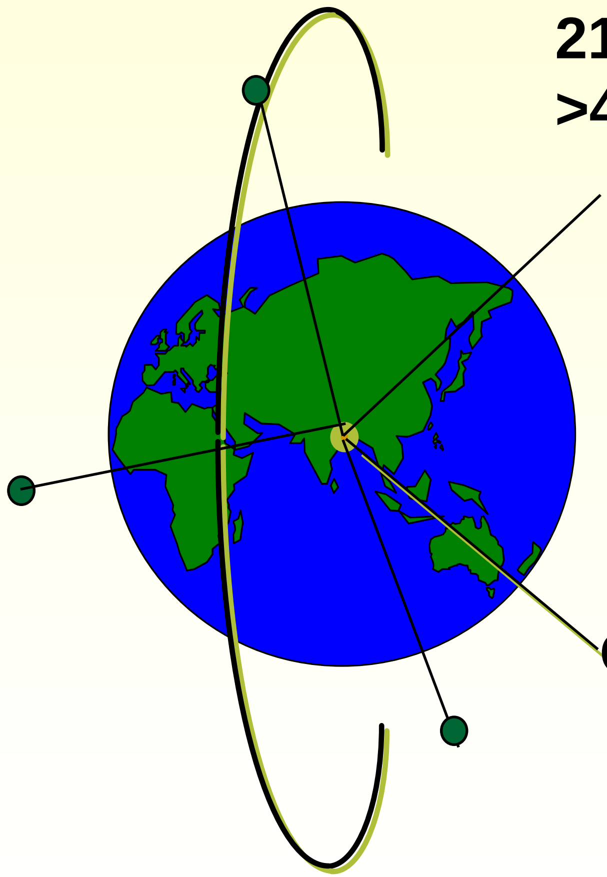
GPS: Global Positioning System, Struzak

6 inclined orbit planes
20.000km

X,Y,Z coordinates
(100m - 15m accuracy)

Time & frequency transfer

21 satellites
>4 visible

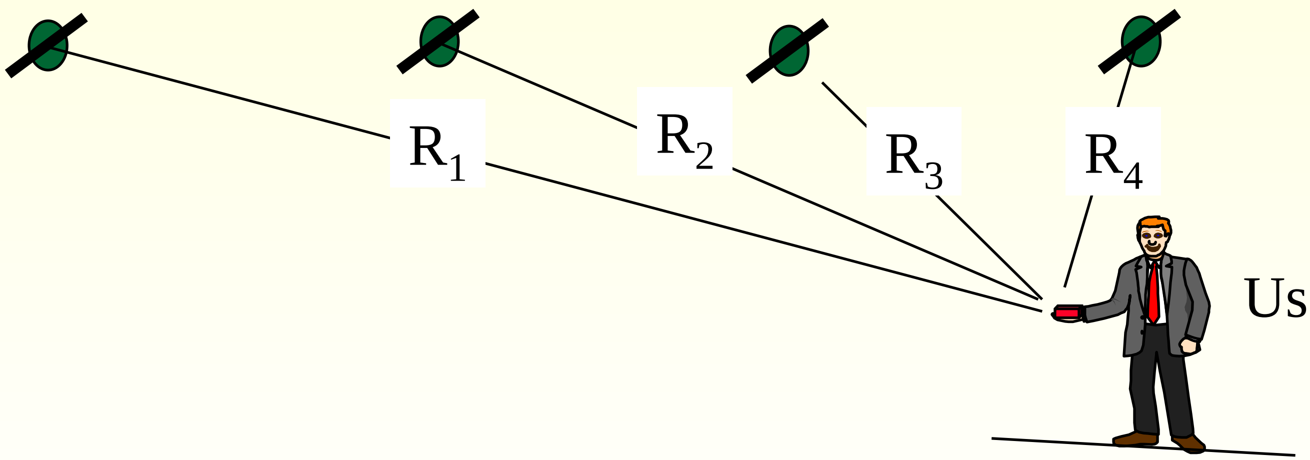


GPS receiver

strong signal

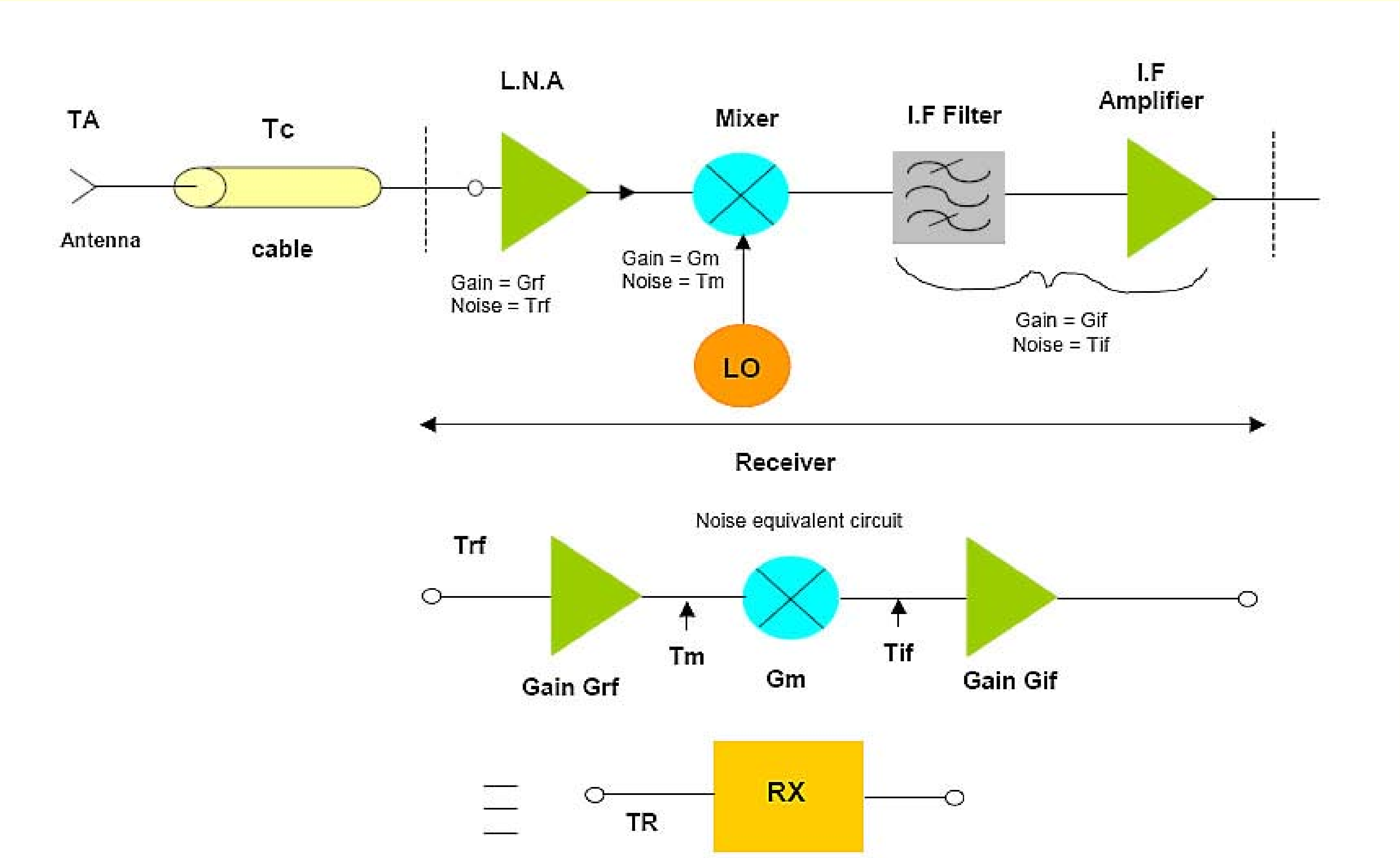
GPS Principle, Struzak

i-th satellite message: ”*my time is T_i; my position is (X_i, Y_i, Z_i)*”



Pseudo-ranges:	$R_i = c(dT_i)$.
Position:	$(X_i-X_u)^2 + (Y_i-Y_u)^2 + (Z_i-Z_u)^2 = (R_i- C_b)^2$
	c = lighy velocity C_b = clock bias i = 1...4.

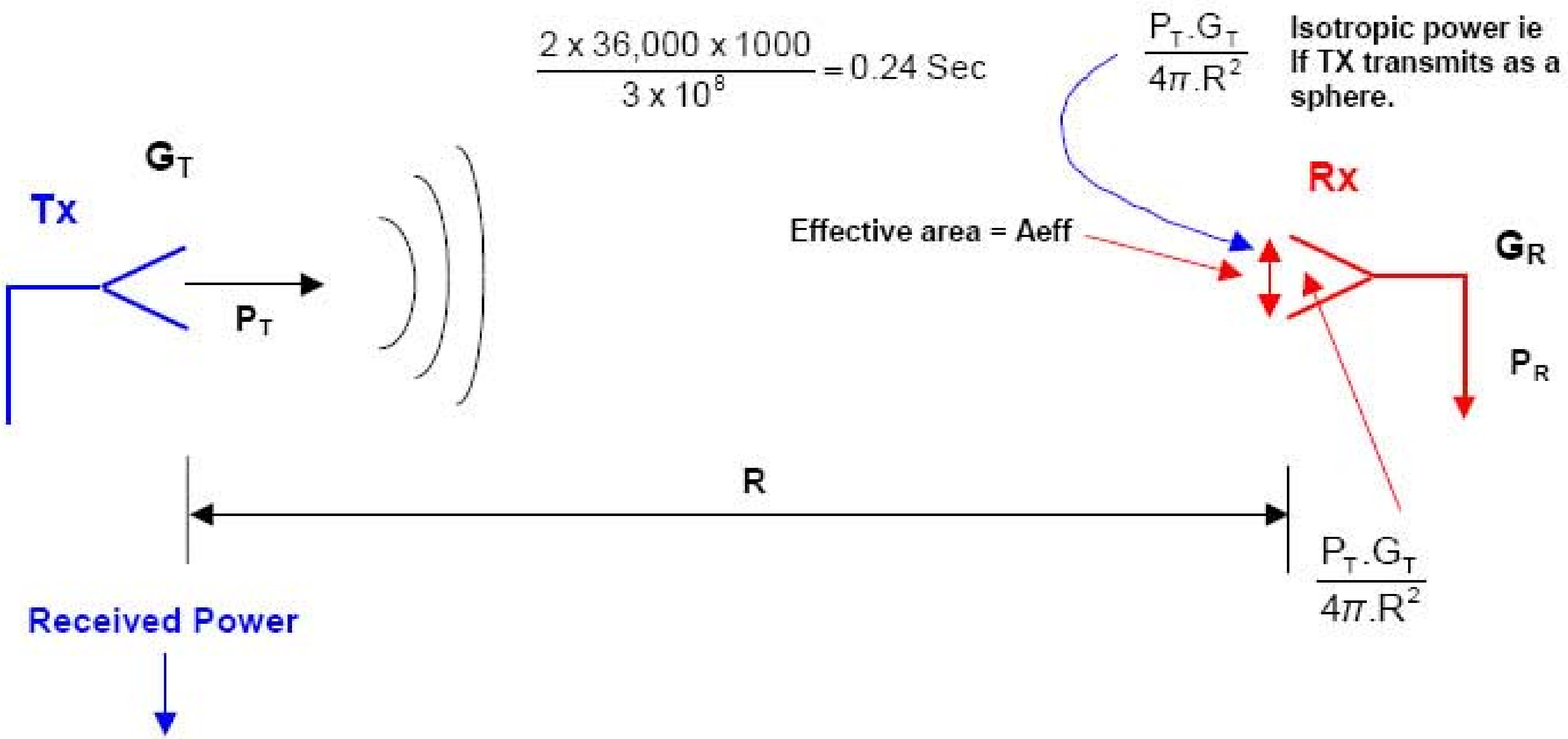
Schematic Link, *Rami*



Typical Frequencies

Band	Frequency Range	Total Bandwidth	General Application
L	1 to 2 GHz	1 GHz	Mobile satellite service (MSS)
S	2 to 4 GHz	2 GHz	MSS, NASA, deep space research
C	4 to 8 GHz	4 GHz	Fixed satellite service (FSS)
X	8 to 12.5 GHz	4.5 GHz	FSS military, terrestrial earth exploration, and meteorological satellites
Ku	12.5 to 18 GHz	5.5 GHz	FSS, broadcast satellite service (BSS)
K	18 to 26.5 GHz	8.5 GHz	BSS, FSS
Ka	26.5 to 40 GHz	13.5 GHz	FSS

Link Budget



$$P_R = \frac{P_T G_T A_{eff}}{4\pi R^2}$$

Basic Elements

General antenna relationship: $G = \frac{4\pi A_{eff}}{\lambda^2}$

$$P_R = P_T G_T G_R \left(\frac{\lambda}{4\pi R} \right)^2$$

G_R is the R_X antenna gain

$P_T G_T$ is the *Effective Isotropic Radiated Power (EIRP)*. It gives a measure of the power flux. For each satellite contours of constant EIRP can be plotted on the earth's surface. A minimum value of EIRP is required for each type of receiver (eg DBS). Usually the EIRP is given in units of dBW - $\text{EIRP[dBW]} = 10\log_{10}(P_T G_T)$.

Free Space Propagation

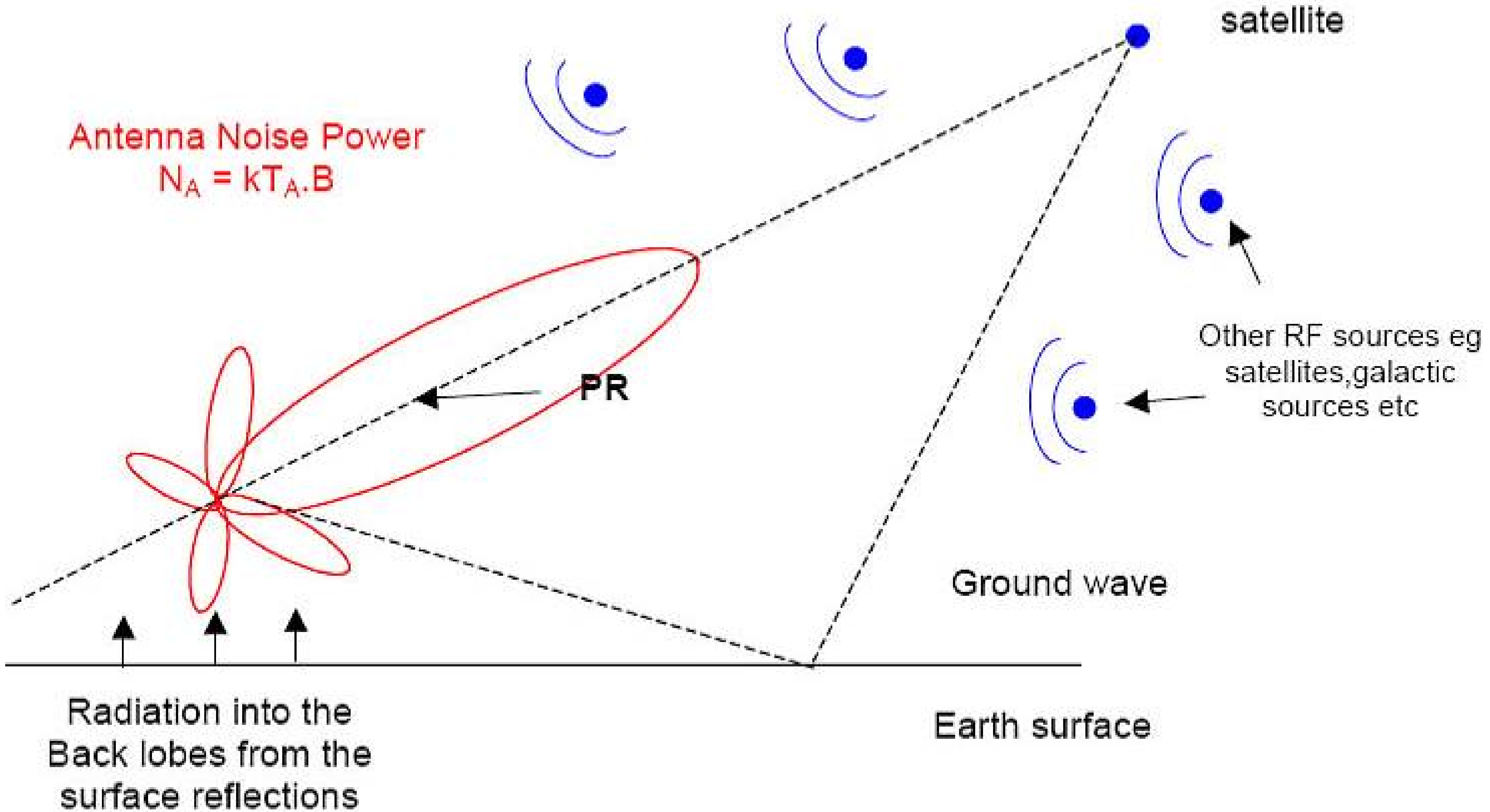
The link attenuation α in dB is given by

$$\alpha = 10\log\left(\frac{P_T}{P_R}\right) = 10\log\left(\frac{4\pi R}{\lambda}\right)^2\left(\frac{1}{G_T G_R}\right)$$

$$= 20\log\left(\frac{4\pi R}{\lambda}\right) - G_T[dB] - G_R[dB]$$

The first term is called the *free space loss* - due to the *spreading* of the radiation, not absorption.

Antenna Noise Temperature T_A due to other source noises including galactic and other satts,



Ministry of Information and Communications Government of Nepal

International Telecommunication Union

Ministry of Communications Government of Israel

Ministry of Foreign Affairs MASHAV-Center for International Cooperation Government of Israel

Propagation

Far-Field, Near-Field (Struzak)

- Near-field region:
  - Angular distribution of energy depends on distance from the antenna;
  - Reactive field components dominate (L, C)
- Far-field region:
  - Angular distribution of energy is independent on distance;
  - Radiating field component dominates (R)

Free space Loss

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

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

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

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

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

$$E_0 = \frac{\sqrt{30\cdot P_t}}{d}$$

Power Transfer in Free Space (Struzak)

$$P_R = PFD \cdot A_e$$

$$= \left(\frac{G_T P_T}{4\pi r^2}\right)\left(\frac{\lambda^2 G_R}{4\pi}\right)$$

$$= P_T G_T G_R \left(\frac{\lambda}{4\pi r}\right)^2$$

- λ: wavelength [m]
- P_R: power available at the receiving antenna
- P_T: power delivered to the transmitting antenna
- G_R: gain of the transmitting antenna in the direction of the receiving antenna
- G_T: gain of the receiving antenna in the direction of the transmitting antenna
- Matched polarizations

Transmission loss due to free-space

$$L_{bfs} = 32.44 + 20\log f\ (MHz) + 20\log d\ \ (km)\ \text{dB}$$

- Free space field strength calculation for broadcasting signals

$$E = 76.9 + P - 20 \log d + H + V$$

- where:
- *E* : field strength (dB(µV/m)) of the broadcasting signal
- *P* : maximum e.r.p. (dBW) of broadcasting station
- *d* : slant path distance (km) (see definition in Annex 4)
- *H* : h.r.p. correction (dB)
- *V* : v.r.p. correction (dB).

Radar frees basic transmission loss

$$P_{TARGET} = PFD \cdot A_e = \left(\frac{G_T P_T}{4\pi d^2}\right) \cdot \sigma$$

$$P_{RADAR} = \left(\frac{G_T P_T}{4\pi d^2}\right) \bullet \sigma \left(\frac{\lambda^2 G_R}{4\pi d^2}\right) = P_{Transmit} G^2 \bullet \sigma \bullet \left(\frac{\lambda}{4\pi d^2}\right)^2$$

$PL = 103.4 + 20 \log f + 40 \log d - 10 \log \sigma$ dB

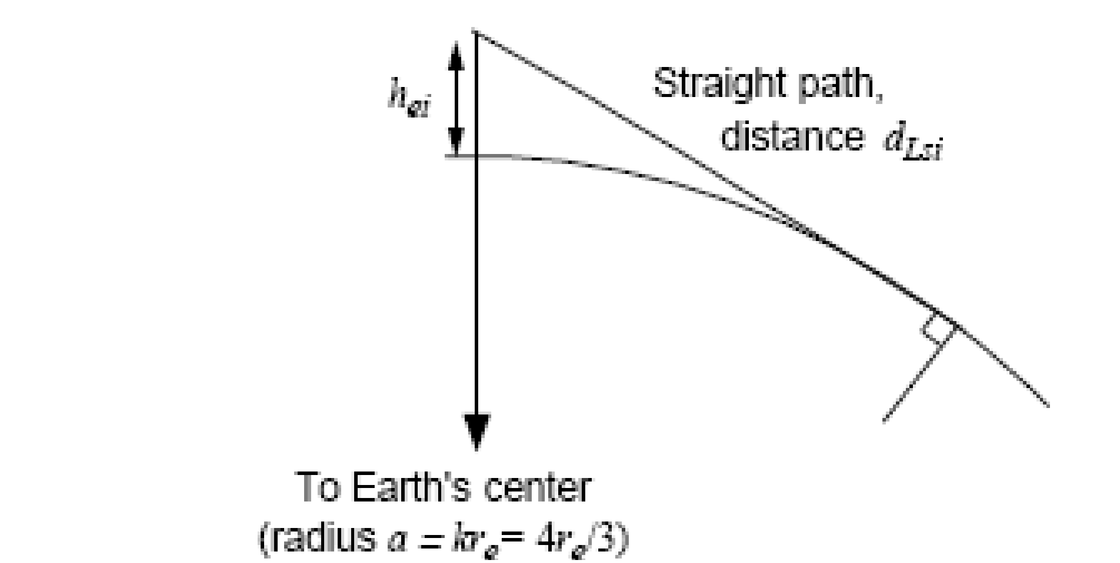
σ: radar target cross-section (m^2) *d*: distance from the radar to the target (km)
f : frequency of the system (MHz)

Elements Influencing Propagation Loss P.1812

- *line-of-sight*
- *diffraction* (embracing smooth-Earth, irregular terrain and sub-path cases)
- *tropospheric scatter*
- *anomalous propagation* (ducting and layer reflection/refraction)
- *height-gain variation in clutter*
- *location variability*
- *building entry losses.*
- *Earth Radius* $=6371 \cdot k50$

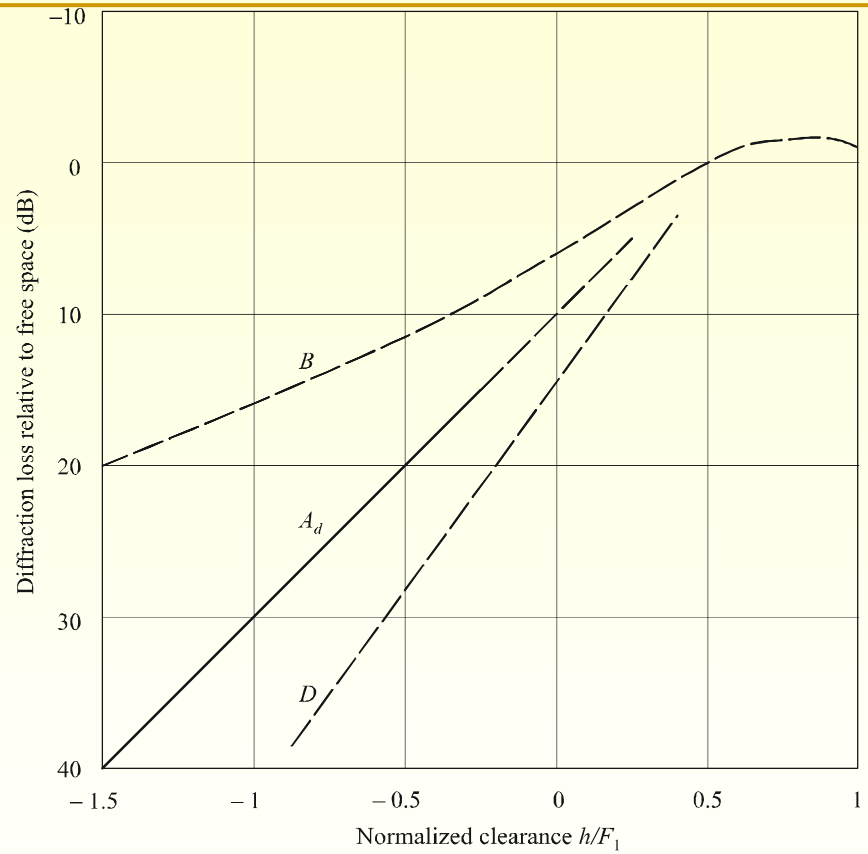
- F_1 is the radius of the first Fresnel ellipsoid
- *f* : frequency (GHz); *d* : path length (km)
- d_1 and d_2 :distances (km) from the terminals to the path obstruction.

$$F_1 = 17.3\sqrt{\frac{d_1\, d_2}{f d}} \ \text{m}$$



$$d_{Lsi} = \sqrt{(a + h_{ei})^2 - a^2} \approx \sqrt{2ah_{ei}}$$

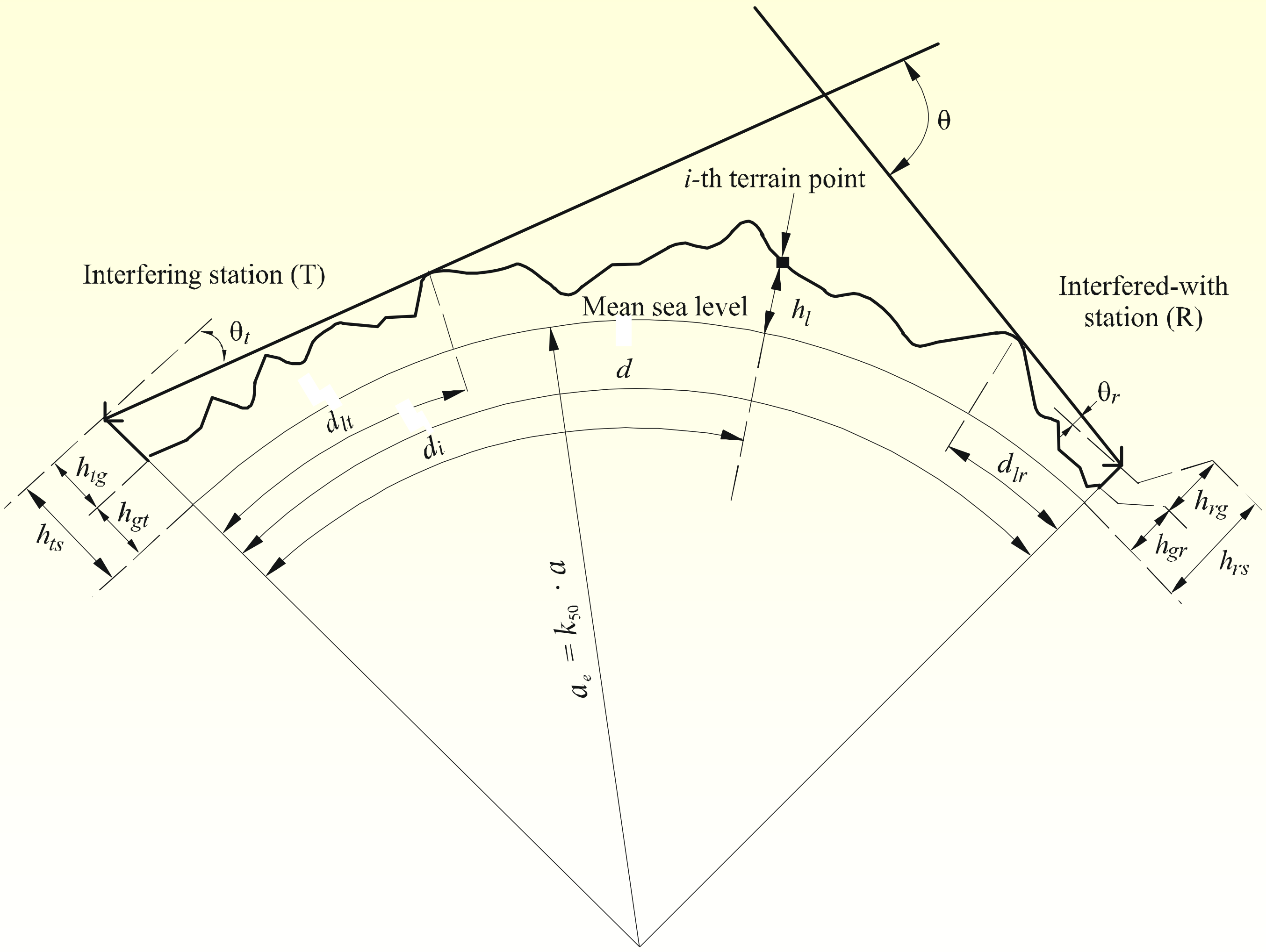
Diffraction loss for obstructed LoS µwave radio paths, P.530



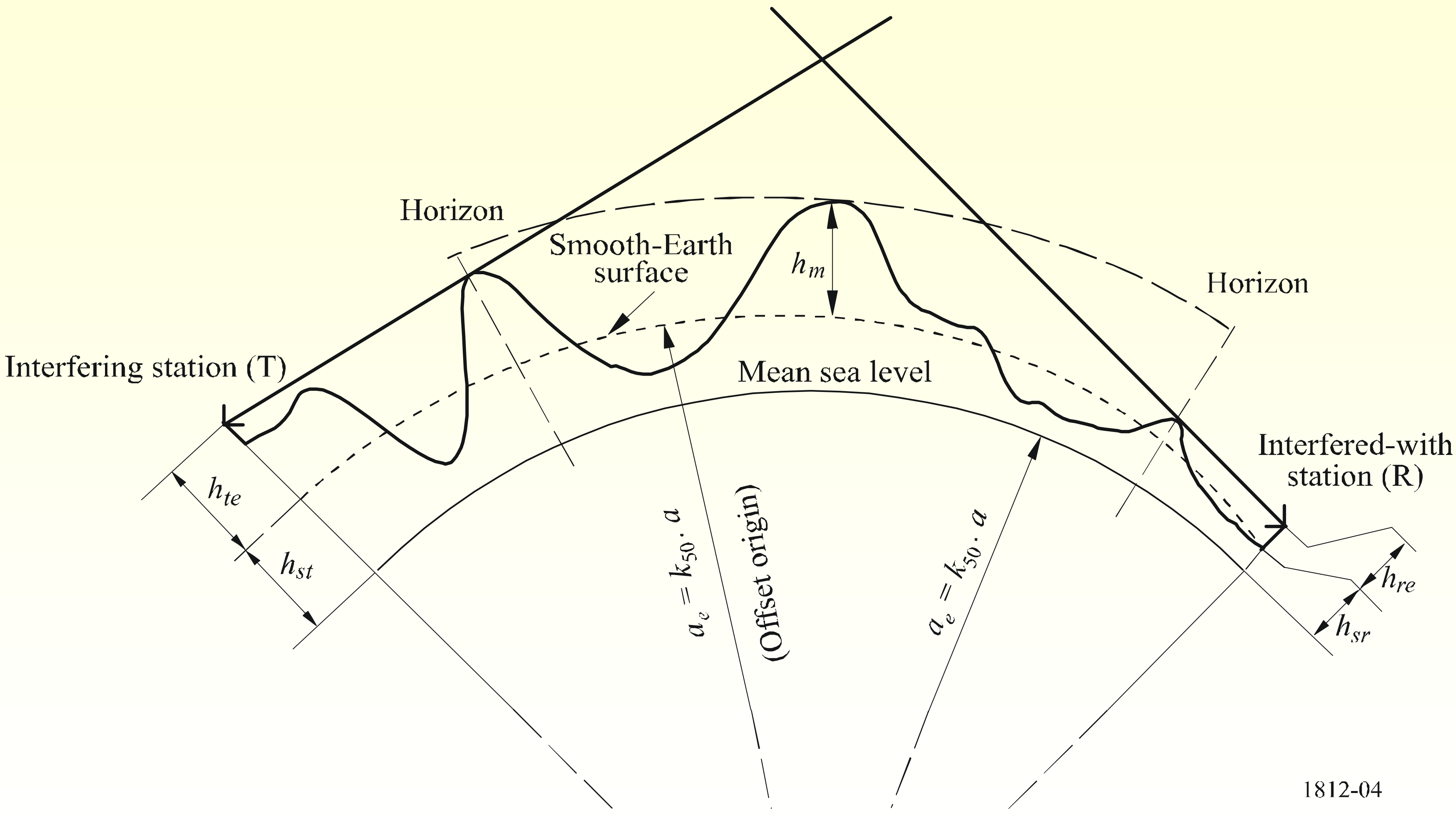
B: theoretical knife-edge loss curve
D: theoretical smooth spherical Earth loss curve, at 6.5 GHz and k_e = 4/3
A_d: empirical diffraction loss based on equation (2) for intermediate terrain
h: amount by which the radio path clears the Earth's surface
F_1: radius of the first Fresnel zone

0530-01

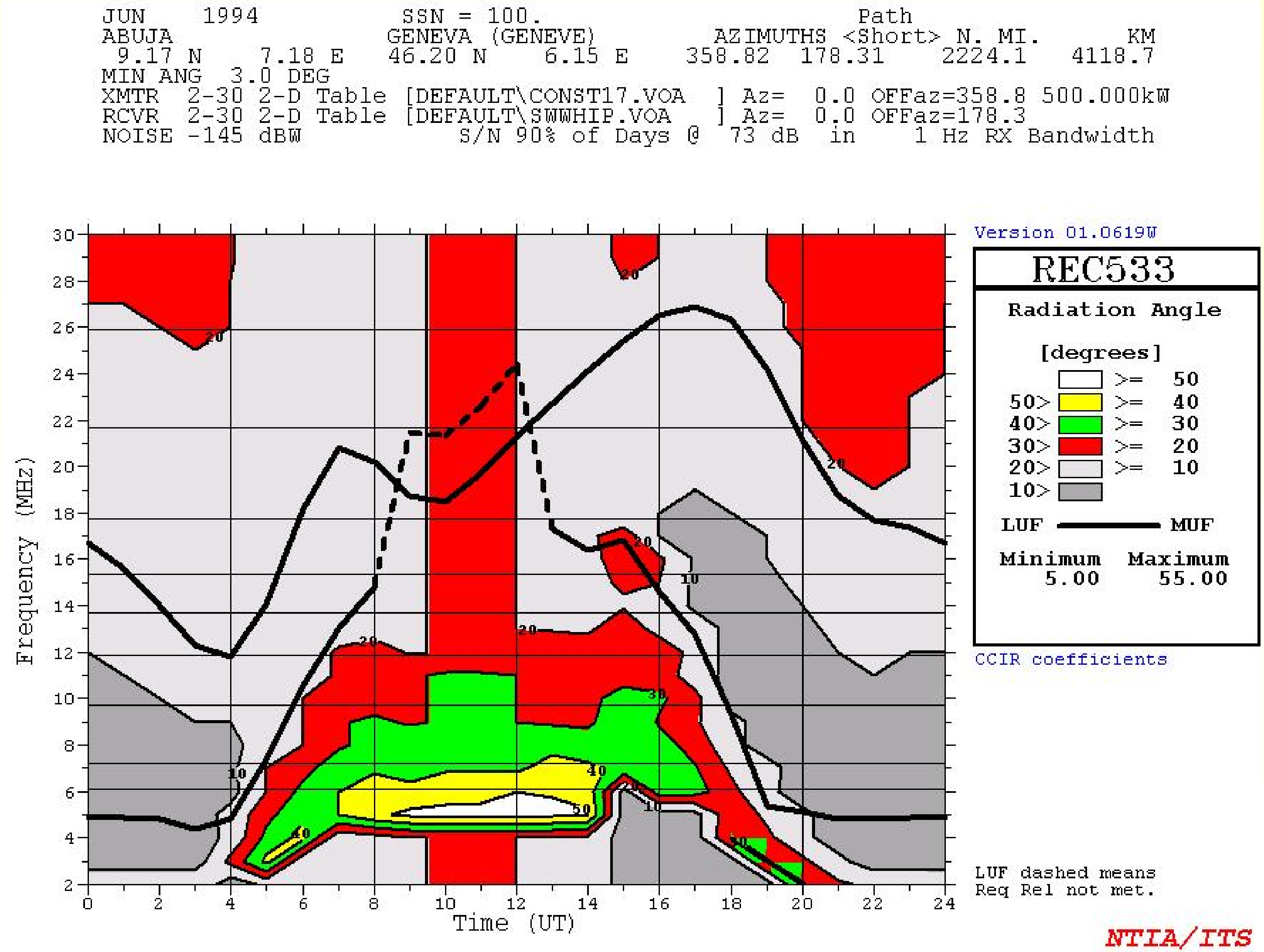
Example of trans-horizon path profile, P. 1812



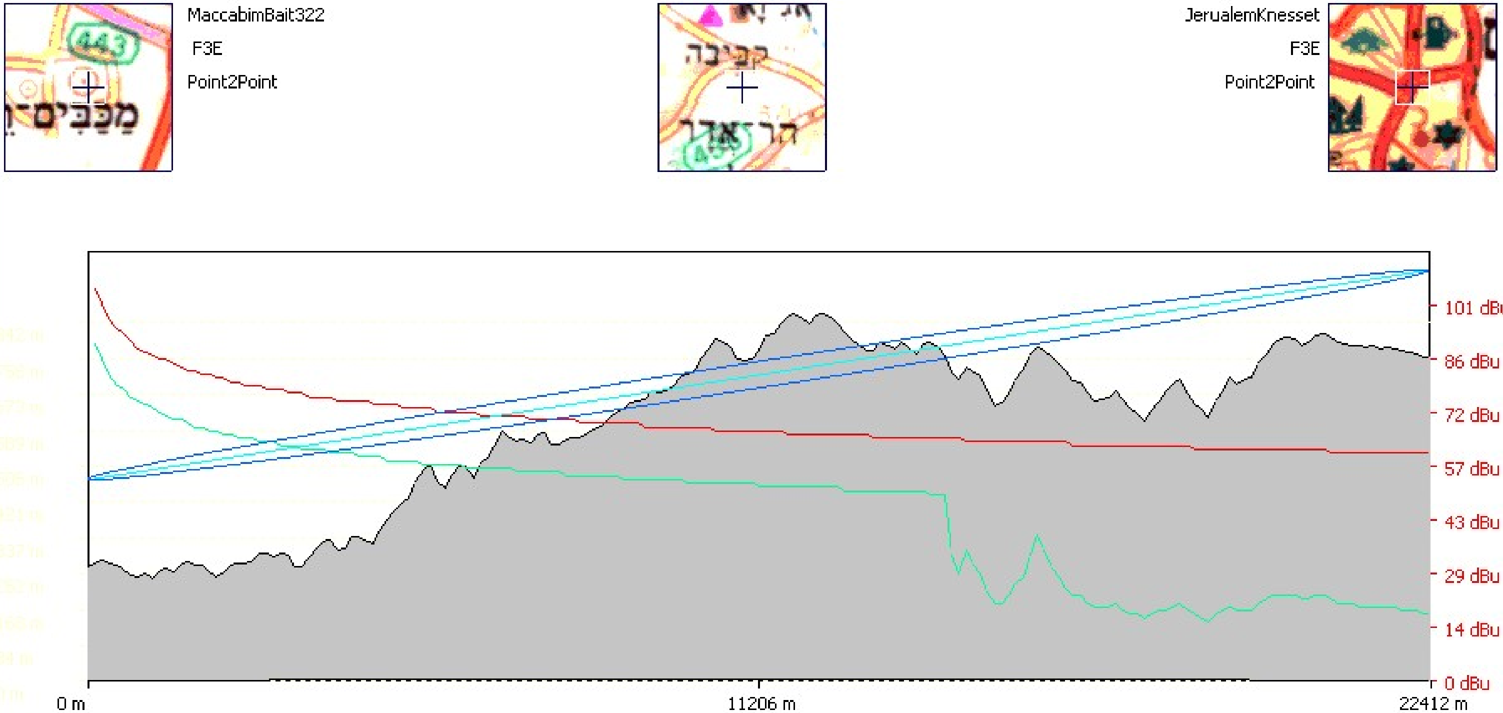
Example of the smooth-earth surface and terrain roughness parameter, P.1812



HF Propagation; Abuja-Geneva, IONCAP



Profile Maccabim-Jerusalem



Altitude - Tx: 271 meters, Rx: 760 meters

Antennas - Tx: 200.00 meters, Rx: 200.00 meters, H1: -139.04(G) -89.31(W) -70.42 (Oku)

FSR: 18.2 dBμV/m, -117.7 dBm (gain=17.00) - FS: 61 dBμV/m, Model att: 3.8 dB - Rx ant: 10.53 dB - IRF+XPD: 0 dB

EIRP (max): 20.04749 Watts , 13.02 dBW 43.021 dBm

FREQUENCY: 1800.00000 Mhz - Radiated power: 1.77499 Watts - Losses: 152.9 dB

Deygout - Attenuation: 28.3 dB - Ground reflections: 0.0 dB - Clutter: 0.0 dB

Distance: 22416 meters - Atmospheric fade margin (0.1 %): 1.87 dB / S2=25.00(*)

Tx: 35.01469 31.53380 271 4DMS

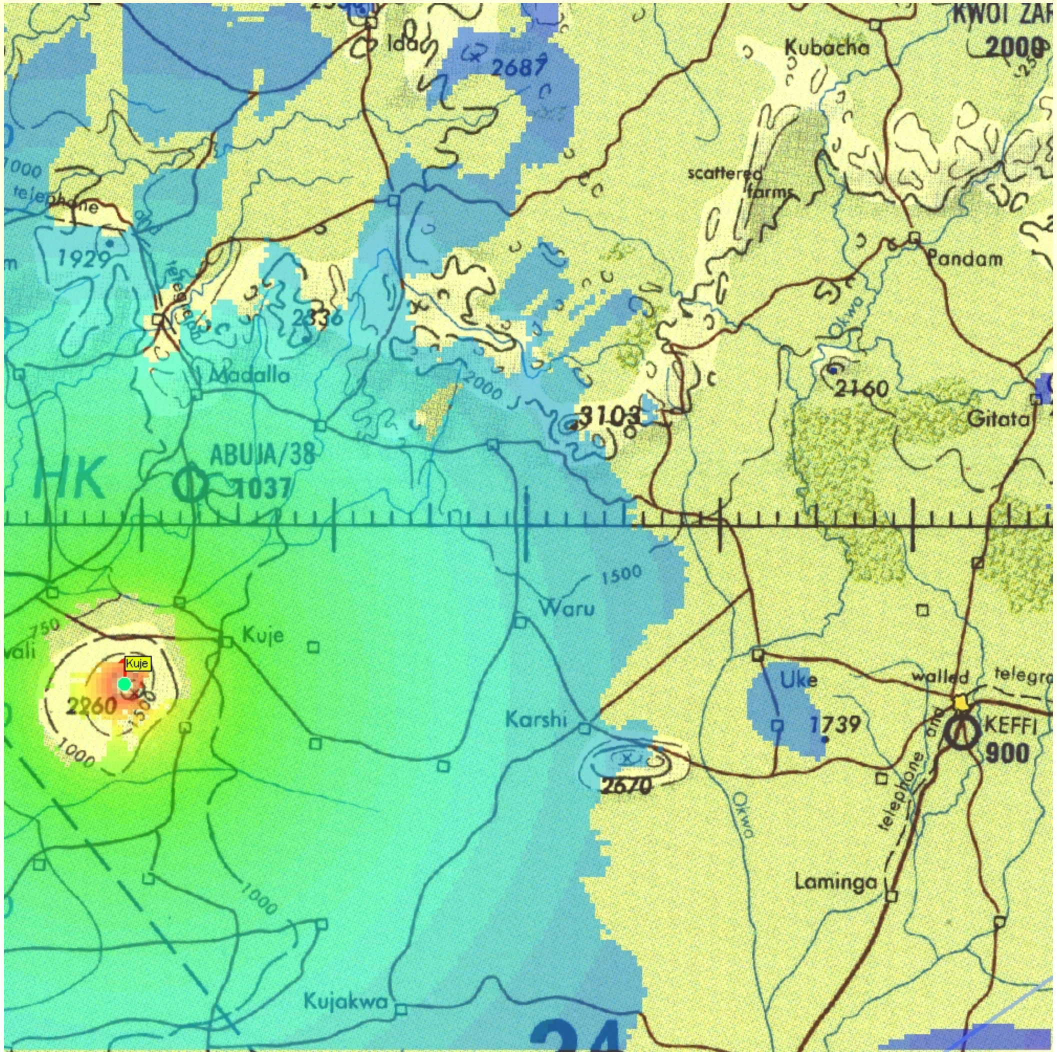
Rx: 35.13442 31.47024 760 4DMS

V-angle: 1.17°, H-angle: 122.98° - loss: 10.53 dB - FSL: 125 dBi

1st 1/2 ellips.: 30.56 m - Earth radius: 8500 km (land) 8500 km (sea) - Rain att.: 0 dB, Gaz. att.: 0.0000 dB

Clutter
terrain
free space

Coverage of an FM transmitter



Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il

Ministry of Information and Communications Government of Nepal

International Telecommunication Union

Ministry of Communications Government of Israel

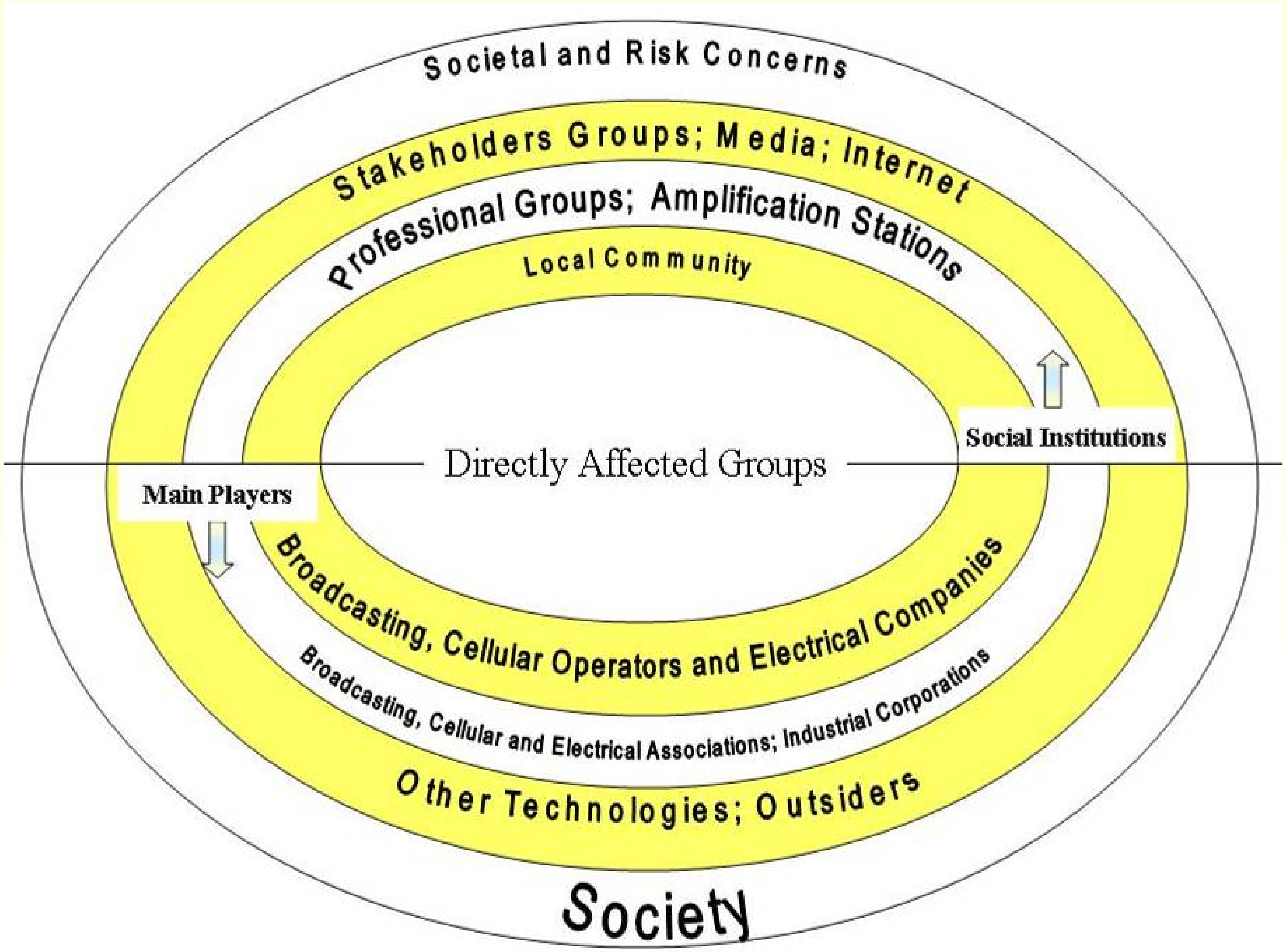
Ministry of Foreign Affairs MASHAV-Center for International Cooperation Government of Israel

RF Human Hazards

Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il

Ripple effects amplifying the Risk, Mazar Thesis

http://www.moc.gov.il/new/documents/frequences/MazarThesisOct08.pdf



Physical Quantities and Units, Mazar Thesis

http://www.moc.gov.il/new/documents/frequences/MazarThesisOct08.pdf

Quantity	Symbol	Unit	Symbol
Frequency	f	Hertz	Hz
Electric field strength	E	Volt per metre	V/m
Magnetic field strength	H	Ampere per metre	A/m
Magnetic flux density	B	Tesla	T
		Gauss	G
Power	P	Watts	W
Specific Absorption Rate	SAR	Watt per kilogram or milliWatt per gram	W/kg or mW/g
Power density or power flux density	S	Watt per square metre	W/m^2
		mWatt per square cm	mW/cm^2

Magnetic flux density is commonly measured in units of microtesla (µT) or milligauss (mG); 1 µT = 10 mG.

ICNIRP/EC, FCC, IEEE reference levels for exposure, Mazar Thesis http://www.moc.gov.il/new/documents/frequences/MazarThesisOct08.pdf

ICNIRP http://www.icnirp.de/documents/emfgdl.pdf and EC reference levels for exposure

Frequency range	Electric field strength (V/m)	Magnetic field strength (A/m)	Equivalent plane wave power density S_{eq} (W/m^2)	Magnetic Flux Density (μT), B
25-800 Hz	250/f	4/f	-	5,000/f
400-2000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	f/200	$0.0046 f^{½}$
2-300 GHz	61	0.16	10	0.2

FCC exposure limits (FCC 2001:67)

Frequency Range MHz	Electric Field (E) (V/m)	Magnetic Field H (A/m)	Power Density (S) (mW/cm^2)
30-300	27.5	0.073	0.2
300-1500	--	--	f/1500
1500-100,000	--	--	1

The new IEEE permissible exposure (IEEE Std C95.1-2005:25, table 9)

Frequency Range MHz	Electric Field (E) (V/m)	Magnetic Field H (A/m)	RMS power density (S) (W/m^2)
100-400	27.5	0.073	2
400-2000	--	--	f/200
2000-5000	--	--	10

Comparing or exposure, Mazar Thesis

http://www.moc.gov.il/new/documents/frequences/MazarThesisOct08.pdf

Derived levels, power density (W/m²): WHO (International), UK, USA

Frequency range	ICNIRP	Old NRPB (UK)	ANSI (USA)
	General Public	Adults and Children	General Public
400 - 1,550 MHz	f /200	$41 \times 10^{-6} f^{2}$	f /150
1,550 - 2,000 MHz	f /200	100	f /150

Maximal power from handsets: Specific Absorption Rate, SAR (W/kg)

ICNIRP	European Community	FCC- USA
10 MHz–10 GHz; Localised SAR (Head and Trunk)		Portable Devices; General Population/ Uncontrolled
2.0; averaged over 10 g tissue		1.6; averaged over 1g tissue

Countries less tolerant of magnetic risk, with more stringent magnetic thresholds

Country	Magnetic Flux Density relative to ICNIRP
Switzerland	0.01
Italy	0.03 (daily mean, for more than 4 hours); 0.1 (for designed lines)
Slovenia	0.1 (for new installations)
Israel	0.1 (proposed in occupational)
Russia	0.1 (Indoor); 0.5 (Outdoor)
Poland	0.75
Greece	0.8

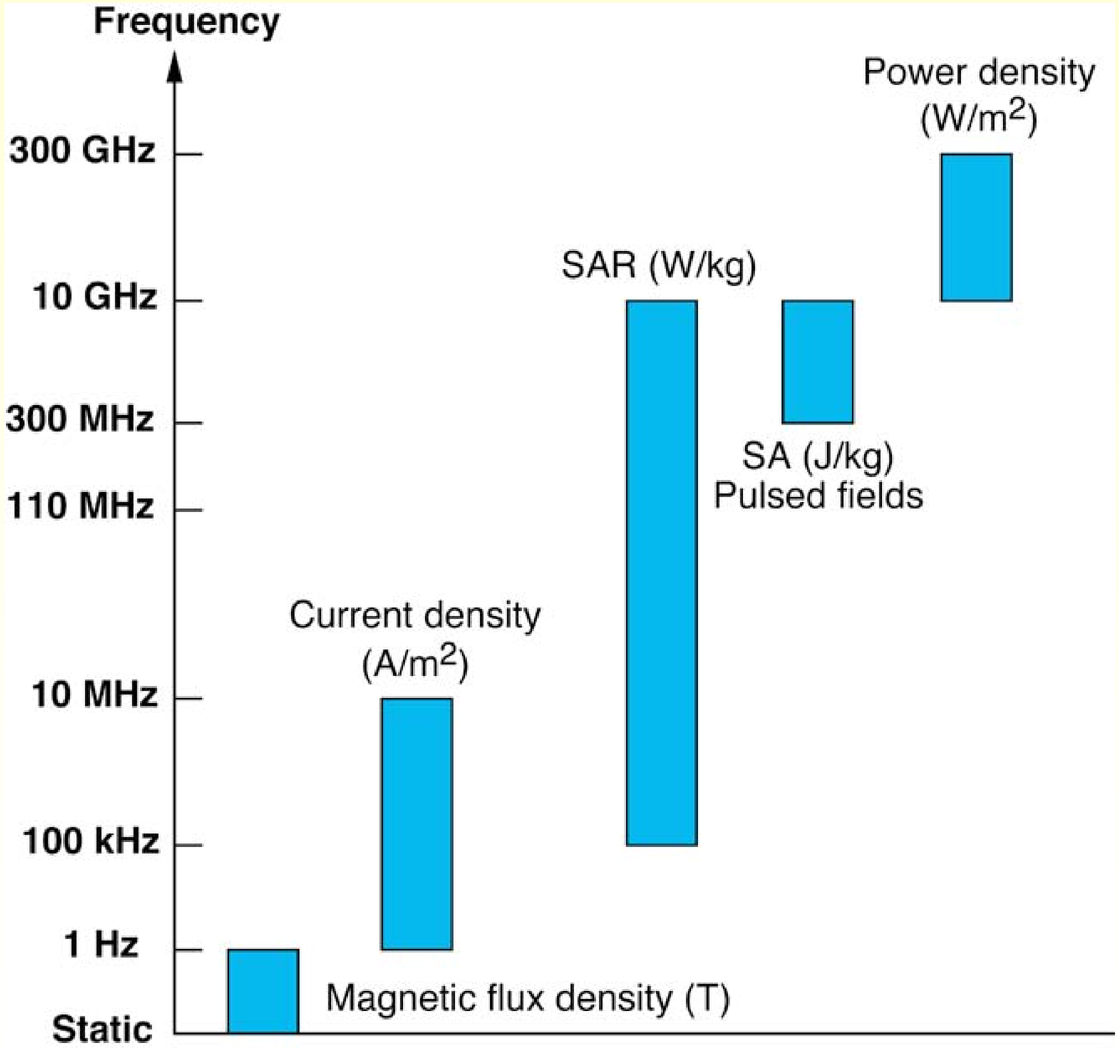
ICNIRP- ESTABLISHED EFFECTS OF EMF

Paolo_Vecchia_i

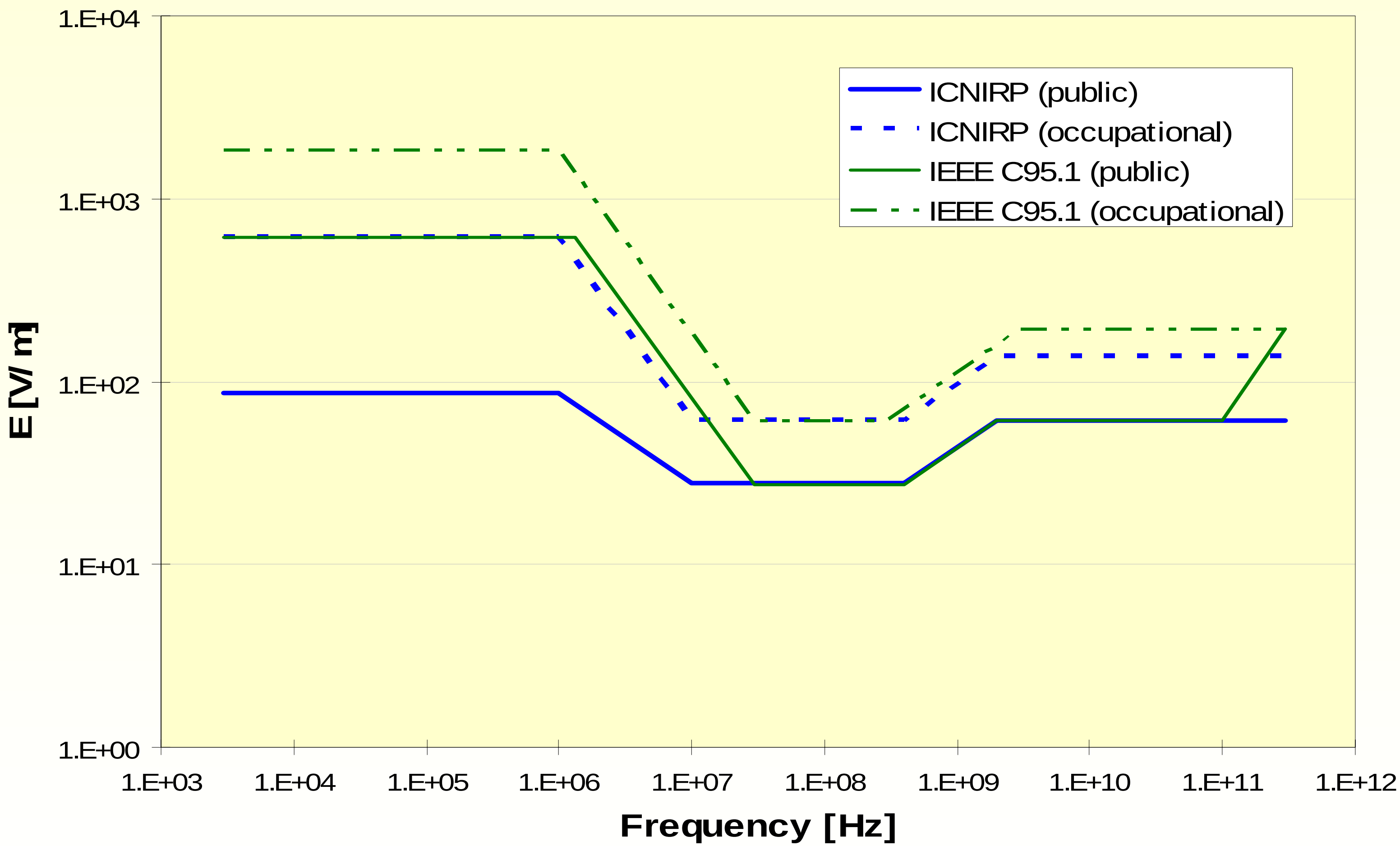
- All effects of EMF that have been established so far are acute in nature
- ELF
- Stimulation of electrically excitable tissues
- RF
- Increase of body temperature (general or local)

Such acute effects occur above given exposure thresholds

Biologically Effective Quantities



ICNIRP vs. IEEE-field limits C_K_Chou_i



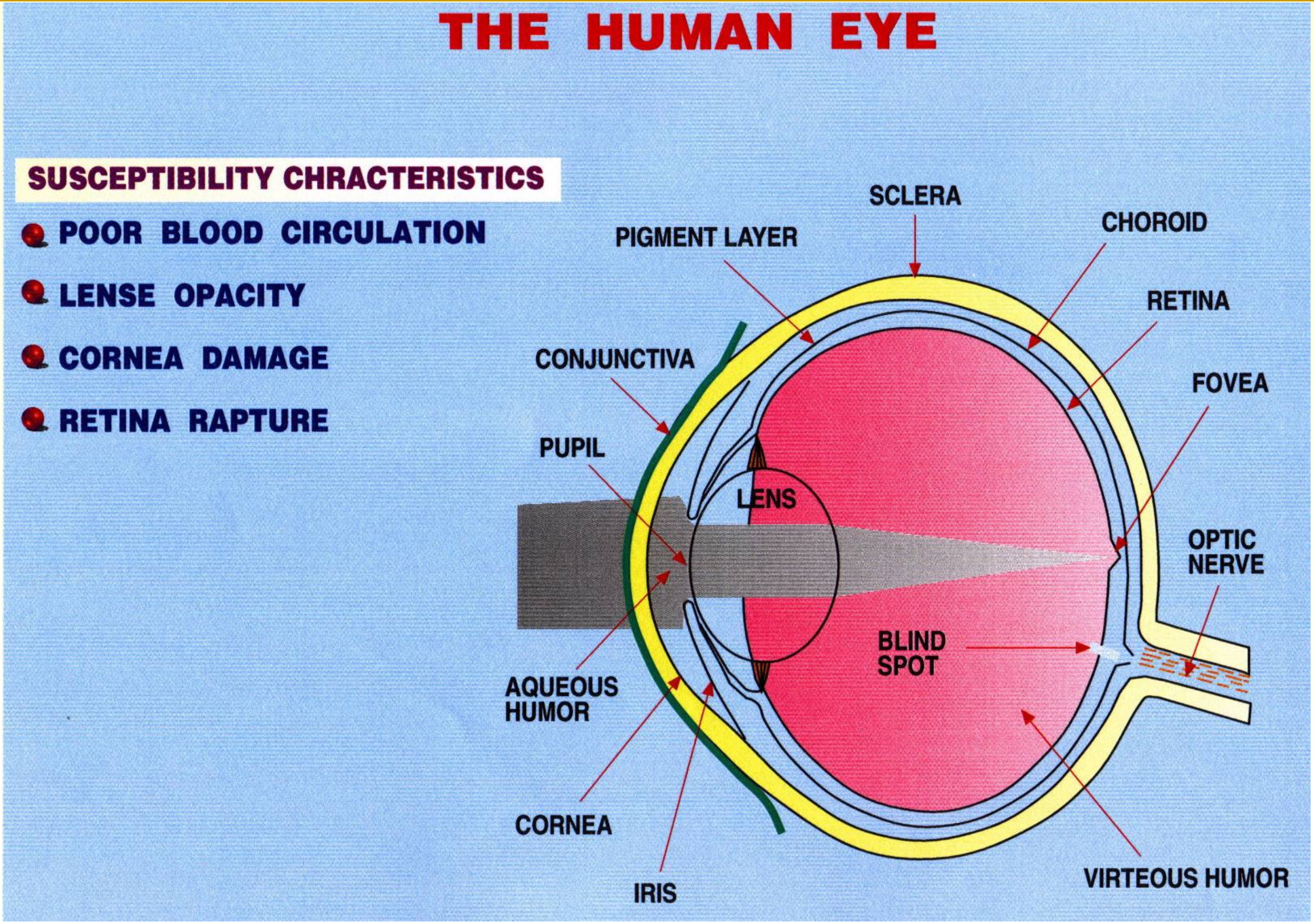
Specific Absorption Rate (SAR) limits for portable wireless devices.

- The SAR is determined from measurements of the E-field (E) in an anatomically-correct phantom model (liquid-filled dielectric shell) of the human head using a robotically-scanned miniature E-field probe.
- The SAR is determined from the relationship between E and the tissue properties, i.e.,

$$SAR = \sigma|E^2|/\rho$$

where σ is the liquid conductivity and ρ is the density

The Human Eye, Moshe Netzer



Ministry of Information and Communications Government of Nepal

International Telecommunication Union

Ministry of Communications Government of Israel

Ministry of Foreign Affairs MASHAV-Center for International Cooperation Government of Israel

RF Regulation (exclusive views of the author)

Dr. Haim Mazar (Madjar) mazar@ties.itu.int , mazarh@moc.gov.il

Items which need to be regulated

1. RF allocations to radio services
2. Assignment of licence and RF to Tx Stations
3. Type approval of equipment; not in CE countries
4. Fee collection
5. Notifying ITU to the Main International Frequency Register (MIFR)
6. Coordination with neighbour countries (no borders to the electromagnetic waves)
7. External relations: toward regional commissions (CEPT) for European Countries) and International (ITU)

Aims of the national Spectrum Management

- Protect the licensed channels
- Solve & avoid interference
- Design long and short range RF spectrum
- Support Engineering: Propagation, DTM
- Assist in solving Near-field, Co-site, Co-ship, Co-a/c
- Exercise and simulate for dense RF environment
- Advance new RF technologies; Participate in R&D of new RF systems
- Coordinate with other Administrations
- Consult all stake holders and interest orgs

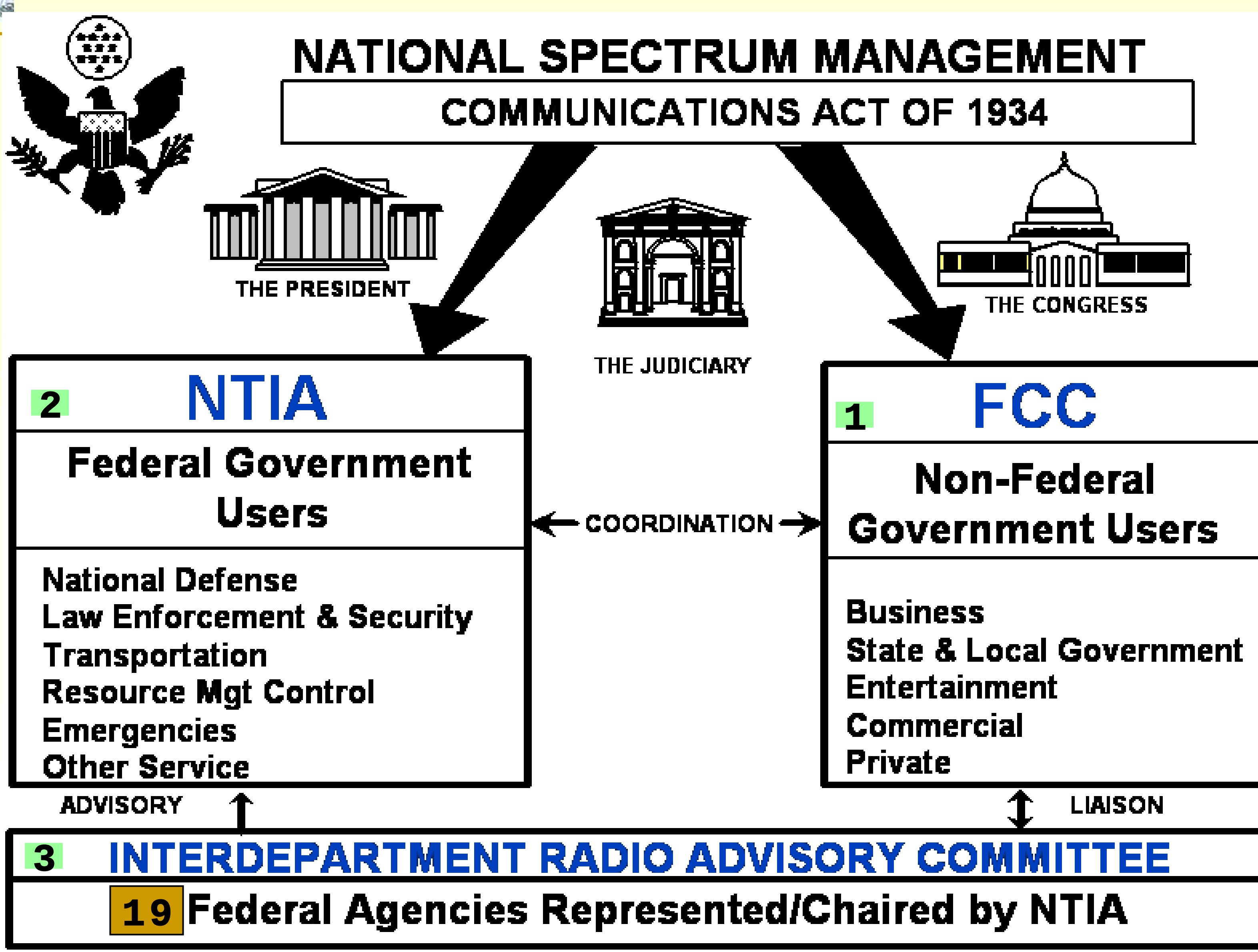
RF Spectrum Management in Developed Countries

- Wealthy countries are similar *All happy families are alike (so begins Leo Tolstoy's Anna Karenina)*
- 'Government of the people, by the people, for the people' *A. Lincoln 'Gettysburg Address' (19.11.1863)*
- Optimal use of RF
- Fair, Objective, Transparent, Nondiscriminatory, Proportionate
- Flexible, Dynamic
- Privatisation, Liberalisation, Competition
- Deregulation; Minimum Intervention (learn from Internet); Light Touch
- Neutral Technology
- More RF Spectrum and more RF power for Unlicensed (unprotected devices)
- Exempt Receivers from any licensing
- Take reasonable risks
- All RF operators may pay fees for the RF spectrum

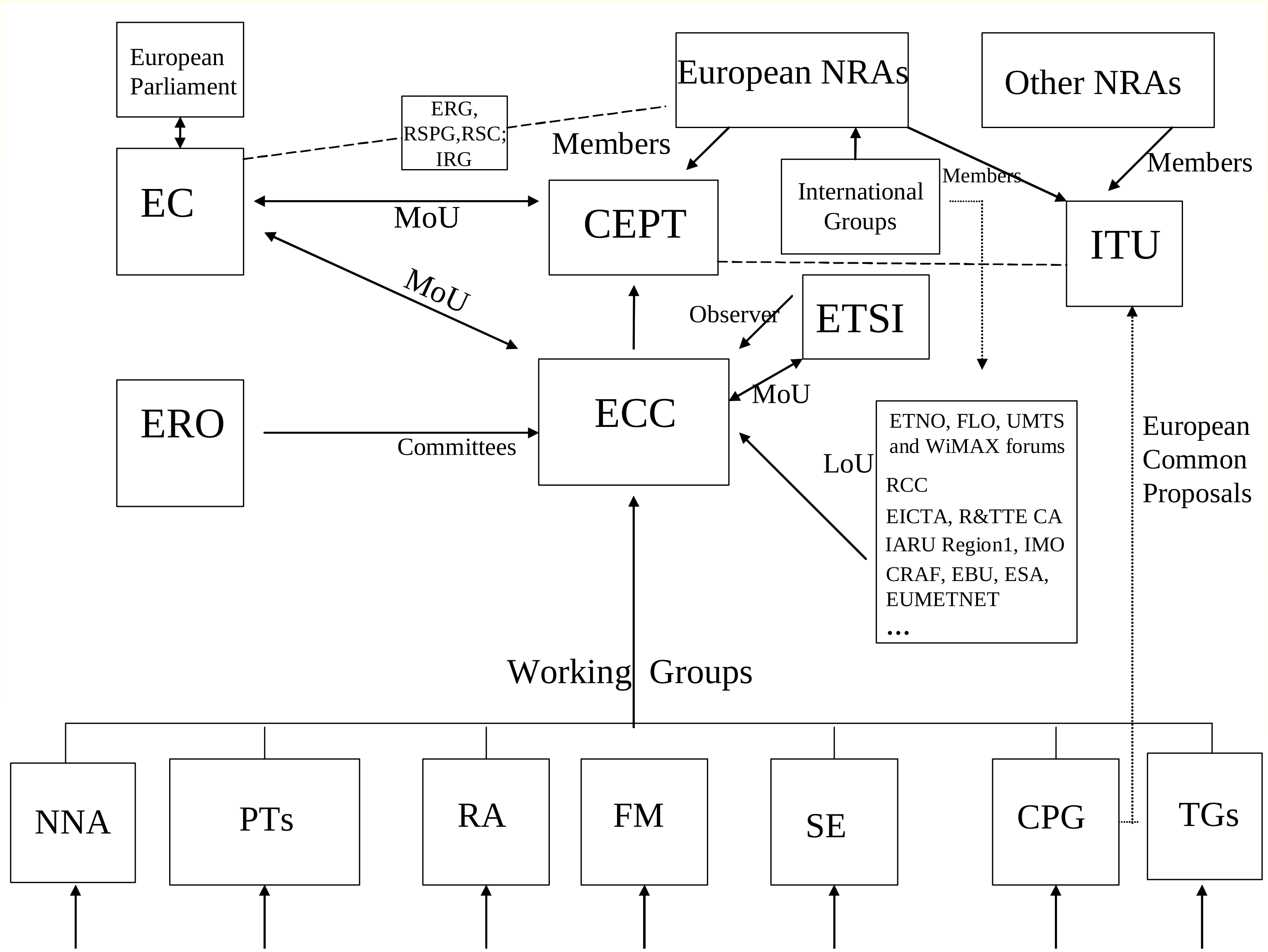
FCC and NTIA differences; Bill Luther

- FCC is an independent regulatory agency, but the U.S. Congress has oversight and controls the FCC budget
- The U.S. president delegates government spectrum management (SM) responsibilities to NTIA, which acts as telecom advisor to the president
- FCC and NTIA serve different interests
  - Federal laws such as the Communications Act and Administrative Procedure Act (APA) govern the FCC interaction with the public and the management of public resources (RF Spectrum)
  - NTIA only governs federal government operations and is not held to the same laws as the FCC
  - Changes to SM policy in government are not subject to rule making (APA); no notice to private industry is required
  - Private industry can meet with NTIA without filing *Ex Parte* notices

US National Spectrum Management; Bill Luther



The Main Players in European RF regulation



Key of Abbreviations

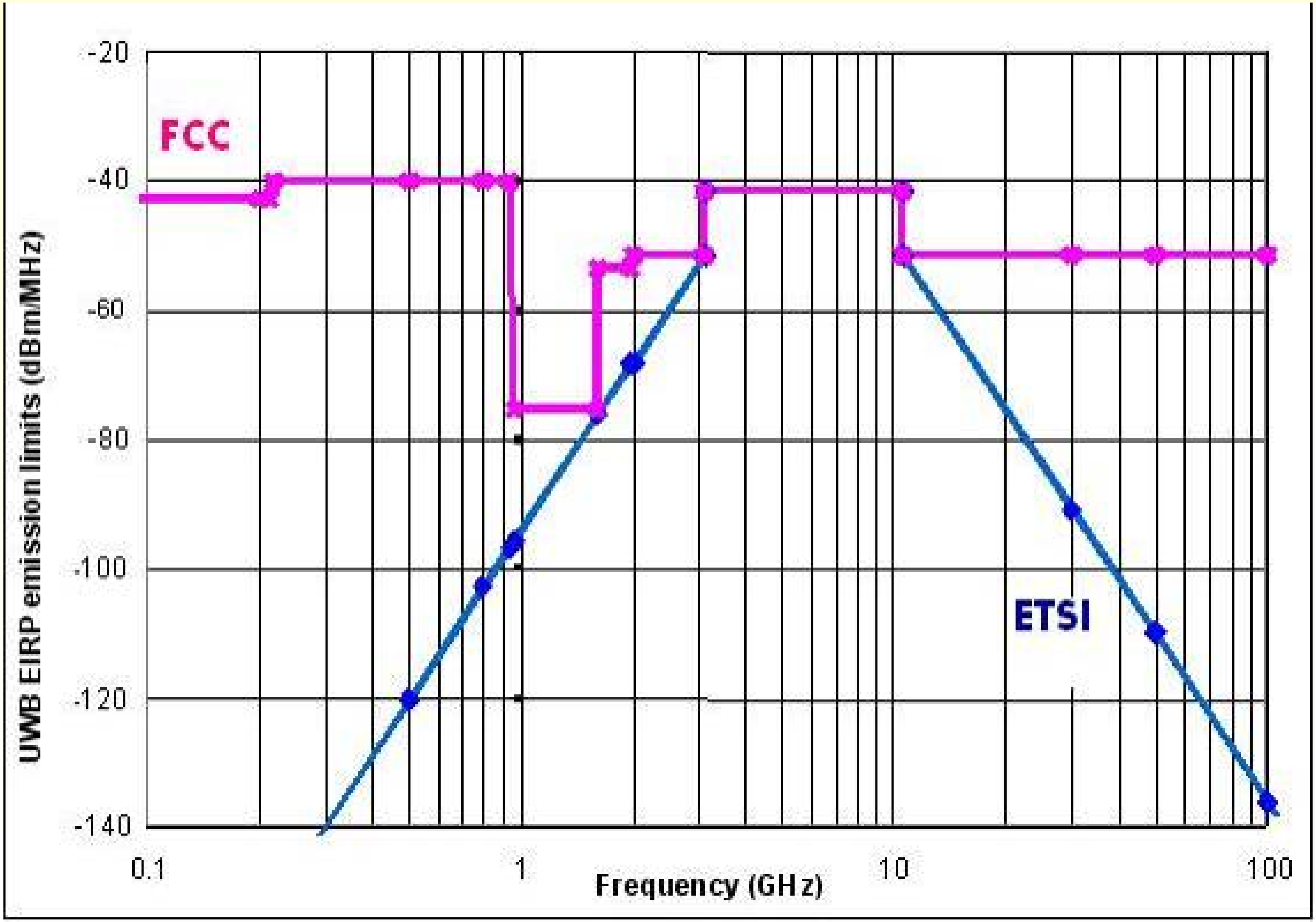
CPG: Conference Preparatory Group (preparations for ITU Conferences); CRAF: Committee on Radio Astronomy Frequencies; EBU: European Broadcasting Union; EC: European Commission; ECC: Electronic Communications Committee (formerly European Radiocommunications Committee ERC); EICTA: European Information 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.

Standards, Thresholds, Regulatory Framework: Europe-N.America

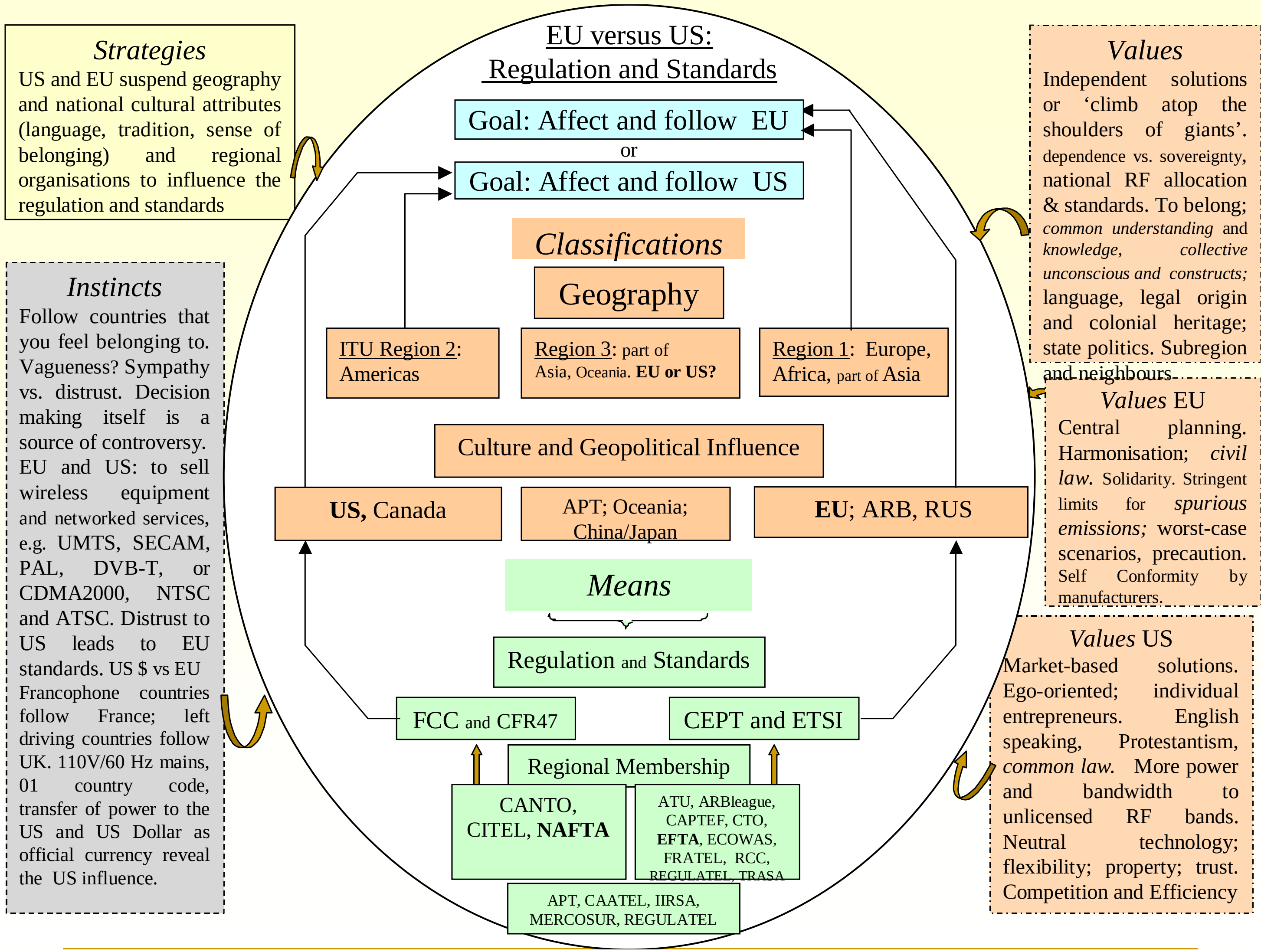
Standard	TV			Cellular standardised	Main Power and TV frames/s	*Spurious Emissions*	*Human Hazards*	
	Analog	Digital	Bandwidth				Base Stations	Handsets
Europe	PAL-SECAM	DVB-T	7-8 MHz	UMTS/ TETRA	50 Hz	Stringent		Flexible
North America	NTSC	ATSC	6 MHz	CDMA2000	60 Hz	Flexible		Stringent

PP10Tables/Standards%20and%20thresholdsEU_US.doc

UWB emissions masks ETSI-FCC



EU versus US; Regulation& Standards



Europe vs the US: Values

1. Independent solutions or ‘climb atop the shoulders of giants’
2. Dependence vs. Sovereignty
3. National RF allocation & standards
4. To belong; *common understanding* and *knowledge*, *collective unconscious and constructs*
5. Language
6. Legal origin and colonial heritage
7. State politics
8. Subregion and neighbours

Values EU and the US

1. EU: Central planning. Harmonisation; *civil law*. Solidarity. Stringent limits for *spurious emissions;* worst-case scenarios, precaution. Self Conformity by manufacturers.
2. USA: Market-based solutions. Ego-oriented; individual entrepreneurs. English speaking, Protestantism, *common law*. More power and bandwidth to unlicensed RF bands. Neutral technology; flexibility; property; trust. Competition and Efficiency.

Strategies

1. US and EU suspend geography and national cultural attributes
2. language, tradition, sense of belonging, clothes, food;
3. regional organisations to influence the regulation and standards

Instincts

1. Follow countries that you feel belonging to.
2. Vagueness? Sympathy vs. distrust.
3. Decision making itself is a source of controversy.
4. EU and US: to sell wireless equipment and networked services, e.g. UMTS, SECAM, PAL, DVB-T, or CDMA2000, NTSC and ATSC.
5. Distrust to US leads to EU standards.
6. US $ vs EU
7. Francophone countries follow France; left driving countries follow UK. 110V/60 Hz mains, 01 country code, transfer of power to the US and US Dollar as official currency reveal the US influence.

Spectrum Control (see ITU-R HB)