



PLANNING OF BROADCASTING SERVICES

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(based on a presentation by Terry O'Leary, EBU)

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COMPARING ANALOGUE & DIGITAL

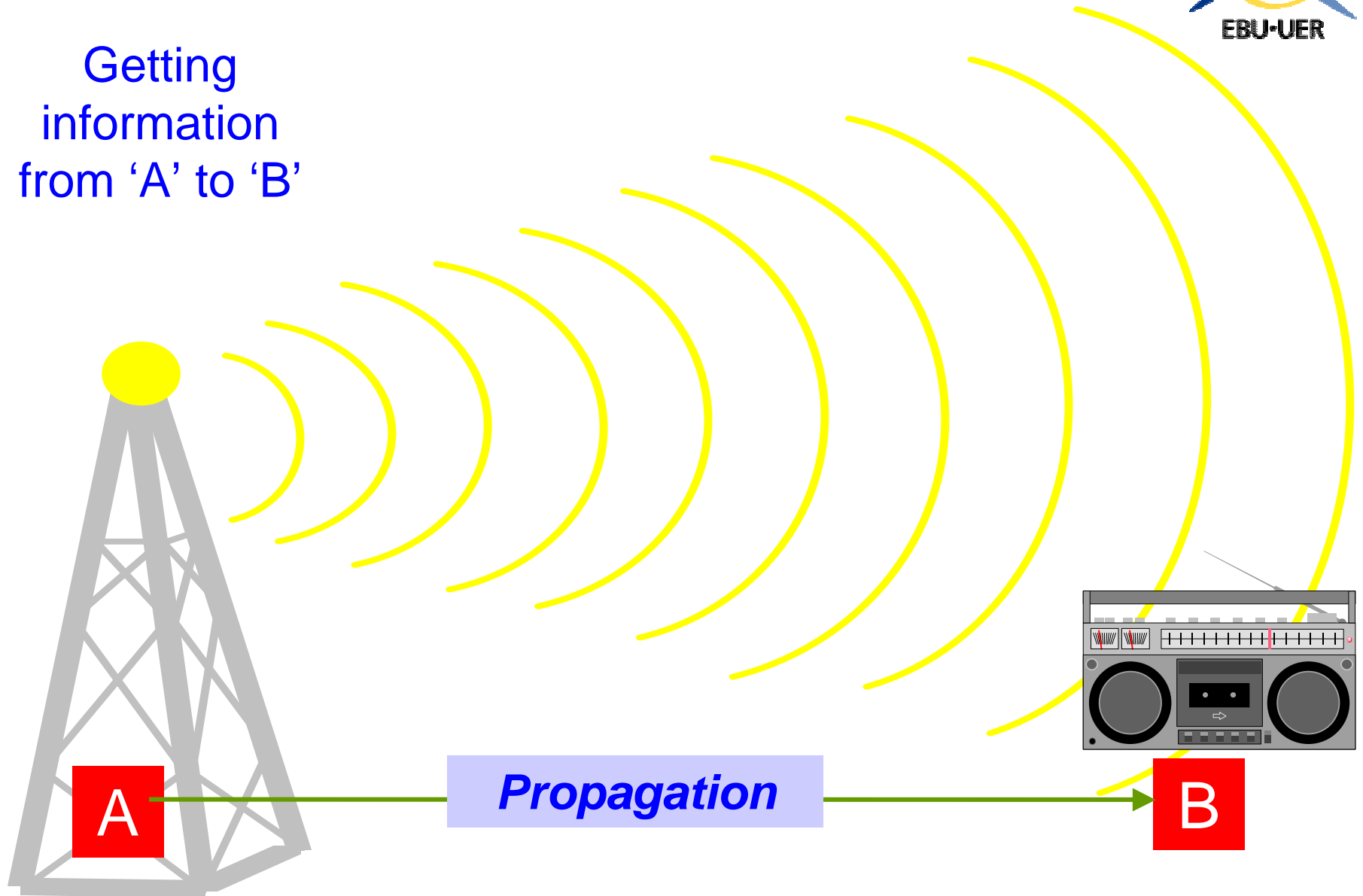


Conventional VHF/FM (narrow band)		<u>ΔdB</u>	Digital T-DAB (wide band)	
S/N	30 - 40 dB	- 20	S/N	10 - 15 dB
PR	30 - 50 dB	- 20	PR	10 - 15 dB
% time	99		% time	99
% location	50	+ 13	% location	99
Rx antenna	10 m (fixed)	+ 10	Rx antenna	1.5m (mobile)
SFN	NO		SFN	YES
Network gain	NO	- 6	Network gain	YES

BROADCASTING



Getting information from 'A' to 'B'



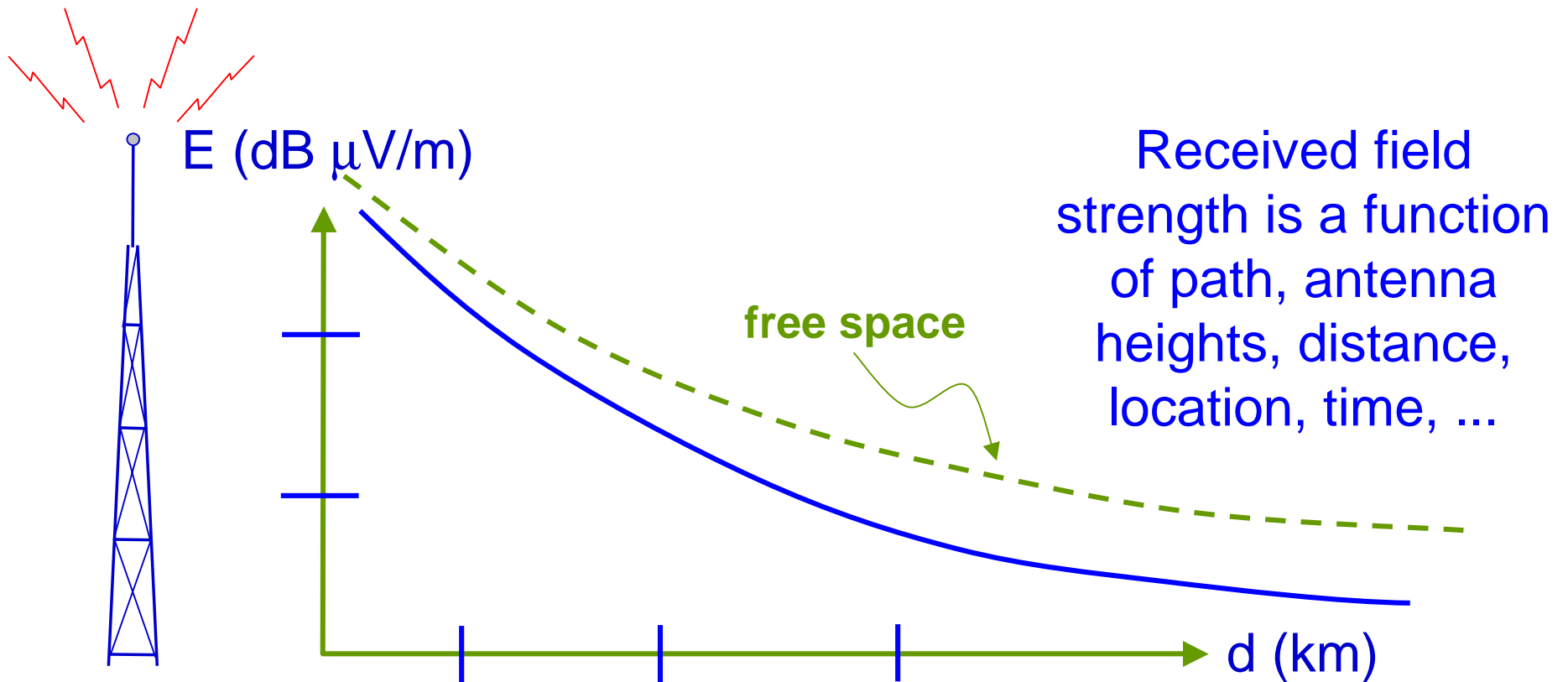
PROPAGATION (A to B)



(Feeder loss)

Free space loss: $\propto 1/d^2$

Path loss: terrain, clutter, diffraction, ...

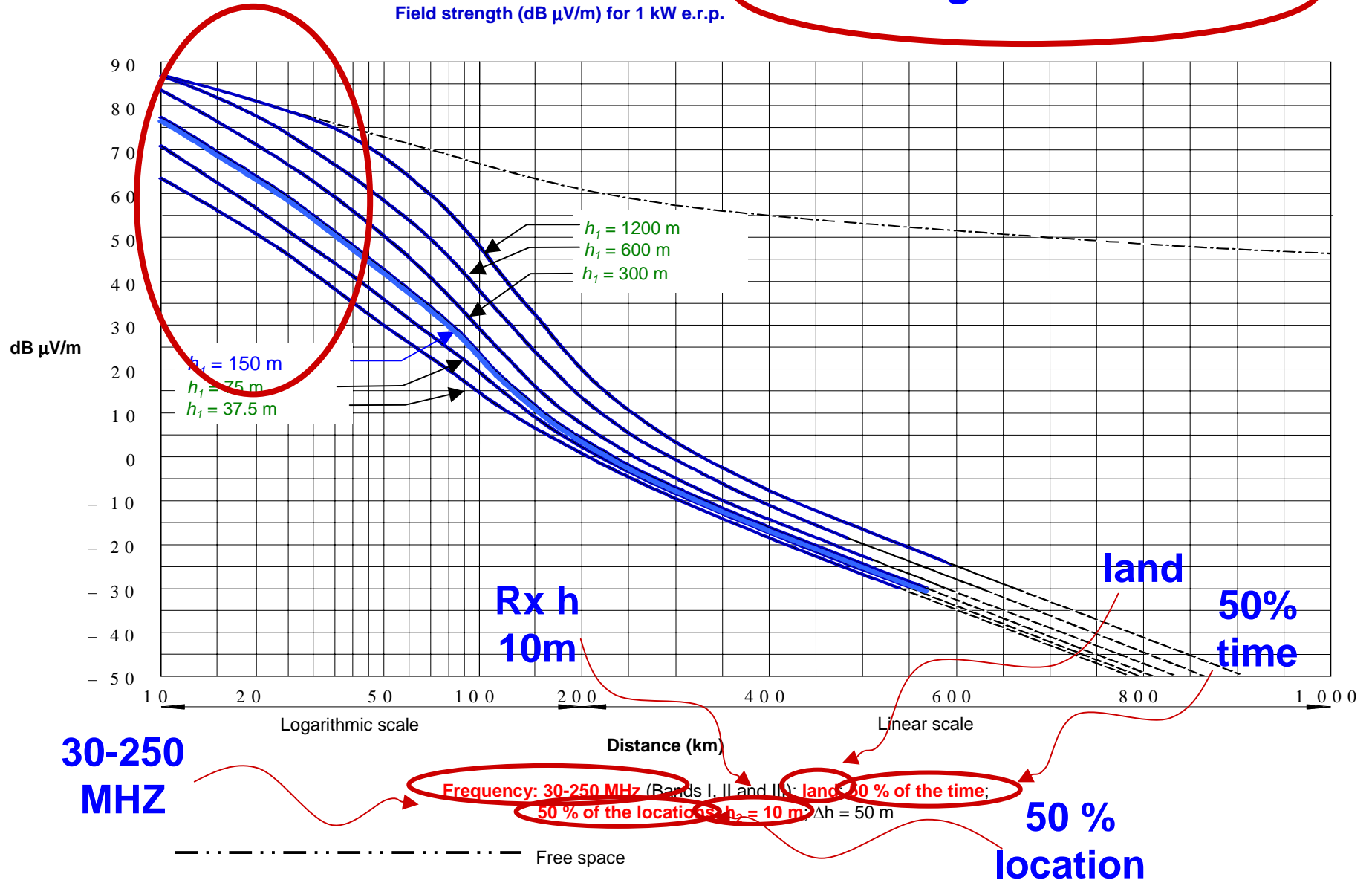


PROPAGATION PREDICTION



Coverage: 50 % time

Field strength (dB $\mu\text{V/m}$) for 1 kW e.r.p.



STATISTICS



Why important?

- rapid failure characteristics of digital systems

EXAMPLE:

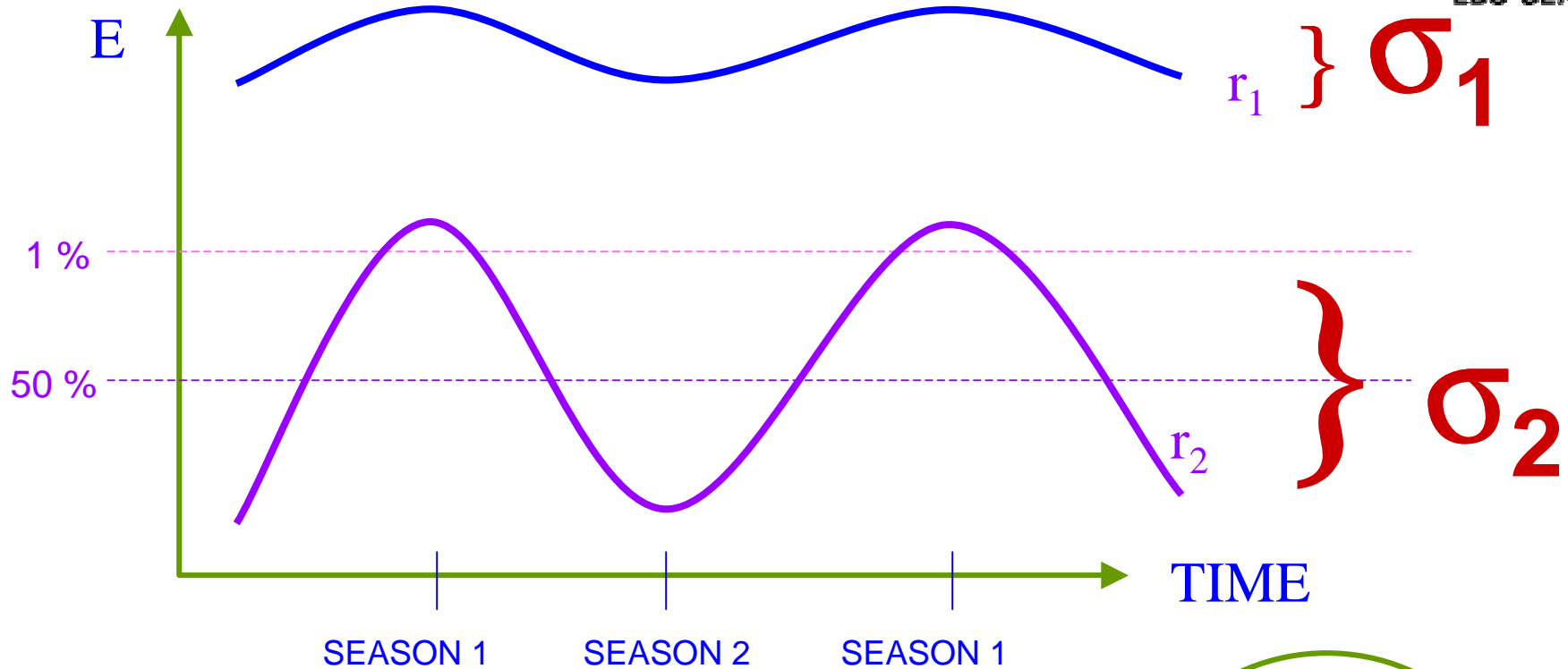
Analogue ('gradual degradation')

Grade 4 → Grade 3 > 10 dB

Digital ('catastrophic degradation')

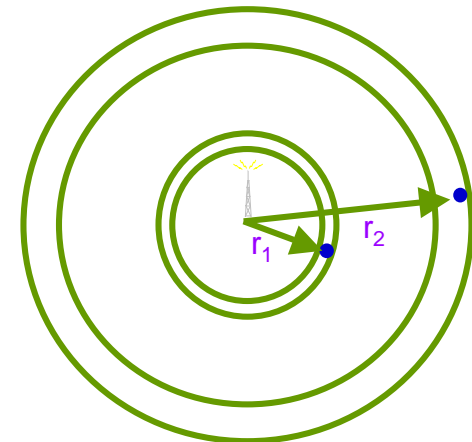
Grade 4 → Grade 1 ~ 2 dB

TIME STATISTICS

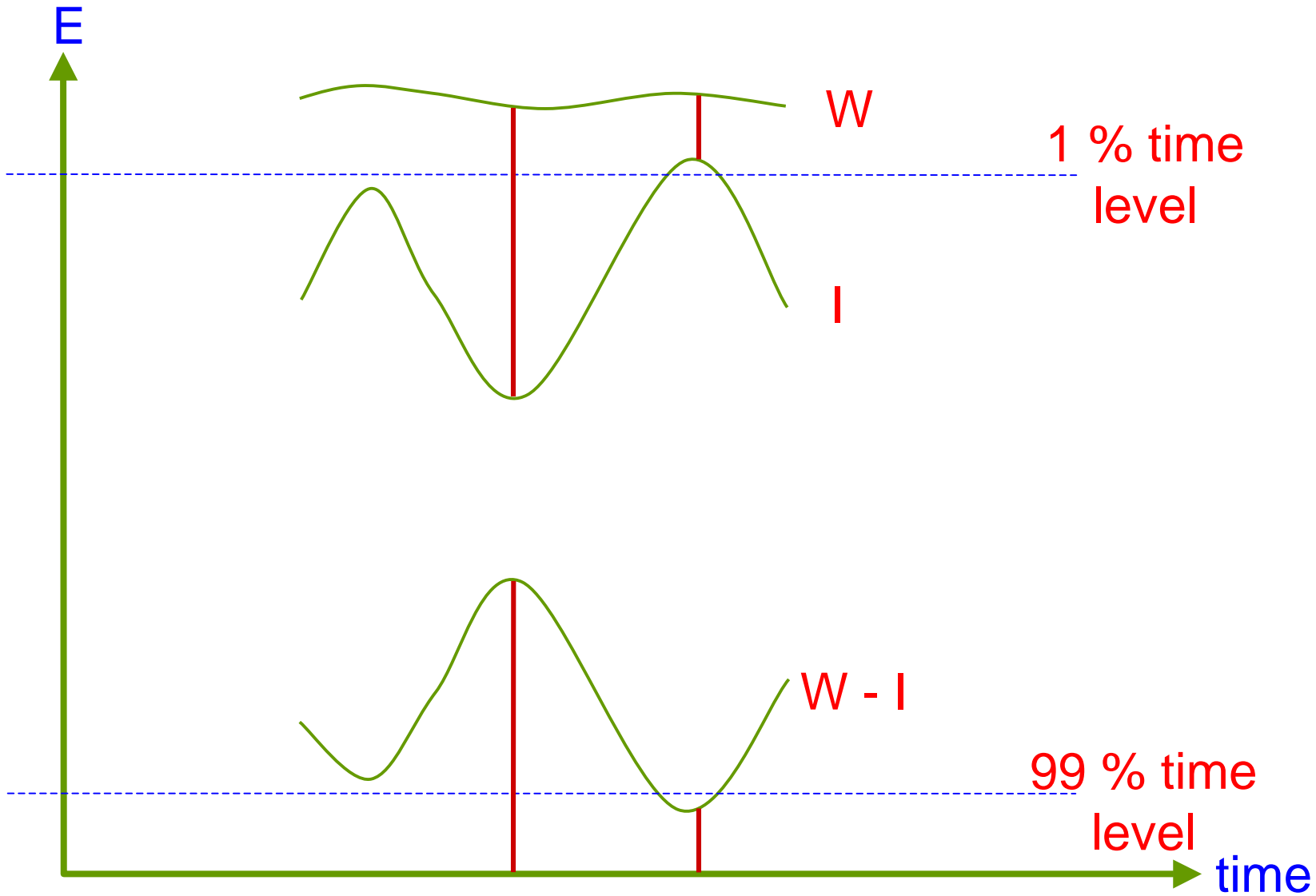


- SEASONAL VARIATION
- STANDARD DEVIATION (σ)

A FUNCTION OF DISTANCE (range 0 — ~ 7 dB)



TIME STATISTICS

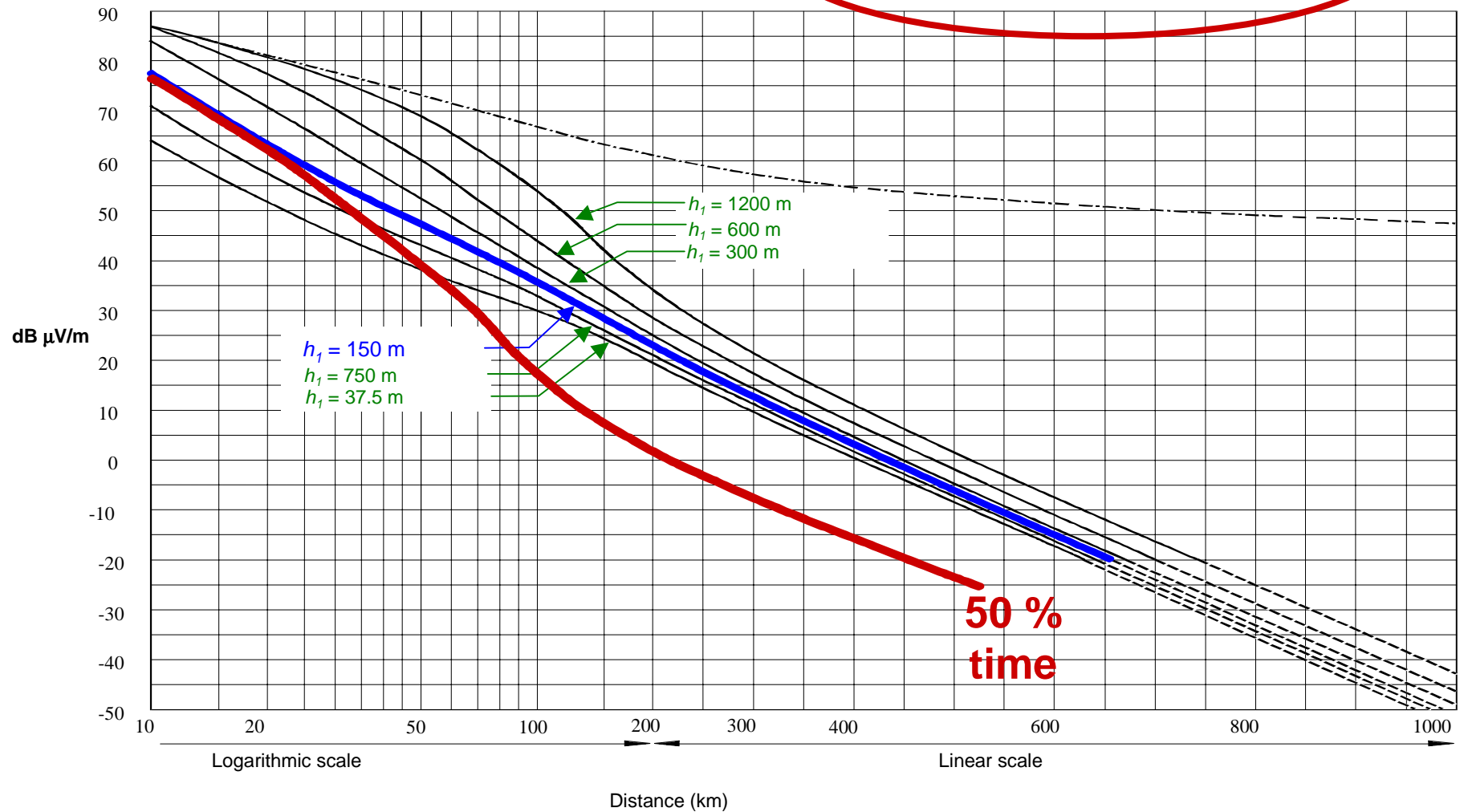


PROPAGATION PREDICTION



Field strength (dB μ V/m) for 1 kW e.r.p.

Interference: 1 % time EBU-GER

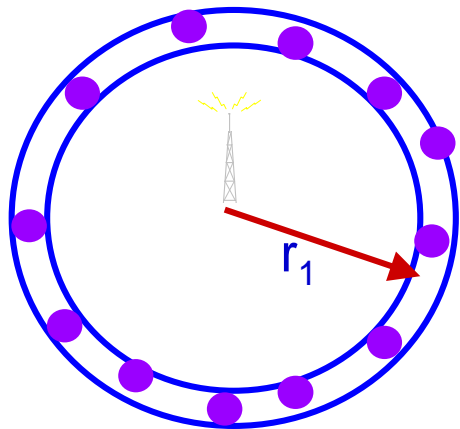
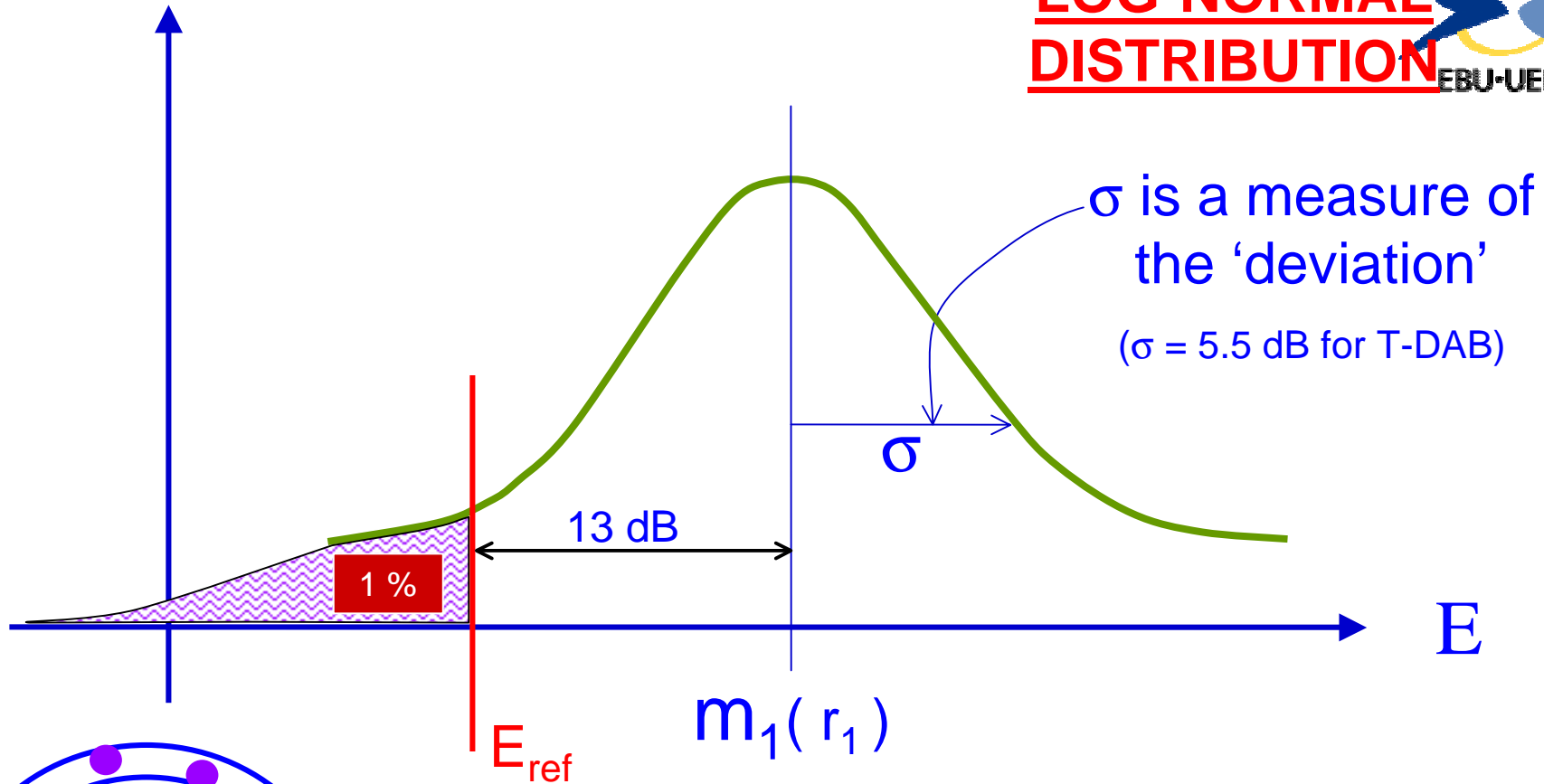


Frequency: 30-250 MHz; Bands I, II, III; Land; 1 % time;
50 % of the locations; $h_2 = 10$ m; $\Delta h = 50$ m

----- Free space

Number (relative occurrence)

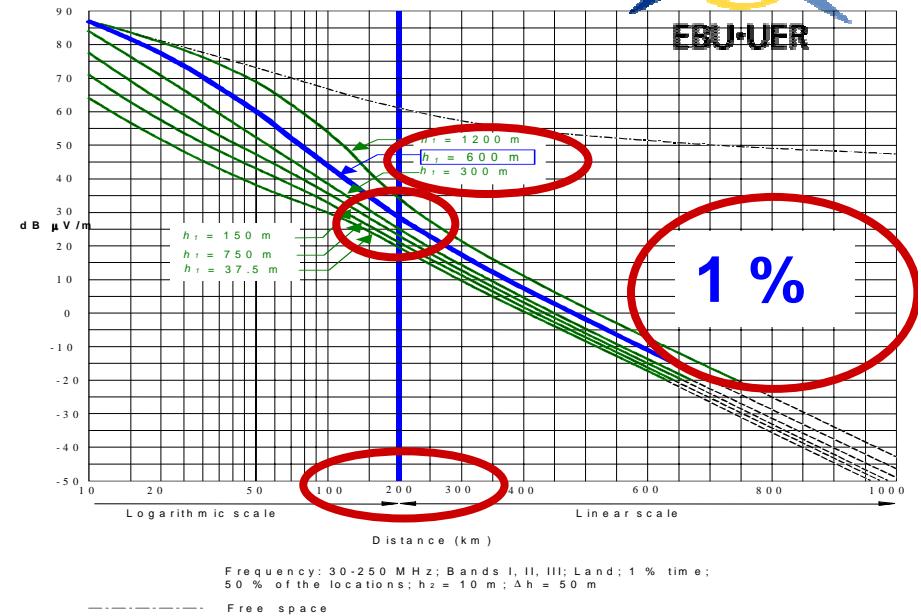
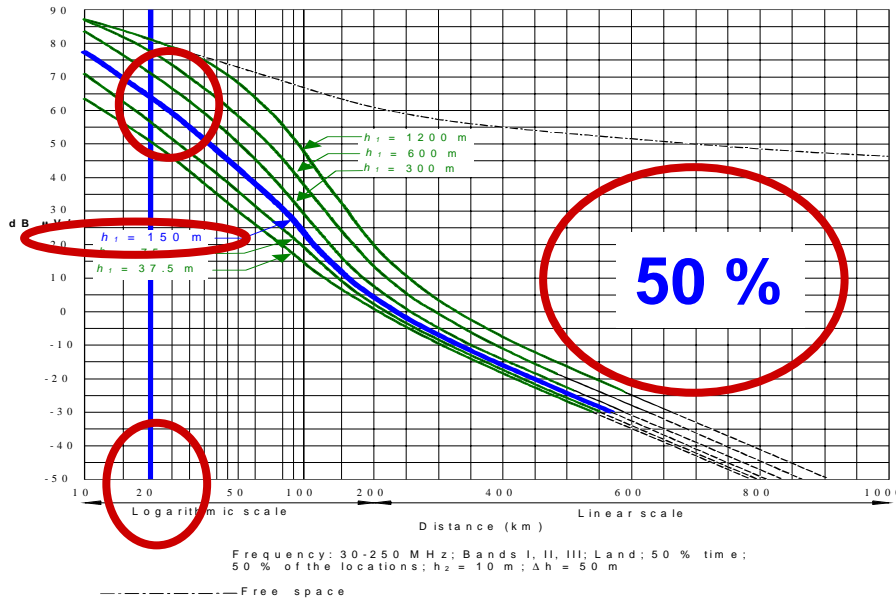
LOG-NORMAL
DISTRIBUTION



$$m_1 = E_{ref} + 13$$

LOCATION DISTRIBUTION

PROPAGATION PREDICTION



EXAMPLES

WANTED SIGNAL

50 % time

$h_1 = 150 \text{ m}$

ERP = 10 kW = 10 dBkW

distance = 20 km

$$E_w = 64 + 10 = 74 \text{ dB}$$

UNWANTED SIGNAL

1 % time

$h_1 = 600 \text{ m}$

ERP = 20 kW = 13 dBkW

distance = 200 km

$$E_i = 29 + 13 = 42 \text{ dB}$$



PROPAGATION PREDICTION

RECEIVED FIELD STRENGTH IS A FUNCTION OF:

- DISTANCE
- EFFECTIVE TX ANTENNA HEIGHT
- RADIATION PATTERN
- RX ANTENNA HEIGHT
- % LOCATION
- % TIME
- INTERPOLATION FOR INTERMEDIATE VALUES
- TYPE OF PATH: LAND, WARM SEA, COLD SEA

STATISTICS



ANALOGUE PLANNING

Gradual degradation

50 % location probability

99 % time probability

Fixed reception

10 m rx antenna height

DIGITAL PLANNING

Rapid degradation

90 - 99 % location probability

99 % time probability

Mobile reception

1.5 m rx antenna height

Propagation Prediction Curves

50 % time wanted ; 1-10 % time unwanted

50 % location wanted and unwanted

Log-normal distribution

MINIMUM WANTED FS



Frequency	↔	500 MHz
Noise	↔	- 128.2 dBW
Allowance for Man Made Noise	↔	0 dB
Minimum C/N required	↔	14 dB
Feeder Loss	↔	5 dB
Rx Antenna Gain	↔	12 dB
Effective Antenna Aperture	↔	- 5.4 dBm²
Min Power Flux Density (PFD) at Rx	↔	- 103.8 dBW/m²
Min Equivalent Field Strength	↔	42 dB μV/m
Location Correction Factor (95%)	↔	9 dB
Min Median PFD (50% time 50% location)	↔	- 94.8 dBW/m²
Min Median Equivalent Field Strength	↔	51 dB μV/m

MINIMUM MEDIAN FIELD STRENGTH FOR PLANNING



Frequency Band	↔	Band IV
Minimum Equiv. Field Strength	↔	42 dB μV/m
Antenna Height Gain (10 → 1.5 m)	↔	+ 10 dB
Corr. Factor (50 % → 99 % locations)	↔	+ 13 dB
Minimum <u>Median</u> Field Strength	↔	65 dB

‘MEDIAN’ means we can use 50 % location curves
(i.e., corrections are already “built in”)

MAIN TRANSMITTER PARAMETERS

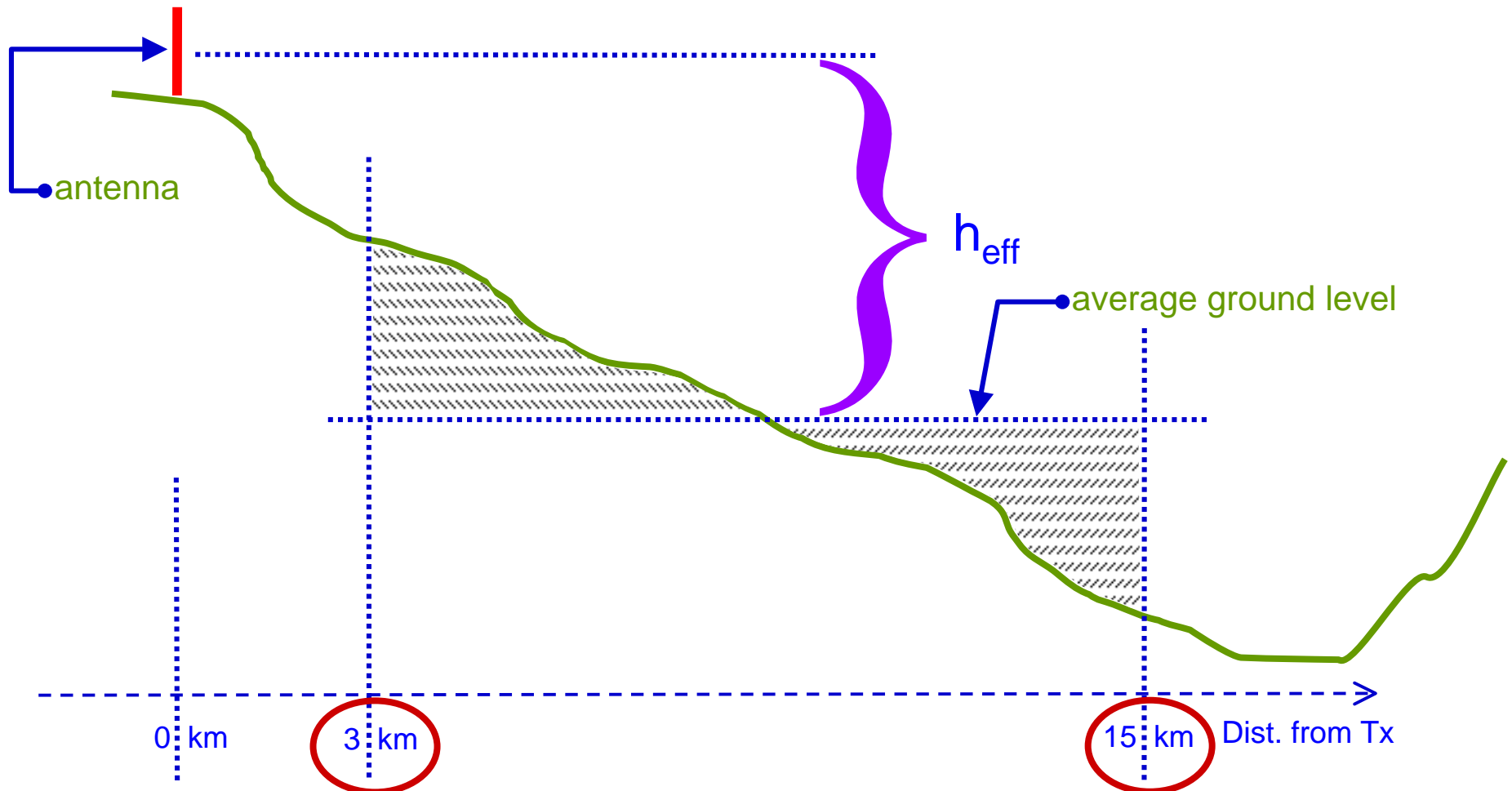


- ERP
- site
- h_{eff}
- antenna pattern
- polarisation

MAIN TRANSMITTER PARAMETERS



EFFECTIVE ANTENNA HEIGHT: h_{eff}



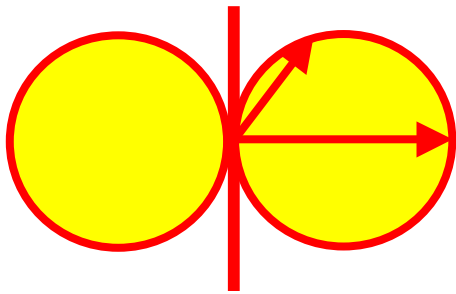
MAIN TRANSMITTER PARAMETERS



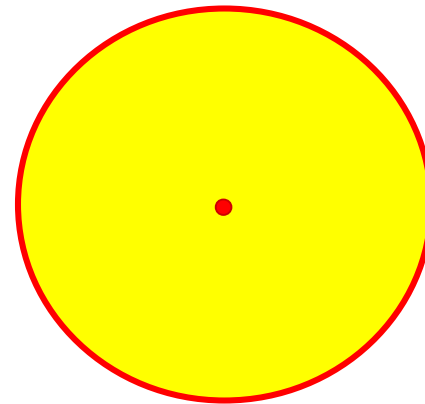
e.r.p.: Power supplied to the antenna times the gain relative to a half-wave dipole.

GAIN

reference: half-wave dipole

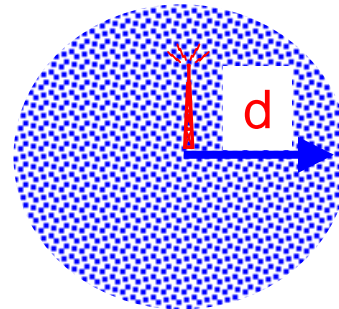
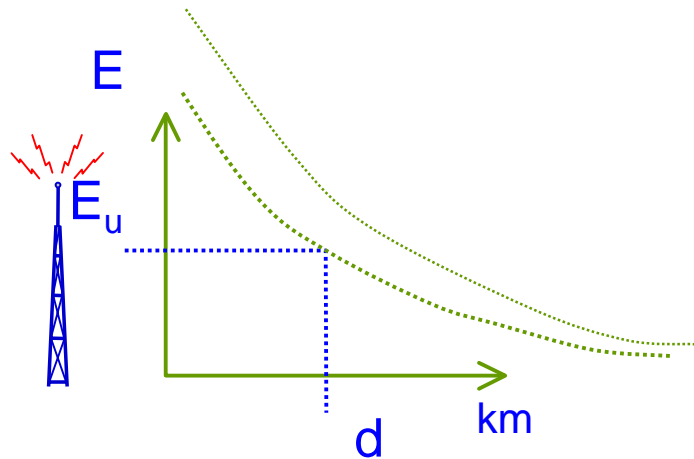


$\frac{1}{2}$ -wave dipole
vertical plane



$\frac{1}{2}$ -wave dipole
horizontal plane

RELATIONSHIP: ERP vs. h_{eff}



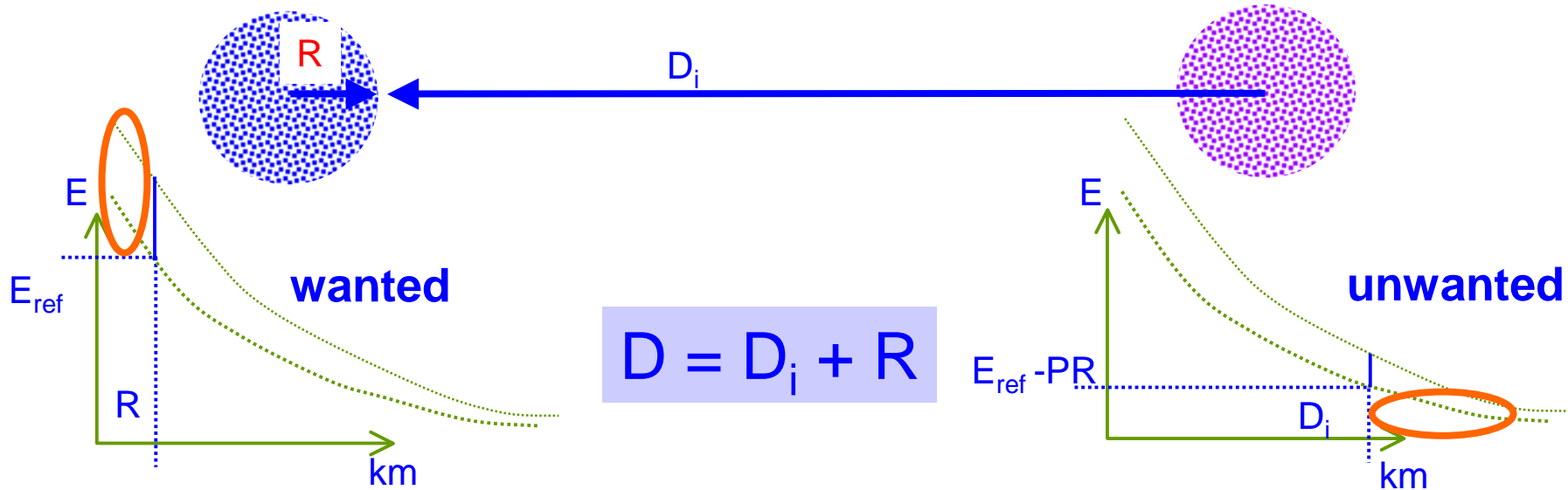
For acceptable reception

- the wanted field strength must equal or exceed

E_{ref} , and

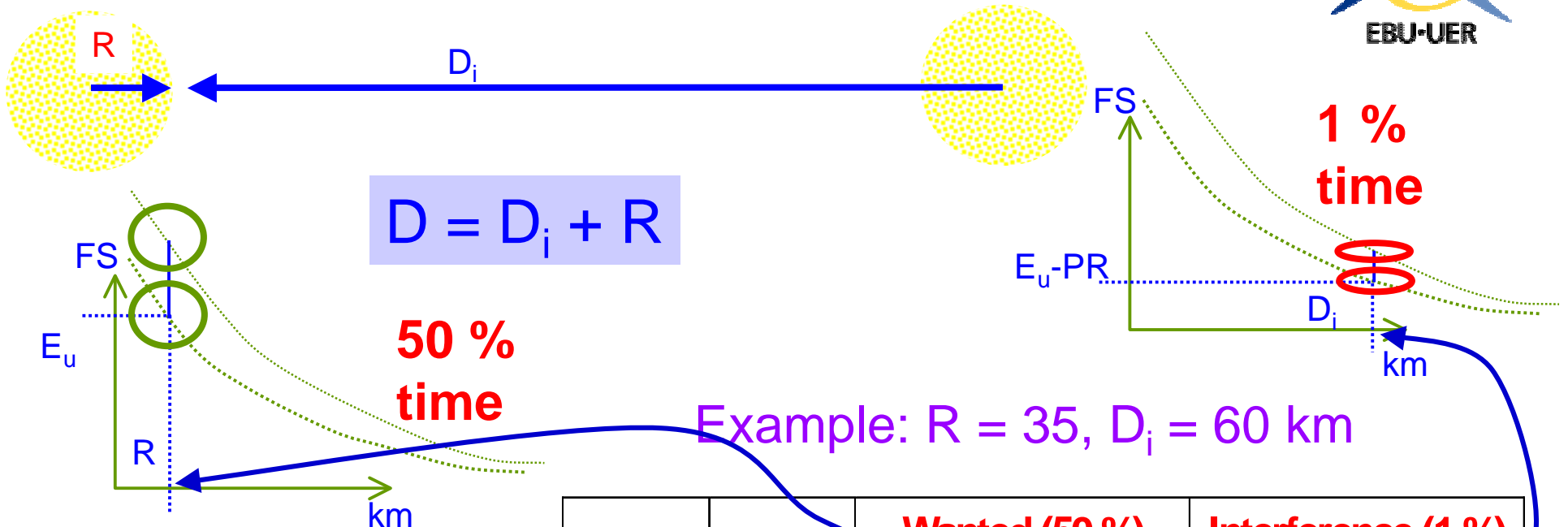
- the unwanted field strength must not exceed

$E_{\text{ref}} - \text{PR}$.



$$D = D_i + R$$

RELATIONSHIP: ERP vs. h_{eff}



For acceptable reception

- wanted field strength must equal or exceed E_{ref} , and
- the unwanted field strength must not exceed $E_{ref} - PR$.

erp (dB kW)	h_{eff} (m)	Wanted (50 %) 35 km ($E_{ref} = 58$ dB μ V/m)	Interference (1 %) 60 km ($E_{ref} - PR = 48$ dB μ V/m)
14	75 m	(14 + 44 =) 58	(14 + 41 =) 55
0	300	(0 + 58 =) 58	(0 + 48 =) 48
Increase \Rightarrow		58 - 44 = 14	48 - 41 = 7

MAIN TRANSMITTER PARAMETERS



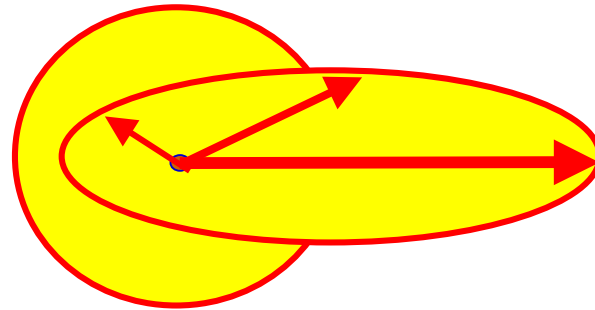
Polarisation

- mobile/portable ⇒ vertical (near ground reflections)**
- ⇒ horizontal (wooded absorption)**
- ⇒ vertical (TV often horizontal, gives ~ 16 dB protection to TV)**
- ⇒ vertical (car antennas ~ vertical)**

MAIN TRANSMITTER PARAMETERS



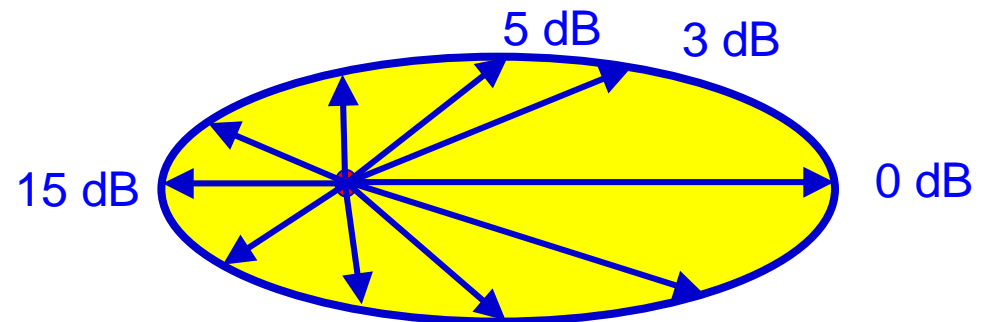
MAXIMUM e.r.p.



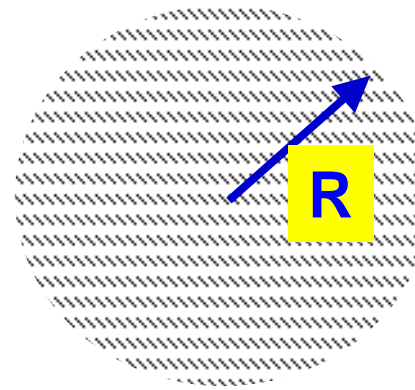
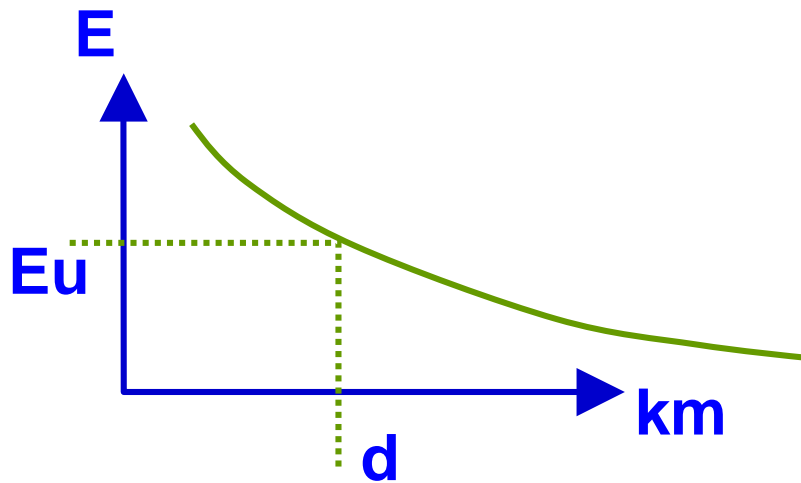
$\frac{1}{2}$ -wave dipole Tx antenna
horizontal plane

ANTENNA PATTERN

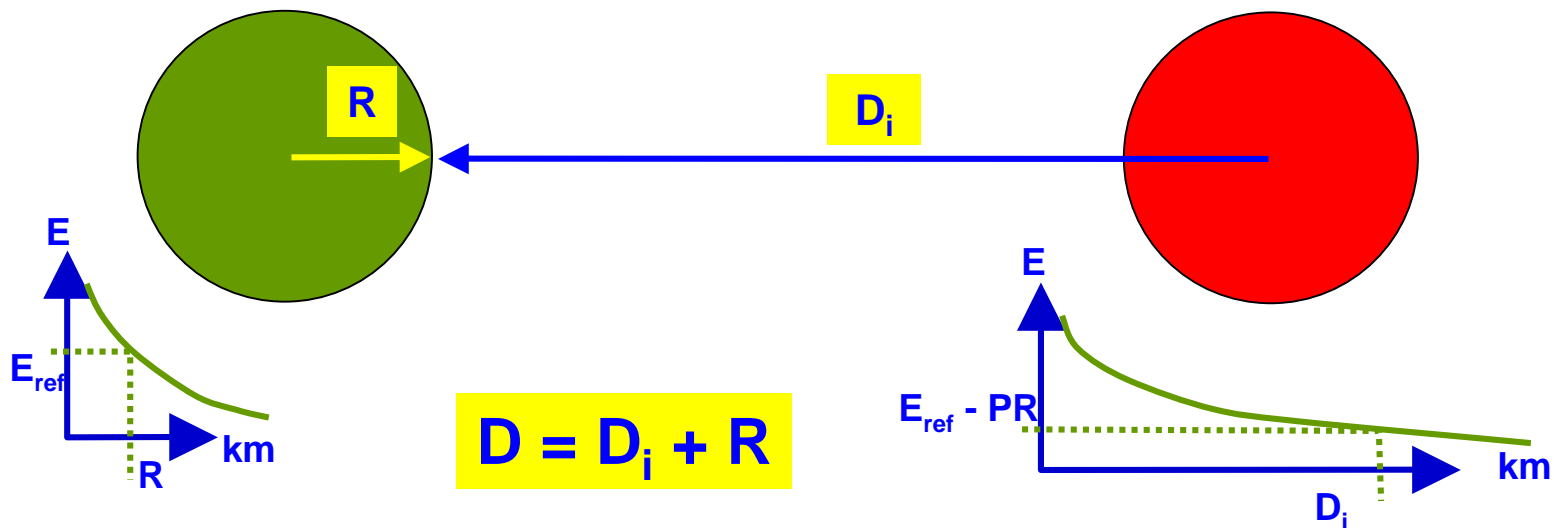
Attenuation with
respect to MAX e.r.p.



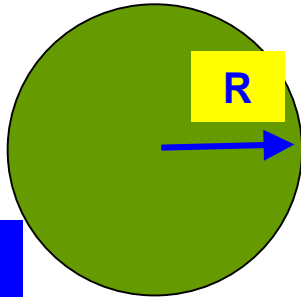
PRINCIPLES OF FREQUENCY PLANNING



For acceptable reception the wanted field strength must equal or exceed E_{ref}



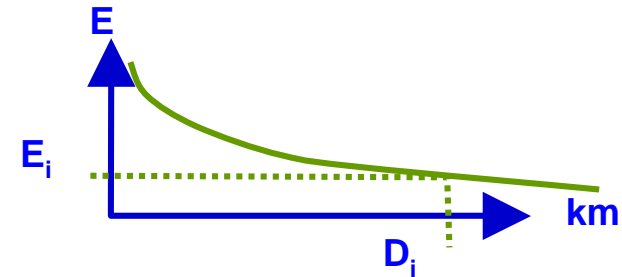
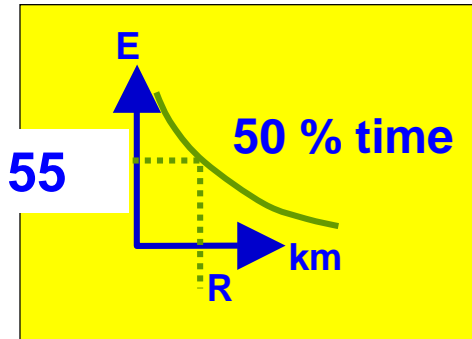
COVERAGE ?



1.0 kW
75 m

EXAMPLE:

- R = 40 km
- ERP = 0 dB; 10 dB
- E_{ref} = 58 dB
- ATT. = 0 dB; 3 dB



$$E(R) + ERP - ATT. \geq E_{ref}$$

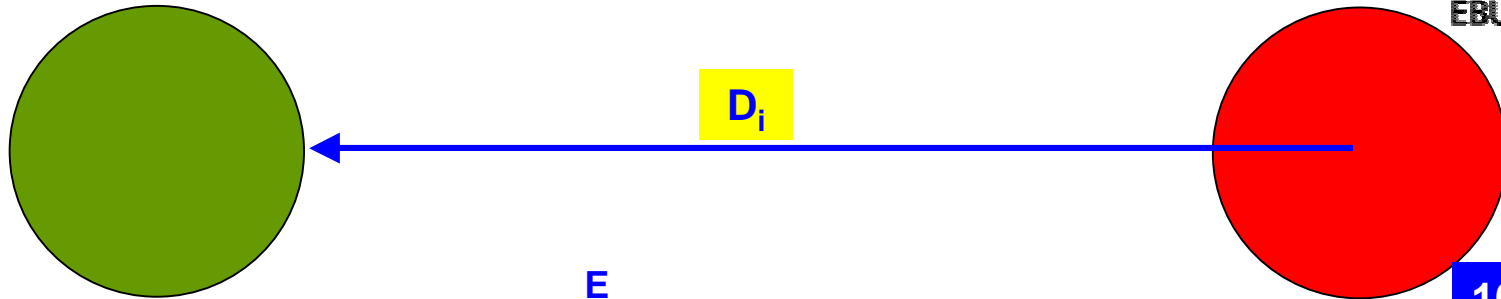
a) $55 + 0 - 0 = 55 < 58$

PROBLEM !!

b) $55 + 10 - 3 = 62 \geq 58$

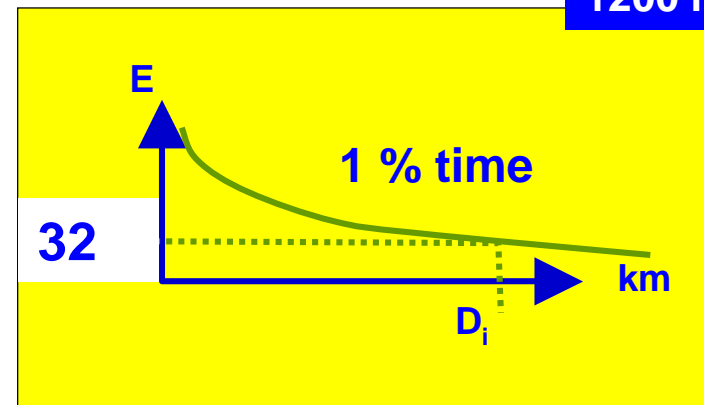
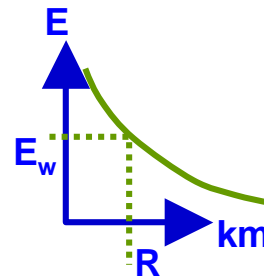
NO PROBLEM

INTERFERENCE ?



EXAMPLE:

- $D_i = 150$ km
- ERP = 20 dB
- PR = 10 dB
- $E_{ref} = 58$ dB
- ATT. = 0 dB, 10 dB



$$E(D_i) + ERP - ATT. + PR < E_{ref}$$

$$a) 32 + 20 - 0 + 10 = 62 \geq 58$$

$$b) 32 + 20 - 10 + 10 = 52 < 58$$

PROBLEM!!

NO PROBLEM