> 19Sep2014 - Radiation equation, Antennas

1145

> 26Sep2014 - Propagation models: Yun Ai
> 26Sep2014 - ~~Range~~ of wireless communications - Raul

freq range and type of wireless comm.

1200

17.Oct

> Oct2014 - LTE - Solomon
> Oct2014 -Voice in LTE - Mikhail Yakubovich
> WiFi

10.Oct

> Oct2014 - WiMAX - Qihaoli
> Oct2014 - Security in NFC - Seraj

WiFi - Mohsen 802.11 ~~b, a~~ n, an, ...

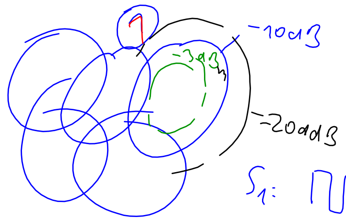
~~3. Oct~~ free

Missing upload:
contact
kaja@unik.no

Remind me of the MIC

Josef: cal.jnoll.net

Cell System



UMTS cell ~ 1 Mbit/s
as interference limited network
HSPA ~ 14.4 .. 28.8 Mbit/s

Interference

Code classes with interference

(2) Code not orthogonal

S_1: → Spread C_1

S_2: → C_2

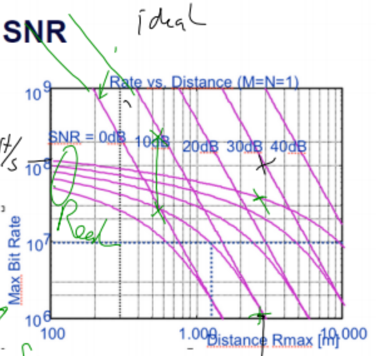
Range Versus SNR

$R_{max} = \log_2(1 + SNR)$ [Source:Valenzuela, BLAST project] ~ year 2000

Comments

Real system

SNR	Range	Capacity
0	600m	10 Mbit/s
30	300m	60 Mbit/s
10	3km(?)	1 Mbit/s (UMTS cell capacity)



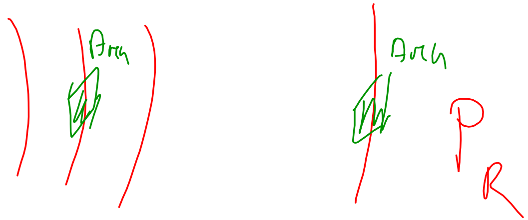
[Source Valenzuela, BLAST project]

why is there no relation to frequency?

Capacity ~ 1 / Range

Capacity ~ f ← Real System

$P_{transmit}$



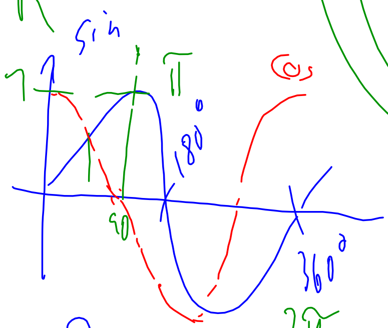
$\frac{1}{4\pi r^2}$

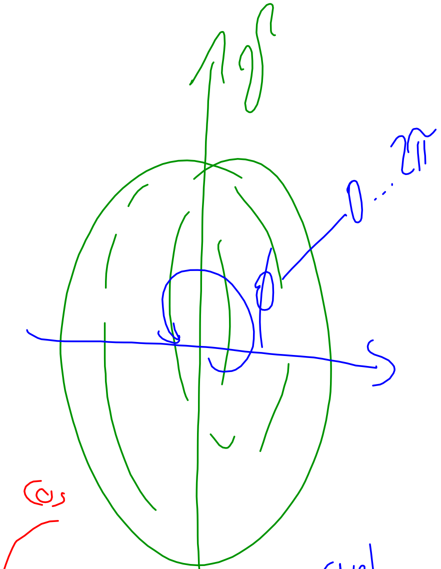
Area of Spere $4\pi r^2$

$P_r = \frac{\lambda^2}{(4\pi r)^2} P_t G_t G_R$?

$\int \Rightarrow 4\pi$

	sin	
0	0	0
30	$\frac{1}{2}\sqrt{1}$	0.5
45	$\frac{1}{2}\sqrt{2}$	0.7
60	$\frac{1}{2}\sqrt{3}$	0.86
90	$\frac{1}{2}\sqrt{4}$	1





$\int_0^{2\pi}\int_0^{\pi} I(\vartheta,\varphi)\,\sin\vartheta\, d\vartheta\, d\varphi$

$\int_0^{\pi} \sin\vartheta = \cos\vartheta \Big|_0^{\pi} = 2$

$2 \cdot 2\pi = 4\pi$

Receive power $P_r = P_t \cdot G_t \cdot G_r \cdot \frac{\lambda^2}{(4\pi r)^2}$

with $\lambda = \frac{c}{f_{Hz}} = \frac{3E8\ m/s}{f\,[GHz]\ 1E9} = \frac{30\ cm}{f\,[GHz]}$

$e^{j(\omega t - \vec{k}\vec{r})}$

$k = \frac{2\pi}{\lambda}$

$\omega = 2\pi f = \frac{2\pi c}{\lambda}$

$\lambda = \frac{30\ cm}{f\,[GHz]}$

$f_m \approx 88.8 \ldots 108\ MHz$

$\lambda \sim 3\ m$

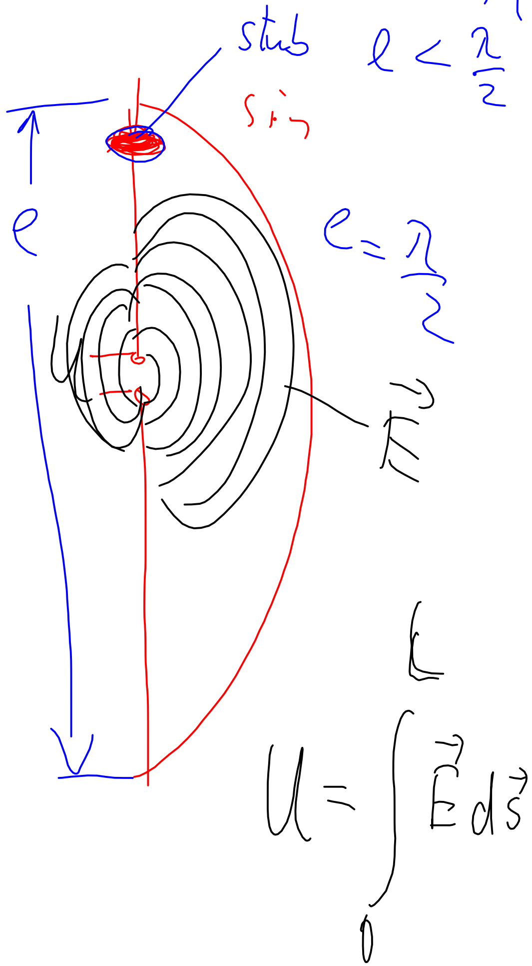
antenna "is best" at $l = \frac{\lambda}{2}$

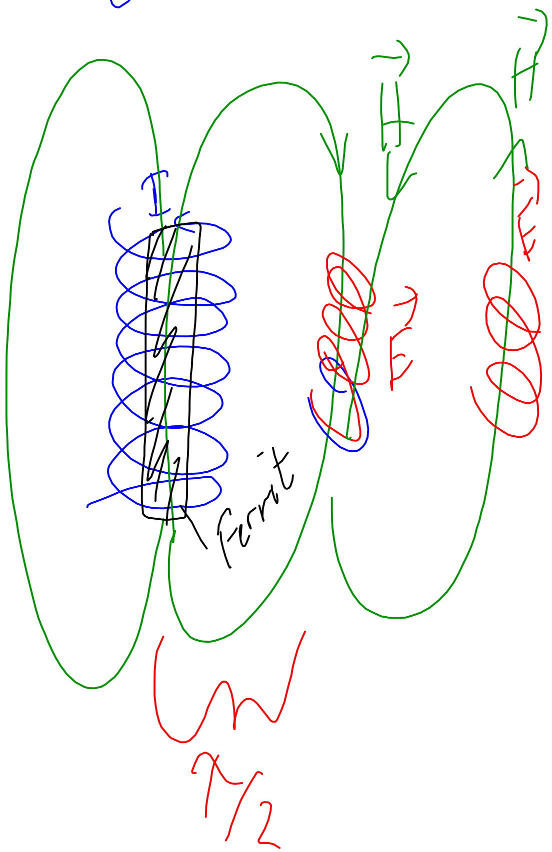
	λ
GSM_{900} (~1GHz)	~ 30cm
$UMTS_{2.1}$	~ 15 cm
WLAN, LTE_{2600}	~ 12 cm
802.11_a (5GHz)	~ 6 cm

Antenna design

electrical antenna

magnetic antenna





iPhone 4 antenna problems

UNIK

	λ
GSM_{900} (~1GHz)	~ 30cm
$UMTS_{2.1}$	~ 15cm
WLAN, LTE_{2600}	~ 12cm
802.11_a (5GHz)	~ 6cm

diversity – 2 or more antennas

patch antenna

λ
4G: 12 cm
$\frac{\lambda}{2} = 6$ cm

a) diversity
b) MIMO ?

4 GHz

D-Link DWR-921 4G ruter

Multi frequency
800 ... 2.6 GHz
Antenna $\frac{\lambda}{2}$ 15 cm ... 6 cm

patch $\varepsilon_r \approx 3\text{-}5$

λ_0 free space wavelength

$l \sim \frac{\lambda}{2\sqrt{\varepsilon_r}} \approx \frac{15}{\sqrt{3.5}}$

7.5 ... 3 cm

$\lambda = \frac{c}{f} = \frac{1}{\sqrt{\mu\varepsilon}\, f}$

$\mu_0 \cdot \mu_r$ $\varepsilon_0 \cdot \varepsilon_r$

Magnetic $\mu_r = 80$
Ferrit

D-link antenna coupling between patches

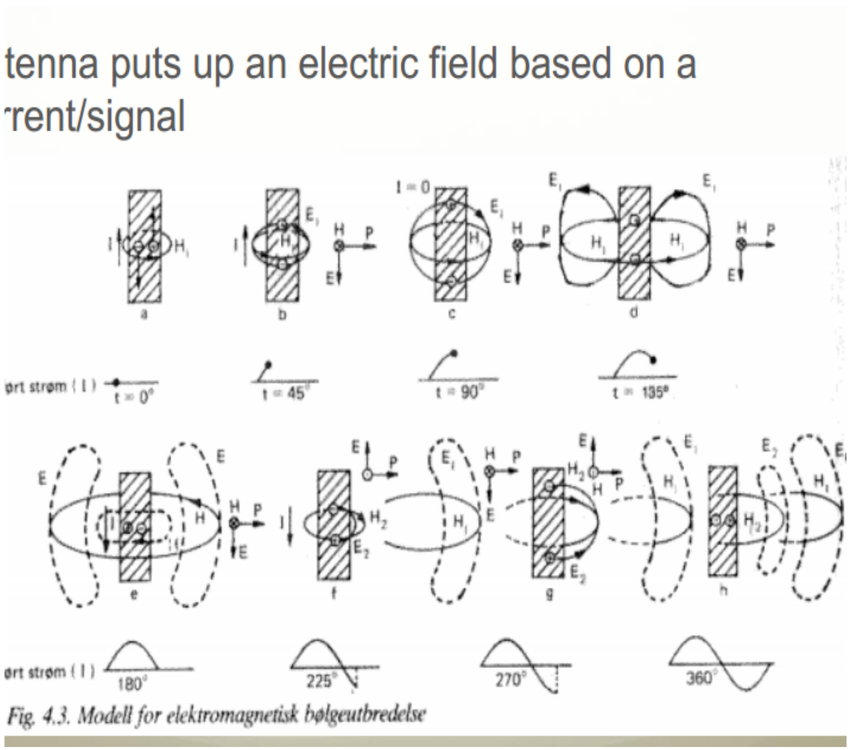
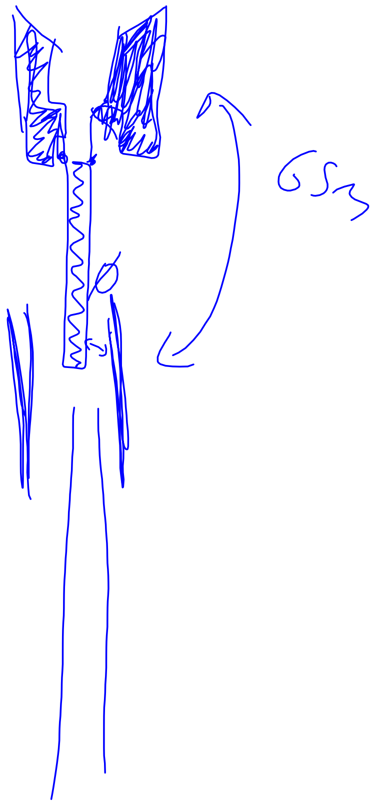
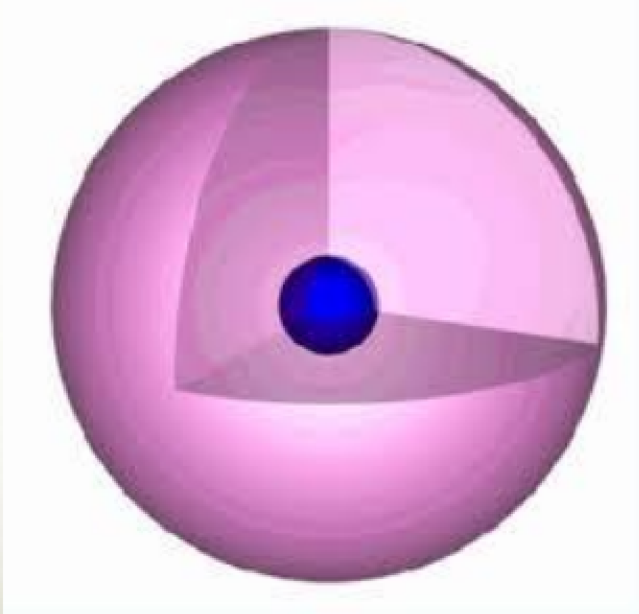


Fig. 4.3. Modell for elektromagnetisk bølgeutbredelse



Isotropic antenna

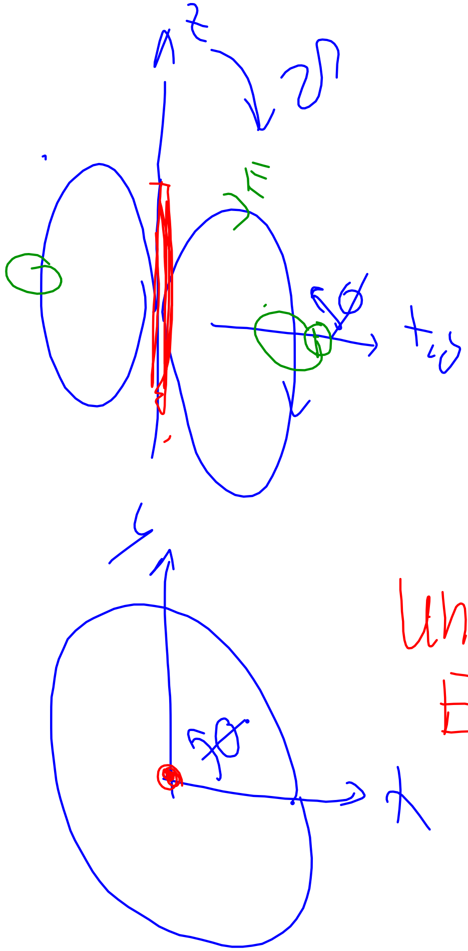
- Theoretical reference antenna (ideal)
- Uniform radiation
- 0db Gain



$\lambda/2$ el antenna

Antenna pattern

$\vec{E}(\vartheta, \phi)$



$E_\vartheta = E_0 \sin\vartheta$

sinoidal

x/y, z plane

ϑ - plane

$E_\phi = 0$

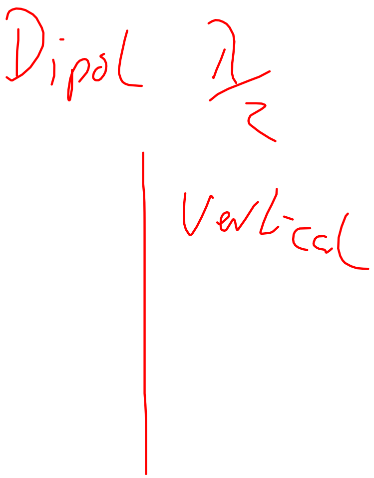
H_ϕ

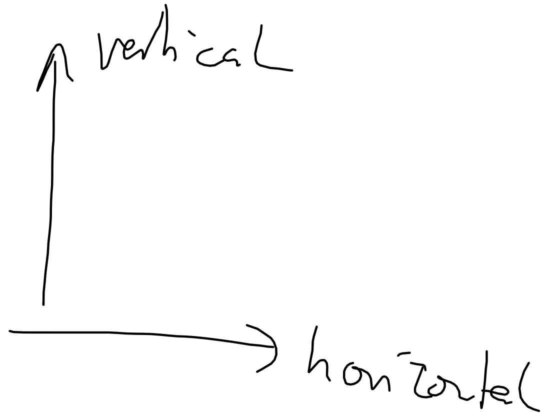
ϕ - plane

uniform

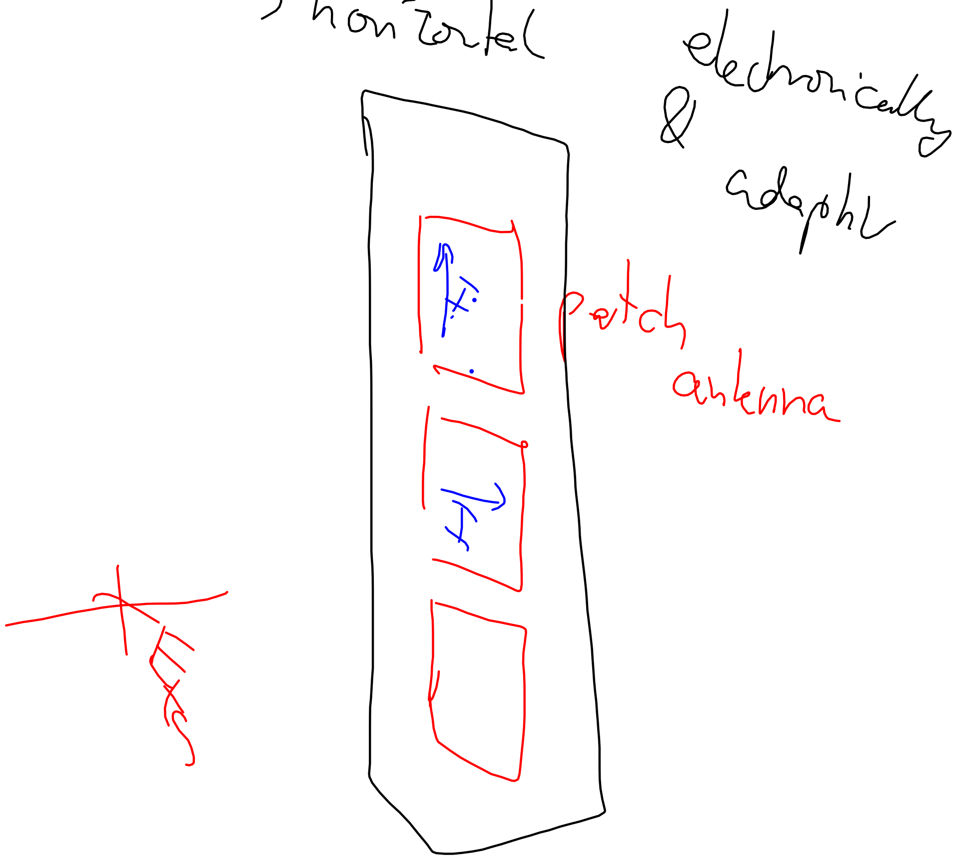
E in xy

Polarization



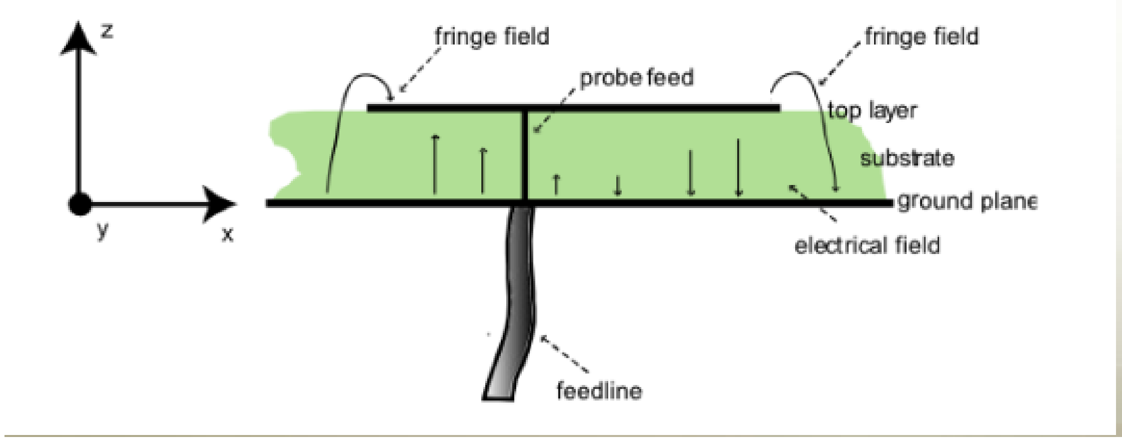


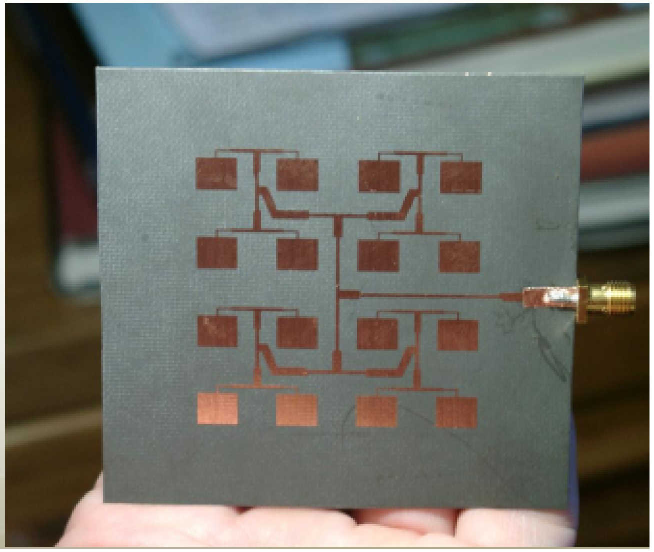
Combination of h, vertical polarisation



Patch antennas

- Also known as microstrip antenna
- Metal "sheet" (patch) placed over a ground-plane
- Isolated by a dielectric materia (PCB)
- Inexpensive to produce/design

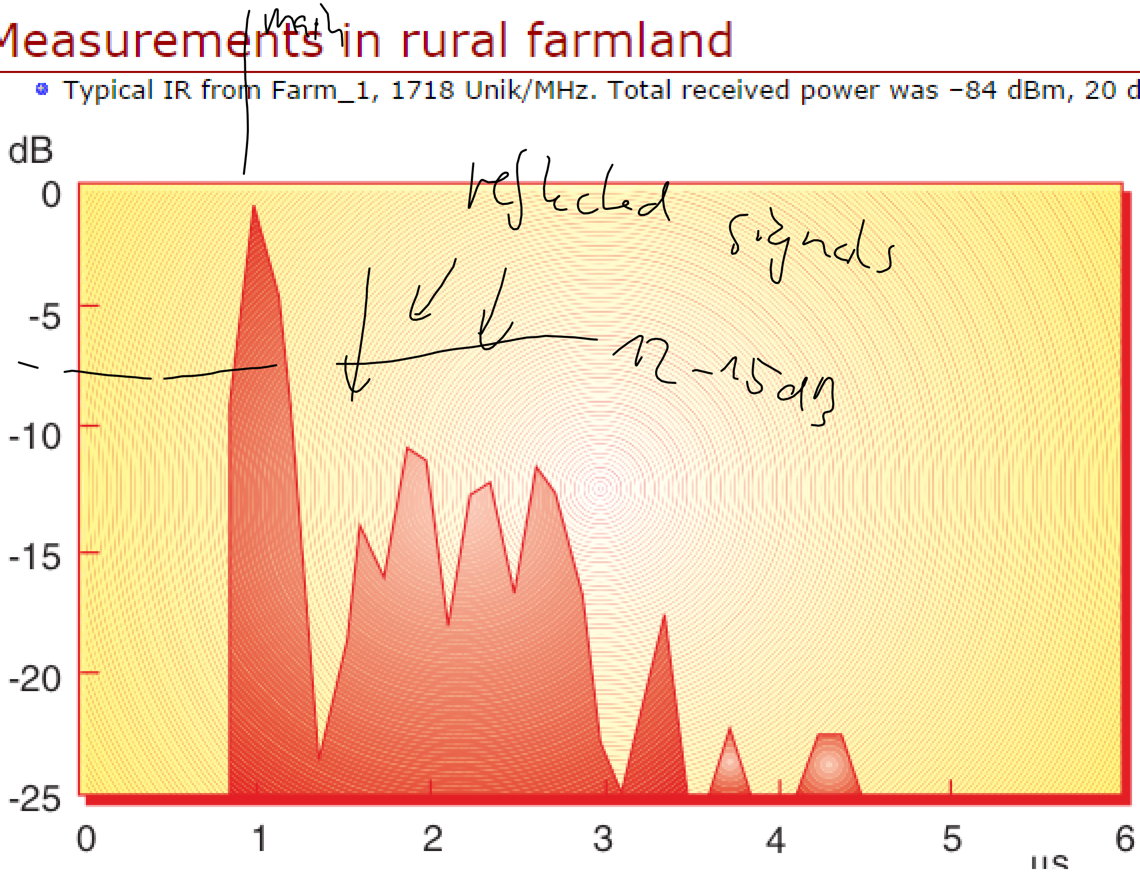




http://wiki.unik.no/index.php/Courses/UNIK4700propagation

Measurements in rural farmland

- Typical IR from Farm_1, 1718 Unik/MHz. Total received power was −84 dBm, 20 dB above GSM sensitivity level



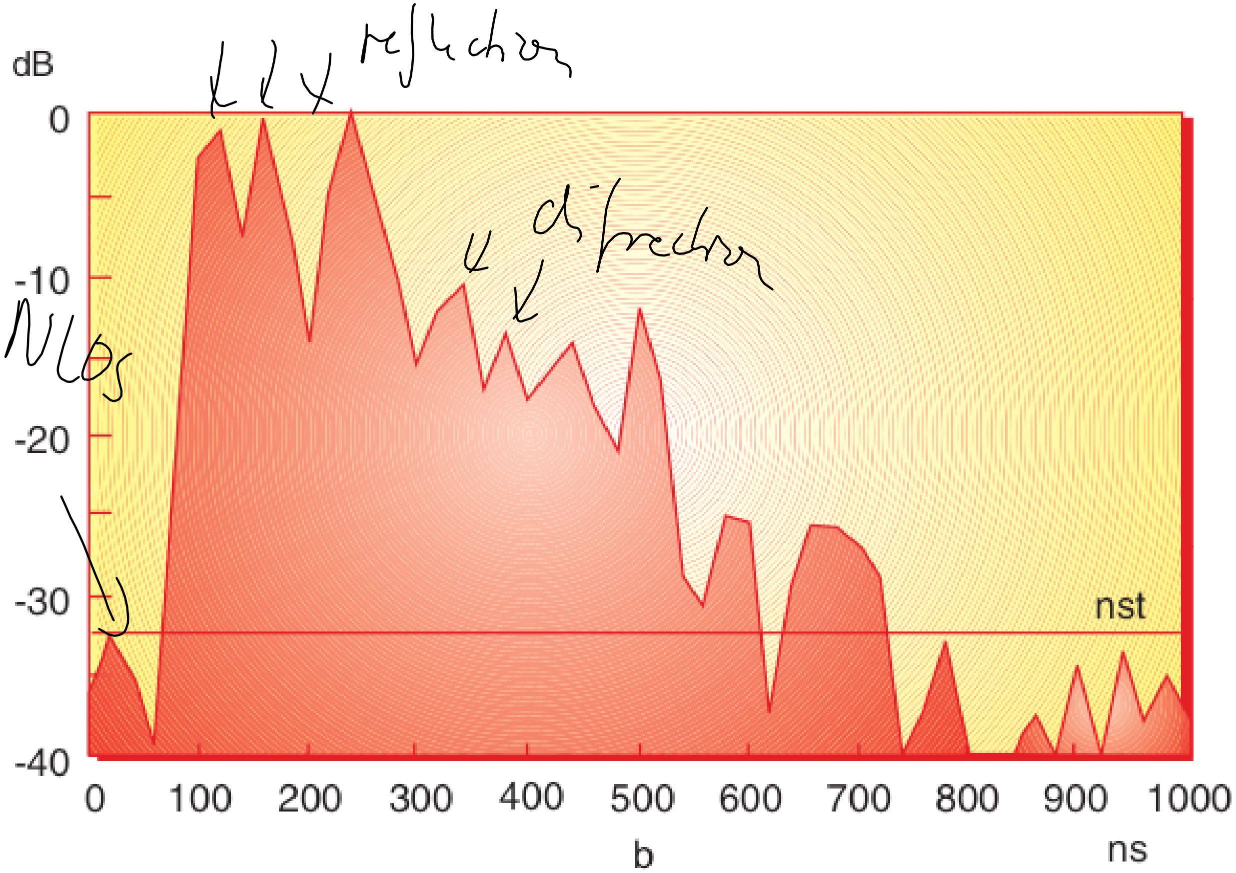
[Source:R Rækken, G. Løvnes, Telektronikk]

These questions are valid for all of the following impulse responses

- from delay, calculate reflection factor and free space attenuation
- describe characteristics of reflection

Measurements in cities

- Typical IR from City street measurements, 1950 Unik/MHz, Oslo. Output power 25 dBm (in mW?). Omnidirectional $\lambda/4$ - Dipoles used as transmit and receive antennas.



[Source:R Rækken, G. Løvnes, Telektronikk]

why almost equal distribution? What effect?