Josef Noll, 3/11

Near Field Communication — NFC

13.56 MHz

RFID standard

0…4 cm

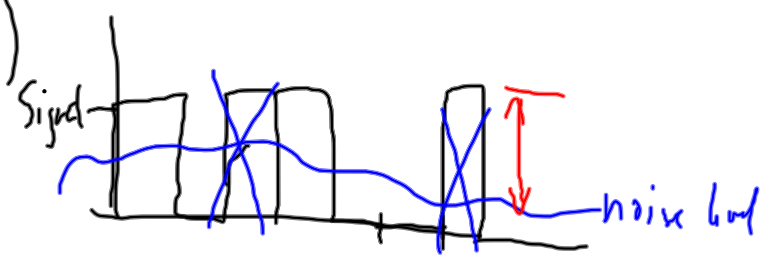
└ bus/tog Ruter

- Android 2.3
- iPhone 5
- Nokia E7 (?)

LDNA, ++,

4.6 GHz (?)

Quick - signal variation (Rayleigh)



physics: ?

$\vec{P} = \vec{E} \times \vec{H}$

↳ $\vec{E} = E_0 \, e^{j(\omega t - \vec{k}\vec{r})}$

Lightning, atmosphere interference

Northern lights

<u>short</u>, bits

Bit error rate = BER

10^{-6} ; 10^{-8}

Effect of fading (1)

- When signal varies, Signal-to-Noise Ratio (SNR) varies and Bit Error Rate (BER) varies over time.
- For BPSK modulation (details in Lec 6 - Modulation), probability of error –

$$p(e) = \frac{1}{2}\operatorname{erfc}\left(\sqrt{\gamma_0}\right) \quad , \quad \text{uten fading}$$

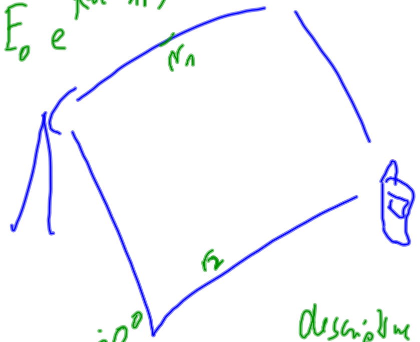
$$p_{fad}(e) = \frac{1}{2}\left[1 - \sqrt{\frac{\gamma_0}{1+\gamma_0}}\right], \quad \text{med fading}$$

Where γ_0 is the SNR

Slow signal

- disturbances
- multipath

$\vec{E} = E_0 e^{j(\omega t - \vec{k}\vec{r})}$



dissipation

$\vec{E}_1 = E_0 e^{j0°} = E_0$

$\vec{E}_2 = E_0 e^{j180°} = -E_0$

$\Sigma\, E_1 + E_2 = 0$

$r_1 = r_2 \pm$

$f = \frac{c}{\lambda}$

$\omega t - kr = n \cdot \pi \quad (n = \pm 1, 3, 5, 7, \ldots)$

$2\pi \frac{c}{\lambda} \cdot t - \frac{2\pi}{\lambda} \cdot r = n \cdot \pi$

$2ct - 2 \cdot r = n \cdot \lambda$

$t = t_0 = 0$

$r = -n \frac{\lambda}{2} \approx \pm \frac{\lambda}{2}; \pm \frac{3\lambda}{2}; \ldots$

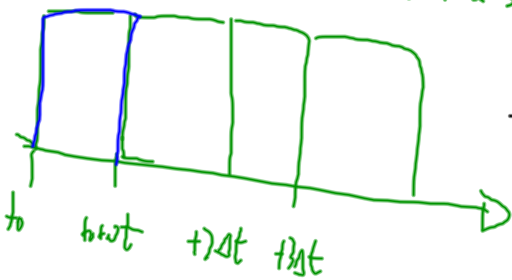
f = 800 MHz

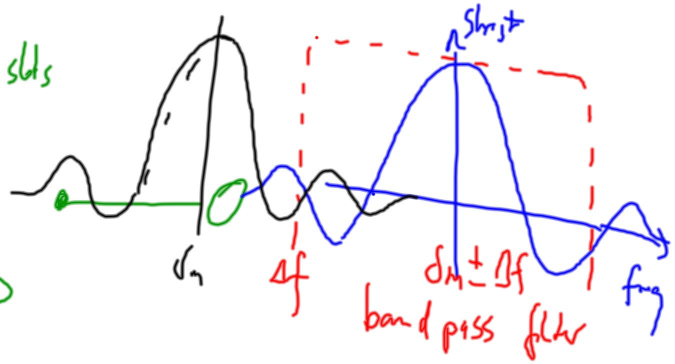
14 cm, 42, ...

$f = 800\,MHz \quad \lambda = \frac{c}{f} = \frac{3E8\ m/s}{800E6\ 1/s} \approx 28\ cm$

Inter Symbol Interference

GSM time 8 time slots

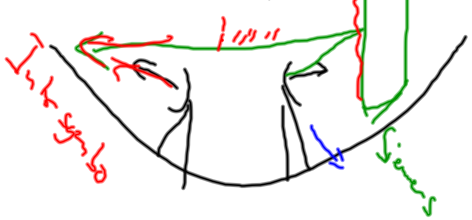


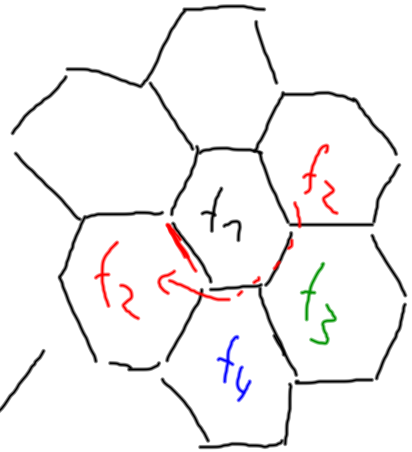


a) signal processing

b) terrain, reflection

Ground data





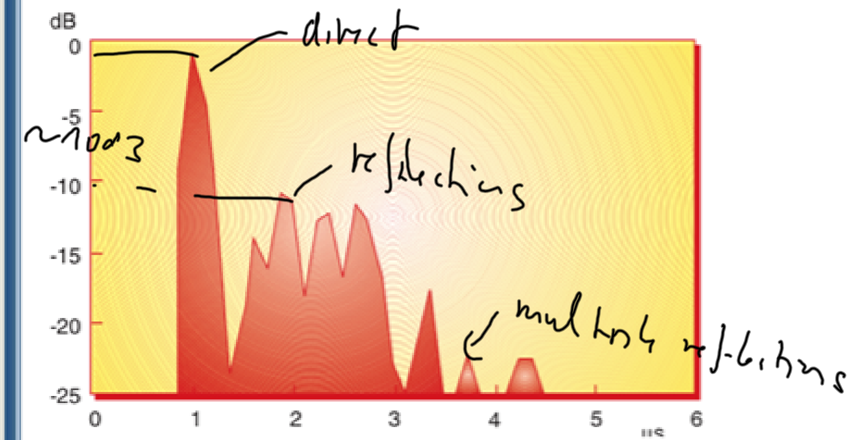
Solutions: • antenna
transmitter effect
change frequency

Reflection at a perfectly plane gives a reflection coefficient Γ= -1. When the surface gets rougher, reflection is still in the main direction, but the reflected power is spread around the main reflection angle. Assuming that no absorption takes place, then the total reflected power is constant.

When the surface becomes extremely rough, and with roughness >> *lambda*, then the reflected wave will be scattered into any direction.

Measurements in rural farmland

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



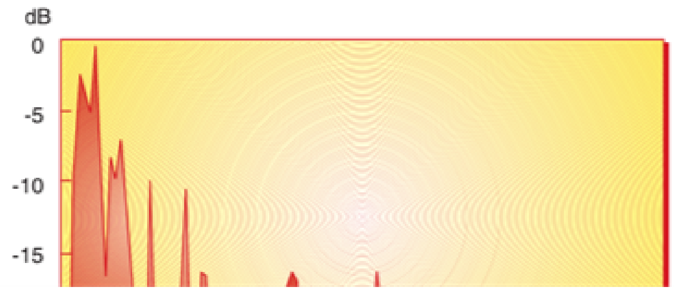
[Source:R Rækken, G. Løvnes, Telektronikk]

These questions are valid for all of the following impulse responses

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

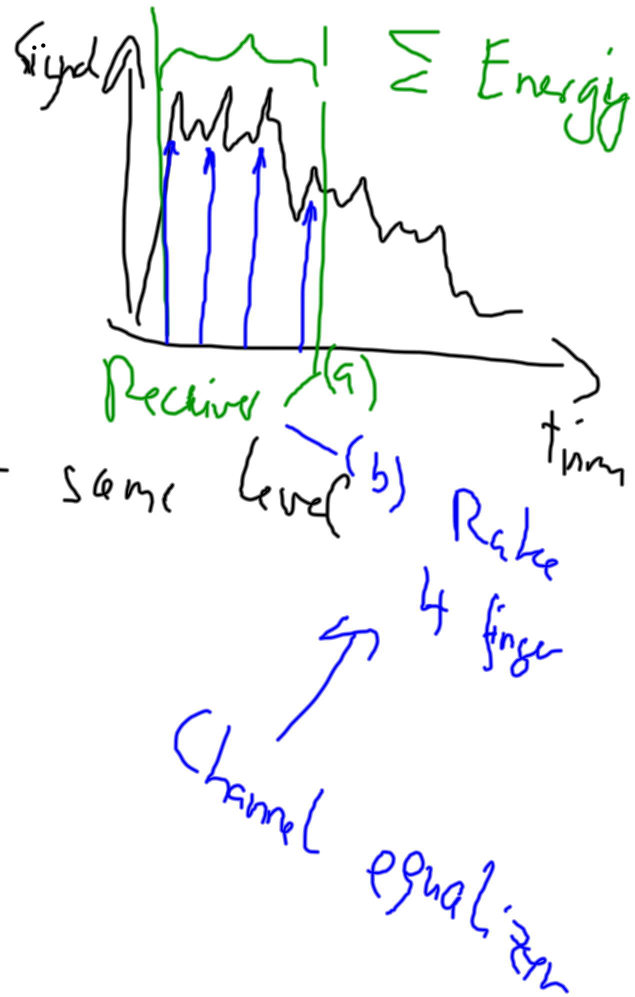
Measurements in rural farmland

- Typical IR from Farm_2, 953MHz. Total received power was -93dBm



Propagation in cities

- no direct signal
- multiple signals at almost same level



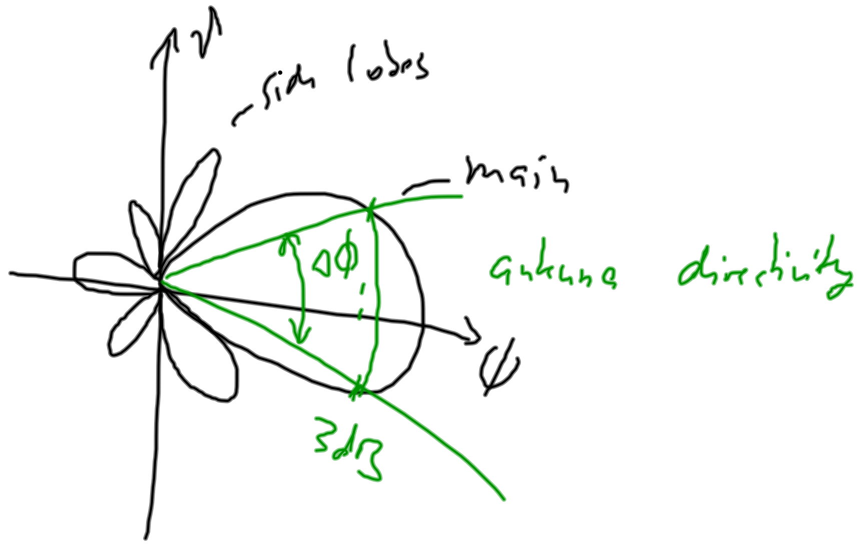
dB — $\log_{10}$ $\quad P_{dB} = 10 \log\left[\frac{P}{1W}\right]$

± 3 dB: $+3$dB $\rightarrow 2\times$; -3dB $\rightarrow 0.5\times$

$$P_{dBm} = 10 \log\left[\frac{P}{1mW}\right]$$

Example

antenna diagramm



WLAN: 802.11b,g = $P_{tx\,max} = 20\,dBm$

$10 \cdot \log\left(\frac{100\,mW}{1\,mW}\right)$

$= 10 \cdot 2\ dBm$

$1\,mW = 0\,dBm$ ← Bluetooth class 0

$4\,dBm$ class 1

$100\,mW = 20\,dBm$ ← WLAN

class 2

$2 \sim +$ 3dB

$1/2 \sim -$

20 W

$43\,dB \leftarrow \left(\frac{20\,E3\,mW}{1\,mW}\right)$

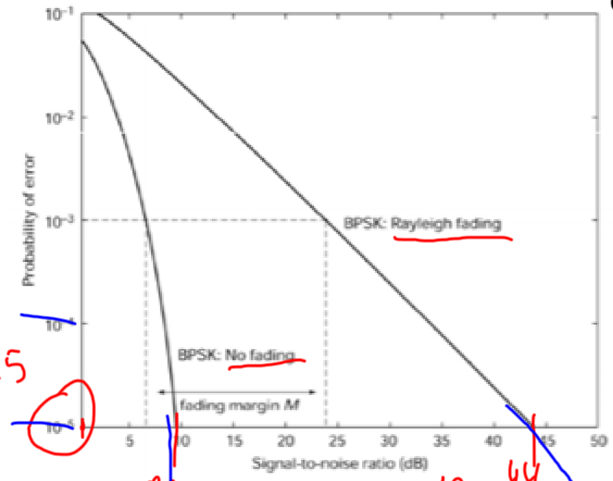
$P_R > P_{sensitivity} + P_{Fading\ margin}$ to achieve BER

wiki.unik.no/index.php/C... | Unik Wiki - Courses - UNI...

wiki.unik.no/index.php/Courses/UNIK4230?action=download&upname=Lec5_2011.pdf

BER for BPSK modulation without fading and with Rayleigh-fading

Fade margin M for BER=10^{-3} is 17 dB



GSM

$P_R = P_T \cdot G_{Tr} G_R \cdot L_{fs}$

20 W

43 dBm +10 +3 −120

$P_R = -64$ dBm

Fading margin: 41 dB

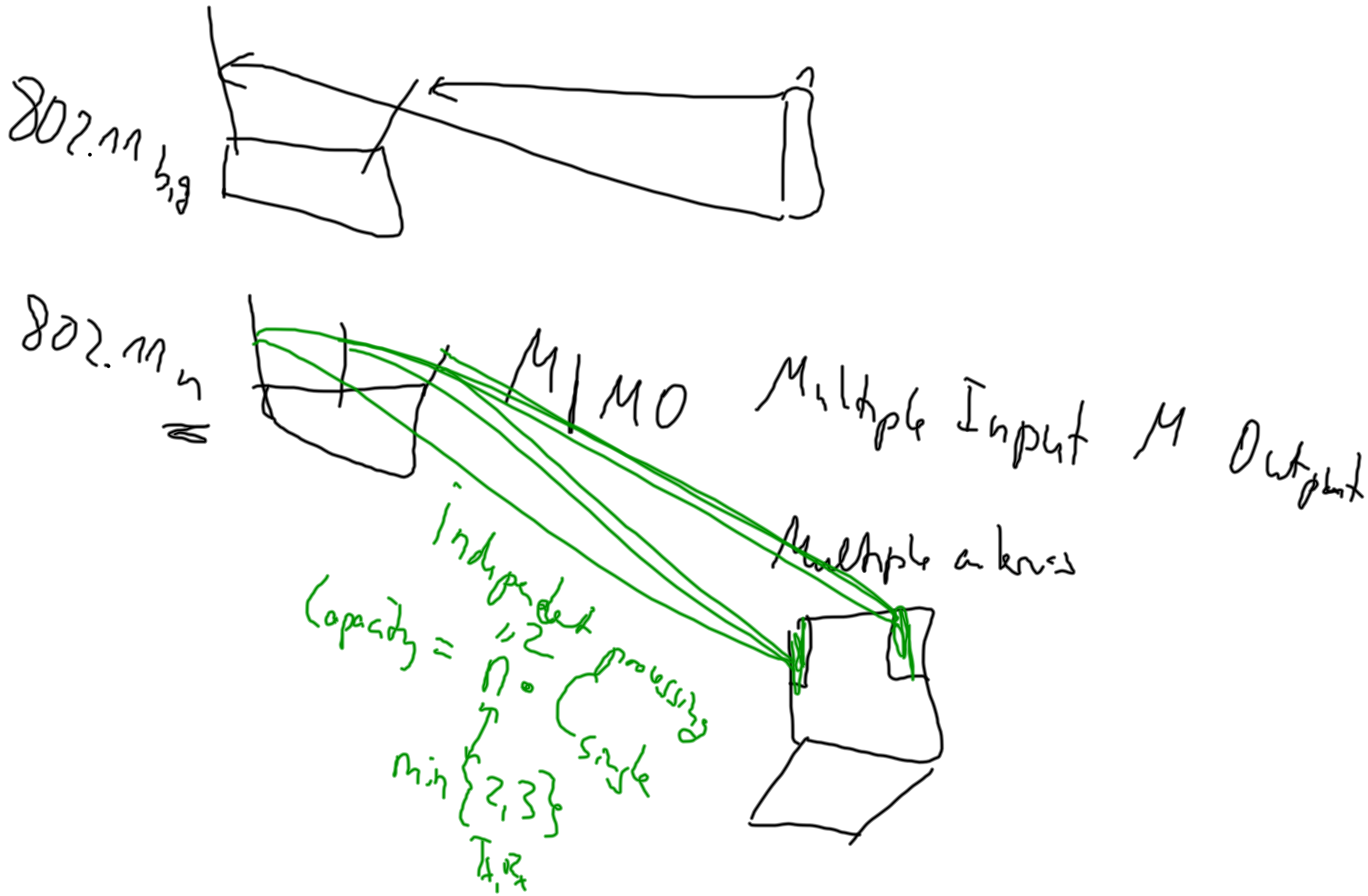
$P_{Sensitivity} = -105$ dBm

(WLAN) −95 dBm

Diversity (1)

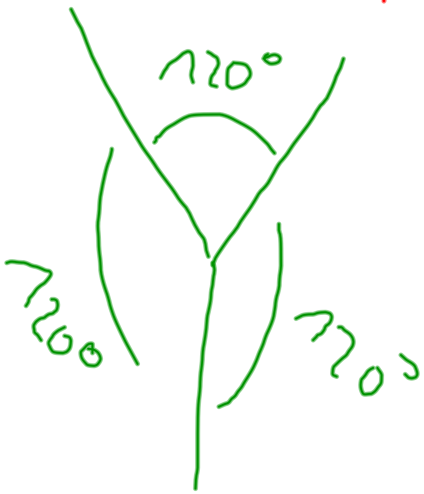
- Diversity means the combination of independent copies of the received signal, for example, by using multiple reciver antenna
- The main idea is the probability that several independent versions of the

Space diversity



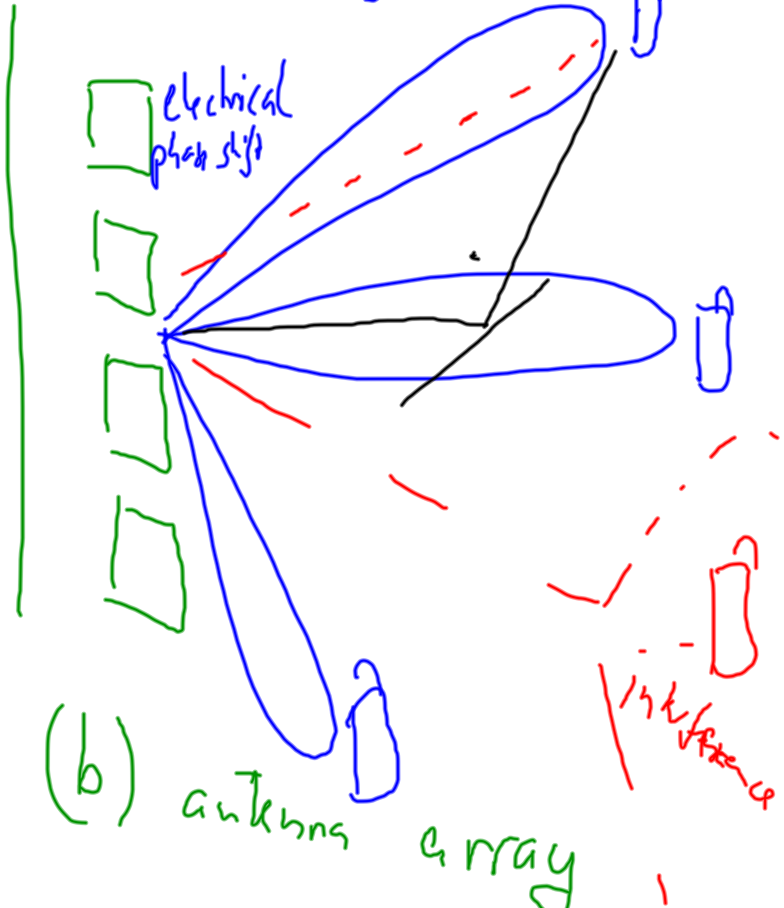
Angular diversity

+ multi path diversity

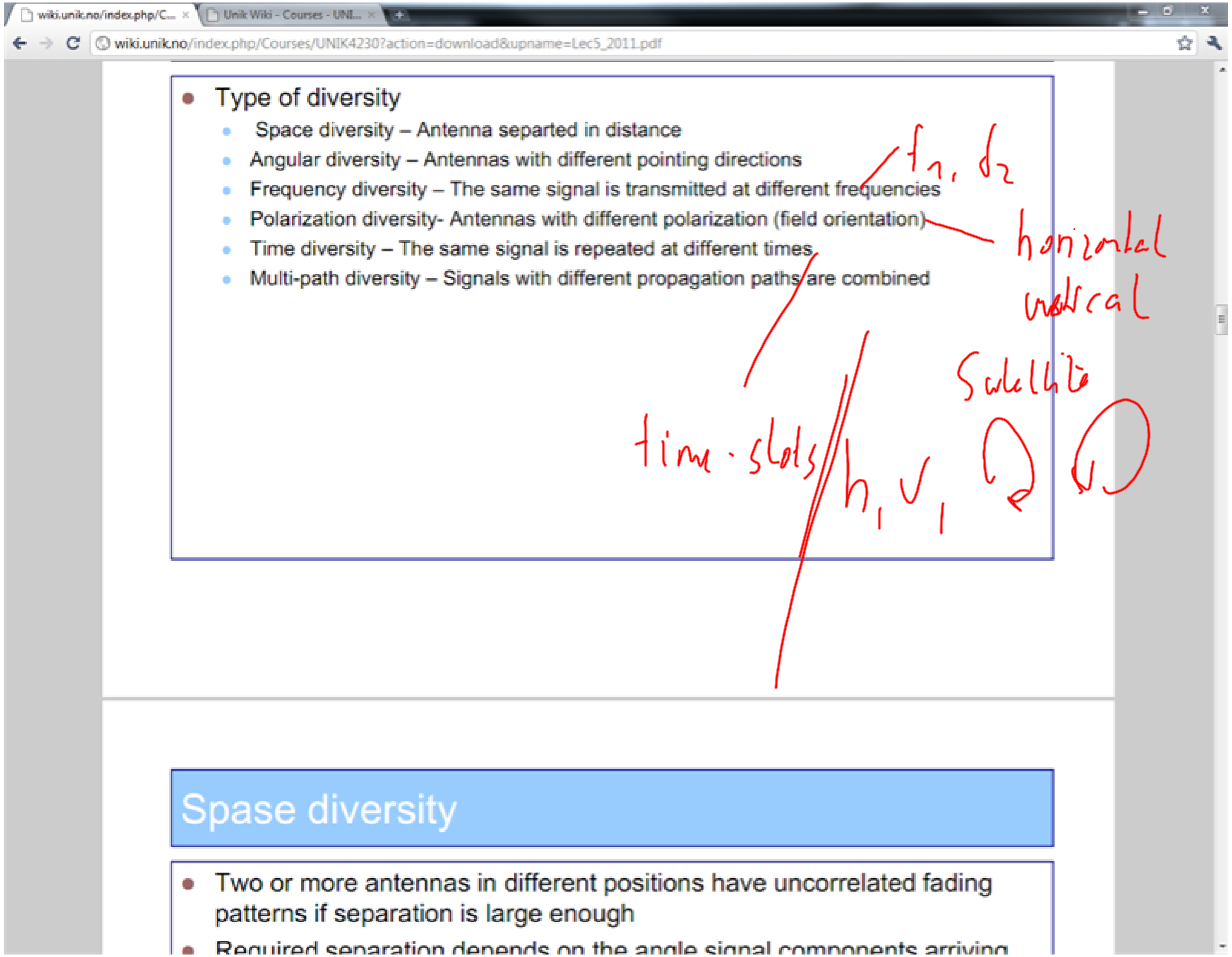


(a) Sector antennas

beamforming



(b) antenna array



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- Type of diversity
  - Space diversity – Antenna separted in distance
  - Angular diversity – Antennas with different pointing directions
  - Frequency diversity – The same signal is transmitted at different frequencies
  - Polarization diversity- Antennas with different polarization (field orientation)
  - Time diversity – The same signal is repeated at different times
  - Multi-path diversity – Signals with different propagation paths are combined

Spase diversity

- Two or more antennas in different positions have uncorrelated fading patterns if separation is large enough
- Required separation depends on the angle signal components arriving