

Cellular System Design: Fundamentals

- ✓ ① Larger subscriber base - Capacity
- ② Efficient use of spectrum - "Spectral efficiency"
"η"
- ③ Nation wide compatibility - Roaming
- ✓ ④ Widespread availability - "Coverage"
- ✓ ⑤ Adaptability to the traffic density - Capacity
- ⑥ Service to vehicles and portables - "Link budget"

⑦ All telephony services - group call

⑧ Telephone quality - "wireline quality"

⑨ Affordable

"SISO"

"MIMO"

≡

Early mobile systems: Large coverage

↓
Single antenna

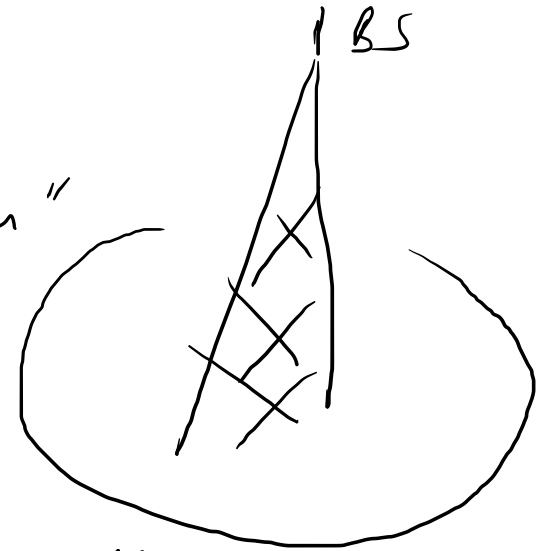
1970's Bell mobile system "high power"

NY City

~ 10 million peoples

~ 1000 sqm

~ 12 simultaneous voice calls



Note: Spectrum allocation is fixed

∴ Imperative to restructure the
radio telephone system to

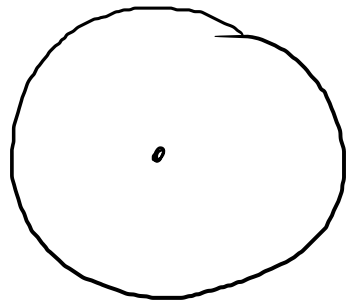
If demand ↑

- a) to achieve high capacity with limited spectrum
- b) Cover large area.

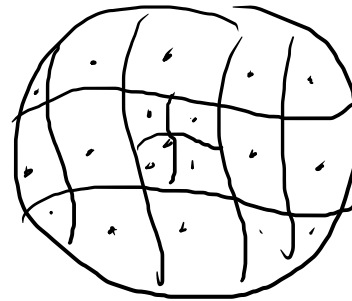
Cellular Concept - major breakthrough

major technical changes x.

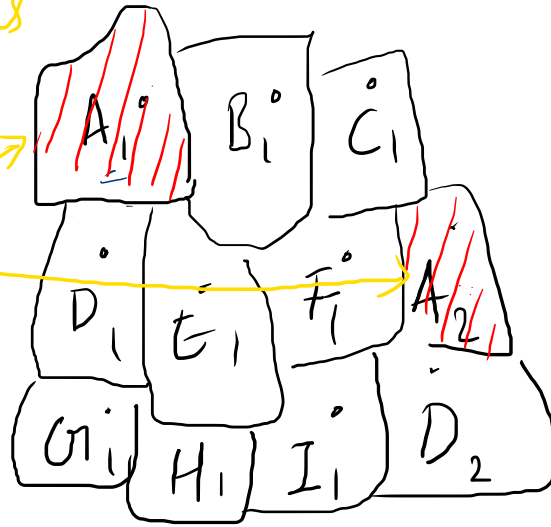
Spectral
Congestion
User Capacity



←
Service area



Co-channels

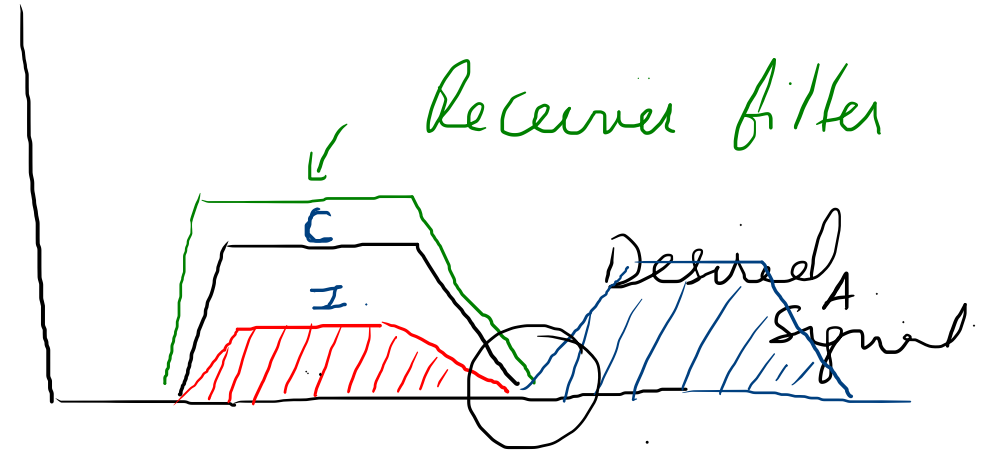


for GSM,

$$\left(\frac{C}{I} \right)_{\min} \geq 11 \text{ dB.}$$

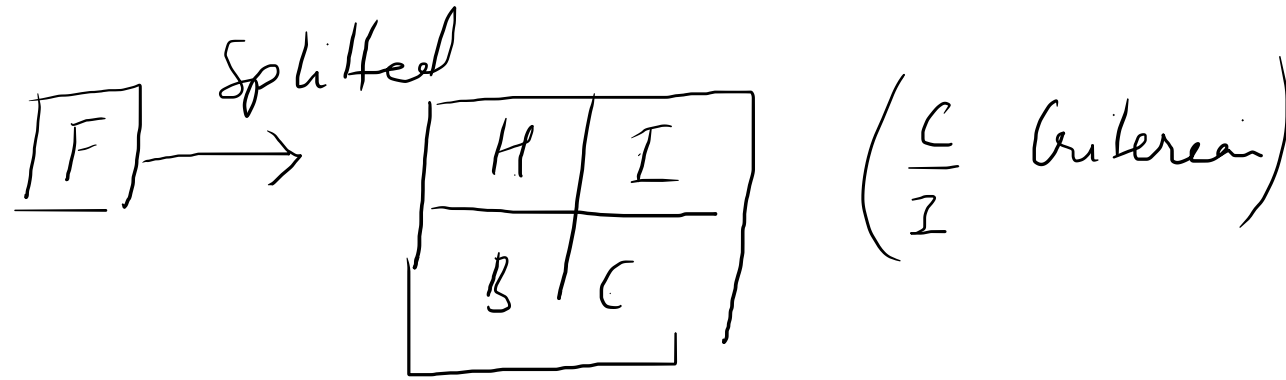
$$\left(\frac{C}{A} \right)_{\min} = -9 \text{ dB.}$$

- Each BS is allocated a portion of the "total no. of channels" available to the entire service area.



CCI % Co-channel interference

A	B	C	D	E	F	G	H	I	A	B		...
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Capacity $\uparrow \rightarrow$ Cells $\uparrow \rightarrow$ # BTS $\uparrow \Rightarrow$ Cost $\uparrow \Rightarrow$ Interference \uparrow

Example: on freq. reuse!

BW allocated for an operator is $BW = 36 \text{ MHz}$

Each user is using 25 kHz

Simplex channel.

UL DL

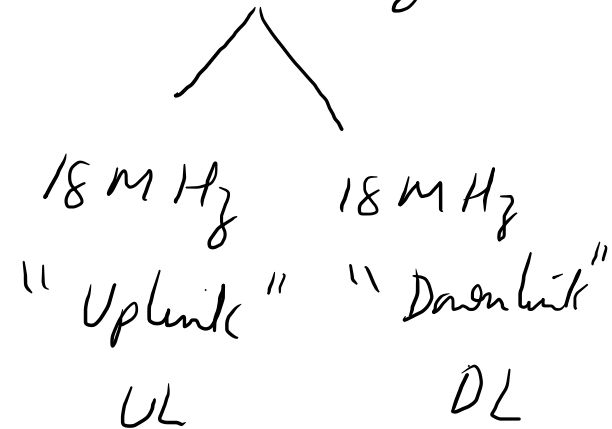
$$\# \text{ channel of channels} = \frac{36 \text{ M}}{25 \times 2 \text{ K}} = 720 \text{ channels}$$

"

$$25 \times 2 \text{ K}$$

20 channels \rightarrow reserved for control."

For traffic \rightarrow 700 channels

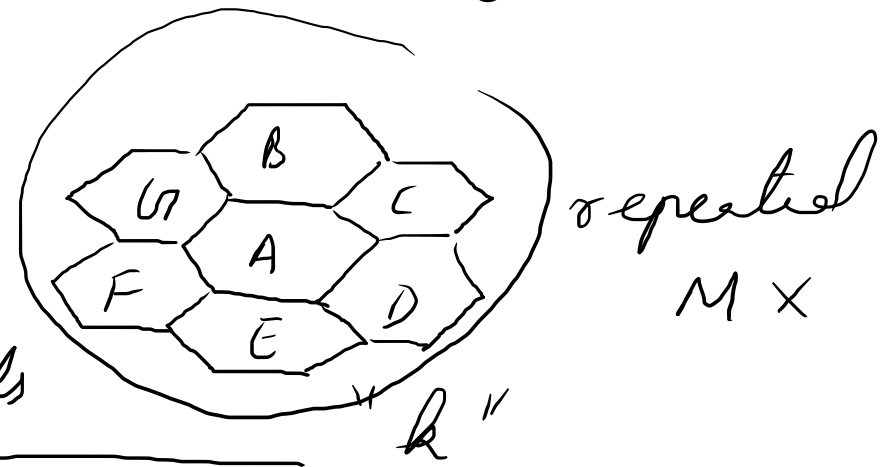


7 Cells / pattern - "N" "Cells / Cluster"

A, B, C, D, E, F, G

for each cell -

assign 100 channels



Total spectrum for the traffic - 700

$$S = k \times N$$

Total no. of channels available for

$$\text{Communication} = M \times k$$

\Rightarrow "C/I will decide"