

Opportunity Driven Multiple Access™

➤ *Beyond 3G™*

Cellular Deployment Issues

How to provide coverage?

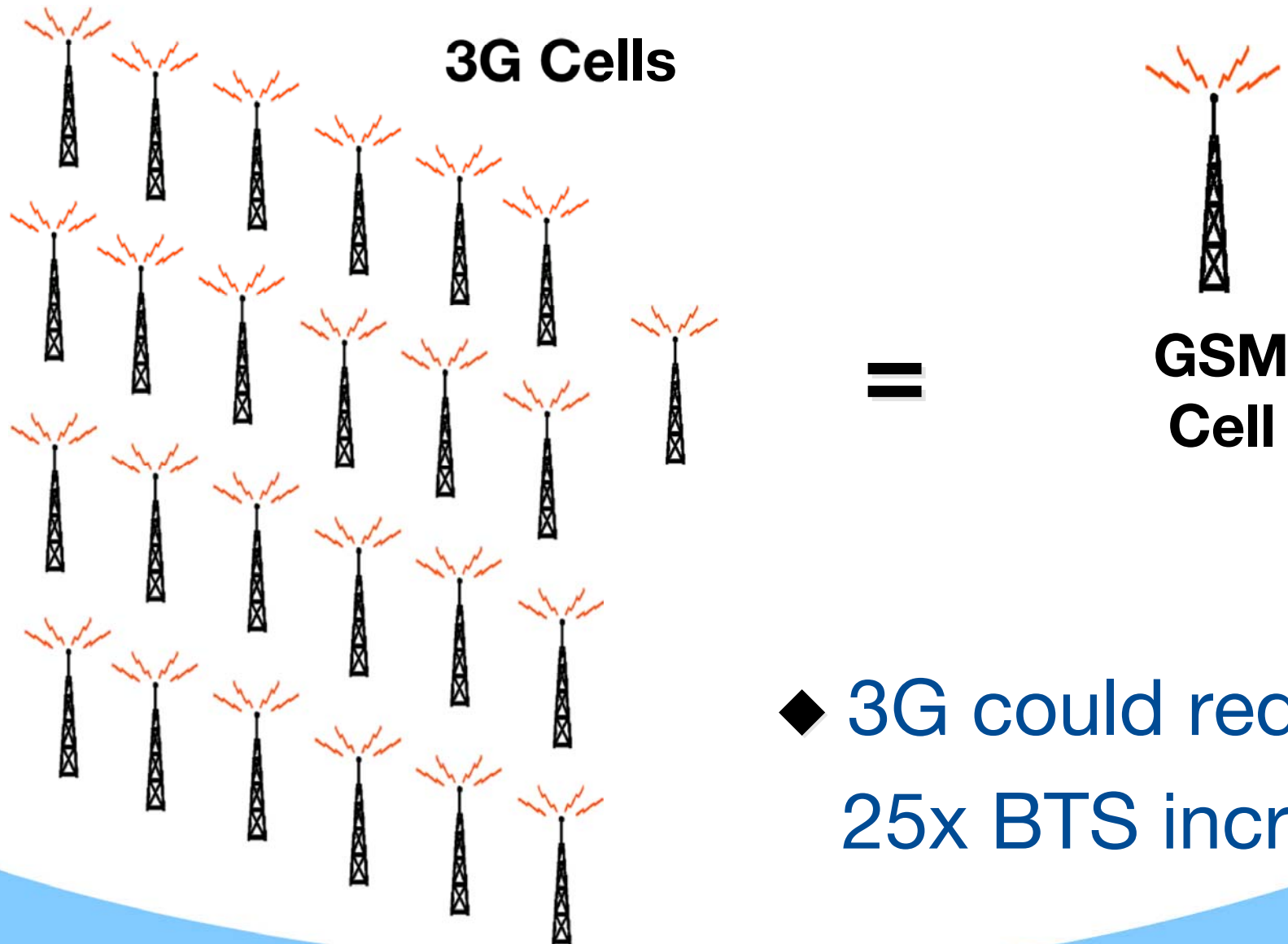
For 3G coverage is essential!

People want GSM coverage with
Cable DSL data rates!

3G Coverage - Example

- GSM - 9.6kbits/s @250mW mean
- 3G - 144kbits/s @100mW mean (-4dB)
 - Assume 2GHz is 8dB worse than 900MHz (-8dB)
 - Assume loss of 3dB every time data rate doubled (-11dB)
 - Assume loss of 10dB halves cell size
- Then 3G is -23dB down on GSM i.e.
 - ◆ The cell radius is reduced by 5x
 - ◆ The cell area is reduced by 25x

3G-GSM Cell Equivalence – only 144 Kbps



- ◆ 3G could require a 25x BTS increase!!

Can coding solve coverage?

- In 1948, Claude Shannon derived the bound on the error correction performance for all possible codes.
- No practical error correction coding system exists that can achieve the theoretical performance limit given by Shannon's law
 - Shannon's Limit $E_b/N_0 = -1\text{dB}$ for a AWGN channel
 - E_b – Energy per bit, N_0 – Noise density
- Modern communication systems including GSM are already within a few dB of the Shannon's limit.
- Conclusion – only a few dB of gain is possible with respect to GSM from coding before Shannon's limit is reached.
- The answer is NO - a fundamental limit of physics.

Can WCDMA solve coverage?

- All methods of coding including spread spectrum are bounded by Shannon's law.
- Spread spectrum spreading gain as expressed in C/I only applies in interference limited and not noise limited cases.
- In performing coverage analysis the noise limited case must be used.
- The answer is NO – a fundamental limitation of physics

Coverage Conclusion

- Coverage a major problem for 3G cellular.
- CT2 and “Hot spots” have failed against wide area coverage such as GSM.
- Three important words in roll out of any wireless service:
 1. Coverage
 2. Coverage
 3. Coverage

Capacity - Spectrum Issues

Bits/sec/Hz

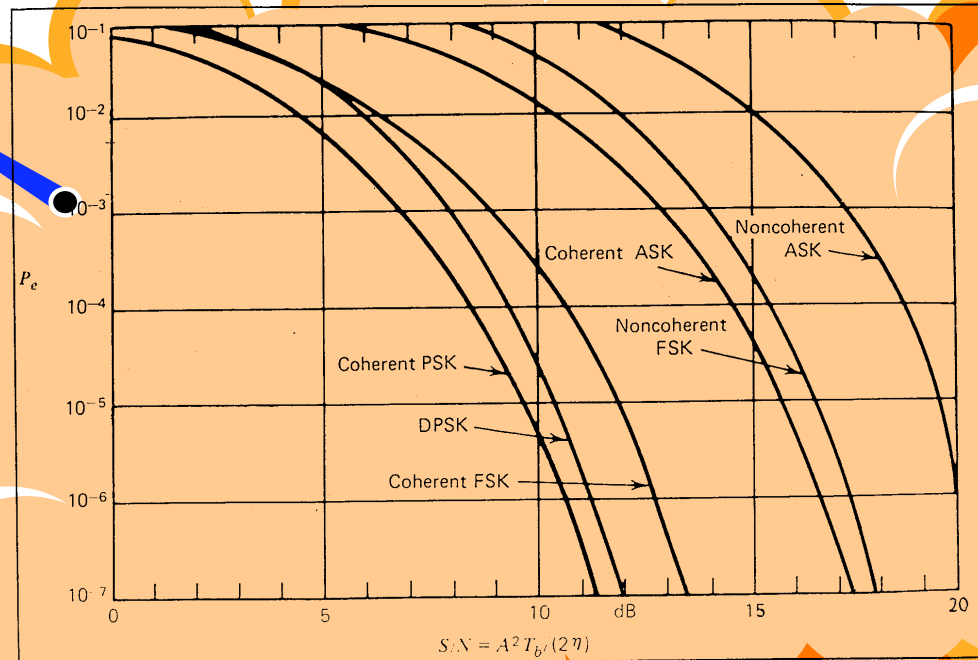
For 3G capacity is essential
Spectrum is expensive and limited!

Capacity - Spectrum Issues

- Early 3G operators have paid a fortune for limited spectrum -
 - a 2x15MHz spectrum allocation (or share of such spectrum)
 - or have to re-farm GSM bands.
 - 3G must have better frequency re-use than GSM
 - 3G may have to support band sharing
 - tolerate other public and private systems
 - 3G should be deployable in a range of Bandwidths
 - for re-farmed and limited spectrum
 - 3G should have a TDD mode
 - so not dependent on paired bands
- The Operators need to solve the above issues and maximize on their investment.

Every wireless engineer is trying to solve bits/sec/Hz and Reduced Signal to Noise Ratio

More Capacity for less spectrum and less power transmitted



Capacity - The Shannon Limit

- Shannon's law: Defines the theoretical maximum rate at which error-free digits can be transmitted over a bandwidth-limited channel in the presence of noise,
- Usually expressed in the form $C = W \log_2(1 + S / N)$, where
 - C - channel capacity in bits per second
 - W - channel bandwidth in hertz
 - S / N - signal-to-noise ratio
- In all cellular systems
 - increased channel capacity requires increased S / N
 - increased S / N results in increased inter cell interference
 - increased inter cell interference results in reduced channel capacity
- The Shannon limit prevents substantial capacity improvement in performance of cellular systems

Capacity - Conclusion

- You cannot cheat Shannon!
- Modulation with more Bits/sec/Hz does not increase cellular capacity!
- A major capacity problem for cellular 3G.

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