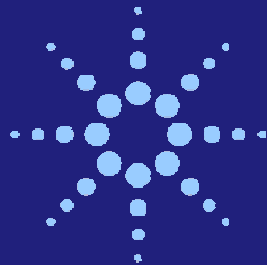


Wireless Technology Seminar:

EDGE/GPRS Basics

Paul Robertson
Wireless MSU



Agilent Technologies
Innovating the HP Way

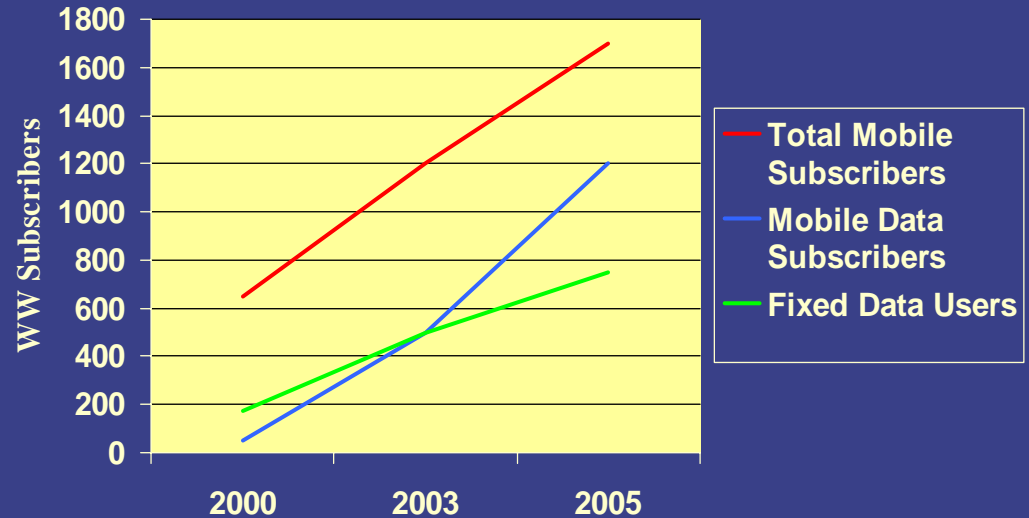
Agenda

- Technology Drivers
- Technology Roadmap
- Acronym Definitions
- Technology Migration
- HSCSD & GPRS
 - Technology Implementation
 - Implementation Challenges
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Market Demand for Data Services

- Demand for wireless data services expected to grow significantly
- Driven by new services:
 - ✓ e-mail/messaging
 - ✓ m-commerce
 - ✓ location-based services
 - ✓ entertainment



Source: Arc Group, Oct. 2000

- Low availability of applications will limit the customer use of data services
- Network Operators are looking to promote data services to increase revenues



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Standards Update

- **HSCSD**

- All standards work complete. Actively under development. Service has started.

- **GPRS**

- Standards work complete. Nokia, Ericsson & Motorola very active. Service introduction Q3'00.

- **ECSD** (Enabled by EDGE)

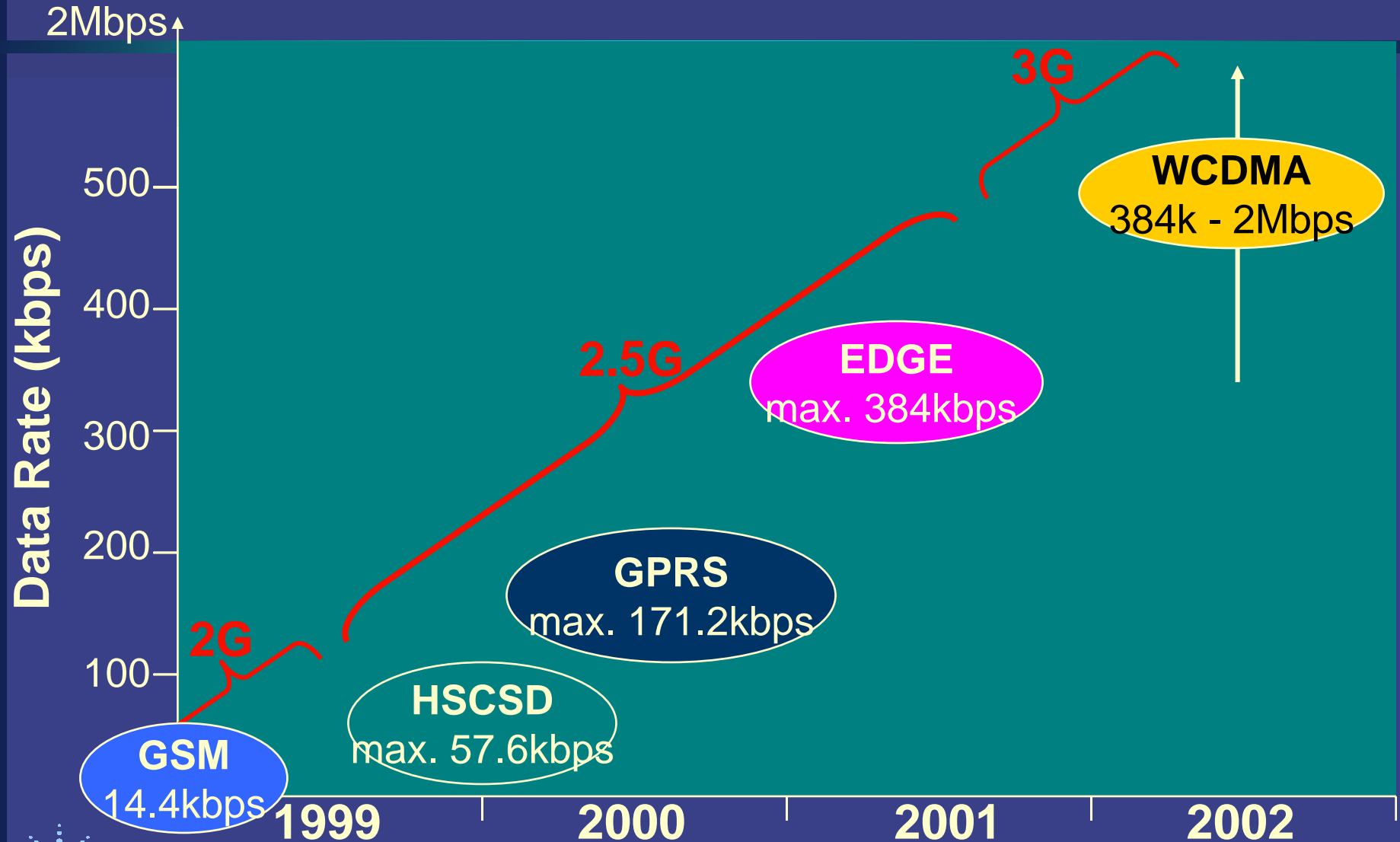
- Standardisation process well underway. Service could start mid '01.

- **EGPRS** (Enabled by EDGE)

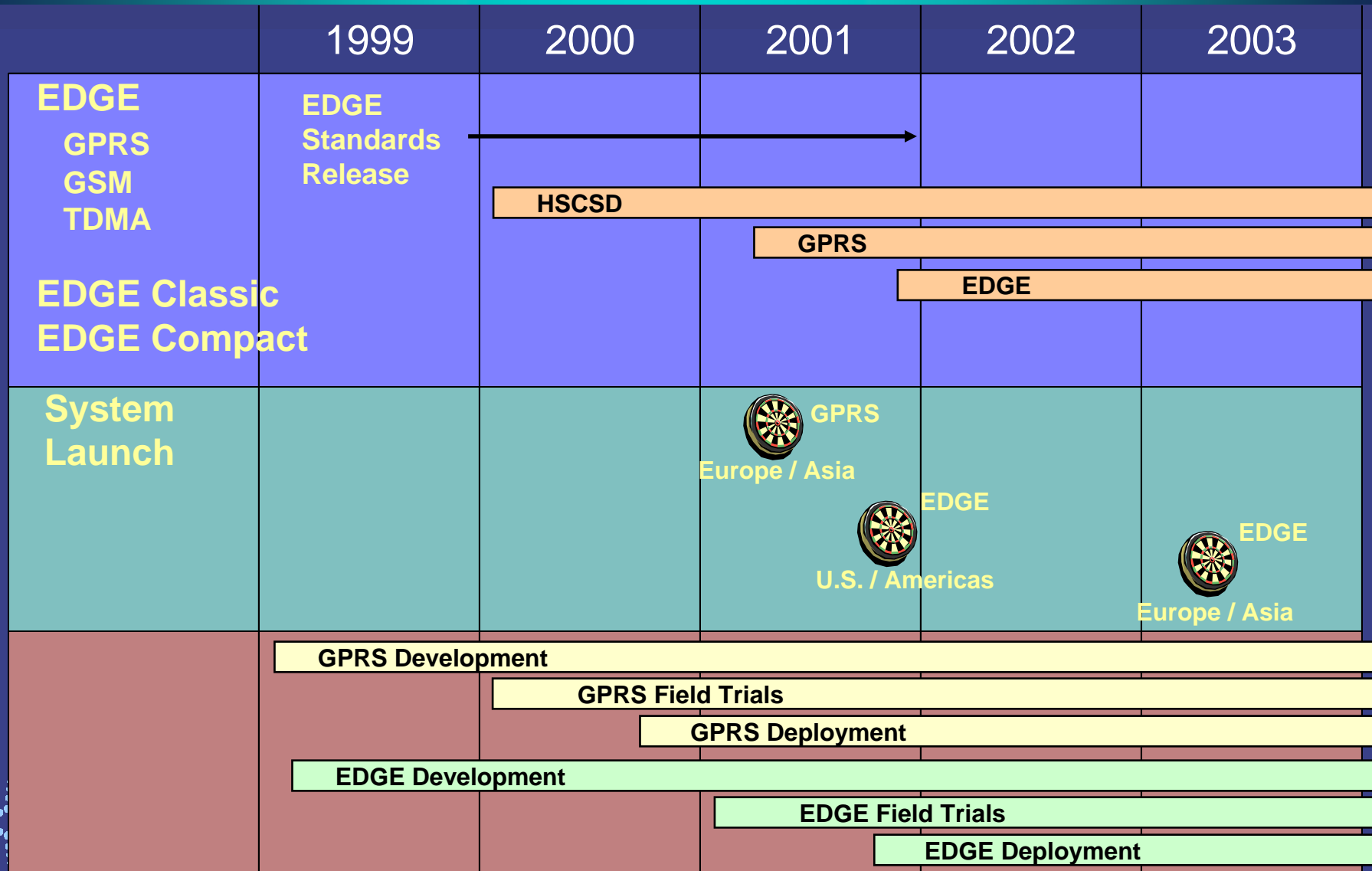
- Standardisation process well underway. Service could start late '01.
'More exciting than ECSD'



Roadmap to Higher Data Rates



Wireless Technology Roadmap - EDGE



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The Acronyms..

- **HSCSD** - **H**igh **S**peed **C**ircuit **S**witched **D**ata
- **GPRS** - **G**eneral **P**acket **R**adio **S**ervice
- **EDGE** - **E**nhanced **D**ata Rates for **G**SM
Evolution

These new technologies provide solutions to increase the data rates over existing GSM and IS-136 Networks

HSCSD, GPRS & EDGE are collectively called 2.5G, however EDGE is regarded by many as a 3G technology.

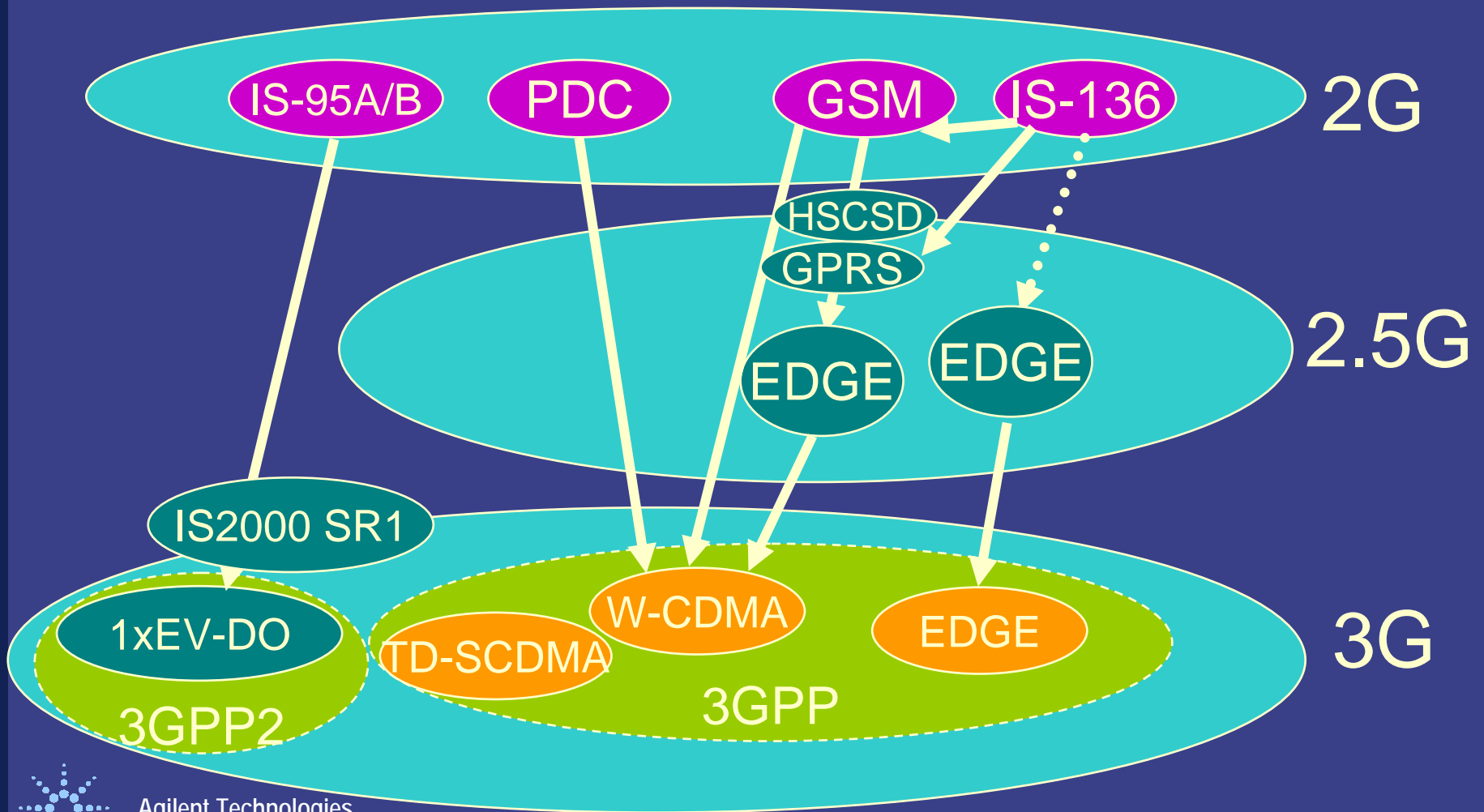


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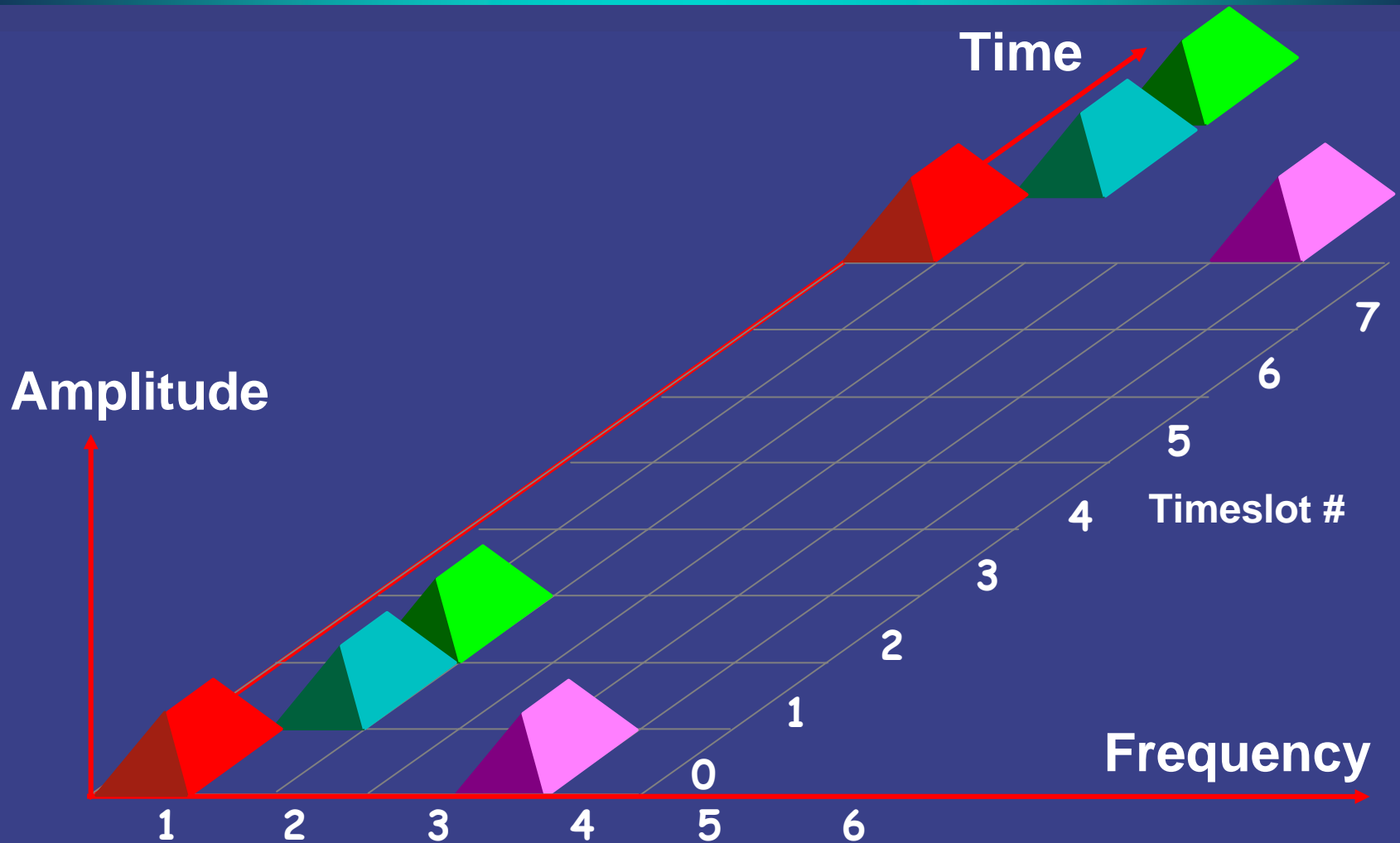
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2nd to 3rd Generation Migration



GSM FDMA and TDMA



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HSCSD

- High Speed Circuit Switched Data - HSCSD
 - HSCSD is a *circuit switched* technology
 - All today's cellular networks are circuit switched
 - A physical channel is assigned for the duration of the call
 - Physical channel connection is maintained even if data is not being transferred



GPRS

- General Packet Radio Service - GPRS
 - GPRS is a *packet switched* technology
 - This is very different to today's cellular network architectures
 - A physical channel is only assigned when data needs to be transmitted or received
 - Physical channels can be shared between different mobile users



Circuit versus Packet Switched

Circuit Switched

- i.e. HSCSD
- Each physical channel is assigned
- Suitable for..
 - Time critical apps
 - e.g. videophone
- Complements..
 - PSTN & ISDN
- Charged by...
 - The minute

Packet Switched

- i.e. GPRS
- Each physical channel is shared
- Suitable for..
 - Web browsing
 - Email
 - Stock Values, etc
- Complements..
 - TCP/IP, X25
- Charged by..
 - The BIT (& QoS)



Physical Layer Aspects of HSCSD & GPRS

- Most changes to 'conventional' GSM are above layer 1 (i.e. protocol)
- However at the physical layer both HSCSD & GPRS...

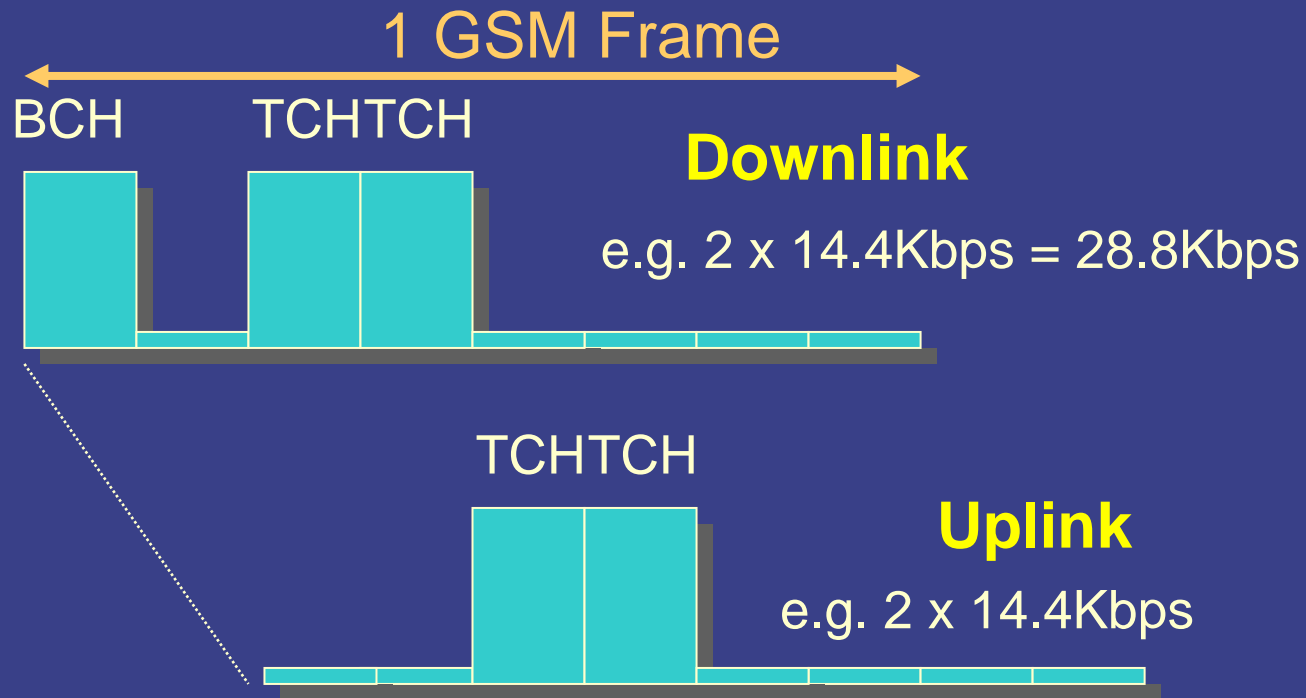
= 'Multi-slot'

- In other words, for the first time Mobile Stations can transmit during *more* than one slot per frame.



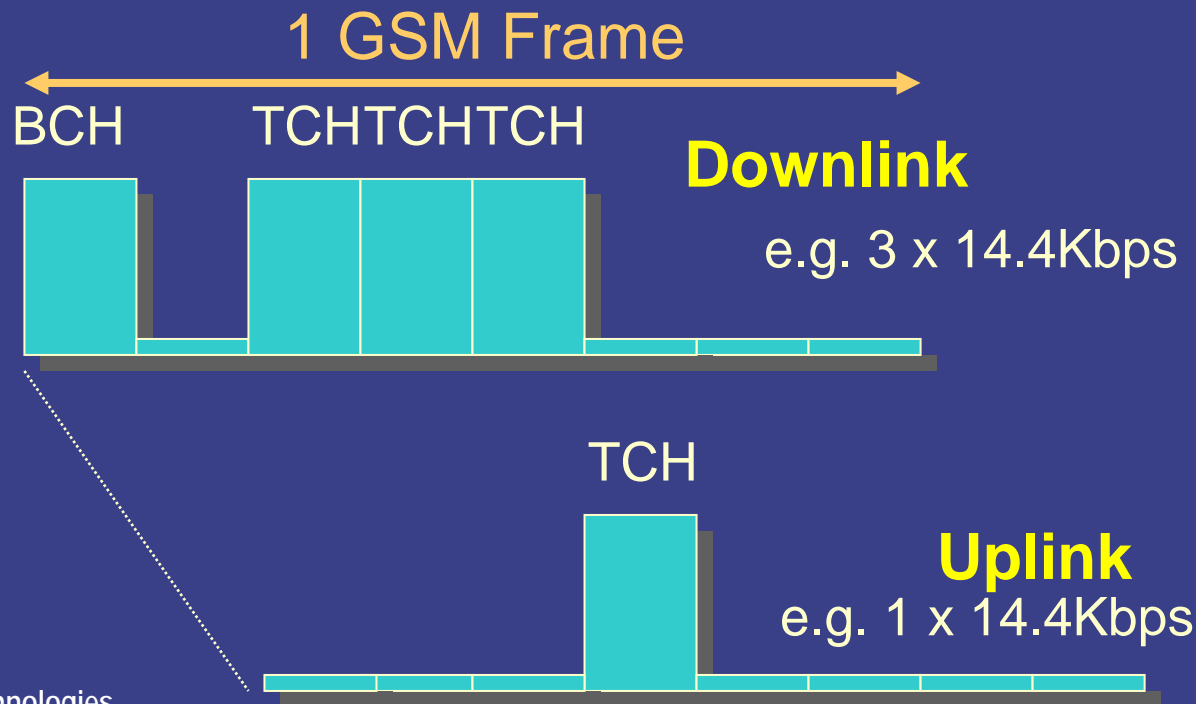
Multi-slot = More data throughput

HSCSD & GPRS mobiles can transmit and receive on *multiple* GSM timeslots per frame.



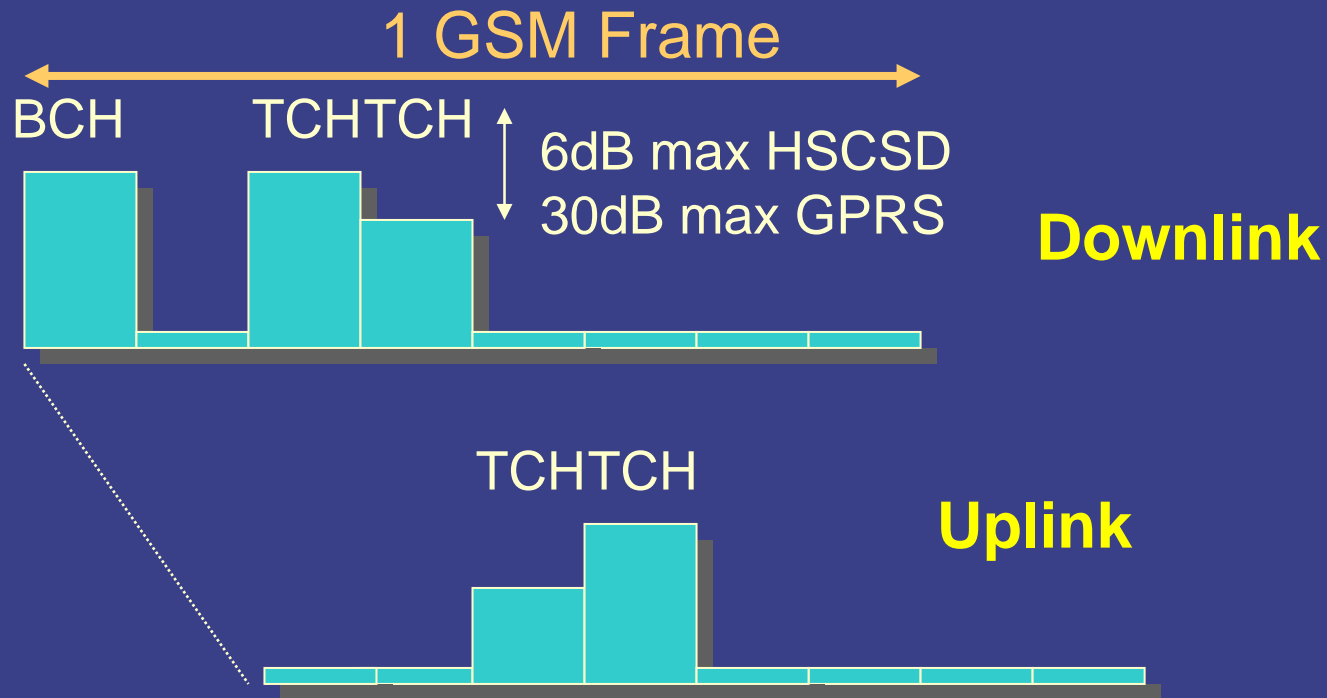
Multi-slot Combinations

Many combinations of Uplink and Downlink data rates are possible. For example a Web browser will require much higher downlink data rates than uplink.



Multi-slot Power Levels

In addition, each uplink and downlink slot can be at different power levels!



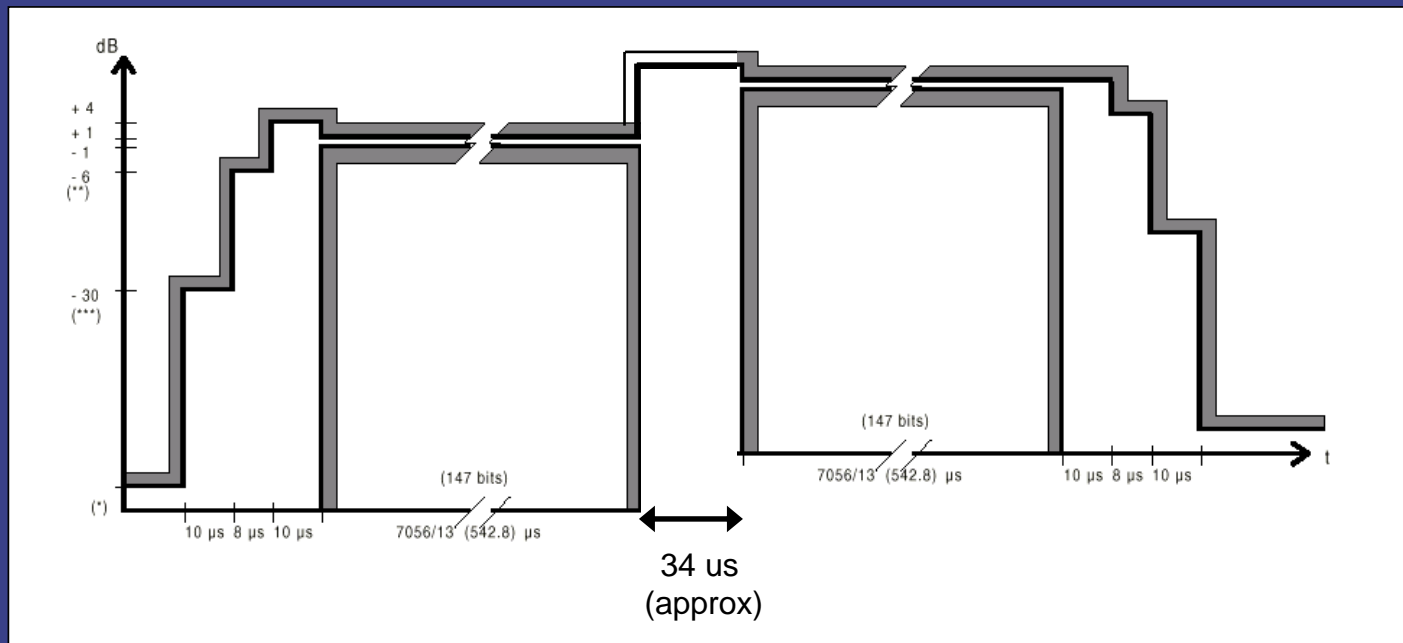
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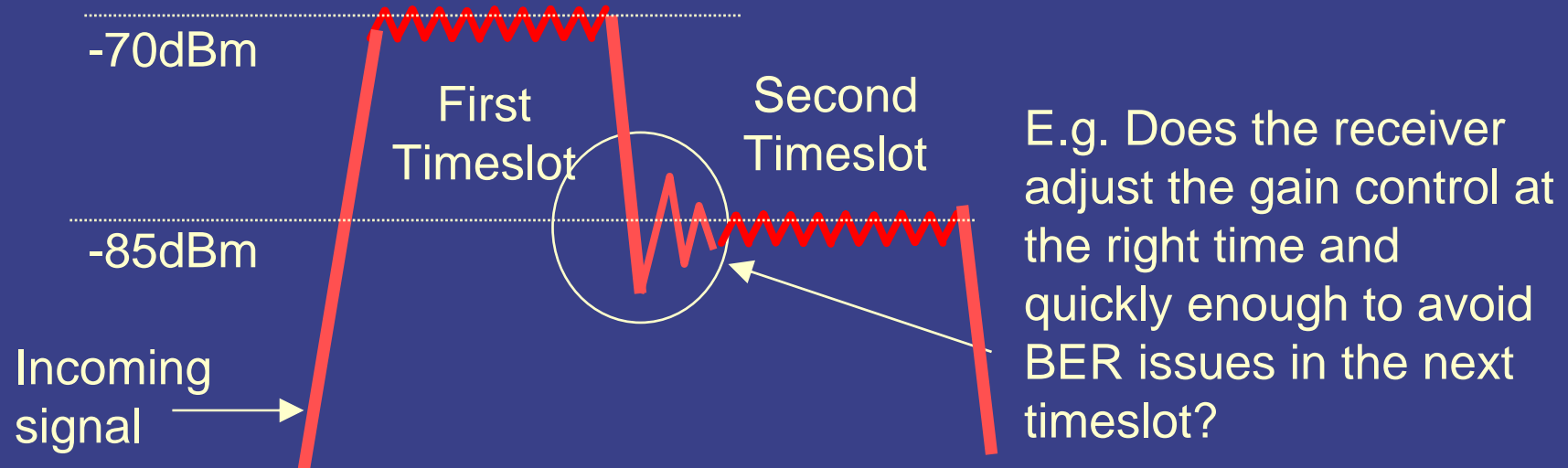
Mobile Transmitter Power Requirements

HSCSD & GPRS mobile's can now transmit on *multiple* uplink slots and these can be at *different power levels*.



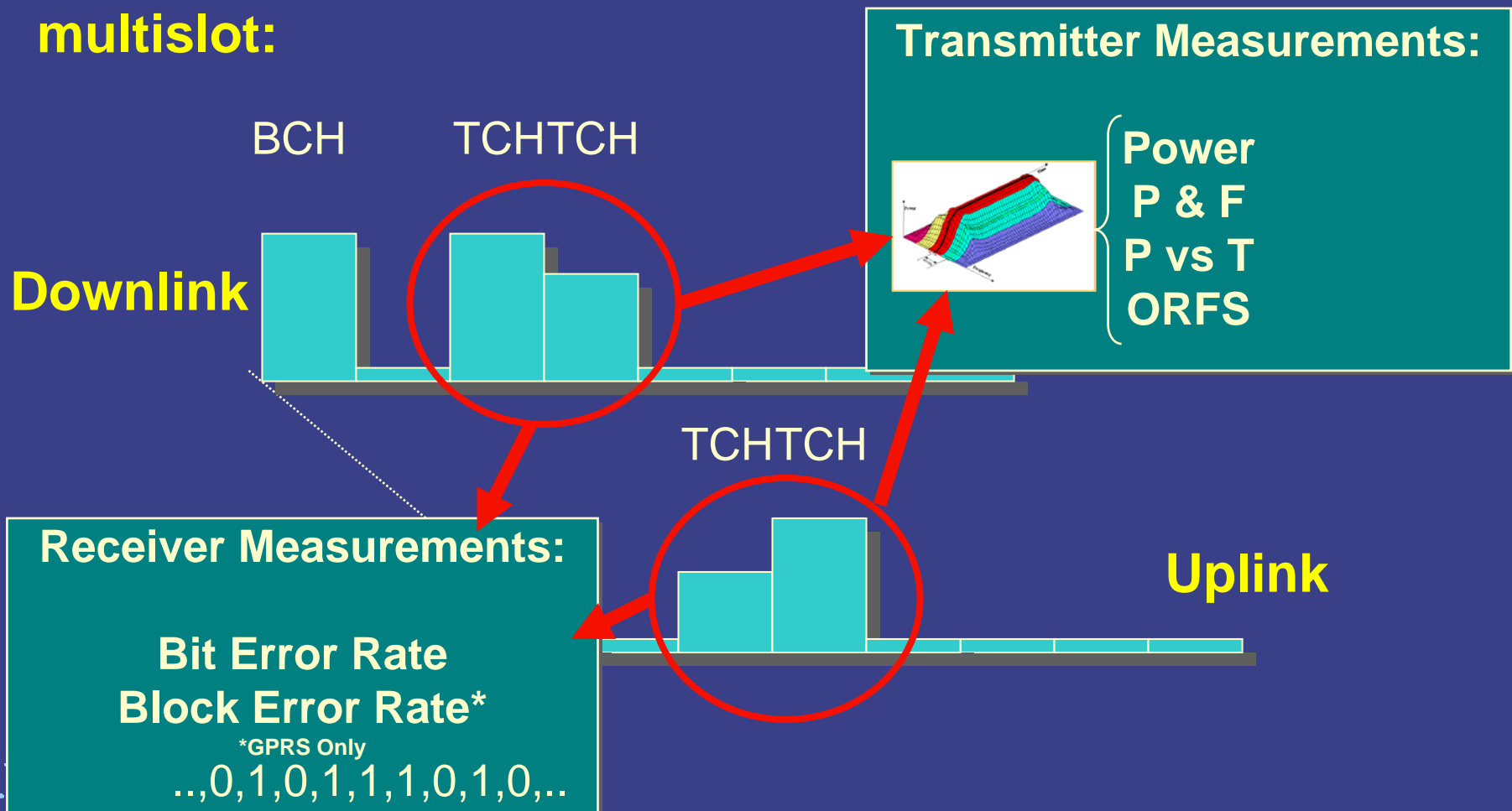
Multislot Receiver Requirements

The mobile can also receive on *multiple* downlink slots and these too can be at *different power levels*.



Multi-slot Test Requirements

The key RF measurements for multislot:



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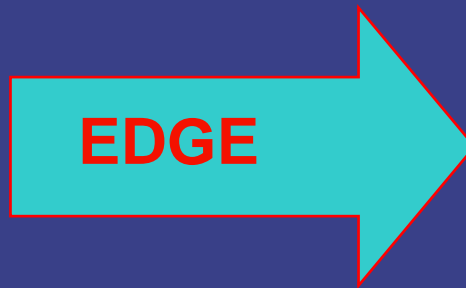


What is EDGE?

- **EDGE** = **E**nhanced **D**ata rates for **G**SM **E**volution
- **EDGE** is an extension to HSCSD and GPRS

HSCSD

GPRS



ECSD

EGPRS

- **EDGE** defines a new modulation format (8PSK) that allows services such as HSCSD & GPRS to go faster



Agenda

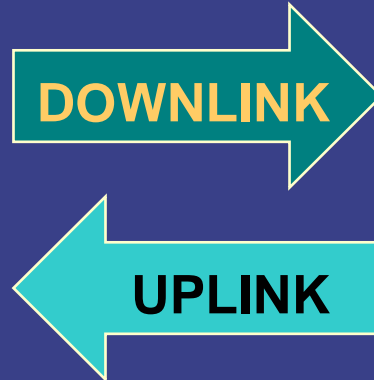
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EDGE Classes



BTS



MS

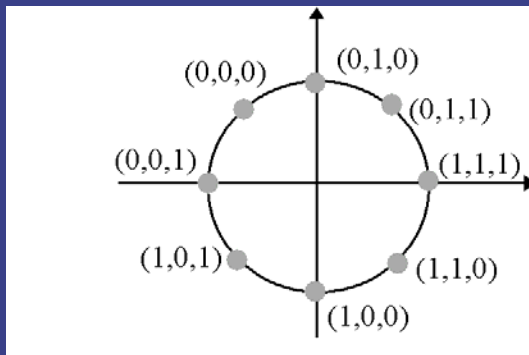
Class	Downlink	Uplink
A	8 PSK	GMSK
B	8 PSK	8PSK

Class A services may come first, however most mobiles will be Class B from the start

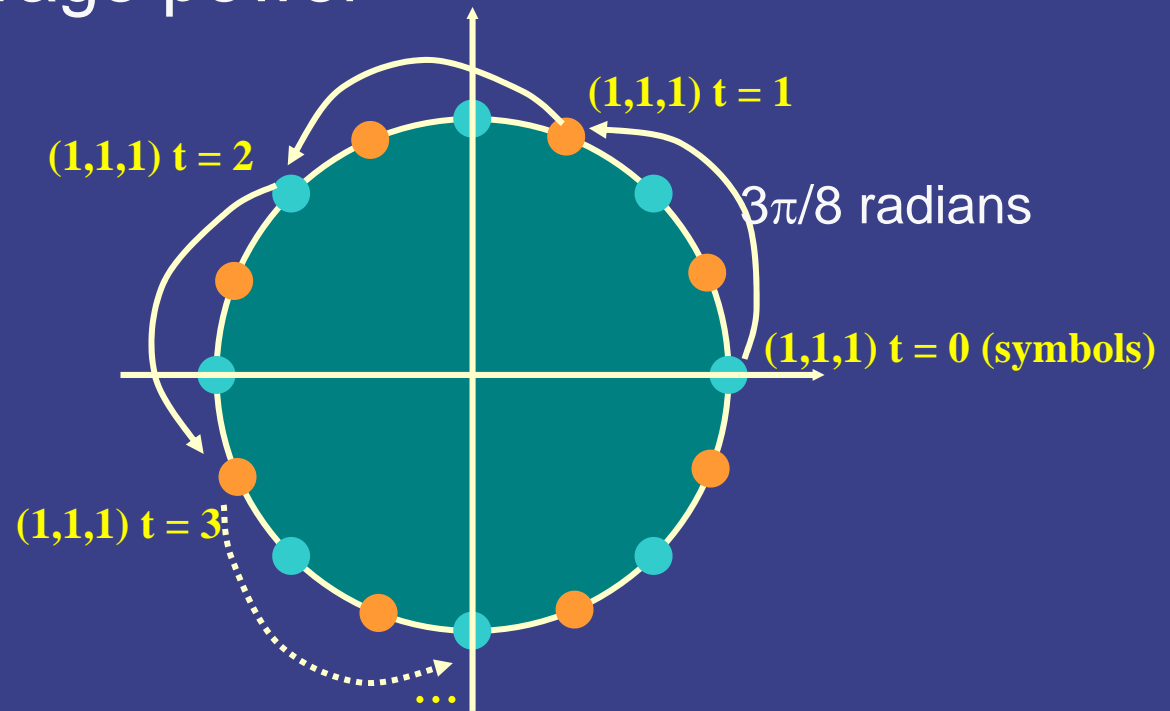


EDGE Physical Layer

- 8PSK constellation rotates $3\pi/8$ radians per symbol period
- Rotation prevents zero crossings, reducing peak-to-average power



Standard 8PSK
Constellation



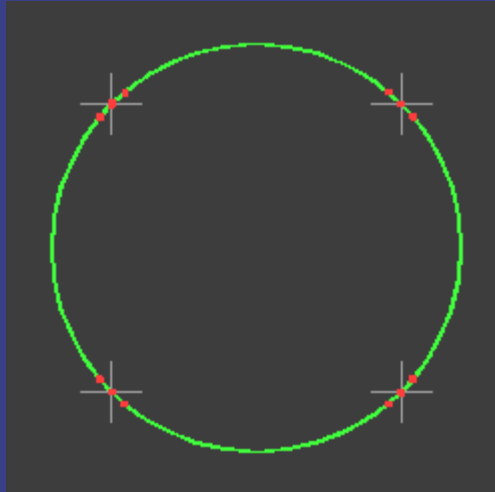
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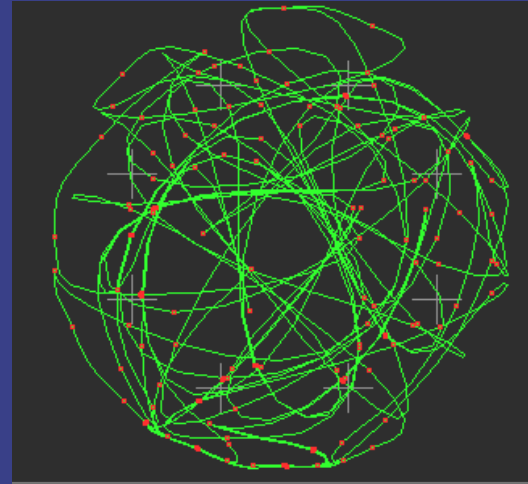


The challenge of moving to EDGE for physical layer developers

GSM
0.3 GMSK



1 Bit / Symbol
Constant Envelope



EDGE
 $3\pi/8$ Shifted
8PSK

3 Bits / Symbol - -3X Data!
Amplitude Changes 16+ dB

- **EDGE is a Non constant amplitude signal!**
- **This introduces significant RF design & test challenges**



New Measurement for EDGE

- New EVM measurement has been defined for EDGE

EVM = Error Vector Magnitude

- Provides a solution for measuring non-constant amplitude signals
- Agilent is playing lead role in EVM measurement definition at ETSI



IS-136 EDGE

EDGE
Compact

EDGE
Classic



GPRS - 136HS EDGE
(High Speed Packet Data)

- IS-136 EDGE Consists of 2 formats:
 - EDGE Compact = 3 Carriers
 - EDGE Classic = Standard EDGE

U.S. IS-136 Operators are aggressively pursuing EDGE

EDGE is needed to enable IS-136 operators to compete directly with IS-95 and IS-2000



Market Summary - Dec 00

- HSCSD

- Considered a niche market, only a few operators plan to introduce an HSCSD service
- Orange (UK) planning to release HSCSD videophone Q1'01 (over 18 months later than planned)

- GPRS

- Late introduction of mobiles has delayed service intro.
- Trials having problems delivering promised data rates

- EDGE

- Unclear if EDGE will happen in Europe
- Recent AT&T announcement has put question mark over EDGE in US
- Long term EDGE seen as a compliment to W-CDMA

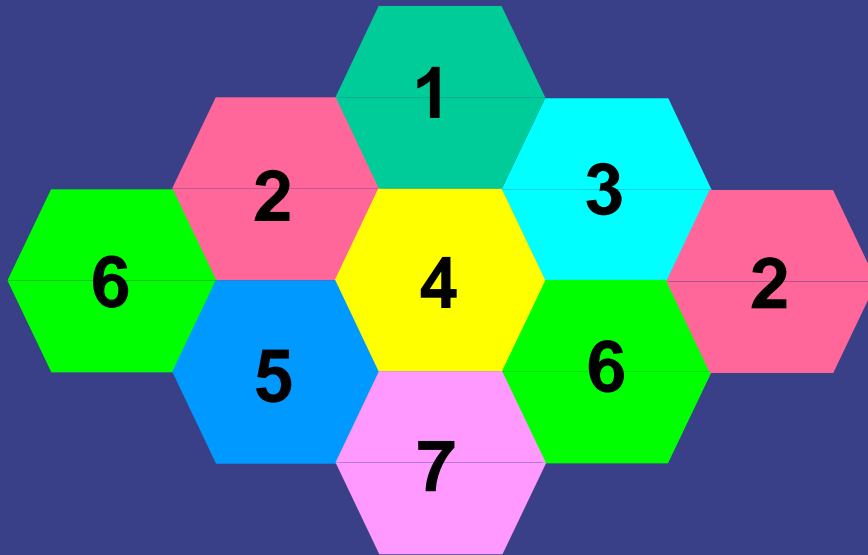


Universal Mobile Telecommunications System (UMTS) 3G

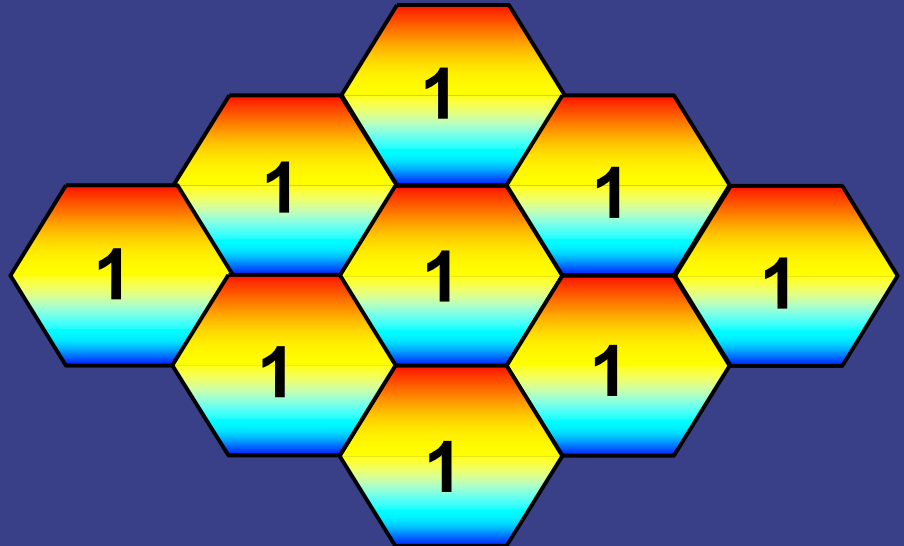


Agilent Technologies

CDMA Frequency Reuse - The Key to Channel Capacity



FDMA Reuse

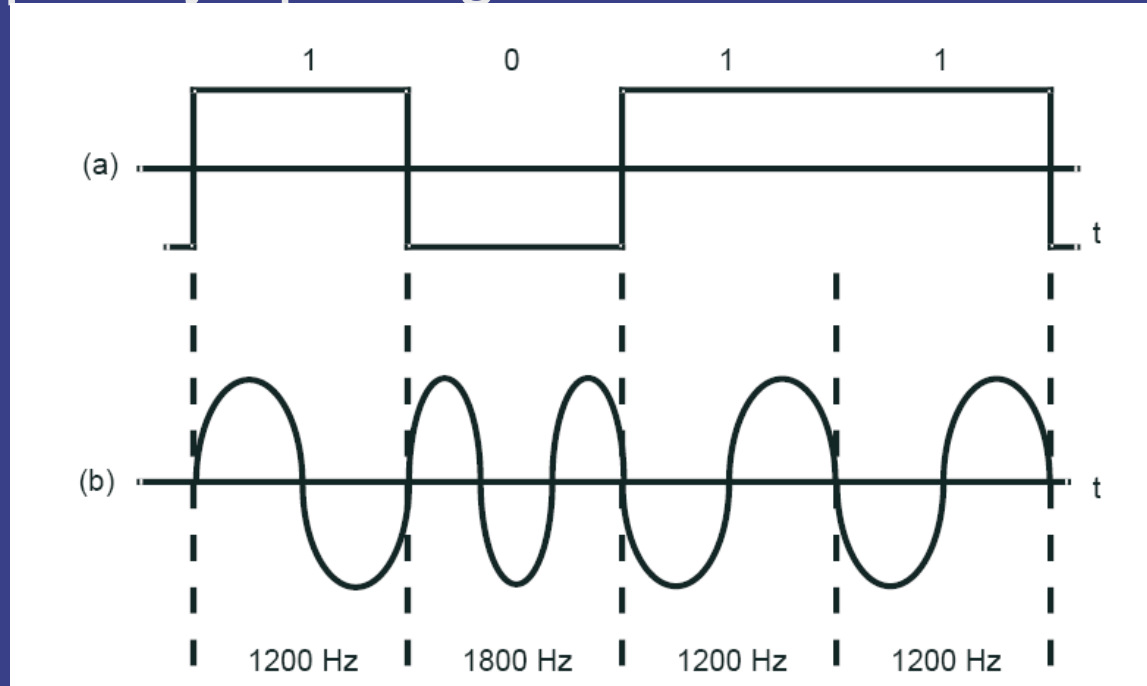


CDMA Reuse



Example of MSK (CDMA)

- 1200 bits/sec baseband MSK data signal
- Frequency spacing = 600Hz



CDMA spec.

Only key features are cited below.

- Radio channels are 5 MHz wide.
- Chip rate of 3.84 Mcps
- Supported mode of duplex: frequency division (FDD)
- Employs coherent detection on both the uplink and downlink based on the use of and channels[2].
- Supports inter-cell asynchronous operation.
- Variable mission on a 10 ms frame basis.
- Adaptive power control based on SIR (Signal-to-Interference Ratio).
- Multiuser detection and smart antennas can be used to increase capacity and coverage.
- Multiple types of handoff (or handover) between different cells including soft handoff, softer handoff and hard handoff.

