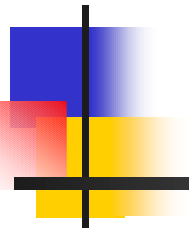
Channel Capacity Evaluation for cdma2000



COE 543 – Mobile and Wireless Networks

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Outline

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- Cdma2000 Protocol Stack
- Physical Layer
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- Conclusion

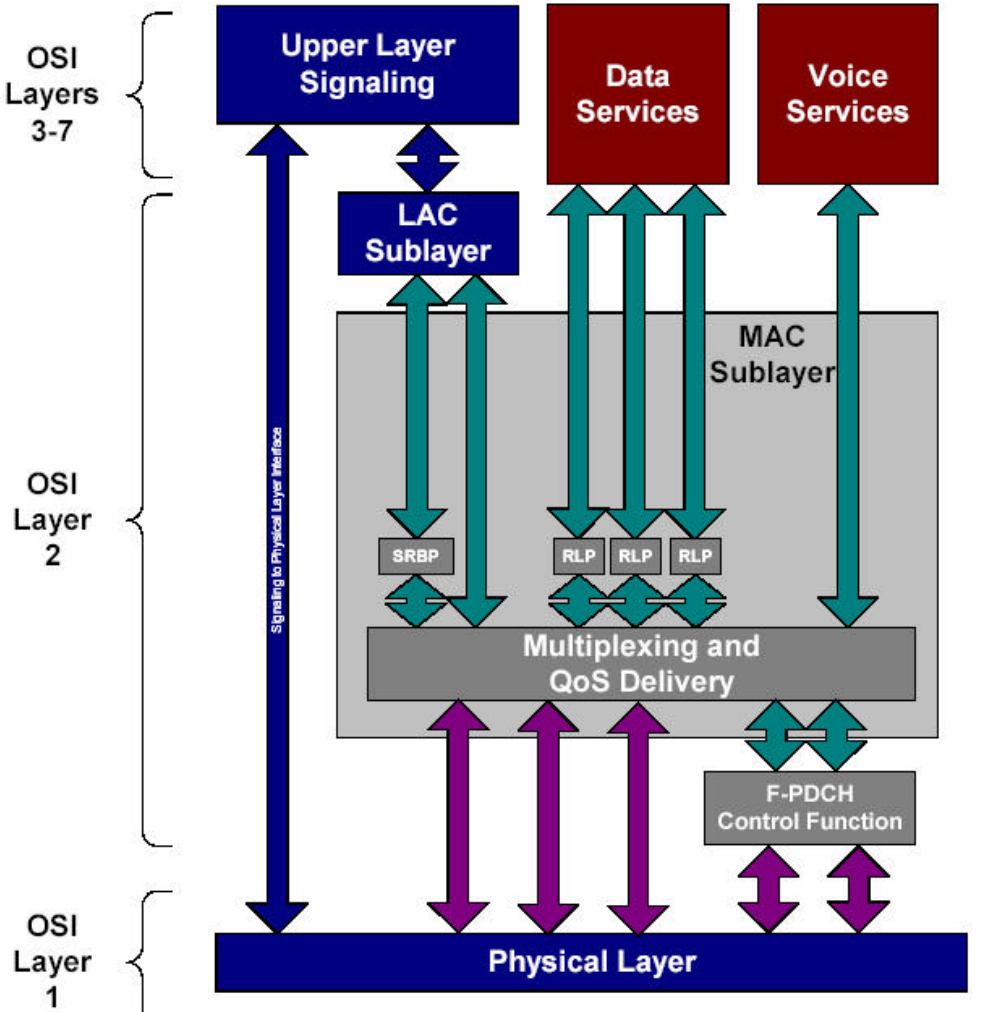
Introduction

- Backward compatibility to TIA/EIA-95-B
  - Supports TIA/EIA-95-B signaling and services
  - Spreading bandwidths compatible with IS-95-B deployments
  - Supports cdma2000 to IS-95/IS-95-B hard handoff
  - Protects operator investment in existing cdmaOne networks
  - Provides simple and cost-effective migration to 3G services
- Overlay upgrade to TIA/EIA-95-B
  - Supports backward compatible common channels
  - Forward Link orthogonality maintained between cdma2000 mobiles and IS-95-A/B mobiles

Introduction (cont.)

- Support of IMT-2000 data rates
  - Vehicular – 144 kbps (supported by 1X systems)
  - Pedestrian – 384 kbps (supported by 3X systems)
  - Indoor – 2 Mbps
- Advanced Medium Access Control (MAC)
  - Support different quality of service for a wide range of advanced services concurrently
  - Simultaneous voice/data support for multi-service
  - QoS support for multimedia applications
- Significantly improved mobile stand-by time
- Spot beam and smart antenna coverage

Cdma2000 Protocol Stack



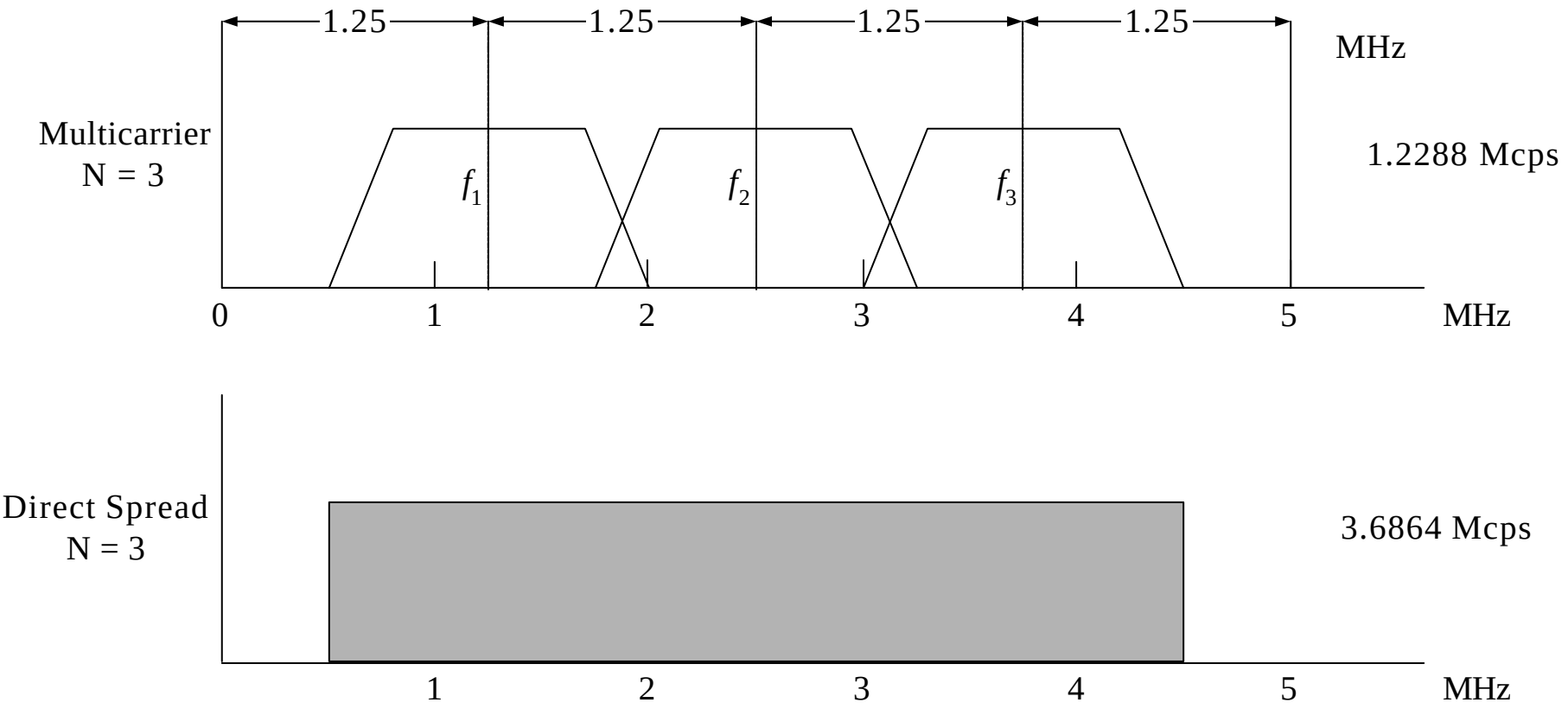
Physical Layer

- The *Radio Configurations* (RCs) specify the data rates, channel encoding, and modulation parameters supported on the traffic channel
- For *Spreading Rates* (SRs) 1 and 3, there are 6 RCs for the reverse link and 9 RCs for the forward link
- RCs 1 and 2 are specified to provide backward compatibility with TIA/EIA-95-B
- There are 6 reverse and 11 forward physical channels in cdma2000

Forward Links Features

- Supports chip rates of N x 1.2288 Mcps, N=1,3,6,9,12
- N = 1
  - similar to IS-95B, but QPSK modulation and fast closed-loop power control are used
- N > 1
  - Multicarrier
  - Direct spread

Multicarrier and Direct Spread



Key Characteristics of Forward Links

- Channels are orthogonal and use variable-length Walsh codes.
- QPSK modulation is used before spreading to increase the number of usable Walsh codes.
- Forward Error Correction (FEC) is used
  - Convolutional codes (k=9) are used for voice and data.
  - Turbo codes (k=4) are used for high data rate on SCHs
- Supports nonorthogonal forward link channelization
  - These are used when running out of orthogonal space (insufficient number of Walsh codes)
  - Quasiorthogonal functions are generated by masking existing Walsh functions

Key Characteristic of Forward Links (cont.)

- Synchronous forward links
- Forward link transmit diversity
- Fast-forward power control (closed loop) 800 times per second

Key Characteristics of Reverse Links

- Continuous waveform
  - Enables the interleaving to be performed over the entire frame
- Orthogonal channels with different-length Walsh sequences
  - Higher data rate channels -> shorter Walsh sequences
- Rate matching
  - Puncturing
  - Symbol repetition
  - Sequence repetition

Key Characteristics of Reverse Link (cont.)

- Independent data channels
  - Enables the system to be optimized for multiple simultaneous services
  - The channels are separately coded and interleaved and may have different transmit power level and FER set points.
- Reverse power control
  - Open loop
  - Closed loop
  - Outer loop

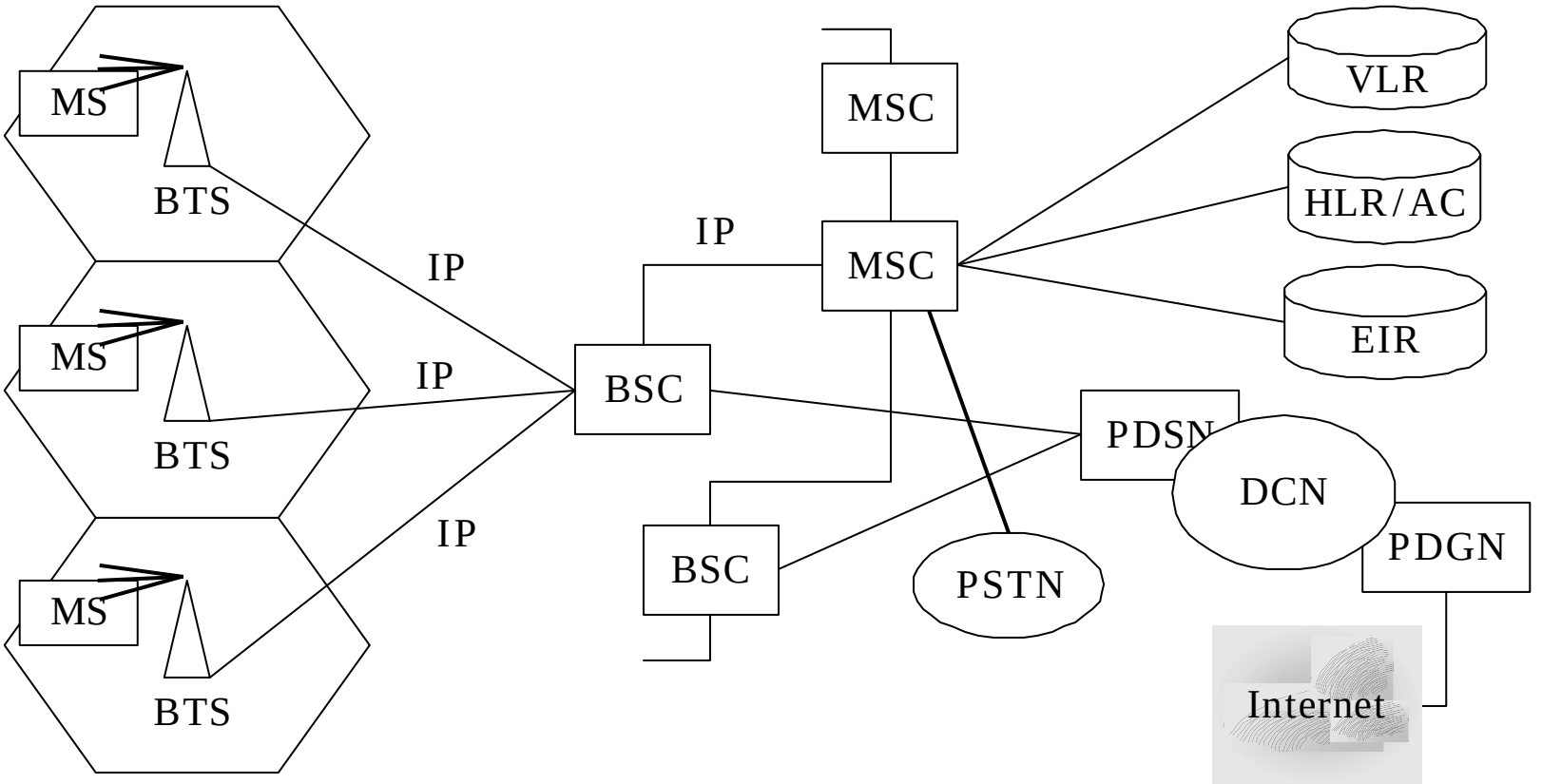
Key Characteristics of Reverse Link (cont.)

- Separate dedicated control channels
  - Allows for a flexible dedicated control channel structure that does not impact the other pilot and physical channel frame structures.
- Forward error correction
  - Convolutional codes (k=9) are used for voice and data
  - Parallel turbo codes (k=4) are used for high data rates on supplemental channels
- Fast-reverse power control
  - 800 times per second

Cdma2000 key Parameters

Item	Parameter
Bandwidth	1.25/5/10/20 MHz
Chip rate	1.2288/3.6864/7.3728/11.0592/18.432 Mcps
Duplex scheme	FDD & TDD
Synchronization	Synchronous
Frame length	20ms
Modulation	Forward - QPSK, Reverse – BPSK
Spreading	Forward - QPSK, Reverse – OQPSK
Multi-rate	Variable rate
Detection	Pilot based coherent detection (Forward and Reverse link)
Power Control	Closed loop 800 bps

Cdma2000 Architecture



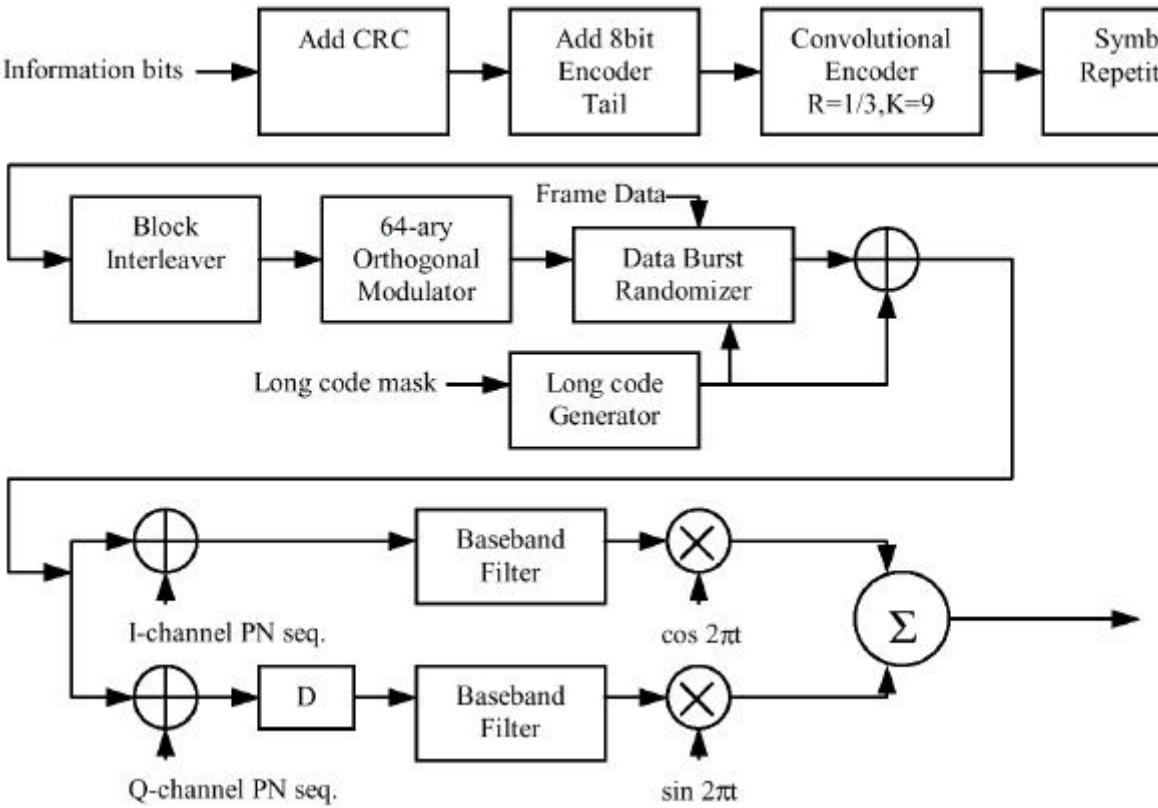
Comparison between cdma2000 and IS-95

Feature	IS-95	Cdma2000
RF channel	1.25	1.25/5/10/15/20
User data rate	9.6-115.2kbps	9.6k-2.4Mbps
Supplemental Ch.	0-7 at 9.6k, 14.4k	0-1 @9.6k-2.4M
Modulation	BPSK-Quad	Quad-Quad
Pilot coherent det.	Fw Link Yes Rv Link No	Fw Link Yes Rv Link Yes
Fw Power control	No	Yes
Fw trans. Diversity	No	Yes
Turbo Code	No	Yes

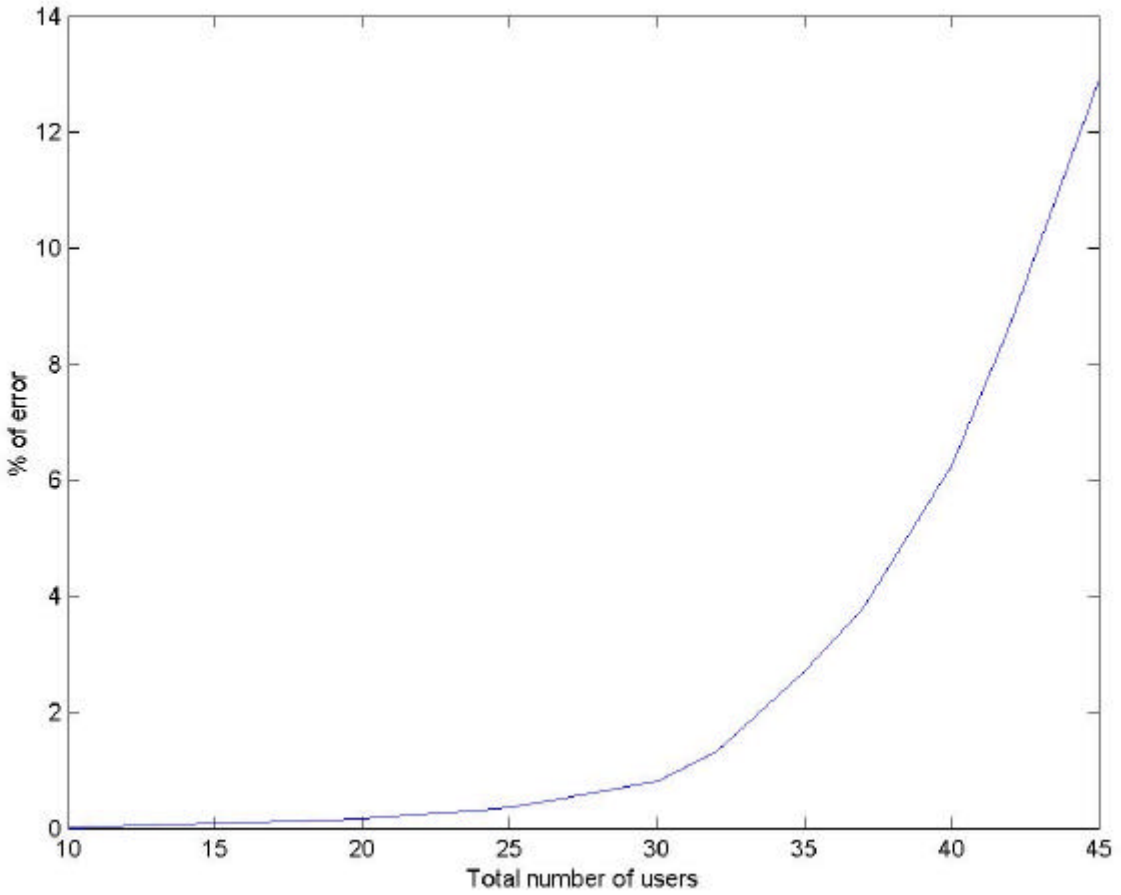
Comparison between cdma2000 and WCDMA

Feature	cdma2000	W-CDMA
Chip rate	3.6864 Mcps	4.096 Mcps (Docomo) 3.84 Mcps (UMTS)
Synchronized BS	Yes	No/Yes (optional)
Frame length	20 ms	10 ms
Multicarrier spreading options	Yes	No
Over head	Low (because of shared pilot code channel)	High (because of nonshared pilot code channel)

Channel Capacity Simulation



Channel Capacity Simulation



Channel Capacity Simulation

- The percentage of error in one frame of one particular user is increased exponentially as the total number of users is increased
- The increasing percentage of error will cause a limitation of total number of users
- Voice detection & Sectorization will increase spectral efficiency (math. model).

Conclusion

- Backward compatibility to IS-95
- Spreading Rate 1 (1X), Spreading Rate 3 (3X)
- Multi-carrier for Forward link, Direct Spread for Reverse link (3X)
- Data rates up to 307.2kbps(1X, N=1) or 2 Mbps(3X, N=3)
- Increased performance and capacity
- Attractive research area