Course ID
3G5D
Course Duration
5 days

Course Title
3G Systems: WCDMA/UMTS and CDMA2000

Related Courses

- 3G Systems: An Overview of WCDMA/UMTS and CDMA2000 (3G3D, 3 days)
- CDMA Technology and Its Evolution to cdma2000 (CDMA, 3 days)
- UMTS-FDD: Network Architecture, Operation, and Design (UMTS-FDD, 3 days)
- UMTS-TDD: Network Architecture, Operation, and Design (UMTS-TDD, 3 days)
- HSDPA: Network Architecture, Operation, and Design (HSDPA, 2 days)
- HSUPA: Network Architecture, Operation, and Design (HSUPA, 2 days)
- Wireless All-in-One: RF Propagation, Cellular Principles, Personal Radio Services, WiFi, WiMAX, CDMA, and GSM (ALL-IN-ONE, 5 days)
- Principles of OFDM and MIMO (OM, 3 days)
- LTE: A Comprehensive Three Day Course (LTE-C3DC, 3 days)
- LTE: A Comprehensive Tutorial (LTE-CT, 3 days)
- WIMAX: A Comprehensive Three Day Course (WIMAX-C3DC, 3 days)

Aimed At

This course is aimed at technical professionals who are familiar with 2G wireless systems such as GSM or CDMA and wish to undertake an in-depth study of the 3G systems, namely WCDMA and CDMA2000.

Group Size

5-25

Prerequisites

Familiarity with 2G technologies such as GSM and/or CDMA.

Course in a Nutshell

This fast-paced, five-day course will help those familiar with 2G technologies migrate to 3G systems. The course begins with a review of the digital modulation techniques, radio propagation characteristics, and performance improvement techniques. This is followed by a comprehensive discussion of the system building blocks and various system operating scenarios for both the CDMA2000 and WCDMA systems. The course concludes with a study of the link budget spreadsheets and system capacity examples.

Customize It!

We can tailor this course to suit the needs of audiences such as hardware engineers, software/application developers, service designers, sales engineers, marketing/sales personnel, radio planners, and persons involved in defense and homeland security endeavors. Those looking for a more compact overview of 3G technologies should consider the 3-day version of this course listed under Related Courses above.

Digital Modulation Overview

- Introduction to key wireless standards
  - IS-95, GSM
- Multiple access principles (TDMA, CDMA, FDMA, SDMA)
- Complex envelope representation of signals and systems
  - Bridge relationship to actual hardware
  - Provide mathematical insight
  - Support computer simulation
- Stochastic theory review
- Digital modulation theory
  - BPSK, QPSK, OQPSK, MSK, GMSK, 16QAM, 64QAM, etc.,
  - Pulse shaping filter selection (Nyquist and Raised Cosine filtering)
  - Nonlinear amplification (spectral regrowth)
  - Migration path and reasoning behind choices available
- Spread spectrum: Frequency Hopping, Direct Sequence CDMA, RAKE receiver, IS-95 CDMA uplink and downlink example, receiver block diagram
- System metrics: BER, SNR, Eb/No definitions

Radio Propagation Characterization

- AWGN channel
- Rayleigh/Rician multipath fading
  - Mathematical background
  - Practical explanation
- Delay spread concept (flat vs. frequency selective fading)
  - Indoor and outdoor propagation measurements
- Delay spread and coherence bandwidth (outdoor and indoor)
- Log normal shadowing
- Path loss models (Free Space, Hata, Cost231, Walfish-Bertoni, etc.)
  - Micro/Macro cell measurements
  - Comparison of worldwide measurements.
- Man-made interference
  - Co-Channel interference (CCI)
  - Adjacent Channel interference (ACI)
- Correlation of frequency and time
- Simulating multipath fading channels : Jakes, LPF-ing, etc.

Performance Improvement Techniques

- Forward Error Correction (FEC)
  - Block (linear codes, encoder, syndrome decoding)
  - Convolutional (trellis diagram, Viterbi algorithm, punctured coding)
  - Turbo (encoder and decoder)
- Interleaver/de-interleaver - advantages and disadvantages
- Antenna receiver diversity techniques : Switching, Equal Gain, Maximal Ratio, Optimal Combining
  - Theoretical SNR improvement

    - Expected BER performance
- Antenna transmit diversity techniques: Space Time Block Codes, Closed Loop Antenna Arrays, MIMO

CDMA2000 System Components (Building Blocks)

- System goals (latency, throughput, etc.)
- CDMA200 Release A, B and C overview
    - Mobile Station State Definition
- CDMA 1xRTT physical channels (UL and DL)
- Logical channels (UL and DL)
- Protocol overview (Layer 1 - PHY, Layer 2- MAC, Layer 3- RLC functions)
- 1xEV-DO Release A, B and C overview
- 1xEV-DO physical channels
    - Access Terminal State Definition
- 1xEV-DO logical channels
- PN sequences discussion: m sequences, gold codes, Walsh
- Spreader and despreader (Complex and Quadrature)
- RAKE receiver

CDMA2000 System Scenarios

- Echo profile manager (searcher)
- PN time tracking and acquisition
- Paging discussion
- Power control
    - Uplink and downlink
    - Comparison to IS-95
    - Multi-user scenarios
- Pilot symbol aided coherent detection
- Channel estimation
- QPSK vs. BPSK pilot symbols
- Variable processing gain
- Cell search and handoffs
- Channel assignment
- Traffic channel and radio configurations
- UL/DL performance
- Available data rates
- Multicode transmission
- Receiver implications
- Network architecture (BTS, BSC, CN)
- Migration from circuit-switched to packet based systems
- Comparison with WCDMA system scenarios

3GPP WCDMA System Components (Building Blocks)

- System goals (latency, throughput, etc.)
- 3GPP Release Overview (Release 99 to Release 8 features)

- WCDMA physical channels
  - UE state definitions
- WCDMA logical channels
- WCDMA protocol overview (Layer1-PHY, Layer2-MAC, Layer3-RLC functions)
- High-speed Downlink Packet Access (HSDPA) overview
- HSDPA physical channels
- High-speed Uplink Packet Access (HSUPA) overview
- HSUPA physical channels
- PN sequences discussion: m sequences, gold codes, OVSF
- Spreader and despreader
- RAKE receiver: Overall block diagram discussion
- RAKE receiver: Signal processing
  - Channel estimation (multi-slot averaging)
  - PN code time tracking (DLL, TDL)
  - AFC (two types)
  - AGC
  - DC offset
  - Modulation comparison
  - Searcher and finger management

3GPP WCDMA System Scenarios

- Echo profile manager (searcher)
- PN time tracking and acquisition
- SIR power control
  - Inner, Outer, and Closed Loop
  - UL and DL Closed Loop comparison
  - Performance improvement
  - Multi-user scenario
- Pilot symbol aided coherent detection
- Channel estimation
- QPSK vs. BPSK pilot symbols
- Rate matching
- Variable processing gain
- Modulation (HPSK) and filtering
- Cell search and handoffs
  - Intra-frequency measurements
- Paging discussion
  - Comparison of IS-95, CDMA2000 and WCDMA paging protocols
  - Power consumption conclusion
- Channel assignment
- Call flow diagrams
  - Mobile originated
  - Mobile terminated
- HSDPA performance results
- Available data rates

- Multicode transmission
- Receiver implications
- Performance
- Network architecture (NodeB, Radio Network Controller - RNC, Core Network -CN)
    - Partitioning of protocol stack across network
- Access Stratum (AS) and Non-Access Stratum (NAS)
- Migration from circuit-switched to packet based systems
    - What needs to change on the 3G systems to support this migration?
- Comparison with CDMA2000 system scenarios
- System architecture
    - Ciphering examples
    - Integrity protection
    - Confidentiality
    - WCDMA and HSDPA examples

Link Budget and System Capacity Examples

- Link budget methodology
- Link budget equations
- Rise over Thermal calculations
- Example for indoors and outdoors (Excel spreadsheets)
- Cell capacity example
- Targeted frequency bands

Course Wrap-up: Recap and Discussion

How You Will Learn

- A highly qualified engineer/instructor, well-versed in a number of 2G, 3G, and 4G+ wireless technologies, will present this course in an interactive lecture format.
- Along with the lecture, we will employ discussion, group activities, and case studies to help you understand the major points.
- If you already know something about 3G technologies, we will build on that knowledge base. We'll compare and contrast what's already known to you with what's new, making the new ideas easier to learn.
- If your background is less technical, we will use appropriate examples and analogies to convey the complex subject matter in terms that make sense.
- You will receive a printed Participant Handbook which will help you remember and retain what you learned in class and use it on the job.

2010 Oct 26f