

Course ID  
**ALL-WIRELESS**  
Course Duration  
**5 days**

Course Title  
**Everything Wireless: RF/Cellular Basics, WiFi, Bluetooth, WiMAX, CDMA, GSM/GPRS/EDGE, UMTS/HSPA, and LTE**

### **Related Courses**

- Wireless All-in-One: RF Propagation, Cellular Principles, Personal Radio Services, WiFi, WiMAX, CDMA, and GSM (ALL-IN-ONE, 5 days)
- 2G to 4G+: Technologies, Drivers, and Business Case (2GTO4G, 4 days)
- 3G Systems: WCDMA/UMTS and CDMA2000 (3G5D, 5 days)
- Review of Select Topics Included in IEEE WCET Exam: RF Propagation, Analysis, and Design (WCET1, 4 days)
- RF Systems: Principles, Design, and Deployment (RFSYS, 3 days)
- RF Propagation, Analysis, and Design for Land Mobile and Public Safety Radio Systems (RF-PUBSAFE, 5 days)
- RF Propagation, Fading, and Link Budget Analysis (RFPROP, 2-3 days)
- Wireless Network Structure, Operation, and Technologies (WIRELESSNET, 3 days)
- WiMAX: A Comprehensive Three Day Course (WiMAX-C3DC, 3 days)
- WiMAX: A Two-Day Tutorial (WiMAX-2DT)
- Bluetooth: A Comprehensive Technology Overview (BLUETOOTH, 3 days)
- Wi-Fi Technology: Principles and Operation (WIFI3, 3 days)
- GSM: Network Architecture, Operation, and Design (GSM-I, 5 days)
- GSM, GPRS, and EDGE: An Intensive Tutorial (GSMPLUS, 3 days)
- CDMA Technology and Its Evolution to cdma2000 (CDMA, 3 days)
- 1xRTT: Network Architecture, Operation, and Design (1XRTT, 2 days)
- EVDO: Network Architecture, Operation, and Design (EVDO, 3 days)
- UMTS-FDD: Network Architecture, Operation, and Design (UMTSFDD, 3 days)
- UMTS-TDD: Network Architecture, Operation, and Design (UMTSTDD, 2 days)
- HSDPA: Network Architecture, Operation, and Design (HSDPA, 2 days)
- HSUPA: Network Architecture, Operation, and Design (HSUPA, 2 days)
- LTE: A Comprehensive Three Day Course (LTE-C3DC, 3 days)
- LTE: A Comprehensive Tutorial (LTE-CT, 3 days)
- iDEN™: Network Architecture, Operation, and Design (IDEN, 4 days)
- Microwave and Fixed Line-of-Sight Link Design Principles (MICROWAVE2, 2 days)

### **Aimed At**

Those whose job involves working with a variety of wireless technologies or who require a broad, technical understanding of the entire field of fixed and/or mobile wireless. This includes individuals in national defense, homeland security, technical investigations, and the private sector.

**Group Size** 5-25

**Prerequisites** The course assumes that the audience is well versed with Physics, Mathematics, and general engineering principles but does not have a great deal of prior experience with wireless communications technologies.

**Course in a Nutshell** We designed this course for the unique needs of those who are new to, or can use a refresher on, the wireless technology, have some technical (engineering or Mathematics/Physics) background, and need a comprehensive course covering the basic principles of RF/wireless as well as all of the current and emerging wireless technologies including GSM/GPRS/EDGE, CDMA, WiFi, Bluetooth, WiMAX, UMTS/HSPA, and LTE. Also included is a discussion of the location based technologies and security issues.

**Customize It** We can customize this course, usually at little to no added cost, in a number of ways that include:

- If you are familiar with some aspects of wireless, such as RF propagation or wireless network architecture, we can omit or shorten their discussion.
- If you are interested in some technologies more than others, we can adjust the emphasis placed on the various topics or build the course around the mix of technologies of interest to you (including technologies other than those listed as part of this outline).
- If your background does not include Mathematics and Physics and you want us to present the course in a non-technical manner, we can do that as well.

**Learn How To** Describe and apply the key concepts, principles, techniques, and technologies of wireless communications including:

- RF basics including propagation/fading, antennas
- Cellular basics including cell planning and reuse
- Architecture and operation of a cellular network
- Modulation and coding
- Evolution of wireless from 1G to 4G
- 2G/2.5G technologies: GSM, GPRS, EDGE, CDMA
- 3G/3G+ technologies: UMTS/HSPA
- 4G technologies: LTE
- Other technologies (briefly): CDMA2000, WiMAX, Bluetooth, WiFi
- Wireless network security
- Location based services

**Part 1: Introduction to Cellular Communications**

- Cellular System Concepts
  - Base station
  - Mobile station
  - Mobile switching center
- Uplink and Downlink
  - Time division duplexing
  - Frequency division duplexing
  - Comparisons
- Multiple Access Methods
  - Frequency Division Multiple Access (FDMA)
  - Time Division Multiple Access (TDMA)
  - Code Division Multiple Access (CDMA)
- Networking
  - Circuit and packet switching
- 1G to 4G Wireless: Evolution of Cellular Communications
  - 1G to 4G
  - Phone comparisons

**Part 2: Radio Wave Spectrum, Propagation, and Antennas**

- The Electromagnetic Spectrum
  - Types of radio services
  - Spectrum characteristics
- Radio Frequency (RF) System Measurements
  - Power measurement using the decibel (dB)
  - Signal to noise and interference ratios
- Antennas
  - Terminology
  - Gain and loss
  - Law of reciprocity
  - Handset antennas
  - Base station antennas
- RF Propagation in Fixed and Mobile Environments
  - Propagation mechanisms
  - Path loss models
  - Maximum range calculations
  - Multipath and fading
- Cell Planning and Frequency Reuse
  - Frequency reuse calculations
  - Cell sectoring
  - Cell splitting

- Antenna downtilt

### **Part 3: Modulation and Coding**

- Basic Modulation Methods
  - Modulated signal structure
  - Amplitude, frequency, and phase shift keying
  - Bit error rate performance in Gaussian noise
- Advanced Modulation Methods
  - Gaussian Filtered Frequency Shift Keying (GFSK)
  - Quadrature Phase Shift Keying (QPSK)
  - Quadrature Amplitude Modulation (QAM)
  - Orthogonal Frequency Division Multiplexing (OFDM)
- Spread Spectrum Systems
  - Frequency hop
  - Direct sequence
  - Multiple access methods
- Error Control
  - Error detection
  - Error correction
  - Automatic repeat request
- Speech Coding
  - Speech quality rating
  - Speech coding techniques
  - Speech coders in practice

### **Part 4: Third Generation Partnership Project and Its Variants**

- 3GPP Standardization Process
  - The need for standardization
  - 3GPP structure and operation
- Motives Behind 3G Evolution
  - Driving forces
  - Radio access evolution
  - Core network evolution
- Summary of 3GPP Standards
  - GSM, GPRS, and EDGE
  - UMTS/WCDMA and HSPA
  - LTE

### **Part 5: 3GPP2 and IEEE LAN/MAN Systems**

- Summary of 3GPP2 Cellular Standards
  - cdmaOne

- cdma2000
- EVDO
- Summary of IEEE LAN/MAN Standards
  - Wi-Fi
  - Bluetooth
  - WiMAX
- Market Penetration and Deployment Status

### **Part 6: GSM, GPRS, and EDGE Operations**

- GSM Architecture and Protocols
  - Base station subsystem
  - Network switching subsystem
- GSM Physical Channels
  - Modulation and coding
  - Time slots and their use within a frame
  - Physical channels and their properties
- GSM Logical Channels and Burst Family
  - Broadcast, control, and traffic channels
  - Bursts: normal, frequency correction, synchronization, access, dummy
  - Call process
- GPRS and EDGE on the GSM Air Interface
  - GPRS/EDGE system architecture
  - Modulation, coding, and ARQ
  - GPRS logical channels and data exchange
  - Packet exchange process

### **Part 7: UMTS and HSPA Operations**

- UMTS Architecture and Protocols
  - UTRAN radio network controller and NodeB
  - Core network architecture and protocols
- UMTS Physical Layer
  - WCDMA modulation and coding
  - Transport channels
  - User data transmission
  - Signaling
  - Cell search and access
- Radio Interface Protocols
  - Medium access control
  - Radio link control
  - Packet data convergence protocol
  - Radio resource control

- Radio Resource Management
  - Power control
  - Handovers
  - Admission control
- High-speed Packet Access
  - HSDPA physical layer structure
  - HSDPA performance
  - Enhanced uplink

### **Part 8: Advanced Antenna Systems**

- Principles of Adaptive Modulation and Coding
  - Adaptive methods
  - Performance
- Receive Diversity
  - Selection, equal gain, and maximal ratio combining
  - Performance and examples
- Transmit Diversity
  - Open and closed loop methods
  - Performance and examples
- Spatial Multiplexing, MIMO, and Beamforming
  - Open and closed loop methods
  - Multi-user antenna techniques
  - Beamforming
  - Direction-of-arrival estimation

### **Part 9: LTE Operations**

- LTE System Architecture
  - Evolved packet core network entities
  - User plane functions and protocols
  - Control plane functions and protocols
- General LTE Operation
  - Frequency bands
  - Downlink and uplink modulation
  - Transmission resource structure
  - Error control
  - Spatial multiplexing
  - Performance requirements
- LTE Downlink
  - User protocol architecture
  - Channel mapping
  - Logical, transport, and physical channel functions
  - Cell acquisition

- IP packet processing and physical data mapping
- Control functions
- Radio resource management
- LTE Uplink
  - UL/DL similarities and differences
  - Channel mapping
  - Random access
  - Data transfer
  - Power save methods
  - Link activity and capacity

### **Part 10: Location-Based Services**

- Introduction to LBS
  - Definitions
  - Classifications and applications
- Location Services Methods and Performance
  - Accuracy requirements
  - Cell identity and timing advance
  - Enhanced observed time difference
  - Uplink time difference of arrival
  - Assisted GPS

### **Part 11: Communication Security**

- Wireless Security Challenges
  - Threat categories and attack methods
  - Disclosure threat
  - Integrity threat
  - Denial-of-service threat
  - General security setup process
- Eavesdropping and Jamming
  - Range of vulnerability to eavesdropping
  - Range of susceptibility to jamming
- Cryptography Implementation Methods
  - Shared key
  - Public key
- Case Study: GSM Security
  - Setup
  - Encryption process
  - Weaknesses
- Course Wrap-up: Recap, Q/A, and Evaluation

**How You Will  
Learn**

- You will learn in interactive lecture format from an instructor who's a subject matter expert in a variety of wireless technologies as well as an excellent teacher.
- If you already know something about an aspect of wireless communications, we will build on that. If your background is less technical, we will use appropriate examples and analogies to convey the important information in an easy-to-understand manner.
- You will receive a copy of the instructor's presentation to which you can add the information and insight acquired in real-time, turning it into a handy back-to-the-job reference resource.

*Revised*

*January 28, 2011f*