Course ID
ALL-WIRELESS
Course Duration
5-7 days

Course Title
All Wireless: 5G, 4G LTE, UMTS/HSPA, GSM/GPRS/EDGE, WiMAX, CDMA, M2M, IoT, SDN, Network Security … with RF/Cellular Basics

Related Courses

- IEEE WCET Exam: RF Propagation, Analysis, Design (WCET1, 4 days)
- Radio Systems Analysis and Design (RF4D, 4 days)
- RF for Land Mobile & Public Safety Radio (RF-PUBSAFE, 5 days)
- 3G: WCDMA/UMTS & CDMA2000 in Depth (3G5D, 5 days)
- GSM - Comprehensive (GSM-I, 5 days)
- UMTS (UMTSFDD, 3 days)
- HSDPA (HSDPA, 2 days)
- HSUPA (HSUPA, 2 days)
- LTE Tutorial (LTE-CT, 3 days)
- WIMAX - Comprehensive (WIMAX-C3DC, 3 days)
- Bluetooth Technology (BLUETOOTH, 3 days)
- WiFi Training in Depth: Technology, Security, Deployment … with M2M, IoT, 5G (WIFI-DIVE, 2-5 days)
- Internet of Things: IoT & IoT Security Training (IoTSEC, 1-2 days)
- SDN/NFV: Software Defined Networks & Network Functions Virtualization (SDN-NFV, 2 days)

Aimed At

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

Prerequisites

Technical background and exposure to telecommunications, RF, or wireless systems will be helpful, though the course can be taught at a level understandable to a less technical audience.

Course in a Nutshell

We designed this course for the unique needs of those who are new to RF/wireless -- or who can use a refresher on it -- and need a comprehensive course covering the basics of RF/wireless as well as all of the current and emerging technologies including GSM/GPRS/EDGE, CDMA, WiMAX, UMTS/HSPA, 4G LTE, 5G, M2M, IoT, SDN, and more. Diversity and smart antenna systems, location-based technologies, and wireless network security are also discussed. The course is taught by a highly qualified subject matter expert experienced with a wide range of

RF/wireless technologies and comes in technical and non-technical versions. While the full course is 7 days long, most clients are able to exclude some topics or reduce their coverage depth to make it a five-day course.

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 RF wireless, we can omit or shorten their discussion.
- 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 included in this outline).
- If you're interested in the short-range wireless technologies such as WiFi and Bluetooth, those can be added to the course.
- If your background is nontechnical, we can exclude the more technical topics, include the topics that may be of special interest to you (e.g., as a manager or policy-maker), and present the course in manner understandable to lay audiences.

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 5G and beyond
- 2G/2.5G technologies: GSM, GPRS, EDGE, cdmaOne
- 3G/3G+ technologies: cdma2000, EvDO, UMTS/HSPA, WiMAX
- 4G/4G+ technologies: LTE, LTE-Advanced, LTE-Advanced Pro, 5G
- Machine-to-Machine Communications (M2M)
- Internet of Things (IoT)
- Software Defined Networking (SDN)
- Augmented Reality (AR), Virtual Reality (VR)
- Wireless network security
- Location based services

Course Outline

Part 1: Introduction to Cellular Communications

- Cellular System Concepts

  - Base stations
  - Mobile stations
  - Mobile switching center
- Uplink and Downlink Duplexing
  - Time Division Duplexing (TDD)
  - Frequency Division Duplexing (FDD)
  - Comparisons
- Multiple Access Methods
  - Frequency Division Multiple Access (FDMA)
  - Time Division Multiple Access (TDMA)
  - Code Division Multiple Access (CDMA)
  - Frequency hopping concept
- Networking
  - Circuit and packet switching
- Evolution of Cellular Communications
  - 3GPP, 3GPP2, and IEEE LAN/MAN standardization
  - 1G to 5G progression and technology differences
  - Mobile phone samples and 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 modulation
  - 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
  - Hybrid methods
- Speech Coding
  - Speech quality rating
  - Speech coding categories and complexity
  - Speech coding techniques and standards
  - Speech frame construction
  - Adaptive Multi-Rate (AMR) speech coding
- SIM Card and Its Contents
  - SIM specification
  - Data stored on the SIM
  - SIM card variations

Part 4: Third Generation Partnership Project (3GPP)

- 3GPP Standardization Process
  - The need for standardization
  - ITU and ETSI
  - 3GPP structure and operation

  - 3GPP releases
- Summary of 3GPP Standards
  - GSM, GPRS, and EDGE overview
  - UMTS/WCDMA and HSPA overview
  - LTE overview
- Major 3GPP Technology Players
  - Worldwide deployment summary
  - Vendor and equipment summary

Part 5: 3GPP2 and IEEE Systems

- Summary of 3GPP2 Cellular Standards
  - cdmaOne
  - cdma2000
  - EVDO
- Summary of IEEE 802.16 WiMAX
  - Usage
  - History
  - Features
- Market Penetration and Deployment Status

Part 6: GSM

- GSM Architecture and Protocols
  - Base station subsystem
  - Network switching subsystem
- GSM Physical Channels
  - Modulation and coding
  - Frame structure and hierarchy
  - Time slots and their use within a frame
  - Physical channels and their properties
  - Uplink and downlink timing
- GSM Logical Channels and Burst Family
  - Broadcast, control, and traffic channels
  - Bursts: normal, frequency correction, synchronization, access, dummy
- Radio Subsystem Link Control
  - Radio performance requirements
  - Channel measurements
  - Transmission power control
  - Cell search, selection, and reselection

  - Channel failure disconnect
  - Power conservation
- Radio Resource Management
  - Connection setup and release
  - Mobility management
  - Connection management
- Call Routing and Termination
  - Routing calls to the mobile station
  - Call termination
- Handover
  - Intra-MSC handover
  - Handover decision process and timing
  - MAP and inter-MSC handover
- 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: 3GPP: GPRS and EDGE

- General Packet Radio Service (GPRS)
  - Network architecture
  - Protocol structures
  - GPRS on the GSM air interface
  - Medium access control
  - Radio link control
  - Mobility management
- Enhanced Data Rates for GSM Evolution (EDGE)
  - EDGE modulation and coding
  - Air interface protocols
  - MAC and RLC procedures

Part 8: 3GPP: UMTS and HSPA

- 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
  - Cell search, selection, and reselection
  - Handovers
  - Admission control

- High-speed Packet Access (HSPA) operation
  - HSPA timeline and features
  - HSPA modulation methods
  - HSDPA physical layer and performance
  - HSUPA physical layer and performance
  - Comparison of HSPA channels carrying user data

Part 9: 3GPP2: cdmaOne, cdma2000, and EvDO

- CDMA Codes and Sequences
  - Maximal length sequences
  - Walsh codes
- Forward Link Channel
  - Modulation
  - Pilot channel
  - Synchronization channel
  - Control channels
  - Paging channels
  - Traffic channels
- Reverse Link Channels
  - Pilot channel
  - Access channel
  - Control channels
  - Traffic channels
- Call Processing
  - Initialization
  - System access
  - Authentication
- Resource Management

  - Power control
  - Handoff
- Evolution-Data Optimized (EvDO) Operations
  - Requirements
  - Reference model
  - Forward and reverse channels
  - Modulation and coding
  - Power control
  - Scheduling

Part 10: Diversity and Advanced Antenna Systems

- Principles of Adaptive Modulation and Coding
  - Adaptive methods
  - Performance
- Antenna Arrays
  - Isotropic radiators and omnidirectional antennas
  - Directional antennas
  - Phased and adaptive arrays
- Diversity Methods
  - Switched diversity, equal gain combining, and maximal ratio combining
  - Delay and cyclic delay diversity
  - Space-time coding
  - Frequency hop diversity
- Spatial Multiplexing, MIMO, and Beamforming
  - Open and closed loop methods
  - Multi-user antenna techniques
  - Beamforming
  - Direction-of-arrival estimation
- Smart Antennas
  - Basic principles and configurations
  - Space division multiple access
  - Benefits and drawbacks

Part 11: 3GPP: LTE and LTE-Advanced

- 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
- Features of LTE-Advanced
  - Background
  - Carrier aggregation
  - Enhanced uplink multiple access
  - Enhanced multi-antenna transmissions
  - Coordinated multipoint transmissions and relaying
  - Self-optimized and self-organized networking
  - Enhanced inter-cell interference coordination (eICIC)
  - Enhancements to LTE TDD (eIMTA)
  - LTE Device to Device Proximity Services
  - Network-Assisted Interference Cancellation (NAICS)
  - RAN Sharing for LTE
  - Dual Connectivity enhancements for LTE
  - LTE Indoor Positioning
  - Group Communication Systems
  - Rel 14 Narrow Band LTE (NB-LTE) & Narrow Band Cellular Internet of Things (NB-CIOT)
  - LTE Unlicensed Operation (LAA and eLAA)
  - LTE and WiLAN Aggregation (LWA)

Part 12: IEEE: 802.16 WiMAX

- Overview
  - Reference model
  - Summary of WiMAX standards
- Physical Layer
  - RX requirements
  - Link budget
  - OFDM parameters
  - Data rates
- Advanced Antennas
  - Receive and transmit diversity
  - MIMO operations
  - Advanced antenna options
- Orthogonal Frequency Division Multiple Access (OFDMA)
  - Subcarrier mapping
- Medium Access Control (MAC)
  - MAC allocations
  - TDD example
- QoS, Security, and Certification
- LTE and WiMAX comparisons

Part 13: 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 14: Communication Security

- Wireless Security Challenges
  - Threat categories and attack methods
  - General security setup process
- Attacks in Mobile Environments
  - Illicit use
  - Spoofing

  - Man-in-the-middle
  - Interception of data
  - Denial of service

- Cryptography Basics
  - Symmetric cryptography
  - Asymmetric cryptography
  - Public Key Infrastructure (PKI)
  - Digital signature
  - Cryptographic attacks
- Access Control and Authentication
  - Weak and strong authentication schemes
  - Attacks on authentication
  - Authorization and access control

- GSM Security
  - GSM security model
  - Attacks on GSM
  - GSM encryption algorithms
- Overview of UMTS Network Security
  - Access and domain security
  - Mitigating GSM security weaknesses
  - Attacks on 3G networks
- Overview of LTE Network Security
  - Security architecture
  - Authentication and key agreement
  - Signaling and user data protection

Part 15: 5G Wireless

- Timeline and Standardization
  - 5G New Radio Stand Alone (NR-SA)
  - 5G New Radio Non-Stand Alone (NR-NSA)
- RAN Sharing
- Green Communications
- Millimeter Wave (mWave), High Frequencies
- Massive MIMO
- Software Defined Networking (SDN)
- Cloud RAN
- Device to Device Communications
- Internet of Things (IOT)
  - Machine to Machine (M2M)
- Device Centric Architecture
- Enhanced Mobile Broadband
- C-V2X Communications

- Private LTE
- Self Backhaul
- NS-SS (Spectrum Sharing)
- GigaBit LTE
- Augmented Reality (AR) and Virtual Reality (VR)
- 5G NR PHY Layer
    - Frame Structure
    - Signals and channels
    - DL Operation
    - UL Operation
    - 5G NR MAC and RLC Layer
    - 5G NR Network

Course Recap, Discussion, and Course Evaluation

DCN V.nNJ.f