Next Generation Wireless Networks Crash Course

Next Generation Wireless Networks Crash Course is an innovative training program covering trends in today's rapidly changing Wireless Industry.

Topics including current and next generation 802.11 and 5G technologies, concepts, standardization activities, regulation, products and services.

Learn about:

- Overview of Current and Future Wireless Technologies
- Next generation wireless capability requirements
- 5G in the technology roadmap
- Trends in Wireless Technologies including next generation 802.11 and 5G
- Fixed vs. Mobile Wireless Trends
- 5G Applications and Use Cases
- Next generation 802.11 applications and usage scenarios
- Next generation 802.11 and 5G deployment options
- Concepts behind security, performance, interoperability and capacity
- Next generation 802.11 and 5G building blocks, architectures and key enablers and components
- Next generation 802.11 and 5G spectrum

Learning Objectives

Upon completion of this course, the participant will:

- Describe the fundamental concepts of LAN, PAN and BAN wireless technologies
- Describe similarities and differences between Wireless LANs, Wirless PANs and Wireless BANs
- Understand the fundamental concepts of 802.15.1, 802.15.4 and 802.15.6
- Describe similarities and differences between RFID, Bluetooth, Bluetooth LE, ZigBee and 6LowPAN
- Understand the fundamental concepts of 802.11a/b/g/n and 802.11ax,az,ay and ah
- Understand the core concepts on 802.11 PHY and MAC layers
- Understand ideas behind OFDM, MIMO spatial streams and Multi-user MIMO (MU-MIMO) features
- Understand Modulation/Coding and Other elements/features behind 802.11
- Understand PHY and MAC modifications for different versions and releases
- List Coexistence mechanisms for different channels
- List 802.11 scenarios and configurations
- Describe 802.11ax futures and requirements
- Describe 802.11az related positioning and location requirements
- Describe 802.11ah futures and requirements
- Describe 802.11ay: Enhanced Throughput for Operation in License-Exempt Bands above 45 GHz

Outline

Executive Summary of Trends in Wireless Industry

- Trends in Wireless
- Fixed vs. Mobile Wireless Trends
- Applications and Use Cases

Overview of Current and Future Wireless Technologies

- Overview of Wireless BAN, PAN, LAN and NAN Technologies
- Comparison between 802.11, 802.15 and 802.16: WiFi, Bluetooth/BLE, RFID, 6LoWPAN, ZigBee and BAN (Body Area Networks)

Executive Summary of 5G

- 5G (5th generation) Wireless
- 5G or “beyond 2020”
- 5G Mobile
- Next major phase of mobile telecommunications standards beyond the current 4G/IMT-Advanced standards
- ITU-R “Vision” of the “5G” mobile broadband connected society and future IMT

Executive Summary of IEEE 802.11

- General description of the IEEE Std 802 standards
- Principles behind 802.11, 802.15.1, 802.15.4 and 802.15.6

- How wireless local area networks (WLANs) are different
- 11 extended range for Internet of Things (IoT) and Machine to Machine (M2M) communications
- 802.11 architecture and protocols
- General description of the IEEE Std 802.11
- How wireless local area networks (WLANs) are different
- 802.11 extended range for Internet of Things (IoT) and Machine to Machine (M2M) communications
- 802.11 architecture and protocols

IEEE Std 802.11 Architecture

- Components of the IEEE Std 802.11 architecture
- 11 Basic Service Set (BSS)
- Differences among ESS, PBSS, and IBSS LANs

Principles behind 802.11a/b/g/n

- Differences between ESS and MBSS LANs
- Principles behind 802.11k/r/w/z/v/u/s/p
- Principles behind 802.11ac/ad
- Comparison of the Wireless Local Network (LAN) IEEE 802.11, Wireless Personal Network (PAN) 802.15.1, 802.15.4 and 802.15.6: Wireless Body Area Network (WBAN) standards

802.11 Systems and Bands

- IEEE 802.11 Variant
- 11n: High Throughput (HT)
- 11ac Very High Throughput (VHT)
- 11ax High Efficiency WLAN (HEW)
- Next Generation 60GHz (NG60)
- Directional Multi Gigabit (DMG)
- Technologies for 5GHz, 24GHz, Below 6GH, Up to 60 GHz
- 24 GHz 802.11 channels
- 36 GHz WiFi band
- 5 GHz WiFi channels & frequencies
- 570 – 640 GHz ISM band (Regional variations apply)
- Channels: 58,32, 6048, 6264, and 6480 GHz
- White-Fi
- 11af: 470 – 710 MHz, TV white space (below 1 GHz)
- 11ah: 700 MHz, 860MHz, 902 MHz

Introduction to 802.11n and 802.11ac

- 11n and 802.11ac core concepts

- Principles behind 802.11an
- Principles behind 802.11ac
- Drivers for 802.11ac
- 11ac technology overview
- 11ac key requirements
- Regulatory Considerations
- 11ac Channelization
- 11n modulation and coding
- Differences Between 802.11ac and 802.11n
- Standards-Based Beamforming
- RTS/CTS with Bandwidth Indication
- All A-MPDUs
- MIMO and MU-MIMO
- Backwards Compatibility
- Coexistence
- Operational Scenarios

Introduction to 802.11ax

- High Efficiency (HE) Physical Layer
- IEEE 802.11ax standardization
- IEEE 802.11ax basics
- Frequency bands
- 11ax PHY and MAC enhancements
- 11ax PHY / radio interface
- Technologies involved in 802.11ax
- State-of-the-art MIMO and MU-MIMO
- Principles behind OFDMA (Orthogonal Frequency-Division Multiple Access)
- OFDM vs OFDA (orthogonal frequency division access)
- 160MHz PPDU, the default mapping per 20MHz
- Default mapping of the two HE-SIG-B channels for a 160 MHz HE PPDU
- HE Data field
- Tone plan
- Resource unit, edge and DC tones
- 160 MHz/80 MHz+80 MHz OFDMA building blocks
- LDPC coding scheme in the HE PPDU Data field
- 1024-QAM Modulation
- MCS10: 1024 QAM with 3/4 code rate

- MCS11: 1024 QAM with 5/6 code rate
- Multi-user (MU) features
- DL OFDMA and UL and DL MU-MIMO
- DL MU operation
- UL MU operation
- MU RTS/CTS procedure
- UL OFDMA-based random access
- Sounding protocol
- GCR BA operation
- MAC functional blocks
- Target Wake Time (TWT)
- Power Save
- Fragmentation
- Frame formats
- Sounding feedback
- Use of OBSS ,overlapping basic service sets
- OBSS interference handling

Introduction to REVmc/location

- General location requirements
- Users of location data
- Client-side vs Network-side
- 11 Signal Strength
- 11 Time of Flight / Time Difference of Arrival
- 11 Direction / Angle of Arrival
- Bluetooth Low Energy
- GPS
- Inertial sensors
- Twists and practical considerations
- Calculating location
- Triangulation on RSSI
- Ray-tracing models
- Fingerprinting
- Crowd-sourcing
- Synthetic heat maps
- Neural networks

Introduction to 802.11ay (802.11 TGay**)**

- Modifications to both the IEEE 802.11 physical layers (PHY) and the IEEE 802,11 medium access control layer (MAC)
- Operation capable of supporting 20 gigabits per second
- Improving the power efficiency per station
- Operations for license-exempt bands above 45 GHz
- Enhanced Throughput for Operation in License-Exempt Bands above 45 GHz
- Principles behind DMG (Directional Multi-Gigabit)
- Principles behind EDMG (Enhanced DMG)
- MAC sublayer
- Channel access
- MIMO channel access
- DMG beamforming
- Security
- EDMG PHY
- SU-MIMO
- Downlink MU-MIMO
- Channel bonding of at least two 216 GHz
- EDMG PPDU format
- Channelization
- EDMG control PHY
- EDMG SC PHY
- EDMG OFDM PHY

Introduction to 802.11TGaz

- Next Generation Positioning (NGP)
- NGP Applied
- Modifications to both the IEEE 802.11 medium access control layer (MAC) and physical layers
- (PHY)
- Fine Timing Measurement (FTM) protocol
- Key Location Requirements
- Expected Horizontal Accuracy
- Expected Vertical Accuracy
- Expected Latency
- Expected Refresh Rate
- Expected number of simultaneous users

- 802.11TFaz Use case
    - Micro location in store
    - Positioning for Home Audio
    - Navigation in Public Buildings
    - Positioning for Spectrum Management
    - Positioning for Medical Applications
    - Indoor Geotagging
    - Positioning for Video Cameras
    - UAV Use Case Description
    - Location services of underground mining
    - Pipe/Vault Robot Positioning
    - Nano Location in store
    - Augmented Reality (AR)
    - Proximity Detection
    - Wearable devices

Introduction to 802.11ah

- IoT or M2M applications
- IEEE 802.11ah standardization
- IEEE 802.11ah basics
- 802.11ah PHY and MAC enhancements
- 802.11ah PHY / radio interface
- 802.11ah orthogonal frequency division multiplexing (OFDM)
- MIMO and DL MMO-MU
- 802.11ah channelization
- Principles behind channel widths of 1, 2, 4, 8, and 16 MHz
- 802.11ah physical layer PHY
- RF principles for bands below 1 GHz
- 1 MHz channel bandwidth
- New Modulation and Coding Scheme, MCS index
- Bandwidths of 2 MHz & more
- 802.11ah MAC
- Support for large number of stations
- Compact MAC header format
- Power saving principles
- Throughput enhancements
- 802.11ah interoperability issues

Principles behind 5G Wireless

- What is 5G?
- Evolution from 3G to 4G and 5G
- Relation Between 5G Radio Access and LTE
- New Radio Access Technology Tight Interworking with LTE
- New Radio Access Technology Loosely Interworking with LTE
- Alternatives for the Evolution Path of LTE
- Co-Existence of LTE with New 5G Radio Access and Core
- 5G Network and Interworking Objectives
- 5G Performance Requirements
- Future Wireless Generations

Market Drivers and Use Cases for 5G

- Internet of Things (IoT)
- Smart Grid and Critical Infrastructure Monitoring
- Smart Cities
- m-Health and Telemedicine
- M2M
- Automotive
- Sports and Fitness
- Extreme Video, Virtual Reality (VR), Augmented Reality (AR) and Gaming Applications
- Explosive Increase in Density of Data Usage
- Public Safety
- Context-Aware Services

Requirements for 5G

- Co-Existence of LTE End-to-End Ecosystem with 5G
- User-Driven Requirements
- Battery Life
- Per-User Data Rate and Latency
- Robustness and Resiliency
- Mobility
- Seamless User Experience
- Context-Aware Network
- Network-Driven Requirements
- Scalability
- Network Capacity

- Cost Efficiency
- Automated System Management and Configuration
- Self-Organization
- Status of SON Technology in 5G
- How Evolution to 5G Affects SON
- Network Flexibility
- Energy Efficiency
- Coverage
- Security
- Diverse Spectrum Operation

Regulatory Considerations Applied to 5G

- Potential Technologies for 5G
- MU-MIMO vs. Massive MIMO
- RAN Transmission at Centimeter and Millimeter Waves
- New Waveforms
- Advanced Multi-Carrier Transmission
- Non-orthogonal Transmission
- Shared Spectrum Access
- Advanced Inter-Node Coordination
- Simultaneous Transmission Reception
- Multi-RAT Integration and Management
- Device-to-Device Communication
- Efficient Small Data Transmission
- Wireless Backhaul/Access Integration