# BWA Systems Technology (TEL-2)

TRN-TEL-LTE A/B/C

## Course Specifics

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| Duration: | 2 days |
| Class capacity: | 10 students |
| Materials provided: | Student Handbook (e-Book) |

**Course Description**

The TEL-2 non-certification course in an advanced course in RF and telecom pertaining to the RDL and non-LTE systems. The course consists of 8 modules focusing on RDL (RDL-3000, RDL-3100, RDL-5000) systems technology building blocks from an engineering perspective, enabling trainees to acquire a comprehensive and applied knowledge of broadband wireless systems.

Courses are **conducted by AVIAT expert trainers** in a mentoring environment backed by their deep technology expertise and experience in

The course is **conducted at Aviat Training locations or can be arranged at customer sites**.

## Target Audience

Telecom/RF/network engineers, wireless networking and installation technicians with wireless certification or equivalent experience in the field, Level-2 support engineers of ISP's and Operators deploying our broadband wireless solutions.

## Prerequisites

- Participants should have at least RCSA-RDL-3000 training and sound familiarity with the features and functionalities of the RDL-3000 systems.
- Each student must have a laptop with administrative rights to install and run IP networking simulation software.

## Objectives

Upon completing this course, the trainees will have gained the necessary expertise to understand the use and working of the following in the RDL systems excluding 4G systems:

- Broadband Wireless Access (BWA) systems from 1G to 4G- an overview
- The OSI and TCP/IP networking models
- Signal and systems-time and frequency domain processing
- Single carrier and multi-carrier signal transmission – bandwidth and transmission reliability parameters
- Basic building blocks of a digital communications system
- TDD and FDD air interfaces, TDM and TDMA overview
- Digital modulation techniques and their operational parameters including SNR requirement, EVM concept and constellation attributes from noise and interference perspectives, dynamic adaptive modulation and link adaption techniques and requirements
- RF signal propagation parameters and properties
- RF channel characteristics and parameters such as coherence bandwidth, coherence time and Doppler effect, multipath and flat and frequency selective fading
- Antennas - characterizing parameters such gain, beamwidth, XPD, front to back ratio and polarization
- Transmitter and receiver building blocks and parameters and properties including linearity consideration, spectral mask and out of band emission, receiver sensitivity, noise floor, phase noise and PLL systems

- OFDM as a multicarrier systems including subcarrier spacing, FFT size and transmission mask, FFT size and mobility requirement, cyclic prefix and multipath handling capability, time and frequency views of the OFDM signal, peak to average power ration (PARP) in OFDM systems and power amplifier constraints.
- Transmit and Receiver diversity, MIMO-B and MIMO-A/STBC systems, MRC and signal combining
- RF interference in BWA deployments, interference types and co-channel and adjacent channel interference, interference and interference mitigation best practices

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## Course Outline

**Modules**

- Module-1: BWA Transmission and Wireless Overview
- Module-2: RF Systems and Signal Parameters
- Module-3: Wireless Frame and Duplexing
- Module-4: Digital Modulation and Error Control in BWA Systems
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- Module-5: RF Channel Characteristics and Link Parameters
- Module-6: Antenna and Deployment Parameters
- Module-7: Orthogonal Frequency Division Multiplexing (OFDM)
- Module-8: MIMO Systems and Their Performance Characteristics

Module-1: BWA Transmission and Wireless Overview

- BWA definitions and evolution – G1 to G4
- BWA in the context of the OSI and TCP/IP protocols
- BWA wireless link parameters
- Layer-2, Layer-3 and Layer-4 packet header usage in BWA solutions
- Capacity and coverage constraints and parameters in BWA systems

Module-2: RF Systems and Signal Parameters

- The Building Blocks of BWA RF systems
- RF signal parameters
- Signal amplitude, phase and frequency
- Wave polarization and transmission characteristics
- Signal quality metrics - SNR, CINR, SINADR, BER and PER
- System gain and Rx threshold definition

Module-3: Wireless Frame and Duplexing

- TDD and FDD overview
- Wireless frame definition
- Fixed and variable size wireless frame
- Wireless frame management
- UL-MAP and DL-MAP definitions
- Time division multiplexing (TDM) and time division multiple access (TDMA)
- Synchronization in multiple cell deployment to mitigate interference

Module-4: Digital Modulation and Error Control in BWA Systems

- Building blocks of a digital communications systems and their functions
- Signal baseband definition and its relationship to the system throughput
- Digital modulation techniques – PSK, QAM and FSK
- Signal constellation of digital modulation schemes
- Spectral efficiency and SNR requirements of different modulation schemes
- Error control in digital systems
- ARQ, dynamic ARQ and Hybrid ARQ
- FEC and coding rate
- Introduction to Convolutional, Reed-Solomon and Turbo coding
- Dynamic adaptive modulation and link adaptation based on SNR and PER

Module-5: RF Channel Characteristics and Link Parameters

- Basic RF transmitter and receiver building blocks and their functions
- IF and RF signals up-conversion and down-conversion
- BWA wireless channel characteristics, channel delay spread
- Flat fading and frequency selective fading channels
- Signal loss and distortion in the transmission process
- Channel coherence bandwidth and coherence time parameters
- Fading and multipath in wireless channels
- Methods of dealing with multipath in wireless systems
- Line of sight (LOS) and non-line of sight (NLOS) propagation
- Rayleigh and Rician fading channels
- RF transmitters and receivers' parameters
- Propagation models for BWA radio channels

Module-6: Antenna and Deployment Parameters

- Antenna parameter such as gain, bandwidth and beamwidth
- Antenna polarization characteristics
- Choice of antenna for SISO and MIMO applications
- Antenna alignment and issues of deployment

Module-7: Orthogonal Frequency Division Multiplexing (OFDM)

- OFDM definition and advantage over single carrier transmission
- OFDM on the time (symbol) and frequency (subcarriers) dimensions
- Subcarrier utilization within an OFDM symbol
- The concept of guard interval – time and sampling view
- Multi-path and channel fading from the OFDM perspective
- OFDM symbol duration as a function of the signal baseband (channel size)
- OFDM symbol duration and system throughput relationship
- BW allocation in the OFDM systems
- OFDM implementation in the broadband wireless solutions
- OFDM implementation in WiMAX and LTE
- OFDM and the Doppler effect

- Time and frequency sensitivity of OFDM signals

Module-8: MIMO Systems and Their Performance Characteristics

- Transmission capacity of a wireless link
- Multi-antenna systems
- SISO and MIMO definition
- MIMO and diversity
- Closed loop and open loop MIMO
- MIMO-A, MIMO-A/STBC and MIMO-B
- Dynamic switching between MIMO-A and MIMO-B
- Beam-switching and beam-forming techniques for nomadic and mobile solutions

# EDUCATION SERVICES

## Required Equipment for Training Sessions at Customer Sites

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| RADIO | Not Applicable. |
| OTHER EQUIPMENT | Not Applicable. |
| CLASSROOM SET UP | Sufficient in size to handle all participants, instructor, desks, chairs, classroom equipment. The room must have enough 110 AC (220) AC power and air conditioning to operate equipment, all students client's PC's and the server or radio as required. |

**Classroom Equipment**

Marker board, SVGA or Overhead projector and screen.

**Desk and Chairs**

Desks or workstations with enough room for each student to write have open books, client PC and / or, keyboard and monitor.

**Internet Access**

Internet access through the server or through client PC.

## Pricing & Scheduling

Please contact your Aviat local sales team for a quote or email aviatcareeducate@aviatnet.com

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| TRN-TEL-LTE-C | LTE System & Technology - ILT, 2 Days, Customer Location - 10 Students Max |
| TRN-TEL-LTE-A | LTE System & Technology - ILT, 2 Days, Aviat Training Center - Open Enrollment - per Student |
| TRN-TEL-LTE-VILT-A | LTE System & Technology: VILT, 2 Days, Open Enrollment - per Student |