

Understanding  
**Antennas for LTE and 4G**  
The Road to MIMO and Beyond



### Course Description

For around a hundred years, single antennas have been used, dipoles, etc. for wireless communications in the last ten years, however, this has all changed and multiple antenna system.

Different types of diversity, beamforming, array antennas and MIMO have all emerged onto the wireless scene. They offer better cell capacity, more user throughput, larger cells too many good things to be true, it seems. However, actual deployments have shown the immense value of current MIMO technology and the potential for the next few years.

Technologies such as IEEE 802.11n, Mobile WiMAX, HSPA and LTE are all dependent on their antenna systems for their performance. The newest and therefore most advanced usage is for LTE so some time will be spent on antennas for that technology and its predecessor, HSPA.

This unique course starts with a refresher on antenna basics before looking at diversity in all its forms and then diversity, MIMO, beamforming and array antennas.

### Target Audience

Anyone needing an in-depth understanding of Antennas for LTE and 4G. Such attendees would be employed by or contracted to operators, manufacturers, integrators or regulators.

### Course Outline

#### Module I: Basic Antenna Theory

- Reciprocity
- Isotropic and Dipole Antennas
- Gain: dBi and dBd
- Beam patterns
- Front to back ratio
- Reactive near-field

Radiating near-field (Fresnel region),  
Far-field (Fraunhofer region)  
Multipath and Inter Symbol Interference

**Module II:** Conventional Antennas

Sectored Cells  
SAIC (Single Antenna Interference Cancellation) for GSM

**Module III: Diversity Techniques**

Diversity Gain  
Receive Diversity  
    Selection Diversity  
    Switched Diversity  
    Linear Combining  
Space Diversity  
Time Diversity  
Frequency Diversity

**Module IV:** MIMO Antenna Systems

Space-Time Diversity Coding  
Spatial Multiplexing

**Module V:** Beamforming Antennas

Principles of Beamforming

Phased Arrays

Butler Matrix

Rotman Lens

**Module VI:** Array Antennas

Uniform,

Binomial

Dolph-Tschebyscheff

**Module VII:** Antennas for LTE and HSPA

UE Challenges

HSPA

DL-MIMO

LTE

Overview of multi-antenna related processing  
Precoded Spatial Multiplexing

DL SU-MIMO and Transmit Diversity

DL Multiuser MIMO

Single-layer dedicated beamforming in LTE

UL Multiuser MIMO

Uplink Single-User MIMO

Downlink Dual-Layer Beamforming

MU-MIMO

Coordinated multi-point transmission/reception (CoMP)

Extended Downlink Single-User MIMO

**Module VIII:** MIMO and Beamforming Elsewhere

Mobile WiMAX Matrix A and Matrix B

IEEE 802.11n Wireless LAN

### **Delivery Method**

Instructor-Led with numerous case-studies and exercises.

### **Equipment Requirements**

**(This apply's to our hands-on courses only)**

BTS always provides equipment to have a very successful Hands-On course. BTS also encourages all attendees to bring their own equipment to the course. This will provide attendees the opportunity to incorporate their own gear into the labs and gain valuable training using their specific equipment.

### **Course Length**

2 Days