

wray castle
training the telecoms world



the essential guide to LTE training

**...delivering knowledge,
maximizing performance...**

- **Technical Overviews**
- **Training Courses**
- **Learning Flows**



leading the way in LTE training

www.wraycastle.com



the essential guide to LTE training

Introduction

LTE was born out of users' increasing demands for improved services and faster service delivery.

The need to deliver voice, data, multimedia and video to and from a variety of user terminals, while moving between fixed and wireless access technologies and roaming between different networks and across national boundaries, presented a serious challenge.

At the same time, the industry was seeking to reduce costs, improve spectral efficiency, deliver more services, use new spectrum and improve integration with other open standards.

3GPP initiated a project to improve the Universal Mobile Telecommunications System (UMTS) to provide a better user experience while simplifying the technology used. The project is a global endeavour involving over sixty operators, vendors and research institutes and has been a model of inter-company and international and inter-industry cooperation.

The result is a continuation of the evolutionary path from 2G beyond 3G and towards 4G.

Wray Castle Telecoms Training has developed a portfolio of LTE training courses to meet the varying needs of those in the industry.

Contents

Inside this launch issue of the "essential guide to LTE training" you will find vital information about the technology and the wide-ranging portfolio of Wray Castle training courses. There are introductory and advanced courses and training courses focused

on specific elements such as the radio access network, the evolved packet core, optimization and many more. There are courses for technical roles and also for non-technical positions.

Why Wray Castle Telecoms Training?	3
Training Delivery Options	3
Technical Levels	3
LTE Technology Overview	4
Wray Castle Training LTE Portfolio	6
Customized Content	6
LTE Course Outlines	7
Technical Briefings	10
Example Training Flows for Key Roles	11
Related Wray Castle Telecoms Training Courses	12
How to Contact Wray Castle Telecoms Training	12



the essential guide to LTE training

Why Wray Castle Telecoms Training?

We are focussed totally on telecoms training and offer a broad range of high-quality courses covering the latest technical developments across all the major global communications technologies. We were developing and delivering great training when GSM was rolled out; we have supported telecoms networks through the launch of GSM, GPRS, EDGE, cdmaOne, CDMA2000™, UMTS, HSPA and WiMAX, and we are still offering best-in-class training now network operators anticipate adopting LTE.

Our courses are developed in-house by a highly skilled team of subject matter and learning experts and are widely regarded as

the best available in the industry. For maximum flexibility and effectiveness, courses are available in a choice of delivery formats and at a variety of technical levels.

Our customers include the best-known names in the industry and range from global telecoms giants to small, hi-tech start-ups. Organizations include mobile operators, fixed-line operators, equipment and handset manufacturers, billing and software companies, regulators and many others. With excellent customer feedback and the experience of delivering training in over 50 countries, Wray Castle telecoms training is the global provider of choice.

Training Delivery Options

Training may be delivered in a variety of formats to meet individual and operational needs. These include:

- Instructor-led training – closed courses delivered on your site
- Instructor-led training – open courses delivered through our public course schedule
- Remote training – closed courses delivered to delegates on multiple sites by webinars, podcasts, etc.
- e-Learning – hosted on your learning management system or supplied on CD providing unlimited access
- Technical Briefings – supplied in PDF softcopy or hardcopy format for open access

Technical Levels

Wray Castle courses are designed to match the specific requirements of different audience types and are written in a way that best addresses delegates' diverse learning styles. A clear description of the prerequisites is given and each course is categorized to indicate the technical difficulty of the subject matter. Throughout this brochure, courses are coded by the colours shown below

Level 1 Courses

Level 1 courses are specially developed and presented in a style designed to be easily understood by those without a technical background. Key characteristics, uses, trends and issues relating to technical topics are examined in a concise, interactive and well-explained way. These courses assume no prior knowledge of the subject matter.

Level 2 Courses

Level 2 courses contain technical material that is suitable for engineering staff. Some will find that these courses completely satisfy their requirements, while for others they will be an ideal introduction to more specialized content. These courses also provide semi-technical staff with a deeper appreciation of technology issues and, although they assume no prior knowledge of the subject matter, they do require the ability to grasp technical concepts.

Level 3 Courses

Level 3 courses have been developed for engineering staff who require detailed knowledge of a specialist area of technology. These courses assume some underlying knowledge of the broader, related topic areas on which the detailed content is built, and general engineering skills and knowledge appropriate to the course topic.

Flexicourses™

Flexicourse™ is a process whereby, typically, Level 3 courses are shortened by the removal of less-relevant content and exercises. Generally, this is done to customize a course for a customer's specific training requirement. The *Flexicourse™* process is a cost and time-effective way of meeting a customer's exact needs for a given group of delegates quickly and within budget.



LTE Technology Overview

What is LTE – why is it important?

Long Term Evolution (LTE) represents the next developmental step for the 3GPP standards group. It provides for a continued evolutionary path from 2G GSM/GPRS, beyond 3G UMTS/HSPA and ultimately towards a 4G solution.

GSM/GPRS has been the most successful communications technology the world has ever known. More than half the world's population has a mobile phone based on GSM technology, far more people even than have had access to fixed line telephones. It is likely that LTE will be even more successful.

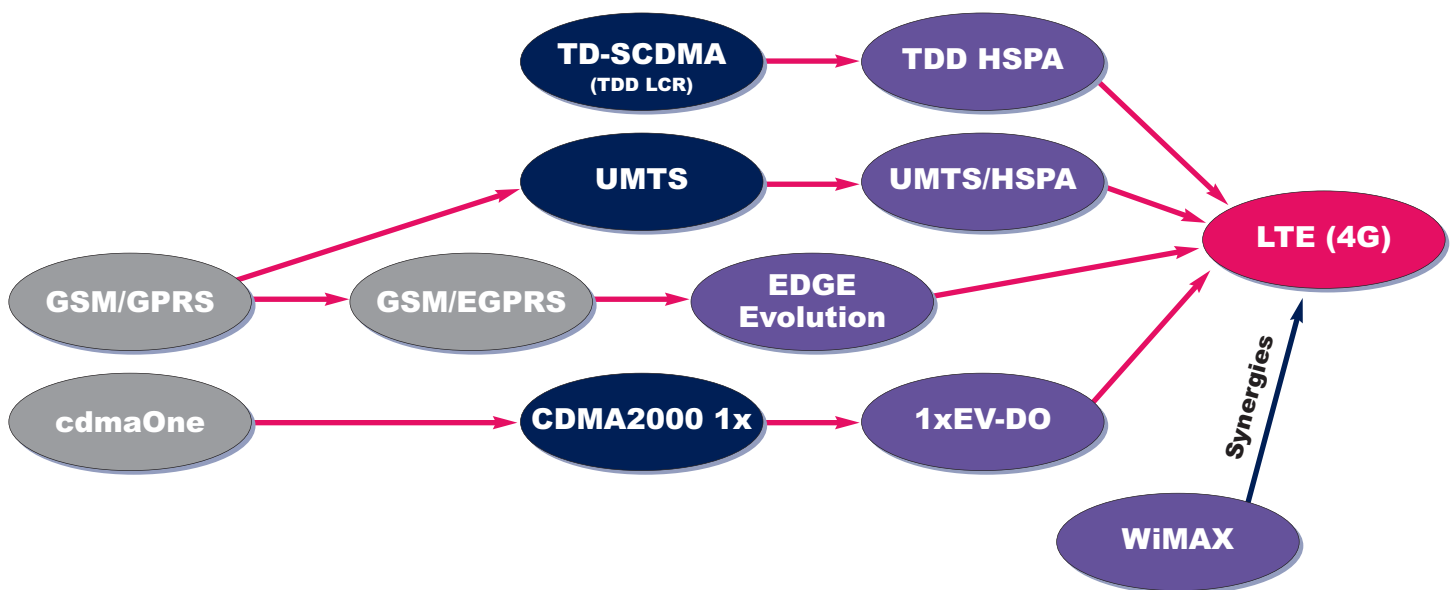
UMTS has continued to build on the success of GSM and momentum is gathering behind its significantly increased capability with the introduction of HSPA. The classic fixed and mobile telecommunications business models are undergoing enormous change with the move towards all-IP switching and a total-communications service profile. Meanwhile, the last decade has seen the Internet develop into a serious business tool and fixed broadband access is fast becoming a basic commodity.

This market landscape is ready for a technology that combines broadband capabilities with an efficient, scalable switching infrastructure and a flexible service delivery mechanism.

LTE provides just such a solution and is designed to address growing global demand for anywhere, anytime broadband access while maintaining efficient provision of traditional telecommunications services, and maximizing compatibility and synergies with other communications systems.

Wide-area LTE radio access combined with the Evolved Packet Core (EPC) represents a complete adoption of an all-IP architecture. This will offer future-proof broadband delivery capability with the potential for bit rates of several hundred megabits per second, and quality of service management suitable for real-time operation of high-quality voice and video telephony.

Although LTE most obviously represents an evolutionary path for UMTS networks, it has also been designed to allow cost-effective upgrade paths from other technology starting points. For example, GSM operators now have the possibility to access 3G-like performance through EDGE Evolution, and this in turn can be used as a direct pathway to LTE. Similarly, the interworking capabilities of the EPC make it possible for CDMA to migrate radio access from 1x or 1xEV-DO to LTE.

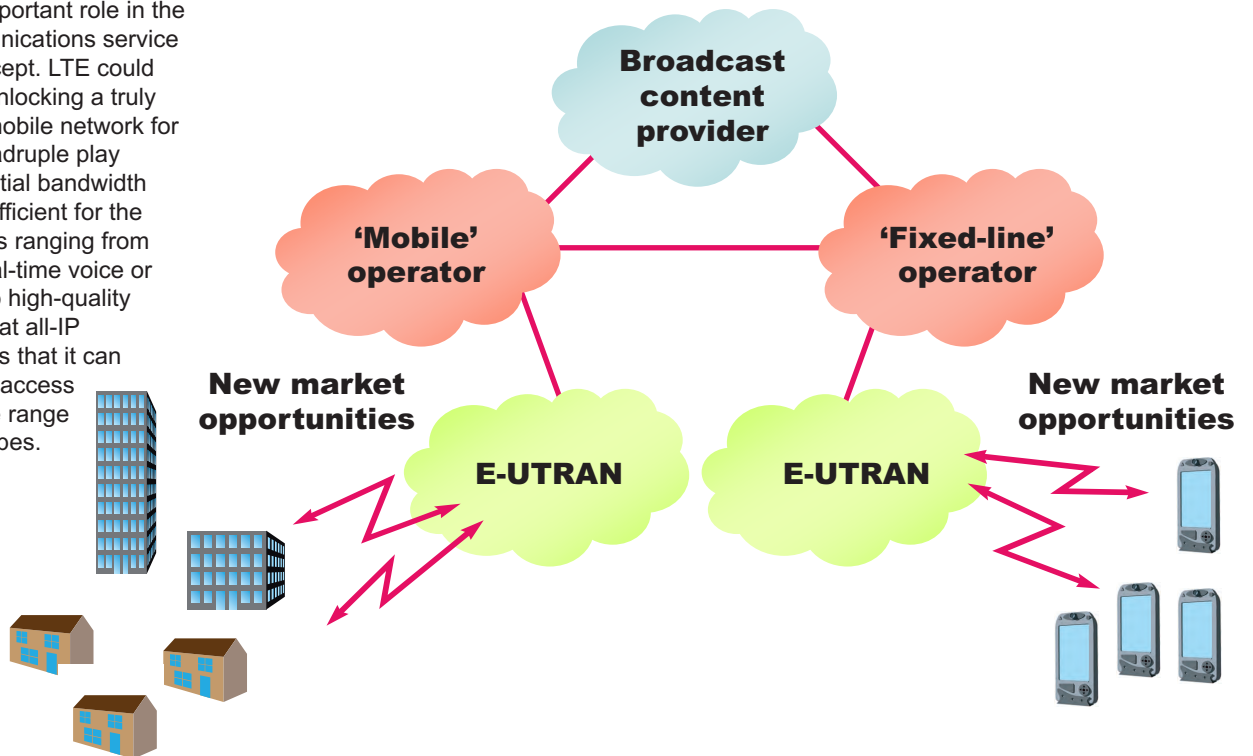




LTE Technology Overview

Realizing Convergence with LTE

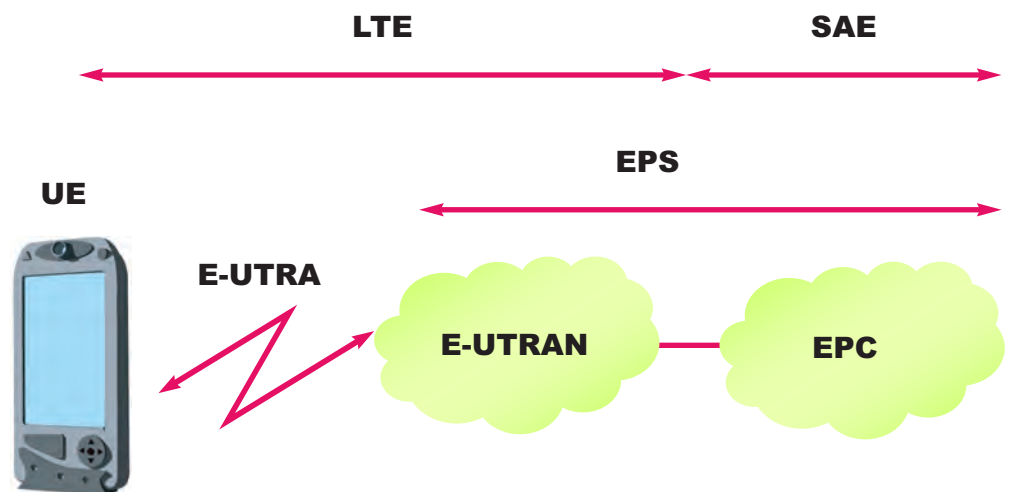
LTE has a very important role in the overall telecommunications service convergence concept. LTE could provide a key to unlocking a truly converged fixed/mobile network for the delivery of quadruple play services. Its potential bandwidth capabilities are sufficient for the support of services ranging from managed QoS real-time voice or video telephony to high-quality streamed TV. Its flat all-IP architecture means that it can act as a universal access network for a wide range of core network types.



Some LTE Terminology

LTE is the term used to describe collectively the evolution of the radio access network into the Evolved Universal Terrestrial Radio Access Network (E-UTRAN) and the radio access technology into Evolved Universal Terrestrial Radio Access (E-UTRA). System Architecture Evolution (SAE) is the term used to describe the evolution of the core network into the Evolved Packet Core (EPC).

There is also a collective term, Evolved Packet System (EPS), which refers to the combined E-UTRAN and EPC.

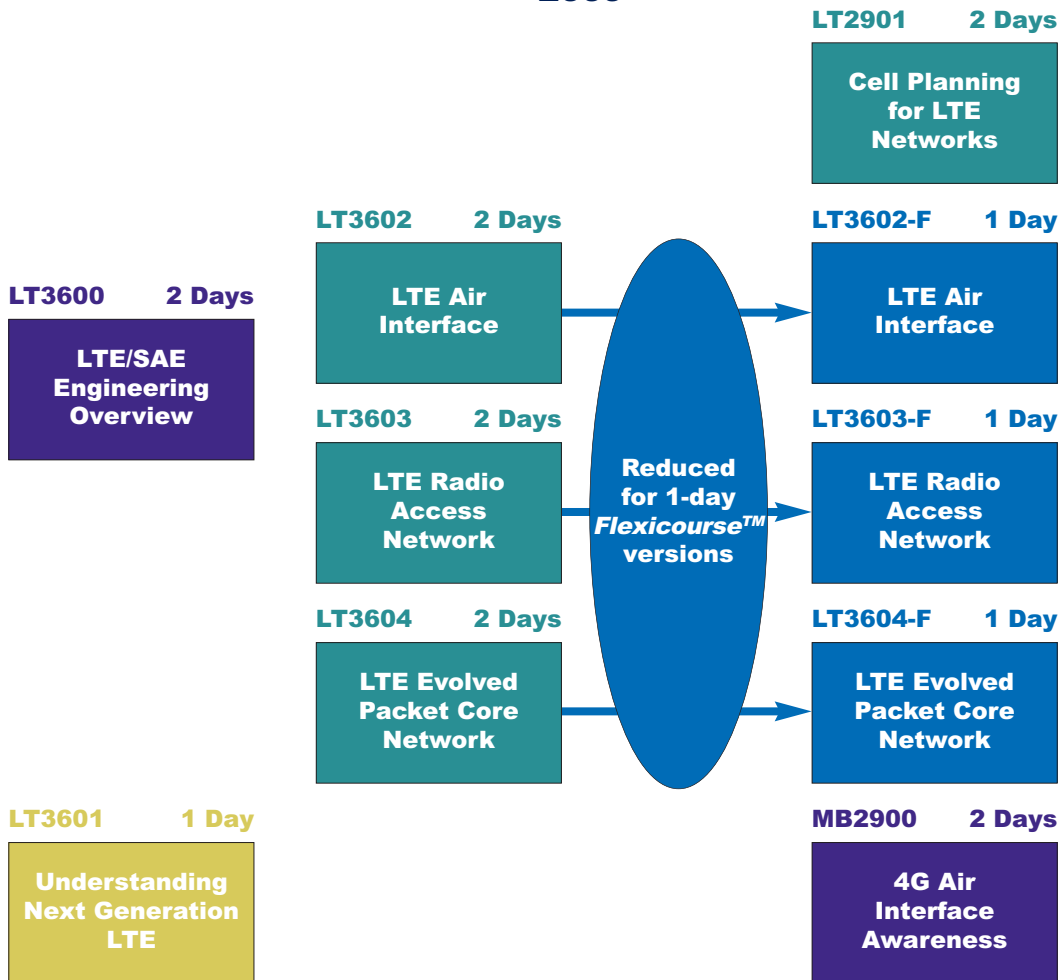




LTE Portfolio

Launch Courses

Phase 1 2009



Phase 2 2010

Customized Content

Wray Castle Telecoms Training creates unique customer-specific courses from scratch or by utilizing our unique *Flexicourse™* technique. Using *Flexicourse™*, Wray Castle Telecoms Training uses material from our mainstream courses and our Content Warehouse to create a course to suit your exact needs. This means:

- No unnecessary content
- Relevant content from other courses
- Added customer-specific data
- Reduced training time
- Better use of training budgets
- Ability for more interactive classes using customer confidential data and providing the opportunity for role-play, team building, problem solving, commanding support for strategic changes – and more.



LTE Course Outlines

LT3600 **2 Days**

LTE/SAE Engineering Overview

This course provides a technical introduction and overview of the complete LTE system, known as the Evolved Packet System (EPS), including the radio access network, core network and other key associated technologies.

Who would benefit

This course is intended for engineers either new to, or already working in, mobile communications.

Prerequisites

Familiarity with telecommunications and general engineering terminology is assumed and some understanding of 2G and 3G cellular systems would be beneficial.

Course contents

- EPS system architecture
- LTE terminology
- EPS services and service aims
- E-UTRAN architecture and interfaces
- X2 and S1 interface protocols
- OFDMA basic principles
- Air interface protocol structure
- Basic physical layer structure
- Radio access channel concepts
- Evolved Packet Core (EPC) architecture
- MME functions and procedures
- 'S' interface protocols
- All-IP architecture
- IP Multimedia Subsystem (IMS) concepts
- QoS concepts
- Security aspects
- Connection establishment
- Radio resource management procedures

LT3602 **2 Days**

LTE Air Interface

This course provides a detailed technical description of the air interface for LTE radio access. This includes OFDMA principles, access and non-access stratum protocols, channel structures, connectivity and mobility management procedures along with radio link control.

Who would benefit

Engineers involved with equipment design, operation, optimization or monitoring of the LTE radio link.

Prerequisites

An engineering background with some knowledge of digital radio systems and general radio principles and techniques is assumed. Experience of existing 2G or 3G systems would be beneficial.

Course contents

- EPS system architecture
- E-UTRAN architecture and interfaces
- OFDMA basic principles
- Concept components for OFDM
- Defining orthogonality
- Principles of QAM
- The Fourier transform
- The OFDM transmitter and receiver
- Modulation and Coding
- Access and non-access stratum protocols
- Logical and transport channels
- Physical layer structures
- Resource allocation strategies
- MIMO concepts and implementation
- QoS concepts
- Security aspects
- Connection establishment
- Radio resource management procedures

LT3603 **2 Days**

LTE Radio Access Network

This course provides a detailed technical description of the radio access network for LTE systems. This includes E-UTRAN structure, transmission protocols, access stratum and non-access stratum signalling protocols, core network interactions and bearer establishment procedures.

Who would benefit

Engineers involved with transmission or architecture design, optimization, network management or monitoring of the LTE radio access network.

Prerequisites

An engineering background with some knowledge of telecommunications technologies and protocols is assumed. Experience of existing 2G or 3G systems would be beneficial.

Course contents

- EPS system architecture
- MME and S-GW functions
- E-UTRAN architecture and interfaces
- X2 and S1 interface protocols
- Air interface protocol structure
- E-UTRAN transmission protocols
- Logical and physical connectivity to EPC nodes
- SCTP application within the E-UTRAN
- S1 Application Protocol structures and operation
- X2 Application Protocol structures and operation
- UE state management
- IMS interactions
- QoS and security concepts
- Connection establishment
- Resource management procedures



LTE Course Outlines

LT2901 **2 Days**

Cell Planning For LTE Networks

This course provides an introduction to the changes required in the techniques, skill sets and tools for planning LTE networks. This includes link budgets, mixed traffic dimensioning, coverage considerations and tool configuration parameters. All elements are reinforced through classroom exercises and tool demonstrations.

Who would benefit

This course is intended for those involved in cell planning, configuration or optimization of LTE-based networks.

Prerequisites

This course assumes existing knowledge of basic cell planning principles and familiarity with the cell planning role. Note: for those new to the cell planning role this course should be combined with the Wray Castle Cell Planning Principles *Flexicourse™* module LT2900-F.

Course contents

- LTE cell structure
- LTE planning philosophy
- OFDMA considerations
- Traffic analysis
- Cell dimensioning
- Mixed traffic link budgets
- Tool capabilities and configuration
- Coverage planning for LTE cells
- Use of hierarchical cell architectures
- Interference scenarios
- Frequency planning requirements
- Co-siting issues with legacy technologies
- Introduction to indoor coverage and femtocell considerations

LT2902 **3 Days**

Introduction to LTE E-UTRA Optimization

This course provides an introduction to the principles and techniques that relate to optimizing the LTE radio access network. This includes coverage and capacity optimization, idle mode parameters, connected mode parameters and handovers to legacy technologies. All elements are reinforced through classroom exercises and tool demonstrations.

Who would benefit

This course is intended for experienced radio access optimizers and those moving into the radio optimization role for LTE-based networks.

Prerequisites

This course assumes an engineering background with some knowledge of digital radio systems in general and good knowledge of the LTE air interface structure and operation. Experience of optimization for 2G or 3G systems would be useful.

Course contents

- Identification of optimization opportunities
- The coverage–capacity–quality relationship
- Optimization software tools
- Drive test tools, performance data and statistics management
- IMS awareness
- Link budgets
- Interference scenarios
- Coverage and capacity optimization issues and solutions
- RAN configurations and dimensioning
- Idle mode and system access
- Connected mode and radio link control
- Inter-system handovers
- MIMO operation and benefits
- Antennas for LTE cells

LT2903 **2 Days**

LTE E-UTRA Log File Interpretation

This course provides guidance on tool set-up, configuration of test sequences, interpretation of output data, network performance determination and report generation for LTE drive-test log files. This course includes practical exercises using a drive-test tool throughout.

Who would benefit

This course is intended for engineers involved with drive test log file capture and interpretation, equipment testing and evaluation, network benchmarking or radio optimization.

Prerequisites

This course assumes existing knowledge of cellular network radio link operation. Some prior experience of drive-test data capture and use of the relevant software tools would be useful.

Course contents

- Review of the LTE air interface and procedures
- Tool set-up and basic operation
- Setting up a drive test
- Viewing, saving and exporting data
- LTE air interface analytical information
- IMS awareness
- Signalling flows and failure messages
- LTE test parameters
- Interpreting real-time data flows and channel activity for VoIP connections
- Interpreting non-real-time data flows and channel activity
- Interpreting handover activity
- Testing multimedia streaming services
- Exporting data for analysis



LTE Course Outlines

LT3604 **2 Days**

LTE Evolved Packet Core Network

This course provides a detailed technical description of the Evolved Packet Core (EPC) for LTE systems. This includes EPC architecture and interfaces, service provision concepts, IMS functionality, application of IP technologies and overall protocol architectures.

Who would benefit

Engineers involved with switching or transmission architecture, optimization, network management, network testing or monitoring of the Evolved Packet Core (EPC).

Prerequisites

An engineering background with some knowledge of transmission and switching technologies including, IP, is assumed. Experience of existing 2G or 3G systems would be beneficial.

Course contents

- EPS system architecture
- Evolved Packet Core (EPC) architecture
- MME and S-GW functions
- E-UTRAN architecture and interfaces
- Application of IP and SCTP
- IMS architecture and functionality overview
- Application of SIP in the EPC
- Logical and physical connectivity for EPC nodes
- EPS bearer establishment and operation
- IETF protocols in the EPC
- EPS network areas and UE tracking
- Service delivery architectures
- EPS interworking options
- QoS and security concepts
- Connection establishment
- Resource management procedures

LT3605 **2 Days**

E-UTRAN Advanced Signalling and Protocols

This course provides an in-depth analysis of the functions and operations of the key protocols used to establish signalling and traffic data flows through the E-UTRAN. This course includes practical exercises based on the review and interpretation of LTE trace files.

Who would benefit

Engineers involved with transmission or architecture design, optimization, network management or monitoring of the LTE radio access network.

Prerequisites

This course assumes a good working knowledge of the operation of the LTE E-UTRAN equivalent to that provided by Wray Castle's LTE Radio Access Network (LT3603) course.

Course contents

- System access and registration procedures
- Security procedures
- Overall EPS bearer establishment procedures
- VoIP session establishment
- Packet data session establishment
- Multimedia streaming session establishment
- Signalling flows and failure messages
- Multimedia and basic messaging procedures
- E-UTRAN transmission protocols and architecture
- IP interactions in the E-UTRAN
- SCTP operation and trace file interpretation
- X2AP operation and trace file interpretation
- S1AP operation and trace file interpretation

LT3606 **2 Days**

EPC Advanced Signalling and Protocols

This course provides an in-depth analysis of the functions and operation of the key protocols used to establish signalling and traffic data flows through the EPC. This course includes practical exercises based on the review and interpretation of LTE trace files.

Who would benefit

Engineers involved with switching, transmission or architecture design, optimization, network management or monitoring of the Evolved Packet Core (EPC) network.

Prerequisites

This course assumes a good working knowledge of the operation of the LTE SPC equivalent to that provided by Wray Castle's LTE Evolved Packet Core Network (LT3604) course.

Course contents

- System access and registration procedures
- Security procedures
- Overall EPS bearer establishment procedures
- VoIP session establishment
- Packet data session establishment
- Multimedia streaming session establishment
- Signalling flows and failure messages
- Multimedia and basic messaging procedures
- EPC transmission protocols and architecture
- IP interactions in the EPC
- SCTP operation and trace file interpretation
- SIP operation and trace file interpretation
- QoS interactions and DiffServ
- GTPv2 operation and trace file interpretation
- RTP and RTCP operation and trace file interpretation
- Database interactions and signalling flows



LTE Course Outlines/Technical Briefings

LT3601

1 Day

Understanding Next Generation LTE

This course provides a non-technical introduction and overview of the complete LTE system, known as the Evolved Packet System (EPS), including the system capabilities, general structure and operation as well as its position as a development of current systems.

Who would benefit

This course is intended for non-technical professionals either new to, or already working in, the mobile or fixed telecommunications sector.

Prerequisites

No technical knowledge is assumed but some familiarity with the mobile telecommunications industry would be beneficial.

Course contents

- The evolving mobile telecommunications market
- LTE services and service aims
- LTE network terminology
- E-UTRAN architecture
- Evolved Packet Core (EPC) architecture
- Why all-IP?
- LTE for fixed and mobile services
- Technology roadmaps toward LTE
- LTE timescales
- Applications for LTE
- LTE technology synergies

MB2900

2 Days

4G Air Interface Awareness

This course provides a technical overview of the range of radio technologies that are relevant to 4G radio communications networks. This will include key technical characteristics and technologies, service capabilities, service applications and technology synergies.

Who would benefit

This course is intended for technology decision makers, radio access engineering staff working for both mobile and fixed operators, equipment manufacturers or regulators.

Prerequisites

Familiarity with radio systems, telecommunications and general engineering terminology is assumed. Some understanding of 2G and 3G cellular systems would be beneficial.

Course contents

- UMTS/HSPA
- UMTS/HSPA+
- EDGE Evolution (EGPRS2)
- LTE
- LTE Advanced
- Mobile WiMAX
- Future Mobile WiMAX (802.16m)
- 1xEV-DO Rev. B
- Wi-Fi 802.11b/g/n
- Femtocell concepts
- Bluetooth
- Near Field Communications (NFC)
- ZigBee (802.15.4)
- DVB-H
- DAB-IP
- MediaFLO
- UMTS TDD Mode

Technical Briefings

Stay updated

Keep-up-to date with all the latest major technology developments. Wray Castle's Research and Development Team is continually monitoring global developments in telecoms technologies, tracking standards bodies, vendor solutions and operator implementations and we should be pleased to share our thoughts with you.

Download the Latest Technical Briefings

Current Technical Briefings include:

- LTE and SAE – A Clearer Picture
- Femtocell Concepts
- HSPA Technical Update
- HSPA+ – Bridging the Gap
- Near Field Communications – The Power of Touch
- The Truth About WiMAX
- EDGE Evolution – Sweating the Assets

Download your free Technical Briefings from
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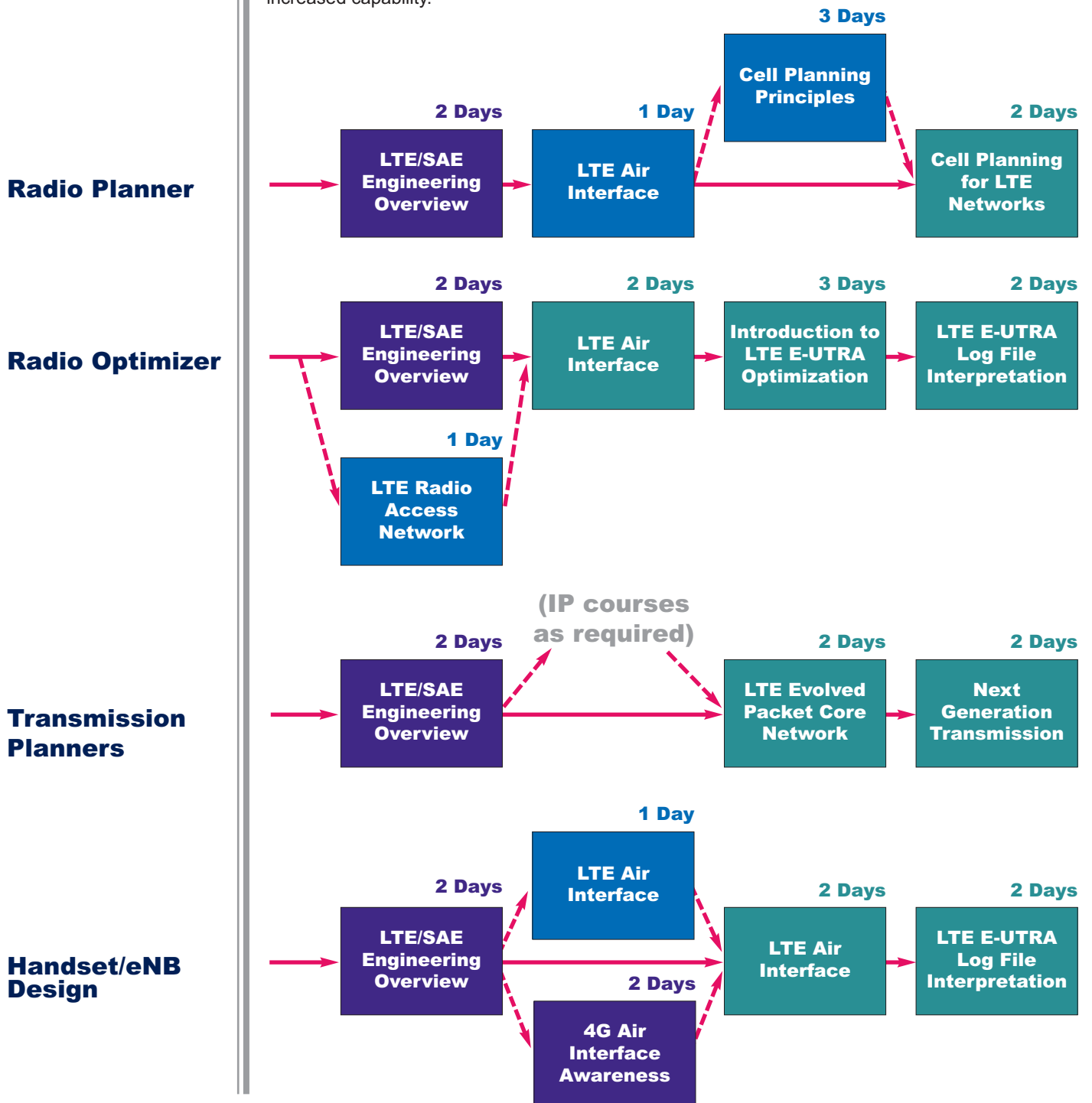


Example Training Flows

Introduction

With a wide range of existing courseware, a Content Warehouse full of useful material and Wray Castle Telecoms Training's *Flexicourse™* modules, the training requirements of a wide range of jobs can be mapped out easily.

Shown below are some examples already prepared for different roles. Each will bring engineers up to speed with all they need to know about LTE and how it will impact their jobs. It's the fast route to increased capability.





Contact us

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- Customer comments
- Organizations in our industry
- Technical Briefings
- Company news

and much more!

To find out more, please go to www.wraycastle.com >>

Other relevant Wray Castle Telecoms Training courses

The following Wray Castle training courses will provide useful background learning for the LTE courses. Full details can be found on www.wraycastle.com

IP2900	5 Days	IP2300	2 Days	IP2301	2 Days
Hands-on IP Networking		IP Engineering Overview		IP Backbone Traffic Engineering	
QS2501	2 Days	IP2001	2 Days	MB2501	1 Day
TCP/IP Protocol Suite		Softswitching and VoIP		MPLS Overview	
QS2600	2 Days	MB2300	3 Days	IP2601	3 Hrs
SIGTRAN		IMS and SIP		IPv6	
IP2602	3 Hrs	IP2600	2 Days	IP2700	2 Days
IP QoS		IP Security		IPTV over Fixed and Mobile Networks	
TY2702	2 Days	MB90	2 Days	MB2705	1 Day
Next Generation Transmission		Mobile Intelligent Networks (CAMEL)		Mobile Web 2.0	

What our customers say

'an excellent course delivered by an excellent trainer and meeting all my objectives'
R.C. (Vodafone)

'Wray Castle is synonymous with good technical training' T.P. (Ericsson)

'an excellent trainer. He managed to convey clearly and in a concise fashion, complicated ideas'
J.S. (Sony Ericsson)

'some of the best course notes I've seen – really useful CD' A.T. (O2)

'excellent presentation [trainer] has a strong knowledge of the subject' S.K. (LogicaCMG)

'well informed teaching with high clarity of presentation' R.M. (Ofcom)