Teaching on Telecommunications

- NGN and IMS Networks and Services
- IP Telephony
- Signaling and Intelligence in Telecommunications
- Mobile Networks and Services
- M2M and IoT
- SDN and NFV

In-House Courses on Telecommunications Networks and Services 2016

EFORT
WWW.EFORT.COM

EFORT is a teaching and consulting company specialized in the area of telecommunications networks and services.

EFORT lecturers and courses

The EFORT lecturers are telecommunications specialists recognized in their field. In addition, they are consultants working on strategic projects for network operators.

The EFORT training courses aim at entitling the Telecom teams in charge of strategy, technical, marketing and finance development as well as operations, to reach the adequate level they need to deal with the non-stop evolving technologies, new services offers, and competitive environments. In order to reach these objectives, EFORT course program permanently integrates the latest developments of international standards and technological innovations in telecommunications.
The courses take place as in-house seminars. The presentation of concepts, architectures, and vendors solutions is confronted with their practical application. Case studies are derived from projects carried out by EFORT lecturers and enable tackling the technical and organizational difficulties.

Most EFORT courses cover the following issues :

- International telecommunications standards,
- Network technology,
- Supported services,
- Network and service architectures,
- Planning and engineering of the technology,
- Management of the technology,
- Impartial vendors solutions analysis
- Strategy of introduction of new services, cost evaluation,
- Business-plan main lines,
- Marketing aspects

Recent references for in-house courses

Operators : Orange, Telefonica Spain, Everything Everywhere, Verizon Wireless, Vodafone UK, Swisscom, Telecom Argentina, Telecom Italia, Entel PCS, Côte d'Ivoire Telecom, Etecsa, Telmex, Telma, Sonatel, Bouygues Telecom, Maroc Telecom, Croatian Telecom, Monaco Telecom, TDF, Proximus, Mobistar, Prosodie, Meditel, Onatel, Completel, UNE, INWI, OPT, Telenet, Andorra Telecom, Zain, BICS.
Vendors : Alcatel-Lucent, Cisco, Oracle, Ericsson, Siemens, Fujitsu, Bull, IBM, Hewlett Packard, Ulticom, Motorola, Kodak, Avaya, Thomson Multimedia, Landis & Gyr, Sofrecom, Keymile, Comverse, Cirpack, Genesys, eServGlobal, N-Soft, Netbricks, Astellia, Tekelec.
Integrators and Users : EDF, La Française des Jeux, Swatch, Carrefour, Groupe ESR, AFD Technologies, Alten, Altran, Atos, Technoserv, SII, Setelia, Ercom, Devoteam, Technoserv.
Research and Training Centers : Cintel, Cenet, Itba, Cmtl, Esmt.

Courses organization

The in-house telecommunications courses are organized in your company and are adapted to the participants profile. These courses may be taught in **English**, **French** or **Spanish**.

For more information, you can get in touch with EFORT lecturers : sznaty@efort.com
Our WEB site is periodically updated with all our proposed public and in-house telecommunications courses : http://www.efort.com

Teaching on Telecommunications

EFORT TELECOMMUNICATIONS COURSES

TELECOMMUNICATIONS NETWORKS AND SERVICES COURSES

Signaling Course Title	Duration
Telecommunications Networks and Services and their Evolutions	2, 3 or 4 days
Designing IP Services	3 days
Voice over DSL	2 days
Very High Speed Rate Access Networks	3 days

TELECOMMUNICATION NETWORKS AND SERVICES AND THEIR EVOLUTION

Course Objective : Introduce the set of components of a Telecommunication Network with their associated services and show their evolution.
Pre-requisites : No specific knowledge
Duration : 2, 3 or 4 days

The telecommunication infrastructure of a network operator consists of a set of networks (transmission, switching, access, signaling, mobile, intelligent network, management network), each performing a particular function towards the provision of the service to the customer. The objective of this course is to briefly introduce the telecommunication network structure to acquire the vocabulary of the field, understand the several types of networks involved in the operator "Telecommunication Network", and gain knowledge on how these networks interface. The several services supplied by each type of network are also emphasized. Moreover the OSS and BSS used for the provisioning, monitoring and billing of these services is presented. Another important objective of the presentation is to introduce the evolutions of these networks and services on the medium and long terms.

1. Telecommunication Network and Service Architectures and their underlying Concepts and Principles
2. Transmission Network: PDH, SDH, D-WDM, Gigabit Ethernet
3. Fixed Switching Network
   - 3.1. Circuit switched network (PSTN) and its evolution towards NGN/IMS
   - 3.2. packet switched network (IP Network)
4. Signaling Network : Signaling System 7 (SS7) and its evolution towards SIGTRAN (Signaling Transport over IP)
5. Intelligent Network (IN) and its services (e.g., prepaid, VPN, etc.)
6. Fixed Access Network : xDSL, FTTx, Cable, etc.
7. Mobile Network
   - 7.1. Mobile access network : BSS (2G), UTRAN (3G), LTE (4G)
   - 7.2. Mobile core network
     - 7.2.5. Circuit switched network and its evolution towards mobile NGN (R4)
     - 7.2.6. Packet switched network : GPRS and its evolution towards Evolved Packet Core
8. Fixed Services : Telephony services, Triple play/ Quad play (Broadband access to the Internet, IP telephony, IPTV and Convergence phone)
9. Mobile Services
   - 9.1. SMS / MMS
   - 9.2. Prepaid/VPN with CAMEL
   - 9.3. Number portability
   - 9.4. Streaming/Mobile TV
   - 9.5. Mobile broadband access to the Internet
10. IP Multimedia Subsystem (IMS) for fixed/mobile Convergence
    - 10.1. Network convergence
    - 10.2. Service Convergence
11. Business and Technical Information System
    - 11.1. Management Network (TMN) and management systems
    - 11.2. OSS and BSS
    - 11.3. Billing system, customer care, SLA management system.
    - 11.4. Middlewares OOM (CORBA), MOM (MQ Series) et TOM (Tuxedo) for the planning of OSS and BSS
    - 11.5. Enterprise Service Bus

DESIGNING IP SERVICES

Course objective : Understand how to design, deploy and manage IP-based services.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : basic knowledge on IP networks
Duration : 3 days

1. Introduction to IP Networks
   - 1.1. TCP/IP Layering : TCP, UDP, ICMP and IP Protocols
   - 1.2. Internet addresses
   - 1.3. IPv4 and IPv6
   - 1.4. IP Routing : RIP, RIP2, IGRP, EIGRP, OSPF, BGP
   - 1.5. IP Multicast
   - 1.6. The Domain Name System
   - 1.7. Some Application Layer Protocols
     - 1.7.1. SMTP
     - 1.7.2. HTTP
     - 1.7.3. SNMP

2. Advanced Quality of Service in IP Networks
   - 2.1. Introduction to QoS in IP Networks
   - 2.2. Integrated Services with RSVP (Resource Reservation Protocol)
     - 2.2.1. RSVP Admission Control
     - 2.2.2. RSVP Signaling Process
     - 2.2.3. RSVP Scalability considerations
     - 2.2.4. Strengths and Weaknesses of RSVP
     - 2.2.5. Case study : Reserving end-to-end bandwidth for an application using RSVP
     - 2.2.6. RSVP for voice over IP
   - 2.3. Differentiated Services
     - 2.3.1. DiffServ Architecture
     - 2.3.2. Strengths and Weaknesses of DiffServ
   - 2.4. Differentiated Services versus Integrated Services

3. IP Switching : MPLS (Multiprotocol Label Switching)
   - 3.1. MPLS terminology
   - 3.2. MPLS Architecture
   - 3.3. Label Distribution Protocol
   - 3.4. MPLS support of RSVP
   - 3.5. MPLS support of DiffServ

4. Service Level Agreements in IP Networks
   - 4.1. SLA Types in IP networks
     - 4.1.1. Network connectivity SLAs
     - 4.1.2. Application SLAs
     - 4.1.3. Service Provider SLAs
   - 4.2. SLA Architectures
   - 4.3. SLA monitoring
     - 4.3.1. Network connectivity SLA monitoring
     - 4.3.2. Application SLA monitoring
     - 4.3.3. Service Provider SLA monitoring

Teaching on Telecommunications

5. IP VPN
   - 5.1. Definition of an IP VPN
   - 5.2. Cost savings with IP VPN
   - 5.3. Architecture of IP VPN
     - 5.3.1. Tunnels : The virtual in VPN
     - 5.3.2. Security services : The “Private” in VPN
     - 5.3.3. Tunneling and security protocols used to build IP VPNs
     - 5.3.4. IP VPN SLA
     - 5.3.5. In-housed and outsourced VPNs
     - 5.3.6. Commercial VPN providers

6. IP Telephony
   - 6.1. H.323 network signaling
   - 6.2. SIP network signaling
     - 6.2.1. Multimedia (voice, video, data) session establishment with SIP
   - 6.3. SIP for IP services
     - 6.3.1. SIP Service architecture
       - 6.3.1.1. SIP application server
       - 6.3.1.2. SIP media server
       - 6.3.1.3. SIP messaging server
     - 6.3.2. SIP services
       - 6.3.2.1. Presence
       - 6.3.2.2. Instant messaging
       - 6.3.2.3. Conferencing
       - 6.3.2.4. Prepaid
       - 6.3.2.5. Telephony supplementary services : call transfer, call forwarding, call screening, CCBS, etc.
   - 6.4. Voice and video transport over IP : RTP and RTCP

7. Telephony signaling transport over IP : SIGTRAN
   - 7.1. SIGTRAN Architecture
   - 7.2. SIGTRAN User Adaptations
   - 7.3. SIGTRAN Common Transport : SCTP
     - 7.3.1. SCTP features
     - 7.3.2. SCTP versus TCP or UDP
     - 7.3.3. Configuration of SCTP for telephony signaling transport
   - 7.4. SIGTRAN architecture deployment in mobile and NGN networks

8. Management of IP Networks and services
   - 8.1. Management protocol : SNMPv1, SNMPv2, SNMPv3
   - 8.2. Management information base : MIB
   - 8.3. OSS and BSS for IP Networks and services
     - 8.3.1. Fulfillment : Planning and Provisioning
     - 8.3.2. Assurance : Fault and Performance Management
     - 8.3.3. Billing of IP services
     - 8.3.4. OSS components and architecture for IP networks and services

9. Security in IP networks
   - 9.1. Security concepts
   - 9.2. Firewalls
   - 9.3. Radius and Diameter
   - 9.4. IPSec

9.5. Internet Key Distribution, Certification and Management
9.6. Internet Key Exchange (IKE)

10. IP in Wireless and Mobile Networks
    10.1. IP Networks in GPRS
        10.1.1. GPRS network architecture
        10.1.2. IP Network for Intra-PLMN and Inter-PLMN
        10.1.3. GPRS Mobility management
        10.1.4. GPRS data transfer and routing
        10.1.5. GPRS Roaming Exchange
        10.1.6. GPRS billing
    10.2. Mobile IP
        10.2.1. Mobile IP Architecture
        10.2.2. Advertisement in Mobile IP
        10.2.3. Registration in Mobile IP
        10.2.4. Datagram delivery in Mobile IP
        10.2.5. Route optimization

VOICE OVER DSL

Course objective : Understand the principles, the architectures, the protocols and services of voice over DSL (Digital Subscriber Line).
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : basic knowledge on networks
Duration : 2 days

1. xDSL Technologies
    1.1. ADSL
    1.2. RADSL
    1.3. CDSL
    1.4. SDSL
    1.5. HDSL
    1.6. HDSL2
    1.7. SHDSL
    1.8. VDSL
    1.9. CAP and DMT Coding
    1.10. Role of ATM in DSL technologies

2. Voice over DSL Applications

3. Voice over DSL Technology
    3.1. Voice directly over DSL
    3.2. Packetized voice over DSL
        3.2.1. Service Broadband Loop emulation (B-LES)
        3.2.2. Multiservice Broadband Network (MSBN)
        3.2.3. Voice over IP over DSL
        3.2.4. Voice over ATM over DSL
        3.2.5. AAL2/ATM and RTP/UDP/IP transport for packetized voice

4. Voice over DSL Architecture components
    4.1. B-LES Solution
        4.1.1. IAD : Integrated Access Device
        4.1.2. Voice Gateway
        4.1.3. Introduction to ATM
        4.1.4. AAL2 Layer
            4.1.4.1. SSCS sublayer
            4.1.4.2. CPS sublayer
            4.1.4.3. AAL2 Signaling
            4.1.4.4. Packetized voice transmission with AAL2
            4.1.4.5. QoS supplied by AAL2 for voice over AAL2 over ATM
        4.1.5. V5.2 Signaling
    4.2. MSBN Solution
        4.2.1. IAD, Trunking Gateway
        4.2.2. Media Gateway Controller or Softswitch

5. Signaling protocols for packetized voice over DSL (MSBN Solution)

5.1. MEGACO/H.248/MGCP
  5.1.1. MEGACO Architecture
  5.1.2. Call establishment with MEGACO
  5.1.3. Provision of supplementary services with MEGACO
5.2. H.323
  5.2.1. Architecture and entities H.323
  5.2.2. H.323 Protocol
  5.2.3. Call establishment with H.323
  5.2.4. Provision of supplementary services with H.323
5.3. SIP
  5.3.1. SIP networ kand service architecture and SIP entities
  5.3.2. SIP protocol
  5.3.3. Call establishment with SIP SIP
  5.3.4. Provision of supplementary services with SIP
5.4. Voice over DSL and Telephony NGN
5.5. Voice over DSL and Multimedia NGN

VERY HIGH SPEED RATE ACCESS NETWORK

Course objective : Understand the principles, the architectures, the protocols and services of very high speed rate access networks.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : basic knowledge on access networks
Duration : 3 days

ADSL is currently reaching its maximum capability while customer demand for more and more bandwidth is becoming a reality. It is time for telecom operators to plan and roll out new network technologies to enable new enriched services such as HDTV and multi broadband services delivery at the customer premises.
New investments as well as migration path from xDSL to FTTx will have to be considered by the operators. This course will present FTTx technology, architecture, services, cost of investment and market situation. Relationship of FFTx with IMS is also explained.

PROGRAM

1. Introduction
   1.1. Capabilities of xDSL and radio access networks
   1.2. Break up solutions
   1.3. Risks and opportunities for operators

2. VHS service provision
   2.1. Multi service delivery
   2.2. HDTV (encoding, TV set, market)

3. GigaEthernet
   3.1. TCP/IP
   3.2. GigaEthernet standard
   3.3. GigaEthernet collect network

4. Introducing IMS
   4.1. State of Art
   4.2. IMS for fixed networks (Tispan,…)
   4.3. Entry strategy for VHS AN

5. FTTH AN
   5.1. PON concept
   5.2. Optical infrastructure
   5.3. FTTH standard
   5.4. FTTH system
   5.5. Vendor solutions

6. Economic issues for FTTH
   6.1. Cost split
   6.2. Entry strategy

7. FTTH roll out

7.1. Regulation issues
7.2. FTTH Roll out in France
7.3. FTTH roll out around the world

8. Information system requirements for FTTH

9. FTTx + VDSL : an alternative to FTTH
   9.1. VDSL standard
   9.2. AN alternatives
   9.3. Economic issues
   9.4. Regulation issues

TELECOMMUNICATIONS REGULATION COURSES

Regulation Course Title	Duration
Telecommunications Regulation	5 days
Operator Interconnection	5 days

TELECOMMUNICATIONS REGULATION

Course objective : Prepare operators to build their strategy and defend their interests in further interactions with their Regulation Authority
Attendance: Decision makers, financial, legal, business development, network planning senior officers of fixed and mobile service providers, telecom consultants
Pre-requisites : Basic knowledge on telecommunications networks
Duration : 5 days

Participants should be deciders, financial, legal, business development, and network planning senior officers of fixed and mobile service providers. It is organized as a workshop with maximum interactivity between participants of different backgrounds. The objective for the participants is to get a good understanding of the current trends and evolution of the Telecom Regulation Worldwide and more specifically when applied to the recipient country. It is intending to prepare operators to build their strategy and defend their interests in further interactions with their Regulation Authority. It is proposed to integrate 2 or 3 case studies and experience-sharing sessions implying participants that have already been involved in related development programs or regulatory issues. The experience sharing sessions would include a short presentation followed by an interactive question/answer and discussion involving the facilitator and the other participants. Such experience sharing session always prove to be very fruitful to all participants and often contributes more to the training than lectures.

1. Concept of telecommunications regulation
   - 1.1. Why regulate?
   - 1.2. ICT and the Transformational Opportunity and risks
   - 1.3. Impact of new technologies on regulation
   - 1.4. The regulator and its role
   - 1.5. Rationale for an effective and independent regulator
   - 1.6. Regulators independence and how is it fostered
   - 1.7. Accountability, transparency and predictability
   - 1.8. Convergence and the role of the regulators

2. Competition policy and regulation
   - 2.1. Forms of competition (perfect, effective and sustainable competition)
   - 2.2. Ex post and Ex ante regulation : advantages and shortcomings of each type of regulation
   - 2.3. Key concepts in competition policy (market relevance, market power
   - 2.4. Types of anticompetitive behavior (dominance abuse, cross-subsidization and squeeze)
   - 2.5. Remedies to competition distortion
   - 2.6. Interconnection regulation: its importance for competition, key principles, price setting
   - 2.7. Specific challenges: cross boarders interconnection, disputes resolution
   - 2.8. International benchmarking and shared experiences

3. Telecommunications licensing and authorization policy
   - 3.1. Introduction to licensing and authorization regimes
   - 3.2. Trends in licensing and authorization
   - 3.3. International trade rules: WTO reference paper on authorization in the telecoms sector

   - 3.4. General authorization: study of the new EU framework as a benchmark
   - 3.5. Individual licensing legal framework (regulatory certainty, content of an individual license)
   - 3.6. Individual licensing process (conditions for prequalification, qualifications and selection of licensees)
   - 3.7. Convergence and multi-services authorization
   - 3.8. Specific studies and shared experiences

4. Universal access policy
   - 4.1. Trends in universal access
   - 4.2. Rational for an efficient universal access policy
   - 4.3. Integration of the universal access with other national programs like E-Government and education
   - 4.4. The engineering of the universal access process
   - 4.5. Improvement of the regulatory framework for an efficient universal access,
   - 4.6. Overview of different universal access approaches
   - 4.7. Universal access funding schemes (advantages and shortcomings)
   - 4.8. Universal access shared experiences

5. Radio spectrum regulation
   - 5.1. Introduction to spectrum management: fundamental management approaches
   - 5.2. Spectrum outsourcing and governance
   - 5.3. Spectrum policy and planning
   - 5.4. Spectrum international standardization
   - 5.5. Spectrum authorization and assignment
   - 5.6. Spectrum pricing (auctions, secondary markets and lotteries)

6. The evolution of the legal framework for an effective regulation
   - 6.1. Introduction to regulation in a transitional and in a fully competitive market
   - 6.2. The legal context and its impact on the regulatory reforms
   - 6.3. Relationship between telecoms and competition legislations
   - 6.4. Convergence and the evolution of the legal framework : telecoms legislation
   - 6.5. Modifications to address the convergence issue
   - 6.6. Specific issues and studies

7. Pricing regulation
   - 7.1. Why regulate prices
   - 7.2. Economic and accounting measures of cost
   - 7.3. Economic Efficiency and pricing
   - 7.4. Concepts of Economies of scale and scope
   - 7.5. Single and multiple service firms (firm integration)
   - 7.6. Prices setting as related to the cost structure (cost based regulation)
   - 7.7. Different approaches to prices regulation (discretionary price setting, rate of return, price cap)

8. Impact of new technologies on telecoms markets regulation and course conclusion
   - 8.1. Telecommunications Technology trends
   - 8.2. New technologies impact on regulation
   - 8.3. VOIP and regulation
   - 8.4. Course conclusion and evaluation

OPERATOR INTERCONNECTION

Course objective : Prepare operators to build their strategy and defend their interests in further interactions with their Regulation Authority
Attendance: deciders, financial, legal, business development, network planning senior officers of fixed and mobile service providers, telecom consultants, Professional staff in charge with interconnection or related matters such as numbering and planning
Pre-requisites : Basic knowledge on telecommunications networks
Duration : 5 days

Interconnection is the set of connection mechanisms between two different telecom networks. Their objectives are to allow each customer to be able to join any other customers connected on the other network. Networks interconnection procedures are essential for the right development of competition in the telecommunication sector. For this reason regulatory entities in each countries establish hard interconnection rules With a special emphasis on migration to NGN, the course enables understanding how: - interconnection is technically achieved; - interconnection costs are calculated using different calculation models; - a reference interconnect offer as well as an interconnection contract are elaborated; - the challenges faced by the regulator as well as the operators when dealing with the interconnection impact on competition; - interconnection regulatory and policy issues are tackled.

1. Interconnection General Principles
   - 1.1. Different types of interconnection
   - 1.2. Mechanism of call routing
   - 1.3. Role of the regulator

2. Interconnection cost calculation
   - 2.1. Comparison of cost models used to compute interconnect conveyance rates charged
   - 2.2. Cost of Capital Calculations;
   - 2.3. Routing factors gradient and exercise
   - 2.4. Cost auditing

3. Advanced Interco services
   - 3.1. Number portability
     - 3.1.1. Number portability in the fixed network
       - 3.1.1.1. Geographical portability
       - 3.1.1.2. Operator portability
       - 3.1.1.3. Service portability
     - 3.1.2. Number portability in mobile networks
       - 3.1.2.1. SRF(Signaling Relay Function) approach
       - 3.1.2.2. All-call-query approach
   - 3.2. Carrier selection
     - 3.2.1. Carrier selection by preselection
     - 3.2.2. Carrier selection call by call
   - 3.3. Local loop unbundling
     - 3.3.1. Partial unbundling
     - 3.3.2. Total unbundling

4. Reference Interconnection Offer (RIO)
   - 4.1. Technical components of the RIO

   - 4.2. RIO requirements

5. Interconnection Agreement study
   - 5.1. Lessons from existing Interconnection Agreements
   - 5.2. Contractual components
   - 5.3. Operational components

6. Billing exercise (case study)

7. Significant Market Power (SMP) and Dominance
   - 7.1. Concept of relevant markets
   - 7.2. Concept of dominance
   - 7.3. SMP Analysis tools

8. International Interconnect and WTO agreement

9. Interconnection Policy and Case Study

10. Conclusion and course evaluation

SIGNALING COURSES

Signaling Course Title	Duration
Signaling System 7 and its Evolutions	2 or 3 days
Intelligent Network and its Evolutions	2 or 3 days
Intelligent Network Evolutions	2 days
Signaling and Intelligence in Fixed and Mobile Networks	5 days
Messaging : Principles, Architectures and Services	1 day
ISUP : ISDN User Part	2 days

Teaching on Telecommunications

THE SIGNALING SYSTEM NUMBER 7 AND ITS EVOLUTIONS

Course objective : Gain knowledge on the principles, architecture, services and evolutions of the Signaling System 7
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : basic knowledge of the OSI reference model
Duration : 2, 3 or 4 days

Signaling System Number 7 (SS7) enables the exchange of control information among the entities of a telecommunication network, such as telephone switches, MSCs, databases (HLR, VLR), and servers (SCP, SMSC, GMLC, etc.). The SS7 is a key element for the introduction of supplementary and value added services. The course objectives are (1) provide a good understanding of the SS7 architecture and functions (2) present the main protocols and the mechanisms that guarantee the availability of the SS7 network (3) show the evolution of the SS7 network in the framework of the Next Generation Network and IP Telephony with SIGTRAN and HSL.

1. Positioning of the signaling network in the telecom network
    - 1.1. SS7 and PSTN
    - 1.2. SS7 and GSM, GPRS, UMTS
    - 1.3. SS7 and Intelligent Network
    - 1.4. SS7 and Next Generation Network

2. The SS7 Network
    - 2.1. SS7 network architecture
        - 2.1.1. Signaling links
        - 2.1.2. SS7 nodes
            - 2.1.2.1. Signaling transfer points
            - 2.1.2.2. Signaling points
        - 2.1.3. Dimensioning of an SS7 Network
    - 2.2. SS7 network protocols
        - 2.2.1. MTP level 1
        - 2.2.2. MTP level 2
        - 2.2.3. MTP level 3
        - 2.2.4. SCCP
        - 2.2.5. TCAP
        - 2.2.6. INAP
        - 2.2.7. ISUP
        - 2.2.8. MAP
        - 2.2.9. BICC
    - 2.3. SS7 Network configuration and entities in the PSTN network
    - 2.4. SS7 Network configuration and entities in the GSM network
    - 2.5. SS7 Network configuration and entities in the Intelligent network
    - 2.6. SS7 Network configuration and entities in the GPRS network
    - 2.7. SS7 Network configuration and entities in the Network Generation network

3. SS7 Evolution
    - 3.1. Signaling Transport over IP : SIGTRAN

3.1.1. SIGTRAN common transport protocol : SCTP
3.1.2.. SIGTRAN Adaptations : M2UA, M3UA, IUA, SUA, TUA, V5UA
3.1.3. Application of SIGTRAN for existing and next generation networks
3.2. Signaling Transport over ATM : HSL (High Speed Link)
3.2.1. HSL configurations
3.2.2. HSL applications

4. SS7 Market
4.1. Market of SS7 products (boards, stacks)
4.2. Market of SS7 equipment (HLR, SCP, SSP, SRP, Service Node, GMLC, SMSC, etc.)
4.3. Potential market for SIGTRAN

THE INTELLIGENT NETWORK AND ITS EVOLUTIONS

Course objective : Gain knowledge on the principles, architecture, services and evolutions of the Intelligent Network
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : No specific knowledge
Duration : 2 or 3 days

The Intelligent Network is one of the keys for service offering by service providers in the forthcoming years, for services such as freephone, prepaid, Internet Call Waiting, Telekiosk, Click-to-Talk, etc. The course objectives are (1) understand the IN principles and current status (2) gain a knowledge on the panorama of services that are offered or will be supplied by the IN (3) comprehend the IN architecture (4) understand the medium term and long term evolutions of the IN, particularly in the IN-Internet, IN-mobile and IN-IP Telephony contexts.

The Intelligent Network is one of the keys for the provision of value added services by service providers, e.g., freephone, prepaid, Internet Call Waiting, VPN, Televoting, short numbering, etc. The course objectives are (1) understand the IN principles and current status (2) gain a knowledge on the panorama of services that are offered or will be supplied by the IN (3) comprehend the IN architecture (4) understand the medium term and long term evolutions of the IN, particularly in the IN-Internet (PINT and SPIRITS), IN-mobile (CAMEL) and IN-IP Telephony contexts (SIP Application Server, Parlay/OSA/JAIN).

1. Intelligent Network Principles
1.1. Intelligent Network Services
1.2. Intelligent Network Service Creation
1.3. Intelligent Network Functional Architecture
1.2. IN protocol and Equipment
1.4.1. The possible Intelligent Network configurations
1.4.2. Deployment and execution of services
1.4.3. Commercial IN solutions
1.5. The IN in some European countries
1.6. Service interactions problem
1.7. IN versus Service Node

2. Signaling System 7 and relationship with IN
2.1. SS7 Architecture to support the Intelligent Network
2.2. SIGTRAN Architecture to support the Intelligent Network

3. IN Evolutions
3.1. IN Capability Sets : CS-1, CS-2, CS-3, CS-4
3.2. IN and Internet : PINT and SPIRITS Architectures
3.3. IN and Mobile
3.3.1. IN and GSM : CAMEL Phase 2
3.3.2. IN and GPRS : CAMEL Phase 3
3.3.3. IN and IMS : CAMEL Phase 4
3.3.4. Prepaid service example in CAMEL Phase 2, Phase 3 and Phase 4
3.4. Open APIs : Parlay/OSA and JAIN

- 3.4.1. Interfaces proposed by Open APIs
- 3.4.2. Parlay/OSA Architecture
- 3.4.3. Parlay/OSA Gateway Solutions

3.5. IN in Next Generation Network and IP Telephony

- 3.5.1. SIP Application Server
  - 3.5.1.1. Conference Server
  - 3.5.1.2. CPL Server
  - 3.5.1.3. UM/IM/Presence Server
  - 3.5.1.4. SIP Media Server
  - 3.5.15. Prepaid in the SIP environment
- 3.5.2. Service Controller

Teaching on Telecommunications

INTELLIGENT NETWORK EVOLUTIONS

Course objective : The objective of this course is to show the evolutions of the Intelligent Network to address the design, deployment and execution of next generation services expected on existing and future networks.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Knowledge on the Intelligent Network
Duration : 2 days

The course starts by briefly recalling the Intelligent Network (IN) services and architecture and the evolution from IN CS-1 to INCS-2.
Then the course focuses on CAMEL and shows the CAMEL evolutions especially CAMEL Phase 3 and Phase 4. The differences between CAMEL Phase 1 and CAMEL Phase 2 are pinpointed and explained and the prepaid service scenario with CAMEL Phase 1 and CAMEL Phase 2 shows the enhancements made in CAMEL Phase 2.
The provision of value-added telephony services is by now mainly in the hands of network operators. This might change with technologies such as Parlay/OSA. OSA and Parlay specify an open, secure interface to the telephony network, which can open the telephony network to 3rd party service providers. This course explains what Parlay is and who is in Parlay, gives an overview on the OSA/Parlay interface (API) and Parlay X API, introduces vendors solutions for Parlay/OSA Gateways and Applications Servers, and describes some possible application areas. Moreover the relation of Parlay to other standards (IN, CAMEL, OMA, IMS, etc.) is studied.
Release 5 of UMTS specifies voice and multimedia services that make use of GPRS for the transport of speech, video and signaling, rather than the circuit-switched domain transport. A new core network domain, the IP multimedia (IM) core network subsystem, or IMS domain for short, is introduced for the control of voice and multimedia calls and sessions and the interconnection to other networks, such as the PSTN and other UMTS networks. The IMS domain also relies on a managed core IP network that is capable of providind the quality of service needed for voice and multimedia services.
The main reasons for the introduction of the IMS domain are to enable new services and to reduce cost. The IMS Service architecture will be described with the service components such as SIP Application Server and SIP Media Server. The course will also introduce the types of services that can be supplied with IMS and the corresponding service execution scenarios. Moreover the application of the IMS Service Architecture to existing networks (e.g., GSM, PSTN) is also studied.

1. IN Architecture
   - 1.1. IN Services
   - 1.2. IN Network entities : SCP, SDP, SSP, SRP, SMP, SCE
   - 1.3. INAP Protocol
   - 1.4. IN vendors solutions
   - 1.5. IN Evolutions : From IN CS-1 to IN CS-2
     - 1.5.1. IN CS-2 Call model to support the multiparty
     - 1.5.2. Exemple of Ring-back tone service

2. From CAMEL Phase 1 to CAMEL Phase 2
   - 2.1. CAMEL Phase 2 Enhancements
     - 2.1.1. Presence of SRF

2.1.2. Presence of DP Criteria in CSI
2.1.3. Support of USSD
2.1.4. Enhanced charging procedures
2.2. Prepaid service scenario with CAMEL Phase 1 and CAMEL Phase 2

3. CAMEL Phase 3
3.1. Services handled by CAMEL Phase 3
3.2. CAMEL Phase 3 Architecture
3.3. Improvements from CAMEL Phase 2
3.4. CAMEL Phase 3 CSIs
3.5. CAMEL Phase 3 call model for PDP Contexts : PDP Context SM
3.6. CAP Phase 3 overview
3.7. Prepaid call scenarios with CAMEL Phase 3
3.7.1. Outgoing voice call from the home network
3.7.2. Outgoing and incoming voice call from a visited network
3.7.3. Outgoing data session
3.7.4. Outgoing SMS
3.8. Other solution for GPRS prepaid based on home GGSN : Intelligent GGSN

4. OSA/Parlay
4.1. Intelligent Network Shortcomings
4.2. Open Network APIs
4.3. Parlay vs OSA vs JAIN
4.4. OSA/Parlay Framework and Service Capabilities
4.5. Advantages and Drawbacks of OSA/Parlay
4.6. OSA Vendors and Products
4.6.1. OSA SCS
4.6.2. OSA Application Server and Service Creation Environment
4.7. OSA/Parlay Applications
4.8. Parlay X

5. IMS Service architecture : SIP Application Server / SIP Media Server
5.1. IMS Network Architecture
5.1.1. IMS network entities : CSCF, HSS, Softswitch, MGW
5.1.2. SIP as the signaling protocol for establishment/ release/ modification of multimedia sessions
5.2. IMS Service Architecture
5.2.1. SIP Application Server
5.2.1.1. SIP Application Server functionalities
5.2.1.2. SIP Application Server vendors solutions
5.2.1.3. Comparison between the solutions
5.2.2. SIP Media Server
5.2.2.1. SIP Media Server functionalities
5.2.2.2. SIP Media Server vendors solutions
5.2.2.3. Comparison between the solutions
5.2.3. SIP Messaging Server
5.2.4. IMS-SSP
5.2.5. OSA SCS
5.3. IMS Service Profile : ASSI (Application Server Subscription Information)
5.4. Service Invocation in IMS
5.5. Reuse of the IMS Service Architecture for current PSTN/GSM networks
5.6. IMS Applications and corresponding scenarios
5.6.1. Messaging services : Ring-back tone, Unified messaging, etc.

Teaching on Telecommunications

5.6.2. Conferencing Services : Push-to-Talk, Pre-arranged conference, ad-hoc conference, etc.
5.6.3. Supplementary services : call hold, advanced call forwarding, etc.
5.6.4. Personal Agent services : Find-me, call screening, caller preferences, etc.
5.6.5. Call management services : Presence, call log

6. CAMEL Phase 4
6.1. Services handled by CAMEL Phase 4
6.2. Multiparty in CAMEL Phase 4
6.3. CAMEL Phase 4 Architecture for IMS
6.4. Improvements from CAMEL Phase 3
6.5. CAP Phase 4 overview
6.6. Prepaid call scenarios with CAMEL Phase 4 for IMS
6.6.1. Outgoing and incoming multimedia call from the home network

7. CAMEL Vs OSA Vs SIP

SIGNALING AND INTELLIGENCE IN FIXED AND MOBILE NETWORKS

Course Objective : Master the principles, the architecture, the signaling and the services of fixed voice networks (PSTN, SS7, IN), of mobile networks (GSM, GPRS, CAMEL, UMTS, VHE) and their evolution towards Next Generation Network and IP Telephony (H.323, SIP, MEGACO, Q.BICC, 3G.IP)
Pre-requisites : Minimum knowledge of the voice networks
Duration : 5 days

The course objective is to present the signaling world for the fixed and mobile voice networks and their evolution towards Next Generation Network and IP telephony, through their entities, their protocols and their services.
Moreover, the course shows the service architectures (Intelligent Network, CAMEL for GSM and GPRS, IP service nodes, Feature servers for IP Telephony, OSA for UMTS)

1. The fixed/mobile telecommunication network of a network operator (1st day)

    1.1. Transmission Network
    1.2. Access Network
    1.3. Switching Network : PSTN, Data networks, GSM, GPRS
    1.4. SS7 Signaling Network
    1.5. Intelligent Network
    1.6. Management Network

2. Signaling Network (1st, 2nd and 3rd days)

    2.1. Signaling System 7 for PSTN and GSM
        2.1.1. Architecture, entities and configuration of SS7
        2.1.2. SS7 Planning
        2.1.3. SS7 protocols : MTP, SCCP, TCAP, ISUP, INAP(IN), CAP(CAMEL), BSSAP, MAP(GSM)
        2.1.4. Supplementary services and value added services
    2.2. Signaling in the GSM Base Station Subsystem
        2.2.1. The Air interface
        2.2.2. The Abis interface
        2.2.3. The A interface
    2.3. Signaling in the GSM Network Subsystem
    2.4. GPRS signaling
    2.5. Evolutions : Signaling in the Next Generation Network (NGN) and IP Telephony
        2.5.1. Architecture, entities and configuration of NGN and IP Telephony
        2.5.2. Migration scenario from PSTN to NGN
        2.5.3. Signaling protocols of NGN and IP Telephony : H.323, SIP, MEGACO, Q.BICC CS-1 et CS-2, SIGTRAN
        2.5.4. NGN and IP Telephony solutions
    2.6. UMTS Releases 1999 and 2000
    2.7. 3G.IP : Towards an All-IP Mobile Network
        2.7.1. Architecture of the All-IP Mobile Network

        2.7.2. Relationship with NGN and IP Telephony

3. Network Intelligence (4th and 5th days)

    3.1. Intelligent Network CS-1, CS-2 and CS-3 for the PSTN
    3.2. Intelligent Network CAMEL Phase 2 for GSM, CAMEL Phase 3 for GPRS and CAMEL Phase 4 for IMS
    3.3. Intelligent Network and Feature Server for NGN and IP Telephony
    3.4. The Virtual Home Environment (VHE) and Open Service Architecture (OSA) for UMTS

MESSAGING : PRINCIPLES, ARCHITECTURES AND VENDORS SOLUTIONS

Course objective : Gain knowledge on Short Messaging, Multimedia Messaging, Unified Messaging and Instant Messaging principles, architectures, services and market solutions.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : basic knowledge on TCP/IP networks.
Duration : 1 day

1. Short messaging
   - 1.1. What is SMS
   - 1.2. SMS in GSM, GPRS and UMTS networks
   - 1.3. SMS in IS-94, CDMA2000
   - 1.4. SMS Architecture
   - 1.5. SMSC vendors solutions
   - 1.6. SMS offload
   - 1.7. Potential applications using SMS

2. Multimedia messaging
   - 2.1. What is MMS
   - 2.2. MMS in GSM, GPRS and UMTS networks
   - 2.3. MMS Architecture
   - 2.4. MMS versus SMS
   - 2.5. MMSC vendors solutions
   - 2.6. Potential applications using MMS

3. Unified messaging
   - 3.1. What is unified messaging
   - 3.2. Why unified messaging
   - 3.3. Unified messaging vs Integrated messaging
   - 3.4. Types of Unified messaging solutions
     - 3.4.1. CPE-based solution
     - 3.4.2. ASP based solution

4. Unified messaging architecture
   - 4.1. Unified messaging components
     - 4.1.1. Unified directory
     - 4.1.2. Unified message store
     - 4.1.3. Unified messaging server
     - 4.1.4. Unified access to an SCP (ASP solution)
     - 4.1.5. WEB and WAP servers
     - 4.1.6. SMSC
   - 4.2. Unified messaging APIs
     - 4.2.1. mail access (IMAP4, POP3, HTTP)
     - 4.2.2. mail transport (SMTP, VPIM)
     - 4.2.3. directory access (LDAP)
     - 4.2.4. notification to wireless devices (SMPP, SMS, TAP, SNPP)
     - 4.2.5. groupeware APIs (MAPI, VIM, CMC, ICAP).
   - 4.3. Unified Messaging Solutions

Teaching on Telecommunications

5. Instant messaging
   - 5.1. What is instant messaging
   - 5.2. Instant Messaging versus Short Messaging
   - 5.3. Instant Messaging and Presence Service
   - 5.4. Instant Messaging Architecture
   - 5.5. SIP for Instant Messaging
   - 5.6. Instant messaging scenarios

ISUP : ISDN USER PART

Objectives: Gain knowledge on the ISUP functions, architecture, services and evolutions
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: Basic knowledge on PSTN
Duration: 2 days

The objective of this course is to understand the ISUP protocol with its functions, its messages, scenarios of call establishment and release, and circuit supervision.
The course also describes the supplementary services supplied with ISUP. Finally, trhe course introduces the evolutions of ISUP on the medium and long terms.

1. SS7 in the telecommunications network

2. Principles of Signaling System 7 (SS7)
   - 2.1. SS7 network architecture
     - 2.1.1. Associated mode
     - 2.1.2. Quasi-associated mode
     - 2.1.3. Dimentioning of an SS7 network

3. SS7 Protocol stack
   - 3.1. MTP2
   - 3.2. MTP3
   - 3.3. SCCP
   - 3.4. ISUP
   - 3.5. INAP

4. Versions of the ISUP protocol
   - 4.1. ISUP v1, ISUP v2, ISUPv3
   - 4.2. SPIROU versus ISUPv3
   - 4.3. SSUTR2 versus ISUPv3
   - 4.4. National ISUP versus international ISUP

5. ISUP v3 protocol
   - 5.1. Functions of the ISUP protocol
   - 5.2. Format of the ISUP messages
   - 5.3. Messages for call establishment and release
     - 5.3.1. IAM, ACM, ANM, CON, SGM, SAM, CPM, INR, INF, IDR, IRS, REL, RLC
   - 5.4. Scenarios of call establishment and release and error processing
   - 5.5. Messages for circuit supervision
     - 5.5.1. BLO and BLA (circuit blocking)
     - 5.5.2. UBL and UBA (circuit unblocking)
     - 5.5.3. CGB and CGBA (circuit group blocking)
     - 5.5.4. CGU and CGUA (circuit group unblocking)
     - 5.5.5. RSC (circuit reset)
     - 5.5.6. GRS and GRA (circuit group reset)
     - 5.5.7. CQM and CQR (circuit group query)
     - 5.5.8. SUS and RES (circuit suspend/resume)
   - 5.6. Continuity check request : CCR, COT
   - 5.7. End-to-end ISUP signaling
     - 5.7.1. SCCP method
     - 5.7.2. Pass along method

   - 5.8. Signaling congestion and unavailability ISUP : UPT, UPA, MTP3 Management
   - 5.9. Functionality messages : FOT, FAR, FRJ, FAA, FAC,
   - 5.10. Values of ISUP timers at national and international levels : Timers T1 to T36
   - 5.11. Supplementary services
     - 5.11.1. Call Waiting Indication
     - 5.11.2. CLIP : Calling Line Identity Presentation
       - 5.11.2.1. NDI and NDS
     - 5.11.3. CLIR : Calling Line Identity Restriction
     - 5.11.4. COLP
     - 5.11.5. COLR
     - 5.11.6. Call Hold
     - 5.11.7. Call Completion on Busy Subscriber
     - 5.11.8. Conference
     - 5.11.9. Call Forwarding Unconditional
     - 5.11.10. Call Forwarding on Busy
     - 5.11.11. Call Forwarding on No Reply
     - 5.11.12. Continuity check : CCR et COT
     - 5.11.13. etc.
   - 5.12. Support of number portability with ISUP
   - 5.13. Calls from and to mobiles

6. ISUP protocol evolutions
   - 6.1. From ISUP to BICC (Bearer Independent Call Control)
   - 6.2. BICC versus SIP-T and SIP-I
   - 6.3. Multimedia session control : SIP and H.323
   - 6.4. From PSTN to Next Generation Network and IP Multimedia Subsystem (IMS)

MOBILE NETWORKS AND SERVICES COURSES

Signaling Course Title	Duration
The GSM Network and its Evolutions	3 days
Mobile Networks and Services and their Evolutions	3 days
The GPRS Network and its Evolutions	3 days
Next Generation Network for Mobile Networks : 3GPP R4	2 days
R4 Control and Signaling Protocols : MEGACO/H.248, BICC, SIP-I	3 days
UMTS R3, R4, R5 and R6 Core Network Architecture	3 days
Long Term Evolution of 3G : LTE, ePC, PCC, CSFB and VoLTE	3 days
Policy and Charging Control in 3G, LTE and IMS	2-3 days
Advanced Evolved Packet Core (ePC)	3 days
Network and Service Architectures of the IP Multimedia Subsystem (IMS)	3 days
Voice over LTE with IMS	3 days
M2M and IOT : Network and Service Architectures	2 days
Mobile Authentication for Mobile, Wireless and Internet Services	3 days
Short Message Service Architecture in GSM/GPRS and ANSI-41 Networks	2 days
3G Service Architectures	2 days
CAMEL and Prepaid for GSM, GPRS, UMTS and SMS	2 days
Mobile Charging Architectures	2 days
MAP Signaling : Mobile Application Part	2 days
Cellular Network Planning	3-4 days
Cellular Network Operations, Maintenance and Optimization	3-4 days
WiMAX	2 days
Roaming in 2G, 3G and 4G Mobile Networks	4 days
LTE Radio Engineering	3 days
RCS : Rich Communication Suite	2 days
WiFi Access to ePC Architectures and Associated VoWiFi Service	2 days
Introduction to 5G	2 days

Teaching on Telecommunications

GSM NETWORK AND SERVICES

Objectives: Gain knowledge on the architecture, protocols, services of GSM and its evolution towards GPRS
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: No knowledge
Duration: 3 days

The course objective is to present the GSM network and service architectures. A minimum emphasis is put on the radio part (Base Station Subsystem). GSM is introduced with its identifies, its basic concepts of roaming management, handover, paging, authentication, etc, its signaling and the services supplied using different service architectures. The course introduces GSM prepaid, VPN, SMS, number portability, WAP, location services, and supplementary services. The evolution towards data is explained with GPRS.

1. GSM Global Architecture
   - 1.1. Base Station Subsystem
   - 1.2. Network Subsystem
   - 1.3. Interworking with the PSTN
   - 1.4. Examples of GSM network configurations in Europe

2. GSM Functional Architecture
   - 2.1. GSM Network Entities
     - 2.1.1. BSS Entities : MS, BTS, BSC
     - 2.1.2. NSS Entities : MSC, GMSC, VLR, HLR, AuC, EIR, SMSC, SCP
   - 2.2. GSM Network Dimensioning
     - 2.2.1. MSC/VLR, SMSC, SCP, HLR Dimensioning
   - 2.3. Identity and addressing in GSM
     - 2.3.1. MSISDN
     - 2.3.2. IMSI
     - 2.3.3. IMEI
     - 2.3.4. LAI and Cell Id
     - 2.3.5. TMSI
     - 2.3.6. MSRN
   - 2.4. GSM Network Interfaces

3. GSM Signaling
   - 3.1. Signaling in the Base Station Subsystem
   - 3.2. Signaling in the Network SubSystem : SS7
     - 3.2.1. MTP
     - 3.2.2. SCCP and Global Title
     - 3.2.3. ISUP
     - 3.2.4. TCAP and MAP
     - 3.2.5. INAP and CAP
     - 3.2.6. BSSAP : DTAP and BSSMAP
     - 3.2.7. Dimensioning and architecture of the SS7 network for GSM
   - 3.3. Roaming Management in the home network and in a visited network
     - 3.3.1. Attachment
     - 3.3.2. Location Area Update
     - 3.3.3. Detachment

   - 3.4. Authentication and Encryption
   - 3.5. Paging
   - 3.6. Call scenarios : GSM-GSM, GSM-PSTN, PSTN-GSM
   - 3.7. Call scenarios for international roaming
   - 3.8. Optimized routing with GSM
   - 3.9. Supplementary Services in GSM
   - 3.10. Handover
     - 3.10.1. Intra-BTS Handover
     - 3.10.2. Inter-BTS / Intra-BSC Handover
     - 3.10.3. Inter-BSC / Intra MSC Handover
     - 3.10.4. Inter-MSC Handover

4. Value Added Services in GSM
   - 4.1. Short messages and GSM: SMSC and MAP Traffic
   - 4.2. Prepaid
   - 4.3. VPN
   - 4.4. Short Numbers
   - 4.5. CAMEL Phase 1 and Phase 2 for Prepaid and VPN for International roamers
     - 4.5.1. CAMEL Architecture
     - 4.5.2. CAMEL Phase 2 Call flows for Prepaid
   - 4.6. USSD for value added services and prepaid without CAMEL
   - 4.7. WAP
   - 4.8. Location-based services
     - 4.8.1. Location techniques
       - 4.8.1.1. COO
       - 4.8.1.2. TOA
       - 4.8.1.3. E-OTD
       - 4.8.1.4. A-GPS
     - 4.8.2. Location service architecture
       - 4.8.2.1. LMU
       - 4.8.2.2. SMLC
       - 4.8.2.3. GMLC
     - 4.8.3. Location service APIs : LIF, Parlay and WAPForum APIs
   - 4.9. Number Portability
     - 4.9.1. Signaling Relay Function Solution
     - 4.9.2. All Call Query Solution
   - 4.10. M-Commerce with GSM
   - 4.11. GSM ancd OSA (Open Service Architecture)
     - 4.11.1. OSA Gateway
     - 4.11.2. OSA Application Server
     - 4.11.3. OSA Applications

5. From GSM to GPRS
   - 5.1. Extension of a GSM Network to support GPRS
   - 5.2. GPRS entities
     - 5.2.1. SGSN and GGSN
     - 5.2.2. PCU
     - 5.2.3. Charging Gateway
     - 5.2.4. OMC-G
     - 5.2.5. Intra-PLMN Backbone
     - 5.2.6. Inter-PLMN backbone
   - 5.3. Dimensioning of a GPRS Network
   - 5.4. Roaming management in the home network and in a visited network with GPRS
   - 5.5. PDP Context establishment / Release with GPRS

5.6. Value added services with GPRS
5.6.1. Prepaid
5.6.2. MMS
5.6.3. Etc.

MOBILE NETWORKS AND SERVICES AND THEIR EVOLUTIONS

Objectives: Gain knowledge on the 2G, 3G and 4G mobile networks, their evolutions, and their services
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: Minimum knowledge on mobile networks and their services
Duration: 3 days

The course objective is to present the current and future mobile network and service architectures including GSM, GPRS, 3G, and LTE.
GSM is introduced with its signaling and the services supplied using an IN architecture (CAMEL), SMSC (Short Message Service Center), and USSD (Unstructured Supplementary Services Data) The evolution towards data is explained with GPRS. The 3G and 3G+ networks are presented through their architecture to enhance data rates. The introduction of Next Generation Network (NGN) as an evolution of the circuit switched domain is explained. Finally evaluation towards 4G is emphasized.
The new 4G all-IP mobile network is called EPS (Evolved Packet System) with its access network called LTE (Long Term Evolution of 3G) and its core network called ePC (Evolved Packet Core). In this context, a user will only access to IP-based services. Since the EPS only provides a bearer path of a certain QoS, control of multimedia applications such as VoIP is provided by the IMS (IP Multimedia Subsystem) which is considered to be access independent and thus, to be outside the EPS itself. The IMS architecture emulating the mobile circuit switched services only (telephony, visiophony, SMS, USSD) is called VoLTE (Voice over LTE). An alternative to VoLTE exists reusing the existing R4 architecture (2G/3G circuit switched domain) called CSFB (Circuit Switched Fall Back).
To assure fair usage of the EPS network, service providers will need to identify the IP service flows, control these flows (authorize, block, restrict) and charge these flows with two possible charging methods (online and offline charging). For this purpose a PCC (Policy and Charging Control) architecture is introduced.

1. Mobile network evolutions
   1.1. 2G Access : GSM, GPRS, EDGE
   1.2. 3G Access: W-CDMA, HSPA, HSPA+
   1.3. 2G/3G common core network : R4 and GPRS
   1.4. 4G Access : LTE, LTE-Advanced
   1.5. 4G core network : ePC

2. 2G/3G circuit switched domain: Mobile NGN also called R4
   2.1. Old Circuit switched domain architecture : GSM
      2.1.1. MSC/VLR, GMSC, HLR, circuit switching
   2.2. R4 network architecture : MSC/GMSC server, MGW, SGW, IP network with QoS
   2.3. SS7/SIGTRAN for signaling transport
   2.4. R4 mobility management
   2.5. R4 call control
   2.6. R4 roaming
   2.7. R4 services
      2.7.1. SMS
      2.7.2. Prepaid/VPN

2.7.3. USSD services
2.7.4. Voicemail
2.7.5. Ring-back tone

3. 2G/3G packet switched domain : GPRS
   3.1. GPRS architecture
   3.2. GPRS mobility management
   3.3. GPRS session management : PDP context establishment/release
   3.4. GPRS roaming : GRX
   3.5. IP-based Data services accessible with GPRS
      3.5.1. Access to Internet/Intranet
   3.6. Evolutions of GPRS with introduction of 3G
      3.6.1. Direct tunnel
      3.6.2. W-CDMA
      3.6.3. HSPA
      3.6.4. HSPA+
      3.6.5. Policy and Charging Control in GPRS
         3.6.5.1. Fair use
         3.6.5.2. Anti bill shock

4. Architectures for value add services in Mobile networks
   4.1. Intelligent Network
   4.2. CAMEL
   4.3. SMS
   4.4. USSD
   4.5. MMS
   4.6. RCS
   4.7. PCC : Policy and Charging Control

5. CAMEL Architecture
   5.1. CAMEL Phases : Phase 1, Phase 2, Phase 3
   5.2. CAMEL entities
   5.3. CAMEL subscription information
   5.4. CAP protocol for service invocation

6. Introduction to LTE and ePC
   6.1. Why LTE?
   6.2. What is LTE?
   6.3. LTE deployments across the world

7. EPS Access Network: LTE
   7.1. Architecture Elements
   7.2. Interfaces
   7.3. Handover
   7.4. Comparaison between LTE access network and 3G/3G+ access network

8. EPS Core Network Architecture : ePC
   8.1. ePC Impact on 3G Core Network
      8.1.1. From 3G SGSN to S4-SGSN
      8.1.2. New S4-SGSN interfaces
   8.2. EPC Architecture elements
      8.2.1. MME
      8.2.2. Serving GW
      8.2.3. PDN GW

Teaching on Telecommunications

      8.2.4. PCRF
      8.2.5. HSS
      8.2.6. PCRF
      8.2.7. OCS
      8.2.8. OFCS
   8.3. Interfaces
   8.4. Control plane with DIAMETER Agents
      8.4.1. Advantages of Agent architecure for DIAMETER signaling delivery
      8.4.2. International roaming with International DIAMETER brokers
   8.5. Mobility Management in non roaming and roaming situations: Attachment, Detachment, Tracking area update
   8.6. EPS authentification
   8.7. Intra and Inter technology mobility management
      8.7.1.1. Session management : Bearer establishment/Release
   8.8. QoS in EPS

9. EPS Policy and Charging Control
   9.1. Policy control
      9.1.1. Gating
      9.1.2. QoS Control
   9.2. Charging Control
      9.2.1. Online charging
      9.2.2. Offline charging
   9.3. PCC Architecture
      9.3.1. PCRF
      9.3.2. AF (e.g., P-CSCF)
      9.3.3. PCEF (e.g., GGSN, PDN GW)
      9.3.4. SPR
      9.3.5. OCF
      9.3.6. OFCF
      9.3.7. ABMF
      9.3.8. RF
   9.4. PCC scenarios
      9.4.1. Fair use
      9.4.2. Anti bill shock
      9.4.3. Freemium
      9.4.4. Speed boost
      9.4.5. Premium mobile video, etc.

10. Alternative solutions to IMS to provide telephony services within EPS : CSFB
   10.1. CSFB Architecture
      10.1.1. Impact on MME
      10.1.2. Impact on MSC Server
      10.1.3. SGs interface
   10.2. Attachment, detachment and TA Update of a CSFB compliant device
   10.3. Establishment of an outgoing call from a CSFB device
   10.4. Establishment of an incoming call towards a CSFB device
   10.5. Outgoing SMS and incoming SMS for a CSCB compliant device

11. EPS and IMS (VoLTE)
   11.1. Why IMS ?
   11.2. IMS architecture for VoLTE
   11.3. Roaming issues in VoLTE
   11.4. IMS registration from visited network with EPS access

11.5. IMS session establishment/release in roaming situations from EPS access
11.6. IMS services for EPS
11.6.1. Voice service
11.6.2. SMS service
11.6.3. Single radio voice call continuity (SR-VCC)

GPRS NETWORK AND ITS EVOLUTIONS

Course objective : The goal of this course is to explain :

- The GPRS network architecture and its integration in the GSM Network Subsystem.
- The TCP/IP concepts necessary to understand GPRS operation (DNS, DHCP, IP routing, etc).
- The GPRS transfer and signaling procedures.
- The GPRS charging mechanisms.
- The similarities between GPRS signaling and GSM signaling
- The application of CAMEL Phase 3 to GPRS for services such as Prepaid.
- The evolution of GPRS with UMTS R3, R4, R5 and R6

Pre-requisites : Knowledge on GSM network signaling and on SS7
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Duration : 3 days

GPRS was developed to enable GSM operators to meet the growing demands for wireless packet data service that is a result of the explosive growth of the Internet and corporate Intranets.

1. GPRS Network Architecture
    1.1. GPRS Integration within the GSM network
    1.2. GPRS Backbone
    1.3. GPRS entities, GPRS Support Nodes (SGSN and GGSN) and PCU
    1.4. GPRS network interfaces
        1.4.1. Gb Interface : Interface between an SGSN and a BSS
        1.4.2. Gn Interface : Interface between two GSNs within the same PLMN
        1.4.3. Gi Interface : Interface between GPRS and an external packet data network
        1.4.4. Gc : Optional interface between a GGSN and an HLR
        1.4.5. Gd : Interface between a SMS-GMSC and an SGSN, and between a SMS-IWMSC and an SGSN
        1.4.6. Gf : Interface between an SGSN and an EIR
        1.4.7 Gp: Interface between two GSNs in different PLMNs
        1.4.8. Gr: Interface between an SGSN and an HLR
        1.4.9. Gs: Interface between an SGSN and an MSC/VLR
    1.5. Interworking between GPRS and Packet Data Networks
        1.5.1. Interworking with X.25
        1.5.2. Interworking with IP

2. GPRS Identities
    2.1. IMSI and Packet TMSI
    2.2. NSAPI and TLLI
    2.3. PDP Address
    2.4. TID
    2.5. Routing Area Identity and Cell Identity
    2.6. GSN Addresses
        2.7. Access Point Name

3. Introduction to TCP/UDP/IP for the understanding of the GPRS network

- 3.1. IP functions
  - 3.1.1. Addressing
  - 3.1.2. Quality of Service
  - 3.1.3. Routing : RIP, OSPF and BGP
- 3.2. TCP and UDP transport protocols
- 3.2. DHCP : Dynamic Host configuration Protocol
- 3.3. DNS : Domain Name System
- 3.4. SNMP : Simple Network Management protocol

4. GPRS operation
- 4.1. GPRS signaling plane
  - 4.1.1. Signaling procedures between MS and SGSN : GMM SM
  - 4.1.2. Signaling procedures between SGSN and HR : MAP
  - 4.1.3. Signaling procedures between SGSN and MSC/VLR : BSSAP+
  - 4.1.4. Signaling procedures between SGSN and EIR : MAP
  - 4.1.5. Signaling procedures between SGSN and SMSC : MAP
  - 4.1.6. Signaling procedures between GSNs : GTP
  - 4.1.7. Signaling procedures between GGSN and HLR : MAP or MAP and GTP
- 4.2. GPRS transmission and routing planes
  - 4.2.1. Packet routing and transfer
  - 4.2.2. GTP Protocol and differences between the protocol versions
  - 4.2.3. Packet data protocol (PDP) state model
  - 4.2.4. PDP Context Activation, Deactivation and Modification
  - 4.2.5. GPRS data transfer from the mobile station
  - 4.2.6. GPRS data transfer to the mobile station
- 4.3. GPRS Mobility Management
  - 4.3.1. Mobility management state model
  - 4.3.2. GPRS MS Attachment procedure
  - 4.3.3. GPRS MS Detachment procedure
  - 4.3.4. Location management procedures
  - 4.3.5. Paging
  - 4.3.6. Subscriber management procedures
  - 4.3.7. Impact of GPRS on GSM mobility management
- 4.4. GPRS Charging
  - 4.4.1. Charging Information in SGSN (S-CDR) and in GGSN (G-CDR)
  - 4.4.2. Charging for SMS in GPRS (SM-CDR)
  - 4.4.3. Charging data collection principles
  - 4.4.4. GPRS CDR Collection by GTP' Protocol
  - 4.4.5. Examples of charging scenarios
  - 4.4.6. Charging Gateway architecture
- 4.5. GPRS Management architecture and management functions

5. GPRS and CAMEL Phase 3
- 5.1. CAMEL Phase 3 Architecture
  - 5.1.1. GprsSSF
  - 5.1.2. GsmSCF
- 5.2. GPRS state models
  - 5.2.1. GPRS Attach/Detach State Model
  - 5.2.2. GPRS PDP Context State Model
- 5.3. CAMEL Phase 3 Information Flows for GPRS services
- 5.4. Prepaid Service Example with GPRS and CAMEL Phase 3
- 5.5. SMS State Model
- 5.6. CAMEL Phase 3 Information Flows for SMS services
- 5.7. Prepaid Service Example with SMS and CAMEL Phase 3

6. GPRS and other Services
- 6.1. SMS and GPRS
- 6.2. MMS and GPRS
- 6.3. i-mode, WAP and GPRS

7. GPRS Evolutions
- 6.1. UMTS R3, R4, R5 and R6
- 6.2. The new IP Multimedia Domain and SIP Signaling
- 6.3. SIP voice and video call establishment scenario over GPRS
- 6.4 New services such a SIP instant messaging and presence, conference, unified messaging, etc.

NEXT GENERATION NETWORK FOR MOBILE NETWORKS : 3GPP R4

Course objective : Understand the principles, the architecture and the services of Next Generation for Mobile networks (3GPP R4)
Pre-requisites : Knowledge on GSM network signaling
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Duration : 2 days

Voice switching is evolving. A new generation of network architectures emerges enabling the provision of new services mixing voice, real time data and video : The Next Generation Networks (NGNs). NGN architecture has two modes of operation : Telephony NGN to emulate PSTN or GSM networks (called R4 for the mobile network evolution) when replacing or adding PSTN switches and MSCs; and Multimedia NGN to offer multimedia services via broadband accesses such as xDSL, 3G, WiMax, etc. Multimedia NGN has been renamed IMS (IP Multimedia Subsystem). The objective of this course is to present the R4 (Telephony NGN for mobile) principles, the R4 network and service architectures, the migration from GSM/3G using traditional MSCs or 3G MSCs to Softswitches/Gateways emulating all the functions and services of the traditional circuit switched domain. The R5 and R6 (IMS) will also be introduced.

1. Short introduction on mobile networks evolution
   - 1.1. GSM
   - 1.2. GPRS
   - 1.3. EDGE
   - 1.4. CDMA and CDMA2000
   - 1.5. 3G (R3) : New radio access with broadband access technologies W-CDMA, HSDPA and HSUPA
   - 1.6. 3G (R4) : New circuit switched architecture relying on the Next Generation Network concept with voice and video over IP
   - 1.7. 3G (R5) : New IP-based multimedia control architecture called (IP Multimedia Subsystem) to provide multi-media based services

2. Introduction to Next Generation Network
   - 2.1. Circuit switched domain of mobile networks
   - 2.2. Why NGN R4 for the mobile network ?
   - 2.3. Advantages of Mobile NGN (R4) : CAPEX/OPEX reduction, flexibility, evolutionary path towards an all-IP network, etc.
   - 2.4. Migration scenarios from GSM to R4

3. R4 architecture components
   - 3.1. Media Gateway : Trunking et Access Gateways
   - 3.2. MSC Server
   - 3.3. GMSC Server
   - 3.4. Signaling Gateway
   - 3.5. IP network with QoS mechanisms

4. R4 Protocols
   - 4.1. Access signaling protocols : BSSAP, RANAP and ISUP

   - 4.2. Network signaling and control protocols : MEGACO/H.248 et BICC
   - 4.3. Service control protocols : INAP, CAP, SIP
   - 4.4. Transport protocols : RTP/RTCP , AAL2/ATM

5. Call scenarios with R4
   - 5.1. Outgoing call establishment/release between a caller attached to an MSC Server / MGW and a called party attached to a traditional MSC
     - 5.1.1. 1st case : 2G Access
     - 5.1.2. 2nd case : 3G Access
   - 5.2. Outgoing call establishment and release between caller and callee, both attached to MSC Servers/MGWs.
   - 5.3. Incoming call establishment and release involving a GMSC Server/MGW and MSC Server/MGW
   - 5.4. Incoming call establishment and release involving a GMSC Server and MSC Server/MGW

6. Charging and emulation of supplementary services with R4

7. Short introduction to IMS (R5)
   - 7.1. Why IMS ?
   - 7.2. IMS contribution
   - 7.3. IMS entities
   - 7.4. IMS interfaces and protocols
   - 7.5. IMS session control and service control scenarios

R4 CONTROL AND SIGNALING PROTOCOLS : MEGACO/H.248, BICC, SIP-I

Course objective : Understand the control and signaling protocols of the mobile R4 architecture
Pre-requisites : Knowledge on GSM network signaling
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Duration : 3 days

The objective of this course is to briefly present the R4 (Mobile NGN) architecture, and then focus on the R4 control (MEGACO/H.248) and signaling (BICC, SIP-I) signaling protocols.
Known as the MEGACO at IETF and H.248 at ITU-T, the MEGACO/H.248 protocol is a master/slave protocol in which controllers known as Media Gateway Controllers (MGCs) control the operation of Media Gateways (MGWs). The MGC takes care of call-control intelligence and related call signaling while the MGW takes instruction from an MGC and basically does what the MGC commands. The MGC commands generally relate to the establishment and release of contexts (connections) from one side of the MGW to another.
This course will introduce the MEGACO architecture with the MGCs and MGWs and the concepts of termination and context related to connectivity. The control messages exchanged between MGCs and MGWs will be described with their parameters called descriptors. The package concept will be developed. Various call establishment scenarios will be considered to understand how MEGACO operates.
Finally the provision of supplementary services with MEGACO will be explained.
There are two signaling protocols between softswitches in an R4 architecture which can set up packetized voice calls (e.g., VoIP): Bearer Independent Call Control (BICC) and SIP-I.
BICC was standardized by the International Telecommunication Union Standardization Sector (ITU-T), SIP-T by the IETF, and SIP-I by ITU-T and then ANSI.
BICC is a network level signaling protocol based on the existing narrowband ISUP specifications. Session Initiation Protocol (SIP) with encapsulated ISUP (SIP-I) provides an extension to the standard SIP signaling protocol to transport ISUP messages across a SIP network as attachments to the SIP messages.
After presenting the two protocols, i.e., BICC and SIP-I, the course compares them and shows how they can interwork.

1. R4 architecture components
   - 1.1. Media Gateway
   - 1.2. MSC/GMSC Server Server
   - 1.3. Signaling Gateway
   - 1.4. IP network with QoS mechanisms
   - 1.5. Mc, Nb, Nc Interfaces

2. MEGACO Architecture
   - 2.1. Media Gateway Controller (MGC)
   - 2.2. Media Gateway
   - 2.3. MEGACO termination
   - 2.4. MEGACO context

3. MEGACO transactions are commands
   - 3.1. MEGACO Transactions

   - 3.1.1. Transaction request
   - 3.1.2. Transaction reply
   - 3.1.3. Transaction pending
   - 3.2. MEGACO Commands
   - 3.2.1. Add
   - 3.2.2. Modify
   - 3.2.3. Subtract
   - 3.2.4. Move
   - 3.2.5. AuditValue
   - 3.2.6. AuditCapabilities
   - 3.2.7. Notify
   - 3.2.8. Service Change

4. MEGACO Descriptors
   - 4.1. Modem Descriptor
   - 4.2. Multiplex Descriptor
   - 4.3. Media Descriptor
   - 4.4. Events Descriptor
   - 4.5. Signals Descriptor
   - 4.6. Audit Descriptor
   - 4.7. Service Change Descriptor
   - 4.8. DigitMap Descriptor
   - 4.9. Statistics Descriptor
   - 4.10. Observed Events Descriptor
   - 4.11. Topology Descriptor

5. MEGACO Packages
   - 5.1. Tone Generator Package
   - 5.2. Tone Detection Package
   - 5.3. Basic DTMF Generator Package
   - 5.4. DTMF detection Package
   - 5.5. Call Progress Tones Generator Package
   - 5.6. Call Progress Tones Detection Package
   - 5.7. Analog Line Supervision Package
   - 5.8. Basic Continuity Package
   - 5.9. Network Package
   - 5.10. RTP Package
   - 5.11. TDM Circuit Package

6. Call scenarios using MEGACO in R4 context
   - 6.1. Outgoing call establishment/release between a caller attached to an MSC Server / MGW and a called party attached to a traditional MSC
   - 6.1.1. 1st case : 2G Access
   - 6.1.2. 2nd case : 3G Access
   - 6.2. Outgoing call establishment and release between caller and callee, both attached to MSC Servers/MGWs.
   - 6.3. Incoming call establishment and release involving a GMSC Server/MGW and MSC Server/MGW
   - 6.4. Incoming call establishment and release involving a GMSC Server and MSC Server/MGW

7. Support of supplementary services with MEGACO

8. BICC : Bearer Independent Call Control
   - 8.1. BICC CS-1 Network Architecture : CSF, BCF, BF
   - 8.2. BICC CS-2 Network Architecture : CSF, BIWF
   - 8.3. BICC protocol and relationship with ISUP
   - 8.4. BICC CIC versus ISUP CIC
   - 8.5. IPBCP protocol
     - 8.5.1. IPBCP messages
     - 8.5.2. IPBCP message parameters and relationship with SDP
   - 8.6. Call establishment and release with BICC
   - 8.7. Handling of supplementary services with BICC

9. SIP-I
   - 9.1. SIP-I Network Architecture
   - 9.2. SIP-I protocol
   - 9.3. Call establishment and release with SIP-I
   - 9.4. Handling of supplementary services with SIP-I

10. BICC versus SIP-I

11. SIP-I / BICC protocols interworking
   - 11.1. Reference model for SIP-I / BICC Interworking
   - 11.2. Incoming call interworking from SIP-I to BICC
   - 11.3. Outgoing Call Interworking from BICC to SIP-I
   - 11.4. Supplementary services
     - 11.4.1. Special procedures for supplementary service interworking
     - 11.4.2. Interworking of CLIP/CLIR supplementary service
     - 11.4.3. Interworking of Call Hold (HOLD) supplementary service
     - 11.4.4. Interworking of Call Completion to Busiy Subscriber CCBS) supplementary service

Teaching on Telecommunications

UMTS R3, R4, R5 AND R6 CORE NETWORK ARCHITECTURES

Course objective : Gain knowledge on the principles, architecture, services and evolutions of the Universal Mobile Telecommunications System (UMTS)
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : basic knowledge on the GSM and GPRS network
Duration : 3 or 4 days

1. From GSM and GPRS to UMTS
   - 1.1. GSM Radio Access Network (GSM BSS)
   - 1.2. GSM Core Network Architecture (GSM NSS)
   - 1.3. GPRS Core Network Architecture (GPRS NSS)
   - 1.4. UMTS Radio Access Network (UMTS RAN)
   - 1.5. UMTS Core Network (UMTS CN)
     - 1.5.1. UMTS Circuit Switched Domain
     - 1.5.2. UMTS Packet Switched Domain

2. UMTS RAN R3
   - 2.1. Entities
     - 2.1.1. RNS : Radio Network Subsystem
     - 2.1.2. Mobile Station : UMST SIM + Mobile Equipment
     - 2.1.3. Node B
     - 2.1.4. RNC : Radio Network Controller
     - 2.1.5. Dimensioning of the UMTS RAN
   - 2.2. UMTS RAN Signaling
     - 2.2.1. NBAP : Node B Application Part
     - 2.2.2. RNSAP : Radio Network Subsystem Application Part
     - 2.2.3. RANAP : Radio Access Network Application Part
     - 2.2.4. ALCAP : Access Link Control Application Part
     - 2.2.5. HSL and SIGTRAN Signaling Transport in UMTS RAN
     - 2.2.6. Handover procedures
   - 2.3. UMTS RAN data transfer
     - 2.3.1. AAL2/ATM
     - 2.3.2. AAL5/ATM
     - 2.3.3. GTP-U v1 : GPRS Tunneling Protocol Version 1

3. UMTS Core Network R3
   - 3.1. Entities of the CS Domain : 3G MSC, GMSC, VLR, HLR, AuC, GLR
   - 3.2. Entities of the PS Domain : 3G SGSN, GGSN
   - 3.3. CAMEL Entities : gsmSSP, gprsSSP, SCP, SRP
   - 3.4. Dimensioning of the CS and PS Domains
   - 3.5. UMTS Interfaces
     - 3.5.1. Interface between UMTS RAN and UMTS CN : Iu_CS and Iu_PS
     - 3.5.2. Interfaces within the Iu-CS domain
     - 3.5.3. Interfaces within the Iu-PS domain
     - 3.5.4. Interface between the Iu-CS and Iu-PS domains
   - 3.6. Signaling protocols in the CS and PS Domains
     - 3.6.1. ISUP

- 3.6.2. MAP
- 3.6.3. CAP, INAP
- 3.6.4. GTP-C Version 1

3.7. UMTS Identities
- 3.7.1. IMSI
- 3.7.2. Packet TMSI
- 3.7.3. NSAPI, RB Identity and RAB ID for Iu mode
- 3.7.4. PDP Address
- 3.7.5. TEID
- 3.7.6. Routing Area Identity
- 3.7.7. RAN Registration Area Identity (Iu mode)
- 3.7.8. Cell Identitiy
- 3.7.9. Service Area Identity
- 3.7.10. GSN Addresses : GSN Address and GSN Number
- 3.7.11. RNC Adresses : RNC address and RNC Number
- 3.7.12. Access Point Name

3.8. Signaling flows
- 3.8.1. Registration
- 3.8.2. Authentication
- 3.8.3. Roaming management
- 3.8.4. Voice call establishment and release
- 3.8.5. PDP context (data call) establishment and release

3.9. Data Transfer in the CS Domain : TDM

3.10. Data Transfer in the PS Domain : GTP-U Version 1

3.11. Charging and Billing in UMTS

4. Location Services (LCS) in UMTS

4.1. LCS Entities
- 4.1.1. SMLC
  - 4.1.1.1. NSS based SMLC
  - 4.1.1.2. BSS Based SMLC
- 4.1.2. GMLC
- 4.1.3. LMU
  - 4.1.3.1. Type A LMU
  - 4.1.3.2. Type B LMU

4.2. UMTS Positioning Methods
- 4.2.1. cell ID based method
- 4.2.2. OTDOA method
- 4.2.3. network-assisted GPS methods.

4.3. Signaling protocols for LCS Support in UMTS

5. Number portability in UMTS

5.1. Operator portability and service portability

5.2. IN-based solution: Number Portability Database (NPDB)

5.3. Signalling Relay-based solution: Mobile Number Portability/Signalling Relay function (MNP-SRF)

5.4. Call scenarios with ported numbers

6. UMTS R4

6.1. Evolution from UMTS R3 to UMTS R4 : Modified CS Domain

6.2. UMTS R4 Entities
- 6.2.1. Access Gateway
- 6.2.2. Trunking Gateway
- 6.2.3. MSC Server

- 6.2.4. GMSC Server
- 6.2.5. Signaling Gateway
- 6.2.6. Vendors solutions

6.3. Signaling Protocols in UMTS R4
- 6.3.1. MEGACO / H.248
- 6.3.2. BICC
- 6.3.3. Signaling Transport with SIGTRAN

6.4. Signaling flows
- 6.4.1. Authentication
- 6.4.2. Roaming management
- 6.4.3. Call establishment (for prepaid and postpaid subscribers)
- 6.4.4. Call Release

6.5. Voice transport over ATM or IP

6.6. Charging and Billing in UMTS R4

6.7. Vendors Solutions

7. UMTS R5

7.1. Evolution from UMTS R4 to UMTS R5 : New IMS Domain

7.2. IMS Entities
- 7.2.1. CSCF (Call State Control Function) : P-CSCF, I-CSCF, S-CSCF
- 7.2.2. MRF (Multimedia Resource Function) : MRF-C, MRF-P
- 7.2.3. HSS (Home Subscriber Server)
- 7.2.4. R-SGW (Roaming Signaling Gateway)
- 7.2.5. MGCF
- 7.2.6. Trunking Gateway
- 7.2.7. Trunking Signaling Gateway
- 7.2.8. Application Server (AS)
  - 7.2.8.1. SIP AS
  - 7.2.8.2. OSA AS
  - 7.2.8.3. IM SSP

7.3. Signaling Protocols in UMTS R5
- 7.3.1. SIP
- 7.3.2. MEGACO/H.248
- 7.3.3. OSA API
- 7.3.4. MAP, CAP
- 7.3.5. Diameter
- 7.3.6. Signaling Transport using SIGTRAN

7.4. Signaling flows
- 7.4.1. Registration
- 7.4.2. Authentication
- 7.4.3. Roaming management
- 7.4.4. Session establishment
- 7.4.5. Session release

7.5. Charging and Billing in UMTS R5

7.6. Voice and video transport in UMTS R5

7.7. CAMEL Phase 4 and IMS
- 7.7.1. CAMEL Phase 4 Entities : IM-SSP, SCP, MRF
- 7.7.2. CAMEL Phase 4 Call State Models
- 7.7.3. CAP Phase 4
- 7.7.4. Prepaid with CAMEL Phase 4 UMTS R5

8. UMTP R6

8.1. UMTS R6 Architecture and comparison with R5,R4,R3 Architectures

8.2. Improvements of the IMS Domain

8.3. UMTS-WLAN Interworking Architecture
8.4. Involved Protocols
8.5. Authentication, Charging, Roaming Procedures

9. Service Architectures in UMTS
   9.1. SIP AS and UMTS
      9.1.1. Types of AS
         9.1.1.1. Application Server
         9.1.1.2. Messaging Server
         9.1.1.3. Media Server
      9.1.2. UAS and B2BUA roles
      9.1.3. Service examples
         9.1.3.1. Instant messaging and presence
         9.1.3.2. Unified messaging
         9.1.3.3. Prepaid
      9.1.4. Vendors Solutions
   9.2. OSA AS and UMTS
      9.2.1. OSA Service Capability Functions and Service Capability Server
      9.2.2. Vendors Solutions
   9.3. CAMEL and UMTS
      9.3.1. CAMEL Phase 3 and Phase 4 Architectures
      9.3.2. CAMEL Services
      9.3.3. Scenarios of call establishment and release involving CAMEL services
   9.4. SMS architecture
   9.5. MMS architecture
   9.6. M-Commerce Architecture

Teaching on Telecommunications

LONG TERM EVOLUTION OF 3G : LTE, EPC, PCC, CSFB, VoLTE

Course objective : Understand the 3G long term evolution, with a new broadband access network (LTE), a new core network (ePC) with all services supplied over IP and the IMS to provide all conversational services.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : basic knowledge on IP networks and mobile networks
Duration : 3 days

The Third Generation Partnership Project (3GPP) has charted the long-term evolution of 3G to ensure the competitiveness of 3G technology during the next 10 years and beyond.
The fundamental aims of this evolution – to further improve service provisioning and reduce user and operator costs – will be met through improved coverage and system capacity and by improving data rates and reducing latency.. A large amount of the work is aimed at simplifying the architecture of the system, as it transitions from the existing 3G circuit + packet switching combined network, to an all-IP system.
The new all-IP mobile network is called EPS (**Evolved Packet System**) with its access network called LTE (**Long Term Evolutin of 3G**) and its core network called ePC (**Evolved Packet Core**).
In this context, a user will only access to IP-based services. The services offered earlier by the circuit switched domain will be now supplied by IMS (IP Multimedia Subsystem). The emulation of voice services with IMS is called **VoLTE** (Voice over LTE).
Alternative solutions exist to reuse the 2G/3G circuit switched domain before IMS becomes a reality : these are called **CSFB** (Circuit Switched Fallback) and SVLTE (Simultaneous Voice and LTE). With CSFB approach, LTE just provides data services, and when a voice call is to be initiated or received, it will fall back to the CS domain. With SVLTE approach, the handset works simultaneously in the LTE and 2G or 3G CS modes, with the LTE mode providing data services and the CS mode providing the voice service.
To assure fair usage of the EPS network, service providers will need to identify the IP service flows, control these flows (authorize, block, restrict) and charge these flows with two possible charging methods (online and offline charging). For this purpose a PCC (**Policy and Charging Control**) architecture has been introduced.
The objective of this course is to introduce the legacy packet switched network called GPRS (**General Packet Radio Service**) to understand the mobility management between 4G and 2G/3G and then provide a comprehensive end-to-end vision of EPS from the access network, then to core network and finally to service levels with PCC, CSFB and VoLTE.

1. 3G Access Technologies
   1.1. W-CDMA (3G)
   1.2. HSDPA (3,5 G)
   1.3. HSUPA (3,75 G)
   1.4. HSPA Evolution
   1.5. Impact of HSDPA/HSUPA introduction on the 3G network

2. 3G packet core : GPRS

1.1. Architecture elements
1.2. 3G SGSN : Functions, interfaces and dimensioning
1.3. GGSN : Functions, interfaces and dimensioning
1.4. Intra-operator IP backbone et inter-operator IP-backbone (GRX)
1.5. GPRS mobility management
1.6. GPRS session management
1.7. GPRS roaming

3. EPS Access Network: LTE
   3.1. Architecture Elements
   3.2. Interfaces
      3.2.1. X2 between eNodeBs
      3.2.2. S1 between eNodeB and EPC
   3.3. Handover
   3.4. Comparaison between LTE access network and 3G/3G+ access network

4. EPS Core Network Architecture : ePC
   4.1. ePC Impact on 3G Core Network
      4.1.1. From 3G SGSN to S4-SGSN
      4.1.2. New S4-SGSN interfaces: S3, S4, S6d, S16
   4.2. EPC Architecture elements
      4.2.1. MME
      4.2.2. Serving GW
      4.2.3. PDN GW
      4.2.4. PCRF
      4.2.5. HSS
      4.2.6. PCRF
      4.2.7. OCS
      4.2.8. OFCS
   4.3. Interfaces
      4.3.1. S1 to S16 Interfaces
      4.3.2. Gx, Gy, Gz, Rx, X2 interfaces
      4.3.3. NAS signaling (EMM, ESM) between UE and MME
   4.4. Protocols
      4.4.1. DIAMETER
      4.4.2. GTPv2-C
      4.4.3. GTPv1-U
      4.4.4. S1-AP
      4.4.5. X2-AP
   4.5. Control plane with DIAMETER Agents
      4.5.1. Advantages of Agent architecure for DIAMETER signaling delivery
      4.5.2. International roaming with International DIAMETER brokers
   4.6. Mobility Management in non roaming and roaming situations: Attachment, Detachment, Tracking area update
      4.6.1. DIAMETER S6a, S6d and SWx with traces
   4.7. EPS authentification
   4.8. Intra and Inter technology mobility management
   4.9. Session management : Bearer establishment/Release in non roaming and romaing situations
      4.9.1.1. Default bearer establishment/release
      4.9.1.2. Dedicated bearer establishment/release
      4.9.1.3. Traces of GTPv2-C messages for all types of bearer control procedures

   4.10. QoS in EPS
      4.10.1. QCI
      4.10.2. ARP
      4.10.3. GBR, MBR, APN-AMBR and UE AMBR
      4.10.4. Examples

5. EPS Policy and Charging Control (PCC)
   5.1. PCC Architecture
      5.1.1. PECF
      5.1.2. PCRF
      5.1.3. OCS
      5.1.4. OFCS
      5.1.5. Interfaces : Gx, Gy, Gz, Sy, Sp/Ud
   5.2. PCC scenarios
      5.2.1. Fair use
      5.2.2. Anti-bill shock
      5.2.3. Parental control
      5.2.4. Turbo button, etc.

6. Alternative solutions to IMS to provide telephony services within EPS : CSFB
   6.1. CSFB Architecture
      6.1.1. Impact on MME
      6.1.2. Impact on MSC Server
      6.1.3. SGs interface
   6.2. Attachment, detachment and TA Update of a CSFB compliant device
   6.3. Establishment of an outgoing call from a CSFB device
   6.4. Establishment of an incoming call towards a CSFB device
   6.5. Outgoing SMS and incoming SMS for a CSCB compliant device

7. EPS and IMS (VoLTE)
   7.1. Why IMS ?
   7.2. IMS architecture for VoLTE
   7.3. Roaming issues in VoLTE
   7.4. IMS registration from visited network with EPS access
   7.5. IMS session establishment/release in roaming situations from EPS access
   7.6. IMS services for EPS
      7.6.1. Voice service
      7.6.2. SMS service

ADVANCED EVOLVED PACKET CORE

Course Objectives : Understand the signaling procedures related to the Evolved Packet Core (ePC), particularly, mobility management, session management and charging.
Attendance : Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Minimum knowledge on mobile networks, GPRS, and IP protocol
Duration : 3 days

EPS (Evolved Packet System) represents the very latest evolution of the UMTS standard. EPS is also known by other acronyms related to technical study items being worked on at 3GPP standard committees: LTE (Long Term Evolution), which is dedicated to the evolution of the radio interface, and ePC (Evolved Packet Core), which focuses on Core Network architecture evolution. The goal of this course is to present the signaling procedure related to ePC, particulary for mobility management, session management and charging. DIAMETER, GTPv2C, GTP-U, PMIP, GRE, X2-AP and S1-AP protocols are studied and applied to different EPS scenarios

1. EPS Core Network Architecture : Evolved Packet Core (ePC)
   - 1.1. Architecture components
     - 1.1.1. eNodeB
     - 1.1.2. MME
     - 1.1.3. Serving GW
     - 1.1.4. PDN GW
     - 1.1.5. PCRF
     - 1.1.6. HSS
   - 1.2. Interfaces
     - 1.2.1. Interfaces S1 to S16
     - 1.2.2. DIAMETER base protocol for the understanding of the S6a, S6d, S9, S13, S13', Gx, Gy, Gz, Rx, SWx interfaces
   - 1.3. 2G/3G and ePC Interworking
     - 1.3.1. S4-SGSN
     - 1.3.2. S3, S4, S16 Interfaces
   - 1.4. I-WLAN and ePC Interworking
     - 1.4.1. e-PDG
     - 1.4.2. AGW
     - 1.4.3. 3GPP AAA Server
     - 1.4.4. SWm, SWx, S2a, S2b, Ta, Wa, Wn Interfaces

2. Mobility Management : Attachement, Detachment, Tracking Area Update, etc.
   - 2.1. EMM protocol between UE and MME
   - 2.2. RRC procedures between UE and eNodeB for mobility management
   - 2.3. SS1-AP procedures between eNodeB and MME for mobility management
   - 2.4. S6 DIAMETER-based Interface between MME and HSS
   - 2.5. S13 DIAMETER-based Interface between MME and EIR
   - 2.6. EPS Authentication with AKA
   - 2.7. End to End procedure for UE attachment to EPS
   - 2.8. I-WLAN access to ePC
     - 2.8.1. PMIP protocol
     - 2.8.2. GRE protocol
     - 2.8.3. EAP protocol

     - 2.8.4. SWx DIAMETER-based Interface
     - 2.8.5. Trusted I-WLAN access to ePC: Attachment procedure
     - 2.8.6. Untrusted I-WLAN access to ePC : Attachment procedure
   - 2.9. 2G/3G access and ePC interworking : Attachment procedure

3. Data session establishment
   - 3.1. ESM protocol between UE and MME
   - 3.2. RRC protocol between UE and eNodeB for bearer establishment
   - 3.3. S1-AP protocol between eNodeB and MME for bearer establishment
   - 3.4. GTPv2-C protocol between MME and Serving-GW and between Serving-GW and PDN-GW
   - 3.5. Gx interface between PDN GW and PCRF for download of charging rules
   - 3.6. Default bearer establishment procedure
     - 3.6.1. Network initiated bearer establishment
     - 3.6.2. UE initiation bearer establishment
   - 3.7. Dedicated bearer establishment procedure
     - 3.7.1. Network initiated bearer establishment
     - 3.7.2. UE initiation bearer establishment

4. Handover
   - 4.1. GTPv2-C, X2-AP, S1-AP, RRC protocols for mobility management in active state
   - 4.2. Intra-E-UTRAN mobility with X2 support
   - 4.3. Intra-E-UTRAN mobility without X2 support
   - 4.4. Intra E-UTRAN mobility with EPC node relocation
   - 4.5. Mobility between 2G/3G packet and E-UTRAN

5. EPS Charging
   - 5.1. Service Flow-based Charging
   - 5.2. Charging rules
   - 5.3. Gx DIAMETER-based interface for charging rules download
   - 5.4. On-line Charging
     - 5.4.1. Gy DIAMETER-based interface for online charging
     - 5.4.2. Online charging scenarios
   - 5.5. Off-Line Charging
     - 5.5.1. Gz DIAMETER-based interface for offline charging
     - 5.5.2. Offline charging scenarios

VOICE OVER LTE WITH IMS

Course objective : Gain knowledge on the IMS architecture and IMS procedures considering LTE/ePC as the broadband access.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, Information System Architects
Pre-requisites : Basic knowledge on the operation of LTE/ePC and on IP protocol
Duration : 3 days

IMS (IP Multimedia Subsystems) has been around for some time, and many infrastructure vendors have invested heavily in developing IMS capabilities, solutions and products. But market acceptance has been slower than expected. Now, with LTE (Long Term Evolution) taking shape, the IMS platform has been given a new role and a niche that will carry it a considerable distance into the future. The goal of this course is to present IMS with LTE/ePC=EPS as the broadband access. The course :

- introduces the requirements that EPS puts on IMS,
- describes the IMS architecture
- presents the IMS protocols
- shows how roaming in IMS applies when an EPS user is in a visited network
- describes how resources are reserved in the EPS access network when an IMS session is established
- illustrates the different IMS procedures considering an EPS user : registration, session establishment/release, SMS delivery, charging
- shows how the voice call continuity is ensured when the user moves from EPS/IMS to 2G/3G R4.

1. IMS for EPS
   - 1.1. Voice over LTE (VoLTE) initiative
   - 1.2. Common IMS for EPS
   - 1.3. Relationship between EPS and IMS

2. LTE/ePC requirements for IMS usage
   - 2.1. ISIM module on USIM
     - 2.1.1. Private User Identity format
     - 2.1.2. Public User Identity format
     - 2.1.3. Authentication Key and AKA for IMS authentication
   - 2.2. USIM without ISUM
     - 2.2.1. Temporary Private and Public User Identities for registration
     - 2.2.2. Authentication based on USIM AKA
   - 2.3. Robust Header Compression for RTP traffic from LTE terminal
   - 2.4. SIP message compression from LTE terminal
   - 2.5. EPS bearer consideration for SIP signaling : default bearer with IMS APN
   - 2.6. EPS bearer consideration for voice : dedicated bearer with GBR

3. IMS Architecture
   - 3.1. IMS entities
     - 3.1.1. CSCF : P-CSCF, I-CSCF, S-CSCF for the control of IMS multimedia sessions
     - 3.1.2. IMS-MGW, MGCF, BGCF, T-SGW for the interworking with circuit switched networks (PSTN, GSM)

     - 3.1.3. HSS database, SLF and proxy agent for the management of user mobility
     - 3.1.4. PCRF for policy and charging control
     - 3.1.5. CCF and OCS for offline and online charging respectively
     - 3.1.6. AS, MRF and SCIM for service execution, media delivery and service interaction management respectively

4. IMS protocols
   - 4.1. Session control and service control protocol: SIP
   - 4.2. Authentication, Authorization and Accounting protocol : DIAMETER
   - 4.3. RTP for real time traffic delivery
   - 4.4. MSRP for data traffic delivery

5. IMS and roaming
   - 5.1. Scenario with EPS and IMS roaming agreements
   - 5.2. Scenario with EPS roaming agreement only

6. IMS and resource reservation with EPS access
   - 6.1. Rx interface from P-CSCF to PCRF
   - 6.2. Gx interface from PCRF to PDN GW
   - 6.3. Scenario for Dedicated bearer establishment for real time traffic such as voice

7. IMS Procedures
   - 7.1. Registration with EPS access
     - 7.1.1. Registration from the home network
     - 7.1.2. Registration from the visited network
   - 7.2. Voice session establishment/release with EPS access with and without roaming situations
   - 7.3. SMS delivery
     - 7.3.1. SMS architecture in the IMS framework
     - 7.3.2. Message flow of SMS delivery and SMS reception
   - 7.4. Charging
     - 7.4.1. Offline charging
       - 7.4.1.1. Rf DIAMETER-based interface
       - 7.4.1.2. IMS CDRs
     - 7.4.2. Online charging
       - 7.4.2.1. Ro, Rc, Re DIAMETER-based interfaces

8. IMS Centralized services (ICS) and Single Radio Voice call Continuity (SR-VCC)
   - 8.1. Telephony services for LTE/IMS and Mobile NGN/R4
   - 8.2. SCC AS (Service Centralization and Continuity) Application Server ffor ICS
   - 8.3. SR-VCC (Single Radio voice call Continuity) to guarantee the continuity of the voice call between LTE+ePC/IMS and 2G/3G R4

M2M AND IOT : NETWORK AND SERVICE ARCHITECTURES

Course Objectives : Understand the M2M (Machine to Machine) and IoT (Internet of Things) application domains, and their associated network and service architectures
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, Information System Architects
Pre-requisites : Minimum knowledge on mobile data networks (e.g., GPRS/ePC)
Duration : 2 days
Maximum Number of participants : 12

PROGRAM

"M2M" is the abbreviated form of "Machine-to-Machine". M2M is defined as the technologies that allow machines, typically (small) computing sensors that perform specific tasks (intelligence) to communicate or relay information as needed typically over simple protocols but more recently over Internet protocols (IP) over wireless or wireline or even SMS. Viewed from the perspective of its functions and potential uses, M2M is causing an entire "internet of things", or internet of objects, to emerge. This course :

- Defines the different terms and issues related to M2M (Machine to Machine) and IoT (Internet of Things)
- Describes the M2M/IoT market - Introduces the different M2M and IoT application domains
- Details the M2M/IoT service and network architectures
- Presents the optimizations specified by 3GPP to adapt the mobile network to M2M/IoT services/applications
- Introduces the different networks/protocols related to M2M/IoT communications : WAN, LPWAN, WLAN, WPAN.

1. M2M and Internet of Things : A definition
   - 1.1. 3GPP and ETSI definitions of M2M
   - 1.2. IoT (Internet of Things) definition
   - 1.3. M2M and IoT functionalities
   - 1.4. M2M as a subset of IoT

2. M2M Market
   - 2.1. M2M business per continent
   - 2.2. M2M value chain
   - 2.3. M2M business models
   - 2.4. Embedded SIM and impact on the M2M market
   - 2.5. Charging/Billing of M2M services

3. M2M and IoT application domains and associated service architectures
   - 3.1. M2M application domain
     - 3.1.1. Fleet management = Tracking and Tracing
     - 3.1.2. Smart metering (e.g., electricity meter)
     - 3.1.3. Remote patient monitoring = eHealth
     - 3.1.4. Surveillance and Security
     - 3.1.5. Home automation
     - 3.1.6. Automated Teller Machine and Point of Sales terminals
   - 3.2. Additional domains with IoT

     - 3.2.1. Agriculture.
     - 3.2.2. Consumer electronics
     - 3.2.3. Infrastructures
     - 3.2.4. Smart city
     - 3.2.5. Utilities
     - 3.2.6. eHealth
     - 3.2.7. Process industries
     - 3.2.8. etc.
   - 3.3. Characterization of M2M/IoT traffic per application domain
   - 3.4. M2M/IoT Service architectures for the different application domains

4. Evolution of addressing of M2M/IoT devices and impact on the existing network/service architectures
   - 4.1. MSISDN (E.164) on 10 digits
   - 4.2. MSISDN (E.164) on 15 digits
   - 4.3. URI (Uniform Resource Indicator)
   - 4.4. IPv4, IPv6 addresses

5. WEB/REST architecture for the M2M/IoT architectures and COAP/LWM2M API for device management and service enablement
   - 5.1. REST Principles
   - 5.2. Proxies and their functionalities
   - 5.3. HTTP protocol for the REST context
   - 5.4. COAP protocol for the REST context
   - 5.5. MQTT protocol
   - 5.6. ETSI and oneM2M service architectures
   - 5.7. LWM2M API for device management and service enablement
     - 5.7.1. Bootstrap
     - 5.7.2. Client registration
     - 5.7.3. Device management and service enablement
     - 5.7.4. Information reporting
     - 5.7.5. Data model related to LWM2M API

6. 3GPP MTC (Machine Type Communication) network architecture for the M2M/IoT applications
   - 6.1. LTE adaptation to support low power IoT devices : LTE Category 0 and NB-IOT
   - 6.2. 2G adaptations to support low power IoT devices : EC-GSM
   - 6.3. Entities of the architecture
     - 6.3.1. MTC-IWF
     - 6.3.2. HSS
     - 6.3.3. GGSN/PGW
     - 6.3.4. SGSN/MME/MSC
     - 6.3.5. MTC AAA
     - 6.3.6. CDF/CGF
   - 6.4. New Interfaces
     - 6.4.1. Tsms
     - 6.4.2. T4, T5a, T5b, T5c, T6m, T6n
     - 6.4.3. Tsp
   - 6.5. MTC Architecture without roaming
   - 6.6. MTC Architecture in roaming situation
   - 6.7. Device triggering
   - 6.8. Data delivery from the device

6.8.1. Control plane : Small data
6.8.2. User plane
6.9. MTC common and specific features : group management, MTC event subscription/notification, low mobility, delay tolerance, small data transmission, time controlled, etc.
6.10. MTC congestion management

7. Communication protocols and support network for M2M/IoT
7.1. WPANs : IEEE 802.15.4, Zigbee, Zwave, Zigbee IP, Bluetooth Low Energy (BLE)
7.2. WLANs : WiFi Low Energy 802.11ah
7.3. LPWANs : Sigfox, LoRa, LTN, Weightless, etc.
7.3.1. Architecture of LPWANs
7.3.2. Comparison between LPWAN technologies : LoRa, Sigfow, Weightless, RPMA, NEUL.

MOBILE AUTHENTICATION FOR MOBILE, WIRELESS AND INTERNET SERVICES

Course Objectives : Understand the mobile authentication and its application to the authentication of mobile, wireless and IP services
Attendance : Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Minimum knowledge on mobile networks and IP technology
Duration : 3 days

New IP-based telecommunications services are starting to appear WLAN access, Presence and Messaging, multicast/broadcast services (MBMS), Digital Video Broadcast- Handheld (DVB-H), etc. All of them need authentication and key agreement. Today, typically each service sets up and manages its own username/password database. Setting up username/password databases costs money and time, inconvenient to users. A solution called GAA (Generic Authentication Architecture) allows reusing the mobile authentication architecture to authenticate the users when accessing their IP Services. The goal of this course is to : - Present the authentication and key agreement in 2G/3G/EPS mobile networks and IMS network. - Describe the GAA architecture with its important building block called GBA - Present the UMA and I-WLAN authentication architectures. - Introduce the AAA principles nad the related protocols, namely, RADIUS and DIAMETER. - Describe the authentication procedure to IMS network for clients without ISIM module (IMS SIM). - Highlight the SSL protocol.

1. Mobile network architectures
1.1. 2G/3G Networks
1.1.1. Access
1.1.2. Circuit Switched Domain : NGN Mobile (R4)
1.1.3. Packet Switched Domain : GPRS
1.2. EPS Network (4G)
1.2.1. Access : LTE
1.3. Packet Switched : Evolved Packet Core (ePC) also called System Architecture Evolution (SAE)

2. Authentication and Key Agreement in Mobile Networks
2.1. 2G Mobile Network
2.1.1. 2G network attachment by a 2G user and Authentication Procedure
2.1.2. Ki and Kc Keys
2.1.3. Authentication Algorithm
2.1.4. Algorithm for Encryption Key generation : A8
2.1.5. 2G Authentication Vector : RAND, RES, Kc
2.1.6. Encryption : A5
2.2. 3G Mobile Network
2.2.1. 3G network attachment by a 3G user and Authentication Procedure
2.2.2. Authentication and key Agreement AKA
2.2.3. Integrity and Encryption
2.2.4. Ki, CK and IK Keys
2.2.5. 3G Authentication Vector: RAND, XRES, AUTN, CK, IK
2.3. EPS Mobile Network (Evolved Packet System) (4G)
2.3.1. EPS network attachment by a EPS user and Authentication Procedure
2.3.2. Authentication and Key Agreement AKA
2.3.3. KASME, KNASenc, KNASint, KeNB, KUpenc, KRRCenc and KRRCint Keys
2.3.4. EPS Authentication Vector : RAND, XRES, AUTN, KASME
2.4. IMS Network
2.4.1. IMS Network Architecture
2.4.2. IMS Service Architecture
2.4.3. Registration to IMS Network and Authentication Procedure for an IMS user with ISIM
2.4.4. Authentication and Key Agreement AKA
2.4.5. K, CK and IK Keys
2.4.6. IMS Authentication Vector : RAND, XRES, AUTN, CK, IK
2.4.7. IPSec Tunnel between UE and P-CSCF to secure SIP Signaling Traffic

3. Generic Authentication Architecture (GAA) in 2G, 3G, EPS and IMS Networks
3.1. What is GAA ?
3.2. GAA Application examples
3.2.1. Multimedia Broadcast and Multicast Services (MBMS) (3GPP)
3.2.2. Broadcast Mobile TV (OMA)
3.3. Architecture elements of GAA and their interfaces
3.3.1. Home Server (HS) : HLR or HSS
3.3.2. Bootstrapping Server Function (BSF)
3.3.3. Network Application Function (NAF)
3.3.4. Terminal or User Equipment (UE)
3.3.5. Interfaces between entities
3.4. GAA Bootstrapping procedures
3.4.1. Detailed message flow for bootstrapping
3.5. Authentication Procedure with GAA
3.5.1. Detailed message flow for Authentication with GAA
3.6. Variations of GBA (Generic Bootstrapping Architecture)
3.6.1. GBA_ME
3.6.2. GBA_U
3.6.3. 2G GBA

4. AAA Protocols : RADIUS and DIAMETER
4.1. AAA (Authentication, Authorization and Accounting) Principles
4.2. RADIUS (Remote Authentication Dial-In User Service)
4.2.1. RADIUS Architecture

4.2.2. RADIUS Messages
4.2.3. Attribute Value Pair (AVP)
4.3. DIAMETER base protocol
4.3.1. DIAMETER versus RADIUS
4.3.2. Types of DIAMETER nodes
4.3.3. DIAMETER Messages
4.3.4. DIAMETER Transport and Routing
4.3.5. DIAMETER Capabilities Negotiation
4.3.6. DIAMETER Security Requirements
4.3.7. DIAMETER Applications for EPS and IMS Authentication
4.3.7.1. S6a : Interface for EPS client authentication
4.3.7.2. Cx : Interface for IMS client authentication
4.3.7.3. Zh : Interface for GBA client authentication

5. UMA, I-WLAN and femtocell Authentication Architectures
5.1. UMA Authentication
5.1.1. UMA Architecture
5.1.1.1. GANC
5.1.1.2. AAA Proxy/Server : Functionalities and Interfaces Wm, Wd, D', Gr'
5.1.2. UMA network attachment and authentication of an UMA client with SIM or USIM
5.1.3. Internet Key Exchange (IKEv2)
5.1.4. Extensible Authentication Protocol (EAP)
5.1.5. EAP-SIM and EAP-AKA
5.1.6. Message flow for UMA Authentication
5.1.7. IPSec tunnel between UE and GANC to secure the signaling traffic and user traffic

5.2. I-WLAN Authentication
5.2.1. I-WLAN Architecture
5.2.1.1. 3GPP AAA Server and Interfaces Dw, Wx, D', Gr', Wf, Wo, Wm, Wg, Wa
5.2.1.2. Wireless Access Gateway (WAG)
5.2.1.3. Packet Data Gateway (PDG)
5.2.2. I-WLAN Network Attachment
5.2.3. I-WLAN Authentication
5.2.4. EAP-SIM and EAP-AKA
5.2.5. Message flow for I-WLAN Authentication

5.3. Femtocell Authentication
5.3.1. femtocell Architecture
5.3.1.1. 3GPP AAA Server
5.3.1.2. Home NodeB
5.3.1.3. HomeNodeB Gateway
5.3.2. Femtocell Network Attachment
5.3.3. Femtocell Authentication
5.3.4. EAP-AKA
5.3.5. Message flow for femtocell Authentication

6. IMS network registration and authentication procedure for an IMS client without ISIM
6.1. IMS identities : Private user identity, Public user identity, public service identity
6.2. NASS-IMS Bundled Authentication
6.2.1. NASS (Network Attachment Subsystem) Authentication

6.3. Message flow for SIP client registration with USIM module and without ISIM module
6.4. Message flow for SIP client registration with USIM module and with ISIM module

7. IPSec
7.1. IP security association
7.2. Security Association Database and Security Policy Database
7.3. Authentication
7.4. Confidentiality
7.5. AH header and ESP IPSec header
7.6. Transport mode and tunnel mode

8. SSL and TLS
8.1. SSL Messages
8.2. SSL Negotiation ("handshake")
8.3. SSL Communication ("record")
8.4. Certificates
8.4.1. Public Key Certificates
8.4.2. Certificate Authority
8.4.3. Certificate Hierarchy
8.4.4. Certificate Revocation Lists
8.5. SSL Usage: HTTPS

POLICY AND CHARGING CONTROL (PCC) IN 3G, LTE, AND IMS

Objectives : Understand the PCC (Policy and Charging control) principles, and architecture in the 3G, EPS (LTE/ePC) and IMS environment and illustrate PCC usage with scenarios
Attendance : Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Minimum knowledge on mobile packet switched networks (e.g., GPRS)
Duration : 1,5 days

By implementing policy control, network service providers can : (1) guarantee bandwidth for higher revenue services (2) allow market segmentation, (3) assure fair usage of the network, (4) stop or reduce service flows that degrade network performance, (5) guarantee optimum end-user experience, (6) ensure appropriate online or offline charging of the service flows based on user subscription data. QoS, gating and charging policies are configured in a centralized node called PCRF (Policy and Charging Rules Function) located between the service and transport domains. PCRF has access to the subscription data of the user which help adapting the usage of the transport resources by the service and the charging of the service flows of that user. Apart from policy control, charging control allows online and offline charging of authorized IP Flows. The objectives of this seminar are (1) present the PCC (Policy and Charging Control) principles, concepts, architecture and interfaces, (2) describe the PCC architecture for 3G, EPS (LTE) and IMS, (3) explain the DIAMETER protocol used by all PCC interfaces (4) illustrate usage scenarios of PCC.

1. PCC : Definition
   - 1.1. PCC principles
   - 1.2. PCC Domains
     - 1.2.1. Policy Control
       - 1.2.1.1. Bearer and service Binding
       - 1.2.1.2. QoS control
       - 1.2.1.3. Gating control
       - 1.2.1.4. Network-initiated bearer establishment
     - 1.2.2. Charging control
       - 1.2.2.1. Online charging
       - 1.2.2.2. Offline charging
   - 1.3. PCC in the mobile network
   - 1.4. PCC in the fixed network

2. 3G packet network architecture (i.e., GPRS) and PCC
   - 2.1. GPRS nodes
   - 2.2. PCRF in GPRS
   - 2.3. GPRS charging
     - 2.3.1. Service flow based charging
       - 2.3.1.1. Online charging
       - 2.3.1.2. Offline charging
   - 2.4. QoS control
     - 2.4.1. QoS and PDP context
     - 2.4.2. PDP context establishment initiated by the UE
     - 2.4.3. PDP context establishment initiated by the network
     - 2.4.4. Qos control and Gating control in GPRS

3. EPS (LTE/ePC) architecture and PCC

   - 3.1. EPS nodes
   - 3.2. PCRF in evolved packet core (ePC)
   - 3.3. Service flow based charging in EPC
     - 3.3.1. Online charging
     - 3.3.2. Offline charging
   - 3.4. Deep Packet Inspection (EPS)
   - 3.5. EPS QoS control
     - 3.5.1. EPS QoS parameters: QCI, ARP, GBR, MBR, APN-AMBR, UE-AMBR
     - 3.5.2. EPS Bearer
       - 3.5.2.1. Default bearer
       - 3.5.2.2. Dedicated bearer
     - 3.5.3. Bearer establishment by the UE
     - 3.5.4. Bearer establishment by the network
     - 3.5.5. QoS control and Gating control in EPS

4. PCC Architecture
   - 4.1. PCRF
   - 4.2. AF (e.g., P-CSCF)
   - 4.3. PCEF (e.g., GGSN, PDN GW)
   - 4.4. BBERF (e.g., Serving GW, ePDG, AGW)
   - 4.5. SPR
   - 4.6. OCS
   - 4.7. OFCS
   - 4.8. ABMF
   - 4.9. RF

5. DIAMETER protocol and PCC Interfaces
   - 5.1. DIAMETER protocol
   - 5.2. Usage of the DRA (DIAMETER routing Agent) for DIAMETER message routing in the PCC context
   - 5.3. Interfaces
     - 5.3.1. Rx between PCRF and AF (e.g., P-CSCF)
     - 5.3.2. Gx between PCRF and PCEF (e.g., GGSN, PDN GW)
     - 5.3.3. Gxa between BBERF and PCRF
     - 5.3.4. Gxb between BBERF and PCRF
     - 5.3.5. Gxc between BBERF and PCRF
     - 5.3.6. S9 between visited PCRF and home PCRF
     - 5.3.7. Sp between PCRF and SPR (Subscription Profile Repository)
     - 5.3.8. Sy between PCRF and OCS
     - 5.3.9. Gy between PCEF (e.g., GGSN, PDN GW) and OCS
     - 5.3.10. Gz between PCEF (e.g., GGSN, PDN GW) and OFCS
     - 5.3.11. Study of call flows related to Rx, Gx and Gy interfaces

6. PCC Rules
   - 6.1. PCC rule definition
   - 6.2. PCC rule content
   - 6.3. Data related to the service flow description
   - 6.4. Data related to QoS description and Gating status
   - 6.5. Data related to service flow based charging
   - 6.6. Dynamic rules versus predefined rules
   - 6.7. Rules and DPI

7. PCC and IMS
   - 7.1. IMS architecture and relationship with PCC

7.2. IMS session establishment and PCC for :
  7.2.1. 3G+ access (GPRS) compliant with 3GPP R7
  7.2.2. EPS access
7.3. IMS session modification and PCC
7.4. IMS session release and PCC

8. PCC scenarios
   8.1. Fair use
   8.2. IMS/VoIP call control
   8.3. Freemium
   8.4. Anti bill shock
   8.5. Spped boost
   8.6. Parental control, etc.

9. Future of PCC

3G SERVICE ARCHITECTURES

Course objective : Understand 3G services and the associated service architectures
Pre-requisites : Minimum knowledge on mobile networks and services
Attendance: Telecommunication Engineers, Pre-sales engineers, sales engineers
Duration : 2 days

1. 3G Market Evolution

2. Visiotelephony
   2.1. Conversational Multimedia and 3G
   2.2. H.324M for mobile videotelephony
   2.3. 3G video call scenario
   2.4. Interworking between 3G videotelephony and IP telephony (SIP) with Gateways

3. Mobile broadband
   3.1. HSDPA, HSUPA, HSPA technologies
   3.2. Availability of compliant terminals and characteristics
   3.3. Migration of a 3G network (W-CDMA) to support HSDPA and HSUPA technologies
   3.4. Exemple of service offers related to mobile broadband

4. Convergent phone
   4.1. Different approaches to provide a convergent phone (fixed and mobile phone)
     4.1.1. Approach of the fixed service provider with a dual phone SIP (WIFI+ voice over IP) + GSM
     4.1.2. Approach of the mobile service provider with a GSM phone and homezone
     4.1.3. Approach of the mobile service provider with a UMA phone (WiFi + GSM)

5. Broadcast mobile TV
   5.1. MBMS (Multimedia Broadcast Multicast Service) approach
   5.2. DVB-H (Digital Video Broadcast Handheld) approach
     5.2.1. Relationship between the mobile service provider, the content provider, and the DVB-H transport network provider

6. MMS
   6.1. Evolution of the MMS service towards video MMS and the associated streaming
   6.2. MMS and fixed network

7. Location-based services
   7.1. Location-based services
   7.2. Location techniques
   7.3. Architecture for location-based services

8. Instant Messaging Service (IM)
   8.1. IM Architecture and Internet-based solutions
   8.2. Mobile service providers approaches to provide Instant messaging

9. IMS based services (IP Multimedia Subsystem)
   9.1. IMS service architecture
   9.2. Potential IMS-based mobile services for current mobile network architectures

10. Music on mobiles
    - 10.1. Ring-back tones
    - 10.2. Mobile ringtones
    - 10.3. Music download

11. Mobile advertisement

SHORT MESSAGE SERVICE ARCHITECTURE IN GSM/GPRS AND ANSI-41 NETWORKS

Course objective : Understand SMS architecture, protocol and services in GSM/GPRS and ANSI-41 networks
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Basic knowledge on mobile networks
Duration : 2 days

Short message service (SMS) is a globally accepted wireless service that enables the transmission of alphanumeric messages between mobile subscribers and external systems such as electronic mail, paging, and voice-mail systems. The goal of this course is to introduce the SMS architecture in both GSM/GPRS and ANSI-41 networks, explain the SMS protocols, how number portability applies to SMS service and how prepaid SMS operates. Moreover, relationship between MAP SMS protocols and TCAP component and transaction is highlighted.

1. GSM, GPRS, ANSI-41 network architectures and SMS procedure in these networks

2. SMS protocols
    - 2.1. MAP v1
    - 2.2.
    - 2.3. v2
    - 2.4. MAP v3
    - 2.5. SMPP
    - 2.6. SM : SM_SUBMIT, SM_SUBMIT_REPORT, SM_DELIVER, SM_DELIVER_REPORT, SM_COMMAND, SM_STATUS_REPORT
    - 2.7. ANSI-41 MAP

3. SMS service implementation
    - 3.1. Mobile Originated SMS implementation in GSM and GPRS networks (SMS-MO)
        - 3.1.1. MO_FORWARD_SHORT_MESSAGE_REQ and CNF
    - 3.2. Mobile Terminated SMS implementation in GSM and GPRS networks (SMS-MT)
        - 3.2.1. MT_FORWARD_SHORT_MESSAGE_REQ and CNF
        - 3.2.2. SEND_INFO_FOR_MO_SMS_REQ and CNF
        - 3.2.3. SEND_ROUTING_INFO_FOR_SM_REQ and CNF
        - 3.2.4. FORWARD_SHORT_MESSAGE_REQ and CNF
        - 3.2.5. READY_FOR_SM_REQ and CNF
        - 3.2.6. REPORT_SM_DELIVERY_STATUS_REQ and CNF
        - 3.2.7. ALERT_SERVICE_CENTER and CNF
        - 3.2.8. INFORM_SERVICE_CENTER_REQ
    - 3.3. Mobile Originated SMS implementation in ANSI-41 networks (SMS-MO)
        - 3.3.1. SMS_DELIVERY_POINT_TO_POINT REQ and CNF
        - 3.3.2. SMS_DELIVERY_BACKWARD REQ and CNF
    - 3.4. Mobile Terminated SMS implementation in ANSI-41 networks (SMS-MT)
        - 3.4.1. SMS_DELIVERY_POINT_TO_POINT REQ and CNF
        - 3.4.2. SMS_REQUEST REQ and CNF
        - 3.4.3. SMS_NOTIFICATION REQ and CNF
        - 3.4.4. SMS_DELIVERY_FORWARD REQ and CNF

3.5. Addressing of the destination network for the SMS-MT
  3.5.1. Addressing E212, E214, E164, MIN, MDN, MSID
  3.5.2. Global Title Translation (GTT) and GTT tables in GSM/GPRS and ANSI-41 networks

4. MAP dialog model at the application level

5. Relationship between MAP SMS, TCAP component and TCAP transaction

6. SMS CDRs

7. Number portability and SMS

8. CAMEL/CAP Phase3/Phase4 and Prepaid MO-SMS and MT-SMS in GSM/GPRS networks and Prepaid SMS in ANSI-41 networks

CAMEL AND PREPAID FOR GSM, GPRS, UMTS AND SMS

Course objective : Gain knowledge on the CAMEL architecture for the provision of value added services IN GSM, GPRS and UMTS with the focus on prepaid for voice calls, data session and messaging services.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, Pre-sales engineers
Duration : 2 days

12. The GSM, GPRS and UMTS R3, R4, R5 and R6 network architectures

13. The Intelligent network concept in mobile networks

14. The prepaid service features

15. CAMEL Phase 1
  15.1. Services handled by CAMEL Phase 1
  15.2. CAMEL Phase 1 Architecture
    15.2.1. CSE, gsmSCF
    15.2.2. gsmSSF
  15.3. CAMEL Phase 1 CSIs : O-CSI, T-CSI
  15.4. CAMEL Phase 1 call models
  15.5. CAP Phase 1 protocol : information flows and associated information elements
  15.6. Prepaid call scenarios with CAMEL Phase 1
    15.6.1. Outgoing voice call from the home network : home routed call
    15.6.2. Outgoing and incoming voice call from a visited network

16. CAMEL Phase 2
  16.1. Services handled by CAMEL Phase 2
  16.2. CAMEL Phase 2 Architecture
    16.2.1. CSE, gsmSCF
    16.2.2. gsmSSF
    16.2.3. gsmSRF
  16.3. CAMEL Phase 2 call models
  16.4. Improvements from CAMEL Phase 1
  16.5. CAMEL Phase 2 CSIs : O-CSI, T-CSI, USSD-CSI, SS-CSI
  16.6. CAP Phase 2 protocol : : information flows and associated information elements
  16.7. Prepaid call scenarios with CAMEL Phase 2
    16.7.1. Outgoing voice call from the home network
    16.7.2. Outgoing and incoming voice call from a visited network
  16.8. CAMEL Phase 2 and MAP
  16.9. CAMEL Phase 2 and USSD

17. CAMEL Phase 3
  17.1. Services handled by CAMEL Phase 3
  17.2. CAMEL Phase 3 Architecture
    17.2.1. CSE, gsmSCF
    17.2.2. gprsSSF
  17.3. CAMEL Phase 3 call models

17.4. Improvements from CAMEL Phase 2
17.5. CAMEL Phase 3 CSIs : O-CSI, T-CSI, VT-CSI, USSD-CSI, SS-CSI, GPRS-CSI, SMS-MO-CSI
17.6. CAP Phase 3 protocol : : information flows and associated information elements
17.7. Prepaid call scenarios with CAMEL Phase 3
17.7.1. PDP context establishment from the home network
17.7.2. PDP context establishment from the visited network
17.7.3. SMS transfer from the home and visited networks
17.8. Prepaid and volume based charging with CAMEL Phase 3
17.9. Other approaches for content based charging

18. CAMEL Phase 4
18.1. Services handled by CAMEL Phase 4
18.2. Multiparty for voice services : Leg, Call segment and Call association
18.3. CAMEL Phase 4 Architecture for UMTS R5
18.4. Improvements from CAMEL Phase 3
18.5. CAP Phase 4 protocol : information flows and associated information elements
Prepaid call scenarios with CAMEL Phase 4
18.5.1. Outgoing and incoming multimedia session from the home and visited networks

19. Relationships between CAMEL and OSA (Open Service Architecture)

20. Relationships between CAMEL and IMS (IP Multimedia Subsystem)

Teaching on Telecommunications

MOBILE CHARGING ARCHITECTURES

Mobile telecom service providers collects usage information of resources in the form of charging records. These records are then processed for the customer bill generation. The telecommunications operators traditionally provide an offline charging system where charging records are collected, correlated and forwarded to the billing system when the service is delivered to the customer. These operators also propose the prepaid service with minimum billing features. The new mobile telecommunications services are data services. They require a real time control of user credit with charging based on volume, content, event, session etc, with an online charging system to mitigate fraud and credit risks. Online charging allows simultaneous prepaid and postpaid sessions to be charged in real time. This feature is important for telecom operators to support multiple service deliveries simultaneously. The subscribers cannot make purchases that either exhaust the prepaid balance or exceed the credit limit. Through online charging, the operator can ensure that credit limits are enforced and resources are authorized on a per-transaction basis. Offline charging is still important. It is used for inter-operator charging and billing when there are interconnection or roaming agreements. The goal if this course is to present - the CAMEL architecture for prepaid voice and prepaid SMS - the GPRS charging architecture with volume based charging and service flow charging for both postpaid and prepaid users. - offline and online charging systems for all mobile services including IMS services

1. Mobile charging
1.1. Charging principles for mobile networks
1.2. charging types
1.2.1. Postpaid charging
1.2.2. Prepraid charging
1.2.3. Offline charging
1.2.4. Online charging
1.3. TAP files and clearing houses

2. GSM Prepaid : CAMEL Phase 2
2.1. Services handled by CAMEL Phase 2
2.2. CAMEL Phase 2 Architecture
2.3. Improvements from CAMEL Phase 1
2.4. CAP Phase 2 Protocol
2.5. Prepaid call sdenarios with CAMEL Phase 2
2.5.1. Outgoing call from home network
2.5.2. Outgoing and incoming calls from visiting network
2.6. CAMEL Phase 2 and USSD

3. Prepaid GSM, GPRS and SMS : CAMEL Phase 3
3.1. Services handled by CAMEL Phase 3
3.2. CAMEL Phase 3 Architecture
3.3. Improvements from CAMEL Phase 2
3.4. CAP Phase 3 protocol
3.5. Prepaid call scenarios with CAMEL Phase 3
3.5.1. Outgoing call from home network
3.5.2. Outgoing and incoming calls from visiting network
3.5.3. Prepaid PDP context establishment with CAMEM Phase 3
3.5.4. Prepaid SMS with CAMEL Phase 3

4. GPRS prepaid and postpaid charging
   - 4.1. Volume-based charging versus flow-based charging
   - 4.2. PCRF entity: Policy and Charging Rules Function
   - 4.3. Charging rules
   - 4.4. Diameter for the charging interfaces
   - 4.5. Gx interface between GGSN/PDN GW and PCRF
   - 4.6. Rx interfaces between PCRF and AF (e.g., P-CSCF)
   - 4.7. Gy interface between GGSN/PDN GW and OCS (Online Charging System)
   - 4.8. Gz Interface between GGSN and Offline Charging System
   - 4.9. Examples of charging scenarios

5. IMS offline charging
   - 5.1. Offline charging architecture
   - 5.2. Interface Rf
   - 5.3. CDRs : P-CSCF-CDR, I-CSCF-CDR, S-CSCF-CDR, MGCF-CDR, BGCF-CDR, AS-CDR, MRFC-CDR
   - 5.4. IMS correlation
   - 5.5. IMS offline charging scenario without interconnexion
   - 5.6. IMS offline charging scenario with interconnexion
   - 5.7. IMS offline charging scenarios without roaming
   - 5.8. IMS offline charging scenarios with roaming
   - 5.9. Mediation function

6. IMS online charging
   - 6.1. OCS architecture
   - 6.2. Ro, Re, Rc interfaces
   - 6.3. Rating function
   - 6.4. Account Balance Management function
   - 6.5. IMS-GW function
   - 6.6. Online charging scnearios
     - 6.6.1. Immediate Event Charging
     - 6.6.2. Event Charging with Unit Reservation
     - 6.6.3. Session Charging with Unit Reservation

MAP SIGNALING : MOBILE APPLICATION PART

Course objective : Gain knowledge on the MAP protocol with its application to mobile networks such as GSM, GPRS and UMTS.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Duration : 2 days

Mobile application part (MAP) is the protocol that is used to allow the GSM network nodes within the Network Switching Subsystem (NSS) to communicate with each other to provide services, such as roaming capability, text messaging (SMS), and subscriber authentication. MAP provides an application layer on which to build the services that support a GSM network.
The goal of this course is to present :

- Telephony signaling and the positioning of MAP
- MAP protocol structure
- Use of the MAP protocol for the following procedures :
  - Mobility management
  - Call control
  - SMS transfer and reception
  - Location based services
  - Establishment of an network-initiated PDP context in the GPRS network
  - Invocation of supplementary and USSD services

1. Introduction to mobile networks : GSM, GPRS, EDGE and UMTS

2. Signaling in mobile networks
   - 2.1. Signaling System Number 7
     - 2.1.1. SS7 network Architecture in the context of mobile network
     - 2.1.2. Dimensioning of an SS7 network
     - 2.1.3. Interworking between national and international SS7 networks
     - 2.1.4. SS7 operation mode
       - 2.1.4.1. Associated mode
       - 2.1.4.2. Quasi-associated mode
       - 2.1.4.3. Non-associated mode
     - 2.1.5. Information transfer in the SS7 network
   - 2.2. SS7 protocol stack
     - 2.2.1. MTP
     - 2.2.2. SCCP
     - 2.2.3. TCAP
     - 2.2.4. SS7 Application
       - 2.2.4.1. BSSAP/RANAP/RNSAP
       - 2.2.4.2. ISUP : ISDN User Part
       - 2.2.4.3. INAP : Intelligent Network Application Part
       - 2.2.4.4. CAP : CAMEL Application Part
       - 2.2.4.5. MAP : Mobile Application Part

3. Mobility services in mobile networks and MAP
   - 3.1. Mobility management
     - 3.1.1. Attachment to the mobile network

3.1.2. Location update
3.1.3. Detachment from the mobile network
3.2. Authentication of the mobile station
3.3. Identities of the mobile station
3.4. IMEI management
3.5. Paging
3.6. Handover
3.7. Subscription data management of the mobile user

4. Call control in mobile networks and relationship with MAP
4.1. Mobile to Fixed call establishment
4.2. Fixed to Mobile call establishment
4.3. Mobile to Mobile call establishment
4.4. Incoming call establishment for a destination currently in a visited network
4.5. Invocation of supplementary services
4.6. Invocation of USSD services

5. Short message service and MAP
5.1. SMS service architecture
5.2. SMS transfer
5.3. SMS Reception

6. Location services
6.1. Architecture of the location-based services
6.2. Location techniques
6.3. Location services

7. Signaling transport evolution over IP : SIGTRAN
7.1. SIGTRAN architecture
7.2. New SCTP over IP transport
7.3. SUA, M3UA, M2UA/M2PA

CELLULAR NETWORK PLANNING

Attendance: Cellular network planning Engineers, Telecommunication Engineers, Telecommunication Consultants
Prerequisites: Minimum knowledge on cellular systems
Duration: 3 or 4 days

The objective of this course is to give a detailed presentation of the planning process of a cellular network. This course will enable the participants to master the planning stages of a cellular network : Definition of quality of service objectives, equipment dimensioning, radio planning, network subsystem planning, etc. A example of radio planning tool will illustrate the presented concepts. Traffic and mobility models are also introduced for the dimensioning od data transmission services.

1. Propagation in mobile radio environment
1.1 Basic mechanisms of propagation in mobile radio environment
1.2 Large scale propagation models
1.3 Calibration of a propagation model
1.4 Antenna basic elements used in cellular networks

2. Cellular concept. Cellular system architecture. Introduction to GSM network
2.1 Architecture and functions of a cellular network : GSM example
2.2 GSM Logical Channels

3. Cellular network dimensioning
3.1 Dimensioning process : Entry parameters, Dimensioning functions (Erlang formulas), Quality of Service constraints,
3.2 Traffic and mobility models
3.3 Application to the dimensioning of the GSM radio interface (Base station subsystem)
3.4 Application to the dimensioning of the GSM network subsystem
3.5 Increasing the capacity of a cellular network

4. Radio planning of a 2nd generation mobile network.

5. Introduction to WCDMA network planning
5.1 Introduction to the UMTS radio interface
5.2 Planning of the CDMA radio interface

6. Planning of the Network Subsystem. Dimensioning of the services and of data transmission
6.1 Planning of location areas
6.2 Optimization of the PSTN architecture ; location of concentrators and of sites
6.3 Traffic and mobility models for data transmission
6.4 Tools for network dimensioning : Application to GPRS and to UMTS

OPERATIONS, MAINTENANCE AND OPTIMIZATION OF CELLULAR NETWORKS

Attendance: Cellular network planning and operations Engineers, Telecommunication Engineers, Telecommunication Consultants
Prerequisites: Minimum knowledge on cellular systems
Duration: 3 or 4 days

The goal of this course is to give a detailed presentation of the operations and maintenance process of a cellular network. This course will enable participants to master how to optimize a cellular system : Definition of performance objectives, quality of service monitoring, parameterization of the operations and maintenance procedures. An example of a radio measure chain illustrates the presented concepts.

1. Introduction to the different components of a cellular network
   - 1.1. Cellular system architecture and quality indicators
   - 1.2. Cellular concept : reuse patterns
   - 1.3. Propagation in mobile radio environments : Propagation models and field measures
   - 1.4. GSM network architecture

2. Parameterization procedures of a cellular system
   - 2.1. Handover and cell selection/reselection
   - 2.2. Call management
   - 2.3. Location management, Location Areas and Routing Areas

3. Cellular network deployment
   - 3.1. Process of acquisition / negotiation of sites
   - 3.2. Radio site installation
   - 3.3. Commissioning and radio site integration
   - 3.4. Validation

4. Cellular system optimization
   - 4.1. Parameters to optimize
   - 4.2. Optimization methods
   - 4.3. Performance indicators
   - 4.4. Measurement tools

5. Operations and monitoring of the quality of a GSM cellular system
   - 5.1. Measures to consider
   - 5.2. Extraction and analysis of OMC counters
   - 5.3. Performance indicators
   - 5.4. Identification of quality problems and solutions(interference, blocking ratio, etc)

6. Organization of operations and maintenance of a GSM network.
   - 6.1. Operations and Maintenance services
   - 6.2. Centralized / Decentralized Organization
   - 6.3. Interaction between Planning/optimization and Operations and maintenance staff

Teaching on Telecommunications

WIMAX

Course objective : Understand the principles, the architecture and the services of WiMAX
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Duration : 3 days

Since many years, after the very slow take-off of third generation mobile services, UMTS at first, many vendors propose alternative systems, some which are proprietary (cf. Flash-OFDM of Flarion), others which are standardized or in a standardization process, such as WiMAX (802.16x). The present training session objective is to introduce WiMAX technology basics as well as the state of art in terms of available services and products and ongoing experiments and operational networks. Technical aspects (implementation and operation constraints, transmission chain …) will constitute the centre of the seminar which will focus on showing the usage of WiMAX within an operator at the practical level, and will identify the introduction constraints of this technology in an existing network, especially mobile

1. WiMAX: the standard and mobile radio environment constraints
   - 1.1. Introduction: radio broadband systems development context
   - 1.2. Mobile radio environment constraints and classical solutions (in TDMA and CDMA systems)
   - 1.3. 802.16 and WiMAX standards

2. WiMAX transmission chain
   - 2.1. OFDM and OFDMA in WiMAX
   - 2.2. OFDMA frame structure
   - 2.3. Sub-carriers allocation
   - 2.4. OFDMA handover
   - 2.5. Channel coding, MIMO, adaptive modulation schemes and link adaptation
   - 2.6. HARQ
   - 2.7. Power control

3. MAC layer and WiMAX services
   - 3.1. MAC layer structure and MAC PDU formats
   - 3.2. Scheduling and priority management
   - 3.3. Idle mode process (cell selection, paging, location update)
   - 3.4. Services classes
   - 3.5. Handover procedures at the MAC level
   - 3.6. Multicast and broadcast services

4. WiMAX planning and network design
   - 4.1. Required components : Cartography and Network components
   - 4.2. The Base Stations network : Optimize the base station locations
   - 4.3. WiMAX coverage : 802.16 Propagation, Coverage calculation
   - 4.4. WiMAX Capacity analysis : Bit rate / modulation map, The WiMAX CPE
   - 4.5. WiMAX Spectrum analysis
   - 4.6. Mobility analysis : Delay spread, Hand-over

ROAMING IN 2G, 3G AND 4G MOBILE NETWORKS

Objectives : Understand the voice, SMS, data and CAMEL roaming azrchitectures, and underlying mobility management, call control, bearer control procedures
Attendance : Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Minimum knowledge on GSM and GPRS networks
Duration : 4 days

Mobility is the key to the success of wireless networks. Roaming has extended the definition of mobility beyond the technology, network, and country boundaries. Isn't it fascinating to make or receive calls anywhere in the world using the same phone and identity? International roaming is already proven to be one of the most popular features of today's wireless network. With the advent and widespread deployment of GSM technology, the mobile users have flexibility to use voice, SMS, USSD and CAMEL services in more than 700 networks. Inter-standard roaming has also made significant progress in recent years. Roaming capability in GPRS and 3G networks is already implemented.
This course first introduces the inter-operator architecture to perform roaming agreements between service providers, particulary, the international SS7, voice, IP and Diameter networks. Then it presents use of voice, SMS, CAMEL and GPRS services in 2G and 3G roaming situations.
Migrating to 4G enables a user to access to data services and get it voice services. Two alternatives exist to provide voice service to a 4G user : Circuit switched fallback (CSFB) and VoLTE (Voice over LTE). 4G, CSFB and VoLTE architectures are explained in roaming situations. Therefore, 4G introduction requires three new roaming agreements ; LTE, CSFB and VoLTE.
The course also introduces the inter-operator invoicing procedure with the role of clearinghouses.

1. Inter-Operator architectures for roaming
   - 1.1. International SS7 network
   - 1.2. International voice network
   - 1.3. International IP network : GRX and IPX
   - 1.4. International Diameter network

2. SS7 and Roaming
   - 2.1. SS7 network of a mobile operator
   - 2.2. International SS7 network
   - 2.3. MTP3 layer: addressing via point codes, routing and congestion control
   - 2.4. SCCP layer: adressing via PC+SSN and Global Title (GT)
     - 2.4.1. GT E.214 and GT E.164
     - 2.4.2. Global Title Translation (GTT)
   - 2.5. MAP related mobility management message routing (e.g., MAP SAI) for a roaming user
   - 2.6. MAP related SMS message (e.g., MAP MO Forward SM) for a roaming user
   - 2.7. SS7 evolution towards SIGTRAN

3. GSM and Roaming
   - 3.1. Structure of the mobile voice network
   - 3.2. Structure of an R4 network which emulates the mobile voice network with NGN concepts
   - 3.3. GSM attachment for a roaming user

   - 3.4. MAP protocol for mobility management
   - 3.5. Momobility management for a roaming user
   - 3.6. Outgoing call establishment for a roaming user
   - 3.7. Incoming call establishment for a roaming user
   - 3.8. Supplementary telephony services in roaming situation
   - 3.9. USSD services in roaming situation

4. SMS and Roaming
   - 4.1. SMS Architecture
   - 4.2. MAP Messages for SMS service
   - 4.3. Delivery of outgoing and incoming SMS for a roaming user
   - 4.4. GSMA IR24 for test specification

5. CAMEL and Roaming
   - 5.1. CAMEL Phase 2 architecture for voice
     - 5.1.1. Functional entities : gsmSCF, gsmSSF, gsmSRF
     - 5.1.2. CAMEL basic call state mobile: O-BCSM et T-BCSM
     - 5.1.3. CAMEL Subscription Information (CSI) : O-CSI, T-CSI, SS-CSI
   - 5.2. CAP Phase 2 Protocole
   - 5.3. CAMEL Phase 3 Architecture for SMS
   - 5.4. Important CAMEL Services : prepaid, Access to voice mailbox from visited network, VPN
   - 5.5. Outgoing prepaid call for a roaming user with CAMEL Phase 2
   - 5.6. Incoming prepaid call for a roaming user with CAMEL Phase 2
   - 5.7. GSMA IR32 for test specification

6. GPRS and Roaming
   - 6.1. GPRS Architecture
   - 6.2. APN principle and APN resolution
   - 6.3. MAP protocol for GPRS mobility management
   - 6.4. GPRS Attachment for a roaming user
   - 6.5. PDP context establishment for a roaming user
   - 6.6. Anti-bill shock for a roaming user consumming mobile data
   - 6.7. GSMA IR.33 and IR.35 pour la spécification des tests

7. 3G and Roaming
   - 7.1. 3G Authentication versus 2G authentication
     - 7.1.1. 2G Triplets
     - 7.1.2. 3G Quintets
       - 7.1.2.1. AKA algorithm
       - 7.1.2.2. Mutual authentication, cyphering and integrity protection
   - 7.2. Visiophony
     - 7.2.1. Outgoing video call fro a roaming user
     - 7.2.2. Incoming video call for a roaming user
   - 7.3. GSMA IR.50 for 3G roaming

8. Invoicing in roaming situation
   - 8.1. TAP : Transferred Accounted Procedures
   - 8.2. TAP-in and TAP-out
   - 8.3. Format of data records for voice, SMS, CAMEL and GPRS services
   - 8.4. Role of clearinghouses

9. Futur of roaming with LTE (1,5 days)
   - 9.1. Data Roaming

9.2. Voice Roaming : CS FallBack and VoLTE
9.3. DIAMETER signaling architecture
  9.3.1. DIAMETER protocol
  9.3.2. DIAMETER-based S6 and S9 interfaces in romaing situations
  9.3.3. DIAMETER signaling agent (DRF) withing a mobile service provider domaing
  9.3.4. DIAMETER DRF for the inter-operator DIAMETER signaling routing
  9.3.5. Inter-operator DIAMETER signaling routing
9.4. Inter-operator IP network : IPX
9.5. LTE user attachment in roaming situation
9.6. LTE mobility management for a roaming user
9.7. Bearer establidhment for a roaming user
  9.7.1. Home routed traffic method
  9.7.2. Local breackout method
9.8. LTE and voice in romaing
  9.8.1. Circuit Switched Fallback (CSFB)
  9.8.2. Voix over IP over LTE (VoLTE)

Teaching on Telecommunications

LTE RADIO ENGINEERING

Objectives : Understand LTE procedures of mobility management, of session management, of traffic operations and of handover.
Attendance : Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Good understanding of mobile communications and 3G architectures
Duration : 3 days

Long Term Evolution (LTE) is a radio technology based on OFDM and MIMO technologies. LTE provides much higher data rates (100 Mbit/s downlink and 50 Mbit/s uplink) to users while reducing cost-per-bit for service providers. This course also describes the LTE architecture and moves on to OFDM and MIMO. The course also covers the downlink and uplink frame structure, OFDM operations at the physical layer, and resource management and scheduling considerations at the MAC layer. It describes mobility management, session management, traffic operations and handover.

1. 3GPP standardization and HSPA Evolution towards LTE

2. LTE Architecture:
  2.1. IP and the new radio access protocols
  2.2. The layered model
  2.3. E-Node B functions
  2.4. E-UTRAN Interfaces
  2.5. S1 Interface and S1 Flex
  2.6. X2 Interface
  2.7. User Plane and Control Plane

3. Multicast-Broadcast and E-MBMS

4. The Physical Layer (E-UTRA) :
  4.1. OFDM, OFDMA, SC-FDMA
  4.2. TDD Frame
  4.3. MIMO
  4.4. Logical and Physical Channels
  4.5. UL channels : PUSCH and PUCCH
  4.6. UL and DL transmission

5. MAC Layer:
  5.1. MAC Frames
  5.2. ARQ and Hybrid ARQ
  5.3. Uplink and downlink scheduling
  5.4. Quality of service
  5.5. La voie balise
  5.6. RLC E-UTRAN protocol layer
  5.7. RRC E-UTRAN protocol layer
  5.8. PDCP E-UTRAN protocol layer
  5.9. NAS (Non Access Stratum) Protocols

6. Network procedures:
   6.1. Network attachment
   6.2. Broadcast of system information
   6.3. Detachment
   6.4. Session establishment
   6.5. Security in LTE
   6.6. Data transmission

7. Mobility management
   7.1. LTE mobility states
   7.2. Cell selection/reselection principles
   7.3. Terminal location management
   7.4. Tracking area update
   7.5. Paging
   7.6. Intra-E-UTRAN mobility management with X2 interface
   7.7. Intra-E-UTRAN mobility management without X2 interface
   7.8. Intra-E-UTRAN mobility management with EPC relocation
   7.9. Mobility management between 2G/3G packet and E-UTRAN

8. Radio engineering elements
   8.1. LTE in 5 MHz and and 20 MHz spectrum allocation
   8.2. Traffic and mobility patterns
   8.3. LTE planning and dimensioning
   8.4. Case studies

RICH COMMUNICATION SUITE

Objectives : Gain knowledge on the RCS service architectures, service enablers and convergence of RCS with VoLTE/ViLTE (RCS-5).
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, Information System Architects
Pre-requisites : Knowledge on IMS network and service architectures
Duration : 2 days

Rich Communication Services (RCS) is backed by the GSM Association and offers subscribers an innovative set of features that enhance the capabilities of SMS and MMS technologies. Subscribers can conduct individual and group chat sessions and exchange images or videos during voice calls or chats. Messaging sessions are effortlessly launched from the address book, which contains traditional contact information as well as enhanced information, including communication capabilities like chat, video/image share, and file transfer. With RCS, operators can combat increasingly popular “over-the-top” (OTT) services like Skype and Facebook Messenger.
RCS has the significant advantage of working across networks and devices, unlike siloed OTT services that typically can be used only by those subscribers who have downloaded the relevant app to their device.
For operators with an IMS core, RCS devices connect via the appropriate access network, be it Wi-Fi, LTE, 3G. The device must then register and authenticate prior to accessing the RCS Messaging Server. Authentication, registration and SIP routing are all handled by different components of the IMS core. Once a device is registered, the IMS core routes all RCS messages to the RCS Messaging Server and other IMS networks.
The current set of services specified by GSMA in RCS 5.3 blends all services from RCS-e 1.2, and most of the functionality from RCS Release 1-4, as well as extending the basis with new services such as IP Voice/Video Calling. RCS 5.3 functionality complements VoLTE (Voice over LTE) and ViLTE (Video over LTE) encompassing a set of advanced communication services based on IMS.
The goal of this course is to present the RCS Service, describe the RCS release functionality and focus on RCS-e and RCS 5.3 services, call flows, roaming and interworking considerations.

1. RCS basics
   1.1. Why RCS and what is RCS?
   1.2. RCS principles
   1.3. RCS simplified architecture
   1.4. Overview of RCS Release functionality
      1.4.1. RCS Release 1 and its functionalities
      1.4.2. RCS Release 2 and its functionalities
      1.4.3. RCS Release 3 and its functionalities
      1.4.4. RCS Release 4 and its functionalities
      1.4.5. RCS-e and its functionalities
      1.4.6. RCS Release 5 and its functionalities
   1.5. RCS versus Joyn
      1.5.1. RCS-e versus Joyn Hot Fixes
      1.5.2. RCS 5 versus Joyn Blackbird Drop
      1.5.3. RCS 5.3 versus Joyn Crane
   1.6. RCS client manufacturers

2. RCS-e
   2.1. RCS-e principles and architecture
   2.2. RCS Service Configuration
      2.2.1. IMS registration related configuration parameters
      2.2.2. RCS-e client configuration parameters
   2.3. Registration process
      2.3.1. RCS identities
      2.3.2. First time registration and discovery of contacts who are also RCS-e users
      2.3.3. Re-registration
      2.3.4. Deregistration
      2.3.5. Authentication methods during registration
         2.3.5.1. SSO/GIBA
         2.3.5.2. IMS Authentication and Key Agreement (AKA) authentication
         2.3.5.3. Digest (user/password authentication)
   2.4. Capability discovery to understand the subset of RCS-e services available to communicate with other contacts
      2.4.1. RCS-e capabilities : chat, file transfer, image share, video share
      2.4.2. Capabilities discovery via SIP OPTIONS message
      2.4.3. Capability discovery via presence
      2.4.4. Capability polling via SIP OPTIONS message
   2.5. RCS-e protocols : SIP, RTP, MSRP
   2.6. APN and roaming considerations for RCS-e
   2.7. RCS-e Service and Feature Tag Value
   2.8. Call flows of RCS-e services
      2.8.1. Instant messaging (IM)/Chat service
         2.8.1.1. 1-to-1 chat : Initiation and termination
         2.8.1.2. Group chat : initiation and termination, adding a participant, removing a participant, message exchange,
      2.8.2. RCS-e during a call
         2.8.2.1. Capabilities exchange during a call
         2.8.2.2. Video share during a call
         2.8.2.3. Image share during a call
      2.8.3. File transfer

3. RCS 5
   3.1. RCS 5 architecture
   3.2. RCS 5 protocols : SIP, RTP, MSRP, HTTP, IMAP, SUPL
   3.3. Call flows of RCS-e services
      3.3.1. Standalone messaging
      3.3.2. 1-to-1 chat
      3.3.3. Group chat
      3.3.4. File transfer
      3.3.5. Content sharing and video share during a call
      3.3.6. Content share and video share without a call
      3.3.7. Social presence information
      3.3.8. IP voice call
      3.3.9. IP video call
      3.3.10. Geolocation
   3.4. RCS-5 Interworking Guidelines (IR 90)
   3.5. APN and Roaming considerations for RCS 5
      3.5.1. Internet APN for RCS 5
      3.5.2. IMS APN for RCS 5
   3.6. Convergence of RCS 5 and VoLTE/ViLTE

WIFI ACCESS TO EPC ARCHITECTURES AND ASSOCIATED VOWIFI/WIFI CALLING SERVICE

Objectives : Understand the architectures and interfaces of WiFi access to ePC and the detailed procedures related to authentication, mobility management, session management and QoS management and how the VoWiFi service is offered
Attendance : Telecommunication Engineers, Network Architects, Telecommunications consultants
Pre-requisites : Knowledge of ePC and VoLTE
Duration : 2 days

The objective of this course is to present the interworking between WLAN (non-3GPP access) and the Evolved Packet Core (ePC). One of the applications foreseen is to offload data traffic from 4G to Wi-Fi. This scenario is called Carrier WiFi. Offload enables to transfer part of the mobile data traffic from mobile users to a fixed broadband network via WiFi cells. This solution enables strong mobile network authentication when accessing the ePC via WiFi, as well as data session mobility between WiFi and LTE and vice versa. Furthermore, the user may access to all his mobile data services. Another important scenario is considered, called VoWiFi or WiFi calling. The client uses WiFi to directly access to his Internet services and WiFi calling to access to his telephony services including, voice, videotelephony, and SMS. The user is connected to ePC via WiFi for WiFi calling and accesses to the IMS architecture. Furthermore handover between VoLTE and VoWiFi is ensured to provide voice call continuity. WiFi calling enables the user access to his telephony services via WiFi when the mobile radio coverage is absent or does not offer a high signal strength. In this seminar, we discuss IP connectivity using non-3GPP access (WLAN to the ePC). We examine architectures for Trusted & Non-Trusted WLAN access and Roaming & Non-Roaming scenarios, mobility management, session management, QoS management, and underlying charging issues. The VoWiFi service is described as well as all the associated handover procedures between VoLTE and VoWiFi and between VoWiFi and VoLTE and DR-VCC which concerns handover between VoWiFi and circuit switching and vice versa.

1. Introduction
   1.1. Why WLAN Interworking (I-WLAN) ?
   1.2. 3GPP path for Evolution of I-WLAN
   1.3. Offload Scenarios
      1.3.1. ANDSF Function (Access Network Discovery and Selection Function) for the discovery of offload methods to apply to IP flows
      1.3.2. MAPCON Method : Multiple Access PDN Connectivity
      1.3.3. IFOM Method : IP Flow Mobility
      1.3.4. NSWO Method : Non-seamless WLAN offload)
      1.3.5. WiFi Calling scenario
      1.3.6. Carrier WiFi scenario
   1.4. Mobility Management, Session Management and Security Handling in EPS with non 3GPP access as WLAN/WiFi
   1.5. Non-Trusted WLAN access scenario
   1.6. Trusted WLAN access scenario

2. WLAN Access to ePC
   2.1. Access Network Selection
   2.2. IP Address Allocation and Mobility handling
   2.3. Charging and QoS handling
   2.4. Non-Trusted WLAN Access:

2.4.1. Architecture and Interfaces
2.4.2. ePDG (SWn)
2.4.3. IP-Mobility Support (S2b and S2c)
2.4.4. Security Handling (SWn, SWm, SWx)
2.4.5. Roaming scenario and related architecture
2.5. Trusted WLAN Access:
2.5.1. Architecture and Interfaces
2.5.2. IP-Mobility Handling (S2a and S2c)
2.5.3. Subscriber Data and 3GPP AAA Server (STa and SWx)
2.5.4. Roaming scenario and related architecture

3. Authentication, Authorization and Security
3.1. Security in WLAN vs 3GPP Networks
3.2. HSS vs 3GPP AAA-Server (SWx)
3.3. Identities used for security, NAI, USIM info, etc
3.4. 3GPP EAP-AKA
3.5. IKEv2
3.6. Authentication And Authorization procedures

4. SWx interface between 3GPP AAA Server and HSS
4.1. Authentication Procedure
4.1.1. Multimedia-Authentication-Request/Answer (MAR/MAA)
4.2. Location Update Procedure
4.2.1. Server-Assignment-Request/Answer (SAR/SAA)
4.2.2. Registration-Termination-Request/Answer (RTR/RTA)
4.3. Data subscription handling Procedure
4.3.1. Push-Profile-Request/Answer (PPR/PPA)
4.4. Fault management Procedure
4.4.1. Use of PPR/PPA et SAR/SAA

5. SWm interface between ePDG and 3GPP AAA Server
5.1. Authentication/Authorization Procedure
5.1.1. Diameter EAP Request.Answer (DER/DEA)
5.1.2. Authenicate Authorize Request/Answer (AAR/AAA)
5.1.3. Re-Authorize Request/Answer (RAR/RAA)
5.2. Session Termination Procedure
5.2.1. Session Termination Request/Answer (STR/STA)
5.2.2. Abort Session Request/Answer (ASR/ASA)

6. STa interface between non-3GPP access network NAS and 3GPP AAA server
6.1. Authentication/Authorization Procedure
6.1.1. Diameter EAP Request.Answer (DER/DEA)
6.1.2. Authenicate Authorize Request/Answer (AAR/AAA)
6.1.3. Re-Authorize Request/Answer (RAR/RAA)
6.2. Session Termination Procedure
6.2.1. Session Termination Request/Answer (STR/STA)
6.2.2. Abort Session Request/Answer (ASR/ASA)

7. S6b interface between PDN GW and 3GPP AAA server
7.1. Authentication/Authorization Procedure
7.1.1. Diameter EAP Request.Answer (DER/DEA)
7.1.2. Authenicate Authorize Request/Answer (AAR/AAA)
7.1.3. Re-Authorize Request/Answer (RAR/RAA)

7.2. Session Termination Procedure
7.2.1. Session Termination Request/Answer (STR/STA)
7.2.2. Abort Session Request/Answer (ASR/ASA)

8. S2a and S2b
8.1. GTP variant
8.1.1. GTPv2-C for the control plane
8.1.2. GTPv1-U for the user plane
8.2. PMIP/GRE variant
8.3. Differences between the two variants and the impacts on the architecture of non 3GPP access to ePC

9. VoWiFi
9.1. VoWiFi Architecture : GSMA IR 51
9.2. Similarities and differences between VoLTE and VoWiFi
9.3. VoWiFi registration
9.4. VoWiFi session establishment
9.5. VoWiFi service invocation
9.6. Policy control during VoWiFi session establishment/modification/release
9.7. VoWiFi roaming
9.8. VoWiFi emergency session
9.9. VoLTE session mobility between VoLTE and VoWiFi and vice versa
9.10. VoLTE session mobility between VoWiFi and mobile vircuit switching and vice versa : DR-VCC

INTRODUCTION TO 5G

Objectives : Understand the evolutions of mobile networks towards 5G, understand 5G from radio, network and service perspectives, present 5G standardization status.
Attendance : Mobile telecommunication engineers, Mobile network architects, Mobile technical consultants
Pre-requisites : Knowledge on mobile networks
Duration : 2 days

3G and 4G technologies have mainly focused on the mobile broadband use case, providing enhanced system capacity and offering higher data rates. This focus will clearly continue in the future 5G era, with capacity and data rates being driven by services such as video. But the future also will be much more than just enhancements to the «conventional» mobile broadband use case. Future wireless networks should offer wireless access to anyone and anything. Thus, in the future, wireless access will go beyond humans and expand to serve any entity that may benefit from being connected. This vision is called «the Internet of Things (IoT)». This changes the nature of the network since 5G will absorb requests from objects which require low bitrates and low energy consumption. The goal of this seminar is to introduce the 5G ecosystem, particulary its access network, its core network, its services and related 5G standardization status.

1. Introduction
   1.1. 2G, 3G, 4G standards
   1.2. 5G with 50 Gbps and Internet of Things as target
   1.3. Current 5G initiatives

2. 5G from radio perspective:
   2.1. OFDM Evolutions : Filter OFDM : FBMC, BFDM, UFMC, GFDM
   2.2. MIMO Evolutions : Massive MIMO, 3D-MIMO
   2.3. Spectrum Evolution : Wideband beyond 10 GHz
   2.4. FDD/TDD Evolution : Dynamic TDD, Single Channel FDD
   2.5. Advanced CA (Carrier Aggregation) schema
   2.6. DMA Evolution : NOMA (Non Orthogonal DMA)
   2.7. M2M/IoT Evolution : LTE-M, D2D, UNB and OSSS solutions

3. 5G from network perspective :
   3.1. Virtualized architectures
   3.2. Mesh architectures
   3.3. SDN architectures
   3.4. Smart and Cloud RAN

4. 5G from service perspective :
   4.1. Video and Audio services evolutions
   4.2. M2M market (Machine-to-Machine)
   4.3. IoT development (Internet of Things)
   4.4. Mobile CDN (Content Delivery Network)

5. 5G Standardization :
   5.1. Standardization players
   5.2. Standardisation planning

5. Conclusion

Teaching on Telecommunications

NETWORK AND SERVICE VIRTUALIZATION, SDN AND NFV

Course objectives : Understand the virtualization of the telecommunications network and service infrastructure. Understand the concept of Network Function Virtualization (NFV). Understand the concept of Software Defined Network (SDN) and programmable network and their application for the control of virtualized network infrastructures.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : No specific knowledge
Duration : 2 days
Maximum Number of participants : 12

PROGRAM

The SDN (Software Defined Networks) and NFV (Network Virtualization Functions) technologies should revolutionize network architectures of service providers and enable the deployment of new services much faster and with significantly reduced costs. They will completely change the ecosystem of the Telecommunications infrastructures in the coming years.
What is it about? Virtualization of Network Functions (NFV in English) is an initiative to virtualize the network services that are now being carried out by proprietary, dedicated hardware. Indeed, it decouples network functions from dedicated hardware devices and allows network services that are now being carried out by routers, firewalls, load balancers and other dedicated hardware devices to be hosted on virtual machines (VMs). Once the network functions are under the control of a hypervisor, the services that once require dedicated hardware can be performed on standard x86 servers. This capability is important because it means that network administrators will no longer need to purchase dedicated hardware devices in order to build a service chain.
In parallel, IP routing and switching material architecture evolve, following the ONF standardization (Open Networking Foundation) called SDN (Software Defined Networking), to separate the IP transport layer and the IP routing control layer, with the specification of a "open" protocol called OpenFlow, allowing the control layer to interoperate with hardwares of different vendors. SDN is complementary to the NFV technology and allows to put in place purely software solutions making possible the control of an IP network of an enterprise or of a service provider.
The objective of this training is to describe network and service virtualization, the new concept to achieve virtualization in the telecommunication world, such as SDN and NFV with their key components, and explain the strategies of the main players in the world of telecommunication networks. Moreover, the Netflow protocol used in the SDN architecture is presented.

1. Virtualization
   1.1. A definition
   1.2. What can be virtualized ?
   1.3. Generic virtualization architecture
   1.4. Virtualization Advantages
   1.5. Virtualization constraints
   1.6. Network virtualization : VLAN and VXLAN

1.6.1. Architecture of VLAN and VXLAN
1.6.2. Modes of operation

2. SDN : Software Defined Network
   2.1. Why SDN ?
   2.2. SDN Architecture
      2.2.1. SDN Characteristics
         2.2.1.1. Separation of control and user planes
         2.2.1.2. Network virtualization and automatization
         2.2.1.3. Openess via standard interfaces and APIs
   2.3. Benefits of SDN
   2.4. SDN Operations
   2.5. SDN Components
      2.5.1. SDN Applications
      2.5.2. SDN Controller
         2.5.2.1. Controller modules
         2.5.2.2. Controller interfaces
      2.5.3. SDN Data path (network device
      2.5.4. SDN interfaces and associated protocols/APIs
   2.6. SDN scenarios and related call flows
   2.7. Examples of SDN solutions : Cisco, Juniper, NSN, Brocade, Vmware
   2.8. SDN standardization
      2.8.1. IETF and SDN
      2.8.2. ITU-T and SDN
      2.8.3. ONF and SDN
      2.8.4. OpenDaylight and SDN

3. Openflow
   3.1. Openflow objective
   3.2. Structure of an Openflow switch
   3.3. OpenFlow tables
   3.4. Openflow channel
   3.5. Openflow protocol versions and differences between versions

4. NFV : Network Function Virualization
   4.1. Definition
   4.2. NFV infrastructure (NFVI) objectives
   4.3. NFVI Architecture
      4.3.1. Principes
      4.3.2. NFVI domains
      4.3.3. NFVI Components
         4.3.3.1. VNF : Virtualized Network Function
            4.3.3.1.1. VNF Architecture
            4.3.3.1.2. VNF Interfaces
            4.3.3.1.3. VNF Properties
            4.3.3.1.4. VNF life cycle
         4.3.3.2. Interfaces
   4.4. NFVI and cloud computing
   4.5. requirements in terms of orchestration management
   4.6. requirements in terms of security
   4.7. Performance and portability of VNF
   4.8. Relationship between NFV and SDN
      4.8.1. SDN in the NFV architecture
      4.8.2. SDN Virtualized Network Function (VNF)

4.9. Use cases
4.10. Some key players and their proposal : Cisco, Juniper, Ericsson, NSN, HP

NEXT GENERATION NETWORK AND IMS COURSES

NGN Course Title	Duration
PSTN Evolution Towards Voice over IP	1 day
Next Generation Network	3 or 4 days
IP-Centrex and its Integration in NGN/IMS Networks	2 days
MEGACO/H.248	2 days
SIP : Session Initiation Protocol	2 days
SIP Service Architectures	2 days
H.323	2 days
SIGTRAN	2 days
SIGTRAN : SCTP and M3UA	2 days
Service Architectures in NGN	2 days
IMS Network and Service Architectures	3 days
SIP/IMS Service Architecture, Parlay/OSA API and Web Services	2 days
Network and Service Architectures for Fixed-Mobile Convergence and IMS	3 days
Introduction to IMS : Network, Services, Migration Scenarios and Investment	1 day

Teaching on Telecommunications

PSTN EVOLUTION TOWARDS VOICE OVER IP

Objective : One of the hottest topics in the telecommunications industry today is the migration of voice traffic from the circuit switched Telco networks to packet switched networks such as IP, ATM, Frame Relay and access technologies such as DSL (Digital Subscriber Line) and Packet Cable. The sheer volume of voice traffic, together with the efficiencies of packet transport and the opportunity to offer new features on voice calls, has made internetworking, between circuit and packet transport, vital while this migration is in progress. The goal of this course is to show the evolution of the circuit switched network towards packet based networks to support voice, data and multimedia applications and to explain the issues related to this migration.

Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, pre-sales engineers
Pre-requisites : Basic knowledge on the PSTN
Duration : 1 day

1. From circuit switching to packet switching
2. The Many Flavors of Voice over IP
3. The Benefits and Challenges of VoIP
4. Protocols, Standards, Buzzwords and Jargon
5. The Voice Over IP Business Case
   - 5.1. Business drivers of Voice over IP in different parts of the network
     - 5.1.1. Public network backbone
     - 5.1.2. Access network
     - 5.1.3. PBX/LAN
     - 5.1.4. Desktop
   - 5.2. Business drivers of Voice over IP for network operators
     - 5.2.1. New competitive public carrier
     - 5.2.2. Cellular company
     - 5.2.3. Cable company
     - 5.2.4. Corporate network
   - 5.3. Business drivers of Voice over IP for new and innovative applications and services
   - 5.4. ROI
6. Voice over IP architectures
   - 6.1. Enterprise voice over IP
   - 6.2. NGN Class 4
   - 6.3. NGN Class 5
   - 6.4. Mobile NGN : R4
   - 6.5. NGN Multimedia : IMS
7. Emerging Next Generation Carriers
   - 7.1. Incumbent carriers
   - 7.2. Next Generation carriers
   - 7.3. Internet telephony service providers

NEXT GENERATION NETWORK AND IP TELEPHONY

Objectives: Gain knowledge on the principles, architecture, services and evolutions of IP telephony for telecommunication networks on one hand (NGN), and for entreprise networks on the other hand
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Prerequisites: Minimum knowledge on voice networks and Internet Protocol
Duration: 3 or 4 days

Voice switching is evolving. A new generation of network architectures emerges enabling the provision of new services mixing voice, real time data and video : The Next Generation Networks (NGNs) for network operators. The goal of this course is to present the principles, the architecture, the services and the management of NGNs.

1. Introduction to Next Generation Network (NGN)
   - 1.1. Introduction to PSTN, SS7 and Intelligent Networks
     - 1.1. Avantages of NGN
     - 1.2. Types of NGN
       - 1.2.1. Telephony NGN
         - 1.2.1.1. Class 4 NGN
         - 1.2.1.2. Class 5 NGN
       - 1.2.2. Multimedia NGN called IMS (IP Multimedia Subsystem)
     - 1.3. Scenarios and cost of migration from existing networks to NGNs
     - 1.4. NGN Standardization: TISPAN and 3GPP

2. Plan of migration to NGN based on service provider profile
   - 2.1. Incumbent : Migration to Class 4 NGN, Class 5 NGN and IMS
   - 2.2. CLEC : Migration to Class 4 NGN, Class 5 NGN and IMS
   - 2.3. IP Service Provider : Migration to Class 5 NGN and IMS

3. The architecture components
   - 3.1. The Media Gateway
     - 3.1.1. Trunking Gateway
     - 3.1.2. Residential Gateway
     - 3.1.3. Access Gateway
     - 3.1.4. Integrated Access Device
     - 3.1.5. Network Access Server
   - 3.2. The Media Gateway Controller
   - 3.3. The Signaling Gateway
   - 3.4. Interfaces between components
   - 3.5. Interface with PSTN, Intelligent Network, and SS7

4. The Protocols
   - 4.1. SIP for signaling in the IP Telephony environment
   - 4.2. H.323 for signaling in the IP Telephony context
   - 4.3. MGCP/MEGACO/H.248 for control within NGN
   - 4.4. Positioning of MGCP/MEGACO/H.248, SIP and H.323 Protocols
   - 4.5. BICC and SIP-T for signaling among Media Gatexay Controller

   - 4.6. SIGTRAN for the transport of telephony signaling
   - 4.7. RTP and RTCP for the transport of multimedia data (voice, video) and for the control of media exchange

5. Mobile Networks and NGN
   - 5.1. Telephony NGN : UMTS R4
   - 5.2. Multimedia NGN (IMS) : UMTS R5, R6 and R7

6. NGN Service Architecture
   - 6.1. SIP Service Architecture
     - 6.1.1. Application Server
     - 6.1.2. Media Server (Multimedia Resource Function)
     - 6.1.3. Messaging Server
   - 6.2. Open APIs
     - 6.2.1. Parlay/OSA/JAIN/Parlay X
   - 6.3. NGN service catalogue

7. Vendors solutions
   - 7.1. ERICSSON : Engine Integral and IPMM
   - 7.2. ALCATEL : OPEN
   - 7.3. SIEMENS : Surpass & IMS@vantage
   - 7.4. CISCO : Open Packet Telephony and Service Exchange Framework
   - 7.5. NORTEL : Succession and MCS
   - 7.6. SONUS NETWORKS : Softswitch
   - 7.7. LUCENT : Softswitch and Accelerate

IP-CENTREX AND ITS INTEGRATION IN NGN/IMS NETWORKS

Objectives: Understand the principles, the architecture and the services of IP-Centrex in NGN/IMS network environments
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Prerequisites: Minimum knowledge on voice networks, Internet Protocol and NGN
Duration: 2 days

1. Introduction to Centrex
   - 1.1. Definition
   - 1.2. Architecture
   - 1.3. Centrex versus PBX

2. Introduction to IP-Centrex
   - 2.1. Definition
   - 2.2. IP-Centrex versus IP-PBX
   - 2.3. Components of IP-Centrex architecture based on NGN
     - 2.3.1. Softswitch
     - 2.3.2. Media Gateway
     - 2.3.3. IP-Centrex Application Server
     - 2.3.4. IP Media Server (called Multimedia Resource Function, MRF)
   - 2.4. Protocols of IP-Centrex architecture
     - 2.4.1. MEGACO/H.248/MGCP
     - 2.4.2. SIP/H.323
     - 2.4.3. VoiceXML
     - 2.4.4. RTP
   - 2.5. Network considerations for IP-Centrex
   - 2.6. Deployment strategies for IP-Centrex
     - 2.6.1. Controlled Migration to IP-Centrex
     - 2.6.2. Greenfield IP-Centrex Implementation

3. IP-Centrex Services
   - 3.1. Anonymous Call Rejection
   - 3.2. Automatic Callback/Ring Again
   - 3.3. Automatic Line/Direct Connect ("Hotline")
   - 3.4. Barge In
   - 3.5. Call Block
   - 3.6. Call Forwarding (Busy, No Reply, Multiple Simultaneous, Variable, Selective)
   - 3.7. Call Hold
   - 3.8. Call Park
   - 3.9. Call Pickup
   - 3.10. Call Restrictions/Station Restrictions
   - 3.11. Last Number Redial
   - 3.12. Customized ringing
   - 3.13. Call Transfer
   - 3.14. Call Waiting Indication
   - 3.15. Caller ID
   - 3.16. Calling Line Identity Restriction
   - 3.17. Consultation Hold

   - 3.18. Distinctive Ringing
   - 3.19. Hunt Groups
   - 3.20. Music-On-Hold
   - 3.21. Speed Dialing
   - 3.22. Station Message Detail Recording (SMDR)
   - 3.23. Three-Way Conferencing
   - 3.24. Toll Restriction
   - 3.25. etc.

4. IP-Centrex architecture as an application of IMS (IP Multimedia Subsystem)

5. Evaluation Criteria of IP-Centrex

6. Financial analyses for the realization of an IP-Centrex

MEGACO/H.248

Objectives: Gain knowledge on the principles, architecture, services and evolutions of IP telephony for telecommunication networks on one hand (NGN), and for entreprise networks on the other hand
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Prerequisites: Minimum knowledge on voice networks and Internet Protocol
Duration: 2 days

Known as the MEGACO at IETF and H.248 at ITU-T, the MEGACO/H.248 protocol is a master/slave protocol in which controllers known as Media Gateway Controllers (MGCs) control the operation of Media Gateways (MGWs). The MGC takes care of call-control intelligence and related call signaling while the MGW takes instruction from an MGC and basically does what the MGC commands. The MGC commands generally relate to the establishment and release of contexts (connections) from one side of the MGW to another.

This course will introduce the MEGACO architecture with the MGCs and MGWs and the concepts of termination and context related to connectivity. The control messages exchanged between MGCs and MGWs will be described with their parameters called descriptors. The package concept will be developed. Various call establishment scenarios will be considered to understand how MEGACO operates.
Finally the provision of supplementary services with MEGACO will be explained.

1. MEGACO Architecture
   - 1.1. Media Gateway Controller (MGC)
     - 1.1.1. Generic structure of an MGC
     - 1.1.2. Call handling function
     - 1.1.3. Resource control function
   - 1.2. Media Gateway (MGW)
     - 1.2.1. Generic structure of an MGW
   - 1.3. MEGACO termination
   - 1.4. MEGACO context

2. MEGACO transactions are commands
   - 2.1. MEGACO Transactions
     - 2.1.1. Transaction request
     - 2.1.2. Transaction reply
     - 2.1.3. Transaction pending
   - 2.2. MEGACO Commands
     - 2.2.1. Add
     - 2.2.2. Modify
     - 2.2.3. Subtract
     - 2.2.4. Move
     - 2.2.5. AuditValue
     - 2.2.6. AuditCapabilities
     - 2.2.7. Notify
     - 2.2.8. Service Change

3. MEGACO Descriptors
   - 3.1. Modem Descriptor
   - 3.2. Multiplex Descriptor
   - 3.3. Media Descriptor
   - 3.4. Events Descriptor
   - 3.5. Signals Descriptor
   - 3.6. Audit Descriptor
   - 3.7. Service Change Descriptor
   - 3.8. DigitMap Descriptor
   - 3.9. Statistics Descriptor
   - 3.10. Observed Events Descriptor
   - 3.11. Topology Descriptor

4. MEGACO Packages
   - 4.1. Tone Generator Package
   - 4.2. Tone Detection Package
   - 4.3. Basic DTMF Generator Package
   - 4.4. DTMF detection Package
   - 4.5. Call Progress Tones Generator Package
   - 4.6. Call Progress Tones Detection Package
   - 4.7. Analog Line Supervision Package
   - 4.8. Basic Continuity Package
   - 4.9. Network Package
   - 4.10. RTP Package
   - 4.11. TDM Circuit Package

5. Call Setup using MEGACO
   - 5.1. Call between residential gateway and trunking gateway
   - 5.2. Call between two trunking gateways
   - 5.3. Call between two residential gateways
   - 5.4. Call between access gateway and residential gateway
   - 5.5. Call between access gateway and trunking gateway
   - 5.6. Connection of a residential gateway with an IVR
   - 5.7. Connection of a trunking gateway with an IVR

6. Support of supplementary services with MEGACO

7. MEGACO versus other control protocols
   - 7.1. MEGACO versus MGCP
   - 7.2. MEGACO versus H.248
   - 7.3. MEGACO versus IPDC

SIP : SESSION INITIATION PROTOCOL

Objectives: Gain knowledge on the principles, architecture and services of Session Initiation Protocol
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: Minimum knowledge on TCP/IP protocols
Duration: 2 days

SIP is a signaling protocol proposed by IETF that handles the setup, modification and release of multimedia sessions. SIP is both a network and service signaling protocol. The course introduces the SIP network architecture, the SIP protocol, the SIP methods and some call scenarios, and the supplementary services that can be emulated with SIP. The course also presents the SIP service architecture with SIP application server / SIP media server / SIP messaging server and some applications such as SIP prepaid, SIP presence/instant messaging, SIP conferencing.

1. Introduction to SIP

2. SIP network entities and architecture

   2.1. SIP User Agent
   2.2. SIP Gateway
   2.3. SIP Proxy Server Stateful and Stateless
   2.4. SIP Redirect Server
   2.5. SIP Registrar
   2.6. Location database

3. SIP Requests and responses

   3.1. Request
      3.1.1. INVITE
      3.1.2. REGISTER
      3.1.3. BYE
      3.1.4. ACK
      3.1.5. CANCEL
      3.1.6. OPTIONS
      3.1.7. INFO
      3.1.8. PRACK
      3.1.9. SUBSCRIBE
      3.1.10. NOTIFY
      3.1.11. MESSAGE
      3.1.12. UPDATE
      3.1.13. PUBLISH
      3.1.14. REFER

   3.2. Responses
      3.2.1. Informational : 1XX
      3.2.2. Success : 2XX
      3.2.3. Redirection : 3XX

      3.2.4. Client Error : 4XX
      3.2.5. Server Error : 5XX
      3.2.6. Global Error : 6XX

4. SIP Call establishment scenarios

   4.1. SIP Call without any server
   4.2. SIP Call with Call Stateful and transaction stateful Proxy Servers
   4.3. SIP Call with Stateless Proxy Server
   4.4. SIP Call with Redirect Server
   4.5. SIP Call with several Proxy Servers (stateless, call stateful, transaction stateful)
   4.6. Call between a SIP terminal and a PSTN phone

5. SIP versus H.323

   5.1. Encoding
   5.2. Addressing
   5.3. Transport
   5.4. Complexity
   5.5. Supplementary services implementation
   5.6. Conferencing

6. SIP versus ISUP

   6.1. Interworking between SIP and ISUP
   6.2. Interworking between SIP and NGN (replacement of PSTN)

7. RTP and RTCP for the transport of voice and video and for the control of transport

8. Application server/Media server/messaging server approach for SIP Services
   8.1. SIP service architecture versus Intelligent network architecture
   8.2. SIP Application server functionalities and interfaces
   8.3. SIP Media server functionalities and interfaces
   8.4. SIP Messaging serving functionalities and interfaces
   8.5. Service scenarios with the SIP application/media/messaging servers

9. Service Development with SIP
   9.1. SIP CPL
   9.2. SIP CGI
   9.3. SIP Servlet
   9.4. SIP and Voice XML
   9.5. SIP an SOAP

DIAMETER AND ITS APPLICATION TO LTE/IMS

Objectives: Present detailed LTE/ePC procedures related to mobility management; *these* procedures are associated with DIAMETER S6a, S6d and SWx interfaces. Present detailed LTE/ePC procedures related to Policy and Charging Control (PCC) with DIAMETER Gx, Gy Gz, and S9. Present detailed LTE/ePC procedures related to registration, session and service control in IMS/VoLTE; *these* procedures are associated with DIAMETER Cx and Sh interfaces
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: Minimum knowledge on 4G and TCP/IP protocols
Duration: 3 days

DIAMETER is an AAA (Authentication, Authorization, Accounting) protocol. It enables service providers to authenticate users, to authorize their access to services and to collect information on resource usage. DIAMETER is the protocol used by 3GPP for its LTE/ePC (Long Term Evolution of 3G/ Evolved Packet Core) and IMS (IP Multimedia Subsystem) architectures. It enables the authentication, the authorization and the charging (online and offline charging) of LTE and IMS users. The goal of this course is to present the DIAMETER base protocol (DIAMETER nodes, DIAMETER messages, DIAMETER transport and routing capabilities, DIAMETER security) and the DIAMETER applications/interfaces related to LTE and IMS, particularly those related to HSS, namely S6a, S6d, SWx, CX, Sh and those related to Policy and Charging Control (PCC), namely, Gx, Gy, Gz, etc.

1. DIAMETER base protocol
   - 1.1. DIAMETER versus RADIUS
   - 1.2. Types of DIAMETER Nodes
     - 1.2.1. Client
     - 1.2.2. Server
     - 1.2.3. Relay agent
     - 1.2.4. Proxy agent
     - 1.2.5. Redirect agent
     - 1.2.6. Translation agent
   - 1.3. DIAMETER messages and parameters
     - 1.3.1. DIAMETER message format
     - 1.3.2. DIAMETER Command codes (Message Type)
     - 1.3.3. AVP format (Attribute-Value Pair)
   - 1.4. DIAMETER Transport and Routing
     - 1.4.1. DIAMETER Transport Concepts
     - 1.4.2. DIAMETER Routing Concepts : Routing Tables (Peer table and Realm-based routing table) and Routing function
   - 1.5. DIAMETER base protocol
   - 1.6. DIAMETER capability negotiation
   - 1.7. DIAMETER security requirements

2. EPS (LTE + EPC) Architecture
   - 2.1. LTE and EPC entities
     - 2.1.1. eNodeB
     - 2.1.2. MME/Serving GW/PDN GW
     - 2.1.3. PCC entities
     - 2.1.4. HSS and EIR
     - 2.1.5. Telephony services with CS Fallback or VoLTE (IMS)

   - 2.2. LTE and EPC interfaces
   - 2.3. 3GPP and non-3GPP accesses to EPC
   - 2.4. DIAMETER based signaling architecture
   - 2.5. Roaming with DIAMETER International Broker/Hub
   - 2.6. Attachment to EPS and bearer establishment

3. DIAMETER applications in LTE
   - 3.1. Mobility Management
     - 3.1.1. S6a/S6d : Interface between the MME/S4-SGSN and HSS to enable the transfer of subscriber related data
     - 3.1.2. SWx : interface between the 3GPP AAA Server and HSS to enable the transfer of subscriber related data
     - 3.1.3. S13/S13' : Interface between MME/S4-SGSN and HSS to enable ME Identity check
   - 3.2. Policy and Charging Control
     - 3.2.1. Gx : Interface between the GGSN (PCEF) and PCRF and between PDN GW (PCEF) and the PCRF to obtain charging rules in the context of PCC (Policy and Charging Control)
     - 3.2.2. S9 : Interface between visited and home PCRFs
     - 3.2.3. Gy : online charging Interface in 3G/LTE between PCEF and OCS
     - 3.2.4. Gz : offline charging interface in 3G/LTE between PCEF and OFCS
     - 3.2.5. Sy : interface between OCS and PCRF for QoS and gating control based on spending limits
     - 3.2.6. Rx : Interface between AF (e.g. P-CSCF) and PCRF for (QoS) policy control

4. Access to ePC and HSS interfaces
   - 4.1. LTE acccess to ePC
     - 4.1.1. S6a interface between MME and HSS
   - 4.2. 2G/3G Access to ePC
     - 4.2.1. S6d interface between S4-SGSN and HSS
   - 4.3. non-3GPP access to ePC
     - 4.3.1. SWx interface between 3GPP AAA Server and HSS

5. Description of the commands of S6a/S6d Interface and their AVPs
   - 5.1. Update-Location-Request (ULR)
   - 5.2. Update-Location-Answer (ULA)
   - 5.3. Cancel-Location-Request (CLR)
   - 5.4. Cancel-Location-Answer (CLA)
   - 5.5. Authentication-Information-Request (AIR)
   - 5.6. Authentication-Information-Answer (AIA)
   - 5.7. Insert-Subscriber-Data-Request (IDR)
   - 5.8. Insert-Subscriber-Data-Answer (IDA)
   - 5.9. Delete-Subscriber-Data-Request (DSR
   - 5.10. Delete-Subscriber-Data-Answer (DSA)
   - 5.11. Purge-UE-Request (PUR)
   - 5.12. Purge-UE-Answer (PUA)
   - 5.13. Reset-Request (RSR)
   - 5.14. Reset-Answer (RSA)
   - 5.15. Notify-Request (NOR)
   - 5.16. Notify-Answer (NOA)
   - 5.17. Traces
   - 5.18. Scenarios
     - 5.18.1. User attachment to EPC from LTE
     - 5.18.2. User attachment to EPC from UTRAN

5.18.3. Inter-MME mobility management
5.18.4. LTE to 3G mobility management

6. Description of the commands of PCC interfaces and their AVPs
   6.1. Gx interface
      6.1.1. CCR/CCA; RAR/RAA
      6.1.2. Trace
   6.2. S9 interface
      6.2.1. CCR/CCA; RAR/RAA
   6.3. Gy interface
      6.3.1. CCR/CCA; RAR/RAA
   6.4. Gz interface
      6.4.1. ACR/ACA
   6.5. Rx interface
      6.5.1. AAR/AAA; RAR/RAA; STR/STA; ASR/ASA
   6.6. Sy interface
      6.6.1. SLR/SLA; SNR/SNA; STR/STA
   6.7. PCC scénarios
      6.7.1. Faire use
      6.7.2. Anti-bill shock
      6.7.3. Freemium
      6.7.4. Parental control
      6.7.5. Speed boost (turbo button)
      6.7.6. Bonus/promo
      6.7.7. Traffic redirection based on user location.

7. DIAMETER application in IMS
   7.1. IMS Architecture
   7.2. User profile in the HSS
   7.3. IMS user identities
   7.4. IMS Interfaces towards HSS
      7.4.1. Cx/Dx Interface
      7.4.2. Sh/Dh Interface
   7.5. IMS Procedures with emphasis on Cx message flows
      7.5.1. Cx interface and AVPs
         7.5.1.1. UAR/UAA
         7.5.1.2. SAR/SAA
         7.5.1.3. MAR/MAA
         7.5.1.4. PPR/PPA
         7.5.1.5. LIR/LIA
         7.5.1.6. RTR/RTA
      7.5.2. IMS Registration and Cx
      7.5.3. IMS Session Establishment/Release and Cx
      7.5.4. IMS profile update and Cx
      7.5.5. IMS deregistration and Cx
   7.6. IMS procedures with emphasis on Sh interface
      7.6.1. Service data in HSS
      7.6.2. Sh interface : Request/Answers and AVPs
         7.6.2.1. UDR/UDA
         7.6.2.2. PUR/PUA
         7.6.2.3. SNR/SNA
         7.6.2.4. PNR/PNA

IP TELEPHONY WITH H.323

Objectives: Gain knowledge on the principles, architecture and services of H.323
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: Minimum knowledge on TCP/IP protocols
Duration: 2 days

H.323 is an umbrella recommendation from ITU-T that covers all aspects of multimedia communication over an IP network. Originally developed for video conferencing over a single LAN segment, the protocol has been extended to cover the general problem of telephony over the Internet. H.323 makes use of RTP for the transport of multimedia flows (voice, video) and RTCP for the control of the media exchange.
This course will introduce the H.323 architecture with its entities, and the signaling protocols defined in H.323. The signaling messages the H.323 entities exchange and the various message headers will be described.
Moreover the course shows all possible call establishment and tear-down scenarios and explain how to supply supplementary services in an H.323 network or between a SIP network and an H.323 network or between a PSTN network and an H.323 network. Finally the differences between the several H.323 protocol versions will be pinpointed.

1. H.323 Introduction

2. H.323 entities and architecture
   2.1. H.323 Terminal
   2.2. H.323 Gateways
   2.3. H.323 MCU
   2.4. H.323 Gatekeeper
   2.5. H.323 Zone

3. H.323 Signaling protocols and associated messages
   3.1. Registration, Admission and Status : RAS
   3.2. Call Signaling : Q.931
   3.3. Control Signaling : H.245
   3.4. H.323 Signaling modes : Gatekeeper routed, directly routed

4. H.323 Call establishment scenarios

   4.1. Call without any Gatekeeper
   4.2. Call with Gatekeeper (Q.931 Directly Routed)
   4.3. Call with Gatekeeper (Q.931 Gatekeeper Routed and H.245 Directly routed)
   4.4. Call with Gatekeeper (Q.931 Gatekeeper Routed and H.245 Gatekeeper routed)
   4.5. Call established between a SIP terminal and an H.323 terminal
   4.6. Call established between a PSTN phone and an H.323 terminal

5. H.323 supplementary services

   5.1. Service architectures
      5.1.1. Services installed into the H.323 terminal

5.1.2. Services installed into a Feature server
5.2. CF (Call forwarding)
5.3. CW (Call Waiting)
5.4. CCBS (Call Completion on Busy Subscriber)
5.5. CT (Call Transfer)
5.6. Etc.

6. H.323 versions and comparison among their features

6.1. H.323 v1
6.2. H.323 v2
6.3. H.323 v3
6.4. H.323 v4

7. RTP and RTCP for the transport of voice and video and for the control of transport

SIGTRAN

Objectives: Gain knowledge on the principles, architecture and functionalities of the SIGTRAN Architecture, Protocol Stack and Applications
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: Minimum knowledge on NGN philosophy and on TCP/IP protocols
Duration: 2 days

Sigtran is a working group at IETF that addresses the issues regarding transport of signaling within IP networks. The group particularly focuses on signaling performance within IP network and on interworking with other networks (PSTN, ISDN, Access networks, etc.) Sigtran defined a common transport protocol called SCTP (Stream Control Transmission Protocol) that ensures reliable signaling delivery and adaptation layers supporting specific primitives, as required by specific signaling applications (e.g., ISUP). This course will introduce the SCTP protocol and the adaptation layers specified by Sigtran. To better understand the transport of legacy signaling over Sigtran, the course also briefly recalls the main telephony signaling protocols (ISUP, Q.931 and V5.2, MAP, BSSAP, CAP, INAP, TCAP).

1. SIGTRAN Framework and its application
    1.1. SIGTRAN in NGN
    1.2. SIGTRAN in PSTN
    1.3. SIGTRAN in GSM, GPRS, UMTS
    1.4. SIGTRAN in IP Telephony
    1.5. SIGTRAN Architecture
        1.5.1. SCTP
        1.5.2. SCTP versus TCP and UDP
        1.5.3. Adaptation layers
            1.5.3.1. M3UA
            1.5.3.2. M2UA / M2PA
            1.5.3.3. SUA
            1.5.3.4. IUA
            1.5.3.5 V5UA
            1.5.3.6 TUA

2. Telephony signaling
    2.1. ISUP
    2.2. Q.931
    2.3. V5.2
    2.4. INAP
    2.5. CAP
    2.6. MAP
    2.7. BSSAP
    2.8. RANAP

3. SIGTRAN configurations
    3.1. SIGTRAN configuration for ISUP signaling transport : Standalone Signaling Gateway (SG) and Integrated SG
    3.2. SIGTRAN configuration for Q.931 signaling transport : Integrated SG
    3.3. SIGTRAN configuration for V5.2 signaling transport : Integrated SG

3.4. SIGTRAN configuration for RANAP signaling and BSSAP signaling transport
3.5. SIGTRAN configuration for MAP / CAP / INAP / TCAP signaling transport
3.6. SIGTRAN configuration for BICC signaling transport
3.7. SCTP for the transport of MEGACO / SIP signaling

10. Migration to SIGTRAN
    10.1. Migration of the SS7 network to SIGTRAN to inscrease the SS7 backbone capacity
    10.2. Migration of the end-systems (HLR, SCP, SMSC, MSC/VLR, Softswitch, etc) to SIGTRAN to increase the end-system signaling connectivity
    10.3. Strategy of a large network operator
    10.4. Strategy of a small network operator
    10.5. Implemention strategy
        10.5.1. Vendor strategy
        10.5.2. Operator strategy
        10.5.3. Integrator strategy

5. SCTP protocol
    5.1. SCTP endpoints
    5.2. SCTP association
    5.3. SCTP streams
    5.4. SCTP chunks
    5.5. SCTP messages
    5.6. Establishment and release of an SCTP association
    5.7. SCTP data transfer
    5.8. SCTP control messages

6. Adaptation layers overview
    6.1. M3UA adaptation and messages
    6.2. M2UA adaptation and messages
    6.3. IUA protocol and messages
    6.4. SUA protocol and messages
    6.5. V5UA protocol and messages
    6.6. M2PA protocol and messages

8. SIGTRAN vendors solutions
    8.1. Signaling Gateway vendors
    8.2. Stack vendors

9. Strategy for user adaptations development

SIGTRAN : SCTP and M3UA

Objectives: Gain knowledge on the principles, architecture and functionalities of the SIGTRAN Architecture, SCTP and M3UA protocols
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: Minimum knowledge on TCP/IP protocols
Duration: 2 days

SIGTRAN is a working group at IETF that addresses the issues regarding transport of signaling within IP networks. The group particularly focuses on signaling performance within IP network and on interworking with other networks (PSTN, ISDN, Access networks, etc.) Sigtran defined a common transport protocol called SCTP (Stream Control Transmission Protocol) that ensures reliable signaling delivery and adaptation layers supporting specific primitives, as required by specific signaling applications (e.g., ISUP, MAP). This course will recall the SS7 architecture, describe the SCTP protocol and present the Sigtran M3UA Adaptation layer.

1. Introduction to SS7
    1.1. SS7 modes
        1.1.1. Associated mode
        1.1.2. Quasi associated mode
        1.1.3. Non associated mode
    1.2. SS7 network architecture
        1.2.1. Signaling links
        1.2.2. SS7 nodes
            1.2.2.1. Signaling transfer points
            1.2.2.2. Signaling points
    1.3. Dimensioning of an SS7 Network
    1.4. SS7 Protocol stack

2. SIGTRAN Framework and its application
    2.1. SCTP
    2.2. SCTP versus TCP and UDP
    2.3. Adaptation layers
        2.3.1. Adaptation layer in asymmetric mode : M2UA, M3UA, SUA
        2.3.2. Adaptation layer in symmetric mode : M2PA, M3UA, SUA

3. Migration to SIGTRAN
    3.1. Migration of the SS7 network to SIGTRAN to increase the SS7 backbone capacity : SIGTRAN TRunking
    3.2. Migration of the end-systems (HLR, SCP, SMSC, MSC Server, etc) to SIGTRAN to increase the end-system signaling connectivity : Application offload
    3.3. Full replacement of SS7 by SIGTRAN

4. SCTP protocol and SCTP service
    4.1. SCTP endpoints
    4.2. SCTP association
    4.3. SCTP streams
    4.4. SCTP chunks
    4.5. SCTP primitives

4.6. SCTP messages
4.7. Establishment and release of an SCTP association
4.8. SCTP data transfer and data acknowledgement
4.9. Release of an SCTP association
4.10. Abort of an SCTP association
4.11. SCTP traces

5. M3UA Adaptation layer
5.1. Common architecture to all User Adaptations
5.1.1. Common Terminology
5.1.1.1. SG, SGP, AS, ASP, IPSP
5.1.2. Common messages
5.1.2.1. ASP Traffic Maintenance Messages
5.1.2.2. ASP State Maintenance Messages
5.1.2.3. Management Messages
5.1.2.4. Routing Key Management Messages
5.2. M3UA Architecture
5.3. M3UA specific messages
5.3.1. MTP3 Transfer Messages
5.3.2. Signaling Network Management Messages
5.4. M3UA traces

SERVICE ARCHITECTURES IN NGN

Objectives: Gain knowledge on the service architectures in NGN networks.
Attendance: Telecommunication Engineers, Network Architects, Telecommunications consultants
Prerequisites: Minimum knowledge on NGN networks
Duration: 2 days

The objective of this course is to show the integration and evolution of the Intelligent Network in Next Generation Networks. The course requires the knowledge of the NGN network architecture. It introduces the IN concept applied to PSTN and GSM (CAMEL). Location based services (LBS) for GSM and GPRS networks are detailed. Messaging services are presented with particularly SMS, UMS, MMS and IM. For hybrid networks (PSTN/INternet Interconnection), hybrid services architectures are highlighted, particularly, PINT and SPIRITS.
New service architectures related to open APIS such as Parlay, OSA, JAIN and Parlay X enable enterprises to develop and deploy their services independently of network operators, but relying on their infrastructure. The Open APIS specifications and the corresponding market solutions are detailed.
the UMTS network and services are described and the corresponding architectures described.

1. Intelligent Network
1.1. IN Architecture
1.2. IN Services
1.3. IN deployment constraints
1.4. Vendors solutions
1.5. IN capability sets

2. Number portability
2.1. Portability types
2.1.1. Location portability
2.1.2. Service portability
2.1.3. Operator Portability
2.2. Realization of the service in the PSTN and GSM networks
2.3. Relationship between portability and IN

3. IN and mobiles
3.1. Prepaid service
3.2. Mobile services and CAMEL
3.3. CAMEL Architecture
3.4. CAMEL Phases: Phases 1, Phase 2 and Phase 3, Phase 4
3.5. Prepaid Service scenario with CAMEL for voice calls, data calls, SMS transfer
3.6. CAMEL Phase 4and Voice over IP in UMTS R5

4. Messaging Services
4.1. Short Messaging Service (SMS)
4.2. Unified Messaging Service (UMS)
4.2.1. UM architecture : UM service, UM store, UM directory, etc.
4.2.2. Unified Messaging versus Integrated Messaging
4.2.3. ASP-based and CPE-based UM solutions
4.3. Multimedia Messaging (MMS)

4.3.1. Multimedia Messaging Architecture
4.3.2. MMS versus SMS
4.3.3. MMSC solutions
4.4. Instant Messaging (IM) and Presence
4.4.1. IM Architecture
4.4.2. Associated Protocols
4.4.3. Realization of the IM and Presence services using SIP

5. Location based services
5.1. Location architecture with mobiles
5.1.1. Location approaches
5.1.1.1. GMLC server approach
5.1.1.2. IN approach
5.1.2. Location approaches : Cell ID-Based, TOA, E-OTD, Assisted GPS
5.1.3. APIs and location protocols
5.1.3.1. LIF : Location Interoperability Forum API
5.1.3.2. WAF : Wap Forum API
5.1.3.3. Parlay / OSA Mobility API
5.1.4. I'I-Mode-based location services
5.2. Location architecture with Internet

6. SIP Services Programming
6.1. SIP network and service Architectures
6.2. SIP CPL (Call Processing Language) for telephony services
6.2.1. Language commands
6.2.2. Service scripts examples : Call Screening and Call Forwarding
6.3. SIP CGI (Common Gateway Interface)
6.4. SIP Servlet

7. Open APIs
7.1. Parlay
7.1.1. Parlay Architecture
7.1.1.1. Parlay Framework Interfaces
7.1.1.2. Parlay Services Interfaces
7.1.1.2.1. Call Control
7.1.1.2.2. Messaging
7.1.1.2.3. User Interaction
7.1.1.2.4. Mobility
7.1.1.2.5. Connectivity Management
7.1.1.3. Service Examples with Parlay
7.2. OSA = Parlay 3.0
7.2.1.1. OSA Architecture
7.2.1.2. OSA Services Examples
7.3. JAIN (JAVA Advanced Intelligent Network)
7.3.1. JAIN Reference Architecture
7.3.2. JAIN Protocol APIs: JAIN INAP, JAIN SIP, etc.
7.3.3. JAIN Call Control
7.3.4. JAIN SPA = Parlay Framework
7.4. Parlay X
7.5. Comparison between Parlay, Parlay X, JAIN et OSA
7.6. Vendors Solutions
7.6.1. ALCATEL OSP (Open Service Platform)
7.6.2. ERICSSON JAMBALA
7.6.3. SIEMENS PARLAY/OSA@vantage

7.6.4. HP OpenCall, Telcordia OSG, ULTICOM Nexworx, etc.

8. UMTS Services
8.1. UMTS Network Architecture : UMTS R3, R4 and R5
8.2. Reference Architecture for UMTS services
8.2.1. OSA
8.2.2. CAMEL
8.2.3. SIP CPL, etc.

9. SIP Application Servers
9.1. Presence Server
9.2. Instant Messaging Server
9.3. Conference Server
9.4. Multimedia Resource Server
9.5. IP VPN Server
9.6. Etc.

10. Other Elements to Consider
10.1. Voice XML
10.2. SOAP
10.3. Etc.

11. Reference Architecture for NGN services

NETWORK AND SERVICE ARCHITECTURES OF THE IP MULTIMEDIA SUBSYSTEM (IMS)

Course objective : Understand the service and network architectures of the IP Multimedia Subsystem in fixed and mobile environments
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Basic knowledge on mobile networks
Duration : 3 days

Many successful services are available today on the Internet, including as e-mail, web browsing, and audio and video downloading/streaming. Internet telephony and Multimedia Communications Services, some of the latest to be launched, are being proposed by Microsoft (MSN), Yahoo (Messenger), Google (GoogleTalk) and Ebay (Skype).
As telephony is simply another Internet application, any company, even if it is not an access provider, can provide a telephony service. The above actors are already active in this market, but are all proposing proprietary Internet telephony solutions.
The operators will want to continue to provide telephony services even after the Internet has replaced telephone networks.
They do not want to abandon user services and simply become Internet packet transporters, as this has become a commodity business which is under strong price pressure and is of little interest to users.
The operators must rapidly push IMS (IP Multimedia Subsystem) before the proprietary solutions can be widely adopted, or they will become just commodity access providers.
IMS defined is a new architecture to build the multimedia communications services of the forthcoming years over an all-IP network : new concepts, new technologies, new partners and ecosystem.
The decision to deploy IMS implies a direction towards an IP-based network architecture, a more sophisticated approach to service delivery and competitive advantage, and a willingness to enter into a broader industry alignment with fixed and Internet players. IMS deployment is a strategic decision, not a network technology decision.
In this context, it is crucial that service providers understand the new issues in the telecommunications world, the possible scenarios for migration towards IMS, IMS cost and investment approaches, the new service categories expected in IMS and the billing of those services.

1. 3G R3, R4, R5 and R6 Network Architectures
2. Fixed network evolution towards broaband access
3. Introduction to IMS
   - 3.1. Why IMS ?
   - 3.2. IMS Advantages
   - 3.3. Strategy of introducing IMS
   - 3.4. Cost evaluation of IMS deployment
     - 3.4.1. Scenario of 3G service provider
     - 3.4.2. Scenario of xDSL service provider
   - 3.5. Approaches for migration towards IMS
   - 3.6. Scenarios for fixed mobile convergence with IMS
   - 3.7. IMS Services differentiation
4. IMS Standardization
   - 4.1. 3GPP standardization (R5, R6, R7)

   - 4.2. TISPAN standardization
5. IMS Network Architecture
   - 5.1. Entities
     - 5.1.1. CSCF : P-CSCF, I-CSCF, S-CSCF for the control of IMS multimedia sessions
     - 5.1.2. IMS-MGW, MGCF, BGCF, T-SGW for the interworking with circuit switched networks (PSTN, GSM)
     - 5.1.3. HSS (HLR Evolution) and SLF
     - 5.1.4. BGF for media control
     - 5.1.5. PDF for policy control
     - 5.1.6. CCF and OCS for offline and online charging respectively
   - 5.2. IMS network interfaces
   - 5.3. IMS Protocols
     - 5.3.1. SIP / SDP : Session Initiation Protocol / Session Description Protocol
     - 5.3.2. DIAMETER
     - 5.3.3. MEGACO
     - 5.3.4. SIGTRAN
     - 5.3.5. COPS
     - 5.3.6. MSRP
     - 5.3.7. RTP / RTCP
     - 5.3.8. GTP
     - 5.3.9. IPv6
   - 5.4. IMS roaming
   - 5.5. IMS session control
     - 5.5.1. Session established between two IMS users in their home network
     - 5.5.2. Session established between an IMS user and a PSTN user
     - 5.5.3. Session established two roaming IMS users
   - 5.6. IMS Charging
     - 5.6.1. Off-line charging : CCF
     - 5.6.2. On-line charging : OCS
   - 5.7. IMS vendors solutions
6. IMS Service Architecture
   - 6.1. Entities
     - 6.1.1. SIP Application Server
     - 6.1.2. OSA SCS (OSA Service Capability Server)
     - 6.1.3. IM SSP (Service Switching Point)
     - 6.1.4. SCIM (Service Capability Interaction Manager)
     - 6.1.5. Media Resource Function
   - 6.2. IMS service interfaces
   - 6.3. Service profile of an IMS user : Application Server Subscription Information
     - 6.3.1. ASSI Structure
     - 6.3.2. Filter Criteria
     - 6.3.3. Trigger Point
     - 6.3.4. Service Point Trigger
     - 6.3.5. Limitations of the ASSI
   - 6.4. Service invocation for incoming and outgoing sessions
   - 6.5. Operation Mode of a SIP Application Server
   - 6.6. Examples of IMS services
     - 6.6.1. Messaging
     - 6.6.2. Presence
     - 6.6.3. Push to Talk over Cellular (PoC)
     - 6.6.4. Audio and Video Conferencing
   - 6.7. IMS Service Architecture and CAMEL Phase 4
     - 6.7.1. CAMEL Phase 4 Architecture
     - 6.7.2. IM-CSIs

6.7.3. CAP Phase 4 Protocol and SIP/CAP Mapping
6.7.4. Prepaid service in the CAMEL Phase 4 architecture
6.7.5. Call establishment scenario for a roaming prepaid IMS user
6.8. IMS Service Architecture and OSA
6.8.1. OSA/Parlay X Architectures
6.8.1.1. OSA SCS
6.8.1.2. OSA Application Server
6.8.1.3. OSA API and SIP / OSA Mapping
6.8.1.4. OSA service examples in IMS context

SIP/IMS ARCHITECTURE, OSA/PARLAY AND WEB SERVICES

Course objective : Understand SIP/IMS service architecture, OSA/Parlay API, and Parlay X API with its web services.
Attendance: Telecommunication and Software Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Basic knowledge telecommunications
Duration : 2 days

The objective of this course is to present the SIP/IMS sevice architecture with SIP Application Servers and Multimedia Resource Functions in a open, distributed and scalable environment. Different types of SIP/IMS service capabilities and applications are described : messagine, voice call continuity, presence, supplementary services, conference, group list management, etc. The course also introduces the OSA/Parlay service architecture with its service enablers and Parlay X. The Parlay X APIs define a set of simple-to-use, high-level, telecom-related Web services for Third Party Call, Network Initiated Third Party Call, SMS, MMS, User Status, Terminal Location, Conference, Presence, etc. The different service architectures will be compared and the course shows how they could be complementary.

1. Concepts behind the IMS service architecture
2. IMS Service architecture
   2.1. Entities
   2.2. Interfaces
   2.3. Used protocols
   2.4. User Profile and Service profile
   2.5. Service marks in the service profile (Initial Filter Criteria)
   2.6. Concepts of network service and user-based service
   2.7. Service Invocation
   2.8. Service provisioning
   2.9. Service combination
3. The service broker (SCIM) in the IMS service architecture
   3.1. Invocation of combined services without a service broker
   3.2. Invocation of combined service with a service broker to manage service interaction problems
4. IMS service capabilities
5. IMS and supplementary telephony services
6. IMS and value added services
7. Charging of IMS services (on-line and off-line)
8. Voice call continuity (VCC) in IMS
   8.1. VCC concept and architecture
   8.2. Impact of VCC on supplementary telephony services
   8.3. Impact of VCC on value added services
9. IMS and CAMEL/IN interworking
   9.1. Example of the prepaid service
10. Parlay OSA Service Architecture
    10.1. Objectives of OSA/Parlay API
    10.2. Differences between Parlay, OSA, JAIN, Parlay X Open APIs
    10.3. OSA/Parlay service capabilities
    10.4. OSA/Parlay products

10.4.1. OSA SCS/Parlay Gateway
10.4.2. OSA Application Server
10.4.3. Service creation environments with OSA/Parlay
10.5. OSA/Parlay Applications
11. Parlay X API
12. Parlay X Web Services
12.1. Third party call
12.2. Call notification
12.3. SMS
12.4. MMS
12.5. Payment and account management
12.6. Terminal status and terminal location
12.7. Multimedia conference
12.8. Multimedia presence, etc.
13. Comparison between SIP/IMS service architecture, OSA/Parlay and Parlay X

NETWORK AND SERVICE ARCHITECTURES FOR FIXED-MOBILE CONVERGENCE AND IMS

Course objective : The goal of this course is to show the different dimensions of convergence, its current development with multi-play service offers and the unified mobile and fixed network and service architectures to achieve full convergence
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Minimum knowledge on fixed and mobile networks
Duration : 3 days

1. Convergence from a historical point of view : How technology, market and players have evolved and have led to convergence of networks and services
   1.1. Access network evolution :
      1.1.1. Roadmap of 2G networks towards 3G and 4G (R3, R4, R5, R6, R7, R8)
      1.1.2. Mobile broadband access evolution : W-CDMA, HSDPA/HSUPA, LTE/SAE
      1.1.3. Cellular access technologies: WiFi, WiMAX, UMA
      1.1.4. Fixed broadband access evolution : xDSL, Cable, FTTx
   1.2. Core network evolution : CS/PS, NGN and IMS
   1.3. Service architecture evolution : IN, CAMEL, Parlay/OSA and Parlay X service architectures , SIP service architecture

2. Dimensions of Convergence
   2.1. Fixed-mobile terminal convergence
   2.2. Fixed-mobile access convergence
   2.3. Transport convergence
   2.4. Fixed-mobile core network convergence
   2.5. Fixed-mobile service convergence
   2.6. OSS and BSS convergence

3. Convergent service offers
   3.1. Quad play : Broadband Internet access, Telephony, IP TV and convergent phone
   3.2. Quad play +: Quad play with SIP-based services such as presence, instant messaging, etc.

4. Convergent network and service architectures: NGN and IMS
   4.1. Fixed telephony NGN (Class 4 and Class 5 NGN) and mobile (R4)
      4.1.1. Strategies of NGN introduction
         4.1.1.1. Mobile NGN scenario with 2G and 3G access networks
         4.1.1.2. Fixed NGN scenario : PSTN/ISDN replacement
         4.1.1.3. Fixed NGN scenario : VoDSL or second play
      4.1.2. Fixed NGN entities
      4.1.3. Mobile NGN entities
      4.1.4. NGN session establishment and release
   4.2. Fixed and mobile IMS
      4.2.1. IMS as convergent network and service architecture
      4.2.2. IMS standardization and the different steps to reach convergence
      4.2.3. Migration steps for the development of a long term architecture compliant with IMS
      4.2.4. IMS network architecture

4.2.5. IMS service architecture
4.2.6. IMS service enablers : Voice Call Continuity, Conferencing, PoC, Messaging, Presence, Group List Management
4.2.7. IMS protocols
4.2.8. IMS roaming
4.2.9. IMS charging
4.2.9.1. Off-line charging
4.2.9.2. On-line charging
4.2.10. IMS authentication
4.2.11. IMS session establishment and release
4.2.12. IMS service invocation
4.2.13. PSTN replacement with IMS as an alternative to NGN
4.2.13.1. PSTN/ISDN emulation with NGN
4.2.13.2. PSTN/ISDN emulation with IMS
4.2.14. IMS for the second, third and fourth plays
4.2.14.1. Second play : Telephony from an analog or ISDN phone attached to a SIP IAD
4.2.14.2. Third play : IPTV with Broadcast TV and Video on demand
4.2.14.3. Fourth play : Convergent phone with voice over (SIP protocol) in the WiFi environment and voice suppled by a GSM network outside the WiFi context
4.2.14.4. Fourth play + : SIP-based services in the WiFi environment
4.3. Vendors solutions
4.4. Investment costs
4.4.1. Application to the 3G mobile context
4.4.2. Application to the xDSL context

5. Other approaches for the fixed-mobile convergence
5.1. UMA : Unlicensed Mobile Architecture
5.2. Homezone based on GSM technology

INTRODUCTION TO IMS : NETWORK, SERVICES, MIGRATION SCENARIOS AND INVESTMENT

Course objective : Understand IMS, migration to IMS and investment in IMS
Attendance: Pre-sales and sales engineers, business managers, Network Architects, Telecommunication Consultants
Pre-requisites : No prerequisite
Duration : 1 day

Many successful services are available today on the Internet, including e-mail, web browsing, chat, and audio and video downloading/streaming. Internet telephony and Multimedia Communications Services, some of the latest to be launched, are already being proposed by Microsoft (MSN), Yahoo (Messenger), Ebay (Skype) and Google (GoogleTalk). As telephony is simply another Internet application, any company, even if it is not an access provider, can provide a telephony service. The above actors are already active in this market, but are all proposing proprietary Internet telephony solutions. In this context, the operators which telephony service was their core business, are facing the following alternatives :

1. Reposition their business towards value-added IP services including telephony, becoming global service providers. In this case, they will have to rapidly push IMS before proprietary solutions become largely adopted. IMS is the only standardized solution in the telecommunications world.
2. Abandon the market of value added services including telephony and reduce their business to that of a commodity access provider or IP packet transporter. The difficulties will be to maintain revenues in a context where the access and transport will become a commodity business under strong price pressure and of little interest to users.

IMS – IP Multimedia Subsystem standardized by the telecommunications world is a new architecture based on new concepts, new technologies, new partners and ecosystem. IMS provides real-time multimedia sessions (voice session, video session , conference session, etc) and non real-time multimedia sessions (Push to talk, Presence, instant messaging) over an all-IP network. IMS targets convergence of services supplied indifferently by different types of networks : fixed, mobile, Internet. IMS is also called Multimedia NGN (Next Generation Network). IMS deployment is a strategic decision, not a network technology decision. It can be taken either by a traditional service provider in the context of repositioning its business on IP services or by any entity that would decide to start an activity in IP services even without owning an access or transport network. This course presents the IMS objectives, IMS architecture, scenarios for migration to IMS and cost of investment in IMS.

1. From PSTN or GSM to Telephony NGN
1.1. PSTN Emulation based on Softswitch
1.2. PSTN Emulation based on IMS
1.3. GSM Emulation based on Softswitch

2. Why IMS?

3. What is IMS and what is not IMS?

4. Strong points and weak points of IMS

5. IMS Network and Services Architecture
5.1. IMS Network entities

5.1.1. CSCFs for the control of IMS multimedia sessions
5.1.2. IMS-MGW, MGCF, T-SGW for the interworking with circuit switched networks (PSTN, GSM)
5.1.3. HSS and SLF for user and service mobility
5.2. IMS Service entities
5.2.1. AS, SCIM and MRF for the application execution

6. Scenarios of migration from mobile and fixed broadband accesses to IMS
6.1. Fixed Network migration
6.2. Mobile Network migration
6.2.1. IMS versus UMA
6.3. Fixed/Mobile convergence with IMS
6.3.1. Convergence of networks
6.3.2. Convergence of services
6.4. IMS deployment across the world to support the four-play bundle of services
6.5. Services foreseen with IMS

7. IMS approaches
7.1. No IMS
7.2. Early IMS
7.3. Closed IMS
7.4. Full IMS
7.5. Only IMS

8. IMS Standardization
8.1. TISPAN, Packet Cable, 3GPP, 3GPP2

9. IMS vendors solutions and strategies

10. Cost of investment in early-IMS Solution
10.1. Cost of investment for a 3G mobile service provider
10.2. Cost of investment for an xDSL service provider

NETWORK MANAGEMENT AND INFORMATION SYSTEM COURSES

Title	Duration
Telecommunication Service and Network Management and its Evolution	2, 3 or 4 days
IP-based Network Management with SNMPv1, SNMPv2, SNMPv3 and RMON	3 days
Telecommunication Service and Network Management Information Modeling	2, 3 or 4 days
OSS and BSS	2 or 3 days
NGN and IP Telephony Management	2 days

TELECOMMUNICATION SERVICE AND NETWORK MANAGEMENT AND ITS EVOLUTIONS

Course objective : Gain knowledge on the principles, architecture, services and evolutions of the management of telecommunication service and networks with an emphasis on the management processes and management data models
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, Software engineers
Pre-requisites : basic knowledge on the object oriented approach
Duration : 2, 3 or 4 days

The course objective is to identify the telecommunication service and network management goals and to propose a methodological approach for the specification of management requirements and evaluation of management systems. the functional (management processes), informational (data models), communication (management protocols) organizational and architectural (TMN, management platforms) aspects of management are introduced. A Map of management systems for network operators is identified in relation with the most well known commercially available management solutions.

1. Introduction to the problematic of telecommunication service and network management

2. Introduction to telecommunication service and network management

3. Information model
   - 3.1. Functional architecture of a transport network: G.805
   - 3.2. Generic network information model (M.3100, GOM, NRIM) and specialized information models (SDH, PDH, ATM, Frame Relay, IP, telecommunication services)
   - 3.3. Importance of management data models in the network operator information system

4. Communication model
   - 4.1. CMIS/CMIP, SNMP
   - 4.2. CORBA

5. Functional Model
   - 5.1. Specific Management Functional (SMFAs)
   - 5.2. Systems Management Functions (ITU-T X.730-X.750)
   - 5.3. Reusable management components (ITU-T G.852.xx, G.853.xx, G.854.xx)
   - 5.4. Business management processes (TeleManagement Forum TOM Map)
   - 5.5. Relationship between functional, information and communication models

6. Architectural Model
   - 6.1. Telecommunication Management Network (TMN)
   - 6.2. Comparison between TMN and SNMP

7. Service and Network Management Platforms
   - 7.1. Services common to all management platforms (event service, communication service, logging service, etc.)
   - 7.2. Commercial management platforms

   - 7.3. Network operator management systems map
     - 7.3.1. Business management : customer care, billing, SLA management
     - 7.3.2. Service management : service configuration, service problem resolution, etc.
     - 7.3.3. network provisioning, inventory management, network maintenance and restoration, performance management, etc.

10. Evolution of service and network management
    - 8.1. CORBA-based, WEB-based and JAVA-based management

IP-BASED NETWORK MANAGEMENT WITH SNMPv1, SNMPv2, SNMPv3, RMON

Course objective : Gain knowledge on the principles, architecture, services and evolutions of the management of TCP/IP-based networks
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, Software engineers
Pre-requisites : basic knowledge on the Internet Protocol
Duration : 3 days

The objective of this course is to introduce the principles, architecture, services and evolutions of the management of TCP/IP-based networks with SNMP (Simple Network Management Protocol). The SNMP management framework is detailed with the SNMP protocol versions, the SNMP management information base and the rules for its definition, subnetwork management with RMON and SMON, and finally the commercially available SNMP management platforms. Finally the SNMP management framework and Telecommunication management network (TMN) are compared.

1. Introduction to SNMP

- 1.1. SNMP evolution
- 1.2. Original goals and purpose of SNMP
- 1.3. SNMP-Based management framework components

2. The SNMP information model

- 2.1. Structure of management information
- 2.2. ASN.1
- 2.3. The MIB Definition tree
- 2.4. MIB II and technology specific MIBs
- 2.5. Remote Network Monitoring MIB
- 2.6. Proprietary MIBs
- 2.7 Examples of MIB definitions
- 2.8. Object Type and Object Instance
- 2.9. Defining your own MIB

3. The SNMP communication model

- 3.1. SNMPv1 and SNMPv2 functions
- 3.2. SNMPv1 PDUs
  - 3.2.1. GetRequest
  - 3.2.2. Get-NextRequest
  - 3.2.3. SetRequest
  - 3.2.4. GetResponse
  - 3.2.5. Trap
  - 3.2.6. Authentication and other requirements
- 3.3. SNMPv2 additional PDUs
  - 3.3.1. GetBulkRequest
  - 3.3.2. InformRequest
  - 3.3.3. Authentication and Access control

- 3.4. Coexistence of SNMPv1 and SNMPv2 by means of proxy-agent
- 3.5. Migrating from SNMPv1 to SNMPv2

4. Managing Network components

- 4.1. Managing interfaces
  - 4.1.1. Ethernet/IEEE 802.3
  - 4.1.2. IEEE 802.5 and 802.4
  - 4.1.3. FDDI
  - 4.1.4. DS1, E1, X.25, DS3, frame relay
- 4.2. Managing hubs, concentrators, bridges and routers
- 4.3. Managing subnetworks
- 4.4. Managing systems
  - 4.4.1. PCs
  - 4.4.2. Workstations
- 4.5. Managing the unmanageable: Modems and Proprietary devices

5. Managing large networks

- 5.1. Enterprisewide internetworks
- 5.2. Management by proxy
- 5.3. Setting up management domains
- 5.4. Manager-to-manager MIB
- 5.5. Remote monitoring (RMON MIB)

6. SNMP/OSI comparison

- 6.1. Communication model
- 6.2. Information model
- 6.3. Organizational model
- 6.4. Architectural model

7. SNMP-based network management platforms (Current capabilities and future directions)

- 7.1. SUNnet Manager
- 7.2. HP OpenView
- 7.3. IBM NetView/6000
- 7.4. Other players

TELECOMMUNICATION SERVICE AND NETWORK MANAGEMENT INFORMATION MODELING

Course objective : Gain knowledge on the principles of and rules for the modeling of telecommunication networks and services for the purpose of their management.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, Software engineers
Pre-requisites : basic knowledge on the Object Oriented Approach
Duration : 2,3 or 4 days according to the necessary degree of deepening

This course objective is to introduce the set of concepts and principles needed for the definition and specification of a generic telecommunication network and service information model (ITU-T G.805 et M.3100, ETSI GOM, SMFs) and to show how to specialize the model to different network technologies (IP, ATM, SDH, Frame Relay) and services (transmission services, data services, etc.). In addition, this course shows the relationship between the management processes and the information model and introduces the commercial service and network inventories (IronMan, Dimension, Objectel, Smallworld, etc).

1. Introduction to modeling
   - 1.1. The object oriented approach
   - 1.2. What does information modeling mean ?
   - 1.3. Why is modeling important ?
2. Telecommunications Resources to model
   - 2.1. Introduction to G.805
   - 2.1.1. Reference points
   - 2.1.2. Transport processing functions
   - 2.1.3. Transport Entities: Trail, network connection, Subnetwork connection and link connection
   - 2.1.4. Topological components : layer network, link, subnetwork
   - 2.2. Application to SDH and PDH: ITU-T G.803
   - 2.3. Application to ATM : ITU-T I.326
   - 2.4. Application to Access Networks
   - 2.5. Application to Internet Protocol
3. Introduction to Modeling Languages
   - 3.1. Textual Management Languages: GDMO, GRM, ASN.1, IDL
   - 3.2. Graphical Langugages : UML
   - 3.3. Modeling tools : Rational Rose
4. Generic Telecommunication Service and Network Management Information Models
   - 4.1. The ITU-T M.3100 Model : Network Element Management Model
   - 4.1.1. Application to SDH : ITU-T G.774
   - 4.1.2. Application to ATM : ITU-T I.751
   - 4.2. The ETSI GOM Model : Network Management Model
   - 4.2.1. Application to SDH and ATM (ATM Forum M4)
   - 4.2.2. Application to Access Networks
   - 4.3. Service Management Information Model
   - 4.4. The Systems Management Functions (SMFs) for support objects
5. Rules for the modeling of telecommunications networks and services

6. Case studies
7. Commercial Network and Service Inventory Tools (IronMan, Dimension, Objectel, Smallworld, etc.)
8. Relationship between the management information and management processes
   - 8.1. The Telecommunication Operation Processes Map (fulfillment, assurance, billing)
   - 8.2. Data manipulated by these processes

OSS AND BSS

Course objective : Gain knowledge on the principles and architecture of a telecommunication network operator information system through its OSS (Operation Support System) and BSS (Business Support System).
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants, Information System Architects
Pre-requisites : Basic knowledge on the operation of a telecommunications operator
Duration : 2 or 3 days

The objective of this course is to introduce the Information System (IS) of a telecommunication network operator through its OSS (Operation Support System) and BSS (Business Support System).
The IS is detailed according to three architectures : Functional Architecture (Business management processes, TMF TOM Map), Information Architecture (Service and Network inventory) and Physical Architecture (customer care, SLA management systems, billing systems, service and network management systems). Emphasis is also put on the IS urbanism by means of EAI (Enterprise Application Integration) and middleware approaches.

1. Telecommunication Networks and OSS and BSS

2. Methodology for the specification and the realization of an OSS and BSS
   - 2.1. Functional Architecture : Management processes (3)
   - 2.2. Informational Architecture: Service and Network topology, connectivity and state information (4)
   - 2.3. Physical Architecture : Systems and Applications that perform the management processes and contain the information manipulated by the processes
   - 2.4. IS Urbanism : interoperability between systems belonging to the OSS and BSS

3. Management Processes Map : TOM and eTOM from TMForum
   - 3.1. Fulfillment
     - 3.1.1. Sales, Order Handling, Service Configuration, Network Provisioning, Network Inventory Management
     - 3.1.2. Commercial Fulfillment Systems
   - 3.2. Assurance
     - 3.2.1. SLA Management, Performance Management, Network maintenance and Restoration,
     - 3.2.2. Commercial Assurance systems
   - 3.3. Billing
     - 3.3.1. Invoicing, Rating, Discounting
     - 3.3.2. Commercial Billing Systems
   - 3.4. Application to some telecommunications services

4. Service and Network Management Information Modeling in the OSS : Network and Service Inventory
   - 4.1. Description of the Functional Architecture of Transport Networks: G.805
   - 4.2. Transport Networks Information Models : ITU-T M.3100, ETSI GOM
     - 4.2.1. Application to the Transmission Network and Access Network
   - 4.3. Telecommunication Services Information Model
     - 4.3.1. Application to transmission services
   - 4.4. Guidelines for the definition and specification of an information model

   - 4.5. Problematics of the realization of a service and network inventory
   - 4.6. The commercial service and network inventories
     - 4.6.1. Integrated Solutions: IronMAn, Capacity Integrator, Dimension
     - 4.6.2. API Solutions: Objectel, SmallWorld

5. OSS and BSS Urbanism
   - 5.1. Problematics
   - 5.2. The Enterprise Application Integration (EAI), ESB (Enterprise Service Bus) and Middleware Approaches
     - 5.2.1. Message Oriented Middleware (e.g., IBM MQSeries)
     - 5.2.2. Objet Oriented Middleware (e.g., CORBA Products)
     - 5.2.2. Transaction Oriented Middleware (e.g., Tuxedo)

6. Conclusion and recommendations

NGN AND IP TELEPHONY MANAGEMENT

Course objective : Understand the NGN and IP Telephony management and the impact of these networks on the telco OSS and BSS.
Attendance: Telecommunication Engineers, Network Architects, Telecommunication Consultants
Pre-requisites : Basic knowledge on the operation of a telecommunications operator
Duration : 2 days
per day

1. New network architectures
   - 1.1. Class 4 NGN: Scenario for the replacement of PSTN transit switches by a Telephony NGN architecture
   - 1.2. Class 5 NGN: Scenario for he replacement of PSTN access switches by a Telephony NGN Architecture
   - 1.3. IP Telephony : Migration of voice and video services over the enterprise data network
   - 1.4. Multimedia NGN : Telephony NGN + IP Telephony
   - 1.5. UMTS Release 3 : New broadband radio interface : UTRAN
   - 1.6. UMTS Release 4 : Telephony NGN within the UMTS core network
   - 1.7. UMTS Release 5 : Multimedia NGN within the UMTS core network
2. NGN Architecture Components
   - 2.1. The Media Gateway
     - 2.1.1. Trunking Gateway
     - 2.1.2. Access Gateway
     - 2.1.3. Residential Gateway or IAD
   - 2.2. Media Gateway Controller or Softswitch
   - 2.3. Signaling Gateway
3. IP Telephony Architectures
   - 3.1. H.323
   - 3.2. SIP
   - 3.3. H.323 and SIP architecture components
   - 3.4. H.323 / SIP comparison
4. Multimedia NGN Architecture Components
5. Vendors Solutions :
   ALCATEL, ERICSSON, NORTEL, SIEMENS, LUCENT, CISCO, SONUS NETWORKS.
6. NGN and IP Telephony equipment management by vendors
   - 6.1. NGN and IP Telephony MIBs
     - 6.1.1. MEGACO MIB
     - 6.1.2. SIGTRAN MIB
     - 6.1.3. H.323 MIB
     - 6.1.4. SIP MIB
     - 6.1.5. Specification of NGN and IP Telephony MIBs : SMIv2
   - 6.2. Management protocol for NGN and IP Telephony

     - 6.2.1. SNMPv1, SNMPv2 and SNMPv3
     - 6.2.2. Trends towards SNMPv3
     - 6.2.3. Q3 for Telephony NGN management
7. Technical Service and Network Management : OSS
   - 7.1. Management processes : TMF TOM
     - 7.1.1. Fulfilment : Planning and Provisioning
     - 7.1.2. Assurance : Fault and Performance Monitoring
     - 7.1.3. Billing
     - 7.1.4. TOM processes applied to Class 4 NGN
     - 7.1.5. TOM processes applied to Class 5 NGN
     - 7.1.6. TOM processes applied to Multimedia NGN
   - 7.2. Service and Network Inventory : Management Data
     - 7.2.1. Underlying concepts : G.805, M.3100
     - 7.2.2. Application to the Class4, Class 5 and Multimedia NGN
   - 7.3. Communication within the OSS Middlewares, EAIs (Enterprise Application Integration) and ESB (Enterprise Service Bus)

Contact information

• For any information on our course portfolio,
• For any request on specific courses,
• For customization of any course to your needs,

Do not hesitate to contact us:

EFORT, 3 Rue de l 'Eperon, 77000 Melun, France
Phone : + 33672193726
E-mail : sznaty@efort.com
WEB site : http://www.efort.com