

IEEE WCET Recertification: Renew Your Credential

Recertification is required after three years for those who certified or renewed their certification in 2015 and later, and after five years for those who certified before 2015, as determined by the year the current certification was issued (shown on the individual's current certificate). For example, credential holders who earn their certification in 2017 will need to recertify by 2020. Credential holders who earned their certification in 2014 will need to recertify in 2019. You will have until the Spring or Fall, depending on the date of your certification, of the third or fifth year after you earned your credential to renew your certification. All recertification's are valid for three years. If you have any questions about when your certification is due for renewal, please send an email to cert@comsoc.org.

You can earn recertification by submitting an application showing the earned Professional Development Units (PDUs) through contributions to the profession and/or personal professional development.

The recertification fee for the three-year period is \$180 for IEEE/ComSoc members and \$210 for non-members.

To Recertify by Submitting the Application Showing the Earned PDUs

Professional Development Units (PDUs) quantify a candidate's professional and educational or learning activities. PDUs can be earned through participation in activities related to contributions to the profession and/or professional development in the area(s) covered by WCET. Depending on the date of your certification, the Spring deadline to submit PDUs for your recertification is 30 April and the Fall deadline is 31 October. You may apply up to six months before your deadline.

A minimum of 60 PDUs distributed over a three-year recertification cycle, or a minimum of 100 PDUs distributed over a five-year recertification cycle, must be earned during in order to maintain certification. To ensure that the candidate has a broad knowledge of the field, these activities must be related to at least three of the seven areas major areas of expertise noted in the following pages.

The following tables outline a variety of ways in which PDUs can be earned and the maximum number of PDUs that can be earned through each activity. Candidates can download an application from www.ieee-wcet.org/recertification into which they can enter their information to apply for recertification. The completed application should be submitted to the WCET recertification committee by sending it by email to wcetrecertification@comsoc.org.

All submissions are subject to selection for an audit. If an application is selected for audit, evidence validating the claimed PDUs will be required. Such evidence may include attestation by a candidate's manager regarding work performed, proof of attendance at a training course or conference, or similar verification. A listing of typical documents that may be requested can be accessed at the Recertification page at the WCET website.

All new certifications will be for a three-year period, in keeping with the accelerating pace of change in the industry and in alignment with numerous other professional certifications. Candidates who earned certification/recertification in 2015 or later will recertify after a three-year period and should refer to the table for a three-year cycle to find out how the required 60 PDUs can be earned. Candidates who earned certification/recertification prior to 2015 will recertify after a five-year period and should

refer to the table for a five-year cycle to find out how to submit PDUs that provide evidence that they maintained their professional activities throughout the five year certification period.

Table of PDUs for Recertification after a 3-Year Certification: 60 PDUs Total

“Contributions to the Profession” include such activities as the following:

Activity	Description	Maximum PDUs Allowed
Professional Activities	Working in wireless communications <ul style="list-style-type: none"> • Submittal or receipt of a patent • At least 50% of your time spent doing professional level work 	30 PDUs (Up to 10 PDUs/year per three-year cycle for professional-level work. Up to 5 PDUs for a patent application/10 PDUs for a patent awarded with a maximum of 10PDUs for patents).
Professional/ Industry Volunteer Services	<ul style="list-style-type: none"> • ComSoc officer • ComSoc committee membership • Relevant industry standards, conference, or similar committee membership 	20 PDUs (1 PDU per hour of volunteer service up to a maximum of 10 PDUs/year)
WCET Program Support	<ul style="list-style-type: none"> • Writing or reviewing exam questions • Developing a WCET-related tutorial • Contributing to the WEBOK 	15 PDUs (1 PDU/hour of effort)
Course Development/ Instruction	Developing and/or teaching a course in wireless communications; Course development earns twice as many PDUs as teaching.	20 PDUs (1 PDU per hour of teaching; 2 PDUs per hour of course development)
Publications	Publishing relevant technical papers, articles, books, book chapters, etc.	15 PDUs (1 PDU per hour of effort)

Continued on next page

“Professional Development” includes activities such as the following:

Activity	Description	Maximum PDUs Allowed
Formal Training Programs	Attending relevant live or on-line courses offered by ComSoc or by educational institutions, commercial training providers, and industry organizations or similar.	15 PDUs (1 PDU per hour of study)
Self-Directed Learning	The use of assessment-based self-directed education, such as online tutorials, CDs, DVDs, printed materials, or instructional manuals	10 PDUs (1 PDU per hour of study)
Other Certifications	Acquiring or maintaining a relevant professional license or certification. For example, a Professional Engineer (PE) license (provided the holder is practicing in the field of wireless communications), various state or regulatory body certifications, or other relevant credentials earned through recognized industry/professional organizations.	15 PDUs (1 PDU per hour of effort provided the hours are not claimed elsewhere [e.g., as training])
Industry Conferences and Events	Attending relevant technical sessions, workshops, and/or training activities offered at conferences and other industry events.	15 PDUs (1 PDU per hour of attendance)
Professional/Industrial Community	Attaining a higher level of membership, such as Senior Member or Fellow, in a relevant professional/industrial community.	15 PDUs (PDUs depend on the prior and new member levels)

Table of PDUs for Recertification after a 5-Year Certification: 100 PDUs Total

“Contributions to the Profession” include such activities as the following:

Activity	Description	Maximum PDUs Allowed
Professional Activities	Working in wireless communications <ul style="list-style-type: none"> • Submittal or receipt of a patent • At least 50% of your time spent doing professional level work 	50 PDUs (Up to 20 PDUs for a patent; 6 PDUs/year, to a maximum of 30 per five-year cycle for professional-level work)
Professional/Industry Volunteer Services	<ul style="list-style-type: none"> • ComSoc officer • ComSoc committee membership • Relevant industry standards, conference, or similar committee membership 	30 PDUs (1 PDU per hour of volunteer service up to a maximum of 10 PDUs/year)
WCET Program Support	<ul style="list-style-type: none"> • Writing or reviewing exam questions • Developing a WCET-related tutorial • Contributing to the WEBOK 	25 PDUs (1 PDU/hour of effort)
Course Development/Instruction	Developing and/or teaching a course in wireless communications; Course development earns twice as many PDUs as teaching.	30 PDUs (1 PDU per hour of teaching; 2 PDUs per hour of course development)
Publications	Publishing relevant technical papers, articles, books, book chapters, etc.	25 PDUs (1 PDU per hour of effort)

“Professional Development” includes activities such as the following:

Activity	Description	Maximum PDUs Allowed
Formal Training Programs	Attending relevant live or on-line courses offered by ComSoc or by educational institutions, commercial training providers, and industry organizations or similar.	25 PDUs (1 PDU per hour of study)
Self-Directed Learning	The use of assessment-based self-directed education.	15 PDUs (1 PDU per hour of study)
Other Certifications	Acquiring or maintaining a relevant professional license or certification. For example, a Professional Engineer (PE) license (provided the holder is practicing in the field of wireless communications), various state or regulatory body certifications, or other relevant credentials earned through recognized industry/professional organizations.	25 PDUs (1 PDU per hour of effort provided the hours are not claimed elsewhere [e.g., as training])
Industry Conferences and Events	Attending relevant technical sessions, workshops, and/or training activities offered at conferences and other industry events.	20 PDUs (1 PDU per hour of attendance)
Professional/Industrial Community	Attaining a higher level of membership, such as Senior Member or Fellow, in a relevant professional/industrial community.	25 PDUs (PDUs depend on the prior and new member levels)

A relevant course, license, session, or community is one whose principal focus is on one or more aspects of wireless communication. Ideally, the activity will be related to a topic in the major areas of expertise noted in the following pages.

Major Areas of Expertise

Area 1 (11-15%) - RF Engineering, Propagation, Antennas, and Signal Processing: Tasks and knowledge related to: antennas, RF engineering, transmission, reception, propagation, channel modeling, and signal processing.

Evaluate system performance and reliability; calculate path loss; evaluate the effects of different fading and empirical path loss models; calculate and evaluate the effects on the received signal of path-related impairments; determine parameters related to antennas or antenna arrays; generate and evaluate coverage and interference prediction maps; develop and analyze procedure to optimize the coverage of a radio; make RF system measurements.

Area 2 (19-23%) - Wireless Access Technologies: Tasks and knowledge related to wireless access networks, especially the physical, MAC, and link layers.

Analyze building blocks, multiple access, mobility management, and spectrum implications in wireless access system design; analyze design considerations to optimize capacity/coverage; design and analyze a wireless access system; analyze the required bandwidth for a wireless system and tradeoffs; analyze wireless access technology standards, their features, and evolution.

Area 3 (19-23%) - Network and Service Architecture: Tasks and knowledge related to network infrastructure, including core networks; service frameworks such as IMS; and application architectures such as voice, video streaming, and messaging. All-IP services architecture as in 3GPP Rel 6 and beyond, including Enhanced Packet Services (EPS) as in 3GPP Rel 8 LTE (Long Term Evolution) and EPC (Enhanced Packet Core).

Analyze service platforms, IP addressing schemes for various technologies; design and test quality of service (QoS); select and test a load-balancing scheme; analyze IP routing and ad hoc routing and mesh protocols; perform capacity planning, error tracking, and trace analysis; analyze the evolution of mobile networks to enable IP multimedia.

Area 4 (19-23%) - Network Management and Security: Tasks and knowledge related to fault, configuration, account, performance, maintenance, security management, management availability, and operation support systems (examples include network service assurance and provisioning).

Design a fault monitoring system and a performance monitoring system; develop/specify types and methods of alarm reporting; compute availability and reliability metrics; assess the potential impacts of known security attacks; plan corresponding solutions to known security attacks.

Area 5 (8-12%) - Facilities Infrastructure, Standards and Regulations: Tasks and knowledge related to the specification, design, implementation, and operation of facilities and sites, and externally imposed compliance requirements and conformance testing, including interoperability.

Determine power consumption; analyze electrical protection requirements and design the electrical protection layout for a wireless telecommunications facility; determine the required antennas for the facility and their positions; develop a specification for the required structure for a wireless base station facility; determine the required cable, antennas, and materials to implement an in-building wireless network; evaluate equipment compliance with industry standards, codes, and site requirements.

Assess service and equipment quality; prepare specifications for purchasing services and equipment and evaluate the responses; verify compliance with regulatory requirements; select and analyze frequency assignments; perform standardized homologation tests as required by regulatory or standardization

bodies; evaluate compliance with health, safety, and environmental requirements; perform conformance/interoperability analyses of systems and components; analyze the use of licensed vs. unlicensed spectrum; obtain licenses and permits.

Area 6 (11-16%) – Emerging New Paradigms and Services: Tasks and knowledge related to ongoing developments in protocols and architectures for emerging new standards in wireless (5G, 802.11) and service requirements and application scenarios.

Analyze new network and service provisioning architectures (e.g. 5G); emerging standards in W-WAN and W-LAN (especially recent developments of IEEE 802.11); network virtualization and slicing; Internet of Things (IoT); Machine Type Communications (MTC); evolution of the Evolved Packet Core; analyze the evolution of wireless systems to support emerging applications.

Area 7 (8-12%) - Fundamental Knowledge: Basic knowledge that a wireless communications engineer would use in order to perform tasks across all domains.

Apply basic concepts related to electrical engineering, communications systems, and general engineering management.

Area 1 — RF Engineering, Propagation, Antennas, and Signal Processing

Tasks:

T1.01 Calculate link budgets to evaluate system performance and reliability based on received signal level and fade margin (examples might include satellite, microwave link, base station to mobile station, wireless LAN and PAN); calculate path loss for various RF transmission systems (examples might include between isotropic or dipole reference antennas, base station to mobile station, base station to repeater, earth station to satellite, LOS/NLOS paths, and clutter losses).

T1.02 Calculate the capacity of various multiple-antenna schemes, and analyze the tradeoffs involved in selecting from among alternative schemes (calculations might include analysis of pre-coding techniques).

T1.03 Evaluate the effects of different fading models (examples might include Rayleigh and lognormal) and empirical path loss models on the received signal strength in various signal propagation environments (examples might include flat terrain, rolling hills, urbanized areas, and indoor environments [such as buildings or tunnels] with losses caused by walls, ceilings, and other obstructions).

T1.04 Calculate and evaluate the effects on the received signal of path-related impairments, such as Fresnel Zone blockage, delay spread, and Doppler shift of a signal received by a moving receiver.

T1.05 Calculate the polarization mismatch loss for various antenna systems (examples might include fixed microwave systems, cellular and mobile radio systems, and satellite systems).

T1.06 Evaluate receive diversity gain for selection, equal gain, and maximal ratio diversity system configurations.

T1.07 Determine parameters related to antennas or antenna arrays (examples might include pattern, beamwidth, gain, SAR-reduction features, distance from an antenna or array at which far field conditions apply, spacing, beam forming, tilt, and sectorization) and analyze the effects of these parameters on coverage.

T1.08 Determine appropriate antenna location at base station sites to prevent inter-system and intra-system interference effects, taking into account required radiation patterns and mutual coupling effects.

T1.09 Generate and evaluate coverage and interference prediction maps (examples might include maps for cellular, mobile radio, and WLAN systems).

T1.10 Develop and analyze a procedure to optimize the coverage of a radio system using propagation modeling and “drive test” measurements.

T1.11 Develop a block diagram of an RF system (examples might include cellular, land mobile, and WLAN) employing standard modules (examples might include filters, couplers, circulators, and mixers) and/or using lumped or distributed matching networks, microstrips, and stripline.

T1.12 Make and analyze RF system measurements (examples might include swept return loss to determine antenna system performance, transmitter output power [peak or average, as appropriate], signal-to-noise ratio at a receiver front end, and co-channel and adjacent-channel interference for specific types of signal spectra).

Knowledge of:

K1.01 different types of losses (examples might include transmission line loss, antenna gain, connector losses, and path loss)

K1.02 procedures to calculate antenna gain and free space path loss

K1.03 statistical fading models and distance-power (path loss) relationships in different propagation environments

K1.04 the effects of outdoor terrain and indoor structures such as walls, floors, and ceilings on signal propagation

K1.05 common deterministic, statistical, and empirical propagation models (examples might include free space, Okumura, Longley-Rice, and ray-tracing) and software modeling tools (examples might include EDX Signal, ATDI, PathLoss, and similar radio network planning tools) used to implement them

K1.06 topographical maps and digital terrain databases

K1.07 indoor and outdoor coverage calculation and verification techniques

K1.08 E_s/N_0 , E_b/N_0 , RSSI, NF, and other system parameters

K1.09 the relationship between receiver noise figure, noise temperature, and receiver sensitivity and the relationship between sensitivity under static conditions and the degradation of effective receiver sensitivity caused by signal fading in different propagation conditions

K1.10 external noise sources and their impact on the S/N ratios of received signals, and techniques for measuring the impact of external noise

K1.11 basic antenna system design and use including antenna types (examples might include omnidirectional, panel, parabolic, dipole array, indoor antennas), antenna patterns, gain and EIRP, EIS, ERP, TIS, TRP, antenna size, antenna polarization, receive and transmit diversity, antenna correlation coefficients (examples might include MIMO antenna systems), and proper antenna installation to provide for coverage, interference mitigation, and frequency reuse

K1.12 adaptive antenna methods and techniques, including null-steering, selection diversity, optimal-ratio combining, adaptive antennas, spatial multiplexing, space-time coding, and MIMO techniques

K1.13 subscriber unit, mobile, and device antennas and their performance characteristics, including SAR-reduction characteristics

K1.14 use of test equipment such as network analyzers, spectrum analyzers, and TDRs

K1.15 co-channel and adjacent channel interference analysis and measurement methods and techniques; multi-user detection and interference-cancellation schemes and their limitations

K1.16 filters, power dividers, combiners, and directional couplers

K1.17 signal processing techniques, including matched filtering, adaptive filtering, adaptive equalization, and Rake processing

Area 2 — Wireless Access Technologies

Tasks:

T2.01 Analyze multiple access schemes for various technologies.

T2.02 Analyze spectrum implications in wireless access system design (examples might include applications, TDD/FDD, inter-modulation, LOS/NLOS, coverage/capacity).

T2.03 Analyze design considerations and perform system design to eliminate coverage holes and to optimize capacity/coverage in urban/indoor areas.

T2.04 Design and analyze a wireless access system (examples might include AP placement and channel selection) according to given bandwidth requirements, coverage, and other considerations.

T2.05 Test devices with respect to interference issues in various operating environments (examples might include TDMA, CDMA, WCDMA, WLAN, 802.15).

T2.06 Perform interference analysis (examples: co-site interference in TDMA, CDMA, WCDMA, WLAN, 802.15, and GSM; effect of interference on capacity in cellular, WLAN, WAN, ad hoc and sensor networks).

T2.07 Compute the required bandwidth for a wireless system given certain network conditions (examples might include BER, flow count, and protocols in use).

T2.08 Analyze the tradeoffs (examples might include bandwidth versus BER) of various error detection and correction techniques.

T2.09 Analyze the tradeoffs and capacity implications of mitigation techniques for time-varying channels, including channel estimation; time- and frequency-recovery and tracking; modulation/demodulation; pre-coding; and power control schemes (examples: scheduling algorithms, bandwidth versus power efficiency analysis).

T2.10 Calculate frequency re-use factor.

T2.11 Design fundamental elements/attributes of wireless network systems (examples might include cellular, 802.16, WLAN, and satellite).

T2.12 Analyze the steps involved in the process of handover/handoff for various wireless systems (examples might include UMTS, CDMA2000, 802.16, and WLAN).

T2.13 Analyze the tradeoff between the size of a paging area and the location update frequency.

Knowledge of:

K2.01 multiple access and multiplexing schemes (examples might include TDMA, CDMA, OFDMA, FDMA, and SDMA)

K2.02 technology standards and their evolution (examples might include WCDMA, CDMA2000, LTE, 802.11, 802.15, and 802.16)

K2.03 error detection and correction, ARQ, HARQ, Turbo Coding, link-adaptation, modulation/demodulation, and pre-coding techniques

K2.04 objectives of channel-estimation and power-control schemes and their operation

K2.05 handover/handoff/mobility management, including inter-technology handover/handoff

K2.06 paging functions

K2.07 the major components of a wireless network topology

K2.08 LEOS, MEOS and geostationary satellites, their bands, and their usage for broadcasting

Area 3 — Network and Service Architecture

Tasks:

T3.01 Analyze service platforms including service enablers (examples might include messaging, positioning, and location), service creation/delivery (examples might include Open Service Access and Parlay), and service-oriented architecture (SOA). Design and engineer various VAS (CRBT, SMS, VMS, Alerts, etc.) services on wireless network CORE. Design optimum network services for data traffic.

T3.02 Analyze IP addressing schemes for various technologies (examples might include Mobile IP, RObust Header Compression [ROHC] as in VoIP over HSPA or LTE, IPv4, and IPv6).

T3.03 Design and test quality of service (QoS) (examples might include design and plan for adequate resources, selecting priority schemes, prioritization of differentiated services, queuing strategies, mapping of QoS classes between network and transport layers and call admission control) for VoIP and IMS-based services. Calculate Capacity and Grade of Service (GOS) for a cellular network e.g., GSM/WCDMA/LTE networks. Provision QoS for different applications per 3GPP standards, e.g. through QCI, ARP, etc. for LTE/EPC networks.

T3.04 Select and test a load-balancing scheme.

T3.05 Analyze IP routing (examples might include interpreting an IP routing table).

T3.06 Analyze ad hoc routing and mesh protocols, and suitability for various deployment scenarios.

T3.07 Perform capacity planning using traffic engineering principles.

T3.08 Perform error tracking and trace analysis on protocol control messages for specific systems.

T3.09 Analyze the evolution of mobile networks to enable IP multimedia services (including circuit-switched to packet-switched network evolution).

T3.10 Analyze intra- and inter-domain roaming (examples might include roaming within a country or in different countries in 3GPP networks). Analyze service continuity across domains (e.g., VoIP in LTE and circuit-switched voice in GSM/W-CDMA networks).

T3.11 Analyze the functioning of TCP/IP major transport protocols (examples might include TCP, UDP, and RTP) in the context of wireless communications and limitations of PING/Ack.

T3.12 Develop a simple block diagram-level design for a network operations center (examples might include digital cellular, web-based mobile content, multimedia broadcast, and SMS).

Knowledge of:

K3.01 IMS (IP multimedia subsystems) and its architecture, including session control and switching plane; knowledge of different VAS in wireless domain

K3.02 VoIP/IP-multimedia protocols

K3.03 wireless service enablers evolution, including call processing architecture/framework, feature development/enhancement, as well as applications such as presence, location, etc. policy rules, decisions, charging and enforcement

K3.04 location and positioning techniques

K3.05 load balancing principles in the context of wireless communications, and methods to avoid single point of failure through active/active or active standby, and concept of self organizing networks (SON)

K3.06 IP routing and mobile IP networking and addressing schemes including WLAN systems. IP evolution in wireless access - backhaul and packet core connectivity

K3.07 error tracking and trace analysis techniques for dropped cells, access failures and other network related problem reports

K3.08 circuit switched and packet switched data and packet cellular networks and the differences between them; knowledge of various data capable technologies - 1xRTT, EVDO, GPRS/EDGE, LTE

K3.09 roaming and roaming controls

K3.10 TCP/IP including transport protocols including WLAN systems

K3.11 Access Point Name and its functionality

K3.12 heterogeneous architecture for single-hop and multi-hop wireless networks

Area 4 — Network Management and Security

Tasks:

T4.01 Design a fault monitoring system (examples might include using SNMP TRAP/NOTIFICATION, and using 2G OAM&P standards at Network Element Layer [NEL], Equipment Management Layer [EML], and Network Management Layer [NML]).

T4.02 Design a performance monitoring system (examples might include using SNMP GET/SET and performance measurement on radio layer, BTS and RNC, usage and traffic analysis and accounting, monitoring SAACH frame error rate in 3GPP networks).

T4.03 Develop/specify types and methods of alarm reporting for an installation, and other OAM&P.

T4.04 Compute availability and reliability metrics from both the “network performance” and “system designer” perspectives (related to equipment failure).

T4.05 Assess the potential impacts of known security attacks on wireless systems (examples might include virus, worm, DoS, network sniffing, flooding and impersonation; additional examples might

include SIM/USIM card cloning, attempting bank transaction using prepaid cellular handsets, integrity of SMS, multi subscription of USIM card etc).

T4.06 Plan corresponding solutions to known security attacks (examples might include stolen SIM card, stolen PIN, use of different handsets using the same SIM card etc).

T4.07 Monitor, log, and audit security-related data (including tasks such as streaming system logs to third party box for analysis and reporting).

T4.08 Analyze security vulnerabilities and prepare/recommend corrective actions; develop comprehensive test plan for network security testing.

T4.09 Design and plan a migration to a new network management scheme (including impacts on OSS, BSS, and billing); design proper access levels (user management) and its implementation.

T4.10 Analyze wireless accounting and billing schemes including inter-operator accounting.

T4.11 Design and establish VPN communications from client to host.

T4.12 Design a secure system using state-of-the-art solutions

Knowledge of:

K4.01 quality of service (QoS) monitoring and control

K4.02 fault management

K4.03 configuration management including licensing mechanisms, feature addition/integration, system initialization and installation, policy-based management, role-base access control, level of security offered OTA by standard cellular and wireless systems, and architectures for service management

K4.04 authentication, authorization, and accounting (AAA) principles and mechanisms and APN security; CAVE, A3/A8 and other authentication algorithms - separating mobile from subscription data; cellular authentication schemes based on HLR, VLR, SIM card

K4.05 types of security attacks on wireless networks (examples might include use of stolen SIM card, fraudulent techniques to use handsets in non-designated areas)

K4.06 protocols to secure wireless networks (examples might include Application Security, Web security and Secure Socket Layer, VPN, RADIUS, DIAMETER, HLR/VLR and encryption methods based on cellular algorithms), and Self Organizing/Optimizing networks for next generation networks

K4.07 security-violation events logging and monitoring, attempts towards billing fraud, SIM card manipulation and detection, etc. and different security testing tools

K4.08 security issue management and resolution (examples might include management of A-key, OTAP and HLR/VLR updates, monitoring handoff and reauthentication during call)

K4.09 network management protocols (examples might include simple network management protocol [SNMP], network scanning for BTS identification, interface measurements, data quality measurements, video quality measurements, verification of test mobile phones, acquisition of calibration data for planning tools)

K4.10 performance metrics pertinent to various access networks (examples might include Carrier to Interface (C/I) matrix; recommended changes to neighbor list to ensure appropriate cell handovers and others)

K4.11 IP security, Encapsulation Security Payload (ESP), Internet Key Exchange, and digital signature; root authentication keys in removable UIM, Data Subscriber Authentication - DSA over the air interface

K4.12 MIB, RMON, and Internet Control Messaging Protocol (ICMP)

K4.13 intrusion detection systems, DDoS attacks, and traceback techniques; GSM security IMSI/TMSI, RAND, SRES-HLR and AuC checking methods, network controlled policies, on-line and off-line charging for pre-paid subscribers

K4.14 operational process models (examples might include ITIL and eTOM); writing A-key into mobile – manual and over-the-air procedures

K4.15 hot billing during call, hot billing after call, and similar cases

K4.16 OTAP (Over the air provisioning methods), USIM (Universal SIM) card architecture, Kasumi security algorithm

K4.17 mobile money transaction methods, near-field communications and security

K4.18 knowledge of state-of-the-art network security solutions

Area 5 — Facilities Infrastructure, Standards and Regulations

Tasks:

T5.01 Determine the power consumption of a unit of communications equipment (examples might include tower amplifier modules, pressurization systems for waveguides).

T5.02 Determine the power consumption for a facility containing communications equipment (examples might include base station amplifier racks, microwave system rack etc.).

T5.03 Design a DC power plant to support the facility for a given required reserve time.

T5.04 Analyze the electrical protection requirements (includes grounding/earthing, bonding, shielding, and lightning protection) and design the electrical protection layout for a wireless telecommunications facility.

T5.05 Design a wireless communication facility layout plan with considerations for heating, air conditioning, ventilation, and structural issues.

T5.06 Determine the required antennas for the facility, including specification of the antenna system from RAN to Antenna. Identify and size common types of antenna, amplifiers, and cable for a given scenario.

T5.07 Determine the required antenna positions on a structure (examples might include towers located in remote/extreme conditions such as mountain tops, arctic areas, etc.).

T5.08 Design the waveguide/transmission line layout between the communications electronics and the antenna(s).

T5.09 Coordinate with other users when implementing a communications system in a shared location.

T5.10 Develop a specification for the required structure for a wireless base station facility based on the required antenna sizes and elevations above ground.

T5.11 Determine the required cable, antennas, distributed antenna systems, and materials to implement an in-building wireless network.

T5.12 Determine the required number of racks on which to mount the equipment and the rack layout and placement, taking into account the maintainability of the equipment.

T5.13 Evaluate equipment compliance with industry standards, codes, and site requirements such as NEBS/ETSI specifications as well as ANSI, IEC, local/city regulations, right of way, and other applicable standards.

T5.14 Design a site-specific alarm and surveillance system.

T5.15 Prepare specifications for purchasing services and equipment, and evaluate the responses, including relevant country-specific standards (examples might include preparing request for proposals for introducing new services/licenses and evaluating submitted proposals for implementation of universal services projects).

T5.16 Verify compliance with regulatory requirements (examples might include licensing, standards, rules, and regulations).

T5.17 Select and analyze frequency assignments.

T5.18 Evaluate compliance with health, safety, and environmental requirements.

T5.19 Perform conformance/interoperability analyses of systems and components, including self organizing and self optimizing networks for NGN.

T5.20 Analyze the use of licensed vs. unlicensed spectrum.

T5.21 Obtain and draft licenses and permits where required, including software, hardware, product licenses (open source, GNU, IP, patent laws).

T5.22 Perform market analysis, study of market indicators, and pricing of telecom services.

Knowledge of:

K5.01 procedures to determine the power consumption of wireless communications equipment (examples might include satellite earth station facility, ship/small island based facility, etc.)

K5.02 how to determine the power required to support a site (examples might include solar and wind based support for tower sites, considerations of bird nests, heated radome, etc.)

K5.03 the application of AC and DC power systems (examples might include urban towers based on roof tops, tunnels and bridges)

K5.04 the application of alternative energy sources to wireless communications facilities (examples might include use of solar, wind power, or bio-mass in rural areas)

K5.05 heating, ventilation, and air conditioning (HVAC) requirements

K5.06 equipment racks, rack mounting spaces, and related hardware

K5.07 electrical protection (including grounding/ earthing, bonding, shielding, and lightning protection)

K5.08 basic waveguides and transmission lines (examples might include elliptical waveguides, multiple cables runs, pressurization and sealing of connectors, etc.)

K5.09 tower specifications and standards (examples might include wind load calculation based on Effective Plate Area, alignment kits, and elevation angle measurements)

K5.10 physical security requirements

K5.11 alarm and surveillance systems

K5.12 effects of environmental exposure (examples might include corrosion, temperature, and UV susceptibility)

K5.13 NEBS/ETSI specifications as well as ANSI, IEC, and other applicable standards, codes, and other relevant site-specific requirements

K5.14 where to find expertise in structural engineering, fire suppression, and other building systems

K5.15 regulatory requirements and telecom laws (examples might include international, national, and local); emerging standards and network evolution (examples might include convergence of networks, IMT-advanced); regulatory pillars (examples might include transparency, free competition) and mandates (examples might include consumer protection, universal service); international organizations and corresponding structure and functions (examples might include the role of ITU and its subdivisions)

K5.16 spectrum licensing (examples might include leasing options, primary and secondary assignments in license)

K5.17 spectrum characteristics, availability, and management including formal methods of measurements to report non-compliance to regulatory bodies

K5.18 local and site-specific rules/codes (examples might include the National Electric Code in the US and analogous codes in other countries) and engineering regulations (examples might include when engineering work needs to be sealed by a Professional Engineer)

K5.19 electrical and RF safety (examples might include UL, EC, CSA, and IEEE C.95)

K5.20 frequency assignment databases and online tools (examples might include verification of registered users in the area, experimental bands and their usages)

K5.21 health, safety, and environmental issues (examples for RF safety might include SAR limits for different countries [e.g., American limits vs. European limits for accepted SAR-values] and their different ways to measure it)

K5.22 equipment type approval processes/requirements

K5.23 how to identify and locate appropriate industry technical standards, applicable codes, and other pertinent requirements

Area 6 — Emerging New Paradigms and Services

Tasks:

T6.1 Analyze new network and service provisioning architectures

T6.2 Design, configuration and dimensioning of an 4G LTE and LTE-A system: protocols and architecture

T6.3 Understand the evolution of cellular networks towards 5G

T6.4 Design solutions for network virtualization and slicing

T6.5 Evolution of Wireless WAN and LAN standards: IEEE 802.11, IEEE 802.15, LoRA, etc.

T6.6 Design of modern WLAN solutions (recent evolutions of IEEE 802.11 beyond ac/ad)

- T6.7** Understand the requirements and deployment scenarios of the Internet of Things (IoT)
- T6.8** Understand the requirements and deployment scenarios of Machine Type Communications (MTC)
- T6.9** Understand the requirements and deployment scenarios of Vehicle Communications (V2X)
- T6.10** Adapt solutions to the evolution of the Evolved Packet Core
- T6.11** Analyze the evolution of cellular wireless systems (RAN and core)
- T6.12** Analyze the evolution of wireless systems to support emerging applications

Knowledge of:

- K6.1** Knowledge of 4G LTE and LTE-A protocols and architecture
- K6.2** Knowledge of 5G New Radio standard
- K6.3** Knowledge of the 5G architecture, including network slicing and virtual network functions
- K6.4** Knowledge of application scenarios for wireless networks (IoT, MTC, V2X)
- K6.5** Knowledge of WiFi and its recent evolutions (IEEE 802.11b/a/g, to .11n/ac, to modern versions)
- K6.6** Knowledge of 5G RAN and EPC architectural components and protocols

Area 7 — Fundamental Knowledge

Knowledge related to electrical engineering

- K7.1** fundamental AC/DC circuit analysis
- K7.2** mathematics including linear algebra, probability, statistics, and Boolean arithmetic
- K7.3** operation of complex test instruments, including oscilloscopes, spectrum analyzers, network analyzers, TDRs, and signal generators
- K7.4** frequency spectrum and Fourier transforms
- K7.5** basic printed circuit board design considerations
- K7.6** transmission theory and lines, antennas, and basic electromagnetic wave theory and applications
- K7.7** power calculations (examples might include dB, dBm, and dBx)
- K7.8** basic concepts of queuing theory and traffic analysis
- K7.9** basic signal processing (examples: analog and digital processing; quantization; linear filtering theory, concepts, and design)
- K7.10** basic concepts related to optical communications basic electronic system-level block diagrams basic power supply design

Knowledge related to communication systems

- K7.13** basic communications and information theory (analog and digital)
- K7.14** basic telephony (including signaling, switching, and transmission)

K7.15 noise impairments

K7.16 basic EMI, EMC, and interference

K7.17 frequency allocations and reuse

K7.18 modulation techniques for analog (examples might include AM, FM, and PM)

K7.19 modulation techniques for digital (examples might include FSK, PSK, and QAM)

K7.20 wireless multiple-access schemes (examples might include FDMA, TDMA, CDMA, and variants)

K7.21 basic satellite communications

K7.22 digital data transmission formats (examples might include E1/T1 and OC-n/SDH)

K7.23 basic components of RF circuitry

K7.24 basic RF circuit design, including filter design

K7.25 basic RF coupling, radiation, and antenna theory concepts

K7.26 measurements for RF circuits and sub systems, such as output power, receiver sensitivity, noise figure, linearity performance, and spectral performance

Knowledge of general engineering management:

K7.27 project management methods and processes

K7.28 fundamental engineering economics

K7.29 design and configuration for ease of maintenance

K7.30 documentation and configuration control schemes

K7.31 IEEE Code of Ethics