

Annex 2

TEC-DEGE REFERENCE FRAMEWORK

Scope of the « TELECOMMUNICATIONS AND NETWORKS » and « DETECTION AND ELECTRONIC WARFARE » themes

The scope of the « Telecommunications and Networks » (TEC) field is defined by the list of keywords below, organised along three scientific and technical axes: I/ « Propagation, frequencies, antennas », II/ « Transmission systems », and III/ « Networks ».

I/ Propagation, frequencies and antennas

1. Propagation and frequencies

- Spectrum engineering
- Moving up in frequency
- Millimetre-wave communications
- Frequency management and planning (conventional systems and cognitive radio)
- Wave propagation (study of propagation channels, complex media, etc.)
- Influence of wave propagation on the performance of transmission systems and waveforms
- Sounding, measurement, spatial characterisation and modelling of the propagation channel (channels of various types: ground-to-ground, ground-to-air, air-to-air, etc.)
- Propagation modelling through deep learning, AI algorithms for propagation prediction by learning

2. Antennas

- Materials for microwave frequencies (absorbers, metamaterials and metasurfaces, miniaturisation, agility, multifunctional surfaces, etc.), magneto-dielectric materials (MDM), etc.
- Additive manufacturing of antennas
- Antenna technologies, co-design and co-construction
- Optimisation of conventional antennas with active modules
- Multi-band, beamforming and multimodal antennas
- MIMO and massive MIMO systems
- Advanced antenna architectures (electronically steered array antennas, multifunction antennas, integrated antennas, compact low-frequency antennas, etc.)

- Antenna design to limit self-interference in in-band full-duplex operation
- Design of direction-finding antennas (angle-of-arrival estimation)
- Reconfigurable intelligent surfaces (RIS)
- RF and antenna filters, electromagnetics and optics (optically switched multi-band filters, etc.)
- Optimising antenna performance (gain, agility, bandwidth, dimensions, etc.)
- Characterisation of antenna systems (antenna gains, far field, near field, etc.)
- Advanced antenna measurement techniques (possibly including AI techniques), antenna measurement techniques in adverse environments
- Embedded systems, integration of antenna systems onto platforms (land, air, naval, space), including drones and robots

3. Radio-electrical compatibility (REC)

- Study of interference between radio transmitters and receivers on the same platform, through the antennas, across a broad frequency spectrum (in-band and out-of-band)
- Coexistence of co-located radio systems on the same platform (vehicle, ship, aircraft, mast, etc.) and processing of electromagnetic signals emitted by the antenna of one system and received by the antenna of another

4. Inter-system electromagnetic compatibility (ISEMC)

- Study of radio interference between different systems
- Coexistence of non-co-located radio systems, and processing of electromagnetic signals emitted by the antenna of one system and received by the antenna of another

5. Modelling and simulation

- Electromagnetic modelling and simulation
- Multiphysics modelling (incorporating material and temperature models, etc.)

II/ Transmission systems

1. Waveforms, signal processing and modems

- Digital communications
- Digital architectures (manycore — GPP + DSP — DSP, FPGA, GPP, MCU, GPU, ASIC, etc.)
- RF characteristics (filtering, ADC, linearity, gains, etc.)
- Microwave components for the radio-frequency chain (filtering, interference cancellation, power limiters, controllable components, etc.)
- Multi-antenna processing and precoding (MIMO, mMIMO, etc.)
- Hybrid analogue/digital antenna processing, reconfiguration of antenna elements
- In-band full-duplex communications (same time slots, same frequency), analogue and digital self-interference cancellation
- Combining spatial modulation and in-band full-duplex operation
- Power amplifiers (satellite communications / SATCOM)
- Non-linear class-D power amplifiers (output transistors operated as switches)
- PAPR optimisation (modulation, predistortion, envelope tracking, etc.)
- Drivers for communications, modems
- Reprogrammable modems: multifunction, multi-waveform, wideband, multi-level security
- Optimal use of resources (time, spectrum, space, power)
- Moving up in frequency, in multispectral capacity and in throughput

- Very high spectral efficiency, spectral and energy efficiency
- Signal processing (classical, sparse), AI and signal processing
- Multi-user access (TDMA, CDMA, SDMA, FDMA, etc.)
- Secure waveforms
- Physical-layer security (PHYSEC, TRANSEC)
- Digital algorithms for interference reduction
- Optimisation of synchronisation mechanisms
- Optimising the jamming resistance of communication waveforms
- Discreet, stealthy and undetectable waveforms
- RadCom waveforms (radar and communications)
- New waveforms, AI and waveforms
- Communication coding
- Coding for blind operation
- New channel coding for waveforms (channel coding as FEC, etc.)
- New source coding for waveforms
- Joint source–channel coding
- Threats to the physical layer of waveforms: detection, interception, localisation, blind recognition and classification of communication signals

2. Transmission systems

- Software-defined radio (SDR)
- Cognitive radio (dynamic frequency reconfiguration)
- Reconfiguration of communications, dynamic reconfiguration of hardware
- Radio transmission systems (land, air, maritime)
- Satellite transmission systems (space segment and ground segment)
- Joint communication and direction-finding systems
- Optical transmission systems (free space, satellite — FSO — or optical fibre)
- Quantum communications (QSN/QKD, QIN)
- Embedded systems, integration of transmission systems onto platforms (land, air, naval, space), including drones and robots

3. Vulnerability of transmissions

- Geolocation and localisation
- SATCOM jamming techniques
- Counter-drone operations (characterisation, identification, localisation, jamming)
- Analysis of frequency-hopping techniques (reconstructing the hopping sequence)
- Analysis of digital telecommunication processes (reconstructing scramblers, FEC, interleavers)
- RF fingerprinting

III/ Networks

1. Network protocols

- Network protocols, transport protocols
- Control-plane protocols (routing and signalling protocols, etc.)

- Network security protocols
- Threats to the MAC (media access control), network (IP) and transport (TCP/UDP) layers
- Network management, monitoring and administration protocols
- Metrology and telemetry protocols
- Network virtualisation and softwarisation (SDWAN, SDN, NFV, etc.)
- Network programmability
- Dynamic network reconfiguration

2. Network architectures

- Heterogeneous network architectures
 - Radio networks (mobile 5G, 6G, etc.)
 - Satellite networks (including 5G/NTN)
 - Optical networks
 - Infrastructure networks
 - Infrastructure-less networks (MANET type)
 - IoT networks
- Routing
- Network virtualisation and softwarisation
- VPNs (L3VPN, EVPN, IPsec, etc.)
- Secure network architecture (including virtualised networks)
- Distributed architecture and processing (MEC, IAB, automatic reconfiguration, etc.)
- Network topology models
- Quantum networks (QSN/QKD, QIN)

3. Cross-cutting network services

- Handling of heterogeneous and sporadic flows, traffic engineering
- Performance on single networks and between heterogeneous networks (throughput, latency, etc.)
- QoS and QoE
- Optimisation of resource allocation
- Reconfiguration of communications, dynamic reconfiguration of hardware
- Network metrology
- Network management, monitoring and administration
- Detection and handling of network anomalies
- Resilience of communications and hardware
- AI and networks (routing, monitoring, network data, etc.)
- Telemetry and network data bases (the « AI and networks » question)
- Optimisation of time synchronisation mechanisms, real-time constrained networks (TSN type, etc.)
- Energy efficiency
- Network simulation

4. Network evolution

- Network impacts of the new « semantic network » approaches
- Named data networking (NDN) technologies

