Conclusion

The first book introduces the reader to the existing systems of fixed and mobile communications. Particular attention is paid to changes in the structure of wireless multi-station radio access networks and how it affected the architecture of radio receivers. The introduction of digital modulation techniques and optimal signal processing techniques on the receiving side has led to changes in the traditional receiver structures of analog modulation modes and the emergence of new ones based on the advantages of digital signal processing methods.

The classical structure of radio engineering systems has radically changed with the organization of communication between mobile users and the division of the service area into cells included in the terrestrial radio access network. This led to an increase in the role of the physical channel between the subscriber and the BS, which determines the performance indicators of the system, and the organization of packet data transmission over cable (copper and optical) and radio lines. Such a complex configuration of networks and their interaction made it possible to organize handover of subscribers within their own network and in the networks of other operators due to the use of compatible interfaces at various levels of interaction of open OSI systems.

All processes at the physical layer are controlled from the upper OSI layers, forming at the output of the BS transmitter of each cell a set of commands to MS characterizing the data transmission rate, modulation type, frequency band, clock signals, MS transmitter power control, etc. All this indicates the complexity signal processing algorithms in the receivers of each BS and MS, not taking into account the algorithms introduced in the system to increase the noise immunity of signals, antenna control, methods of coding, and signal detection. All this indicates a close relationship between the structure of radio access networks and the architecture of the receiver.

Open space, as a signal transmission guiding system, is affected by the external environment and highly dependent on the occupied bandwidth allocated to system, operating frequency, and signal propagation features. To reduce the influence of the external environment, the transmission of information about the state of the channel in the "up" direction is organized, which are included in the instructions for the MS, which determine the type of modulation and the data transmission rate for the transmitter.

A separate problem solved in the receiver is to build a non-tunable RF front-end when operating in the frequency ranges of systems of different standards and the occupied bandwidth of operating frequencies. This becomes especially relevant when mastering the frequency band allocated to the 5G standard. The RF front-end and its components must be designed to meet the stringent standards of each interoperating wireless communication system.

It is proposed to assess the properties of individual stages of the receiver and the RF front-end as a whole, with the possibility of analysis in the frequency domain and in the time interval in the MicroCap environment, which has a friendly interface and allows the use of conventional graphic designations adopted for the circuit diagrams of radio engineering devices.

The book describes the interconnection of systems, networks, and radio receivers as an integral part of such architectures. Possible ways of constructing receivers at the level of structural diagrams are shown, and influencing effects are described, starting with the properties of the radio channel and ending with the components used, as well as ways to assess their properties using circuit simulation.

The designs of the individual stages and possible ways of their implementation will be described in the second book "Elements of radio receivers of digital radio electronic systems" (in press).

V. V. Logvinov, S. M. Smolskiy, *Radio Receivers for Systems of Fixed and Mobile Communications*, Textbooks in Telecommunication Engineering, https://doi.org/10.1007/978-3-030-76628-3

Abbreviations

AAA	Authentication, authorization, accounting
AAC	Advanced audio coding
AAS	Adaptive antenna system
AC	Adjacent channel
ACF	Auto-correlation function
ACI	Adjacent channel interference, adaptive compensator of interferences
ACK/NACK	Acknowledge/not acknowledge
ADC	Analog to digital conversion
ADSL	Integrated digital subscriber line
AE	Active element
AES	Automatic error correction
AFC	Amplitude-frequency characteristic, automatic frequency control
AFR	Amplitude-frequency response
AGC	Automatic gain control
AGCN	Access grant channel
AIS	Analyzer of interference situation
AM	Amplitude modulation
AMPS	Advanced mobile personal system
AMR	Adaptive multi-rate
AMS	Adaptive MIMO switching
AP	Access point
APC	Automatic power control
ARN	Active remote node
ASK	Amplitude shift keying
ASM	Antenna switch module, analog signal multiplier
ASN	Access service network
ATM	Asynchronous transfer mode
ATS	Automatic telephone station
ATSC	Advanced television systems committee
AUC	Authentication center
AWGN	Additive white Gaussian noise
AWPM	Amplitude-width pulse modulation
BB	Base band
BBU	Base band unit
BCCH	Broadcast control channel
BER	Bit error rate
BLAST	Bell laboratories layered space-time
BM	Base model
BPF	Band pass filter
BPSK	Binary phase shift keying
BS	Base station
BSC	Base station controller
BSIC	Base station identity code

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BSS	Basic service set, base station subsystem
BT	Bipolar transistor
BTS	Base transceiver station
BOC	Binary offset code
BQM	Balanced quadrature mixers
CA	Collision avoidance, carrier aggregation
CAT	Cable television
CC	Component carrier
CCCH	Common control channel
CCI	Co-channel interference
CCK	Complementary code keying
CCN	Cognitive control network
CCS	Control-correcting station
CD	Compact disk
CDMA	Code division multiple access
CDMA-DS	Code division multiple access direct spread
CDMA-FH	Code division multiple access frequency hopping
CDMA-TH	Code division multiple access time hopping
CEPT	European Conference of Postal and Telecommunication Administrations
CMN	Cognitive mesh network
CMOS	Complementary metal-oxide semiconductor
C-NMS	Cognitive network management system
CO	Central office
C-OFDM	Code OFDM
CoMP	Coordinated multi-point
CP	Central port
CPE	Customer premises equipment
CPC	Cognitive pilot channel
CR	Cognitive radio
C-RAN	Cloud radio access network
CRC	Cycling redundancy check, cyclic redundancy code
CSMA	Carrier-sense multiple access
CSN	Circuit switched network
CSP	Central system processor
CSPDN	Circuit-switched public data network
CSS	Customer switching system
CT	Cordless telephony
CTA	Cordless terminal adapter
CTM	Cordless terminal mobility
CTV	Color TV
CWN	Cognitive wireless network, composite wireless network
DAA	Data access arrangement
DAB	Digital audio broadcasting
DAMA	Demand assigned multiply access
DAMPS	Digital advanced mobile phone system
DBPSK	Differential double-position phase shift keying
DC	Directional coupler, direct current, data center
DCI	Downlink control information
DCMS	Differential correction and monitoring system
DCS	Digital cellular system
DDS	Direct digital frequency synthesizer
Det	Detector
DECT	Digital enhanced cordless telecommunication
DFS	Dynamic frequency selection
DRiVE	Dynamic radio for IP services in vehicular environments

DRM	Digital radio mondiale
D-RAN	Distributed RAN
DRSF	Double-circuit pass-band filter
DQPSK	Differential quadrature phase shift keying
DSP	Dynamic spectrum allocation
DSMA	Digital sense multiple access
DS-CDMA	Direct spectrum CDMA
DSP	Digital signal processor
DSSS	Direct sequent spread spectrum
DSL	Digital subscriber line
DSS-UWB	Direct spread spectrum UWB
DTV	Digital television
DVB	Digital video broadcasting
DVB-T	Digital video broadcasting terrestrial
DWDM	Dense wavelength-division multiplexing
E-UTRAN	Enhanced UMTS terrestrial radio access network
ECC	Electronic communications committee (of Europe)
RMF	Electromotive force
EDACS	Enhanced digital access system
EDGE	Enhanced data rate for global evolution
EGSM	Extended Global System for Mobile Communications),
EIR	Equipment identification register
eMBB	Enhanced Mobile Broadband
EMC	Electromagnetic compatibility
EMF	Electromotive force
EMI	Electromagnetic interference
EPC	Electronic product code
eNB	Evolution node B, base station
EPIC	Electrical-physical information converter
ET	Ephemerid time
ETSI	European Telecommunications Standards Institute
FBC	Feedback circuit
FBMC	Filter bank multi carrier
FC	Frequency converter
FCC	Federal Commission of Communication
FCCH	Frequency correction channel
FCD	Frequency channel division
FDD	Frequency division duplex, full function device
FDM	Frequency division multiple
FDMA	Frequency division multiple access
FEC	Forward error correction
FEM	**F**ront-end module
FET	Field-effect transistor
FFD	Full function device
FFT	Fast Fourier transform
FIC	Fast information channel
FH	Frequency hopping
FHDC	Frequency hopping diversity coding
FHSS	Frequency hopping spread spectrum
FHSS-UWB	Frequency hopping spread spectrum UWB
FI	Fluctuation interference
FIC	Fast information channel
FIFO	First in, first out
FLS	Filter of lumped selectivity
FM	Frequency modulation

F-OFDM	Filtered orthogonal division multiplexing
FS	Frequency synthesizer
FSA	Field spectrum allocation
FSK	Frequency shift keying
FSS	Federal communication commission (of USA)
FUSC	Fully used sub-carrier
GBCMC	Ground-based complex for monitoring and control
GBS	Ground-based station
GERAN	GSM EDGE radio access network
GFDM	Generalized frequency division multiplexing
GMSC	Gateway mobile switching center
GMSK	Gaussian minimum shift keying
GNSS	Global navigational satellite system
GoS	Grade of service
GPIO	General purpose input/output
GPRS	General packet radio service
GPON	Gigabit passive optical network
CP	Compression point, cyclic prefix
CR	Cognitive radio
GSO	Geostationary orbit
GTP	GPRS tunneling protocol
HARQ	Hybrid automatic repeat request
HBT	Heterojunction bipolar transistor
HD	High definition
HDTV	High-definition television
HDR	High data rate
HEMT	High emitted mobility transit
HF	High frequency
HI	HARQ indicator
HIPERLAN	High performance local area network
HIPERMAN	High performance metropolitan area network
HLR	Home location register
HoA	Home address
HSAGC	High-speed AGC
HSCSD	High-speed circuit switched data
HSDPA	High-speed downlink packet access
HSPA	High-speed packet access
HSUPA	High-speed uplink packet access
I	Inphase
IASA	Inter access spectrum anchor
IBOC	In band on channel
IC	Integrated circuit, input circuit
ICI	Inter-channel interferences
iDEN	Interactive data entry network, integrated digital enhanced network
IGSL	Integrated digital subscriber line
IEEE	Institute of Electrical and Electronics Engineers
IEC	International Electrotechnical Commission
IF	Intermediate frequency
IFA	Intermediate frequency amplifier
IMA2	Intermodulations-apart-product 2
IMD	Intermodulation distortion
IMP2	Intermodulations-product 2
IMP3	Intermodulations-product 3
IMS	IP multimedia subsystem
IMSI	International mobile subscriber identity

IMT/UMTS	International mobile telecommunication/universal mobile telecommunications system
IN	Input circuit
IOS	International organization on standardization
IP	Internet protocol
IP2	Intercept point on 2 harmonic
IP3	Intercept point on 3 harmonic
IPD	Incumbent profile detection
IPv4	Internet protocol version 4
iPSDN	Integrated packet switched digital network
IRI	Industrial radio interference
IRFM	Input RF module
ISDN	Integrated switched digital network
ISM	Industry science medicine (range)
ISO	Open system interconnection
ITU	International Telecommunications Union
JRRM	Joint radio resource management
LAI	Location area identity
LAN	Local area network
LDSS	Local differential sub-system
LFM	Linear frequency modulation
LNA	Low-noise amplifier
LO	Local oscillator, low-orbit
LSI	Large-scale IC
LTE	Long-term evolution
LTE/E-UTRAN	Long-term evolution/evolved-UMTS-terrestrial radio access network
MAC	Media access control
MAHO	Mobile-assisted handover
MAI	Multi-access interference
MAN	Metropolitan area network
MB-OFDM	Multiband OFDM
MBS	Multicast and broadcast service
MBWA	Mobile broadband wireless access
MC	Multicarrier
MCS	Mobile communication system
MDHO	Macro diversity handover
MESFET	Metalized semiconductor field-effect transistor)
METIS	Mobile and wireless communications enablers for the twenty-twenty information society
MF	Matched filter
MFA	Amplifier of the modulation frequency
MI	Multiplicative interference
MIMO-OFDM multi-channel input	multi-channel output
MISO	Multiple input single output
MLH	Maximal load hour
MME	Mobility management entity
MMSE	Minimum mean squared error
mMTC	Massive machine type communications
MO	Middle orbit
MPEG	Motion pictures experts group
M-PSK	Multi-phase shift keying
MP2MP	Multipoint-to-multipoint
MS	Mobile station
MSC	Main service channel, mobile switching center
M2M	Machine to machine

MTC	Machine type communications
MUE	Multiuser equipment
MU MIMO	Multiuser MIMO
N	Noise factor
NAP	Network access provider
NCO	Numerically controlled oscillator
NE	Nonlinear element
NF	Noise factor, dB
NGN	Next-generation network
NG-PON2	New generation of passive optical network
NLS	Noise-like signal
NMS	Network management system
NMT	Nordic mobile telecommunication
NRZ	Not return to zero
NSA	Navigational space apparatus
NSP	Network service provider
NSS	Noise shape signal
NVF	Network function virtualization
OATS	Office automatic telephone station
OFDM	Orthogonal frequency division multiplexing
OFDMA	Orthogonal frequency division multiple access
OLT	Optical line terminal
OMC	Operating and maintenance center
ONU	Optical network units
OOB	Of-of-band
OOK	On-off keying
OS	Open service
OSI	Open system interconnection
OSM	Operator spectrum management
PaLFI	Passive low-frequency interface
PAA	Phased antenna array
PAC	Perceptual audio coding
PAN	Personal area network
PBCC	Packet binary convolution coding
PCH	Paging channel
PCM	Pulse-code modulation
PCS	Personal communication system, personal communication services
PDC	Personal digital cellular
PDN	Public data network
PDP	Packet data protocol
RFA	Radio-frequency amplifier
PFC	Phase-frequency characteristic
PG	Processing gain
PHS	Personal handyphone system
PHY	Physical layer protocol
PI	Pulse interference
PLL	Phase locked loop
PMP	Point-to-multipoint
PNF	Physical network function
PNI	Pseudo-noise in-phase
PON	Passive optical network
PPM	Pulse position modulation
PNQ	Pseudo-noise quadrature
PRS	Pseudo-random sequence, public regulated service
PRCS	Personal radio call systems

RPE-LTP	Regular pulse excitation long-term prediction
PRMA	Packet reservation multiply access
PRP	Pseudo-random process
PRS	Pseudo-random sequence, public regulated service
PRS	Public regulated service
PSTN	Public switched telephone network
PT	Potable termination
PTN	Public telephone network
PUSC	Partially used sub-carrier,
Q	Quadrature
QC	Quadratic couplers
QPSK	Quadrature phase shift keying
QoS	Quality of service
RACE	Research in advanced communications equipment
RACH	Random access channel
RAM	Radio access method, random access memory
RAN	Radio access network
RBER	Residual bit error ratio
RDSS	Regional differential sub-system
RFA	Radio-frequency amplifier
RF front-end	Radio-frequency front-end
RFID	Radio-frequency identification
RFN	Reduced frame number
RLL	Radio local loop
RNS	Radio navigation system
RM	Reversible modulator
RO	Reference oscillator
ROADM	Reconfigurable optical add/drop multiplexer
ROG	Reference oscillation generator
RR	Radio receiver
RRL	Radio relay line
RRNP	Reference radio navigation point
RRS	Radio relay system, reconfigurable radio system, remote radio heads
RS	Relay station
RSSI	Receive signal strength indicator
SAE	System architecture evolution
SB	Single band
SBR	Spectral band replication
SC	Single carrier
SC-FDMA	Single carrier frequency division multiple access
SCH	Synchronization channel
SD	Subtraction device
SDM	Space division multiplexing
SDMA	Space division multiplex access
SDN	Software defined networking
SDR	Soft defined radio
SE	Subscriber equipment
SF	Spreading factor
SIM	Subscriber identity module
SISO	Single input single output
SMS	Short message service
SMR	Specialized mobile radio (system)
SNR	Signal noise ratio
SoC	System-on-chip
SOC	Single oscillating circuit

S-OFDMA	Scaling-OFDMA
SPDT	Single pole double throw
SPI	System programming interface
SPRC	System of the personal radio call
SR	Soft radio
ST	Subscriber terminal
STBC	Space timing block code
STC	Space-time coding
SU MIMO	Single user MIMO
SV	State vector
TCP	Transmission control protocol
TDD	Time division duplex
TDMA	Time division multiple access
TD-SCDMA	Time division-synchronous CDMA
TH-UWB	Time hoping UWB
3G1X EV-DO	Enhanced version data only
TLL	Time of the largest load
TETRA	Terrestrial trunked radio
TH-SS	Time hoping spread spectrum
TMSI	Temporal identifier of the mobile station
TPC	Transmit power control
UCN	Unified communication network
UE	User equipment
UFMC	Universal filtered multicarrier
UHD	Ultra-high definition
ULP	Ultra-low power
UMB	Ultra-mobile broadband
UMTS	Universal mobile telecommunications system
UPE	User plane entity
URLLC	Ultra-reliable and low latency communications
UTRA	UMTS terrestrial radio access
UTRA-FDD	UMTS terrestrial radio access, frequency division duplex
UTRA-TDD	UMTS terrestrial radio access, time division duplex
UTRAN	UMTS terrestrial radio access network
UWB	Ultra-wideband
VAC	Volt-ampere characteristic
VC	Virtual cell
VCN	Virtual cellular network
VCCO	Voltage controlled crystal oscillator
VCO	Voltage controlled oscillator
VHE	Virtual home environment
VHF	Very high frequency
VLR	Visitor location register
VOFDM	Vector OFDM
VoIP	Voice over IP
VoLTE	Voice over LTE
VPN	Virtual private network
VSAT	Very small aperture terminal
WBS	Wideband signals
WCDMA	Wideband CDMA
WCDMA/UMTS	Universal mobile telecommunication services in WCDMA
WDM	Wavelength-division multiplexing
WDSS	Wide-zone differential sub-system wide-zone differential sub-systems
WiFi	Wireless fidelity
WiFiG	Wireless fidelity gigabit

WiMAX	Worldwide interoperability for microwave access
WLAN	Wideband local-area network
WLD	Wideband-limiter-decision
WLL	Wireless local loop
WLN	Wideband-limiter-narrowband
WMAN	Wireless local area network
WP	Wireless port
WPAN	Wireless personal area network
WRS	Wireless relay station
WRZ	Without the return to zero
WSD	White spice devices
WSN	Wireless sensor network
WWAN	Wireless world area network
ZigBee	Zigzag bee
ZIF	Zero intermediate frequency

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V. V. Logvinov, S. M. Smolskiy, *Radio Receivers for Systems of Fixed and Mobile Communications*, Textbooks in Telecommunication Engineering, https://doi.org/10.1007/978-3-030-76628-3