# **2022 Systems of Signal** Synchronization, Generating and **Processing in Telecommunications** (SYNCHROINFO 2022)

Arkhangelsk, Russia 29 June – 1 July 2022



IEEE Catalog Number: CFP22P67-POD **ISBN:** 

978-1-6654-7065-0

# Copyright © 2022 by the Institute of Electrical and Electronics Engineers, Inc. All Rights Reserved

*Copyright and Reprint Permissions*: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

## \*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.

IEEE Catalog Number:	CFP22P67-POD
ISBN (Print-On-Demand):	978-1-6654-7065-0
ISBN (Online):	978-1-6654-7064-3

### Additional Copies of This Publication Are Available From:

Curran Associates, Inc 57 Morehouse Lane Red Hook, NY 12571 USA Phone: (845) 758-0400 Fax: (845) 758-2633 E-mail: curran@proceedings.com Web: www.proceedings.com



#### **Table of Contents**

A. S. Adzhemov, A. Y. Kudryashova, I. G. Kuskova

INVESTIGATION OF BIJECTIONS DURING THE CONVERSION OF A DIGITAL SIGNAL INTO A CONTINUOUS SIGNAL AND INVERSE CONVERSION WITH CONVERSIONS CARRIED OUT IN THE MODULATOR AND DEMODULATOR...1

*Yu. V. Babkin, A. V. Timoshenko, E. I. Minakov, A. B. Silantyev, C. A. G. Fernandu* FUNCTIONING OF CHANNELS OF MULTI-SCANNING MONITORING IN RADARS WITH REGULAR OR CONTROLLED SURVEILLANCE...6

*A. Yu. Baikov, O. A. Baikova* ON THE POSSIBILITY OF CREATION OF THE MULTI BEAM BROADBAND IOT...12

#### O. V. Biryukova, I. V. Koretskaya

INFLUENCE OF ELECTROMAGNETIC INTERFERENCE ON THE OPERATION OF THE MEASURING AND CONTROL UNIT...17

Boris B. Borisenko, Sergey D. Erokhin, Ivan D. Martishin, Aleksander S. Fadeev HOW THE CSE-CIC-IDS2018 DATASET IS RELATED TO THE MITRE MATRIX...22

D. S. Chirov, E. O. Kandaurova, A. A. Kuchumov ESTIMATING THE EFFICIENCY OF THE ALGORITHM FOR SELECTING THE ADAPTIVE SIGNAL DETECTION THRESHOLD IN COGNITIVE RADIO SYSTEMS...28

*A. N. Degtyaryov, A. S. Kozhemyakin, I. L. Afonin, G. V. Slyozkin, A. L. Polyakov* TWO-STEP ALGORITHM FOR MATCHED FILTERING OF SIGNALS...33

V. I. Djigan

LOW COMPLEXITY PARTIALLY ADAPTIVE ANTENNA ARRAY BASED ON RECURSIVE LEAST SQUARE ALGORITHM...39

*S. S. Dymkova, O. V. Varlamov* PEER REVIEW PROCEDURE AS THE MAIN CRITERION FOR CONFIRMATION RESEARCHER'S SCIENTIFIC WORK QUALITY. According results of the international conference SYNCHROINFO...44

S. D. Erokhin, B. B. Borisenko, I. D. Martishin, A. S. Fadeev THE DATASET FEATURES SELECTION FOR DETECTING AND CLASSIFYING NETWORK ATTACKS...49

*E. I. Glushankov, I. A. Boyko, D. I. Kirik, K. O. Korovin* CHANNEL VECTOR ESTIMATION USING COVARIANCE MATRICES REGULARIZATION METHOD....57

*M. H. Hasanov, N. A. Atayev* EARLY CONCEPTUAL MODEL OF NANOSATELLITE WITH LASER BEAM CONTROL AND ACTIVE TRANSPONDER SYSTEM...61

O. V. Ilina, M. V. Tereshonok STUDY OF DEEP CONVOLUTIONAL NEURAL NETWORK FOR VEHICLE LOCALIZATION ON BLURRED AERIAL IMAGERY...65

Dmitry Ivanov, Vladimir Ivanov, Natalya Ryabova, Vladimir Ovchinnikov STUDYING THE EFFECT OF CHIRPING OF THE IMPULSE RESPONSE OF AN ULTRA-WIDEBAND IONOSPHERIC HF CHANNEL UNDER THE INFLUENCE OF INTRAMODE FREQUENCY DISPERSION...72

Vladimir Ivanov, Dmitry Ivanov, Aleksey Elsukov VERTICAL SOUNDING OF IONOSPHERIC RADIO CHANNELS BY MULTICARRIER PHASE-SHIFT KEYING SIGNALS...77

N. A. Kandaurov, V. I. Lipatkin, E. O. Kandaurova, K. Y. Sokolov IMPLEMENTATION OF A MULTI-CHANNEL DEMODULATOR OF DISCRETE-FREQUENCY SIGNALS USING DDC ON A GPU...83 A. A. Karimov, Lolai Husenzoda, Nuriddini Fayz, R. Sh. Umaralizoda, D. Ch. Ravshanov MICROSTRIP IMPLEMENTATION OF CROSSOVER ON ARTIFICIAL TRANSMISSION LINES...87

V. L. Karyakin

ANALYSIS OF TECHNICAL REQUIREMENTS FOR DVB-T2 NETWORK EQUIPMENT ... 92

L. N. Kazakov, V. A. Botov, E. P. Kubyshkin, D. E. Paley ADAPTIVE ALGORITHM FOR FLIGHT RESTRUCTURING OF A GROUP OF UNMANNED AERIAL VEHICLES...97

Vladimir Khryashchev, Nikita Kotov, Roman Larionov, Andrey Priorov SEMANTIC SEGMENTATION OF SATELLITE SAR-C IMAGES USING DEEP LEARNING BASED ALGORITHMS...102

D. V. Kochemasov, N. N. Udalov

PM AND AM NOISE IN THE RING QUADRATURE LC-OSCILLATORS WITH PHASE SHIFTING RC-CIRCUITS...107

N. A. Kovaleva, I. V. Mozgovoy DESIGN AND IMPLEMENTATION OF A COMPACT FOUR-BAND BANDPASS FILTER ON METAMATERIAL...111

*V. B. Kreyndelin, E. D. Grigorieva* AN ANALYSIS OF COMPUTATIONAL COMPLEXITY OF VARIOUS IMPLEMENTATION TECHNIQUES OF MMSE DEMODULATION ALGORITHM...115

E. P. Kubyshkin, P. E. Petukhov, D. Yu. Vishnyakov SIMULATION OF NETWORK TRAFFIC OF THE INFORMATION EXCHANGE AND CONTROL SYSTEM OF A GROUP OF UNMANNED AERIAL VEHICLES...120

A. Y. Kudryashova, A. S. Adzhemov, I. G. Kuskova INVESTIGATION OF MINIMIZING THE PROBABILITY OF ERRORS ARISING IN THE DEMODULATION OF SIGNALS WITH MULTIPLE PHASE MODULATION...124

A. S. Kukharenko, R. V. Shaymardanov, A. A. Yelizarov, E. A. Zakirova, A. A. Skuridin ALGORITHM FOR ANALYZING THE INTEGRITY OF NAVIGATION INFORMATION OF CONTROL AND CORRECTING STATIONS NETWORK...129

*T. A. Kuzovkova, O. I. Sharavova, V. O. Tikhvinskiy, E. E. Devyatkin* MATCHING OF 6G NETWORK CAPABILITIES TO DIGITAL SERVICES REQUIREMENTS...134

A. V. Lenshin, V. N. Tikhomirov, E. V. Shatalov, M. P. Savchenko, N. M. Tikhmirov MODERNIZATION OF FREQUENCY SYNTHESIZERS VHF RADIOS...139

*I. M. Lerner, A. N. Khairullin, G. I. Il'in* ON THE ISSUE OF SIGNAL RESOLUTION IN THE PRESENCE OF INTRASYSTEM INTERFERENCE THROUGH THE USE OF THE THEORY OF RESOLUTION TIME...146

Vladislav Lesnikov, Tatiana Naumovich, Alexander Chastikov ALIASING'S STUDY ON BANDPASS SAMPLING...151

E. A. Liberman, E. A. Nefedov ANALYSIS OF EXISTING TECHNOLOGIES FOR CONSTRUCTING AN ESPAR ANTENNA SYSTEM. THEORY AND MODELING...157

*N. Yu. Liberovskiy, V. S. Priputin, I. A. Volkov* BLIND TWO COMPLEX SIGNALS SEPARATION METHOD BASED ON FOURTH ORDER CUMULANTS...163

*V. V. Logvinov, Phan Tuan Anh* CONTROLLED MICROWAVE AUTOGENERATOR ON A COMPLEMENTARY PAIR OF MOSFET TRANSISTORS...170 A. L. Makarevich, D. V. Garaga, S. M. Sokovnich, L. I. Matyna, V. V. Sorochan INVESTIGATION OF THE CHARACTERISTICS OF REGULATED VOLTAGE GENERATORS FOR PLL SYSTEMS AND FREQUENCY SYNTHESIZERS...174

#### Sergei Melnik, Vasily Vikulin, Vladimir Babkin, Elena Petrova

TIME AND FREQUENCY SYNCHRONIZATION FOR INTERNET SERVICE PROVIDER NETWORKS DATA RATES DETERMINATION...179

V. Y. Mikhaylov, R. B. Mazepa

MODELING AND THE EFFECTIVENESS EVALUATION OF SIGNAL-LIKE INTERFERENCE EXPLOITING THE VULNERABILITIES OF THE RTS / CTS MECHANISM IN 802.11 NETWORKS...184

N. E. Miroshnikova, A. I. Sattarova

ANALYSIS OF ERROR-CORRECTION CODES PROPERTIES FOR UNDERWATER OPTICAL COMMUNICATION SYSTEMS WITH OCDM MODULATION...191

Grach Mkrtchian, Yury Furletov

CLASSIFICATION OF ENVIRONMENTAL SOUNDS USING NEURAL NETWORKS...197

*O. G. Morozov, I. I. Nureev, A. Zh. Sakhabutdinov, R. Sh. Misbakhov, A. A. Kuznetcov* ADVANCED MICROWAVE PHOTONICS SENSOR SYSTEMS: ADDRESS FBG SENSORS, INTERROGATION AND CALIBRATION...201

*M. S. Moseva, M.G. Gorodnichev, K. A. Polyantseva, G. G. Vlasov, M. D. Gromov* DEVELOPMENT OF A SYSTEM FOR FIXING ROAD MARKINGS IN REAL TIME...206

D. R. Mukhametov

HOW ICT-INFRASTRUCTURE DEFINES ECONOMIC COMPLEXITY: INFORMATION POLICY TO FACILITATE INNOVATIONS...213

*O. A. Mukhametzyanov, T. F. Shcherbakova, R. R. Mukhamiev, S. S. Sedov* DEVELOPMENT OF HIGH-RESOLUTION ELECTROCARDIOGRAPHY FOR TELEMEDICINE SYSTEMS...218

*R. R. Mukhamiev, O. A. Mukhametzyanov, T. F. Shcherbakova, S. S. Sedov* POWERLINE INTERFERENCE'S FILTERING INFLUENCE ON VENTRICULAR LATE POTENTIALS...223

K. I. Nezhivleva, A. M. Drebuzhan, A. A. Davydova, Andrei Balobanov, A. I. Mozhaeva COMPARING OF MODERN METHODS USED TO ASSESS THE QUALITY OF VIDEO SEQUENCES DURING SIGNAL STREAMING WITH AND WITHOUT HUMAN PERCEPTION...228

D. C. Nguyen, O. V. Varlamov

SIMULATION MODEL FOR SWITCHING MODE ENVELOPE ELIMINATION AND RESTORATION RF POWER AMPLIFIERS RESEARCH...234

K. N. Pankov, M. M. Glukhov-jr

USING ERROR-CORRECTING CODES TO ENSURE INFORMATION SECURITY OF UNMANNED VEHICLES AND IOT SYSTEMS...240

S. V. Pavlov, V. V. Maklachkova, V. A. Dokuchaev IMPROVING THE STABILITY OF SATELLITE SYNCHRONIZATION OF SINGLE-FREQUENCY TELEVISION TRANSMITTERS UNDER THE INFLUENCE OF INTERFERENCE...248

I. W. Peshkov, N. A. Fortunova, I. N. Zaitseva MINIMIZING THE CRAMER-RAO LOWER BOUND FOR ANTENNA ARRAYS WITH DIRECTIONAL RADIATORS FOR DIRECTION-OF-ARRIVAL ESTIMATION OF RADIO SIGNALS...254

*A. V. Pestryakov* HYBRID SYSTEM OF MOVING OBJECTS GLOBAL MONITORING...259

A. N. Petukhov, S. D. Erokhin, P. L. Pilyugin ADAPTATION PROCESSES IN ASYMPTOTIC SAFETY MANAGEMENT...263 N. E. Poborchaya, E. O. Lobova ANALYSIS OF THE USE OF THE KALMAN FILTER FOR SIGNAL DETECTION IN A DIRECT CONVERSION RECEIVER IN MIMO...267

K. A. Polyantseva, M. G. Gorodnichev, G. G. Vlasov, Yu. B. Mironov DEVELOPMENT OF AN INTELLIGENT SYSTEM FOR ENSURING THE SAFETY OF EMPLOYEES AT WORK...272

S. A. Presnyakov, A. D. Kasatkin, N. P. Kravchenko, S. V. Mukhin EXPERIMENTAL ANALYSIS OF THE ELECTRODYNAMIC CHARACTERISTICS OF THE COAXIAL-RADIAL LINE TYPE SLOW-WAVE STRUCTURES AND ITS MODIFICATIONS...277

*Ch. B. Ravshanov, Sh. A. Amirshoev, A. A. Karimov, D. Ch. Ravshanov, R. Z. Mahmadulloev* SYNTHESIS OF A RING DIVIDER HAVING SMALL DIMENSIONS AND WEIGHT...281

D. Ch. Ravshanov, A. A. Karimov, M. L. Mirzohasanov, S. M. Karimov, F. B. Holov REDUCTION OF THE OCCUPIED AREA OF THE BROADBAND POWER DIVIDER...287

N. V. Ryabova, D. V. Ivanov, V. A. Ivanov, A. A. Kislitsin DEGRADATION PERIOD OF ANOMALOUS DISPERSION PARAMETER OF TRANSIONOSPHERIC WIDEBAND RADIO COMMUNICATION CHANNEL...292

A. V. Ryzhkov, V. M. Aladin, M. L. Schwartz, A. V. Isupov EXPERIENCE IN THE DEVELOPMENT AND IMPLEMENTATION OF TIME-FREQUENCY SYNCHRONIZATION SYSTEMS ON TELECOMMUNICATIONS...297

A. N. Sak USING VECTOR PROXIMITY FOR NLP ANALYSIS OF SPECIALIZED TEXTS...304

*V. G. Sannikov, A. V. Alyoshintsev, A. N. Sak* ADVANCED DMT MODEM AS AN ELEMENT OF THE PON / XDSL SYSTEM...310

M. L. Schwartz, V. M. Aladin, A. V. Ryzhkov PERSPECTIVE EQUIPMENT OF PRIMARY REFERENCE TIME AND CLOCK FOR SYNCHRONIZATION SYSTEMS...314

A. N. Serov, A. A. Shatokhin, K. A. Ivanenko, N. A. Serov, P. M. Tzvetkov FEATURES OF THE IMPLEMENTATION OF THE REACTIVE POWER MEASUREMENT METHOD BASED ON THE APPLICATION OF INTEGRATOR AND DIFFERENTIATOR...320

A. A. Shatokhin, A. N. Serov, N. A. Serov, Gennady Antipov, P. K. Makarychev EVALUATION OF THE INFLUENCE OF THE APERTURE TIME AND APERTURE JITTER ON THE RMS MEASUREMENT ERROR...326

E. A. Shilenkov, D. S. Koptev, E. A. Titenko, A. N. Schitov, L. A. Semenova A MATHEMATICAL MODEL FOR ESTIMATING THE EFFECT OF IONOSPHERIC DISTORTIONS ON THE AMPLITUDE - PHASE FREQUENCY RESPONSE (NYQUIST PLOT) OF PHASE-SHIFT SIGNALS RECEIVED FROM SMALL SPACECRAFTS...332

*O. A. Shorin, V. O. Shorin, G. O. Bokk* IMPROVED FBMC (5G) SIGNAL STRUCTURES FOR CRITICAL COMMUNICATIONS SYSTEMS Increase of noise immunity in conditions of multipath propagation...338

A. A. Shvidkiy, A. A. Savelieva, A. A. Zarubin APPROACHES ANALYSIS TO DETERMINING THE CHARACTERISTICS OF THE LOAD ON THE DISK SUBSYSTEM CREATED BY USER APPLICATIONS...347

K. Y. Sokolov, V. S. Priputin, E. A. Nefedov SIMULATION OF A REFLECTIVE ANTENNA ARRAY WITH A LIQUID CRYSTAL SUBSTRATE...355

*E. P. Stroganova, S. E. Grychkin* PHASE INFORMATION DESTRUCTION DURING RADIO SIGNAL PROPAGATION IN FLUCTUATING ATMOSPHERE...362 *A. G. Tatashev, N. P. Susoev, M. V. Yashina* ERGODICITY OF STOCHASTIC COMPONENT FOR DSM – MULTI-LANE TRAFFIC MODEL...367

*A. V. Timoshenko, A. Yu. Perlov, A. M. Kazantsev, N. A. Khodataev, K. V. Lvov* METHODOLOGY FOR THE DEVELOPMENT OF A DIGITAL TWIN OF RADAR STATIONS OF A FUNCTIONAL BLOCK STRUCTURE...372

A. M. Valuev, A. A. Solovyev PROBLEMS OF STRUCTURAL AND PARAMETRIC TRAFFIC CONTROL FOR AN URBAN ROAD NETWORK FRAGMENT...376

*O. V. Varlamov, Andrei Grebennikov* EXPERIMENTAL STUDIES OF ENVELOPE ELIMINATION AND RESTORATION HF POWER AMPLIFIER CHARACTERISTICS WITH NARROW-BAND MATCHED LOAD...382

*Michael Vekselman* SECURITY OF GNSS-BASED SYNCHRONIZATION SYSTEMS. Monitoring the quality of navigation systems...386

D. Yu. Vishnyakov, L. N. Kazakov, V. A. Botov COMPARISON OF VARIOUS RADIO NETWORK CONFIGURATIONS...390

S. L. Yablochnikov, I. O. Yablochnikova, V. B. Dzobelova, A. V. Sharopatova, M. N. Makhiboroda SYNCHRONIZATION OF REAL AND VIRTUAL PROCESSES IN THE CONTEXT OF THE INDUSTRIAL REVOLUTION 4.0...394

*M. R. Yakimov* FEATURES OF THE USE OF GEOANALYTICAL DATA IN THE DEVELOPMENT OF TRANSPORT PLANNING DOCUMENTS...400

*M. V. Yashina, P. I. Pospelov, D. V. Lyanguzov, L. N. Slabkevich* SIMULATION MODEL OF A RAILWAY CROSSING FOR CAPACITY EVALUATION...405

A. A. Yelizarov, A. A. Skuridin, I. V. Nazarov, E. A. Zakirova SIMULATION OF A FREQUENCY SELECTIVE SURFACE WITH FRACTAL JERUSALEM CROSS UNIT CELLS...410

*I. O. Yuskov, E. P. Stroganova* CORPORATIVE COMBINED NETWORKS INVESTIGATION WITH NEURAL NETWORKS METHOD...414

*M. I. Zhodzishsky, F. B. Serkin, R. V. Kurynin* SENSITIVITY OF GNSS RECEIVERS...418

*A. P. Zhuravlev, T. A. Chadov* QAM SIGNAL DEMODULATION ALGORITHM WITH MINIMUM SAMPLE PER SYMBOL RATE...437

V. V. Ziyadinov, M. V. Tereshonok NEURAL NETWORK IMAGE RECOGNITION ROBUSTNESS WITH DIFFERENT AUGMENTATION METHODS...441

*M. Yu. Zuev, E. A. Bobina, S. S. Loginov* FPGA IMPLEMENTATION OF A PSEUDO-RANDOM SEQUENCE GENERATORS BASED ON THE MODIFIED LORENTZ SYSTEM...445