





WARSAW UNIVERSITY OF TECHNOLOGY

Presentation of results of a Research and Development project

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AVIONIX ENGINEERING sp.z o.o.



Fundusze Europejskie Inteligentny Rozwój









- Program
 - POIR.01.01.01-00-0169/15
- Title
 - System Kontroli Ruchu Lotniczego Nowej Generacji ADS-B/MLAT
 - Next Generation ADS-B/MLAT Air Traffic Surveillance System
- Project duration
 - 06/2015 01/2018
- Budget

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Inteligentny Rozwój

- PLN 2.000.408 / EUR 470.000 EUR







- AVIONIX ENGINEERING sp. z o.o.
 - Founded in 2010
 - Situated in Kraków, Poland
 - RF Hardware/Software Development
 - 10 Employees, mainly software and hardware engineers





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Project Content

- RF Receiver and Transmitter Hardware
- High precision timestamping
- FPGA signal processing and decoding
- Research on Multilateration Algorithms
- ADS-B Directional Validation
- Frequency Monitoring
- 3D Visualisation
- Electrical Engineering



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AGH University of Science and Technology

- RF hardware design
 - Comparison of different approaches based on modern technology
 - Logarithmic detector, superheterodyne, synchrodyne receivers
 - High precision timing solution based on GNSS
 - ZYNQ-7000 FPGA/ARM platform selected for signal and data processing
 - Multi-channel receiver solution for directional validation
 - Transmitter and RF amplifier design
 - Antenna design



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Developed Hardware









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Measurements







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FPGA signal processing - Mode A/C/S decoding



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• Research on Multilateration Algorithms

- Taking some new evolutions into account
- For variable number of receivers
- Dilution of precision calculation
- Filtering and tracking algorithms













ADS-B Directional Validation

- Angle of Arrival Validation
 - There are some vulnerabilities of ADS-B
 - AoA validation as countermeasure for spoofing attacks
 - "Phase Interferometry Direction Finding" Approach
 - As alternative to multi sector antenna setup
 - Accuracy < 1 degrees





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ATC Frequency Monitoring

- Permanent Monitoring of 1030/1090MHz Surveillance Frequencies
- Decoding of signals and statistical analysis of utilization
- Analysis of performance of Radar and MLAT system
- Recognition of non-compliant transponders
- Detection of interfering signals and interference patterns
- Localization of sources of interference via multilateration and direction finding
- Automatic generation of regular reports and incidental warnings
- Alarming in case of major incidents (SNMP, Email)



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ATC Frequency Monitoring



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Implementation of R&D Results

- Frequency Monitoring 1030/1090 MHz
 - Contract with EUROCONTROL
 - Provision of 100 1030/1090 receivers
 - Role-out over Europe in progress
 - Some additional receivers sold directly to local agencies
 - Raw RF data and decoded data is buffered locally on 6TB HDD
 - Mode S and statistic data uploaded to server via Internet





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Frequency Monitoring with EUROCONTROL



https://www.eurocontrol.int/communications-navigation-and-surveillance

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Situational Awareness System for Dundee Airport

- "An Electronic Surveillance Solution to Support the Low Density and Low Complexity Airspace Trial at Dundee Airport"
- Evaluation of a low-cost system for enhanced situational awareness
- 5 ADS-B/MLAT/FLARM receiver stations and 1 Mode-S Interrogator
- Receiver Stations transmit data via UMTS to central server







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Autonomous Receiver Unit (ARU)

- Fully autonomous ADS-B/MLAT Station
- Solar and Wind powered
- LTE data transmission
- Remote Monitoring & Control
- Webcam for supervision
- Trial setup in Summer 2018



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- Direction Finding on 1090 MHz
 - 6 channel coherent receiver
 - Phase Interferometry Direction Finding
 - 5 omni-directional antennas placed in a circle



• Tests are running to use it as kind of static radar in combination with an interrogator











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INTERNATIONAL SCIENTIFIC CONFERENCE

Thank you

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