Modern surveillance system.
Punctual and space distributed system

ADS-B and MLAT modern view & evolution
VNIIRA-OVD & NPP CRTS - leadership in modern surveillance technologies in Russia:

- First ADS-B 1090 ES GS “Onyx” (2007)
- First Mode-S MSSR “Aurora-S” (2011) and “Aurora-2” (2013)
- First WAM “Mera” (2014)
- First ADS-B vehicle transponder “Gnome” (2015)
Experience in installations

Wide experience in secondary surveillance and ADS-B systems:

- MSSR “MVRL-SVK” (44 pcs)
- MSSR “Aurora” (~30 pcs)
- ADS-B GS “NS-1”, “NS-1A”, ... (~45 pcs)
- MSSR “Aurora-S”/”Aurora-2” (~5 pcs in installation)
- WAM/MLAT “Mera” (2 pcs)
Key products for surveillance

- Mode S MSSR “Aurora-2” (2013)
  - RBS, Mode-S (EHS), UVD (Russian), ADS-B 1090 ES
  - Range up to 465 km, rotation period from 4 sec
  - 3’ azimuth/15 m range precision
- ADS-B GS “Sota-X1”/”Sota-X4” (2015)
  - Full ED-129/DO-260B compliance
  - Outdoor (Sota-X1) installation, 20W consumption
- ADS-B Vehicle Transponder “Gnome” (2015)
  - DO-260B compliance
- ADS-B Server (2015)
  - Up to 64 ADS-B sources, data mixing
  - ASTERIX 021/023/064/247, almost all versions
  - RBS, Mode-S (EHS), ADS-B 1090 ES
  - Passive and active (own interrogators) operation
  - Synchronization GPS, GLONASS, transponder-based
ADS-B ground stations modern view

- Single-channel and multichannel (sector antenna)
- Compact size, outdoor installation
  - Outdoor 4-channel ground station planned on 2016
- Full ED-129 and DO-260B compliance
- Multilateration support:
  - Decoding RBS and Mode-S replies
  - Precise time counter (OCXO)
  - Timestamps LTC and UTC
  - GPS/GLONASS synchronization, support operation without GNSS
  - Data source for several MLAT servers
- Remote control & management
- Choice of antennas

Radial A5-ADSB 5 dB, 0.5 m
AR5-1090 5 dB, 1 m
AS12-1060 12 dB, 1.6 m
AS13-1060 13 dB, 2 m
024 8 dB, 3 m
ADS-B and WAM in Europe

- Implementation of ADS-B and WAM in Europe coordinated by CASCADE program
- EU No 1207/2011, after 2015/2017:
  - All aircrafts IFR: ELS
  - Aircrafts from 5700 kg or 250 knots: EHS and ADS-B 1090 ES
- Preferred way is combination WAM/ADS-B
  - More 370 WAM/ADS-B sensors as of 2014
  - Expected about 700 in 2017

Main ADS-B development direction is combination of WAM and ADS-B
Deployment of new WAM/ADS-B systems allows to decrease 1090 MHz line workload

ICAO Eurocontrol report on surveillance and ACAS activities in Europe, IP ASP16-08 7.04.2014.
If ADS-B sensors are MLAT-capable, ADS-B network may be smoothly transformed into ADS-X and WAM system by adding new sensors.

- Stage 1: ADS-B network
- Stage 2: ADS-B with trajectory confirmation (ADS-X)
- Stage 3: WAM

- No clear understanding for ADS-X technical specifications
- But it provides definite advantages for ATC
Further trends for ADS-B ground stations

- Further reduction of:
  - Size
  - Power consumption
- Outdoor installations in any climate (from Arctic to tropical)
- Autonomous power supply ability
- Embedding to different radar systems

**ADS-B receiver “Amber-2” (2016):**

- Compact:
  - Size 115x126x49 mm, weight 2 kg
  - Power consumption 15 W
- Protected:
  - Dust- and waterproof IP68 stainless enclosure
  - Temperature from -50°C to +50°C
- Functional:
  - 2 independent channels (1-3 GHz tunable)
  - Operate as ADS-B ground station (ED-129, DO-260B) and/or MLAT sensor
  - GPS/GLONASS synchronization
MLAT systems modern view

- Dependent and independent synchronization
  - GPS and GLONASS in any combination
  - Transponder-based synchronization
  - Mix methods in a single system
- Sensors and interrogators sharing between systems
- Remote control & management
- Multifunction systems (next slide)

Multifunction MLAT systems

- Multifunction MLAT – emerging MLAT technology
  - Offered today by leading MLAT producers
- Different functions on the single system: WAM, Surface MLAT, ADS-B, HMU
- Key benefits:
  - Much cheaper than separate systems
  - New ATC applications in approach zone:
    - Precision approach monitoring (PAM)
    - Parallel runway approach
    - Reduced spacing on take-off
- Most effective use-cases:
  - Airport Surface+TMA MLAT with high precision in approach zone
  - HMU on the normal WAM

- New way for surveillance: implement different functions on a single system instead of separate systems
- Adding new functions result in improvement of other functions
Long-range MLAT

- **Wide-based MLAT** (sensors distributed >~100 NM)
  - Active or passive surveillance, high precision
  - GNSS only synchronization
  - Requires high-band data communication channels

- **Short-based MLAT** (all sensors in ~10 NM area)
  - Only active surveillance in far zone, precision degrades with distance (as for radar)
  - GNSS or independent synchronization
  - Local data channels (directed Wi-Fi, radio relay)
  - Range is usually limited by interrogation potential

- **Short-based “Mera”**: range up to 100/115 NM
- **“Almanac-2”** (planned for 2016): up to 200 NM
  - Full replacement for airdrome MSSR
  - All MLAT advantages: cheap, simple service, ...
  - Novel applications: seashore, regions with no infrastructure (desert, far north)
Vehicle transponders

- Make vehicles visible for surface guidance and control
  - Using ADS-B and/or MLAT
- Make vehicles visible for pilots
- Automate vehicles movement management

**ADS-B 1090 ES vehicle transponder “Gnome” (2015)**

- DO-260B compliant, transmit DF18
- Power consumption 1.5 W, transmitting power 18 W
- Temperature from -50°C to +65°C
- GLONASS/GPS
MLAT installation experience

Saint-Petersburg (Russia) WAM

- TMA WAM at Pulkovo airport, Saint-Petersburg, Russia
- First fragment deployed in 2014
  - 5 Rx and 1 Tx stations (30 NM base)
  - GPS, Glonass synchronization
- Operational area up to 120 NM range
  - ADS-B receive up to 250 NM
- Almost constant precision ~50 m (STD)
- Operational trial planned on 2016
MLAT installation experience

Varadero (Cuba) WAM+MLAT

- TMA WAM + Surface MLAT at Juan Gomez airport, Varadero, Cuba
- Deployed in 2014
  - 6 Rx and 2 Tx (4 NM base, 1 station at 12 NM)
- Operational area: surface & TMA zone up to 40 NM
  - ADS-B receive up to 200 NM
- Precision depends on range, average 100 m
- On operational trial since 2014
Remote control and management

- Remote control and management
  - Supported for all VNIIRA/CRTS surveillance systems: MSSR, ADS-B, MLAT
  - Remote control & monitoring, management & configuration, software & firmware update
  - Connection to external CMS (next slide)

- MLAT is particularly suitable for remote operation:
  - Simple hardware, no routine service
  - High degree of reliability due to separate hardware units, installed with redundancy
  - Redundancy +2 or +3 stations preferred
    - Repairs may be performed by schedule, no interrupt of service

- MLAT well suits for remote ATC:
  - Easy remote operation
  - Built-in surface surveillance
VNIIRA/CRTS “Superterminal” (2011) – solution for regional monitoring, archiving and management center

- Simultaneous access to multiple MSSR, ADS-B and MLAT systems
- Simple and extended monitoring
- Management and configuration
- Flight situation display
- Hardware status archives
- Configurable periodical reports

Deployed in the control center, Havana, Cuba (2011)

- 6 MSSR
- 1 WAM/MLAT
- In operational use
Conclusions

✓ Combined ADS-B+MLAT sensors is the most effective way of ADS-B development today
  ✓ Provides for smooth transition from independent to dependent surveillance
✓ Modern MLAT systems are:
  ✓ Multifunction
  ✓ Sensor/interrogator sharable
  ✓ Flexible configuration
✓ Remote control and management
  ✓ MLAT systems are well suitable for remote operation
  ✓ Surface&TMA MLAT is a good solution for remote ATC
Thank you for your attention

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