RESEARCH AND PRODUCTION ENTERPRISE
DIGITAL RADIO SYSTEMS

Modern surveillance system. Punctual and space distributed system

ADS-B and MLAT modern view & evolution

About the company

VNIIRA-OVD & NPP CRTS - leadership in modern surveillance technologies in Russia:

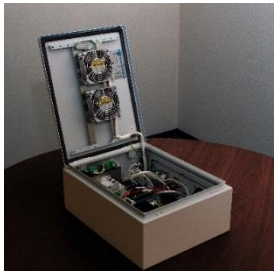
- ✓ First ADS-B 1090 ES GS “Onyx” (2007)
- ✓ First Mode-S MSSR “Aurora-S” (2011) and “Aurora-2” (2013)
- ✓ First WAM “Mera” (2014)
- ✓ First ADS-B vehicle transponder “Gnome” (2015)
- ✓ First ED-129/DO-260B compliant ADS-B GS “Sota-X1”/“Sota-X4” (2015)

ADS-B GS “Onyx”
2007

MSSR “Aurora-2”
2013

WAM “Mera”
2014

ADS-B vehicle transponder “Gnome”
2015



ADS-B GS “Sota-X1”
2015

ADS-B GS “Sota-X4”
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
- WAM “Mera” (2014), MLAT/WAM “Almanac” (2015)
  - ✓ 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



ADS-B ground station
“Sota-X1” (2015)

Radial A5-ADSB
5 dB, 0.5 m

AR5-1090
5 dB, 1 m

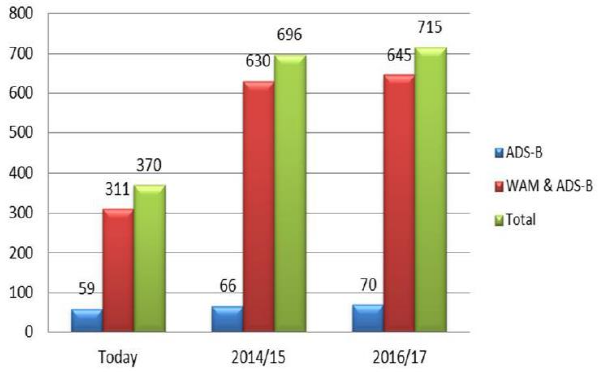
AS12-1060
12 dB, 1.6 m

AS13-1060
13 dB, 2 m

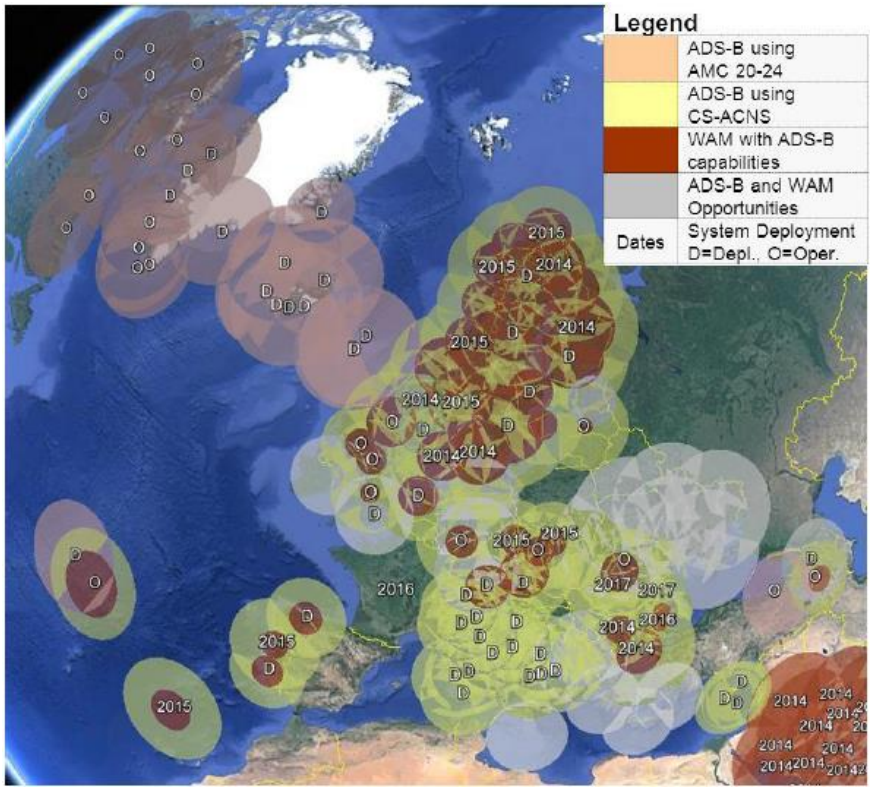
024
8 dB, 3 m

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



Note: Only deployed or firmly committed are included

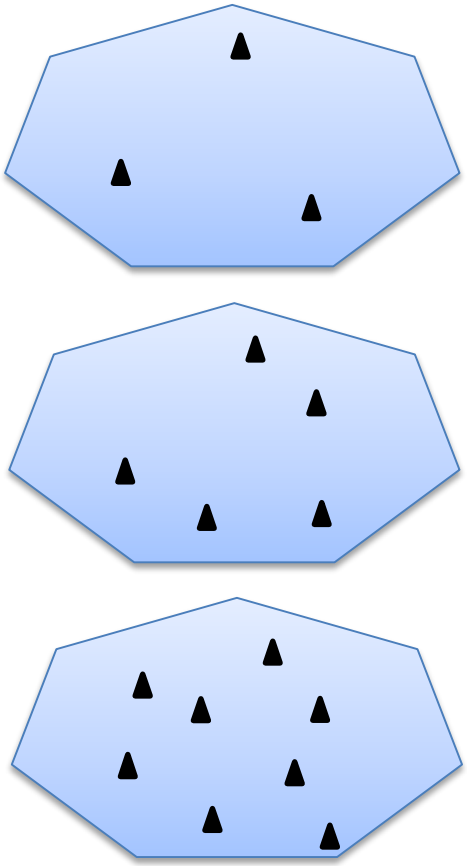


- Main ADS-B development direction is combination of WAM and ADS-B
- Deployment of new WAM/ADS-B systems allows to decrease 1090 MHz line workload

- ICAO Eurocontrol report on surveillance and ACAS activities in Europe, IP ASP16-08 7.04.2014.

Evolution of ADS-B network to WAM

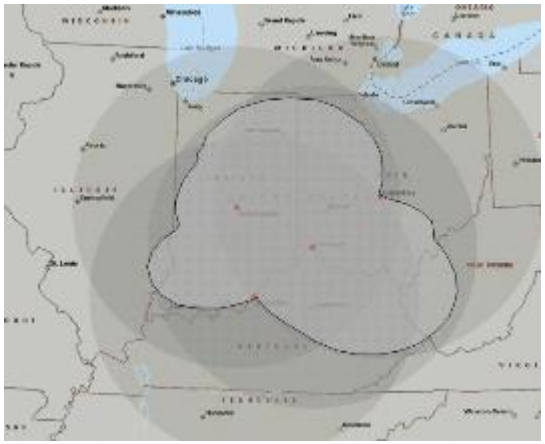
If ADS-B sensors are MLAT-capable, ADS-B network may be smoothly transformed into ADS-X and WAM system by adding new sensors.



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

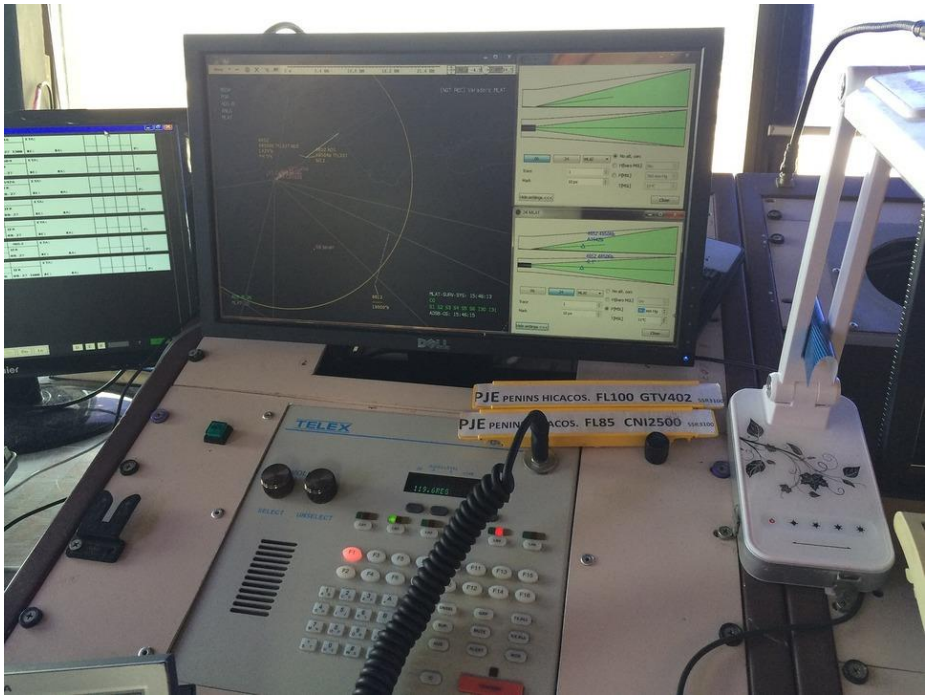
ADS-B receiver “Amber-2” (2016):

- ✓ 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

ADS-B receiver
“Amber-2” (2016)

MLAT systems modern view

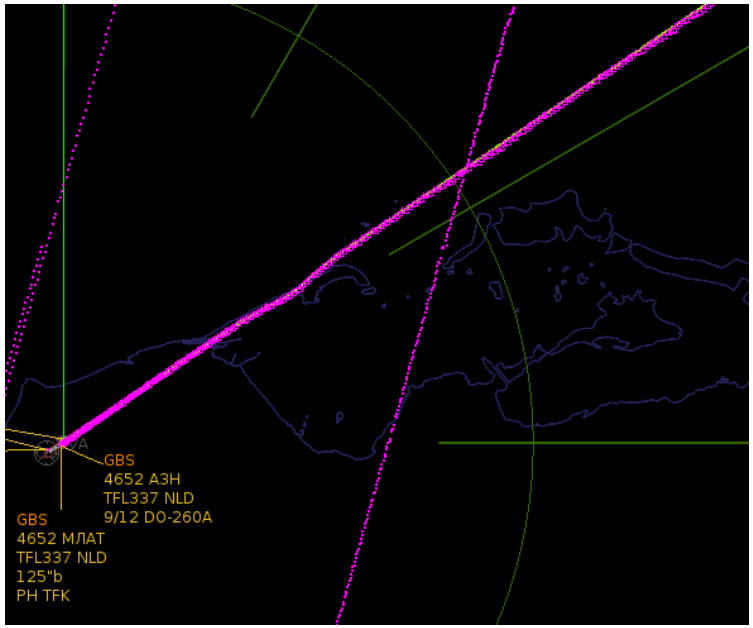
- ✓ Dependent and independent synchronization
  - ✓ GPS and GLONASS in any combination
  - ✓ Transponder-based synchronization
  - ✓ Mix methods in a single system
- ✓ Sensors and interrogators sharing between systems
- ✓ Remote control & management
- ✓ Multifunction systems *(next slide)*



WAM/MLAT “Mera” (2014)/”Almanac” (2015)

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

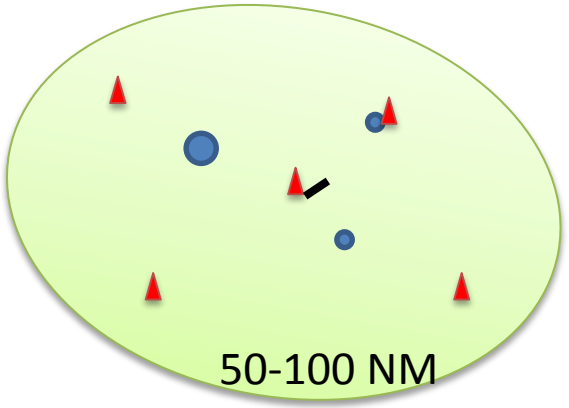


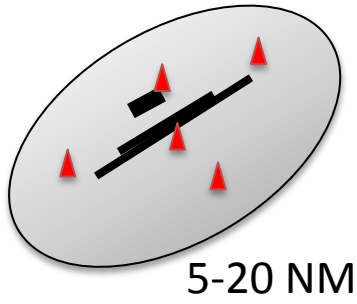
WAM/MLAT “Mera” (2014)/”Almanac” (2015)

- 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

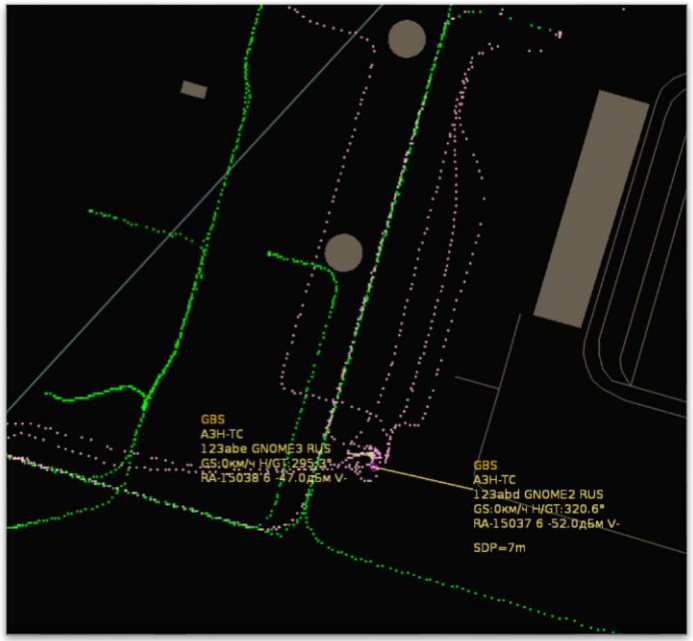
- Wide-based MLAT (sensors distributed >~100 NM)
  - ✓ Active or passive surveillance, high precision
  - − ✓ GNSS only synchronization
  - − ✓ Requires high-band data communication channels
- Short-based MLAT (all sensors in ~10 NM area)
  - ✓ Only active surveillance in far zone, precision degrades 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



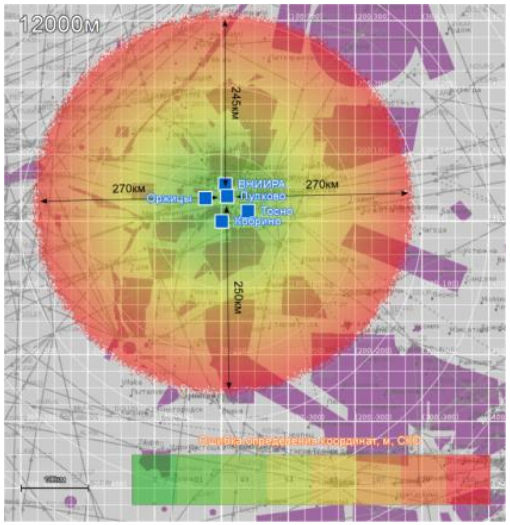
ADS-B 1090 ES vehicle transponder “Gnome” (2015)

- ✓ 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

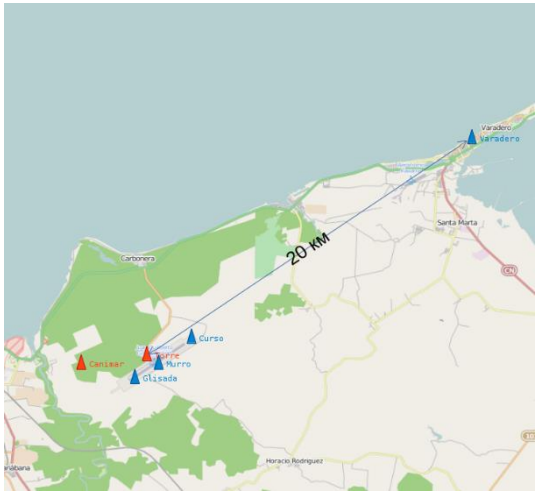
- TMA WAM at Pulkovo airport, Saint-Petersburg, Russia
- First fragment deployed in 2014
  - 5 Rx and 1 Tx stations (30 NM base)
  - GPS, Glonass synchronization
- Operational area up to 120 NM range
  - ADS-B receive up to 250 NM
- Almost constant precision ~50 m (STD)
- Operational trial planned on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

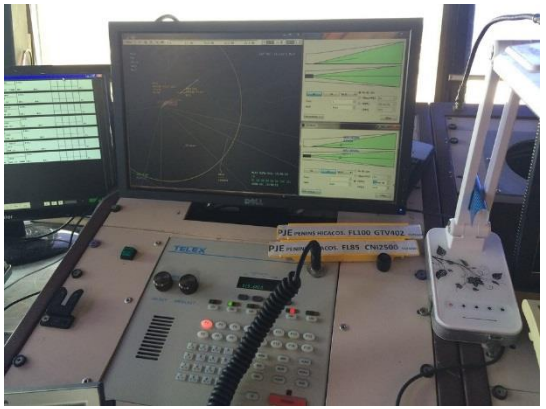


MLAT installation experience

Varadero (Cuba) WAM+MLAT

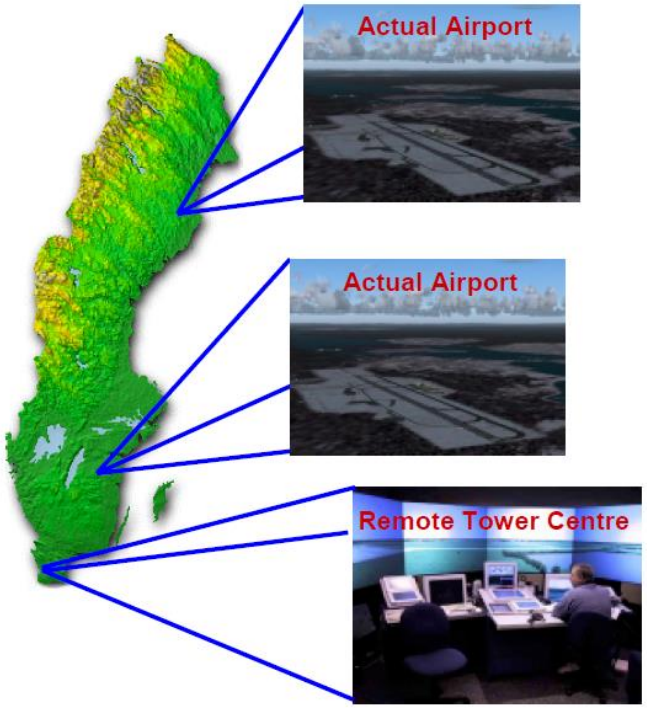
- TMA WAM + Surface MLAT at Juan Gomez airport, Varadero, Cuba
- Deployed in 2014
  - 6 Rx and 2 Tx (4 NM base, 1 station at 12 NM)
- Operational area: surface & TMA zone up to 40 NM
  - ADS-B receive up to 200 NM
- Precision depends on range, average 100 m
- On operational trial since 2014





Remote control and management

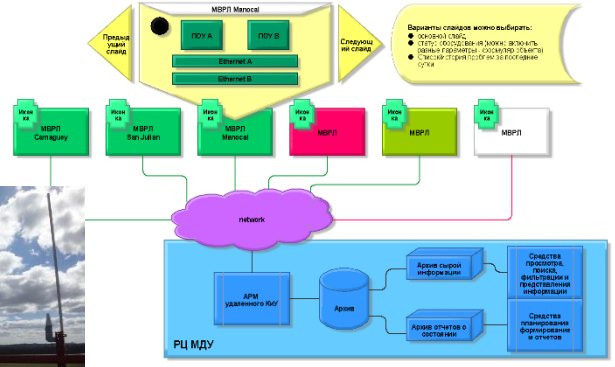
- Remote control and management
  - ✓ Supported for all VNIIRA/CRTS surveillance systems: MSSR, ADS-B, MLAT
  - ✓ Remote control & monitoring, management & configuration, software & firmware update
  - ✓ Connection to external CMS *(next slide)*
- MLAT is particularly suitable for remote operation:
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



Superterminal

- 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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