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Modern Radio Navigation Techniques: Automatic Dependent Surveillance- Broadcast.



Outline



- Introduction to ATC
- Today's surveillance techniques: PSR, SSR
- ADS-B as a technology for the future
- Summary

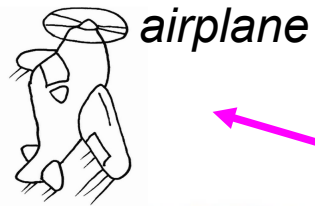


ATC — Air Traffic Control

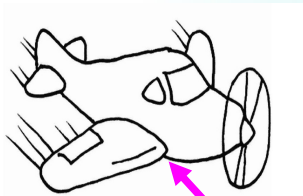


What is Air Navigation?

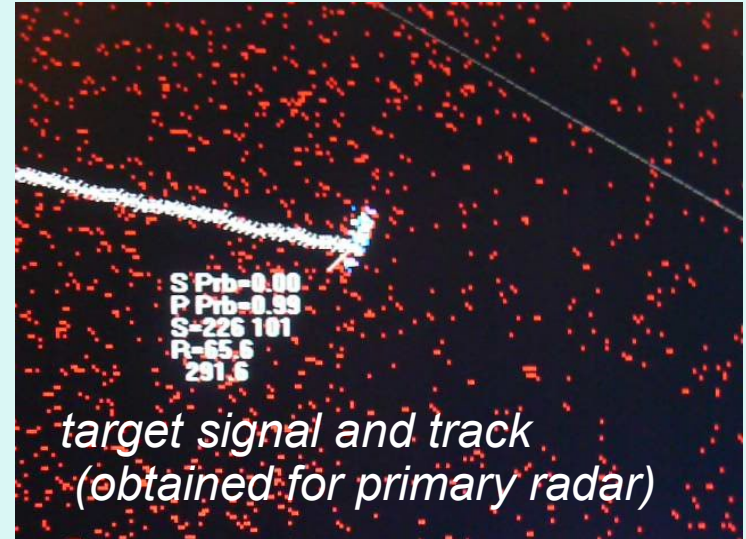
Navigation is the process of reading, and controlling the movement of an aircraft from one place to another.



airplane



civil
ATC
radar
station

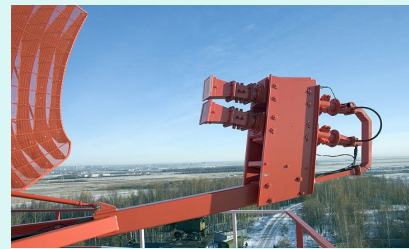
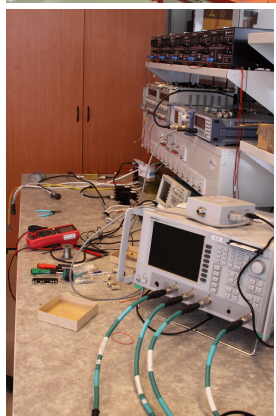


Air traffic control (ATC) is a service provided by ground-based controllers who direct aircraft on the ground and in the air. The primary purpose of ATC systems worldwide is to separate aircraft to prevent collisions, to organize and expedite the flow of traffic, and to provide information and other support for pilots when able.

NRPL Group



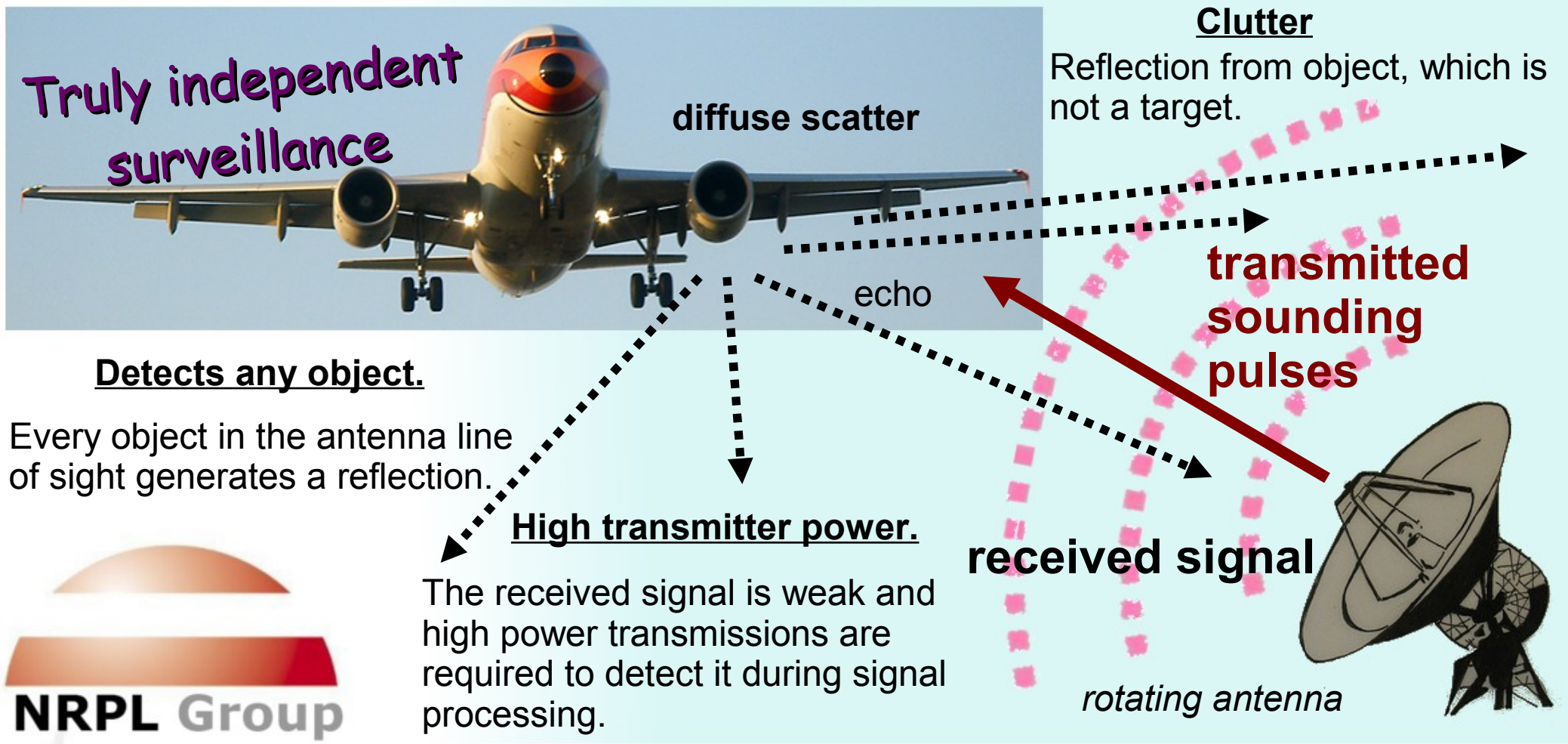
- International Group of ATC and IT Systems Companies with headquarters in Vantaa, Finland
- Group Members in Finland and Czech Republic
- More than 400 professionals in development and production



since 1992



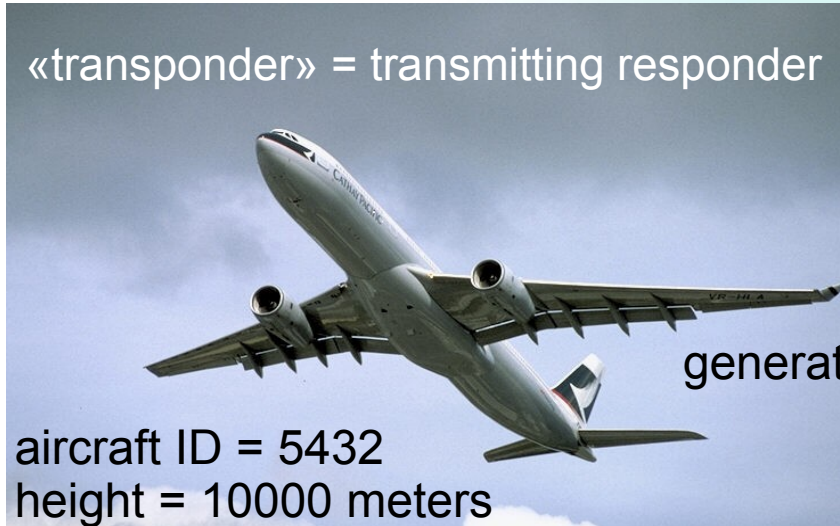
Primary radar(PSR) principles



Secondary radar(SSR) principles



«transponder» = transmitting responder



aircraft ID = 5432
height = 10000 meters

generated reply

«co-operative surveillance»

A piece of equipment (known as a transponder) requires to be installed on-board every aircraft and be switched on and operating.

Detects only co-operating targets. No clutter.
Tracks are more stable than those derived by PSR systems.

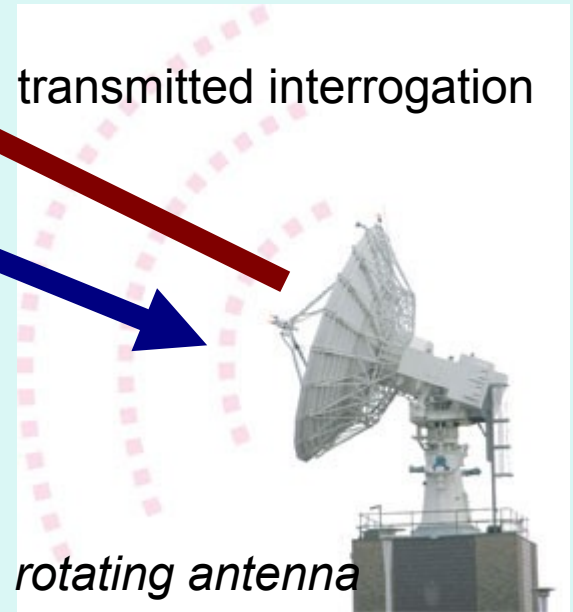
Accurate altitude and identification are available.

Lower transmitter power.

If an aircraft is fitted with a transponder, then it sends a strong signal back as an „echo”.

transmitted interrogation

rotating antenna



«Morava» radar station description



- Digital radar signal processing system;
- Coherent receiver and transmitter provide detection quality improvement;
- Solid-state transmitter with air cooling;
- Linear and circular polarization decrease the influence of weather clutter;
- Digital generation and compression of signals provides higher stability;
- Processing a meteorological information;
- Control and monitoring system (CMS);
- Operation of the radar without continuous staff presence;

- Modular design provides easy change of the configuration;

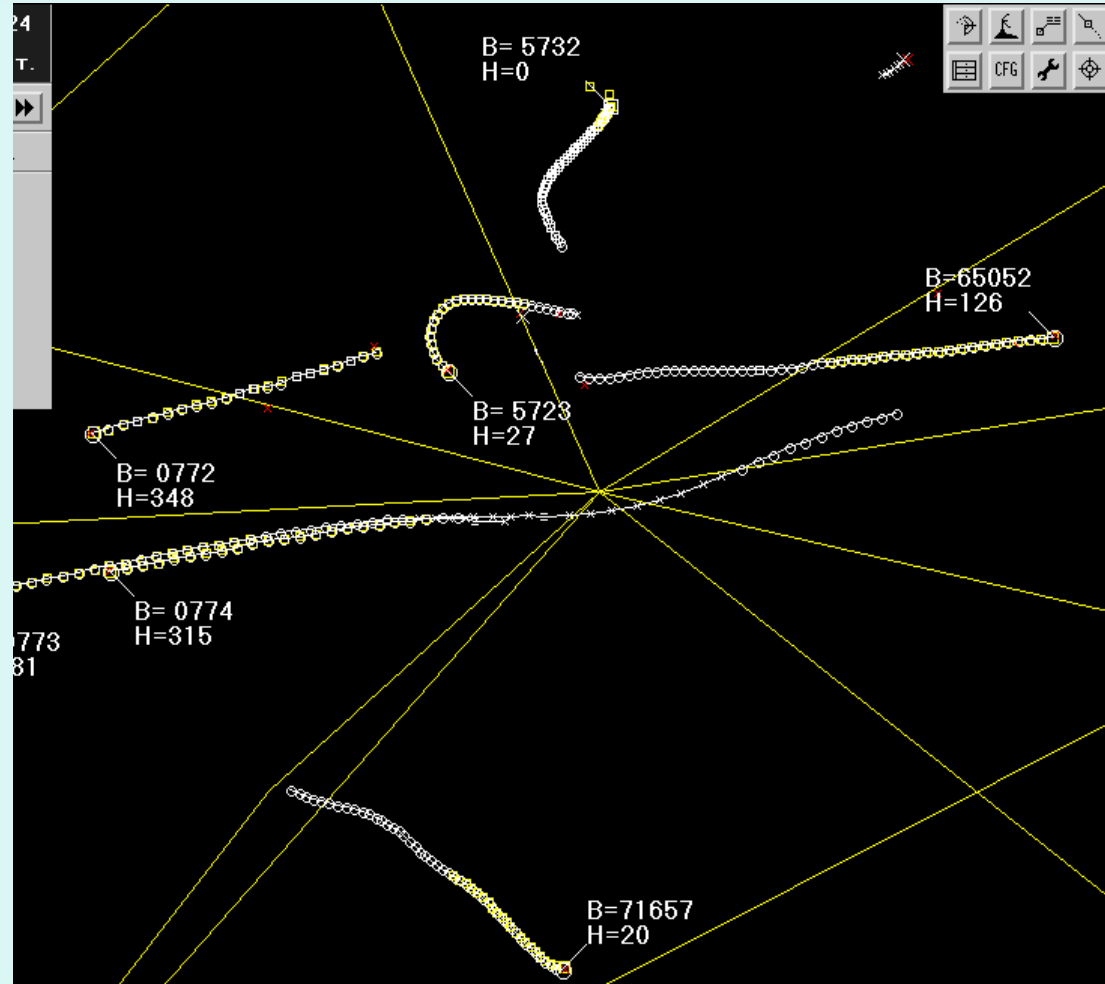
NRPL Group - ~ 4 sec update rate;



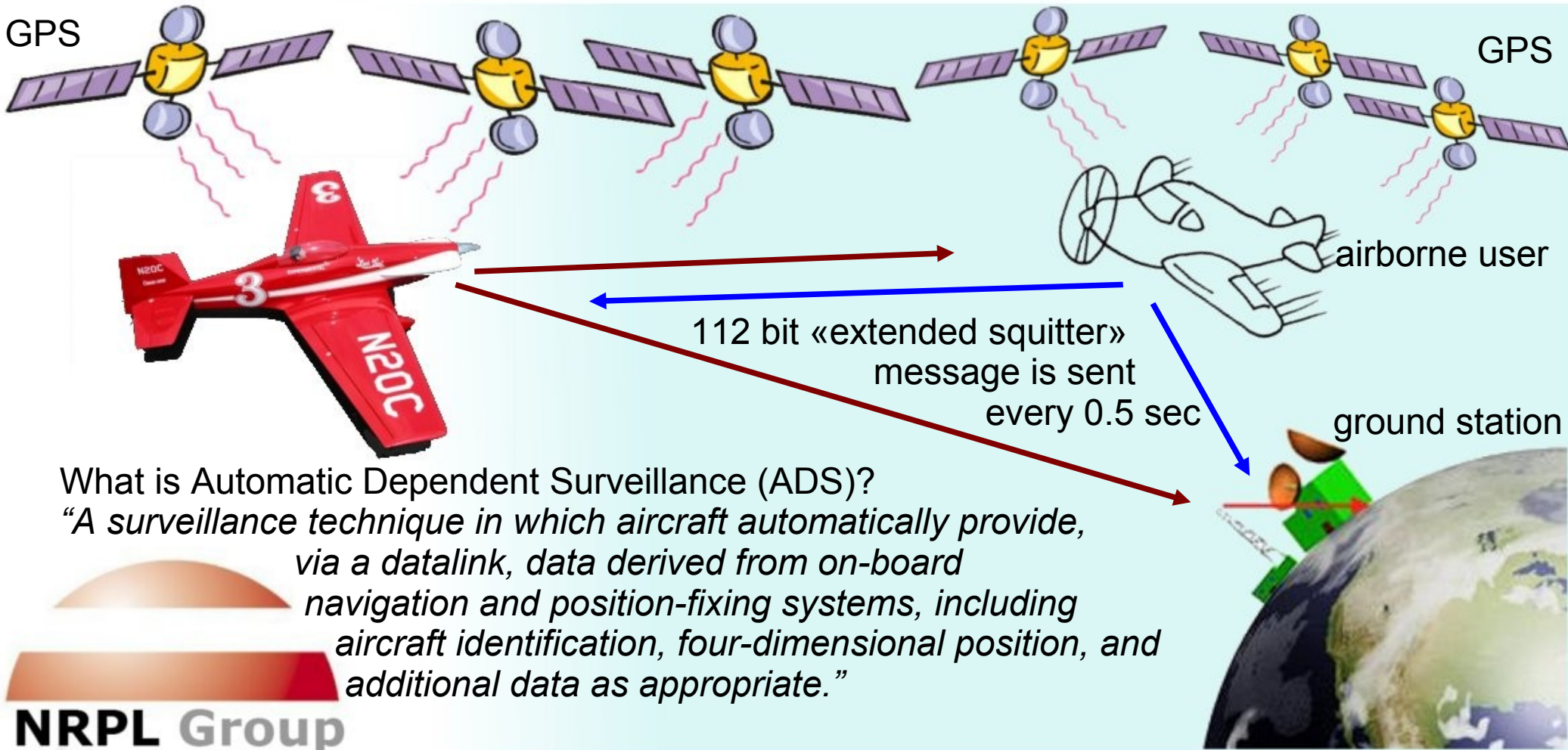
Today's surveillance structure



- 1) Known radar limitations:
 - accuracy (the further away from radar you are, the less the accuracy);
 - buildings, mountains limited range.
- 2) Primary and secondary radar network:
 - limited coverage of airspace.
- 3) High cost to install, maintain, operate.
- 4) Requires ATC for aircraft separation:
 - self-separation is not used.
- 5) Data refreshing rate is limited in terms of rotation speed:
 - you can't spin the radar head fast enough.



ADS-B principles



ADS-B technology



Technology where the aircraft is equipped with GPS and transponder, needs going to be sending signal to the ground every half of second.

Not ground controlled.

Each ADS-B report broadcast to all aircraft. No guarantee of reception.

Recipients may be communications receivers ('data acquisition units') on other aircraft, ground vehicles or at fixed ground sites.

Since ADS-B could deliver surveillance information to the pilot, he will have access to similar surveillance information as the ground air traffic control station.



ADS-B message types



Airborne position (altitude, latitude, longitude),
accuracy ~5.1m

Surface position (ground track, latitude, longitude),
accuracy ~1.2m

Aircraft identification (aircraft category (small/medium/large),
callsigns)

Airborne velocity (ground speed or air speed)



ADS-B message structure

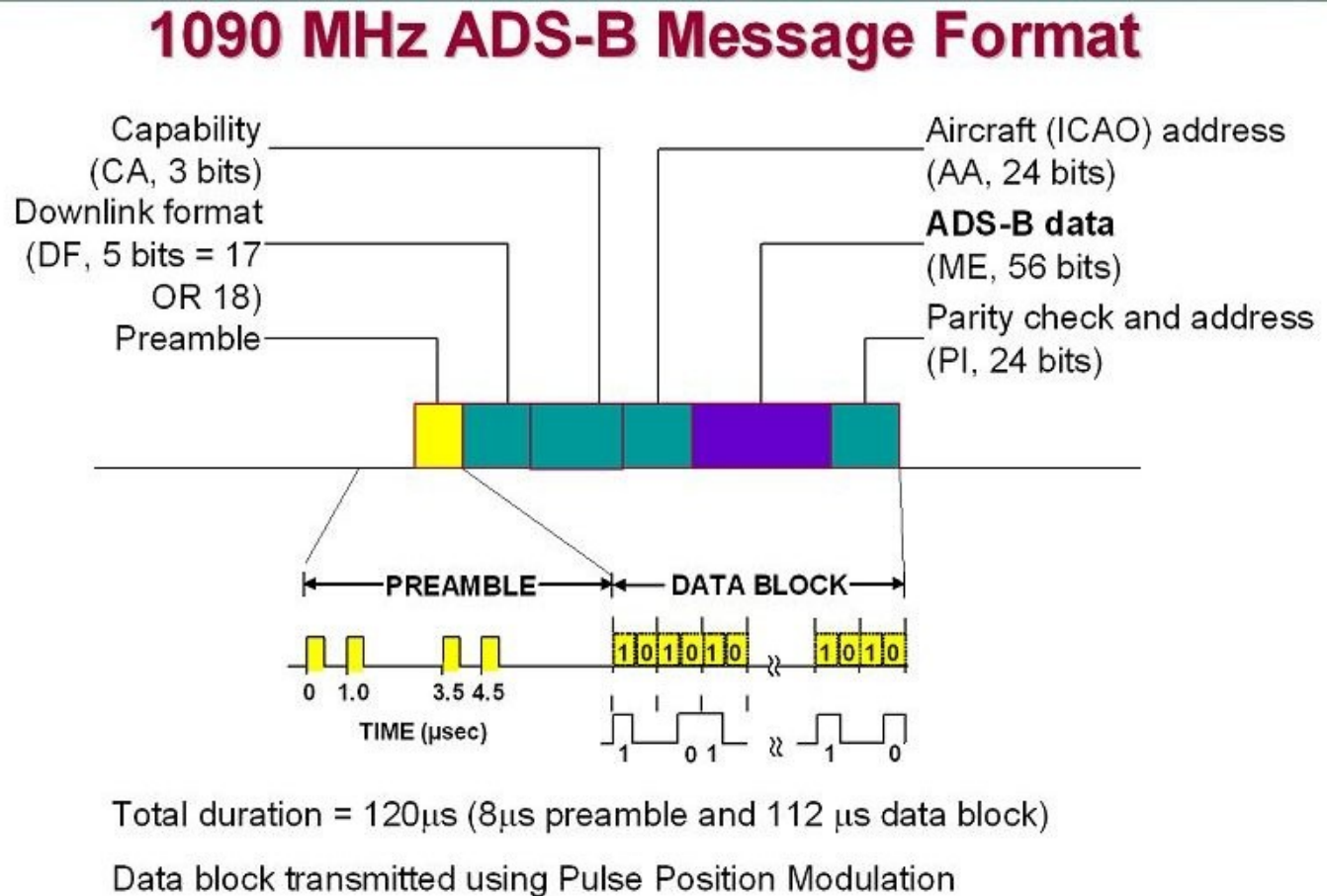


Preamble: This is special bit sequence to allow the receiver to identify and synchronise with a received message.

Data Block: 112 bits encoded of 112µs containing the ADS-B position reports.

Aircraft (ICAO) address: This is the 24 bit address of the aircraft.

ADS-B data: contents depend on ADS-B message type.



Parity check: 24 bit error detection code to help a receiver determine errors in the received message.

ADS-B advantages



Extremely Accurate

independent of distance
1 sec update rate

More Information

identity of the aircraft
input for alert processing

Small receivers

more than 400 km range
existing 1090 Mhz

Two-way structure

aircraft position broadcasting
receiving other aircraft position

Non-radar space

provides surveillance
outside of the radar coverage

Difficult areas

stable surveillance
in mountain areas

Low cost

low cost to install
low cost to maintain

No interrogation

ground receiver doesn't
cause additional interference



Summary



ADS-B is clearly a critical technology for the future of the aviation industry, addressing what surveillance need.

An airplane becomes much more active participant of the procedure, transmitting its coordinates, identification and other relevant information instead of being just a passive radar target.

Primary radar is true independent surveillance technology, it is working today, and it will be working tomorrow. Even if an aircraft has switched off its avionics, it will be detected by primary radar.

Secondary radar technology in future may be replaced by ADS-B and other next generation surveillance technologies.





Thank you.



Abbreviations



ATC	Air Traffic Control
ANSP	Air Navigation Service Provider
ADS-B	Automatic Dependent Surveillance-Broadcast
PSR	Primary Surveillance Radar
SSR	Secondary Surveillance Radar
RADAR	Radio Detection And Ranging
ICAO	International Civil Aviation Organization