ADS-B For Beginners
What is ADS-B*?

• ADS-B is an Air Traffic Management (ATM) Surveillance system that replaces traditional radar based systems

• ADS-B is like a large wireless network - the ground stations are Wireless Access Points and the aircraft are Clients

• Aircraft report their own position via the network and receive back, from the ground system, traffic and other information

• Computers on the ground integrate all the information and provide controllers with timely warnings of problems

*The Acronym "ADS-B" stands for "Automatic Dependent Surveillance - Broadcast"
Why do we need ADS-B?

- **The Air Traffic Management System needs ADS-B because**
  - Radars are large, expensive and old
  - Radar coverage is limited by distance, terrain and atmospheric conditions

- **Aircraft Operators need ADS-B because**
  - It will be mandated
  - It improves safety by providing flight following, improved separation services and useful cockpit data such as traffic and graphical weather
  - It enables more efficient routing
Safety

Accident Prevention

Weather is directly responsible for around 5% of General Aviation accidents - and around 15% of General Aviation fatalities. Weather is a contributing factor in many more accidents and incidents. Up to date awareness of weather is a real factor. Studies have shown that many incidents and accidents start with limited weather briefings and/or with weather conditions that changed in flight. Having real time, graphical, aviation specific weather available in the cockpit helps pilots make good decisions and avoid weather related difficulties. With ADS-B, this information is available from the FAA, subscription free.

Traffic related accidents have received a lot of attention in the past couple of years. Operations close to busy airfields bring airplanes close together and provide controllers with very high workloads - a dangerous combination. ADS-B equipped aircraft provide a higher quality signal to ATC - making integration of the overall traffic picture more automated and less dependent on human processing. An ADS-B equipped aircraft will also receive a tailored traffic picture - giving the pilot a simple, reliable, comprehensive picture of traffic around him - enhancing his “see and avoid” capability.

Accident Survival

ADS-B makes you visible to ATC - with reports once a second. The FAA makes this information available to search and rescue teams which can in turn dramatically shorten rescue time. If you are unfortunate enough to go down in a remote area this can literally be the difference between life and death.

We also believe in the value of a reliable ELT. Units are available now with integral GPS and antennas - so they work even if they are disconnected from the aircraft. Current, accurate position reports form the FAA and a robust ELT means you will be found fast, even in difficult locations.
How does ADS-B work?

• Each aircraft automatically transmits information about itself and its position - there is a message sent every second

• The ground system integrates that information and uses it to provide “smart” data to air traffic controllers

• The ground system rebroadcasts this integrated information (and legacy radar targets) back to the sky once a second - any aircraft in range can receive the data. This data broadcast is usually called “TIS-B”. Aircraft can also see each other if they are within line of sight

• The ground system also broadcasts additional flight information such as graphical weather and NOTAMS. This data is called “FIS-B”
Which aircraft will need to be ADS-B capable?

Pretty much anybody who, today, is required to have a transponder
What is ADS-B “Out” and ADS-B “In”?  

**Out**
- ADS-B “Out” is the broadcast by aircraft of ADS-B data
- When the FAA talks mandated equipage, they are referring to ADS-B “Out”

**In**
- ADS-B “In” is the reception by aircraft of FIS-B and TIS-B data and other ADS-B data such as direct communication from nearby aircraft
- ADS-B “In” is optional
What aircraft equipment is required for ADS-B “Out”? 

• For ADS-B “Out”

  – A precision GPS source
  
  *GPS Source: Standards vary worldwide but an enhanced (TSO-C145 or TSO-C146) GPS will work anywhere

  – A transmitting radio
  
  *Transmitting Radio: An ADS-B qualified Mode-S transponder (1090 MHz)
  - or -
  [US only, below 18K Ft only] a dedicated ADS-B data radio (978 MHz)

  – Simple controls

  *Simple Controls: Some way to enter a mode 3/A code and verify that ADS-B is working

*1090 MHz Data Link is commonly referred to as “Mode S” 978 MHz data link is commonly referred to as “UAT” (Neither is very descriptive or accurate - we will call them “1090” or “978”)
Certified ADS-B Out Equipment Examples

**ADS-B Position Sources**

- FreeFlight Systems 1201 SBAS/GPS receiver
- FreeFlight Systems 1203 SBAS/GPS receiver

**ADS-B Data Radios**

- FreeFlight Systems “RANGR” 978 MHz ADS-B Transmitter with Control Head
- 1090 MHz ADS-B Transponders
• TSO-C154c Class B1 / B1S Data Radio
  – Diversity capable
  – Internal or external GPS
  – Transmitter only or transceiver configurations
  – Weight 0.8 lbs
  – Nominal 60W output power
  – Supports “GDL-90” protocols
  – Design assurance level C
Datalink Capacity

1090 MHz datalink is transponder based. It is used by TCAS and is already very crowded. Addition of ADS-B Data takes this datalink to the limit of its capacity.

Zero growth capacity

The 978 MHz datalink is dedicated to ADS-B and carries no other data giving it enormous growth capacity - over and above the high data content services already offered.

Capacity for Future Products and Services

High Data Content Services

Zero growth capacity

Traffic Receiver

ADS-B Out

TCAS

Xponder

Graphical Weather

Other FIS-B

Spare / Growth

1090 MHz

978 MHz
This guy has a 978 receiver to get the free stuff

This guy will only be seen if he is transmitting at 978

ADS-B Coverage limit
Technology - Old vs New

1090 MHz Mode S ES transponder
Not 2011 technology

978 MHz ADS-B Transceiver
Weight ~ 0.8 lbs
Tested To DO-160G
Meets DO 282B MPOS
Meets TSO-C154c

1090 MHz
978 MHz

2011 technology

Transponder technology was introduced in WW2
“Mode S ES” technology was introduced in the early 1990’s with TCAS

First generation 978 MHz radio was introduced in 2003
Current generation is 100% “today” technology

“Its Like VHS vs Blue Ray”
John DeBusk, VP Engineering, FreeFlight Systems
What aircraft equipment is required for ADS-B “In”?

- Prerequisite - you must have a valid ADS-B “Out” system
- TIS-B traffic data is transmitted at both 1090 MHz and 978 MHz
- FIS-B graphical weather and other data is transmitted only at 978 MHz
- At either frequency you can use a dedicated receiver or a transmitter that has “In” Capability. Displaying the ADS-B “In” data requires an ADS-B capable display. This sounds obvious but different manufacturers have different approaches. In general:
  - 978 TIS-B / FIS-B data can be displayed on any surface that accepts the standard interface. This includes most Chelton products and a few Garmin displays such as the MX 20/ GMX 200. For other Garmin products or other manufacturers we recommend that you call them to discuss TIS-B/FIS-B interfaces

Or ....
...iPad

ADS-B Traffic and Weather shown on iPad
When Will ADS-B be Up and Running?

USA

• Over 80% coverage by the end of 2011

• All USA (at least the same coverage as radar today) by the end of 2013

Non USA

• ADS-B “Out” at 1090 MHz will be required in most non-US airspace by 2014 - 2017
Subscription FreeTraffic and Graphical Weather - ADS-B service by altitude - end 2011

Source ITT
A little bit on GPS

State Of The Art Portable Device GPS Circuitry

- Often Right

State Of The Art Aviation GPS Circuitry

- Knows if its right
- Knows if the satellites are right and excludes bad ones
- Knows it is going to know if it is right
- Only gives bad information once in every 1,000,000,000 Hours (One hundred and forty one thousand years)
The basic, free FIS-B service transmits graphical and textual weather, as well as other aeronautical products. These include:

- Aviation Routine Weather Reports (METARs).
- Non-Routine Aviation Weather Reports (SPECIs).
- Terminal Area Forecasts (TAFs) and their amendments.
- NEXRAD (regional and CONUS) precipitation maps.
- Notice to Airmen (NOTAM) Distant and Flight Data Center.
- Airmen’s Meteorological Conditions (AIRMET).
- Significant Meteorological Conditions (SIGMET) and Convective SIGMET.
- Status of Special Use Airspace (SUA).
- Temporary Flight Restrictions (TFRs).
- Winds and Temperatures Aloft.
- Pilot Reports (PIREPS).
- TIS-B service status.

Source: FAA
Hockey Pucks and Other Traffic

Properly equipped aircraft (978) sees this target from FAA re-broadcast. He sees this one air to air. He does not see these.

Improperly equipped aircraft sees this target from FAA re-broadcast. Improperly equipped aircraft (978) sees some targets but misses others.

Ground System sends hockey puck of traffic info centered around a valid ADS-B client.

Receive only (traffic) or uncertified ADS-B “out” installs with traffic receivers lead to dangerous conditions and are not allowed.
Backup Slides
# ADS-B “Out” Transmitter - 1090 MHz vs 978 MHz

<table>
<thead>
<tr>
<th>1090 MHz</th>
<th>978 MHz</th>
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<tbody>
<tr>
<td><strong>Pro</strong></td>
<td><strong>Pro</strong></td>
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<tr>
<td>• Required above 18K Ft or outside of the US</td>
<td>• Coexists peacefully with existing transponder</td>
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<tr>
<td>• Integrated with Mode-S ES Transponder</td>
<td>• Inexpensive</td>
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<tr>
<td>• Integrated transponder and ADS-B Control</td>
<td>• FAA preferred solution for light aircraft</td>
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<tr>
<td><strong>Con</strong></td>
<td><strong>Con</strong></td>
</tr>
<tr>
<td>• Older aircraft will require new transponder or a significant upgrade to installed equipment</td>
<td>• Limited to US below 18K feet</td>
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<td>• Requires additional squawk control</td>
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