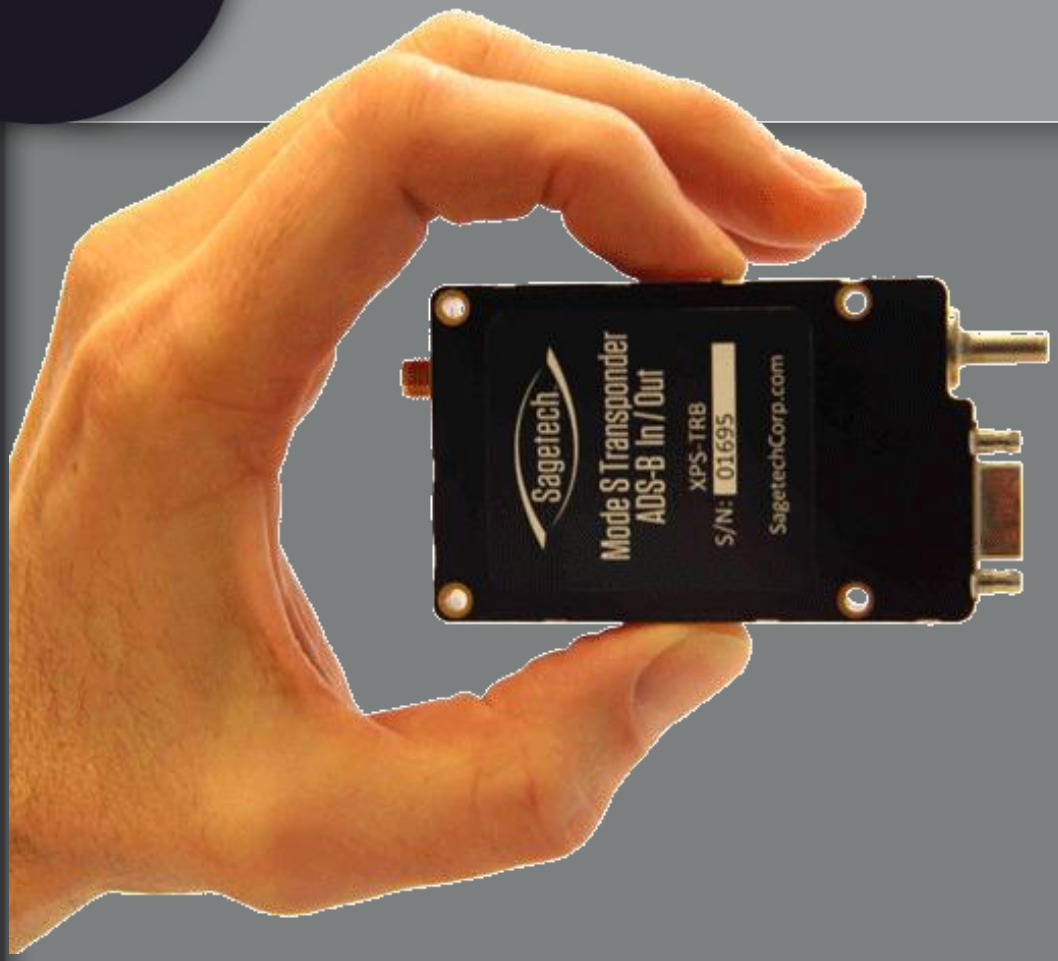
ADS-B Sense and Avoid



Kelvin Scribner
President
Sagetech Corporation

Introduction

- Demonstration of ADS-B
  - Camp Roberts, CA
- Tutorial on Surveillance
- Military Mode 4/5
- UAS in NAS
- Summary

Camp Roberts Demo
Oct 24, 2012

- Arcturus T-20 UAV
- Cirrus SR-22 (manned aircraft)
- All aircraft “visible” via ADS-B Out, COTS Hardware
  - iPad
  - Sagetech Clarity ADS-B Receiver

UNMANNED AIRCRAFT

Demonstrating ADS-B Out capability

Equipment: Mode S ADS-B Out Transponder

MANNED AIRCRAFT

Squitters ADS-B Out Messages so the operator can maintain separation between the two aircraft.

Equipment: Mode S ADS-B Out Transponder / GPS / Battery

Tracking the T-20 via Clarity ADS-B Receiver

Equipment: Clarity / iPad / WingX Pro7

MOBILE GROUND PERSONNEL

Tracking the unmanned and manned aircarft via an portable ADS-B Receiver

Equipment: Clarity / iPad / WingX Pro7

GROUND CONTROL

Operating T-20 Aircraft

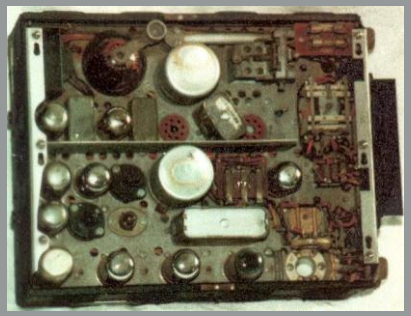
Sagetech

Surveillance Tutorial

- Primary Surveillance Radar, “Skin Paint”
- Secondary Surveillance Radar
- ADS-B, the corner stone of “NextGen”

Radar Systems

- Primary Surveillance Radar
  - Skin paint
  - Small UAVs, Small Radar X-Section
- Secondary Surveillance Radar
  - Transponder Active Reply



U.S. Navy 470MHz IFF Transponder (1940)

Transponders: Mode A and Mode C

- Mode A squawk code
- Mode C Altitude
- Altitude Encoder
  - Encoders vs. Altimeters
  - Pressure Altitude (not GPS altitude!)
  - Compliance vs. Certification

Selective Interrogation

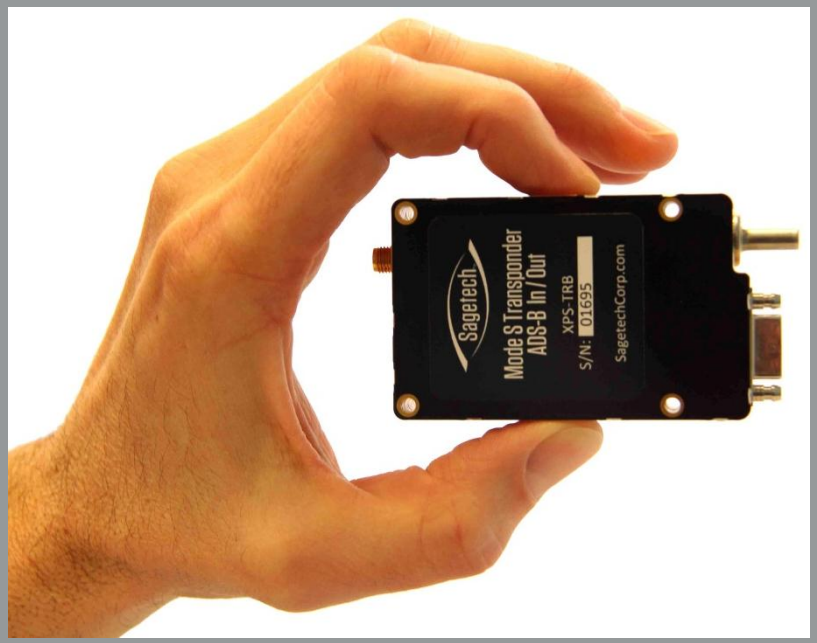
- Mode S
  - All standards of Mode A and Mode C
  - Extended Squitter
  - Datalink
  - TCAS
- Required for General Aviation in Europe

Automatic Dependent Surveillance-Broadcast (ADS-B)

- “Squitters” GPS Position
- Required for GA aircraft in 2020
  - where Mode C Transponders are presently required.
- Infrastructure
  - Ground Based (ITT-Exelis)
    - ADS-B Broadcast Services – weather and traffic
  - Space Based
    - Aireon-Iridium, NavCanada, Harris, Sagetech

ADS-B Out

- Position Source: Certification?
  - Accord Technology Nexnav Mini
  - COTs GPS Receiver



ADS-B Data Products

- TIS-B (Traffic Information Service Broadcast)
  - Roughly, ATC Traffic Picture Relay
  - Limited to Participating Aircraft
- FIS-B (Flight Information Service Broadcast)
  - Weather, Notams
  - TFR’s Etc

ADS-B Channels

- 1090 MHz Extended Squitter (1090ES)
  - Required above 18,000’ (Class A airspace)
  - Traffic, but no weather
- Universal Access Transceiver (UAT)
  - 978 MHz (dedicated ADS-B channel)
  - Traffic
  - Weather

ADS-B Channel	Under 18,000'	Over 18,000'	Traffic (TIS-B)	Weather and other information (FIS-B)	Notes
1090ES	X	X	X		Included with Mode S Transponders
UAT	X		X	X	Separate installation

Military Transponders
IFF CI

- Mode 4 (legacy)
- Mode 5
  - Spread-Spectrum
  - Includes ADS-B like protocol
- Required on Shadow and bigger
  - BAE (5lbs)
  - Raytheon (10lbs)
  - Sagetech (0.5 lb)

UAS in NAS

- Sense and Avoid
- Rule Making
  - Create MASPS and MOPS
  - Create ConOps
  - Spectrum Allocation for C^3
- Certificates of Authorization
  - Mode C Transponder
  - ADS-B Out

Conclusion

- Technology largely exists
- Certification and Compliance
  - Transonder
  - Mode C Altitude Encoder
  - GPS Position Source for ADS-B Out
- Situational Awareness Benefits
- SWaP – C Enabled

Questions / Discussion

- UAS Transponder Options

Manufacturer	Mode	Alt Enc	UI	TSO	ManufacturerPN	Max Altitude	ADS-B Out	ADS-B In	Weight
Becker	Mode C		X	X	ATC-4401-250	50,000 ft			720 g
	Mode S		X	X	BXP6401-1-(01)	50,000 ft	X		720 g
Microair	Mode C		X	X	T2000SFL	unlisted			600 g
					T2000AV-L BNC	unlisted			454 g
Trig	Mode S	X	X	X	TT22	35,000 ft	X		500 g
				X	TT22	35,000 ft	X		454 g
Sagetech	Mode C	X	X	P	XPC-TR	50,000 ft			100 g
	Mode S	X	X	P	XPS-TR	50,000 ft	X		100 g
		X	X	P	XPS-TRB	50,000 ft	X	X	100 g