

Aircraft Information Systems Security



Presented to the Information Assurance Seminar
Iowa State University

by
Steve F. Russell
Iowa State University
Department of Electrical and Computer Engineering
September 21, 2001



**A robust and successful
aviation industry is
absolutely essential for a
healthy U.S. economy**





Aircraft Information Systems Security?

There isn't any!



The End

Any Questions?



Just Kidding!
You were supposed to
Laugh!

!HA HA!

Aviation Systems

The Players

- ❖ **The Regulator (FAA)**
- ❖ **The Equipment Manufacturers (Aircraft and its Avionics)**
- ❖ **The Service Providers (Airline Company)**
- ❖ **The Customers (you the passenger)**

The Regulator (FAA)



- ❖ **Public Benefit (#1)**

- ❖ **Reliability**

- ❖ **Safety**

- ❖ **Government Cost**

- ❖ **Tight Control**

The Equipment Manufacturers (Aircraft and Avionics)

- ❖ Cost and Profitability
- ❖ Reliability and Maintainability
- ❖ Customer and Service Provider Perceptions

The Service Providers (Airline Companies)

- ❖ Maximize Revenue and Profit
- ❖ Maintain Quality of Service
- ❖ Obtain Favorable Customer Perceptions
- ❖ Information System Services at a Minimum Cost

The Customer (YOU!)



✦ Transportation that is:

- ◆ Practical
- ◆ Economical
- ◆ Safe
- ◆ Reliable

Aircraft Communication Systems

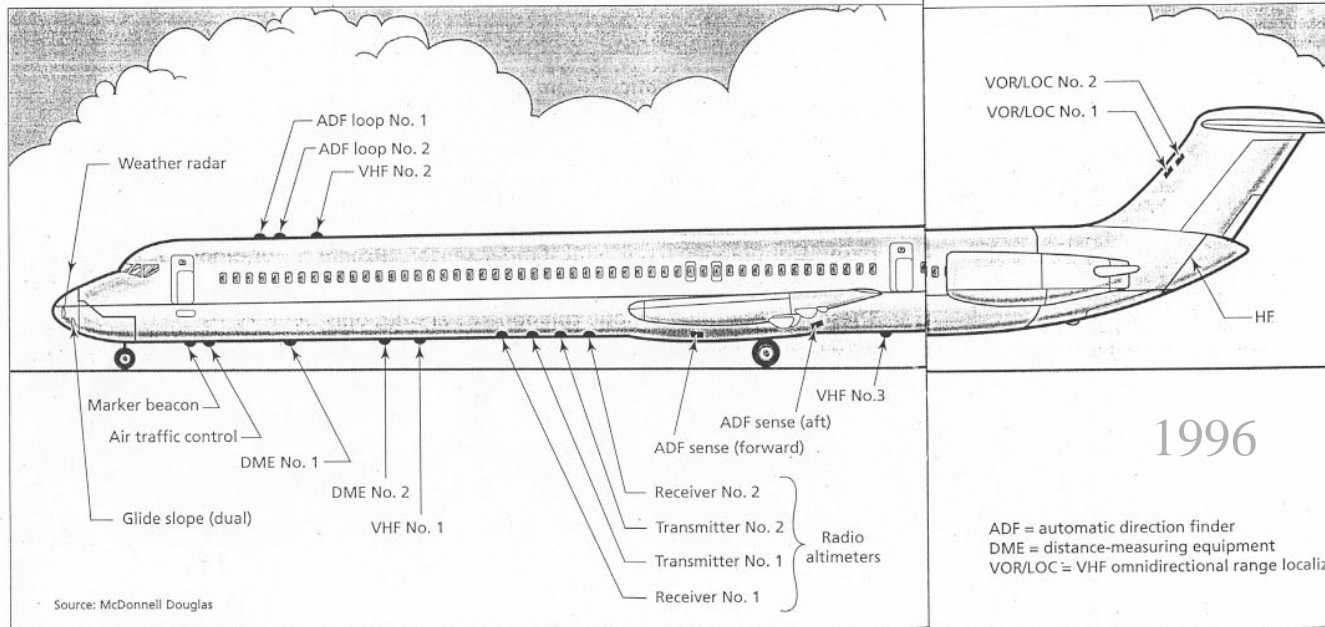
A "Big" Concern Prior Sep 11, 2001

Do portable electronics endanger flight? The evidence mounts

According to a new study, the risk that RF emissions from carry-on electronic devices will affect avionics, although not high, is still high enough to warrant tougher government regulations

our safety briefing video momentarily. We would appreciate your attention to this important information. Use of portable electronic devices is not permitted during taxi, takeoff, and landing. Your crew will let you know when we reach an altitude when you can begin using an approved electronic device.

The business travelers on the plane continue to work on their laptops, oblivious to the loudspeaker announcement. A teenager, plugged into his Gameboy with earbuds, shoots down another space alien. A couple sharing a CD player daydream to their favorite opera. Eventually, they are woken up by flight attendants making a final check down the cabin. They all grudgingly turn off what the airline industry calls portable electronic devices (PEDs).



Aircraft Communication Systems Today – A Loss of innocence

September 19, 2001

New York Region

THE PLANES

The New York Times

Design Goal: Keeping Jets From Misuse as Missiles

By KENNETH CHANG

In the aftermath of the attack on the World Trade Center, aviation experts have begun considering changes in aircraft design that would help prevent terrorists from turning passenger airplanes into kamikaze weapons.

In the short term, design of the cockpit

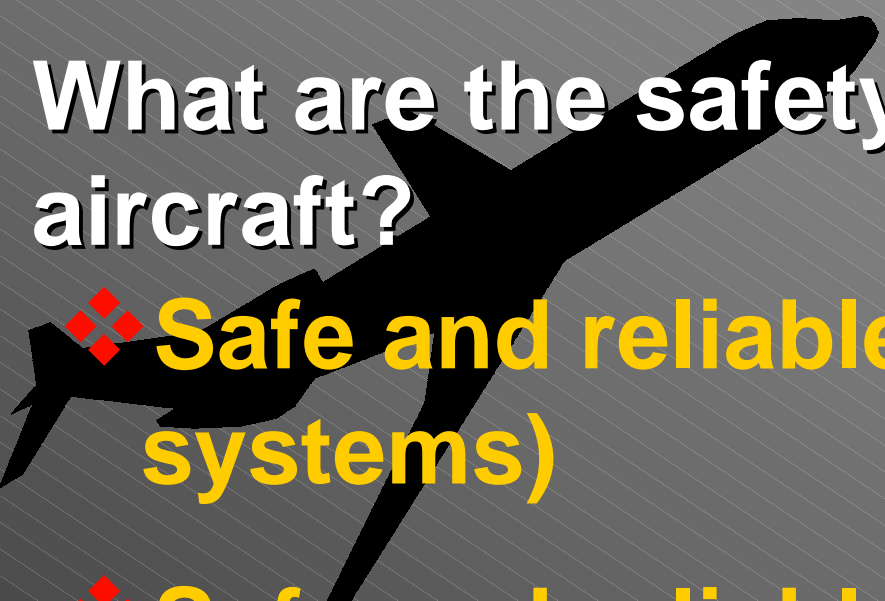
MULTIMEDIA

-  [Interactive Feature: Attack on America](#)
-  [Images of Terror](#)

James K. Coyne, president of the National Air Transportation Association, said that such a system could also be used to thwart terrorist attacks, by defining forbidden zones in the computer database.

Mr. Coyne also said that two-way radios between pilots and air-traffic controllers, essentially unchanged for decades, should be upgraded to a state-of-the-art, high-bandwidth wireless network. Transmittable data could include video of what was happening inside the plane as well as the information now captured by the black box flight recorders.

What are the safety issues for aircraft?

- 
- ❖ **Safe and reliable aircraft (airframe systems)**
 - ❖ **Safe and reliable navigation**
 - ◆ Takeoff, landing, in-route (airway) navigation
 - ◆ Collision avoidance
 - ◆ Position-Location universally available
 - ❖ **Safe and secure cockpit and cabin**

What are the safety issues for aircraft? (cont.)

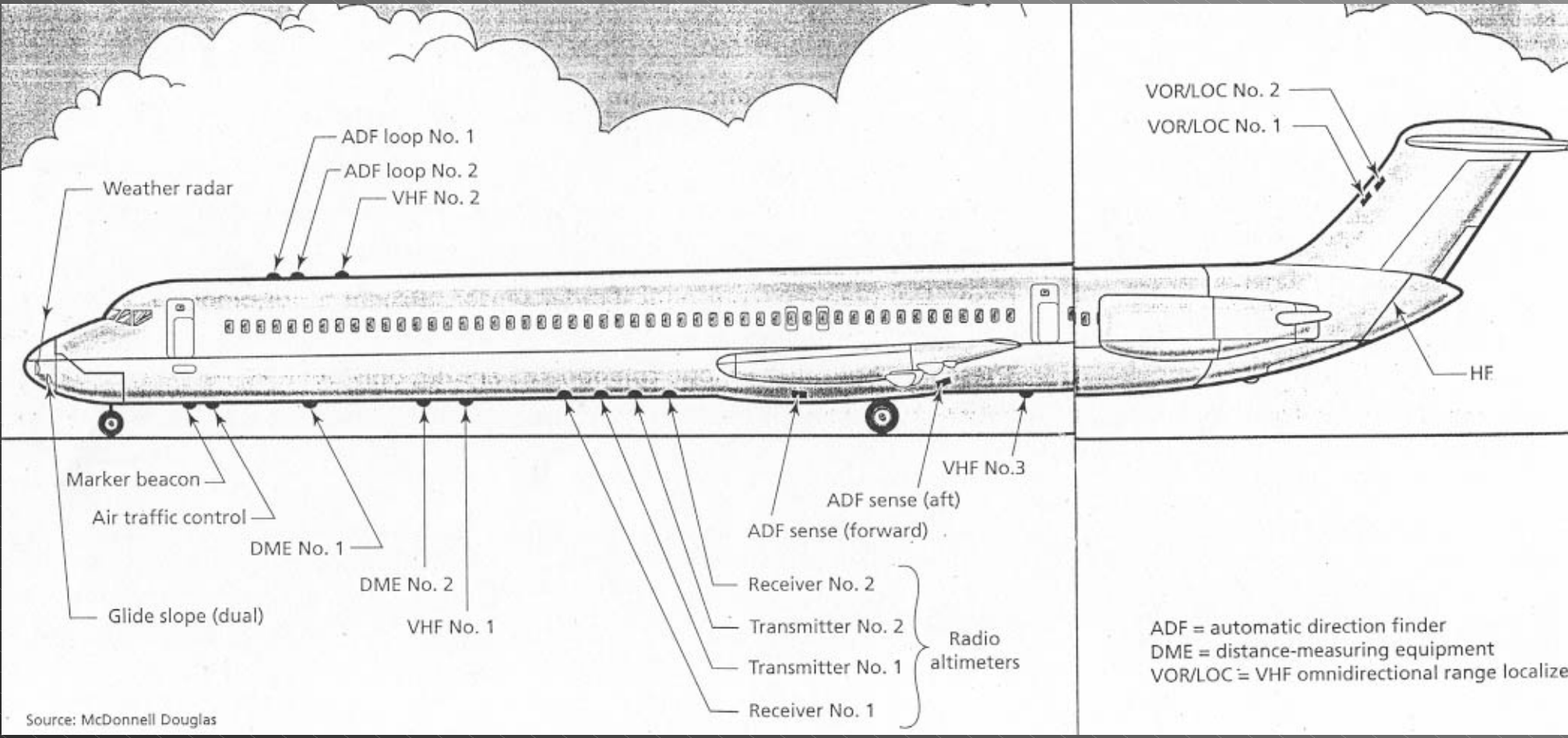
❖ Secure and reliable aircraft communications

- ◆ Air-to-ground 2-way communications
- ◆ Air-to-air 2-way communications
- ◆ Air Traffic Control radar transponder
- ◆ Cockpit Voice Recorder
- ◆ Flight Data Recorder

*This is where
Information Systems
Security plays a big roll*

Aircraft Communication Systems


Circa 1996 (but might as well be 1956)



Source: McDonnell Douglas



Some Current Avionics Systems



- ❖ VHF 2-Way Radio (air-to-ground, air-to-air)^(1,2)
- ❖ High-Frequency Radio (HF)
- ❖ Air Traffic Control (ATC) Radar Transponder (air-to-ground)^(1,2)
- ❖ Navigation (ADF, VOR/DME, Compass, GPS)⁽¹⁾
- ❖ Autopilot (in-route navigation)⁽¹⁾
- ❖ Landing: Glideslope and Localizer (LOC) ⁽¹⁾

1. Essential to navigation/flight safety
2. Essential to aviation system security

Some Current Avionics Systems (cont.)

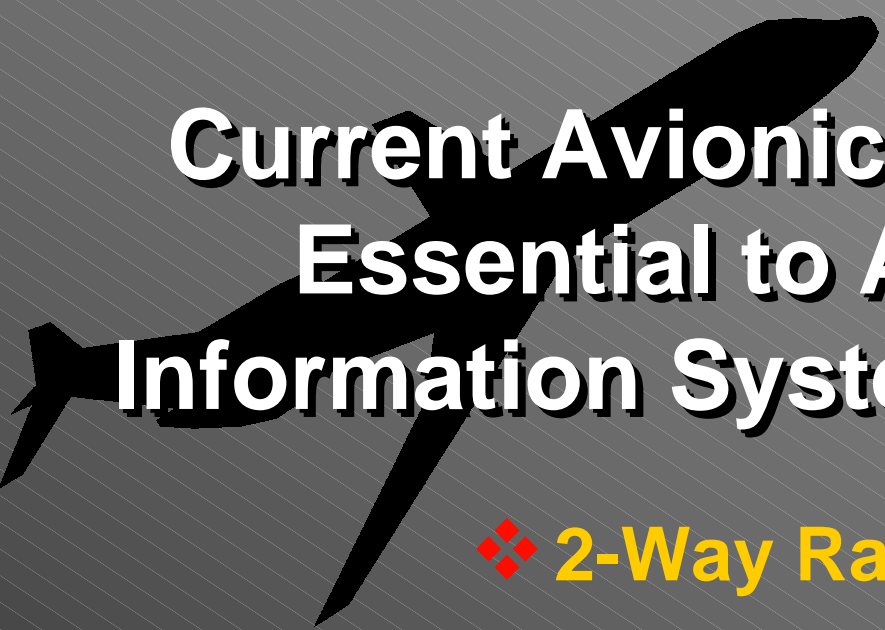
- ❖ Weather Radar⁽¹⁾
- ❖ Marker Beacon^(1,2)
- ❖ Collision avoidance (proposed new systems)⁽¹⁾
- ❖ Cockpit Voice Recorder (“black box”)^(1,2)
- ❖ Flight Data Recorder (“black box”)⁽¹⁾
- ❖ Airphone (satellite telephone)
- ❖ Passenger entertainment system (Music, Video)

1. Essential to navigation/flight safety
2. Essential to aviation system security

Lets remove navigation/flight safety systems and issues from our discussion

❖ Why?

- ❖ This has been the focus of government and industry effort and resources for many years
- ❖ Both government and industry have done a good job of this
- ❖ From the issue of navigation/flight safety, flying has never been safer



Current Avionics Systems Essential to Aviation Information System Security

- ❖ 2-Way Radio (air-to-ground, air-to-air)
- ❖ Radar Transponder (air-to-ground)
- ❖ Cockpit Voice Recorder (“black box”)
- ❖ Flight Data Recorder (“black box”)

The cockpit does not have a “silent alarm”

Background

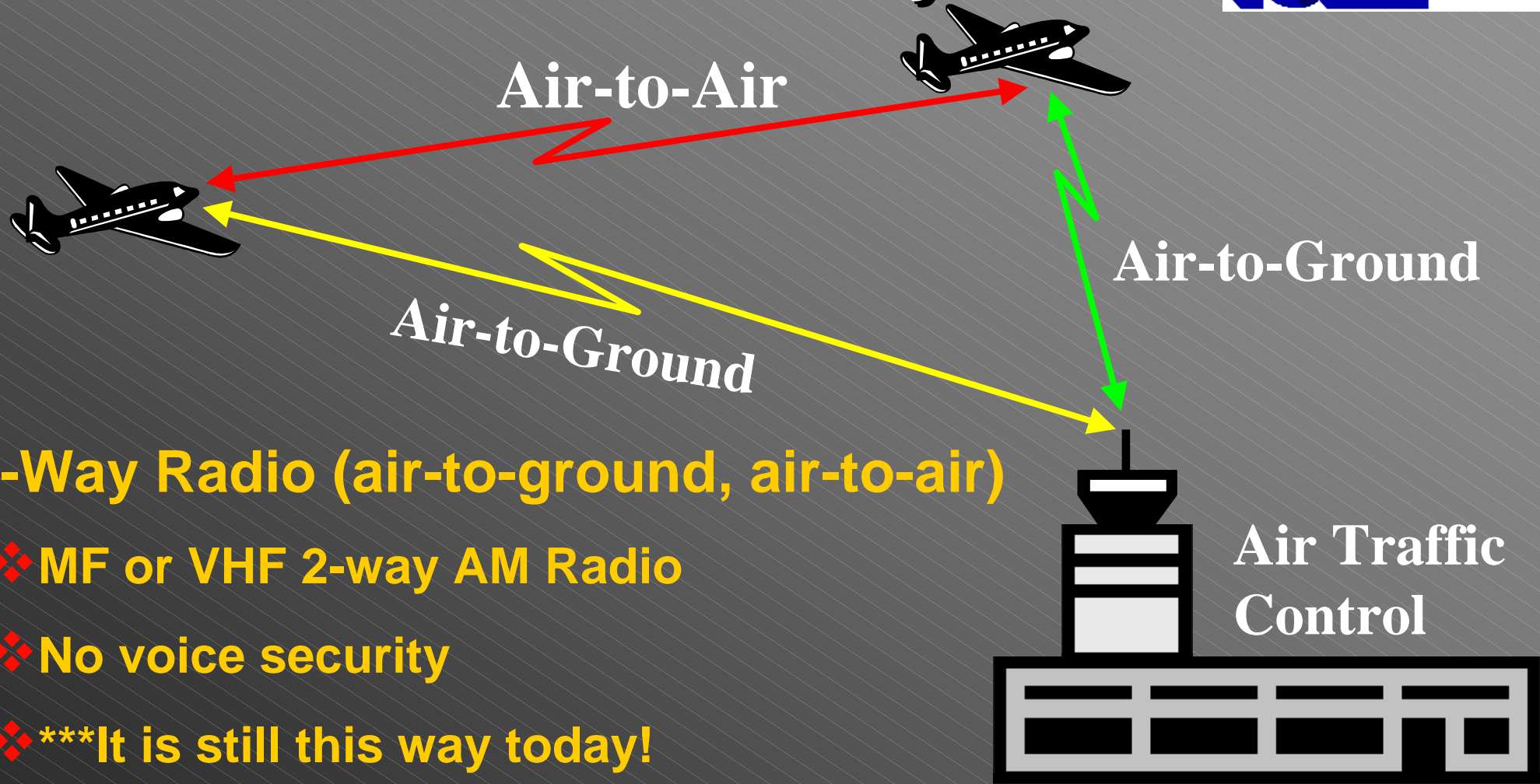
The First Communication Systems

- ❖ **2-Way Radio (air-to-ground, air-to-air)**
 - ❖ **Amplitude Modulation (no security)**
 - ❖ **No protection against jamming and interference**
 - ❖ **No protection against eavesdropping**
 - ❖ **No protection against spoofing (false communications)**

The original cockpit had no transponder or voice recorder

Background

The First Communication Systems



❖ 2-Way Radio (air-to-ground, air-to-air)

❖ MF or VHF 2-way AM Radio

❖ No voice security

❖ ***It is still this way today!

Background

Current Transponder System



Background

How the Transponder Works

- ❖ Sends a coded microwave signal in response to radar request
- ❖ Code is not unique to aircraft and can be changed at any time (as often required) by pilot
- ❖ Can be turned off in the cockpit
- ❖ Pilot can dial up a special emergency code on the transponder which is a “procedural” fix of the need for a silent alarm (see “turned off” above)

Background

Current Voice and Data Recorders

- ❖ Stand-Alone System
- ❖ Does not communicate with ground stations
- ❖ Frequently cannot be found or is damaged beyond recovery



Cockpit Voice and
Flight Data Recorders

What is needed

1. A secure (private and interference proof) cockpit voice communication system. (Military communication technology)
2. A secure data communication system between air and ground control for cockpit voice recorder and flight data recorder
3. A secure radar transponder that send out an unchanging electronic serial number for each aircraft and cannot be turned off
4. A silent alarm for the cockpit using a secure data channel


FAA Proposals: A blueprint for the new National Airspace System (2002-2015)

- ❖ New multi-mode digital radios for voice and data communications among pilots, controllers, and ground facilities (2008-2015)
- ❖ Automatic dependent surveillance-broadcast (ADS-B) avionics that transmit the GPS-based position, velocity, and intent information to ground stations (air-to-ground) and other aircraft (air-to-air)
- ❖ Multi-functional cockpit displays to improve situational awareness.
- ❖ Terrain awareness warning system (TAWS)

FAA Blueprint (2002-2015) What's Missing?

- ❖ The new digital-mode communication systems are not designed for security. They are intended to improve spectrum utilization and data communications.
- ❖ The transponder system does not appear to change significantly
- ❖ The cockpit voice recorder and flight data recorder system are still not sending the voice and data to ground control. This will be hard to change because the Airline Pilots Association opposes it!
- ❖ No silent alarm!

Miscellaneous Issues

- 
- ❖ Cockpit protection (defense system for pilots)
 - ❖ Terrain and Position-Aware navigation systems (good!)
 - ◆ Automated and enforced avoidance of obstacles
 - ◆ Automated and enforced avoidance of “no-fly” zones
 - ❖ Cockpit control from the ground (not a good idea)
 - ❖ Cockpit and cabin surveillance video (perhaps)

Some Comments from My Students:

- ❖ It is better to be on the ground wishing you were in the air than in the air wishing you were on the ground
- ❖ How about a pilot recognition system (face, eye, voice, fingerprints)
- ❖ Can we get all the countries of the world to cooperate in developing a standardized information security system for world-wide aviation?
- ❖ Airplanes stay in the air because of Bernoulli – not Marconi

Aircraft Information Systems Security



❖ **QUESTIONS?**

Steve F. Russell
sfr@iastate.edu