Midair Collision Involving US Army PAT25 and PSA Airlines Flight 5342 Washington, DC January 29, 2025

Caleb Wagner
Airplane Systems Group Chairman

Overview of ADS-B and Collision Avoidance Systems

- Background information
  - Automatic Dependent Surveillance-Broadcast (ADS-B)
  - Airborne Collision Avoidance System (ACAS)
- Limitations of airplane's collision avoidance system
- New collision avoidance technology for
  - Commercial airplanes
  - Rotorcraft

NTSB

Automatic Dependent Surveillance-Broadcast (ADS-B)

- Surveillance technology using GPS, aircraft avionics, and network of ground stations to determine aircraft's location

- More precision than legacy radar technology

- Two services
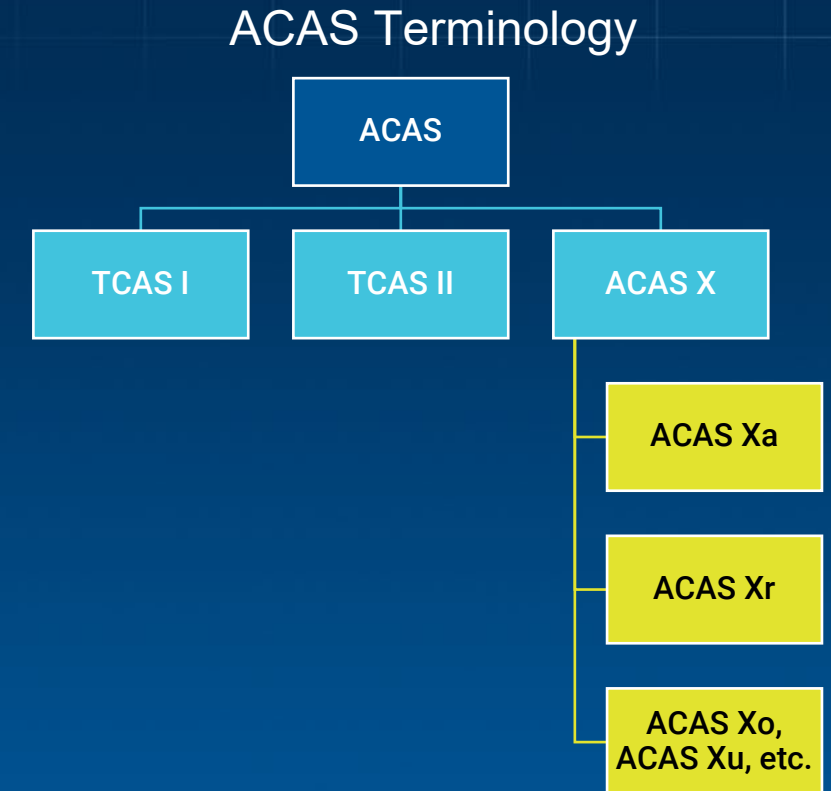 - ADS-B Out
  - ADS-B In

NTSB

ADS-B Out

- Broadcasts aircraft information at least once per second to
  - Ground stations
  - Nearby ADS-B In-equipped aircraft
- Since January 1, 2020, ADS-B Out has been required in most controlled airspace

NTSB

ADS-B In

- Capability to receive ADS-B information
  - From nearby aircraft broadcasting ADS-B Out
  - From nearby ground stations
- Applications can utilize ADS-B In to display and alert nearby traffic
- FAA does not mandate ADS-B In
- Accident airplane
  - Equipped with and transmitting ADS-B Out
 - Not equipped with ADS-B In

NTSB

Airborne Collision Avoidance System (ACAS)

- Onboard system to reduce risk of midair collision

- Displays traffic information and alerts pilots

- Monitors positions and altitudes of nearby aircraft that have active transponder

- Last resort safety net when other safety barriers have failed

- ACAS iterations include Traffic Alert and Collision Avoidance System (TCAS) I, TCAS II, and ACAS X

ACAS Terminology

```
                    ACAS
        ┌────────────┼────────────┐
     TCAS I       TCAS II       ACAS X
                                  │
                              ┌───┤
                              │ ACAS Xa
                              │
                              │ ACAS Xr
                              │
                              │ ACAS Xo,
                                ACAS Xu, etc.
```
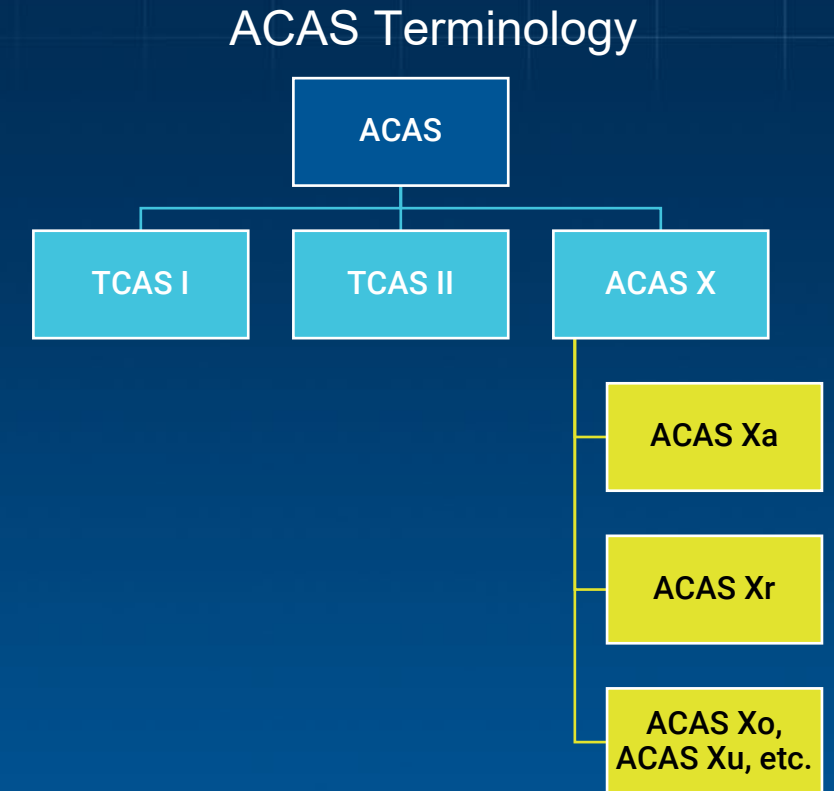
NTSB

Airborne Collision Avoidance System (ACAS)

- Traffic advisories (TAs)
  - Aural and visual warnings to alert pilot of potential collision threat
  - Pilots instructed not to maneuver based on TAs alone

- Resolution advisories (RAs)
  - Aural and visual warnings with vertical maneuvers to avert midair collision
  - Issued by TCAS II and ACAS X
  - Pilots are trained to immediately obey RAs
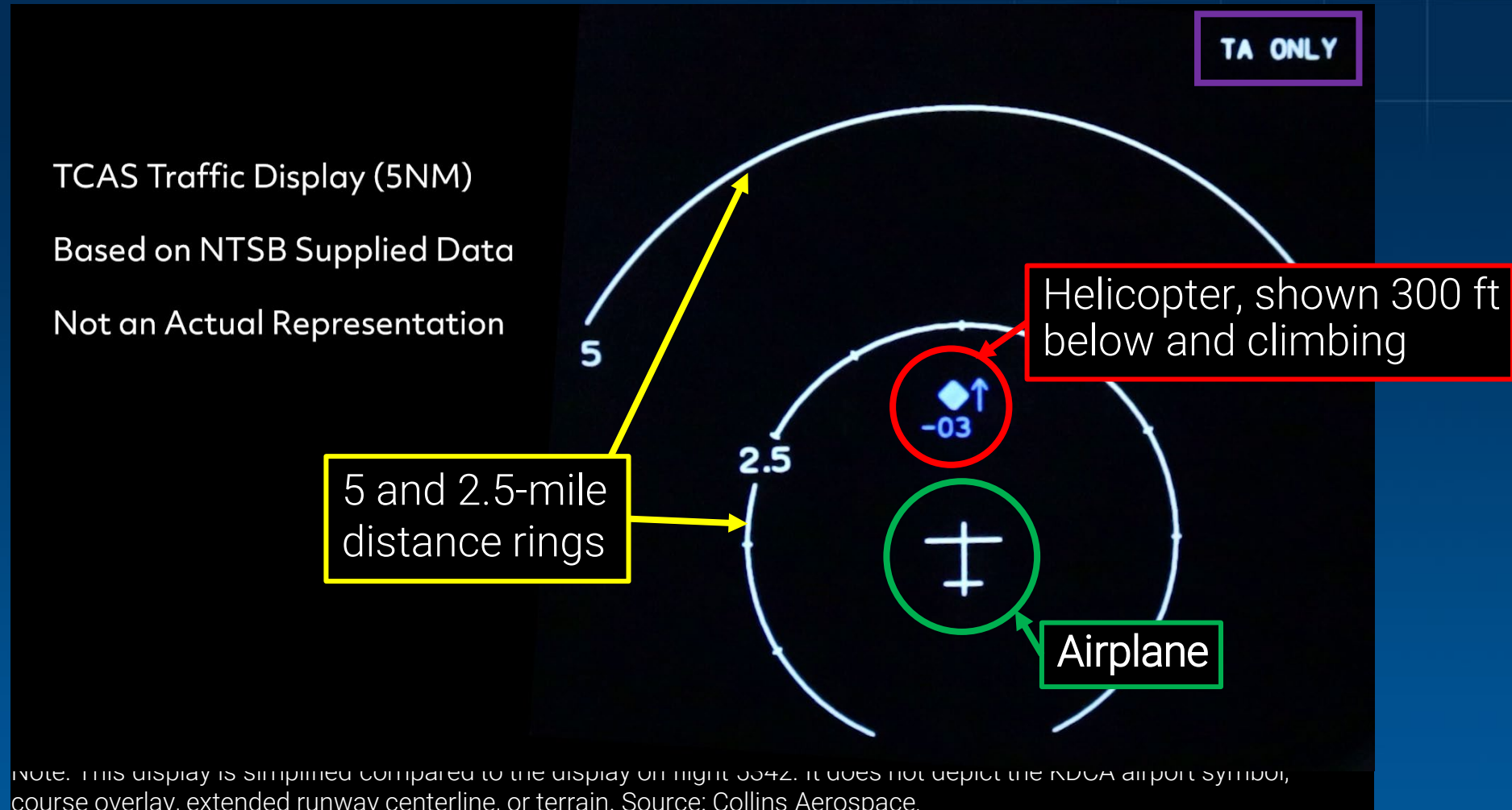
ACAS Terminology

NTSB
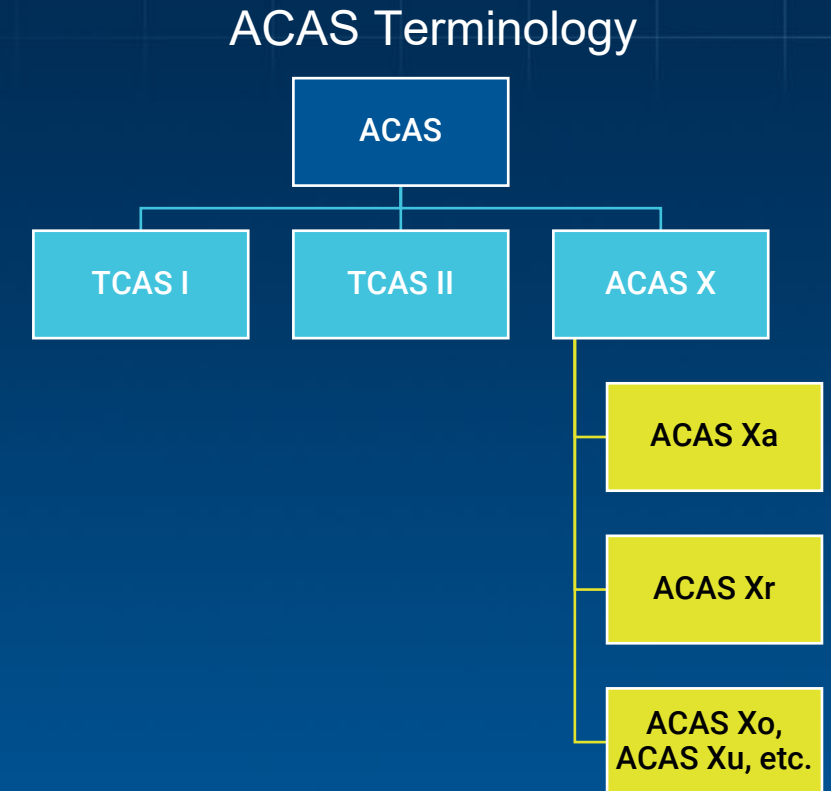
Airborne Collision Avoidance System (ACAS)

- TCAS I provides only TAs—no RAs
- TCAS II mandated for certain commercial aircraft since 1993
- Accident airplane was equipped with TCAS II

ACAS Terminology

```
                    ACAS
         ┌───────────┼───────────┐
      TCAS I      TCAS II      ACAS X
                                 │
                              ACAS Xa
                                 │
                              ACAS Xr
                                 │
                              ACAS Xo,
                              ACAS Xu, etc.
```

NTSB

TCAS II Display Symbology

TA ONLY

TCAS Traffic Display (5NM)

Based on NTSB Supplied Data

Not an Actual Representation

Helicopter, shown 300 ft below and climbing

5 and 2.5-mile distance rings

Airplane

Note: This display is simplified compared to the display on flight 5342. It does not depict the KDCA airport symbol, course overlay, extended runway centerline, or terrain. Source: Collins Aerospace.

NTSB

TCAS II Simulation of Accident

- Flight 5342 crew received TA about 20 seconds before collision

- TCAS did not generate RA at this altitude

- TCAS worked as designed

TCAS Traffic Display (5NM)

Based on NTSB Supplied Data

Not an Actual Representation

TA ONLY

5

2.5

-03

NTSB

TCAS II Inhibits

- TCAS inhibits RAs
  - Below 1,100 ft agl when climbing
  - Below 900 ft agl when descending
- Above inhibit altitudes, TA progresses to RA if threat increases
- Inhibit altitudes were established as tradeoff to minimize nuisance alerts
- Accident airplane below RA inhibit altitude; no RA issued

1,500 ft

1,100 ft   **All RAs**

1,000 ft

All RAs   900 ft

500 ft

Ground
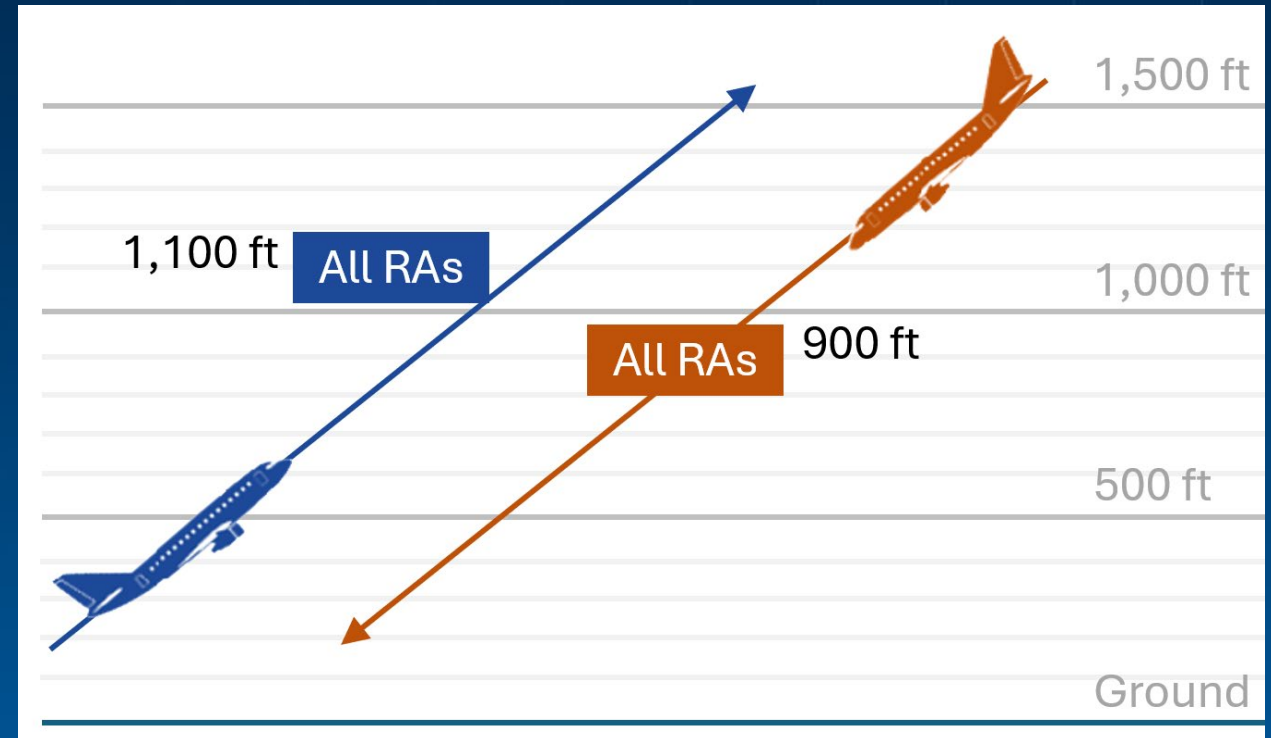
TCAS inhibit altitudes for all RAs

Source: Eurocontrol, modified

NTSB

ACAS X

- ACAS X is next evolution of TCAS II
  - ACAS Xa for commercial airplanes
  - ACAS Xr for rotorcraft
- ACAS X uses ADS-B In and transponder replies
- Utilizes improved algorithms
- ACAS Xa standards are approved by FAA

ACAS Terminology

NTSB
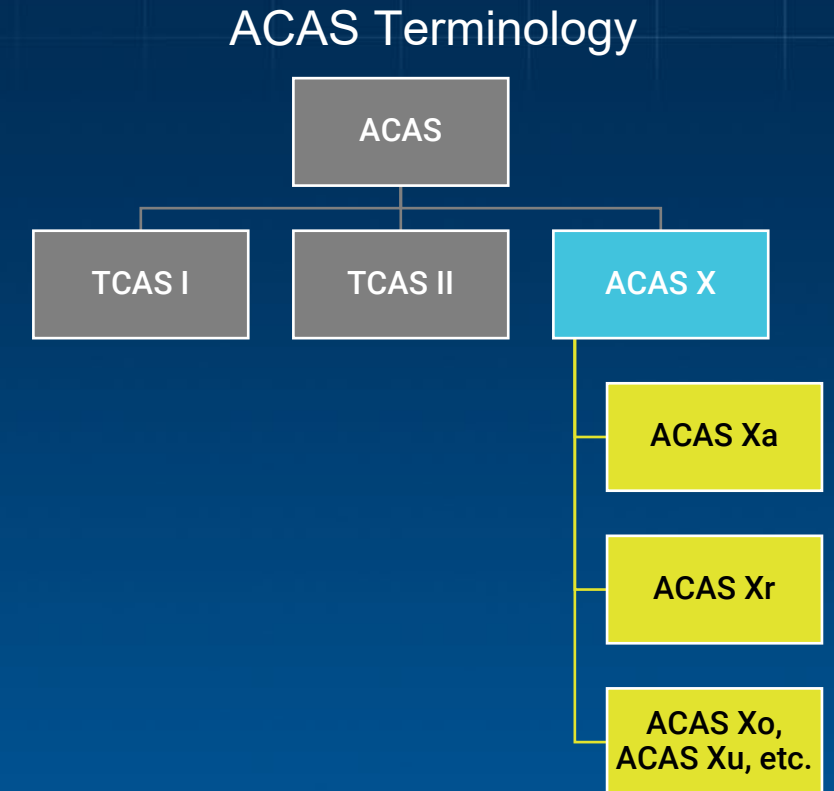
What We Found: ACAS Xa Alerts Improved Over TCAS II

- Simulated airplane equipped with ACAS Xa in accident circumstances
- ACAS Xa provided TA 8 seconds earlier than TCAS II

What we propose:

- Two recommendations to FAA

What We Found: RA Inhibit Altitudes Could Be Lowered for ACAS Xa

- ACAS Xa systems currently has same RA inhibit altitudes as TCAS II

- Simulated RA inhibit altitudes were lowered to 300 ft agl

- Risk of near midair collision with lowered RAs was reduced by more than 90%

What we propose:

- Two recommendations to FAA

NTSB

What We Found: Directional Traffic Symbols Can Improve Pilot Awareness

- ADS-B In displays can show directional traffic symbols that indicate target's direction of flight

- Most TCAS I and II systems display nondirectional traffic symbols

- Directional traffic symbols not required for ACAS Xa certification

What we propose:

- One recommendation to FAA

Basic Nondirectional Traffic Symbol

Basic Directional Traffic Symbol
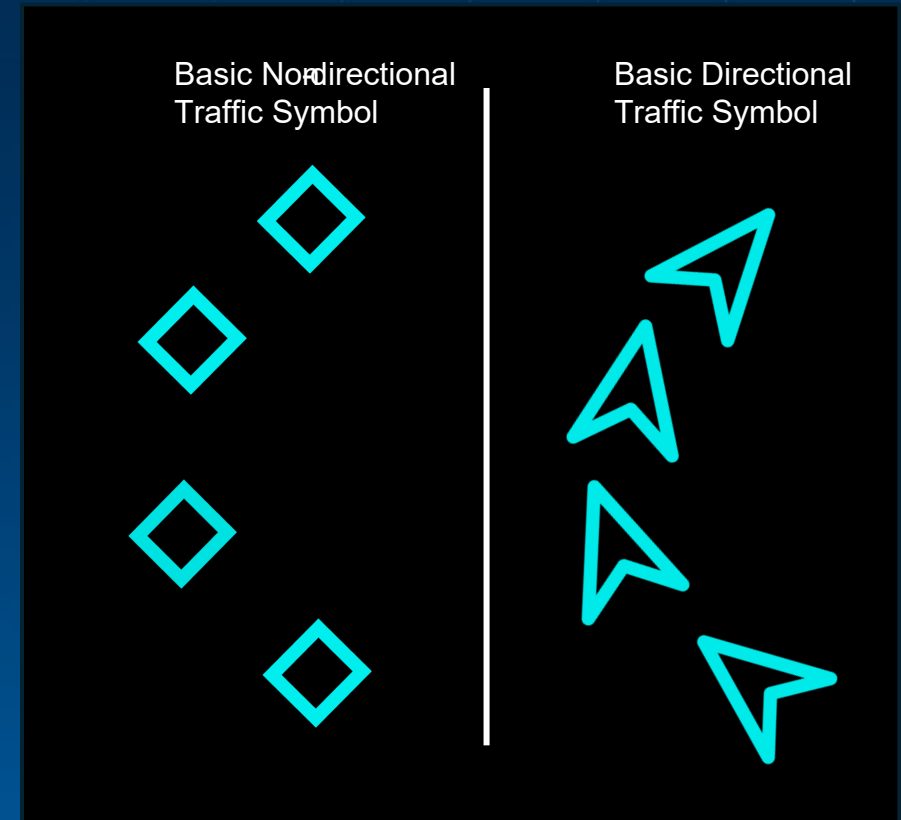
Source: RTCA DO-317C

NTSB

What We Found: Traffic Callouts Could Help Pilot Find Target Faster

- ATAS generates detailed traffic callouts improving situation awareness

- ACAS does not include detailed traffic callouts

> Traffic, two o'clock, high, two miles, descending
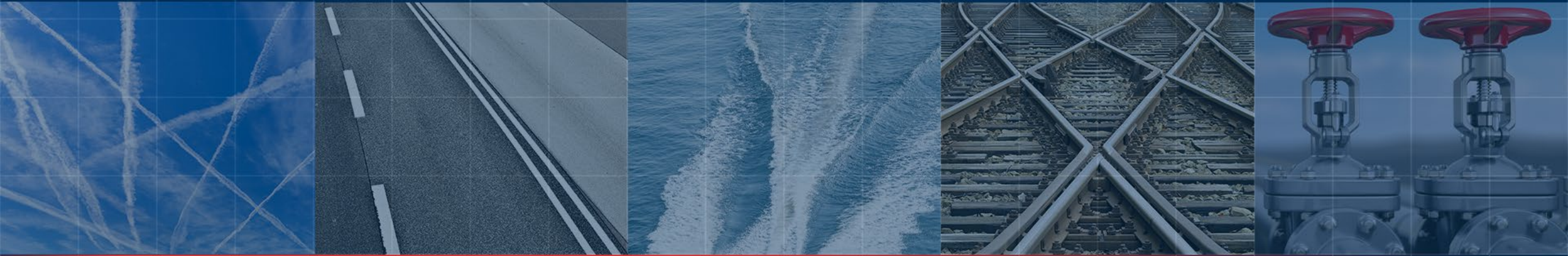
What we propose:

- One recommendation to FAA

NTSB

What We Found: ACAS Xr Can Reduce Midair Risk

- ACAS Xr is version for rotorcraft still under development

- Simulated helicopter equipped with developmental version of ACAS Xr

- Risk of near midair collision reduced by more than 50% without changing airplane TCAS II inhibit altitudes

What we propose:

- One recommendation to FAA
- One recommendation to RTCA

NTSB

ntsb.gov