



National Aeronautics and Space Administration

Flight Deck Interface Technologies – NextGen Research

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Flight Deck Interface Technologies Team

- **Developing Flight Deck Technologies To:**
 - **Proactively Overcome Aircraft Safety Barriers That Would Otherwise Constrain The Full Realization Of The Next Generation Air Transportation System (NextGen).**

- **Key Technologies Thrust Areas:**
 - Visual Display Technologies
 - Head-Worn & Large Area Display Technology
 - Visual Interface Methods, Concepts, and Metrics
 - Communicative Interface Technologies
 - Voice Communication Replacement Technologies
 - Next-Gen Datalink, Aircraft Interface Methods and Concepts
 - Culture-/Language-Neutral Flight Deck Technologies





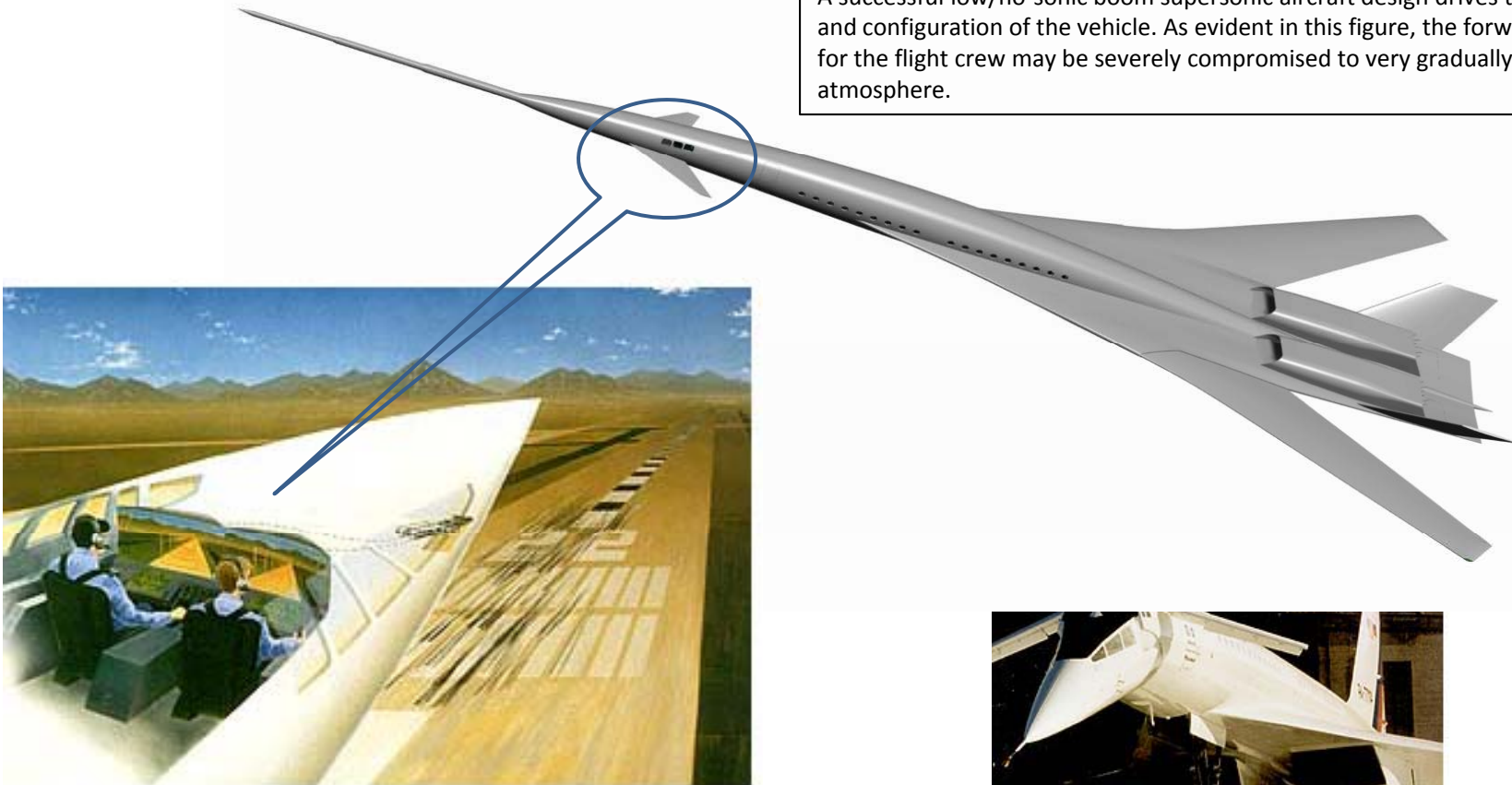
Overview

- NASA Research
 - Aeronautics Research Mission Directorate
 - Aviation Safety Program – Intelligent Integrated Flight Deck (IIFD)
 - Airspace Systems Program – Collision Avoidance for Airport Traffic (CAAT)
 - Interagency Agreements
 - FAA Data Comm Program Office
 - NextGen Human Factors
- Introduce Demo in Research Flight Deck (RFD)



eXternal Vision System (XVS)

A successful low/no-sonic boom supersonic aircraft design drives the shaping and configuration of the vehicle. As evident in this figure, the forward visibility for the flight crew may be severely compromised to very gradually disturb the atmosphere.



eXternal Vision System (XVS) –

The XVS becomes an “enabling technology” for low/no-boom supersonic vehicle. XVS is a combination of sensor and display technologies designed to achieve an equivalent level of safety and performance to that provided by forward-facing windows in today’s subsonic aircraft.

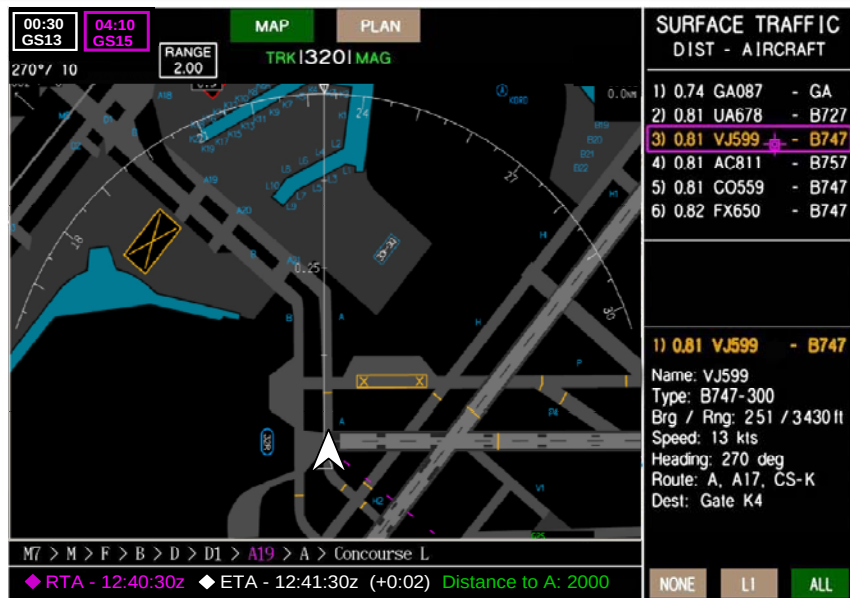


“Drooped” Nose:

Previous Generation’s Method Of Providing Visibility for Supersonic Aircraft During Approach, Landing and Take-off; Very Heavy and Complex Mechanisms



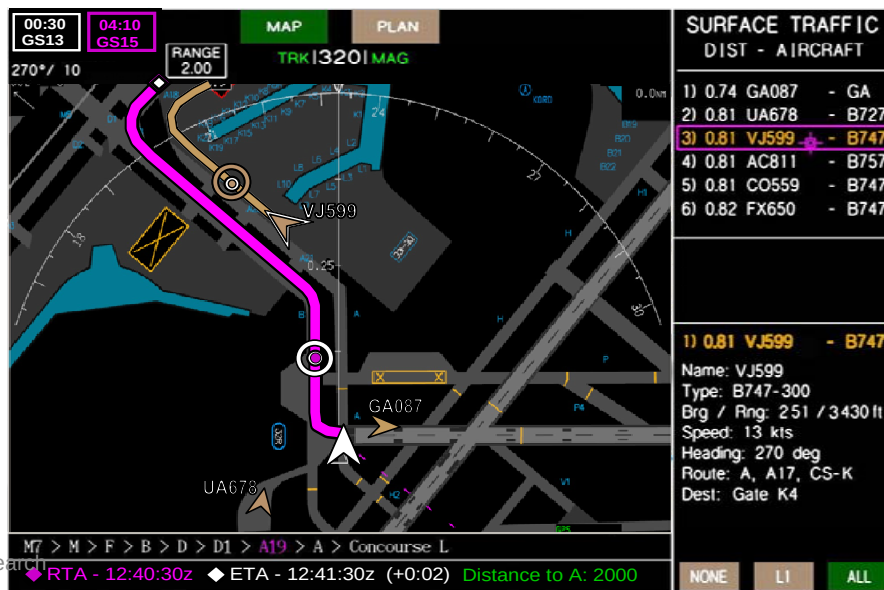
4D TBO - Surface Map Display Concepts



Baseline



Baseline + Traffic + Route



Advanced
Graphical
Display



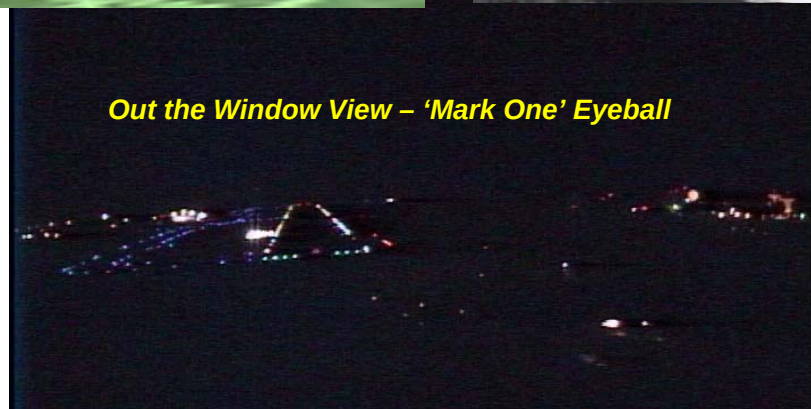
SEVS for NextGen

- Objective: Evaluating The Potential Use Of Enhanced Flight Vision System (EFVS) And Synthetic Vision (SV) For Reduced Landing Weather Minima And The Influence Of Cockpit Display Of Traffic Information (CDTI) For NextGen Operations



Moving Map

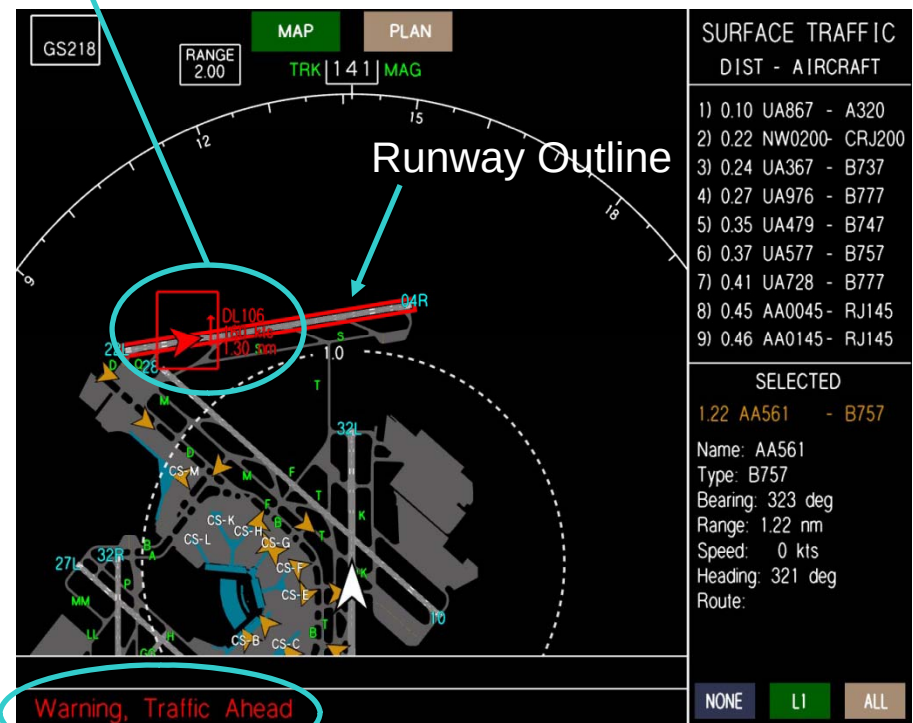
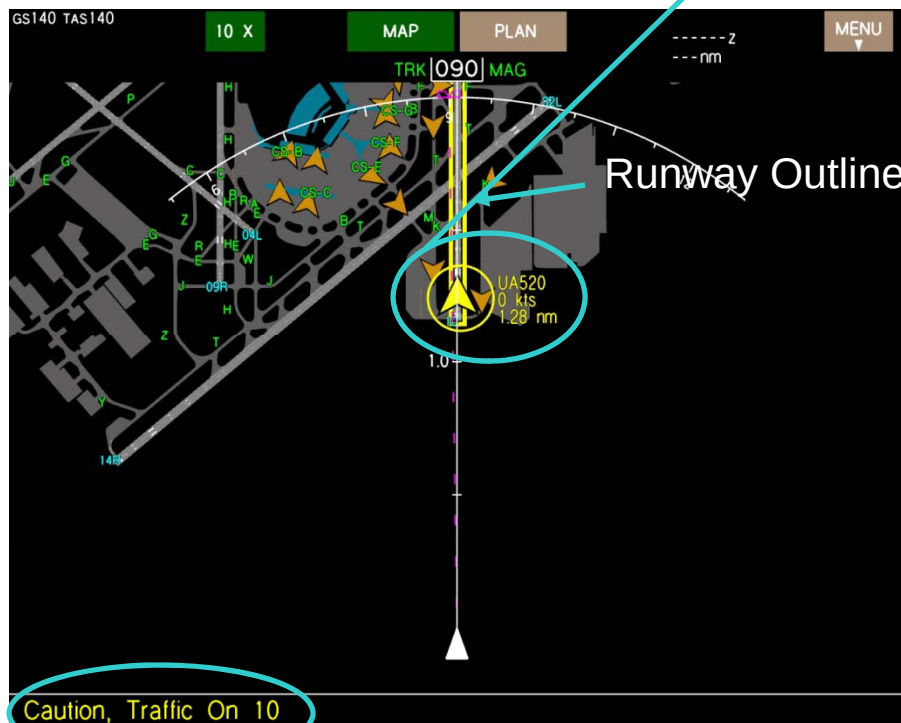
Runway Inset





Conflict Detection & Resolution (CD&R)

- Provide Immediate Flight Crew Awareness And Identify Non-normal Operational Or Airplane System Conditions That May Require Immediate Flight Crew Response



Alert Message

Caution Alert

Auditory
Callout

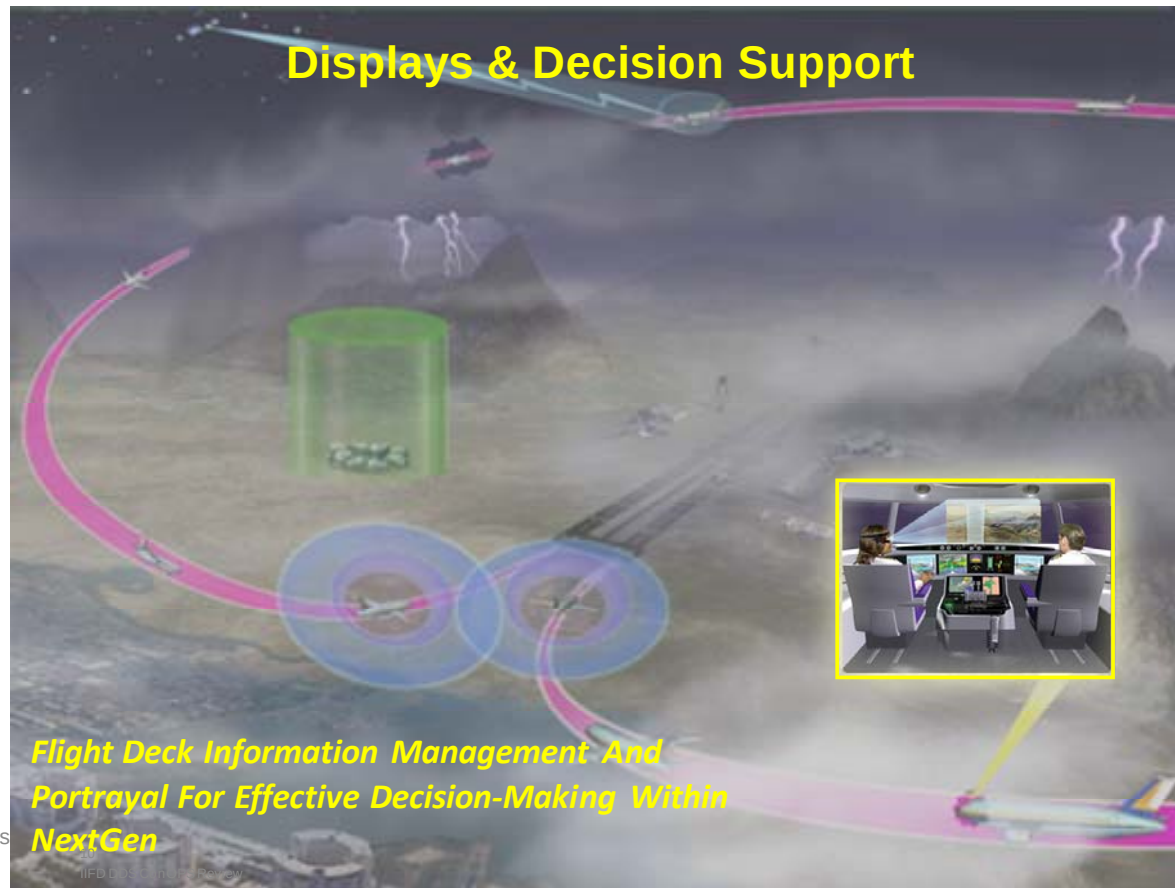


Warning Alert



NextGen Merging and Spacing

- Objective: Evaluate Flight Deck Technologies to Support Emerging NextGen Merging and Spacing Operations
 - Flight Deck Interval Management (FIM) Paired Dependent Speed (PDS) Technologies For Delegated Airborne Spacing





Comparative Baseline Analysis

Measuring Safety?

- Risk Measurements / Margins
- Comparative Baseline

Technology Insertion for NextGen

- Vast Majority of Aircraft That Will Operate In NextGen Have Already Been Designed / In-Service
- Maximize Benefits for Equipage

Boeing 787 Flight Deck



*NextGen
“Baseline”
Flight Deck*



Enhanced Vision System

January 9th, 2004

- FAR 91.175 (l) and (m)
 - For Straight-In Instrument Approach Procedures other than Cat II or Cat III, no pilot operating under this section or Sections 121.651, 125.381, or 135.225 may operate an aircraft ... below the authorized MDA ... or DA ... **unless**:
 - (3) The following visual references for the intended runway are distinctly visible and identifiable to the pilot **using the enhanced flight vision system**:
 - (i) **The approach light system** (if installed); **OR**
 - (ii) **Both** of the following visual references:
 - (A) **The runway threshold**;
 - (B) **The touchdown zone**,





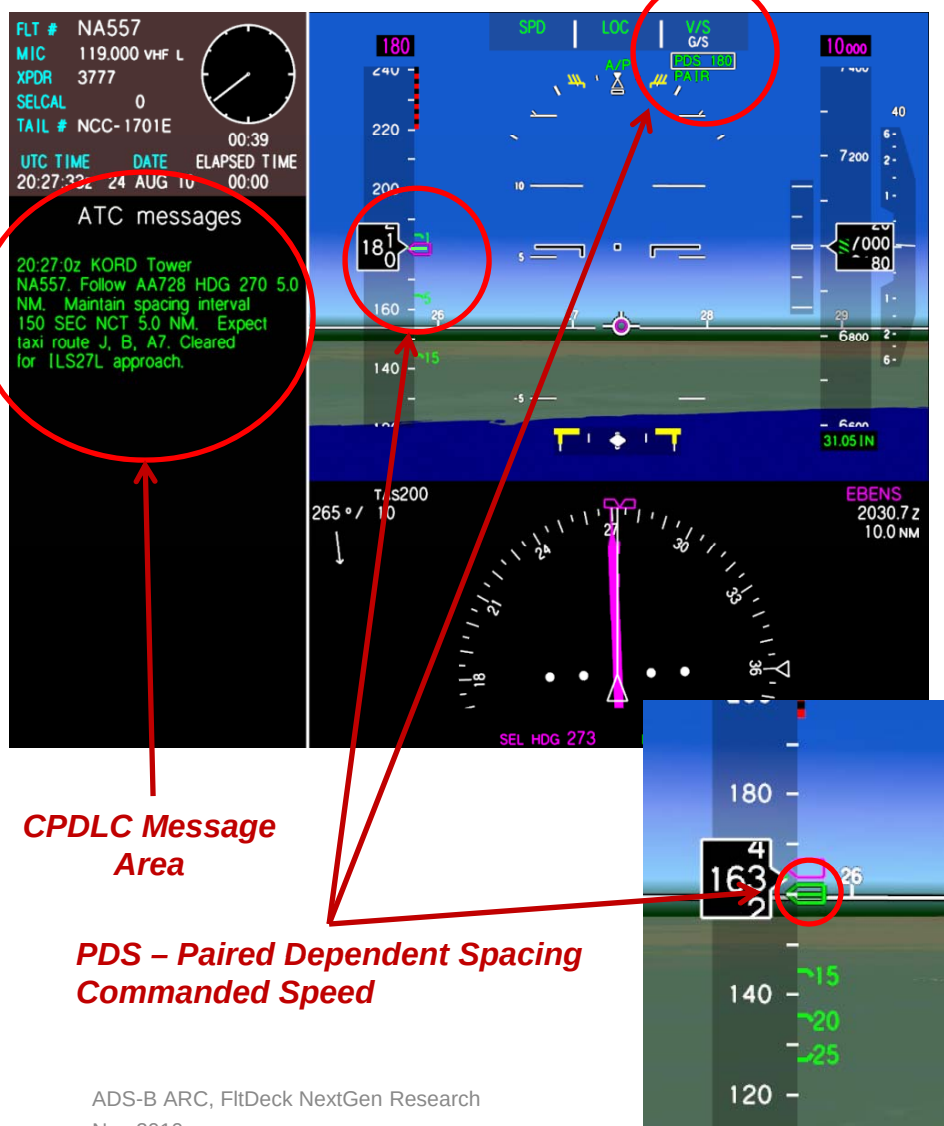
Two Situations Being Evaluated

- Airborne Precision Spacing (APS)-
Spacing Only
 - 150 Sec Spacing Interval With No-closer-than (NCT) 5.0 nmi
 - Enter 150 In R2 And 5.0 In R4
 - **ATC Responsible For Traffic Flow And All Traffic Separation**
 - Flight Crews Use EFVS To Complete Approach To Landing Based On Enhanced Flight Vision System (EFVS)
- Airborne Precision Spacing (APS)-
Spacing and Equivalent Visual Separation
 - 90 Sec Spacing Interval With No-closer-than (NCT) 3.0 nmi
 - Enter 90 In R2 And 3.0 In R4
 - **Pilot Responsible For Both Spacing And Separation With Paired Aircraft**
 - **Target Aircraft Paired For Spacing Only With “Equivalent Visual Contact”**

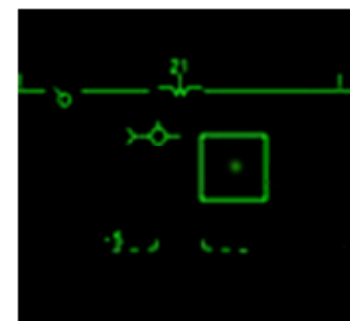
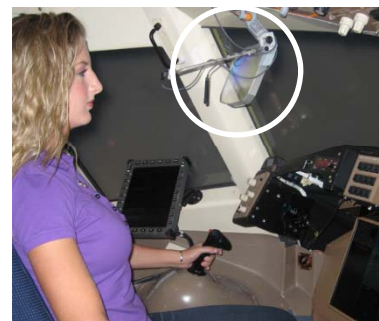


Pilot-Flying and Pilot-Not-Flying Displays

Primary Flight Display (PFD)



HUD Target Locator Box



~ 5 nmi Range

Primary Flight Display (PFD) for PNF





PNF – Navigation Display





Simulated ADS-B Data Accuracies

Table 3-6: Navigation Accuracy Categories for Position (NAC_P)

NAC _P	95% Horizontal and Vertical Accuracy Bounds (EPU and VEPU)	Comment	Notes
0	EPU $\geq$ 18.52 km (10 NM)	Unknown accuracy	3
1	EPU < 18.52 km (10 NM)	RNP-10 accuracy	1,3
2	EPU < 7.408 km (4 NM)	RNP-4 accuracy	1,3
3	EPU < 3.704 km (2 NM)	RNP-2 accuracy	1,3
4	EPU < 1852 m (1NM)	RNP-1 accuracy	1,3
5	EPU < 926 m (0.5 NM)	RNP-0.5 accuracy	1,3
6	EPU < 555.6 m (0.3 NM)	RNP-0.3 accuracy	1,3
7	EPU < 185.2 m (0.1 NM)	RNP-0.1 accuracy	1,3
8	EPU < 92.6 m (0.05 NM)	e.g., GPS (with SA)	1,3
9	EPU < 30 m and VEPU < 45 m	e.g., GPS (SA off)	2,3,4
10	EPU < 10 m and VEPU < 15 m	e.g., WAAS	2,3,4
11	EPU < 3 m and VEPU < 4 m	e.g., LAAS	2,3,4

Airborne

Table 3-7: Navigation Accuracy Categories for Velocity (NAC_V)

NAC _V	Horizontal Velocity Accuracy (95%)	Vertical Geometric Velocity Accuracy (95%)
0	Unknown or $\geq$ 10 m/s	Unknown or $\geq$ 50 feet (15.24 m) per second
1	< 10 m/s	< 50 feet (15.24 m) per second
2	< 3 m/s	< 15 feet (4.57 m) per second
3	< 1 m/s	< 5 feet (1.52 m) per second
4	< 0.3 m/s	< 1.5 feet (0.46 m) per second

Surface
(Switch at
100 ft HAT)



NASA Langley Research Impacts

- NASA Research
 - Aeronautics Research Mission Directorate
 - Aviation Safety Program and Airspace Systems Program
- NASA Research Via FAA Sponsorship
- Dissemination of Results Through Peer-Reviewed Publications
- RTCA Participation
 - SC-186 ADS-B
 - SC-213 Enhanced and Synthetic Vision System
 - SC-206 Aeronautical Information Services / Data-link



Questions?



How Big is the Problem?

In one year (2009) with visibility less than 1/4 NM...

	FG/DZ/BR (Hours)	# of Affected Operations
DCA	16.2	808
BOS	45.5	2123
ORD	12.8	1280
DEN	42.3	2999
SEA	40.0	1577
PDX	133.3	3836
Total:	290.0	12,623

*Similar to ~1
week of
operations at
ORD!*





Straight-In Follow Scenario

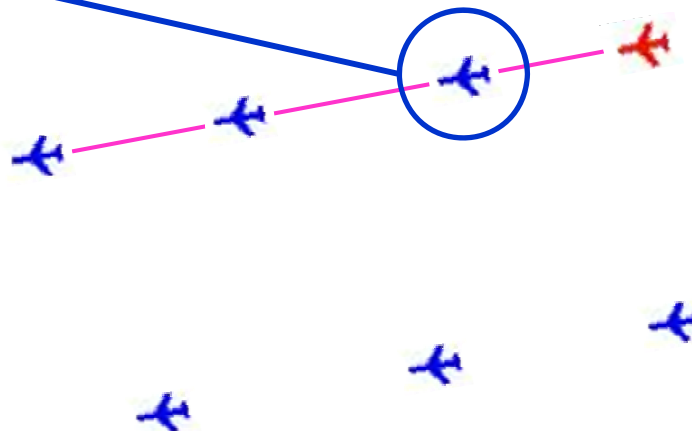


Delegated Separation

19:48.0z KORD Tower
NA557, Follow AA728 HDG 270 5.0
NM. Maintain spacing interval
90 SEC NCT 3.0 NM. Expect taxi
route J, B, A7. Cleared for
ILS27L approach.

Spacing Only

20:6:26z KORD Tower
NA557, Follow AA728 HDG 270 5.0
NM. Maintain spacing interval
150 SEC NCT 5.0 NM. Expect
taxi route J, B, A7. Cleared for
ILS27L approach.



ILS27L Approach



Pilot CDU Entry Required



Merging Scenario



Spacing Only

18:23:44z KORD Tower
NA557. Follow AA728 HDG 270
5.0 NM. Maintain spacing
interval 150 SEC NCT 5.0 NM.
Expect taxi route J, B, A7.
Cleared for ILS27L approach
direct BASHH via GRABL direct.

Delegated Separation

18:38:11z KORD Tower
NA557. Follow AA728 HDG 270 5.0
NM. Maintain spacing interval
90 SEC NCT 3.0 NM.
Expect taxi route J, B, A7.
Cleared for ILS27L equivalent visual
approach direct BASHH via GRABL direct.

- Engage A/P in LNAV/VNAV mode
- Simism: Don't arm APP until roll-out on RWY HDG

ILS27L Direct BASHH Via GRABL

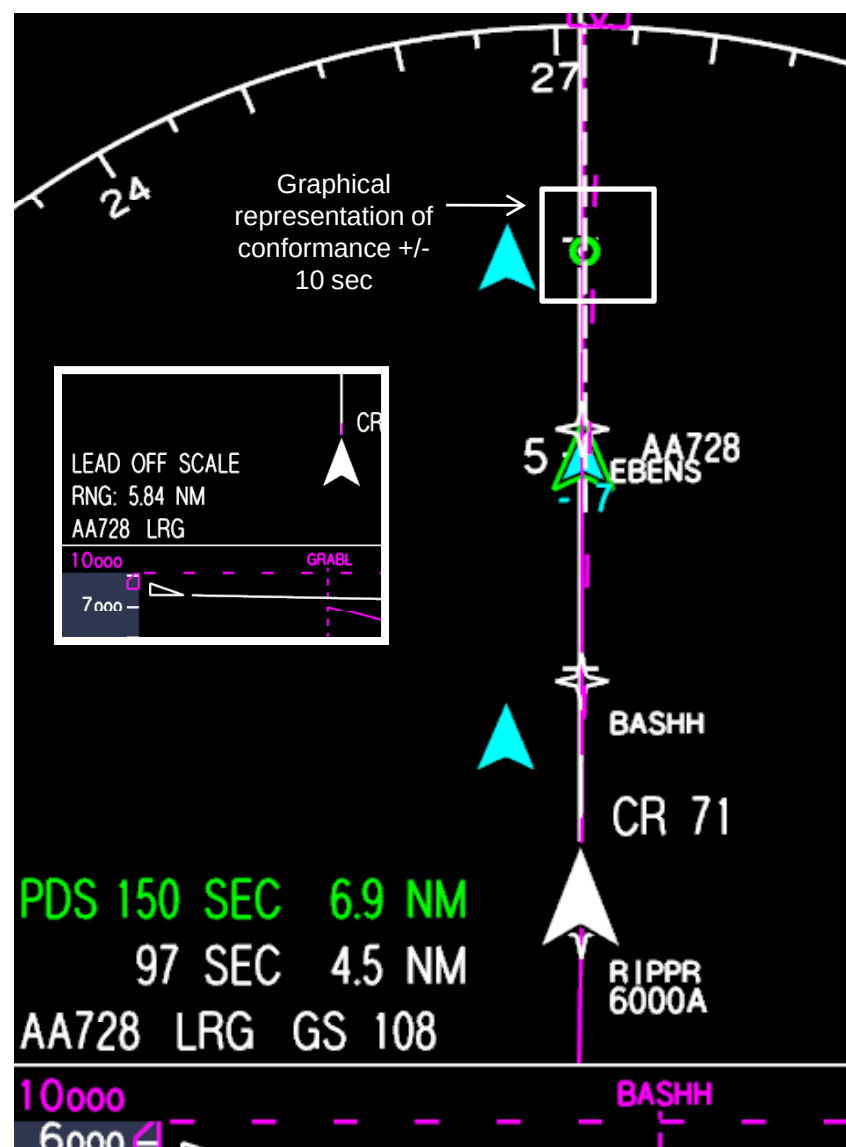




Pilot-Flying Map Display

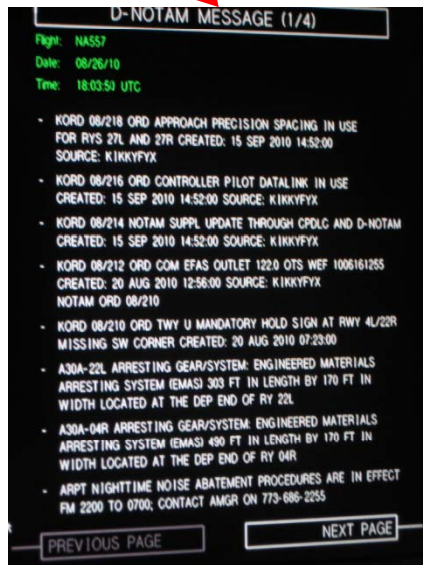
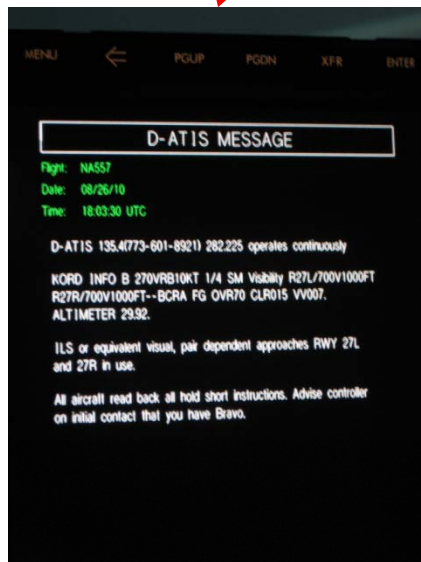
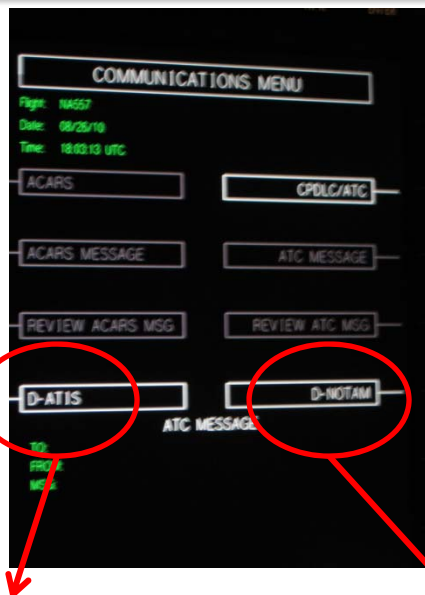


ADS-B ARC, FltDeck NextGen Research
Nov 2010





Digital Information





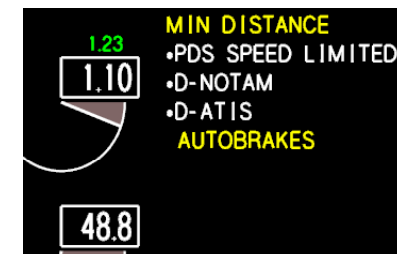
EICAS Alerting

EICAS Message

Meaning

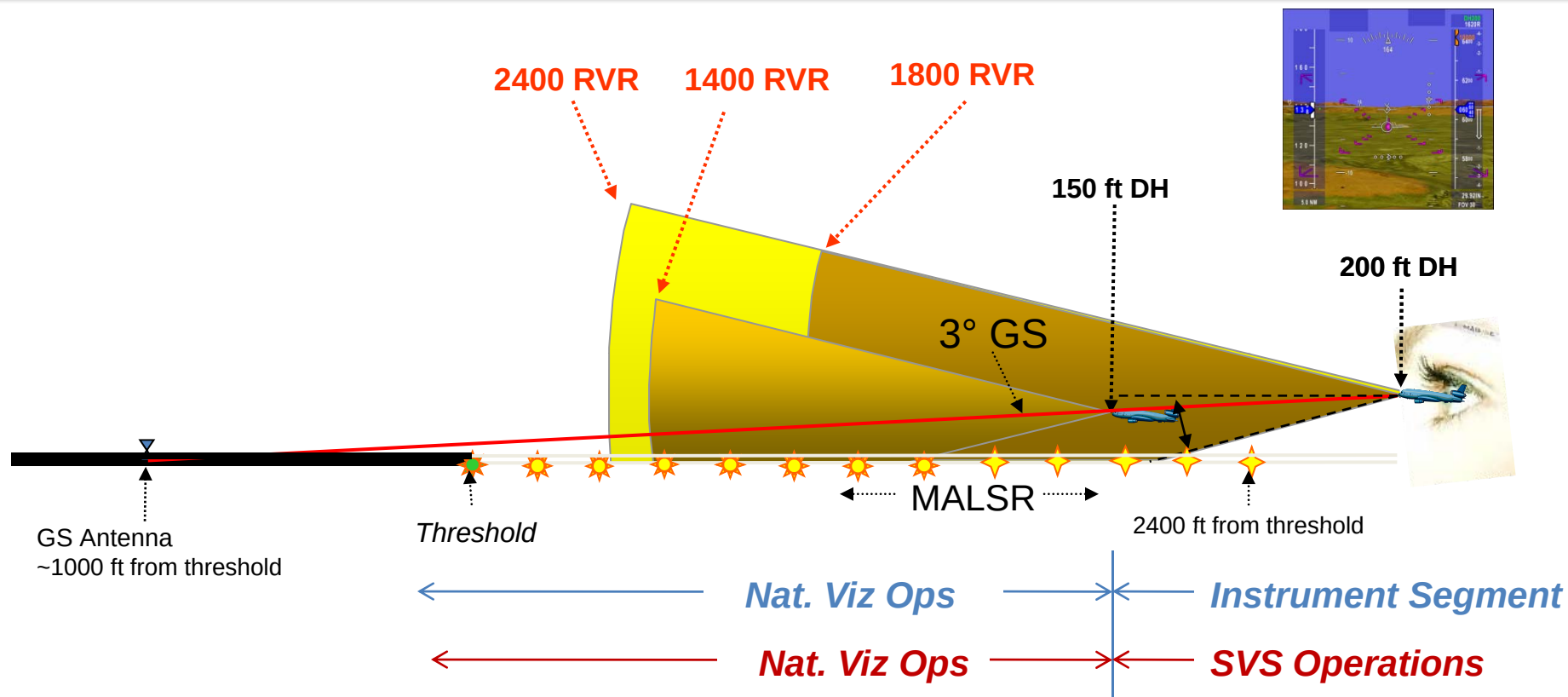
Ownship No Path	Arrival route is not in database
Ownship Bad Path	Cannot meet constraints in arrival route
Ownship Off Path	Ownship has deviated from arrival route
Traffic Data Loss	Lead aircraft is no longer broadcasting data
Traffic No Path	Arrival route data has not been received from lead aircraft or is not in database
Traffic Bad Path	Cannot calculate lead aircraft's arrival trajectory
Traffic Off Path	Lead aircraft has deviated from approach path
Speed Limited	Speeds are limited by Profile +/- 10% or aircraft configuration
MIN DISTANCE	Ownship is within the range of the pilot entered CDU "min distance" from lead aircraft (based on <u>current</u> range not predictive range at RWY threshold)

EICAS





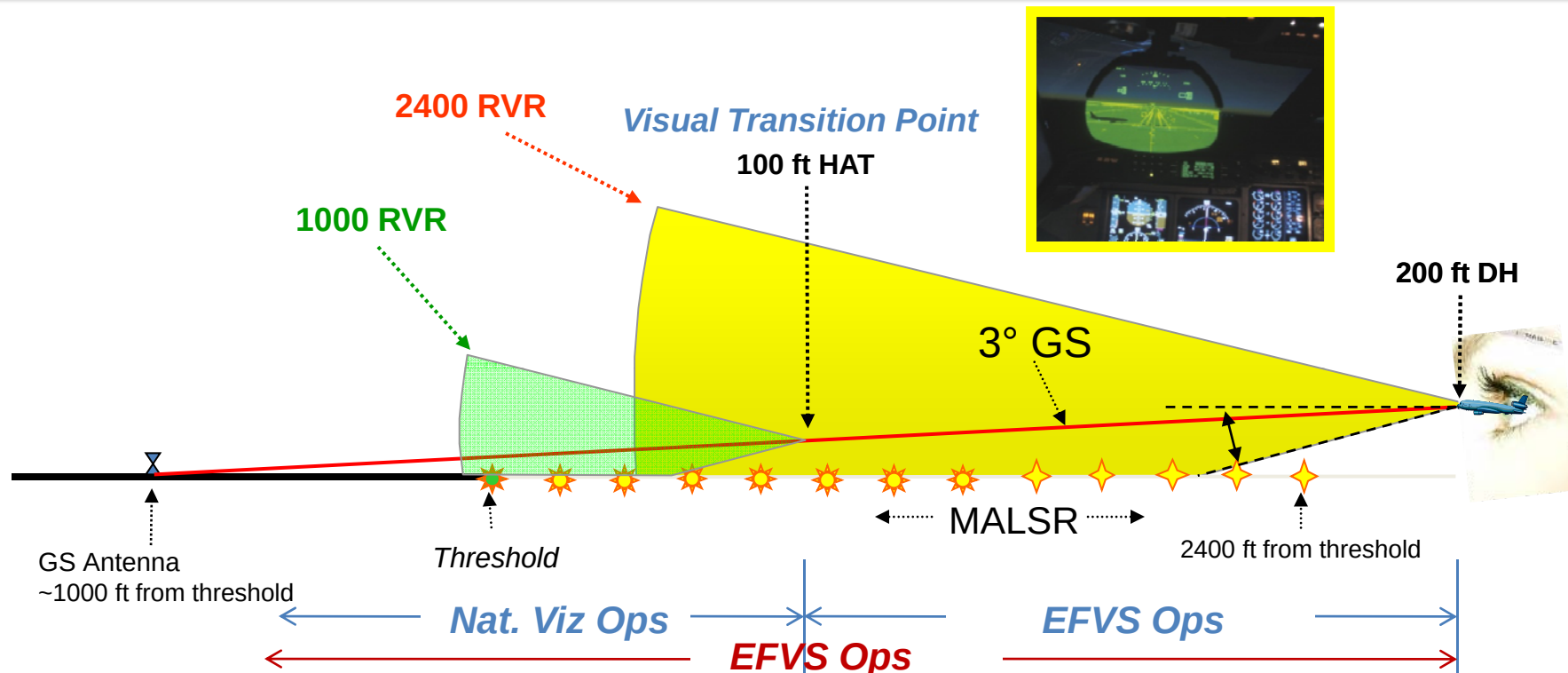
SVS Ops Changes?



- Current Rule
 - No Operational “Credit” for SVS Equipage
- Concept
 - Enable Lower DA(H)



EFVS Ops Changes?



- **Current Rule**
 - No Lower Than 100 ft Height Above Touchdown Zone Elevation (TDZE)
 - Pilot Must See Required Landing Visual References Using Natural Vision
- **Concept**
 - Eliminate Visual Transition Point Requirement (Using At Least 1000 ft RVR)