# GPS – Benefits for Aviation


Captain Joe Burns

Managing Director

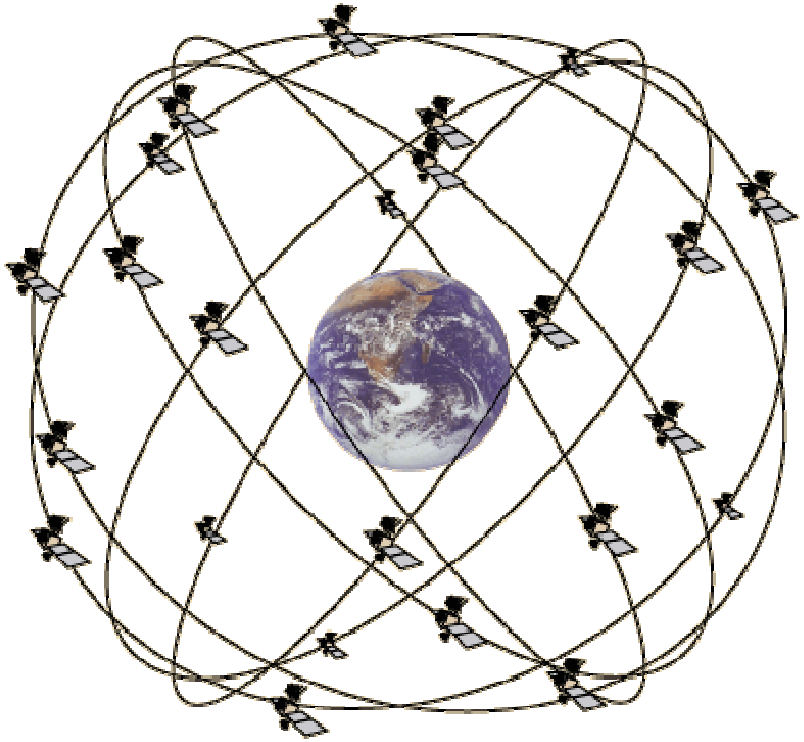
Flight Standards and Technology

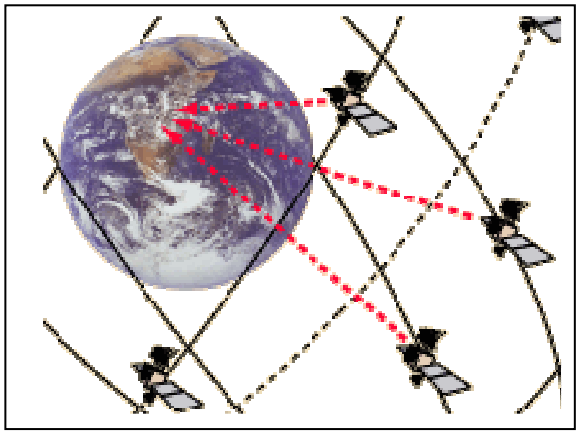
United Airlines

## How does GPS benefit Aviation?:

- Precision Navigation = MORE CAPACITY, MORE ALL WEATHER OPS
- Precision Timing = BETTER FLOW MANAGEMENT, COMMON TIME PLATFORM
- Position awareness = SAFETY
- Repeatability =
  - Reduced fuel burn
  - Reduced block times

# GPS Description



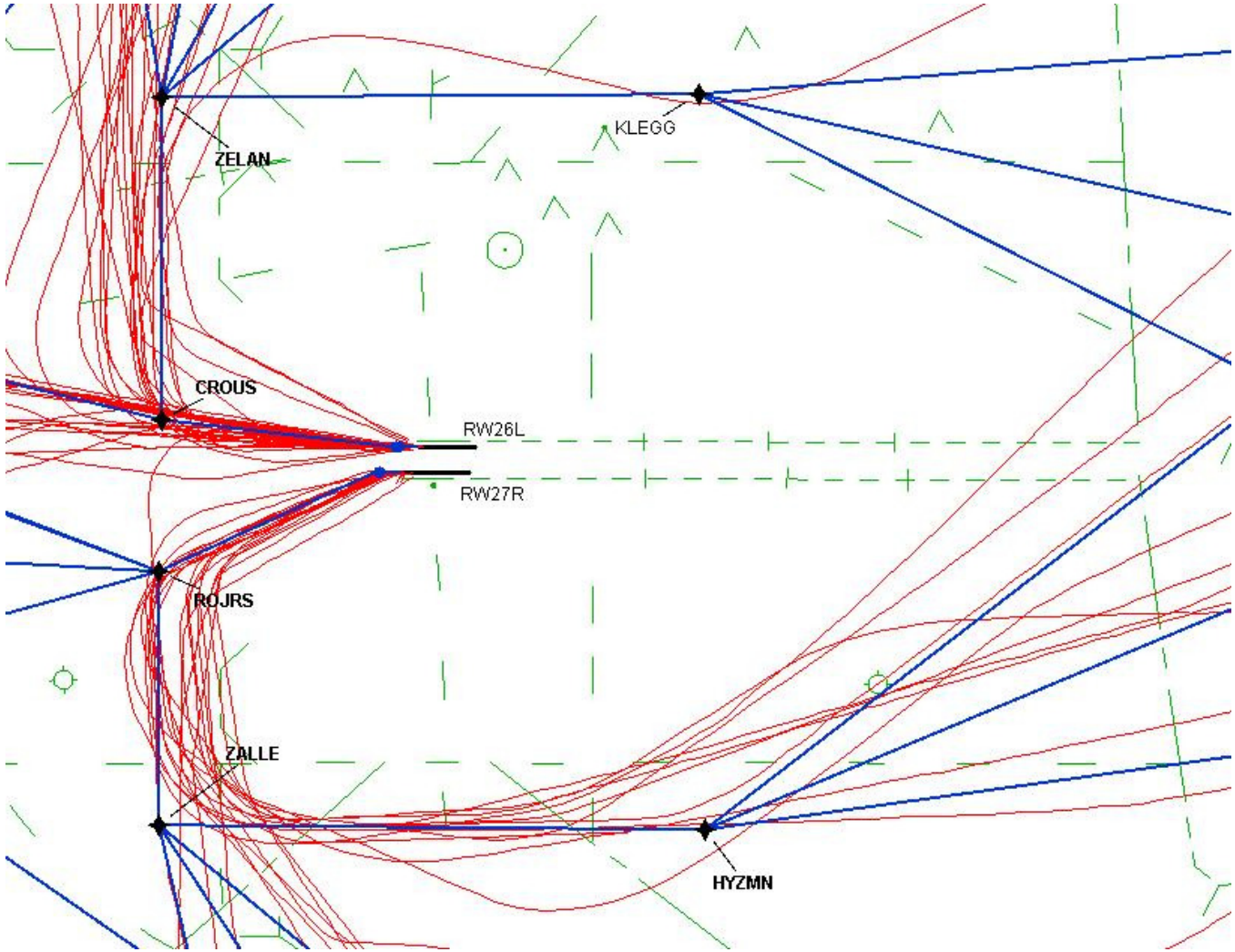


The 24 satellites of the GPS are placed in orbits at about 3.75 times the radius of the Earth (11000 nm). A GPS receiver can triangulate its position on the Earth's surface within 30 meters or less with signals from three of the satellites. The satellites are arranged in six orbital planes with four satellites in each plane. Single frequency receiver, 5 degree mask angle

## How can we use GPS today?:

- **Area Navigation (RNAV)**
- **Required Navigation Performance (RNP)**
- **Position and event reporting**
- **Common Timebase**
- **Surface Moving Map**
- **Runway Awareness and Advisory System (RAAS)**
- **Automatic Dependent Surveillance (FANS, ADS-B)**

# ATL Non RNAV Tracks

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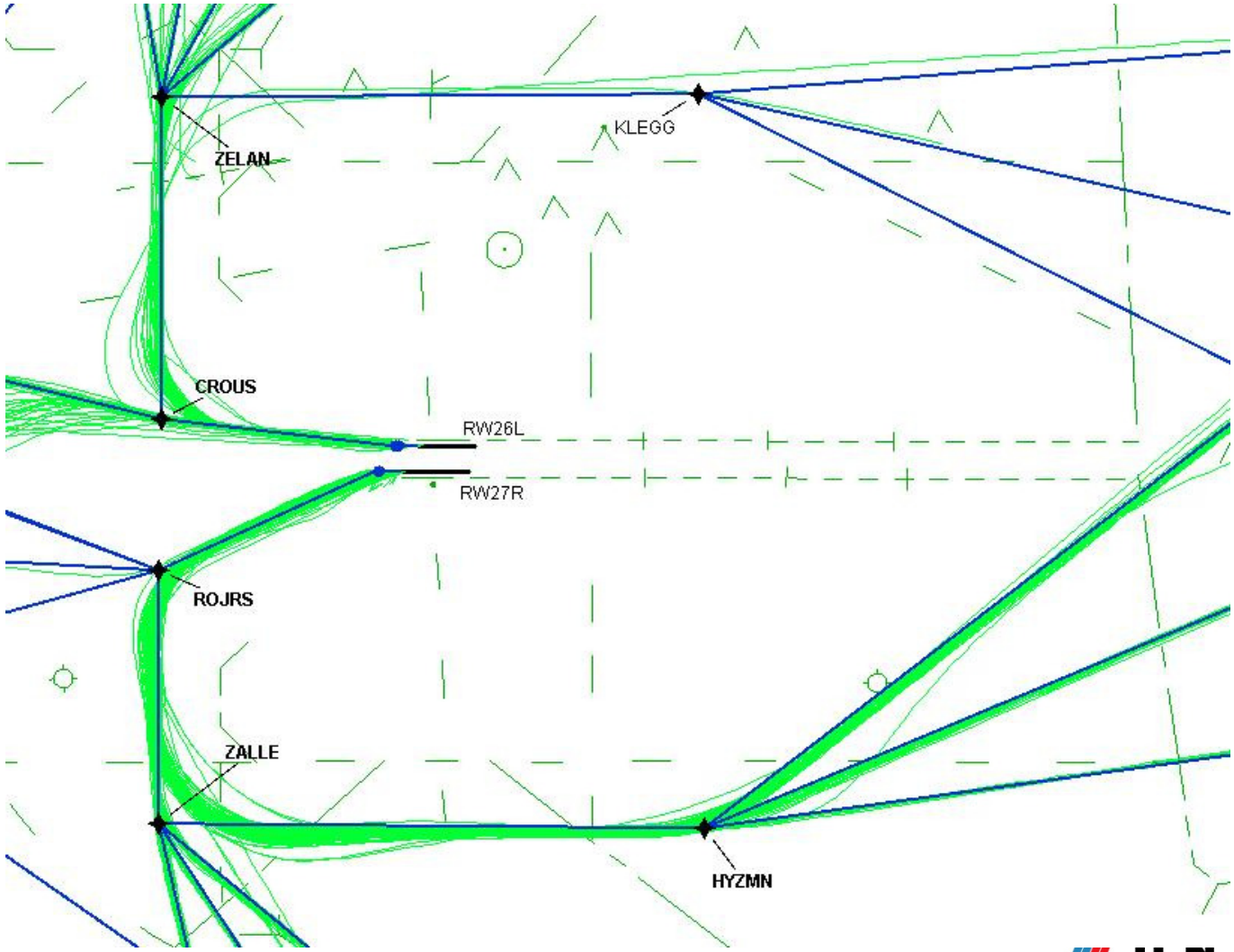
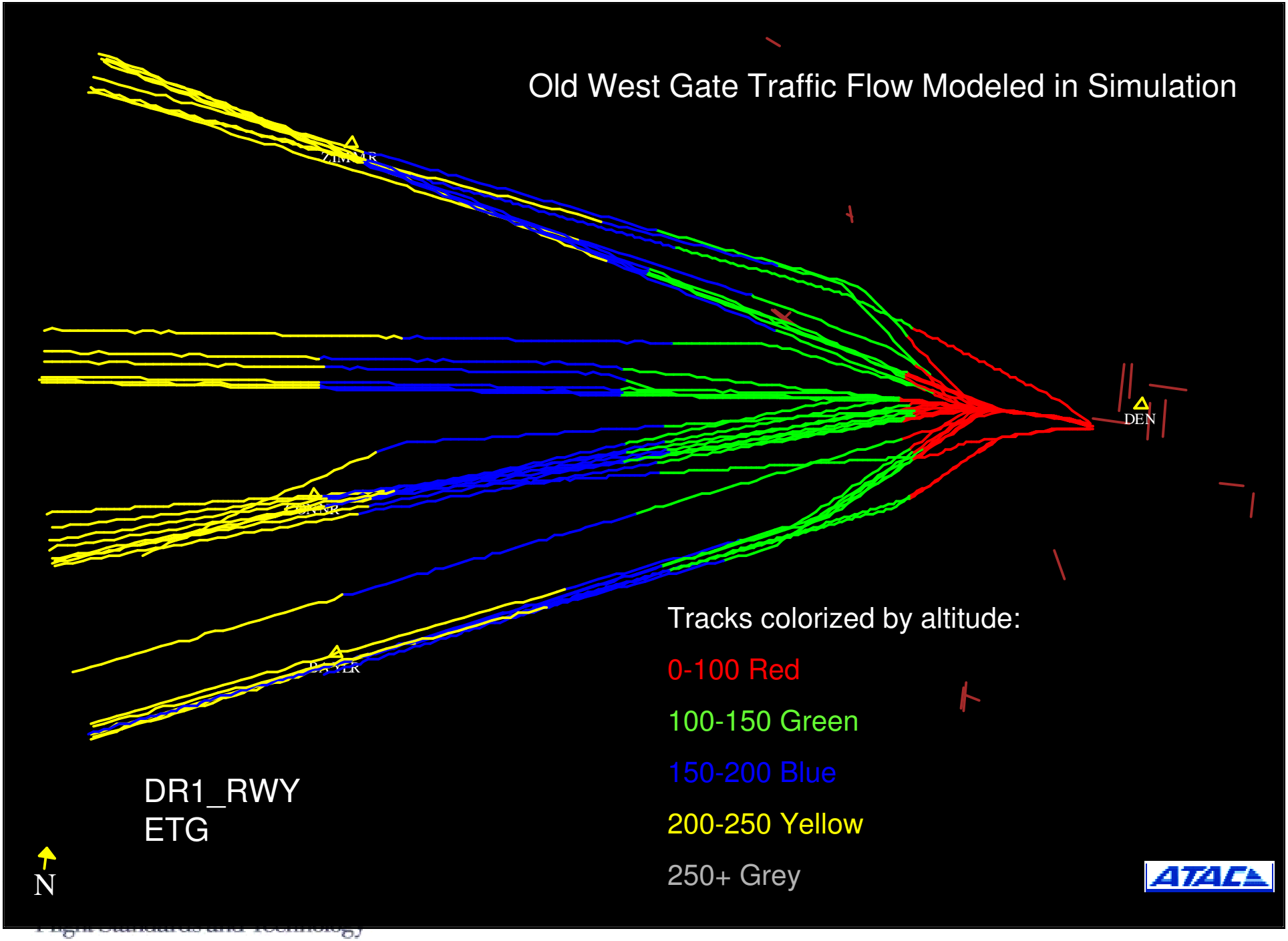
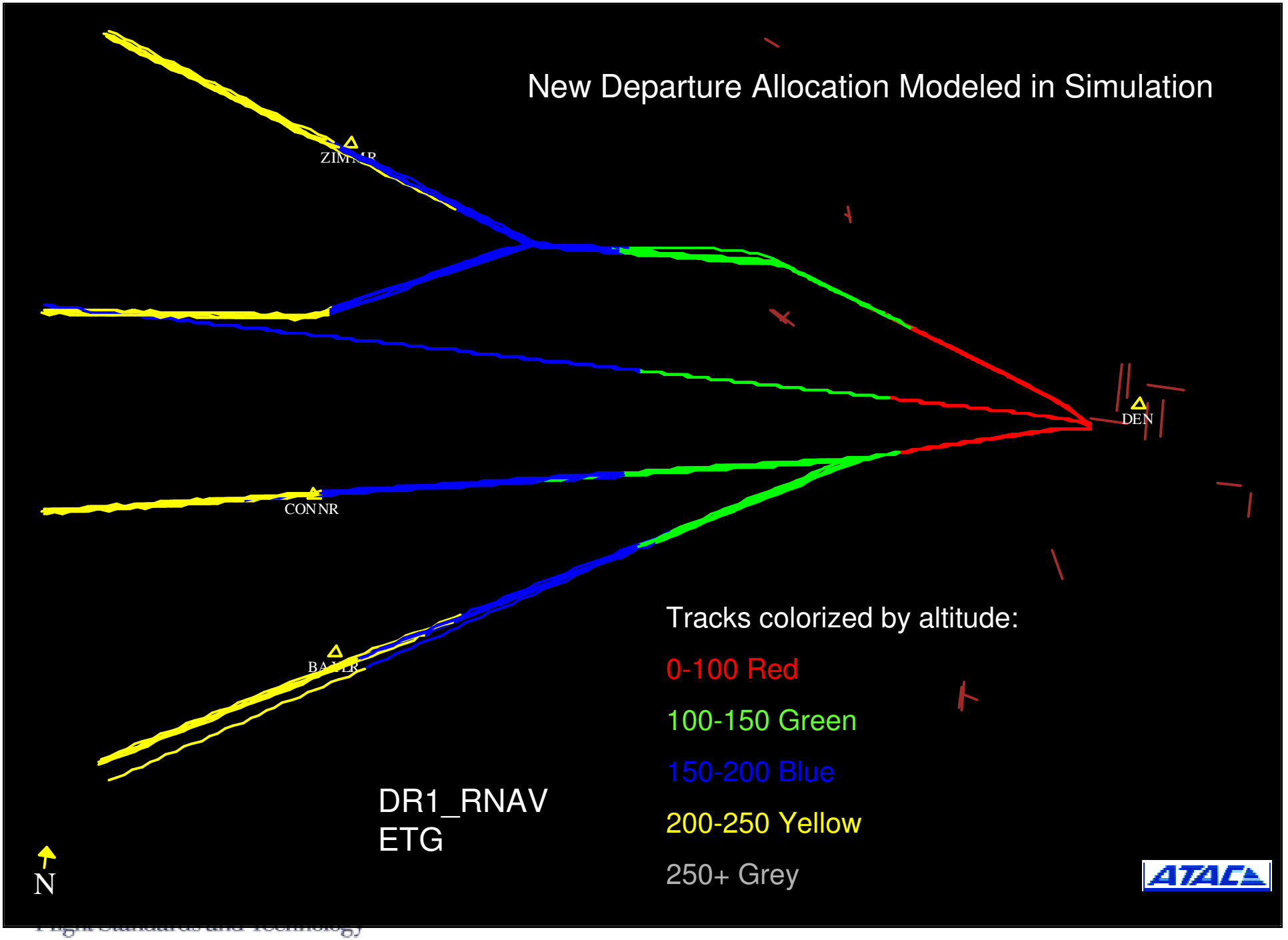
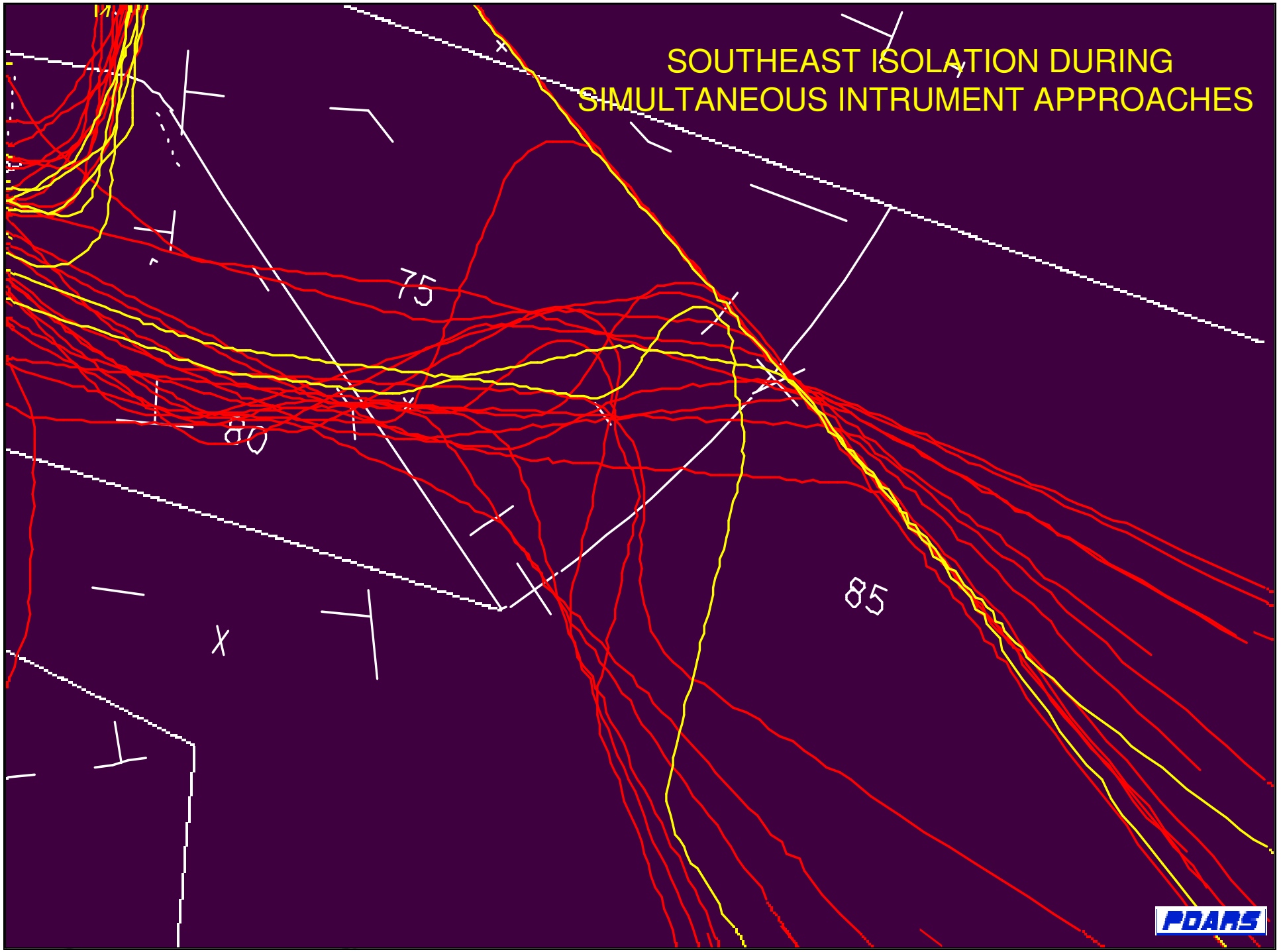
# ATL with RNAV Tracks

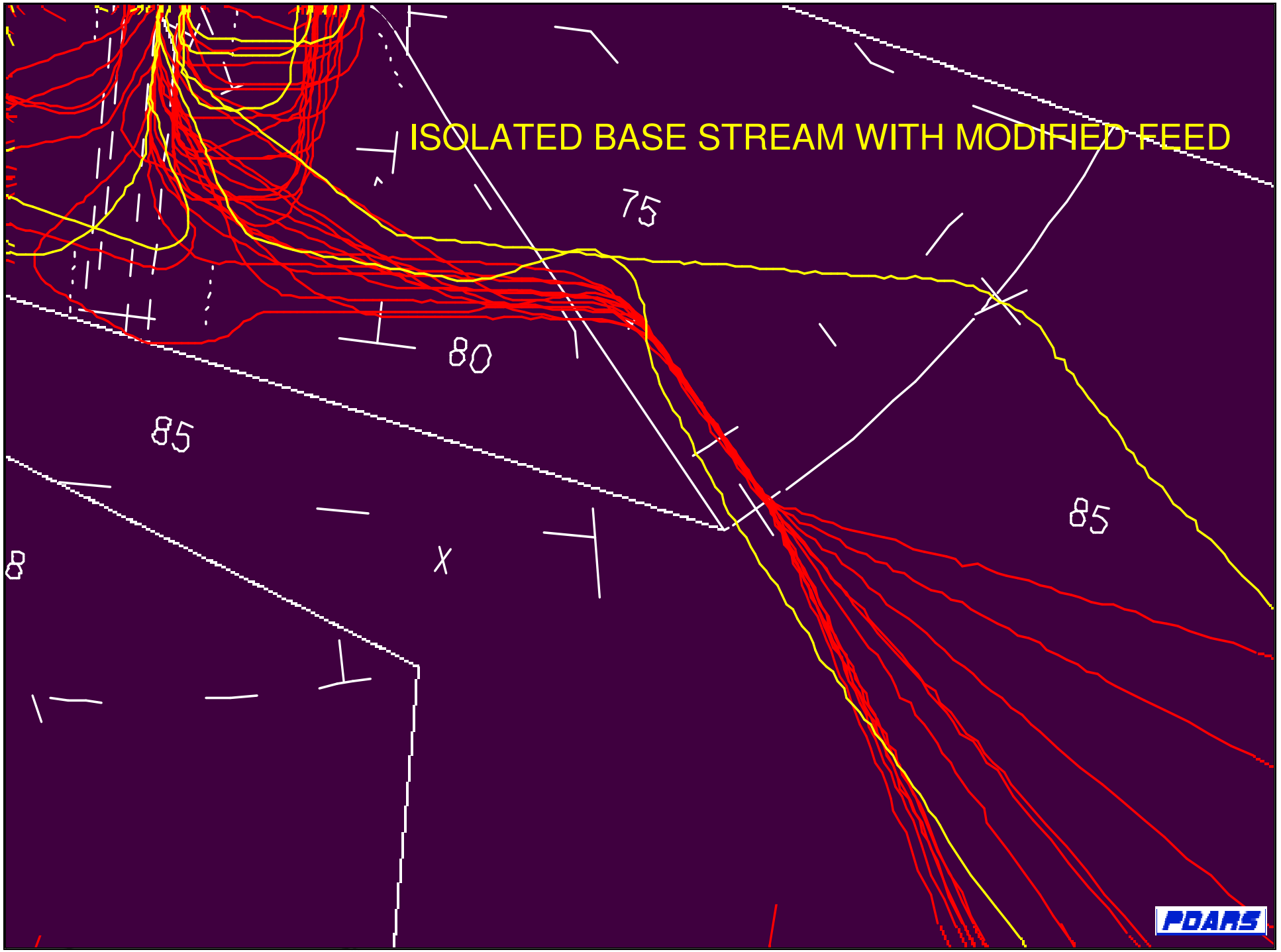


# Old West Gate Traffic Flow Modeled in Simulation

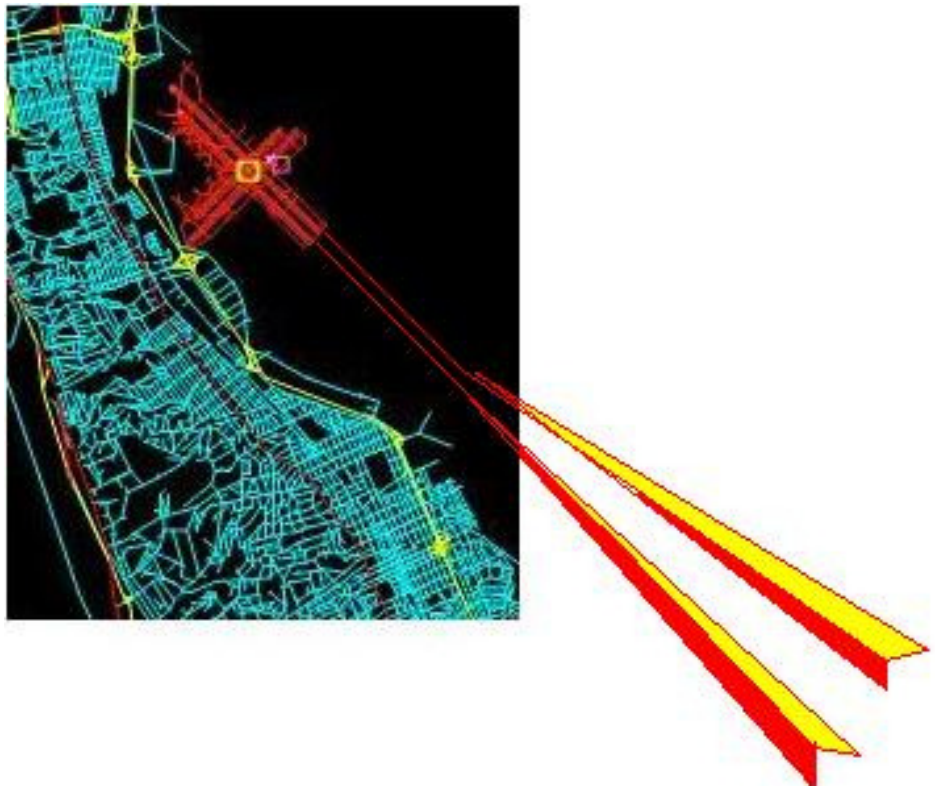



New Departure Allocation Modeled in Simulation
ZIMMR
CONNR
DEN
Tracks colorized by altitude:
0-100 Red
100-150 Green
150-200 Blue
200-250 Yellow
250+ Grey
DR1_RNAV
ETG
N


SOUTHEAST ISOLATION DURING
SIMULTANEOUS INTRUMENT APPROACHES
75
80
85
PDARS

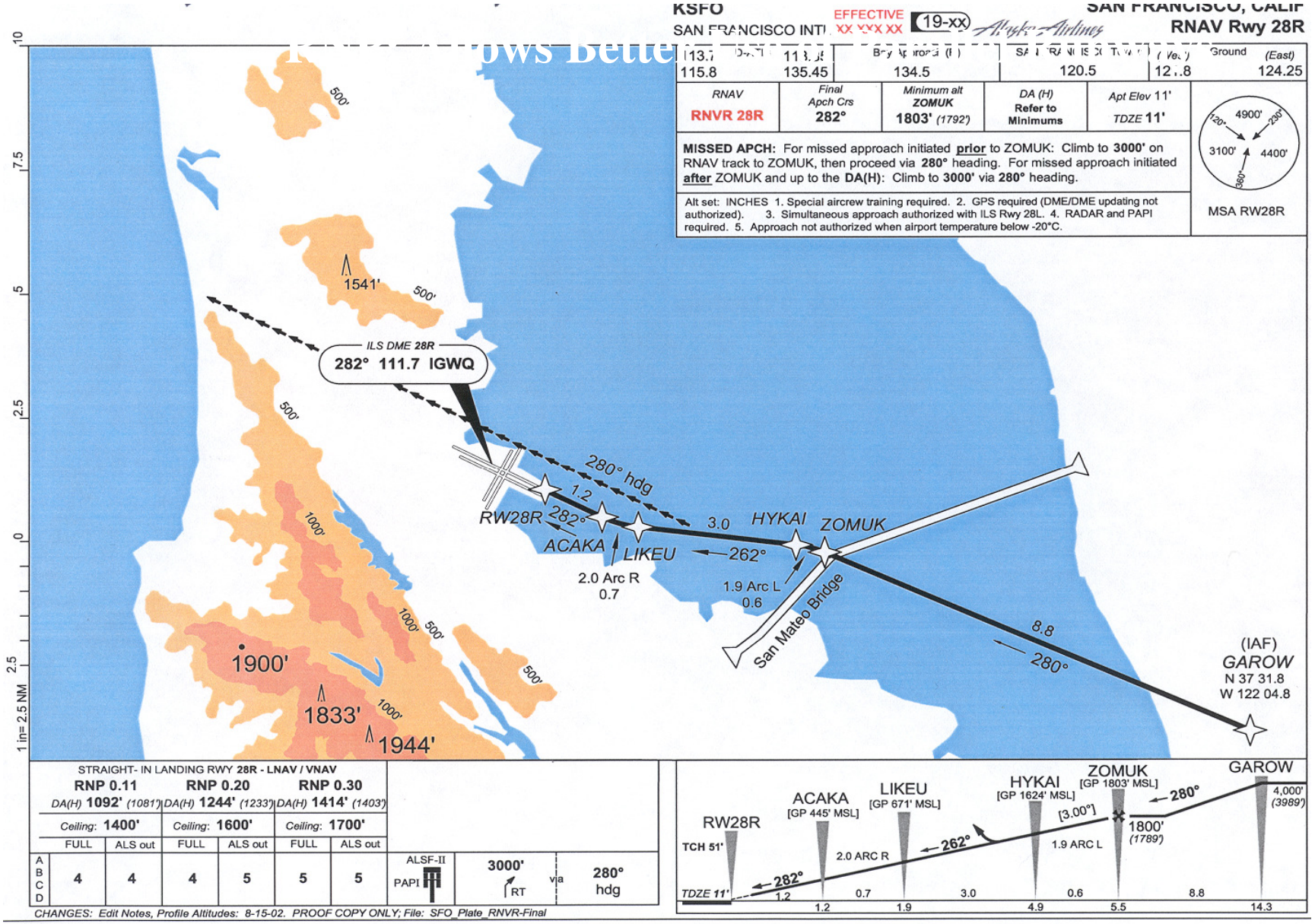

ISOLATED BASE STREAM WITH MODIFIED FEED
75
80
85
85
PDARS

# Simultaneous Offset Instrument Approaches SOIA at SFO



SFO 28L

- Allows 3400’ Parallels
- Visual after that
- 25% Arrival rate increase over single runway option
- Will allow dual runway operations to 2,100 foot ceilings initially, later to 1,600 feet, & visibility of 4 miles
- Began 10/26/04

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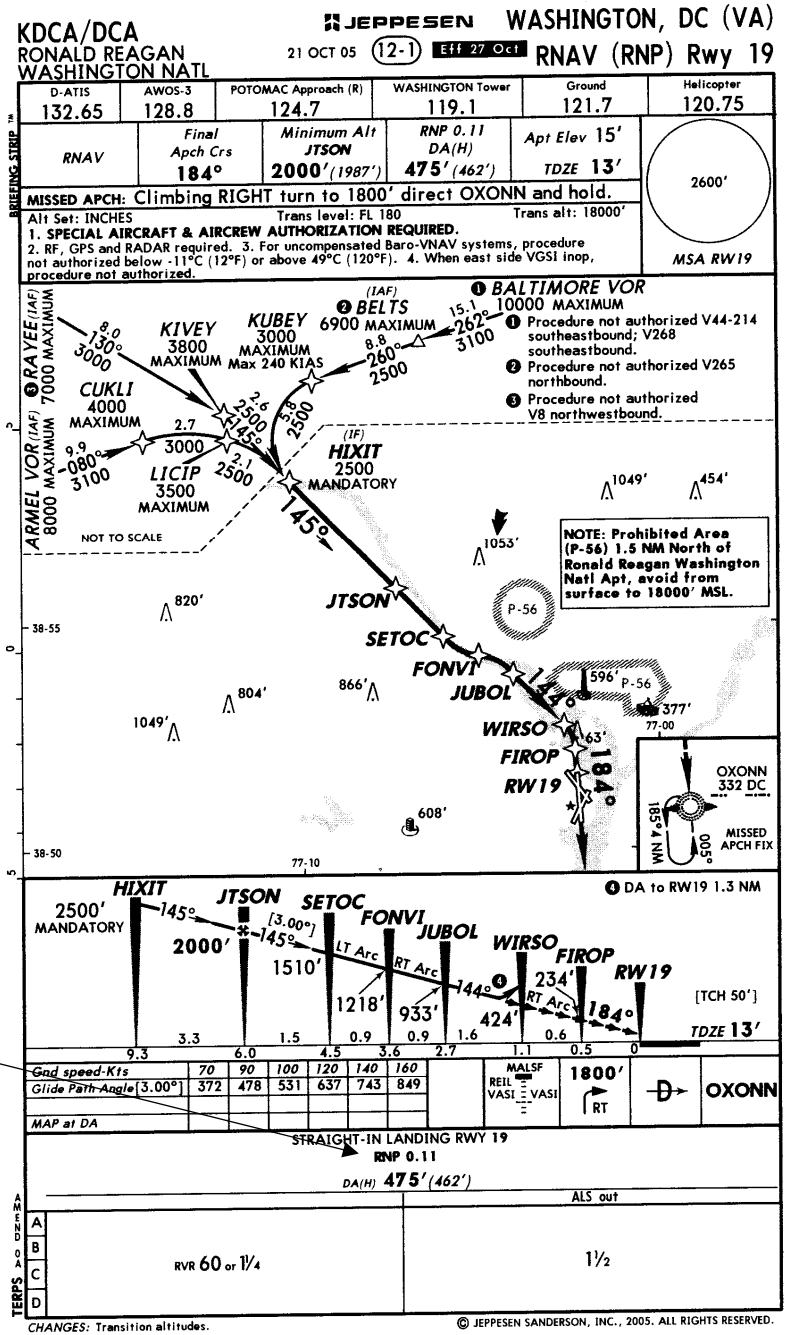
# KDCA-
# RNP
# Approach

RNP .11 required

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# RNP in Terrain

- Using RNP in terrain environment increases safety margin and adds capacity – typical RNP 0.3

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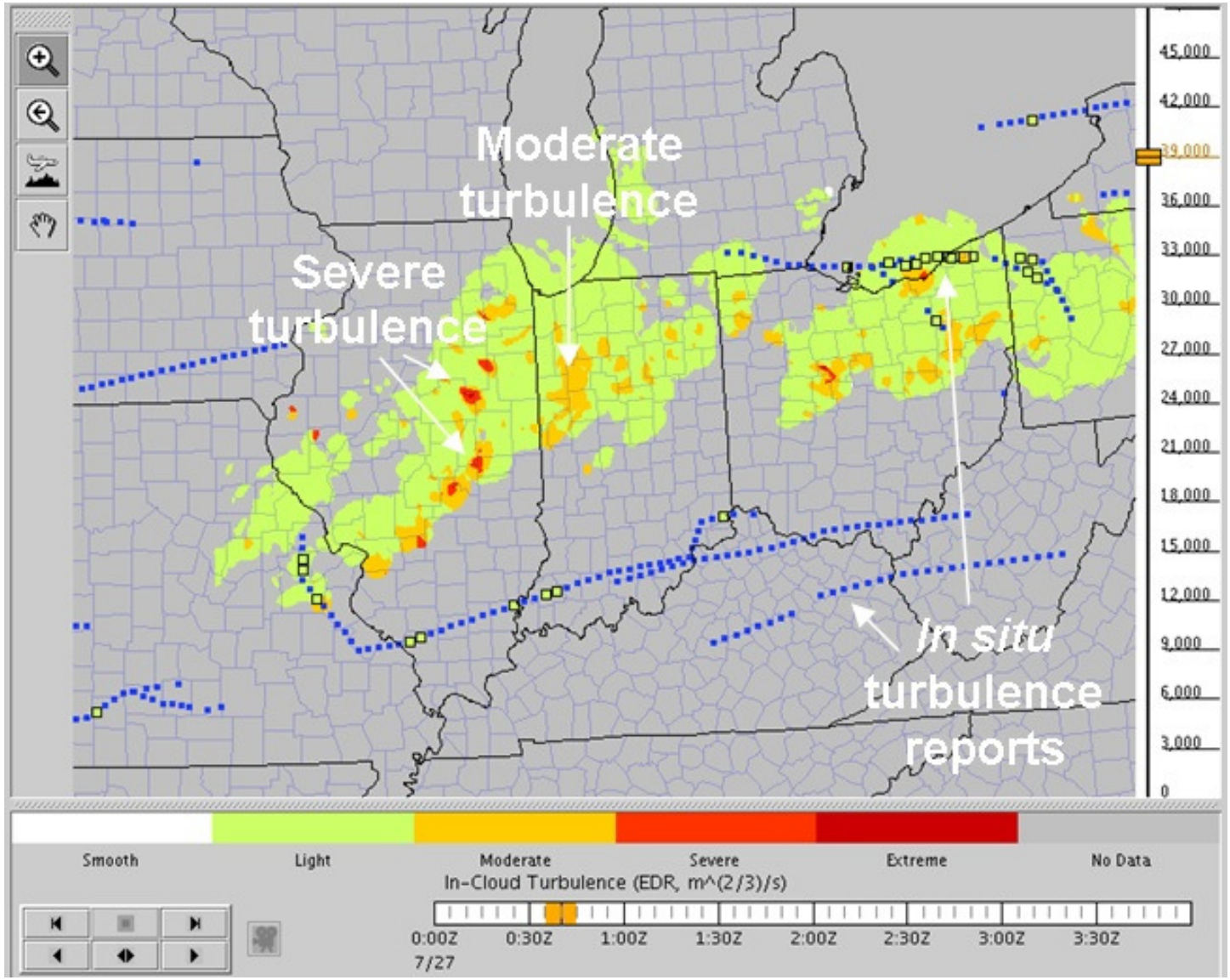
# Tracking turbulence/weather with GPS position

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# Surveillance: UAL Surface Moving Map Test

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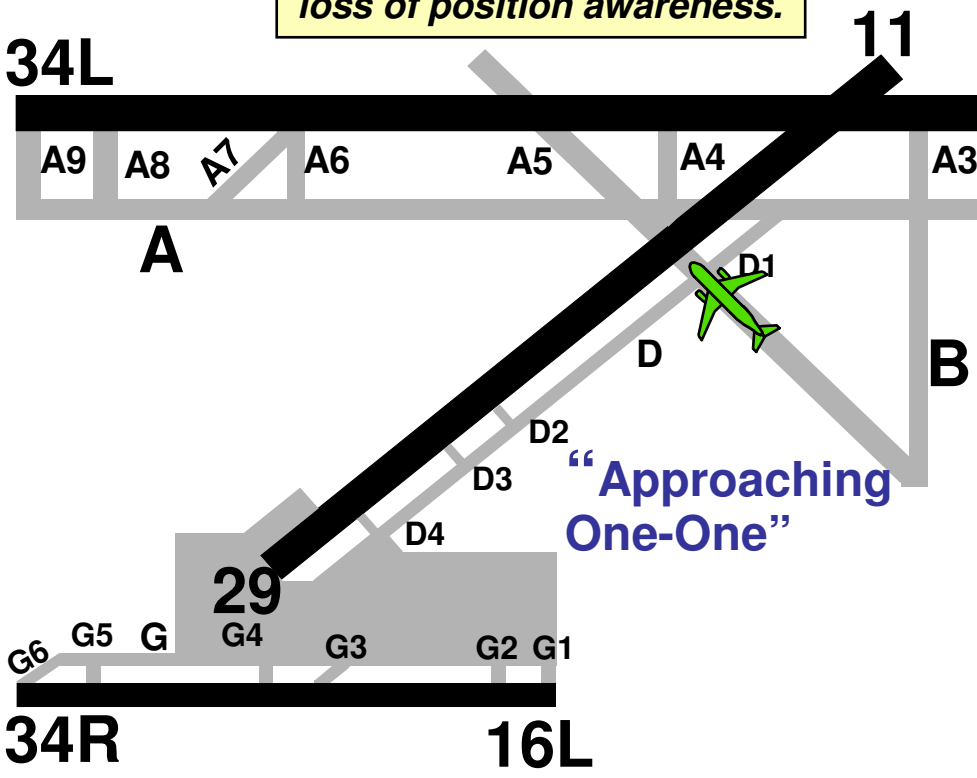
# **RAAS** System
# Approaching Runway - On Ground

***44% of Runway Incursions in our study involve loss of position awareness.***




**Conditions for advisory:**

- **Advisory depends on aircraft groundspeed, heading and nearest runway end**
  - ***Earlier call-out at higher speeds***
- **Inhibited above 40 knots**
  - ***No distraction during take-off/landing ground roll***

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# RAAS in action (UAL B777 @DEN)

## Runway End Advisory Call-Out

- Aircraft on the runway
- Aircraft heading +/- 20 deg of runway heading
- Aircraft enters last 100 feet of runway
- Aircraft groundspeed in < 40kts

**“100 remaining”**


100 remaining.AVI

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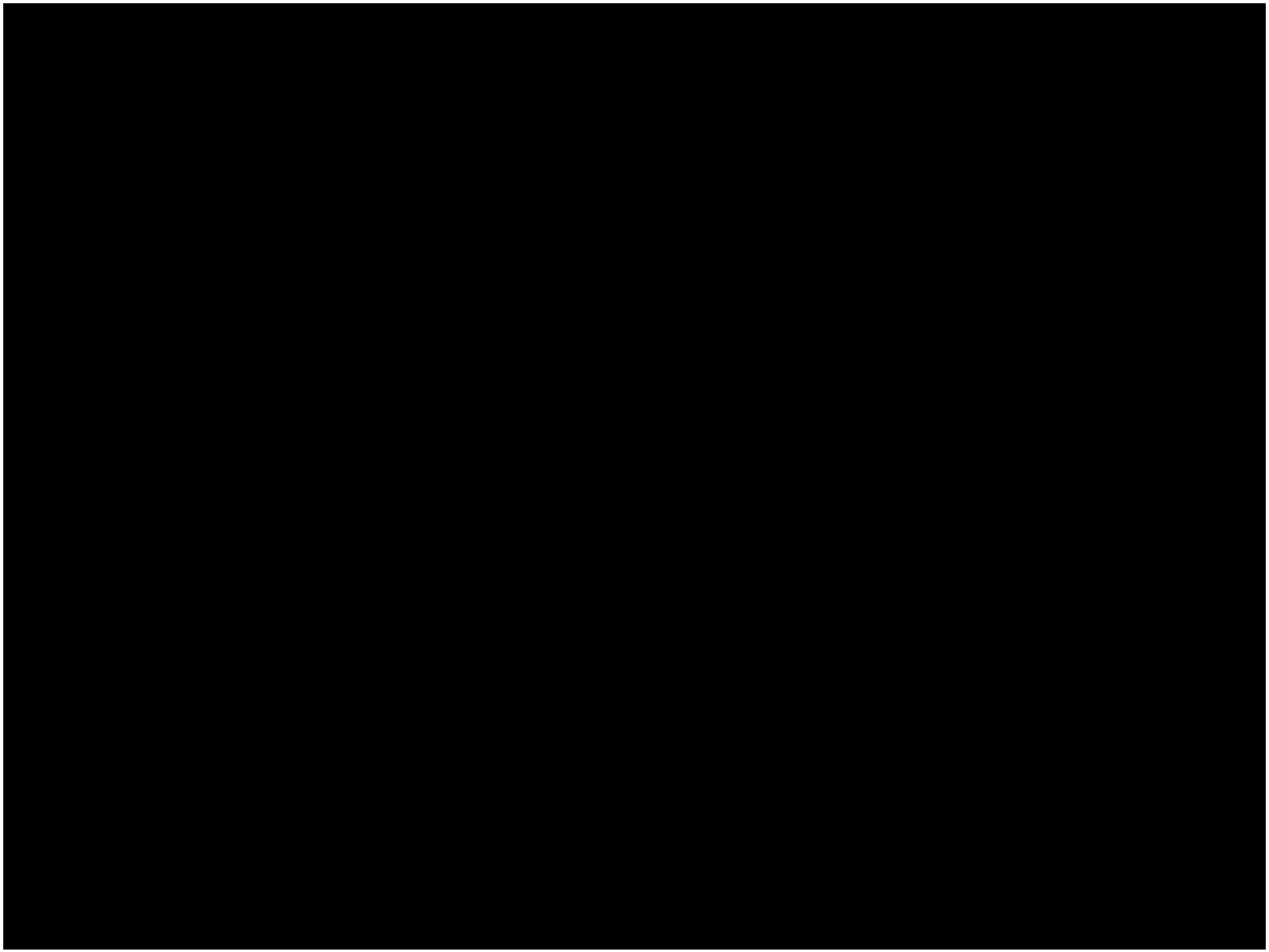
# RAAS in action #2

Intersection Departure – Insufficient Runway

- Aircraft must enter into runway
- Aircraft heading +/- 20 deg of runway heading
- Distance for takeoff less than nominal (user selected)

**"On runway 34 Left, one thousand two hundred remaining"**



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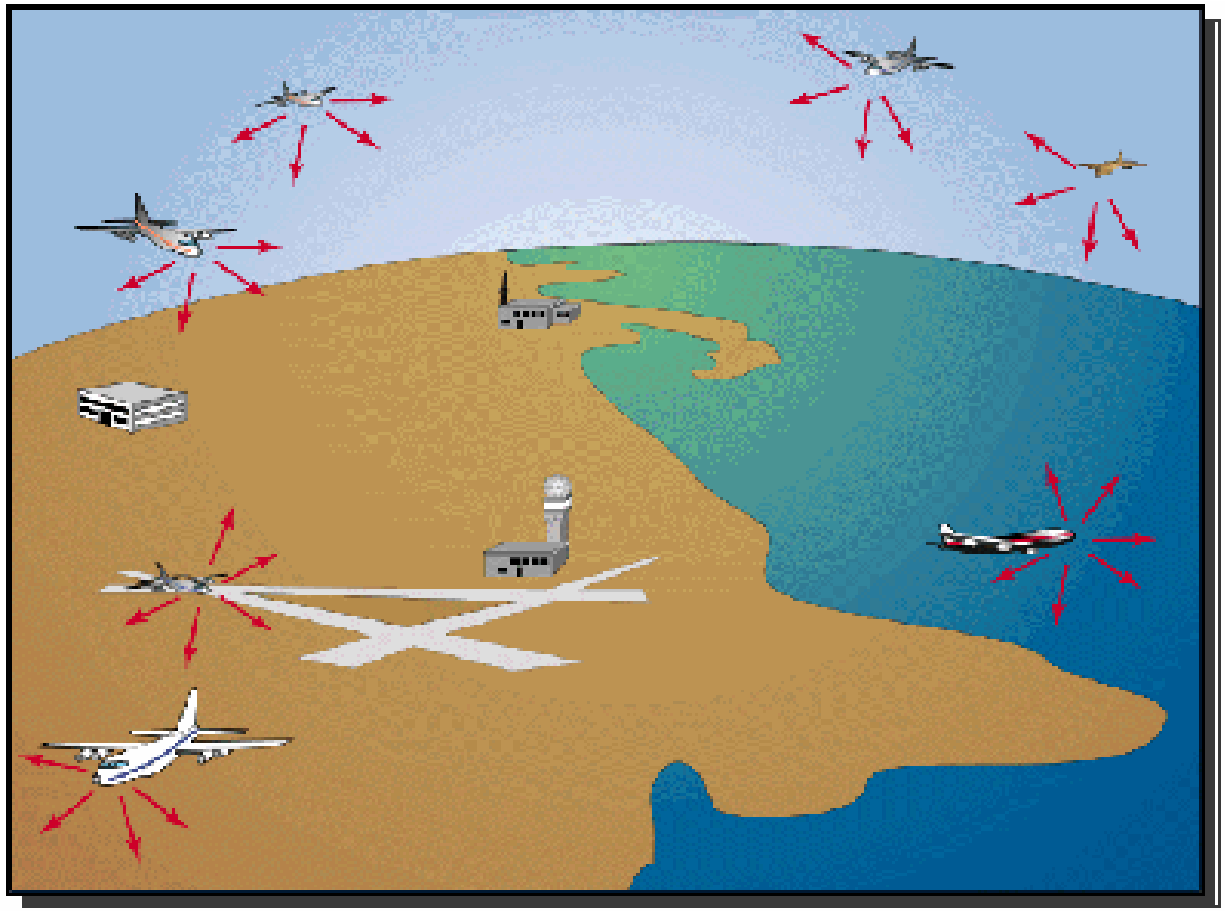
# What is ADS-B?



- Automatic
- Dependent
- Surveillance
- Broadcast

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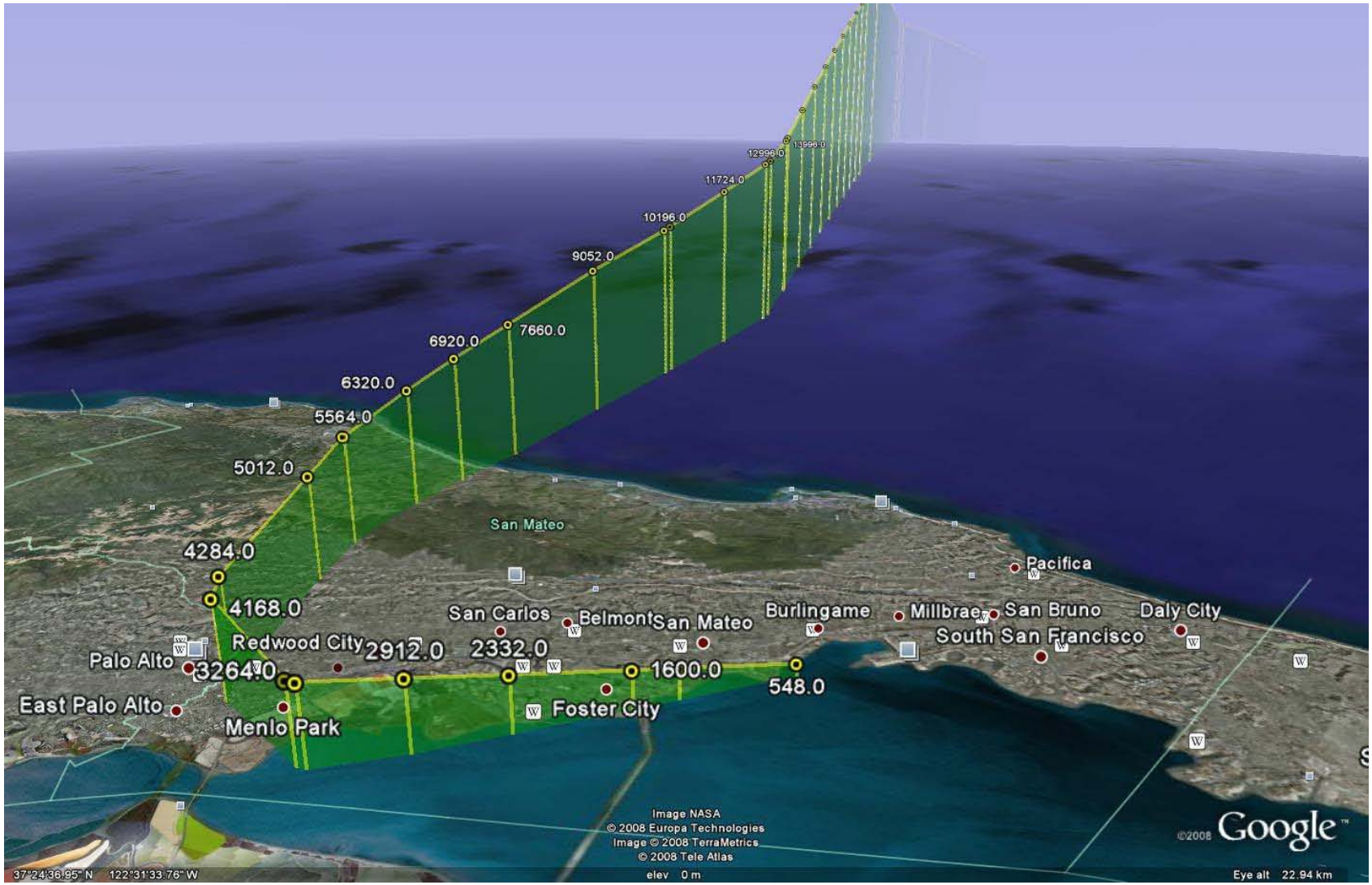
# Oceanic Tailored Arrivals using GPS

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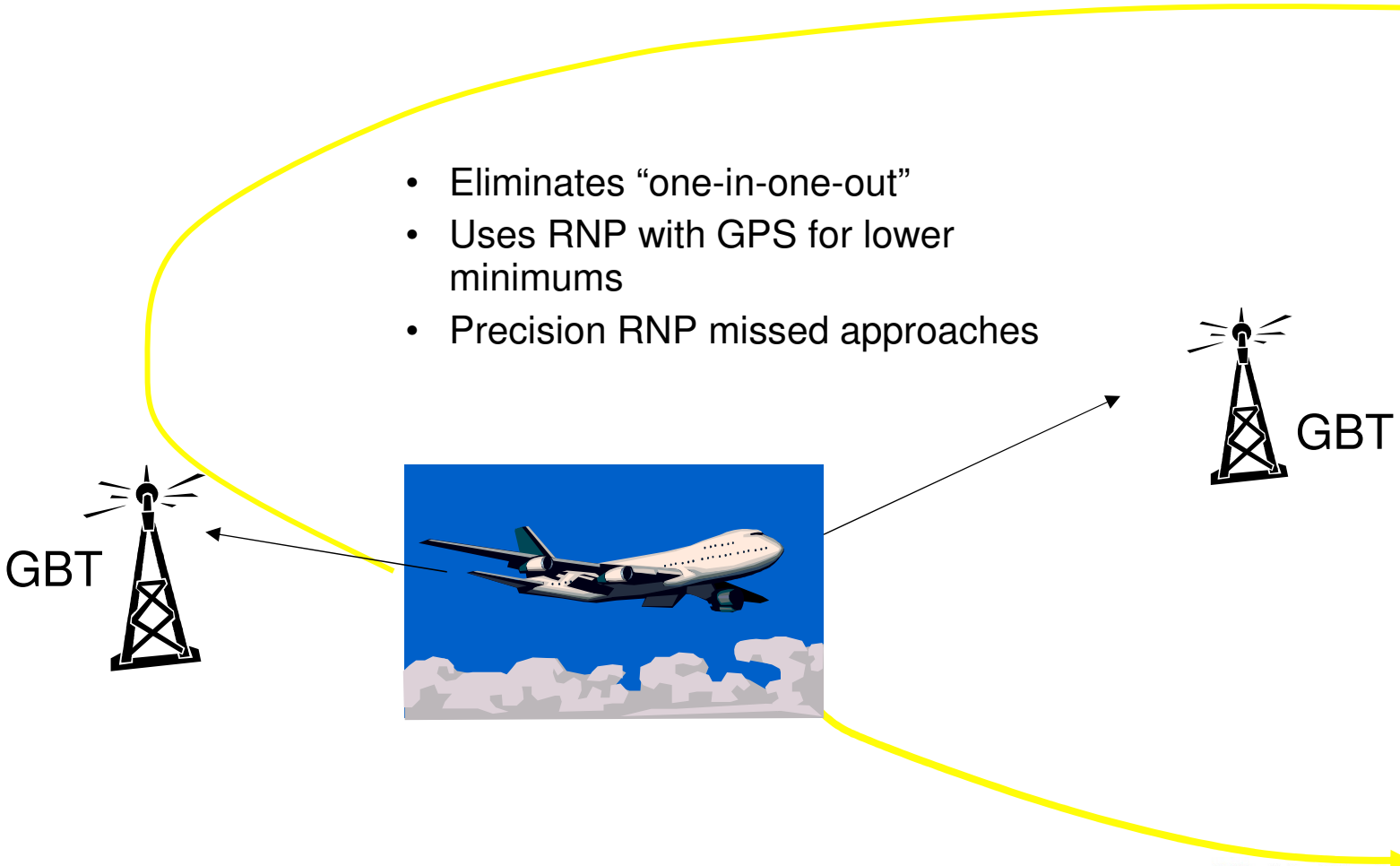
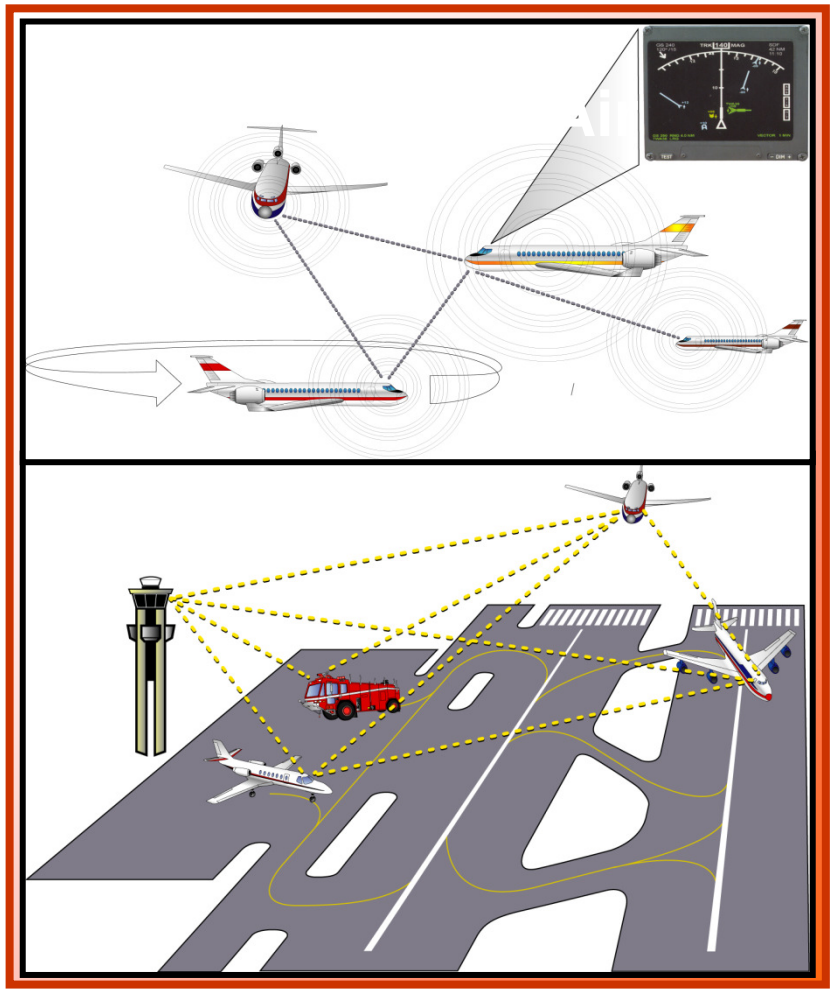
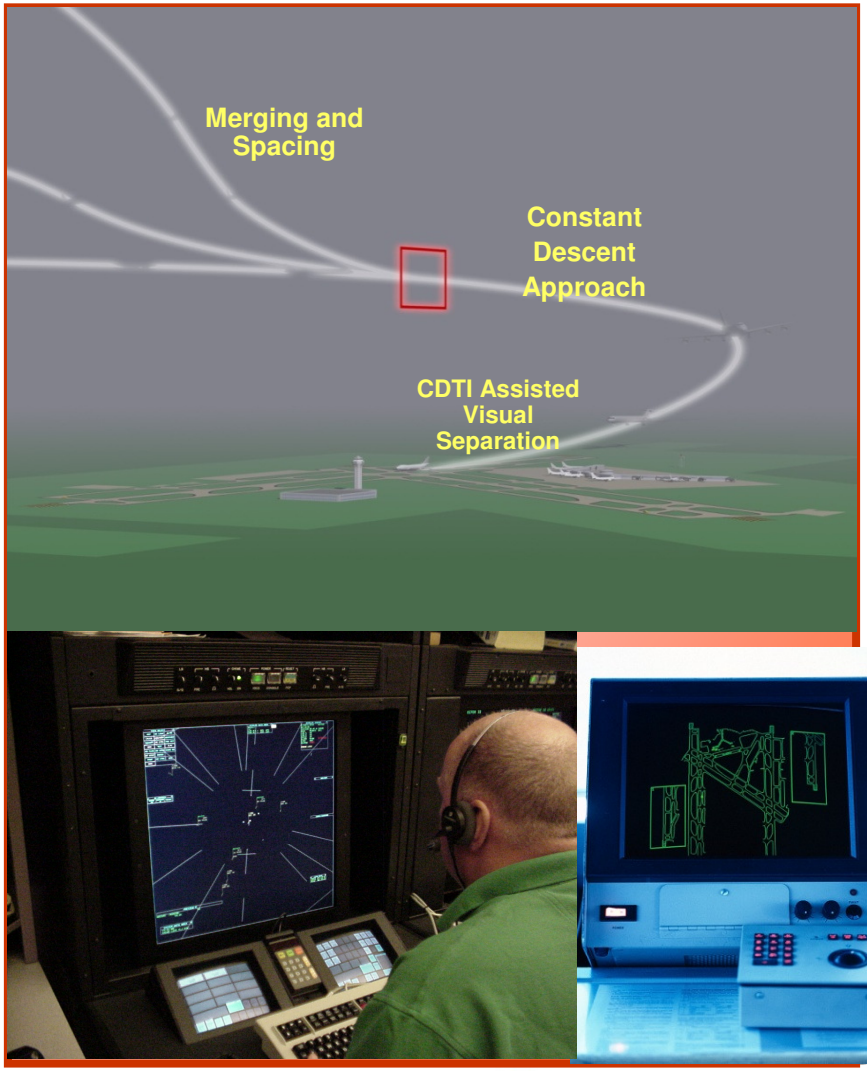
# Radar Equivalent Services in High-Terrain Airspace Using ADS-B Out

- Eliminates “one-in-one-out”
- Uses RNP with GPS for lower minimums
- Precision RNP missed approaches



# ADS-B Improves Performance & Efficiency






Ramp Tower Display
UPS at Louisville

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# Current RADAR Separation Standards

- 5nm En Route
- 3nm Terminal
- 2.5nm Terminal on approach
- 1.5nm Terminal on staggered dependent approaches
- 4,300 feet on independent parallel approaches

# Separation Mins with GPS/ADS-B

| Separation Standard | Satellite Constellation Av >0.9999 (with 2 deg. Mask Angle) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 24 | | | 27 | | | 30 | | |
| | No SV Unusable | 1 SV Unusable | 2 SVs Unusable | No SV Unusable | 1 SV Unusable | 2 SVs Unusable | No SV Unusable | 1 SV Unusable | 2 SVs Unusable |
| 5NM En Route | Yes | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| 3NM Terminal | Possible | No | No | Yes | Yes | No | Yes | Yes | Yes |
| 2.5NM Terminal on Final Approach | Possible | No | No | Yes | Yes | No | Yes | Yes | Yes |
| 1.5NM Terminal on Parallel Dependent Approach | Uncertain | No | No | Yes | Yes | No | Yes | Yes | Yes |
| 4300FT Terminal on Parallel Independent Approach | No | No | No | Yes | Yes | No | Yes | Yes | Yes |

# Why GPS for aviation?

- ”Space-based navigation” will allow more aircraft in our airspace:
  - Guarantee of 30 GPS satellites will reduce en-route and terminal spacing
- GPS will reduce fuel burn and greenhouse gas emissions:
  - More direct, time-based routings
- GPS will enable safer operations due to position awareness:
  - Reduce runway incursions
  - Provides greater situational awareness


Thank you!