

GNSS Operational Implementation Activities

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Operational Implementation

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The Mind Is Like A Parachute.....

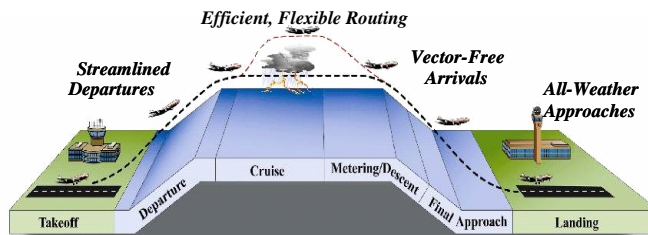
It Works Best When It Is Open



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Performance-Based Navigation

- Complete Transition By 2025
- Consistent With ICAO Global Vision
- Operational Capability Based On GPS And Augmentations
- Enhance Safety, Capacity, Efficiency
- Reduce Cost For Legacy Navigation Systems



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Navigation Evolution Roadmap outlines the overall transition timeline

Today's *ground based, human-centered* Air Transportation System has reached its technological and capacity limits

Route structure tied to ground based nav aids
 - Coverage limited service, dictated routing
 GPS, WAAS provides increased coverage, access and routing options



NDBs, Marker Beacons, VORs already being turned off

2005 - 177 facilities divested
 2006 - 277 facilities divested
 2007 - 100 facility divest goal

2007 → 2015 VOR drawdown

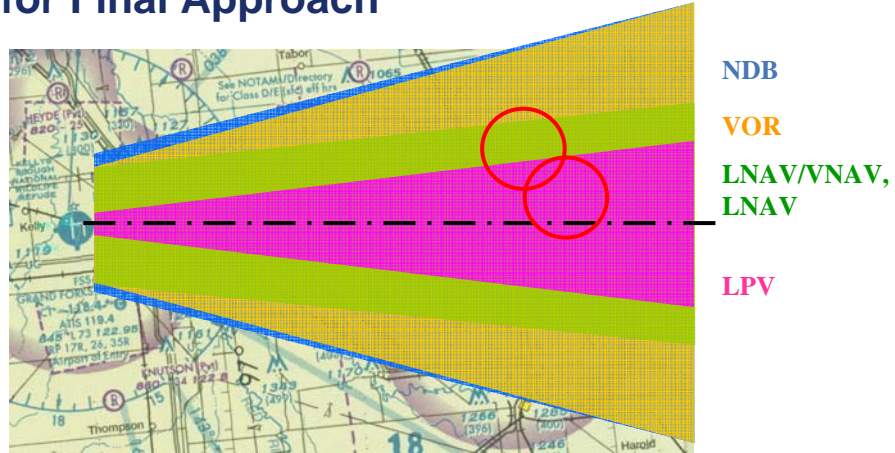
2008 DME rightsizing decision

2012 → 20xx ILS drawdown



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Comparison of Obstacle Evaluation Areas for Final Approach



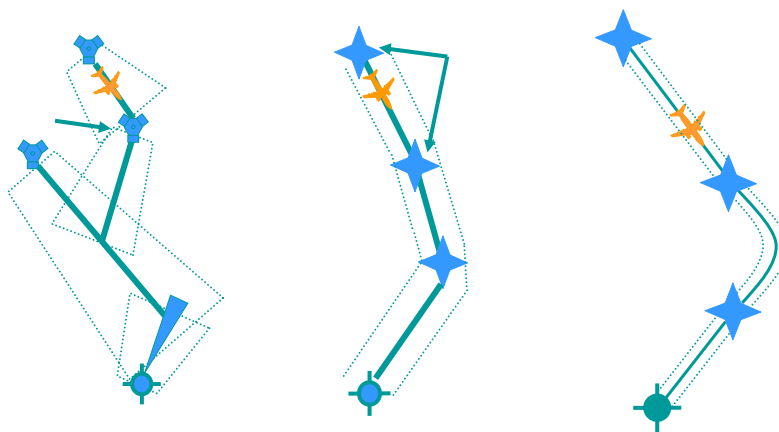
NDB and VOR areas may be larger depending on navaid location



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Evolution to Performance-Based Navigation



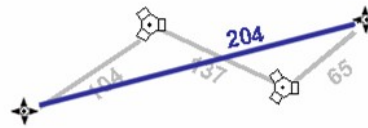
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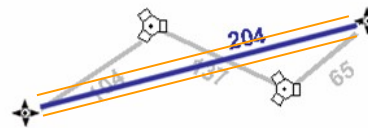
Definitions

- **RNAV** - a method of navigation enabling aircraft to fly on any desired flight path within the coverage of referenced NAVAIDS or within the limits of the capability of self-contained systems, or a combination of these capabilities
- **RNP** is RNAV operations with the added feature of on-board navigation performance monitoring and alerting

RNAV Point-to-Point



RNP



What Is GPS/WAAS? What Can It Do?

- Provides Consistent Accuracy Everywhere In the Service Volume
- High Level Of Integrity (what you can rely on and when)
- **No** Ground Equipment Required Anywhere
- Can Put Rotorcraft and Fixed Wing Aircraft On A Common and Equal Ground
- Ground Track Predictability
- Flight path Reliability



Vertical Flight – “In Progress”

- **Dallas/Ft Worth Trauma Centers and IFR Route Infrastructures**
- **LPV IFR Criteria and IFR Inter and Intra-City Routes For Vertical Flight Only**
- **Increase The Life Saving Capabilities In The Dallas-Ft Worth Area**
- **In The Mill – New York and San Diego**



What Is It?

- **Develop 3-5 LPV Point in Space LPV Approaches to Hospital Pads**
- **Define and Develop Missed Approach Criteria**
- **Develop Intra City IFR Route Structures**
- **Develop Departure IFR Routes To The Intra City IFR Network**
- **Couple The Network To Local Emergency Operations Requirements**



HORIZON WAAS PROJECT

- **Q400 Procedure Development Project**
- **First Commercial Carrier to Equip With WAAS**
- **En Route Structure To Build Cost Beneficial Procedures To Save Time and Fuel**
- **Terminal Area Structure To Save Time and Fuel While Gaining Environment Benefits**
 - Continuous descent paths to final approach path
 - Shorten paths to eliminate the ILS procedure turn



Horizon/Portland – In Progress

- **FAA Data Collection Effort To Demonstrate and Validate Technical, Operational, Economic and Environmental Efficiencies of WAAS in a Regional Airline Application**
- **Horizon Airlines Deciding If To Equip 48 Q-400's With Dual UNS-1E/w FMS (RNP Capable)**
 - Working on STC
 - Alaska Airlines Monitoring Potential Benefits



FedEx Cargo Feeder Fleet - Done

- **First Cargo Fleet With Complete WAAS Equipage**
- **Cessna Caravan 208's (253 A/C)**
- **Garmin GNS-530 Avionics**
 - Part Of Caravan Safety Enhancement Program
- **Pilots Currently Flying LPV Approaches**
 - Very Positive Pilot Feedback and Demand for More
- **Looking At Installation for the ATR-72**



WAAS AVIONICS STATUS

- **GARMIN PRODUCT LINE – GPS AND LPV (NO LP)**
- **UNS-1 PRODUCT LINE (DUAL SYSTEM) – SINGLE SYSTEM (TSO MAY 08)**
- **ROCKWELL COLLINS MMR – WAAS TSO 4Q08**
- **BENDIX KING – KSN 770 TSO 4Q08**
- **HONEYWELL – TBD**
- **NOT MUCH OUT THERE**



Avionics – What?

- **Discussions With Augusta, Eurocopter and Sikorsky To Develop and Implement WAAS STC's**
- **Meeting With Manufacturers To Identify Who Can Provide What Capability When**
- **Arm Twist To Advance WAAS IFR Approach and Terminal Area Applications**



SAFETY PROCESSES

- **We Will Manage The SMS Process To Ensure All Organizations Are Included And Implementations Are Thought Through**
- **Program Office Has People Who Will Work This issue and Is Coordinating with RNP Program Office**
- **Program Office Is Also Working Through Existing Vertical Flight FAA Organizations**



LAAS PROJECTS



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LAAS Complex Procedure Development Plan for the

Memphis Terminal Area



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Memphis - GBAS Flight Testing Concepts

- **TAP/RNP Approaches**
 - **No Radar Vectors** (single paths from cornerpost to the DH)
 - High Integrity Data Base Up Links – No FMS Differences
 - Low Engine Power TAP (CDA but with deceleration points)
 - Missed Approach*****
 - Auto-Coupled Curved Turns (Precision Ground Tracks)
 - **Environmental**
 - Long Curved Turns To Short Finals To Decision Height
 - **Timing, Spacing And Path Merging (Auto Sequencing Arrivals)**
 - Land Long – Closely Spaced/Wake Turbulence (Close Parallels)
 - Dynamic Downwind/Shortened
- **TAP/RNP Departures**
 - Low Visibility/4D (Same As Approach tasks But For Departures)
- **TAP/RNP – 4D/RTA Approaches (Flex Applications)**
 - **Multiple Runways/Closely Spaced Parallel Simultaneous Landings**
 - Sequencing, Spacing, Timing Starting at En Route Altitude



GBAS Flight Testing Concepts (cont.)

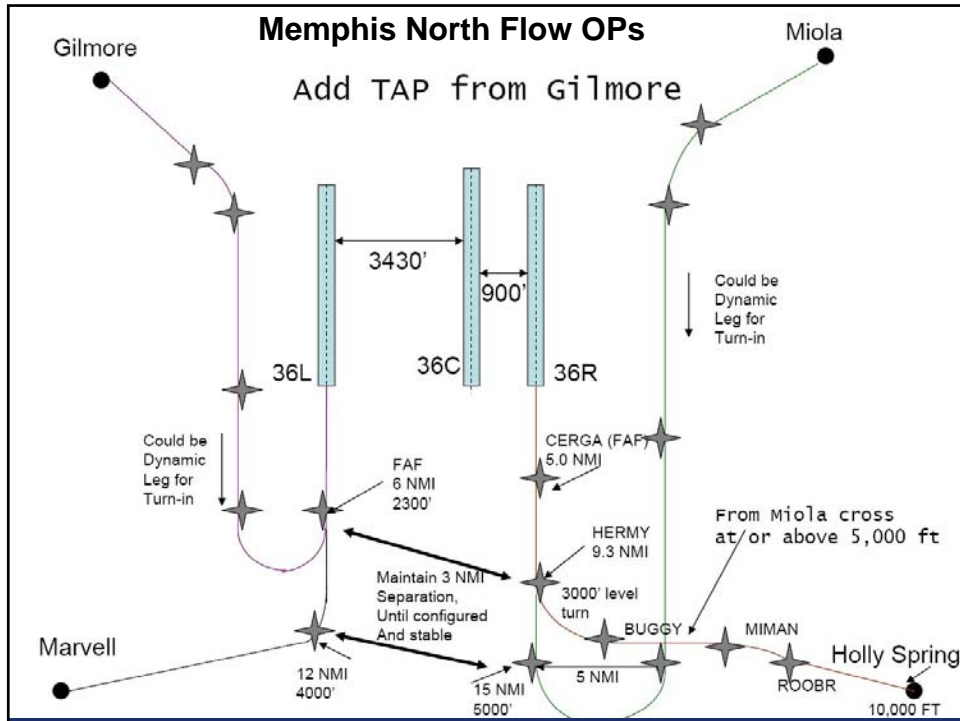
- **Aircrew Training/Workload/Safety**
 - FMS Reload (17 Steps) vs GBAS Re-tune (1 Step)
- **Airspace Design**
 - Non-Ground Based Corner Post/Arrival Gate Restrictions
- **Surface Movement**
 - Map vs Non-Map (nav display)
- **Adjacent Airport FAS**
 - NPA (Issue On DCSP Service Availability or Avionics)
- **Procedure/Airport Oddities**
 - Closely Spaced And Low RNP Approaches
- **Database (Reduce and Simplify) (Data Integrity Uplink)**
- **Critical Area Capacity Enhancements**
 - “GBAS Performance” (No Hold Short Taxi Areas)
- **Highest Availability of Low RNP Value**
- **LAAS Provides “BEST” Navigation Values**



MERGING/SPACING TASK - Memphis

- **Optimizing Aircraft Sequencing and Spacing in the Terminal Area Airspace to Increase Airport Capacity and Reduce Fuel Burn and Emissions and Noise Reductions on Developed Terminal Paths**
- **Illustrate Increases in Airport Throughput By Demonstrating How Currently-Available Technologies That Exploit the Advances in Communication, Navigation and Surveillance (CNS) Systems, Optimize Aircraft Flight Tracks, Sequencing, and Timing in the Terminal Area Airspace**
- **Lead Test To Align Aircraft For Close Parallels**
- **Independent Arrival Operations**





Plan for Future Flight Testing - Memphis

- **Incorporate Other Aircraft In Flight Tests**
 - TAP Compliant and Useable for All Aircraft
 - Turn Radius and Deceleration
- **Coordinate Other Terminal Area RNAV/RNP Applications Into Concept Of Operations**
- **Continue To Work On LP TAP's For Metering Of Aircraft (Spacing and Timing-4D)**
- **Develop and Implement Standardized Data Collection For All Areas and Participants**
 - Approved Truth Source
- **Ensure Applications Have ATC Approval and Applied TERPS Criteria**

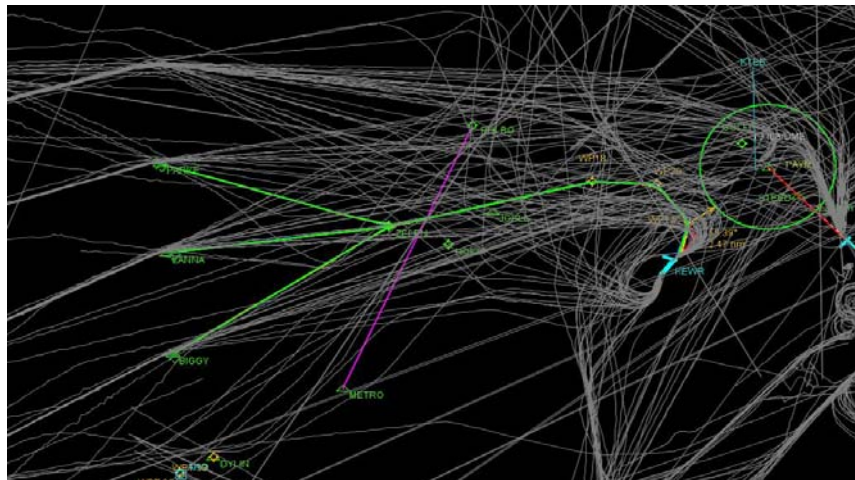


Why LAAS?

- **Elimination Of ILS Critical Areas**
 - Increases in Departure Rates (Current Hold Short Restrictions)
- **Runway Offset Approach Configurations (Airspace Separation)**
- **Curved Path Transitions To Final Approach Segments Without Radar Intervention**
- **Pre-defined Terminal RNAV/RNP Routes**
- **Optimum Flexibility For Dynamic Routing**
- **Close Parallel Arrivals**
 - Digital Technology Reduces the Dimensions of Transgression Zones Due to Superior Accuracy Over Analog Technology
- **Supports Multi Mode Approach (MMA) Technology**
 - Variable Geometric Lateral and Vertical Paths – Approach and Departure
- **One LAAS System Supports All Runway Ends – 360 Degree Precision Navigation**



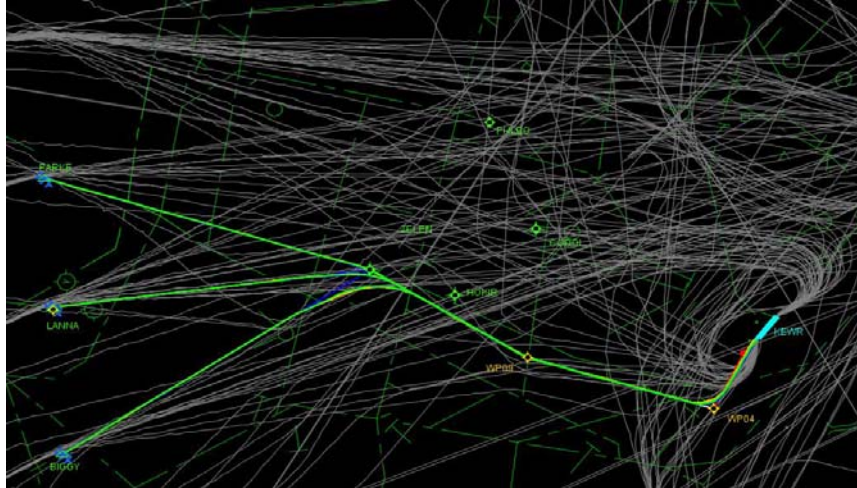
EWR RWY 4 RNAV SID



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EWR RWY 22 RNAV SID



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Commitments

- FAA**
 - **Develop and approve RNP-based approach and landing procedures for EWR**
 - Utilize FAA resources at the WJH Technical Center for pre-testing of procedures and operational concepts
 - **Analyze potential of increasing capacity and improving efficiency**
- Industry/Users**
 - **Provide/operate GNSS-equipped aircraft**
 - Continental Airlines Boeing 737-800 Non-NG Aircraft (65 During Initial Phase)
 - **Develop/market GNSS avionics**
 - **Procure/Install Honeywell LAAS Ground Station**



Resources – The Newark Team

- **FAA**
 - New York TRACON and Eastern Service Center ATC
 - FAA GNSS Team, AFS, ATO-P, RNP Office
 - Stanford University
- **Industry/Users**
 - Newark Airport
 - Teterboro User Group
 - Eastern Region Helicopter Council
 - Continental Airlines
 - Port Authority of New York and New Jersey
 - Honeywell
 - Rockwell Collins
 - CMC



What - Implementation Strategy

- Build a Little, Field a Little, Test a Little
- Evaluate GNSS Procedures That Could Result in Improved Capacity and Efficiency
- Facilitate Avionics and Airframe MMR Integration Which Will Lead to 4D Continuous and Autonomous Aircraft Operation Solutions
- Develop GNSS Operations To Assist in Airspace Separation and Non-Interfering Operations



GBAS

Operational Features

- **Increased number of approaches – Each GBAS facility has the capacity to support 48 distinct precision instrument approaches to a combination of runways and airports within a 23 nm radius of the transmitter.**
- **Elimination of ILS Critical Zones – Increased rate of departures**
- **Close parallel arrivals – Digital technology reduces the dimensions of transgression zones due to superior accuracy over analog technology.**
- **Runway offset approach configurations.**
- **Supports Multi Mode Approach (MMA) Technology**
Variable geometric lateral and vertical paths –
Approach and Departure

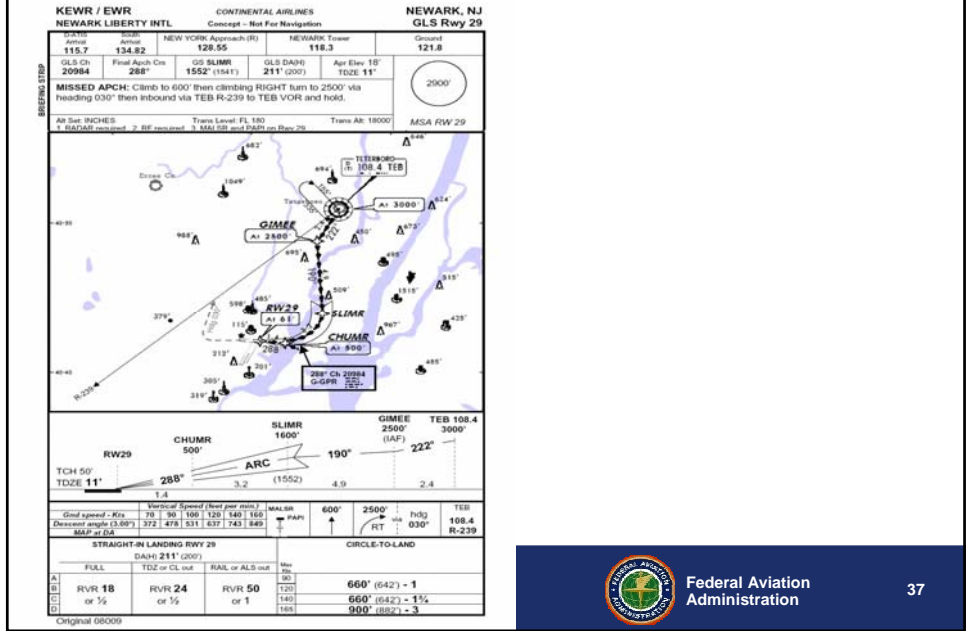


EWR GLS Station CDA Arrivals

- 120 NM TOD to Touchdown
- B787 TAPS
- Off Peak Fuel Savings



GLS RWY 29 CAT I



TAP Definition (FMS & NON-FMS)

- A Terminal Area Path (RNAV-RNP) Starting at Either the Terminal Area ATC Airspace Edge or an En Route waypoint
- A Path That Defines Vertical and Lateral Containment (Narrow Grounds-.06RNP)
- A Path That Allows for Non-Radar Transitions Under Aircraft Specific Optimum Performance Characteristics
- Gate to Gate GNSS Connectivity

Terminal Area Path (Complex) Procedures

- TAP Supports Approach, Missed Approach and Departures
- TAP **Mitigates ILS Shortcomings**
 - ILS is a Single, “Straight-in” Approach Path
 - ILS Susceptible to Sighting and Over Flight Effects
 - ILS Approaches Require **Detailed Vectoring** By ATC
 - Limited Landing Rates Under IFR Conditions
- TAP - GLS Approaches Enable (GBAS Supports 360 Degree Precision Navigation)
 - Reductions for Obstacle and ATC Separations
 - Better Airport Access Through Shorter Final Approaches
 - Increased Airport Capacity
 - Better Schedule Reliability
 - Better Time and Fuel Efficiency
- TAP Navigation Can Be Performed in the LAAS Avionics
 - Not Position Information Sent to the FMS (Use of modern FMS will add more and better capabilities)

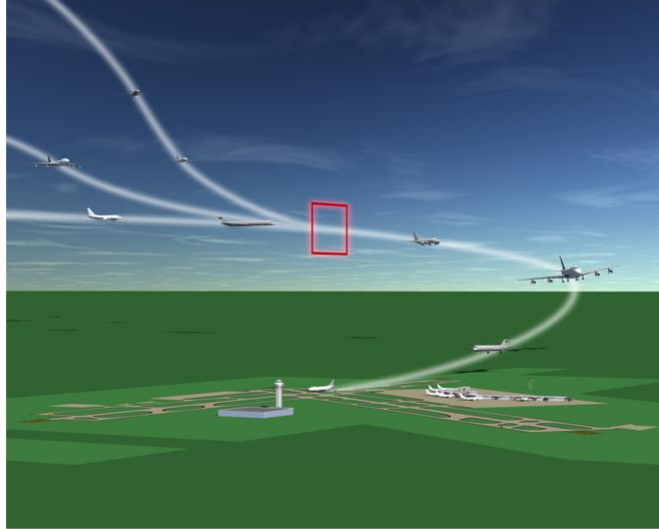


POTENTIAL SOLUTIONS

- Continuous Arrival Paths Based On Operation Need and/or Community Restrictions, Not On Existing Ground Based Structures
- Unrestricted Climbs – Cruise Climb – Flight Idle Descents
- **Eliminate Radar Vectoring**
- **Benefits That Could Be Achieved**
 - Significant Fuel Savings and Payload Increases
 - Significant Reduction In Terminal Airspace Conflicts
 - Reduced Airspace Congestion
 - Reduced Terminal Arrival and Departure Delays
 - Reduced Air Pollution/Emissions
 - Reduced Noise Pollution



Reliable Precision Operations Improve Predictability, Safety and Airspace System Capacity



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Juneau Alaska



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CONCLUSION

- **Today's Scenario Will Not Support a 25% Traffic Increase Predicted Over 3-5 Years**
- **An Operational Concept and New Set of Capabilities Has Been Demonstrated To Provide Significant User Benefits**
- **These Capabilities Take a Major Step Forward To NEXTGEN Desired Capabilities**
- **Ground Based Structure Does Not Support Further Increases Nor Needed Efficiencies – That Is Why We Have The problems We Have Today**



Recommendations

- **Countries Support Proposed Testing Concepts**
- **Push For More Operational Testing**
 - Build a Little, Field a Little, Test a Little
- **Use This Forum To Help Direct Tests**
- **More Operational Test Before Implementation Of Technology**
- **Identify Next Steps**
 - POC's
 - Multi-National Testing
 - User Driven Implementation Uses, NOT OEMs



Approach 5



startrack5.exe

