Project Newark: Goals, Objectives, and Simulations

Presentation to:
CAAC Team
October 22, 2010
Atlantic City, New Jersey, USA

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Presentation Overview

• Project Newark Basics
  • Partners
  • Initial Results
• Simulations
• Phase II Runway 29 Procedure Rework
• Summary
Newark Project Overview

Conduct an operational demonstration project using the satellite navigation technology of Local Area Augmentation.


• A LAAS will be installed at Newark Airport to:
  • Demonstrate the improved performance and precision and interoperability with other GNSS capabilities.
  • Provide data to support FAA decisions on ground equipage and airline decisions on avionics.
GNSS Implementation Overview

**GNSS Implementation**

**LAAS**
- Newark
- Continental
- ATC
  - Approaches to RWY 29, RWYs 4/22 LR
  - Helicopter approaches, RNP

**WAAS**
- Teterboro
- Vertical Flight
  - NY/NJ Airspace Initiative
    - Must solve pieces of puzzle simultaneously, not just one part

**Memphis**
- TAPS
- 4D approaches
- Time/Space merging
- NGATS Environment
  - Continuous descent approaches
- Air Traffic Control
- Closely spaced parallels
- RNP
- RNAV: Radius to Fix leg

**Vertical Flight**
- Care Flite - SAAARs
- Helicopter LPVs
- Transition routes
- IFR infrastructure
- Helipads
- Public support
- Bell: Public VF criteria

**Fixed Wing**
- Allegiant
- Horizon
- Operations
- American

FAATC Proving Ground
FAA Technical Center
Demo Development and Proof of Concept for GNSS Applications
# Newark Project Partner Contributions

## FAA
- Develop GLS Overlay Procedures
- Provide Data Collection Equipment
- Develop and Coordinate Prototype Terminal Procedures
- Collect Data and Analyze Performance
- Support GBAS Facility and Service Approval

## Continental
- Equip 10 B-737NG Aircraft with LAAS Avionics (STC)
- Support FAA Data Collection Activities
- Apply for Special Approval for LAAS Cat I Operations
- Conduct Flight Test Operations
- Support Procedure Development and Simulation
- Complete Service Approval for Cat I Operations

## PANYNJ
- Procure the Honeywell SLS-4000 LAAS
- Complete Site Preparation
- Install SLS-4000 System
- Provide Maintenance and Support
- Complete Facility Approval for Cat I Operations

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Project Newark  
October 22, 2010
Strategic Objectives

Demonstrate improved performance, precision, and interoperability with other SATNAV capabilities.

Identify and implement via ATC participation required RNAV/RNP operations to meet the performance based navigation that will support capacity and efficiency enhancements.

Incorporate ATC developed procedures and terminal applications to achieve increased capacity and efficiency.
Newark Project Core Team

- FAA Flight Standards
- Aviation System Standards
- FAA Eastern Region
- Eastern Flight Procedures Office
- Eastern Service Center
- New York Terminal Radar Approach Control (TRACON)
- Newark Air Traffic Control Tower (ATCT)
- Continental Airlines
- Boeing
- Honeywell
- FAA Engineering Development Services Navigation Team
- LAAS Operational Implementation Team (OIT)
Procedure Development Phases

- First phase
  - Developing and implement the straight-in approaches from the FAF using deviation guidance provided to the current cockpit instrumentations
  - Missed approach will be a straight ahead 4 NM runway heading with expected radar vectors
  - http://aeronav.faa.gov

- Second Phase
  - Focus on the curved approaches to Runways 29 and 22R
  - The team will examine what procedures, or ideas for procedures, and seek air traffic’s feedback on the “pros and cons” of each piece of those procedures
  - Changes will be made to the procedures based on air traffic’s inputs
  - Flight testing at ACY to determine technical feasibility and flyability using Terminal Area Paths (TAP)
  - Continental will also fly these procedures in their LAAS-capable simulator
Federal Aviation Administration

Project Newark

October 22, 2010

ARP

ILS 4R

EWRAT

GP 2000

DOOIN

1700

2.35 NM

EWRAA (FROP) GP 823

EWRAA (FAF) GP 823

EWRAT GP 2000

EWRAB GP 2328

DOOIN 3000

COL R-023

RW29

EWRAC 3000

Image © 2008 DigitalGlobe
Image © 2008 Sanborn
© 2008 Sanborn
Atlantic City RNP Overlay
Newark RWY 29
Initial Flight Test Results

FAA TAP Project Newark Flight Test @ ACY
14-Oct-08 A / Appr#005 Aircraft: N39

Start: 231730 2053
Stop: 230246 6064

FAA TAP Project Newark Flight Test @ ACY
14-Oct-08 A / Appr#004 Aircraft: N39

Start: 224529 2061
Stop: 230253 2062
Variations are caused by bank angle limits in executing the turns (blue and green tracks). This is an example of difficulty in using fly-by turns in RNP (PBN) procedures as the airspace required is much larger than the corridor one would expect with RNP.
Navigation Team Analysis Products

FAA LAAS Flight Test @ ACY
Navigational Sensor Error (NSE)

FAA TAP Project Newark Flight Test @ ACY
Vertical GLS Deviation Plot

FAA TAP Project Newark Flight Test @ ACY
Horizontal GLS Deviation Plot
Project Newark Phase II Simulation

• A two part simulation effort was identified:
  • The first step is to define scenario-based simulations to evaluate the benefit of new procedure to RWY29
    • Fast-time capacity study
    • ATC input is needed to ensure that the simulation quantifies realistic capacity improvement
  • Based on the successful outcome of the first step, Human-in-the-loop testing was planned
    • Evaluate tools to aid Air Traffic Control (ATC)
    • Determine ATC workload
    • Examine Missed Approach scenarios
### Phase II – Modeling and Simulation Activities

Phase II includes the conduct and analysis of a series of modeling and simulation (M&S) activities:

1. **Fast-time** – performed to examine system performance, including benefits assessment (e.g. delay, fuel burn, time/distance flown) & analysis of capacity, safety, risk, and efficiency

2. **Real-time, Human-in-the-loop (HITL)** – performed to examine and demonstrate an end-to-end concept at a higher fidelity. Identify and assess specific human performance issues as a result of new air traffic management (ATM) activities

<table>
<thead>
<tr>
<th>M&amp;S Activity</th>
<th>Modeling Tool/Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast-Time Capacity Analysis – 1</td>
<td>Runway Delay Simulation Model (RDSIM)</td>
</tr>
<tr>
<td>Real-Time Tower Feasibility Demonstration</td>
<td>Airport Facilities Terminal Integration (AFTIL)</td>
</tr>
<tr>
<td>Real-Time Tower Concept Refinement Demonstration</td>
<td>AFTIL</td>
</tr>
<tr>
<td>Fast-Time Capacity Analysis – 2</td>
<td>RDSIM</td>
</tr>
<tr>
<td>Real-Time Tower Concept Validation Simulation</td>
<td>AFTIL</td>
</tr>
<tr>
<td>Tower-TRACON Concept Validation Simulation</td>
<td>NextGen Integration and Evaluation Capability (NIEC)</td>
</tr>
</tbody>
</table>
Initial Simulation Activities

• Capacity Analysis Baseline
• Several baseline days were selected and analyzed
  • Traffic Flow, conditions, fleet mix
  • Data presented for April 12, 2010
    • VFR day using 4R for arrivals and 4L for departures
• VFR and IFR Results are presented for completeness, conditions under which RWY29 can be used will be addressed under operational constraints
## Aircraft Mix

<table>
<thead>
<tr>
<th>Air Carrier</th>
<th>Air Taxi</th>
<th>General Aviation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>768</td>
<td>399</td>
<td>24</td>
<td>1,191</td>
</tr>
<tr>
<td>64.48%</td>
<td>33.50%</td>
<td>2.02%</td>
<td>100.00%</td>
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</table>

### Fleet Mix

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Heavy</td>
<td>8.66%</td>
</tr>
<tr>
<td>2 – B757</td>
<td>11.32%</td>
</tr>
<tr>
<td>3 – Large</td>
<td>79.16%</td>
</tr>
<tr>
<td>4 – Small +</td>
<td>0.26%</td>
</tr>
<tr>
<td>5 – Small-T</td>
<td>0.00%</td>
</tr>
<tr>
<td>6 - Small-S</td>
<td>0.60%</td>
</tr>
</tbody>
</table>
RNAV/RNP Approach to Runway 29

- Baseline
  - Arrive 4R Depart 4L

- Improvement
  - Arrive 4R & 29 Depart 4L

- Potential Benefit
  - Move 5-10 aircraft per hour from 4R to 29.
  - Addresses Non-homogenous mix
    - Potential aircraft for RW29 will be the small and smaller large
## Separation Rules as Applied

<table>
<thead>
<tr>
<th>Lead</th>
<th>Lead Rwy</th>
<th>Trail</th>
<th>Trail Rwy</th>
<th>Separation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival</td>
<td>29</td>
<td>Arrival</td>
<td>29</td>
<td>With GBAS providing a consistent flight path to a visual approach, it should be possible to reduce the minimum in trail separation to 15NM.</td>
</tr>
<tr>
<td>Arrival</td>
<td>4R</td>
<td>Arrival</td>
<td>29</td>
<td>Arrival on 4R must land and stop, exit or acknowledge prior to an arrival on 29 given clearance to land.</td>
</tr>
<tr>
<td>Arrival</td>
<td>29</td>
<td>Arrival</td>
<td>4R</td>
<td>Arrival on 29 must be through intersection prior to arrival on 4R reaching taxiway J.</td>
</tr>
<tr>
<td>Arrival</td>
<td>4R</td>
<td>Arrival</td>
<td>4R</td>
<td>5MIT, reduce to 2.5MIT based on runway occupancy times</td>
</tr>
<tr>
<td>Arrival</td>
<td>4R</td>
<td>Depart</td>
<td>4L</td>
<td>In IFR these runways act as a single runway. In VFR, these runways are independent.</td>
</tr>
<tr>
<td>Depart</td>
<td>4L</td>
<td>Arrival</td>
<td>4R</td>
<td>In IFR these runways act as a single runway. In VFR, these runways are independent.</td>
</tr>
<tr>
<td>Arrival</td>
<td>29</td>
<td>Depart</td>
<td>4L</td>
<td>Arrival on 29 must be clear of intersection prior to 4L depart roll</td>
</tr>
<tr>
<td>Depart</td>
<td>4L</td>
<td>Arrival</td>
<td>29</td>
<td>Departure must be airborne and through the intersection prior to arrival crossing threshold.</td>
</tr>
</tbody>
</table>
VFR – Daily Delay Estimates

![Graph showing the relationship between daily demand and average delay per operation with baseline and improvement lines.]

<table>
<thead>
<tr>
<th>Weighted Daily Demand</th>
<th>Equivalent Days</th>
<th>Annual Operations</th>
<th>Avg. Delay/Operation (mins.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>1,191</td>
<td>331</td>
<td>394,221</td>
<td>10.2</td>
</tr>
<tr>
<td>1,309</td>
<td>331</td>
<td>433,279</td>
<td>21.1</td>
</tr>
<tr>
<td>1,427</td>
<td>331</td>
<td>472,337</td>
<td>36.9</td>
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<tr>
<td>1,549</td>
<td>331</td>
<td>512,719</td>
<td>52.9</td>
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<tr>
<td>1,667</td>
<td>331</td>
<td>551,777</td>
<td>71.2</td>
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</table>
IFR – Daily Delay Estimates

<table>
<thead>
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<th>Weighted Daily Demand</th>
<th>Equivalent Days</th>
<th>Annual Operations</th>
<th>Baseline</th>
<th>Improvement</th>
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</thead>
<tbody>
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<td>394,221</td>
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VFR – Hourly Delay Estimates

<table>
<thead>
<tr>
<th>Hour</th>
<th>Demand</th>
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<th>Average Delay Per Operation (min.) Improvement</th>
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<td>0.1</td>
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<td>1</td>
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<td>3</td>
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<td>4</td>
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<td>7</td>
<td>70</td>
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<td>8</td>
<td>75</td>
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<td>9</td>
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# IFR – Hourly Delay Estimates

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<th>Average Delay Per Operation (min.) Improvement</th>
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<tr>
<td>23</td>
<td>30</td>
<td>256.4</td>
<td>80.2</td>
</tr>
</tbody>
</table>
Initial Simulation Result/ Next Steps

• Providing access to RWY 29 via a generic path was shown to reduce airport delay
  • Perhaps an obvious result, but now it is verified

• Next Steps:
  • Refine the RWY 29 approach path so that it fits within the existing airspace
    • Agree on the right operational constraints
    • Identify which separation standards will be used
  • Determine the workload impact
    • Identify tools to assist with RWY29 traffic
    • Missed Approach is the largest concern for ATC
Planned Airport Facilities Terminal Integration Laboratory (AFTIL) Simulation

• The AFTIL being used for Project Newark testing.

• To help with the previous “spacing tool” discussion, the AFTIL will be configured exactly as the EWR Tower with the addition of several spacing tools:
  • Converging Runway Display Aid (CRDA)
  • Go-Around Spacing Tool
  • Arrival/Arrival or Arrival/Departure Windows

• RWY29 scenarios can be demonstrated first in the AFTIL for initial hands-on feasibility studies
Project Newark Phase II Simulations
Project Newark Phase II Simulations

- Result of the simulation:
  - Getting the TRACON and the Tower to work the problem together in a controlled environment
  - Tools were useful
    - List of revisions were collected
    - Actions for the TRACON to define airspace needs
  - Next simulations planned for Feb 2011
  - Detailed test plan available
Phase II Changes to RWY29 RNP

• Discuss changes to the RWY29 procedure
  • Ground track
  • Leg types used
  • Desired time to complete procedure
    • Design speed and distance

• Review of recent flight testing
KEWR RNAV (RNP) Z RWY 29 (VIA RWY 4R)
Oct 30, 2008 Targets Package
KEWR  RNAV (RNP) Z RWY 29 (VIA RWY 4R)
Atlantic City RNP Overlay

Newark RWY 29
Expected Performance

• In previous analysis, we asked the subject pilots, FAA crew, to focus on minimizing Flight Technical Error (FTE) during manual flight
• We ended up with a wide variation in the procedure speed, and inconsistent FTE
• For current testing, the procedure speed were defined, and TAP tests were conducted using the ILS autopilot
  • Performance can be predicted based on the speed, turn radius, and bank angle limit of the navigator
ACY RNAV (RNP) Plan View

FAA GBAS RNP29 Flight Test @ ACY 150kts
19-Jan-10 A / Appr#003 Aircraft: N49

X axis(m)
- DFP
- Start
- Every 60
- Stop
- Data

Y axis(m)
-25,000
-20,000
-15,000
-10,000
-5,000
0
5,000
10,000
15,000
20,000
25,000

Start: 230550 / Stop: 231019
Time Elapsed: 469
ACY RNAV (RNP) Plan View

FAA GBAS RNP29 Flight Test @ ACY 160kts
19-Jan-10 A / Appr#005 Aircraft: N49

Start: 232263 / Stop: 232751
Time Elapsed: 468
ACY RNAV (RNP) Flight Technical Error

FAA GBAS RNP29 Flight Test @ ACY Horizontal GLS Deviation Ensemble

Mean 200'DH: 25.26
StdDev 200'DH: 17.73

NMI from FTP
N49 / RPDS33 / 19-Jan-10 A / MMR / 7 Appr / at 150 knots
ACY RNAV (RNP) Flight Technical Error

FAA GBAS RNP29 Flight Test @ ACY
Horizontal GLS Deviation Ensemble

GLS Deviations

NMI from FTP
N49 / RPDS33 / 19-Jan-10 A / MMR / 2 Appr / @160kts

Mean 200 DH: -6.01
StdDev 200 DH: 2.55
Newark RWY 29
Prototype LAAS TAP
ACY RNAV (GLS) Plan View

FAA GBAS RNAV29 Flight Test @ ACY 150kts
20-Jan-10 A / Appr#004 Aircraft: N49

Start: 317455 / Stop: 317977
Time Elapsed: 522
ACY RNAV (GLS) Plan View

FAA GBAS RNAV29 Flight Test @ ACY 160kts
20-Jan-10 A / Appr#005 Aircraft: N49

Start: 318501 / Stop: 318994
Time Elapsed: 493

- DFP
- Start
- Every 60 Sec.
- Stop
- Data

X axis (m)
Y axis (m)
ACY RNAV (GLS) Plan View

FAA GBAS RNAV29 Flight Test @ ACY 170kts
20-Jan-10 A / Appr#008 Aircraft: N49

X axis (m)
- DFP - Start - Every 60 - Stop - Data
- Time - Sec. - Time

Y axis (m)
-18.2 -15.1 -1.8 -4 -7

Start: 321492 / Stop: 321970
Time Elapsed: 478
ACY RNAV (GLS) Flight Technical Error

FAA GBAS RNAV29 Flight Test @ ACY
HorizontalGLSDeviation Ensemble

Mean 200'DH: 9.58
StdDev 200'DH: 3.39

NMI from FTP
N49 / RPDS34 / 20-Jan-10 A / MMR / 4 Appr / @150kts
ACY RNAV (GLS) Flight Technical Error

FAA GBAS RNAV29 Flight Test @ ACY
Horizontal GLS Deviation Ensemble

Mean 200DH: 2.54
StdDev 200DH: 2.25

NMI from FTP
N49 / RPDS34 / 20-Jan-10 A / MMR / 3 Appr / @160kts
Path Shape Considerations

• An area of continuing study is how to best address non-FMS aircraft

• An R&D project, Terminal Area Path (TAP), provides steering guidance for complex paths
  • These paths would exactly overlay RNP procedures

• If the RNP were designed such that ILS autopilots could fly them with minimal FTE, more costly aircraft upgrades could be avoided
  • Easing mixed equipage issues
Procedure Development Phases (cont.)

• Third Phase
  • Curved approaches to Runways 04L/R and 11
    • Same concept of obtaining input from air traffic and flight testing at the Tech Center applies for this stage of procedure development

• Fourth Phase
  • Displaced threshold approach to Runway 22R

• Final Phase
  • Closely spaced parallels and time, spacing, metering and sequencing procedures
  • Input from air traffic and flight testing are crucial
Summary

• The Local Area Augmentation System (LAAS) is one of the FAA Satellite Navigation programs.
  • Current work is geared toward supporting FAA and industry decision points on equipage.
• Project Newark is a NextGen operational demonstration.
  • Will identify performance based navigation procedures that will support capacity and efficiency enhancements.
  • Will also be used to help make decisions on LAAS implementation.