Surveillance and Broadcast Services

Benefits Analysis Overview

August 2007 Final Investment Decision Baseline

January 3, 2012
Program Status: Investment Decisions

- **September 9, 2005 initial investment decision:**
  - Establish an ATO-level Surveillance and Broadcast Services office
  - Obtain funding to support the agency-wide resources required to develop, implement, and manage the ADS-B future surveillance services

- **June 7, 2006 final investment decision (Segment 1):**
  - Baseline key site deployment
  - Return for Final Investment Decision for Balance of Program prior to Contract Award
  - ATO Chief Operating Officer (COO) and Associate Administrator for Aviation Safety (AVS) Designation for Co-ISD Authority

- **February 21, 2007 final investment decision (Segment 2):**
  - Baseline NAS-wide deployment
  - Return for Program Baseline of Segments 1 and 2 prior to Contract Award
  - Integration of Capstone Program

- **August 27, 2007 final investment decision (Segments 1 and 2):**
  - Program Baseline prior to Contract Award

- **March 16, 2011 baseline change decision:**
  - Integration of Colorado Wide Area Multilateration (WAM) Phase 2
  - Rebaseline of Alaska Service Volumes
Business Case Summary

- **Total Cost / Benefit Summary (Risk Adjusted, Present Value) Through 2035**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td></td>
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<tr>
<td>FAA</td>
<td>1882.0</td>
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<tr>
<td>Aviation System User</td>
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<tr>
<td><strong>Total FAA, User and Other Costs</strong></td>
<td><strong>4513.1</strong></td>
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<tr>
<td>Benefits</td>
<td></td>
</tr>
<tr>
<td>FAA</td>
<td>451.7</td>
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<tr>
<td>Aviation System User</td>
<td>4591.5</td>
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<tr>
<td><strong>Total FAA, User and Other Benefits</strong></td>
<td><strong>5043.2</strong></td>
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</tbody>
</table>

- **FAA Baseline Cost Summary**

<table>
<thead>
<tr>
<th>Estimated Cost</th>
<th>Baselined</th>
<th>Total Baselined (FY07 - FY14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment 1 and 2 F&amp;E Program Plan</td>
<td>FY07: $90.0 FY08: $100.0 FY09: $308.4 FY10: $198.2 FY11: $175.2 FY12: $284.2 FY13: $270.7 FY14: $254.7</td>
<td>$1,681.5</td>
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</tbody>
</table>
# Air Transport Benefits Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Application</th>
<th>Outcome</th>
<th>Risk Adjusted PV $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONUS, Hawaii, and Caribbean Surveillance</td>
<td>Radar Airspace ATC Surveillance</td>
<td>Reduction and more efficient maneuvers in response to URET</td>
<td>$801.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More efficient metering based on improved TMA accuracy</td>
<td>$417.0</td>
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<tr>
<td></td>
<td></td>
<td>Increased safety on the surface by controllers</td>
<td>$3.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More efficient ATC management of surface movement</td>
<td>$26.9</td>
</tr>
<tr>
<td>CONUS, Hawaii, and Caribbean Aircraft Applications</td>
<td>Enhanced Visual Approach - Initial Application</td>
<td>More efficient spacing on approach in VMC</td>
<td>$300.4</td>
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<tr>
<td></td>
<td>Enhanced Visual Approach - CAVS</td>
<td>Continuation of Visual Approaches in marginal conditions</td>
<td>$196.4</td>
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<tr>
<td></td>
<td>Enhanced Visual Approach - Merging and Spacing</td>
<td>Increased ability to allow continuous descent approaches</td>
<td>$796.0</td>
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<tr>
<td></td>
<td>ADS-B ATC Automation Integration</td>
<td></td>
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<tr>
<td></td>
<td>Airport Surface Situational Awareness</td>
<td>Increased safety on the surface by pilots</td>
<td>$70.5</td>
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<td></td>
<td>Final Approach and Runway Occupancy Awareness</td>
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<tr>
<td>Gulf of Mexico Surveillance</td>
<td>Non-radar Airspace ATC Surveillance (includes weather and comm as needed)</td>
<td>High Altitude - Increased Capacity</td>
<td>$459.3</td>
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<td></td>
<td></td>
<td>High Altitude - Optimal Routing</td>
<td>$86.5</td>
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<tr>
<td>Alaska Surveillance and Broadcast Services</td>
<td>Non-radar Airspace ATC Surveillance</td>
<td>Increased IFR capacity (JNU)</td>
<td>$1.1</td>
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<tr>
<td>Total</td>
<td>Non-radar Airspace ATC Surveillance</td>
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<td>$3,159.1</td>
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## General Aviation Benefit Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Application</th>
<th>Outcome</th>
<th>Risk Adjusted PV $M</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONUS, Hawaii, and Caribbean Broadcast Services</td>
<td>Enhanced Visual Acquisition and Conflict Detection</td>
<td>Fewer aircraft-to-aircraft conflicts</td>
<td>$203.6</td>
</tr>
<tr>
<td></td>
<td>Weather and NAS Status Situational Awareness</td>
<td>Fewer encounters with hazardous weather</td>
<td>$232.5</td>
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<tr>
<td></td>
<td></td>
<td>More efficient routes in adverse weather</td>
<td>$1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduction in user costs to obtain weather info</td>
<td>$26.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fewer aircraft-to-terrain conflicts</td>
<td>$284.3</td>
</tr>
<tr>
<td>Gulf of Mexico Surveillance</td>
<td>Non-Radar Airspace ATC Surveillance (includes weather and comm as needed)</td>
<td>Low Altitude - Increased Capacity</td>
<td>$84.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Altitude - Reduction in Weather Related Accidents</td>
<td>$3.0</td>
</tr>
<tr>
<td>Alaska Surveillance and Broadcast Services</td>
<td>Weather and NAS Status Situational Awareness Enhanced Visual Acquisition and Conflict Detection</td>
<td>Fewer aviation accidents in Alaska</td>
<td>$300.1</td>
</tr>
<tr>
<td></td>
<td>Non-Radar Airspace ATC Surveillance</td>
<td>Access to lower altitude routes in Alaska</td>
<td>$19.5</td>
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<tr>
<td></td>
<td></td>
<td>Fewer aircraft-to-aircraft conflicts (NU)</td>
<td>$0.0</td>
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<tr>
<td></td>
<td></td>
<td>Improved search and rescue services in Alaska</td>
<td>$7.0</td>
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<tr>
<td>Alaska Airport IFR Upgrade Services</td>
<td>Weather Automation upgrade and IFR Approach Development</td>
<td>Increased access to remote villages in Alaska</td>
<td>$90.0</td>
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<tr>
<td></td>
<td></td>
<td>Increased Medevac access to remote villages in Alaska</td>
<td>$175.4</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$1,432.6</strong></td>
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</table>

- **ADS-B Out**
- **ADS-B In**
- **ADS-B In / Out**
## FAA Benefits Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Application</th>
<th>Outcome</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONUS, Hawaii, and Caribbean Surveillance</td>
<td>Radar Airspace ATC Surveillance</td>
<td>Surveillance cost avoidance</td>
<td>$371.1</td>
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<tr>
<td></td>
<td></td>
<td>Reduction in FAA subscription charges due to value added services</td>
<td>$80.6</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$451.7</td>
</tr>
</tbody>
</table>

- **Total Benefits = $5,043.2**
Benefits Analysis Process

- Identify capability shortfall or technological opportunity
  - Specify current and future infrastructure and equipage components
  - Describe how each benefit type is produced
  - Develop methods to estimate each benefit type
    - Identify data requirements
    - Collect and analyze data
    - Develop models and estimate benefits
    - Compare results to baseline metrics
    - Incorporate risk analysis
Mission Need

FAA Goals

Safety
- Reduce Commercial Airline Fatal Accident Rate
- Reduce Number of Fatal GA Accidents
- Reduce Risk of Runway Incursions

Capacity
- Increase Capacity to Meet Demand
- Increase On-Time Performance of Scheduled Carriers

Enhanced Surveillance
MNS 326 - Dated May 2001

Gulf of Mexico
MNS 0094: Feb 1999

Aeronautical Data Link (ADL)
MNS 042: May 1998

Runway Incursion
MNS 323: May 1998

Enroute/Oceanic
MNS 309: Nov 1997

Airport Surface Traffic Mgt
MNS 212: Dec 1994

Traffic Flow Mgt

Surveillance and Broadcast Services
### Performance Gaps

<table>
<thead>
<tr>
<th>Service Area</th>
<th>Shortfall</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Inability to precisely predict demand and capacity values, accommodate user preferred trajectories, system inflexibility (MNS #307)</td>
<td>Arrival rates; Taxi times; Departure delays; Fleet management; Surface accidents</td>
</tr>
<tr>
<td></td>
<td>Limited pilot, controller, and vehicular shared situational awareness (MNS #323)</td>
<td></td>
</tr>
<tr>
<td>Terminal</td>
<td>Lack of shared situational awareness and limited aircraft information (MNS #326)</td>
<td>Arrival delays</td>
</tr>
<tr>
<td></td>
<td>Inability to provide surveillance coverage at reduced cost (MNS #326)</td>
<td>FAA life cycle costs; Terminal airspace congestion; User and Service Provider workloads</td>
</tr>
<tr>
<td></td>
<td>Decreasing flight efficiency due to domestic routes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unusable airspace caused by increased terminal congestion (MNS #172)</td>
<td></td>
</tr>
<tr>
<td>En Route / Oceanic</td>
<td>Lack of surveillance coverage within specific regions of the NAS, lack of shared situational awareness, and limited aircraft information (MNS #326)</td>
<td>Delays due to constraints; Reduce probability of mid-air collisions; Search &amp; rescue</td>
</tr>
<tr>
<td></td>
<td>Lack of communication coverage, limited ATC options for severe weather avoidance, sustained traffic growth and a unique and compressed demand (NPI #0094)</td>
<td>Inefficiencies due to constraints; Reduce probability of mid-air collisions; Weather-related accidents; User and Service Provider workloads</td>
</tr>
<tr>
<td></td>
<td>Decreasing flight efficiency due to oceanic track restrictions and domestic routes (MNS #172)</td>
<td></td>
</tr>
<tr>
<td>Broadcast Services</td>
<td>Inability to readily access in-flight weather data, congested voice channels (MNS #42)</td>
<td>Weather-related accidents; NOTAM related accidents; Reduce probability of mid-air collisions; Weather deviations</td>
</tr>
<tr>
<td></td>
<td>Limited pilot situational awareness (MNS #326)</td>
<td></td>
</tr>
</tbody>
</table>
Benefits Analysis Process

• Identify capability shortfall or technological opportunity

  ➢ Specify current and future infrastructure and equipage components

• Describe how each benefit type is produced

• Develop methods to estimate each benefit type
  – Identify data requirements
  – Collect and analyze data
  – Develop models and estimate benefits
  – Compare results to baseline metrics
  – Incorporate risk analysis
Automatic Dependent Surveillance - Broadcast (ADS-B)

- **Automatic**
  - Periodically transmits information with no pilot or operator input required

- **Dependent**
  - Position and velocity vector are derived from the Global Positioning System (GPS) or a Flight Management System (FMS)

- **Surveillance**
  - A method of determining position of aircraft, vehicles, or other asset

- **Broadcast**
  - Transmitted information available to anyone with the appropriate receiving equipment

- “**ADS-B Out**” refers to an appropriately equipped aircraft’s broadcast of various aircraft information
- “**ADS-B In**” refers to the ability of an appropriately equipped aircraft to receive ADS-B Out transmissions from other aircraft and information broadcast from ground stations
Surveillance and Broadcast Services (SBS) Program

The FAA SBS program will provide:
- Air Traffic Control surveillance using ADS-B Out messages
- Traffic Information Service - Broadcast (TIS-B) and
- Flight Information Service - Broadcast (FIS-B)

TIS-B is a service which provides ADS-B In equipped aircraft with position reports from secondary surveillance radar on non-ADS-B equipped aircraft.

FIS-B transmits graphical National Weather Service products, temporary flight restrictions (TFRs), and special use airspace to ADS-B In.
## Initial ADS-B Services and Applications

<table>
<thead>
<tr>
<th>Services:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surveillance Broadcast Services (En Route, Terminal, Surface)</strong></td>
</tr>
<tr>
<td><strong>Traffic / Flight Information Broadcast Services</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Applications:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced Visual Acquisition</td>
</tr>
<tr>
<td>Enhanced Visual Approaches</td>
</tr>
<tr>
<td>Final Approach and Runway Occupancy Awareness</td>
</tr>
<tr>
<td>Airport Surface Situational Awareness</td>
</tr>
<tr>
<td>Conflict Detection</td>
</tr>
<tr>
<td>Merging and Spacing</td>
</tr>
<tr>
<td><strong>Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS)</strong></td>
</tr>
</tbody>
</table>
Air Transport Equipage
GA and Air Taxi ADS-B Equipage

General Aviation and Air Taxi
ADS-B Equipage

Year End

ADS-B Out
ADS-B In
Benefits Analysis Process

- Identify capability shortfall or technological opportunity
- Specify current and future infrastructure and equipage components
  - Describe how each benefit type is produced
- Develop methods to estimate each benefit type
  - Identify data requirements
  - Collect and analyze data
  - Develop models and estimate benefits
  - Compare results to baseline metrics
  - Incorporate risk analysis
Benefits Identification

• Aviation system user benefits grouped into four categories:
  – Flight Safety
  – Surface
  – Terminal and En Route Radar Airspace
  – Non-Radar Airspace
Flight Safety Benefits

1. Technology
2. Application
3. Direct Impact
4. Outcome
5. Benefit

- Flight Information Service - Broadcast (FIS-B)
- Multi-Function Display for pilots including access to CDTI, TIS-B, FIS-B, Terrain Map for pilots
- Traffic Information Service – Broadcast (TIS-B)

Enhanced Visual Acquisition, Conflict Detection and Weather and NAS Status Situational Awareness

- Improved traffic situational awareness
  - Fewer aircraft-to-aircraft conflicts
  - Mid-air collision rate
- Improved weather situational awareness
  - Fewer encounters with hazardous weather
  - Weather related accident rate
  - More efficient deviations
  - Airborne delay because of en route weather
- Improved terrain situational awareness
  - Fewer controlled flights into terrain
  - CFTT accident rate
Surface Benefits

Technology

Application

Direct Impact

Outcome

Benefit Metric

ASDE-X upgrade to remaining ASDE-3 only sites

Radar Airspace ATC Surveillance for ATC Tower

Increased ability to monitor runway queues

More efficient ATC management of surface

Taxi times

Multifunction Display for pilots

Airport Surface Situational Awareness and Final Approach and Runway Occupancy Awareness

Increased ability to anticipate ETA and order of arrivals

Better communication between airline, pilots, and ATC

Departure rates

Surface Moving Map Database

Increased situational awareness of aircraft/vehicle positions between ATC, Airlines, and pilots

Increased safety on the surface by ATC

Controller productivity

Increased pilot airport surface and traffic situational awareness

Increased safety on the surface by pilots

Surface accident rate

More efficient movement on airport surface by pilots
Terminal and En Route Radar Airspace Benefits

- **Technology**
  - Multi-Function Display for pilots including access to CDTI, TIS-B for pilots
  - Traffic Information Service – Broadcast (TIS-B)

- **Application**
  - Enhanced Visual Acquisition and Enhanced Visual Approach (for pilots)
  - ADS-B ATC Automation Integration

- **Direct Impact**
  - Increased pilot ability to identify, visually acquire, and maintain ADS-B traffic
  - Improved ability to maintain efficient spacing with lead aircraft
  - Increased pilot awareness of overall traffic flows

- **Outcome**
  - Continuation of visual approaches in marginal conditions
  - More efficient spacing during visual approaches
  - More efficient merging and spacing en route
  - Better communication between ATC and pilot

- **Benefit Metric**
  - Interarrival spacing, Peak airport arrival throughput, and Flight times from extended terminal area to runway
  - Controller Productivity and En route sector capacity
  - Delay for aircraft in circular holding
  - Number of CDAs
  - Projected conflict rate

**Increased automation spacing accuracy and update rate**

Surveillance and Broadcast Services

Federal Aviation Administration
Non-Radar Airspace Benefits

Technology

- ADS-B ATC Automation Integration
- Improved Communications Services
- Automated Weather Observations
- IFR Route and Approach Development

Application

- Non-Radar Airspace ATC Surveillance (for ATC)
- Upgrade IFR Infrastructure

Direct Impact

- Ability to use reduced separation standards
- Increased number of available routes
- Improved weather situational awareness for ATC
- Improved traffic situational awareness for ATC
- Ability to perform IFR airport approaches

Outcome

- More efficient separation on approach (non-radar)
- More efficient separation en route (non-radar)
- Optimal routing
- Increased access to lower altitude routes
- Increased ability to fly Part 135 IFR operations
- Fewer encounters with Hazardous weather
- Improved search and rescue services
- Increased commercial access to remote villages
- Increased Medevac access to remote villages

Benefit Metric

- Peak airport arrival throughput and Arrivals delays caused by terminal congestion
- En route sector throughput
- En route sector flight time
- Weather-related accident rate
- Search and rescue time
- Cancellation rate
- Medical access time
Benefits Analysis Process

• Identify capability shortfall or technological opportunity
• Specify current and future infrastructure and equipage components
• Describe how each benefit type is produced
  ➢ Develop methods to estimate each benefit type
    – Identify data requirements
    – Collect and analyze data
    – Develop models and estimate benefits
    – Compare results to baseline metrics
    – Incorporate risk analysis
Global Benefits Analysis Inputs

1. **Future Demand** – The FAA Terminal Area Forecast (TAF) projects demand at each NAS airport with the 2207 version covering from 2008-2027. Gulf of Mexico non-radar region demand was based on current ETMS recorded demand levels and FAA Policy and Planning Office estimates of demand growth from US to Latin America.

2. **Airport Capacities** – The arrival and departure capacities used within the SBS model come from the FAA Future Airport Capacity Task 2 (FACT 2) report. The future capacities at some airports change because of scheduled infrastructure improvements (i.e. runways).

3. **Economic Values** – Average Fuel costs, Aircraft Direct Operating costs, Passenger Value of Time, Injury, and Aircraft Damage unit costs provided by “Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs”.

4. **ADS-B Out and In Projected Equipage** – Equipage based on ATMAC ADS-B Work Group and other industry inputs.
Flight Safety Benefit Example

• Fewer Encounters with Hazardous Weather
  – With weather information in the cockpit, the GA aircraft will avoid more hazardous weather and prevent accidents due to hazardous weather.
  – ADS-B In with weather information broadcast (e.g., Flight Information Service-Broadcast (FIS-B) in US)

• Primary Analysis Inputs
  – Historical accident rates by weather type
  – Effectiveness of capability in avoiding accidents by weather type
  – GA projections for ADS-B In equipage and future operations
Surface Benefit Example

- **Increased safety on the surface by pilots**
  - With surface traffic information in the cockpit, the aircraft will avoid hazardous runway and taxiway situations and prevent surface accidents.
  - ADS-B In, a cockpit surface moving map display, and indication and alerting application software.

- **Primary Analysis Inputs**
  - Historical surface accident rates
  - Effectiveness of capability in avoiding accidents incremental to other surface safety improvements (e.g. ASDE-X, Runway Status Lights)
  - Projections for ADS-B In equipage and future operations.
Terminal and En Route Radar Airspace Benefit Example

- **Continuation of Visual Approaches in Marginal Conditions**
  - In good weather, pilot visually acquires runway and a target aircraft to follow
  - With ADS-B and CDTI, pilots can more reliably acquire relevant traffic in marginal conditions
  - Range of acceptable weather for visual approaches increases
  - Arrival rate increases in marginal weather

- **Primary Analysis Inputs**
  - Effective arrival capacity at major airports during VMC and Marginal VMC
  - Frequency of Marginal VMC at top 100 airports
  - Percentage of ADS-B Out arrivals and percent of ADS-B In Air Transport arrivals
Non-Radar Airspace Benefit Example

• More Efficient Separation
  – SBS program will provide ATC with surveillance for non-radar regions in the Gulf of Mexico allowing radar-like separation (~ 5 miles in trail), as opposed to current non-radar procedural separation (~ 50 miles in trail)

• Primary Analysis Inputs
  – Increase in capacity because of ADS-B surveillance*
  – Future Gulf of Mexico demand
  – Percentage of ADS-B Out flights

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Instantaneous Capacity (MAP)</th>
<th>Hourly Capacity</th>
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</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>30 (18+12)</td>
<td>56</td>
</tr>
<tr>
<td>Baseline with Surveillance*</td>
<td>40</td>
<td>75</td>
</tr>
</tbody>
</table>

* The instantaneous capacity with true radar-like separation would be much higher than 40; however, the new capacity assumption takes Mexican border constraints and maintaining the current number of sectors into account.
Summary

• Detailed and thorough benefits analysis used to support a wide array of decision making

<table>
<thead>
<tr>
<th>Types of Analysis Results</th>
<th>Use of Analysis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall benefits</td>
<td>• If SBS is viable program for FAA</td>
</tr>
<tr>
<td>Benefits by service and by Air Transport and General Aviation users</td>
<td>• Internal implementation decisions</td>
</tr>
<tr>
<td></td>
<td>• Convincing Air Transport and General Aviation to equip</td>
</tr>
<tr>
<td></td>
<td>• Equipage strategies for user</td>
</tr>
<tr>
<td>Benefits by airport and application</td>
<td>• At which airports to implement infrastructure elements</td>
</tr>
<tr>
<td>Benefits by year for applications and benefit types</td>
<td>• Plan implementation schedules for infrastructure elements</td>
</tr>
</tbody>
</table>