Massport and FAA RNAV Pilot Study Overview Public Briefing

February 22, 2017
State Transportation Bld.
Boston, MA

As of 02/13/2017

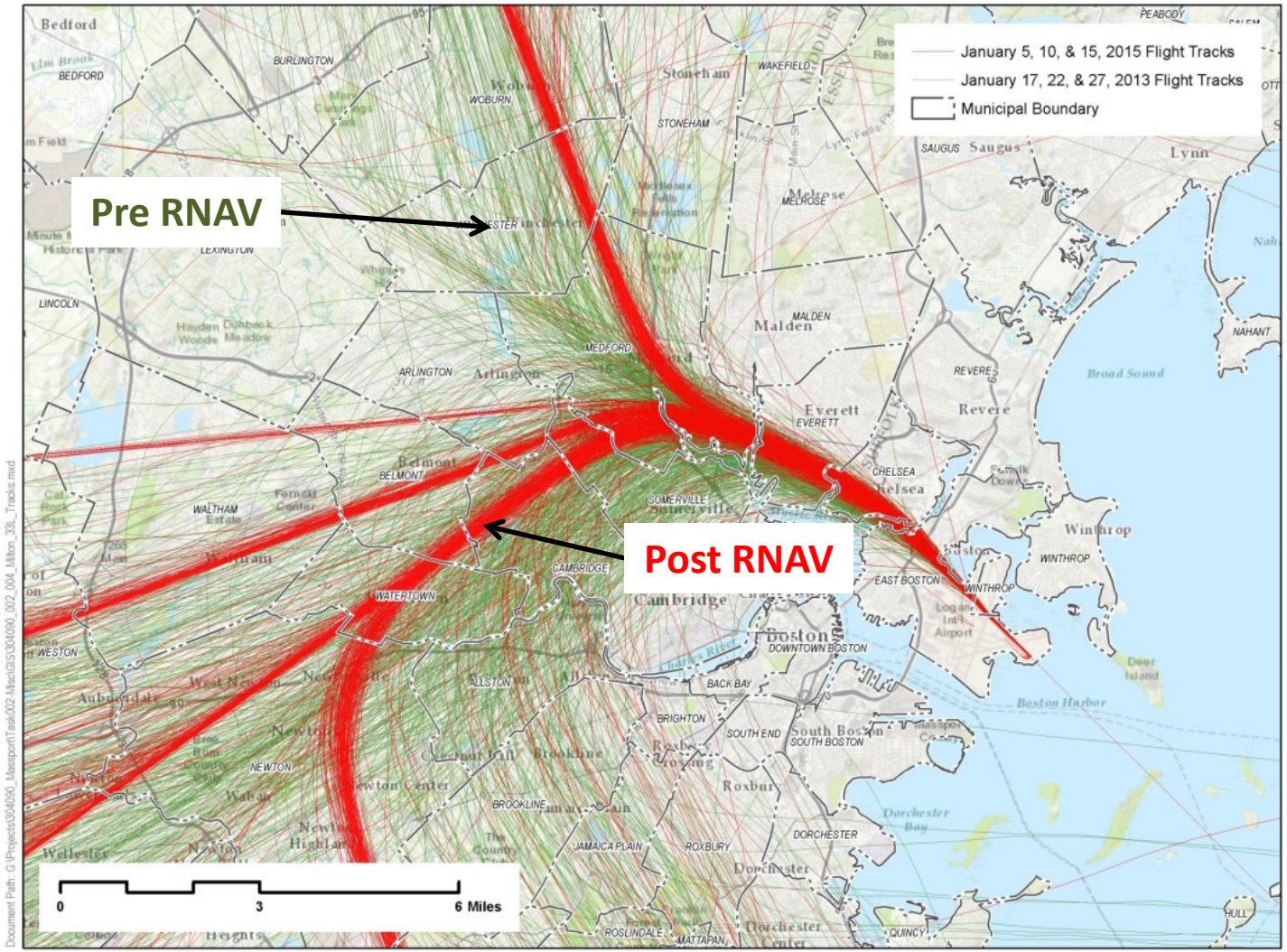
Agenda

- Welcoming Remarks
  - Tom Glynn (Massport CEO)
  - David Carlon (Massport CAC Chair)
  - FAA (TBD)
- Massport\FAA RNAV MOU Pilot, Overview
  - Flavio Leo (Massport)
  - John Hansman (MIT)
- Public Comment

Massport/FAA RNAV MOU Context

An outcome of RNAV is concentration of flights...

Example- Departures - Runway R33L



FAA and Massport MOU on RNAV Pilot Study

- RNAV Procedures Nationwide Deployment by FAA
- Overflight noise versus concentration
- Discussions with communities and elected
- Engagement with FAA
  - National Issue
  - Specific solutions to test
  - National model to address RNAV related issues
- Near-term actionable ideas tested and, if successful, applied to other runways and nationwide (12 to 18 month process)
- Collaboration with Massport CAC for review and input
- Massport CAC opportunity to add ideas
  - Narrow focus on RNAV, limited and prioritized by the Massport CAC

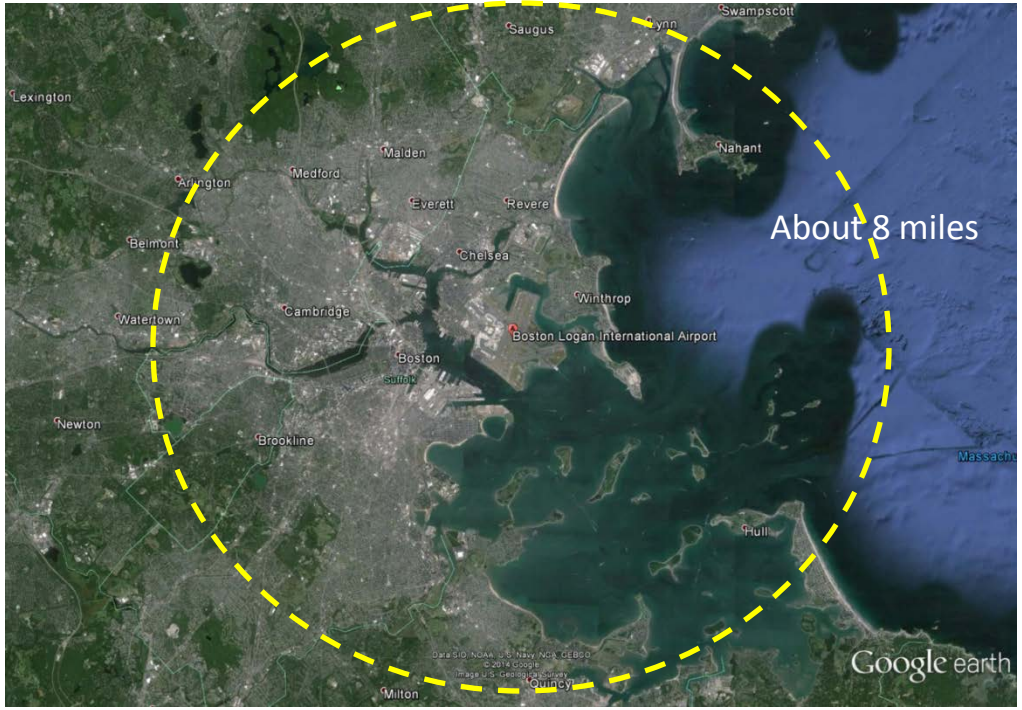
Boston Logan Context

Boston Logan International Airport

- Largest Commercial Airport in New England Region
- Over $13 Billion in Annual Economic Impact
- Over 17,000 Direct Jobs
  - About 80% Private Sector
- Over 100,000 Total Direct/Indirect Jobs
- Origin and destination airport- over 90% of passengers originate or end trips from Boston
- Served by all major airlines and not a major connecting hub
- Extensive domestic and international non-stop service. Varied aircraft fleet mix
- Demand is driven primarily by local socio-economic conditions

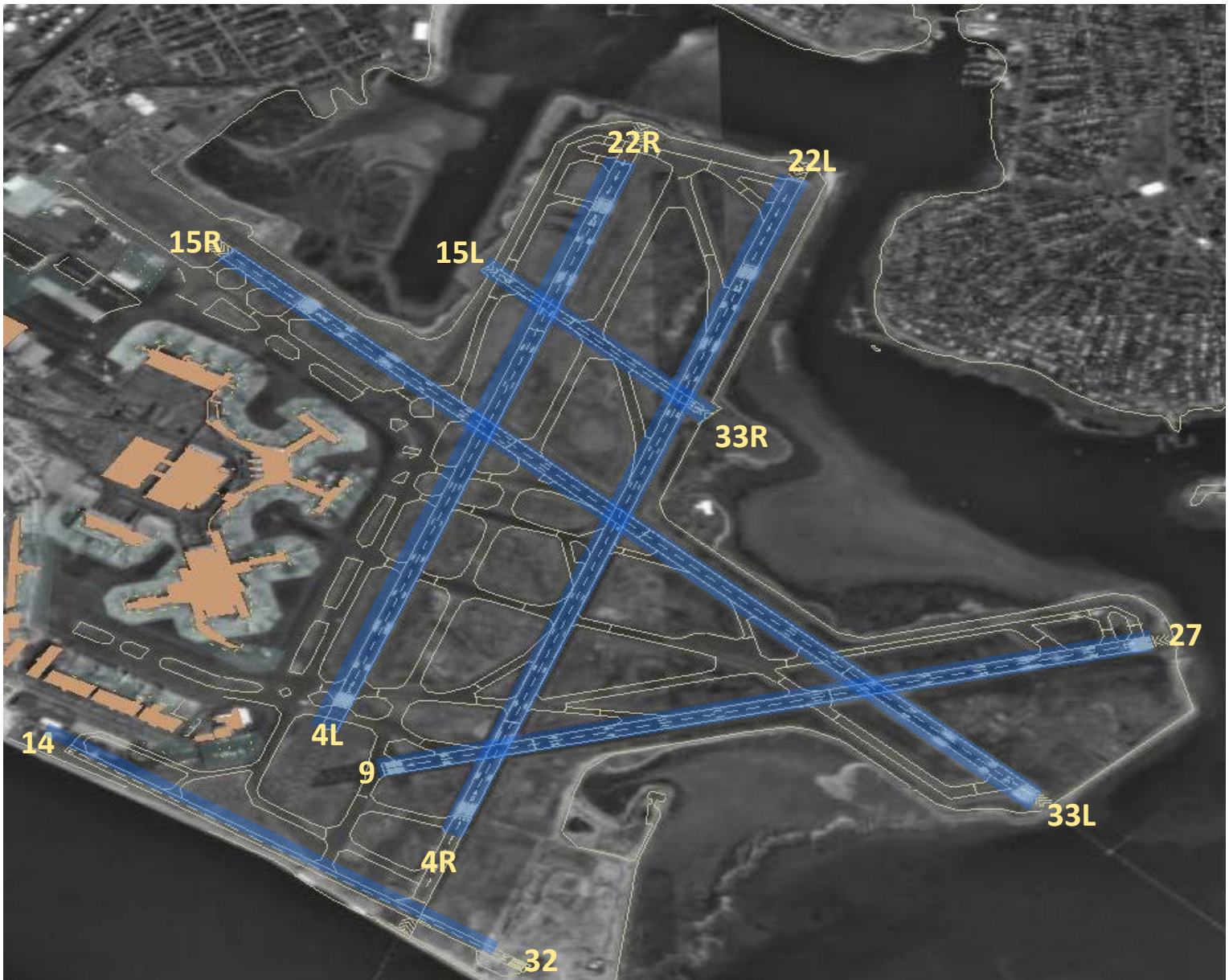
Boston Logan is an urban airport

- The airport has been operating for over 90 years
- The FAA is responsible for choosing which runways to use
- For safety, aircraft land and depart into the wind
- Current and forecasted weather is primary
- Other operational factors include runway closures, fleet mix, efficiency



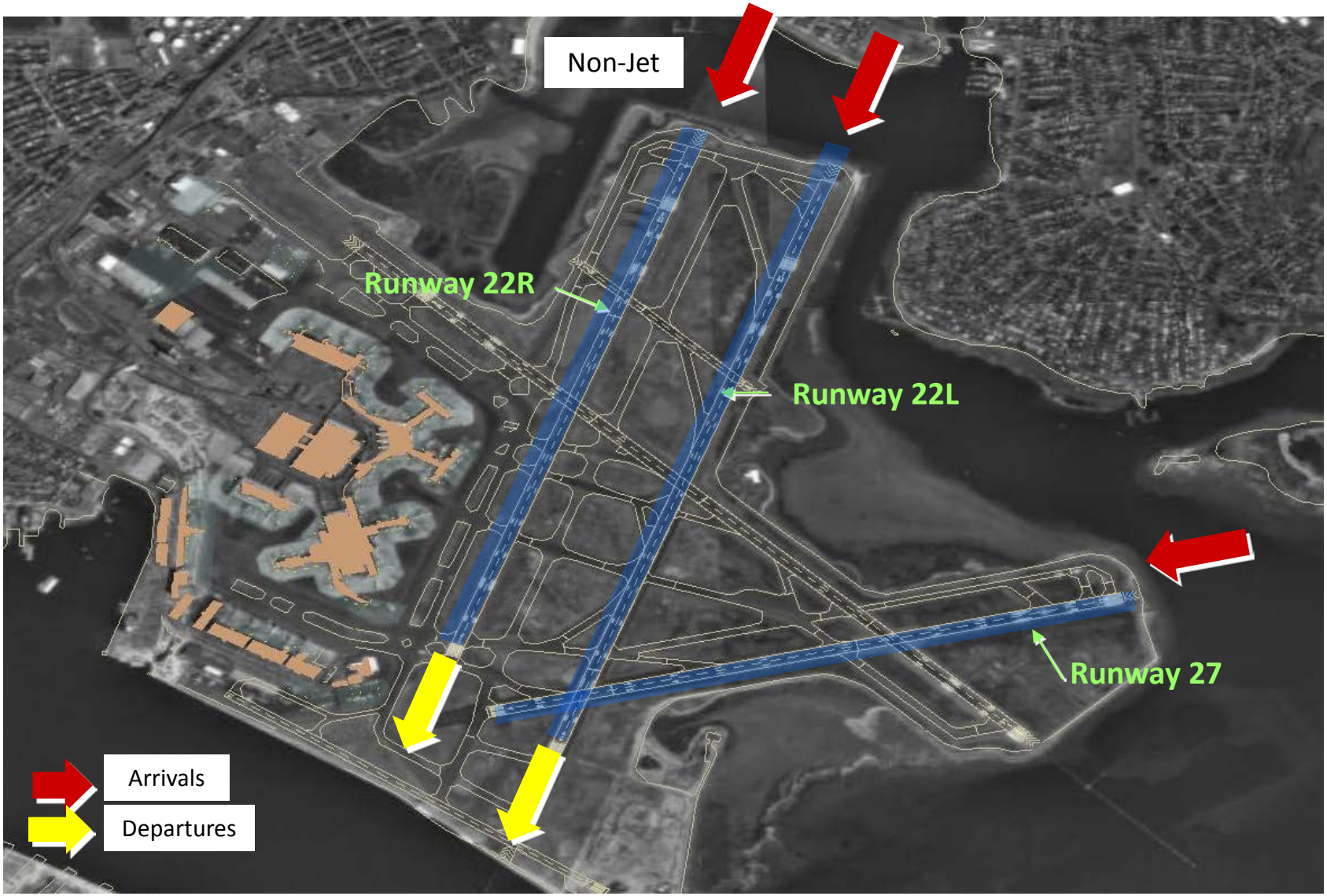
Wind and weather patterns are the primary driver of the number of hours and flights a particular runway's configuration is used by the FAA. Depending on the runways in use, different neighborhoods/communities are overflown.

Based on wind/weather, the FAA uses Logan runways in combinations to safely and efficiently meet demand. Based on which configuration the FAA selects, different communities are impacted



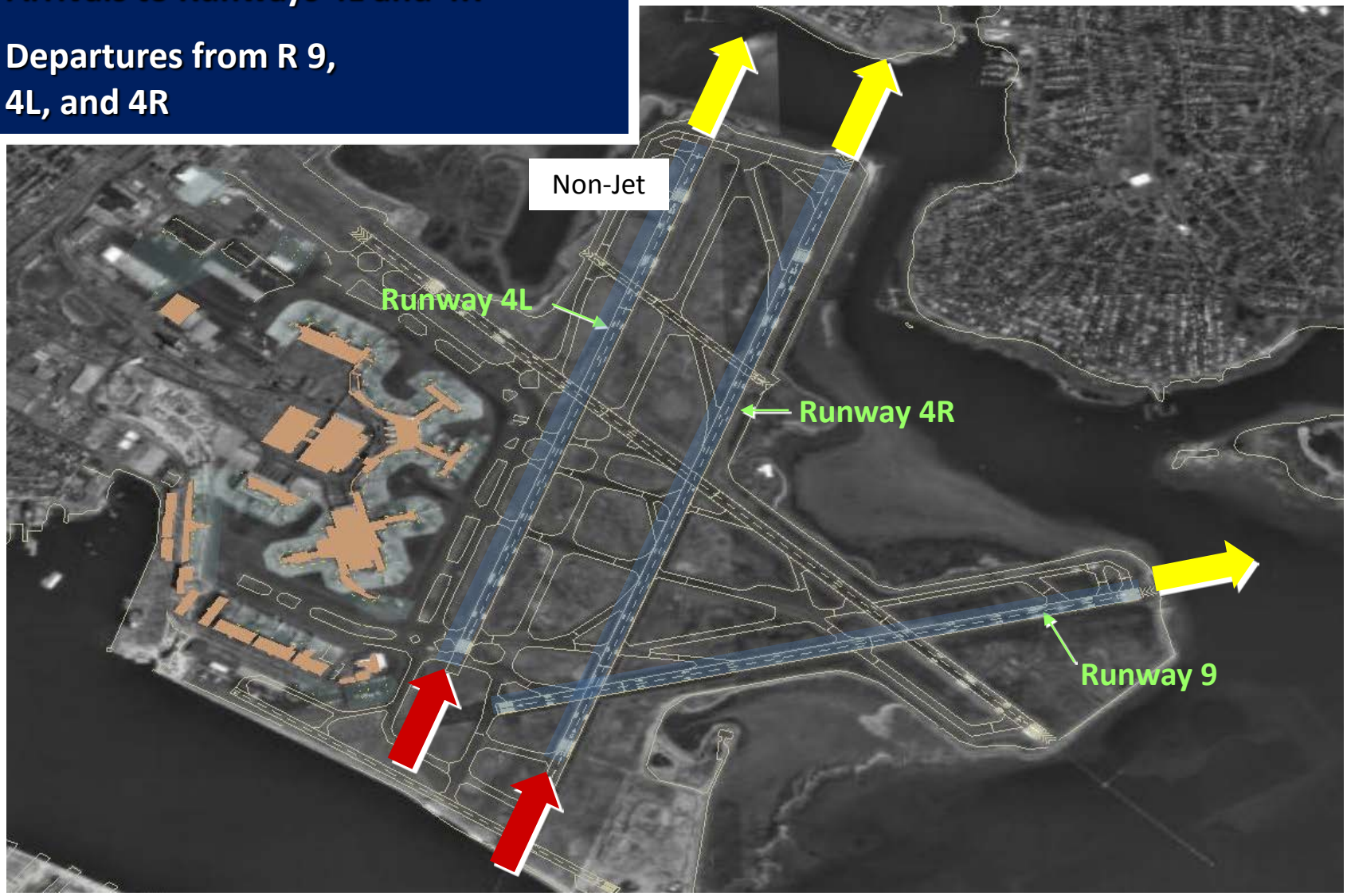
Southwest Flow Operating Configuration

- Arrivals to R 22L and 27
- Departures from R 22L and 22R



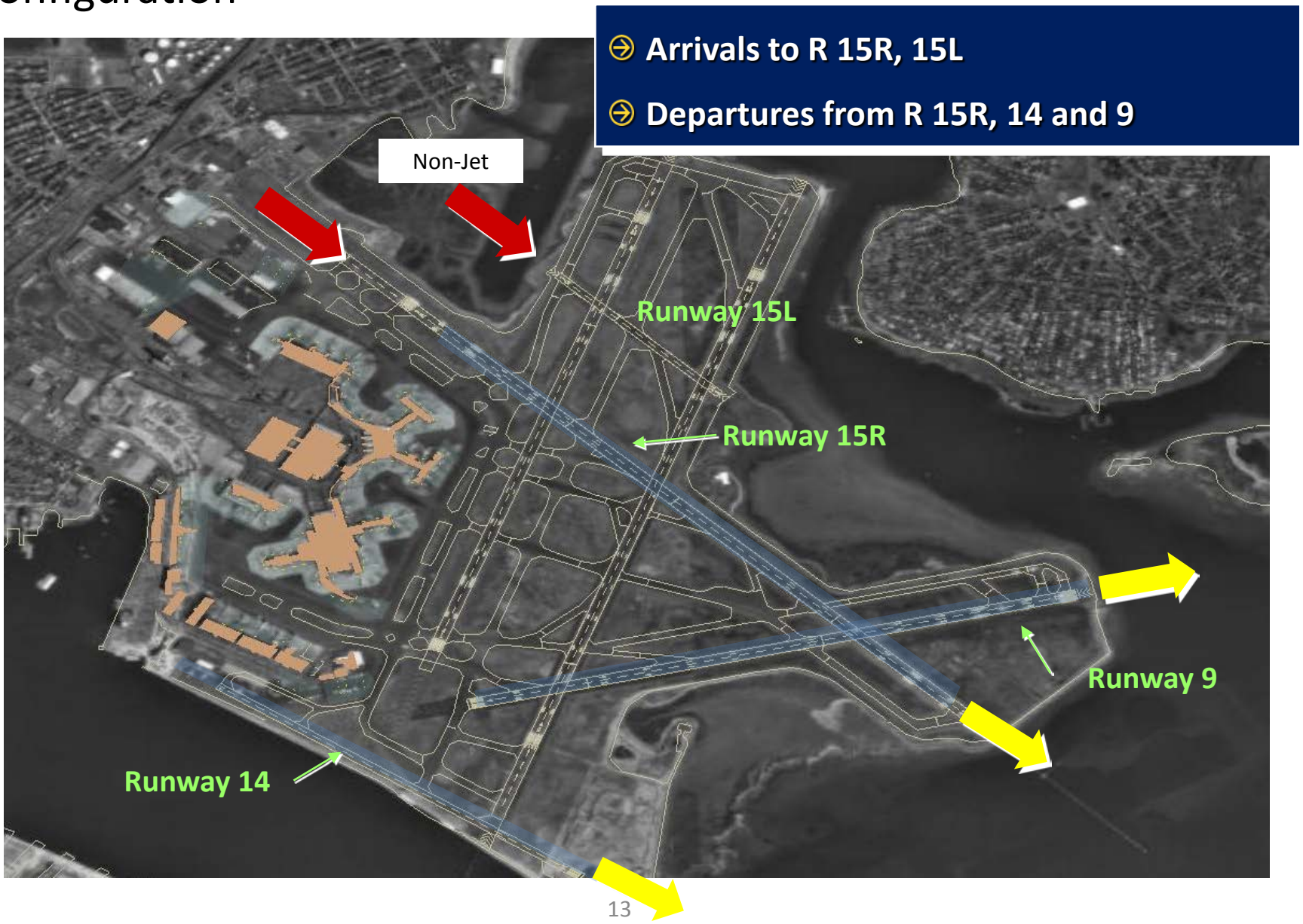
Northeast Flow Operating Configuration

- Arrivals to Runways 4L and 4R
- Departures from R 9, 4L, and 4R

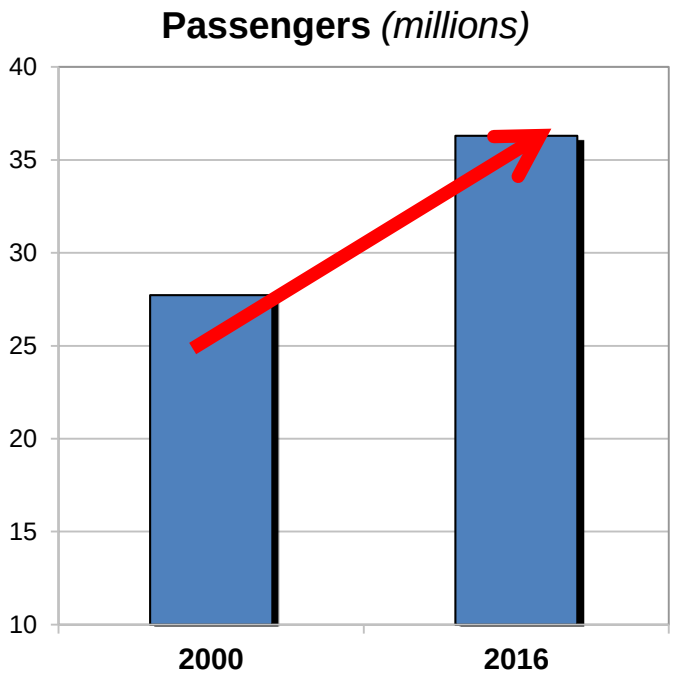


Northwest Flow Operating Configuration

Southeast Flow Operating Configuration



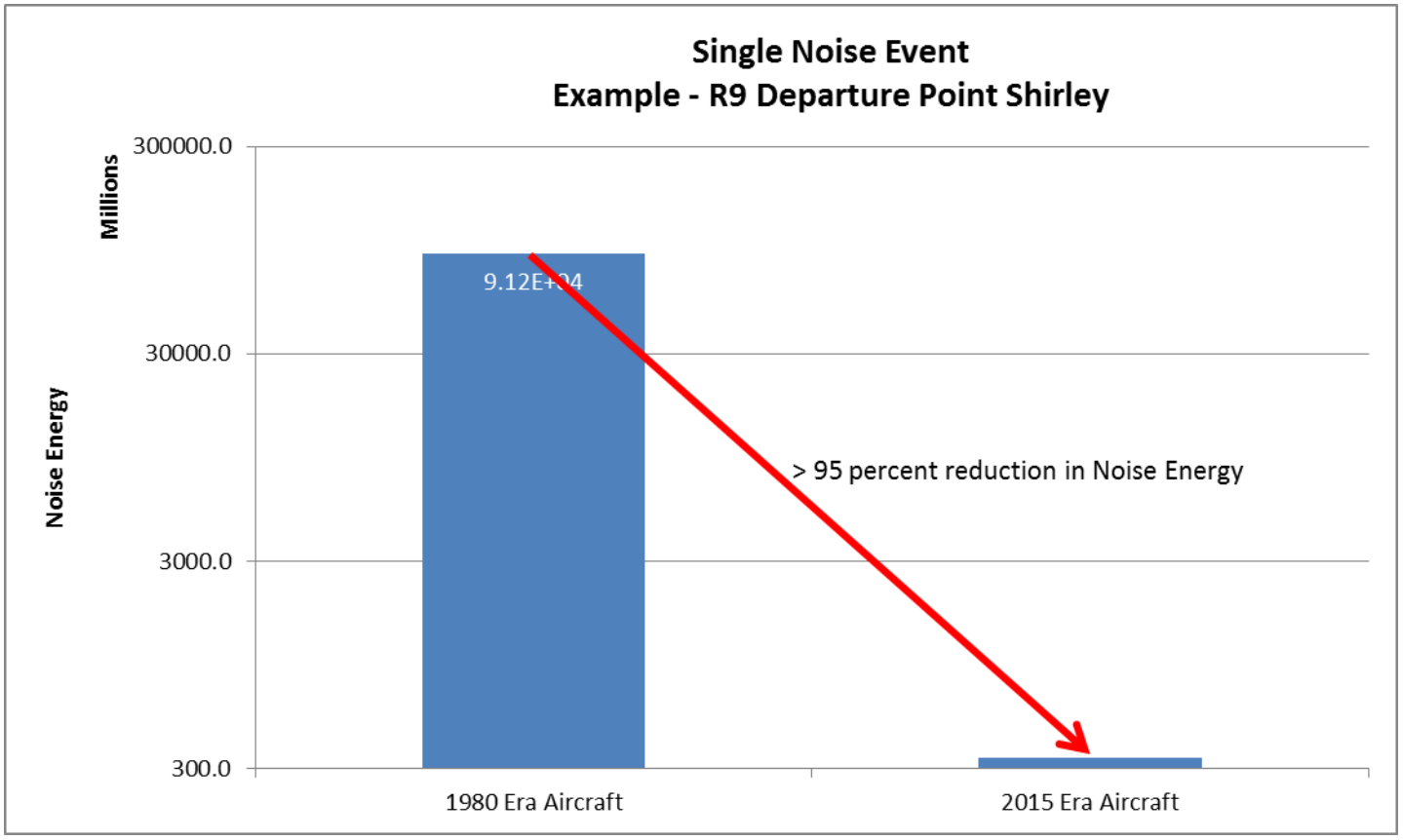
Although flights fluctuate year to year, over the long term Logan Airport is serving more passengers on fewer flights



For Example…

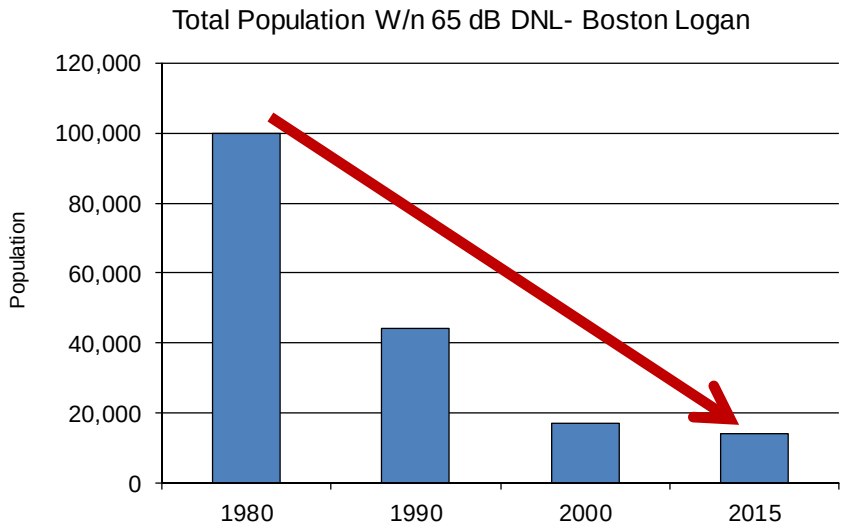
- 2014 to 2015 flights up +2.5% and passengers up +5.7%
- 2008 to 2009 flights down -7.1% and passengers down -2.3%

New engine technology has reduced noise by greater than 95% since the 1980s. About 97% of Logan's fleet meets engine stage 4 standards, the strictest noise and emissions designation



In the 1980s a typical aircraft at Logan was the B727-200. Today a typical aircraft is the A320 or B737-8. Point Shirley is located in Winthrop.

Reflecting new engine technology and a reduction of total flights, Logan's noise emissions contours have shrunk significantly over the last decades



Note: 65db DNL is FAA's designation of significant noise exposure.

Source: Massport NOMS / ERA Multi-Lat, Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs, U.S. Department of Agriculture, National Agriculture Imagery Program (NAIP) 2010

2012 - 65 dB DNL Contour (INM 7.0c)
2000 - 65 dB DNL Contour
1990 - 65 dB DNL Contour

Comparison of 65 dB DNL Contours - 1990, 2000 and 2012

Figure

Because of Logan's urban location, Massport has developed a comprehensive noise abatement program.

- Noise abatement departure procedures
- Late night opposite direction operations
- Decibel restriction on R4L departures and 22R arrivals
- Unidirectional/Wind restriction use R14/32
- Residential and School Soundproofing Program
- Engine run-up restrictions
  - Limited time
  - Specific locations
- Encourage use of single engine taxiing and reverse thrust
- 24/7 noise complaint line 617-561-3333
- State of the art Noise Monitoring System
- Near live flight tracking on website
  - http://www.massport.com/environment/environmental_reporting/Noise%20Abatement/overview.aspx

Overflights - Principals

- Safety for passengers and people on the ground
- Weather as factor
- Data driven
- Regional fairness across metropolitan region
- Massport CAC as regional voice
- Massport/FAA MOU to test five/plus experiments

Massport/FAA RNAV MOU Update

Officials will study plane noise after complaints about Logan

JOHN TLUMACKI/GLOBE STAFF

A new air navigation is concentrating more planes in and out of Logan into narrower flight paths, increasing the volume of noise for neighborhoods below.

By Megan Woolhouse | GLOBE STAFF OCTOBER 07, 2016

Facing increasing pressure from lawmakers, the Federal Aviation Administration and the Massachusetts Port Authority said they will consider changes to flight patterns in and out of Logan International Airport that have triggered thousands of noise complaints from residents.

Overview of Technical Process and Pilot Tests- Ideas reflect input from communities close to Boston Logan

1. **Persistence of RNAV departures**

2. **Increasing aircraft altitudes, Departures**

3. **Increase aircraft altitudes, Arrivals**

4. **RNAV separation requirements**

5. **Alternative RNAV Special designs**

6. **Other (?) – consistent with purpose of study and priority**

Apply alternative metrics – Develop supplemental metric(s) to better identify the potential for community impacts associated with proposed procedural changes

Critical Steps

- MOU with FAA Identifies roles and responsibilities
  - Commitment of resources to effort
- Technical Team and Work Program
  - MIT
  - HMMH
  - Ex-FAA Manager
  - FAA Technical Support\Coordination
- Coordinate with Massport CAC (and public) at important milestones
  - October 7th Announcement with FAA and elected officials
  - Massport Press Release
  - Briefing to CAC Executive Committee 10/24
  - Briefing to CAC Aviation Committee 11/2
  - Massport briefing to Executive Committee 11/29
  - Briefing to full Massport CAC 12/08
  - Briefing to Massport Executive Committee (2/14/17)
  - Public Meeting (2/22/17)
  - Ongoing Coordination

End Massport

MIT International Center for Air Transportation

Procedure Design for Logan Airport Community Noise Reduction

R. John Hansman
rjhans@mit.edu

Performance-Based Navigation (PBN)

NEXT GEN Components: RNAV/RNP

Moving to Performance-Based Navigation

Conventional Routes

Today's airways connect ground-based navigation aids

Limited Design Flexibility

RNAV

Area Navigation (RNAV) routes follow defined "waypoints"

Increased Airspace Efficiency

RNP

Required Navigation Performance (RNP) routes within specified "containment area"

Optimize Use of Airspace

Source: Federal Aviation Administration

RNAV Track Concentration

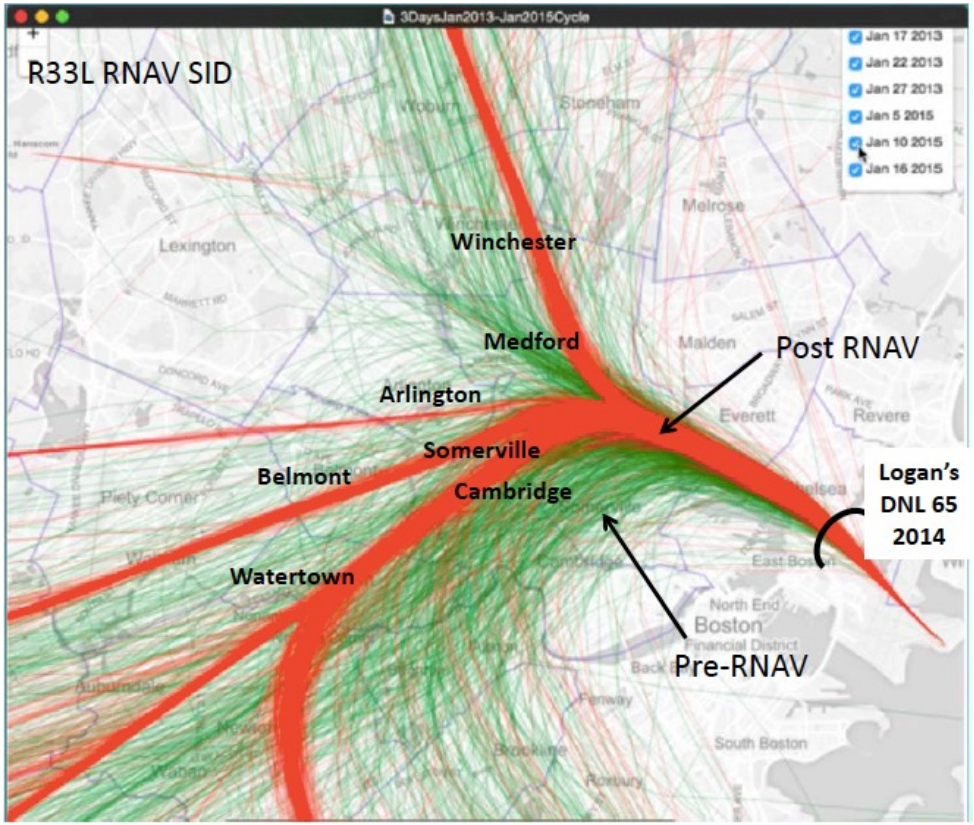
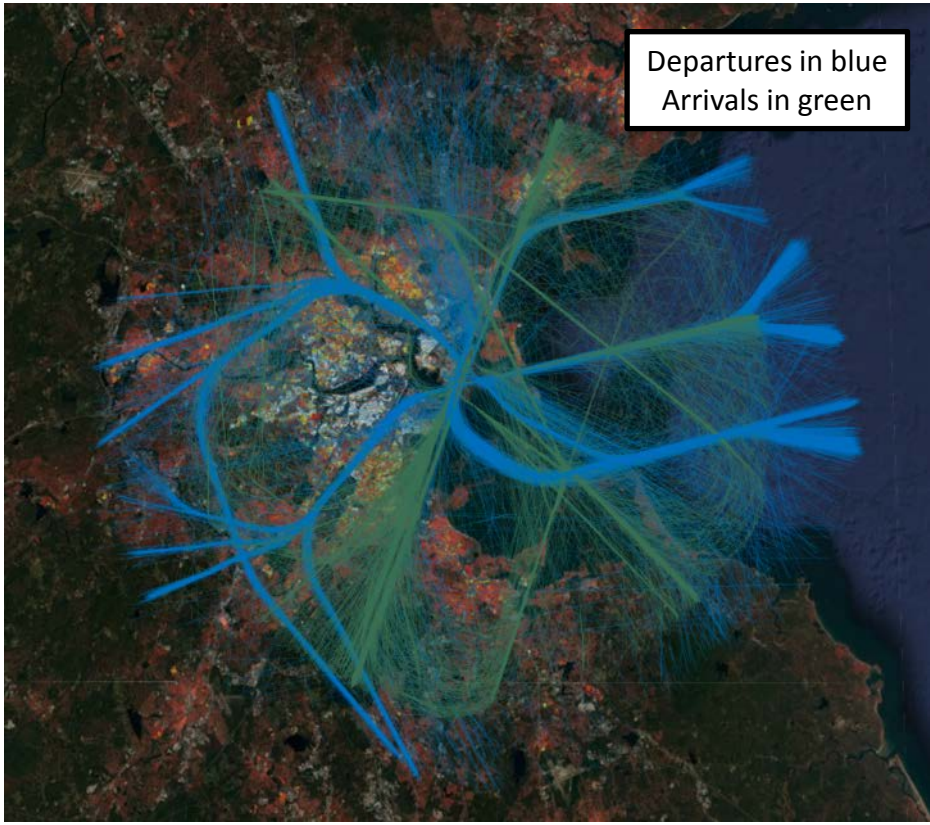


Image Source: Massport
from original Kent Johnson
2016-10-10



Source: ASDE-X
8 days in 2015

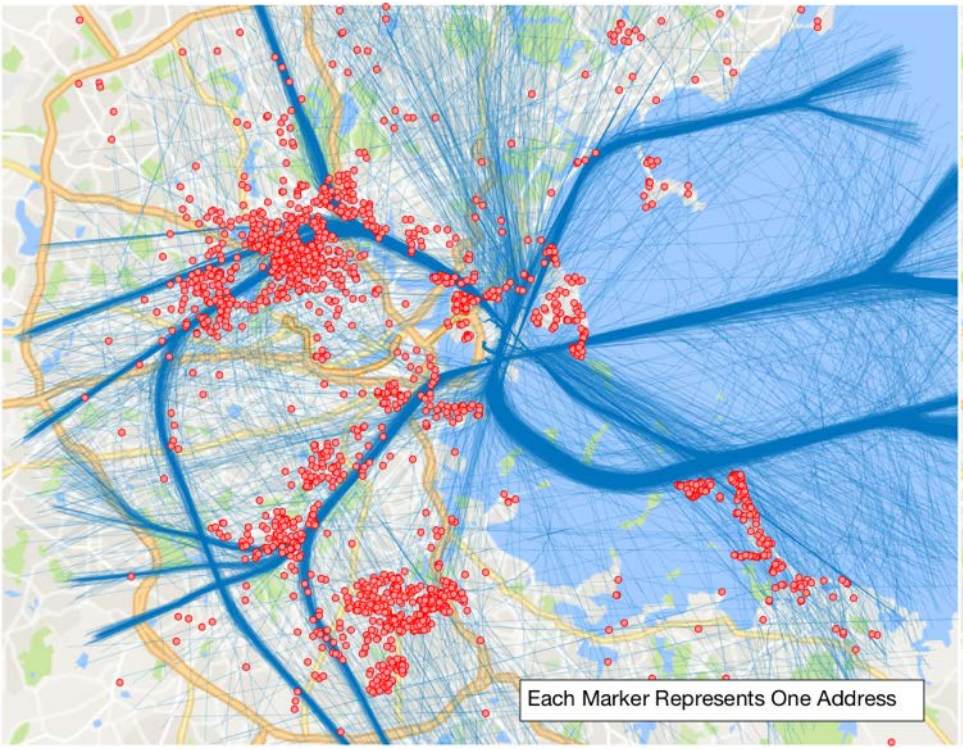
Impact of PBN Concentration

- Population sensitive to changes at levels well below the 65 DB “significant” Day-Night Noise Level(DNL)
- Overflight frequency perceived to increase under tracks
  - Precise overflight tracks make visual identification easier
- Exposure less attributable to “random” processes
  - Track directly related to procedure
- Traditional Metrics not perceived to capture overflight frequency
  - At lower DNL levels the number or frequency of events may be more important than DNL or Lmax
- Concentration raises issues of Equity
  - Popular to propose dispersion as a solution
  - Dispersion results in more noise impact
- Can PBN capability be used to reduce community noise impact

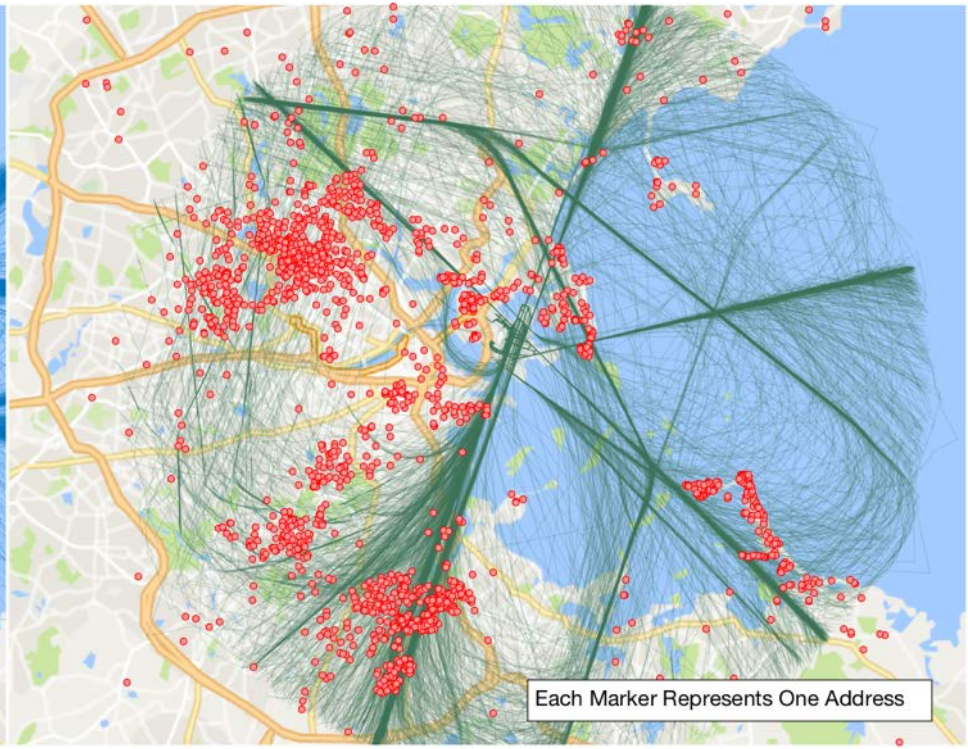
Noise Complaints at BOS: One Dot per Address

Each dot represents an address that registered at least one complaint during period

Departures



Arrivals

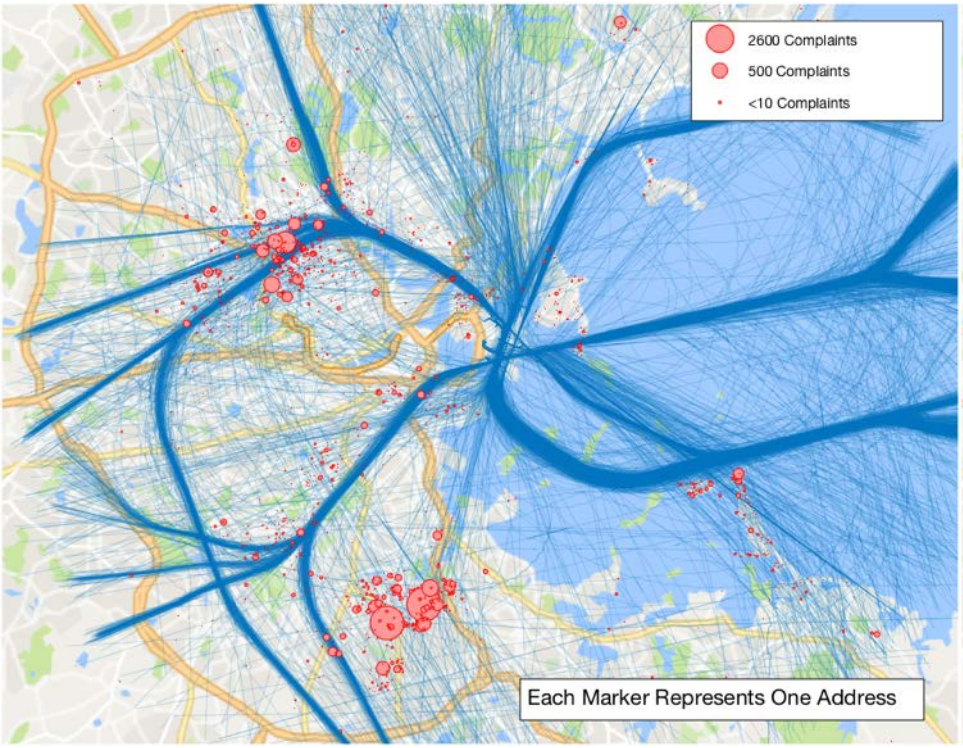


Complaint Data: August 2015– July 2016
Track Data: ASDE-X from 12 days of operation, 2015-2016

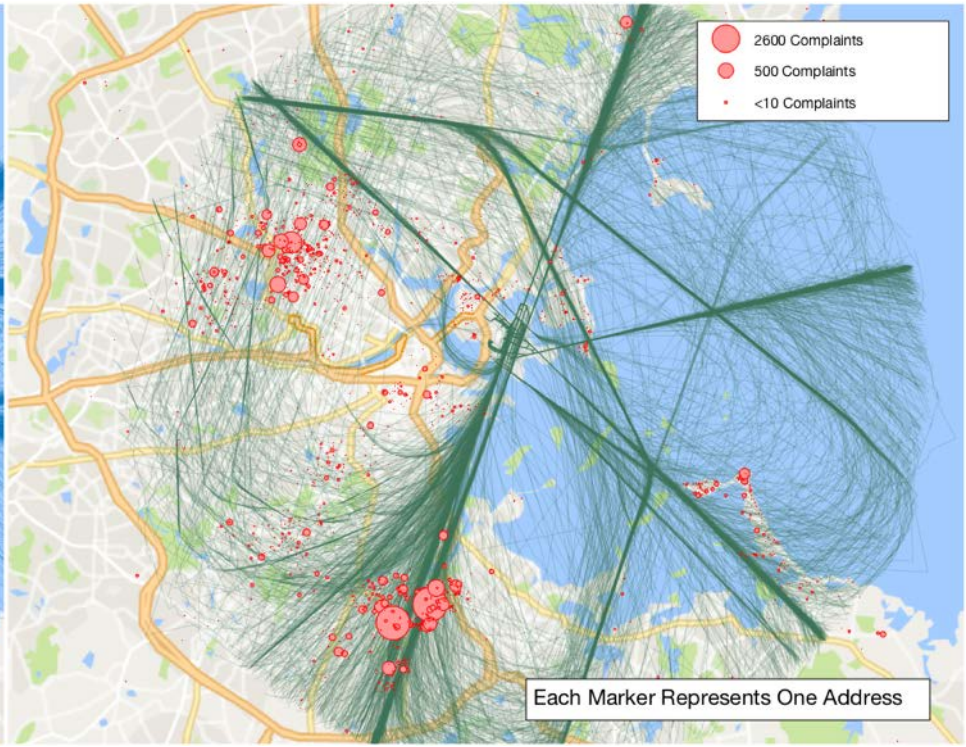
Noise Complaints at BOS: Dots Weighted by Complaint Frequency

Each dot represents an address that registered at least one complaint during period
Marker size corresponds to number of complaints registered by address

Departures



Arrivals



Complaint Data: August 2015– July 2016
Track Data: ASDE-X from 12 days of operation, 2015-2016

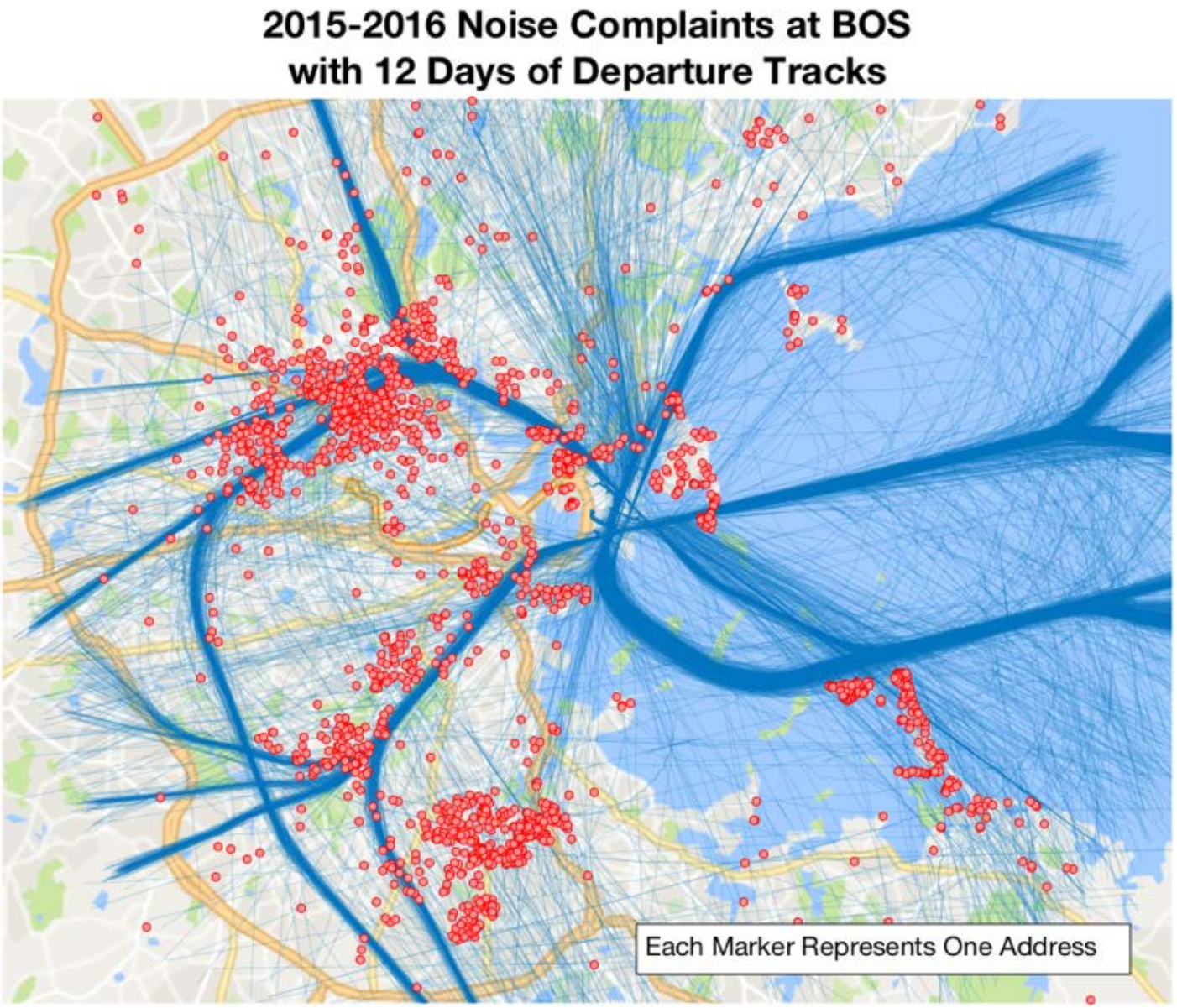
Potential Uses of PBN for Reducing Noise

- Spatial Management
  - Noise preferred arrival and departure routes
    - Precise Lateral Trajectories
    - Low population density or background shielding
    - Critical point avoidance
  - Flight track dispersion or concentration
- Vertical Management
  - Modified Departure Angles
    - Speed or Thrust Scheduling
  - Modified Approach Angles
    - Continuous Descent Arrival (CDA)
    - 2 Segment or Steep Approaches
- Speed/Drag Management
  - Low power/low drag approach profiles (DDA)
- Others?

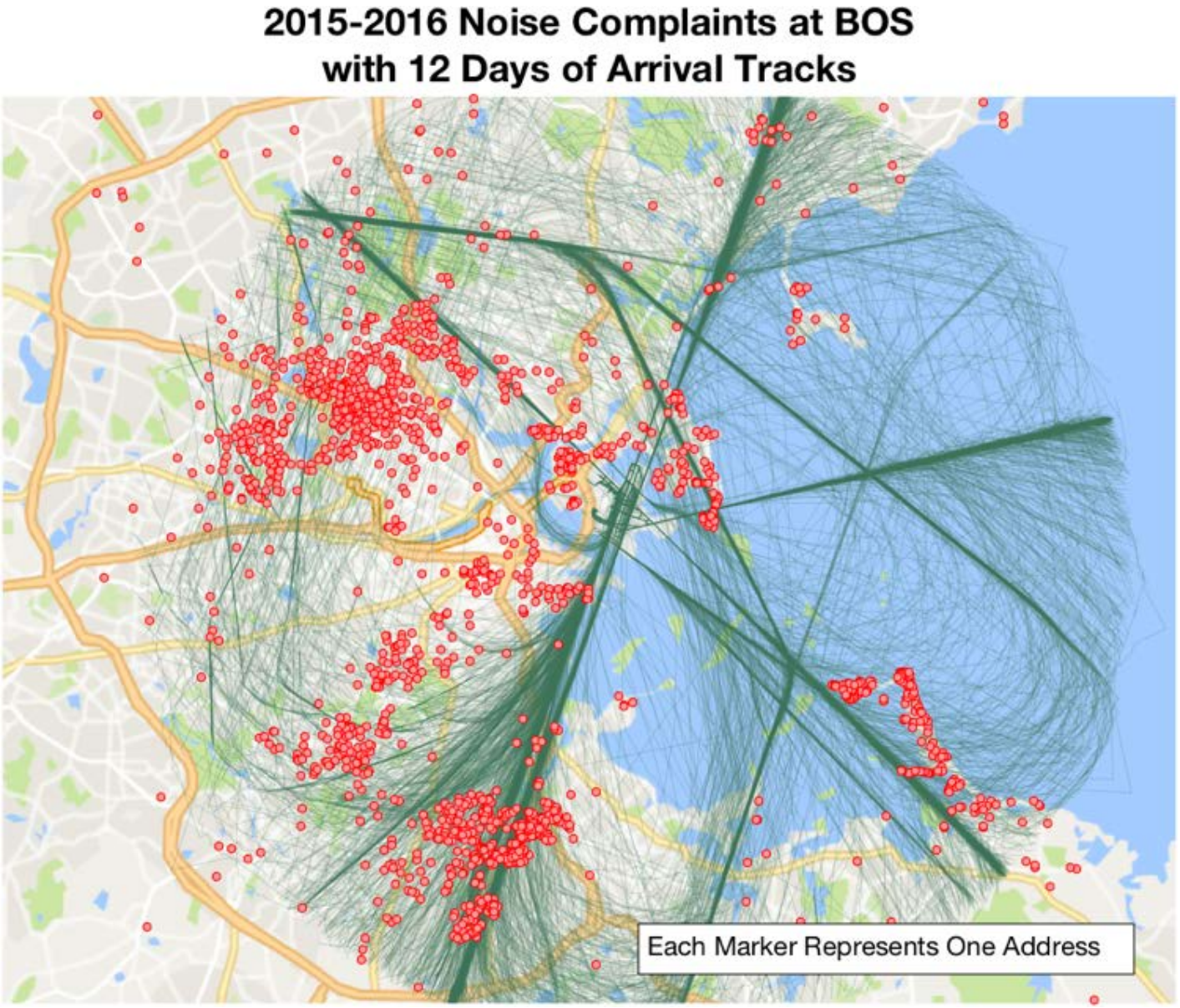
Technical Approach

- Collect Data and Evaluate Baseline Conditions
  - Pre and Post RNAV
- Identify current procedures which appear to have community noise benefit
- Determine Technical and Operational Limitations
  - Aircraft Performance
  - Navigation and Flight Management (FMS)
  - Flight Crew Workload
  - Safety
  - Procedure Design
  - Air Traffic Control Workload
- Identify Candidate Procedure Modifications
  - Block 1/Block 2
- Model Noise Impact
  - Standard and Supplemental Metrics
- Evaluate Implementation Barriers
- Recommend Procedural Modifications to Massport and FAA
- Repeat for Block 2

Departures


2015-2016 Noise Complaints at BOS
with 12 Days of Departure Tracks
Each Marker Represents One Address

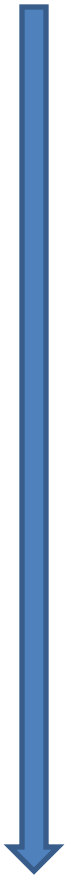
Arrivals


2015-2016 Noise Complaints at BOS
with 12 Days of Arrival Tracks
Each Marker Represents One Address

Project Schedule

Preliminary/Subject to Change

- FAA/ Massport Discussions — Winter – Fall 2016
- Announcement — Oct 2016
- Consultant Team Organization — Fall 2016
- Historical Flight Comparison\Analysis — Dec to Feb 2016
- Block 1 Procedure Opportunity — Feb 2017
  - lower complexity, benefits with minimal/no negative impacts
  - DNL and Alternative Metrics (single event above threshold)
- Block 1 Recommendations — Apr 2017
- Block 2 Procedure Opportunity — Jun 2017
  - More complexity, benefits and potential negative impacts
  - DNL and Alternative Metrics (single event above threshold)
- Block 2 Recommendations — Fall 2017
- FAA Review Process — Ongoing/TBD
- Implementation/Final Report — TBD

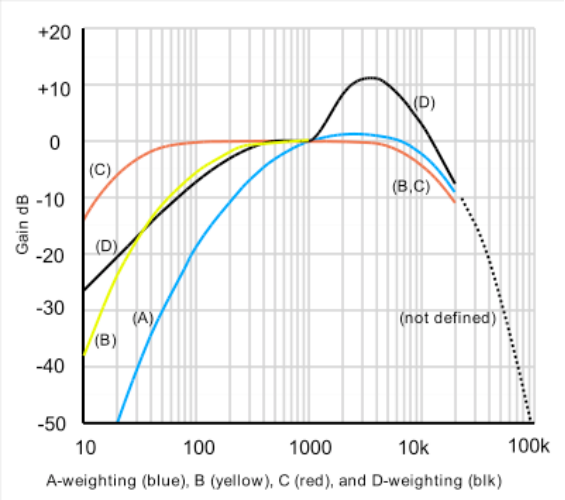


Review\Input
MPA CAC
At Key Milestones

Backup

Noise and DNL: A Primer

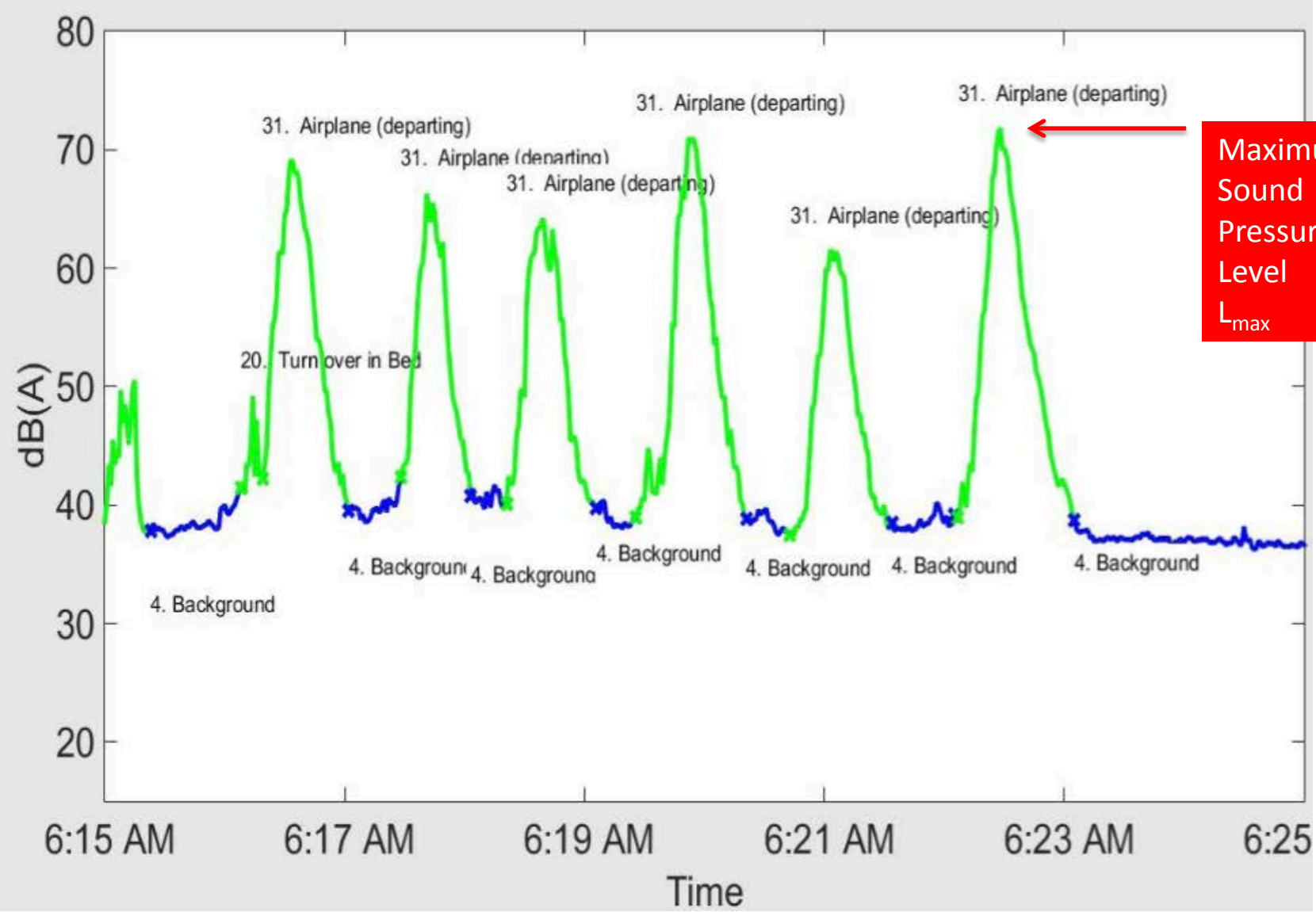
- Sound Pressure Level
  - Ratio to minimum audible baseline
  - The dB is with reference to sound power (intensity)
  - A Weighting is a correction to reflect frequency range of human hearing



A-weighting (blue), B (yellow), C (red), and D-weighting (blk)

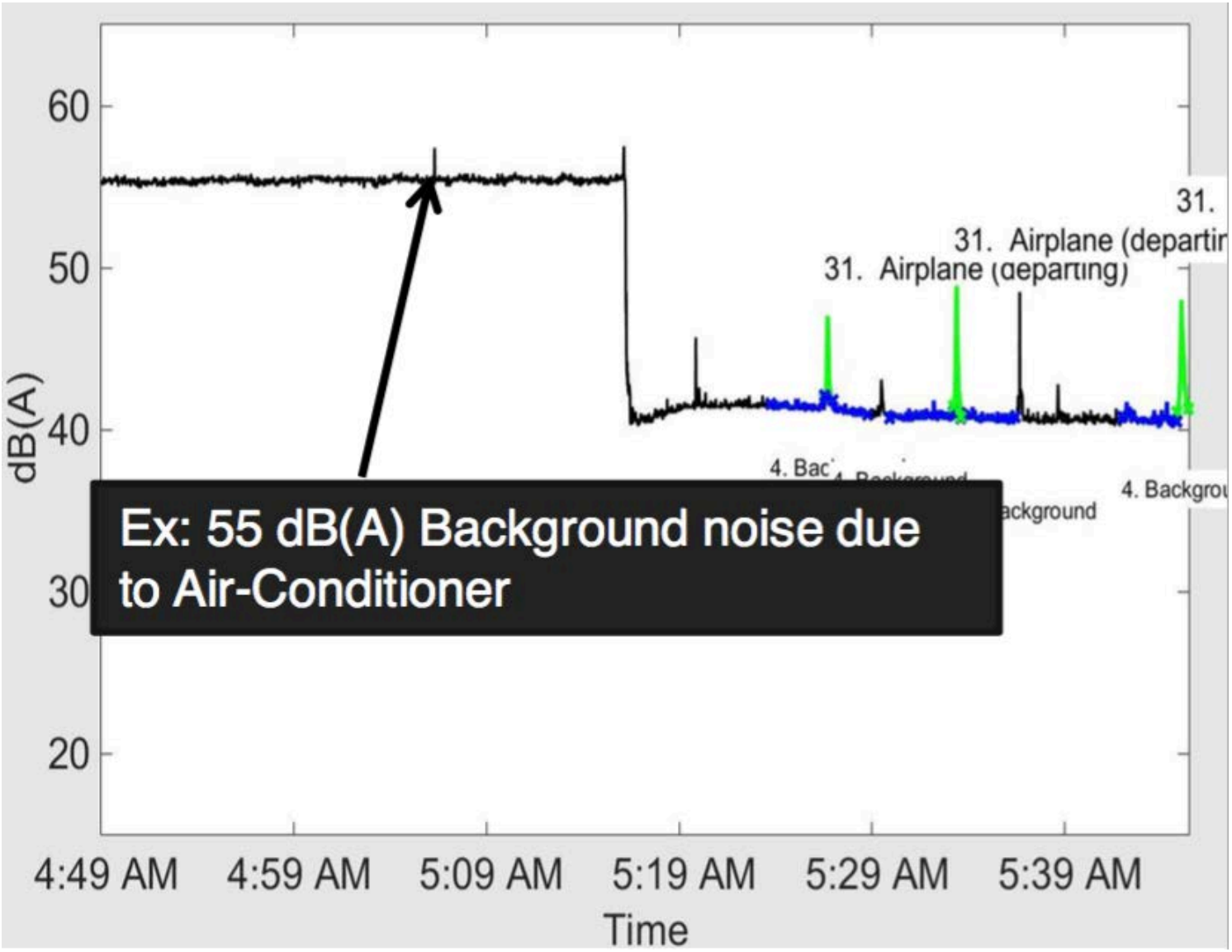
dB	power ratio	amplitude ratio
100	10 000 000 000	100 000
90	1 000 000 000	31 620
80	100 000 000	10 000
70	10 000 000	3 162
60	1 000 000	1 000
50	100 000	316.2
40	10 000	100
30	1 000	31.62
20	100	10
10	10	3.162
3	1.995	1.413
1	1.259	1.122
0	1	1
-10	0.1	0.316 2
-20	0.01	0.1
-30	0.001	0.031 62
-40	0.000 1	0.01
-50	0.000 01	0.003 162
-60	0.000 001	0.001
-70	0.000 000 1	0.000 316 2
-80	0.000 000 01	0.000 1
-90	0.000 000 001	0.000 031 62
-100	0.000 000 000 1	0.000 01

Examples of SPL from Overflights



Source Mathias Basner, Univ. of Penn. ASCENT 17 – Pilot Study on Aircraft Noise and Sleep

Effect of Background Level



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Sound Exposure Level

- Starting point: raw SPL recordings (or 1s equivalent noise) for a specific observer
- Need a measure of **sound energy exposure** at that point
  - Solution: integrate the antilog of the raw dB trace
  - Notionally represented in figure by red shaded area
- Referred to as Sound Exposure Level (SEL) for a single overflight and observer location

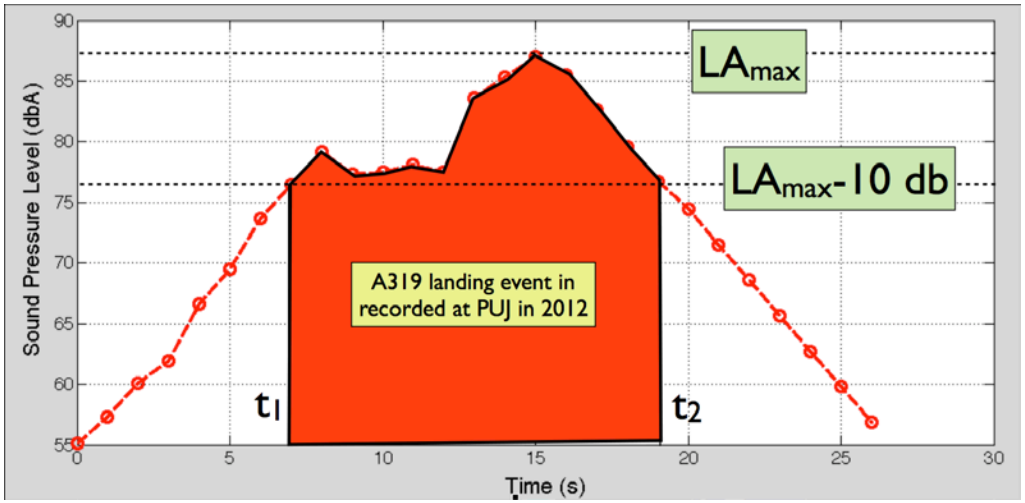
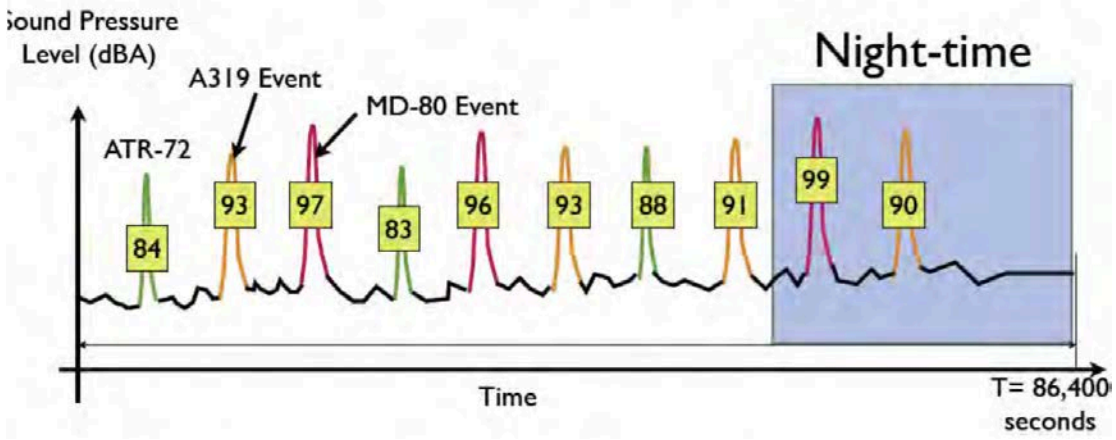


Figure: A. Trani, Virginia Tech

Day-Night Level

- DNL incorporates the multitude of single-flight SEL building blocks
- Represents equivalent (average) noise level over a full day (86,400 seconds)
- 10 dB penalty for night operations



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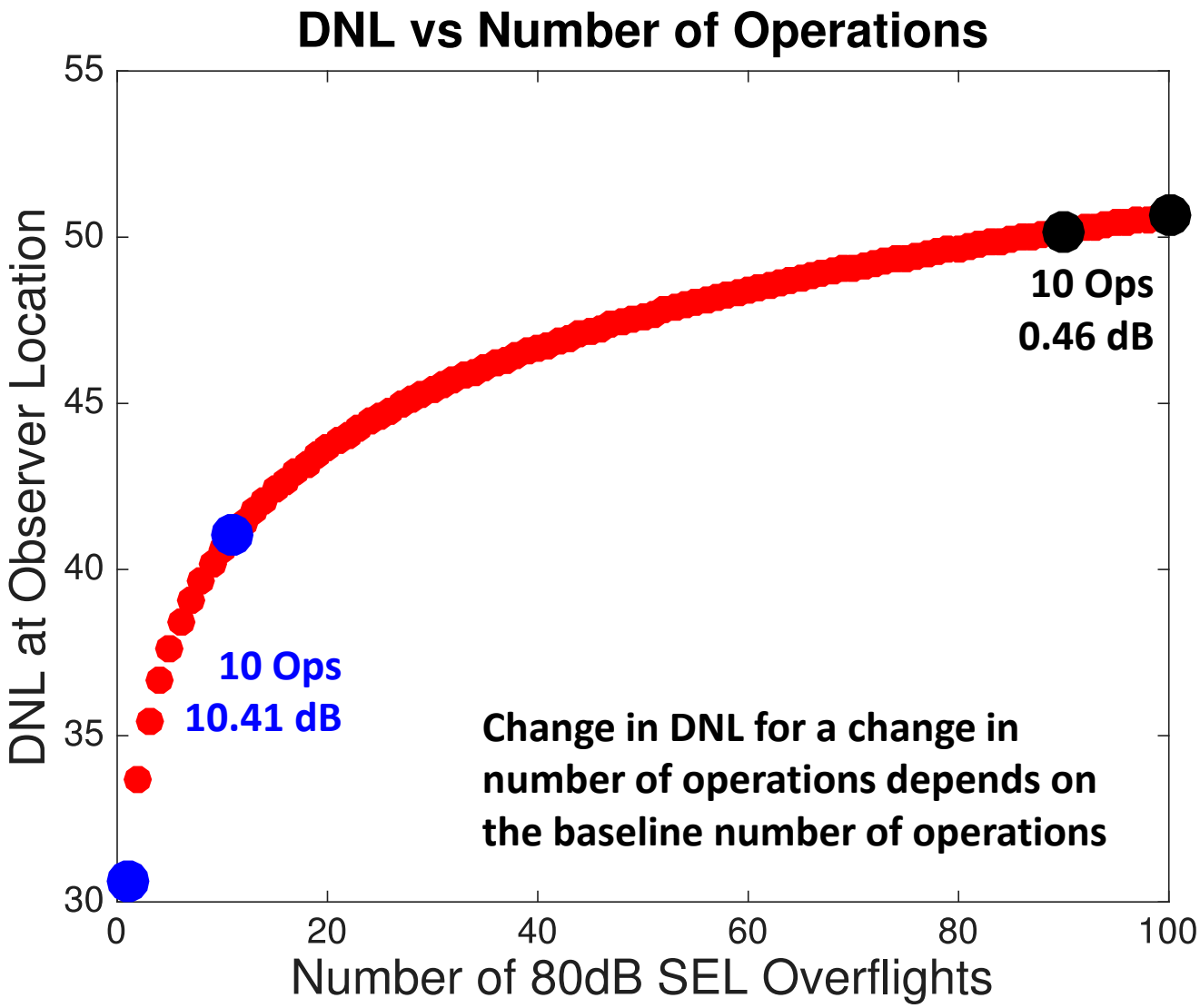
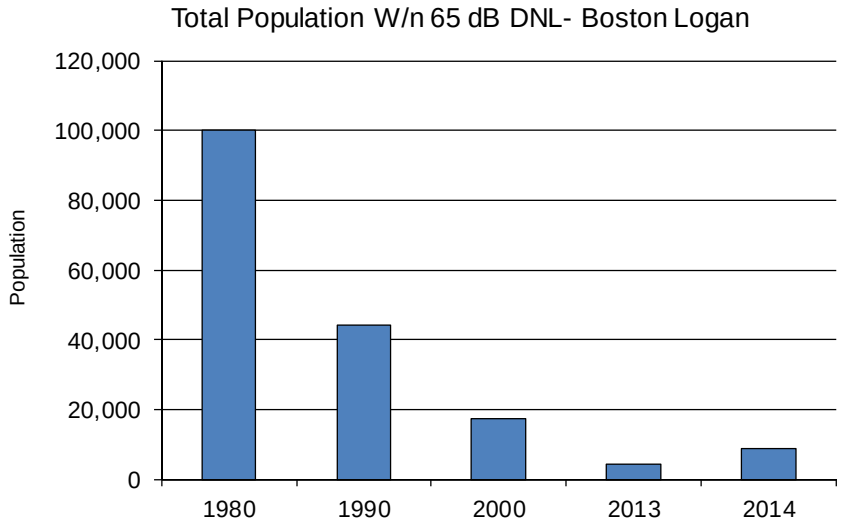
Implications of DNL



Shrinking DNL65 Impact at Airports



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Comparison of 65 dB DNL Contours - 1990, 2000 and 2012

Figure

Slide Source: Massport