PARTNER

Partnership for AiR Transportation Noise and Emission Reduction

An FAA/NASA/TC-sponsored Center of Excellence

Near Term Operational Changes

FAA PARTNER Project 32

Steve Urlass, project manager
Presentation by Prof. Karen Marais, Purdue, lead investigator
Dr. Tom Reynolds & Prof. John Hansman, MIT, co-investigators

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Motivation

- Need to identify and evaluate ways to reduce the environmental impacts of aviation in the near-term with minimal implementation barriers

- Minor adjustments to operating procedures or limited equipment/infrastructure changes
  - Some techniques already being implemented, e.g. CDAs
  - Some still in research stage, e.g. surface movement optimization
  - Others yet to be fully defined

- Require effort to systematically identify, evaluate and prioritize potential near-term operational changes

Objectives

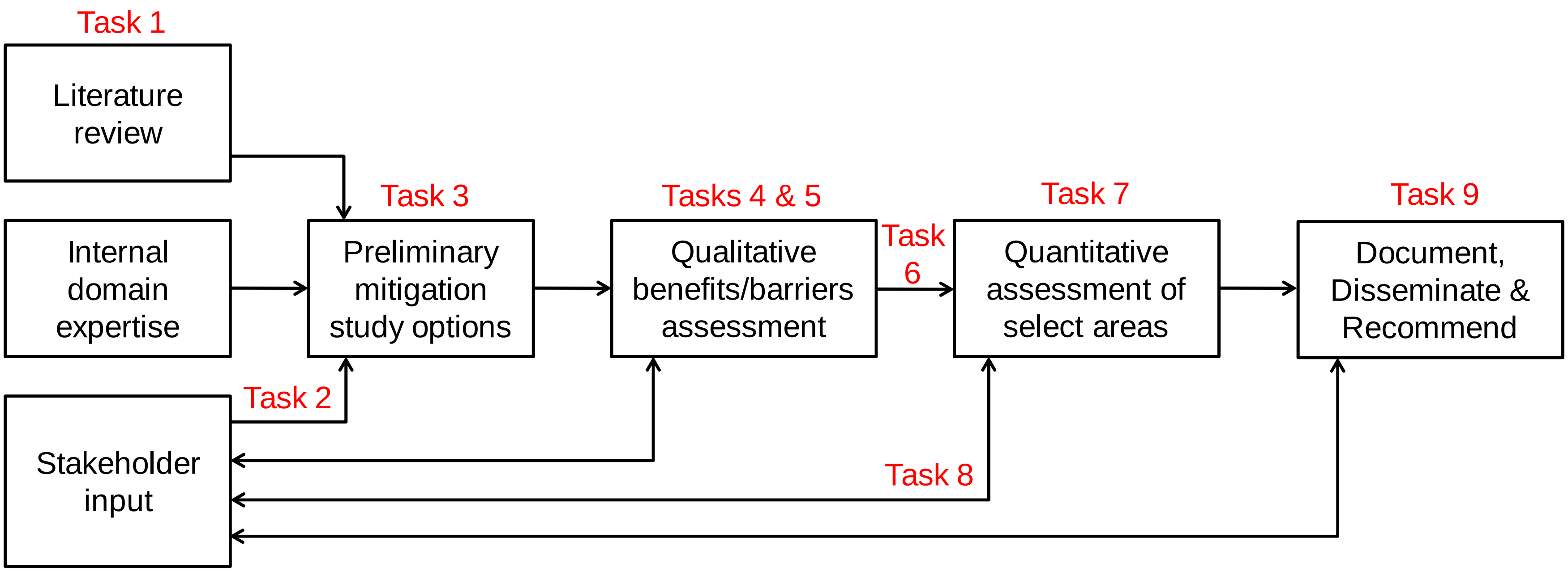
- Systematic identification and assessment of environmental impact reduction potential of a comprehensive set of near-term operational changes in terms of:
  - Environmental impact mitigation potential (climate, air quality, noise)
  - Interdependencies
  - Operational implications (e.g. procedures, capacity, efficiency, workload)
  - Barriers to implementation (e.g. costs, technology)

- In-depth analysis of most promising operational changes
  - Implementation plans based on stakeholder costs and benefits

- Collection of operational changes prioritized according to environmental benefits and feasibility of implementation

- Work with aviation industry and government partners to successfully identify and implement appropriate environmental mitigation options

Approach



Stage 1

1. Identification of Benefits Pool via Literature Review & System Analysis
2. Obtain Stakeholder Input
3. Categorize Mitigation Options
4. Evaluate Potential Environmental Impact of Identified Mitigation Options
5. Identify Barriers to Implementation of Identified Mitigation Options
6. Identify Most Promising Mitigation Options for Detailed Investigation in Stage 2

Stage 2

7. Investigate Environmental and Operational Impact of Selected Mitigation Options
8. Stakeholder Interviews on Selected Mitigation Options
9. Document and Disseminate Results

Mitigation Identification

- Mitigation options & barriers collected from variety of sources
  - Journals, conferences, key industry docs (e.g. ICAO, RTCA, IPCC, etc.)
  - Expert interviews with **wide spectrum of stakeholders**
  - Professional knowledge

Stakeholder Group	Organization	Department
Regulator	FAA	AEE: Project Managers (x4)
		ATO: Chief Scientist, Terminal Services, Environmental Programs
		APP: Airport Planning
		ARC: NY Area Program Integration
		FAA/Eurocontrol Liaison
ATC	FAA	Controllers: Oak ARTCC, DFW TRACON, LAX Tower
	ISAVIA	Iceland Oceanic
Airlines	United	Pilot
	American	Pilot
	Alaska	Airspace & Technology Director
Airports	PANY&NJ	Airspace Senior Advisor, Environment Manager
	Massport	Environment Manager
R&D	CSSI	Environment Programs
	NASA	Researchers at Ames

Mitigation Evaluation

- Concepts and technologies compiled into a master mitigation list
  - Sorted according to the primary phase of flight addressed
    - Surface (S)
    - Departure (D)
    - Cruise (C)
    - Approach (A)
    - Miscellaneous (M)
  - Along with associated comments and feedback about potential barriers or other adverse effects
- All-inclusive compilation of concepts in the master list
- Categorized and prioritized using expert judgment
  - Environmental benefit (Fuel/CO_2, climate, air quality, noise)
  - Implementation barriers

Environmental Impact and Implementability Classification

- Mitigations rated **Primary** (P), **Secondary** (S), **Neutral** (0), or **Adverse** (A) in each environmental impact category
- Ease of implementation rated **Easy**, **Medium**, or **Hard**
  - "**Easy**" if they had already been successfully implemented somewhere, or did not require significant stakeholder change or technical development
  - "**Hard**" if there were significant technical barriers or stakeholder opposition
  - E.g., a mitigation requiring major ATC changes or controversial policy shifts would be "Hard," while building a new taxiway or modifying an instrument approach procedure might be "Easy" or "Medium"
- Potential impact rated **Strong**, **Moderate**, or **Weak** depending on environmental impacts at a system-wide level
- Short-listed options are now under further investigation

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
S	S	P	S	Medium	Strong

Short-Listed Options (1 of 2)

Mitigation	Fuel (F)	Climate (C)	Air Quality	Noise	Implementability	Potential Impact
SURFACE (S)						
S-1: Queue Management Systems						
S-1.2: Advanced Systems (optimized strategies)	S	S	P	S	Medium	Strong
S-2: Taxi Fuel Minimization						
S-2.4: Improved surface situational awareness, harvesting ASDE-X data	S	S	P	S	Easy	Moderate
S-4: Improved Airport Taxiway Configurations						
S-4.3: Hold or passing areas near runway ends	S	S	P	S	Medium	Moderate
S-5: Improved coordination tools						
S-5.1: Improved information sharing	S	S	P	S	Medium	Strong
S-5.2: Flight plan change delivery over datalink	S	S	P	S	Medium	Moderate
DEPARTURE (D)						
D-1: Departure procedures						
D-1.5: Trajectories to minimize population noise exposure	A	A	A	P	Easy	Strong
D-1.6: Max-climb departures	S	S	S	P	Easy	Moderate
D-1.10: Operating in best noise configuration	0/A	0/A	0/A	P	Easy	Strong
D-2: Increased flexibility in departure routes						
D-2.1: RNP/RNAV Enabled SIDs	P	P	S	S	Medium	Moderate
CRUISE (C)						
C-1: Horizontal Route Efficiency						
C-1.1: RHSM, multi-laning	P	P	0	0	Hard	Strong
C-1.2: Minimize lateral route inefficiency	P	P	0	0	Medium	Strong
C-2: Vertical Routing Efficiency						
C-2.2: Increased directional airways	P	P	0	0	Easy	Moderate
C-2.3: Cruise climb	P	P	0	0	Medium	Strong
C-2.4: Step-climb	P	P	0	0	Easy	Moderate
C-2.5: Increase priority for giving requested/optimal altitudes	P	P	0	0	Easy	Moderate
C-3: Speed Efficiency						
C-3.1: Individual aircraft fuel-optimized cruise speeds	P	P	0	0	Hard	Strong
C-3.2: Cruise Mach reductions	P	P	0	0	Easy	Strong
C-3.3: More efficient passing options	P	P	0	0	Medium	Strong

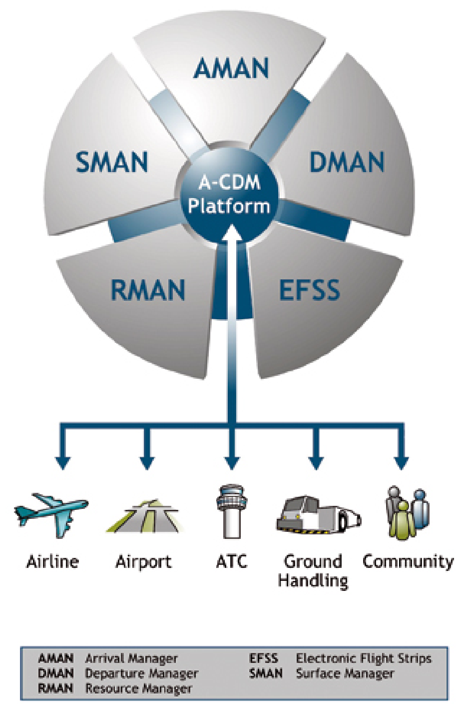
Short-Listed Options (2 of 2)

Mitigation	Fuel (F)	Climate (C)	Air Quality	Noise	Implementability	Potential Impact
APPROACH (A)						
A-1: Advanced Approach Procedures						
A-1.2: Steeper descent and approach	S	S	S	P	Medium	Moderate
A-1.3: Low power/low drag	S	S	S	P	Medium	Moderate
A-1.4: RNP/RNAV Enabled STARs	P	P	S	S	Medium	Moderate
A-3: Absorbing Delay Enroute Instead of Terminal Area	P	P	S	S	Medium	Moderate
LANDING (L)						
L-2: Reduced Thrust Reverse	S	S	S	P	Easy	Moderate
MISCELLANEOUS (M)						
M-2: Improved Airline/ATC Coordination						
M-2.1: Airborne flow program	P	P	0	0	Easy	Moderate
M-2.2: Increased use of TMA or similar tools	P	P	0	0	Medium	Moderate
M-2.3: Integrated CDM/TFM solutions	P	P	S	0	Medium	Moderate
M-2.5: Information sharing tools (SWIM)	S	S	S	0	Medium	Moderate
M-2.6: Special activity airspace real-time status & scheduling	P	P	0	0	Hard	Moderate
M-2.8: Flight plan change delivery over datalink	P	P	S	0	Medium	Strong
M-3: Policy Measures						
M-3.2: Increase ATC priority for environmental performance	P	P	P	P	Medium	Strong
M-5: Airspace Redesign to Increase Efficiency	P	P	S	S	Medium	Strong

S-1.2 Advanced Queue Management Systems

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
S	S	P	S	Medium	Strong

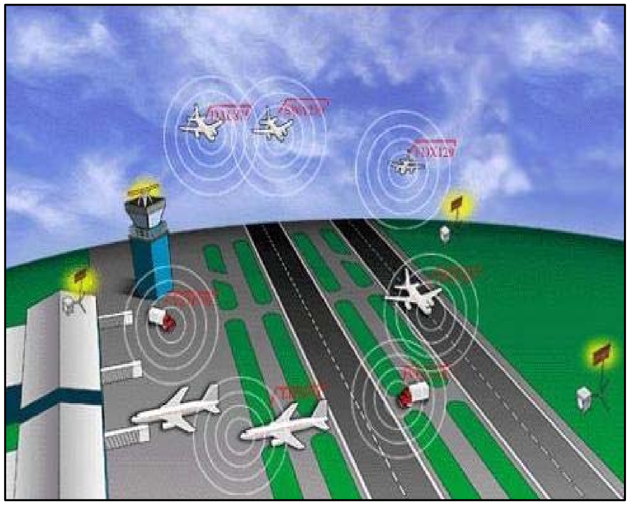
- ***Improve air quality through reduced fuel use on surface***
- Queue management systems' aim is to improve the overall efficiency of operations, reduce taxi times, and hence increase the throughput of airports
- Includes various approaches: N-control, AMAN, DMAN, SMAN and RMAN
- **Barriers and Comments**
  - Gate Conflicts
  - Controller workload and responsibility
  - Push crew and tug availability
  - De-icing hold procedures
  - Implications of external constraints (enroute, departure fix, MIT, APREQ)
  - Coordination between ramp and FAA
  - Requires a priority shift - Environment vs. Capacity (policy changes required)



S-2.4 Improved Surface Situation Awareness & Harvest ASDE-X Data

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
S	S	P	S	Easy	Moderate

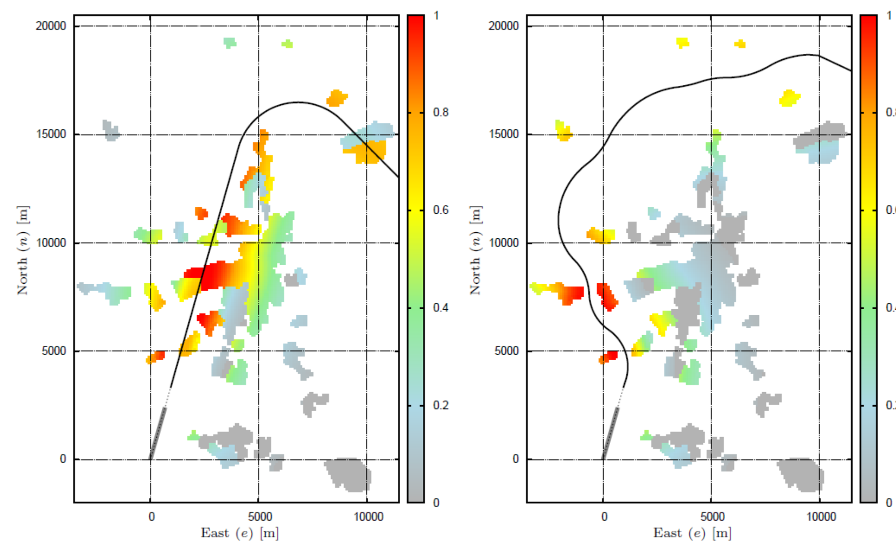
- ***Improve air quality through reduced fuel use on surface***
- ASDE-X is an airport surface surveillance system that provides aircraft and ground vehicle identification to ATC
- ASDE-X enables improved surface situation awareness with potential for improved environmental performance
- ASDE-X data can be harvested and analyzed to identify operational inefficiencies
- **Barriers and Comments**
  - Share information among FOCs, ATC and Airport
  - Increased awareness can prevent premature push-backs, thus decrease fuel consumption
  - ASDE-X not available at all airports
  - Analysis algorithms need to be tailored to individual airports



D-1.5 Trajectories to Minimize Population Noise Exposure

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
A	A	A	P	Easy	Strong

- ***Reduce noise impact by avoiding noise sensitive areas***
- Generation of an optimized departing trajectory for each flight
- Based on the population density, airport layout, meteorological conditions, and aircraft performance, and airspace constraints



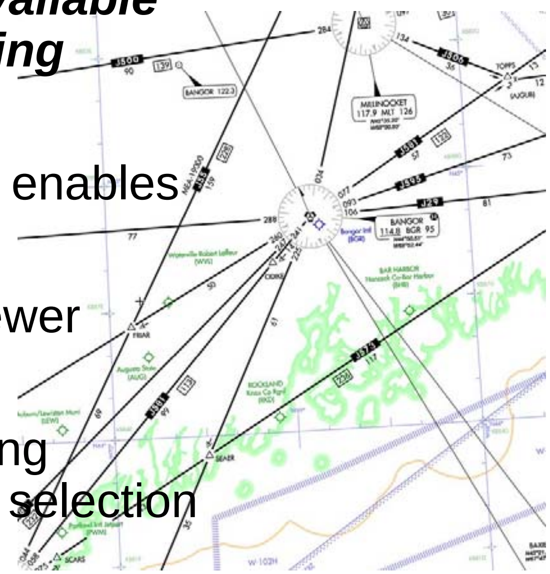
(a) Baseline trajectory (b) Optimised trajectory

- **Barriers and Comments**
  - Ability to implement individual high precision trajectories (requires RNP?)
  - ATC Complexity and clearance delivery
  - Concentration of noise at specific locations
  - EWR Dispersal headings
  - Trades with efficiency and fuel/climate (e.g. BOS noise procedures add distance)

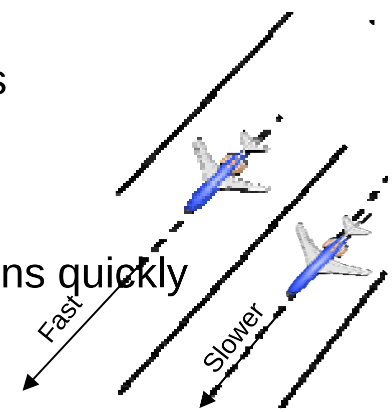
C-1.1 RHSM and Multi-laning

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
P	P	0	0	Hard	Strong

- ***Reduce fuel burn by allowing more efficient use of available airspace through increased capacity and better passing maneuvers***
- Higher navigational precision via RNAV/RNP and ADS-B enables reduced separation en route
- Reduced separation allows higher airway capacity and fewer inefficient traffic avoidance maneuvers
- Multilaning can enable passing along an airway, preventing avoidance maneuvers and allowing custom cruise speed selection



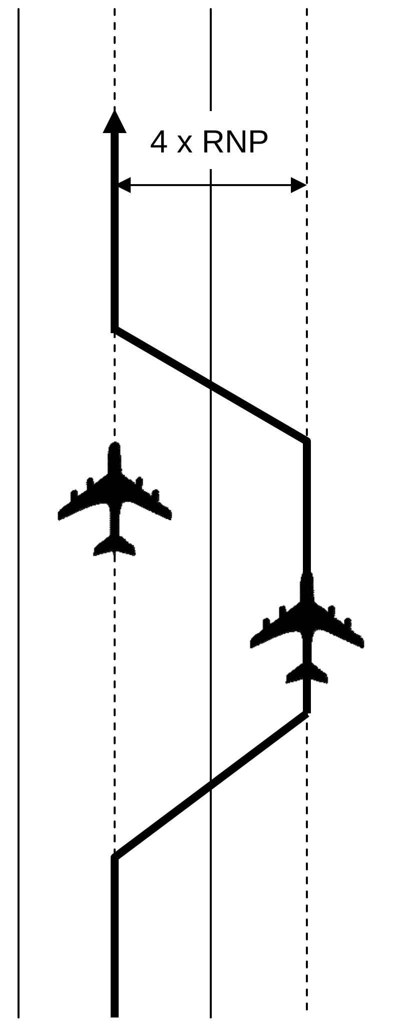
- **Barriers and Comments**
  - Change in separation minima require significant safety analysis
  - Passing distances can be significant
  - FMS needs special route offset capability
  - Need to understand how to identify and correct blunder situations quickly



C-3.3 More Efficient Passing Options

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
P	P	0	0	Medium	Strong

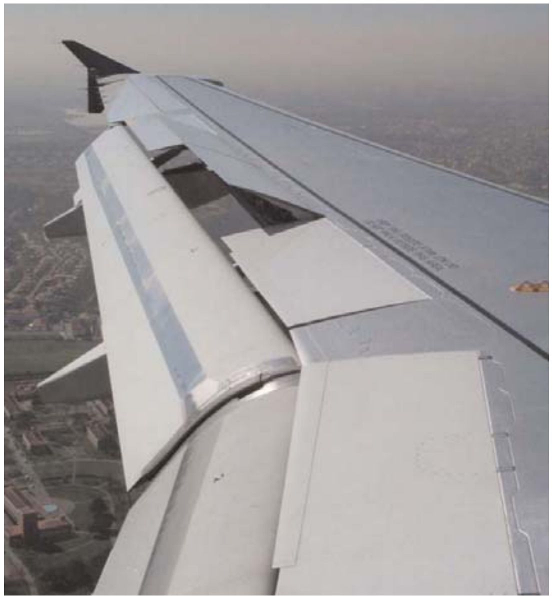
- ***Reduce fuel burn by allowing more efficient handling of aircraft flying at different speeds***
- Separation conflicts along an airway are often handled via
  - a heading change off route, which increases trip distance
  - an altitude change, which can move an aircraft away from its fuel-optimal altitude
- RNAV and ADS-B would enable more precise aircraft position information to ATC, and tighter passing procedures
- RNP and multilaning could enable a “passing lane” for minimal route disturbance
- **Barriers and Comments**
  - ATC uncertainty requires large margin in separation when passing for safety
  - Mixed equipage issues, all participating aircraft need to be equipped
  - Long passing distances



A-1.3 Low-Power Low-Drag

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
S	S	S	P	Medium	Moderate

- ***Reduce noise and fuel use by using clean aero-dynamic configuration for longer on approach***
- Keep aircraft speed higher for longer during descent/approach keeps aircraft in clean aerodynamic configuration and low engine power for longer, with noise and fuel reduction benefits
- Delay deployment of high lift devices, drag devices and undercarriage to reduce airframe drag and need for engine power

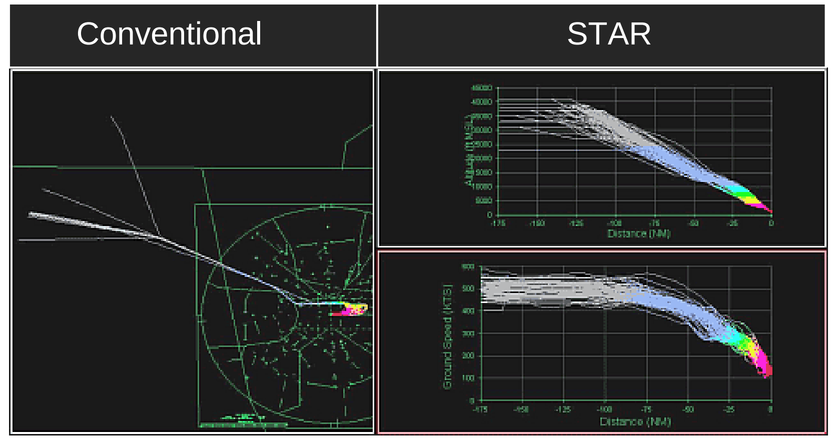


- **Barriers and Comments**
  - ATC prefers to run everyone slow from a long way out to make sure runways are being used to maximum extent possible
    - More time to get everyone lined up and hit minimum spacing more easily
  - Deceleration to final stabilized approach speed occurs later and hence unpredictable aircraft stream compression closer to airport may lead to capacity loss

A-1.4 RNP/RNAV Enabled STARs

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
P	P	S	S	Medium	Moderate

- ***Reduce noise impact by avoiding noise sensitive areas***
- ***Reduce fuel use by enabling more precise and flexible arrival trajectories***
- Potential to reduce path length
- Can route around noise sensitive areas
- May allow OPDs



NextGen FAA

- **Barriers and Comments**
  - Potential environmental review of modified procedures
    - Individual stakeholders vs overall population exposure
  - Need mechanisms to deal with mixed levels of performance (aircraft and avionics)
  - Aircraft equipage and flight crew/controller training
  - Procedure development
    - Explore trade-offs in procedures with downwind vs. base leg only vs. straight in
    - Move away from current approach procedure design philosophy of overlaying advanced procedures upon existing profiles

M-3.2 Increase ATC Priority For Environmental Performance

Fuel	Climate	Air Quality	Noise	Implementability	Pot. Impact
P	P	P	P	Medium	Strong

- ***Reduce fuel burn and noise by encouraging controllers to increase priority of aircraft environmental performance***
- ATC operational priorities currently focus on safety, capacity and controller workload
- Environmental performance not an explicit ATC consideration: need policy shift
- Environmental metrics and flight optimization information provided to controllers could help them make better decisions

Source: http://www.volpe.faa.gov

- **Barriers and Comments**
  - Measurement of environmental performance information can be difficult
  - Cannot sacrifice safety
  - Controller workload implications

Summary

- **Stage I** complete
  - Literature review (new research will be added as it appears)
  - Stakeholder interviews
  - Mitigation Identification and Evaluation
    - Identified over 50 mitigation options
    - Quantitative evaluation of environmental impacts and barriers to implementation
    - Short-list of options identified

- Next steps?
  - Quantitative evaluation of environmental impact of selected options
  - Potential topics
    - Vertical speed and altitude optimization
    - RNP/RNAV
    - LPLD
  - More detailed assessment of barriers to implementation
    - Follow-up interviews to assist in detailed evaluation

- Key challenges/barriers
  - Identification of “best” mitigation options
  - **Requesting stakeholder input from this workshop**

References

- Tom G. Reynolds et al., "**Potential of Operational Changes to Mitigate Environmental Impacts of Aviation**", 27th Congress of the International Council of the Aeronautical Sciences, Nice, France, 19-24 September 20.
- Delri Muller et al., "**Evaluation of Operational Measures to Mitigate Environmental Impact through Reduced Aircraft Fuel Use**", ATIO 2010, Texas, September 2010.

Contributors

- Investigators
  - Karen Marais (Purdue)
  - Tom Reynolds and John Hansman (MIT)
- Students
  - Delri Muller and Payuna Uday (Purdue)
  - Jonathan Lovegren (MIT)