NASA Research to Support the Airlines

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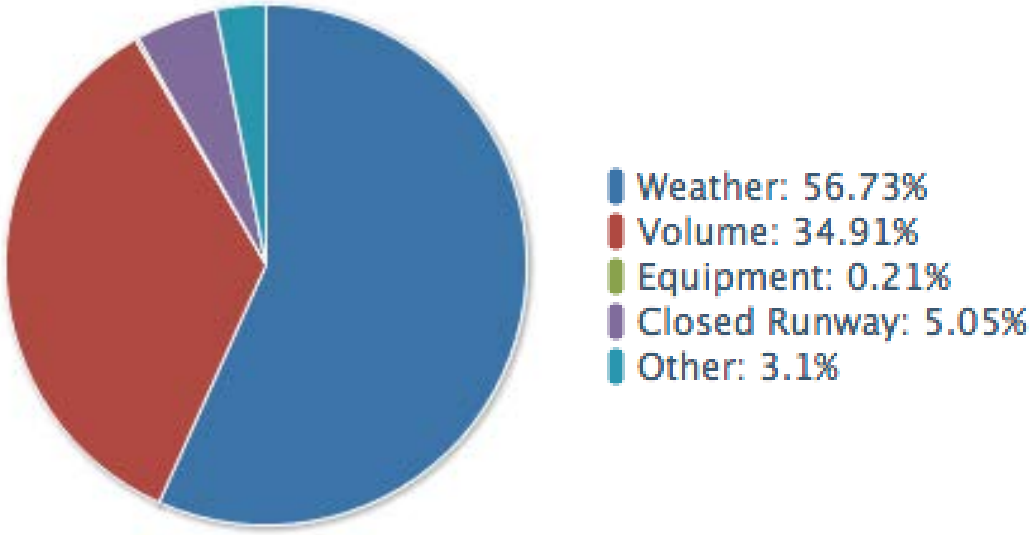
Let’s Talk About Disruption Management

Disruption Management

- Weather is the primary disruptive element in the National Airspace System
- Must detect, analyze, coordinate, and take action



Causes of National Aviation System Delays
(January - September, 2016)

Disruption Management

- Detection
  - Forecasting and detection tools for convective weather and winter storms are fairly mature
- Analysis
  - Analysis and prediction of effects are often subjective and inaccurate
- Coordination/collaboration
  - There are few ways that dispatcher, pilot, controller, and airport personnel can interact to devise a mutually beneficial plan
- Action
  - Communication of actions is dispatcher-to-pilot-to-controller or controller-to-pilot
  - Some key personnel only see the indirect effects of decisions regarding weather

Disruption Management

- Detection
  - Develop NASA tools for detection of clear air turbulence
- Analysis
  - Continue to work on NASA concepts such as Dynamic Weather Routes, Traffic Aware Strategic Aircrew Requests, and the Flight Awareness Collaboration Tool
  - Create new tools requested by the airline industry
- Coordination/collaboration
  - Using high-bandwidth data exchange, improve the communication between dispatcher, pilot, controller, and airport staff
- Action
  - Improve the sharing of and review of decisions by using enhanced data communications between dispatcher, pilot, controller, and airport staff

Dispatcher Workload Study

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Dispatcher Workload Study

- Suggestions for a human factors study of dispatcher tasks after the Airline Operations Workshop at NASA Ames in August 2016
- Partnered with Alaska Airlines and Delta Airlines
- Will visit airline operations control centers to shadow dispatchers during various shifts across several days
- Trying to better understand the conditions for dispatchers across shifts in various configurations
  - Extended operations flights
  - Transcontinental flights
  - Weather events
  - Hubs/regional
- Will allow for innovation and research by leveraging current technology used by the dispatcher
- Study will take place starting in the Spring of 2017 at Delta

Flight Awareness Collaboration Tool

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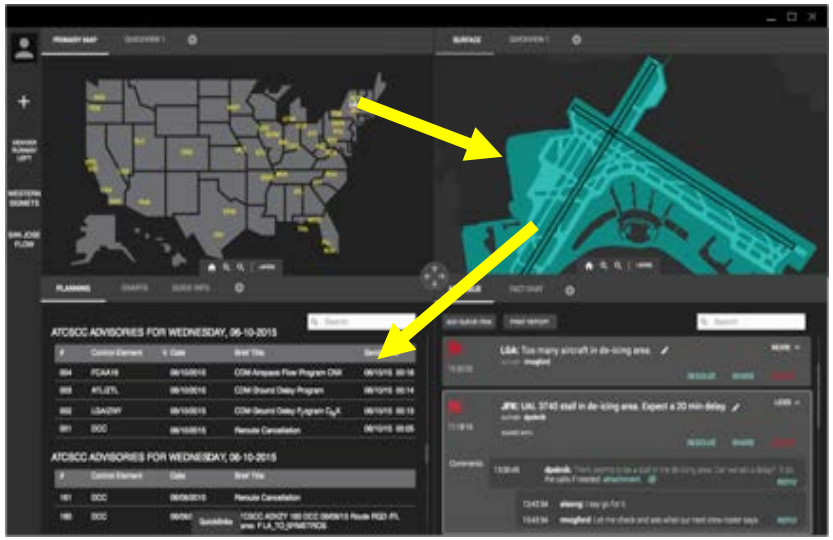
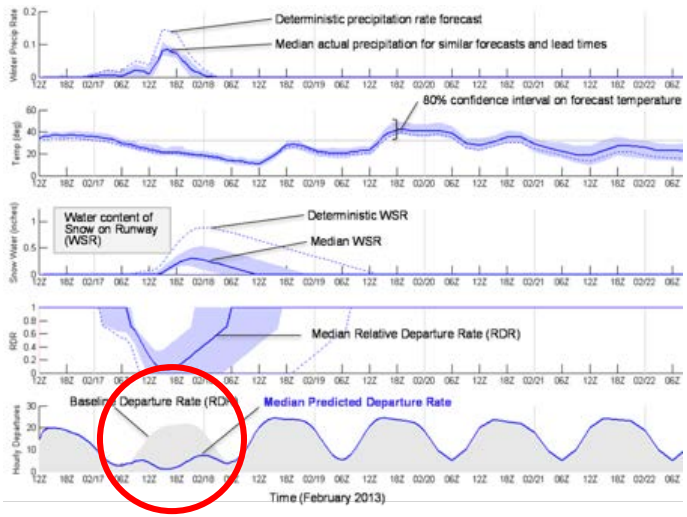
Flight Awareness Collaboration Tool

- Developing the “Flight Awareness Collaboration Tool” (FACT)
- Concentrates information about winter weather events on one display
- Includes predictive tools
- Supports collaboration between airline operations center, air traffic control, airport authority, and de-icing operators

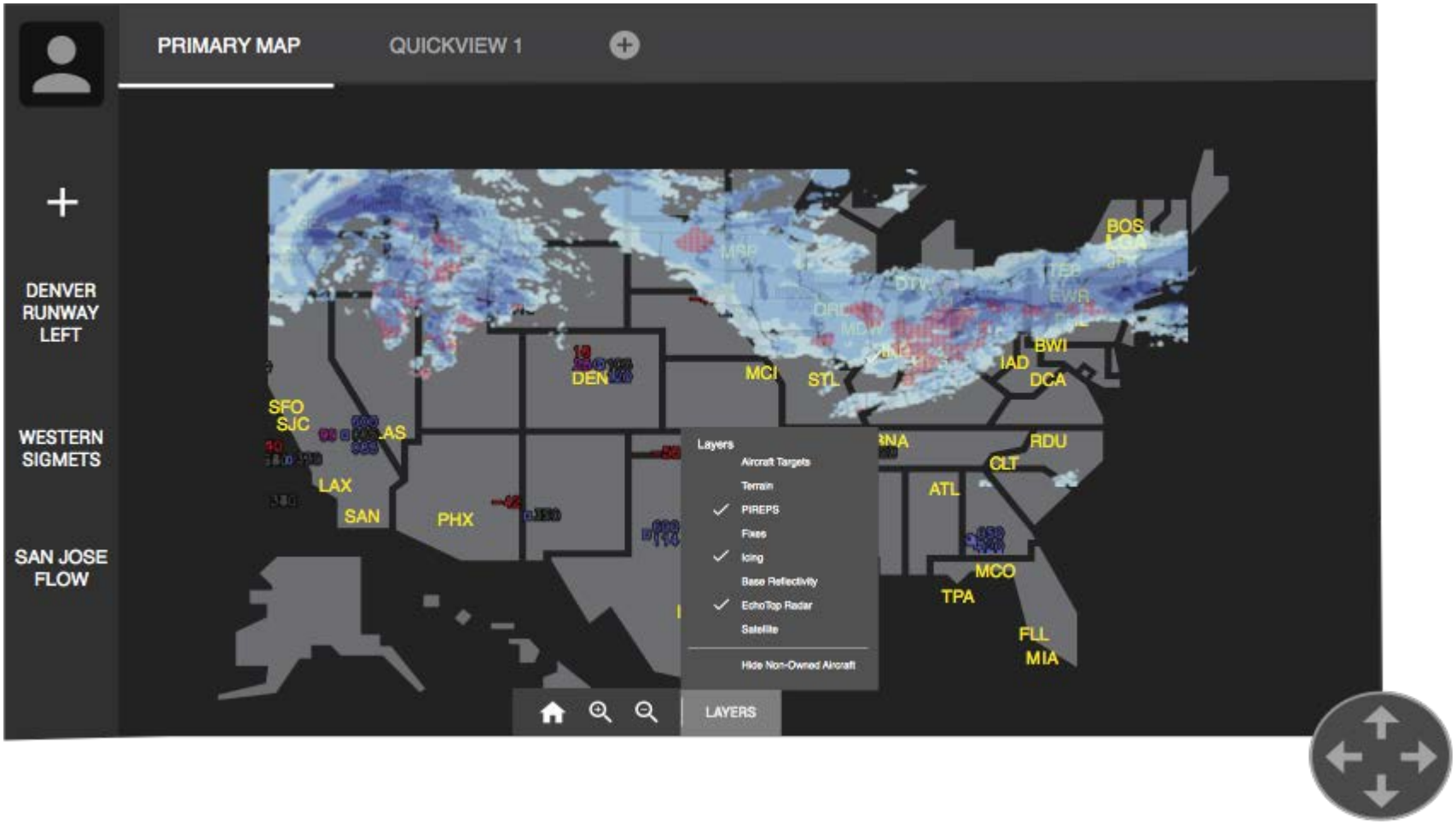


FACT Screen

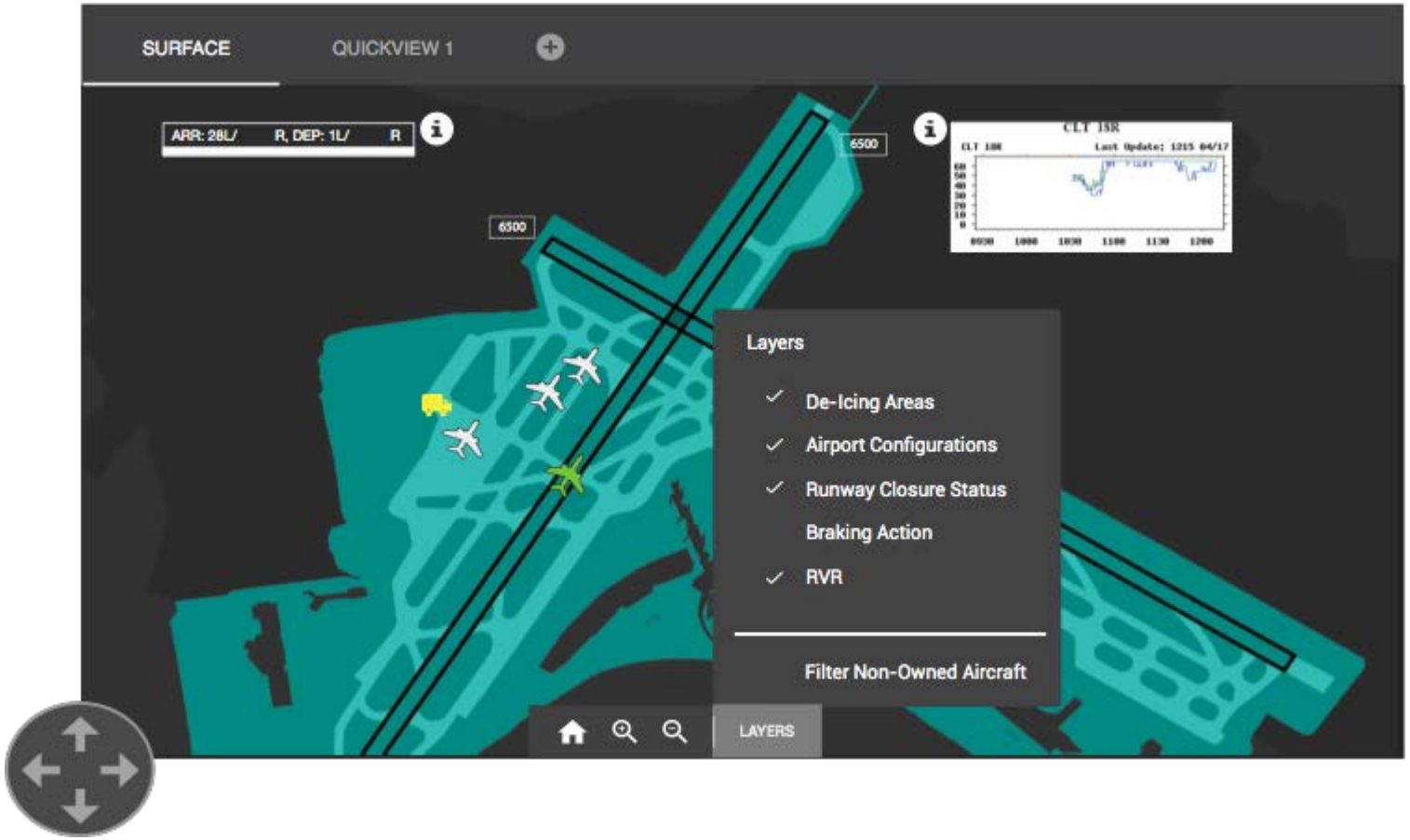


Winter Weather Airport Capacity Model

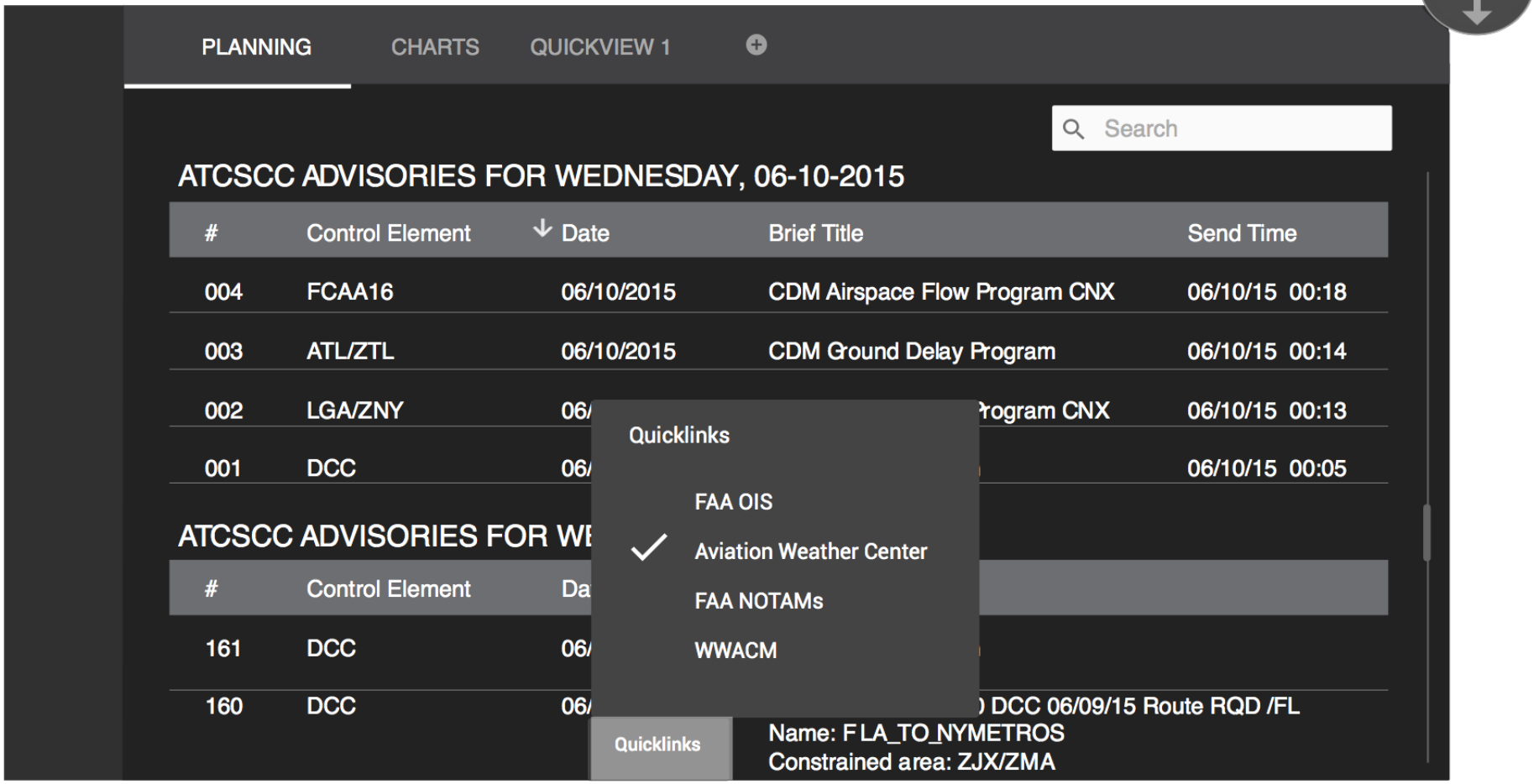
FACT Primary Map View



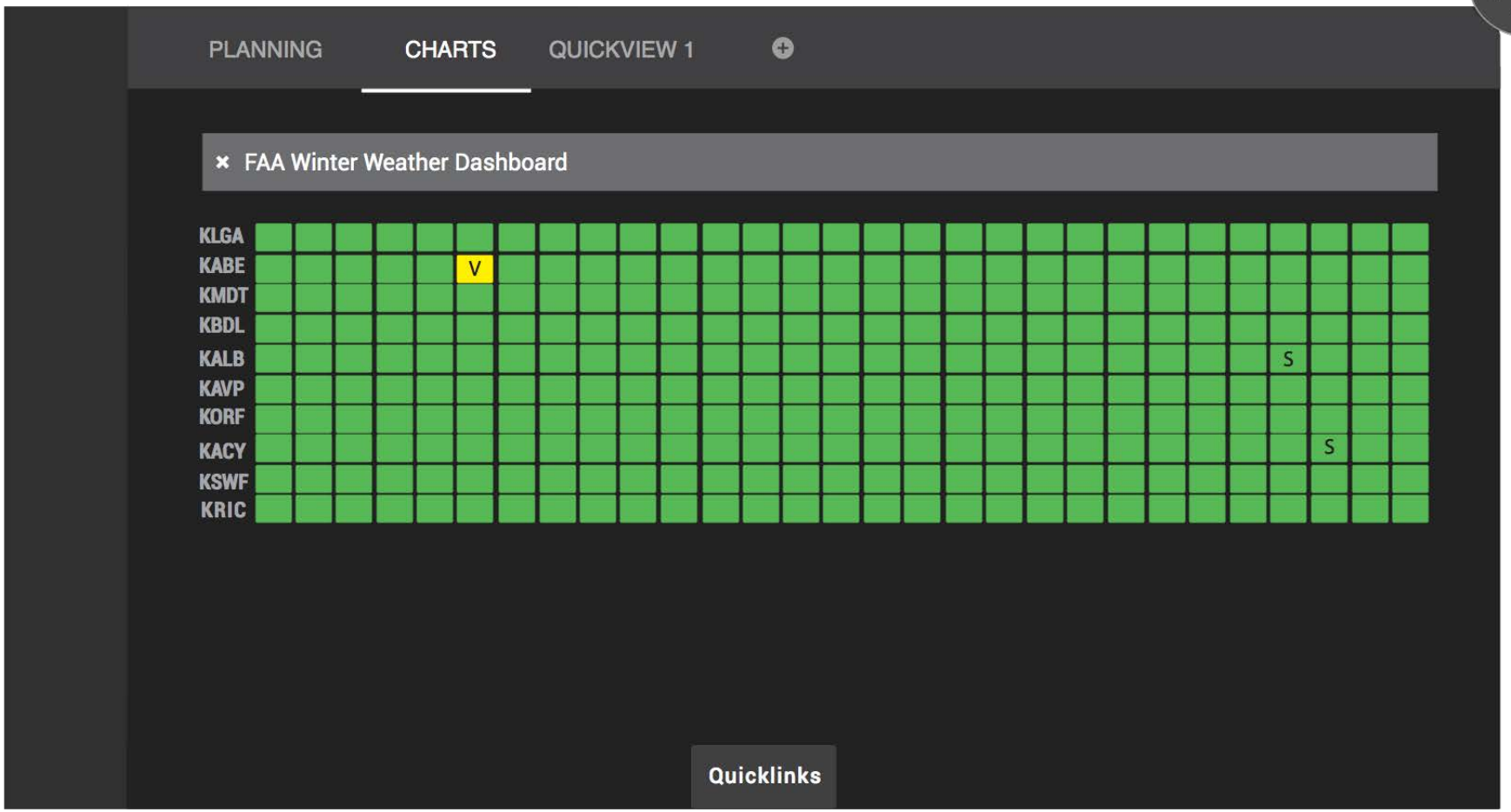
FACT Surface Map View



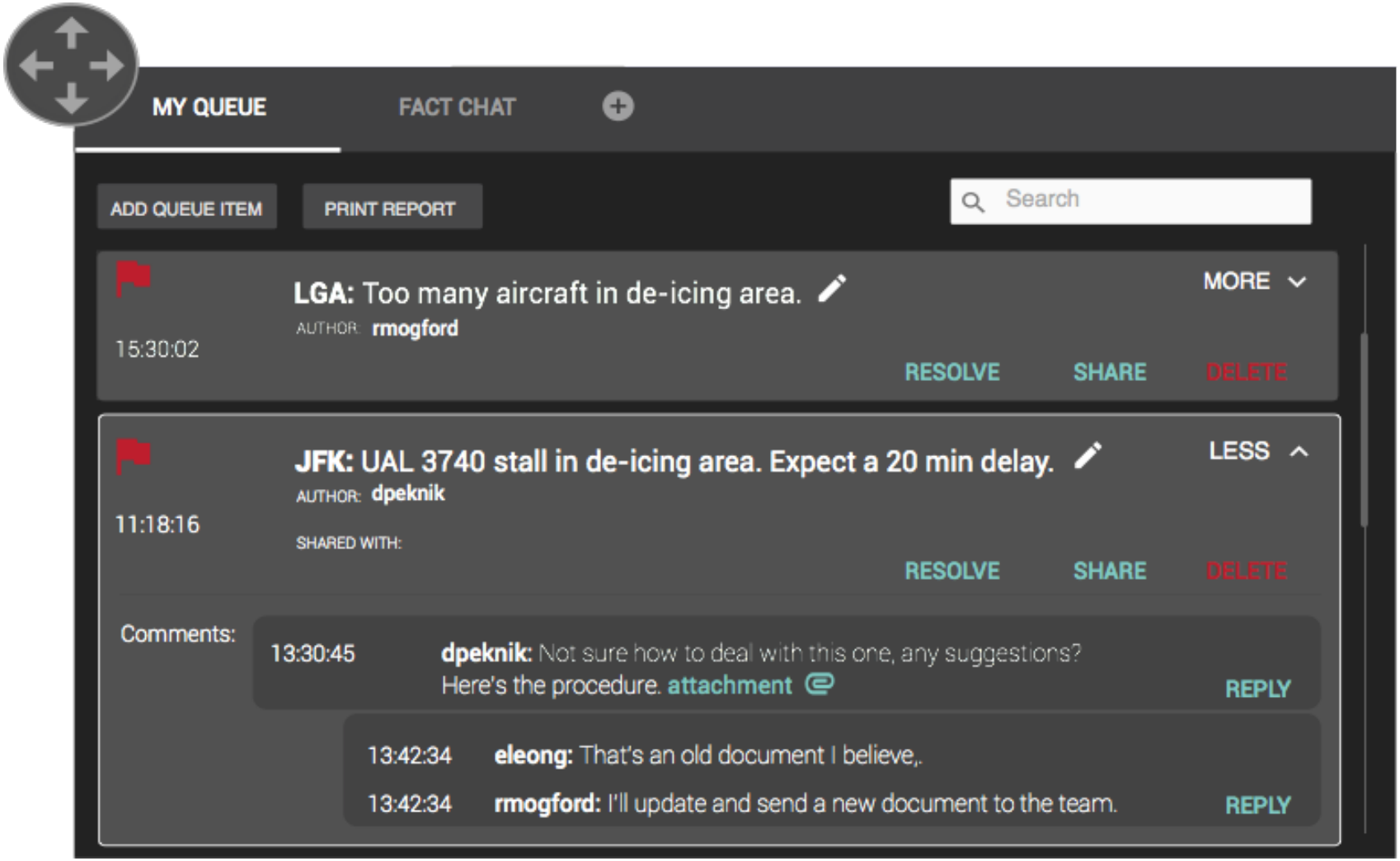
FACT Information View



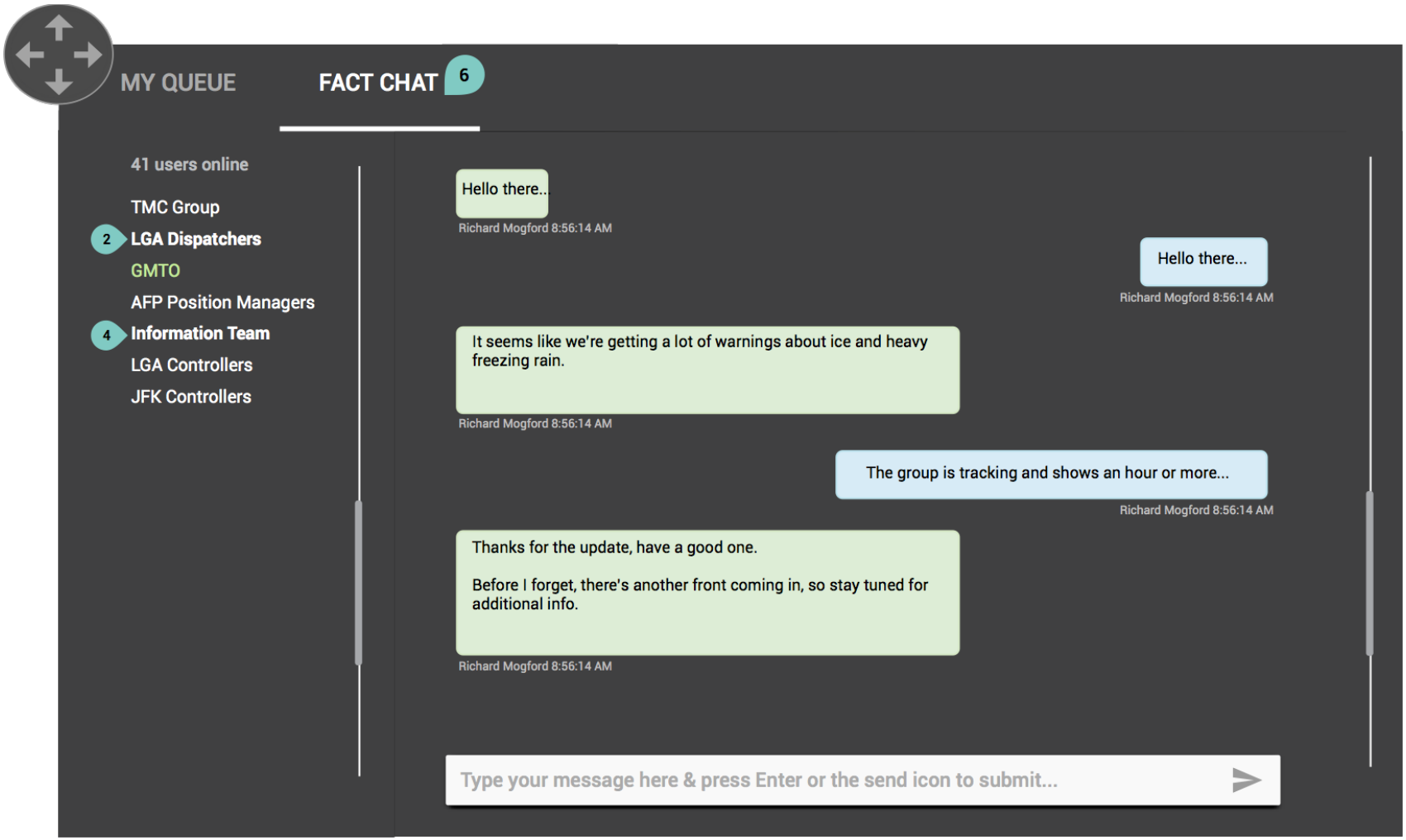
FACT Information View (Graphical)



FACT Communication View (MyQueue)



FACT Communication View (Chat)



Flight Awareness Collaboration Tool Status

- User interface designed completed and web-based prototype under development
- Winter Weather Airport Capacity Model being evaluated at several facilities
- Plan to begin showing FACT to the airlines in July 2017 to request feedback on functionality and user interface design
- Will visit Southwest Airlines in June to review FACT and other research issues
- Creating a forum for NASA/industry discussion of operational and research needs

Human-autonomy Teaming with the Dispatcher

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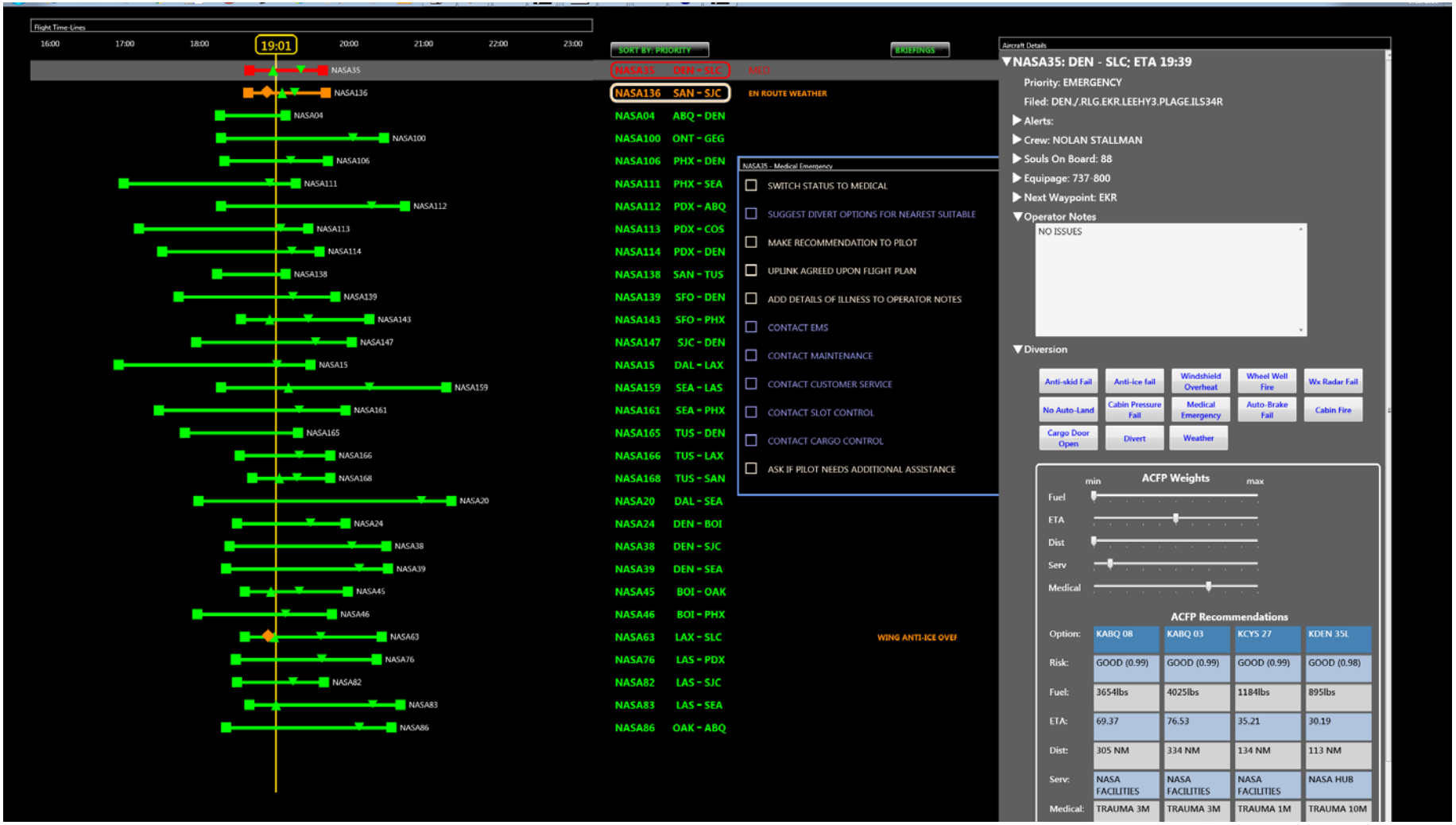
Problems with Automation

- Brittle
  - Automation often operates well for a range of situations but requires human intervention to handle boundary conditions
- Opaque
  - Automation interfaces often do not facilitate understanding or tracking of the system
- Miscalibrated trust
  - Disuse and misuse of automation have lead to real-world mishaps and tragedies
- Out–of-the-loop loss of situation awareness
  - Trade-off: automation helps manual performance and workload but recovering from automation failure is often worse

Human-autonomy Teaming with the Dispatcher

- Brittle
  - Negotiated decisions puts a layer of human flexibility into system behavior
- Opaque
  - Requires that systems be designed to be transparent and present rationales and confidence in solutions
  - Communication should be in terms the operator can easily understand (shared language)
- Miscalibrated trust
  - Automation display of rationale helps human operator know when to trust it
- Out–of-the-loop loss of situation awareness
  - Keep operator in control: adaptable, not adaptive automation
  - Greater interaction (e.g., negotiation) with automation reduces likelihood of being out of the loop

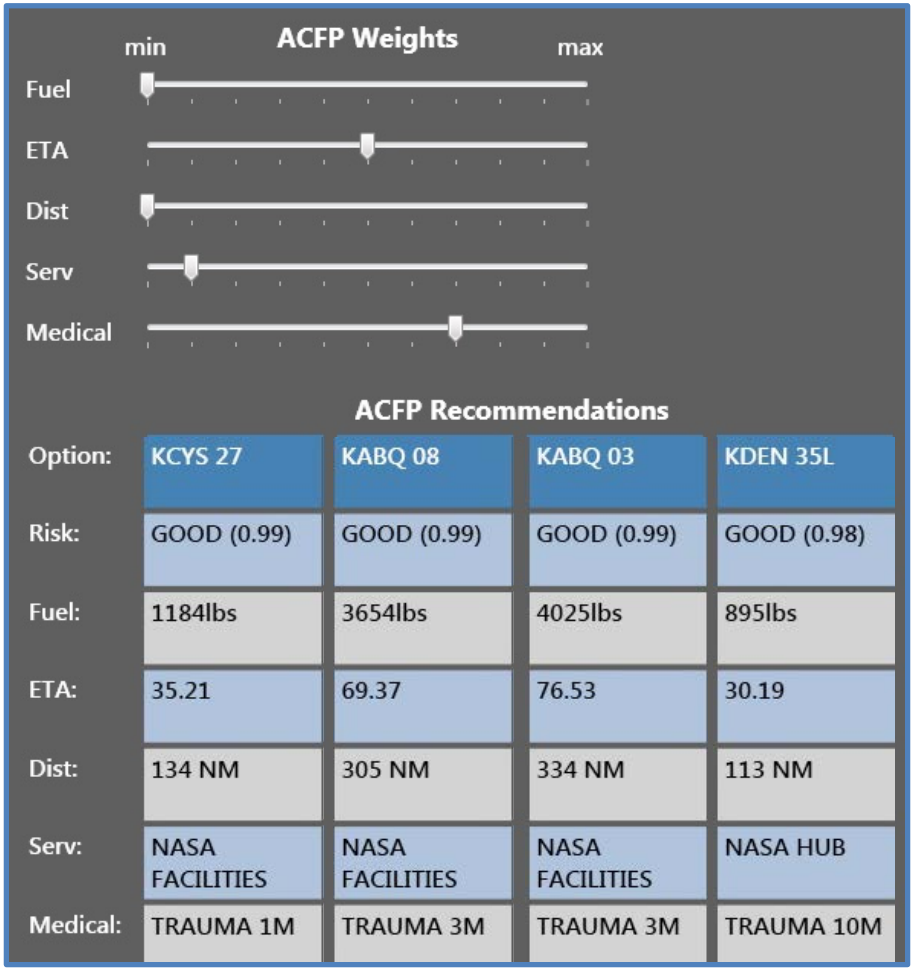
Human-autonomy Teaming and the Dispatcher



Flight list with Autonomous Constrained Flight Planner

Human-autonomy Teaming and the Dispatcher

- Transparency: Divert reasoning and factor weights are displayed
- Negotiation/dialog: Operators can change factor weights to match their priorities
- Shared language/communication: Numeric output from the Autonomous Constrained Flight Planner was found to be misleading by pilots
- Display now uses English categorical descriptions



ACFP Recommendations

Option:	KCYS 27	KABQ 08	KABQ 03	KDEN 35L
Risk:	GOOD (0.99)	GOOD (0.99)	GOOD (0.99)	GOOD (0.98)
Fuel:	1184lbs	3654lbs	4025lbs	895lbs
ETA:	35.21	69.37	76.53	30.19
Dist:	134 NM	305 NM	334 NM	113 NM
Serv:	NASA FACILITIES	NASA FACILITIES	NASA FACILITIES	NASA HUB
Medical:	TRAUMA 1M	TRAUMA 3M	TRAUMA 3M	TRAUMA 10M

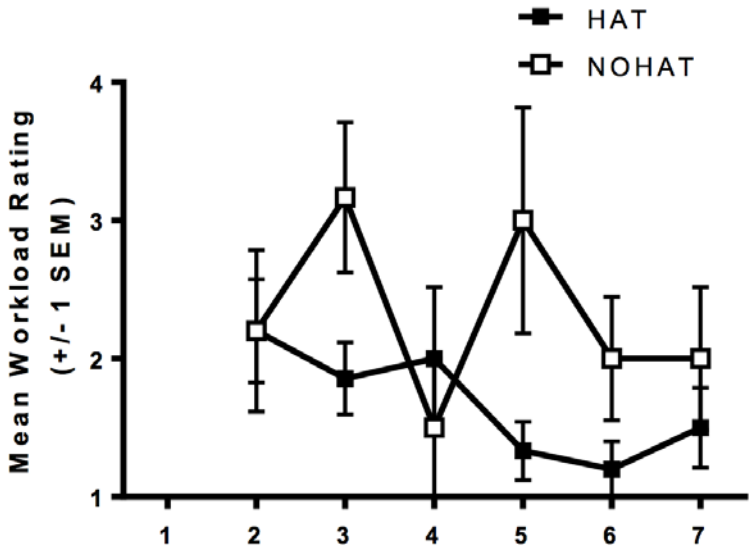
Autonomous Constrained Flight Planner

Human-autonomy Teaming and the Dispatcher

- Participants, with the help of automation, monitored 30 aircraft
- Alerted pilots when
  - Aircraft was off path or pilot failed to comply with clearances
  - Significant weather events affect aircraft trajectory
  - Pilot failed to act on EICAS alerts
- Rerouted aircraft when
  - Weather impacted the route
  - System failures or medical events force diversions
- Ran with and without human-autonomy teaming (HAT) tools

Human Autonomy Teaming and the Dispatcher

- Participants preferred the HAT condition overall (rated 8.5 out of 9)
- HAT displays and automation preferred for keeping up with operationally important issues (rated 8.7 out of 9)
- HAT displays and automation provided enough situational awareness to complete the task (rated 8.7 out of 9)
- HAT displays and automation reduced the workload relative to no HAT (rated 8.3 out of 9)



Infrasound Turbulence Detection

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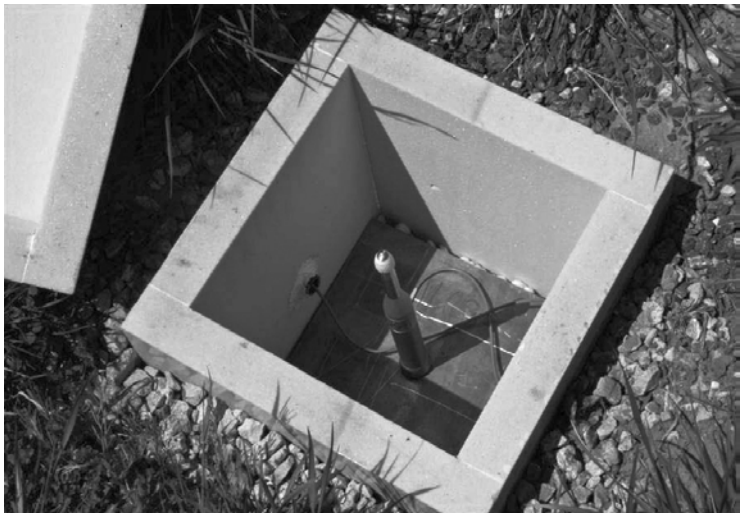
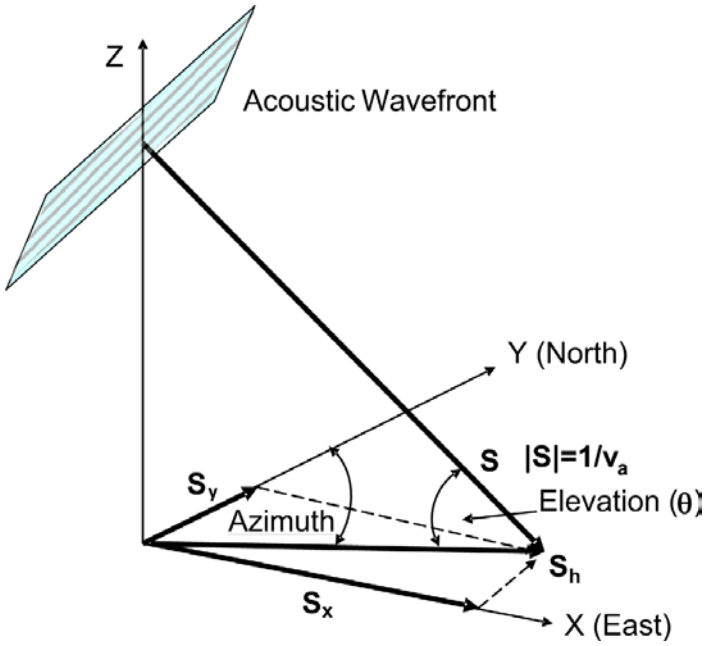
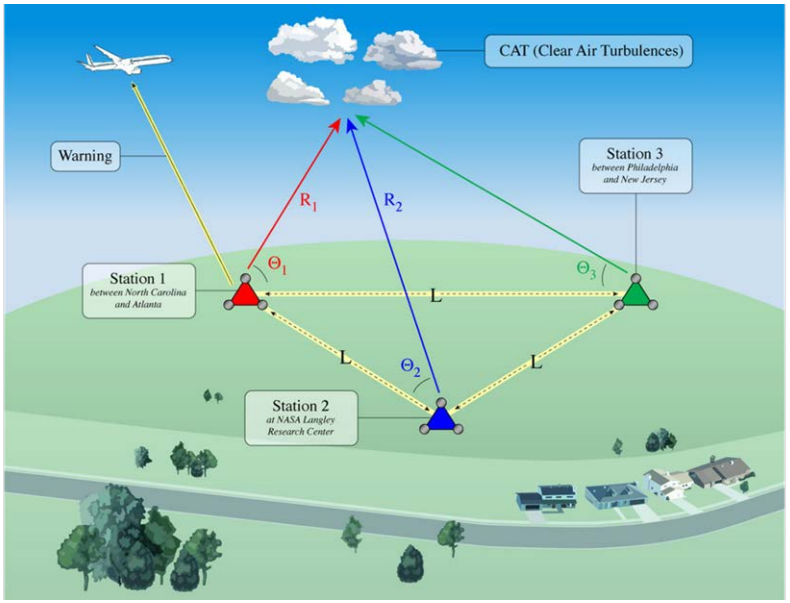
Infrasound Turbulence Detection Feasibility Study

- Partnering with University Corporation for Atmospheric Research to determine if clear air turbulence detection by infrasonic microphone arrays is feasible
- Dr. Qamar Shams at NASA Langley has an array set up but additional arrays will increase accuracy
- Study objectives:
  - What are the spectral characteristics of the acoustic energy?
  - How are the spectral characteristics of the acoustic energy related to turbulence intensity metrics (e.g., energy dissipation rate), that in turn can be related to aircraft response?
  - What are the transmission properties of the acoustic signal, i.e., attenuation, refraction, and diffraction, as the acoustic waves propagate from the source to the receivers?
  - Given proposed geometries of a receiver array, what are the temporal and spatial accuracies that can be achieved?
  - What are the appropriate signal processing methods to ensure adequate detection and minimal false alarms?

Infrasound Clear Air Turbulence Detection Feasibility

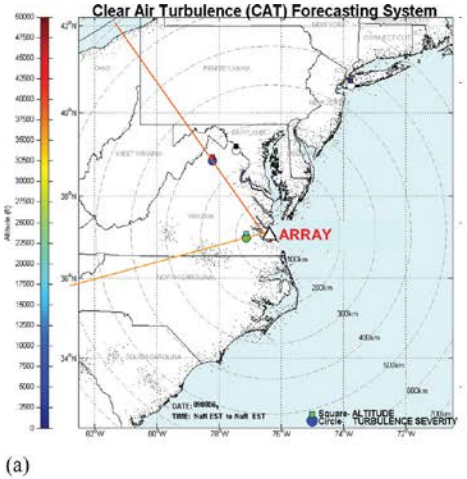






Microphone Array and Detection Example

Infrasound Turbulence Detection



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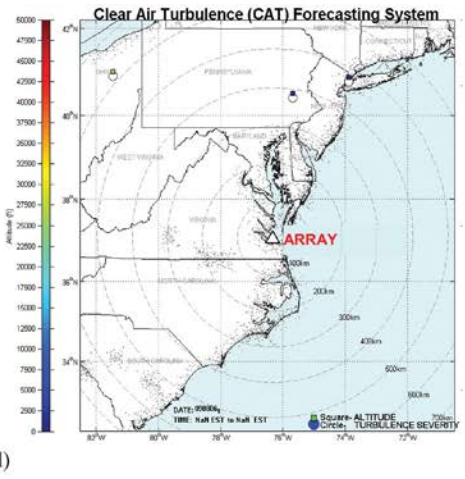

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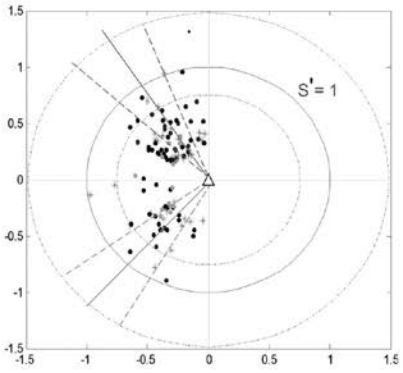

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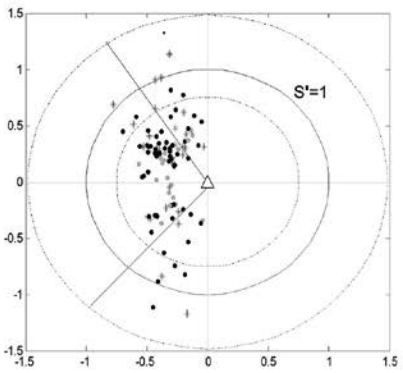

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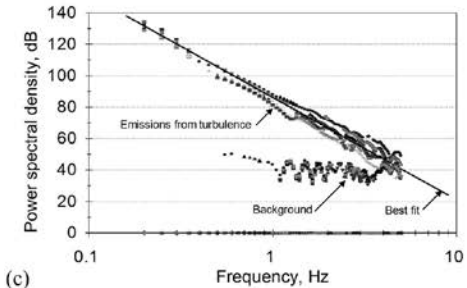

(c)

Clear Air Turbulence Detection Event

Traffic Aware Strategic Aircrew Requests

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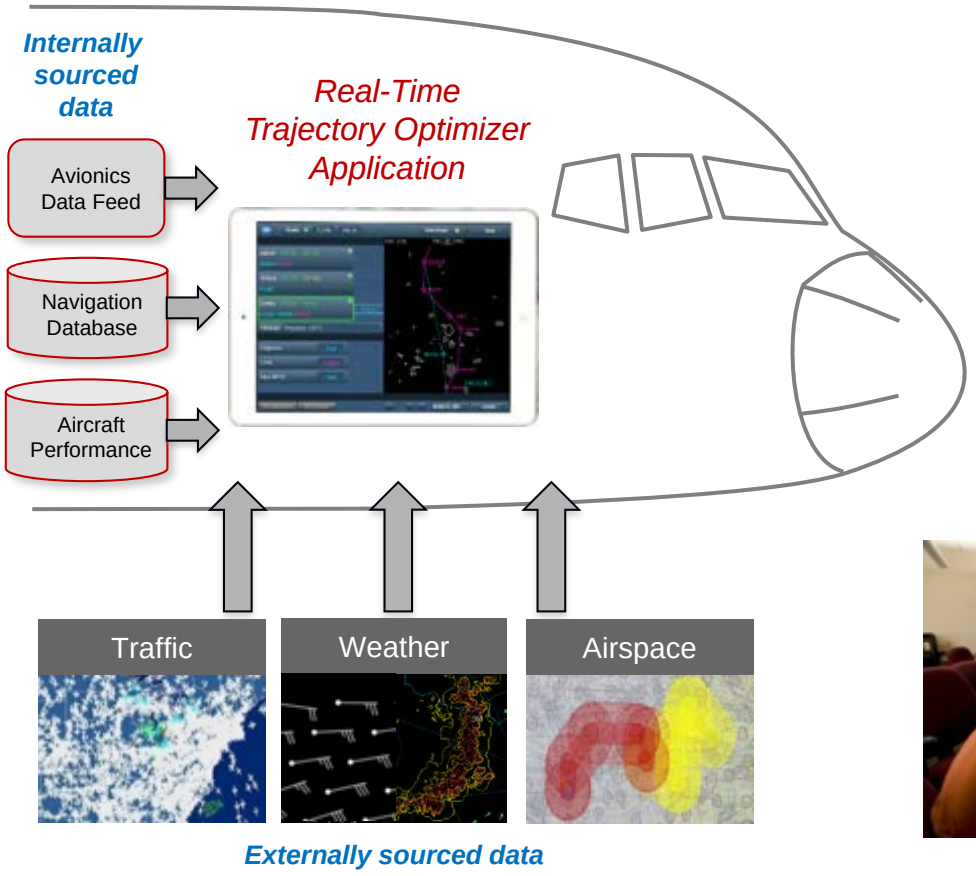
Traffic Aware Strategic Aircrew Requests

Enhanced User Request Process leveraging Cockpit Automation and Networked Connectivity to real-time operational data to optimize an aircraft's trajectory en route

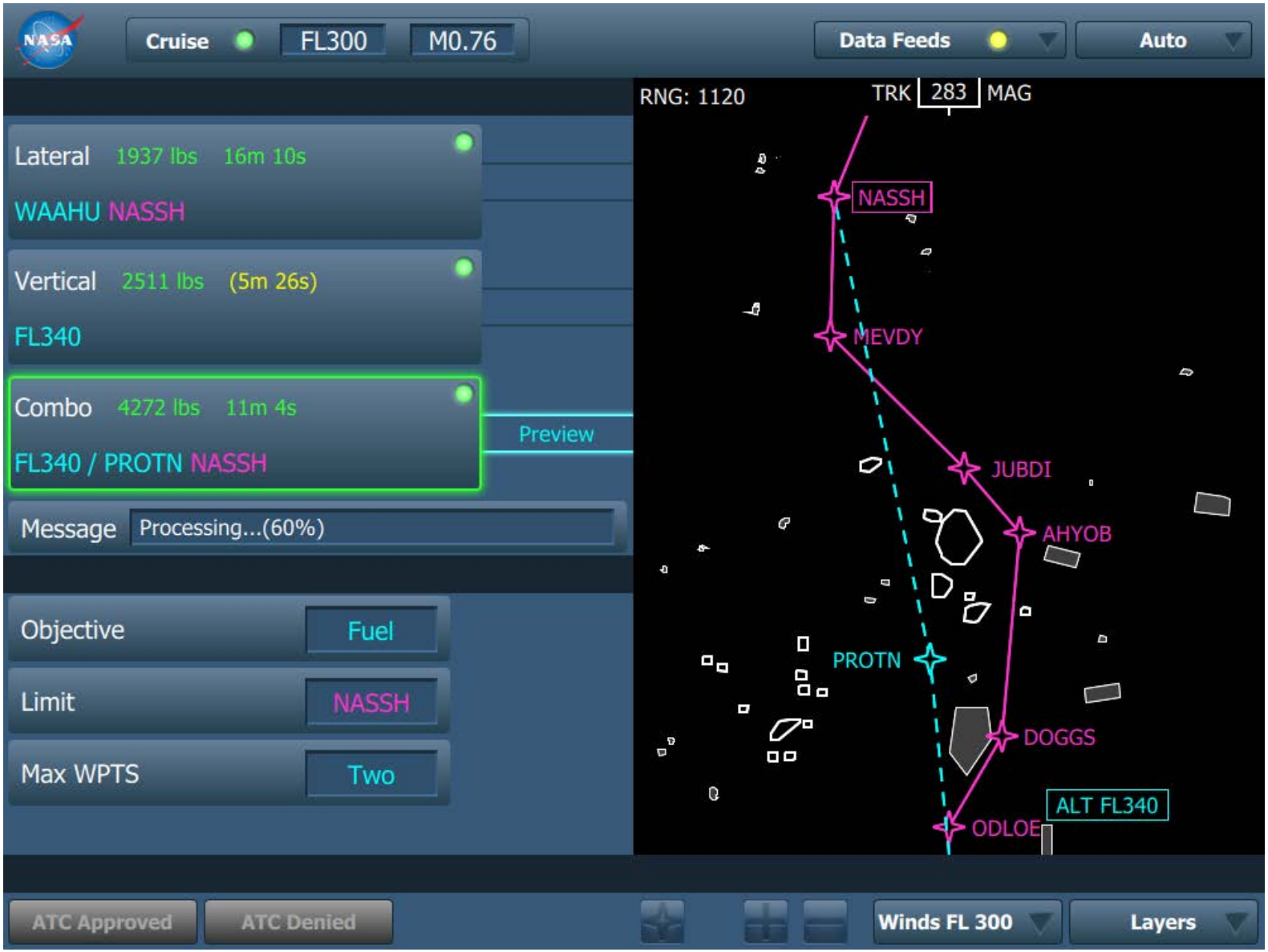


Increased flight efficiency

Enhanced ATC request/ approval process

Enhanced dispatch/aircrew coordination

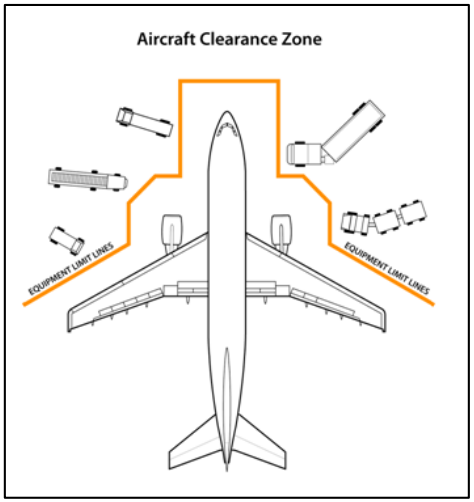
Traffic Aware Strategic Aircrew Requests



Visual Detection in Aircraft Safety Zone

Visual Detection in Aircraft Safety Zone

- Develop approaches to reducing ground vehicle incidents
  - Will analyze ramp area video recordings provided by Southwest Airlines
  - Determine if ground vehicle incursion into aircraft safety zone can be detected or prevented



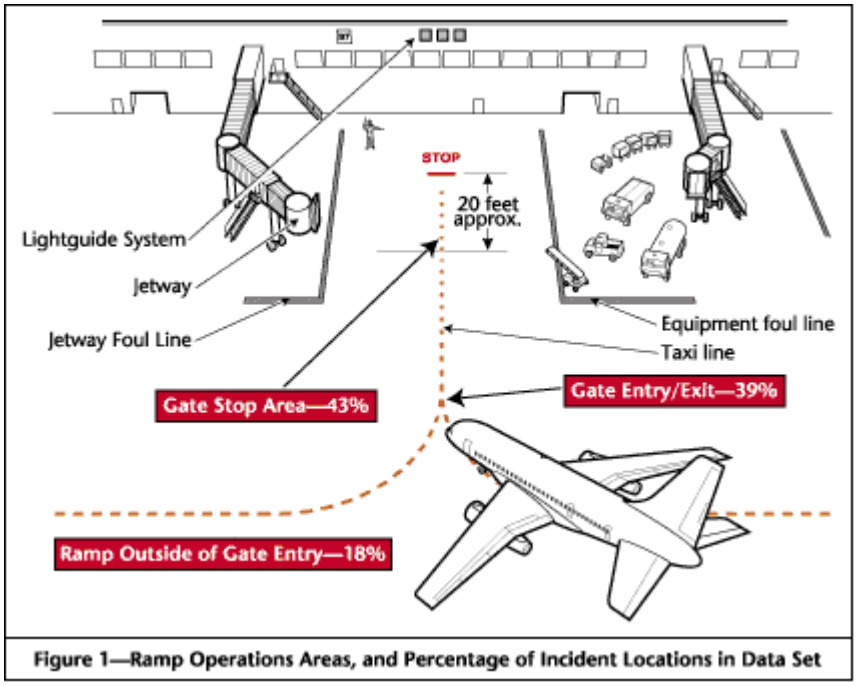


Figure 1—Ramp Operations Areas, and Percentage of Incident Locations in Data Set

Accident Percentages in Aircraft Clearance Zones

Questions?

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Work With Us!

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