Insights Gained from the Ongoing Integrated Arrival/Departure/Surface (IADS) Traffic Flow Operational Prototype

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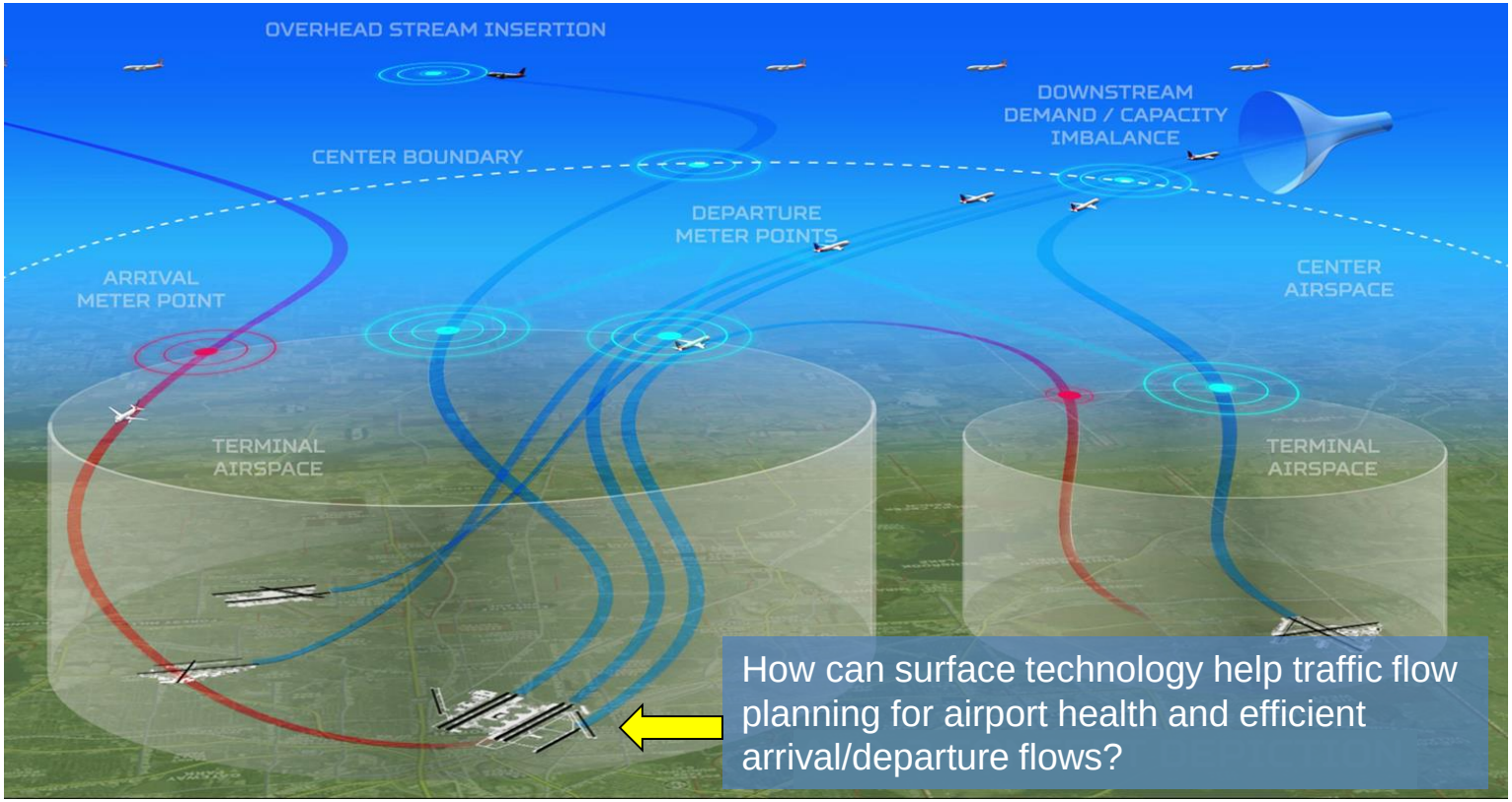
Learning Objectives

- Learning objectives:
  - Understand the collaborative integrated environment in which the future surface system will operate and the importance of wholistic traffic flow measures
  - Identify several traffic flow capabilities on the horizon with the surface system and insights gained from ongoing prototyping and analysis

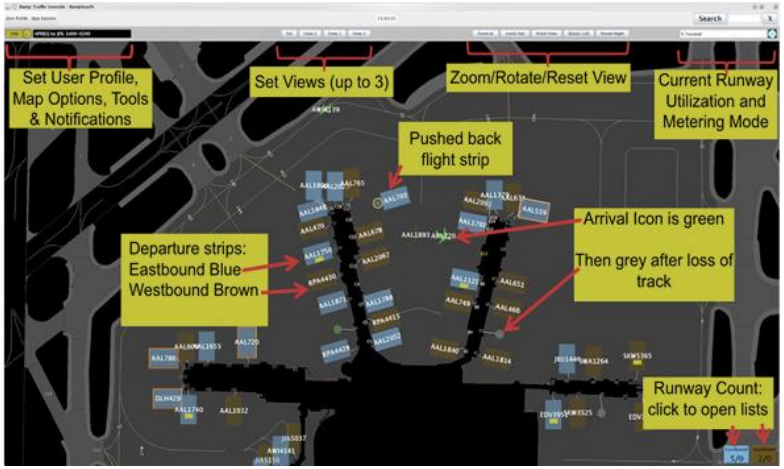


Overview video online at: http://aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2.shtml

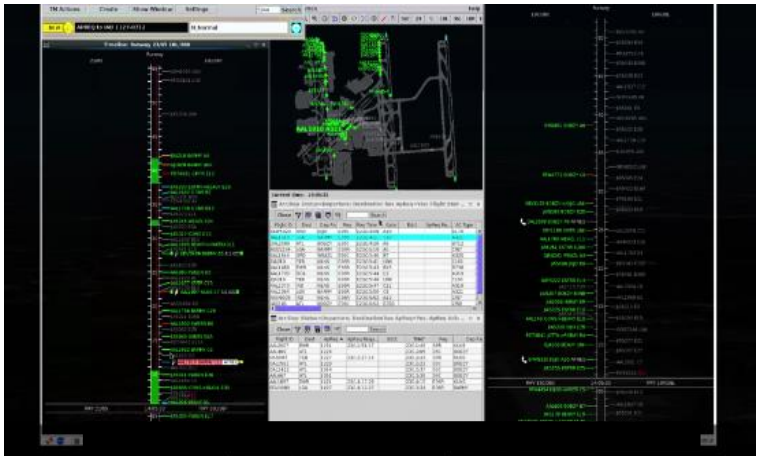
Airspace Technology Demonstration 2 (ATD-2)

ATD-2 is a ***field demonstration*** that evaluates the benefits of ***wholistic consideration*** of arrival, departure and surface (***IADS***) traffic flows while introducing new technologies and procedures into its ***collaborative operational environment***

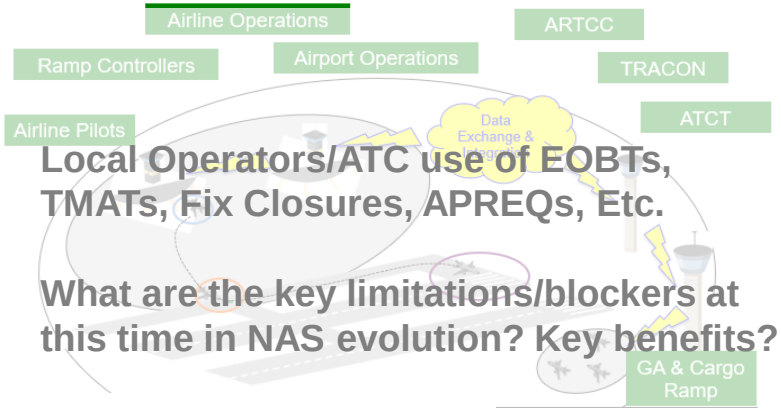
Collaborative Surface Metering w/Ramp Tool



Overhead Stream Operational Integration

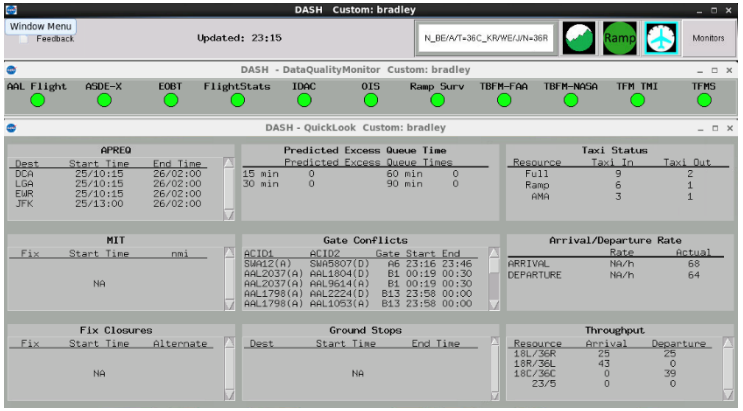


ATC/Operator Data Exchange and Integration



- **Local Operators/ATC use of EOBTs, TMATs, Fix Closures, APREQs, Etc.**
- **What are the key limitations/blockers at this time in NAS evolution? Key benefits?**

Collaborative Planning the Real-Time Flow



ATC/Operator Data Exchange and Integration Foundational for Advanced Surface Capability

ATC to Operator

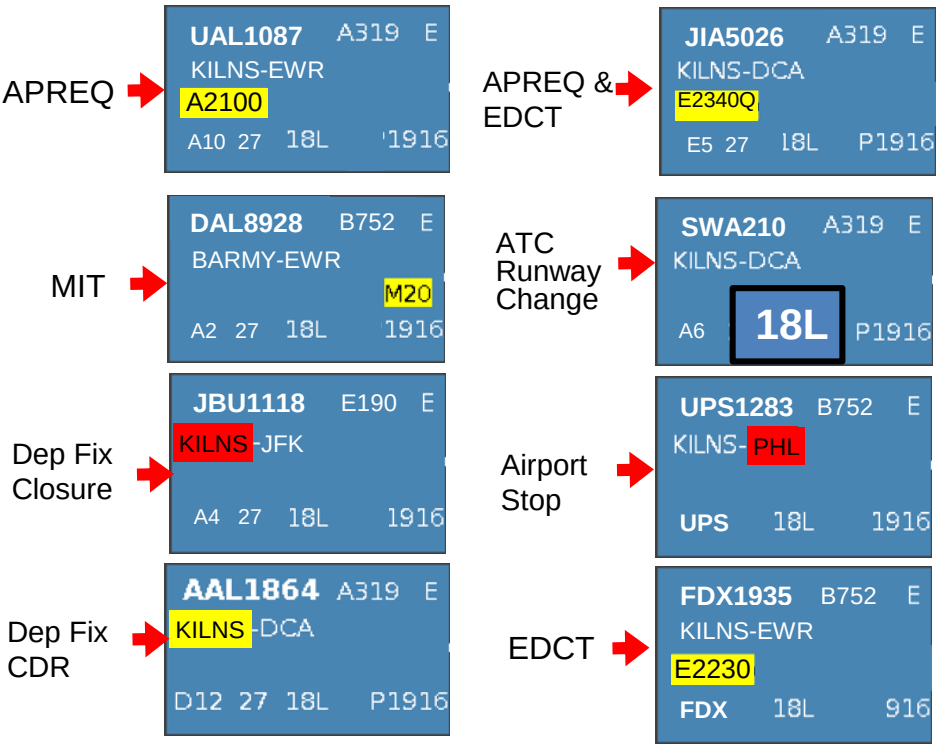
Displayed in Ramp Operations

Operator to ATC

ATC Use of Earliest OFF Block Times (EOBT)

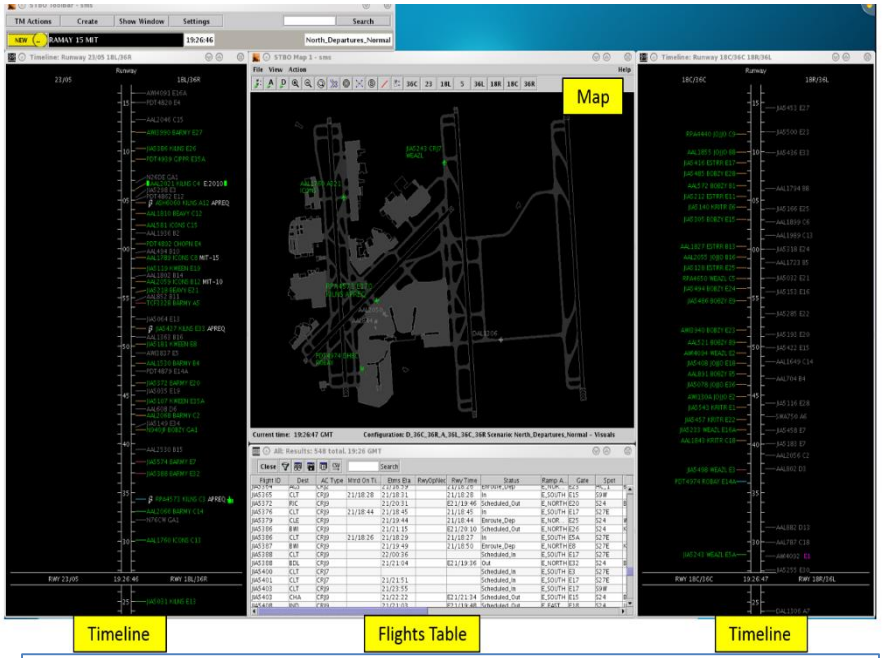
EOBT prediction accuracy increases at:

- 10m prior. 40.9% more accurate w/17.6% more predictability
- 15m prior. 27.8% more accurate w/8.7% more predictability
- 20m prior. 35.1% more accurate w/6.7% more predictability
- For 25 minutes and greater. EOBTs are same as legacy



Better gate conflict information

Better runway intent information



TMC Planning Display with Traffic Forecast

ATC/Operator Data Exchange and Integration Research Questions and Insights

Research questions the field demonstration is seeking to inform

- There are many uses of Earliest Off Block Times (EOBTs), some with competing goals. The same EOBT prediction is used for TMC planning, overhead stream insertion, downstream system integration and surface metering. Given this, what are the most important EOBT metrics that Operators can use as a guideline? How does improvement in EOBT equate to benefit for the broader aviation community?

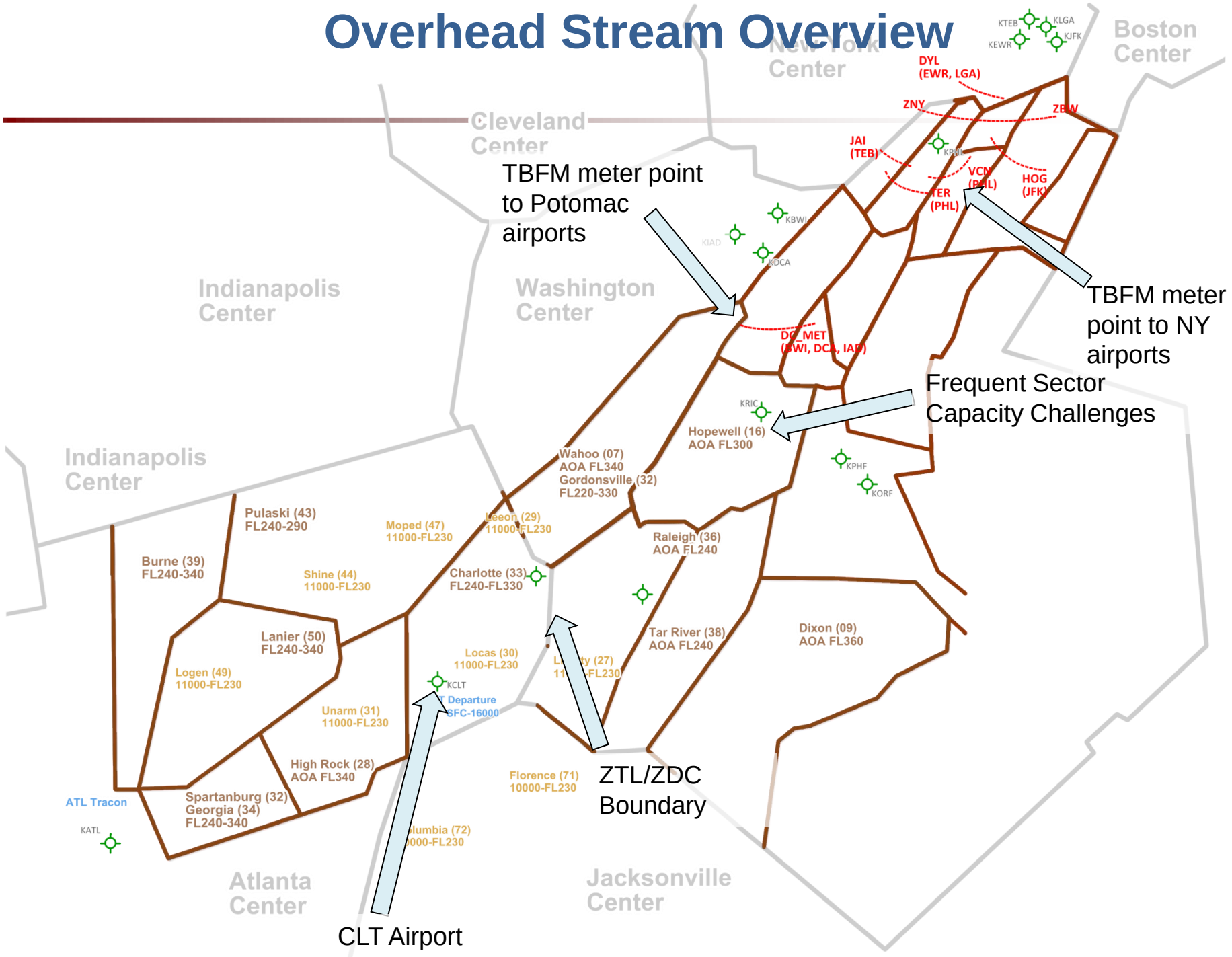
- How should Operators more fully integrate tactical overhead stream scheduling (“wheels up”) information into their operations to fully support future Trajectory Based Operations (TBO) goals and greater predictability?

Insights from field demonstration

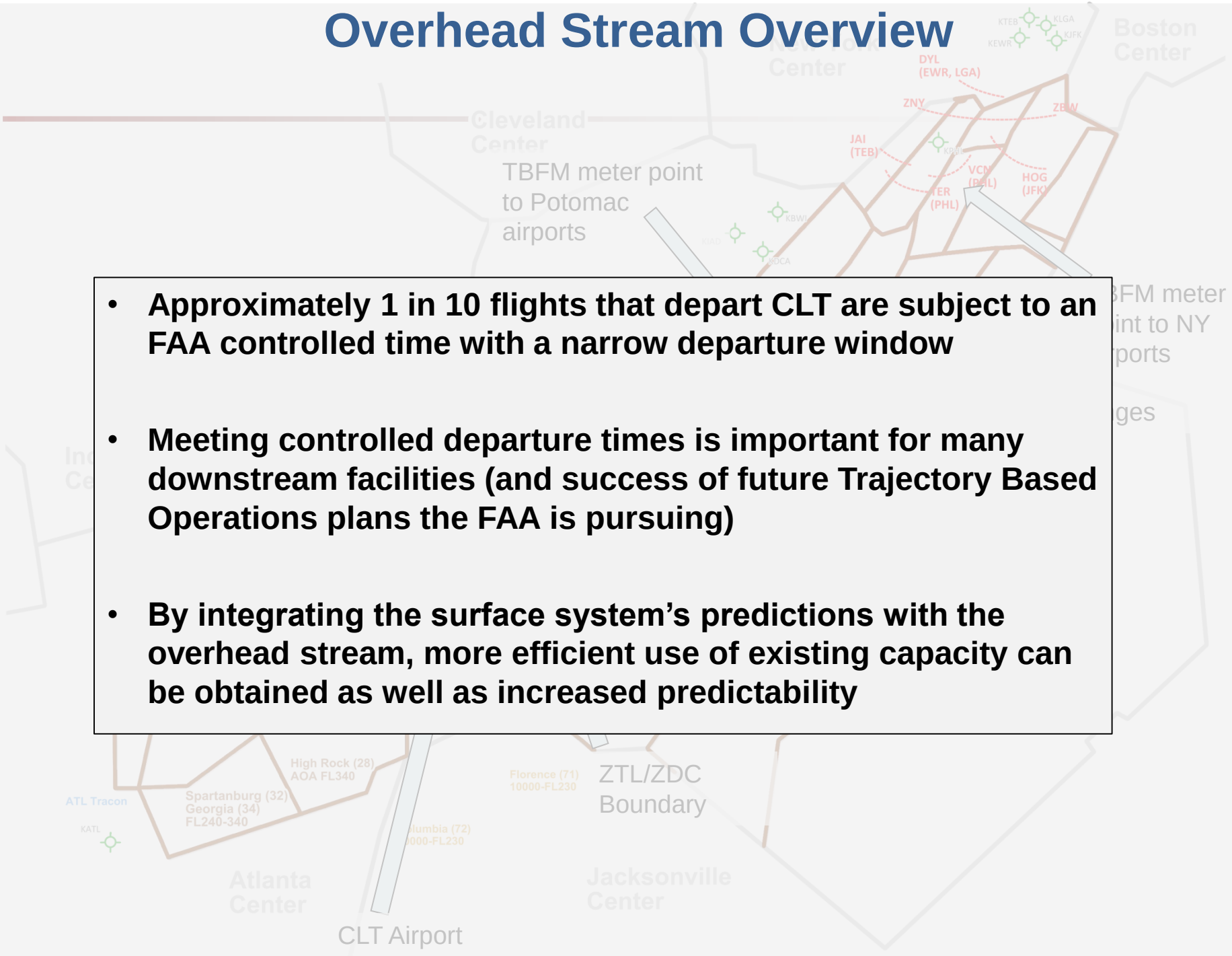
- High quality gate conflict detection information is important to overall surface health. Arrival flight backups in the ramp can extend into the airport movement area and lead to surface gridlock. High quality gate conflict information in turn leads to the need for high quality arrival data, as well as inputs to keep up with untracked flights in the ramp.

- Integrating new data into an intuitive display for complex ramp operations requires procedural and cultural changes. The ramp traffic console in operational use at CLT has a number of ‘best practices’ integrated from these lessons to help facilitate this transition.

Overhead Stream Overview



Overhead Stream Overview

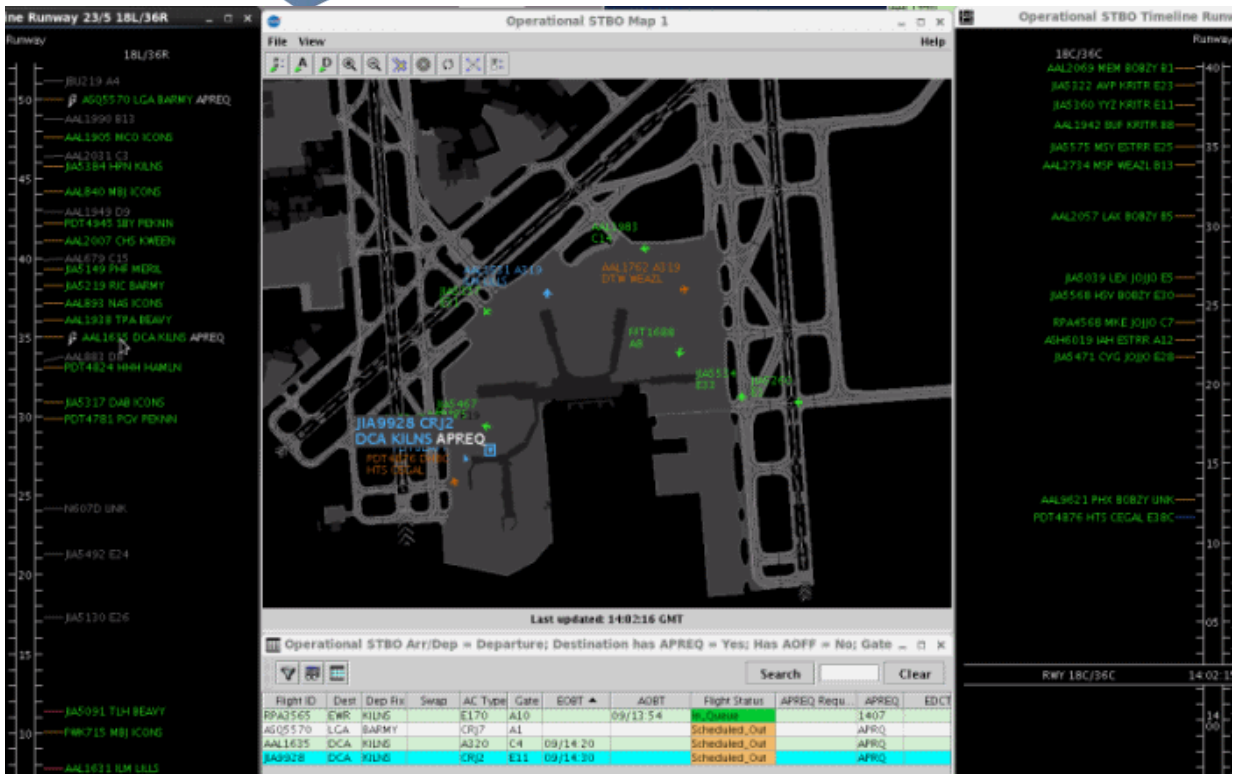


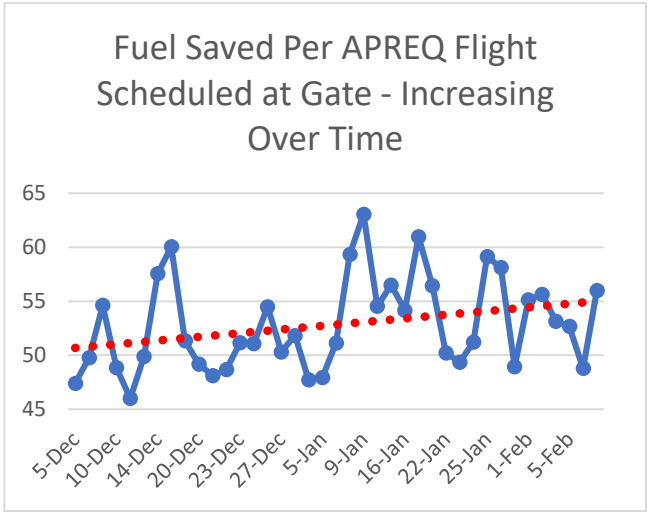
- **Approximately 1 in 10 flights that depart CLT are subject to an FAA controlled time with a narrow departure window**
- **Meeting controlled departure times is important for many downstream facilities (and success of future Trajectory Based Operations plans the FAA is pursuing)**
- **By integrating the surface system's predictions with the overhead stream, more efficient use of existing capacity can be obtained as well as increased predictability**

Overhead Stream Operational Integration Benefits Preview

22.5 hours of delay saved by electronically renegotiating a better overhead stream time for over 172 flights. Trending upward.

42,824 lbs. of fuel saved by scheduling APREQs at gate. Trending upward.





- The benefits described here are associated with better use of existing capacity in the overhead stream, and technology to reduce surface delay.
- These benefits are in addition to (distinct from) surface metering savings.

Overhead Stream Operational Integration Research Questions and Insights

Research questions the field demonstration is seeking to inform

- What is the ideal look-ahead scheduling time horizon considering the tradeoffs between scheduling too early with uncertain data that can lead to re-planning, versus too late with more predictive certainty but less ability to hold delay at the gate?

- What are the important trade off considerations when calibrating surface generated taxi out times? Erring on the ambitious side of taxi estimates can lead to less airport movement area delay but more re-planning, versus on the conservative side with less re-planning but more airport movement area congestion.

Insights from field demonstration

- Showing available overhead stream capacity (“red space, green space”) to surface planners in an integrated and intuitive manner can reduce delay and lead to substantial benefits.

- Target Movement Area entry Times (TMATs) are an important hand off point for FAA controlled flights and Operators. However, treating TMATs for both surface metering and FAA controlled flights of equal importance to Operators may have the undesired side-effect of de-accentuating the importance of FAA controlled flights which have NAS-wide impact.

Surface Metering Process Flow Overview

1 Generate Demand and Capacity Predictions

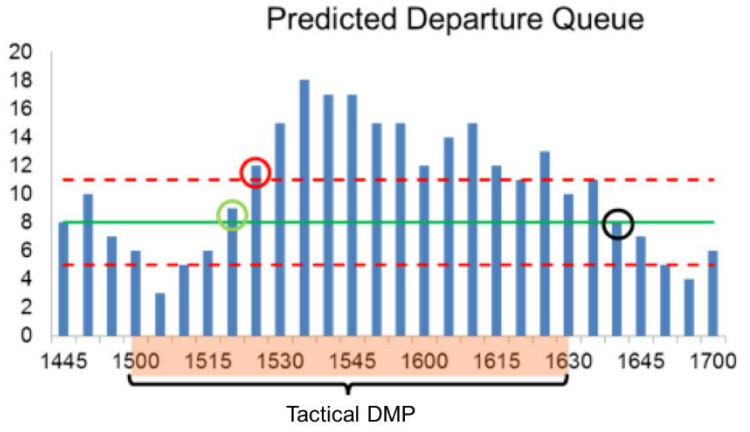
ATC TMC Runway Utilization Intent →
TRACON controller runway intent →
Highly accurate TBFM de-conflicted ON time estimate →
TFM SWIM ETAs →
TMIs. Controlled Take Off Times (CTOT) →
Flight Operator Provided EOBTs →
Tactical airline intent (ramp controller) →

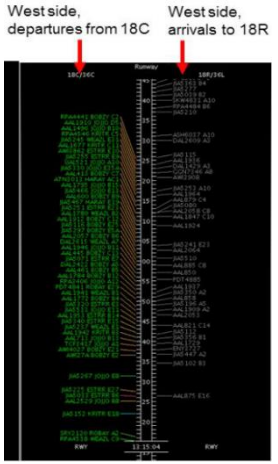
Surface Predictive Engine
(Updates every 10 seconds)

Surface modeling logic
- Earliest IN time estimate
- Earliest OFF time estimate
- Latest OUT estimate
- Pushback duration model
- Ramp and AMA taxi time
- Trajectory hovering logic

Scheduling Logic:
- Converging runways
- Flight spacing requirements
- Dual use runways
- Runway crossing delays
- Departure fix separation
- Use of flight state

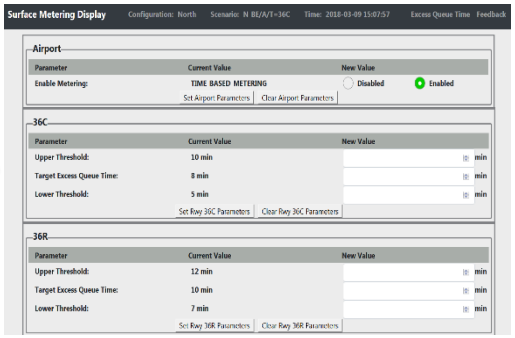
2 Monitor Surface Demand Capacity Imbalances





"What If" available. If Surface Metering, Go to Step 3

3 Enable Metering. Set Hold Level

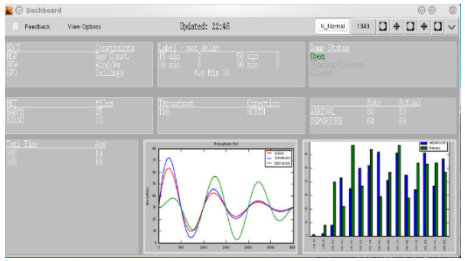


4 Honor TOBT and TMAT advisories

TOBT Advisory →

TMAT Advisory →

5 Evaluate Metering Effectiveness

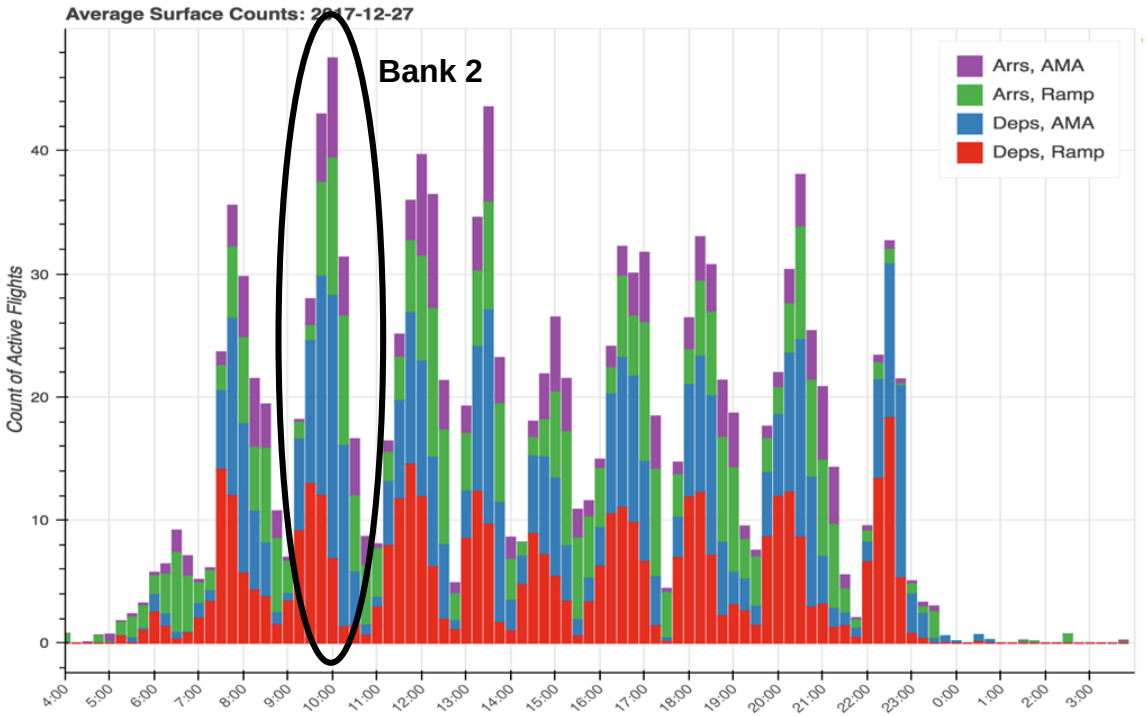


Local Surface Demand/Capacity Imbalance

- Surface metering seeks to shift existing excess taxi time to the gate to allow a more fuel efficient and environmentally friendly departure

- Surface metering is enabled during local demand/capacity imbalances on the surface of the airport. This is distinct from down stream (airspace) imbalances.

- Surface metering at CLT was evaluated beginning with the largest bank of the day (bank 2), and has recently begun expanding to other banks

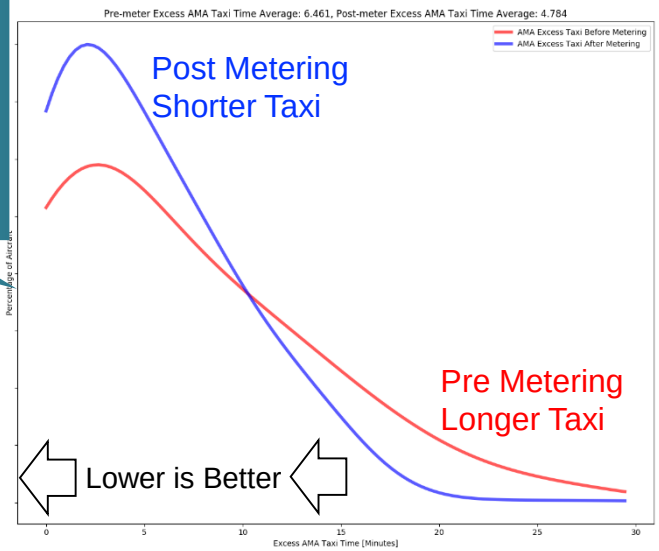


CLT has 9 banks a day

Collaborative Surface Metering Benefits

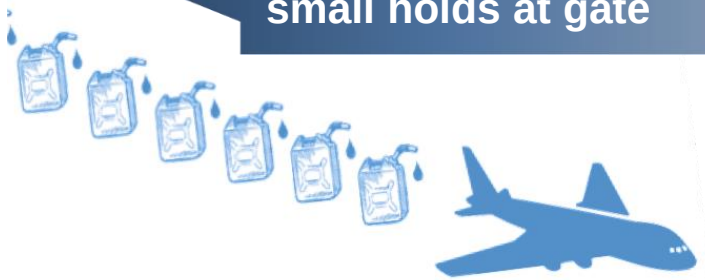
Initial benefits observed from S-CDM surface metering during Bank 2 and 3 at CLT:

Reduced AMA taxi out times during its use via small holds at gate

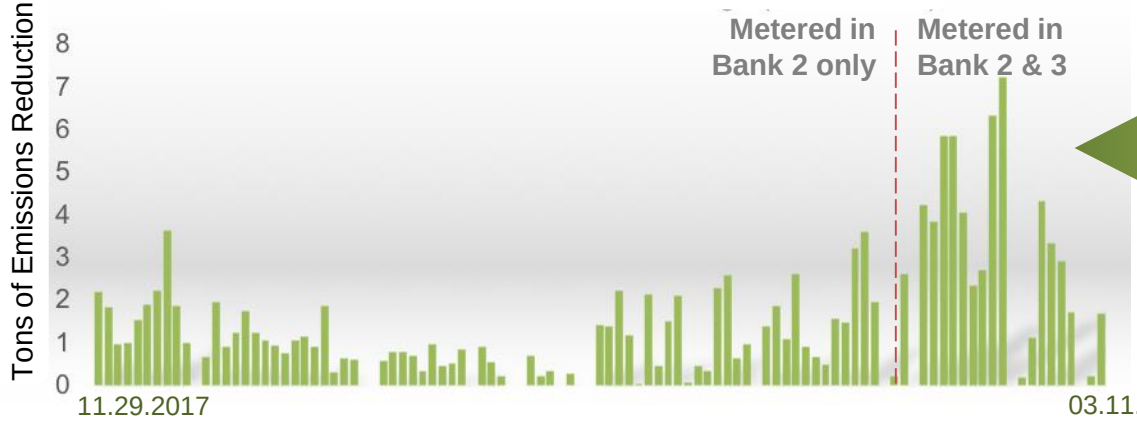


AMA Excess Taxi Duration

Saved approximately 104,339 lbs of fuel by small holds at gate



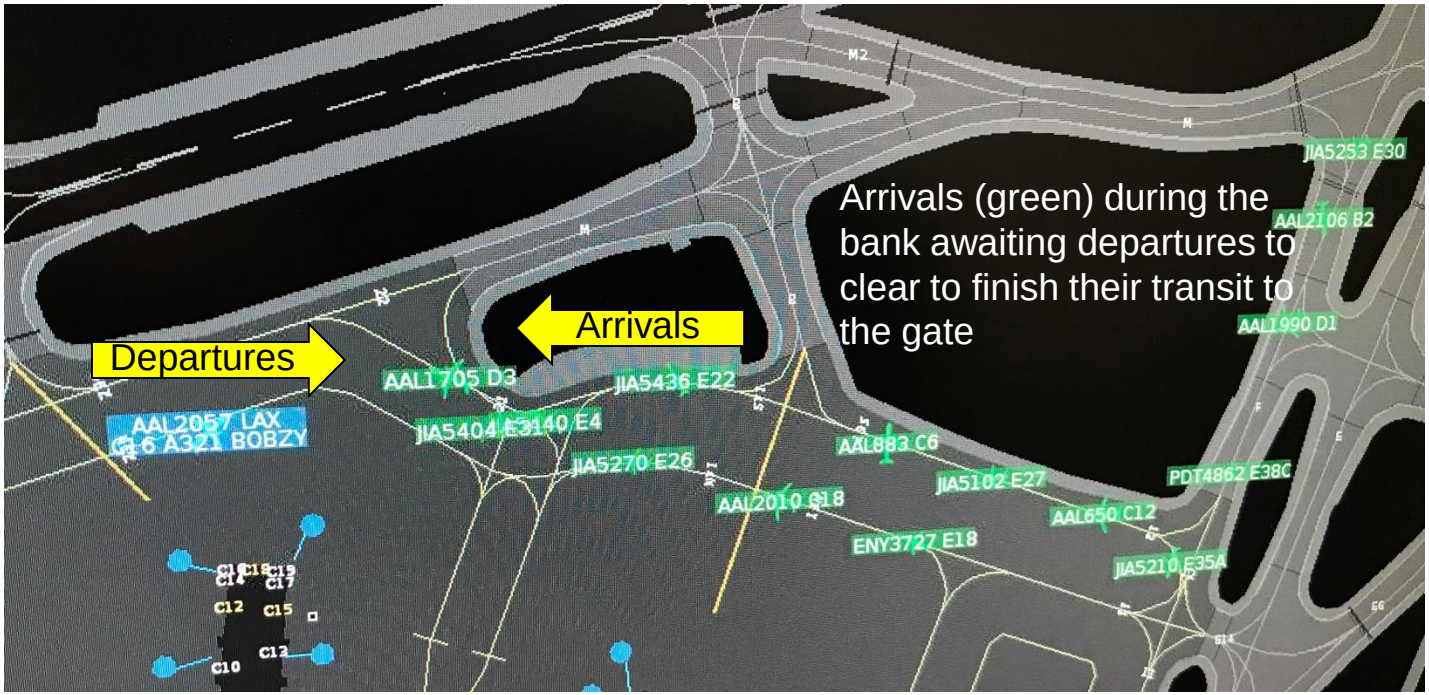
Emissions Reduction During Surface Metering



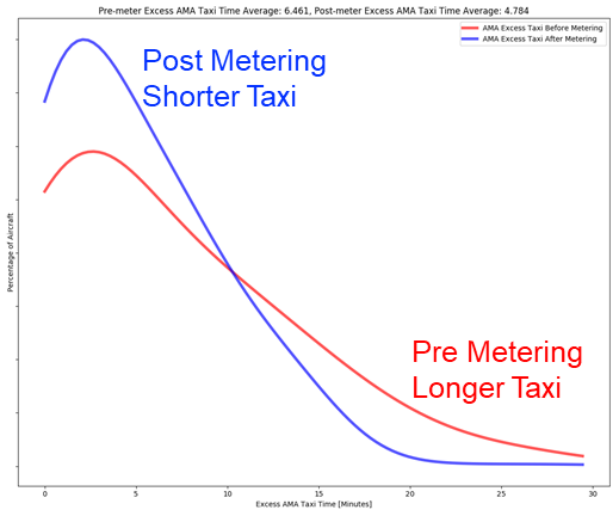
Saved approximately 146 metric tons of emissions, equivalent to planting 3,738 urban trees

Importance of Surface Health In Collaborative Traffic Flow Decisions

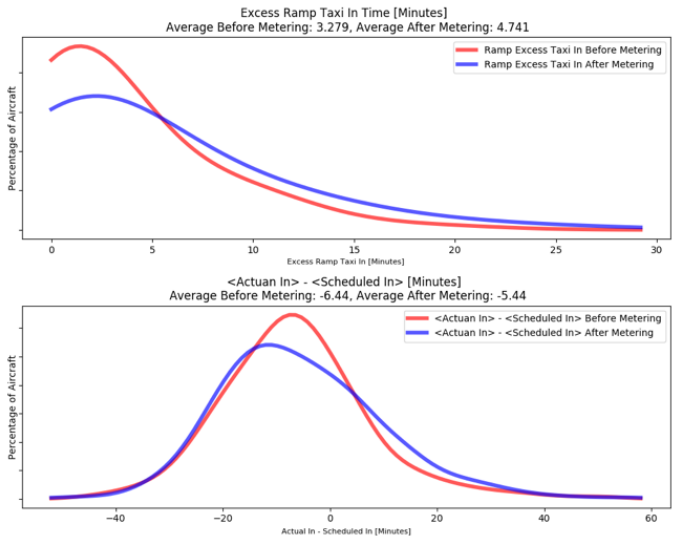
- Below, a departure (in blue) pushes back in the ramp to depart on time. This causes multiple arrival flights to delay their final taxi to the gate.
- Challenges in the ramp can extend back to the airport movement area
- Traffic flow decisions that involve both the ramp and airport movement area are traditionally beyond the scope of either group



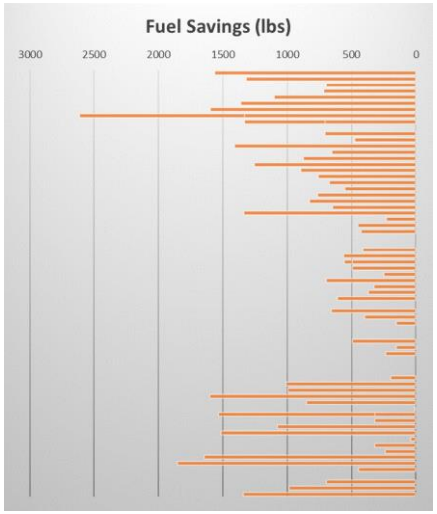
Need: Wholistic Measurements of Traffic Flow
"Do No Harm" While Achieving Benefits



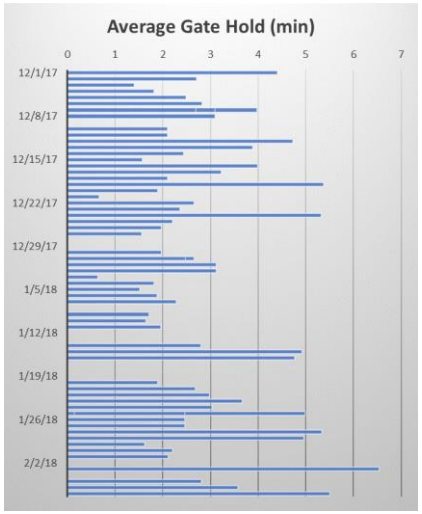
Taxi Out Aggregate



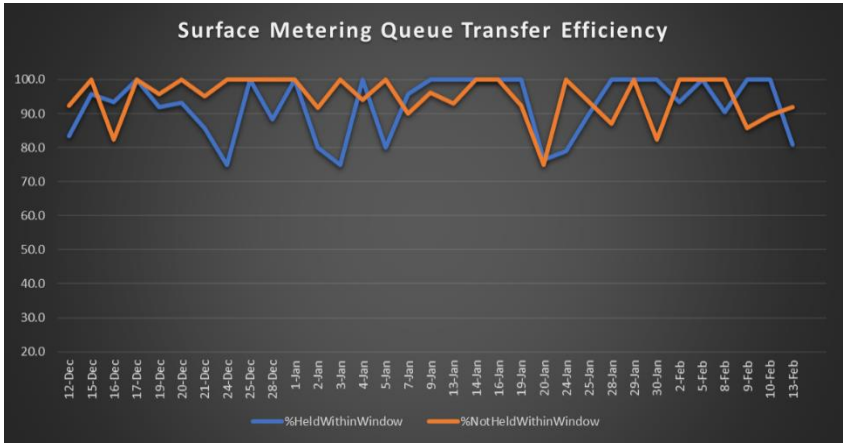
Taxi In and A14 (Arrival late) for Inbound



Fuel/Emissions Savings



Size of Gate Holds



Queue Transfer Efficiency to Ensure no Harm for Outbound A14 (downstream arrival late)

Collaborative Surface Metering w/Ramp Tool Research Questions and Insights

Research questions the field demonstration is seeking to info

- At what look-ahead time are the pre-departure predictions accurate enough to finalize the surface metering plan while also allowing advanced notice of gate holds for stakeholders?

- How does arrival configuration and TMC runway utilization strategy factor into surface metering decisions? Do certain flows not lend themselves to surface metering given negative impact to wholistic stakeholder metrics? How does the calibration change by flow?

Insights from field demonstration

- For maximum benefit, the ability to front load a surface metered bank is important to both departure and arrival flows. Otherwise, a ‘slow start’ to releasing flights from the gate may ripple through the departure metering procedure which can negatively impact performance.

- Given current levels of EOBT accuracy, using actual flight pushback/taxi is useful to start and stop metering. Using actual demand on the surface for metering initialization gives substantially more predictability of metering performance and leads to more consistent taxi out.

What is Next for ATD-2?

Phase 2 (Fusion, Sept 2018)

- Strategic planning tools (strategic/tactical fusion)
- Electronic Flight Data (EFD) Integration
- TFDM Terminal Publication (TTP) prototype
- Mobile app for EOBTs (GA community)
- ZTL/ATL airspace tactical scheduling
- Agile development from:
  - Field demo partner requests
  - TFDM risk reduction needs (as requested)
  - CDM community inputs (as requested)

Phase 3 (Terminal, Sep 2019)

- Terminal departure airspace constraints
- Additional APREQ features
- Agile development from:
  - Field demo partner requests
  - TFDM risk reduction needs (as requested)
  - CDM community inputs (as requested)

Equation for IADS Success

Strong Collaboration + ***Surface Automation*** = ***Game Changing Benefits***

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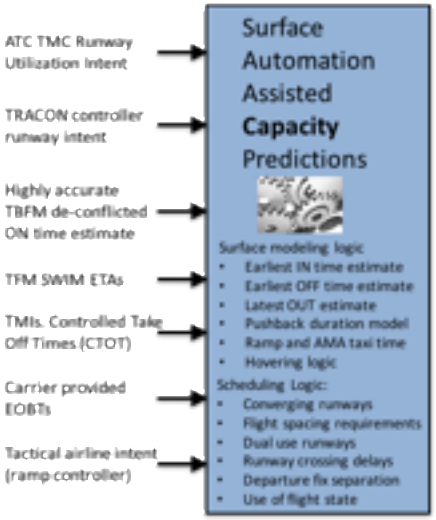

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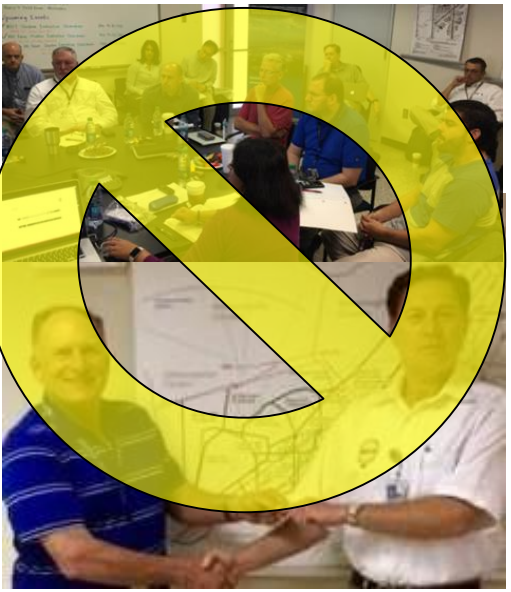
Equation for IADS Success

Some…

~~Strong~~ Collaboration + Surface Automation =

Some…

~~Game Changing~~ Benefits



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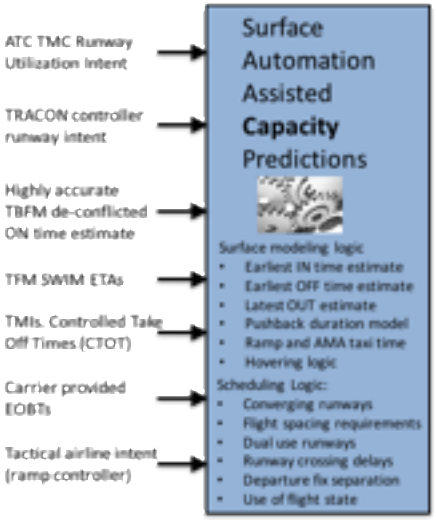

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Questions?