National Aeronautics and Space Administration

Airspace Technology Demonstrations (ATD) Project Industry Day

ATD-2 IADS Metroplex Traffic Management Overview Brief

Shawn Engelland
ATD-2 Sub-Project Manager

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NASA Ames Research Center
http://www.aviationsystems.arc.nasa.gov/atd-industry-day/

Outline

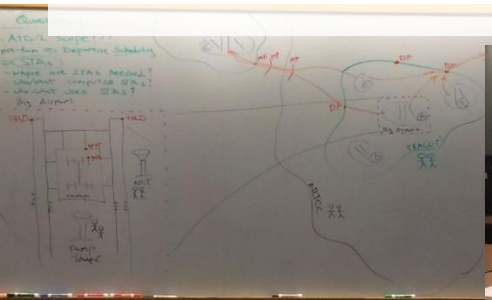
- Introduction
- Technical Approach
- Technology Transfer
- Partnerships

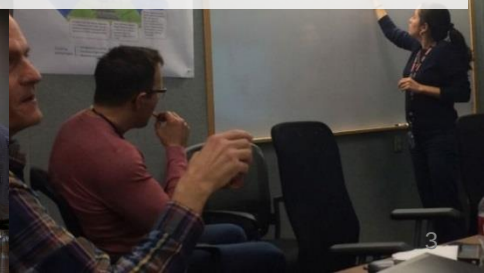
Key Events During Formulation

	Early 2014	NASA begins ATD-2 planning
★	Oct 2014	FAA and NAC† deliver "NextGen Priorities Joint Implementation Plan" to Congress
	Oct – Mar	FAA and NASA explore collaboration on ATD-2
★	Mar 31	FAA informs NAC† of intent to collaborate with NASA on ATD-2 ***to evaluate the integration of departure metering that reflects the FAA's Surface CDM ConOps***
	April	NASA and FAA jointly assess sites for ATD-2 demonstration
★	May 12	FAA announces Charlotte Douglas International Airport (CLT) as ATD-2 demonstration site
★	May 22	Kickoff for FAA-to-NASA Surface CDM tech transfer
★	Jun 22	FAA/NASA executive deep dive at NTX
★	Jul 16	VIP Kickoff at CLT
★	Jul 29	FAA/NASA executive deep dive at ARC
★	Aug 18-19	Stakeholder summit at CLT
	Sep 16-17	Stakeholder deep dive at NTX
	Sep 30	Initial draft of ATD-2 Project Plan delivered to FAA/NASA IADS RTT
	Oct 15	Stakeholder engagement with Surface CDM Team
	Nov 17	Sub-Project Formulation Review before FAA/NASA independent panel

FAA/NASA Collaboration Notes

†	FAA NextGen Advisory Committee
★	FAA AA for NextGen (ANG-1) events
Sep 2016	ATD-2 system installation at CLT
Sep 2017	ATD-2 demonstration commences



ATD-2 Goal, Objectives and Outcomes

GOAL ATD-2 will improve the predictability and the operational efficiency of the air traffic system in metroplex environments through the enhancement, development and integration of the nation's most advanced and sophisticated arrival, departure and surface prediction, scheduling and management systems.

- **Predictability**: Reduce the variability of aircraft movement times
- **Efficiency**: Manage and schedule operations to reduce aircraft movement times and fuel burn by leveraging enhanced predictability
- **Throughput**: Maintain or improve metroplex airspace throughput

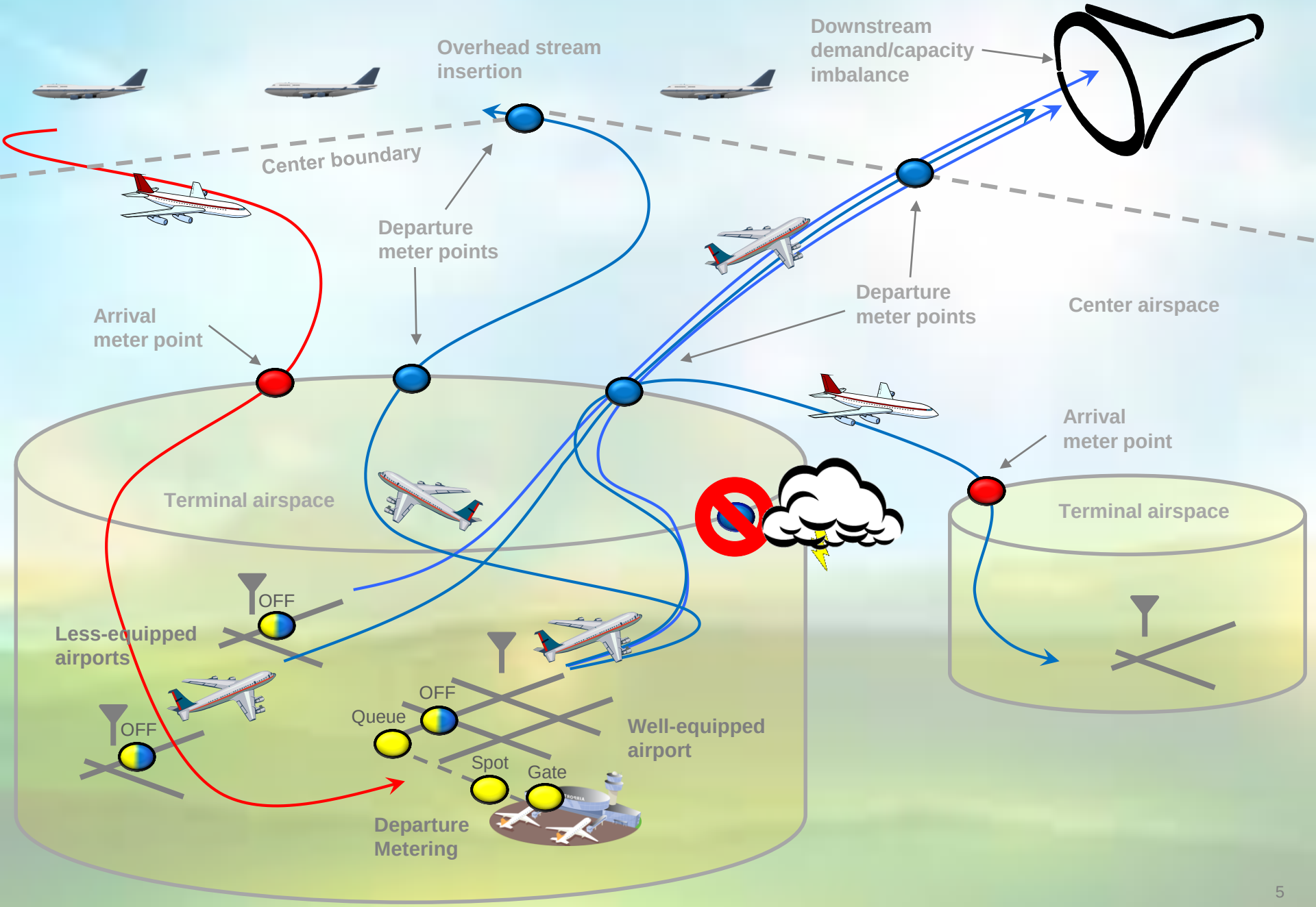
OBJECTIVES

- Demonstrate improved aircraft arrival, departure and surface movement predictability and efficiency by integrating evolving collaborative decision-making capabilities with state-of-the-art air traffic management scheduling technologies.
- Enable effective use of collaborative decision making by demonstrating efficiency gains through enhanced two-way sharing of prediction and scheduling information.
- Demonstrate Integrated Arrival/Departure/Surface (IADS) traffic management for metroplex environments.

OUTCOMES

- Demonstrate the ATD-2 technologies in an operationally relevant environment
- Quantify the benefits, performance, acceptability, and limitations of the ATD-2 technology
- Transfer an integrated set of technology to the FAA and airlines, airports, and suppliers.

Operational Environment for the ATD-2 Concept



Contributing Technologies: FAA Decision Support Systems

DSS components: 3Ts are the engines of DSS

Traffic Flow Management System (TFMS)

Decision support system for planning and mitigating demand-capacity imbalances in the NAS.

Time-Based Flow Management (TBFM)

Decision support system for metering based on time to optimize the flow of aircraft.

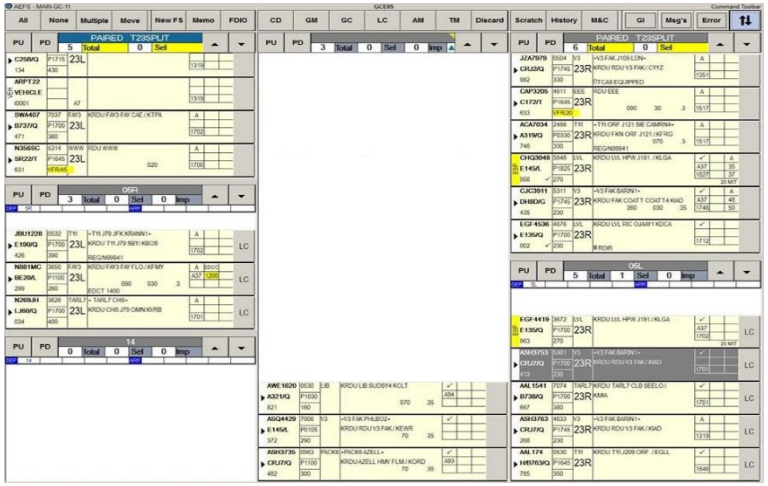
Terminal Flight Data Management (TFDM)

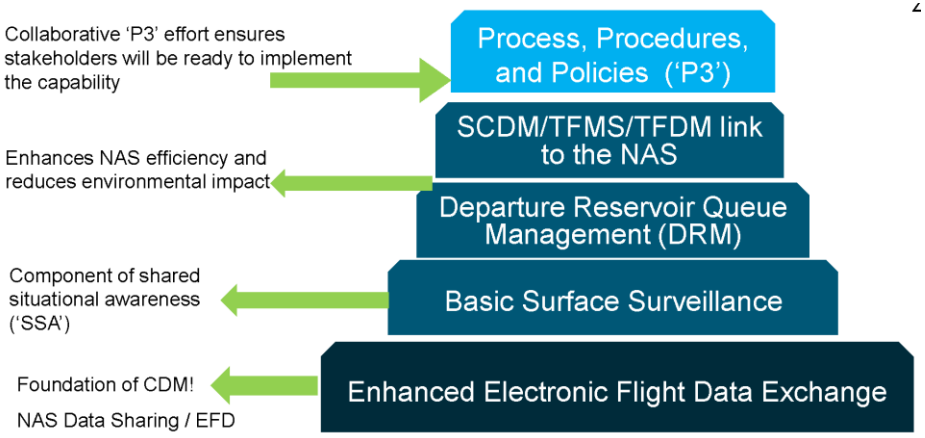
A new decision support system for airport surface management and ATC tower functions.

Contributing Technologies: Elements of FAA's TFDM System

TFDM Electronic Flight Data (EFD)

- A key element of TFDM is electronic flight data interfaces (a.k.a. electronic flight strips) for Tower controllers
- FAA is deploying the Advanced Electronic Flight Strips (AEFS) prototype as part of TFDM early implementation
- FAA plans to deploy AEFS at: PHX, CLE, EWR, SFO, LAS, and CLT
- ATD-2 depends on FAA deployment of AEFS or alternative TFDM EFD solution at CLT





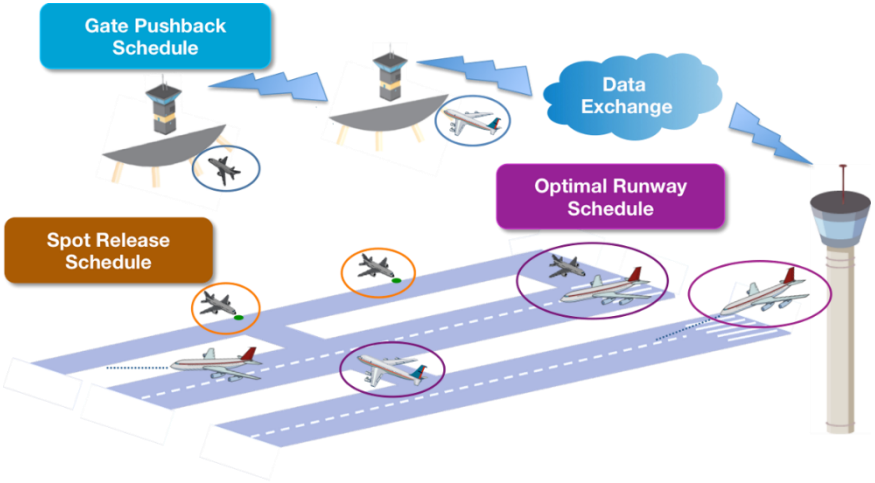
Surface Collaborative Decision Making (CDM)

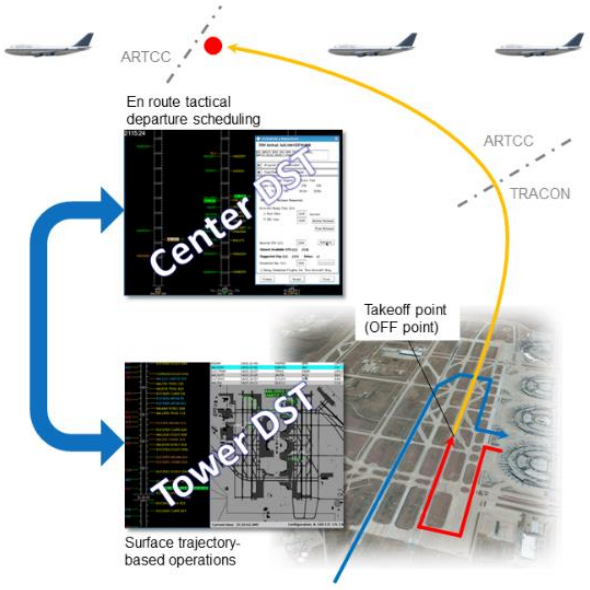
- Extend CDM principles to surface domain by developing:
  - Concept of Operations (ConOps)
  - Process, Procedures and Policies (P3)
- Collaboration between FAA and industry led by Surface Office and Surface CDM Team
- ConOps features a ration-by-schedule departure metering algorithm that produces Target Movement Area entry Times (TMATs)
- FAA has transferred Surface CDM concept and technology to NASA for ATD-2

Contributing Technologies: NASA SARDA and PDRC Research

Spot and Runway Departure Advisor (SARDA)

- Builds an optimal runway schedule
- Generates spot release sequence and timing
- Determines when to push back from gates
- 2013-2014 six high-fidelity HITLs of SARDA ramp tool configured for CLT
- Collaboration with US Airways/American Airlines

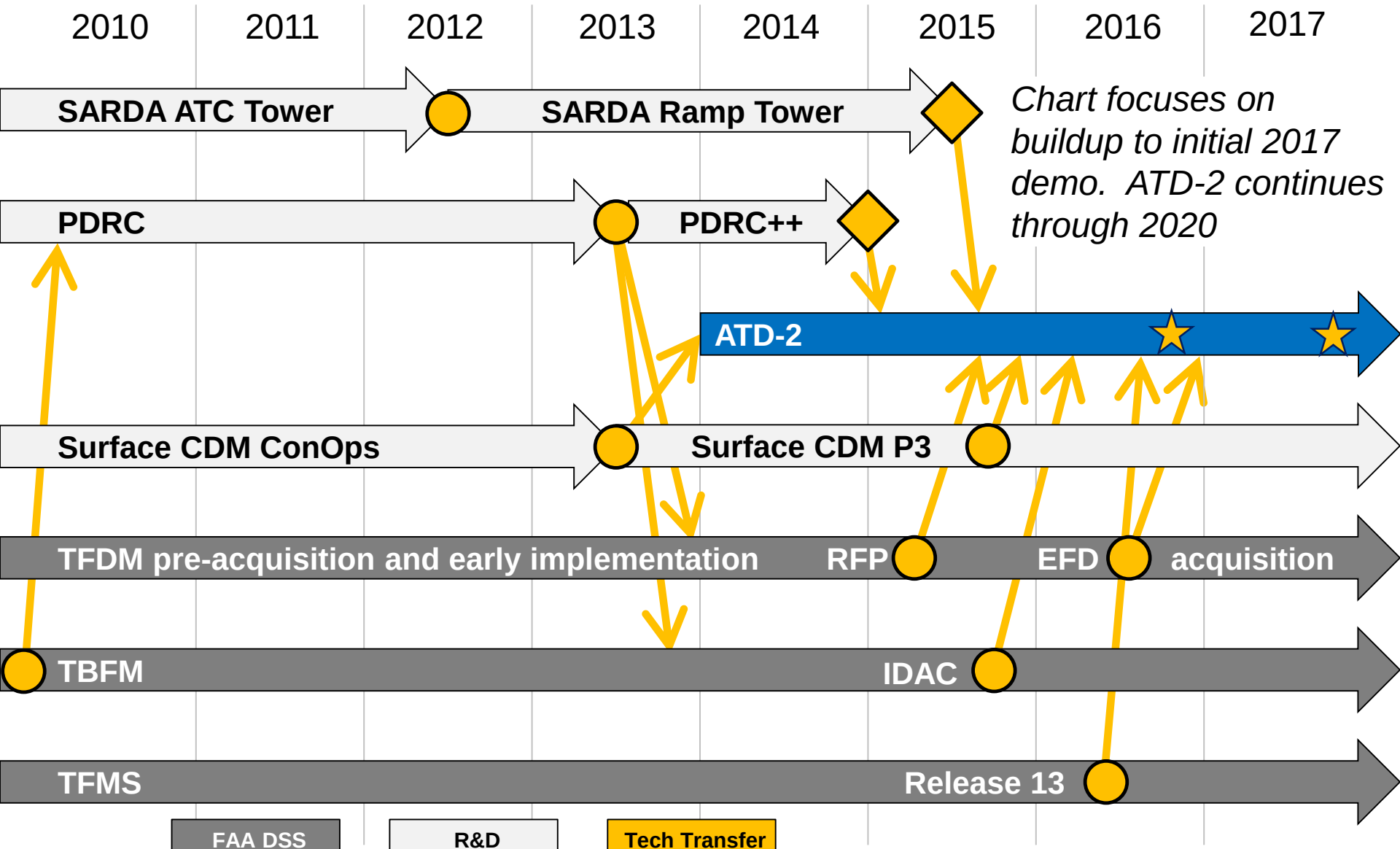




Precision Departure Release Capability (PDRC)

- Improve tactical departure scheduling through Tower/Center data sharing
- Surface trajectory based OFF times and runways used by TBFM scheduler
- 2012-2013 operational evaluation at DFW
- Follow on PDRC++ work extended tactical departure scheduling to Metroplex:
  - terminal constraints
  - less-equipped airports

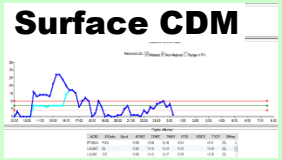
Contributing Technologies



Operational Concept Graphic (OV-1)

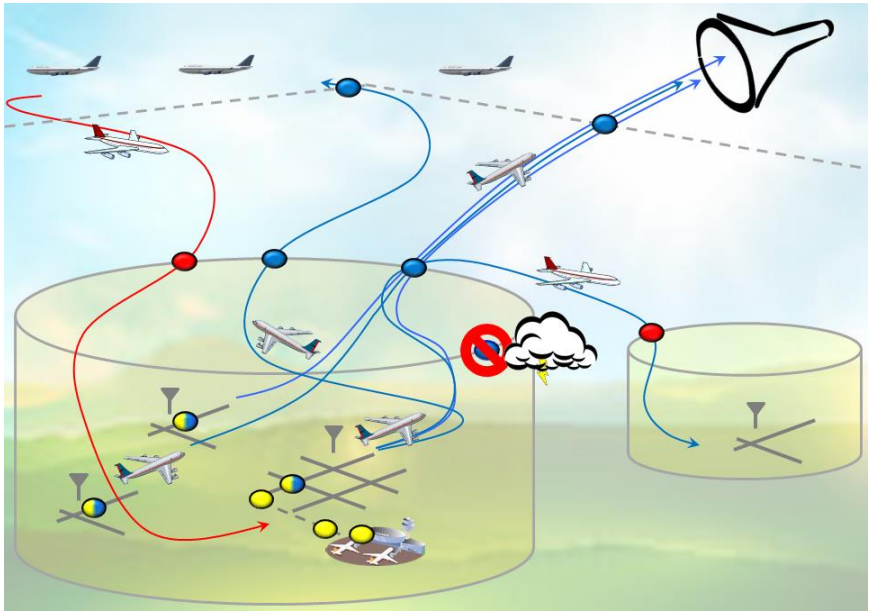
- TFDM EFD is controller interface to ATD-2 scheduling and metering
- Better predictability improves TMI compliance

- Tactical pushback advisories build on SARDA research
- Manage ramp traffic and meet strategic TMATs
- Ramp and gate status and intent information



- Builds on Surface CDM concept engineering effort
- Identify need to meter and compute ration-by-schedule strategic TMATs
- Accommodate airline priorities

Surface Components



- Earliest off block times
- Airline priorities via CDM
- Flight data

- Strategic TMIs
- Surface delays
- Multi-center coordination

- Airport conditions
- Additional flight operators

- Information exchange with commercial applications

External interfaces via SWIM and SWIM extensions

- Tactical departure scheduling builds on IDAC and PDRC
- Manage traffic to satisfy TMIs and departure metering

- Integrate TBFM/IDAC with ATD-2 surface system
- Improve TBFM departure trajectory predictions
- Departures into overhead and metered arrival streams

- Local TMIs and demand predictions for all airports
- Metroplex coordination and planning functions
- Explore departure controller advisory requirements

Airspace Components

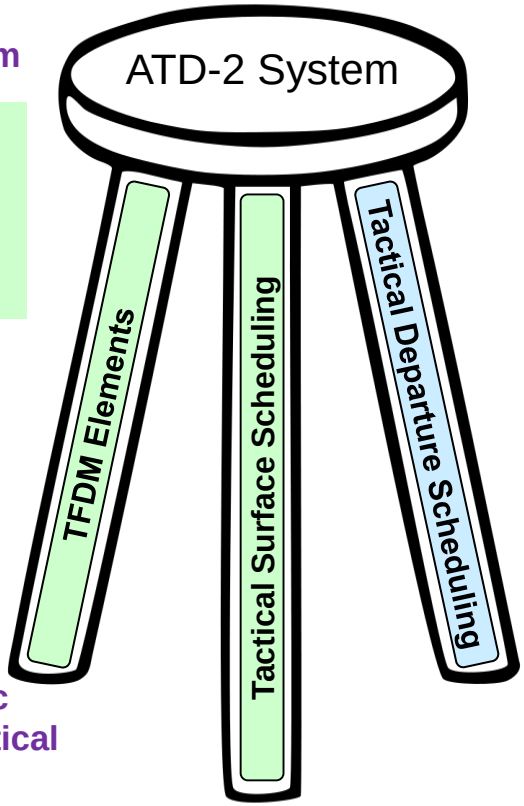
Simplified View of Integrated System

Previous investments form a solid foundation for…

ATD-2 system development and integration.

Interface TFDM EFD with ATD-2 System

FAA **TFDM EFD** early implementation
- AEFS prototype in use at PHX and upgraded version being tested at CLE
- Prototype s/w and h/w requirements provided to NASA



FAA **TBFM/IDAC**
- Operational deployment underway
- Latest version running with live data in NASA labs

Re-implement PDRC to take advantage of IDAC features

Industry/FAA **Surface CDM**
- 5-year concept engineering effort
- ConOps, requirements, P3 info and prototype system provided to NASA

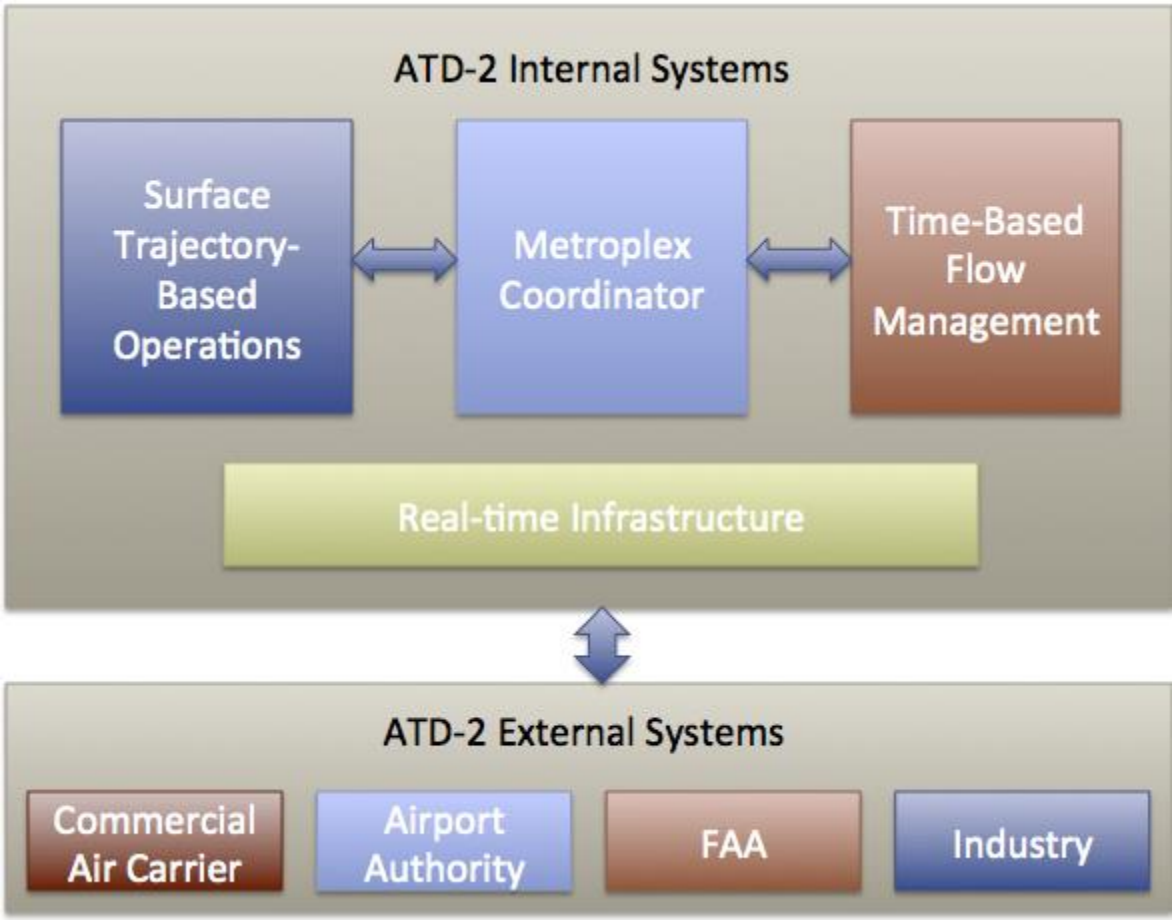
NASA **PDRC** research
- Built on FAA's TBFM system
- Demonstrated at DFW in 2012-2013

Fusion of Surface CDM strategic metering times with SARDA tactical pushback advisories

Re-implement PDRC and SARDA data sharing features to align with FAA SWIM architecture

NASA **SARDA** research
- High-fidelity CLT simulations in 2013-2014
- Prior groundwork for CLT field evaluation

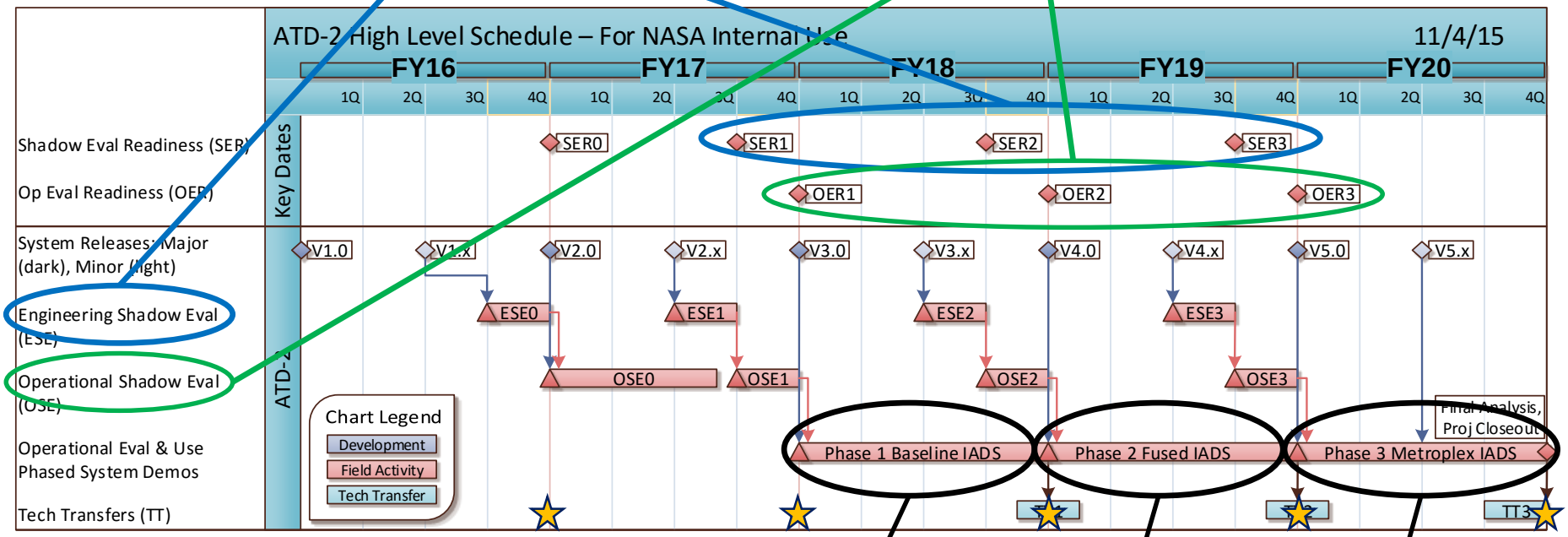
System Architecture – Simplified



Field Demonstration Strategy

Engineers assess readiness for shadow evaluation by operators

Operators assess readiness for operational evaluation & use



	Commitments to FAA
Sep 2016	ATD-2 system installation at CLT
Sep 2017	ATD-2 demonstration commences
Sep 2018	interim technology transfer
Sep 2019	interim technology transfer
Sep 2020	final technology transfer

Phase 1: Baseline IADS

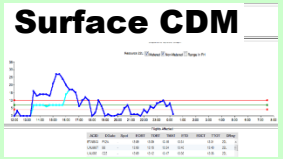
Phase 2: Fused IADS

Phase 3: Metroplex IADS

Phase 1: Baseline IADS Demonstration

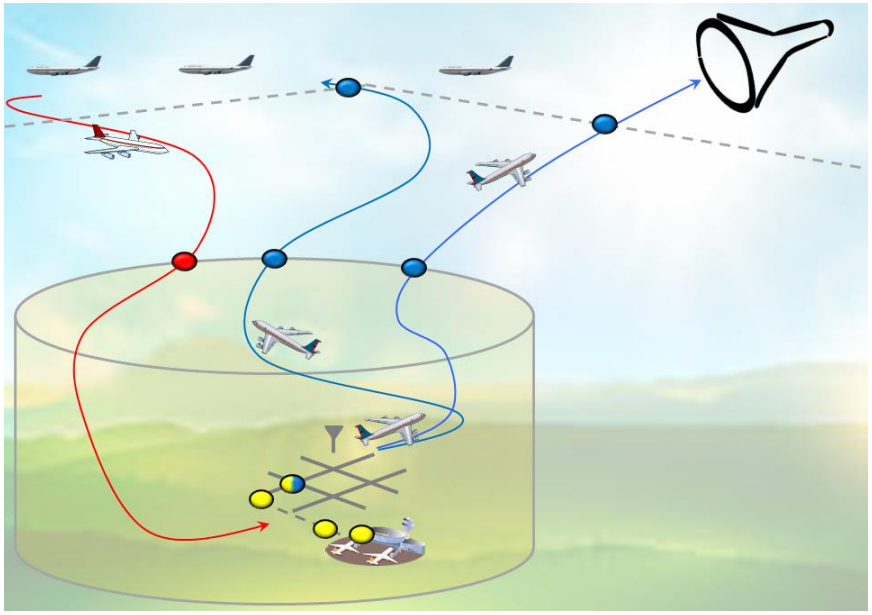
- CLT ATCT control positions
- Baseline electronic flight data capability via TFDM EFD

- AAL ramp controller and manager positions
- Tactical pushback advisories via RTC/RMTC display



- All positions as needed
- Predictive mode: strategic metering info for situational awareness and analysis

Surface Components



Phase 1 Demonstration Goals

- Evaluate the Baseline IADS capability
- Enhance American Airlines CLT “departure sequencing” procedure with ATD-2 surface tactical metering
- Demonstrate improved compliance for a significant percentage of tactical TMIs
- Mature strategic Surface CDM capability via operational use, analysis, and feedback
- Reduce ATCT workload by replacing paper strips with EFD

- CLT ATCT TMU position
- Tactical departure scheduling capability via SDSS display

- ZDC or ZTL TMU
- Tactical departure scheduling via modified TBFM/IDAC

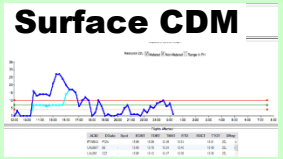
Airspace Components

Interfaces to external systems via SWIM plus ATD-2 SWIM extensions

Phase 2: Fused IADS Demonstration

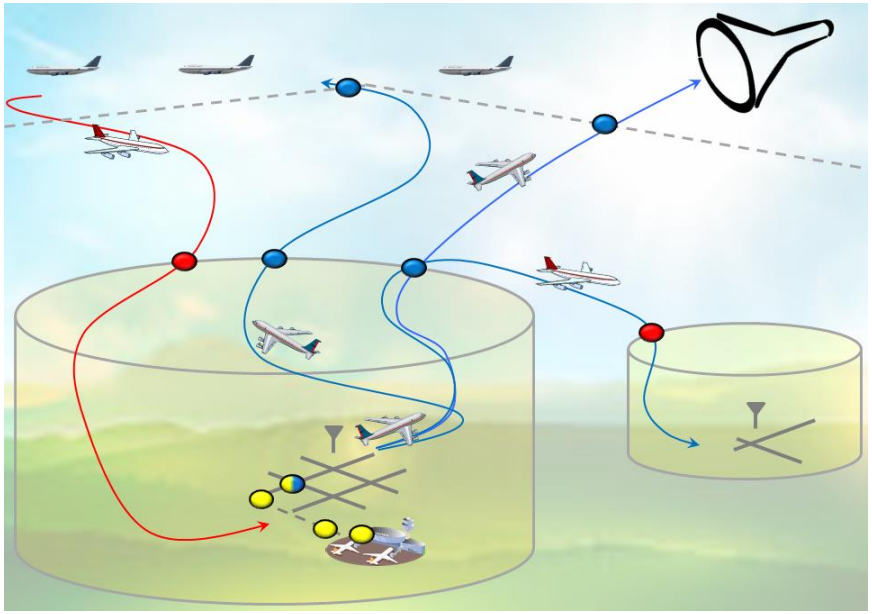
- Phase 1 capability plus:
- Include IADS info on EFD

- Phase 1 capability plus:
- Fused scheduler pushback advisories honor strategic TMATs



- Phase 1 capability plus:
- Prescriptive mode: strategic TMATs applied as constraints in fused scheduler

Surface Components



Phase 2 Demonstration Goals

- Evaluate the Fused IADS system capability
- Demonstrate benefits of strategic surface metering during periods of significant demand/capacity imbalance
- Enhance tactical surface metering to improve *non movement area* predictability and throughput
- Evaluate inclusion of IADS data on EFD
- Expand to demonstrate more scheduling scenarios for Washington and Atlanta Centers

- Phase 1 capability plus:
- Improvements as needed

- Phase 1 capability plus:
- Expand to ZTL or ZDC TMU
- Integrate with arrival metering

- CLT TRACON TMU
- ATD-2 UI for TMI entry and situational awareness

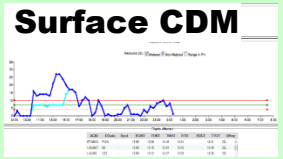
Airspace Components

Interfaces to external systems via SWIM plus ATD-2 SWIM extensions

Phase 3: Metroplex IADS Demonstration

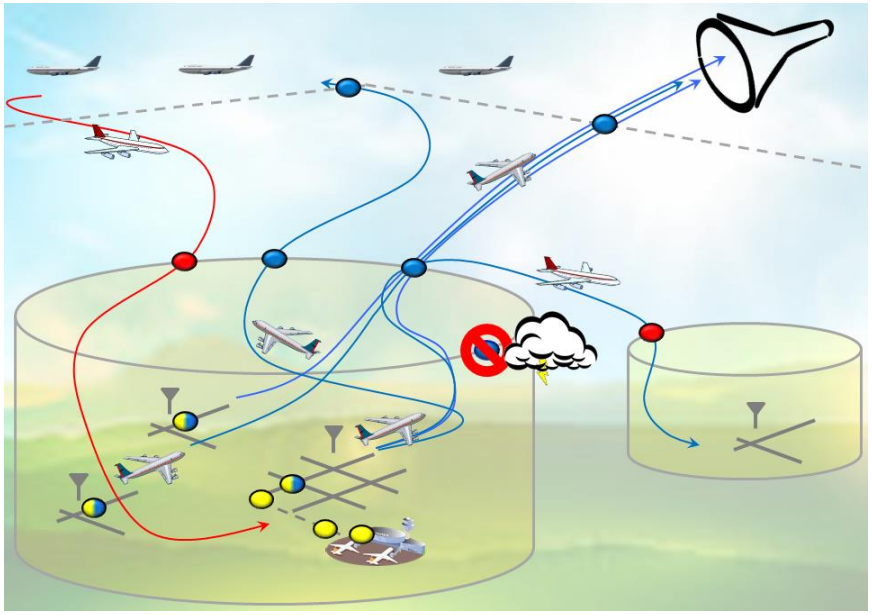
- Phase 2 capability plus:
- Integrate EFD with ATD-2 scheduling and metering

- Phase 2 capability plus:
- Improvements as needed



- Phase 2 capability plus:
- Improvements as needed

Surface Components



Phase 3 Demonstration Goals

- Evaluate the Metroplex IADS system capability
- Integrate EFD with ATD-2 scheduling
- Mature and enhance core ATD-2 capabilities
- Enhance CLT tactical surface metering to improve *movement area* predictability and throughput
- Reduce delay and increase throughput under Metroplex departure constraints *[NOTE: Metroplex Coordinator to be demonstrated for DFW TRACON (D10) environment via HITL or field experiment]*

- Phase 2 capability plus:
- Improvements as needed

- Phase 2 capability plus:
- Improvements as needed

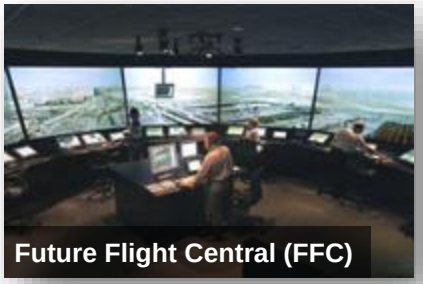
- Phase 2 capability plus:
- Metroplex coordinator implemented for DFW TRACON (D10) environment

Airspace Components

Interfaces to external systems via SWIM plus ATD-2 SWIM extensions

Facility Utilization

- **CLT Operational Facilities (CLTops)**
  - FAA Air Traffic Control Facilities
    - CLT ATCT, CLT TRACON, Atlanta ARTCC (ZTL), Washington ARTCC (ZDC)
  - Air carrier operational facilities
    - AAL CLT Ramp Tower, AAL Integrated Operations Control (IOC), other air carrier facilities [possible]
- **ATD-2 Field Laboratory (CLTlab)**
  - A dedicated NASA computer laboratory on the premises CLT airport
  - CLTlab will support shadow evaluations, training, data collection, and other on-site ATD-2 activities
- **NASA Ames facilities**
  - North Texas Research Station (NTX)
    - Shakedown testing to reduce risk prior to deploying ATD-2 systems to CLT
  - Verification and Validation Lab (V&V Lab)
    - Unit-level and system-level testing for all ATD-2 system releases
  - Simulation facilities
- **FAA William J. Hughes Technology Center (WJHTC)**
  - Data feeds including primary SWIM interface for ATD-2
  - May support regression and non-interference testing of ATD-2 modifications to TBFM and TFDM EFD


Future Flight Central (FFC)


Air Traffic Control Lab (ATC Lab)


Airspace Operations Lab (AOL)

Technology Transfer Strategy

- Intentional approach to technology transfer
  - Technology transfer is a Level 1 requirement
  - ATD-2 system architecture is designed to facilitate tech transfer
    - Uses FAA TBFM/IDAC (v4.4) system with minimal enhancements
    - Leverages FAA TFDM system requirements and interface specifications
    - Uses Surface Data Elements delivered via FAA TFMS (Release 13)
    - Follows FAA SWIM model for data feeds and external communication
  - Follows ATD-1 model for development of system requirements and design documents to facilitate technology transfer

- NASA to FAA technology transfer
  - NASA will engage with FAA AJV and AJM organizations via IADS RTT to ensure that timing and content of technology transfers are aligned with FAA needs
  - Enhancements to FAA Decision Support Systems tools (i.e. 3Ts) and SWIM will be fully documented as deltas to reference versions known to the FAA

- NASA to industry technology transfer
  - Regular engagement with industry partners
  - ATD Industry Day set for 13 Jan 2016
  - System architecture designed to enable industry solutions

Current Partnerships

Federal Aviation Administration (FAA) multiple organizations led by NextGen (ANG)

- Interagency partnership coordinated via IADS RTT provides for:
  - Participation by and routine access to SMEs at participating facilities
  - Data (flight plan, surveillance, TMI, SWIM, etc.) for all participating facilities
  - Decision support system (e.g. TBFM, TFMS, etc.) s/w and information
  - Surface CDM departure metering prototype s/w and information
  - ATD-2 user interfaces in operational areas at all participating facilities
  - TFDM EFD system interfaced to ATD-2 at participating Towers

American Airlines (AAL)

- FAA-designated lead carrier for ATD-2
- Nonreimbursable Space Act Agreement (originally with US Airways) provides for:
  - Participation by and routine access to SMEs at participating facilities
  - Data for all participating facilities
  - ATD-2 user interfaces in operational areas at all participating facilities

Charlotte Douglas International Airport (CLT)

- Nonreimbursable Space Act Agreement (under development) provides for:
  - Dedicated ATD-2 computer laboratory space
  - Airport information and data feeds
  - Communications and logistics support

National Air Traffic Controllers Association (NATCA)

- FAA/NATCA agreement provides for designated NATCA representatives to serve in a collaborative and expert capacity in the planning, development, and testing of all air traffic control modernization projects including ATD-2
- Statements of support and the cooperation of NATCA Leadership

Summary

- Technical approach builds on solid foundation
  - Leverages previous investments by NASA, FAA, and industry
- Sub-project status
  - Formulation review complete and implementation underway
- Partnerships
  - Collaboration with key partners underway
  - Exploring opportunities for additional partnerships

Acronyms (1 of 3)

ACRONYM	ACRONYM DEFINITION
3T	TFMS, TBFM, and TFDM
4D	Four Dimensional
AAL	American Airlines
AAR	Airport Arrival Rate or Airport Acceptance Rate
AC or A/C	Aircraft
ADR	Airport Departure Rate
ADW	Arrival Departure Window
AEFS	Advanced Electronic Flight Strips
AJM	FAA ATO Program Management Operations
AJR	FAA ATO Systems Operations Services
AJV	FAA ATO Mission Support Services
AMA	Airport Movement Area
ANG	FAA NextGen Office (?)
ANSP	Air Navigation Service Provider
AOBT	Actual Off Block Time
AOC	Airline Operations Center
AOL	Airspace Operations Laboratory
AOSP	Airspace Operations and Safety Program
APREQ	Approval Request (CFR)
APM	Assistant Project Manager
APT	Analysis, Planning, and Tracking
ARC	Ames Research Center
ARMD	Aeronautics Research Mission Directorate
ARTCC	Air Route TRAFFIC Control Center
ASDE-X	Airport Surface Detection Equipment – Model X
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
ATD	Airspace Technology Demonstrations
ATD-1	Airspace Technology Demonstration-1
ATD-2	Airspace Technology Demonstration-2
ATD-3	Airspace Technology Demonstration-3
ATL	Hartsfield-Jackson Atlanta International Airport
ATM	Air Traffic Management

ACRONYM	ACRONYM DEFINITION
ATO	Air Traffic Organization
ATOT	Actual Takeoff Time
ATCSCC	Air Traffic Control System Command Center
CD	Clearance Delivery
CDM	Collaborative Decision Making
CFR	Call for Release (APREQ)
CLT	Charlotte Douglas International Airport
CLTlab	CLT ATD-2 Field Laboratory
CLTops	CLT Operational Facilities
ConOps	Concept of Operations
ConUse	Concept of Use
CORE™	Computer-Assisted Systems Engineering Support Tool
CPM	Composite Predictability Metric
CTOT	Controlled Takeoff Time
CRM	Continuous Risk Management
D10	DFW TRACON
DFW	Dallas/Fort Worth International Airport
DLR	German Aerospace Center
DMP	Departure Metering Program
DoD	Department of Defense
DPM	Deputy Project Manager
DRC	Departure Reservoir Coordinator
DRM	Departure Reservoir Manager/Management
DSPM	Deputy Sub-Project Manager
DSS	Decision Support System
DST	Decision Support Tool
EDC	En route Departure Capability
EDCT	Estimated Departure Clearance Time
EFD	Electronic Flight Data
EOBT	Earliest Off Block Time
ERAM	En Route Automation Modernization
ESE	Engineering Shadow Evaluation
ETOT	Estimated Takeoff Time

Acronyms (2 of 3)

ACRONYM	ACRONYM DEFINITION
FAA	Federal Aviation Administration
FDIO	Flight Data Input/Output
FFC	Future Flight Central
FIM	Flight-deck Interval Management
FSM	Flight Schedule Monitor
FTE	Full Time Equivalent
FY	Fiscal Year
GA	General Aviation
GC	Ground Control/Controller
HITL	Human In The Loop
HQ	Headquarters
IADS	Integrated Arrival/Departure/Surface
ICE	Independent Cost Estimate
ICN	Incheon International Airport
ID	Identify
IDAC	Integrated Departure Arrival Capability (TBFM)
IDS	Integrated Display System
IIAC	Incheon International Airport Corporation
IOC	Integrated Operations Center
IRP	Independent Review Panel
IT	Information Technology
JFK	John F. Kennedy International Airport
KAIA	Korea Agency for Infrastructure Technology Advancement
KARI	Korea Aerospace Research Institute
KPP	Key Performance Parameters
LaRC	Langley Research Center
LC	Local Control/Local Controller
LGA	LaGuardia Airport
MINIT	Minutes-in-Trail
MIT	Massachusetts Institute of Technology
MIT	Miles-in-Trail
MOP	Measure of Performance
MP	Meter Point

ACRONYM	ACRONYM DEFINITION
N90	New York TRACON
NAC	NextGen Advisory Committee (FAA)
NARP	National Aviation Research Plan
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NATCA	National Air Traffic Controllers Association
NextGen	Next Generation Air Transportation System
NM or NMI	Nautical Mile
NPR	NASA Procedural Requirement
NRA	NASA Research Announcement
NTML	National Traffic Management Log
NTX	NASA/FAA North Texas Research Station
OAG	Official Airline Guide
OER	Operational Evaluation Readiness
OEU	Operational Evaluation and Use
OIA	Operational Integration Assessment
OGA	Other Government Agency
OSE	Operational Shadow Evaluation
P3	Processes, Procedures and Policies
PBN	Performance-Based Navigation
PCT	Potomac Consolidated TRACON
PDC	Pre-departure Clearance
PDRC	Precision Departure Release Capability
PIC	Pilot In Command
PM	Project Manager/Management
PRP	Performance Review Panel (see slide 45 to review)/ AOSP Program Director Panel
QA	Quality Assurance
QSR	Quarterly Status Review
R&D	Research and Development
R&R	Roles & Responsibilities
R&T	Research and Technology
RBS	Ration By Schedule

Acronyms (3 of 3)

ACRONYM	ACRONYM DEFINITION
RDR	Runway Departure Rate
RFP	Request For Proposal
RMTC	Ramp Manager Traffic Console
RNAV	Area Navigation
RNP	Required Navigation Performance
RTC	Ramp Traffic Console
RTCA	(formerly) Radio Technical Committee on Aeronautics (not in Form. Review or ConUse)
RTP	Research Transition Product (not in either)
RTT	Research Transition Team
SA	System Architect
SAA	Space Act Agreement
SAIC	Science Applications International Corporation
SARDA	Spot and Runway Departure Advisor
SBIR	Small Business Innovative Research
SDSS	Surface Decision Support System
SDT	Scheduled Departure Time
SE	Systems Engineering
SER	Shadow Evaluation Readiness
SID	Standard Instrument Departure
SIP	Strategic Implementation Plan
SMA	Safety and Mission Assurance
SME	Subject Matter Expert
SOA	Surface Operation Automation
SOAR	Sharing of Airspace Resources
SOBT	Scheduled Off Block Time
SPM	Sub-Project Manager
SRR	Systems Requirements Review (not in either)
STAR	Standard Approach Route (not in either)
STARS	Standard Terminal Automation Replace System
STBO	Surface Trajectory-Based Operations
STMC	Supervisory Traffic Management Coordinator
SUA	Special Use Airspace (not in either)

ACRONYM	ACRONYM DEFINITION
SWIM	System Wide Information Management
TBD	To Be Determined
TBFM	Time Based Flow Management
TC	Technical Challenge
TFDM	Terminal Flight Data Manager
TFM	Traffic Flow Management
TFMS	Traffic Flow Management System
TIM	Technical Interchange Meeting
TMA	Traffic Management Advisor
TMAT	Target Movement Area entry Time
TMC	Traffic Management Coordinator
TMI	Traffic Management Initiative
TMU	Traffic Management Unit (FAA)
TOBT	Target Off Block Time
TOC	Top Of Climb (?)
TOD	Top of Descent (?)
TRACON	Terminal RADAR Approach Control
TRL	Technology Readiness Level
TSAS	Terminal Sequencing and Spacing (formerly, TSS)
TT	Technology Transfer
TTOT	Target Takeoff Time
UI	User Interface (?) (slide #29, Form. Review)
US	United States
V&V	Verification & Validation
WBS	Work Breakdown Structure
WJHTC	William J. Hughes Technical Center (FAA)
WYE	Work Year Equivalent
ZDC	Washington Air Route Traffic Control Center (ARTCC)
ZTL	Atlanta Air Route Traffic Control Center (ARTCC)