ATM/Weather Integration - Weather Event Detection and Advisory (WEDA)

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Agenda

- What is the Problem?
- What is the WEDA Solution?
- Atlanta Operational Thresholds
- Notional Display Concepts
- NextGen Line-of-Sight

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What's the Problem?

Meteorologist's Briefings

Weather Radar

Source: MIT Lincoln Lab CIWS display [1]

Approach Type?

Visual

Instrument

Low Instrument

Terminal Weather Forecasts

KATL TAF	METAR KVPC 071952Z AUTO VRB05KT 10SM FEW100 32/16 A2979 RMK A02 SLP073

Center Weather Advisory
CWSU: ZMA [Miami]
Ends: 2016-10-05T01:25:00Z
Hazard: TS
Top: 400 ft

ZMA2 CWA 042327
ZMA CWA 205 VALID UNTIL 050125
FROM 220E TRV-100E ZQA-100SE MIA-50E TRV-220E TRV
AREA OF SHRA AND TS MOV FROM 09010KT. TOPS TO FL400. EXP LTL CHG THRU 0125Z.
AQ

4x/day

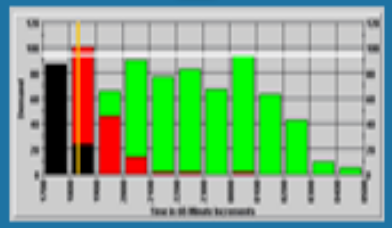
Traffic Manager/ Front Line Manager

Decision

Terminal Weather Observations

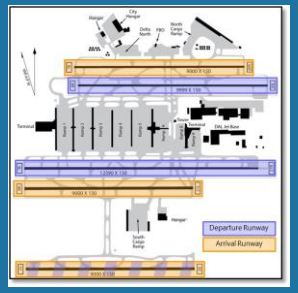
VPC METAR	METAR KVPC 071952Z AUTO VRB05KT 10SM FEW100 32/16 A2979 RMK A02 SLP073
RYY METAR	METAR KVPC 071952Z AUTO VRB05KT 10SM FEW100 32/16 A2979 RMK A02 SLP073
MGE METAR	METAR KVPC 071952Z AUTO VRB05KT 10SM FEW100 32/16 A2979 RMK A02 SLP073
FTY METAR	METAR KVPC 071952Z AUTO VRB05KT 10SM FEW100 32/16 A2979 RMK A02 SLP073
CTJ METAR	METAR KVPC 071952Z AUTO VRB05KT 10SM FEW100 32/16 A2979 RMK A02 SLP073

Hourly, variable



Traffic Demand

Runway Config?



Source: FAA.gov [2], augmented by MITRE

Airport Arrival and Departure Rates

Capacity Estimates

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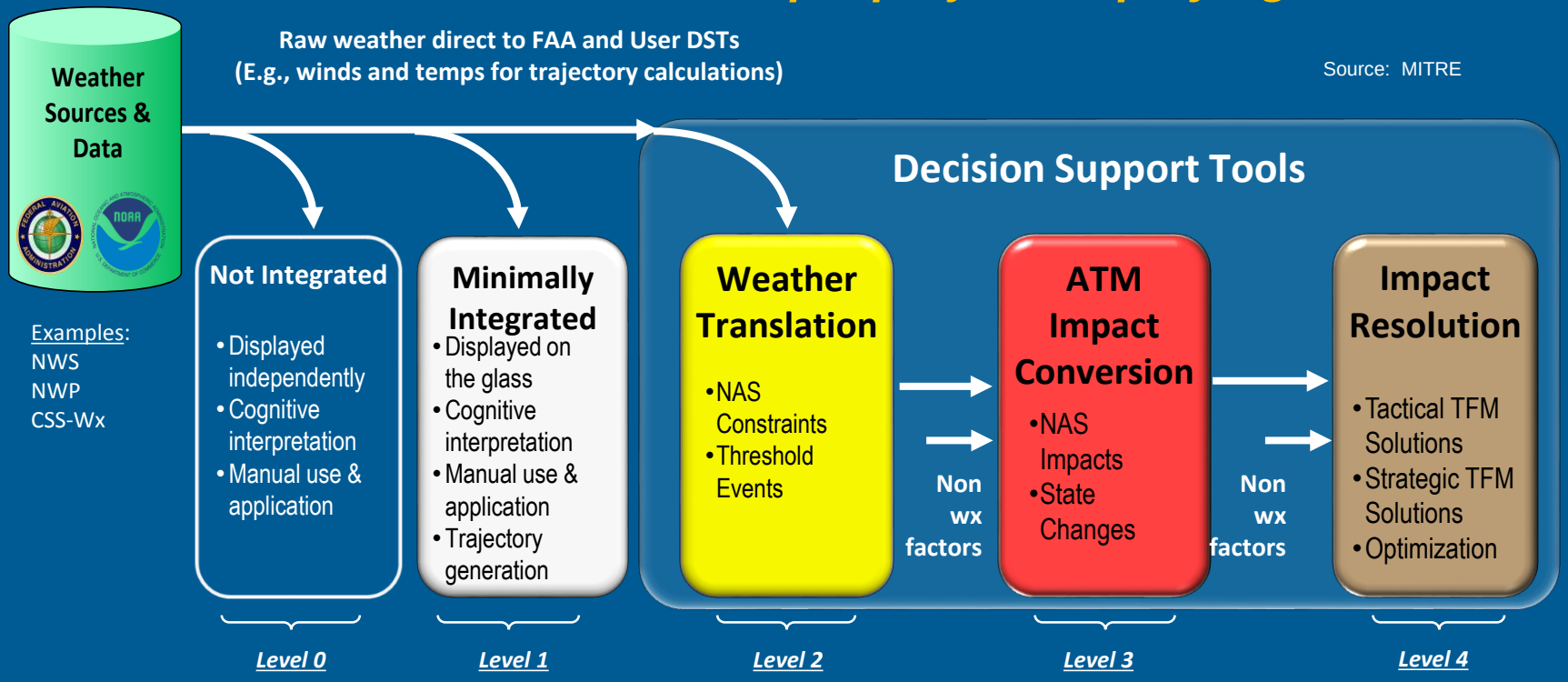
Addressing the Problem with the ATM-Weather Integration Framework

WEDA – an example project employing this framework



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What is WEDA

…as applied to airport operating state

- **Translates raw ceiling, visibility and winds data into airport/terminal operational terms such as runway and/or approach configuration**
- **An automated capability that detects when current or predicted changes in cloud heights, visibility, wind speed and direction cross, or are expected to cross, site-adapted threshold values ➔ weather event**
- **Upon detecting a weather event, WEDA**
  - sends an advisory to downstream decision support tools
  - provides a depiction of observed and predicted weather events translated to airport operational state on an appropriate NextGen display system

Source: MITRE

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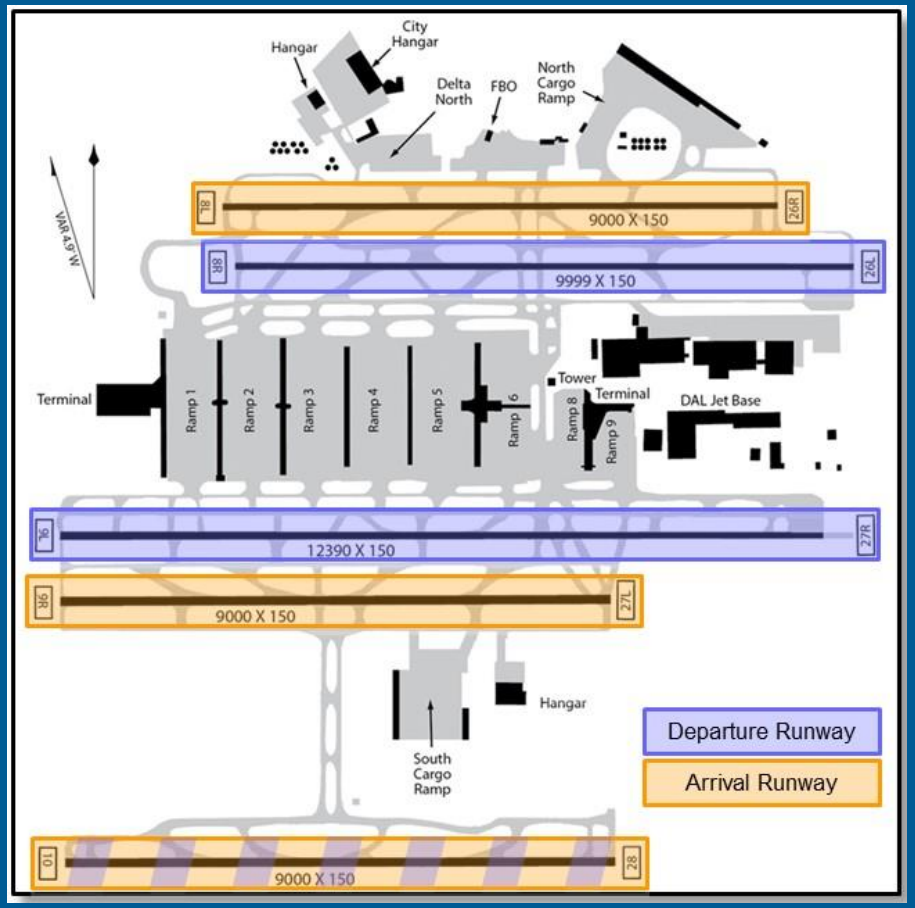
KATL – Airport Layout

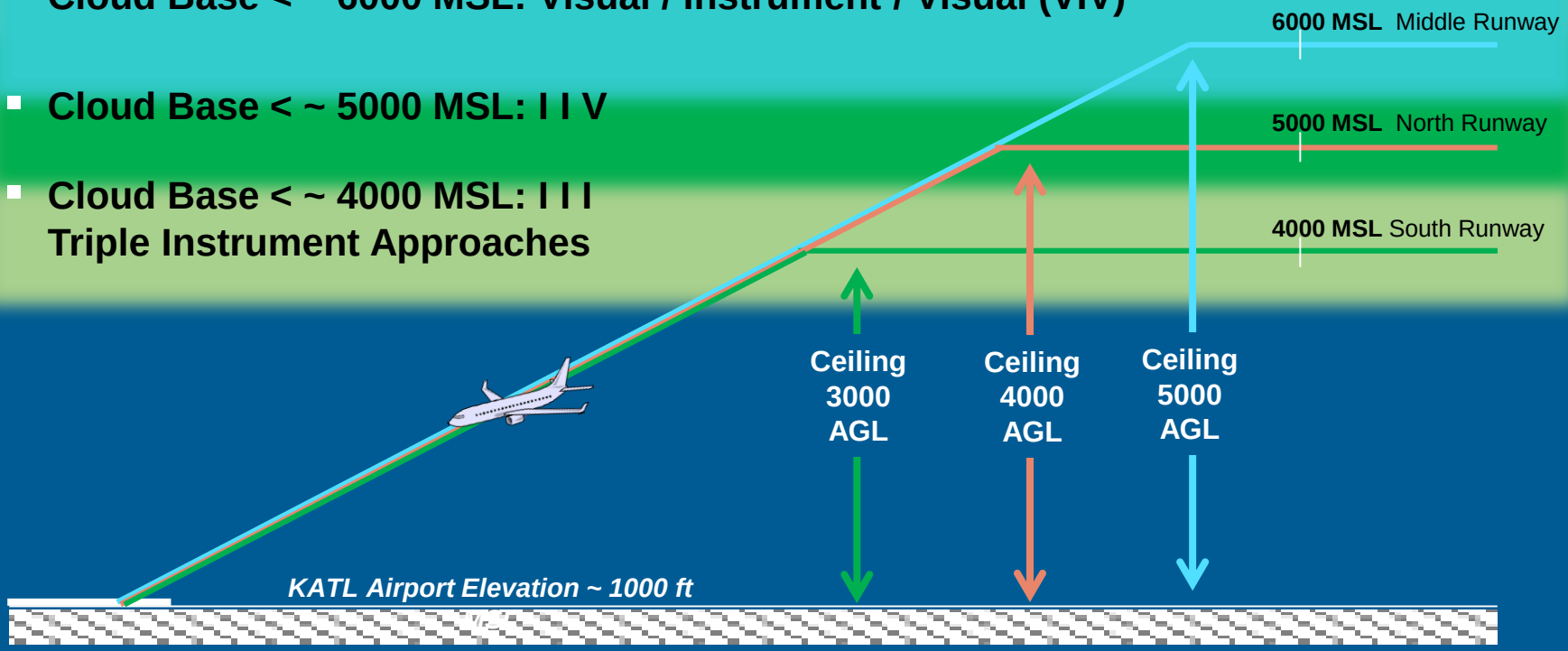


Source: FAA.gov [2], augmented by MITRE

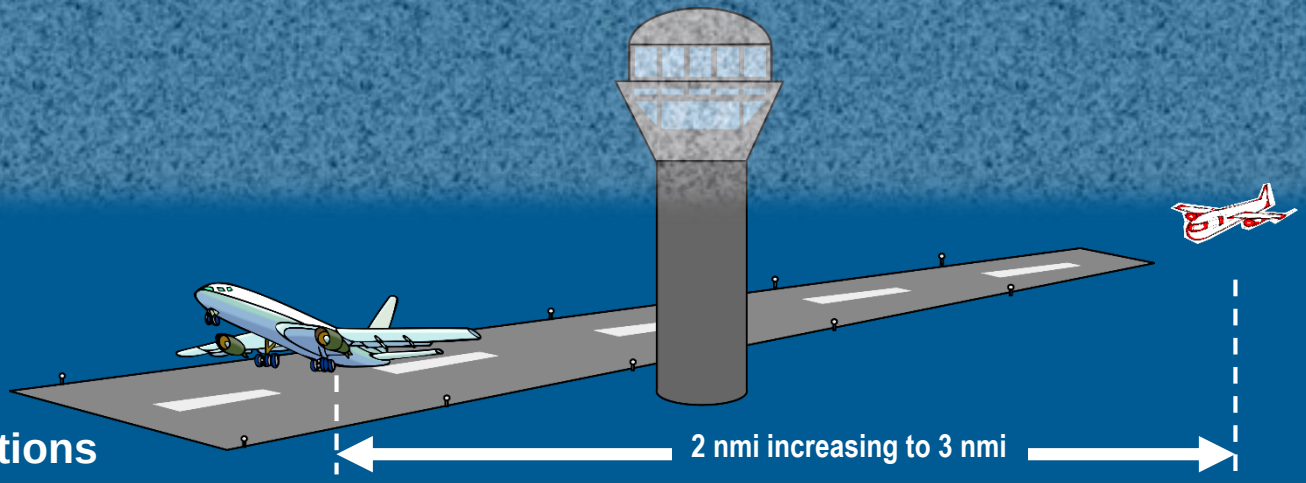
ATL Approach Types and Weather Thresholds (1/2)

Approach types (V,I): read left to right correlating to ATL North, Middle, South runways (N M S)

- **Visual Approaches (VVV): Pilot must see aircraft ahead on other approaches or the airport itself**
- **Cloud Base < ~ 6000 MSL: Visual / Instrument / Visual (VIV)**
- **Cloud Base < ~ 5000 MSL: I I V**
- **Cloud Base < ~ 4000 MSL: I I I Triple Instrument Approaches**



ATL Approach Types and Weather Thresholds (2/2)



Triple ILS Configurations

- **Below 1000-3 AGL**
  - 2 nmi increasing to 3 nmi for departure –to- arrivals separation
- **Below 800-2 AGL**
  - Must protect ILS critical areas (around glide slope, localizer antennas)
- **Below 400 ft AGL**
  - Minimum Radar Separation (MRS) is 3.0 nmi
- **Below 200-1/2**
  - CAT II/III operations

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ATL Weather Thresholds Matrix – Triple Arrival Runway Configuration

Weather State — Normal[1] (Procedural)[2]			Arrival Procedure Name	Procedure Description	Additional Information
Clouds (h)[3]	Visibility (v)	Airport Runway Configuration			
h > 6000 MSL (5000 AGL)	v > 5 SM	East Landing 8L, 9R, 10	Triple Visuals (Trips)	Visual Approach Procedures (VAPS) to 08L, 09R and 10	• Clouds above normal turn on altitudes[4] for runways 08L/26R (5000 MSL), 09R/27L (6000 MSL), 10/28 (4000 MSL) • AAR 132 • Maximum tailwind component 5-7 KTS per FAA Order 8400.9
		West Landing 26R, 27L, 28		Visual Approach Procedures (VAPS) to 26R, 27L and 28	
5000 MSL (4000 AGL) < h ≤ 6000 MSL (5000 AGL)	v > 5 SM	East Landing 8L, 9R, 10	VIV	Visual Approach Procedures (VAPS) to 8L and 10, Instrument Approach Procedures (IAPS) to 9R	• Clouds at or below normal turn on altitude for runway 09R/27L (6000 MSL), but above normal turn on altitudes for runways 08L/26R (5000 MSL) and 10/28 (4000 MSL) • AAR 124 • Maximum tailwind component 5-7 KTS per FAA Order 8400.9
		West Landing 26R, 27L, 28		Visual Approach Procedures (VAPS) to 26R and 28, Instrument Approach Procedures (IAPS) to 27L	
4000 MSL (3000 AGL) < h ≤ 5000 MSL (4000 AGL)	v > 5 SM	East Landing 8L, 9R, 10	IIV	Instrument Approach Procedures (IAPS) to 8L and 9R, Visual Approach Procedures (VAPS) to 10	• Clouds at or below normal turn on altitude for runways 08L/26R (5000 MSL) and 09R/27L (6000 MSL), but above normal turn on altitude (4000 MSL) for runway 10/28 • AAR 118 • Maximum tailwind component 5-7 KTS per FAA Order 8400.9
		West Landing 26R, 27L, 28		Instrument Approach Procedures (IAPS) to 26R and 27L, Visual Approach Procedures (VAPS) to 28	
1000 AGL < h ≤ 4000 MSL (3000 AGL)	3 SM ≤ v < 5 SM	East Landing 8L, 9R, 10	Triple ILS	Instrument Approach Procedures (IAPS) to 08L, 09R and 10	• Clouds below normal turn on altitudes for all three arrival runways and/or visibility below that required for visual separation • AAR 118 • Maximum tailwind component 5-7 KTS per FAA Order 8400.9
		West Landing 26R, 27L, 28		Instrument Approach Procedures (IAPS) to 26R, 27L and 28	
400 AGL < h ≤ 1000 AGL	1 SM ≤ v < 3 SM	East Landing 8L, 9R, 10	Triple ILS	Instrument Approach Procedures (IAPS) to 08L, 09R and 10	• 2 nm increasing to 3 nm rule for closely spaced arrivals and departures required below 1000 AGL ceiling and 3 SM visibility (potential need for arrival gaps) • ILS protection required at 800 AGL ceiling and 2 SM visibility • AAR ≤ 110 • Maximum tailwind component 5-7 KTS per FAA Order 8400.9
		West Landing 26R, 27L, 28		Instrument Approach Procedures (IAPS) to 26R, 27L and 28	
200 AGL < h ≤ 400 AGL	½ SM or RVR 1800 FT ≤ v < 1 SM	East Landing 8L, 9R, 10	Triple Low ILS	Low Instrument Approach Procedures (IAPS) to 08L, 09R and 10	• KATL tower cab (~400 FT) in the clouds, unable to see aircraft at runway turnoffs • AAR 98 • Maximum tailwind component 5-7 KTS per FAA Order 8400.9
		West Landing 26R, 27L, 28		Low Instrument Approach Procedures (IAPS) to 26R, 27L and 28	
h < 200 AGL	v < ½ or RVR 1800 FT	East Landing 8L, 9R, 10	Triple Very Low ILS	CAT I, II or III Low Instrument Approach Procedure (IAPS) to 08L, 09R and 10	• 27L and 28 available down to CAT II minimums. But 26R CAT I and II requires use of heads up display (HUD) • AAR ≤ 98 • Maximum tailwind component 5-7 KTS per FAA Order 8400.9
		West Landing 26R, 27L, 28			

[1] Normal cloud heights, visibilities, tailwinds and altitudes are values used by traffic managers to achieve an acceptable level of operational consistency and minimize procedural and clearance changes and controller time on frequency while simultaneously maximizing airport arrival tare (capacity)

[2] Procedural cloud heights, visibilities, tailwinds and altitudes are values consistent with FAA Orders, facility standard operating procedures (SOPs) and regulatory limitations

[3] Cloud heights are expressed in feet and are indicated if referenced to mean sea level (MSL) or above ground level (AGL).

[4] Altitudes expressed in height above mean sea level (MSL) are equivalent to height above ground level (AGL) + mean field elevation (~1,000 FT for KATL).

Source: MITRE

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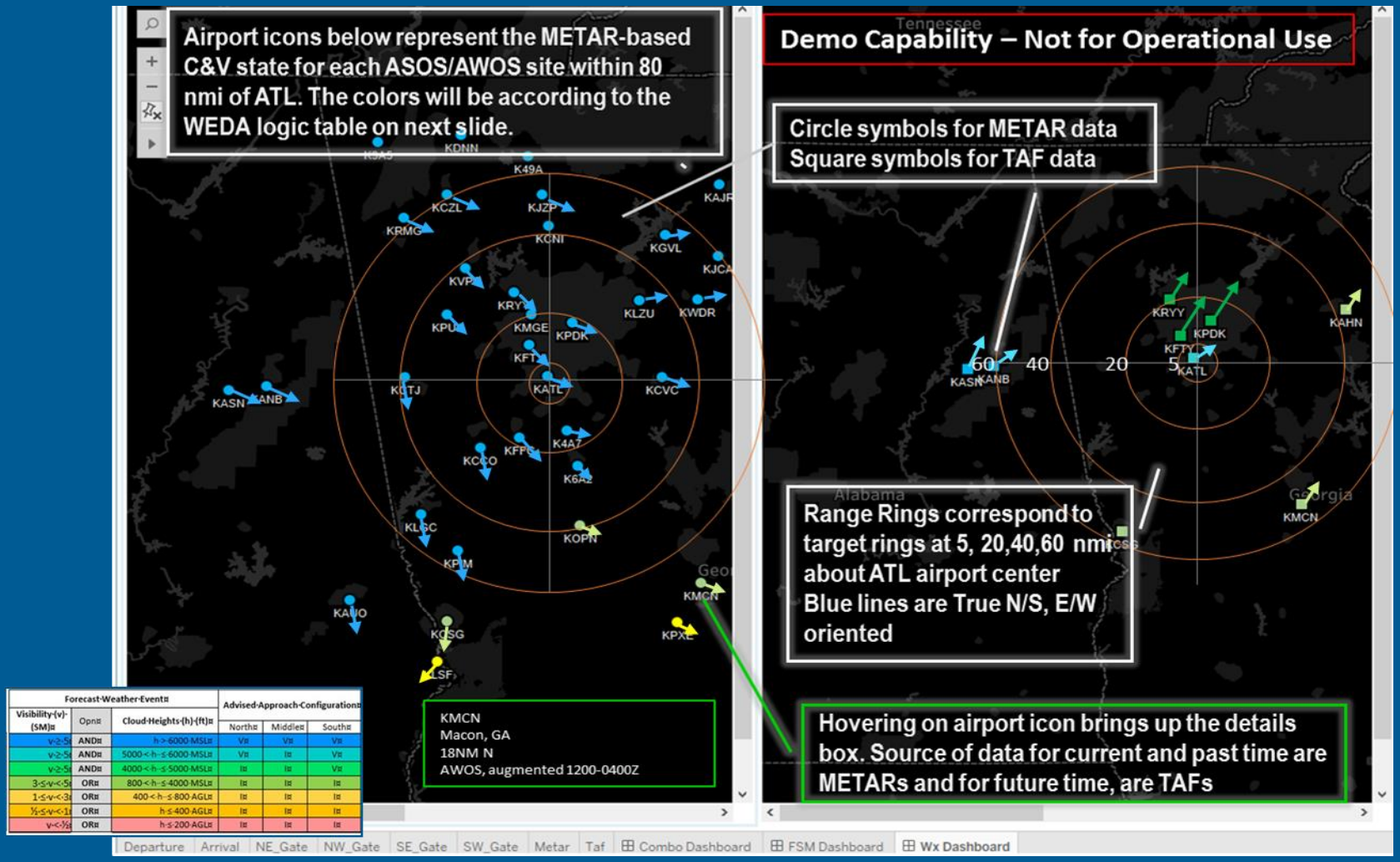
WEDA Notional Weather Situation Display

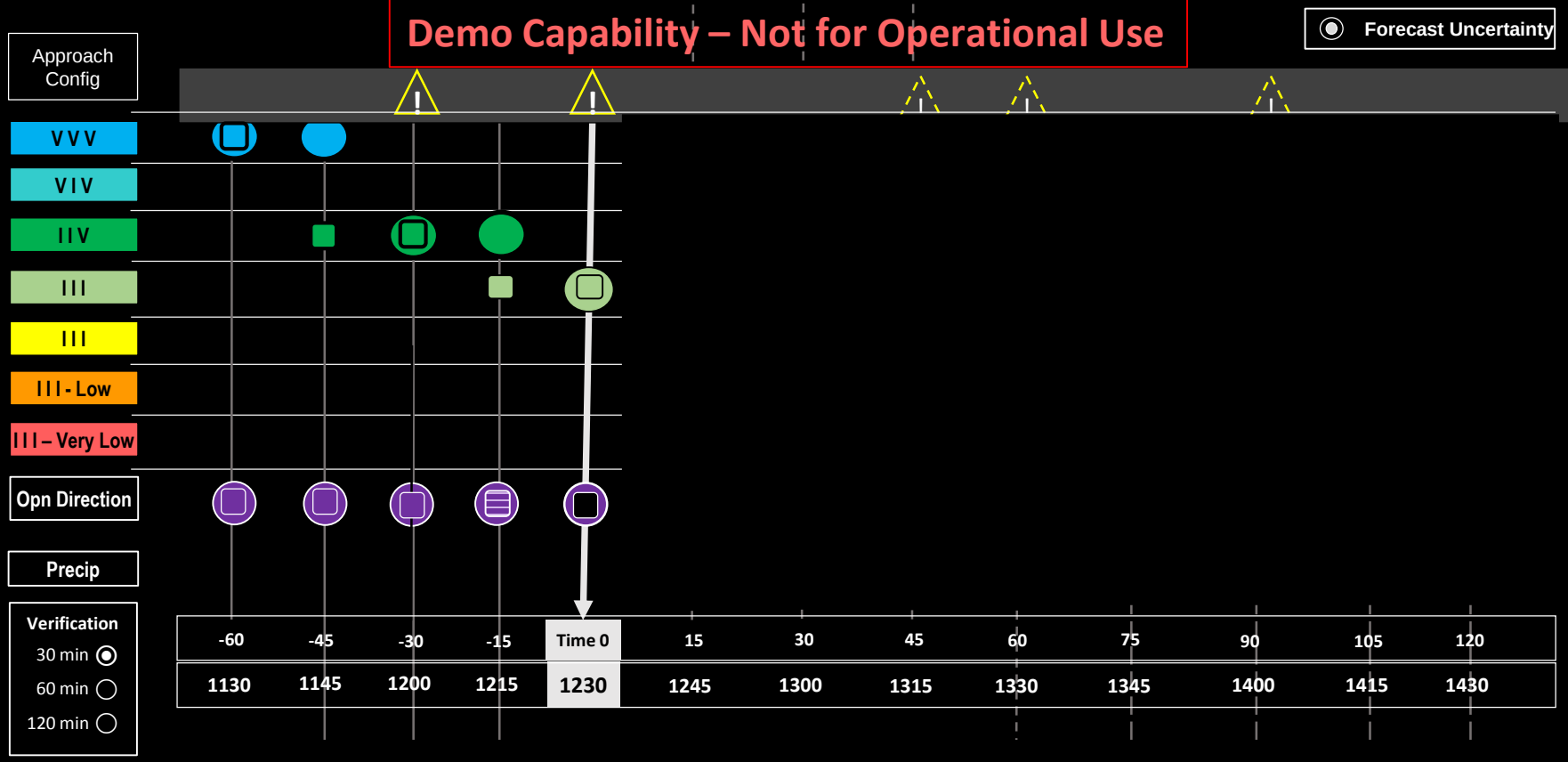


Forecast Weather Event			Advised Approach Configurations		
Visibility (v) (SM)	Opn	Cloud Heights (h) (ft)	North	Middle	South
v ≥ 5	AND	h > 6000 MSL	VII	VII	VII
v ≥ 5	AND	5000 < h ≤ 6000 MSL	VII	III	VII
v ≥ 5	AND	4000 < h ≤ 5000 MSL	III	III	VII
3 ≤ v < 5	OR	800 < h ≤ 4000 MSL	III	III	III
1 ≤ v < 3	OR	400 < h ≤ 800 AGL	III	III	III
½ ≤ v < 1	OR	h ≤ 400 AGL	III	III	III
v < ½	OR	h ≤ 200 AGL	III	III	III

Source: MITRE

WEDA Notional Decision Support Display

Demo Capability – Not for Operational Use



rain frozen

Source: MITRE

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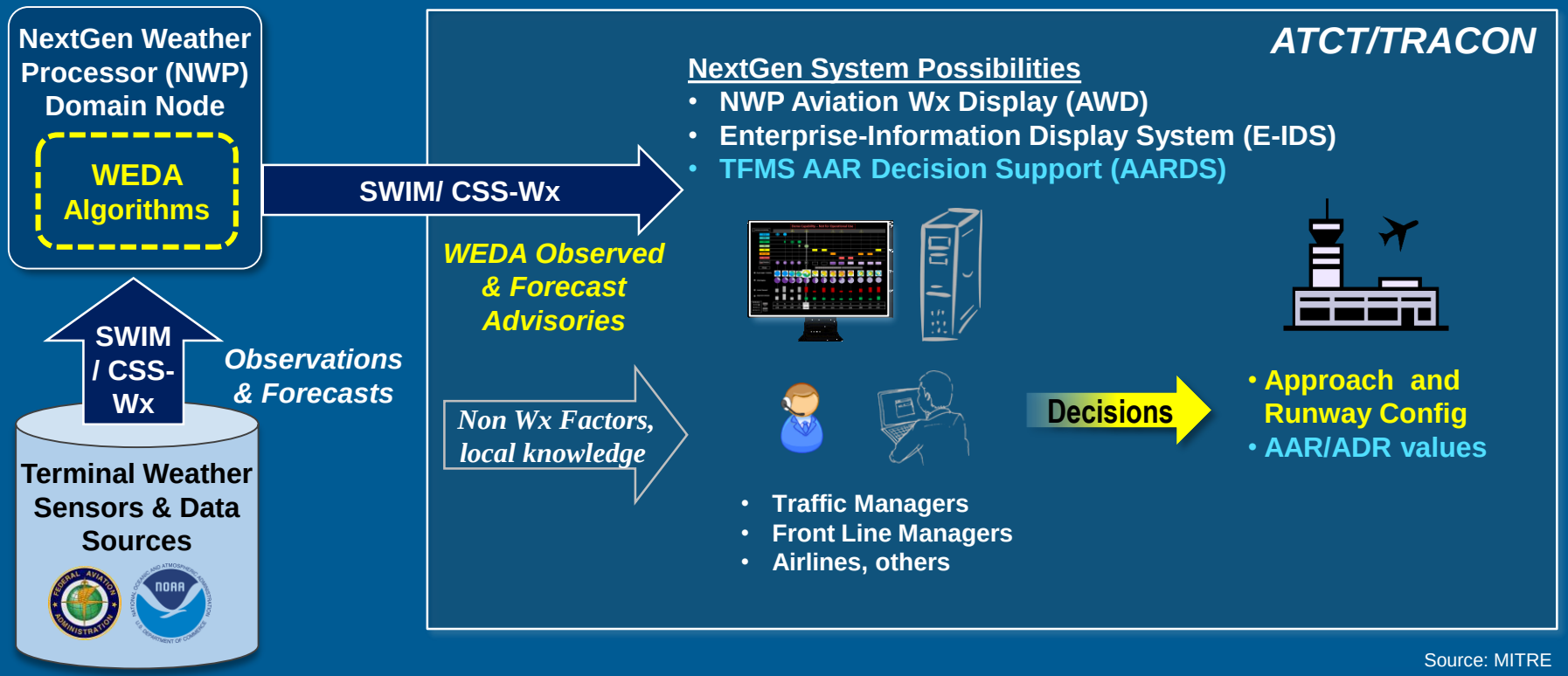
WEDA Line-of-Sight to NextGen Programs

- A decision on the approach and runway configuration, airport arrival rate (AAR) and airport departure rate (ADR) is based on a combination of weather data, operational doctrine, ATC terminal operations and local knowledge
- **WEDA contributes one set of weather factors to the decision thread**



Source: MITRE

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Backup

WEDA Project Research Objectives

- **Initial Concept Development focusing on Airport Operating State**
- **Identify key weather thresholds pertinent to airport operating state**
  - ✓ Deliverable: Annotated briefing – "Summary of Triggering Thresholds, Alerting Parameters and Probabilities for Atlanta Airport" [Aug 31, 2016]
- **Identify weather events, forecast uncertainties and advisories**
  - ✓ Deliverable: Annotated briefing – "Concept Validation Results – Initial Report" [Dec 16, 2016]
  - ○ Deliverable: Initial WEDA Demonstration Capability [April 30, 2017]
- **Evolve the WEDA operational concept through tabletop and field evaluations**
  - ✓ Deliverable: White Paper – "Preliminary Concept – Threshold Event Identification and Alerting" [April 30, 2016]
  - ○ Deliverable: Technical Report – "A Concept of Weather Event Detection and Advisory (WEDA)" [April 30, 2017]

Research sponsored by FAA 's Advanced Concepts & Technology Development Office – NextGen Aviation Weather Division (ANG-C6)

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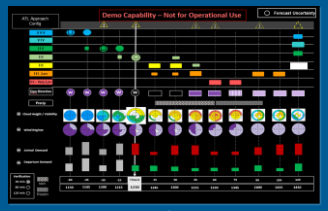
Next Steps

WEDA Demonstration Capability (WDC)



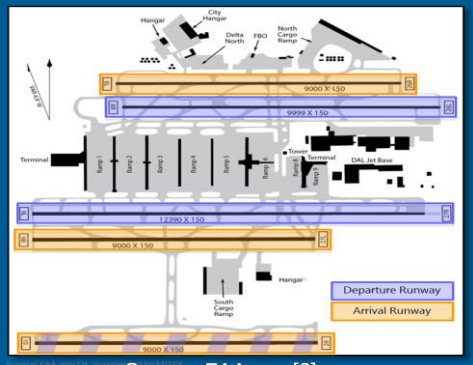
Source: MITRE

Web-based application that ingests and processes live weather observation and forecast data to explore ways to display weather event and threshold information and exploring the relationships between weather forecast uncertainties, alert parameters and operational risk management.

- ***WEDA evaluation exercises at KATL and A80 using WEDA Demonstration Capability – February/March 2017***
- ***WEDA Operational Concept Description Update – April 2017***

KATL/A80 Field Evaluation

Active operational users from KATL and A80 TRACON evaluate WEDA operational concept using the WEDA Demonstration Capability



Source: FAA.gov [2], augmented by MITRE

Update Operational Concept Description

Evaluation exercises inform the evolution of the WEDA Operational Concept Description

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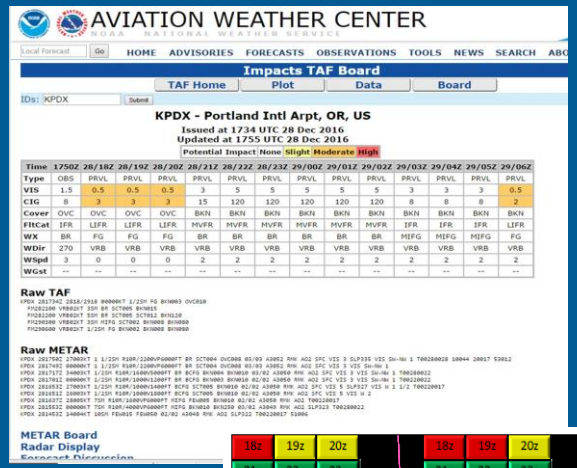
Related Prior Work – Example CWSU Tactical Decision Aids

Terminal Aerodrome Forecast-based Tactical Decision Aid

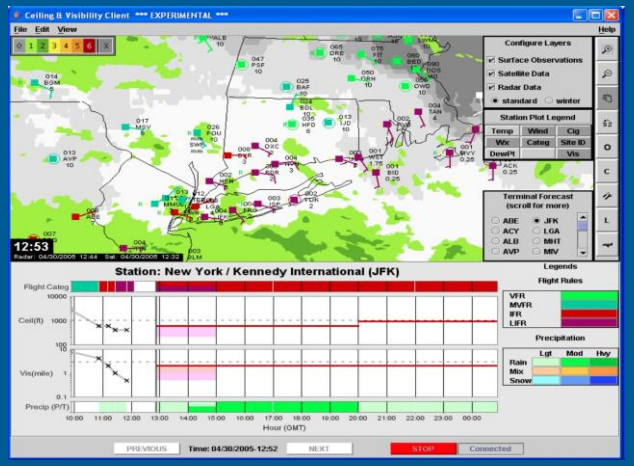
Impacts TAF Board

Source: NWS https://www.aviationweather.gov/taf/board

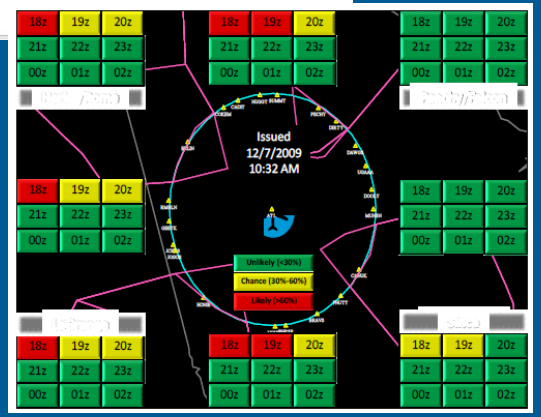


MIT Lincoln Lab Experimental Terminal Ceiling & Visibility Product 2006 AMS Conference

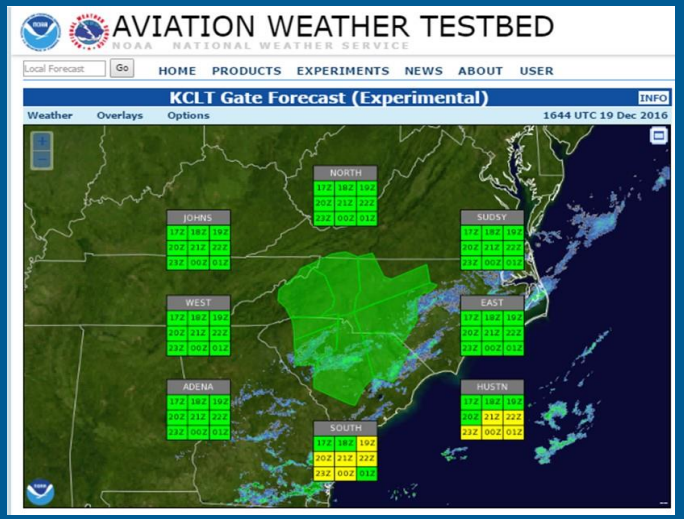
Source: ams.confex.com/ams/Annual2006/techprogram/paper_103710.htm



CWSU-based Thunderstorm Tactical Decision Aid



Source: NWS CWSU Various Tactical Decision Aids (winds, icing, convection, etc.) http://www.weather.gov/ztl/



AWC Gate Forecast Product

Source: NWS https://www.aviationweather.gov/trafficflowmgmt/gate

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“Observations Lead the Way”

1. **Observations (or networks) that are needed to benefit your future research, application or product development**
   - Denser network of approved weather stations (e.g., AWOS/ASOS) within 60-80 nm of major airports with 1 min or 5 min rather than 15 min updates available for wide area dissemination
   - Additional network bandwidth will be needed to accommodate the increased attendant demand
2. **Recommended instruments that are needed to make these observations**
   - Generally, improved sensor accuracies and rapid updates (e.g., OMO) widely disseminated….which will require additional attendant network bandwidth

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Refrences

Number	Reference
[1]	MIT Lincoln Laboratory. Corridor Integrated Weather System (CIWS)Description. https://www.ll.mit.edu/mission/aviation/faawxsystems/ciws.html
[2]	The Federal Aviation Administration, "NextGEN Hartsfield-Jackson Atlanta International Airport," 6 July 2016. [Online]. Available: https://www.faa.gov/nextgen/snapshots/airport/?locationId=54.

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NOTICE