

NASA AMES
Virtual Airspace Modeling and Simulation (VAMS)

Air Traffic Management System Development & Integration (ATMSDI)



VAMS TIM #2

**Airspace Concepts Evaluation System:
Build 1 Assessment and Validation**



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Build 1 Assessment Objectives



- **Demonstrate the ability to perform assessment of NAS performance under various operating conditions**



Build 1 Validation Objectives

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- **Obtain the same order of magnitude for the simulated performance metric vs NAS data for given scenarios**
- **Ensure that the simulation results demonstrate the same trends as real-world NAS data over a range of scenarios**

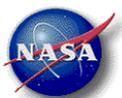


ACES Build 1 Assessment and Validation



The Build 1 assessment and validation involves

- **Defining the metrics to be used**
- **Defining the data to be collected**
- **Demonstrating the capability to perform assessments**
- **Validating the simulation**



Assessment/Validation Scenarios

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	Initial	Stretch Adds
NAS System Characteristics	Current NAS	20% increase in airport acceptance rates
NAS Environmental Factors	No significant en route weather Scripted en route winds Good weather at all airports	Locally bad weather at selected airports
NAS Demand	Low traffic day High traffic day	High Traffic + 20%



Build 1 Metrics



- **Flight Event Times**
- **Delays**
- **Total Fuel Consumed**
- **Controller Workload**
- **TFM Restrictions**



Flight Events and Delays



- Gate Departure
- Taxi Out
- Take Off
- Airborne
- Landing
- Taxi In
- Gate Arrival
- Block Time

Note: Not all events and delays can be validated against real data. This depends upon the availability of real data



Flight Events Eye Chart



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Flight Event	TIMES				DELAYS				AVERAGE DELAYS			
	Actual	Measured (ETMS/OOOI)	Phase II Simulation	Can We Validate?	Actual	Measured (ETMS/OOOI)	Phase II Simulation	Can We Validate?	Actual	Average from ASPM	Ave from Phase II Simulation	Can We Validate?
1. Gate Departure	True Gate Departure	Not available OOOI Out	Set to GDT from OAG + Simulated Gate Departure Delay	No Yes	True Gate Departure Time - Scheduled Gate Departure Time	Not available OOOI Out - GDT from OAG	Simulated Gate Departure Time - Scheduled Gate Departure Time	No Yes	Ave of True Gate Departure Delays	Ave OAG Based Gate Delay	Ave of Simulated Gate Departure Delay	Yes
Scheduled Gate Departure	GDT from OAG	GDT from OAG	GDT from OAG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2. Taxi-Out	True Taxi-Out	Not available OOOI Off - OOOI Out	Set to Nominal Value + Simulated Taxi Out Delay	No Yes	True Taxi Out Delay	Not available	Simulated Taxi Out Delay	No	Ave of True Taxi Out Delay	Ave Taxi Out Delay	Ave of Simulated Taxi Out Delay	Yes
3. Take-Off	True Take-Off	DZ - Average Departure Gap OOOI Off	Simulated Gate Departure Time + Simulated Taxi Out Time	Yes Yes	True Gate Departure Delay + True Taxi Out Delay	Not available	Simulated Gate Departure Delay + Simulated Taxi Out Delay	No	Ave of True Take Off Delay	Ave OAG Based Airport Departure Delay	Ave of Simulated Take Off Delay	Yes
4. Airborne	True Airborne	Measured Landing Time - Measured Take Off Time OOOI On - OOOI Off	Calculated in Simulation	Yes Yes	True Airborne Time - Scheduled Airborne Time	Measured Airborne Time - ETE from FZ msg	Simulated Airborne Time - ETE from FZ msg (see note below)	Yes Yes	Ave of True Airborne Delay	Ave Airborne Delay	Average Simulated Airborne Delay	Yes
5. Landing	True Landing	AZ - Average Arrival Gap OOOI On	Set to Simulated Take Off Time + Simulated Airborne Time	Yes Yes	True Gate Departure Delay + True Taxi Out Delay + True Airborne Delay	Not available	Simulated Gate Departure Delay + Simulated Taxi Out Delay + Simulated Airborne Delay	No	Ave of True Landing Delay	Ave Gate Departure Delay + Average Taxi Out Delay + Ave Airborne Delay	Ave of Simulated Landing Delay	Yes
6. Taxi-In	True Taxi-In	Not available OOOI In - OOOI On	Set to Nominal Value	No Yes	True Taxi In Delay	Not available	Not calculated; set to 0	No	Ave of True Taxi In Delay	Ave Taxi In Delay	Not calculated; set to 0	No
7. Gate Arrival	True Gate Arrival	Not available OOOI In	Set to Simulated Landing Time + Simulated Taxi In Time	No Yes	True Landing Delay + True Taxi In Delay	Not Available OOOI In - GAT from OAG	Set to Simulated Landing Delay	No Yes	Ave of True Gate Arrival Delay	Ave OAG Based Airport Arrival Delay	Ave of Simulated Gate Arrival Delay	Yes
Scheduled Gate Arrival	GAT from OAG	GAT from OAG	GAT from OAG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8. Block Time	True Gate Arrival Time - True Gate Departure Time	Not available OOOI In - OOOI Out	Set to Simulated Gate Arrival Time - Simulated Gate Departure Time	No Yes	True Gate Arrival Delay - True Gate Departure Delay	Not available Measured Gate Arrival Delay - Measured Gate Departure Delay	Set to Simulated Gate Arrival Delay - Simulated Gate Departure Delay	No Yes	Ave of True Block Time Delay	Ave Block Time Delay	Ave of Simulated Block Time Delay	Yes

The difference between the measured airborne delay and the Phase II simulation airborne delay is mathematically equal to the difference between the measured airborne time and the Phase II simulation airborne time. Therefore the conclusions about validation of airborne delay are the same as those for validating the airborne times. However, when validating simulated airborne delays against the average delays obtained from ASPM data, the simulated airborne delay must be calculated using the formula as above.



Observations from Flight Event Chart



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- **Many real world data can only be partially or imprecisely observed**
 - Gate Departure, Gate Arrival, Taxi Out, Taxi In times require OOOI data, available on only 10 airlines at selected airports
 - Airborne Time requires OOOI for accurate measurement; can only be imprecisely obtained from ETMS data
 - Many delay measures are not known because “nominal” values are not know (against which to measure delays)
 - » Taxi In/Out/Take Off/Landing delay
- **The previous eye chart identifies parameters that can be accurately validated, approximately validated, and not validated at all**



Total Fuel Consumed



- Fuel consumed by all aircraft in a scenario
- Cannot be validated (lack of real world data)



Controller Workload Metrics



- **Number of speed changes per 15 minute interval**
- **Number of path changes per 15 minute interval**
- **Number of speed changes per 15 minute interval due to CD&R action by en route agent**
- **Number of path changes per 15 minute interval due to CD&R action by en route agent**
- **Cannot be validated (lack of real world data)**



TFM Restrictions



- **ATCSCC**
- **ARTCC**
- **TRACON**
- **Airport**
- **AOC**



Limited Build 1 Assessments



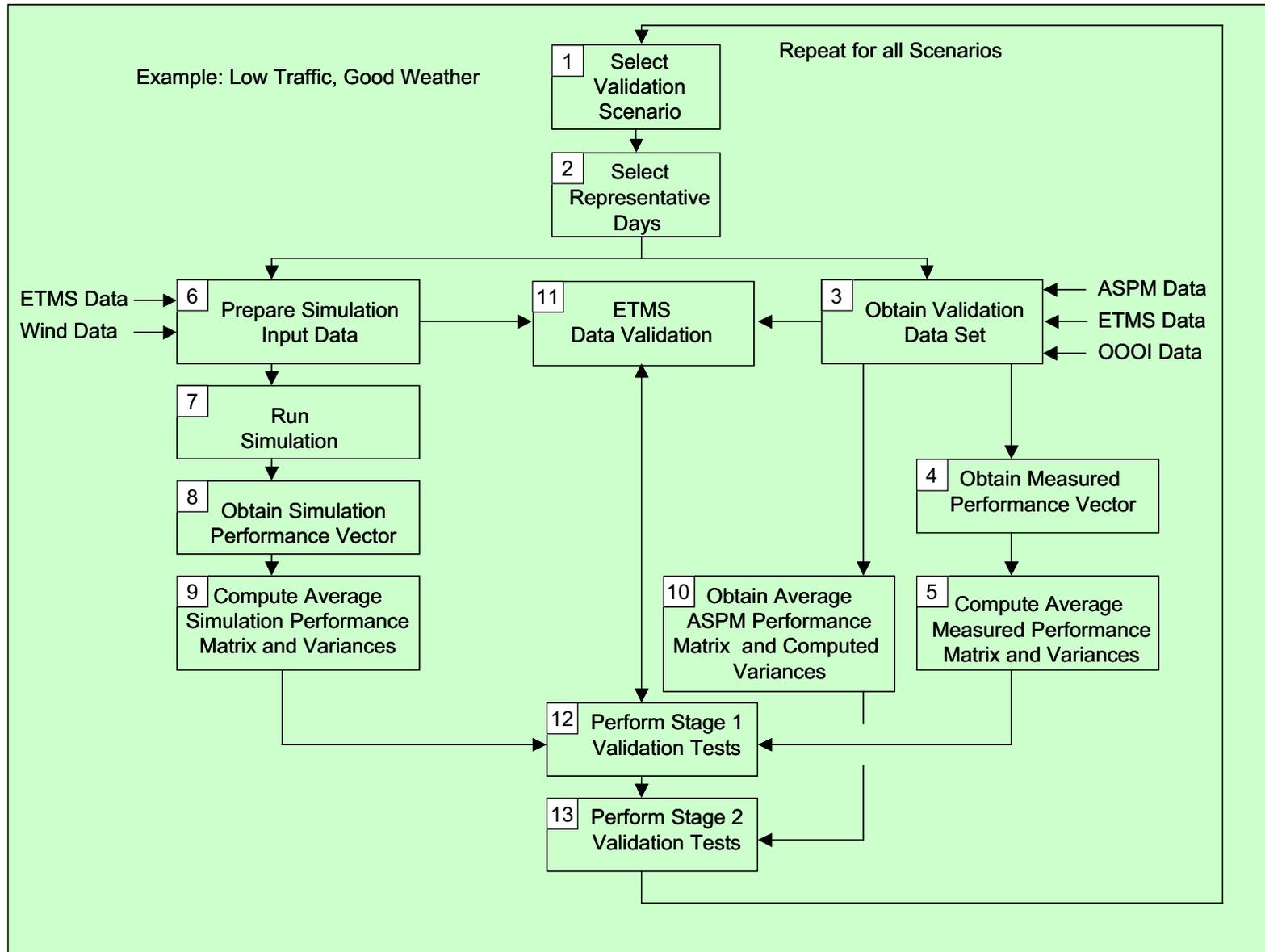
- **Build 1 assessments = validation scenarios because**
 - **No new DSTs to “assess”**
 - **Limited time available for assessments**



Validation Process



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Steps in the Validation Process



- **Boxes 1 – 2** Pick the days to be simulated and validated
- **Box 3, 4, 5, and 10:** Obtain and process the real world data against which we will validate
- **Box 6:** Prepare simulation input data (mainly flight plans and winds aloft data)
- **Boxes 11:** ETMS data validation to ensure that ETMS flight plan data used to drive the simulation compares (on average) with average ETMS derived data from FAA ASPM data system
- **Boxes 7, 8, and 9:** Run the simulation and process the output data
- **Box 12: Stage 1 Validation –** Average simulation outputs compared to averages of pertinent input data (OOOI, ETMS data)
- **Box 13: Stage 2 Validation –** Average simulation outputs compared to ASPM average performance data (much richer set of averages available in ASPM)

Run multiple days per scenarios, and then multiple scenarios



Sources of Validating Data



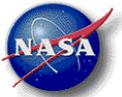
- **FAA ASPM Data System – average performance at 50 airports every 15 minutes**
- **FAA ASPQ Data System – OOOI data**
- **ETMS Data – Flight plan plus Activation Times (~ takeoff), Deactivation Times (~ landing), Estimated Time En Route**



Real World Issues



- **Need accurate winds aloft data for each day to be validated**
 - Nobody seems to have or archive hourly winds aloft data
 - Rapid Update Cycle data (short term winds aloft forecasts) are going to be used as surrogate for actual winds aloft
- **Many parameters are hard to observe**
 - OOOI data is essential for some elements, but only exists for 10 airlines at some airports
 - Actual departure and arrival times from ETMS are only approximate
- **Build 1 simulation has modeling limitations that must be accounted for in the validation effort**
 - Limited Surface Model
 - Low Fidelity Terminal Area models
 - Effects of Bad Weather via flow restrictions



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Questions?