Predictability Metrics

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Outline

- Project overview
- Workshops
- Block time scheduling
- Contingency fuel loading
- Ground Delay Program called rates
- Conclusion

Workshops

- Workshop 1
  - Airline participants
- Workshop 2
  - Air traffic control and Command Center participants
- Workshop 3
  - Combined group from workshops 1-2

Workshop results

Communicate company policies to ATC. SOP that affects airspace flow needs to be communicated to facilities; related to #14; mergers can affect procedures; whole generation of air traffic controllers who have never met a pilot	Clarify and limit controllers' responsibility to provide weather information related to policy and workload; what they are required to do; wx is a component; tying up the frequency by issuing wx to multiple pilots; more with GA pilots; driven by courts.
Better coordination between pilots and controllers to understand what is needed, e.g., for "opposite direction" departures with radar vectors, what is the quickest way to get turned around?	Make more timely decisions and announcements about GDPs and AFPs. Better weather data to support more timely decisions; need to be better about going into and out of GDPs. Make a decision early rather than just talking.
Improve PDC reliability and functionality. Change reliability to readability (by pilots); get it rolled out and done.	Streamline voice communications. For many frequency changes and handoffs; proceduralize comm changes. Saying hello and goodbye.
Have more decisive outcomes from strategic planning telecons.	Improve information exchange.
Improve block time reliability	Improve collaboration
Reduce overall number of rolling ground stops. Maybe GDP that gives you more predictability	Improvement in time required to implement change; e.g., new air routes, airspace redesign, new procedures, etc.
More accurate, consistent rates on flow programs	Improve tool deployment strategies
Improve management of flows into airports using controls starting during the en route portion of flight – about 500 NM out. Have some system that can sequence; technology; specific NM outbound; have some limit but don't put it in there (like the 500 NM). Put it out at top of climb coming into the airport.	Surface management exchange and coordination between towers and carriers
Improve predictions of surface delays and taxi time.	Communication and coordination across TMUs.
Improve ETA accuracy on day of operations	Extending flow management to the gate
Regular forums – probably web-based – where controllers and pilots identify opportunities to clarify mutual expectations and opportunities to make operations run more smoothly	When a controller assigns a delay of some duration, how firm is that estimate? Include airborne vs. ground; EFCs; extreme vs. non-extreme delay.

Highest payoff items

Red Team	Blue Team
Improve block time reliability	Improve block time reliability
More accurate and consistent rates on flow programs	Improvement in time required to implement change
Improve data exchange and communications (4 items)	Improve predictions of surface delays and taxi time

Immediacy / ease of implementation

Red Team	Blue Team
More accurate and consistent rates on flow programs	Surface management exchange and coordination between towers and carriers
Improved data exchange and communication (4 items)	Make more timely decisions and announcements about GDPs and AFPs
Communication and coordination across TMUs	Have more decisive outcomes from strategic planning telecons

Classification of Responses

- GDP and flow programs
  - Timely, decisive, early, accurate
  - Better weather data
- Airspace changes and ATM automation
  - Flow management farther out
  - More time to respond, better tool deployment
- Collaboration and communication among facilities
  - Streamline voice comm
  - Surface management
  - Extend TFM to the gate
- FAA/Airline actions
  - Coordination and meetings between pilots and controllers
  - Improve PDC reliability and functionality
- Research
  - Reliability of delay estimates, ETA accurary
  - Improve block time reliability
  - Improve surface and taxi delay predictions

Subsequent research agenda

- GDP and flow programs
  - Timely, decisive, early, accurate
  - Better weather data
- Airspace changes and ATM automation
  - Flow management farther out
  - More time to respond, better tool deployment
- Collaboration and communication among facilities
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- FAA/Airline actions
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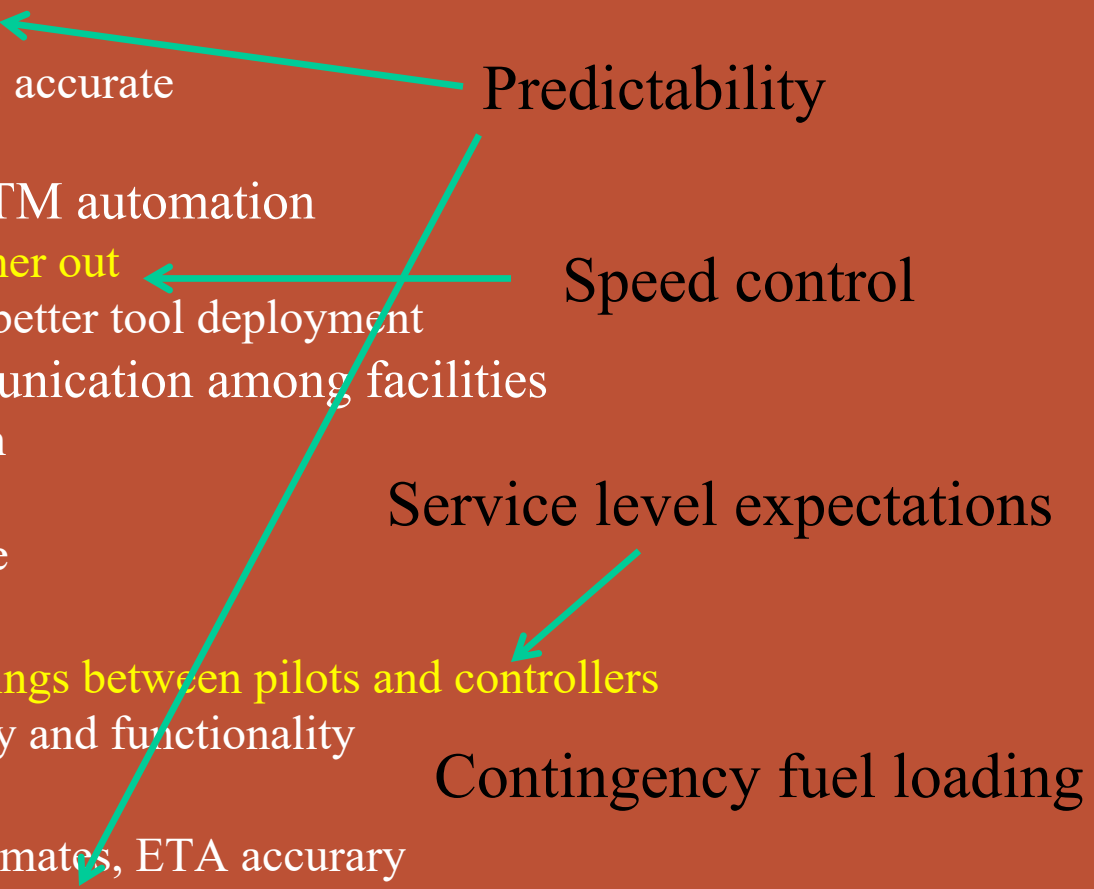
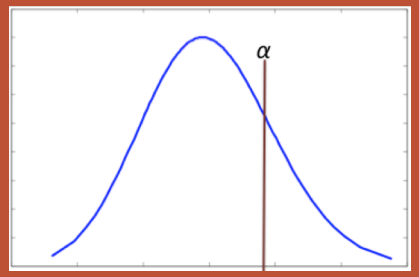
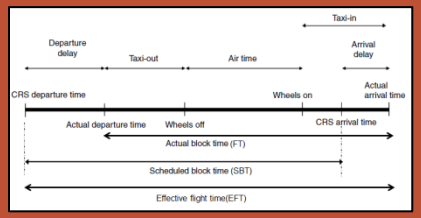
- Research
  - Reliability of delay estimates, ETA accurary
  - Improve block time reliability
  - Improve surface and taxi delay predictions



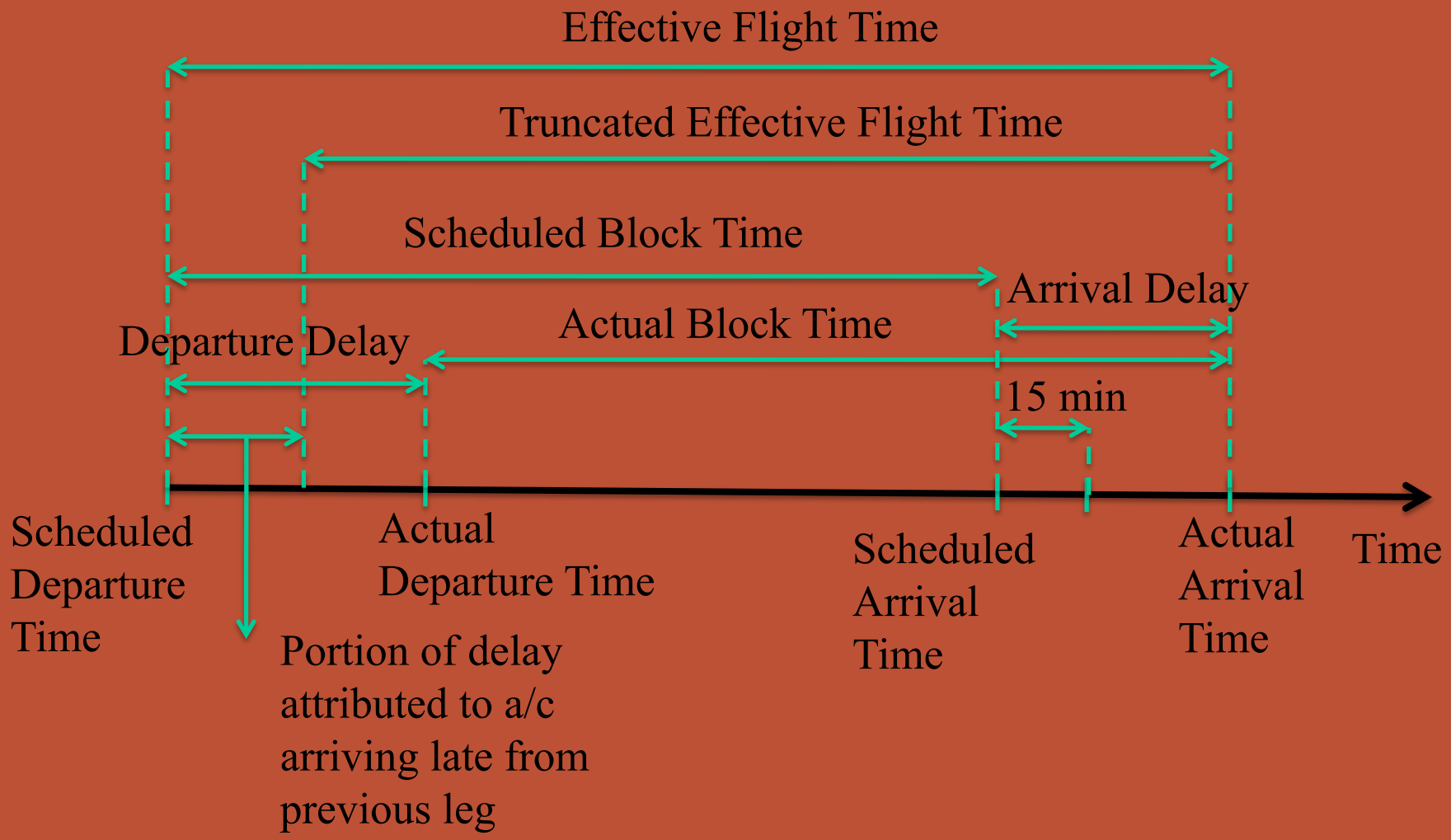
Block Time Variability

Distribution of block times → Scheduled block times → Airline operating cost

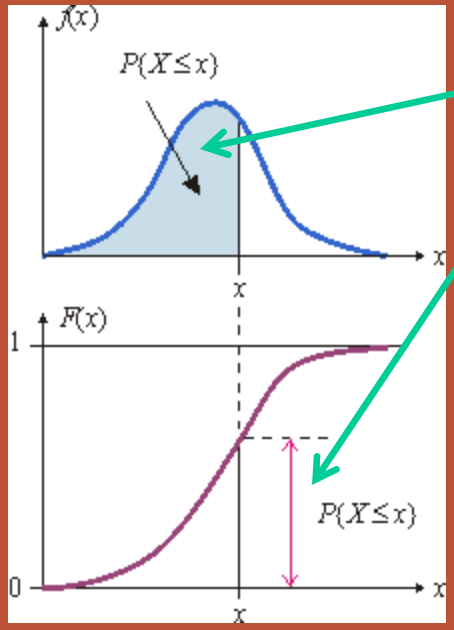




Scheduled vs. actual block time



How do carriers set SBT?



- Block time reliability: set SBT at some percentile of realized block times (65-75%)
- Adjustments for hub airports, flight characteristics, turn times, construction, etc.

Statistical model of SBT

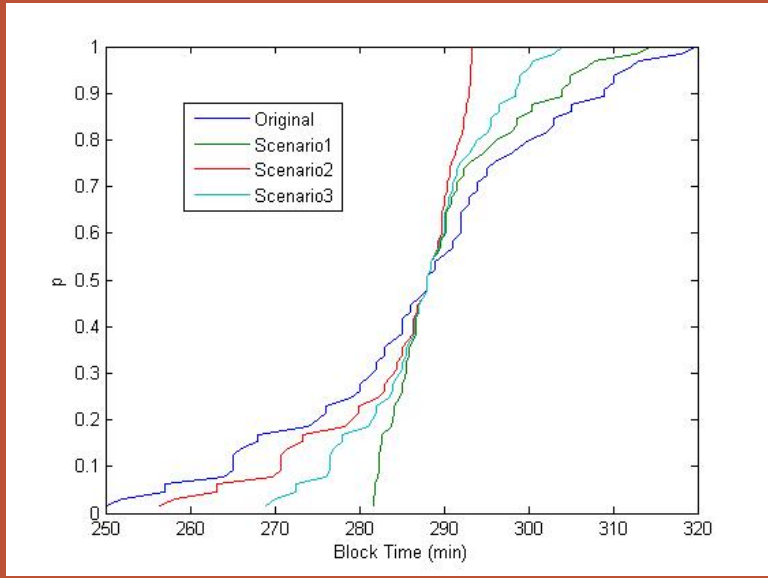
- Model included detailed description of the distribution of actual block times, departure delay, seasonal effects, hub status, competition, airport traffic level
- Assumed actual block times from 2009 influenced SBT for 2010

Results from statistical analysis

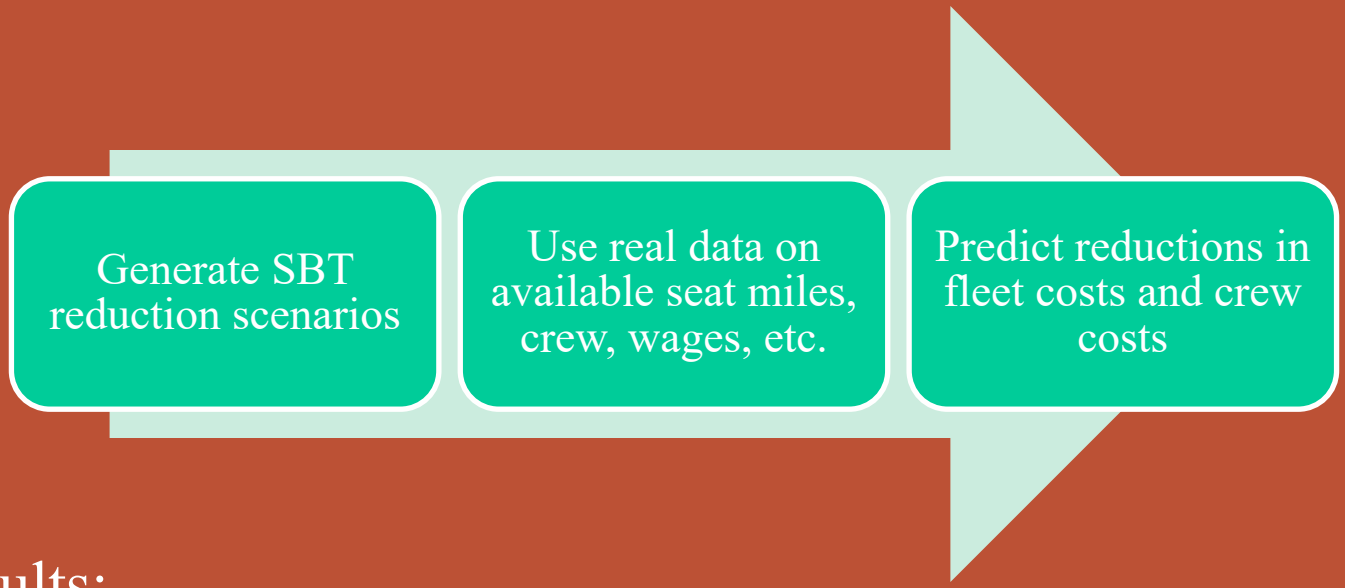
- Confirms the general recipe for SBT shared with us by the carriers
- Mean departure delay has almost no impact
- Carriers are more conservative with longer flights
- The median plus the inner right tail of the historical distribution are most important
- In competitive markets, SBT is higher (better on-time performance?)
- Some differences between legacy carriers
- LCCs set shorter SBT into busy airports (competitive advantage in flight time?)

Predictive model of impact

- Hypothesize changes to actual block time distribution
- Median block time stays the same under all scenarios
- Test impact on SBT and other metrics
- **Main conclusion**: benefits assessments should pay close attention to a policy's impact on near right tail of block time distribution



Benefits assessment

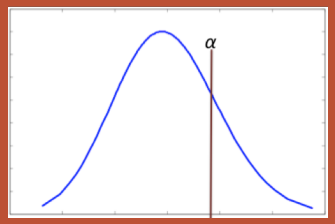


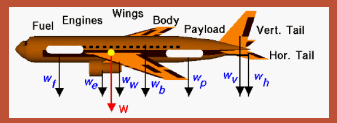
Results:

- Fleet costs on the order of $10M might be available to major carriers
- Salary savings on the order of $1M for cockpit and cabin crew, including for LCCs

Contingency Fuel Loading

Block time unpredictability → Contingency fuel uploading → Aircraft weight and fuel burn → Costs





Model development

- 221,893 domestic flights
- 3,227 combinations of OD pair, month, and dispatcher work shift
- Two metrics of unpredictability:
  - Standard deviation of actual airborne time
  - Difference between actual and planned airborne times
- Assume that fuel loading conditions for month *m* were influenced by experience from month *m* – 1
- Other independent variables: dispatcher ID, weather, meteorological conditions, congestion @ destination airport

Fuel model results

- Estimated minimum contingency fuel comports with stated company practice
- 1 minute of standard deviation in air time ➔ ~1-1.5 minute increase in contingency fuel
- Weather plays a large role, in expected ways
  - Thunderstorms are worse than low ceilings
  - Forecast more important than current conditions
  - Destination airport more important than origin
  - Months April – October most influential
- Caveats:
  - En route weather not considered
  - Relatively low coefficients of determination

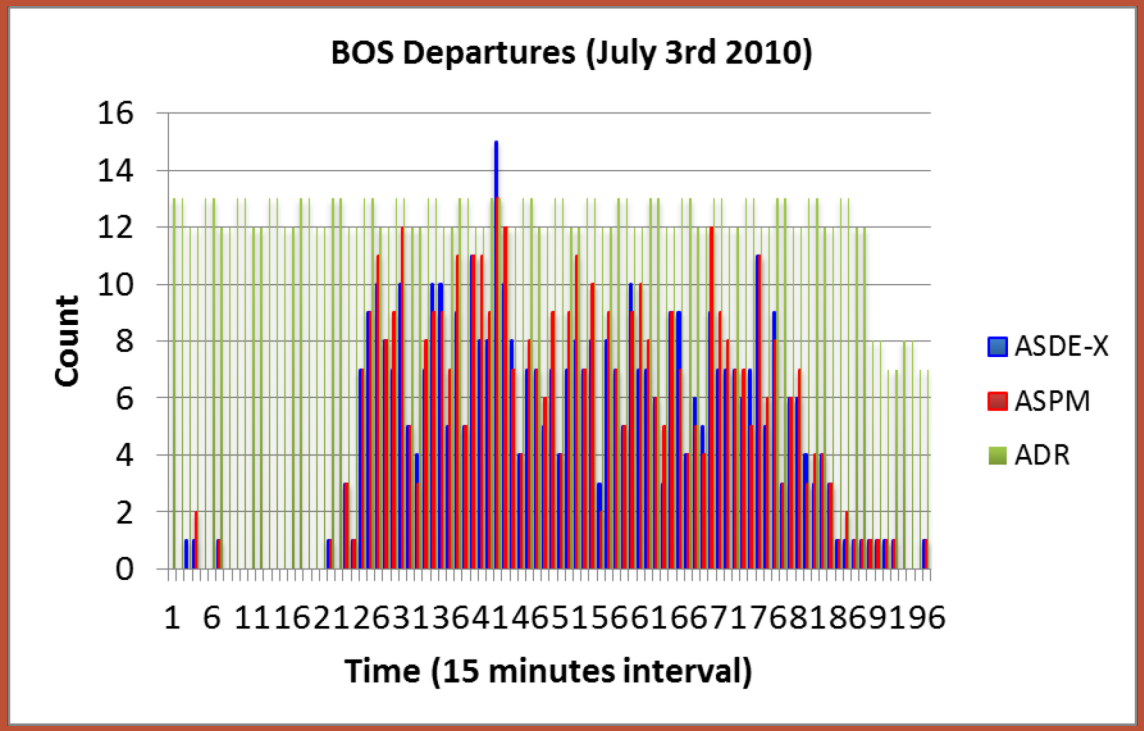
Cost to carry

- Uses the statistical model to estimate monetary and environmental impacts of unpredictability
- Results extrapolated to all domestic operations using BTS T-100 Segment Database
- Contingency and alternate fuel: 423 million lbs
- CO2: 1.35 billion lbs
- Fuel cost: $126 million ($2/gal), $252 million ($4/gal)

GDP Data Dive

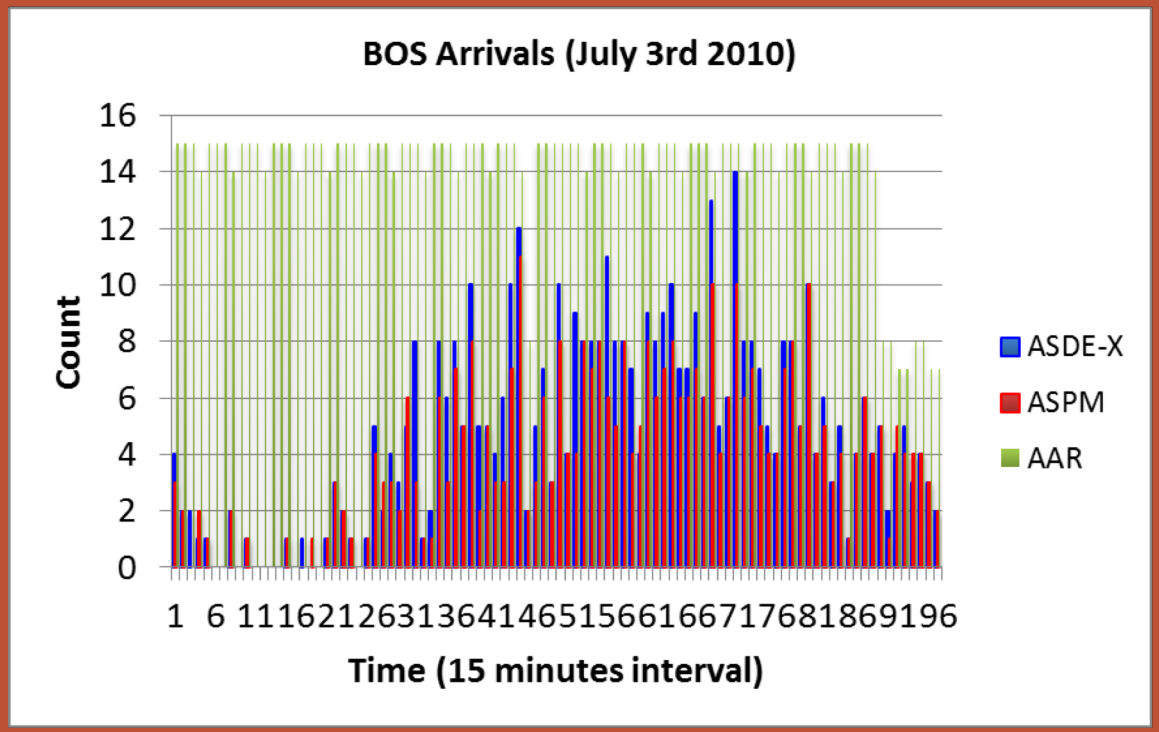
- Adequacy of publicly available data
- AAR/ADR variability
- GDP called rate variability

ASDE vs. ASPM vs. ADR/AAR



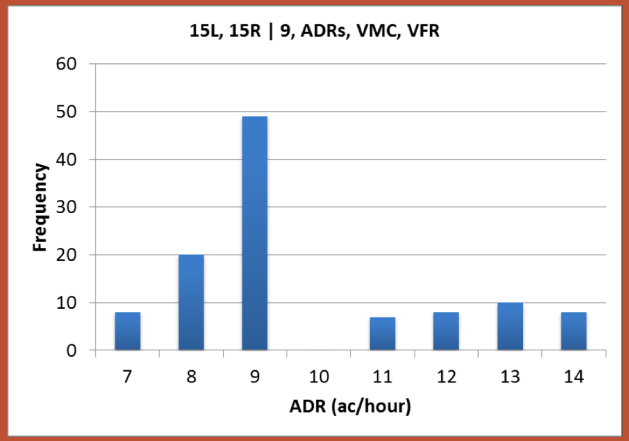
- ASDE & ASPM in reasonably close agreement

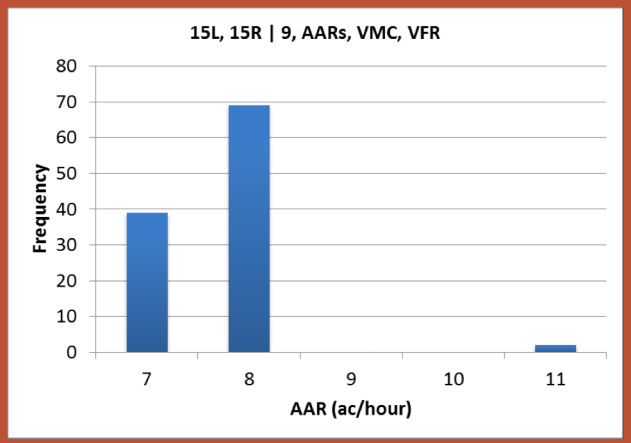
ASDE vs. ASPM vs. ADR/AAR

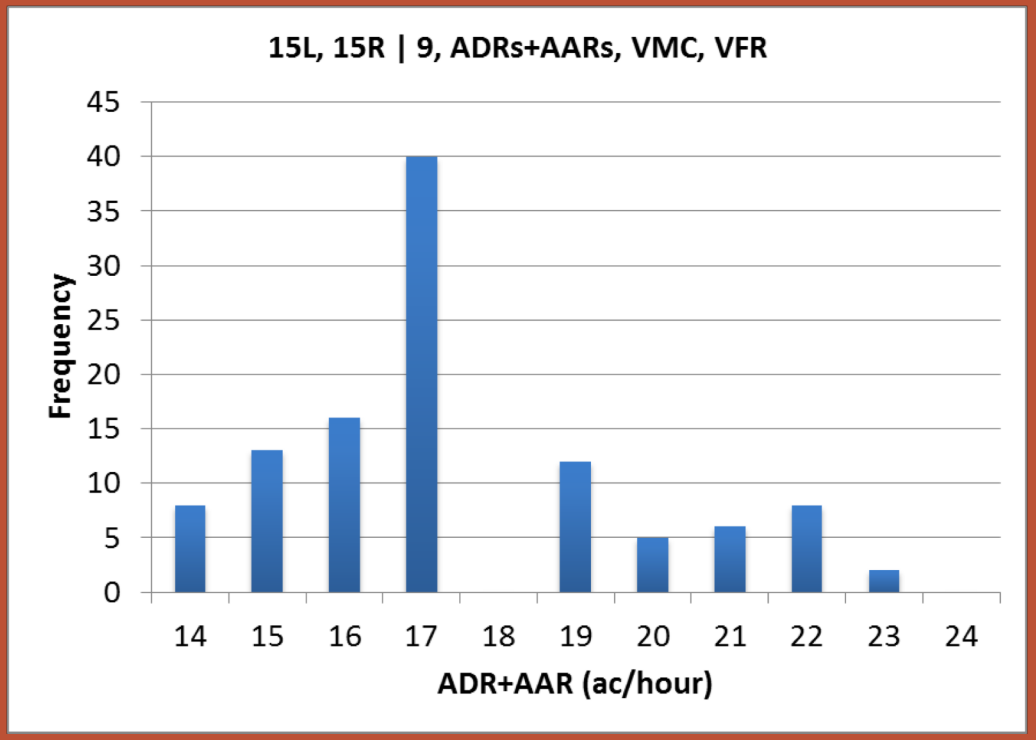


During busy hours, capacity governed by something other than what is reported in AAR/ADR

Controlling for runway configuration





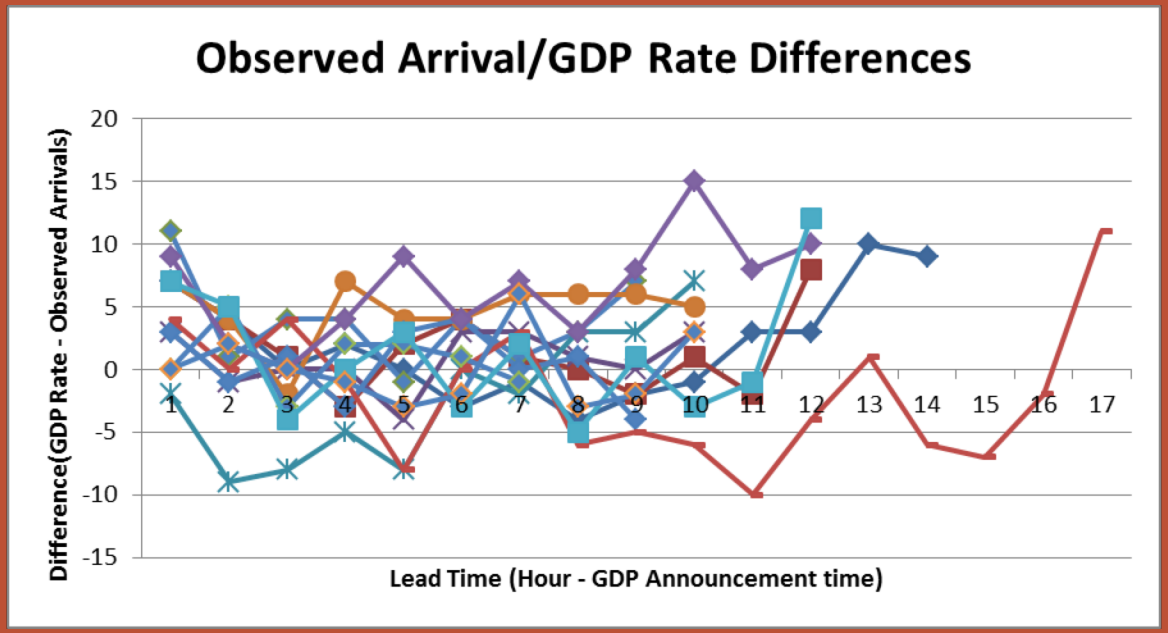


Example GDP evolution

Program Period / Time	16	17	18	19	20	21	22	23	0	1	2	3	4	5
16	32	32	32	32	32	32	32	32	32	32	32	32	32	32
17			32	32	32	32	32	32	32	32	32	32	32	32
18														
19														
20														
21														
22							36	36	36	36	36	36	36	36
23														
0									38	38	38	38		

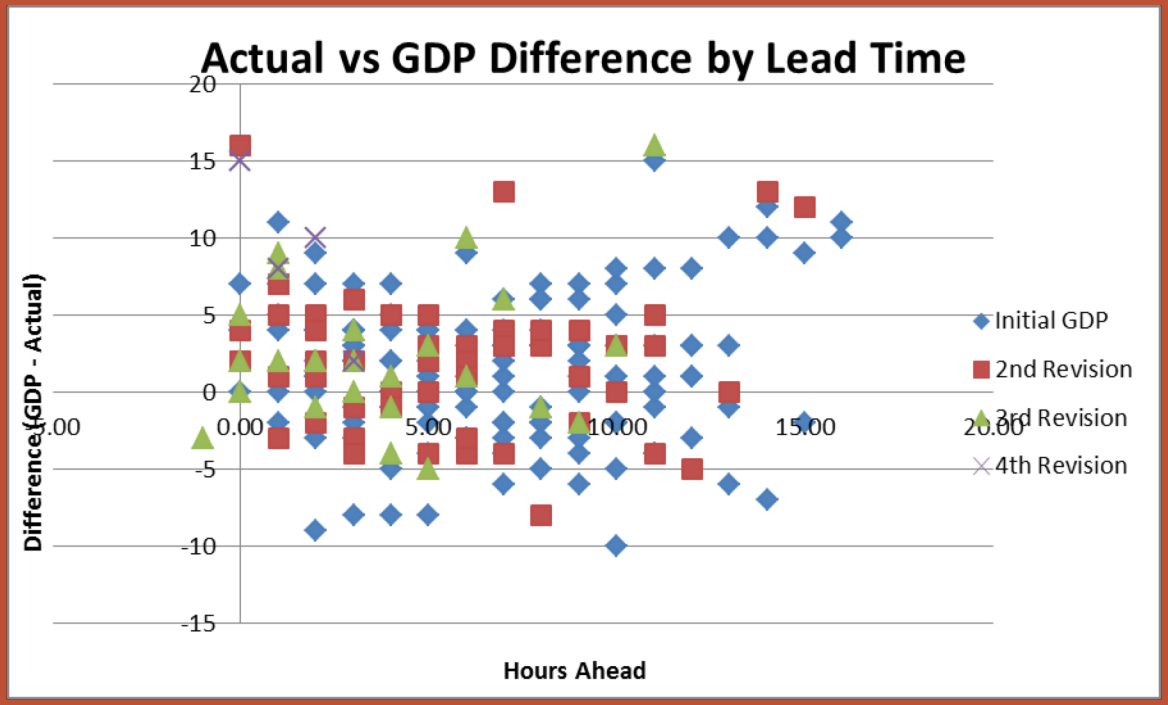
Two different time dimensions: vector of scheduled GDP rates, and revisions

Initially declared GDP rates



- Dropoff in demand at end of GDPs
- Oversubscribed at beginning (popups, exempt, etc.)
- Unfilled capacity early in GDPs?

Effect of GDP revisions



- Vertical spread = uncertainty for that revision class
- Improved predictability ➔ uncertainty is reduced for 2nd, 3rd, etc. revisions – this was not evident

Final notes on GDP analysis

- At the time of the predictability project, we didn't have the same access and understanding of NTML data that we do now
- We were scraping GDP data from fly.faa.gov, which is clunky and unreliable
- A future effort at understanding GDP rate reliability could now be much better supported by data, and perhaps by analysis from our "similar days" project with NASA, but we would want to much more clearly articulate what the questions are