CSSI, INC.
Moving Research to Reality

Enhancing Capacity Profiles with Detailed Surface Operations Modeling Tools

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Goal

Improve situational awareness in the context of changing conditions by providing a continuous estimate of the capacity profile and expected delays

How?

- 2 hour look-ahead rolling capacity curve
- Historical and forecasted data (e.g., surface movement, weather)
- Ability to quickly and intuitively add assumptions (e.g., diversions)

Outline

- ADSIM+
- Effect of surface movement on overall capacity
  - Construction
  - Runway crossings
  - ILS hold nodes
  - High speed exits
- Capacity profile over time
- Look-forward capacity estimate and animation

ADSIM+

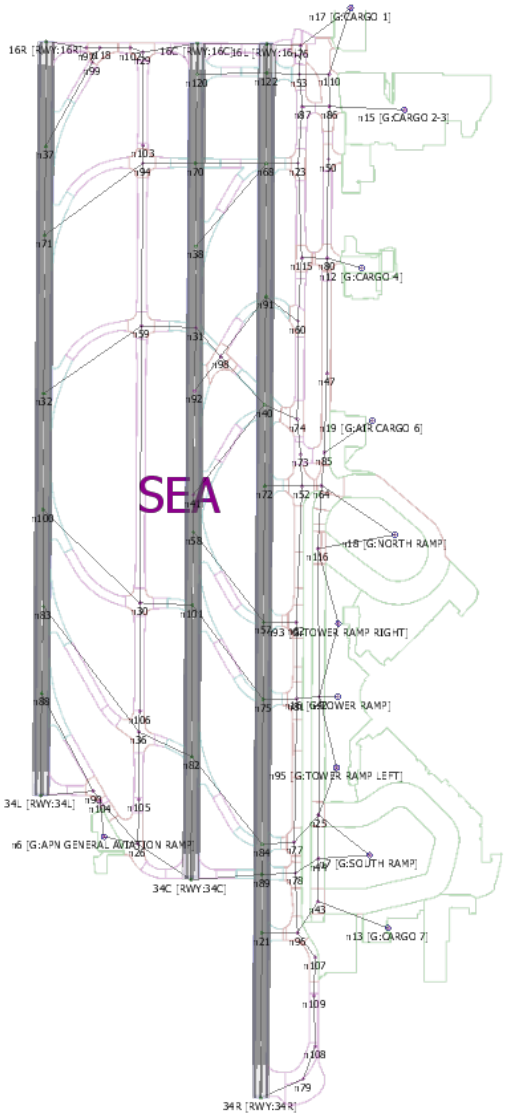
- ADSIM (Airfield Delay SImulation Model) was developed by the FAA in the 1970's
- ADSIM+ is the modernized version developed by CSSI Inc. since 2009
  - Written in C++ with a Graphical User Interface
  - Prioritizes usability and import capabilities
- It is a discrete event (Monte Carlo) simulation of airfield operations
- Has two modes of operations:
  - Delay (output is a standard set of delay statistics)
  - Airport Runway Capacity (output is a capacity envelope)
- Heavy focus on surface operations
- ADSIM+ is being actively developed to add more features and support studies in the FAA's ANG-B71 and other groups

Capacity Profile

- Capacity profiles are well established for major airports
  - Under a specific set of conditions
  - Mainly interested in variations (preferably a continuous update)

  ⇒ Support decision making and enhance awareness
- Main *operational* capacity profile dependencies
  - Fleet mix
  - Aircraft characteristics (runway occupancies, equipage)
  - Flight rules (VFR, IFR)
  - Runway configuration
  - ATC / Airport directives
  - Entrances, Exits
  - **Surface operations**

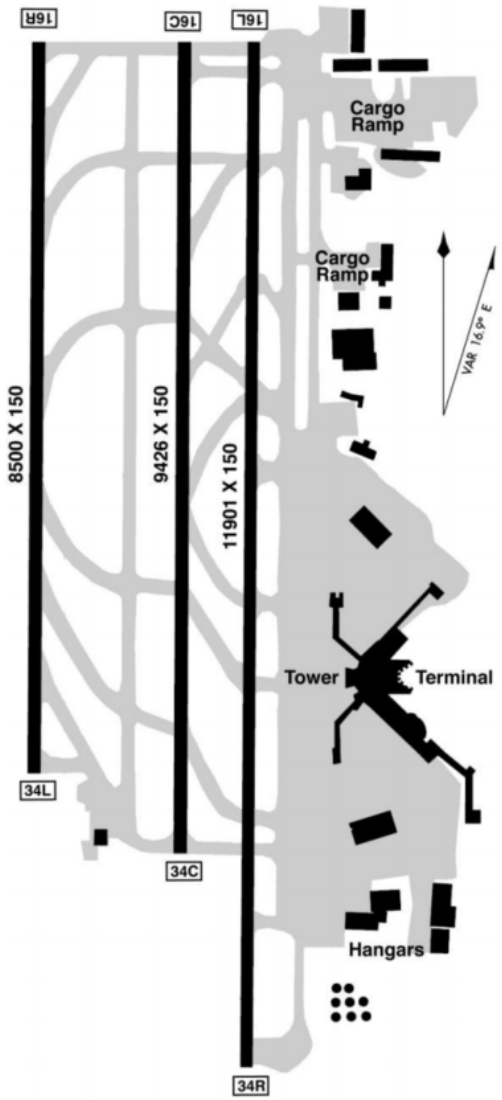
SEA



Fleet Mix

Type	%
H	12
J	0
L	87
A319	1
A320	8
A321	0
B733	1
B734	8
B735	0
B737	13
B738	25
B739	11
CRJ2	1
CRJ7	1
CRJ9	0
DH8C	1
DH8D	30
E135	0
E190	0
MD83	0
S	1

SEATTLE-TACOMA INTERNATIONAL



Construction

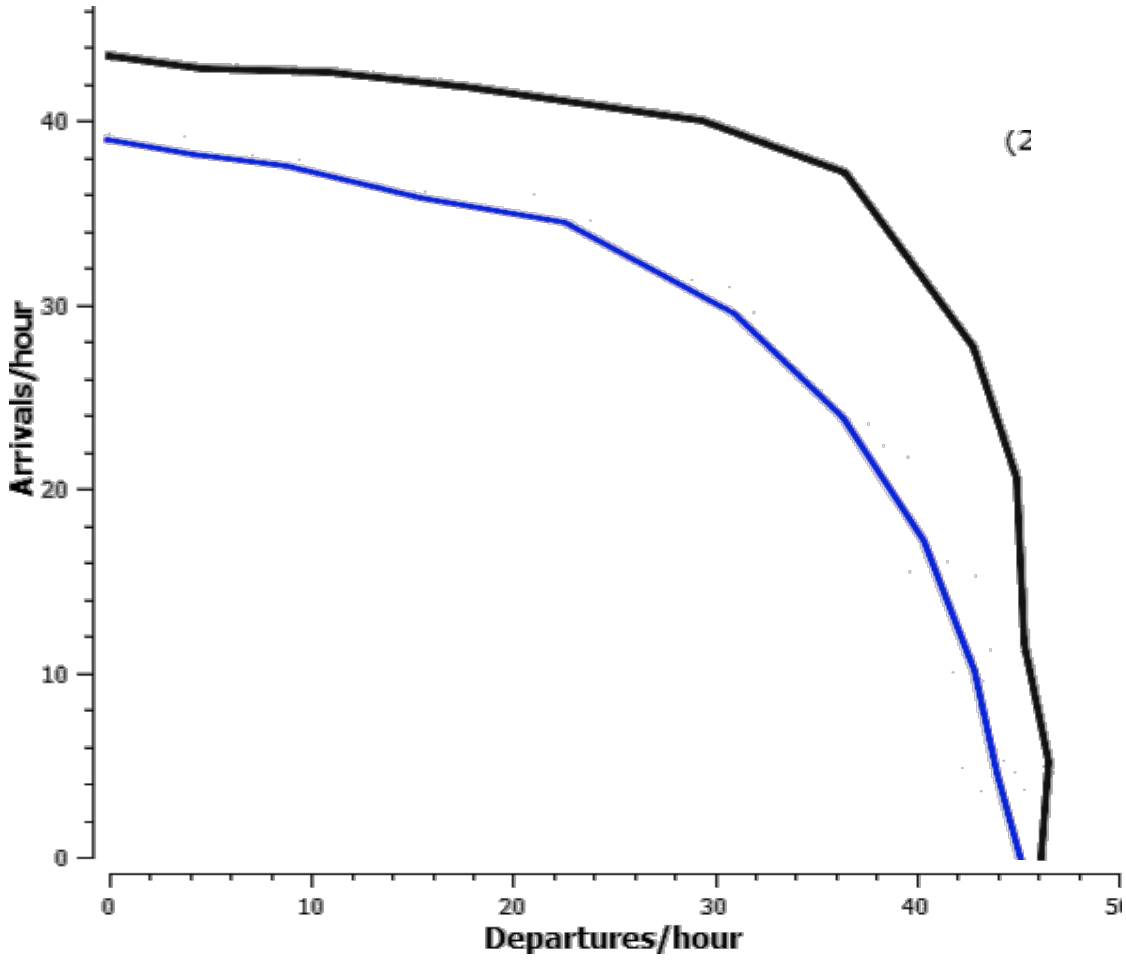
- Construction may cause a runway closure, but also some other changes in the layout of the airport
- Procedures and fleet mix may be revised
- Taxiways may be shutdown
  - Taxipaths would have to be adjusted
  - Runway occupancies need to be closely looked at since exits change
- Runway crossings (when taxiing) might have adjusted parameters for safety

⇒ A more detailed surface model could better capture the new resulting capacity

SEA Results

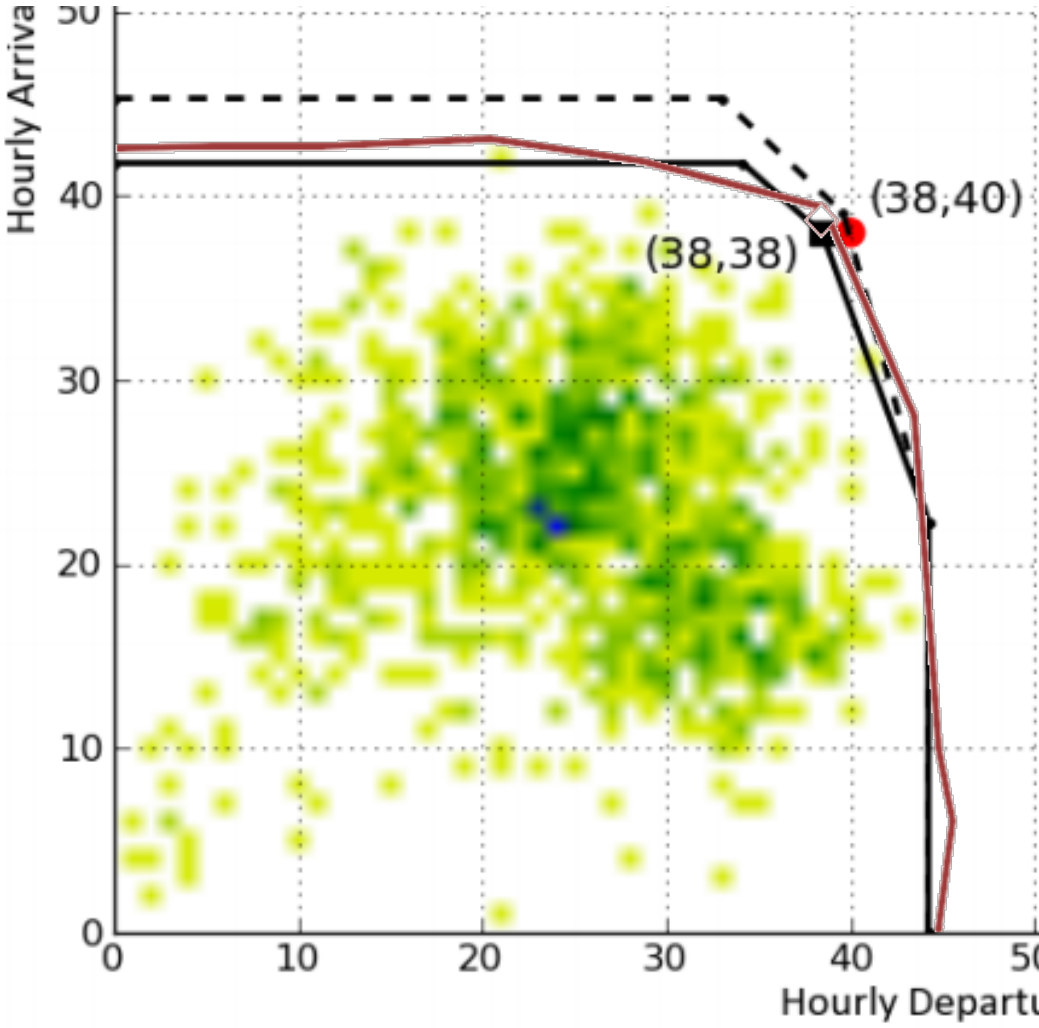
Center runway (2015) reconstruction impact

- 16C closed
- IFR
- Assuming an unchanged fleet mix
- 16R for arrivals and Small departures
- 16L for arrivals and Heavy departures



Runway Crossings in SEA

- SEA has its gates on one side of the terminal, which results in frequent runway crossings
- In trail Arrival-Arrival delay is added:
  - 20 sec for arrivals on 16L simulates the unavailability of the runway
  - Re-sequencing enabled
- ADSIM+ results compared to FAA provided capacity profile

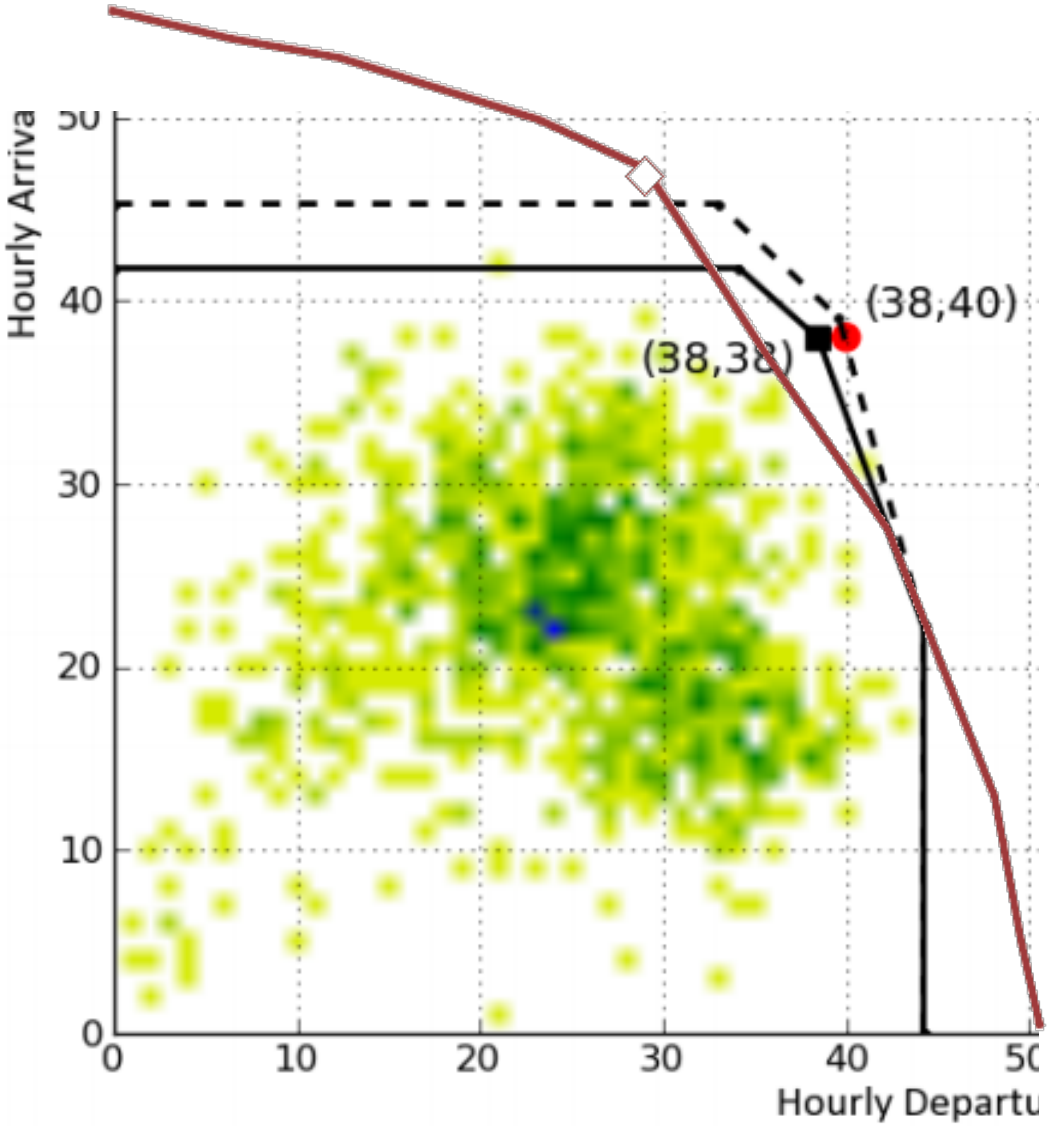


Runway Crossings in SEA

A more detailed surface analysis can be performed with ADSIM+

- 30 sec arrival crossing hold time
- 10 sec departure crossing hold time
- Re-sequencing gives surface traffic priority

⇒ Improvement in throughput BUT the workload on the tower is unrealistic without surface movement automation



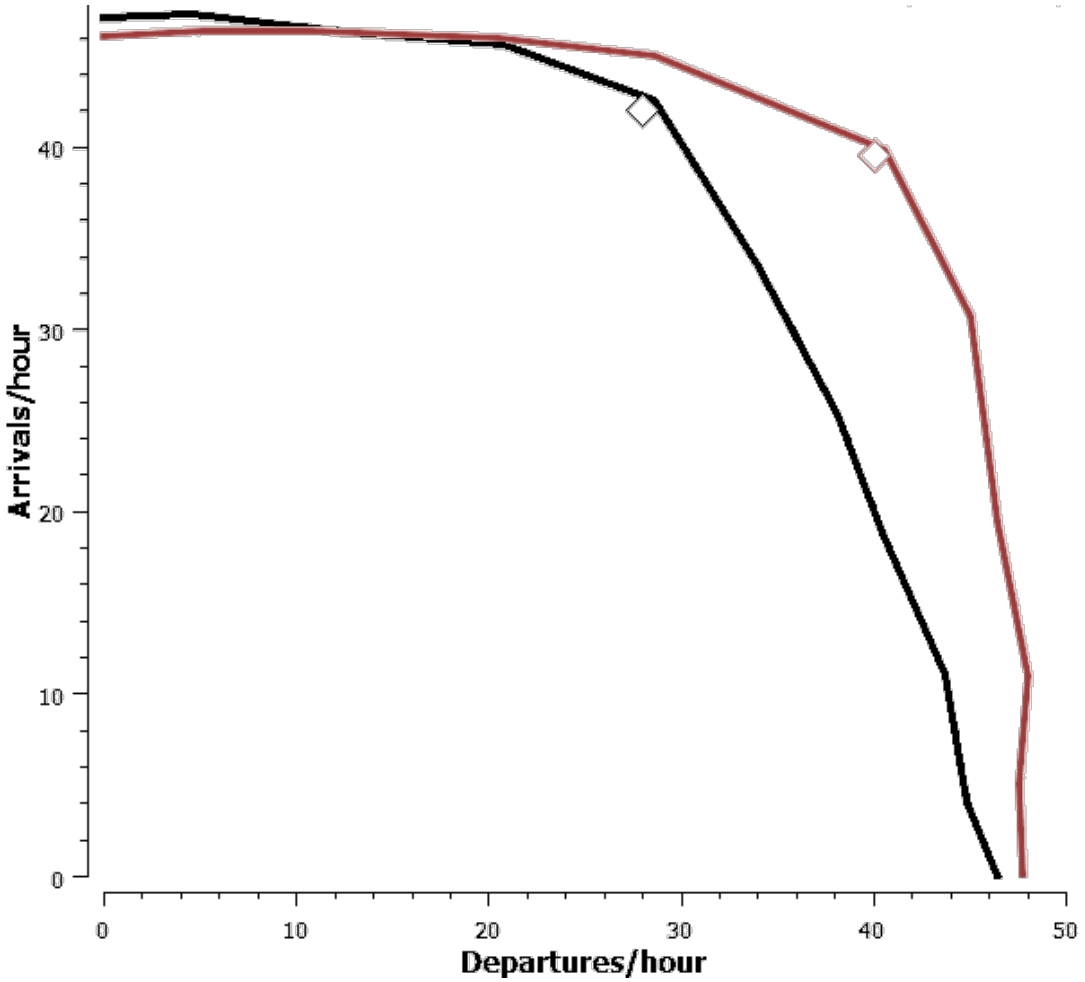
ILS hold node in SEA

- With the introduction of Ground-Based Augmentation System (GBAS), ILS hold nodes are no longer relevant (Precision Object Free Zones - POFZs)

ILS hold node in SEA

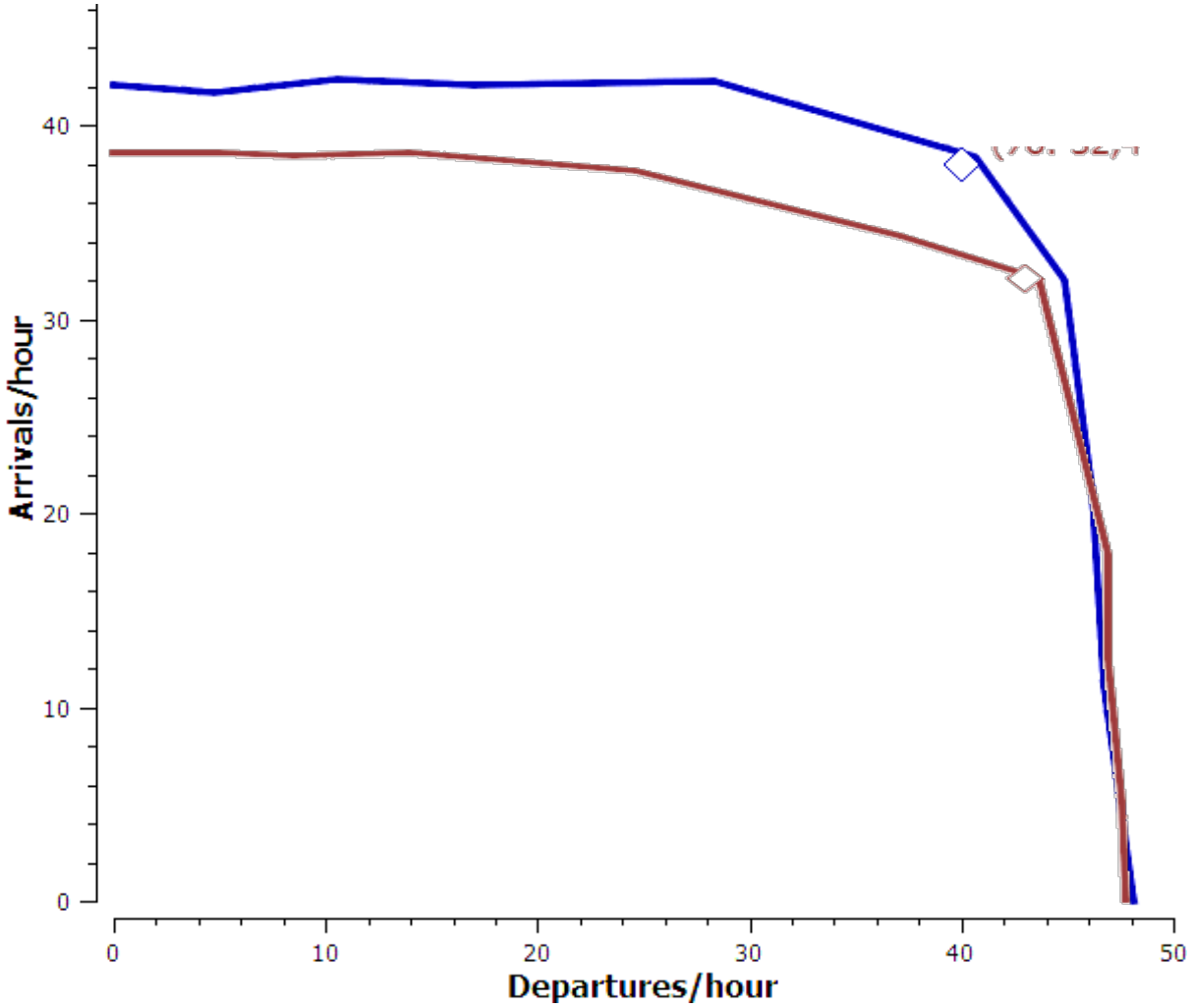
ILS hold Nodes

GBAS



Theoretical Single Exit in SEA

Capacity in change profile during severe winter weather when only 1 exit per runway is allowed (to facilitate snow removal)



Look-forward Capacity

Provides a continuously updated 2 hour capacity estimate using:

- Weather forecast
- Planned ATC directives
- Schedule to adapt fleet mix
- Current ground conditions
  - Blocked taxiways
  - Saturated gates / holding areas
- Dynamic surface constraints (Deicing)

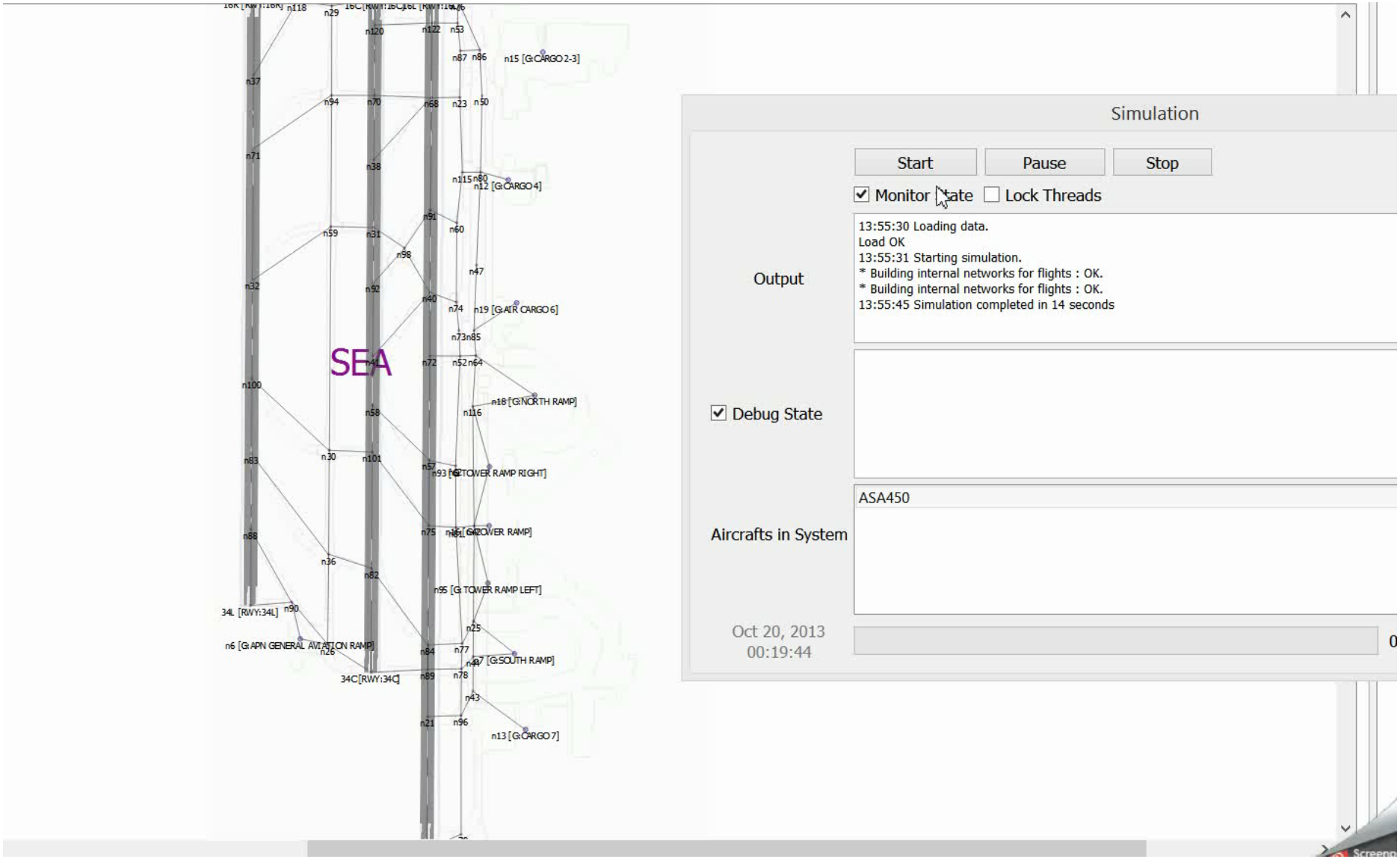
Feasibility

- Runtime in capacity mode is less than one minute
- ADSIM+ has several import capabilities that also run in interactive times; e.g., fleet from ADSE-X runtime is less than 1 min/hour

Constraint Capacity Profile for Diversions

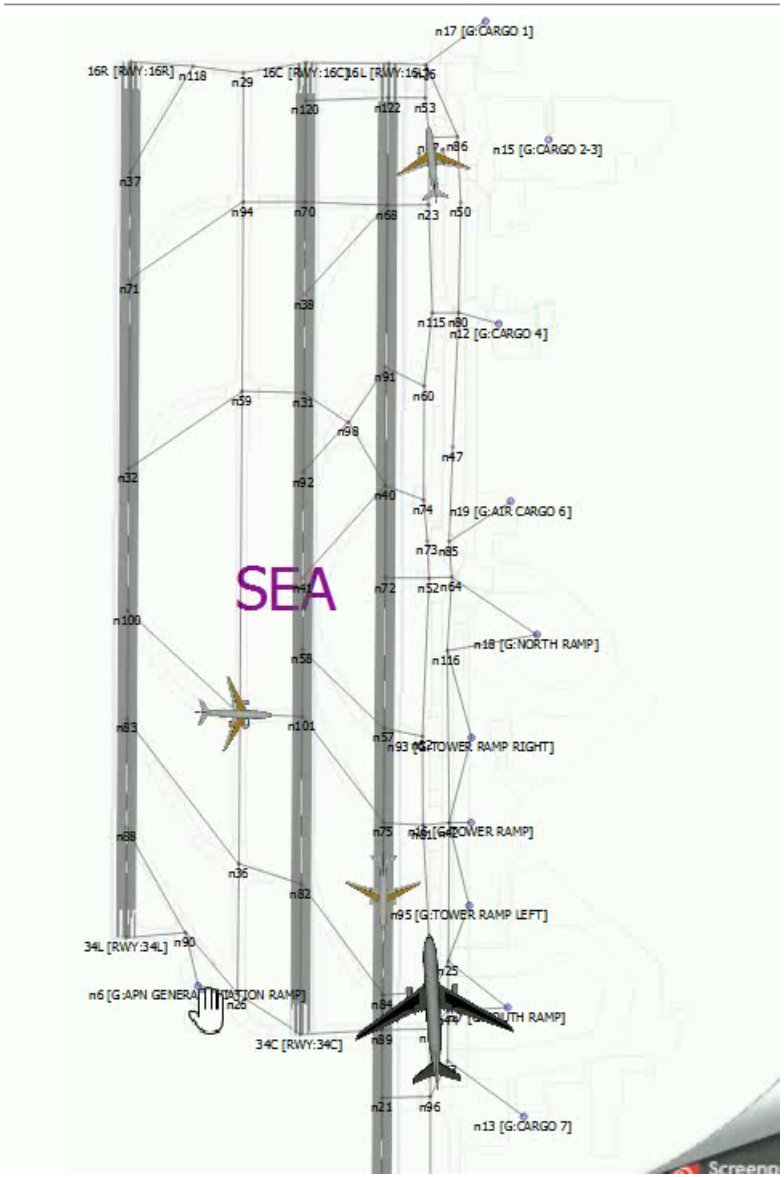
- Potential Future Work
  - Residual capacity profile will take into account the difference in fleet mix between the original airport and diversion airport
  - The capacity will be computed by saturating the existing schedule with flights drawn from the original airport's fleet mix
  - Advantages: More Accuracy
    - Existing schedule is a better measure than historical fleet mix in the diversion airport
    - Fleet mix between original and diversion airport can be significantly different, or behave differently (e.g., equipage support)
  - Disadvantages: Heavier to Compute
    - More information to integrate and process
    - Need to balance allowed changes in schedule times versus efficiency

Delay mode


SEA
n15 [G:CARGO 2-3]
n12 [G:CARGO 4]
n19 [G:AIR CARGO 6]
n18 [G:NORTH RAMP]
n93 [G:TOWER RAMP RIGHT]
n95 [G:TOWER RAMP LEFT]
n6 [G:APN GENERAL AVIATION RAMP]
n7 [G:SOUTH RAMP]
n13 [G:CARGO 7]
34L [RWY:34L]
34C [RWY:34C]
Simulation
Start
Pause
Stop
Monitor State
Lock Threads
Output
13:55:30 Loading data.
Load OK
13:55:31 Starting simulation.
* Building internal networks for flights : OK.
* Building internal networks for flights : OK.
13:55:45 Simulation completed in 14 seconds
Debug State
Aircrafts in System
ASA450
Oct 20, 2013
00:19:44

Play Forward Capability

- Potential Future Work
  - Augment the capacity profile with delay mode animation:
  - Can show bottle necks or unexpected surface movement
  - Provides a good communication medium



Thank You

Many thanks to Martin Durbin from ANG-B71, who's vision has been shaping ADSIM+ for several years now.

Questions?