



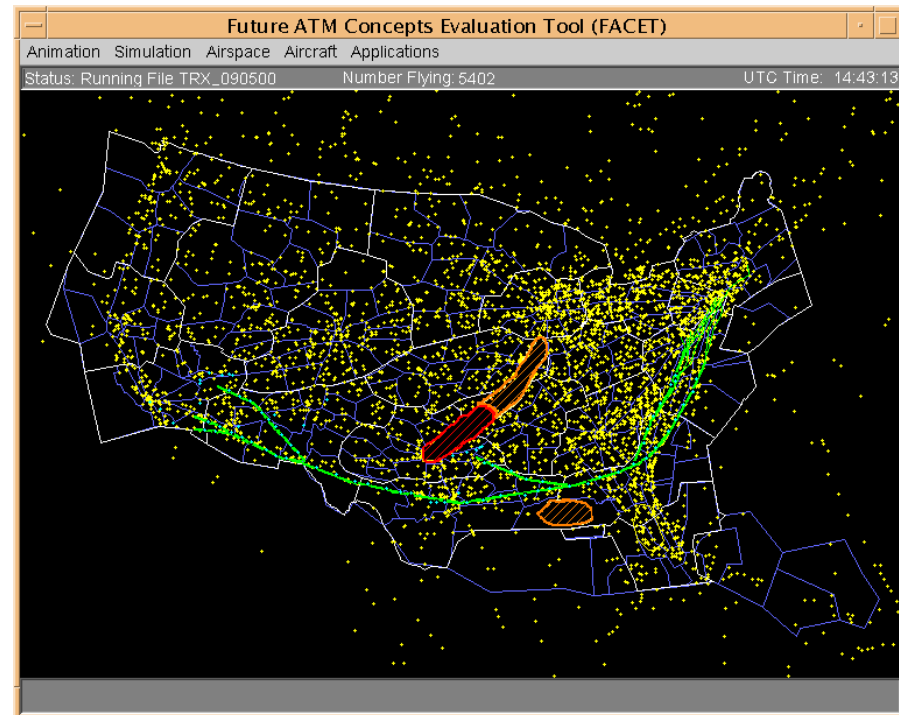
## NASA Simulation Capabilities

Aug 7, 2017  
ver. 072517b



## Simulation Tool Overview

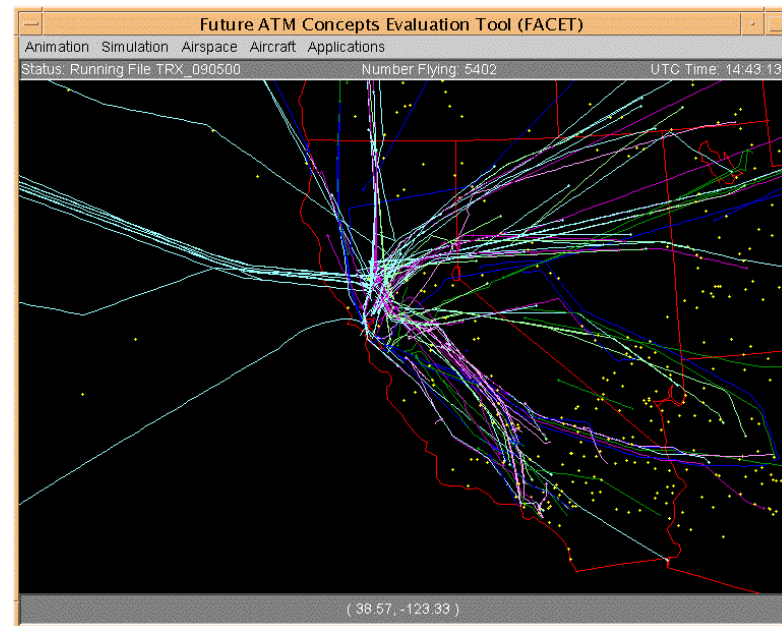
- The Future ATM (Air Traffic Management) Concepts Evaluation Tool (FACET) has provided a core capability to conduct air traffic management research for NASA's Aeronautics Research Mission Directorate (ARMD) since 2000



- Under the NASA-CAE agreement, FACET will be adapted to support simulations and analyses of Shanghai Pudong International Airport (IATA: PVG, ICAO: ZSPD) arrival and departure operations

# FACET Overview

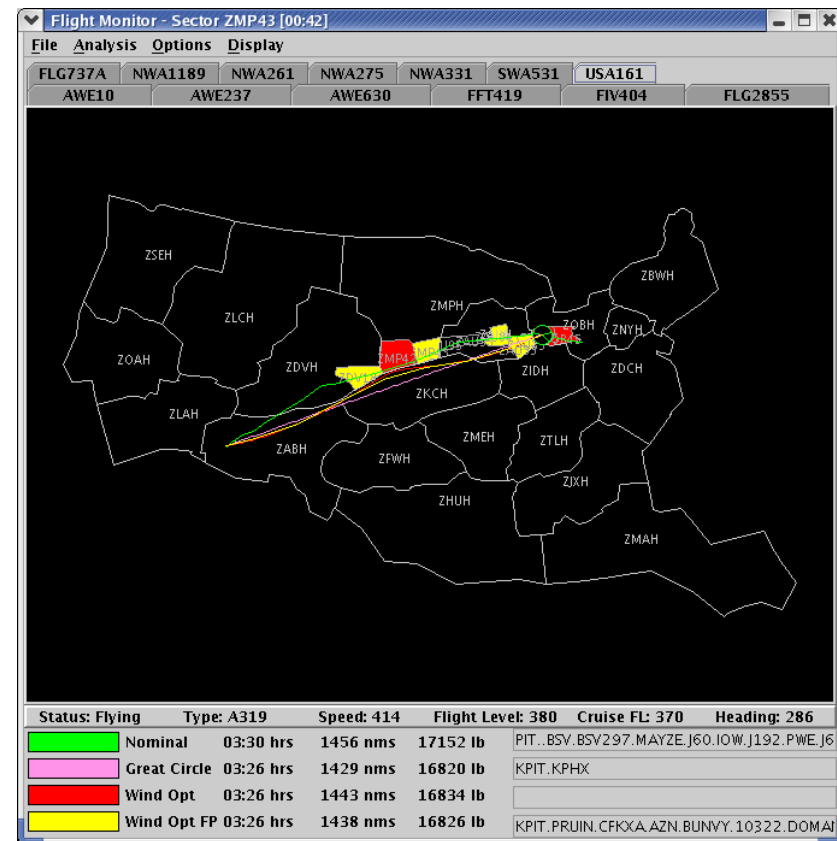
- National Airspace System (NAS) - wide simulations and planning on a laptop computer
- Ability to model airspace operations at U.S. national level (~50,000 aircraft per day)
- Alternative navigation modes available
  - Flight Plan Routing
  - Great Circle Routing
  - Wind Optimal Routing
- Software written in 'C' and 'Java' programming languages
- Can be used for both off-line analyses and real-time applications



San Francisco Bay Area Arrivals and Departures

# Sample of FACET Supported Studies

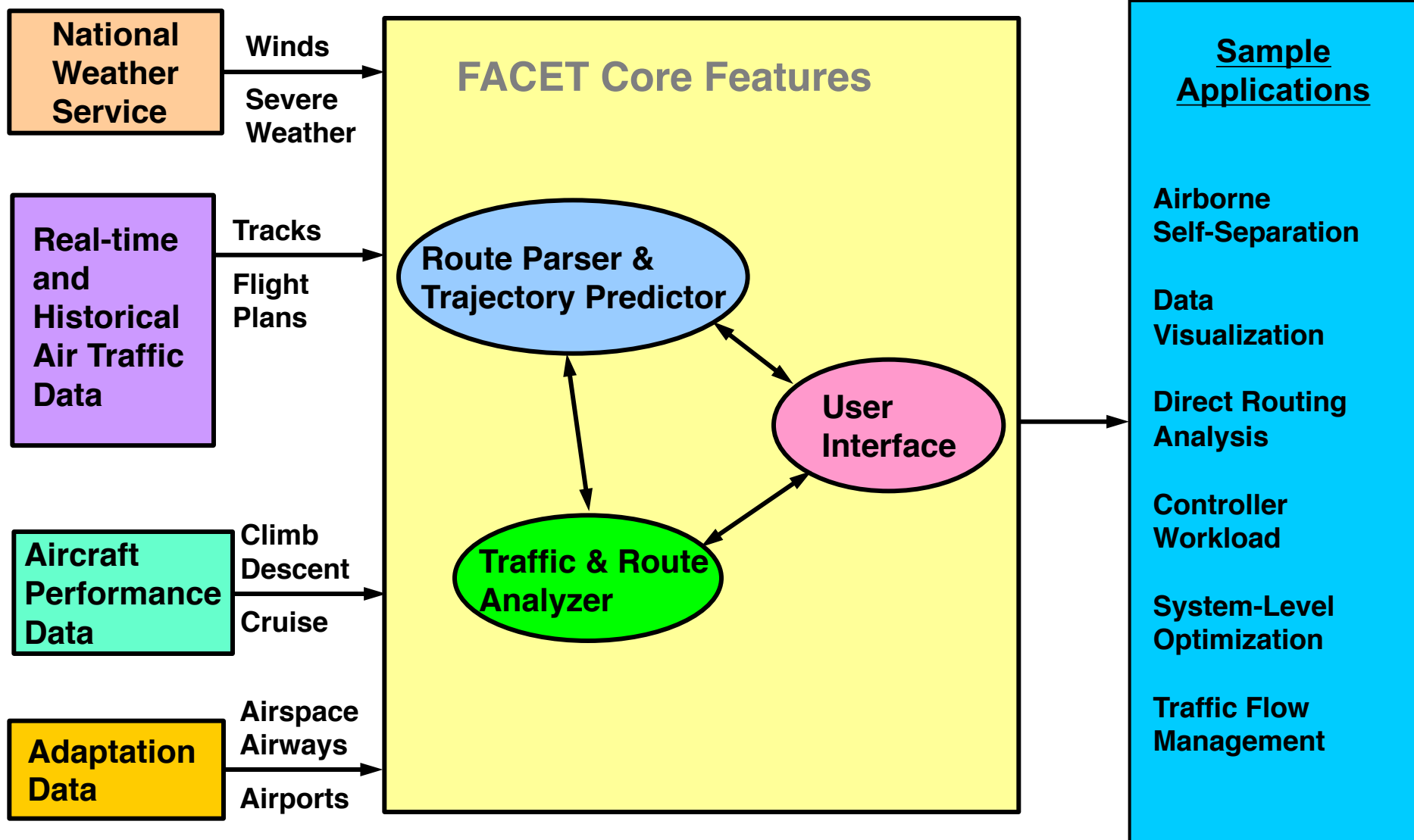
- “What-if” capabilities for evaluating traffic flow options to avoid bad weather and airspace congestion while minimizing air traffic delays
- Airspace performance metrics using operations data
  - Relationships between traffic, weather and delay
  - Techniques for clustering and data mining to identify similar types of days/operations
- U.S. domestic and Pacific wind optimal routing studies
- Aggregate air traffic flow models
  - Transform collections of similar trajectories into flow streams
  - Linear models with 100-fold order reduction



Sample “what-if” evaluation display



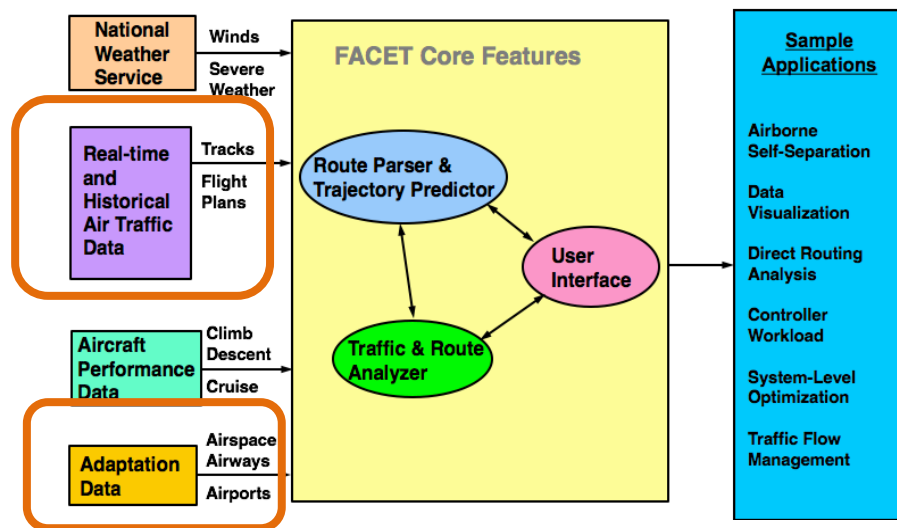
# High-level FACET Architecture





# FACET Inputs

- FACET Interface Control Document (ICD) provides a comprehensive description of the system's airspace adaptation and air traffic data requirements



- Airspace adaptation requirements included for navigational aids, waypoints, airways, airport locations, Flight Information Regions (FIRs), sectors, Special Use Airspace (SUA), standard arrival and departure routes and airspace capacities
- FACET formatted ASCII air traffic data format derived from the FAA's System Wide Information Management (SWIM) data provided

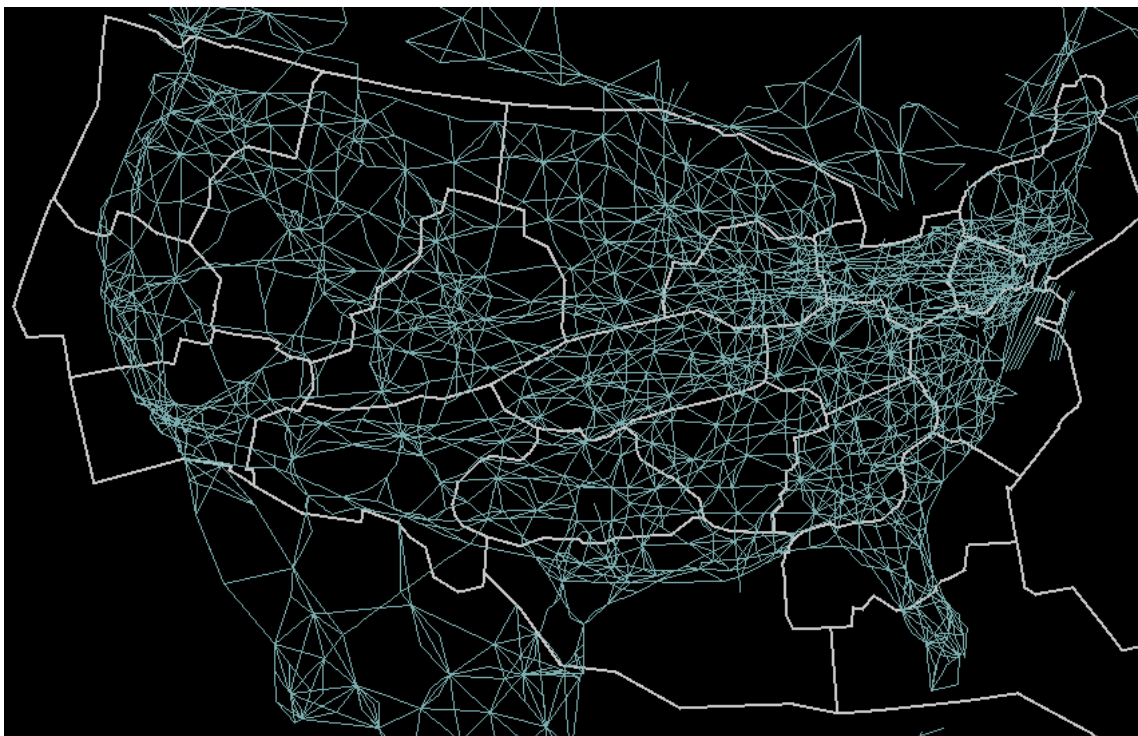
# FACET Inputs :: Airways Example

airway identifier



J476	YYC	ALOMO	YEA	YQV				
J507	BRW	SCC	FYU	ORT	BORAN	YAK		
V111	BSR	SNS	HENCE	CATHE	KARNN	WINDY	PATYY	MOD

airway waypoints/navigational aids

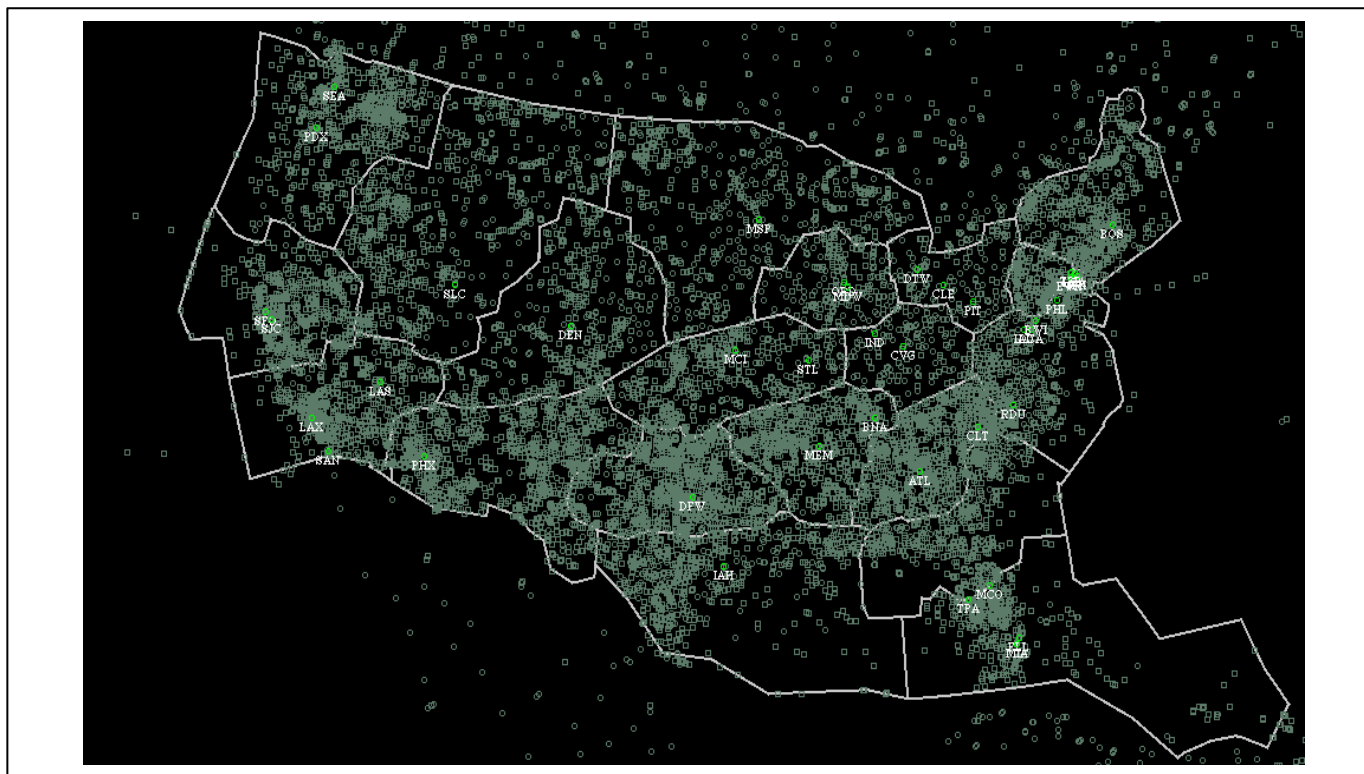


# FACET Inputs :: Navigational Aids (NAVAIDS) Example

NAVAID identifier  
↓

HET	N35	24	16.366	W096	00	49.997	1000
HEU	N42	51	10.674	W073	56	03.448	1200

latitude
longitude
elevation





# FACET Inputs :: Flight Information Region (FIR) / Center Boundary Example



<u>Albuquerque_Center</u>					
ZAB					
0	450000				
N36	43	00.00	W105	20	30.00
N36	43	00.00	W105	00	00.00
N37	18	30.00	W103	09	00.00
N37	30	00.00	W102	33	30.00
N37	30	00.00	W102	33	00.00

← FIR/Center Name

← FIR/Center Identifier

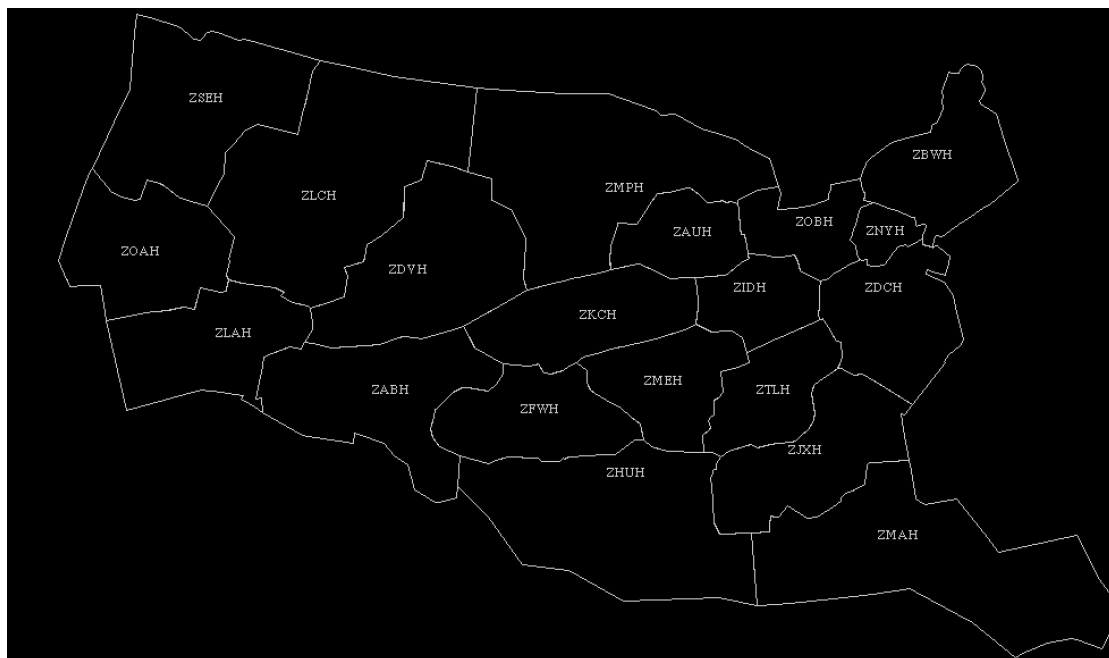
← Min/Max Altitude

← Latitude/Longitude of Vertex 1

.

.

← Latitude/Longitude of Vertex N



# FACET Inputs :: Sector Example



ZAB90					
24000	60000				
N47	01	18.33	W105	54	27.86
N46	43	05.56	W105	30	19.41
N47	28	11.11	W103	44	20.44
N47	30	22.21	W102	33	30.00
N47	30	00.00	W102	33	00.00

← Sector Name

← Min/Max Altitude

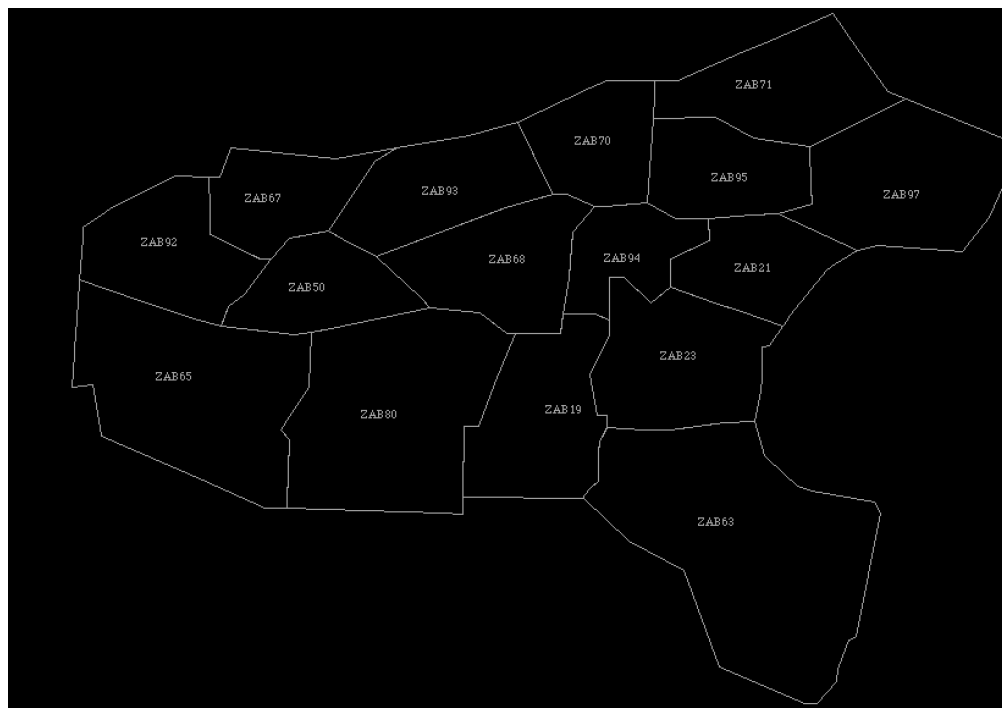
← Latitude/Longitude of Vertex 1

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← Latitude/Longitude of Vertex N





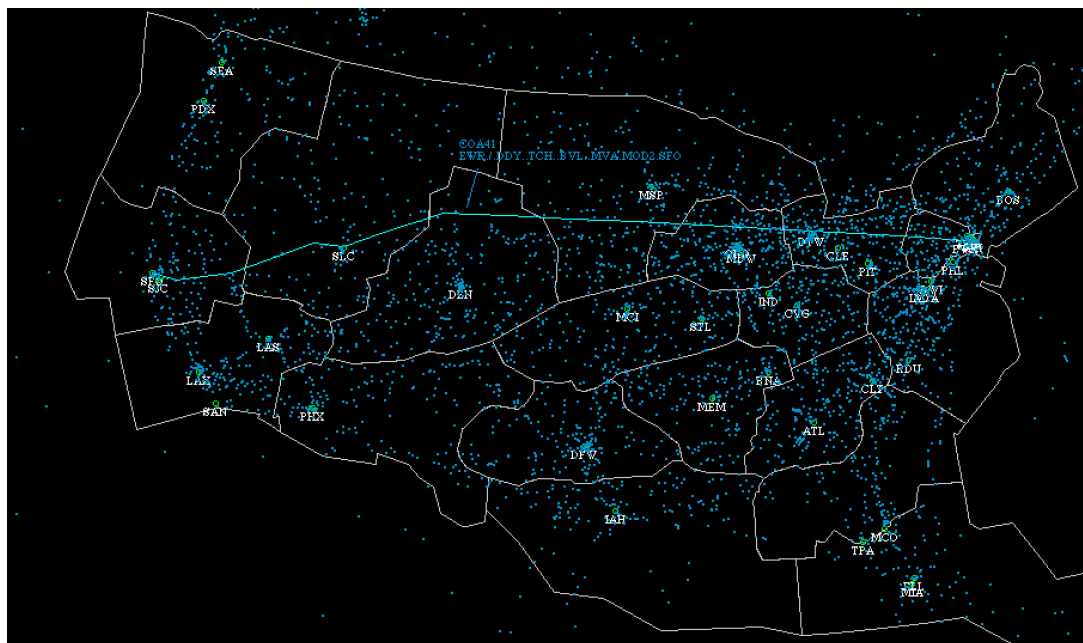
# FACET Inputs :: Air Traffic Example

TRACK\_TIME 1124841777 ← Unix epoch time in seconds since Jan. 1 1970 (midnight UTC/GMT)

TRACK	NASA1	B772	375900	835700	516	366	69	ZID	ZID93
	aircraft identifier	aircraft type	current latitude	current longitude	ground speed	flight level	heading	current center	current sector

FP\_ROUTE KDFW..MEM359067..RBV..RIFLE..ACK..TUSKY.YQX.NATY.LIMRI.DOLIP.CRK.EXMOR.GIBSO.EGKK

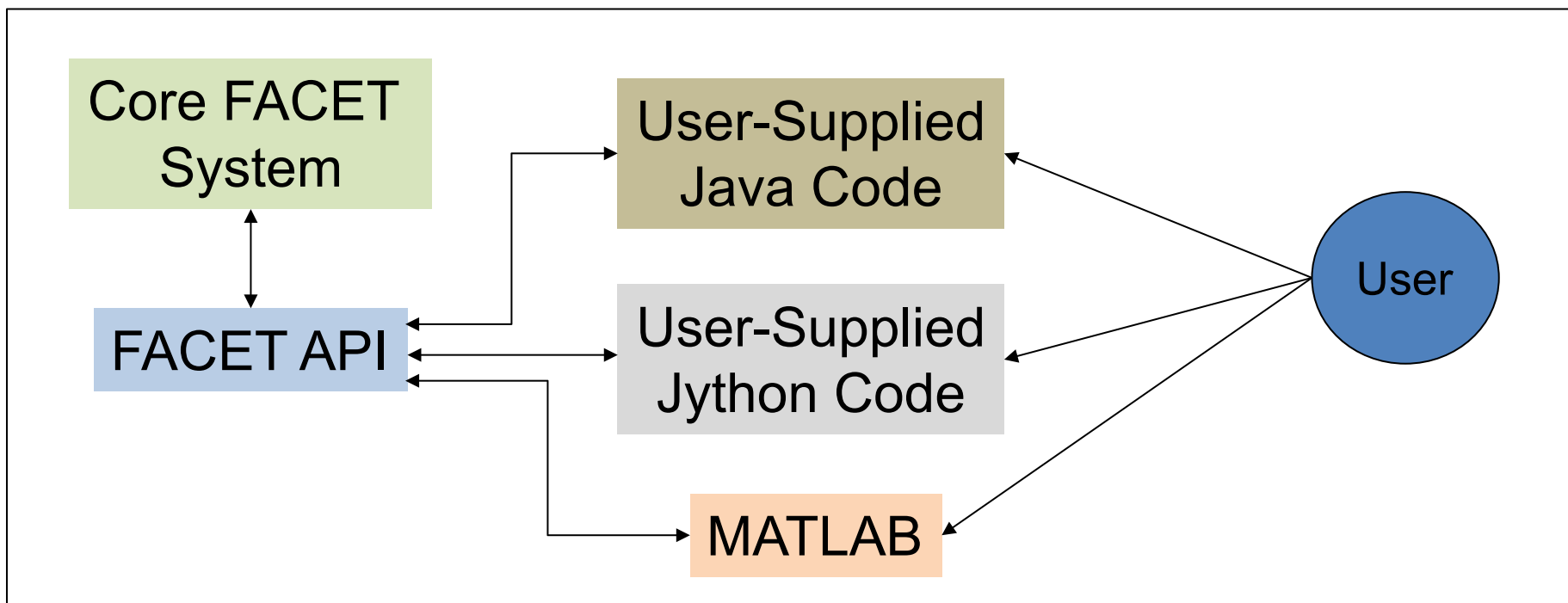
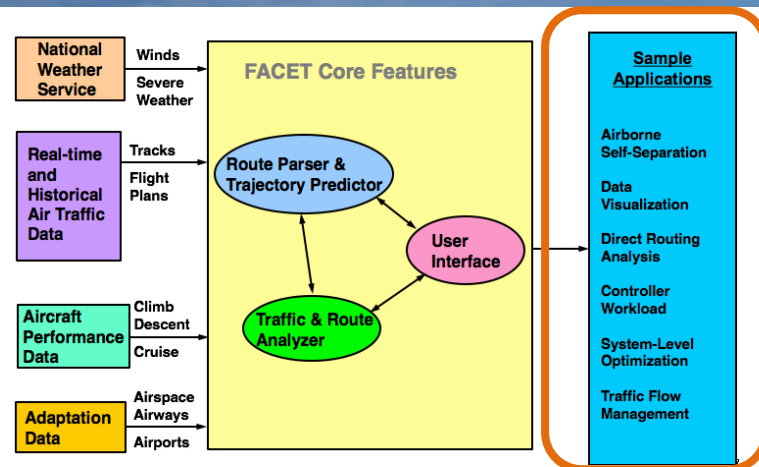
flight plan route





# FACET Application Programming Interface

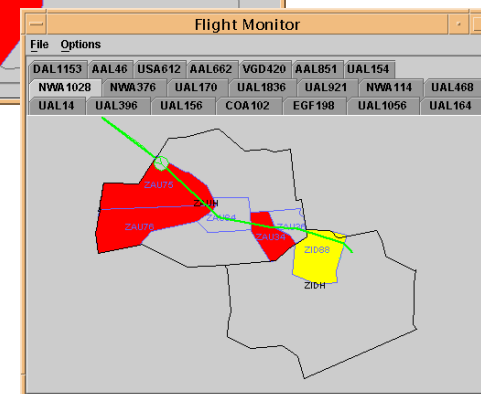
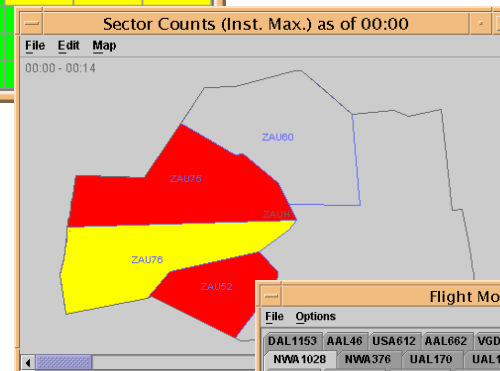
- FACET Application Programming Interface (API) enables scripting of FACET functionality from Java, Jython, Matlab, etc.
- Over 600 methods for accessing FACET functionality



# FACET Outputs

- Predefined FACET output capabilities provide:
  - Aggregate aircraft counts in FIRs/Centers/Sectors, arrivals, departures and user defined traffic streams
  - Aircraft-level statistics available for displaying aircraft state information (e.g., heading, speed, altitude, etc.) versus time, fuel burn, path distance and length, etc.
- FACET Application Programming Interface (API) provides complete access to all aircraft state information for user defined metrics calculations

Sector Counts				
File Edit Table				
Time	ZAU52	ZAU60	ZAU75	ZAU76
Cap	16	18	16	20
00:00	17	15	21	21
00:15	17	18	21	34
00:30	14	17	26	36
00:45	12	20	19	29
01:00	12	20	20	21
01:15	9			
01:30	9			
01:45	6			



Sample Sector Count and Alert Displays