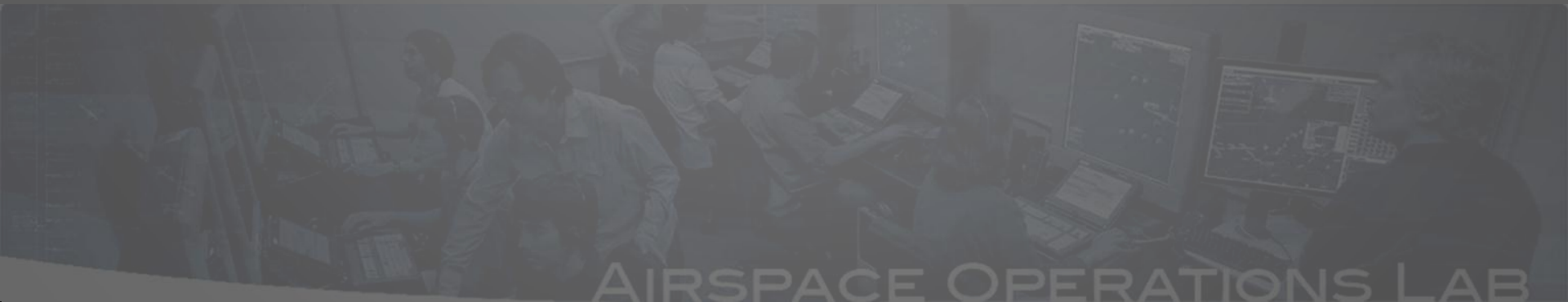


TRAC Overview

Todd Callantine & Michael Kupfer



Capabilities and Assumptions

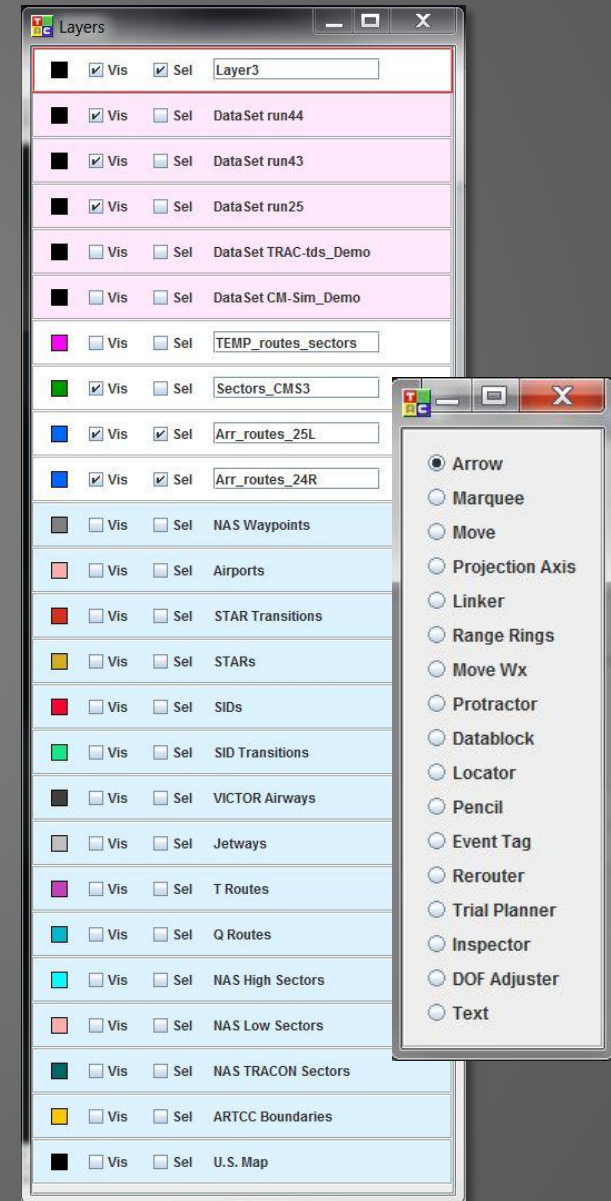
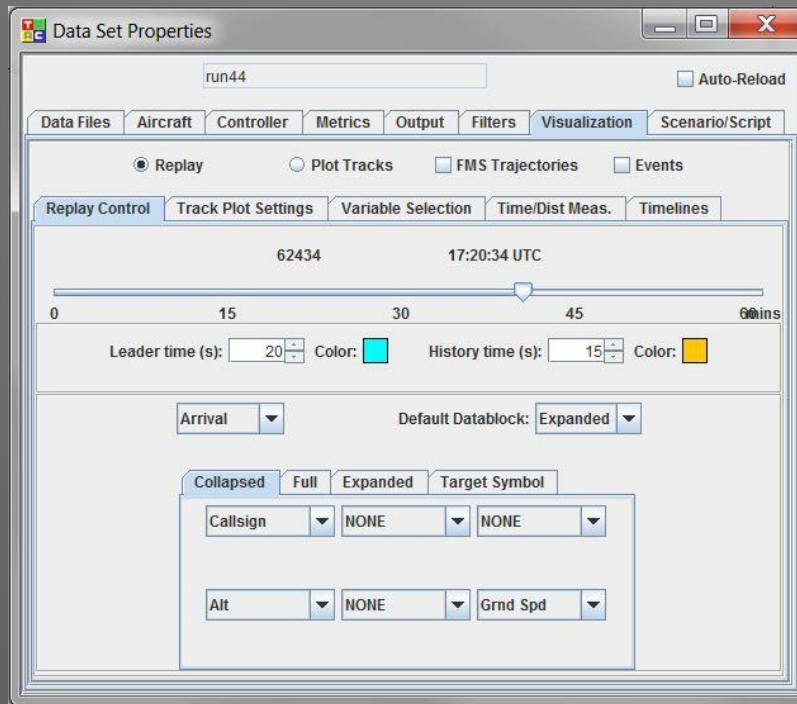
- Airspace/Route Design:
 - NFDC '56-day update'
 - Tools for graphical route/sector construction and analysis
- Fast-Time Simulation
 - BADA model
 - Trajectory-based operations ONLY
 - Tools for constructing traffic scenarios, schedules, and visualizing and trial-planning trajectories
- Data Visualization and Analysis
 - Loads variety of traffic data formats
 - 'Pure' data presentation
 - Tools for organizing and visualizing data, conducting analyses, constructing simulations from data

TRAC Support for MACS

- Read/write MACS airspace/route formats
- Read and analyze MACS/ADRS data
 - Output typical metrics
 - Adjust 'open-loop' MACS traffic scenarios
- Present actual/simulated track data in MACS tabular format to support scenario development

TRAC/MACS Workflow Examples

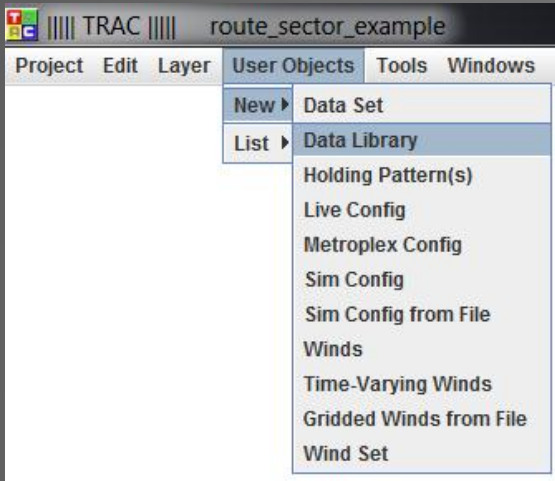
- MACS Data Analysis
- Route/Airspace Design
- Data Visualization
- Scenario Design



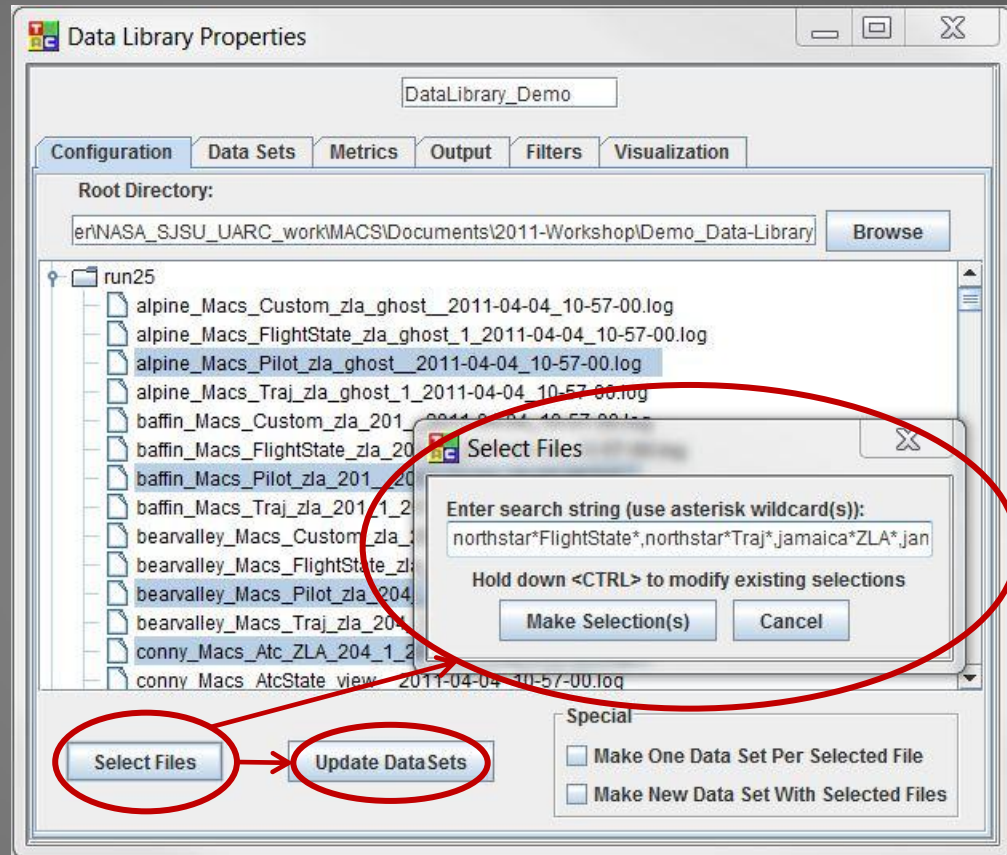
MACS Data Analysis

- Data Visualization
- Compute metrics and output

MACS Data Analysis



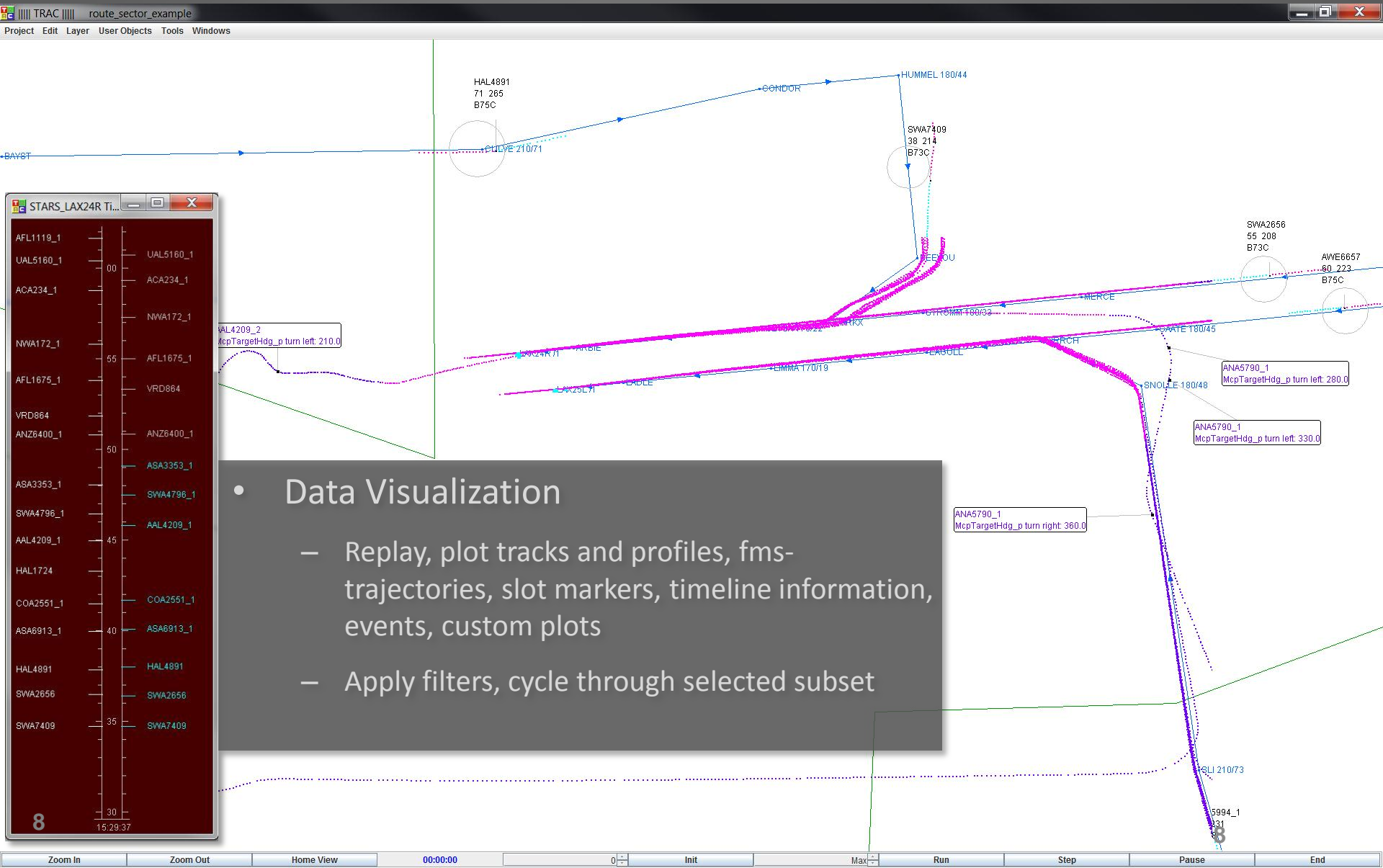
- Create Data Library
- FlightState
- Traj_plan_b
- Atc
- Macs_Pilot
- TimelineMeterList



Select MACS data log files using data library search strings

- full MACS data except ATC states (including confederates):
- full MACS data including ATC states (including confederates)
- full MACS data except ATC States (no confederates, no slot markers, no timelines)
- ...

MACS Data Analysis



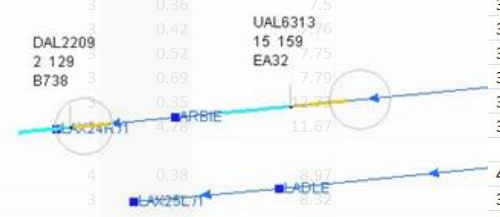
MACS Data Analysis

Metrics:

- Known waypoint crossing times
- Waypoint Crossing Details (incl. schedule conformance)
- Overall Separation Violations
- Sequence Data
- Average Interarrival Data
- Interarrival Data

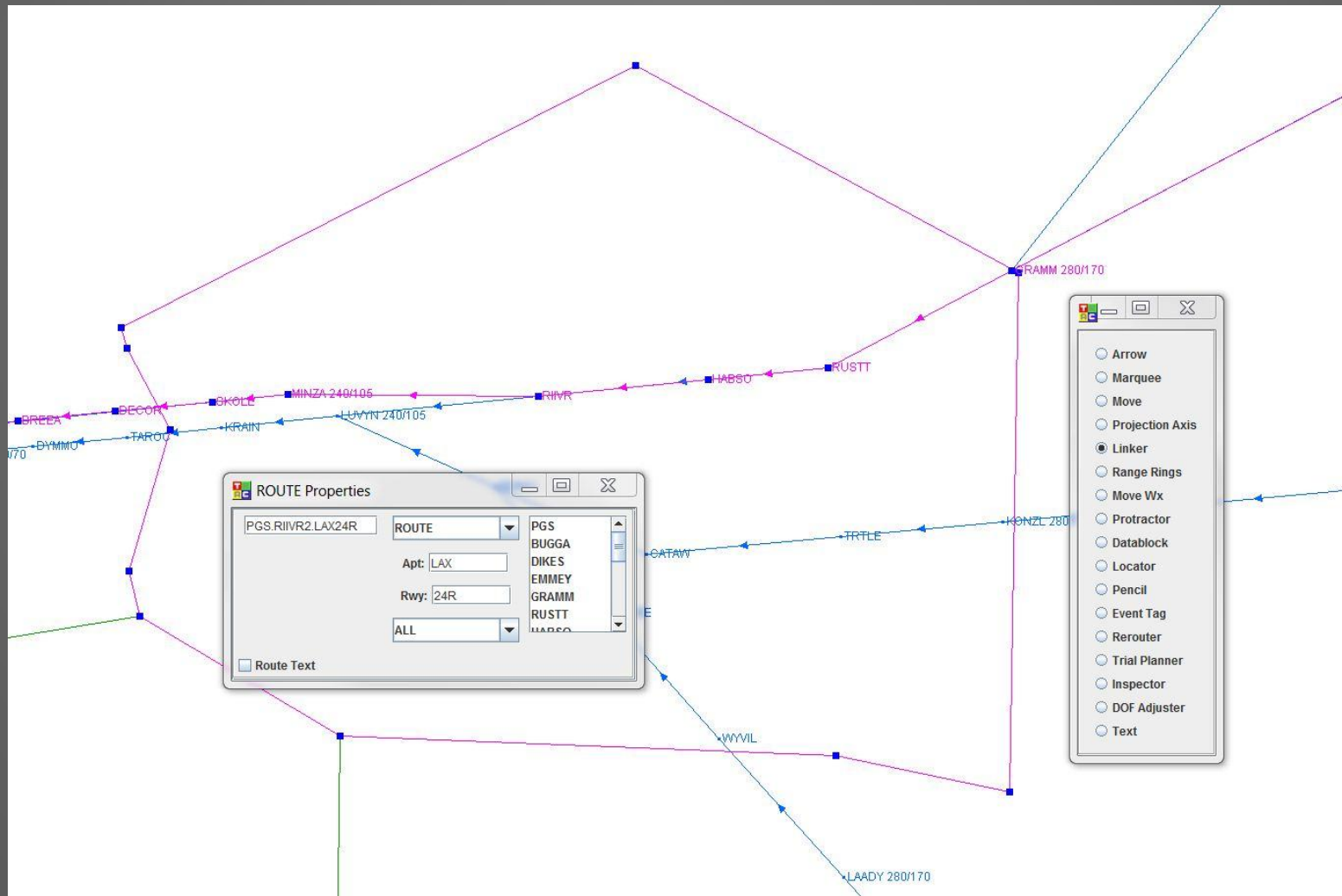
- Control Gate Flux
- Level Segment Data
- Sel. Route Conformance
- Control Gate Schedule Conformance
- Schedule Adjustment Data
- ETA-STA error
- Try time-to-fly-tool
- Script (schedule conformance)

#	Lead	LeadType	LeadTime	Trail	TrailType	TrailTime	Wpt	Merge	RelAlt	Time	ReqTimeSpc	RelTime	Dist	ReqDistSpc	RelDist	DistTwoBehind	ReqDistTwoBehind
2772	Interarrival Data:																
2773	# Lead	LeadType	LeadTime	Trail	TrailType	TrailTime	Wpt	Merge	RelAlt	Time	ReqTimeSpc	RelTime	Dist	ReqDistSpc	RelDist	DistTwoBehind	ReqDistTwoBehind
2844	DAL2704	Large	60928	DAL6716	Large	61013	LAX24R	0	1.57	85	80	5	3.05	3	0.05	6.99	3
2845	DAL6716	Large	61013	SKW7797	Large	61115	LAX24R	0	-4.62	102	80	22	3.5	3	0.5	7.74	3
2846	SKW7797	Large	61115	AAL4795	Heavy	61202	LAX24R	0	4.1	87	80	7	3.37	3	0.37	9.68	3
2847	AAL4795	Heavy	61202	USA2475	Large	61353	LAX24R	0	0.66	151	120	31	5.51	5	0.51	9.73	5
2848	USA2475	Large	61353	ASA5063	Large	61445	LAX24R	0	-4.1	92	80	12	3.27	3	0.27	7.34	3
2849	ASA5063	Large	61445	UAL6897	B757	61545	LAX24R	0	4.75	100	80	20	3.6	3	0.6	8.85	3
2850	UAL6897	B757	61545	DAL2209	Large	61665	LAX24R	0	-1.79	120	100	20	4.38	4	0.38	8.42	4
2851	DAL2209	Large	61665	UAL6313	Large	62970	LAX24R	1	-0.73	1305	80	1225	2.78	3	-0.22	6.44	3
2852	UAL1205	Large	61849	UAL2904	B757	61967	LAX24R	0	3.22	118	80	38	3.79	3	0.79	9.49	3
2853	UAL2904	B757	61967	AAL5376	Heavy	62093	LAX24R	0	0.51	126	100	26	4.27	4	0.27	10.52	4
2854	AAL5376	Heavy	62093	UAL1015	Heavy	62217	LAX24R	0	-4.21	124	100	24	5.20	4	1.20	11.12	4
2855	UAL1015	Heavy	62217	AAL1522	Large	62360	LAX24R	0	1.71	143	120	23	5.15	5	0.15	9.35	5
2856	AAL1522	Large	62360	AAL6660	Large	62460	LAX24R	0	2.83	100	80	20	3.36	3	0.36	7.5	3
2857	AAL6660	Large	62460	SWA1844	Large	62557	LAX24R	0	-3.37	97	80	17	3.42	3	0.42	7.75	3
2858	SWA1844	Large	62557	UAL2974	Large	62654	LAX24R	0	2.49	97	80	17	3.52	3	0.52	7.75	3
2859	UAL2974	Large	62654	UAL224	Large	62763	LAX24R	0	0.36	109	80	29	3.69	3	0.69	7.79	3
2860	UAL224	Large	62763	SWA696	Large	62860	LAX24R	0	0.95	97	80	17	3.35	3	0.35	7.78	3
2861	SWA696	Large	62860	UAL3883	B757	63058	LAX24R	0	-4.64	198	80	118	7.78	3	0.78	11.67	3
2862	UAL3883	Large	62970	UAL1205	Large	61849	LAX24R	1	-0.52	-1121	80	-1201					
2863	UAL1205	Large	63058	AAL1907	Large	63186	LAX24R	0	2.72	128	100	28	4.38	4	0.38	8.07	4
2864	AAL1907	Large	63186	USA7225	Large	63288	LAX24R	0	-0.86	102	80	22	3.43	3	0.43	8.52	3
2865	USA7225	Large	63288	UAL7297	Heavy	63375	LAX24R	0	-1.36	87	80	7	3.66	3	0.66	9.75	3
2866	UAL7297	Heavy	63375	FFT6388	Large	63525	LAX24R	0	-1.21	150	120	30	5.55	5	0.55	10.2	5
2867	FFT6388	Large	63525	JZA6826	Large	63622	LAX24R	0	1.61	97	80	17	3.49	3	0.49		3



Route/Airspace Design

- Draw a sector in TRAC and export to MACS format
- Draw a route in TRAC and export it to MACS format



Data Visualization

- Add a data set, select a data file, load it
- Various supported formats: CM-Sim, Adrs, TRAC tds, ... (for large files use preprocess data)

The screenshot displays the TRAC software interface with several windows open:

- TRAC Main Window:** Shows a flight path visualization with waypoints labeled DEANO 280/200, PIRUE 280/180, and FIM. The menu is open to 'New > Data Set'.
- Data Set Properties Window:** Shows configuration for a data set with ID 726595916. The 'Data Files' tab is active, showing a file path: 'A:\Data\traffic_data\CM_SIM\SCT-LAX\ZLA_SCT\20090303.0750Z.86385.cm_sim'. The 'Preprocess Data' checkbox is checked. Other tabs include Aircraft, Controller, Metrics, Output, Filters, Visualization, and Scenario/Script.
- Select Data Time Range Window:** Shows a graph of 'Track Hits' (Y-axis, 0 to 400) versus 'Time (hrs)' (X-axis, 08:05 to 08:04). A blue area represents the data, and a vertical line indicates a 3.00 hrs time range.

Data Visualization

The screenshot displays the TRAC software interface with a flight path visualization. Three 'Data Set Properties' windows are overlaid on the main view, each showing different configuration options for data visualization. The background shows a complex network of flight tracks with various waypoints labeled like 'GOATZ', 'DYP50', and 'HOME 280 TS'. The interface includes a menu bar (Project, Edit, Layer, User Objects, Tools, Windows) and a status bar at the bottom with buttons for Zoom In, Zoom Out, Home View, and a timeline from 00:00:00 to Max.

- Plot tracks or replay them using the time slider
- Color code the tracks according to various criteria
- Filter the data set according to various criteria
- Lateral or vertical plots

Scenario Design

- Usage of actual traffic recordings (CM-Sim)
 - Load traffic file and filter flights (flight type, destination runway, etc.)
 - Using the Data Set Flight Table save the aircraft information in the MACS format
 - Use the MACS a/c table editor, MS Excel, or any text editor to edit the file to build a MACS traffic scenario
 - The route, filed route, etc. usually need tweaking; other parameters such as cruise speed or cruise altitude often need to be filled in
 - Python scripts are available that use the TRAC output file and cm-sim data to populate missing data (see question 27) in the MACS Questions and Answers¹)

1) <https://aol1.arc.nasa.gov:8443/display/macs/MACS+Questions+and+Answers>

The screenshot shows the CM-Sim software interface. The 'Data Set Properties' window is open, displaying the 'Aircraft' tab. The 'Show Table' button is circled in red. The 'Data Set Flight Table' window is also open, showing a table of aircraft data.

callsign	entryTimeSeconds	entryToDeleteTimeSeconds	type	atcType	destination
AAL1063	2110	15394	B738	B738	LAX
AAL1915	3957	17410	B738	B738	LAX
AAL1	3981	18012	B762	B762	LAX
AAL2049	6181	23450	B738	B738	LAX
AAL2413	935	11714	MD82	MD82	LAX
AAL2417	6011	21889	MD82	MD82	LAX
AAL299	132	10347	B752	B752	LAX
AAL33	0	9528	B762	B762	LAX
AAL581	1368	13740	MD82	MD82	LAX
AAL774	8446	26505	B738	B738	LAX
AAL793	3586	16978	B738	B738	LAX
ASA562	860	11178	B737	B737	LAX
ASH2704	202	10370	CRJ2	CRJ2	LAX
AWE1433	4620	18975	A321	A321	LAX
AWE797	10	9609	A321	A321	LAX
COA1495	1344	12626	B753	B753	LAX
COA1595	7163	24287	B738	B738	LAX
COA735	47	11065	B753	B753	LAX
DAL1169	0	7874	A320	A320	LAX
DAL1299	7008	24964	B752	B752	LAX

References

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- Callantine, T. (2009). TRAC trial planning and scenario generation to support super-density operations studies. AIAA-2009-5836. Reston, VA: American Institute of Aeronautics and Astronautics.
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- Callantine, T. (2011). Modeling off-nominal recovery in NextGen terminal-area operations. AIAA-2011-6537. Reston, VA: American Institute of Aeronautics and Astronautics.

Additional Information

- Contacts:
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 - Michael Kupfer: michael.kupfer@nasa.gov (650) 604-6424
- URL: <http://humansystems.arc.nasa.gov/groups/AOL/technologies/trac.html>
- Other documentation available:
 - Basic TRAC tutorial slides
 - TRAC shortcuts and keyboard functions
 - Documentation of MACS log file output options using python scripts in TRAC
 - Documentation of BADA calculations using python scripts in TRAC

Questions and Answers