

2015 US DOT Datapalooza

New Capabilities of Terminal Area Forecast (TAF-M)

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Federal Aviation
Administration



Context

Interest in an integrated view of local, national and global socio-economic development on aviation

Offer an integrated view of the aviation system from the most granular level of data that are available

Understanding airport, route and network impacts of NEXTGEN development, policies and environmental regulations

U.S. and international aviation community focus on

- Measuring effects of new technologies and operational procedures
- Incorporate economic and uncertainty at the local and metro economies
- Maintaining strong leadership role in all areas of international aviation



Briefing Topics

Overview & Capabilities

Modelling, Databases, and Infrastructure

Further Improvement and Research Areas

Concluding Remarks and web-site demonstration



Overview & Capabilities



TAF-Modernization Goals

Projection of future air transport activity through time

- Projection of future passengers by origin and destination (O&D) market routes and network routes;
- Projection of aircraft operations by market and network routes
- Integrated operations and passenger flows through the NAS network thus reducing the need for post processing

Considering inputs to represent

- Underlying demand for passengers as determined by local economies, economics and markets and routes
- Determining aircraft operations driven by underlying passenger demand
- Changing characteristics of aircraft fleet and routes
- Impacts of changes in economic, demographic, market, and airport characteristics on demand

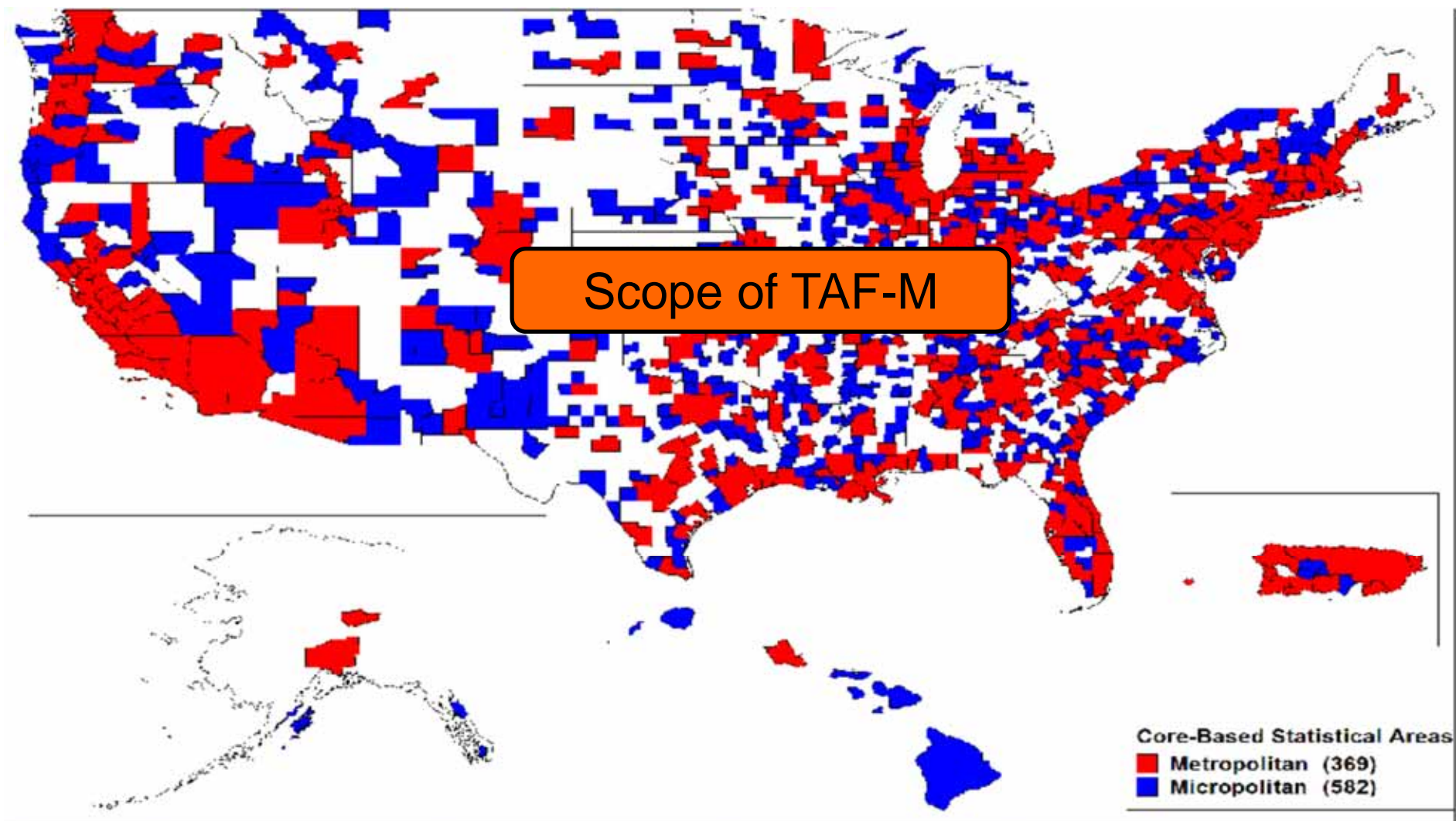


Comparison of TAF and TAF-M

Existing TAF	Modernized TAF
Airport level Passengers & Operations	Origin-Destination and Segment level Passengers & Operations
No information on passenger flow, i.e., no network information	Embeds detailed network information on passenger flow
Output must be post processed for use by NAS modelers; airport consultants	Output ready for use by NAS modelers, airport consultants and other users
Passenger and operations forecasts linked at airport level (via assumptions of seat/load factors)	Passenger and operations forecasts integrated at route level and driven by allocations routines
Stand-alone modeling for Core 30 and 2 nd tier airports (110 airports)	Standard model for all commercial airports (~500 airports)
Annual forecasts adjusted by schedule information (12 months) from FSDS	Quarterly and annual forecasts incorporate short-term schedule info



Basic Topology: Metropolitan Areas



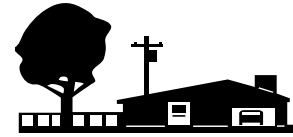
•Source: Office of Management and Budget (OMB)



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TAF-M: Integrated Schematic View

Air passengers from geographic centers, i.e.,
Metropolitan Statistical Area (cities)



Assignment
Algorithm

Airport
Choice



Primary demand for air travel
by Origin-Destination
city/airport pairs



TAF-M: Integrated Schematic View

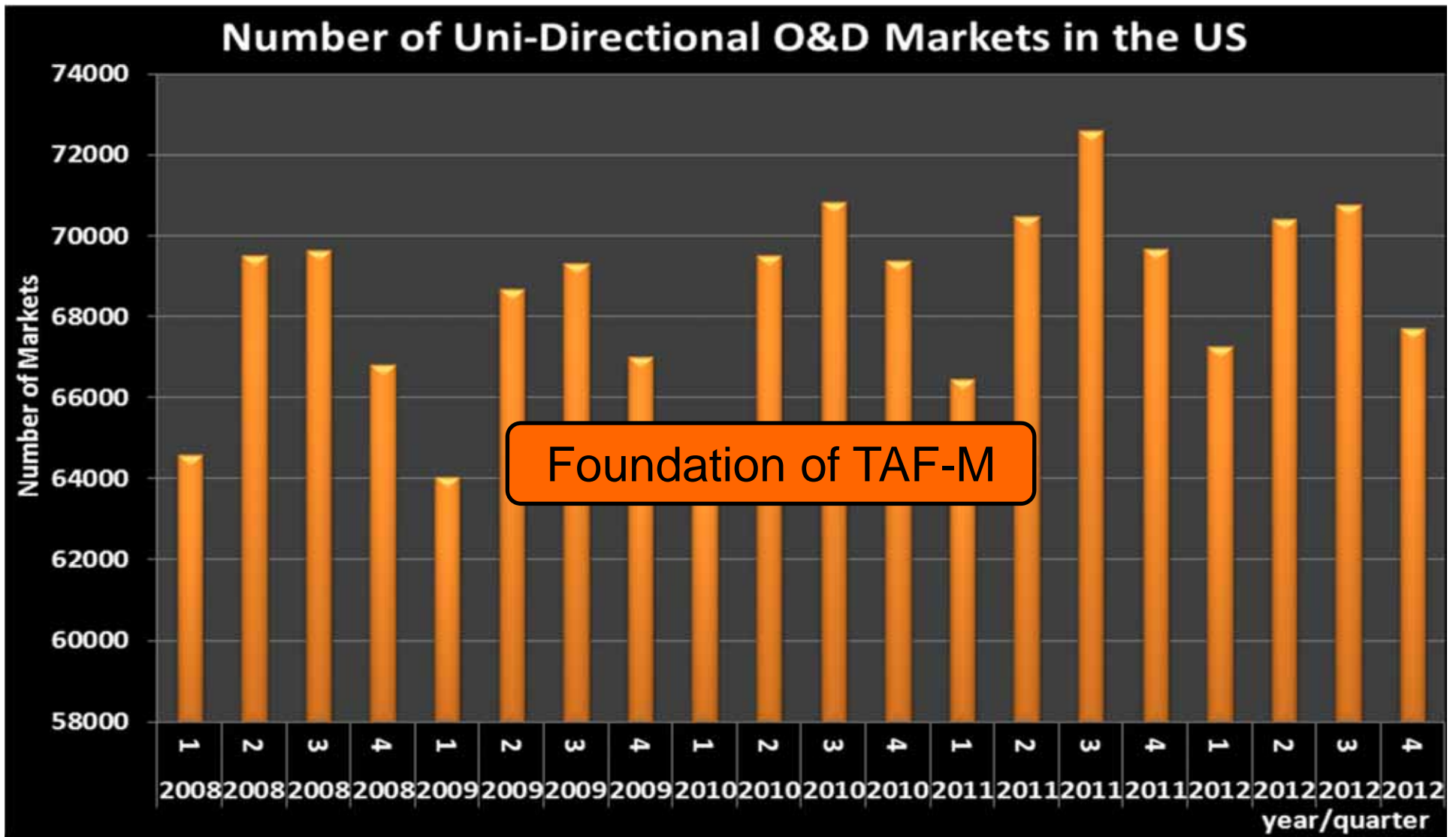
- Bi-directional BOS-SAN market:
- BOS-SAN \simeq SAN-BOS



- Uni-directional BOS-SAN market:
- BOS-SAN \neq SAN-BOS



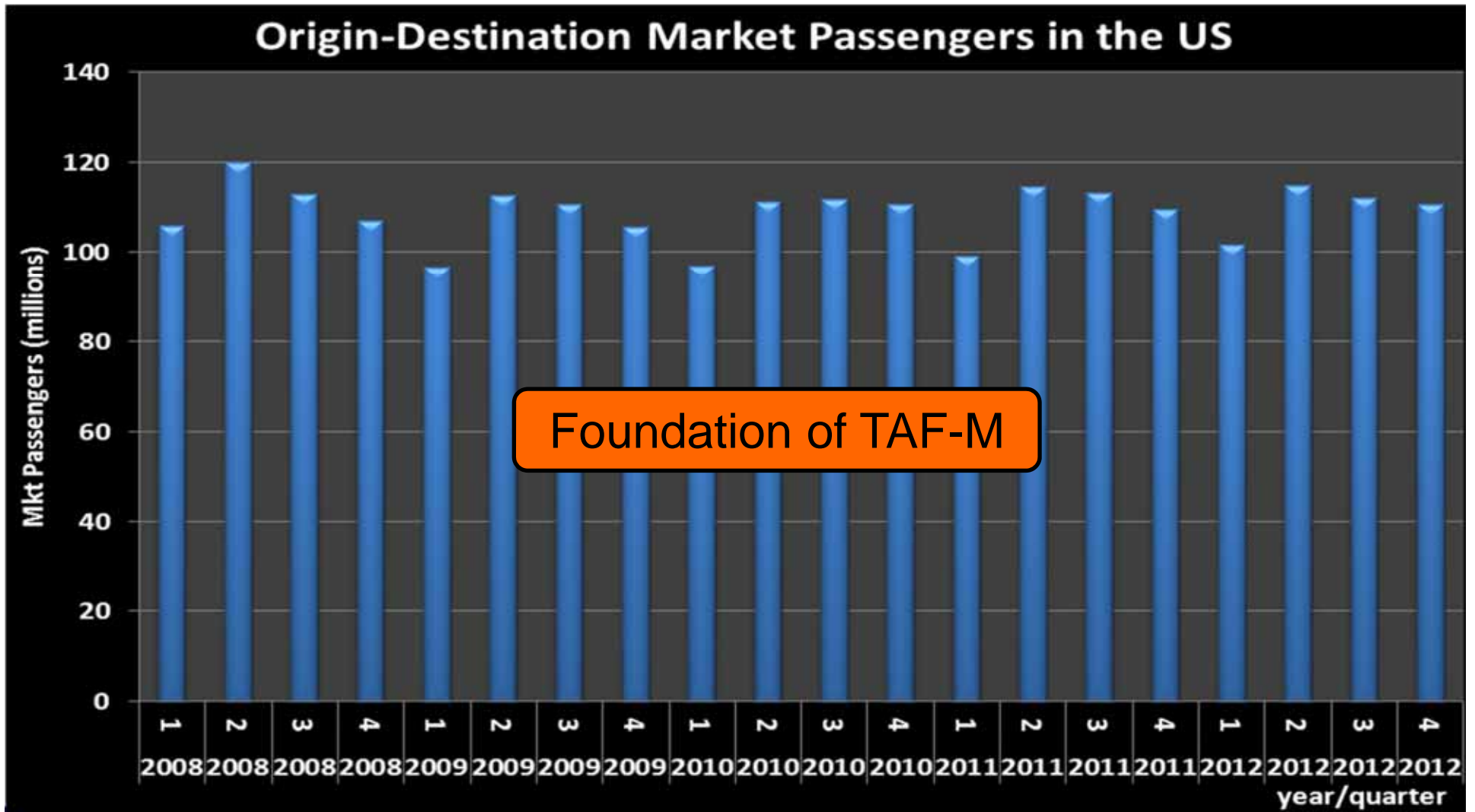
Number of Uni-Directional Markets



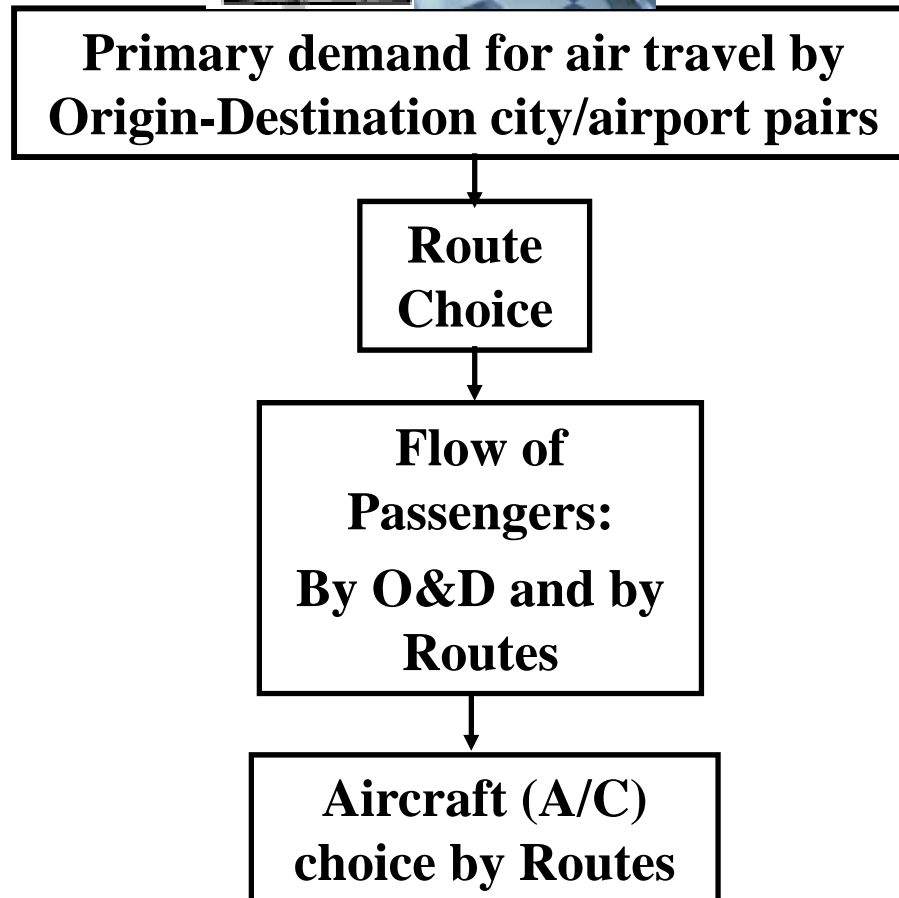
Foundation of TAF-M



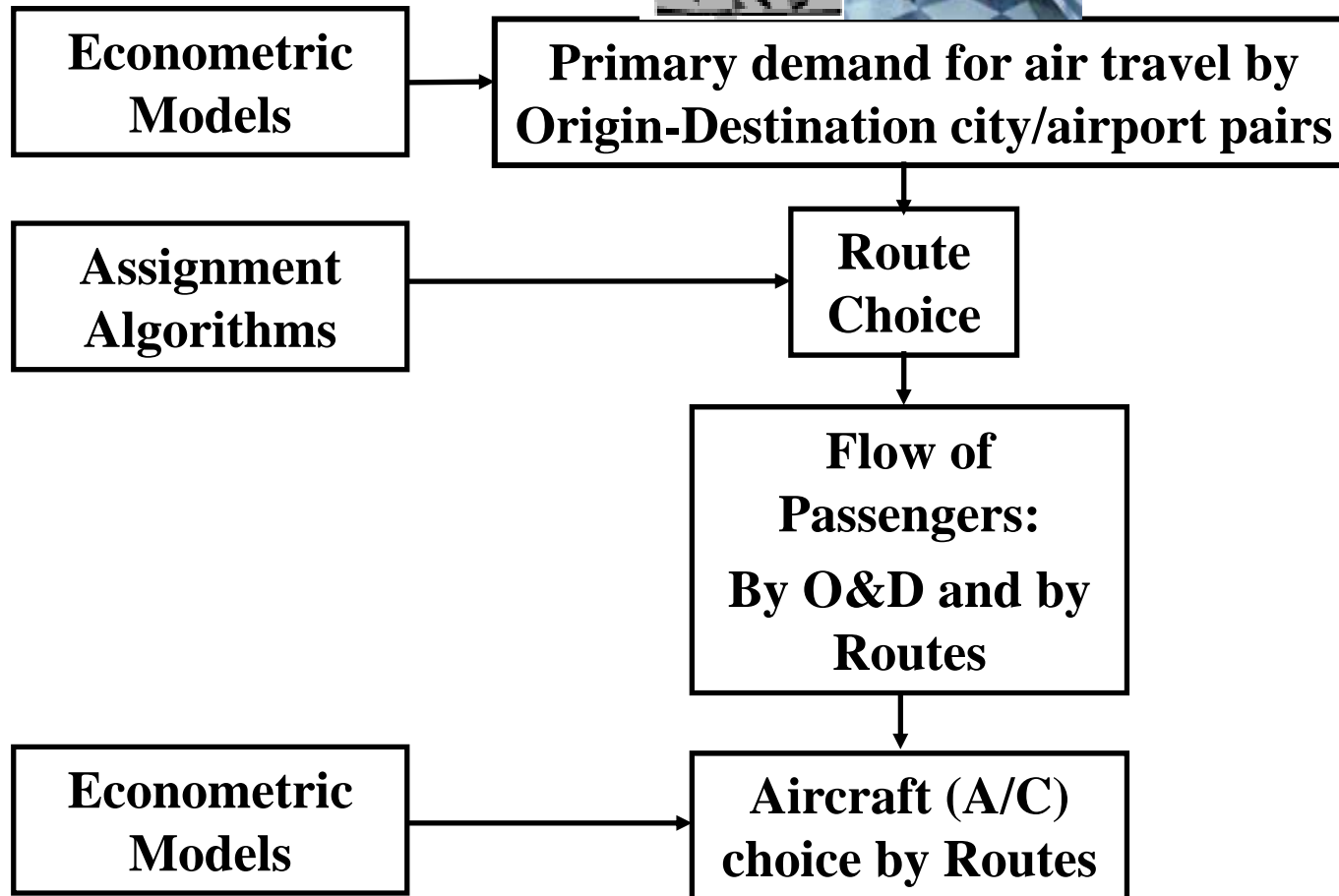
Uni-directional Market Passengers



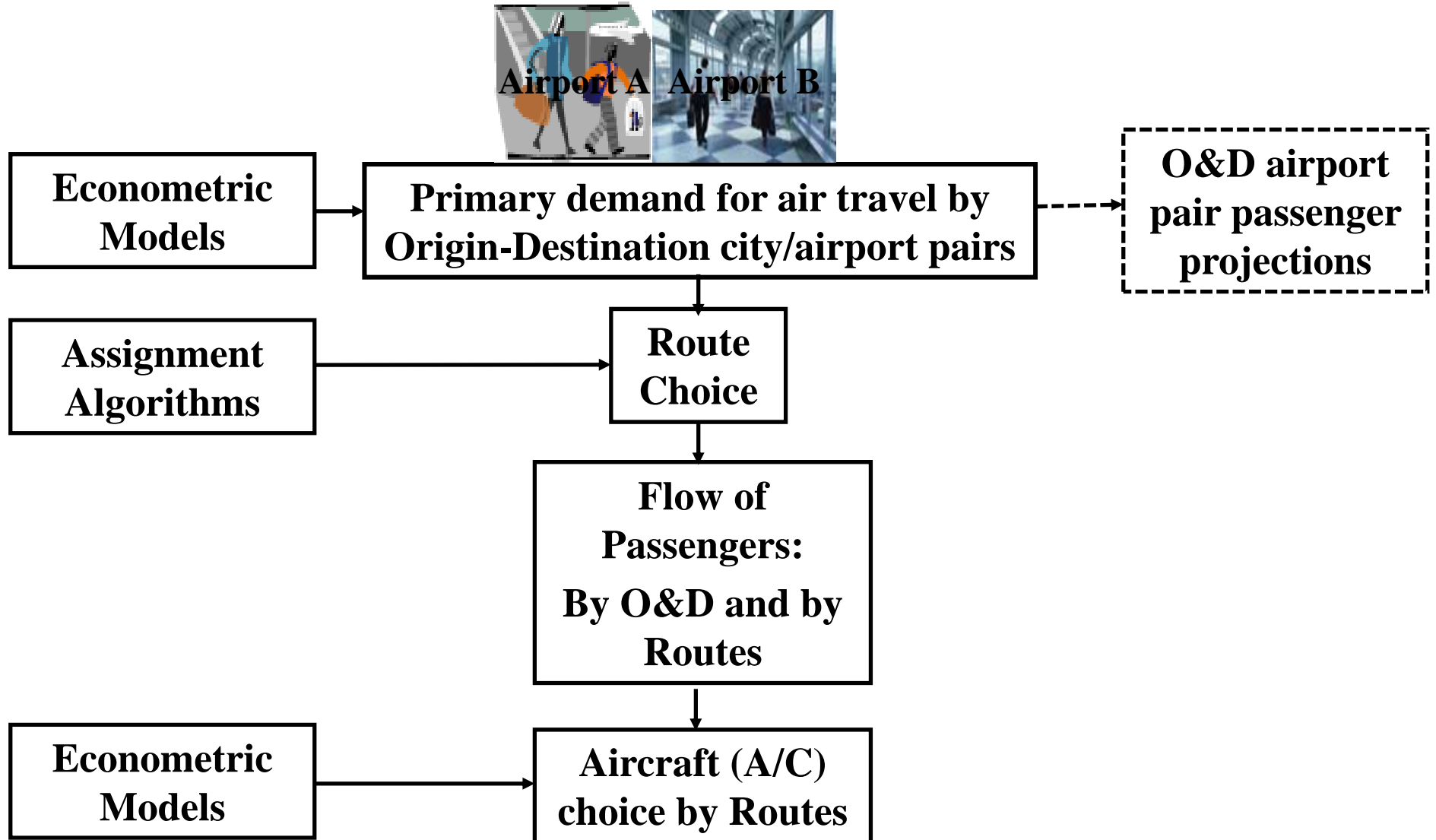
TAF-M: Integrated Schematic View



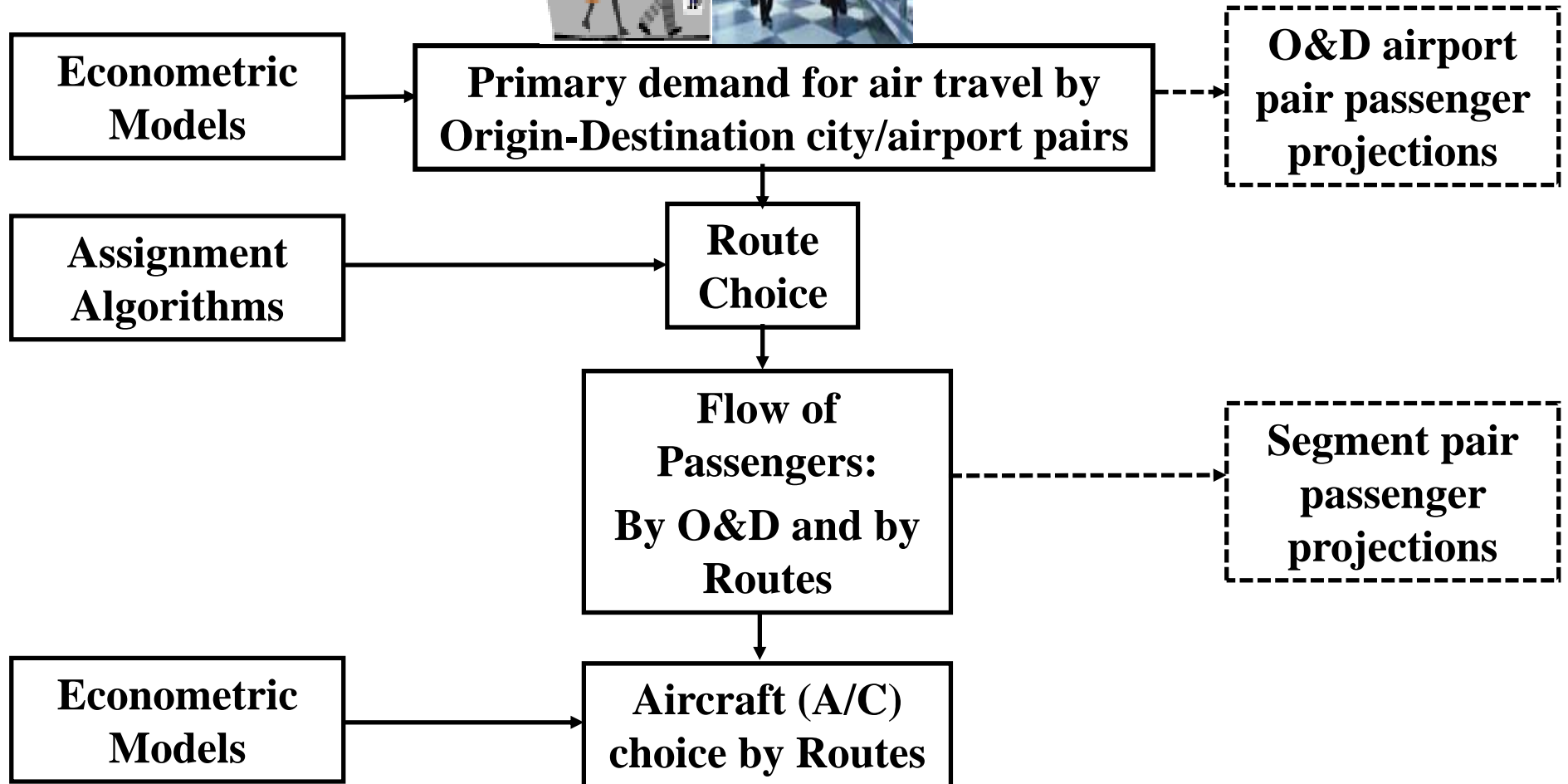
TAF-M: Integrated Schematic View



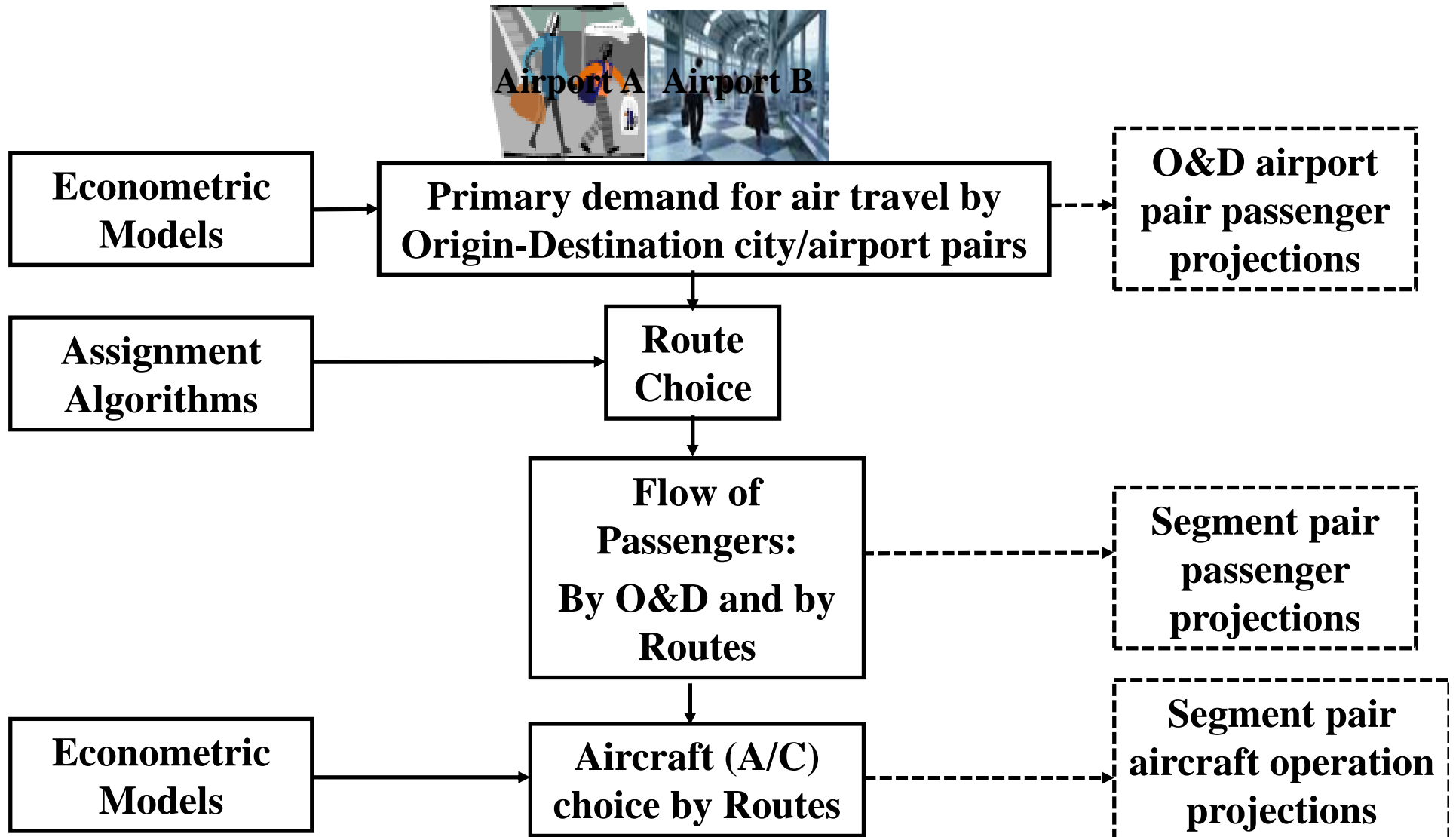
TAF-M: Integrated Schematic View



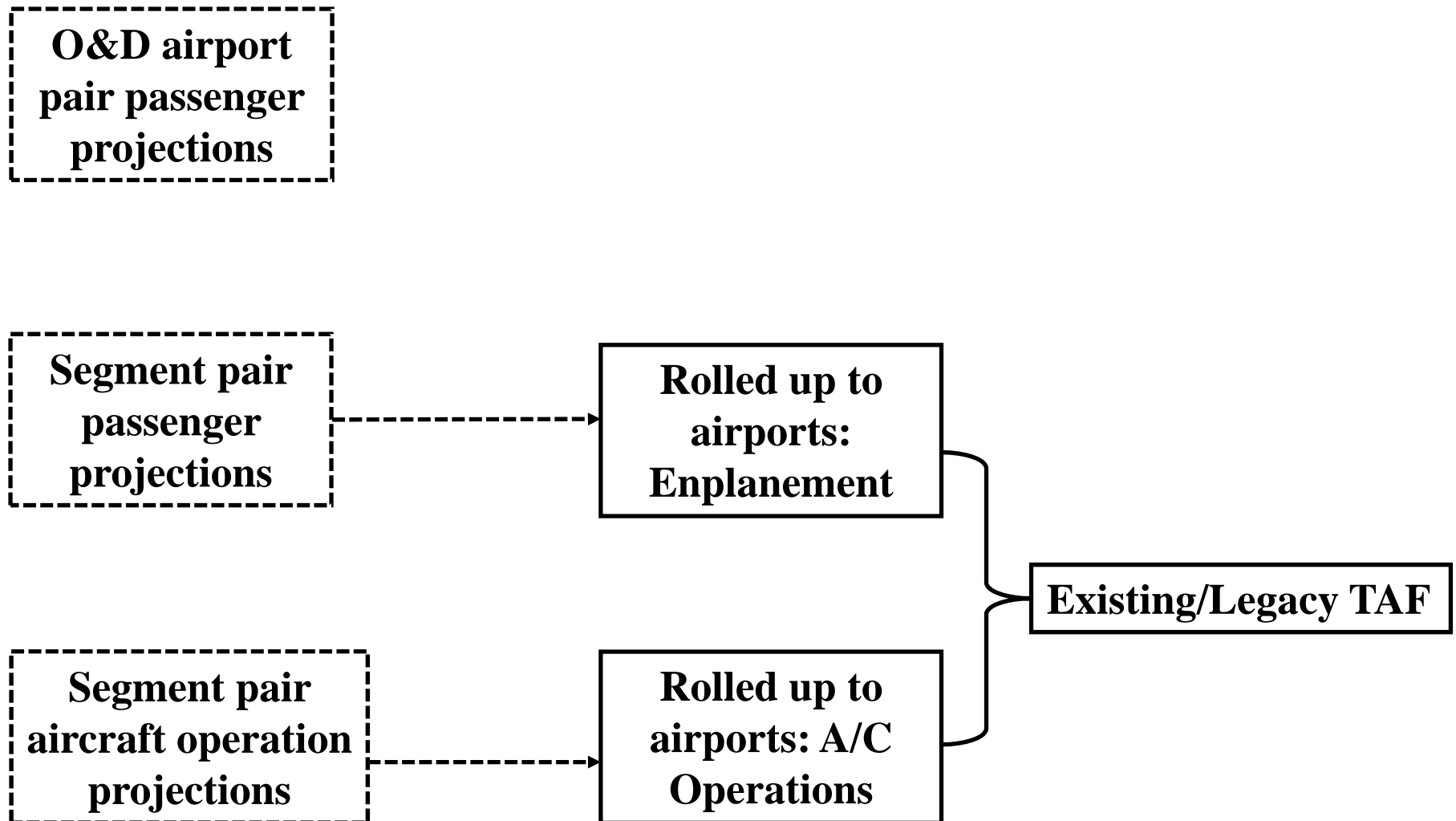
TAF-M: Integrated Schematic View



TAF-M: Integrated Schematic View



TAF-M: Integrated Schematic View



TAF-M: Flow of Passenger Traffic between Metropolitan areas

Using forecasts of the external drivers and assumptions/industry knowledge, we generate passenger forecasts by Metro Area O&D pairs.

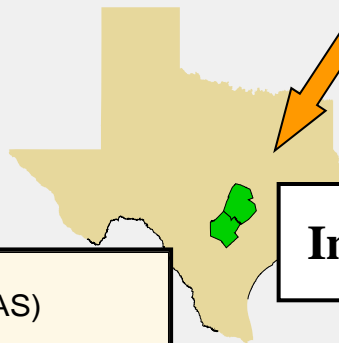
Income, Population, Hub Status

Fare, Distance, Carrier, Service/Route Frequencies

Income, Population, Hub Status

Semi Log-Linear Specification
(Segmented by Market Sizes in the NAS)

$$\ln(P_{ij}) = \alpha + \beta * \ln(f_{ij}) + \chi_i * \ln(P_i) + \chi_j * \ln(P_j) + \delta_{ij} * \ln(\text{route/svc freq}) + \gamma_i * (\text{hub statusOrigin}) + \gamma_j * (\text{hub statusDestination}) + \varphi * \ln(\text{Distance}_{ij}) + \rho * (\text{season}) + \varepsilon_{ij}$$



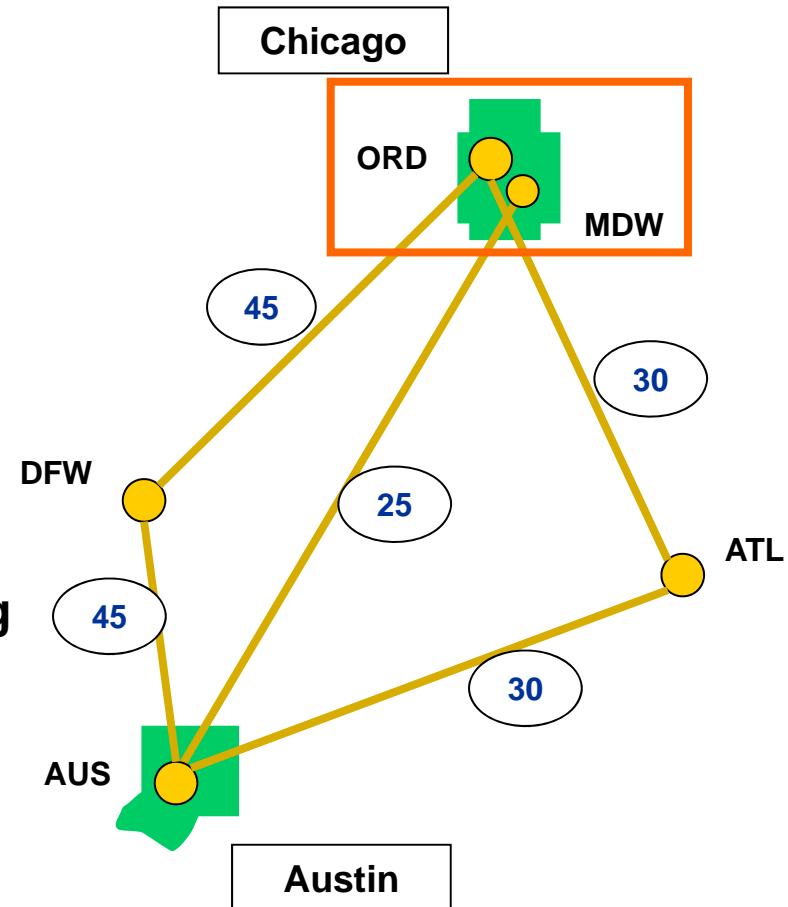
Source: Bhadra, D. (2003). "Demand for Air Travel in the United States: Bottom-Up Econometric Estimation and Implications for Forecasts by O&D pairs", *Journal of Air Transportation*, Volume 8, number 2, p. 19-56, September, 2003.



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Allocating O&D Passengers to Available Routes

- Assume 100 passengers are predicted to fly between Austin and Chicago.
- We first identify valid routes flown at present (same quarter last year: reference point)
- Note that the option of multiple airports within a single MSA is treated as part of the “route” choice.
- We allocate passengers among existing route segments according to the current percent distribution for that O&D market.
- We currently do not attempt to predict new routes. However, this is in our research agenda.*

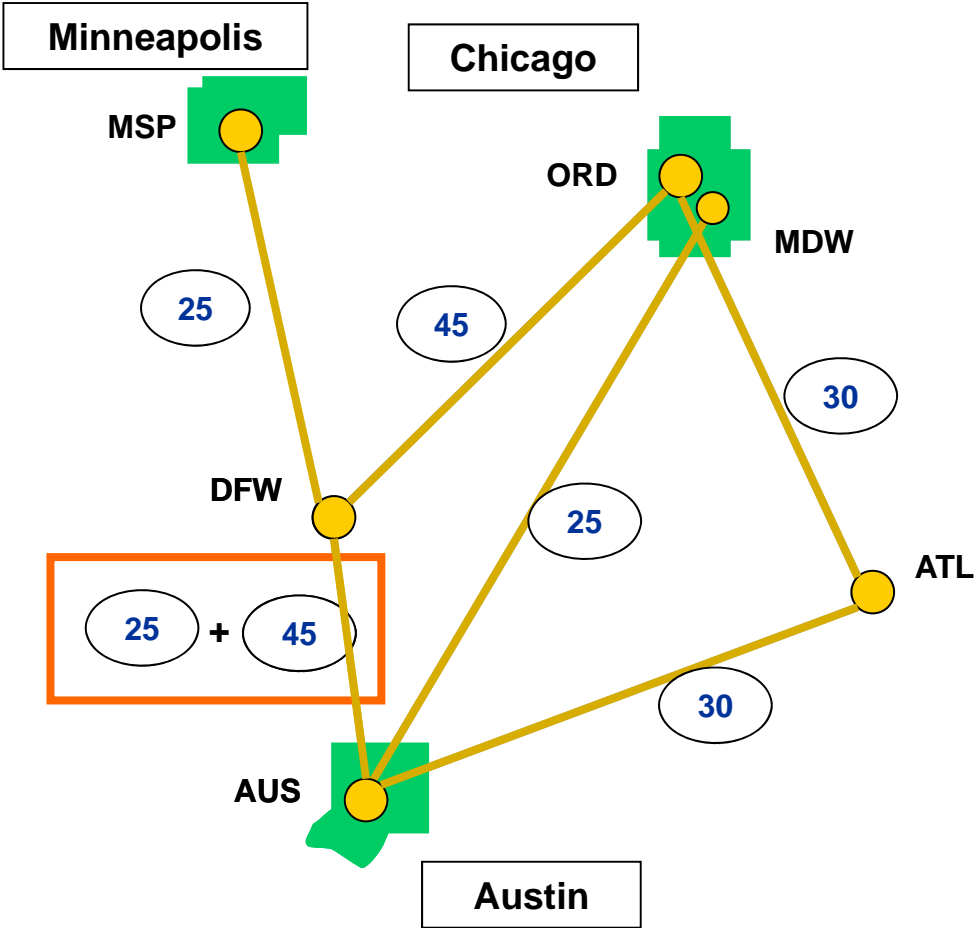


* We have experimented with multi-nomial logit choice and neural network modeling techniques to capture route choice and network evolutions. We are doing some further work in this area. A more detailed presentation on this aspect is also available.

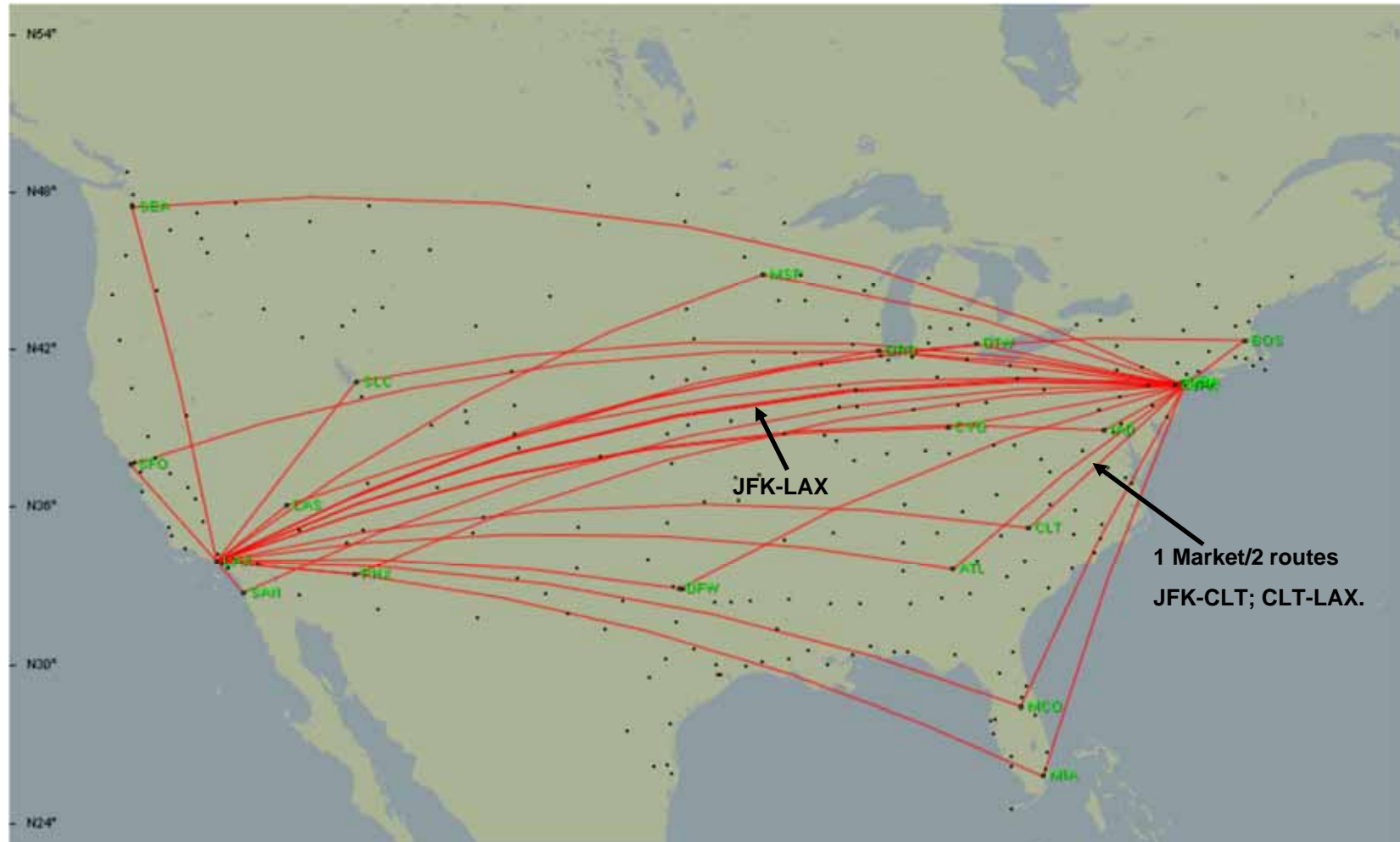


Adding Up Segment Totals for the NAS

- We now continue from one market to the next...
- ... adding up the segment traffic as we go along.
- When we have completed looping through all O&D pairs, we have passenger totals by segment.



JFK-LAX Market Case: Only Top 20 Reported in the Map Below



From Passengers to Aircraft Departures

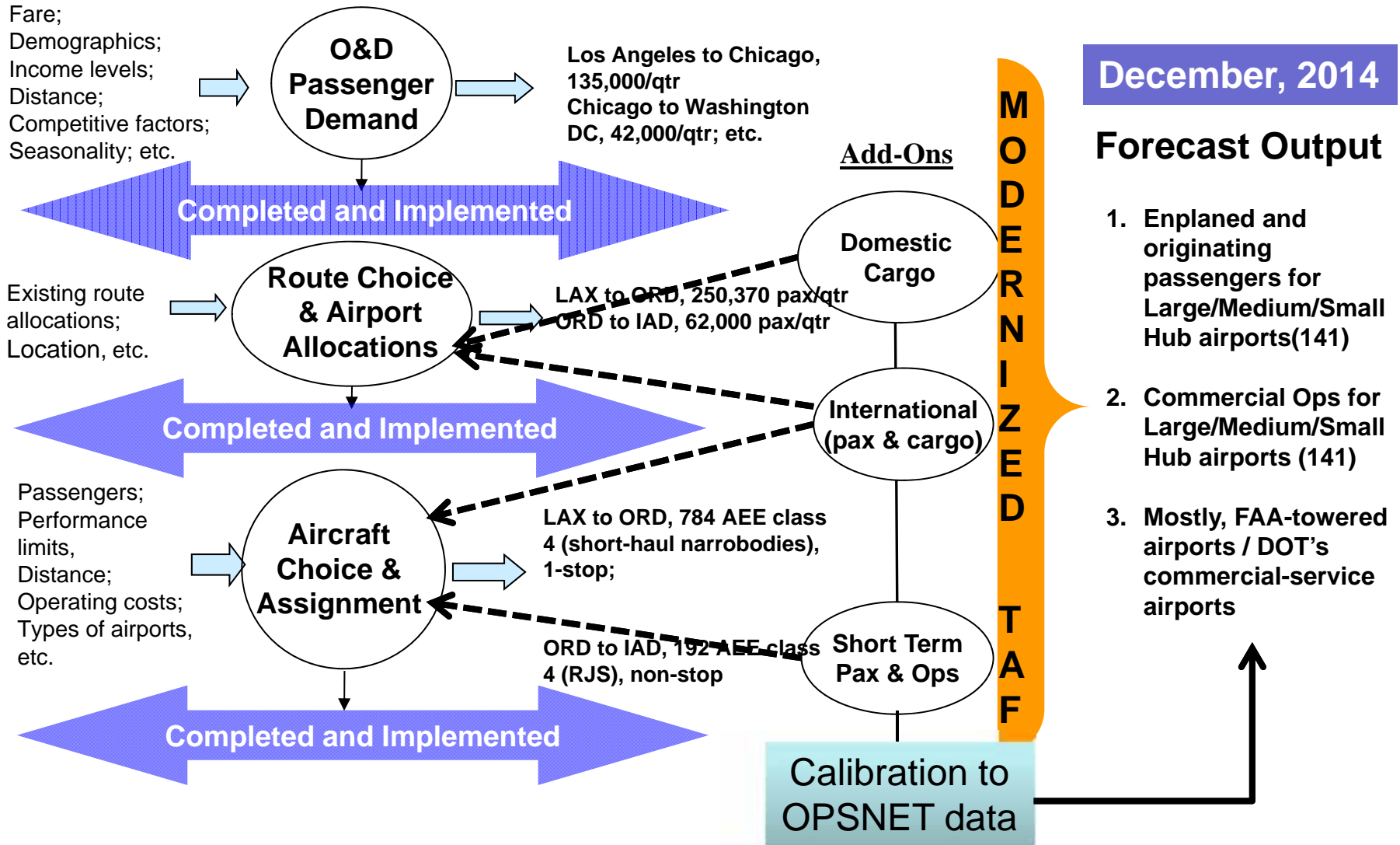
**Passengers;
Performance
limits,
Distance;
Operating
costs;
Types of
airports, etc.**



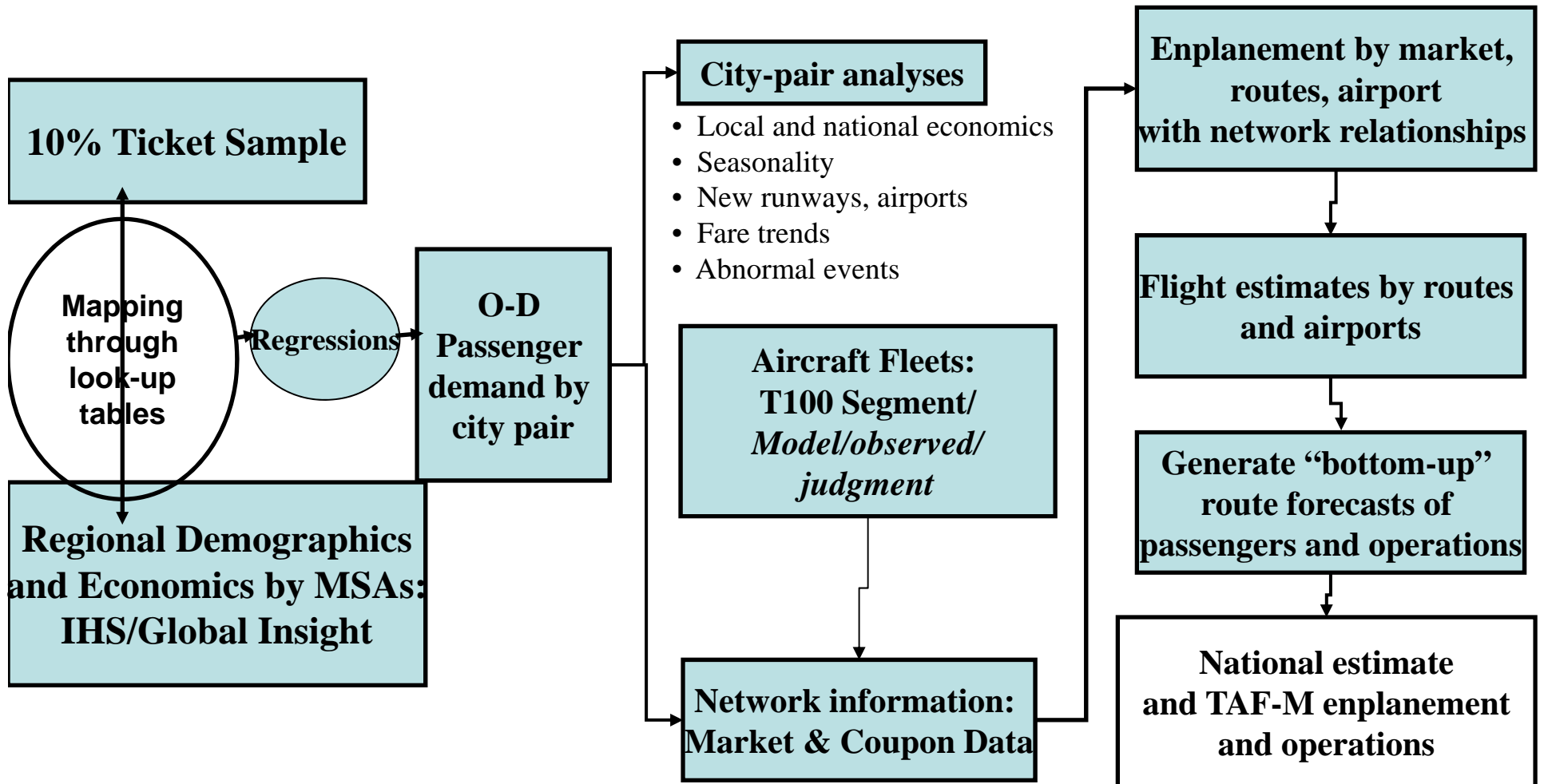
**LAX to ORD, 4 short-haul
narrow-bodies, 1-stop
ORD to DCA, 2 RJS, non-
stop**



TAF-M: Models, Output and Forecast



Model Scheme, Process Links and Architecture

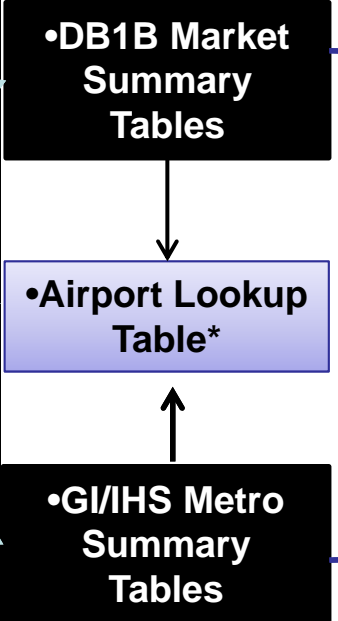


Database design: analysis & OD forecasts

•Raw & processed data resides in an internal SQL server at

APO

Table Name	Rows	Indexes	Database	IndexSize	IndexSpace	UnloadedSize
APO_Airports	172	1	16 KB	16 KB	16 KB	40 KB
APO_DayInDir	172	1	16 KB	16 KB	16 KB	40 KB
APO_MarketSummary_GIData	1455585	1433976 KB	852888 KB	549752 KB	1338 KB	1338 KB
APO_MarketSummary_BB_ByAirportGroup	17458734	225512 KB	225512 KB	24 KB	24 KB	352 KB
APO_MarketSummary_BB_ByOrigDest	3692555	603728 KB	603728 KB	16 KB	16 KB	592 KB
APO_MarketSummary_BB_ByOrigDest_KeepLast	3692555	602960 KB	602872 KB	16 KB	16 KB	72 KB
APO_MarketSummary_BB_ByOrigDest_Old	176821	602256 KB	602048 KB	16 KB	16 KB	200 KB
APO_MarketSummary_UD_ByAirportGroup	17454575	2283968 KB	2283632 KB	32 KB	32 KB	304 KB
APO_MarketSummary_UD_ByOrigDest	3425099	393048 KB	392400 KB	24 KB	24 KB	324 KB
APO_Summary	432	24 KB	16 KB	16 KB	16 KB	8 KB
APO_SummaryDBP	383	24 KB	16 KB	16 KB	16 KB	8 KB
APO_T100SegmentAllCarrier_ByAircraftType	1578769	231168 KB	222656 KB	8 KB	8 KB	1732 KB
APO_T100SegmentUSCarrier_Only_ByAircraftType	1601559	204344 KB	203704 KB	32 KB	32 KB	584 KB
APO_T100SegmentAllCarrier_ByAircraftType	386279	47832 KB	47688 KB	24 KB	24 KB	112 KB
APO_T100SegmentUSCarrier_Only_ByAircraftType	298794	51192 KB	51192 KB	24 KB	24 KB	32 KB
APO_T100SegmentAllCarrier_ByAircraftType	1941048	245720 KB	245564 KB	24 KB	24 KB	32 KB
APO_T100SegmentUSCarrier_Only_ByAircraftType	181732	17728 KB	17728 KB	16 KB	16 KB	112 KB
DOT	100844	143852 KB	143852 KB	16 KB	16 KB	48 KB
GI/IHS	172	16 KB	16 KB	16 KB	16 KB	16 KB
GIS info	172	16 KB	16 KB	16 KB	16 KB	16 KB
Look up tables	172	16 KB	16 KB	16 KB	16 KB	16 KB
Processed/summary tables	172	16 KB	16 KB	16 KB	16 KB	16 KB
GI/IHS Metro Summary Tables	172	16 KB	16 KB	16 KB	16 KB	16 KB



•O&D Econometric Models in SAS

•Airport-pair forecasts

•Forecasts data reside in the same server at APO

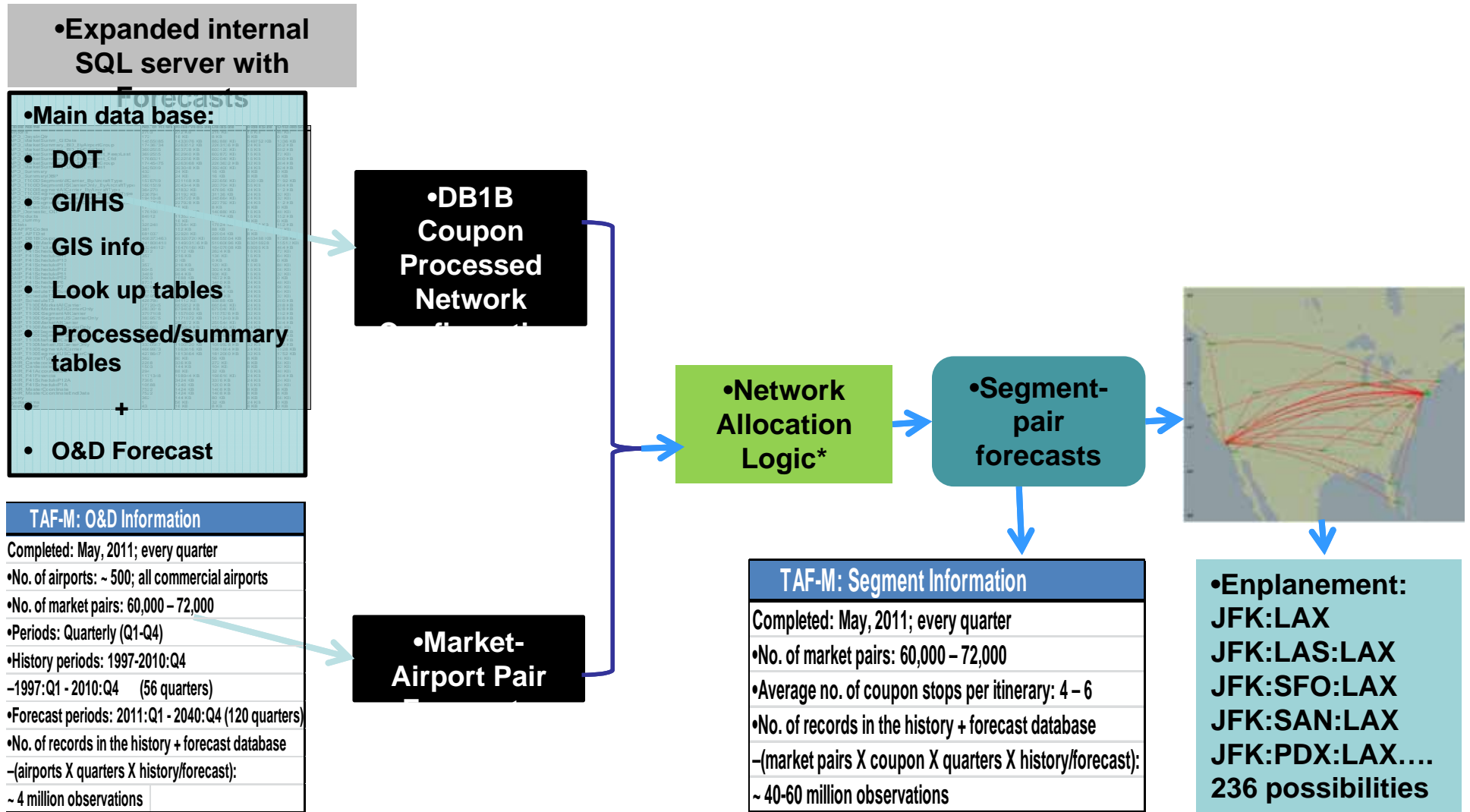
TAF-M: O&D Information

Completed: May, 2011; every quarter
•No. of airports: ~ 500; all commercial airports
•No. of market pairs: 60,000 – 72,000
•Periods: Quarterly (Q1-Q4)
•History periods: 1997-2010:Q4
–1997:Q1 - 2010:Q4 (56 quarters)
•Forecast periods: 2011:Q1 - 2040:Q4 (120 quarters)
•No. of records in the history + forecast database
–(airports X quarters X history/forecast):
~ 4 million observations

•*: Observed airport allocations assumed. Models for airport allocation is being investigated



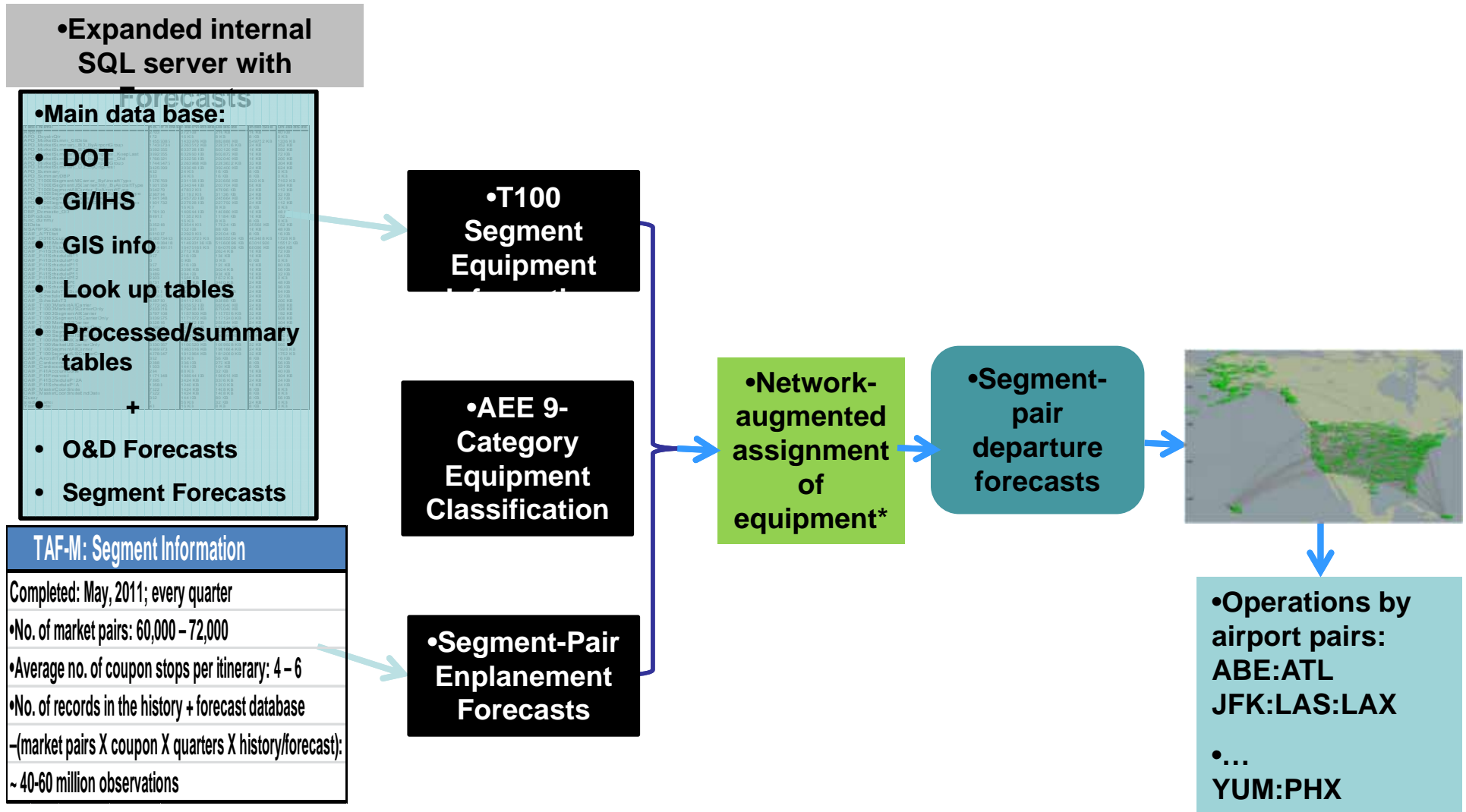
Database design: analysis & segment forecasts



•*: Network evolution workshop hosted by APO provided technical guidance in this area.



Database design: analysis & departure forecasts



•‘*’: Network evolution workshop hosted by APO provided technical guidance in this area along with MITRE/Volpe work.



Key Dimensions

Spatial

Aggregate (airport) and disaggregate (O&D markets and routes/segments) information available

Temporal

Forecasts quarter-on-quarter

Aircraft Operations

Grouped by commonality of mission purpose, i.e., seat categories

Demand and Aircraft Operations

Passenger (by markets and routes), and operations (by markets and routes)

Scenarios

Built-in capabilities to evaluate local socio-economic impact on aviation demand flows



Summary

TAF-M improves on existing forecasts and provides technical support to inform U.S. decision making, providing

- demand effects at granular levels (market & routes)
- eliminates post processing and provides integrated view of the US aviation system
- analysis of multiple aviation scenarios and policy outcomes
- flexibility in spatial representation
- providing insights into key relationships and impacts
- Opens up new areas of research



Web-site demonstration

<http://aspm.faa.gov/tafm/Default.aspx>

