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The Role of Trip-Based Models in Statewide Travel Demand Modeling

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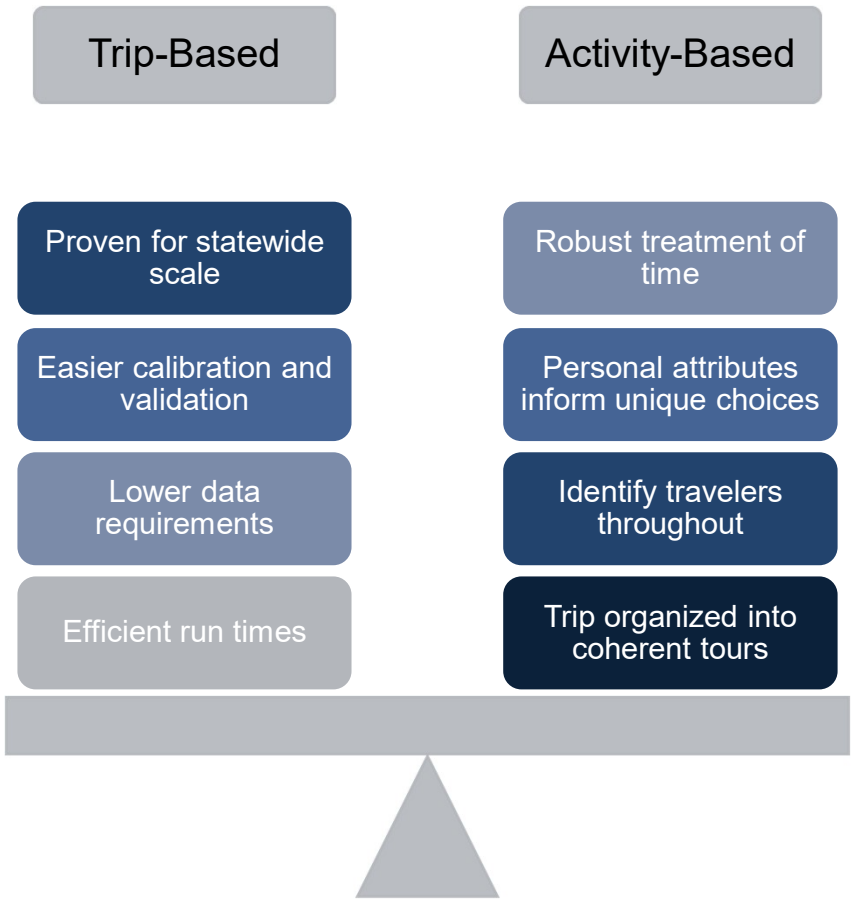
Trip-Based vs. Activity-Based?

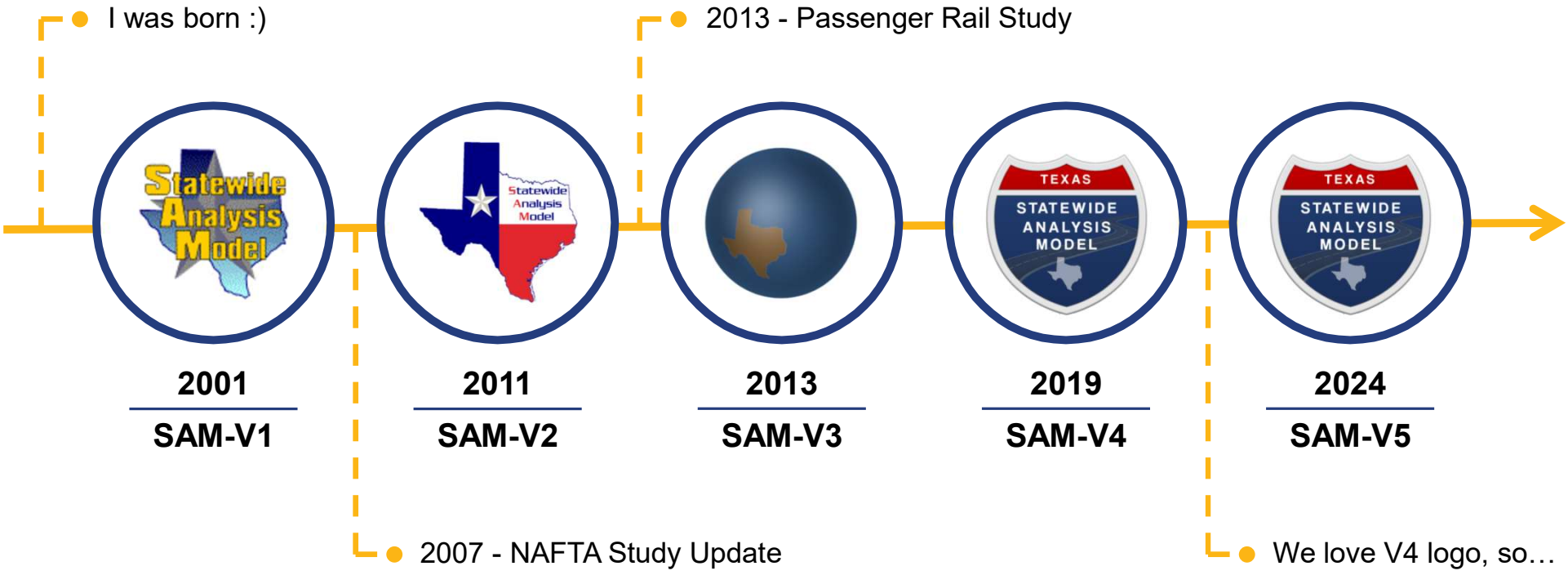
Not a Simple Trade-Off

Sometimes choice depends on more than pros and cons.

- **State size & geography:** larger areas may favor scalability over detail.
- **Funding availability:** resources shape model scope and complexity.
- **Starting point of models:** existing frameworks can strongly guide direction.
- **Data availability & quality:** drives what's feasible.
- **Purpose & use cases:** what analyses will the model support?
- **Development timeline:** short timeframes often favor simpler approaches.
- **Staff expertise & capacity:** influences implementation and maintenance.



History of Texas Statewide Analysis Model (SAM)



What is SAM?

A primary tool for evaluating large **intercity** transportation projects

A **multimodal trip-based** travel demand model with **passenger and freight** components, and **weekday and weekend** scenarios

A statewide framework that complements urban models with a **consistent network and socioeconomic** background

Use Cases of SAM

- Used in 80+ projects by TxDOT-TPP, TxDOT Districts, MPOs, etc.:
  - Texas Transportation Plan
  - Texas Freight Mobility Plan
  - Traffic Analysis
  - Passenger Rail Studies
  - 2024 Solar Eclipse Study

From Basic Trip-Based to SAM

Basic Trip-Based

- 4-step (generation, distribution, mode choice, assignment)
- Highway-focused, minimal multimodal
- Special generators (ad hoc adjustments)

SAM Today

Basic Trip-Based Structure Plus

- Expanded multimodal (highway, urban rail, intercity rail, air)
- Socioeconomic inputs aligned with MPO forecasts
- Two complete model streams (passenger, freight)
- Weekday and weekend scenarios
- Enhanced passenger and freight modeling

Passenger Destination Choice Model

More realistic behavioral representation

- Gravity model: distributes trips based mainly on travel impedance and simple size variables.
- Destination choice: uses a **utility-based** framework that **considers multiple factors simultaneously**.

Better treatment of special generators (SGs)

- Gravity model: hard-coded, inflexible.
- Destination choice: embedded in utility, **adaptive to network and scenario changes**.

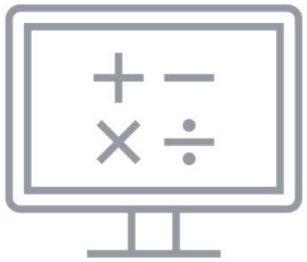
Passenger Destination Choice Model

Avoids reliance on workplace survey-based attraction rates

- Recent surveys only captured two trips per employee, missing midday and visitor movements, limiting purpose-specific rate estimation.
- Destination choice removes this dependency, enabling more flexible calibration.

Multinomial logit (MNL) models to distribute trips

- Weighted sampling reflects observed trip patterns with less computation.
- Utility combines size (population, employment, etc.), impedance (time, cost), and indicators (SGs) to capture destination attractiveness.



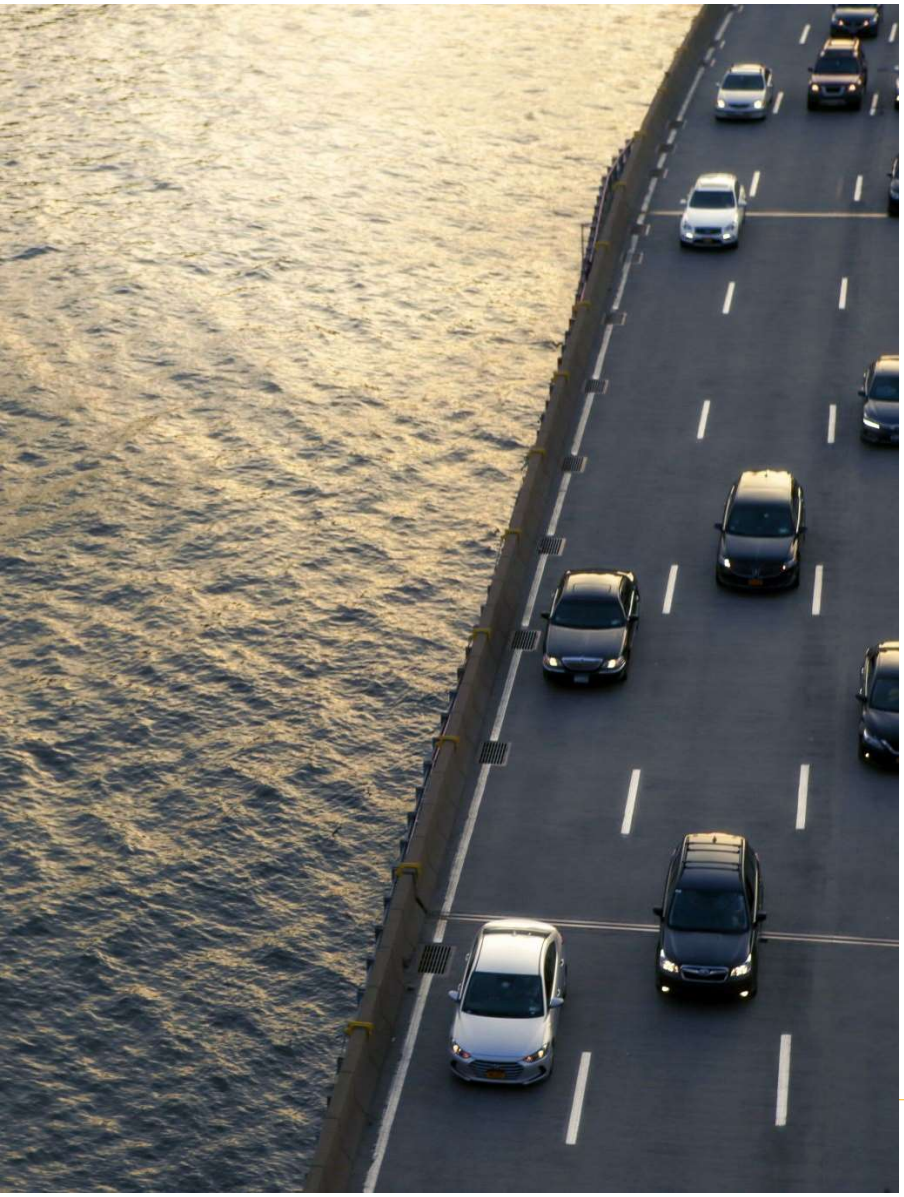
Long-Distance Passenger Modeling

Why distinguish by distance?

- Trip characteristics (trip rates, purposes, and mode shares) vary substantially with distance, as shown by survey data.
- Short-distance trips: under 50 miles, primarily auto after mode share.
- Long-distance trips: 50-400 miles and over 400 miles, with multiple modes available (auto, air, rail).

How long-distance trips are modeled?

- Two TAZ layers:
  - Within Texas: detailed 6,000+ zones.
  - Continental US: BEA economic areas split by state boundaries.
- Three trip production sources: Texas households, neighboring states, rest of continental US.
- Four income groups used to stratify generation, distribution, and mode choice.



Passenger Mode Choice

Short-Distance Passenger Trips

- Previously modeled with full mode choice.
- Now simplified to a **mode share** approach to meet current statewide needs.
- Calibrated to **survey data** and **urban model outputs** to ensure statewide results match local transit and non-auto shares.

Long-Distance Passenger Trips

- Uses nested logit mode choice structure.
- Modes: auto, air, intercity rail, high-speed rail.
- Calibrated to multiple datasets:
  - FAA DB1B airport boarding data
  - Amtrak ridership data
  - AirSage data (weekday and weekend non-auto share)
- Sensitive to distance, income group, and trip purpose.

Freight Mode Choice

- Part of the complete freight model stream.
- Uses **incremental logit** framework.
- Calibrated to **Transearch data**.
- Modes: truck, carload rail, intermodal rail, air, water.
- Differentiates by commodity type, cost, and travel time to capture realistic modal competition.
- Assignment: truck trips are merged with passenger auto trips for highway assignment, while rail tonnage is assigned to the freight rail network.

From Better Models to Better Decisions

Rich Outputs from SAM

- **User-Friendly Reports:** Clear Excel & interactive HTML, focusing on metrics planners, project managers, and policy makers care about.
- **ArcGIS Online Dashboard:** dynamic, map-based tool to link SAM outputs directly, compare results across geographies, and visualize trends easily.

Potential Integration with Other Tools

- **Ready Inputs for Strategic Tools:** Outputs like county-level VMT or trip length distributions can plug directly into tools such as VisionEval, reducing setup time.
- **Policy and Climate Applications:** Useful for evaluating GHG reduction targets, climate action plans, and sustainability progress.
- **Enhanced Scenario Testing:** Network-sensitive outputs allow realistic testing of freeway, transit, and land use changes, improving forecasts for GHG, energy, and equity impacts.

Looking Ahead

Trip based models remain practical and scalable

- Thoughtful design, ongoing enhancements, and integration with supporting tools make them reliable solutions for statewide planning. SAM is a strong proof of concept.

Applicable across diverse contexts

- The same philosophy is applied in different settings. For example, in Arkansas we adapt trip-based structures to limited budgets and scarce data while reflecting local context and stakeholder priorities.

Model choice depends on context

- Architecture is not a theoretical debate. It depends on fit for purpose, available data, policy needs, and usability.

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Thank you!

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