Modeling PEV Charging Behavior in an Integrated Activity-Based Demand and Dynamic Network Modeling Framework

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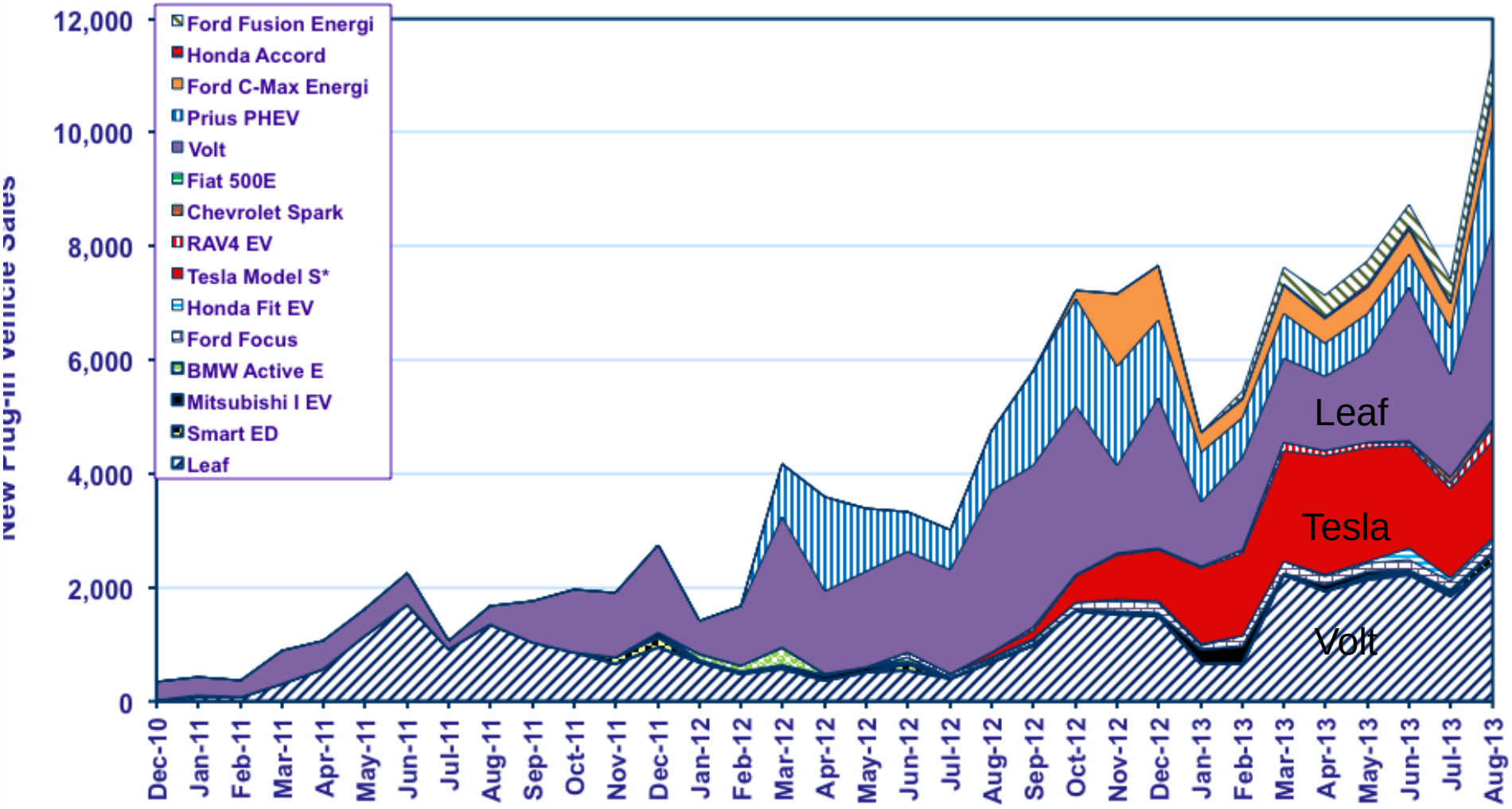
Plug-In Electric Vehicles Sales



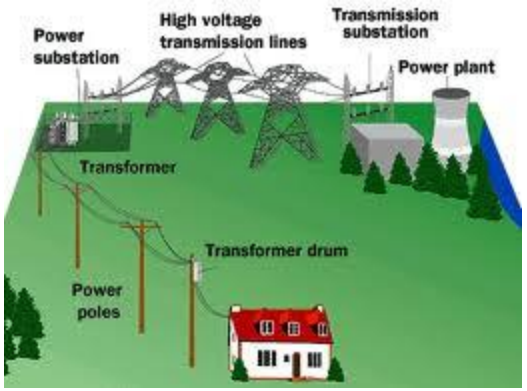
Source: Argonne National Laboratory, 2013

Plug-In Electric Vehicles Sales in August 2013

- Total **11,363** plug-in vehicles (6,407 PHEVs and 4,956 AEVs) were sold in August 2013, up 140% over the sales in August 2012. **This is the first time that monthly PEV sales are over 10,000.** PEVs captured a 1.51% share of car sales in this month.
- These sales included 3,351 Chevrolet Volt, 2,420 Nissan Leaf, 1,791 Prius PHEV, 1,700 Tesla Model S (est.), 621 Ford C-Max Energi, 600 Ford Fusion Energi, 231 RAV4 EV, 182 Smart ED, 175 Ford Focus Electric, 102 Chevrolet Spark, 66 Honda Fit EV, 54 Honda Accord, 50 Fiat 500E and 30 Mitsubishi I.
- Fiat 500E is introduced to the market in this month with 50 units sold.

PEV Charging Behavior

- Plug-in Electric Vehicles
  - Connect the power grid and transportation network systems
  - PEV Charging behavior impacts both systems
    - Intelligent energy management systems in smart grids
    - Intelligent Transportation Systems (ITS) in transportation networks
- PEV Charging Demand
  - Power Grid Systems
    - New Type of Load
    - Uncertainty Demand
      - Charging Load (How Much?)
      - Charging Location (Where?)
      - Charging Time (When?)
  - Transportation Network Systems
    - New Type of Vehicle Travel Demand
    - Restricted Travel Pattern (due to battery capacity and charging time)
      - US Charging Station Standards: Level 1, Level 2, Level 3.
      - Driving Range: Chevrolet Volt (35miles); Nissan Leaf (75miles); Tesla Model S (265miles).
      - Driving Behavior: Braking behavior can recharge the battery.

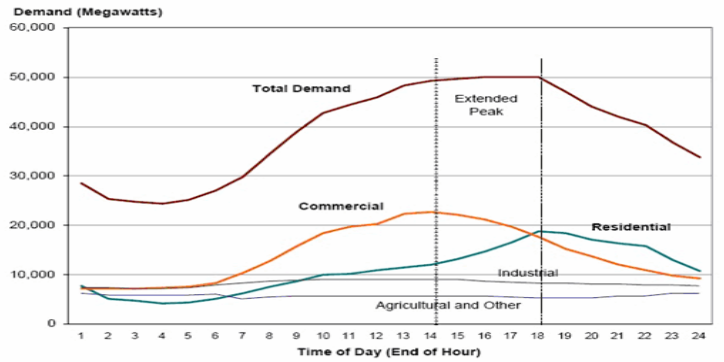


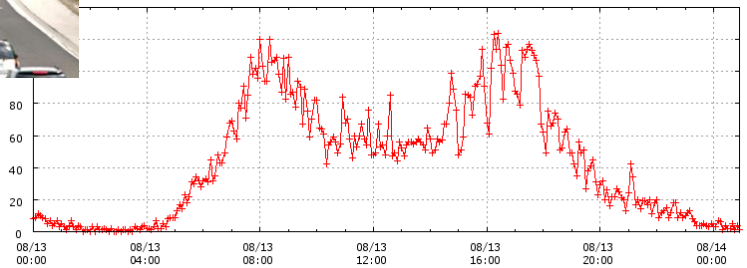
Impact Factors of the PEV Charging Behavior

- Charging Time (Charging Standards)
  - Charging time of current charging techniques available in the market is still longer than gasoline fueling time
- Driving Range (Activity Location Choice and Traffic Flow Dynamics)
  - Most of on-sale PEVs can finish home-work trips without roadside charging
- Parking Duration (Activity Duration)
  - At-Home and At-Work activities are still the major ones for charging
  - Shopping activity is another good choice for charging

Modeling the PEV Charging Behavior

- Charging load pattern is some distribution?
  - 24-hour charging demand
- Traffic Network Dynamics
  - Route choice
  - Traffic flow dynamics
- Travel Demand Dynamics
  - Activity purpose
  - Activity location
  - Activity duration
  - Activity schedule
  - Travel mode
- Integrated Demand and Network Modeling
  - PEV charging decisions should be included into a 24-hour integrated activity-based demand and dynamic network modeling framework

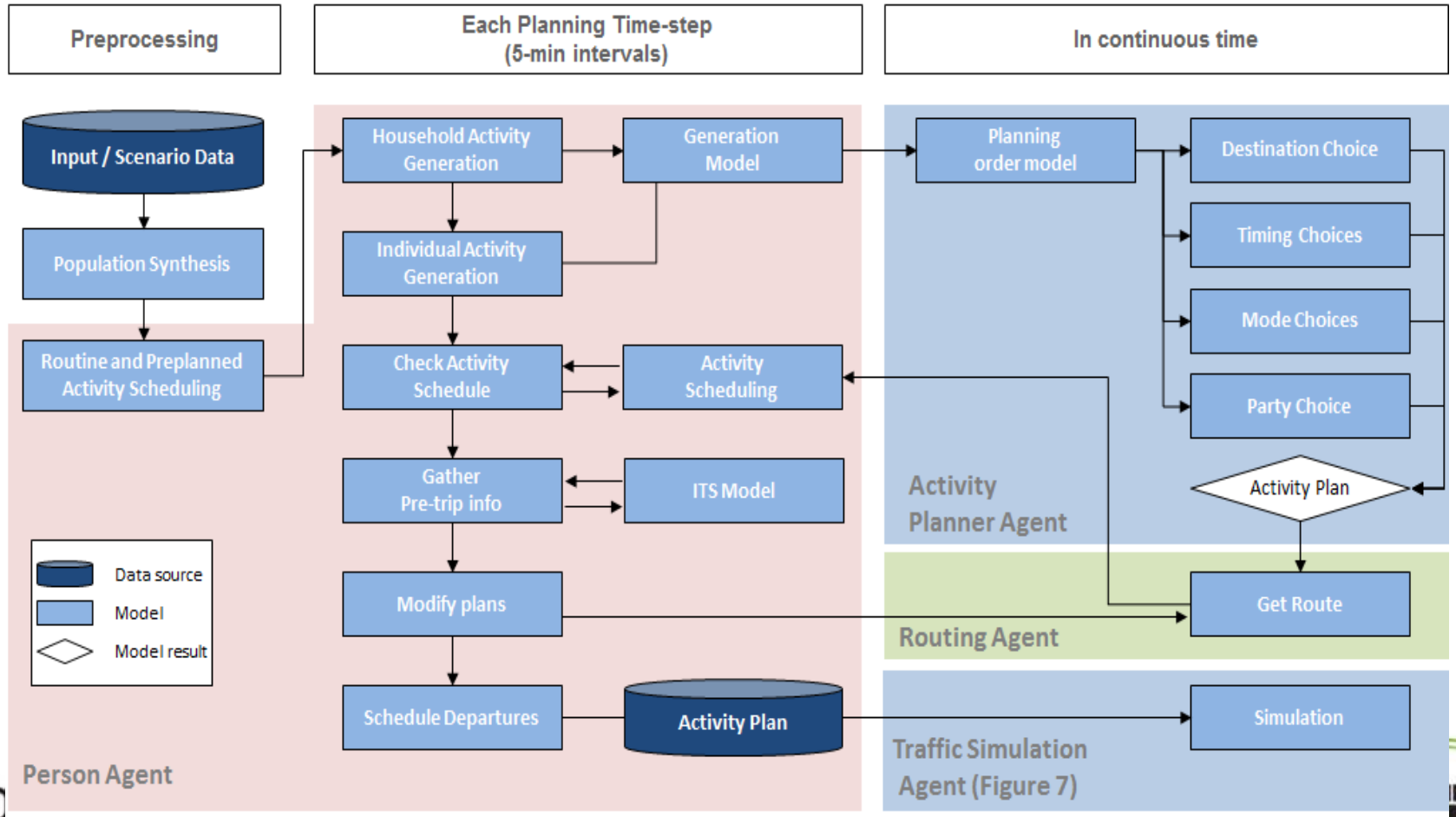




POLARIS

(Planning and Operations Language for Agent-based Regional Integrated Simulation)

POLARIS-Demand Model



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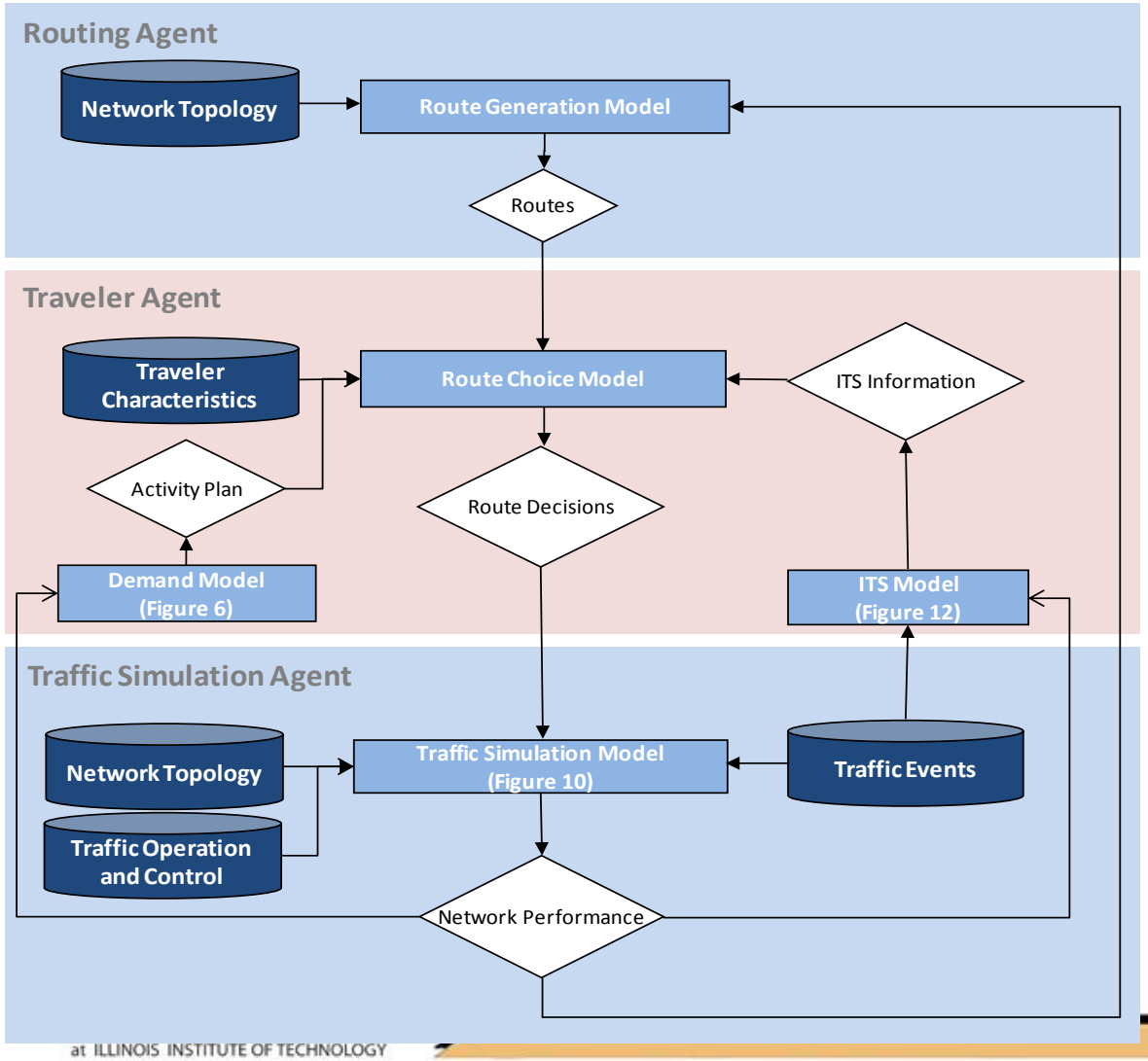
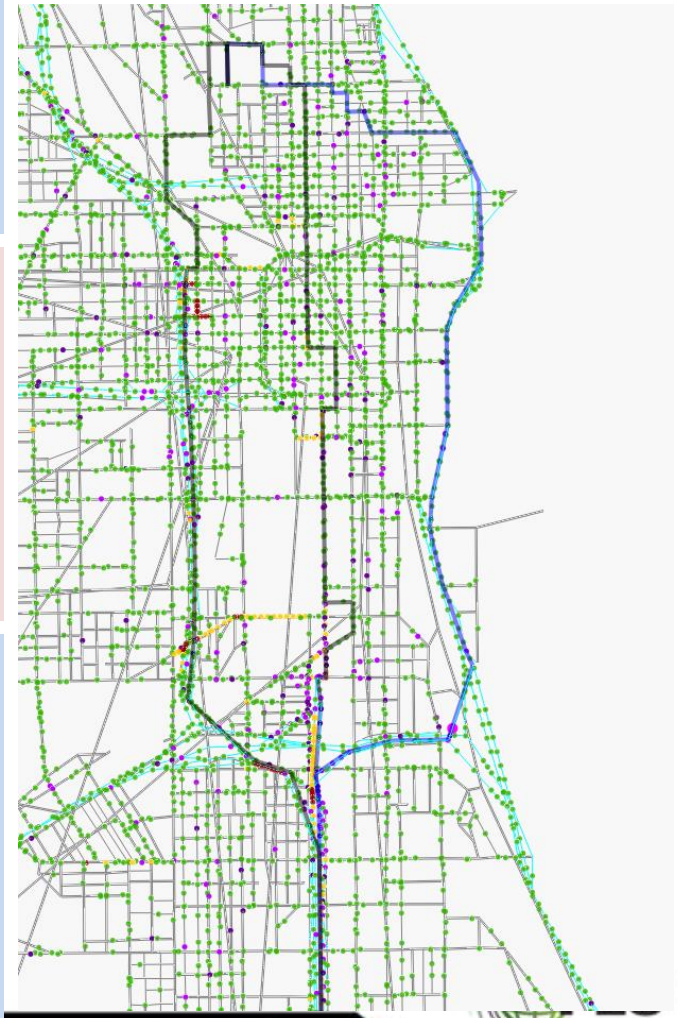
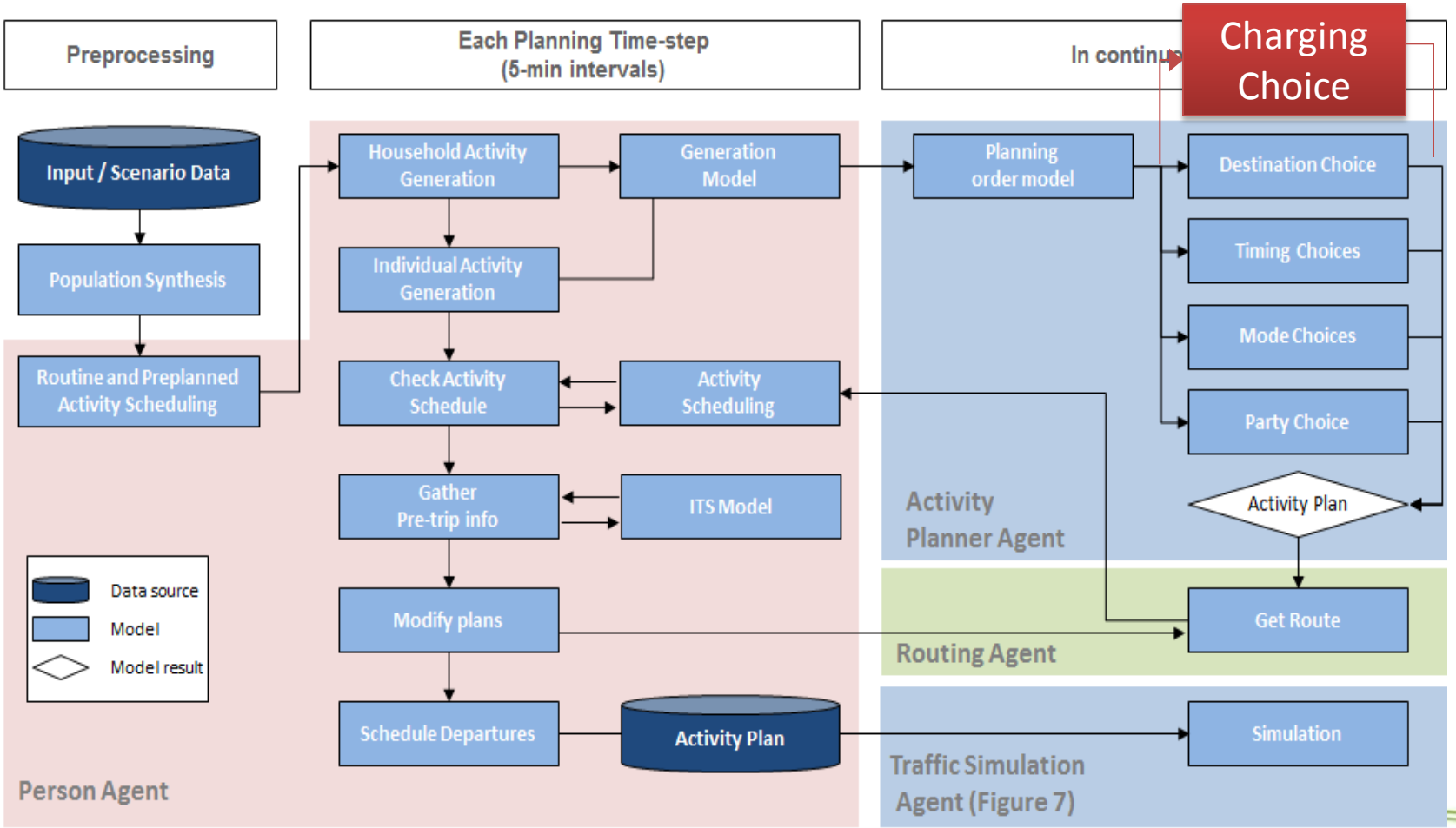
POLARIS-Network Model





Modeling PEV Charging Behavior in POLARIS



Concluding Remarks

- PEVs in the market can finish daily commuting trips without road-side charging
- The decision for PEV charging is to charge vehicle at a activity location with a long period of parking (or activity duration, e.g. at-home, at-work, or shopping)
- A realistic approach to modeling PEV charging behavior should be in a 24-hour integrated demand and network modeling framework
- POLARIS provides such a modeling framework to incorporate PEV charging behavior that considers both demand and network dynamics