

Caltrans

# California Statewide Freight Forecasting Model (CSFFM)



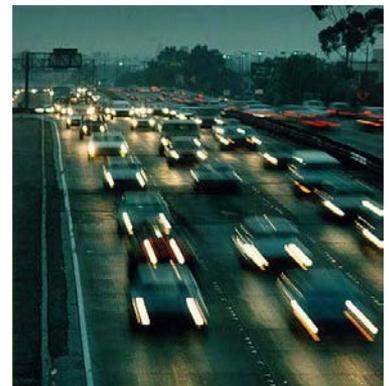
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*Presented at Technical Advisory Committee (TAC) Meeting  
June 26, 2013*



# Outline

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# Project Team from ITS-Irvine

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# **OVERVIEW OF CSFFM**

# Introduction

- California is a major gateway and hub for international trade:
  - Process over 40% of the U.S. container trade (2005)
  - Goods movements contributes significantly to the California economy and the U.S. economy.
    - However, benefits are threatened by the adverse effects on infrastructure, communities, and the environment.
- Senate Bill (SB) 391
  - The state of California currently *“lacks a comprehensive, statewide, multimodal planning process* that details the transportation system needed in the state to meet objectives of mobility and congestion management consistent with the state’s greenhouse gas (GHG) emission limits and air pollution standards”.
  - One of the key strategic responses by Caltrans to this issue is the development of the California Statewide Freight Forecasting Model (CSFFM).

# Relevant California Statewide Initiatives

- **Amended SB 391**

- Requires that the California Transportation Plan be updated by December 31, 2015 with:
  - A plan that identifies integrated multimodal transportation system options to address how emissions reductions would be achieved.

- **AB 32: Global Warming Solutions ACT**

- Reduces GHG emissions; transportation fuels is largest source, almost 40% of all CO<sub>2</sub> production from fossil fuel combustion.
  - 25% by 2020 (back to 1990 levels, a 28% reduction from business as usual forecasts)
  - 80% by 2050

- **SB 375**

- Focuses on regional land use & transportation planning to reduce Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VEH).
- Likely to have profound effects on future transportation, development and many other projects.

# ROLE OF CSFFM FOR REGIONAL MODELS

- **Although CSFFM does not provide fine zonal information for the regional models, it will be able to address the following features:**
  - **Commodity-based Statewide Freight Model**
    - **Capable of analyzing the impact of demo-economic condition and infrastructure changes on the freight flows of commodities and commercial vehicles at FAZ levels**
  - **Provides the relative impacts of policies and strategies compared with neighboring regions within California**
  - **Captures the changes of through-commercial vehicles in the given region**
- **The CSFFM team is currently investigating disaggregation of CSFFM zone to CSTDM zone level.**

# California Statewide Freight Forecasting Model

- [Commodity-based Model](#)

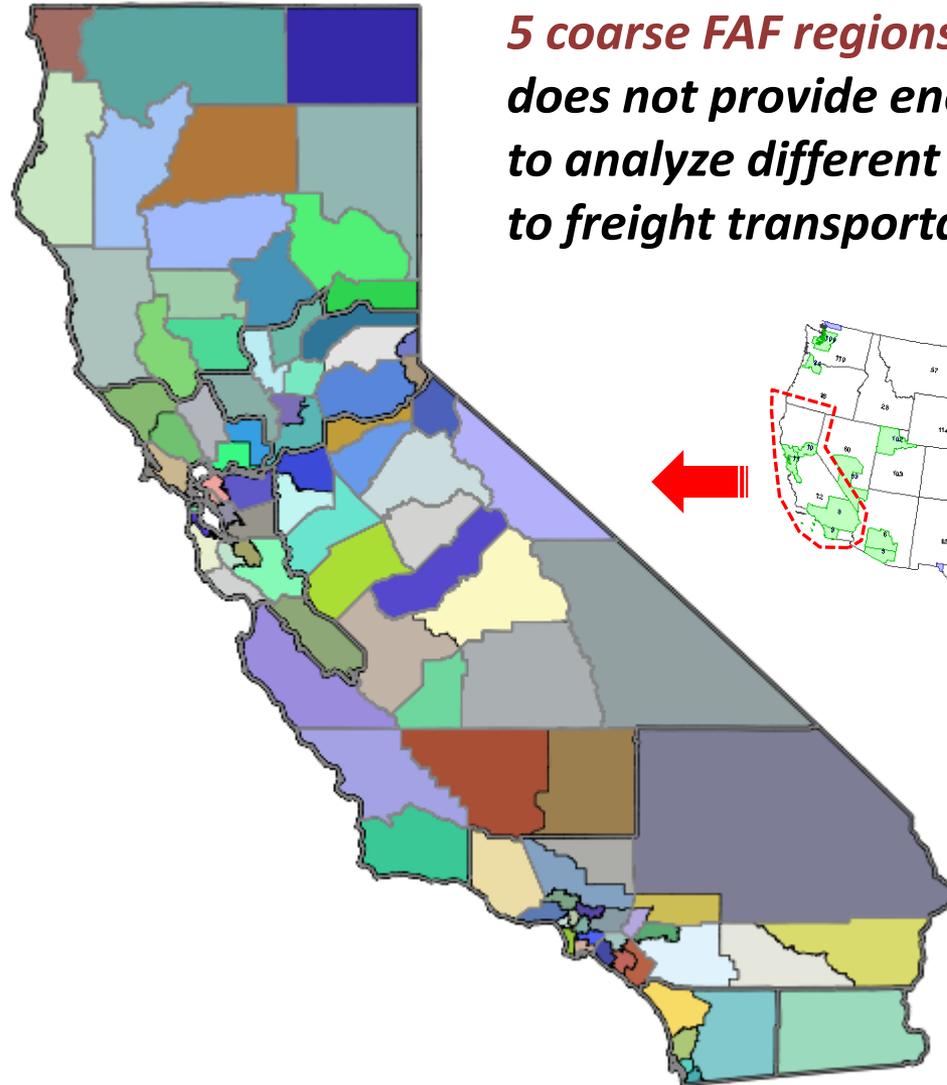
- Forecasts the freight flow of commodities and commercial vehicles and the impact on freight infrastructure as a function of demo-economic conditions and infrastructure parameters.
- *Captures the relative impacts among states because CSFFM relies on Freight Analysis Framework 3 (FAF 3).*

- [15 Commodity Groups](#)

CSFFM Commodity Group	SCTG Code*	CSFFM Commodity Group	SCTG Code*
<i>G1 Agriculture products</i>	1-4	<i>G9 Chemical/ pharmaceutical products</i>	20-23
<i>G2 Wood, printed products</i>	26-29	<i>G10 Nonmetal mineral products</i>	31
<i>G3 Crude petroleum</i>	16	<i>G11 Metal manufactured products</i>	32-34
<i>G4 Fuel and oil products</i>	17,18,19	<i>G12 Waste material</i>	41
<i>G5 Gravel/ sand and non metallic minerals</i>	10-13	<i>G13 Electronics</i>	35,38
<i>G6 Coal / metallic minerals</i>	14-15	<i>G14 Transportation equipment</i>	36-37
<i>G7 Food, beverage, tobacco products</i>	5-9	<i>G15 Logs</i>	25
<i>G8 Manufactured products</i>	24,30,39,40,42,43		

\* SCTG Code: Standard Classification of Transported Goods Code used in Freight Analysis Framework 3(FAF3)  
 source: [http://2bts.rita.dot.gov/publications/commodity\\_flow\\_survey/survey\\_materials/pdf/sctg\\_booklet.pdf](http://2bts.rita.dot.gov/publications/commodity_flow_survey/survey_materials/pdf/sctg_booklet.pdf)

# California Spatial Disaggregation



*5 coarse FAF regions in California does not provide enough resolution to analyze different policies related to freight transportation.*

**5 FAF3 Zones**

**58 Counties**

**97 CSFFM FAZs**  
Defined at county and sub-county levels



# California Spatial Disaggregation

## [Inside CA]

- **Freight Analysis Zones (FAZs) : 97**
- **Import/Export Gateways: 38**
  - 19 Land Ports (6 in Arizona) US-MEX
  - 8 Airports
  - 11 Seaports
- **Transport Logistic Nodes (TLNs or Transshipment Nodes): 26**
  - 13 Airports (8 of these are Gateways)
  - 13 Rail Terminals (including 4 rail terminals directly connected to seaports)

## [Outside CA]

- **118 domestic FAF\* regions and 8 international FAF regions**

\* FAF: Freight Analysis Framework

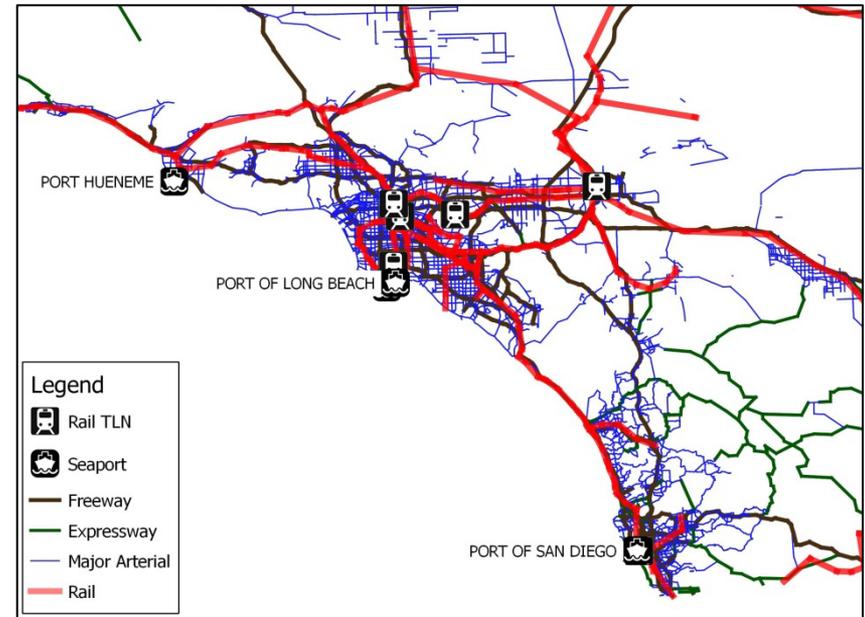
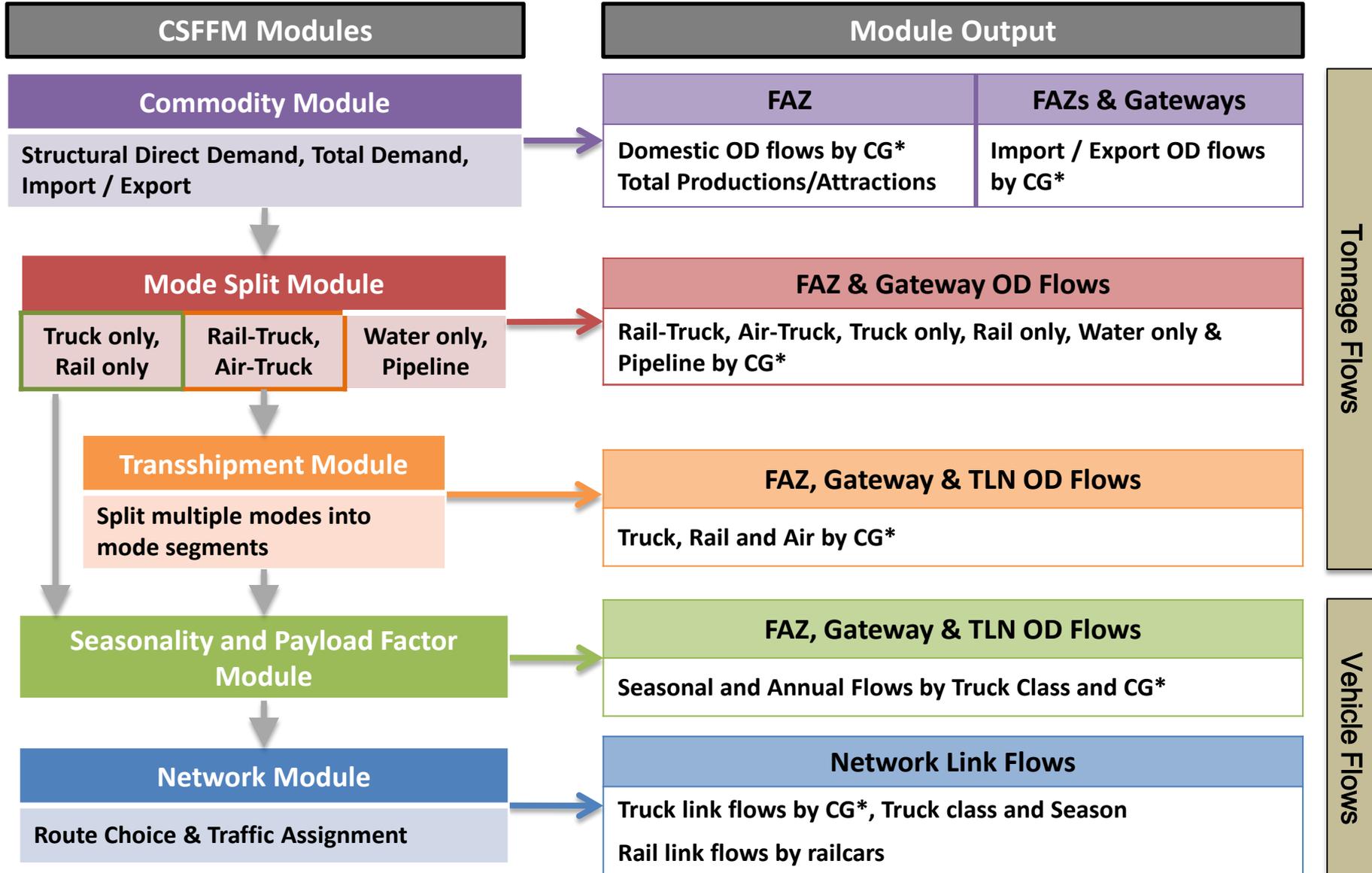


Figure. A part of *CSFFM network* :  
Los Angeles, Ventura, and San Bernardino counties

# CSFFM Primary Modules



\* CG: Commodity Group

# **CSFFM MODULES**

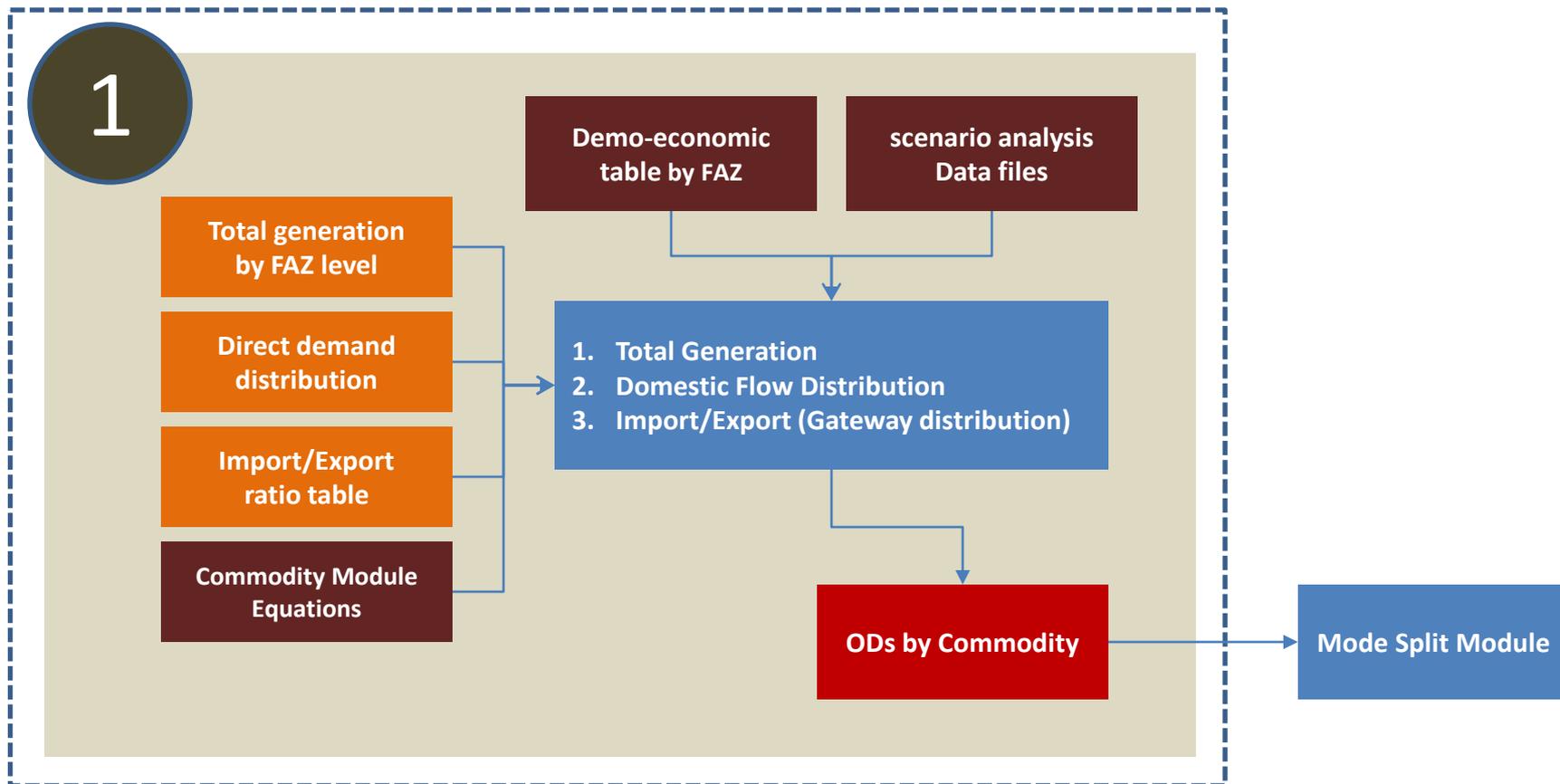
# Commodity Module

Data Files

Modules

Parameters

Model Output



- Generates Production/Consumption and Distribution based on demo-economic data and impedance information (e.g., travel time and cost)
- Estimate import/export freight on gateways in CA

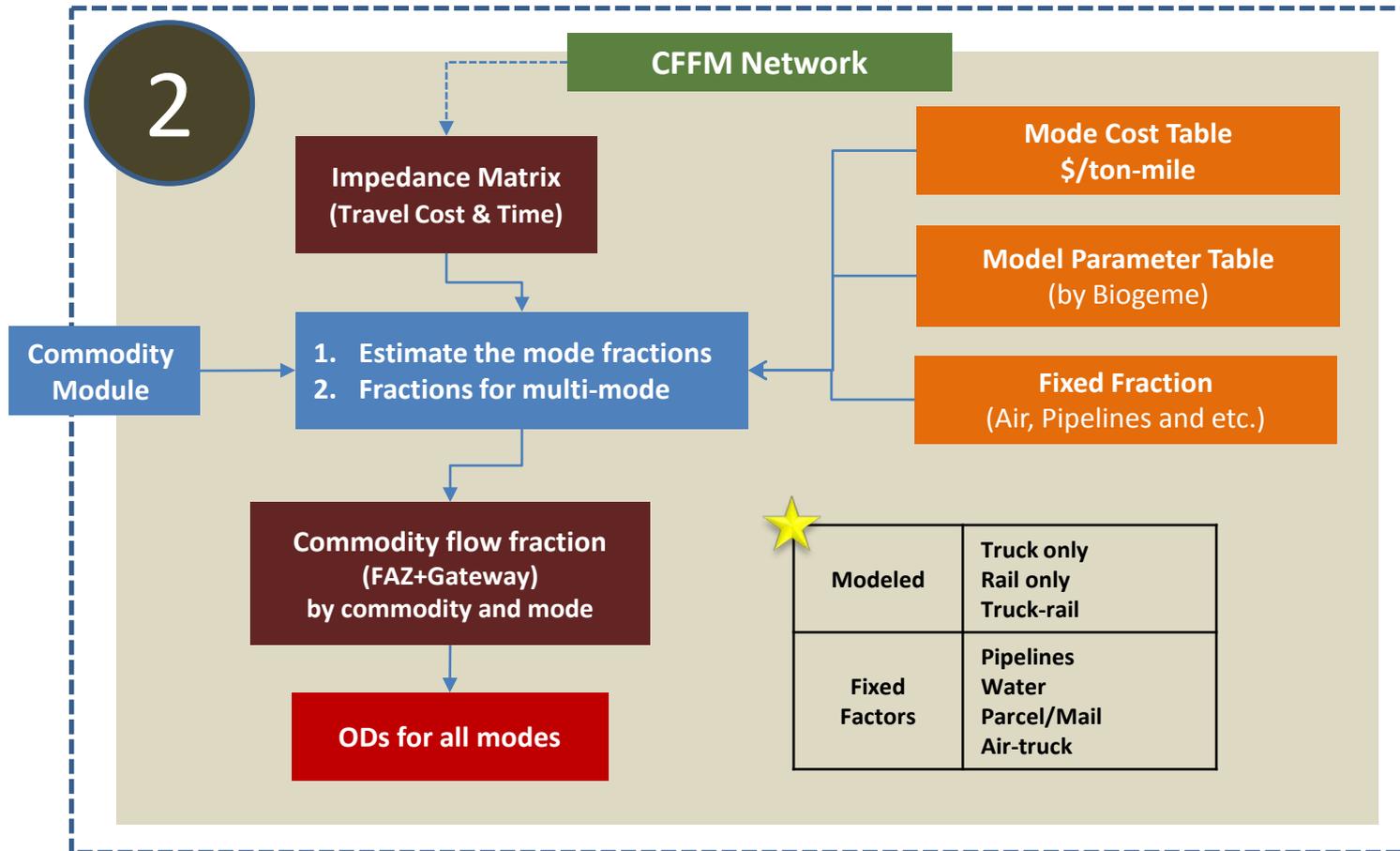
# Mode Split Module

Data Files

Modules

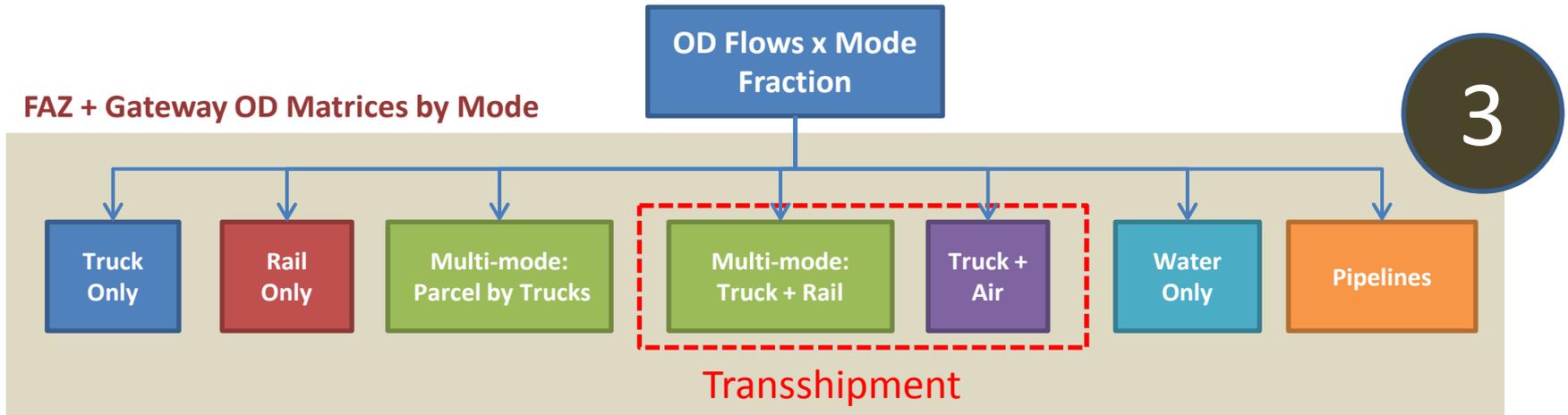
Parameters

Model Output



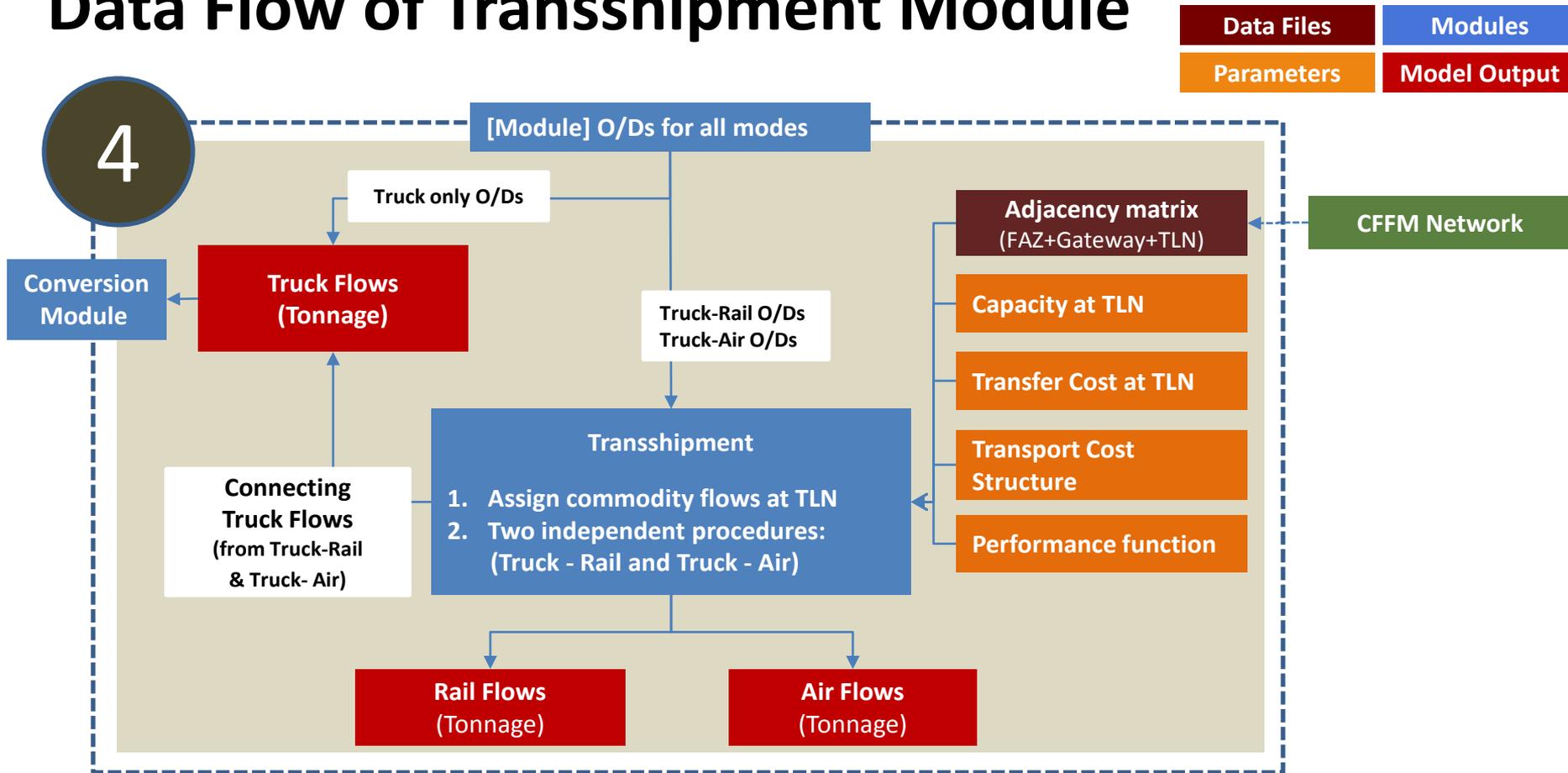
- Determine mode-share by each mode in each OD pair
- Use of a multinomial LOGIT functional form
- Employ FAF3 data for parameter estimation

# Commodity Flow ODs for All Modes



- Commodity ODs for Water Only and Pipelines are final output for those modes.
- Commodity ODs for Truck only, Rail only, and Multiple-mode (parcel by Truck)
  - Bypasses Transshipment Module from the model structure
  - Procedure: (Commodity ODs) → Conversion from Tonnage to Vehicle → Network Module
- Commodity ODs for Truck-rail and Truck-Air
  - Procedure: (Commodity ODs) → **Transshipment Module** → Conversion from Tonnage to Vehicle → Network Module

# Data Flow of Transshipment Module

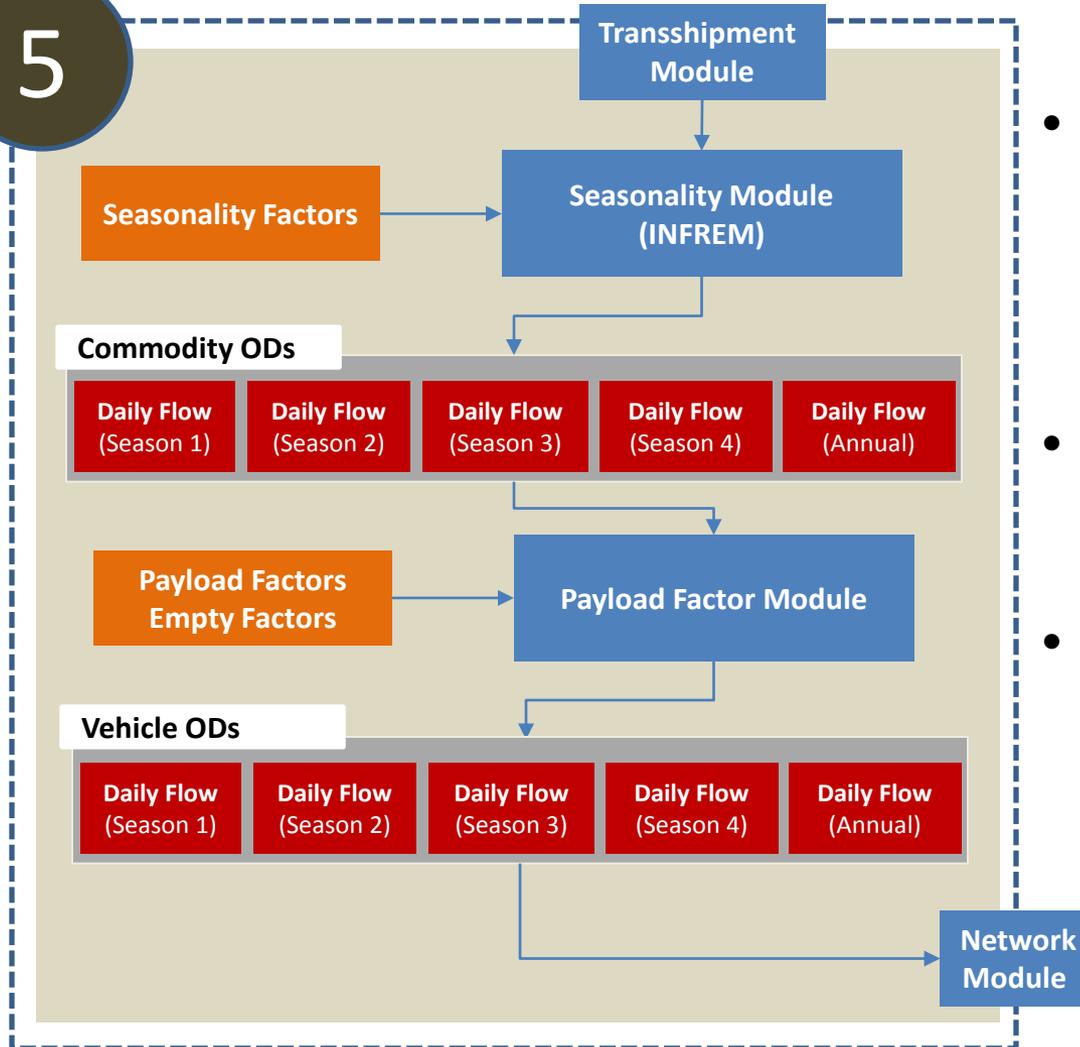


- Decompose inter-modal trips into Truck/Rail/Air segments (Tonnage based)
- Determine which TLNs are used for each freight movement
- Three major inputs: (1) Truck-Air O/D, (2) Truck-Rail O/D, (3) Facility Data
- Three major outputs: (1) Truck O/D, (2) Air O/D, and (3) Rail O/D at FAZ + Gateway +TLN level

# Seasonality and Payload Factor Module

5

Data Files	Modules
Parameters	Model Output



- Three major inputs:
  - Truck tonnage
  - Multi-mode (Parcel by Truck)
  - Truck from Transshipment
- Seasonality by INFREM
  - 4 seasons and annual tonnage
- Tonnage to Vehicles
  - Daily/Annual truck flows
  - Payload factor
  - FHWA Truck types
  - Empty factor

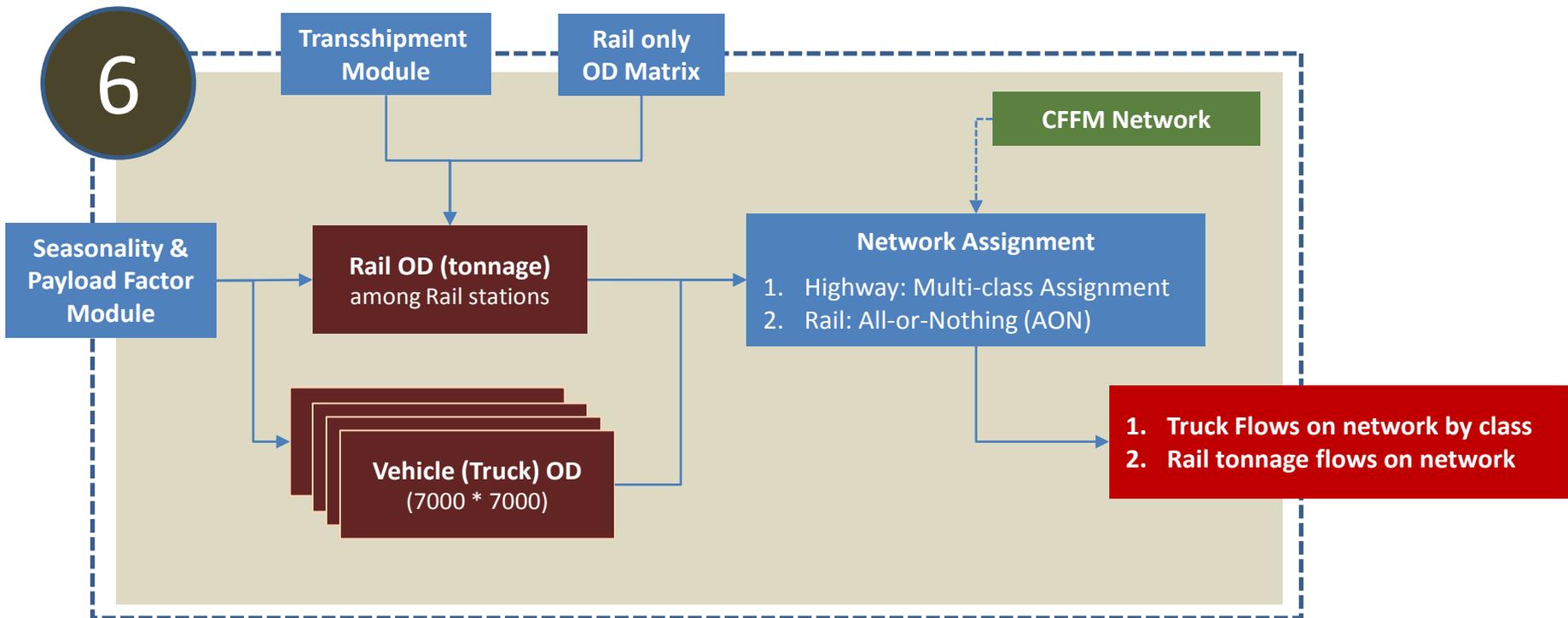
# Network Module

Data Files

Modules

Parameters

Model Output



- **Highway Truck Assignment (Multi-class Assignment):**
  - Multi-class Multi-path static assignment (calibrated with ATRI truck GPS)
- **Rail Assignment:**
  - All-or-Nothing (AON) – tonnage based

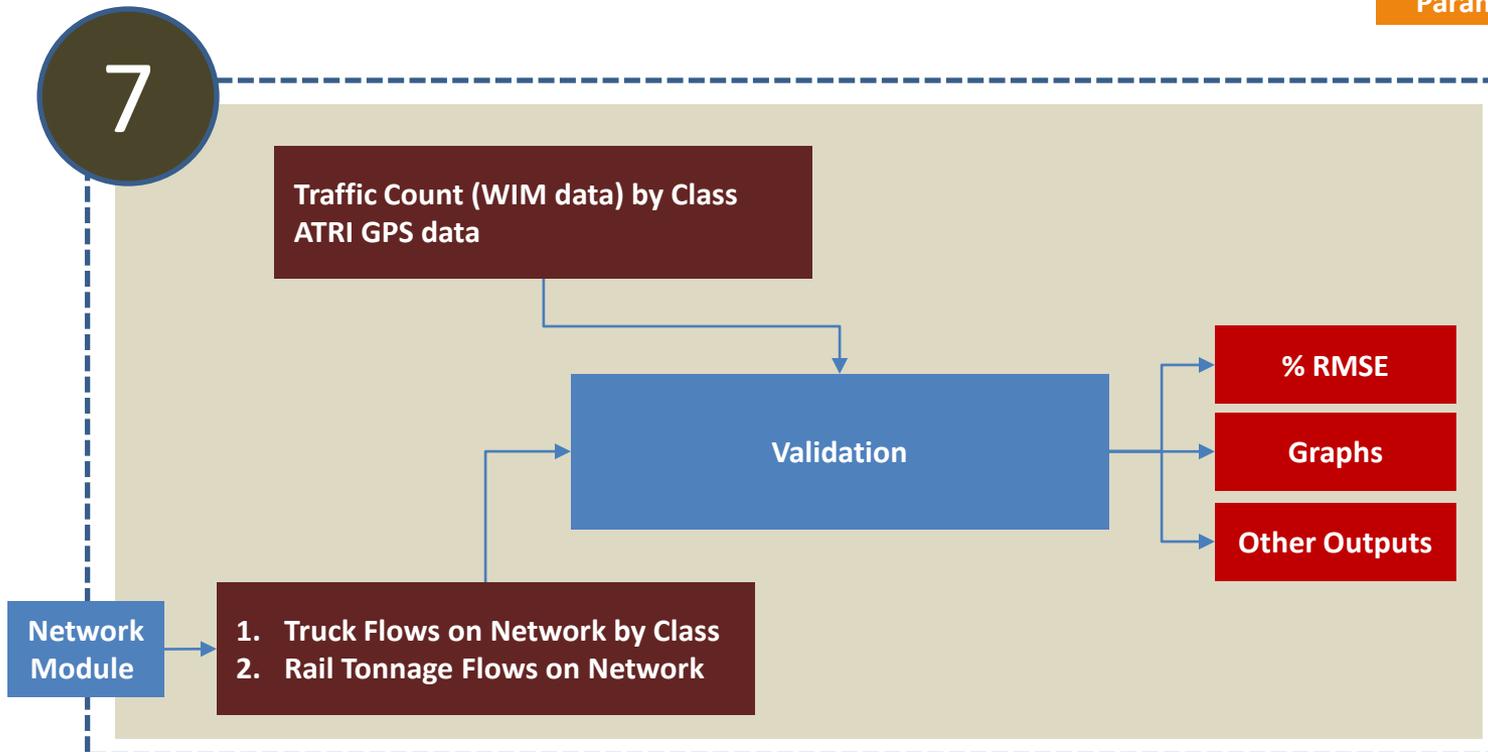
# Model Validation

Data Files

Modules

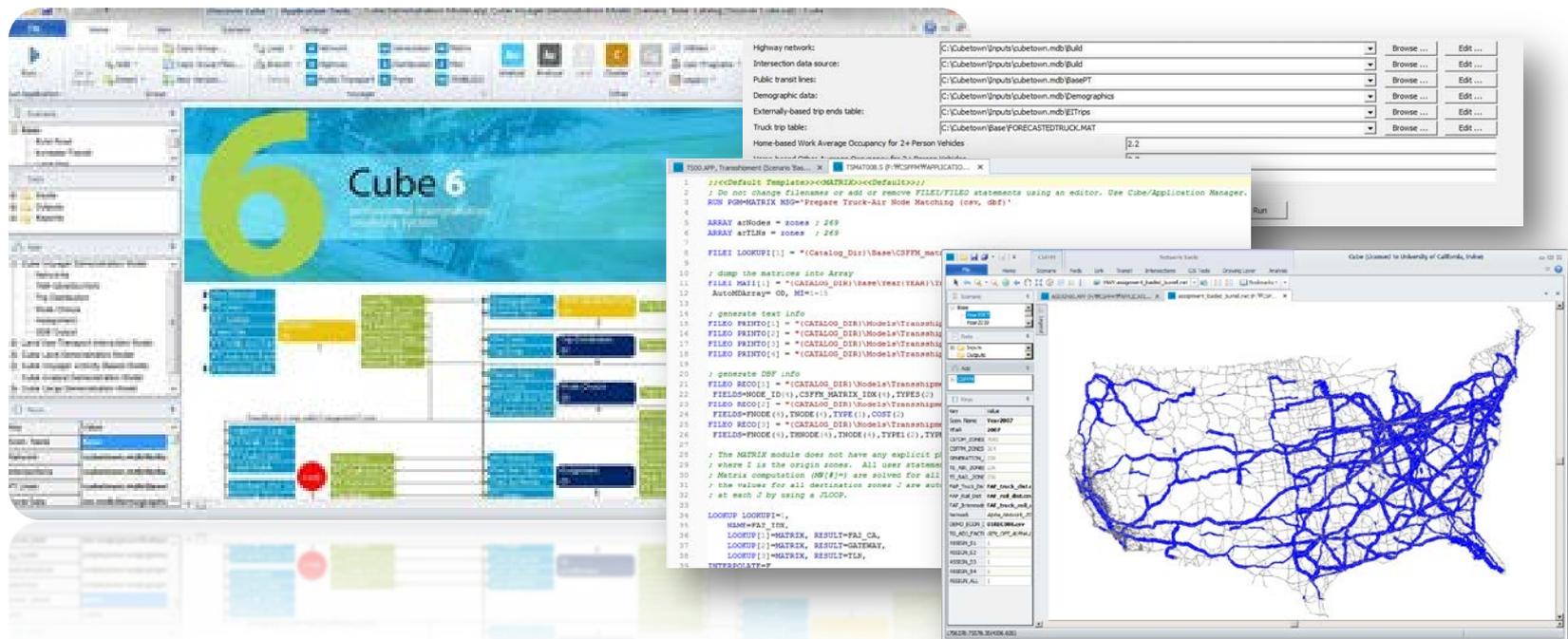
Parameters

Model Output



- **Truck flows**
  - WIM traffic counts
  - ATRI GPS Trajectories (truck routes in California)
- **Rail tonnage flows**
  - Inbound/outbound traffic at rail stations based on way-bills

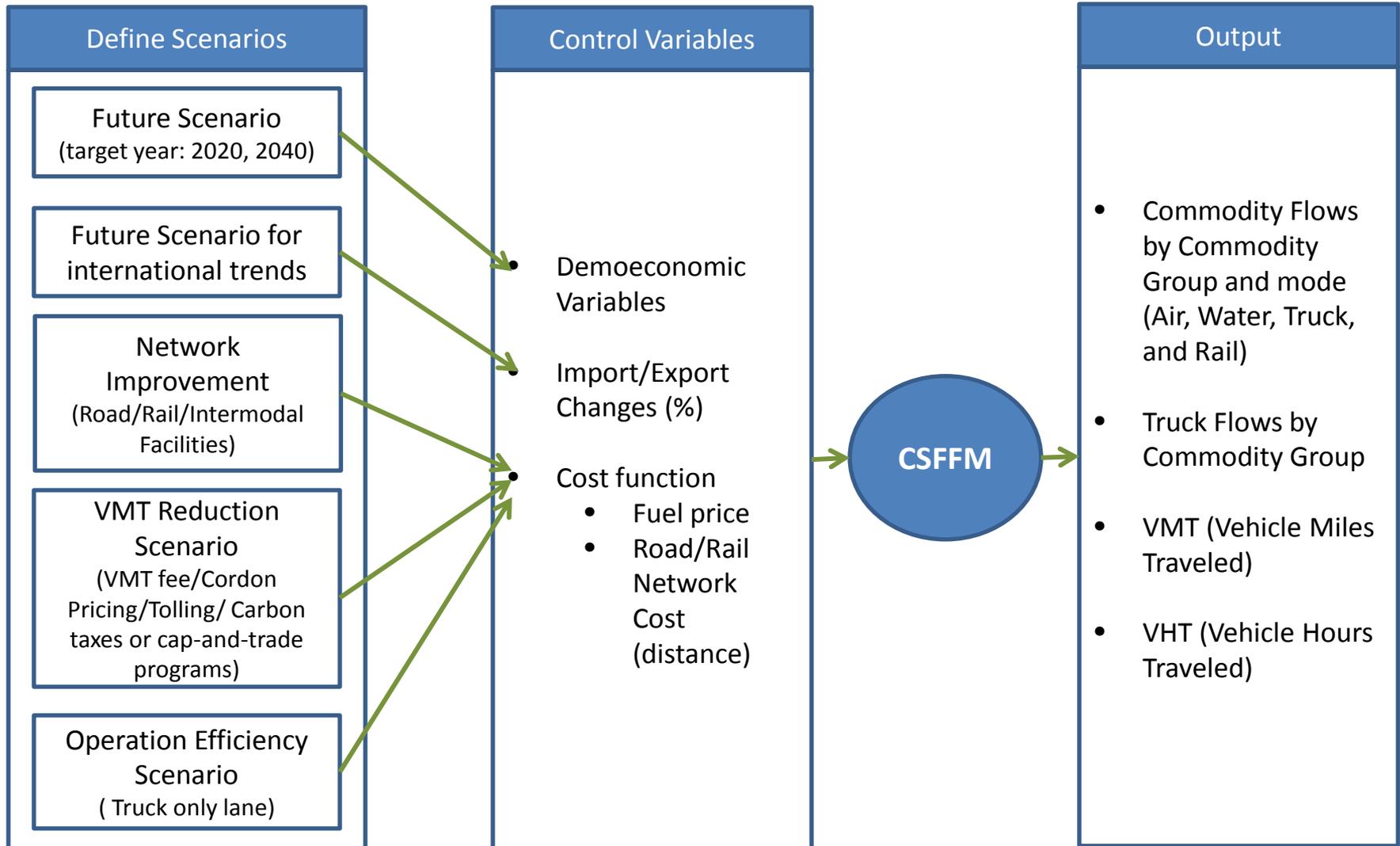
# CUBE IMPLEMENTATION



- CUBE Base and CUBE Voyager
- Minimize unnecessary use of other programming languages such as Python (.py), C++ (.exe)
- Support Scenario-Base Analysis of CSFFM
- Use of MAT, CSV, DBF, and TEXT data file types
- Feedback among commodity generation, mode split, and transshipment

# **SCENARIO ANALYSIS**

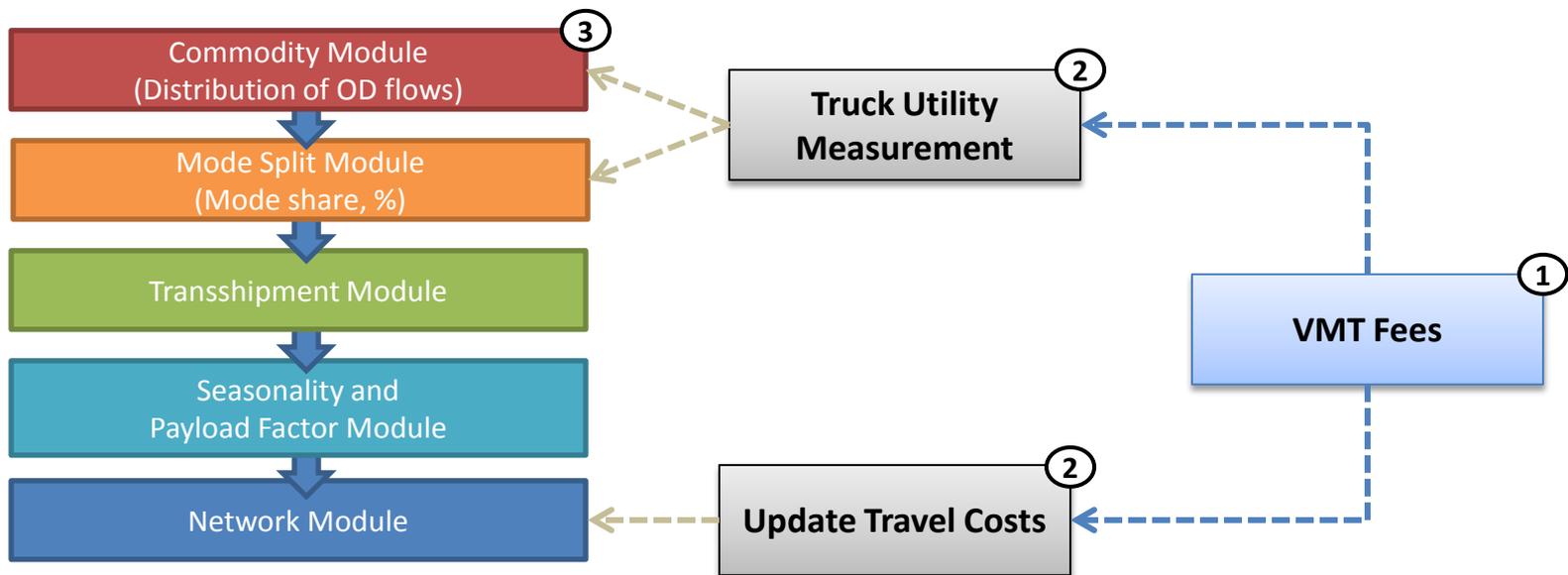
# FLOW CHART FOR CSFFM SCENARIO ANALYSIS





# Mileage-based highway user fee (VMT fee)

- Affects commodity, mode split, and network modules
  - Modify the truck utility (e.g., cost) that consists of **distances** and **fuel prices**
  - Update truck utility by travel distances and travel time (using value of time parameters)
- Scenario Input: VMT fees to be reflected in truck utility or travel impedance

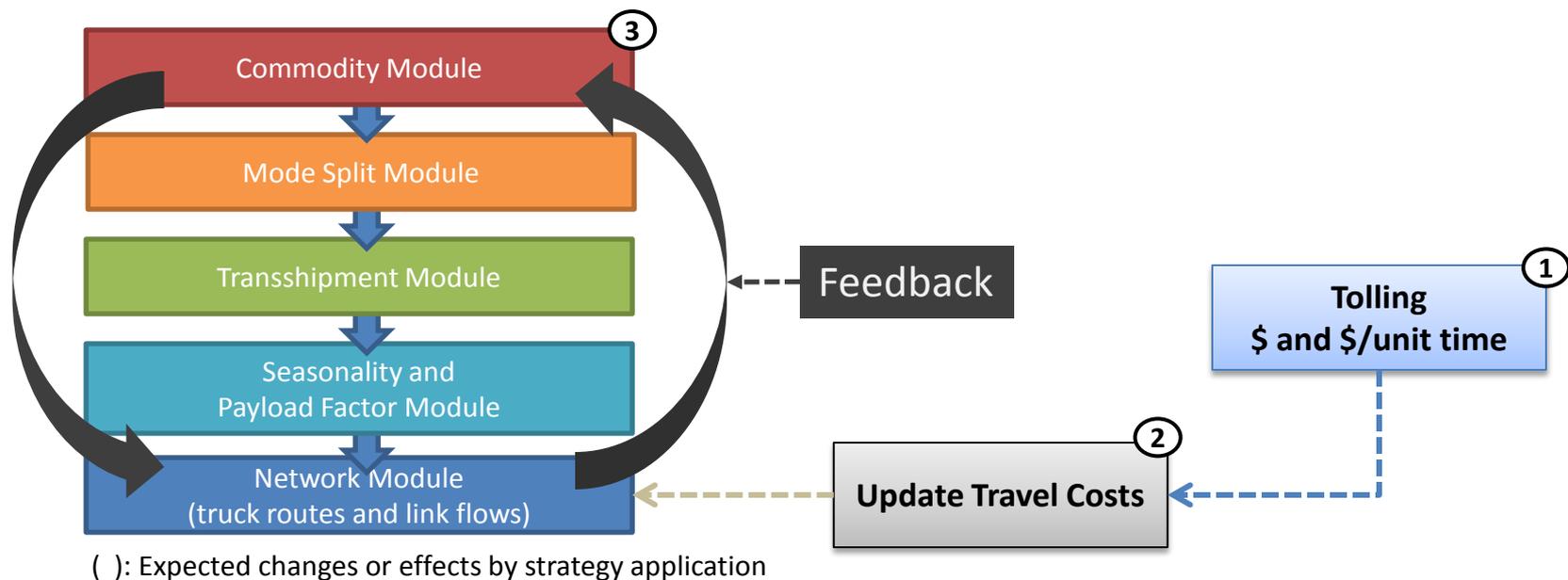


( ): Expected changes or effects by strategy application



# Tolling

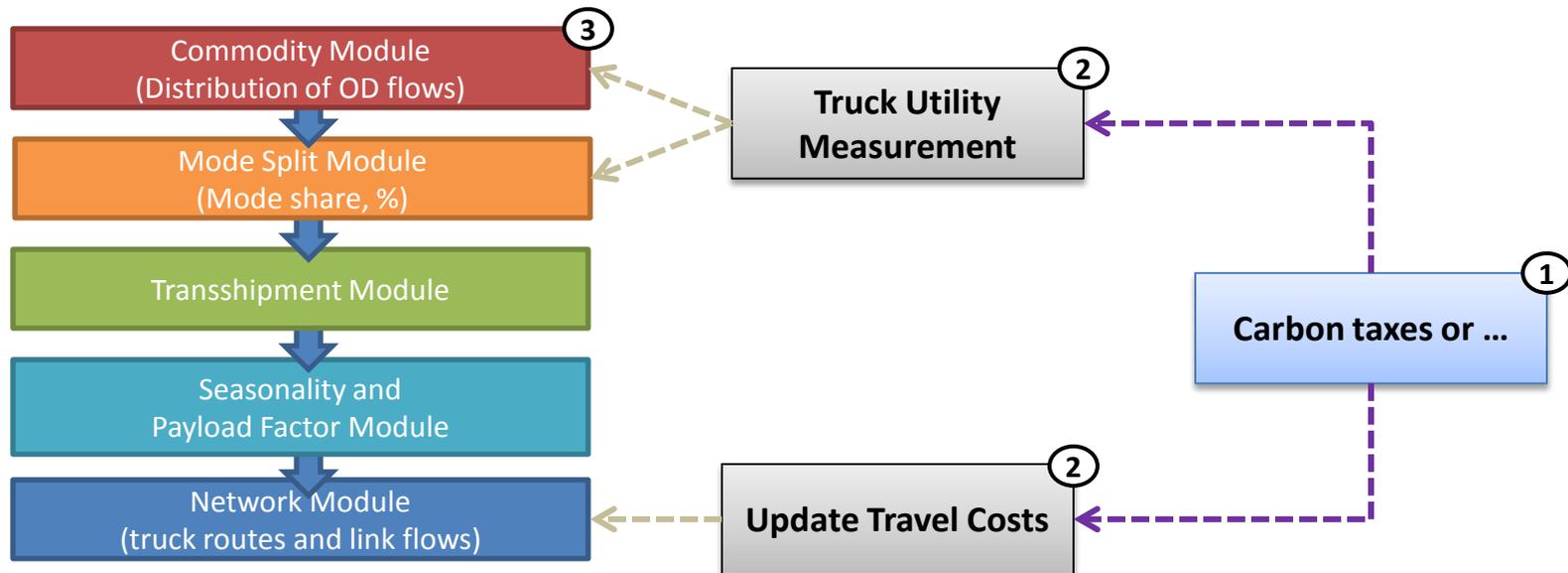
- Mainly affect network module
  - Update travel costs by travel distances and travel time (by assuming value of time)
  - Feedback procedure to commodity generation
- Scenario input:
  - Toll price, tolling section on highway network, value of time for trucks





# Carbon taxes or cap-and-trade programs

- Affects commodity, mode split and network modules
  - Modify the truck and rail utility functions (cost) consisting of **distances** and **fuel costs**
- Scenario input:
  - Types of tax: How much impact on fuel price or truck rate (cost) ?



( ): Expected changes or effects by strategy application

# FURTHER DISCUSSION

- **Once disaggregation of CSFFM at CSTDM zonal level is completed, more scenarios can be assessed with CSFFM.**
- **In general, individual scenario needs to be specifically described; otherwise scenario is mostly like to be sensitivity analysis with the given information.**
- **Sophisticated scenarios such as import/export flow changes should be further investigated to identify control variables that affect on the given scenario.**

**QUESTIONS OR COMMENTS?**

# APPENDIX

# Gateways

- **Nodes of entry or exit for freight movements from/to California**
  - **Corresponding commodity flows directly impact on California freight networks after passing through gateways.**
  - **Approximately 38 gateways in California**



Figure Example of Gateway: Tecate

# Transport Logistic Nodes (TLNs)

- Nodes where transition between two different modes occurs within California
- Approximately 26 in California

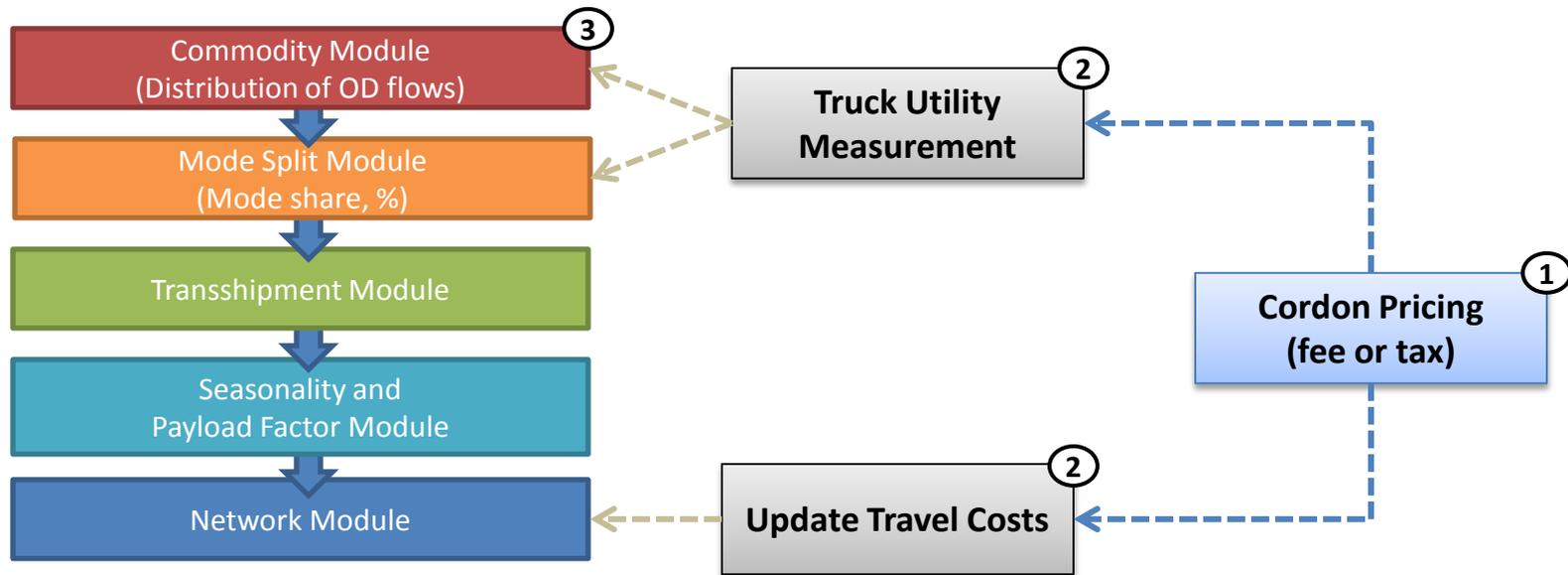


Figure Example of TLN: Commerce Intermodal Facility



# Cordon pricing

- Although “Cordon Pricing” is NOT mainly aimed at freight demand, it can be assessed with the similar procedure used for the “VMT fees” strategy
- Need detailed scenario input:
  - How the fees for the cordon pricing (restriction types) will be determined; specific area, time period, vehicle type, and etc.



( ): Expected changes or effects by strategy application