

# ***O-D Allocation and Mode-Mix Optimization Model*** for **India's Transport Policy Analysis**

Presented at the International Conference of  
Asia-Pacific Operational Research Society (APORS), January 2010

Rahul Pandey<sup>1,3</sup>, Ravibabu Manchala<sup>4</sup>, Narayan Rangaraj<sup>2</sup>, Sridhar Vallala<sup>3</sup>,  
V K Batra<sup>4</sup>, Pradeep Kapoor<sup>4</sup>, Sandeep Kumar<sup>4</sup>, Hesham Rafi<sup>3</sup>, Sandeep L<sup>3</sup>

*1 Indian Institute of Management, Lucknow*

*2 Indian Institute of Technology, Bombay*

*3 IGSA Labs*

*4 RITES Ltd.*

# Purpose of the Project

To develop a model to help answer the following policy questions for India's freight transport sector:

- For centrally planned commodities, given supply and demand potential in each district in a future year, what are the optimal o-d allocation flows and route-mode mix?
- For market driven commodity flows, given the o-d flows in a future year, what is the optimal route-mode mix?
- What are the bottleneck sections in the transport network?
- What will be the effect of 'containerization' on optimal mode-mix? What are desirable mode-switching locations?
- What will be the impact of various scenarios on total system cost, congestion, and emissions?

# Scale of the Problem

- 623 Nodes – districts, major ports, etc.
- 623 x 623 Origin-Destination (o-d) matrix
- 13 Commodities (coal, fertilizer, iron ore, steel, cement, food grains, sugar, etc.)
- 4 Transport Modes (road, rail, air, coastal shipping)

# Network Mode-Mix Optimization Model: Purpose of the Project

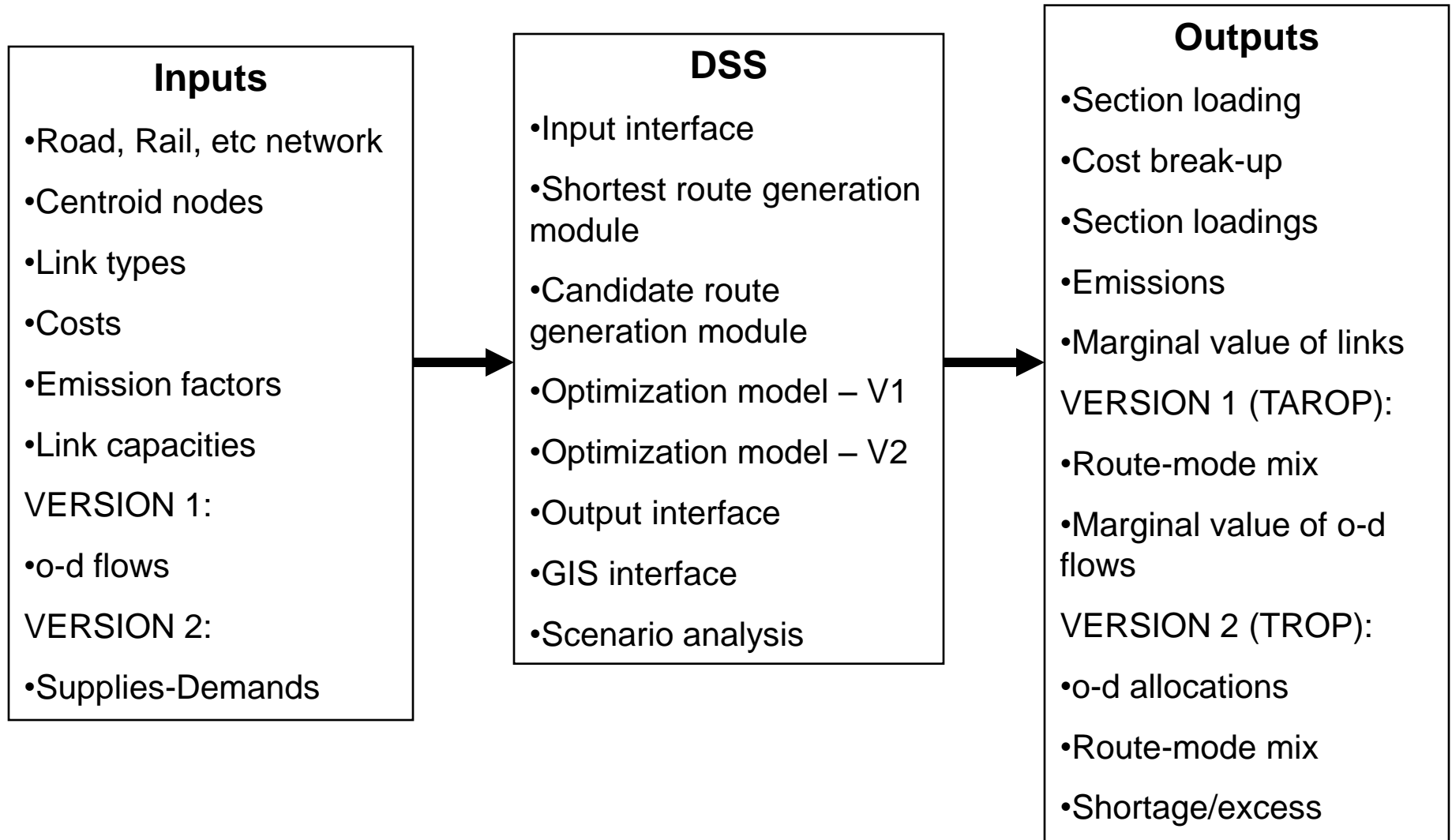
## **To model ..**

- India's transport network (O-D matrix)
- Route-mode options
- "o-d Flows" OR "Supplies & Demands" for commodities
- Costs (user/handling, operating/O&M, congestion, etc.)
- Capacities
- Mode-switching dynamics
- Emissions from fuel use

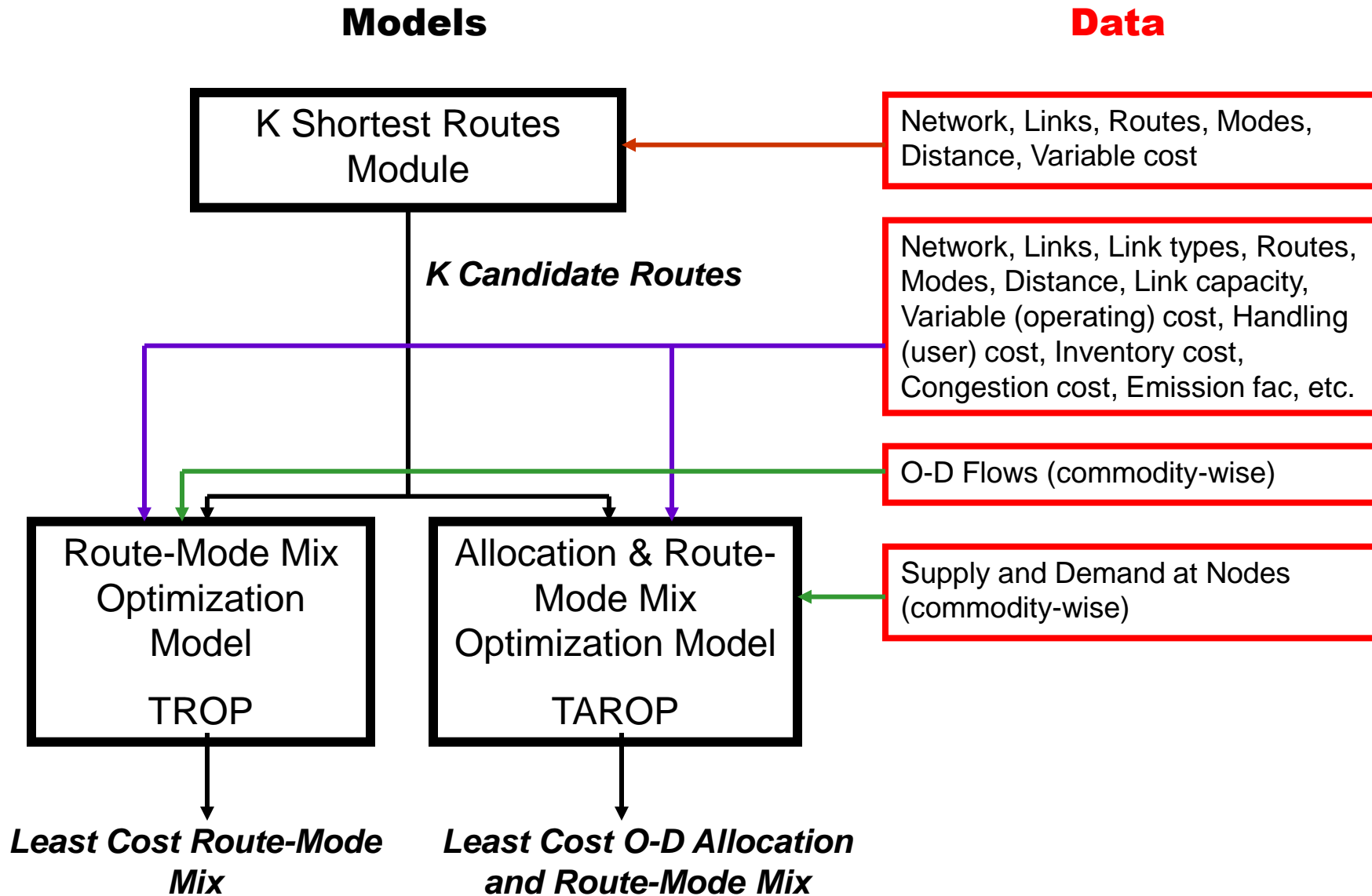
## **So as to ..**

- Calculate optimal route-mode mix
- Calculate optimal o-d allocation plan (in case of "Supplies-Demands" data)
- Assess impacts on various indicators like costs, section loading, and emissions
- Calculate section loadings and identify bottlenecks
- Perform sensitivity analysis

# Network Mode-Mix Optimization Model-DSS



# India's Transport Network Optimization Model Framework



# Optimization Model Versions

## Version 1 (TROP):

Minimize sum of all costs

Subject to..

- Forecasted flow of each commodity on each O-D pair
- Capacity of a link
- Link-flow, Route-flow balance
- User cost as a function of level traffic load utilization on each link-type

*TROP calculates least cost route-mode mix for transporting commodities for all O-D pairs. It takes commodity-wise flow data for each O-D pair, besides candidate routes, link level costs, route level costs and link capacities*

## Version 2 (TAROP):

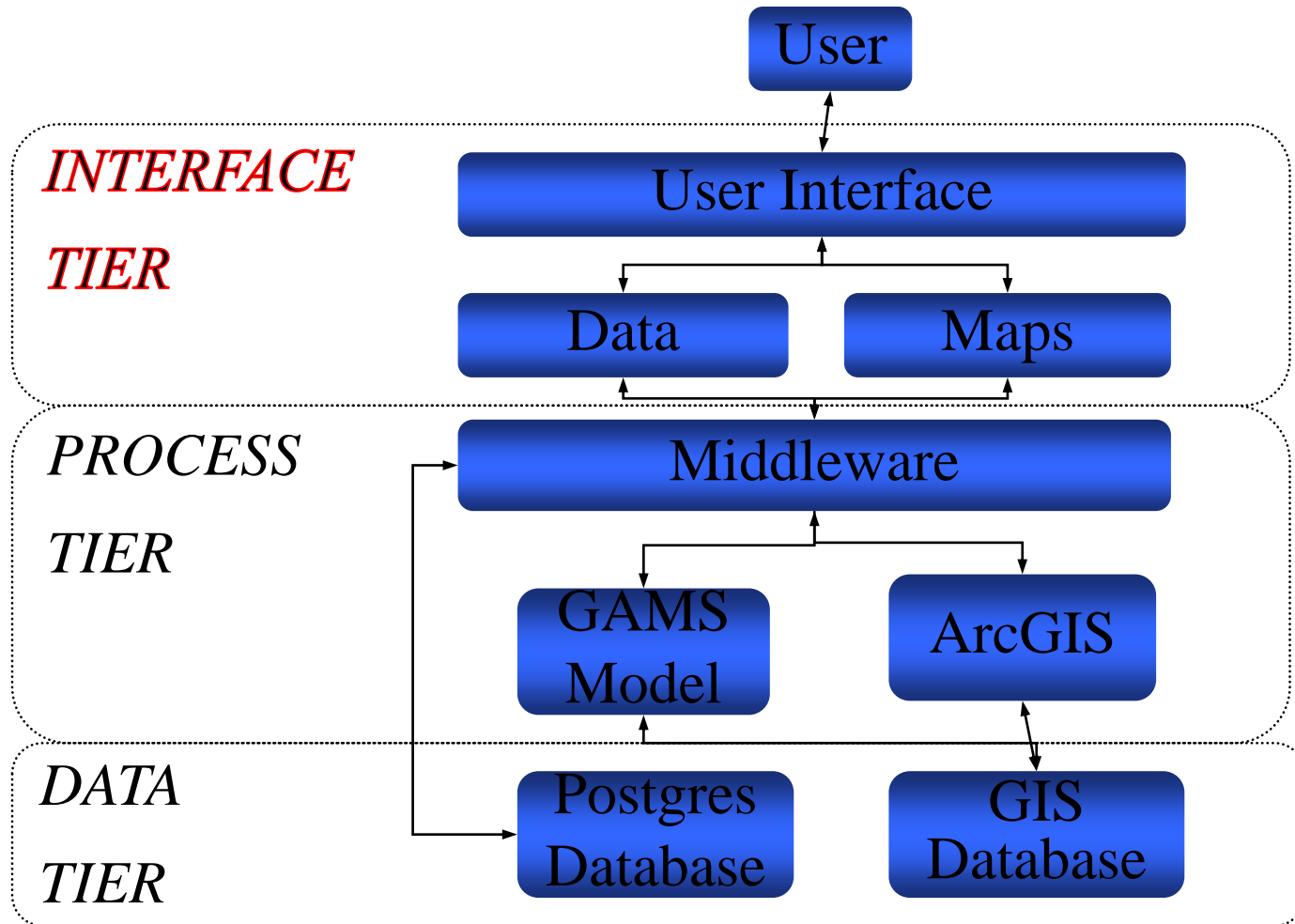
Minimize sum of all costs

Subject to..

- Forecasted supply of each commodity at each node
- Forecasted demand of each commodity at each node
- Capacity of a link
- Link-flow, Route-flow balance
- User cost as a function of level traffic load utilization on each link-type

*TAROP calculates least cost O-D flow allocation and route-mode mix for transporting commodities for all O-D pairs. It takes commodity-wise supply and demand data for each node, besides candidate routes, link level costs, route level costs and link capacities*

# DSS Architecture





# Modeling of costs

- Variable transport cost
- Telescopic variable transport cost
- Congestion related cost
- Handling cost
- Mode-switching cost