NIM: Navigation Investment Model

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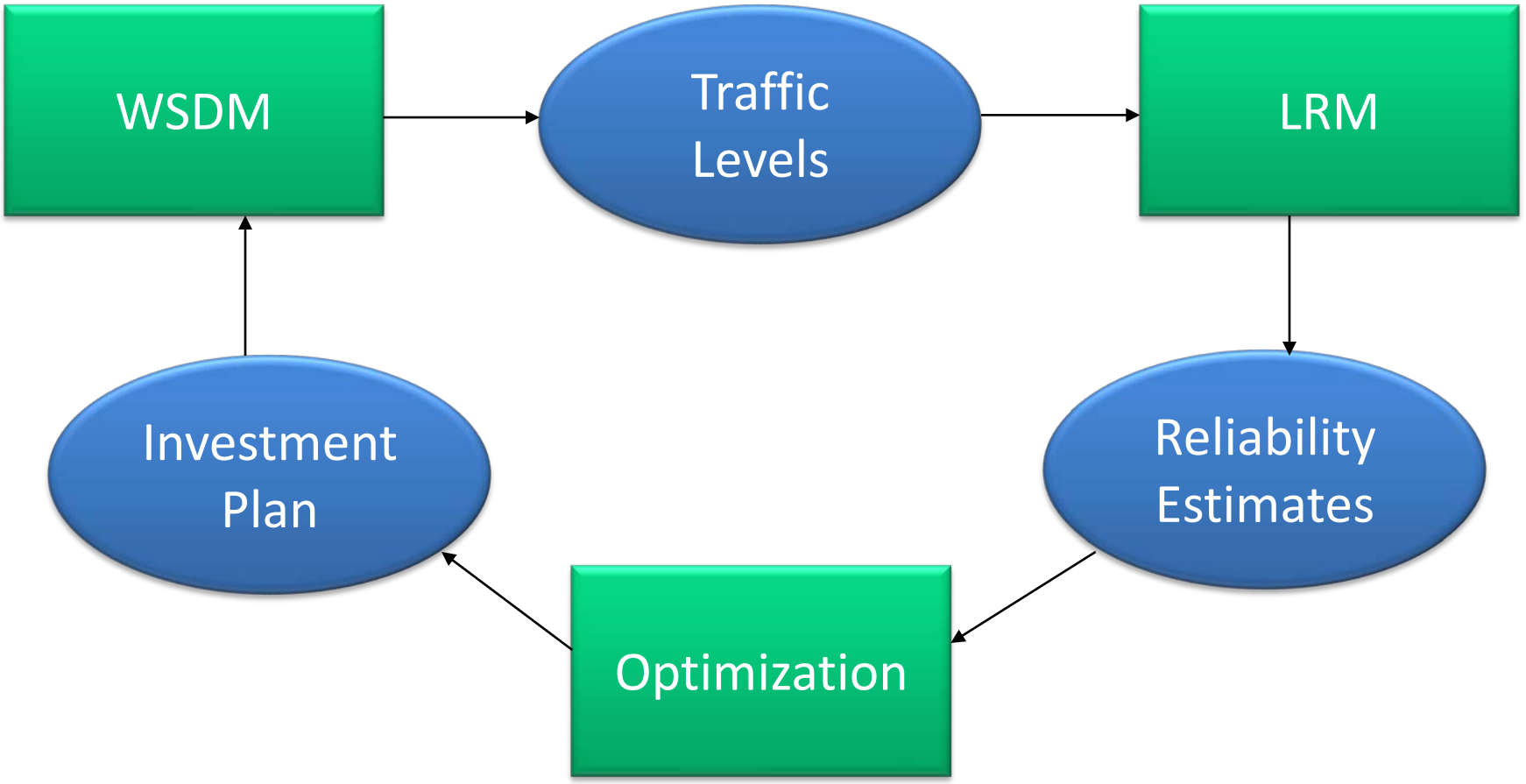
NIM in Brief

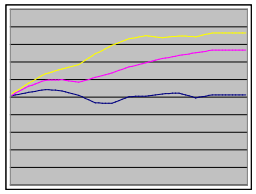
- Set of analysis tools that are used to evaluate the benefits of investments in a river system
- Developed for the Huntington District of the US Army Corps of Engineers, beginning in 1995
- Comprises three major modules:
  - Waterway Supply and Demand Model (WSDM)
  - Lock Risk Model (LRM)
  - Optimization Module

ORNIM Modules

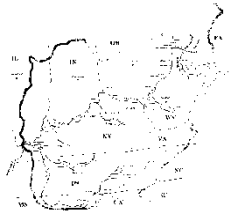


Waterway Supply and Demand Module

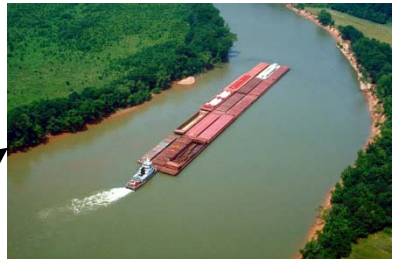
…determines equilibrium waterway traffic levels under a given system configuration and forecast scenario for each year in the analysis period, taking into account scheduled lock closures.



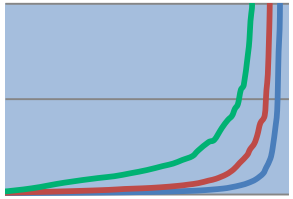
Cargo Forecasts



Waterway Network

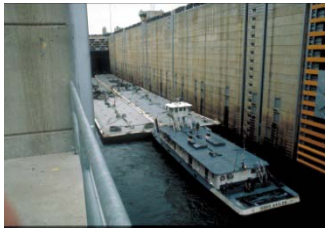


Shipping Plans

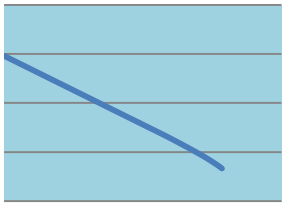


Transit Time Curves

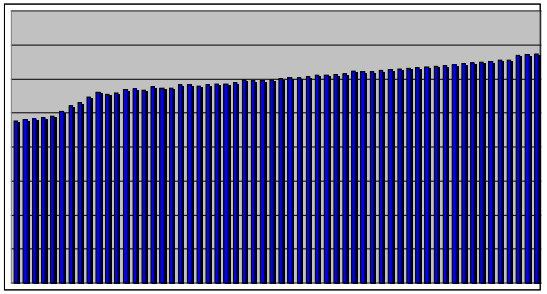
WSDM



Lock Operations



Demand Functions



Equilibrium Tonnage Levels

WSDM: Calibration

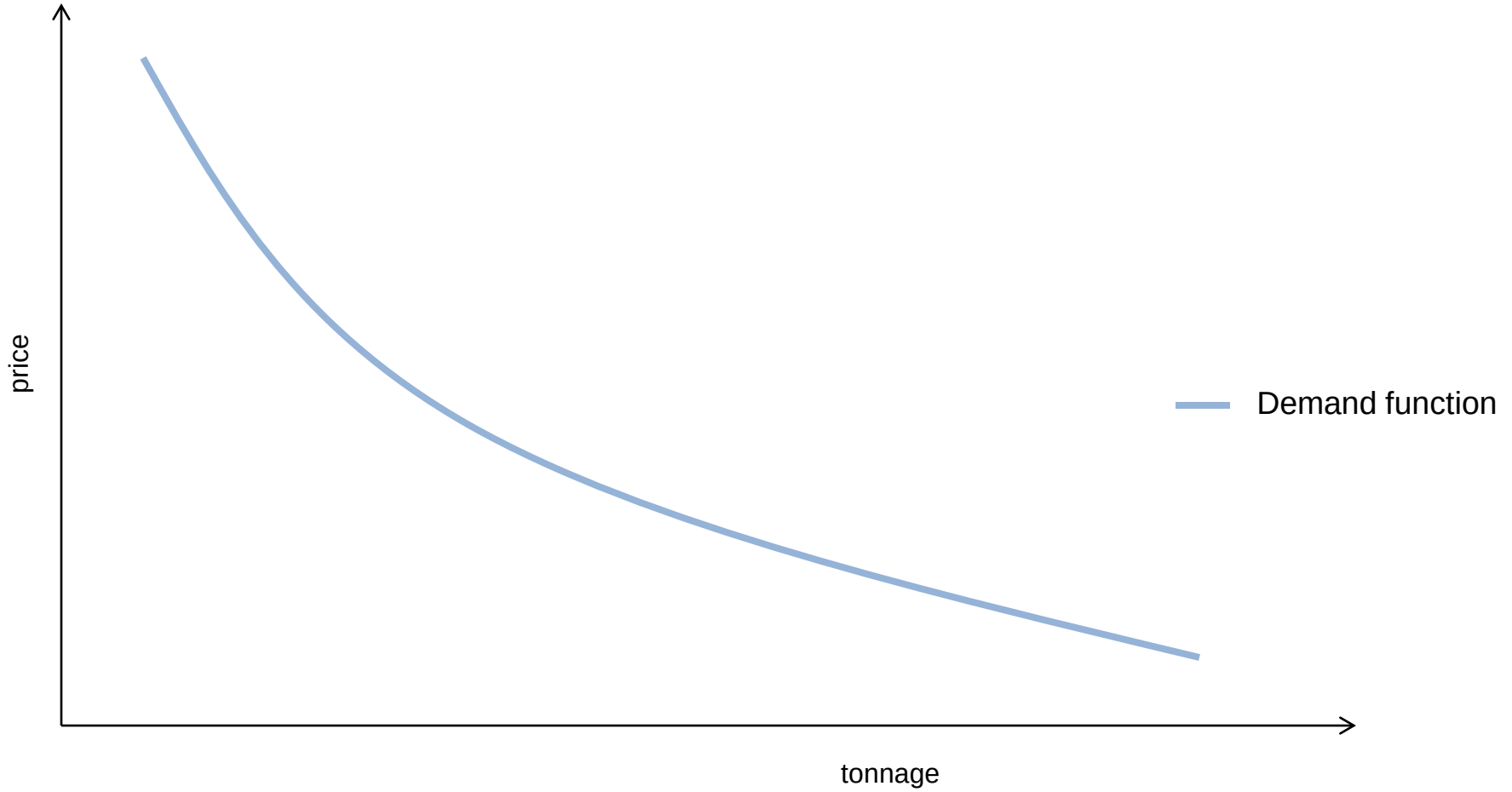
The NIM calibration process involves modifying movement and network parameters to force WSDM to develop shipping plans that mimic historic navigation shipping plans.

- Movement dedication factors
- Tow size limits
- Towboat utilization factors

Statistics are compared to targets at projects.

WSDM Equilibrium Process

Each movement has its own cost curve and demand function:



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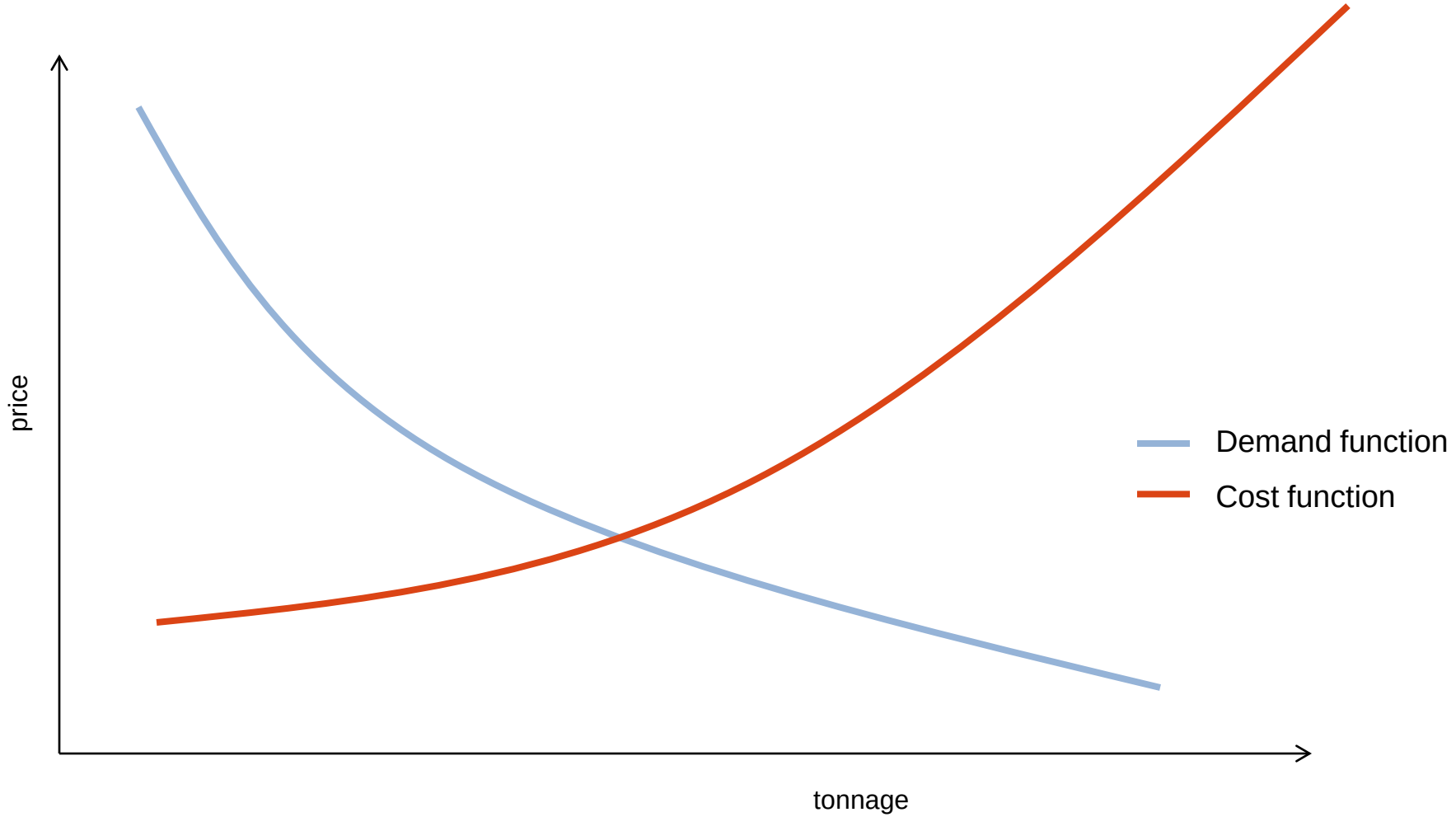

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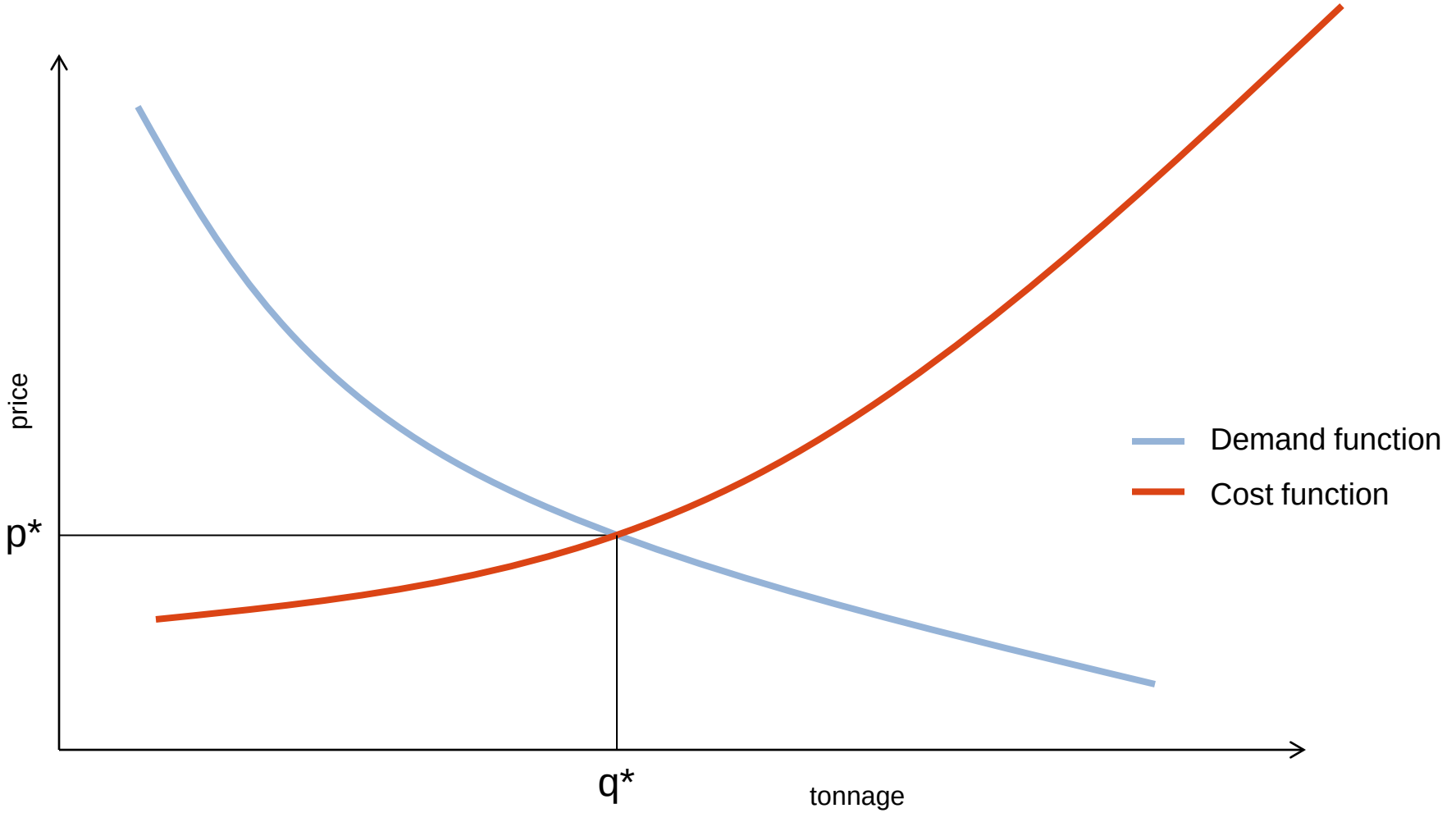

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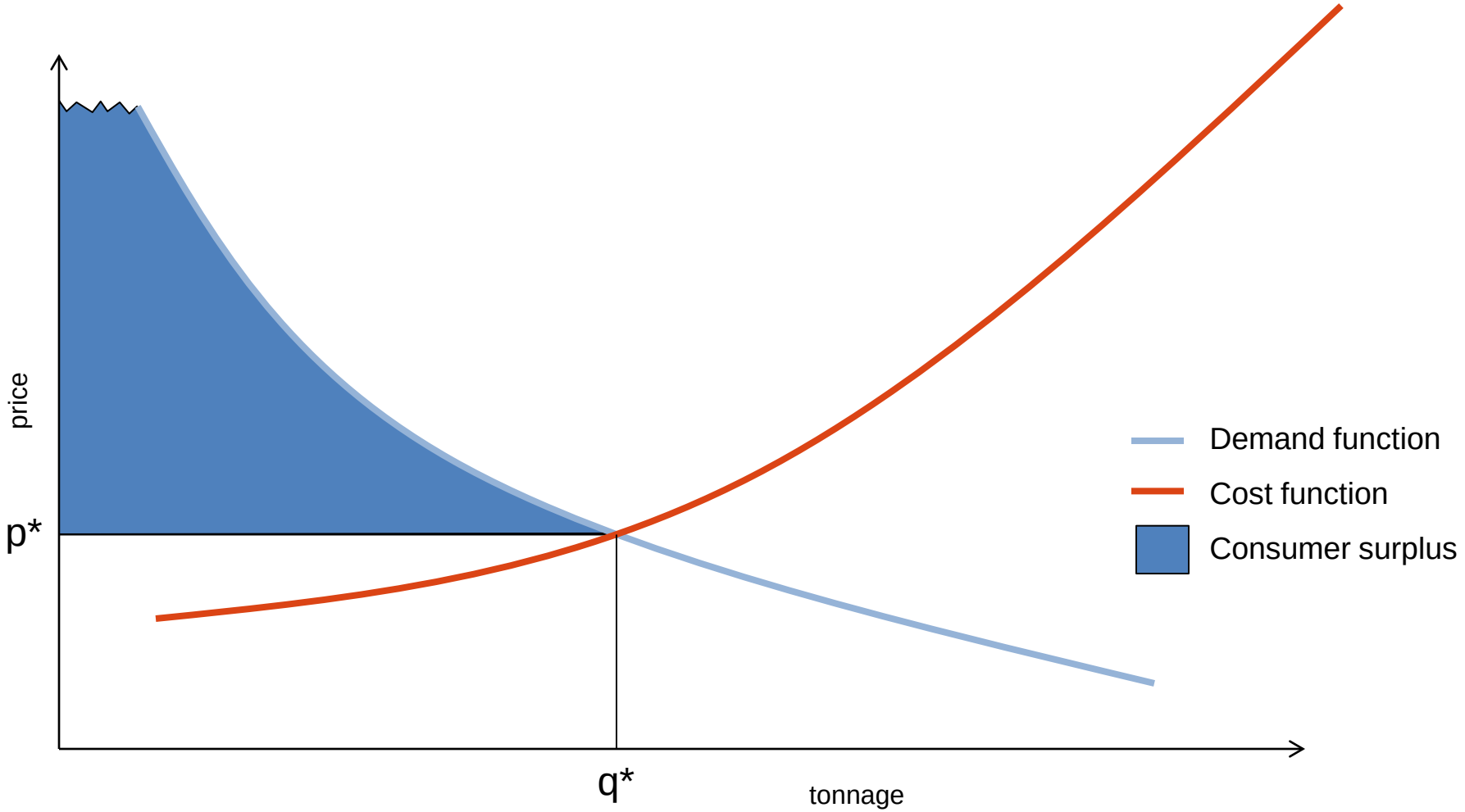


WSDM Diversion

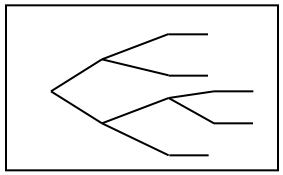
For short closures (1 day, 3 days, 10 days, *etc.*), movements are expected to accept the resulting delays. What about longer closures?

NIM provides a mechanism to indicate the response of each movement to a closure.

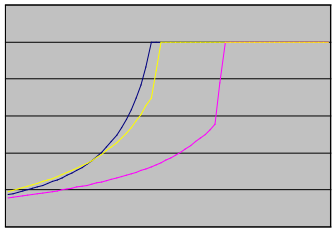
- Length of closure
  - *e.g.*, different response to 15 – 59 vs 60 – 180 days
- Range of years
  - *e.g.*, different response in years 2020 and 2037
- Externality costs by category
  - *e.g.*, truck accidents, emissions, delay

Lock Risk Module

…estimates the probability of each potential closure in each year of a component's life, given equilibrium traffic levels, hazard functions and event trees.



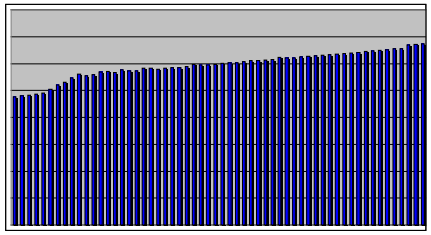
Event Tree



Hazard Function

LRM

Expected Failures and Costs



Equilibrium Tonnage Levels

Lock Risk Module

Monte Carlo Simulation: A series of dice rolls.

For each component, step through its lifetime:

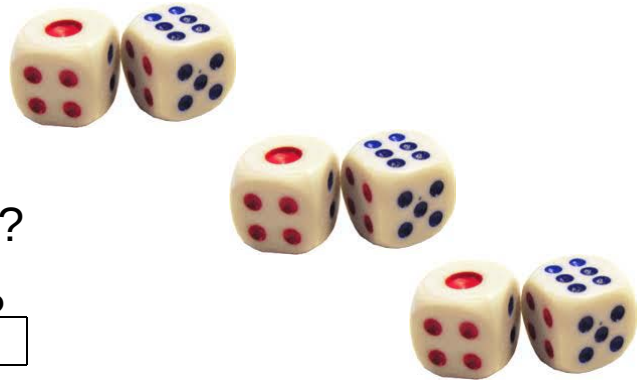
In year *y*, does it fail?

If no, increment y

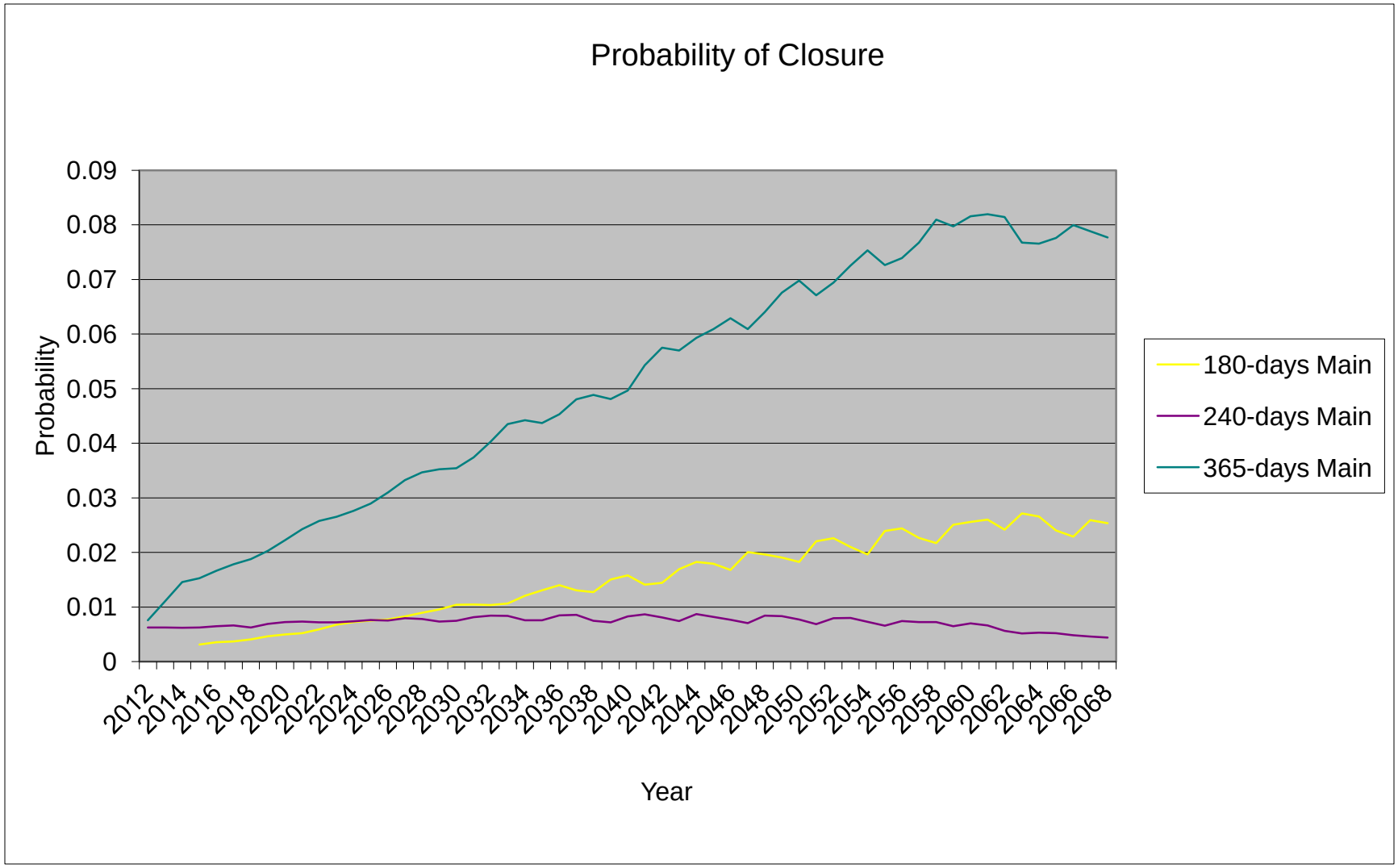
If yes, what is its failure level?

what is its fix level?

Apply repair consequences.



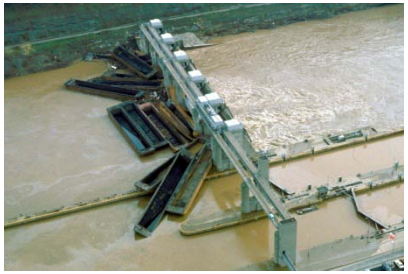
Lock Risk Module Results



Optimization Module

…systematically compares investments, selects the optimal investment strategy and summarizes the results.

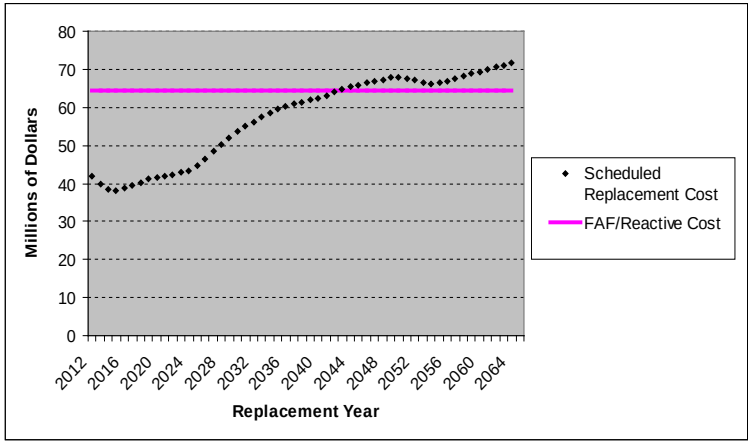
Construction Plans



Random Minors

Expected Failures and Costs

Optimization



Optimal Alternative Selection and Timing

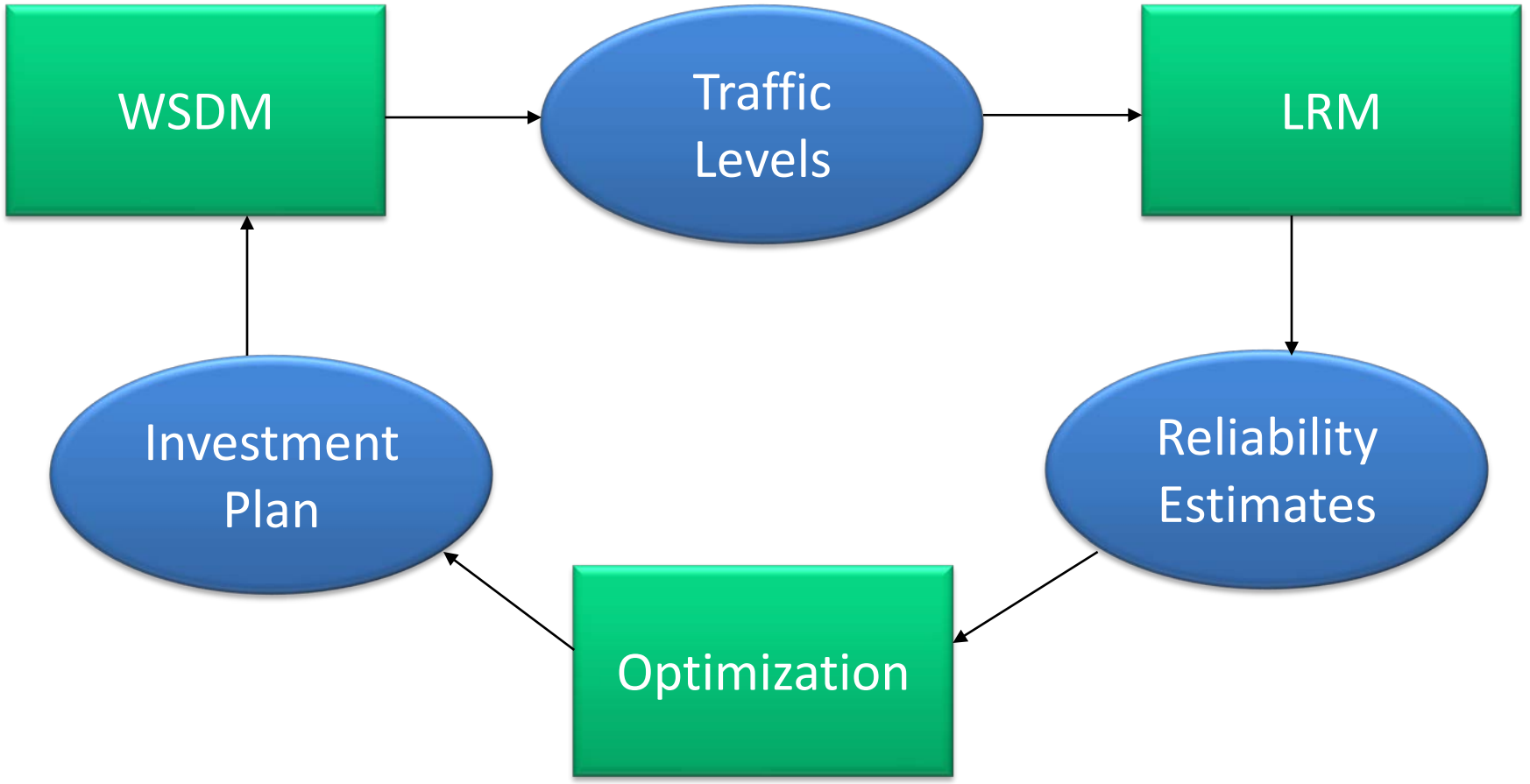
Optimization Alternatives

- Cover a range of improvements:
  - Component replacement
  - Rehabs
  - Extensions
- Can change
  - Components
  - Transit times
  - Maintenance schedules / costs
  - Costs

Optimization Objective

- Net Economic Benefits
- Include
  - Cost reduction benefits
  - Shift-of-mode benefits
  - Shift-in-origin or –destination benefits
  - New movement benefits
  - Induced movement benefits

ORNIM Modules



Metrics Reported

- Tonnage accommodated
- Tonnage diverted
- Transit times
- Average delay
- Externalities estimates
  - Road damage
  - Safety
- Tonnage by river segment

National Needs →Metrics and Objectives

National Needs

- Reduced Cost
- Increased Profits
- Economic Growth
- Jobs
- Security
- Resiliency
- Safety
- Environment
- Energy reduction

Metrics

- Traffic accommodated
- Traffic diverted
- Average Delays
- Capacity utilization
- Transit times

Objective

- Net benefits