HDM-4

An Overview

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HDM-III vs HDM-4

Highway Design and Maintenance Tools

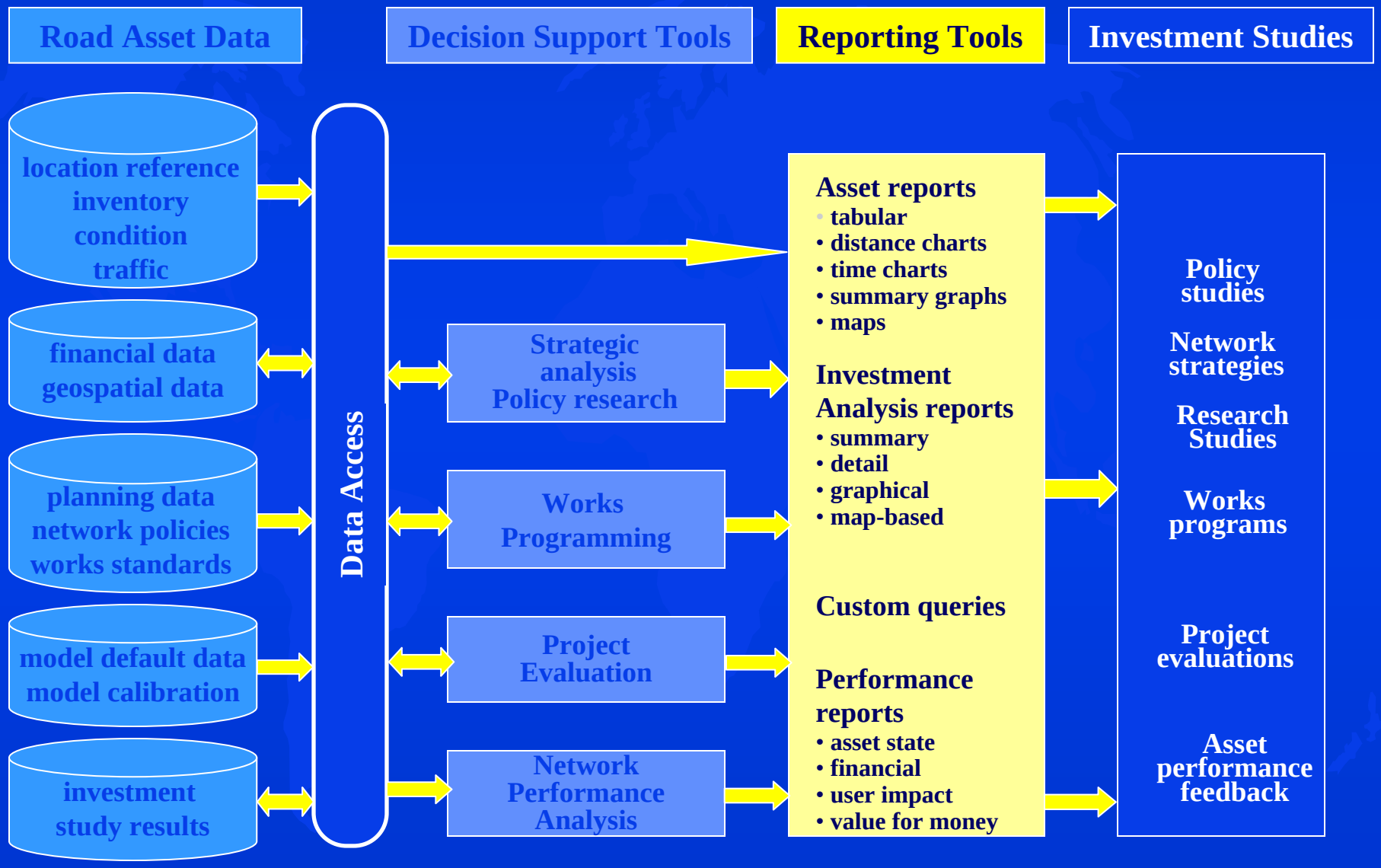
vs

Highway Development and Management Tools

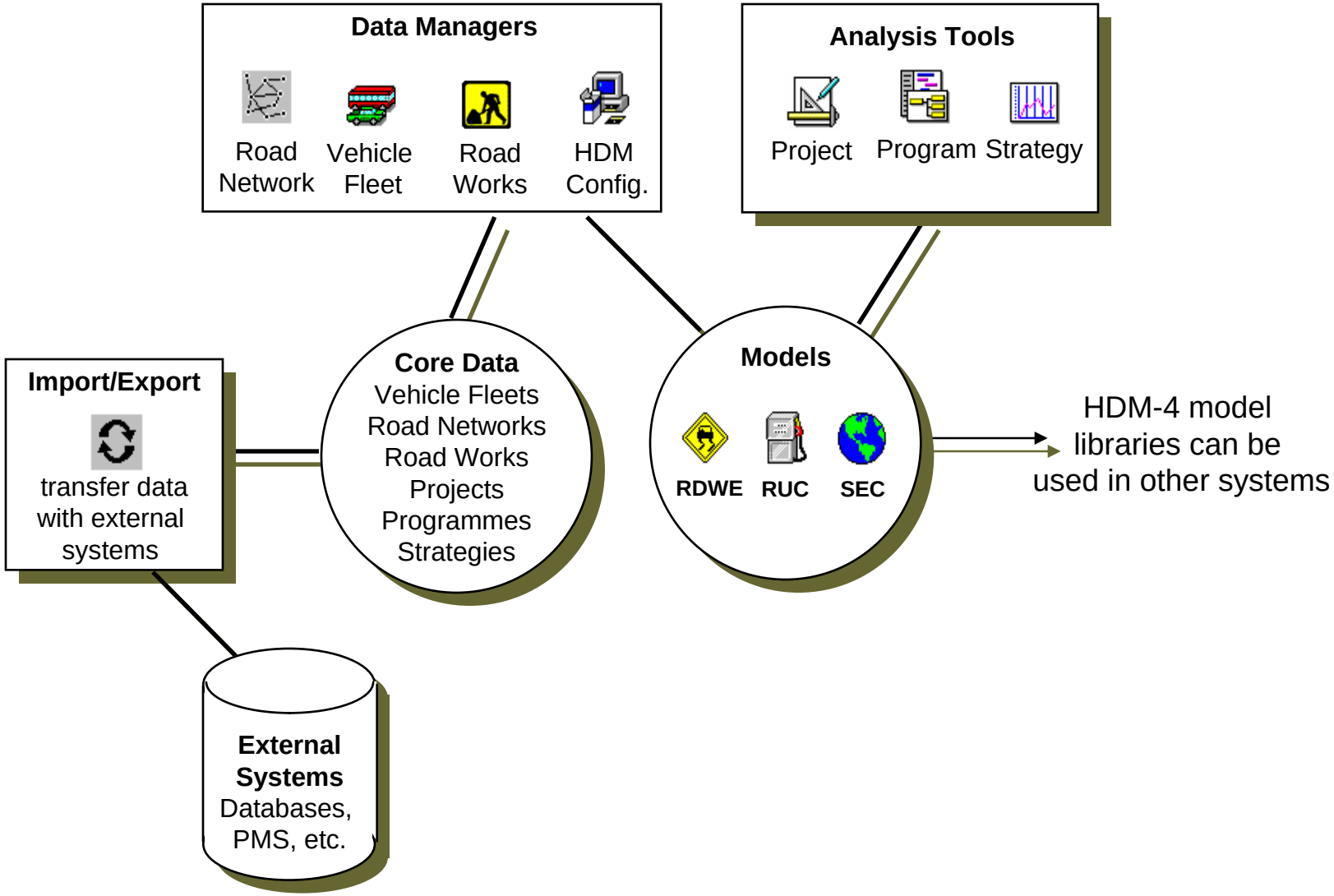
Scope of HDM-4

- Project Level Analysis
- Network Programme and Budgeting
- Road System Strategy Analysis
- Research and Policy Studies

Road Asset Management System



HDM-4 System Architecture



Analysis framework - Main elements

- Defining the problem to be solved
  - Network elements, Vehicles
  - Investment options, Traffic
- Modelling future impacts on road performance and road users
- Economic analysis
  - Comparisons
  - Optimisation/Prioritisation
- Outputs

1. Defining the Problem

Network Elements

- Sections
  - a length of road that is homogeneous in terms of its physical attributes (basic unit of analysis)
- Network
- Sub-networks

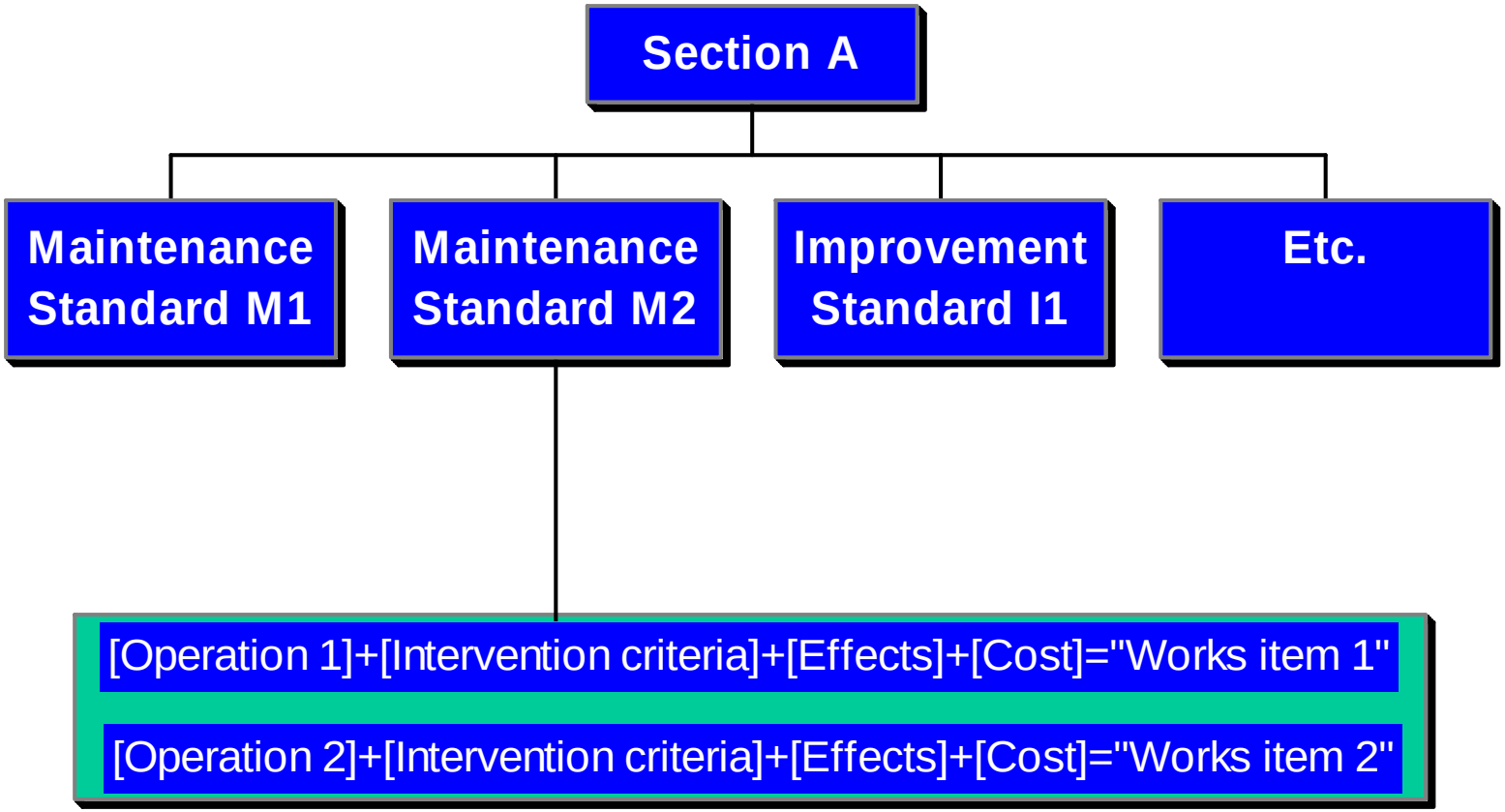
Vehicles

- Categories:
  - Motorised transport (MT)
  - Non-motorised transport (NMT)
- Classes
  - For example: motorcycles, cars, buses, trucks
- Types
  - 16 standard MT types (e.g., small car, medium car, large car)
  - 4 standard NMT types (e.g., bicycle, rickshaw, bullock cart)

Investment Options

- **Operation or works activity**
  - ↑ **e.g., overlay, patching**
- **Standards**
  - ↑ e.g., overlay 50 mm @ 6 IRI
- **Section alternatives (or options)**
- **Project alternatives (or options)**

Works Standards



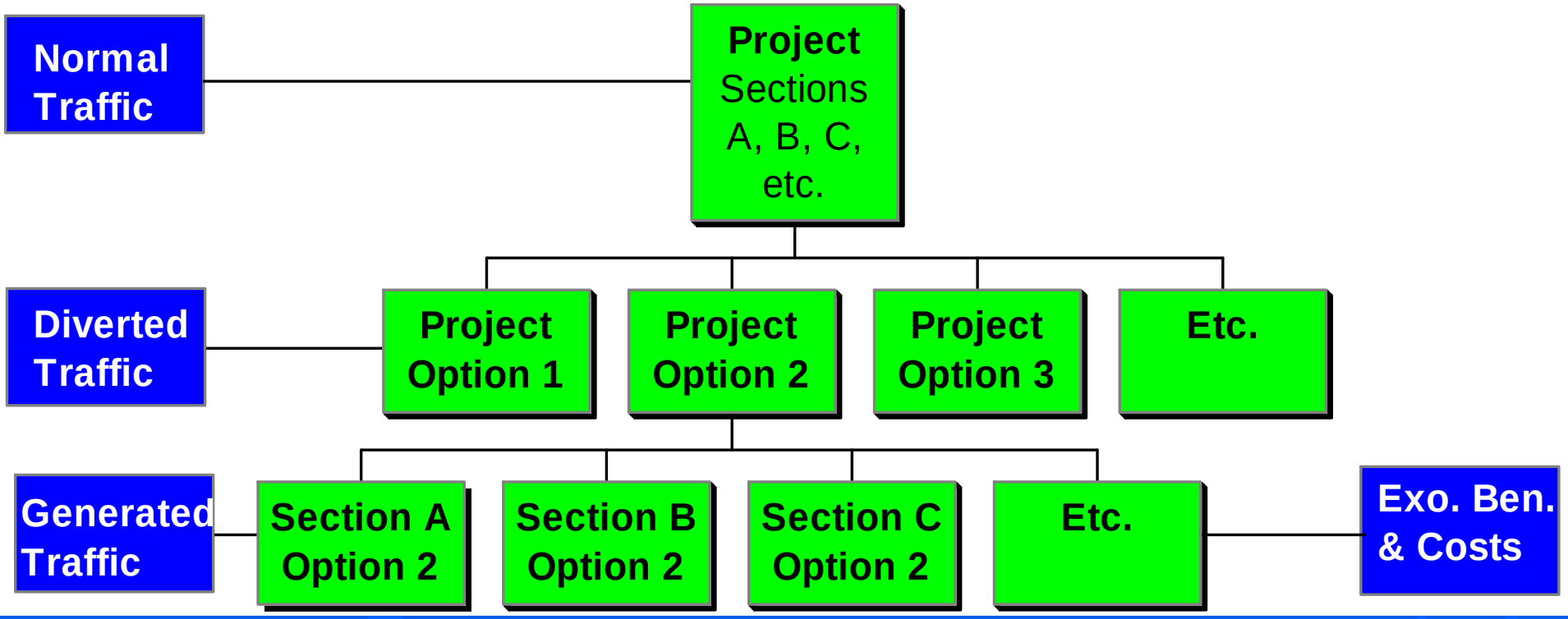
Traffic Data

- Traffic categories
- Composition, volumes and growth rates
- Axle loading
- Road capacity and speed-flow relationship
- Traffic flow pattern

Traffic Categories

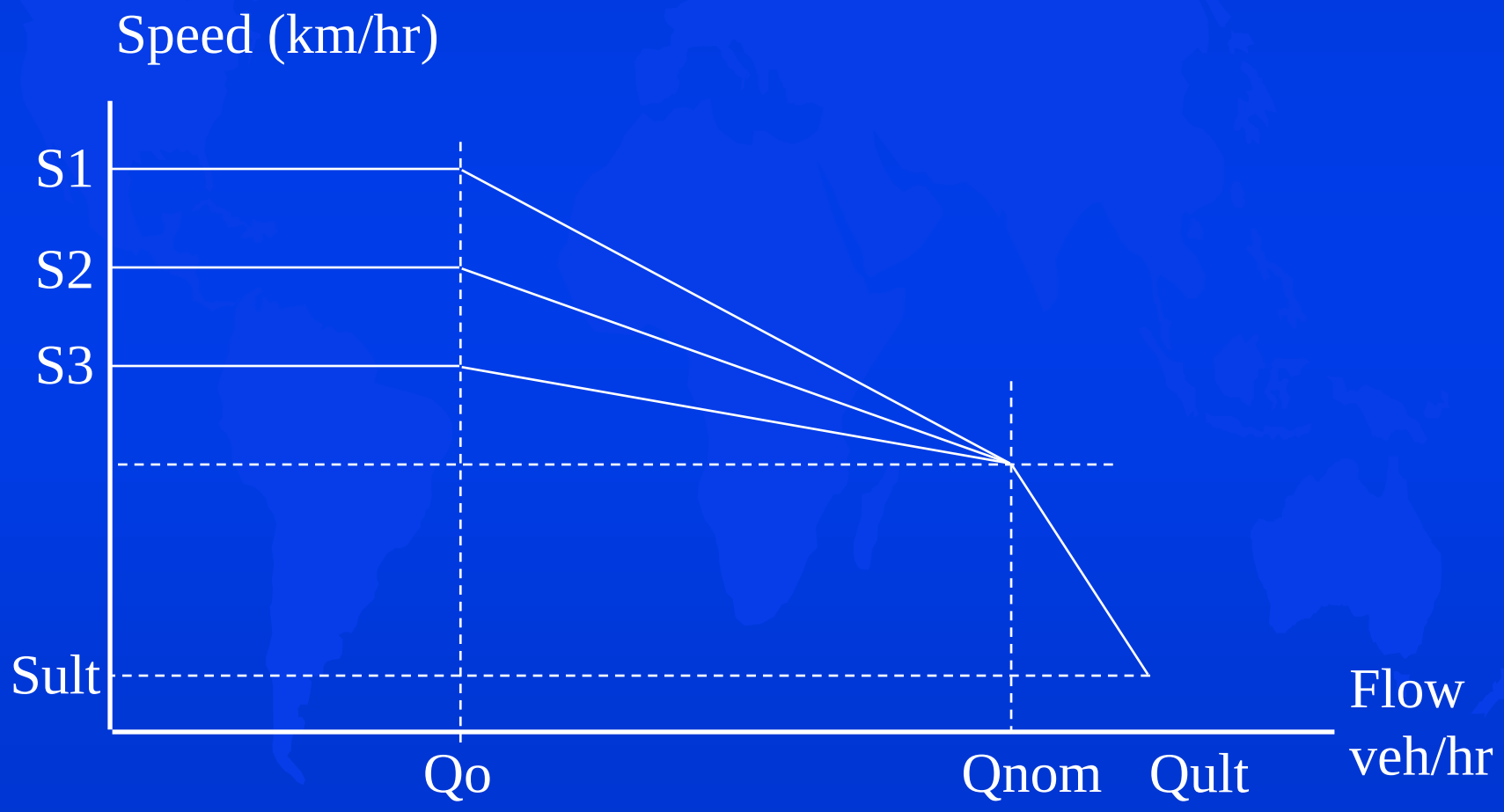
- Normal traffic
  - traffic that would pass along the project road if no investment took place
- Diverted traffic
  - traffic that changes from another route (or transport mode) to the project road
- Generated traffic
  - additional traffic that occurs in response to the road investment

Traffic and Investment Options

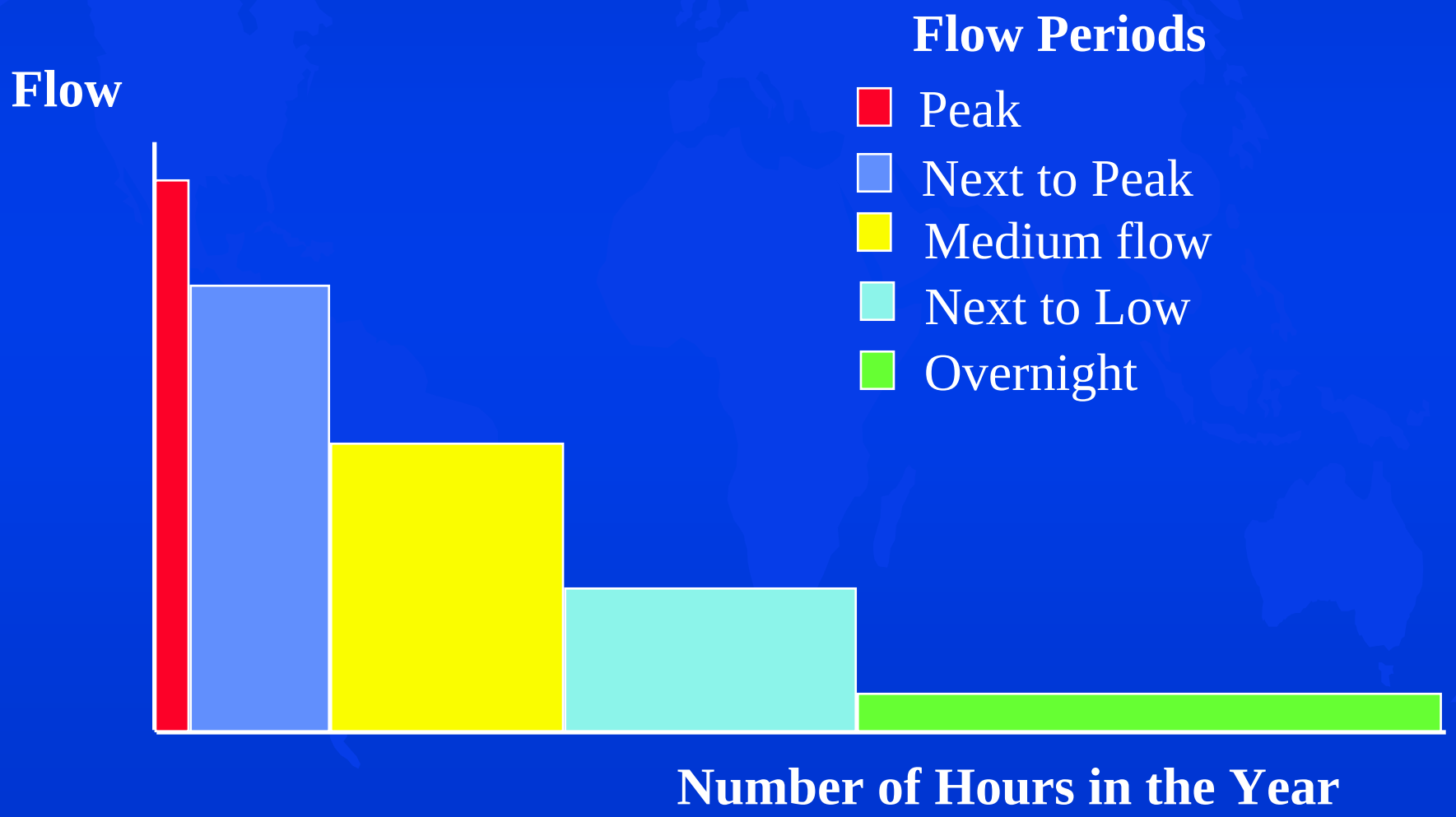


Speed-Flow Effects

Three Zone Model



Annual Distribution of Hourly Flows



Other Traffic Related Issues

- Representation of traffic data by level of analysis:
  - ↑Project
  - ↑Programme
  - ↑Strategy
- Degree of conflict between MT and NMT
- Roadside friction

2. Modelling Impacts

Technical relationships provided for the following purposes:

- Calculation of future traffic
- Prediction of road deterioration
- Prediction of works effects and costs
- Prediction of road user effects
- Evaluation of emissions and energy use

Road Deterioration

Scope of modelling road deterioration

- Physical environments (climatic zones)
- Rigid concrete and a wide range of flexible pavements
- Drainage effects and shoulders deterioration effects on pavement strength
- Road capacity improvement and a broader range of maintenance techniques for different pavement types

Pavement Defects Modelled in HDM-4

Bituminous	Concrete	Block	Unsealed
Cracking	Cracking	Rutting	Gravel loss
Rutting	Joint spalling	Surface texture	Roughness
Ravelling	Faulting	Roughness	
Potholing	Failures		
Roughness	Serviceability		
Edge break	loss		
Surface texture	Roughness		
Skid resistance			

- *Drain deterioration*
- *Shoulders deterioration*

Modelling Framework

- For each pavement type there is a generic model which describes how the pavement deteriorates
- To take account of the different behaviour of a particular pavement Type constructed with different materials the coefficients of the generic model depend on the different combinations of the materials
- After maintenance treatments the generic pavement type can change. All pavements with an AM surfacing become pavements with an AP base for resurfacing maintenance

Works Effects

Road Works Classification

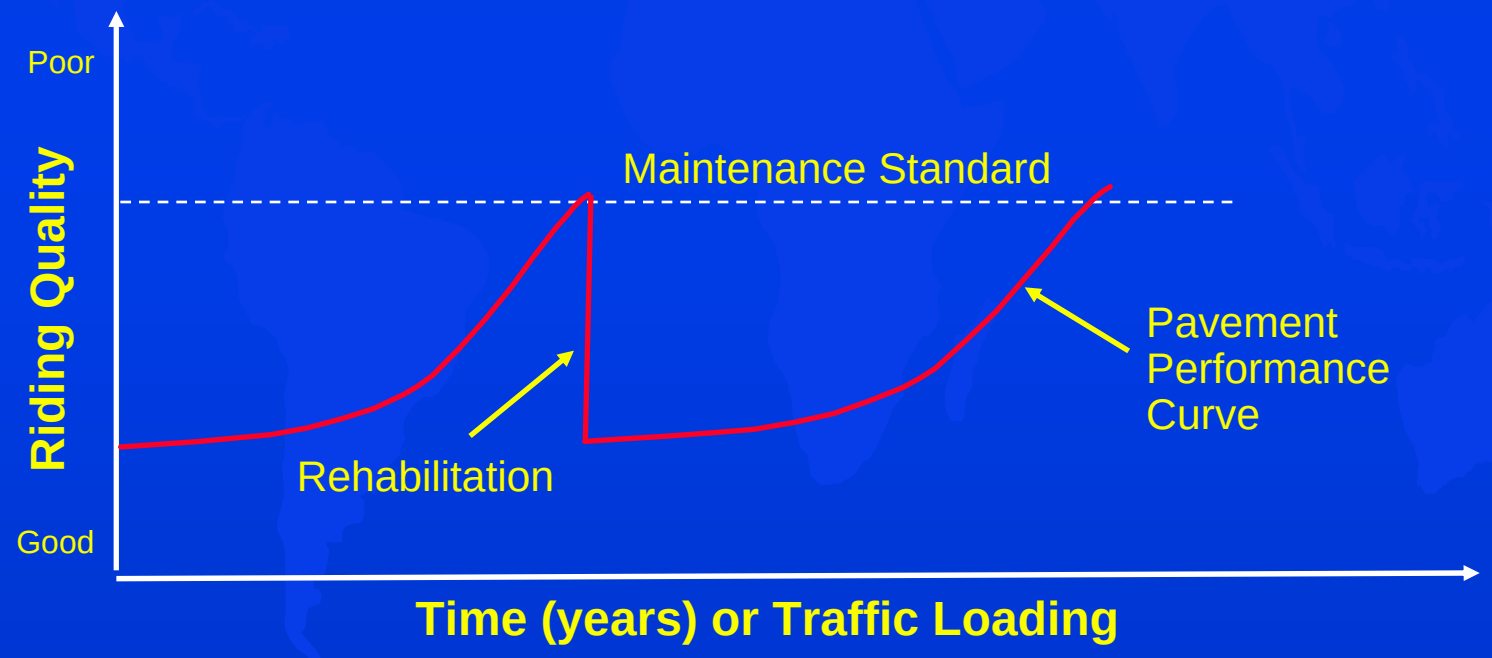
Works Category	Works Class	Works Type	Works Activities
Maintenance/ Preservation	Routine Maintenance	Routine Pavement (Reactive)	
		Drainage	
		Routine Miscellaneous (Cyclic)	
	Periodic Maintenance	Preventive Treatment	
		Resurfacing	
		Rehabilitation	
		Reconstruction	
	Special	Emergency	
		Winter	
Development	Improvement	Widening	
		Realignment	
		Off-carriageway	
	Construction	Upgrading	
		New section	

Road Features

- Carriageway
- Shoulders
- NMT lanes
- Drainage structures
- Intersection

Road Maintenance & Improvement

- Affects long term pavement performance



Road User Effects

Road user costs depend on the following:

- The number and types of vehicles using the road
- Road geometric design and standards
- Road surface condition
- Driver behaviour

RUE Components

- MT Vehicle operating costs (VOC)
- MT Travel time costs (TTC)
- NMT Time and operating costs (NMTOC)
- Accident costs (AC)

- RUC = VOC + TTC + NMTOC + AC

Vehicle Free Speed Models

- Free speeds
  - Uphill
  - Downhill
- Constraining Speeds
  - Desired Speed (VDESIR)
  - Drive Power (VDRIVE)
  - Braking Power (VBRAKE)
  - Road Curvature (VCURVE)
  - Riding Quality (VROUGH)

Vehicle Operating Costs

- Fuel & oil consumption
- Tyre wear
- Parts consumption
- Depreciation
- Interest on capital
- Crew costs
- Overheads
- Impassability cost (unsealed roads)

Travel time costs are calculated as a function of vehicle operating speed:

- Passenger travel time
  - ↑Working hours
  - ↑Non-working hours
- Cargo holding time

Social and Environmental Effects

- Energy balance
- Vehicle emissions
- Noise (not yet implemented)

Exogenous Benefits and Costs

- Due to other road related investments
  - ↑bridge repair, slope stabilisation, etc.
- Development benefits
  - ↑agricultural, commercial, industrial, etc.
- Environmental impacts
- Social & resettlement impacts

3. Economic Analysis

Comparison of Options

- Loop for each pair of investment options
  - Loop for each analysis year
    - Loop for each road section
      - Calculate net monetary benefits
      - Calculate net emissions and energy use
    - End loop
    - Calculate net benefits over all the road sections
  - End loop
  - Calculate economic indicators (NPV, IRR, etc.)
- End loop
- Perform optimisation (Programme & Strategy)

4. Outputs

Detailed Reports

- Road deterioration and works effects
  - deterioration trends, timing of works
- Road user effects
  - speeds, traffic flows, vehicle resources
- Cost streams
  - road agency costs, road user costs
- Environmental effects
  - emissions, energy use

Asset valuation

Summary Reports

- Project summary report, including cost summary and economic indicators
- Works programme optimised under budget constraints
- Estimate of budget requirements
- Forecast of pavement performance and road user effects