SAPPORO

A Platform for Intelligent Integrated Traffic Management

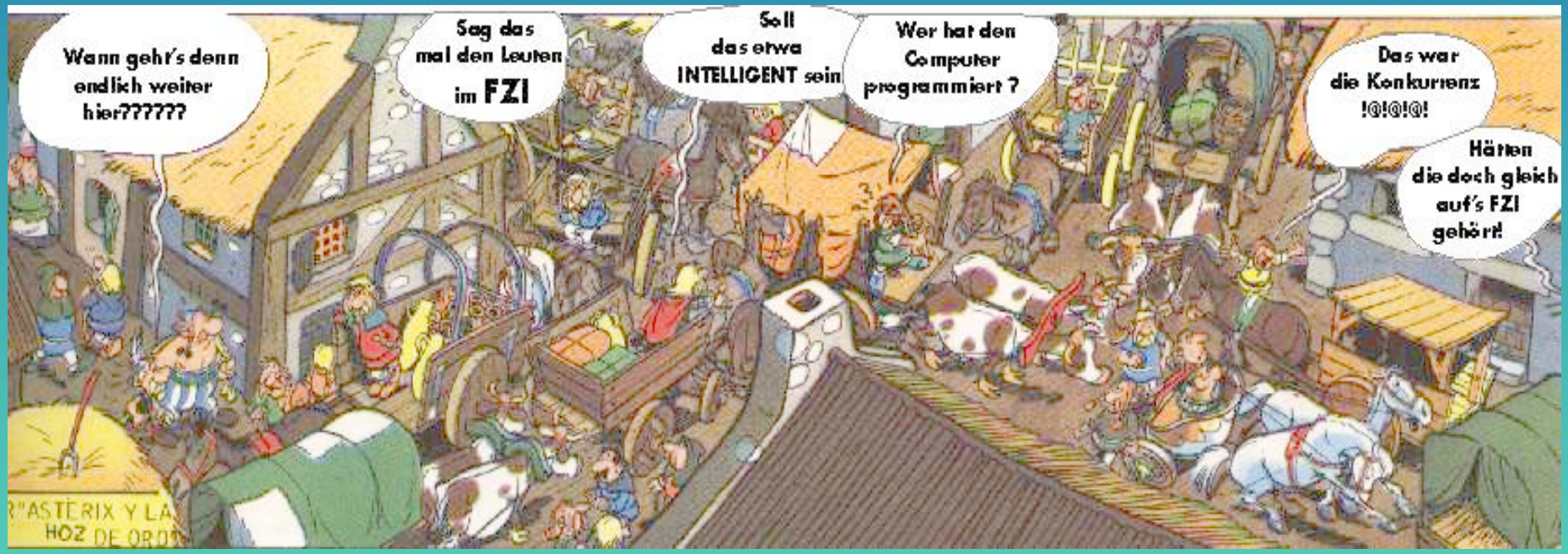
SAPPORO

Final Report and Further Research

Overview

- architecture of Sapporo
- methods and techniques
- new features
- extensions
- further research

Motivation


Wann geht's denn endlich weiter hier??????
Sag das mal den Leuten im FZI
Soll das etwa INTELLIGENT sein
Wer hat den Computer programmiert ?
Das war die Konkurrenz !@!@!@!
Hätten die doch gleich auf's FZI gehört!

Project Goals

- Artificial Intelligence-based methods for traffic modeling, simulation and control
- prototype system
- advanced solutions to traffic control problems

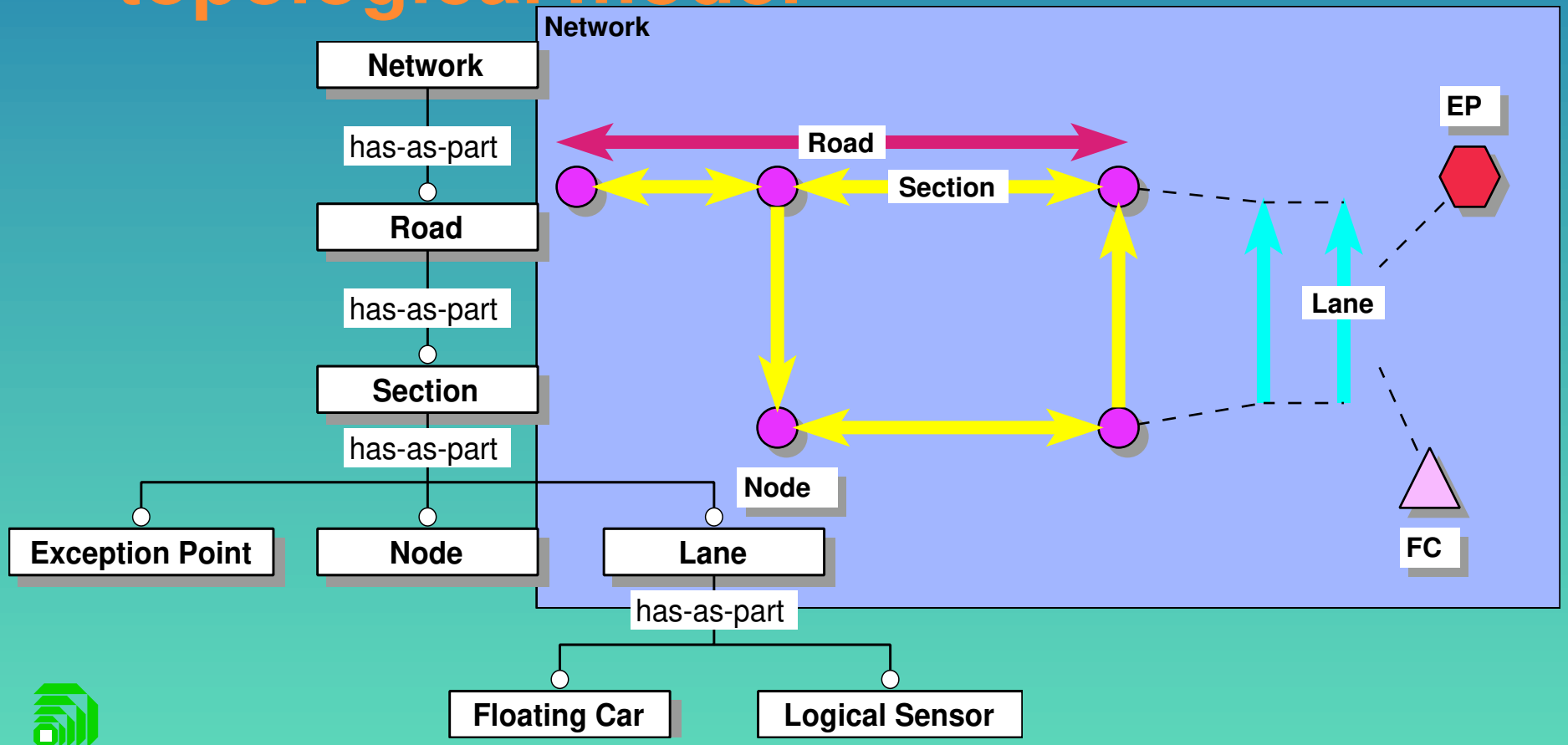
Architecture of Sapporo

- basic models
- tools
- interfaces

Basic Models

Architecture

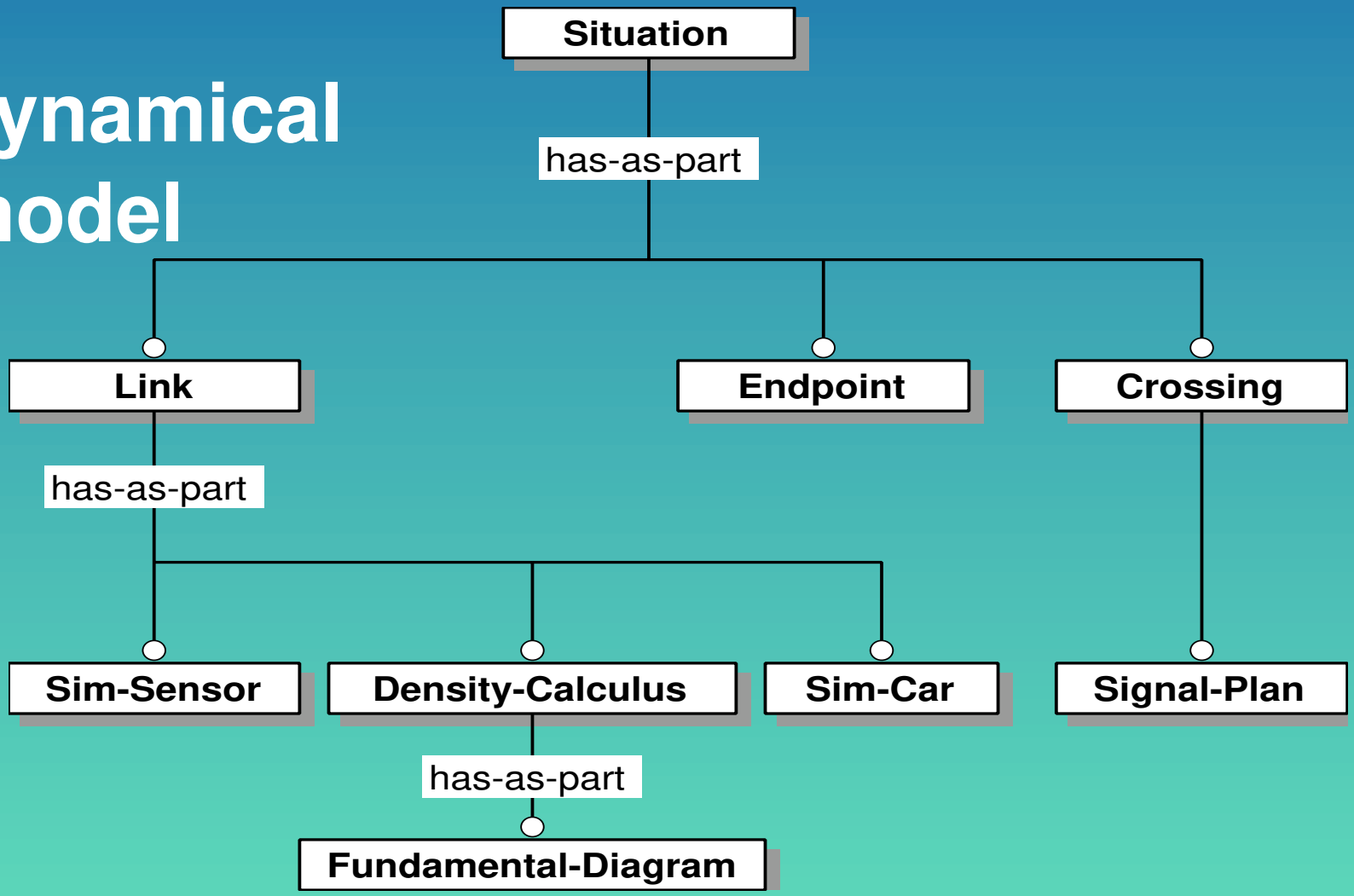
- topological model



Basic Models

Architecture

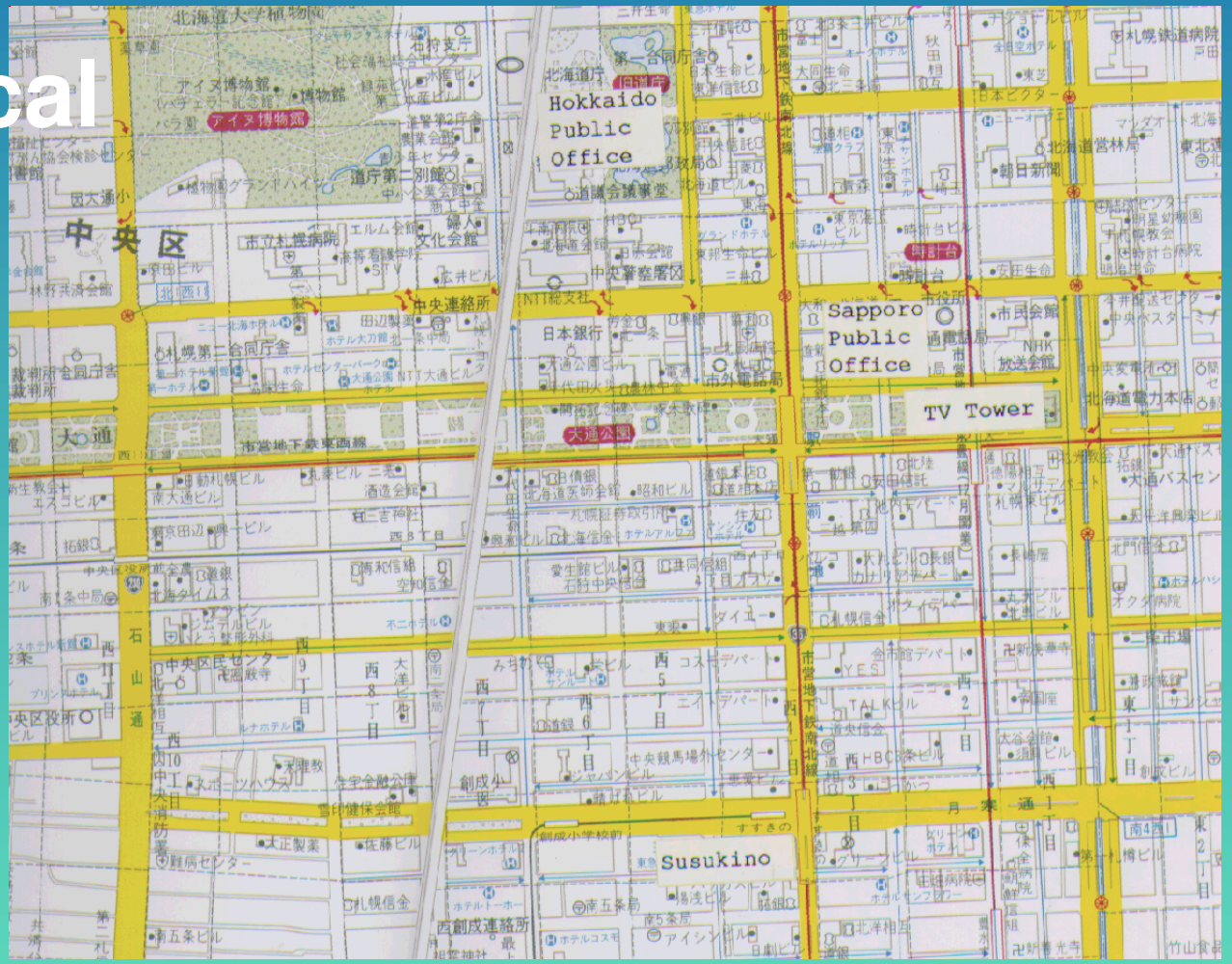
- dynamical model



Basic Models

Architecture

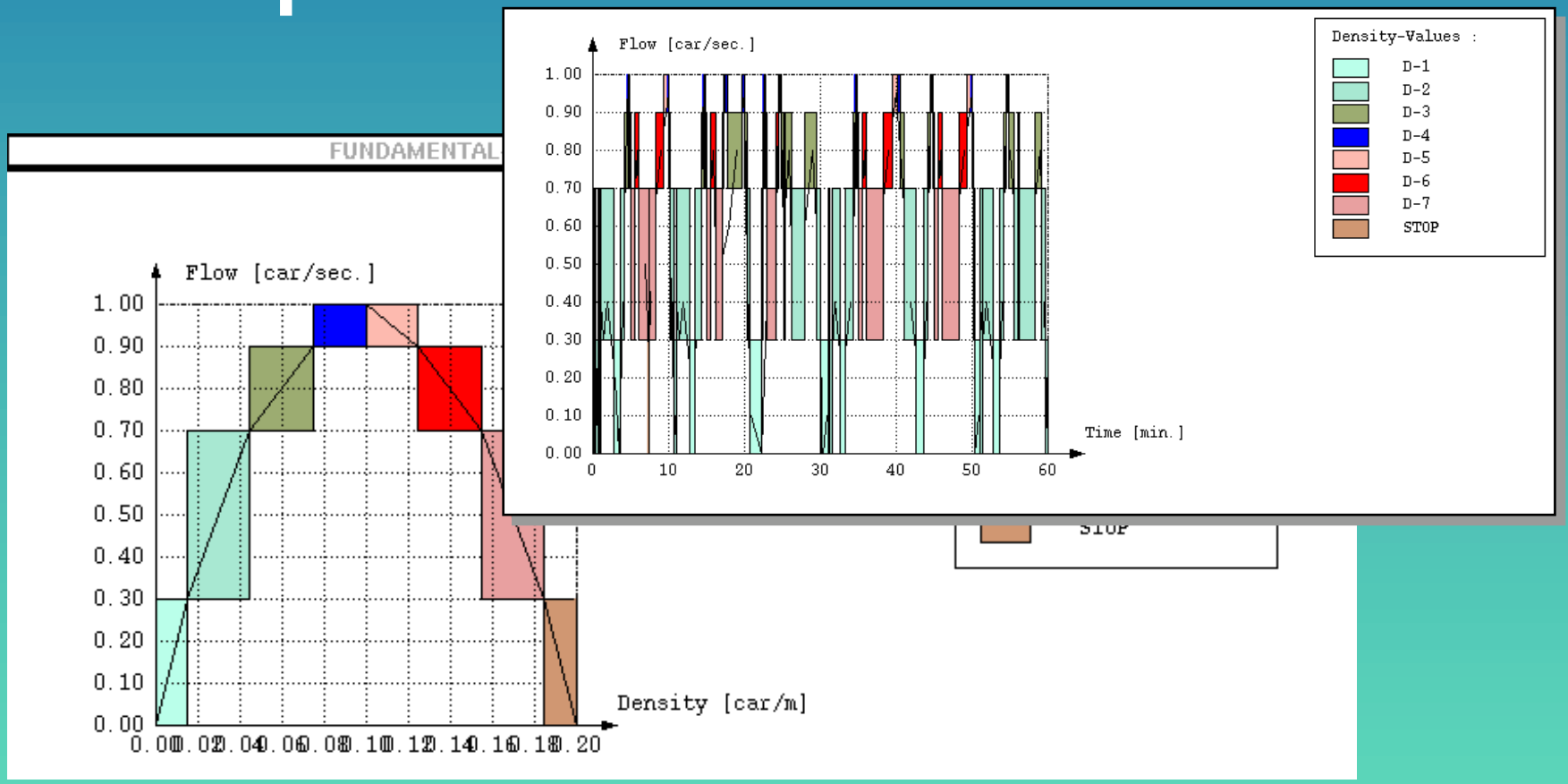
- **geometrical model**



Basic Models

Architecture

- **traffic parameter model**



Basic Models

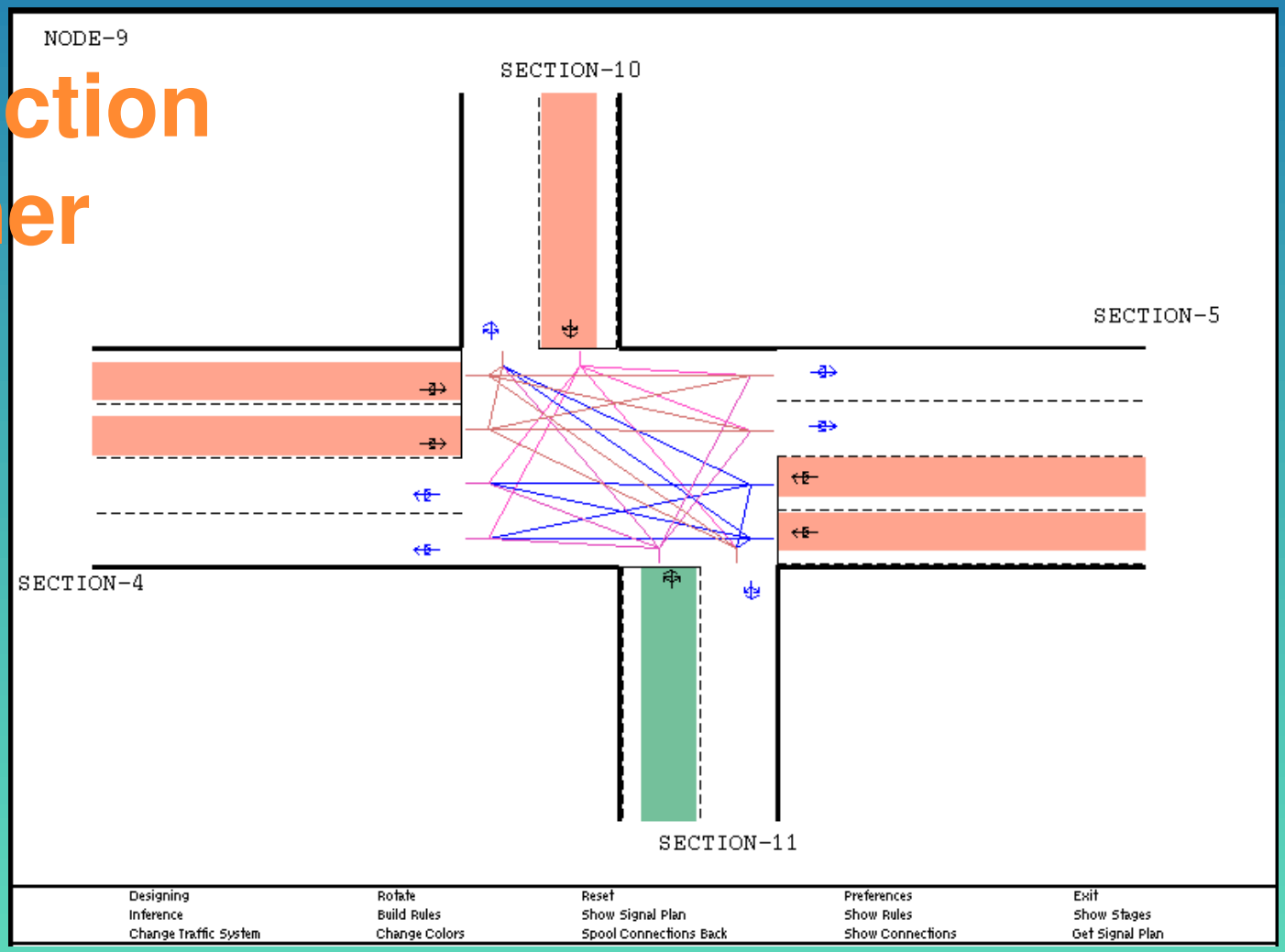
Architecture

- **logical model**
  - **insertion rules for density zones**
  - **meta-rules for generation of individual signal plan generation rules**
  - **constraint system for propagation of changes in the associative object network**

Tools

Architecture

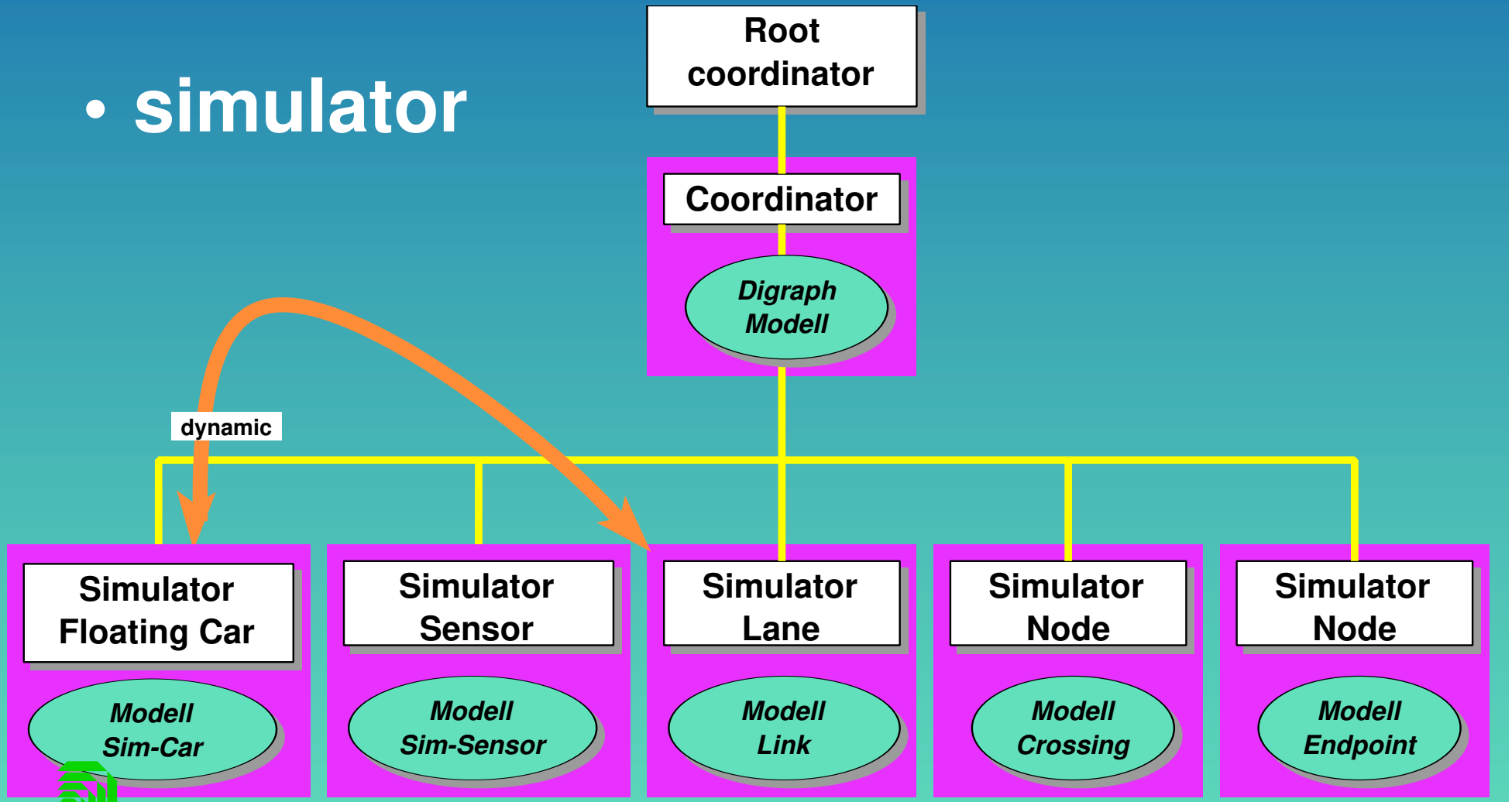
- **Intersection Designer**



Tools

Architecture

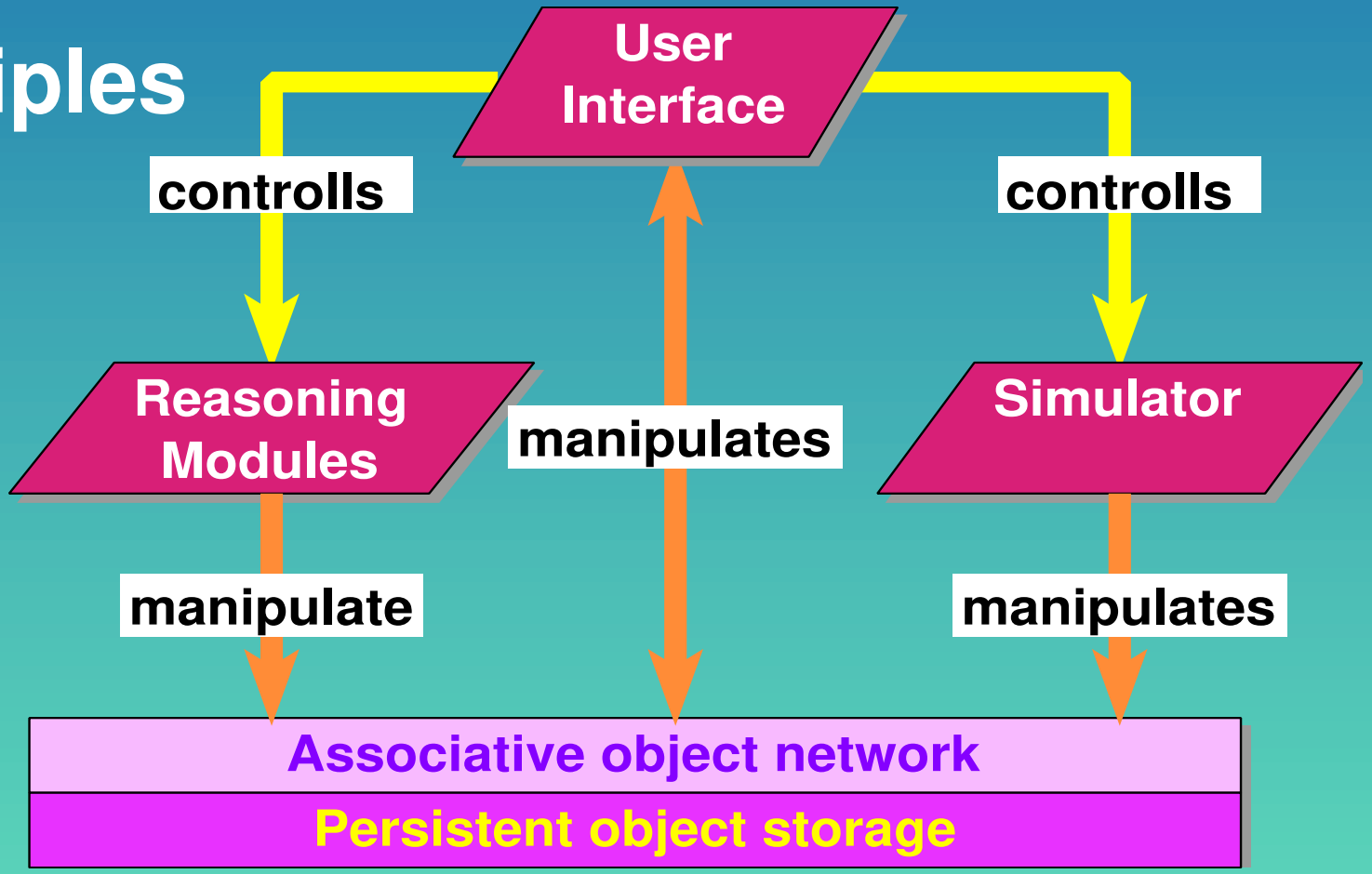
- **simulator**



Interfaces

Architecture

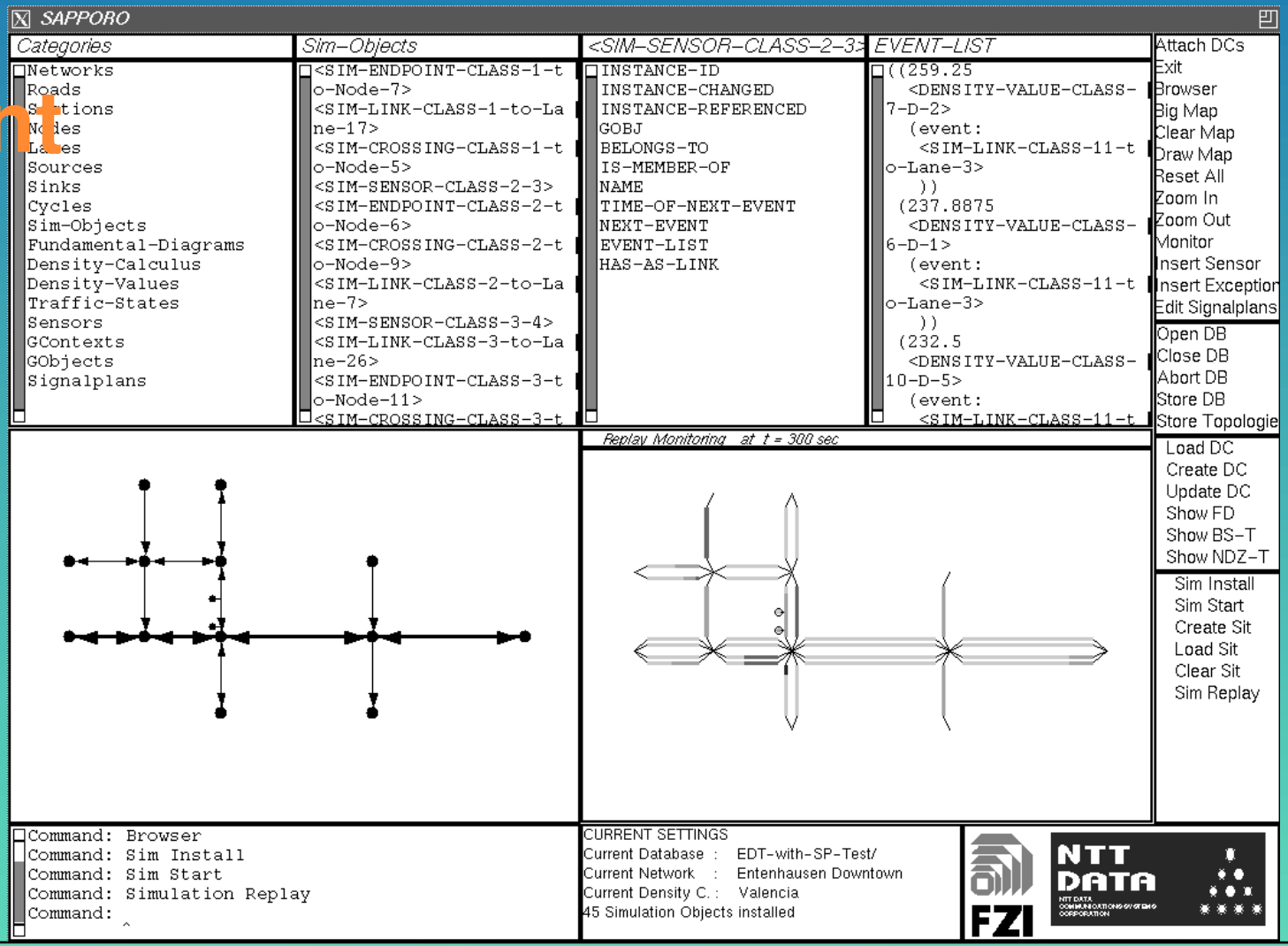
- principles



Interfaces

Architecture

- current look



Methods and Techniques

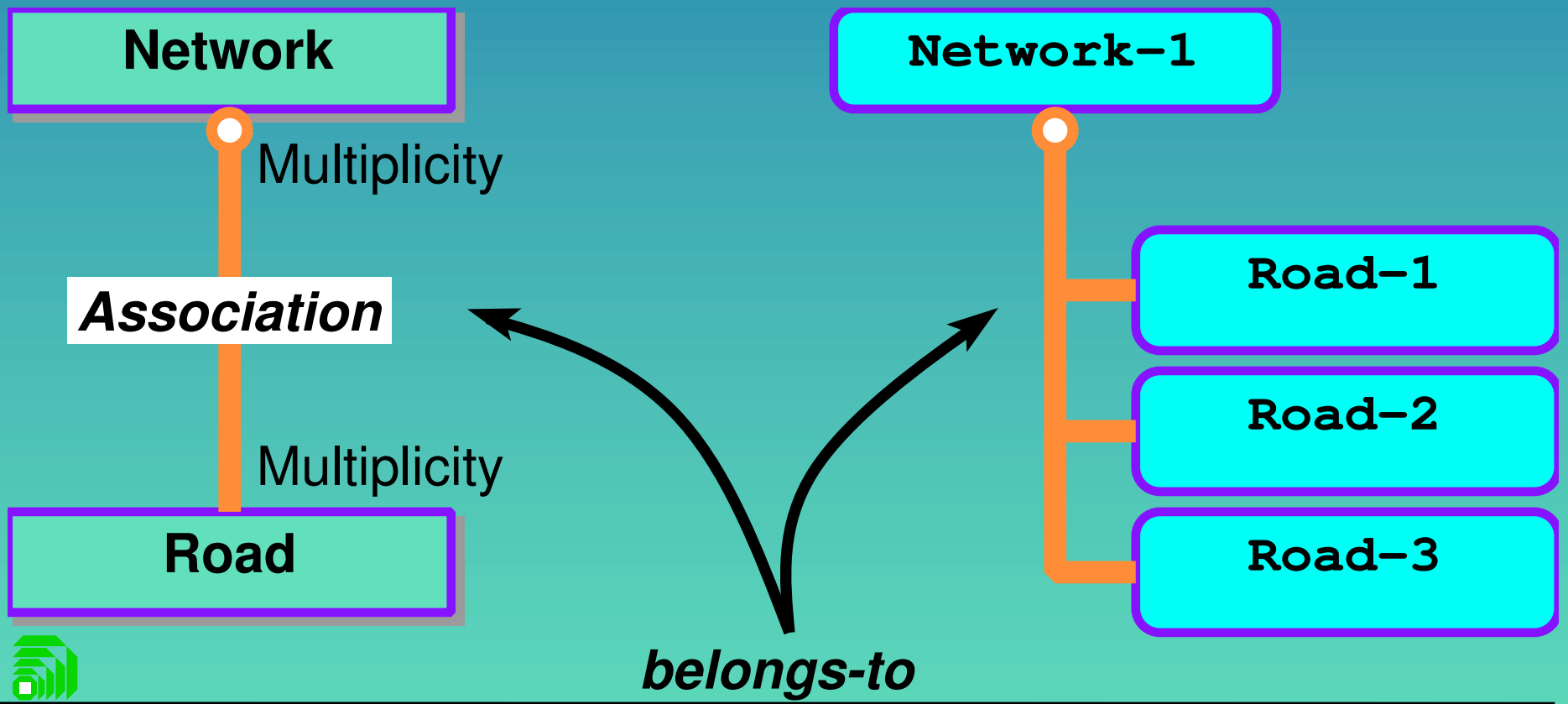
- qualitative reasoning for traffic modeling
- object-oriented programming for overall implementation
- rule- and constraint-based reasoning for signal plan generation
- DAI methods for intersection control

- **associative object networks**
  - **semantic networks**
  - **reasoning capability**
  - **flexible knowledge representation**
  - **support by tools necessary**

OOP

Methods

- **principle of associative object nets**



- **example: topological model**

New Features

- persistent objects
- logical sensors
- exception points
- floating cars
- traffic control

Persistent Objects

New Features

- high connectivity among objects
  - long instantiation time
  - static character of relations
  - system snapshots: situations + configurations
- CLOS-DB
  - public domain by FZI
  - textual storage
  - instance manager
  - support of asscіation nets

Logical Sensors

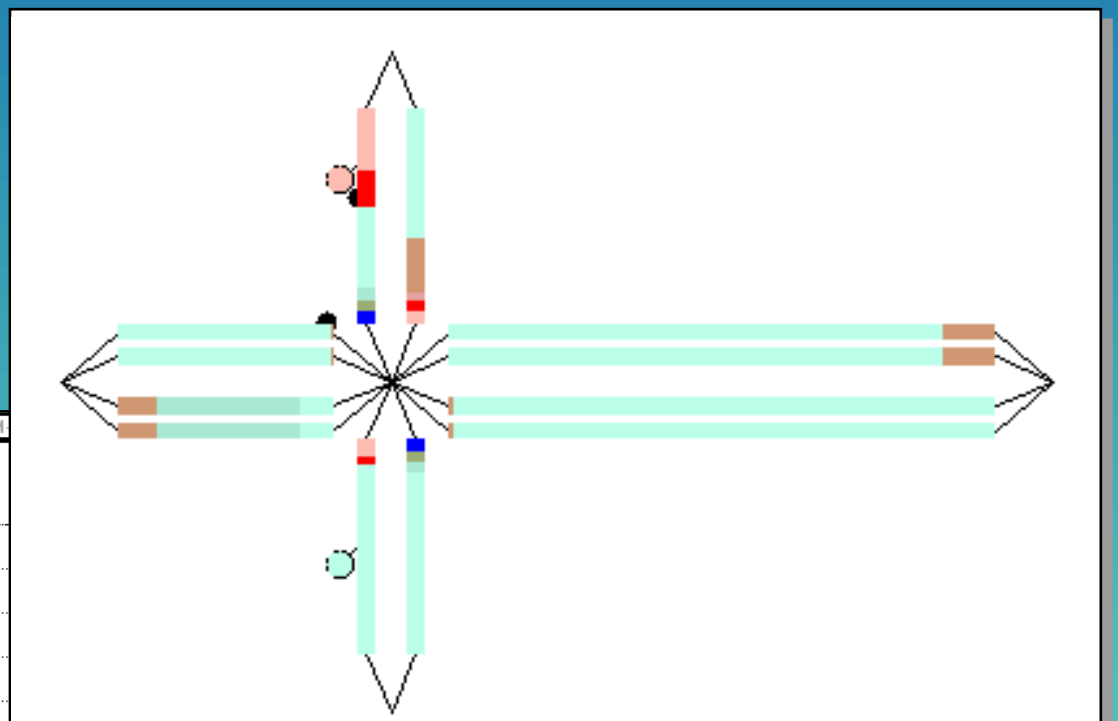
New Features

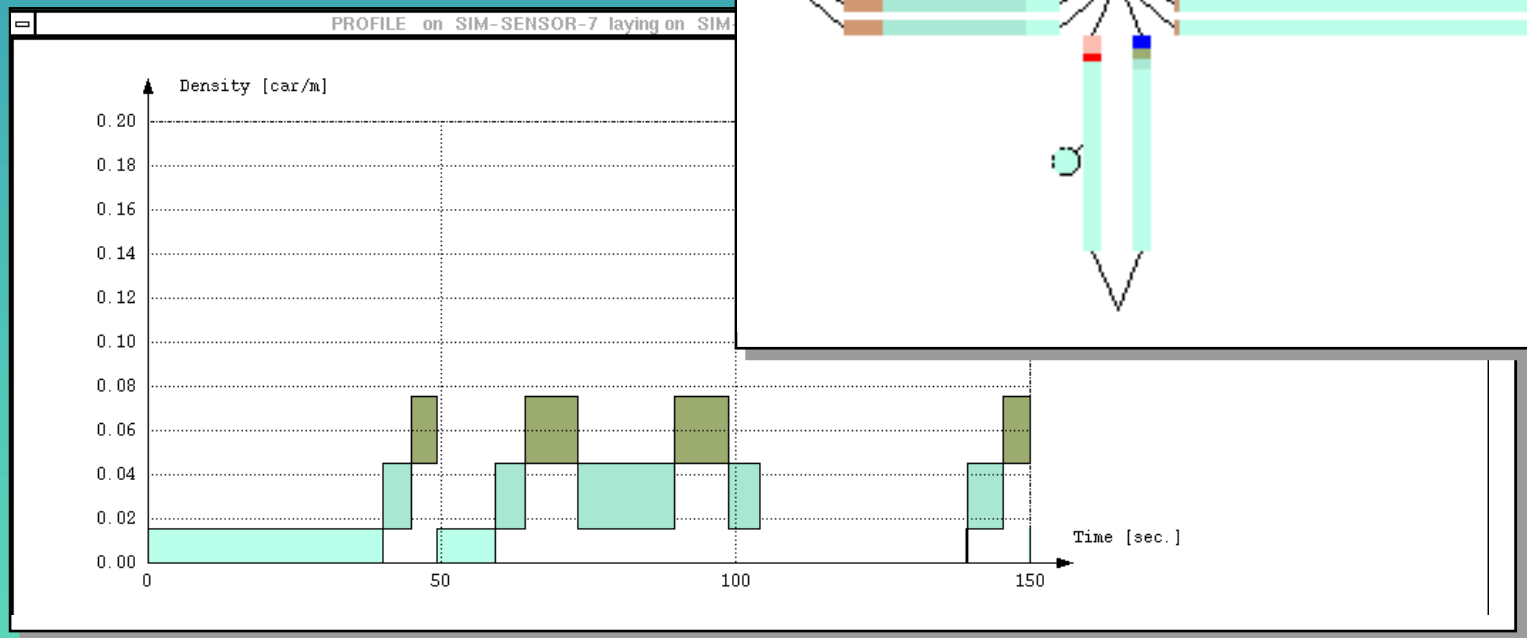
- **abstract sensor**
  - **independent of physical device**
  - **measurement of occupancy, density**
  - **calculation of mean occupancy, mean density, mean speed**
- **local traffic information for control and management**
- **interactive manipulation in Sapporo**

Logical Sensors

New Features

- interfaces





Exception Points

New Features

- incident locations
  - accidents, road works, blockings
- abstract node
  - turning ratios
  - lane connectivity
  - signal plan

Floating Cars

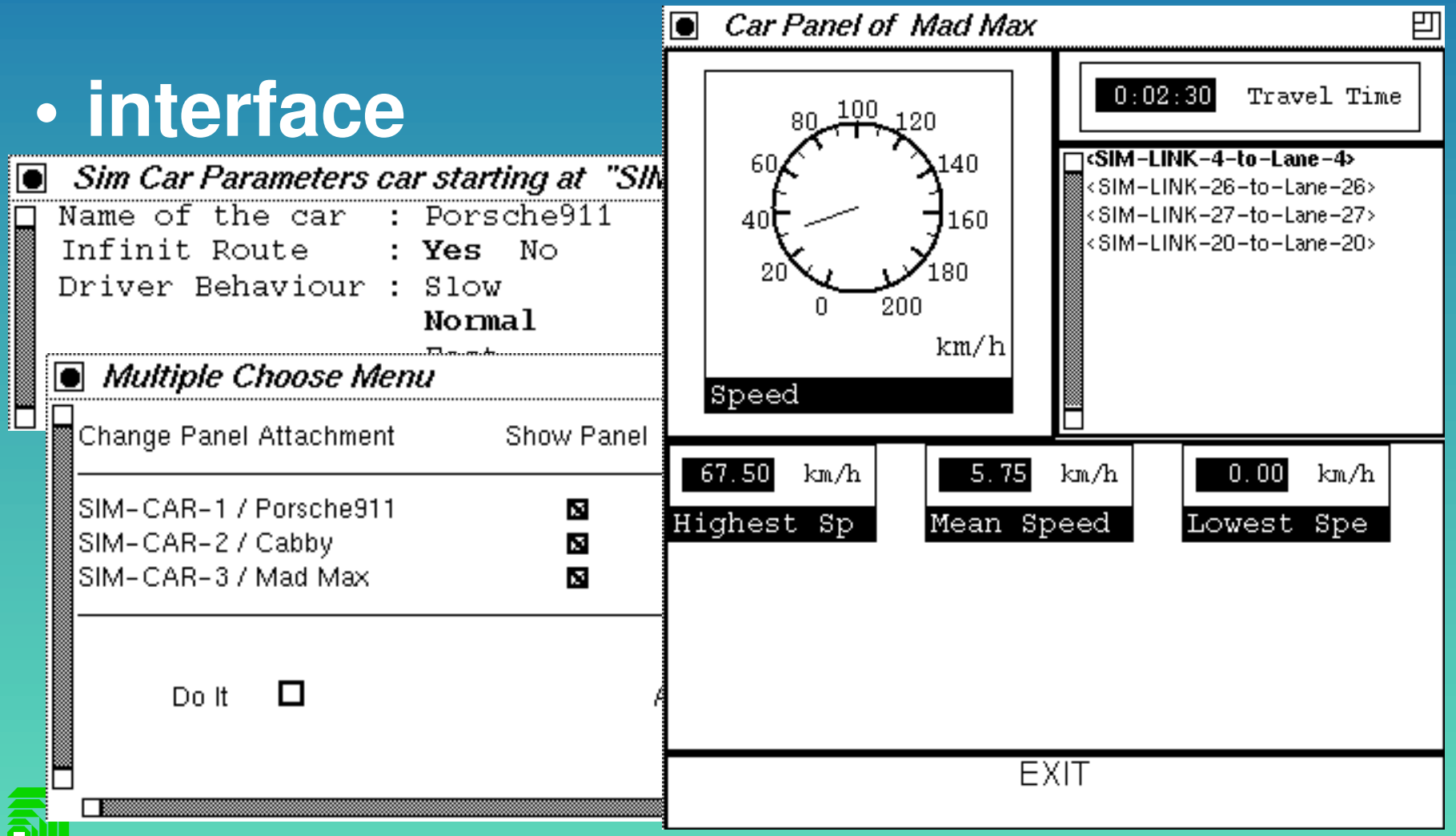
New Features

- general aspects
  - quality measurement of control regime
  - best cost/benefit ratio
  - realization by sensors and transponders in taxis and public vehicles
- modeling aspects
  - microscopic
  - integration via DEVS simulation architecture
  - actor paradigm for microscopic components

Floating Cars

New Features

- **interface**



Traffic Control

New Features

- every node has at least 1 signal plan
- signal plan editor

Enter Phase Parameters for Signal-Plan "SIGNAL-PLAN-1":

POSITION:	DURATION:	PHASE:
1	25	(0 29 ((<LANE-19-noname> <LANE-11-noname> 50) (<LANE-19-noname> <LANE-12-noname> 50) (<LANE-20-noname> <LANE-11-noname> 50) (<LANE-20-noname> <LANE-12-noname> 50) (<LANE-13-noname> <LANE-21-noname> 50) (<LANE-13-noname> <LANE-22-noname> 50) (<LANE-14-noname> <LANE-21-noname> 50) (<LANE-14-noname> <LANE-22-noname> 50)))
a number	*a number*	(30 49 ((<LANE-10-noname> <LANE-4-noname> 100) (<LANE-3-noname> <LANE-9-noname> 100)))
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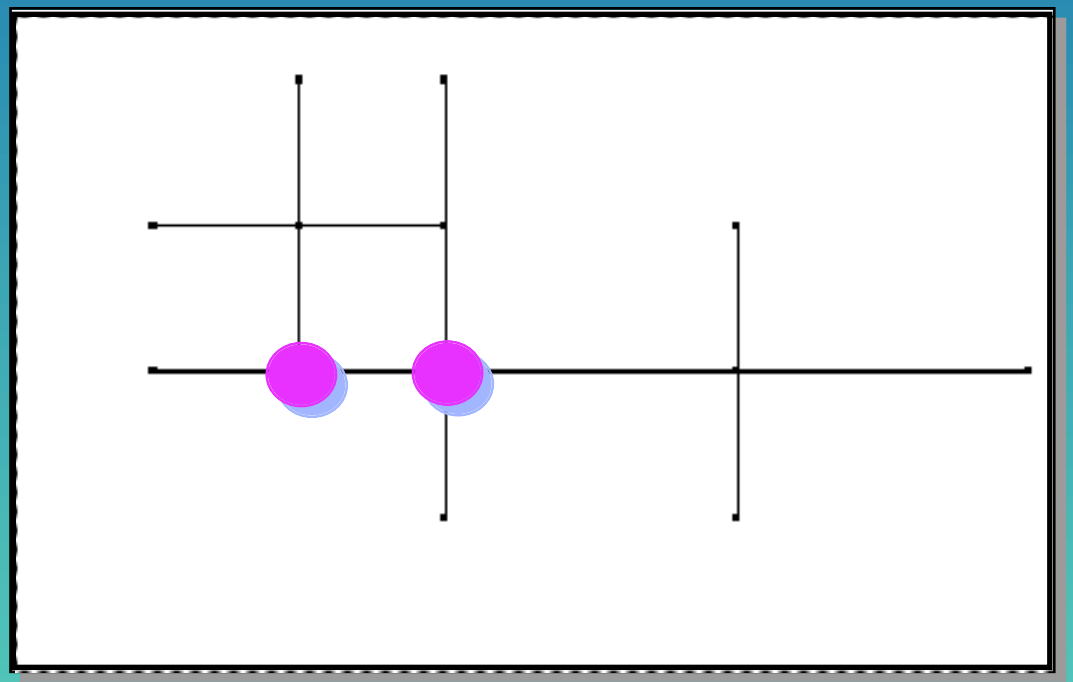
Traffic Control

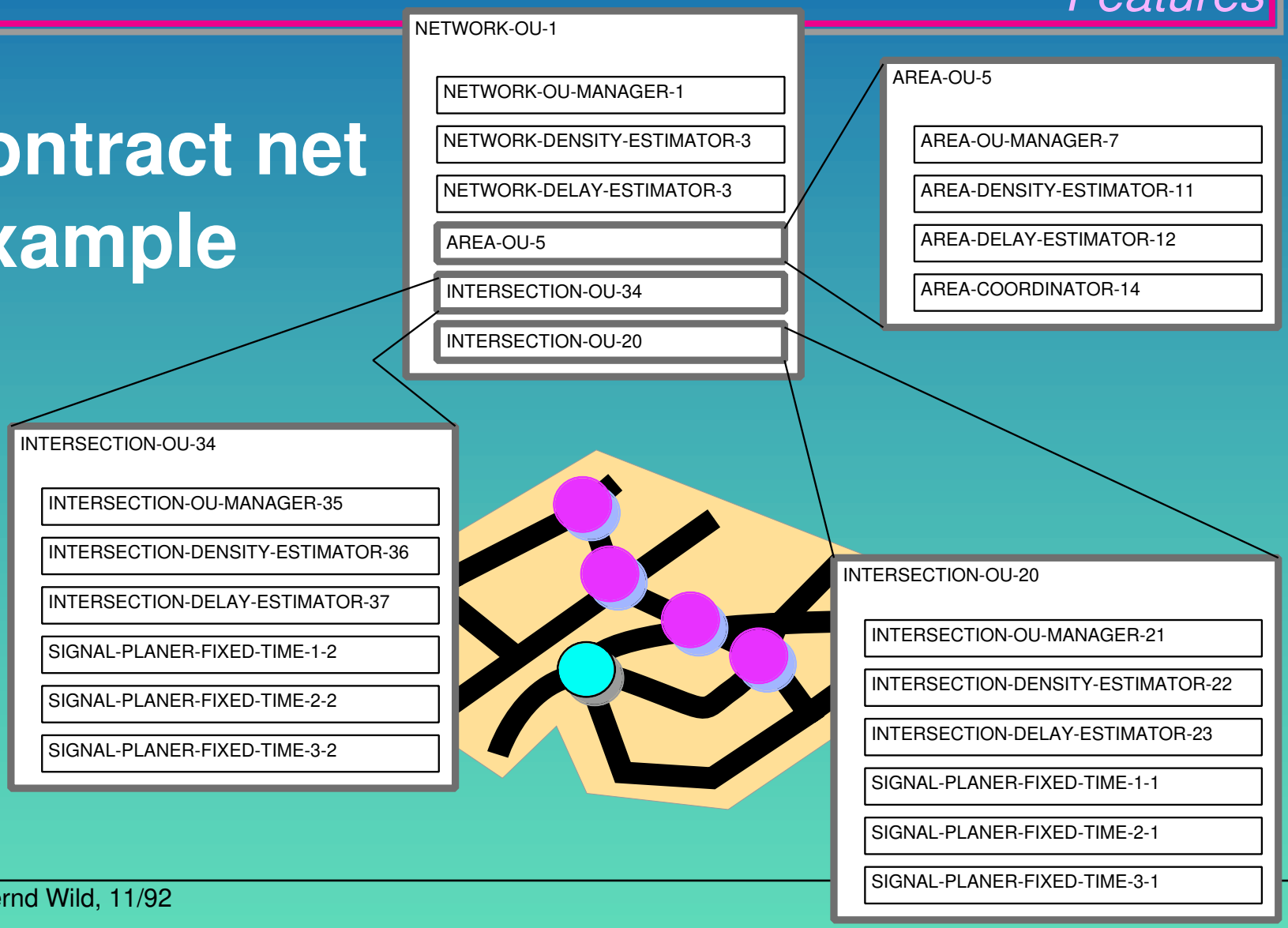
- contract net example
- 2 coordinated intersections
- 3 fixed-time signal plans



Traffic Control

New Features

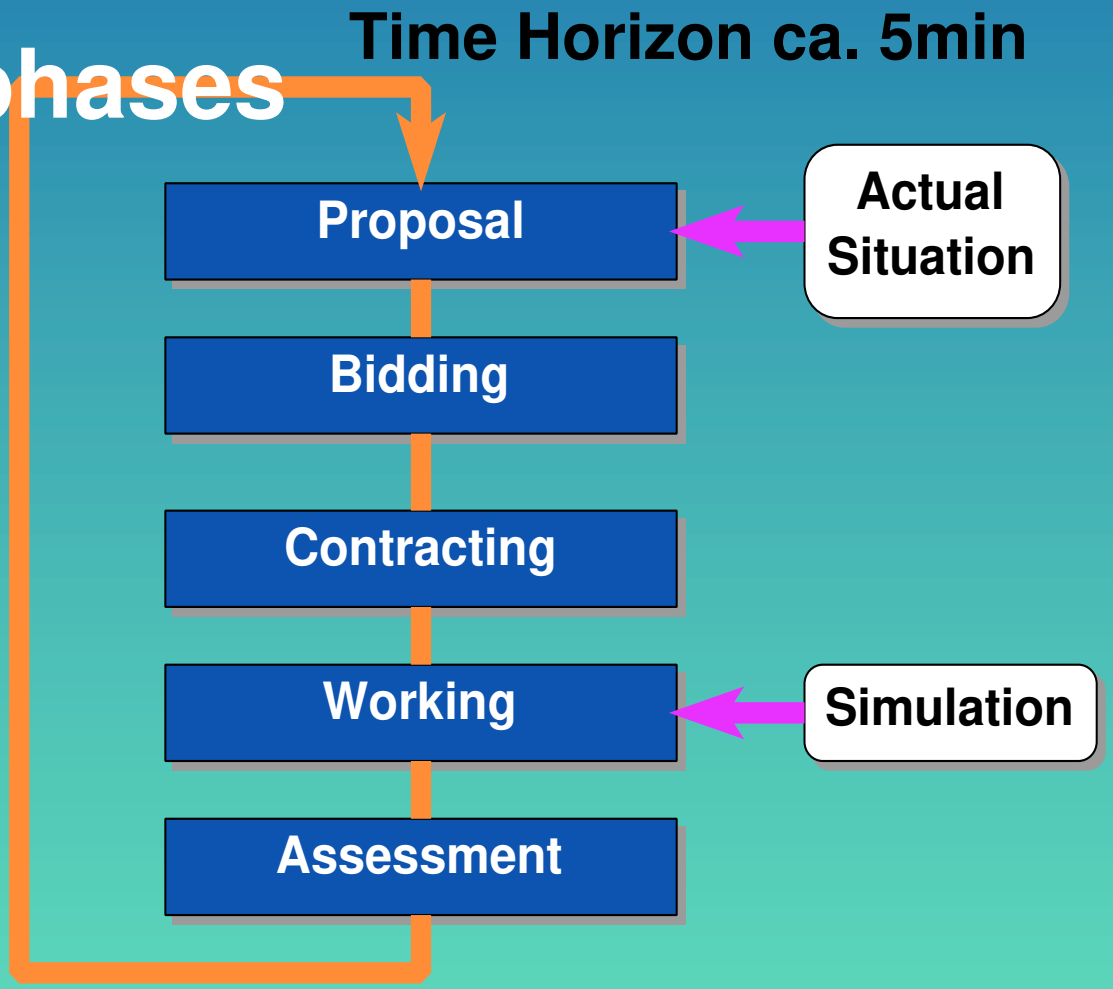
- **contract net example**



Traffic Control

New Features

- **contract net phases**
  - **change of signal planner**
  - **change of rating level**
  - **change of area-node mapping**



Extensions

- public transport
- pedestrians
- emergency planning
- driver information systems

Public Transport *Extensions*

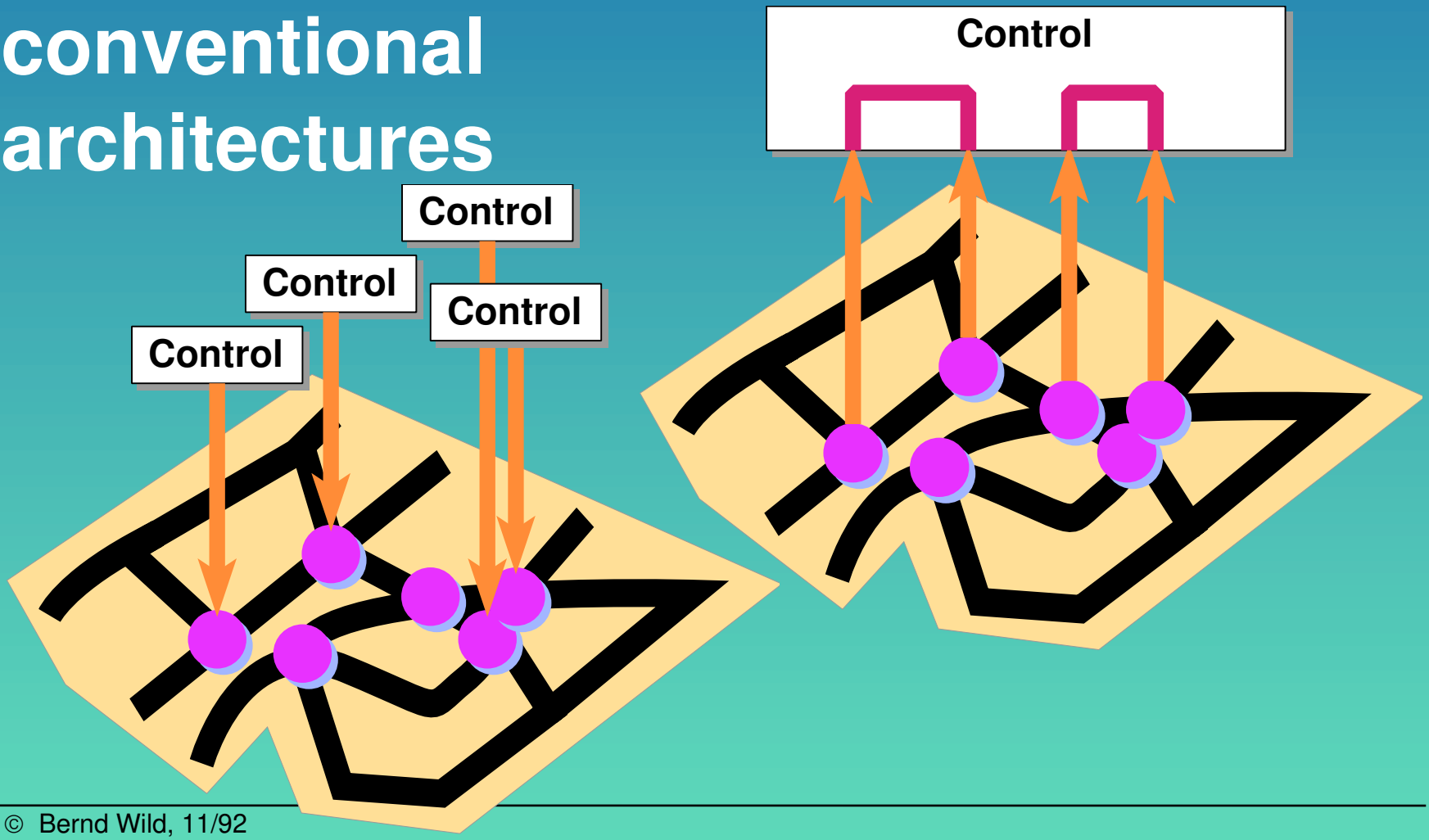
- floating cars
  - buses
  - taxis
- separate bus lanes
  - arrival estimation
  - priorization
- emergency vehicles

Further Research

- traffic control as distributed problem solving among cooperative nodes
- concurrent architectures for traffic control
- AI-based framework
  - integration of traffic engineering optimization methods

Traffic Control as DPS

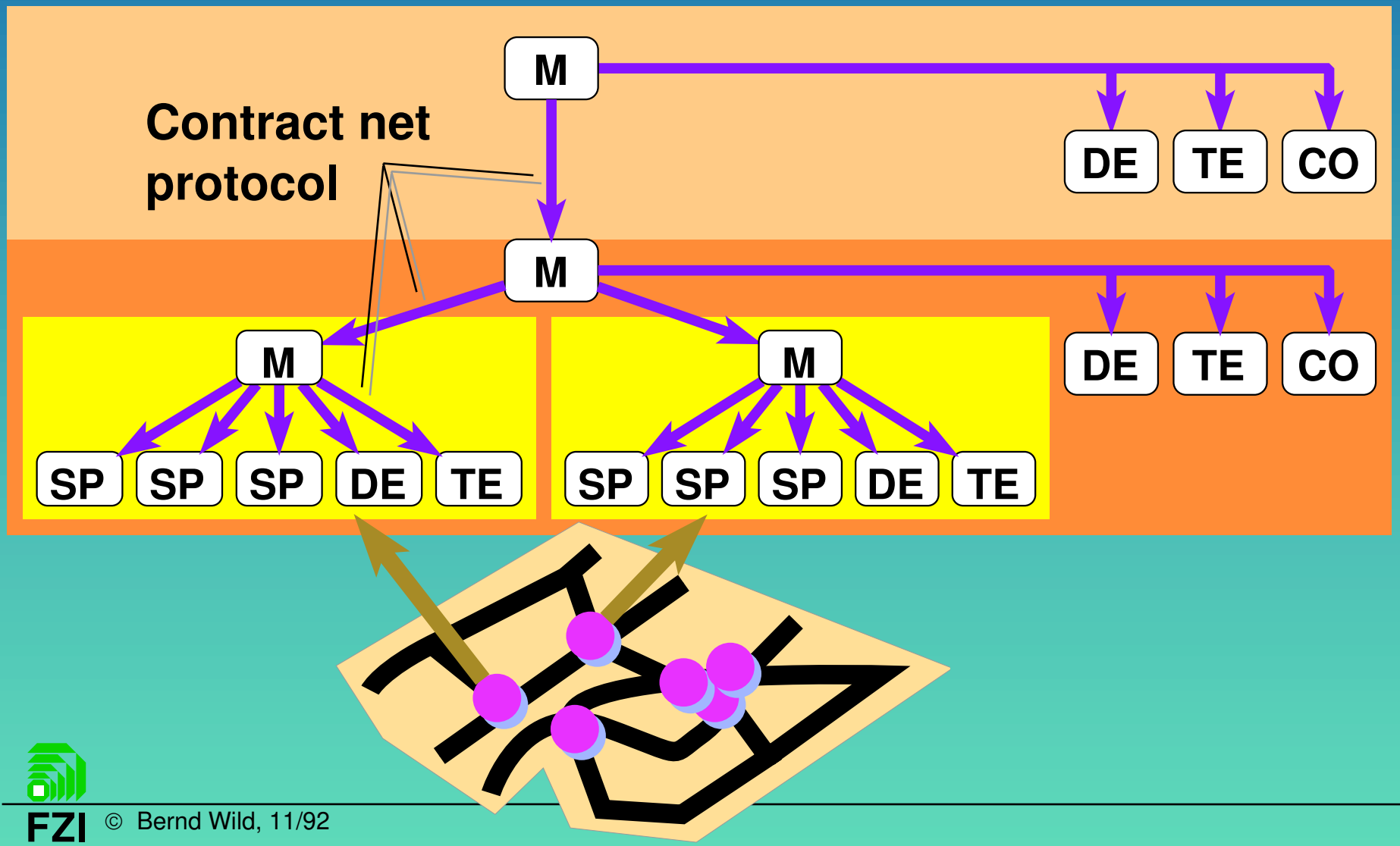
- conventional architectures



Traffic Control as DPS

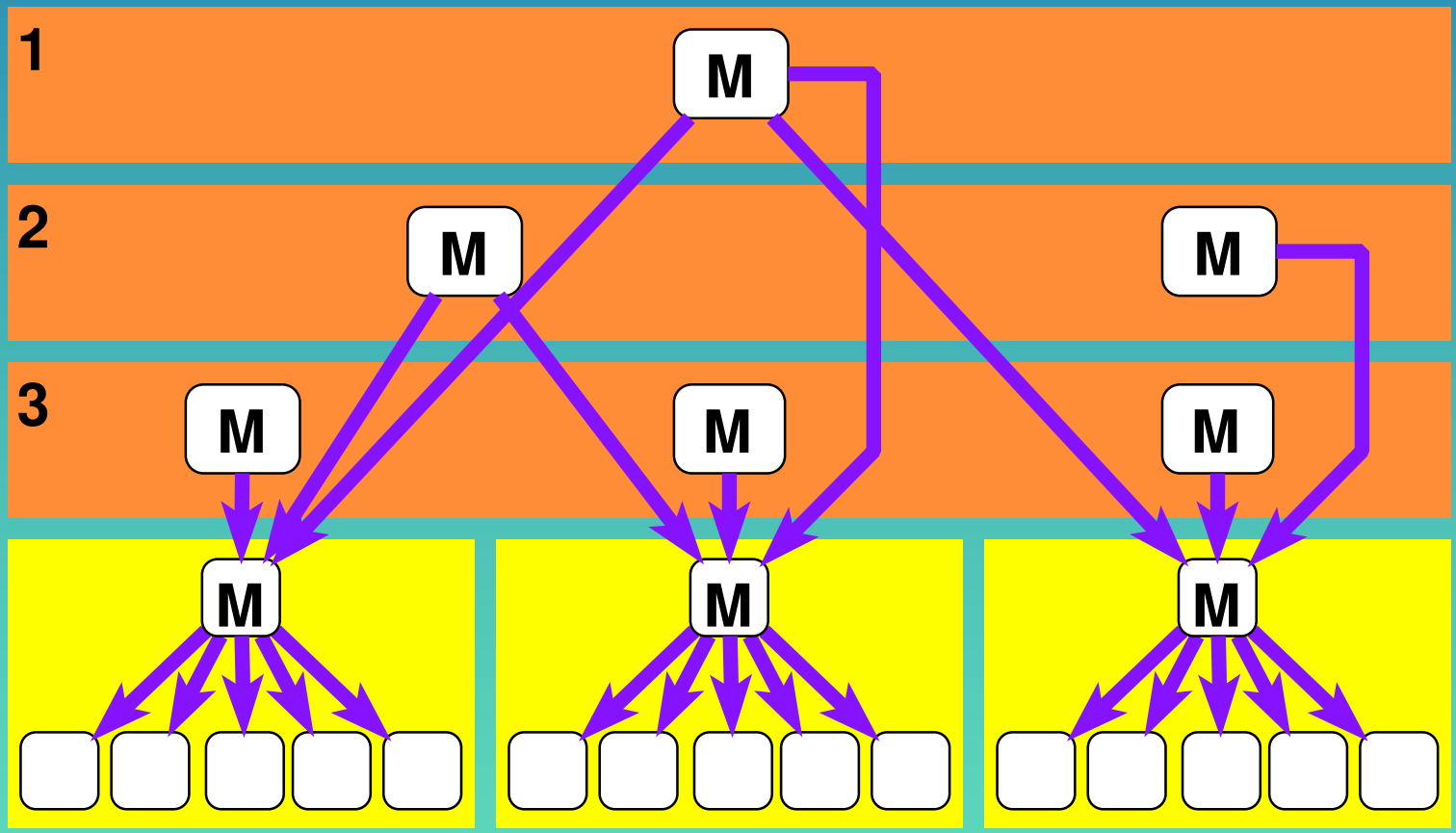
- hierarchical organization
- distributed optimization
- cooperative problem solving

Traffic Control as DPS

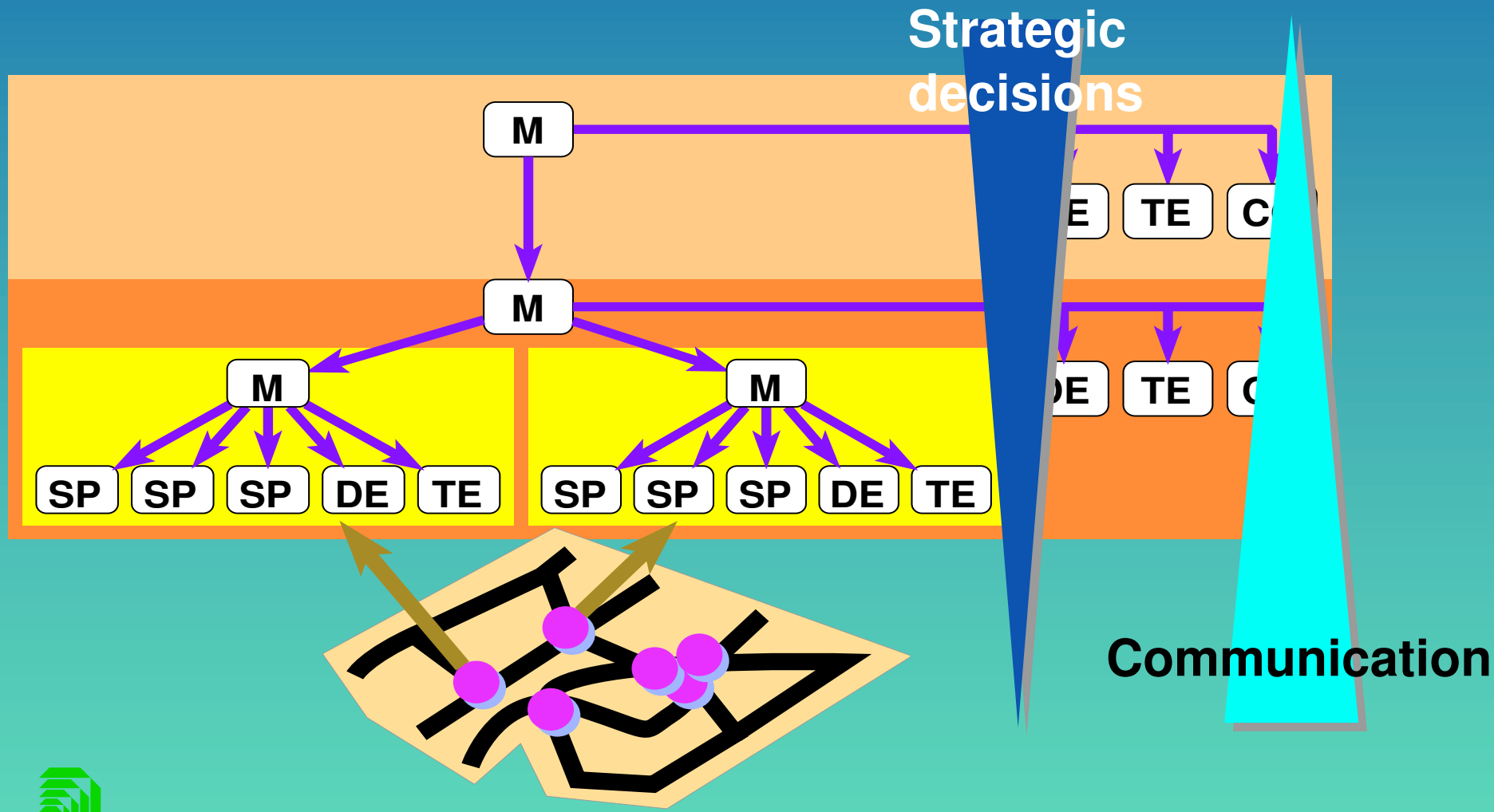


Traffic Control as DPS

- coupling + reorganization



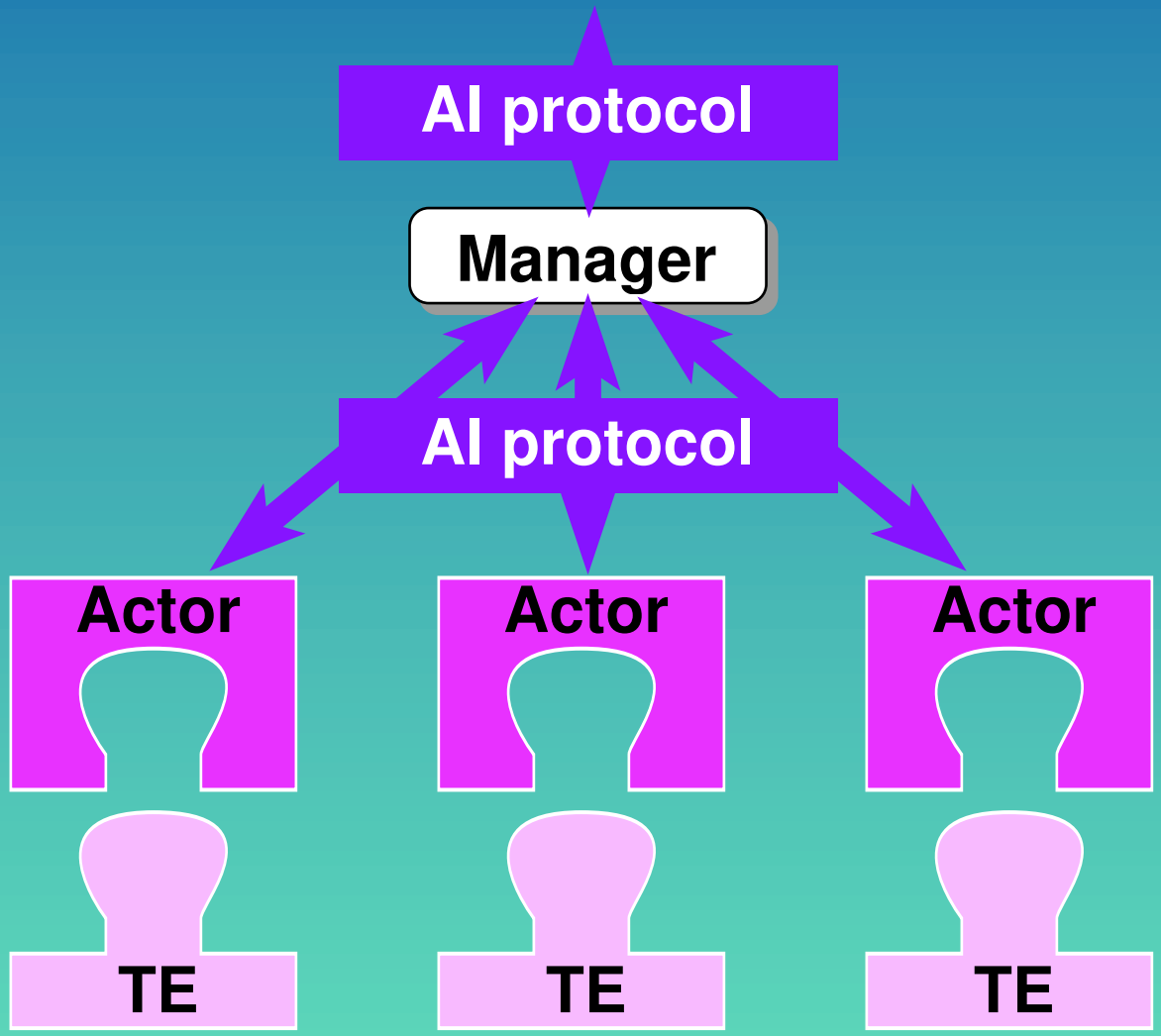
Concurrent Architectures



AI-based Framework

- optimization by TE methods (NO AI!!)
- integration of TE methods
  - abstract interfaces
  - AI protocol
  - AI selecetion mechanisms
  - Knowledge-bases
  - support of concurrent problem solving

AI-based Framework



Conclusion

- review of AI methods in traffic engineering
  - analysis of candidate methods
  - adoption of 4 basic techniques
- construction of a software prototype
- research in distributed traffic control models

The End