SAPPORO

A Platform for Intelligent Integrated Traffic Management

FZI

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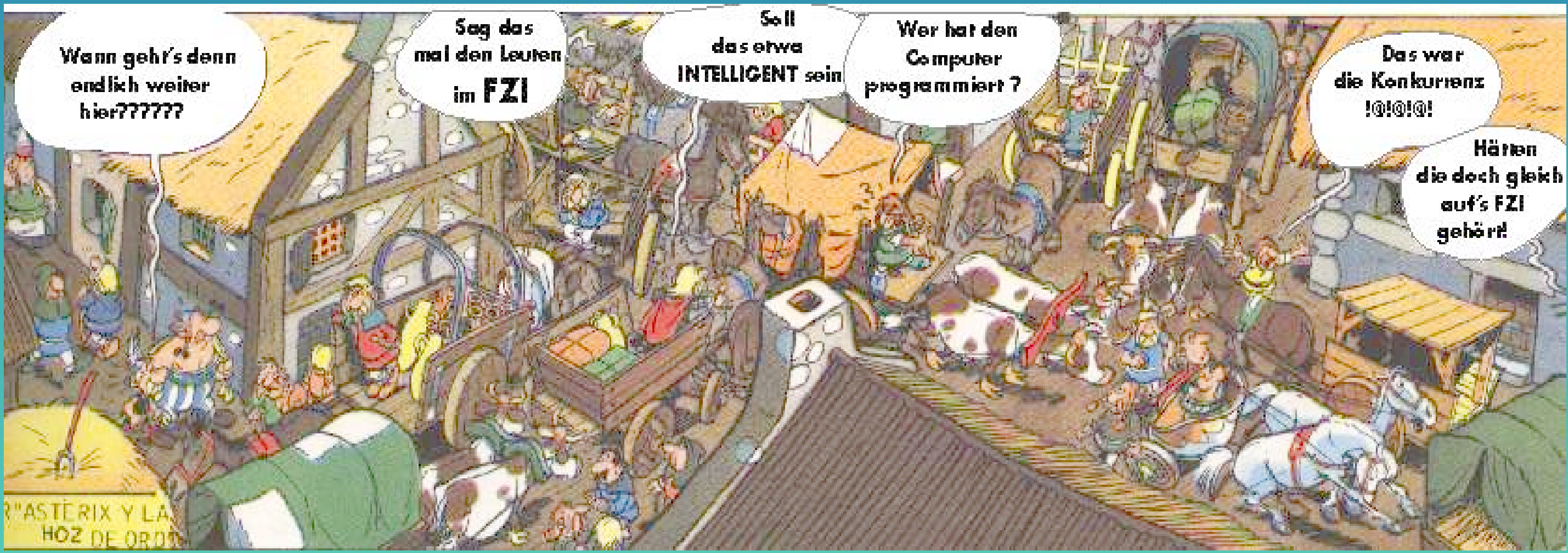
SAPPORO

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

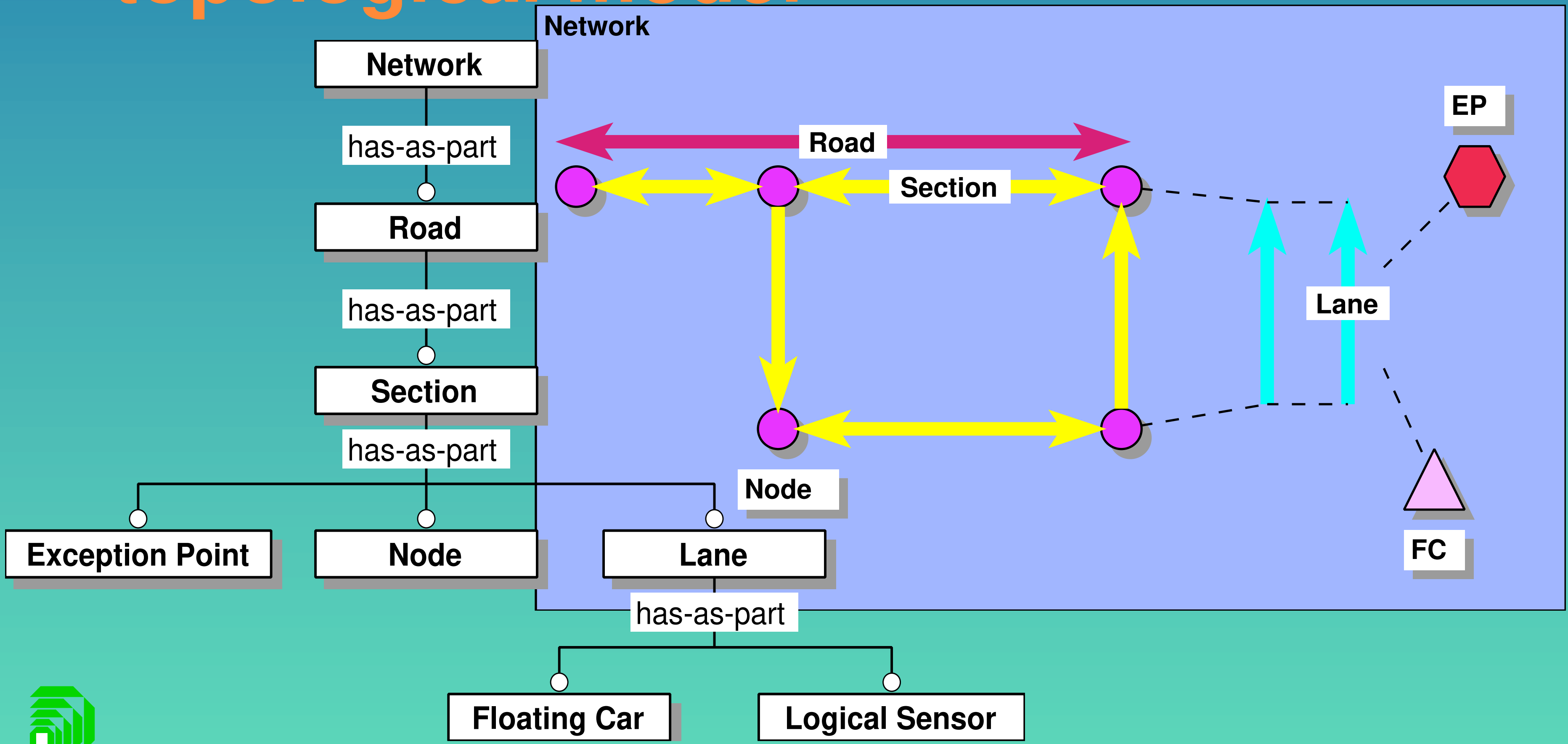
Architecture of Sapporo

- basic models
- tools
- interfaces

Basic Models

Architecture

- topological model



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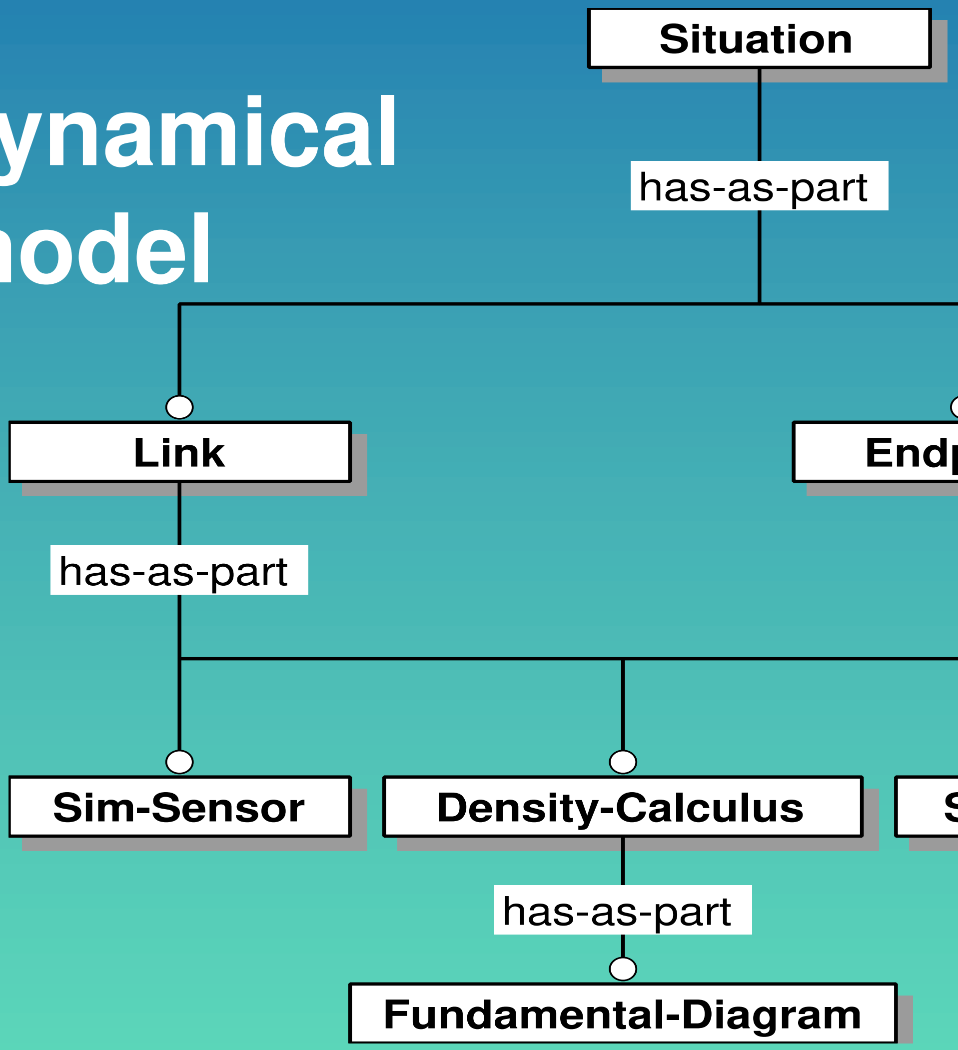
Basic Models *Architecture*

- **dynamical model**



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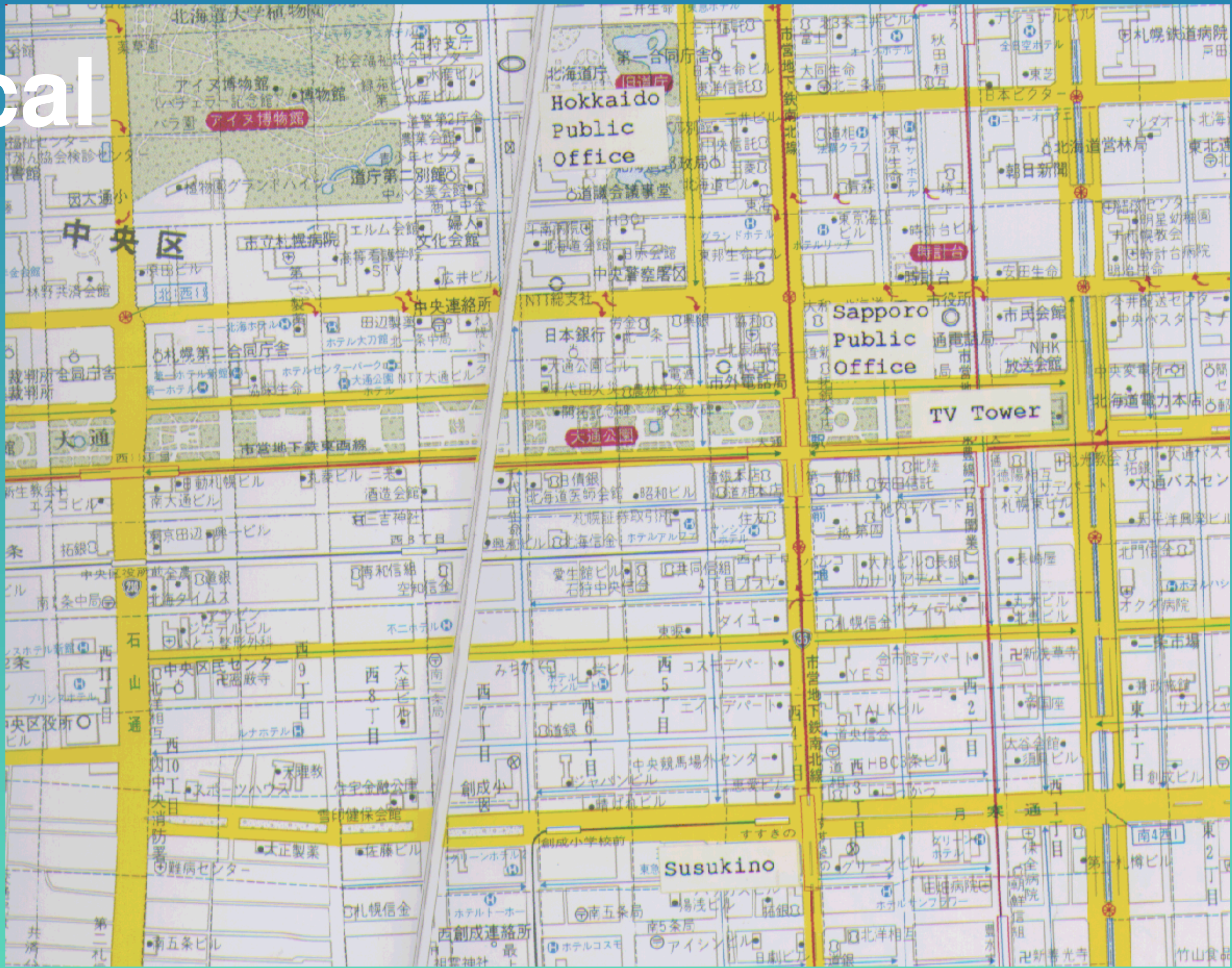
Basic Models

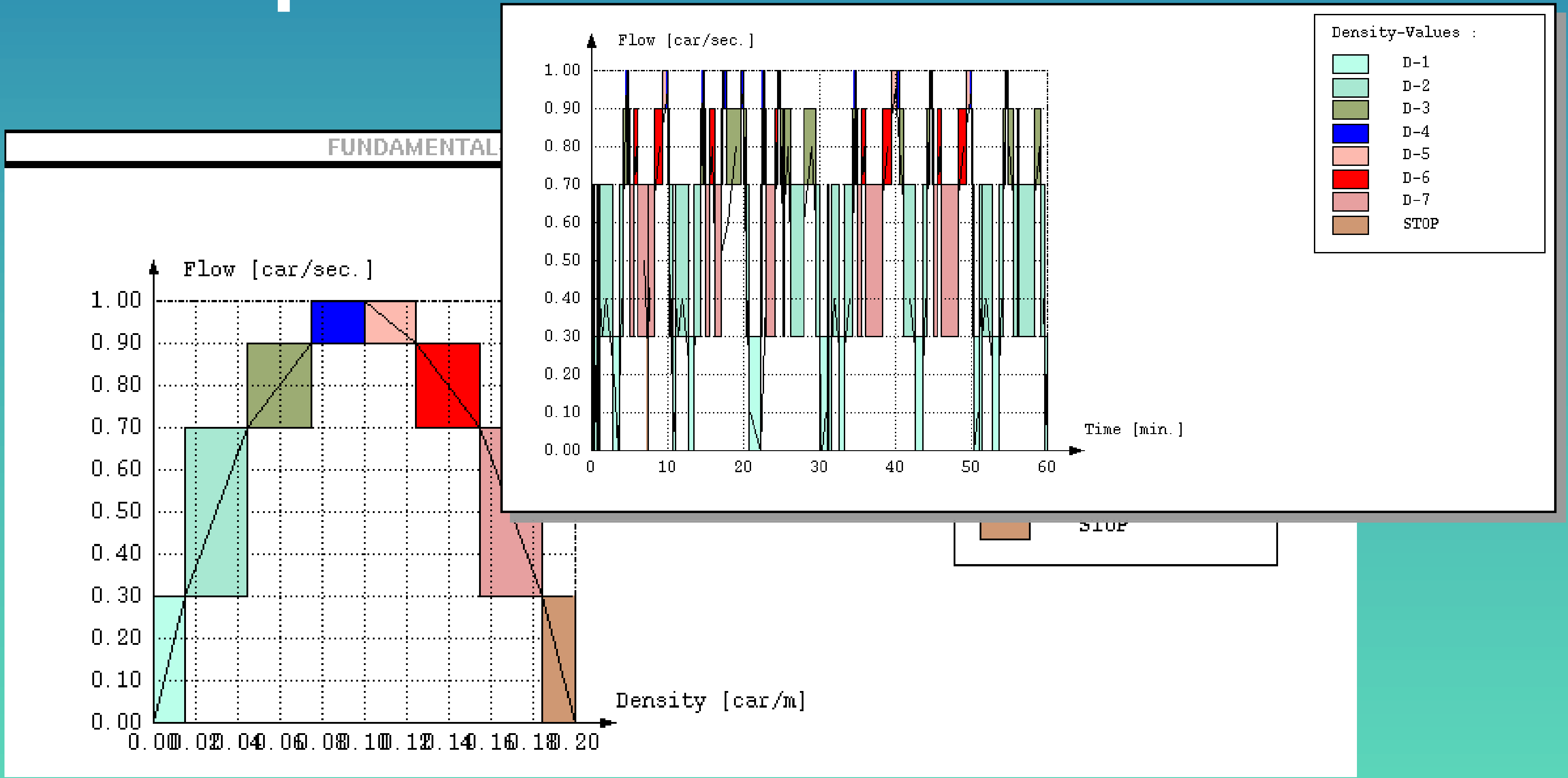
Architecture

- **geometrical model**



Basic Models
Architecture

- traffic parameter model



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Basic Models

- **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**

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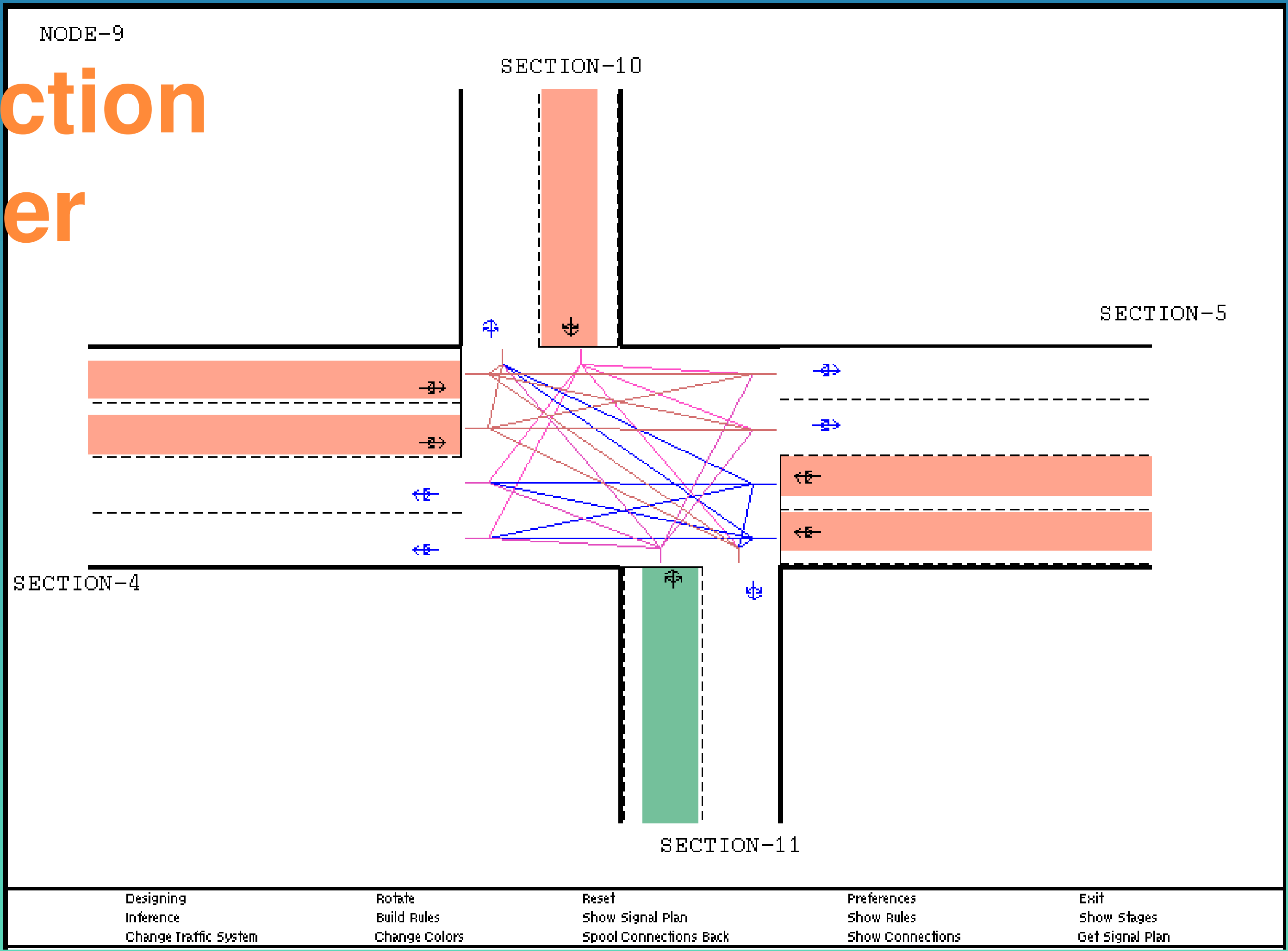
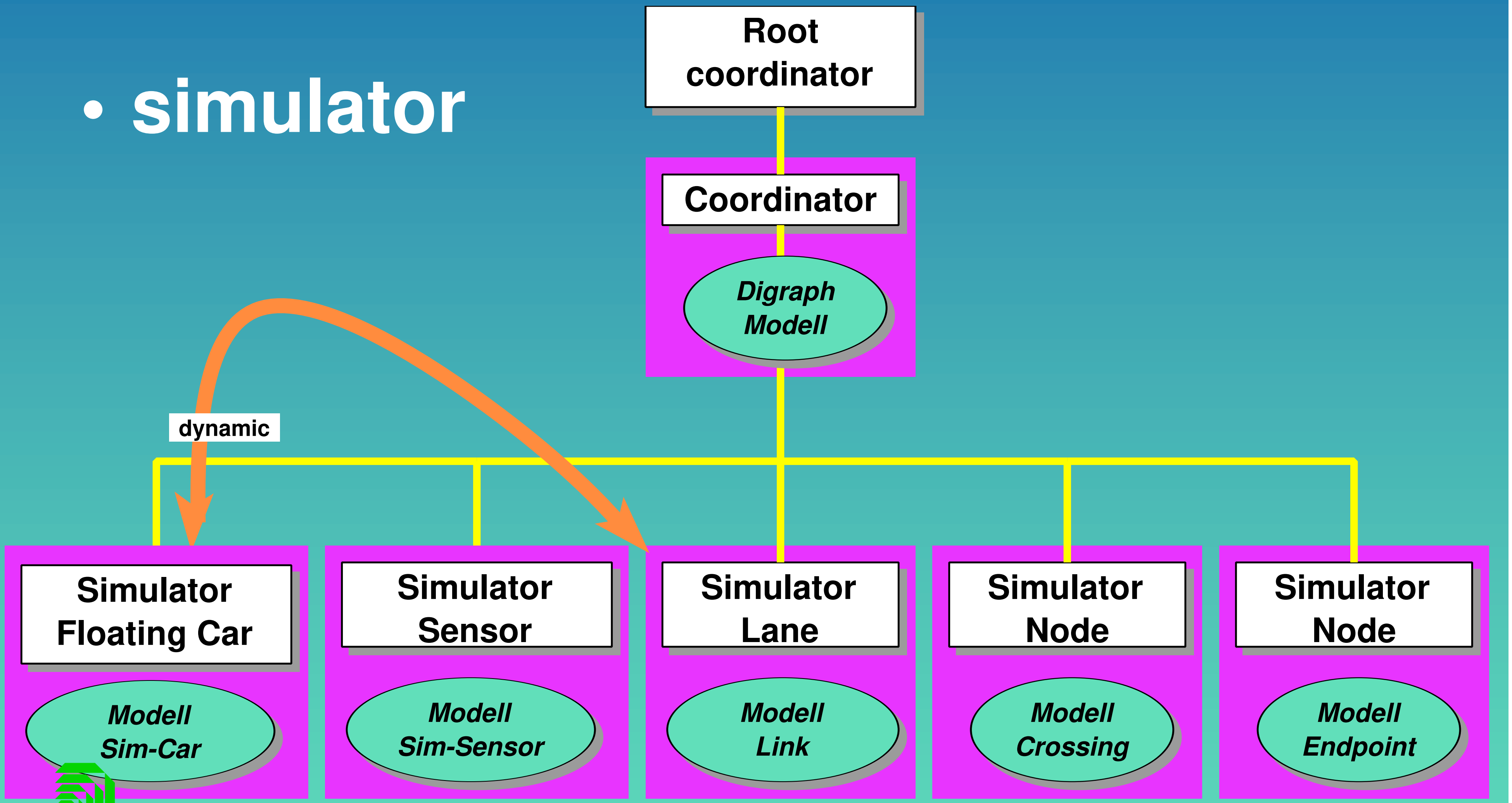
Tools
Architecture

- **Intersection Designer**



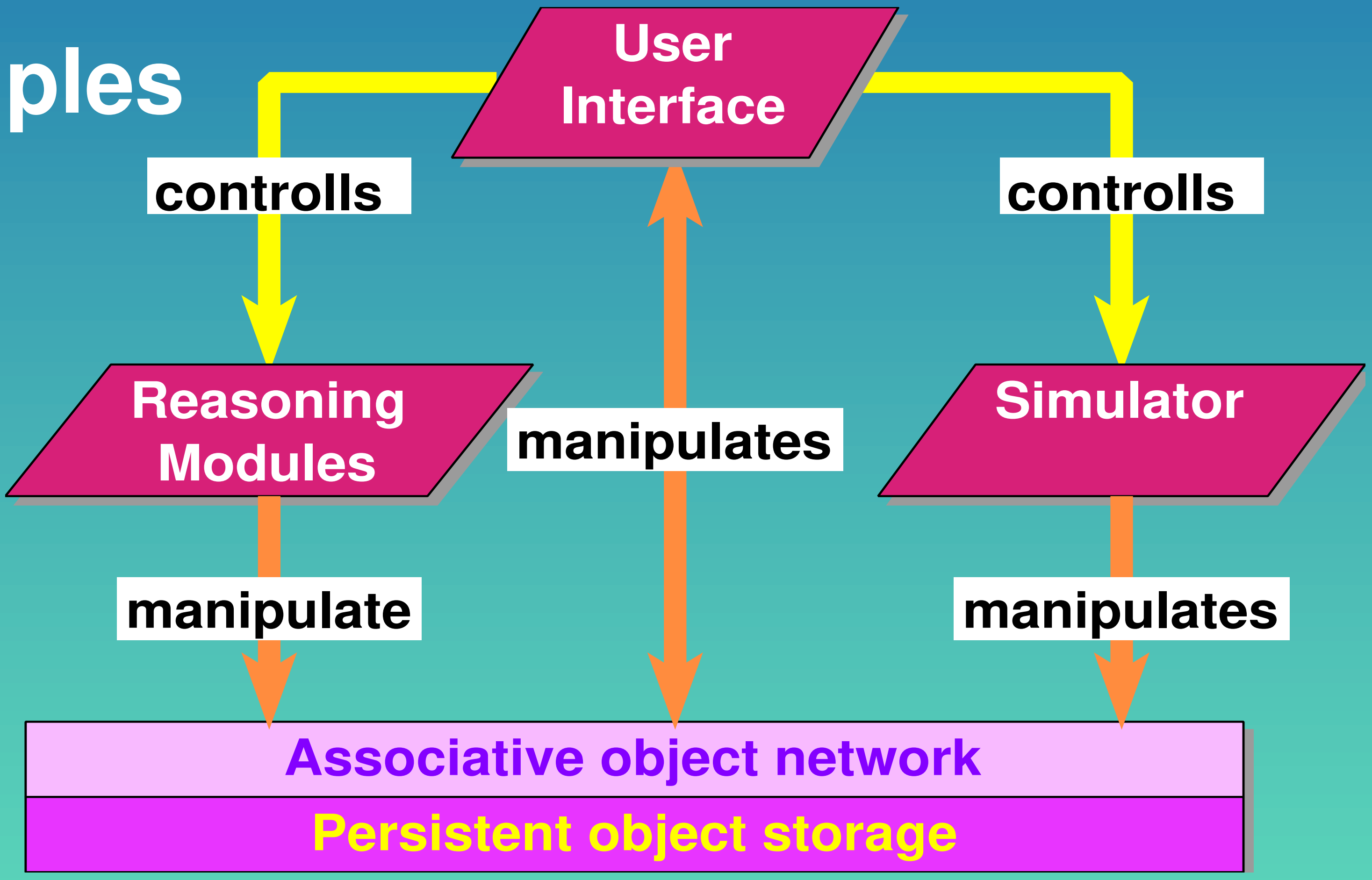
Tools — *Architecture*

- **simulator**



Interfaces

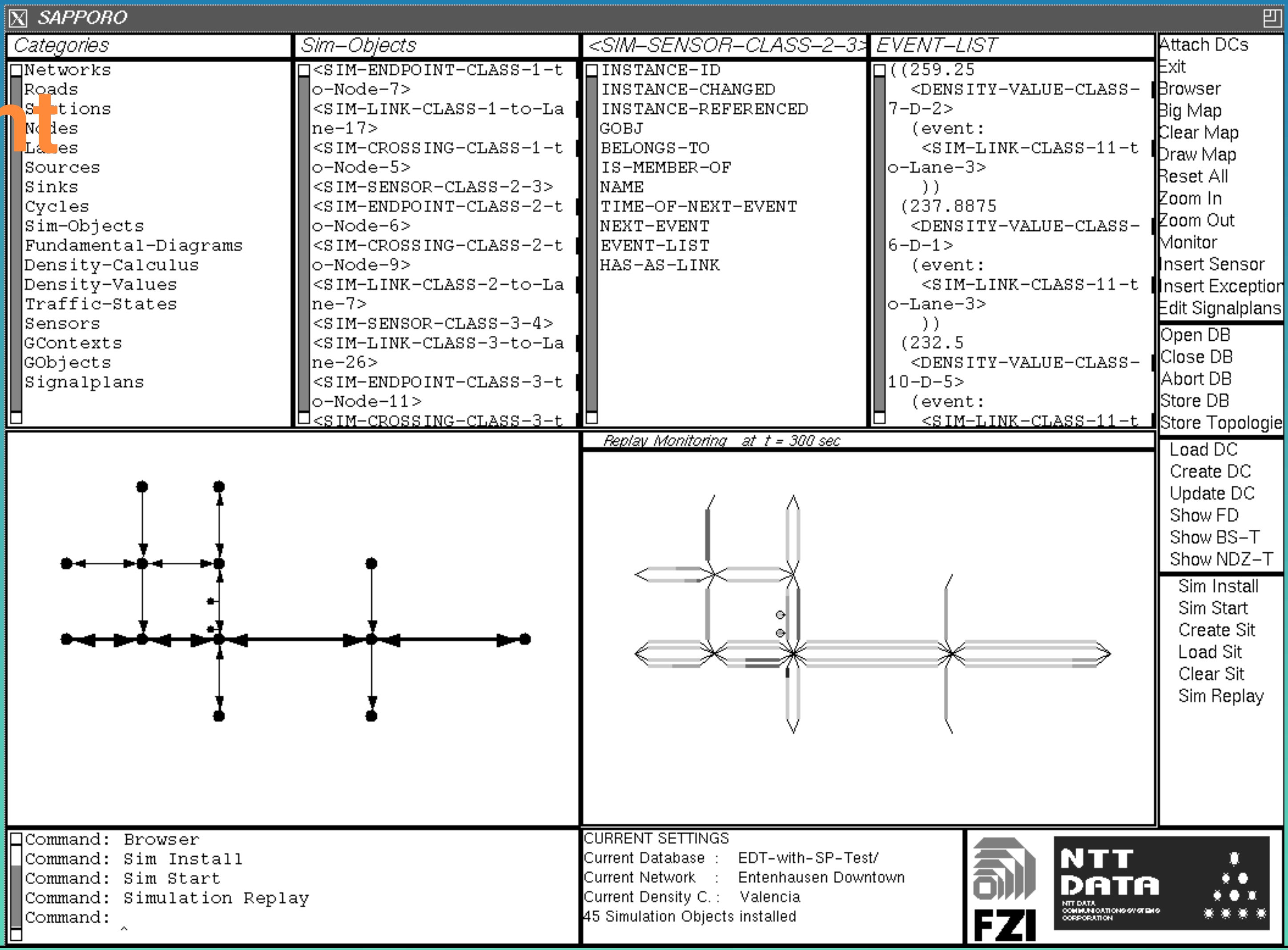
- principles



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

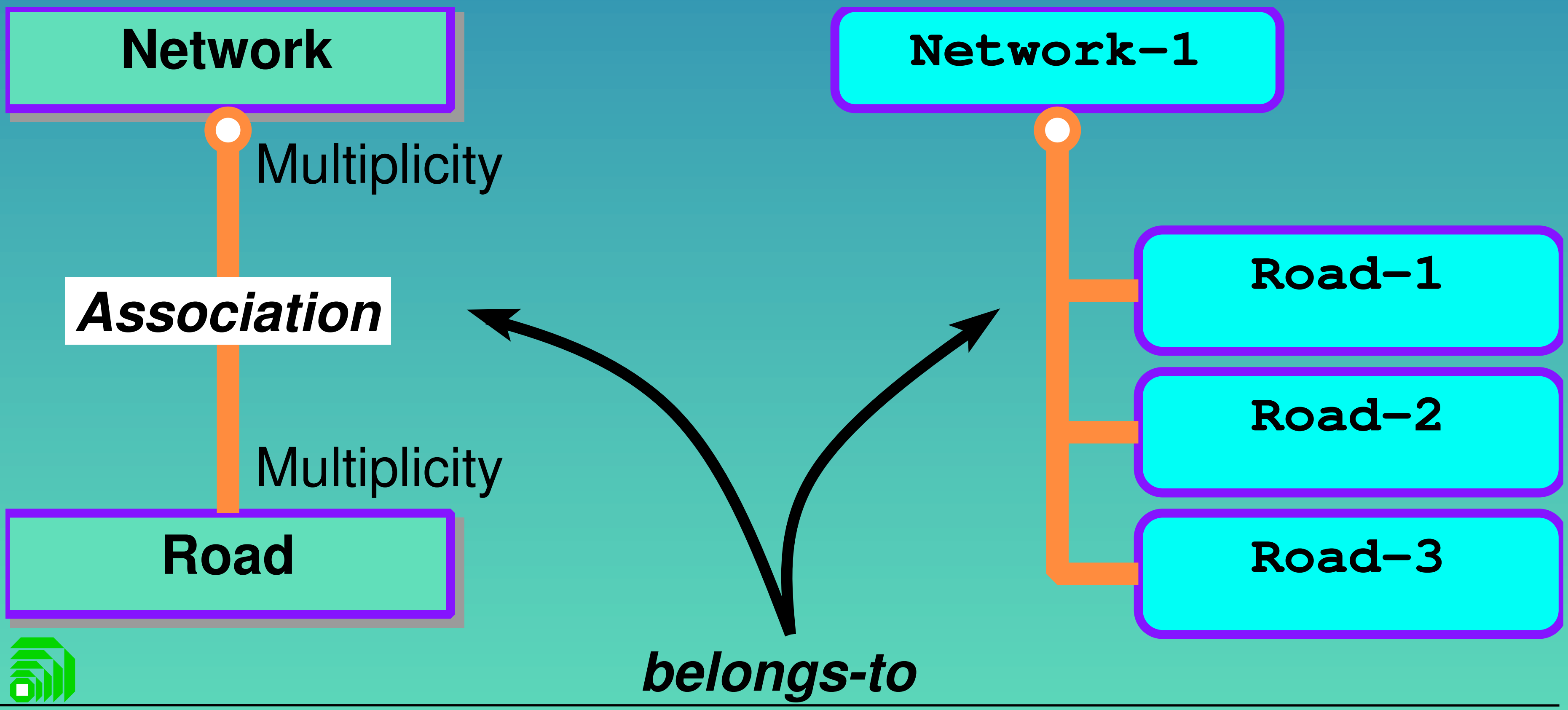
OOP

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

OOP

Methods

- principle of associative object nets



OOP

Methods

- **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 assciation nets

Logical Sensors

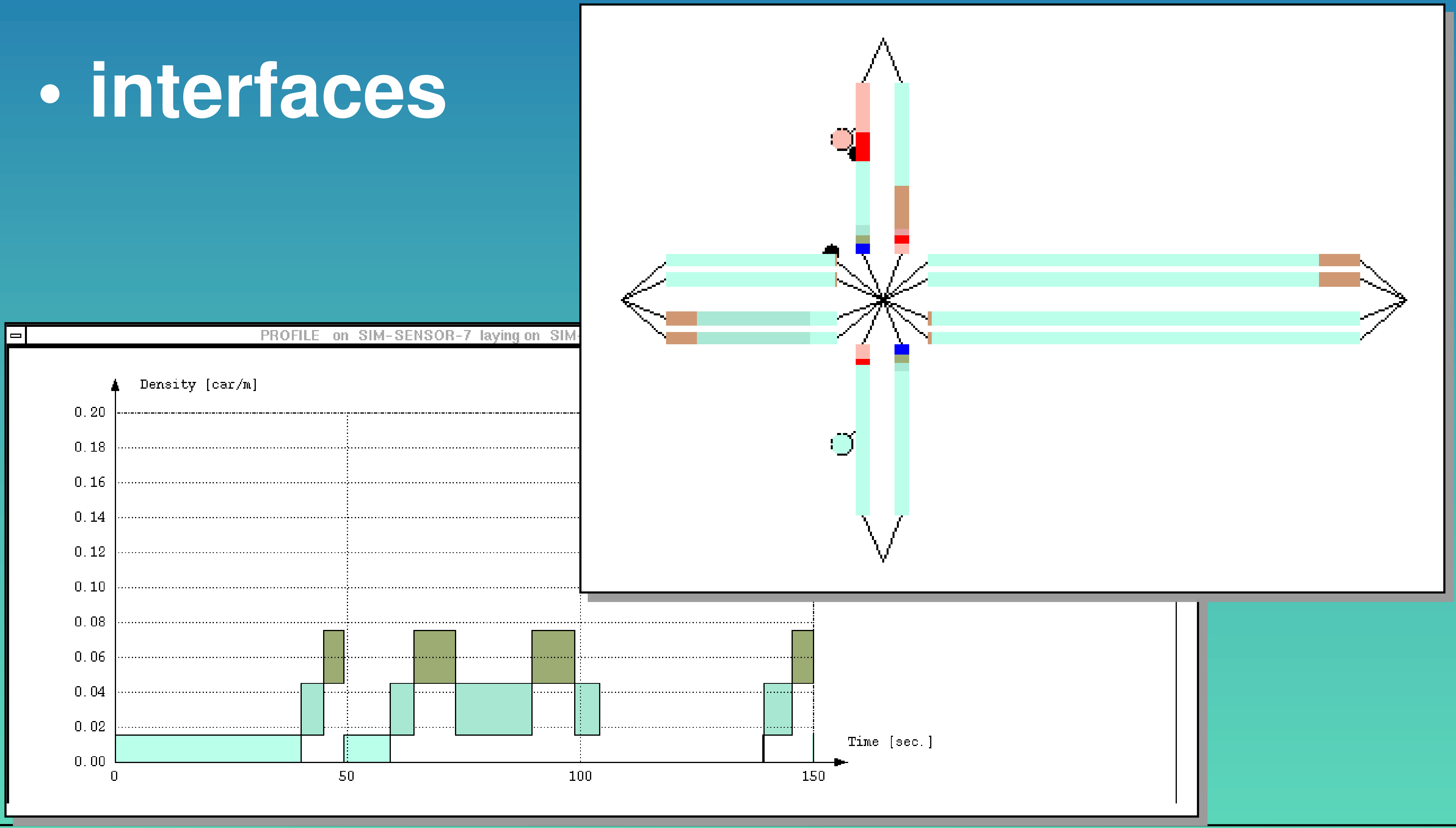
New Features

- 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

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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

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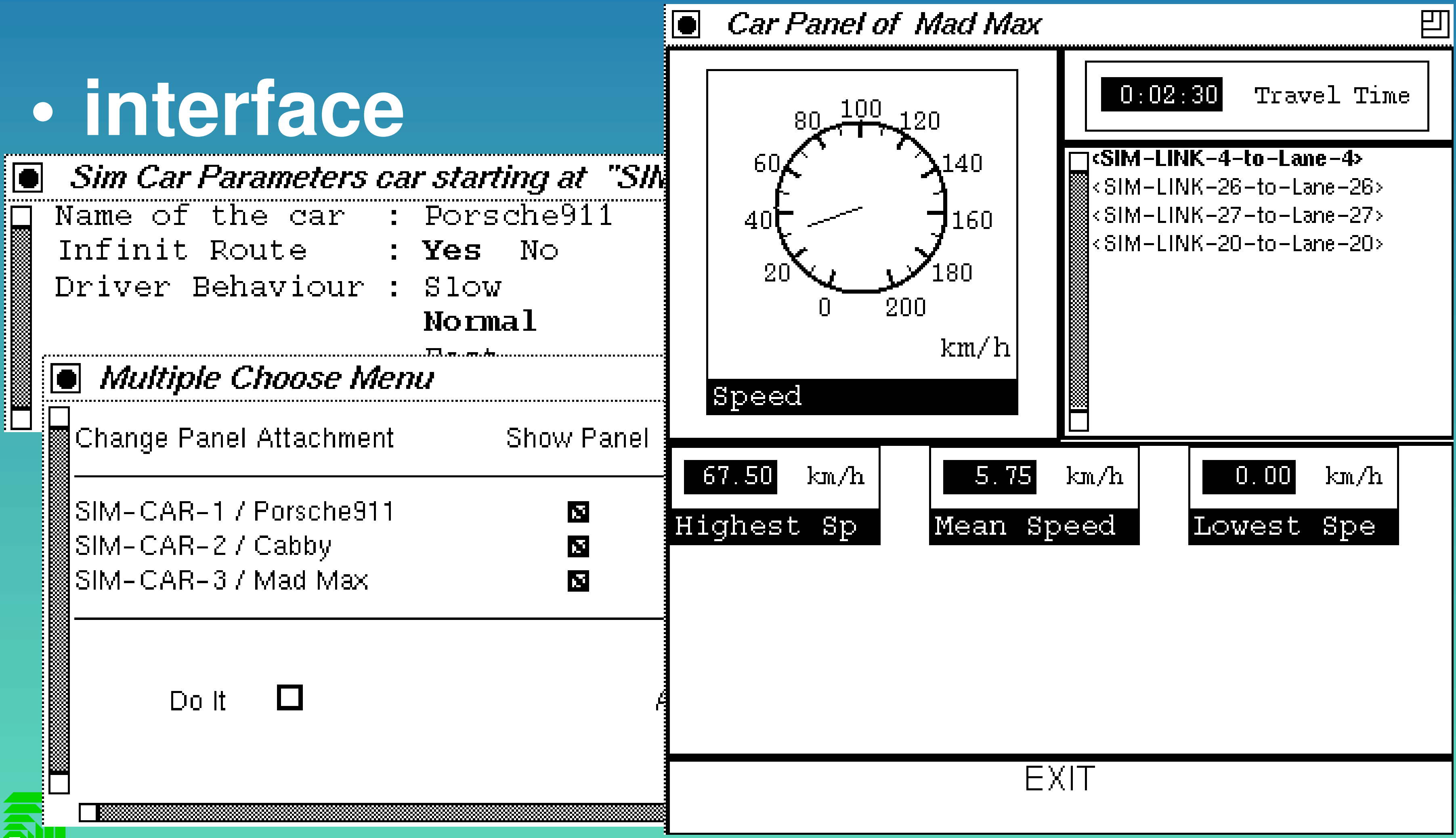
Floating Cars

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)))
    a number         25           (50 74
                                   ((<LANE-19-noname> <LANE-9-noname> 100) (<LANE-20-noname> <LANE-9-noname> 100)
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                                    (<LANE-10-noname> <LANE-21-noname> 50) (<LANE-10-noname> <LANE-22-noname> 50)
                                    (<LANE-3-noname> <LANE-11-noname> 50) (<LANE-3-noname> <LANE-12-noname> 50)))
    a number         a number     (75 99
                                   ((<LANE-19-noname> <LANE-4-noname> 100) (<LANE-20-noname> <LANE-4-noname> 100)
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                                    (<LANE-3-noname> <LANE-21-noname> 50) (<LANE-3-noname> <LANE-22-noname> 50)))
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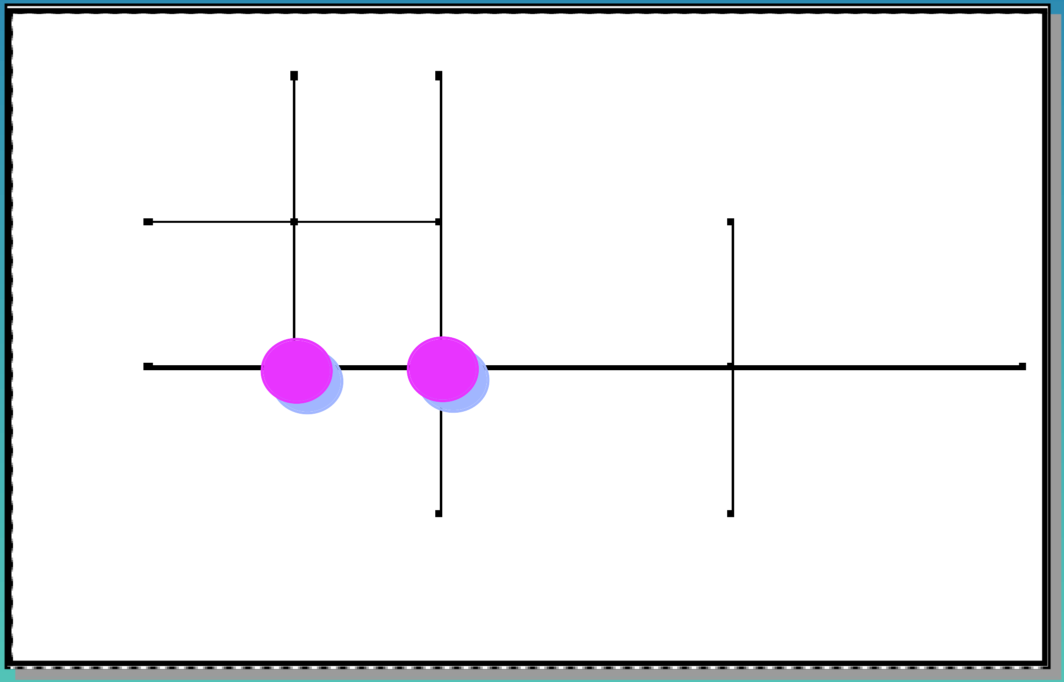
Traffic Control

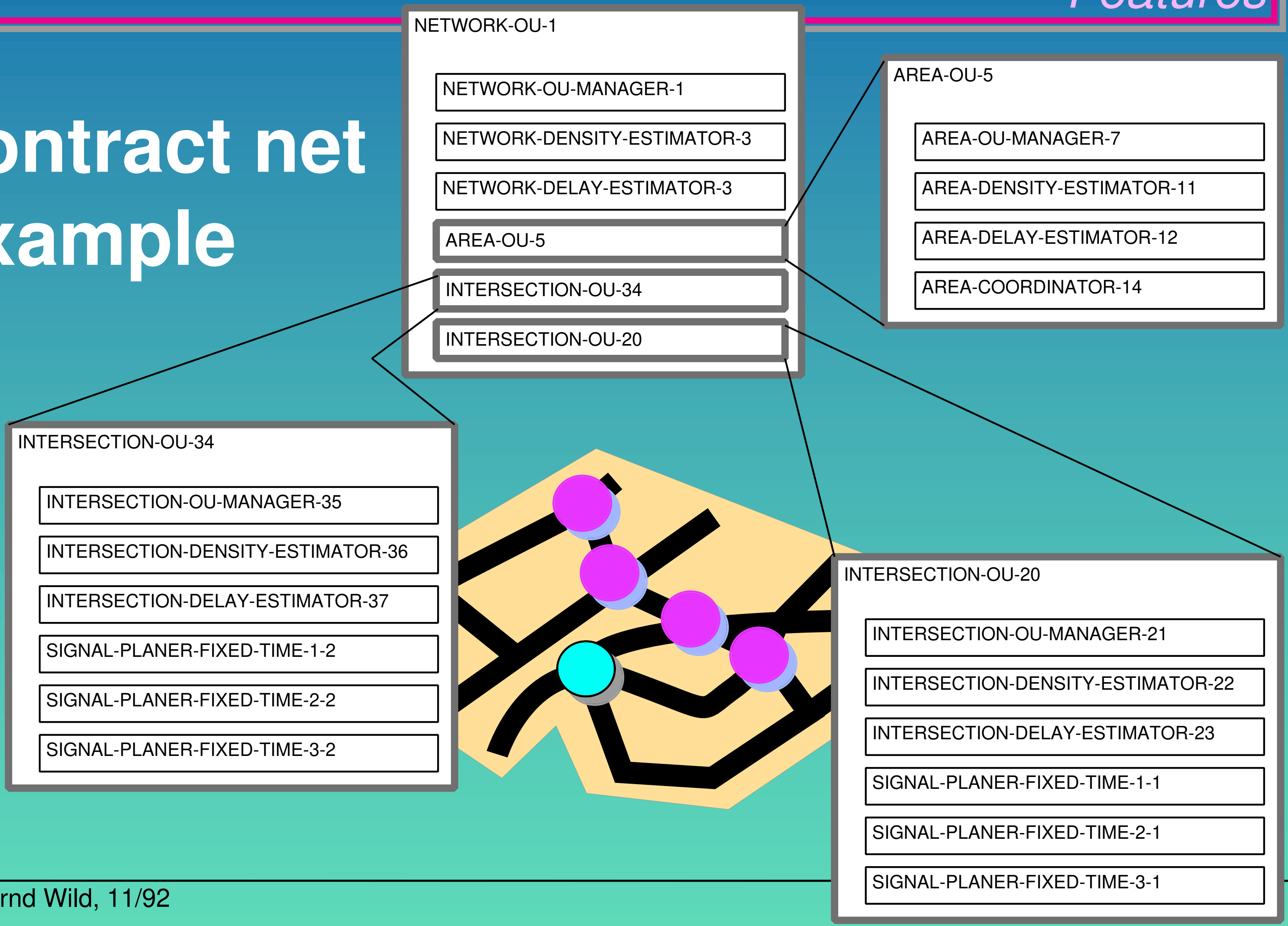
- contract net example
- 2 coordinated intersections
- 3 fixed-time signal plans



Traffic Control

New Features

- **contract net example**

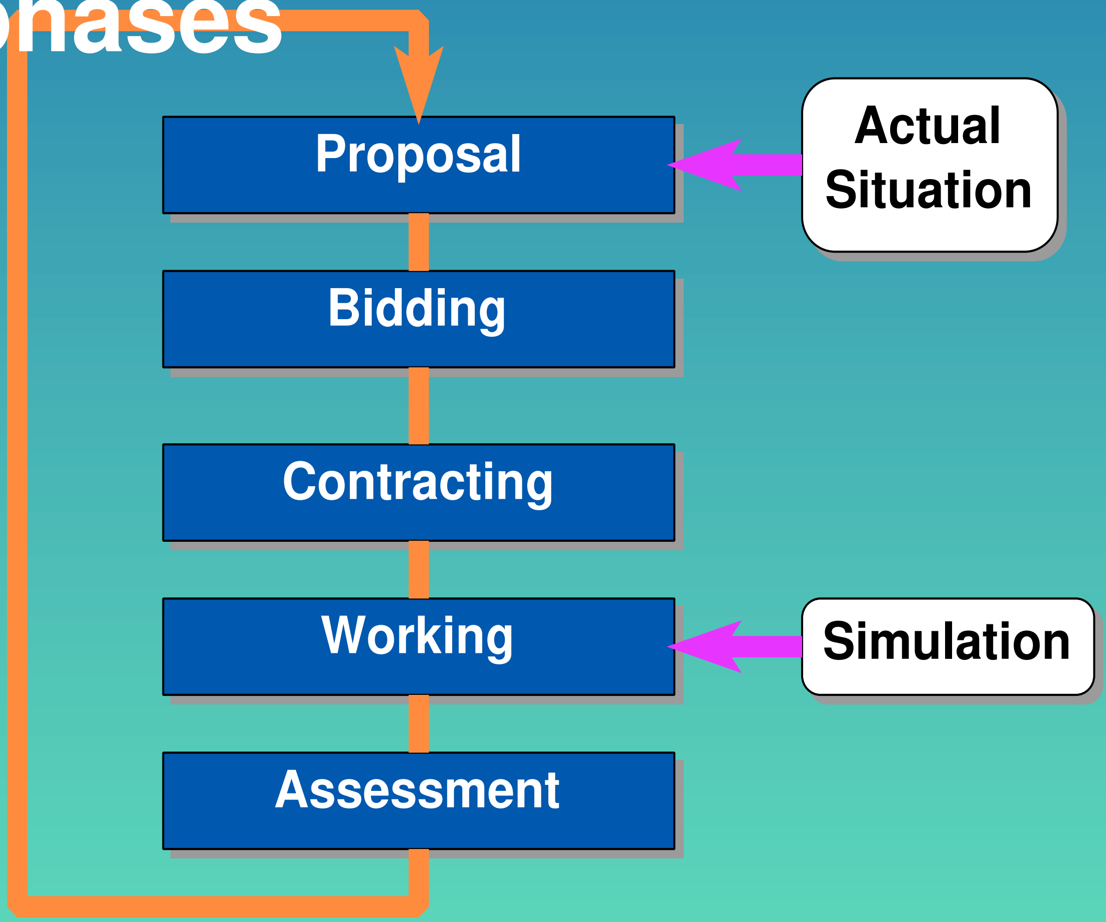


Traffic Control

New Features

Time Horizon ca. 5min

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



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Extensions

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

Public Transport *Extensions*

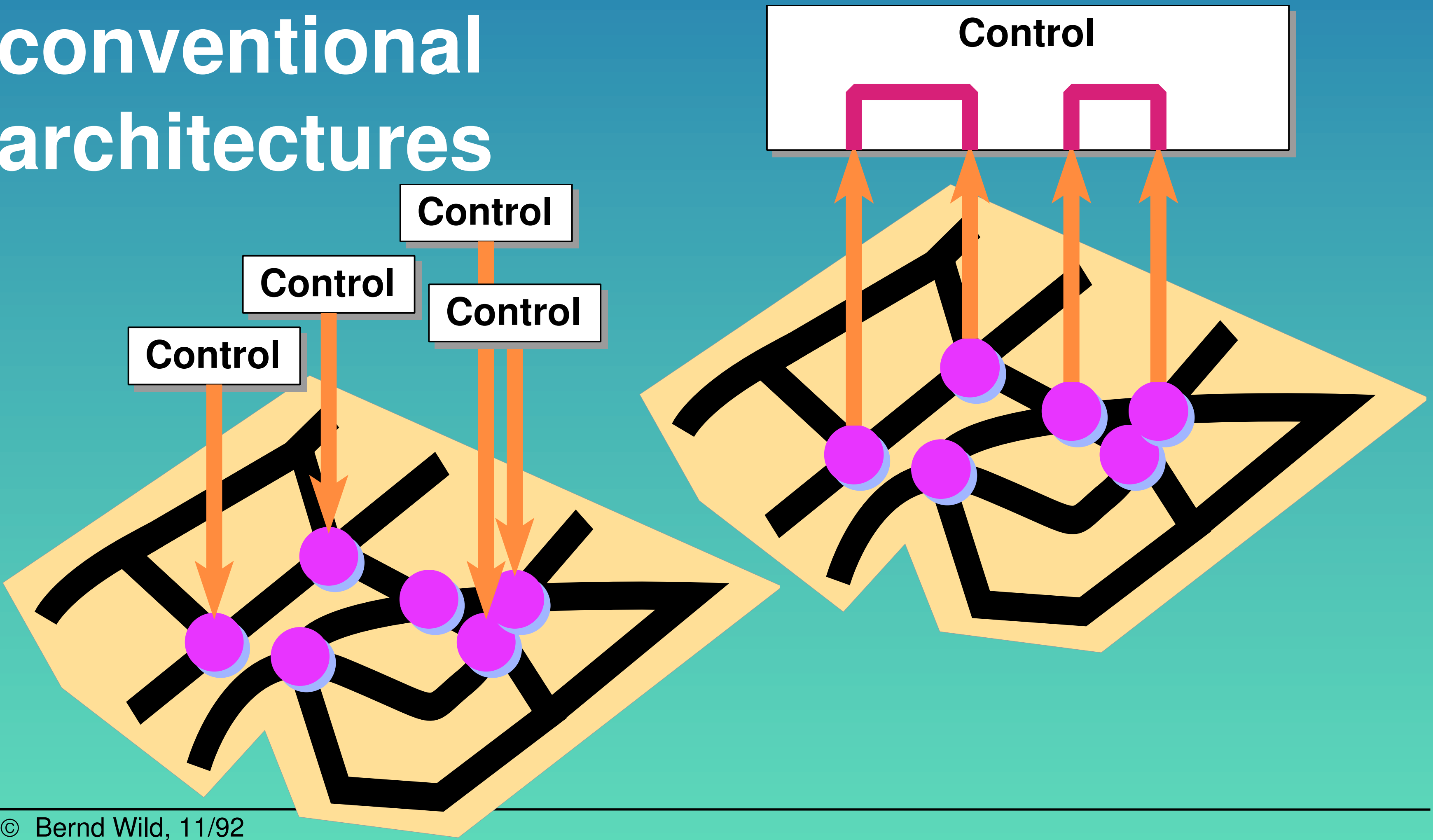
- floating cars
  - buses
  - taxis
- separate bus lanes
  - arrival estimation
  - priorization
- emergency vehicles

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

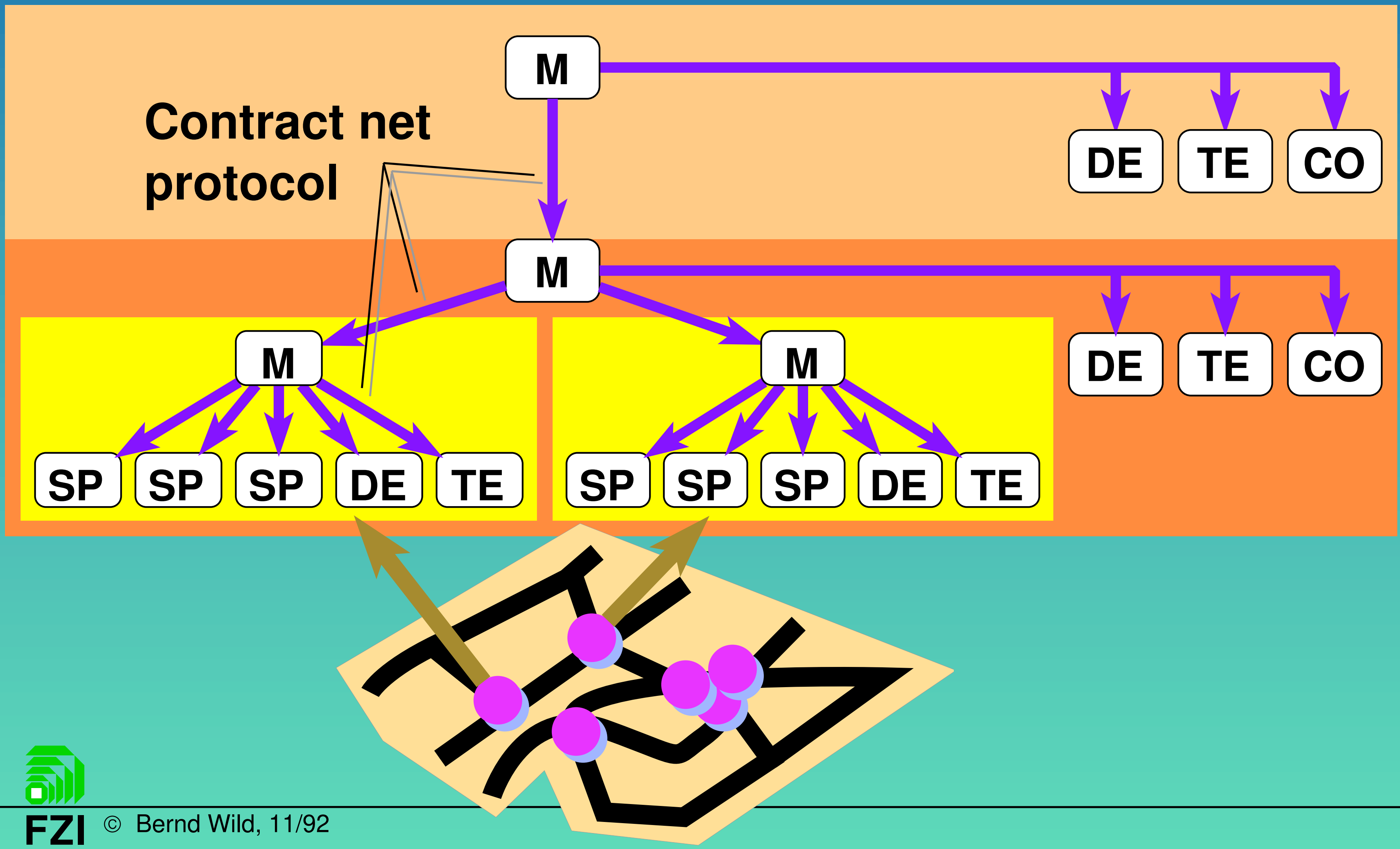
- conventional architectures



Traffic Control as DPS

- hierarchical organization
- distributed optimization
- cooperative problem solving

Traffic Control as DPS



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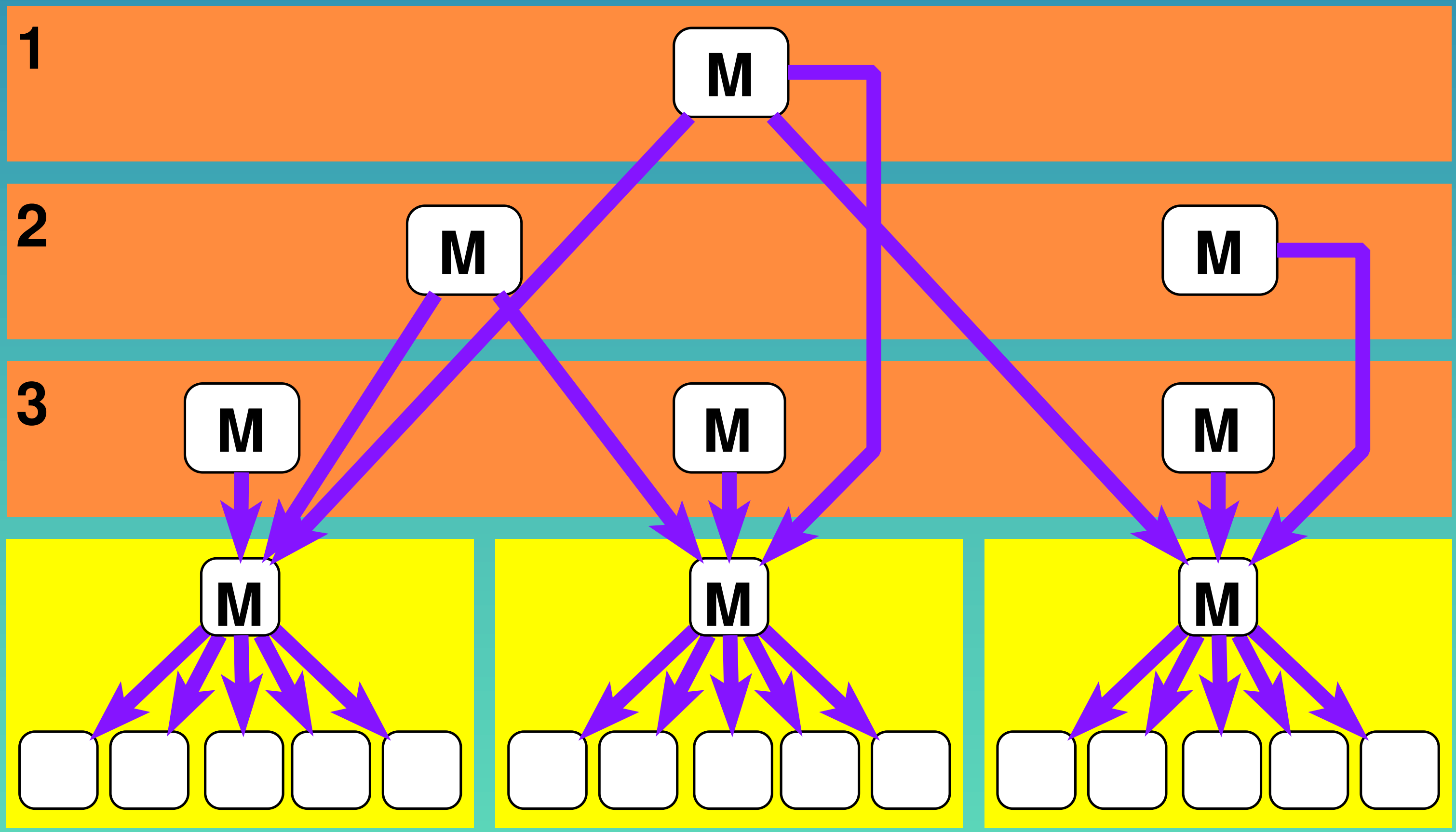
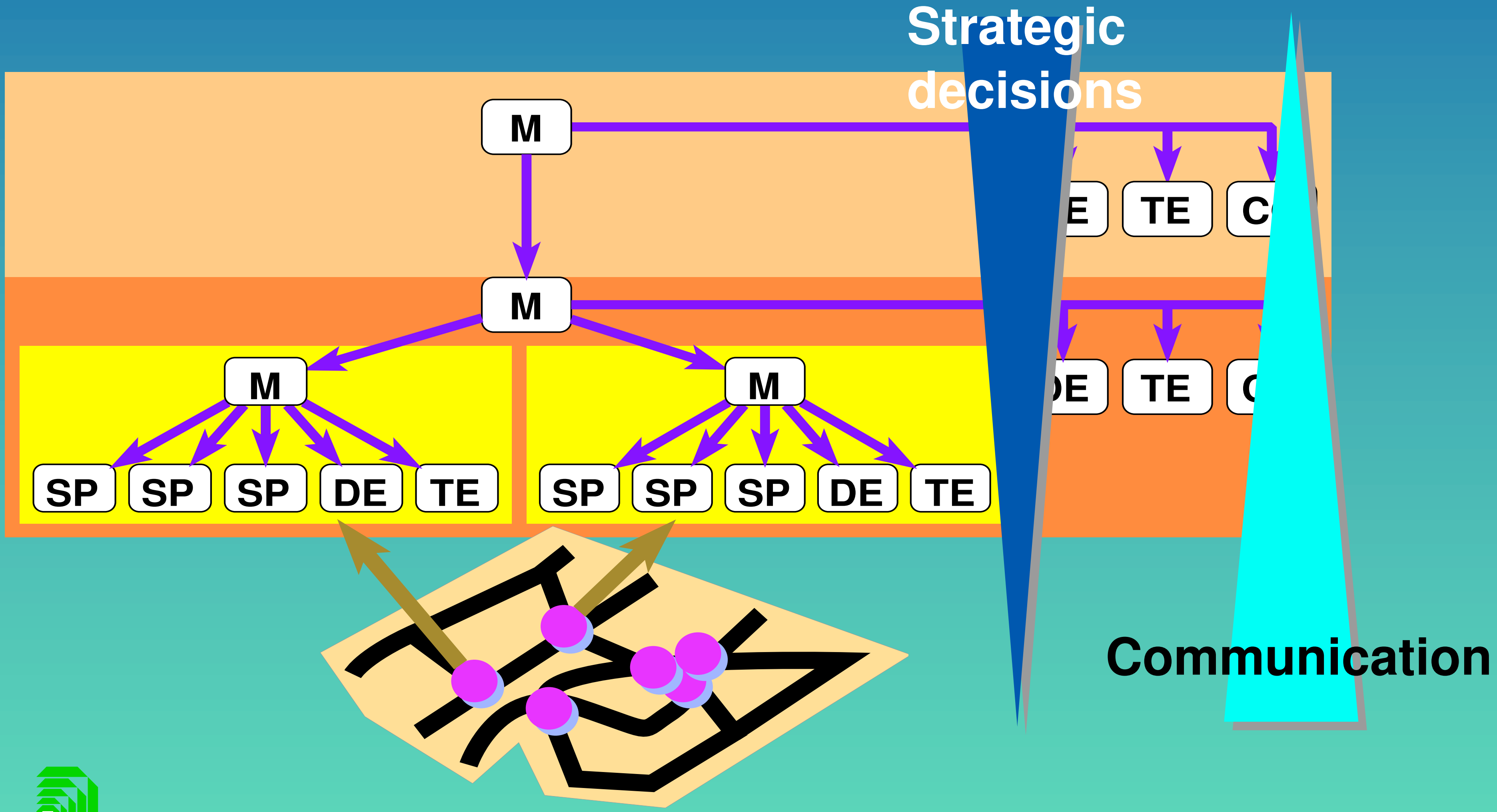
Traffic Control as DPS

- coupling + reorganization



Concurrent Architectures



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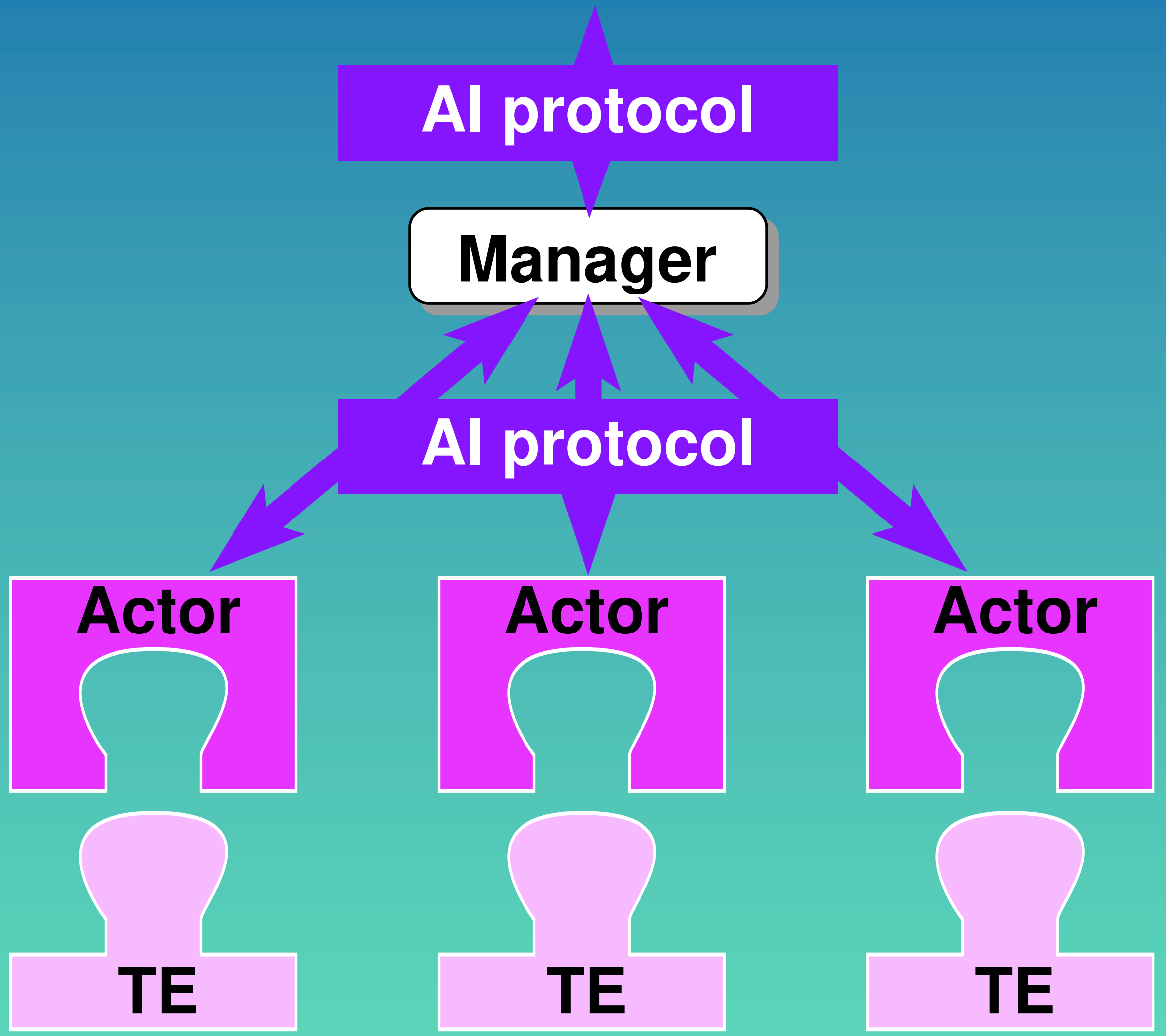
AI-based Framework

- 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



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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