

May, 2010, MATSim Usermeeting, ETH Zurich

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# Within Day Replanning with MATSim

**ETH**

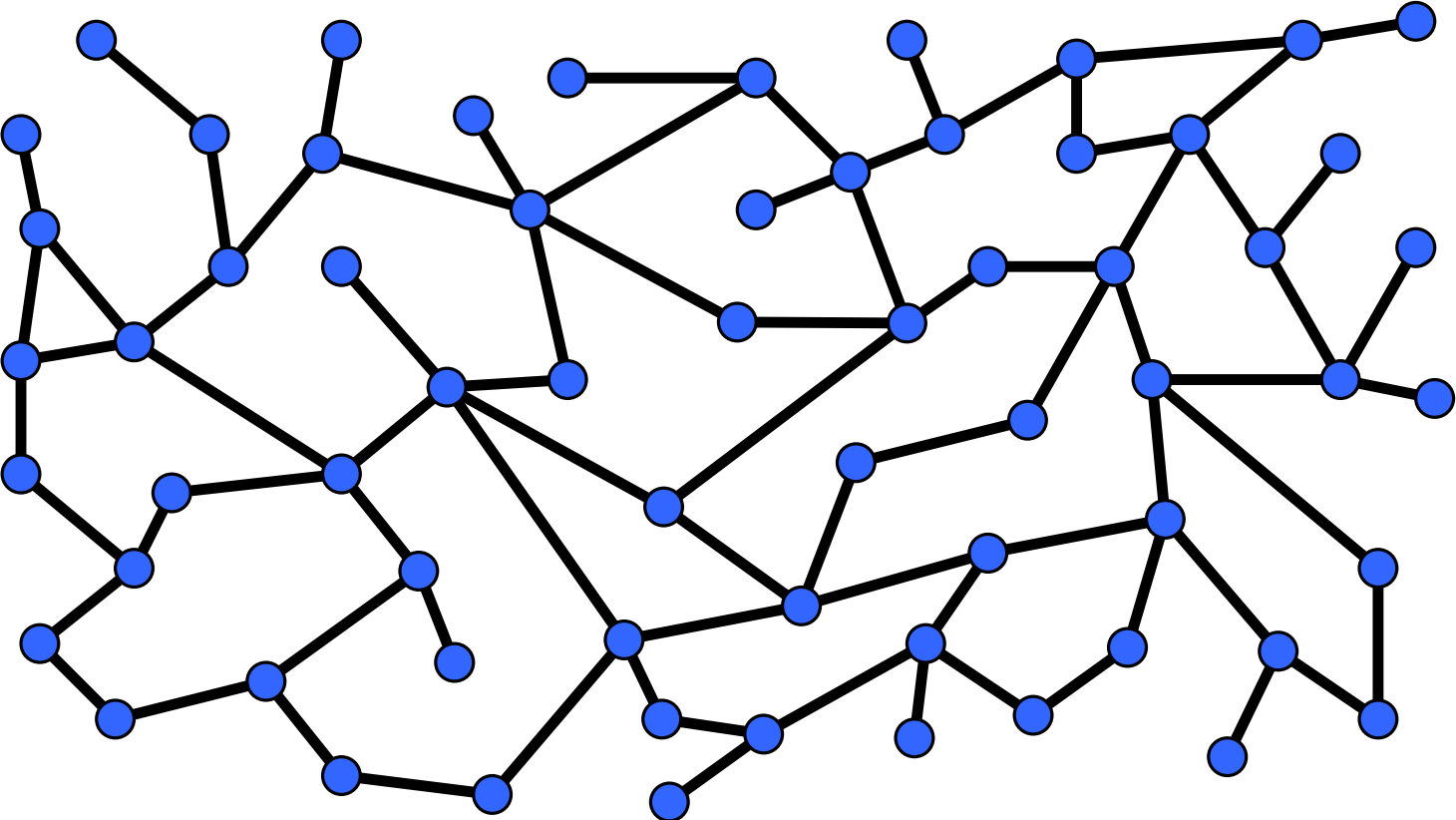
Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zurich

**MATSim**  
Multi-Agent Transport Simulation

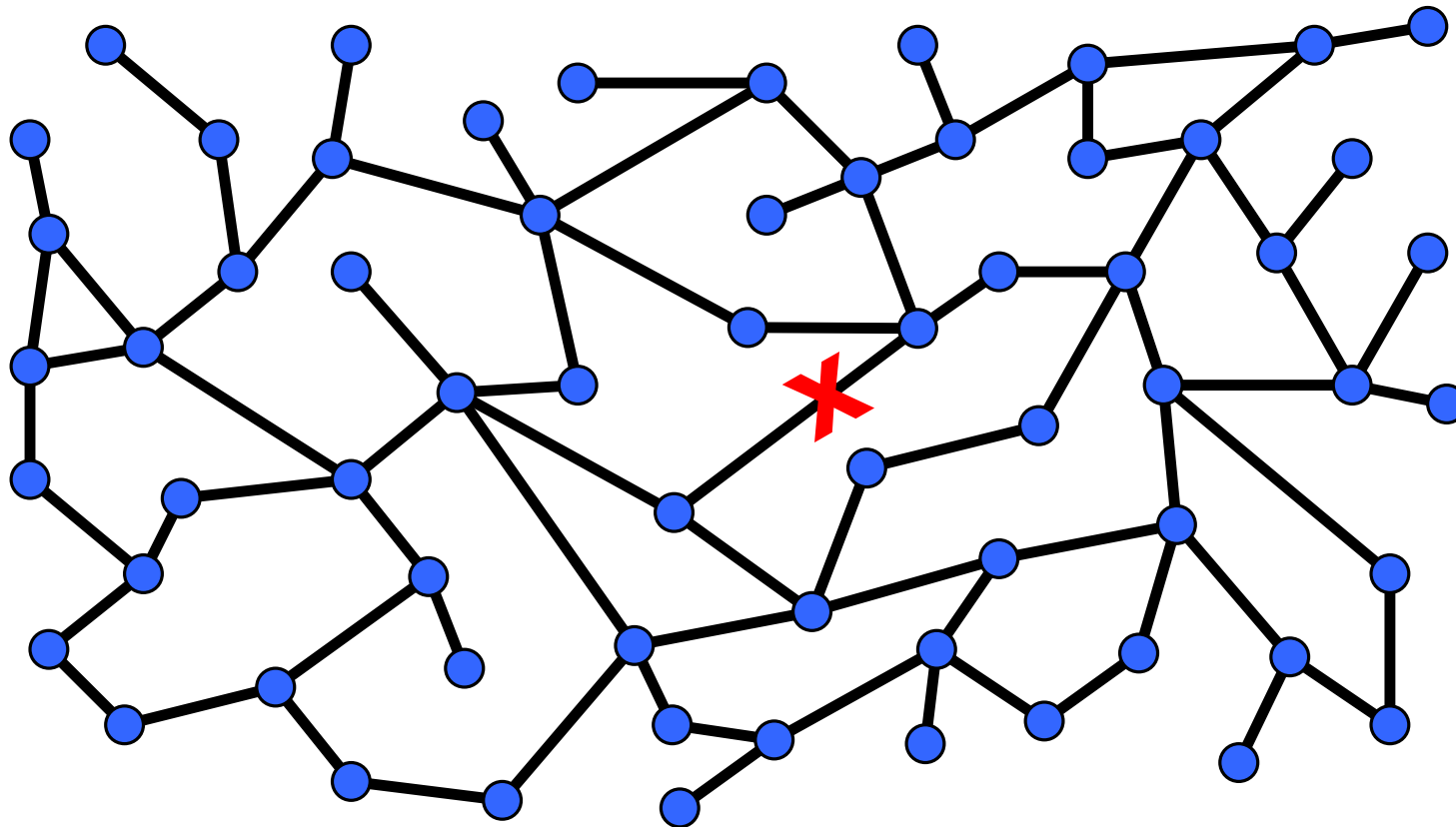
# Why Within Day Replanning?

- MATSim uses an iterative simulation approach
  - Agents use information from previous iterations when creating new plans
  - Meaningful for “typical day” scenarios
- But how to simulate scenarios with unpredictable events?
  - What happens if trying to do so using an iterative approach?

# Unpredictable Events in MATSim – Network

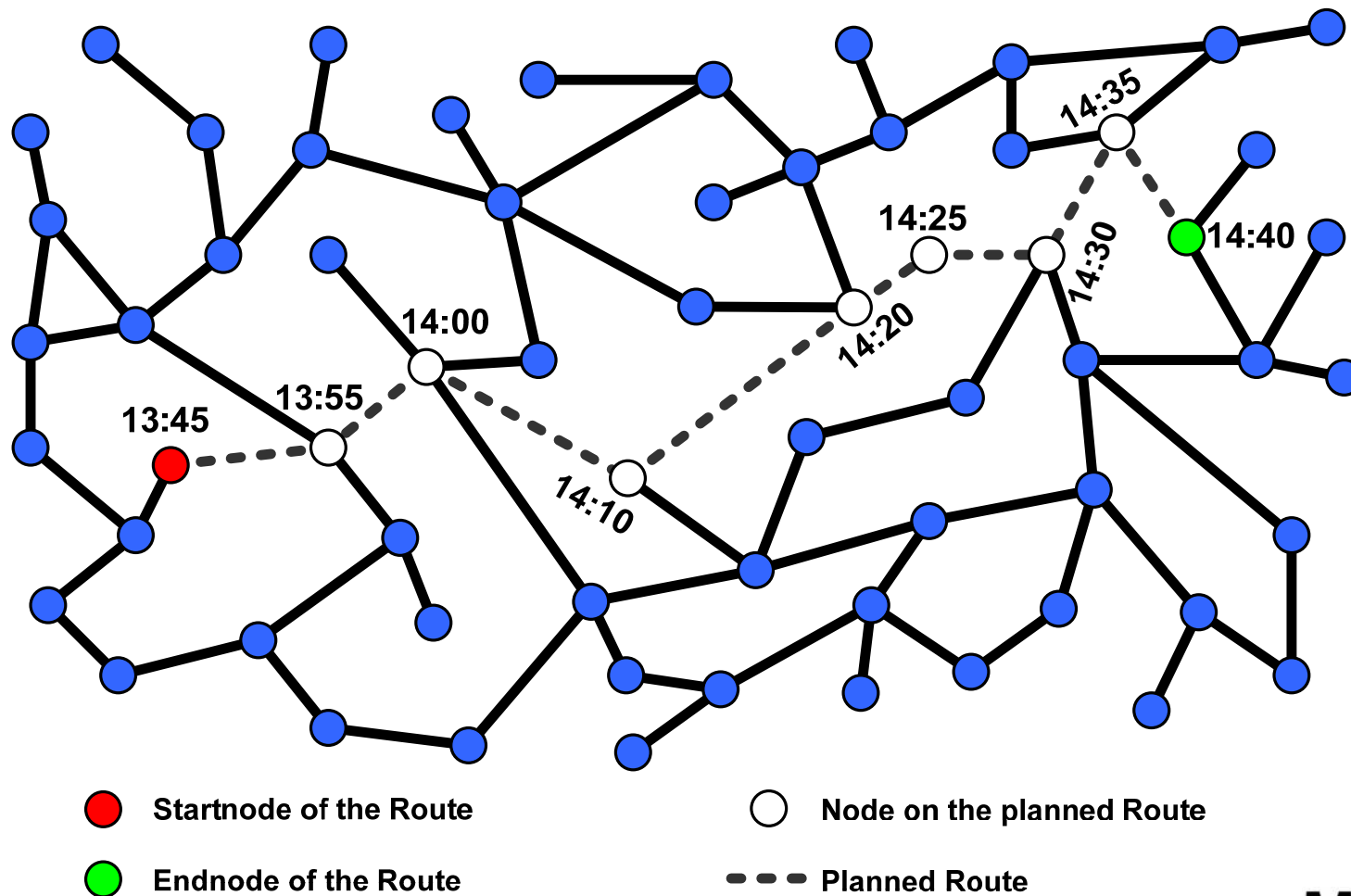


# Unpredictable Events in MATSim – occurring Event

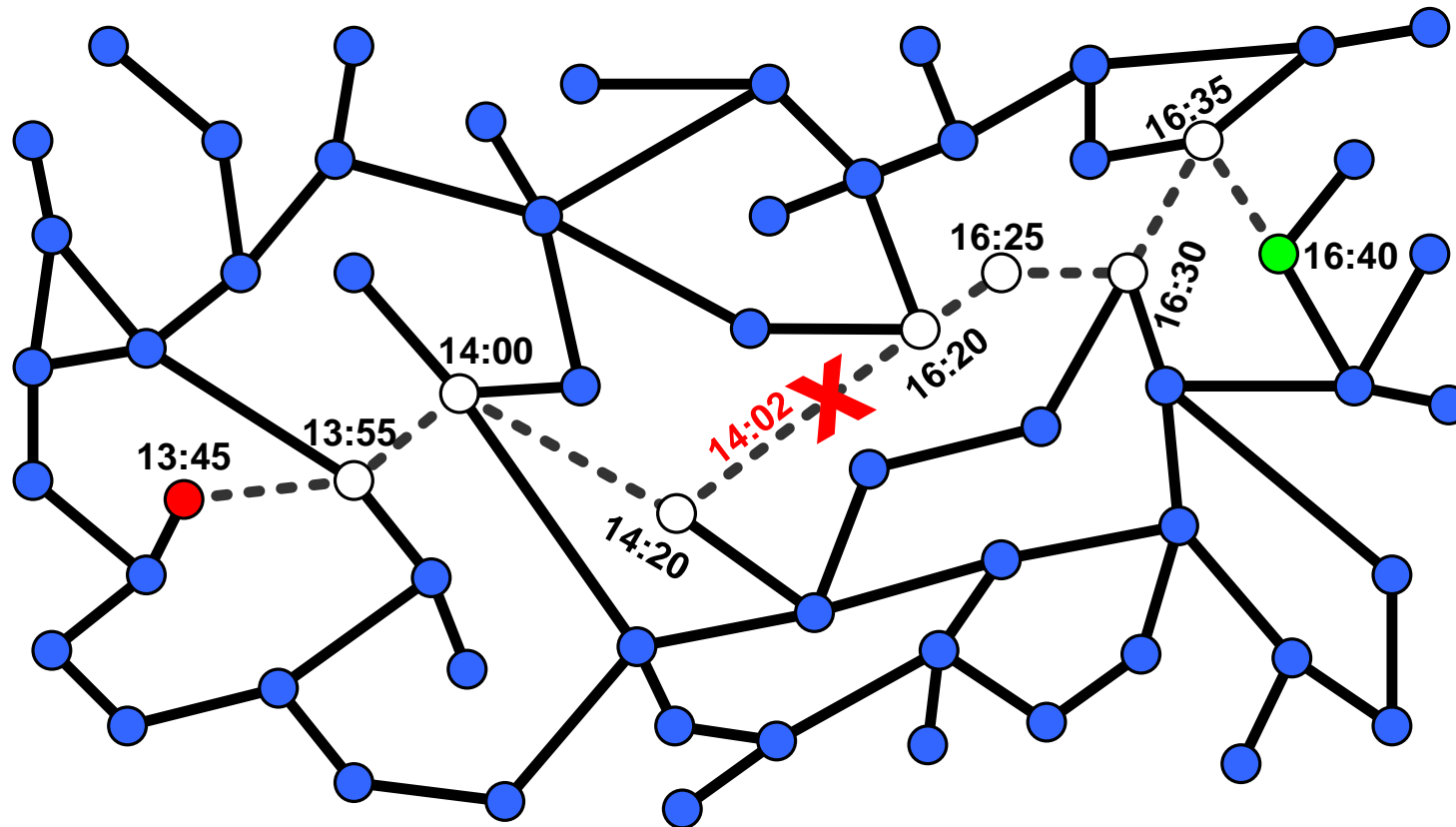


**X** Event that blocks a Link

# Unpredictable Events in MATSim – planned Trip

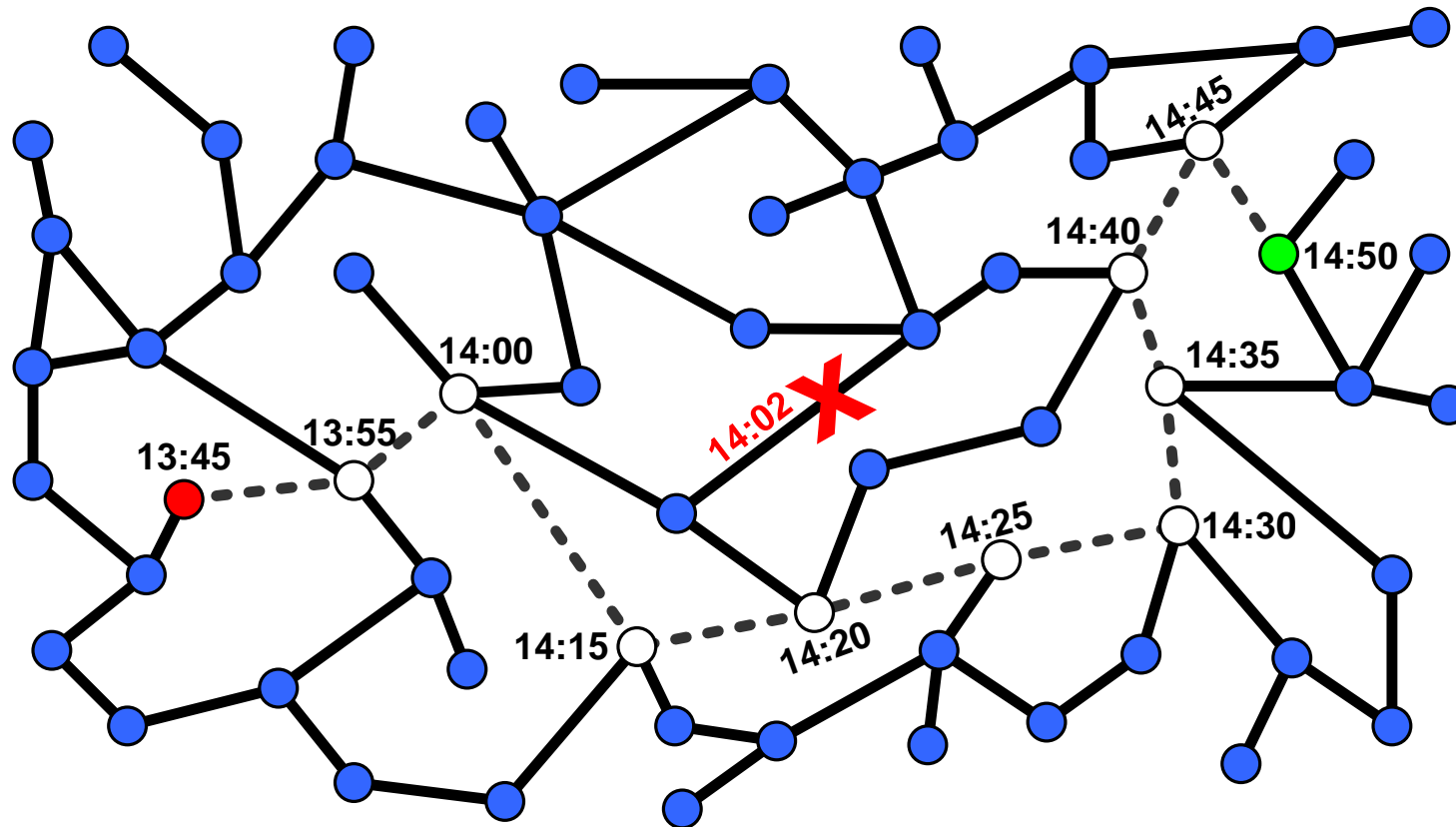


# Unpredictable Events in MATSim – real Trip



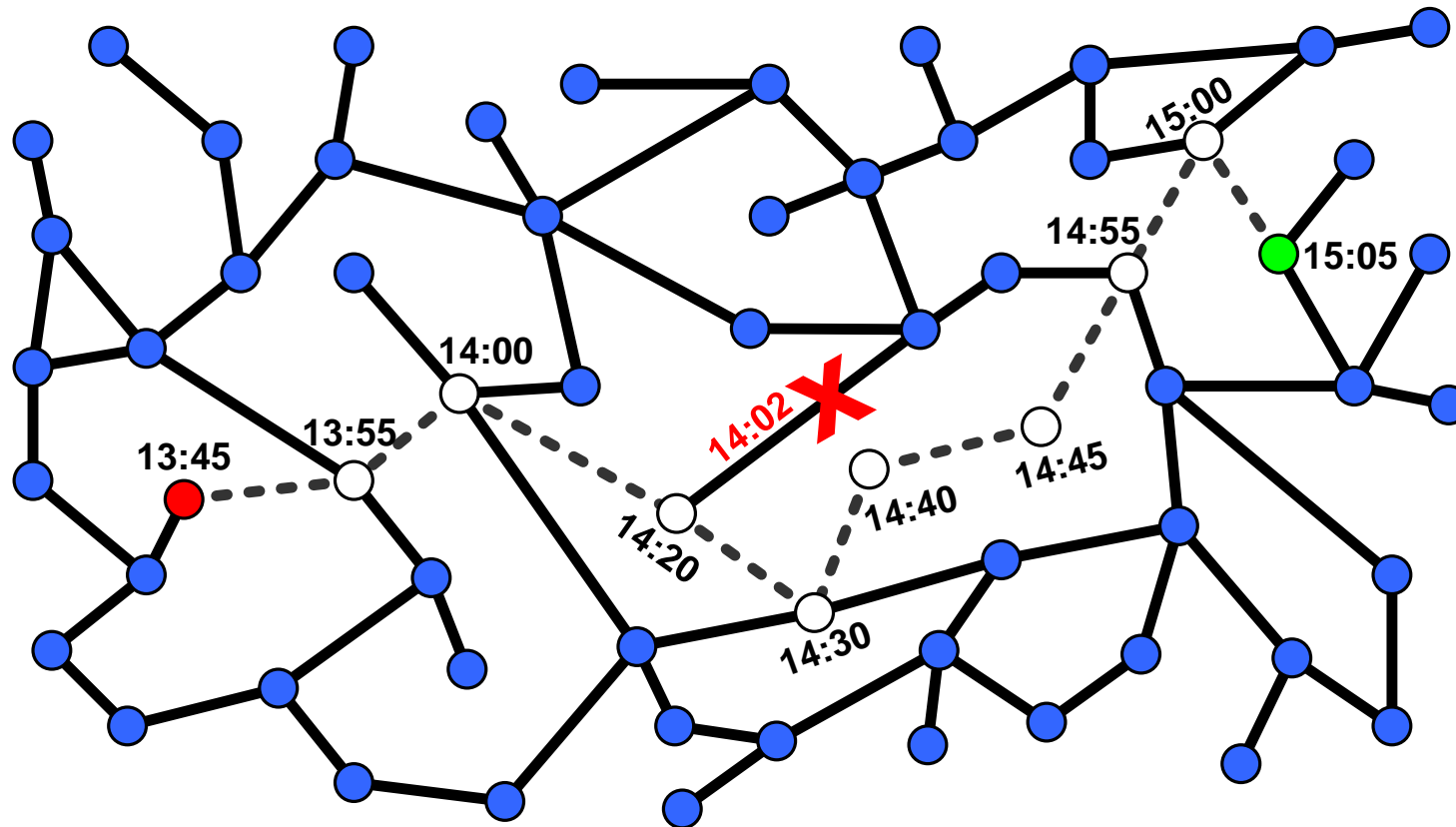
⇒ Trips duration is much higher than expected and therefore the executed plan will get a very bad score.

# Unpredictable Events in MATSim – iterative Approach



⇒ Iterative Approach: the Agent decides that another route will be faster.  
BUT: The new route differs from the original one even before the event has happened!

# Unpredictable Events in MATSim – Within Day Replanning Approach



⇒ Within Day Replanning Approach: the agent reaches the blocked link, recognizes its congestion and adapts his route.

# Objectives

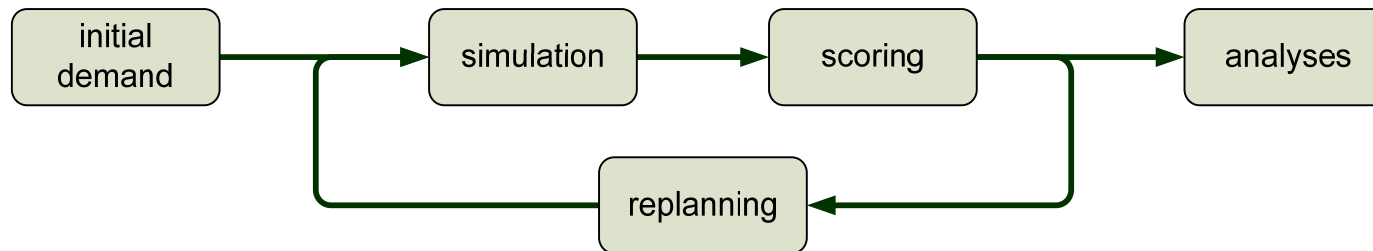
- Simulation of unpredictable, dynamic scenarios with changes in the
  - network structure and capacities of the links.
  - desires of the people.
  - amount of available (traffic) information.
  - traffic volumes.

# Requirements

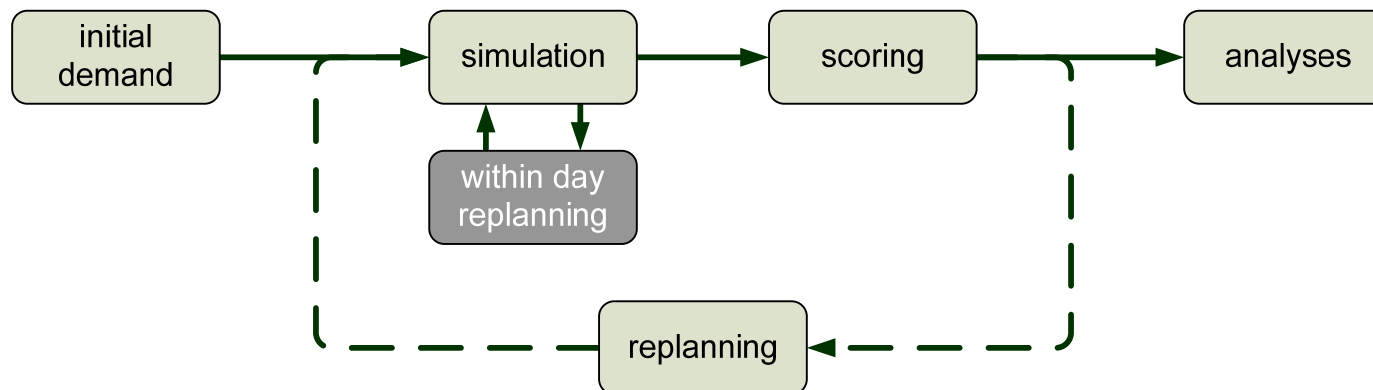
- Individual replanning strategies and parameters for each agent, depending on facts like
  - When is the replanning executed?
  - How is the replanning triggered?
  - Which information is available for the router?
- Adaption of current and future routes, adding and removing of activities.
- Parallel replanning of multiple agents using multiple threads.

# How to implement Within Day Replanning in MATSim?

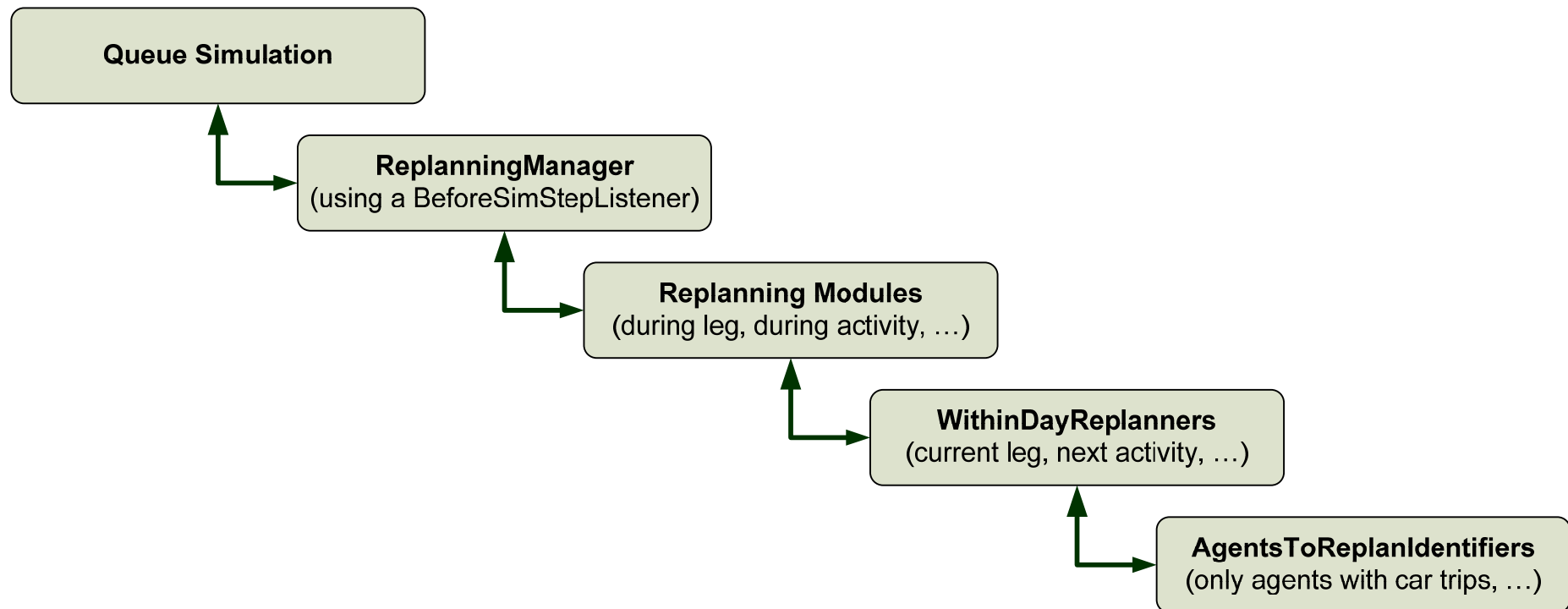
- Adaption of the iterative MATSim structure
  - traditional structure



- within day replanning structure



# Implementation in MATSim



# Replanning Manager

- Manages the interactions between the *Queue Simulation* and the *Within Day Replanning Modules*.
- The *Queue Simulation* uses a time-step based approach. At various points of a simulated time-step interactions with the simulation are possible (e.g. before and after the time-step is simulated).
- The *Replanning Manager* is a so called *BeforeSimStepListener*.
  - All used *Within Day Replanning Modules* have to be registered at the Replanning Manager.
  - During the simulation the Manager informs all registered Modules that they should check, whether they have to do a replanning.

# Replanning Modules

- Three different situations, where an agent can perform a replanning – each represented by a separate *Replanning Module*. Replanning ...
  - initially before the simulation is started.
  - during an activity is performed.
  - during a trip is performed.
- Every *Replanning Module* hosts at least one *Within Day Replanner* which implements a replanning strategy. (e.g. adapt the duration of an activity, change the destination of a trip, ...).

# Within Day Replanner

- Every replanning strategy is implemented in a separate *Within Day Replanner*.
- Various replanning strategies are possible
  - during an activity is performed
    - adapt departure time, next trip or next destination
  - during a trip is performed
    - adapt route or next destination
- Each of these *Replanners* uses at least one *Agent to Replan Identifiers*.
  - They identify those agents that need an adaption of their plan.
  - Various possibilities to identify, e.g. attributes like gender or age, but also lists of agent Ids are possible.

# Agents to replan Identifiers

- Identifies those agents that need an adaption of their executed plan.
- Identification can depend on various attributes, e.g.
  - Used mode (e.g. only car or everything except walk)
  - Age, gender or income of the agents.
  - Destination of the current trip.
  - Remaining duration of the current activity.

# Sample Applications

- Modelling and validation of traffic control systems and traffic forecast systems
- Simulation of scenarios with unexpected events
  - Changed network status
  - Evacuations
- In combination with iterative MATSim runs
  - Parking search
  - Car-sharing / collective taxis

# Combination of Within Day Replanning with iterative MATSim runs

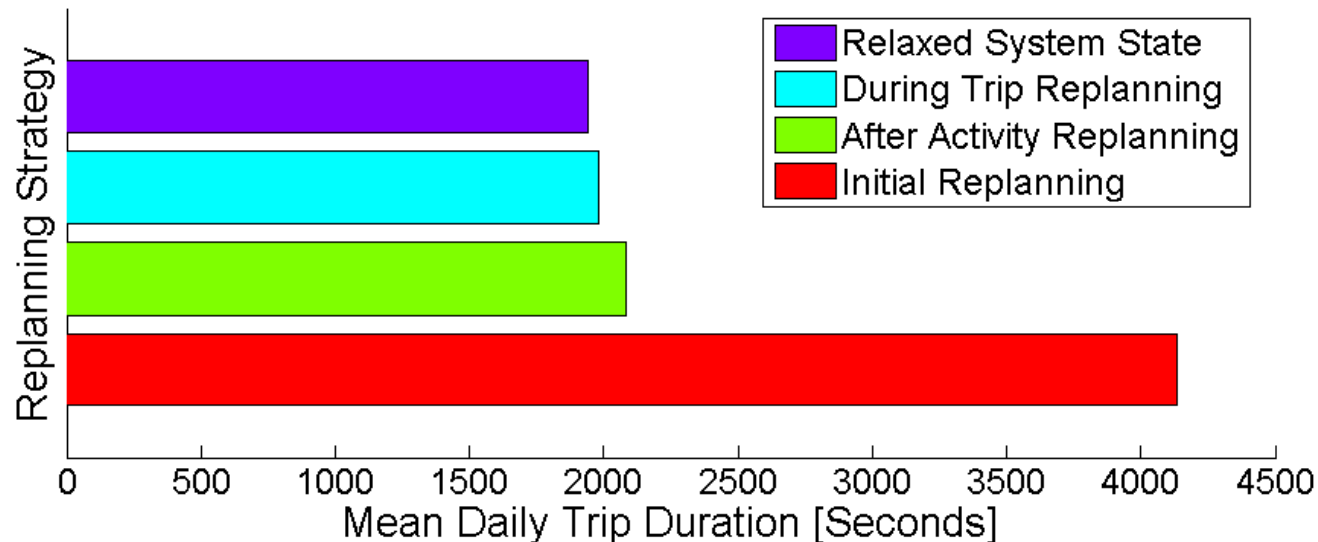
- Parking search using iterative approach
  - Agents plans to park at a certain parking area
  - What happens, if there is no space left, when the agent arrives?
    - The agent may wait until another vehicles departs – but maybe there are free parking lots only some metres away...
    - Ignore the capacity restriction of the parking area but add a penalty to the parking activity.
- Parking search using iterative approach in combination with Within Day Replanning
  - Agent enters the link where the next activity is scheduled.
  - If there is a free parking lot, the agent parks there – otherwise the agent can interactively decide where to look for a free parking lot.

# Combination of Within Day Replanning with iterative MATSim runs

- Taxis driving around and look for passengers using iterative approach
  - Really hard to implement – how to plan that a certain taxi is at a given time at a given position to pick up an agent there???
- Taxis driving around and look for passengers using iterative approach in combination with Within Day Replanning
  - Very simple to implement – the agent that wants to take a taxi waits at a link until an empty taxi enters that link.
  - The taxi drivers recognizes the waiting person and adds a “pick up passenger” activity to his plan
  - Finally the taxi reaches the passenger, picks him up and sets the passengers desired destination as next activity point.

# First Sample Results

- Sample Canton Zurich scenario using different replanning strategies
  - Relaxed system state using iterative approach
  - Within Day Replanning at the end of each activity or multiple times during a trip is performed
  - Initial replanning on an empty network



# Future work & outlook

- The Within Day Replanning Framework is still under development – finish work and add it as package to org.matsim.
- A working paper that describes the technical implementation will be published in Q4 2010.
- Usage of the framework in the sample applications.