Université Gustave Eiffel

Self organized train traffic

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ERA-NET Cofund Urban Accessibility and Connectivity

European Commission

URBAN EUROPE

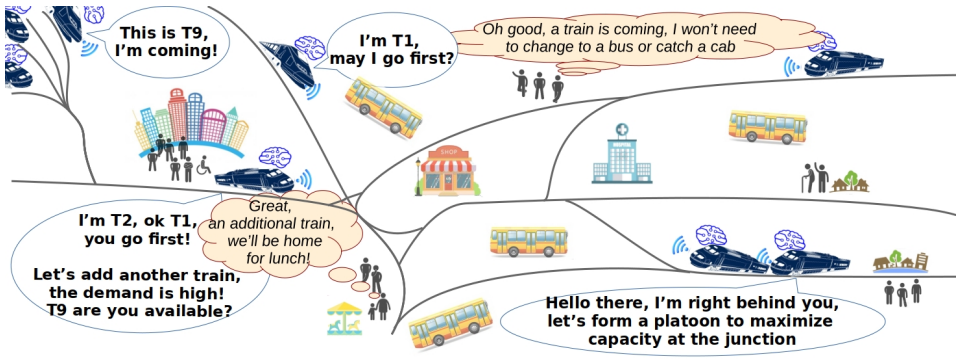
SORTEDmobility

Self-Organized Rail Traffic for the Evolution of Decentralized MOBILITY

H2020 ERA-NET Cofund

Period: 01/06/2021 - 31/05/2024

Budget: 1 841 776 €



Railway as mobility backbone:
intelligent trains **self-organize** to respond to **perturbations** and satisfy **demand**

Thorough assessment in **simulation**

Coordinator

Université Gustave Eiffel

Partners

DTU Technical University of Denmark

CNR ISTITUTO DI SCIENZE E TECNOLOGIE DELLA COGNIZIONE

TU Delft Delft University of Technology

BANEDANMARK

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Advisory board

BTH Blekinge Tekniska Högskola

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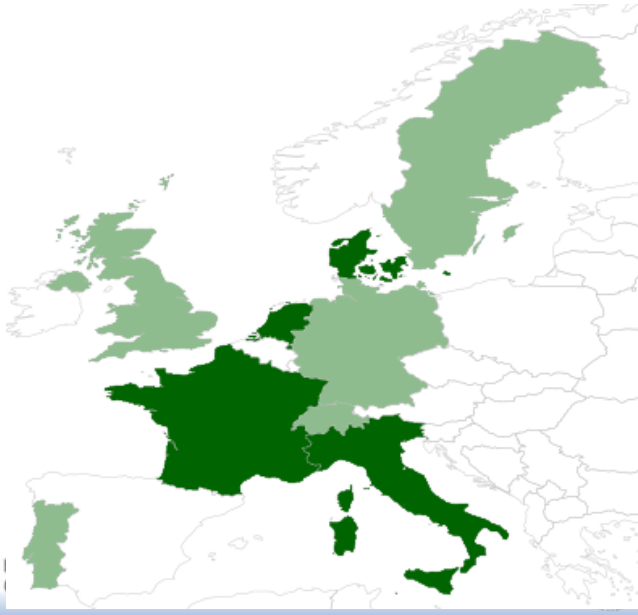
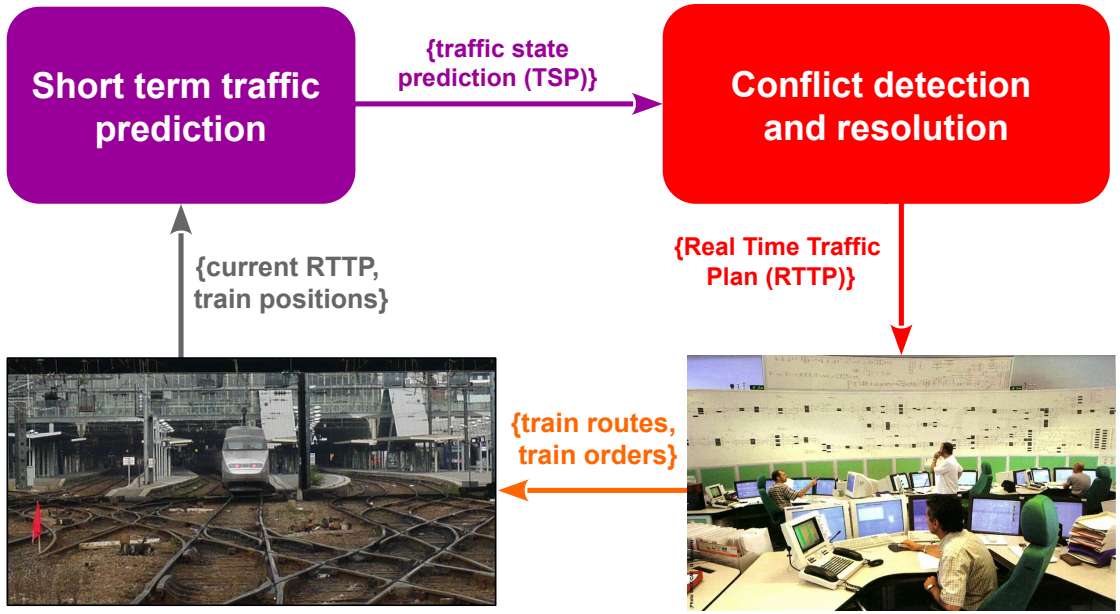
NetworkRail



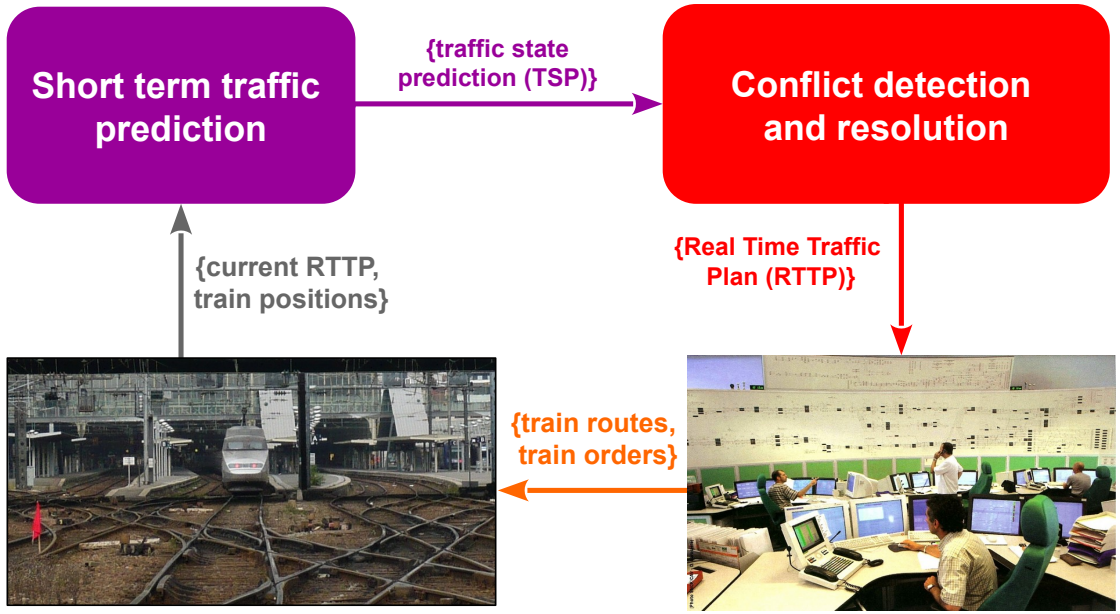
Real-time Traffic Management



Periodic **re-routing** and **re-scheduling** decisions

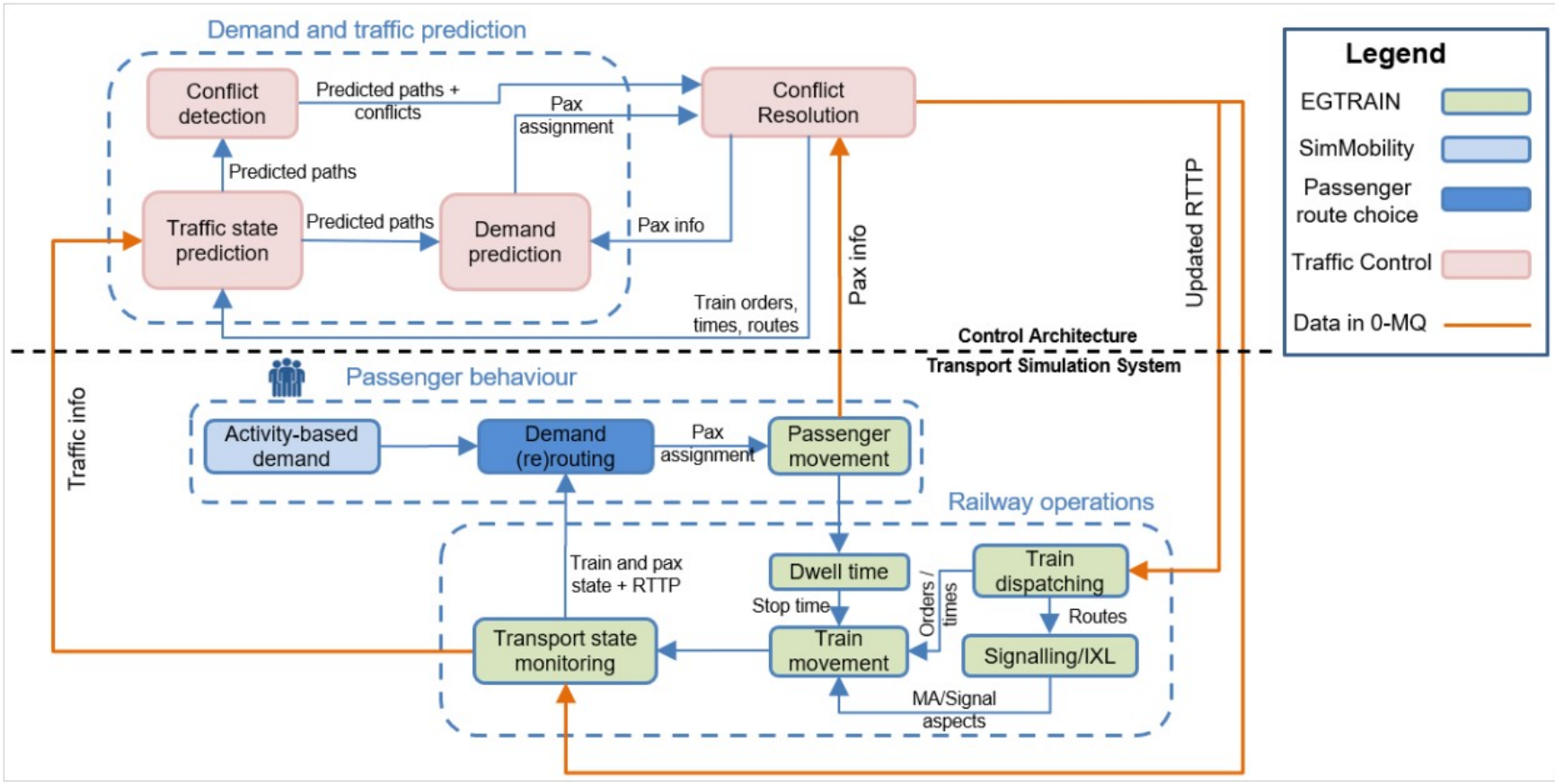
Aim: minimize **train** and **passenger delay** when dealing with small perturbations

Real-time Traffic Management

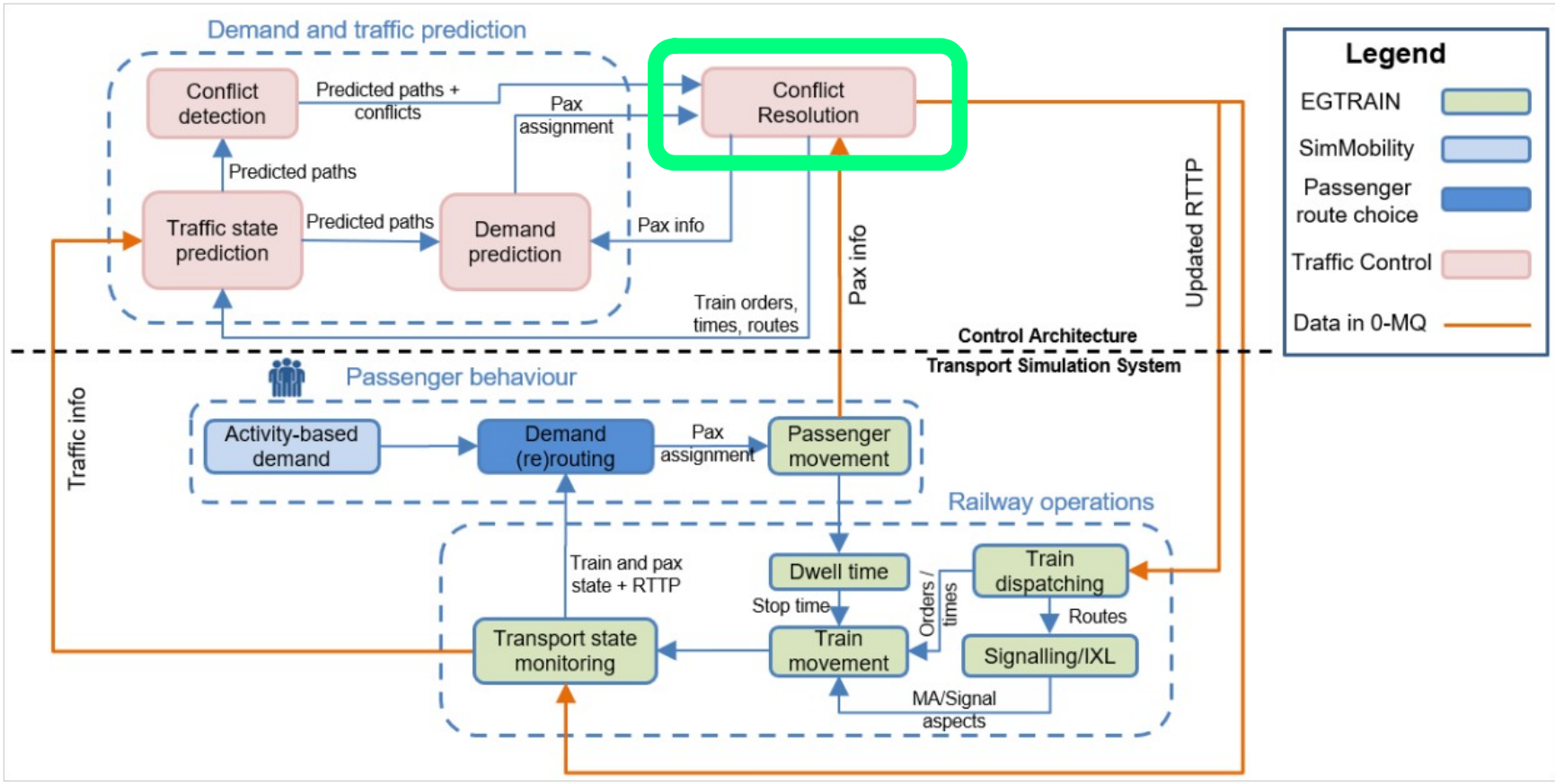


Intelligent trains replace the traditional centralized decision making system for **conflict resolution**

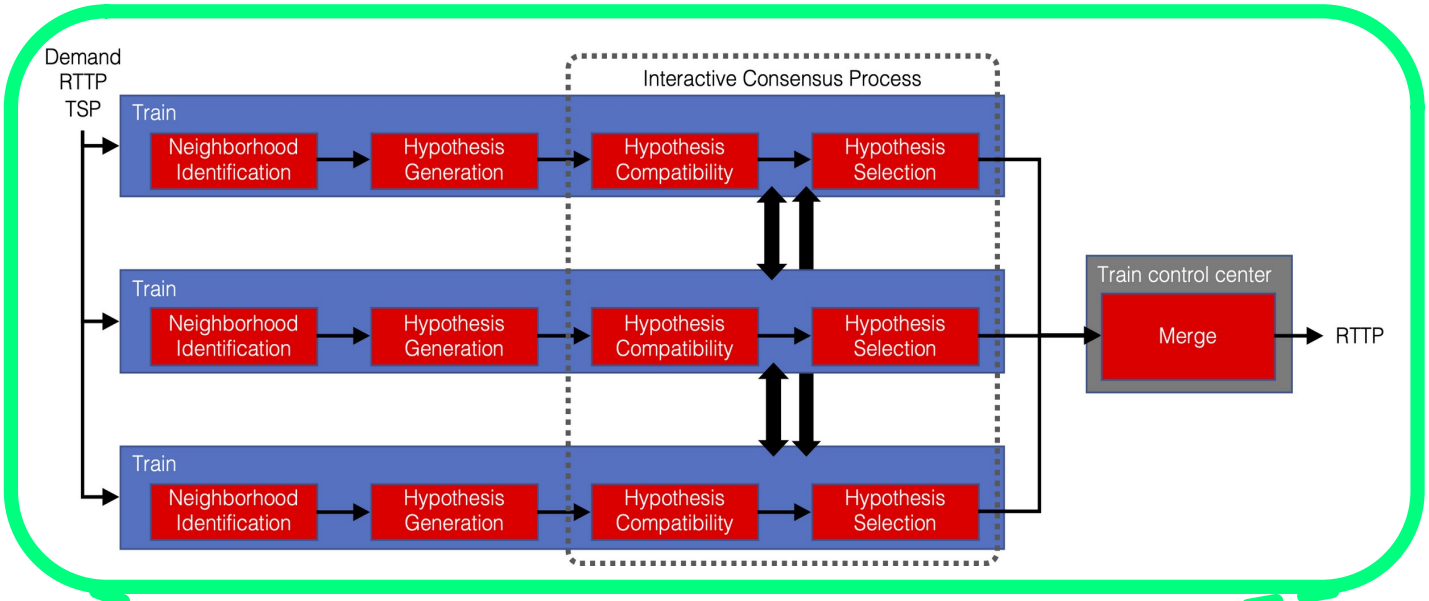
SORTEDMOBILITY framework

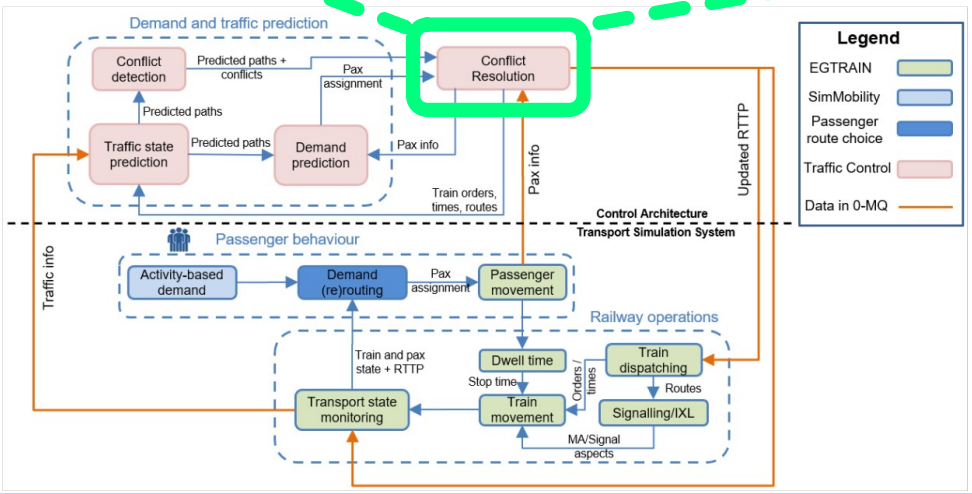


SORTEDMOBILITY framework

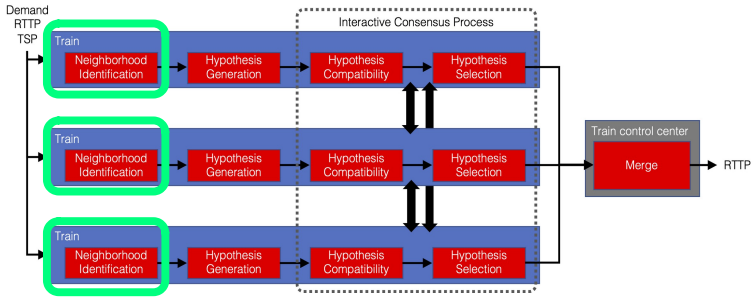


SORTEDMOBILITY framework

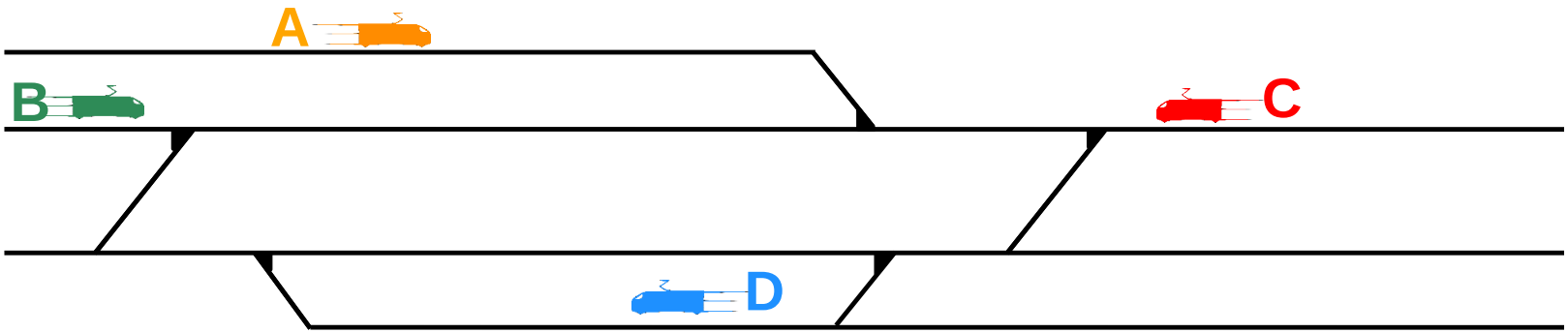




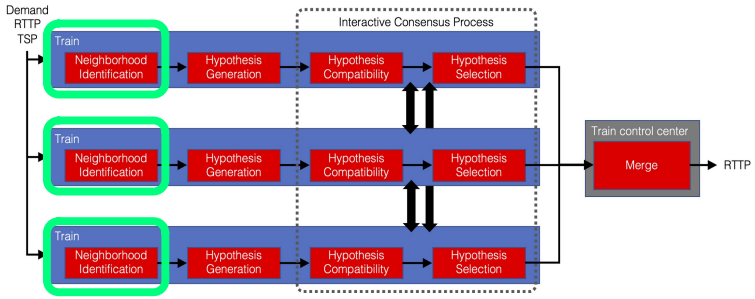
Neighborhood identification



Each train identifies the trains it may have interactions with in the near future



Neighborhood identification



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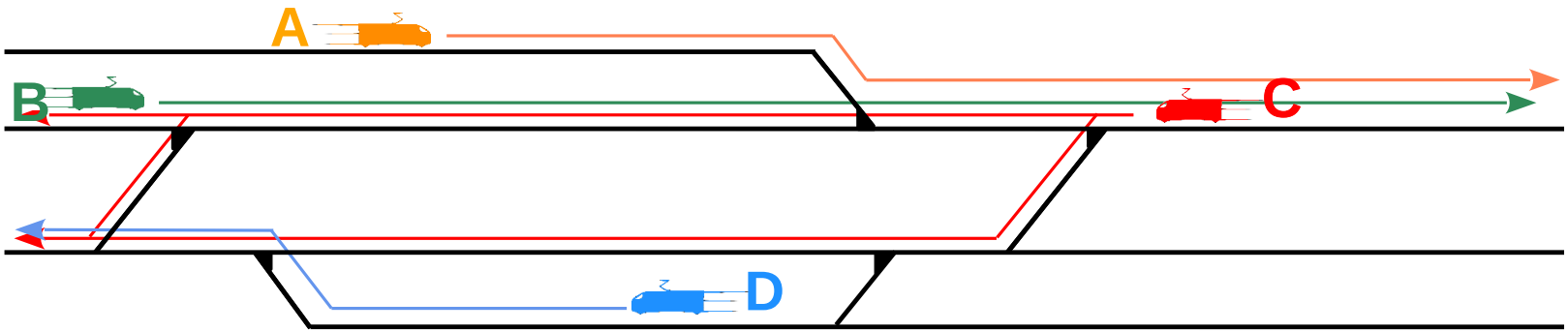
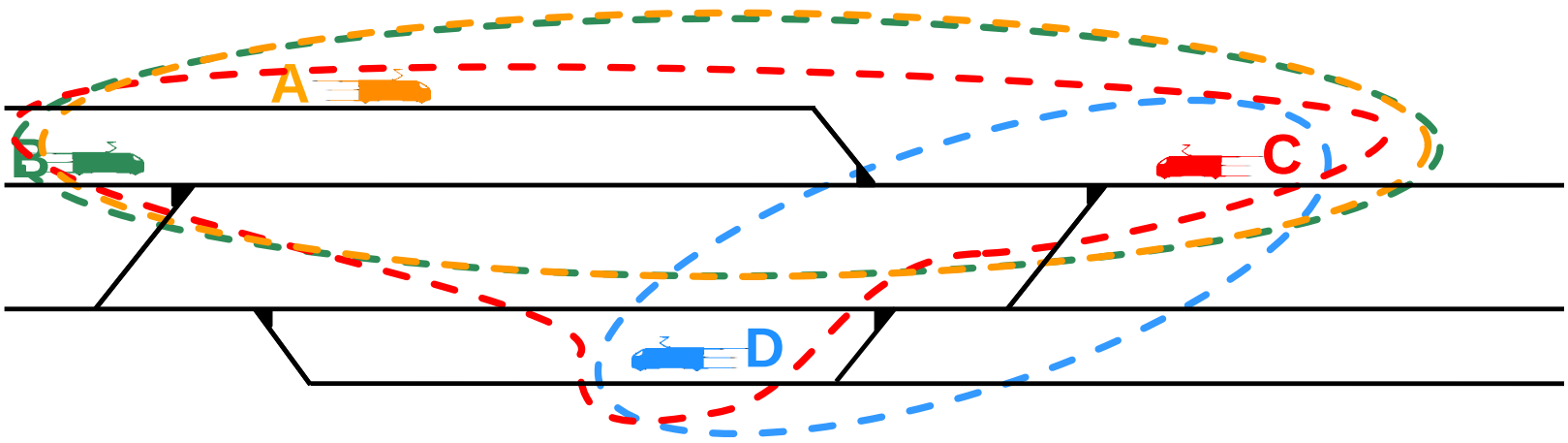
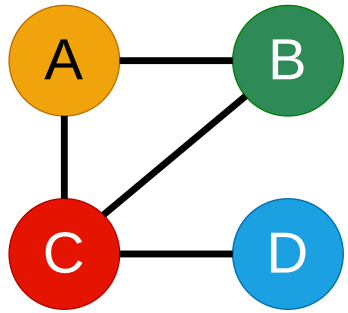


Neighborhood identification

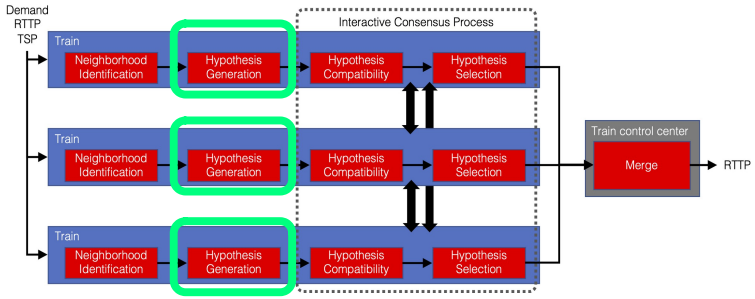


- A may interact with B and C
- B may interact with A and C
- C may interact with A, B and D
- D may interact with C

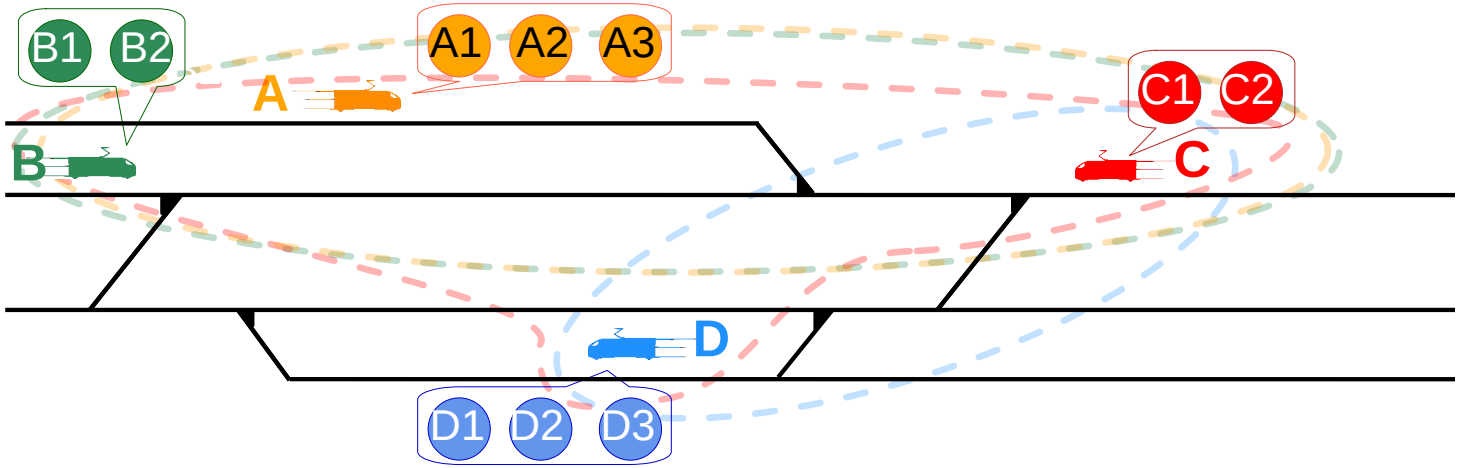
Interaction Graph



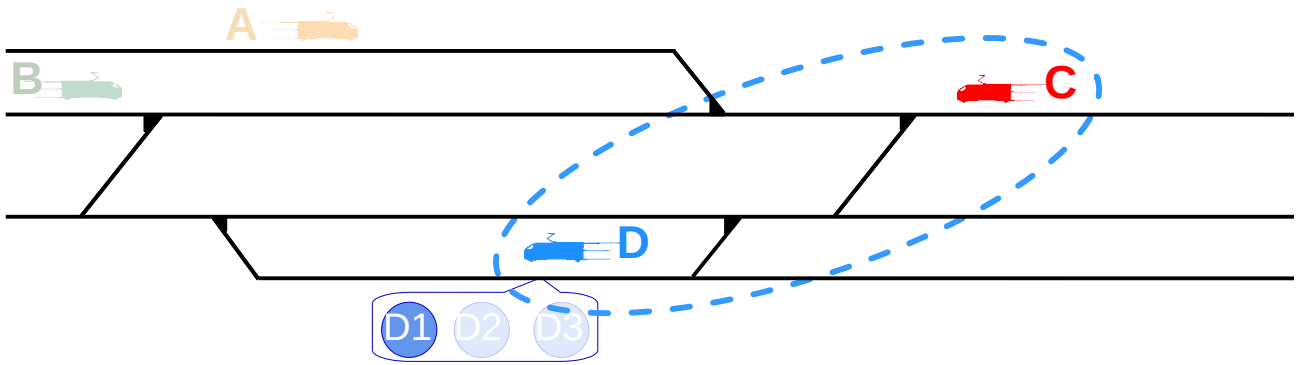
Hypothesis Generation



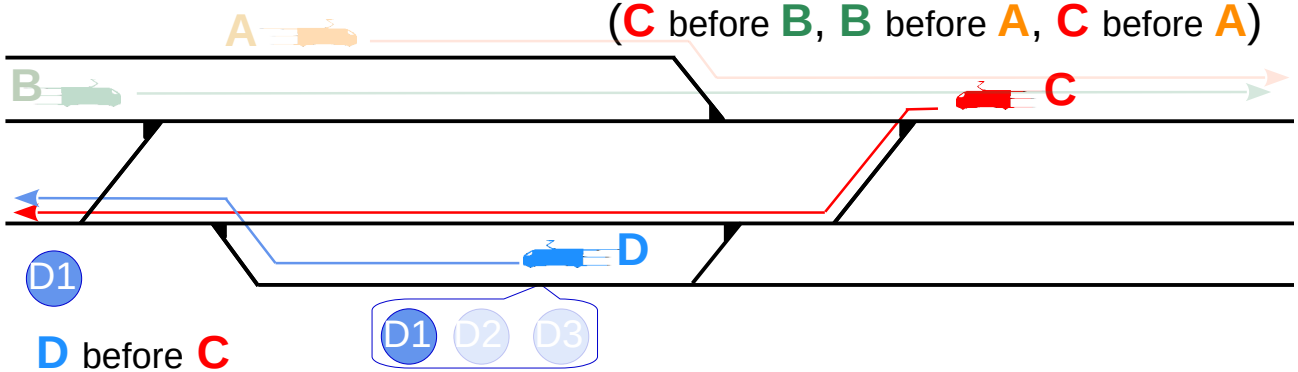
Each train identifies alternative hypotheses for traffic management in its neighborhood



Hypothesis Generation



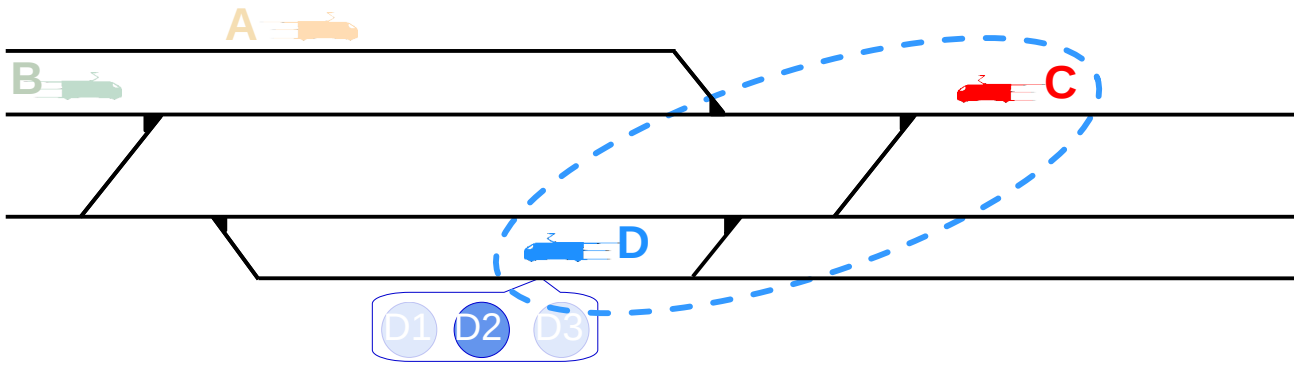
D1 Current routes for A and B
Current order between A, B and C
(C before B, B before A, C before A)



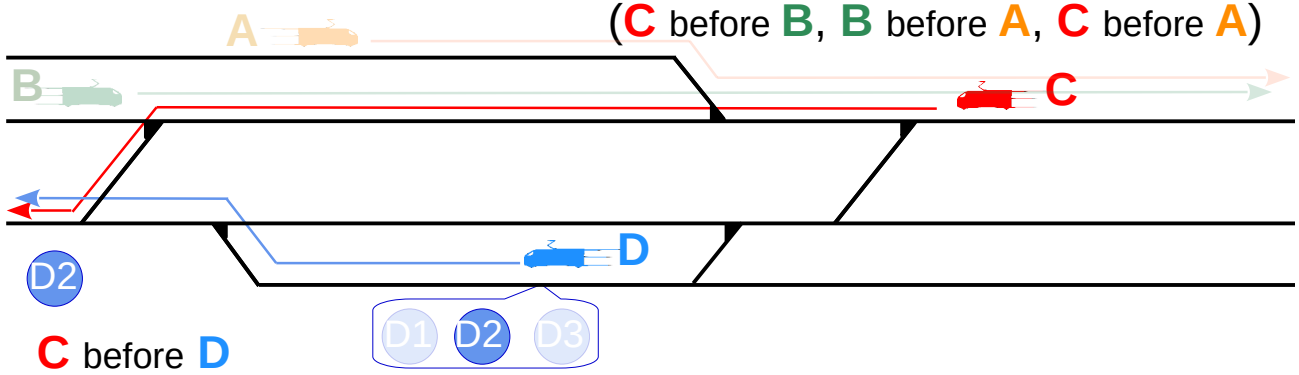
D before C

KPIs for D, KPIs for the system

Hypothesis Generation



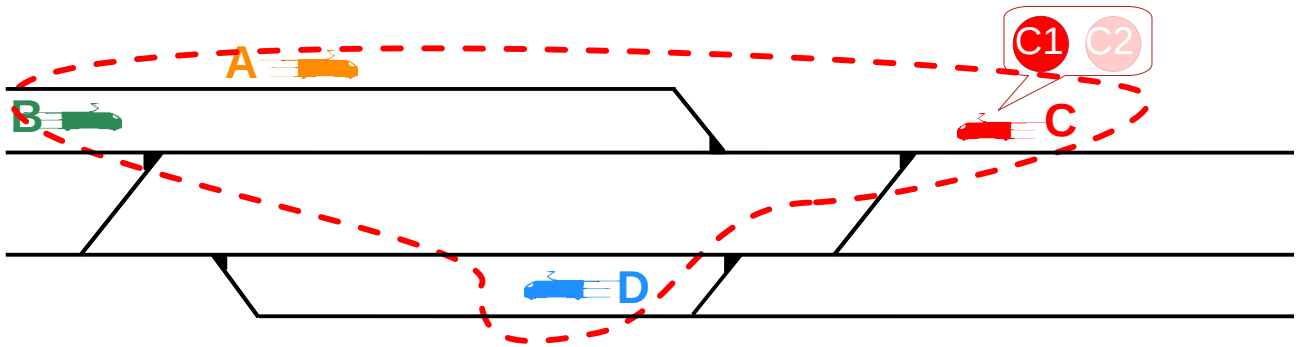
D2 Current routes for A and B
Current order between A, B and C
(C before B, B before A, C before A)

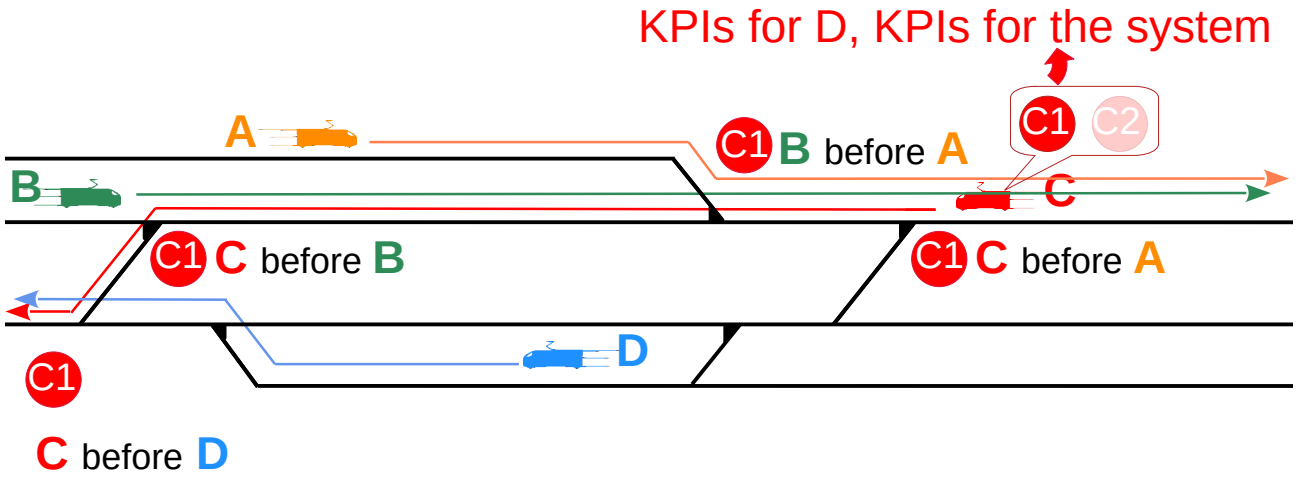


C before D

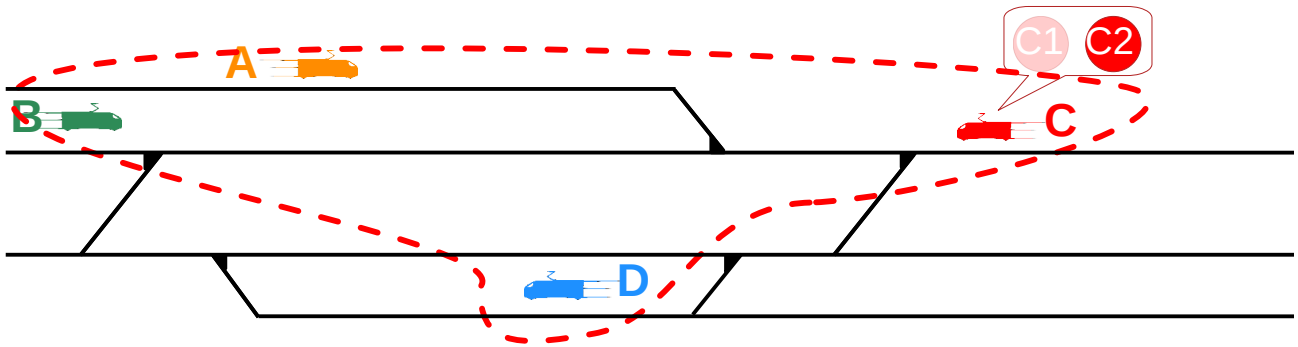
KPIs for D, KPIs for the system

Hypothesis Generation

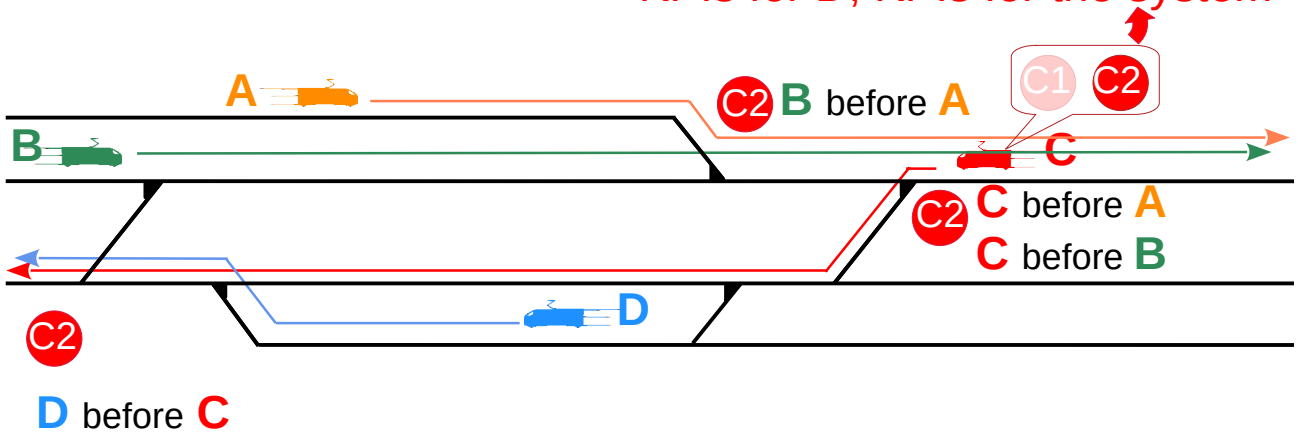




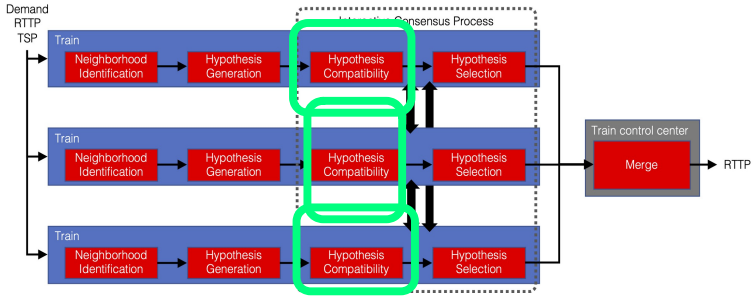
Hypothesis Generation



KPIs for D, KPIs for the system

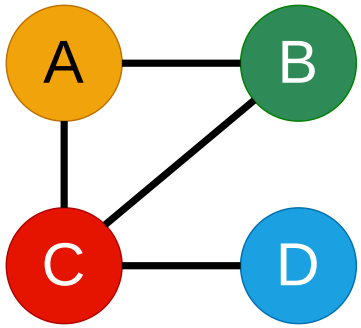


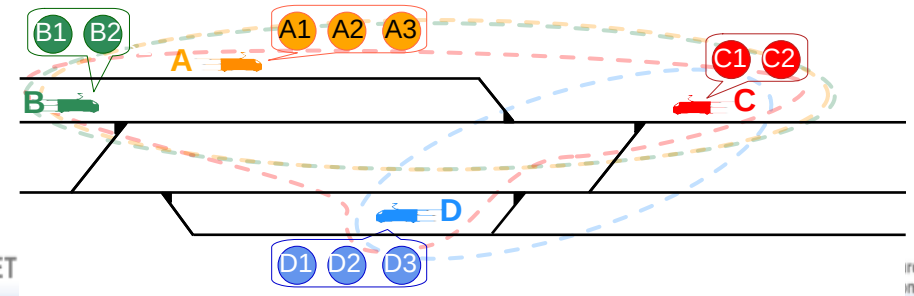
Hypothesis Compatibility



Each train:

- shares hypotheses with neighbors
- identifies hypotheses compatible with its own





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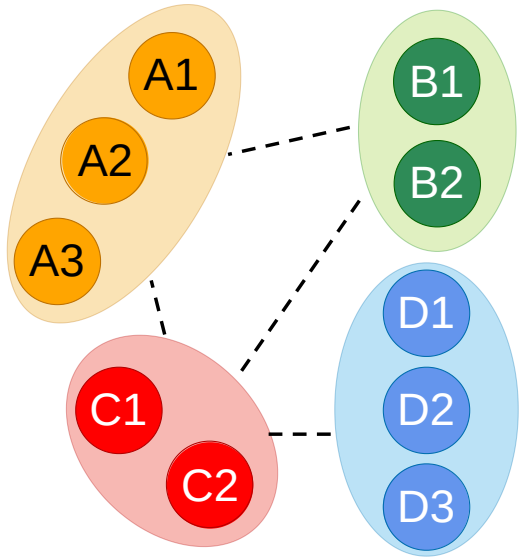
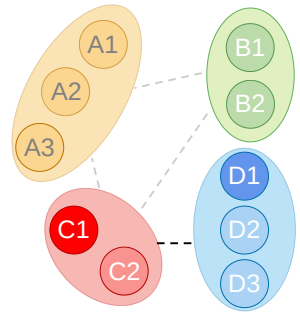
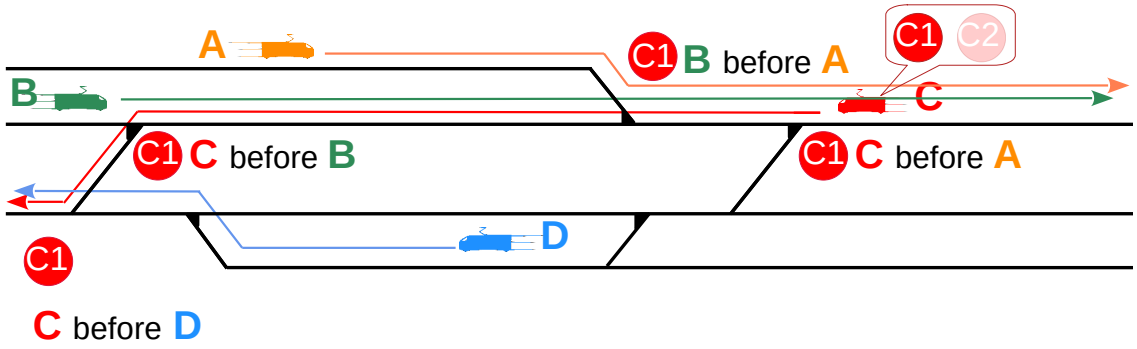
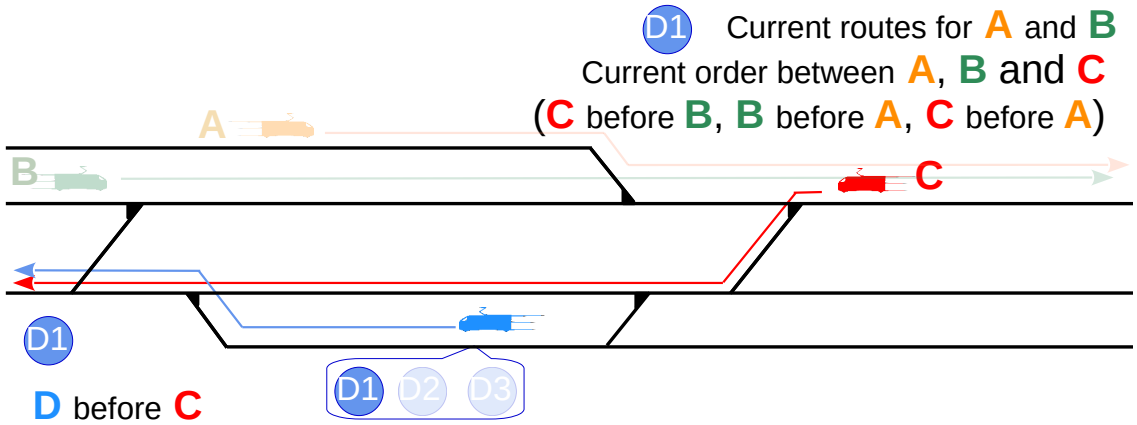


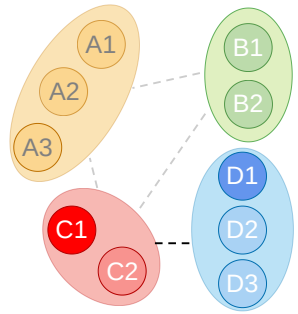
Hypothesis Compatibility

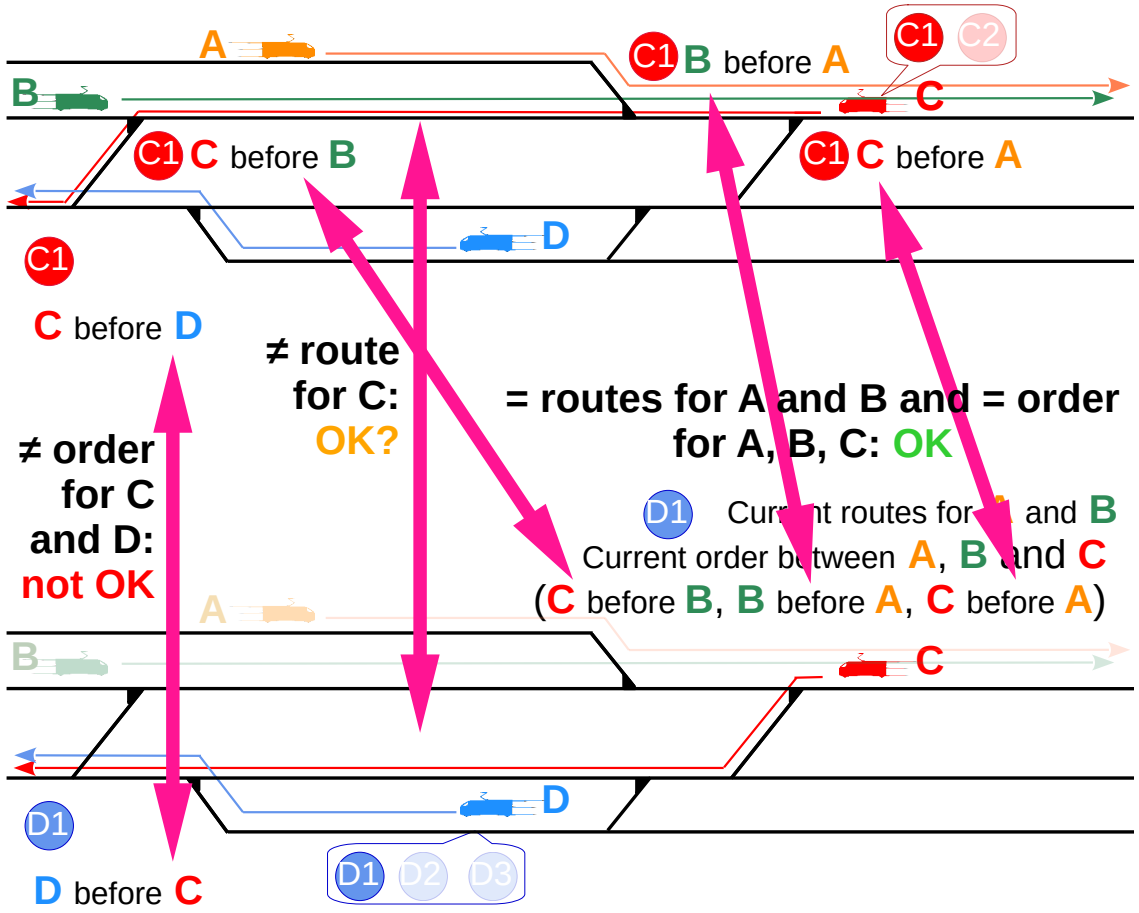




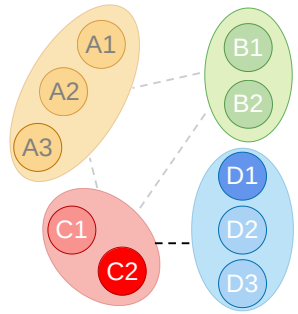


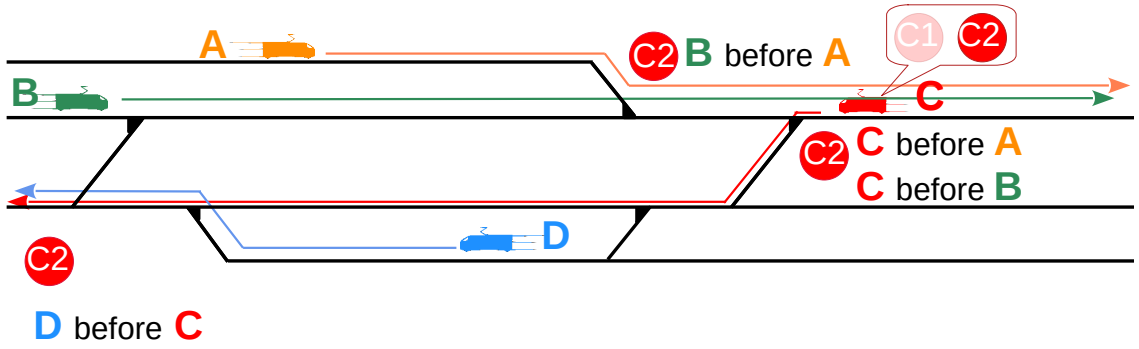
Hypothesis Compatibility

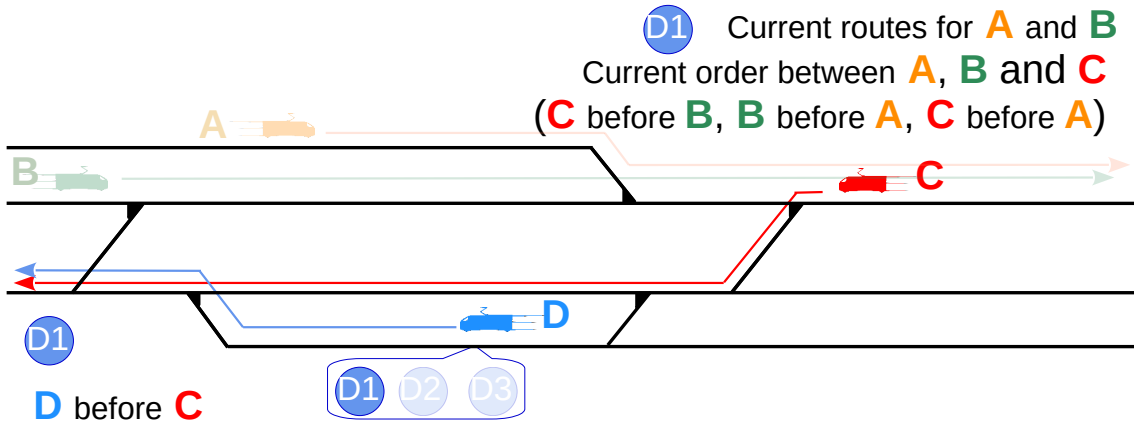




Hypothesis Compatibility







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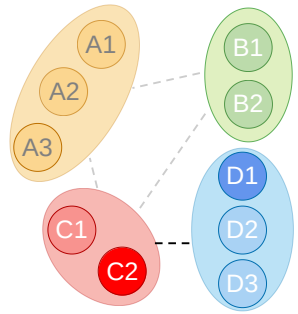

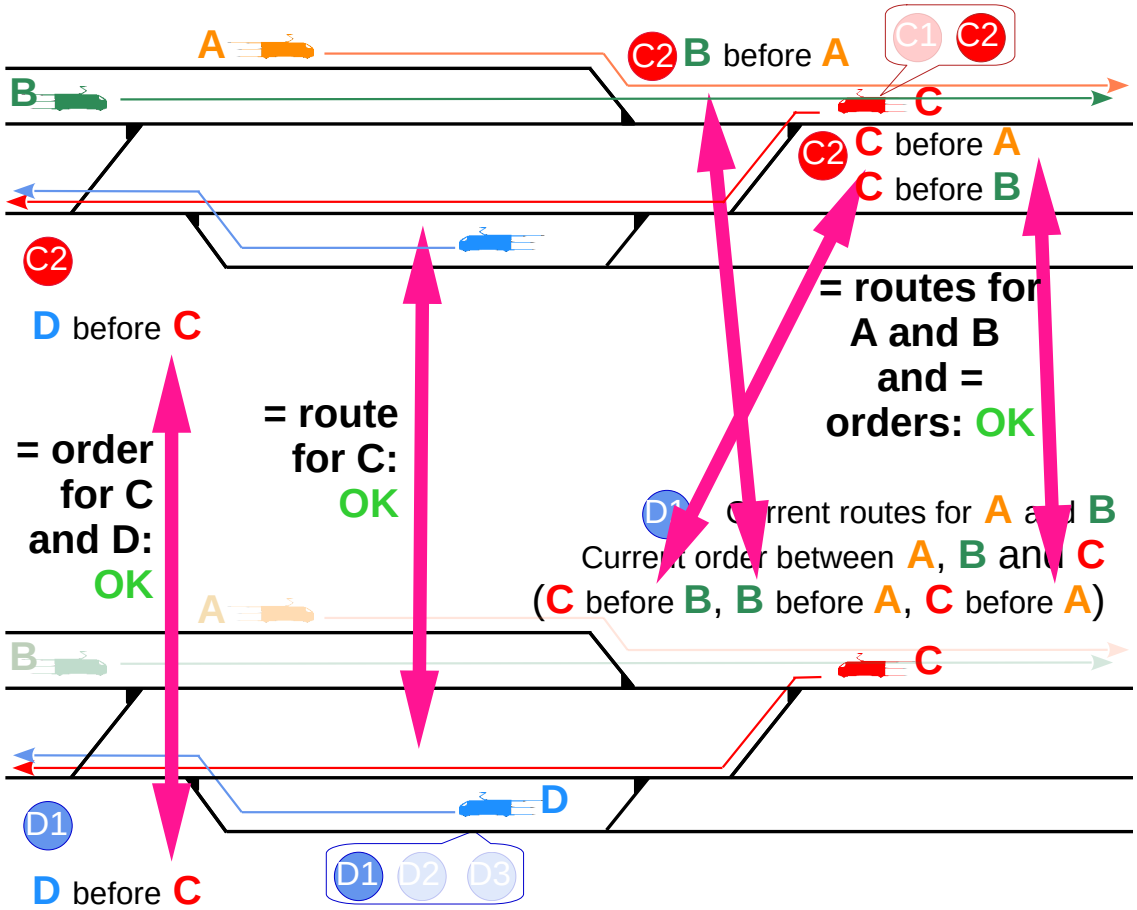

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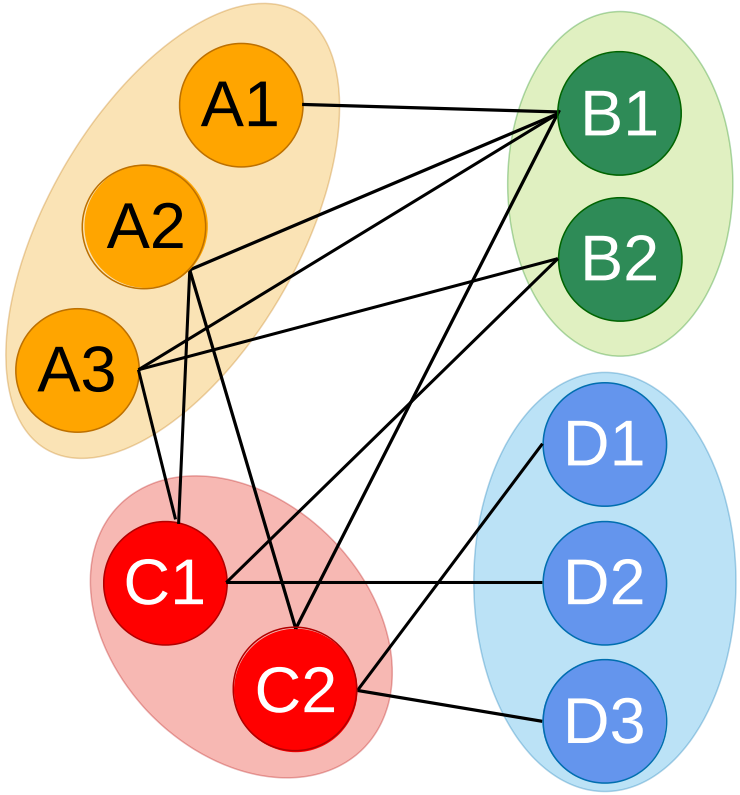
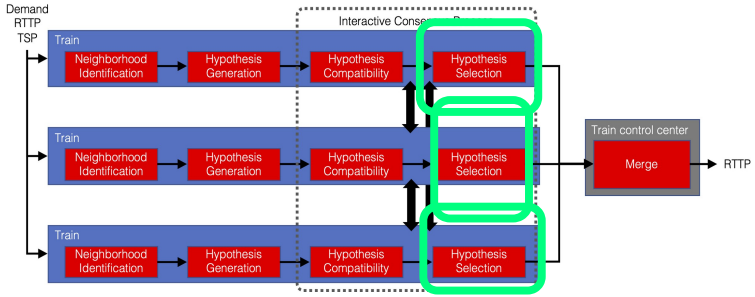


Hypothesis Selection



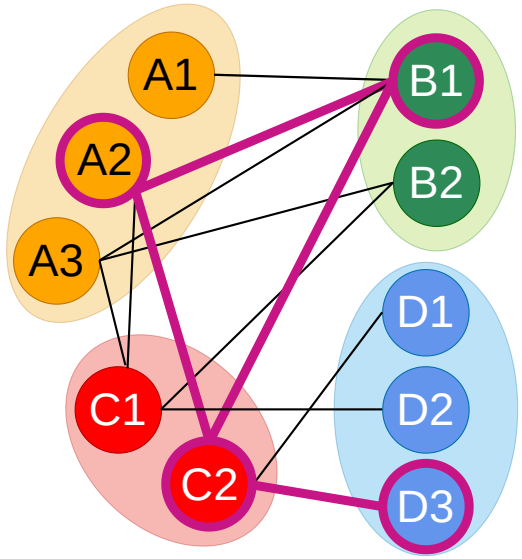
Each train seeks consensus with its neighbors

Trains implement a **consensus algorithm**:

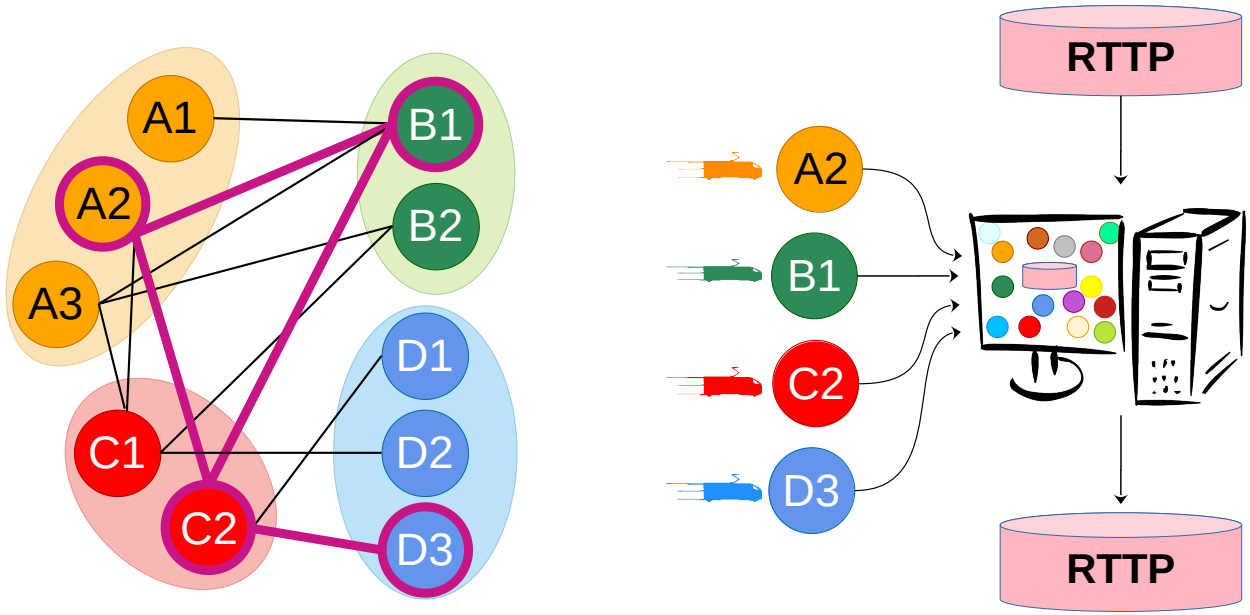
1. Each train selects an hypothesis
2. iteratively, trains change their selected hypothesis
   - if they are not compatible with their neighbor's one
   - trying to move to a "more compatible" one with high KPIs as evaluated by the train
3. if all hypotheses in all neighborhoods are compatible, **consensus is reached**

Merge

When consensus is reached, each train has one hypothesis

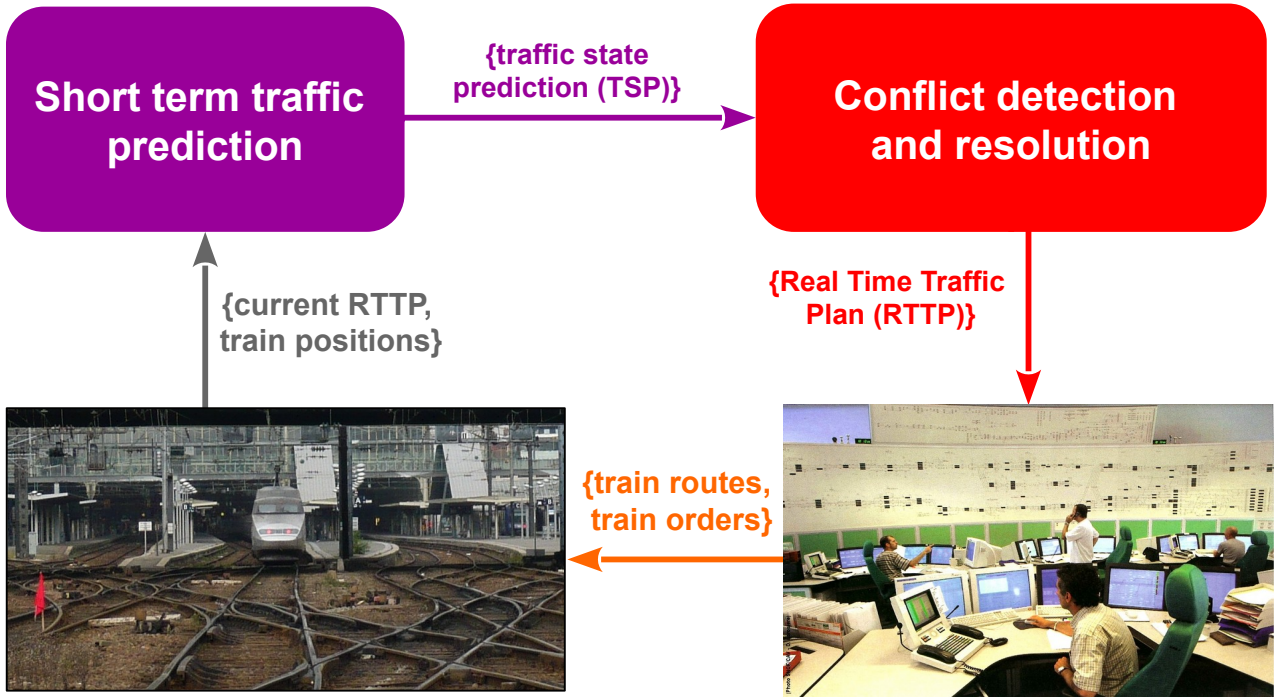


Merge



- Hypotheses are merged into the currently implemented RTTP by the traffic control center
- If incompatibilities arise, the RTTP is repaired
- The result is the new RTTP

Real-time Traffic Management in SORTEDmobility



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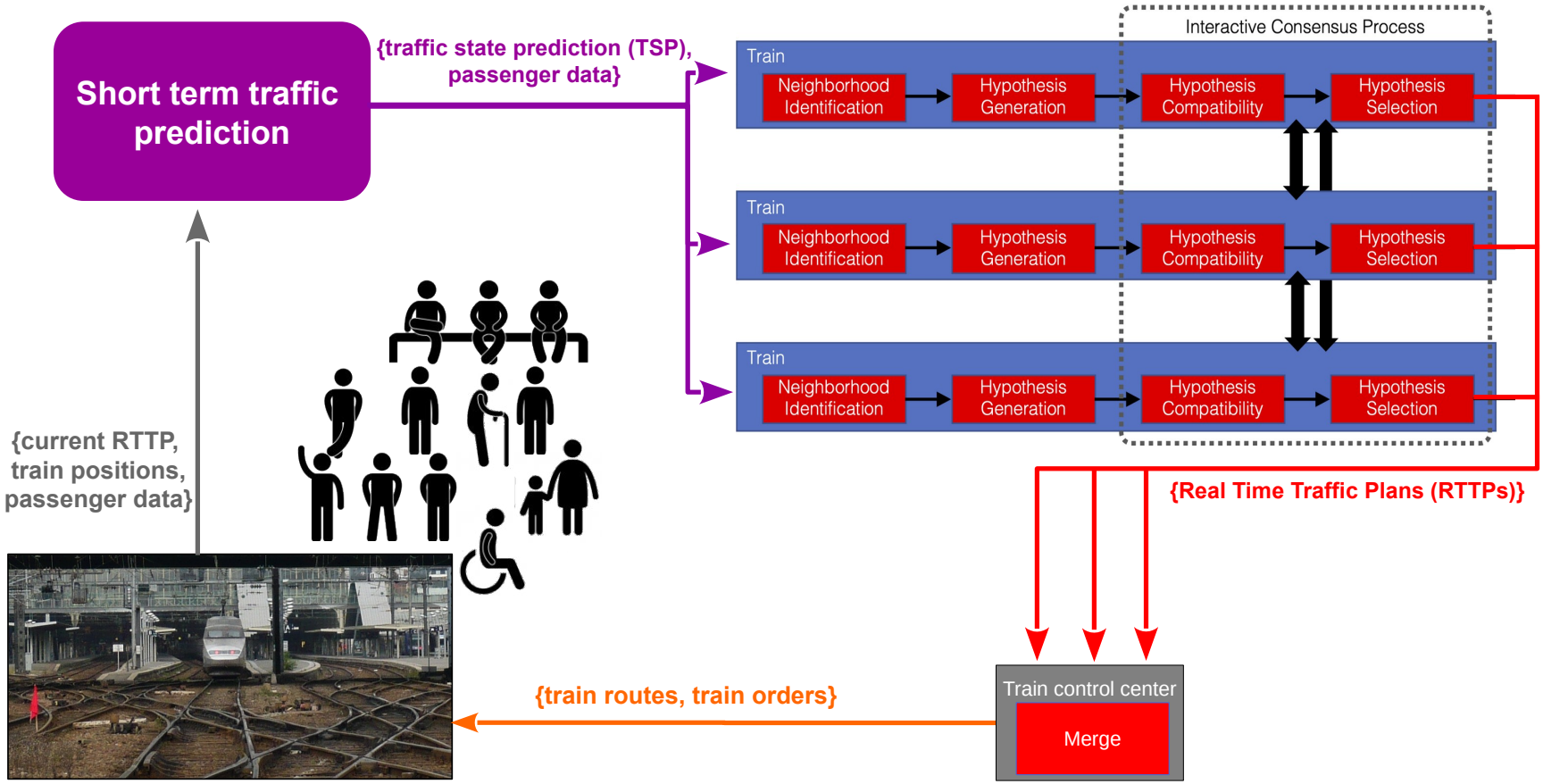
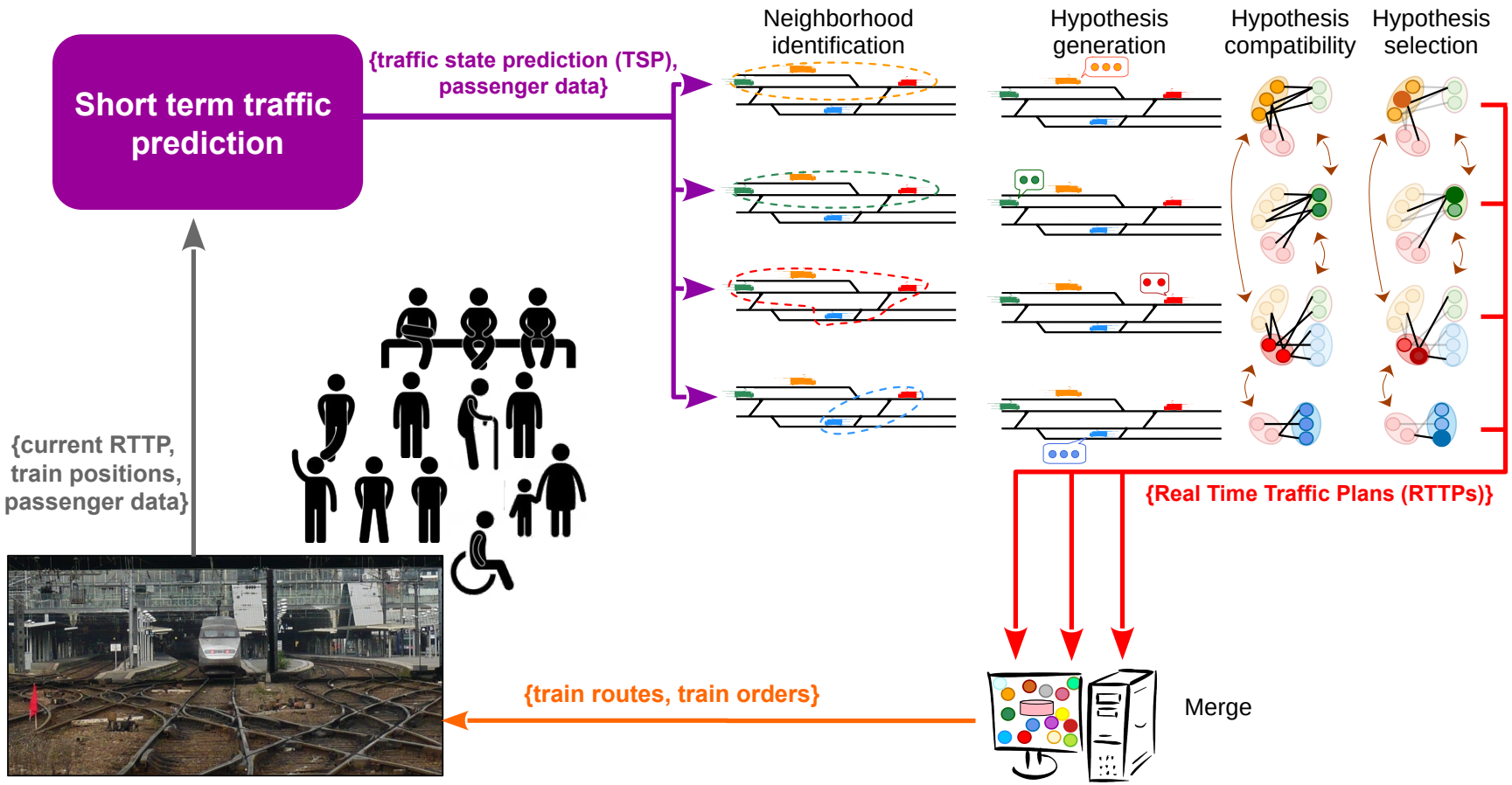


Real-time Traffic Management in SORTEDmobility



Conclusions

- We formalized the **self-organization process**
- We designed a first version of each **module**
- We are finalizing the **software implementation**
- We are **testing** the modules on a first case study
  preliminary results suggest that:
  1. consensus is reached quickly
  2. it often converges to the best possible solution
  3. the solution is of the same order of magnitude of the centralized optimum

Future works

In the next year we will

- identify critical module parts and **improve** them e.g., improve **passenger consideration**[1]
- **impact assessment** in three case studies[2]
- produce **recommendations**

[1] presentation at 14:38 - J. Victor Flensburg
[2] presentation at 13:30 - Fabrizio Cerreto

For further information and comments

www.sortedmobility.eu

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