



EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



**COST ACTION TU1103:**

**OPERATION AND SAFETY OF TRAMWAYS  
IN INTERACTION WITH PUBLIC SPACE**

Final conference – Frankfurt, Germany – 29 September 2015

## **COST Action TU1103**

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Operation and safety of tramways in interaction with public space

**Infrastructure and Design:**

# **Road Junctions and Roundabouts**

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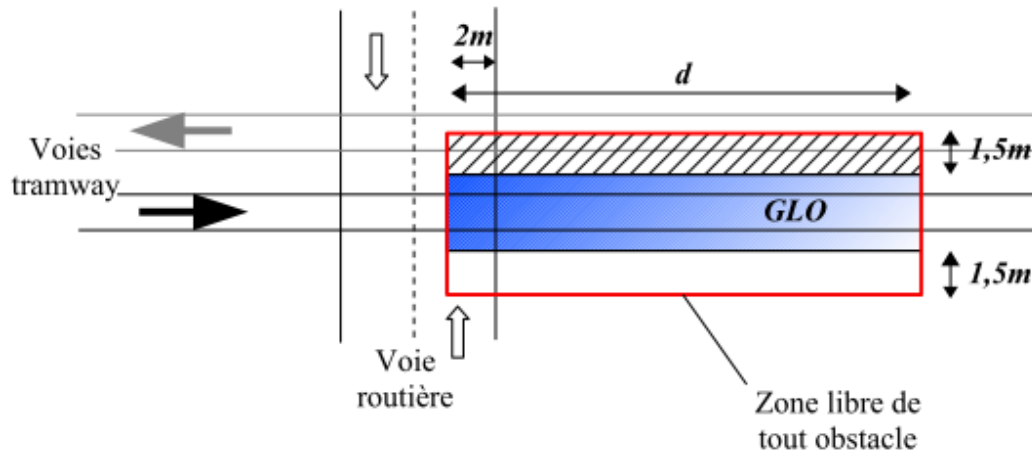
Margarita Novales (University of A Coruña - Spain)

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### Road junctions and roundabouts – General considerations

#### Basic principles for improving safety in junctions and roundabouts with tramway

- Compliance with regulation about road signals
- Operation as simple as possible
- Fixed obstacles



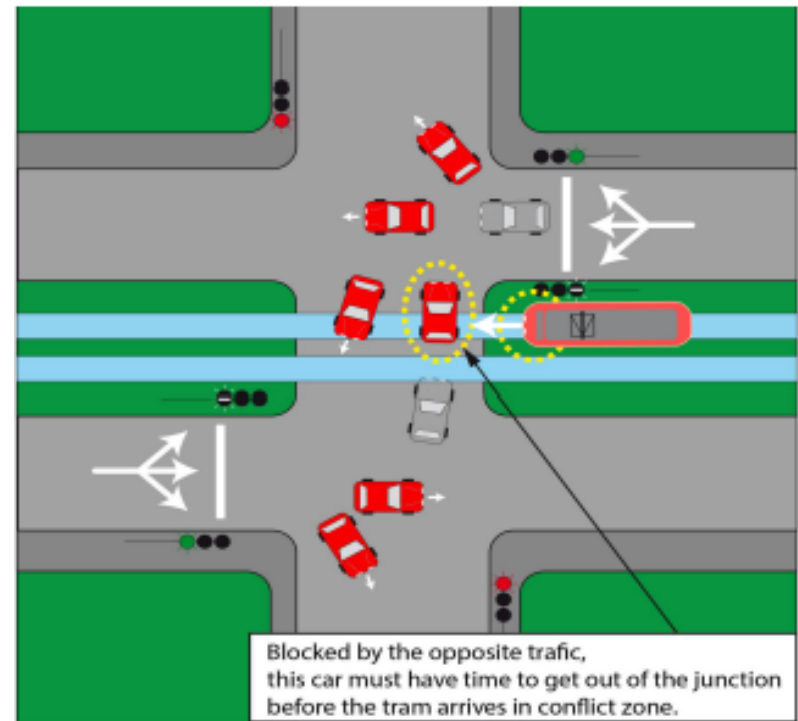
- Speeding
- Red light infringements by motorists: capacity, red light cameras, visibility, synchronization

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# Road junctions and roundabouts – General considerations

## General design

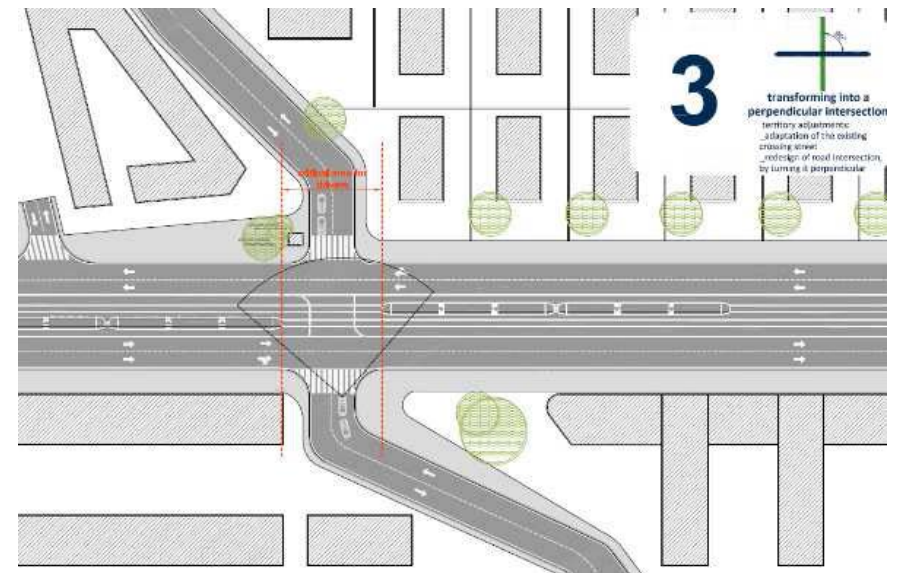
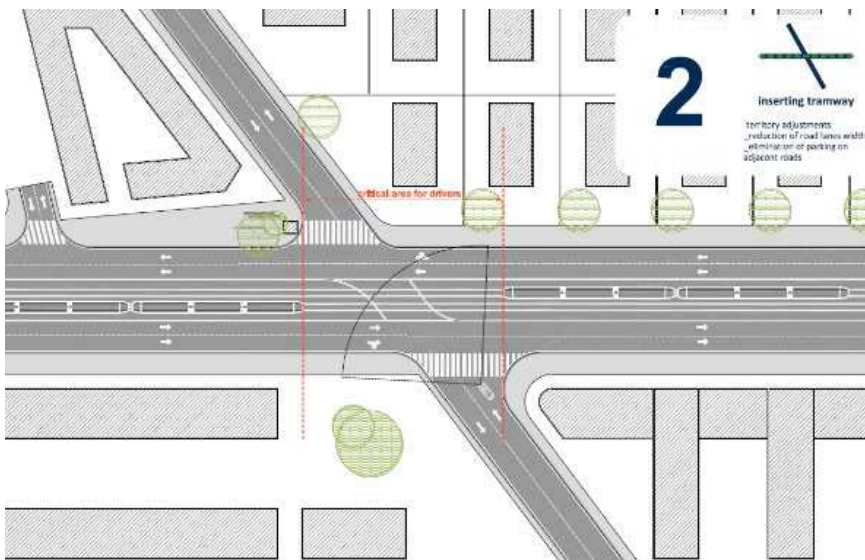
- Appropriate geometry for traffic demand
- Tramway must be recognisable by all road users
- Alert road users to tram presence on its approach
- Axes of junctions as perpendicular as possible
- Reduction of conflict zone area increases safety; two limits:
  - turning of large vehicles
  - storage of vehicles turning left at the end of a green light phase



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### Example

- HAZARD: Blind spots
- OBJECTIVE: Improve mutual visibility
- MEASURE: Increase angle of crossing



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# Road junctions and roundabouts – General considerations

## General design

- Maximize visibility for
  - tram drivers to see the junction clearly
  - road users to see approaching trams clearly
- Road equipment and street furniture must not impair visibility
- Prevent or discourage illegal movements with kerbs, pillars, fences, etc.



Switzerland | Geneva

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### Example

- HAZARD: Lack of visibility
- OBJECTIVE: Improve visibility and reduce speed of road vehicles
- MEASURE: Change type of fence and adapt road signal sequence



Before

Junction: Ireland | Dublin | Bow Street Junction



After

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### Example

- HAZARD: Conflict due to illegal movement by road vehicles
- OBJECTIVE: Prevent illegal movement (here: left turn)
- MEASURE: Install physical barriers



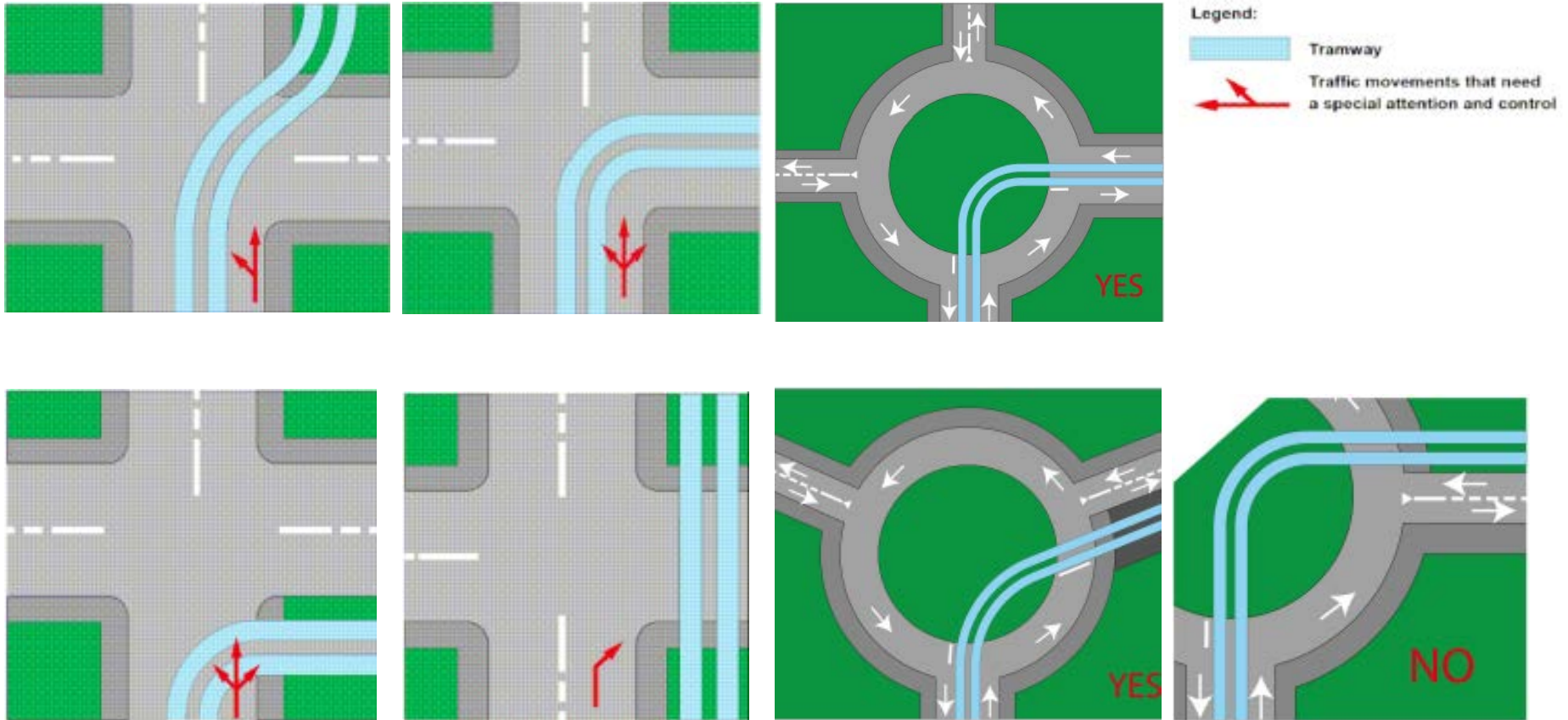
Section: Belgium | Antwerp | Turnhoutsebaan – Venneborglaan



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# Road junctions and roundabouts – General considerations

## Junctions and roundabouts with tramway changing direction



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### Road junctions

#### Priority junctions (without traffic lights)

- Junctions controlled by either stop or give-way lines or signs
- Appropriate if
  - low traffic flows on minor road
  - low number of turning vehicles
  - good visibility
- Suitable only for secondary intersections
- Tramway should be regarded as if it were the major road



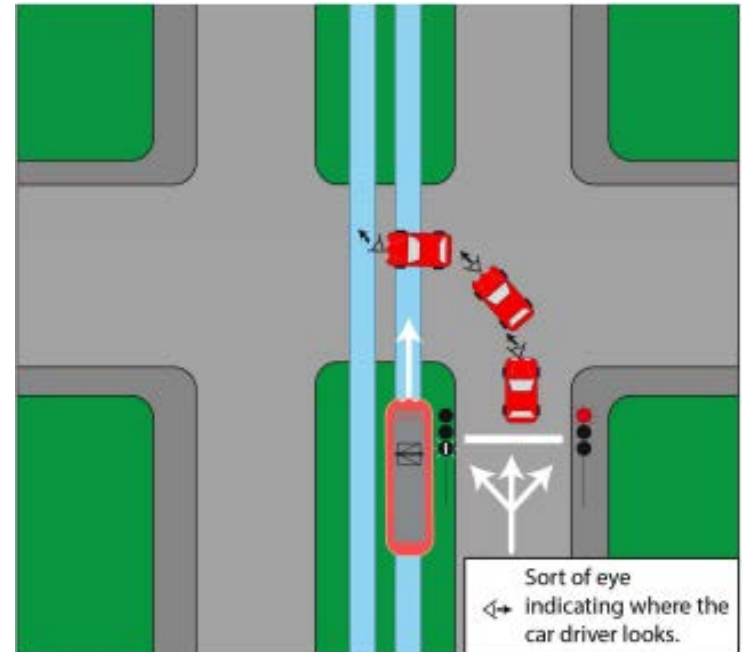
France | Grenoble

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### Road junctions

#### Priority junctions (without traffic lights): Left turn

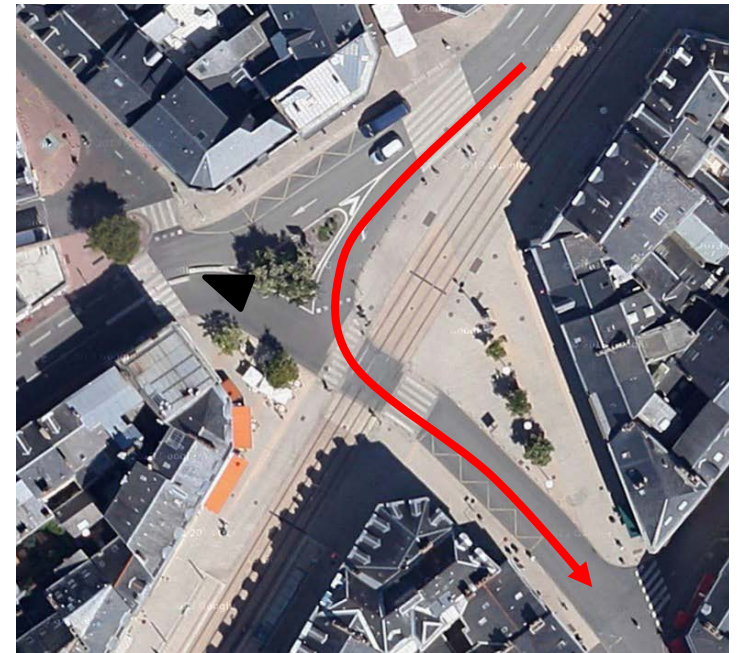
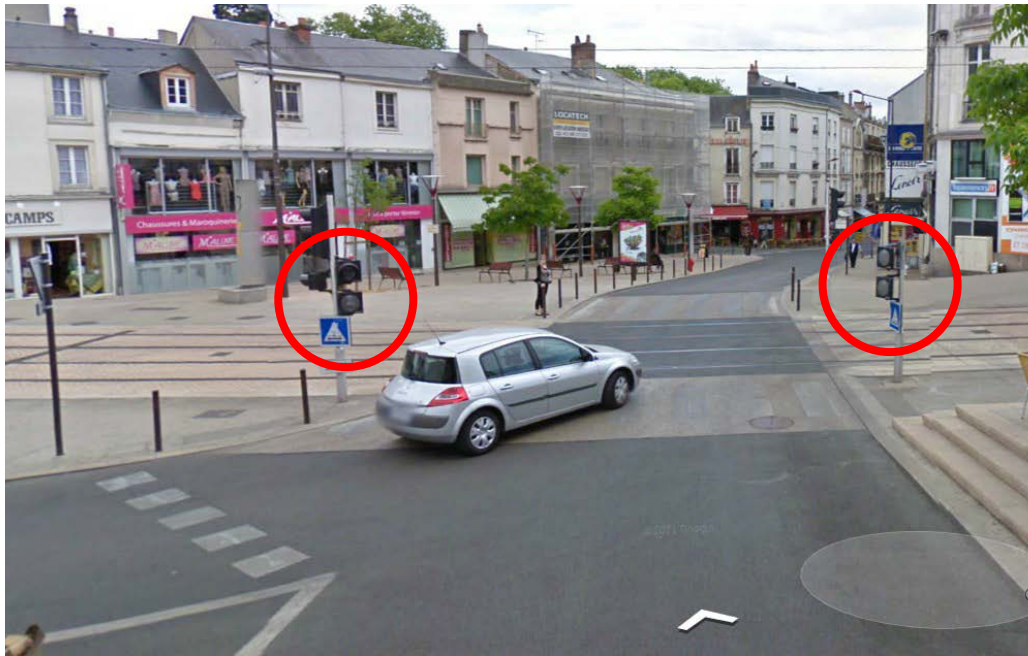
- Problem: (Left) turn across tramway: motorist might only look forwards, unaware of a tram approaching from behind
- If city structure allows, traffic should be reorganized
- Where rerouting is not possible and warning signs are not effective: traffic lights may be a better solution



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### Example

- HAZARD: Unintentional traffic light infringement
- OBJECTIVE: Improve traffic light visibility
- MEASURE: Install a second signal



Left turn: France | Le Mans | Intersection Roosevelt – National

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### Road junctions

#### Signalised junctions (with traffic lights)

- Usual solution for managing conflicts at junctions with tramway
- Often used to increase reliability with tram priority
- Sensors detect tram upstream of junction and affect traffic light cycle for:
  - adding a special phase for the tram,
  - or passing to a compatible phase with the movement of the tram,
  - or extending a compatible phase with the movement of the tram.
- When two road vehicle movements in the same entry arm are allowed in different phases, each should have a specific lane and separate signals

France | Montpellier



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### Example

- HAZARD: Unintentional traffic light infringement
- OBJECTIVE: Avoid confusion about traffic light aspect for vehicles turning left
- MEASURE: Separate left turn lane with a physical separator



Left turn: France | Grenoble

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### Example

- HAZARD: Confusing traffic light information
- OBJECTIVE: Clarify traffic light aspect
- MEASURE: Install additional signal for straight lane



Left turn: Austria | Vienna | Quellenstrasse/Herndlgasse

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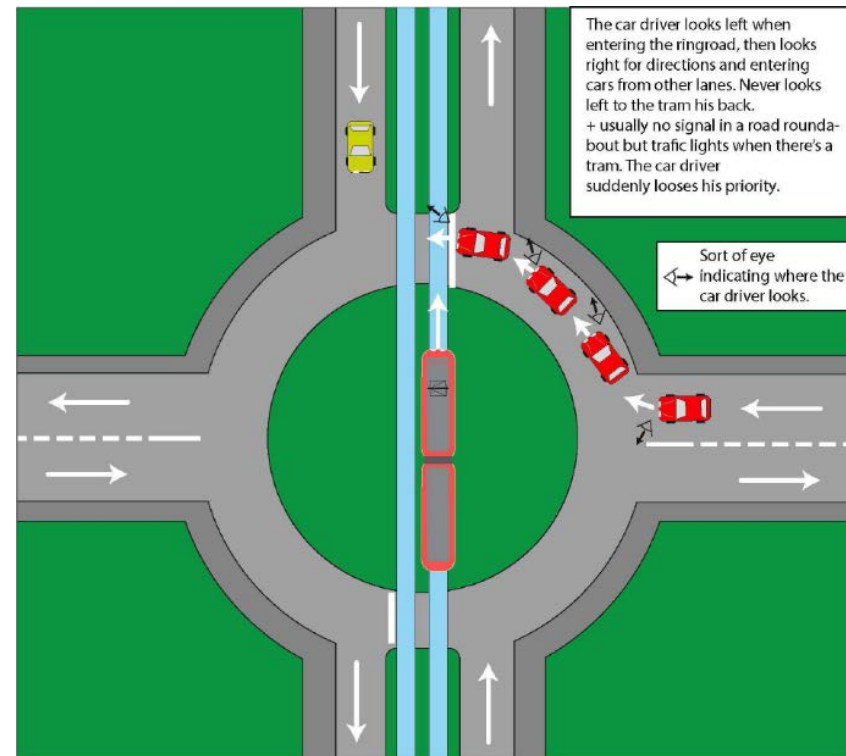
### Roundabouts – General aspects

Very common solution for junctions without tramways in some European countries:

- Safe and almost continuous traffic flow
- Left turns → Right turns
- U turning points
- Avoid the need for traffic lights
- Reduce road vehicles' speed

The roundabout operation changes when a tramway is added to the roundabout:

- It works as a conventional one when the tram is not present or approaching
- Traffic lights are provided to give priority to an approaching or present tram



**It is crucial that the road vehicle drivers perceive at the right time what kind of situation they are facing (with or without priority for them on the roundabout).**



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### Roundabouts – When to use them?

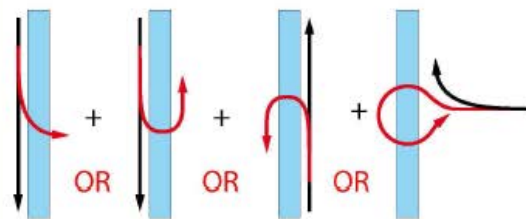
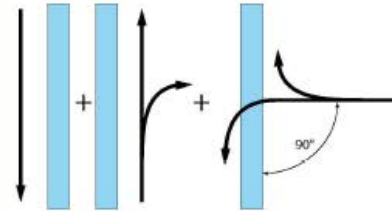
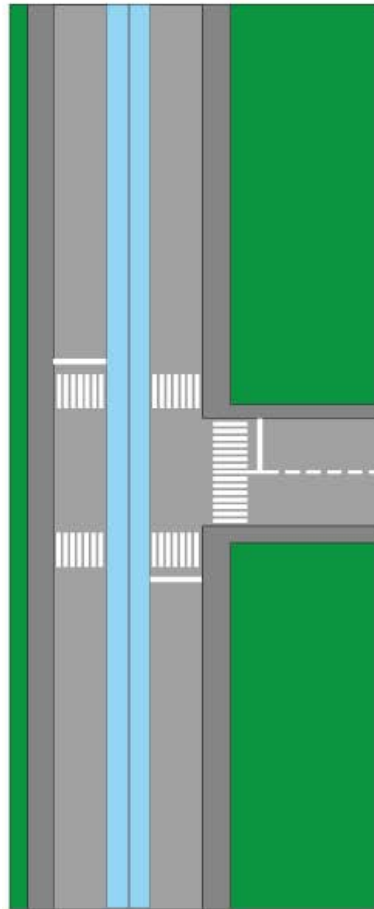
**Main recommendation: do not use roundabouts as a general solution, but only when there are strong reasons that make this configuration preferable to a conventional signal controlled junction**

- Depending on movements needed
- But sometimes there is the possibility of avoiding a specific movement at one location and allowing it more easily and safely nearby

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# Roundabouts – When to use them?

### Roundabout with three arms – T junction



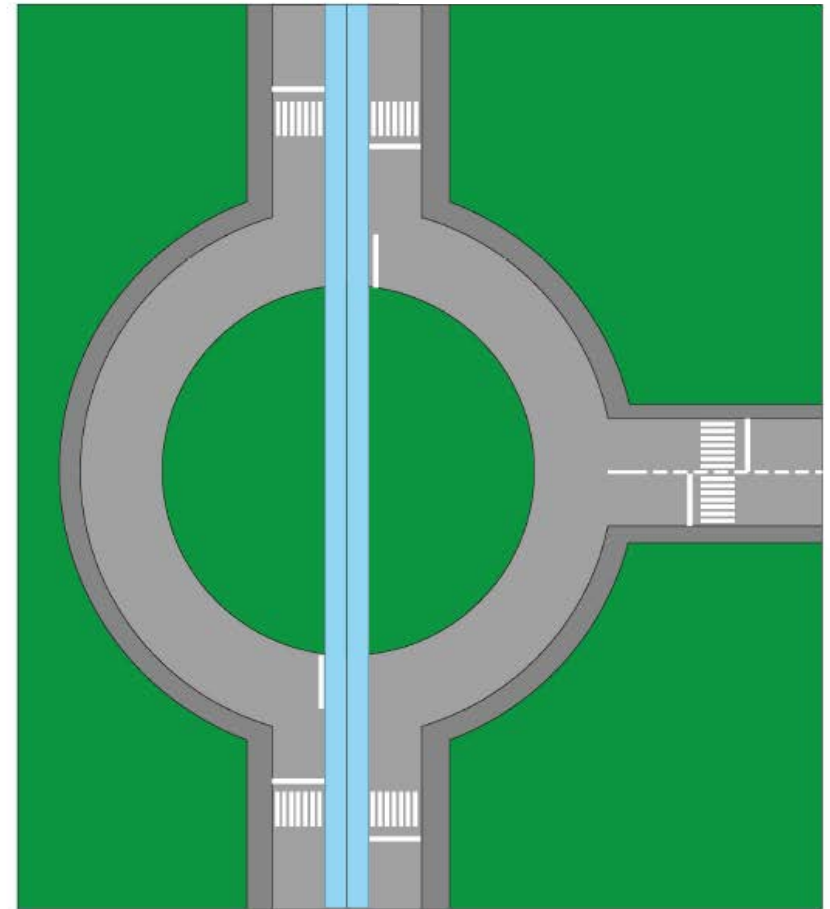
Legend:



Tramway



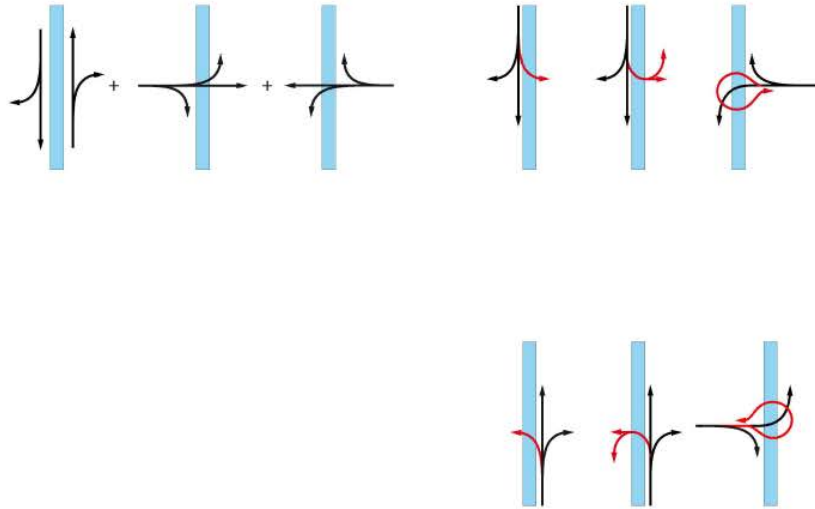
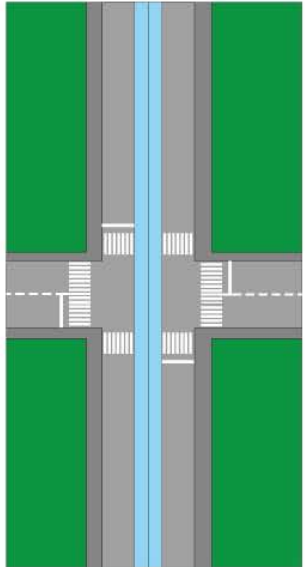
Traffic movements that need a special attention and control



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# Roundabouts – When to use them?

### Roundabout with four arms



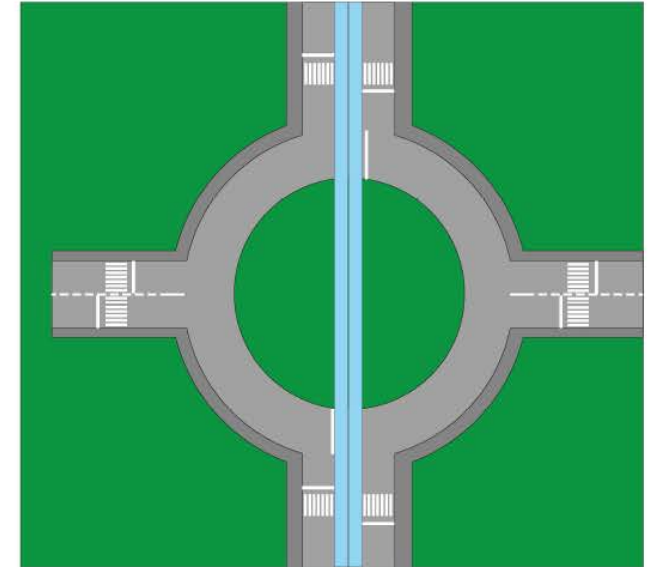
Legend:



Tramway



Traffic movements that need a special attention and control

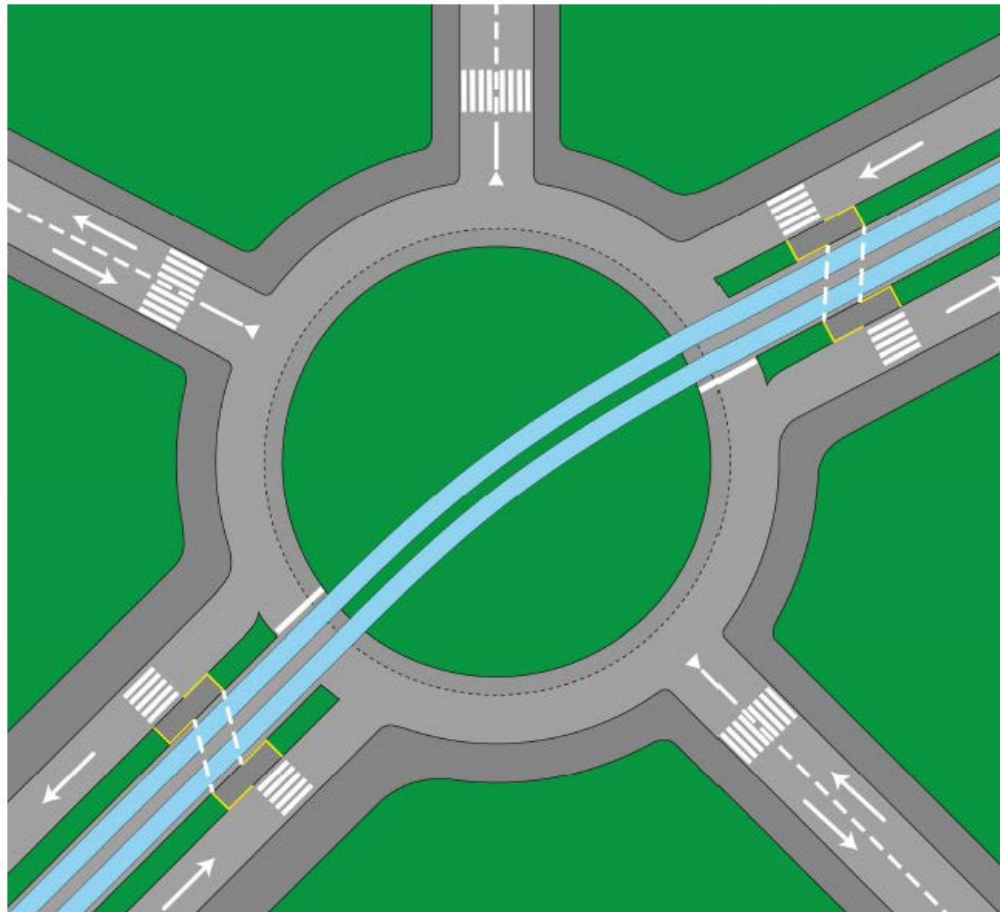


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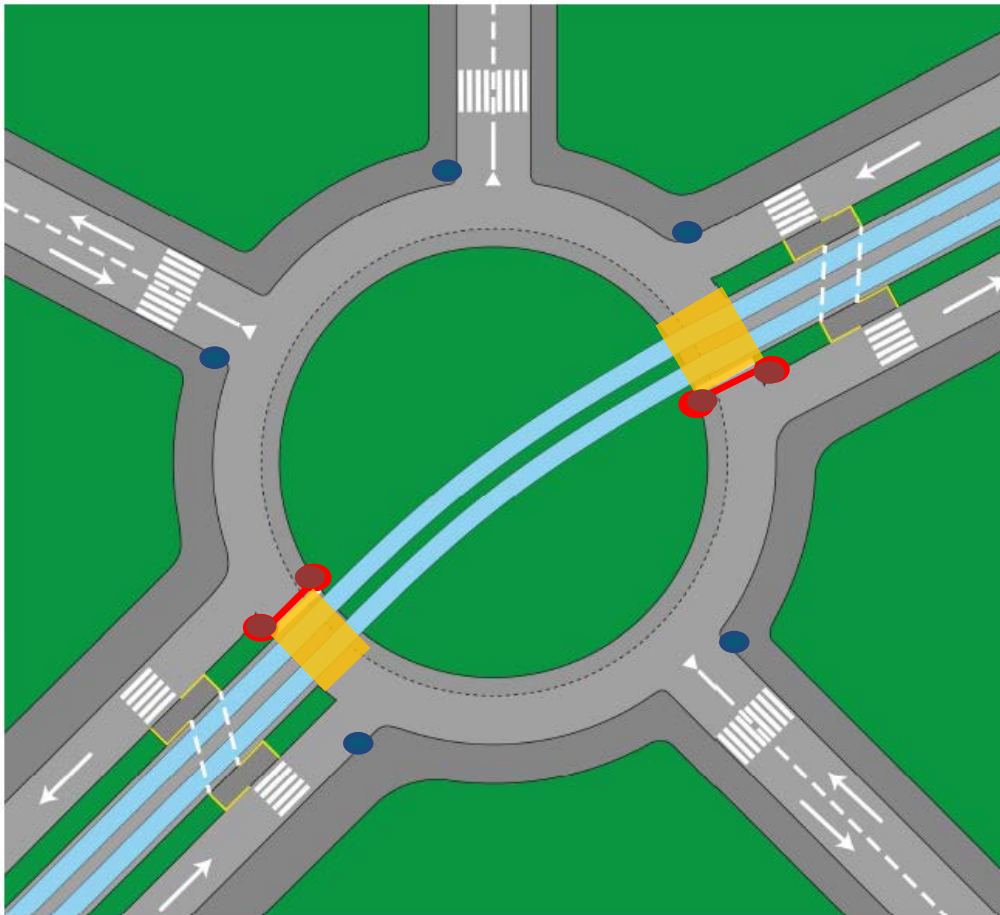
### Roundabouts – When to use them?

Roundabout with five arms, four arms in non-perpendicular direction, ...



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### Roundabouts – How to protect the tramway



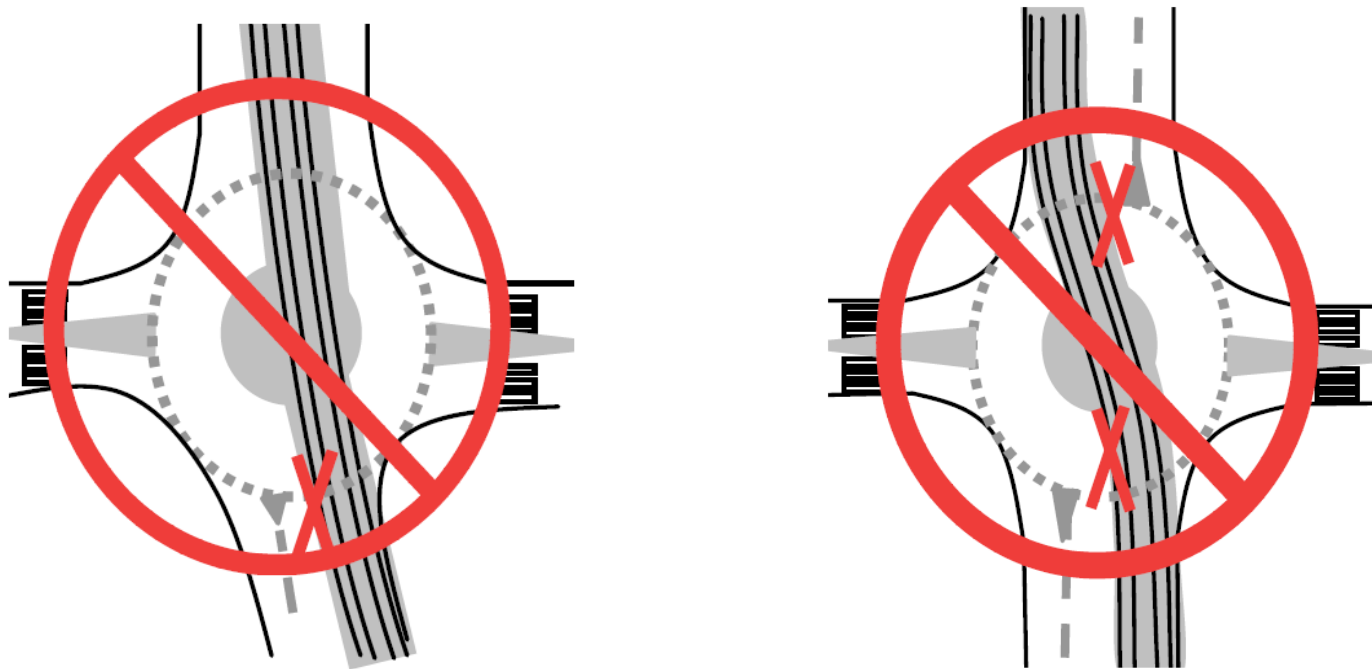
1. Differentiation of the road colour
2. Traffic lights before the tramway crossing
3. Stop line away from the swept path (around 1.5 m)
4. Vertical signs for improving awareness
  - Before the entrance of the roundabout
  - Before the tramway crossing (on the pole of the traffic light)



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### Example

- HAZARD: Third party drivers' attention is diverted in two directions in roundabout
- OBJECTIVE: Reduce complexity of roundabout situation for driver
- MEASURE: Avoid layouts where the crossing point with the tramway is immediately after the entrance into the roundabout

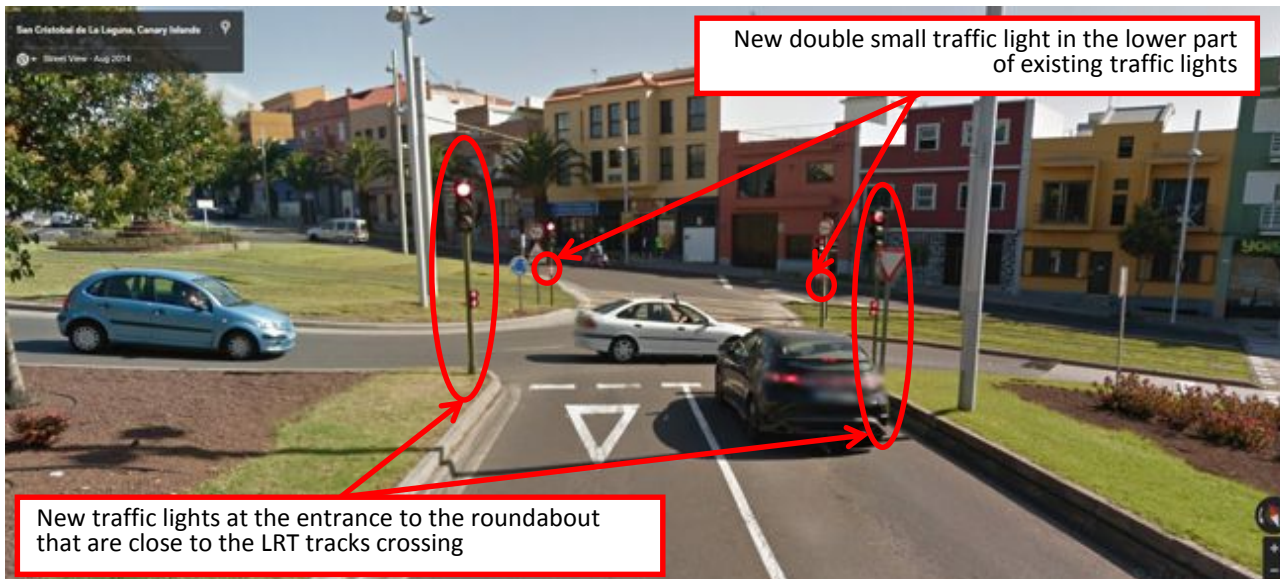
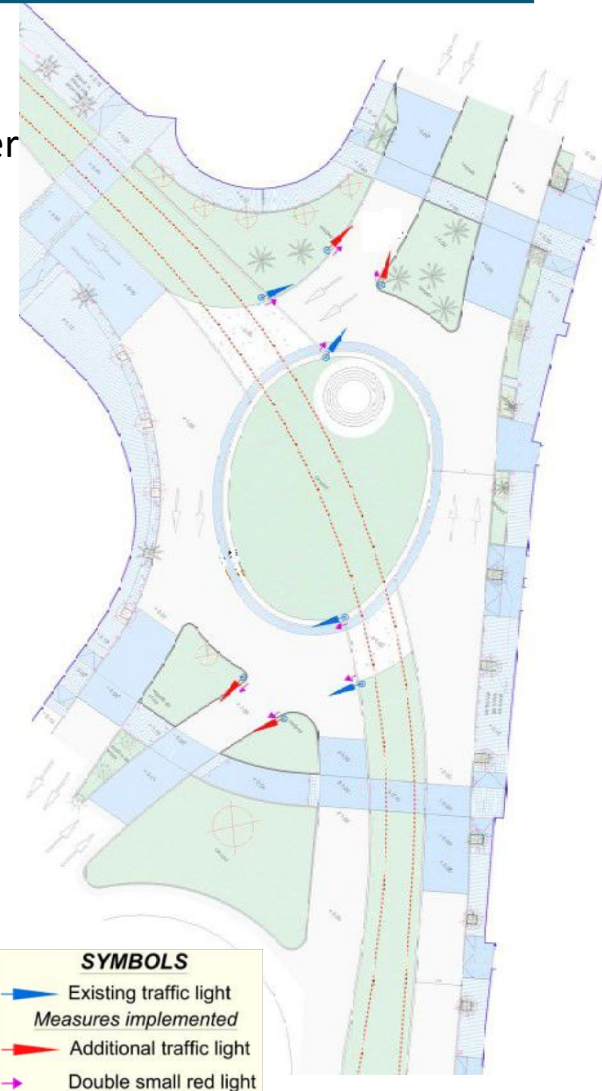


STRMTG and CERTU. « Giratoires et tramways. Franchissement d'un giratoire par une ligne de tramway. Guide de conception » (2008)

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### Example

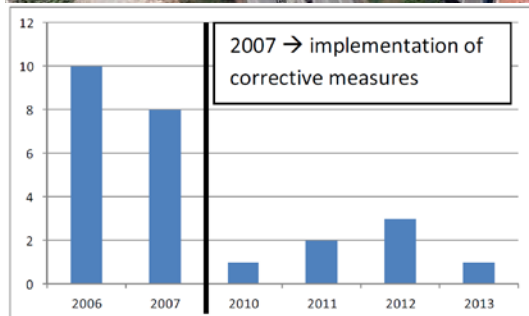
- HAZARD: Unintentional traffic light infringement by third party driver
- OBJECTIVE: Reinforce traffic light information
- MEASURE: Duplication of traffic lights:
  - At the entrances to the roundabout in addition to the ones at the tramway crossing.
  - At two heights



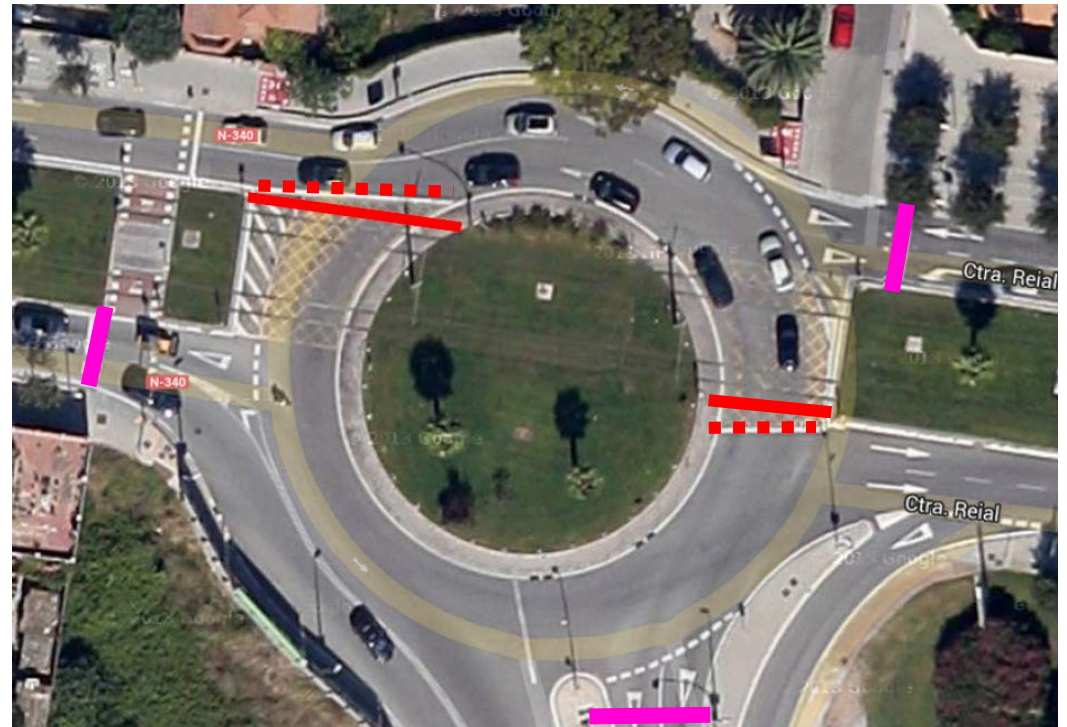
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### Example

- HAZARD: Unintentional traffic light infringement by third party driver
- OBJECTIVE: Simplify traffic light regime
- MEASURE: “All red” situation when the tram is approaching



Roundabout: Spain | Barcelona | Carretera Reial – Av. Baix Lobregat

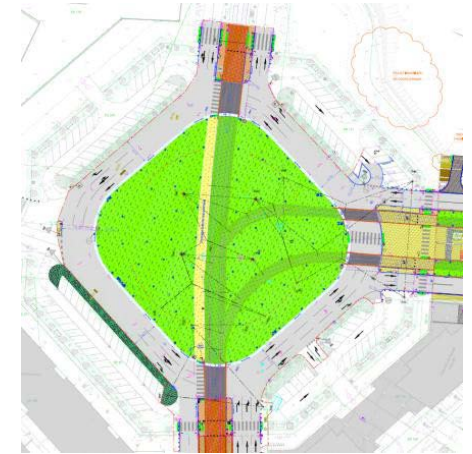




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### Example

- HAZARD: All the hazards at roundabouts
- OBJECTIVE: Change to other configuration to avoid the hazards
- MEASURE: Transforming the roundabout into another solution



Roundabout: France | Montpellier | Rond Point Ernest Granier





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Thank you for your attention !

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[www.tram-urban-safety.eu](http://www.tram-urban-safety.eu)