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IFS Institute of Transportation Systems

Requirements for Safety Relevant Positioning Applications in Rail Traffic

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- **Data required**

- **Reliability**

- **Precision**

- **Availability**

- **Economic issues**

- **GNSS based positioning systems**

- **Solutions and outlook**

Requirements for Safety Relevant Positioning Applications in Rail Traffic

You will get

- **Information, how to find out what you need**

You won't get

- **Exact values**

Data required

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Position data

- WGS 84 coordinates
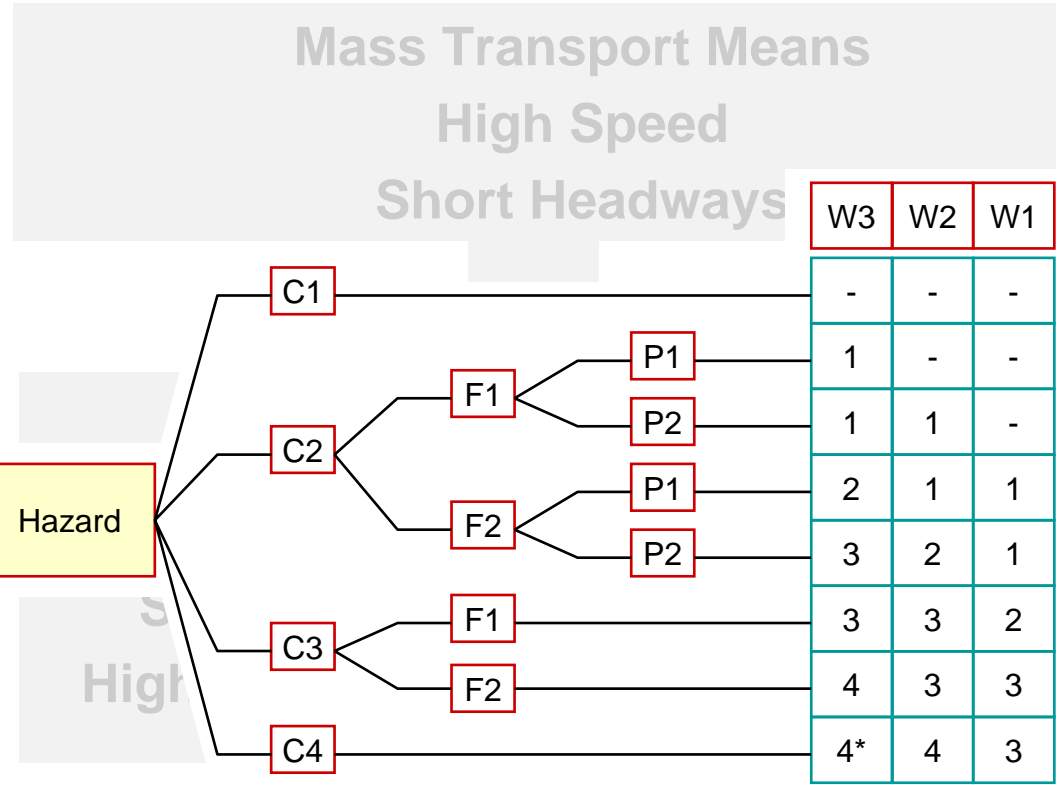- Distance from certain location

Speed

Direction

Depending on application

- Train Protection
- Route Protection
- Work Gang Warning
- Automatic Train Control
- Dispatching
- Passenger Information
- Waggon/Goods Tracing
- Energy Saving Train Control

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> **Mass Transport Means**
>
> **High Speed**
>
> **Short Headways**

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> **High frequency of exposure**
>
> **Limited possibility to control hazards**
>
> **Severe consequences possible**
>
> **High probability of hazardous event**

Reliability - Railway Environment

Mass Transport Means
High Speed
Short Headways

|	W3	W2	W1
C1	-	-	-
F1 → P1	1	-	-
F1 → P2	1	1	-
F2 → P1	2	1	1
F2 → P2	3	2	1
C3 → F1	3	3	2
C3 → F2	4	3	3
C4	4*	4	3

Hazard → C1, C2, C3, C4

Therefore: Safety related positioning applications in railway field require SIL 3 or SIL 4

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Depending on application and sensors to be replaced

Safety related applications

- Train Speed Monitoring
- Train Protection
- Route Protection
- Track Vacancy Detection
- Work Gang Warning
- Notification of Accident
- Automatic Train Control
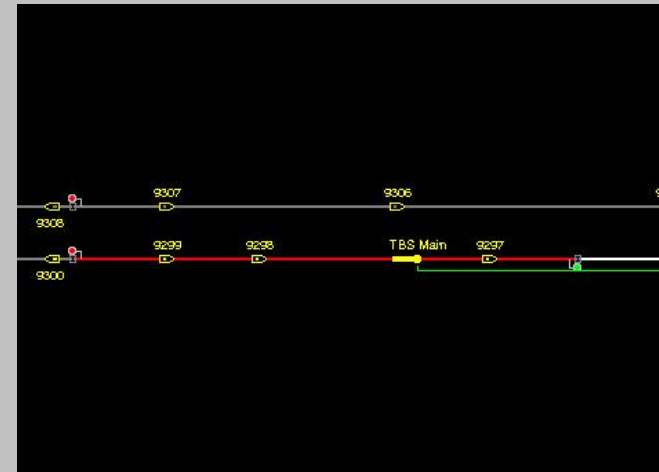
Depending on application and sensors to be replaced

Two directions

- **Across the track**

  Track selectivity is needed

- **Along the track**

  Precision of sensor to be replaced is assumed to be sufficient

Sensors in use

- Wheel detectors

- Balises / Transponders

- IR beacons

- Track circuit

- Odometer

- VSB Radar

- GNSS based systems

Availability

Depending on application and sensors to be replaced

Possible requirements

- Continuously available

- Available when Train is on certain location

- Available upon request

- Available at certain event

Place of data processing

- Trainside

- Trackside

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Economic issues

Two types of equipment

- Trackside equipment
- Trainside equipment

To be taken into conside-ration

- Length of track
- Train frequency
- Communication needs

Life Cycle Costs

- Acquisition and installation
- Operation, incl. communication
- Maintenance
- Removal

EU policy: Funding of trackside equipment only

GNSS based positioning systems

Problems / challenge

- **Availability of signal**

  Shadowed signal in tunnels, roofed stations

  Partially shadowed in forests, cuttings and hilly terrain

- **Accuracy of signal**

  Multipath propagation and reflection in urban areas, gulches

  Interference of signal

- **Reliability of calculated position**

  Constellation of visible satellites

  Questionable integrity of signal

- **Route Atlas / Digital Map**

- **Operators of GPS and GLONASS are military**

Aerospace technology for road and railway

Fusion of data of diverse sensors

- Odometer
- Transponders
- GSM
- Radar
- Inertial Systems
- Eddy-current sensor

New civil European satellite based navigation system GALILEO

- Increased accuracy and availability
- Integrity information