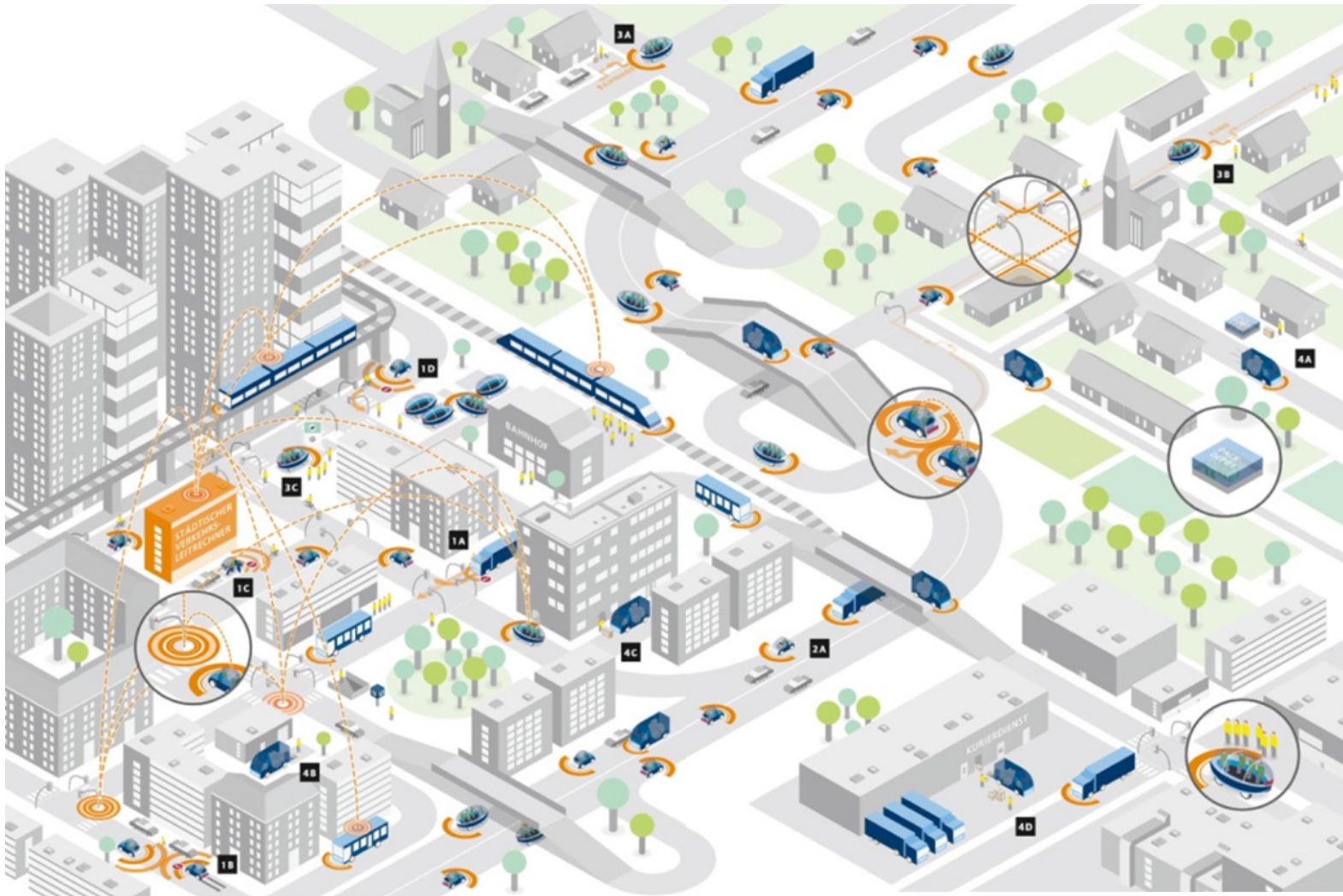
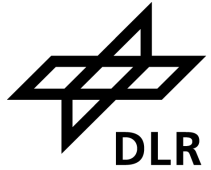


# Condition Monitoring for Predictive Maintenance

Research Topics @ Institute of Transportation Systems (TS)

Working Group Asset Monitoring and Management

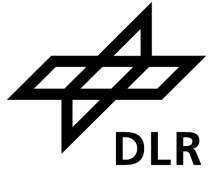
# The predictively maintained transport infrastructure of the future



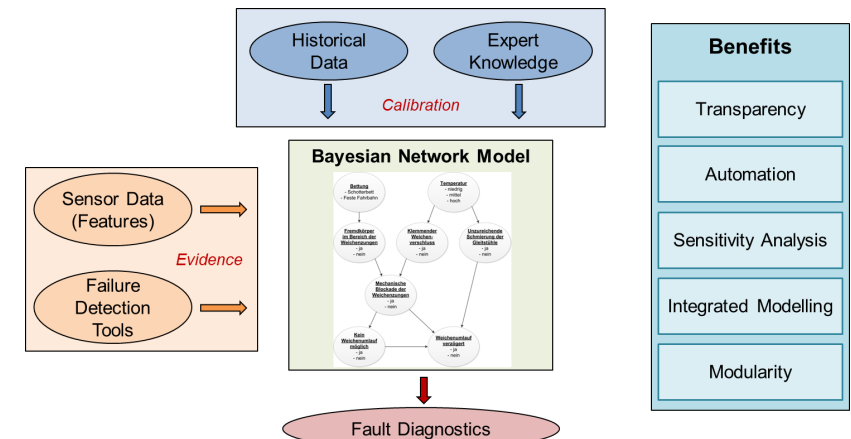
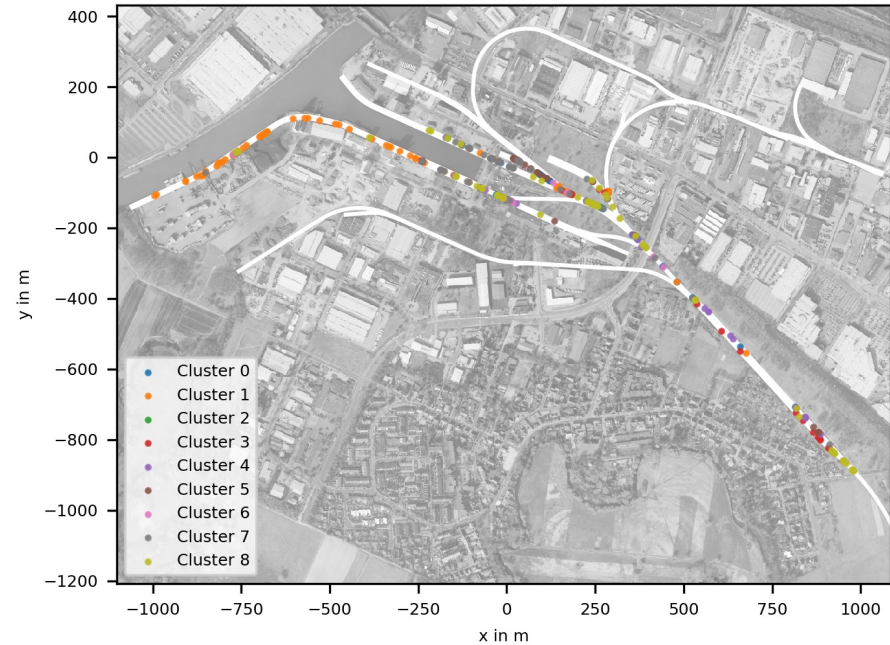
- Autonomous and connected vehicles as information sources for embedded condition monitoring of the road and rail tracks
- Increasing use of embedded sensors for condition monitoring of stationary infrastructure elements (esp. signaling and safety systems)

# Asset Monitoring and Management

## Data Science Research

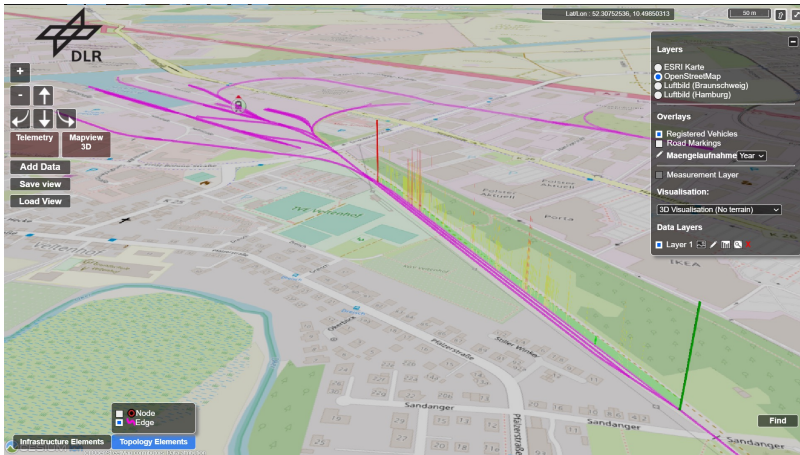


- **Detection:** Analysis of complex and highly dynamic signals due to numerous influencing factors
  - Data-driven methods for the separation of signal components (e.g. blind signal separation)
  - Anomaly detection based on numerous engineered features (utilizing domain expert knowledge)
  - Unsupervised detection and grouping of anomalies (e.g. with Convolutional Autoencoders)
  - Partial modelling of single factors (e.g. temperature effects)
- **Diagnosis:** Handling of complex assets / insufficient training data
  - Development of comprehensible diagnostic models (e.g. with Bayesian networks) based on available data and domain knowledge (i.e., hybrid models)
- **Prognosis:**
  - Time series prediction for individual features
  - Selection and parameterization of suitable supervised learning approaches

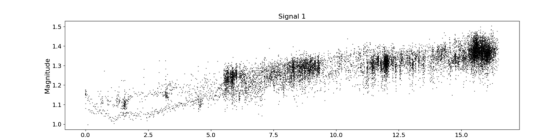
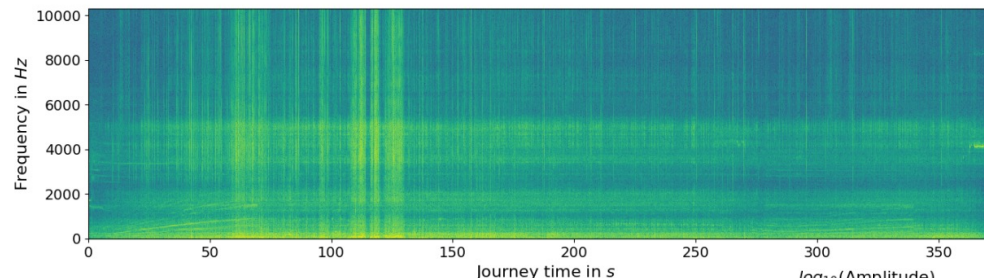
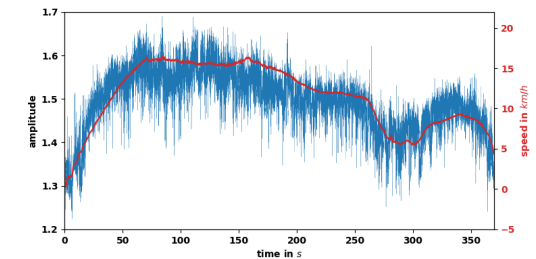
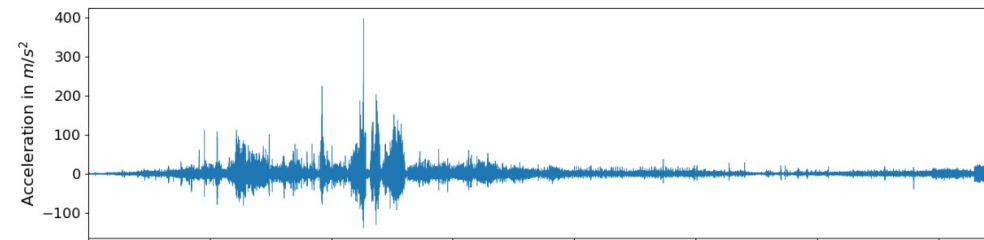
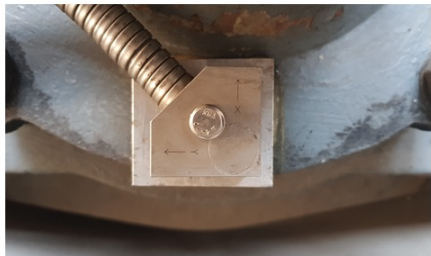


<https://www.youtube.com/watch?v=S3UtxjnQOh0>

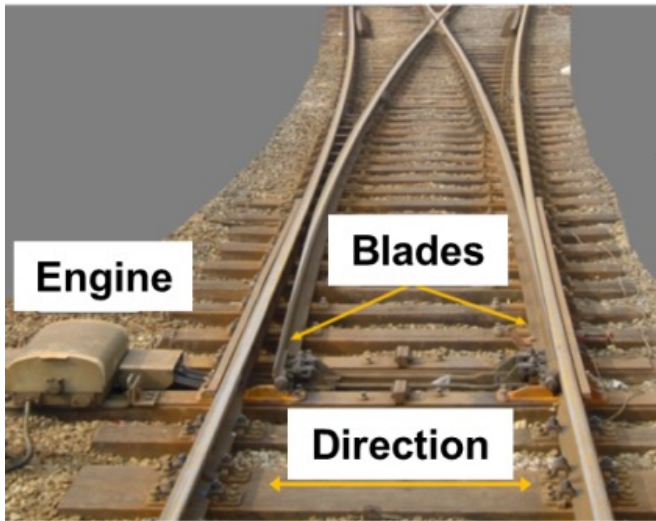
# Monitoring with onboard sensors: Retrieving track condition information from dynamic vehicle-track-interactions



- Large data set of axle box accelerations measured at a in-service shunter locomotive
- Analysis of high frequency acceleration time series (20 kHz), e.g.
  - Data-driven methods for the separation of signal components (e.g. blind signal separation)
  - Unsupervised detection and grouping of anomalies (e.g. with Convolutional Autoencoders)
  - Supervised learning for time series prediction (e.g. vehicle speed from vibrations, ...)



# Embedded wayside sensors: Monitoring of railway turnouts with electrical measurements



- Realistic synthetic data set representing normal and defective behaviour including systematic external influences
- Analysis of complex signals due to numerous influencing factors
  - Unsupervised detection and grouping of anomalies (e.g. with Convolutional Autoencoders)
  - Detection and partial modelling of single factors (e.g. temperature effects)
  - Development of anomaly scores
  - Detection and forecasting of degradation trends

