CAISR

Centre for Applied Intelligent Systems Research

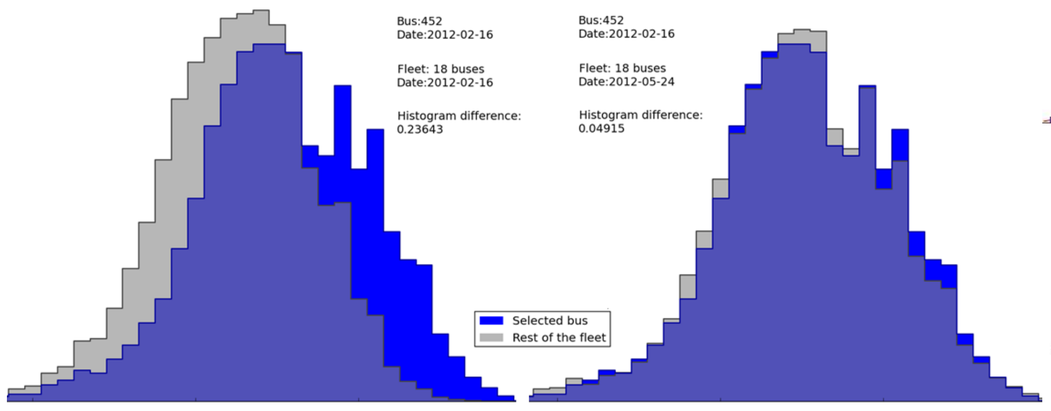
ReDi2Service

Remote Diagnostic Tools and Services

Knowledge Foundation

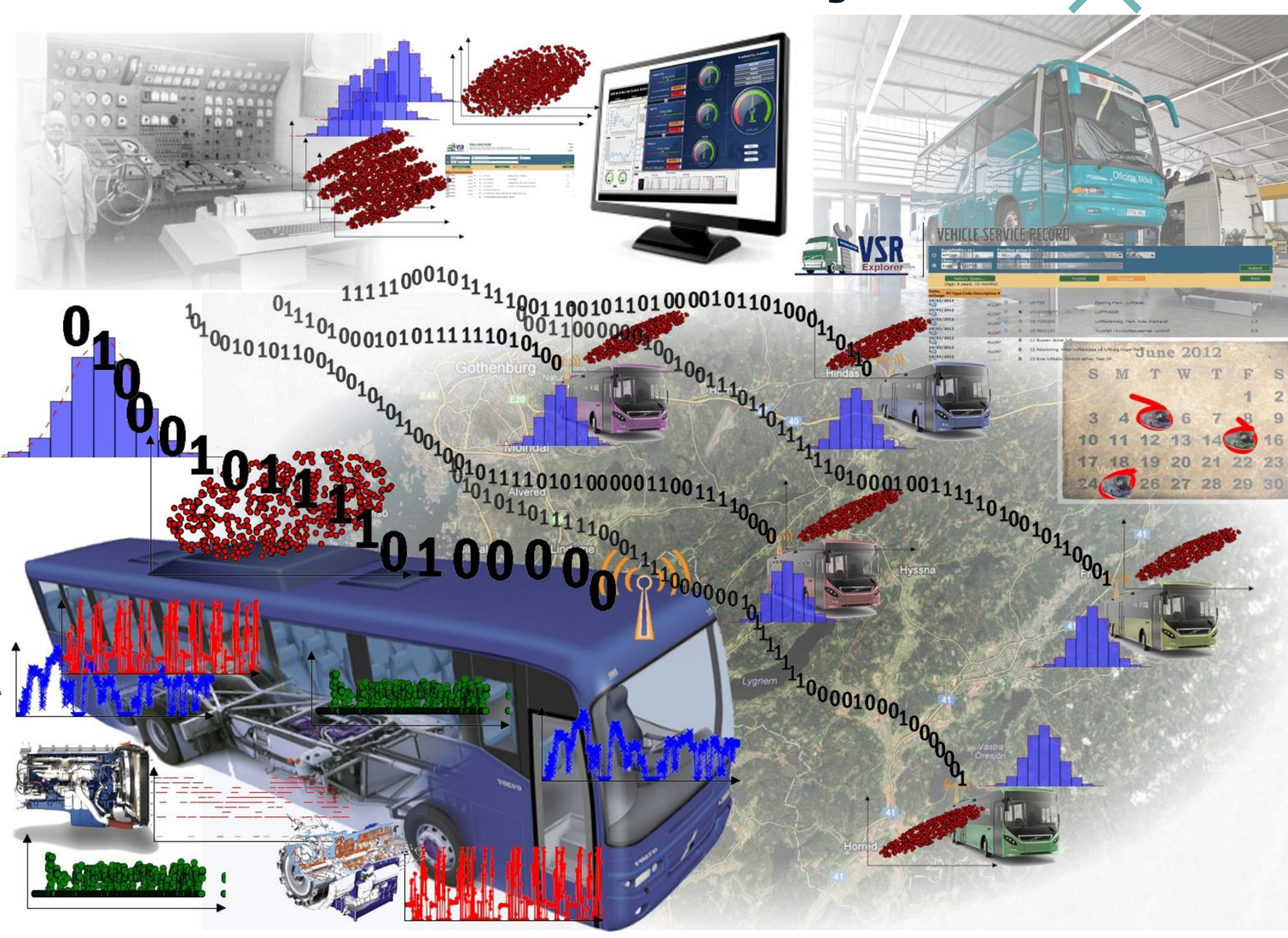
The main idea behind R2S project is to develop algorithms for self-monitoring vehicles, capable of discovering and describing their own operation, and detecting when deviations from the norm occur.

By using data mining across many data streams available on-board a modern truck or bus, and by comparing discovered relations across the whole fleet, both faults and component wear can be discovered early and continuously monitored.



In our research we take advantage of the fleet aspect, focusing on differences in operation between similar individuals, since modern trucks are too complex to be accurately modelled as a complete system.

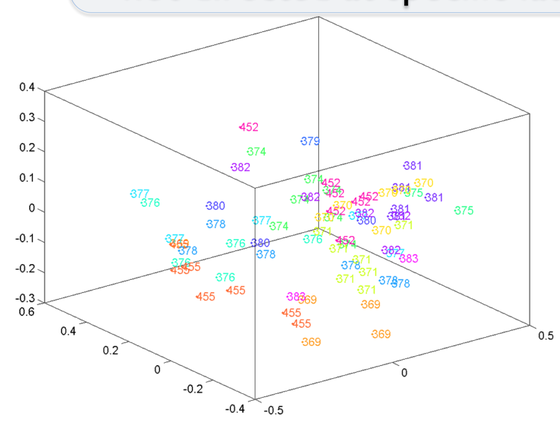
In the plot above, we show that essentially the same sensor readings can be correct under one set of circumstances, but indicate a fault under another. The difference is not always obvious in the absolute, but can be clearly seen when compared against the group.

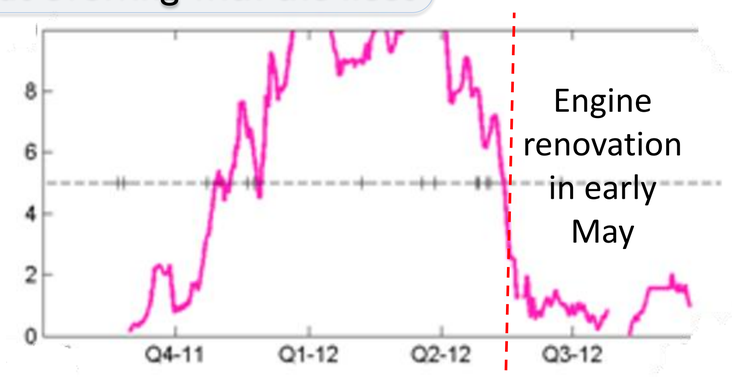


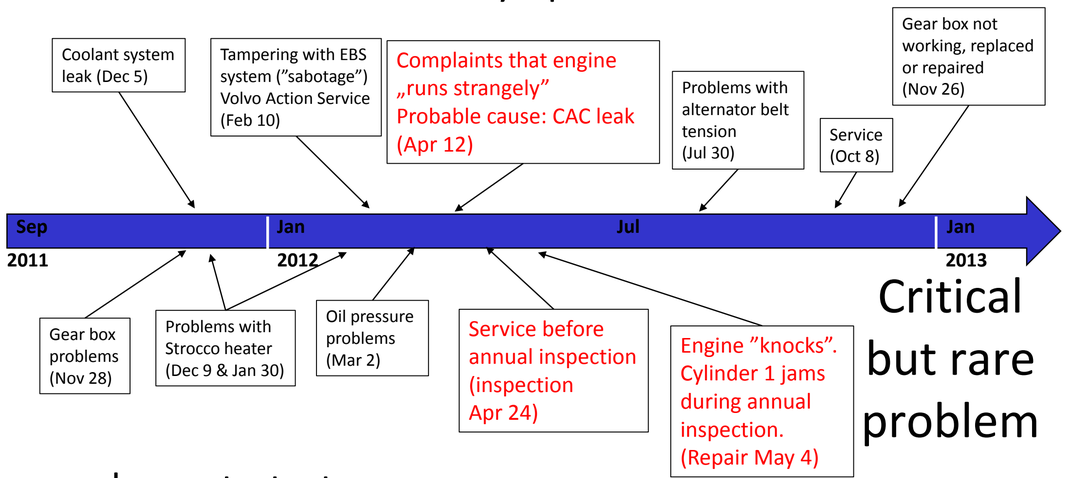
Our system continuously mines the on-board sensor streams, looking for interesting relations in the data. Parameters of discovered models are then sent to the central server or to other vehicles in the fleet. We compare them and match observed deviations against available reference data, building a repository of information about faults and their symptoms.

We are using a generic and adaptive approach:

not directed at specific faults, but evolving with the fleet

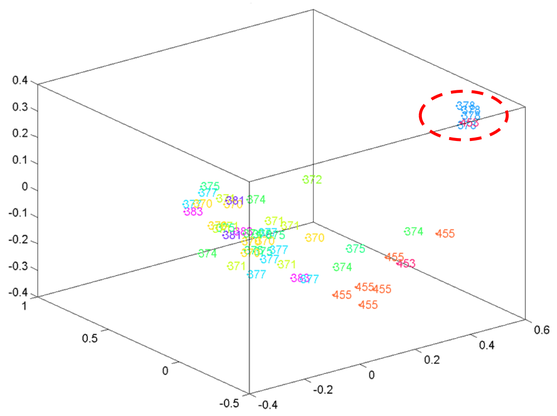






Critical but rare problem

By analysing deviations across signals and over time, we are able to quantitatively describe the state of health of any particular vehicle as a whole, as well as that of many components of interest.



When one of the group members starts to deviate from the normal behaviour, it is reflected in the differences between data models obtained from individual vehicles.

A broken truck separates itself from the fleet, because the natural variability of the data gets overshadowed by effects of the fault. Thus, a more uniform fleet offers higher sensitivity.

By estimating the likelihood of observing a particular values of model parameters based on the empirical probability distribution obtained from the rest of the fleet, we can provide manufacturers, workshops and fleet owners with a measurement of a health state of each individual vehicle and component.

COOLING FAN PROBLEMS

Continuously running at full speed due to e.g. ECU fault (over six months)

- power consumption grows ~ (speed)^3
- maximum power is ~ 15 kW = 20 hp
  - 5-7% of the total engine power
- normally full speed is <10% of the time
- discomfort for the driver
  - colder bus and more noise

Not a critical problem, it is infeasible to design specialized diagnostics for it

During over two years of data collection and analysis we have shown that a self-monitoring system like this one can reduce the number of unplanned stops. The adaptive nature of our approach allows it to evolve with the fleet, always focusing on the relevant faults. Especially for rare or non-critical faults it offers a cost effective complement to engineered diagnostics, and can also be used to increase knowledge about vehicle’s usage.

Project consists of two parts:

Technical part: Development of data collection system, installation in a bus fleet, collection and analysis of data, combining data with various sources of knowledge.

Service development part: Identification of possibilities for service innovation through business analysis, workshops and interviews with different stakeholders.

hh.se

HALMSTAD UNIVERSITY