MSc thesis proposal: The vehicle interface importance of e-dolly combination performance

Background
The HELPED project is a research project within the vehicle dynamics group at Chalmers. The aim of this project is to evaluate aspects of introducing an electrified converter dolly (e-dolly) with propulsion. A converter dolly is a small vehicle intended to convert the connection of a trailer from a drawbar to a fifth wheel, see figure below.

![Figure 1 An example of a dolly converter vehicle. From Wikipedia. By Teppo Lainio - Own work, CC BY-SA 2.5, https://commons.wikimedia.org/w/index.php?curid=456523](https://commons.wikimedia.org/w/index.php?curid=456523)

Introducing an (electrically) propelled axle on a dolly converter vehicle is motivated by a flexibility argument, where existing vehicles in a vehicle combination can be used without modification. An additional argument is that an electrified axle can increase the fuel efficiency of the internal combustion engine of the primary mover.

![Figure 2 Example of an A-double combination in LEGO, consisting of a (from right to left) tractor, semi-trailer, dolly converter (single axle), and last another semi-trailer.](https://example.com/legocombination)

With predictive control, there is a potential to save fuel using the extra energy buffer that the electrified axle and its battery provide and allowing some deviation of the longitudinal speed. However, with actuation on more axles in the vehicle combination comes the risk of creating
dangerous situations. Energy efficiency and traffic safety can be dealt with simultaneously using optimal control strategies, see [1].

To achieve the best possible performance, it is assumed that the communication between vehicles in the vehicle combination exchange all possible states. This information exchange between vehicles may be referred to as the (signal) interface between them. The interface of real vehicles is set by standards and general agreements across manufacturers of trailers, edollies and tractors, and tracks. Changing interfaces is a long process and many aspects need to be considered, such as backward compatibility. Hence, determining the potential performance loss of losing information exchange between vehicles is central to setting the standard interface.

Problem description
The core problem to investigate in this project is how performance is influenced when the information exchange between the vehicles varies. The invested vehicle combination may be a so-called A-double combination, see figure 2, with an edolly that propels in the middle of the combination. Performance may be quantified in either energy consumption or energy consumption and traffic safety

Research question
Questions that should be considered in the project are,

- How is the energy-saving performance influenced by reduced information exchange between the vehicles of the combination?
- Can a reduced information exchange be replaced by an inexpensive sensor set on the edolly?
- What is a minimum information exchange to keep a vehicle combination safe and stable?

Deliverables
- Models suitable for the problem at hand
- Formulation of an optimization problem that captures different interfaces and assesses performance in a realistic manner
- A study revealing the performance losses w.r.t. different interfaces.

Tentative plan
- Literature study
- Inventory models for the projects purpose and possible develop new ones
- Formulating and solving optimal control problems with various levels of information exchange (interfaces) between the vehicles

Administrative
- Number of credits: 30 points per student (nominally 20 weeks).
- Starting date: any time
- Requirements:
  - Good understanding of system dynamics
  - Good understanding of modeling (vehicle dynamics preferable)
  - Knowledge and skill in a modeling and simulation tool (e.g. Modelica, Simulink/Matlab etc)
  - Good understanding in optimal control
- Resources/Stakeholder: Chalmers and Volvo (the thesis will be strongly connected to the HELPED project and the partners within this consortium.).
- Responsible subject/research group at Chalmers: Vehicle dynamics
  o Examiner: Fredrik Bruzelius
  o Supervisor
    ▪ Fredrik Bruzelius
    ▪ Toheed Ghandriz
- Application to Fredrik Bruzelius, fredrik.bruzelius@chalmers.se, with CV and transcripts.
- Physical location: Chalmers and possibly also at Volvo GTT

References