PI-Transporter Requirements as an Enabler for the Implementation of the Road-Based Physical Internet (RBPI)

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Aim and objectives

The contribution of this research poster to the Physical Internet (PI) is to present PI-Transporter functionality that enables vehicles to take part in the road-based Physical Internet (RBPI). The requirements are derived from detailed protocol analyses and applied to road-based PI-Transporters [1, 3]. This ranges from remote access to the cargo space of PI-Transporters, cargo securing through an adaptive 3D surface cargo space interior, an automated vacant cargo space detection, up to a standardized interface for V2X communication in order to negotiate freight forwarding within the road-based vehicle network.

Cargo Space Observation

The objective of the Cargo Space Observation is to track and trace freight components and to identify vacant cargo space capacity. The two approaches are applicable as separate systems or in conjunction via:

- AUTO-ID methods (e.g. RFID, NFC, QR-Barcodes)
- Sensors for automated detection of transported freight as a basis for identifying remaining cargo space capacities (e.g. optical or ultrasonic systems).

For communication, In-Vehicle-Network technologies like WiFi, Bluetooth, Zigbee, or LoRaWAN might be used for both methods.

V2X Communication Interface

The V2X Communication Interface ensures interoperability of road-based PI-Transporters, both directly with each other and/or via a cloud connection [2]. Vacant cargo space capacities and the planned routes of the PI-Transporters are exchanged ‘anonymously’ with each other by means of identity management. This allows the negotiation of rendezvous between PI-Transporters for the exchange of freight or freight components. Alternatively, this negotiation can be performed by software representatives of PI-Transporters on a virtual marketplace.

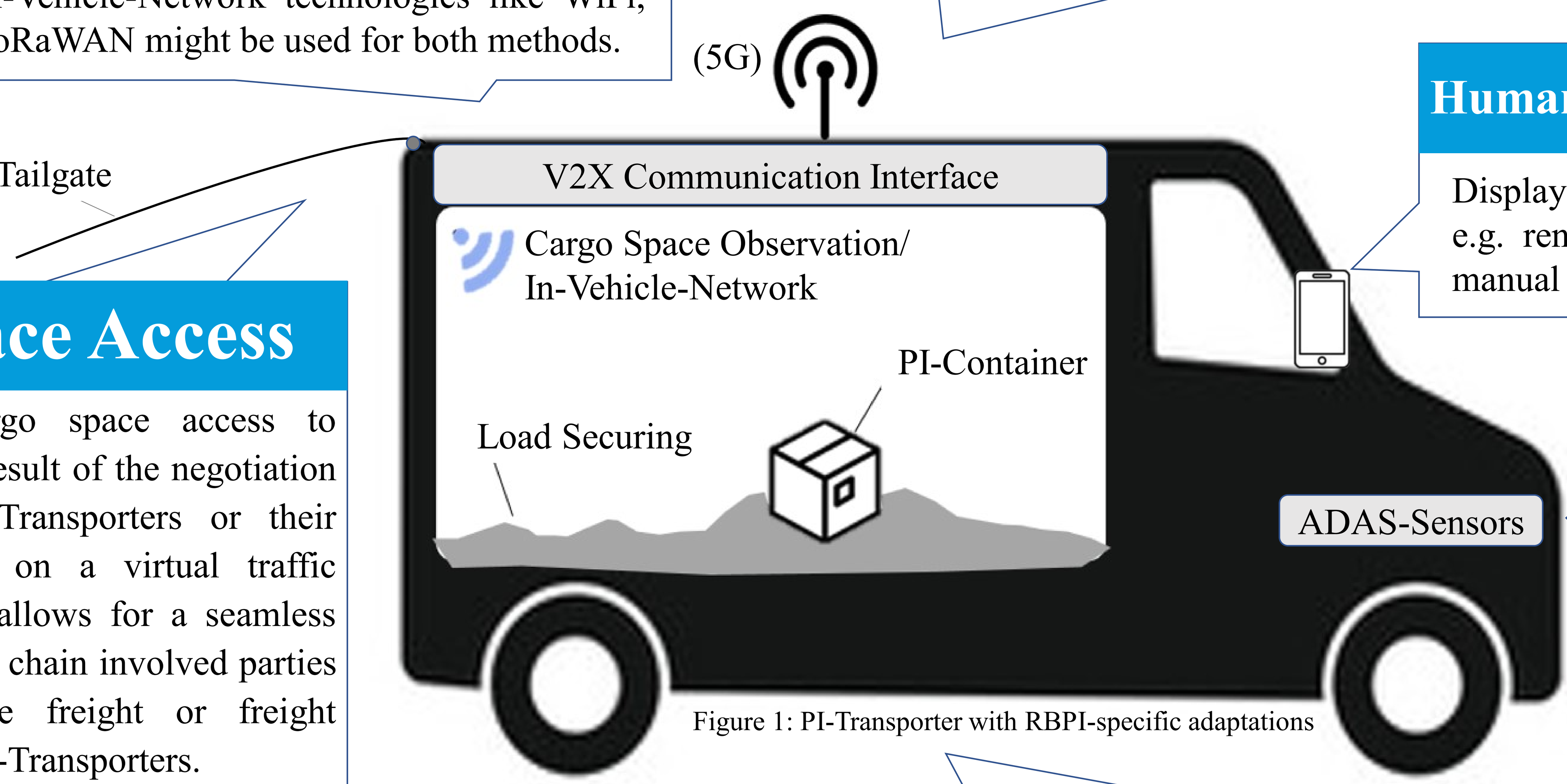

Figure 1: PI-Transporter with RBPI-specific adaptations

Human Machine Interface

Displaying of relevant information, e.g. rendezvous-points, in case of manual operation.

Cargo Space Access

Authorization for cargo space access to PI-Transporters is the result of the negotiation process of either PI-Transporters or their digital representatives on a virtual traffic marketplace [3]. This allows for a seamless interaction for transport chain involved parties in order to exchange freight or freight components between PI-Transporters.

Optional: Driver Assistance

Detection of road conditions, e.g. potholes and icy roads, to better predict arrival times of PI-Transporters.

Optional: Automated Load Securing

An automated shape shifting interior can make a significant contribution to protect load from slipping or damage during the ride within PI-Transporters [4]. This becomes possible through an adaptive 3D surface cargo space interior. Electrically controllable piezoresistive elongation elements (Figure 2a) are arranged in the form of a matrix.

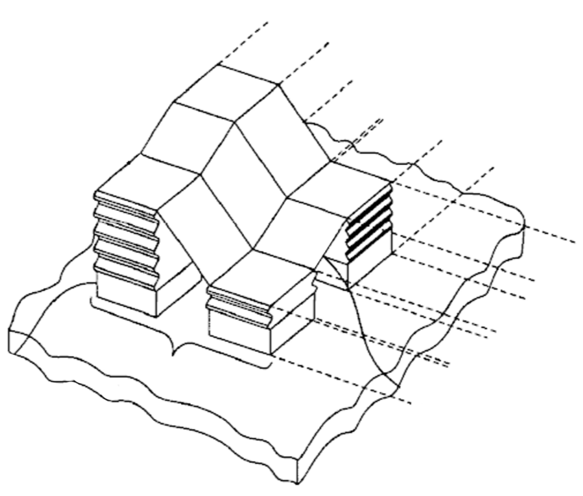
Figure 2a: Elongation elements

This actuator matrix of elongation elements provides load restraint by form closure with a freight component corresponding surface buildup (Figure 2b). The retention force of the matrix is determined by the used expansion material and the applied voltage on the corresponding elements. (Figure 2b, factor x).

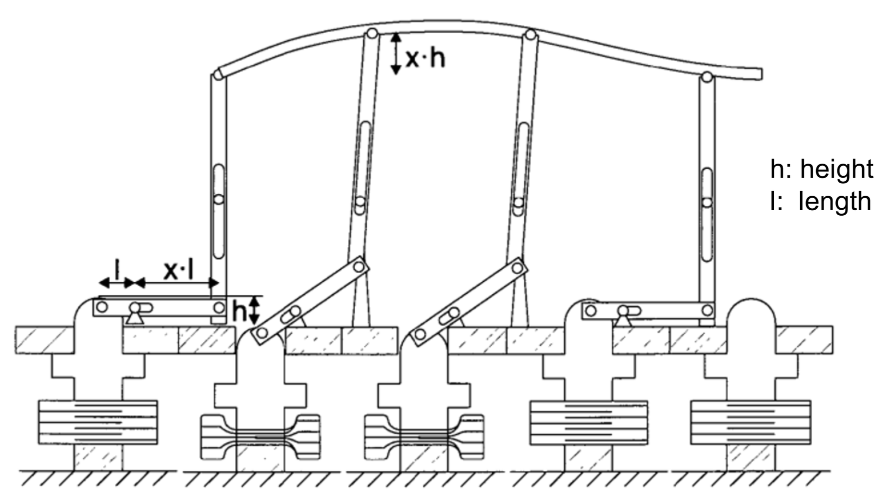

Figure 2b: Shape shifting surface buildup

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