IPIC 2021 | 8th International Physical Internet Conference

Presentation of the Paper

Framework Artifact for the Road-Based Physical Internet based on Internet Protocols

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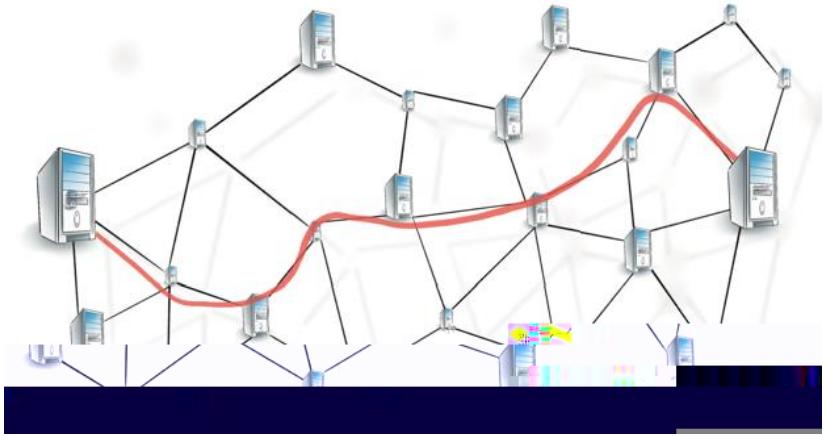
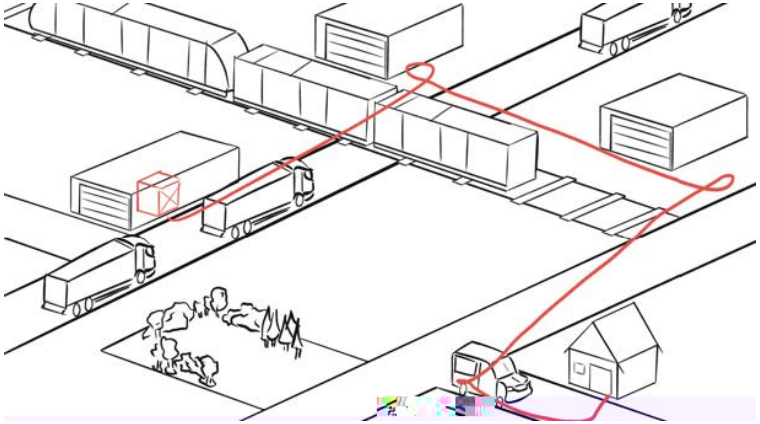
INTRODUCTION: FROM DATA INTERNET TO PHYSICAL INTERNET





On the Data Internet, logistics mechanism are implemented in protocols. In order to transfer these to the Physical Internet, they have to be analyzed in detail.

FRAMEWORK ARTIFACT FOR THE ROAD-BASED PHYSICAL INTERNET BASED ON INTERNET PROTOCOLS

RESEARCH QUESTIONS

Central Research Question (CRQ):

What are the corresponding functionalities and attributes within the Road-Based Physical Internet (RBPI) resulting from the analysis of Digital Internet protocols?

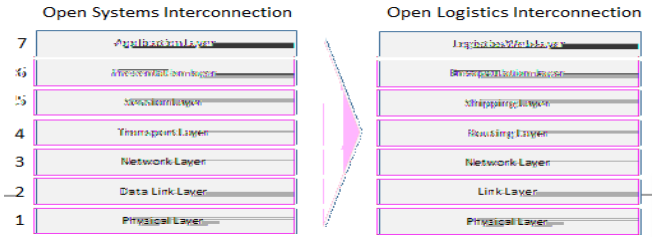
Sub-Questions (SQ):

SQ_1: Which functions and/or attributes can be transferred one to one from the DI protocols to the RBPI?

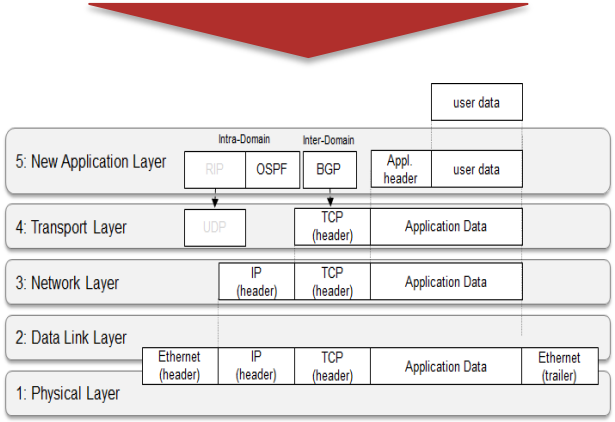
SQ_2: Which of the non-transferable functions and/or attributes require replacement?

SQ_3: What vehicle requirements can be derived from the protocol transformation?

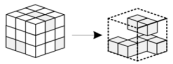
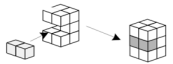
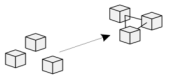
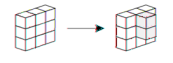
METHODOLOGY: FROM ANALYSIS TO FRAMEWORK DESIGN



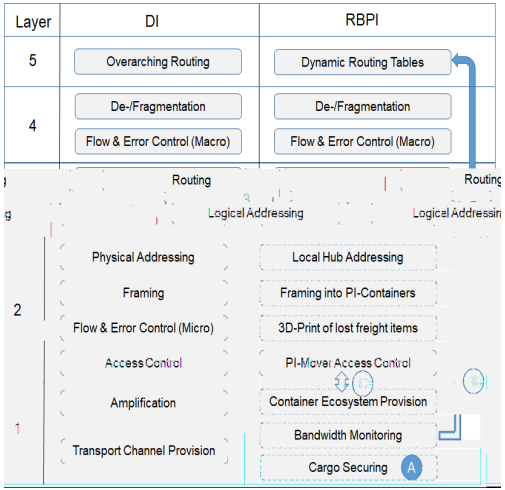
OPEN LOGISTICS INTERCONNECTION MODEL,
ADAPTED FROM (MONTREUIL, MELLER AND BALLOT, 2010)



DETAILED PROTOCOL ANALYSIS

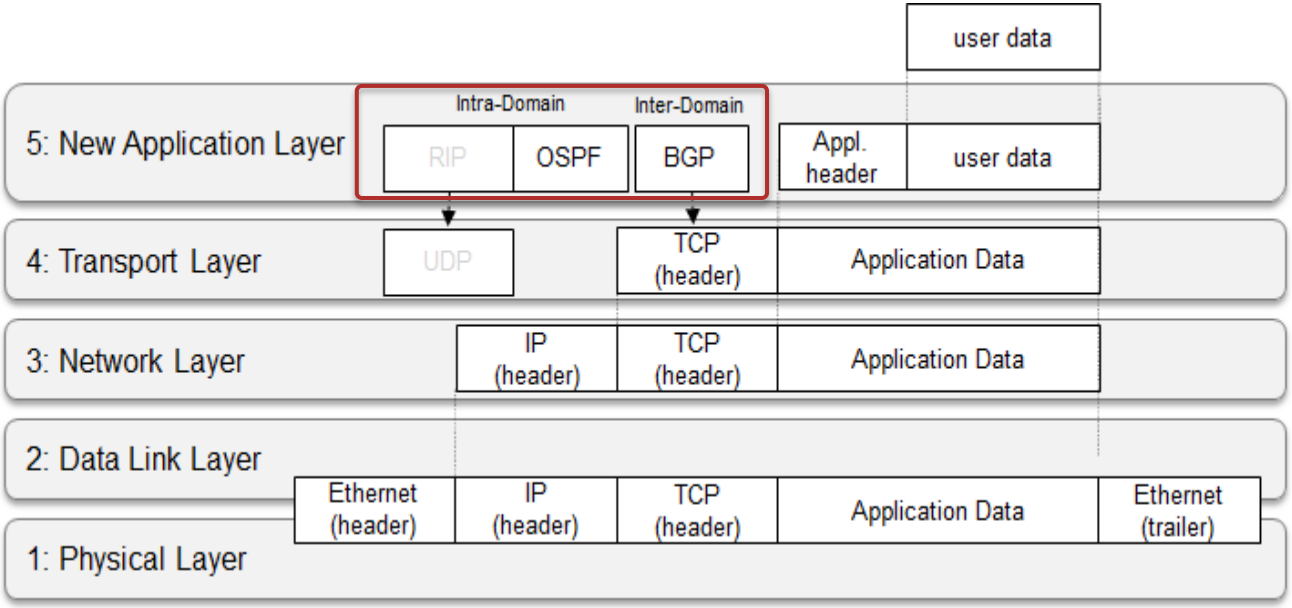
Principle	Visualization	Description
Configuration		The derived model is a selection of relevant properties and methods of the original model.
Instantiation		Instantiation offers the opportunity to construct models for which both the methods as well as the properties required for appropriation can be reused.
Aggregation		Aggregation offers the potential of combining model statements of original models in new contexts.
Specialization		Specialisation allows the taking over of general construction methods and/or properties and extending them to specific demands.
Analogy		The relation between the original model and the resulting model is based on a perceived similarity of both models regarding a certain aspect.

PROTOCOL TRANSFORMATION BASED ON DESIGN SCIENCE RESEARCH



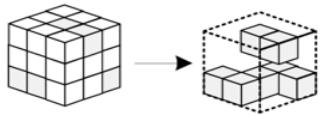
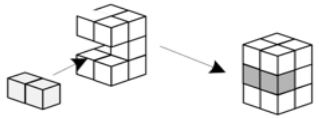
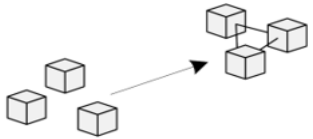
FRAMEWORK ARTIFACT DESIGN

OVERVIEW: INTERNET PROTOCOLS BASED ON FIVE LAYER MODEL



The protocols RIP, OSPF and BGP implement different routing strategies (red rectangle). The TCP/IP protocol family seem to be suitable for the transformation process.

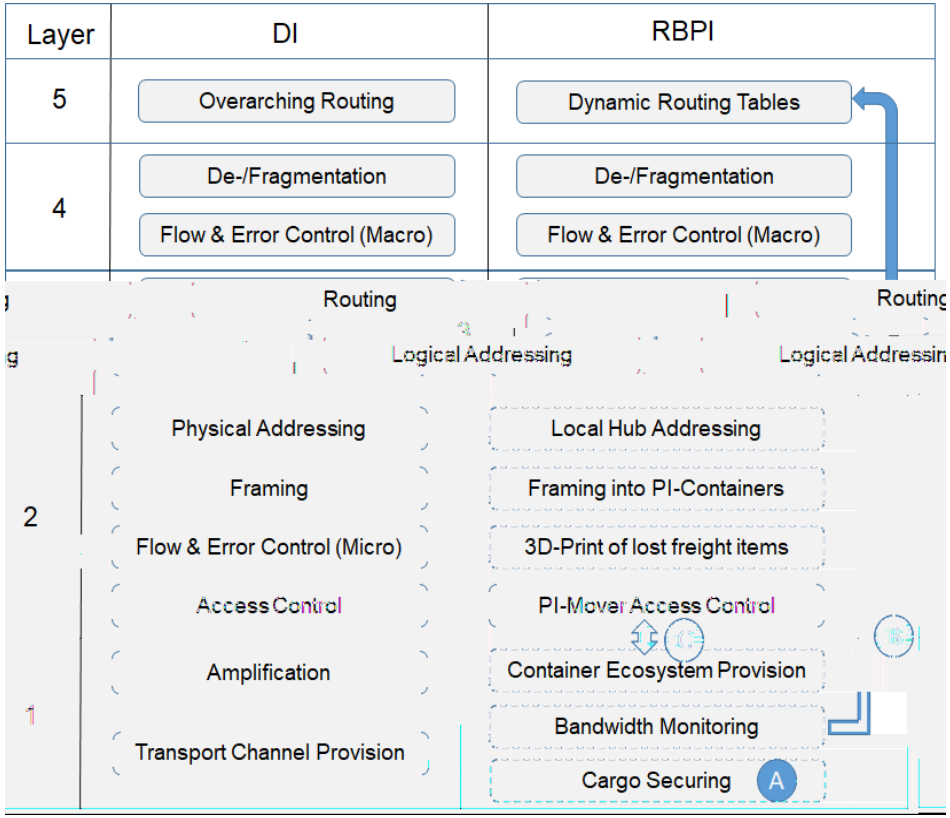
PRINCIPLES FOR REUSE IN DSR MODELING*

Principle	Visualization	Description
Configuration		The derived model is a selection of relevant properties and methods of the original model.
Instantiation		Instantiation offers the opportunity to construct models for which both the methods as well as the properties required for appropriation can be reused.
Aggregation		Aggregation offers the potential of combining model statements of original models in new contexts.
Specialization		Specialisation allows the taking over of general construction methods and/or properties and extending them to specific demands.
Analogy		The relation between the original model and the resulting model is based on a perceived similarity of both models regarding a certain aspect.

Transformation Results
Instantiation ▪ Addressing Issues
Specialization ▪ Framing
Analogy ▪ Segmentation and Reassembly ▪ Flow, Error and Access Control ▪ Routing ▪ Transport Channel Provision, Amplification

* The detailed protocol transformation is described in the paper

RESULT: TRANSPORTATION LAYER ARTIFACT FOR RBPI



A — Load has to be secured against slipping in the cargo space.

B — Feedback of the freely available capacities of vehicles on the roads.

C — Power supply of π-containers that provide goods with special treatment (e.g. cooling).

CONCLUSIONS AND FURTHER WORK

Central Research Question (CRQ):

What are the corresponding functionalities and attributes within the road-based Physical Internet resulting from the analysis of Digital Internet Protocols??

Conclusions:

- There is no 1:1 transfer from DI to PI possible, but with some adaptions it can be done
- An automated load securing system might be implemented by car manufacturers
- As an option, containers might provide an ecosystem for special goods treatment

→ Result: An Artifact for Road-Based Physical Internet Transportation

REFERENCES (ALPHABETICAL ORDER)

Badach, A. and Hoffmann, E. (2007) *Technik der IP-Netze: TCP/IP incl. IPv6-Funktionsweise, Protokolle und Dienste*. Hanser Verlag.

Badach, A., Hoffmann, E. and Knauer, O. (1997) *High Speed Internetworking*. Addison-Wesley Longman.

vom Brocke, J. (2007) 'Design Principles for Reference Modeling: Reusing Information Models by Means of Aggregation, Specialisation, Instantiation, and Analogy', in *Reference Modeling for Business Systems Analysis*. IGI Global, pp. 47–76. doi: 10.4018/978-1-59904-054-7.ch003.

Dong, C. and Franklin, R. (2020) 'From the Digital Internet to the Physical Internet: A conceptual framework with a stylized network model', *Journal of business logistics*, (jbl.12253). doi: 10.1111/jbl.12253.

Fielding, R. T. (2000) *Architectural styles and the design of network-based software architectures*. University of California, Irvine Irvine. Available at: https://www.ics.uci.edu/~fielding/pubs/dissertation/fielding_dissertation.pdf.

International Transport Forum (2019) *ITF Transport Outlook 2019*. OECD Publishing. Available at: https://play.google.com/store/books/details?id=p8SZDwAAQBAJ.

Kaup, S. and Demircioglu, A. V. (2017) 'Von der Crowd-Logistik hin zu einem ganzheitlichen Ansatz hocheffizienten Warentransports', *Wirtschaftsinformatik & Management*, 9(3), pp. 18–27. doi: 10.1007/s35764-017-0052-z.

Kaup, S., Ludwig, A. and Franczyk, B. (2020) 'Design and Evaluation of Routing Artifacts as a Part of the Physical Internet Framework', *arXiv [cs.NI]*. Available at: http://arxiv.org/abs/2011.09972.

Kaup, S. and Neumayer, B. (2003) *Rechnernetze und Datensicherheit*. Shaker.

Liesa, F. (2020) 'Physical Internet Roadmap'. SENSE Project (D2.1).

Markillie, P. (2006) 'The Physical Internet, A survey of Logistics', *The Economist*, 17 June.

Montreuil, B. (2012) 'Physical Internet Manifesto, Version 1.11. 1', *CIRRELT Interuniversity Research Center on Enterprise Networks, Logistics and Transportation*, pp. 2–3. Available at: https://www.slideshare.net/physical_internet/physical-internet-manifesto-eng-version-1111-20121119-15252441.

Montreuil, B., Meller, R. D. and Ballot, E. (2010) 'Towards a Physical Internet: the Impact on Logistics Facilities and Material Handling Systems Design and Innovation'. Available at: https://digitalcommons.georgiasouthern.edu/pmhr_2010/40/ (Accessed: 16 June 2020).

Schouten, B., Peytchev, A. and Wagner, J. (2017) 'Costs and Logistics', *Adaptive Survey Design*, pp. 89–110. doi: 10.1201/9781315153964-6.

THANKS FOR YOUR ATTENTION

!BOE!FOKP !SFBE OH!Ul F!QBQFS

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