

Towards Cyber-Physical Internet

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Introduction

The concept and practice of PI are global and require worldwide cooperation to achieve more efficient, sustainable and intelligent logistics and supply chain networks, relying heavily on advanced information and communication technologies (ICT). Cyber-physical systems(CPS), with powerful computing, communication and control capabilities, is one of the key technologies to support dynamic decision-making based on real-time information. CPS shows great potential for implementing PI. Despite current studies have made preliminary exploration of empowering PI with digitalization capacity from CPS, it is still challenging to conduct a seamless combination of CPS with PI due to their unclear integration boundary.

Objectives

- This study aims to demonstrate the potential for CPS integrated with PI by addressing the following research questions:
- What are the necessities, rationales and opportunities to enhance PI's cyber digitalization capacity toward a Cyber-Physical Internet (CPI)?
 - What is the fundamental framework of CPI to innovate the next evolution of logistics system as simple as sending emails?
 - What are the building blocks of CPI that must be further explored, designed and discussed to enable the application prospects for typical logistics scenarios?

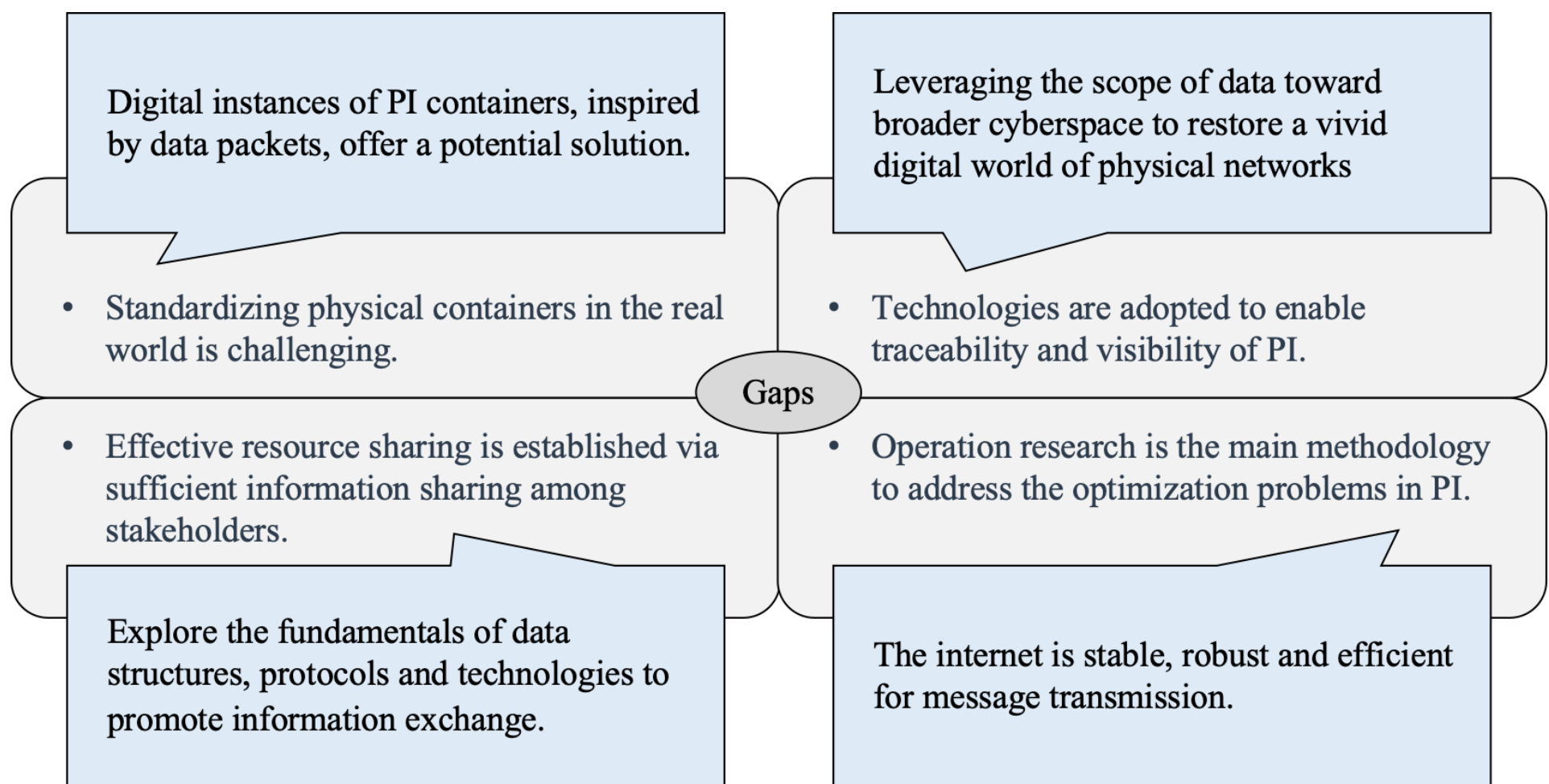
Methodology

- To respond to above reseach questions, this study first conducts a systematic literature review (SLR) on PI to extract and reveal the research trends and remaining gaps, which is a well-established review method in the field of management sciences (Durach et al., 2017).
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- Step 1: Defining the research questions
- Step 2: Determine the including/excluding criteria
- Step 3: Retrieving potentially relevant literature
- Step 4: Synthesizing the literature
- Step 5: Selecting the pertinent literature
- Step 6: Reporting the results
- Q1: What are the main topics and research trends of PI?
- Q2: How do information and communication technologies affect PI?
- Q3: What are the challenges for PI development and opportunities for PI integrating CPS?
- We are interested in the literature with a focus on PI which is a specific concept in the logistics and transportation field.
- Searching term: Physical Internet
- Language: English
- Period: 2010.1-2023.8
- 628 PI-related publications
- 327 PI-related publications
- Excluding irrelevant publications by manual screening titles, abstracts and contents.
- Including supplements by tracking cited literature.
- PI Initiatives
- PI Implementations
- PI Applications
- data collection and communication
- physical and digital integration
- simulation and optimization
- data analysis and modeling
- The previous explorations of digitalization in PI studies
- Based on the key findings, and to extend the research focus of PI, a five-layer model, which works as the OSI model for computer networks, is proposed as the fundamental framework to define CPI at the abstract level.

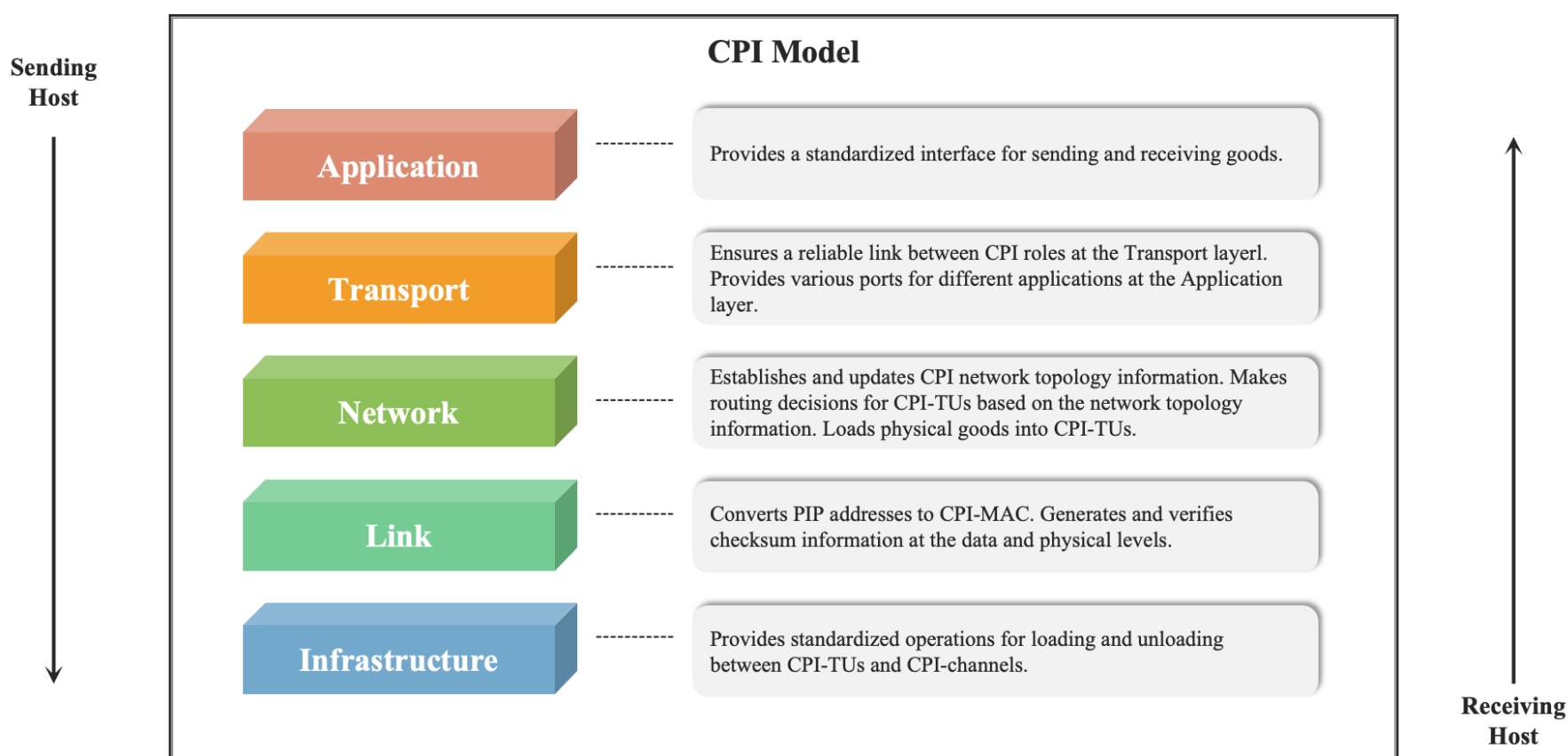
- Finally, based on this proposed model, further research directions are summarized in terms of CPI digitalization, network configuration and operation.

Results

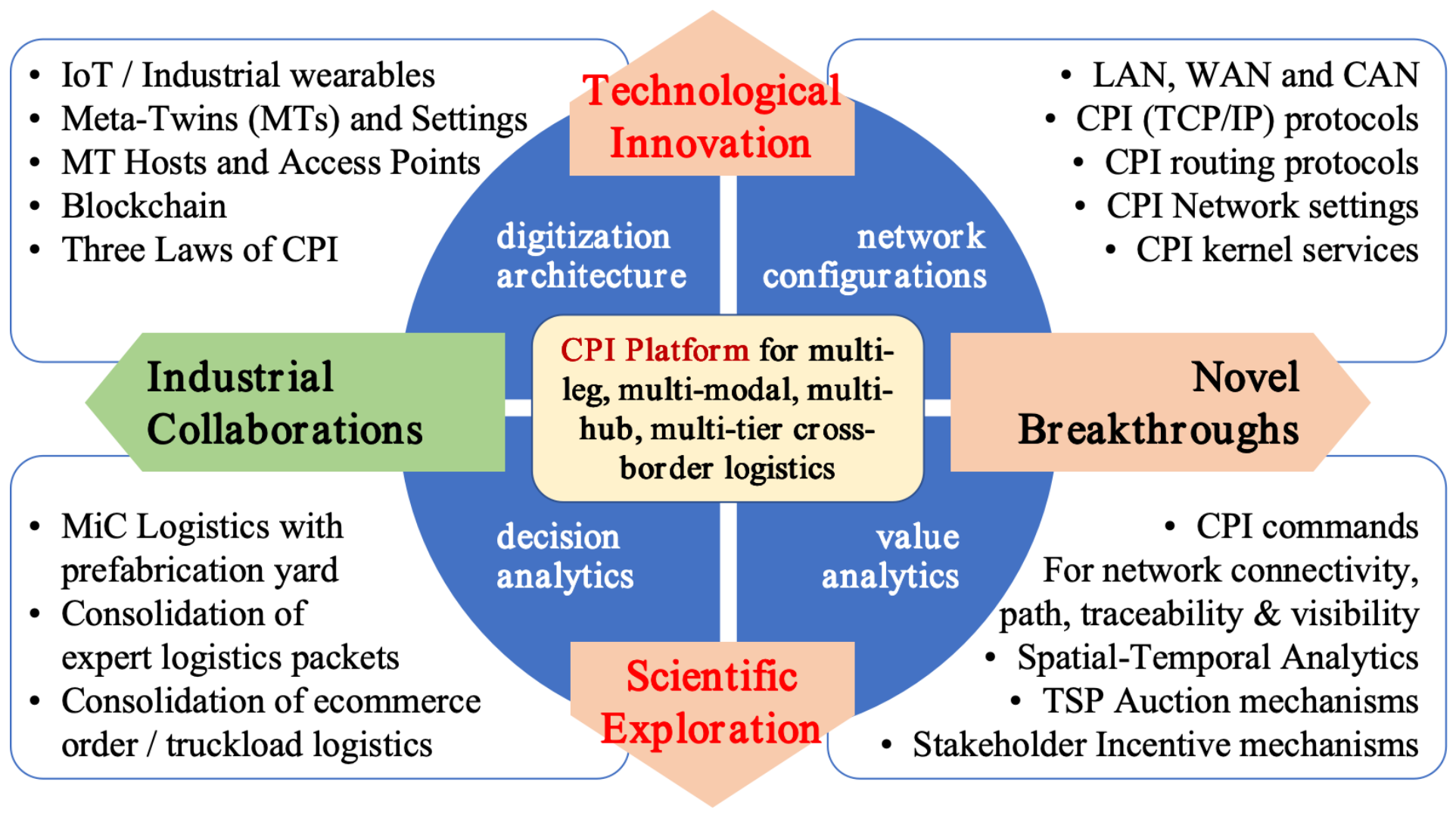
- First, our review has revealed that insufficient digitization in the PI has generated limitations at the physical, digital, and operational levels, which motivates the emergence of CPI.



- Second, the CPI five-layer model is designed as a fundamental framework to maintain the separation of responsibilities so that protocols, mechanisms, and standards can be loosely coupled to suit different logistics scenarios.



- Third, some future research directions on CPI have been systematically summarized, providing a clear depiction of CPI short-term roadmaps.



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