



Innovations in Clouds,  
Internet and Networks

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# A Reputation and Knowledge Based Trust Service Platform for Trustworthy Social Internet of Things

Nguyen B. Truong,  
Tai-Won Um, Gyu Myoung Lee



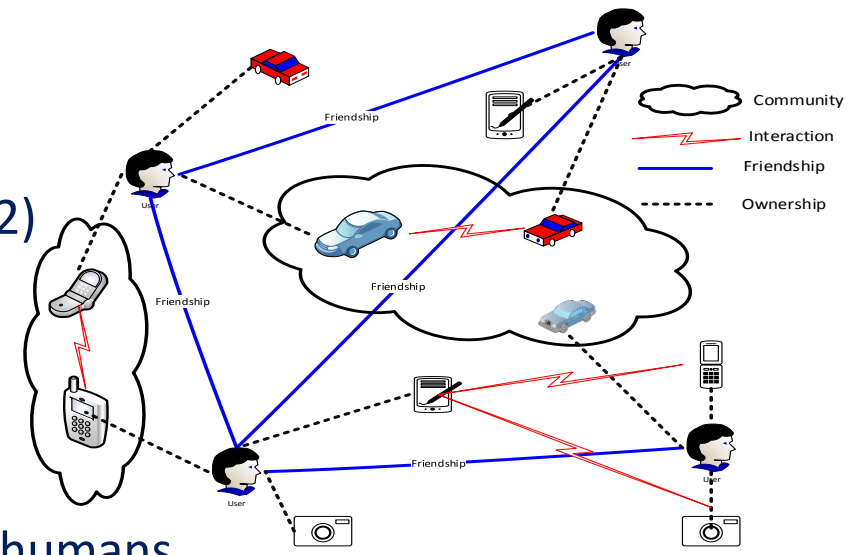
- I. Introduction
- II. Trust Model and System Architecture
- III. Car-sharing Use Case
- IV. Discussion and Future Work
- V. Q&A

## ➤ Internet of Things (IoT)

- By 2020, 50 billion devices are connected (1)
  - 30 billions are wireless & smart devices (2)
  - 6.58 devices per person
  - Billions of transactions every day
- ➔ complex security & privacy scenarios

## ➤ Social Internet of Things (SloT)

- Separation between two levels: devices and humans
  - Leverage social relation models of humans to devices
  - Allow devices to have their own social networks
  - Offer humans to impose rules on their devices
  - Personalize privacy
- Consider the SloT environment proposed by Atzori et al. [3]



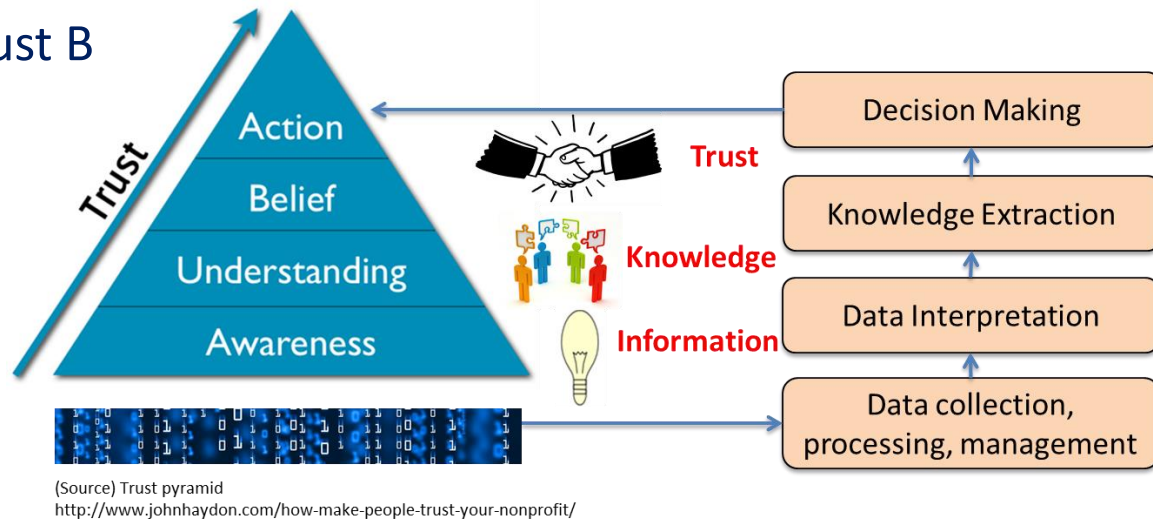
(1) *The Internet of Things: How the Next Evolution of the Internet Is Changing Everything* (Cisco White Paper, 2011)  
 (2) *The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things* (EMC and IDC, 2014)  
 (3) *SloT: Giving a Social Structure to the Internet of Things* (Communications Letters, 2011)

## ➤ Trust in the IoT Era

- “To what extent A (trustor) trust B (trustee) in the context T?”
- A key property to establish reliable and seamless connectivity in IoT
- Offer securer and more privacy for IoT services

## ➤ Motivation

- Create a Trust Service Platform
  - Evaluates *trust* between two entities in SIoT
  - As a core service offering *trust* for other apps and services

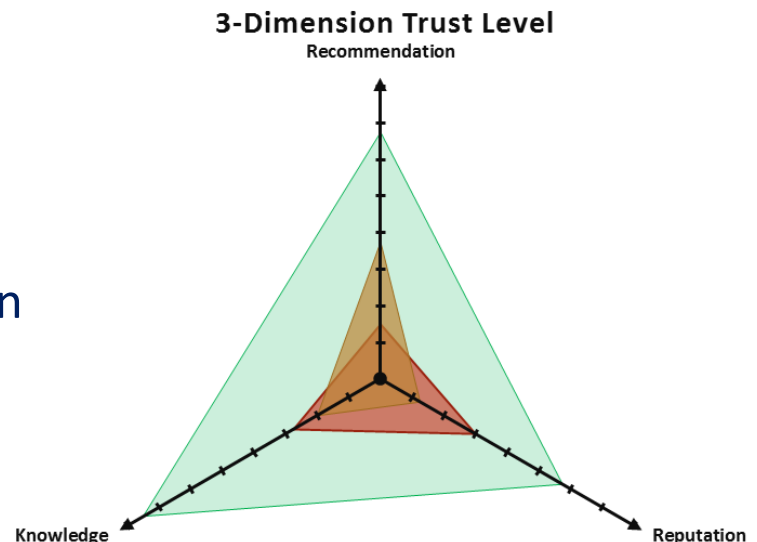
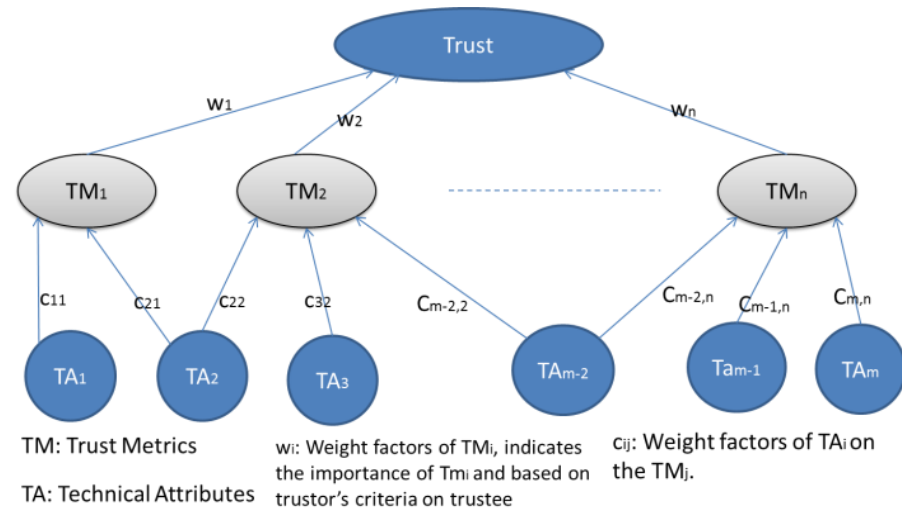


## ➤ Trust Model

- Trust Metrics (TMs) and Technical Attributes (TAs)
- Proposed Model: Reputation, Recommendation and Knowledge TMs
  - Imitate trust processing in human brain
  - Some TAs vary, depending on particular service

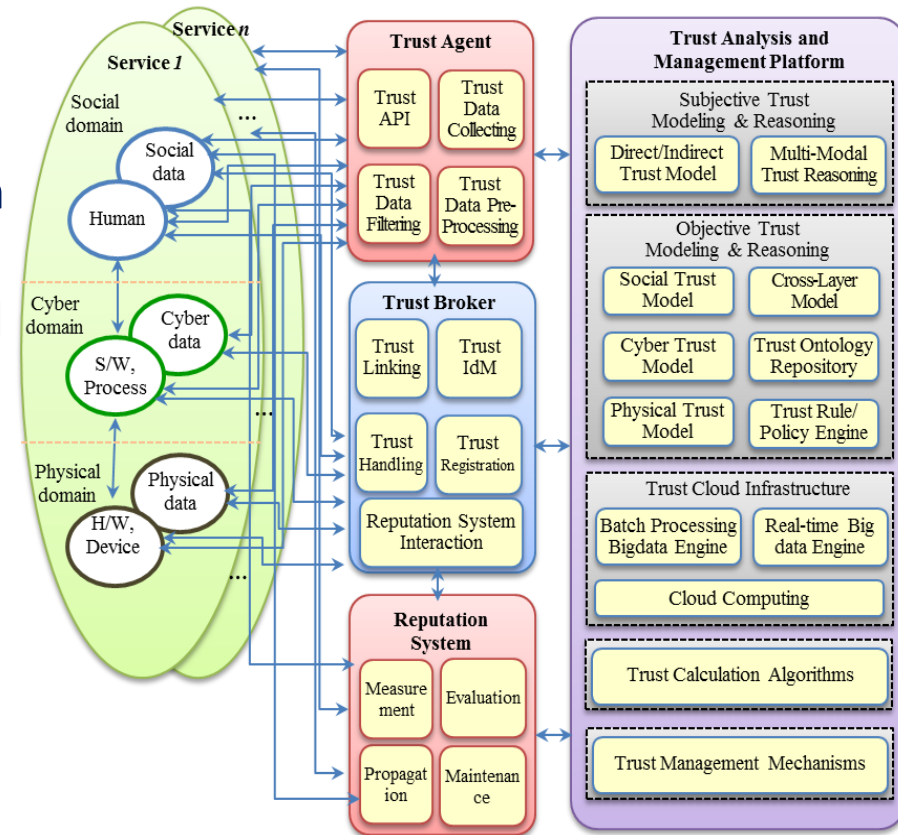
## ➤ System Architecture

- New components to SIoT environment
  - Trust Agent, Trust Broker, Reputation System and Trust Analysis & Management System



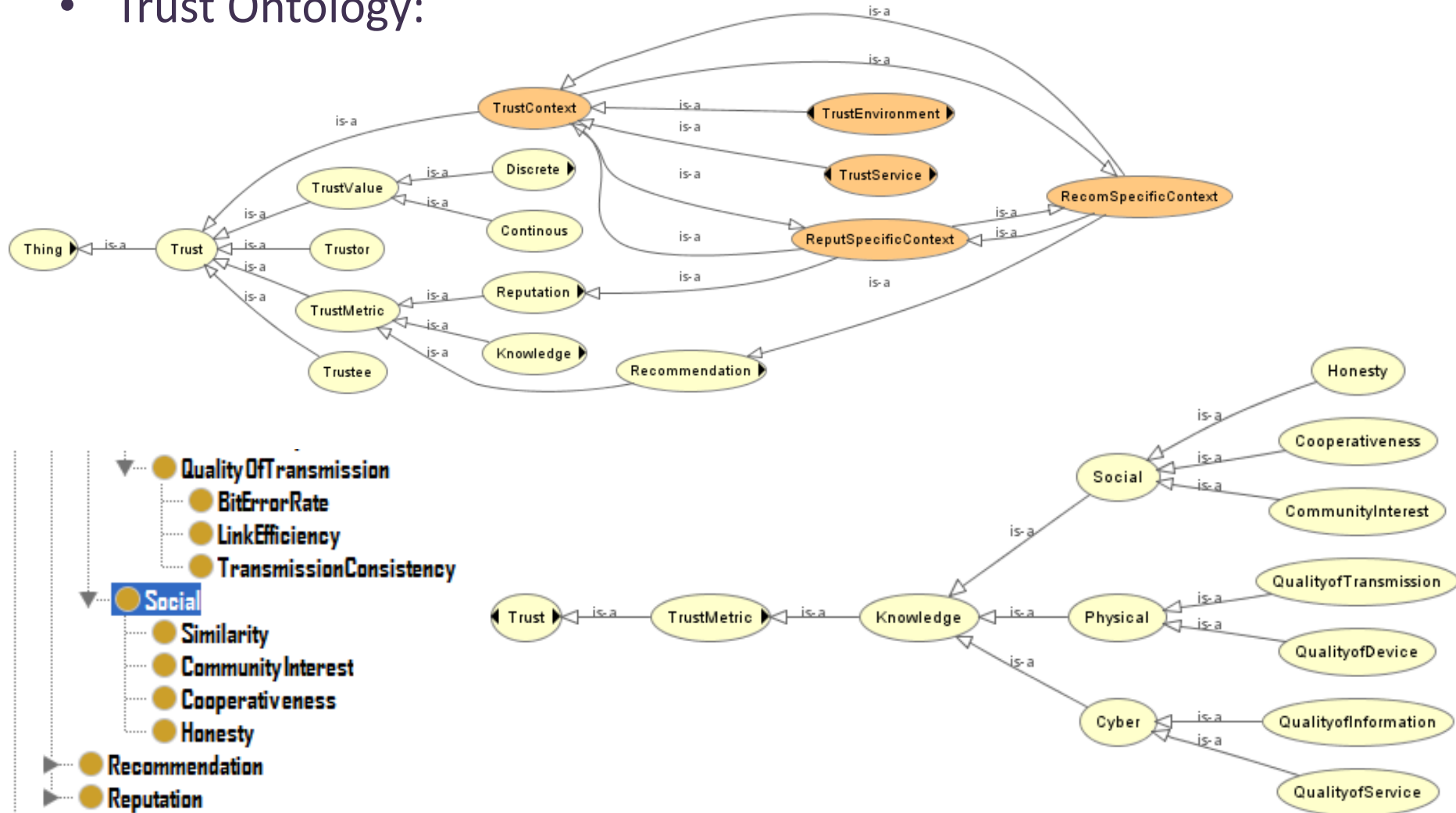
## ➤ From Data Collection to Trust Computation

- **Trust Agent:** trust-related Data Collection, Processing and Annotation
- **Trust Broker:** handle *trust knowledge* from context, services and users
- **Reputation System:** handle *reputation* and *recommendation* based on Google PageRank model
- **Trust Analysis and Management**
  - Trust Analysis: handle *knowledge base* for trust
  - Trust Computation: *reason* trust score from trust knowledge base
  - Management: *establish, disseminate, update and maintain* trust



# Trust Metrics

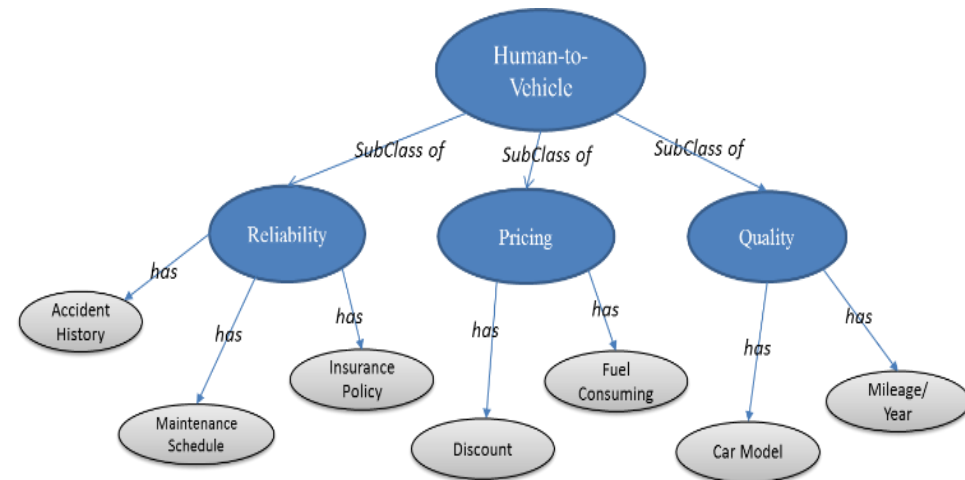
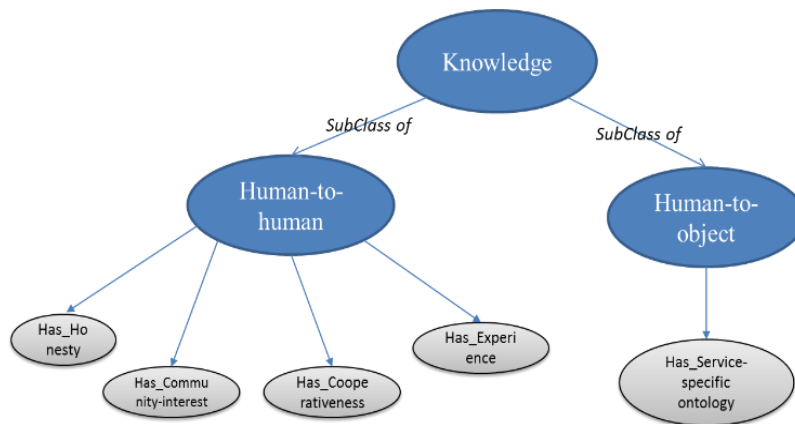
- Trust Ontology:





## ➤ Demonstrate of trust-based service in the trust platform

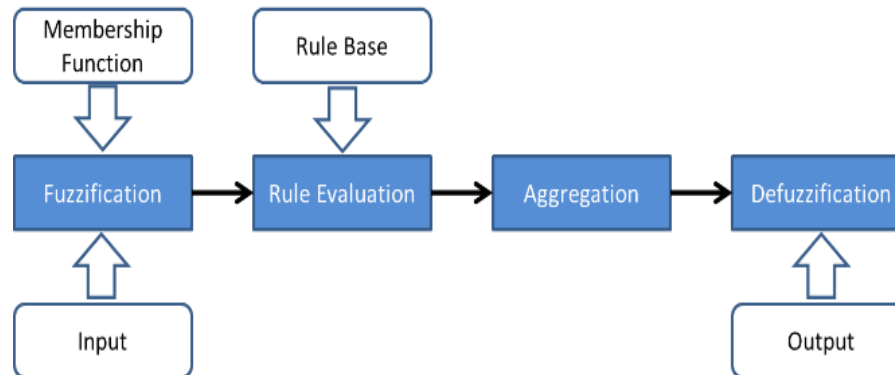
- Calculate *trust* between *a user* and *a vehicle* belonged to a *car rental*
- Assume that Reputation and Recommendation TMs are already obtained from the reputation system
- Illustrate how to calculate Knowledge TM using *Fuzzy Logic*
- *Knowledge TM schematic* for car-sharing:
  - Between *user to vehicle* and *user to car rental*





## ➤ Fuzzy Logic for *knowledge base* Construction for TM

- Knowledge is represented in form of input metrics, membership functions and fuzzy rules.
- Mamdany Fuzzy Interference System for reasoning Knowledge TM. The output is a linguistic value in fuzzy set. Here is *low/medium/high*



- The Knowledge TM value is then converted into crisp value in order to combine with other TMs (Reputation and Recommendation) for Final Trust Score.
- Final Trust Score is then calculated using weighted sum or utility theory

- Our current research are *trust knowledge base construction* and *trust reasoning mechanism*
  - Considering Rule-based techniques
  - Hybrid techniques (future)
- Each service has particular knowledge base, which includes:
  - Trust Schematic: require trust-domain expert, trust model, trust ontology and base ontology
  - Knowledge Acquisition for trust knowledge base: require trust ontology, base ontology, and trust schematic
  - Knowledge Representation: Fuzzy Logic, predicate logic, non-monotonic logic (i.e defeasible logic)
  - Knowledge Verification: for checking knowledge base
  - Inference Engine (Reasoning mechanism): Mamdany Fuzzy Interference System, Inference Rules for Logic



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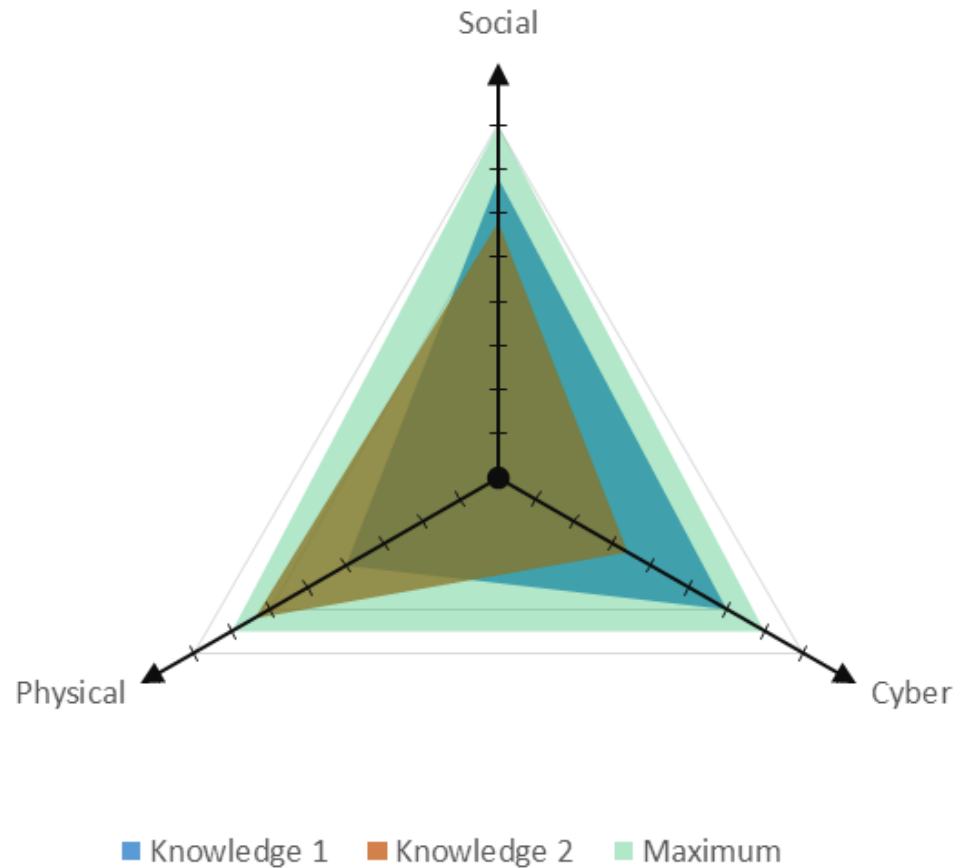


## Thank you!



# Backup slides

## 3-Dimension Knowledge Trust Metric



## 4-Dimension Social Technical Attributes

