unibz
Fakultät für Informatik
Facoltà di Scienze e Tecnologie informatiche
Faculty of Computer Science

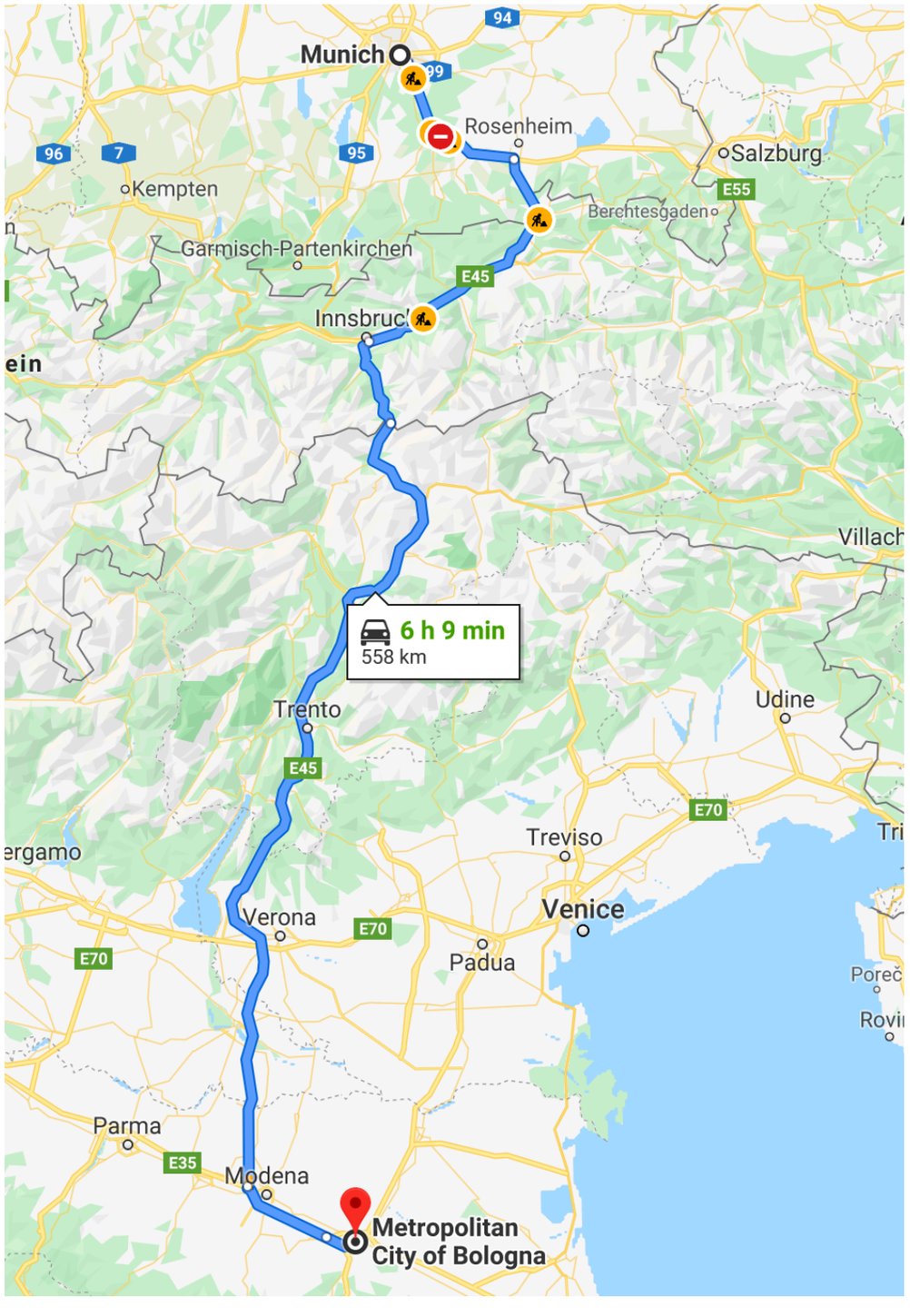
Blockchain Based Service Continuity in Mobile Edge Computing

Nabil El Ioini

Free University of Bozen-Bolzano
Italy

Context

- 5G-CARMEN
  - 5G-enabled corridor from Bologna to Munich to conduct cross-border trials of 5G technologies
  - Leverage a distributed mobile edge cloud spanning from the vehicle itself to the centralized cloud



https://www.5gcarmen.eu/

Context

- Huge amount of traffic data
  - IoT devices and sensors, audio, video
- Users demand
  - Real time services
  - High performance
  - 99.999999999999% Availability

Context

- The need for infrastructures that provide
- Data processing at the source
- Real time data analysis
- Reliable

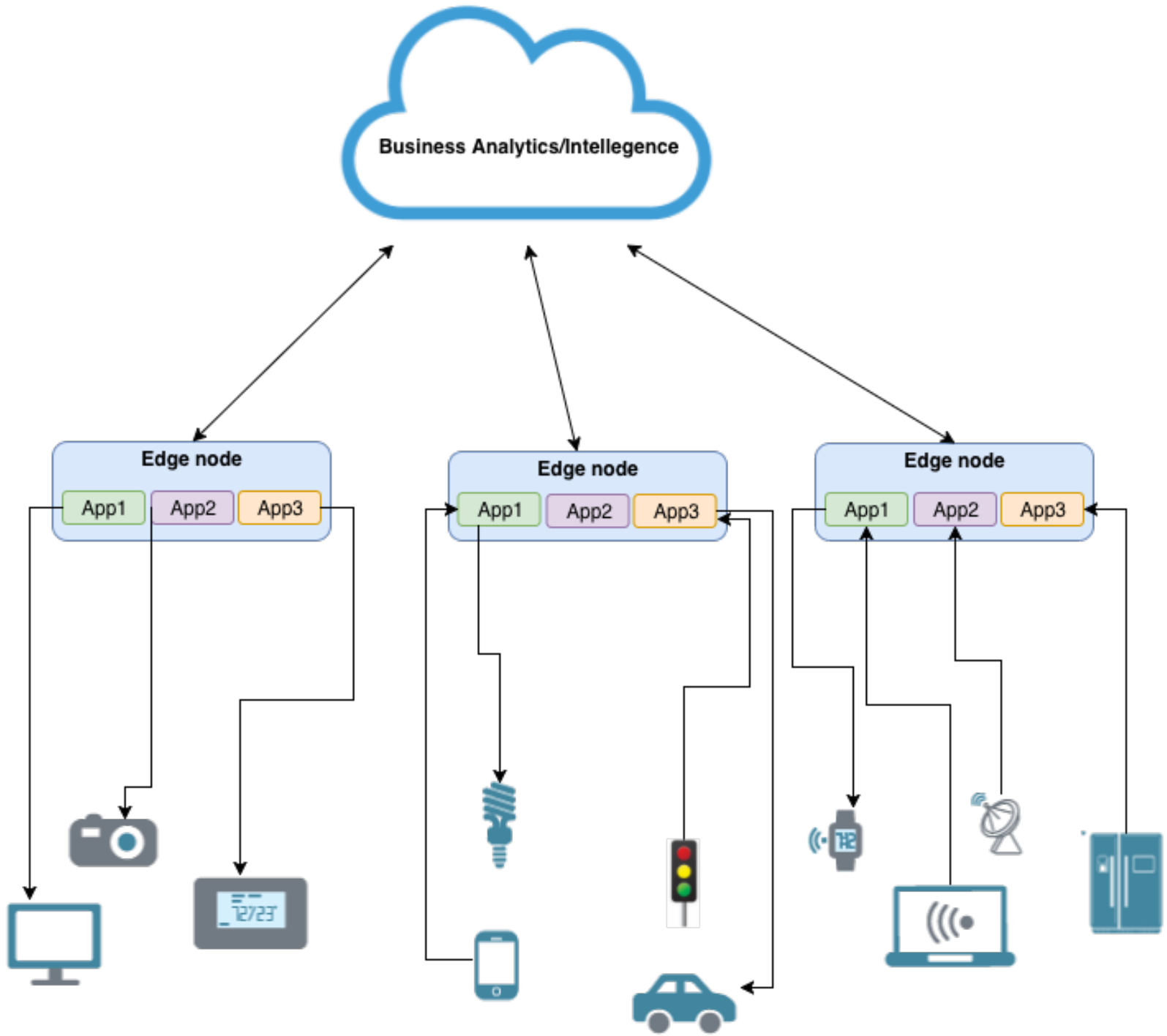
Edge Computing

Moves applications and data away from centralised nodes (Cloud) closer to the “things” (devices, users, data).

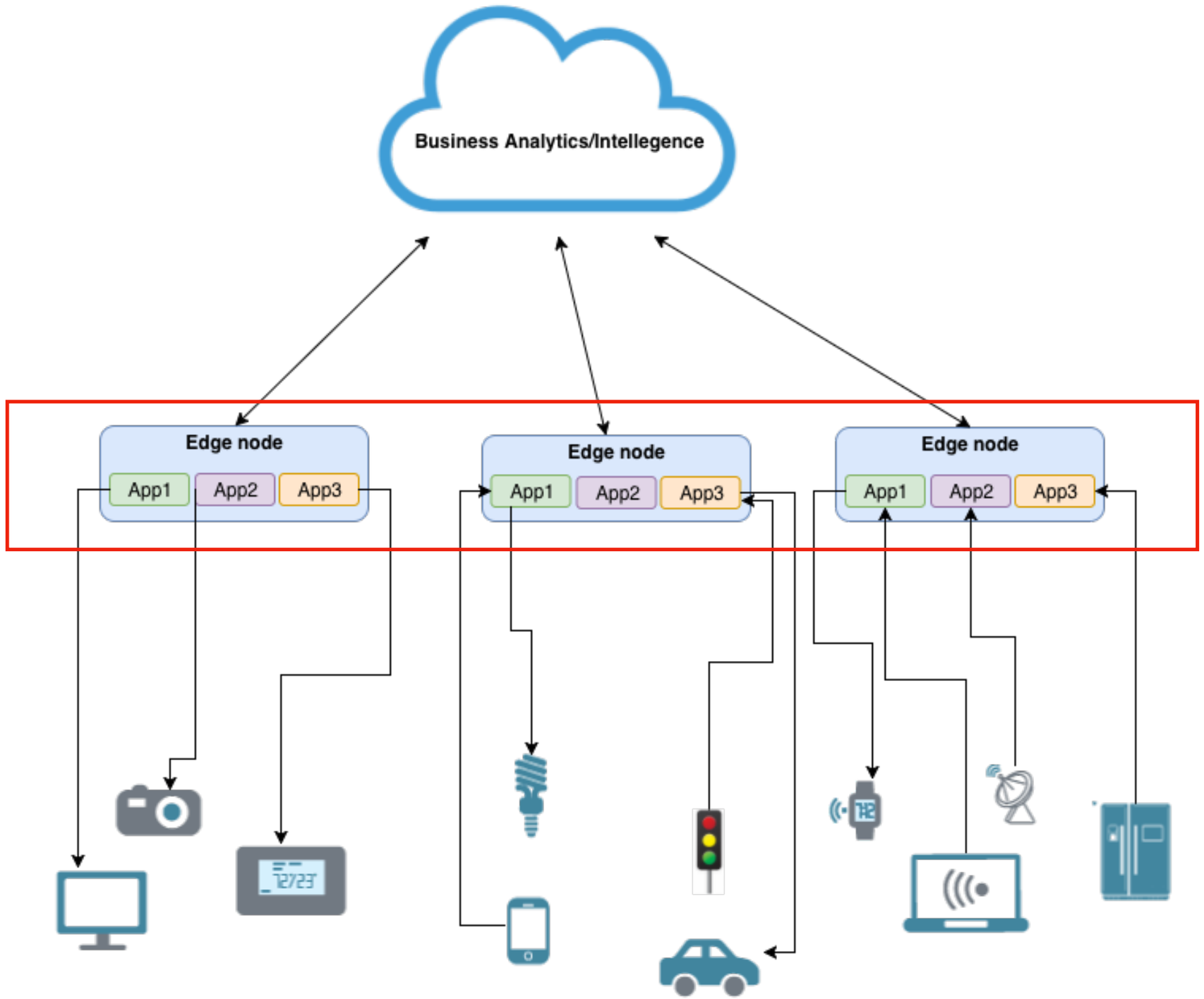
- **Characteristics**
  - Distributed
  - Location/context aware
  - Could be deployed on premise

- **Benefits**
  - Less data transfer - remove bottlenecks
  - Local processing/storage - decision making
  - Improves user QoS
  - Privacy preserving

Edge Computing



Edge Computing



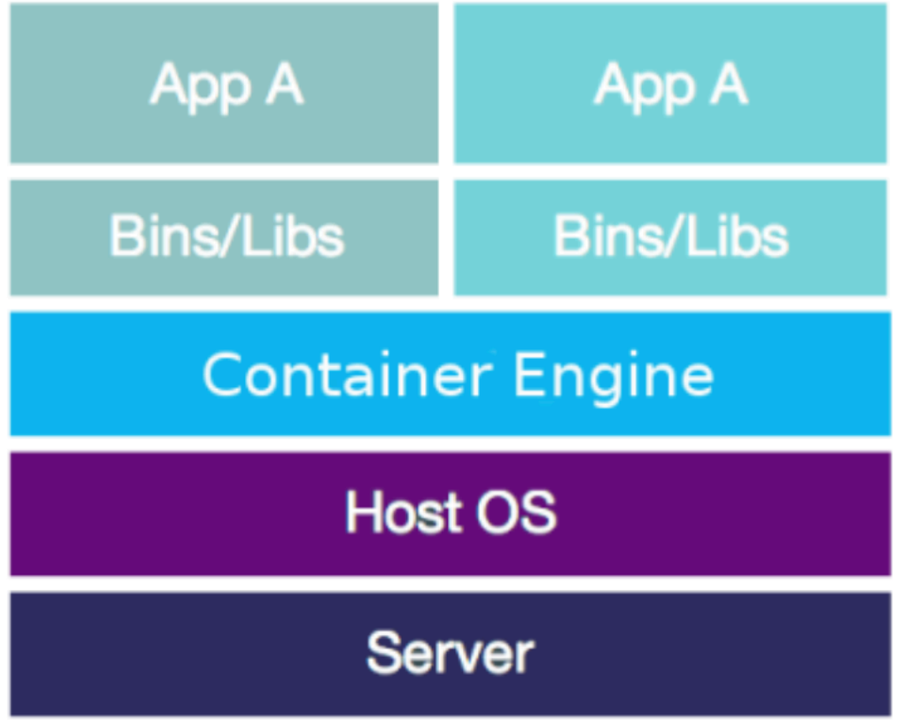
Challenges

- Multiple services and providers
    - The same infrastructure needs to support multiple services (multi-tenancy)
- Cross organisational boundaries
    - Trust and security

Multiple services and providers

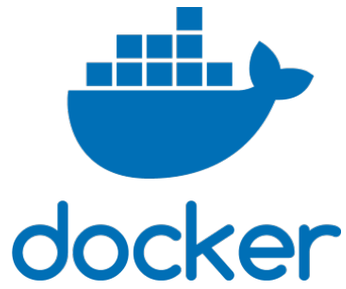
“Container Technology”

- Lightweight virtualisation solution
- Decouples hardware resources from software solutions
    - Fast initialisation and instantiation of the virtualised instances

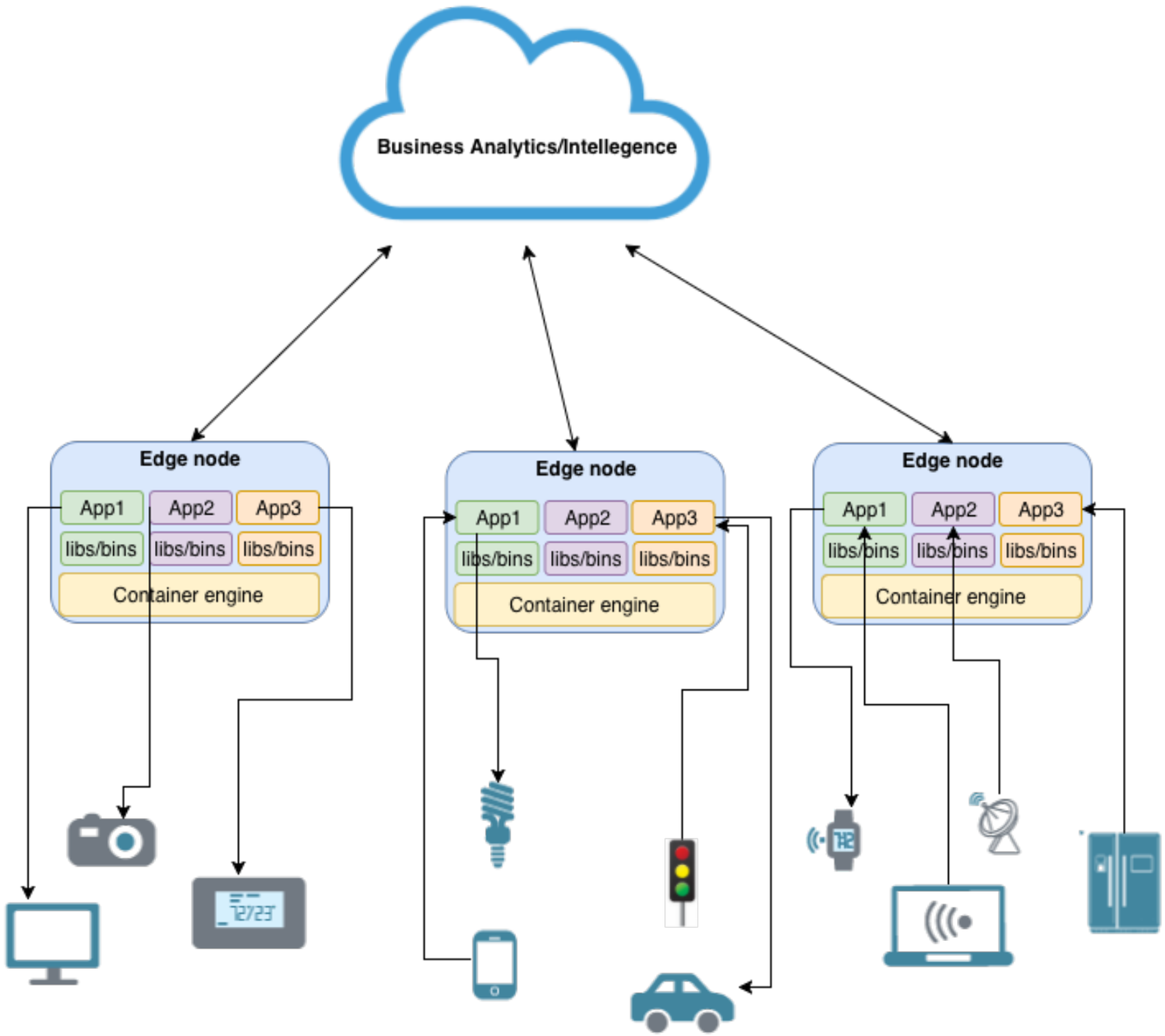


Why Containers for Edge Computing?

- Application Provisioning
  - Simplifies distribution, installation & execution of app.
- Remote management
  - Easy to update
  - Pre-configured = easy to manage
- Can run on small devices
  - Lightweight & Small footprint



Edge Computing



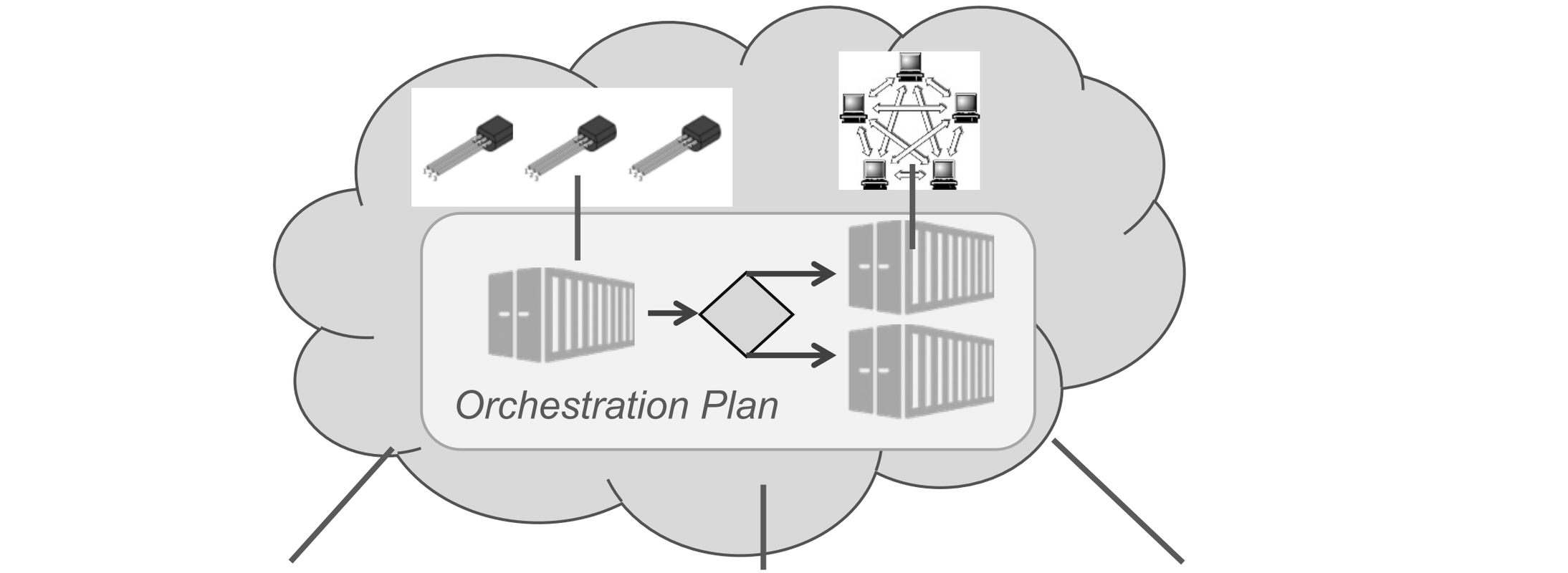
Cross organisational boundaries

- The collaboration of multiple SPs and edge applications vendors are posing new challenges
  - Decentralised and distributed environment
    - Who manages what?
- Trustworthiness
  - Verification of client/edge software & hardware
  - Trusted sources
  - Traceability

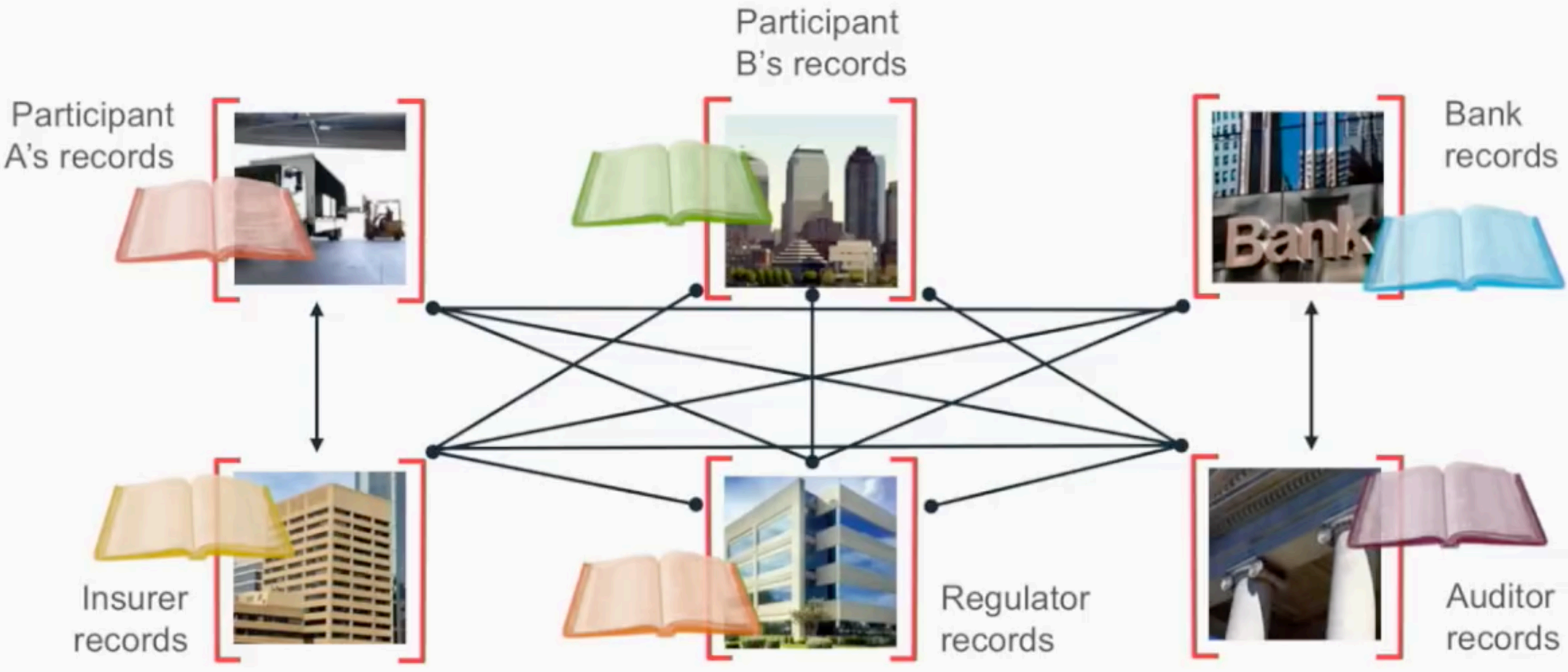
Focus

- Management
  - Increase automation
    - Orchestration: actions, decisions
- Trustworthiness
  - Identification: things, data
  - Provenance: data creation and chain of custody

Trusted Orchestration Management (TOM) for the Edge with Blockchain



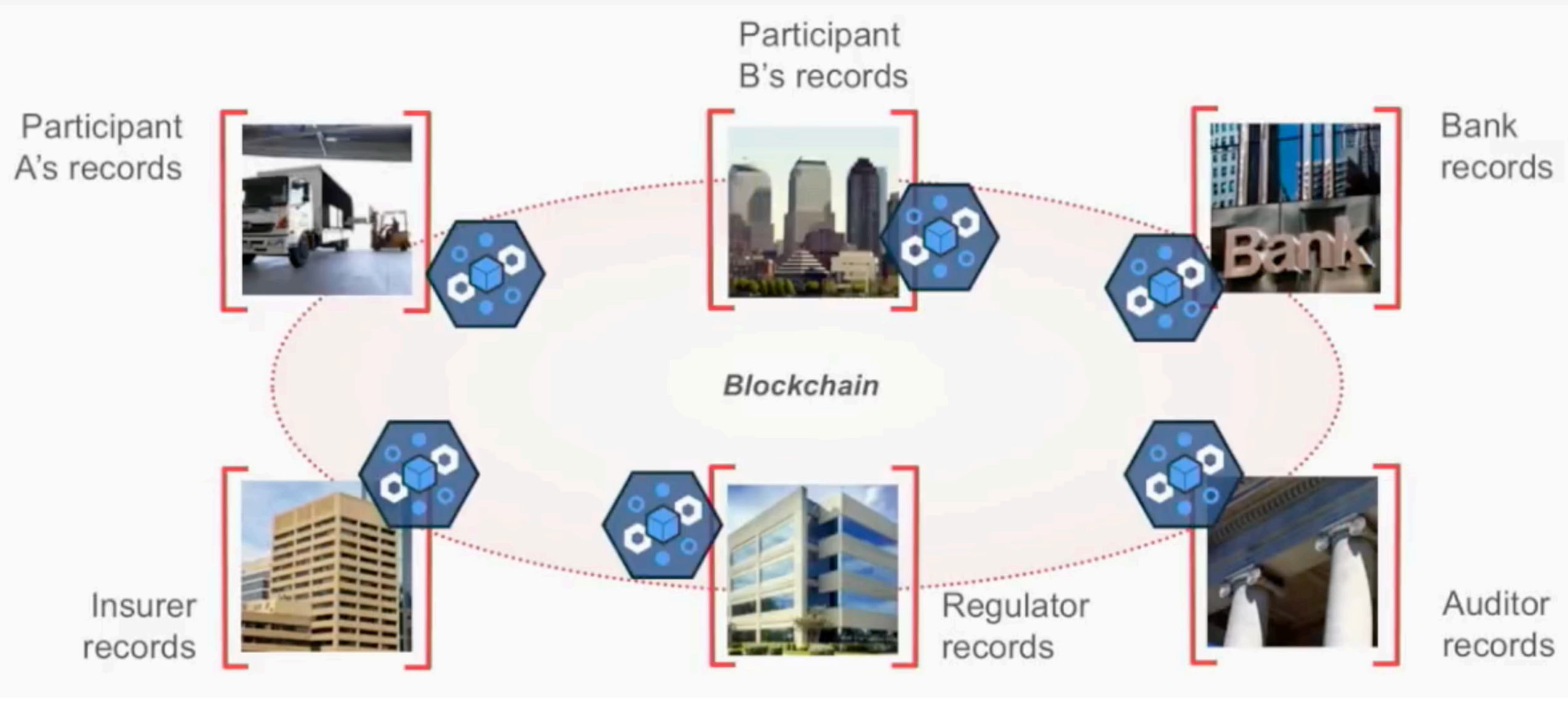
Problem…



… inefficient, expensive, vulnerable

Source: IBM Hyperledger composer

Shared replicated, permissioned ledger …

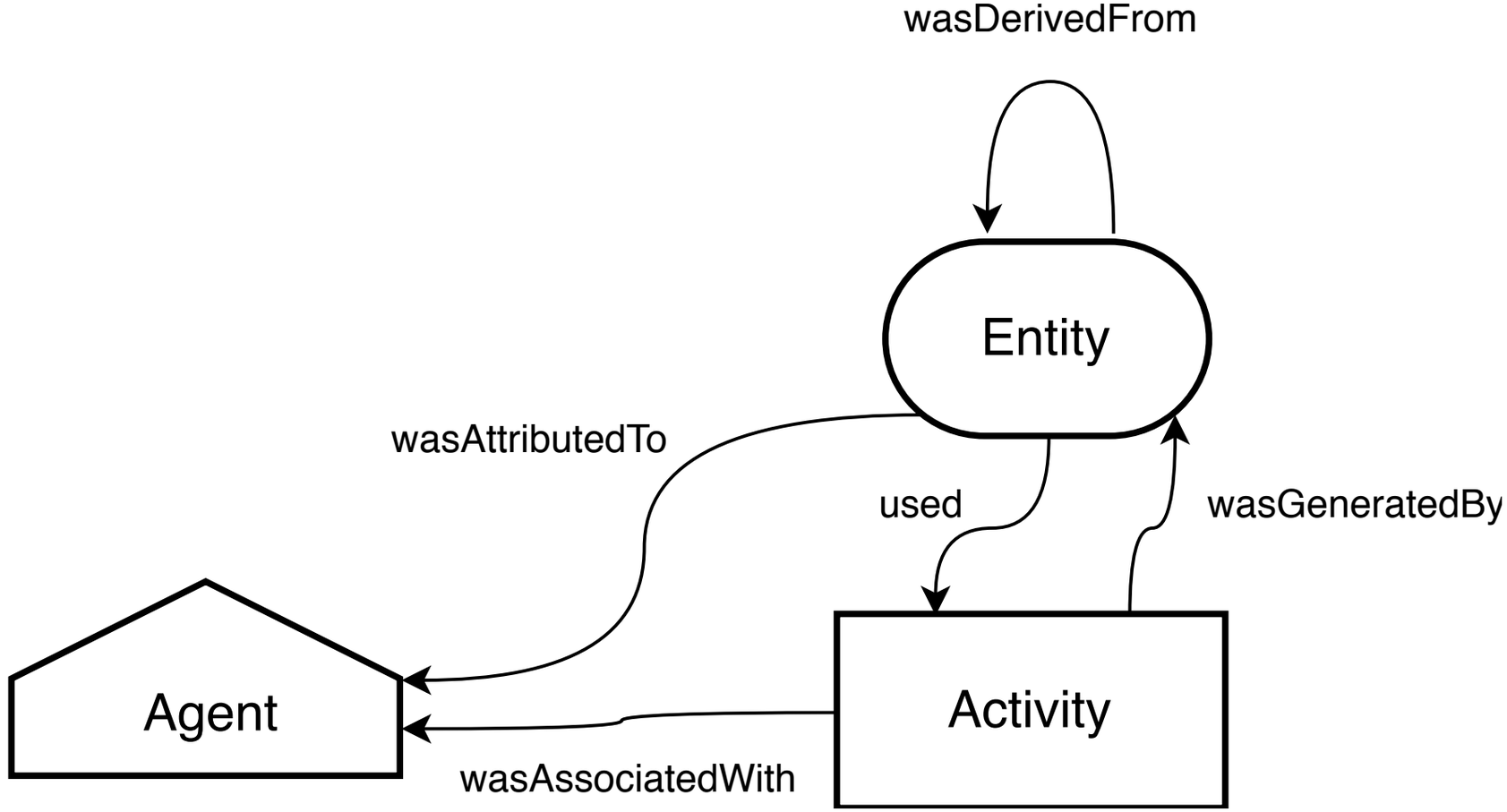


… consensus, provenance, immutability and finality

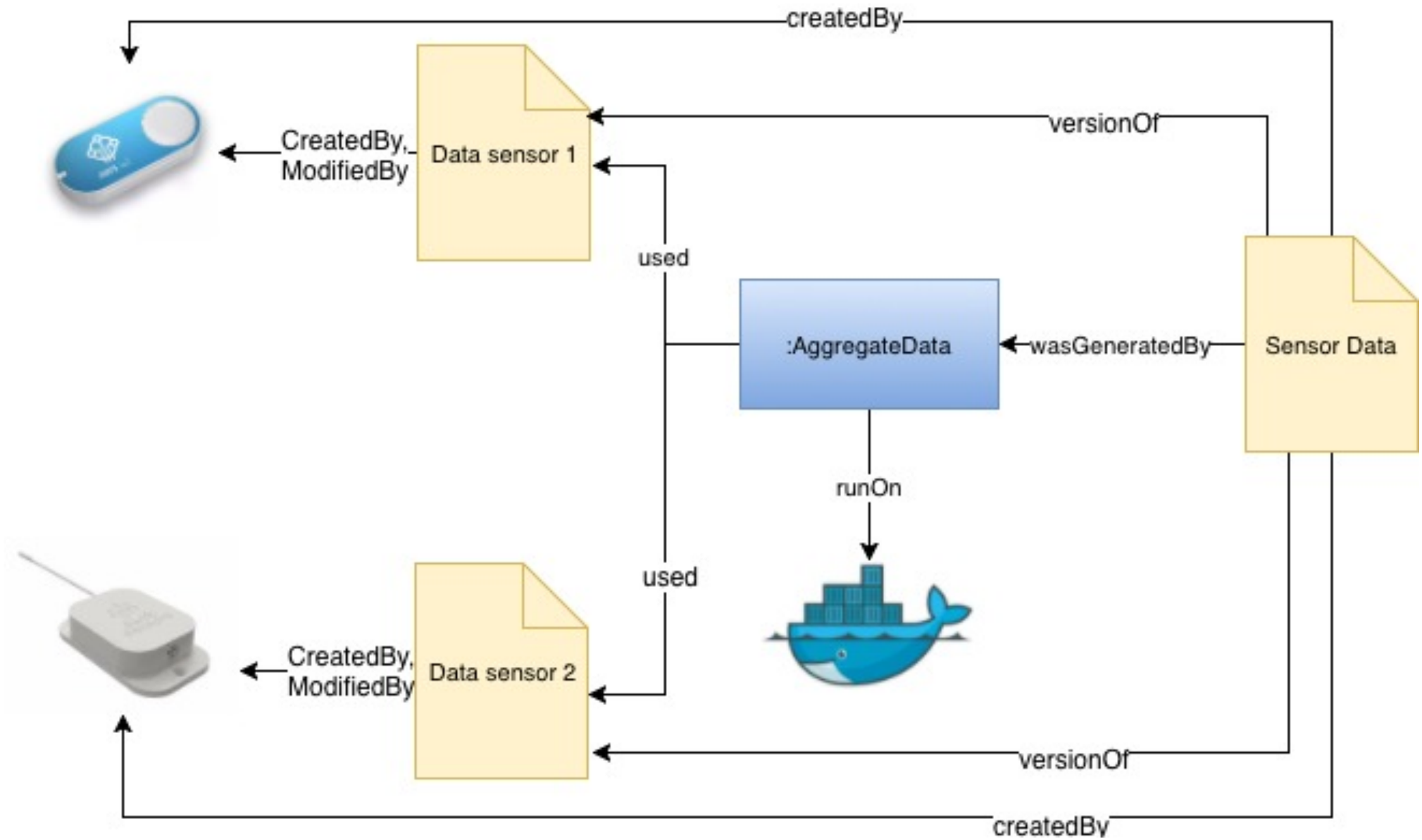
Source: IBM Hyperledger composer

W3C-PROV standard

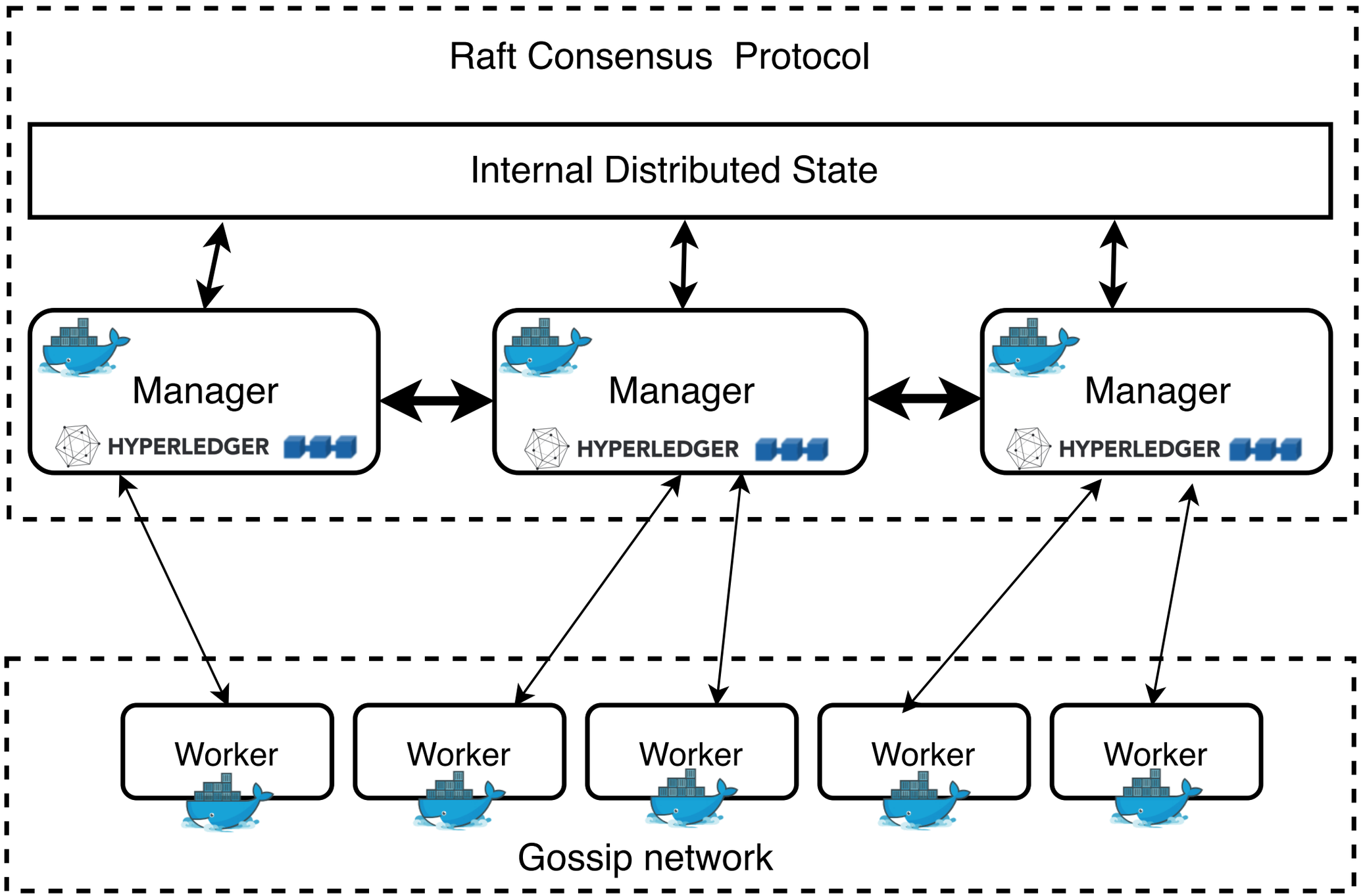
- W3C PROV outlines a generic model for Provenance
- Defines the architecture and the compliance requirements for software tools



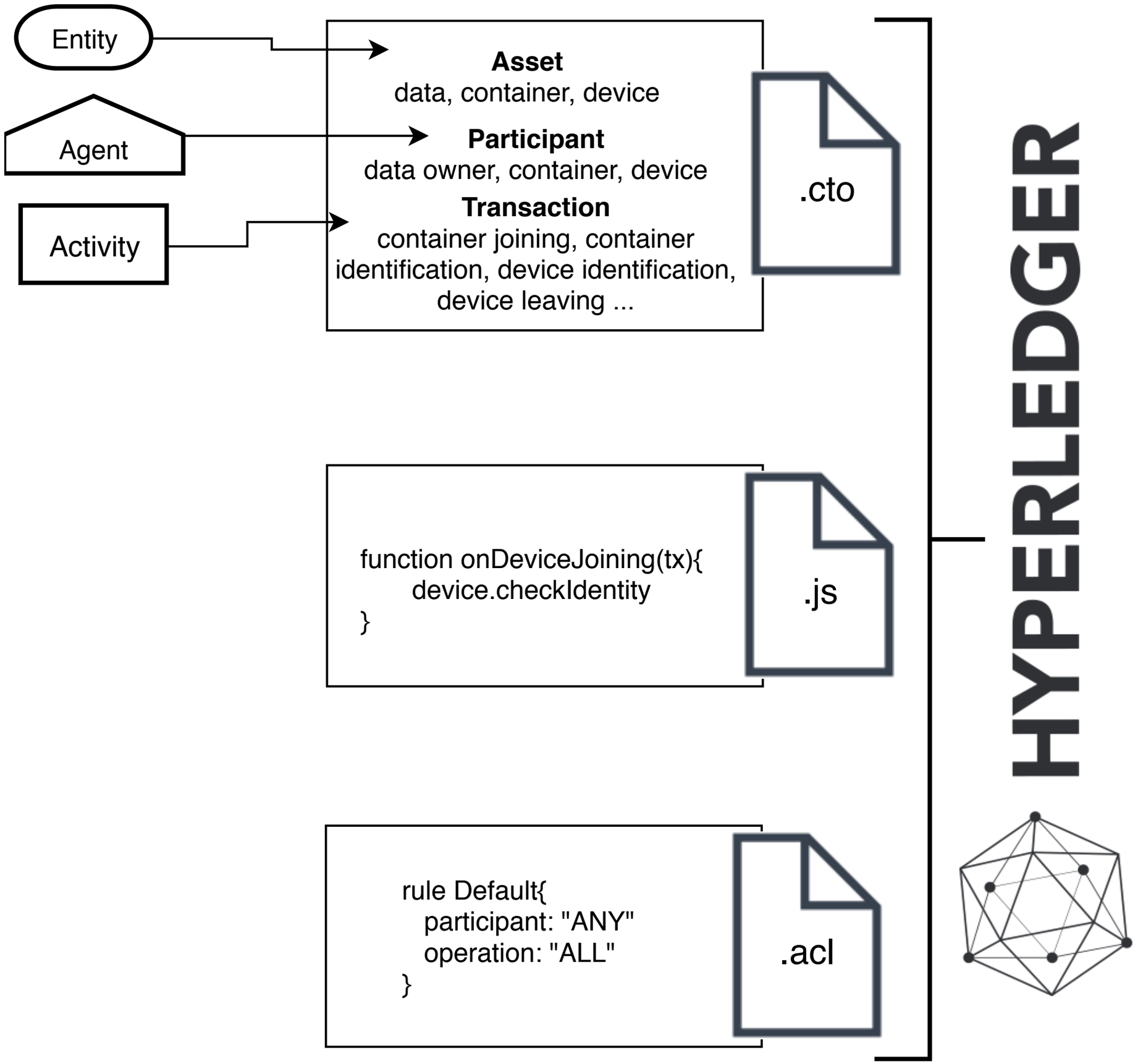
Example


createdBy
CreatedBy,
ModifiedBy
Data sensor 1
versionOf
used
:AggregateData
wasGeneratedBy
Sensor Data
runOn
used
CreatedBy,
ModifiedBy
Data sensor 2
versionOf
createdBy

High Level Architecture



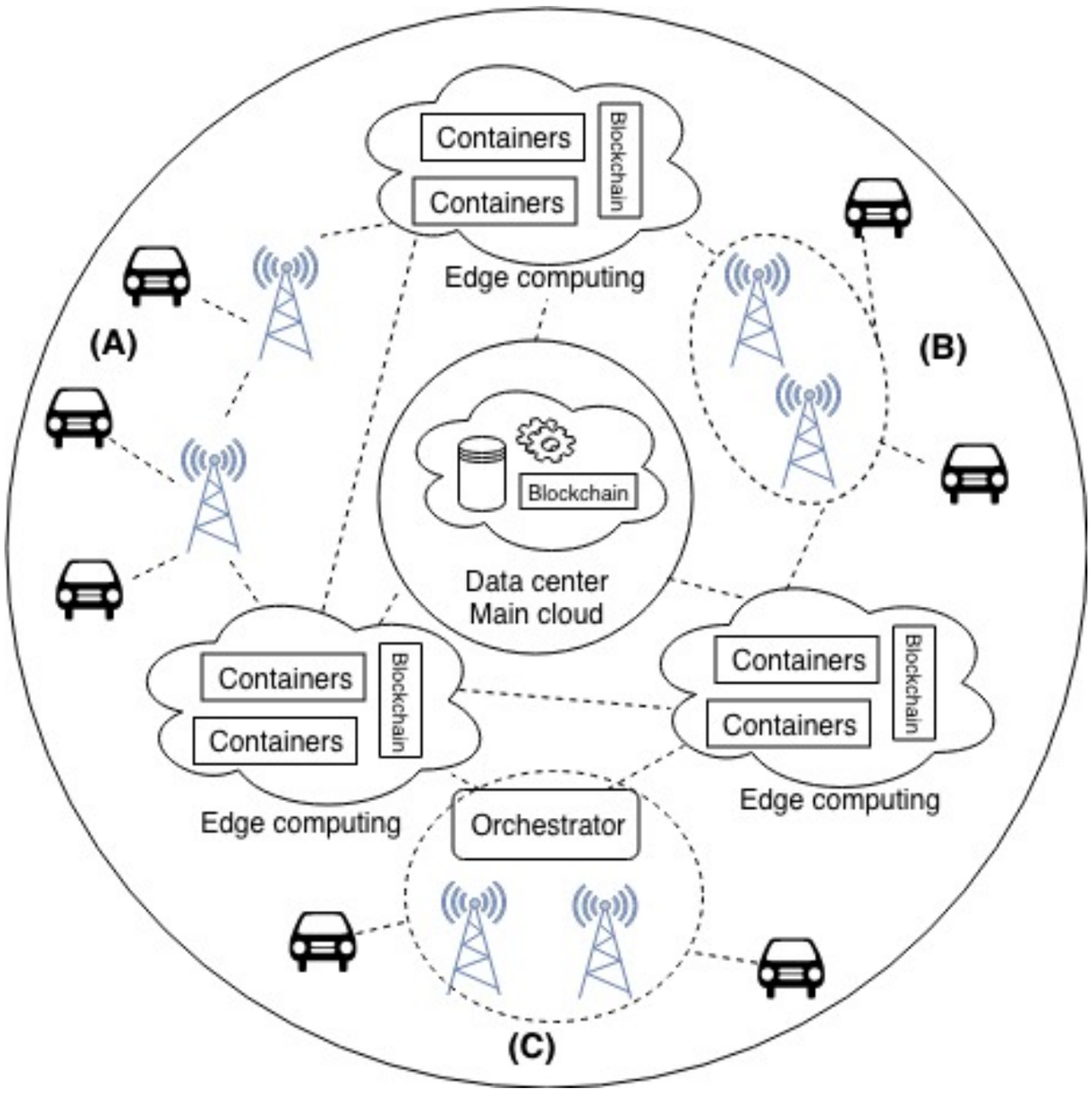
Mapping W3C-PROV to Hyperledeger composer



Scenarios

- Identification
  - Device joining: new devices added to the network
  - Container joining: new container lunched in the network
  - Data added: new data object is sent by containers or IoT devices
- Provenance
  - W3C-PROV implementation (derivedFrom, createdBy…)
- Orchestration
  - Template of smart contract
  - Access to blockchain API to define different levels of traceability
    - record invoked functions
    - execute actions on chain

Current work



MEC Service continuity Architecture

A – Single MEC
- node acts independently
- reactive migration

B – MEC Cluster
- MEC nodes join clusters to collaborate
- pre-defined contracts

C - MEC Swarm
- MEC nodes in a swarm
- delegate the communication to the orchestrator

Contact

Dr. Nabil El Ioini
Software and Systems Engineering Research Group
Free University of Bozen-Bolzano

Group website: www.inf.unibz.it/swse

E-mail: nelioini@unibz.it