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Opportunity to leverage Information-as-an-Asset in the IoT — the road ahead

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Cyril Cassagnes, Luxembourg University, SnT - Interdisciplinary Centre for Security, Reliability & Trust
Kary Främling, Aalto School of Science and Technology, Finland
Dimitris Kiritsis, Ecole Polytechnique Fédérale de Lausanne, Switzerland
Mark Skilton, Warwick Business School Coventry, UK

UNIVERSITÉ DU LUXEMBOURG

SUMMARY

- Introduction
- The Seven Laws of Information from the IoT perspective
- Open Platform 3.0™ — The Open Group initiative
- Conclusion

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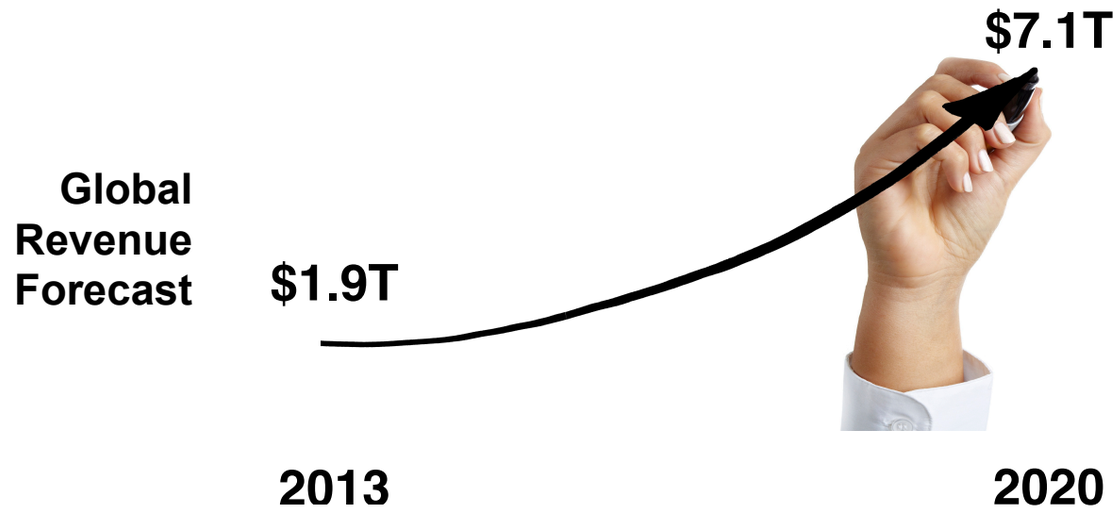
Forecasting the Future of the Internet of Things in Europe

(According to IDC and TXT on behalf of DG Connect)



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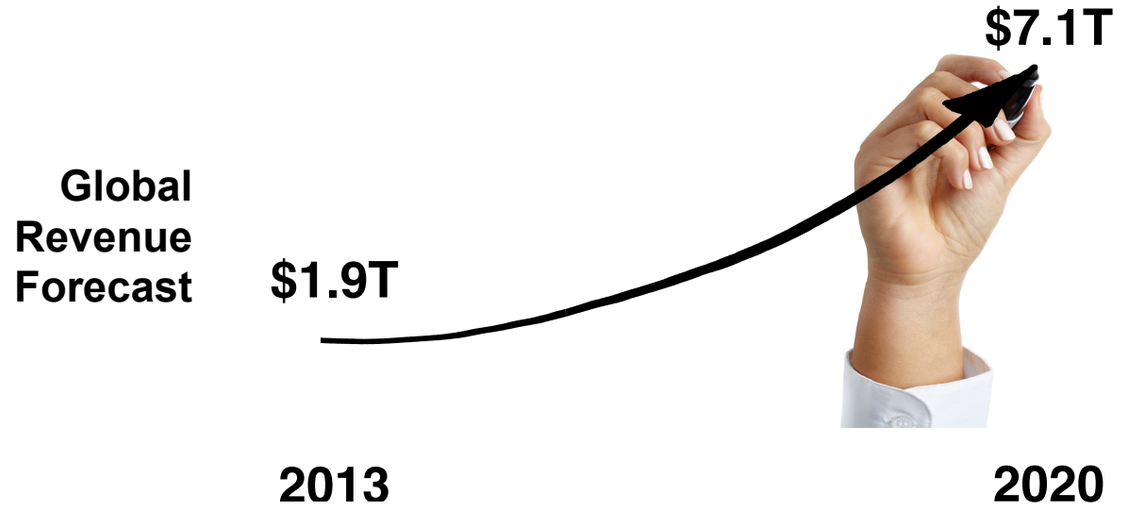
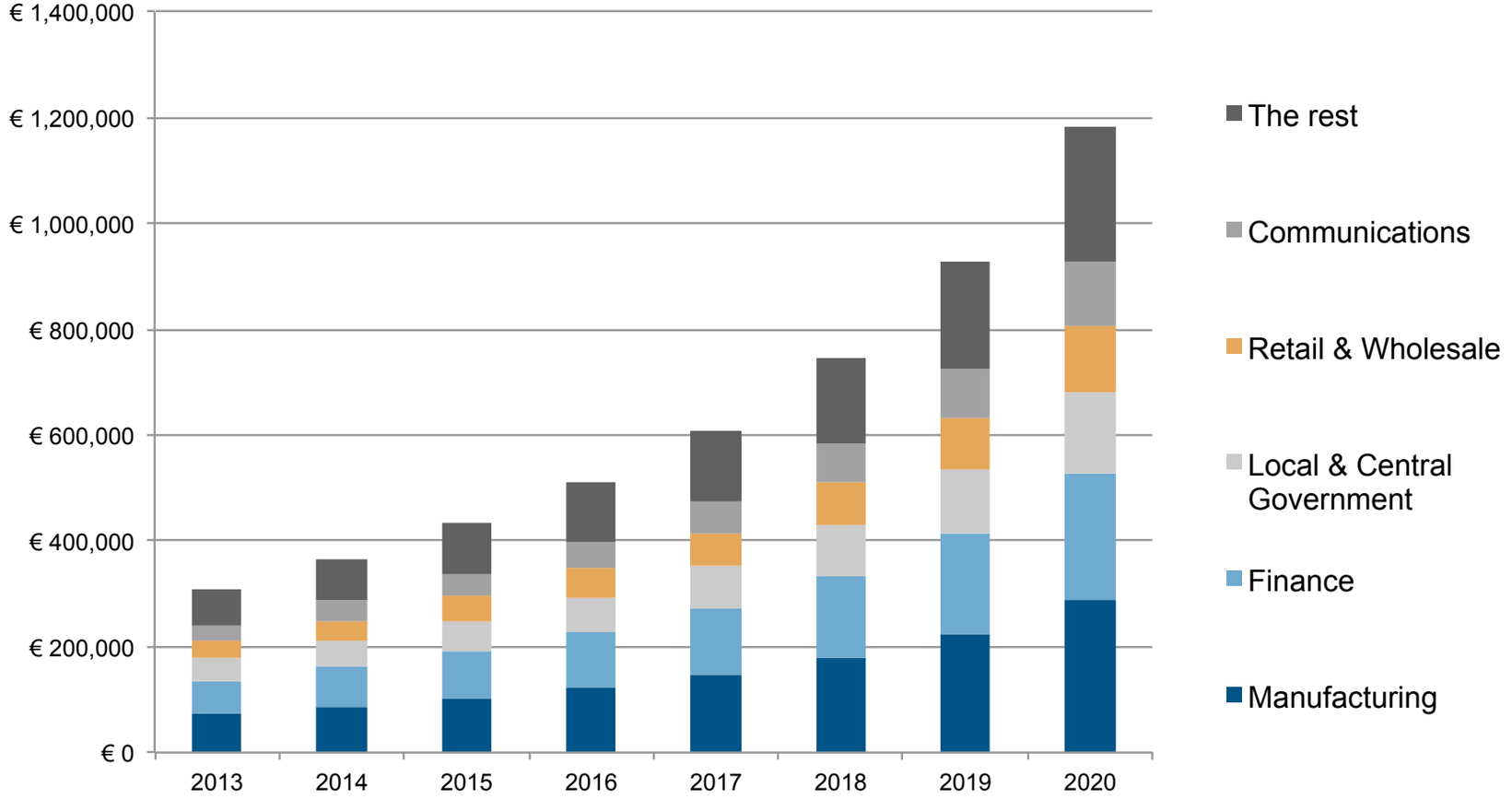


IoT Forecast Revenues by sector (EU Baseline scenario)



Forecasting the Future of the Internet of Things in Europe

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Global Revenue Forecast

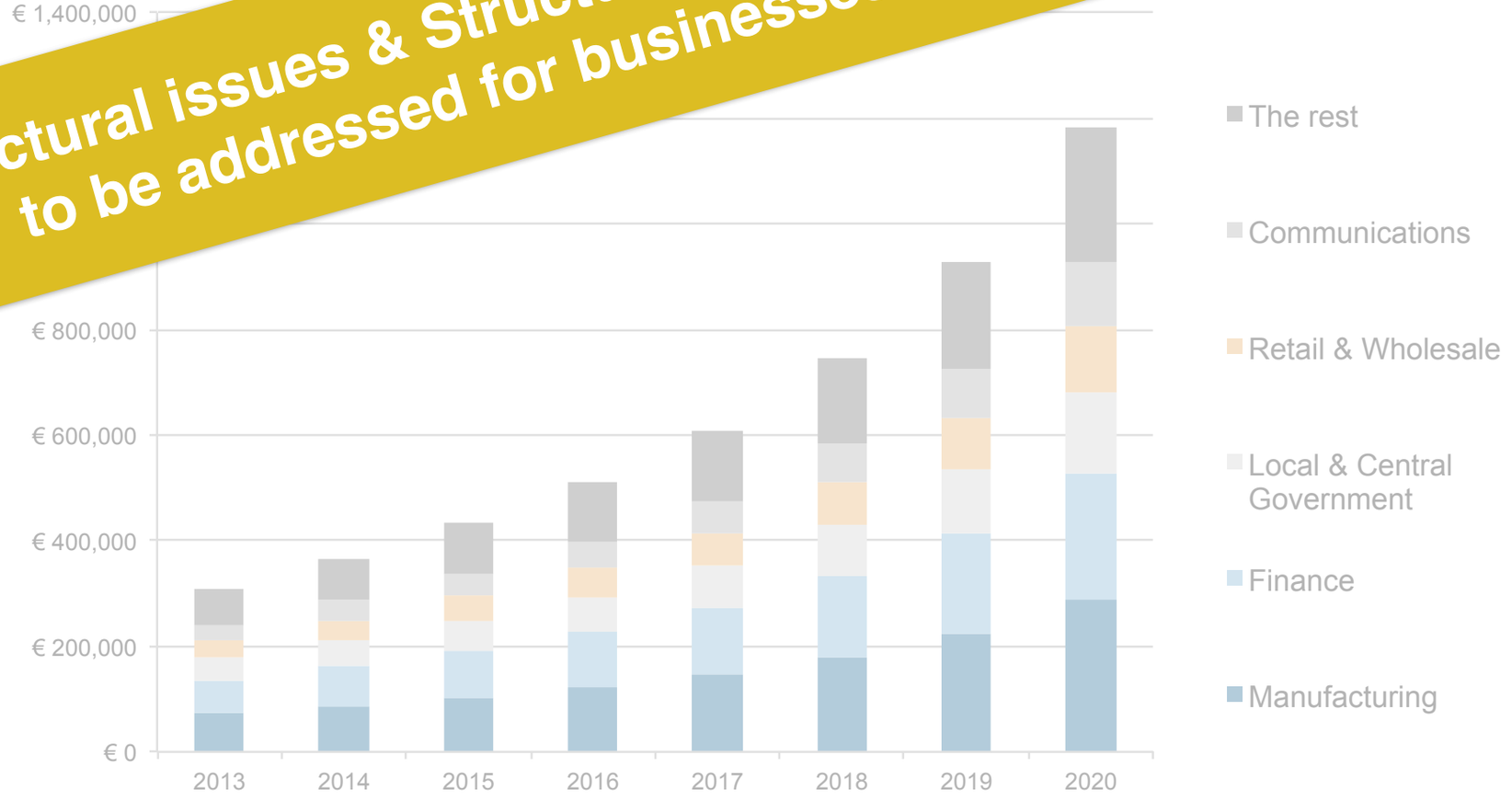
$1.9T

2013

$7.1T

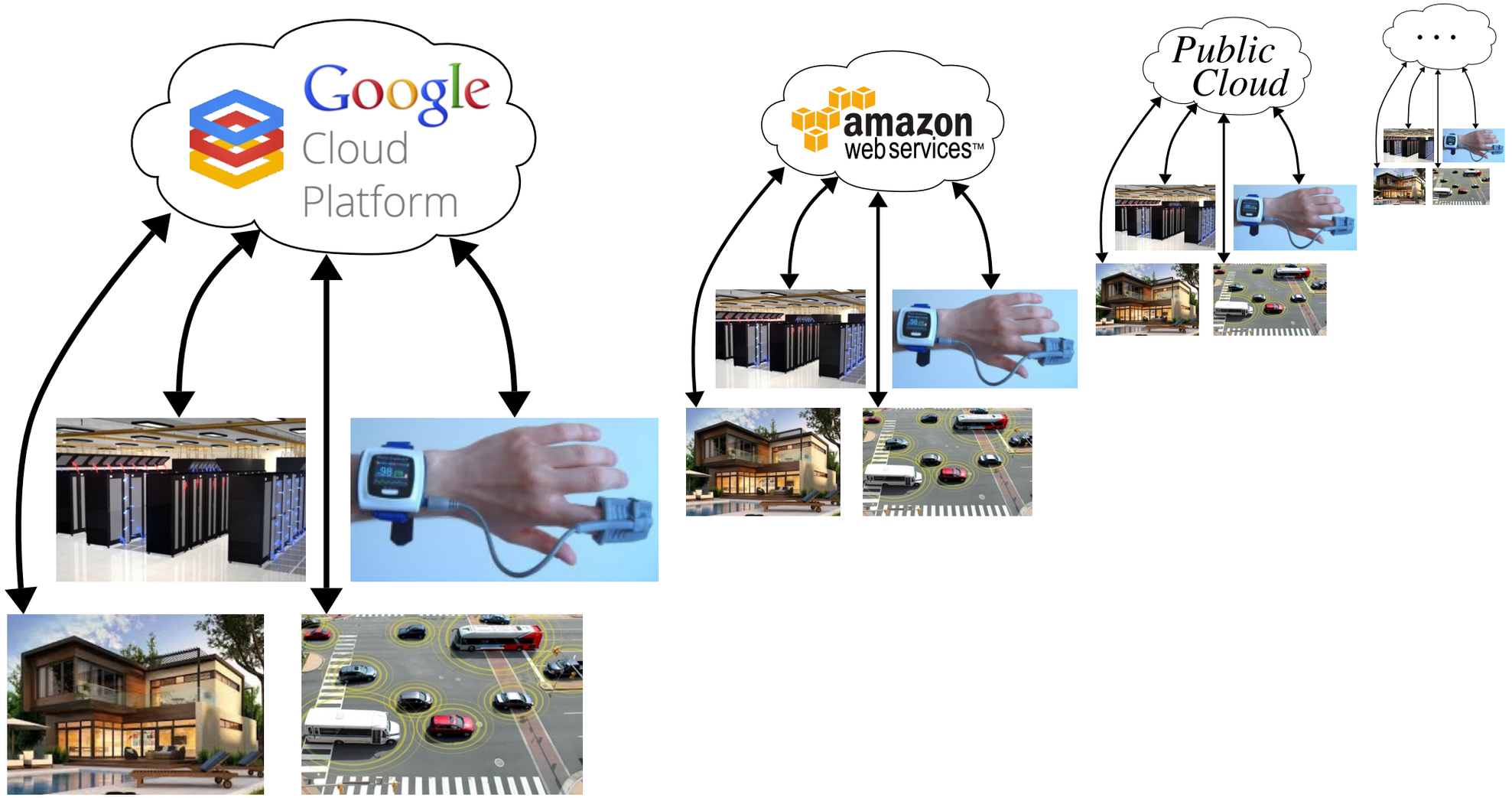
Architectural issues & Structural considerations still need to be addressed for businesses to benefit !

Revenue forecast by sector (EU Baseline scenario)



Architectural Issues & Structural Considerations in the IoT

1 - Challenge of Vertical Silos shaping today's IoT



Legend

⟷ Today's IoT : Data collected into vertical silos (pushed to vertical servers)

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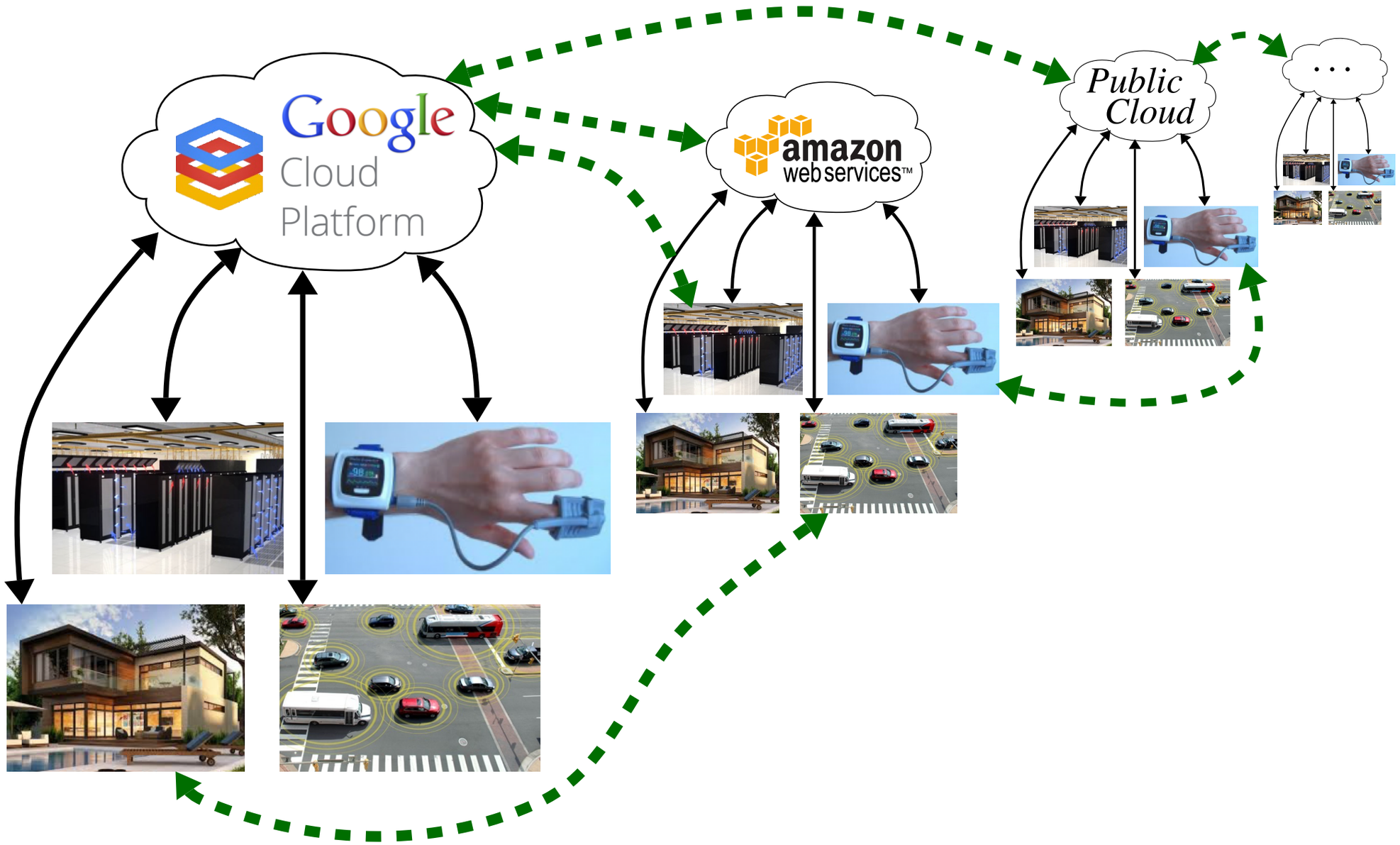


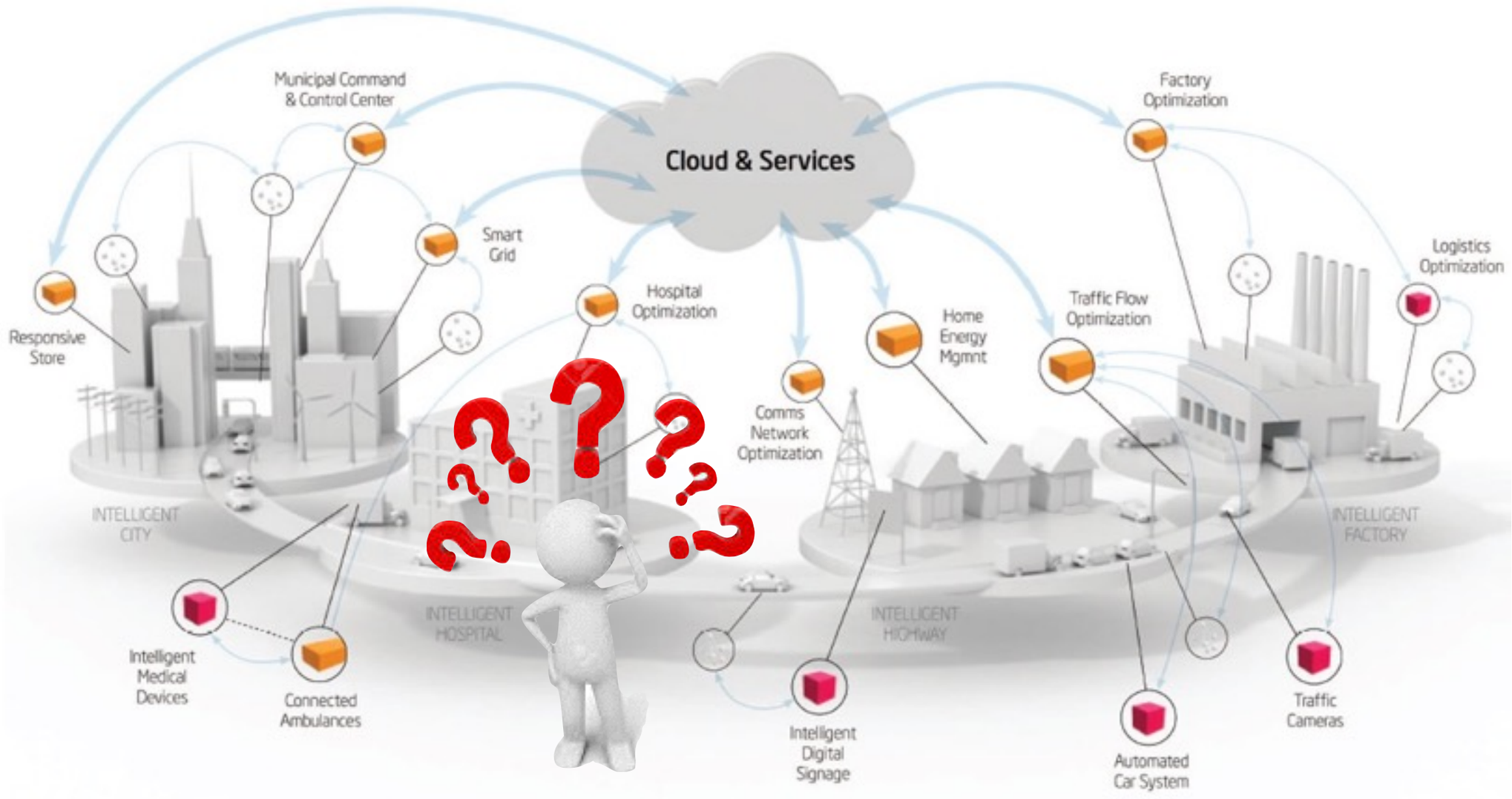
Legend

Today's IoT : Data collected into vertical silos (pushed to vertical servers)

Ideal IoT : Communication allowed between vertically-oriented closed systems

Architectural Issues & Structural Considerations in the IoT

2 - People may be reluctant to step into the IoT arena



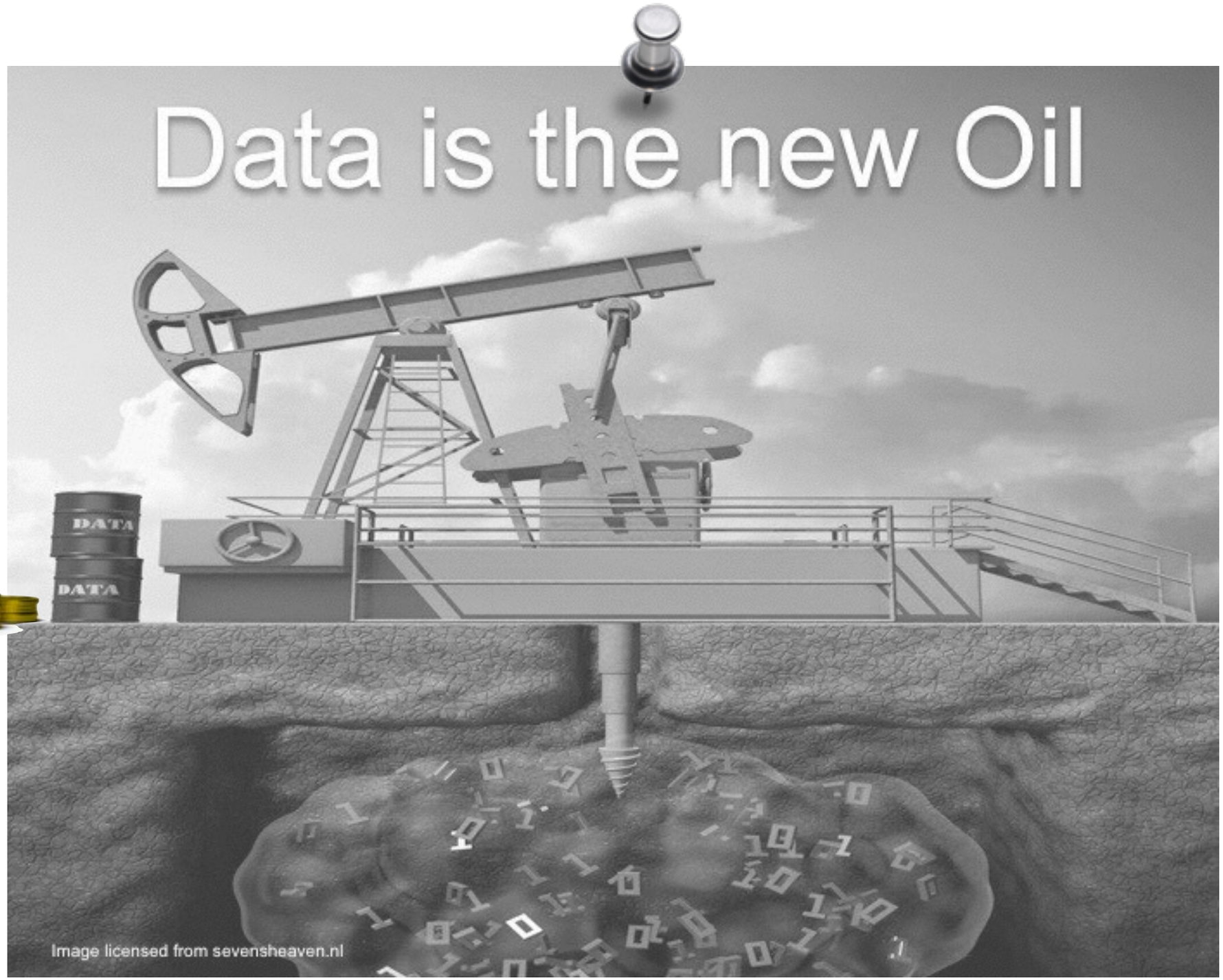
- Major ICT players hand over customer data and are not willing to let the customers have a full end-to-end control, resulting in user frustration;

- The non-maturity of the IoT makes it challenging to develop a clear approach to foster innovation, trust and ownership of data, while at the same time respecting security and privacy in complex environments.

Architectural Issues & Structural Considerations in the IoT

3 - Difficulty to leverage information-as-an-asset

Still challenging to perceive, extract the real value of the information & knowledge assets (not as tangible as physical assets)



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(introduced by Moore and Walsh*)

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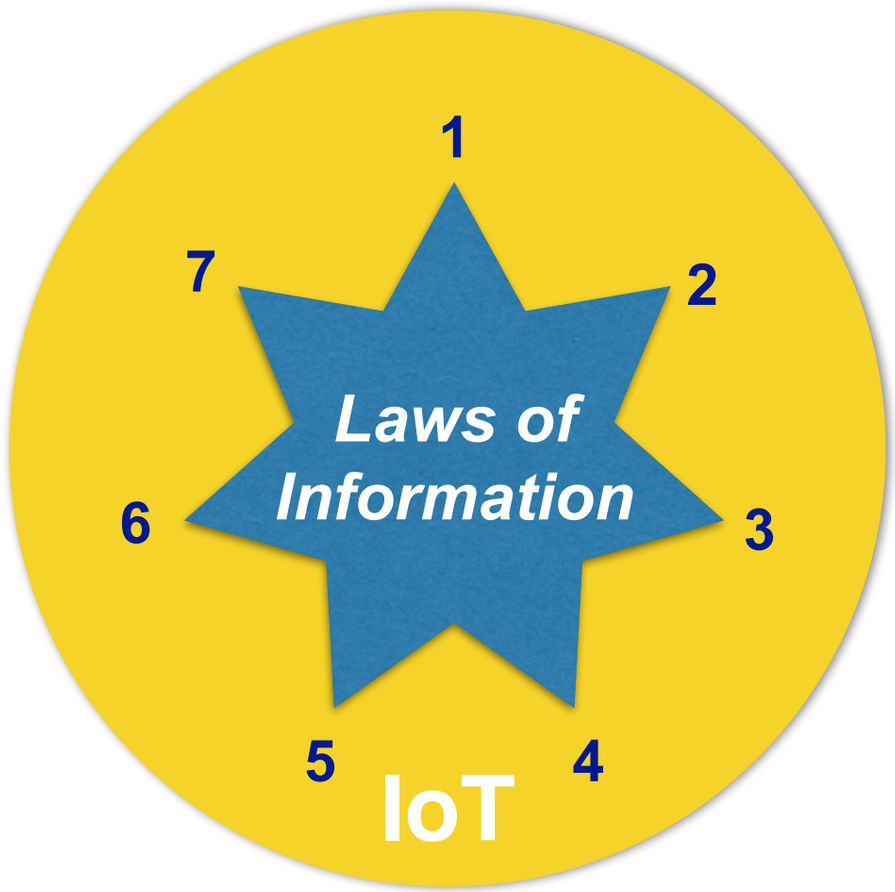

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New Opportunities

1

7

2

Laws of Information

6

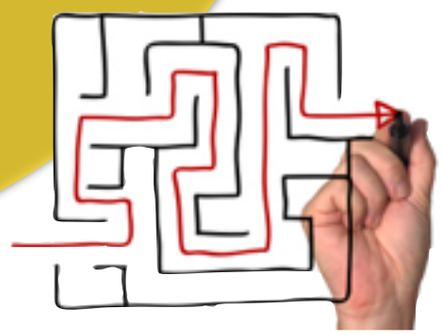
3

5

4

IoT

Along with Challenges



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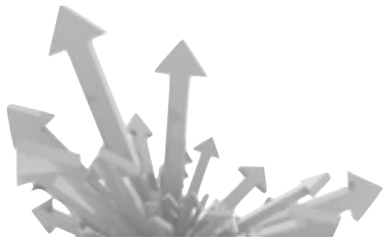
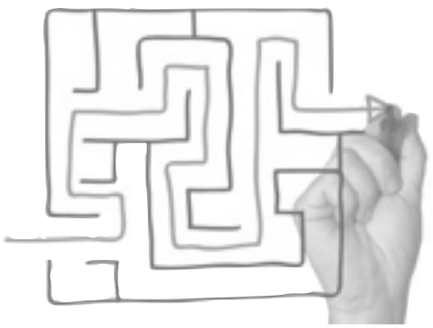


1

Information is infinitely shareable and can be shared with others without a loss of value

Laws of Information

IoT



New Challenges

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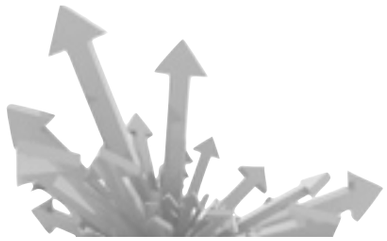

Data is Intangible

IoT eases the sharing of object-related data & knowledge

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Laws of Information

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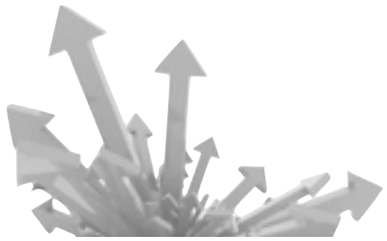

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To foster open IoT ecosystem to easily share IoT-related information

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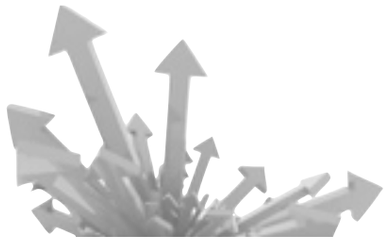

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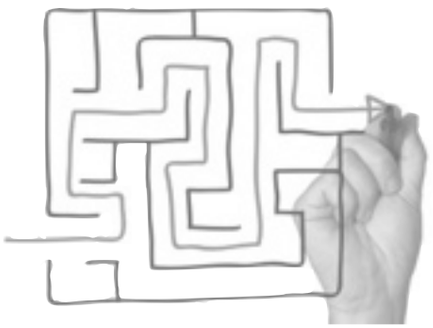

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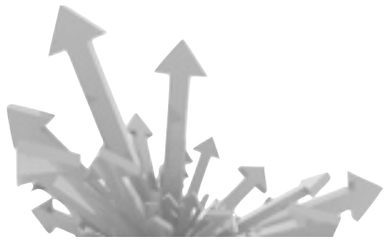

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Exploring Block Chain-based smart contracts (e.g., Bitcoin)

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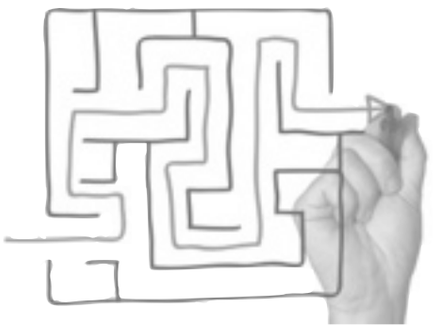

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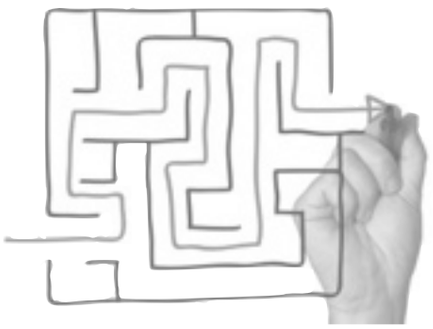
New Opportunities

Value of information increases with use, and it does not provide any value if it is not used at all



New Challenges

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Laws of Information

IoT

New Opportunities

IoT helps decision-makers to interpret and use information in a beneficial way

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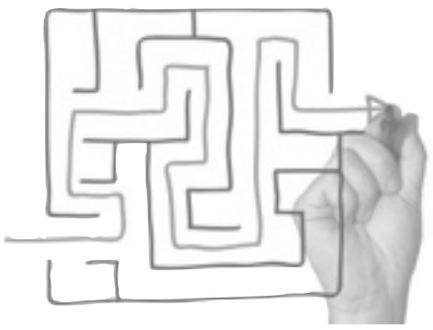

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(need for more advanced geo-location, semantic discovery mechanisms)

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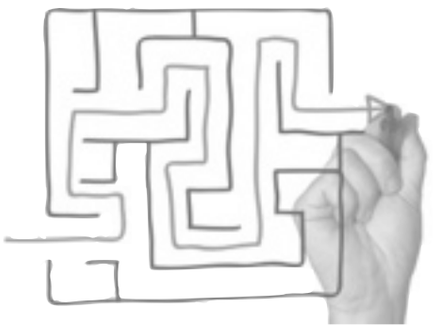

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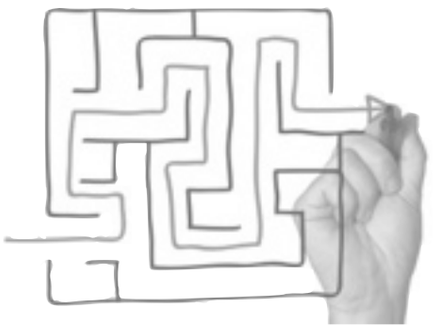

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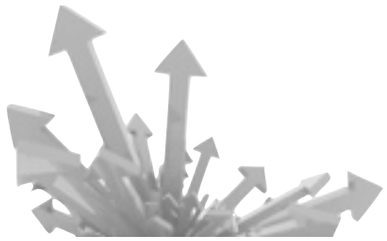

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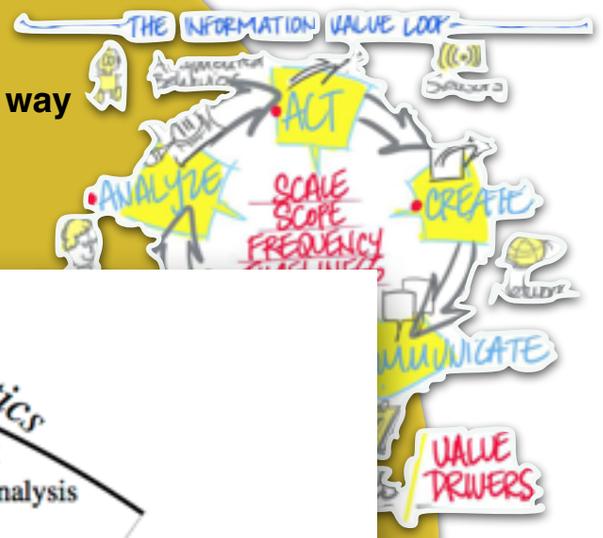

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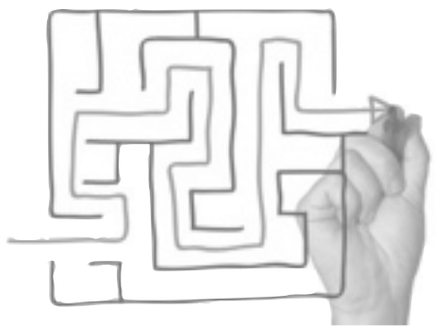

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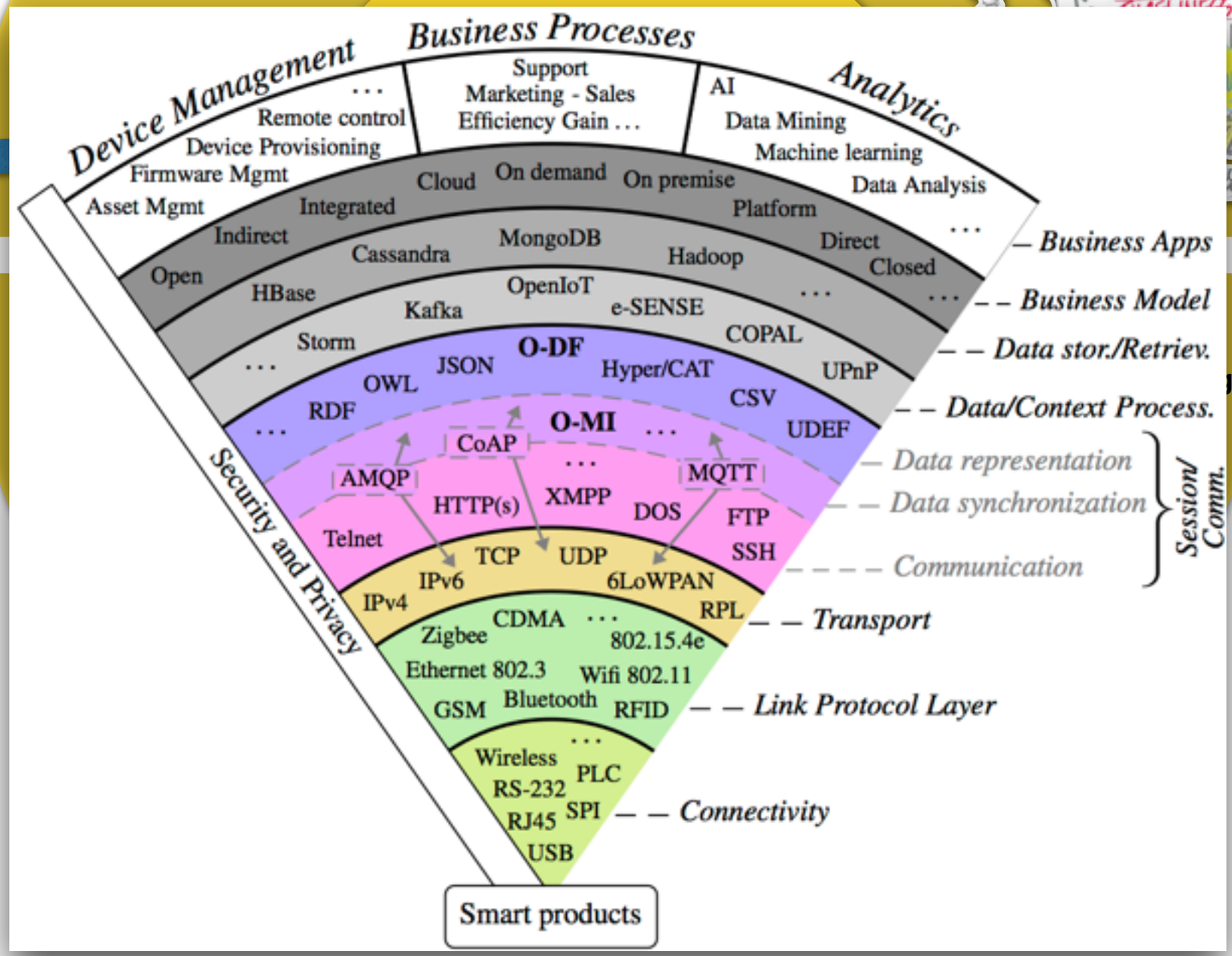

New Opportunities

Allow for innovative Context-Aware applications

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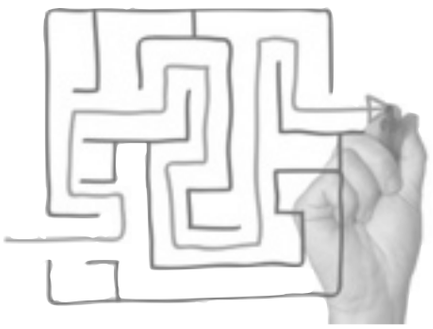

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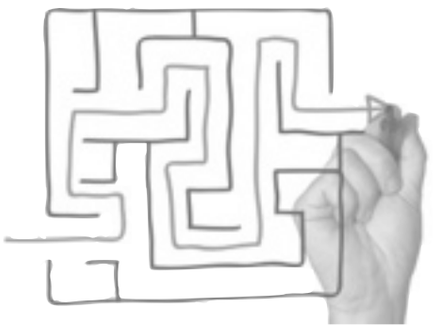
Enhanced Context-Aware tools/services



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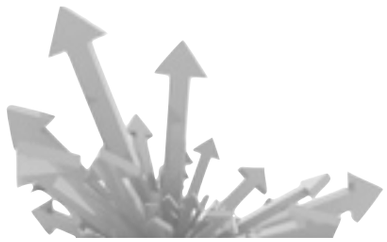
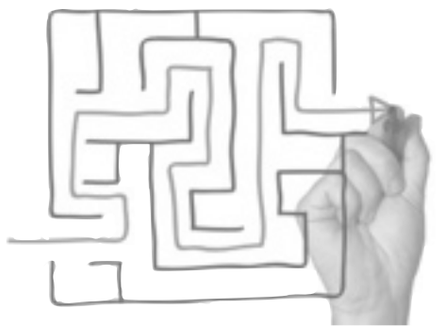


Information is perishable and depreciates over time

Laws of Information

3

IoT



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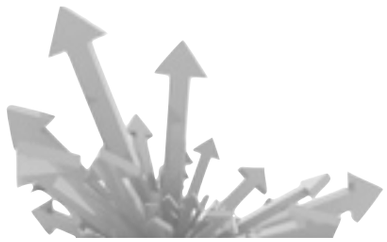

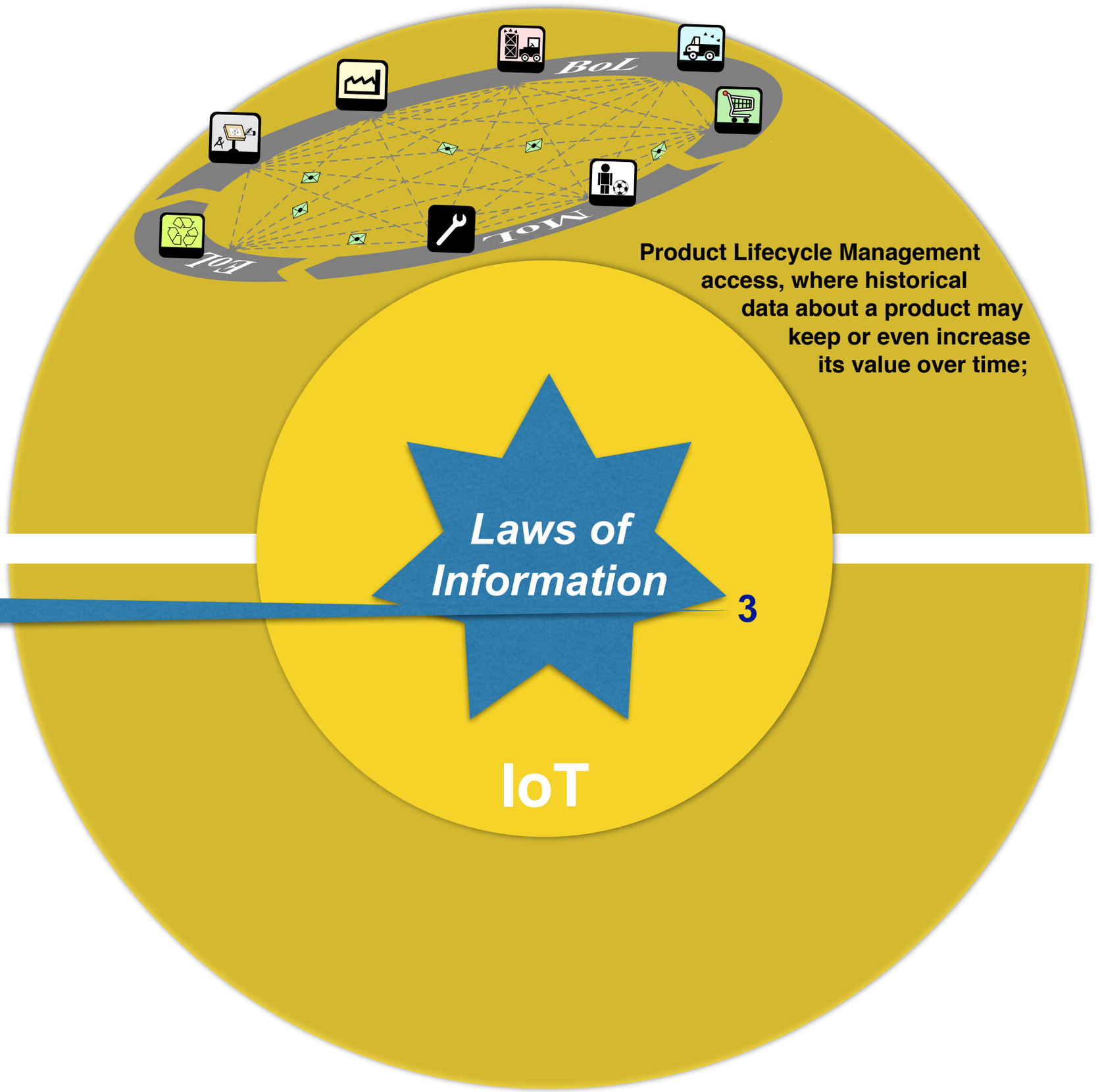

Product Lifecycle Management access, where historical data about a product may keep or even increase its value over time;

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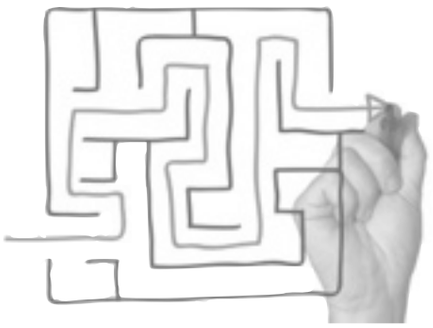

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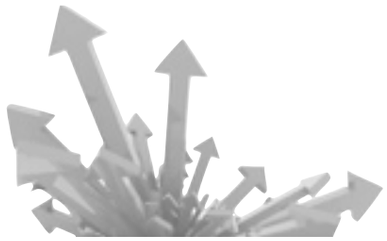

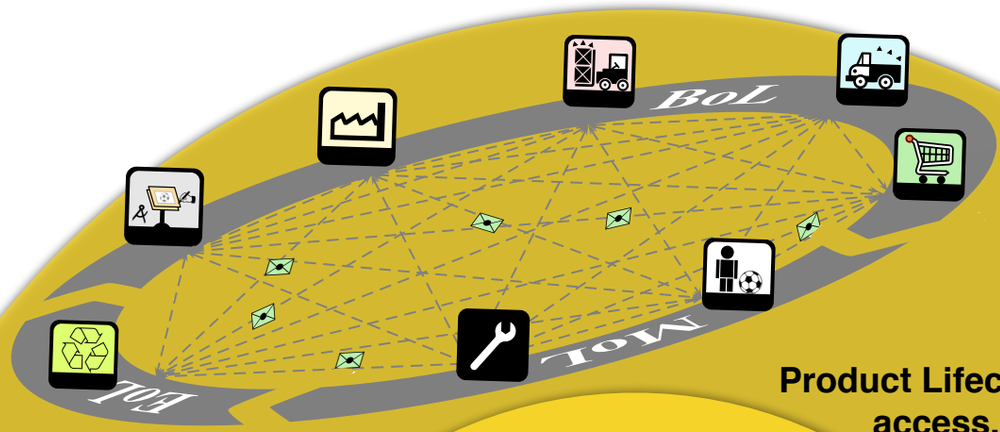

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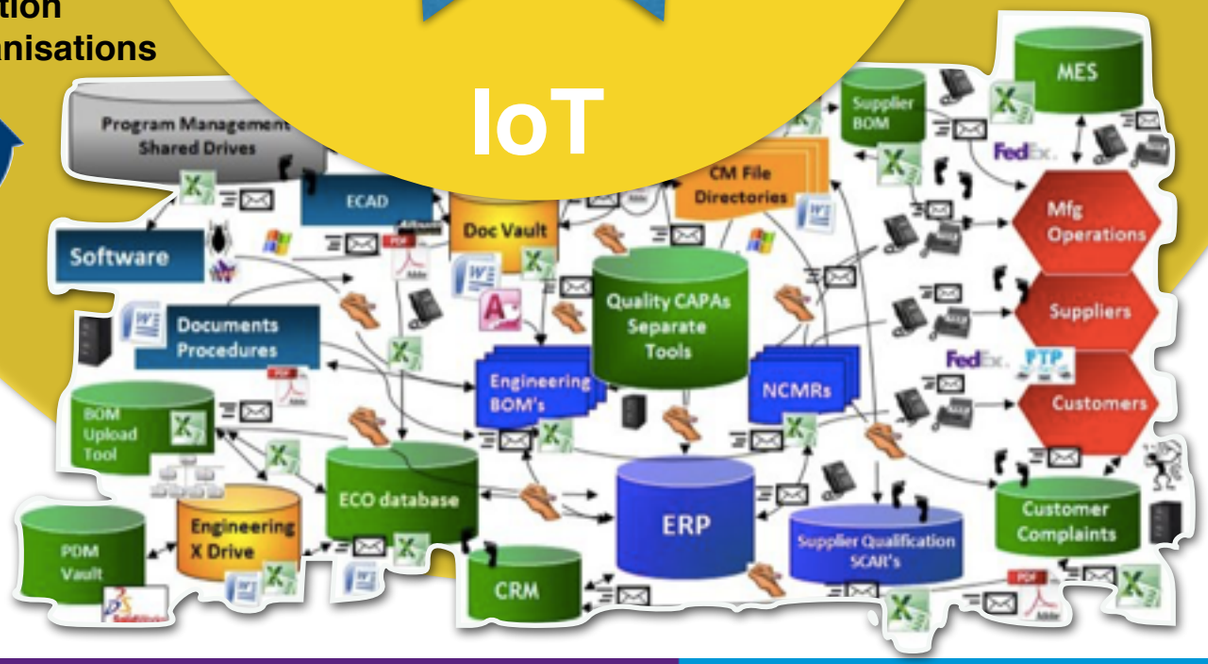
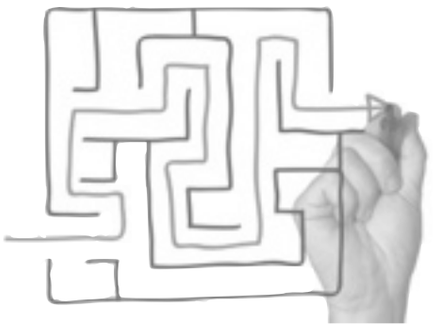
Need to improve data interoperability and synchronisation across organisations

IoT





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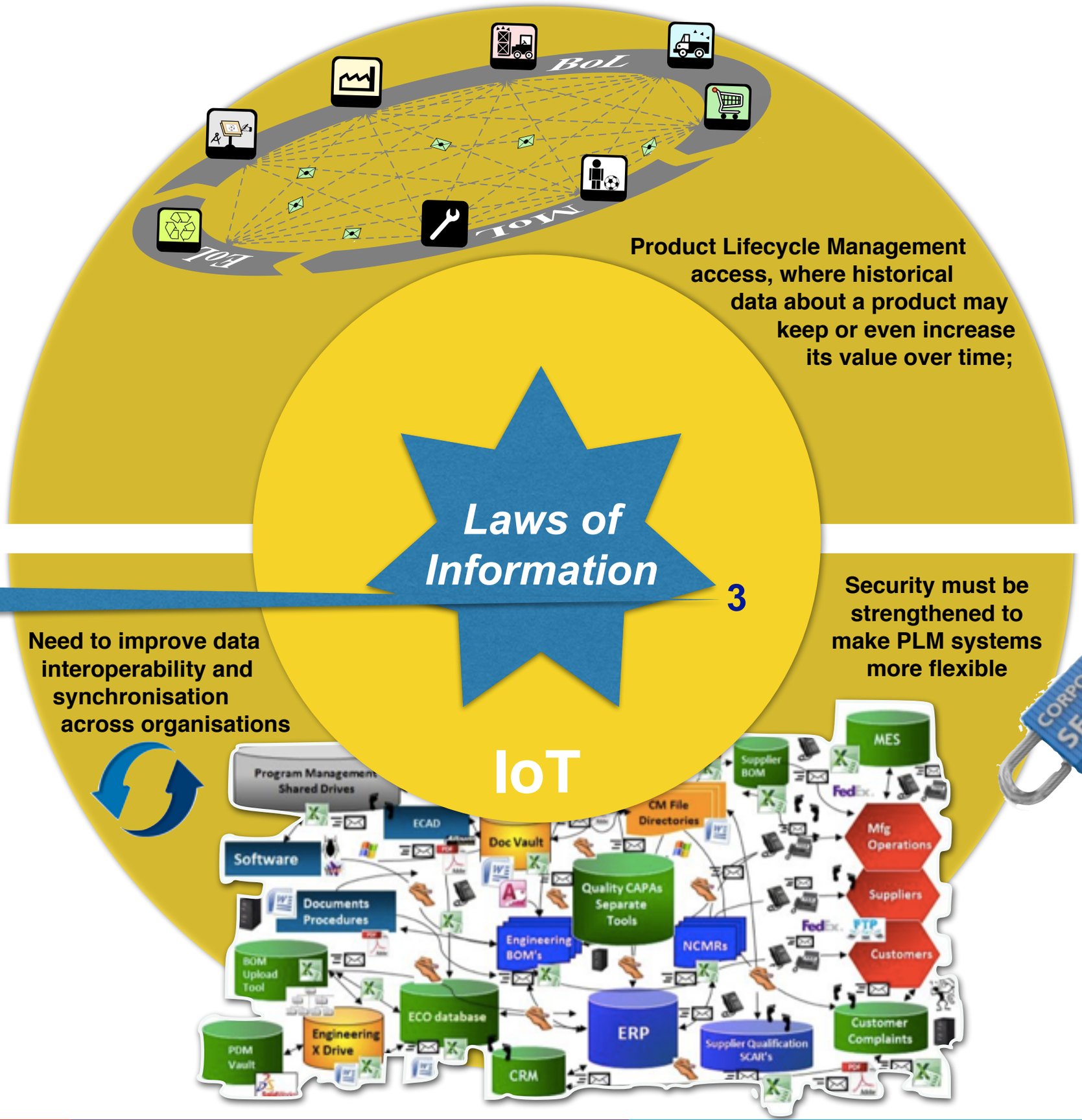
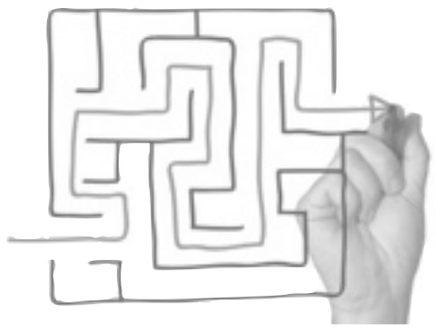
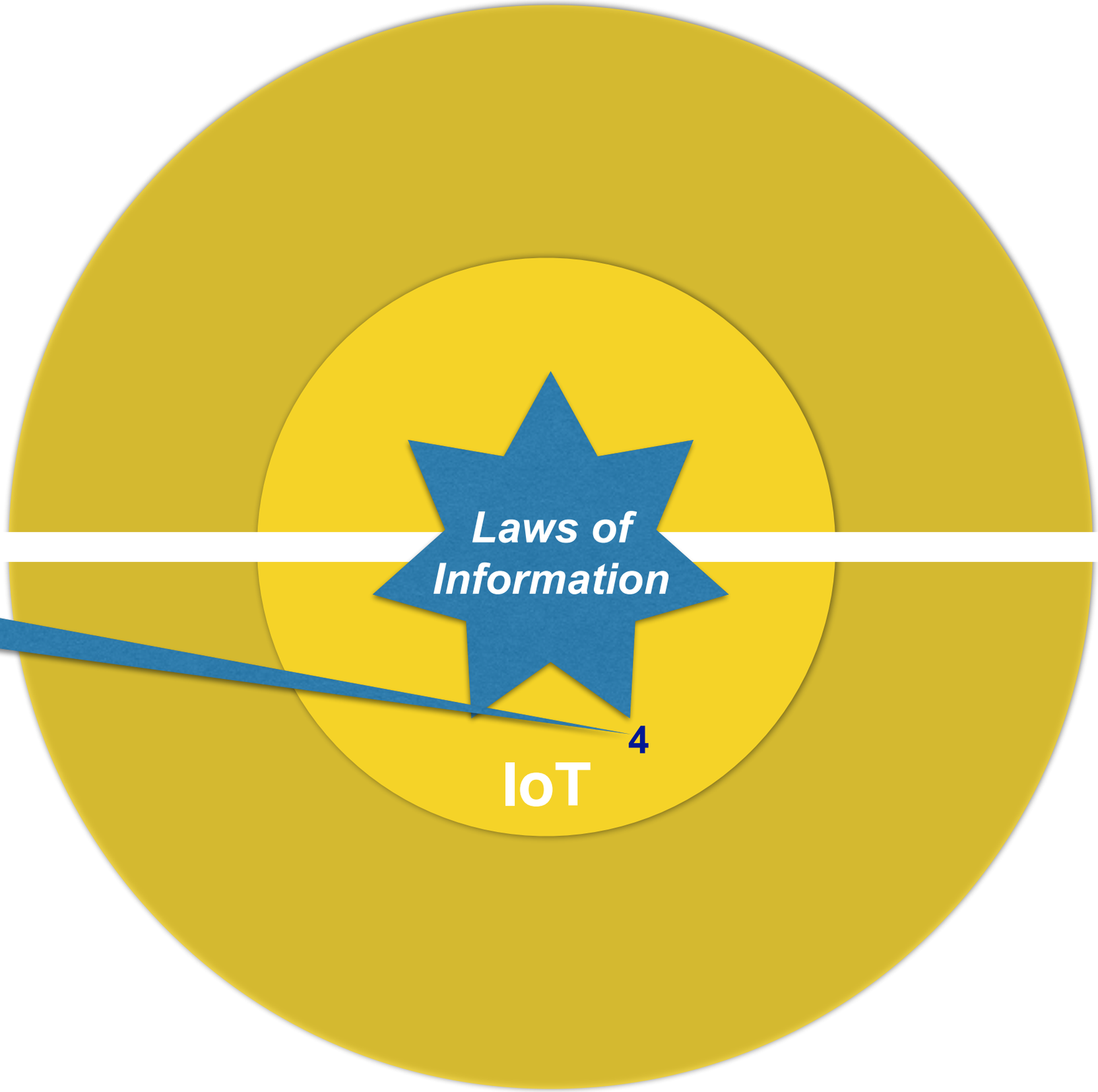


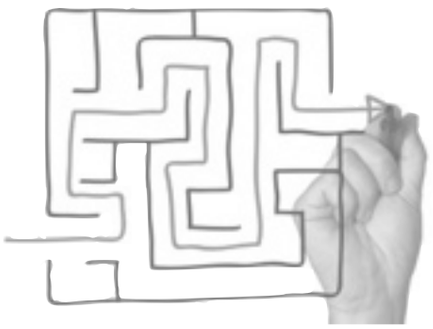


New Challenges

New Opportunities

The value of information increases with accuracy





New Challenges

New Opportunities

Incentives for people taking care of information dimensions

Laws of Information

The value of information increases with accuracy

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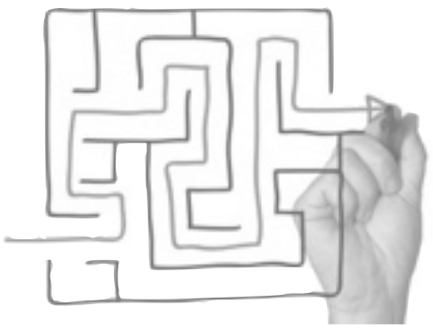
IoT



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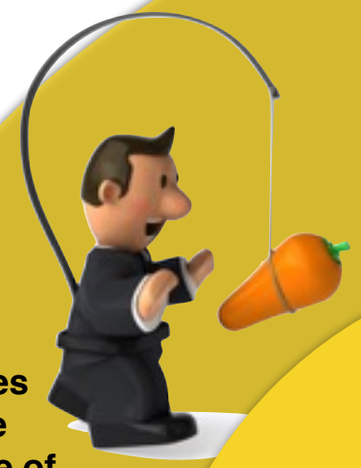

Incentives for people taking care of information dimensions

Laws of Information

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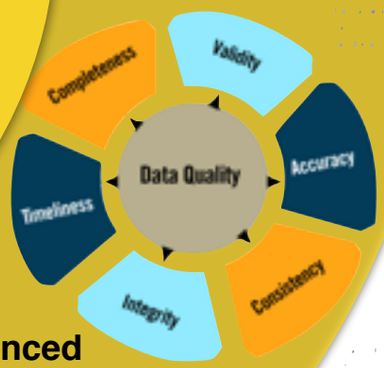
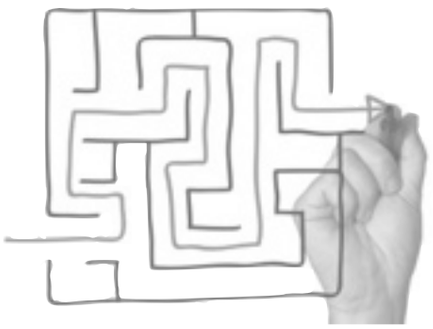
IoT

Associated with mirco-billing pltaforms



More advanced Data Quality (DQ) frameworks for the IoT



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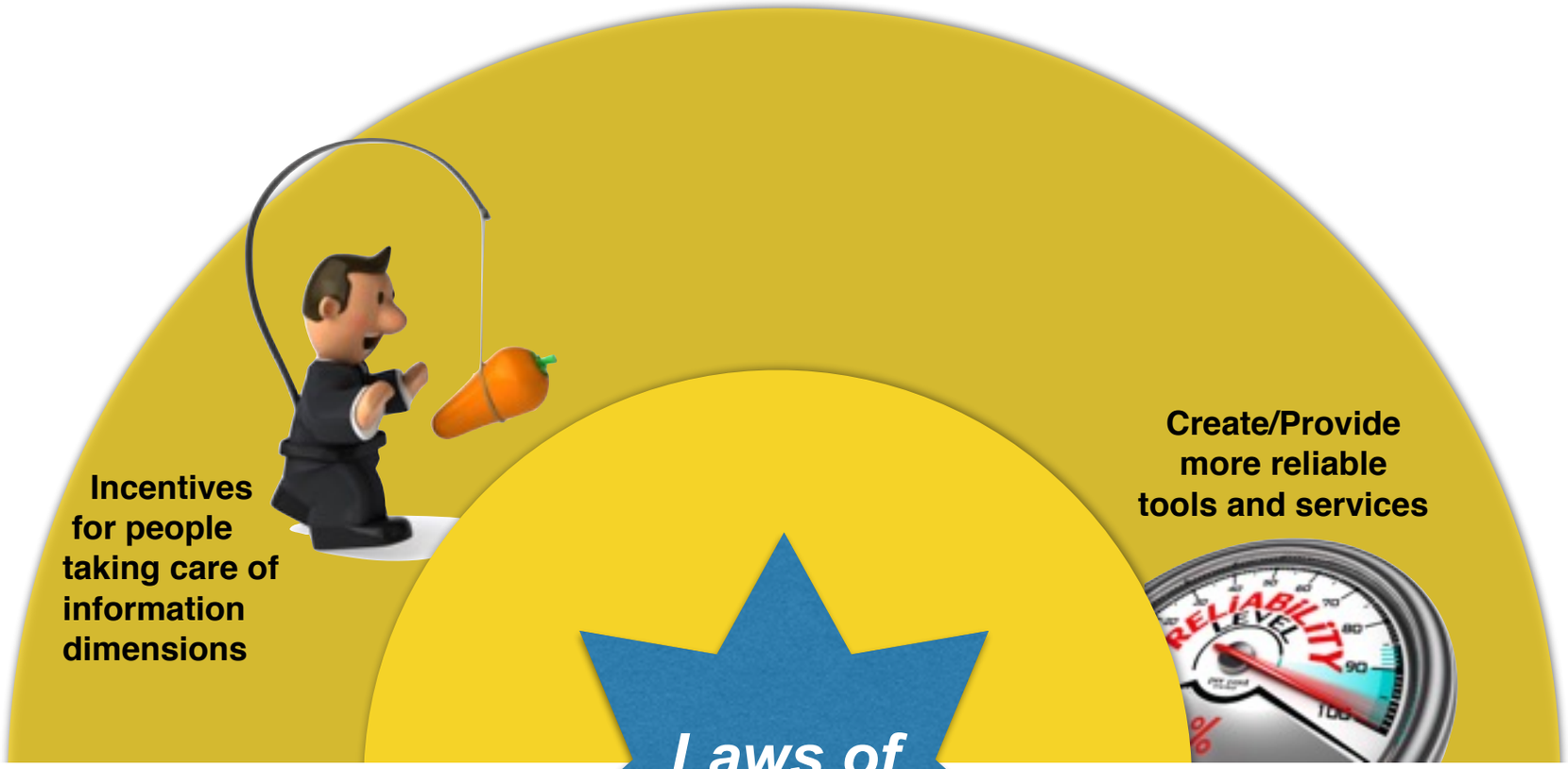

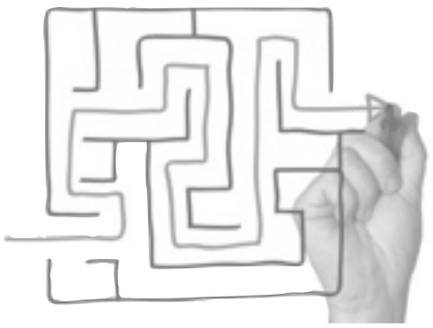

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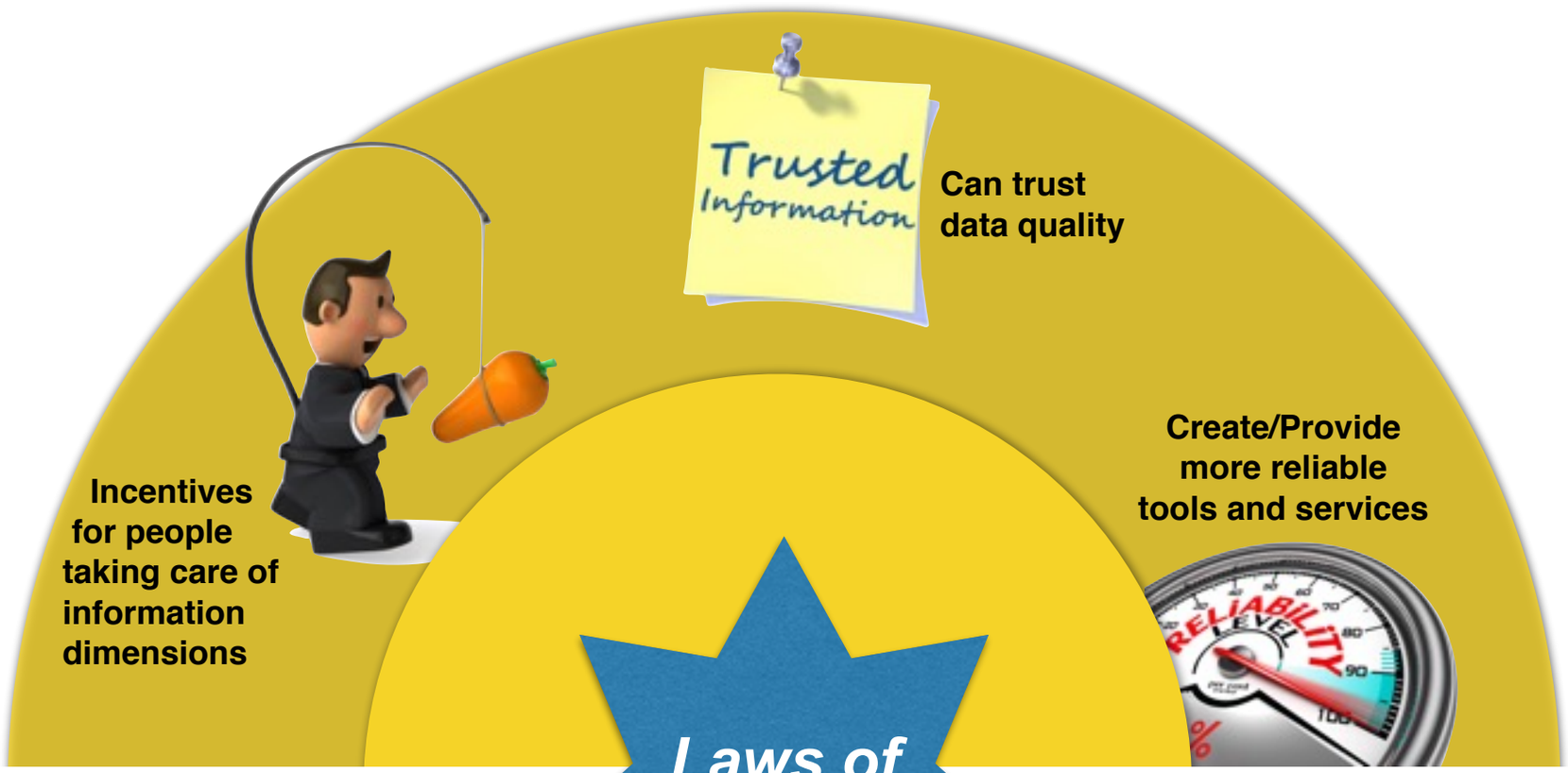

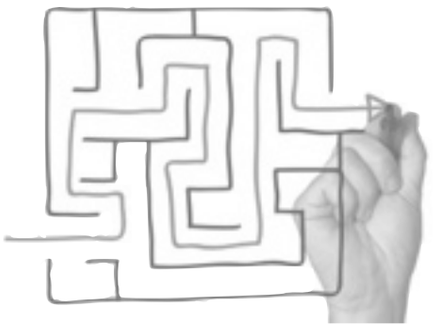

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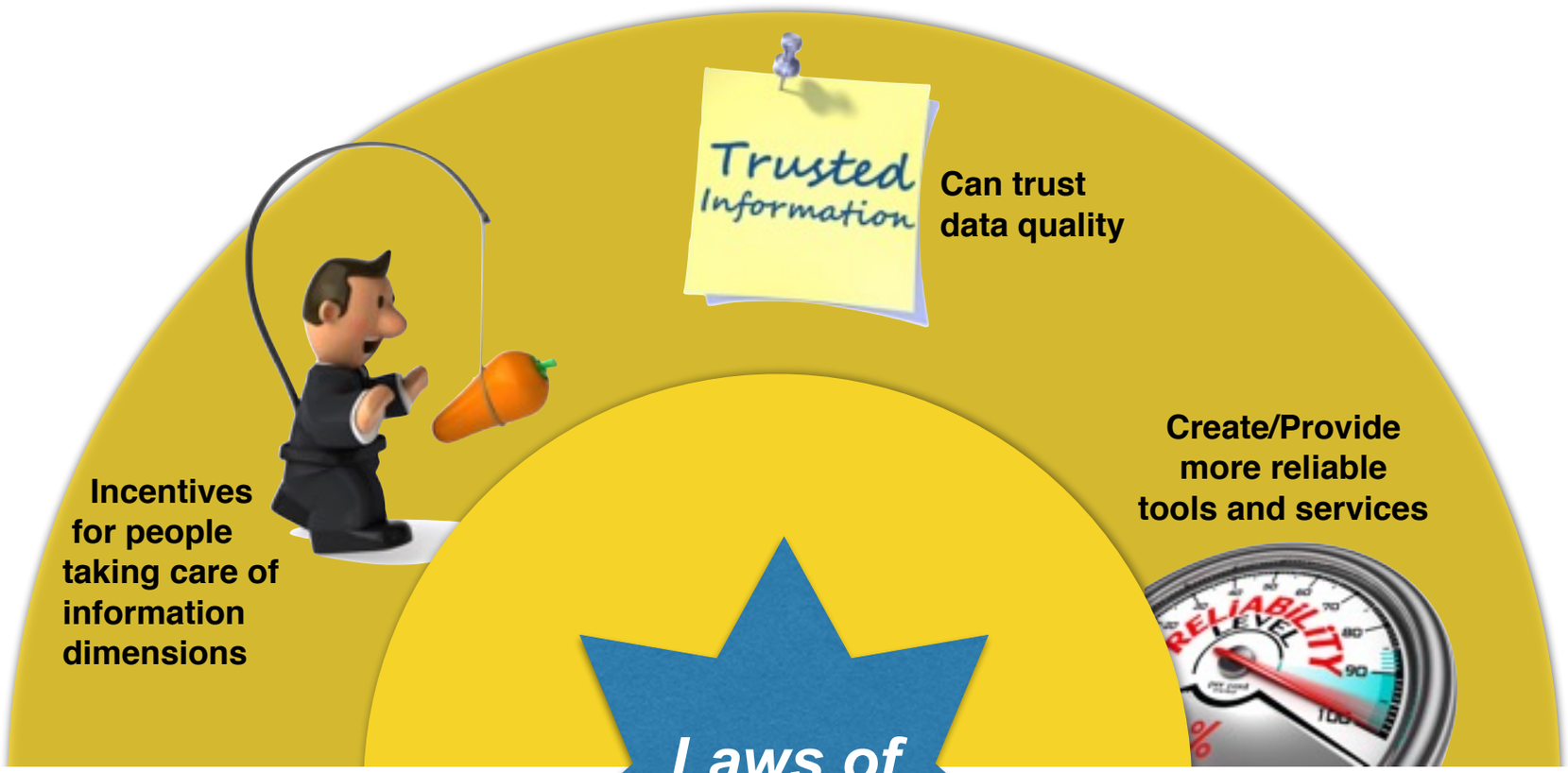
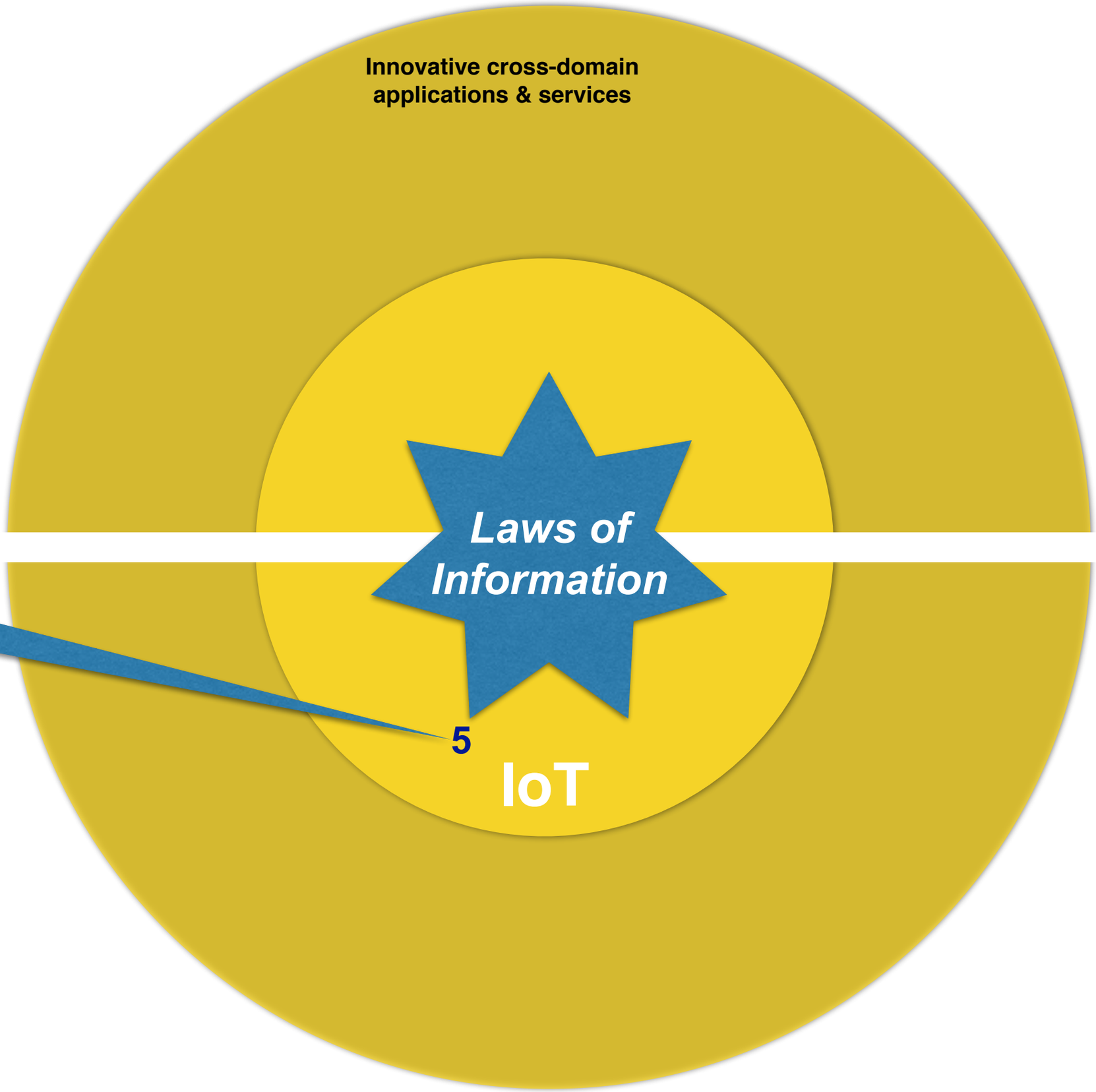
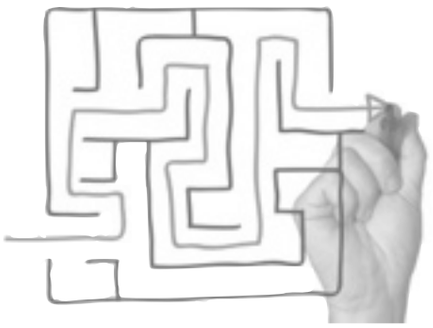


New Challenges

New Opportunities

The value of information increases when combined with other information





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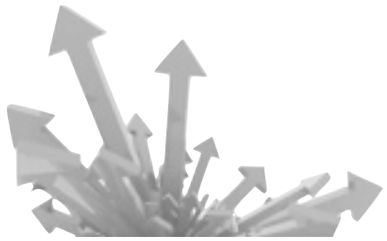
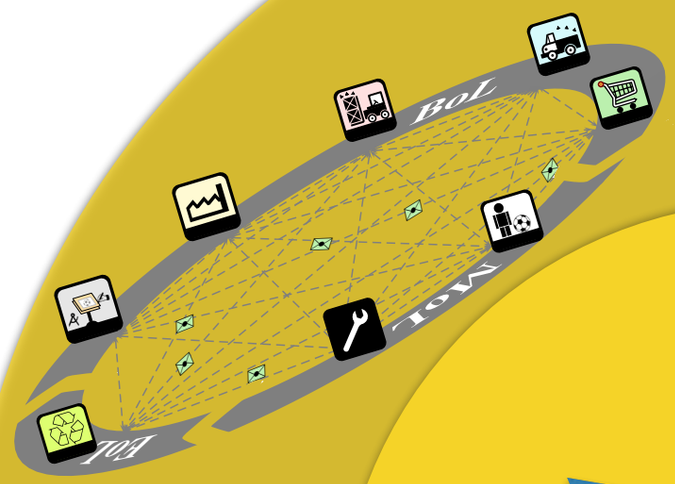


Innovative cross-domain applications & services



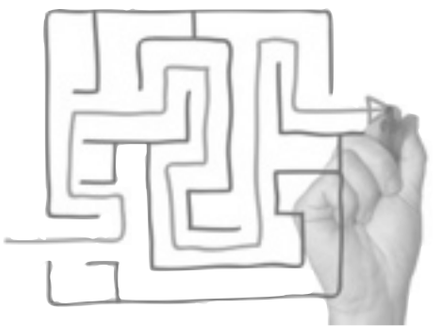
Product Lifecycle Management

Laws of Information

IoT

The value of information increases when combined with other information

5



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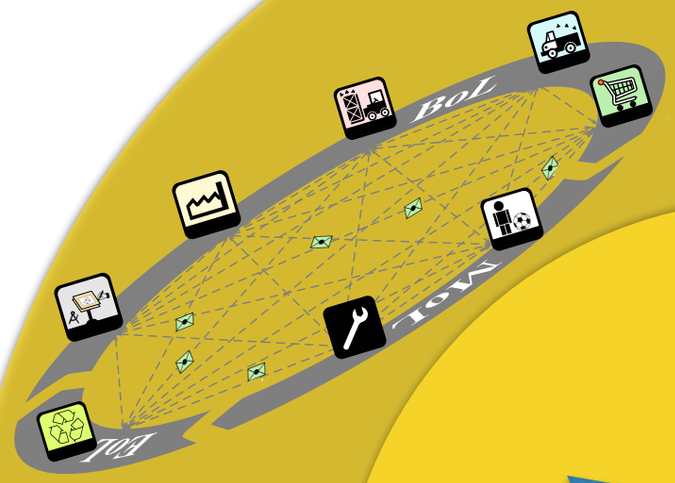

Product Lifecycle Management

Connected Smart Cities

Laws of Information

The value of information increases when combined with other information

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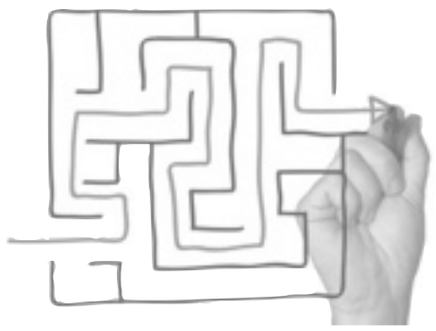
IoT



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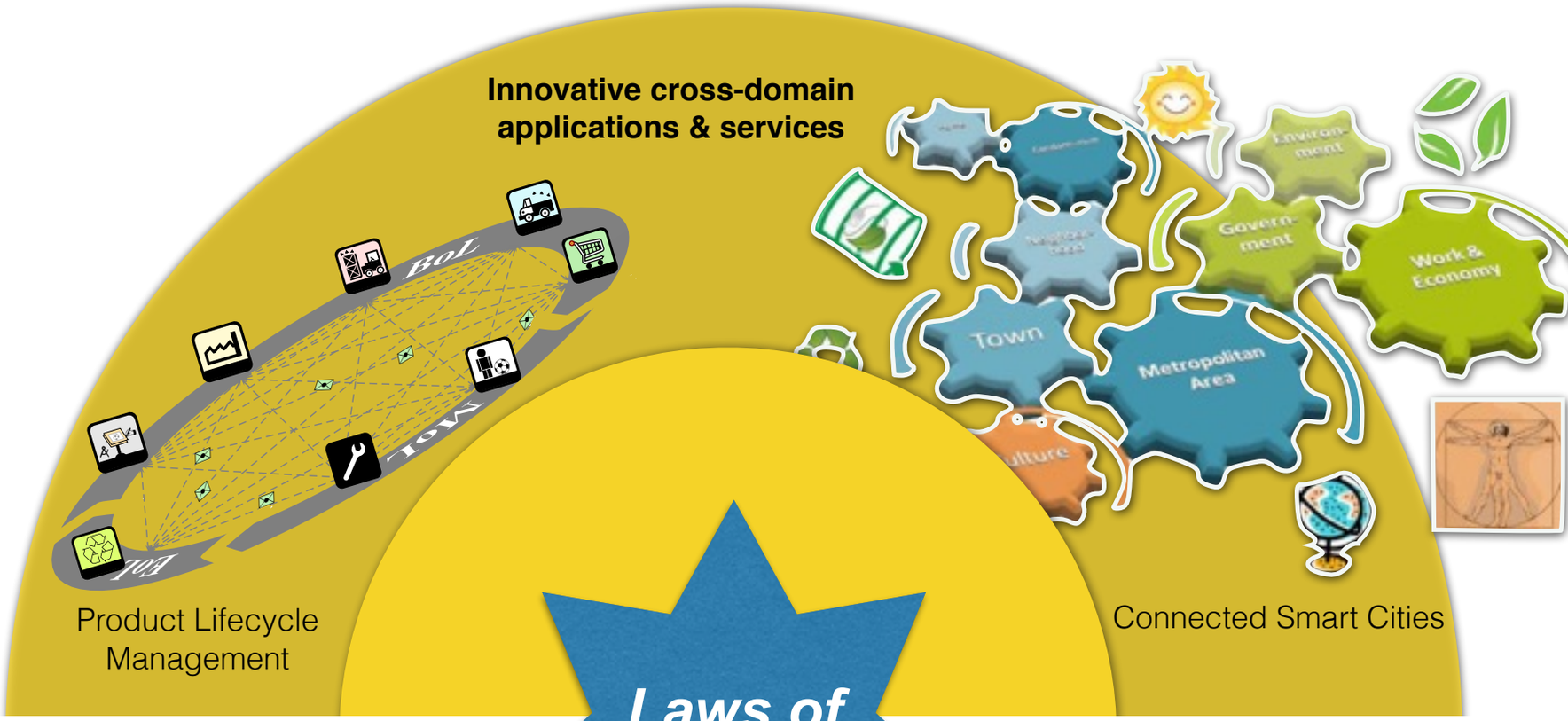

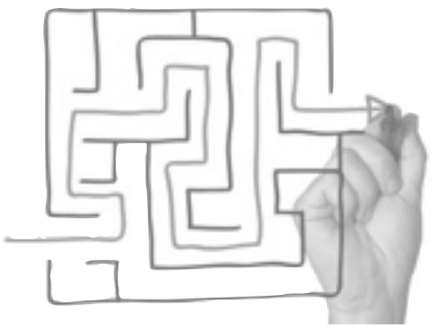

New Challenges

New Opportunities

More information is not necessarily better

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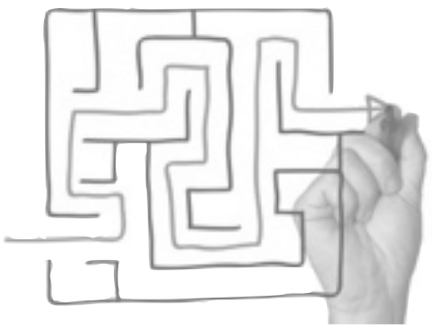

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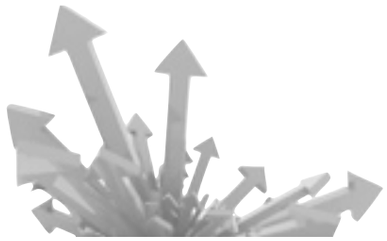

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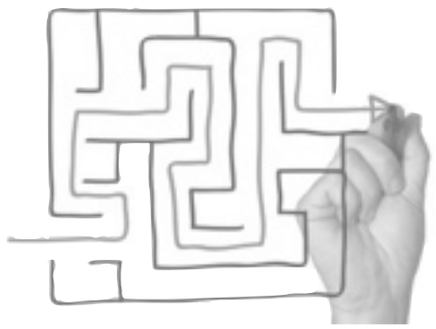

New Challenges

Reduce data storage and processing

Laws of Information

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IoT

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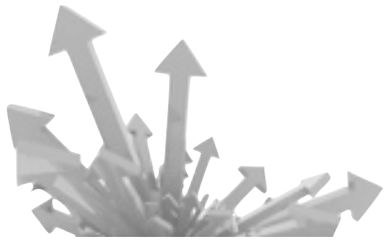

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Reduce data storage and processing

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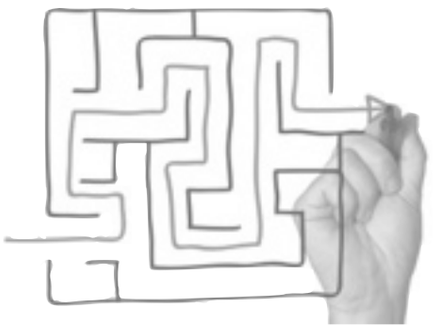
Big Data related-challenges



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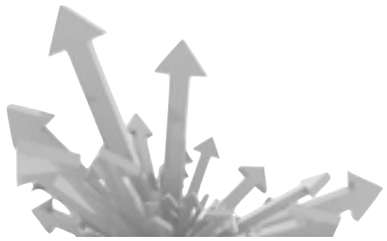

More information is not necessarily better

Reduce data storage and processing

Access only relevant information, when and as needed

Laws of Information

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IoT

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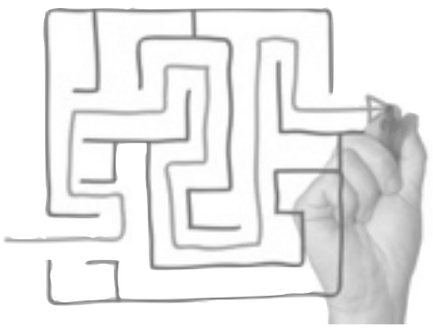

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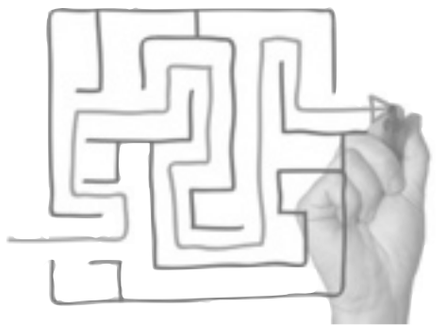


Reduce data storage and processing

Access only relevant information, when and as needed

Laws of Information

IoT

Big Data related-challenges

More advanced context-filtering, reasoning & validation tools

New Opportunities

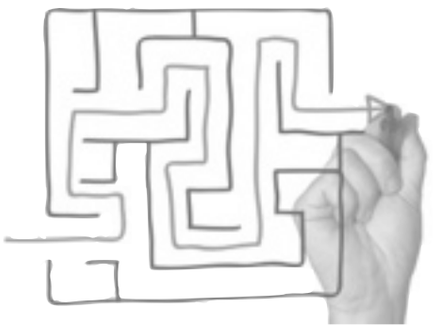
Information is rather self-generating as summarizing, combining or analyzing information leads to more information

7

Information is not depletable

Laws of Information

IoT



New Challenges

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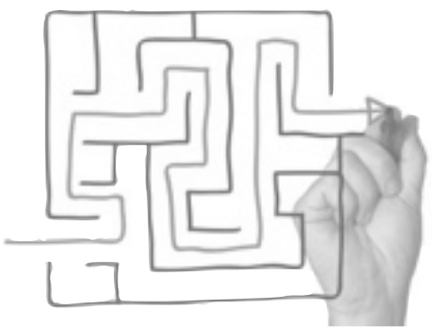
Information is not depletable

Laws of Information

Moving towards more collaborative, open and ecosystem-based service models in the IoT

IoT

Enhanced Context-Aware tools/services



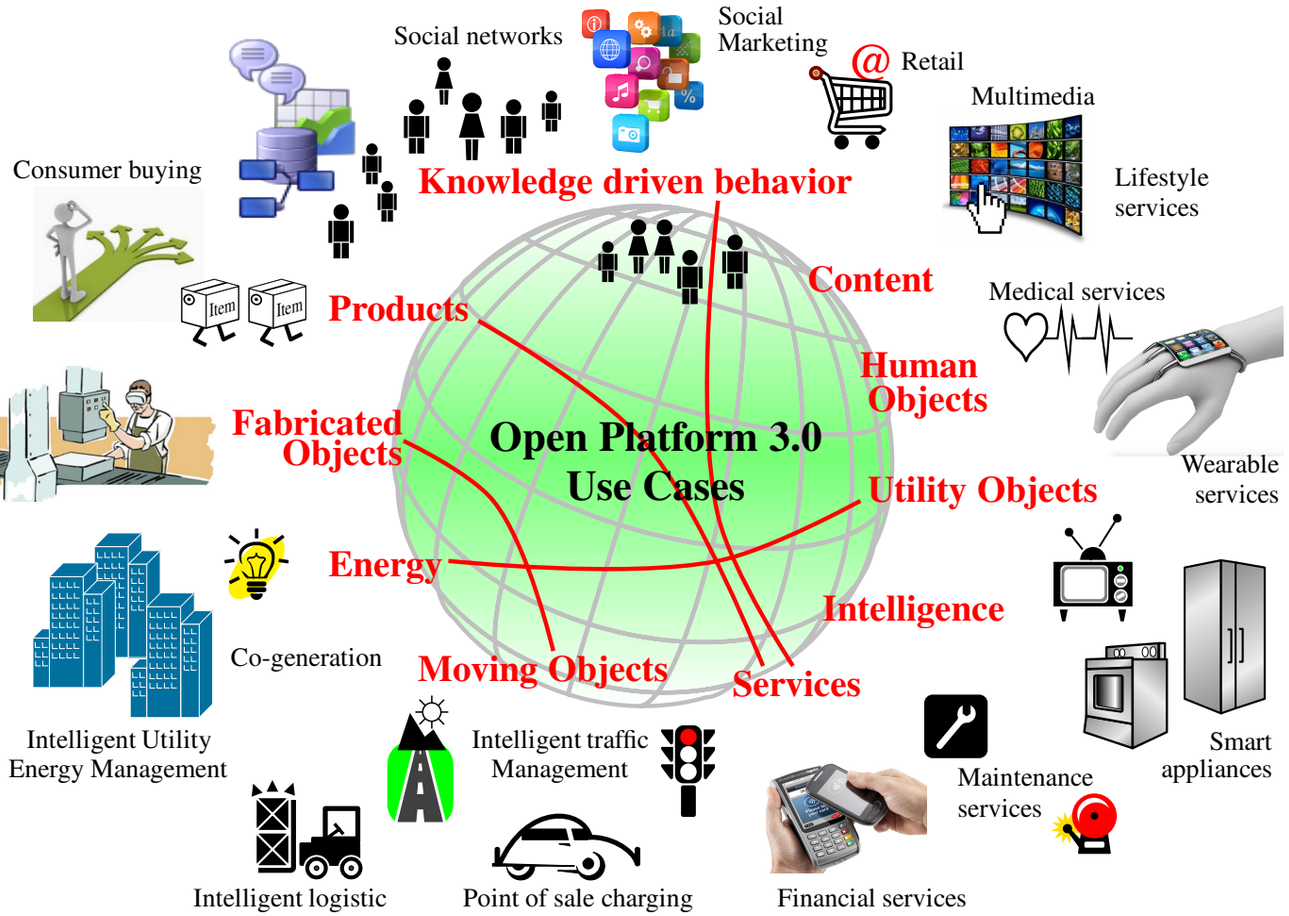
New Challenges

SUMMARY

- Introduction
- The Seven Laws of Information from the IoT perspective
- Open Platform 3.0™ — The Open Group initiative
- Conclusion

The Open Platform 3.0™

22 Use Cases defined in the White Paper (Nexus in Force)



THE Open GROUP

The Nexus of Forces in Action

Business Use-Cases of Open Platform 3.0™

A White Paper by:

Members of the Open Platform 3.0™ Forum, a Forum of The Open Group
Led by Mark Skilton, Synthetic Spheres Ltd.

March 2014

TABLE II
OVERVIEW OF WHAT LAW(S) OF INFORMATION CAN PRODUCE RELEVANT ADDED-VALUES CONSIDERING 18 BUSINESS USE CASES DEFINED BY THE OPEN PLATFORM 3.0 FORUM

	Use Case Title	Law 1	Law 2	Law 3	Law 4	Law 5	Law 6	Law 7	Use case description
1	Retail Smart Store	✔	✔			✔		✔	A customer wants to browse through items in a store and potentially to purchase one or more items. He pauses from time to time to examine items. He receives value in the form of good advice leading to an optimal (price/quality) choice of product – or even to a decision not to buy. The system is aware (via sensors) of the items being examined and provides information to the customer about offers and other similar or related items (cross/up-selling) or about use/manufacture/ingredients of the item. The customer can consult reviews of the item by professionals or other customers (e.g., via social clusters) and analysis of recent purchase history for the item versus similar items.
2	Sustainable Shopping and Restaurant Street	✔	✔	✔	✔	✔	✔	✔	Enable efficient energy usage by stores, restaurants, transport, and municipal services. Local government, transport providers, energy providers, chamber of commerce develop shared solutions to optimize energy usage, improve quality and efficiency of public, private, and shared services.
3	Supply Chain Store Brand Integration	✔	✔	✔	✔	✔		✔	The ability to plan merchandise across multiple supply chain online markets, with paired store ordering, enhanced VMI, and enhanced shared transport planning and fleet usage.
4	Multi-Channel Customer Service	✔	✔			✔		✔	The ability to coordinate customer service response across different contract channels and devices, which includes customer service contact management, cross-device management for single customer account view, and customer preferences and behavior analytics.
5	Social Gamification Orchestration	✔	✔			✔		✔	The ability to affect and reinforce customer and employee behavior across multiple platforms and devices by directing feedback and incentives.
6	Augmented Lifestyle Sensor Feedback		✔		✔		✔		Platform data aggregation and sensor visualization feedback
7	Augmented Patient Care Sensor Feedback		✔	✔	✔	✔			Personal Ambient Management (PAM) is a technique in which sensors are used to monitor and manage the behavior and movement of a patient. The sensors collect data on movement, sleep patterns, body function, and noise levels of communication. These can be analyzed to determine repetitive and anomalous behavior that can indicate self-harm or other conditions of the patient. Location and movement monitoring can create "geofencing" features that can detect that the patient has left a designated safe area, or the level of contact and interaction. Measures can be put in place from analysis of the data to improve patient care and quality of life as well as potential value for money and cost efficiencies in use of improved precision care interventions, and use of lower-cost automatic monitoring systems not requiring human support for all processes.
8	Open Government Data Interchange	✔	✔			✔		✔	Government data made available free to anyone to use. Data produced or commissioned by government or government controlled entities. Data that is open as defined in the Open Definition that is, it can be freely used, re-used, and redistributed by anyone. Ability to transfer and acquire products and services across multiple country borders. Provide secure, regulation-compliant information to citizens and businesses via open APIs.
9	Incident Management		✔			✔	✔		Using information from social channels and mobility to tackle incidents such as terrorist attacks, natural disasters, evacuation, and response. Possible steps for incident management include, among other things, natural disasters, terrorist attacks, *etc.*
10	Information Control		✔		✔	✔			Governments want to prevent unwanted rumor or fake-threat spread that can cause security issues. Some are switching off cell towers or putting a cap on SMS messaging to control this. They would want to have similar control on the social channels. Filtering and dealing with junk, abuse, and trolls on social channels.
11	E-Medical Data Access and Exchange		✔	✔					A person on vacation needs emergency medical care while in a foreign country. The medical care provider needs access to the medical history of the person needing medical care. One possible scenario: a person on vacation suffers a stroke while in a foreign country. The stroke prevents the person from speaking. The medical provider in the foreign country needs access to the person's medical history to determine the proper treatment. Some medical history is maintained by the person's primary care physician in the person's home country. Some medical history is located in a variety of other systems. Once medical treatment is completed, the medical history data needs to be updated by the medical provider. The medical provider will need to submit a claim to the patient's medical insurer.
12	Translational Research – Bench to Bedside	✔	✔		✔	✔		✔	Provide ability to quickly apply translational research at the bench-side to the patients on the bed as personalized care. One potential scenario: clinical researchers conduct disease (cancer) research, which is referred to as bench-side, while treating the patients on the bedside. Their study of molecular diagnostics involves studying the genomic and proteomic expression patterns to distinguish between the normal, pre-disease, and post-disease tissue or blood samples at the molecular level.
13	Electric Vehicles Ecosystem	✔	✔	✔	✔	✔	✔	✔	The Electric Vehicles (EV) use-case aims to extend conventional cars through the implementation of the EV ecosystem enabling interactions between different actors ranging from designers and manufacturers to drivers and services providers. An open web-based system provides real-time control of the smart car data stream, enabling personal, relevant, and timely services from different perspectives.
14	Smart Buildings and Home Appliances	✔	✔	✔	✔	✔	✔	✔	This use-case addresses the optimization of human machine interfaces of private households such as the TV control menus, in terms of customization, personalization, and product and service feedback. The key stakeholders are companies in the white goods and brown goods markets, software companies, and accessory (e.g., programmable remote controls) companies.
15	Smart Retail Distribution	✔	✔		✔	✔	✔	✔	Optimization of logistics of customer goods in urban areas, in particular in city centers. Both Security and Efficiency is targeted as scenarios. The efficiency one is: During transport, an RFID tag attached at the van is read on entry to a limited traffic zone, using short-range communication between the van and sensors located on fixed points at the city center. Forecasts based on big data analysis of roads and traffic provide a cloud-based service to the mobile of the driver for more efficient routing.
16	Safe Mobility	✔	✔			✔		✔	This concept applies to children traveling from home to school, but it is also extendable to elderly people or patients, and women traveling alone at night. For example, when a child leaves home, he or she wears an article of clothing with an embedded RFID tag. The event is read and recorded by the intelligent home infrastructure, and may be forwarded to the parents as a text message, email, or similar, if required, or only if the event deviates from the scheduled or "learned" expected behavior.
17	Investments and Asset Management		✔		✔				Key scenarios include qualitative and quantitative analysis, portfolio rebalancing, and managing risk. Many of the publicly traded companies and their leadership teams provide feeds (twitter feeds, blog posts, etc.), which many times provide indications about their performance and plans. Such inputs help investments personnel in making investments decisions.
18	Open Innovation, Crowd-Sourcing/-Funding		✔				✔		Use of external innovation sourcing for product and market development and the integration with crowd- sourcing and crowd-funding to facilitate bringing ideas to market.

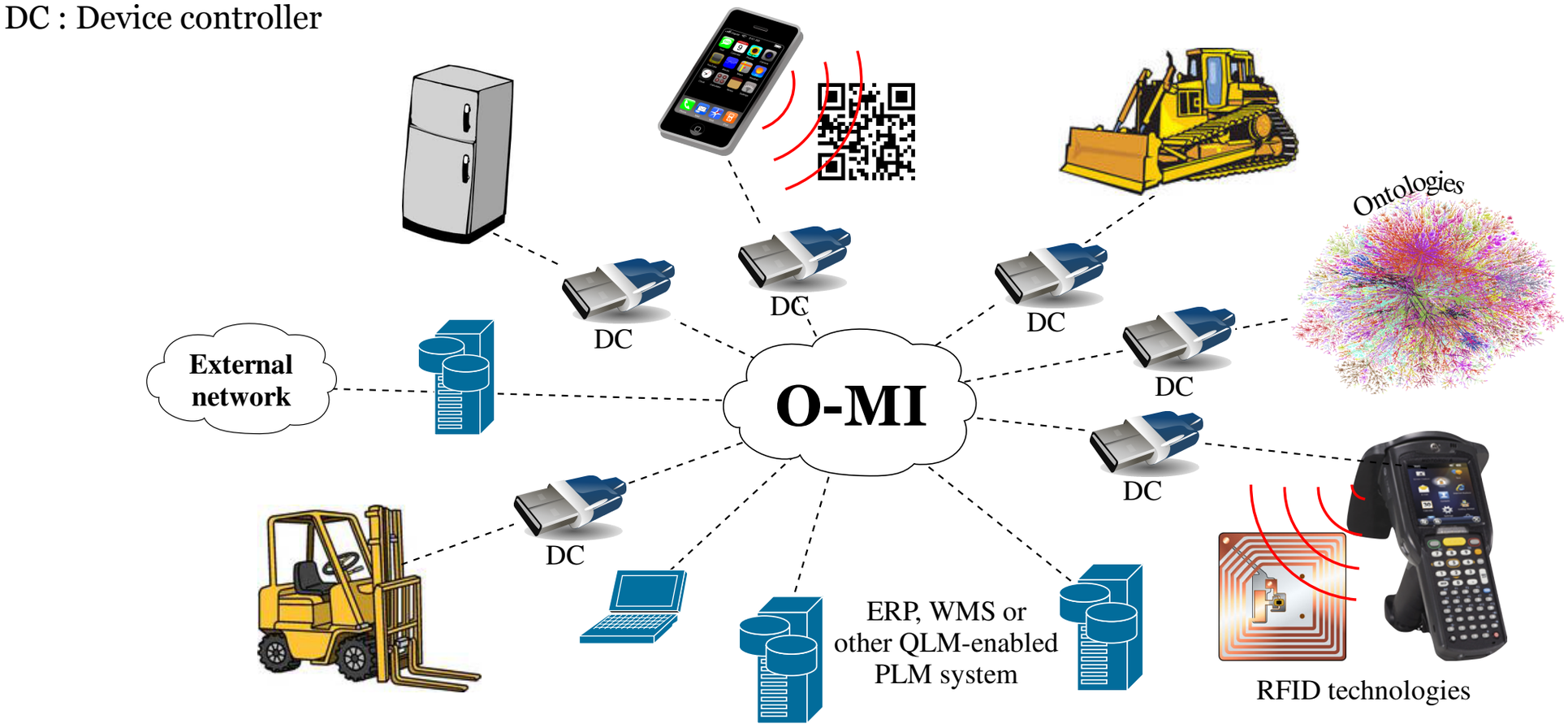
The Open Platform 3.0™

O-MI & O-DF standards as foundation of Systems-of-Systems

O-MI/O-DF philosophy

It is based on the peer-to-peer philosophy where any "thing" can communicate with any other "thing". Two standards:

- Open Messaging Interface (O-MI)
- Open Data Format (O-DF)



The Open

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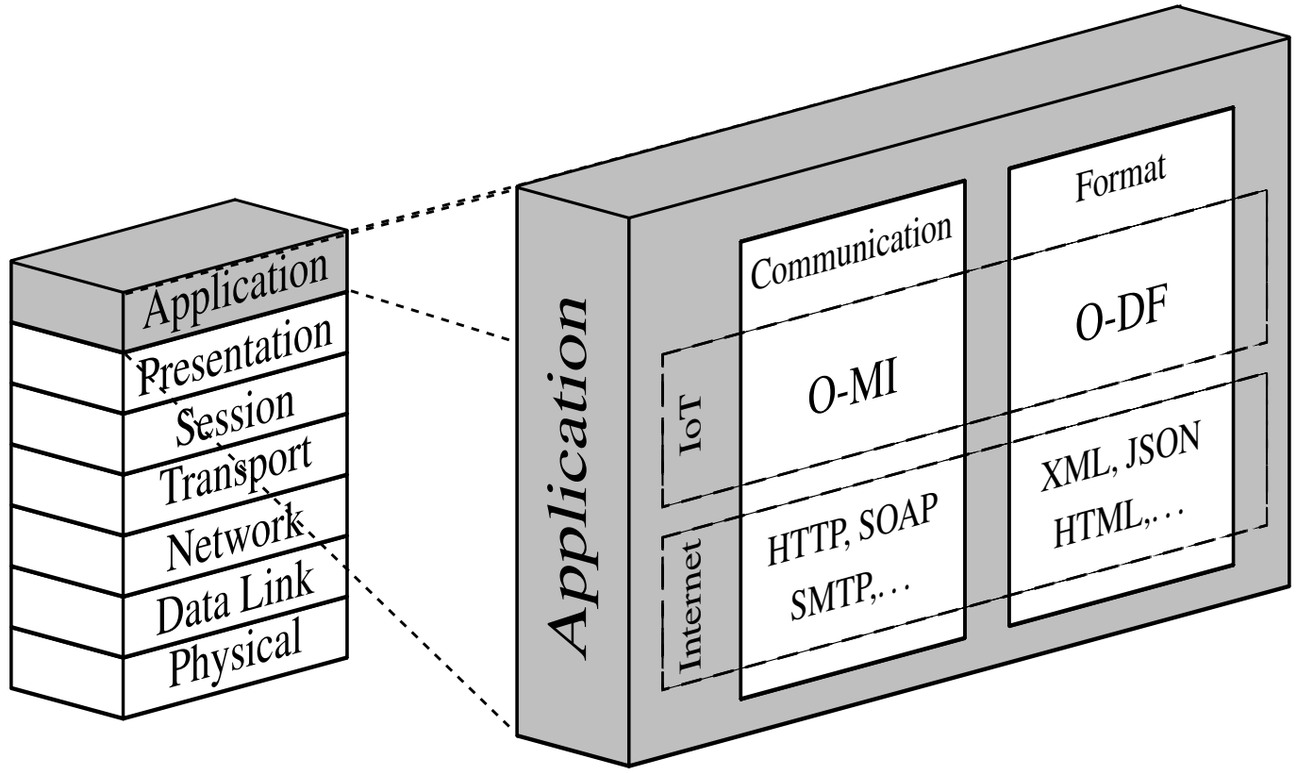
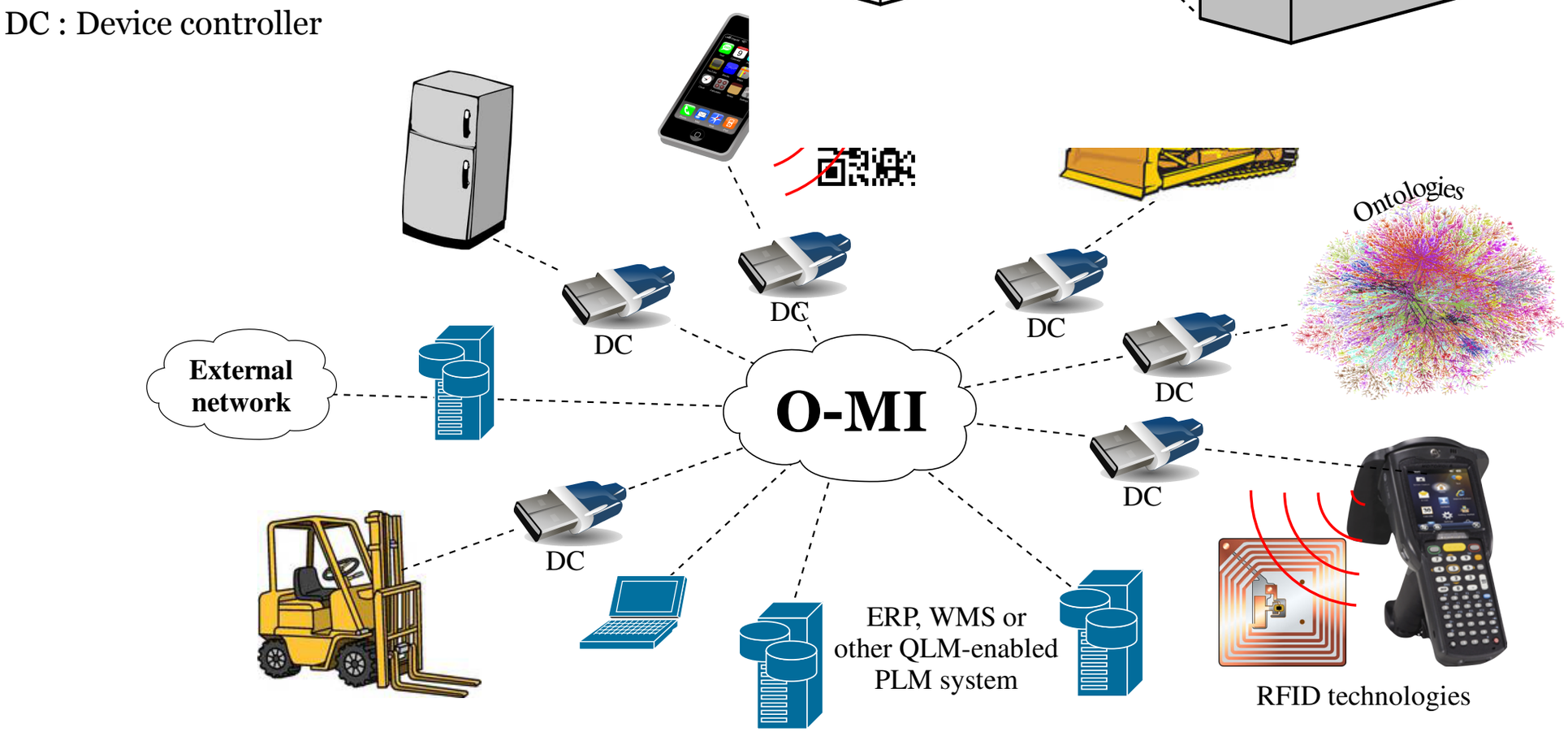


DC : Device controller



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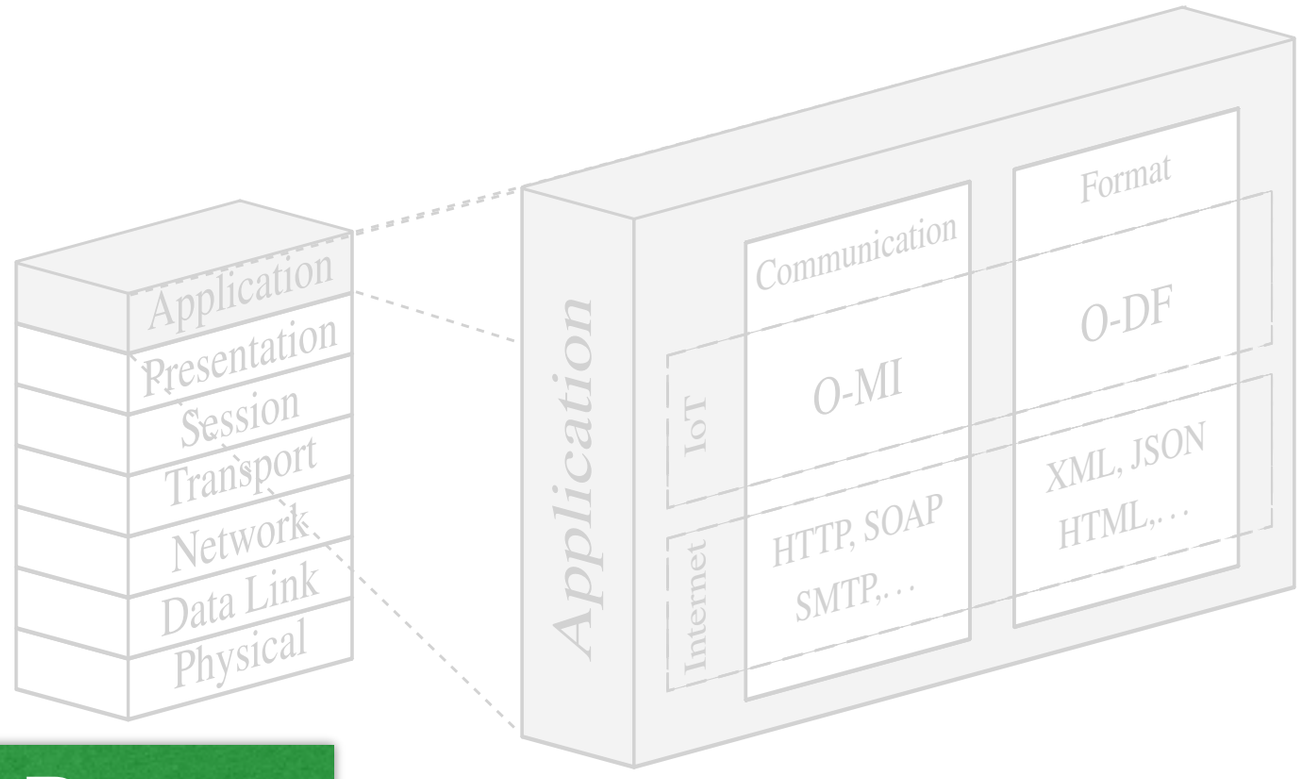

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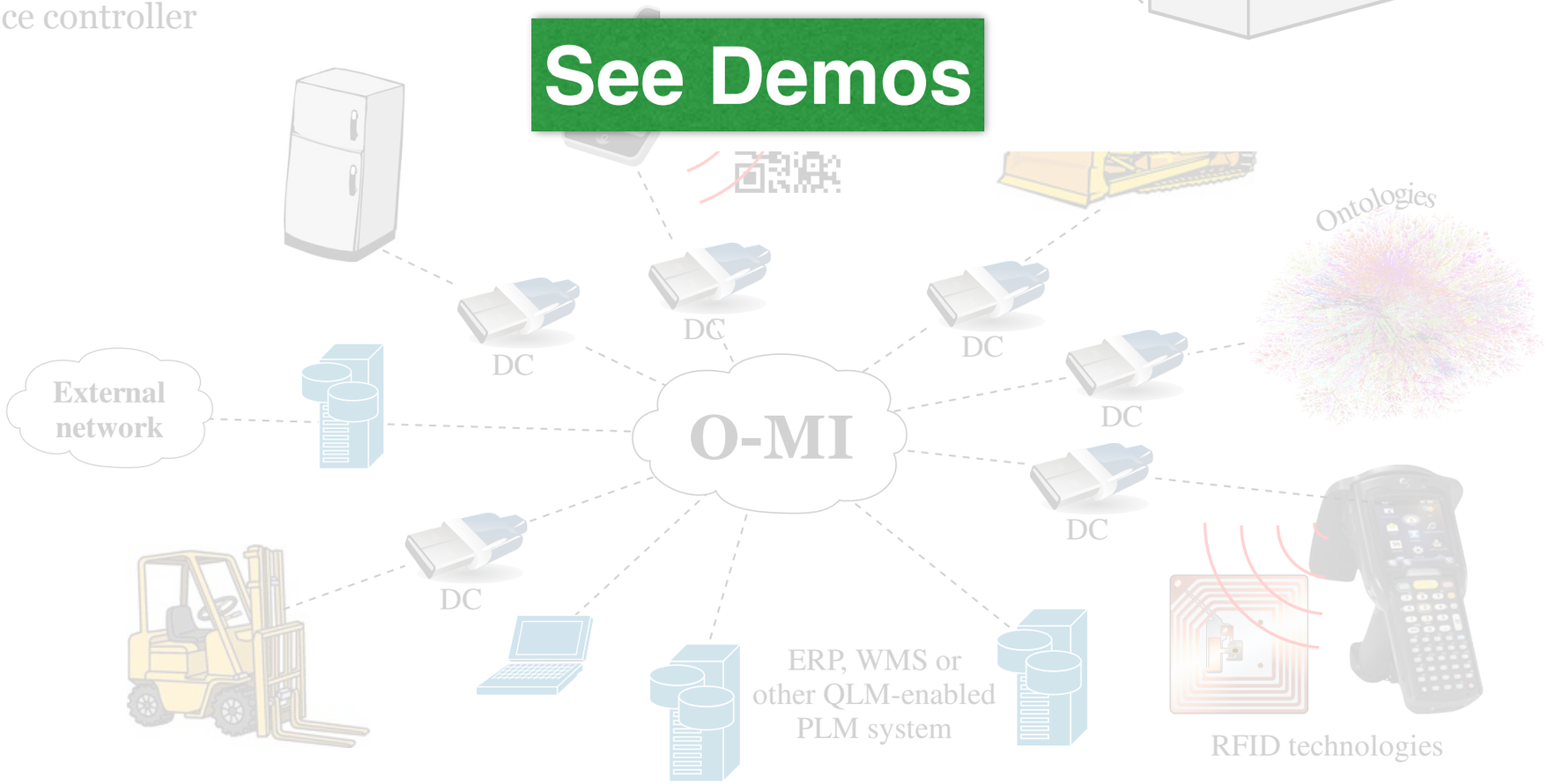
See Demos



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Conclusion

- **Challenge of Vertical Silos shaping today's IoT**

- **Need for more advanced:**
  - **Micro-billing mechanisms for the IoT (e.g., block chain-based smart contracts);**
  - **IoT ecosystems for Systems-of-Systems (based upon Open IoT standards);**
  - **Data discovery mechanisms (e.g., geo-location, semantic-based discovery);**
  - **P2P trust networks;**
  - **Data Quality framework coping with IoT peculiarities;**
  - **Context-aware services and Context-brokers* (e.g., context-filtering, reasoning & validation)**

- **The Open Platform 3.0™:**
  - **22 Business Use Cases (using Open IoT standards)**
  - **An Industry Wide Network;**

- **Upcoming H2020 EU project —** *ICT30: Internet of Things and Platforms for Connected Smart Objects*

* Roy Schulte (2015) Gartner Business Intelligence, Analytics & Information Management Summit, Sydney, Australia

Conclusion

H2020-ICT-2015: Information and Communications Technologies
Internet of Things and Platforms for Connected Smart Objects
ICT-30-2015

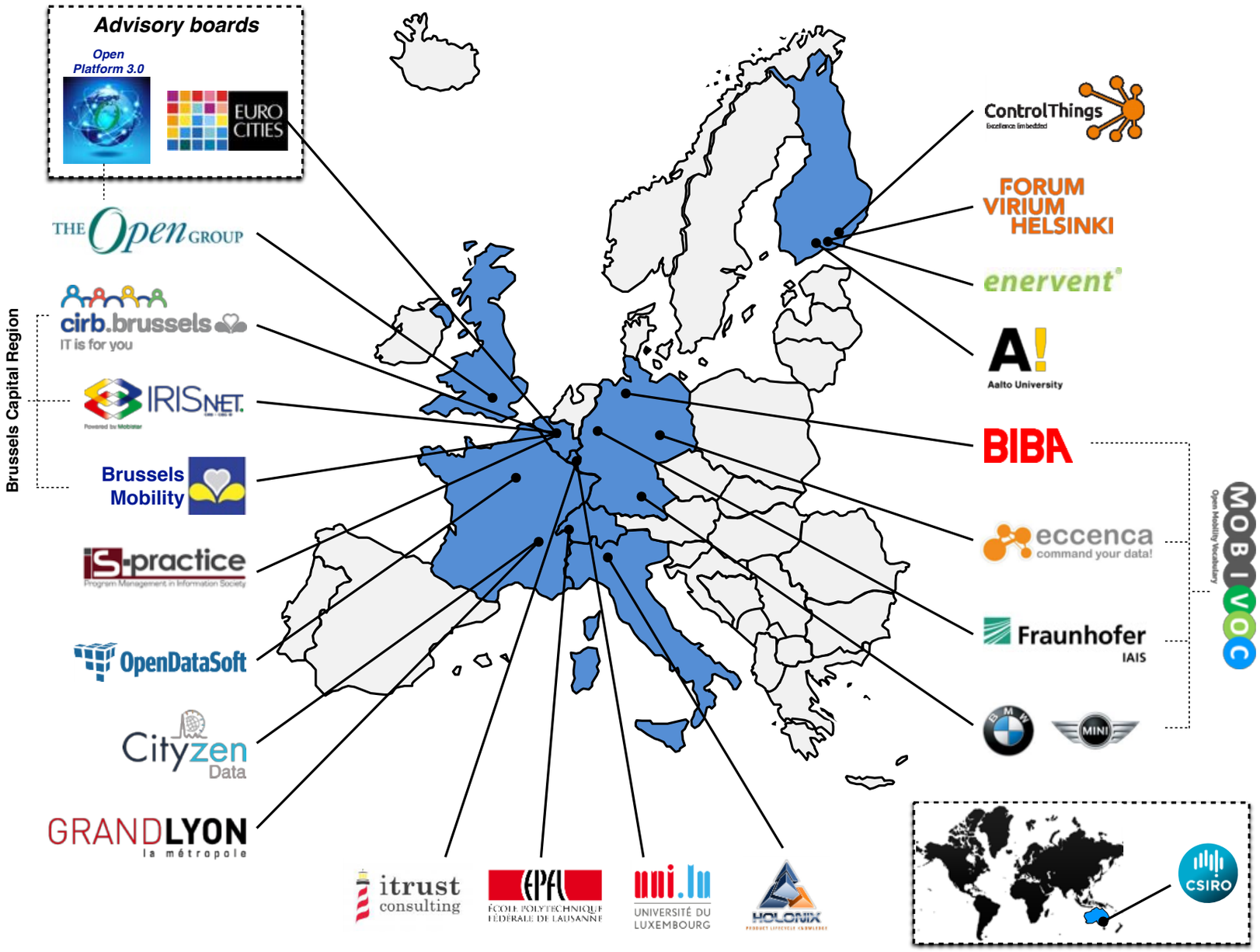
Winners

INTER-IoT	Interoperability of Heterogeneous IoT Platforms
symbIoTe	Symbiosis of smart objects across IoT environments
TagItSmart	Smart Tags driven service platform for enabling ecosystems of connected objects
bIoTope	**Building an IoT OPen innovation Ecosystem for connected smart objects**
VICINITY	Open virtual neighbourhood network to connect intelligent buildings and smart objects
AGILE	Adoptive Gateways for dIverse muLtiple Environments
BIG IoT	Bridging the Interoperability Gap of the Internet of Things
Be-IoT	The business engine for IoT pilots: Turning the Internet of things in Europe into an economically successful and socially accepted vibrant ecosystem
UNIFY-IoT	Supporting Internet of Things Activities on Innovation Ecosystems

Conclusion

bIoTope

Building an IoT OPen innovation Ecosystem for connected smart objects



securityandtrust.lu

Opportunity to leverage Information-as-an-Asset in the IoT — the road ahead

Sylvain Kubler, Luxembourg University, SnT - Interdisciplinary Centre for Security, Reliability & Trust
Min-Jung Yoo, Ecole Polytechnique Fédérale de Lausanne, Switzerland
Cyril Cassagnes, Luxembourg University, SnT - Interdisciplinary Centre for Security, Reliability & Trust
Kary Främling, Aalto School of Science and Technology, Finland
Dimitris Kiritsis, Ecole Polytechnique Fédérale de Lausanne, Switzerland
Mark Skilton, Warwick Business School Coventry, UK

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