Data and Al driven Infrastructure

Gyu Myoung Lee

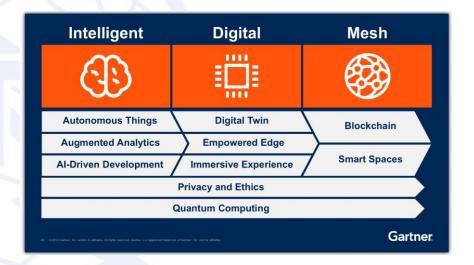
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Top 10 Strategic Technology Trends for 2019

- IoT with Artificial Intelligence
- Edge Computing
- Blockchain technologies
 - New decentralized operating and distributed business models
 - Blockchain inspired approaches



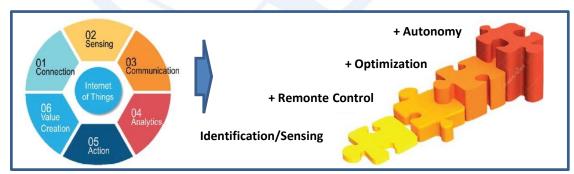


IoT and Data:

Artificial Intelligence of Things (AIoT)

Extension of IoT Applications Leverage the massive amount of data CONSUMER INDUSTRIAL Internet of Things Internet of Things **Artificial Intelligence of Things** Energy A Wearable **Data Explosion** Transportation Data-based learning Disaster Smart Device Smart City Projected Growth of Smart Phone Data (Zettabytes) 60 Internet Data: Capture, storage, analysis of data Personal 50 **Things** Unstructured Smart Home Industries 40 Structured IOT: Data Collection through IoT Appliance Farm 30 Home 5 Factory Home Monitorina Healthcare 2010 2012 2014 2016 2018 2020

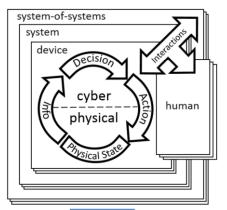
From
Connecting
Devices to
Creating
Value



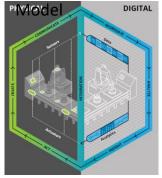


From CPS to Digital Twin

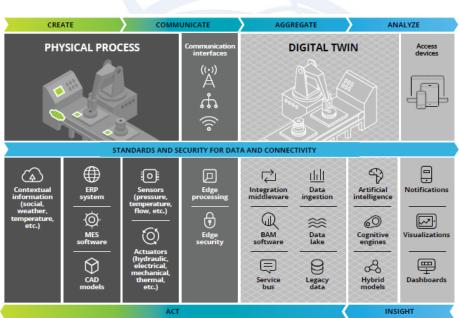
Internet of Things Cyber Physical Systems



Digital Twin



Source: Deloitte University Press



AI is an enabler for Digital Twin



Future of Things

Robotized Things

- Smart Appliances
- Al Assistant & Social Robots

Digital Twined Things

- Mission-Critical Things
- Convergence of IT & OT

Tiny Things

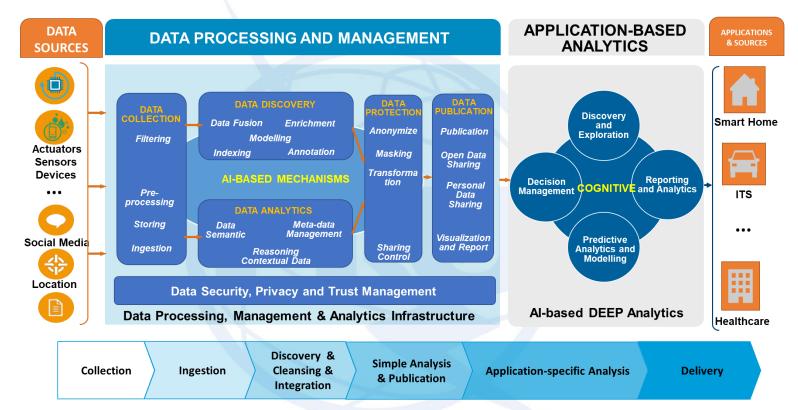
Microscopic RFID Chips

OT: Operational Technology



Data-driven AloT







Data Security, Privay, Trust and Governance for trustworthiness in AloT

Trustworthiness encompasses the concerns of **security**, **privacy**, **safety**, **reliability and resilience**, which are too often addressed separately and in isolation in risk management approaches. (NIST CPS Framework)

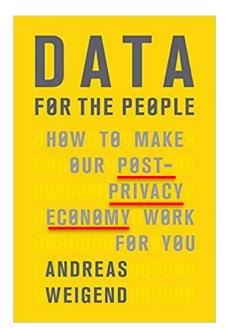


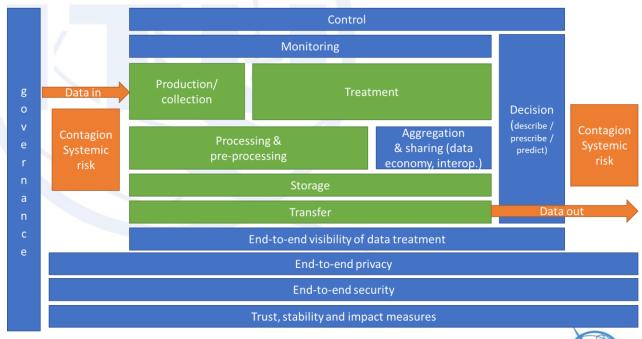
Trustworthiness in AloT

Trust is an essential element in Big Data and Analytics for Intelligence.

"Trust is the oxygen which will breathe life into the IoT. Industry needs to show data is safe and that it is properly treated." (source: www.techuk.org.)







Source: ITU-T FG-DPM Ad-hoc group (by Nathalie Feingold)



rovenance

Credibility

Trust



BLOCKCHAIN Internet of Value

A machine for creating trust



- The currency in the Internet is data.
- Revolutionizes how transactions are recorded
 - a decentralized digital ledger that records transactions
 - builds trust with accountability and transparency

The **IoV** is as a platform of the next generation Internet that enables various types of assets to be digitalized and represented as digital value using **Blockchain**.



Decentralization



Decentralized AI Platforms







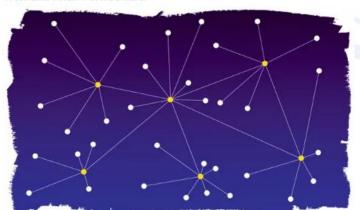


Closed and centralized IoT networks Open access IoT networks, centralized cloud

Open access IoT networks, distributed cloud

Decentralisation: the next big step for the world wide web

The decentralised web, or DWeb, could be a chance to take control of our data back from the big tech firms. So how does it work and when will it be here?





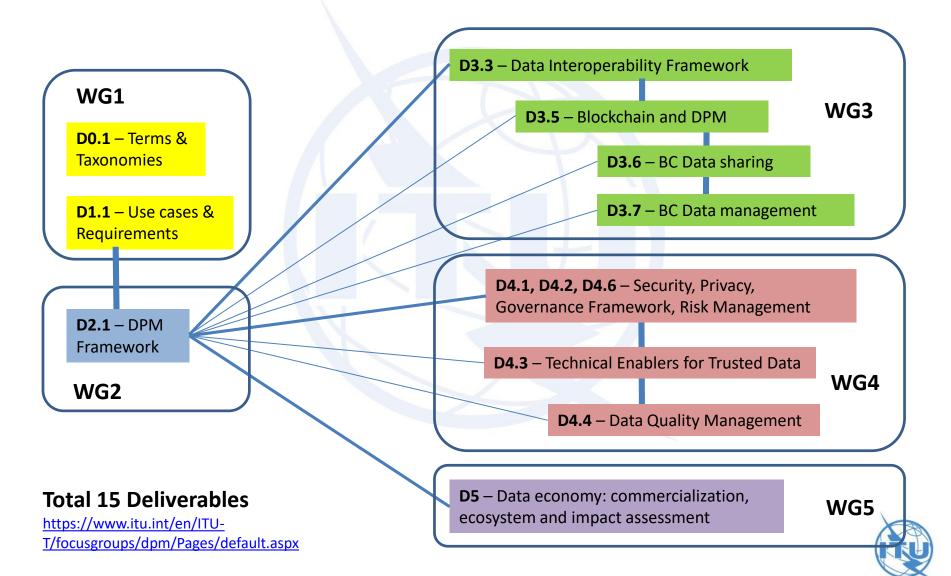


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the

guardian

FG-DPM Core Deliverables



Lessons from ITU-T FG-DPM

- Data → DPM (the new oil)
- Sharing data Blockchain
- Data interoperability
- Data Security, Privacy, Trust and Governance for trustworthiness

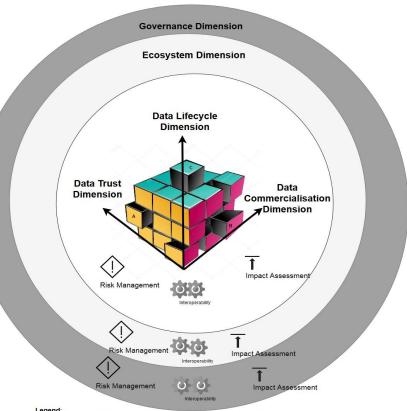








REUSABL



Legend:

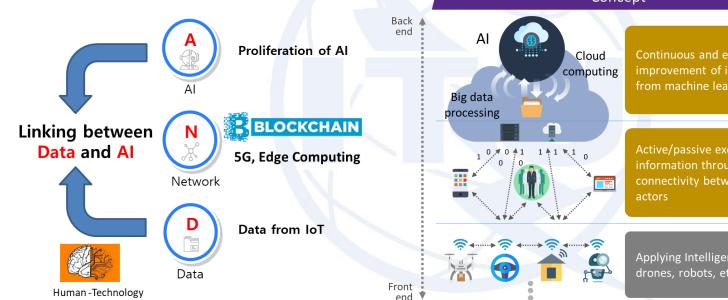
Point A: Trusted, and Processed data over the Trust and Data lifecycle dimensions, but not commercialised Point B: Processed and commercialised data over the Data lifecycle and commercialisation dimensions, but not trusted Point C: Trusted, Processed and commercialised data over the Trust, the Data lifecycle and commercialisation dimensions



Data - Network - AI (DNA)

Driving Force for Changes

"The combination of AI, data, and networks is beginning to emulate human intelligence."



Concept Characteristics Continuous and exponential Self evolution improvement of intelligence from machine learning Supporting human decision-making Active/passive exchanges of information through connectivity between all Data in Everything Applying Intelligence in Real-time response drones, robots, etc.



Potential Items for Future Work

- DNA core technologies
 - A new networking paradigm Data-driven networking
 - DNA platform Technology convergence (IoT+Big Data+Cloud+AI)
 - Data-Information-Knowledge-Wisdom (DIKW) process
- Use of AI in ICT infrastructures and services (trustworthy autonomous ICT)
 - Automative control and management in networking and services
 - Operational efficiency in Things + Processing + Coomunications + Stroage
- Data-driven applications with AI (linking between data and AI)
- Security, privacy and trust including regulatory issues
 - Trust in DNA, particularly human-technology interface including social aspects



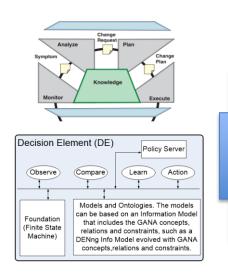
Key Topic – Computing and Networking Integration

- Data on the Edge and In-Network Computation
 - to improve network and application performance,
 agility, security, and privacy by better integration

 IRTF Research Group - Computing in the Network (COIN)



Key Topic – Intelligence Defined Networking



ESTI - GANA - Generic Autonomic Networking Architecture Manually
Defined Network

Basic approach

- > Step 1: network planning
- Step 2: CLI configuration
- Step 3: network optimization, diagnostic, debug

Characteristics

- Fully human depended. Human drives operations
- > Linear complexity
- Network utilization totally decided by human plan, which is rigid afterwards

Software Defined Network

Basic approach

- > Abstract the Control layer
- South bound & North bound cooperate
- > Stateless -> Stateful + Stateless

Characteristics

- Semi-automatic. Human drives control.
- Allow large scale and high frequency operations
- Network utilization increased

■ Basic approach

 Machine learning: network traffic patterns, network modelling and application patterns

Intelligence

Defined Network

- Machine controls and support the decision
- > Automatic control

Characteristics

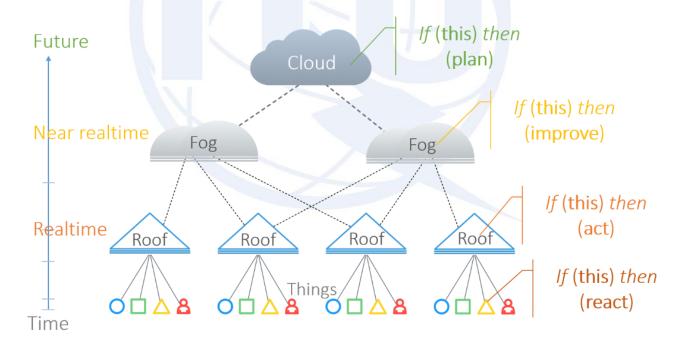
- Al-enhanced Semi-automatic. Alassisted human control
- Full-automatic. Brain drives Control
- > Minimum cost
- > Support new operation pattern

ETSI GR NGP 006 (06/18), ITU-T Y.3324 (12/18)



Key Topic – Distributed Intelligence

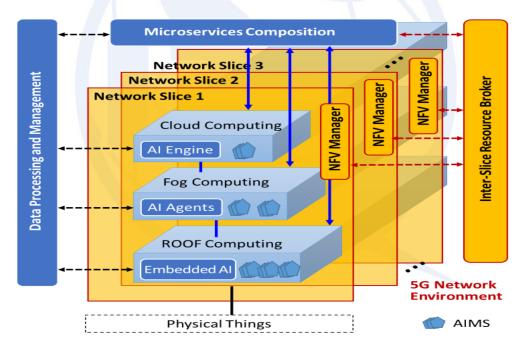
- Decision making hierarchy
 - Action (AI + Networking)
- Collaborative problem solving





An example - AIMS

 The ecosystem of microservices distributed across the ROOF-Fog-Cloud systems over 5G networks

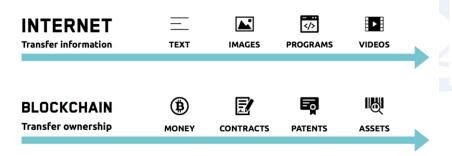


Soure: Gyu Myoung Lee, Tai-Won Um, Jun Kyun Choi, "Al as Microservice (AIMS) over 5G networks," ITU Kaleidoscope 2018, November 2018. (Santa Fe, Argentina)

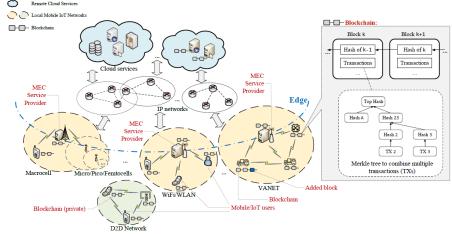


Key Topic - Internet of Blockchains

- Launch networks of individual and interoperable chains
- Enable programmers to innovate, allow for quick value transfers and seamless scalability



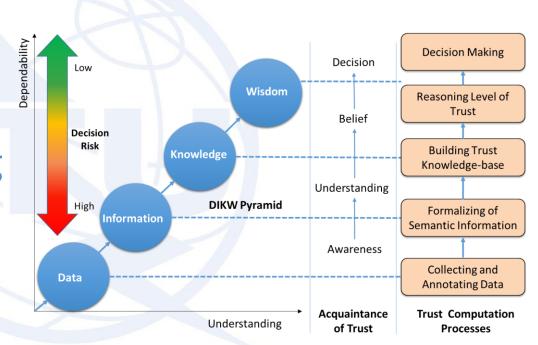
An example of MEC enabled Blockchain





Key Topic - Trustworthiness

- Transparency
- Data protection
- Privacy preserving
- Policy and regulatory issues
- Ethics





Goal: Data and Al driven Infrastructure

- Trusted Decentralized Data Driven Networking and Services
- Hyper-Connected Distributed Intelligence



Strategic direction to be taken by ITU-T

- Maximize to use FG results
 - FG-ML5G (Machine Learning for Future Networks including 5G)
 - FG NET-2030 (Technologies for Network 2030)
- Restructuring
 - SG13 a new group on Data and AI driven networking considering Network 2030
 - SG20 a new Question on DPM and its applications
 - Coordination with other SGs (SG2, SG11, SG16 and SG17, etc.)



Questions for discussion

- How to identify challenging work items?
 - Gap analysis
- How to provide a good place?
 - Restructuring
- How to stimulate related activities?
 - Strategical direction and contribution driven
- How to collaborate and cooperate?
 - Liaison

Standardization of Data-Driven ICT

 Common features, but unlimited number of solutions



- Fregmentization
- Assembling



