THE INTERNET OF THINGS:

EXTRACTING THE SIGNAL FROM THE NOISE

WHAT IOT IS ABOUT

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IOT FOR MANUFACTURING WORKSHOP

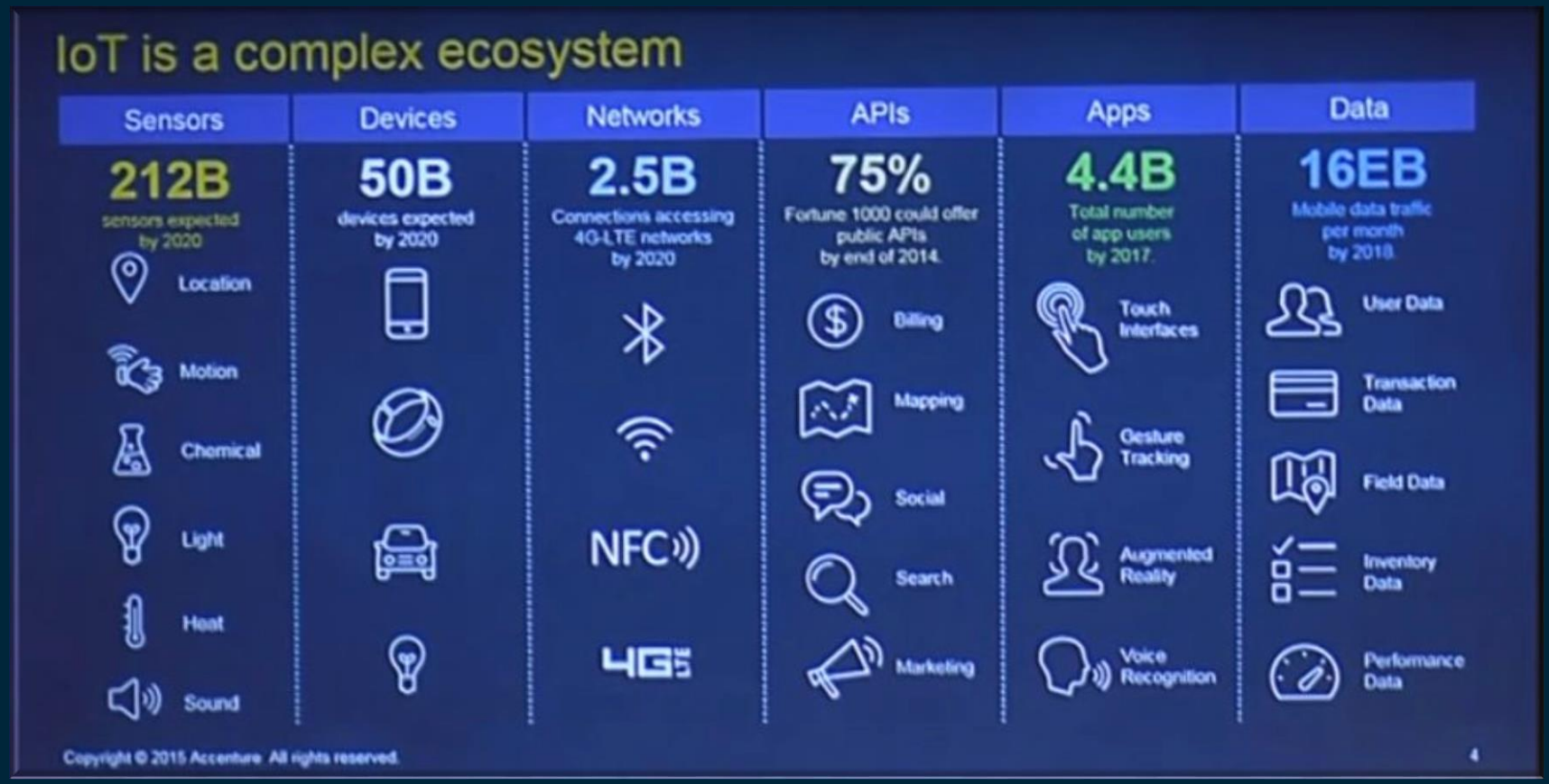
GEORGIA TECH MANUFACTURING INSTITUTE

NOVEMBER 11, 2015

ATLANTA, GA, U.S.A.

THE INTERNET OF THINGS: COMPLEX AND POTENTIALLY BIG

Frédéric Bazille, The Fortune Teller (1869)



M2M Summit (M2M Alliance) – September 9, 2015 - Opening Keynote: Ben Salama, Connected Operations Lead Accenture Mobility - *The Fourth Industrial Revolution – when Digital Technology meets the Shop Floor*
https://www.youtube.com/watch?v=PSp_SGxTH5g

THE FOREST AND THE TREES

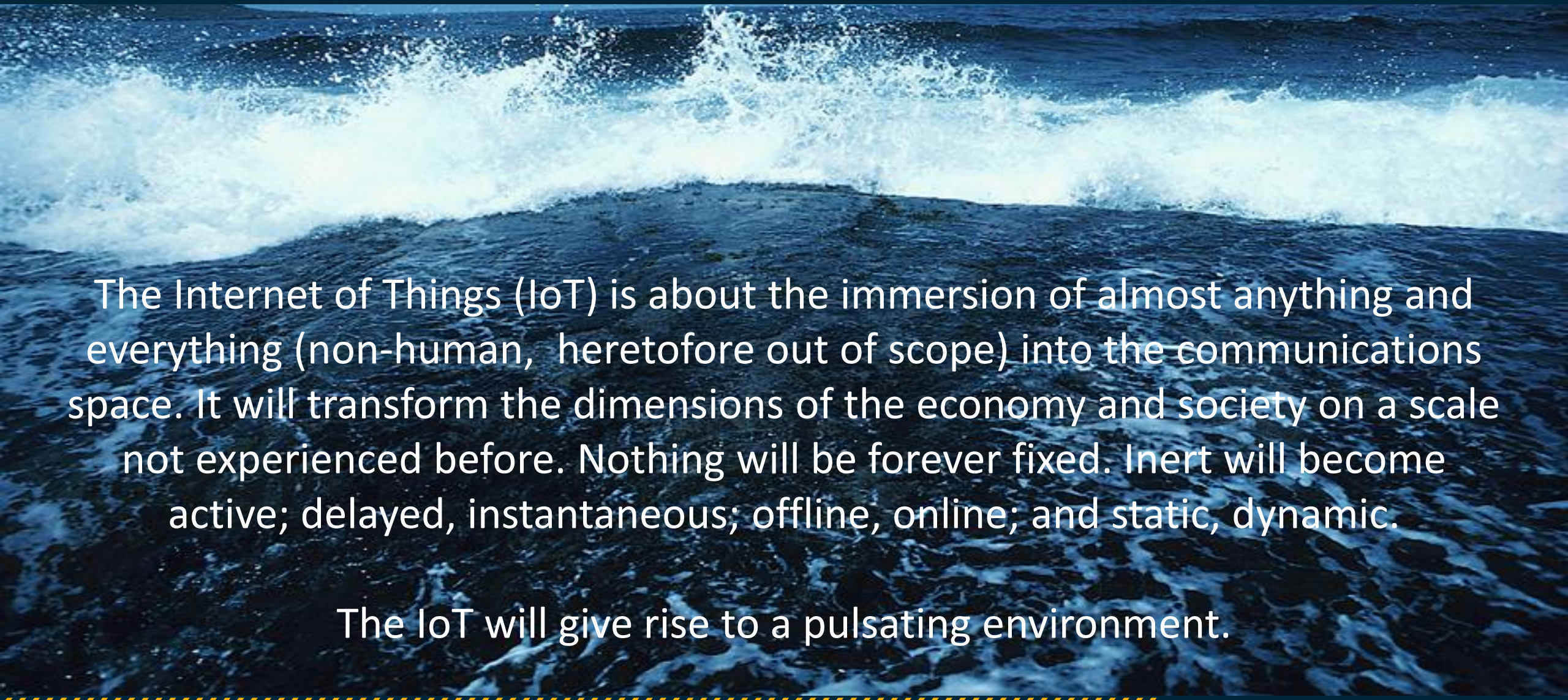
"The signal is the truth. The noise is what distracts us from the truth."

Nate Silver, *The Signal and the Noise: Why So Many Predictions Fail - But Some Don't (2012)*

Internet of Things

Web of Things - Siemens
Connected Devices
ThingSpace - Verizon
Smarter Planet - IBM
Ambient Computing - Deloitte
Internet of Me - Accenture
Internet of Everything – Cisco, Qualcomm, etc.
Real-Time Location Systems (RTLS)
SmartDust
System of Systems Engineering
iBeacon – Apple
Autonomic Computing
Digital Excellence – Stanley Black & Decker
AllJoyn - Qualcomm
SCADA
Digital Lifestyle Malaysia (DLM)
AT&T Drive Studio
Digital Enterprise – Tech Mahindra
Bluetooth
WiFi
Ubiquitous Network Societies
(e.g., u-Japan & u-Korea)
Thinking Things - Telefónica
Connected Machines Solutions – Verizon
Industrial Internet of Things (IIoT)
Social Web of Things (Networked Society) - Ericsson
Industry 4.0 (Germany)
Unmanned aerial vehicles (UAV)
Smart Cities
Industrial Control Systems
Infinite – EMC, Vodafone, CIX
Connected Enterprise – Rockwell Automation
Intelligence of Things – Flextronics
Outcome Economy - Accenture
System(s) of Things - SAP
Physical Internet (Pi or π)
(logistics meets the IoT)
openDOF - Panasonic
Wearable
Computing/Technology
Internet of Things and Services
Total Asset Visibility
Telehealth & Telemedicine
Distributed Computing
HealthKit, HomeKit, CarPlay – Apple
Project Mobii – Ford & Intel
Location-Based Services (LBS)
IBM Bluemix
AT&T Foundry
Intelligent
Transportation
Systems
Intelligent Supply Chain and Logistics
Connected Car
micro-electromechanical systems
(MEMS)
SmartThings - Samsung
Internet of nano-things
Programmable World – Nokia
Enterprise IoT – CA Technologies
Brillo, Weave, Project Jacquard, Project Soli, Project Tango - Google
The Economy of Things – IBM
Lab of Things - Microsoft
Data Sensing Lab
Smart Grid
Human Computer Interaction (HCI)
Future Internet
Telematics
Intelligent/Smart Building/Home
Home Automation
oneM2M
HyperCat
FIWARE
Smart 2.0 - ZTE
Algorithm Economy – Intel, etc.
Factory Automation
GPS of Things
Big Data
Intelligent Robotics
Sensor Fusion
Central Nervous System of the Earth – HP
Dash Button - Amazon
Industrial IP Advantage
Smart/Advanced
Manufacturing
3D Printing
(as IoT enabler)
Animal Tracking
Wireless Sensor Networks
Industrial Internet – GE, Industrial Internet Consortium, etc.
Machine Learning
Open Web of Things – Google
Digital Transformation
Internet of Better Things - Ikea
Intel IoT Solutions Alliance
Digital Life – AT&T
ARTIK Platform - Samsung
Cyber-Physical Systems (CPS)
Precision Agriculture/Farming
Simultaneous Localization and Mapping (SLAM)
The Era of Living Services – Accenture
Internet of Your Things – Microsoft
Connected Things
Connected Objects
IoT Cloud Ecosystem – Texas Instruments
Precision Medicine
Consumer IoT
Telemetry
Embedded Systems
Computer Graphics and Interactive Techniques
Physical Web – Google
Machine-to-Machine
communications or M2M
Connected SmartHome - Qualcomm
Predix Platform – GE
LoRa Alliance
Thread
Zigbee
Z-Wave
Radio Frequency Identification or RFID
Pervasive Sensing – Emerson, Schneider, etc.
Smart Agriculture
Augmented Reality (as IoT enabler)
IBM Internet of Things Foundation
IoT Cloud Ecosystem – Texas Instruments
Sensor Web
Automatic Identification and Data Capture
Pervasive Computing
Connect More – TI
Network of Everything (Open Internet Consortium, etc.)
Ubiquitous Computing
Internet of Tomorrow - Freescale
Internet of Things Platform - Oracle

THE INTERNET OF THINGS WHEN EVERYTHING IS SAID AND DONE



The Internet of Things (IoT) is about the immersion of almost anything and everything (non-human, heretofore out of scope) into the communications space. It will transform the dimensions of the economy and society on a scale not experienced before. Nothing will be forever fixed. Inert will become active; delayed, instantaneous; offline, online; and static, dynamic.

The IoT will give rise to a pulsating environment.

THE INTERNET OF THINGS

Much more than technology…

"…The economy is going to churn and change in ways that none of us can even anticipate … How rapidly technology is transforming everything we understand, everything we know, everything from drones to artificial intelligence to driverless cars. We don't yet know how all that is going to shape the nation that you inherit but we know it's going to shape it dramatically…"

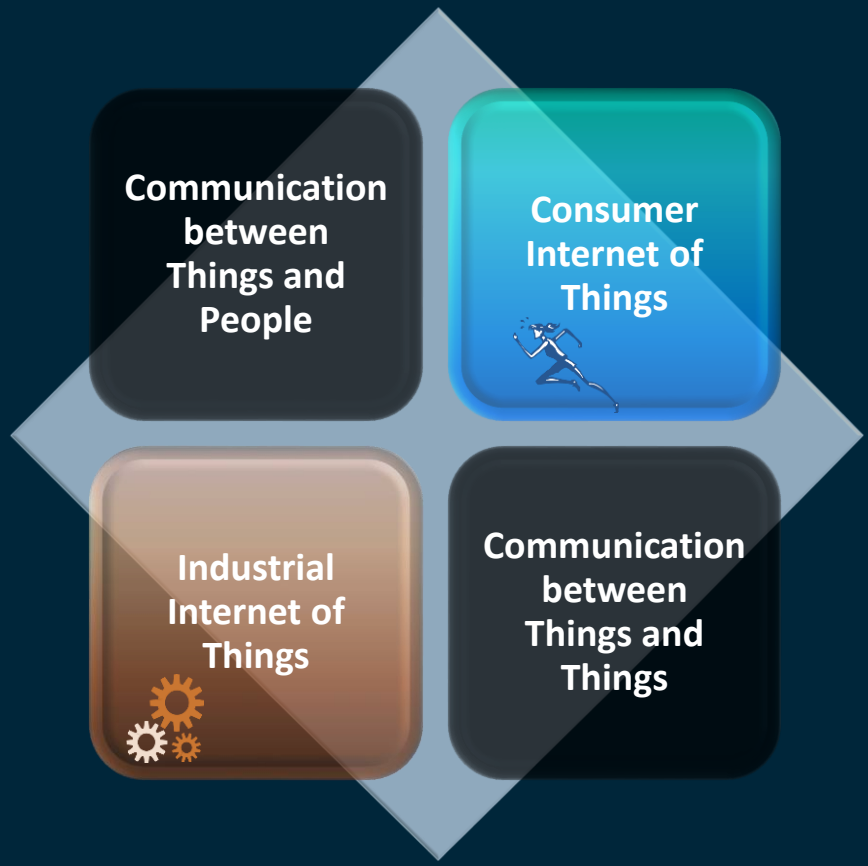
President Barack Obama, Remarks delivered at Georgia Tech, March 10, 2015 (https://www.youtube.com/watch?v=ZFYnxzGX_uM)

- **Reality vs. perception** (« Big Brother», lack of privacy, etc.)
- **Ethics** («we can but should we?»)
- **Education** (future workforce) **& training** (current workforce)
- **Enterprise Management** (business models; marketing; etc.)
- **Advocacy** (what is IoT, its potential, its benefits; how to overcome inertia; etc. ?)
- **Social acceptability** (e.g., job creation vs. job destruction)
- **Economic engine** (4th industrial revolution?)
- **Policy, laws and regulations**
- **Expectations** («Amara's law»)
- **International cooperation, etc.**

"Internet of Things"?

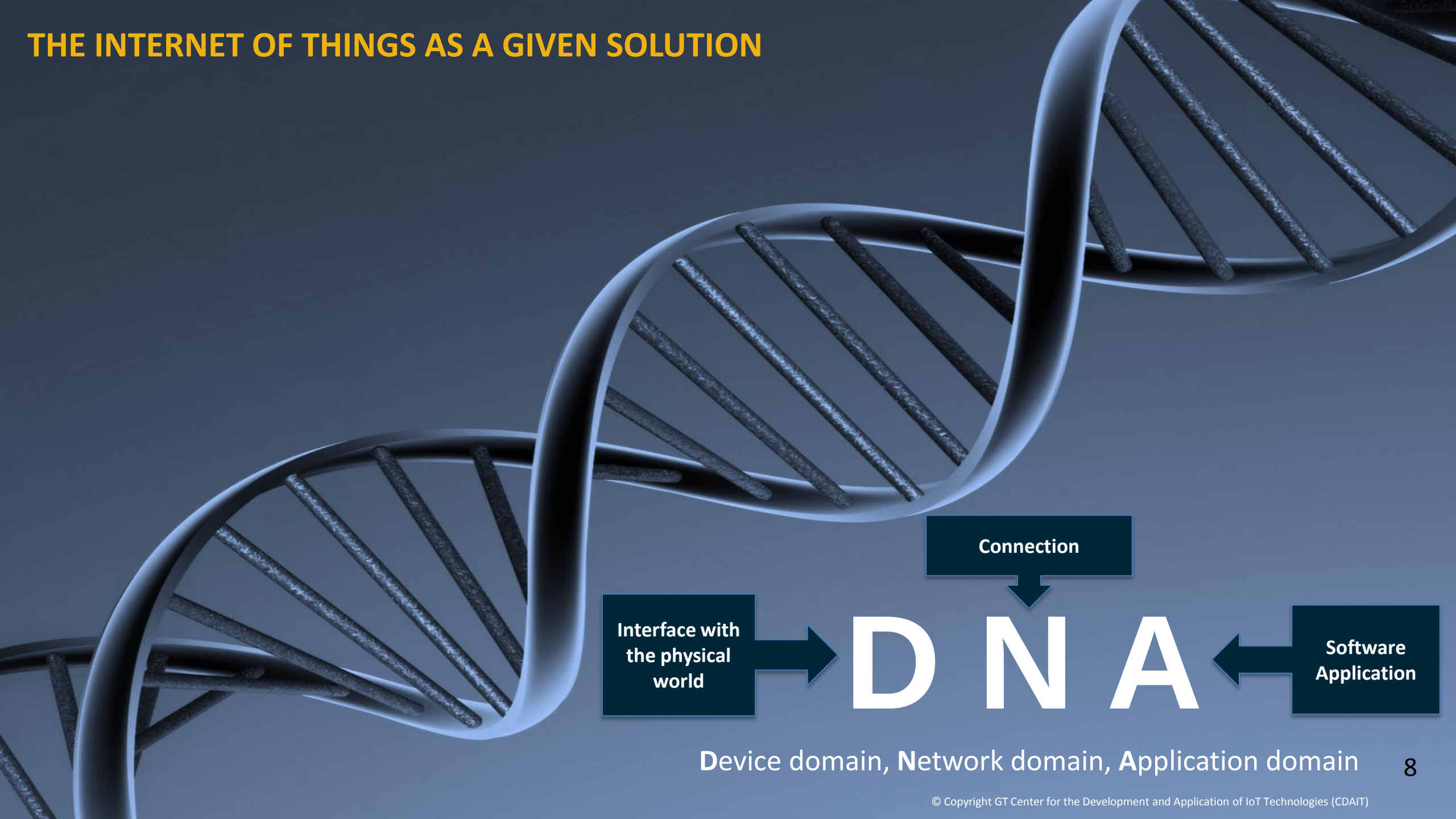
INTERNET OF THINGS = CONSUMER + INDUSTRY

"It is the IoT's industrial applications, or the 'Industrial Internet', which may ultimately dwarf the consumer side in potential business and socioeconomic impacts. The Industrial Internet will transform many industries, including manufacturing, oil and gas, agriculture, mining, transportation and healthcare. Collectively, these account for nearly two-thirds of the world economy." (*)



(*) World Economic Forum: Industrial Internet of Things: Unleashing the Potential of Connected Products and Services (January 2015), p. 7

THE INTERNET OF THINGS AS A GIVEN SOLUTION



Device domain, **N**etwork domain, **A**pplication domain

THE INTERNET OF THINGS AS A SYSTEM, OR SYSTEM (S) OF SYSTEMS (CPS)

"Cyber-physical systems are engineered systems that are built from, and depend upon, the seamless integration of computational algorithms and physical components."

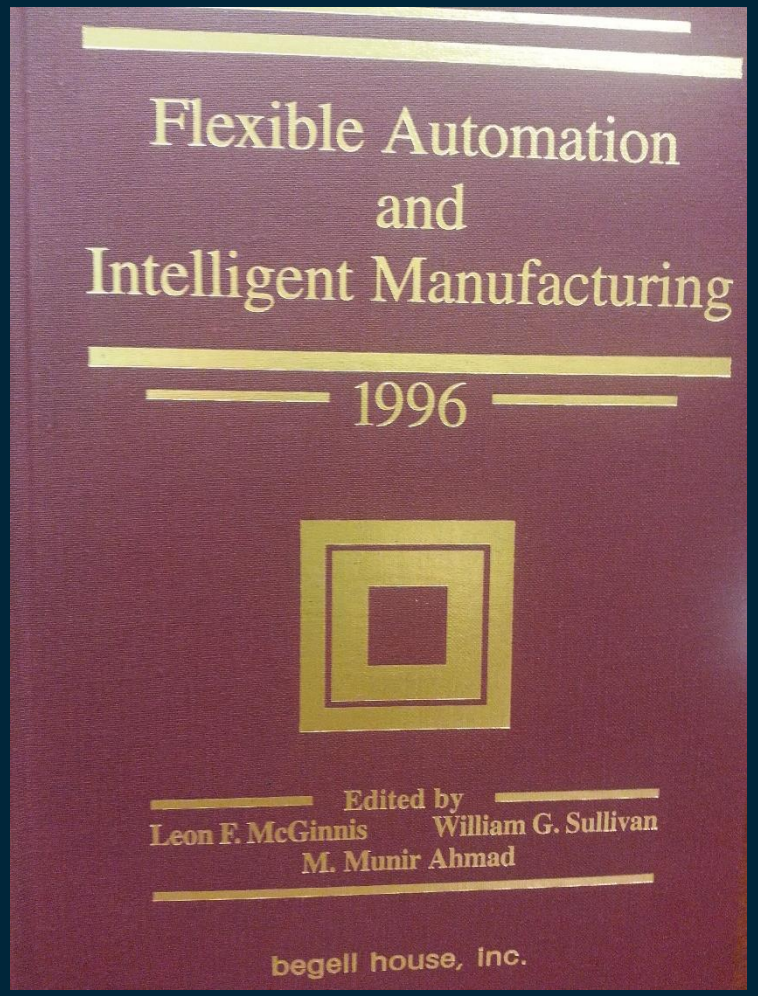
(U.S. National Science Foundation - Cyber-Physical Systems website)

"Cyber-physical systems integrate computation, communication, sensing, and actuation with physical systems to fulfill time-sensitive functions with varying degrees of interaction with the environment, including human interaction."

(U.S. NIST CPS Public Working Group – DRAFT - Framework for Cyber-Physical Systems – Release 08 – September 18, 2015, p. 7)

CPS are akin to the integrated work of a guiding conductor ("computational algorithm") interacting with an orchestra and/or choir ("physical components") for the optimal ("time-sensitive") generation of a harmonious (collective) sound a.k.a. music.

IOT IN MANUFACTURING: CHRONICLE OF A BIRTH FORETOLD

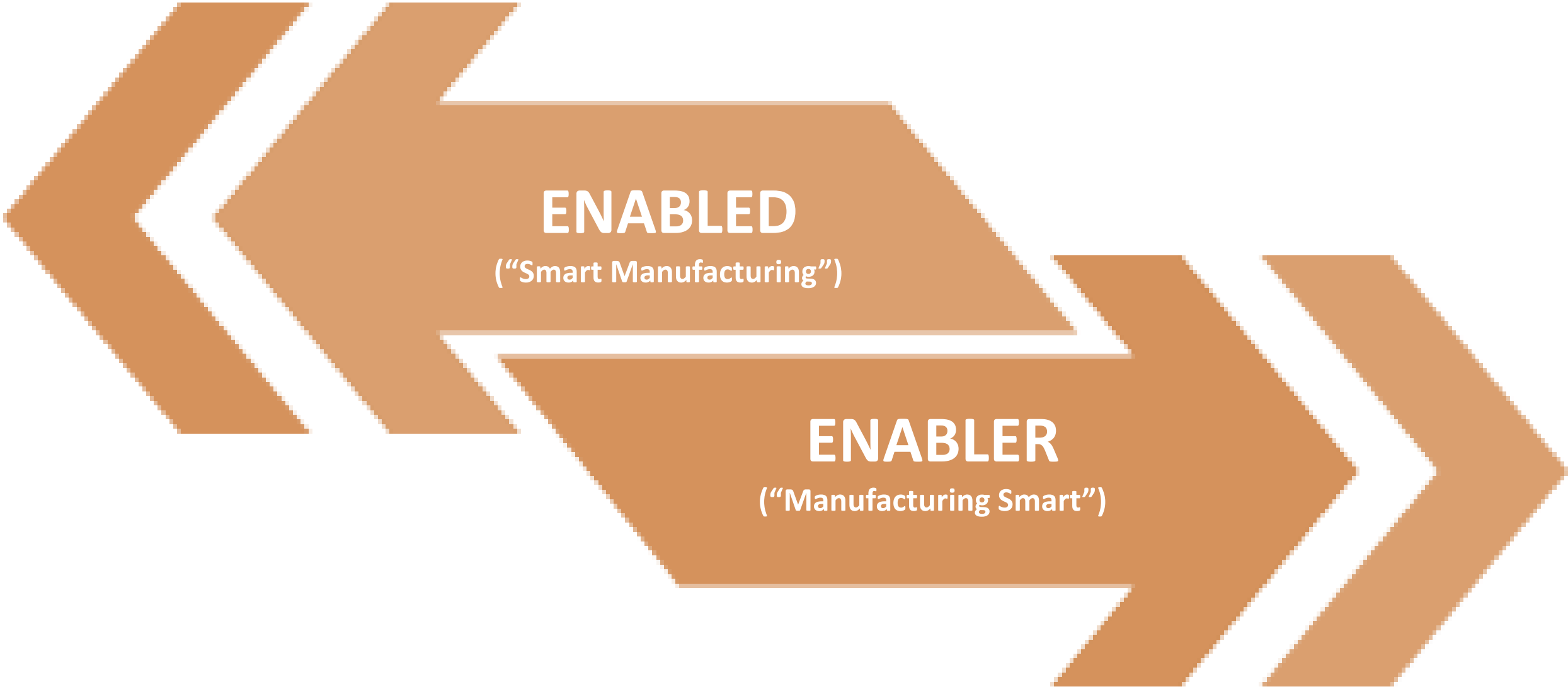


FAIM 2016, June 27-30, 2016, Seoul, Korea

> *"The past is never dead; it's not even past"*
> William Faulkner

The insertion of IoT concepts and technologies throughout the fabrication cycle has been researched way before the expression "Internet of Things" was born.

MANUFACTURING AND THE INTERNET OF THINGS: A TWO-WAY RELATIONSHIP



MANUFACTURING IS CENTRAL TO THE DAWN OF THE INTERNET OF THINGS

South China Morning Post EDITION: INTERNATIONAL TUE OCT 13, 2015

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Till decorating do us part: Chinese team develops chameleon-like house paint that changes colour to keep the whole family happy

Stephen Chen
binglin.chen@scmp.com

PUBLISHED : Monday, 12 October, 2015, 7:30am
UPDATED : Monday, 12 October, 2015, 7:30am

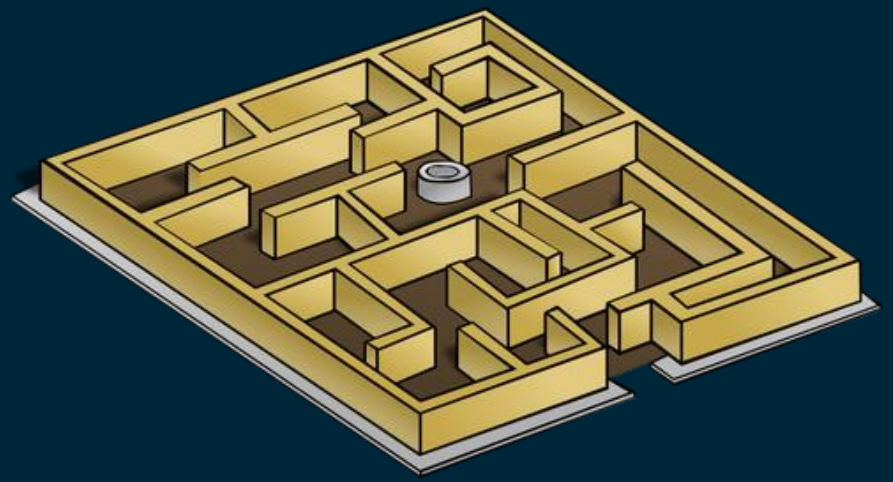
The colour of the paint can be changed in a variety of ways, such as by spraying water on it, firing weak electric currents at it, or just waiting for the room temperature to change significantly. Photo: SCMP Pictures

"We are working with some companies in the chemicals industry to bring the technology from the lab to mass production," said Dr. Du [Xuemin who works with the Shenzhen Institutes of Advanced Technology (SIAT) under the Chinese Academy of Science (CAS) and is the lead scientist of the project.] "The idea of a paint that can change color like a chameleon has generated enormous interest," Du added. "When the product will be available to consumers for home decoration depends on many factors. In my conservative estimate, it will hit stores shelf within three years." (*)

(*) Source: http://www.scmp.com/tech/science-research/article/1865840/till-decorating-do-us-part-chinese-team-develops-chameleon

INTERNET OF THINGS: TECHNOLOGICAL CHALLENGES (EXAMPLES)

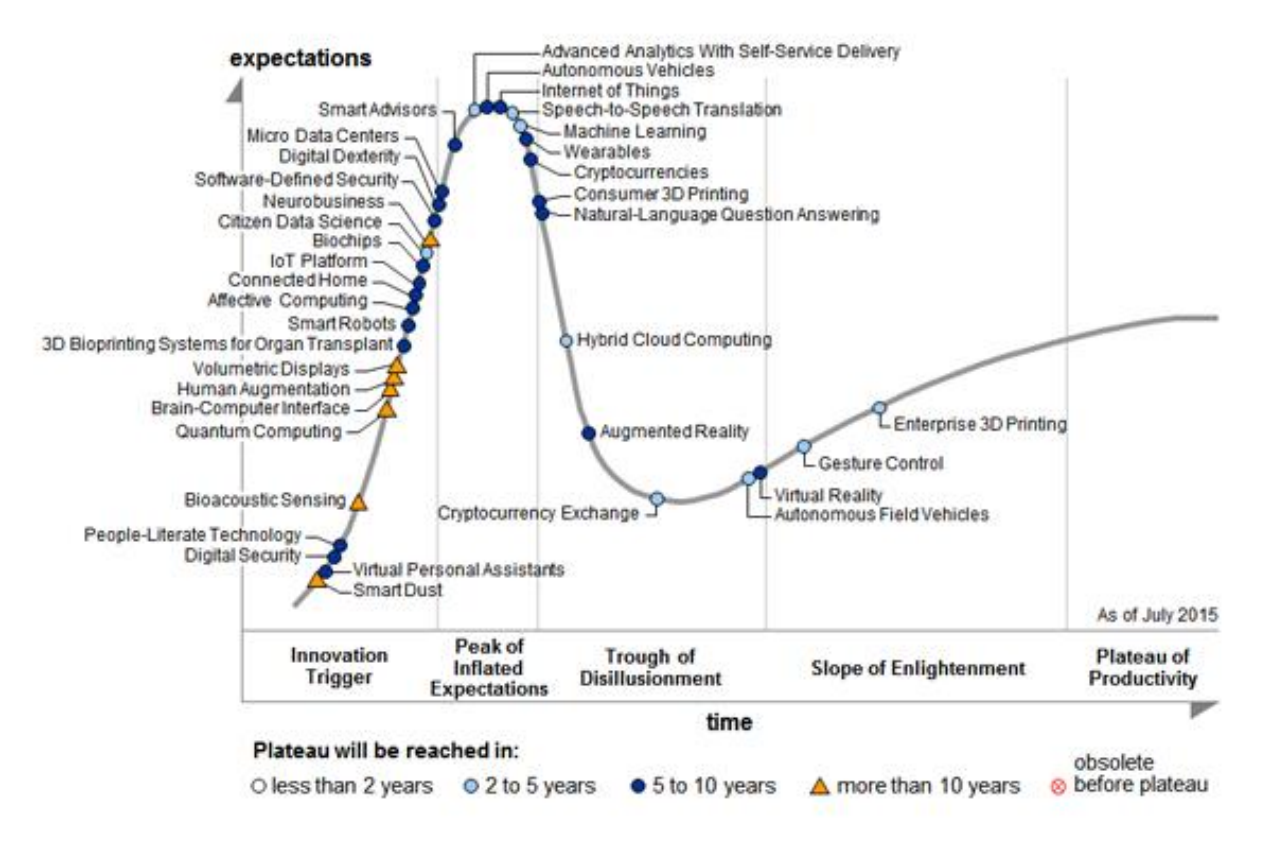
- **Scale** (Modeling & Simulation, etc.)
- **Energy** (LPWA, energy harvesting, etc.)
- **Standards** (interoperability, ontology, etc.)
- **New architectures** (memory and system levels, computing at the edge or in the cloud, etc.)
- **Impact on data centers** (storage, UPS, PDU, etc.)
- **Advanced antenna technologies**
- **Frequency availability**
- **Integration** (complex value chain)
- **Link between the past and the future** (« legacy systems»)
- **System trustworthiness** (according to NIST (*): cybersecurity, privacy, safety, reliability and resilience)



INTERNET OF THINGS: OVERHYPED OR UNDERHYPED?

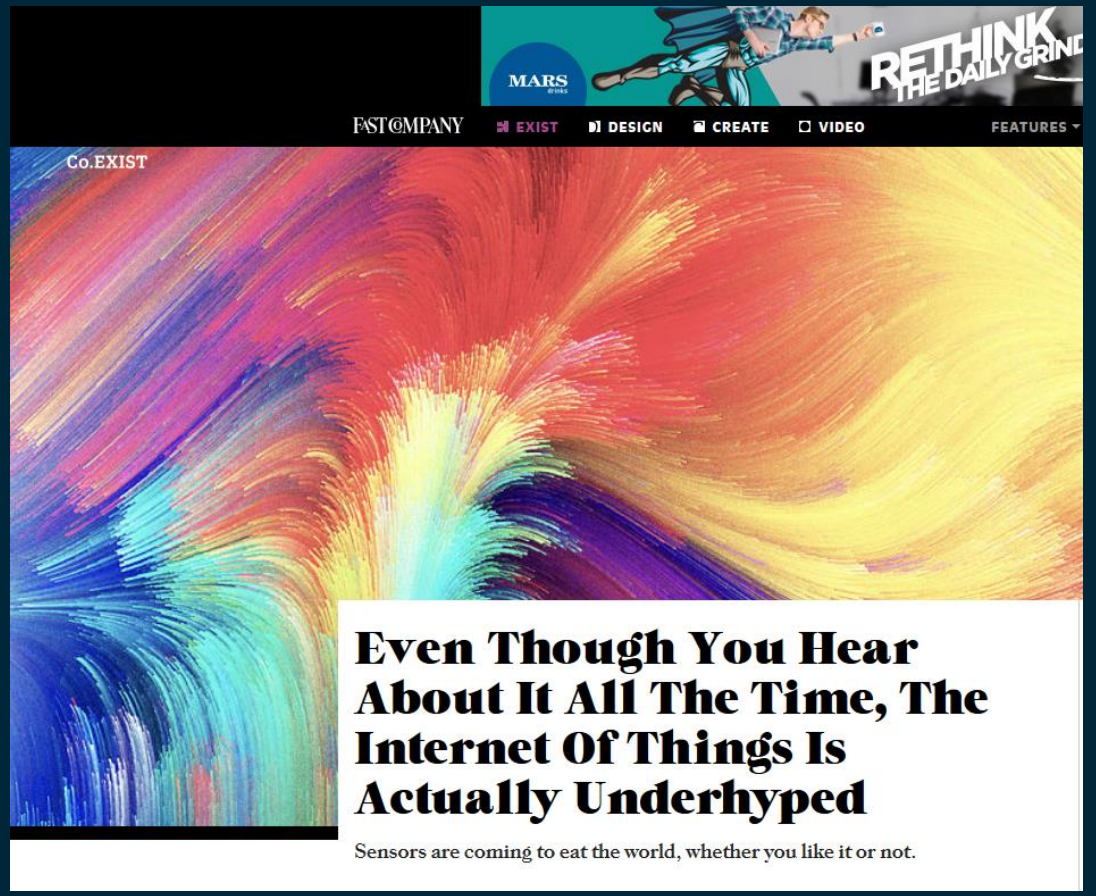
"Overhyped" (Gartner)

Hype Cycle for Emerging Technologies, 2015



Source: http://www.gartner.com/newsroom/id/3114217 (August 2015)

"Underhyped" (McKinsey)



Sources : http://www.fastcoexist.com/3048100/even-though-you-hear-about-it-all-the-time-the-internet-of-things-is-actually-underhyped and http://www.mckinsey.com/insights/business_technology/the_internet_of_things_the_value_of_digitizing_the_physical_world (June 2015)

INTERNET OF THINGS: RECENTLY PUBLISHED RESOURCES

- **Semiconductor Industry Association/Semiconductor Research Corporation:** "Rebooting the IT Revolution: A Call to Action," September 1, 2015 (35 pages)

- **National Institute of Standards and Technology (NIST), Cyber Physical Systems Public Working Group**: "Draft – Framework for Cyber-Physical Systems – Release 08," September 18, 2015 (213 pages)

- **Computing Community Consortium (CCC) Computing in the Physical World Task Force**: "Systems Computing Challenges in the Internet of Things," September 22, 2015 (15 pages)

- **The Internet Society (ISOC):** "The Internet of Things: An Overview – Understanding the Issues and Challenges of a More Connected World," October 15, 2015 (50 pages)

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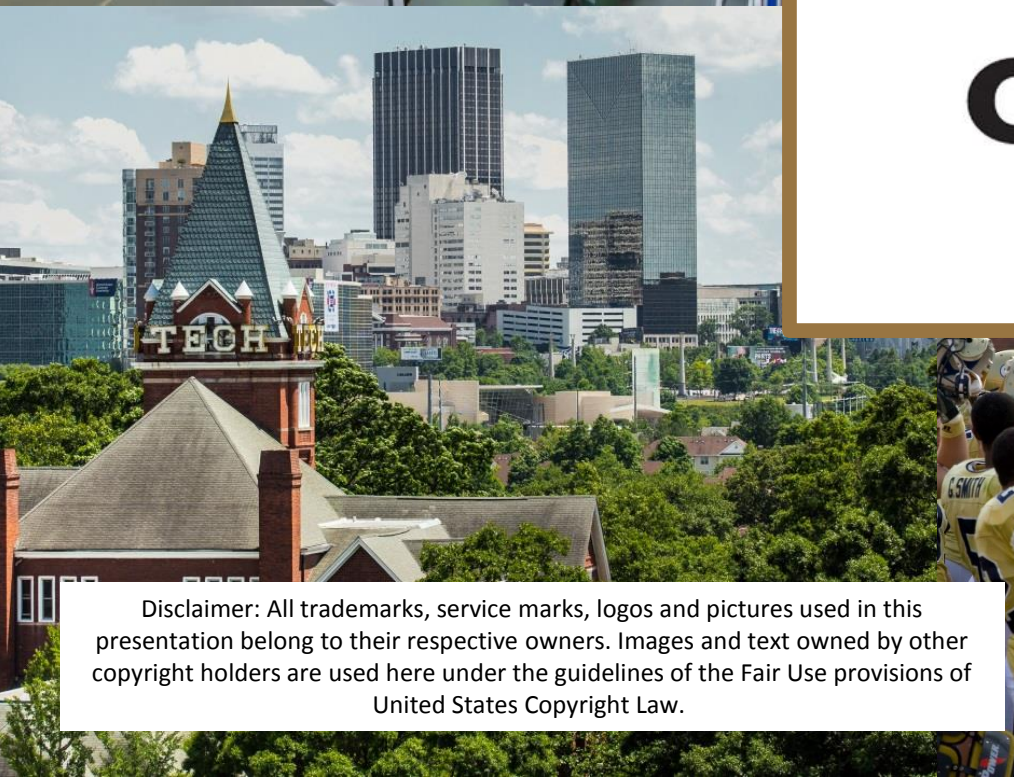

Thank You!