

# → IoT 생태계 실현을 위한 오픈소스 기술과 전략 그리고 **Oliot Open Source Project**

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May 13, 2015

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Professor, School of Computing, KAIST

- [kimd@kaist.ac.kr](mailto:kimd@kaist.ac.kr), <http://oliot.org>, <http://autoidlab.kaist.ac.kr>, <http://resl.kaist.ac.kr> <http://autoidlabs.org> <http://gs1.org>

# Experiences in RFID, Wireless Sensor Networks and Internet of Things



FASCINATING FACTS ABOUT THE INTERNET OF THINGS

**Impressive Beginnings**

Kevin Ashton originated the phrase "Internet of things" in 2009. He's co-founder of MIT's Auto-ID Center, which developed a global standard system for RFID and other sensors.

Baseline

**ANTS Pilot Project – Harobang for Disaster management & U-tourism**

**EPC Sensor Network Components**

**USN Sensor Platform and Network Systems**

1. compact/low-power sensor module and signal processing technology
2. USN hardware/software platform
3. USN network system
4. multi-platform network and connectivity technology

Global USN Laboratory

Integration & Testbed

Field Test in Halla Mountain (1950m high)



1998 1999 2002 2003 2004 2005 2006 2007 2008 2009 2011 2013 2014



**Greenhouse Monitoring**

SAMSUNG

**Fire Monitoring (2006)**

**Flood Monitoring / Disaster Management (2007)**

**School Zone / ITS Applications (2008-2009)**

**무인감시**  
Unmanned surveillance system



# IoT research groups at KAIST



## • Auto-ID Labs, KAIST

- A leading global network of academic research laboratories in the field of RFID and IoT
- Research Projects
  - OIiot: GS1 based IoT Platform
  - SNAIL: lightweight IPv6 (6LoWPAN) stack
  - SeaHaven: Visual IoT Platform
  - iGAP: IoT GPGPU Analytics Platform
- Members
  - Prof. Daeyoung Kim
  - 1 Post Doctor, 13 Ph.D Students and 6 Master Students
  - >60 alumni in universities, companies, and research institute
- <http://autoidlab.kaist.ac.kr>
- <http://resl.kaist.ac.kr>

## • IoT Research Center in KI (KAIST Institute)

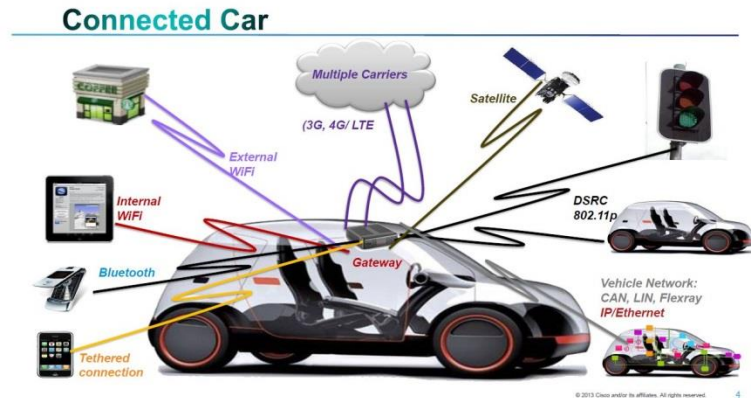
- IoT Research Center in KI is one of research organizations in KAIST, conducting interdisciplinary and integrated research to create Korea's new growth engine
- Research Fields of IoT Research Center
  - Future device
  - Future communications
  - Vehicle/Construction-IT convergence
  - Knowledge Convergence
- Members: Prof. Daeyoung Kim, 12, including research professors, senior researchers, and researchers
- <http://itc.kaist.ac.kr/x/>



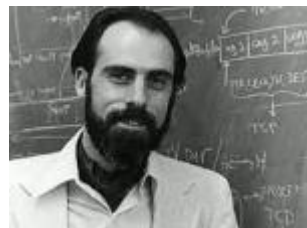
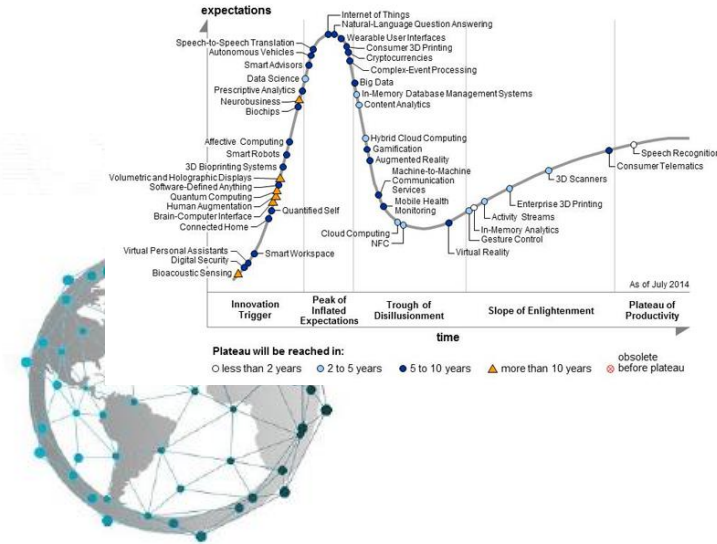
# (사물) 인터넷 [Internet of Things] 이란?



Sprouting



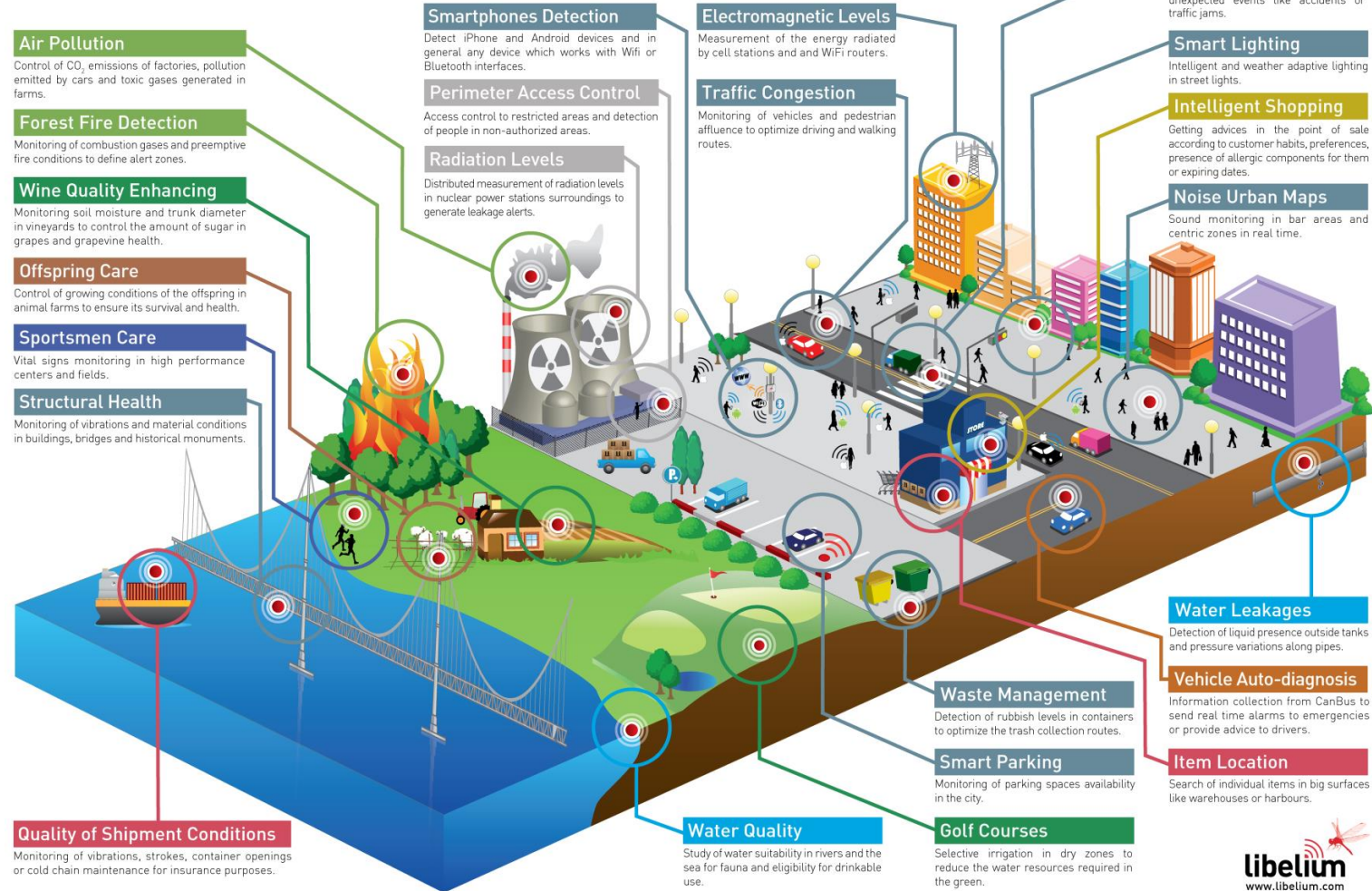
# 사물인터넷의 파~급~~효~~~과~~~~



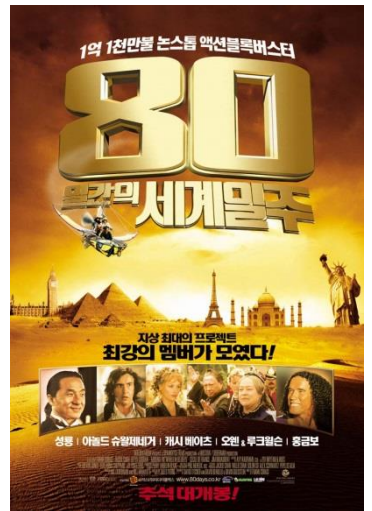
# 사물 인터넷 사회



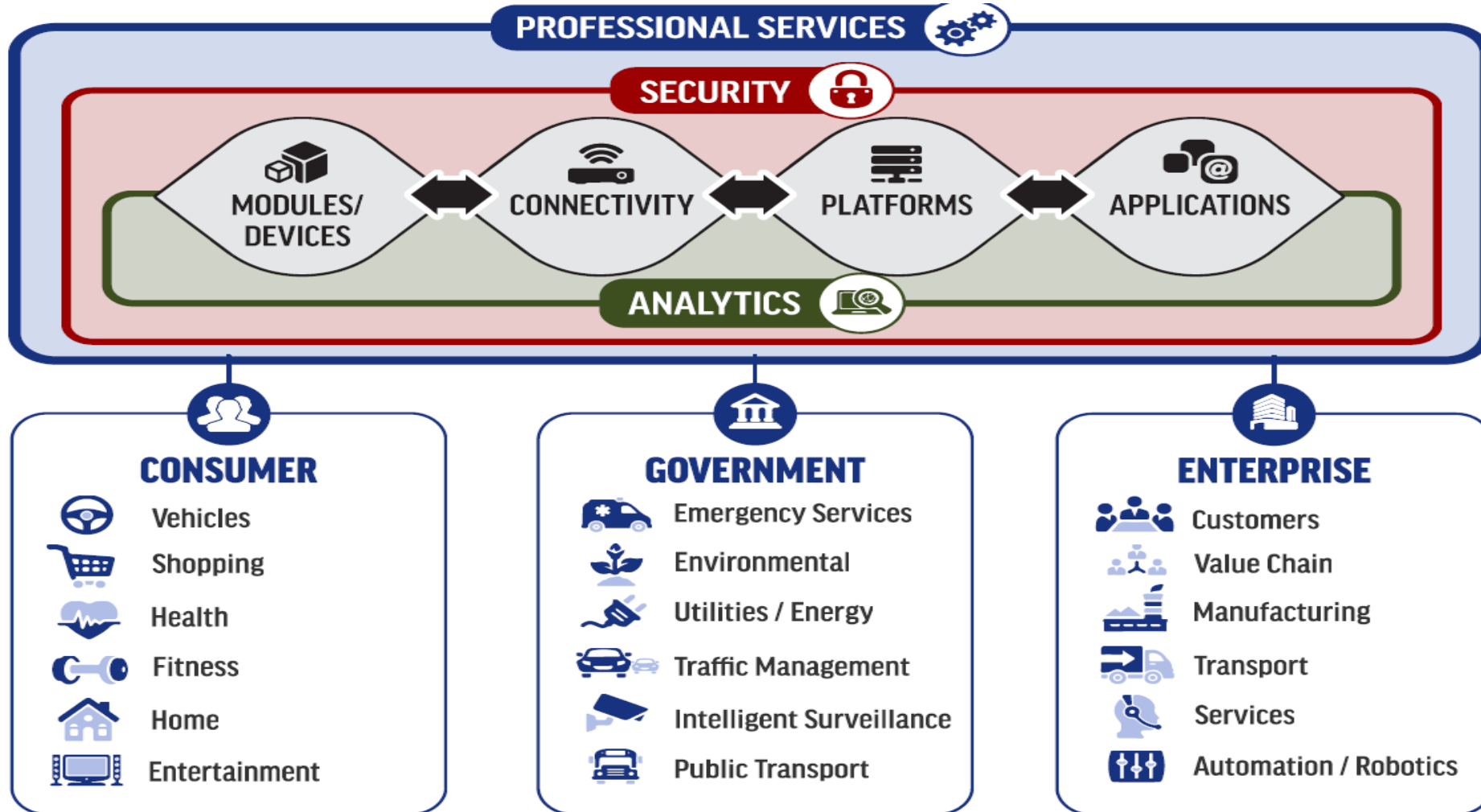
## Libelium Smart World



## Passepartout



# 사물 인터넷 생태계를 이루는 요소들



# Hot 한 사물인터넷 표준과 기술들

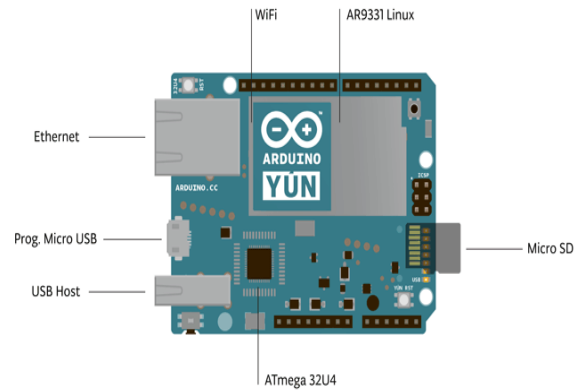




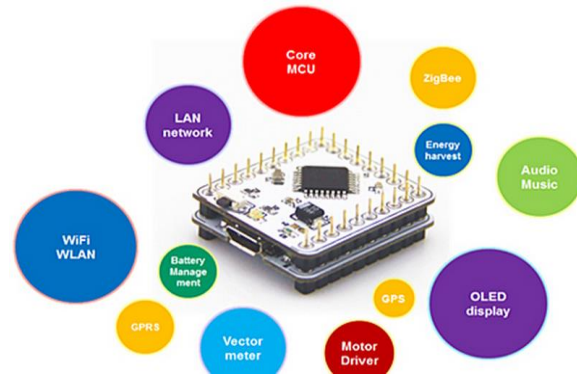
# IoT 오픈소스 - 하드웨어



<http://www.arduino.cc/en/Main/ArduinoBoardYun?from=Main.ArduinoYUN>



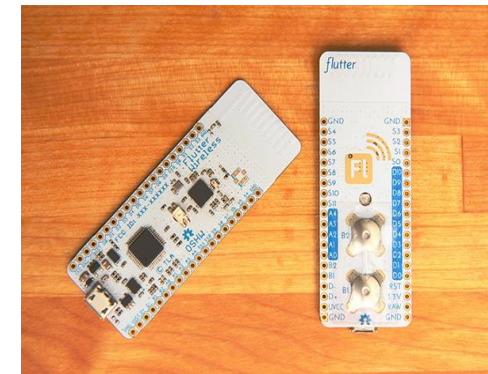
<http://beagleboard.org/>



<https://www.microduino.cc/>

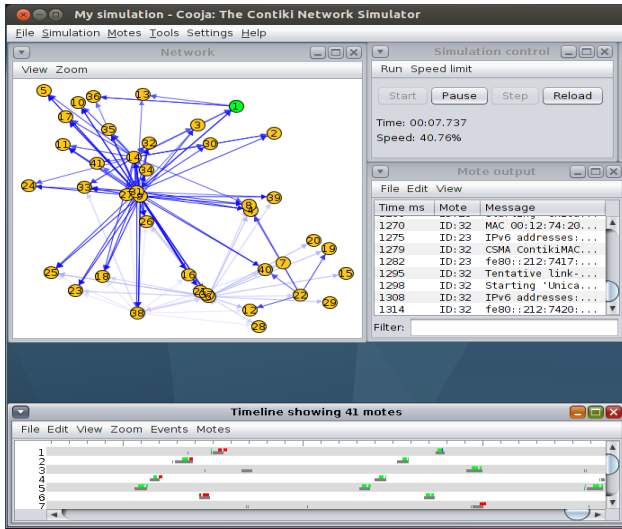
Slide 9

© Auto-ID Lab Korea / KAIST

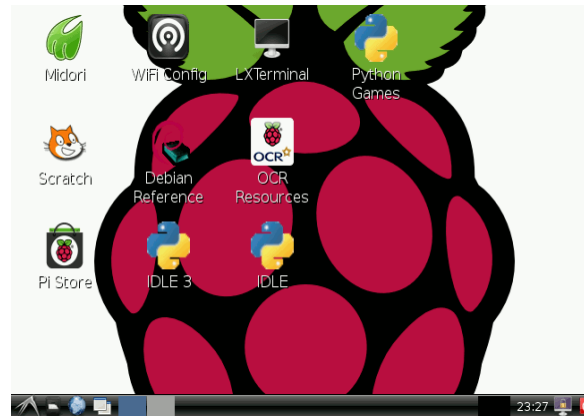


<http://www.flutterwireless.com/>

# IoT 오픈소스 - 운영체제



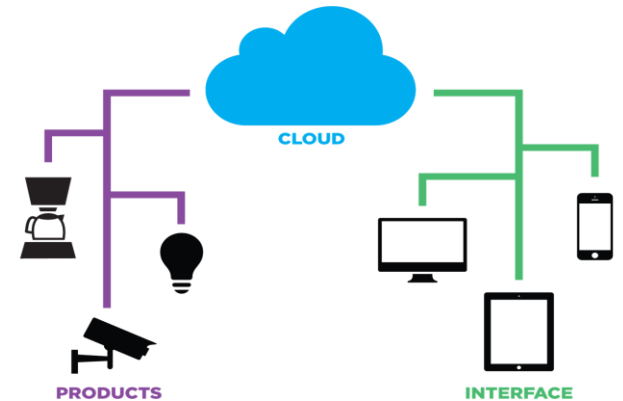
<http://www.contiki-os.org/>



<http://raspbian.org/>



<http://riot-os.org/>



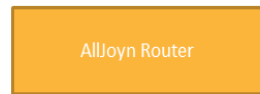
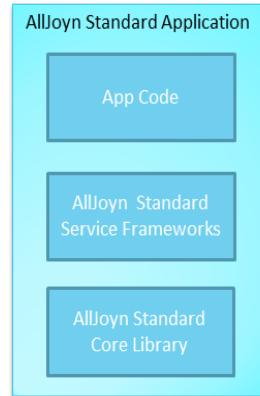
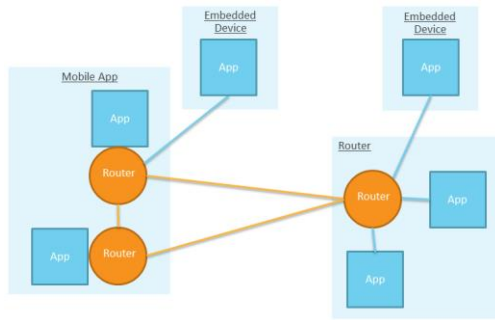
<https://www.spark.io/>

Applications	Community Libraries
C++ APIs	
Event Framework	Communication Management
Threads	CoAP, HTTP, MQTT, LWM2M
Device Management Bootstrap, Security, FOTA	TLS, DTLS
Crypto & Device Security	IPv4, IPv6   6LoWPAN
CMSIS	Drivers



<https://mbed.org/>

# IoT 오픈소스 - 미들웨어 / 프레임워크



Non-embedded OS  
(e.g. Android, iOS, Windows, Mac OSX, Linux)



RTOS, Embedded OS  
(e.g. Arduino, ThreadX, etc)

## FRAMEWORK APIs Common Object Model

PROFILES:



FRAMEWORK:



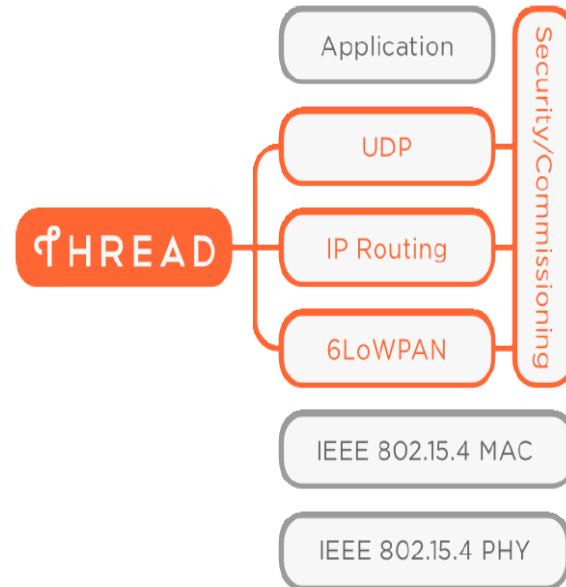
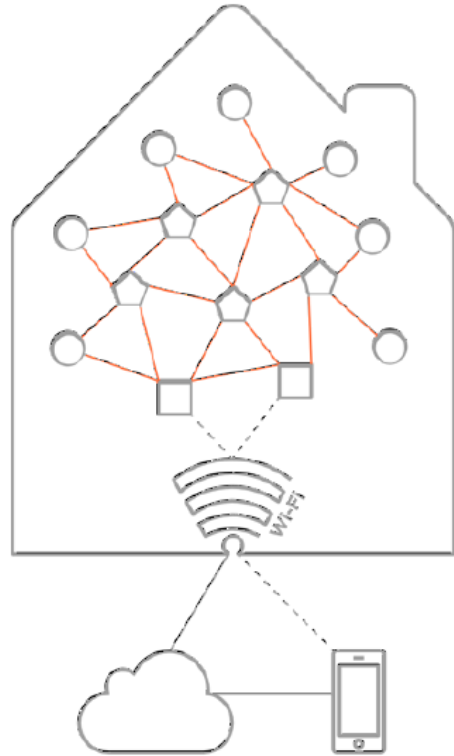
TRANSPORTS:



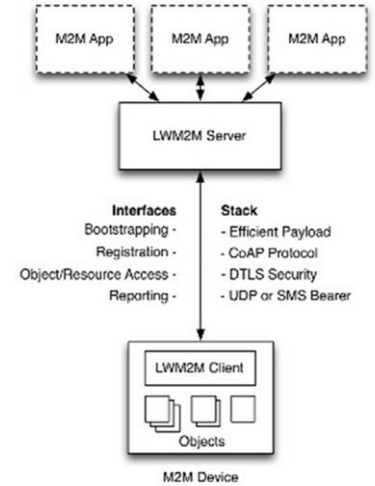
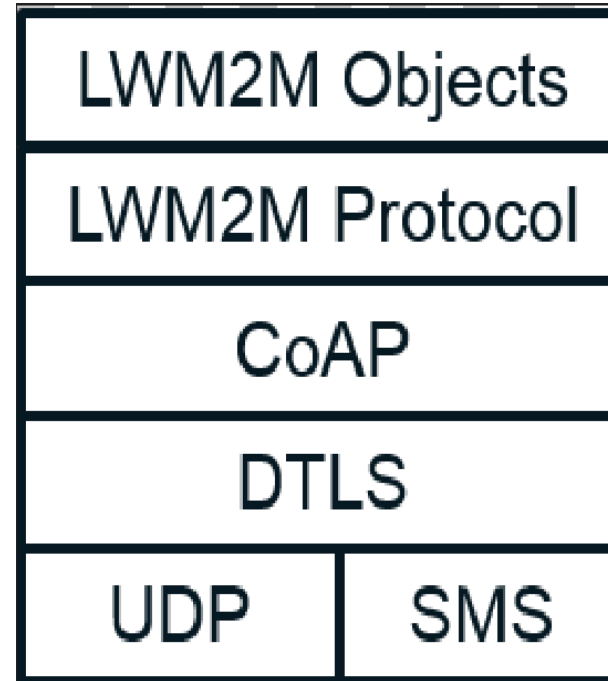
<https://allseenalliance.org/>

<https://www.iotivity.org/>

# IoT 오픈소스 - 네트워크



<http://threadgroup.org/>

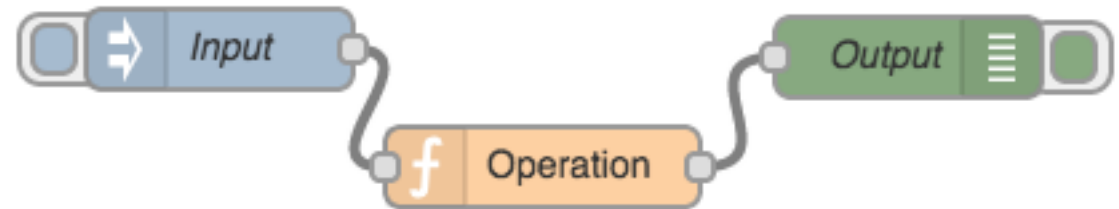
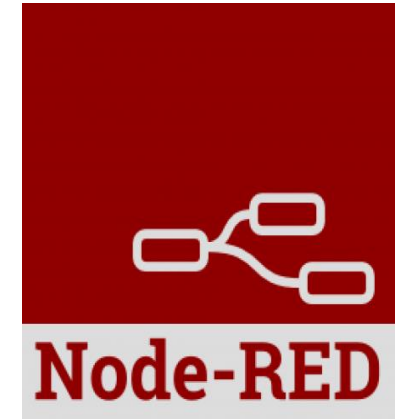


<http://technical.openmobilealliance.org/Technical/technical-information/omna/lightweight-m2m-lwm2m-object-registry>

# IoT 오픈소스 - 개발환경



<http://iot.eclipse.org/>



<http://nodered.org/>

# 사물인터넷에 다가가기 위한 전략



오픈 테스트베드



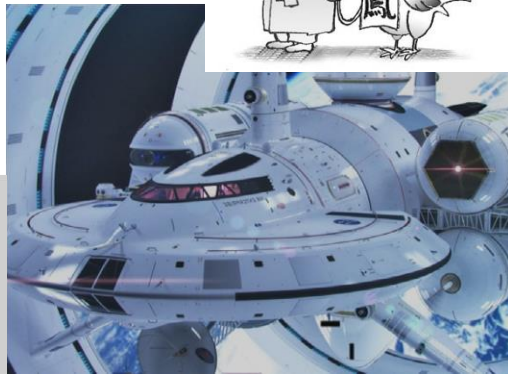
선택과 집중



# 사물인터넷에 다가가기 위한 나의 길? (대로, 오솔길?)



봉이(鳳伊)



# GS1 (International Non Profit Organization)



In 1999, the "Internet of Things" was first coined by *Kevin Ashton* who cofounded the Auto-ID Center(Labs) at the MIT



**The global language of business**

**OVERALL BENEFIT: Improving efficiency & visibility in supply and demand chains**

**GS1 SOLUTIONS & SERVICES USING GS1 STANDARDS**  
 Solutions: POS / Inventory Management / Asset Management / Collaborative Planning / Traceability  
 Services: Global (GSMP, GEPIR, Global Registry, Training and Accreditation) & Local (e.g. Certification, Implementation, Training)

**GS1 System - Integrated system of standards**

 Global standards for automatic identification Rapid and accurate, item, asset or location identification	 Global standards for electronic business messaging Rapid, efficient & accurate business data exchange	 The environment for global data synchronisation Standardised, reliable data for effective business transactions	 Global standards for RFID-based identification More accurate, immediate and cost-effective visibility of information
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GS1 Identification Keys (e.g. GTIN, GLN, SSCC, GRAI, GIAI, GSRN, EPC) & Attribute Data (e.g. Best Before Date)

■ Countries with a GS1 Member Organisation  
■ Countries served on a direct basis from GS1 Global Office (Brussels)

대한상공회의소 GS1  
 유통물류혁신센터

**111 Member Organisations . . .  
 in 155 Countries . . .  
 with over 2,000,000 Members.**



# Auto-ID Labs



- The Auto-ID Labs are an independent network of currently six academic research labs that research and develop new technologies for revolutionizing global commerce and providing previously un-realizable consumer benefits.

<http://autoidlabs.org>



Partnership between 100 global firms, including founders:

- Uniform Code Council
- EAN International
- Procter and Gamble
- Gillette



*Global:*

- Standards Development
- Adoption
- Brand Management and Marketing
- Policies (Privacy, Intellectual Property)

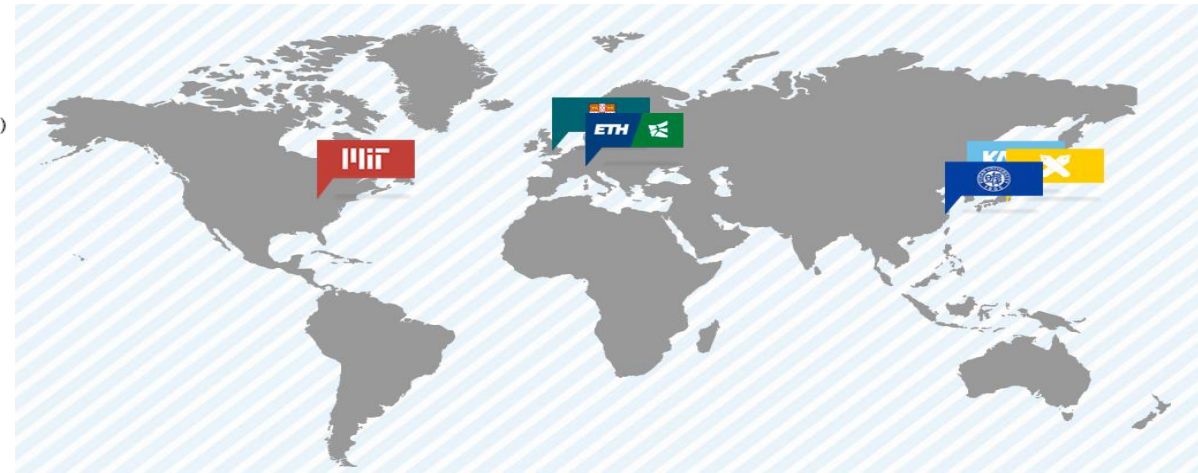


*Local:*

- Market Development
- Implementation Support
- Member Communication
- Member Support
- Training and Education



Continued Research



Research Partner



Research → Commercialization

## RESEARCH DIRECTORS



PROF. SANJAY SARMA  
MASSACHUSETTS INSTITUTE OF TECHNOLOGY



PROF. DUNCAN MCFARLANE  
UNIVERSITY OF CAMBRIDGE



ASS.-PROF. ALEXANDER ILIC  
ETH ZÜRICH & HSG



PROF. HAO MIN  
FUDAN UNIVERSITY



PROF. JUN MURAI  
KEIO UNIVERSITY



PROF. DAEYOUNG KIM  
KAIST



Business Processes and Applications



Massachusetts Institute of Technology



Keio University



ETH  
Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zurich



UNIVERSITY OF CAMBRIDGE



University of St. Gallen

Software and Network



Massachusetts Institute of Technology



Keio University



KAIST

Hardware



Massachusetts Institute of Technology



KAIST

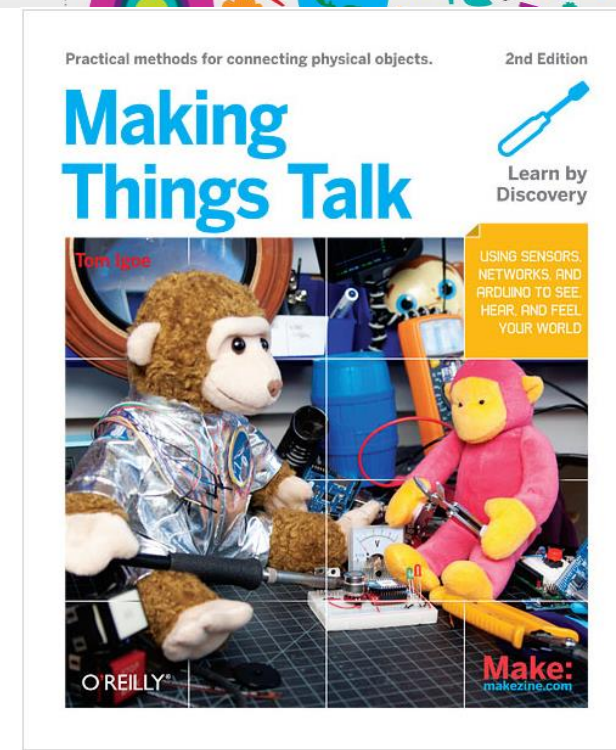
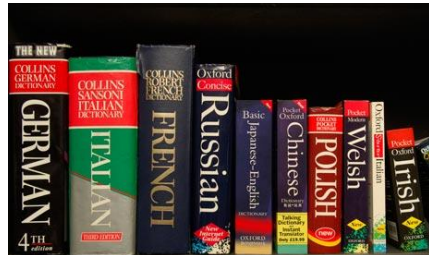


TSINGHUA UNIVERSITY  
1909

# GS1 Philosophy and Internet of Things



*my opinion...*

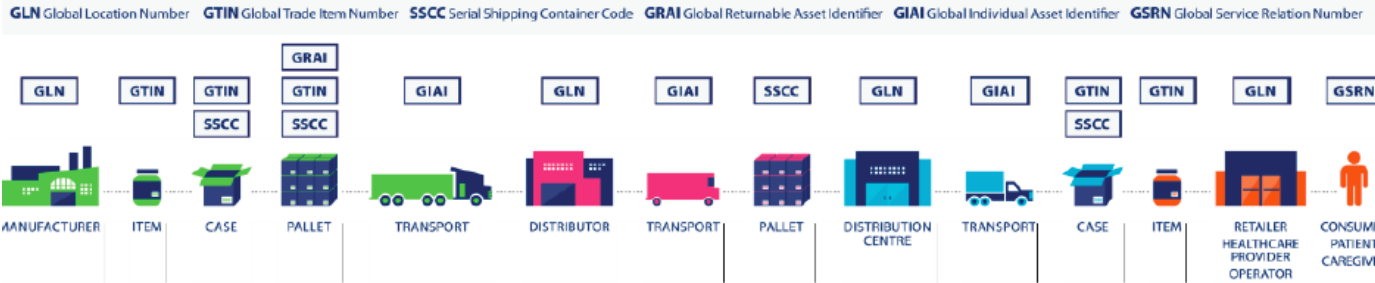


# We remodel GS1 Architecture for IoT



## Identify – Capture – Share

### IDENTIFY: GS1 Standards for Identification



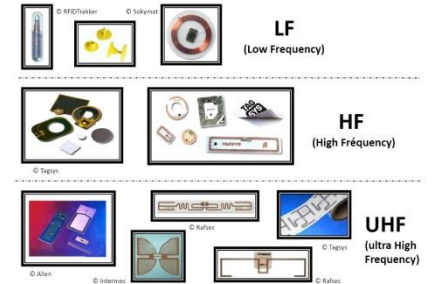
### CAPTURE: GS1 Standards for Barcodes & EPC/RFID



### SHARE: GS1 Standards for Data Exchange



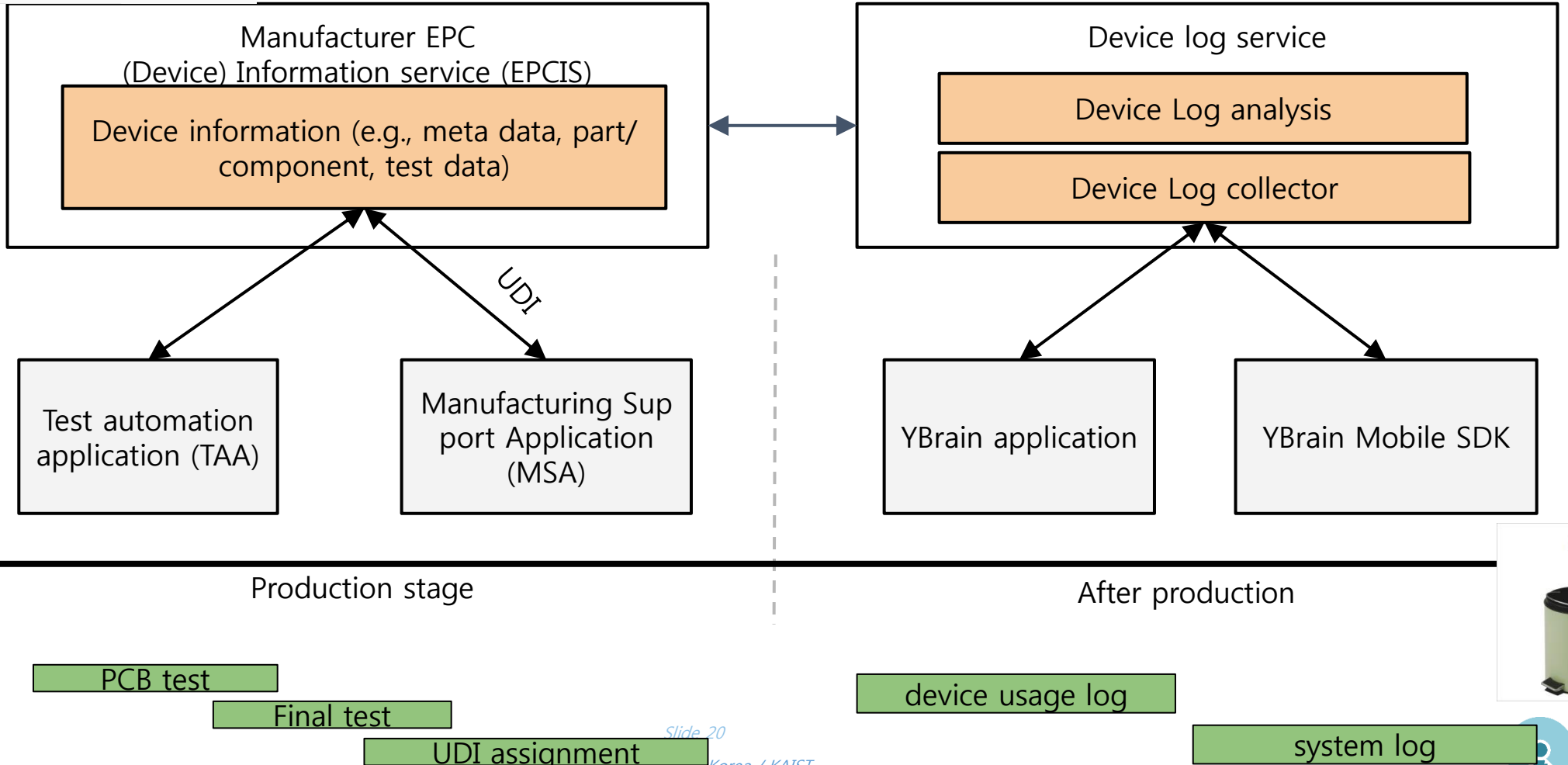
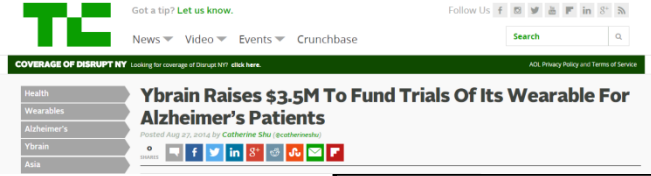
© 2014 GS1



50 billions interconnected  
"things"  
by 2020



# 사물 생애 주기 관리를 통한 IoT 서비스



# What are things?, but not limited



(00) 0 0123456 000000001 8  
 Application Identifier    Extension Digit    GS1 Company Prefix    Serial Number    Check Digit  
 GS1 Prefix or Serial Number based on length of GS1 Company Prefix

))) NFC )))

Social Media QR Codes

**Passive Things**

**Active Things**

Your current electric usage (kWh) 125478  
 Register number 01  
 Meter number 640 364 107

Remove Screws To Access Battery  
 Antenna Barrel Connector  
 Power Switch

**Wireless Sensors/Actuators**

**Smart Devices**

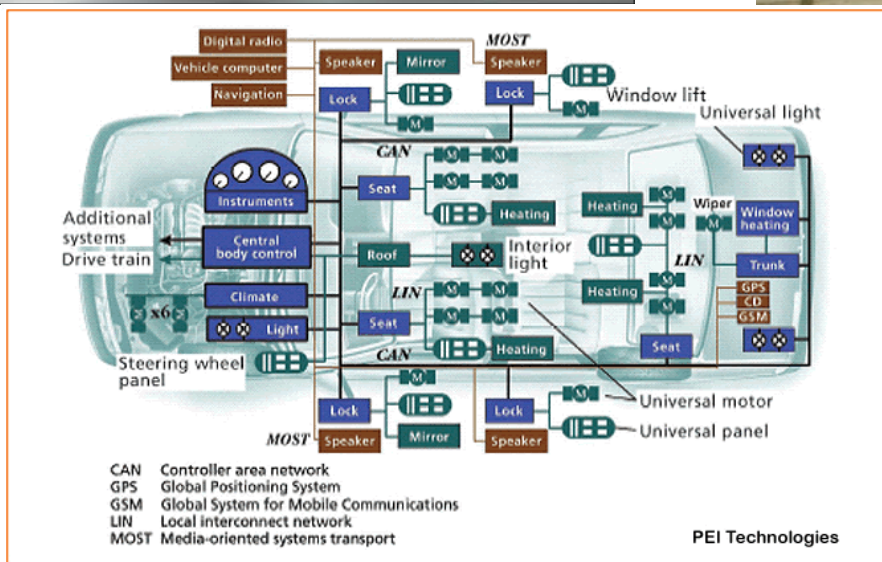
**Smart TV**

**Consumer Electronics**

**Smart TV**

**BIG DATA**

# What are things?, but not limited



# My Vision as a GS1 research partner



**Any third party  
Application/service**



# What OIiot stands for?



## Finnish [\[edit\]](#)

([index](#) [ol](#))

### Etymology [\[edit\]](#)

*olla* (*to exist*) + *-io*

### Noun [\[edit\]](#)

olio

1. *creature, being, thing*
2. (*philosophy*) *object*
3. (*programming*) *object*

## oliot

### Finnish [\[edit\]](#)

#### Noun [\[edit\]](#)

oliot

1. *plural form of olio*

## English [\[edit\]](#)

### Etymology [\[edit\]](#)

From Spanish *olla* or Portuguese *olha*, both from Latin *olla* ("pot, jar").<sup>[1]</sup>

### Noun [\[edit\]](#)

olio

1. A rich, thick, Spanish *stew* consisting of meat and vegetables.
2. A mixture or medley, a *hotchpotch*.
3. A collection of various musical, theatrical or other artistic works: a *miscellany*.
4. By extension of the above, *Vaudeville* or similar *miscellaneous* musical or theatrical entertainment *skits* presented between the main acts of *minstrel* or *burlesque* shows.



[transparent]



[white]



# GS1/EPCglobal Standards

## GS1 Keys



### • GS1 Identification Keys (현재)

- URI-convertible ID (GTIN, GLN, SSCC, GRAI, etc)
  - e.g., *urn:epc:id:sgtin:0614141.112345.400*

#### Companies

- GS1 Company Prefix
- Global Location Number (GLN)
- Electronic Product Code (EPC) Manager Number

#### Product

- Global Trade Item Number (GTIN)
- Serialized Global Trade Item Number (SGTIN)

#### Services

- Global Service Relation Number (GSRN)
- Global Document Type Identifier (GDTI)

#### Location

- Global Location Number (GLN)
- Serialized Global Trade Item Number (SGTIN)

#### Pack, Case, Pallet

- Global Trade Item Number (GTIN)
- Serialized Global Trade Item Number (SGTIN)
- Serial Shipping Container Code (SSCC)

#### Assets

- Global Individual Asset Identifier (GIAI)
- Global Returnable Asset Identifier (GRAI)



### NGPI (표준화중)

Results of a preliminary NGPI bar code capability study give us reason to believe that change is possible

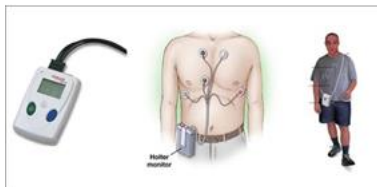
Symbol (relative to scale)	Current	Short-term options		Long-term options	
	1D EAN/UPC	1D EAN/UPC+ addition	1D Data Bar	2D GS1 QR Code	2D GS1 Data Matrix
Readability by today's POS scanner	100%	72%	86%	9%	9%
POS systems able to use additional data	n/a	49%	56%	1%	1%
Type of Upgrade Required	n/a	Software	Software	Hardware	Hardware

- While most retailer systems can read the GTIN in more advanced 1D barcodes, few have the ability to use the additional information...
- Next Generation 1D Bar Codes offer minimal downside (software costs) and huge upside (for investment)
- 2D Bar Codes, while technically superior, are 10+ years away from scaled adoption

### IoT (표준선행연구)



### Digital Coupon Management (Serialized) Global Coupon Number (SGCN)



ECG measurement device (GRAI)



Surgical tools (GIAI)



Membership ID (GSRN)

### Component / Part Management Component / Part Identifier (CPID)



# GS1/EPCglobal Standards Global Product Classification (GPC)

Expand All | Brick | Class | Family | Collapse All

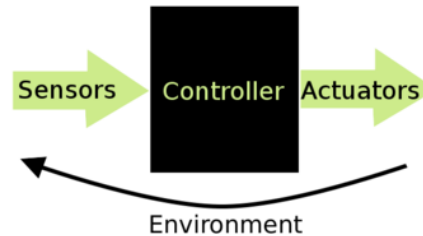
- ☒ Segment: 70000000 - Arts/Crafts/Needlework
- ☒ Segment: 68000000 - Audio Visual/Photography
- ☒ Segment: 77000000 - Automotive
- ☒ Segment: 54000000 - Baby Care
- ☒ Segment: 53000000 - Beauty/Personal Care/Hygiene
- ☒ Segment: 83000000 - Building Products
- ☒ Segment: 74000000 - Camping
- ☒ Segment: 47000000 - Cleaning/Hygiene Products
- ☒ Segment: 67000000 - Clothing
- ☒ Segment: 66000000 - Communications
- ☒ Segment: 65000000 - Computing
- ☒ Segment: 58000000 - Cross Segment
- ☒ Segment: 78000000 - Electrical Supplies
- ☒ Segment: 50000000 - Food/Beverage/Tobacco
- ☒ Segment: 63000000 - Footwear
- ☒ Segment: 87000000 - Fuels/Gases
- ☒ Segment: 51000000 - Healthcare
- ☒ Segment: 72000000 - Home Appliances

☒ Family: 72010000 - Major Domestic Appliances

- ☒ Class: 72010600 - Kitchen Washing Appliances
- ☒ Class: 72010300 - Major Cooking Appliances
- ☒ Class: 72010500 - Major Laundry Appliances
- ☒ Class: 72010700 - Major Water Dispensers
- ☒ Class: 72010200 - Refrigerating/Freezing Appliances

- ☒ Brick: 10003710 - Beverage Chillers Other
- ☒ Brick: 10001940 - Coolers/Heaters
- ☒ Brick: 10003698 - Freezers
- ☒ Brick: 10001938 - Ice Makers
- ☒ Brick: 10001941 - Refrigerating/Freezing Appliances Other
- ☒ Brick: 10001942 - Refrigerating/Freezing Appliances Replac
- ☒ Brick: 10003695 - Refrigerator/Freezers
- ☒ Brick: 10003694 - Refrigerators

## GPC for Smart Things?



☒ Brick: 10003694 - Refrigerators

Definition: Includes any products that may be described/observed as an Copy

☒ Attribute: 20001529 - Energy Type

Definition: Indicates with reference to the product branding, labelling or Copy

Value: 30008570 - ELECTRIC

Value: 30008571 - GAS

☒ Value: 30002515 - UNCLASSIFIED

Definition: This term is used to describe those product attributes that are unable Copy

☒ Value: 30002518 - UNIDENTIFIED

Definition: This term is used to describe those product attributes that are Copy

☒ Attribute: 20001527 - Includes Built-in Ice Maker

Definition: Indicates with reference to the product branding, labelling or Copy

Value: 30002960 - NO

☒ Value: 30002515 - UNCLASSIFIED

Definition: This term is used to describe those product attributes that are unable Copy

Value: 30002654 - YES

☒ Attribute: 20001353 - Installation Type

Definition: Indicates, with reference to the product branding, labelling or Copy

Value: 30007757 - BUILT-IN

Value: 30010514 - COUNTERTOP

Value: 30009198 - FREESTANDING

Value: 30009202 - INTEGRATED UNIT

☒ Value: 30007608 - PORTABLE

Definition: This term is used to describe those products that the manufactures Copy

☒ Value: 30002515 - UNCLASSIFIED

Definition: This term is used to describe those product attributes that are unable Copy

☒ Value: 30002518 - UNIDENTIFIED

Definition: This term is used to describe those product attributes that are Copy

<http://www.gs1.org/1/productsolutions/gdsn/gpc/browser/index.html>

Language: English  
 Publication: GPC as at June 2014 (Latest publication)  
 Segment:   
 Family:   
 Class:   
 Search:    
 Exact wording

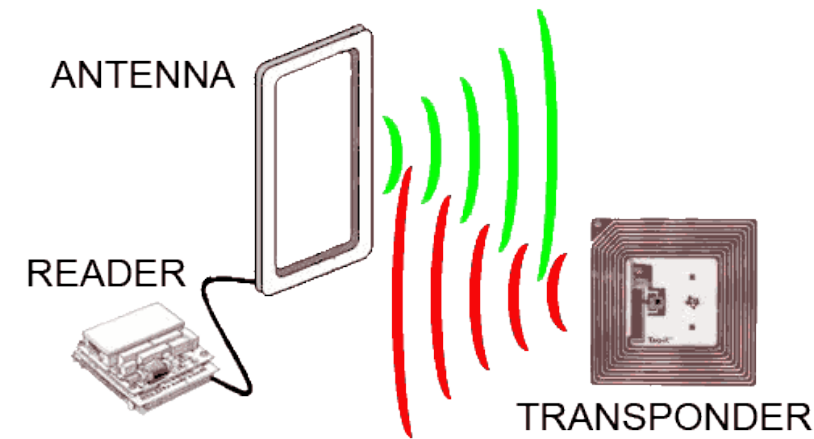
# GS1/EPCglobal Standards

## Electronic Product Code (EPC)

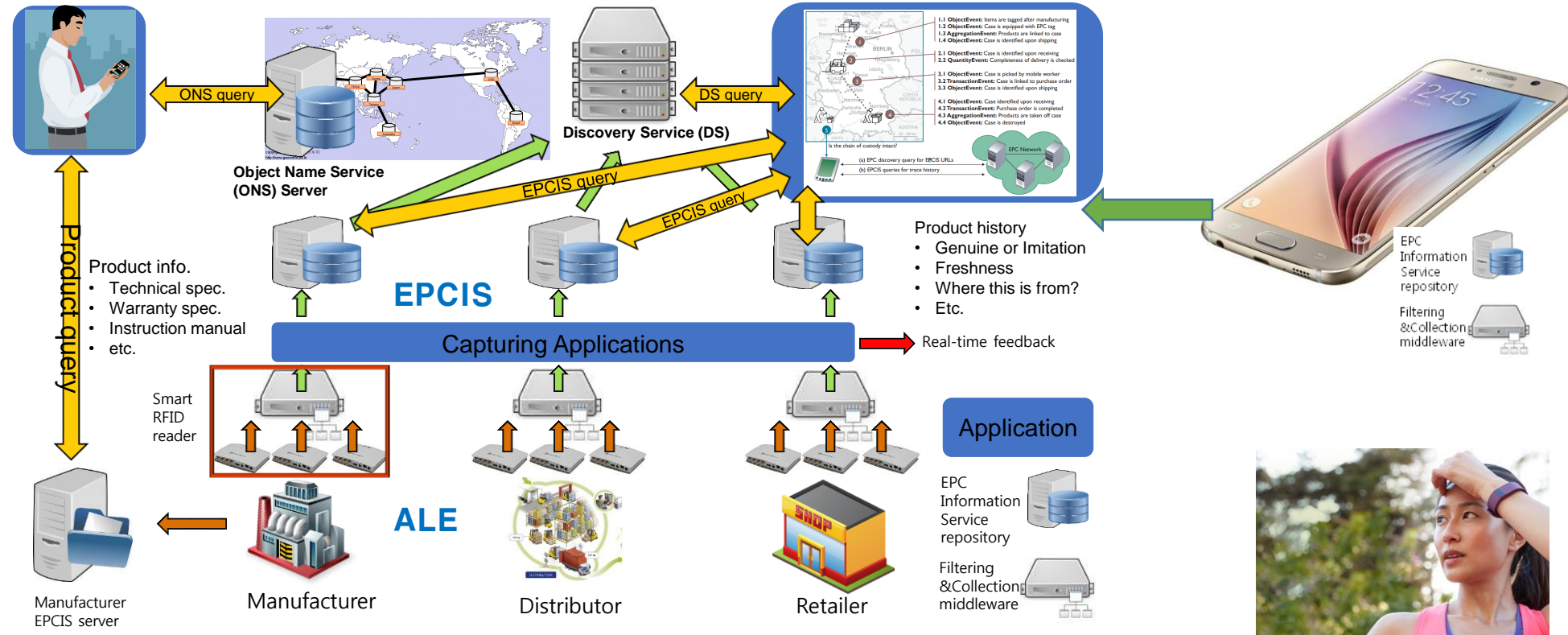


- EPC
  - universal identifier that provides a unique identity for any physical object

EPC Scheme	Tag Encodings	Corresponding GS1 Key	Typical Use
sgtin	sgtin-96 sgtin-198	GTIN key (plus added serial number)	Trade item
sscc	sscc-96	SSCC	Pallet load or other logistics unit load
sgln	sgln-96 sgln-195	GLN key (with or without additional extension)	Location
grai	grai-96 grai-170	GRAI (serial number mandatory)	Returnable/reusable asset
giai	giai-96 giai-202	GIAI	Fixed asset
gdti	gdti-96 gdti-113	GDTI (serial number mandatory)	Document
gsrn	gsrn-96	GSRN	Service relation (e.g., loyalty card)



# GS1/EPCglobal Standards GS1/EPCglobal Architectural Framework



# GS1/EPCglobal Standards

## GS1/EPCglobal Architectural Framework

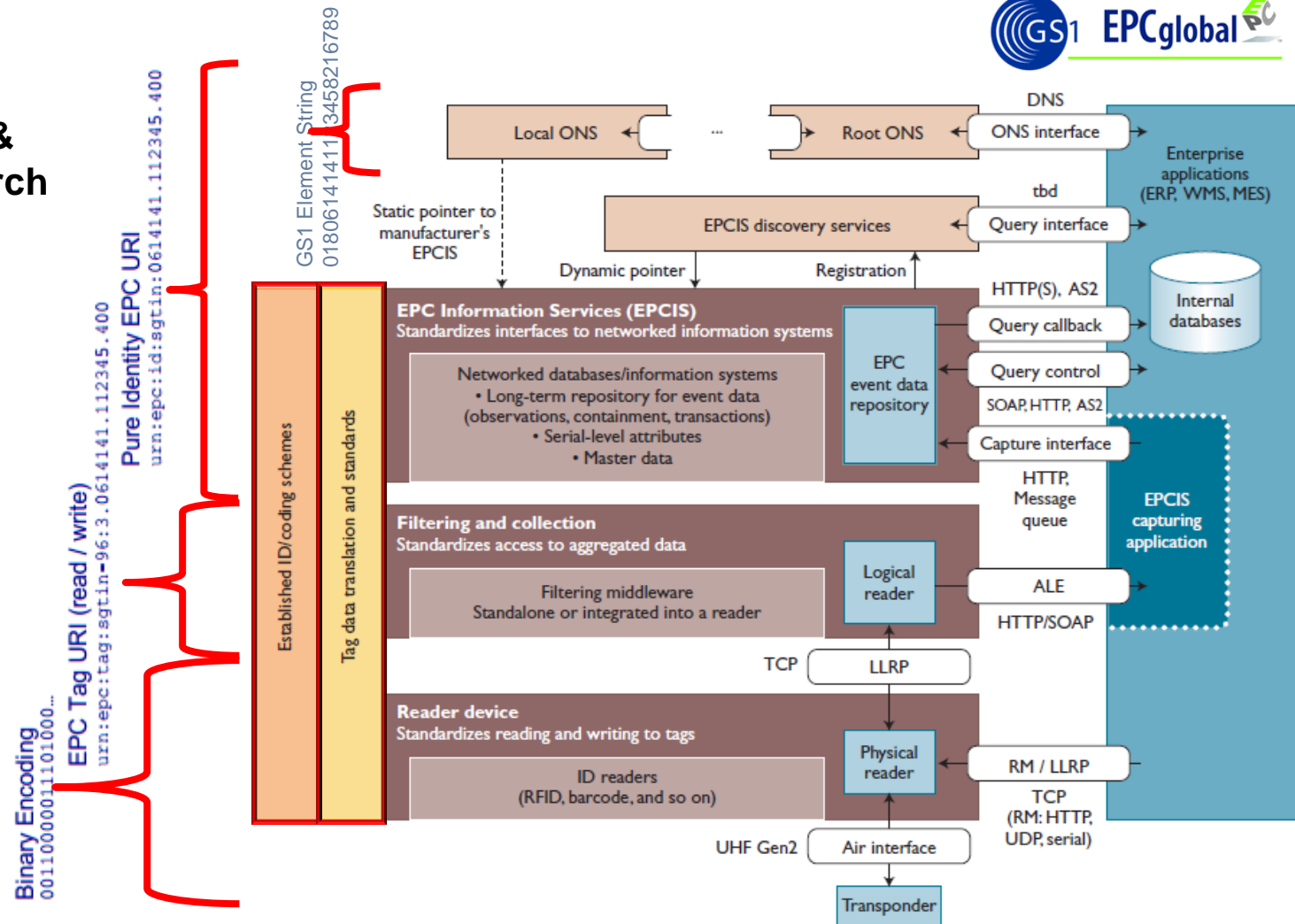


Item Discovery & Information search

Data store and share

Data filtering & grouping

Identification & sensing



# Eg.) Extending EPCIS (EPC Information Service) Internet of Things Global Data Repository



Business Apps.

Query Interface

EPCIS – Visibility Event Data

Capturing Interface

ALE – Event Capturing



RFID Reader  
& Antenna



Barcode  
Reader

```
<?xml version="1.0" encoding="UTF-8" standalone="yes" ?>
<!DOCTYPE object>
<eplcis:EPCISDocument xmlns:eplcis="urn:epcglobal:eplcis:xsd:1"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:epcglobal:eplcis:xsd:1 http://www.epcglobal.org/2007-07-11/111130-47.02_schemaVersion=1.1">
  <EPCISBody>
    <EventList>
      <ObjectEvent>
        <eventTime>2001-12-31T00:00:00-06:00</eventTime>
        <eventTimezoneOffset>-06:00</eventTimezoneOffset>
        <eplcis:ist>
          <epcurn:eplcis:ist:urn:1234567.000000.68719476746</epcurn:
        </eplcis:ist>
        <action>OBSERVE</action>
        <bizset:epurn:eplcis:cbi:bi:zet:shipping</bizset:epurn:
        <disposition:urn:eplcis:cbi:dis:in_transit</disposition>
        <readPoint>
          <id>urn:eplcis:is:in:061411.07346.1234</id>
        </readPoint>
        <extension>
          <example:Temperature xmlns:example="http://ns.example.com/eplcis">
            31.099
          </example:Temperature>
          <example:Humidity xmlns:example="http://ns.example.com/eplcis">
            21
          </example:Humidity>
        </extension>
      </ObjectEvent>
    </EventList>
  </EPCISBody>
</eplcis:EPCISDocument>
```

TDS – Unification of GS1 Codes

GS1 EPC/RFID

EPC HF Gen 2



EPC UHF Gen 2



GS1 BARCODES

EAN/UPC



9 501101 021037

GS1-128



(00) 3 9501100 000001001 9

ITF-14



GS1 DataBar



(01) 0 9501101 02103 7

GS1 DataMatrix



GS1 QR Code



GS1 Composite Barcode



Everyday  
Object

Attaching

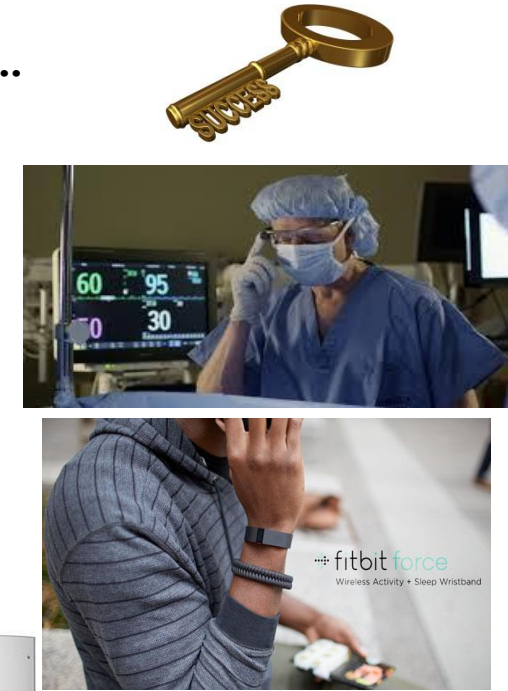
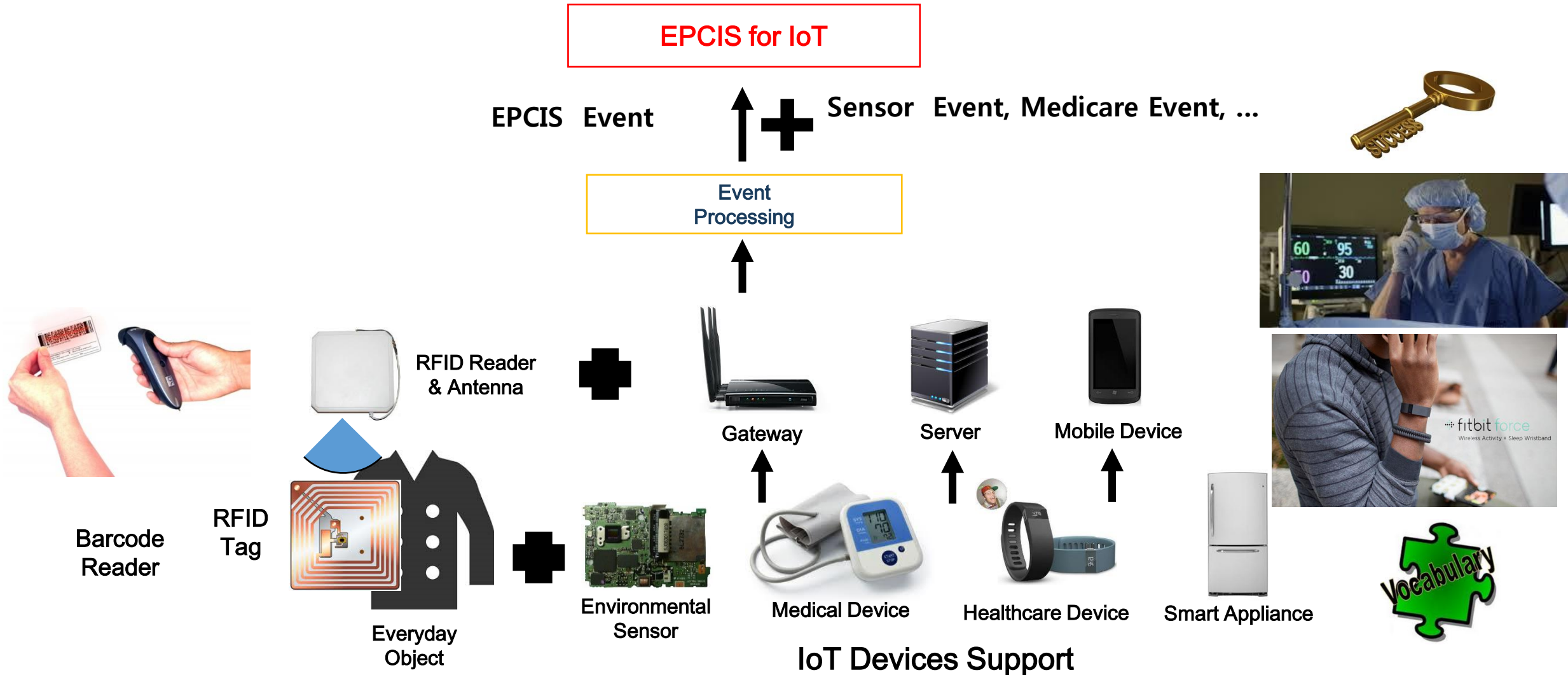
EPC Tag

Attaching

Bar Code



# Eg.) Extending EPCIS (EPC Information Service) Internet of Things Global Data Repository



# Eg.) Extending ONS (Object Naming Service) Internet of Things Service Discovery



The Internet of Things - GS1 France & Afnic major contributors to the ONS 2.0

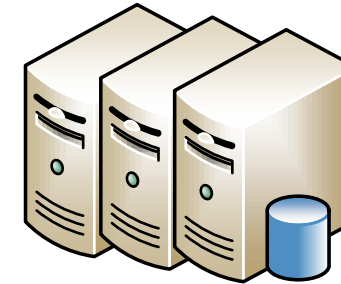
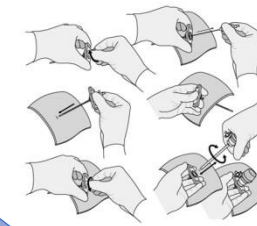
PRESS RELEASE February 18, 2013

GS1 France and Afnic are continuing their cooperation in the Internet of Things, with a view to the global deployment of the ONS 2.0 standard.

## ONS 2.0 Object Name Service

The ONS 2.0 standard, the result of a partnership initiated in 2008 between GS1 France and Afnic, is now available to users. The publication of the standard provides new opportunities for companies that develop services for connecting objects to the Internet. GS1 France and Afnic have played a leading role in the development of this new version of the standard (also called "a federated ONS"), which was ratified and published in December 2012. On the one hand, the international standardization group for ONS 2.0 was co-chaired by GS1 France, and on the other, Afnic was the editor of the compliance specification and played an active role in prototype testing. The respective expertise of each organization has therefore enabled the design of interoperable industrial information systems and innovative services based on the Internet of Things (IoT).

Object Name Service  
(ONS)



Manual Service

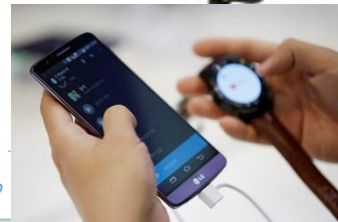
Service list

- manual
- shopping
- epcis
- ...

GS1 ID from  
Reader  
xID from  
Smartphone

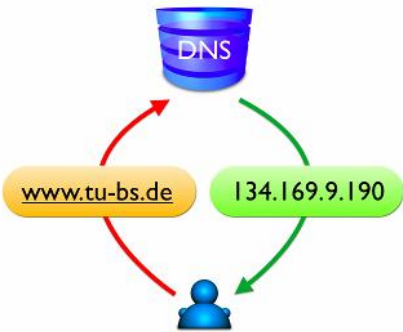
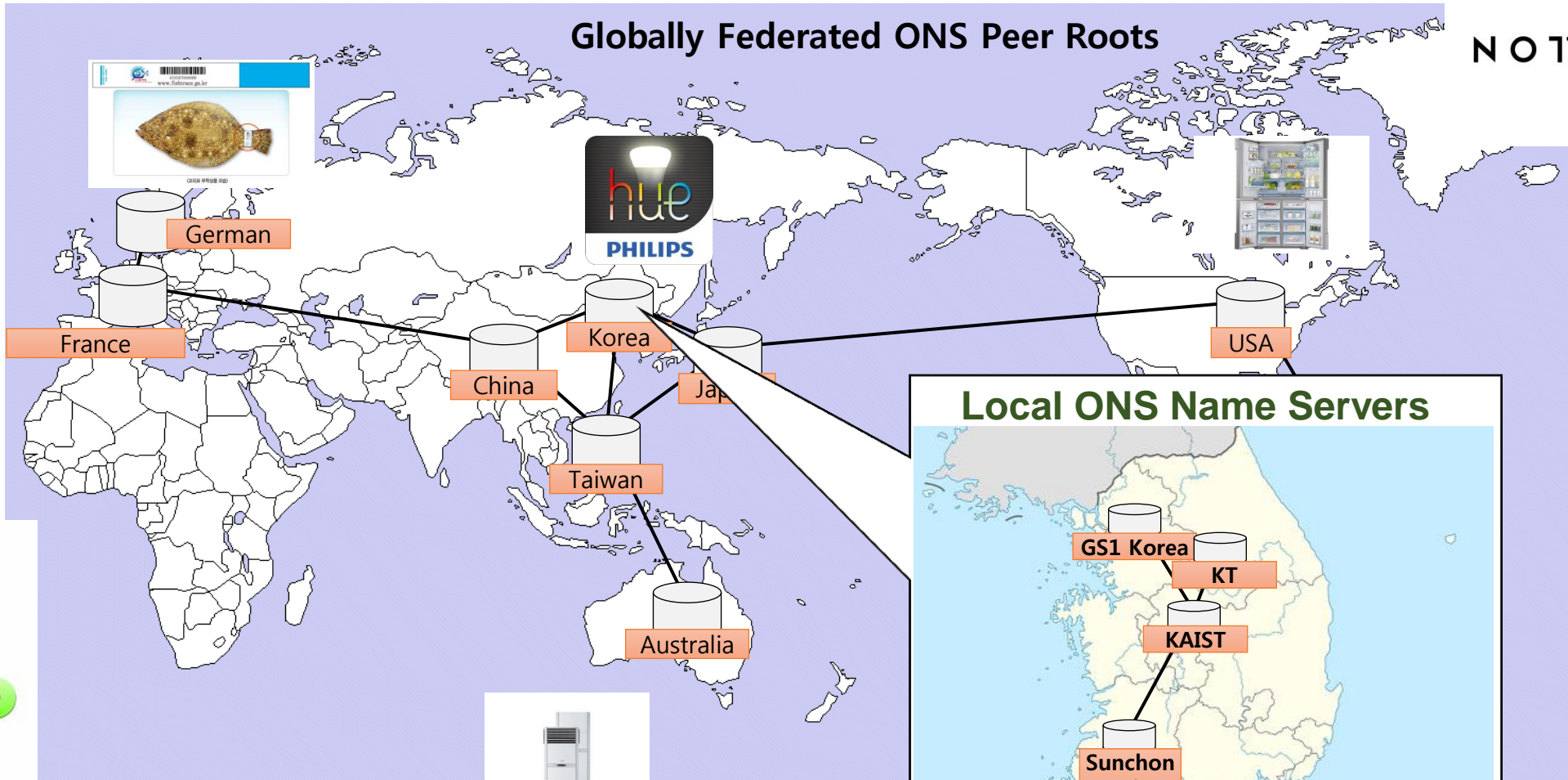
Service  
Access

Service  
Access





# Testbed for Federated Object Naming Services



onsepc.kr  
at KAIST

Slide 33

© Auto-ID Lab Korea / KAIST

# Eg.) Discovery Services for the Internet of Things



- Search for product history
- Search for retailer locations which sell the desired EPC products.



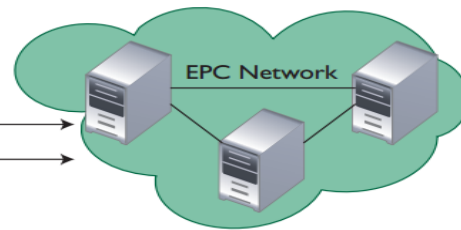
- 1.1 **ObjectEvent:** Items are tagged after manufacturing
- 1.2 **ObjectEvent:** Case is equipped with EPC tag
- 1.3 **AggregationEvent:** Products are linked to case
- 1.4 **ObjectEvent:** Case is identified upon shipping
- 2.1 **ObjectEvent:** Case is identified upon receiving
- 2.2 **QuantityEvent:** Completeness of delivery is checked
- 3.1 **ObjectEvent:** Case is picked by mobile worker
- 3.2 **TransactionEvent:** Case is linked to purchase order
- 3.3 **ObjectEvent:** Case is identified upon shipping
- 4.1 **ObjectEvent:** Case identified upon receiving
- 4.2 **TransactionEvent:** Purchase order is completed
- 4.3 **AggregationEvent:** Products are taken off case
- 4.4 **ObjectEvent:** Case is destroyed

Is the chain of custody intact?



- (a) EPC discovery query for EPCIS URLs
- (b) EPCIS queries for trace history

Supply chain



Discover Nearby EPCIS storing product/thing Information



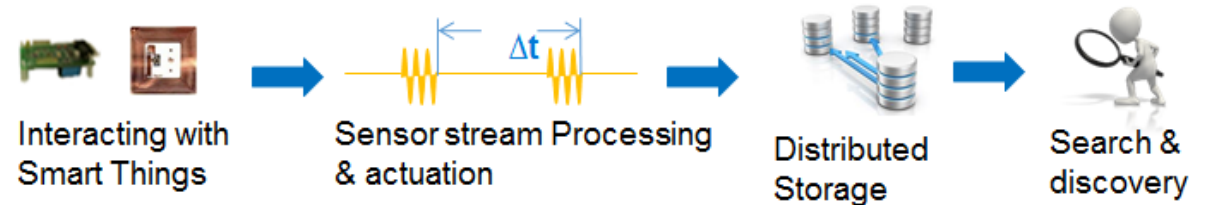
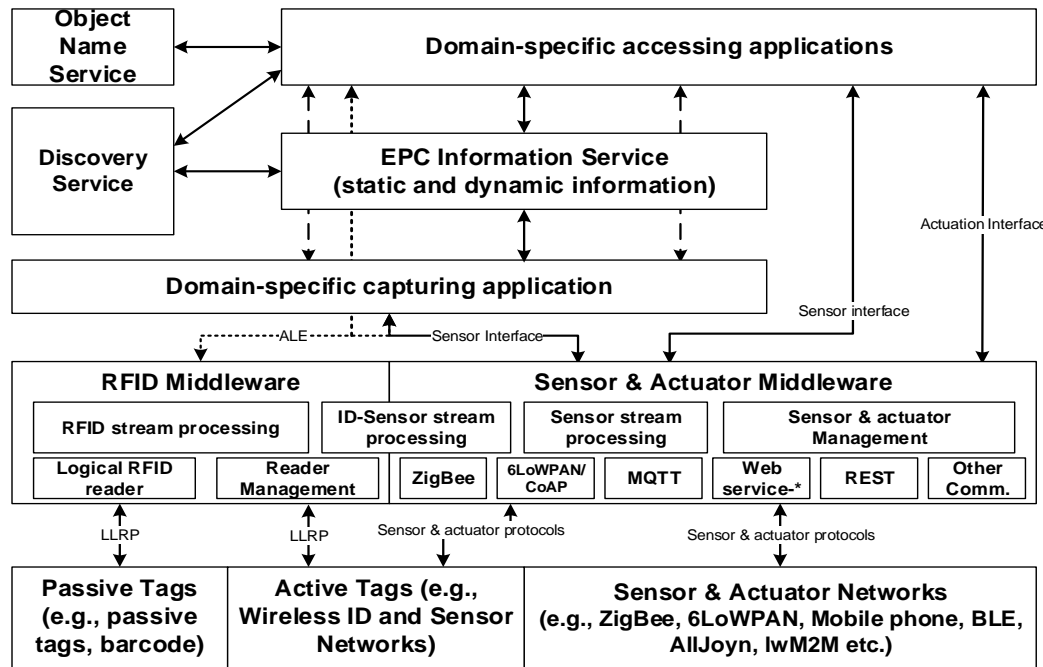
# Open Language for the Internet of Things



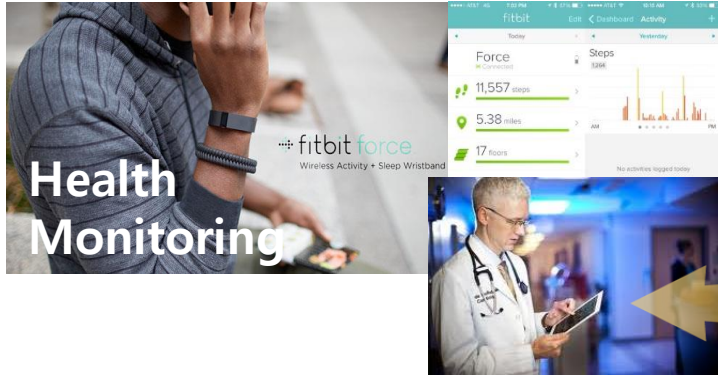
Open Language for IoT (Oliot) is an ID-based IoT framework.



- Based on GS1 standard ID (e.g., URI-convertible GTIN)
- Is to build a ID-based framework to identify, capture, control and share information about smart things



# (CASE STUDY I) Healthcare Application - KAIST Dr. M Project (Season 2 Started)



Analysis  
Prediction

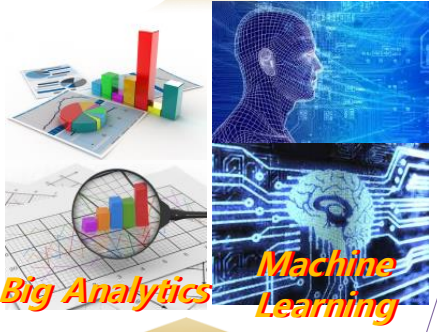
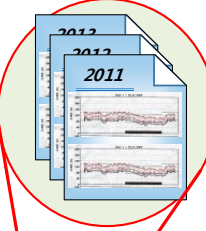
Smart Sensors

**Disease knowledge**

RESEARCH/DISEASE AREA	#P2011
1. CANCER	8816
2. GENETICS	7221
3. PREVENTION	5853
4. NEUROSCIENCE	5623
5. HEART AND CARDIOVASCULAR	5049
6. MEN'S HEALTH	4144
7. WOMEN'S HEALTH	3881
8. INFECTIOUS DISEASES	3664
9. MEDICAL SOCIAL SCIENCE	3073
10. NERVE DISORDERS	3027
11. INFECTIOUS DISEASES	3383
12. NEUROSCIENCE	3333
13. PREVENTION	3272
14. GENETICS	3112
15. HEALTHY DISPARITIES*	2915
16. AGING	2912
17. STROKE AND NEUROLOGY	2828
18. INFECTIOUS DISEASES	2728
19. NERVE DISORDERS	2728
20. INFECTIOUS DISEASES	2728
21. NERVE DISORDERS	2728
22. INFECTIOUS DISEASES	2728
23. NERVE DISORDERS	2728
24. VACCINE RELATED	1917
25. INFECTIOUS DISEASES	1822
26. NEUROSCIENCE	1822
27. INFECTIOUS DISEASES	1822
28. INFECTIOUS DISEASES	1411
29. INFECTIOUS DISEASES	1172
30. HEALTH SERVICES	1078
31. INFECTIOUS DISEASES	1078
32. INFECTIOUS DISEASES	1078
33. INFECTIOUS DISEASES	1078
34. INFECTIOUS DISEASES	1078
35. INFECTIOUS DISEASES	1078
36. INFECTIOUS DISEASES	1078
37. INFECTIOUS DISEASES	1078
38. INFECTIOUS DISEASES	1078
39. INFECTIOUS DISEASES	1078
40. INFECTIOUS DISEASES	1078
41. INFECTIOUS DISEASES	1078
42. INFECTIOUS DISEASES	1078
43. INFECTIOUS DISEASES	1078
44. INFECTIOUS DISEASES	1078
45. INFECTIOUS DISEASES	1078
46. INFECTIOUS DISEASES	1078
47. INFECTIOUS DISEASES	1078
48. INFECTIOUS DISEASES	1078
49. INFECTIOUS DISEASES	1078
50. INFECTIOUS DISEASES	1078

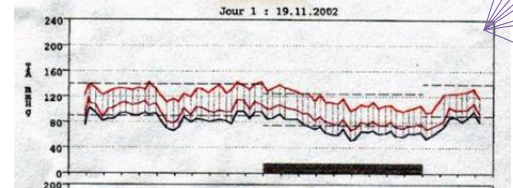
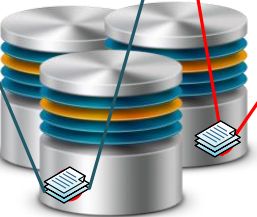
Discover  
Knowledge

Historical Data

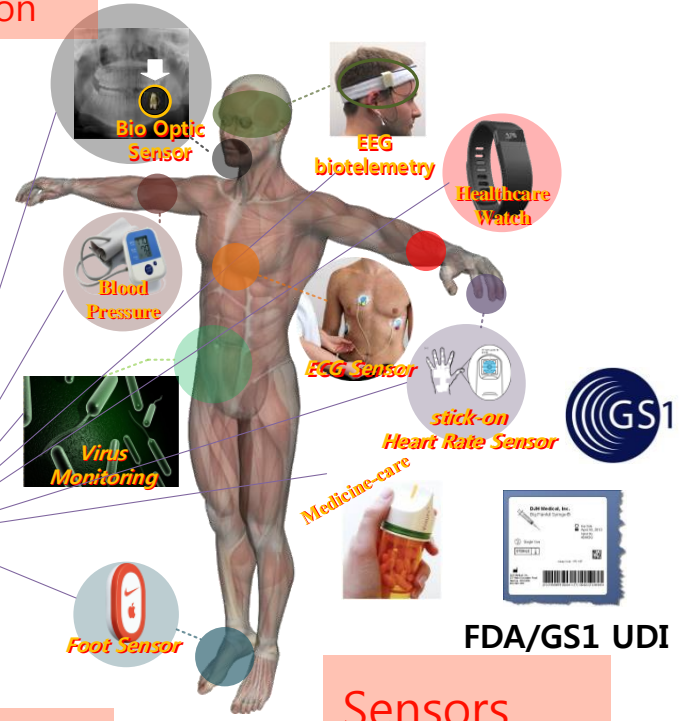


Big Analytics

DrM Database



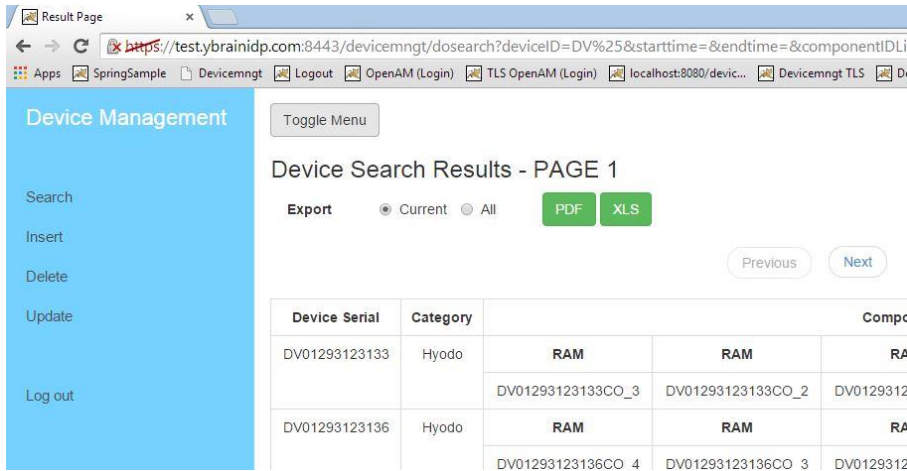
Real-time Monitoring Data  
Communications, IoT Platform



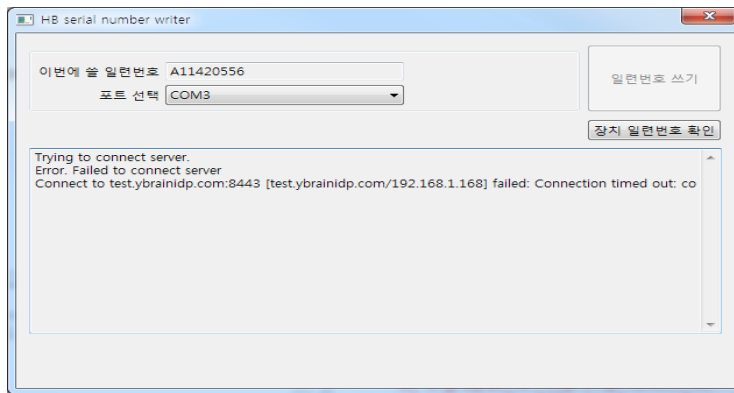
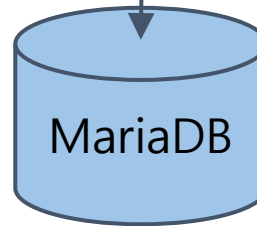
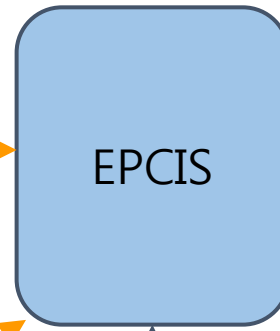
Sensors

FDA/GS1 UDI

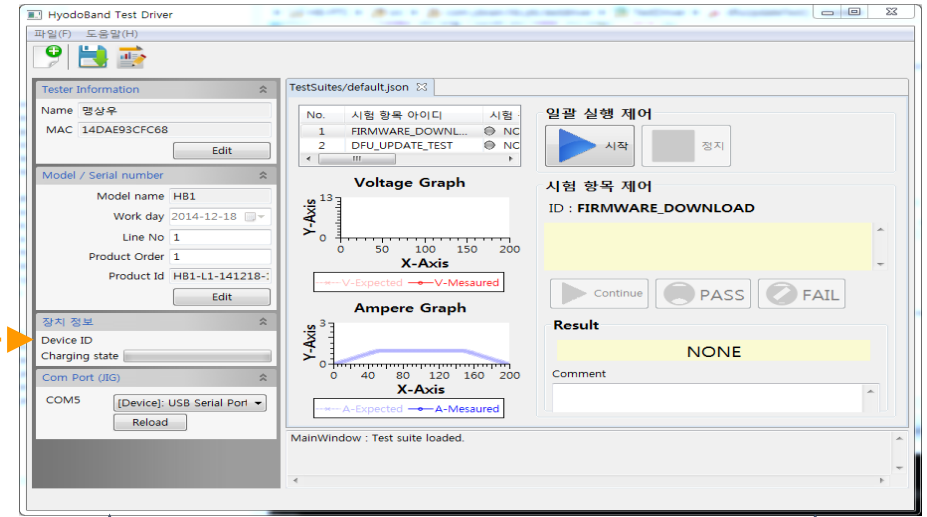
# (CASE STUDY I) Healthcare Application - Ybrain's approach



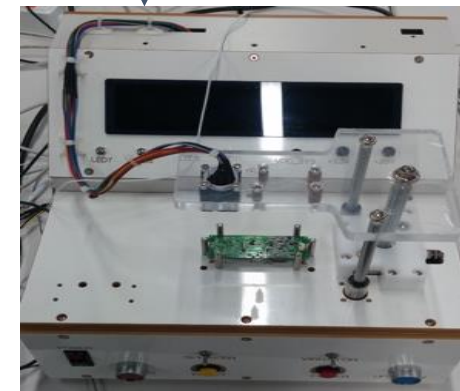
Web-based UI for device management



Manufacturing Support Application  
(UDI assignment & device check)



Test Automation Software



PCB test hardware



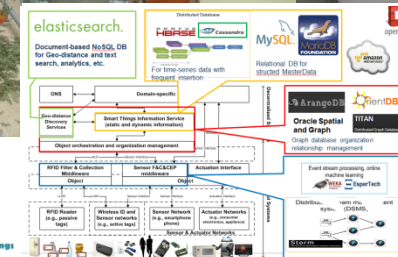
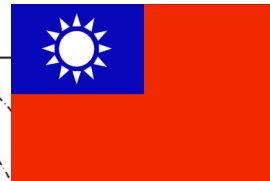
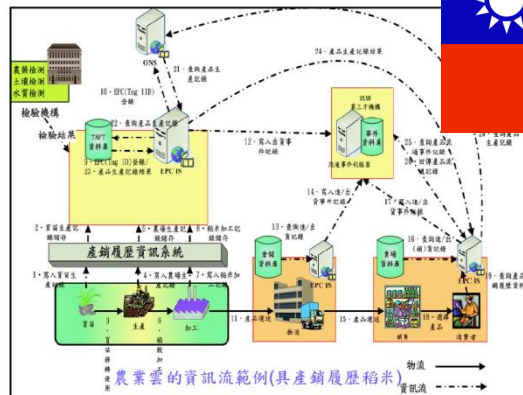
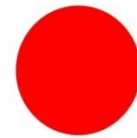
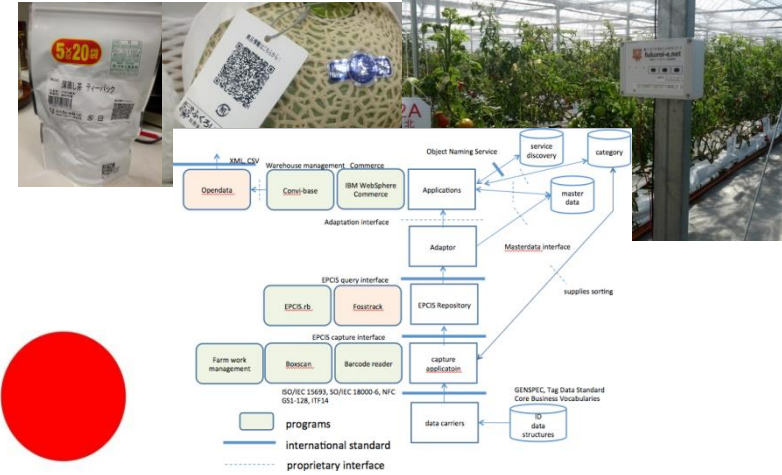
Measurement device



# (CASE STUDY II) Smart Agriculture and Food Safety Systems Pilot Project



- Title: agricultural IoT systems for food safety and quality
- Funded by the High-Tech Development Plan (863) of the Science and Technology (MOST), China.
- Objectives
  - Food safety and quality management
  - Core technologies development
  - Scalable platform and standards
  - Credible platform for government, B2B and end users
  - Business model
  - Pilot project in Shandong and Shanxi province
- Participants: >20 universities, institutes, and companies
- Duration: 2011.1.1-2013.12.31



# (CASE STUDY II) Smart Agriculture and Food Safety Systems Pilot Project



## GS1 표준기반의 균형생산/투명유통/안전소비를 위한 농/축산 클라우드 및 응용서비스





# (CASE STUDY III) Bridge Management

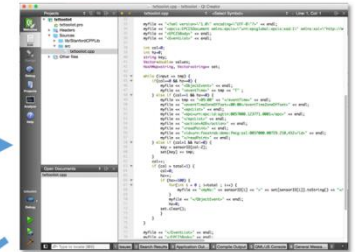


## Embedded Sensor Data



**Stanford ENGINEERING**  
Civil & Environmental Engineering

	Sensor ID			
	VJ-3A-D5G-05	VJ-3A-D5G-01	VJ-3A-D5G-06	
1				
2	2014-01-22 1:34	1689.636108	-698.3094482	503.1740417
3	2014-01-22 1:34	1689.700928	-698.4356689	503.1577454
4	2014-01-22 1:34	1689.700928	-698.4194336	503.1577454
5	2014-01-22 1:34	1689.688843	-698.3257446	503.1577454
6	2014-01-22 1:34	1689.765991	-698.3257446	503.1903381
7	2014-01-22 1:34	1689.717285	-698.2890625	503.2188416
8	2014-01-22 1:34	1689.672607	-698.3745728	503.2840271
9	2014-01-22 1:34	1689.753784	-698.3868408	503.3166504
10	2014-01-22 1:34	1689.733521	-698.3257446	503.1699524
11	2014-01-22 1:34	1689.835083	-698.2727661	503.1577454
12	2014-01-22 1:34	1689.688843	-698.3583374	503.1740417
13	2014-01-22 1:34	1689.506226	-698.2890625	503.1536566
14	2014-01-22 1:34	1689.640137	-698.3053589	503.2229309
15	2014-01-22 1:34	1689.684814	-698.2727661	503.2188416
16	2014-01-22 1:34	1689.737671	-698.2890625	503.3166504



Raw data-to-Oliot Translator (.cpp)

```

<?xml version="1.0" encoding="UTF-8"?>
<oliot:EPCIS xmlns:oliot="urn:epcglobal:epcis:xsd:1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" creationDate="2008-03-06T11:42:15.816-01:00" schemaLocation="http://www.oliot.com/oliot.xsd">
  <oliot:Header>
    <oliot:EventTime>
      <oliot:Timestamp>2014-01-22T11:34:04.000Z</oliot:Timestamp>
    </oliot:EventTime>
    <oliot:AppList>
      <oliot:AppID>1602</oliot:AppID>
    </oliot:AppList>
    <oliot:SensorID>
      <oliot:SensorID>1689.717285</oliot:SensorID>
      <oliot:SensorID>1689.688843</oliot:SensorID>
      <oliot:SensorID>1689.733521</oliot:SensorID>
    </oliot:SensorID>
  </oliot:Header>
  <oliot:Transaction>
    <oliot:TransactionID>16027000.00720.210.4324</oliot:TransactionID>
    <oliot:Product>
      <oliot:ProductID>16027000.00720.210.4324</oliot:ProductID>
    </oliot:Product>
  </oliot:Transaction>
</oliot:EPCIS>
  
```

Oliot-EPCIS Input File (.xml)

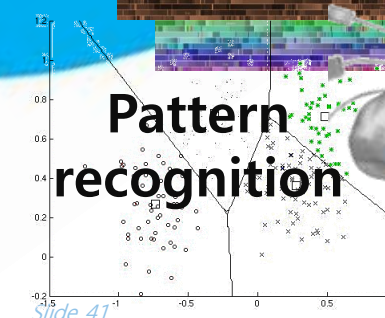
Slide 85

- Object Naming Service (ONS)  
2002:8ff8:6a87::8ff8:6a87
- EPC Information Service (EPCIS)  
2002:8ff8:6a89::8ff8:6a89
- Filtering and Collection (F&C)  
2002:8ff8:6a6c::8ff8:6a6c



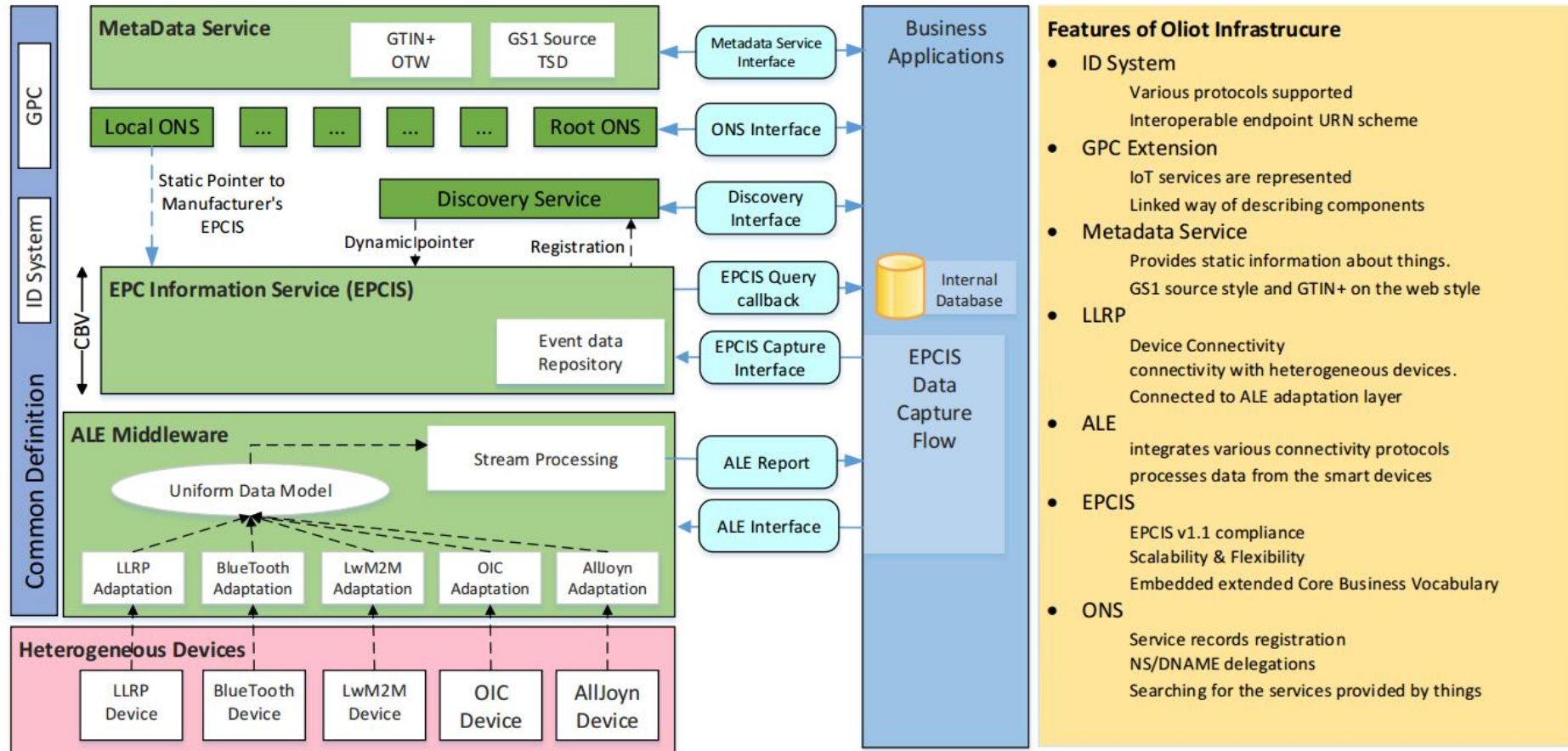
Pattern recognition

Machine learning



Slide 41

# Oliot 2.0



## Features of Oliot Infrastructure

- **ID System**
  - Various protocols supported
  - Interoperable endpoint URN scheme
- **GPC Extension**
  - IoT services are represented
  - Linked way of describing components
- **Metadata Service**
  - Provides static information about things.
  - GS1 source style and GTIN+ on the web style
- **LLRP**
  - Device Connectivity
  - connectivity with heterogeneous devices.
  - Connected to ALE adaptation layer
- **ALE**
  - integrates various connectivity protocols
  - processes data from the smart devices
- **EPCIS**
  - EPCIS v1.1 compliance
  - Scalability & Flexibility
  - Embedded extended Core Business Vocabulary
- **ONS**
  - Service records registration
  - NS/DNAME delegations
  - Searching for the services provided by things

# License (Oliot 1.0)



- Oliot-llrp (EPCglobal LLRP Implementation)
  - Apache License
- Oliot-fc (EPCglobal F&C Implementation)
  - GNU Lesser General Public License (LGPL, v2.1)
- Oliot-epcis (EPCglobal EPCIS Implementation)
  - GNU Lesser General Public License (LGPL, v2.1)
- Oliot-ons (EPCglobal ONS Implementation)
  - Apache License
- Apache
  - You can use the software for any purpose (distribute, modify, distribute modified version of S/W) without concern for royalties
- LGPL
  - As long as you don't modify the source code of Oliot, you don't need to open your proprietary software which is linking to Oliot

# Github Organization “GS1Oliot”



- Repositories for 'Oliot' is powered by 'Github'
- Oliot source code is maintained by a github organization 'GS1Oliot'

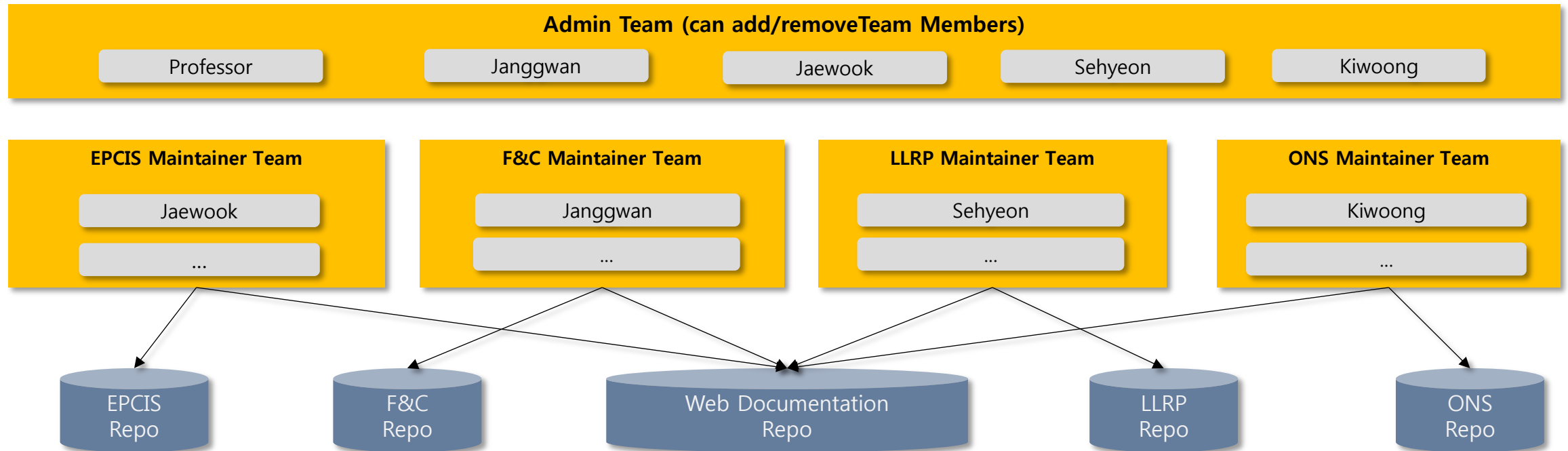
The screenshot shows the Github interface for the 'gs1oliot' organization. The top navigation bar includes the Github logo, a search bar, and links for 'Explore', 'Gist', 'Blog', and 'Help'. The user 'Janggwan' is logged in. Below the navigation, there are tabs for 'News Feed', 'Pull Requests', 'Issues', and 'View gs1oliot'. The main content area is divided into two columns. The left column shows recent activity, including repository creations and user additions. The right column shows a list of repositories with a search bar and a '+ New repository' button. The repository list includes:

Repository Name	Description
gs1oliot/oliot-ons	ONS repository
gs1oliot/oliot-llrp	LLRP repository (ELFIN)
gs1oliot/oliot	Overview page (gs1oliot.github.io/oliot)
gs1oliot/g1oliot.github.io	Forwarding page (gs1oliot.github.io)
gs1oliot/oliot-epcis	EPCIS repository
gs1oliot/oliot-fc	F&C repository

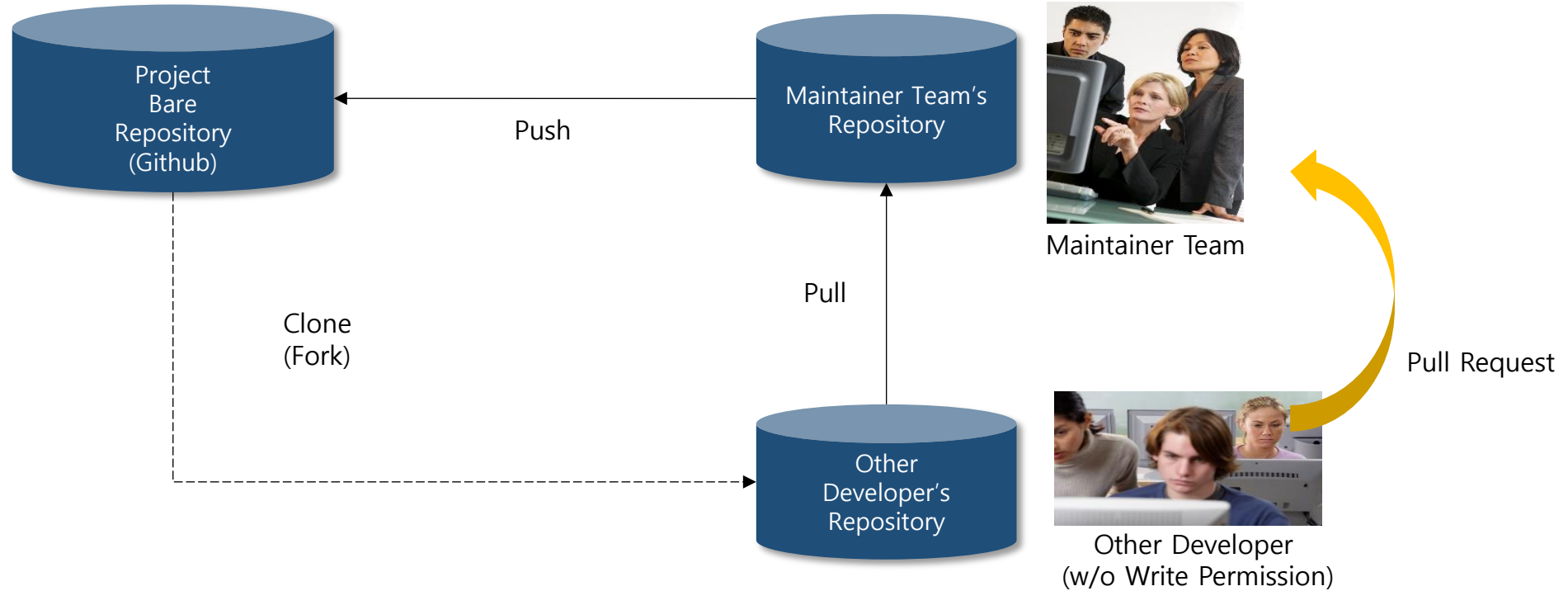
# Teams in GS1Oliot



- GS1Oliot has
  - Admin Team: maintains memberships for other teams
  - Maintainer team: maintains source code for each module



# How do we participate in development?



# Web Page for OIiot Project



- <http://gs1oliot.github.io>
- Overview Page for OIiot Project
- Provides
  - News
  - Links to Github Organization Page
  - Links to repositories



## OIiot 프로젝트란?

OIiot은 바코드, RFID 코드, QR 코드 등 전세계 모든 사물에 표준 코드를 할당할 수 있는 국제 표준기관인 GS1의 코드 시스템과 표준 아키텍처를 기반으로 바코드/ RFID/ ZigBee/ 6LoWPAN 등 다양한 IoT Connectivity 및 프로토콜들을 수용하도록 확장하여, Internet of Things 인프라 플랫폼이 될 수 있는 국제 표준 지향 IoT 플랫폼입니다. GS1의 표준 구현으로도 전세계에 공개될 예정입니다. OIiot은 Open Language for Internet of Things의 약자이며, 또 *olio*는 핀란드어로 사물이란 뜻이고, 스페인어로는 잡탕밥이라는 의미입니다. *oliot*은 *olio*의 복수형입니다.

## GS1과 Auto-ID Labs

Internet of Things라는 용어는 GS1 (<http://gs1.org>)의 국제공동협력연구소인 Auto-ID Labs, MIT (<http://www.autoidlabs.org>)의 Kevin Ashton에 의해 1999년 처음으로 소개되었습니다. GS1 국제표준은 사물 인식을 위한 바코드, RFID 코드, QR 코드 등의 GS1 코드와 이들 식별자를 통해

# Oliot Project Repository Page



GitHub repository page for **gs1oliot / oliot-fc**. The repository is public and has 1 commit, 1 branch, 0 releases, and 1 contributor. The current branch is **master**.

The repository description is: **EPCglobal Filtering and Collection (F&C) implementation by Auto-ID Lab Korea as a part of Oliot project**.

The commit history shows an initial commit by **Janggwan** on 21 May, with files **LICENSE** and **README.md**.

The **README.md** content is:

```
oliot-fc

EPCglobal Filtering and Collection (F&C) implementation by Auto-ID Lab Korea as a part of Oliot project
```

On the right sidebar, the **Pull Requests** section is highlighted with a red box, and the **HTTPS clone URL** section is also highlighted with a red box.

3) Create Pull Request !

4) After review, modifications are applied

2) Develop your code in your local repository!

1) Clone this repository with this URL !



# Mailing Lists



- Mailing lists are the open source community itself, feel free to join!
- You can view the archived mails in the following URL
  
- LLRP mailing list
  - [oliot-llrp@resl.kaist.ac.kr](mailto:oliot-llrp@resl.kaist.ac.kr)
  - <https://groups.google.com/a/resl.kaist.ac.kr/forum/#!forum/oliot-llrp>
- F&C mailing list
  - [oliot-fc@resl.kaist.ac.kr](mailto:oliot-fc@resl.kaist.ac.kr)
  - <https://groups.google.com/a/resl.kaist.ac.kr/forum/#!forum/oliot-fc>
- EPCIS mailing list
  - [oliot-epcis@resl.kaist.ac.kr](mailto:oliot-epcis@resl.kaist.ac.kr)
  - <https://groups.google.com/a/resl.kaist.ac.kr/forum/#!forum/oliot-epcis>
- ONS mailing list
  - [oliot-ons@resl.kaist.ac.kr](mailto:oliot-ons@resl.kaist.ac.kr)
  - <https://groups.google.com/a/resl.kaist.ac.kr/forum/#!forum/oliot-ons>

# Mailing Lists



- You can join the mailing list by clicking 'Join group' button on the previous URL after logging in as any Google account

Google Search for topics

Groups NEW TOPIC Mark all as read Filters

My groups Home My discussions Starred

▼ Favorites Click on a group's star icon to add it to your favorites

▼ Recently viewed Oliot F&C develop...

Oliot LLRP Development Team Shared publicly  
0 of 0 topics ★ Join group 8+1

No topics are available in this group

# Mailing Lists with Related Projects



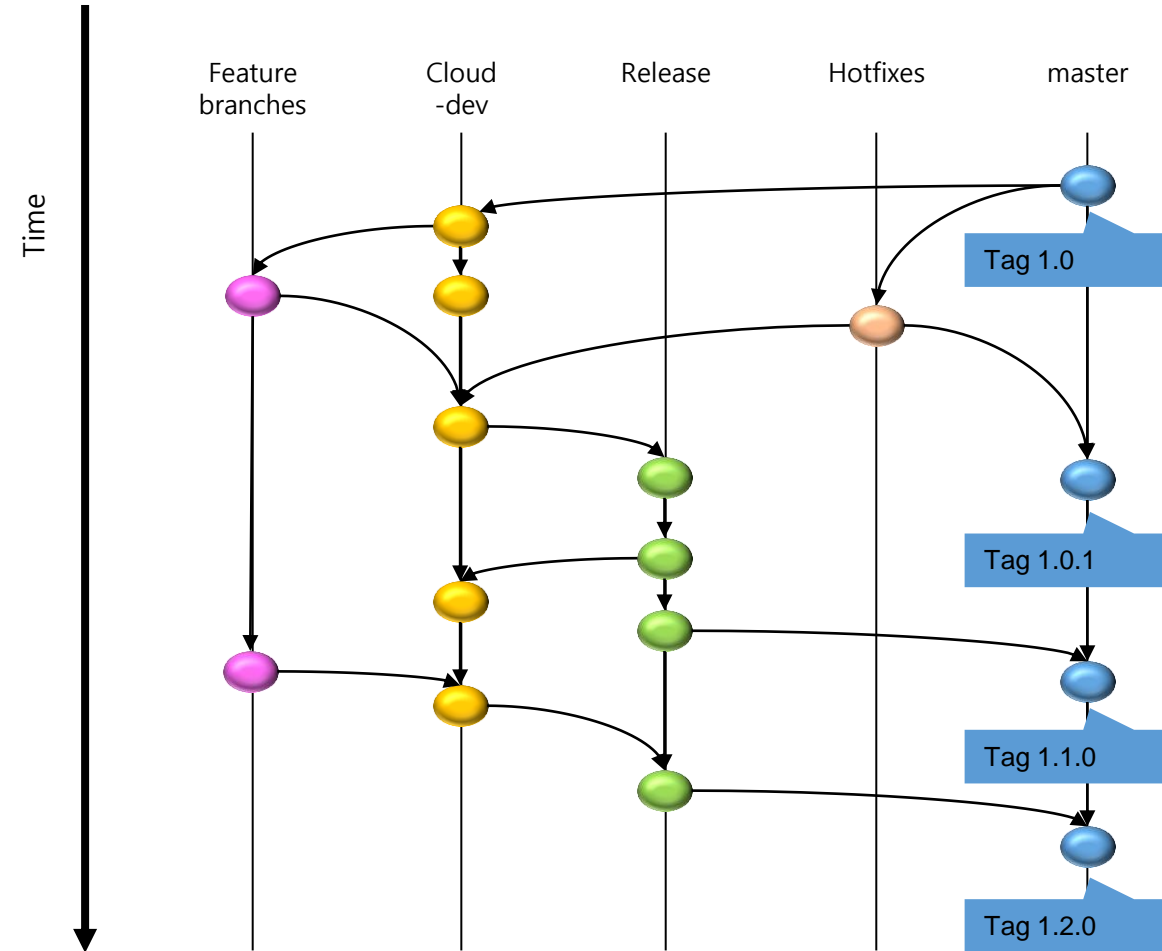
- If we manage our mailing list with that of specification working groups or other related open source project , it brings an advantage for our project to become popular
- LLRP Toolkit Project
  - <http://sourceforge.net/p/llrp-toolkit/mailman/llrp-toolkit-devel/>
- EPCIS and Core Vocabulary Working Group of GSMP
  - [gsmpepcis1\\_1cbvmswg@community.gs1.org](mailto:gsmpepcis1_1cbvmswg@community.gs1.org)

GS1 GSMP: GS1 Global Standards Management Process

# Branch Management



- Branch 'master'
  - Maintains source code, not used for workspace
  - Used to version release with git tag
- Branch 'release'
  - Hotfix and feature branches are merged in merge-window period
- Branch 'hotfix'
  - For emergent patch after release
- Branch 'cloud-dev'
  - Used for cloud-specific feature
  - Integration of other features
  - Source of release branch
- Feature branches
  - Used for feature development
  - Manages independent branch for each feature
- Version Release
  - Release with git tag in master branch after branch 'release' is merged to branch 'master'





- July 7 2014 – oliot 1.0 (latest implementation of EPCglobal framework, run on any cloud and supporting mysql and cassandra)
- 2Q 2015 – oliot 1.1 (provide EPCIS 1.1, strengthened to support food industry)
- 2015 – oliot 2.0 (support internet of things, merging auto-id lab, KAIST's Epc sensor network, STIS and more)

We are hiring and inviting open source project experts!!!



# Thank you!