R&D of energy Internet of Things in Korea

Towards KEPCO IoT tech.

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KEPCO

Contents

Introduction

Target:

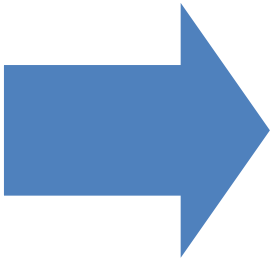
- To introduce **KEPCO 4.0 key technologies** including **IoT**(Internet of Things), Big Data, AI(Artificial Intelligence) for **Digital KEPCO**, **Open KEPCO**, and **Connected KEPCO**

Network Paradigm

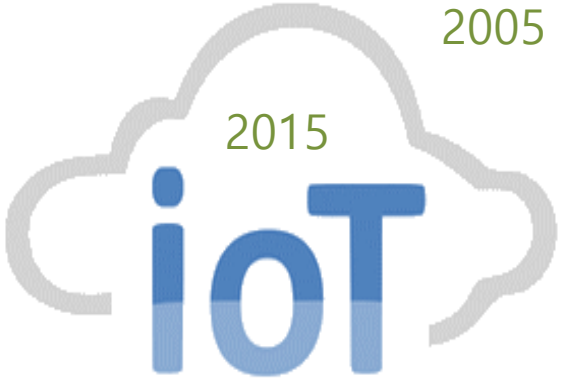
Generic Communication	Power Communication

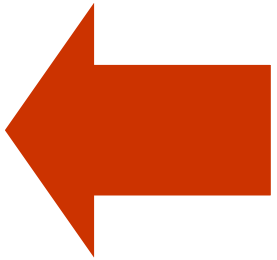
Next-generation Network

BcN



2015





PLC, Digital TRS

2005 Power IT

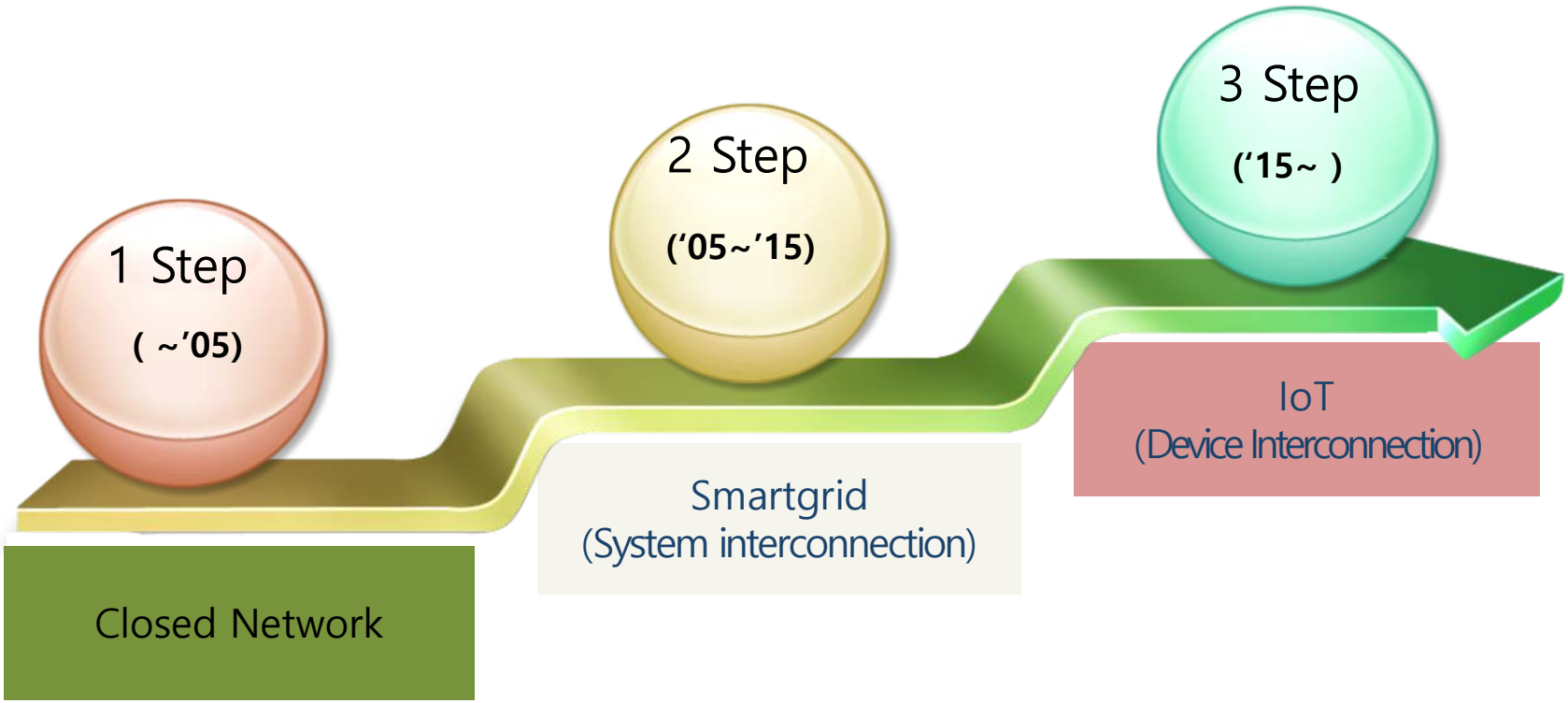
Ubiquitous Network

USN, M2M

Remote Metering Infra

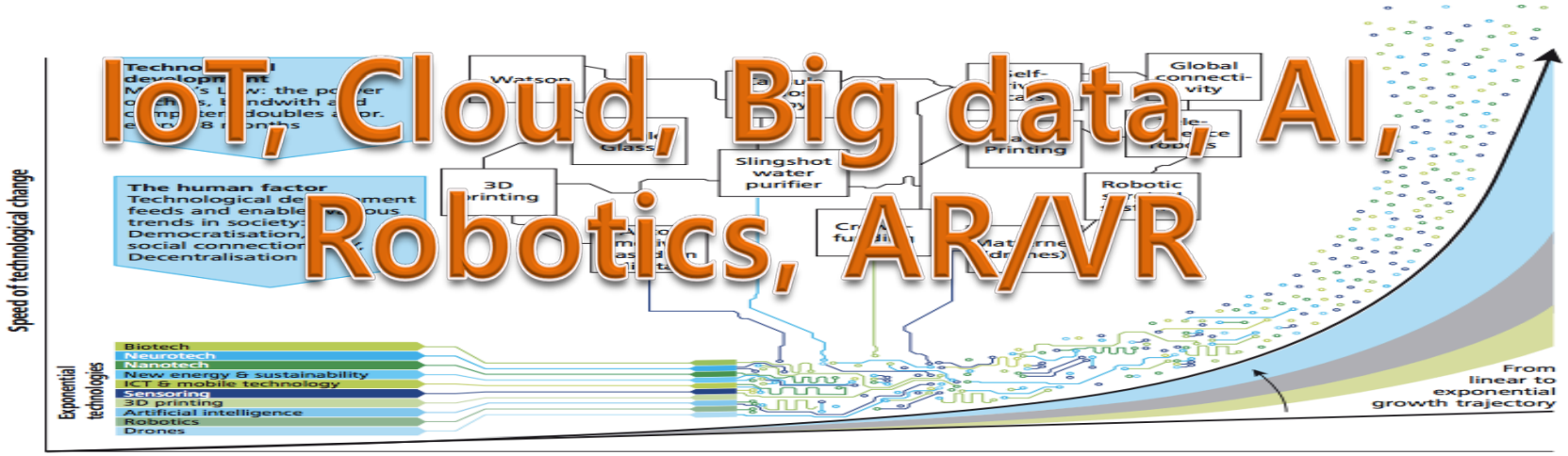
2010 Smart Grid

KEPCO IoT platform Needs



"Establish infrastructure to pioneer new industry in energy IoT sector"

4th Industrial Revolution Technology



Source : Deloitte

KEPCO 4.0 Key Issues

① IoT (Internet of Things)

② Digitalization

③ Big Data

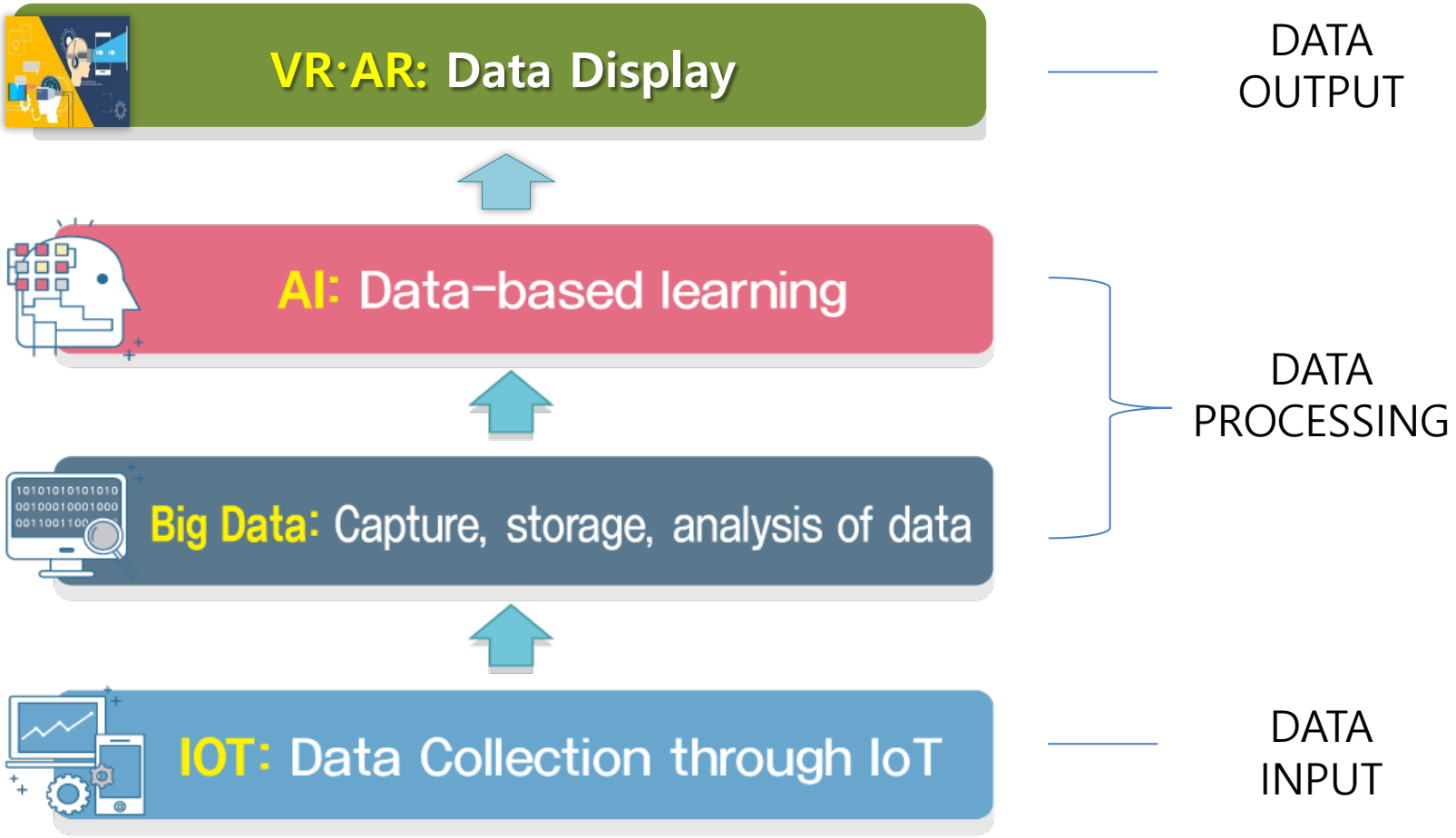
④ AI (Artificial Intelligence)

⑤ CPS (Cyber-Physical System)

⑥ Robotics

⑦ M2M (Machine to Machine)

Virtuous Circle of IoT, Big Data, AI

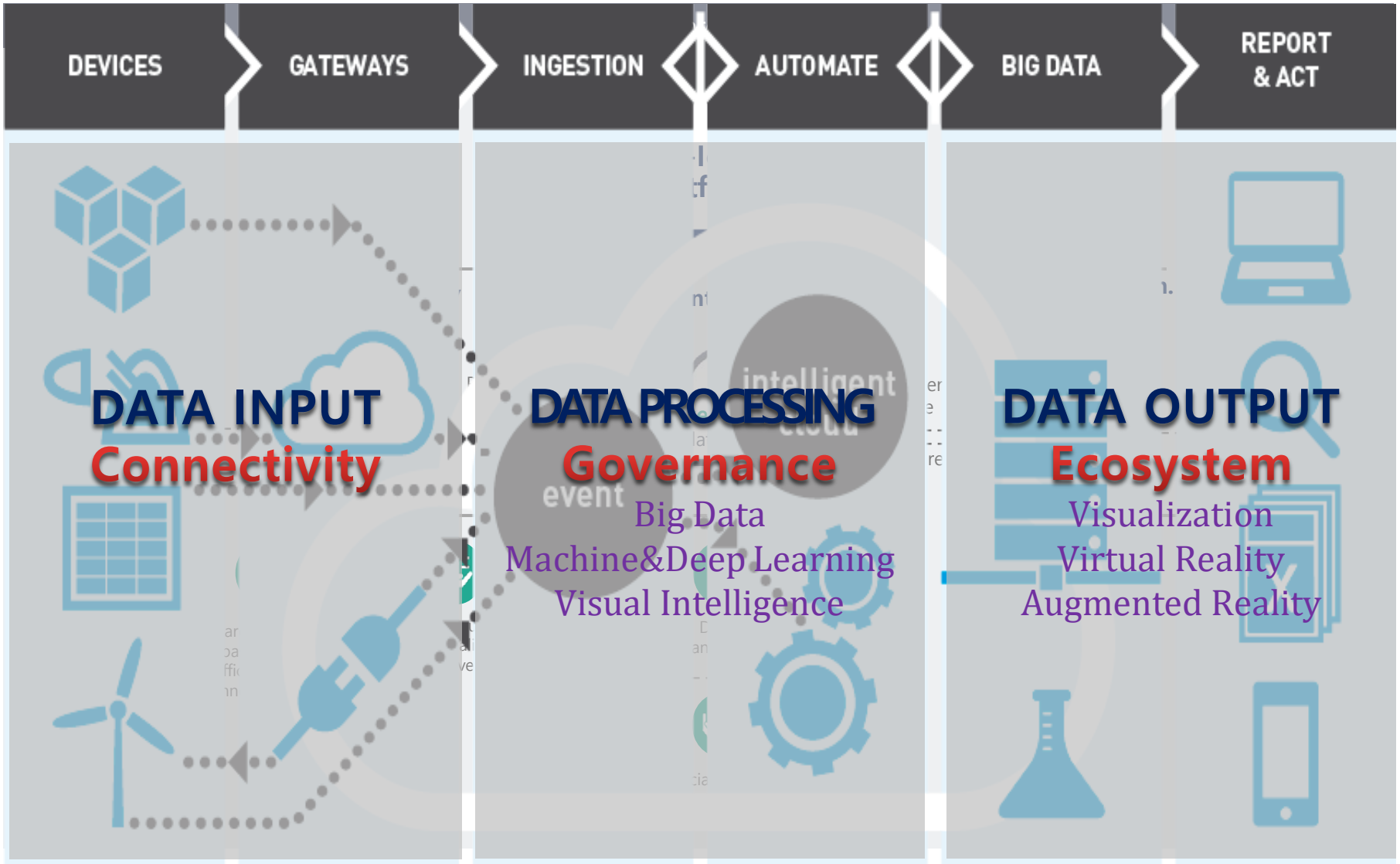


Source : I-ON Communications Blog

Technology development based on Data Science

Enterprise	Technology	Case
C3IoT	**IoT Platform**	• Utilities Assets, data analysis and value creation opportunities • Engie : Company-wide introduction of 'Digital Transformation' • Enel : Introduction for smart meter data analysis and use
GE	**Predix**	• Supports SW development by analyzing large-scale on-site data • IoT and Data analysis platform based on Industrial Internet • Expanded application to aviation, power generation, transportation, medical, and power grid • Utilizing utilities worldwide
SIEMENS	**MindSphere**	• Cloud based IoT platform • Provides data management and storage analysis for application development for user's purpose
ABB	**Ability**	• Cloud-based data collection, analysis automation solution platform • Mainly providing solutions for power networks and facilities
SAP	**HANA**	• Data-lifecycle management service with cloud-based data platform • 51 solution services for utilities

KEPCO IoT(e-IoT) Architecture



KEPCO IoT(e-IoT) Standardization

Standardization → Platform → Eco-system

oneM2M Global Certi.

(June, 2016)

KEPCO Standard

(September, 2016)

TTA Grand Prize

(December, 2016)

대상 한국전력 'e-IoT 에너지플랫폼/게이트웨이'

지능형 전력망 구현할 오픈 플랫폼

김동섭 전력연구원장

'2016 TTA 시험인증 대상' 대상은 한국전력의 'e-IoT 에너지 플랫폼/게이트웨이'에 돌아갔다.

전력 현장에 설치된 사물인터넷(IoT) 센서 데이터를 수집·분석·처리하는 솔루션이다. 전력시스템에 IoT를 접목, 지능형 전력망을 구현하는 플랫폼이다. 에너지 신산업을 발굴하기 위한 기반 인프라로 활용될 예정이다.

e-IoT 에너지 플랫폼은 IoT 전용망인 로라(LoRA)와 와이선(Wi-Sun) 기술을 활용한 세 개 영역으로 구성된다.

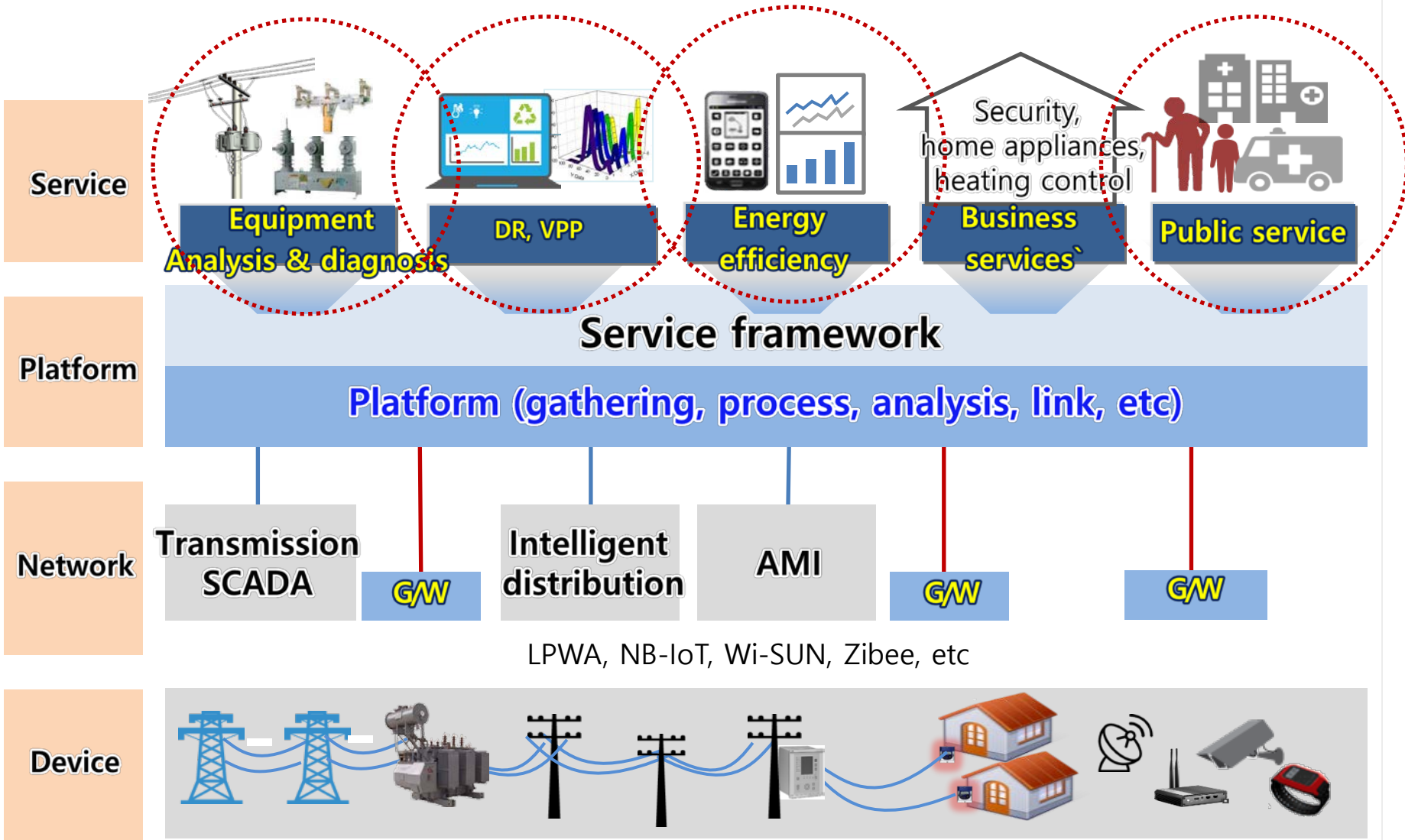
'커넥티비티' 영역은 원엠투엠(oneM2M) 국제표준을 토대로 다양한 센서를 수용하고 데이터를 실시간 수집·처리한다. '거버넌스' 영역은 전력정보와 센서 정보를 실시간 분석한다. '에코시스템' 영역은 개방형 프로그래밍인터페이스(Open API)를 제공, 개발자를 지원한다.

김동섭 한전 전력연구원장은 "누구나 손쉽게 전력 분야 신서비스를 창출할 수 있는 개방형 IoT 사업 환경을 구축, 세계 표준과 트렌드를 주도하겠다"고 말했다.

SPIN (Smart Power IoT Alliance)

(October, 2016)

KEPCO IoT(e-IoT) for Power facilities Mgmt.



ICT R&D Status and Future

Target:

- To introduce **on-going IoT R&D projects**, its **Road Map** related to ICT Technology, and **R&D Strategy** for **4th Industrial Revolution Technology**

On-going Project (1)

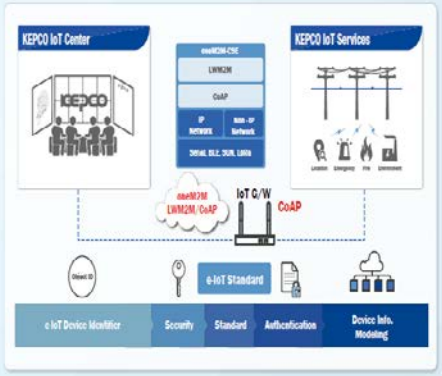
No.	Project
1	Development of energy platform and gateway based on IoT

IoT Standard

e-IoT Standards

e-IoT standards are KEPCO's internal standard that is established for its energy power businesses in IoT field. Through this standard, it is possible to connect the IoT devices (sensors and actuators), planned to be implemented to KEPCO's diverse utilities, and collect and control the measured data.
The standard also defines the "IoT information modeling" and "interface specification" to transfer the collected data to the e-IoT platform.

Architecture



Energy IoT Standards

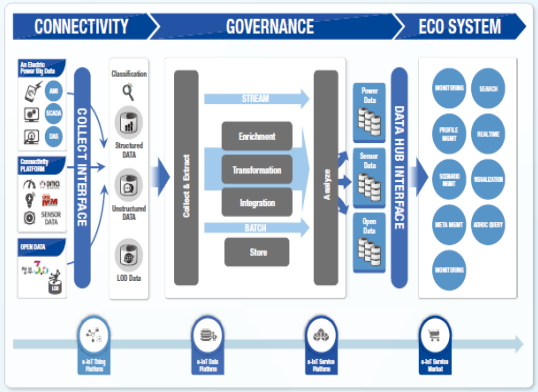
Features

- e-IoT standard optimized for KEPCO IoT services, based on oneM2M and LWM2M
- Light-weight CoAP and LWM2M module optimized for e-IoT devices
- LWM2M Light-weight registration method for narrow band wireless networks
- Proved Interoperability through oneM2M Interop and OMA LWM2M Testfest
- Globally unique OID assigned for KEPCO e-IoT device, and resource
- LWM2M gateway proxy function for e-IoT devices

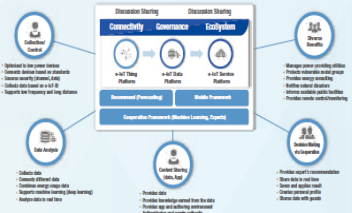
e-IoT Platform

An e-IoT platform is enabling connectivity among "things" or devices. The architecture may also consist of a CONNECTIVITY platform, a big data GOVERNANCE platform or an analytics platform, an ECO platform.
KEPCO has been certified by oneM2M Telecommunications Technology Association (TTA) Verified.

Configuration Diagram



Functions



Features

Collect data based on open e-IoT platform
Collect diverse data such as location, environment, bio, video (image), etc.

Combine diverse energy data and find new value
Combine diverse data with energy usage pattern data to find new values.

Comply with international e-IoT standards
Follow international standards for e-IoT ID system, service, security (channel, data), and architecture so that it is possible to connect to other IoT industries easily.

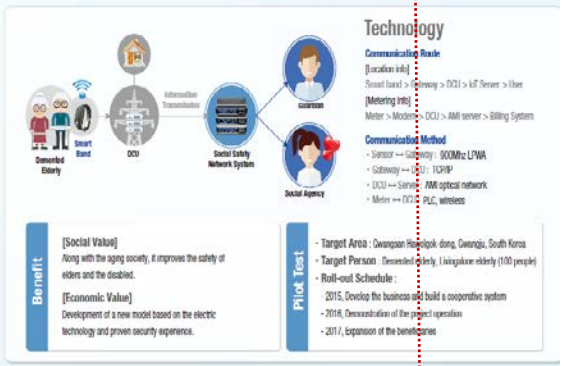
Manage energy-providing utility
Utility poles, wires, insulators, underground structures / transformers / cables, underground transformers, and relevant switches, etc.

e-IoT Social Safety Service

KEPCO provides 'New Social Safety Service' to the public, using Electric facilities & IoT technology

SSN(Social Safety Network) provides the location service that prevents missing of senior citizen using ICT facilities on a utility pole across the country. It also provides the service that notifies family members or social workers if there is any abnormality of the senior citizen by checking electric usage periodically.

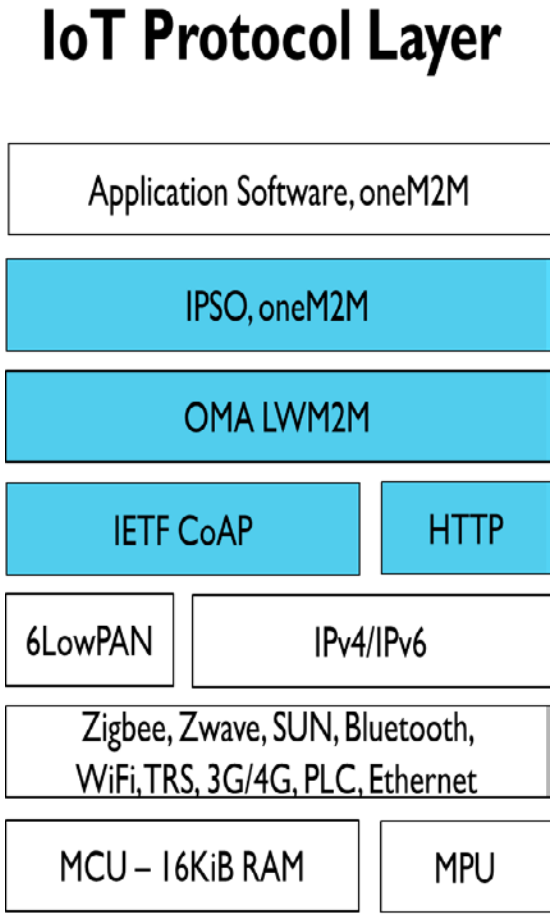
Configuration

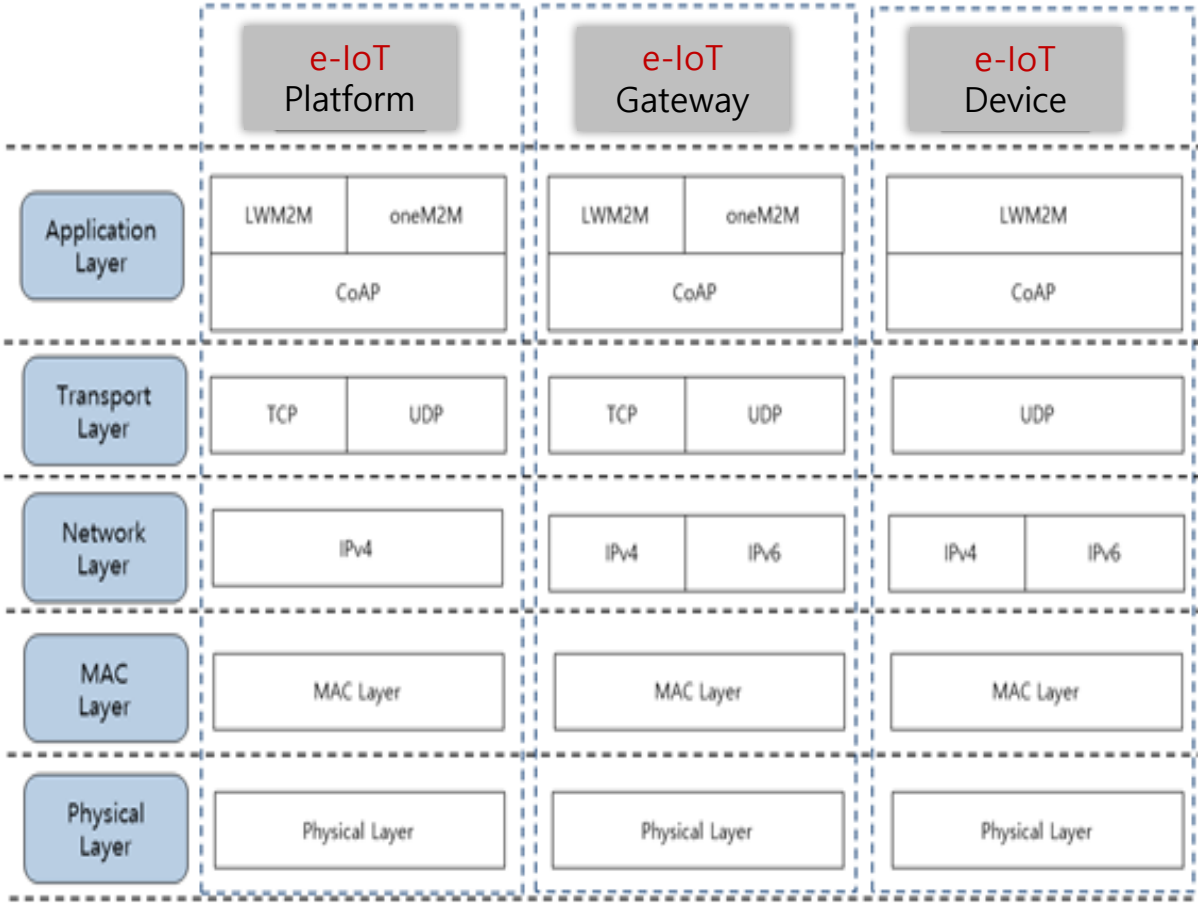


Diagram

Equipment

Perspective on Protocol (IoT)





On-going Project (2)

No.	Project
2	Construction Project of New Energy Industry Software Convergence Cluster

IoT over VR&AR

Power-Gen Europe(2017.6, Germany)

e-IoT Based Realistic Power Facility Visualization Solution

Features

- Development of virtual power maintenance facility, combining IoT and VR technology

  - Virtual reality simulator
  A technology that guides the field worker in the 3D simulation space(using real 765kV Transmission tower data in GoChang)
  - Experience of transmission tower:
  A technology that helps field workers to virtually experience transmission tower maintenance

Specifications & Benefits

- H/W
  - 3D VR simulator implementation using HTC Vive
  - HMD 2160 × 1200 resolution and 3D 360 rendering support
  - Support for virtual activity space within 5 meter
- S/W
  - 3D modelling based on actual measurement error (less than 1cm, using Lidar scan data)
  - Transmission Tower 3D UI and UX using Unity 3D engine
  - Transmission Tower 3D road view and control service

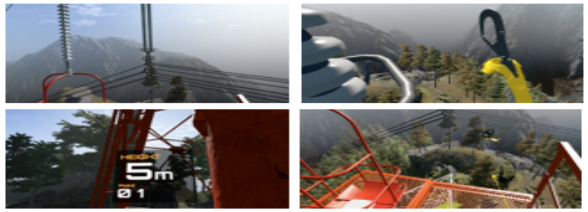
Applications

- Eco System
  - Experience of power facility maintenance
- Integration of energy IoT & energy Big-data
  - Visualization of facility information

1. Collection Real Data

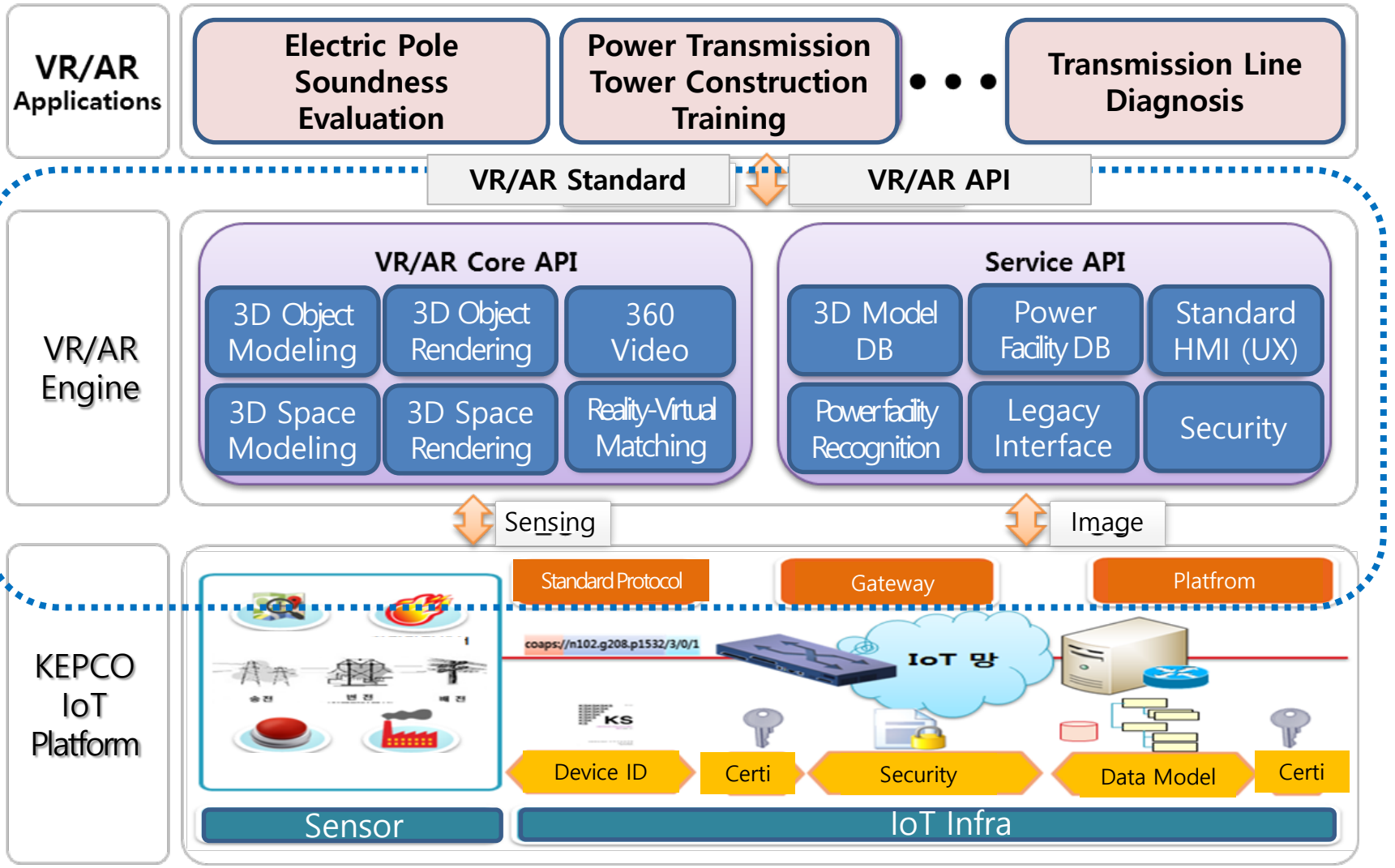
2. Transmission tower 3d modelling using real data(using Lidar scan data)

3. Transmission Tower VR Contents



[Experience of VR Transmission Tower using HMD]

Perspective on Protocol (IoT over VR· AR)

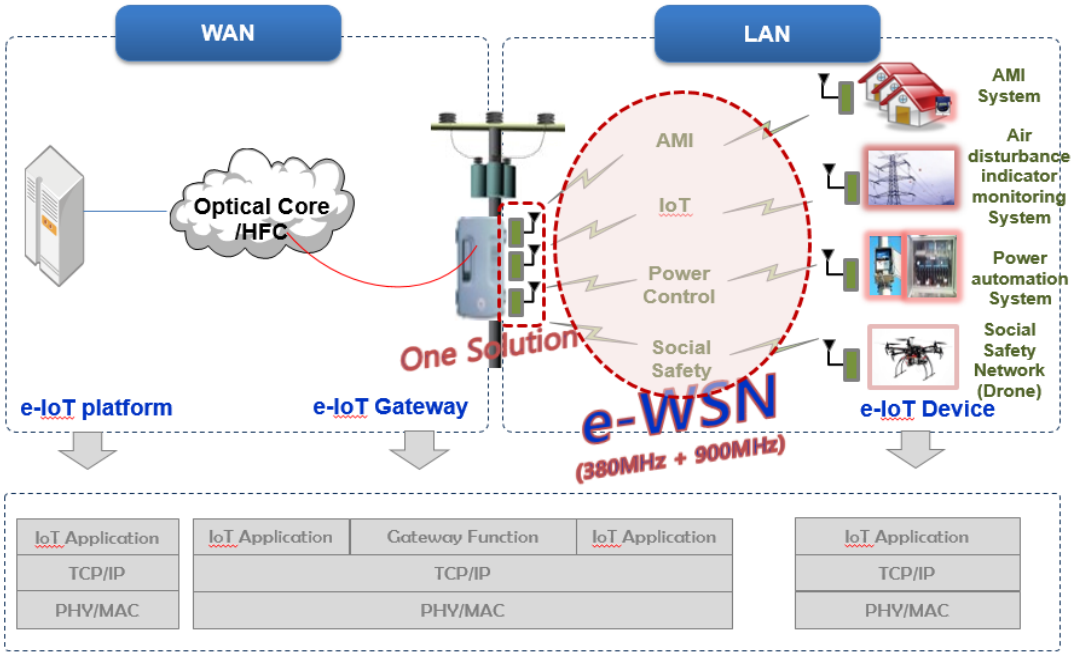


On-going Project (3)

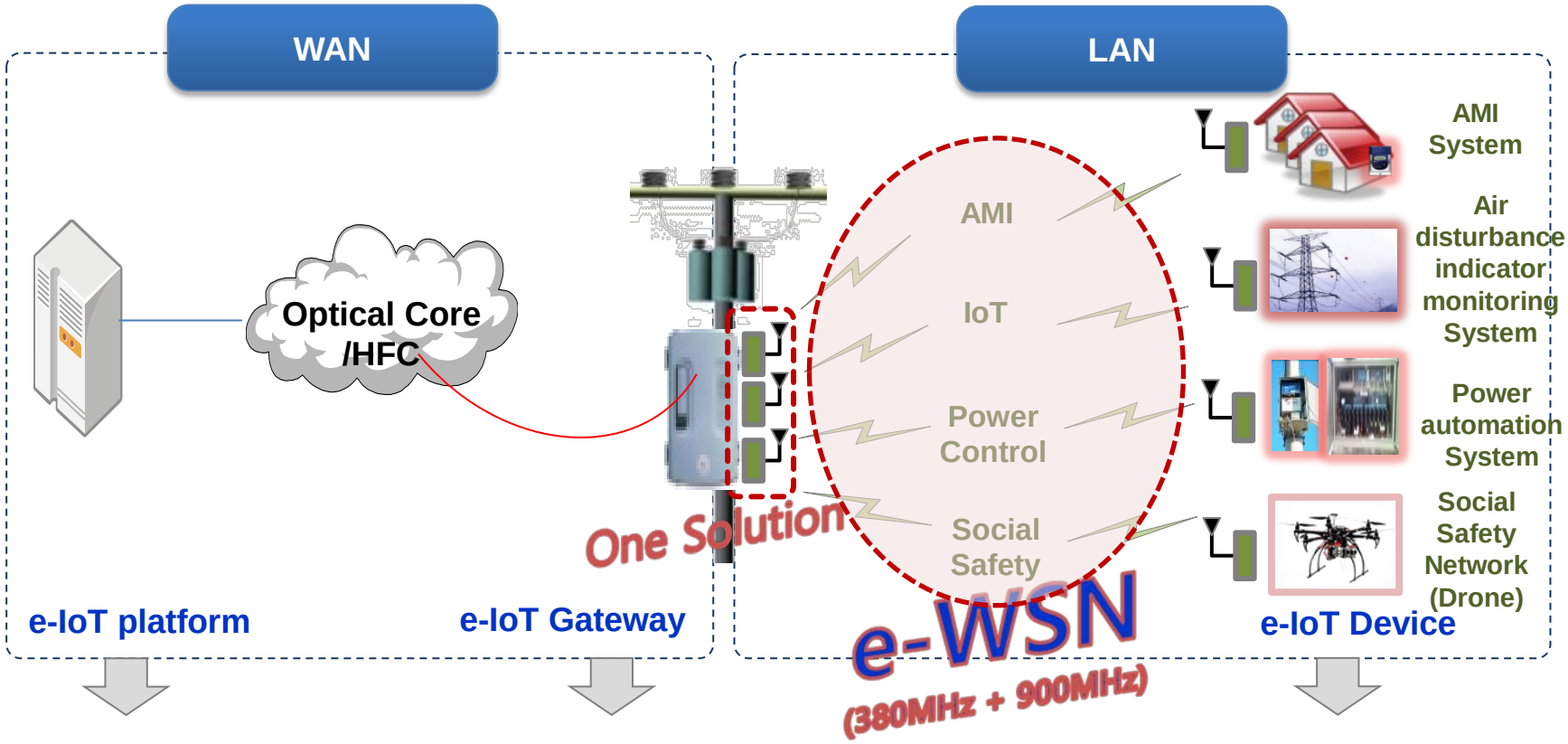
No.	Project
3	Development of Wireless Communication Systems for 380㎒ band

IoT Wireless Network

- ❖ IEC (International Electrotechnical commission)
- ❖ IEC White Paper show that the Market Strategy Board will identify key technology trends, eight different themes.



Perspective on Protocol (IoT Wireless Comm.)

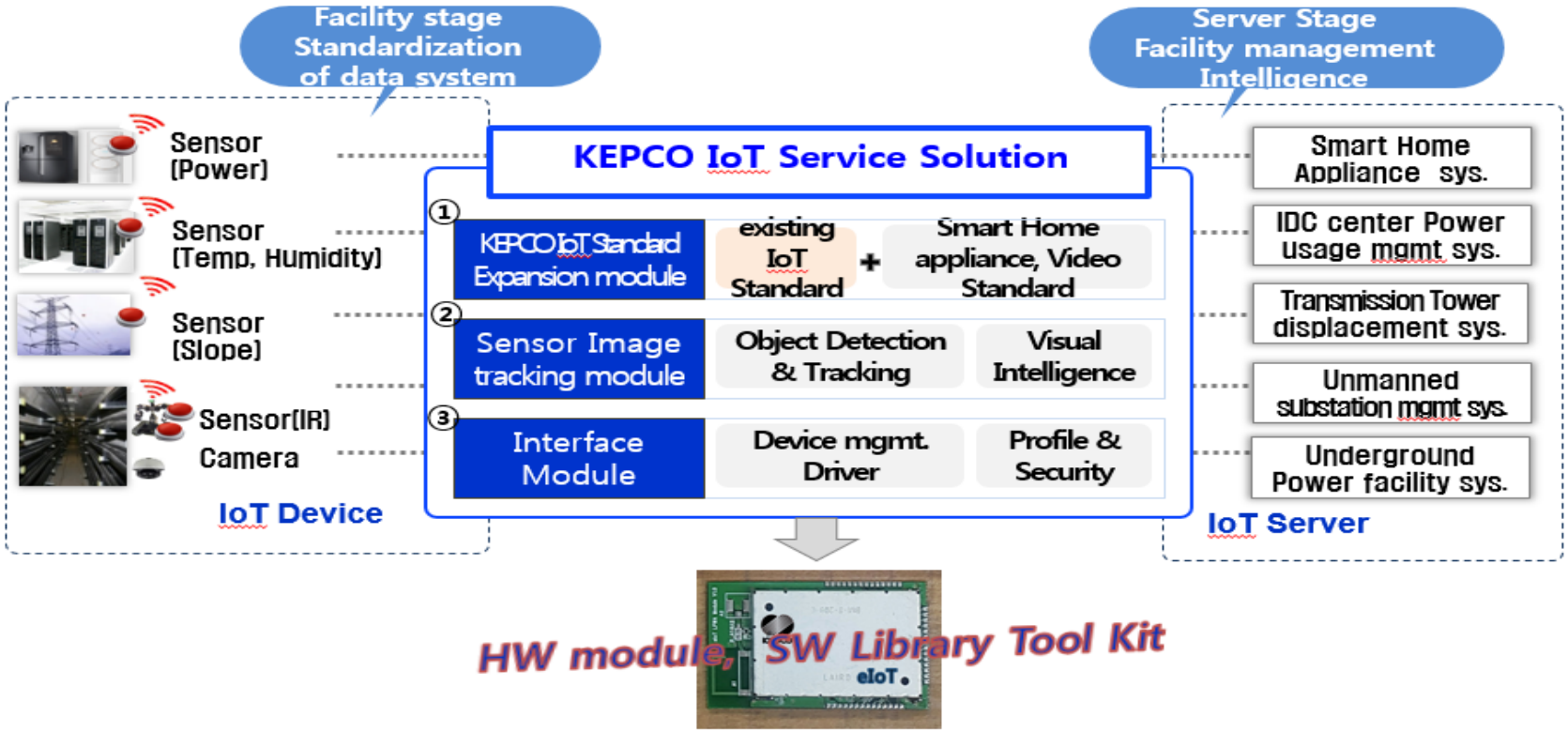


IoT Application	IoT Application	Gateway Function	IoT Application	IoT Application
TCP/IP	TCP/IP			TCP/IP
PHY/MAC	PHY/MAC			PHY/MAC

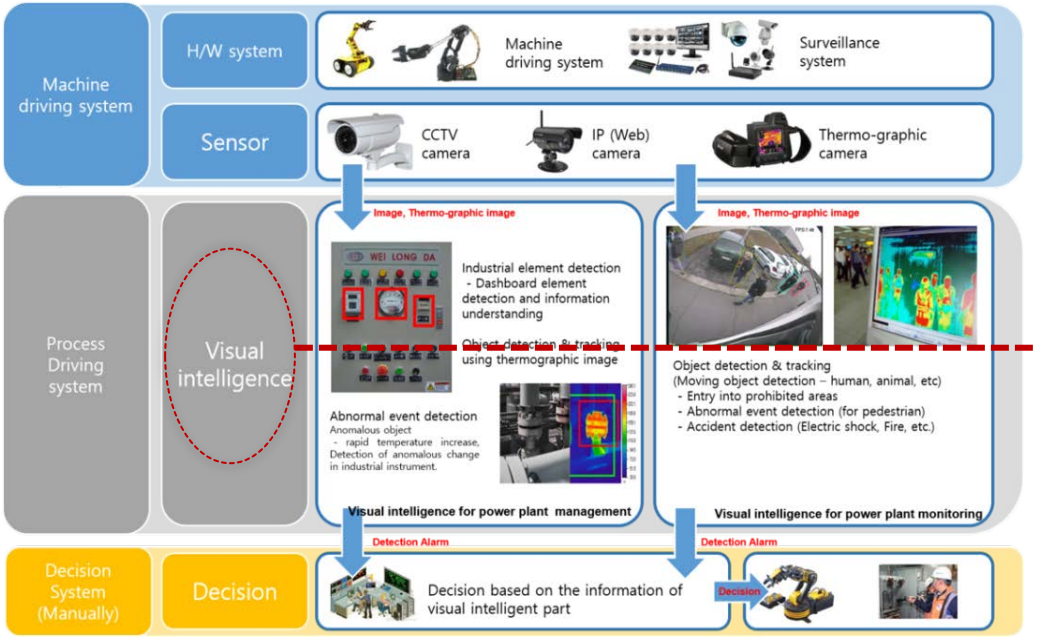
On-going Project (4)

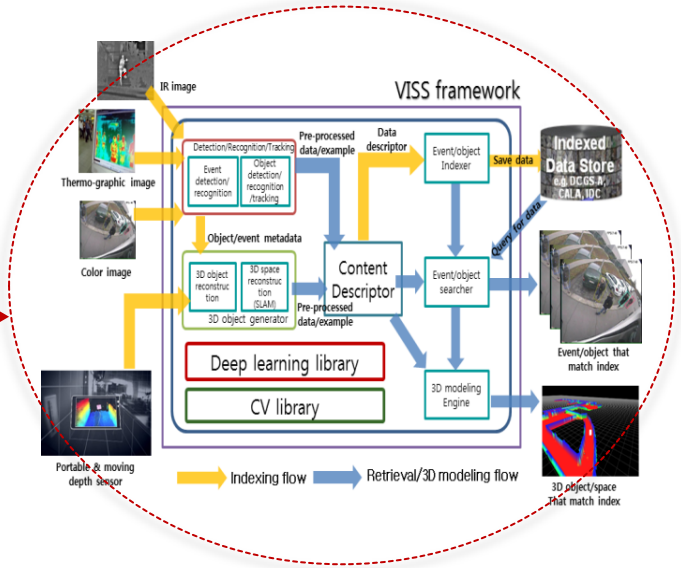
No.	Project
4	Development of IoT Common Solution and Application Technology for Electric Power Service based on International Standards

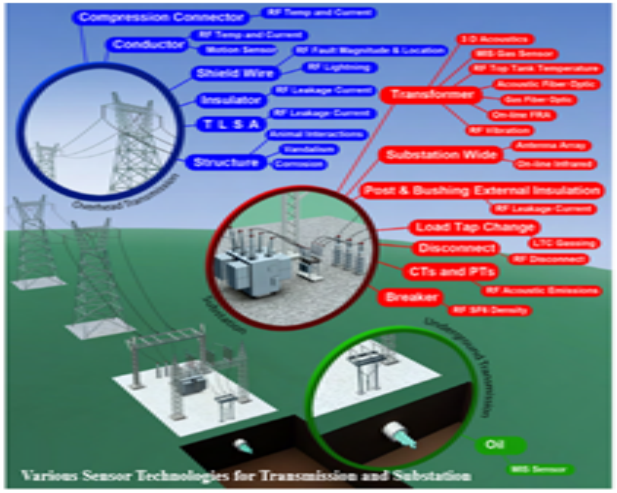
IoT Service Solution



Perspective on Protocol (Visual Intelligence)







- Object detection, identification & Tracking(Area Surveillance)
- Thermal image analysis(Underground Transmission Tunnel)
- Using machine learning technology enabled on a mobile robot deployed at an unmanned power substation.

R&D Strategy for 4th Industrial Revolution

4th Industrial Revolution Technology (industry4.0)

1. **CPS**(Cyber Physical System)
2. **AR(Augmented Reality)**
3. Smart Sensor
4. **Industrial IoT**
5. 3D printer
6. **AI(Artificial Intelligence)**
7. **Robotics**

IoT Solution

KEPCO Power Information Service (R&D)

SERVER

e-IoT Platform

INFRA

Network

Transmission & Transformation (unmanned substation)

DISTRIBUTION (UNDER-GROUND)

CUSTOMER (SMART HOME APPLIANCE)

DEVICE

CAMERA

SENSOR

ROBOT

HOME APPLICANCE

Visual Intelligence Engine

Data Collection Facility

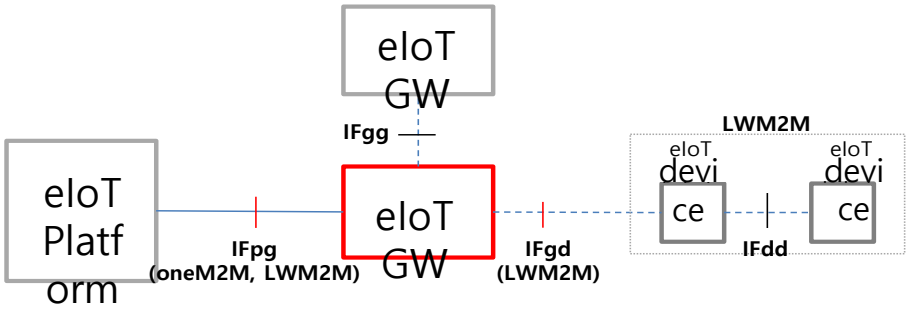
IoT Project ①

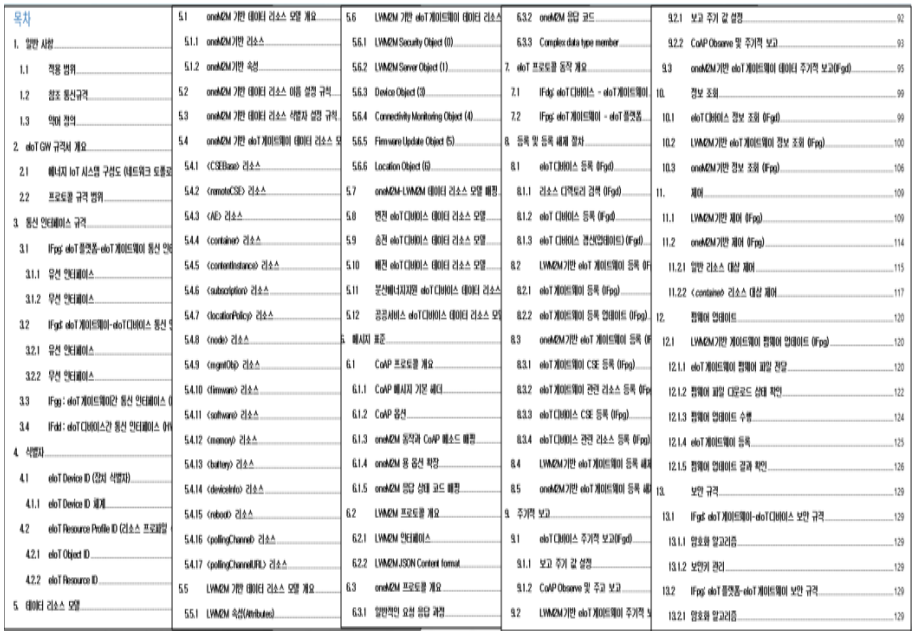
Target:

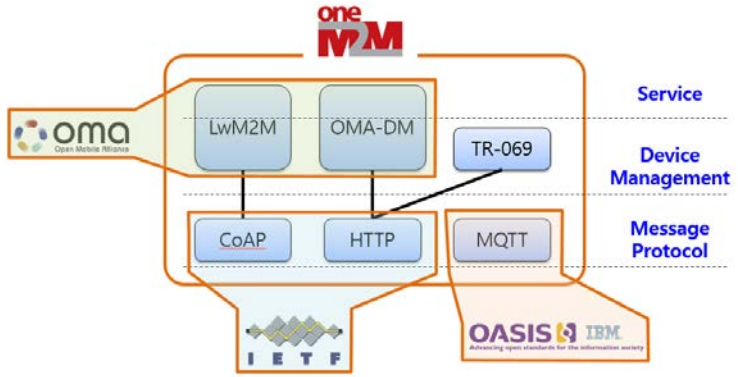
- To introduce technology development status and outcome of IoT Project of which title is "**Development of energy platform and gateway based on IoT**"

R&D deliverable 1/3 (Standardization)

- Establishment of information modelling and linking protocols that IoT Device can be connected to collect & control the measured information and the collected data can be delivered to the platform







R&D deliverable 2/3 (Communication module)

❖ Implementation of KEPCO-ARM IoT Integration and distribution of joint logo chip to SPIN alliance

	Sensor Device	Gateway		Platform
Maker	Application	Application		Application
Develop-ment Tool	LWM2M	LWM2M		LWM2M
	UDP/COAP	UDP/COAP		UDP/COAP
	IPv6	IPv6	IPv4	IPv4
Comm. Module	6LoWPAN	6LoWPAN		Ethernet
	IEEE 802.15.4	IEEE 802.15.4	Ethernet	
	Wi-Sun/LPWA	Wi-Sun/LPWA		

R&D deliverable 3/3 (Standard Authentication)

한국전력연구원
34056 대전광역시 유성구 문지로 105
042-865-5114 I 042-865-5203
www.kepri.re.kr

한전 eIoT 시험 인증서

KEPCO

인증 번호 CERTIFICATION NUMBER	KEPCO HE-2017-098456566
규격 STANDARD	Version 0.9.9 / Standard 0.9.9
제품 PRODUCT	Device
제조사 MANUFACTURER	DegitaTec
모델명 MODEL NAME	Model-KEPCO-987653900
주소 ADDRESS	34056 대전광역시 유성구 문지로 105 (문지동)

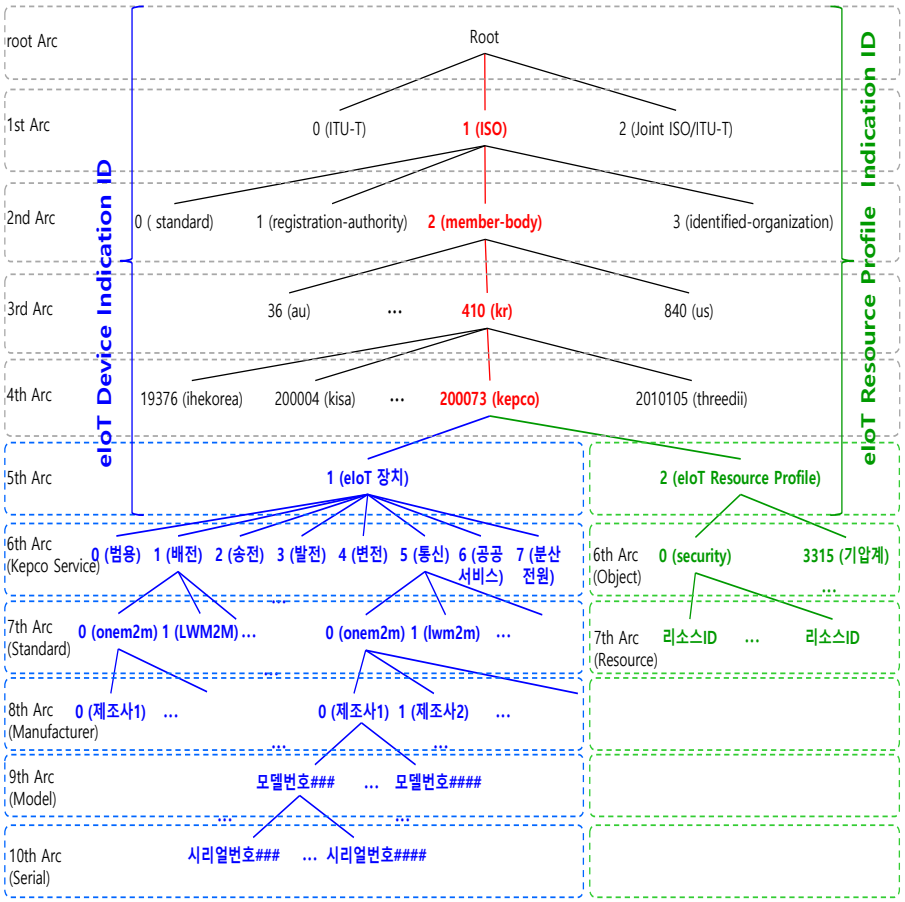
상기 기기에 대하여 한국전력 원격검침 프로토콜에 적합한 기기임이 인증되었기에 인증서를 발급합니다.

DATE OF CERTIFICATION
2017-09-30

KEPRI 한전전력연구원장

IoT Identification Code System

OID(Object Identification) : Member-body (2) National arc : KOREA : 410



- eIoT Device OID : 1.2.410.200073.**1**.1.0.111.99123.1234567
  - eIoT Device Indication
  - Distribution Service (1)
  - oneM2M Standard(0),
  - Manufacturer : ETRI (111),
  - Model # (99123),
  - Serial #(1234567)

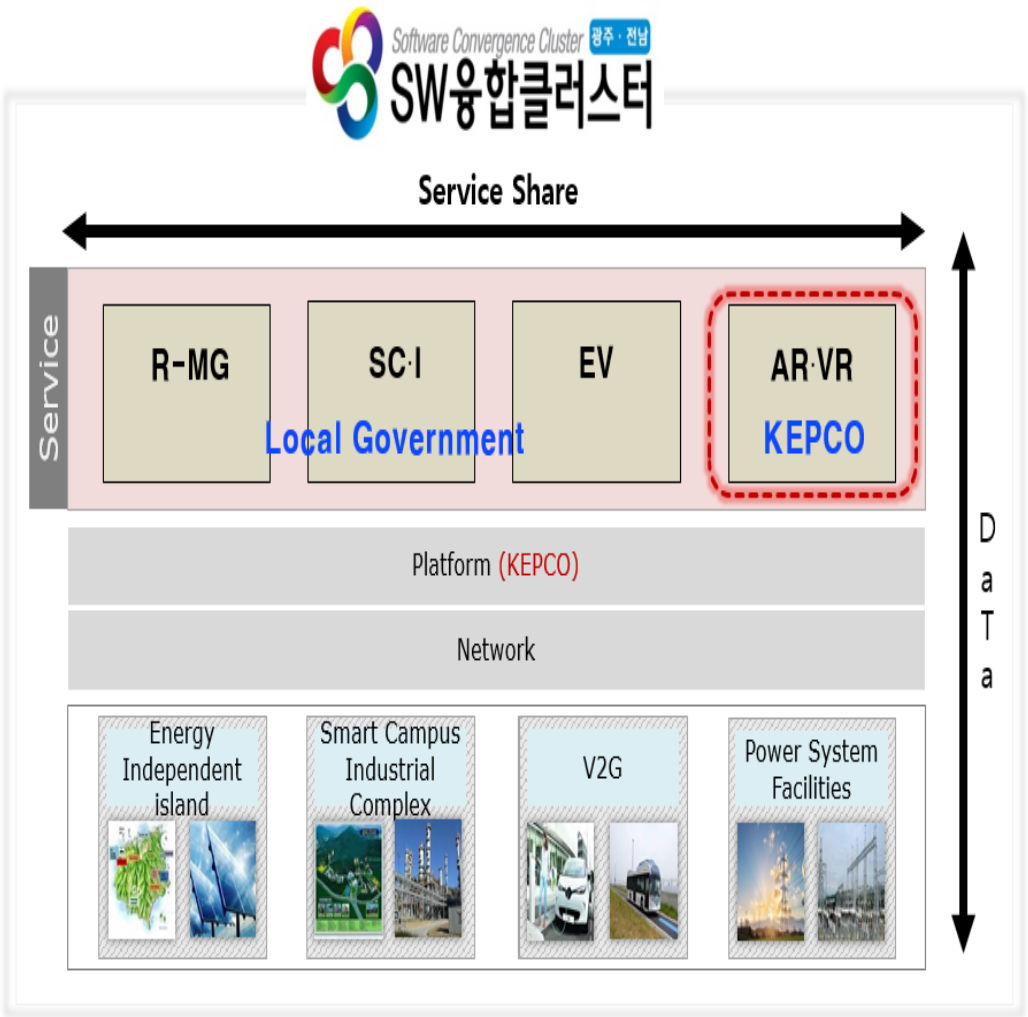
- eIoT Resource Profile OID : 1.2.410.200073.**2**.3303.5700
  - eIoT Resource Profile Indication
  - Temperature Sensor Object (3303)
  - Sensor Value (5700)

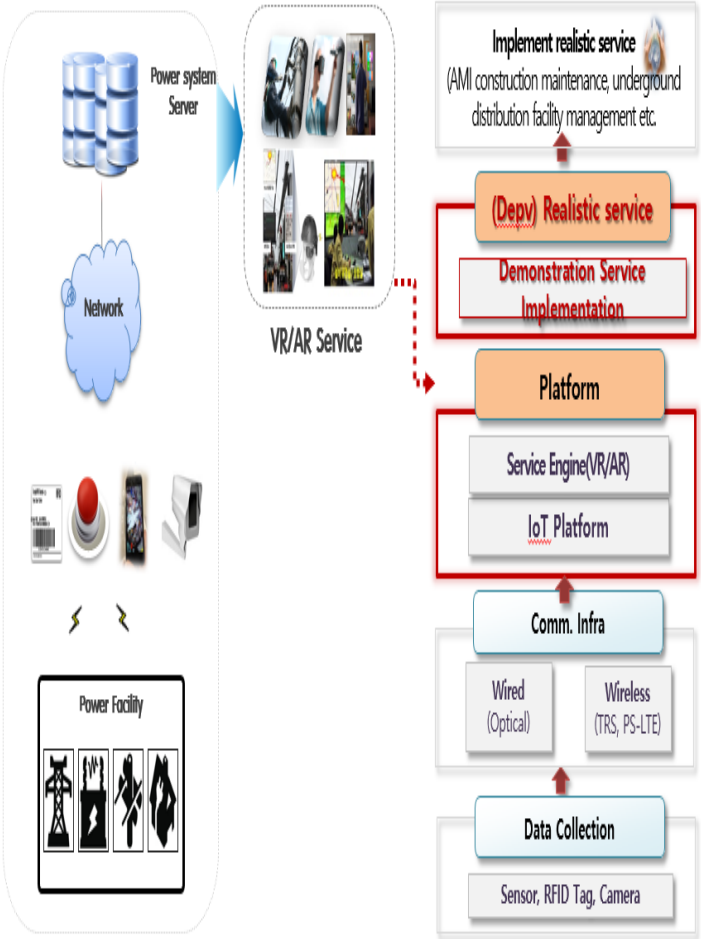
IoT Project ②

Target:

- To introduce technology development status and outcome of VR & AR over IoT Project of which title is "**Construction Project of New Energy Industry Software Convergence Cluster**"

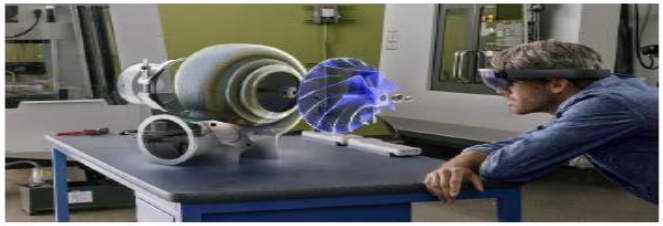
e-IoT over VR·AR Ecosystem





※ R-MG(Remote Micro Grid), SC·I (Smart Campus, Industry), EV(Electric Vehicle), AR(Augumented Reality), VR(Virtual Reality), V2G(Vehicle to Grid)

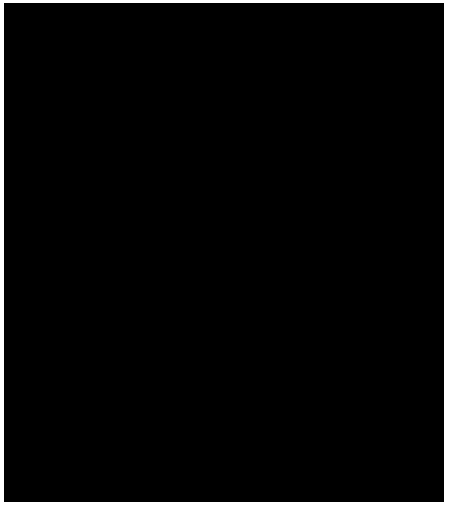
VR & AR demonstration contents



AR

VR

KEPCO AR contents

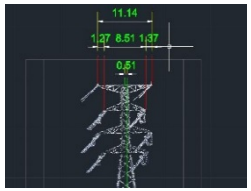


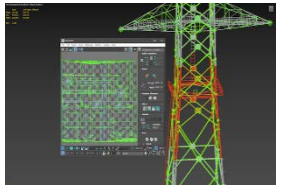
KEPCO VR contents

e-IoT Realistic Power Facility Visualization Solution (VR)

Collection Real Data

Transmission tower 3d modelling using real data(using Lidar scan data)





Transmission Tower VR Contents

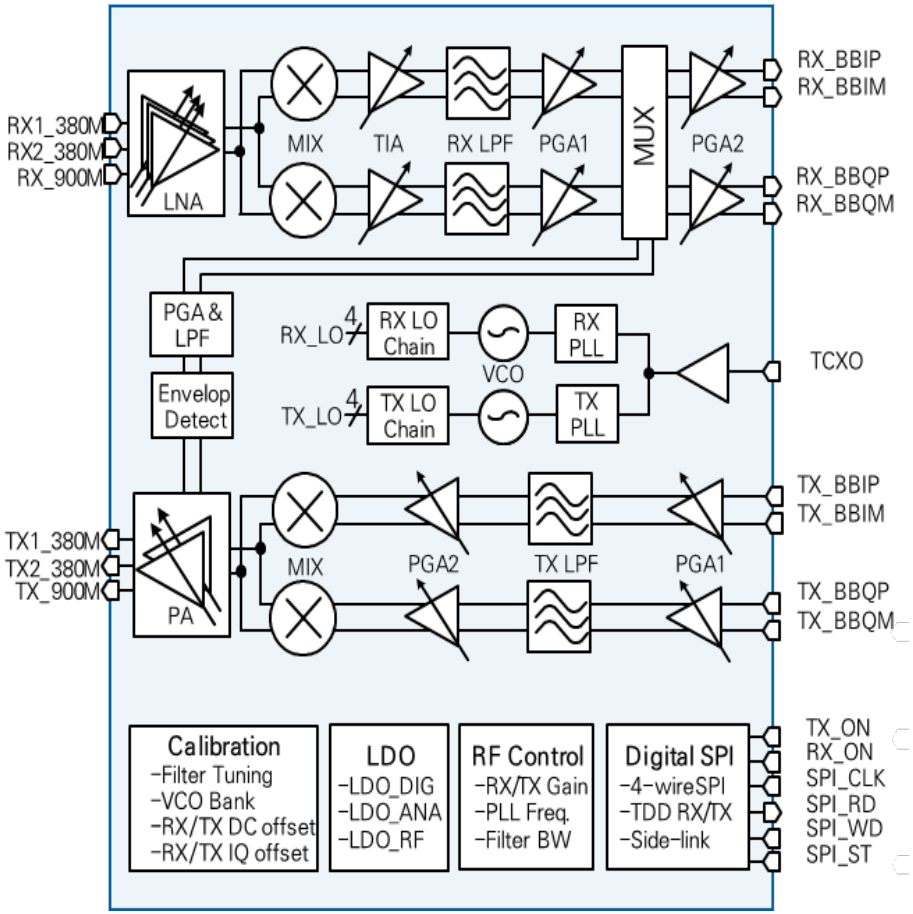
IoT Project ③

Target:

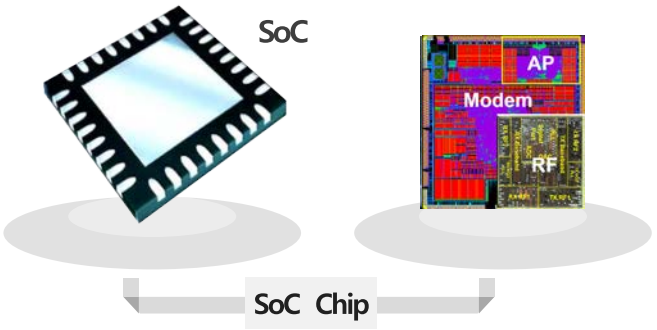
- To introduce technology development status of wireless sensor network Project of which title is "**Development of Wireless Communication Systems for 380㎒ band**"

R&D deliverable (Wireless Communication System)

Multiband CMOS RF Transceiver Specification



SoC chip & SDK



e-WSN Research Item

① **380MHz Transceiver design**

- Radio wave method and system analysis for 380㎒ utilization
- Development of middle & low speed wireless comm. implementation algorithm
- Development of physical layer tech. & performance enhancement algorithm

② **Networking Tech. Development**

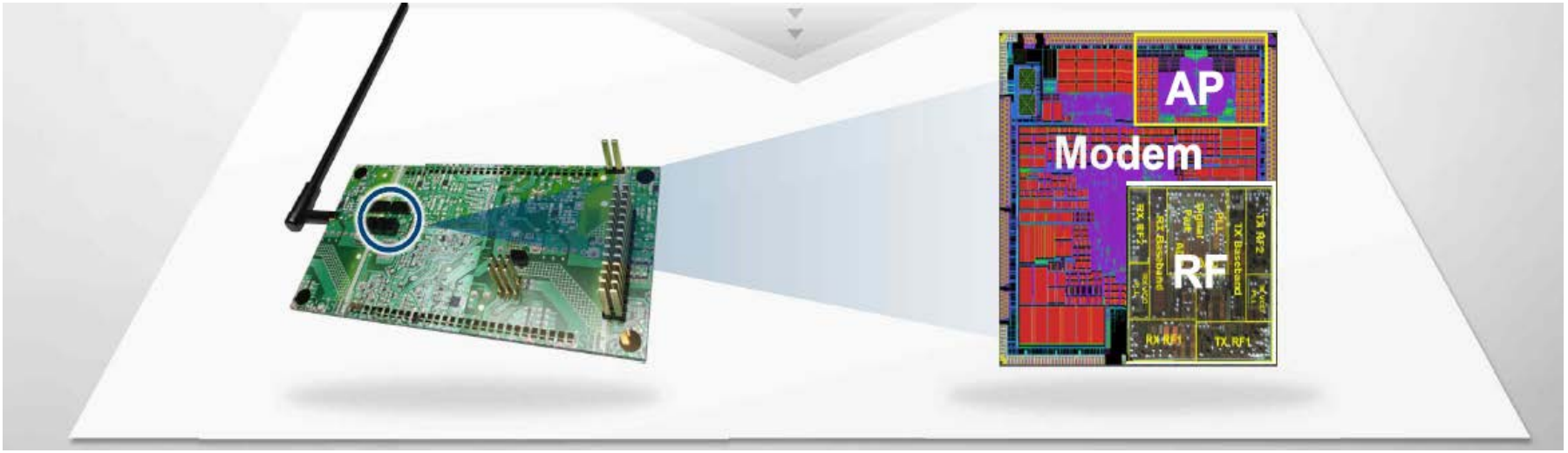
- Radio resource management technology and interface development
- Development of radio resource mgmt. tech in multi-hop environment
- Data transmission scheduling & resource allocation tech development

③ **e-WSN Local area comm. System Development**

- Implementation of develop tech system & optimization of protocol stack
- Development of wireless IC & interworking test of physical networking
- Hybrid Service (Power sytem control & IoT etc) Field demonstration

e-WSN one-chip Solution

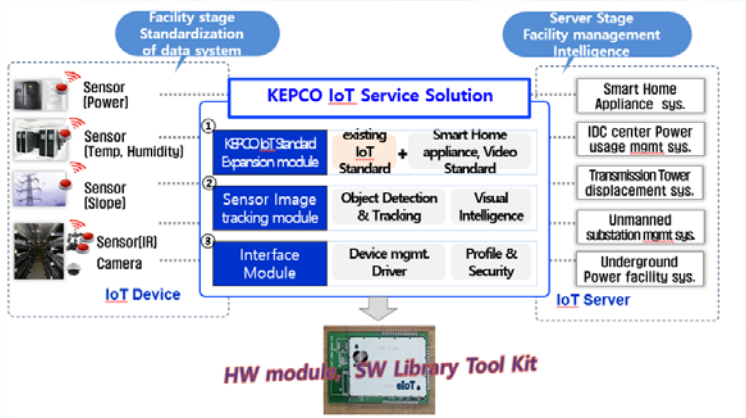
Network	RF Transceiver	Modem	Device Platform
3GPP based Relay link for Radio Shadow Area	Communication & Accuracy Improvement	FMT modulation Technology for mid&high speed	ARM IoT Platform & mbed OS based AMI, IoT solution



IoT Project ④

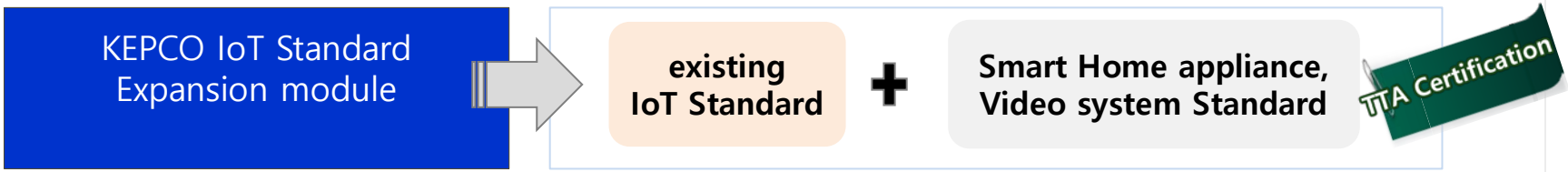
Target:

- To introduce technology development strategy of IoT service solution & application Project of which title is "**Development of IoT Common Solution and Application Technology for Electric Power Service based on International Standards**"



KEPCO IoT Service Solution Module(1/3)

☐ **KEPCO Iota** (e-IoT) **+ smart home appliance standard & image system standard**



Increase acceptability and scalability of heterogeneous protocol of power facilities

※ Smart Home appliance standard : OCF (international), KS (Korea)

※ Video system standard : ONVIF (international), K protocol (korea)

- Service-specific e-IoT operational scenarios and systematized design
  - ❖ Operational design of sensor / image data ↔ e-IoT platform for each power facility / service
- Develop standard protocol interworking technology
  - ❖ Development of Connectivity based e-IoT↔OCF interworking standard technology
  - ❖ IoT delay communication technology design
  - ❖ Robot complex sensor data model standard design
  - ❖ Established OCF-based service information model standard

※ TTA(Telecommunications Technology Association, 통신기술표준인증기관)

KEPCO IoT Service Solution Module(2/3)

☐ Development of visual intelligence framework for sensor & video tracking analysis

Sensor Image tracking modu → **Object Detection & Tracking** → **Visual Intelligence** → KISA Certification

- Data network design and systematization design
  - ❖ Design of data network based on sensor&image acquisition informa
  - ❖ Underground Power Section Check Robot Agent Prototype Design

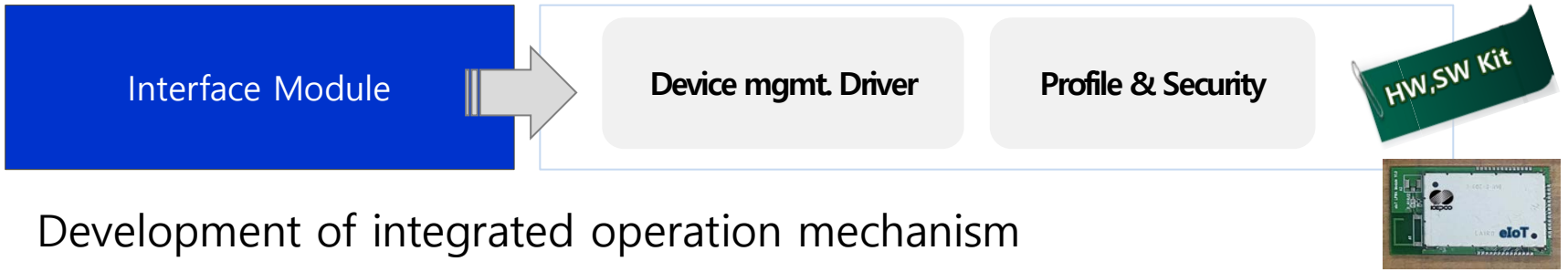
Power data set secure

- Object tracking and anomaly detection algorithm development
  - ❖ Sensor&image data ↔ e-IoT operation desig,n
  - ❖ Development of tracking recognition algorithm and anomaly detection algorithm
  - ❖ Construction of video monitoring system
  - ❖ Multiple image based facility monitoring & fault diagnosis analysis

※ KISA(Korea Internet & Security Agency, 지능형 영상인증기관)

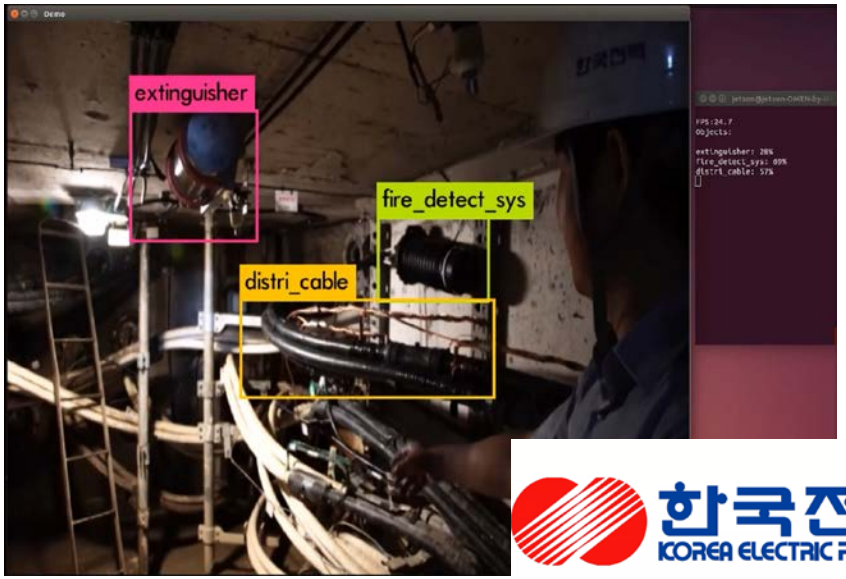
KEPCO IoT Service Solution Module(3/3)

☐ **Development of protocol / security authentication / management control communication interface for power equipment connection**



- Development of integrated operation mechanism
  - ❖ Design of network management, supplementary services, control, security authentication scenario
  - ❖ Design based on e-IoT standard sensing and image data intelligent operation (equipment ↔ communication network ↔ server platform)
- Development of power service operation technology scenario
  - ❖ Development of electricity service purchase specification
  - ❖ Development of power service communication protocol specification
  - ❖ Development of electric service operation procedure

Progress in R&D(Detection & Tracking, Power System Data Set)



한국전력공사
KOREA ELECTRIC POWER CORPORATION

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Thank you for your attention