

Self-organizing Software Platform

Seolyoung Jeong, Ph.D.

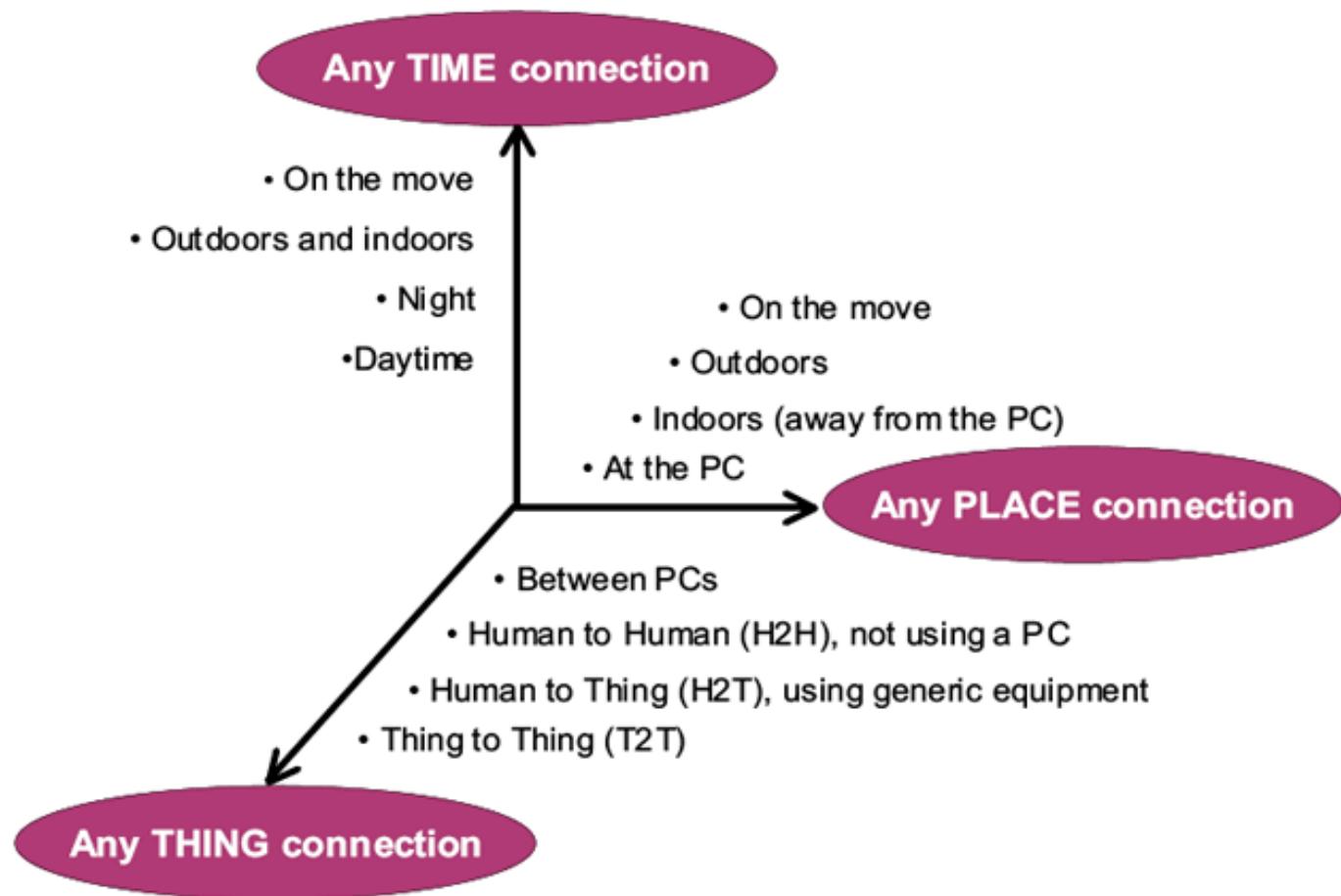
경북대학교 IT 대학

Future IoT World



(source: Helen Gill, Ph.D. CISE/CNS NSF presented in the Symposium of Safe & Secure Software and Systems, June 15,2010)

Future Internet



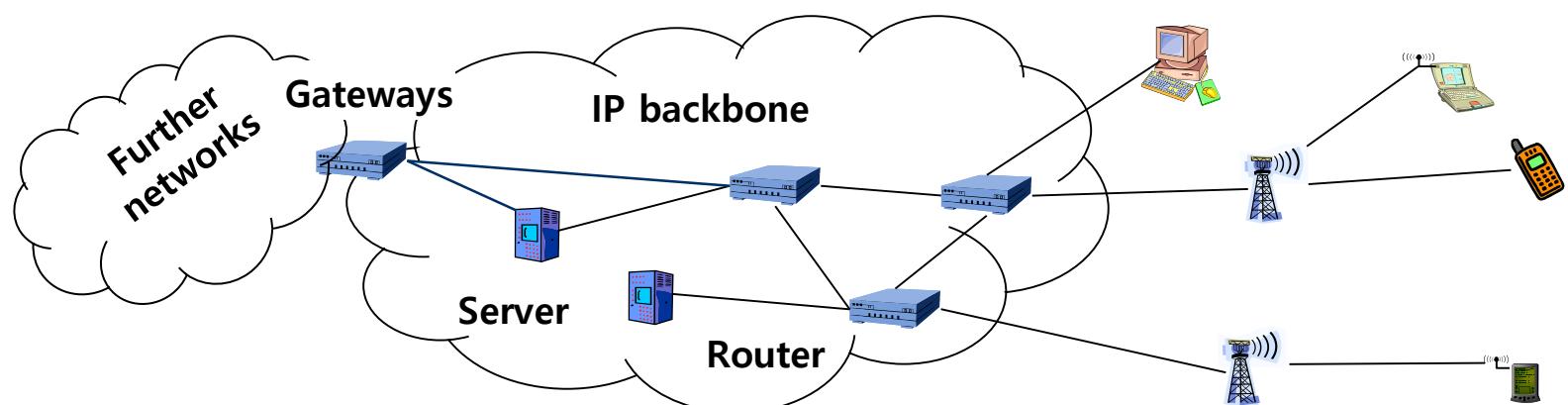
Source: ITU adapted from Nomura Research Institute

Problems of current IoT

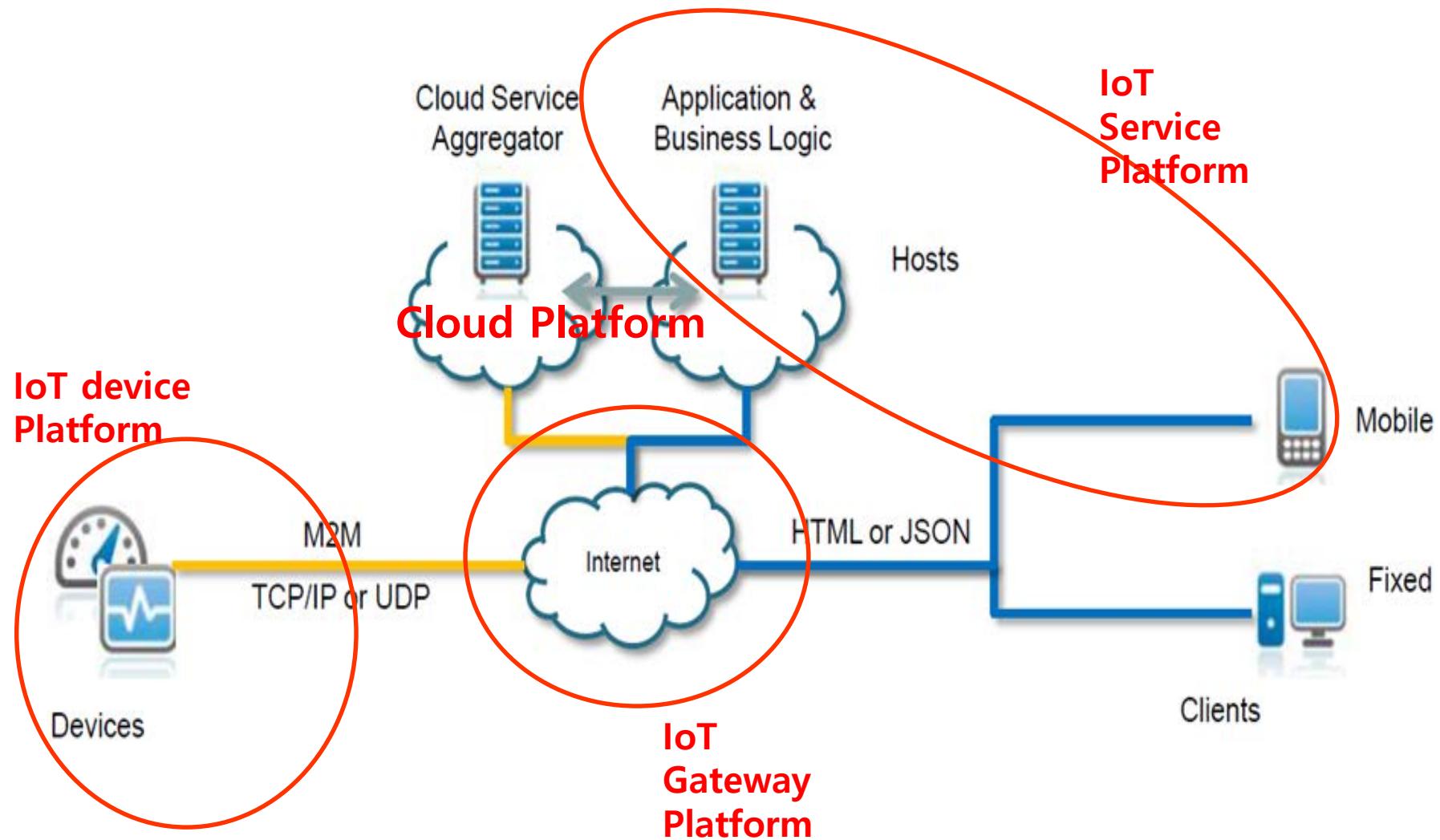
- ◆ How to build the service infra-structure?
- ◆ Why and how to messaging among mobile and stationary IoT?
- ◆ The Big Data technology increase the quality of human life?

Centralized Infrastructure-based IoT Service

- ♦ Typical wireless network are based on infrastructure
 - E.g., GSM, UMTS, WLAN, ...
 - Base stations connected to a wired backbone network
 - Mobile entities communicate wirelessly to these base stations
 - Traffic between different mobile entities is relayed by base stations and wired backbone
 - Mobility is supported by switching from one base station to another
 - Backbone infrastructure required for administrative tasks



Centralized or Public-Infrastructure



Problems in Centralized IoT Service

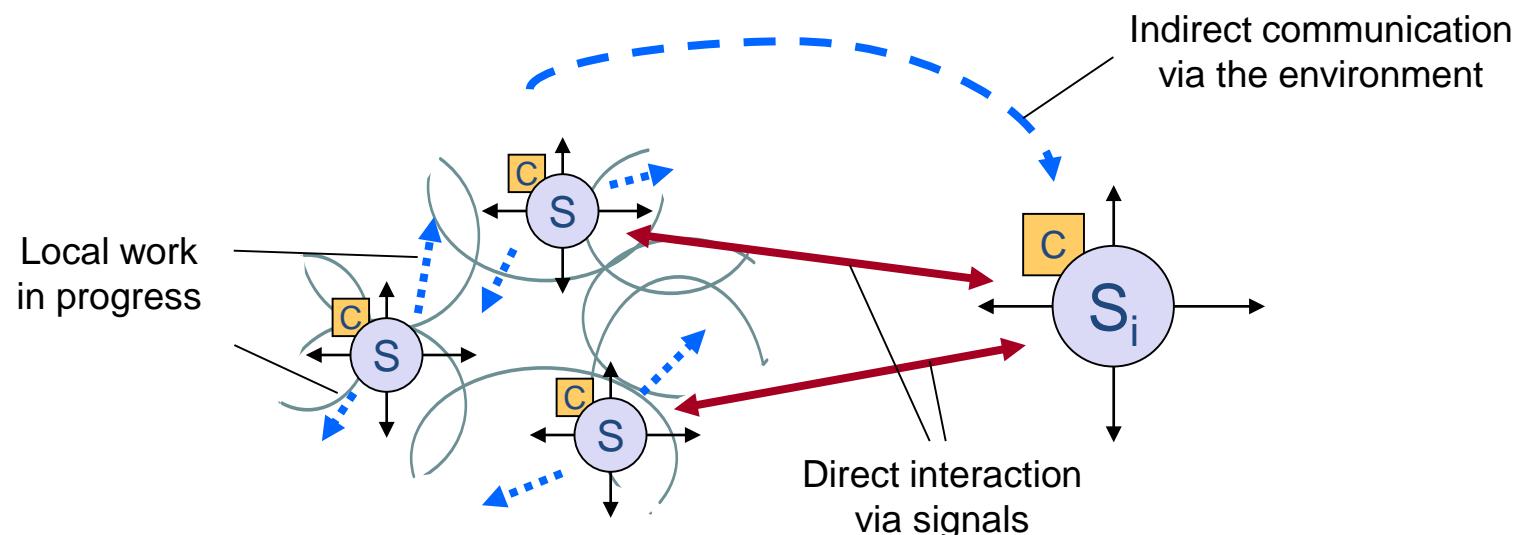
- ◆ Though the services operate on a local level, all data are stored and managed from a centralized server,
 - causing a tremendous waste of communication cost and energy.
- ◆ Even the highly personalized data such as the biometric signals, personal fitness information, and house utility usage are monopolized by the global service providers
 - 2nd Naver in Korea
- ◆ Even though(Everyday around 20 quintillion (10^{18}) bytes of data are produced) the massive quantity of the raw data, is it really valuable?
- ◆ Finally, there is the problem of ‘Big Brother’ corporations holding monopoly over the entrepreneurial rights, excluding potential newcomers within the industry

Self-Organization in Natural Systems



Characteristics of Self-Organizing Systems

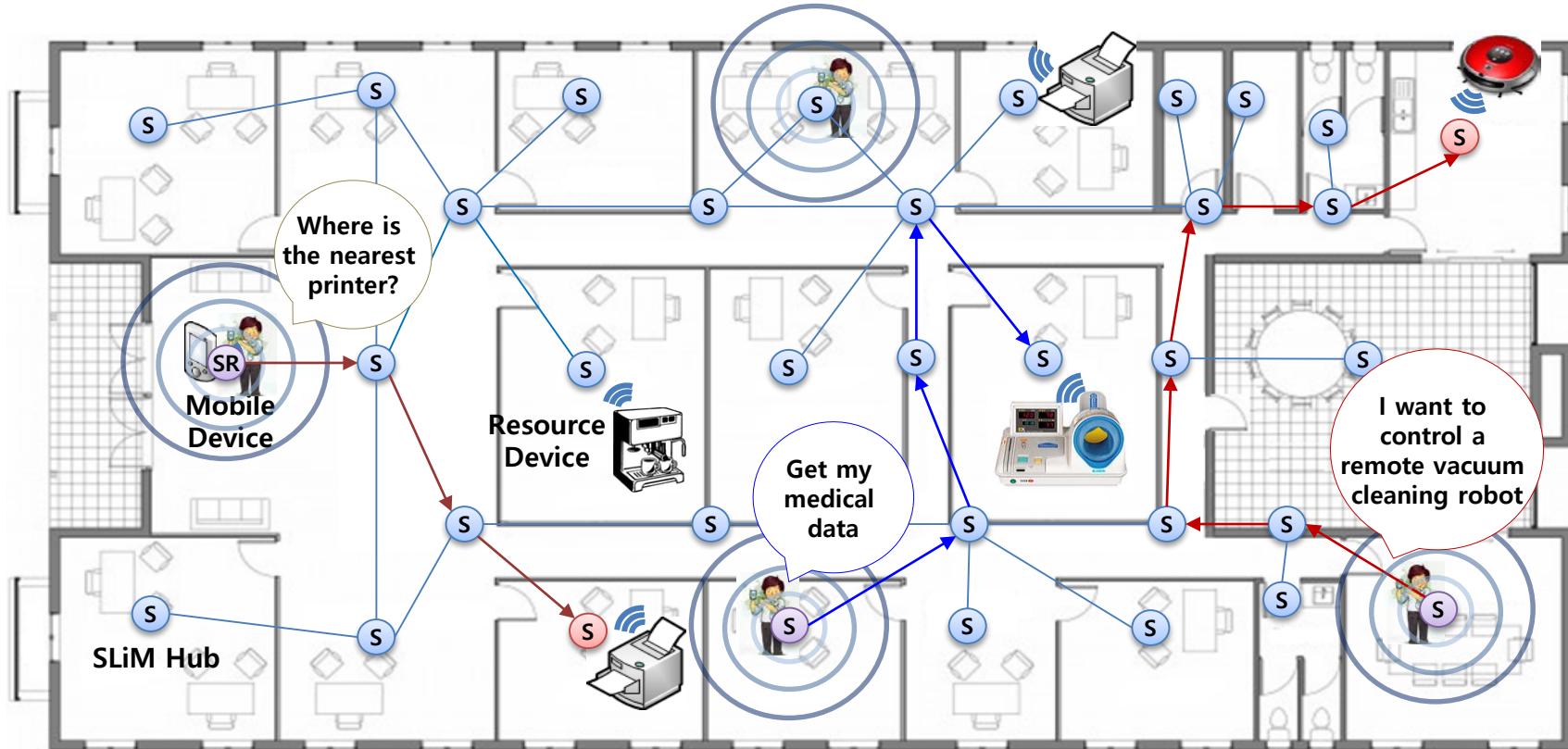
- ♦ Introducing among Individuals and with the Environment
 - Direct communication among neighboring systems (gossiping)
 - Indirect communication via the environment (stigmergy)
 - Interaction with (stimulation by) the neighbors and environment
 - Identifying location of itself and neighbors
 - Clustering and collaboration
 - Delay Tolerant Communication
- Opportunistic service
(activated when the time, the location, the users just matched)



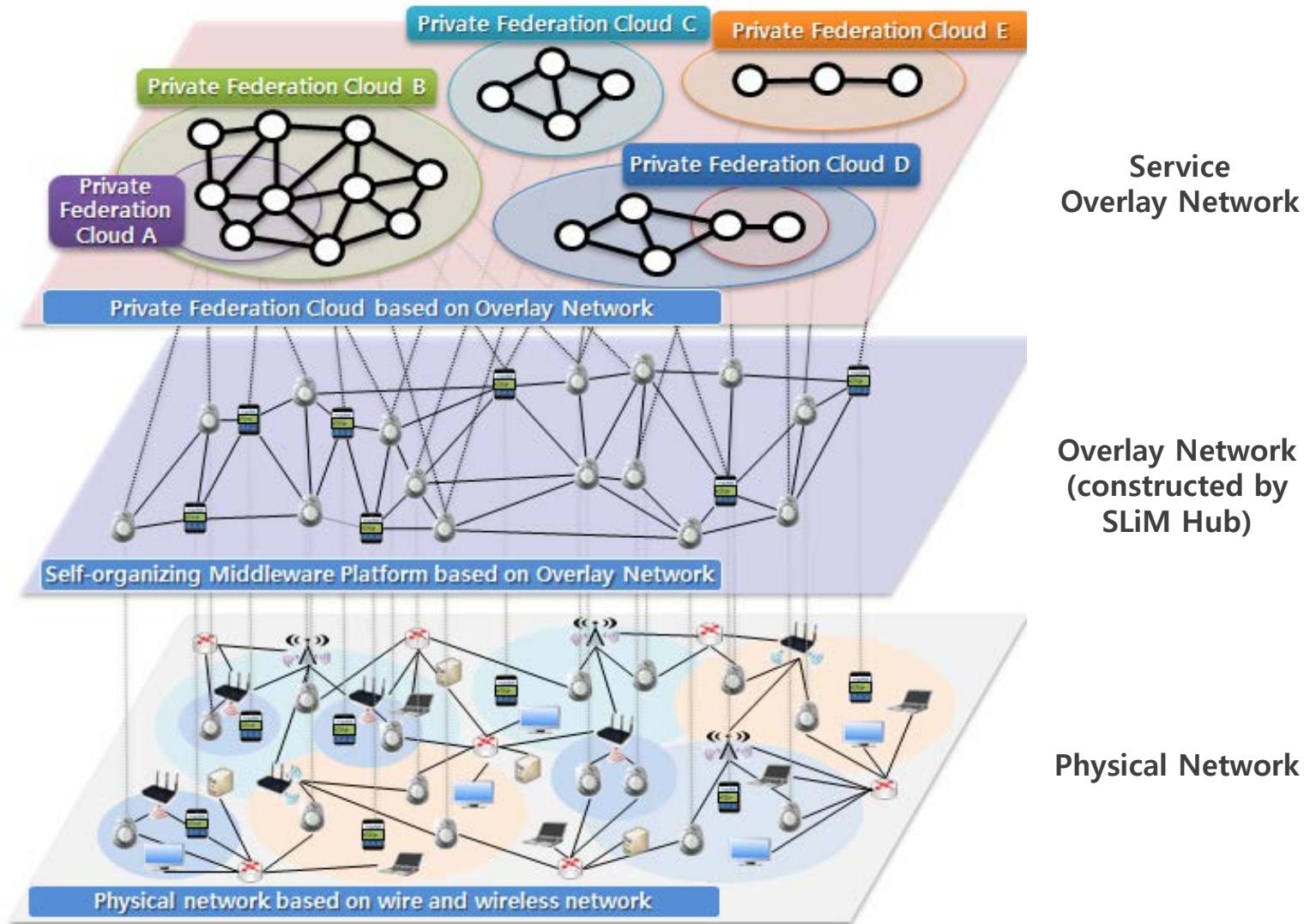
Self-organizing Software Platform Service Infra

◆ The roles of the SLiM Hub (S) :

- Anchor (location sensor) node for location positioning.
- Access point for various wireless communications (such as WiFi, Bluetooth, ZigBee, and so on).
- Node in a distance graph to configure an overlay network.

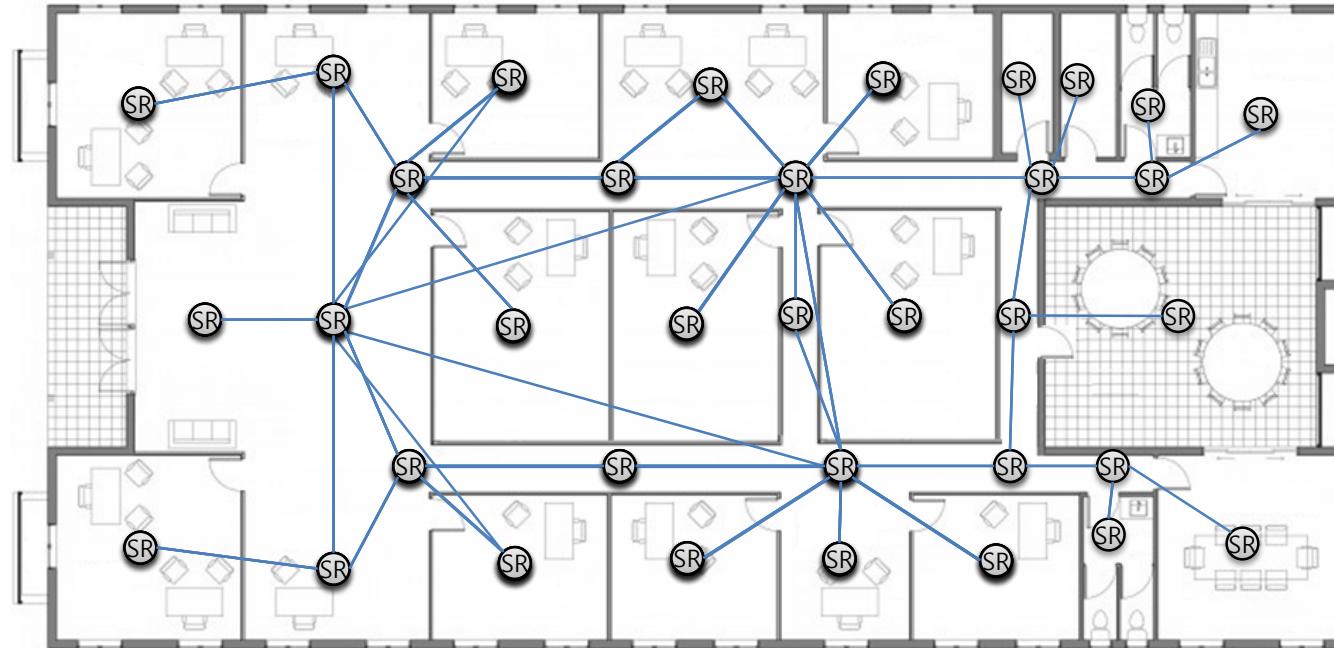


Abstraction Level of SoSp Overlay Network

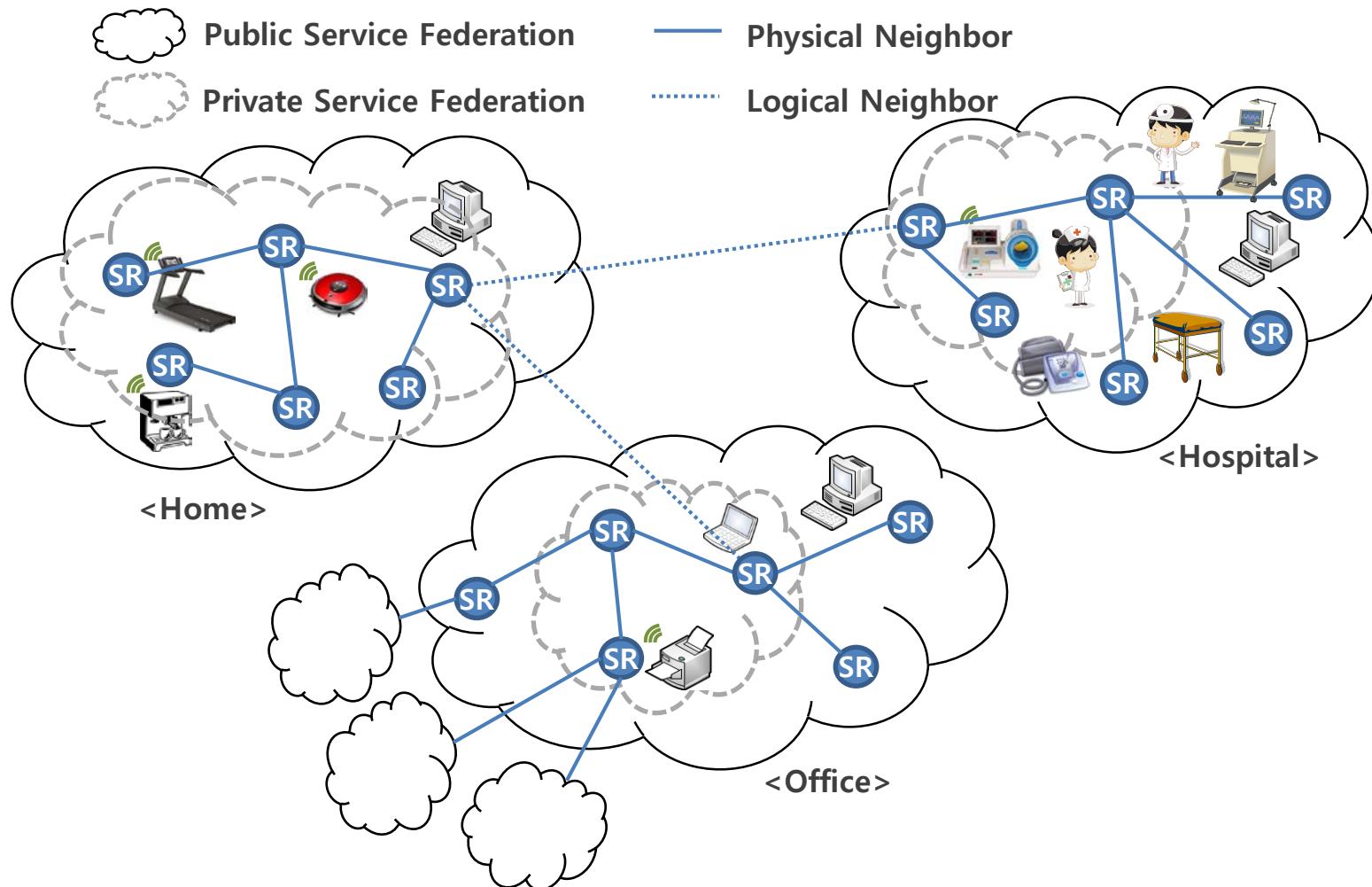


Dynamic Space Expansion & Reduction

- ◆ A method of expanding and reducing for supporting scalability in self-organization property
- ◆ Insert / Delete / Re-activate



Long-Distance Service Space Extension



Assumption

◆ Stationary Nodes(SLiM Hub)

- Know current location → anchor node
- Know neighbor stationary nodes → neighbor SLiM Hub
- Can notify current location to the mobile nodes which are located in its area
- Can be added or deleted dynamically
- No. centralized management server(self-organizing overlay network)
- Several wireless and wired protocol support → WiFi, Zigbee, BT4.0, ANT, etc.

◆ Mobile Nodes → mobile tags

- ID-client : act as a Personal ID device
- Resource-client: device supply a certain service
- Can move freely
- Low power consumption is essential
(should be activated under the opportunistic computing manner)
- Communication protocols:
 - Smart phone(pad) → WiFi
 - Watch, tags, etc → Zigbee,BT.4.0, ANT+,etc.

SLiM(Self-organizing Localized IoT Messaging) Hub

◆ 특징

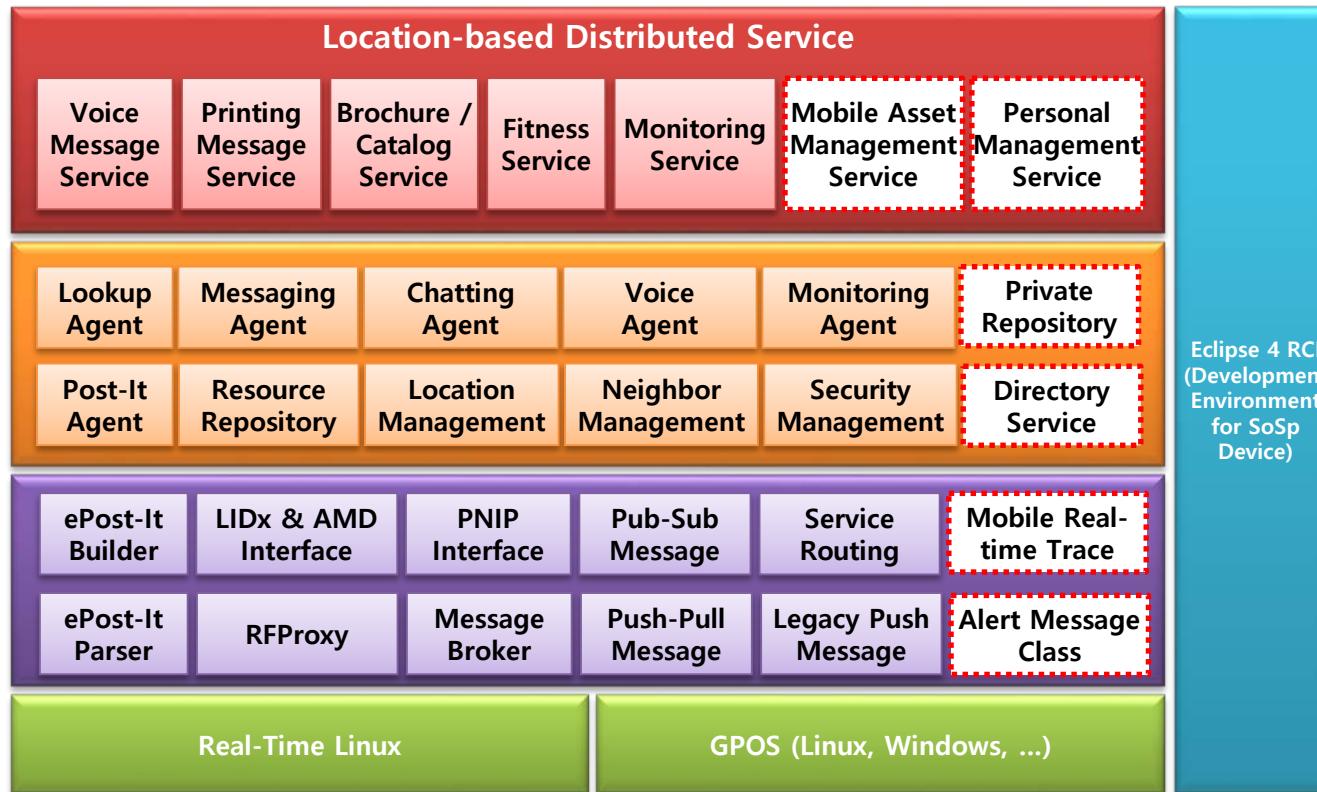
- 실내 위치기반 서비스 단위 공간을 대표하는 위치 앵커노드
- 다양한 유무선 통신 프로토콜 지원
- 실시간 위치 인식 기술을 이용한 위치기반 서비스 제공
- 이웃 노드 검색을 통한 서비스 찾기 및 매칭
- IoT(Internet of Thing) Messaging Hub
- 개인 및 그룹별 자율인지형 서비스 제공
- 위치 기반의 Delay Tolerance를 지원하는 비동기 푸시/풀 서비스 제공
(포스트잇 개념 도입, 예: 음성 등 멀티미디어 메시지 송수신)

◆ 지원 서비스

- 지역 위치기반 비동기 메시징 서비스, 비동기 푸시/풀 메시징 서비스, 실시간 스트리밍, 위치기반 방송 서비스)

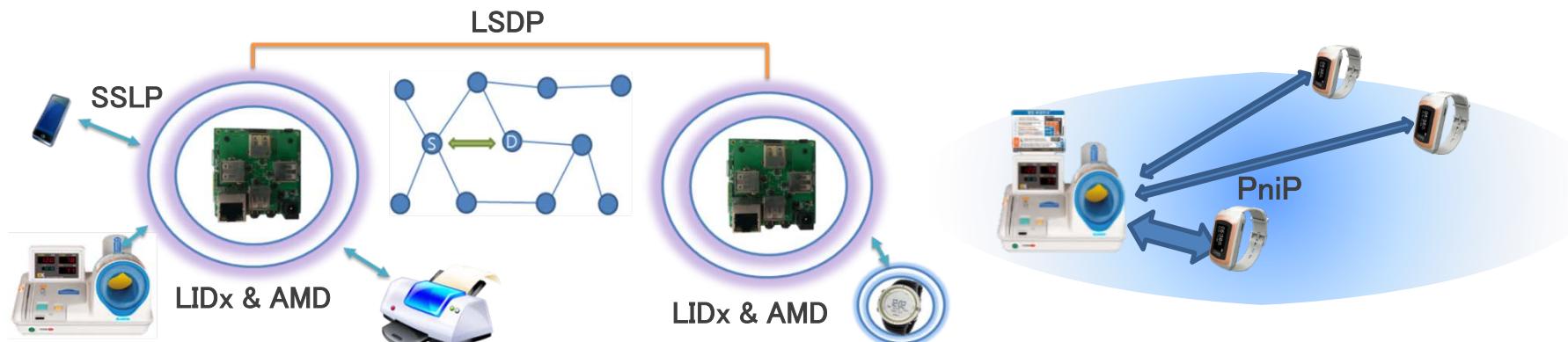


SoSp Service Platform – SLiM Hub Middleware



Protocols in SoSp infra

- ◆ **SLiM Hub ↔ Smart Mobile Device(Smart phone or pad)**
 - SSLP(SmartDevice to SLiM Hub Service Lookup Protocol)
- ◆ **SLiM Hub ↔ SLiM Hub**
 - LSDP (Location-based Service Discovery Protocol)
- ◆ **SLiM Hub ↔ Resource Devices**
 - LIDx&AMD (Location ID exchange and Asynchronous Message Delivery)
- ◆ **Resource Devices ↔ Resource Devices (Mobile ID device)**
 - PnIP (Proximity based Neighbor Identification Protocol)



Concept of PNIP



PNIP (Proximity-based Neighbor Identification Protocol)

Opportunistic
Communication

User
Identification

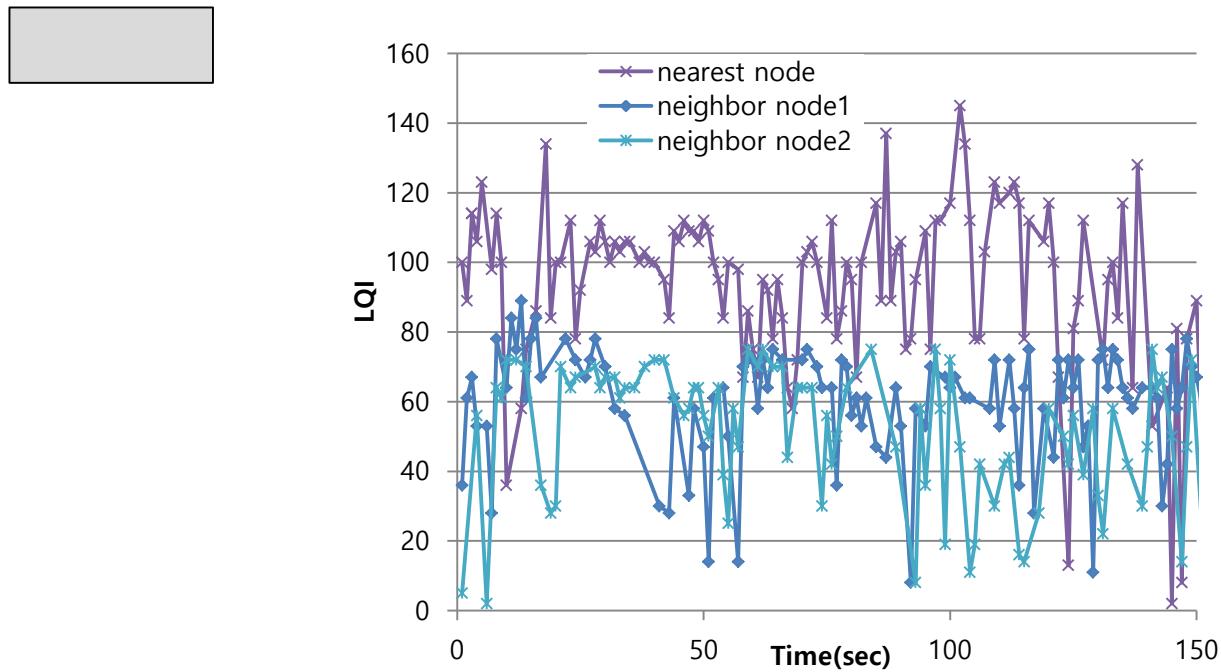
Low power
Consumption

- PNIP Client (ex: watch) has unique ID of user. → ex) Who was use the burner?
- When a resource device is used (ex: burner, health machine), PNIP host and client automatically exchange the ID and data.
- Requirement to achieve low power consumption: Opportunistic Direct M2M

Localization Protocol

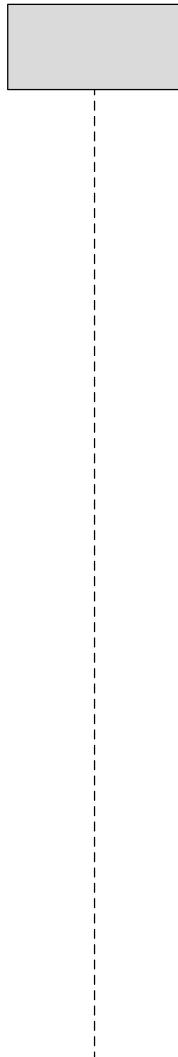
- ◆ **LIDx (Location ID exchange) protocol**

- ID exchange between a mobile node and SoSp-Routers
- Cell based localization
- Support numerous mobile nodes



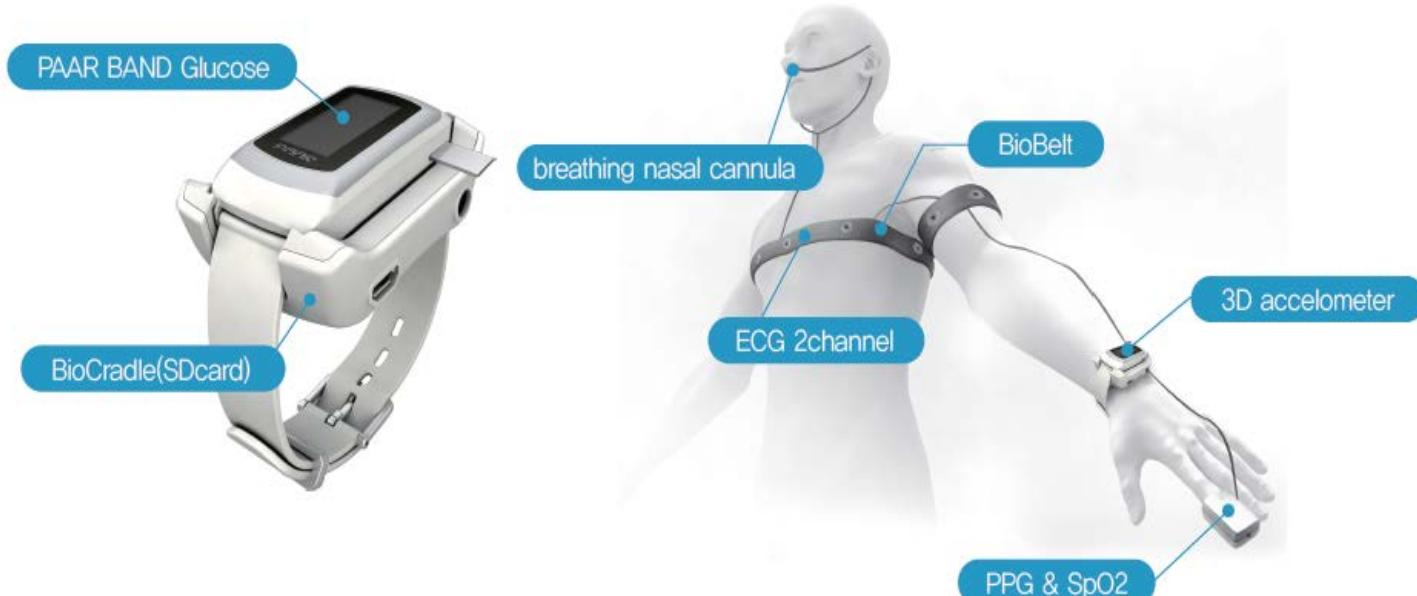
Message Delivery Protocol

- ◆ AMD (Asynchronous Message Delivery) Protocol

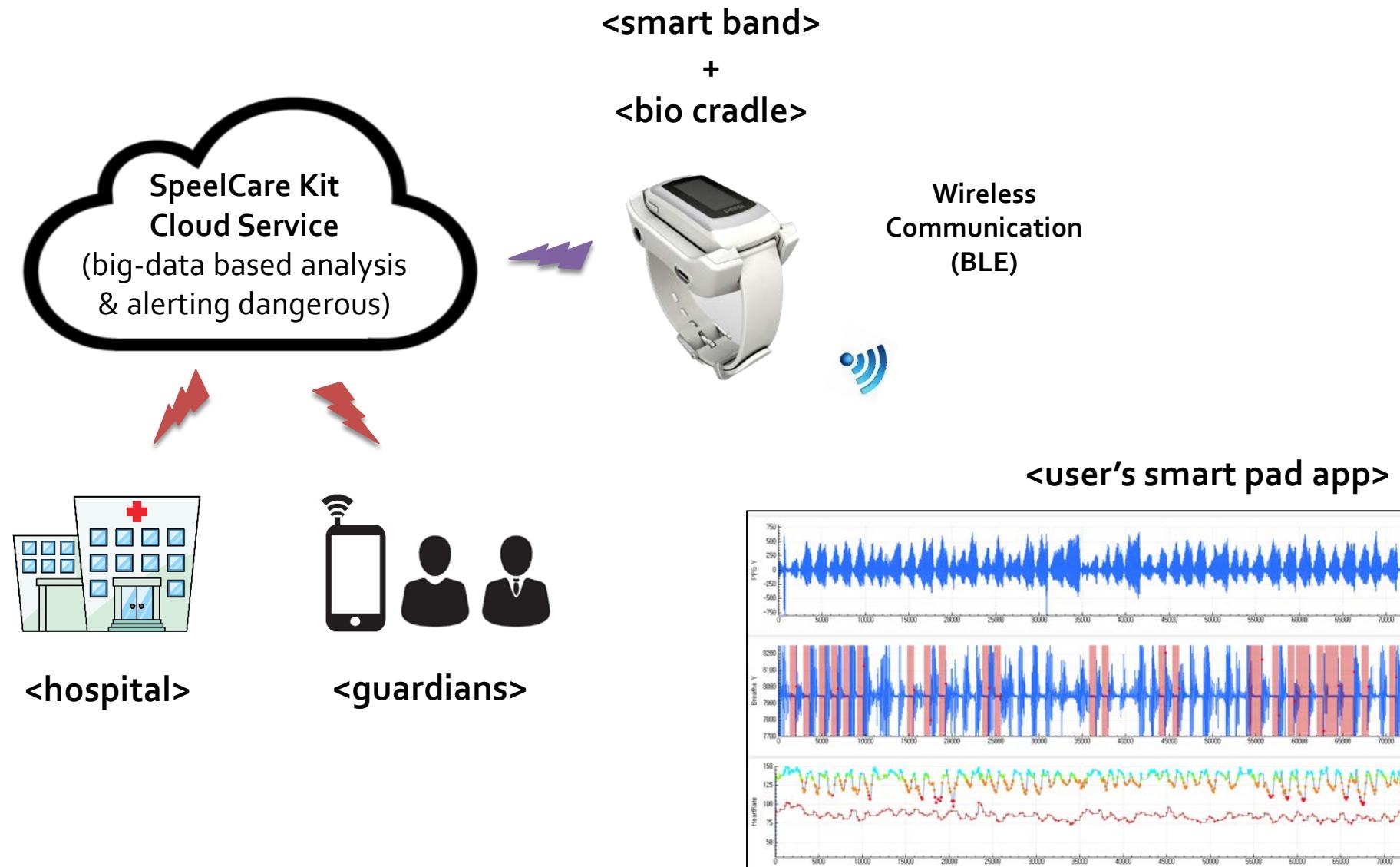


SleepCare Kit

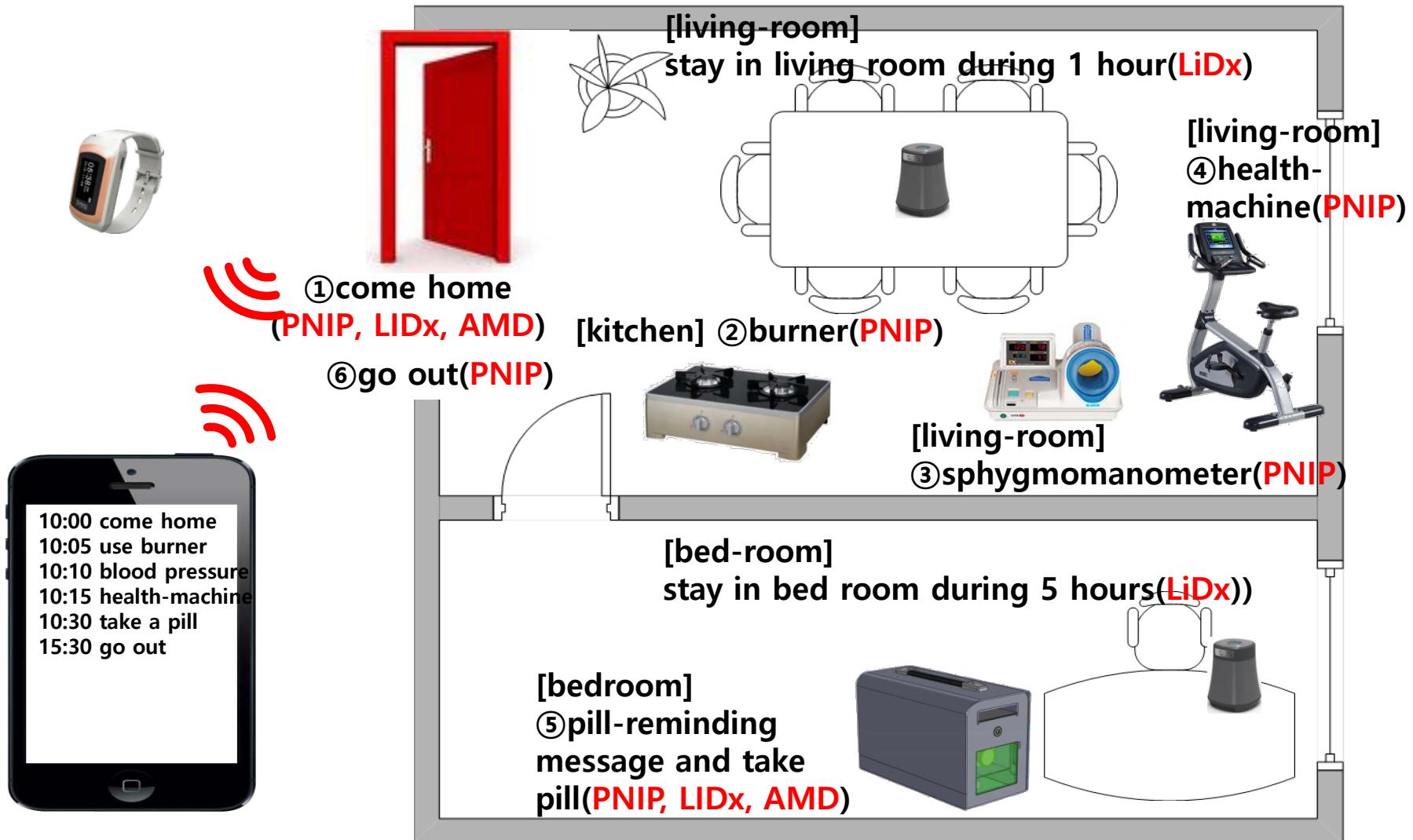
- ◆ Home based Patient Monitoring Devices
- ◆ Measurement of Multi-Vital Signals and Archiving
- ◆ Applications
 - Blood glucose monitoring and diabetes management
 - Sleep apnea self-diagnosis and prevention
 - Real-time monitoring of heart failure patients
 - After the falling, the body emergency monitoring and alerting



SleepCare Kit Service

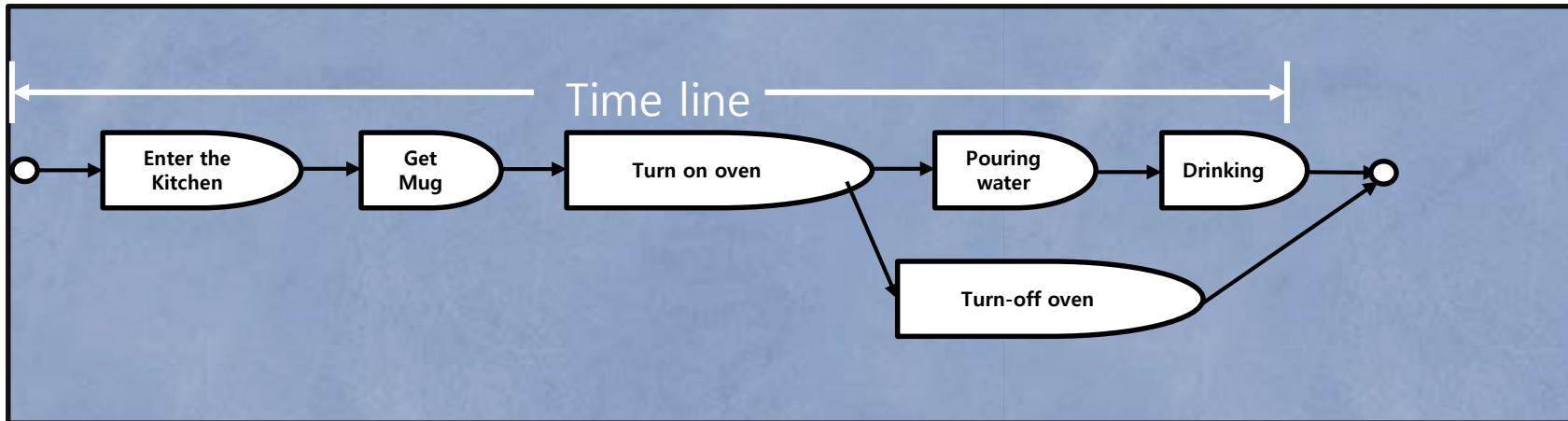


Personal Life Logging with PAAR watch/band

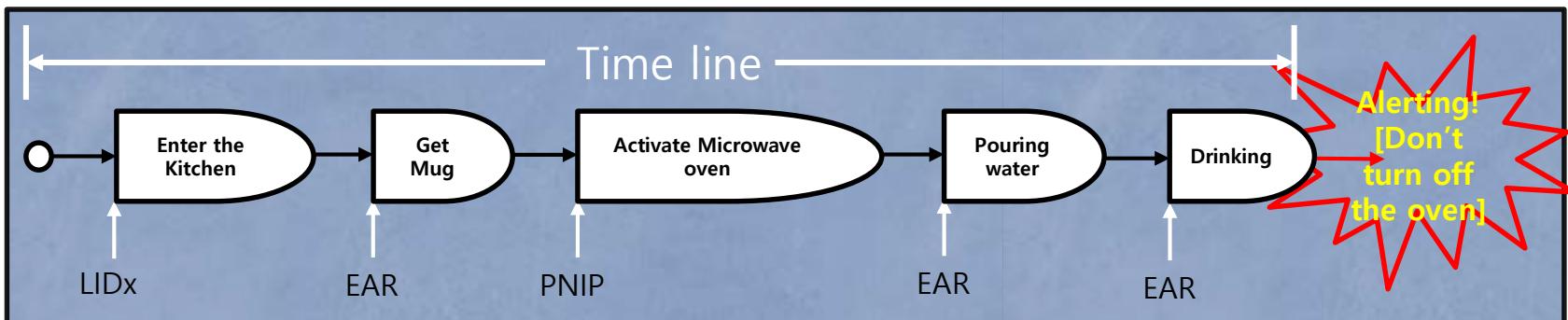


Activity Matching and Alerting in Real-Time

- Predefined activity(making Tea)



- Matching the accumulated activity in real-time



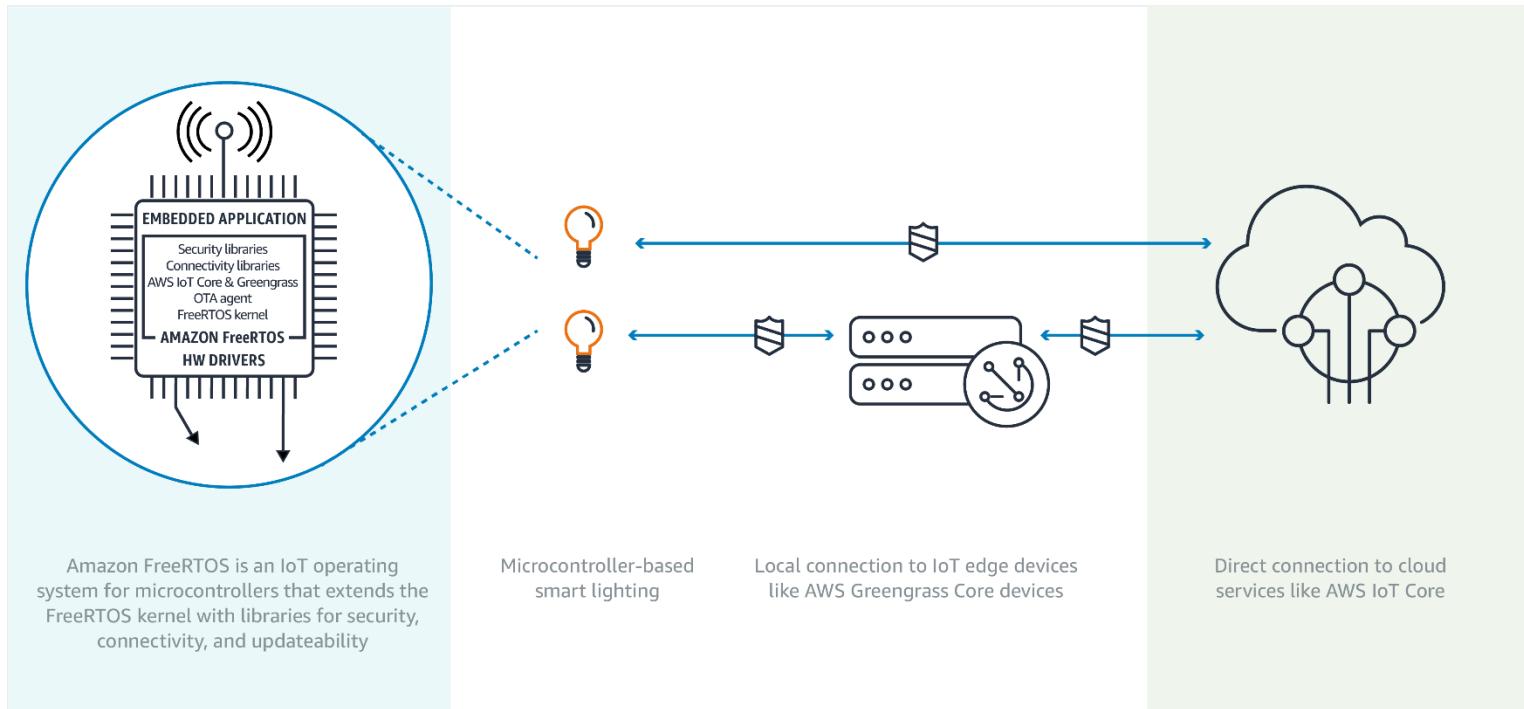
SLiM Hub with AI

- ◆ **Distributed Database System**
- ◆ **Big Data Analysis of Personal Health Data**
- ◆ **Voice Streaming for Remote Assistance**
- ◆ **TTS(Text-to-Speech) Engine for Alerting**
- ◆ **Voice Recognition Service**
- ◆ **Vision & Image Processing**
- ◆ **etc.**

AI based IoT Platform [Amazon]

♦ Amazon AWS IoT

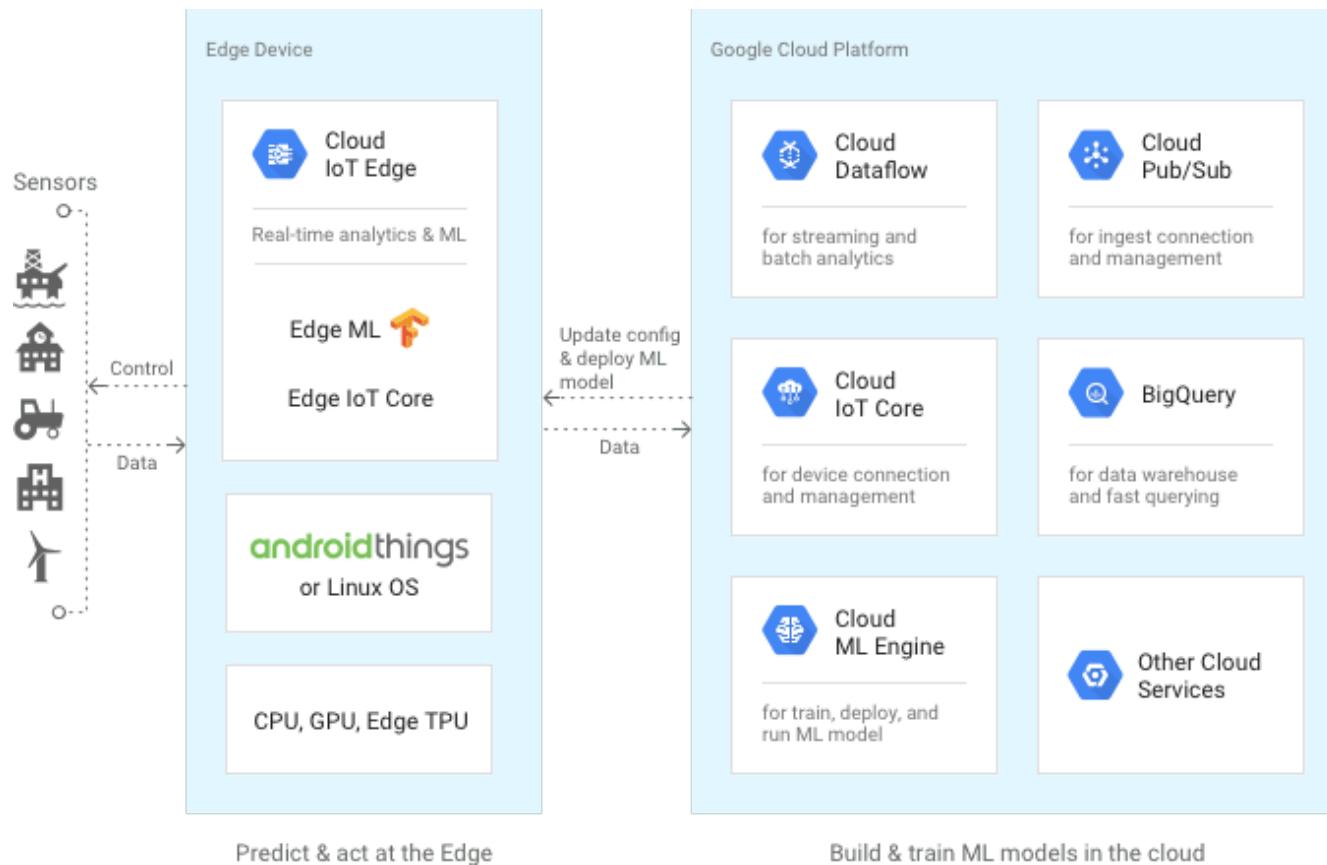
- Amazon FreeRTOS Device -
- AWS IoT Core (Cloud Service)
- AWS Greengrass Device (Local Edge Device)



AI based IoT Platform [Google]

◆ Google Cloud IoT Edge

- Edge IoT Core : securely connect edge devices to the colud
- Edge ML (TensorFlow Lite), Edge TPU

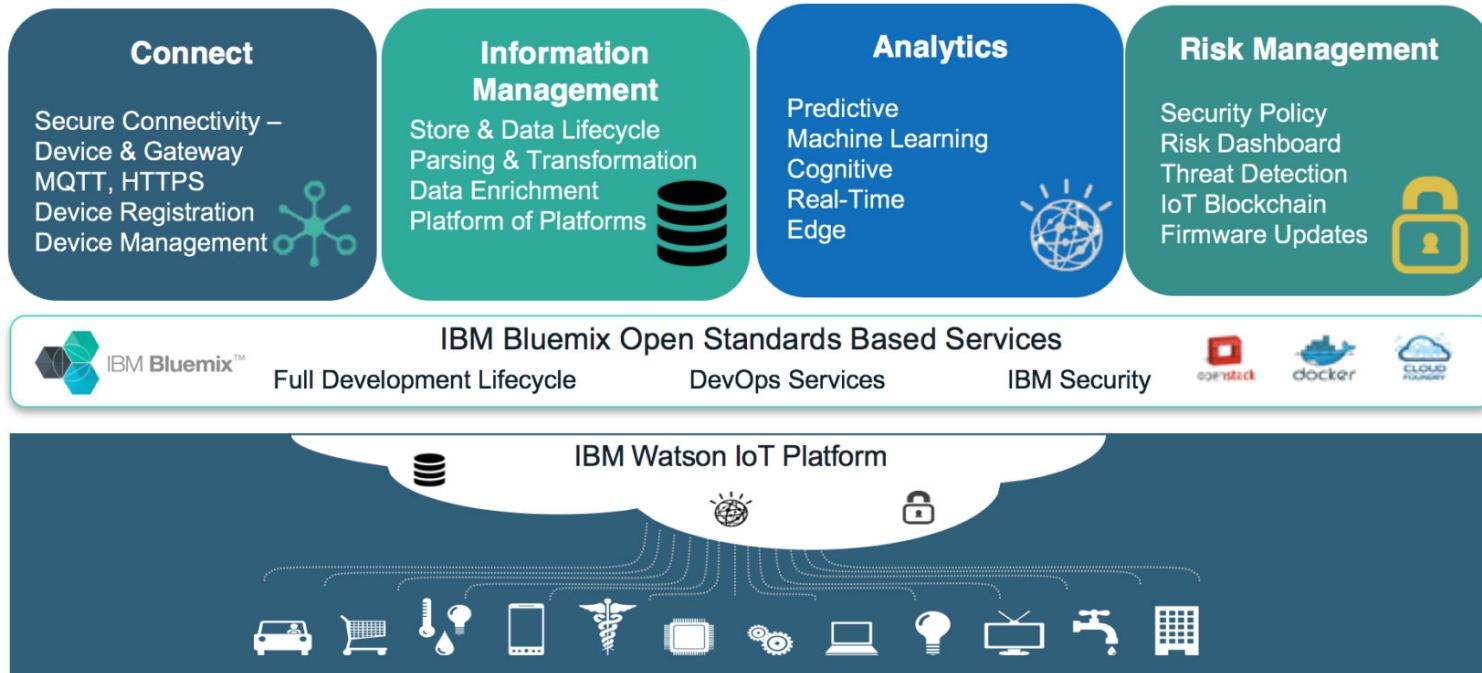


AI based IoT Platform [IBM]

◆ IBM Watson IoT

What is the Watson Internet of Things Platform (WIoTP) ?

The Watson IoT Platform is the environment to cognitively act upon the IoT



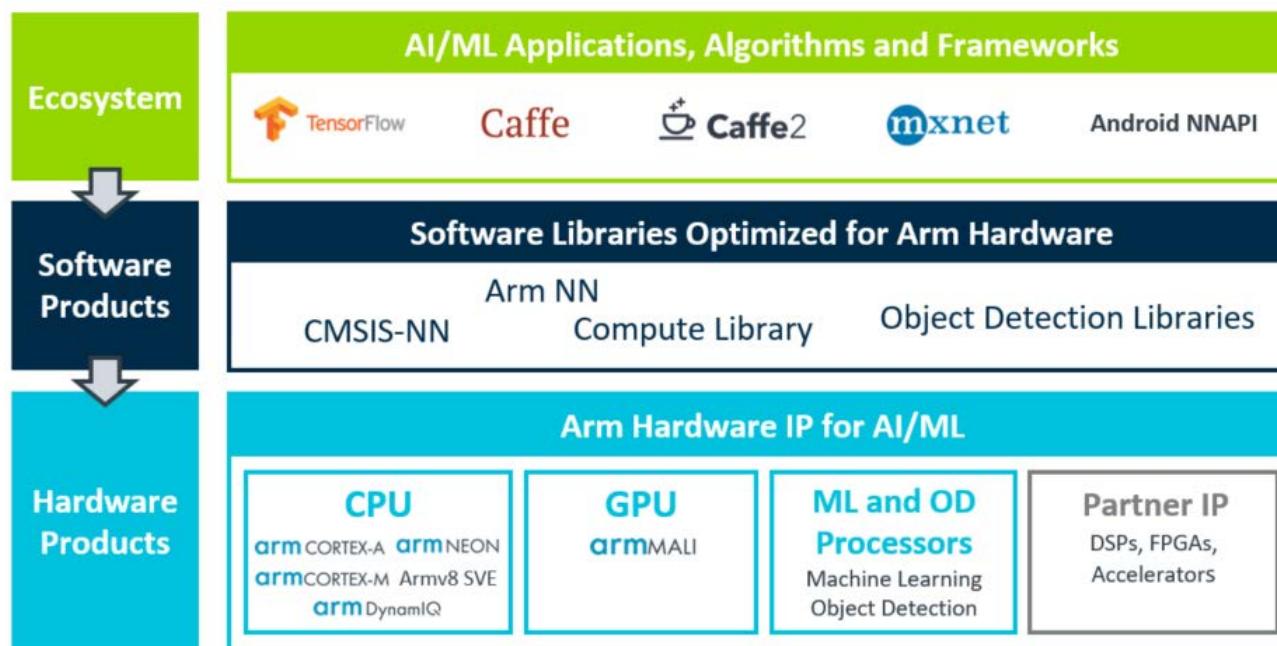
AI based IoT Platform [Microsoft Azure]

- ◆ Microsoft Azure ML and IoT Edge + Qualcomm Vision Intelligent Platform (May 7, 2018)



Embedded AI Computing Device [ARM]

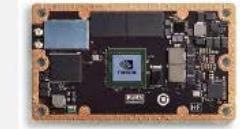
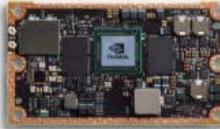
- ◆ ARM's Project Trillium : Machine learning for every device
 - ARM Machine Learning(ML) compute platform (CPU, GPU, DSP, etc.)
 - ARM Object Detecting(OD) Processor (CPU, GPU, etc.)
 - Detect objects in real time running with Full HD
 - ARM Neural Network(NN) frameworks (ARM Cortex CPUs and ARM Mali GPUs)



Embedded AI Computing Device [ARM/NVIDIA]

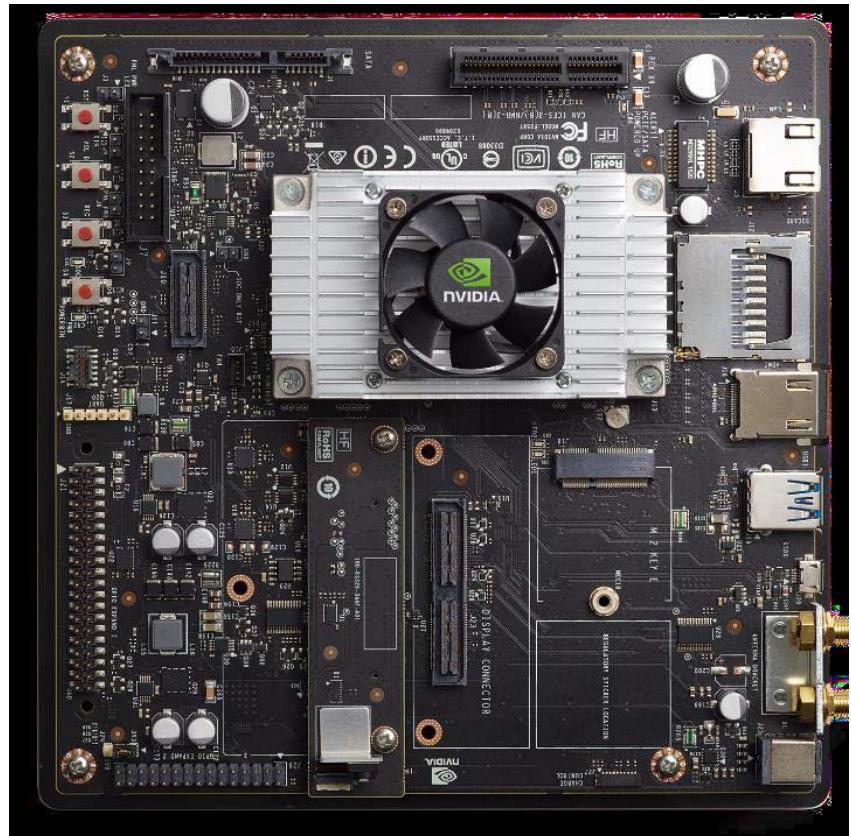
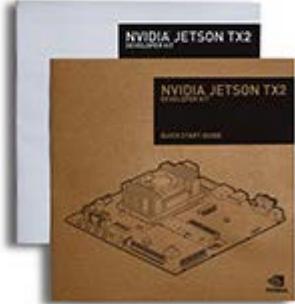
◆ ARM Trillium Platform + NVIDIA Deep Learning Accelerator (GTC 2018)

- NVDLA Xavier (SoC)
- Line up of Jetson

Series / Generation		Tegra K1		Tegra X1	Tegra X2	Xavier
CPU	Instruction set	ARMv7		ARMv8		
	Cores	4+1 A15	2 Denver	4 A53 + 4 A57	2 Denver2 + 4 A57	8 Nvidia custom Carmel
GPU	Architecture	Kepler		Maxwell	Pascal	Volta
	CUDA Cores	192		256		512
RAM	Protocol	DDR3		LPDDR3/LPDDR4		LPDDR4
공급 단위	AP & Module					
	Development Kit	단종				

NVIDIA Jetson TX2

Jetson TX2 DK (Developer Kit)

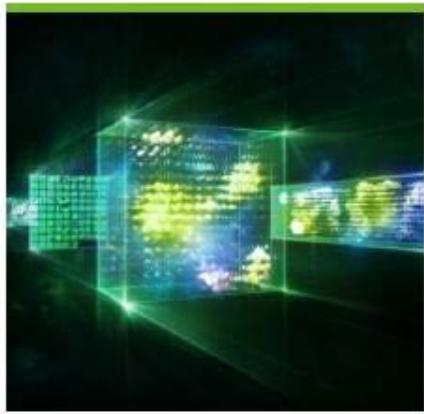


Jetson TX2 Developer Board

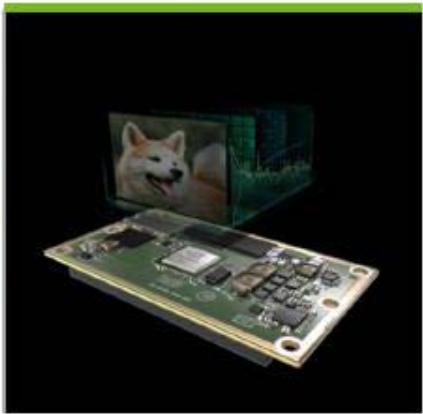
	Jetson TX2	Jetson TX1
GPU	NVIDIA Pascal™, 256 CUDA cores	NVIDIA Maxwell™, 256 CUDA cores
CPU	HMP Dual Denver 2/2 MB L2 + Quad ARM® A57/2 MB L2	Quad ARM® A57/2 MB L2
Video	4K x 2K 60 Hz Encode (HEVC) 4K x 2K 60 Hz Decode (12-Bit Support)	4K x 2K 30 Hz Encode (HEVC) 4K x 2K 60 Hz Decode (10-Bit Support)
Memory	8 GB 128 bit LPDDR4 59.7 GB/s	4 GB 64 bit LPDDR4 25.6 GB/s
Display	2x DSI, 2x DP 1.2 / HDMI 2.0 / eDP 1.4	2x DSI, 1x eDP 1.4 / DP 1.2 / HDMI
CSI	Up to 6 Cameras (2 Lane) CSI2 D-PHY 1.2 (2.5 Gbps/Lane)	Up to 6 Cameras (2 Lane) CSI2 D-PHY 1.1 (1.5 Gbps/Lane)
PCIe	Gen 2 1x4 + 1x1 OR 2x1 + 1x2	Gen 2 1x4 + 1x1
Data Storage	32 GB eMMC, SDIO, SATA	16 GB eMMC, SDIO, SATA
Other	CAN, UART, SPI, I2C, I2S, GPIOs	UART, SPI, I2C, I2S, GPIOs
USB		USB 3.0 + USB 2.0
Connectivity		1 Gigabit Ethernet, 802.11ac WLAN, Bluetooth
Mechanical		50 mm x 87 mm (400-Pin Compatible Board-to-Board Connector)

NVIDIA JetPack SDK

- ◆ OS Image (A sample file system derived from Ubuntu for Jetson)
- ◆ Libraries
 - CUDA Toolkit for Host PC (Ubuntu w/ cross-development support)
 - CUDA Toolkit for Jetson
 - OpenCV / VisionWorks / cuDNN / TensorRT / MultiMedia API
 - NVIDIA System Profiler / Tegra Graphics Debugger
- ◆ Samples / NVIDIA GameWorks OpenGL samples



Deep Learning SDK



DIGITS Workflow



VisionWorks



Jetson Media SDK

and other technologies:

CUDA, Linux4Tegra, NSIGHT EE, OpenCV4Tegra, OpenGL, Vulkan, System Trace, Visual Profiler

NVIDIA Developer Site

- ◆ <https://developer.nvidia.com/deep-learning>

The screenshot shows a web browser window for the NVIDIA Developer Site. The URL in the address bar is <https://developer.nvidia.com/deep-learning>. The page title is "Deep Learning | NVIDIA". The navigation bar includes links for Downloads, Training, Ecosystem, Forums, Search, Join, and Login. A banner at the top features the NVIDIA logo and the text "DEEP LEARNING". Below the banner, there's a section titled "Home" with a brief introduction to deep learning: "Deep learning is a subset of AI and machine learning that uses multi-layered artificial neural networks to deliver state-of-the-art accuracy in tasks such as object detection, speech recognition, language translation and others." To the right of this text is a timeline diagram showing the evolution of AI from 1950s to 2010s, with three main stages: Artificial Intelligence (1950s-1970s), Machine Learning (1980s-1990s), and Deep Learning (2000s-2010s). The Deep Learning section highlights its breakthroughs like AlphaGo and self-driving cars. Below this is a section titled "NVIDIA AI Platform for Developers" with a paragraph about GPU-accelerated deep learning frameworks.

Deep learning is a subset of AI and machine learning that uses multi-layered artificial neural networks to deliver state-of-the-art accuracy in tasks such as object detection, speech recognition, language translation and others.

Deep learning differs from traditional machine learning techniques in that they can automatically learn representations from data such as images, video or text, without introducing hand-coded rules or human domain knowledge. Their highly flexible architectures can learn directly from raw data and can increase their predictive accuracy when provided with more data.

Deep learning is responsible for many of the recent breakthroughs in AI such as Google DeepMind's AlphaGo, self-driving cars, intelligent voice assistants and many more. With NVIDIA GPU-accelerated [deep learning frameworks](#), researchers and data scientists can significantly speed up deep learning training, that could otherwise take days and weeks to just hours and days. When models are ready for deployment, developers can rely on GPU-accelerated inference platforms for the cloud, embedded device or self-driving cars, to deliver high-performance, low-latency inference for the most computationally-intensive deep neural networks.

NVIDIA AI Platform for Developers

Developing AI applications start with training deep neural networks with large datasets. GPU-accelerated deep learning frameworks offer flexibility to design and train custom deep neural networks and provide interfaces to commonly-used programming languages such as Python and C/C++. Every major [deep learning framework](#) such as TensorFlow, PyTorch and others, are already GPU-accelerated, so data scientists and researchers can get productive in minutes without any GPU programming.

NVIDIA Developer Site - Forum

- ◆ <https://devtalk.nvidia.com/>

The screenshot shows the NVIDIA Developer Forum homepage. At the top, there's a navigation bar with links to NVIDIA DEVELOPER, COMPUTEWORKS, Gameworks, JETPACK, DESIGNWORKS, a search icon, a 'Join' button, and a 'Login' button. Below the navigation bar, there are two main sections: 'Deep Learning Training and Inference' and 'Accelerated Computing'. Each section contains a list of topics with their respective counts of topics and comments. To the right of these sections is a 'Popular Topics' sidebar, which lists various forum topics along with their last update time and comment counts. The sidebar also includes a 'Latest Topics' section at the bottom.

Deep Learning Training and Inference

- Deep Learning Libraries (cuDNN / TensorRT / Other Libraries) - 397 Topics, 1,096 Comments

Accelerated Computing

- NVIDIA Container Technologies (NVIDIA Container Runtimes / Kubernetes on NVIDIA GPUs) - 8 Topics, 8 Comments
- NVIDIA GPU Cloud (NGC) Users (Announcements / FAQ / NGO Account / TITAN / Alibaba Cloud Image (阿里云) / AWS AMI / Google Cloud Platform (GCP) / Oracle Cloud Infrastructure / Docker and NVIDIA Docker / Feature Requests / General / Container: CUDA / Container: HPC Visualization / Container: HPC / Container: Inference server / Container: DIGITS / Container: NVCaffe / Container: Caffe2 / Container: Microsoft Cognitive Toolkit (CNTK) / Container: MXNet / Container: PyTorch / Container: TensorFlow / Container: Theano / Container: Torch) - 169 Topics, 454 Comments
- DRIVE Platforms (General / FAQ / DRIVE Hardware / DRIVE - Linux / DriveWorks) - 1,011 Topics, 4,181 Comments
- Announcements (Updates on the latest releases, upcoming events, and more) - 301 Topics, 701 Comments
- CUDA Setup and Installation (Installing and configuring your development environment for CUDA C, C++, Fortran, Python (pyCUDA), etc.) - 3,091 Topics, 12,041 Comments
- CUDA Programming and Performance (General discussion area for algorithms, optimizations, and approaches to GPU Computing with CUDA C, C++, Thrust, Fortran, Python (pyCUDA), etc.) - 34,180 Topics, 165,970 Comments
- GPU-Accelerated Libraries (General discussion on cuBLAS, cuSPARSE, cuFFT, NPP, Thrust, and other libraries) - 1,321 Topics, 3,707 Comments

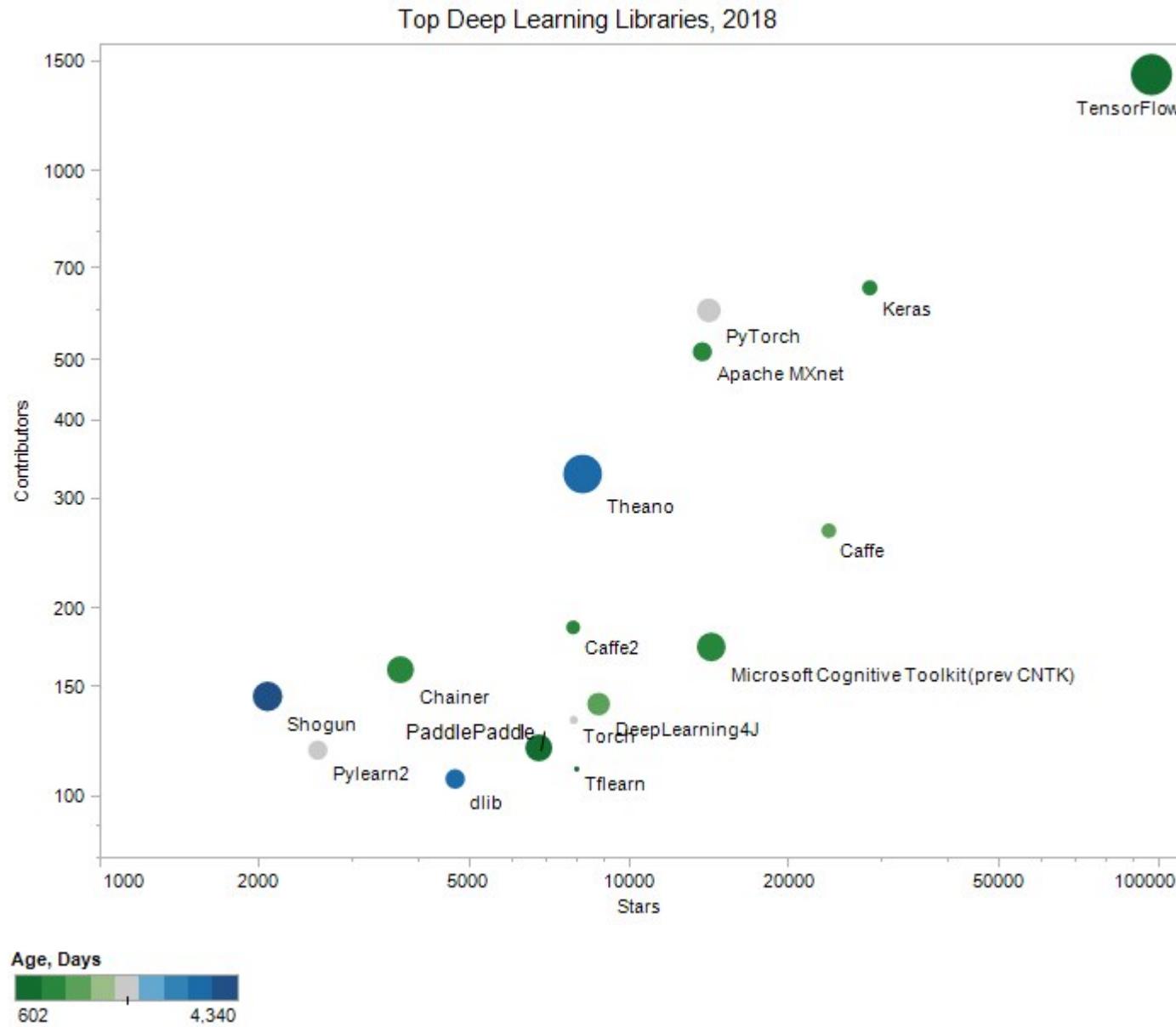
Popular Topics

- nvidia-390 driver error d... (CUDA Setup_and_...) - 3 days ago
- USB 3.0 hub not work on T... (Jetson TX2) - 4 days ago
- Point Grey USB 3.0 camera... (Jetson TX2) - 3 days ago
- Best graphics card for ru... (CUDA Programmin...) - 7 days ago
- Access to github repo (PhysX and Physi...) - 7 hours ago
- Question about 64 Bit Int... (CUDA Programmin...) - 6 days ago
- Oddly high regcounts in s... (CUDA Programmin...) - 2 days ago
- Unable to get back to a r... (Jetson TX2) - 13 hours ago
- from conventional python ... (CUDA Programmin...) - 1 week ago
- performance enhancement p... (CUDA Programmin...) - 21 hours ago

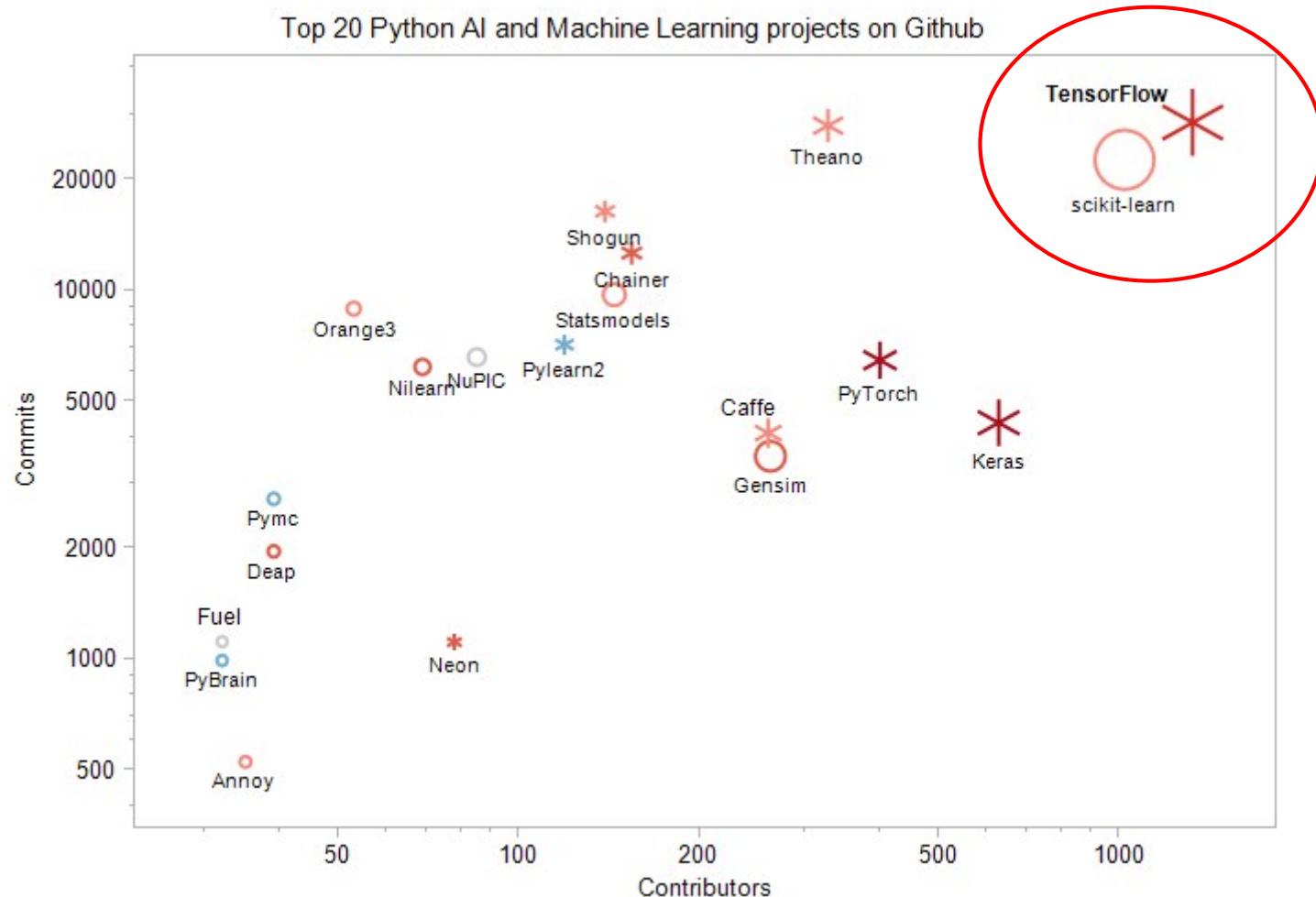
Latest Topics

- from #2 configuration (4x...) (Jetson TX2) - 52 seconds ago
- I want to change camera e... (Jetson TX1) - 7 minutes ago
- error : TVMR Video Dec Unsu... (Unsu...) - 0 minutes ago

Deep Learning Libraries

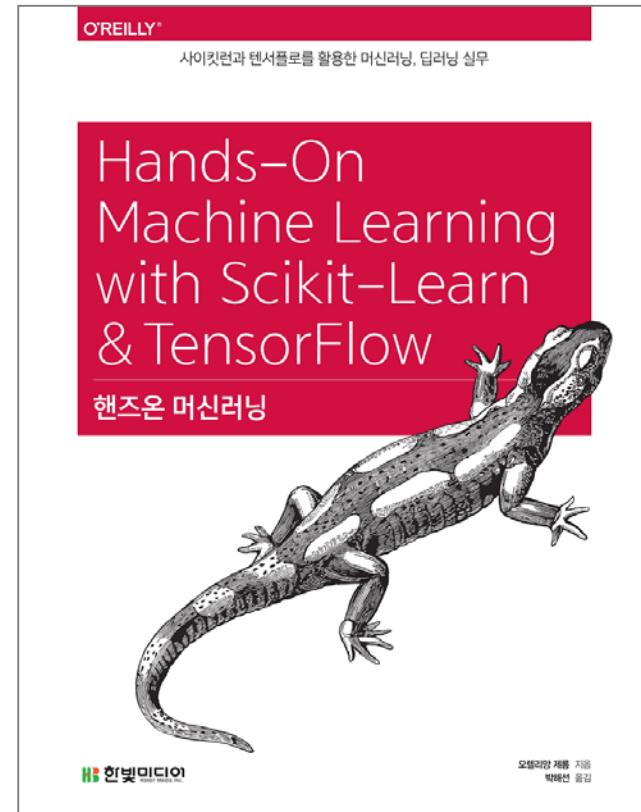
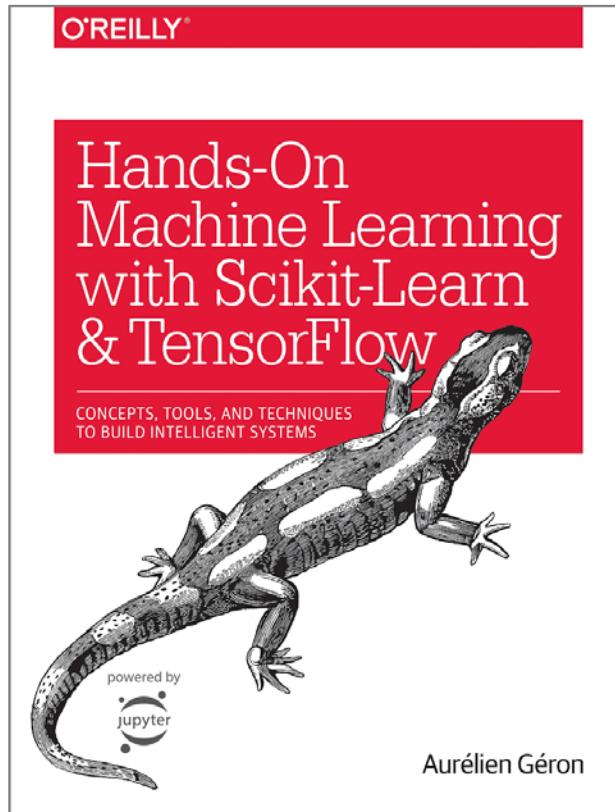


Python AI and Machine Learning projects



Textbook & Schedule

- ◆ Hands-On Machine Learning with Scikit-Learn & TensorFlow
(핸즈온 머신러닝, 한빛미디어)



Web Sites

- ◆ Jupyter notebook (영문) 예제코드
 - <https://github.com/ageron/handson-ml>
- ◆ Jupyter notebook (한글) 예제코드
 - <https://github.com/rickiepark/handson-ml>
- ◆ [교재] 한글 번역 버전
 - https://github.com/Hahnnz/Hands_on_ML-Kor
- ◆ 텐서플로우 블로그
 - 교재 errata, 수정사항들 업로드
 - <https://tensorflow.blog/핸즈온-머신러닝>

수업진행

◆ 발표(필수)

- 교재 한 챕터
- 논문 한 편

◆ 개발환경

- 임베디드 환경 : NVIDIA Jetson BD
- 데스크탑 환경 : NVIDIA GTX 그래픽카드
- 클라우드 환경 : AWS, Google ML 등

◆ 설치환경

- Python (Anaconda 패키지: NumPy, SciPy, Pandas, Matplotlib 등 포함)
- Jupyter Notebook (크롬 등 브라우저 기반)
- CUDA (for GPU)
- CuDNN (NVIDIA libraries for deep learning)

GitHub Sites

◆ GitHub ID

- <https://goo.gl/forms/GyMN6I6A9q3MsCXw1>
- GitHub ID – contributor 추가

◆ GitHub Repository

- <https://github.com/snow1809/Self-organizing-Software-Platform/>
- 교재 세미나 : 교재 발표자료 업로드
- 소스 : 실습 소스 업로드 (dataset 포함)
- 논문 세미나 : 논문 발표자료 업로드
- 논문 리스트 (추가 및 변경 예정)

1	Deep learning for health informatics	2017
2	Big Data, Smart Homes and Ambient Assisted Living	2014
3	The Internet of Things for Ambient Assisted Living	2010
4	SpO2 based sleep apnea detection using deep learning	2017
5	Sleep Quality Prediction From Wearable Data Using Deep Learning	2016
6	Using deep learning for energy expenditure estimation with wearable sensors	2015
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11	Convolutional neural networks for human activity recognition using mobile sensors	2014
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Any Questions... Just Ask!

