

SAMSUNG Research

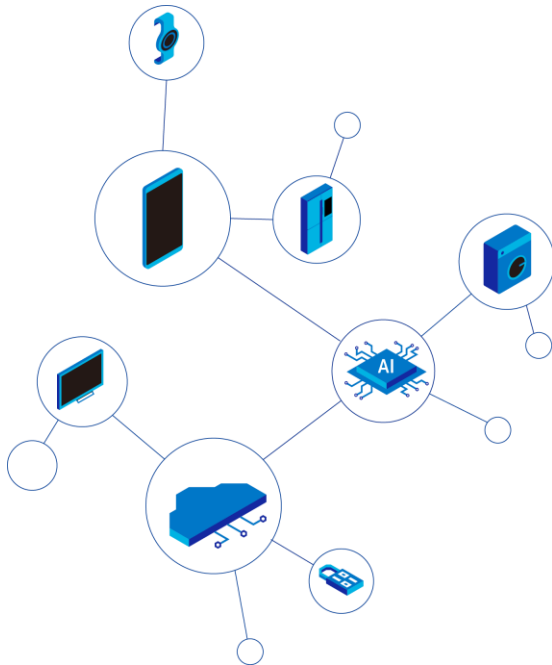
Intelligent IoT and Edge Computing Open Source

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Shape the Future with Innovation and Intelligence

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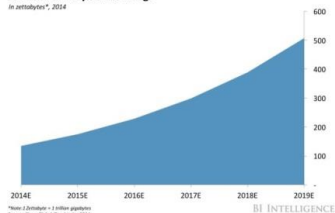
I. Why Edge | Background





- At the verge of "4th Generation Industry Revolution" era, we need;
 - **Efficient Transmission / Analytics / Processing** of the explosively increasing IoT Data
 - **Real-time Data Analytics** for handling industry needs in Industrial IoT solutions

Increasing # of Connected Devices/Data

- Explosive data transmission under BW limitation
 - Amount of IoT Data in 2019 : 507 ZB¹⁾
- Orchestration among a various types of data
 - Complexity of Cloud ↑ and Efficiency ↓

Total Amount Of Data Created Worldwide By Connected People And Things
in petabytes¹⁾, 2014



	Energy Utility Co.	.5TB/day
	Offshore Oil Field	.75TB/week
	Large Refinery	1TB/day
	Airplane	10 TB/30 min of flight

Emerging Services of Time-Critical

- Request real-time analytics : Safety/Efficiency
 - Connected Car : Autonomous driving
 - Smart Factory : Abnormality and defects resolutions



¹⁾ Projected by Cisco ('15), 1ZB=1 Trillion GB

I . Why Edge | Expectation

Low Latency	Satisfy requirements from mission-critical apps (< a few tens of ms)
Data Locality	Prevent unnecessary exposure of privacy data as firewall for IoT data
Save Bandwidth	Save the required BW by IoT Data Analytic at Edge instead of Cloud
Disconnected Operation	Improve usability by Masking against disconnection of public network

Requirements	Cloud	Edge
Geo-distribution	Centralized	Distributed
Distance client and server	Multiple hops	One hop
Latency	High	Low
Delay Jitter	High	Very low
Location awareness	No	Yes
Support mobility	Limited	Supported
Location of service	Within the Internet	At the edge

Ref : <http://blogs.cisco.com/perspectives/iot-from-cloud-to-fog-computing>

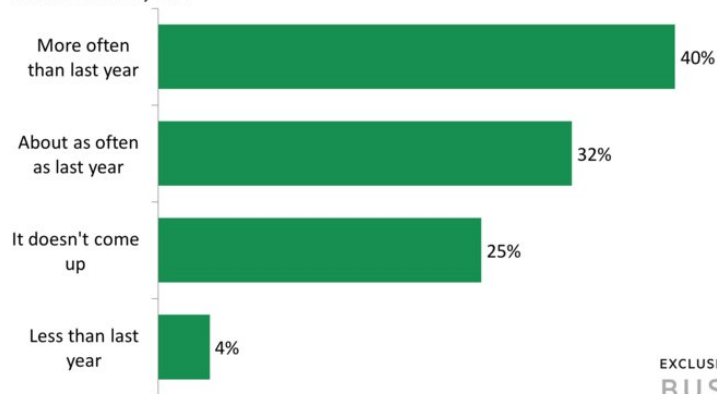
I . Why Edge | Impact on IoT

There are three particular types of problems that edge computing solutions are helping to combat across industries:

- 1. Security issues.** Edge computing can limit the exposure of critical data by minimizing how often it's transmitted. Further, they pre-process data, so there's less data to secure overall.
- 2. Access issues.** These systems help to provide live insights regardless of whether there's a network connection available, greatly expanding where companies and organizations can use connected devices and the data they generate.
- 3. Transmission efficiency.** Edge computing solutions process data where it's created so less needs to be sent to the cloud, leading to lower cloud storage requirements and reduced transmission cost.

Edge Computing Becoming A More Sought-After Part Of IoT Solutions

Q: Does edge computing — processing data from devices where it's created rather than in the cloud — come up more with your customers than it did last year?

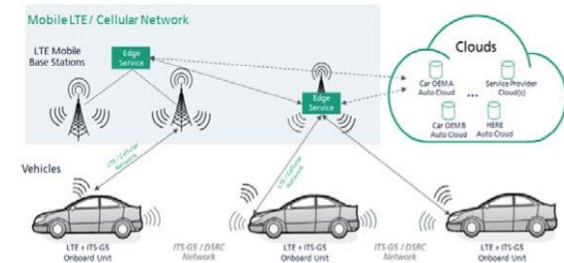
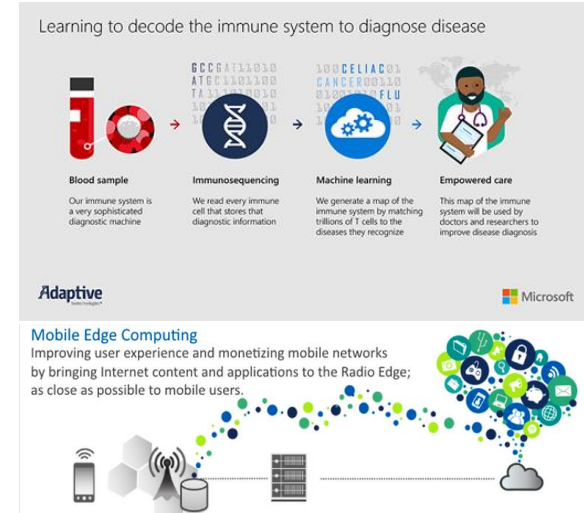


Source: Business Insider Global IoT Executive Survey, n=85 IoT providers, 2017

EXCLUSIVE DATA FROM
**BUSINESS
INSIDER**
INTELLIGENCE

I . Why Edge | Intelligent IoT

- In healthcare, companies and organizations are using edge computing to improve telemedicine and remote monitoring capabilities.
- For telecommunications companies, edge computing is helping to reduce network congestion and enabling a shift toward the IoT platform market.
- And in the automotive space, edge computing systems are enabling companies to increase the capabilities of connected cars and trucks and approach autonomy.



I . Why Edge | Value Chain



GAFA

Google, Amazon, Facebook, Apple

On Premise

Privacy
Security
AI

Intelligent and Secure Service at Home and Office



Automatic and Safe Service at Factory & Hospital



I . Why Edge | Biz Domain (3/3)



I . Why Edge | Trends (1/2)

▪ Categorization of Edge Platform per Functionality

Category	Functionality	Target Device
Collecting	Machine / Sensor Data Collection (Protocol – OPC UA, PLC, etc.) Stream Data Query (Data Redundancy Mitigation / Filtering, etc.) Status Monitoring – Machine / Sensor Connection	Raspberry Pi
Computing	Data Pre-Processing / Analytics Framework (TensorFlow, Caffe2, Flink, etc.) Running ML Engine : Vision / Voice Recognition (Learning at Cloud) Machine / Sensor Operation Control by Data Processing Result at Edge	PC, Mobile, etc.
Storage	Storage / compression / offering of private data Metadata management for data searching service Cyclic data backup and synchronization (Transferring data into cloud)	Server, NAS
Common	Service deployment / update / monitoring (Auto-scaling) Security : Authentication, Identification, Secure Communication	-

I . Why Edge | Trends (2/2)

▪ Edge Platform Solutions on the Market

List	Category	Key Features	Deployment Method	Supporting Platform
MS Azure IoT Edge	Computing	Deploy ML Model after Learning from Cloud, ML, Stream Data Query / Filtering, Edge Computing Device Mgmt. based on Cloud	Microservice	Linux, Mac, Windows
Amazon AWS Greengrass	Computing	Run AWS Functions (Lambda, Shadow) at Edge, Deploy ML Model after Learning from Cloud	Proprietary (MQTT)	Linux, RPi
Google Edge IoT Core	Computing	Deploy ML Model after Learning from Cloud, AI Services Oriented (based on Deep Learning), H/W (NPU, GPU, Designated AI Processor)	SDK	Android iOS,macOS,tvOS
ARM MBed Edge	Collecting	Protocol Translation for Connected Devices with Edge Computing Device	Microservice	Linux, RPi

I . Why Edge | Edge + Analytics (1/3)

▪ MS, Azure IoT Edge

- Employing AI and Advanced Analytics Services at Edge

: Deploy Analytics, ML, AI Models into IoT Edge after Learning from Cloud (Container based)

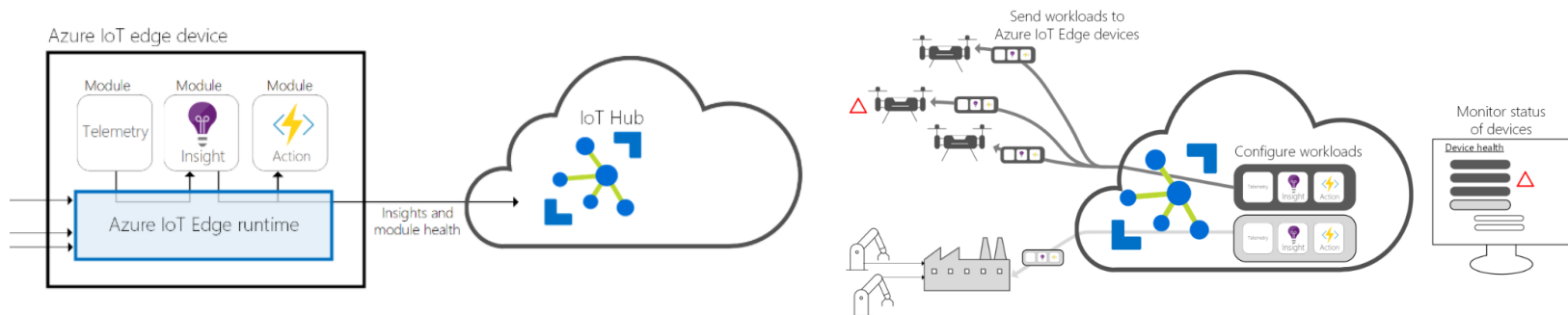
: AI / Advanced Analytics Services : Using Azure ML, Azure Stream Analytics, Azure Functions

- Composition : IoT Edge Module, Runtime, Cloud Interface

: Module – Container-based Deployment Function Unit

: Runtime – Container Installation / Run / Update, Device Abstraction (Linux, Mac, Windows)

: Cloud Interface – Compatible to Azure IoT Suite (Device Mgmt., Monitoring)



I . Why Edge | Edge + Analytics (2/3)

▪ Amazon, AWS Greengrass

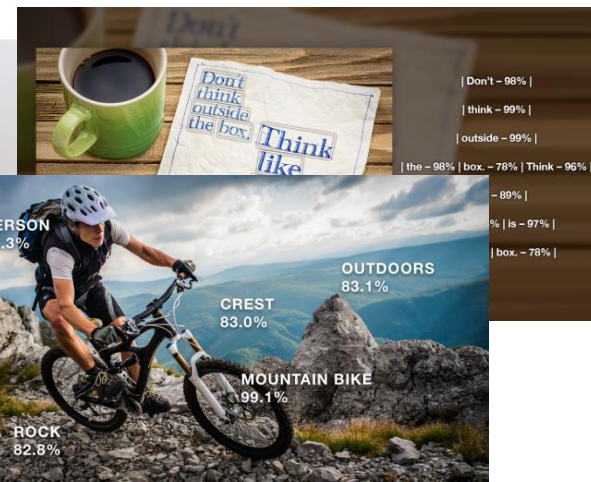
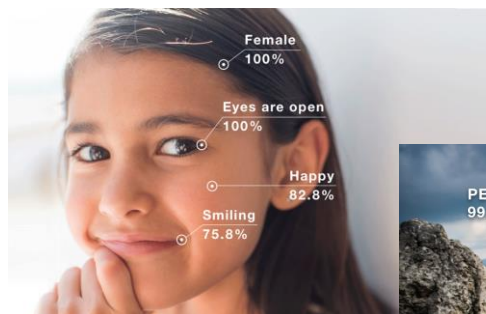
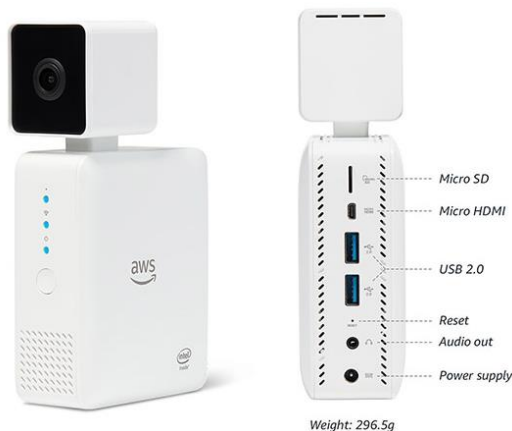
- Expansion of AWS Cloud Functionality into Local Device

: Local Computing, Messaging, Data Caching / Sync., and ML Inference

: Run Apps at AWS Cloud and Local Device using AWS Lambda and AWS IoT

- AWS DeepLens :

: Deep Learning Video Camera for Developers (Based on Intel Atom® Chipset, '17.11)



I . Why Edge | Edge + Analytics (3/3)

■ Google, Edge IoT Core (ALPHA) ('18. 7)

- Google's Edge Platform : Compatible to Google Cloud IoT Core™ (Not Public yet)
 - : Support Android Things & Linux, Google Kubernetes Engine (GKE) (Google Optimized Version)
 - : Run TensorFlow Lite Model at Local Edge (Learning at Cloud)
 - : Edge TPU™ - Google's Purpose-Built AI Chip



Edge IoT Core

Securely connect edge devices to the cloud, enable software and firmware updates, and manage the exchange of data with Cloud IoT Core.



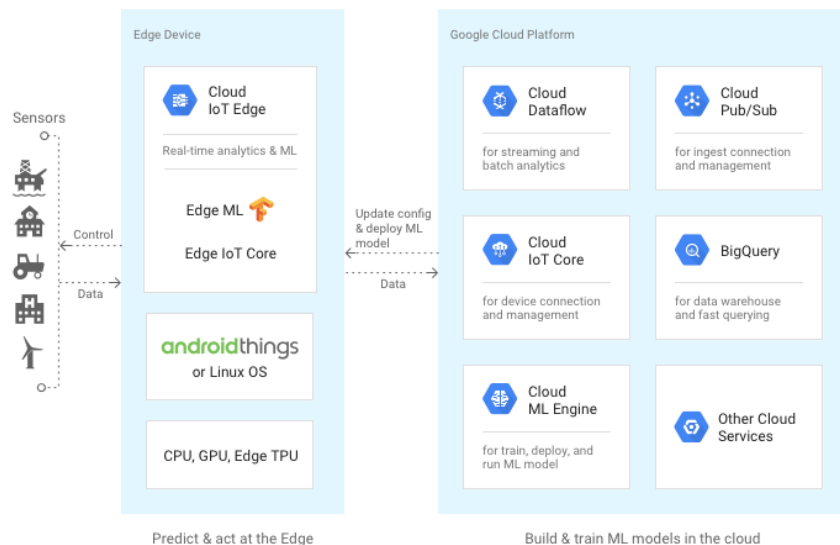
Edge ML

Run ML inferences of pre-trained TensorFlow Lite models locally, significantly increasing the processing power and versatility of edge devices. This enables the next wave of machine learning applications and use cases.



Edge TPU

Google's purpose-built AI chip designed to run TensorFlow Lite ML models at the edge. Edge TPU offers high performance per watt with a small footprint, enabling a broad set of use cases. This hardware accelerator complements Cloud TPU, which is used for training models in the cloud.



II. Edge Open Source | Challenges

Interoperability



IoT standards work is progressing, but there will always be widespread fragmentation in connectivity

Annotation



Data harmonization is really important to extract the insight, but the each Data has its own format

Vender-Neutrality



Many solutions are available, but customers hesitate to select the best w.r.t. their changing market needs

Domain Knowledge based



Many different tools and skill sets are required to address myriad industry verticals and use cases

Trustworthy



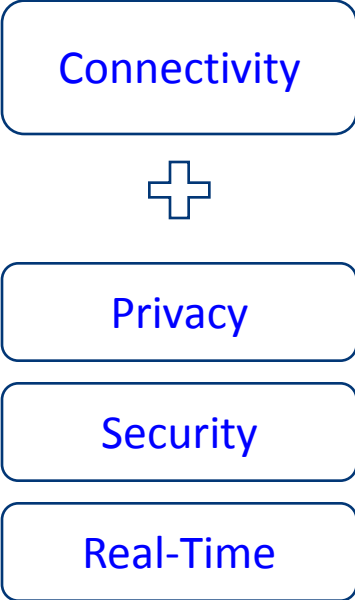
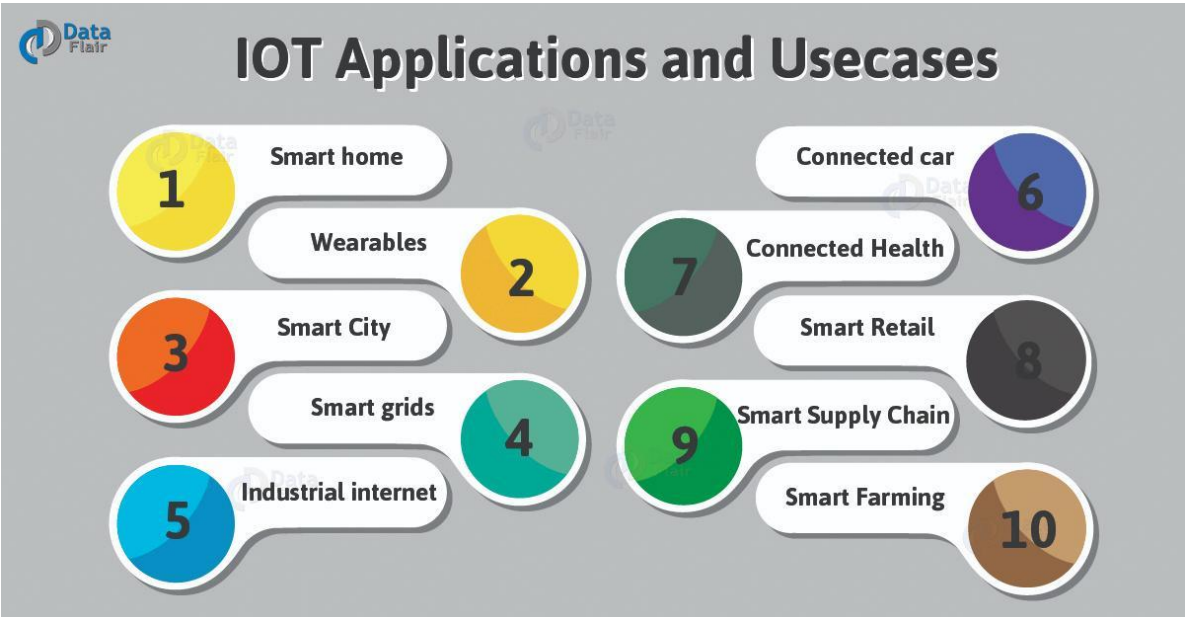
Misoperation leads a serious safety accidents and loses, so we need a trustworthy system for the techs

Dynamic Adoption



Techs have been advanced dynamically w.r.t. the market needs, but ask "Openness" to stakeholders


II. Edge Open Source | IoT Issues



REF) 4 Jun, 2018 in [IOT Tutorials](#) by [Data Flair](#)

II. Edge Open Source | Philosophy

EDGE X FOUNDRY™

Sponsored by 

EdgeX Foundry™ is a vendor-neutral open source project hosted by The Linux Foundation building a **common open framework for IoT edge computing**.

At the heart of the project is an **interoperability framework** hosted within a full hardware- and OS-agnostic reference software platform to enable an **ecosystem of plug-and-play components** that unifies the marketplace and accelerates the deployment of IoT solutions.

Architected to be agnostic to silicon (*e.g.*, x86, ARM), OS (*e.g.*, Linux, Windows, Mac OS), and application environment (*e.g.*, Java, JavaScript, Python, Go Lang, C/C++) to support customer preferences for differentiation

II. Edge Open Source | Community Growth

- Project progress since its launch from April in 2017
 - Considerable Momentum, now over 70 ecosystem members with most recent additions of Samsung at Platinum and Thales, Cavium, and Wanxiang Group at Silver. More in flight.

EDGE X FOUNDRY™



Official Mascot of EdgeX



II. Edge Open Source | Tools of the Trade

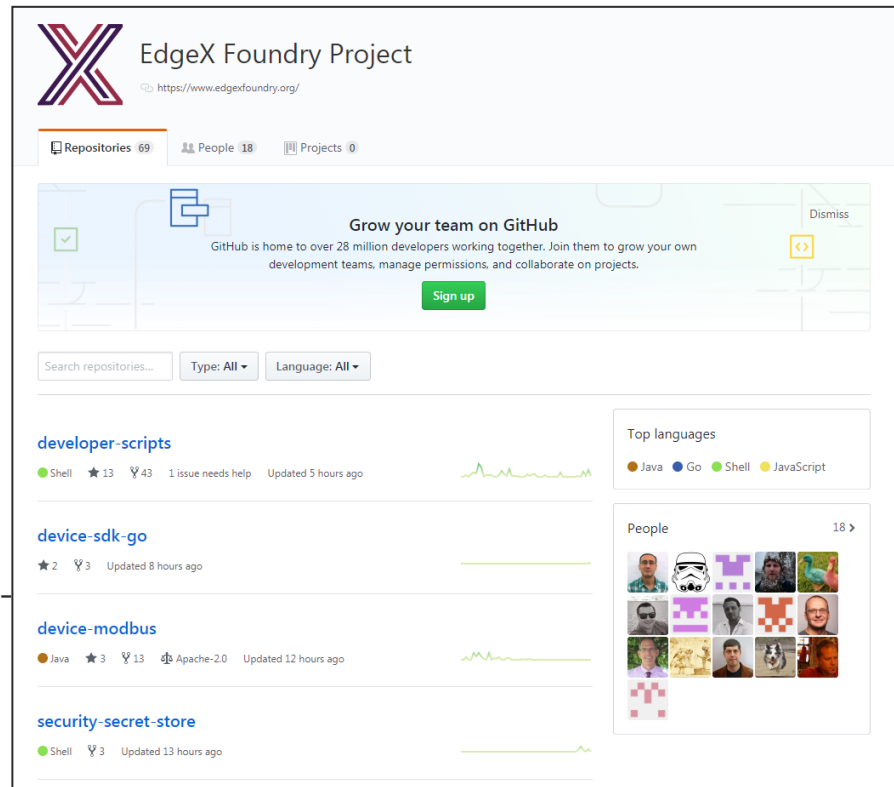
- **What you need to get in order to develop EdgeX today;**
 - Git
 - MongoDB*
 - ZeroMQ*
 - Java JDK (version 1.8 or better)
 - Go Lang IDE : VS Code, GoLand, Atom, etc.
 - Eclipse (recommend Mars version or better)
 - Docker and Docker Compose*
 - * Optional depending on your work

- **EdgeX has been developed a cross variety of OS;**
 - Windows
 - Linux
 - Mac



II. Edge Open Source | Getting EdgeX

- Download the project repositories with Git at github.com/edgexfoundry
- EdgeX is comprised of many microservices and libraries
- Learn the landscape (dependencies and connection points) as you go.
 - <https://wiki.edgexfoundry.org/display/FA/Get+EdgeX+Foundry+-+Developers#GetEdgeXFoundry-Developers-Dependencies>

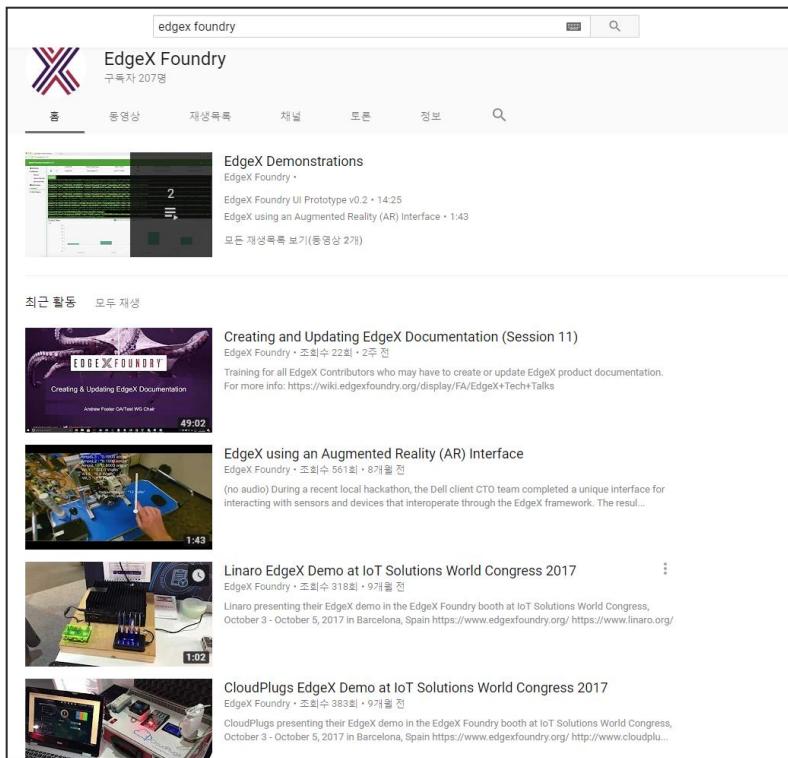


The screenshot shows the GitHub page for the EdgeX Foundry Project. At the top, there is the EdgeX logo (a stylized 'X' in red and blue) and the text 'EdgeX Foundry Project' with the URL 'https://www.edgexfoundry.org/'. Below this, there are statistics: 'Repositories 69', 'People 18', and 'Projects 0'. A prominent banner for GitHub is visible, encouraging users to 'Grow your team on GitHub' with a 'Sign up' button. Below the banner, there is a search bar for repositories and filters for 'Type: All' and 'Language: All'. The main content area lists several repositories:

- developer-scripts**: Shell, 13 stars, 43 forks, 1 issue needs help, updated 5 hours ago.
- device-sdk-go**: 2 stars, 3 forks, updated 8 hours ago.
- device-modbus**: Java, 3 stars, 13 forks, Apache-2.0 license, updated 12 hours ago.
- security-secret-store**: Shell, 3 forks, updated 13 hours ago.

On the right side, there are two sidebars: 'Top languages' showing Java, Go, Shell, and JavaScript; and 'People' showing a grid of 18 profile pictures.

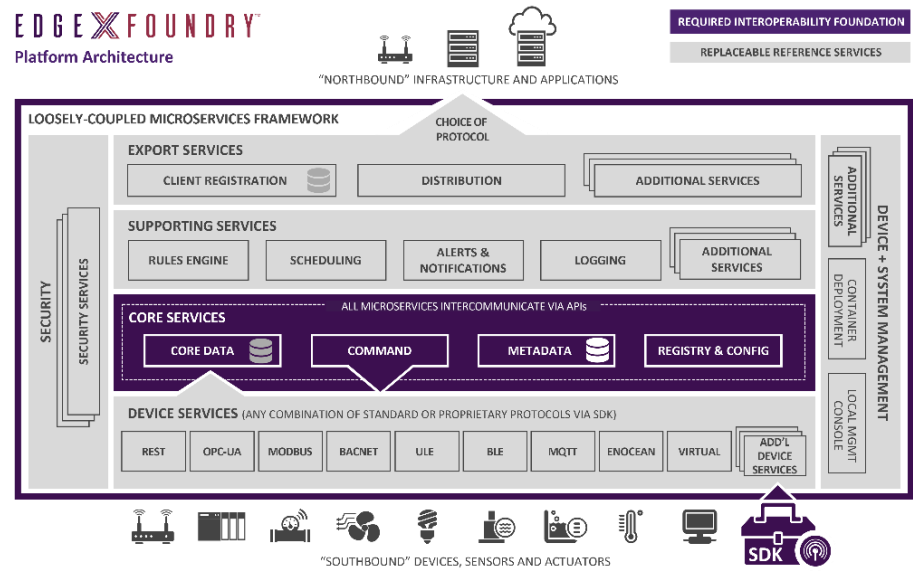
II. Edge Open Source | Resources



- **Wiki** (wiki.edgexfoundry.org)
- **Rocket Chat** (chat.edgexfoundry.org)
- **TechTalk : Wiki 및 Youtube 채널**
(<https://www.youtube.com/channel/UC30DbbsoqbkGJYJ5omJJsng>)
- **Web Site** (edgexfoundry.org)
- **Github** (github.com/edgexfoundry)

II. Edge Open Source | Architecture

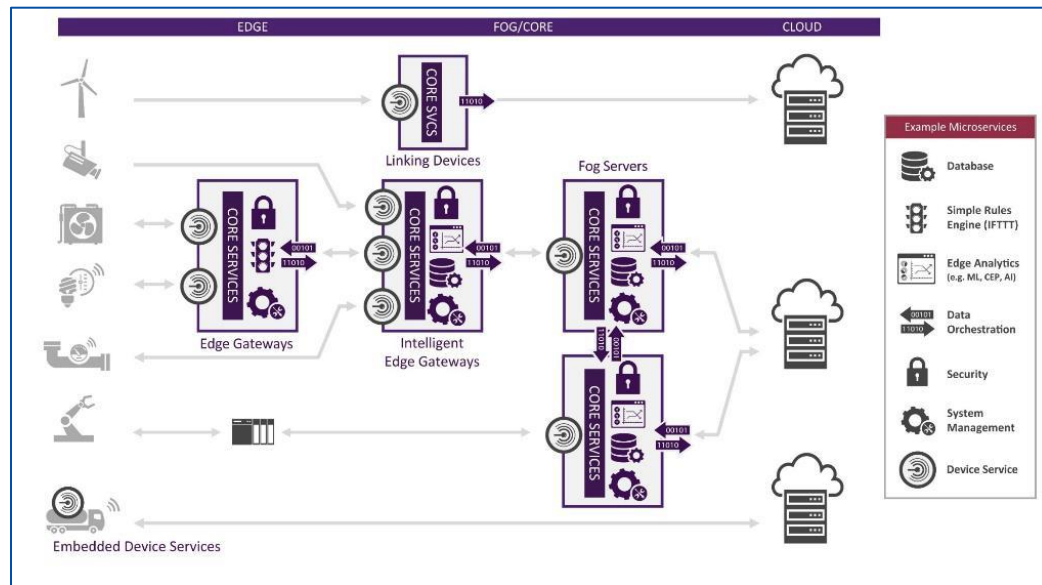
- **Containerized architecture : A common open framework for IIoT Edge Platform**



- **Core** : Ensures interoperability between northbound and southbound microservices thru common APIs
- **Device** : Defines common means to create device interfaces using preferred connectivity protocols
- **Supporting** : Provide edge analytics and intelligence, from logging, scheduling, and data clean up (scrubbing)
- **Export** : Interface with cloud services with client registration and off-gateway management
- **Security** : Protect the data and command of devices, sensors, and other IoT objects managed by EdgeX
- **System Mgmt** : Provide the installation, upgrade, start, stop, and monitoring of microservices and BIOS firmware, OS, and other gateway-related S/W

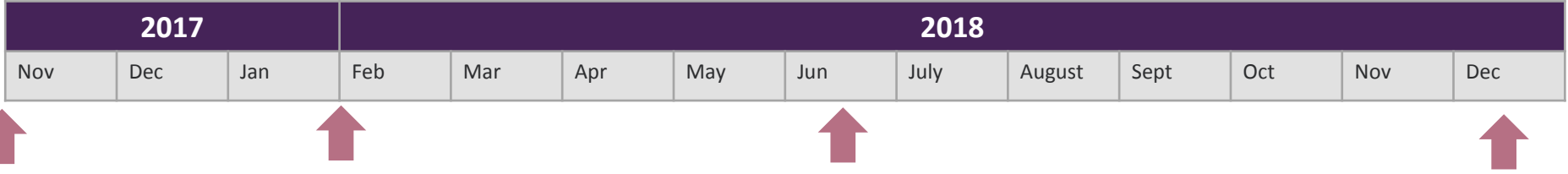
II. Edge Open Source | Tiered Fog Deployments

- Loosely-coupled architecture enables distribution across nodes to enable tiered edge/fog computing
- Scope includes embedded sensors to controllers, edge gateways and servers
- Quantity and function of microservices deployed on a given node depends on the use case and capability of hardware
- Discrete Device Services can be run on capable smart sensors/systems and communicate directly with other backend systems, including the cloud



II. Edge Open Source | Release Roadmap

In order to provide EdgeX consumers with a predictable foundation to base their commercial offerings on it is the goal of the TSC to outline key release themes at least 12 months in advance and to plan features to be delivered in a given release 6 months in advance. As with any open source software project, delivery of planned features is based on priority and available developer bandwidth.



'Barcelona' Release

(Released Oct 20 2017)

- Improved fit and finish, for malized Core Service APIs, additional Device and Export Services, test apparatus
- Intended to ramp developer engagement and PoCs with end customers for feedback and further hardening

'California Preview'

(Jan 2018)

- Drop-in Go Lang microservice replacements demonstrating reduced footprint and higher performance
- Stretch goal: C-based Device Service SDK

'California' Release

(June 2018)

- First integration of security and manageability APIs
- Improved fit and finish, more Export and Device Services
- Intended as first product-quality OSS foundation for commercial differentiation and field deployments

'Delhi' Release

(Dec 2018)

- Additional security and manageability extensions
- High performance message bus option
- Extensions for distributed/ fog computing
- Beginning of EdgeX certification program

II. Edge Open Source | Latest Release

- **California Release : Lightweight, secure**

(<https://www.edgexfoundry.org/blog/2018/07/19/welcome-california/>)

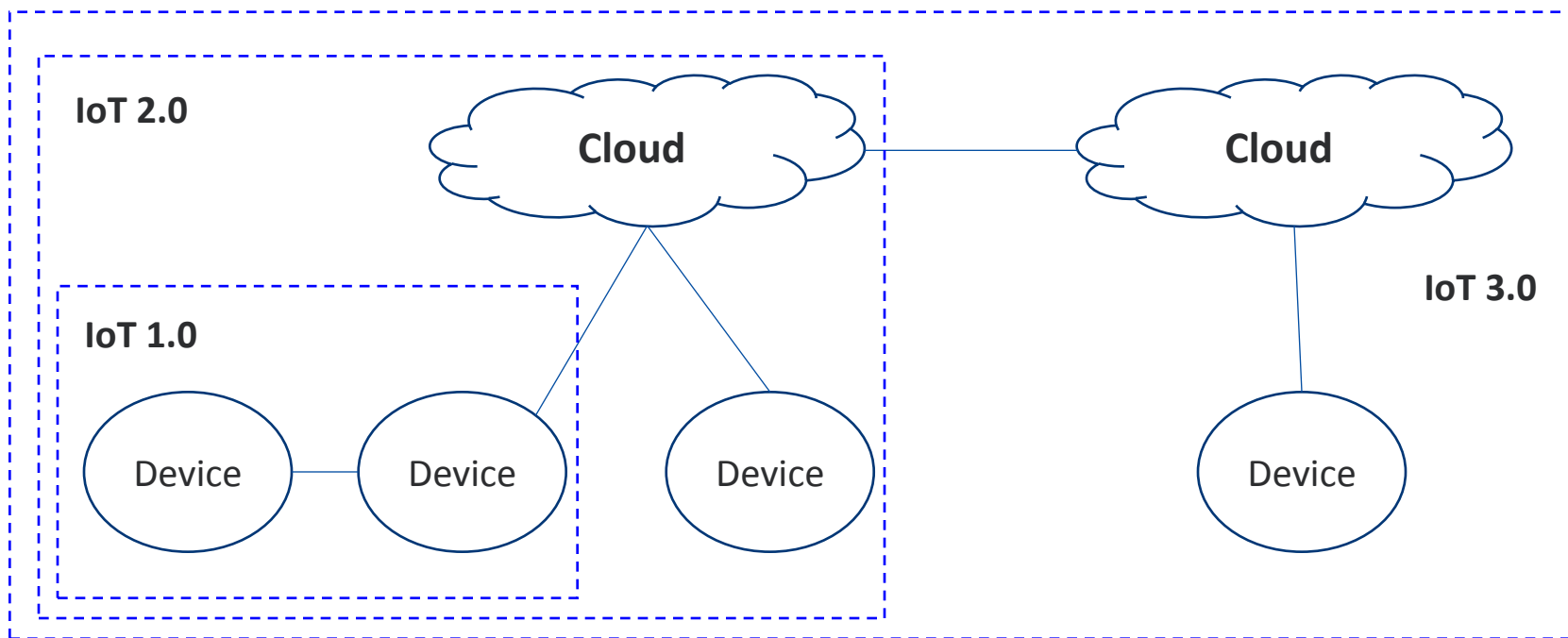
	Barcelona Java Services	California Go Services
<i>Total Footprint</i>	267MB	42MB
<i>Total Footprint w/ Container</i>	519MB	68MB
<i>Total Memory usage (simulated 100 devices)</i>	1302MB	27MB
<i>Startup time per service</i>	~35 seconds/service	< 1 second/service

Note: these tests are inclusive of core, metadata, command, export client and export distribution micro services

- **Security :**
Reverse Proxy – Protect REST API comm. (Authenticate)
Secure storage – Credentials, Cert., Secure token, etc.
- **Performance :**
Rebuild microservices in Go Lang, lowered footprint, startup time, memory/CPU usage
- **Additional :**
Additional northbound connectivity, arm64 support, blackbox test for all the microservices, etc.
- **And next? :**
2 major releases in a year : Oct. in 2018 “Delhi”

III. Concluding Remarks

Edge Computing that can support Security, Privacy and Real-Time is the future IoT



SAMSUNG Research

Thank You



Shape the Future with Innovation and Intelligence