EDGE X FOUNDRY™

A Microservice Approach to IoT Edge Computing

Jim White - Dell Technologies

DELL Technologies

LINUXCON containercon CLOUDOPEN CHINA 中国

• May 2018

Agenda

- The inherent challenges of IoT
- Introduce EdgeX – a microservice architecture for the edge
- Addressing 5 key challenges of the edge & how microservices help
- Microservices no silver bullet – challenges microservice architecture bring
- Resource list for more info, call to action

Who is this guy?

- Jim White
  - Dell Technologies IoT Solutions Division – Distinguished Engineer
  - Team Lead of the IoT Platform Development Team
  - Chief architect and lead developer of Project Fuse
    - Dell's original IoT platform project that became EdgeX Foundry
    - Yes – I wrote the first line(s) of code for EdgeX (apologies in advance)
  - EdgeX Foundry …
    - Technical Steering Committee member
    - Ad hoc and unofficial lead architect

iot for all

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Launch Advice

Why the
It's Becau

The adoption of IoT is off t
IoT projects will take 2x as

By David Houghton

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IoT Proto

When entering the w
your way around the
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by Candace Letizia

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Look before you leap

Data errors, security holes and rapidly cha

By Stephen Lawson

Senior U.S. Correspondent, IDG News Service | MAR

WIRED 7 Reasons Why the Internet of Things Is Doomed SUBSCRIBE

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PARTNER CONTENT JASON BLOOMBERG, INTELLYX.

7 REASONS WHY THE INTERNET OF THINGS IS DOOMED

Image: Kyle Slattery/Flickr

Why is IoT hard to do?

- Heterogeneity of platforms
  - Diverse collection of OS and OS variants
    - Linux, Unix, Windows, VxWorks, embedded and RTOS, …
  - Various Hardware (Intel, AMD, ARM,…)
  - Cloud, gateway, smart thing (the “Fog continuum”)
- Thing protocol soup
  - Industrial: BACNet, Modbus, OPC-UA,…
  - Wireless: BLE, Z-Wave, Zigbee,…
  - Message: MQTT, AMQP, DDS, …
- Variety of cloud platforms
  - Azure IoT Hub, AWS IoT Platform, Google IoT Core, IBM Watson IoT Platform, …
- Add your favorite selection of…
  - Applications, edge analytics/intelligence, security, system management, …
- Difficulties in determining where to start

IoT is a post doctorate in all we know and have done in computing for the last 30-40 years

- Networks/protocols
- Mobile computing
- Distributed compute
- Cloud compute
- AI/Machine learning
- …

Introducing EdgeX Foundry

- An open source, vendor neutral project (and ecosystem)
- A **microservice**, loosely coupled software framework for IoT edge computing
- Hardware and OS agnostic
  - Remain agnostic with regard to microservice implementation
  - Many of the microservices were in Java and are now in Go
  - C/C++ is envisioned for south side connectors and to address real time needs
  - JavaScript for UI
- Goal: enable and encourage growth in IoT solutions
  - The community builds and maintains common building blocks and APIs
  - Plenty of room for adding value and getting a return on investment
  - Allowing best-of-breed solutions

A Brief EdgeX History

- Chartered by Dell IoT marketing in July 2015
  - A Dell Client CTO incubation project (Project Fuse)
- Designed to meet interoperable and connectivity concerns at the IoT edge
- Started with over 125,000 lines of Dell code
- Entered into open source through the Linux Foundation on April 24, 2017
  - Started with nearly 50 founding member organizations; today we have more than 75
- Release Cadence: 2 formal releases a year

'Barcelona' Release
(Released Oct 20 2017)

'California' Release
(June 2018)

'Delhi' Release
(Oct 2018)

'Edinburgh' Release
(Apr 2019)

Disclaimer

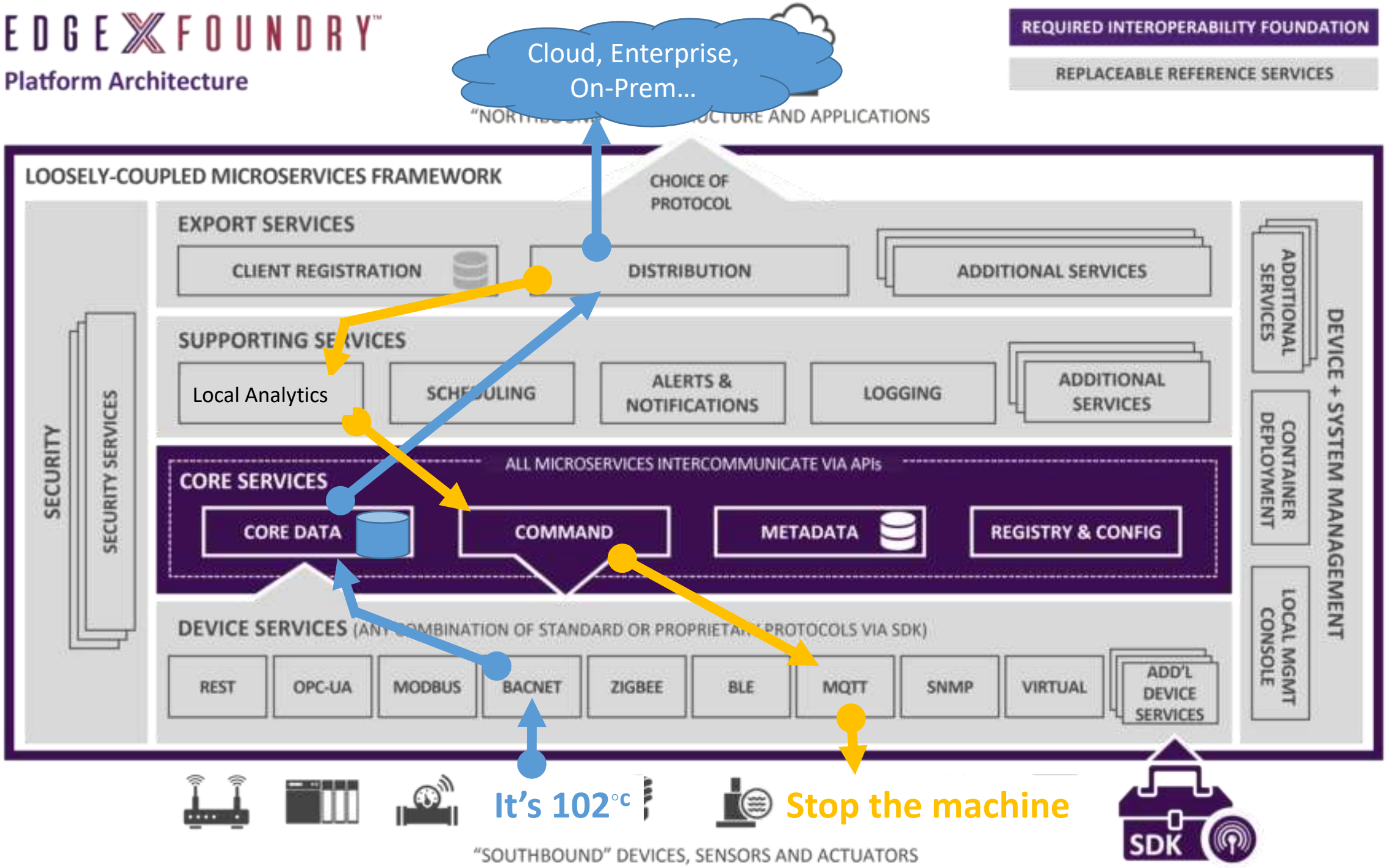
- I am not here to sell you on EdgeX Foundry (the product or org)
  - Although that would be a nice by-product ☺
- I am here to present a microservice based solution to solve some of the more challenging IoT problems
  - The EdgeX implementation helps to demonstrate (validate?) the concept
  - Consider the architecture in your decision making
  - Use our lessons learned where you can
  - Replicate/duplicate if you must
  - Join us if you can
    - If you think the approach correct and you don’t feel like starting from scratch

EdgeX Primer - How it works

- A collection of a dozen+ microservices
  - Written in multiple languages (Java, Go, C, … we are polyglot believers!!)
  - Several commonly used library projects (common domain objects, client libraries, etc.)
- EdgeX data flow:
  - Sensor data is collected by a **Device Service** from a thing
  - Data is passed to the **Core Services** for local persistence
  - Data is then passed to **Export Services** for transformation, formatting, filtering and can then be sent “north” to enterprise/cloud systems
  - Data is then available for edge analysis and can trigger device actuation through Command service
- REST communications between the service
  - Some services exchange data via message bus (core data to export services and rules engine)
- Microservices are deployed via Docker and Docker Compose

EDGE X FOUNDRY™

Platform Architecture



Performance Targets

- The target is to run all of EdgeX on a Raspberry Pi 3 type of device
  - 1 GB RAM, 64bit CPU, at least 32GB storage space
- Additional “developer community” targets
  - Startup in 1 minute or less (post OS boot)
  - Latency for one piece of data from data ingestion to actuation will be < 1 second
- Remaining OS and Hardware agnostic
  - Windows, Linux, *nix, …
  - Intel/Arm 64/Arm 32

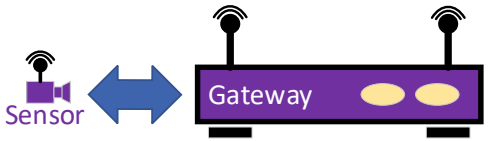
Current #'s	
Footprint	76 MB
Footprint with container	113 MB
Memory (idle)	26 MB
Memory with 100 devices	40 MB
Startup time	< 10 sec
without DB or device services	

The Challenges of IoT

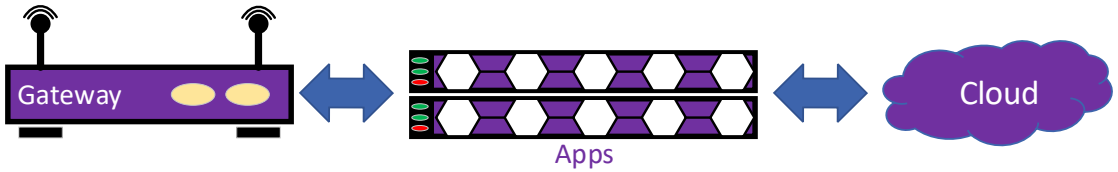
- #1 Dealing with the diversity
  - Dealing with the diversity of device connectivity protocols
  - Working with multiple cloud and enterprise systems
  - Dealing with multiple IoT data models and data formats
- #2 Incorporating any analytics package
- #3 Allowing for the continual improvements and upgrades of parts of the IoT solution
- #4 Respond to evolving business needs and technological advancements (how to make a ROI in IoT)
- #5 Addressing limited resources in an IoT environment

Problem 1: protocols, models, and formats

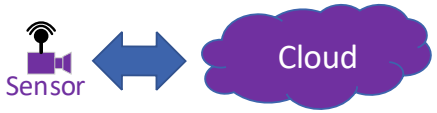
- IoT is inherently a multi-transform problem
- Communicating across multiple protocols, using different data models and formats (JSON, XML, etc.)
  - From “thing” to edge platform (like a gateway)



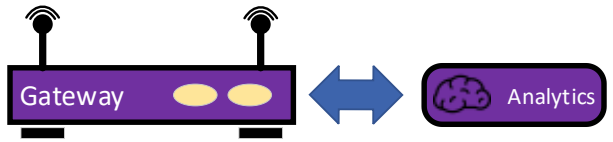
  - From edge to application layer or cloud



  - Sometimes from thing to cloud

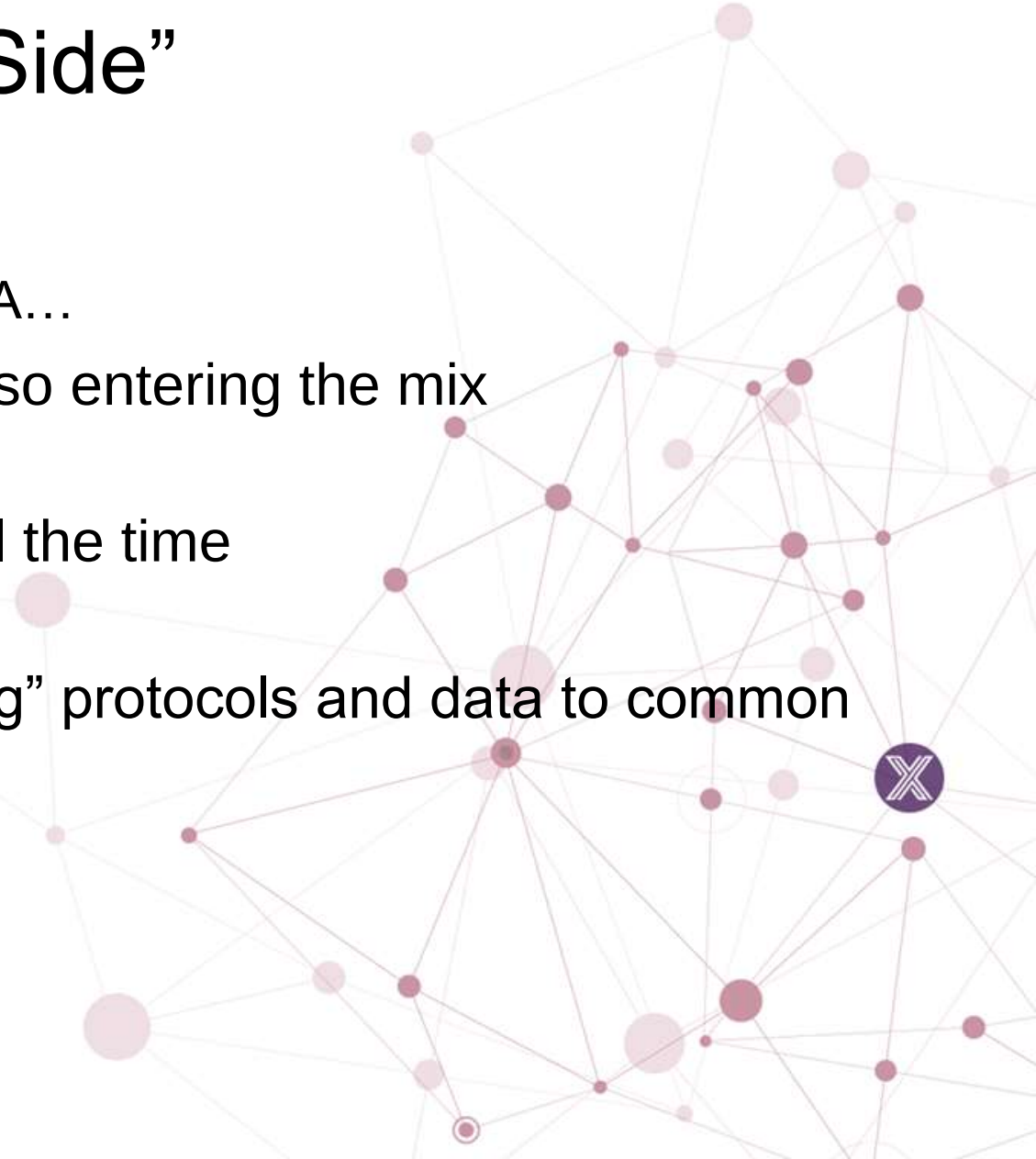


  - To/from analytics applications

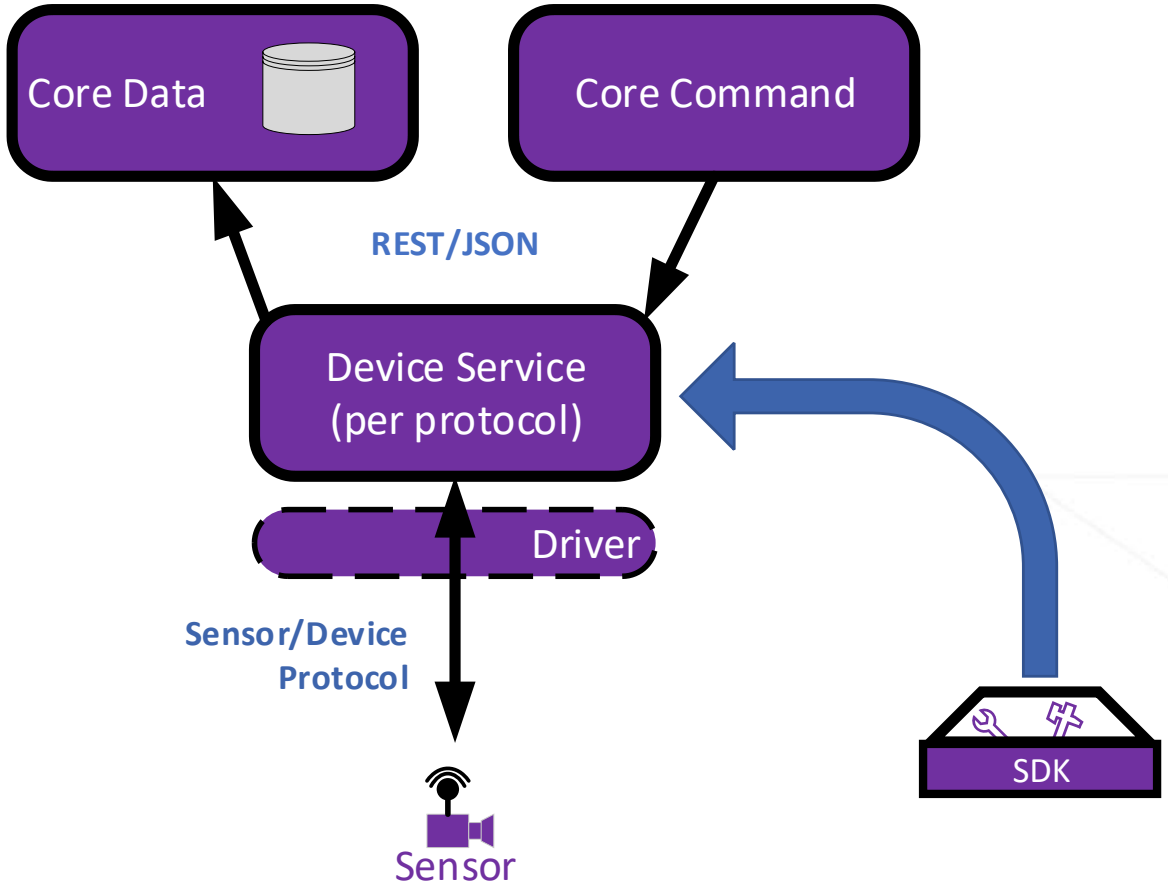


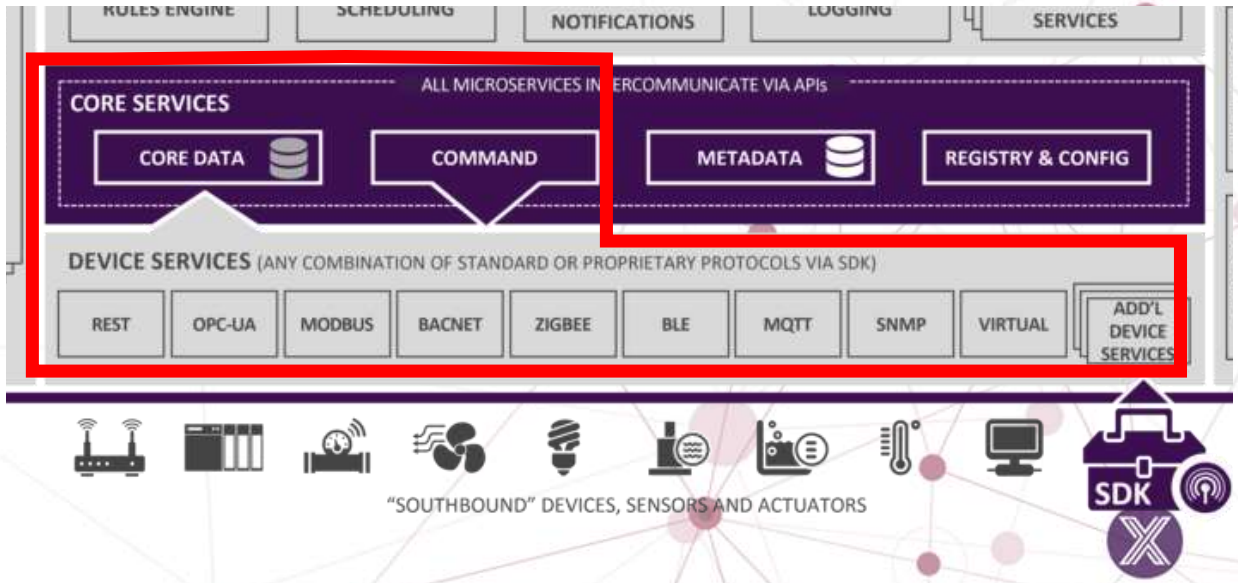
Transformation on the “South Side”

- The world of OT protocol soup
  - Modbus, BACNet, Profibus, CANBus, OPC-UA…
- Consumer and traditional IT protocols are also entering the mix
  - BLE, Zigbee, ZWave, MQTT, SNMP, …
- New “things” & protocols are being added all the time
  - You can never keep up with them all
- EdgeX Device Services transform from “thing” protocols and data to common Core Data (micro) Service



Device Services

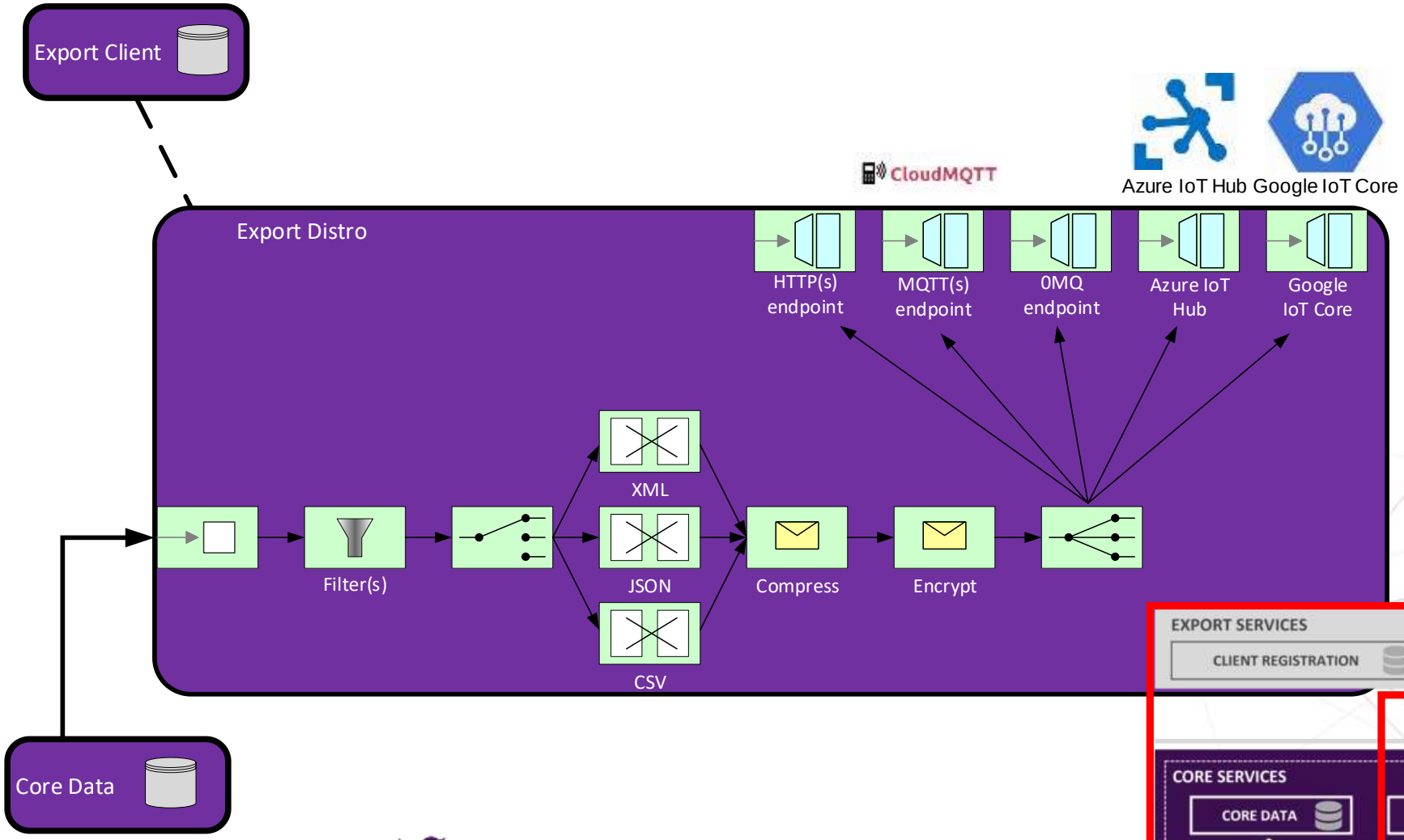


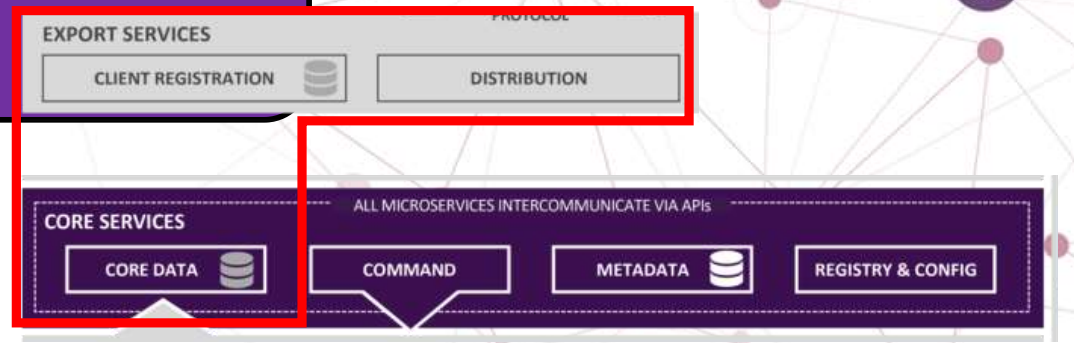


Transformation on the “North Side”

- North side endpoints need data…
  - Filtered
  - Transformed (data model of choice)
  - Enriched (add device metadata, location, etc.)
  - Formatted (XML, JSON, CSV, …)
  - Compressed, Encrypted, etc.
- This is classic EAI (enterprise application integration)
  - aka pipe & filter architecture
- EdgeX Export Services take the data from Core Data and get it to the applications/cloud

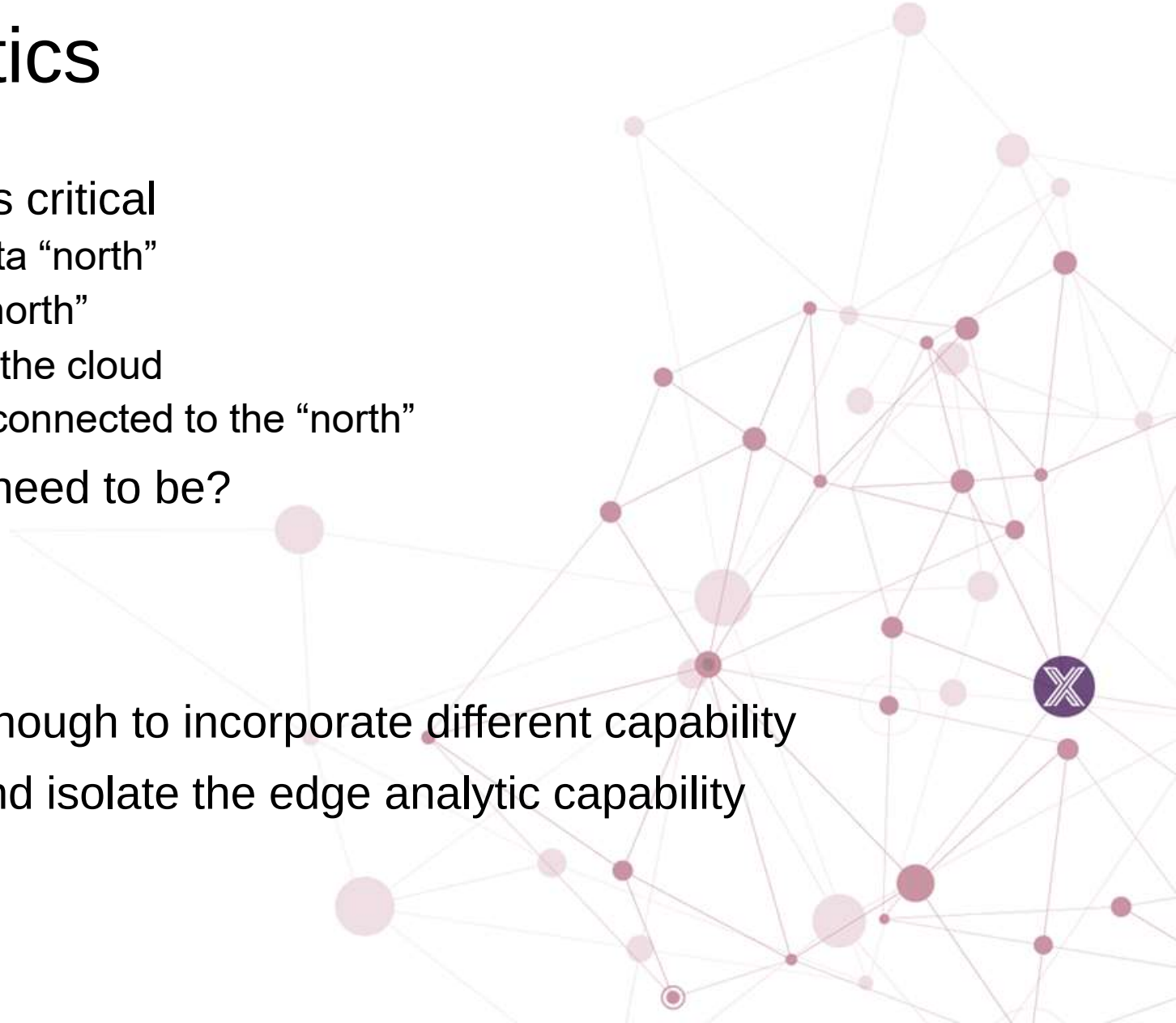
Export Services





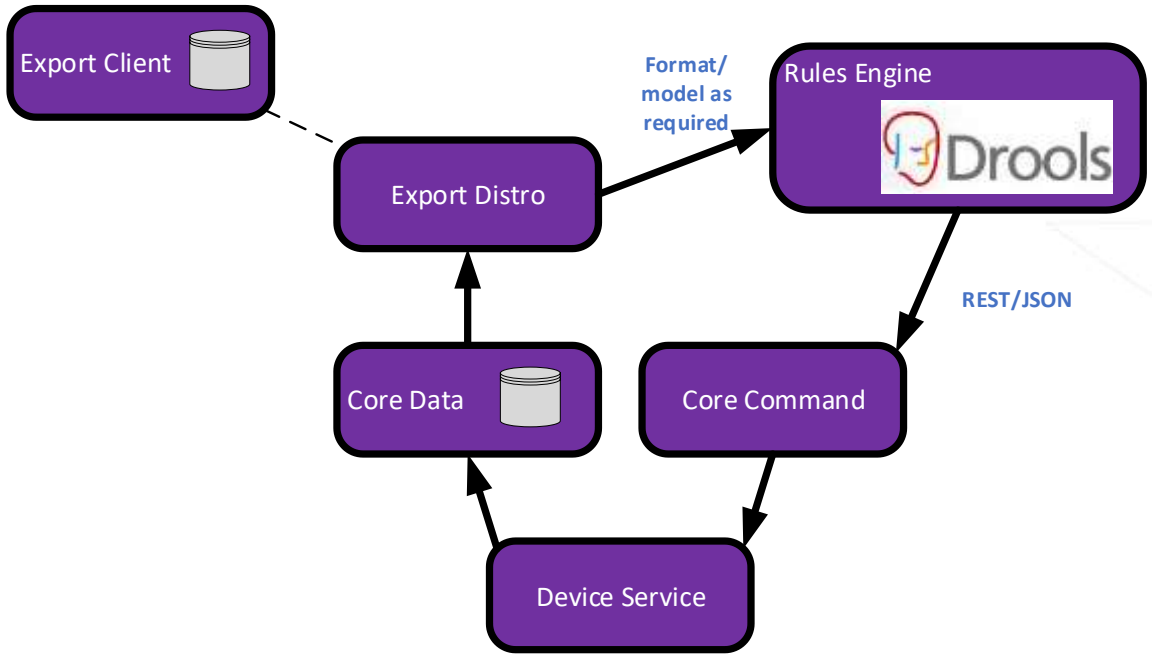
Problem 2: edge analytics

- Intelligence or analytics at the edge is critical
  - It's too expense to transport all the data "north"
  - It's too expense to store all the data "north"
  - It's too late to react to a problem from the cloud
  - Your devices/sensors are not always connected to the "north"
- How smart does your edge platform need to be?
  - Simple rule engine smart?
  - Complex event process (CEP) smart?
  - Machine learning/AI smart?
- The edge platform must be flexible enough to incorporate different capability
- EdgeX's analytic service can wrap and isolate the edge analytic capability

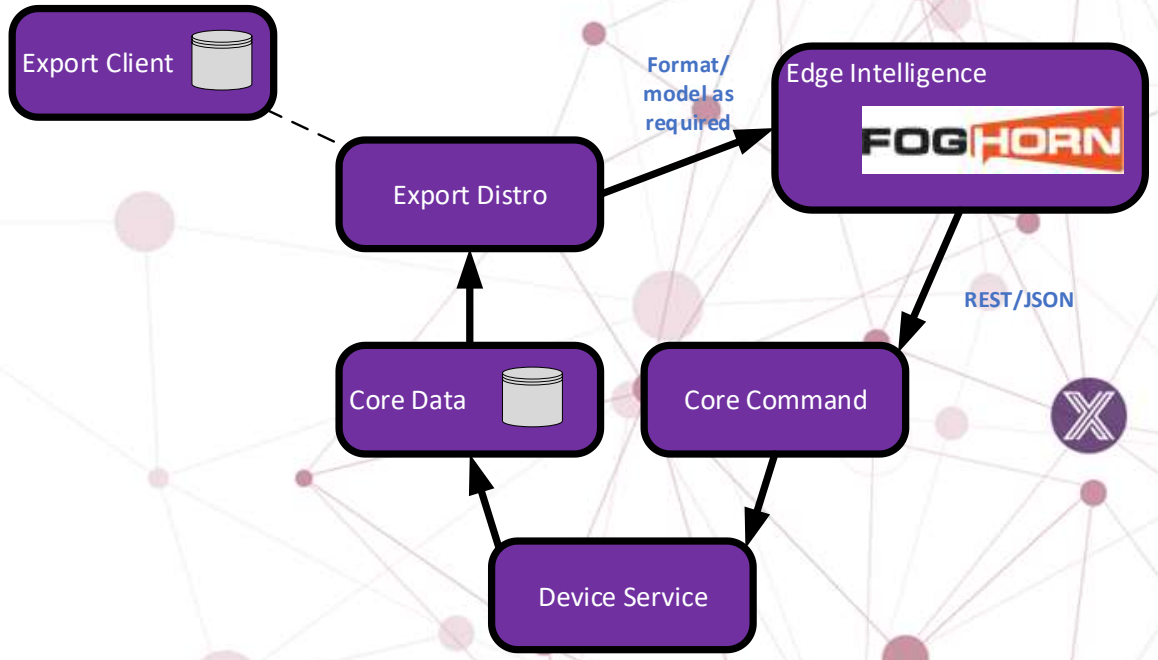


Rules Engine Service

EdgeX Reference Implementation



3rd Party Value Add



Problem 3: Fast Continual Improvements

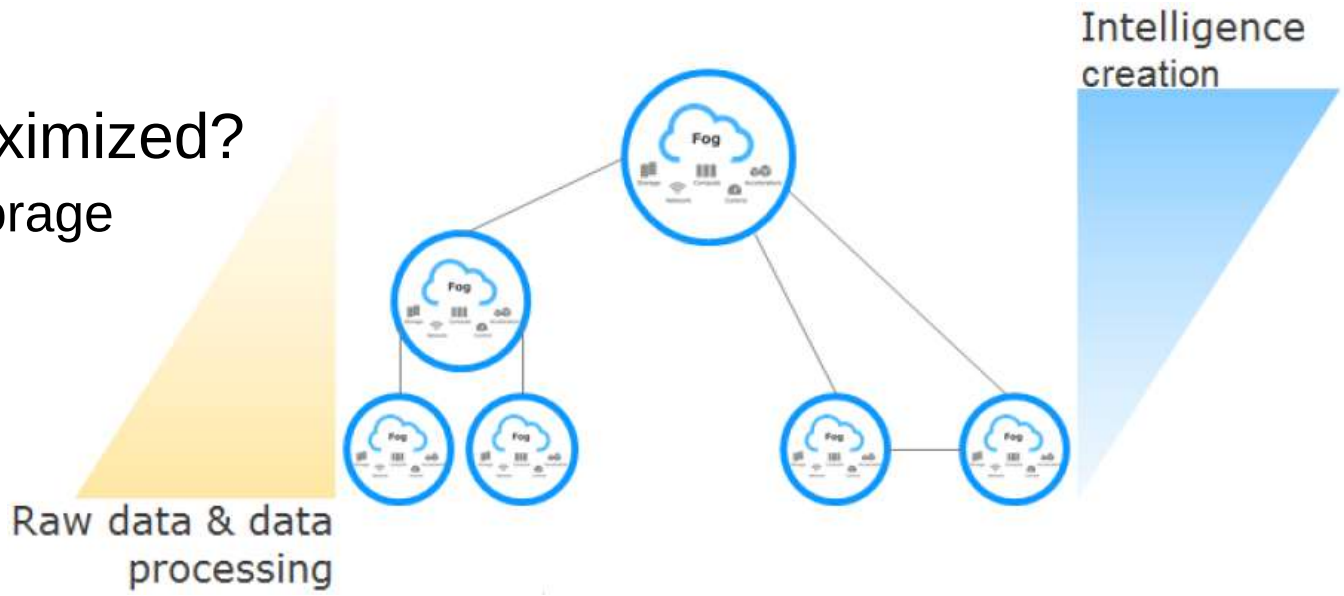
- Microservice architecture allows for continual improvements, future break throughs
  - Ex: device services that do their own device discovery
  - Ex: streaming analytics over core data/analytics services
- Upgrades to microservices without impact to others
  - Example: upgraded the config/registry service that used Consul 0.8 to Consul 1.0
- Improve performance over time, so they fit on more constrained devices
  - Ex: Moving from Java to Go for massive performance and footprint improvements
- Grow them over time and distribute/migrate them to the cloud
  - Ex: Machine Learning analytic services with a local edge agent
- Promote best of breed solutions
- Allow specialization to occur

Problem 4: Differentiation and Value Add

- EdgeX was created with commercialization in mind!!!
- Allow for value additions
  - RedHat style commercial support packages (IoTech)
  - Improved data synchronization between edge and cloud (MongoDB)
  - Edge analytics customized for the vertical or use case (many orgs)
  - Security features to protect trust devices, secure the data, etc. (RSA)
- Allow for low/no value commodity to be taken care of by a community
  - Ex: open logging probably suffices for a large part of the user base
- Allow specialization to demand higher price
  - Ex: IoTech creating a real time extension on the south side for embedded systems
  - Ex: Aicas using Jamaica and other technologies to run faster/smaller Java microservices
- Provide incentive to commercial (even competing) companies and reason to support an open source effort

Problem 5: How to maximize the use of resources

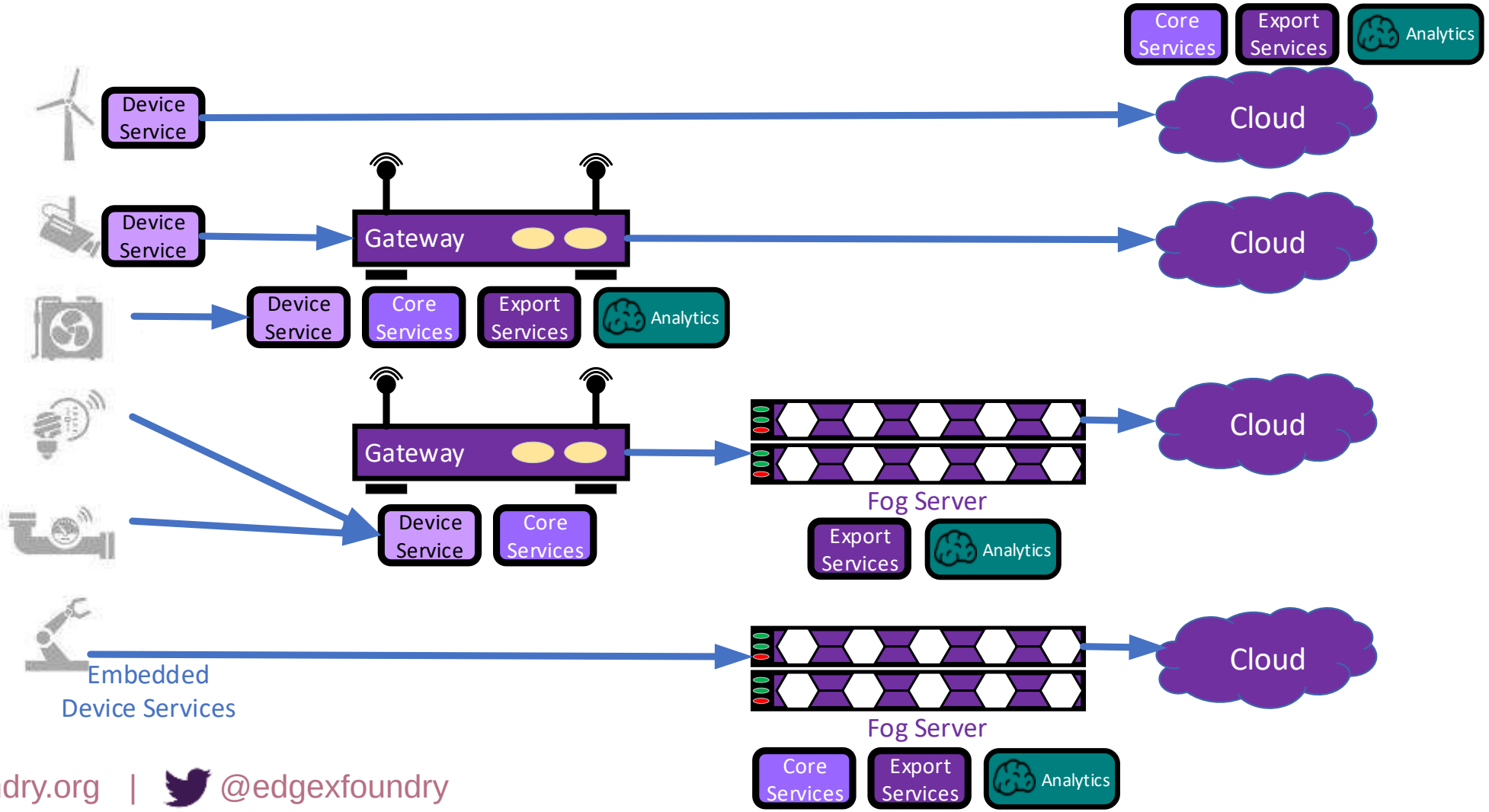
- From sensor to cloud, there exist a continuum of
  - Compute
  - Storage
  - Networking/connectivity
  - Management
  - Security
- How can all these resources be maximized?
  - Sensors will get more compute and storage
  - Pipes to the cloud may get bigger



Microservice Distribution

- Microservices can live where they can get the resources they need
- With a tendency to push to the south
  - Latency needs
  - Storage and transportation costs
  - Disconnected modes
- Allow the microservices to adapt to the use case
- Requires extremely loose coupling
- In some uses, microservices might be collapsed or combined

EdgeX Flexible Deployment Possibilities

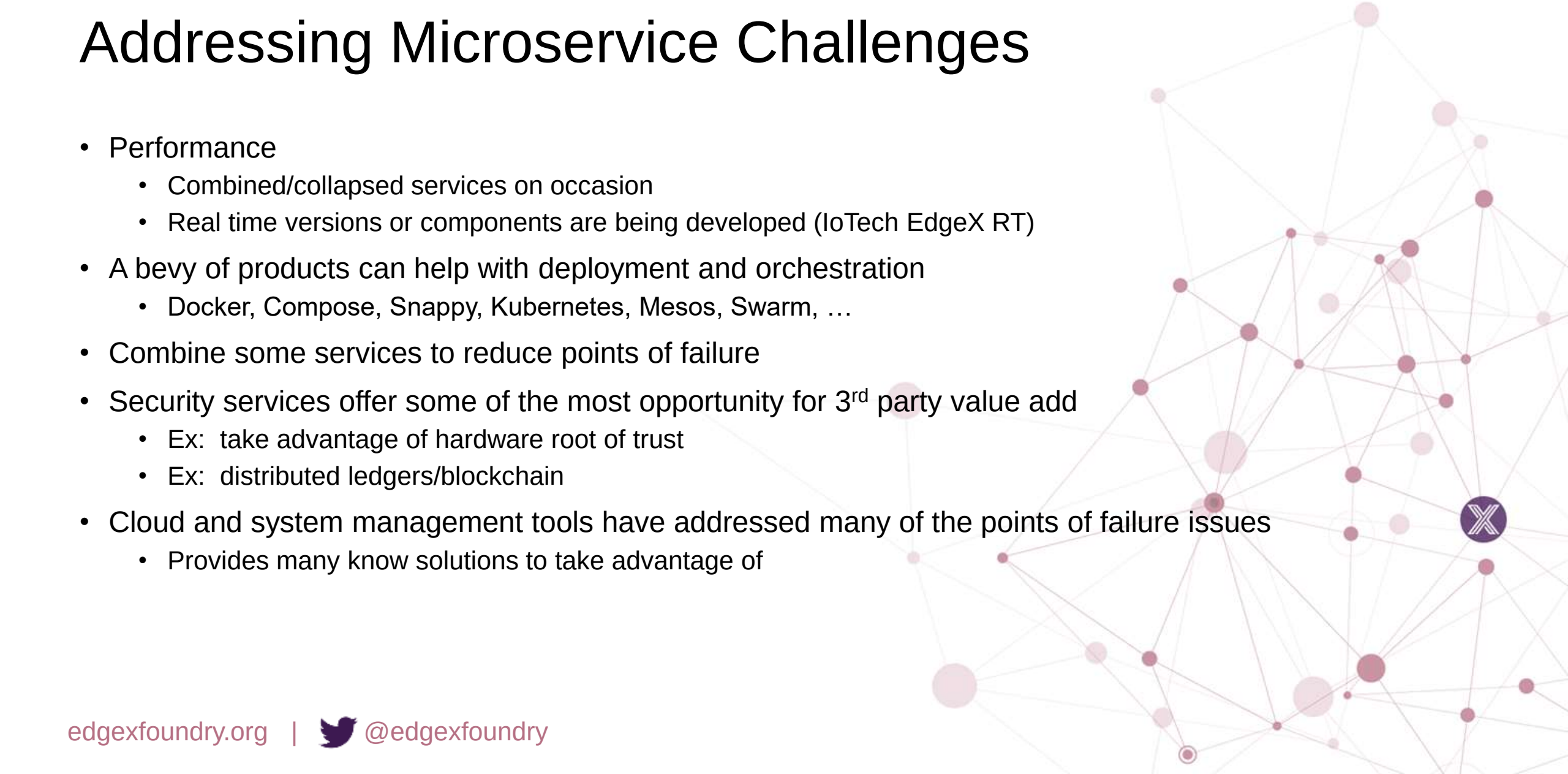


Microservices challenges

- Microservices offers aid to addressing some of the significant IoT issues
  - A microservices architecture inherently introduces challenges
- Performance
  - More microservices = more communications
  - More communications = more latency concerns
- Orchestration
  - Deploying microservices (especially when distributed across platforms)
  - Managing/updating microservices
  - Configuring (how to provide platform dependent/environmentally dependent configuration to each service)
  - Registering (how does one service know where to go to get another service)
  - Getting status/health (where microservices are dependent on one another, how do you know a microservice is up and ok)
- More points of failure
- Security – more interfaces and endpoints to secure

Addressing Microservice Challenges

- Performance
  - Combined/collapsed services on occasion
  - Real time versions or components are being developed (IoTech EdgeX RT)
- A bevy of products can help with deployment and orchestration
  - Docker, Compose, Snappy, Kubernetes, Mesos, Swarm, …
- Combine some services to reduce points of failure
- Security services offer some of the most opportunity for 3rd party value add
  - Ex: take advantage of hardware root of trust
  - Ex: distributed ledgers/blockchain
- Cloud and system management tools have addressed many of the points of failure issues
  - Provides many know solutions to take advantage of



Now Backed by 70+ Members

EDGE X FOUNDRY™

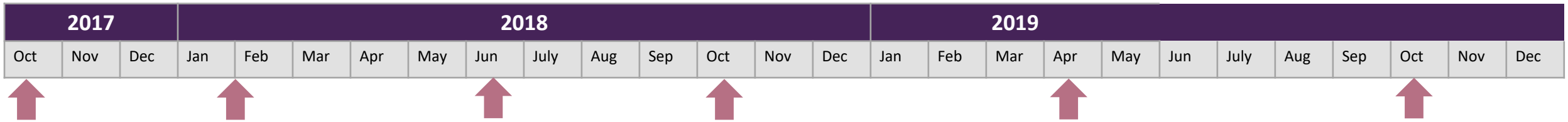
With more in process!

edgexfoundry.org | @edgexfoundry

Current Status

- EdgeX California Release on track for release at the end of June 2018. Key features include:
  - Initial security building blocks (reverse proxy, secure store)
  - Most services transitioned from Java to Go (exception: device services and SDK)
  - Dramatically improved performance, resource usage, and footprint (~7x reduction in size)
    - Already hitting our system performance targets
  - Additional “northbound” connectors
  - Improved documentation (documentation treated more like code in its management)
  - Arm 64 support
  - Blackbox testing for all services
  - Improved continuous integration
- Technical Steering Committee meet in Palo Alto, June 4-6
  - Scoped next release (code named Delhi) due Oct 2018
  - Roadmapped future releases (Edinburgh – Apr 2019, Fuji – Oct 2019)
- Current membership: ~70 companies/organizations
  - Code contributions from ~40 developers

EdgeX Releases



'Barcelona' Release

(Released Oct 20 2017)

- Improved fit and finish, formalized Core Service APIs, additional Device and Export Services, test apparatus

'California Preview'

(Made available Jan 2018)

- Drop-in Go Lang microservice replacements demonstrating reduced footprint and higher performance

'California' Release

(Released June 2018)

- First integration of security
- Run in < 1 GB RAM, come up in < 30 sec, < 1 second actuation latency

'Delhi' Release

(Oct 2018)

- Additional security and first manageability capabilities
- Go / C device service SDKs
- EdgeX UI

'Edinburgh' Release

(Apr 2019)

- Certification Program
- Improved and more scalable northbound connectors
- Southbound connectors to common protocol devices
- ARM 32 support

'Fuji' Release

(Oct 2019)

- Load balancing
- Multi-host EdgeX
- Additional security and system management capability

Delhi Major Themes & Objectives

- Smaller development cycle (due to California length) so scope has to match
- High level scope
  - Initial System Management APIs and agent
  - Device Service SDKs (Go/C) & at least one example device service
  - The next wave of security features
    - Access control lists to grant access to appropriate services, and improved security service bootstrapping
  - Improve testing
    - Better/more unit, complete black box and add performance testing
  - Refactored and improved Go Lang microservices
  - Design and architecture work in advance of Edinburgh release
    - Options and implementation plan for database replacement
    - Design and implementation plans for export service replacement with application services
  - An EdgeX UI suitable for demos and smaller installations

Call to action

- We could use your help!
- There are plenty of places to contribute to EdgeX
  - Additional southside connectivity
  - Additional northside connectivity
  - Replacement and refactor work
  - Security & microservice management work
  - Checkout Github Issues and our roadmap for more

Key Project Links

- Access the code:
  - https://github.com/edgexfoundry
- Access the technical documentation:
  - https://wiki.edgexfoundry.org
- EdgeX Blog:
  - https://www.edgexfoundry.org/news/blog/
- Join an email distribution:
  - https://lists.edgexfoundry.org/mailman/listinfo
- Join the Rocket Chat:
  - https://chat.edgexfoundry.org/home

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Thanks!

james_white2@dell.com