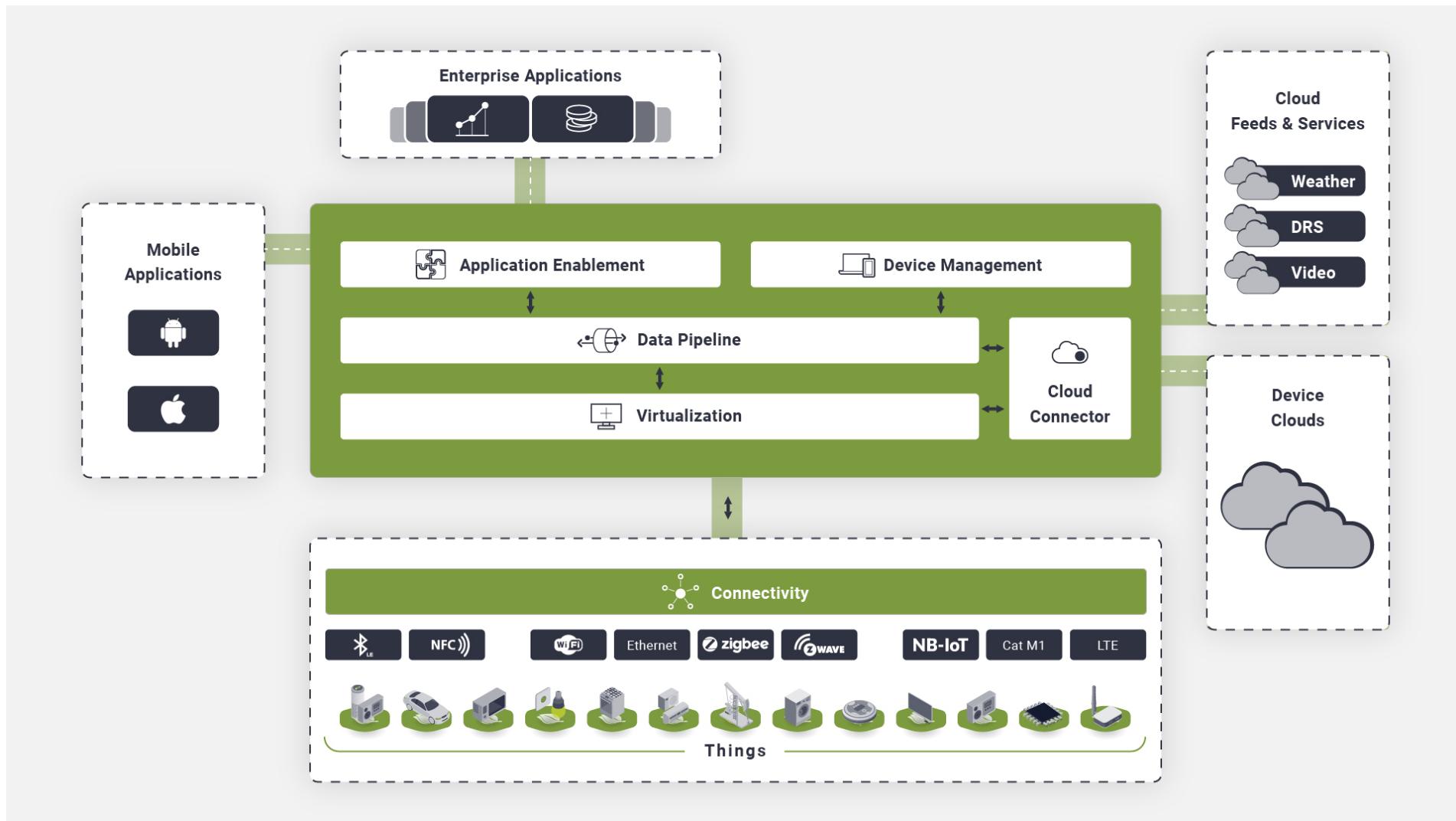
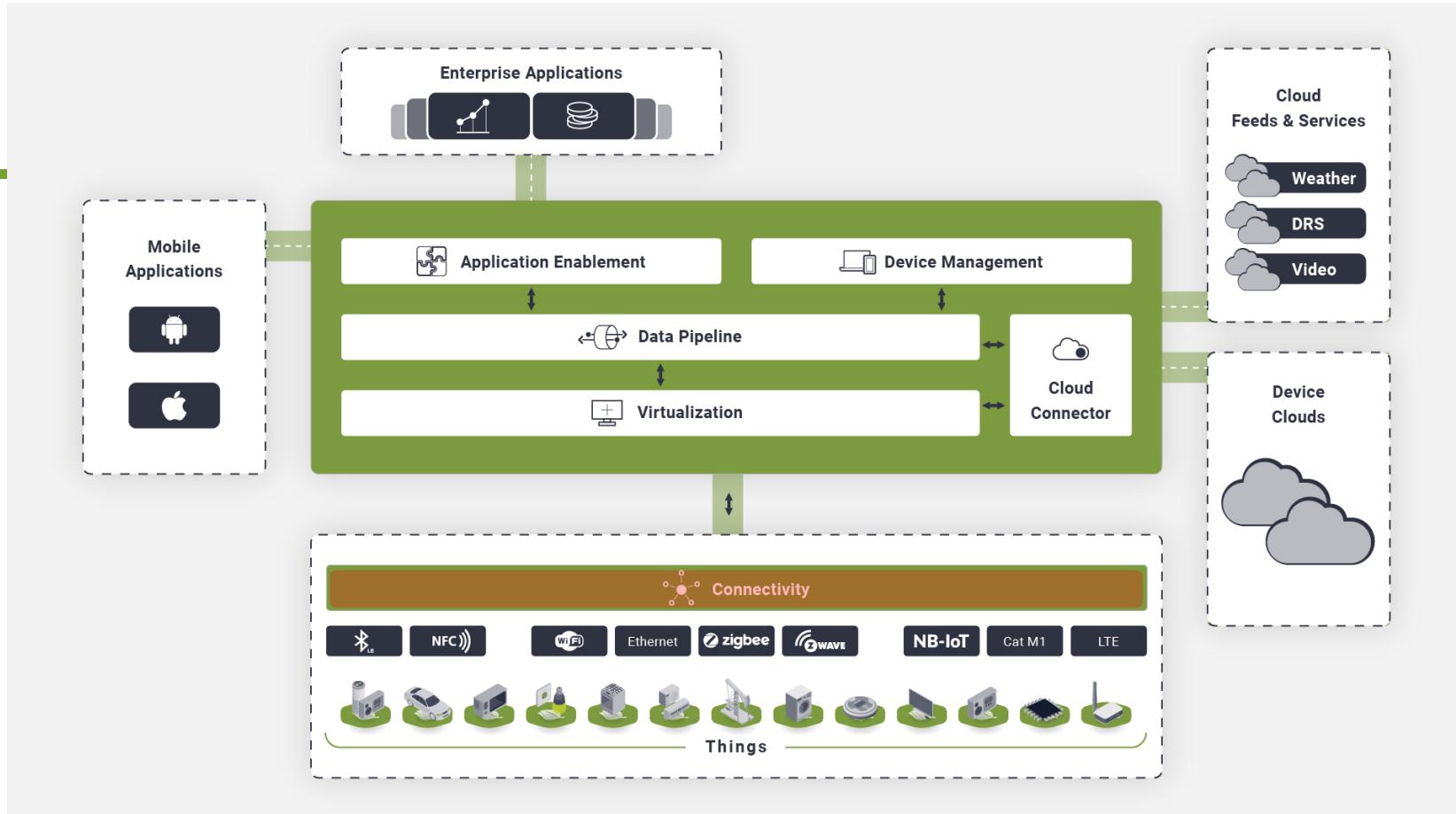


Core Platform Components



Edge Management



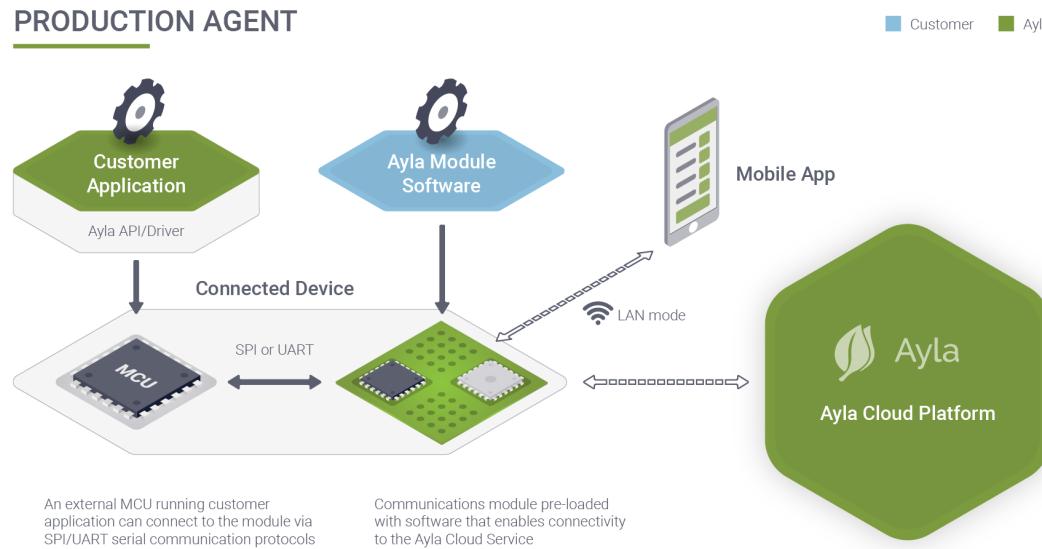
Edge Management Products

Broad range of embedded agents

- **Support for common communication protocols and device types**
 - LAN (Wi-Fi, Z-Wave, BLE, ZigBee) and LPWAN (NB-IoT, CAT-M1, LTE) with singular device or gateway / node solutions
- **“Complete” out of the box functionality**
 - Production agents provide core networking security with ZERO embedded coding required
- **Flexibility for specific solution needs**
 - Leverage and extend core networking and security with solution-specific customizations on embedded agent
- **Support for major embedded OS types**
 - Native support for RTOS, Linux, and Android OS

Production Agent

PRODUCTION AGENT



Quick Time-to-Market

- Modules come pre-loaded with Ayla code and pre-provisioned for the Ayla Service
- Out-of-the box OTA support for module and customer images
- Modules pre-certified globally (e.g. FCC, IC, CE, Telec) for OEMs to leverage
- Ayla manages partnership/support with industry-leading chipsets (Qualcomm, Marvell, Cypress)

Common Code Across All Production Agent Modules Means Common Behavior

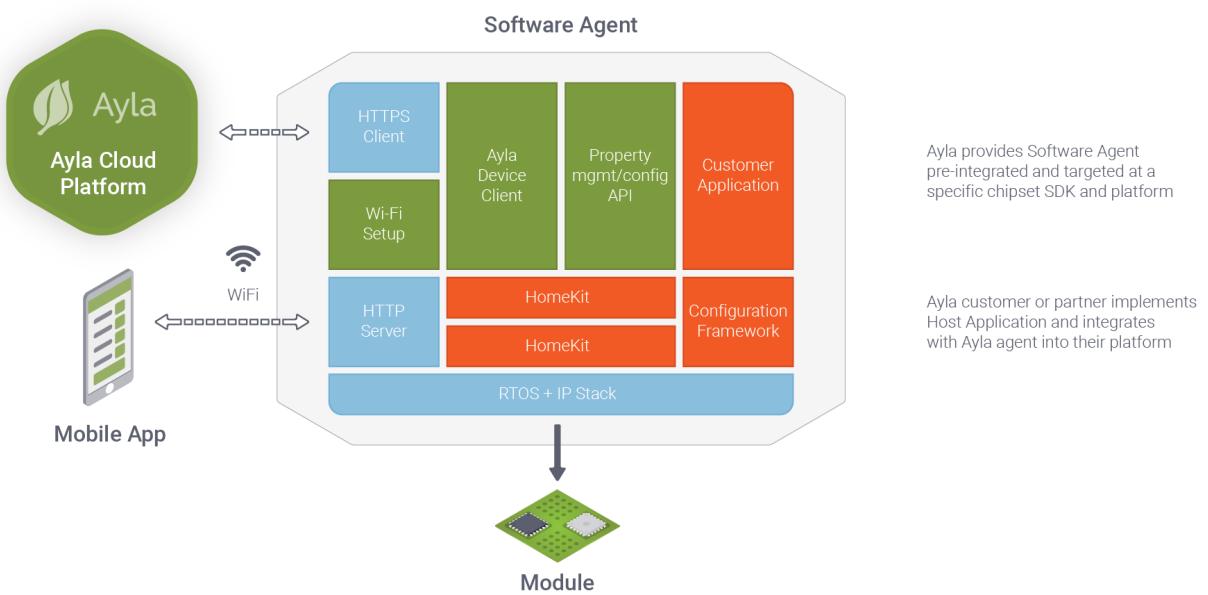
- All external interactions are the same for all modules
- Customers can use different modules on the same products; no change to application code
- Common features and unified testing across all modules

Production Agent is Designed to be Application Agnostic

- Support for almost any Microcontroller-based system
- All networking & security capabilities are pre-built onto the modules – no custom dev needed by OEMs

Software Agent (White Box)

SOFTWARE AGENT (WHITE BOX)



Lower per-unit cost

- Avoids the need for separate MCU for the customer application
- Product footprint savings - customer application integrated with Ayla Agent and chipset platform, runs on the same module

Enables more flexible solutions

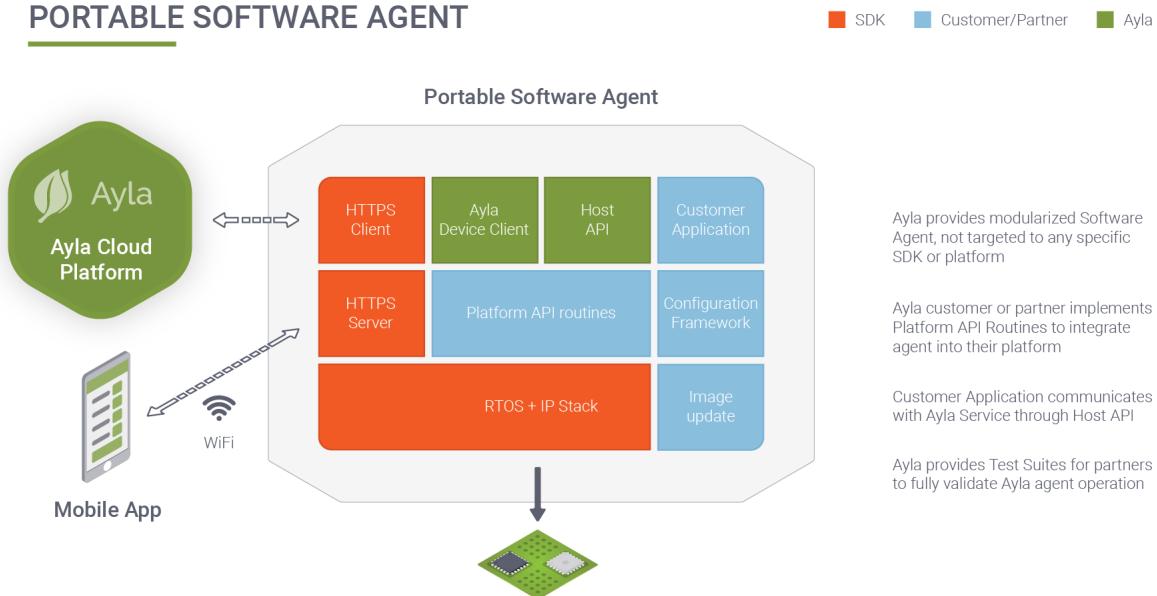
- Customer application can access module resources and I/O
- Allows deeper customization of Wi-Fi module behavior

Ayla software agent is distributed as source code

- Enables integration with applications and SDK versions
- License allows changes but not source code redistribution

Portable Software Agent

PORTABLE SOFTWARE AGENT

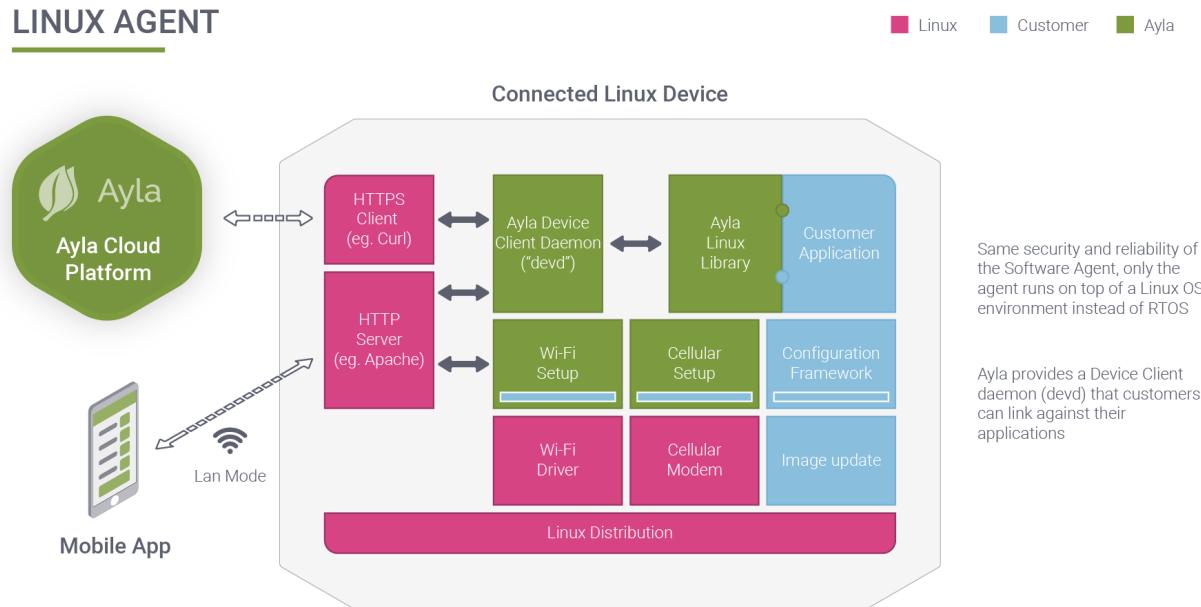


- Customers and partners can now enable Ayla connectivity on their preferred platform, SDK and host application
- Modular agent simplifies the integration and increases flexibility
 - Pick and choose features that are relevant (WiFi setup, LAN mode, OTA, etc.)
- Customers have more control over their development, testing, and deployment schedules
 - Earlier availability and stability of Ayla agent for customers to test
- Allows for ownership, increased accessibility, and customization of chipset behavior by partners

Portable Agent Test Suite

- **Platform/Adaptation Layer tests**
 - Customers develop own Platform APIs that adapts to OS and SDK of choice
 - Test Suite to verify that the low-level Platform APIs are implemented to Ayla's specifications
 - Minimize risks before integrating the Ayla Agent/Libraries on top of the Platform APIs
 - Covers low-level testing in Memory management, Threads, Locks, Timers, Networking, WiFi core functionality, Config, etc.
- **Application Layer tests**
 - Application level testing to ensure end-to-end functionality after Ayla Agent integration
 - Similar to test cases covered in our internal Ayla Device Agent testing
 - Covers testing in setup + registration, properties, schedules, LAN mode, OTA, etc.

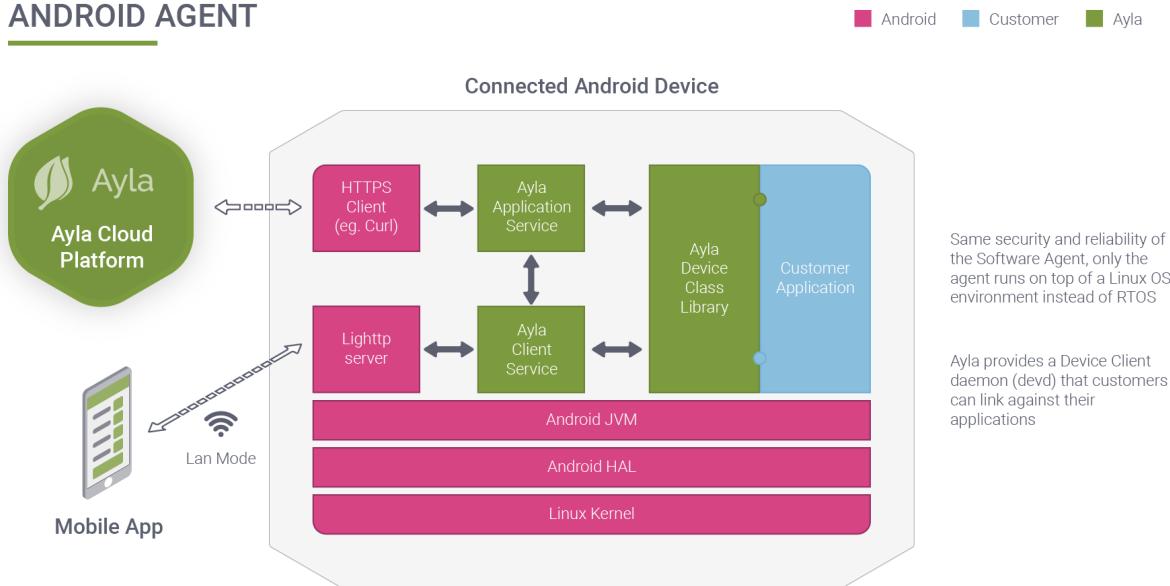
Linux Agent



- Customers may want to take advantage of robust Linux-based features
 - Device support, file systems, network connectivity, open-source applications
- Ayla code is fully portable to any Linux distribution
- Available reference implementations for customers to jump-start development

Android Agent

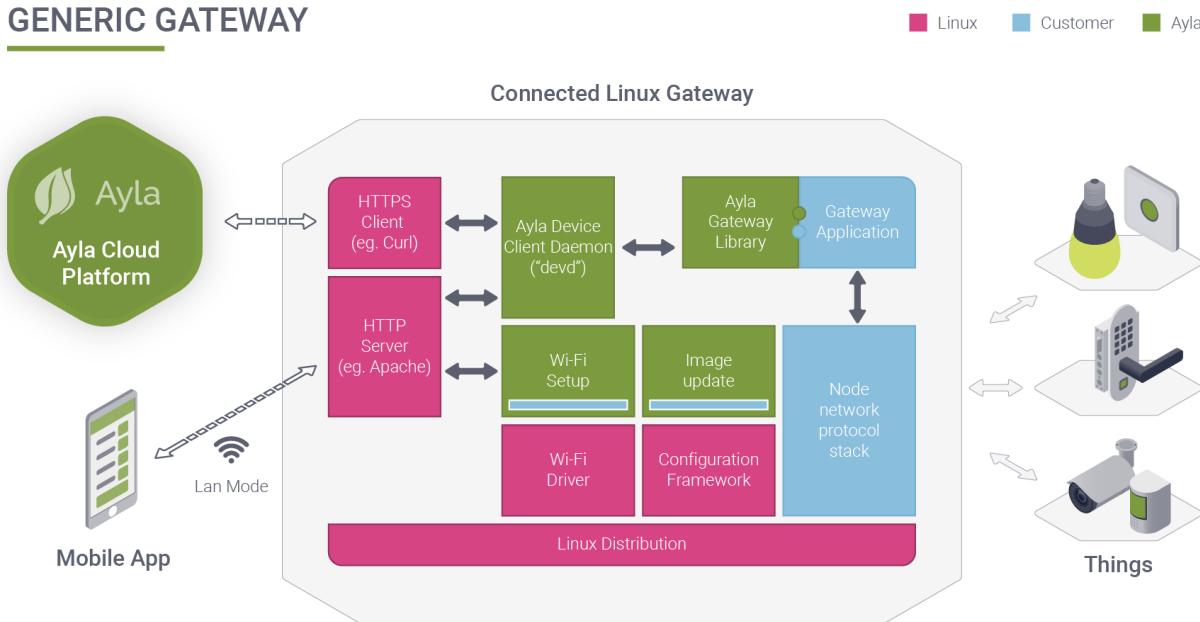
ANDROID AGENT



- Android is built on top of a Linux version that is customized by Google
- Android typically offers access to rich libraries for developing modern UI, and some customers would like to integrate Ayla connectivity on their Android agent
- Demo Android application available for customers to jump-start development

Generic Gateway

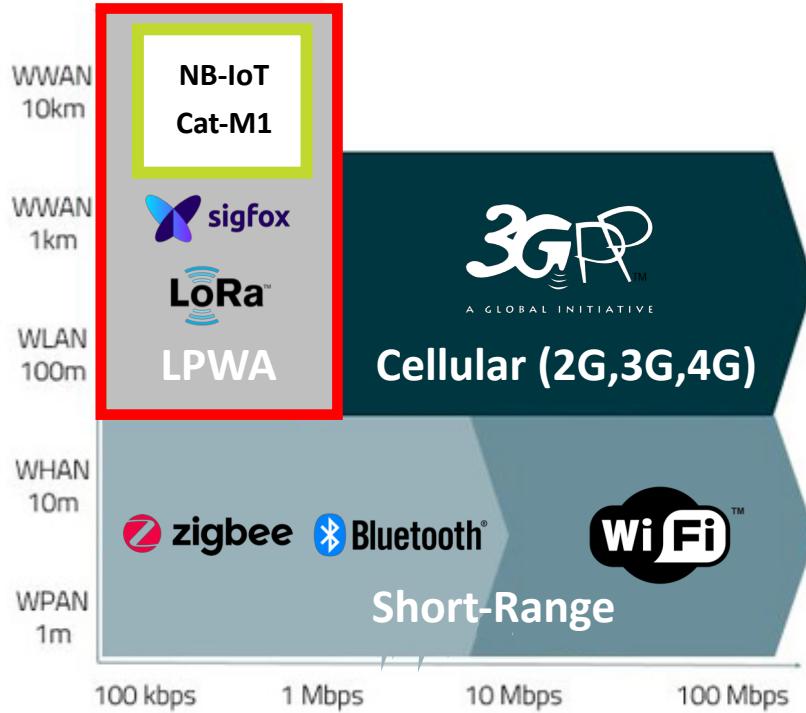
GENERIC GATEWAY



- For devices that are connected via local protocols (e.g. Bluetooth, Zigbee, Sub-GHz, proprietary connectivity) that may not be able to connect to the cloud directly
- The Generic Gateway API libraries can be integrated into a Linux-based gateway product, enabling nodes on a local network to be represented as separate devices on the Ayla Cloud (own DSN and properties)
- OEMs only need to focus on gateway application and node management, leaving the cloud networking portion to Ayla
- Reference application for Bluetooth, Zigbee, and a Multiprotocol gateway implementation available on the popular Raspberry Pi platform – customers save time on early development

What are Low-Power Wide Area (LPWA) Networks?

A wireless wide area network technology that interconnects low bandwidth, battery-powered devices with low bit rates over long ranges



Wireless Technology Comparison

Suitable Applications	LPWA	Cellular (2G,3G,4G)	Short-Range PAN WLAN
Agriculture	●	●	●
Asset Tracking	●	●	●
Appliances	●	●	●
Automotive	●	●	●
Consumer	●	●	●
Energy	●	●	●
Enterprise	●	●	●
Healthcare	●	●	●
Industrial	●	●	●
Smart City	●	●	●
Smart Home	●	●	●
Transportation	●	●	●

Ayla's Cellular Solution Today

IoT Edge Agents

- **Production Agent:**
 - RTOS Based
 - All Qualcomm IoT Chipsets
 - SimCom, Longsung, FoxConn, Quectel
- **Portable Agent:**
 - RTOS Based
 - Work across any module/chip combination
- **Software Agent:**
 - Linux & Android OS Support
- **Device Onboarding**
 - AFS support IMEI in addition to DSN

IoT Cloud

Virtualization

Transport:

- Support for HTTP, CoAP & MQTT (Q3)

Management:

- Cellular optimized OTA
- Cellular Metrics Collections

LPWAN Support:

- Works with PSM & eDRX Modes for NB-IoT & Cat-M1

IoT Applications

Insights:

- Understand product performance & data usage

Cellular data optimization & prediction (Q3):

- To reduce data overage charges

Battery Life Prediction:

- For LPWAN connected devices

Ayla's Cellular Partnerships

Cellular Chipset

#1 IoT Chipset



- IoT SDK Partner, enabling Ayla on any module using Qualcomm Chipset
- QWES partner, enabling Ayla to leverage Qualcomm hardware security & services

Cellular Module

#1 IoT Module



- Owned by Ayla JV Partner
- Every SimCom Module will be Ayla Enabled
- SimCom has 25% WW IoT cellular module market share

Cellular Management

#1 Connectivity Management



- API integration enables Ayla to provide connectivity management in addition to device management

Linux Cellular Agent

The same as the existing Linux Agent, with improvements to work better over 3G/4G/LTE/Cat-M1

- No changes to Device/Cloud protocols
- Reliability tuning for resilience to packet loss and higher network latency
- Put control/knobs in the hands of customers
 - Application control to trade off data usage vs responsiveness
 - Application control of notification vs polling modes
- More reliable file transfers

Intended for use with any serial/USB-attached cellular modem or module integrated with a Linux platform

Cellular Portable Software Agent

Initial release of Portable Software agent optimized for Cellular networks

- No changes to Device/Cloud protocols
- Modular software agent not targeted to any specific SDK/platform
- Removal of unneeded features for smaller footprint
 - No Wi-Fi setup, LAN mode, LAN OTA, etc.

Intended to enable module partners to release Software Agents and Production Agents for their modules

Beta Available June 2018

NB-IoT Cellular Agent

NB-IoT is a low bandwidth, high latency cellular network for IoT

- Designed for large numbers of devices with infrequent traffic (eg. sensors)
- Not intended for interactive applications

Cellular Portable Software Agent + Redesign of Device/Cloud message protocols

- Initial design based on UDP, DTLS and CoAP, to eliminate connection setup
- Overall design goal is to define a messaging API that is highly portable to any transport, such as HTTP and MQTT
- Reduced message data size and exchanges for common operations
- Optimized for infrequent data updates, with limited remote access (eg OTAs)

Initial Release will be Available Q3/Q4 2018

Qualcomm-Integrated Cellular Agent

Cellular Portable Software Agent + Qualcomm IoT SDK

- Ayla Agent that is pre-integrated and pre-tested against the Qualcomm IoT SDK
- Enables module manufacturers using the Qualcomm IoT SDK to easily integrate Ayla connectivity into the module
- Potentially enable customers to reduce BOM cost with fewer MCU resources, a tightly-coupled integration between Ayla-Qualcomm will help reduce functionality overlap

Release Planned Q3/Q4 2018

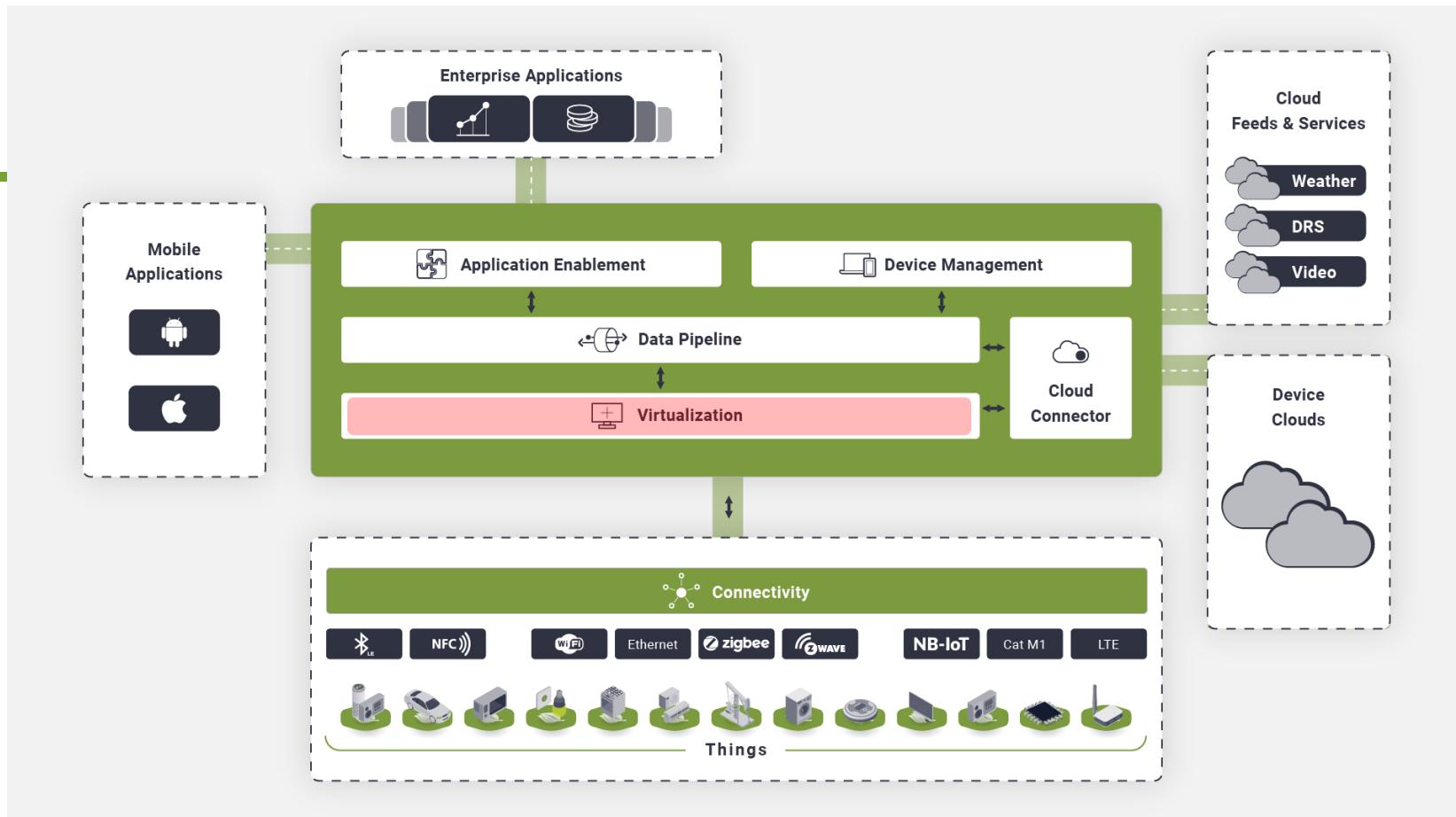
Module Partners



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Device Virtualization



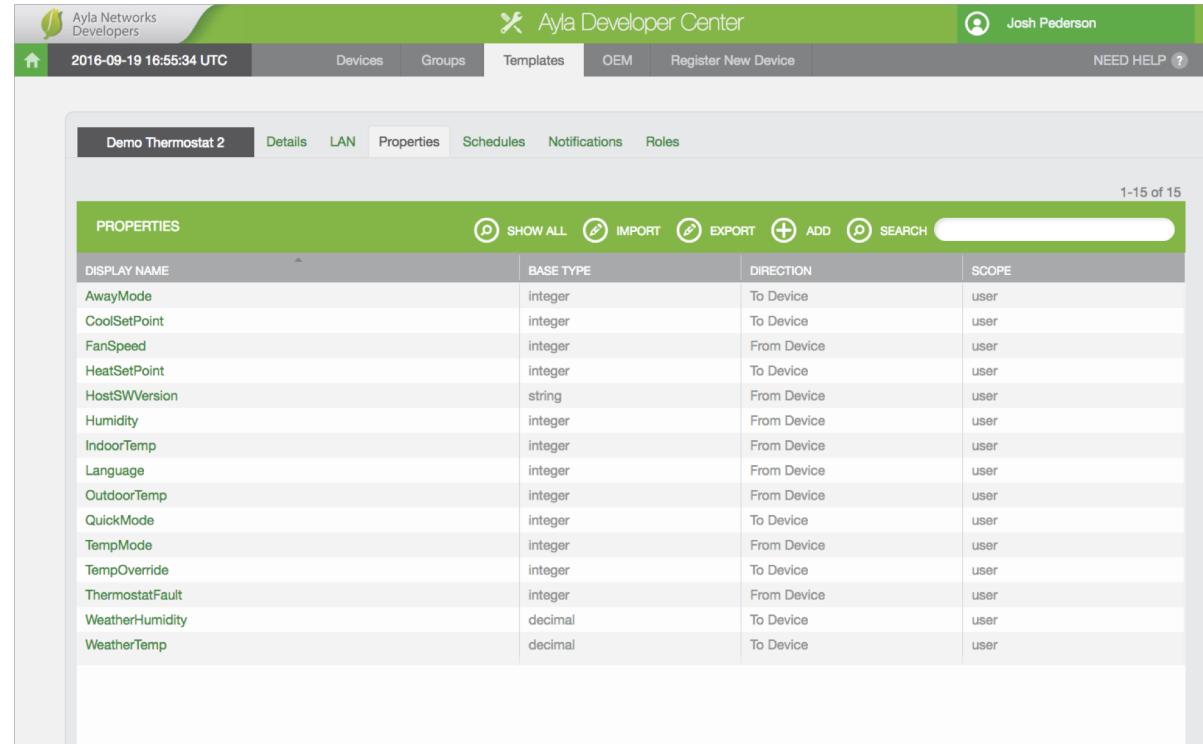
Device virtualization

Create digital twin of physical device

- **Ayla starts with digital representation of device**
- **Template is a 'blue print' for the device**
 - Captures physical and logical characteristics of a device
 - Versioned, allowing for multiple versions of a device to co-exist
- **Provides flexibility to change device behavior in the field**
 - Create a new version of the template, push to device

Developer Portal

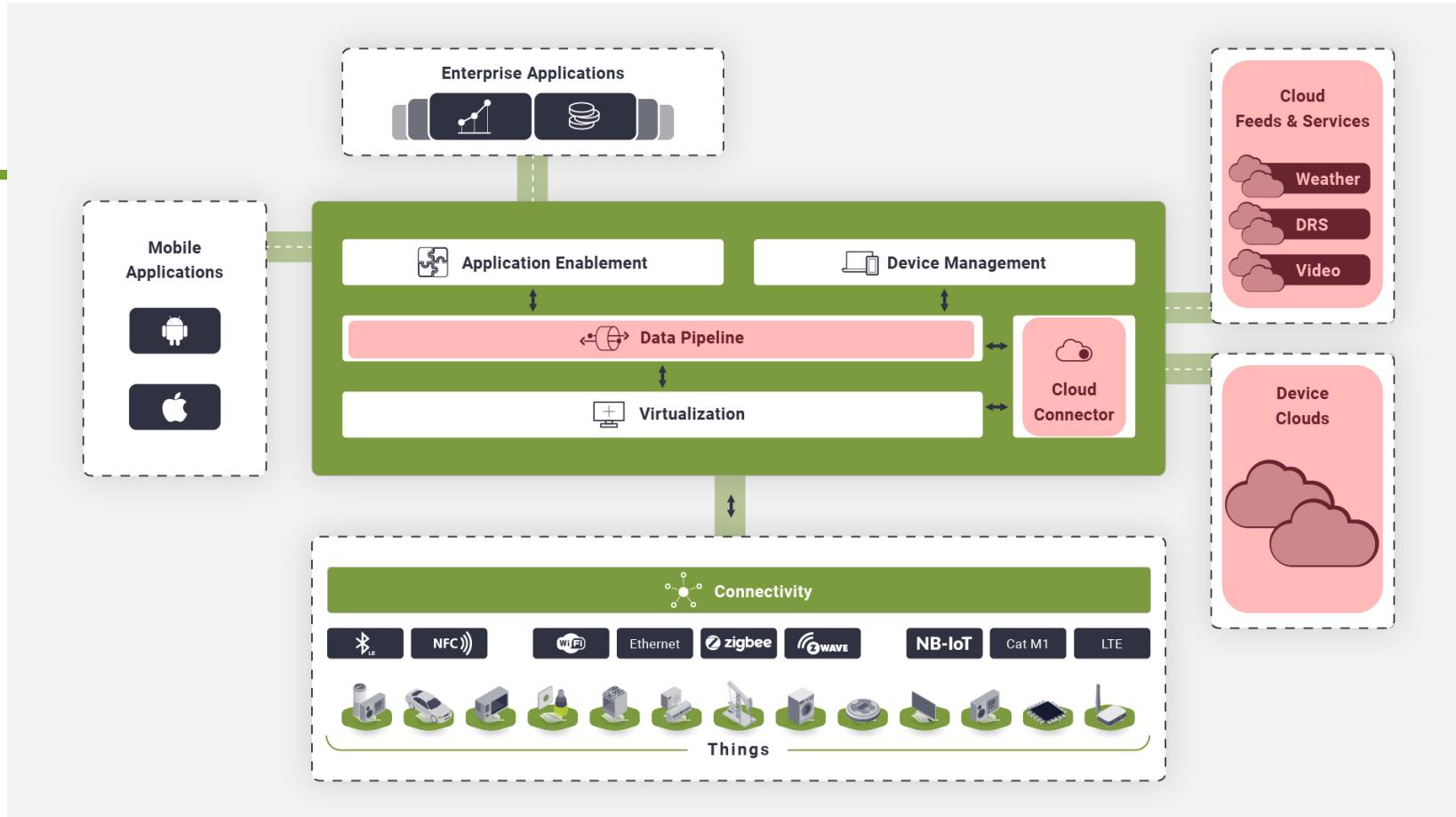
- Rapid solution proto-typing
- Virtual device configuration environment
 - Device properties, schedules, data restrictions, notifications, more
- Sand-box for testing configuration changes



The screenshot shows the Ayla Developer Center interface. The top navigation bar includes the Ayla Networks Developers logo, a date and time indicator (2016-09-19 16:55:34 UTC), and links for Devices, Groups, Templates, OEM, Register New Device, and Need Help. The user profile 'Josh Pederson' is also visible. The main content area is titled 'Demo Thermostat 2' and shows tabs for Details, LAN, Properties, Schedules, Notifications, and Roles. The 'Properties' tab is selected, displaying a table of device properties. The table has columns for DISPLAY NAME, BASE TYPE, DIRECTION, and SCOPE. The properties listed are: AwayMode (integer, To Device, user), CoolSetPoint (integer, To Device, user), FanSpeed (integer, From Device, user), HeatSetPoint (integer, To Device, user), HostSWVersion (string, From Device, user), Humidity (integer, From Device, user), IndoorTemp (integer, From Device, user), Language (integer, From Device, user), OutdoorTemp (integer, From Device, user), QuickMode (integer, To Device, user), TempMode (integer, From Device, user), TempOverride (integer, To Device, user), ThermostatFault (integer, From Device, user), WeatherHumidity (decimal, To Device, user), and WeatherTemp (decimal, To Device, user). A footer at the bottom right indicates '1-15 of 15'.

DISPLAY NAME	BASE TYPE	DIRECTION	SCOPE
AwayMode	integer	To Device	user
CoolSetPoint	integer	To Device	user
FanSpeed	integer	From Device	user
HeatSetPoint	integer	To Device	user
HostSWVersion	string	From Device	user
Humidity	integer	From Device	user
IndoorTemp	integer	From Device	user
Language	integer	From Device	user
OutdoorTemp	integer	From Device	user
QuickMode	integer	To Device	user
TempMode	integer	From Device	user
TempOverride	integer	To Device	user
ThermostatFault	integer	From Device	user
WeatherHumidity	decimal	To Device	user
WeatherTemp	decimal	To Device	user

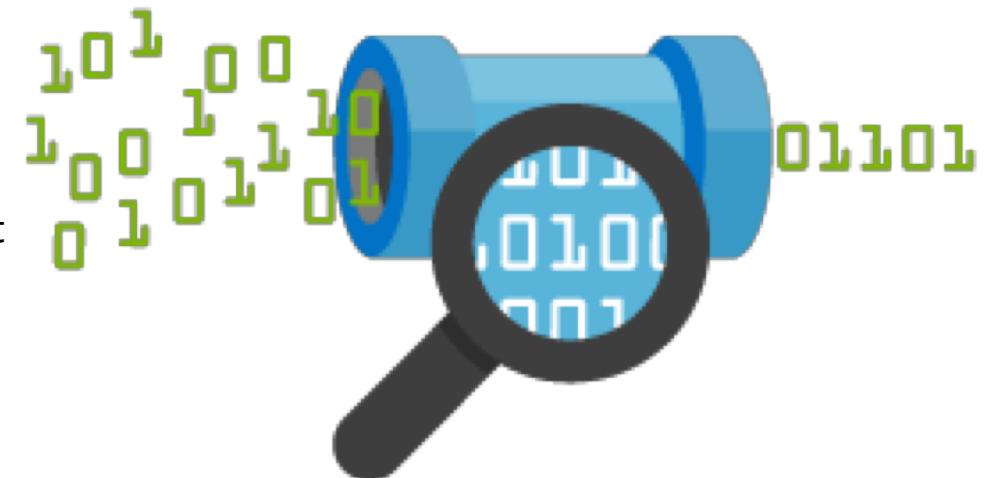
Data Pipeline and Cloud Adaptor



Data Pipeline

Highly efficient routing of data

- **Ingest and storage**
 - Device data is captured and stored in the appropriate container
- **Normalization**
 - Process data from different devices with different data models, and provide in a standard way for applications to interact with
- **Efficient routing**
 - Data is routed to core areas of the Ayla Platform (Device Management and Application Enablement)
- **Forwarding to external cloud targets**
 - Data streaming service (DSS) enables forwarding of data to external cloud targets for additional processing



Cloud Adaptor Framework: The Problem

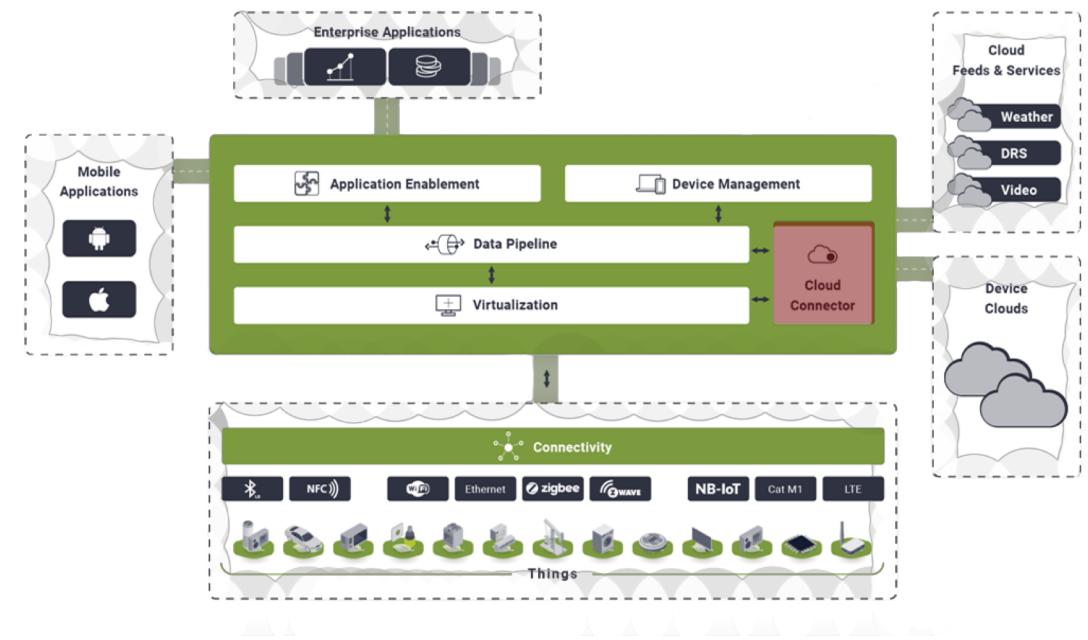
- IoT has moved beyond “connection”
- Customers now want to expand their product(s) value
 - What if you already have connected, virtualized devices?
- Interoperate with other companies products & services
 - Enable cloud-to-cloud integrations
 - How do you develop these integrations quickly & cost effectively?

CAF Overview

Ayla's **Cloud Adapter Framework** (**cloud connector**) is an **integration infrastructure** for which developers can use to build **adapters** between Ayla & 3rd Party Clouds

Features & Value:

- Quickly & easily enable **2-way C2C** connections
- Enable devices connected to 3rd party clouds to be more **easily consumed** for application enablement
- Devices that communicate through CAF developed adapters are manageable via the Ayla Cloud
 - Becoming a part of Ayla's ecosystem
- All CAF adapters are hosted & managed by Ayla



Available Integrations



Google Home



Upcoming Integrations



Google Cloud Platform



Cloud IoT Core



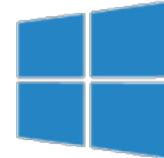
amazon
web services



SAMSUNG



SmartThings

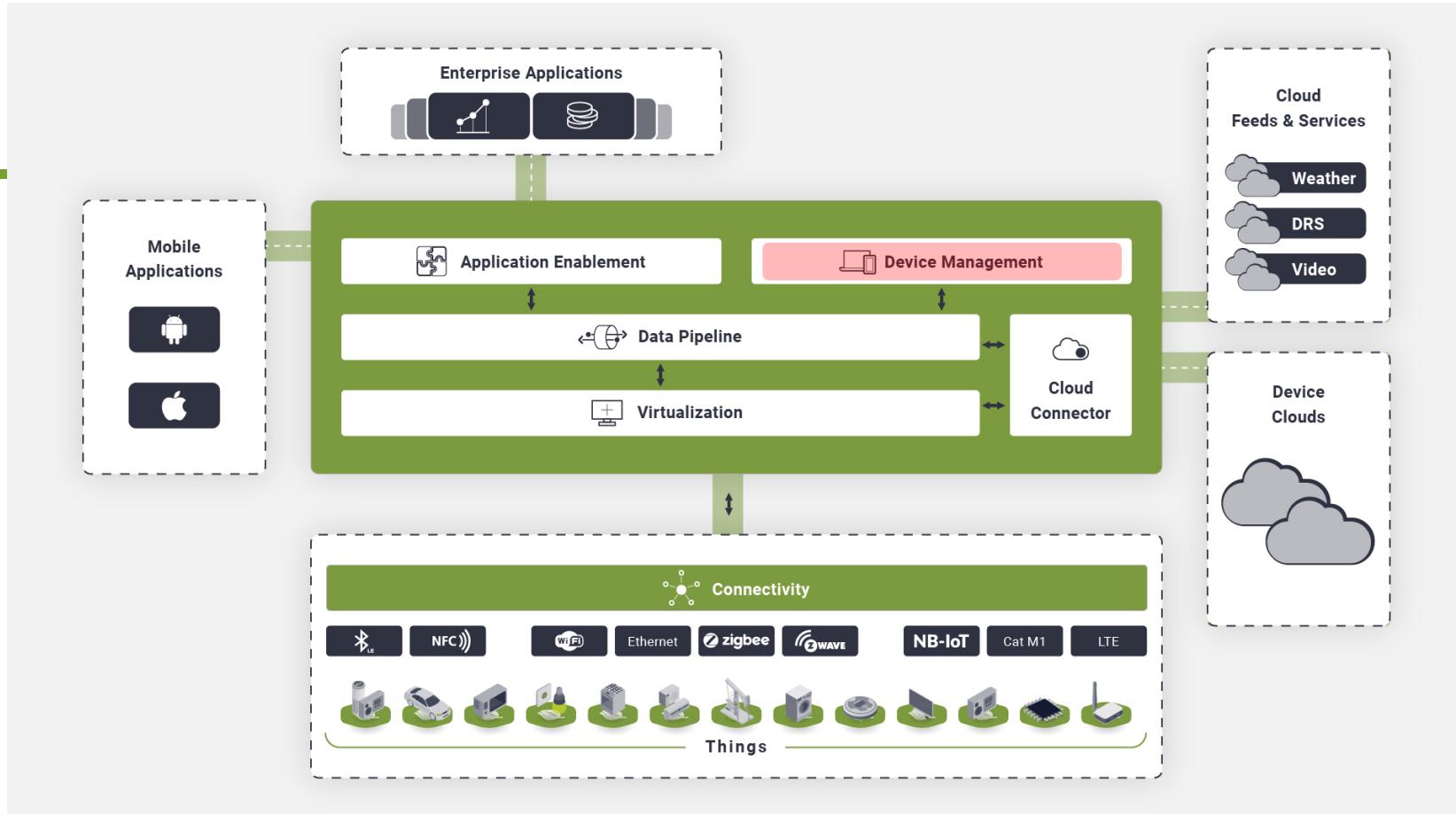


Microsoft Azure



IoT Hub

Device Management



Device Management with the Ayla Dashboard

Critical solution component for IoT success

- **Reliably manufacture and provision devices**
 - Configure device agents with DSN and authentication information
- **Understand status and health of the fleet**
 - Set and maintain a baseline level of knowledge to best support the fleet
- **Maintain stability and performance**
 - Apply configuration changes and firmware updates to adjust behavior of fleet devices
- **Optimize ability to leverage the data**
 - Set and apply data management policies to best leverage the data being generated by fleet devices
- **Manage access of operations team to device fleet**
 - Ensure strict access to devices, data, and configuration functionality within the team

Five Core Areas of Ayla's DM

- Manufacturing and Provisioning
- Device Activation
- Monitoring and Reporting
- Fleet Maintenance
- Firmware OTA Updates

Firmware OTA Updates

Core Values

- Simple **storage and management** of both Host MCU firmware images and Ayla provided images
- Intuitive mechanism to **initiate firmware OTA runs** on singular or across fleet devices
- Fine-grained reporting on status of firmware OTA runs to provide operations team with **clear understanding** on outcome of current and historic OTA runs

Firmware OTA Updates

Features

- Both Ayla firmware and Host MCU firmware images can be uploaded, managed, and pushed in OTA runs via the Ayla Dashboard
- Selected firmware images can be pushed to device groups containing up to 1M devices
- Status of current OTA runs is displayed in the Dashboard UI in near real-time
 - Pending, Completed, Failed
- Reporting on past OTA runs is provided in the Dashboard UI for audit and reporting use cases

Dashboard / OTA / Jobs / 31495

OTA Job: 166-167

Status	ID	DSN	Product	Model	OEM Model	Host SW Version	Image	User	Connected at (UTC)
●	24440126	AC000W001613470	AC000W001613470	AY001MUX1	2350x-hw-1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	04/23/2018 at 12:43:56	
●	24440073	AC000W001613530	AC000W001613530	AY001MUX1	2350x-hw-1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	04/20/2018 at 18:00:28	
●	24440419	AC000W001613632	AC000W001613632	AY001MUX1	2350x-hw-1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	04/22/2018 at 15:56:43	
●	24468448	AC000W001697076	AC000W001697076	AY001MUX1	2350x-hw-1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	04/22/2018 at 7:28:26	
●	24468982	AC000W00078803	AC000W00078803	AY001MUX1	2350x-hw-1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	bc 2.7.2-beta 01/24/18 23:47:15 ID 409f9e1	04/20/2018 at 15:53:14	

Dashboard / OTA

OTA Jobs

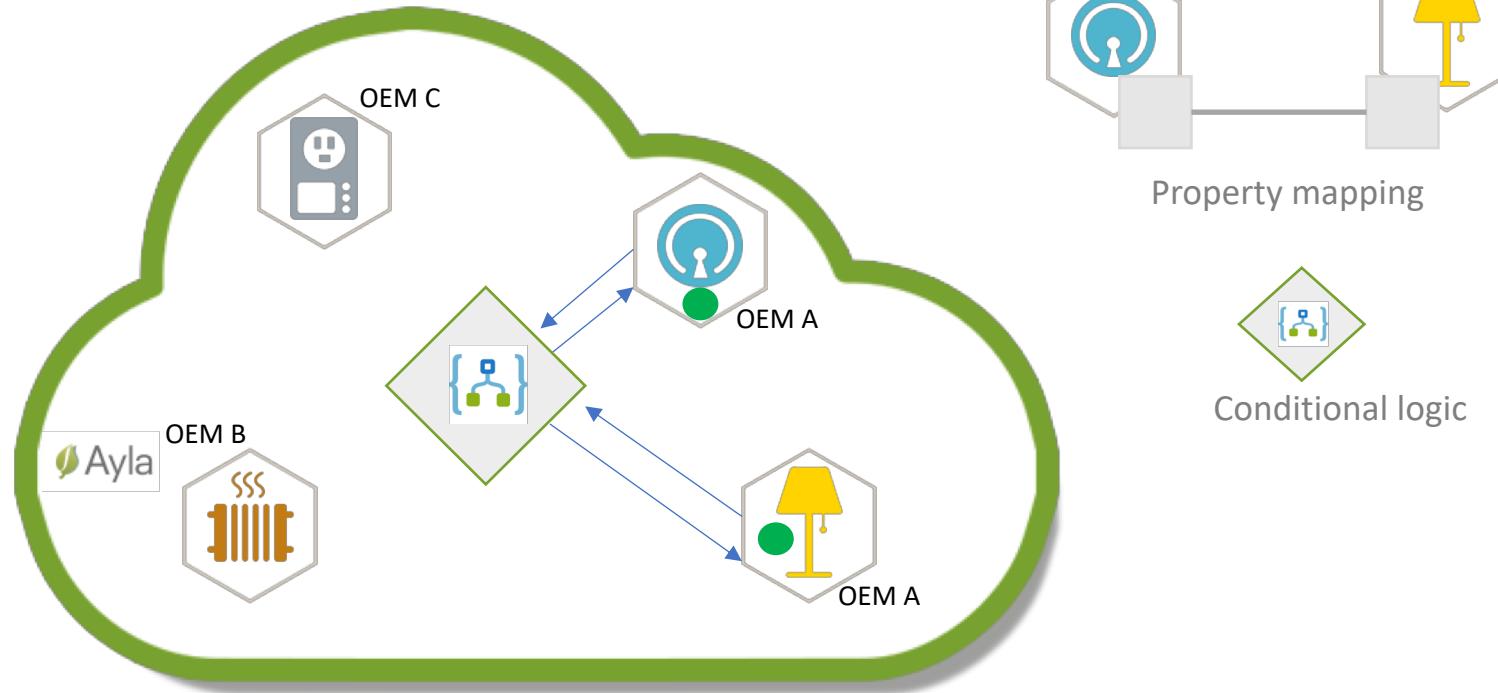
Name	Status	User	Creation Date (UTC)	Type	Image Version	SW Version (from)	Devices	Passed	Failed	Last Updated (UTC)	LAN OTA	Action
test	finished	101010	12/20/2017 at 0:11:09	module	2.5-beta	2.6-beta	1	1	0	12/20/2017 at 0:11:09		 
test	canceled	101010	12/20/2017 at 0:08:57	module	2.5-beta	2.6-beta	1	0	0	12/20/2017 at 0:08:57		 
test	finished	101010	12/20/2017 at 0:02:18	module	2.5-beta	2.6-beta	1	0	1	12/20/2017 at 0:02:18		 
test	finished	101010	12/19/2017 at 23:56:54	module	2.5-beta	2.6-beta	1	0	1	12/19/2017 at 23:56:54		 
test	finished	101010	12/19/2017 at 23:52:55	module	2.5-beta	2.6-beta	1	0	1	12/19/2017 at 23:52:55		 
tet	finished	101010	12/19/2017 at 22:32:27	module	2.5-beta	2.6-beta	1	0	1	12/19/2017 at 22:32:27		 
tianheng-module-ota	finished	101010	12/19/2017 at 22:25:42	module	2.5-beta	2.6-beta	1	0	1	12/19/2017 at 22:25:42		 
JobTest	initialized	205994	07/06/2017 at 20:01:36	host_mcu	.01	2950	0	0	0	07/06/2017 at 20:01:36		 

Rules Engine

Cloud-based rules for device behavior

- **Device to device interactions**
 - IF DeviceA.Property1 = 1, THEN SET DeviceB.Property2 = 1
 - IF motion sensor triggered THEN turn light on
- **External data feed to device interactions**
 - IF DeviceA.Property1 > 70, THEN SET DeviceA.Property2 = 65
 - Weather feed temperature > 70 THEN SET cooling temp = 65
- **Rule creation**
 - OEM generated
 - Within Developer Portal for specific device (DSN)
 - Hard coded within mobile application code (for consumer to enable/disable)
 - Consumer generated
 - In mobile application UI
 - OEM limits properties available for rule creation

Rules Engine: Device to Device

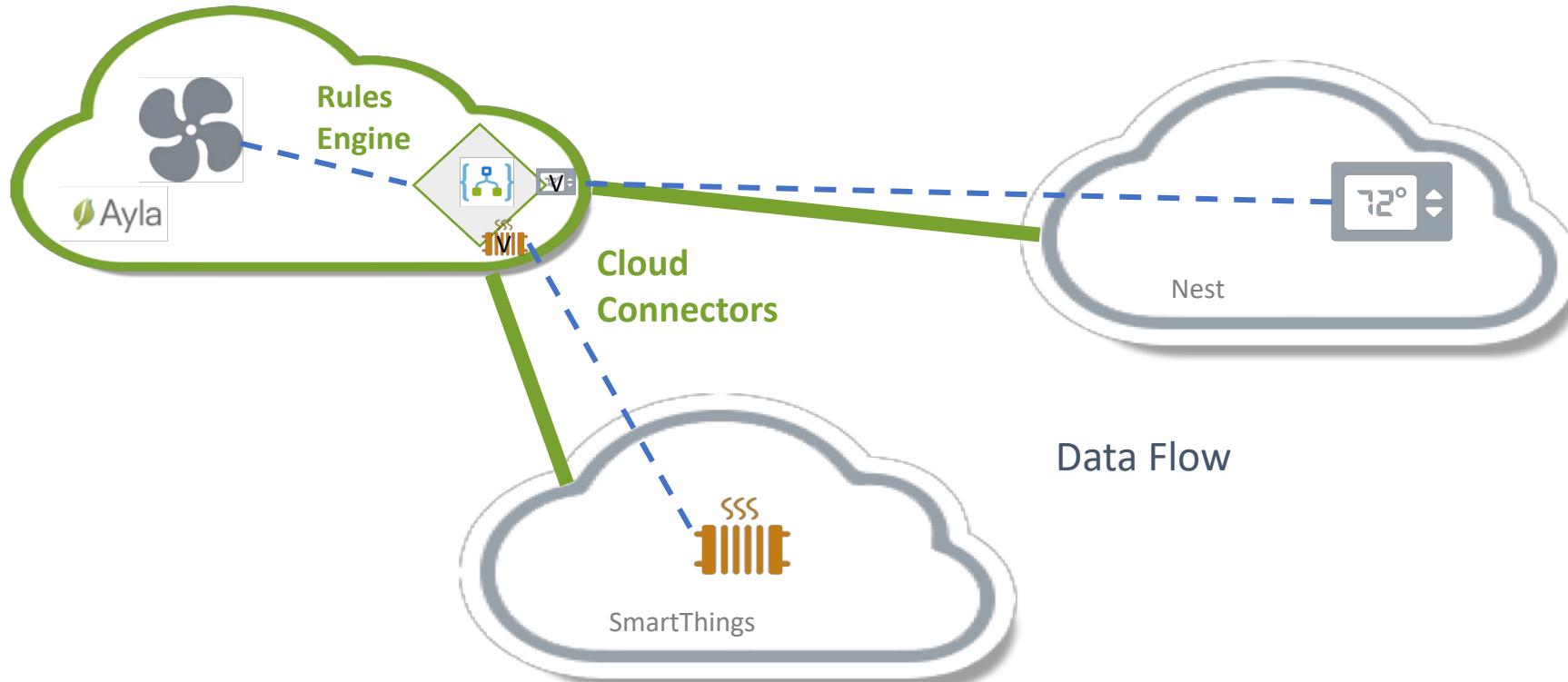


Rules Engine: Use Cases

- **General use cases**
 - Outdoor humidity level (feed) triggers de-humidifier
 - Motion sensor triggers light
- **Customer use cases**
 - Fujitsu (maintaining indoor air quality)
 - Air quality index (PM 2.5 / weather feed) triggers air purifier
 - AO Smith (balancing temperature of multiple heaters)
 - Heater 1 temperature triggers Heater 2 adjustment

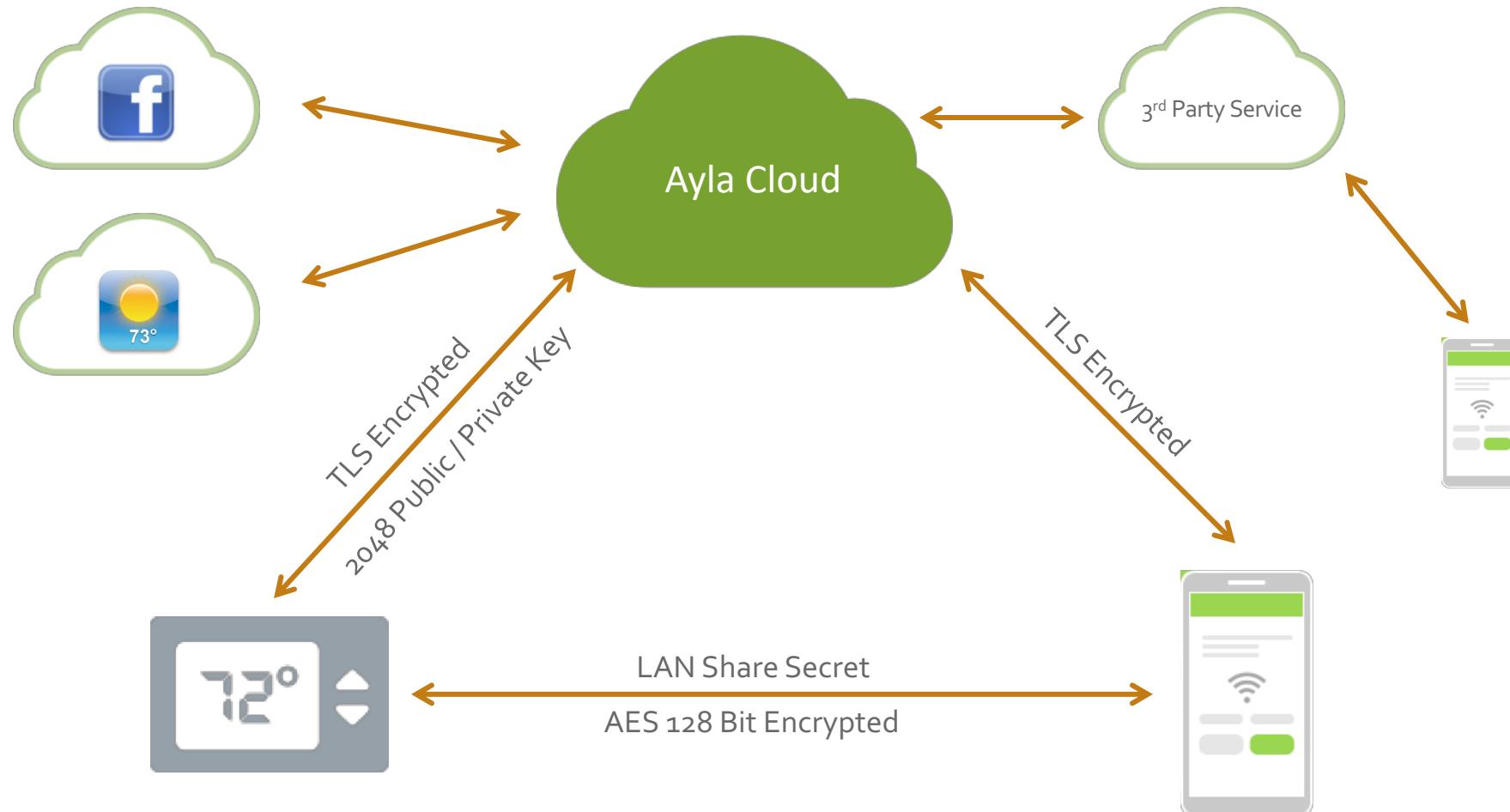


Rules Engine: V2 (Multi-Cloud + Device to Device)



Security

Holistic Security



Security Controls

Security Cannot Be an Afterthought

- Multi-factor authentication
- Devices uniquely authenticated with unique key pair
- Encrypted LAN Mode communication
- Data encryption in transit and at rest
 - HTTPS encrypted with TLS
 - UDP channel encrypted with AES-128 encryption
 - At rest data encrypted with AES-256 encryption
- Layered access control
 - Limit surface area in the event of a breach
 - Breach of one device or one user does not compromise the whole system

Infrastructure Security

Security Starts with a Solid Foundation

- Services deployed within a VPC in AWS
- Service and databases installed in different subnets
- Instances are not directly accessible from the internet
- Firewalls protect services at a network level
- Intrusion detection systems on instances
- DDoS filters and web application firewalls

Compliance

Security is an Ongoing

- Certifications
 - Ayla Cloud infrastructure, security practices and processes audited
 - ISO 27001, SOC 2 – SSAE16 / ISAE 3402 Type II
- Penetration Test through a third party
 - Bi-annual schedule
 - OWASP Top-Ten
 - Cross-tenant access
 - All Cloud APIs in scope



Data Access Controls

- Access to data determined by user's role and associated privileges
 - OEM can define custom roles aligned with their organization structure
- Dealer use cases enabled
 - Dealers can remotely monitor devices and offer services
 - Owners can control what the dealer can see and control
- Granular controls
 - Property level access controls to partners, dealers, developers, and other users
- Devices can be shared among family members/guests
 - Defines what the receiver of the share can view or control
- Consumers can opt-in to share their devices' data with partner services

Data Privacy and Ownership

The Internet of Things Is All about the Data

Clear Data Ownership

- Registered user of device
- Authorized OEM Users

Device Registration Controls

- Ensures physical possession before registering a device to an account
- Physical proximity challenged presented to authenticated user

Handling of Personally Identifiable Information (PII)

- All PII identified and documented
- PII encrypted or anonymized