

CON4441 - Plugging Configurability into your IoT Application Gateway

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Marco Carrer

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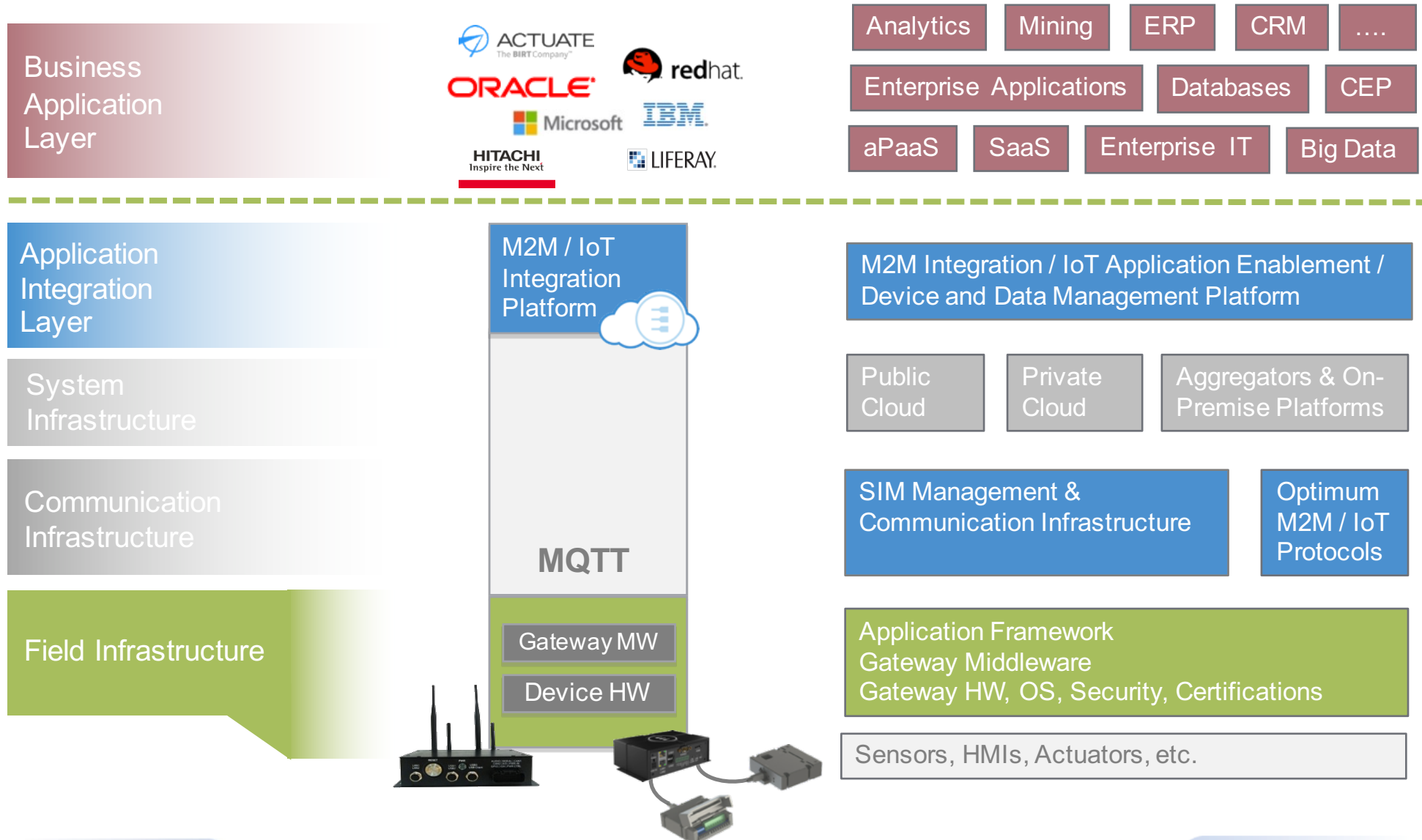
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Agenda

- **IoT Gateways**
 - Use Cases
 - Challenges
- **IoT Gateway Application Framework**
 - Eclipse Kura+Reactive Blocks
 - Example Application
- **IoT Gateway Remote Management**
 - Use Cases
 - Example

IoT Architecture



IoT Gateways

Duties

- **Hardware and Field Abstraction**
 - Sensor Connectivity
 - I/O Access
- **Manage Network and Connectivity**
 - Wireless Modems, Firewall, Wi-Fi Hotspot, VPN
 - Online / Offline mode
- **Manage Applications**
 - Remote Start/Stop, Install/Uninstall of applications
 - Remote Configuration Management and Snapshots
- **Manage IoT Connectivity**
 - MQTT / CoAP Connections
 - Data Buffering and Retries
 - Provisioning, Credentials and Certificates

IoT Gateways

Challenges



fragmentation



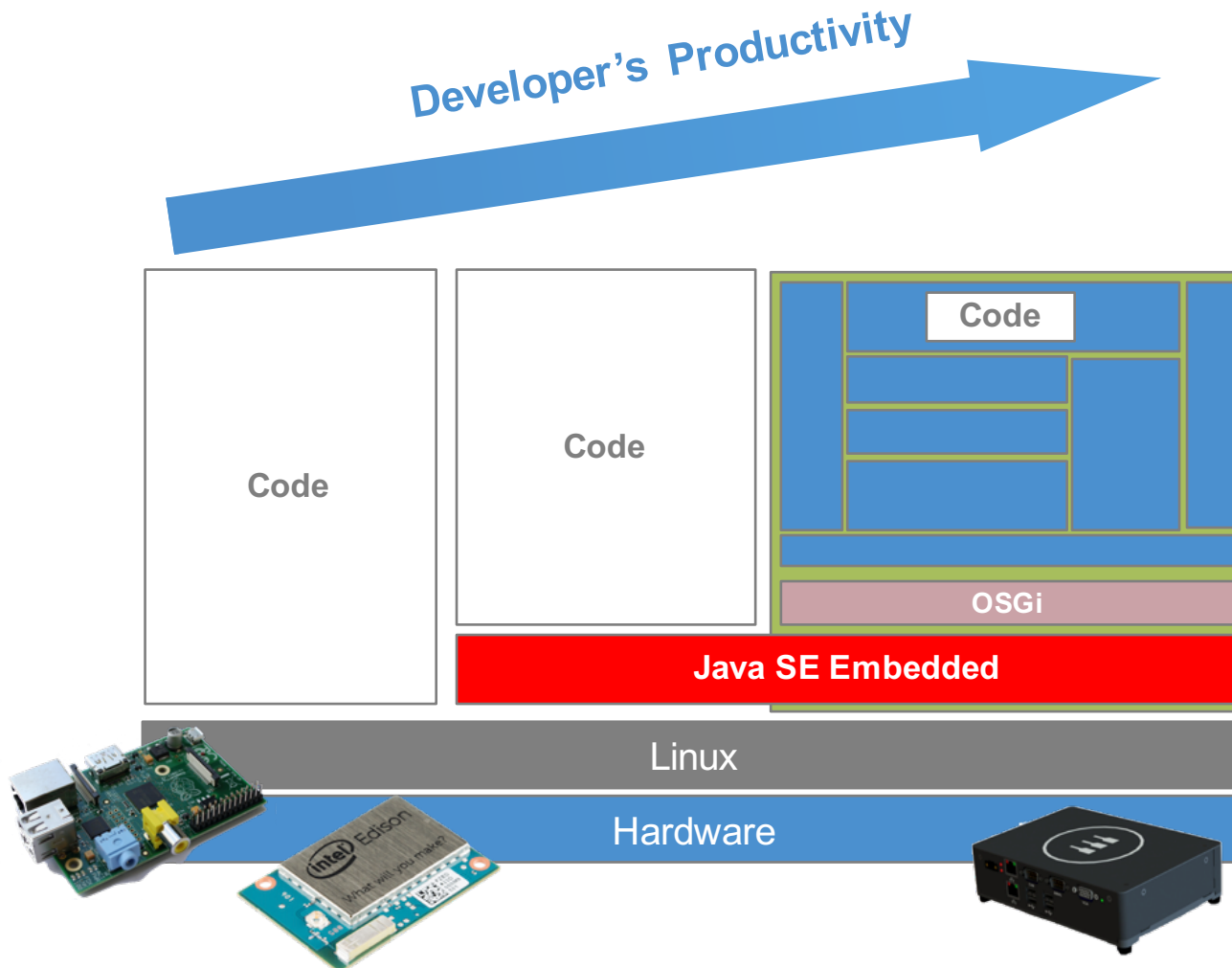
complexity



lock-in

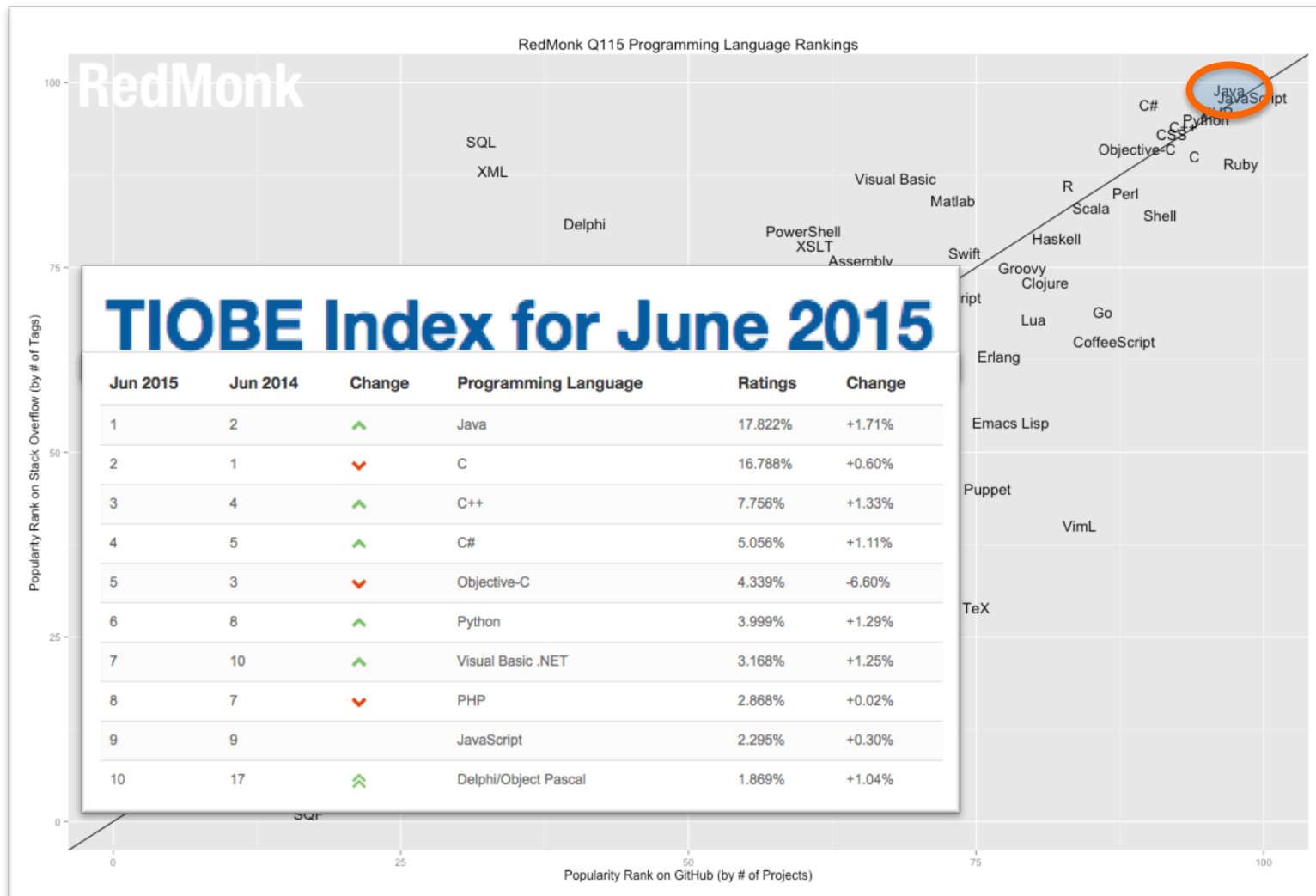
A Java IoT Middleware?

Increased productivity



Java IoT Middleware

Lower time to market and Investment Protection



9+ MILLIONS
JAVA
DEVELOPERS



MOST USED
PROGRAMMING
LANGUAGE FOR
ENTERPRISE
APPS

<http://redmonk.com/sograpy/2015/01/14/language-rankings-1-15/>
<http://www.tiobe.com/index.php/content/paperinfo/tpci/index.html>
<http://java.dzone.com/articles/how-many-java-developers-are>

Open Source Java IoT Middleware

IoT Gateway Challenges:

- Pressure to add value in shrinking timeframes
- Velocity of technology changes outstrips staffing
- Interoperability trumps exclusive differentiation
- Quest for quality w/o lock-in

Open Source is the Answer!



Founded in 2012 by

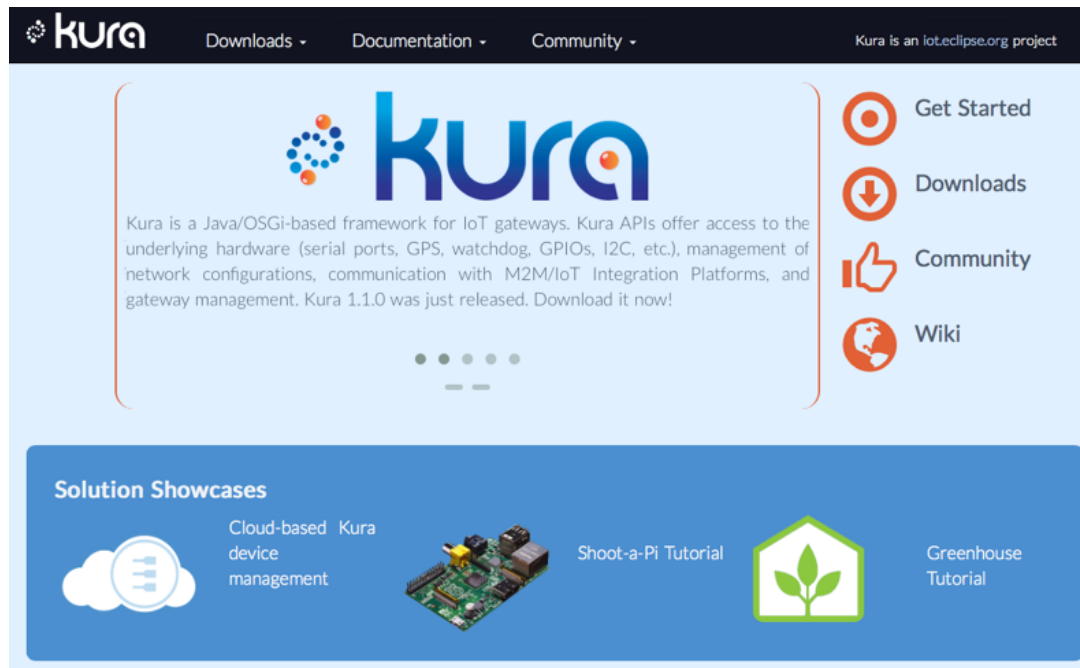


- **Now ...**
 - 23 Members
 - 15+ new projects
 - 1M+ lines of source code
 - The fastest growing Eclipse workgroup

<http://www.slideshare.net/blackducksoftware/iot-and-open-source>

Eclipse Kura

Open Java Framework for IoT Gateways

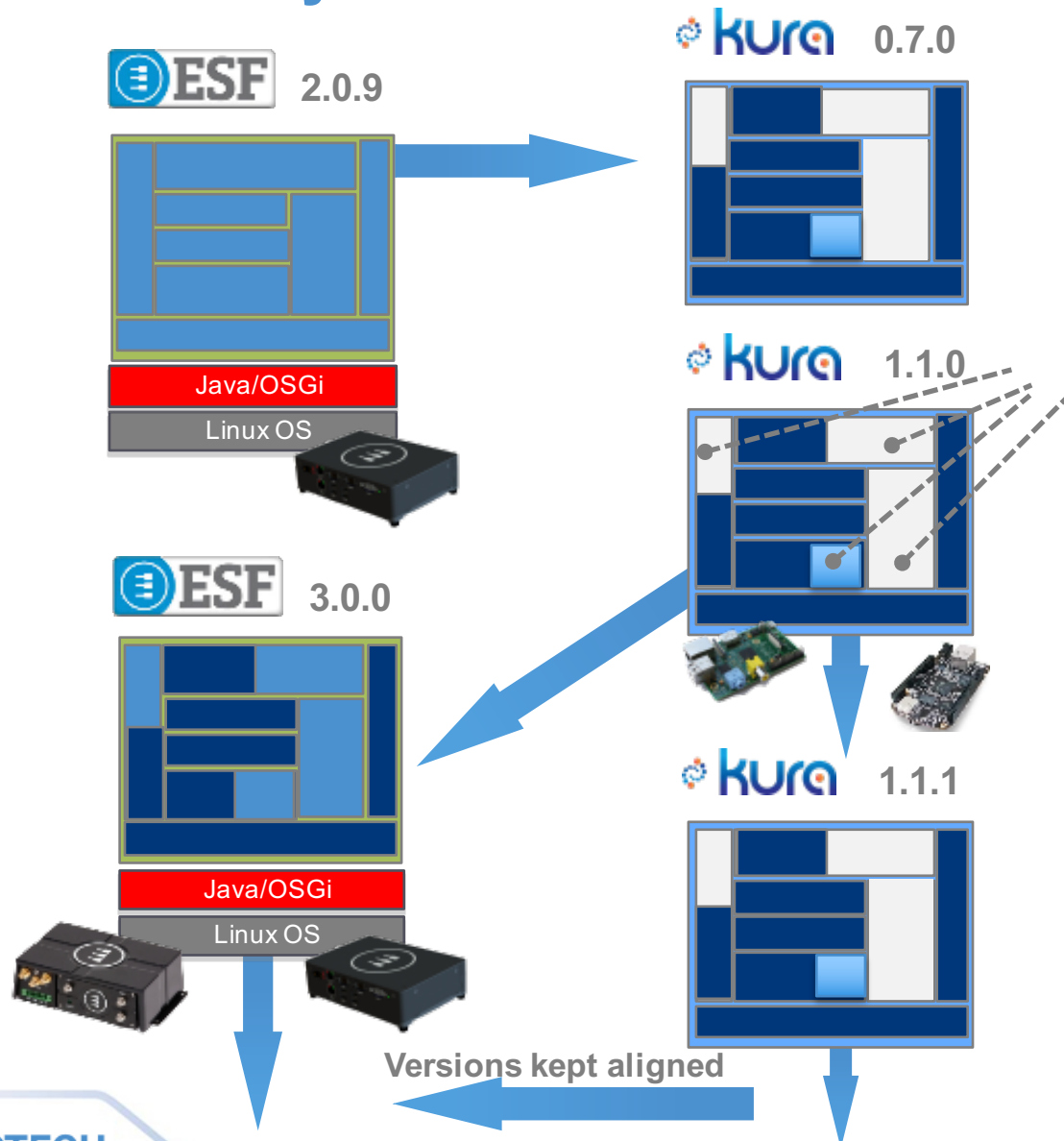


www.eclipse.org/kura/
iot.eclipse.org/java/



Everyware Software Framework (ESF)

A Short History



ESF has Kura at its Core.

ESF-only components:

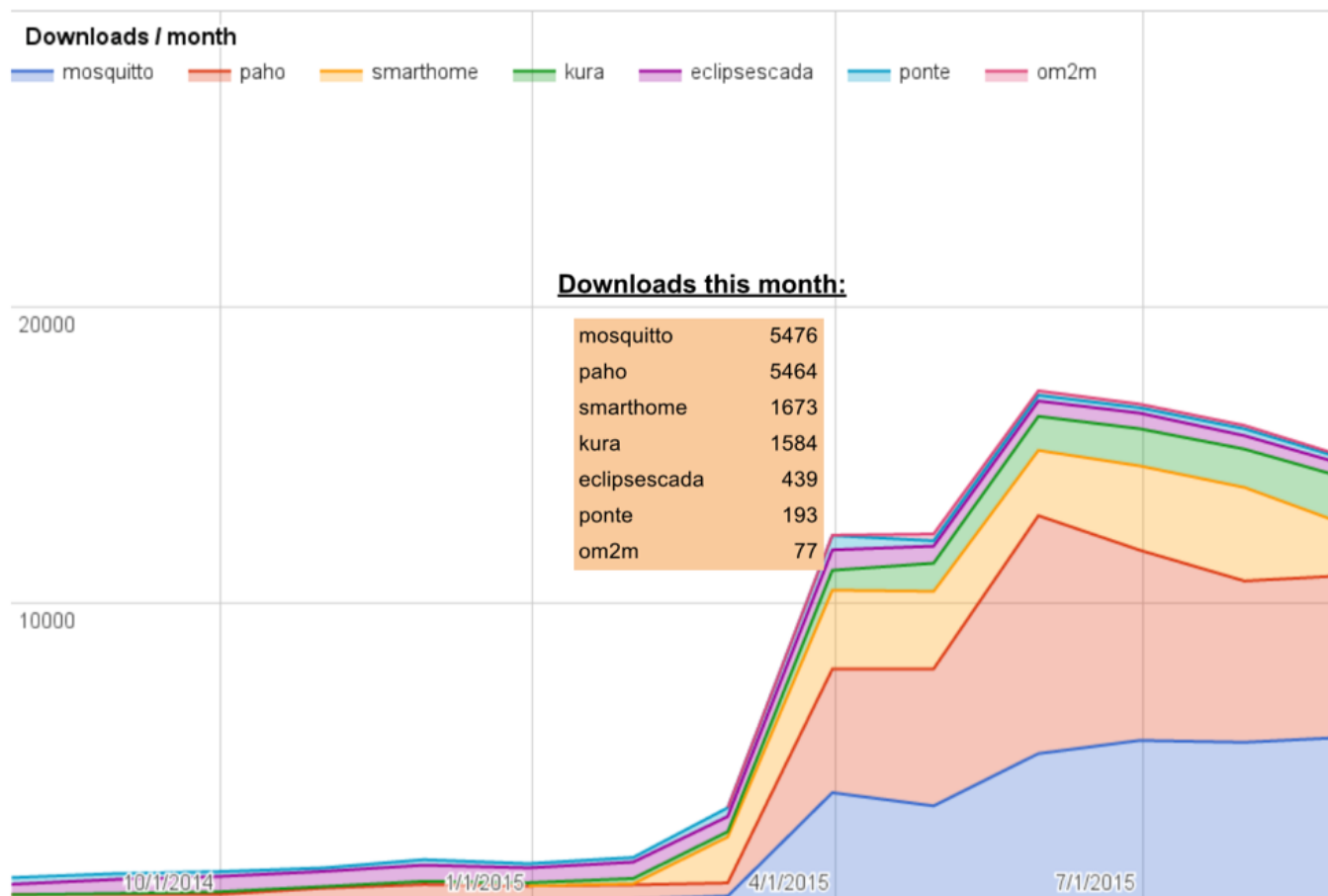
- Commercial Support
- Advanced Security
- Everyware VPN
- Diagnostics
- Field Protocols
- Bundles for specific vertical applications

Eclipse Kura

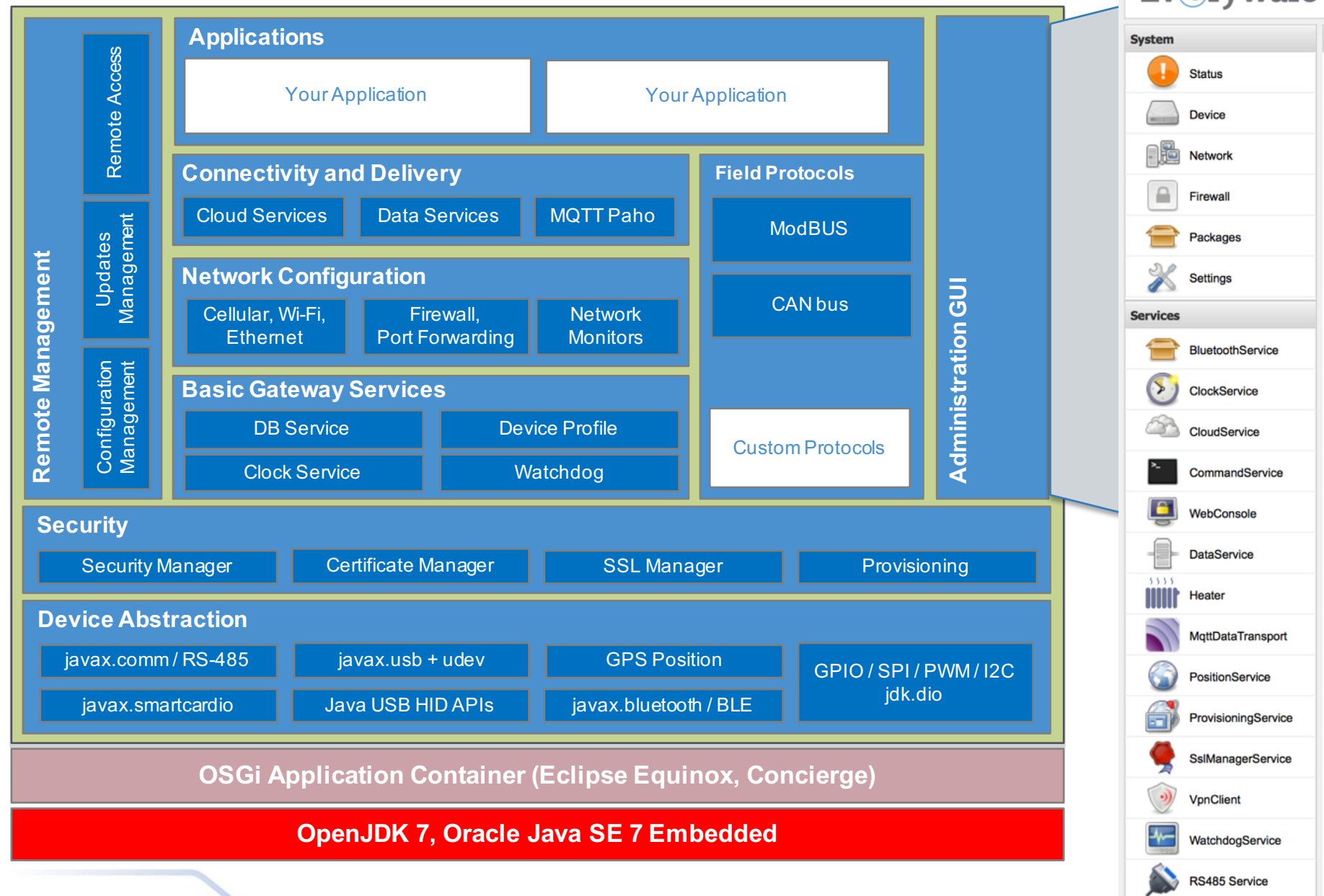
Open Java Framework for M2M/IoT Gateways



1K+ downloads/month



ESF/Kura Under the Covers



From Prototype to Production

Efficient Development & Investment Protection

Application portability
across HW Platforms



Industrial
M2M/IoT
Gateways



Open Hardware



Device Abstraction

Beyond Java SE

- Serial Access (javax.comm)
- RS-485 (javax.comm)
- USB (javax.usb)
- USB HAPI
- Linux udev (ESF APIs)
- Smart Card (javax.smartcardio)
- Bluetooth (javax.bluetooth)
- Bluetooth LE (ESF APIs)
- Location (GPS NMEA)
- GPIO, I2C, PWM, SPI (jdk.io)
- Network Configuration Mgmt
- ModBUS
- CAN bus
- People Counters
- More to come:
 - ZigBee
 - Apache Camel Msg Routing
 - S7
 - OPC
 - MQTT-SN
 - Virtual COMs

Connectivity and Delivery

Message Queue Telemetry Transport (MQTT)

- M2M Messaging Protocol
- Low Bandwidth / Low Power
- 2-way Communication
- Publish and Subscribe
- Hierarchical Topic Namespaces
- Data Payload Agnostic
- Device Initiated Connection
- Firewall-friendly
- SSL and Authenticated
- Large ecosystem



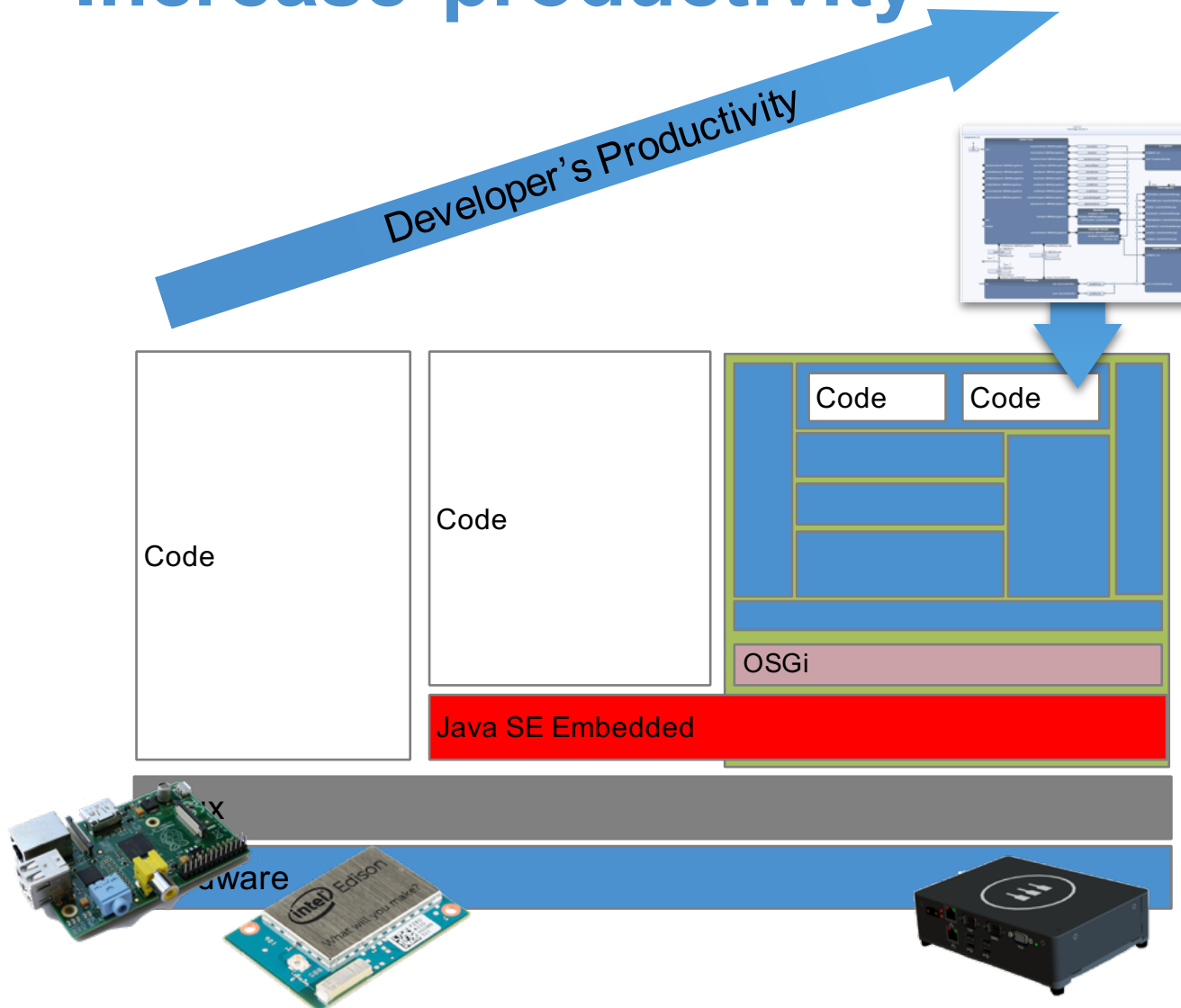
Benefits of MQTT versus HTTP

- **Push delivery of messages / data / events**
 - MQTT – low latency, 2-way communication
 - HTTP – push from client but poll from server
- **Efficient use of network**
- **Reliable delivery over fragile network**
- **Decoupling and publish subscribe – one to many delivery**
- **Battery Efficiency**

		3G		Wifi	
		HTTPS	MQTT	HTTPS	MQTT
receive	messages / hour	1,708	160,278	3,628	263,314
	% battery / msg	0.01709	0.00010	0.00095	0.00002
	msgs (note losses)	240 / 1024	1024 / 1024	524 / 1024	1024 / 1024
send	msg / hour	1,926	21,685	5,229	23,184
	% battery / msg	0.00975	0.00082	0.00104	0.00016

How about the Applications?

Increase productivity



 Reactive Blocks

 ESF

 kura

 OSGi[™]
Alliance

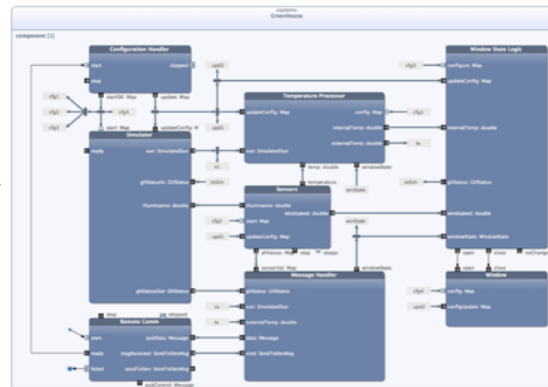
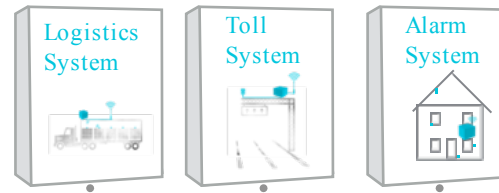
 Java[™]

Reactive Blocks

Libraries of building blocks

- ▼ **ModBus** 1.3.0 (1) com.bitreactive.library.modbus
 - ModBus Simple
- ▼ **KML** 1.0.2 (2) com.bitreactive.library.kml
 - KML Parser
 - KML2 Parser
- ▼ **GSON** 1.2.0 (2) com.bitreactive.library.gson
 - Json Deserializer
 - Json Serializer
- ▼ **OSGi** 1.1.0 (2) com.bitreactive.library.osgi
 - Simple Service Tracker
 - Termination
- ▼ **Buffering** 2.4.0 (14) com.bitreactive.library.buffering
 - Reactive Buffer
 - Timed Cache
- ▼ **Serial I/O (rxTxSerial)** 1.1.3 (2) com.bitreactive.library.serial
 - Enumeration
 - Reader and Writer
- ▼ **Timers** 1.2.0 (13) com.bitreactive.library.timers
 - Measure Time
 - Timeout
 - Timer
 - Timer Periodic
 - Timer Random
- ▼ **MQTT** 1.3.0 (1) com.bitreactive.library.mqtt
 - MQTT
- ▼ **Session Utils** 1.5.1 (4) no.ntnu.item.artcis.library.sessions
 - Allocator
 - Allocator 2
 - Constructor
 - Constructor 2
- ▼ **Geofence** 1.1.0 (6) com.bitreactive.library.geofence
 - CircleToFence
 - Contained
 - Geofence
 - Geofence for Fleet

Ready-Made Reference Applications



 **Reactive Blocks**

code ready
to deploy



1 Pick existing blocks from the libraries

2 Build by combining blocks and Java code

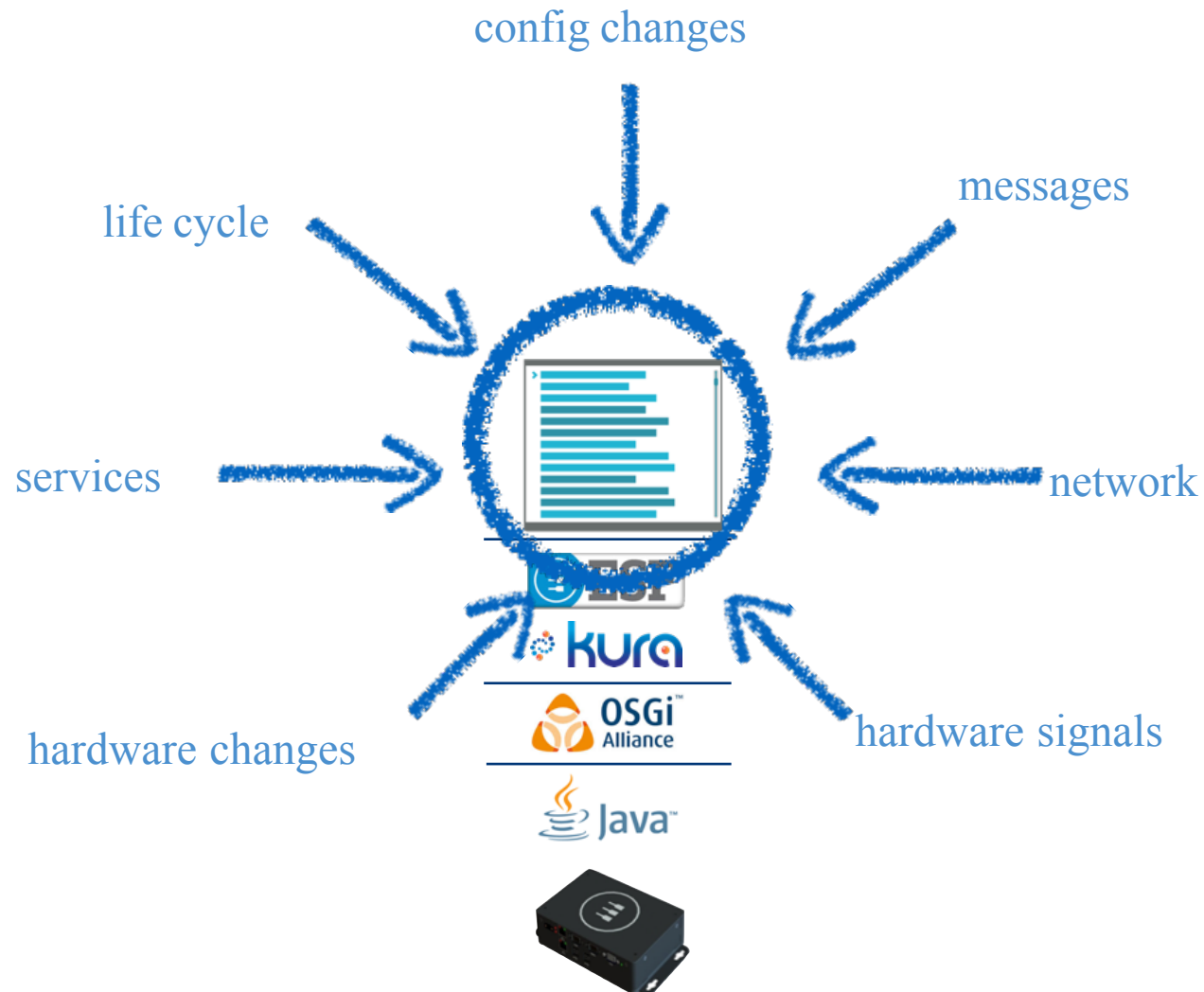
3 Automatically generate code ready to deploy

Code is One-Dimensional

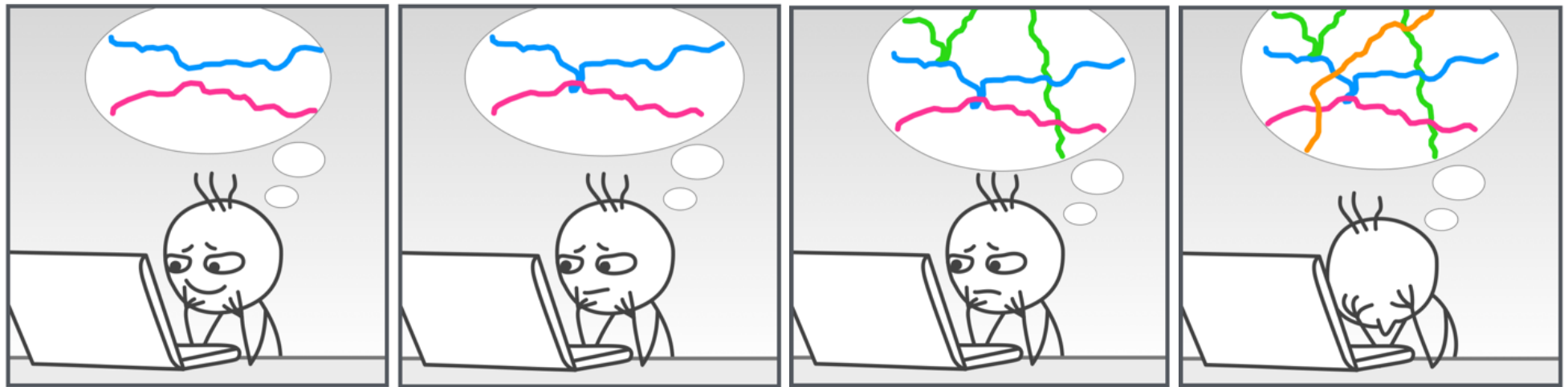


The complete application
(generated automatically)

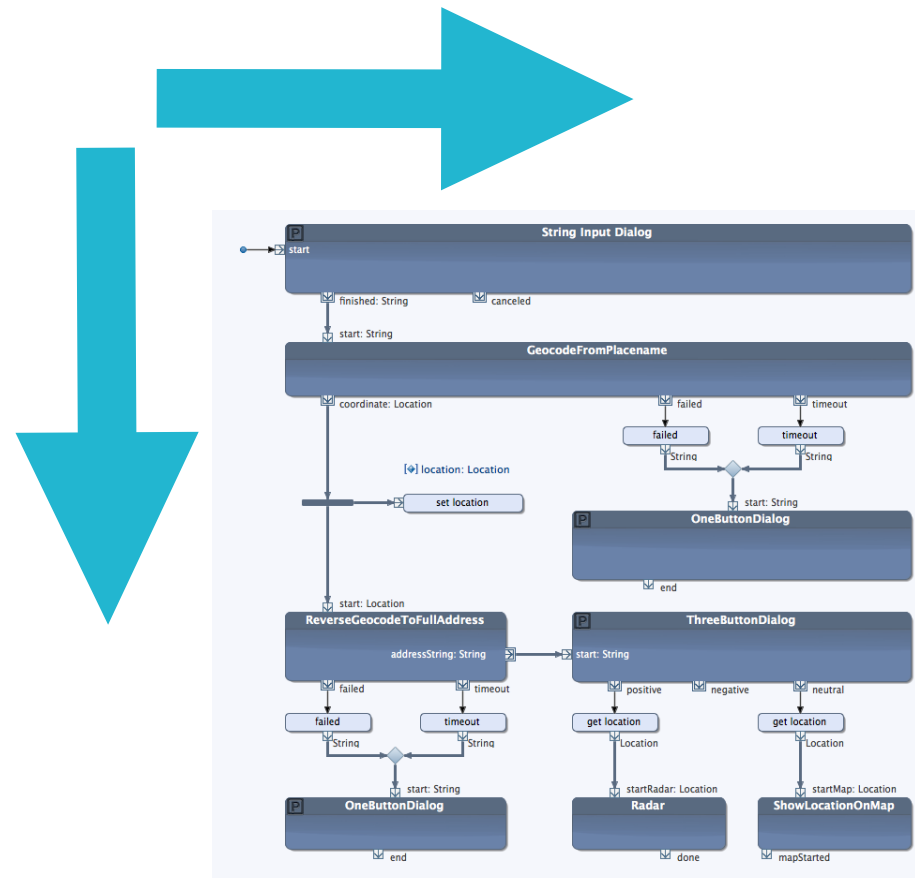
Concurrency



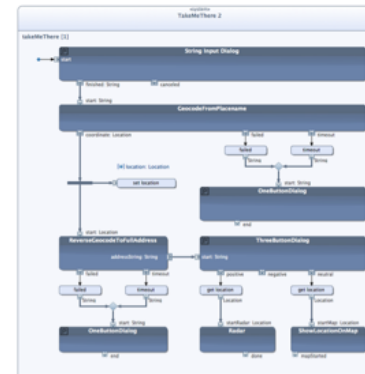
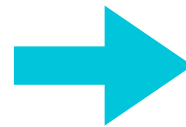
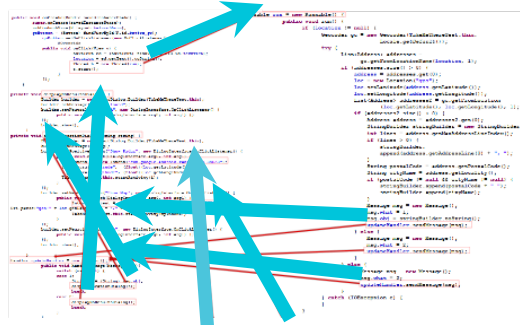
Concurrency



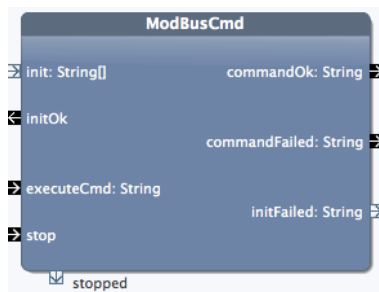
Graphics have Two Dimensions



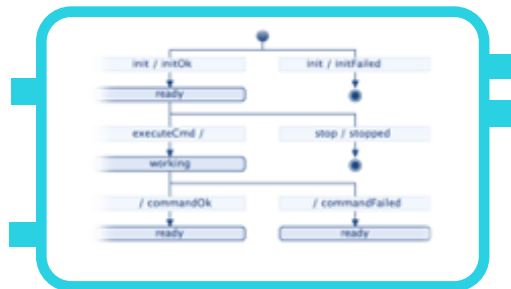
Graphics have Two Dimensions



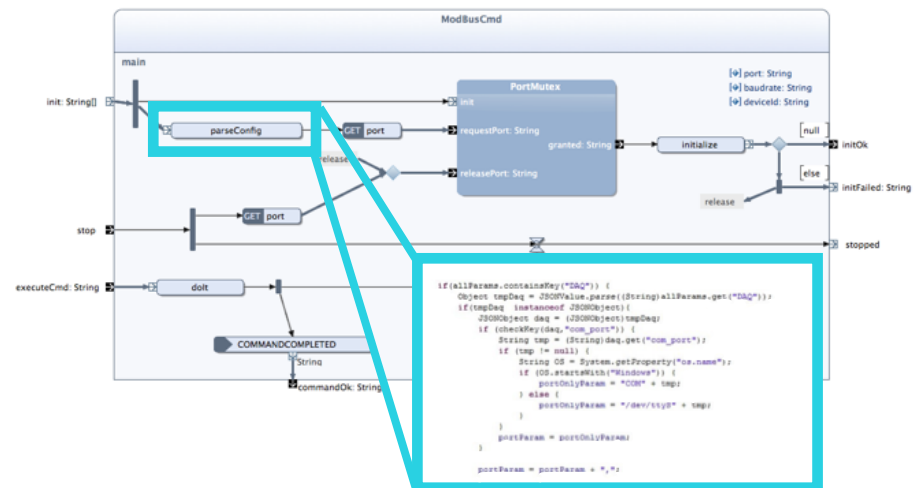
Building Blocks



Behavioral Contract



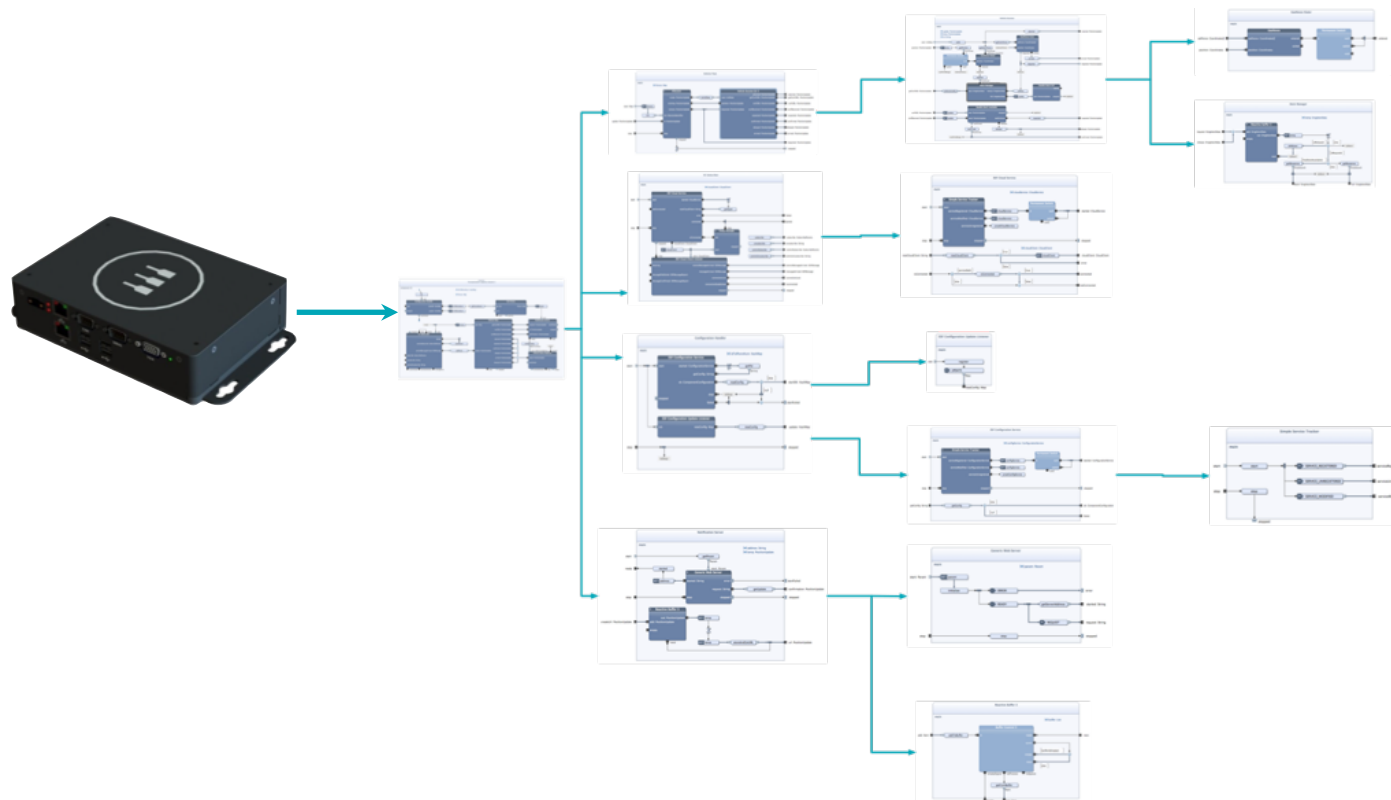
Activity Diagram



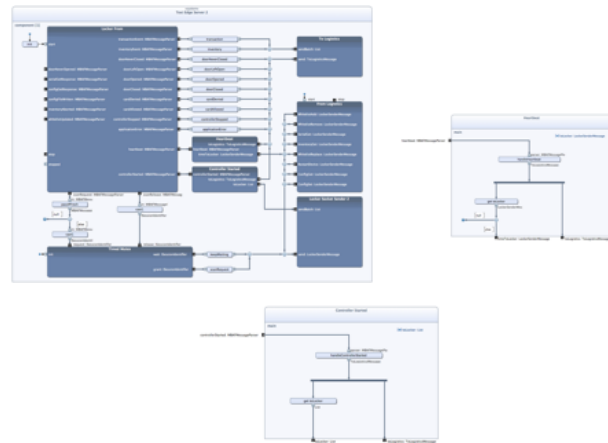
Java Code

```
if(allParams.containsKey("DAQ")) {
    Object tmpObj = J2OValue.parse((String)allParams.get("DAQ"));
    if(tmpObj instanceof J2OObject){
        J2OObject obj = (J2OObject)tmpObj;
        if (obj.containsKey("com_port")) {
            String tmp = (String)obj.get("com_port");
            if (tmp != null) {
                String OS = System.getProperty("os.name");
                if (OS.startsWith("Windows")) {
                    portOnlyParam = "COM" + tmp;
                } else {
                    portOnlyParam = "/dev/tty" + tmp;
                }
            }
            portParam = portOnlyParam;
        }
        portParam = portParam + ",";
    }
}
```

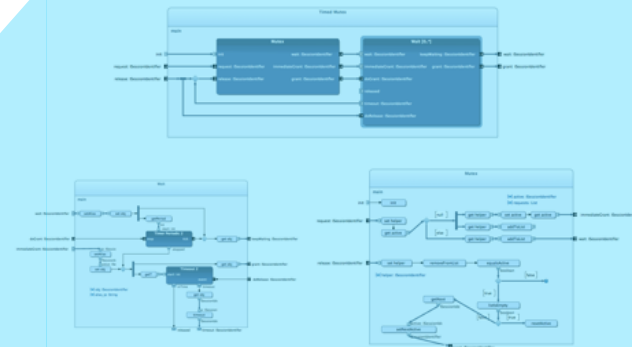

System Structure



Reuse



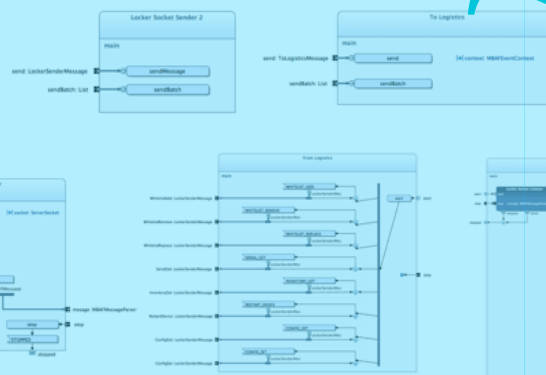
Application-Specific



Reusable from Libraries

Communication

~70 %



Building Block Libraries

Generic Functionality

- Buffering
- Counters
- Flow Logic
- Session Utilities
- Iterator

Timers

- Timers
- Periodic Timers
- Watchdogs

Hardware Connections

- Modbus
- Serial I/O
- Raspberry Pi GPIO
- USB Camera

Files

- Files Utilities
- File I/O
- Properties

User Communication

- SMS
- Email
- XMPP

Communication

- HTTP/HTTPS
- MQTT
- CoAP
- JSON-RPC
- AMQP
- Network Monitoring
- OPC-UA

Security

- Cryptography
- OAuth 2.0

Transformation of Data

- GSON
- XML Parsing
- XSL Transformation

Location

- Geofence
- KML

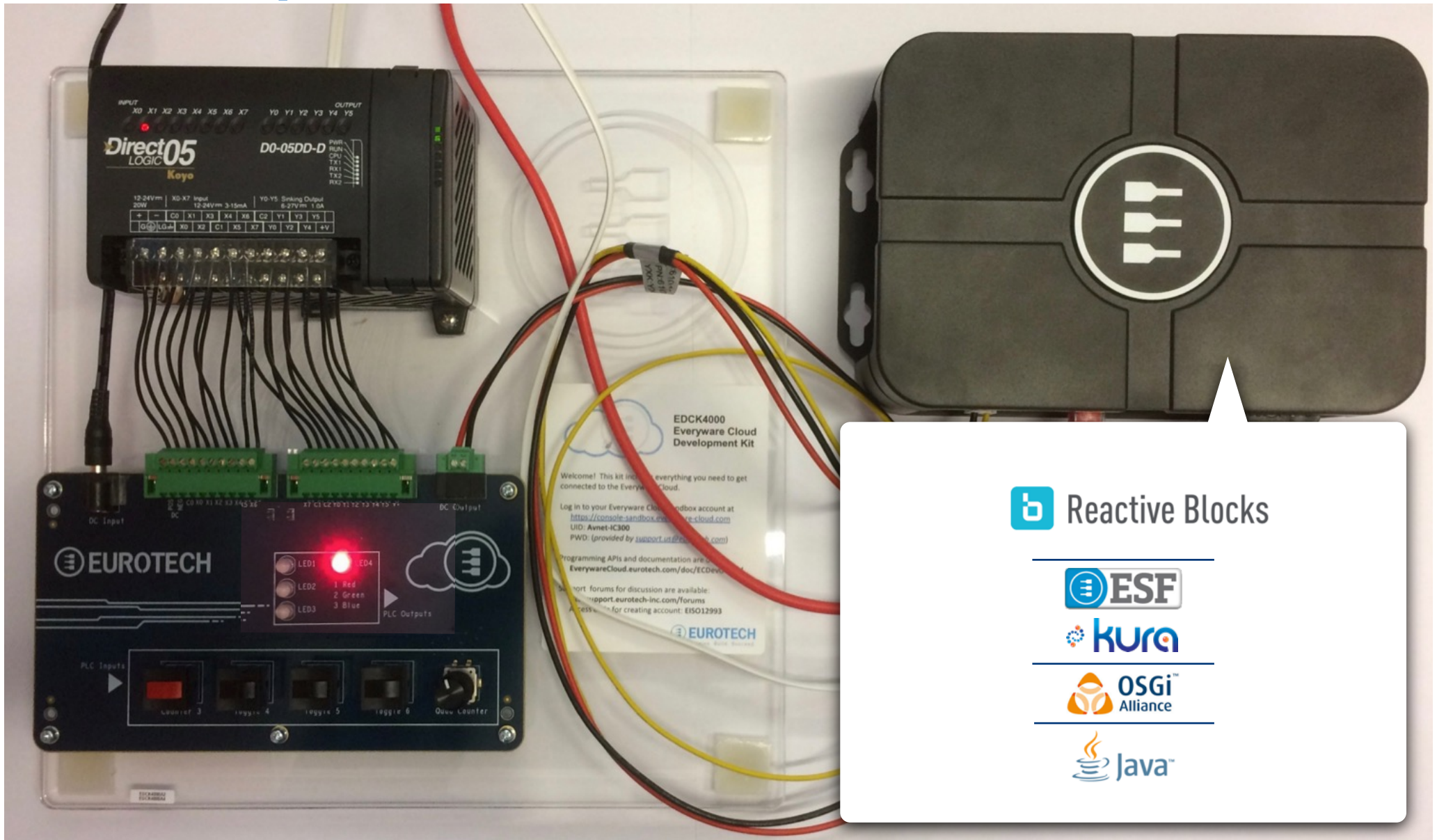
Data Processing

- Video Recording
- Image Processing

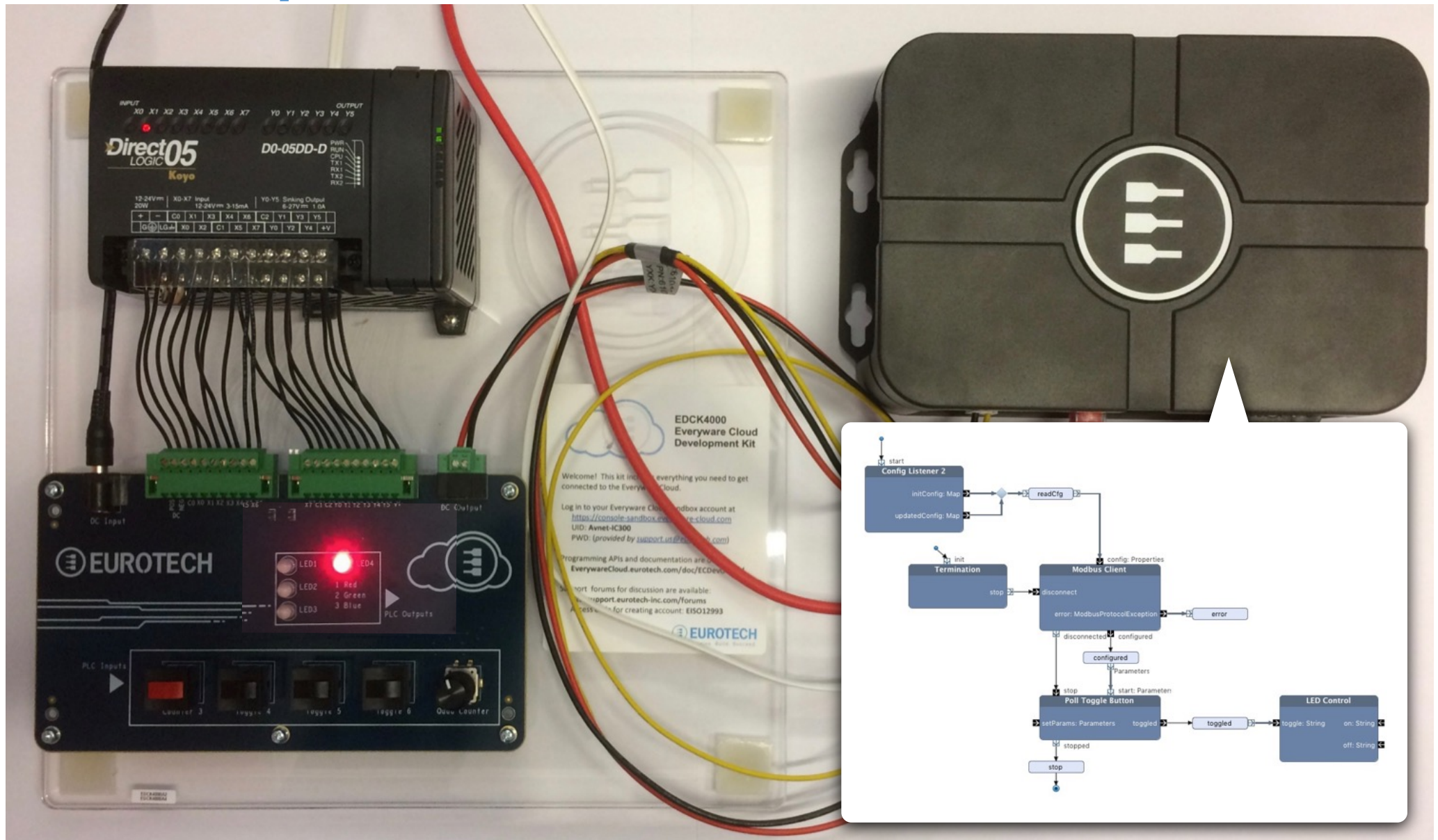
Eclipse Kura and OSGi

- Configuration Listener
- Cloud Client Handler
- Event Admin
- Service Tracker
- Termination
- Service Register

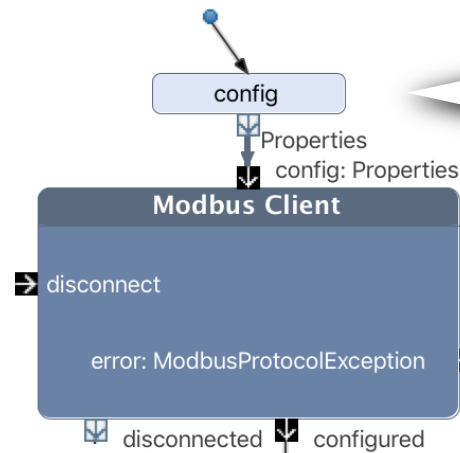
Developer Kit



Developer Kit

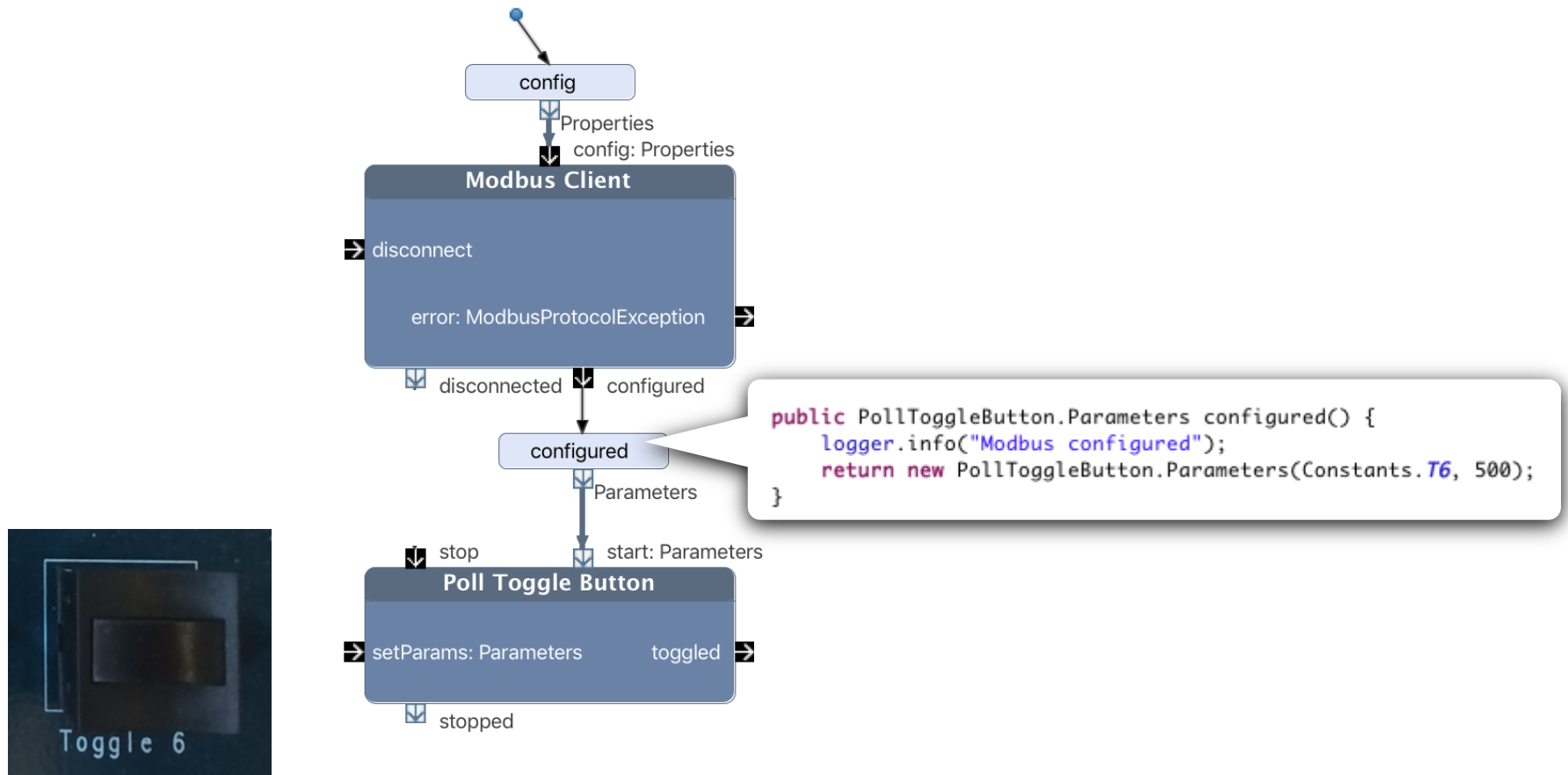


Reactive Blocks Application

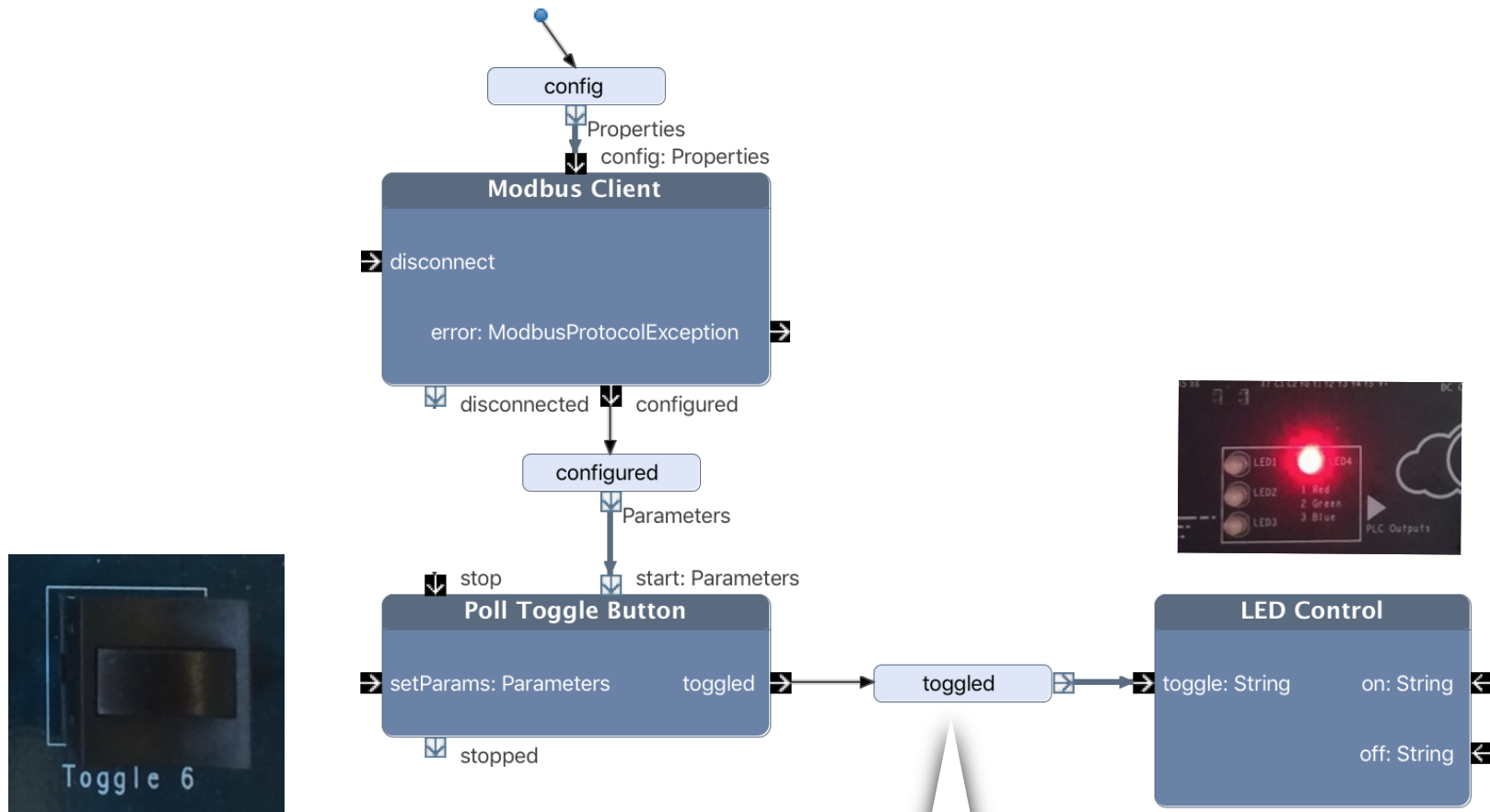


```
public Properties config() {  
    logger.info("System START - configure modbus");  
    Properties p = new Properties();  
    p.setProperty("connectionType", "SERIAL");  
    p.setProperty("serialMode", "RS232");  
    p.setProperty("port", "/dev/ttymxcl");  
    p.setProperty("exclusive", "false");  
    p.setProperty("mode", "0");  
    p.setProperty("baudRate", "9600");  
    p.setProperty("stopBits", "1");  
    p.setProperty("parity", "1");  
    p.setProperty("bitsPerWord", "8");  
    p.setProperty("slaveAddr", "1");  
    p.setProperty("transmissionMode", "RTU");  
    p.setProperty("respTimeout", "1000");  
    return p;  
}
```

Reactive Blocks Application

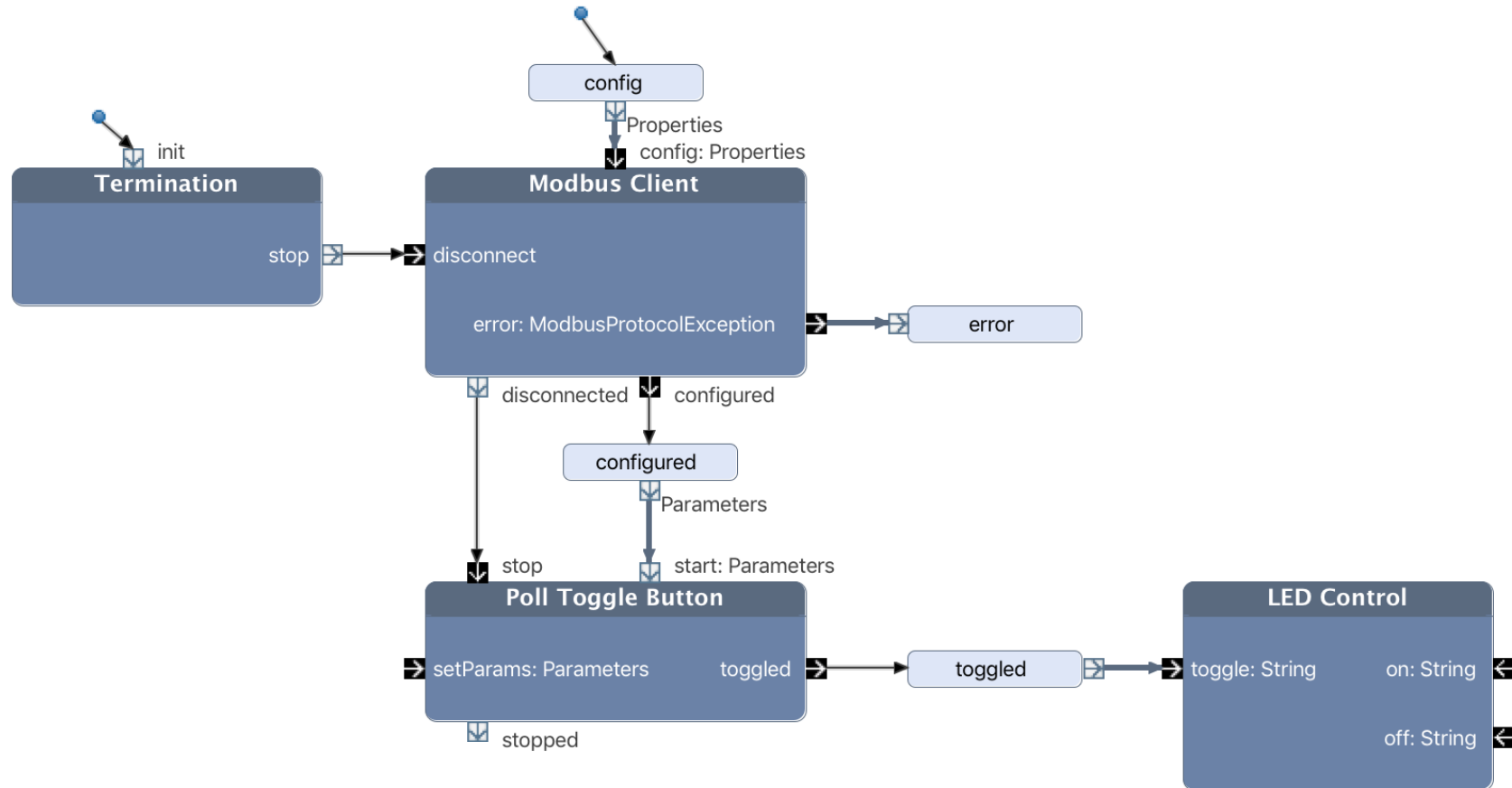


Reactive Blocks Application

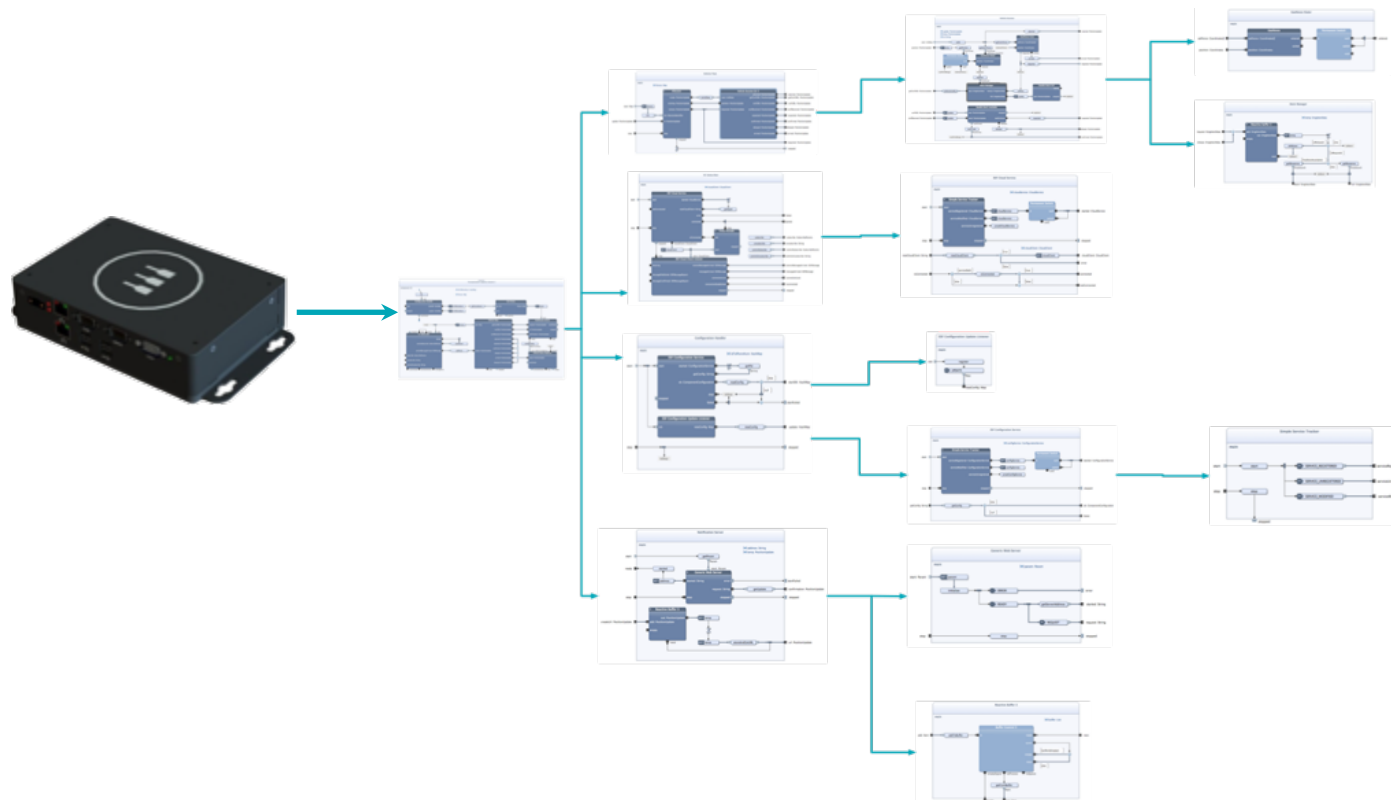


```
public String toggled() {
    logger.info("Button " + button + " TOGGLED");
    return Constants.LED_4_BLUE;
}
```

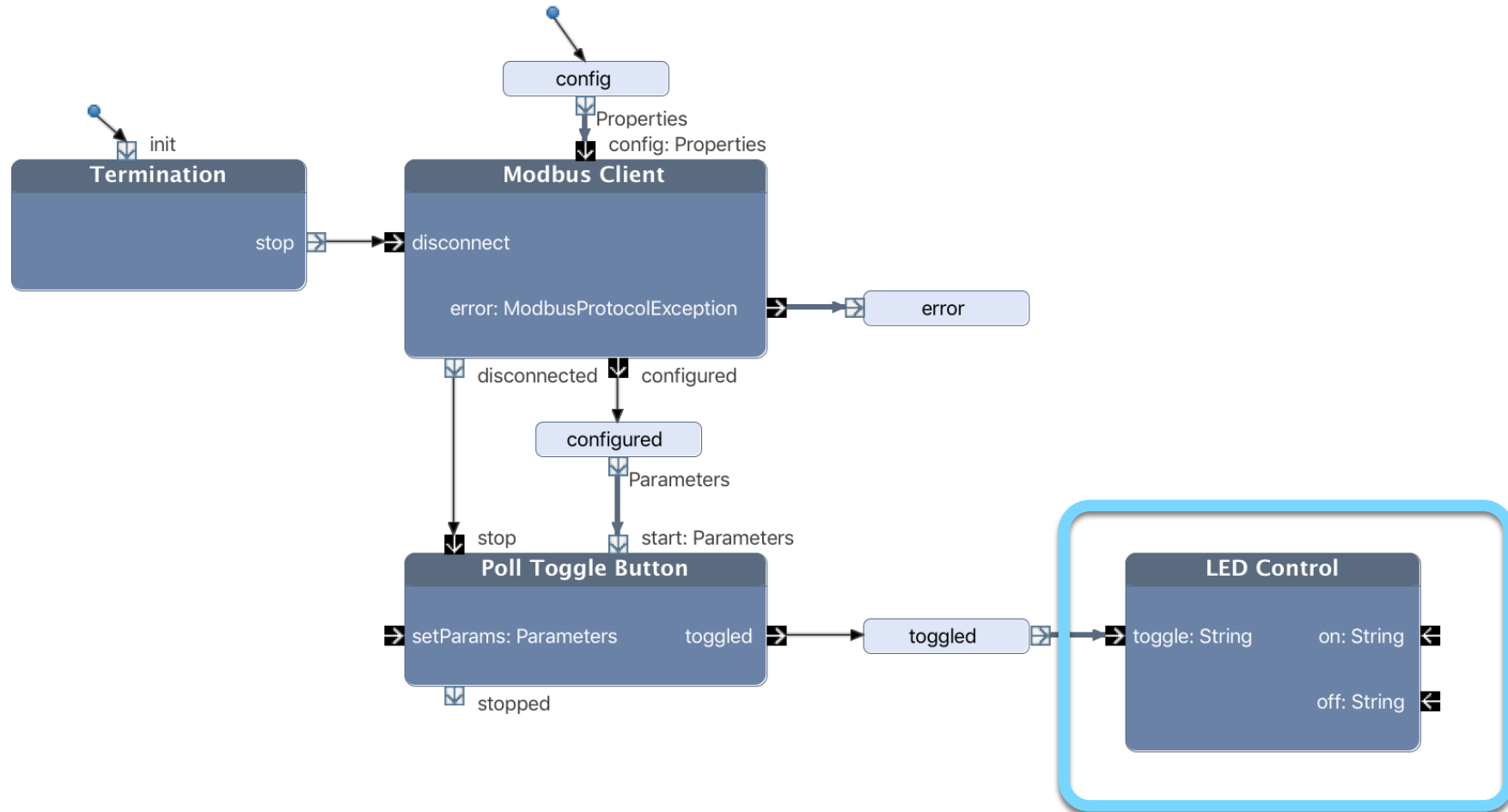

Reactive Blocks Application



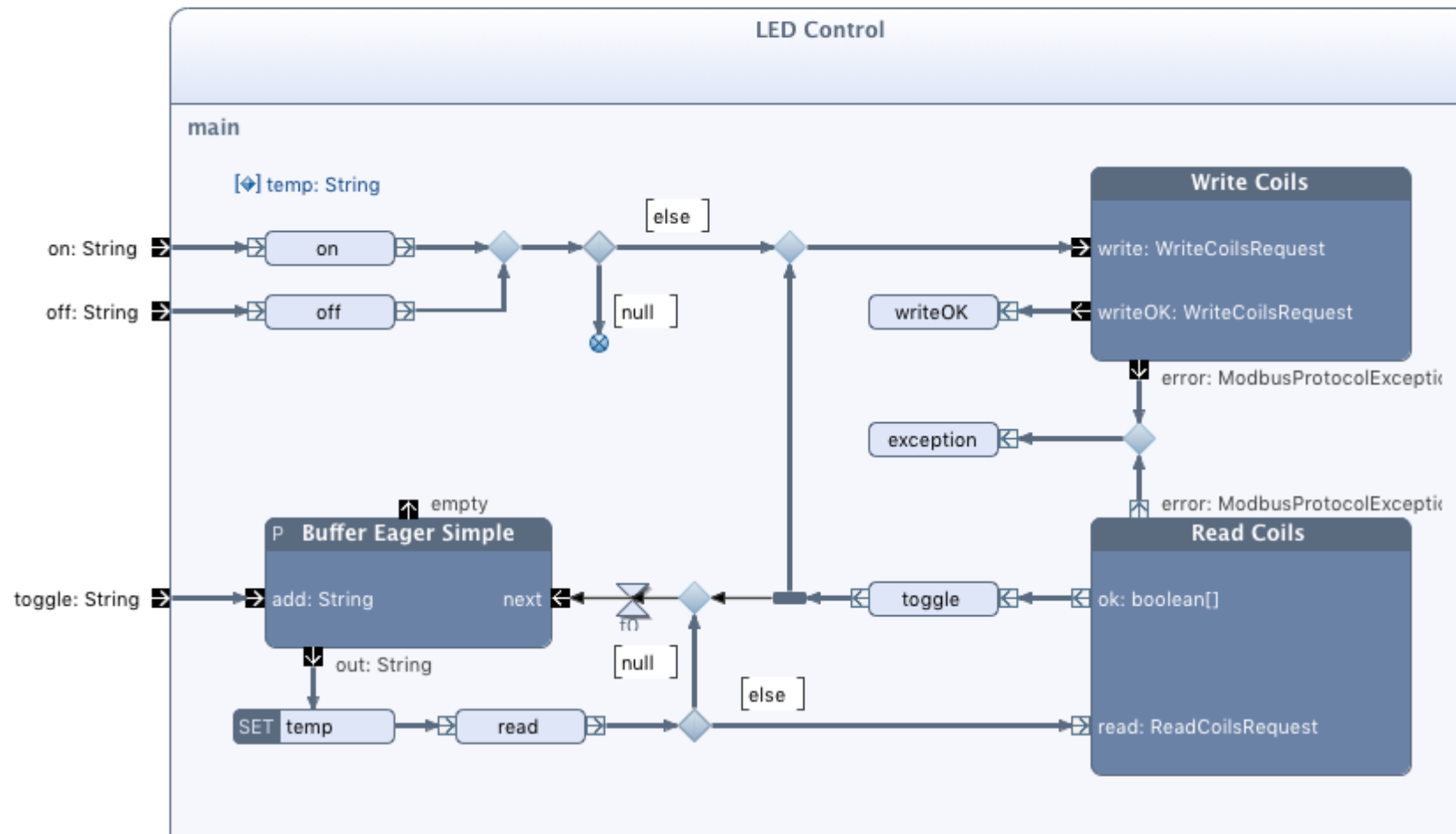
Reactive Blocks Application



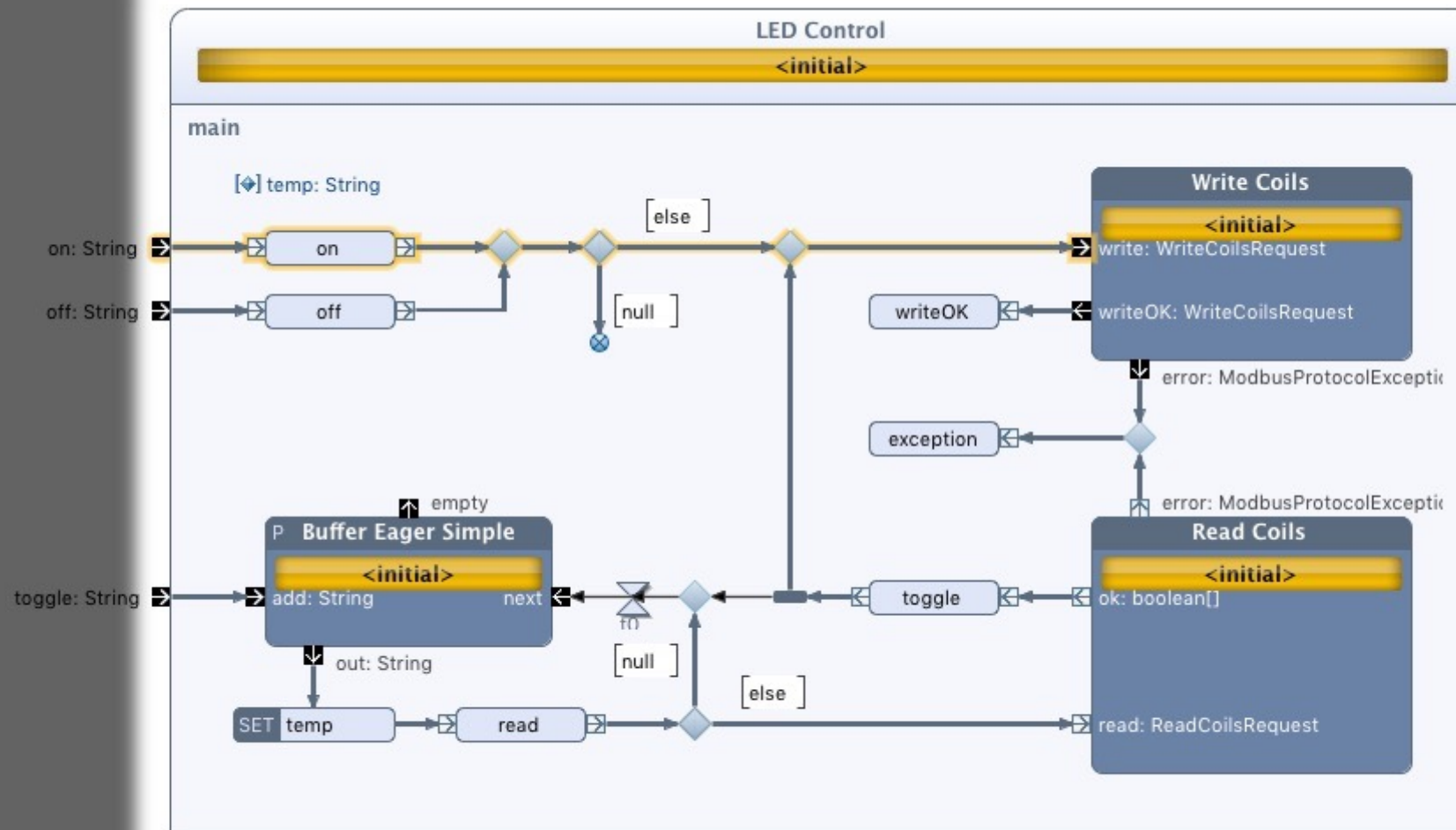
Reactive Blocks Application



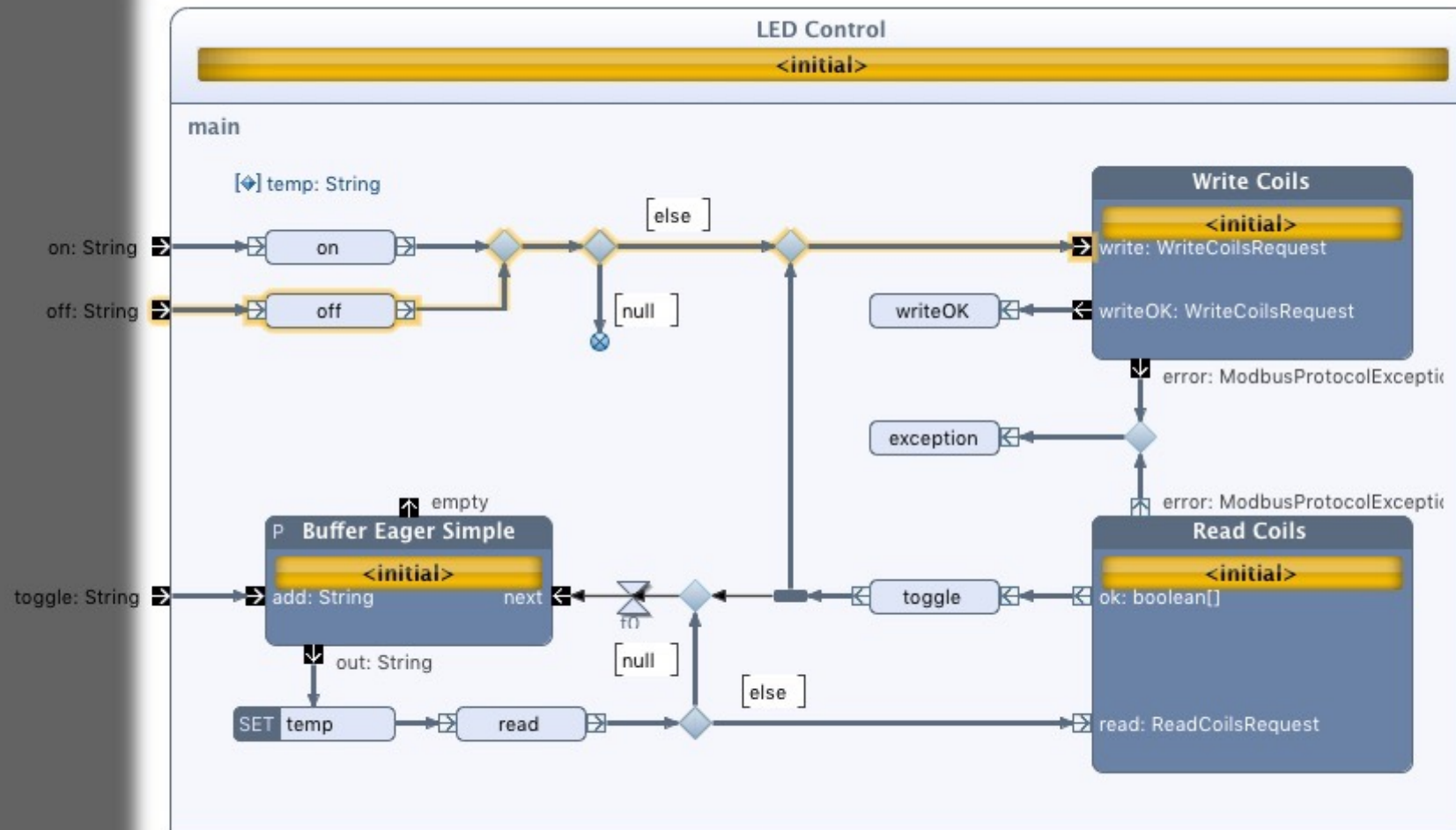
Reactive Blocks Application



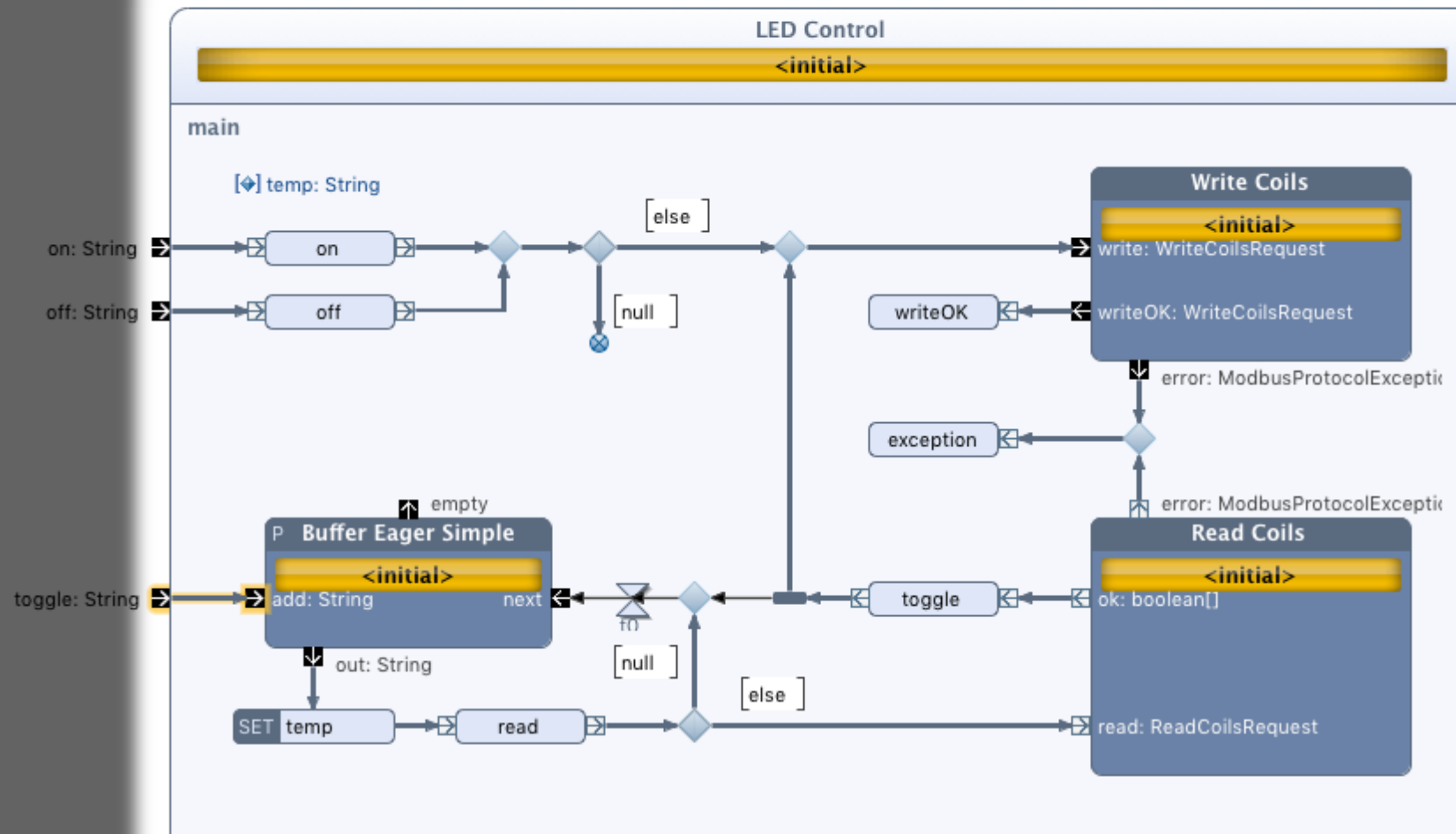
Reactive Blocks Application



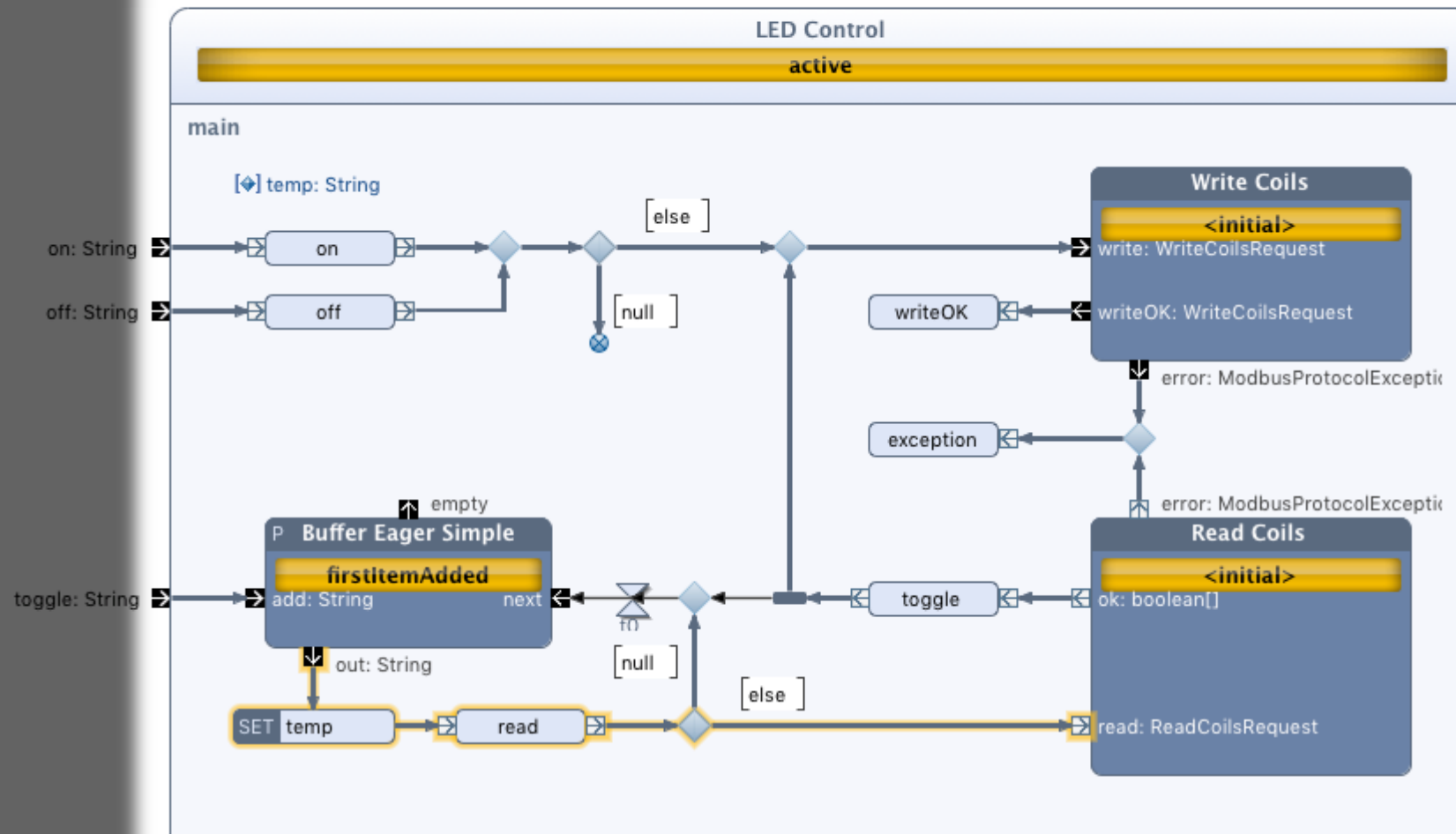
Reactive Blocks Application



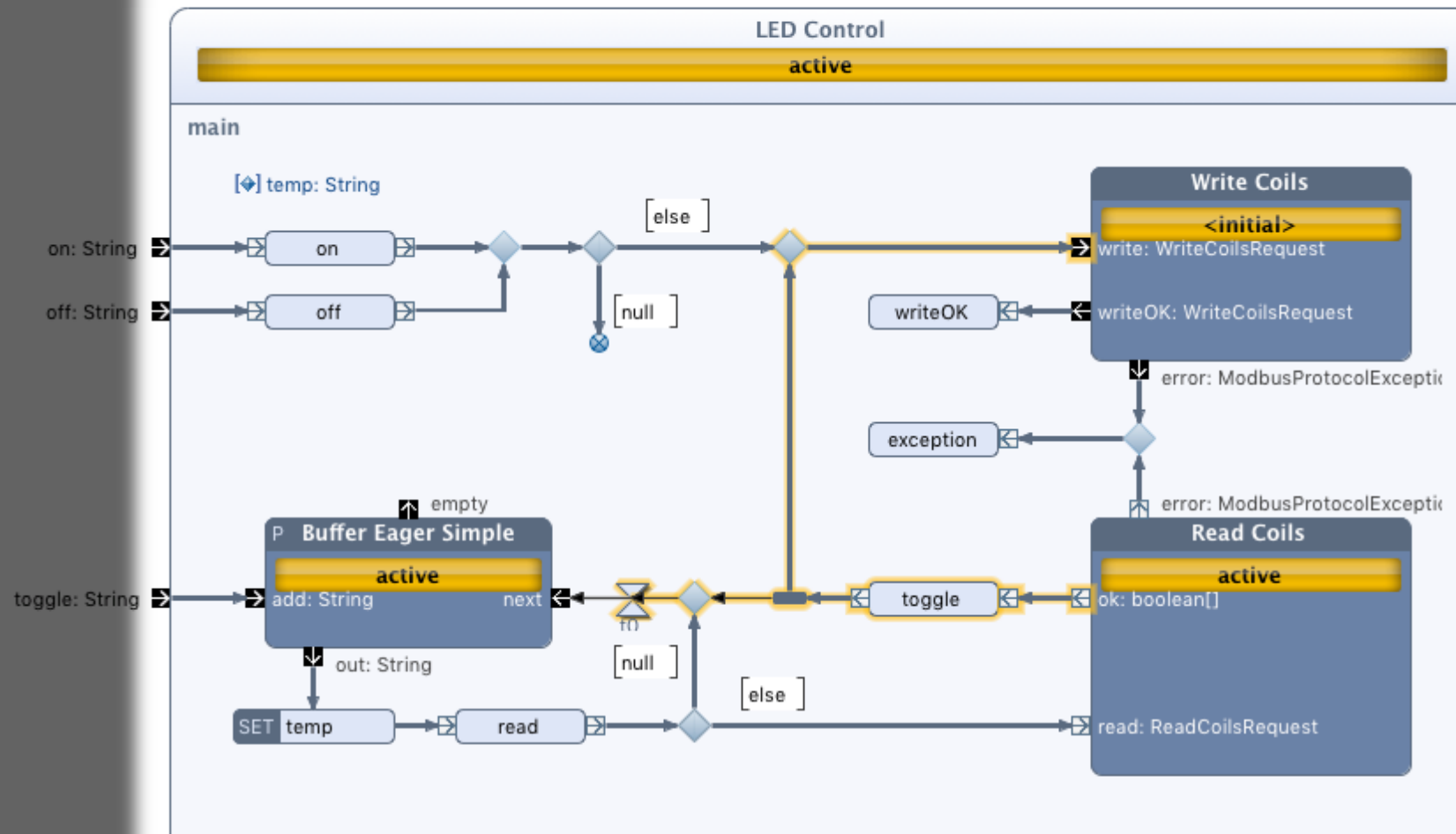
Reactive Blocks Application



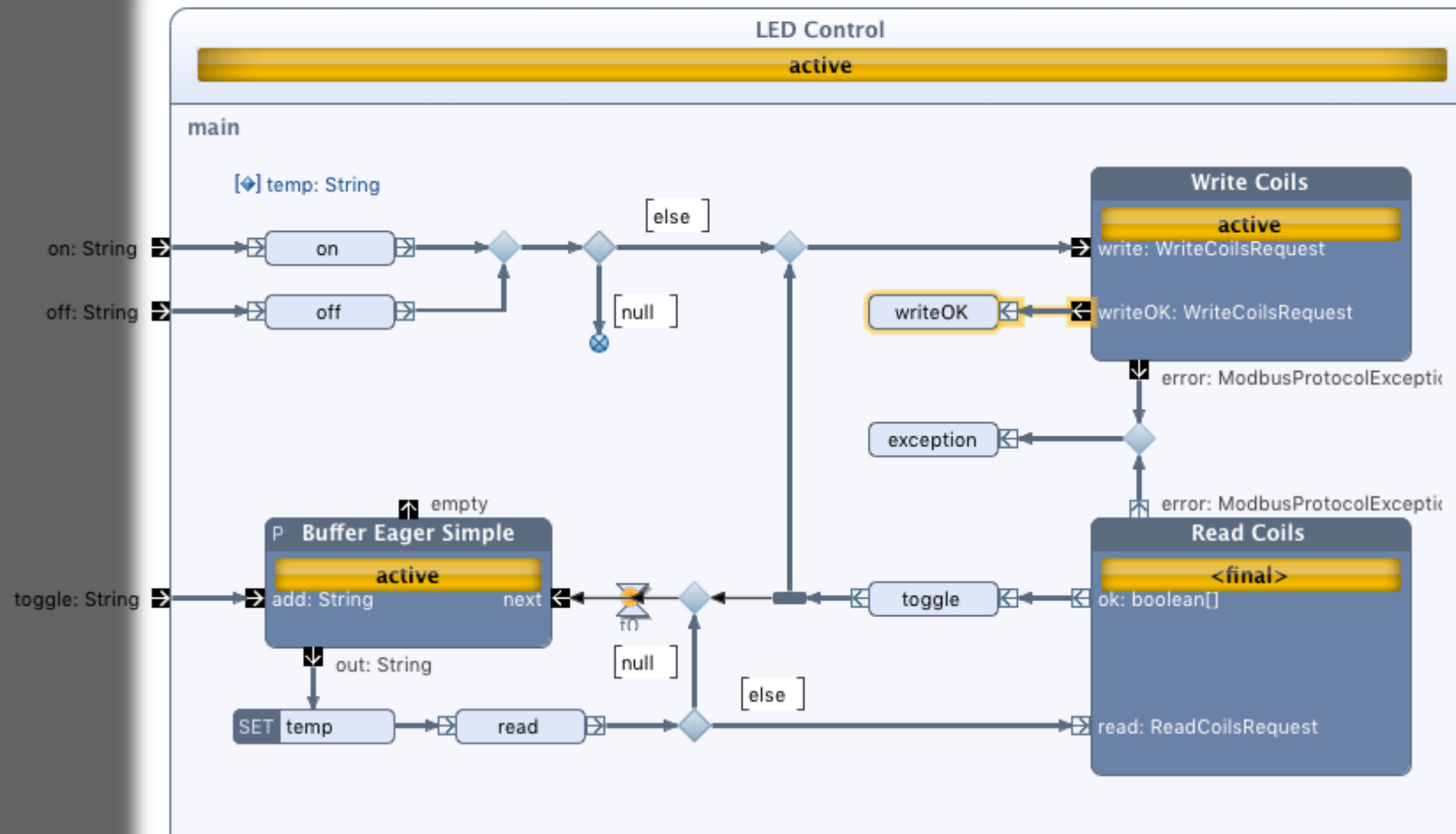
Reactive Blocks Application



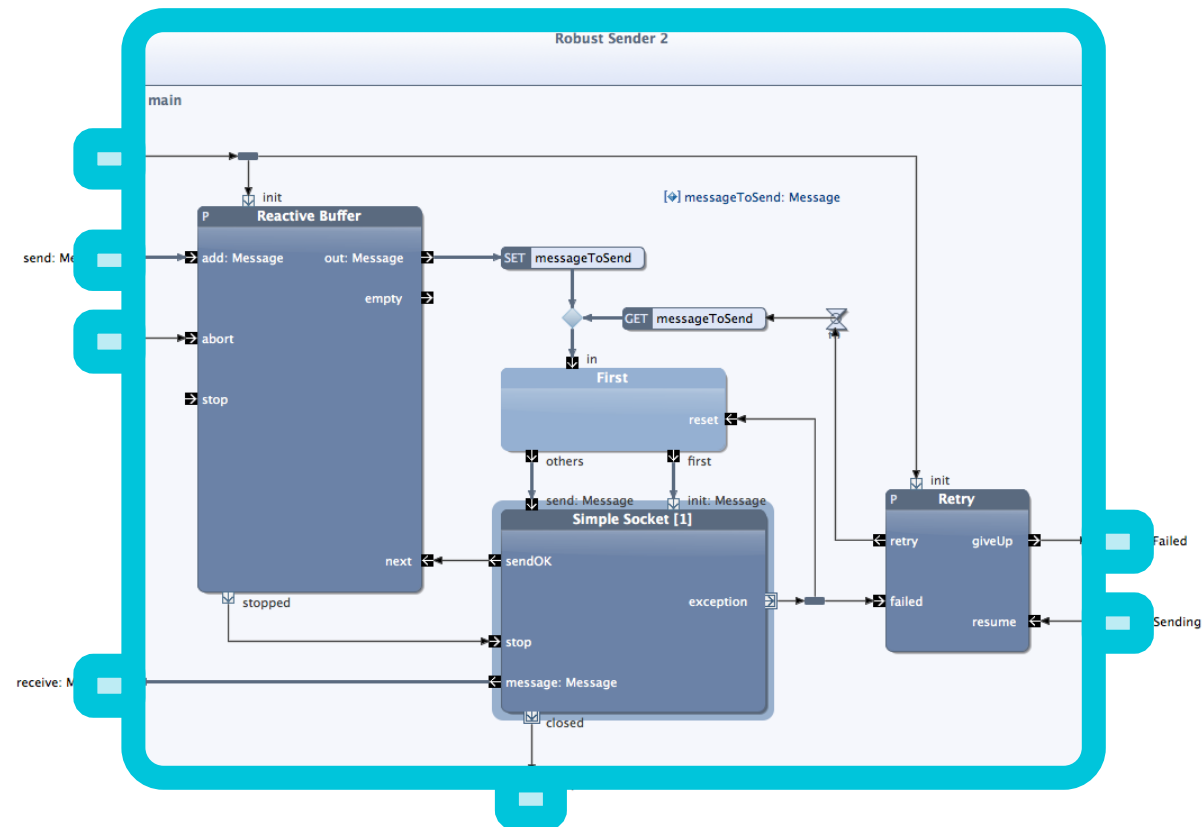
Reactive Blocks Application



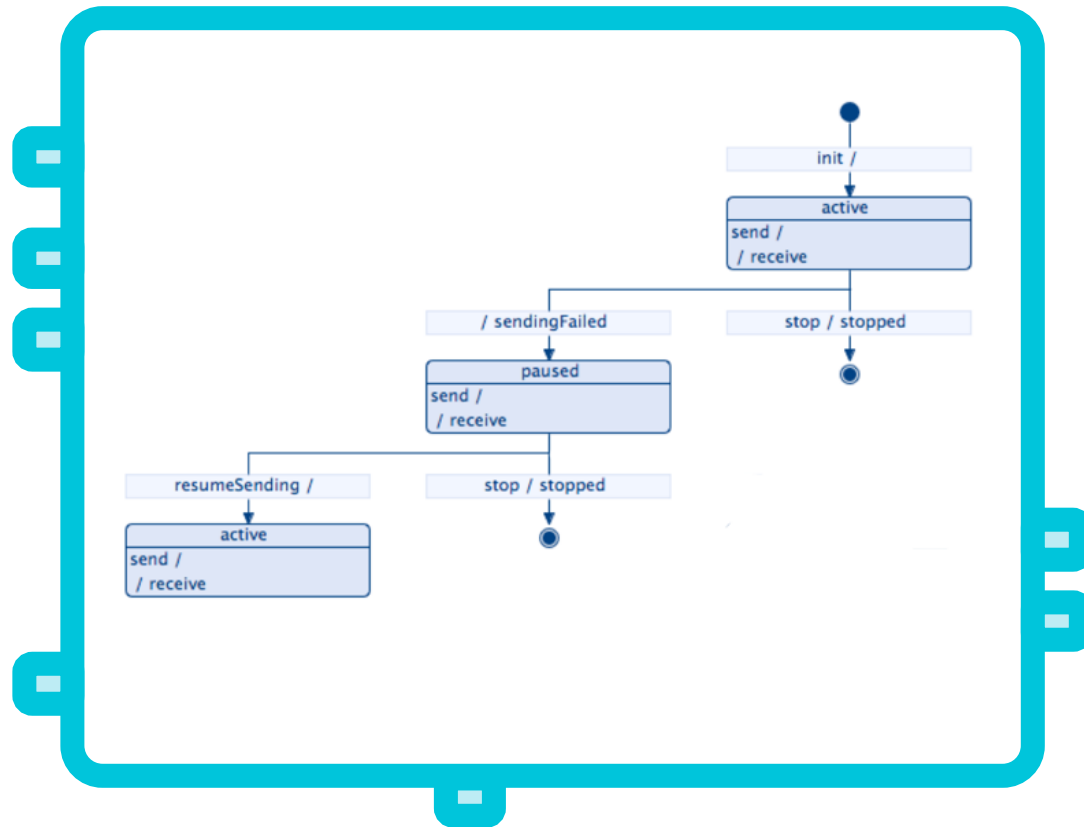
Reactive Blocks Application



Building Block Contracts

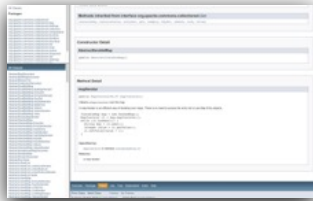


Building Block Contracts

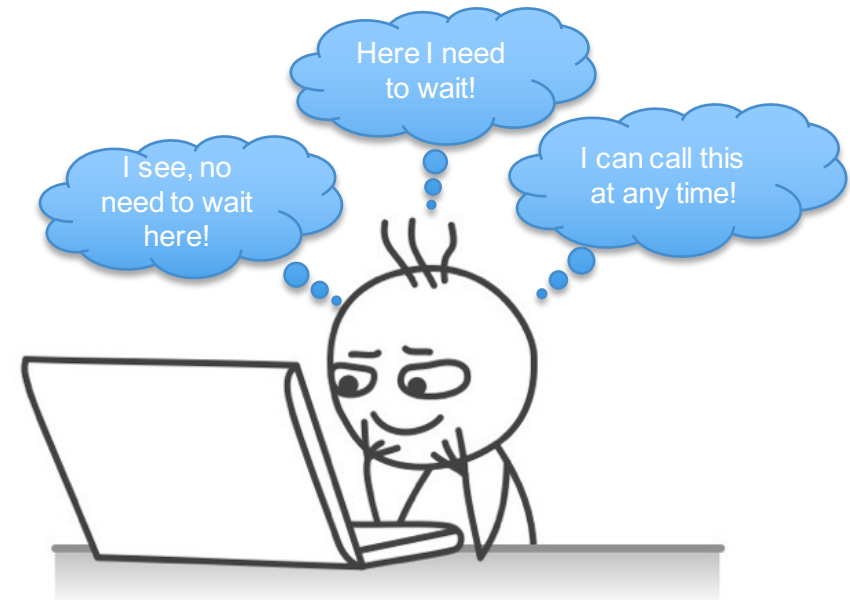
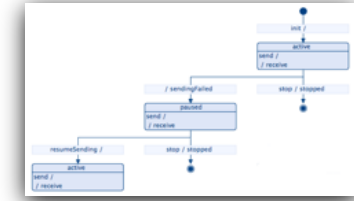


Building Block Contracts

Traditional API documentation only...

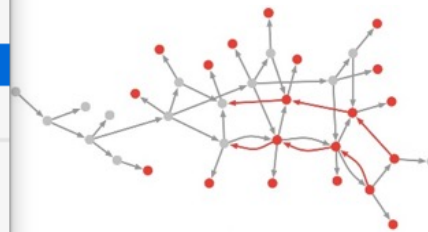
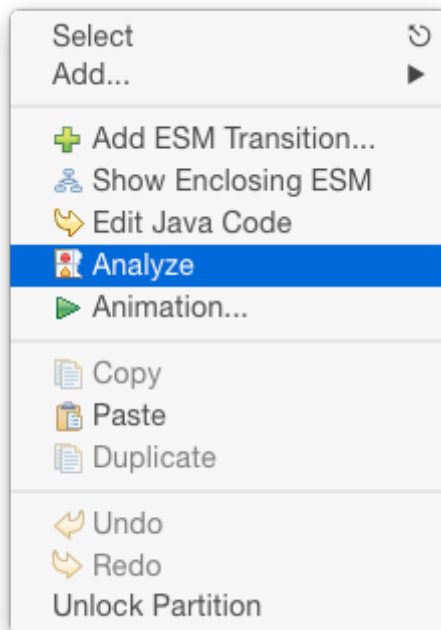


Traditional API documentation and block contract



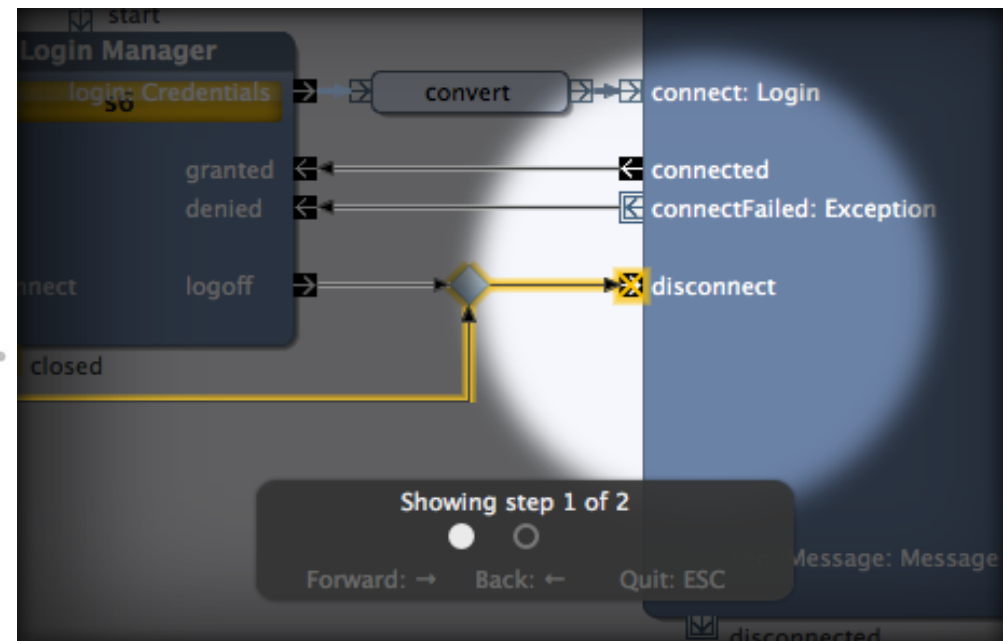
Automatic Analysis

Single action to start...



Calculation of all possible event traces. (Hidden)

...presentation of any results as animations.



Remote Management



- Modbus 1.3.0 (1) com.bitreactive.library.modbus
 - Modbus Simple
- KML 1.0.2 (2) com.bitreactive.library.kml
 - KML Parser
 - KMZ Parser
- GSON 1.2.0 (2) com.bitreactive.library.gson
 - Json Deserializer
 - Json Serializer
- OSGi 1.1.0 (2) com.bitreactive.library.osgi
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 - Geofence for Fleet



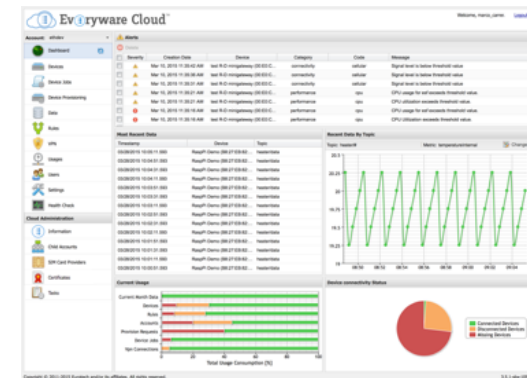
Develop

Manage

Gateway Application



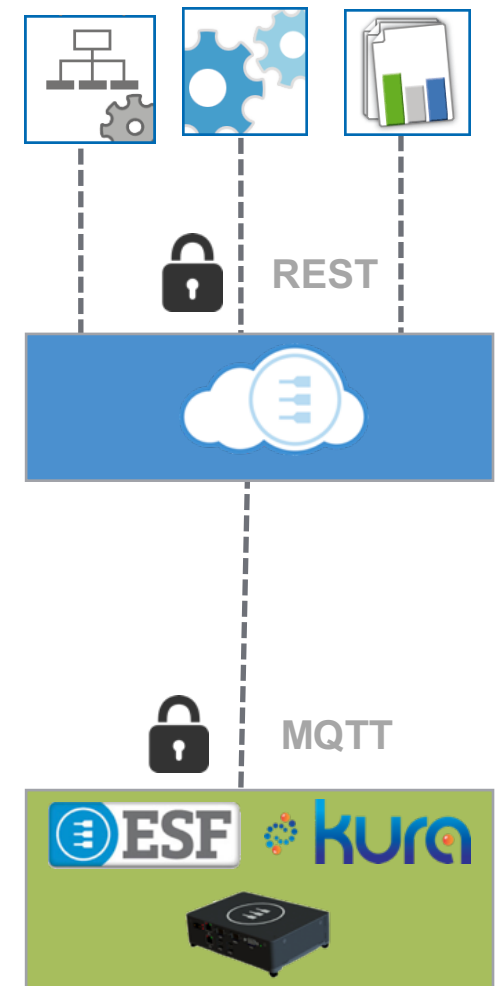
Everyware Cloud™



Everyware Cloud

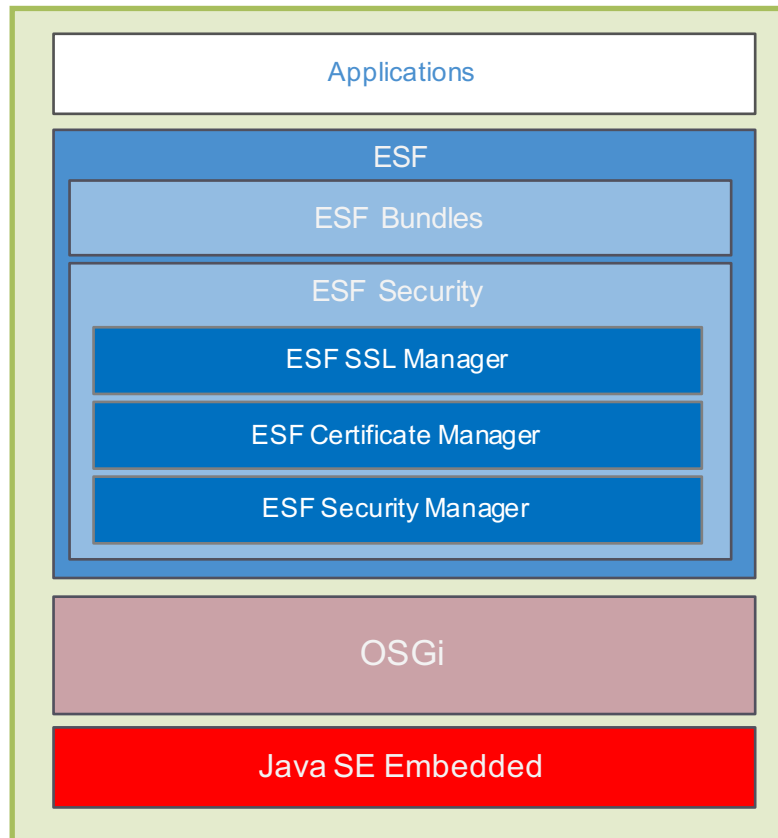
Remote Management of IoT Gateways

- **Secure Management the IoT Gateway Middleware**
 - Provisioning
 - Bundle Updates
 - Service Configuration
 - Remote Executions
 - Batch Updates
 - Based on OSGi; transparent to the developer
- **Management of the Device**
 - Full Remote Access
 - Monitor and Diagnostics
 - Firmware Updates
- **One Protocol for Telemetry and Device Management**
 - Single protocol
 - Single security
 - Simplified deployment
 - Simplified management



Remote Management

Edge Security



JKS ESF



JKS SSL

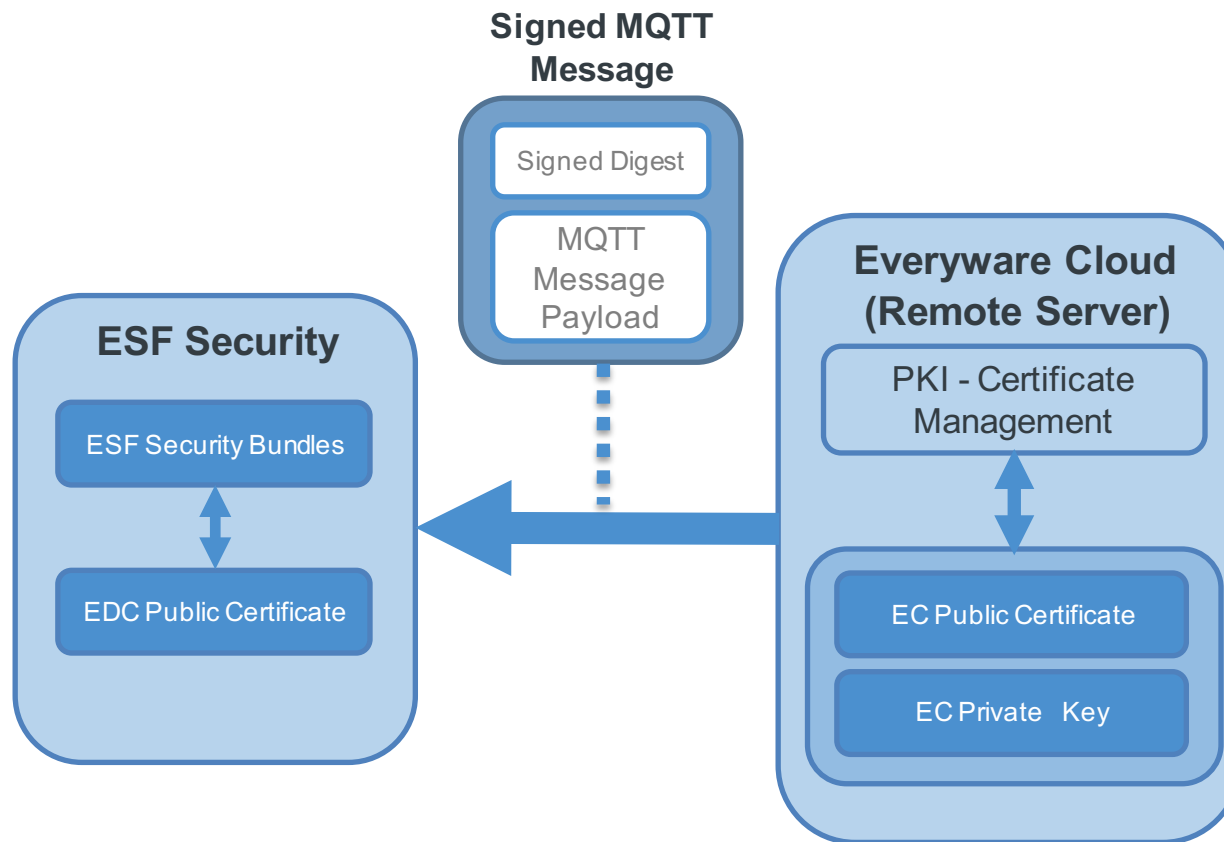


Encrypted
Configuration
Snapshots

- **Java/OSGi Security**
 - Signed Bundles
 - Integrity
 - Authenticity
- **Security Manager**
 - Environment Integrity
 - Runtime Access Policies
 - Allowed Jar / Bundle Signatures
 - Allowed Services Invocations
 - Encrypted Configuration Storage
 - Device Unique Master Password
- **Certificate Manager**
 - Remote Certificate Management
 - Management Platform Signature Validation
 - Integrity
 - Authenticity
- **SSL Manager**
 - SSL Socket Factory Configuration
 - SSL Hostname Validation
 - SSL Mutual Authentication

Remote Management

Secure and Signed Communication



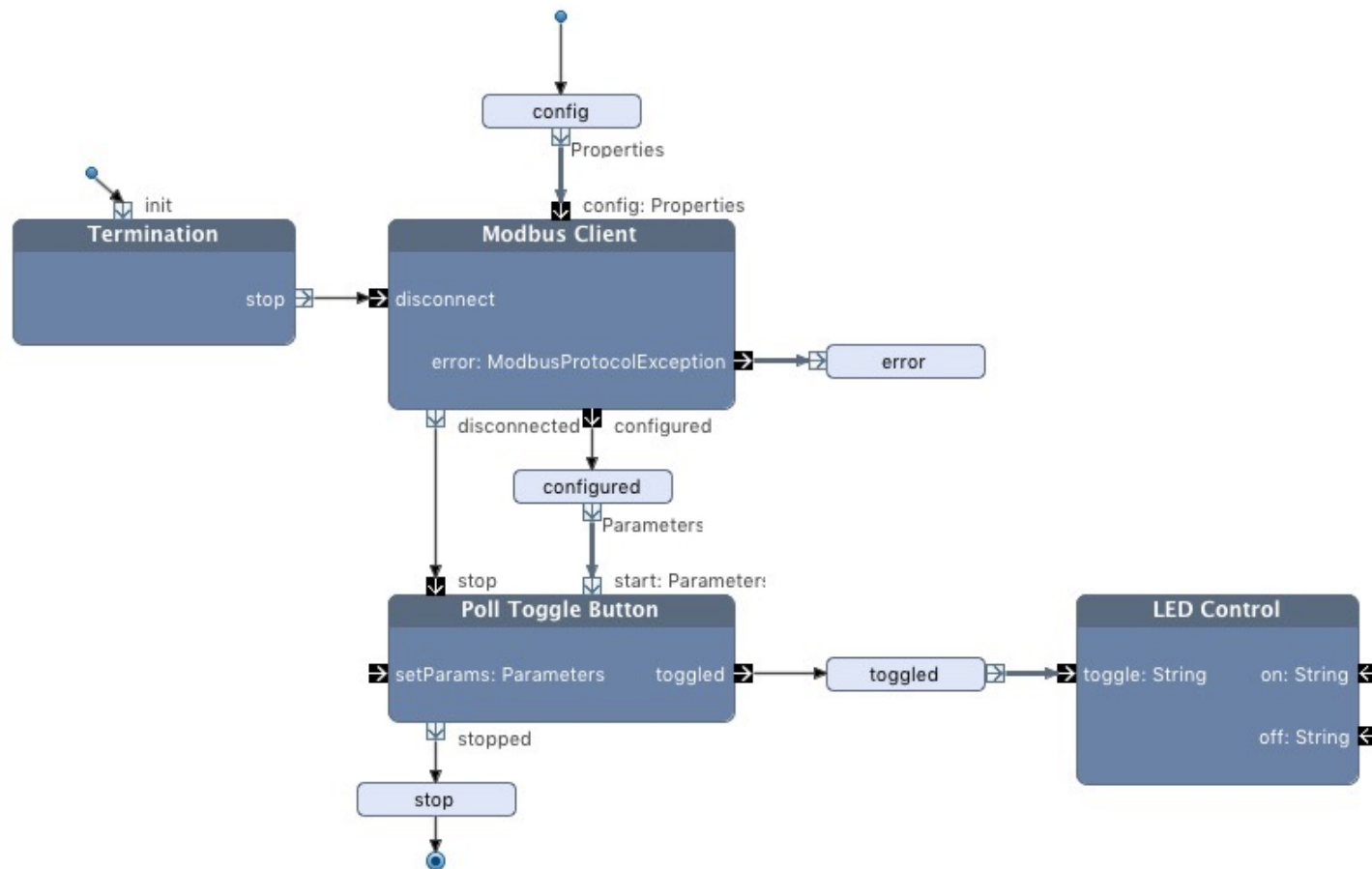
Guarantees

- Integrity
- Authenticity
- Non-repudiation of origin

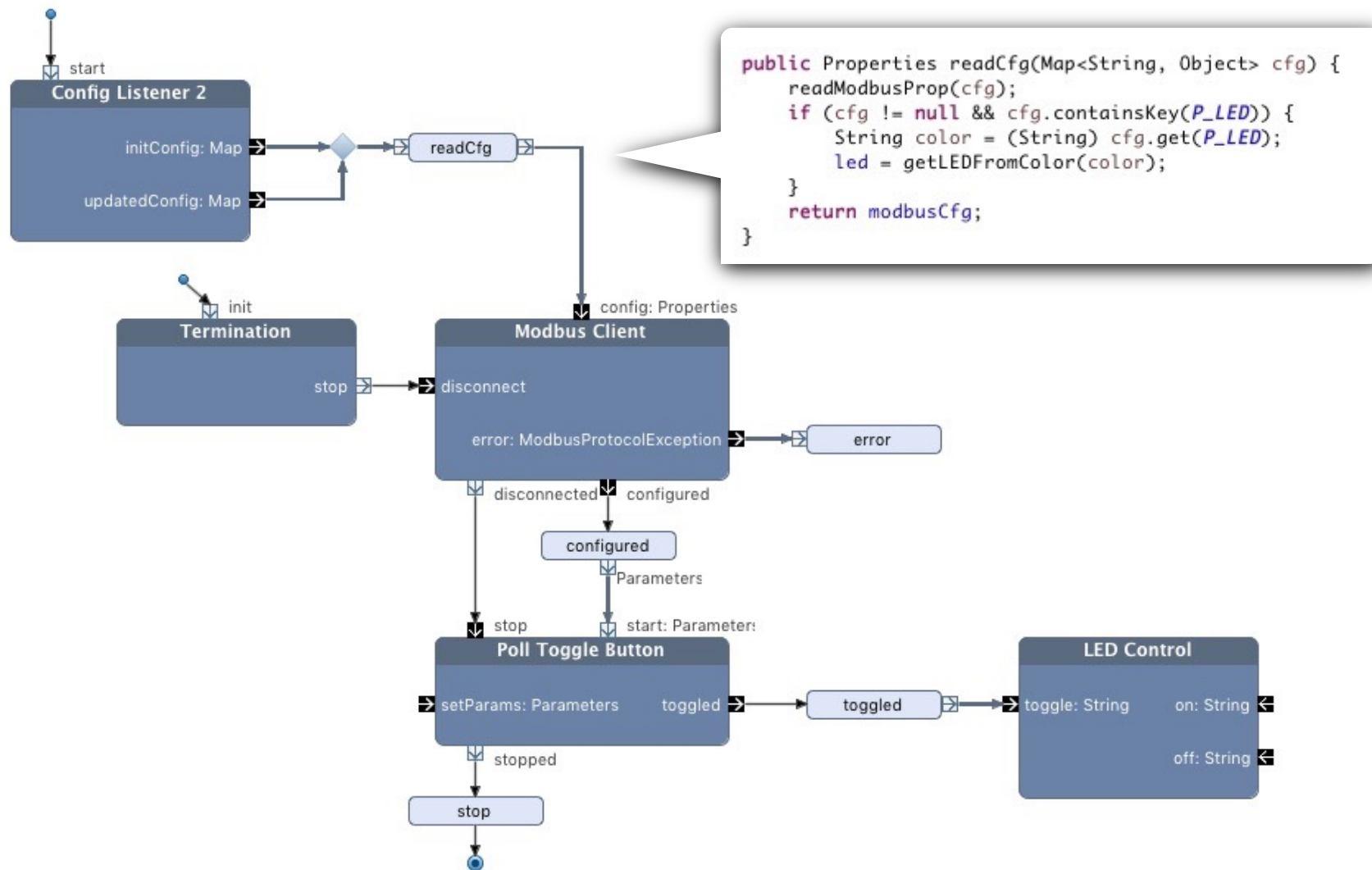
• Certificate Management

- Dedicated administrative web panel
- Standard X509 certificate format
- Certificate chain support
- Certificate validations and export functionalities
- Trusted message server signed digest over MQTT
- EDC jobs to provision, update and revoke certificates

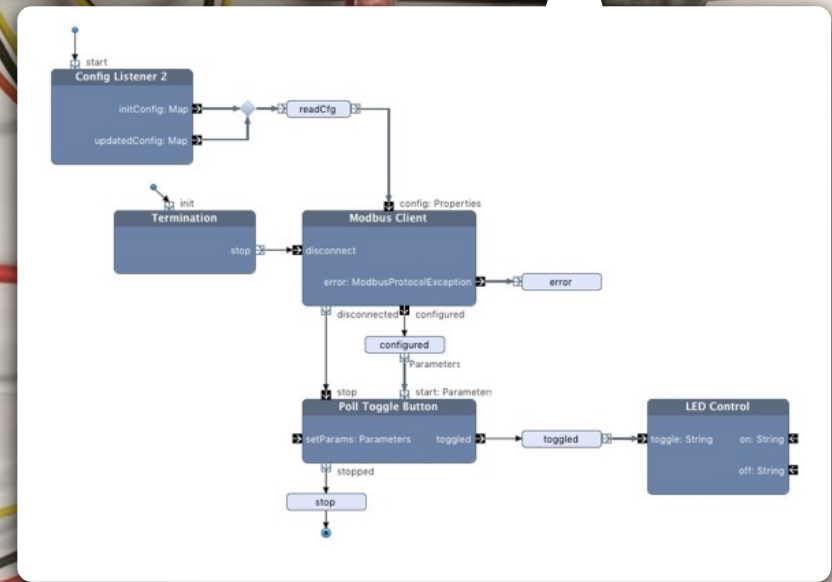
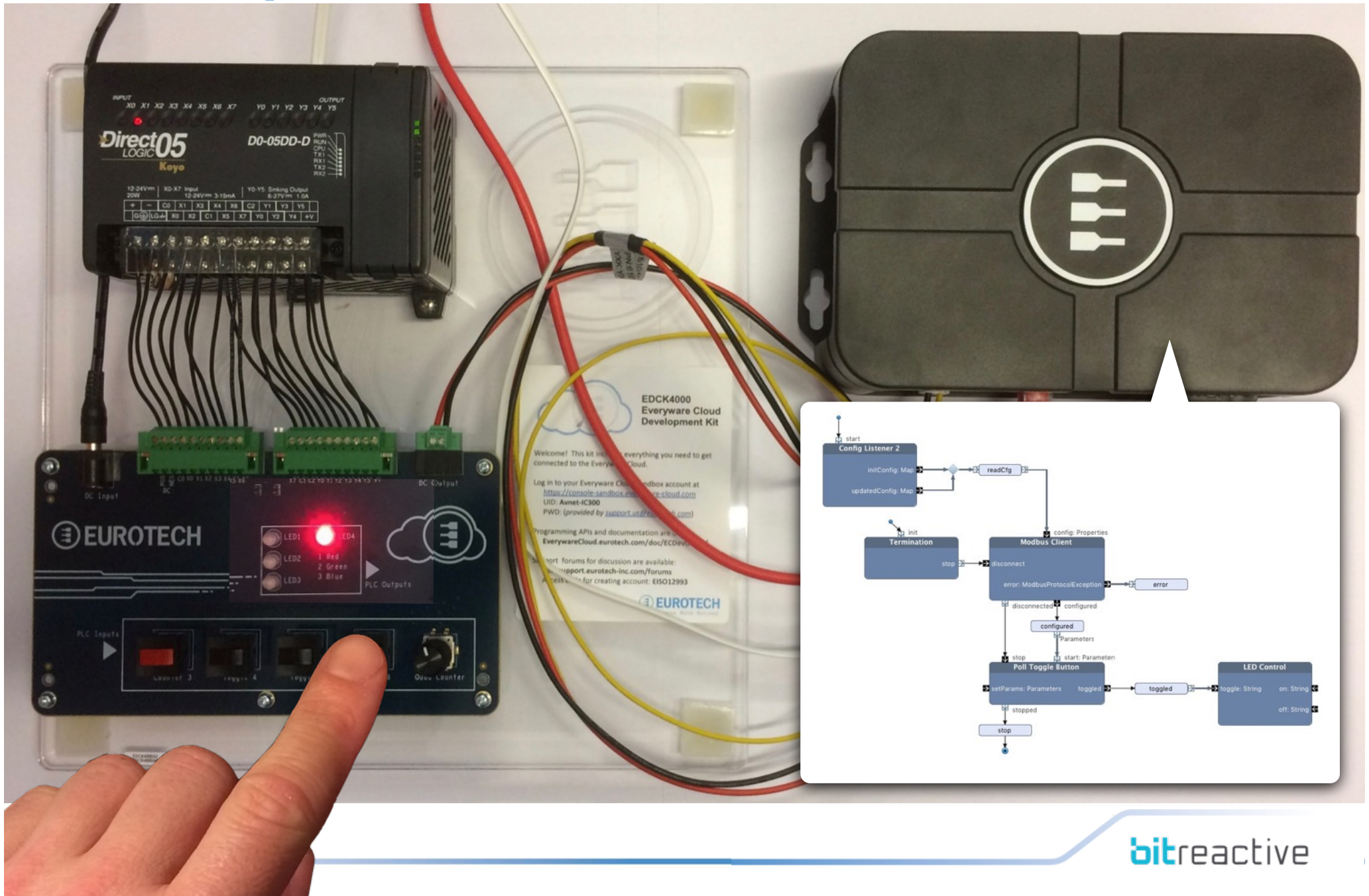
Autonomous Operation



Autonomous Operation



Developer Kit



Everyware Gateway

System



Status



Device



Network



Firewall



Packages



Settings

Services



BluetoothService



ClockService



CloudService



CommandService



Toggle LED 2



WebConsole



DataService

Toggle LED 2

Apply Reset

Listening for event toggle from button t6 and toggle LED number 4

* led:

Which color to display on LED number 4.

serialMode:

Serial Mode (RS232 or RS485)

* port:

Serial Port Name (such as /dev/ttyUSB0)

baudRate:

The baud rate of the serial connection.

bitsPerWord:

The number of bits per word or the 'data bits' for the serial connection.

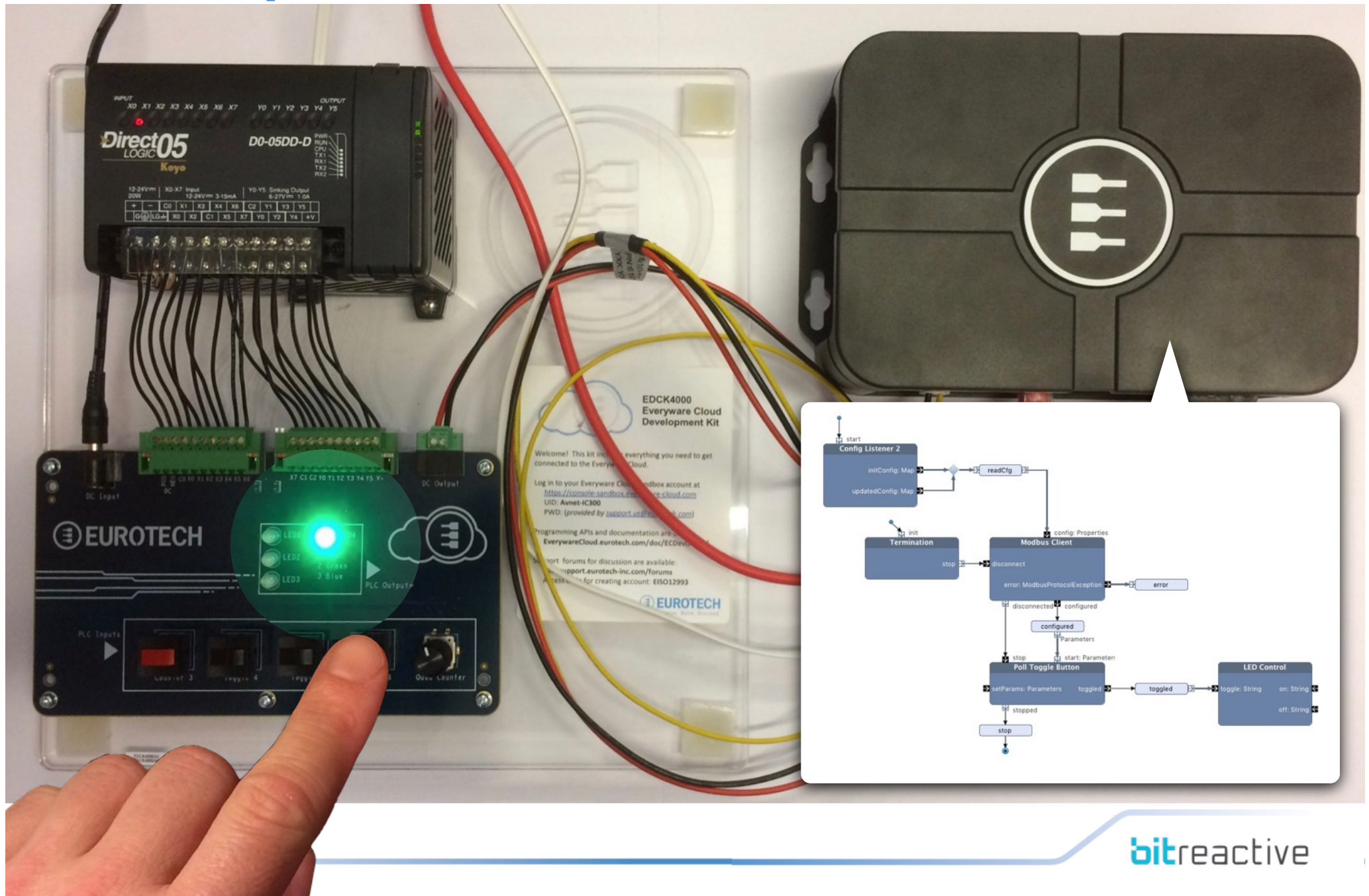
stopBits:

The stop bits for the serial connection.

parity:

The parity for the serial connection.

Developer Kit



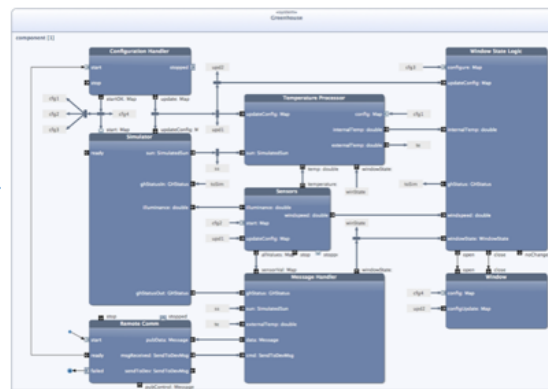
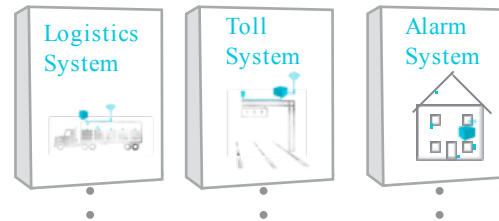
Summary

Eclipse Kura+Reactive Blocks

Libraries of building blocks

- ▼ **ModBus** 1.3.0 (1) com.bitreactive.library.modbus
 - ModBus Simple
- ▼ **KML** 1.0.2 (2) com.bitreactive.library.kml
 - KML Parser
 - KMZ Parser
- ▼ **GSON** 1.2.0 (2) com.bitreactive.library.gson
 - Json Deserializer
 - Json Serializer
- ▼ **OSGi** 1.1.0 (2) com.bitreactive.library.osgi
 - Simple Service Tracker
 - Termination
- ▼ **Buffering** 2.4.0 (14) com.bitreactive.library.buffering
 - Reactive Buffer
 - Timed Cache
- ▼ **Serial I/O (extSerial)** 1.1.3 (2) com.bitreactive.library.serial
 - Enumeration
 - Reader and Writer
- ▼ **Timers** 1.2.0 (13) com.bitreactive.library.timers
 - Measure Time
 - Timeout
 - Timer
 - Timer Periodic
 - Timer Random
- ▼ **MQTT** 1.3.0 (1) com.bitreactive.library.mqtt
 - MQTT
- ▼ **Session Utils** 1.5.1 (4) no.ntnu.item.arctis.library.sessions
 - Allocator
 - Allocator 2
 - Constructor
 - Constructor 2
- ▼ **Geofence** 1.1.0 (6) com.bitreactive.library.geofence
 - CircleToFence
 - Contained
 - Geofence
 - Geofence for Fleet

Ready-Made Reference Applications



 **Reactive Blocks**

code ready
to deploy



1 Pick existing blocks from the libraries

2 Build by combining blocks and Java code

3 Automatically generate code ready to deploy

Summary

Eclipse Kura+Reactive Blocks

Emulate on PC	Deploy on Target	Cloud Managed
		
Start developing your IoT /M2M application in the comfort of your PC. • Full Eclipse Integration • Target Platform Definition • Emulated Services • Run/Debug from Eclipse • Support Mac/Linux Hosts	When you are ready, deploy your application on the gateway. • One-click Deployment • Eclipse Plugin • Remote Debugging	Provision and manage your applications in field devices from the Cloud. • Remote OSGi Management via MQTT • Web-based Console

Where can I start from?

- Visit us at the @ JavaOne Booth #5616
- Eclipse Kura and Everyware Cloud
 - <https://eclipse.org/kura/>
 - <https://eclipse.org/kura/downloads.php>
 - <http://iot.eclipse.org/java/tutorial/>
 - <http://www.eurotech.com/en/portal/cloudtrial>
- Reactive Blocks for Kura/ESF and the DevKit
 - <http://bitreactive.com/eurotech>
 - Building Blocks, Tutorials, Examples
 - Contact us for Dev Kit





Thank You



www.eurotech.com

Account: ethdev

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[Rules](#)

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[Health Check](#)

Cloud Administration

[Information](#)

[Child Accounts](#)

[SIM Card Providers](#)

[Certificates](#)

[Tasks](#)

Alerts

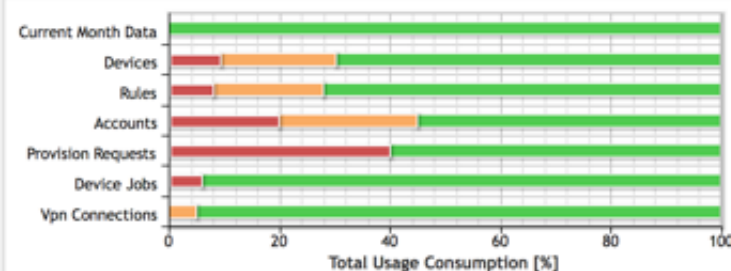
Delete

Severity	Creation Date	Device	Category	Code	Message
Warning	Mar 10, 2015 11:35:42 AM	test R-D minigateway (00:E0:C...	connectivity	cellular	Signal level is below threshold value
Warning	Mar 10, 2015 11:35:36 AM	test R-D minigateway (00:E0:C...	connectivity	cellular	Signal level is below threshold value
Warning	Mar 10, 2015 11:35:31 AM	test R-D minigateway (00:E0:C...	connectivity	cellular	Signal level is below threshold value
Warning	Mar 10, 2015 11:35:21 AM	test R-D minigateway (00:E0:C...	performance	cpu	CPU usage for esf exceeds threshold value.
Warning	Mar 10, 2015 11:35:21 AM	test R-D minigateway (00:E0:C...	performance	cpu	CPU utilization exceeds threshold value.
Error	Mar 10, 2015 11:35:16 AM	test R-D minigateway (00:E0:C...	performance	cpu	CPU usage for esf exceeds threshold value.
Error	Mar 10, 2015 11:35:16 AM	test R-D minigateway (00:E0:C...	performance	cpu	CPU Utilization exceeds threshold value.

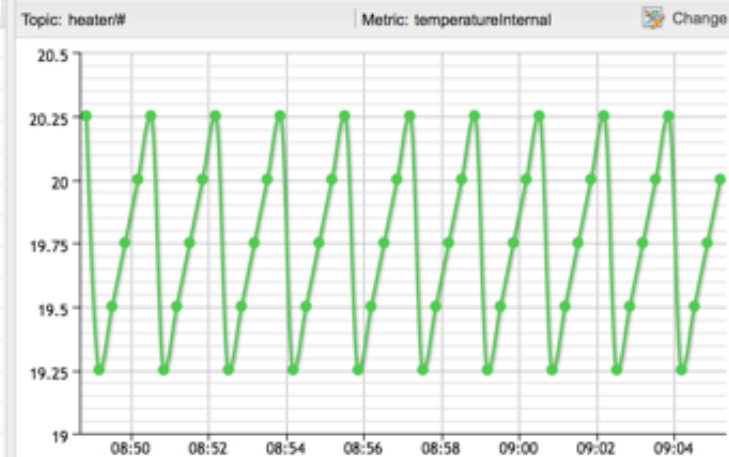
Most Recent Data

Timestamp	Device	Topic
03/28/2015 10:05:11.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:04:51.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:04:31.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:04:11.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:03:51.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:03:31.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:03:11.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:02:51.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:02:31.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:02:11.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:01:51.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:01:31.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:01:11.593	RaspPi Demo (B8:27:EB:82:...	heater/data
03/28/2015 10:00:51.593	RaspPi Demo (B8:27:EB:82:...	heater/data

Current Usage



Recent Data By Topic



Device connectivity Status

