REVOLUTIONIZING INDUSTRIAL IOT WITH APACHE PLC4X

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WHO AM I?

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- Apache PLC4X & Apache Edgent
- Member of the Apache Foundation
- Open-Source Enthusiast
- Son of an electroengineer
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AGENDA

- What we’re doing
- What the industrial automation is/has been doing
- Histories compared
- Why should we change this?
- How could we change this?
- Apache PLC4X (Incubating)
- PLC4X Architecture
- CODE!!!
WHAT WE’RE DOING

Cloud
Big Data
HTML5
Container
Apps
Fast Data
Microservices
IoT
Machine Learning
WHAT THE INDUSTRIAL AUTOMATION IS/HAS BEEN DOING

- Logic initially hard-wired
- Connection based controllers (1950s)
- Programmable logic controllers (PLCs) (1960s/1970s)
HARD-WIRED LOGIC CONTROLLERS

Figure 1. Courtesy of Signalhead via Wikimedia Commons
Figure 2. Courtesy of Siemens: SIMATICS-Controller for a turret lathe (Revolverdrehbank), 1959
PROGRAMMABLE LOGIC CONTROLLERS (PLCs)

Figure 3. Courtesy of https://www.automation.com PLC Pioneers, from left to right, Dick Morley, Tom Bossevain, George Schwenk,
and Jonas Landau
MODERN PLCS

Figure 4. Courtesy of https://www.automationdirect.com
Figure 5. 'Code' for my IoTree Application
Figure 6. Release Dates of major products in the areas: PLC, BigData and Cloud
BUILDING WALLS

- Automation industry have been doing their thing since ...
  forever
- Long cycle times in the production industry
- Automation industry didn’t have the time to react
- Customers have become used to consume only what their supplier offers
- First proprietary Cloud & BigData solutions by the large automation vendors
WHY SHOULD WE WANT CHANGE THIS?

Quelle: Deutschland in Zahlen 2016
WHY SHOULD WE WANT TO CHANGE THIS?

- Huge market
- Great part of it not served yet
- Need of market matches our haves
- Industry 4.0 is all about:
  - Cloud
  - Big Data
  - Machine Learning
  - ...

Huge market
Great part of it not served yet
Need of market matches our haves
Industry 4.0 is all about:
WHY SHOULD THEY WANT US TO CHANGE THIS?

- Drastic cost reduction
- Freedom of choice
- Small & mid-sized companies cut off from innovation
- On-Premise solutions don’t scale / Not extensible
- Security
- Automation industry cloud solutions not as mature as ours
  - Only few professionals available
HOW COULD WE CHANGE THIS?
WHAT’S WRONG WITH THAT?
WHAT’S WRONG WITH THAT?
PLC4X is a set of libraries for communicating with industrial programmable logic controllers (PLCs) using a variety of protocols but with a shared API.

— Apache PLC4X Project Statement
APACHE PLC4X (INCUBATING)

- Applications only use API module
- Integration modules available for multiple frameworks
- Currently plain Java, but Scala, C, C++, C#, JavaScript, ... planned
- Driver implementations implement the functionality
  - Native
    - Simulated where needed & where possible
- Ability to write software (almost) independent of the actual PLC used
PLC4X ARCHITECTURE
• Asynchronous example:

```java
try (PlcConnection plcConnection =
     new PlcDriverManager().getConnection("s7://10.10.64.20/1/1")) {

    Optional<PlcReader> reader = plcConnection.getReader();
    if (reader.isPresent()) {
        PlcReader plcReader = reader.get();

        Address inputs = plcConnection.parseAddress("INPUTS/0");

        CompletableFuture<TypeSafePlcReadResponse<Byte>> asyncResponse =
            plcReader.read(new TypeSafePlcReadRequest(Byte.class, inputs));

        asyncResponse.thenAccept(bytePlcReadResponse -> {
            Byte dataAsync = bytePlcReadResponse.getResponseItem() .orElseThrow(() -> new IllegalStateException("No response")) .getValues().get(0);
            System.out.println("Inputs: " + dataAsync);
        });
    }
}
```
Apache Edgent (Incubating)

- Programming model and Micro-Kernel Runtime
- Runs on very limited hardware
- Developed around the concept of streams
- Realtime analysis of data streams
- Connectors to many different data sources
• Data collection on Siemens S7 PLCs

```java
try (PlcConnectionAdapter plcAdapter =
     new PlcConnectionAdapter("s7://10.10.64.20/1/1")) {
    DirectProvider dp = new DirectProvider();
    Topology top = dp.newTopology();
    TStream<Byte> internalVariableStream = top.poll(
        PlcFunctions.byteSupplier(plcAdapter, "INPUT/0"),
        10, TimeUnit.MILLISECONDS);
    internalVariableStream.sink((Consumer<Byte>) inputs -> {
        System.out.println("Inputs: " + inputs);
    });
    dp.submit(top);
}
```
Data collection on Beckhoff PLCs

```java
try (PlcConnectionAdapter plcAdapter =
     new PlcConnectionAdapter("ads:tcp://10.10.64.10.1.1")) {

    DirectProvider dp = new DirectProvider();

    Topology top = dp.newTopology();

    TStream<Byte> internalVariableStream = top.poll(
        PlcFunctions.byteSupplier(plcAdapter, "Allgemein.Eingaenge"),
        10, TimeUnit.MILLISECONDS);

    internalVariableStream.sink((Consumer<Byte>) inputs -> {
        System.out.println("Inputs: " + inputs);
    });

    dp.submit(top);
}
```
Application based on PLC4X & Edgent

PLC: SPS S7-1200

Virtual Factory (Sorting of boxes)

Data storage in Elasticsearch

Dashboard with Kibana
WHAT’S TO COME (PLC4X)?

- Implementation of additional protocols:
  - Modbus, OPC-DA, OPC-UA, Ethernet/IP, ...
- Extending the features of some drivers
- Publish & Subscribe for Siemens
- Building the community
WHAT’S TO COME (EDGENT)?

- Implementation of additional connectors
  - AWS IoT Cloud
  - Google IoT Cloud
  - Azure IO
  - Siemens Mindsphere
  - MQTT5 (MQTT Bee Integration)
- Building the community
THANKS FOR LISTENING

• Questions?
• Suggestions?
• Want to join us??
• Want to try it out?