Agenda

“Connected Factory Exchange”

1. The CFX Demo
2. Overview Of CFX
3. Under The Hood Of CFX
4. CFX & Industry 4.0
Objectives:

• Introduce CFX to a wider industry group, in a unique and memorable way

• Show the differentiation and value behind a true IoT standard

• Help drive the momentum and critical mass of adoption

• Highlight industry thought leadership by participating companies
The CFX Visitor Experience At APEX

- Visitors scan QR code to access any CFx-enabled machines on the show floor (also through APEX App)
- Visitors scan vendor-specific QR code in each booth to access those machines directly
Technology Overview

- CFX messages are sent from vendor machines through IPC-provided Wi-Fi into the cloud.
- The cloud consists of an open-source AMQP broker, an analytics engine, database and web-server.
- Web pages stream data to the client handsets.
CFX Real-Time Monitoring Demo Headline Participants

CFX Live Data Generators:

- ASM Assembly Systems
- Creative Electron
- CyberOptics
- Europlacer
- FlexLink
- Fuji
- Hanwha
- Heller Industries
- JBC Tools
- KIC
- Koh Young
- Parmi
- Pillarhouse International
- Tri
- Universal Instruments
- Viscom
- Vitrox

CFX Manufacturers / Partners:

- Aegis Software
- BTU
- Cogiscan
- HUAWEI
- The Hermes Standard
- MTC
- SPEA
- YXLON
The Hermes Standard:
• SMEMA Replacement – simple, effective multi-vendor line management

IPC CFX Standard:
• IIoT Technology – comprehensive technology for smart production

The Hermes Standard & CFX Together:
• The CFX – Hermes Bridge – both technologies working together
  • Line to line build-record transfer
  • Hermes Trace (execution data) communication
What Is CFX?

Name:
• Task Group is: “Connected Factory Initiative”
• Standard is: “Connected Factory Exchange” (CFX)

Objectives:
• A consensus-based standard for “plug and play”, omni-directional, IoT data exchange
• Enable modern, smart, digital, computerized Industry 4.0 solutions
• Connect every process: Automated, semi automated & manual
• Eliminate waste & enable value creation throughout the industry
• Applicable to companies in all sizes and sectors
• Publish in 2018 (summer)
CFX Overview

Communication Protocol

Language

Content

Content is Encoded with

JSON
CFX Transport – AMQP v1.0

- Established transport
- Built-in security (financial transactions)
- “Send it & forget it” and direct point to point
- Open source brokers available
CFX Encoding In JSON

- Very light, modern encoding format
- Easy “upgrade” from XML
- Libraries available in all development platforms
<table>
<thead>
<tr>
<th>PCB Arrives</th>
<th>Stop / Start</th>
<th>Material Trace</th>
<th>Visual Check</th>
<th>PCB Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB Arrives</td>
<td>PCB Arrives</td>
<td>PCB Arrives</td>
<td>PCB Arrives</td>
<td>PCB Arrives</td>
</tr>
</tbody>
</table>

- **Product Tracking**
- **Asset Utilization**
- **Material Traceability**
- **Closed Loop**

**CFX Message Topics & Flow**

**Applications**

- **ERP**
- **Quality**
- **Industry 4.0**
IPC CFX Developer Toolkit

Simplifying & Speeding Up CFX Implementation:

• CFX ready-made open-source developer toolkit (SDK)
• Uses an open-source AMQP v1.0 transport engine
• No licensing agreement or usage fees, ever!
The CFX Demo - Under The Hood

IPC CFX SDK:

- A .NET 1.3 Library That Integrates Into Machine / Platform Software
  - Used within the Microsoft Visual Studio development environment
  - Available as a NuGet package
  - Supports full .NET Framework, .NET Core, .NET Micro Framework, UWP, etc.

- Provides:
  - Class / Object representations of all CFX messages
  - Serialize and de-serialize CFX message objects to / from JSON format
  - Publishes CFX messages to any destination
  - Receives CFX messages from multiple sources

- Fully Automated Network Connection Fault Management:
  - Maintains AMQP connections even when network is unreliable

- Message “spooling”:
  - Queues CFX messages that were delayed due to faulty network conditions
  - Messages are transmitted in their original order once network service resumes
The CFX Demo - Under The Hood

AMQP v1.0 Broker:

- Can be “anywhere”, in this case, a cloud-based AMQP v1.0 broker
- Demo uses an open source broker: RabbitMQ (Apache Qpid etc. also OK)
- Connects through IPC APEX Wi-Fi
- Each machine is identified by a unique CFX Handle, in the format:
  - “VENDOR.MACHINE.SERIAL”
- The broker routes messages, according to the CFX handle, to a database
The CFX Demo - Under The Hood

Coding Flow To Make Connection:
• Create an “Open” button
• Create a “click-handler method”
• Add code to initialize a new AMQP channel to the APEX cloud server

```
using CFX;
using CFX.Structures;
using CFX.ResourcePerformance;
using CFX.Transport;

... ...

AmqpCFXEndpoint theEndpoint;

private void btnOpen_Click(object sender, EventArgs e)
{
    if (theEndpoint != null) btnClose_Click(sender, e);

    theEndpoint = new AmqpCFXEndpoint();
    theEndpoint.Open("MyHandle-" + Guid.NewGuid().ToString());
    theEndpoint.AddPublishChannel(new Uri("amqp://cfx.aiscorp.com:5672"),
                                "/exchange/AegisCloud");
    btnSend.Enabled = true;
}
```

Initialize an AMQP CFX Publish Channel
The CFX Demo - Under The Hood

Coding Flow To Send A Message:
• Add a Send button to your form
• Create a click handler method
• Add code to send the message to the APEX cloud server

That’s it!
• You can download the full source code for this example on GitHub at: https://github.com/IPCConnectedFactoryExchange/CFX/tree/master/APEX%20CFX%20Demo%20App

```csharp
private void btnSend_Click(object sender, EventArgs e)
{
    CFXEnvelope msg = new CFXEnvelope(new StationStateChanged()
    {
        NewState = ResourceState.On,
        OldState = ResourceState.Off,
        OldStateDuration = TimeSpan.FromMinutes(43)
    });

    theEndpoint.Publish(env);
}
```

Construct a CFX Message and Publish
The Demo Uses Just Three CFX Messages

<table>
<thead>
<tr>
<th>Message Name</th>
<th>Description</th>
<th>Parameter Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFX.ResourcePerformance.StationStateChanged</td>
<td>Sent when the production state transitions</td>
<td>“Setup”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“ReadyProcessingExecuting”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Idle”</td>
</tr>
<tr>
<td>CFX.ResourcePerformance.FaultOccurred</td>
<td>Sent when a fault is encountered (fault duration timeout is made for the demo if FaultCleared not used)</td>
<td>“Hood Open”</td>
</tr>
<tr>
<td>(option CFX.ResourcePerformance.FaultCleared)</td>
<td></td>
<td>“Emergency Stop”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“BarcodeError”</td>
</tr>
<tr>
<td>CFX.Production.WorkCompleted</td>
<td>Sent to indicate work has been completed, or unit processed</td>
<td>“Success”</td>
</tr>
<tr>
<td>(or: CFX.Sensor.IndentifiersRead)</td>
<td></td>
<td>“Failure”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Aborted”</td>
</tr>
</tbody>
</table>
CFX In Your Pocket!

QR Code:
• Using just the CFX “home” QR code:

• See a summary of the demo across all machines
• For the first time, ever:
  • *All machines of all types from all vendors using a single language, protocol and data encoding method*
• Select your favorite vendor from the list in the top left corner
Selected Machine Display

Machine Vendor Screen:
- Summary over an hour and day
- Available live anywhere in the world
CFX Messages:

- Encoded in JSON
- Message Envelope with unique ID
- Every message precisely time-stamped
- Defined source (and target)
- Standard defines message content in topics:
  - Production events (affecting product)
  - Resources performance (affecting process)
  - Sensor events (including ID scanning)
  - Material events (logistics, consumption)
  - MES events (work-order, operators etc.)
## Anticipated CFX Adoption Roadmap

<table>
<thead>
<tr>
<th>Who?</th>
<th>Future Products</th>
<th>Current Products</th>
<th>Supported Products</th>
<th>Legacy Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFX Team Machine Vendors</td>
<td>Yes</td>
<td>2018 ~</td>
<td>Market Demand</td>
<td>Vendor converter</td>
</tr>
<tr>
<td>Other Machine Vendors</td>
<td>Expected</td>
<td>Very likely</td>
<td>Market Demand</td>
<td>Converter</td>
</tr>
<tr>
<td>CFX Solution Providers</td>
<td>Yes</td>
<td>2018 ~</td>
<td>Unlikely</td>
<td>No</td>
</tr>
<tr>
<td>Other Solution Providers</td>
<td>Market Demand</td>
<td>Market Demand</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>In-House IT</td>
<td>Yes</td>
<td>Depends Architecture</td>
<td>Unlikely</td>
<td>No</td>
</tr>
</tbody>
</table>

Almost 150 Companies Working Together Today!
CFX Differentiators

For The Entire Factory:
- Same Physical Connections:
  - Plug & Play connection
  - Reduced implementation cost and time
- Same Data Content Definition:
  - Consistency and accuracy
  - Greater value of data
- No Dependencies:
  - On any 3rd party software, middleware, hardware or licensing
- Easier To Use:
  - In-house adaptations / enhancements (processes and IT solutions)
Values of Industry 4.0 With CFX

For Manufacturers:
• Flexible manufacturing without loss of performance
• Increasing local business opportunity
• Single interface connection to enterprise systems

For Machine Vendors:
• Optimization & value creation opportunity
• Reduce the number of “MES Interfaces” to one

For IT Teams & Solution Suppliers:
• Integrated computerized decision-making solutions
• Focus on added value software development
CFX Going Forward

- Powering Industry 4.0 for all companies
- A cornerstone of the new IPC Trusted Digital Manufacturing Platform
- Working with IPC-2581 digital product model
- Provider of the highest level of IPC-1782 traceability data
Wisdom Wednesday

APEX Demo