Equipment Automation Framework (EAF)
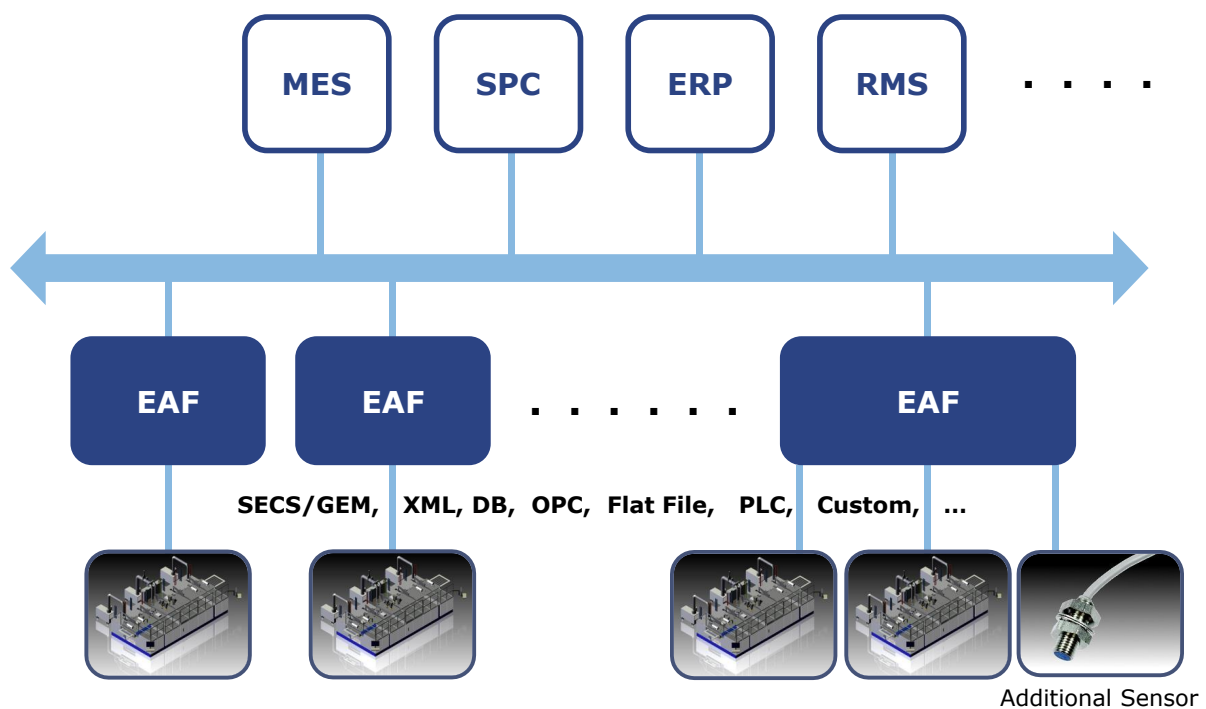
Introduction

PEER Group's Equipment Automation Framework (EAF) is an easy to customize, highly maintainable, industry-proven equipment automation framework that factories use to connect and integrate any type of industrial equipment.

By closing the digital gap and providing seamless communication between all equipment, IIOT devices, sensors, factory systems, and people, EAF helps transition your factory into a lean manufacturing environment that supports smart production. It is the first step to achieving the efficiency, productivity and performance benefits envisioned by Industry 4.0 initiatives.

EAF also acts as abstraction layer and provides factory-wide unified automation interfaces and operational scenarios.

MES   SPC   ERP   RMS   . . . . .

EAF   EAF   . . . . . .   EAF

SECS/GEM,   XML, DB,   OPC,   Flat File,   PLC,   Custom,   ...

Additional Sensor

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Success Story

Infineon Technologies did a thorough analysis and review of the EAF product and decided to build its Baseline Station Controller using the EAF technology.

EAF is now the target platform for Infineon's Equipment Automation in all 200mm, 300mm, back-end and wafer test manufacturing facilities around the world. Even though the global harmonization and migration from several legacy platforms to EAF is still ongoing, there are already almost 8000 instances running at 13 production sites (as of August 2019) and proving it's benefits every single day.

Different Levels of Automation

PEER Group's **Equipment Automation Framework** will support

- Manual Operation
    - Driven by Operator Interactions (GUI, Reader, …)
    - Fab-specific operational scenarios

- Partial Integration
    - Interface to the Equipment, but
    - Manual Interactions by the Operator necessary (Inputs and Decisions)

- Complete Integration
    - Fully automated operation
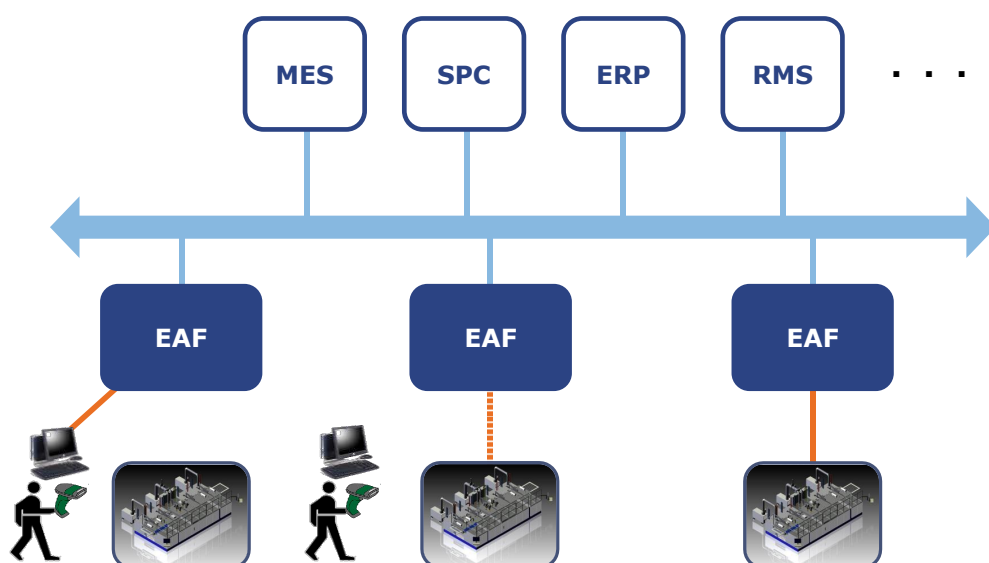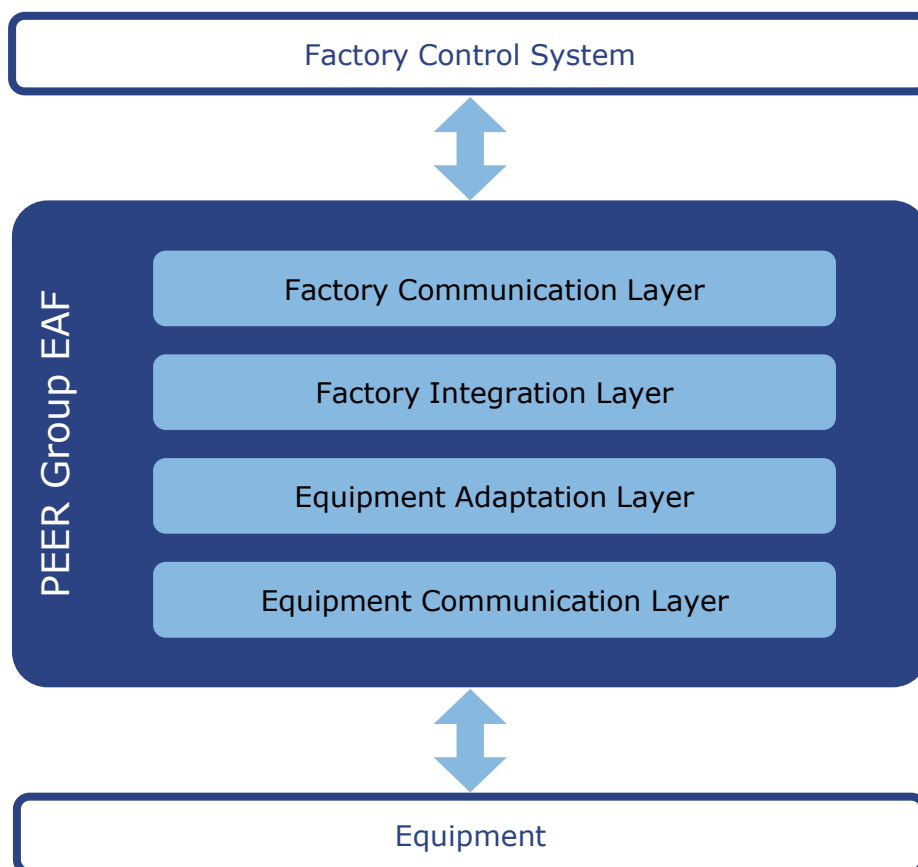
EAF Product Benefits

- Cost-efficient
    - Significant faster integration of first-of-a-kind equipment compared to typical commercial solutions
    - "Use instead of develop" concept based on pre-implemented standard behavior (objects, scenarios)
    - Maximum reuse of standard functionality across all tools and sites

- Intuitive
    - Easy to use out-of-the-box functionality

- Configurable
    - Use the EAF UI and pre-defined standard scenarios and adapters to build your individual connectivity solution
    - Data Collection support for end-user through single unified Industry-standard channel (separated Data Requestor/Distributor via EDA even for non-EDA equipment)

- Customizable
    - All out-of-the-box building blocks provide customizable entry points to allow adaptation as needed

- Inexpensive operation
    - The EAF Management server and operations UI provide all required infrastructure to conveniently configure, deploy, operate, manage and monitor thousands of EAF Runtime Instances from any location

- High quality
    - Strong change and dependency management enabled by strict versioning of deployed configuration and components
    - Tracking UI interactions via audit trail significantly reduces human error

- High availability and uptime
    - Support for life lossless EAF instance moves between servers without downtime

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Multitier Architecture

The multitier approach as shown in the picture below ensures a maximum of reusability of all components without limiting flexibility.

All EAF layers are highly configurable to meet most of the common requirements but even very special requirements can be satisfied by writing custom code.

```
                    Factory Control System
                            ↕
   PEER Group EAF
                    Factory Communication Layer

                    Factory Integration Layer

                    Equipment Adaptation Layer

                    Equipment Communication Layer
                            ↕
                        Equipment
```

The EAF layers are explained on the following page, listed in bottom-up order.

Multitier Architecture

Equipment Communication Layer

- Implements the transport protocol.

- Translates the data traffic to a generic approach for (incoming) events and from generic to specific for (outgoing) commands.

- The configuration includes the selection of a protocol and the definition of data items access, their meaning and validity context.

- Reusable across all equipment using the same protocol.

- Configuration of data items is reusable for all sites and lines of a company using the same type and version of equipment.

- It is possible to run several equipment connections within a single instance of EAF, all independent from each other

Equipment Adaptation Layer

- Implements the equipment behavior and adapts it to an abstract equipment model.

- Reduces the range of different behavior into just a few ones like Fixed Buffer, Internal Buffer and Cluster Tools.

- It is possible to have multiple independent equipment as well as implementing common relations like the integration of external RFID reader.

- Equipment Adaptations are reusable for all fabs of a company using the same type of equipment.

Factory Integration Layer

- Implements the operational scenarios of a given fab. This includes the control of adapted equipment as well as the FCS component specific data collection, processing and analysis.

- Reusability is given within a fab for equipment with same abstract behavior, which reduces the count of different integrations to a small number.

- Bundling all Fab specifics inside this layer provides a very powerful approach for migrating FCS solutions.
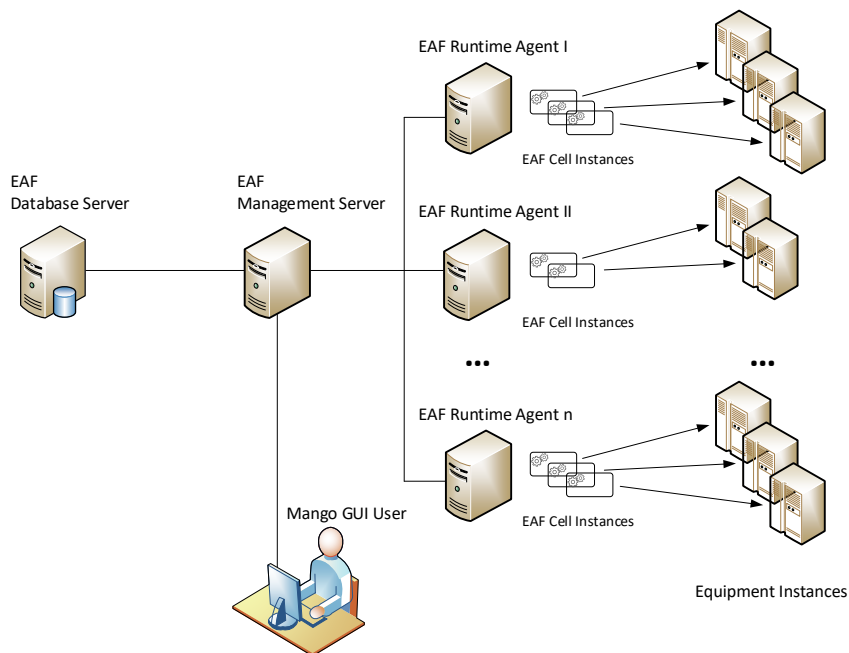
Factory Communication Layer

- Responsible for exchanging messages with different FCS components.

- Custom protocols are supported.

- Those custom protocols are reusable for all integration in all fabs of a company using the same FCS component.

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Central Configuration, Deployment & Operations

EAF is highly configurable and extensible. Managing all the various configurations and extensions is challenging. EAF comes with a centralized repository (Management Server) for all configuration and versioning tasks.

The Mango GUI (EAF Management Console) allows easy administration and operation even for a large number of equipment. EAF instances may run on any number of service hosts that can be real or virtual machines. The schema below shows the main components of an EAF environment.

EAF Runtime Agent I

EAF Cell Instances

EAF Runtime Agent II

EAF Cell Instances

EAF Runtime Agent n

EAF Cell Instances

EAF Database Server

EAF Management Server

Mango GUI User

Equipment Instances

Configuration

All component configurations are versioned, i.e., EAF keeps not only the active configuration but also previous ones. It is always possible to roll back to proven configuration in case the roll-out of a new configuration was not successful.

Configurations may be exported and/or imported and modified by either external editing or in the GUI itself. Before any configuration can be used, it has to be released to production.

Deployment

Deployment includes not only choosing the right configuration but also choosing the right binaries. EAF provides a versioned storage for binaries, so called deployment packages. These are copied to the hosting computer before the equipment integration instance starts.

Deployment packages are created externally and are imported to the EAF repository.

Even deployment packages have to be released to production before they are available for use.

Operations

One of the biggest challenges especially for large Fabs is operating the equipment integration instances. This does not only include starting, stopping, and moving instances but also monitoring status and discovering issues as soon as possible.

After starting an instance, it can run independently of the Management Server.

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Hardware Requirements

In order to support flexible deployment architectures and to allow for efficient hardware usage, all EAF components can be virtualized. Gigabit Ethernet or faster is recommended. For the various EAF components following specific minimum hardware requirements apply:

EAF Service Hosts

- 1.5 GHz Processor or faster per single running instance
- 0.5 GB RAM or more per single running instance
- At least 50 MB free hard drive disk space for the installation files
- At least 15 GB additional free hard drive disk space for writing log files at runtime are recommended

Database Server

- 1.5 GHz Processor or faster
- 4 GB RAM or more
- At least 50 MB free hard drive disk space for the installation files
- Hard drive disk space for database tables depends on size of system

Management Server

- 1.5 GHz Processor or faster per single running instance
- 4 GB RAM or more per single running instance
- At least 50 MB free hard drive disk space for the installation files
- At least 15 GB additional free hard drive disk space for writing log files at runtime are recommended

Mango GUI

- 1.5 GHz Processor or faster
- 1 GB RAM or more
- At least 50 MB free hard drive disk space
- Screen resolution of 1024 x 768 or more

Software Requirements

EAF software can run on following operation systems
- Microsoft Windows Server 2008 R2, 2012 or 2016 (x86 or x64)
- Microsoft Windows 7 Professional Service Pack 1 (x86 or x64) or higher

and requires
- Microsoft .NET Framework 4.6.1

For the EAF Database Server, following database versions are supported
- Microsoft SQL Server 2005 – 2016
- Oracle9i Release 2 – Oracle 12c

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About PEER Group

PEER Group provides innovative factory automation software solutions and consulting services to the semiconductor, photovoltaic, and electronics industries. The world's best manufacturing companies turn to PEER Group to solve their most challenging equipment automation, data management, and process control problems.

With more than 100,000 licenses shipped, we are the leading supplier of equipment connectivity and testing products to automated factories around the globe. Our products and services help lower the cost of automation for high-volume manufacturers and their equipment suppliers. Learn more about PEER Group at www.peergroup.com.

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