Boost 4.0: The Lighthouse Initiative towards a European Industrial Data Space (EIDS)
Industry 4.0 Big Data Transformation
Project No: 780732

Duration: 36 months

Start date: January 1st 2018

Partnership: 50 partners, 16 countries

Strategic Objective: ICT-15-2016-2017 (Big Data Lighthouse)

Total Eligible Cost: 18,925,990.00 €

EC Contribution: 14,983,566.26 €

Project Web Site: www.boost40.eu
Factory 4.0: Where are we heading?
By 2020, 40% of All Digital Transformation Initiatives, and 100% of All Effective IoT Efforts, Will Be Supported by Cognitive/AI Capabilities
Industry 4.0 Business Value

New business models

- Speed
- Flexibility
- Quality
- Efficiency

Security
Software-Defined Autonomous Factory 4.0 Vision

Vision

Fast product-process planning or proactive production control is realized through

• **Modular automation and control software services** that can be trusty deployed, reliably run and flexibly orchestrated at will anywhere, anytime and on any platform.

• **Data shared** across digital manufacturing platforms and factories with full usage control meeting production demands and

• **Factory reconfiguration, flexible human-robot collaboration** and easy task programming.
Boost 4.0: Big Data Lighthouse with an Impact
The Industry 4.0 digital platform stars are.....
The advantage of being digital, is that we can always play not to be, however being the opposite is completely impossible ………….. the manufacturing process and the business value

Source of picture: audi-mediaservices.com
Factories 4.0 – Industrial manufacturing processes

Plug & Produce
Modular Assembly Cells
Flexible operations
Mass customisation

Autonomous
Transportation & Logistics
Components move
Machines move
Products move
Factories 4.0 – Industrial manufacturing processes

**Safe human-robot collaboration**

Human-robots-machines come together as needed for mission-oriented tasks

**Digital twin – Real factory synchronised operations**

Real-time digital and physical actuation

**Continuous Production Planning Adaptation for Zero Defect Manufacturing**

**Human in the loop - Augmented Virtual Decision Support**
Collaborative Cognitive Manufacturing Processes

- OEE + Productivity
- OEE + Productivity
- OEE + Productivity

- Event Data
- Event Data
- Event Data

- Maintenance Service Provider
- + USP + Profitability + Customer Retention

- PLM Data

- Machine OEM
- + Customer Retention + Usage-based Business Models

www.industrialdataspaces.org
Icon sources: ingieder.de (2018); Legend: PLM - Product Lifecycle Management; OEE - Overall Equipment Effectiveness; USP - Unique Selling Proposition.
Strategy for high value & impact generation

High added value products

Lighthouse manufacturing processes

High performance big data algorithms & platforms
High Added Value Products

- (Electric) Connected Car
- Smart Washing Machine
- Smart Connected Shaver
- Machine Tool & Automation
Lighthouse Manufacturing Processes

- **Light metal Casting**
- Augmented Manual Assembly
- **ZDM (Hot) Stamping & Hydro-forming**
- **Autonomous Assembly Islands**
- Predictive Maintenance Service
- **Autonomous (Intra) logistics & warehouse**
- High-precision Lot-size-1 Machining
- **Mass-manufacturing Injection Molding 4.0**
- Adaptive Welding
- Spare Part Customer Service Management
High Performance Big Data Algorithms & Platforms

- Hybrid Twin Engineering Analytics
- Real-time Simulation Based Planning
- Data Lake Operational Analytics
- Distributed Production Scheduling
- Rule-based Fault Detection & Prediction
- Edge-powered Engineering Analytics
- Hybrid Predictive Production Planning
- IoT Stream Operational Analytics
- 3D Industrial Lake Visual Production Analytics
- In-memory Demand Forecasting
Industrial Smart Data Value Network Challenges
European Industrial Data Space
99%

Manufacturing Data Value is Lost
Big Data and EU Industry 4.0 Facts

- Only 15% use Big Data solutions.
- Only 50% use data to drive decisions.
- Only 3% data is tagged & analysed
Industry 4.0 Big Data Fears

- 57% worry about revealing valuable data and business secrets.
- 59% fear the loss of control over their data.
- 55% feel inconsistent processes and systems as a (very) big obstacle.
- 32% fear that platforms do not reach the Critical mass, so that data exchange will be interesting.
Factory 4.0 challenges do not lie just in the actual “storage of data or exchange of assets across digital platforms.”

The real **smart industry data challenge** primarily lies on the **speed, transparency and trustfulness** in which highly heterogeneous and multi-domain interoperable data networks can be established and accessed.

Factory 4.0 operations will rely on the **real-time synchronisation** of such data networks across the many cross-sectorial big data lifecycles.
European Industrial Data Value Networks for Factories 4.0

- Speed
- Transparency
- Trust & Sovereignty
- Synchronisation
- Heterogeneity
- Interoperability
European Industrial Data Space Pillars
European Industrial Data Space Pillars

- Global Standards
- Secure Digital Infrastructures
- Trusted Big Data Middleware
- Digital Manufacturing Platforms
- Certification
“Big Data for RAMI 4.0”

BDVA REFERENCE ARCHITECTURE


RAMI 4.0

Reference open implementation, Standardisation
Reference Architecture for Manufacturing Industry 4.0 (RAMI 4.0)

Smart production

Smart supply chain

Smart product
From Industry 4.0 towards data driven operations
Boost 4.0 Reference Architecture for Industry 4.0

**BIG DATA REFERENCE ARCHITECTURE**

---

**Collaborative Analytics Service Marketplace**
- Facilitates access to Open Data Model (ODM), Data Space Areas (DSA), and Data Analytics Services (DAS)

**Application Layer**
- Use-case specific logic, business process support, services

**Information & Core Big Data Layers**
- Data Visualization: 3D, 2D, 3D, 4D, VR/AR
- Data analytics: Descriptive, Diagnostic, Predictive, Prescriptive
- Data processing architectures: Batch, Interactive, Streaming/Realtime
- Data management: Collection, Preparation, Curation, Linking

**Integration Layer**
- Facilitates access to external data sources/infrastructure, and data ingestion

**External Data Sources**
- PLM systems, Production data acquisition systems (RFID, etc.), ERP/MES, Open Web-APIs, Things/Assets, Sensors and Actuators

**Infrastructure**
- Cloud, HPC, Hyperledger Fabric

---

**RAMI4.0: The Factory**
- Connected world
- Enterprise
- Workcentre
- Station
- Devices
- Product

---

**Data value chain**
- Development - Engineering and DevOps
- Communication
- Standards
- Cybersecurity and Trust

---

**Manufacturing entities**
(Industrial Ontologies Foundry)
Boost 4.0 Big Data Business Reference Architecture for Factories 4.0

European Industrial Data Space (EIDS) = Open Big Data Europe (BDE) smart data, IDS data sovereignty & Hyperledger distributed traceability principles
Boost 4.0 Big Data Business Reference Architecture for Factories 4.0

1 STARTER KIT

IDS STARTER KIT

This document contains the most important sources for information on how to get started with the implementation of IDS components, referring to documents, webinars and reproductions for example source code. In case of questions or comments regarding the content of this document, please contact info@innovativa.org. We are thankful for feedback in order to improve this document.

Most Important Documents and Other Sources

IDS - A Graphical Overview

The IDS document is a good first impression on how an IDS ecosystem looks like. https://www.ossmarketplace.com/ids/

IDS: Reference Architecture Model

IDS Reference Architecture Model Version 3.0: https://www.ossmarketplace.com/ids/

GitHub Sources

At the moment there is more than one repository on different aspects of the IDS. These repositories will be consolidated in the future, nevertheless for the moment please find the relevant resources here:

- IDS Information Model: https://github.com/IndustrialDataSpace
- Trusted Connector and Trust Model: https://github.com/IndustrialDataSpace
- IDS Common: https://github.com/IndustrialDataSpace

An additional repository of the project, ASGI (member of the ISSP), gives access to a reference implementation of a Dynamic Attribute Provisioning Service (DAPS) for the Developers Community (DC).

SIS: https://github.com/IndustrieSIC/Developer_V6

Figure 2 shows an example of a Connector that connects data sources from external sources to the IDS ecosystem. The sources are from the perspective of the ecosystem in an untrusted environment. Nevertheless, the data from these sources are processed by the connector (e.g., anonymized and de-identified) towards the IDS ecosystem. The trusted environment is then processed by the Connector. This means that customized applications for the specific application from the App Store, an alternative design could be that the data is processed via the App Store Container, where the standard application is deployed.

Figure 3 shows an example of an architecture that is a gateway to the IDS ecosystem. The source of data and the IT systems that process these data are at the source of the architecture. The connector will only connect the untrusted source to the IDS ecosystem. A typical example of this architecture can be used in the architecture of a data portal to the IDS.

Figure 4 shows an example of a Connector that is a gateway to the IDS ecosystem. The source of data and the IT systems that process these data are at the source of the architecture. The connector will only connect the untrusted source to the IDS ecosystem. A typical example of this architecture can be used in the architecture of a data portal to the IDS.

Step 2) Define your "Execution Core Container"

Figure 5 shows the perspective from the "Execution Core Container" with other IDS Components. In order to define the "Execution Core Container" of the connector, the following steps are to be followed:

1. Define the Execution Core Container of the connector. This Core Container connects the control layer, which is part of the IDS ecosystem, with the untrusted side of the connector, which is not part of the ecosystem (e.g., it can be installed in a separate system). Figure 5 gives an intuitive view of the component module design of the data by determining the Data Bus and the Core Cluster itself. Furthermore, before being able to wrap the services, there have to be performed additional steps.

2. Figure 5 depicts the external side of the connector, where the execution Core Container is located and the external side of the connector, where external functions reside in the Ecosystem. The components of which the IDS ecosystem can be divided into three categories: functional components, fundamental components, and optional components.

The Ecosystem will not work without the essential components. These are the connectors of the application layer and the application layer components of the Ecosystem. The components are defined in the Architecture Overview. DAPS, and the Dynamic Attribute Provisioning Service (DAPS).

The CI grants a 3202 certificate for each participant of the ecosystem in order to provide digital identities to connect with other entities. In order to provide digital identities, the participants are first certified by the CI. These certificates are signed by the CI. This ensures that the participant's identities are protected.

Regarding the 3202 certificate, the following information is required:
Boost 4.0 Software-Defined Modular Data-Driven Factory 4.0 AI Models - Containerizing Models

1. Query for models
2. Pull down model files
3. Pull SAS base container
4. Pull down model files
5. Container repository
6. Launch
7. Data to Score
“Platform Integration & Full Data Governance”

Certification
Boost 4.0 Platform Alignment & Full Data Governance

Internet of Everything

Today

**DATA PROVISIONING**

- Interoperability
- Asset Digitisation
- Networks
- Processing

---

**DATA USAGE**

- Reference Architecture
- Data Sovereignty
- Standard for CIM
- Data Models
- Data Monetization

Focus on concept and architecture
Focus on open source based implementation

---

Building Frameworks

*Frameworks of building blocks to assemble smart solutions*

---

Commercial Solutions

---

Open Source Building Blocks

CEF Context Broker
NGSI-LD
Boost 4.0 Platform Alignment & Full Data Governance
Boost 4.0 Platform Alignment & Full Data Governance

IIC, FIWARE Foundation & IDSA Agreement (Hannover Messe, 2018)

IVI, FIWARE Foundation & IDSA Agreement
Boost 4.0 Platform Alignment & Full Data Governance

Robot Revolution Initiative
(Hannover Messe, 2019)
Boost 4.0 – Joint MSP/DEI Working Group

Requirements, behaviour, architecture, validation.
Connected world, smart factory, connectivity, safety, services.

Digital Transformation

Systems Engineering

Industrie 4.0

IoT, Internet of Things

Enabling Interoperability

Engineering IT Standards for Product Properties
Manufacturing Standards for Structure Plants, Control Logic & Shop Floor
General IT Standards for Safety, Interoperability & Communication

CIM, JT/STEP, RegIF, ISO, OASIS, GfSE, OPC UA, AutomationML, OMG, W3C
Boost 4.0 Big Data Business Reference Architecture for Factories 4.0

Human-Centric Algorithms & Services

Data

Digital Infrastructures
The Digital Twin PLM use case demonstrates how *factories* can benefit from an open source FIWARE based implementation of the IDS Reference Architecture enabling manufacturing excellence across the product lifecycle.
Boost 4.0 – Standardised Digital Twin Continuity
Boost 4.0 – Certification Strategy & Laboratories

ISO/IEC 62443

IDS_ready Component

IDS_ready Organization

Common Criteria

ISO 17025

ISO 27001
Factory 4.0 Relative Business Value: How do we get there?
Low Deployment **Cost**

Fast Return of **Investments**

Easy **Configuration & Operation**

Reliable **Solutions**

**Incremental** deployment

**Open** Systems

**Digital Shopfloor Innovation Relative Business Value Drivers**
Boost 4.0 – Relative Business Value Solution Framework

• Building
  • Smart Spaces – Infrastructure
  • Smart Products – Networked Physical products, machines...
  • Smart Data – Software defined data-driven platforms
  • Smart Services – Data-driven added value apps.
Migration Paths for Smart Connected Factories 4.0

Hyperconnected Factories
Networked enterprises in complex, dynamic supply chains and value networks

Autonomous Factories
Optimised and sustainable manufacturing including advanced human-in-the-loop workspaces

Collaborative Product-Service Factories
Data-driven product-service engineering in knowledge intensive factories

Small-Scale Digital Factories
Mission-focused digitalisation for SME-driven sustainable manufacturing

Optimised and sustainable manufacturing including advanced human-in-the-loop workspaces

Networked enterprises in complex, dynamic supply chains and value networks

Data-driven product-service engineering in knowledge intensive factories

Mission-focused digitalisation for SME-driven sustainable manufacturing
Factories 4.0 Business Value: A big data driven AI perspective
Industrial AI Paths for Factories 4.0

Are we ready?
THE INTERNATIONAL DATA SPACES APPROACH CONNECTS ALL KINDS OF DATA ENDPOINTS

When broadening the perspective from an individual use case scenario to a platform landscape view, the INTERNATIONAL DATA SPACES positions itself as an architecture to link different cloud platforms through secure exchange and trusted sharing of data, short: through data sovereignty.

By proposing a specific software component, the INTERNATIONAL DATA SPACES Connector, industrial data clouds can be connected, as well as individual enterprise clouds and on premise applications and individual connected devices.
Software-defined Factory 4.0 Cognitive Service Framework

- Service Platforms
- International Data Space
- Connected Physical Products
- Technical Infrastructure

- Smart Services
- Smart Products
- Smart Spaces

- Identity Management
- Certification
- Data Transaction Logging
- Data Transformation
- Data Provenance
- Brokering of Data Demand and Supply
- Vocabulary Management
- Dynamic Trust Management
- Open Data Source Integration
Software-defined Factory 4.0 Cognitive Service Framework

VALUES & FRAMEWORK FOR INNOVATIONS
(EU Law and regulations)

ENTERPRISE/DIGITAL ECOSYSTEM (using EU standards)

SERVICE PLATFORMS
DATA SHARING INFRASTRUCTURE
CLOUD/EDGE INFRASTRUCTURE
NETWORK

SMART TALENT
SMART SERVICES
SMART DATA
SMART PRODUCTS
SMART NETWORK


Essential Trust Services

Base Data Services

CLEARING HOUSE
CERTIFICATION BODY
CERTIFICATION AUTHORITY

Dynamic Trust Management
Dynamic Attribute Provisioning

Broker, auditability
Transaction services
Quality scoring

Micro-payment services
Data Usage Control

Sensor/platform interoperability
Data connector services

Appstore
Encryption services

Data Governacl/Privacy
Platform access, anti-fraud

Right to Play

Lead Idea of Politics match EU strategy and values:
- EU controlled
- Industry neutral
- Secure, Trusted
- Performant

Urgent demand for neutral enabler for trusted data sharing & data usage across multiple service platforms across industries!
Boost 4.0 - Edge to Cloud, IDS & AI

AI-Based Business Models in Ecosystems

- Mobility
- Smart Cities
- Healthcare
- Logistics
- ...

Open Interfaces

- AI Service Space
  - Cross-Domain AI Services (Algorithms, Tools)

- AI Data Space
  - Data Ecosystems
    - International Data Spaces

- AI Edge Space
  - Distributed Edge AI Services
    - Cognitive Gateway Components
Software-defined Factory 4.0 Cognitive Service Framework
Software-defined Factory 4.0 Cognitive Service Framework

Augmented interaction & planning
Insight generation & management
Edge control, stream perception & actuation
Smart memory

AI Ready

Digital Manufacturing Platforms & Services
- ERP
- CRM
- MES
- DSS
- Business Management Services
- CAD
- CAM
- CAE
- VRtx
- Assisted Reality (AR/VR) & Engineering Services

Digital Infrastructure
- HPC
- Cloud
- Big Data Lake / Data Center
- IoT Hub
- PLC/Ind. PC
- Open Edge Node
- 5G Multi-Access Edge Computing (MEC)

Two-way secured communication

Data at rest
- Plant IT Network: Wireless/5G, Wired Ethernet
- Data-driven Learning Services
- Digital Twin Planning Services
- Simulation Services

Data in motion
- Production OT Network: Deterministic Ethernet (TSN), ROS, OPC-UA, IIDS/NGSI-LD
- IoT Automation Services
- Real-Time Control Interface (125–1000 Hz)
- 5G URLLC
- Field Device Network (Time Sensitive Network): Real-Time Ethernet, Digital IOs, Camera Link, F&F

Field Devices & Product

Robot
Workcell
Machine Tool
CMM
AGV
Factory 4.0
Big Data
Pilots
FACTORIES 4.0

10 Lighthouse
- Automotive (6)
- Machine Tool (2)
- White Goods & Appliances (2)

3 Replication
- Textile
- Ceramics
- Elevation / AERO

Lighthouse Factory 4.0
Replication Factory 4.0

OPEN BIG DATA PIPELINES PROOFS OF CONCEPT (POC)
Big Data Factory 4.0 Processes

Smart Digital Engineering
- Volkswagen

Smart Planning
- +GF+
- Volkswagen

Smart Operations & Digital Workplace
- Philips

Smart Connected Production
- Volvo
- Gestamp

Smart Maintenance & Service
- Benteler
- Whirlpool
Coordination

Big Data Infrastructure

Factory 4.0 Big Data Expertise

Big Data Tools & Smart Machines

Lighthouse Factories 4.0

Replication Factories 4.0

Open Communities

Scientific Management & Digital Transformation

Certification & Standards
Thanks!

Any questions?

👤 Prof. Dr. Oscar Lazaro (INNOVALIA)
✉️ olazaro@innovalia.org
🌐 www.boost40.eu
🐦 boost4_0
LinkedIn: www.linkedin.com/groups/12075988