Organization and Goals of the Industry 4.0 Platform
Industry 4.0

In essence, the **fourth industrial Revolution** will involve the technical integration of **Cyber-Physical Systems** into manufacturing and logistics and the use of the **Internet of Things and Services** in industrial processes. \(^{(1)}\)

Industry 4.0 is the German strategic initiative to take up a pioneering role in industrial IT which is currently **revolutionizing the manufacturing engineering sector.** \(^{(2)}\)

Sources:  
(1) Recommendations for implementing the strategic initiative Industrie 4.0, acatech, 2013  
(2) Future Markets: INDUSTRIE 4.0, Smart Manufacturing for the Future, Germany Trade & Invest, July 2014
Cyber-Physical Systems (CPS)

“A cyber-physical system (CPS) is an integration of computation with physical processes. Embedded computers and networks monitor and control the physical processes, usually with feedback loops where physical processes affect computations and vice versa.”

A CPS contains at least the following elements:
• One processing unit (CPU)
• One data memory
• One physical system
• One communication interface

Digital data are the resource of the future

Optimization and predictive diagnostics

Communication and record of data

Data storage and analysis

Analytics

Smart Factory

Smart Devices

Smart Data

Big Data

User Interface
Industry 4.0 Challenges

Pull together the different established ways of seeing things that currently exist in the realms of

- production engineering, mechanical engineering, process engineering,
- automation engineering and
- IT and the Internet

and establish a **common approach**.

Source: Recommendations for implementing the strategic initiative Industrie 4.0, acatech, 2013
Industry 4.0 Professional Associations

**BITKOM**
- Federal Association for Information Technology, Telecommunications and New Media
- www.bitkom.org

**VDMA**
- German Machinery and Plant Engineering Association
- www.vdma.org

**ZVEI**
- The Electrical and Electronic Manufacturers' Association
- www.zvei.org
Platform Industry 4.0

www.plattform-i40.de
Platform Industry 4.0 Organisational chart

Leitung
BM Gabriel, BM’ in Wanka
Vertreter Wirtschaft, Gewerkschaft, Wissenschaft
Politische Flankierung

Technisch-praktische Kompetenz, Entscheidung

Lenkungskreis (Unternehmen)
- Leitung durch Unternehmer unter Beteiligung BMWi, BMBF
- AG-Leitungen und weitere Gäste/ Promotoren
- Industrielle Strategieentwicklung, technische Koordinierung, Entscheidung und Umsetzung

Arbeitsgruppen
- Referenzarchitektur, Standardisierung und Normung
- Forschung und Innovation
- Sicherheit vernetzter Systeme
- Rechtliche Rahmenbedingungen
- Arbeit, Aus-/Weiterbildung
- Weitere nach Bedarf
- Arbeitseinheiten mit technisch-praktischer Kompetenz; Beteiligte Ressorts BMWi, BMBF, BMI, BMJ, BMAS

Politische Steuerung, Gesellschaft, Multiplikatoren

Strategiekreis
(Politik, Verbände, Gewerkschaft, Wissenschaft)
- Leitung StS Machning, StS Schütte
- Vertreter Lenkungskreis
- Vertreter Bundeskanzleramt, BMI
- Vertreter Arbeitskreis Bundesländer
- Vertreter Verbände (VDMA, ZVEI, BITKOM, BDI, VDA, BDEW)
- Vertreter Gewerkschaft (IG Metall)
- Vertreter Wissenschaft (FhG)
- Agenda-Setting, politische Steuerung, Multiplikatoren

Aktivitäten am Markt

Industriekonsortien und Initiativen
Realisierung am Markt: Prüfstände, Anwendungsfälle

Internationale Standardisierung
Konsortien, Standardisierungs- gremien, DKE u. ä.

Wissenschaftlicher Beirat

Geschäftsstelle als Dienstleister
Netzwerkoordination, Organisation, Projektmanagement, interne und externe Kommunikation

Source: Industrie 4.0 – Made in Germany - Informationen zum Start der Plattform Industrie 4.0, Bundesministerium für Wirtschaft und Energie (BMWi) und Bundesministerin für Bildung und Forschung (BMBF), April 2015
Platform Industry 4.0 Cooperation's

**Plattform Industry 4.0 Working Groups**

WG 1  Reference architecture and Standardization
WG 2  Research and Innovation
WG 3  Security of networked systems

**Fokusprojet I4.0**
GMA
FA 7.21 I4.0
FA 7.20 Cyber-Physical Systems
FA 7.22 Arbeiwelt I4.0
FA 7.23 Geschäftsmodelle mit I4.0

**Kompetenzbereich I4.0**
AK Cyber-Physical Systems
AK I4.0 Markt und Strategie
AK I4.0 Interoperability

**Führungskreis I4.0**
Spiegelgruppen wie AG’s der Plattform
SG 1 ...
SG 2 ...
SG 3 ...
SG 4 ...

**VDMA-Forum I4.0**
Handlungsfelder Forschung
Standardisierung IT-Sicherheit
Mensch & Arbeit
Produktionsorganisation & Geschäftsmodelle

**DIN/DKE Steuerkreis Normung I4.0**
Deutsche Normungs-Roadmap I4.0
Normungs-Roadmap IT-Sicherheit
Platform Industry 4.0 Working Group 1
Reference architecture and Standardization

Reference Architecture
• One single, common approach and basic terminology
• Existing standards has to be incorporated

Model-based Development Platforms
• Framework for software applications and software services

➢ Standardization and open standards for a reference architecture
Implementation Strategy Industrie 4.0

• **Horizontal integration** through value networks
• **End-to-end digital integration** of engineering across the entire value chain
• **Vertical integration** and networked manufacturing systems

Adapt existing basic technologies and experiences on the particularities of the production engineering

Exploring and developing solutions for new locations and new markets

Source: Recommendations for implementing the strategic initiative Industrie 4.0, acatech, 2013
Greatest challenges connected with implementing Industry 4.0?

- Regulatory framework
- Lack of specialist staff
- Training and CPD
- Research
- Security know-how protection
- New business models
- Product availability
- Process/work organisation
- Standardisation

Source: Recommendations for implementing the strategic initiative Industrie 4.0, acatech, 2013
Eight Priority areas for Industry 4.0 actions

(1) **Standardisation and open standards for a reference architecture**
(2) Managing complex systems
(3) Delivering a comprehensive broadband infrastructure for industry
(4) Safety and security as critical factors for the success of Industrie 4.0
(5) Work organisation and work design in the digital industrial age
(6) Training and continuing professional development for Industrie 4.0
(7) Regulatory framework
(8) Resource efficiency

Source: Recommendations for implementing the strategic initiative Industrie 4.0, acatech, 2013
The German Standardization Roadmap
Industry 4.0

Standardization as a driving force for innovation

• Subject areas with a need for standardization for Industry 4.0
  ✓ System architecture
  ✓ Reference Models
  ✓ Use Cases

• Recommendations for action in the Standardization of Industrie 4.0

• Relevant standards and specifications

Source: The German Standardization Roadmap Industrie 4.0, DKE, 2013
Architecture descriptions

Architecture

- Fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution

Architecture framework

- Conventions, principles and practices for the description of architectures established within a specific domain of application and/or community of stakeholders

Source: ISO/IEC/IEEE 42010:2011: Systems and software engineering — Architecture description is an international standard for architecture descriptions of systems and software
System architecture

Architecture neutral in terms of technology

- Reference model for the overall architecture

Focuses

- Service-orientation
- Autonomy
- Adaptivity
- Cooperatitivity

Source: The German Standardization Roadmap Industrie 4.0, DKE, 2013
Reference models of the technical systems and processes

Reference models

- Product identification, product tracing and life cycle documentation
- Integrative description of production and business processes
- Description of systems and production networks
- Description of technical processes
- Description of technical equipment

Source: The German Standardization Roadmap Industrie 4.0, DKE, 2013
Service Oriented Architecture - SOA

Definition

• SOA is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains.  

Service-oriented architecture

• A service is a function that is well-defined and self-contained
• Services have control over the logic they encapsulate (autonomy)
• Service is abstracted from the implementation
• Services are registered in a directory

Source: (1) Reference Model for Service Oriented Architecture 1.0, Committee, OASIS Standard, 12 October 2006
Service Oriented Architecture - SOA

IEC 18384
Reference Architecture for Service Oriented Architecture (SOA)

- Definitions Service Provider, Service Consumers and Services
- Compositions and Processes
- Service Registration and Discovery
- SOA Architectural Principles

Source: ISO/IEC 18384 Information Technology - Reference Architecture for Service Oriented Architecture (SOA)
Generic service platform with system services

IEC 62541

OPC Unified Architecture

- Independence of the communication technology and operating system
- Service-orientated architecture (SOA)
- Transport via established standards such as TCP/IP, HTTP, SOAP and XML
- Robust data transfer independent of communication protocols
- Safe transfer and authentication at user and application level
- Scalability for integrated networking in the communication

Source: OPC Unified Architecture - Pioneer of the 4th industrial (r)evolution, OPC Foundation,
Summary Report Industry 4.0

(1) Research and Innovation
(2) Reference architecture and Standardization
   – Reference architecture model for Industry 4.0 (RAMI4.0)
   – Reference model for the I4.0 components
   – Standardization Overview
(3) Security of networked systems
   – Security-by-Design for Industry 4.0
   – Identity Management
   – Standardization Overview

Quelle: Umsetzungsstrategie Industrie 4.0 – Ergebnisbericht, Plattform Industrie 4.0, BITKOM, VDMA, ZVEI, 2015
Reference Architectural Model Industrie 4.0 (RAMI4.0)

Source: Umsetzungsstrategie Industrie 4.0 – Ergebnisbericht, Plattform Industrie 4.0, 2015
Derivation of the hierarchy levels of RAMI4.0

- Enhancement Industrie 4.0
- IEC 62264-1:2013 Enterprise-control system integration
  Part 1: Models and terminology
- IEC 61512-1:1997 Batch Control
  Part 1: Models and terminology
- ISA Draft 88/95 Technical Report
  Using ISA-88 and ISA-95 Together

Source: Umsetzungsstrategie Industrie 4.0 – Ergebnisbericht, Plattform Industrie 4.0, 2015
Industry 4.0 component (I4.0)

The I4.0 compliant communication must be performed in such a way that the data of a virtual representation of an I4.0 component can be kept either in the object itself or in a (higher level) IT system.

Source: Umsetzungsstrategie Industrie 4.0 – Ergebnisbericht, Plattform Industrie 4.0, 2015
Properties of an I4.0 Component (Part 1)

Identification
• The I4.0 component can be uniquely identified and its physical things are bi-uniquely identified by an identifier (ID). Is it an actively communicating entity respectively an I4.0 compliant communicating entity the I4.0 component is addressable via a communication address (i.e. IP address)

Compliant Communication
• The I4.0 components communicates between each other using the Service Oriented Architecture (SOA) principle (including common I4.0 compliant semantics)

Compliant Services and States
• The I4.0 component supports the commonly standardized (also reloadable) service functions and states of an I4.0 system

Virtual Description
• The I4.0 component offers its virtual description including its dynamic behavior. This description is achieved by the manifest and the administration shell

Source: Umsetzungsstrategie Industrie 4.0 – Ergebnisbericht, Plattform Industrie 4.0, 2015
Properties of an I4.0 Component (Part 2)

Compliant Semantics
• The I4.0 component supports the I4.0 compliant semantics

Security und Safety
• The I4.0 component offers sufficient protection according to the application to be fulfilled. In addition, measures for functional safety and machine for safety may be necessary.

Quality of Services
• The I4.0 component has the required „Quality of Services“ (QoS) in order to fulfill its application task. Related to automation technology properties like real-time capabilities, reliability, clock synchronization etc. are relevant. These properties may be described as profiles.

State
• The state of an I4.0 component is accessible at any time.

Nested Components
• Each I4.0 component can be nested with other I4.0 components.

Source: Umsetzungsstrategie Industrie 4.0 – Ergebnisbericht, Plattform Industrie 4.0, 2015
Examples for I4.0 Components

No I4.0-Component

(Uunknown) (Anonymous) (Individually known) (Entity)

Thing

□ = Interfaces/ data formats I4.0-compliant designed

Examples for I4.0-Components

Administration Shell ▽

Thing e.g. machine ▽

Administration Shell ▽

Thing e.g. Electr. Axis ▽

Administration Shell ▽

Thing e.g. Terminal Block

Administration Shell ▽

 Thing provides access to Administration Shell

(Super ordinated system provides access to Administration Shell)

I4.0-compliant communication □

Source: Umsetzungsstrategie Industrie 4.0 – Ergebnisbericht, Plattform Industrie 4.0, BITKOM, VDMA, ZVEI, 2015
DIN SPEC 91345: 2015-07
Reference Architecture Industrie 4.0

DIN SPEC
• Is the fastest way to turn research into a marketable product
• DIN make sure that a DIN SPEC does not conflict with any existing standards or rules of procedure
• Can be published within only a few months

Reference Architecture (Chapter 6)
• Submitted and published business plan
• Publicly Available Specification (PAS)
• Reference architecture model for Industrie 4.0 (RAMI4.0)
• Reference model for the I4.0 components
Thank you very much for your attention. Do you have questions?

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