RE4DY

MANUFACTURING DATA NETWORKS

Shaping the Future of Manufacturing Data Networks

Dr Oscar Lazaro

25-26 September 2023, EFFRA Manufacturing Partnership Day

PROJECT DESCRIPTION

RE4DY

MANUFACTURING DATA NETWORKS

European “Data as a PRoduct” Value Ecosystems for Resilient Factory 4.0 Product and ProDuction ContinuitY and Sustainability

Project No: 101058384

Duration: 36 Months

Start Date: 1st June 2022

Partnership: 31 Partners, 12 Countries

Strategic Objective: HORIZON-CL4-2021-TWIN-TRANSITION-01-08

Total Budget: 11.944.650 €

EC Contribution: 7.991.699 €

Business Challenge: Resilient Green Growth

Technical Challenge: Manufacturing Data Networks

Project Website: www.re4dy.eu

Who is RE4DY?

RE4DY
MANUFACTURING DATA NETWORKS

Coordination

innovalia ASSOCIATION

Open Digital Manufacturing Platforms & Infrastructures

SIEMENS
netcompany intrasoft
VISUAL COMPONENTS
ENGINEERING
AtoS
CEIT by asseco
JUNTA DE ANDALUCIA SANDETEL
S21 SEC

Manufacturing Resilience Expertise

UNIVERSITAT POLITÈCNICA DE VALÈNCIA
Consiglio Nazionale delle Ricerche
UNIVERSITAS Miguel Hernández
KU LEUVEN
CHALMERS UNIVERSITY OF TECHNOLOGY
POLITECNICO MILANO 1863
UNINOVA
CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS
UiO University of Oslo

Advanced Manufacturing Technology Providers

DATAPIXEL QUALITY CONTROL ENGINEERING
NOVA id FCT
ATLANTIS ENGINEERING
core
FILL

Resilient Product and Process Pilots

AVL
Avio Aero A GE Aviation Business
+GF+
fraisa

Standards & TEFs

SWISS SMART FACTORY
INTERNATIONAL DATA SPACES ASSOCIATION
INDUSTRY COMMONS

CHALLENGES & BARRIERS

99%

Manufacturing Data Value is Lost

Manufacturing Data Network

Market Challenges

LACK OF TRUST

57 % of organizations **reveal valueable data**

59 % of organizations have **loose control over data**

55 % of **processes & systems are inconsistent**

32 % of organizations **use common tools & platforms**

LACK OF COST-EFFICIENCY

55 % of organizations find **High cost** in 3rd party data licensing

49 % of **Contracting terms** of (data licenses) are very diverse

54 % of organizations have **Low confidence** in data quality

50 % of organizations find **Hard** to combine data

LACK OF INTEROPERABILITY

70-80%

Time & Efforts in organizations are invested in managing

- Data acquisitions
- Integration
- Quality Management

Manufacturing Data Network

Stakeholder Barriers

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MANUFACTURING DATA NETWORKS

LACK OF SUPPLIER-MANUFACTURER CONNECTION

Most manufacturing **organizations don't share their data with their suppliers** to drive efficiency

LACK OF TOOLS

Most manufacturing **organizations don't have any tools** to respond to the data and continuity challenge

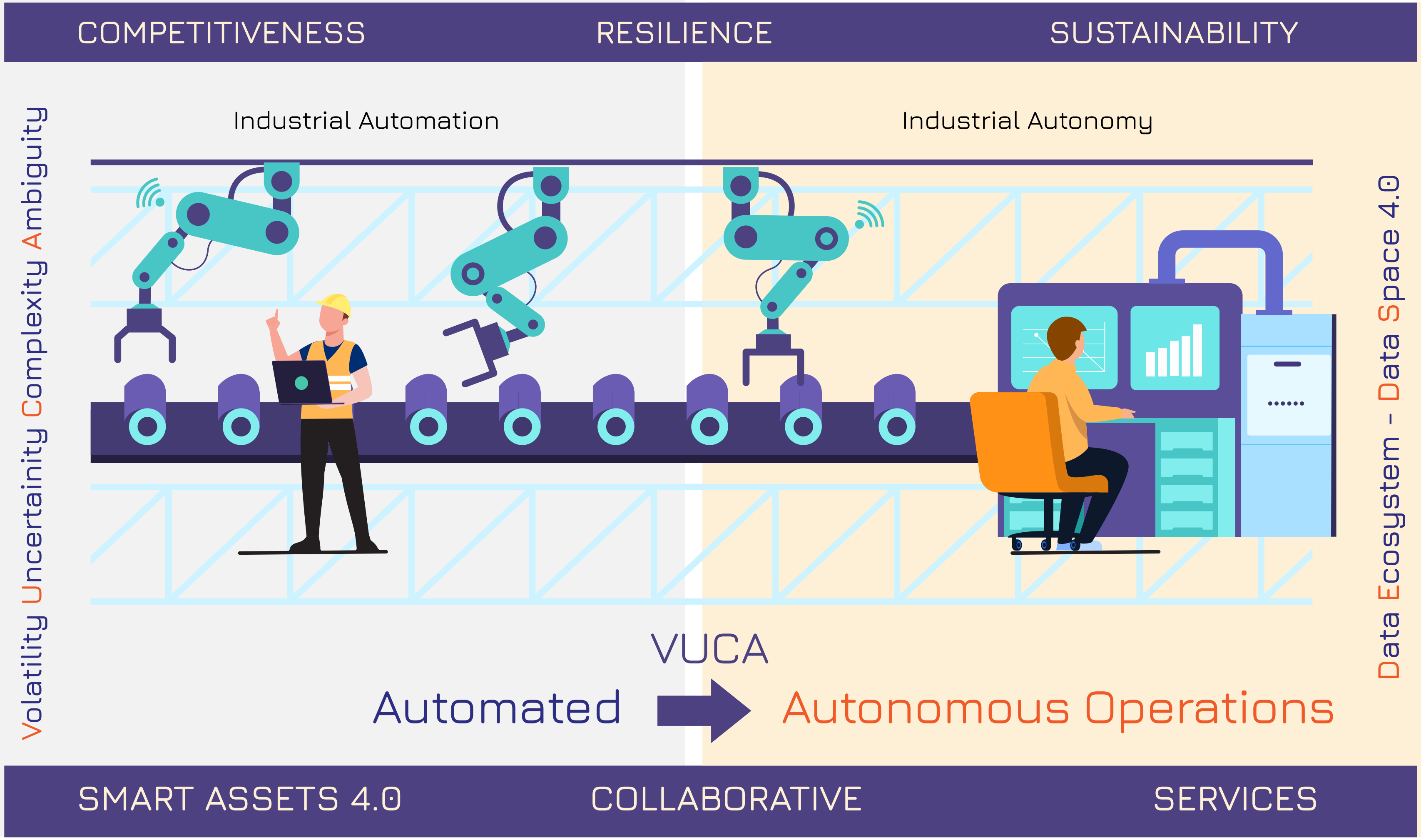
LACK OF OPERABILITY

Most manufacturing **organizations struggle with data exchanges and keeping safe, reliable functioning operable processes and systems**

PROJECT APPROACH

RE4DY Vision

RE4DY
MANUFACTURING DATA NETWORKS



COMPETITIVENESS RESILIENCE SUSTAINABILITY

Industrial Automation

Industrial Autonomy

Volatility Uncertainity Complexity Ambiguity

Data Ecosystem - Data Space 4.0

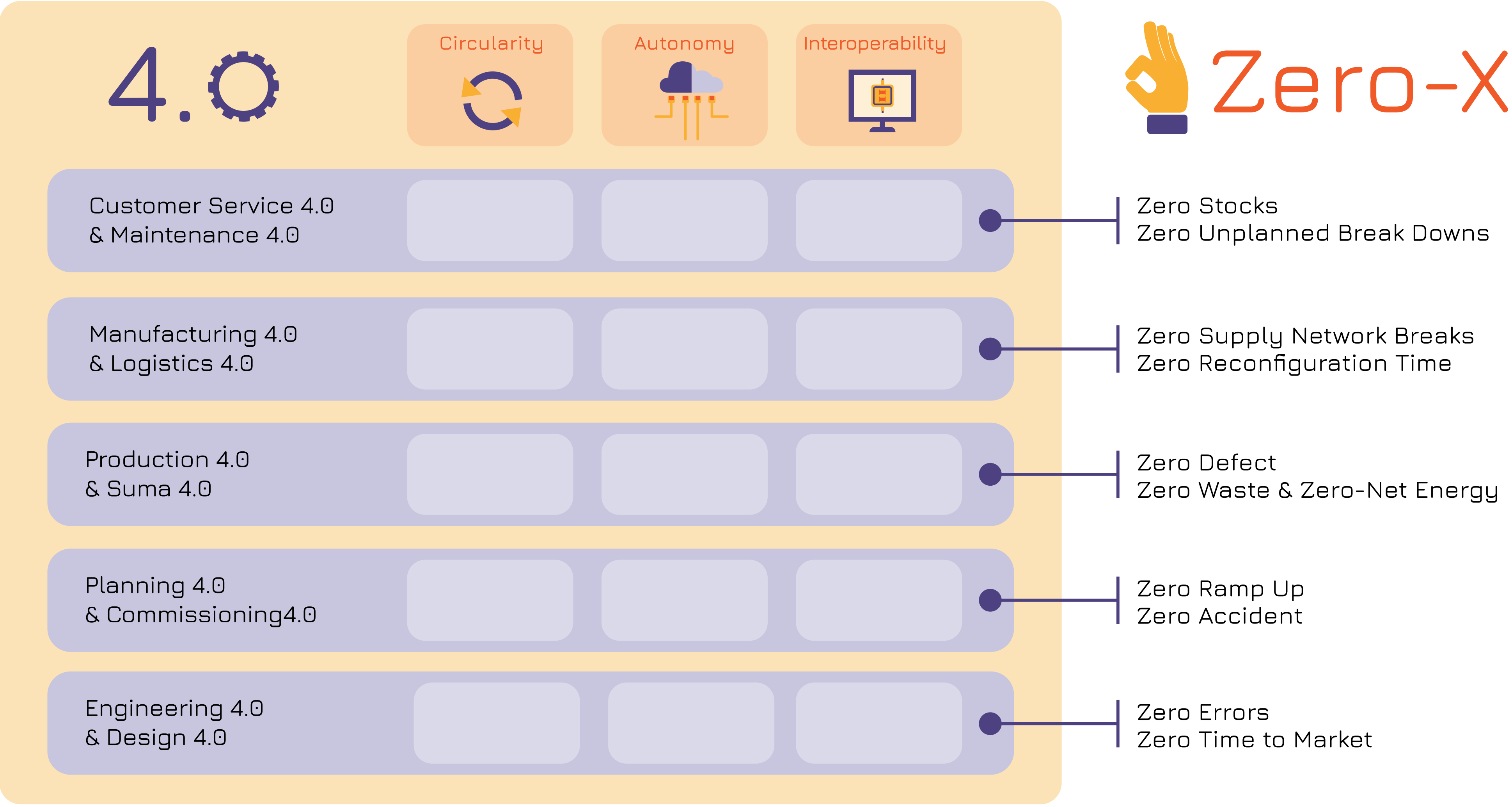
VUCA

Automated → Autonomous Operations

SMART ASSETS 4.0 COLLABORATIVE SERVICES

Zero-X Manufacturing Framework

RE4DY
MANUFACTURING DATA NETWORKS



4.0	Circularity	Autonomy	Interoperability	Zero-X
Customer Service 4.0 & Maintenance 4.0				Zero Stocks Zero Unplanned Break Downs
Manufacturing 4.0 & Logistics 4.0				Zero Supply Network Breaks Zero Reconfiguration Time
Production 4.0 & Suma 4.0				Zero Defect Zero Waste & Zero-Net Energy
Planning 4.0 & Commissioning4.0				Zero Ramp Up Zero Accident
Engineering 4.0 & Design 4.0				Zero Errors Zero Time to Market

Active Resiliency Strategies for Zero-X Manufacturing

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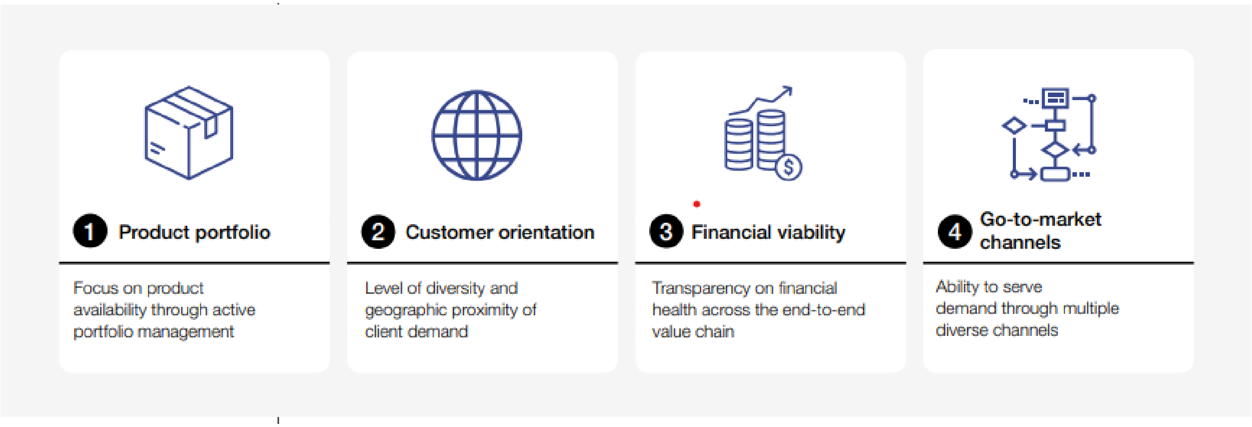
MANUFACTURING DATA NETWORKS

Demand Facing Resiliency



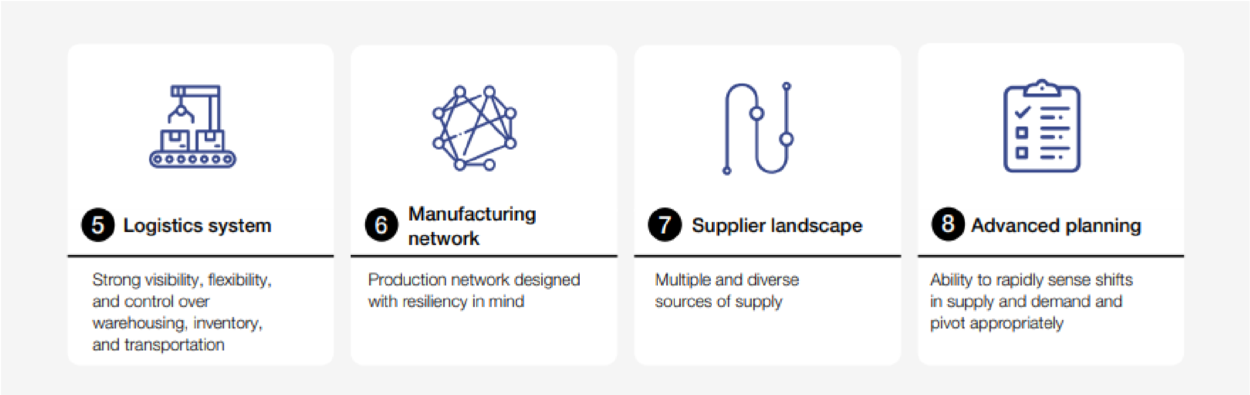
1 Product portfolio
Focus on product availability through active portfolio management

2 Customer orientation
Level of diversity and geographic proximity of client demand

3 Financial viability
Transparency on financial health across the end-to-end value chain

4 Go-to-market channels
Ability to serve demand through multiple diverse channels

Supply Facing Resiliency



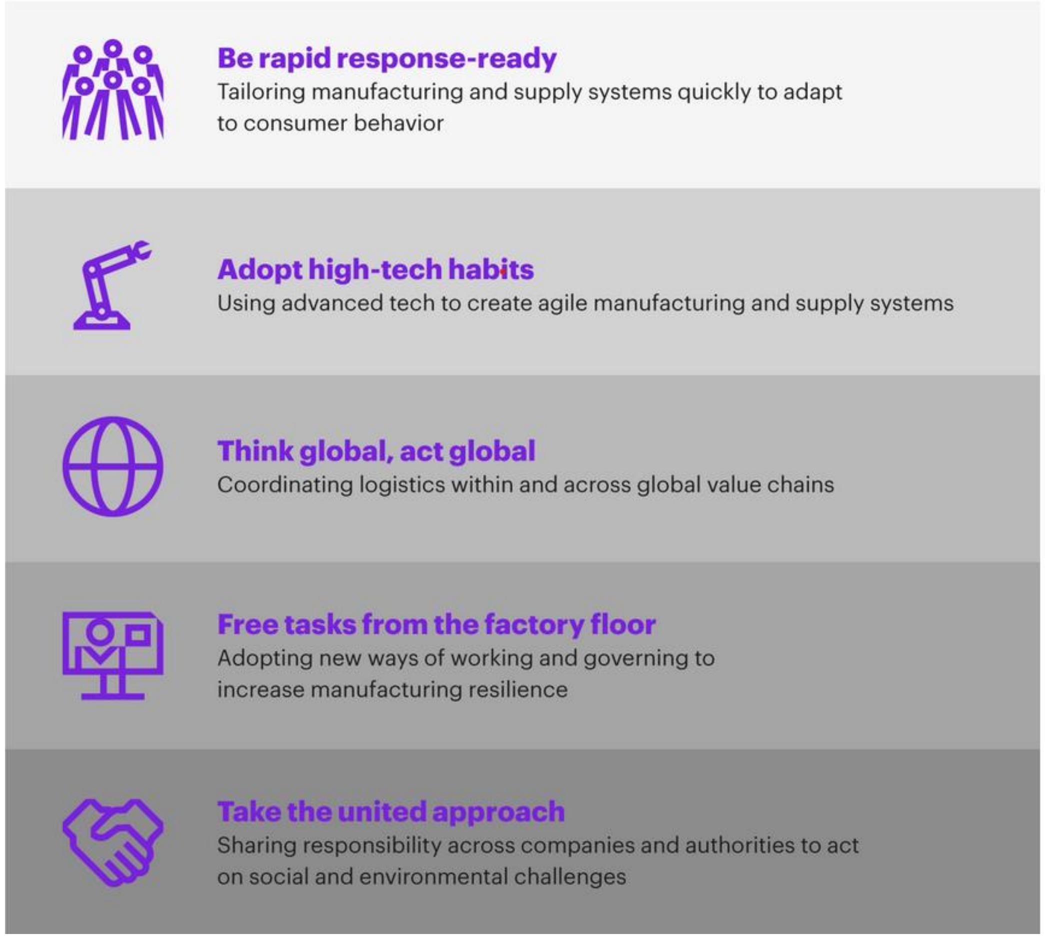
5 Logistics system
Strong visibility, flexibility, and control over warehousing, inventory, and transportation

6 Manufacturing network
Production network designed with resiliency in mind

7 Supplier landscape
Multiple and diverse sources of supply

8 Advanced planning
Ability to rapidly sense shifts in supply and demand and pivot appropriately

Business approach



Be rapid response-ready
Tailoring manufacturing and supply systems quickly to adapt to consumer behavior

Adopt high-tech habits
Using advanced tech to create agile manufacturing and supply systems

Think global, act global
Coordinating logistics within and across global value chains

Free tasks from the factory floor
Adopting new ways of working and governing to increase manufacturing resilience

Take the united approach
Sharing responsibility across companies and authorities to act on social and environmental challenges

CONNECTED FACTORIES

Data Spaces for Manufacturing Pathway

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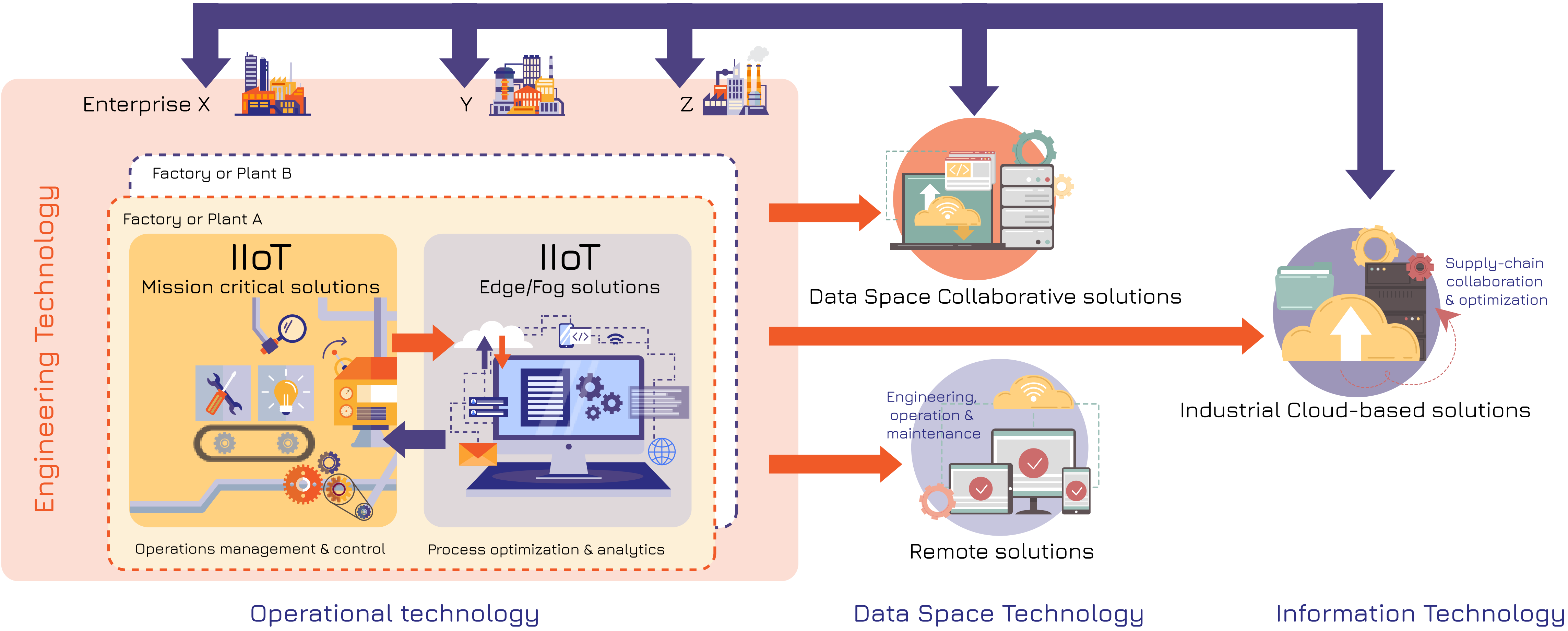
MANUFACTURING DATA NETWORKS

			Data Governance models for Trust and Data Sovereignity / GDPR	Multi-stakeholder Digital Passports for complex Product-Service Systems
	(Hyperconnected Factories) Data is locked in ERP SCM CRM enterprise applications	Heterogeneous Data Sources integrated on a case-by-case basis	Industrial Data Platforms for Data Processing and Sharing	Flexible cross-sector Manufacturing Data Marketplaces
Data are locked in Smart Products, Value Chains with limited access by external Users and Systems	(Colaborative Product-Service Factories) Data is locked in CAD, PDM, PLM enterprise applications	Data Integration and Security / Privacy issues are hardly addressed	FAIR Data Spaces enable AI-driven applications; Digital Assistants; VR/AR	Open Data Ecosystems enabiling Living Labs and Open Innovation
Data are generated, processed and visualised by closed CPPS and I4.0 systems	(Smart Autonomous Factory) Data is locked in SCADA, MES, ERP enterprise applications	Ad-hoc Data Bridges area created between Enterprise Applications for specific purposes	Data Interoperability by design, standard data models and ontologies adoption	Data Economy take-up, Data-driven Innovative Business Models
No Data Control	Data Silos	Data Bridges	Data Interoperability	Data Valorisation
1	2	3	4	5

Manufacturing Data Networks Vision


Enterprise X
Y
Z
Engineering Technology
Factory or Plant B
Factory or Plant A
IIoT
Mission critical solutions
IIoT
Edge/Fog solutions
Operations management & control
Process optimization & analytics
Data Space Collaborative solutions
Engineering, operation & maintenance
Remote solutions
Supply-chain collaboration & optimization
Industrial Cloud-based solutions
Operational technology
Data Space Technology
Information Technology

RE4DY Pillars

- Global Standards
- Federated Digital Infrastructures
- Trusted Sovereign Data Exchange
- Digital Continuity Toolkit
- Certification & Compliance
- Data as a product

PROJECT
RESULTS

RE4DY Achievements so far

1
DIGITAL 4.0 CONTINUITY REF. ARCHITECTURE

1
ACTIVE RESILIENCE REF. ARCHITECTURE

1
DaaP GOVERNANCE & LEGAL FRAMEWORK

4
4C MANUFACTURING DATA NETWORKS (MDN) SCENARIOS

4
PILOT FACTORIES RAMPED-UP

10+
MDN BUSINESS PROCESSES

4
OPEN MDN PROOFS OF CONCEPT (POC)

1
TOOLKIT DESIGNED

4
STANDARDISATION COMMUNITIES PARTICIPATION

3
OPEN TEFS RAMPED-UP

2
DATA SPACE BLUEPRINTS ALIGNED

1
EDIH NETWORK ENGAGED

TO THE
LACK OF TRUST

RE4DY
MANUFACTURING DATA NETWORKS

RE4DY MANUFACTURING DATA NETWORKS | Legal/IP
Onto Commons

RE4DY MANUFACTURING DATA NETWORKS | Resilience
Onto Commons

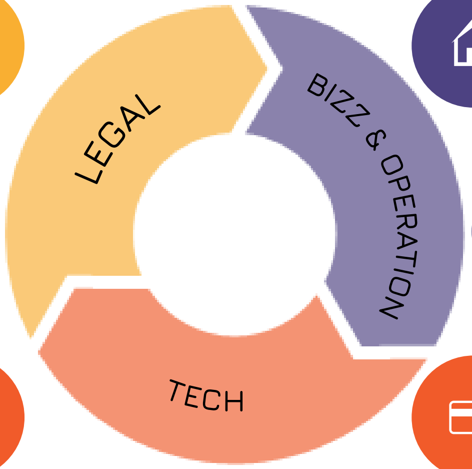
REGULATION - COMPLIANCE

PERSONAL DATA PROTECTION

STANDARDS - INTEROPERABILITY

VOLUME - VELOCITY

DATA QUALITY & VERACITY



INCENTIVES - TRUST

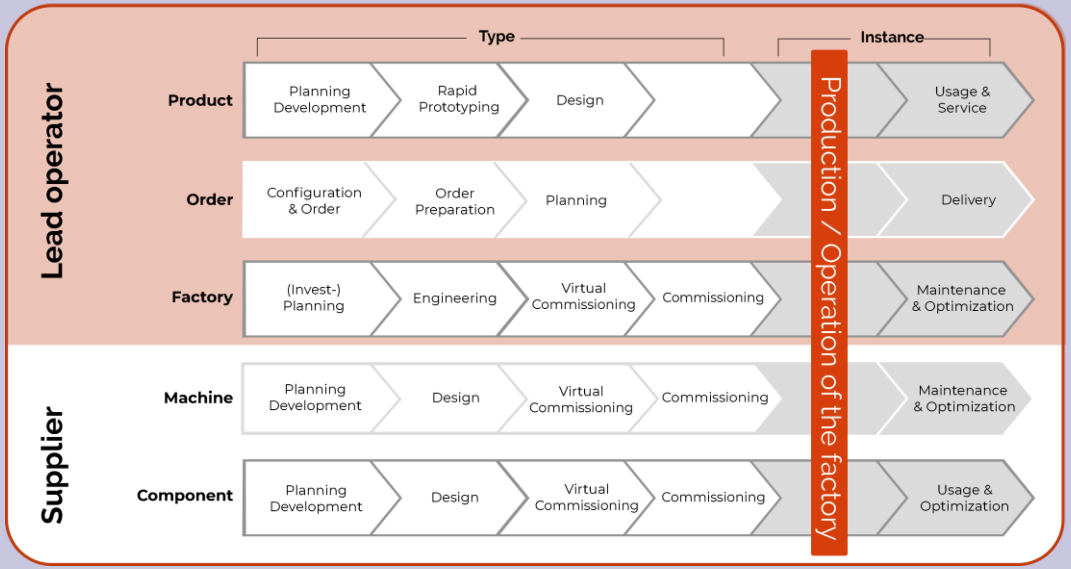
DATA LIFE-CYCLE MANAGEMENT

HUMAN FACTOR / CULTURE

USE & ACCESS CONTROL

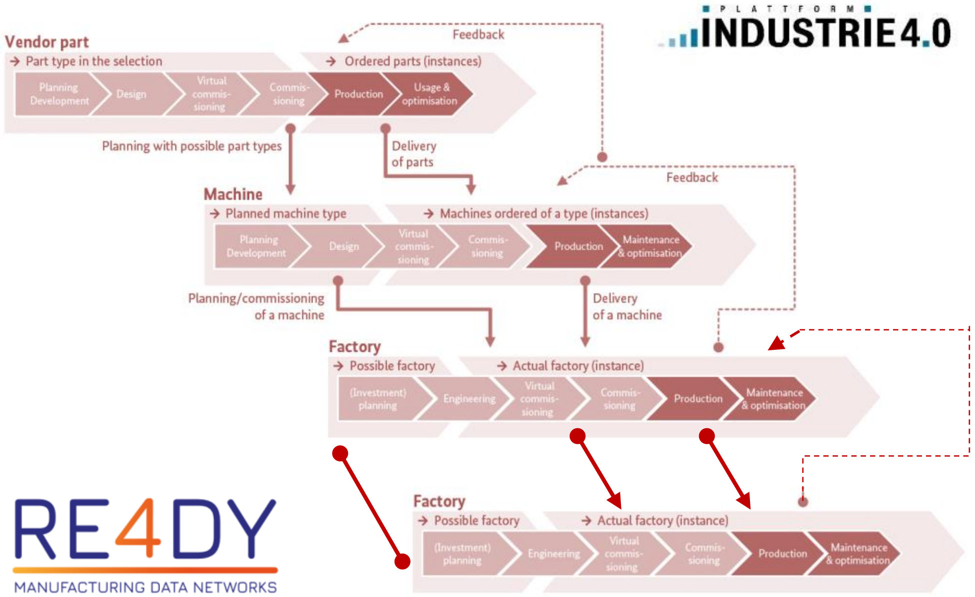
TRUSTED DATA EXCHANGE

RE4DY MANUFACTURING DATA NETWORKS | Circular & Data 4.0
Onto Commons



		Type				Instance	
Lead operator	Product	Planning Development	Rapid Prototyping	Design			Usage & Service
	Order	Configuration & Order	Order Preparation	Planning			Delivery
	Factory	(Invest-) Planning	Engineering	Virtual Commissioning	Commissioning		Maintenance & Optimization
Supplier	Machine	Planning Development	Design	Virtual Commissioning	Commissioning		Maintenance & Optimization
	Component	Planning Development	Design	Virtual Commissioning	Commissioning		Usage & Optimization

Production / Operation of the factory


PLATTFORM INDUSTRIE 4.0
Vendor part
Part type in the selection
Ordered parts (instances)
Feedback
Planning Development
Design
Virtual commis-sioning
Commis-sioning
Production
Usage & optimisation
Planning with possible part types
Delivery of parts
Feedback
Machine
Planned machine type
Machines ordered of a type (instances)
Planning Development
Design
Virtual commis-sioning
Commis-sioning
Production
Maintenance & optimisation
Planning/commissioning of a machine
Delivery of a machine
Factory
Possible factory
Actual factory (instance)
(Investment) planning
Engineering
Virtual commis-sioning
Commis-sioning
Production
Maintenance & optimisation
Factory
Possible factory
Actual factory (instance)
(Investment) planning
Engineering
Virtual commis-sioning
Commis-sioning
Production
Maintenance & optimisation

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.

TO THE LACK OF INTEROPERABILITY

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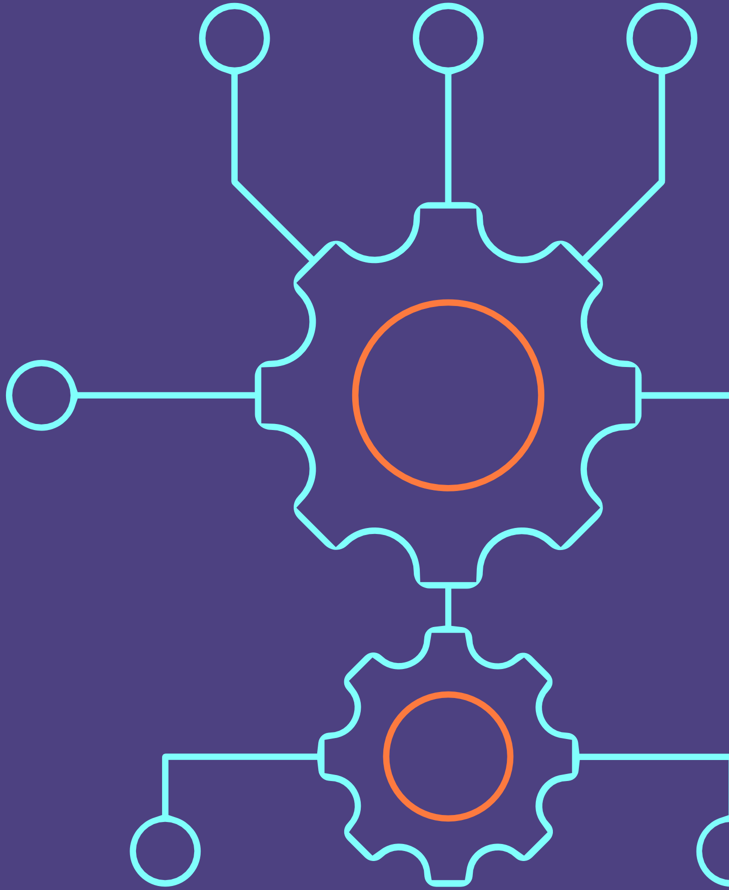
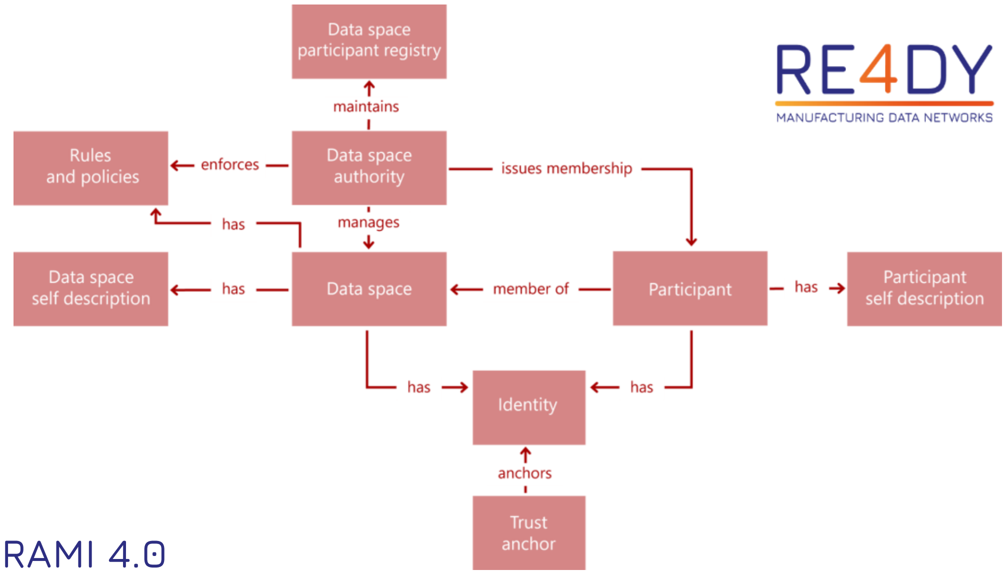
MANUFACTURING DATA NETWORKS



DSSC Data Space Operational Model Reference Architecture

RE4DY
MANUFACTURING DATA NETWORKS


Data space participant registry
maintains
Rules and policies
enforces
Data space authority
issues membership
has
manages
Data space self description
has
Data space
member of
Participant
has
Participant self description
has
Identity
has
anchors
Trust anchor

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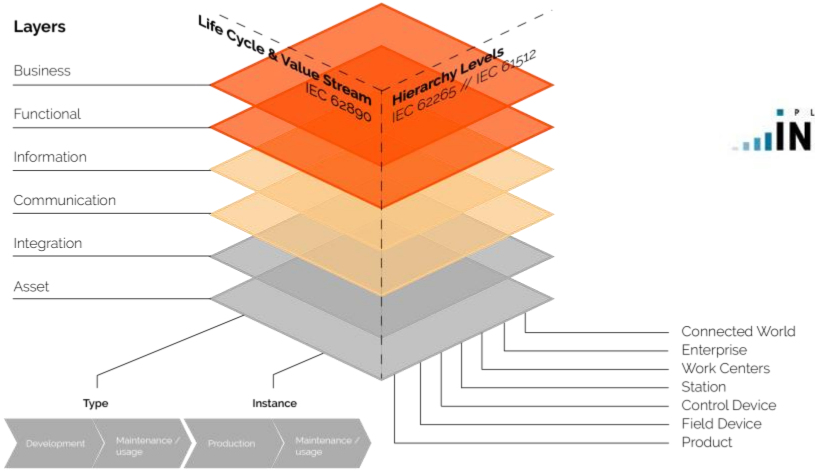
MANUFACTURING DATA NETWORKS

RAMI 4.0


Layers
Business
Functional
Information
Communication
Integration
Asset
Life Cycle & Value Stream
IEC 62890
Hierarchy Levels
IEC 62265 // IEC 61512
Connected World
Enterprise
Work Centers
Station
Control Device
Field Device
Product
Type
Instance
Development
Maintenance / usage
Production
Maintenance / usage

PLATTFORM INDUSTRIE 4.0

"Data Space for RAMI 4.0"

Reference open implementation, Standardisation

DATA SPACES SUPPORT CENTRE

DATA SPACE 4.0

FIWARE FOUNDATION

BDV BIG DATA VALUE ASSOCIATION

STANDARDIZATION COUNCIL INDUSTRIE 4.0

Catena-X Automotive Network

EFFRA EUROPEAN FACTORIES OF THE FUTURE RESEARCH ASSOCIATION

MX MANUFACTURING-X

gaia-x

INTERNATIONAL DATA SPACES ASSOCIATION

Data Spaces Building Blocks

DATA SPACES
SUPPORT CENTRE

DATA SPACE 4.0

DATA INTEROPERABILITY

- Data Models & formats
- Data Exchange API
- Provenance & Traceability

DATA SOVEREIGNITY AND TRUST

- Identity Management
- Trusted Exchange
- Access & Usage Control/Policies

DATA VALUE CREATION

- Metadata & Discovery Services
- Publication & Marketplace Services
- Data Usage Accounting

TECHNOLOGY BUILDING BLOCKS

DATA SPACES GOVERNANCE

- Business Agreements
- Operational Agreements
- Organizational Agreements

TO THE LACK OF COST-EFFICIENCY

RE4DY

MANUFACTURING DATA NETWORKS

Strategy for high value & impact generation

High
added value
products

Lighthouse
manufacturing
processes

High performance
manufacturing data networks
toolkits & ecosystems

High Added Value Products

Automotive

Aero / Space

E-Batery

Machine Tool & Automation

European Manufacturing Data Networks for Connected Factories 4.0

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MANUFACTURING DATA NETWORKS

Quality

Transparency

Trust & Sovereignty

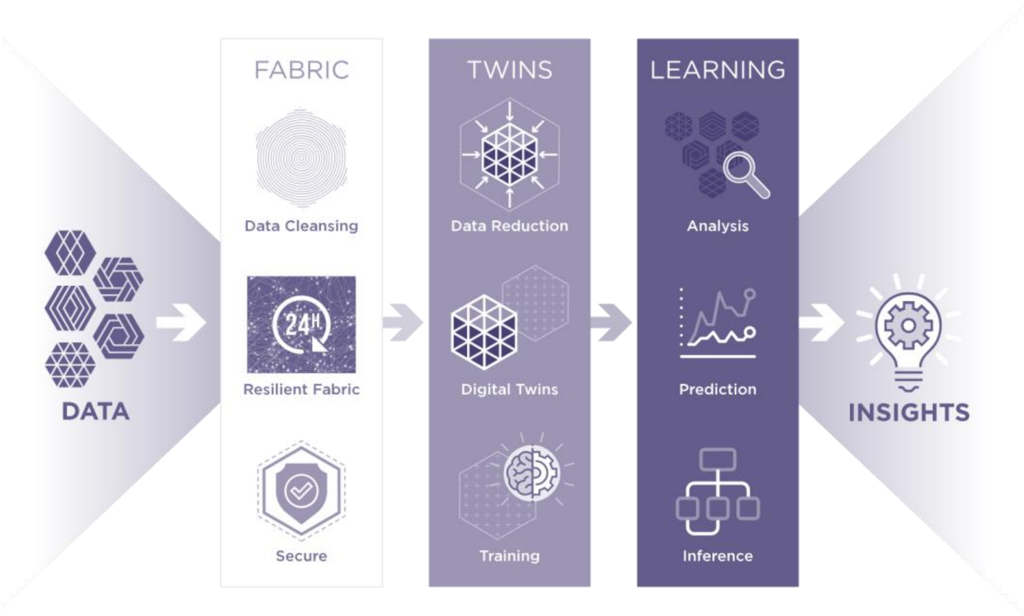
Continuity

Heterogeneity

Interoperability

RE4DY
MANUFACTURING DATA NETWORKS

Controlled
Coordinated
Collaborative
Cooperative


DATA
FABRIC
Data Cleansing
Resilient Fabric
Secure
TWINS
Data Reduction
Digital Twins
Training
LEARNING
Analysis
Prediction
Inference
INSIGHTS

CONNECTED RESILIENT LOGISTICS DESIGN & PLANNING IN AUTOMOTIVE

CEIT by asseco

COLLABORATIVE ECOSYSTEM RESILIENT PRODUCT/PRODUCTION SYSTEM ENGINEERING

AVL

FILL

COORDINATED ECOSYSTEM INTEGRATED PERFORMANCE SELF-OPTIMISATION

+GF+

fraisa

COOPERATIVE MULTI-PLANT TURBINE PRODUCTION WITH PREDICTIVE QUALITY CHAINS

Avio Aero
A GE Aviation Business

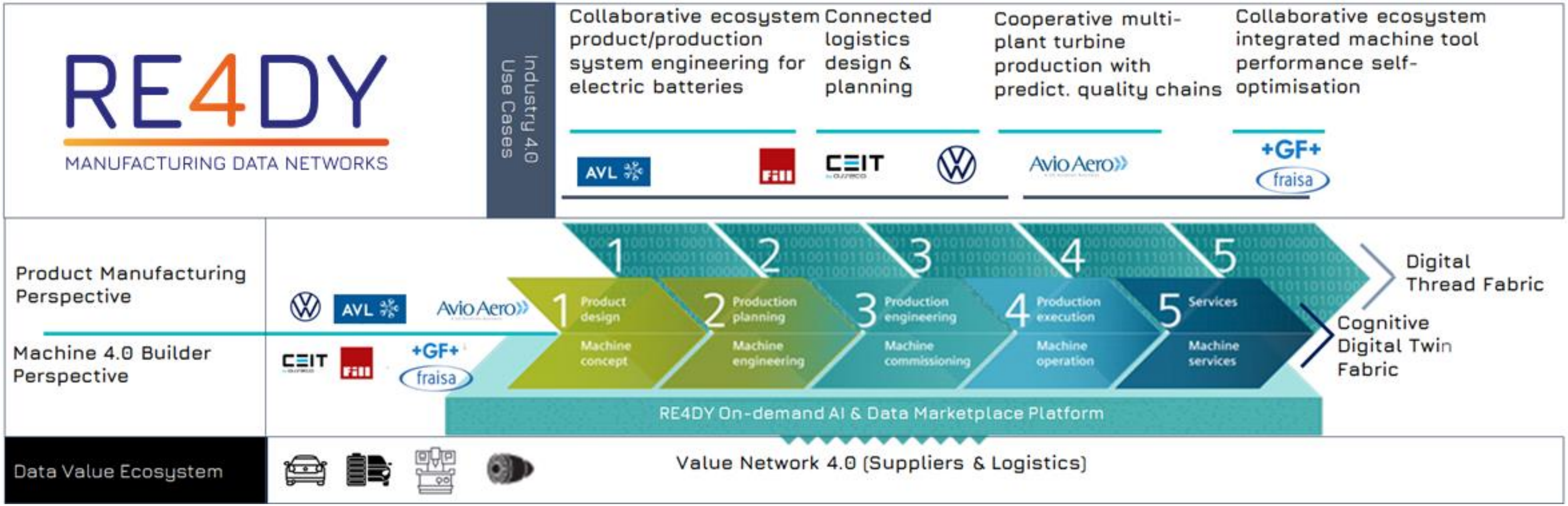
ENGINEERING

10+
MDN BUSINESS PROCESSES

4
OPEN MDN PROOFS OF CONCEPT (POC)

Resilience and autonomy are built across all the product and process lifecycle

RE4DY
MANUFACTURING DATA NETWORKS


RE4DY
MANUFACTURING DATA NETWORKS
Industry 4.0 Use Cases
Collaborative ecosystem product/production system engineering for electric batteries
Connected logistics design & planning
Cooperative multi-plant turbine production with predict. quality chains
Collaborative ecosystem integrated machine tool performance self-optimisation
AVL
Fill
CEIT
Avio Aero
+GF+
fraisa
Product Manufacturing Perspective
Machine 4.0 Builder Perspective
1 Product design
Machine concept
2 Production planning
Machine engineering
3 Production engineering
Machine commissioning
4 Production execution
Machine operation
5 Services
Machine services
1
2
3
4
5
Digital Thread Fabric
Cognitive Digital Twin Fabric
RE4DY On-demand AI & Data Marketplace Platform
Data Value Ecosystem
Value Network 4.0 (Suppliers & Logistics)

MDN Factory 4.0 Competitive Advantages

RE4DY
MANUFACTURING DATA NETWORKS

1. AVL electric battery product/production collaborative system **engineering** & virtual **commissioning**
2. VWAE resilient automotive logistics **generative** design & planning

Smart Digital Product and Process Engineering & Planning

3. +GF+ Integrated machine tool performance **self-optimisation**
4. AVIO Multi-plant **predictive ZDM** turbine production

Dynamic **Circular** Asset Management & Agile Production

4
PILOT
FACTORIES
RAMPED-UP

Data-driven Factory Processes vs Manufacturing Data Value Networks

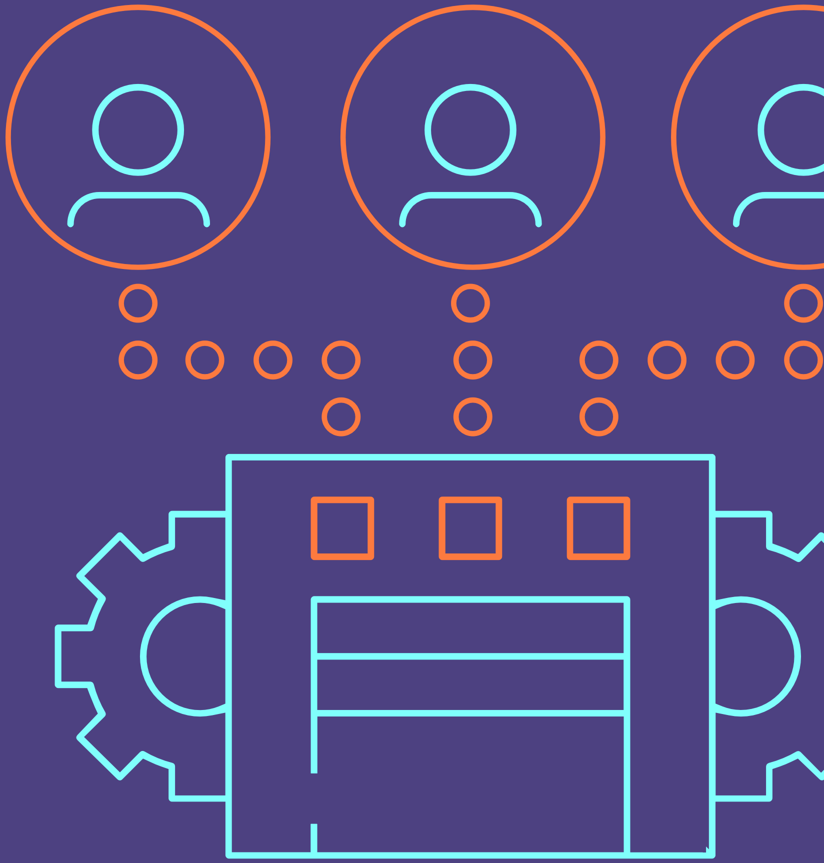
4

BIG DATA VALUE NETWORK SCENARIOS

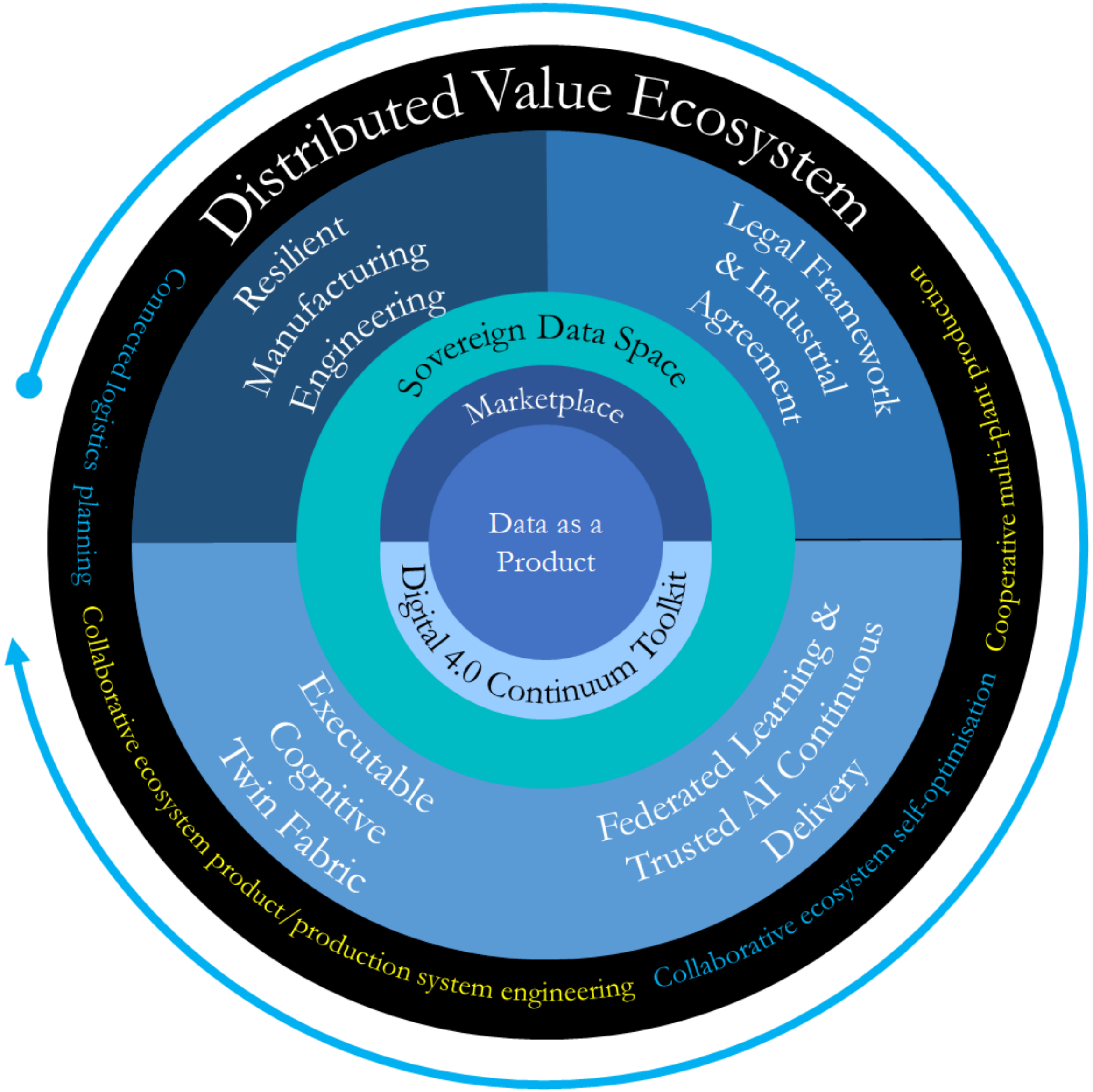
	Smart Digital Product and Process Engineering & Planning		Dynamic Circular Asset Management & Agile Production	
	Fill AVL	VW CEIT by asseco	Avio Aero ENGINEERING	+GF+ fraisa
All products One manufacturer			++	
All machines One production line	+	++	+	
All data sources One business activity		+		++
All suppliers & consumers One product	++			+

TO THE LACK OF MANUFACTURER-SUPPLIER CONNECTION

RE4DY
MANUFACTURING DATA NETWORKS



RE4DY Manufacturing Data Networks



Distributed Value Ecosystem

Resilient Manufacturing Engineering

Legal Framework & Industrial Agreement

Sovereign Data Space

Marketplace

Data as a Product

Digital 4.0 Continuum Toolkit

Executable Cognitive Twin Fabric

Federated Learning & Trusted AI Continuous Delivery

Connected logistics planning

Cooperative multi-plant production

Collaborative ecosystem self-optimisation

Collaborative ecosystem product/production system engineering

Hierarchical & Non-hierarchical Data Value Network Scenarios

1

All products
One manufacturer

Interoperability across **vertical** services, data sources & **platforms**

2

All machines
One production line

Interoperability across **digital twins** & administration shells

3

All data sources
One business activity

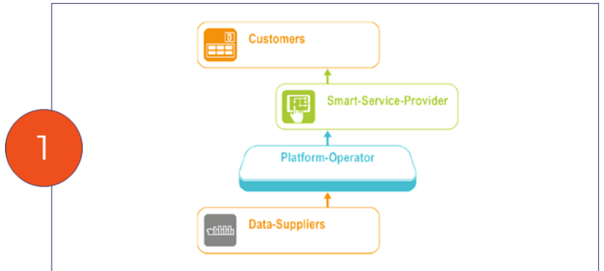
Interoperability across open & industrial **data assets**

4

All suppliers & consumers
One product

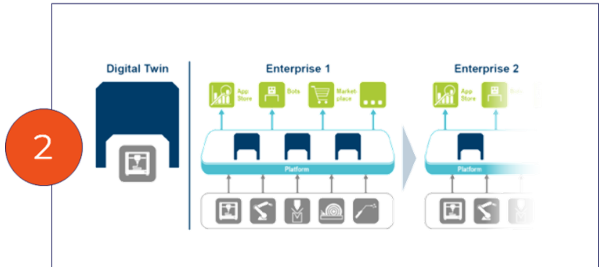
Interoperability across data silos in the **product lifecycle**.

1


Customers
Smart-Service-Provider
Platform-Operator
Data-Suppliers

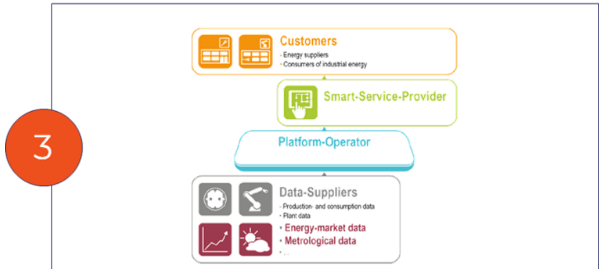
All products of one manufacturer

2


Digital Twin
Enterprise 1
Enterprise 2
Platform
Platform

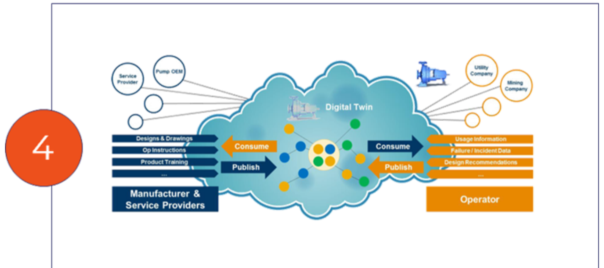
All machines of one production line

3


Customers
Energy suppliers
Consumers of industrial energy
Smart-Service-Provider
Platform-Operator
Data-Suppliers
Production- and consumption data
Plant data
Energy-market data
Metrological data

All data sources for one business activity

4


Service Provider
Pump OEM
Utility Company
Mining Company
Digital Twin
Designs & Drawings
Op Instructions
Product Training
Consume
Publish
Consume
Publish
Usage Information
Failure / Incident Data
Design Recommendations
Manufacturer & Service Providers
Operator

All suppliers and consumers of one product type

TO THE LACK OF OPERABILITY

RE4DY

MANUFACTURING DATA NETWORKS

Reference Architecture for Manufacturing Industry 4.0 (RAMI 4.0)

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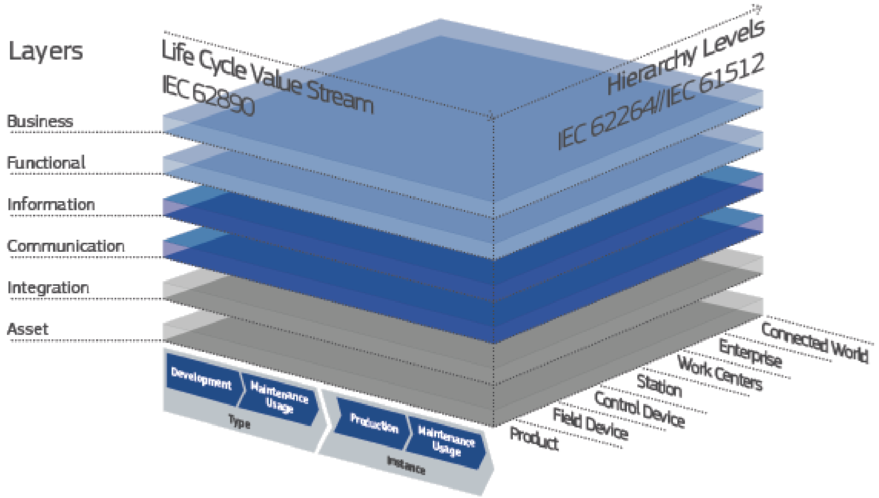
MANUFACTURING DATA NETWORKS

PLATTFORM INDUSTRIE 4.0


Layers
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Life Cycle Value Stream
IEC 62890
Hierarchy Levels
IEC 62264//IEC 61512
Connected World
Enterprise
Work Centers
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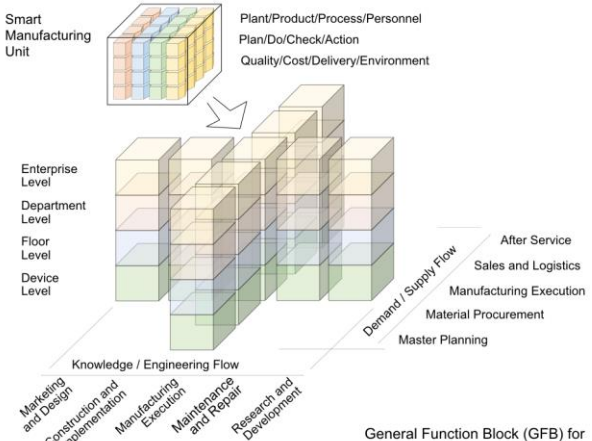
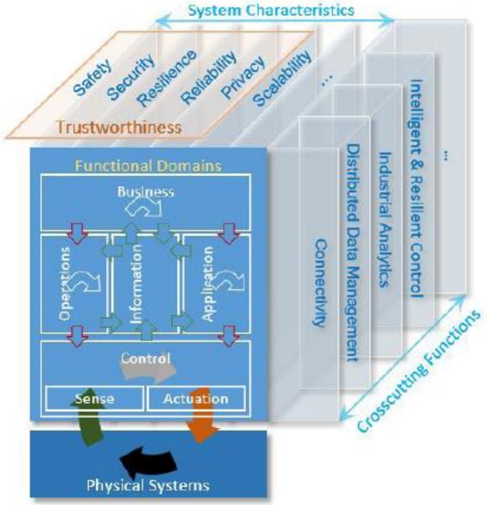
Control Device
Field Device
Product
Development
Maintenance Usage
Type
Production
Maintenance Usage
Instance

Source: Plattform Industrie 4.0 and ZVEI

Smart production


Smart Manufacturing Unit
Plant/Product/Process/Personnel
Plan/Do/Check/Action
Quality/Cost/Delivery/Environment
Enterprise Level
Department Level
Floor Level
Device Level
After Service
Sales and Logistics
Manufacturing Execution
Material Procurement
Master Planning
Demand / Supply Flow
Knowledge / Engineering Flow
Marketing and Design
Construction and Implementation
Manufacturing Execution
Maintenance and Repair
Research and Development

General Function Block (GFB) for smart manufacturing


System Characteristics
Safety
Security
Resilience
Reliability
Privacy
Scalability
...
Trustworthiness
Functional Domains
Business
Operations
Information
Application
Control
Sense
Actuation
Physical Systems
Connectivity
Distributed Data Management
Industrial Analytics
Intelligent & Resilient Control
...
Crosscutting Functions

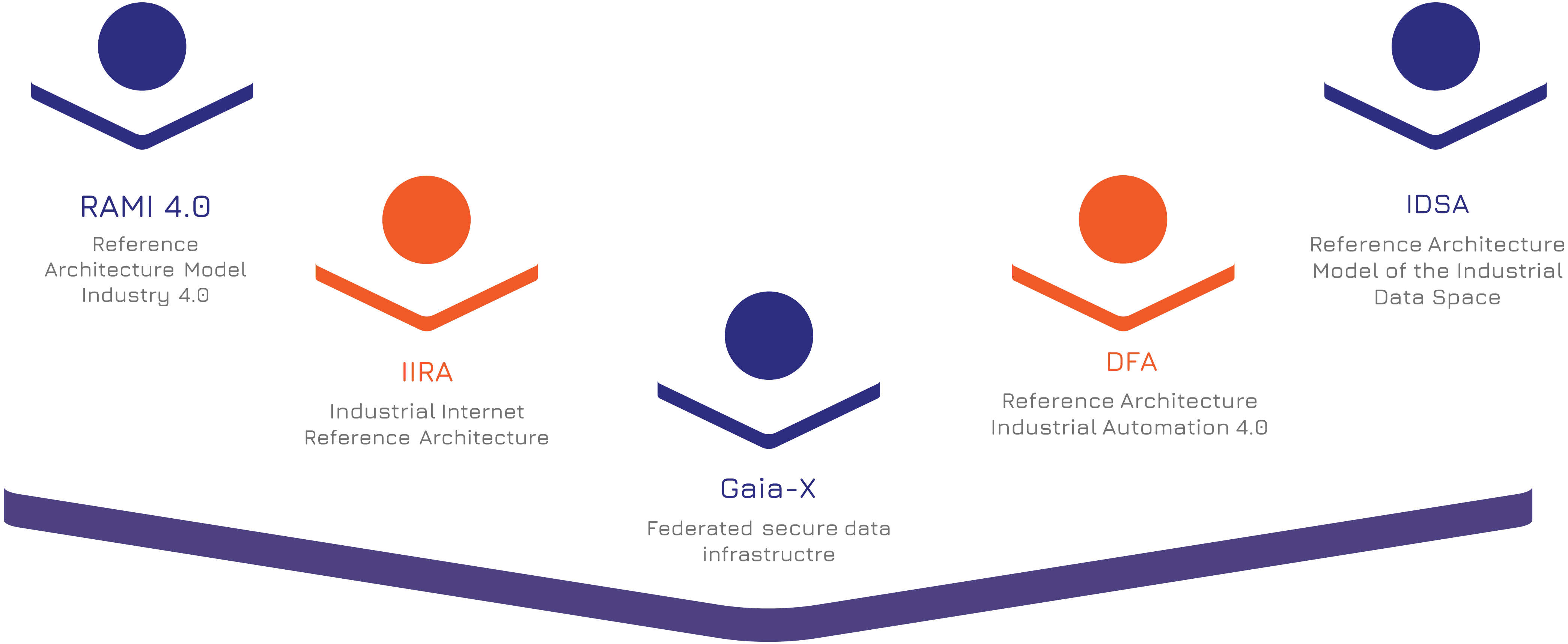
IVI Industrial Value Chain Initiative
Connected ! Manufacturing

Smart supply chain

Smart product

industrial internet CONSORTIUM

From Industry 4.0 towards data driven operations



RAMI 4.0

Reference
Architecture Model
Industry 4.0

IIRA

Industrial Internet
Reference Architecture

Gaia-X

Federated secure data
infrastructre

DFA

Reference Architecture
Industrial Automation 4.0

IDSA

Reference Architecture
Model of the Industrial
Data Space

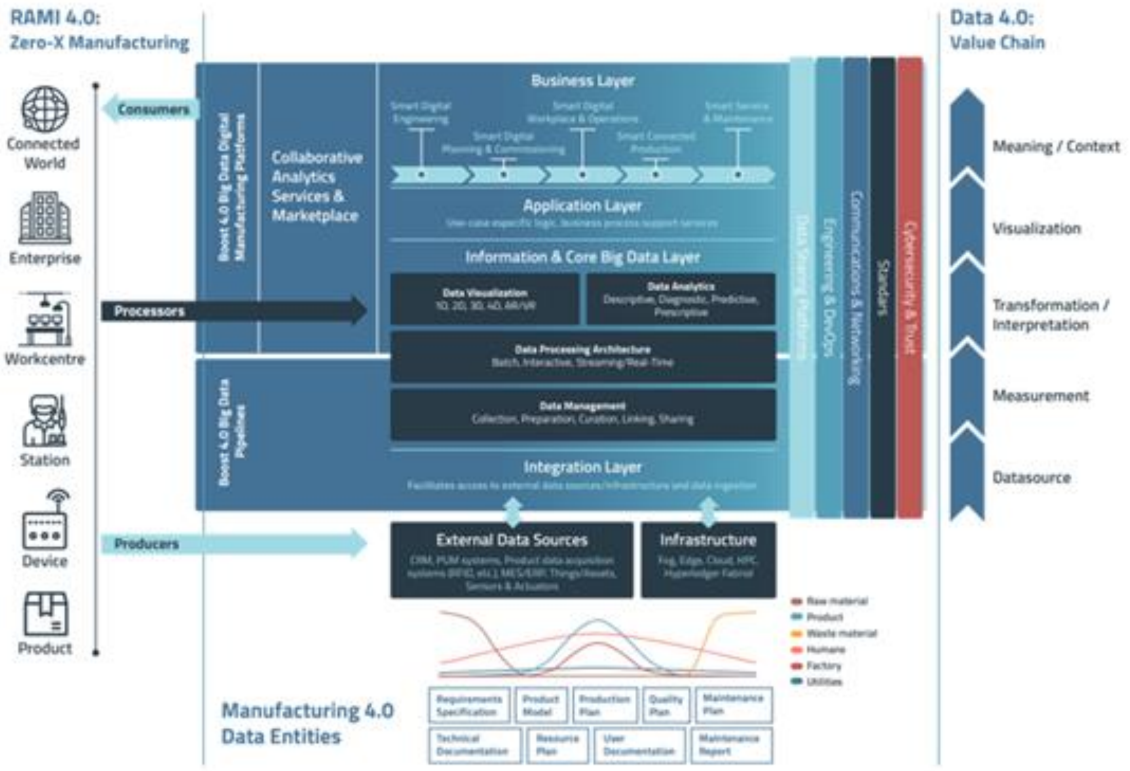
RE4DY Reference Architecture

modelled using ISO/IEC/IEEE 42010

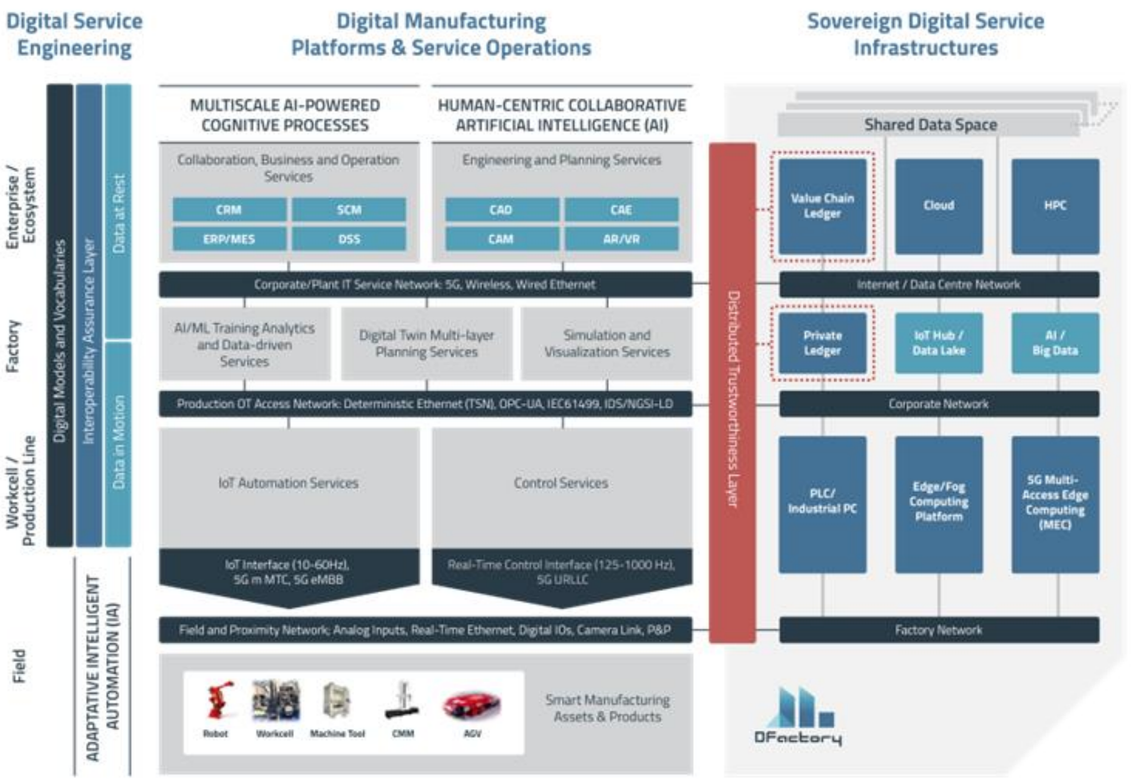
Reference architecture for Industry 4.0: Towards data driven digital manufacturing platforms

RE4DY
MANUFACTURING DATA NETWORKS

ISO 20547 – (BIG) DATA PIPELINE REF. ARCH


RAMI 4.0:
Zero-X Manufacturing
Connected World
Enterprise
Workcentre
Station
Device
Product
Consumers
Processors
Producers
Boost 4.0 Big Data Digital Manufacturing Platforms
Collaborative Analytics Services & Marketplace
Boost 4.0 Big Data Pipelines
Business Layer
Smart Digital Engineering
Smart Digital Planning & Commissioning
Smart Digital Workplace & Operations
Smart Connected Production
Smart Service & Maintenance
Application Layer
Use-case specific logic, business process support services
Information & Core Big Data Layer
Data Visualization
1D, 2D, 3D, 4D, AR/VR
Data Analytics
Descriptive, Diagnostic, Predictive, Prescriptive
Data Processing Architecture
Batch, Interactive, Streaming/Real-Time
Data Management
Collection, Preparation, Curation, Linking, Sharing
Integration Layer
Facilitates access to external data sources/infrastructure and data ingestion
External Data Sources
CRM, PLM systems, Product data acquisition systems (RFID, etc.), MES/ERP, Things/Assets, Sensors & Actuators
Infrastructure
Fog, Edge, Cloud, HPC, Hyperledger Fabric
Data Sharing Platforms
Engineering & DevOps
Communications & Networking
Standars
Cybersecurity & Trust
Data 4.0:
Value Chain
Meaning / Context
Visualization
Transformation / Interpretation
Measurement
Datasource
Raw material
Product
Waste material
Humans
Factory
Utilities
Manufacturing 4.0 Data Entities
Requirements Specification
Product Model
Production Plan
Quality Plan
Maintenance Plan
Technical Documentation
Resource Plan
User Documentation
Maintenance Report

ISO/IEC/IEEE 42010 OPEN INDUSTRIAL AUTOMATION SERVICE INTEGRATION REF ARCH


Digital Service Engineering
Digital Manufacturing Platforms & Service Operations
Sovereign Digital Service Infrastructures
Enterprise / Ecosystem
Factory
Workcell / Production Line
Field
Digital Models and Vocabularies
Interoperability Assurance Layer
Data at Rest
Data in Motion
ADAPTATIVE INTELLIGENT AUTOMATION (IA)
MULTISCALE AI-POWERED COGNITIVE PROCESSES
HUMAN-CENTRIC COLLABORATIVE ARTIFICIAL INTELLIGENCE (AI)
Collaboration, Business and Operation Services
CRM
SCM
ERP/MES
DSS
Engineering and Planning Services
CAD
CAE
CAM
AR/VR
Corporate/Plant IT Service Network: 5G, Wireless, Wired Ethernet
AI/ML Training Analytics and Data-driven Services
Digital Twin Multi-layer Planning Services
Simulation and Visualization Services
Production OT Access Network: Deterministic Ethernet (TSN), OPC-UA, IEC61499, IDS/NGSI-LD
IoT Automation Services
Control Services
IoT Interface (10-60Hz), 5G m MTC, 5G eMBB
Real-Time Control Interface (125-1000 Hz), 5G URLLC
Field and Proximity Network: Analog Inputs, Real-Time Ethernet, Digital IOs, Camera Link, P&P
Robot
Workcell
Machine Tool
CMM
AGV
Smart Manufacturing Assets & Products
Distributed Trustworthiness Layer
Shared Data Space
Value Chain Ledger
Cloud
HPC
Internet / Data Centre Network
Private Ledger
IoT Hub / Data Lake
AI / Big Data
Corporate Network
PLC/ Industrial PC
Edge/Fog Computing Platform
5G Multi-Access Edge Computing (MEC)
Factory Network
DFactory

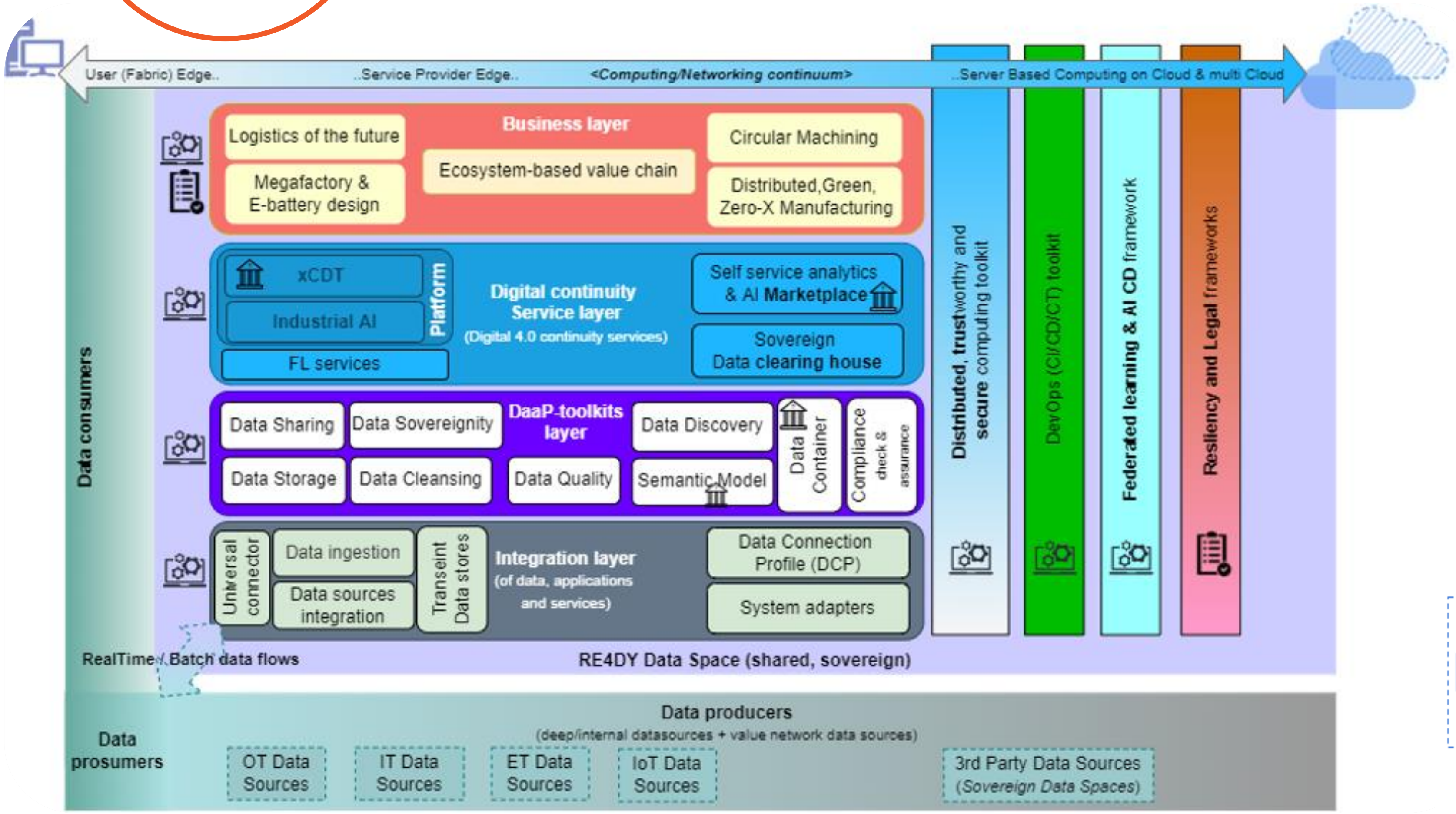
Boost 4.0
BIG DATA FOR FACTORIES

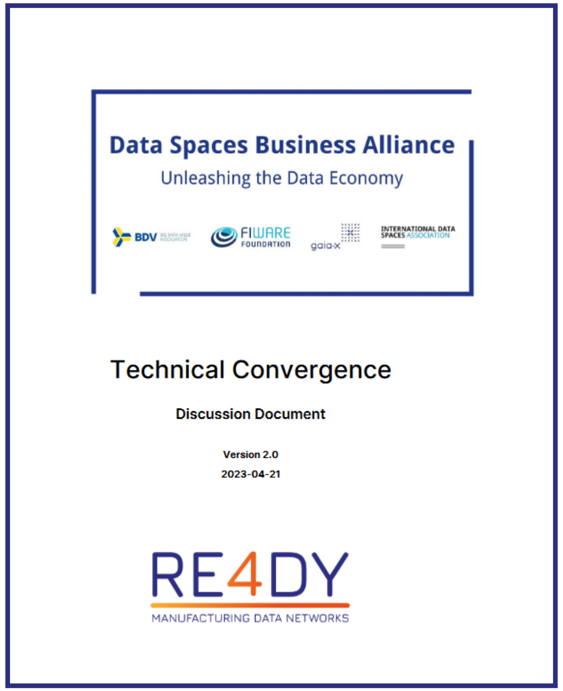
1

DIGITAL 4.0
CONTINUITY REF.
ARCHITECTURE

RE4DY Reference Architecture for Manufacturing Data Networks

RE4DY
MANUFACTURING DATA NETWORKS


User (Fabric) Edge..
..Service Provider Edge..
<Computing/Networking continuum>
..Server Based Computing on Cloud & multi Cloud
Data consumers
Business layer
Logistics of the future
Megafactory & E-battery design
Ecosystem-based value chain
Circular Machining
Distributed, Green, Zero-X Manufacturing
xCDT
Industrial AI
Platform
FL services
Digital continuity Service layer
(Digital 4.0 continuity services)
Self service analytics & AI Marketplace
Sovereign Data clearing house
Data Sharing
Data Sovereignity
DaaP-toolkits layer
Data Discovery
Data Container
Compliance check & assurance
Data Storage
Data Cleansing
Data Quality
Semantic Model
Universal connector
Data ingestion
Data sources integration
Transeint Data stores
Integration layer
(of data, applications and services)
Data Connection Profile (DCP)
System adapters
Distributed, trustworthy and secure computing toolkit
DevOps (CI/CD/CT) toolkit
Federated learning & AI CD framework
Resiliency and Legal frameworks
RealTime / Batch data flows
RE4DY Data Space (shared, sovereign)
Data prosumers
Data producers
(deep/internal datasources + value network data sources)
OT Data Sources
IT Data Sources
ET Data Sources
IoT Data Sources
3rd Party Data Sources
(Sovereign Data Spaces)

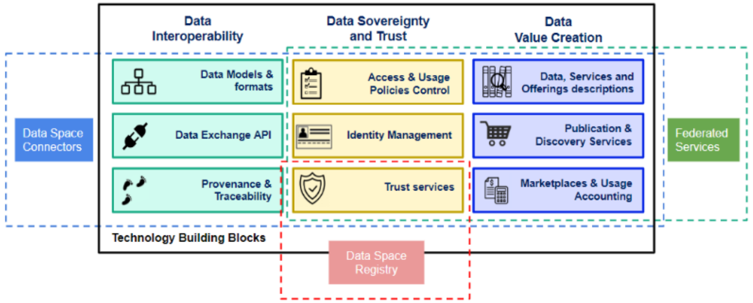

Data Spaces Business Alliance
Unleashing the Data Economy

Technical Convergence

Discussion Document

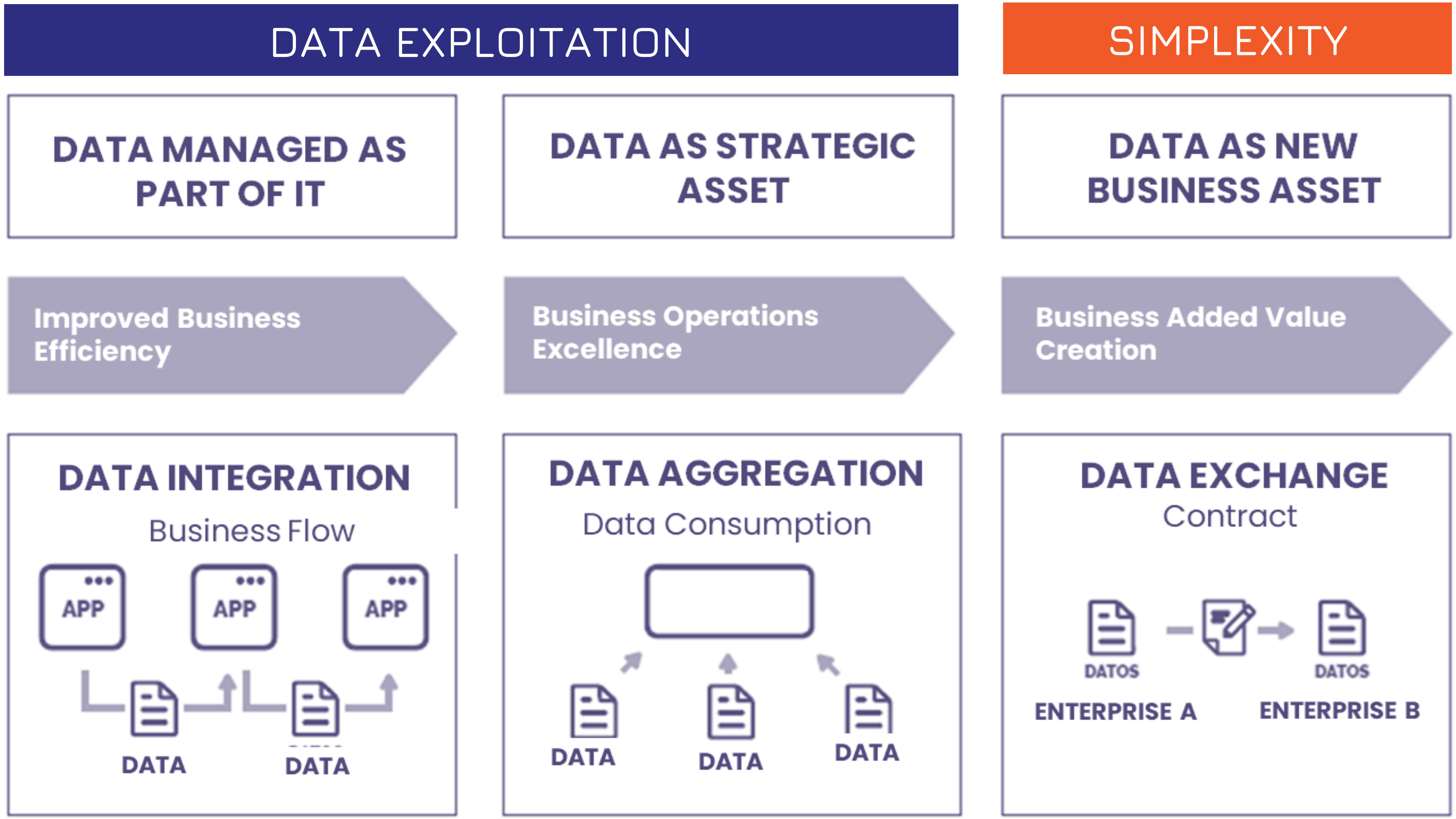
Version 2.0
2023-04-21

RE4DY
MANUFACTURING DATA NETWORKS


Data Interoperability
Data Sovereignty and Trust
Data Value Creation
Data Models & formats
Access & Usage Policies Control
Data, Services and Offerings descriptions
Data Space Connectors
Data Exchange API
Identity Management
Publication & Discovery Services
Federated Services
Provenance & Traceability
Trust services
Marketplaces & Usage Accounting
Technology Building Blocks
Data Space Registry

Hierarchical & Non-hierarchical Data Value Network Scenarios

RE4DY
MANUFACTURING DATA NETWORKS



DATA EXPLOITATION

DATA MANAGED AS PART OF IT

Improved Business Efficiency

DATA INTEGRATION

Business Flow

APP
APP
APP
DATA
DATA

DATA AS STRATEGIC ASSET

Business Operations Excellence

DATA AGGREGATION

Data Consumption

DATA
DATA
DATA

SIMPLEXITY

DATA AS NEW BUSINESS ASSET

Business Added Value Creation

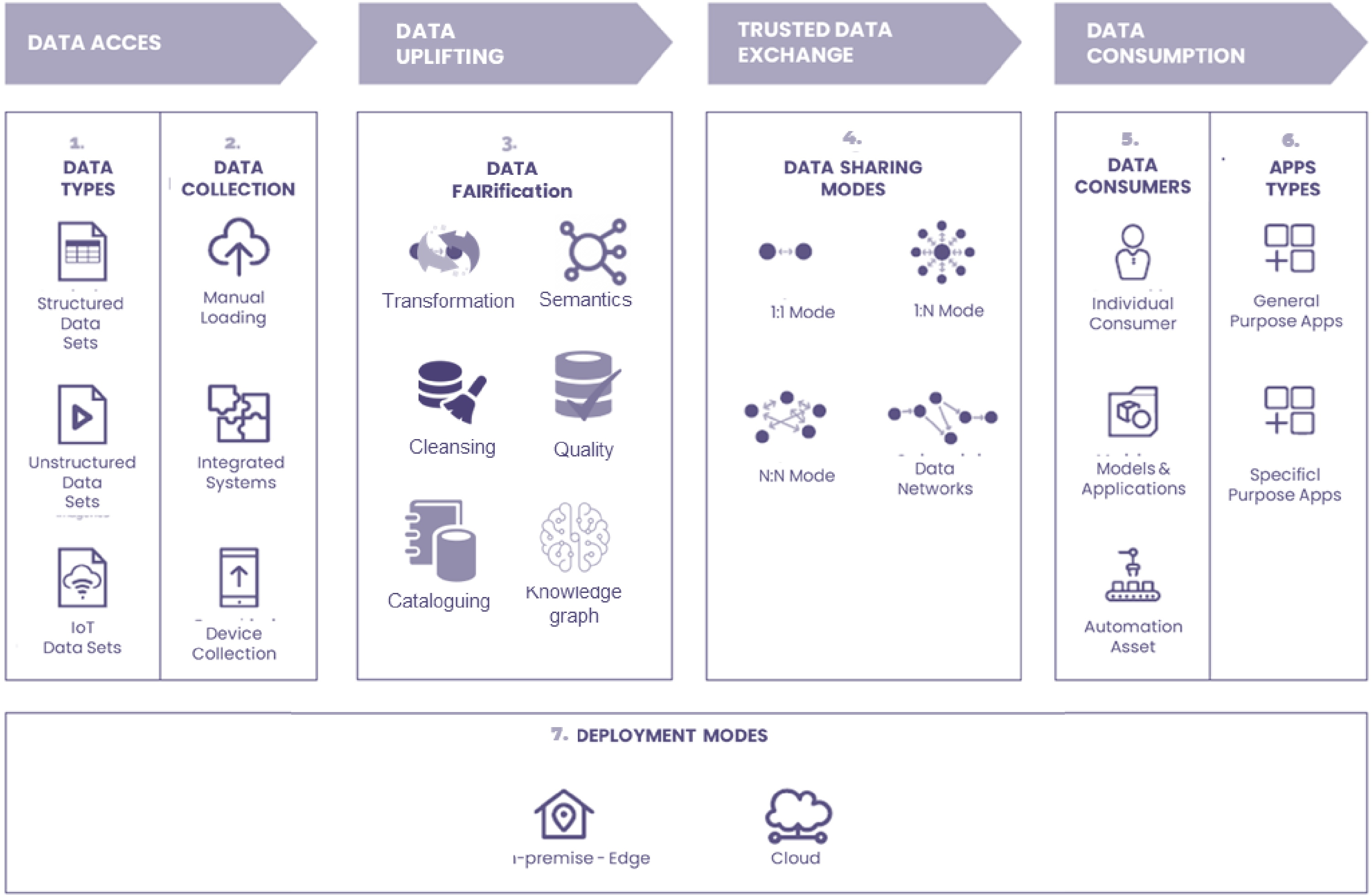
DATA EXCHANGE

Contract

DATOS
DATOS
ENTERPRISE A
ENTERPRISE B

80 20

Hierarchical & Non-hierarchical Data Value Network Scenarios



DATA ACCES

1. **DATA TYPES**
- Structured Data Sets
- Unstructured Data Sets
- IoT Data Sets

2. **DATA COLLECTION**
- Manual Loading
- Integrated Systems
- Device Collection

DATA UPLIFTING

3. **DATA FAIRification**
- Transformation
- Semantics
- Cleansing
- Quality
- Cataloguing
- Knowledge graph

TRUSTED DATA EXCHANGE

4. **DATA SHARING MODES**
- 1:1 Mode
- 1:N Mode
- N:N Mode
- Data Networks

DATA CONSUMPTION

5. **DATA CONSUMERS**
- Individual Consumer
- Models & Applications
- Automation Asset

6. **APPS TYPES**
- General Purpose Apps
- Specificl Purpose Apps

7. **DEPLOYMENT MODES**
- ı-premise - Edge
- Cloud

INTEROPERABILITY

TECHNOLOGY FOUNDATION

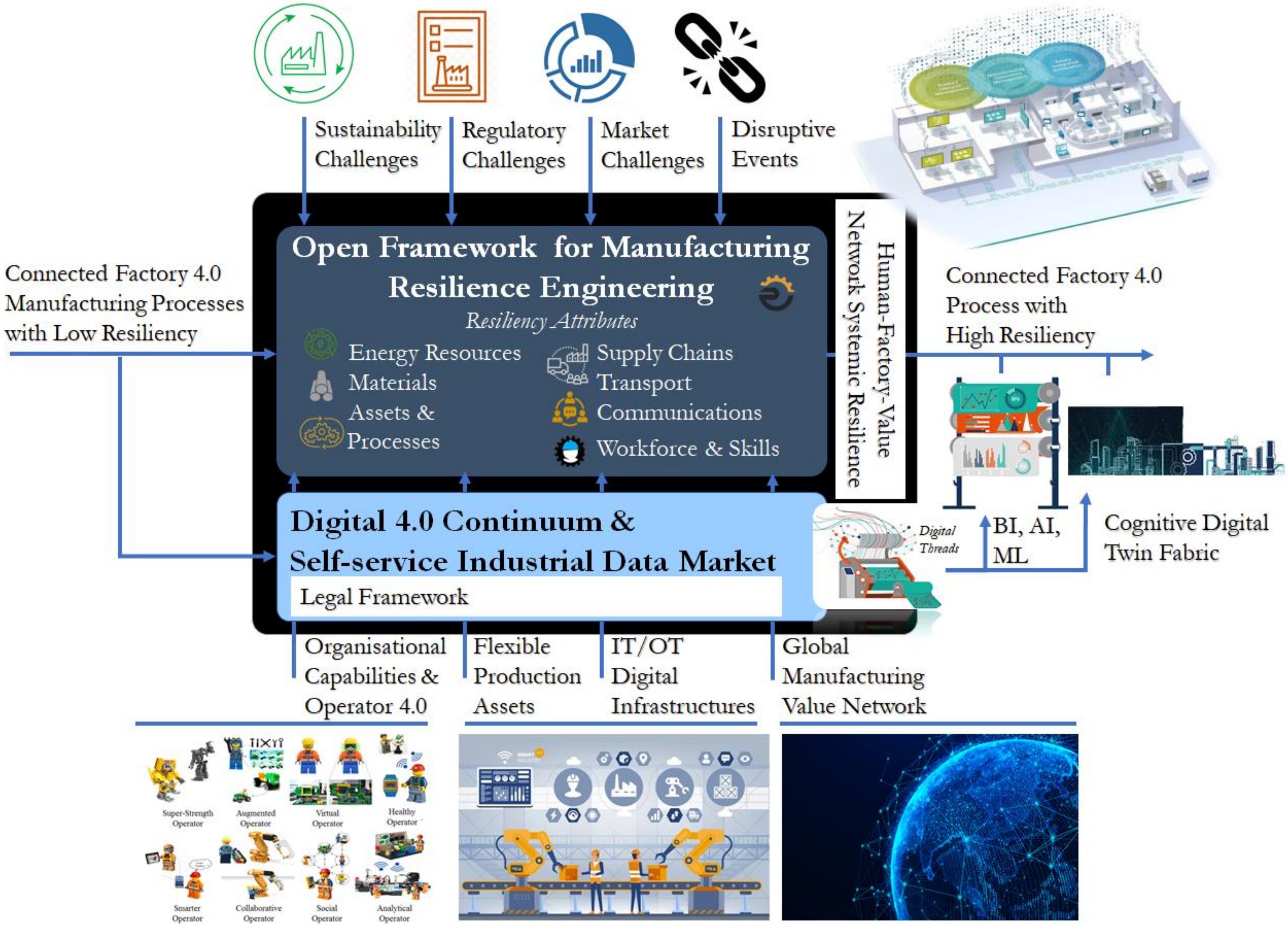
TO THE LACK OF COMMON TOOLS

RE4DY
MANUFACTURING DATA NETWORKS

RE4DY Active Resilience Reference Framework

RE4DY
MANUFACTURING DATA NETWORKS

1
ACTIVE RESILIENCE
REF.
FRAMEWORK



Sustainability Challenges

Regulatory Challenges

Market Challenges

Disruptive Events

Connected Factory 4.0 Manufacturing Processes with Low Resiliency

Open Framework for Manufacturing Resilience Engineering

Resiliency Attributes

- Energy Resources
- Materials
- Assets & Processes
- Supply Chains
- Transport
- Communications
- Workforce & Skills

Human-Factory-Value Network Systemic Resilience

Connected Factory 4.0 Process with High Resiliency

Digital 4.0 Continuum & Self-service Industrial Data Market

Legal Framework

BI, AI, ML

Cognitive Digital Twin Fabric

Organisational Capabilities & Operator 4.0

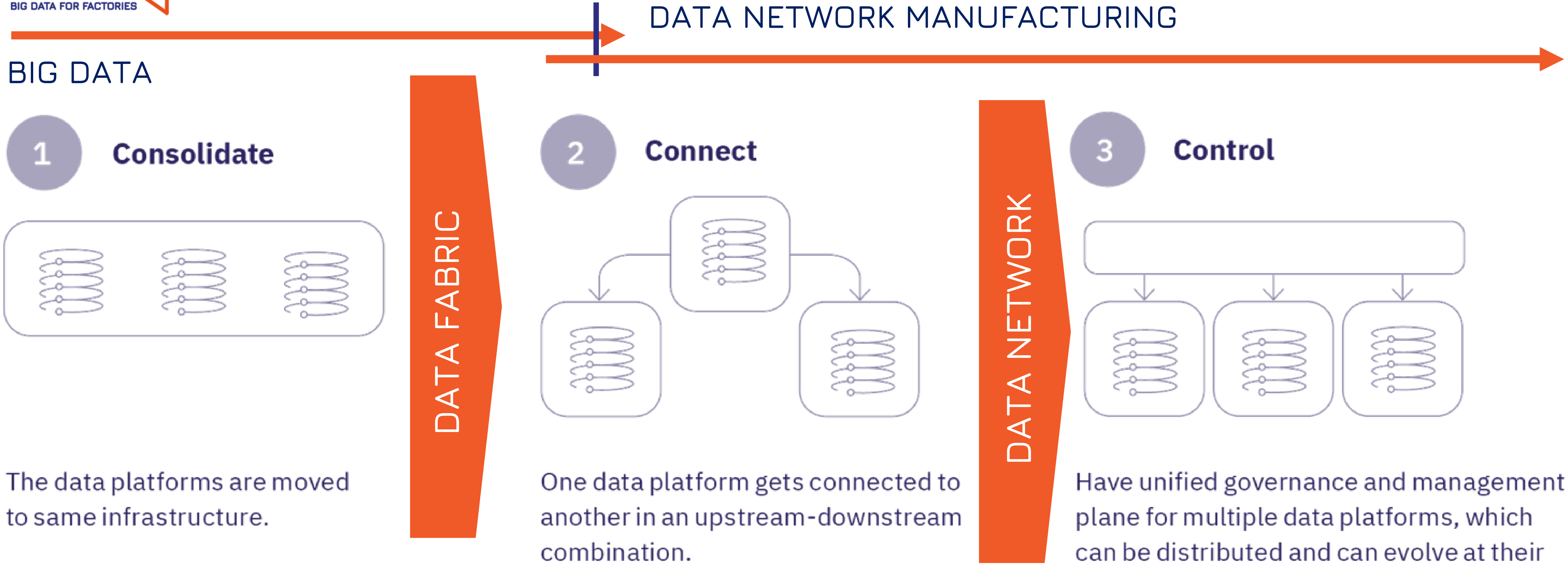
Flexible Production Assets

IT/OT Digital Infrastructures

Global Manufacturing Value Network

Digital Threads
Super-Strength Operator
Augmented Operator
Virtual Operator
Healthy Operator
Smarter Operator
Collaborative Operator
Social Operator
Analytical Operator

Manufacturing Data Networks Vision



BIG DATA

DATA NETWORK MANUFACTURING

DATA FABRIC

DATA NETWORK

1 Consolidate

The data platforms are moved to same infrastructure.

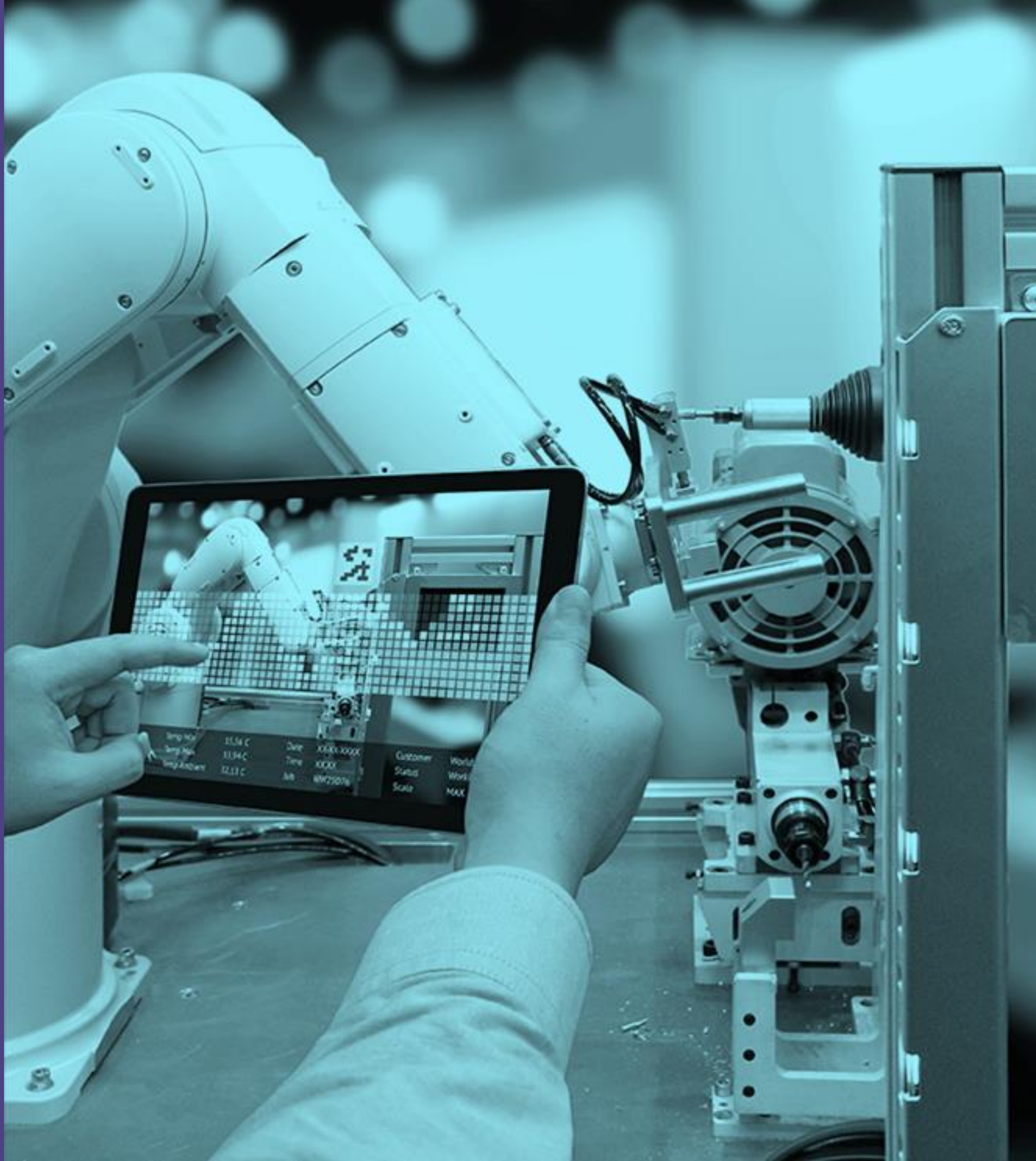
2 Connect

One data platform gets connected to another in an upstream-downstream combination.

3 Control

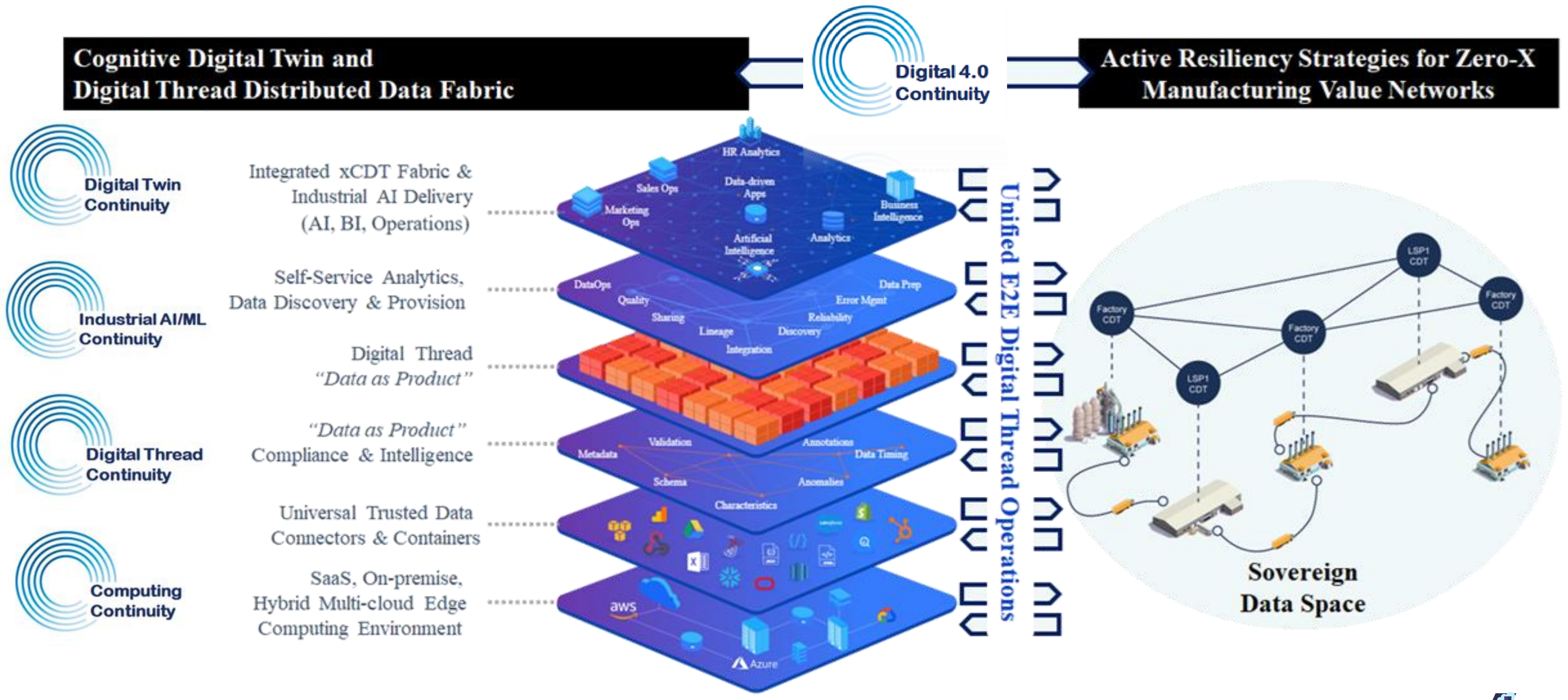
Have unified governance and management plane for multiple data platforms, which can be distributed and can evolve at their own pace and strength.

“Digital Continuity Toolkit”



Digital Continuity 4.0 Reference Model

RE4DY
MANUFACTURING DATA NETWORKS



Cognitive Digital Twin and Digital Thread Distributed Data Fabric

Digital 4.0 Continuity

Active Resiliency Strategies for Zero-X Manufacturing Value Networks

Digital Twin Continuity

Industrial AI/ML Continuity

Digital Thread Continuity

Computing Continuity

Integrated xCDT Fabric & Industrial AI Delivery (AI, BI, Operations)

Self-Service Analytics, Data Discovery & Provision

Digital Thread *"Data as Product"*

"Data as Product" Compliance & Intelligence

Universal Trusted Data Connectors & Containers

SaaS, On-premise, Hybrid Multi-cloud Edge Computing Environment

Unified E2E Digital Thread Operations

Sovereign Data Space

HR Analytics
Sales Ops
Data-driven Apps
Marketing Ops
Business Intelligence
Artificial Intelligence
Analytics
DataOps
Data Prep
Quality
Error Mgmt
Sharing
Reliability
Lineage
Discovery
Integration
Validation
Annotations
Metadata
Data Timing
Schema
Anomalies
Characteristics
aws
Azure
LSP1 CDT
Factory CDT
Factory CDT
Factory CDT
LSP1 CDT

RE4DY: Digital 4.0 Fabric Management Toolkit

- Static & dynamic executable cognitive digital twin (xCDT) commissioning tools
- Trusted industrial AI & federated data continuous delivery tools (data marketplace)
- Knowledge quality tools, reusable models, common semantics & vocabularies 4.0
- Distributed data fabric FAIRness, quality, sovereignty, security & compliance tools
- Optimised distributed data edge-fog-cloud computation & networking

ENGINEERING
NOVA id FCT
SIEMENS
POLITECNICO MILANO 1863
Digital Twin Continuity

Atos
netcompany intrasoft
core
ATLANTIS ENGINEERING
Industrial AI/ML Continuity

OiU University of Oslo
INDUSTRY COMMONS
VISUAL COMPONENTS
DATAPIXEL QUALITY CONTROL ENGINEERING
Digital Thread Continuity

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S21 SEC
UNINOVA
innovalia ASSOCIATION
Digital Thread Continuity

UNIVERSITAT POLITÈCNICA DE VALÈNCIA
Consiglio Nazionale delle Ricerche
UNIVERSITAS Miguel Hernández
JUNTA DE ANDALUCIA SANDETEL
Computing Continuity

RE4DY

MANUFACTURING DATA NETWORKS

MANY THANKS!

Dr Oscar Lazaro