

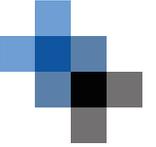


**INC
INVENTION
CENTER**



Application technology of Industrie 4.0 for Print 4.0

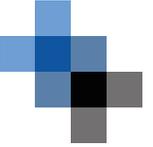
Dr. Benny Drescher and Dr. Andreas Kraushaar



Please ask your questions at any time in the Questions and Answers function.

A moderator collects your questions, which will be answered in a 20-30 minute Q&A session at the end of the seminar.

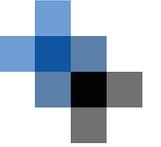
Welcome – About us



Dr. Benny Drescher
Director Technology Hong Kong
INC Invention Center at RWTH
Aachen Campus



Dr. Andreas Kraushaar
Head of Department Prepress
Fogra Research Institute for Media
Technologies



Technology trends

Idea to Industry

Disruptive Strategies

Time to market

Innovation culture

OEM to ODM

Agile Development

»We create world class innovators«

Market trends

New business models

Decision making

Market launch

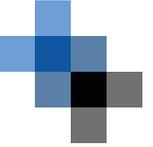
Digitalization

Portfolio Management

Roadmapping

Success Stories

»» A clear strategy and mastered process to success



e.GO Mover



e.GO



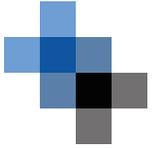
STREETSCOOTER!



e.SAT



Your entrance card to 'Engineering Valley' at RWTH campus



Research: Fraunhofer IPT and WZL

Opinion leaders since the beginning and current internationally renowned strong expertise



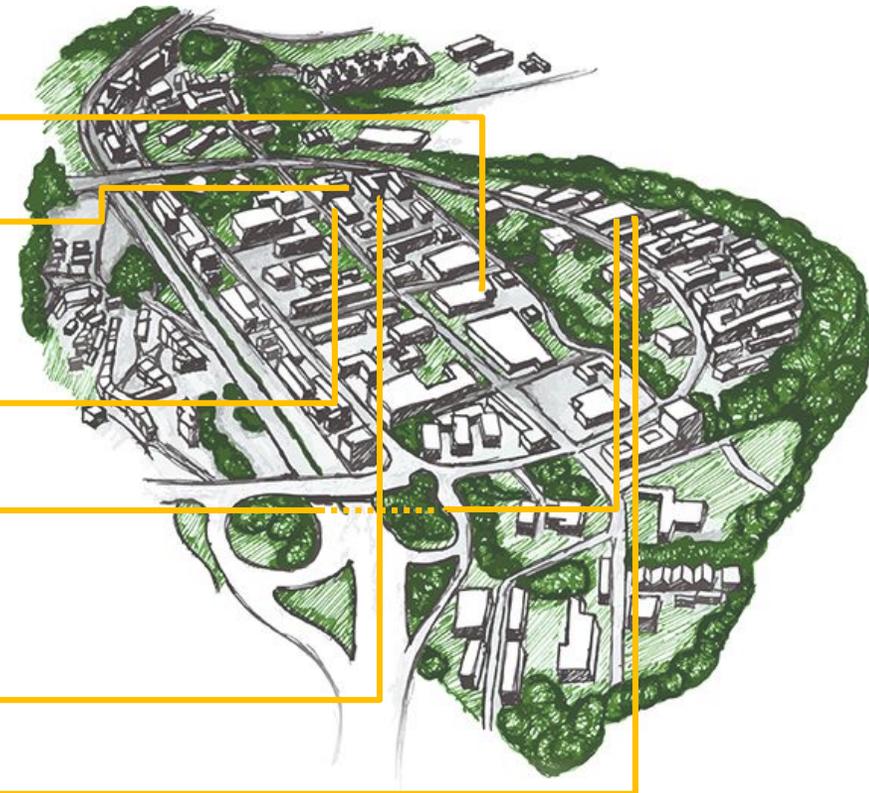
Industry support: KEX and I4.0MC

Cutting-edge research interpreted and condensed to meet industry needs

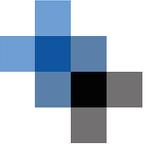


Application: e.GO

Examples of Industrie 4.0 in real production – from prototyping to electric car production in series



What we do



Community

Interact with our community of leading innovators and researchers to find valuable collaboration opportunities



Advisory

Get support from the concept to the implementation phase to make your innovations faster and more successful



Implementation

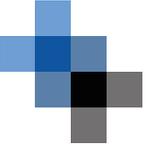
Get access to top technology, market & innovation experts and find out about relevant trends & developments ahead of time



Trainings

Build up the skills in your employee base to become a world-class innovator for your products, production and services

Your partner for innovation in Hong Kong



Our focus areas in Hong Kong are:



INDUSTRIE 4.0

Helping companies to
Industrie 4.0 in the
Greater Bay Area



TECHNOLOGY

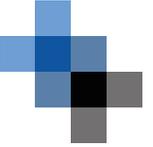
Bringing top-edge
German technology
expertise and
engineering in
Industrie 4.0 and Data
Analytics to your
projects



INNOVATION

Program to transform
traditional OEM
manufacturers to OBM
companies

Together with HKPC, our Hong Kong office will support you from the starting point to becoming a world-class innovator

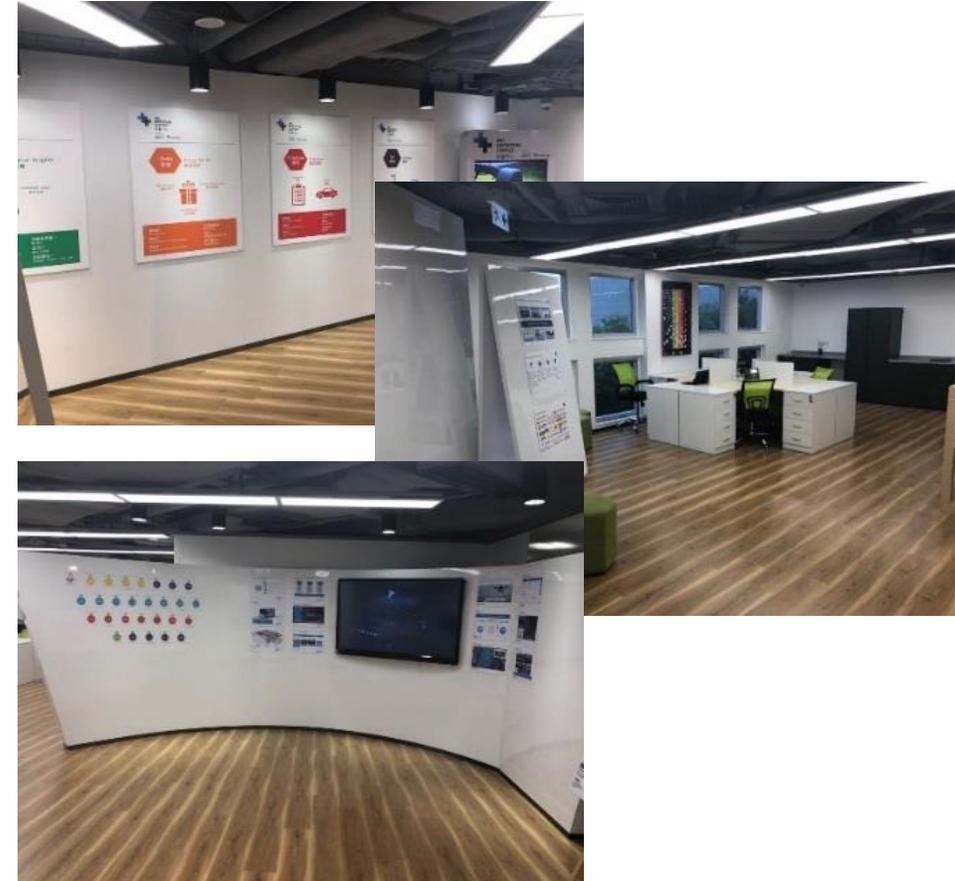


Services:

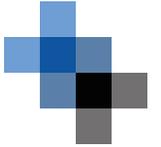
- Trainings
- Strategy definition
- Assessments
- Coaching and advisory
- Finding relevant experts
- Joint development of prototypes

Topics:

- Industry 4.0
- Product and service innovation
- Data Analytics



The Invention Center network enables Big Innovations to happen



World-leading innovators as corporate members interested in joint development of the solutions of tomorrow



**INC
INVENTION
CENTER**
Aachen | Munich
| Hong Kong

...



80 Fraunhofer institutes in Germany and all leading innovation hubs (USA, Scandinavia, Asia, ...)



Over 200 institutes at a leading technical university in Germany



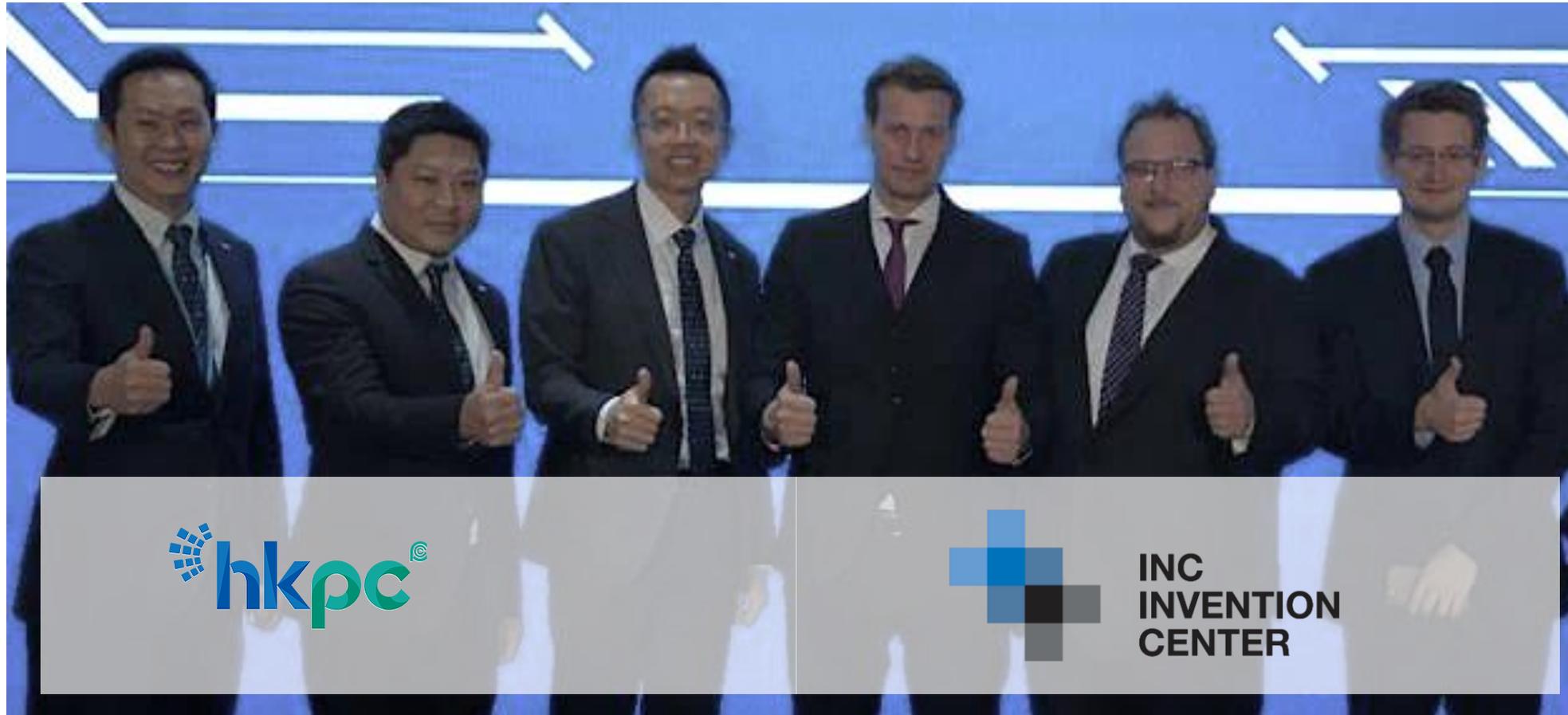
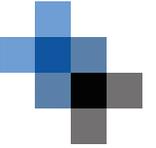
Leading solution providers in Industry 4.0, Additive manufacturing, Data analytics and future mobility



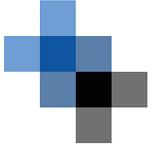
Local partners for implementing innovation, Industry 4.0 and Advanced Manufacturing

Leading research partners provide expertise and access to a worldwide network of knowledge

Local understanding and Global expertise - We are looking forward to cooperate with you



Want to know more about INC Invention center



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www.invention-center.hk



INC Invention Center
Hong Kong Office
Your Partner for innovation in Hong Kong

INC Invention Center
科創中心

Aim of the Invention Center, which counts around 40 German and international market leaders as its current members, is to create worldclass innovators and provide advice especially in the subjects Industrie 4.0 and Digital Transformation.

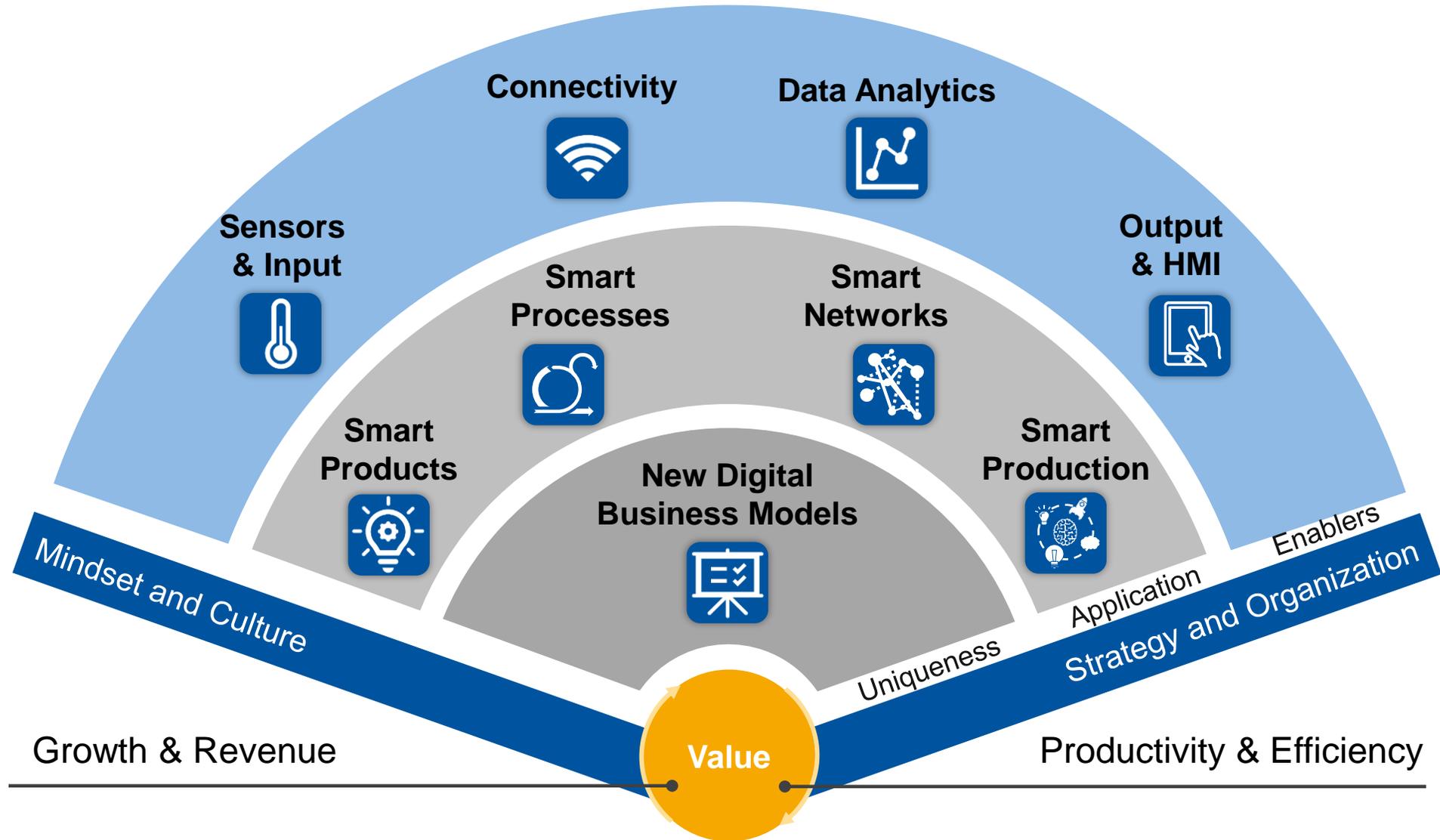
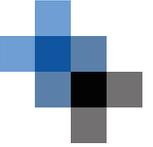
The Invention Center supports Hong Kong enterprises in smart products and services invention, time-to-market development and prototyping by leveraging the intensive expertise and diverse technology networks of KEX and the HKPC.

In order to reach our aim, we are building up a strong community, jointly developing ground-breaking innovations, and providing direct links to technology and market experts in the engineering innovation hub of Aachen, Germany, as well as links to innovation and technology experts across Germany and globally.



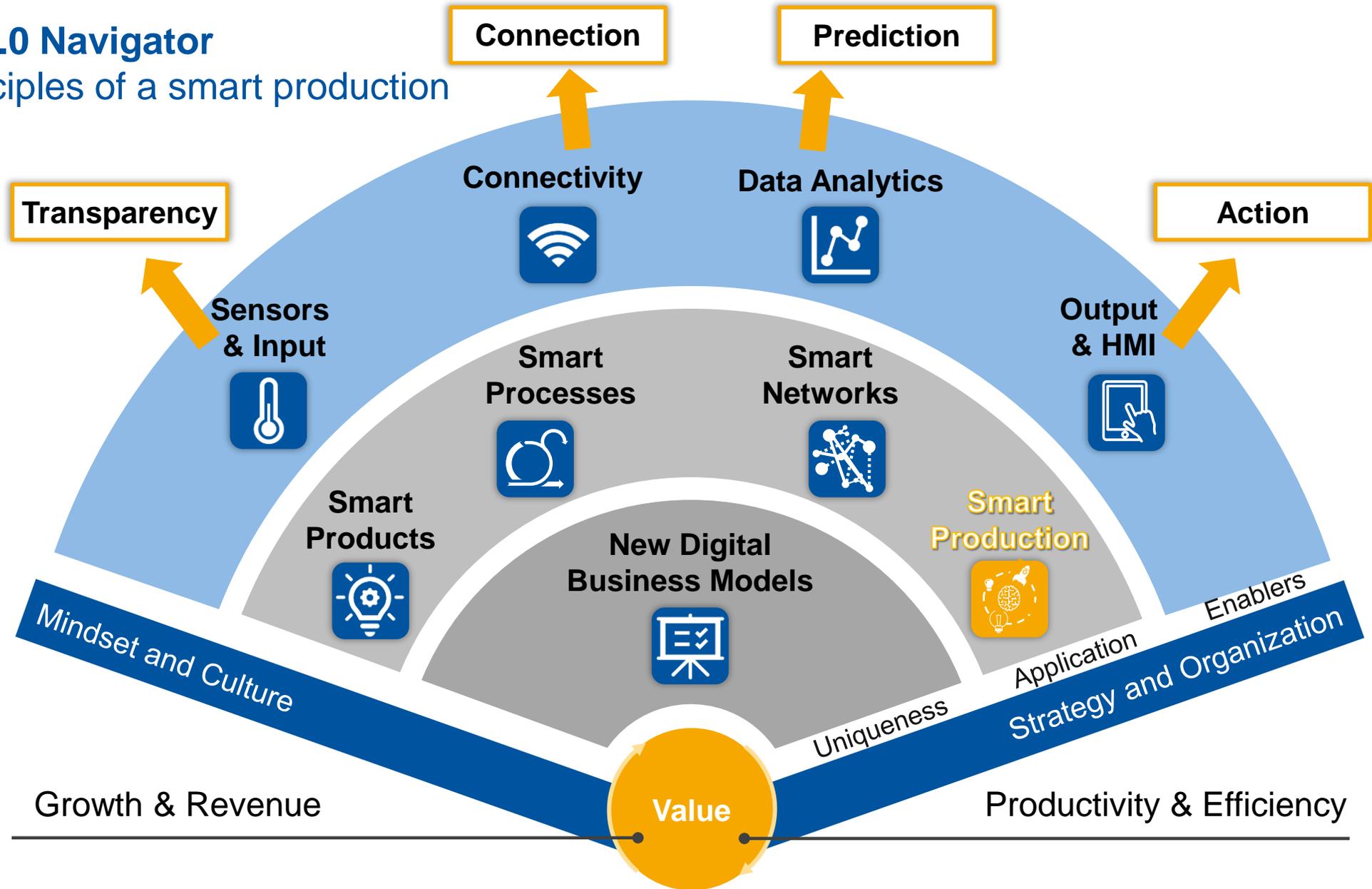
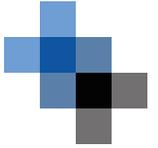
»» Write us an e-Mail:
info.asiapacific@invention-center.de

Smart i4.0 Navigator



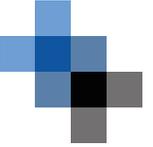
Smart i4.0 Navigator

Key principles of a smart production



Key principles of Industry 4.0

Value drivers and challenges for a successful implementation



Transparency

What are the most important sources of information that help to create transparency about all relevant shop floor activities?

Prediction



How to evaluate the potentials of data analytics and what are the prerequisites for implementation?

Which architecture supports the exchange of information between IT and OT technologies in the best possible way?

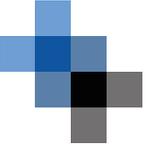


Connection

Action

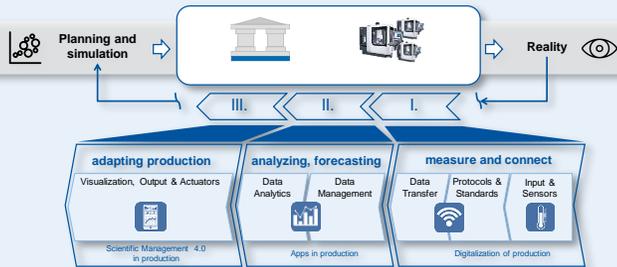


Different perspectives of understanding Industry 4.0 technology



1

What does it do? ▶ Control loop

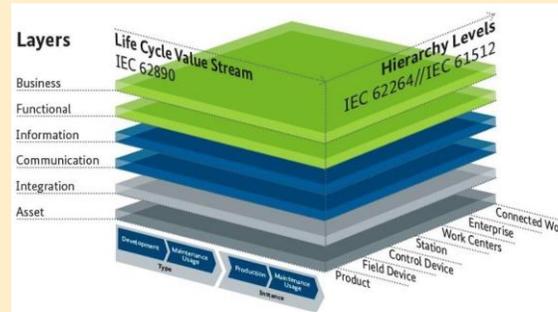


RWTH Aachen WZL, Fraunhofer IPT

The concept of an individual I4.0 application: Controlling an aspect of the Smart Factory or Smart Product – with distinct technology blocks to support this

2

How is it related to components? ▶ Reference Architecture Model Industry 4.0 (RAMI 4.0)

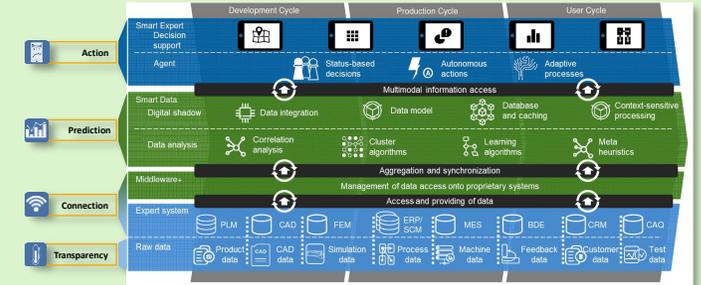


Platform Industry 4.0; DIN SPEC 91345

How to sort Industry 4.0 devices available on the market? How can general component technologies be structured?

3

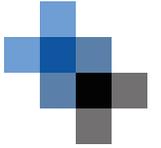
How is it integrated? ▶ Internet of Production Architecture



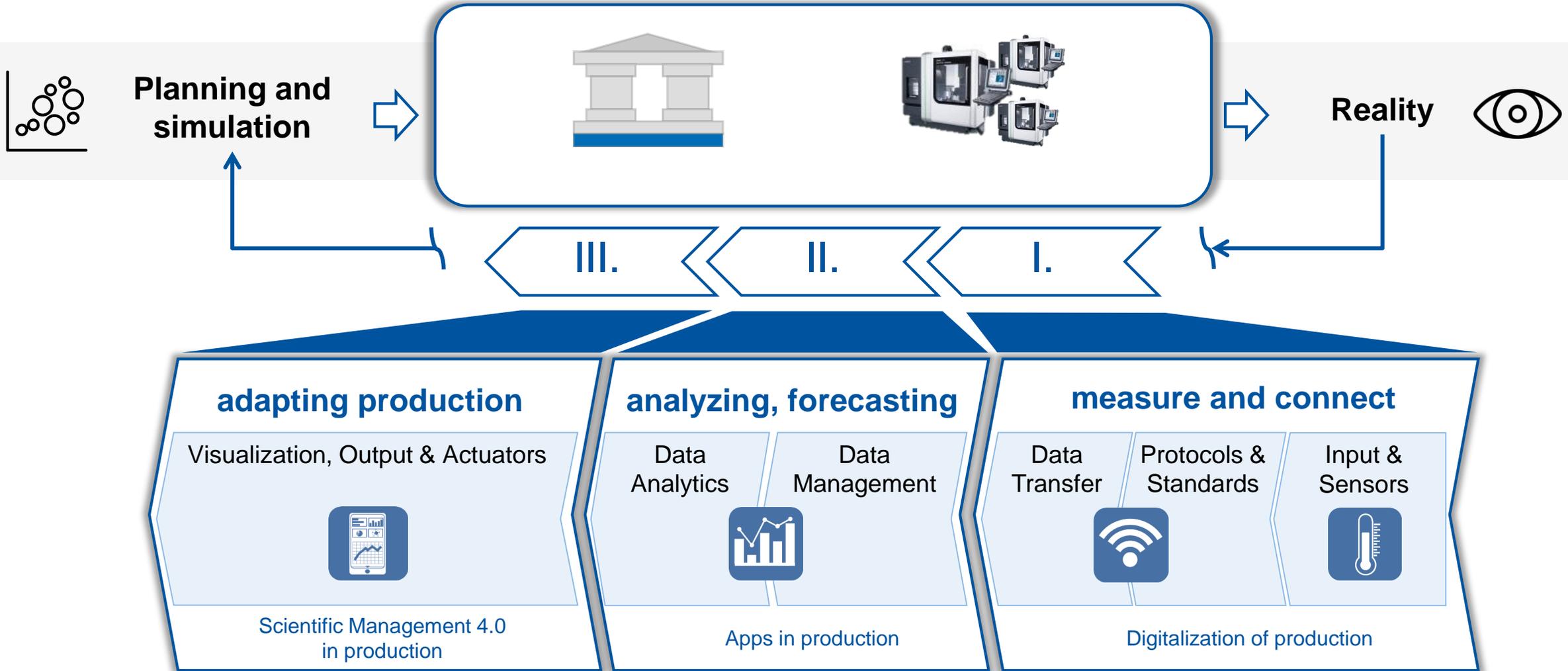
RWTH Aachen WZL, Fraunhofer IPT

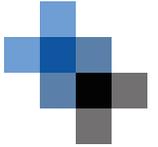
How to build up an Industry 4.0 architecture in a specific company? There are many architectures out there; we will use the Aachen reference architecture in the training.

It is necessary to understand the multiple concepts of how I4.0 technology is structured: Component technologies solve individual problems (Control loop), interact with other components (RAMI 4.0) and are embedded into an IT/OT architecture (e.g. IoP architecture)

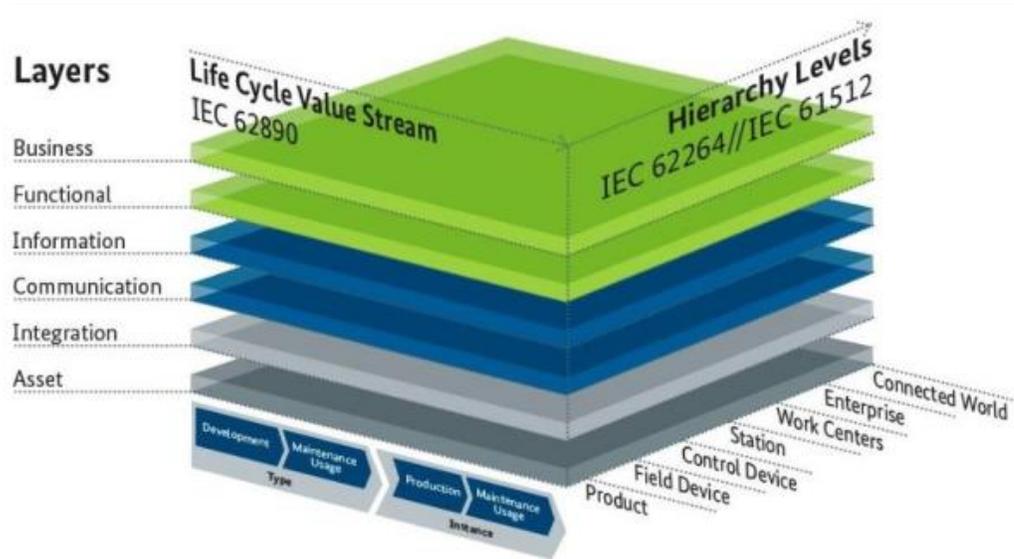


1 The “control loop” perspective: I4.0 solutions can be understood as “controller” with several technological components

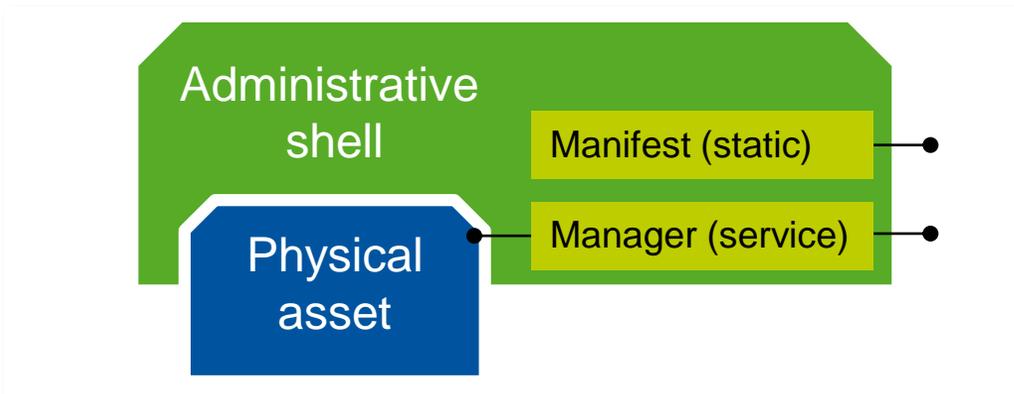




2 The “architectural” perspective: Standardized RAMI model of the German Platform Industry 4.0



- **Architecture layer:** How does data flow from physical asset to business logic
- **Life cycle layer:** How does information flow from design to production to usage?
- **Hierarchy layer:** How does information flow from subsystems to aggregating systems and vice versa?

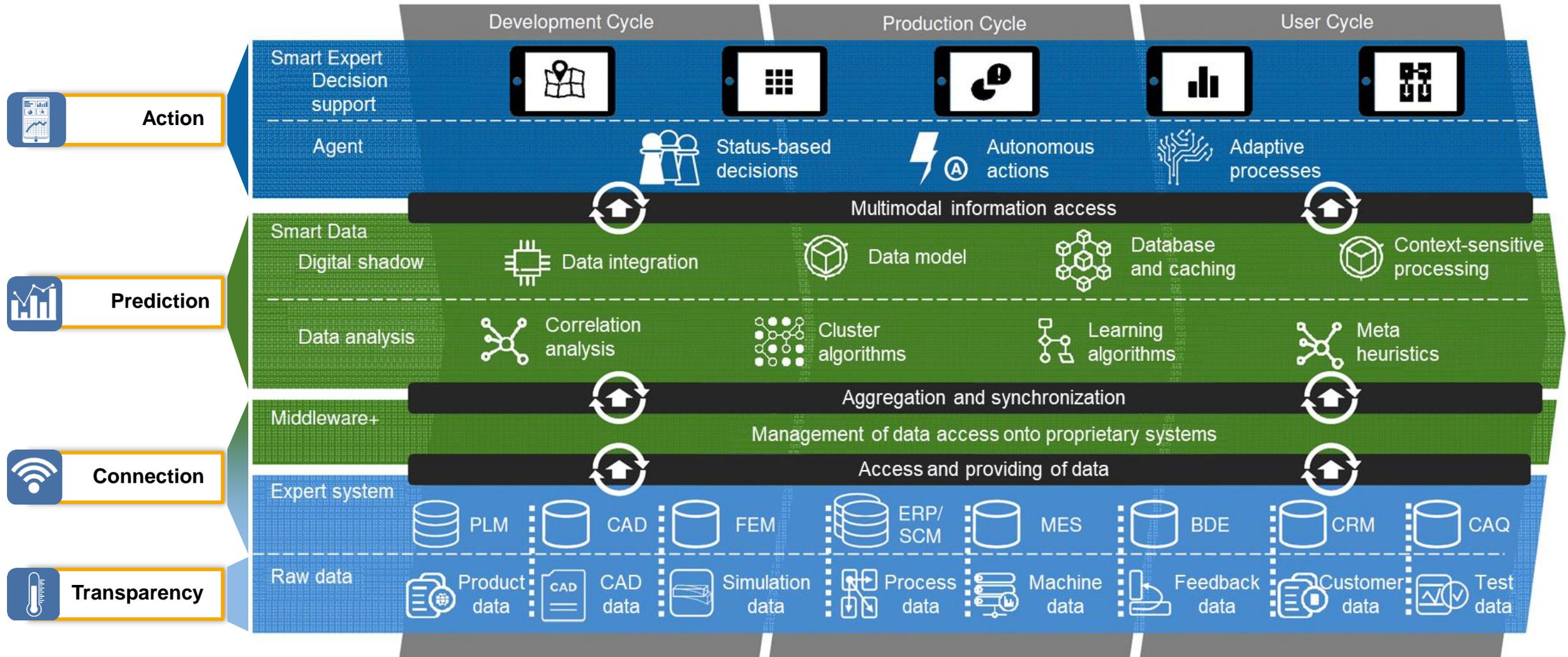


Each RAMI-compatible Industry 4.0 component should provide the following interface

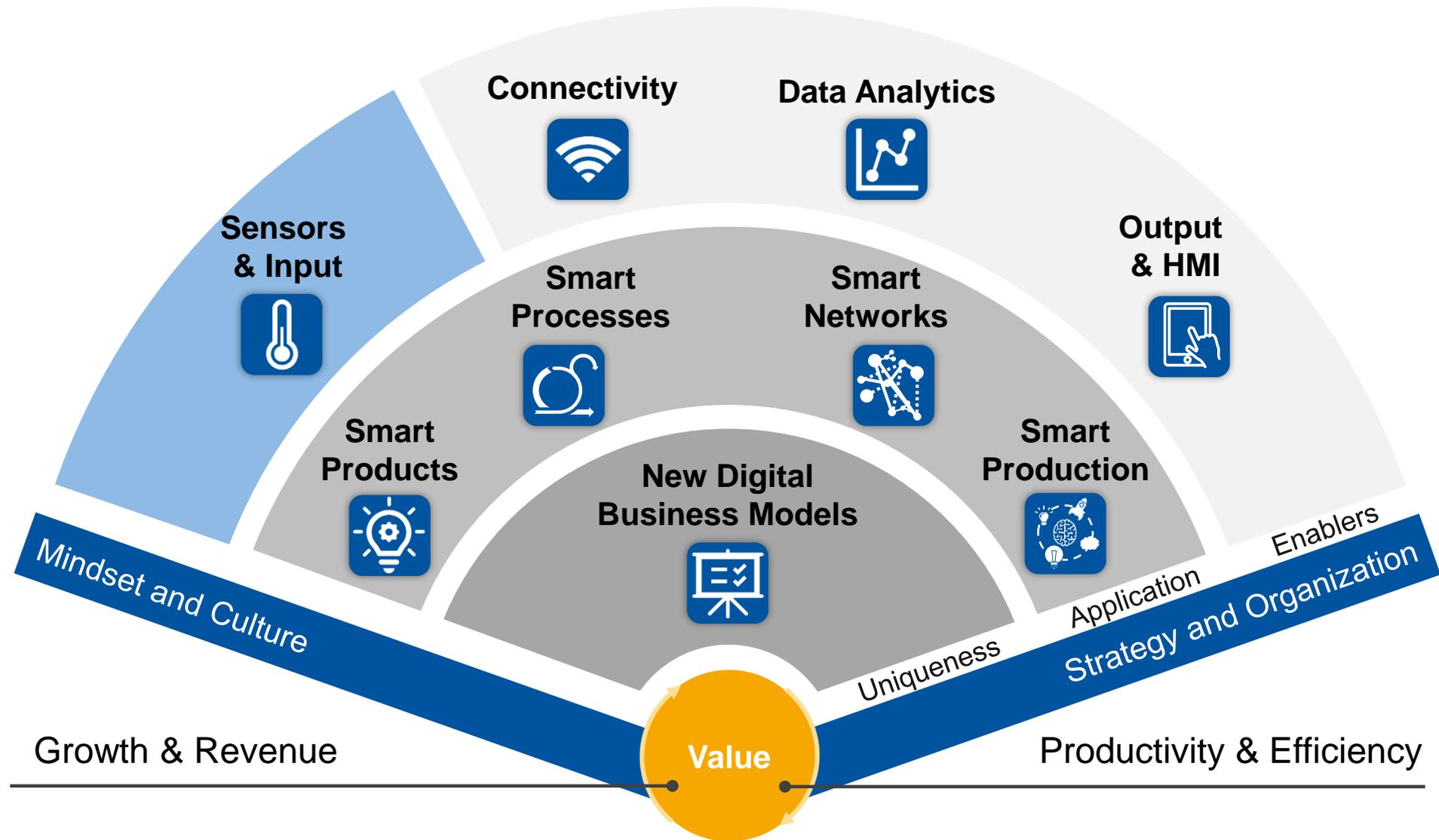
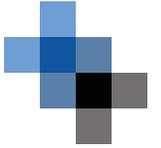
- An **administrative shell** around the physical component exposing its **capabilities** (“Manifest”) and **control interface** (“Component/ Resource manager”) in a standardized and documented way



3 The "integration" perspective: The Internet of Production IT/OT Framework

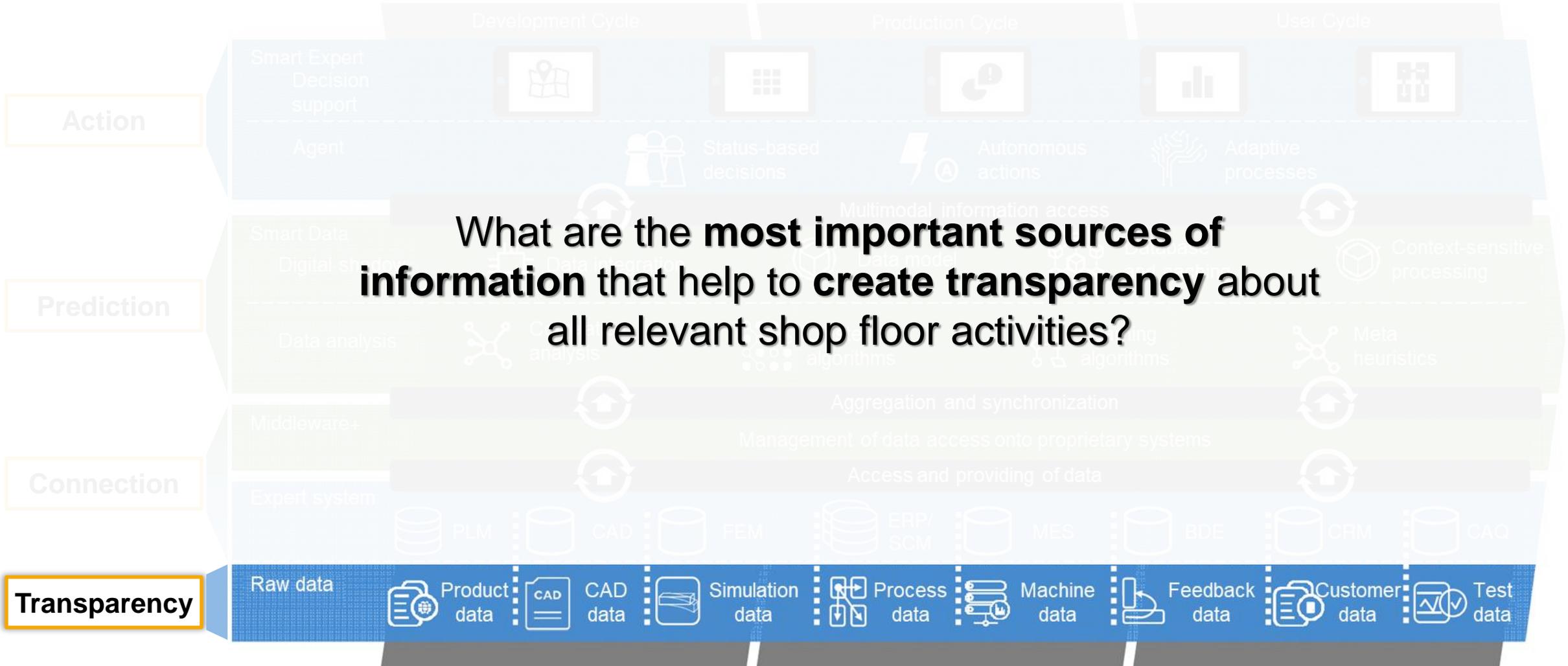
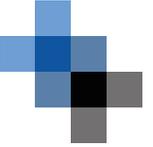


Transparency: Sensors and Input



Industry 4.0 Enabler

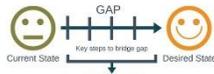
...that create transparency about relevant shop floor activities



What sources for data are there in I4.0?



How to gather needed data and retrofitting



Data Gap Analysis



Data Tapping



PLC Data Mirroring



Retrofitting

Key considerations

Relevant technology fields

Machine data



Machine Sensors



PLCs

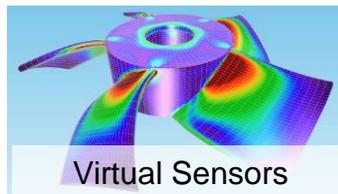
Sensors



Industry Sensors

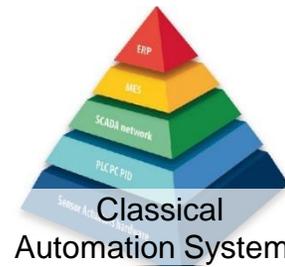


Sensor Retrofit Kits



Virtual Sensors

Systems



Classical Automation Systems



Expert Systems

Human-Machine Interfaces (HMIs)



Human Sensors



User Interfaces



Handheld Devices

External data



Application Programming Interfaces



Web-Services



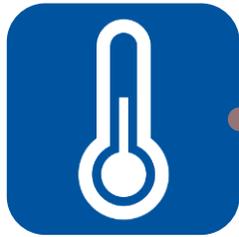
1. A structured data gap analysis should be conducted to determine concrete actions for preparatory data acquisition activities which helps to avoid a time-consuming trial and error proceeding.
2. Use the simplest reliable possibility to get access to missing data. System access is preferable, retrofitting or sensor addition helps fill blank spots.
3. Retrofit options are various. Consult process experts, asset operators, equipment and sensor vendors to identify the best approach and technology.
4. The output of one application is the input of the other. Always keep the whole lifecycle in mind and make use of corporate information and expert systems to contribute to the setup of valuable data assets.
5. Where data is missing and collection cannot be automated, don't underestimate the sensing capabilities of your people. Provide them with easy-to-use technologies that facilitate human data input and reduce errors.
6. If you don't have the information maybe others do. Make use of publicly available data sources and be open to share.

Smart Products

Time Temperature Indicator System



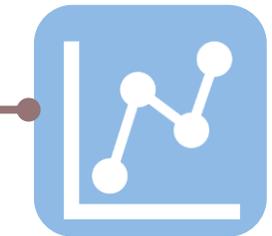
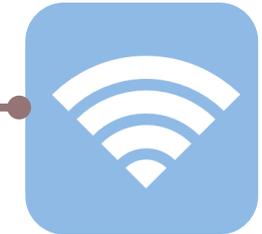
**Sense
Condition**



**Visualize
& Adapt**



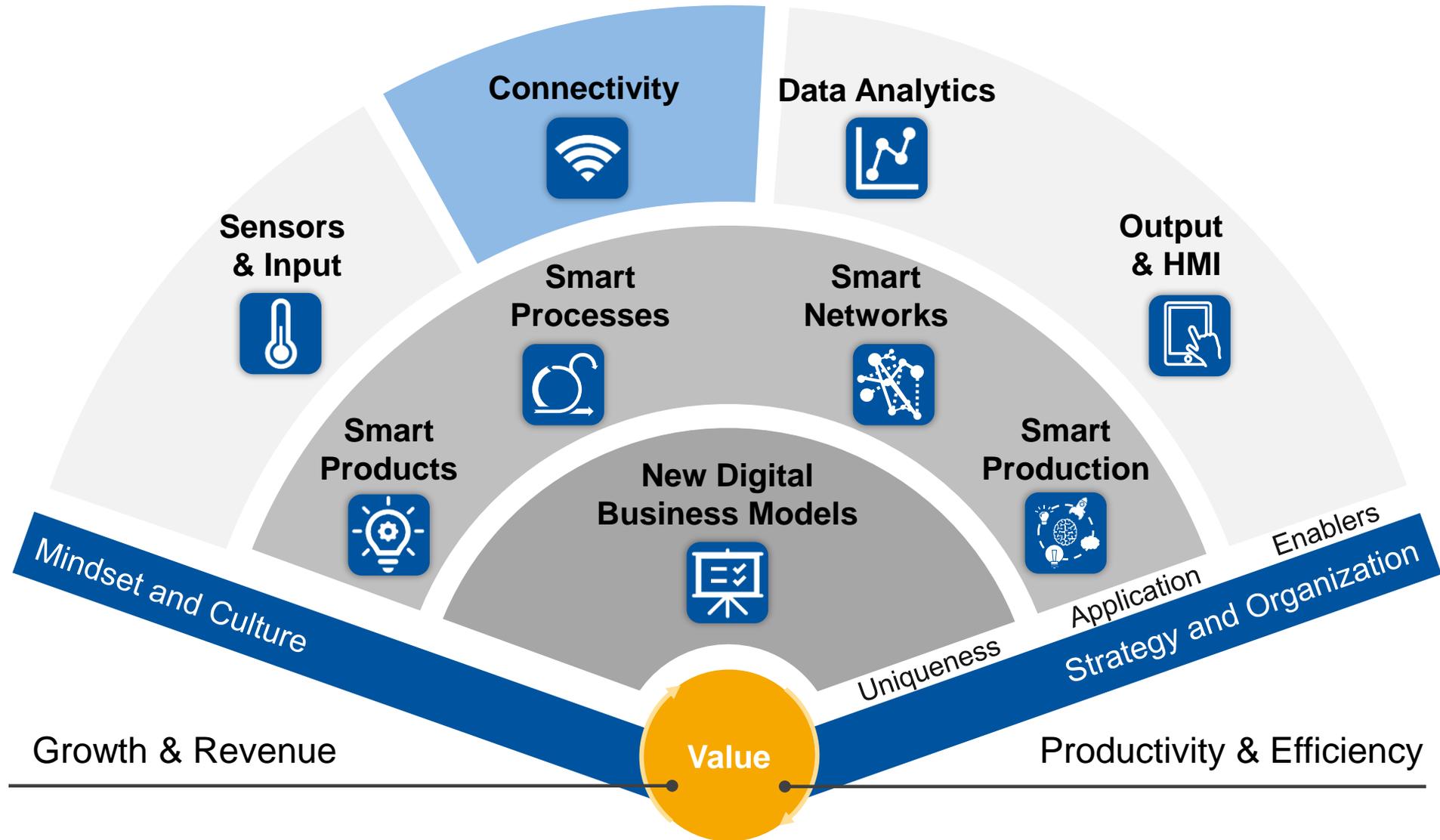
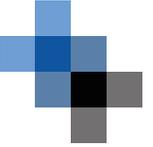
**Connect
Network**



**Analyze
& Predict**

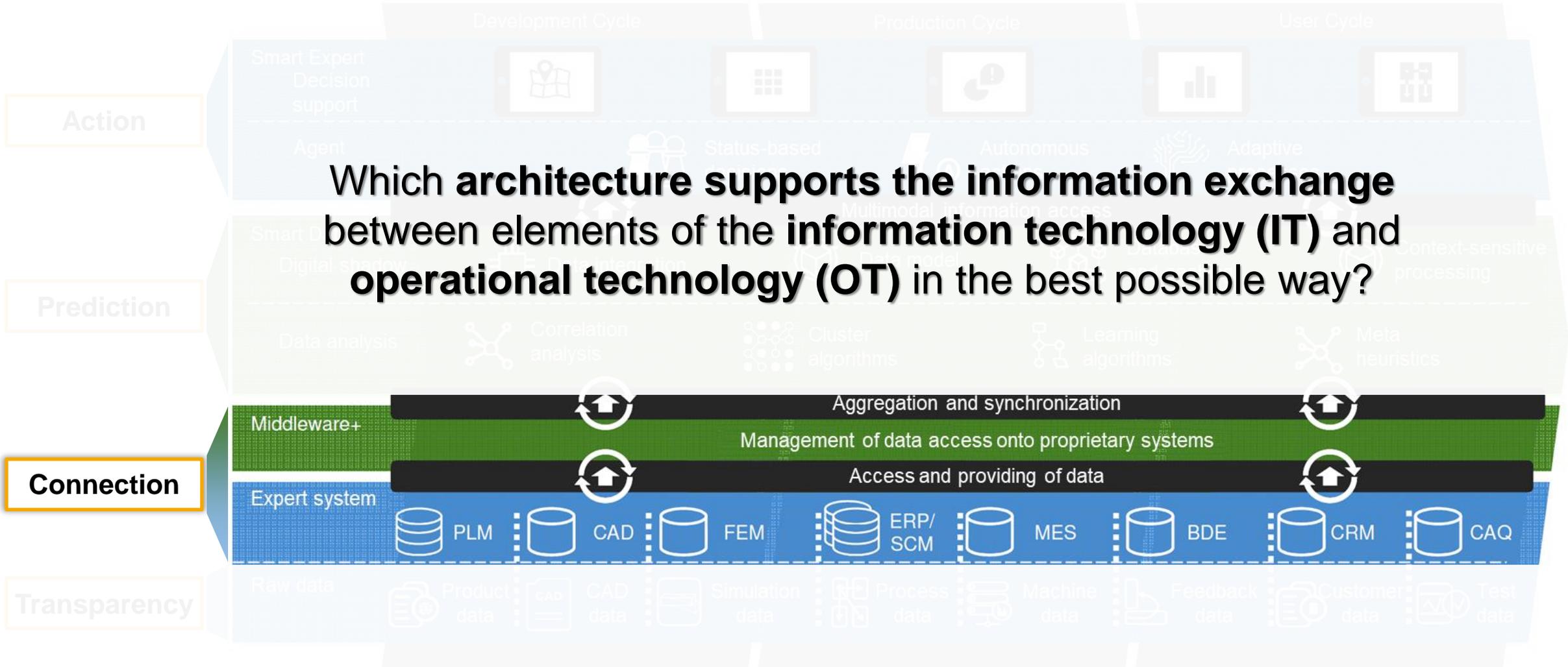
Over time, TTIs measure the "heat dose", which is a decisive variable for bacterial growth. For example, it can indicate whether the **cold chain** has always been maintained for deep-frozen products or sensitive foods.

Connectivity: Standards, interfaces, transfer



Industry 4.0 Enabler Technologies

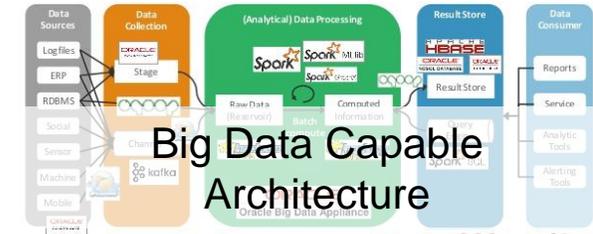
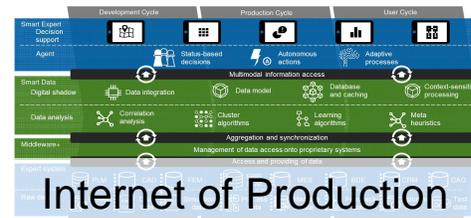
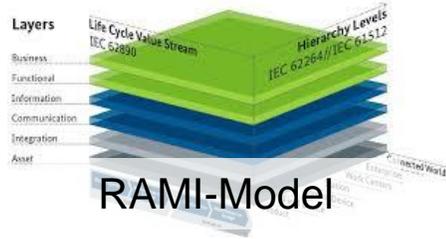
...that support the exchange of information



What protocols and connection standards are important for I4.0?



System architecture



Key considerations

Relevant technology fields

Real-time data access



Physical network



Information transfer



Storage and databases



Middleware and services



Connection – Single source of truth

Data should only be stored in one place; consistency and quality need to be assured



Connection



No duplication of master data

To avoid inconsistencies in data through editing data in one system but not another, data should be linked through locators and identifiers, but not duplicated in different databases (or multiple tables in one database) unless temporarily required. This especially applies for master data (suppliers, orders, ...) which changes rarely but does change.

Clear data ownership

Each relevant data should have clear ownership by a person or role. This both applies to the way data is collected (through sensors, data entry, ...) and how data is updated. Responsibility for the data itself should rest with the domain departments where the data is generated, not with IT. Responsibility for the handling and update consistency should be with IT.

Temporary storage and aggregation of data for analytics purposes may be necessary
▶ but authoritative source remains in respective defined original location

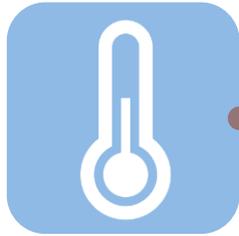


1. Define a clear IT architecture for current –but also future– needs now. It will be very hard to change architectures. Do not start from scratch but think of how to best and easiest integrate your current landscape. **An IT infrastructure decision can last longer than a machine, but its use changes yearly.**
2. The assets you buy now are meant for 20 years – but your IT applications may change much faster in the future, even in the factory. **Question every decision for a proprietary protocol or monolithic system without a way to customize or access.**
3. Industry 4.0 will both allow and require many more IT services than the current environment. **To prevent an unmaintainable amount of complexity and unrealistic requirements for competences in too many fields, make sure all communication is handled through a middleware system interfacing with each actor** rather than creating a plethora of links with thousands of different protocols

Smart Processes



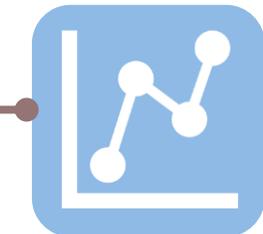
**Sense
Condition**



**Visualize
& Adapt**



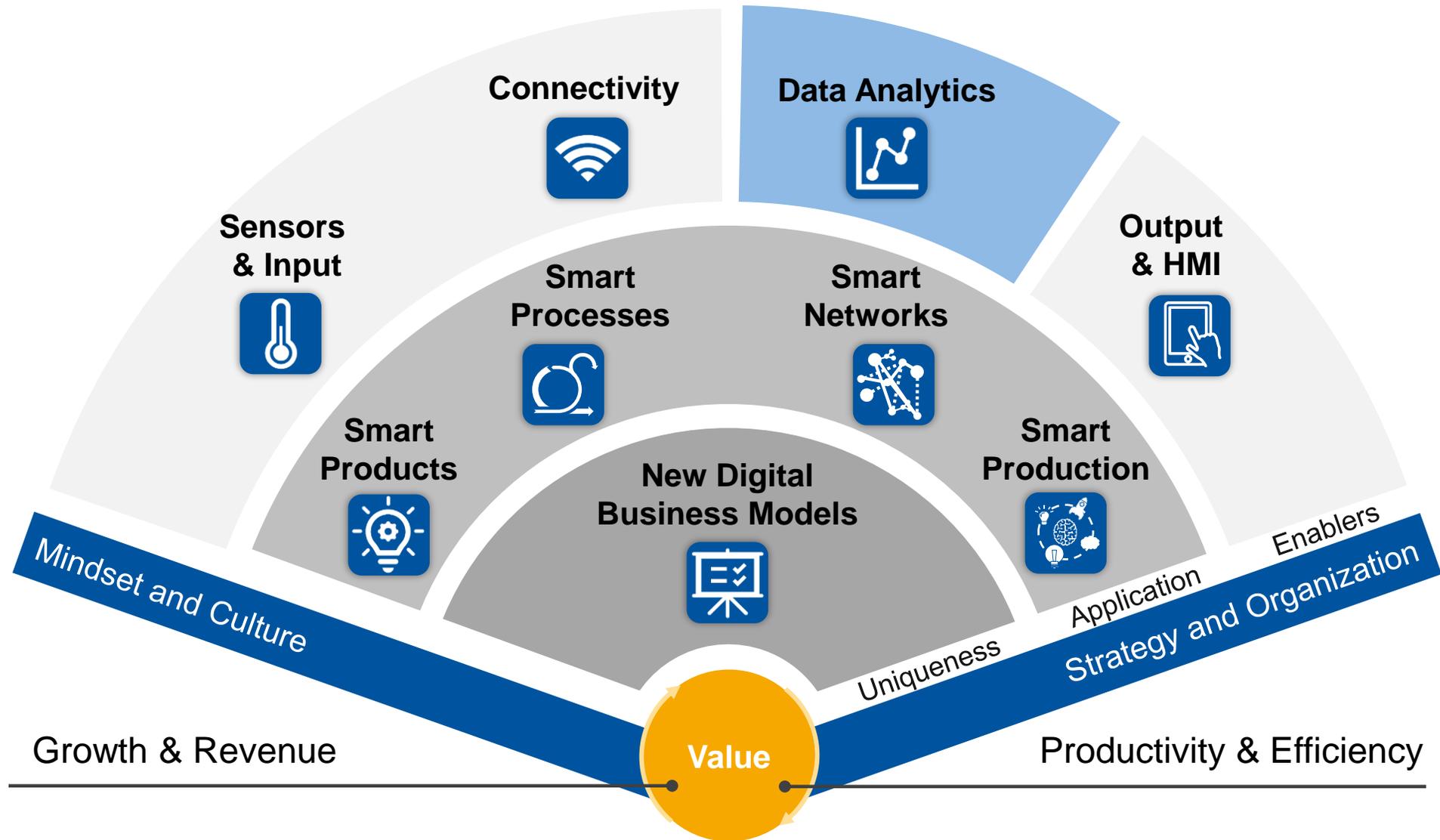
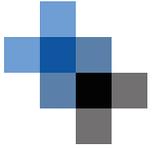
**Connect
Network**



**Analyze
& Predict**

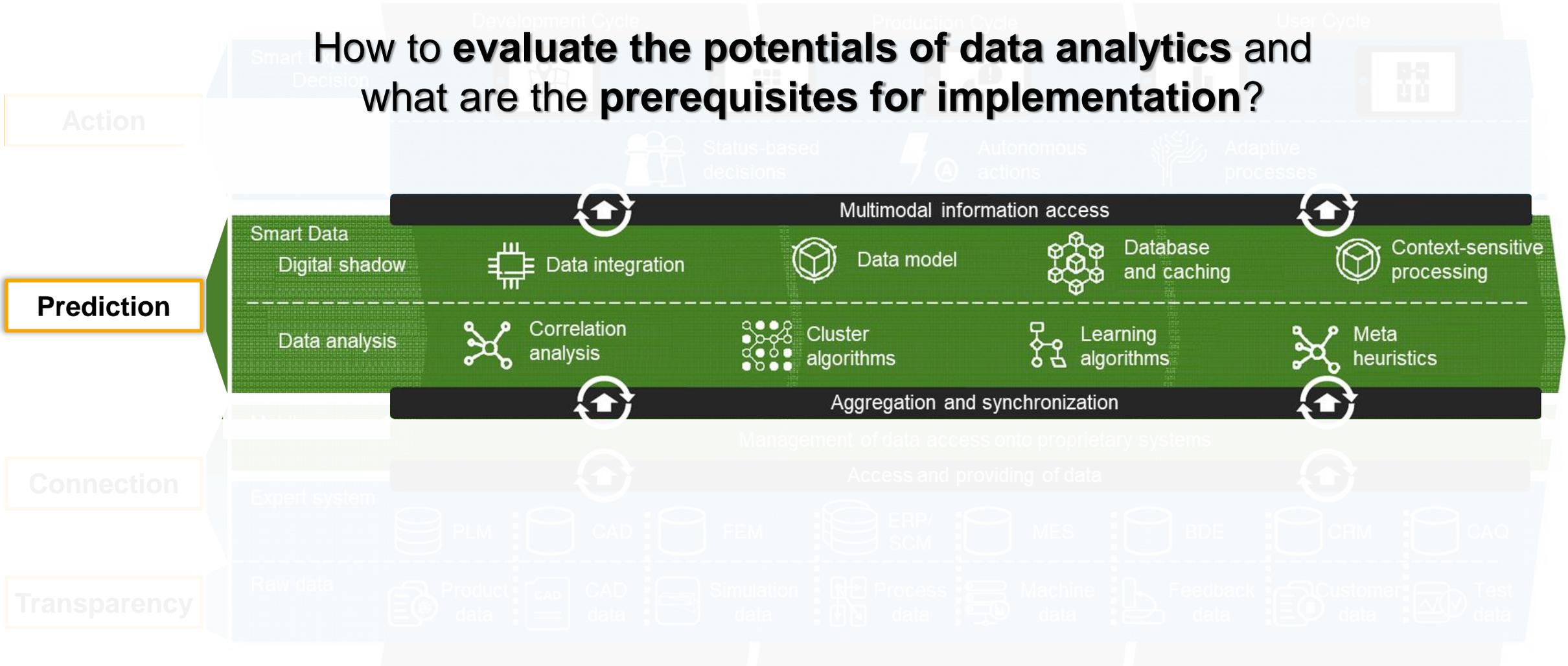
Web-to-print platforms offer an intuitive user interface for the creation of individual print products and are therefore relevant for both large industrial customers and private individuals.

Prediction: Data management and analytics



Industry 4.0 Enabler Technologies

...that create value through data analytics



What analytics is needed for I4.0?

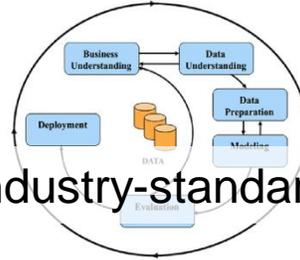


How to implement data analytics?

Key considerations



Focusing on valuable data



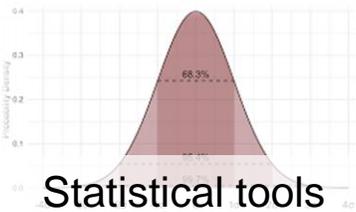
Cross-industry-standard-process



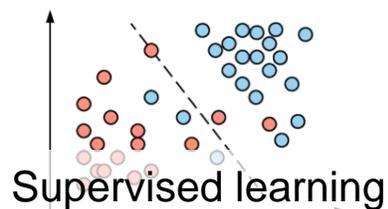
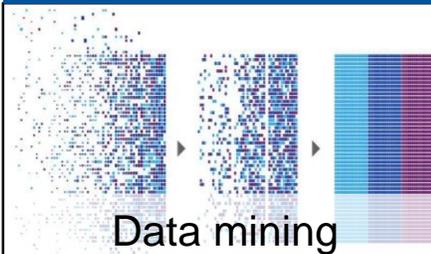
Data governance

Relevant technology fields

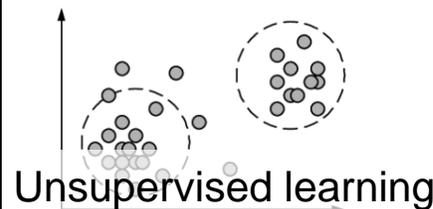
Descriptive



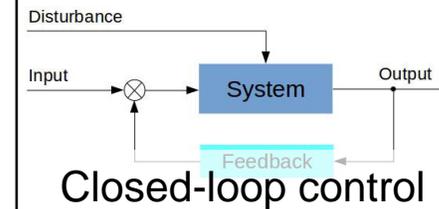
Diagnostic



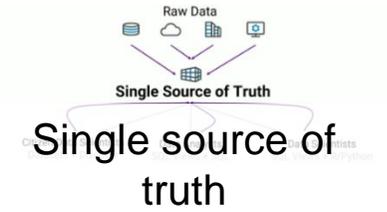
Predictive



Prescriptive



Data quality and integrity



The top 5 lessons learned from data analytics projects help to gather hands-on experience for the specific application



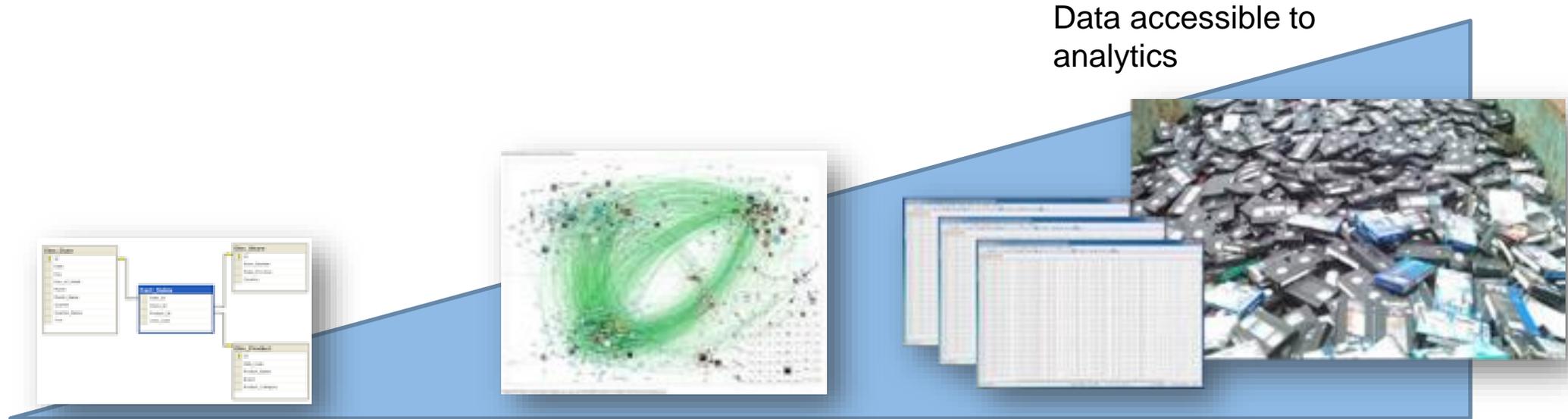
1. For most manufacturers, data acquisition is the first step
2. Challenge lies in volume, variety, veracity and velocity of data
3. Combination of different data sources brings value to the result
4. Consider cost, source, complexity and employee competence
5. Select tools according to core strength and complexity of project

Lesson Learned No.1

For most manufacturers, data acquisition is the first step



- 1.
- 2.
- 3.
- 4.
- 5.



Structured,
relational
datasets

NoSQL datasets:

- Graph-based databases
- Document-based databases
- Column-based databases
- ...

Unstructured,
„dark“ data

Lesson Learned No.2

Challenge lies in Volume, variety, veracity and velocity of data – that is what “Big Data” is about. Technologies to deal with these challenges are evolving quickly



1.

2.

3.

4.

5.

Volume

Too much data to be analyzed on a single machine



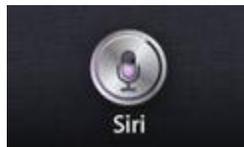
Veracity

Possibly inaccurate or even wrong data points



Variety

Various sources, formats and structures of data – to be analyzed jointly



Velocity

Results are needed in real-time – no time for long processing



Lesson Learned No.3

Combination of different data sources brings value to the result



1.

2.

3.

4.

5.

Combining different data for analytics makes them more valuable – three similar data items will not add value, but including e.g., external data can



Lesson Learned No.4

Consider cost, source, complexity and employee competence



1.

- Close cooperation between all involved departments including process knowledge and data scientists

2.

- All employees should have a clear understanding of the company's business and goals

3.

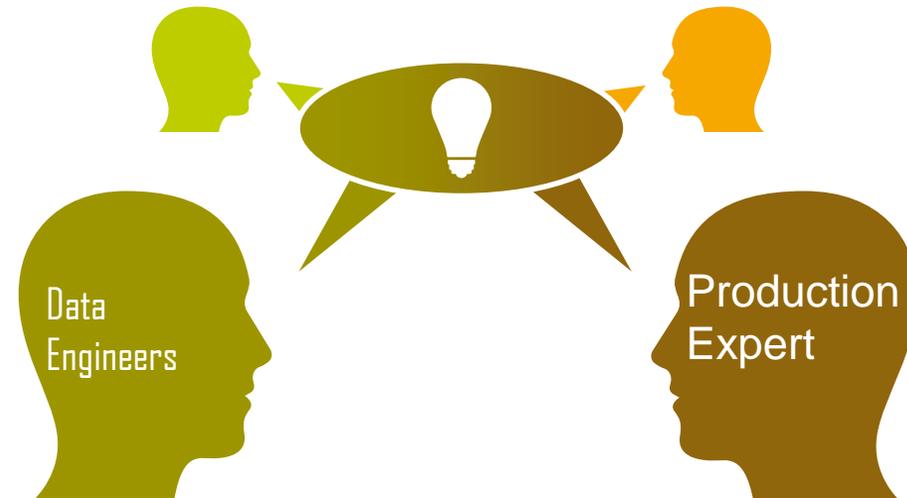
4.

- Process Know-How is important (i.e. interpretation of raw data and analysis results)

5.

Mathematicians,
Computer Scientists

Head of department,
Employees



Lesson Learned No.5

Select tools according to core strength and complexity of project



1.

2.

3.

4.

5.



Depending on the skills of the interdisciplinary team, and the already known maturity of analytics in the company, different levels of analytics and different sophistication of tools may be suitable – there is not a “best solution” for all cases

Lesson Learned No.5

Select tools according to core strength and complexity of project



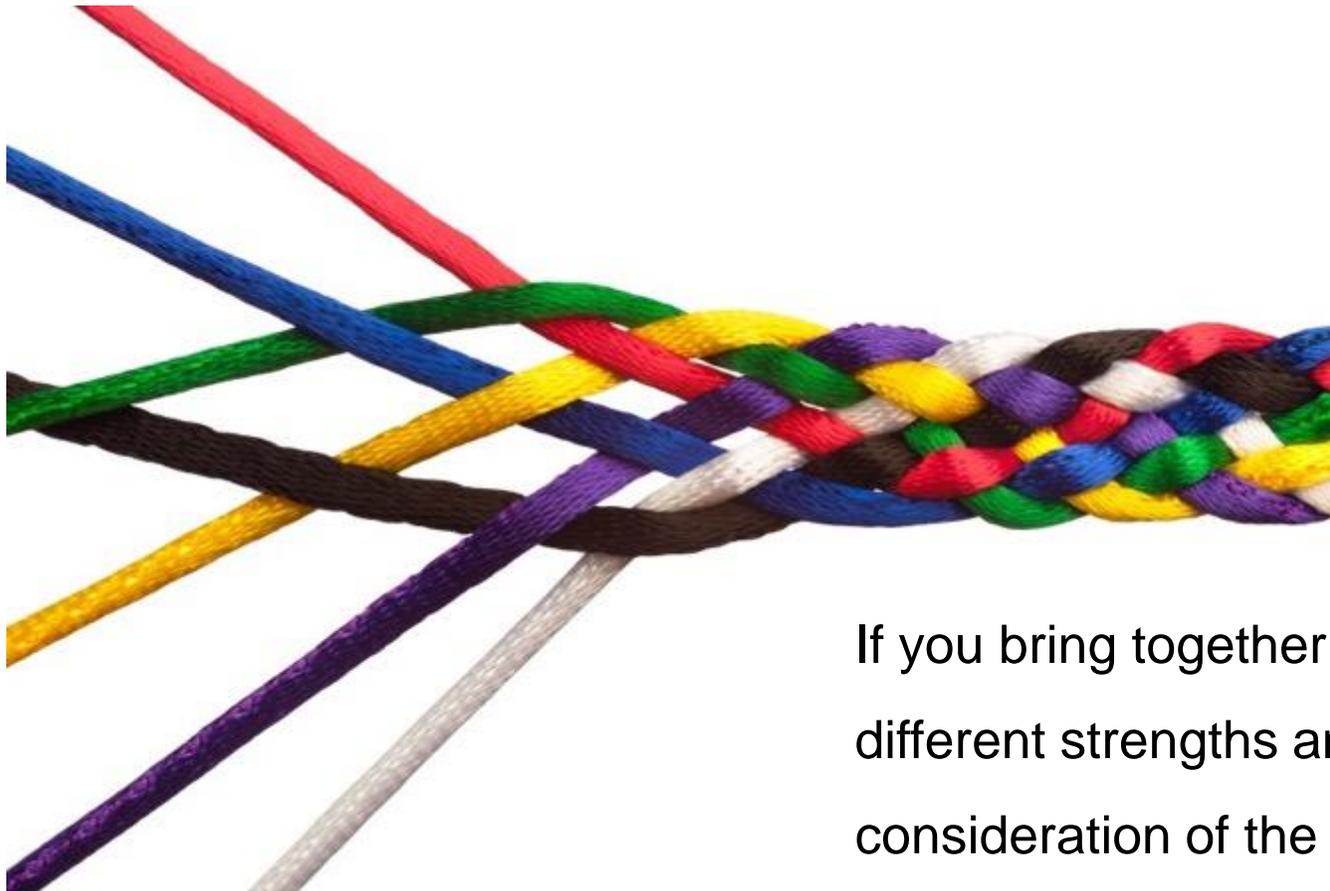
1.

2.

3.

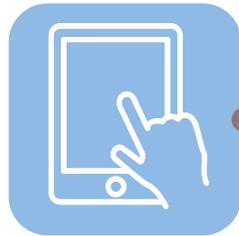
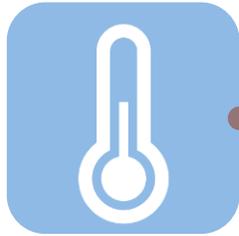
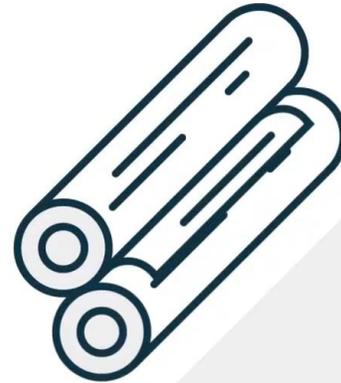
4.

5.

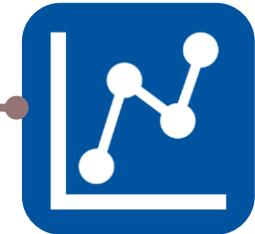


If you bring together qualified employees with different strengths and different skill sets with consideration of the project to be managed, complex projects can be tackled with confidence.

Smart Processes

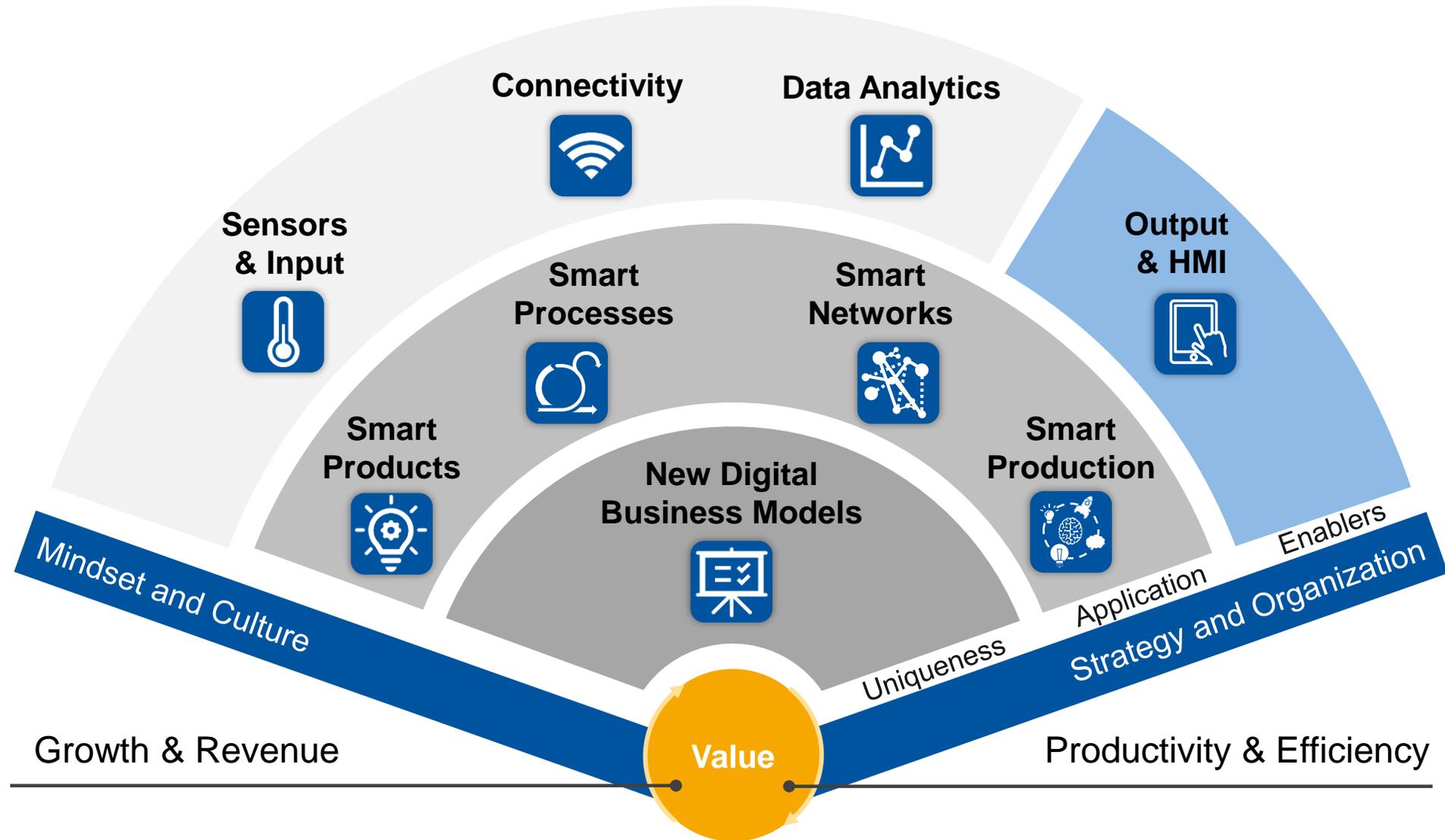
Sense
ConditionVisualize
& Adapt

PRINTING
6 /20,000
COPIES

Connect
NetworkAnalyze
& Predict

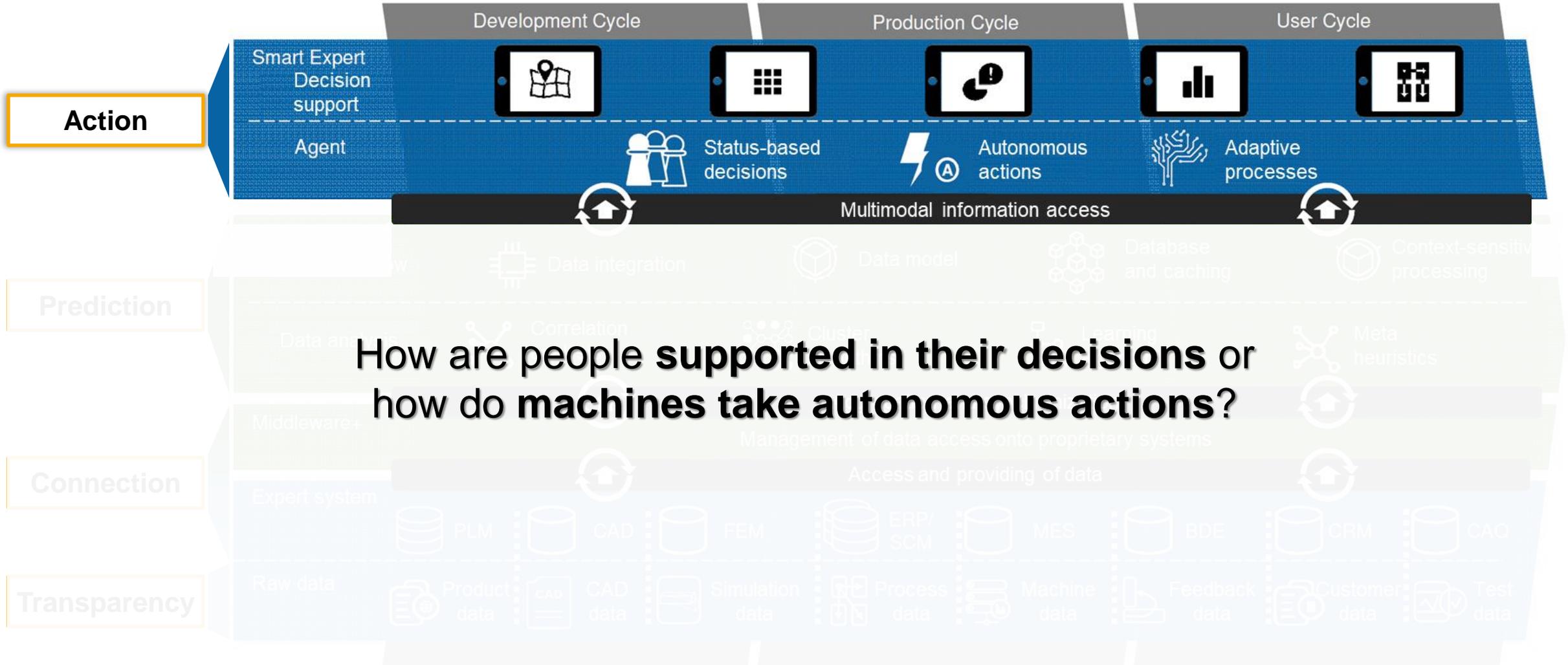
MIS software supports automated workflows in the area of job acceptance as well as in production planning in terms of optimized scheduling of individual print jobs. Target functions can be the minimization of makeready times, resource efficiency or adherence to deadlines.

Action: Output, Visualization, HMI



Industry 4.0 Enabler Technologies

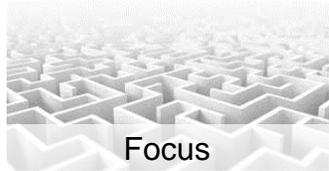
...that support people's decisions or act autonomously



The are of output technologies is broad and not limited to physical assets



User Experience (UX)



Focus



Customization



Efficiency



Functionality

Key considerations

Relevant technology fields

Dashboards

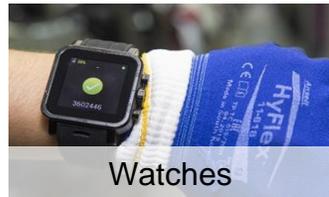


KPI Dashboards

Wearables, AR/VR



Smart Glasses



Watches



Smart Gloves

Integrated HMI stations



Production (Line) Displays



Control Room



Pick-by-light

Mobile systems



AGV (Automated Guided Vehicle)



Drone

Robotics



Cobots



Modular Design Kits

With Industry 4.0 the variety of robots increases



One of the greatest achievements in the field of robotics is the flexibilization and increased adaptivity of robots and the ability of human-robot interaction

Modern robotic systems are safe and allow collaborative use together with humans as well as easier and more flexible set-up and programming



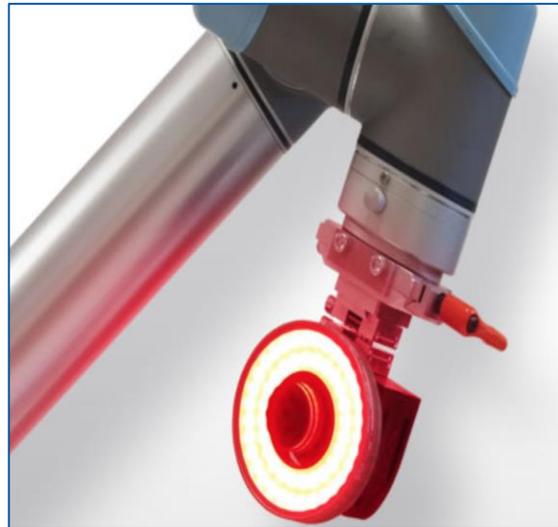
Teaching instead of programming

- Faster, intuitive and requires no knowledge for 3D trajectory
- No coding necessary for the functions



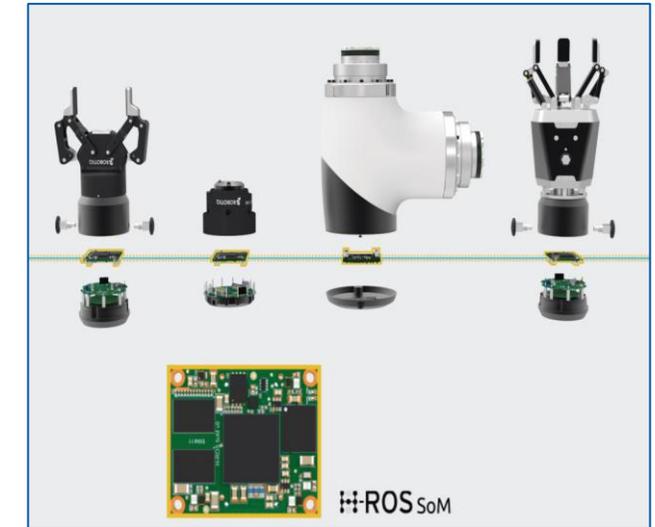
Low-Cost Robotic Solutions

- Robotic arms with lower payload capacity & movement freedom, but at much lower cost
- Mostly used for handling processes
- Useful for small & compact designs



Modular Robot Design Kits

- Interoperable, reconfigurable and modular industrial robotic kits
- Sensor/Actuator Integration in Platforms (e.g. ROS System¹)
- Modular jigs, universal/ flexible grippers

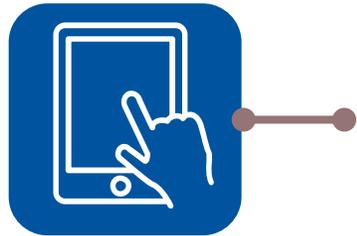
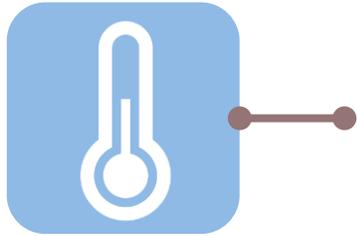




1. Information provided to humans should be reduced to the specific information needed for the task at hand
2. There are several ways to provide information to people. Choose the one disturbing their activities in the least way.
3. Choose the simplest and most cost-effective way of providing output. More flexible automation solutions are developed every year, but at the moment many things are faster done by humans with some additional support e.g. pick-by-light technology
4. Consider flexibility need in the future. A more flexible robot may be more expensive now but better usable if change-overs increase due to higher product variety



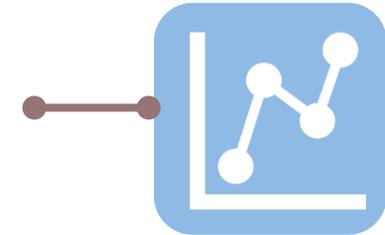
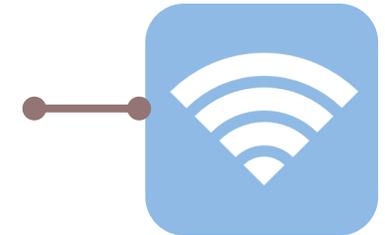
**Sense
Condition**



**Visualize
& Adapt**



**Connect
Network**



**Analyze
& Predict**

With the help of QR codes and image recognition technology, additional web content can be accessed and brought into the reader's field of vision via augmented reality.

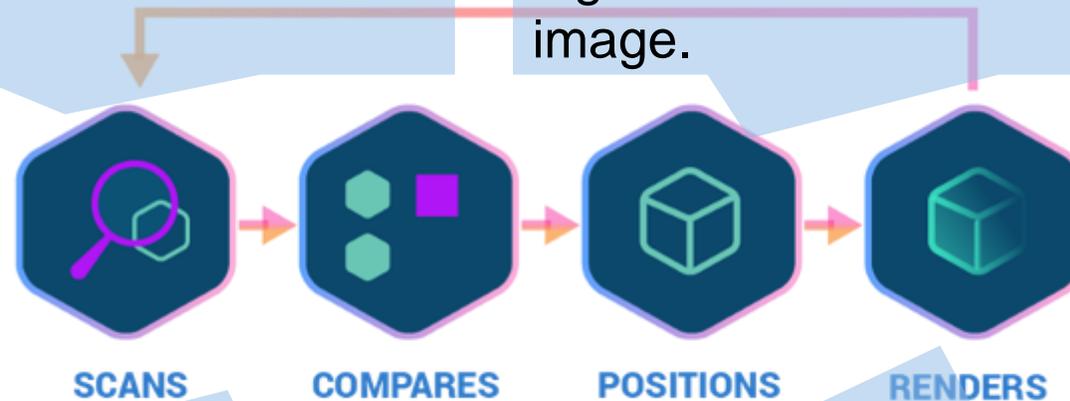


1) Scan:

Typically, the user sees live images of an object (product) through a mobile device (often a smartphone or tablet)..

3) Position:

Once matches are found, the AR device will simultaneously display or superimpose the digital content associated with a particular image.



2) Compare:

The AR software on the device identifies and interprets live images by searching and comparing them with images stored in a local or remote database.

4) Continuous rendering:

The overlay is rendered/shown seamlessly as user changes orientation or moves around or new images emerge.

Augmented Reality



HP Reveal

Unity/Vuforia

Type

online platform

computer program

Use

small projects with simple overlays

large projects with complex overlays, site-specific applications

Pros

users can instantly access overlays, no coding required

create standalone applications, more control over interface design, overlays load quickly

Cons

file size limits for overlays, requires internet connection

steeper learning curve, must upload completed application files to Google Play or Apple Store for others to access

Access

[HP Reveal Studio](#)

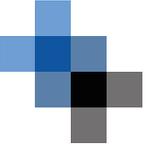
[Unity](#) [Vuforia](#)

Minimum Hardware Needed

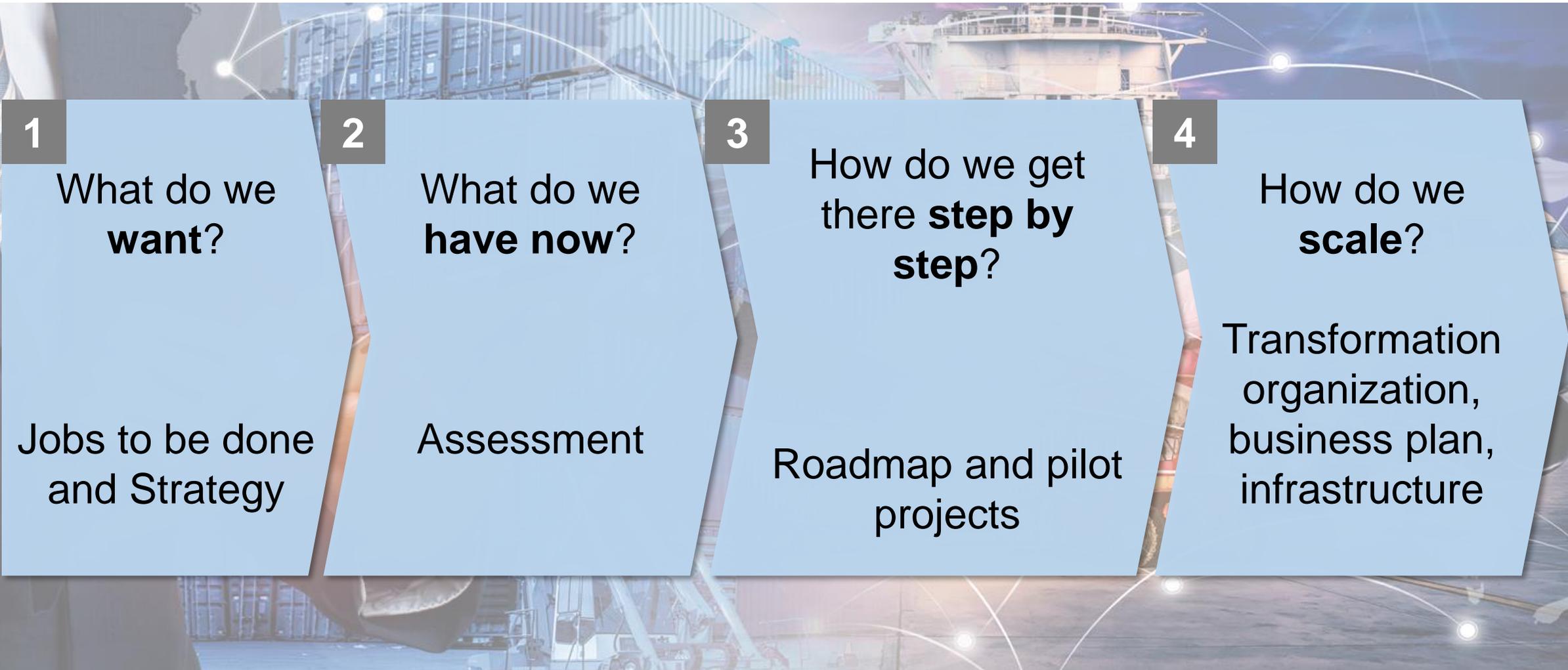
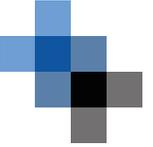
iOS or Android Mobile Device

Laptop/Desktop and iOS or Android Mobile Device

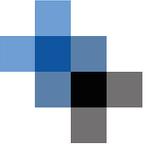
To sum it all up: What technology aspects do you need to focus your attention to as a manager?



- **Data is the new oil** – make sure you harvest it. To move your operations to Industry 4.0, eventually you will need data about your process. Make sure to especially keep data about failures, quality defects, etc. – this is the most valuable to use later.
- **In the near future you may need access to data and systems which you are not aware of yet** – make sure when you set up infrastructure and assets that they are compatible with open standards and you have full data access.
- **Machine learning and artificial intelligence no black magic.** While they can leverage large opportunities, they require a well understood and systemized process, and a lot of time and work to really reach their potential. Do not enter without a clear goal, and do not be too impatient for the result.
- **User Experience is key to getting benefits out of Industry 4.0.** If your factory interfaces feel like modern consumer systems, employees will know much better how to make the most productive use of them, you will invest less in training while getting better results.

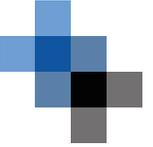


Joint project support for assessment, roadmapping and implementation



Projects jointly conducted by INC Invention Center and HKPC, with quality control and endorsement by Fraunhofer IPT

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