

# General

ID <sup>1</sup>		
Use case name	Order-Controlled Production	
Application domain	Manufacturing	
Deployment model	Cloud Services	
Status	Prototype	
Scope <sup>2</sup>	Automatic distribution of production jobs across dynamic supplier networks	
Objective(s)	The objective is to enable automatic supplier contracting for optimized utilization of manufacturing capabilities at suppliers, novel degrees of flexibility in contract manufacturing, and enable (mass) customized customer ordering	
Narrative	Short description (not more than 150 words)	A network of production capabilities and capacities that extend beyond factory and company boundaries allows for a quick order-controlled adaption to changing market and order conditions. The result is a largely fragmented and dynamic value chain network that change as required by the individual order, and thereby make the best use of capabilities and capacities of existing production facilities. The goal is to allow for automated order planning, allocation and execution, thereby considering all production steps and facilities required to facilitate linking external factories into a company's production process, as automated as possible.
	Complete description	<p>Use Case description taken from [1,2,3]. Many contemporary products are changing at an ever-increasing rate. Whereas up until just recently, smartphone displays were flat, the first curved displays are already on the market. The array of materials used in the automotive sector is also continually expanding – from aluminum, to high-strength steels and even fiber-reinforced plastics, today many types of materials are used.</p> <p>Innovation and product cycles are getting shorter all the time, and new production technologies are putting pressure on manufacturing companies to react more and more rapidly and make quick investment decisions regarding both consumer goods and investment goods. In order to confront this trend and avoid lengthy investment decisions, companies are starting to increase the network of their production capabilities beyond their own company boundaries.</p> <p><b>Key aspects</b> The Order-Controlled Production application scenario describes a flexible manufacturing configuration. Owing a network of production capabilities and capacities that extend beyond factory and company boundaries, this company can quickly adapt to a changing market and order conditions, and thereby make the best use of capabilities and capacities of existing production facilities. In this way the potential provided by a network to other factories out-side of the company's own facilities is used to align the company's own portfolio – and especially its production – to quickly changing customer and market demands. Specifically, manufacturing chains are optimized for various parameters, such as cost and time.</p>

At its core, order-controlled production is based on standardization of the individual process steps on the one hand and the self-description of production facility capabilities on the other hand. This standardization allows for auto-mated order planning, allocation and execution, thereby considering all production steps and facilities required. This helps to combine individual process modules much more flexibly and earlier than previously possible, and to make use of their specific capabilities.

In this respect, companies offer their available production capacities to other companies and thereby increase the utilization of their own machinery. Other companies may access these capacities as needed, thereby temporarily expanding their own production spectrum. In so doing, available production capacities are utilized better and order fluctuations can be smoothed out. The goal is to facilitate linking external factories into a company's production process, as automated as possible. In particular, the order placement process required for this should be executed automatically.

**Effect on value chains**

Today's relatively rigid and separately negotiated relationships between companies along the value chain will be transformed into a largely fragmented and dynamic value chain network that changes as required by the individual order. This applies both horizontally over the entire manufacturing process as well as vertically, with regard to production depth. Manufacturing companies focus on value-added steps that distinguish them significantly from other competitors. The possibility of creating fast and global client-manufacturer relationships can lead to unexpected competitive situations, because companies may change their role from order to order. Dynamically integrating production capacities will lead to better machine utilization and, as a result, diminishing demand for machinery suppliers.

**Value added for participants**

On the one hand, manufacturing companies will be able to automatically expand their production capabilities and capacities ad hoc in line with demand, by utilizing external production modules. No investment is required. This enables companies to react very flexibly to changing market and customer demands. On the other hand, companies offering their machines on the market can optimize their utilization rates.

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Stakeholders <sup>3</sup>	Customer, Producing companies, Broker
Stakeholders' assets, values <sup>4</sup>	Customer orders a good via the broker (separate stakeholder), Producing companies operate factories and machine parks.
System's threats and vulnerabilities <sup>5</sup>	

Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
AI features	Task(s)	Automatic reasoning, AI (task) planning, distributed coordination and negotiation (cf. [5-8] for details and overview)		
	Method(s) <sup>6</sup>			
	Hardware <sup>7</sup>			
	Topology <sup>8</sup>			
	Terms and concepts used <sup>9</sup>			
Standardization opportunities/ requirements	Standardization needs for setting up this use case is currently under further investigation. Some initial intentions on standardization needs are the following: Standardization of data formats and semantic for exchanged data is enabler for this use case where multiple companies and institutions are involved (formal semantics for reasoning about 3d models, task decomposition and planning), standardization of interaction protocols between participants (esp. coordination and negotiation) enables automatic cross-company contracting.			
Challenges and issues				
Societal concerns	Description	Enabling mass-customized production in global dynamic supply chains, and by that, ease production of small lot sizes for customized products.		
	SDGs <sup>10</sup>	Industry, Innovation, and Infrastructure		

## Data (optional)

Data characteristics	
Description	
Source <sup>11</sup>	
Type <sup>12</sup>	
Volume (size)	
Velocity (e.g. real time) <sup>13</sup>	
Variety (multiple datasets) <sup>14</sup>	
Variability (rate of change) <sup>15</sup>	
Quality <sup>16</sup>	

## Process scenario (optional)

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition <sup>17</sup>	Post-condition <sup>18</sup>



# Evaluation (optional)

Scenario name	Evaluation				
Step No.	Event <sup>22</sup>	Name of process/Activity <sup>23</sup>	Primary actor	Description of process/activity	Requirement

Input of evaluation <sup>24</sup>	
Output of evaluation <sup>25</sup>	

## Execution (optional)

Scenario name	Execution				
Step No.	Event <sup>26</sup>	Name of process/Activity <sup>27</sup>	Primary actor	Description of process/activity	Requirement

Input of Execution <sup>28</sup>	
Output of Execution <sup>29</sup>	



## Retraining (optional)

Scenario name	Retraining				
Step No.	Event <sup>30</sup>	Name of process/Activity <sup>31</sup>	Primary actor	Description of process/activity	Requirement

Specification of retraining data <sup>32</sup>	
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## References

References						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link

[1] Working Group on Research and Innovation of the Plattform Industrie 4.0. Aspects of the Research Roadmap in Application Scenarios, Working Paper, German Federal Ministry for Economic Affairs and Energy, url: <https://www.plattform-i40.de/I40/Redaktion/EN/Downloads/Publikation/aspects-of-the-research-roadmap.html> , 2016.

[2] Working Group on Research and Innovation of the Plattform Industrie 4.0 and Alliance Industrie du Futur: Plattform Industrie 4.0 & Alliance Industrie du Futur: Common List of Scenarios. url: <https://www.plattform-i40.de/I40/Redaktion/DE/Downloads/Publikation/plattform-i40-und-industrie-du-futur-scenarios.html>, 2018

[3] Communication Promoters Group of the Industry-Science Research Alliance and German National Academy of Science and Engineering. Recommendations for implementing the strategic initiative INDUSTRIE 4.0, Final report of the Industrie 4.0 Working Group, url: <https://www.acatech.de/Publikation/recommendations-for-implementing-the-strategic-initiative-industrie-4-0-final-report-of-the-industrie-4-0-working-group>, April 2013

[5] Birgit Vogel-Heuser, Jay Lee, and Paolo Leitao. Agents enabling cyber-physical production systems. *at – automatisierungstechnik* 63(10). DOI: 10.1515/auto-2014-1153, 2015.

[6] Weyer, Stephan, et al. "Towards Industry 4.0-Standardization as the crucial challenge for highly modular, multi-vendor production systems." *Ifac-Papersonline* 48.3 (2015): 579-584.

[7] Lasi, Heiner, et al. "Industry 4.0." *Business & information systems engineering* 6.4 (2014): 239-242.

[8] Monostori, László. "Cyber-physical production systems: Roots, expectations and R&D challenges." *Procedia Cirp* 17 (2014): 9-13.



## Footnote

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<sup>1</sup> Leave this cell blank.

<sup>2</sup> The scope defines the limits of the use case.

<sup>3</sup> Stakeholder involved in the scenario - examples are: type of organization; customers, 3rd parties; end users; humans; environment; negative stakeholders (attackers, criminals, etc).

<sup>4</sup> Assets and values that are valuable to the stakeholders and at the risk of being compromised by the AI system deployment – examples can include competitiveness; reputation or trust; fairness; safety; privacy; stability; etc.

<sup>5</sup> Threats and vulnerabilities can compromise the assets and values above. Examples are: different sources of bias; incorrect AI system use; new security threats; challenges to accountability; new privacy threats (hidden patterns).

<sup>6</sup> AI method(s)/framework(s) used.

<sup>7</sup> Hardware system used.

<sup>8</sup> Topology is the study of geometric forms differentiated by intersection and bifurcation. The term is used for the graphic aspects network architectures.

<sup>9</sup> Terms and concepts listed here can be used to extend the work of WG 1 (AWI 22989 and AWI 23053) as necessary.

<sup>10</sup> The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a collection of 17 global goals set by the United Nations General Assembly. SDGs are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. See URL for more details: <http://www.undp.org/content/undp/en/home/sustainable-development-goals.html>

<sup>11</sup> Origin of data, which could be from instruments, IoT, web, surveys, commercial activity, or from simulations.

<sup>12</sup> Structured/unstructured Images, voices, text, gene sequences, and numerical. Composite: time-series, graph-structured

<sup>13</sup> The rate of flow at which the data is created, stored, analysed, or visualized.

<sup>14</sup> Data from a number of domains and a number of data types. The wider range of data formats, logical models, timescales, and semantics complicates the integration of the variety of data.

<sup>15</sup> Changes in data rate, format/structure, semantics, and/or quality.

<sup>16</sup> Completeness and accuracy of the data with respect to semantic content as well as syntactical of the data (such as presence of missing fields or incorrect values)

<sup>17</sup> Describe which condition(s) should have been met before this scenario happens.

<sup>18</sup> Describe which condition(s) should prevail after this scenario happens. The post-condition may also define "success" or "failure" conditions.

<sup>19</sup> The event that triggers the step. This might be completion of the previous event.

<sup>20</sup> Action verbs should be used when naming activity.

<sup>21</sup> Training data can be further specified.

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- <sup>24</sup> Specify input of evaluation.
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- <sup>31</sup> Action verbs should be used when naming activity.
- <sup>32</sup> Retraining data can be further specified.