



International Academy for Production Engineering

7th CIRP Conference on Assembly Technologies And Systems

Tianjin, China

May 10 - 12, 2018



Industrial Image Processing Applications as Orchestration of Web Services

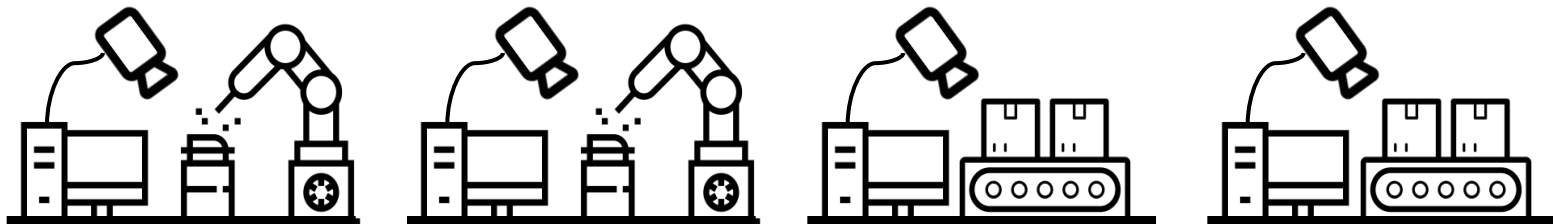
by

Martin Rudorfer, Jörg Krüger

Industrial Automation Technology Group
Technische Universität Berlin, Germany

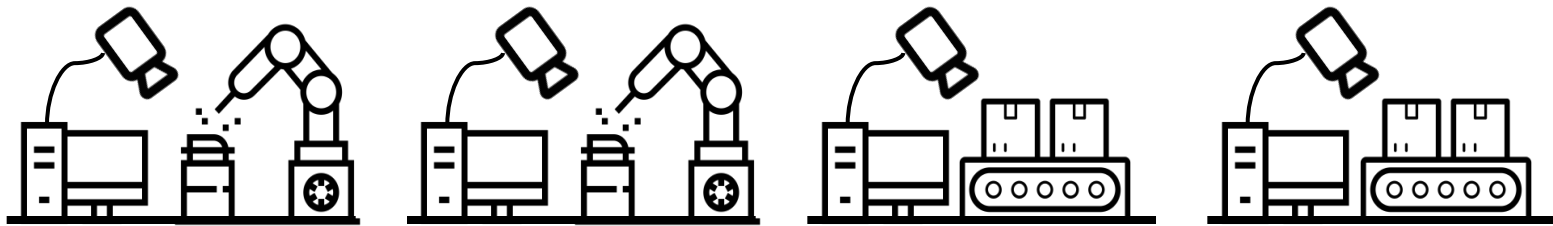
Motivation

- Highly automated production lines can rely heavily on image processing



Motivation

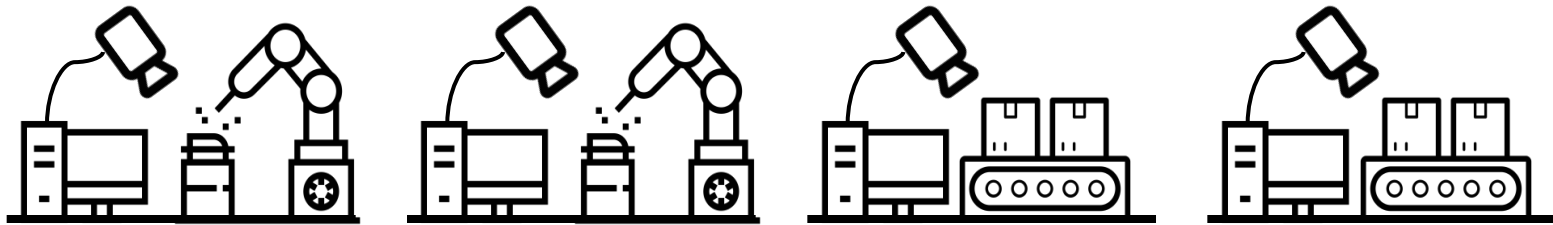
- Each image processing task typically uses a dedicated computer



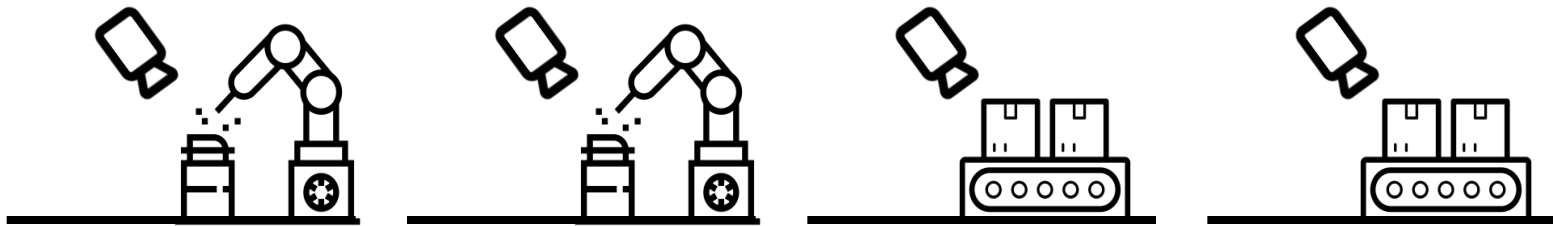
- inefficient use of hardware
- difficult maintenance (updates & redeployment)

Motivation

- How can we improve this?

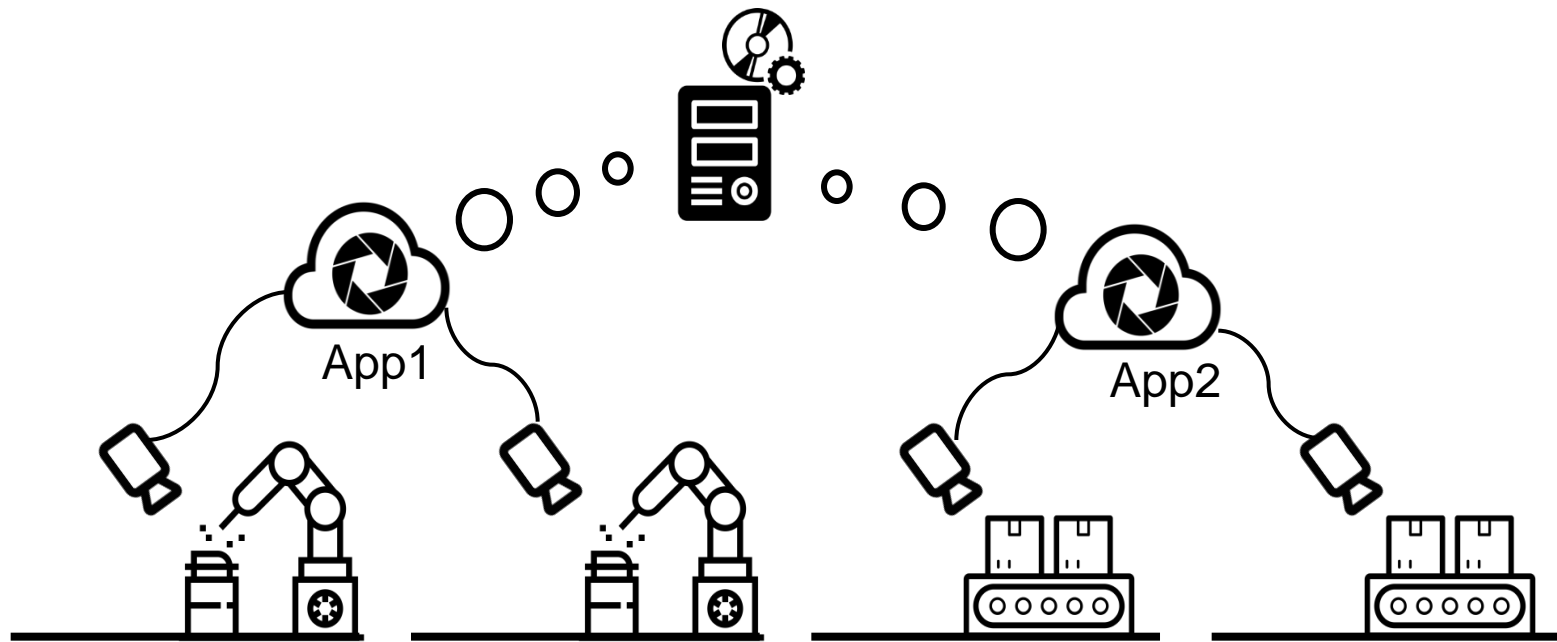


Motivation



- Erase the dedicated computer systems

Motivation



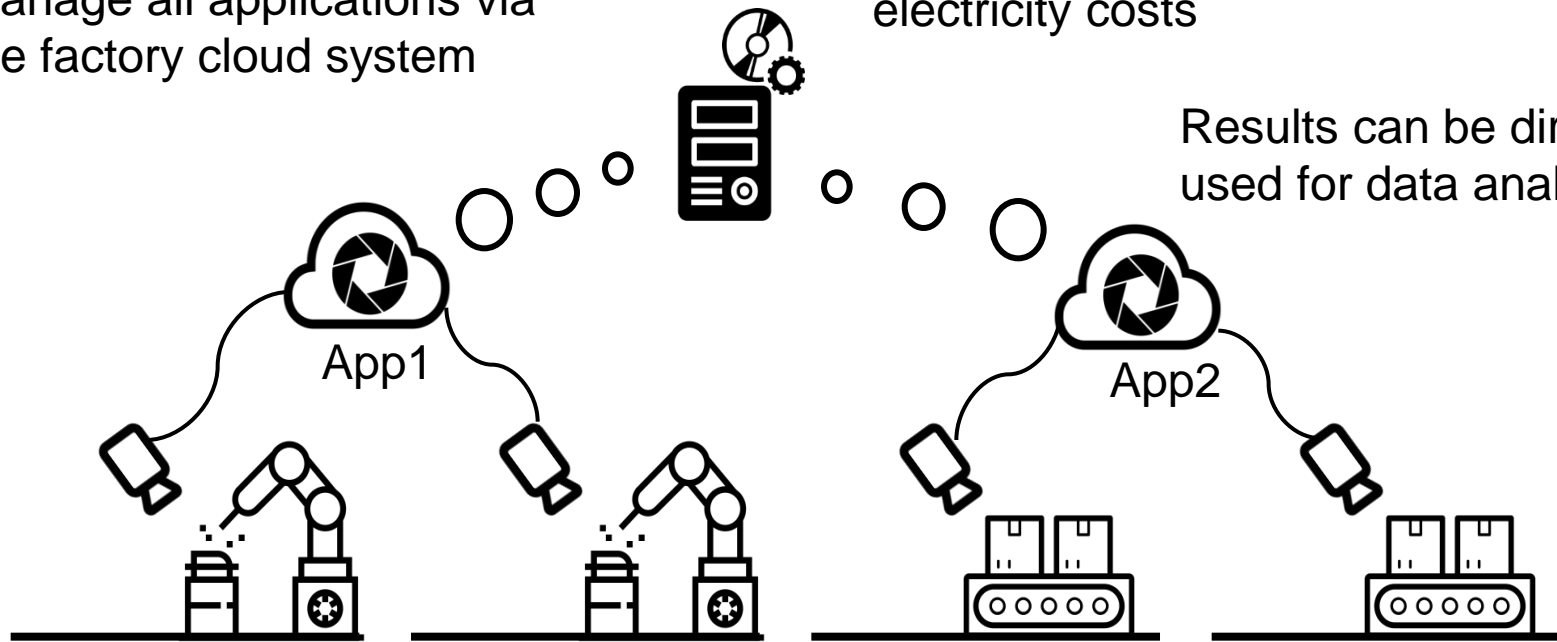
- Image Processing Applications as Web Services

Motivation

Manage all applications via the factory cloud system

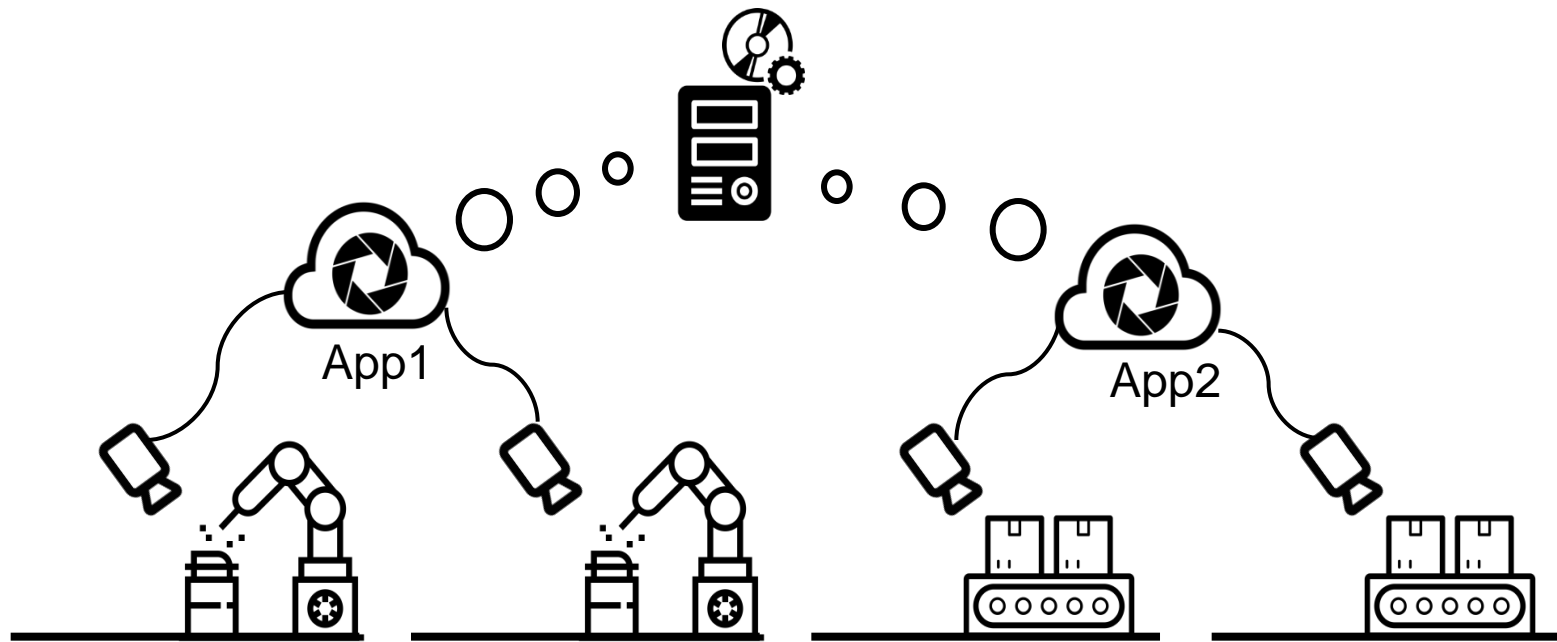
Fewer hardware and electricity costs

Results can be directly used for data analysis



- Image Processing Applications as Web Services

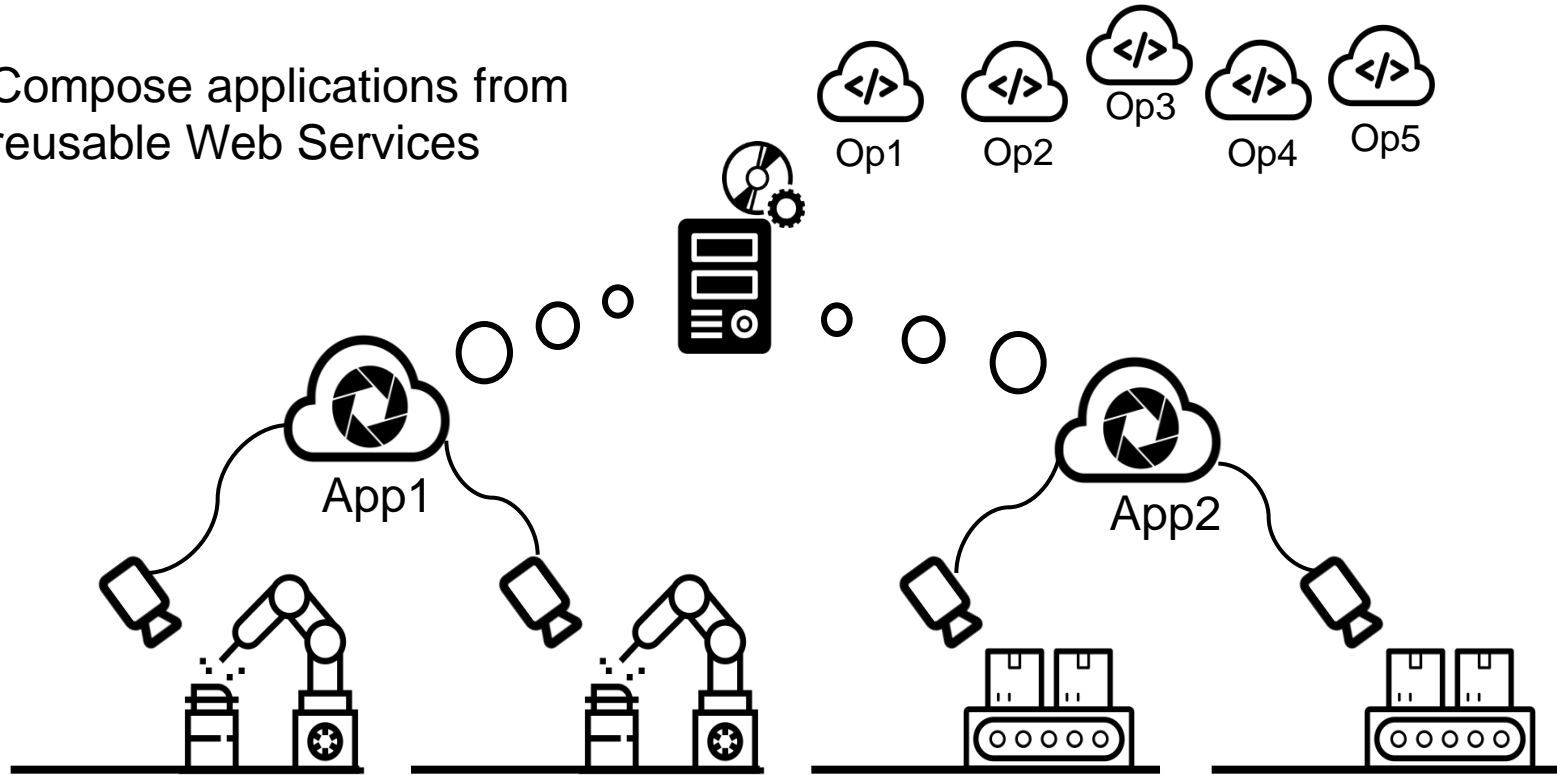
Motivation



- Industrial applications are very specific
- Yet, they consist of similar building blocks (Ops)

Motivation

Compose applications from reusable Web Services

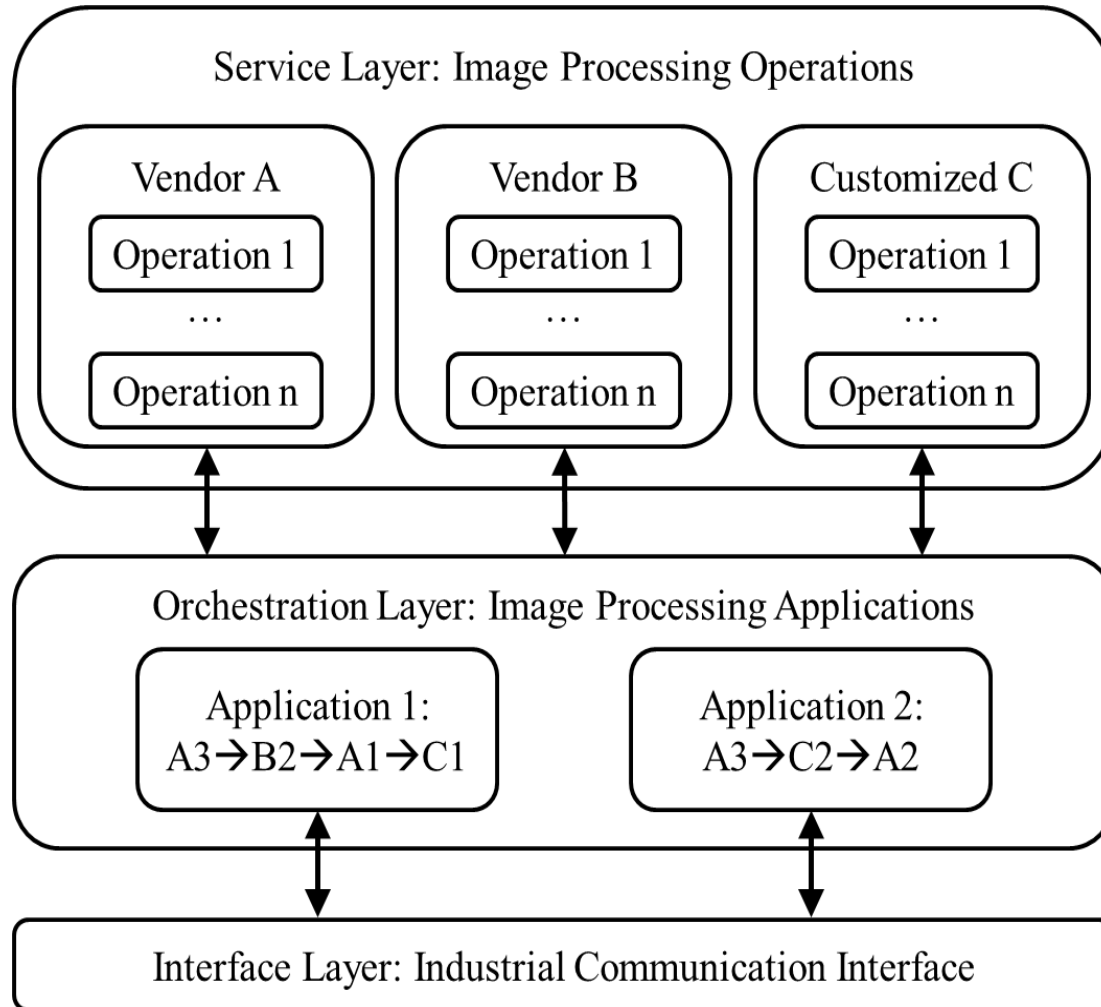


- Industrial Image Processing Applications as Orchestration of Web Services

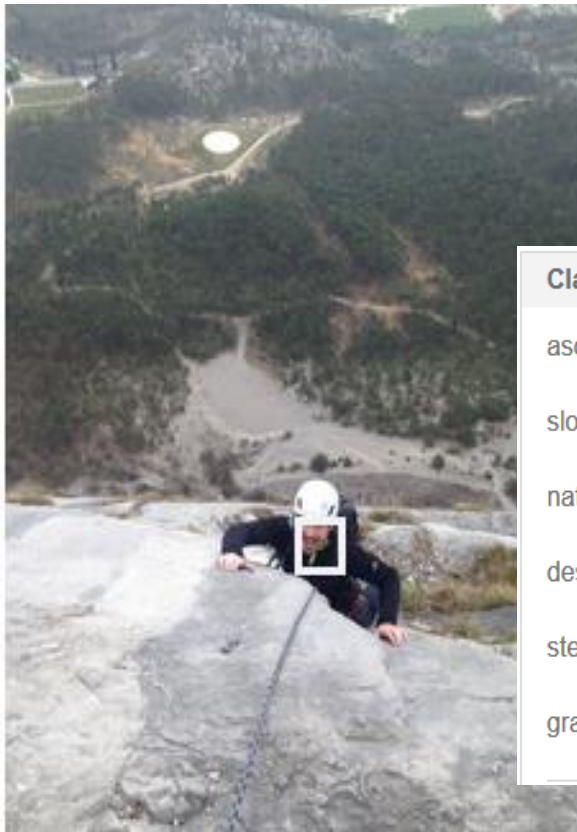
Goals

- Provide basic image processing operations as Web Services
- Create industrial image processing applications by composing these services
- Provide these applications as service again







Concept





Service Layer



Existing recognition services: IBM Watson, Google Cloud Vision, Amazon Rekognition

Classes	Score
ascent	0.81 
slope	0.92 
nature	0.93 
descent	0.66 
steep	0.50 
gray color	0.97 

Faces	Score
age 18 - 24	0.39 
female	0.00 

Did We Wow You? Yes No



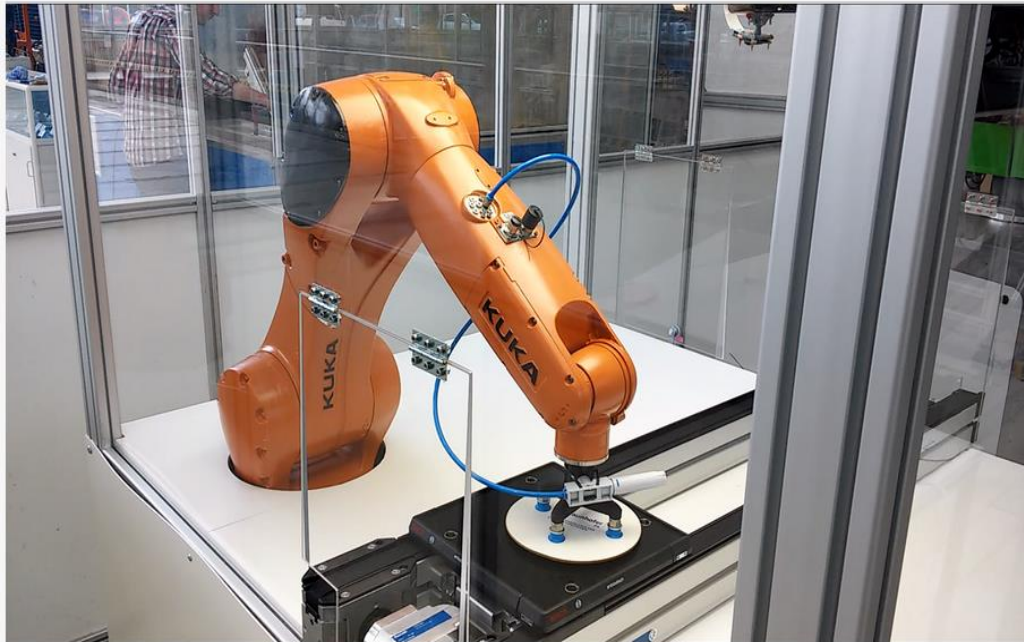
Service Layer

However, they don't work for industrial environments yet...



Object and scene detection

Rekognition automatically labels objects, concepts and scenes in your images, and provides a confidence score. (Your images aren't stored.)



Done with the demo?

[Download SDKs](#)

▼ Results

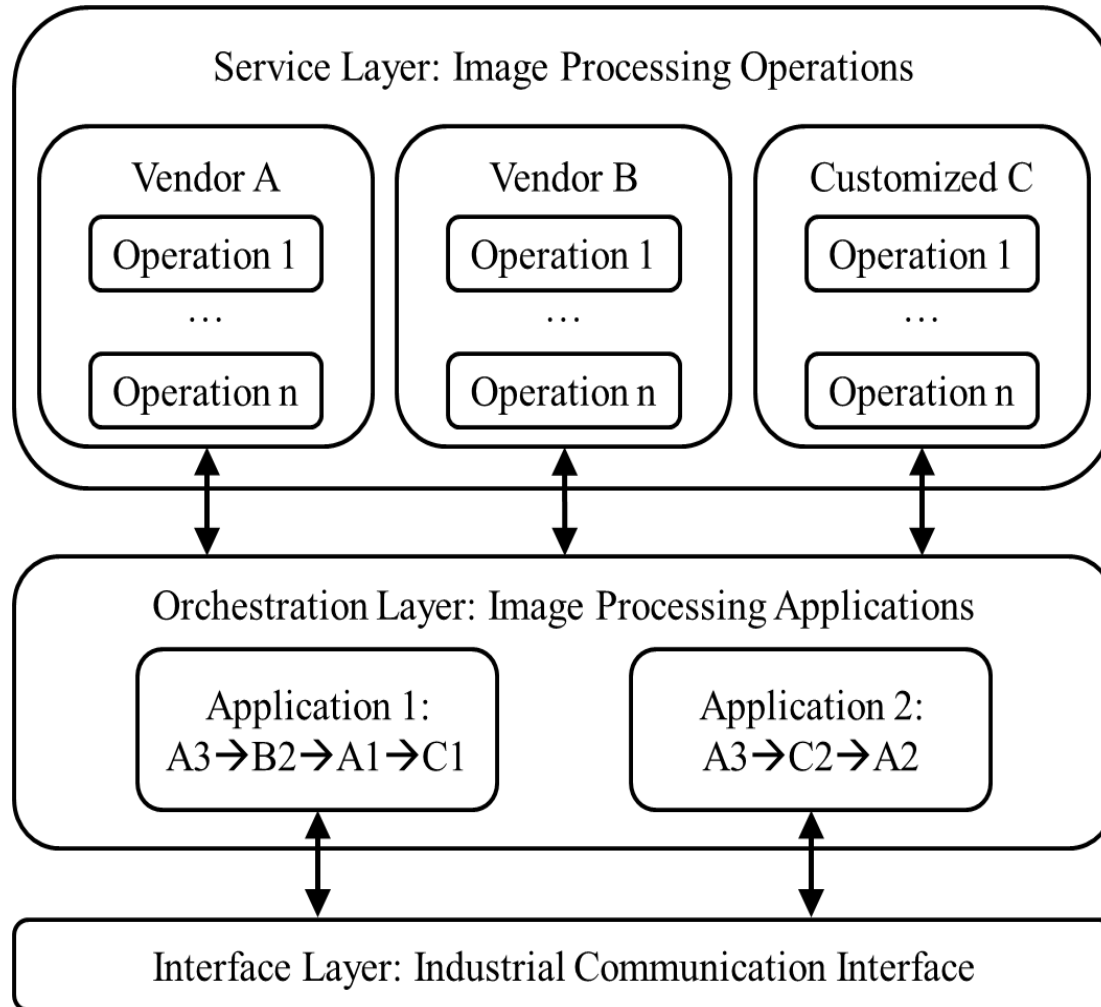
Motor Scooter	94.6%
Motorcycle	94.6%
Vespa	94.6%
Scooter	94.6%
Vehicle	59.9%
Footwear	51.1%
Shoe	51.1%

???

Service Layer

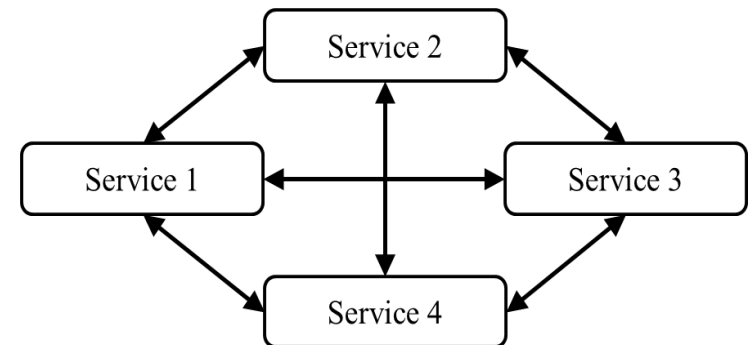
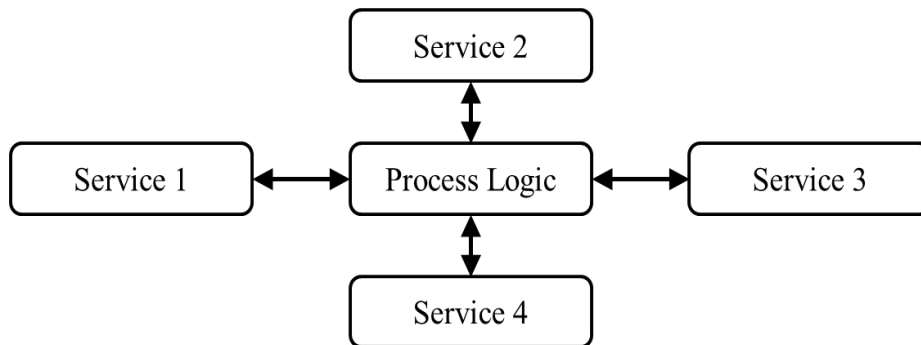
- Available technologies / protocols:
 - HTTP/JSON (RESTlike) [1, 8]
 - SOAP, WSDL [7]
 - Protocol Buffers, or gRPC

Concept



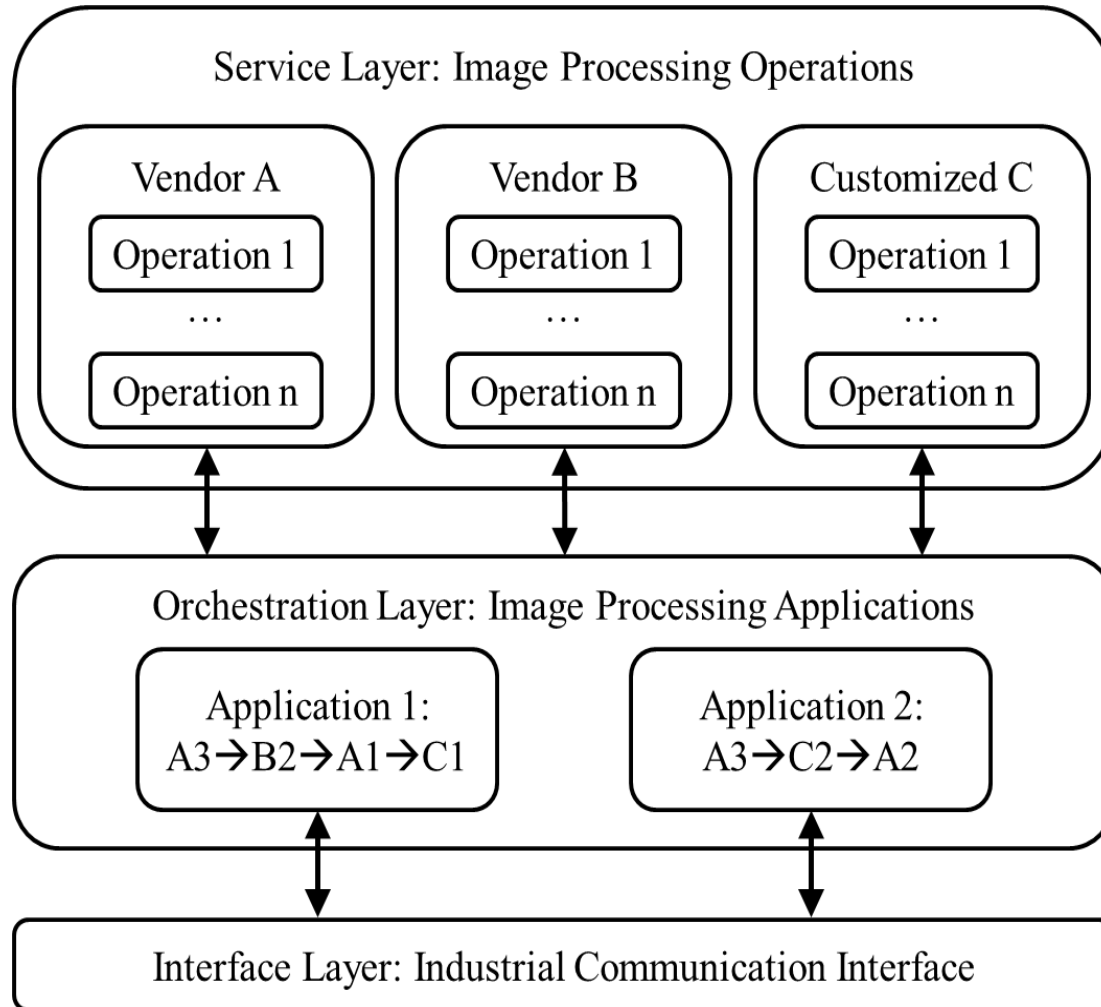
Orchestration Layer

- Composition of individual operations
- Orchestration vs. Choreography [11]



- Available technologies: BPEL, YAWL

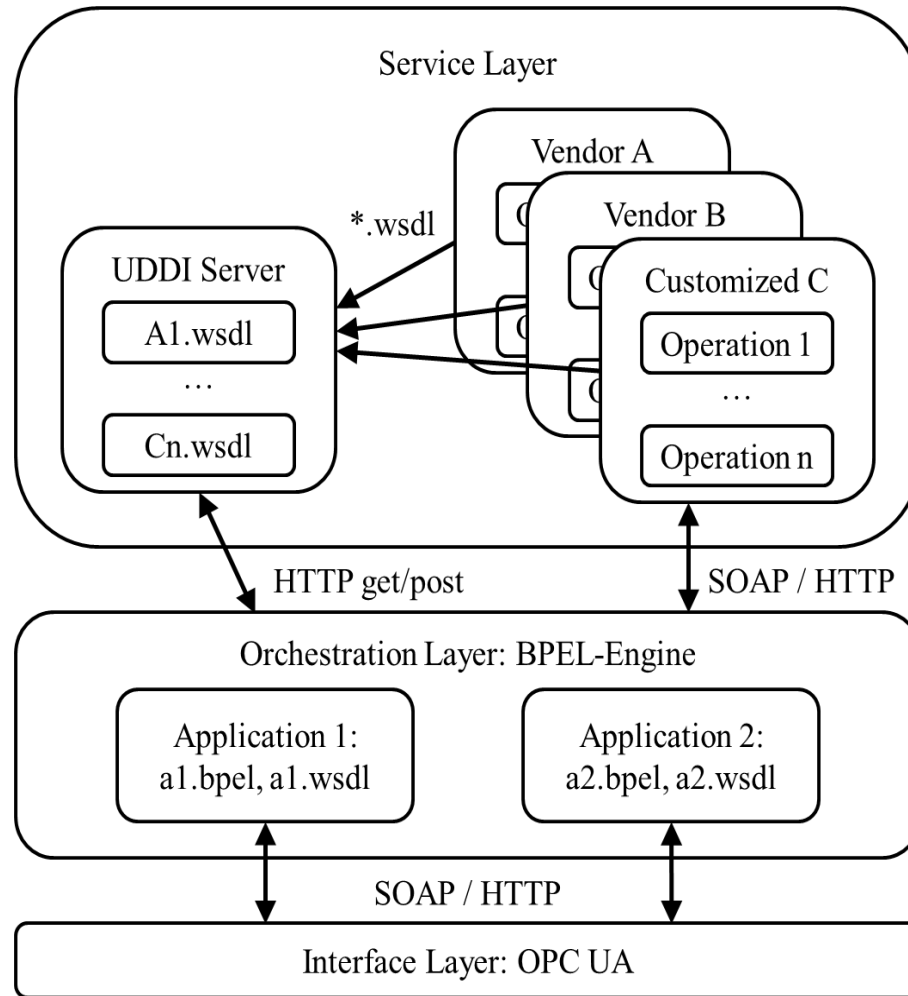
Concept



Interface Layer

- Technologies for industrial communication:
 - OPC UA [9]
 - MQTT

Exemplary Implementation



Results and Discussion

- Proof-of-concept implementation works
 - A lot of open source software is available
 - WSDL files can be mostly generated
 - It is relatively straightforward to compose a process using BPEL

- Usability should be further improved
 - Support for more interface types on the service layer required
 - Not applicable under real-time conditions

Summary

- Our concept allows
 - Orchestration of web services to create image processing applications from basic building blocks
 - Seamless integration into the production process by standard industrial interface
- But
 - Usability and real-time capabilities are to be improved, e.g. with TSN [12]

Outlook

- Industrial Vision Services enable
 - Next generation of web-based smart cameras
 - More computing power for complex 3D image processing
 - Machine learning in industrial contexts by providing a sufficient database

References

- [1] Mark Richards, . Microservices vs. Service-Oriented Architecture. Sebastopol, CA: O'Reilly Media; 2016. ISBN 978-1-491-94161-4.
- [2] Newman, S.. Microservices (mitp Professional). 1., 2015 ed.; Wachtendonk: MITP; 2015. ISBN 3958450814.
- [3] Bauernhansl, T., Krüger, J., Reinhart, G., Schuh, G.. Wgp-standpunkt industrie 4.0. Wissenschaftliche Gesellschaft für Produktionstechnik WGP eV 2016;.
- [4] Vick, A., Horn, C., Rudorfer, M., Krüger, J.. Control of robots and machine tools with an extended factory cloud. In: Factory Communication Systems (WFCS), 2015 IEEE World Conference on. 2015, p. 1–4.
- [5] Branchenführer industrielle bildverarbeitung 2017/2018. 2016.
- [6] MacKenzie, C.M., Laskey, K., McCabe, F., Brown, P.F., Metz, R., Hamilton, B.A.. Reference model for service oriented architecture 1.0. OASIS standard 2006;12:18.
- [7] Newcomer, E.. Understanding Web Services: XML, Wsdl, Soap, and UDDI. Addison-Wesley Professional; 2002.
- [8] Fielding, R.T., Taylor, R.N.. Architectural styles and the design of network-based software architectures. University of California, Irvine Doctoral dissertation; 2000.
- [9] Leitner, S.H., Mahnke, W.. Opc ua–service-oriented architecture for industrial applications. ABB Corporate Research Center 2006;.
- [10] Grüner, S., Pfrommer, J., Palm, F.. Restfulindustrialcommunicationwithopc ua. IEEE Transactions on Industrial Informatics, 2016;12(5):1832–1841.
- [11] Peltz, C.. Web services orchestration and choreography. Computer 2003;36(10):46–52.
- [12] Henzmann, H.. Echtzeitfähig: opc ua mit tsn. In: Aktuelle Technik; vol. 12. 2015, p. 26–27. URL: [www.aktuelletechnik.ch/Web/InternetAT.nsf/0/DD07E3A843FBF86DC1257F1F003E3DA1/\\$file/35836.pdf](http://www.aktuelletechnik.ch/Web/InternetAT.nsf/0/DD07E3A843FBF86DC1257F1F003E3DA1/$file/35836.pdf).



Thank you for your attention.
Any remarks or questions?

