A Field Study: The Perception of Edge Computing for Production Industry

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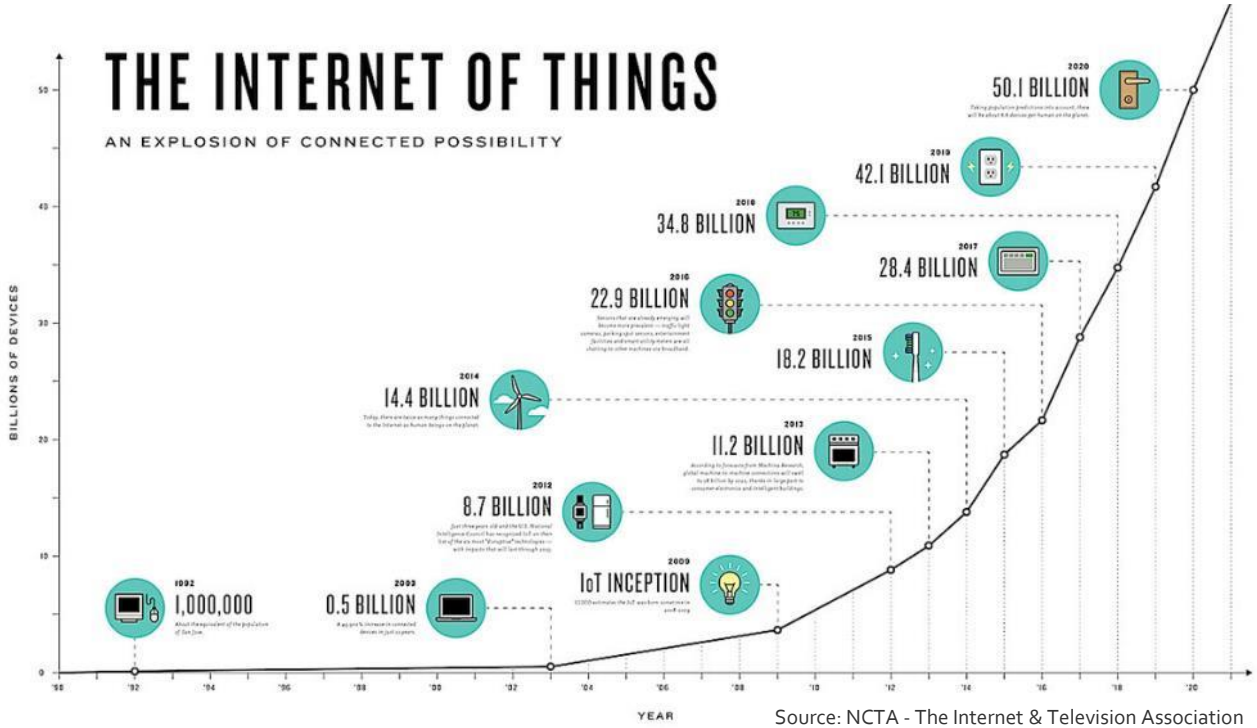
DFKI - SmartFactory

TU Kaiserslautern	Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI)	Technologie-Initiative SmartFactory KL e.V.
		
Department Production and Automation (pak) Subject: Machine-Process engineering	Kaiserslautern Research subject: Innovative Factory Systems	Registered association 50 members from industries and research institutes

SmartFactory Lab

Motivation



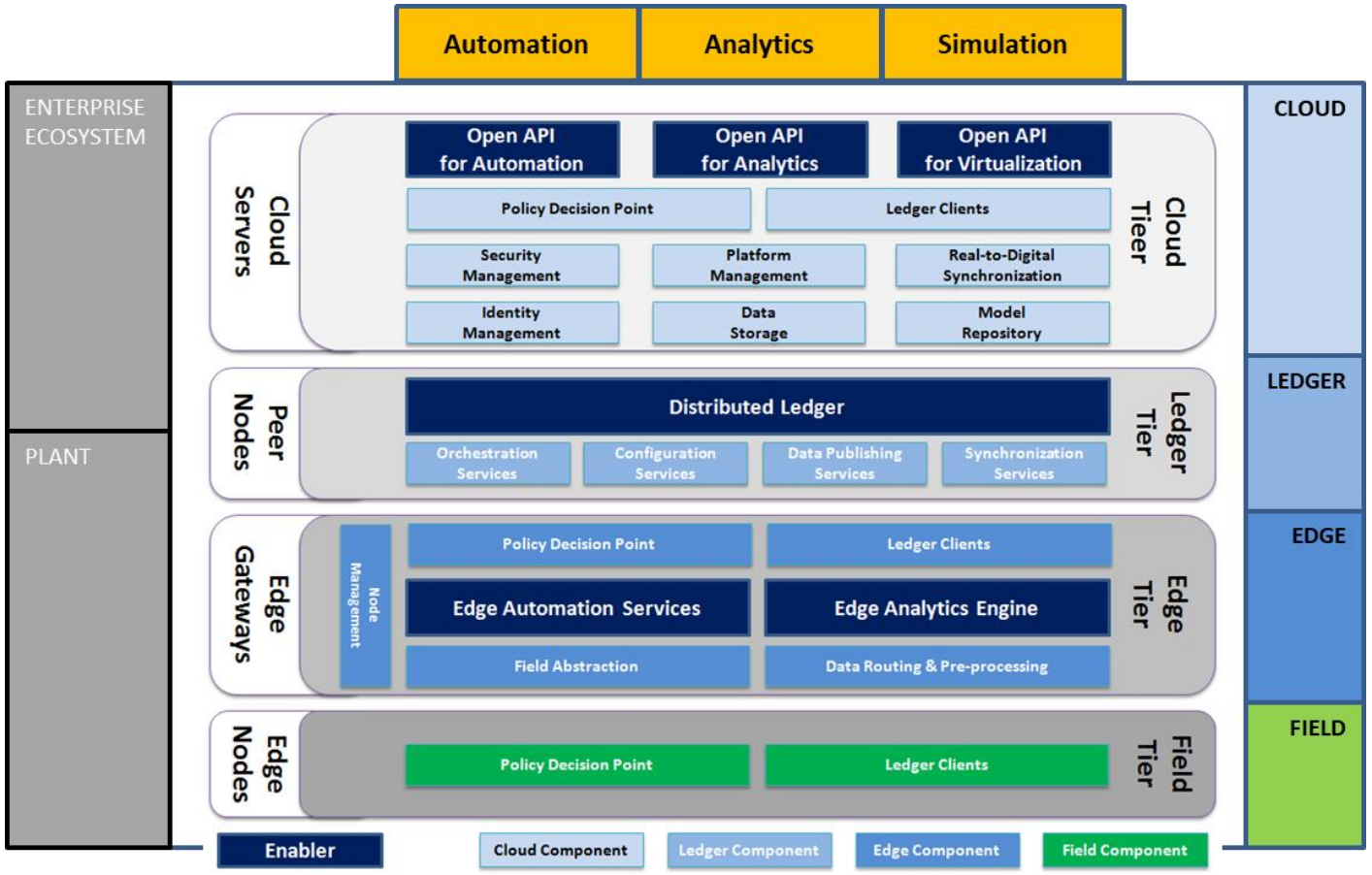
Source: NCTA - The Internet & Television Association

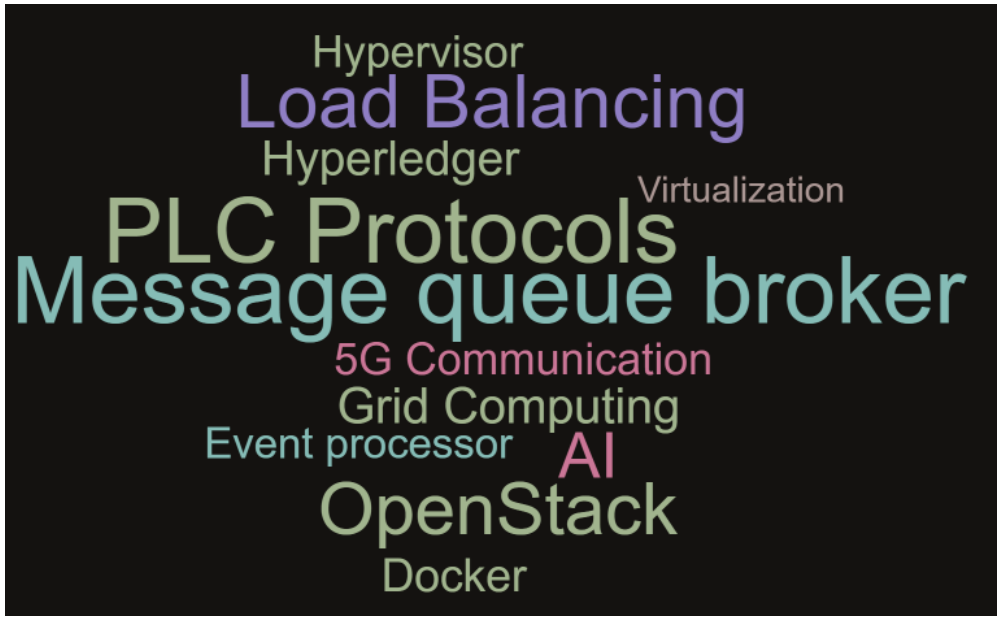
Problems with Cloud Computing

- Increased raw data generation within factories/field level
- Increased load in the Cloud server
- Increased load on the network
- Increased latency
- Reduced performance
- No computing in case of network failure
- Security & privacy

Edge Computing

Edge Computing moves computation power, applications and services from centralized units into the logical extremes to the source.





Source: Gezer, Um, Ruskowski: An Introduction to Edge Computing and A Real-Time Capable Server Architecture, International Journal of Intelligent Systems 11(1&2):105, UBICOMM 2018

FAR-EDGE

- An ongoing EU Project which defines a reference architecture on three domains:
  - Analytics
  - Automation
  - Simulation
- The architecture is applied in 13 active use cases on three use case partners:
  - Volvo Trucks Company
  - Whirlpool
  - SmartFactory Lab
- The project aims to solve the challenges of use case partners.

Survey

Purpose:

- To determine the level of relevance and focus of Edge Computing within industry and academia.
- To determine which factors are more relevant and should be prioritized in the development.
- To estimate necessary development time and cost for software development and compare with Cloud solutions.

Process:

- A set of relevant Edge Computing factors are defined.
- Each interviewee is asked the same questions with slight adaptations.
- None of the answers were shared with other partners.

Survey

Organized in five distinct sections.

1. Evaluation of Relevant Factors for Edge Computing: Set of factors preselected based on prior experience and literature: latency, data ownership, autonomy, quantity, and connectivity.
2. Importance of Additional Edge Computing Benefits: Set of additional factors to determine the importance of requirements: reliability, scalability, extensibility, abstraction, and interoperability.
3. Development Time Distribution for an Application: Time distribution in percentage during analysis, design, implementation and build, deployment, testing, revision, and training.
4. Development Cost Distribution for an Application: Similar to (3), but in terms of cost.
5. Hardware and Software Distribution: Estimated distribution in percentage.

Survey Results – Section 1

Aim: To evaluate to which degree the Edge Computing is better alternative to the Cloud.

Question:
How important are these criteria for you? (Separate answer for each use case)

Survey Results – Section 1 and 2

Automation Use Cases:

VTC: #1-#3

WHR: #1

SFK: #2-#7

Analytics Use Cases:

SFK: #1

VTC: #5

Simulation Use Cases:

VTC: #4

Scenario	Use Case ID	Interviewee	Latency	Data Ownership	Autonomy	Data Quantity	Connectivity	Reliability	Scalability	Extensibility	Abstraction	Interoperability
VTC	1,2,3	Owner										
		Provider #4										
	4	Owner										
		Provider #5										
	5	Owner										
		Provider #3										
		Provider #2										
WHR	1	Owner										
		Provider #6										
SFK	1	Owner										
		Provider #3										
	2,3,4	Owner										
		Provider #6										
	5	Owner										
		Provider #6										
		Provider #3										
	6,7	Owner										
		Provider #6										

Legend	
1	Not applicable
2	Very Low
3	Low
4	Medium
5	High
6	Very high
7	Crucial

VTC: Volvo Trucks

WHR: Whirlpool

SFK: SmartFactoryKL

Survey Results – Section 1 and 2

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VTC: #4

Scenario	Use Case ID	Interviewee	Latency	Data Ownership	Autonomy	Data Quantity	Connectivity	Reliability	Scalability	Extensibility	Abstraction	Interoperability
			Factors for EC									
VTC	1,2,3	Owner	4	3	7	2	6					
		Provider #4	4	6	6	3	6					
	4	Owner	2	3	3	2	2					
		Provider #5	1	5	1	1	1					
	5	Owner	3	3	7	2	6					
		Provider #3	2	7	5	6	5					
		Provider #2	4	7	6	7	6					
WHR	1	Owner	6	1	7	1	5					
		Provider #6	6	1	7	1	5					
SFK	1	Owner	2	7	4	5	6					
		Provider #3	2	7	5	6	5					
	2,3,4	Owner	2	7	4	2	6					
		Provider #6	2	7	4	2	6					
	5	Owner	2	7	4	2	6					
		Provider #6	6	1	7	1	5					
		Provider #3	2	7	5	6	5					
	6,7	Owner	2	7	4	2	6					
		Provider #6	4	5	7	1	5					

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		Provider #4	4	6	6	3	6					
	4	Owner	2	3	3	2	2					
		Provider #5	1	5	1	1	1					
	5	Owner	3	3	7	2	6					
		Provider #3	2	7	5	6	5					
		Provider #2	4	7	6	7	6					
WHR	1	Owner	6	1	7	1	5					
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	2,3,4	Owner	2	7	4	2	6					
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Survey Results – Section 2

Aim: To figure out if the solution satisfies the Industry 4.0 requirements from the partners.

Question:
How many of the additional important factors have been covered by the developed or in progress solutions? Add if missing.

Survey Results – Section 1 and 2

Automation Use Cases:

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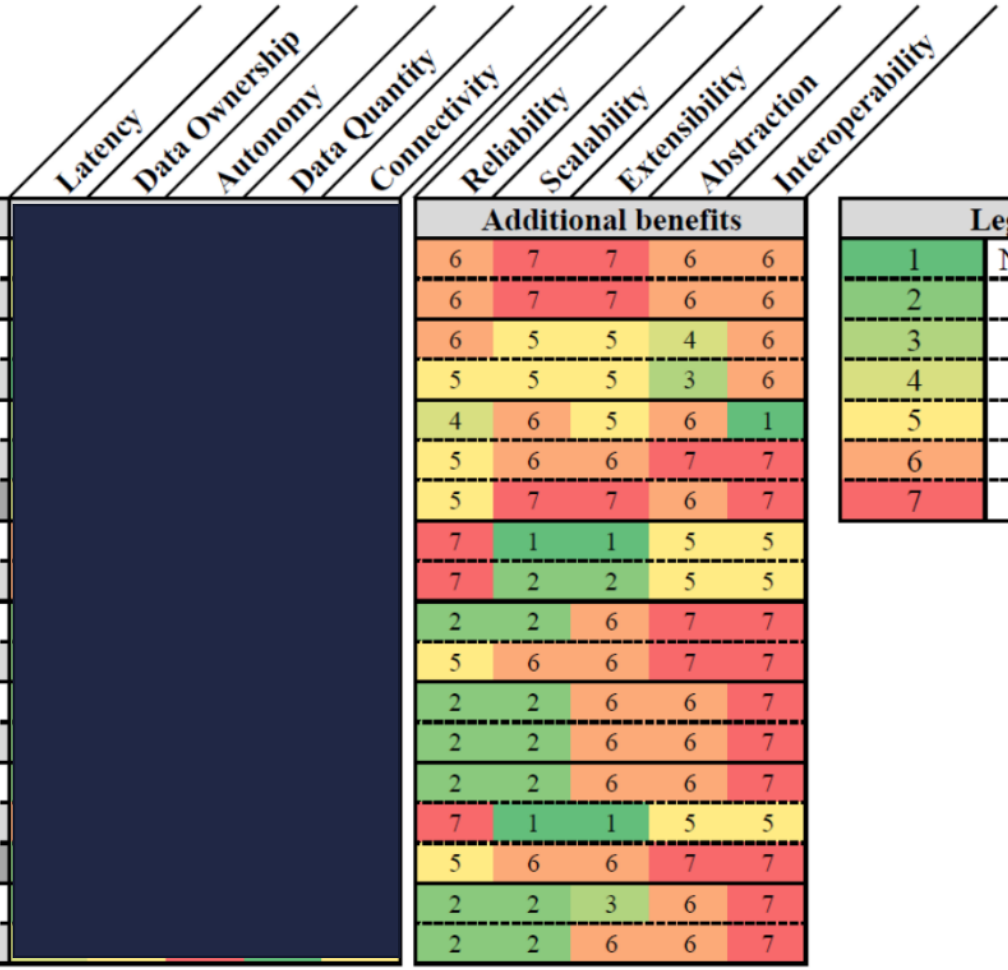
VTC: #5

Simulation Use Cases:

VTC: #4



Scenario	Use Case ID	Interviewee	Latency	Data Ownership	Autonomy	Data Quantity	Connectivity	Reliability	Scalability	Extensibility	Abstraction	Interoperability
			Additional benefits									
VTC	1,2,3	Owner	6	7	7	6	6					
		Provider #4	6	7	7	6	6					
	4	Owner	6	5	5	4	6					
		Provider #5	5	5	5	3	6					
	5	Owner	4	6	5	6	1					
		Provider #3	5	6	6	7	7					
		Provider #2	5	7	7	6	7					
WHR	1	Owner	7	1	1	5	5					
		Provider #6	7	2	2	5	5					
SFK	1	Owner	2	2	6	7	7					
		Provider #3	5	6	6	7	7					
	2,3,4	Owner	2	2	6	6	7					
		Provider #6	2	2	6	6	7					
	5	Owner	2	2	6	6	7					
		Provider #6	7	1	1	5	5					
		Provider #3	5	6	6	7	7					
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		Provider #6	2	2	6	6	7					

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		Provider #4						7	7	6	6	
	4	Owner						5	5	4	6	
		Provider #5						5	5	3	6	
	5	Owner						6	5	6	1	
		Provider #3						6	6	7	7	
		Provider #2						7	7	6	7	
WHR	1	Owner						1	1	5	5	
		Provider #6						2	2	5	5	
SFK	1	Owner						2	6	7	7	
		Provider #3						6	6	7	7	
	2,3,4	Owner						2	6	6	7	
		Provider #6						2	6	6	7	
	5	Owner						2	6	6	7	
		Provider #6						1	1	5	5	
		Provider #3						6	6	7	7	
	6,7	Owner						2	3	6	7	
		Provider #6						2	6	6	7	

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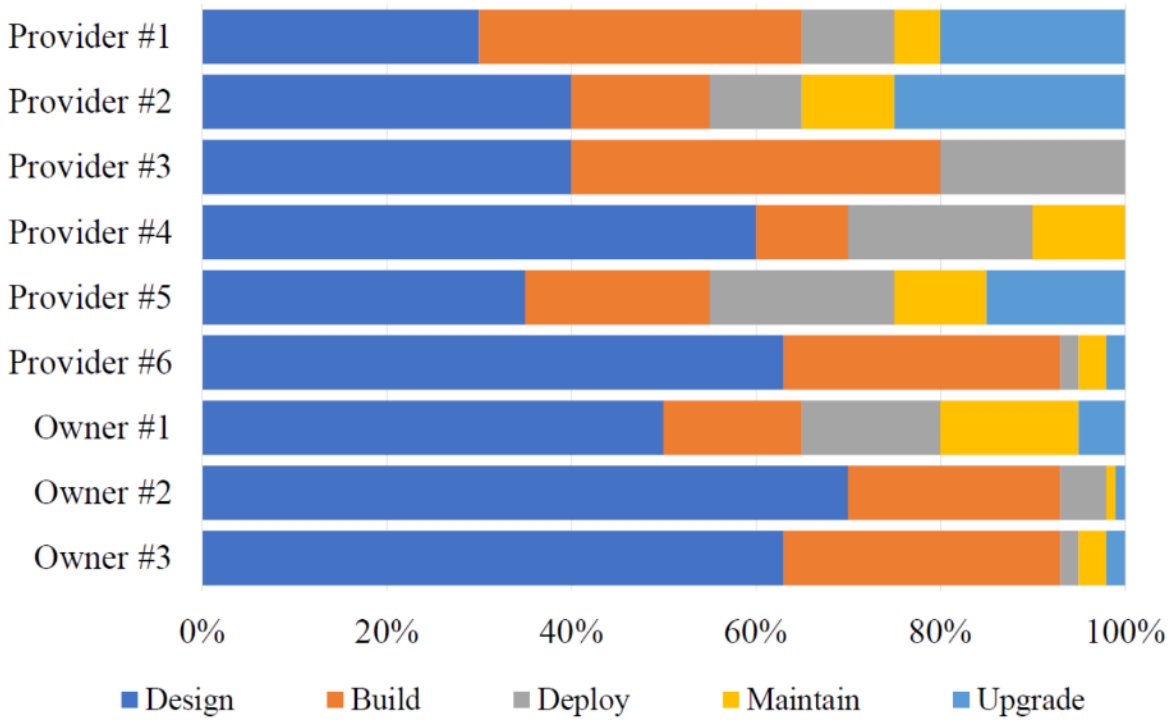
Survey Results – Section 3 and 4

Aim: To figure out how much saving w.r.t time and cost is estimated with the Edge Solution.

Question:
How much time/cost is expected to be reduced with Edge Solution?

Survey Results – Section 3 and 4



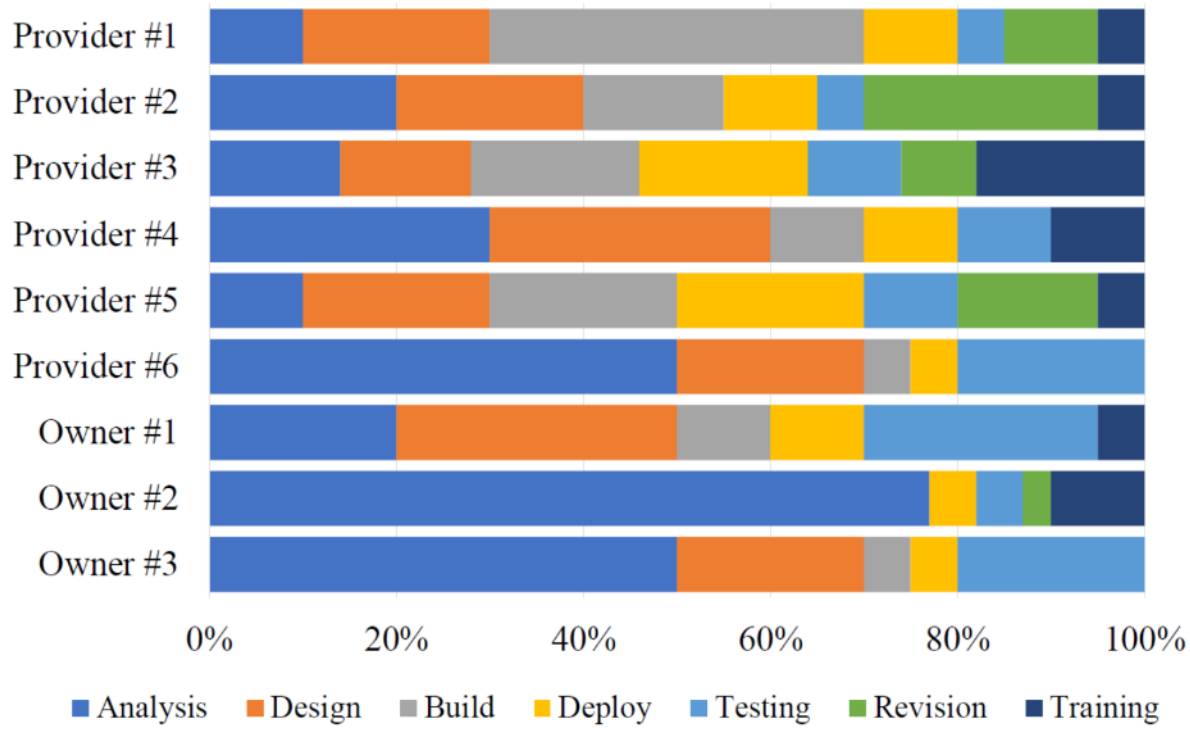
Development Time Distribution

Development Cost Distribution

Survey Results – Section 3 and 4

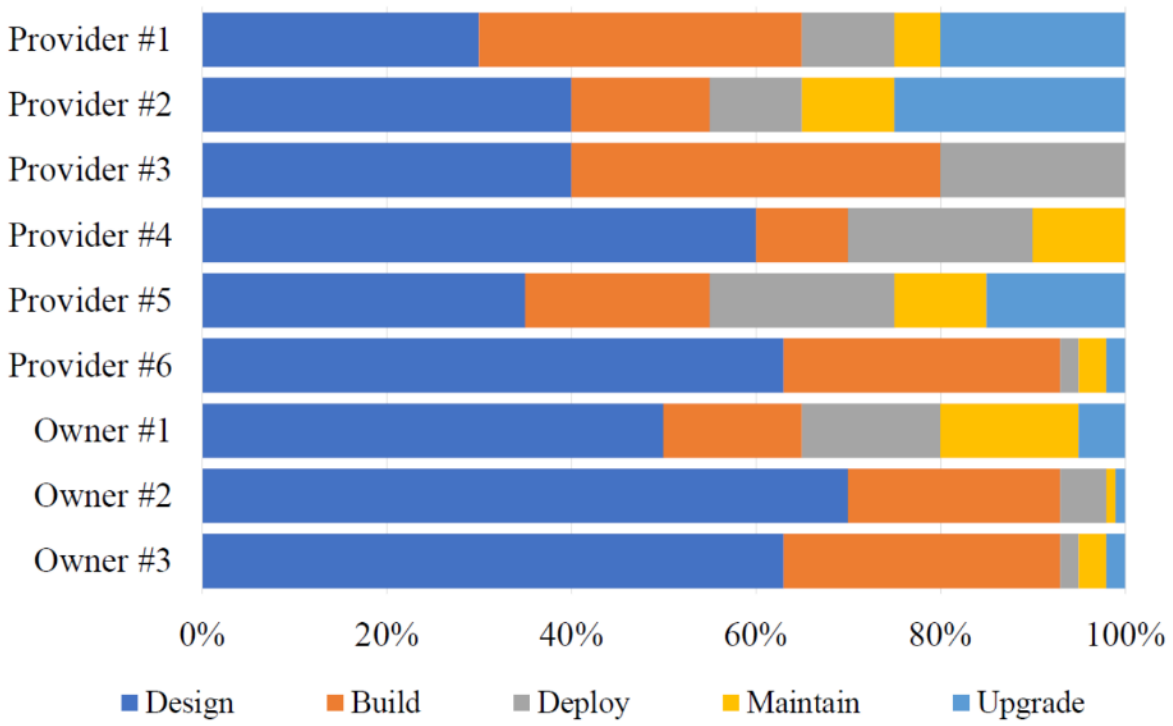
Results 2

Development Time Distribution

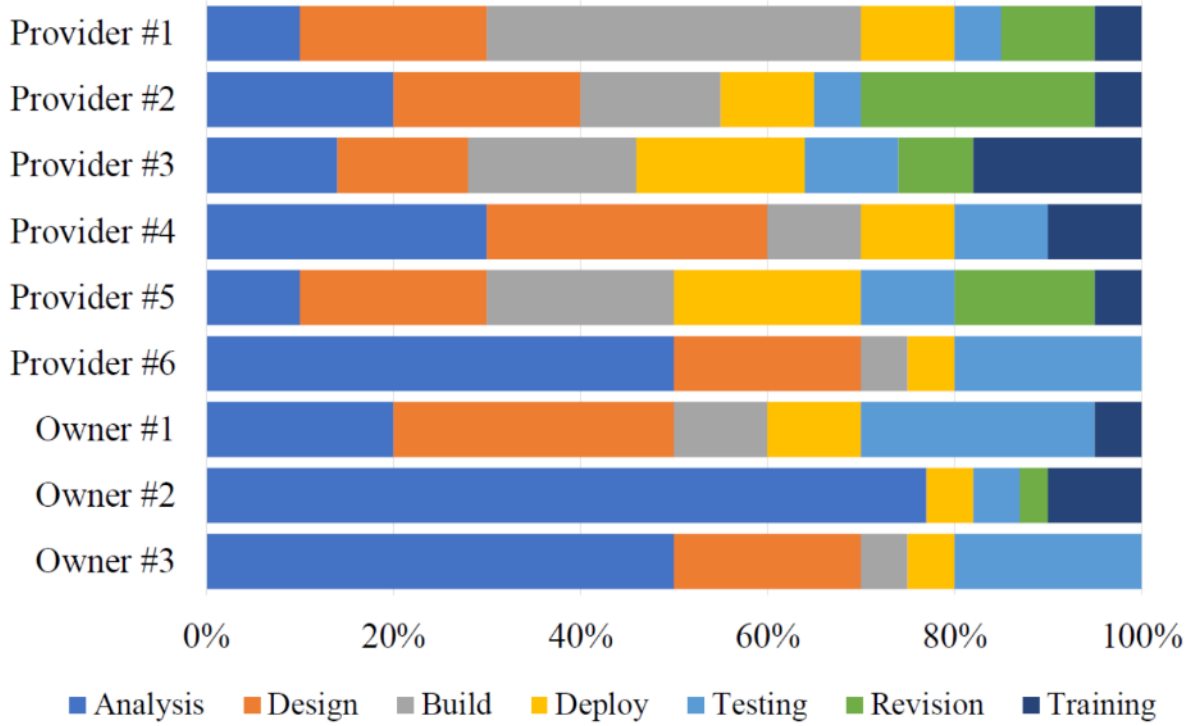


Development Cost Distribution

Survey Results – Section 3 and 4



Development Time Distribution



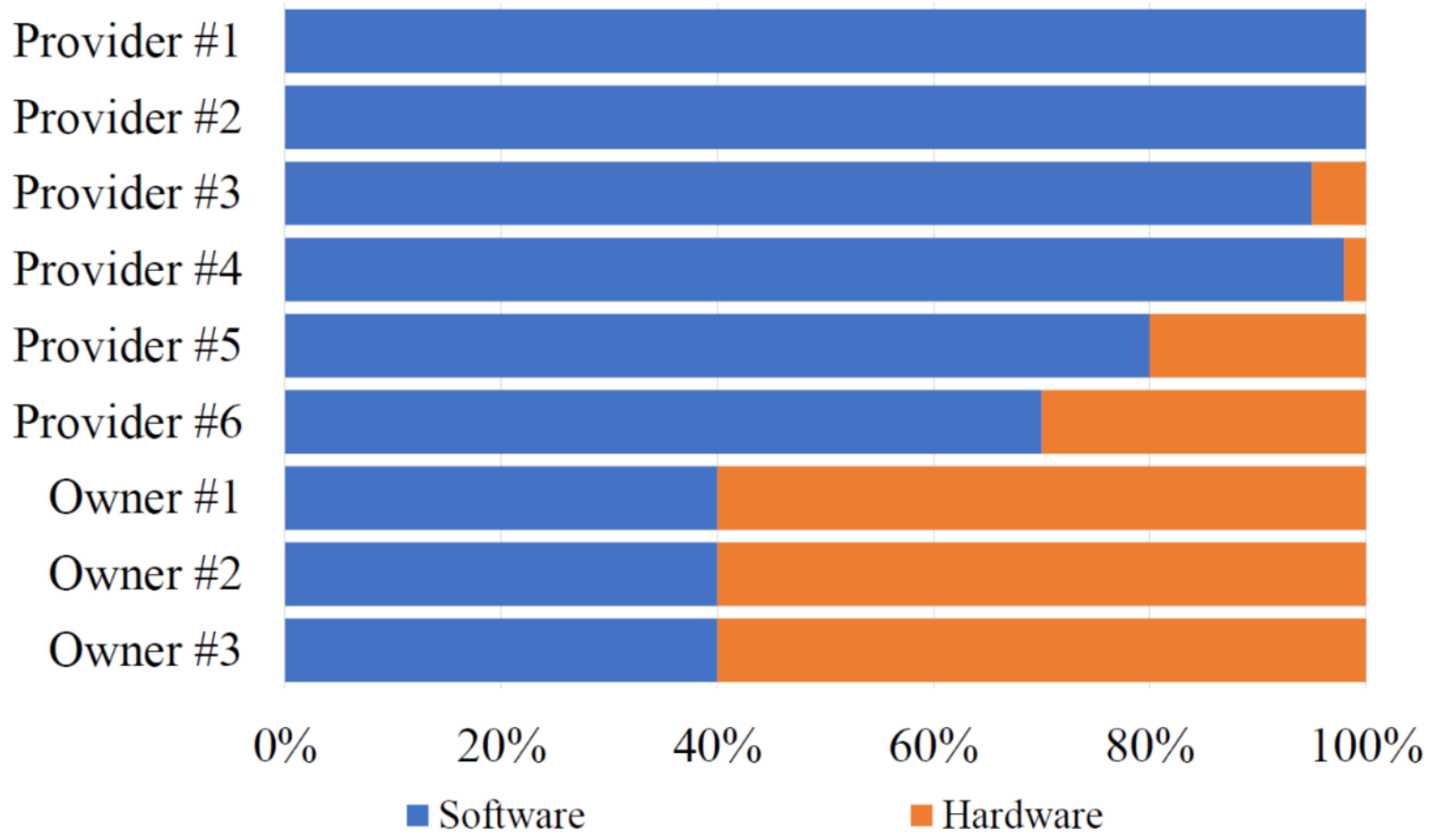
Development Cost Distribution

Survey Results – Section 5

Aim: To understand whether the solutions require more hardware or software

Question: How much hardware/software do you expect to use in the use case? (For each case you are involved in)

Survey Results – Section 5



Conclusion

- Edge Computing moves computation power, applications and services from centralized units into the logical extremes to the source.
- The list is „complete" (partners were ask to extend - no necessity to extend was found).
- Cost primarily software for solution developers but hardware needs to be considered.
- Different use cases, different requirements → Necessity of an Edge platform to cover everything.
- More than a third of cost associated with design → Saving potential in time and cost in case of a common architecture (Validates: Zietsch, J., L. Büth, M. Juraschek, N. Weinert, S. Thiede, und C. Herrmann. „Identifying the potential of edge computing in factories through mixed reality". In *Procedia CIRP*, 81:1095–1100, 2019.).

Future Work

- Compare the estimated numbers with the real ones.
- Extend the survey by more participants (only 9 interviewees)
- A clear picture will be visible when this number is increased.

Questions?