Information Spaces
A method and business setup to retrieve Information from any source, process it and display the results as expected.
MAS Digitales Bauen FHNW
Master Thesis
Abstract

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Summary. This Master Thesis describes the concept of 'Information Spaces'. Initially thought of as Information Spaces for the digital twins of buildings that are planned, built and operated using virtual tools and systems. The Information Space is designed to provide all and complete information of a building and to provide it in real-time. The Thesis describes a system concept and work environment, a multiple level network environment, developed using digital means which: retrieves project data and information on demand and in real-time and makes them available for processing in real-time; at any point in time can data be retrieved from any available source to run specific applications which are part of workflows for use cases; the number of use cases or applications is not limited, nor is the combination of applications limited; results of applications are presented in real-time on dashboards, configured to give the user/customer the information he needs in a format he immediately understands; incorporates a feedback loop, assuring that information from prior iteration loops is secured and input for following iteration loops; the feedback loop can also trigger other applications and the combined (or aggregated results) provide additional intelligence; as an integrated system, it is of use for all project participants, usable for all workflows and supports each decision process needing data processing; has the potential to be configured as integrated information management for an integrated project delivery environment. Because of its network design and scalability features, Information Spaces are independent of the size of environment and applicable on large and small-scale projects. Exemplarily, two business models were developed, both based on the same concept of Information Spaces but for different purposes.

1. Goals for this work

1. Establish the fundamental concept and the mechanisms for information spaces, addressing the question, what kind of process requirements must be fulfilled by information spaces.

2. Develop a system architecture which is scalable without limitation and with only incremental effort and designed to exploit network capability of parallel (simultaneous) processing.

3. Identify work processes and system components, which can be automated and augmented with Artificial Intelligence.

4. Developments will be done as opportunity arises, our focus topic being the Information Space for IPD (Integrated Project Delivery), which we call IPDx.

5. Key elements of IPDx will be tested and validated in a Proof of Concept (PoC).

6. Business models are developed for Information Spaces 'as a Service' or to be introduced into existing business models.

2. Information Space for VDC

Our ambition is to develop and operate for a truly VDC environment the corresponding Information Space, which allows to harvest the enormous potential of digital systems. Our definition of Information Spaces starts with fundamental characteristics, as they:

- connect all system components in a network configuration
- safeguard the automated and reliable data transfer independent from data format
- process data simultaneously and with algorithms that are exponentially scalable without much effort.

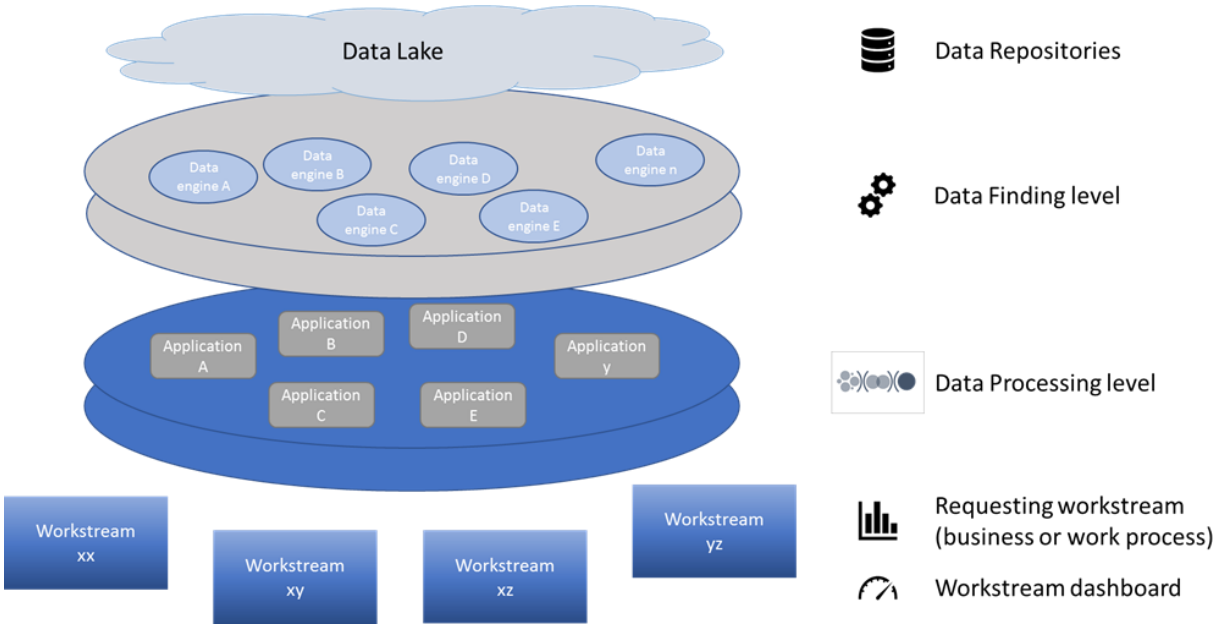

Fig.1: Schematic of the functional levels of Information Space.

3. Use Cases

Use Cases are the starting point of innovation, noting down who wants to achieve something specific and for what purpose. They should be developed to also provide the expectations towards new functionalities and what results are expected.

The descriptions of use cases are then translated by the innovators into functional descriptions of the solution systems and also a first assessment on which components (technology (hardware) and methodology (software)) are required to build the solution. Combinations of the components are studied and if possible, several solution approaches developed. A solution proposal includes a non-detailed but intrinsic logical system concept and first concrete ideas of a system architecture. Also important at this point in time is to capture the critical success parameters of the solution proposal, they are key for the success of further work.

A competitive assessment of the solution proposals, based on the potential of their prospects and leveraged by weighing against their risk profile, allows to focus on the favorite solution proposal which will be progressed through the further development. The alternate solutions remain on back-hand as alternatives in the case that the initial favorite, for whatever reasons could not be developed or did not show the expected performance. Combining these learnings with the initial assessment could lead to new proposals with higher probability of success.

Another experience tells us not cut back on performance criteria, just to proclaim successful innovation. With the initial solution proposal comes the promise to fulfill the underlying use cases and this is basically all the user/customer is interested in. If we do not fulfill the initial expectations and in this case achieve an agreement with the user to cut back on expectations, the user will be disappointed and lose confidence in our solution. We also fool ourselves, which is different from accepting the first learnings to reprocess them to a better solution. And finally do multiple component systems need reliable performance specifications from each component, to make the whole system run as intended and to be able to analyze it towards optimization. Unreliable component performance becomes a problem instead of being part of the solution.

4. Solution proposal

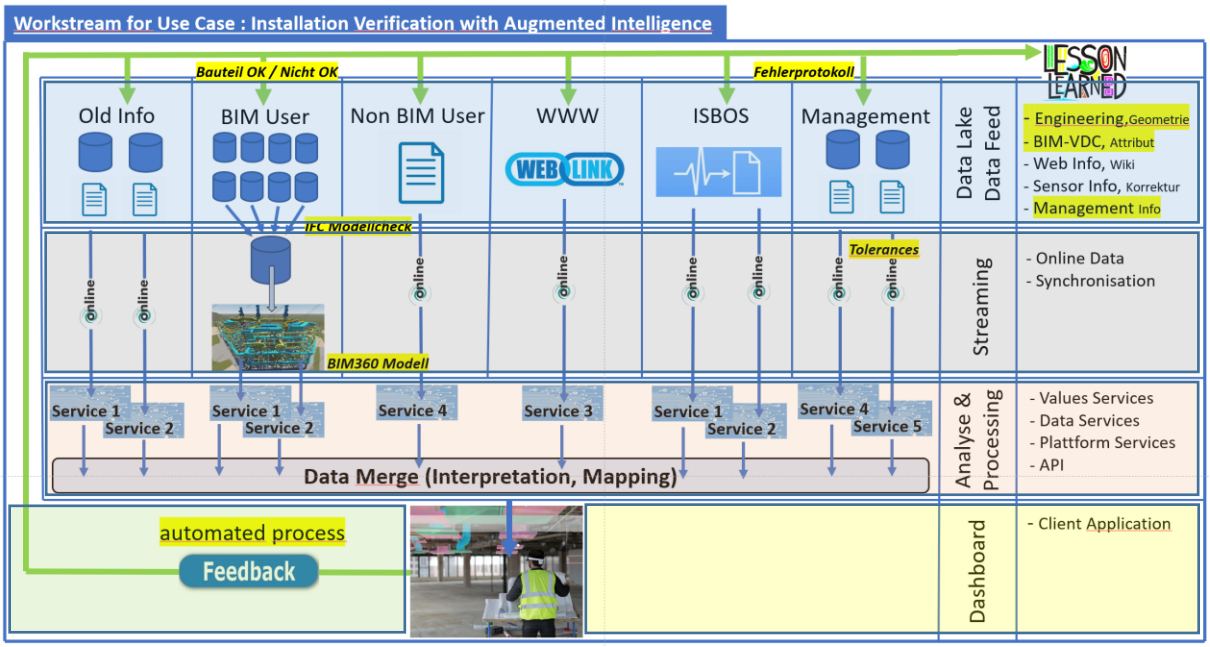

Fig. 2: General overview of the work stream for use cases
(specific use case 'Installation Verification' highlighted in yellow).

Search and Find: Search engines find requested data in their search on all open internet and local platform sources. They are capable of identifying and reading multiple formats.

Stream: Streaming software reads and transmits the required data and converts the data format into the format required by the application. This is where data mapping takes place.

Data processing: Once the streaming routines are established, the applications where data is processed, calculated and analyzed, can pull the data anytime when needed. Results of the applications are available without interrupt to the following steer and operate level.

Steer and operate: Results of the work stream are immediately available on preconfigured dashboards. This ensures, that the results are available in real-time and displayed in a format completely understandable by User.

Feedback loop: The findings out of evaluating the dashboard results, are returned as new information to the corresponding sites for further processing when the system is synchronized. This closes the circle of information update.

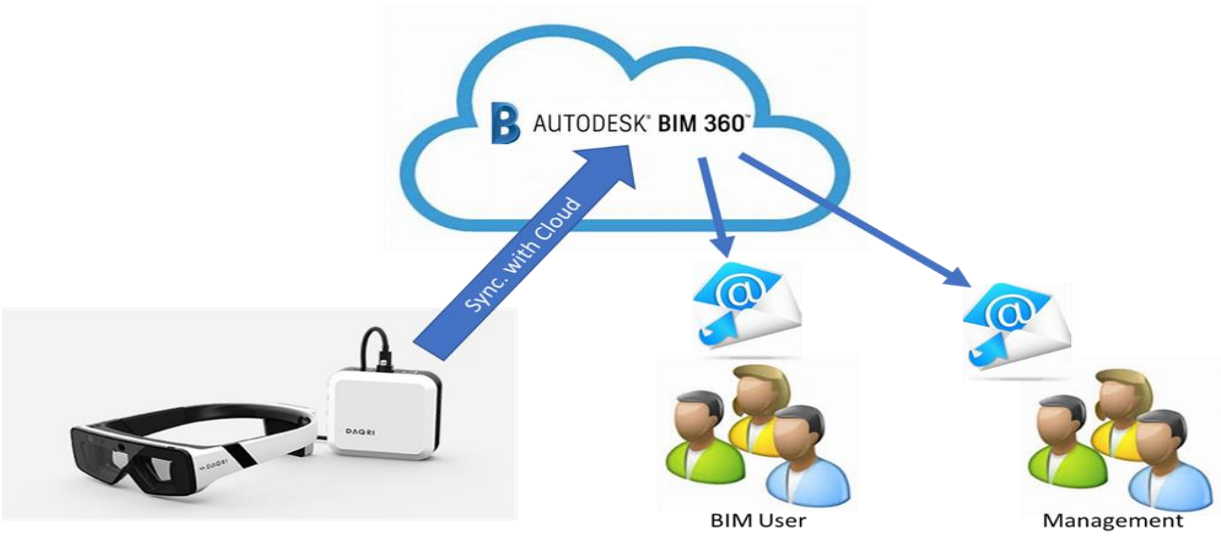

Fig. 3: Feedback loop with DAQRI™ Smart Glasses to BIM360™ cloud.

5. Scalability

A general and game changing advantage of digital systems, is that by connecting formerly independent systems to a network and making automated data transfer possible, the usages of the system become almost unlimited and can grow exponentially. If the work stream applications are designed to incorporate volume growth (in data amount or calculation routines) without limitation and handling it with parallel processing, then the system is in the sweet spot of exponential growth without proportional effort. But the system still needs a general purpose, otherwise the seduction is too big to devote time on solutions that look pretty cool in the first place but don't actually contribute to overall efficiency of the system.

For building projects, the Integrated Project Delivery (IPD) framework /1/, is certainly the reference today and in the coming years. We have the ambition with our Information Spaces to make them work as Integrated Information Management systems for IPD projects.

The idea is to start with certain use cases described in IPD and over time expand on the number of use cases and also to increase interconnectivity between the work streams. Over time a high degree of integration and interoperability is the goal. Primary focus will always be what kind of system configuration satisfies best the customer needs and demands and what the least number of work streams is, to achieve all required results. Efficiency focuses on the most relevant and dominant work streams for the project or business/work process. Simplicity is essential, to keep oversight and not loos efficiency gains right back to maintenance of system complexity.

6. Business Models

The first Business Model developed is for an independent company whose purpose is to provide Services exclusively and solely by digital methods, digital processes and using digital tools.

The company will focus on two areas of business, one is to develop new digital solutions and to offer development 'as a service', second is full digital services directly in and for the areas of Engineering, Project Management and Digital Innovation Management. The company provides integrated solutions either as solution provider or as service provider or as both.

The second Business Model developed is for a new organizational department in an existing organization, whose purpose it is to transform the underlining business towards Digitization. Main purpose for the new digital department is to manage the change process for Digitization.

7. Conclusion

What are the achievements so far?

- A concept for Information Spaces, initially focused on project environments working with VDC methods, expandable to IPD projects and beyond.
- A system environment, freely configurable and potentially scalable without limits, deploying platform thinking but without platform constraints.
- A strategy to continuously expand the associated business models.
- A way to make a business out of data management and data processing.
- A process and associated system that works with pull mechanisms.
- Found a way around format restrictions and limitations.
- Freed the User from the dubious task of having to be a system expert before the paid experts even start working. With our approach the user only has to know what he wants, our Information Space takes care of getting it.

What we have not yet achieved:

- Our system is not an open platform yet.
- Too little number of pilot runs, not yet regular access to test environments.
- System is only partially automated.

Learnings and Motivation:

- Pre-launch marketing with very positive feedback, prospective customers and potential partners want to start business.
- We truly believe that it is necessary to take the time to think through thoroughly the fundamental and structural implications of how to develop a system architecture for digital data management systems, for it to be sustainable in the years to come. Focus on solely individual components or even systematic short cuts will vanish as quick as they appeared.
- New processes, applications and system components must be piloted, they cannot be developed solely theoretically.
- Proof of Concept (PoC) is imperative. Without PoC, the business model is a blind flight.
- We are fully motivated and excited to see how far we can get with our concept, but in any case, it will continue to be an enrichment of our professional life. We feel privileged to explore new territories and enjoy the excitement of developing innovative solutions that were un-thinkable before and could really make a difference.

8. Literature

[1] M. Fischer, H. Ashcraft, D. Reed, A. Khanzode, Integrating Project Delivery, John Wiley & Sons Inc., 2017.