W3C LBD Community Group
Minutes - Call 19/02/2024

Attendees

- Katja Breitenfelder (Fraunhofer IBP, Germany)
- Alex Donkers (Eindhoven University of Technology, The Netherlands)
- Hervé Pruvost (Fraunhofer IIS, Germany)
- Rahel Kebede
- Nicholas Nisbet
- Mads Holten Rasmussen
- Klaus Linhard (HM Munich, Germany)
- Martin (HM Munich, Germany)
- Rebekka Benfer (University of Applied Sciences Cologne, Germany)
- Piotr Marek Smolira (DTU Kopenhagen)
- Luis Miguel Blanes Restoy (University of Galway)
- Ganesh Ramanathan (Siemens)
- Edrisi Munoz Mata (Empa)
- Joel J. Bender
- Maria Husmann (Siemens)
- Sergio Acero Gonzalez
- Al-Hakam Hamdan
- James Allan
- Amin Anjomshoaa
- Christopher Krueger
- Maria Laura Leonardi
- Jakob Martin
- Dimitris Mavrokapnidis
- Melina Rohne
- Pierre Bourreau
- Wolfram

Please join the W3C LBD CG and subscribe to the internal mailing list:
Linked Building Data Community Group (w3.org)

Presentation slides

- Slides: GitHub link
- Ontologies by Hervé Pruvost:
    - https://w3id.org/mm
    - https://w3id.org/risk
    - https://w3id.org/baf
    - https://w3id.org/esim

Date and time

- Monday 19th of February 2024, 15:00-16:30@UTC/ 16:00-17:30@CET/ 07:00-08:30@PST

Moderators

1. Katja Breitenfelder

Agenda

1. Introduction of new members
2. Hervé Pruvost (Fraunhofer IIS) on "Ontologies to automate the configuration and deployment of monitoring services for building energy systems"
3. Discussion
4. Further topics

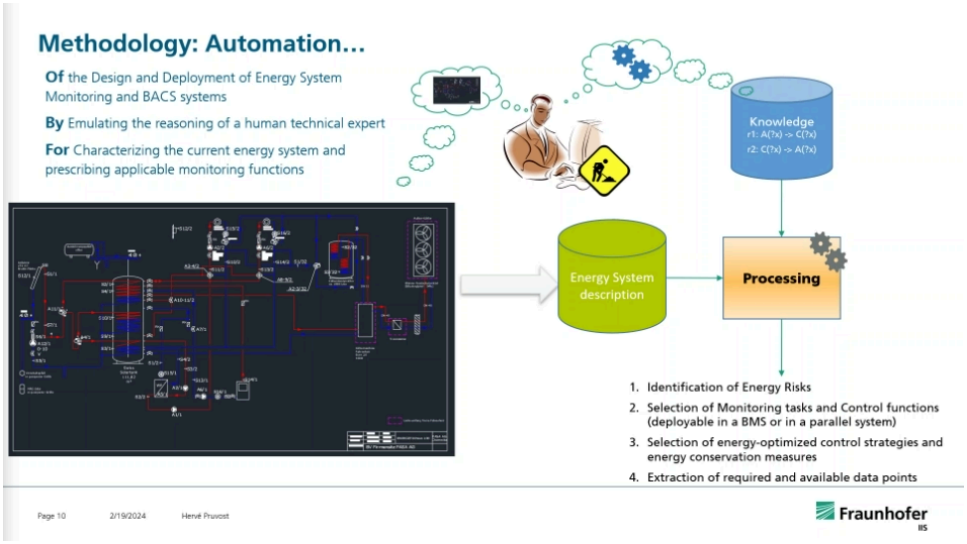
Minutes

1. **Introduction of new members**
    - Edrisi Munoz Mata, working at Empa. Working with semantic models for buildings and cities for +/- 13 years.
    - Ganesh Ramanathan, working at Siemens, Smart Infrastructure division. Mainly interested in operations of automation systems in buildings.
    - Luis Miguel Blanes Restoy, University of Galway. Was active in ontology development projects. Joined todays call because the interesting talk of Hervé Pruvost. Working in the energy domain, smart grids, operation of those grids, etc.
    - Piotr Marek Smolira, PhD at DTU in Kopenhagen, Denmark in digital twins for bridges. Interested in creating ontologies for bridges and sensor data, and wants to learn from the group.
    - Rebekka Benfer, working at University of Applied Sciences in Cologne, Germany. Building automation and monitoring. Interested in Hervé's presentation as it is relevant to her work.

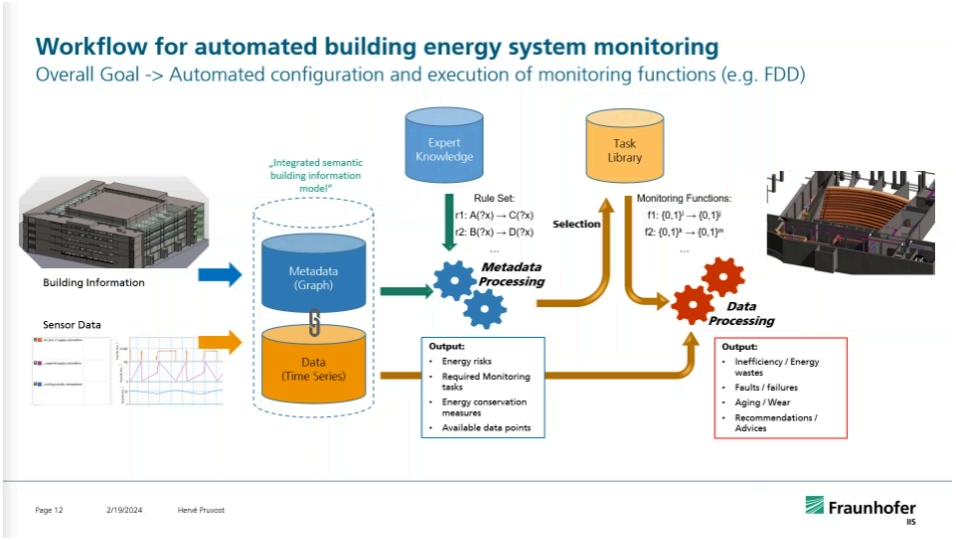
      Warm welcome to all new members!

2. **Hervé Pruvost (Fraunhofer IIS) on "Ontologies to automate the configuration and deployment of monitoring services for building energy systems"**
    - **Presentation: Speaker & working environment**
      R&D Engineer BIM / Knowledge Graphs / Computational Analytics at the Fraunhofer Institute for Integrated Circuits IIS, Division Engineering of Adaptive Systems EAS, Dresden, Germany.
        - studied mechanical and industrial engineering at ENSAM, France
        - Worked at BNP Paribas Real Estate, and then went to TU Dresden in Prof. Scherers group. After 6 years, Hervé moved to Fraunhofer working on data-related topics in the built environment. He works in the Division **Engineering of Adaptive Systems EAS**.
    - Motivation of this project: **Scalable monitoring systems to save energy in buildings**
        - Instead of making many different building-specific applications, why don't we create 1 application that works on 'any' building?
        - This requires a digital workflow, including BIM and linked data.
        - A lof of relevant information for energy monitoring and optimization is generated during various lifecycle stages of the building. This project aims to use this information better by integrating it.
        - To do this, there are three options
            - Use the information that is already captured in existing systems (BAC/…)

        - Using a metadata model (graph database)
        - A BIM model generated from CAD design, and reusing this in other workflows (BIM2BMS, BIM2FDD, BIM2BACS, etc.)

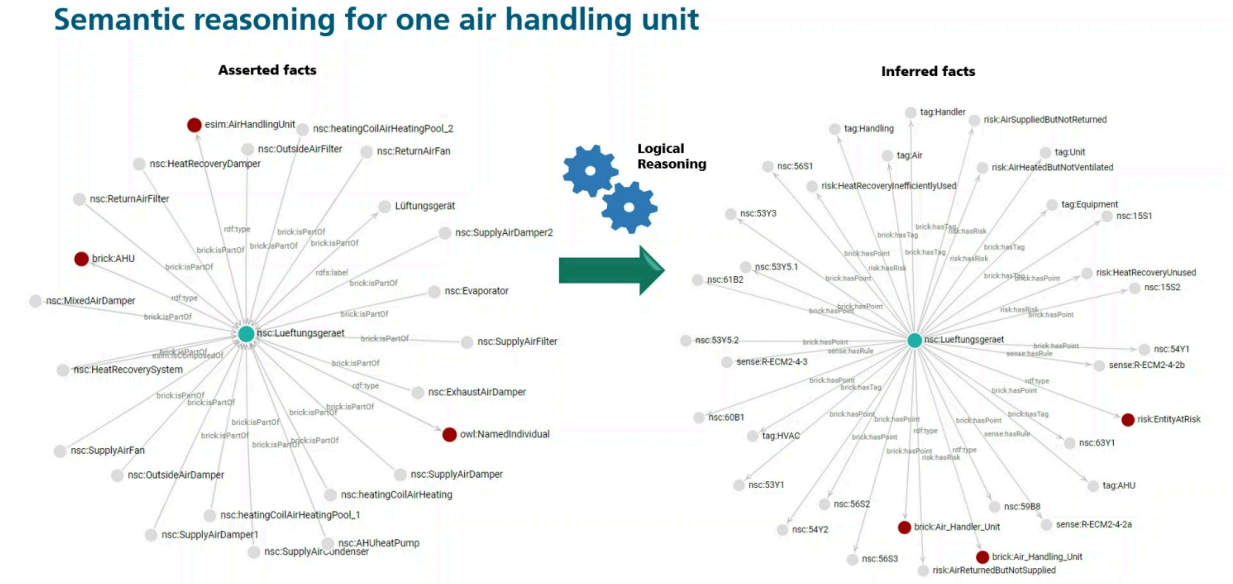


    - Workflow:
        - Link BIM and sensor data via graphs and time-series databases.

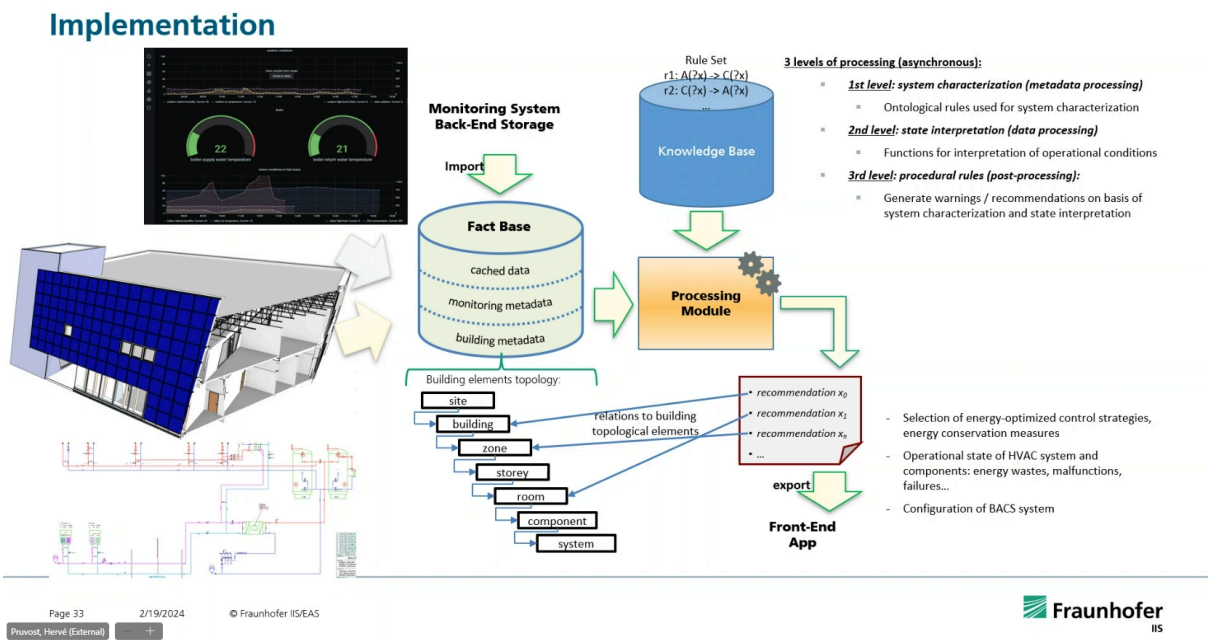


- Data processing: **monitoring use cases for checking energy waste and prescribing energy conservation measures**
    - ECMs (energy conservation measures) are defined and added to the knowledge base. These can then be applied based on the state of a building.
    - Various ontologies were reused to build a specific ontology for this project. These include ifcOWL, BOT, Brick, QUDT, SSN, SOSA and CTRLont (a control ontology).
    - Brick is used to capture the HVAC domain, BOT is used as a matryoshka-kind of notation of the building. SSN is used for sensor data, and CTRLont to formalize control logic.
    - **ESIM (Energy System Information Model)** is created on top of this to “provide information of the urban and building energy system including the automation and control of systems.
    - ESIM is kind of modular internally, distinguishing specific parts for specific elements in the energy flow.

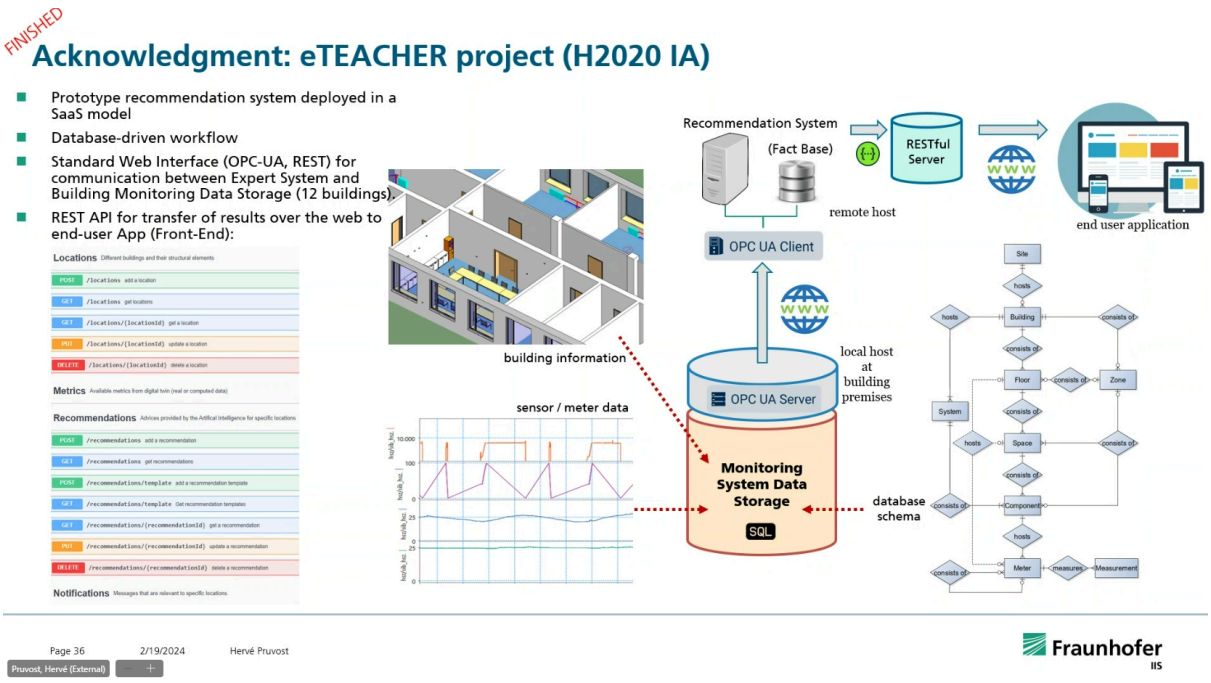
- **MM (Metric Model)** is also created, as a taxonomy of engineering quantities specifically for those use-cases. It extends the other ontologies in a similar way as QUDT would do this.
- **BAF: Building Automation Functions** extends the CTRLont ontology. It contains specific control terminology for the energy domain.
- **RISK ontology:** formalizes risks in the project.
- https://w3id.org/mm
- https://w3id.org/risk
- https://w3id.org/baf
- https://w3id.org/esim
- **SENSE ontology:** characterizing systems through semantic reasoning and adds typical OWL logical axioms and rules. It supports reasoning based on specific qualities and characteristics of specific HVAC elements.
- This reasoning was tested in use cases related to Air Handling Units. The logical reasoning was able to infer new facts based on some asserted facts:



- This was also tested in a full scale use case in the form of an expert system:



- A similar project was part of the eTEACHER project (see image below).
- Here, the ontology was mainly used to allocate data points and not per say for reasoning. The project was developed for multiple types of end user applications, including phone and pc-based web-apps.



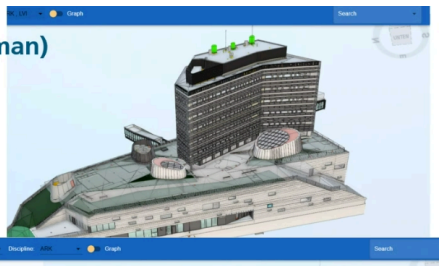
- And another application of the framework in the BIMLIFE project, where a digital twin is created for energy prediction using this framework.

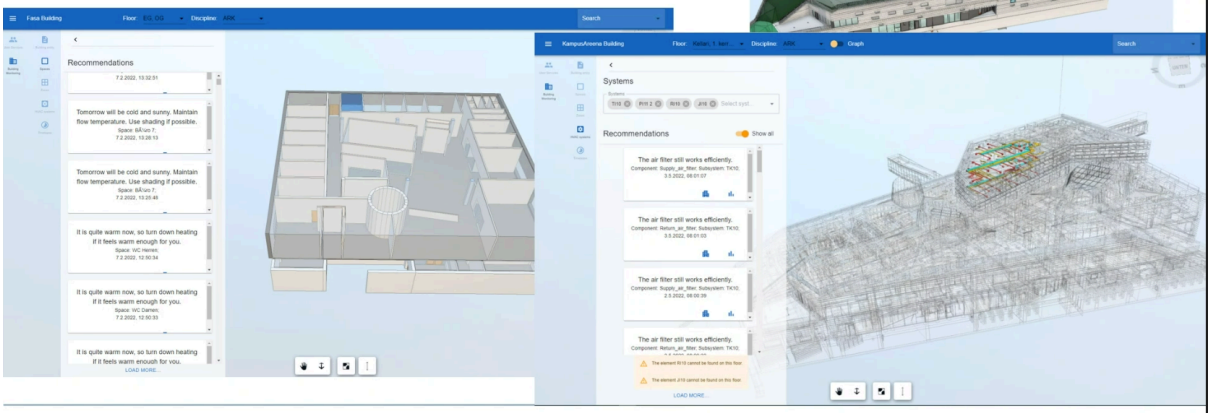
FINISHED

Acknowledgment: BIMLIFE project (EU Set-Plan Finnish / German)

- Target application -> Reuse of BIM into a Digital Twin for Energy Assistance and predictive maintenance
- Software platform: „Granlund Manager"

  -> https://www.granlundgroup.com/news/data-driven-building-is-future-proof/





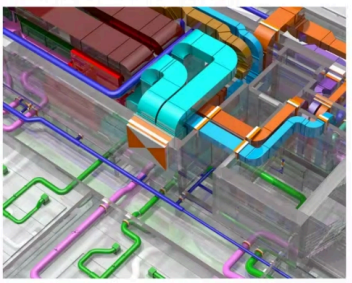
- The framework is also used in Munich airport to research in critical infrastructure systems focussing on ventilation systems and their energy consumption.

Ongoing project: SKAMO (BMWi, N5GEH Project)

- Target application -> Integration of IoT and legacy BACS systems into the workflow

Munich airport

- Automated FDD in HVAC systems
- When provisioning new sensors -> their data points and related metadata automatically integrated into the semantic digital twin
- And into relevant FDD and energy monitoring functions
- Use of „FIWARE" IoT Stack as background
- 3 Pilot buildings on airport site



- But, there are some barriers that we still need to overcome:
  - The availability of metadata
  - Graph generation is still a manual process
    Possible solutions might be found in BIM, ML, standardization, …

- Forthcoming:
  - Continuation of SKAMO and iECO projects

- Automated provisioning of sensors into the semantic digital twin
- Reuse of the FIWARE stack as IoT framework
- BIM2FM workflow
- And finally, Hervé is going to make this into a PhD! See the relevant publications below:

Journal / Conference Proceedings	PhD contribution
Journal articles:	
Pruvost, H., Wilde, A., & Enge-Rosenblatt, O. (2023). **Ontology-Based Expert System for Automated Monitoring of Building Energy Systems.** Journal of Computing in Civil Engineering, 37(1), https://doi.org/10.1061/(ASCE)CP.1943-5487.0001065	Main methodology
Pruvost, H., Calleja-Rodríguez, G., Enge-Rosenblatt, O., Jiménez-Redondo, N., & Peralta-Escalante, J. J. (2022). **A recommendation system for energy saving and user engagement in existing buildings.** Proceedings of the Institution of Civil Engineers-Smart Infrastructure and Construction, 176(1), https://doi.org/10.1680/jsmic.21.00023	SW application, architecture, workflow, impact
Pruvost, H., & Scherer, R. J. (2017). Analysis of risk in building life cycle coupling BIM-based energy simulation and semantic modeling. Procedia engineering, 196, 1106-1113, Elsevier, https://doi.org/10.1016/j.proeng.2017.08.068	Former concept
Papers:	
Pruvost, H., Forns-Samso, F., Gnepper, O., & Enge-Rosenblatt, O. (2023, October). **Integrating Energy System Monitoring and Maintenance Services into a BIM-Based Digital Twin.** In IECON 2023-49th Annual Conference of the IEEE Industrial Electronics Society (pp. 1-6). IEEE, https://doi.org/10.1109/IECON51785.2023.10311659	BIM integration, semantic digital twin
Pruvost, H., & Wilde, A. (2023, May). **Ontologies for Formalizing the Process of Configuring and Deploying Building Management Systems**. In European Semantic Web Conference (pp. 205-209). Cham: Springer Nature Switzerland, https://doi.org/10.1007/978-3-031-43458-7_39	Knowledge Engineering
Pruvost, H., & Enge-Rosenblatt, O. (2022). **Using ontologies for knowledge-based monitoring of building energy systems**. In Computing in Civil Engineering 2021 (pp. 762-770), https://doi.org/10.1061/9780784483893.094	Methodology
Pruvost, H., Enge-Rosenblatt, O., & Haufe, J. (2018, October). **Information integration and semantic interpretation for building energy system operation and maintenance**. In IECON 2018-44th Annual Conference of the IEEE Industrial Electronics Society (pp. 813-818). IEEE, https://doi.org/10.1109/IECON.2018.8591740	Research question, preliminary concept and literature review

3. Discussion

- [Alex]: Did you use spatial knowledge (e.g. in BOT) in the reasoning using the SENSE ontology?
  - [Hervé]: Yes, I used spatial reasoning in heating use cases. e.g. IF there is a heating component in a space, and there is also a datapoint measuring temperature in a space, one could find inferred facts on those aspects.
- [Katja]: Can this be used for load shifting/smart grid operations and more complex use cases, and to what extent did you include changing weather conditions?
  - [Hervé]: I only considered the building level, not the grid. But this would be a perfect use case for this framework. Temperature setpoints are included in the workflow
- [Katja]: Based on this work, do you have recommendations for information requirements and data models for real world projects?
  - [Hervé]: Problem in monitoring systems is that they have very specific naming conventions. Many systems use their own naming conventions. We also organized some databases, and even without all the ontologies, this also gave some structure to projects. It is also recommended to work on a better oorganization of data in the different databases.
  - [Hervé]: IFC is too complex for those use cases. Simultaneously, many terms in the HVAC domain are unclassified in IFC.
- [Alex]: Is standardizing HVAC datapoints a requirement for automated sensor/HVAC graph creation?
  - [Hervé]: That would be the easiest way, yes. Brick and ASHRAE are going in that direction. But I think that we can also recognize the datatype from the data itself using machine learning. Based on patterns in this data, we could potentially understand the thing we're measuring and fill gaps in metadata.
- [Alex]: How to deal with the large amount of the ontologies that you created? How could we reuse those? Isn't this too complex? Is there a distinction between ontologies that are a bit more 'core' and some that are 'use-case specific'.
  - [Hervé]: No, this was not per say the purpose of the project. The ontologies are mainly project specific. They do however show how the 'standardized' ontologies can be extended and what opportunities this would bring.

- [Klaus]: Are the ontologies available?
    - [Hervé]: Yes. I'm still working on aligning them to other ontologies, e.g. BOT and ifcOWL.
- [Klaus]: Will you extend this with other ontologies?
    - [Hervé]: Yes, I'm considering aligning the work with other ontologies as well in the future, such as SAREF, CIM, SARGON and apply this to other use-cases.

4. **Further topics**
    - Upcoming LBD CG presentation on 18th of March 2024 to be confirmed.

Next Call

- 18/03/2024, Monday, 15:00-16:30@UTC/ 16:00-17:30@CET/ 07:00-08:30@PST

  Agenda: TBC

  We are interested in getting suggestions from the community about potential agenda items and **Elevator Pitches** for the following calls. Please send your suggestions to the chairs or to internal-lbd@w3.org, whether you have a short presentation to bootstrap the discussion, and an approximate duration you think the discussion will last.

Previous minutes

https://github.com/w3c-lbd-cg/lbd/tree/gh-pages/minutes