

# Overview of the 2021 Edition of the Workshop on Very Large Internet of Things (VLIoT 2021)

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## ABSTRACT

The Very Large Internet of Things (VLIoT) workshop aims at discussing the solutions of problems arising especially for large-scale Internet-of-Things (IoT) configurations. After online conferences and workshops are becoming the normal mode for running scientific events, after continuously monitoring the global COVID-19 pandemic this year with falling incidence rates in the last times due to vaccination successes, the workshop changes the format the first time to a hybrid event. This ensures that still problems are overcome like travel restrictions, but offers face-to-face discussions among those going to the local event. A hybrid format has still chances like an increased number of participants, less travel burdens and saving budget, but offers the possibility for going to the local event already for a large portion of the participants. Hence we received many high-quality submissions, from which we accepted 9 to be introduced in this editorial.

## TYPE OF PAPER AND KEYWORDS

Editorial: *Internet of Things, Very Large Internet of Things, VLIoT@VLDB 2021, IoT visions*

## 1 INTRODUCTION

The Internet of Things (IoT) is not only about small devices, but also the interplay between them and the user with the goal of higher-level applications. Research questions may arise to optimize the communication regarding message number and sizes, the processing to speed up performance, and minimize latency for optimal user experiences and power consumption to increase battery lifetime. High availability is often achieved by intelligent replication of data and processing. Masses of data are generated by the IoT devices, which are

often processed and aggregated by streaming engines the components of which are placed along the topology of the IoT devices. Intelligent utilization of the heterogeneity of the IoT environment is another key for the success of IoT systems. There is a strong need of all IoT systems and applications to be designed for security and privacy. Hence, research in the area of IoT tackles these areas in combination with other areas like databases, security and cryptography, machine learning, Semantic Web, networks, operating systems, smart home and cities applications, distributed systems, compression, blockchains and many more.

Hence, many different research areas are discussed at the Very Large Internet of Things (VLIoT) workshop being the fifth edition this year. Being already used to the pandemic situation for those researchers, who managed

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to stay healthy, research efforts got back to nearly the same level compared to before the pandemic. Hence we received many high-quality submissions and accepted many valuable contributions.

Fortunately, many of the papers accepted for VLIoT 2021 address some of these relevant aspects of the development, implementation, and deployment of large-scale, distributed, mobile, stream handling, heterogeneous and multi-tenant Internet of Things systems. We also accepted a few number of papers with a strong vision.

Since its first edition in 2017 the main goal of the VLIoT workshop has been to bring together academic researchers and industry practitioners working in the broad field of IoT and related subjects, and to allow them to present and exchange their research findings, their experience and share their vision about the future of IoT at a very large scale. Besides the above mentioned issues, this workshop also intended to discuss other related topics, such as coordination between fog-, edge-, and dew-computing in IoT, Connected Nanotechnology, Artificial Intelligence for IoT (AIoT), Internet of Vehicles, Connected Automated Vehicles, and others.

## 2 VLIoT CALL: TYPES OF PAPERS

This fifth edition of VLIoT solicited papers of different types containing contributions describing original ideas, promising new concepts, and practical experience, namely:

- Research papers: proposing new approaches, theories or techniques related to IoT, including new data structures, algorithms, whole systems, and frameworks. They should make substantial theoretical and empirical contributions to the research field.
- Experiments and analysis papers: focusing on the experimental evaluation of existing approaches including data structures and algorithms for the IoT and bring new insights through the analysis of these experiments. Results of experiments and analysis papers can be, for example, showing benefits of well known approaches in new settings and environments, opening new research problems by demonstrating unexpected behavior or phenomena, or comparing a set of traditional approaches in an experimental survey.
- Application papers: reporting practical experiences on Internet of Things applications. Application papers might describe specific application domains in the IoT such as smart homes/offices/cities, continuous health care, waste management, emergency response, intelligent response, and Industry 4.0.

- Vision papers: identifying emerging or future research issues and directions, and describing new research visions in the IoT area that may have a great impact on our society.

## 3 VLIoT CALL: TOPICS OF INTEREST

The VLIoT 2021 solicited papers in the following, non-exclusive, list of topics:

- Semantics and Spatial and temporal reasoning for IoT
- Privacy-by-design and security-by-design in IoT
- System architectures for IoT, e.g. things-, data-, event- and service-centric.
- IoT applications including smart homes, smart cities, healthcare, etc.
- Internet of Nano Things, Nano Computing and Communications.
- IoT programming toolkits, frameworks and evaluation test-beds
- IoT data mining and analytics
- IoT management and interoperability
- Management of distributed data streams
- Enabling technologies and standards for the IoT
- Sustainability of IoT platforms, e.g. business models for deployment and maintenance
- Societal challenges and IoT, e.g. urban planning and decision making tools
- Ownership of data in IoT scenarios
- Fog, Edge and Dew Computing for IoT
- IoT benchmarks and performance measurement
- Indexing and search in IoT environments, discovery of devices, services and data
- IoT transactions, concurrency control and recovery
- Hardware accelerators and energy savers for IoT applications and core infrastructure

## 4 SUMMARY OF THE ACCEPTED PAPERS

In total, nine papers were accepted for presentation at the workshop. One major focus of the contributions is handling of streams [1, 9, 3]. The contributions about streams reach a consensus for moving away from the Cloud to store IoT data and run IoT applications and investigate possibilities beyond the Cloud [1], going to the edge [9] and even to a multi-tiered Cloud/fog/edge IoT environment [3].

Another focus of our contributions is concerned with the deployment of IoT devices: The authors in [5] propose techniques to detect network metrics to support IoT application orchestration. The second contribution [8] deals with massive deployments of power beacons, which use radio frequency wireless energy transfer for eliminating the need for frequent battery replacement.

Machine learning plays a major role for an increasing number of contributions in scientific events across the different scientific communities. Surprisingly, this year we received only few approaches applying machine learning: [7] introduces an approach utilizing convolutional neural networks for video source forensics for IoT devices. [2] describes necessary steps towards digital twins in smart cities including some IoT applications based on machine learning.

A very interesting IoT application is described in [4] for crowdsourcing OBD-II vehicle data within a mobile and web platform. Finally, the authors in [6] promise building the next generation IoT infrastructure for enabling M2M crypto economy.

## 5 SUMMARY AND CONCLUSIONS

The IoT domain offers many chances for interesting research and as result of it interesting applications for daily life improving the living conditions and conveniences of its users. We recognize that there is a shift in IoT research going away from very special limited topics and more and more researchers try to offer complete systems providing solutions for large scale IoT configurations. However, still many visions need to be realized having space for many years of research.

We wish you interesting hours when studying the contributions of this year's Very Large Internet of Things (VLIoT) workshop.

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## WORKSHOP ORGANIZATION

### Chairs

- Sven Groppe, Universität Lübeck, Germany
- Weizhi Meng, Technical University of Denmark (DTU), Denmark

### Program Committee

We have recruited 33 PC members and chairs listed below who are experts in the topics of interest of our workshop. The current PC members and chairs are selected from 15 nations all over the world. While most PC members are from academia, we have 2 experts also from industry (6%). 7 of the PC members and chairs are women (21%).

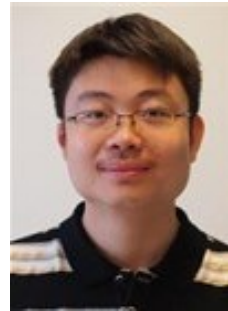
- Omar Boucelma, Aix-Marseille University, France
- Flávia C. Delicato, Universidade Federal Fluminense (UFF), Brazil
- Lorena Etcheverry, Universidad de la República, Uruguay
- Mirian Halfeld Ferrari, Université d'Orléans, France
- Jonathan Fürst, NEC Labs Europe, Heidelberg, Germany
- Abdessamad Imine, INRIA-LORIA Nancy Grand-Est, France
- Peiquan Jin, University of Science and Technology of China, China
- Verena Kantere, University of Ottawa
- Ahmed Khaled, Northeastern Illinois University, USA
- Abdelmajid Khelil, Landshut University of Applied Sciences, Germany
- Jan Lindström, MariaDB Corporation, Finland
- Riccardo Martoglia, University di Modena and Reggio Emilia, Italy
- Abderrahmen Mtibaa, University of Missouri-St. Louis, USA
- Luis Muñoz, University of Cantabria, Spain
- San Murugesan, Western Sydney University, Australia
- Anne H. Ngu, Texas State University, USA
- Rahul Pandey, George Mason University, USA
- Paulo F. Pires, Universidade Federal Fluminense (UFF), Brazil
- Elaheh Pourabbas, National Research Council of Italy, Italy
- Gowri Sankar Ramachandran, University of Southern California, USA
- Luis Sánchez, University of Cantabria, Spain
- Igor Leão dos Santos, Centro Federal de Educação Tecnológica Celso Suckow da Fonseca (CEFET-RJ), Brazil
- Sana Sellami, Aix-Marseille University, France
- Georgios Smaragdakis, TU Berlin, Germany
- Mu-Chun Su, National Central University, Taiwan
- Reza Tourani, Saint Louis University, USA
- Marco Vieira, University of Coimbra, Portugal
- Yingwei Wang, University of Prince Edward Island, Canada
- Demetris Zeinalipour, University of Cyprus, Cyprus
- Steffen Zeuch, DFKI, Germany

## AUTHOR (AND CO-CHAIR) BIOGRAPHIES



**Sven Groppe** earned his diploma degree in Informatik (Computer Science) in 2002 and his Doctor degree in 2005 from the University of Paderborn. He earned his habilitation degree in 2011 from the University of Lübeck. He worked in the European projects B2B-ECOM, MEMPHIS, ASG and TripCom. He was a member of the DAWG

W3C Working Group, which developed SPARQL. He was the project leader of the DFG project LUPOSDATE, an open-source Semantic Web database, and one of the project leaders of two research projects, which research on FPGA acceleration of relational and Semantic Web databases. He is also leading a DFG project in the Semantic IoT area and a DFG project on GPU and APU acceleration of main-memory database indexes. He is also the chair of the Semantic Big Data (SBD) workshop series (so far 2016 to 2020) and Big Data in Emergent Distributed Environments (BiDEDE) in 2021, both are affiliated with the ACM SIGMOD conference, and of the Very Large Internet of Things (VLIoT) workshop in conjunction with the VLDB conference (so far 2017 to 2021). His research interests include databases, Semantic Web, query and rule processing and optimization, Cloud Computing, acceleration via GPUs, FPGAs and quantum computers, peer-to-peer (P2P) networks, Internet of Things, data visualization and visual query languages.



**Weizhi Meng** is currently an Associate Professor in the Department of Applied Mathematics and Computer Science, Technical University of Denmark (DTU), Denmark. He obtained his Ph.D. degree in Computer Science from the City University of Hong Kong. Prior to joining DTU, he worked as a research scientist in Institute for

Infocomm Research, A\*Star, Singapore. He received the Hong Kong Institution of Engineers (HKIE) Outstanding Paper Award for Young Engineers/Researchers in both 2014 and 2017, as well as several best paper awards from ACISP 2020, Inscript 2019, ISPEC 2018, etc. His primary research interests are cyber security and intelligent technology in security, including intrusion detection, IoT security, biometric authentication, trust management, and blockchain in security. He served as associate editors / editorial board members for several reputed journals, as well as PC chair for many international conferences including IEEE Blockchain 2018, IEEE ATC 2019, IFIPTM 2019, ICICS 2020, Globecom (CISS) 2020 and IEEE DSC 2021. He is the Chair of IEEE Young Professionals Affinity Group in Denmark.