

## **ITSS Technical Committee Proposal: Internet of Things in Intelligent Transportation Systems**

### **Chair**

Ziran Wang, Research Scientist, Toyota Motor North America, [ryanwang11@hotmail.com](mailto:ryanwang11@hotmail.com)

Ziran Wang is currently a Research Scientist at Toyota Motor North America R&D - InfoTech Labs in Silicon Valley, co-leading the “Digital Twin” project with the aim to build an AI-based data-driven vehicle-to-cloud framework. He received the Ph.D. in Mechanical Engineering from the University of California, Riverside in 2019, and the bachelor degree in Mechanical Engineering and Automation from Beijing University of Posts and Telecommunications in 2015. His research interests include motion planning and control, driver behavior modelling, and digital twin of connected and automated vehicles.

Dr. Wang is the recipient of the National Center for Sustainable Transportation Dissertation Award, issued by U.S. Department of Transportation. He also received the Vincent Bendix Automotive Electronics Engineering Award (i.e., best paper in 2019) from SAE International. Dr. Wang is serving various roles in multiple academic organizations, including Associate Editor of SAE International Journal of Connected and Automated Vehicles, Committee Member in the IEEE Intelligent Transportation Systems Society-Technical Committee on Cooperative and Connected Vehicles, Committee Member in the IEEE Control Systems Society-Technical Committee on Smart Cities, Committee Member in the IEEE Industrial Electronics Society-Technical Committee on Industrial Cyber-Physical Systems, and Member in the SAE On Road Automated Driving (ORAD) Simulation Task Force. He also organized four workshops in IEEE, including three in IEEE ITSS (ITSC’20, IV’20, IV’21) as the lead organizer.

### **Co-Chair**

Qi Zhu, Associate Professor, Northwestern University, [qzhu@northwestern.edu](mailto:qzhu@northwestern.edu)

Dr. Qi Zhu is a tenured Associate Professor at the Department of Electrical and Computer Engineering (ECE) in Northwestern University. He was an Assistant Professor and later Associate Professor at the ECE Department in University of California, Riverside from 2011 to 2017, and a Research Scientist at the Strategic CAD Labs in Intel from 2008 to 2011. Dr. Zhu received a Ph.D. in EECS from University of California, Berkeley in 2008, and a B.E. in CS from Tsinghua University in 2003. His research interests include design automation for cyber-physical systems (CPS) and Internet of Things, cyber-physical security, safe and secure machine learning for CPS, and system-on-chip design, with applications in domains such as automotive electronic systems, connected vehicles, and energy-efficient buildings. He received best paper awards at Design Automation Conference (DAC) 2006, DAC 2007, International Conference on Cyber-Physical Systems (ICCPs) 2013, and ACM Transactions on Design Automation of Electronic Systems (TODAES) 2016. He received the NSF CAREER award in 2016, the IEEE Technical Committee on Cyber-Physical Systems (TCCPS) Early-Career Award in 2017, and the Humboldt Research Fellowship for Experienced Researchers.

Dr. Zhu is an Associate Editor for IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD), ACM Transactions on Cyber-Physical Systems (TCPS), and IET Cyber-Physical Systems: Theory & Applications. He has served as an Associate Editor for IEEE

TCCPS, IEEE TC-VLSI, and ACM SIGDA Newsletters; and as a Guest Editor for Proceedings of the IEEE, ACM TCPS, IEEE Transactions on Automation Science and Engineering (T-ASE), Journal of Systems Architecture (JSA), and Integration, the VLSI Journal. Dr. Zhu is the Conference Chair of IEEE TCCPS, and VP of Young Professionals at IEEE Council for Electronic Design Automation (CEDA). He has served as the General Chair for the 15<sup>th</sup> IEEE International Conference on Embedded Software and Systems (ICESS), the Program Chair for the 1<sup>st</sup> and 2<sup>nd</sup> ACM/IEEE Workshops on Design Automation for CPS and IoT (DESTION), the General Chair for the 3<sup>rd</sup> DESTION, and on the technical program committee and as organizer for a number of conferences in design automation, cyber-physical systems, embedded systems, and real-time systems, including DAC, ICCAD, DATE, ASP-DAC, ICCPS, ICPS, CODES+ISSS, RTSS, RTAS, ICES, GLVLSI, SAC, SIES, MEMOCODE, SAMOS, FDL, etc. He received the ACM SIGDA Service Award in 2015.

## **Scope and Mission**

The recent development of the Internet of Things (IoT) brings forward numerous novel technologies whose application scenarios are not only limited to the user level (e.g., individual consumer or private company), but can also be applied to the system level (e.g., commercial or industrial sector). For example, the IoT plays a significant role in the current Intelligent Transportation System (ITS), which is a system consisting of vehicular communications, cloud computing, intelligent control, massive data management, and many other elements. By leveraging the IoT, different entities (e.g., vehicles, drivers, riders, infrastructures, traffic management centers, etc) in the existing transportation system get connected with each other, thus making the entire system smarter, safer, and more efficient.

A rising and ubiquitous trend in this IoT context is represented by “digital twin”, where a real-time update of big data from the physical world’s entities is required to update the corresponding digital replicas in the cyber world. As an extension concept to digital twin, “parallel driving” also considers the mental world besides the physical world and the cyber world, which models the cognitive behaviors of human drivers, with the ability of enabling learning and interaction between the physical and cyber drivers. Both the computing architecture and the communication networks/protocols within the framework of digital twin or parallel driving are built to achieve higher efficiency, fidelity, and reliability.

However, these developments also bring significant challenges for authorities, industry, as well as scientific communities. In terms of system design and control, current IoT applications in ITS need to be refined or even redesigned to better function under uncertainties in demand, and to better cooperate with existing conventional vehicles and infrastructures. From the performance assessment perspective, models and simulation tools based on artificial intelligence and big data have been widely developed to verify the performance of IoT applications, in particular taking into account the increasing trends in vehicle connectivity and automation. However, the validity of these models needs to be re-examined with field implementations.

This new technical committee focuses on sharing the state-of-the-art design, models, algorithms, simulation, and field implementation of a wide range of IoT applications in ITS (such as digital twin and parallel driving), and identifies challenges as well as research needs, aiming to encourage cross-disciplinary cooperation.

## Topics

- Digital twin of intelligent vehicles
- Vehicular cyber-physical systems (VCPS)
- Cyber security of connected and automated vehicles
- Internet of things (IoT) in intelligent transportation systems
- System design and field implementations of Internet of Vehicles (IoV)
- Parallel driving/transportation
- Vehicle-to-cloud (V2C) communications
- Remote driving
- Artificial intelligence and big data application in urban mobility
- Modelling and simulation tools for network computing and communication

## Plan of the Year

In 2021, this new TC will propose a workshop at ITSC 2021, which will be the second edition in the “IoT in ITS” workshop series (the first one was held at IV 2020). The TC will solicit paper submissions from the research society and invite speakers from leading research/industry organizations to deliver keynote speeches.

Besides the workshop, this new TC will also propose a special issue about the same topic on a IEEE journal (potentially T-ITS, T-IV, or OJITS). Chair, co-chair, and several committee members of the TC will serve as the guest editors of this special issue, and solicit paper submissions from the research society (including the ones from the workshop).

During IV 2021 and ITSC 2021, this new TC will host committee meetings with all members, with the aim of connecting researchers in this domain across the world, and facilitating cross-disciplinary collaborations.

Towards the end of the year, this new TC will submit a yearly report to ITSS VP Technical Activities, summarizing all activities conducted throughout the year, and identify the goals for the next year.

## Tentative Committee Members

- Guoyuan Wu, Associate Researcher, University of California, Riverside (Digital Twin; CAV)
- Jiaqi Ma, Associate Professor, University of California, Los Angeles (CAV; VCPS)
- Yiheng Feng, Assistant Professor, Purdue University (CAV; smart transportation)
- Shuo Feng, Postdoctoral Researcher, University of Michigan (CAV; smart city)
- Jia Hu, Professor, Tongji University (CAV; VCPS)
- Jibonananda Sanyal, Group Leader, Oak Ridge National Lab (Digital Twin; high performance computing)
- Ruimin Ke, Postdoctoral Research Associate, University of Washington (Edge computing; smart city)
- Chung-Wei Lin, Assistant Professor, National Taiwan University (CPS/IoT; automotive systems)
- Mohammad Al Faruque, Associate Professor, University of California, Irvine (CPS/IoT security; V2V security)
- Abhishek Dubey, Assistant Professor, Vanderbilt University (CPS; smart transportation)

- Guni Sharon, Assistant Professor, Texas A&M University (transportation systems; machine learning)
- Qi Alfred Chen, Assistant Professor, University of California, Irvine (security; security for CAV)
- Yier Jin, Associate Professor, University of Florida (IoT security; worked on V2V security before)