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Digital Twin and Parallel Intelligence Based on Location and Transportation: A Vision for New Synergy Between the IEEE CRFID and ITSS in Cyberphysical Social Systems

The IEEE Council on Radio-Frequency Identification (CRFID) focuses on the technology and applications of RFID systems and the Internet of Things (IoT) to serve the overall IEEE and global technical communities. CRFID is positioned to be the leading global, collaborative community for RFID and IoT technology and is "bridging the physical and the digital" elements to applications in networks, power harvesting, tagging, smart cities, and intelligent transportation systems (ITSs) and blockchains as examples (Figure 1). RFID represents an interesting solution for traffic monitoring with its lower costs and is well standardized. The RFID system is an affordable technology for ITSs in developing countries and a reliable alternative for traffic and public transport vehicle monitoring. The IEEE Intelligence Transportation System Society (ITSS) was one of the founding members of sponsoring societies and among the strongest supporters of the IEEE CRFID. By strengthening the cooperation between the IEEE CRFID and ITSS, they have worked synergistically like a digital twin and functioned effectively with parallel intelligence in serving their corresponding fields and communities.

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The Background of the IEEE CRFID

In 2005, the IEEE Technical Activities Board (TAB) and Board of Directors approved the transition of its ITSs Council into the IEEE ITSS and it became the newest technical Society in IEEE. In 2015, the IEEE TAB and Board of Directors again ratified the transition of the IEEE Technical Committee on Radio Frequency Identification into the IEEE Council on Radio-Frequency Identification, and the newly named IEEE CRFID became the newest technical council in IEEE. The IEEE ITSS was one of the founding members of sponsoring Societies and among the strongest supporters of the IEEE CRFID. In many ways, in its efforts to promote and support professional activities for applications; R&D of smart techniques; and intelligent methods for solving problems with location, identification, logistics, mobility, and transportation, the IEEE CRFID and the ITSS have worked synergistically in serving their corresponding fields and communities [1], [2].

The purpose of the IEEE CRFID is to advance technology and applications of RFID and the IoT to serve the overall IEEE and global technical communities. The CRFID is positioned to be the leading global, collaborative community for RFID systems and IoT technology. The technical scope of CRFID is from RFID devices, to system-level RFID technology, to RFID-related IoT technology, to general IoT technology, where RFID technologies and systems to include data analytics are the framework for the changing applications and nomenclature in the community [3]. After all, the IoT is an outgrowth of RFID. As a cutting-edge technological development, the scope incorporates new advanced technologies, such as big data, artificial intelligence, and blockchains. The vertical application areas of the CRFID also expand to transportation, power and energy, agriculture, consumer electronics, logistics, health care, and so forth.

The CRFID follows the technical development of RFID and RFID-related systems and broadens

CRFID areas to the frontiers of technology innovations, such as the IoT, blockchains, cyberphysical systems (CPSs), cyberphysical social systems (CPSSs), digital twins, parallel systems, the ITSS, and so forth [4]. The CPSS augments the CPS capacity by integrating an additional dimension, human and social characteristics, to achieve more effective CPS design and operation [5]. Along with artificial systems, computational experiments, parallel execution-based parallel management and control and its wide real-world applications, CPSS-based parallel driving has been steadily developed [6]–[10].

New Opportunities Brought by New Technologies

RFID represents an interesting solution for traffic monitoring for different reasons: Presently, it is a mature technology with lower costs than a decade ago, and it is well standardized to allow governments and institutions to adopt it in a faster and more effective way. In the last two years, Colombia's government has adopted the ISO 18000-63 as a car identification alternative and electronic toll road technology [11]. This decision has been promoting the use of RFID tags and represents an important reason to consider RFID for traffic monitoring in Colombia.

RFID is an emerging technology with low cost and low power consumption. Azpilicueta et al. [12] proposed the assessment of an ultrahigh frequency RFID system for vehicular applications, which is an alternative approach for propagation prediction in vehicular environments. This novel technique gives Doppler shift and Doppler spread results, which can be useful when analyzing the impact of the system on this complex specific environment. The work showed that by considering radio planning tasks in the vehicular applications, the overall system performance can be strongly optimized, reducing power consumption as well as no interference levels. In [13], the channel modeling of an RFID system for vehicular identification on roads and freeways is presented.

An RFID system is an affordable technology for an intelligent transportation system (ITS) in developing countries and a reliable alternative for traffic and public transport vehicle monitoring. Compared with GPS monitoring systems, RFID presents a lower cost when many vehicles are monitored because of the low cost of RFID tags. GPS monitoring systems cost hundreds of dollars per vehicle, and communications interfaces to report positions increases its cost. Pedraza et al. [14] proposed a new platform called *intelligent platform for vehicular control* (*PCIV*) for traffic monitoring, which is based on RFID and cloud computing, and applied to road traffic monitoring in public transportation systems. PCIV provided information to the authorities about the behavior of the public transport vehicles in real time by using RFID technology in seven spots along the main entry and exit of the city.

ITSs will effectively alleviate urban traffic congestion, reduce traffic accidents, reduce environmental pollution, and improve the transportation system, which is regarded as an important development direction of transportation in the 21st century. RFID technology is applied to urban traffic management, which has become the construction force of ITSs and traffic information exchange platforms, and it gives full play to its advantages of automatic identification, long-distance identification, and dynamic information collection.

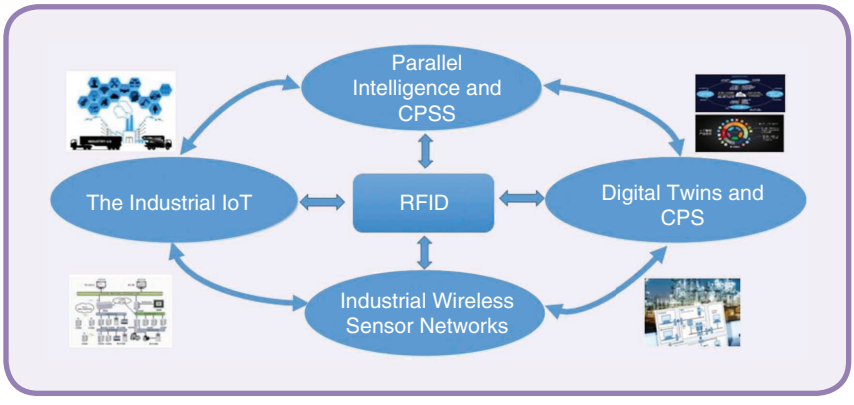

FIG 1 CRFID and the coming future. CPS: cyberphysical system; CPSS: cyberphysical social system.

Organizational Measures to Ensure the Upgrading of Cooperation

Institutionalization of Leadership Network Meeting

The digital twin technology can assist the ITS to fit the parallel system simulating the real traffic state. The CRFID and the ITSS should deepen technical exchanges and policy cooperation. We will establish a leadership network meeting system between CRFID and ITSS, which will be held twice a year and require council leaders to participate. The first meeting will start this year at the Department for Infrastructure and Transport conference, which will discuss the development from various perspectives, such as technical committee (TC) activities and cooperation from the ITSS. The second meeting will be held a few months later.

Assisting With the Organization of TC Activities

CRFID TC members could assist the ITSS in organizing some special interest groups to be more flexible when rising topics are also considered for the development of technical activities around them. As RFID, parallel intelligence technology, and CPSSs can be well applied to the ITSS, the

members focusing on the RFID conference may also be interested in the ITSS association. Therefore, the cooperation among TC members helps to expand the association's influence.

Service Operations and Logistics, and Informatics Conference Activities

Service science, service operations, logistics, and informatics are becoming ever more complex and interdependent. They are playing an increasingly important role in today's world economy. Information and communications technology provides cyber infrastructure and platforms to achieve more efficient and productive services operations. The IEEE Service Operations and Logistics, and Informatics (SOLI) conference series aims to bring together researchers and practitioners to discuss issues, challenges, and future directions, and to share their R&D findings and experiences in relative areas.

The ITSS and CRFID cosponsored three SOLI conferences: SOLI 2017, Sep, Italy (ITS); SOLI 2018, Singapore (ITSS); and SOLI 2019, Zhengzhou, China (ITSS). In the future, CRFID will continue to sponsor SOLI conferences in collaboration with the ITSS to contribute to the development of service science, service operations, logistics, and informatics.

Active Participation From the CRFID TC

Technical activities are all of the collective activities that the ITSS organizes as an association, such as special sessions, workshops, or tutorials, at conferences; public demonstrations; dissemination of activities to the community to be aware of what is happening at the ITSS; challenges or competitions; summer schools; and more. CRFID TC members will actively participate in the ITSS activities in various forms. RFID technology is widely used in ITSs, so the interaction among TC members is helpful to the development of new technology and even the proposal of new concepts.

Encourages Participation in "Mega-Challenges" Competitions

The RFID conference community has emphasized engagement with young engineers, incorporating numerous Young Professionals events, student competitions, senior design poster sessions, educational activity, and student travel grant opportunities. As such, IEEE CRFID conferences have been a launching ground for technical innovation, launching initiatives in energy harvesting, digital twinning, and wireless motion capture, and even originating the concept of the IoT.

Annual student competitions and international mega-challenges have been a regular part of CRFID events. The CRFID deliberately involves younger volunteers in its organizing committees. The RFID conferences scour emerging fields and showcase diverse, early-career researchers in "hot topics" and keynote sessions.

The CRFID TC actively encourages ITSS members to participate in our competition, which is created to cultivate and explore new technologies. It will promote the integration of RFID, digital twin technology, and ITSs, and put forward a new concept to serve for the ITSS.

Conclusion

With the wide application of RFID technology in the ITS field, the ITSS and CRFID have common pursuits in technology development. Meanwhile, the IEEE ITSS was one of the founding members of sponsoring societies along with the strong support of the IEEE CRFID. The CRFID TCs will strengthen cooperation with the ITSS, establish a network meeting system for leaders of the two associations, actively assist and participate in the ITSS activities, cosponsor SOLI conferences, and encourage the ITSS members to participate in mega-challenges competitions. The CRFID and IEEE ITSS have worked synergistically like a digital twin and functioned effectively with parallel intelligence in serving their corresponding fields and communities.

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The 2014–2017 George N. Saridis Best Transactions Paper Award

In 2015, the Board of Governors of the IEEE Intelligent Transportation Systems Society approved the proposal to name the Best Paper Award in *IEEE Transactions on Intelligent Transportation Systems* as the George N. Saridis Best Transactions Paper Award (Figure S1). After nearly five years of preparation and planning and almost one year of hard and concentrated effort by the Award Committee, we are pleased to announce the 2014–2017 George N. Saridis Best Transactions Paper Award for articles published in *IEEE Transactions on Intelligent Transportation Systems*.

The selection procedures are summarized as follows.

- *Eligibility*: All articles published in *IEEE Transactions on Intelligent Transportation Systems* during the three calendar years preceding the year of the award are eligible. The article publication date is determined by the journal volume date (not the online publication date).
- *Evaluation*: Two types of Best Papers are selected: Regular Papers and Review/Position Papers. Originality, citations, impact, and importance are considered for Regular Papers, and originality, timeliness, technical content, insight, and broader impact are considered for Review/Position Papers.
- *Selection*: First, the top-10 most-cited articles according to Google Scholar, plus any article solicited or nominated through the open call, are considered as Candidate Papers. Next, the Award Committee is responsible for organizing the review process to select two to three Award Finalists Papers. Finally, the Award Committee votes and selects the final Best Papers.

The following is the list of final results for the 2014–2017 George

Dr. George N. Saridis, Pioneer in Intelligent Control, Robotics, and Intelligent Transportation Systems

Dr. George N. Saridis (Figure S1), a professor at Purdue University and Rensselaer Polytechnic Institute, was the Founding Director of the U.S. National Science Foundation's Systems Engineering and Control Program and the Founding President of the IEEE Robotics and Automation Society. He was a pioneer in *Intelligent Control, Robotics, and Intelligent Transportation Systems*, and he led the effort in initiating research and development of those fields in the 1960s and 1970s.

FIG S1 George N. Saridis (1931–2006).

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