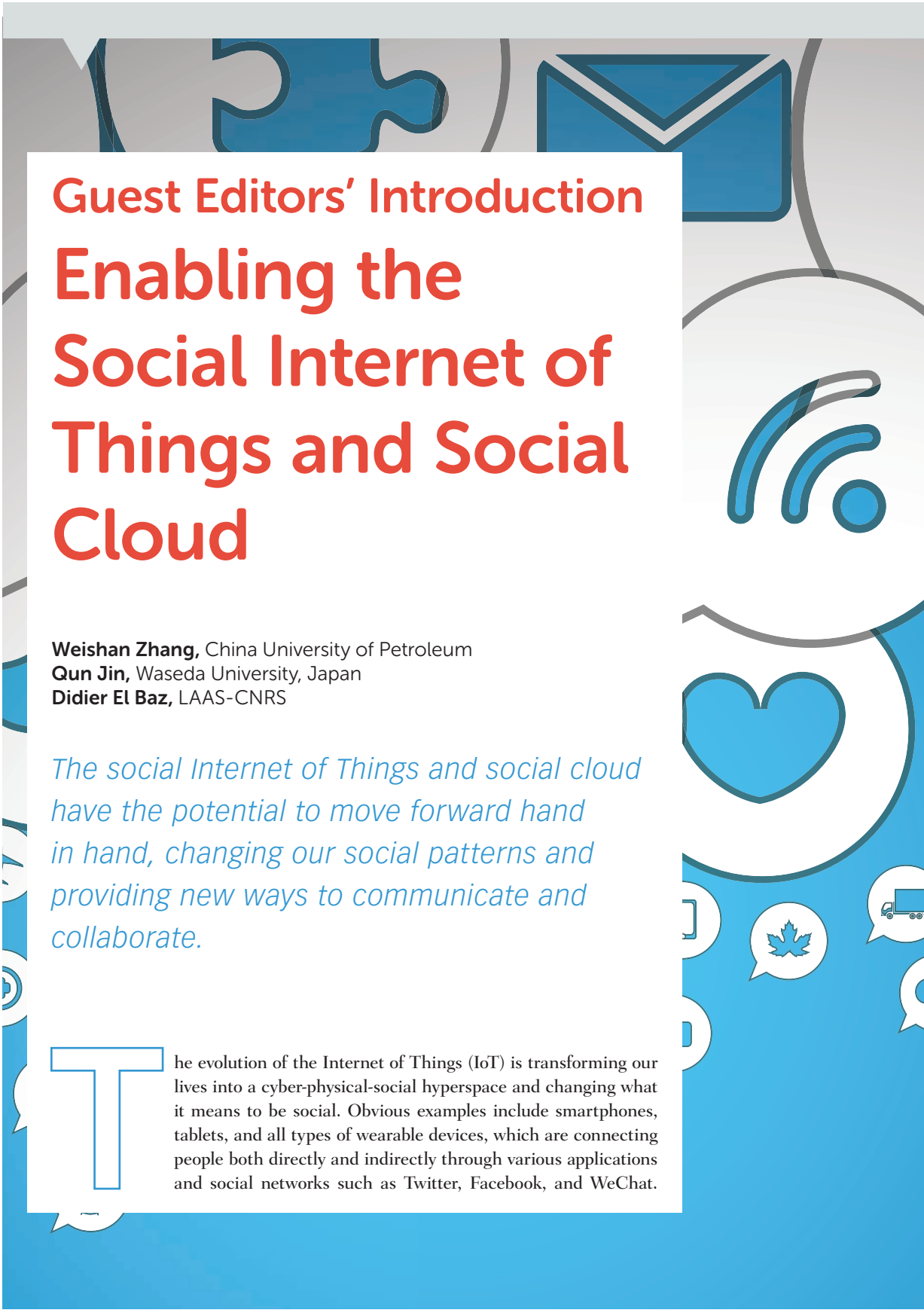

Guest Editors' Introduction

Enabling the Social Internet of Things and Social Cloud

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The social Internet of Things and social cloud have the potential to move forward hand in hand, changing our social patterns and providing new ways to communicate and collaborate.

The evolution of the Internet of Things (IoT) is transforming our lives into a cyber-physical-social hyperspace and changing what it means to be social. Obvious examples include smartphones, tablets, and all types of wearable devices, which are connecting people both directly and indirectly through various applications and social networks such as Twitter, Facebook, and WeChat.

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People and their connections to everyday objects are establishing new relationships as a form of social network, referred to as the social Internet of Things (SIoT).[1] The SIoT is the interconnection of different services, objects, and people, where participants can benefit from being networked. For example, smart transportation brings together vehicle networks, driver profiles, smartphones, and GPS data to minimize traffic congestion by analyzing and disseminating such data in real time.

Although the SIoT is expected to enhance object discovery, service composition, and evaluation of objects' trustworthiness,[2] projects such as Social-IoT (www.social-iot.org) and Input (www.input-project.eu) show that SIoT-enabling technologies need further efforts. Important research directions include[2]:

- definition of interobject relationships, such as semantic representational models for social relationships, and solutions for autonomously sensing other objects and exchanging information;
- network analysis algorithms tailored to the SIoT after the establishment of a social network; and
- architecture tailored to the SIoT that allows for establishment and exploitation of social relationships, resources, and services.

The *social cloud* (SoC) field is closely related to the SIoT and can potentially improve resource sharing in social networks.[3,4] The SoC plays an important role in areas such as software crowdsourcing, where it can serve as shared infrastructure.[5] Another example is an SoC-supported approach to help alleviate communication breakdowns due to asymmetries in media and time preferences among family members of varying ages.[6]

The SoC and SIoT paradigms can be integrated to exploit their advantages. Novel data fusion algorithms and artificial intelligence techniques can be used to realize automated decision making in the SoC to support better communication and collaboration among people and things in the SIoT. The combination of the SoC and SIoT can also realize ubiquitous sensing and computing beyond the capability of individual people or things, and stimulate innovations in various fields.

What Do We Cover in This Special Issue?

The four articles in this special issue represent the most recent research on the SoC and SIoT. One article provides an integration approach to these paradigms; another proposes using edge clouds to host social virtual objects (SVOs) to alleviate the problem of scarce resources to manage social relationships; a third presents an overview of SoC research; and the fourth provides a radio access network (RAN) virtualization to facilitate the management of social groups.

The SIoT, empowered by the interconnectivity and friend-of-a-friend (FOAF) feature offered by social networking services (SNSs), can support the integration of a variety of devices into people's daily lives. As a promising paradigm, the SIoT can provide an infrastructure to study and integrate the intelligence mechanisms required to enhance service adaptability and user friendliness. In their article, "Social Cloud-Based Cognitive Reasoning for Task-Oriented Recommendation," Dina Hussein, Son N. Han, Gyu Myoung Lee, and Noel Crespi describe their approach to the integration of cognitive reasoning into the SIoT for recommending quotidian tasks in smart homes, in which reasoning about both physical and social aspects of context is required to achieve situation characterization. They propose and develop an intelligent recommendation framework as a service built on top of the SoC by utilizing the reasoning mechanism on context elements represented by ontologies. They also describe ThingsChat,

their proof-of-concept prototype. Experimental results with ThingsChat demonstrate improvement in adaptability of recommendation results to users' situations.

Implementations of the SIoT model envision cyber counterparts of physical objects, called *social virtual objects* (SVOs), virtualized in the cloud. However, few IoT devices have the processing and communication capabilities required to create and manage social relationships. The article "Social Virtual Objects in the Edge Cloud," by Ivan Farris, Roberto Girau, Leonardo Militano, Michele Nitti, Luigi Atzori, Antonio Iera, and Giacomo Morabito, investigates how to address this issue by exploiting computing resources in the edge of a network to host SVOs in the SIoT. They use edge cloud technologies to implement their SIoT platform, which they expect will reduce latency, increase scalability, and ease management of physical node mobility. Through experimental simulations, they investigate the frequency of each type of message exchanged under different intercloud migrations of processes associated with virtual objects, and assess the latency reduction with regard to conventional cloud solutions.

There have been three types of efforts to enable the SoC since it was proposed in 2010: the social compute cloud, which supports sharing of compute resources between friends; the social storage cloud, which supports storage resource sharing, allowing users to store data on friends' resources; and the social content delivery network (S-CDN), which provides a fabric for replicating and sharing data using friends' resources as intermediate content delivery nodes.[3] In "Social Clouds: A Retrospective," Kyle Chard, Simon Caton, Omer Rana, and Kris Bubendorfer summarize these efforts. Based on their previous implementations, the authors propose a general social cloud architecture to facilitate heterogeneous bilateral resource sharing. Interoperability and cloud federation standards thus will be important to ensuring seamless resource usage. Similar to SIoT research, suitable algorithms and metrics are needed to analyze social clouds.

In the SIoT, devices are usually divided into groups with different relationships in social networks. However, using a RAN to connect IoT devices falls short of supporting SIoT groups. For this, network virtualization with a software-defined network (SDN) structure is a scalable solution. But it's hard to support enough groups with this solution because of rule space limitations in existing SDN enabled devices. In "Cloud Radio Access Network Virtualization for Social Internet of Things," He Li, Mianxiong Dong, and Kaoru Ota propose a SDN-based RAN virtualization framework to maximize the number of SIoT groups with limited SDN rule space. Extensive simulations show that the proposed solution provides more SIoT groups than some other allocation methods, and offers better performance.

Both the SIoT and SoC are at an early stage of research and development, and more research efforts are needed to produce a better, and probably more unified, supporting architecture to integrate with heterogeneous technologies involved in the SIoT and SoC. Security and trust issues obviously need more attention, especially in social environments. And, clearly, the SIoT and SoC have great potential to move forward hand in hand, each supporting the other. We believe the two technologies can merge into a unified paradigm.

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