TCSN Newsletter –Issue Four– May 2019

Social Networks Technical Committee

Editors: Prof. Valeria Loscri and Prof. Anna Maria Vegni

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CHAIR'S MESSAGE

When social media dominates the traffic over the Internet and mobile communication networks, there are further insights and engineering that could be developed based on understanding social networks in depth. Such interplay between technological networks and social networks have so many different aspects to inspire IEEE Communications Society members toward further frontier of communication technology and benefits of human society. Under such background, Technical Committee on Social Networks (TCSN) has been established since 2016, after incubation as a sub-committee in Emerging Technology. When we get to two years old, we are launching the TCSN Newsletters to allow more fluent exchange of vision, ideas, and technological opportunities, in addition to website and social media platforms. We have to appreciate remarkable volunteers at TCSN to make this inauguration issue come true. Last but not the least, we wish TCSN Newsletters serving an effective means for this exciting multi-disciplinary knowledge on social networks to blend humanity and technology in an even better way. Most important, please continue your interest in social networks and actively participate or initiate more volunteer services to TCSN and IEEE Communications Society.

Best wishes,

Neeli Prasad, Chair, TCSN, 2018-2020

UPCOMING CONFERENCES & CFP FOR SOCIAL NETWORKS TRACK

IEEE Globecom 2019: December 9 – December 13, Waikoloa Village, HI, United States
IEEE ICC 2020: June 7 – June 11, Dublin, Ireland

Social networks have become prevalent forms of communication and interaction on the Internet and make up an increasingly part of the network traffic. As a result, social networks have attracted significant research interests in a large number of related areas. Social networks have traditional been studied outside of the technological domains, but focus is now changing towards networking challenges such as cloud, privacy, data analytics, etc. while still keeping the social perspective such as focusing on improving quality-of-life. The interplay between social networks and technological networks such as mobile networks and mobile computing is becoming still strong and many areas are still to be exploited.

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SOCIAL INTERNET OF PLATFORMS: THE NEXT FRONTIER OF THE IOT

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The Internet of Things (IoT) paradigm has been investigated in the academic and industrial fields for several years. Various technologies, applications, protocols for the IoT have been proposed so far and some of these are entering into the standardization process. Yet, one of the primary goals that had pushed toward the realization of an idea of the Internet of Things at the moment turns out to be far from being achieved. Rather, recent developments in the IoT seem to go in the opposite direction. Originally, IoT was supposed to be "A worldwide network of interconnected objects, uniquely addressable based on standard communication protocols". In its current stage, instead, IoT appears to be "an abundant heterogeneous group of platforms that are not uniquely addressable and interact with each other mostly through their servers only, possibly, using proprietary semantics and protocols". Without going too far into the causes that led to this phenomenon, it is worthwhile to dwell on the consequences on the end user.

From a purely technological point of view this has brought to difficulties / impossibilities of interactions among platforms to which different objects are registered, lack of global resource directory and discovery, highly heterogeneous data semantic, impossibility to merge tasks performed by objects in different platforms for the implementation of more complex applications. All this brings to significant difficulties and complexity that are clearly visible to the user in the interaction it has with IoT objects in everyday pervasive environments, which are more and more those where she will be performing daily activities. In a smart home, all the devices and objects of a single brand have no problem exchanging data on a manufacturer's proprietary platform and are easily remotely accessible via the Internet. But if user tries to include a new device from a different brand in the system, it is often extremely complex if not impossible to do it successfully.

And here comes a concept that has supported human beings for millennia in their evolutionary history: the concept of sociality. If you have friends, through the resulting social networks you can ask them for assistance, you can discover new people passing through chains of friendships, you can reach anyone in an average low number of hops thanks to the principle of the small world ruling over social communities. Recently it has been proposed to extend these properties up to now of exclusive competence of human beings also to devices by giving rise to the paradigm of social networks of objects, with the social internet of things (the Social IoT, SIoT - http://www.social-iot. org) as the progenitor.

A social network established between IoT devices and objects helps to address the major problems mentioned above. Indeed, by augmenting each object with a social attitude they acquire the capabilities to opportunistically interact with other peers in the IoT for the exchange of data and services. This is possible through the implementation of clear social APIs that allow them to identify themselves, search for other peers by crawling the social network of friends, evaluate the trust of each peer by contacting chains of friends, and easily find the provider of information they may be looking for towards the deployment of complex applications that require the integration of tasks performed by different objects. Through the implementation of this paradigm, devices could interact opportunistically as soon as they need to find peers that could provide services in a given geographical or logic area. For instance, as already mentioned, the use of our personal and domestic electronic devices is making our lives a hassle due to the complexity in their configuration. The technological assistant installed in our devices may help us if it drives the social objects toward the exchange of best practices. This is the case of a user, who has just bought a new smartphone with a flat rate Internet connection that she wishes to use in an always-tethering modality with her other devices. This may not be simple if for this she has to use a new smartphone device with a new operating system; this may be a jumble for her because of the difficulties in finding the right configuration. Exploiting parental (objects of the same brand) relationships with other smartphones, her smartphone can autonomously find a mate (through such key features as class of object, brand, and typology), which has already addressed the same configuration issues, and fix the problem.

This fairly innovative concept is giving rise to several researches focusing on aspects ranging from the definition of social bonds between devices in reference to specific contexts (smart cities and smart homes, logistics, automotive, etc.), to the study of semantics designed for social environments, from the definition of trustworthiness policies in the exchange of data between social devices to the definition of the rules that should be followed by the devices and set by the owners when interacting with the other peers.

The most disruptive potential of this paradigm manifests itself by coupling it with the emerging paradigm of Software Defined Networking (SDN) and the virtualization of IoT devices in Edge and Fog computing platforms. This technological mix allows for moving the concept of Social Network of devices to lower layers of the protocol suite and to exploit it fully towards the design of a Future Internet capable of integrating and making interoperable platforms of heterogeneous objects.

For this purpose, in fact, the possibility of realizing the interoperability of heterogeneous platforms, with the consequent possibility of exchanging data between devices registered in different platforms and easily reachable and addressing in a univocal and global manner, is promoted directly by acting in the control plane of the network layer.

In the envisaged solution, a specific Service, defined at the network control plane, may perform a double task: create and maintain digital counterparts of the devices, and interact with the SIoT functionalities at the application layer to receive information and updates relevant to the establishment of social relationships between devices.

As for the first task, it consists in handling digital counterparts of the physical devices, virtualized in Fog / Edge spaces. Device's digital counterparts and all the information about the social relations associated with each of them can be contained in a purpose-built distributed data structure. Each virtual image of a device keeps track of meta-data providing a description of the nature of the device, the list of friend devices, feedback about the trust level associated with them, information about the type(s) of friendship(s), defined according to the SIoT paradigm, and the latest IP addresses of the repositories of the digital counterparts of friend devices.

As for the second task, functionalities shall be included that are responsible for: the relationships' lifecycle management, i.e., detecting, creating, updating and deleting relationships (by interacting with the SIoT platform at the higher layer); handling the data delivery service, by interacting with an SDN controller, whenever queried by a device; navigating the social network to find potential recipients of data packets, according to their position in the social network of devices.

This scenario should be implemented by allowing each device to generate a communication request towards another device and this request is intercepted by the control plane services; then, through a navigation of the information handled by each digital counterparts connected to each other by friendly relations, and distributed in the various repositories, the discovery and identification of the destination IP address (or destinations in the case of group communications) is carried out. In this way, it is possible to link devices connected to different network platforms (data plane), whether their address is known a priori or unknown, by carrying out a search on a social basis. This also opens the ground to other types of communications where the recipients are selected on the basis of the social distance with respect to the source. As an example, the recipients of one communication could be the group of devices that are linked by co-location social relationships with the source (relationship created among devices that are geographical close, or have been for a while) because are those that are likely to have the desired information about events happened in this area.

The depicted scenario is achievable under the following conditions: (i) no need for changes in the core functions of end host operating system. Users are reluctant to update or even configure the operating systems in their devices whereas they are willing to install new applications and apps. Accordingly, our

vision involves only application layer functions in the end hosts; (ii) incremental deployment, meaning that it should be conceived in such a way that, in the initial stage of its introduction, it can work

compatibility with IPv4 /IPv6 by exploiting existing protocols; (iii) no need for an entity which manages the service, because the major components envisioned can be implemented in a distributed and peer-to-peer fashion to avoid the presence of a single management entity with full control on the operations which would be a crucial limitation; (iv) independence from the specific network layer deployment, by initially assuming for example the network infrastructure to be deployed through the SDN paradigm, neatly decoupling the control and data plane and leveraging the centralized intelligence of a controller entity to decide packet forwarding rules, and then design the envisaged functionalities with the proper Application Programming Interfaces (APIs) to interact with network elements so to let them forward packets to the intended social destinations.

In conclusion, one of the greatest values of social networks among human beings is undoubtedly that of having allowed them to overcome social barriers and having enabled a greater exchange of ideas among people regardless of their ethnic and cultural differences. Today, the challenge to take up is to obtain the same exceptional result by using the same social notions applied to devices to overcome, likewise, also the barriers among IoT platforms and to bring an ever closer connection between heterogeneous devices regardless of their technological specificities.

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INSIGHTS ON THE PRESENT AND FUTURE OF UNMANNED AERIAL VEHICLES

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UAVS ARE HERE TO STAY

Nowadays, Unmanned Aerial Vehicles (UAVs), popularly known as drones, are becoming prevalent and they are gradually being adopted for an increasing number of daily tasks. After a short time period where their main area of applicability was the military field, usually in the form of large, fixed-wing UAVs, they have quickly reached the masses as smaller, low-cost multirotor UAVs. In fact, we surely expect that, in just a few years, they will become widespread among both professionals and technology enthusiasts.

Regarding professional applications, they have gradually moved from more established areas like aerial photography and video, to new areas like precision agriculture, border surveillance, package delivery, thermal inspections, and rescue operations, among others. In addition, they are gradually replacing helicopters for aerial recordings since they represent a much cheaper alternative. In fact, professionals from different areas are finding new and exciting uses for these devices every day.

Regarding recreational uses by enthusiasts, we can see how these flying devices have experience a huge sales increase worldwide, and have become one of the preferred gifts for teenagers worldwide. They have also found new uses, including drone racing championships, which are becoming widespread, and the building custom (DIY) UAVs is now frequent by both home users and students in different stages of the educational process, from high school to the university.

SOCIAL IMPACT

The huge success of UAVs has led the society as a whole to become more aware about the pros and cons of the presence and potential impact of these flying devices. While the benefits they are able to provide are obvious, as described above, improper uses by unskilled and bold users has raised fears concerning privacy (as aerial recordings are hard to detect), and also fears about accidents. In fact, different studies

have recently highlighted the potential damage UAVs can cause to commercial planes, both on their wings or the nose cone of the plane. Such fears have been further aroused by events like those taking place at Gatwick airport in December 2018, where the presence of drones near this airport caused hundreds of flights to be cancelled, affecting more than 120.000 passengers. In fact, this event was not the first of this kind, and in the United Arab Emirates similar events have led local research groups to collaborate with authorities to design systems that are able to detect and take control over such rogue UAVs, forcing them to land in a safe location, thereby achieving an elegant and graceful solution to this particular problem.

LEGISLATION

Above we referred to events where users knowingly use UAVs in an attempt to disrupt airport operations or to invade the privacy of others. However, the fact is that most people remain unaware of the actual flight restrictions of the different countries regarding maximum flight altitudes, flight in urban areas or during the night, flight near airports or in other restricted areas, or over groups of people. All these flight operations are forbidden for non-professionals in most countries that have regulated the use of these devices, and the simplicity of buying such products contrasts with the complexity at getting accurate information about their use. Fortunately, the situation is slowly changing, and amateur users nowadays have access to smartphone applications (e.g. IcarusRPA) that simplify the access to such information.

For professionals, initial regulations were very restrictive, and we could see how gradually operations in scenarios that were initially forbidden (night flights, flight near airports, flights in urban areas, flights over crowds) are now possible in different countries as long as adequate measures are taken to guarantee the safety of citizens. In the particular case of urban environments, or in similar scenarios where UAVs must fly over groups of people, endangering them in case unexpected problems cause the device to fall, additional safety features are typically required, like the presence of parachutes or other security measures that avoid a free fall. In fact, SKYCAT, PARAZERO, Fruity Chutes and MARS Parachutes are just some of the different companies now offering such features as upgrades to commercial UAV models.

POWER ISSUES

Despite research in the UAV field has caused this area to experience significant advancements in recent years, battery lifetime remains as one of the greatest challenges. Current battery technology based on Lithium Polymer (LiPo) is able to offer significant storage and discharge capacity given a relatively low volume and weight. However, this technology has several issues regarding maximum discharge thresholds or long-term storage problems if the charge is too high, in addition to problems when operating at subzero temperatures.

Regarding flight times achieved with these batteries, they typically range from 10 to 30 minutes in most UAVs. Although these flight times are acceptable for several types of operations, they can represent a limitation in other cases such as package delivery, search and rescue operations, or maritime missions. Thus, to address this deficiency, several efforts are undergoing:

- **New battery technologies:** different alternatives to the LiPo technology are being sought that are able to extend the battery capacity while also mitigating the well-known issues associated to LiPo technology. Among the possible options being developed we have graphene-based batteries,

solid-state batteries, and lithium-metal batteries, all of them promising to significantly improve upon current LiPo batteries.

- **Alternative power sources:** recently, some efforts to create UAVs that combine miniature combustion engines with batteries have emerged as an alternative to extend the flight time of UAVs. In fact, Spanish company Quaternium was the first to introduce in the market the Hybrix2.0 UAV[1], achieving flight times ranging from 2 to 4 hours. More recently, company BShark has proposed the Narwhal 2[2] drone, which is powered by a hydrogen fuel cell, and is able to achieve 2-hour flights as well.
- **In-flight charging:** the idea behind in-flight charging is achieving a potentially limitless flight time without the need to land for switching batteries. However, such technologies are still in an incipient state. For instance, companies like Global Energy Transmission[3] have proposed a mid-air inductive recharging system that can charge up several drones at once without requiring them to land. The US Army has also plans for using lasers to remotely recharge UAVs. Laser light would be pointed to the drone's onboard photovoltaic cell, which would then convert laser energy into electricity to recharge the drone's batteries. This could reportedly be achieved from a distance of nearly 500 meters, but significant challenges like accurate beam control and heat management are yet to be solved efficiently.

A LOOK INTO THE FUTURE

In the coming years UAVs are expected to become more prevalent, flying around in urban environments, both indoors and outdoors. Such a massive number of UAVs raises new issues that deserve scrutiny, like the detection and avoidance of potential collisions between UAVs. To address this problem, solutions based on direct communications between UAVs to solve risky situations have already been proposed and validated in field tests[4]. Other issues, like the management of UAV swarms to accomplish joint tasks is also being addressed by different research groups worldwide. In 2016, Intel was a pioneer in this area, using 500 drones to create the first UAV-based Light Show with such a massive number of UAVs. In December 2017, EHANG used 1180 drones to create a similar show in China, a number that was increased to 1374 drones in April 2018. Later, in July 2018, Intel broke the Guinness World Record for simultaneously flying the largest number of unmanned aerial vehicles, with 2.018 drones.

Moving our focus to the transportation field, in Dubai, the first autonomous UAVs capable of carrying one human passenger to predetermined places in the city are already operating, allowing citizens to envision an exciting future as we gradually bridge the gap towards some science fiction concepts like flying cars. In fact, replacing our cars by their flying counterparts, and making use of the vast aerial space, could solve the ever-grown traffic congestion problems that large metropolitan areas around the world are currently facing.

1 http://www.quaternium.com/uav/hybrix-20/

2 https://www.bsharktech.com/portal/narwhal2.jsp

3 http://getcorp.com/

4 https://www.youtube.com/watch?v=xHnMuMOd9C0

At a smaller scale, advanced indoor navigation systems are being developed that, combined with reconfigurable UAVs, image analysis, and deep learning algorithms, will allow these devices to adapt to their environment seamlessly. This way, UAVs can benefit from advanced features like passing through narrow spaces, recognizing people, animals and objects, and performing a wide range of tasks that will hopefully make everyone's lives easier and boost safety and comfort levels by, e.g., assisting workers, helping the elder, or anyone facing a sudden problem requiring immediate physical intervention.

Overall, we could say that UAVs represent nowadays one of the most exciting and promising research fields. In the upcoming years we will see if they are indeed able to meet the great expectations they have raised, and their actual social benefits. In the meantime, enjoy your flights, and fly safe!

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TOWARDS TRUSTED SOCIAL INTERNET OF THINGS

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DEFINITION

Social Internet of Things (SIoT) is envisioned as a network of social smart objects[5]. The social smart objects (SSOs) are being implemented to satisfy human needs in daily life ubiquity, such as distributed and Device-to-Device (D2D) applications in mobile phone device-to-device interaction under 5G communication, driverless vehicles cooperation for traffic safety, wearable devices for customer behavior analysis, self-cooperation and self-management handling robots in a smart factory[6], etc. When an individual SO cannot provide a single full service, it may interact with partner SOs to organize a collaborative full service to satisfy human service requests[7]. In addition, the SO can autonomously join large communities of objects and cooperate in the same way as Online Social Networking (OSN)[8]. However, the rapidly growth of the number of SOs is bringing crowdsourcing environments around human beings, so that the interaction among humans and devices will increase complexity in such a distributed physical environment.

OPEN ISSUES

SIoT combines IoT devices with social attributes, aiming to increase the service organization efficiency of group of objects and reduce the complexity of human-IoT interoperation[9]. The social attributes can be used to aid SOs to discover partners, candidates for cooperating services, and to generate relationships

[5] Frustaci, Mario, et al. "Evaluating critical security issues of the IoT world: present and future challenges." *IEEE Internet of Things Journal* 5.4 (2018): 2483-2495.

[6] Yang, Lin, et al. "A social-D2D architecture for People-centric Industrial Internet of Things." *Networking, Sensing and Control (ICNSC), 2017 IEEE 14th International Conference on*. IEEE, 2017.

[7] Fortino, Giancarlo, et al. "Forming Groups in the Cloud of Things Using Trust Measures." *International Symposium on Intelligent and Distributed Computing*. Springer, Cham, 2018.

[8] Jung, Jooik, et al. "Quantitative computation of social strength in social Internet of Things." *IEEE Internet of Things Journal* 5.5 (2018): 4066-4075.

[9] Fortino, Giancarlo, et al. "Guest Editorial Special Issue on Emerging Social Internet of Things: Recent Advances and Applications." *IEEE Internet of Things Journal* 5.4 (2018): 2478-2482.

among devices. Similar to OSN, the relationships of SOs may be described by using community, centrality, influence, candidates ranking and recommendation. Hence, the research context may focus on how to create the relationship among SOs, and on the suitable strategies for selecting partner and making decisions aided by social attributes. Looking at the relationship of human beings, we may naturally find the key: the mutual trust concept. The trustworthiness is a key metric, and it is a factor to make SOs interaction in communities of SIoT more reliable[10].

OUR CONTRIBUTIONS

A recent work of SIoT reported a solution to address the issue of trust measurement[11] for SOs. A method of agent-oriented cooperative SOs[12] is introduced to model the behavior of interactions in SIoT. Moreover, it is possible to realize the independence of the agents/SOs from the physical device hardware, to add social attitudes of entities in cyber and physical ecosystems. There are two mainly contributions: a) exploiting trust measures to model a distributed group formation process aimed to maximize from one hand the benefits of an agent/SO to join with a group and, from the other hand, that of a group in accepting a new member. And b) how to deal with the modality to combine trust values to take a decision about accepting or refusing an affiliation request to a group.

RESEARCH CHALLENGES

By using the trust measurement reported above, is it reliable for the selected partner with the highest trustworthiness? Obviously, there are still a lot of research challenges, and the specific scenarios should be considered in different processes of SIoT devices interaction, such as trust of an SIoT device in event sensing, data transmission, and results reporting. For example, in a traffic safety scenario of Internet of Vehicle, a driverless car may detect an incorrect traffic jam or malicious participants to provide invalid sensing data. And then in the process of safety alarm transformation in crowdsourcing neighbor vehicles, the routing partner selected by using trust metrics may perform a character of selfish and non-cooperation. Moreover, the behavior of the selected partner may show wrong result of traffic jam location to mislead other vehicles in communities, in order to make its own safe route priority. So, trustworthiness faces reliability issues according to the social attributes of smart devices. We can guess that the research challenges depend on how in depth we understand and define the behavior of society of human and social devices.

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[10] Lin, Zhiting, and Liang Dong. "Clarifying trust in social internet of things." *IEEE Transactions on knowledge and data engineering* 30.2 (2018): 234-248.

[11] Fortino, G., et al. "Using trust and local reputation for group formation in the Cloud of Things." *Future Generation Computer Systems* 89 (2018): 804-815.

[12] Fortino, Giancarlo, et al. "Agent-oriented cooperative smart objects: From IoT system design to implementation." *IEEE Transactions on Systems, Man, and Cybernetics: Systems* 99 (2017): 1-18.

CONCLUSION

Even if the SIoT technology is facing these challenges, we can look forward the benefits from it in near future. Let smart devices have their own friends and make friends freely, and it will decrease the interaction complexity among human and living environments fulfilled crowdsourcing SOs. A long shot? Maybe. However, the trust metric of SIoT is a good opening we see to address congestion and dynamic partner selection of SOs.

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