ALL-IN-ONE INTERNET OF THINGS FOR TECH WORLD

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Abstract— Tech world is envisioned as an era in which objects (e.g., tv, microwave, cars, computers, buses, washing machine, and all electrical gadgets) can automatically and intelligently serve people in a collaborative manner. Paving the way for tech world, Internet of Things (IoT) connects everything in the tech world. Motivated by achieving a sustainable tech world, this paper provides the facilities on various technologies and issues regarding IoT, which further reduces the time, energy consumption and usage of IoT. Particularly, an overview regarding IoT and aio IoT is performed first. Then, all-in-one (aio) information and communications technologies (ICTs) (e.g., aio radiofrequency identification, aio wireless sensor network, aio cloud computing, aio machine to machine, and aio data center) enabling aio IoT are studied, and general aio ICT principles are summarized. Furthermore, the latest developments and future vision about sensor cloud, which is a novel paradigm in aio IoT, are reviewed and introduced, respectively. Finally, future research directions and open problems about aio IoT are presented. Our work targets to be an enlightening and latest guidance for research with respect to aio IoT and tech world.

Index Terms— Tech world, Internet of Things, all-in-one, Smart world, radio-frequency identification, wireless sensor network, cloud computing, machine to machine, data center, sensor-cloud.

I.INTRODUCTION

INTERET OF THINGS

Internet of thing is the technology that uses to communicate to each other without human. The technology that makes the things to communicate directly between each other can save the communication energy with user. ICT (Information and communications technology): including IoT technologies and applications have a direct effect on lowering CO_2 emissions. Internet of Things (IoT) is an integrated part of Future Internet and could be defined as a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things " have identities physical have identities, physical attributes, and virtual personalities.

The Internet of Things allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service. Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

TECH WORLD

With the rapid development of science and technology, the World is becoming ''smart''. Living in such a smart world, people will be automatically magnetize and served by the smart devices (e.g., watches, mobile phones, computers), etc. Fc five major categories come in picture; location-determining a postio tracking-monitoring object or personal movement, mapping-creating

Tech World helps to improve the usage of human resources in efficient manner. It provides the useful information to people which helps them to utilize their resources in cheap and best manner.

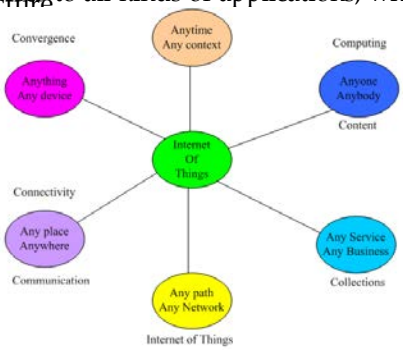
In addition, tech world involes smart phones, digital imaging, Better fibre-optic cables, mind-controlled prosthetics, 3d prinTing, small smart sensors, predictive policing, serious solar, Biohacking, genetic scanning etc.

II. OVERVIEW OF IoT AND AIO IoT

IoT

DEFINITION

A proposed development of the Internet in which everyday objec send and receive data. It's a uniquely identifiable objects and



ssly integrated into th usiness processes. Ser e their state and any e perspective of techn bling advanced servic information and com communication capab thing the required priv

In short, as shown in Fig. 1, the basic idea of *IoT* is that everything (made artifacts to natural objects , from village to cities) around us municate over the Internet.

2) ELEMENTS

Fig 2. Shows the element in IoT. Specifically, there are six elements in

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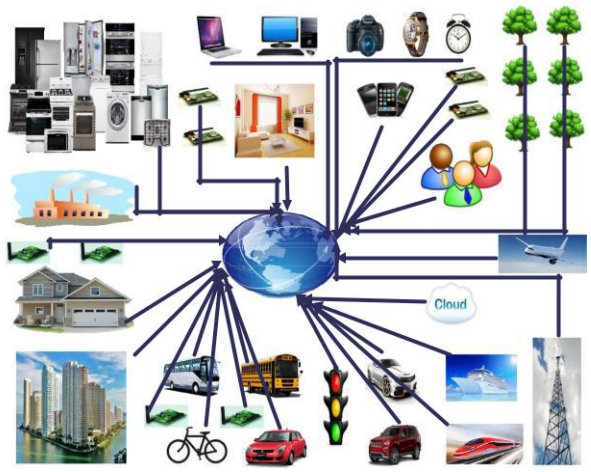


FIGURE 2. Elements in IoT.

Communication technologies, computation, services and semantic.
The "traditional" ubiquitous world is represented by the component (A) including industries and all other realities.
The extension of the above-mentioned reality by new enabling and emergent technologies is represented by the (C) component (C).
The (B) component shows the missing element, making possible such scenario, which might be the RFID, transforming real life members into digital things, ready to enter into the Internet of Things.
It is therefore expected that the Internet of things will become a reality over the next 20 years; with omnipresent smart devices wirelessly communicating over hybrid and ad-hoc networks of devices, sensors and actuators working in synergy to improve the quality of our live sand in synergy to improve the quality of our lives and consistently reducing the ecological impact of mankind on the planet.

B. AIO IoT

Enabling the new world, IoT is key to understand the powerful things around us and to learn the newly problem solving techniques.
It is foreseen by NIC that ''by 2025, internet nodes may reside in everyday things, i.e., cooking, cleaning, body fitness, education, etc.,'' However, to enable a sustainable tech world, the IoT should be characterized by energy efficiency. Particularly, since all devices in the tech world are supposed to be equipped with additional sensory and communication add-ons. These can be use to sense the world and communicate with each other, they will require more energy.

''The energy efficient procedures (hardware or software) adopted by aio IoT either to facilitate decreasing the greenhouse effect of existing applications and services or to lower the impact of greenhouse effect of IoT itself. In the earlier case,
The continuous use of IoT will help reduce the greenhouse effect, whereas in the latter case footprint will be taken care by further optimization of IoT greenhouse footprint . The entire life cycle of aio IoT should focus on aio design, aio production, aio utilization and finally aio disposal/recycling to have no or very small impact on the environment.''

C. APPLICATION
With respect to IoT and aio IoT, there are a lot of applications. We list some application scenarios as follows

Smart Home: Let you easily monitor, control and secure your home from anywhere. It is use and control of home appliances remotely or automatically. Personal life-style at home is enhanced, by making home appliances and systems more convenient and easier to monitor and operate services (e.g., oven, air conditioner, heating systems, microwave, etc.) remotely. For instance, based on the weather forecast information, a smart home can automatically lower the blinds of windows and close the windows. The rise of smart home is predicted to grow, with some estimates putting the market value over $10 billion by 2020.

Industrial Automation: Robotic devices are programmed and computerized to finish manufacturing tasks, with a minimal human involvement. It helps automatically controlled and monitored the machines' operations, functionalities, and productivity rates. For example, if there is a sudden issue about a machine, a maintenance request to the maintenance department will immediately deliver the system for handling the problem. In addition, by analyzing production data, timing and causes of production issues, the productivity is improved

Smart Healthcare: By embedding sensors and actuators in patients and their medicine for monitoring and tracking, Performance of healthcare applications is improved. For instance, the clinical care could monitor physiological statuses of patients in real-time and make suitable actions when necessary by gathering and analyzing patients' body data with sensors and further delivering analyzed data to a processing center.

Smart City: Quality of life in the city is ameliorated, by making it more suitable and easier to obtain information of interest. For instance, according to people's needs, the desirable services are getting intelligently offered by various interconnected systems desirable services (e.g., transportation, food, utilities, health, etc.) to people.

Domain	Description	Indicative examples
Industry	Activities involving financial or commercial transactions between companies, organizations and other entities	Manufacturing, logistics, service sector, banking, financial governmental authorities, intermediaries, etc.
Environment	Activities regarding the protection, monitoring and development of all natural resources	Agriculture & breeding, recycling, environmental management services, energy management, etc.
Society	Activities/ initiatives regarding the development and inclusion of societies, cities, and people	Governmental services towards citizens and other society structures (e-participation), e inclusion (e.g. aging, disabled people), etc.

III. ICT ENABLING AIO IoT

In this section, we present an overview of ICT. Then Summary of five hot aio ICT (i.e., aio RFID, aio WSN, aio M2M, aio CC and aio DC) enabling aio IoT are discussed, followed with the general principles of aio ICT.

A. OVERVIEW OF ICT

ICT is an umbrella term that relates to any facility, application (e.g., radio, television, cellular phones, computers, hardware, software, machines, networks, middleware, storage, satellite systems, video conferencing, distance learning), technology, regarding information and communication, store, transmit, enabling users to access, and manipulate a variety of information. In this paper, we list the following ICT, regarding communication, identification, sensing and computation which are IoT elements.

RFID (radio-frequency identification): a small electronic device that consists of a small chip and an antenna, automatically identifying and tracking tags attached to objects.

WSN (wireless sensor network): a network consisting of spatially distributed autonomous sensors that cooperatively monitor the physical or environmental conditions (e.g., temperature, sound, vibration, pressure, motion, etc.).

WPAN (wireless personal area network): a low-range wireless network for interconnecting devices centered on an individual person's workspace.

WBAN (wireless body area network): a wireless network consisting of portable or wearable computing devices (e.g., sensors, actuators) situated on or in the body.

HAN (home area network): a type of local area networks (LANs), connecting digital devices present inside or within the close vicinity of a home.
NAN (neighborhood area network): an offshoot of Wi-Fi hotspots and wireless local area networks (WLANs), enabling people to connect to the internet quickly and at very little expense.

M2M (machine to machine: a technology that allows both wired and wireless devices to communicate with other devices of the same type.

CC (cloud computing) : a novel computing model for enabling convenient, on-demand network access to a shared pool of configurable resources (e.g., networks, servers, storage, applications, services). Integrating CC into a mobile environment, mobile cloud computing (MCC) can further offload much of the storage tasks and data processing from mobile devices (e.g., smart phones, tablets, gadgets etc.) to the cloud.
DC (data center): a repository (physical or virtual) for the management, storage and dissemination of data and information.

APPLICATION AREAS OF ICT
Sectoral and thematic applications: Development work is categorized by sectors and themes by the international development assistance community. Sectors are made up of the following: infrastructure; industry; agriculture; natural resources; health; education; private; and public. Agriculture, education and rural livelihoods are the most extensively studied sectors.
Civic engagement: Civic engagement plays a large part in E-Government, particularly in the area of Transparency and Accountability. ICTs are used to promote openness in the government as well as a platform for citizens to report on anomalous government activities for the purpose of reducing corruption and in promoting efficiency.
Climate, weather and emergency response: The use of ICT in weather forecasting is broad. Weather forecasting offices use mass media to inform the public on weather updates. After tropical storm Ondo in the Philippines, the Filipino people are more curious and aware about the weather hazards. Meteorological offices are also using advanced tools to monitor the weather and the weather systems that may affect a certain area.
People with disabilities: According to World Health Organization (WHO), 15% of the world's total population have disabilities. This is approximately 600 million people wherein three out of every four are living in developing countries, half are of working age, half are women and the highest incidence and prevalence of disabilities occurs in poor areas. With ICT, lives of people with disabilities can be improved, allowing them to have a better interaction in society by widening their scope of activities.
In education: Education is recognized as an important factor in addressing and solving social issues that exist in societies. While education indeed is recognized as important in addressing social issues, the limited resources that countries have also limits the expansion and quality of education that is being delivered by traditional educational systems.
In rural livelihood: Ever since people have this natural way of thinking on how they can survive and make a living by harvesting crops used for food and fiber, raising livestock such as cow, sheep and poultry that produces animal products like wool, dairy and eggs, catching fish or any edible marine life for food or for sale, forestry and logging to grow and harvest timber to build shelter.
In healthcare : According to WHO, the use of ICTs in

healthcare is not only about technology (Dzenowagis,2005), but a means to reach a series of desired outcomes, such as:
health workers making better treatment decisions;
hospitals providing higher quality and safer care;
people making informed choices about their own health;
governments becoming more responsive to health needs;
national and local information systems supporting the development of effective, efficient, and equitable health systems;
policymakers and the public becoming more aware of health risks; and
People having better access to the information and knowledge they need for better health.
In e-environment : The government, civil society and private sector are encouraged to use and promote ICTs as instruments for environmental protection and the sustainable use of natural resources; to implement green computing programs; and to establish monitoring systems to forecast and monitor the impact of natural and man-made disasters. ICT can be seen as both a boon and a bane for the environment as their relationship can be multifaceted.

IV SENSOR-CLOUD TOWARDS ALL-IN-ONE IOT

In this section, towards aio IoT, we present the overview of sensor-cloud. Recent developments regarding the future sensor-cloud is envisioned.

A. OVERVIEW OF SENSOR-CLOUD

Sensor-cloud is ''an infrastructure that allows only truly pervasive computation using sensors as an interface between cyber and physical worlds, the data compute clusters as the cyber backbone and the internet as the communication medium'' .

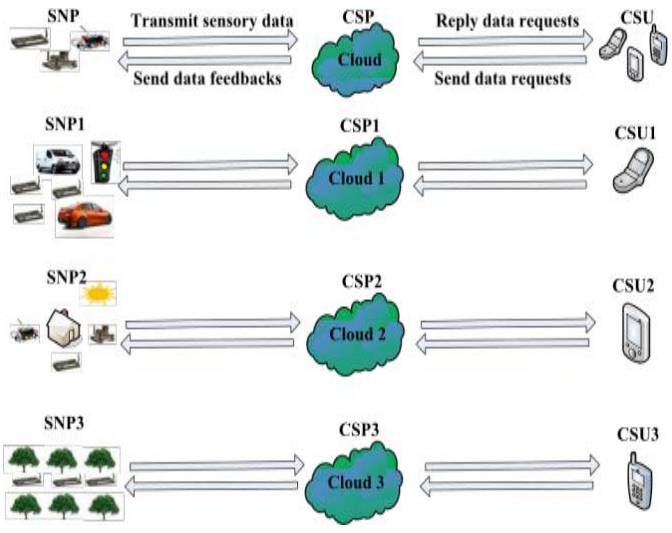


FIGURE 3. An example of sensor-cloud.

Attracting increasing interest from both industrial and academic communities, *sensor-cloud* is a new paradigm, motivated by complementing 1) the ubiquitous data gathering and data sensing capabilities of WSNs as well as 2) the powerful data processing and data storage abilities of CC. Particularly, as presented in Fig. 3, the general application model of sensor-cloud is, to use the ubiquitous sensors (e.g., static sensors, video sensors , mobile sensors, etc.) offered by the SNP (sensor network provider) to collect sensory data (e.g., temperature, traffic, house surveillance, humidity etc.) about the surrounding environment.

B. RECENT DEVELOPMENTS OF SENSOR-CLOUD

With respect to the *sensor-cloud framework*, It proposes a novel sensory data processing framework (named as NSDPF in this paper) with mobile cloud to integrate WSN. The problem researched is sensory data processing in sensor-cloud.
Analytical and experimental results are to be provided regarding the proposed NSDPF, in terms of enhancing the performance of sensor-cloud (e.g., enhancing the storage requirement, enhancing the network lifetime, enhancing the security and monitoring performance of WSNs, enhancing the security of the transmitted sensory data, reducing the cloud storage and processing overhead , reducing the traffic and bandwidth required for sensory data transmissions).

Analytical and experimental results shows the effectiveness of TPSS about enhancing sensory data's usefulness and WSN's reliability for sensor-cloud.

C. FUTURE SENSOR-CLOUD

A comparison of the above recent research regarding sensor-cloud is shown in Table 2.

Scheme	Focus
NSDPF	Framework
CLSS	Energy efficiency
TPSS	Data transmission
ATRCM	Security
PTMM, PTAM	Job scheduling
TASC	QoS
SCPM	Pricing

TABLE 2. A comparison and summary of recent developments about sensor-cloud.

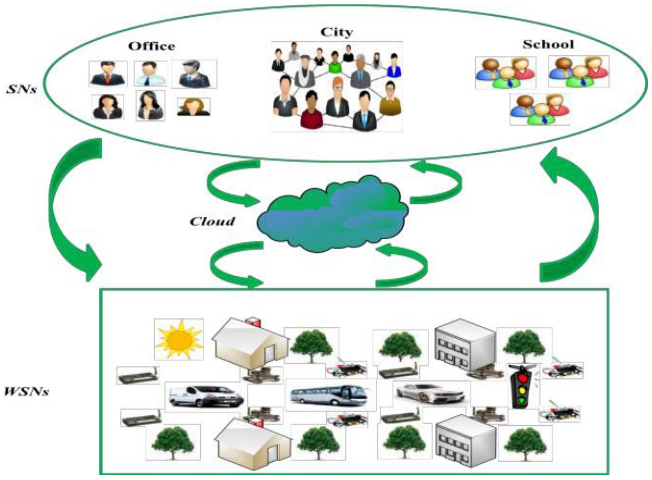
Regarding the future sensor-cloud, we envision that future sensor-cloud will evolve into the *social-sensor cloud (SSC)*, in which social networks (SNs) WSN and cloud connect and complement each other, shown in Fig. 4. In *social-cloud*, integrating SNs and CC, there are already much research in which the key idea is to share the cloud resources and services utilizing the relationships established between members of a SN. The SNs could be used to achieve better energy efficiency for sensor-cloud in the following ways.

Sharing the sensor-cloud services and resources to other users with SNs, will substantially reduce the services and

resources requested by the sensor-cloud users. As a result, the energy consumption of sensor-cloud can be decreased dramatically.

The massive user behavior information in SNs, could be collected and analyzed as well as further utilized to enhance the usage of energy in sensor-cloud (e.g., optimize the data gathering and data transmission in WSN, improve the data processing and data storage in cloud, etc.). In return, users' needs will also be better satisfied.

Based on the amount of resource consumption and service usages created by a variety of users in SNs, the deployment of resources could be optimized and waste of resources could be lowered in sensor-cloud.



V FUTURE RESEARCH DIRECTIONS AND OPEN PROBLEMS

The future research directions and open problems concerning aio IoT, are observed.

The *design of aio IoT*, should be tackled from an overall system energy consumption perspective, subject to satisfying all service objectives and achieving acceptable performance, QoS or quality of experience (QoE).

Characteristics of different IoT applications and service requirements for these applications, need to be better understood.

Realistic energy consumption models of different parts of aio IoT systems (e.g., WSN, core network, embedded system, CC, etc.), are needed.

With pervasive deployment of sensors, *a virtualized sensor as a service (SNaaS)* may be envisioned, in which users have control and access to their virtually private IoT.

Within the context of SNaaS, it is of interest to investigate *a) energy efficient service composition strategies; b) energy efficient system architecture; c) situation and context awareness regarding applications and users(e.g., learn and predict); d) energy efficient WSN management; e) energy efficient cloud management.*

VI. CONCLUSION

As an inspiring and latest guidance for research concerning tech world, this paper has discussed various technologies and issues with respect to aio IoT, which plays a significant role in achieving a sustainable tech world. Specifically, the overview regarding IoT and aio IoT has been performed. The technologies related to aio IoT including five hot ICT (e.g., aio RFID, aio WSN, aio CC, aio M2M, aio DC) have been introduced, with the summary of general aio ICT principles. In addition, bestowing particular attention to sensor-cloud which is a novel paradigm in aio IoT, the best and latest developments about sensor-cloud have been shown and the future sensor-cloud has been envisioned. Finally, open problems regarding aio IoT and future research directions have been presented.

REFERENCES

[1] Q. Han, S. Liang, and H. Zhang, ''Mobile cloud sensing, big data, and 5G networks make an intelligent and smart world,'' *IEEE Netw.*, vol. 29, no. 2, pp. 40–45, Mar./Apr. 2015.

[2] L. Atzori, A. Iera, and G. Morabito, ''The Internet of Things: A survey,''
Comput. Netw., vol. 54, no. 15, pp. 2787–2805, Oct. 2010.

[3] C. Perera, C. H. Liu, S. Jayawardena, and M. Chen, ''A survey on Internet of Things from industrial market perspective,'' *IEEE Access*, vol. 2, pp. 1660–1679, Jan. 2014.

[4] L. Da Xu, W. He, and S. Li, ''Internet of Things in industries: A survey,''
IEEE Trans. Ind. Informat., vol. 10, no. 4, pp. 2233–2243, Nov. 2014.

[5] C. Perera, C. H. Liu, and S. Jayawardena, ''The emerging Internet of Things marketplace from an industrial perspective: A survey,'' *IEEE Trans. Emerg. Topics Comput.*, to be published.

[6] A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Ayyash,
''Internet of Things: A survey on enabling technologies, protocols and applications,'' *IEEE Commun. Surveys Tuts.*, to be published.

[7] F. K. Shaikh, S. Zeadally, and E. Exposito, ''Enabling technologies for green Internet of Things,'' *IEEE Syst. J.*, to be published.

[8] V. Namboodiri and L. Gao, ''Energy-aware tag anticollision protocols for
RFID systems,'' *IEEE Trans. Mobile Comput.*, vol. 9, no. 1, pp. 44–59, Jan. 2010.

[9] Y.-H. Lin, Z.-T. Chou, C.-W. Yu, and R.-H. Jan, ''Optimal and maximized configurable power saving protocols for corona-based wireless sensor networks,'' *IEEE Trans. Mobile Comput.*, to be published.

[10] F. Farahnakian *et al.*, ''Using ant colony system to consolidate VMs for green cloud computing,'' *IEEE Trans. Services Comput.*, vol. 8, no. 2, pp. 187–198, Mar./Apr. 2015.

[11] C.-H. Chang, R. Y. Chang, and H.-Y. Hsieh, ''High-fidelity energyefficient machine-to-machine communication,'' in *Proc. IEEE*

25th Annu. Int. Symp. Pers., Indoor, Mobile Radio Commun., Sep. 2014, pp. 91–96.

[12] J. Shuja *et al.*, ''Survey of techniques and architectures for designing energy-efficient data centers,'' *IEEE Syst. J.*, to be published.

[13] A. Alamri, W. S. Ansari, M. M. Hassan, M. S. Hossain, A. Alelaiwi, and M. A. Hossain, ''A survey on sensor-cloud: Architecture, applications, and approaches,'' *Int. J. Distrib. Sensor Netw.*, vol. 2013, Nov. 2013, Art. ID 917923.

[14] S. Misra, S. Chatterjee, and M. S. Obaidat, ''On theoretical modeling of sensor cloud: A paradigm shift from wireless sensor network,'' *IEEE Syst. J.*, to be published.

[15] P. Sathyamoorthy, E. C.-H. Ngai, X. Hu, and V. C. M. Leung, ''Energy efficiency as an orchestration service for mobile Internet of Things,'' in
Proc. 7th IEEE Int. Conf. Cloud Comput. Technol. Sci., Nov./Dec. 2015, pp. 1–8.

[16] A. Juels, ''RFID security and privacy: A research survey,'' *IEEE J. Sel. Areas Commun.*, vol. 24, no. 2, pp. 381–394, Feb. 2006.

[17] C. Zhu, L. Shu, T. Hara, L. Wang, S. Nishio, and L. T. Yang, ''A survey on communication and data management issues in mobile sensor networks,'' *Wireless Commun. Mobile Comput.*, vol. 14, no. 1, pp. 19–36, Jan. 2014.

[18] J. A. Gutierrez, M. Naeve, E. Callaway, M. Bourgeois, V. Mitter, and B.
Heile, ''IEEE 802.15.4: A developing standard for low-power low-cost wireless personal area networks,'' *IEEE Netw.*, vol. 15, no. 5, pp. 12–19, Sep./Oct. 2001.