IoT standards for Africa and Sustainable Development Goals (SDGs)

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Abstract: IoT is a major worldwide topic but can really be deployed if there are well-established standards. Today there are some important actions on standardisation, which are promoted either by ITU, which has a major impact in Africa or directly adopted in Africa by some operators. This article presents such important activities.

Keywords: ITU, IoT, standards, SDG, OneM2M, 5G, LPWAN, LoRaWAN, Sigfox, FIWARE

1. Introduction

As reported in [1] in the WG3 standardisation of the Alliance for Internet of Things (IoT) Innovation [2], IoT requires and triggers the development of standards and protocols in order to allow heterogeneous devices to communicate and to leverage common software applications. Several standardization initiatives currently co-exist, in individual SDOs or partnerships (e.g. ETSI SmartM2M, ITU-T, ISO, IEC, ISO/IEC JTC 1, oneM2M, W3C®, IEEE™, OASIS®, IETF®, etc.) and also in conjunction with a number of industrial initiatives (e.g. All Seen Alliance, Industrial Internet Consortium (IIC), Open Connectivity Foundation (OCF), Platform Industrie 4.0, Thread group, etc.).

In front of the jungle of standards and in view of the importance of deploying IoT including with new radio technologies where African regulators might be attempted to issue new regulation, this article will provide some fact and guidelines in some important IoT standardisation activities which can impact the development of IoT in Africa in particular through the involvement of the International Telecommunication Union (ITU) where recommendations are largely followed up in Africa. We will present some issues on radio matters as discussed by ITU-R and on IoT infrastructures promoted by oneM2M standards about to be adopted by ITU-T. We will present other important standards deployed in Africa through the FIWARE programme. As Africa is also very concerned by its sustainable future, Africa must use standards that support the Sustainable Development Goals (SDGs) and then we will present 10 keys actions on how IoT can address the 17 SDGs [3].

2. ITU-R view on standards for Africa

The ITU Global Standards Initiative on IoT defined the IoT as “the infrastructure of the information society”. It enables a wide range of devices to be sensed or controlled remotely and to exchange data through connection to the Internet network infrastructure.

The range of application of IoT is very broad – extending from smart clothing, to smart cities, to global monitoring systems. To meet these varied requirements, a range of access technologies, both wired and wireless, are required to provide access to the network. While most current IoT applications use wired technologies and short-range wireless technologies, these are now being augmented by the deployment of low power wide area networks and optimized mobile cellular and satellite systems.

Different radiofrequency bands, many of which provide communication channels, infrastructure and capacity, could be used in IoT deployment with the aim of ensuring cost-effective deployment and efficient use of the radiofrequency spectrum. In addition, IoT is a concept encompassing various platforms, applications, and technologies that are, and will continue to be, implemented under a number of radiocommunication services.

Among many activities, those related to achieve harmonization for Short-Range Device (SRD) play an important role in successful deployment of IoT: Technical & operating parameters and spectrum use for SRDs (Rep. ITU-R SM.2153) and Frequency ranges for global/regional harmonization of SRDs (Rec. ITU-R SM.1896). Figure 1 shows some widely deployed SRD technologies in the sub-6GHz band.

Source: Presentations at the ITU Workshop on Spectrum Management for IoT Deployment (www.itu.int/go/ITU-R/RSG1SG5-IoT-16)

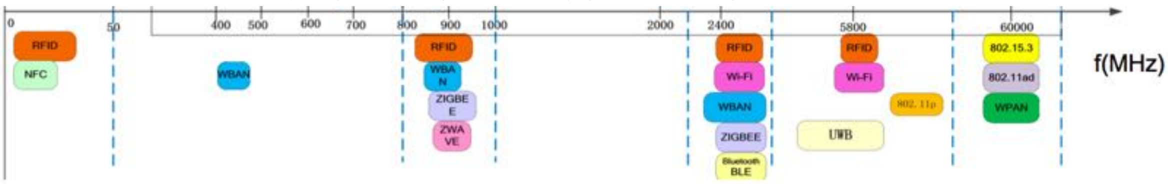

Figure 1: some widely deployed SRD technologies in the sub-6GHz band

Another important activity is the support for massive machine-type communications within the framework of the standards and spectrum for IMT-Advanced (4G) and IMT-2020 (5G). In the short term, the current IMT-Advanced 4G standard (Rec. ITU-R M.2012) is being enhanced to include support for IoT (e.g. NB-IoT systems). In the longer term, IoT is seen as an integral element of the IMT-2020 5G standard being developed in ITU – extending the benefits of the IMT massive economies of scale and globally harmonized frequencies and standards to all industry sectors, see Figure 2.

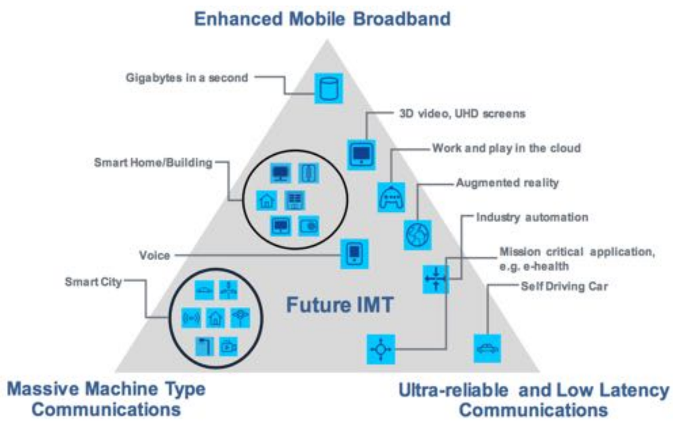

Figure 2: 5G usage scenario

The framework and overall objectives of the future development of IMT for 2020 and beyond is detailed in Rec. ITU-R M.2083. There are specific studies on Wide-area Sensor and Actuator Network (WASN) Systems where the Automatic sensing and information collection functionality is of particular importance in the Africa context. 2 documents describe these studies: Rec. ITU-R M.2002 "Objectives, characteristics and functional requirements of WASN systems" to support machine-to-machine service applications irrespective of machine location and Rep. ITU-R M.2224 "System design guidelines for WASN systems" which provides detailed information for system design policy, the wireless applications and examples of WASN systems for information sharing.

3. Standards on growing interest for long range – low power in Africa

3.1– Low-Power Wide Area Networks (LPWAN) technologies

Traditional cellular network infrastructures (e.g., GSM/GPRS, 3G/4G) are still very expensive for deploying IoT devices on a large scale. Moreover, they are definitely not energy efficient for autonomous devices that must run on battery for years. Short-range technologies such as IEEE 802.15.4 can eventually be used by implementing multi-hop routing to overcome the limited transmission range but this can only be envisaged with high node density and easy access to power in scenarios such as smart-cities environments. They can hardly be considered in isolated or rural environments.

Recently, LPWAN concept based on ultra-narrow band modulation (UNB) – for Sigfox [4] – or Chirp Spread Spectrum modulation (CSS) – for LoRa [4] – has attracted attention with their capability to provide long range communication with a much lower power consumption to enable several years of operations on batteries. These technologies can achieve more than 15km in LOS condition and they definitely provide a better connectivity answer for battery-operated IoT by avoiding complex and costly relay nodes as a star topology with a central gateway can be deployed similar to cellular network topology. Therefore, even though these technologies are not yet standards endorsed by recognized standardization bodies, they can be considered as de-facto standards in the emerging LPWAN ecosystem.

Obviously, Sigfox and LoRa are competitors targeting the same IoT segment. They are currently both using the sub-GHz unlicensed band to maximize technology uptake but nothing prevents them to use licensed-band in the future (thus avoiding strict duty-cycle regulations in unlicensed band). However, in addition to the different underlying physical modulation approach, Sigfox also differs from LoRa as it positions itself as an operator whereas LoRa is only the physical modulation techniques patented by Semtech company. Third parties can use LoRa products to deploy their own LoRa networks. Some third parties may be themselves operators with a traditional business model but some others can simply be end-users deploying their own ad-hoc LoRa networks. This variety of deployment scenarios is one main motivation behind the so-called LoRaWAN specification proposed by the LoRa Alliance to additionally defines common data and control channels, packet format, data link level commands, etc., for deploying nationwide networks with multiple gateways in an interoperable manner. LoRaWAN also defines 3 classes of end-device depending on the communication needs. Each class has its own set of service requirements that are also defined in the LoRaWAN specifications. Here, again, even though LoRaWAN is not a standard endorsed by recognized standardization bodies, it can be considered as one de-facto standard for LoRa-based networks.

Figure 2(left) illustrates the typical multi-tenant, nationwide LPWAN IoT topology showing end-devices, LPWAN gateways, Network & Application Servers and finally the end-users.

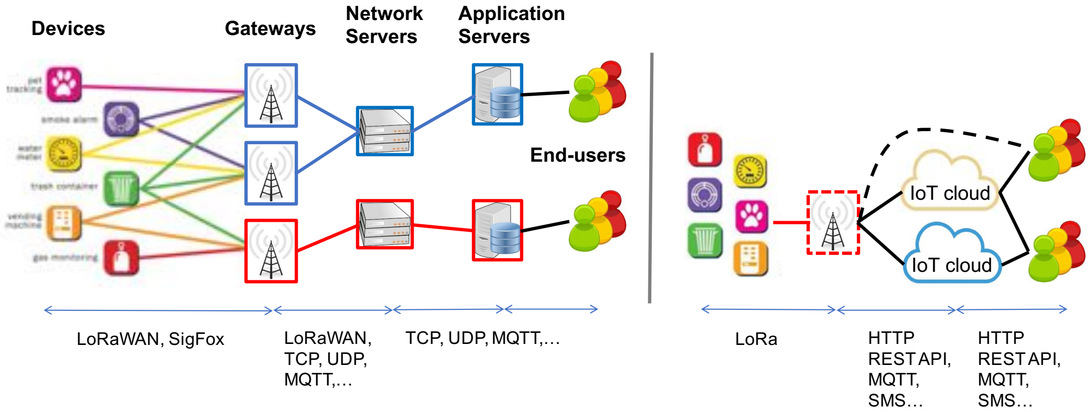

Figure 2: typical nationwide LPWAN topology (left), simplified small-medium LPWAN topology (right)

3.2– What LPWAN "standard" for Africa?

While the nationwide LPWAN architecture depicted in Figure 2(left) offers the highest data transparency level, it needs various network elements and heavily relies on high-quality Internet connectivity. In Africa, economy is still strongly based on very small to medium size businesses that are highly independent from each other, spread in remote and rural areas where SMS/USSD usage is still predominant. The main target of IoT in Africa is therefore to address small to medium size deployment scenarios for specific use cases instead of addressing large-scale, multi-purpose deployment scenarios. Figure 2(right) illustrates such a simplified architecture where LoRa technology is still the de-facto standard for connecting remote device to a gateway but the gateway is now a more versatile, open and flexible device capable of handling a larger variety of IoT frameworks independent from LPWAN operators. Moreover, by shifting from nationwide to small-medium topologies such gateways can be built with low-cost hardware, running innovative open-source software such as those proposed by the EU H2020 WAZIUP and Agile projects.

4. Standards on ITU-OneM2M for Africa

Beyond radio matters, it is important to have IoT standards and ITU is about to adopt the oneM2M [5] specifications as the main industry driven standards for IoT. oneM2M is a global standards initiative covering requirements, architecture, API specifications, security solutions and interoperability for Machine-to-Machine (M2M) and IoT technologies. oneM2M was formed in 2012 and consists of eight of the world's preeminent standards development organizations: ARIB (Japan), ATIS (U.S.), CCSA (China), ETSI (Europe), TIA (U.S.), TSDSI (India), TTA (Korea), and TTC (Japan), together with six industry fora or consortia (Broadband Forum, Continua Alliance, Global Platform, Next Generation M2M Consortium, OMA) and over 200 member organizations. oneM2M specifications provide a framework to support applications and services such as the smart grid, connected car, home automation, public safety, and health. oneM2M actively encourages industry associations and forums with specific application requirements to participate in oneM2M, in order to ensure that the developed solutions support their specific needs.

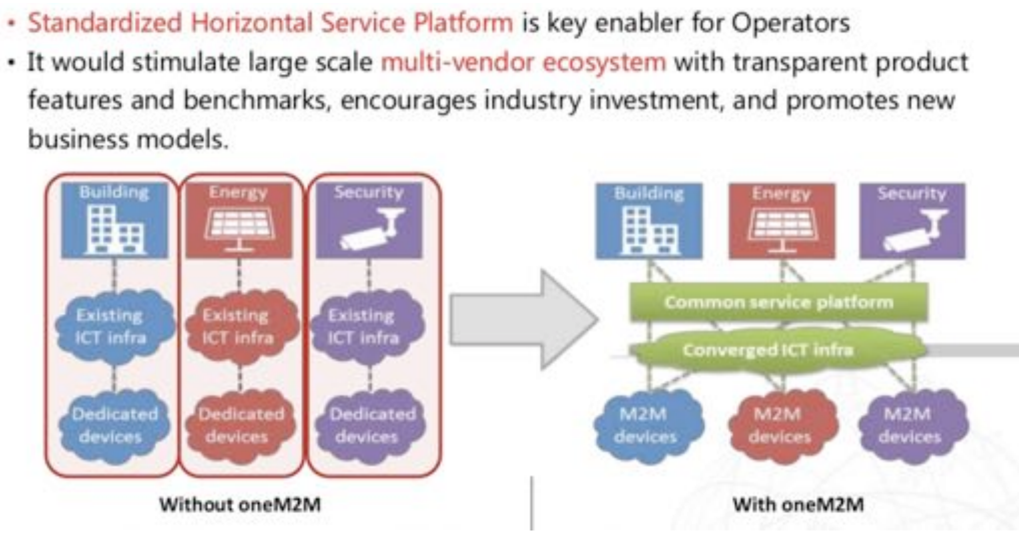

Figure 3: OneM2M goal: IoT Cross domain Interoperability

As far as the International Telecommunication Union is concerned, IoT has been defined in Recommendation ITU-T Y.2060 (06/2012) as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

The Global Standards Initiative on IoT (IoT-GSI) concluded its activities in July 2015 following TSAG decision to establish the new Study Group 20 on "IoT and its applications including smart cities and communities". All activities ongoing in the IoT-GSI were transferred to the SG20. Currently oneM2M is working on its Release 3 which includes semantic interoperability, smart cities and industrial domain enablement. Release 3 builds on top of Release 2 set of specifications, **currently proposed to ITU-T SG20 on IoT for a possible transposition into ITU-T recommendations**. Adoption of oneM2M standards will have a major impact in Africa

5. Standards for future network and cloud in Africa – the FIWARE case

One important aspect for Africa is the capability to have, amongst others, cloud environments with advanced network features. Offering these demanded services by exporting in Africa the success stories of the FIWARE [6] program would be an efficient approach. The European Commission has funded the FIWARE program from 2011 to 2016 as the future network flagship project with the objective to develop an open platform facilitating application development in the fields of big data, IoT and Cloud.

Such a platform should be able to collect information from different sources such as IoT networks, open data, user data, … and store them in a standard model in order to be easily used by application developers. For that reason, the first idea was to reuse a well-known data structure standard NGSI coming from OMA (Open Mobile Alliance). This standard was able to support most of the requirements from the different vertical sectors supported by FIWARE (Smart City, Smart Agri and Smart Industry). The platform provides enhanced OpenStack-based Cloud capabilities and a set of tools and libraries known as Generic Enablers (GEs) with public and open-source specifications and interfaces. These FIWARE GEs are distributed in different technical chapters and provide different capacities. For example, the IoT chapter provides tools to connect sensors and other devices; while the applications' chapter offers powerful business intelligence tools and for the development of interfaces; or as the chapter for Advanced Interfaces allows to implement functionalities related to virtual reality, augmented reality or 3D.

Among other initiatives to adopt FIWARE as Smart City platform, more than 100 cities from European countries (but also outside Europe) are belonging to the "Open & Agile Smart Cities" initiative which is based on four main strategic elements: (1) adopting common APIS accessing data from cities through NGSI, (2) adopting a common platform for the publication of data such as CKAN, (3) working on a driven-by-implementation basis and on building applications allowing to reuse and (4) improve and define data models for different vertical markets in cities and to prove the interoperability in a city and among different cities. To that purpose, existing initiatives and models like **CitySDK** will be used.

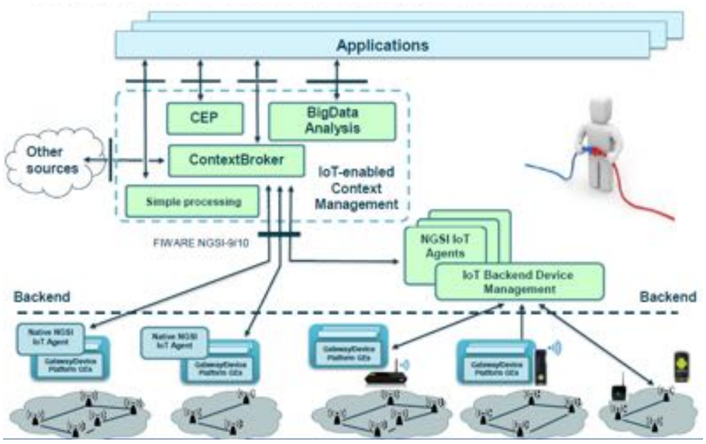

Figure 4:Fiware IoT& context management altogether

In order to extend the capacity of the data structure and also to align with other existing standards in this area, ETSI has created of a new Industry Specification Group on cross-sector Context Information Management (ISG CIM) [7] for IoT-enabled applications. The group will focus its activities on developing the specifications for a common CIM API, Data Publication platforms and standard Data Models, in order to achieve and improve cross-sector interoperability for smart applications, with FIWARE NGSI as starting point.

With regards to the success in Europe, some partners who have business outside Europe took the opportunity to use such an open solution in countries outside Europe (Latin America, North America, Asia, India and Africa). Orange is leading the initiative in Africa because the number of countries operated. The most advance case is **Senegal where a FIWARE Lab is already operational** and used for pilots in the domain of Smart Agriculture using LoRa IoT networks. Last but not least, initiatives also exist in Ivory Coast, Morocco, Tunisia, Egypt, Ghana, etc. where platforms and pilots are being investigated. **In Senegal, a FIWARE platform is already running** and open to support applications from European startups to showcase capacity of the solution but also from African developers. In order to do so, an accelerator able to support developer is being setup together with the European Commission. It has the following objectives:

1. Collect local information in order to feed the FIWARE database in partnership with the UCAD university,
2. Organise call for proposals inviting developers to submit innovative service propositions that could take advantage of the FIWARE technology in the Senegal priority domains (Agriculture, Environment including cities),

3. Fund and incubate a number of these ideas in order to put on the market useful services for citizens.

The idea is to replicate such a methodology in other African and Mediterranean countries in order to help service development in the domains of Smart Environment/Smarty city and Smart Agriculture, there are already initiatives in Morocco, Tunisia, Egypt and Cote d'Ivoire. Worth to say that a study of interest based on IST Africa 2015 outputs shown that the following African countries should have interest in IoT, Big Data and cloud looking to their respective research capacities (Botswana, Cameroon, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Tanzania and Uganda)

6. IoT standards for SDGs

IoT is emerging as a powerful enabler in many application domains, such as water and energy management, environmental monitoring, health, smart cities, smart industry and supply chain management. IoT has the potential to address some of the most acute human, economic and environmental needs. It can also directly contribute to reach the objectives of SDGs: emerging IoT paradigm has the potential to create an efficient, effective and secure ecosystem taking advantage of connected devices for managing the major global challenges faced by this, and future generations. In this context, at the 7th IoT Week held in Geneva in June 2017, the IoT research and industry community, together with ITU and other stakeholders, took the opportunity to express their support for researching, developing and leveraging IoT technologies for sustainable development and for building a brighter future for our planet and its inhabitants.

Participants of the IoT Week 2017 declared to strive to promote international dialogue and cooperation for innovation in IoT with regard to the following 10 key activities :

1	Promoting the development and adoption of IoT technologies for the benefit of humanity, the environment and sustainable development. This includes promoting the research and the use of IoT technologies to address the 17 Sustainable Development Goals adopted by the United Nations and the international community. Governments and policy-makers from developed and developing countries should be encouraged to examine the future challenges and benefits to their economies and accelerate global competitiveness of their economy, region, continent and people by establishing plans and strategies to leverage IoT for SDGs.
2	Supporting the implementation of the IoT in urban and rural context to foster the application of ICTs in providing services to build smarter and more sustainable cities and communities. This will allow urban and community stakeholders to take advantage of technological advances and offer new opportunities for quality of life for different strata of society, by promoting accessibility to amenities, technologies and services (including social infrastructure, energy, water and healthcare), and by supporting IoT systems and data interoperability.
3	Promoting a broad, vibrant and secure ecosystem for IoT, including support for start-ups and incubators. This includes promoting policies to facilitate research, innovation and development of new solutions and eliminating policies that restrict job creation, hinder economic growth or prevent innovation. It may also include appropriate incentives, and policies to promote IoT deployment, privacy protection and secure data management. This will gradually assist in fostering an IoT data market, which contributes to the consolidation stakeholders.
4	Encouraging the development and implementation of standards that facilitate interoperability among IoT technologies and solutions in order to pave the way to an open and interoperable IoT ecosystem, with cost-effective solutions in line with the vision for an open economy.

5	Adopting new and innovative IoT applications to deal with challenges associated with hunger, water supply, and food security through resource monitoring to cope with the increasing consumption needs of a global population. By leveraging IoT, sensors can detect and monitor water leaks, potential contamination, soil moisture, pollutions, weather conditions, livestock movements, while remotely managing and controlling harvesters and irrigation equipment to improve the quality, quantities, yield rates, cost-effectiveness, energy efficiency and sustainability of agricultural production, including the packaging and transportation of food supplies. IoT can also be used for research and analysis into water-borne diseases and potentially new types of diseases.
6	Galvanizing interest in the use of IoT for risk reduction and climate change mitigation, taking into consideration the diversity and complexity of the Earth's geography and vulnerable populations. The IoT framework has the ability to gather and analyze real-time information for proactive prevention and faster response to deal with toxic wastes and pollutants, disasters and other natural calamities
7	Identifying and supporting the growing trend of using IoT technologies for education and improving the access of disadvantaged and excluded groups to ICT infrastructure by promoting basic ICT literacy, virtual classrooms and interactive vocational training programmes for vulnerable segments of society.
8	Embracing the application and use of IoT for biodiversity conservation and ecological monitoring to protect the natural life and its diversity on land, air and below waters. IoT can help monitor natural ecosystems, as well as sanctuaries, detect threats linked to poaching, overfishing (or illegal fishing) and deforestation and can send alerts in real-time to authorities for immediate response.
9	Contributing to global research and discussions on IoT for smart and sustainable cities through global initiatives such as United for Smart Sustainable Cities (U4SSC). ICT-based transformative action for sustainable urban development can help highlight efficient, transparent, and equitable regulatory frameworks, inclusive planning systems, effective financial management with increased transparency and accountability to all inhabitants and urban stakeholders alike, which should help accelerate the transition to smart sustainable cities and communities.
10	Promoting international dialogue and cooperation on the IoT for sustainable development by bringing the various stakeholders together, including inter alia the academic and research community, the specialized international organizations and fora, the industry, SMEs and start-ups, the governments and public authorities (including smart cities), and other relevant stakeholders such as specialized NGOs and indigenous peoples

7. Conclusions

As reported in [8] "..*Africa is the cockpit of change in terms of the global digital transformation. Internet users have gone from a few thousand to millions over the past decade*". IoT is also seen as a major driver for Africa [9] and in that context it is important to ensure smooth adoption of IoT standards in Africa. On the basis of the previous section we recommend that :

1- IoT standards in particular from ITU and oneM2M should be promoted also in view of addressing Sustainable Development goals
2- SDRs technologies such as long range, low energy like LORA in unlicensed radio band should be promoted in Africa
3- Open platform with open source generic enablers such as FIWARE should be promoted in Africa to replicate EU success stories in stimulating innovations and creating of new SMEs and start-ups.

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