# Into the Internet of Things Era: the African Context

**Riad Hartani, Frank Rayal, Ananda Sen Gupta and Rolf Lumpe** look at the changing data management dynamics driven by the IoT evolution across industry verticals. They analyse the most significant trends and considerations that are likely to shape the emerging services and business models and how these have an impact on the African eco-system

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**AS** we progressively evolve towards the Internet of Things (IoT) era, various industry verticals are likely to see disruptive transformations, with a direct impact on their underlying business models, enabling technologies and competitive environments. At the same time, this is opening up new opportunities for new ways of delivering novel digital services. The African context, with its own set of diverse specificities, forms an ideal setting for leveraging such advancements, with potentially profound socio-economic impacts.

➲ **Devices:** Sensors, identifiers and gateways are types of IoT devices used to collect and convey information. Devices are designed and deployed to meet the application use case requirements. They can range from simple identifiers that provide specific information on the object, or more complex devices that have the ability to measure (sensors) and process data (gateways). A variety of IoT devices have emerged in various business verticals, with the utility / energy business being some of the precursors and more recently, devices in the health, transportation, home and finance eco-systems.

➲ **Connectivity:** Devices can be connected to the network directly or indirectly through another similar device (mesh) or a gateway that is provisioned to support multiple devices. Connectivity can be through a number of physical media such as copper, fibre optical cable or over the air through a number of wireless technologies. Examples of connectivity would include the traditional 2.5/3/4G networks, as well as various local area solutions (zigbee, Wi-Fi, etc.) and low power wide area solutions (weightless protocols, etc.) among others.

➲ **Applications:** These define the use case of the device and include all the necessary functions required to make use of the device for the intended purpose including the hardware and software architectures. IoT application stores are emerging with applicability to specific industry verticals, with the health wearable devices being a recent example. Platforms: devices and connectivity requires a platform to provide a service. Platforms are used to provision devices, manage and control them. They are used for billing and fraud detection.

➲ **Services:** This primarily refers to the IoT service to the end-customer. The service provider leverages all the downstream elements in this value chain: platforms, applications, connectivity and devices. Examples would include automotive automated diagnostic, medical geriatrics and remote power consumption optimisation.

## ➲ IoT: Fundamental Observations and Nascent Opportunities

Africa, although very diverse in terms of digital infrastructure, levels of development and economic needs, shares three common themes across most of its countries: (a) the requirement for an aggressive cost structure efficiency to make the deployment on novel technologies a viable and sustainable business over time and (b) the relatively little legacy in terms of infrastructure and applications, that makes it ideal for the rollout of new technologies with little backward compatibility constraints and finally (c) a significant portion of the population with little access to various mainstream digital services that leads to a more urgent adoption of new services innovations, versus what we would likely find in more developed regions of the world where such innovations would be a substitution to existing services. Examples include the recent successful adoption of Internet payment/banking and mobile health models.

The development of the IoT eco-system has been progressive and will continue evolving over the next decade and beyond. Some of the most relevant considerations are highlighted, with a specific focus on ways of leveraging them in an African context, with its specific emerged and emerging economies constituents.

➲ **Proliferation of connectivity standards:** Connectivity standards can be divided into different categories depending on fundamental characteristics. We consider three categories: Spectrum requirements (for wireless connectivity; devices can be connected through wireline technologies); and range, power and cost, which are highly correlated. 3GPP standards such as GPRS, UMTS and LTE are licensed band access schemes that rely on high power for long range, consequently are relatively expensive in comparison with other connectivity techniques.

On the other hand, technologies such as Bluetooth are meant for short-range communications in unlicensed spectrum and are low on power consumption. Various LPWA proprietary solutions have also recently emerged, mostly in unlicensed sub-1GHz spectrum but also in some licensed bands. Wi-Fi relies on higher power and provides longer range than Bluetooth albeit at a higher cost. The policy and regulatory environment in the various African countries, shall consider such developments to facilitate the rollout of new connectivity models that would speed up the rollout of IoT networks.

➲ **Commoditisation of devices:** Devices and connectivity continue to march on a downward slope of cost reduction (Figure 1).

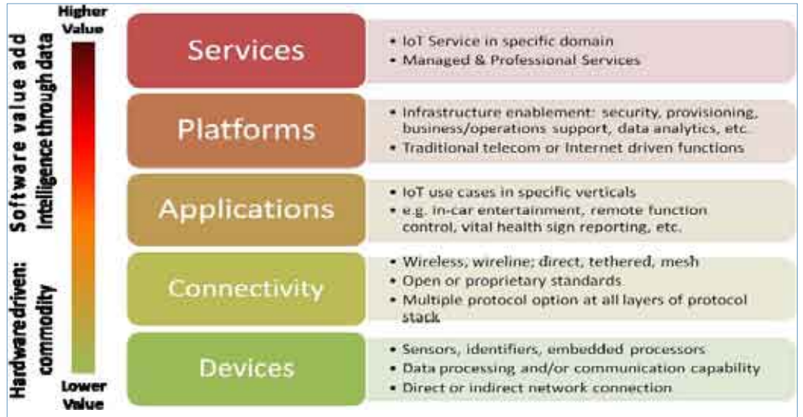


Figure1. IoT ecosystem reference model

| | Xiaomi Mi Band | Fitbit Flex | Jawbone Up |
|---|---|---|---|
| Steps taken | ✓ | ✓ | ✓ |
| Calories burned | ✓ | ✓ | ✓ |
| Distance traveled | ✓ | ✓ | ✓ |
| Active time | ✓ | ✓ | ✓ |
| Sleep time | ✓ | ✓ | ✓ |
| Sleep quality | ✓ | ✓ | ✓ |
| Map routes | | ✓ | |
| Average pace | | ✓ | |
| 3rd party apps | | ✓ | ✓ |
| Diet tracker | | | ✓ |
| Waterproof | ✓ | ✓ | ✓ |
| Bluetooth | ✓ | ✓ | |
| Social sharing | ✓ | ✓ | ✓ |
| Alarm | ✓ | ✓ | ✓ |
| Notifications | | | ✓ |
| Indicator lights | ✓ | ✓ | ✓ |
| Price | $13 | $99 | $79 |

Figure 2. Device commoditisation

This is essential to enable the business case for IoT applications. The challenge to device manufacturers is how to differentiate from competition. Our observation in this space is that software applications and platforms, including operating systems, are the essential leverage used by device manufacturers to differentiate (e.g. Apple/iOS, Google/Android; Samsung attempt at differentiating through Tizen, and in a similar way with Alibaba and XiaMi's own platforms design). Such commoditisation, leading to lower cost structure, shall enable new business models with long term viability in areas such as health, finance and education, all of which having significant socio-economic impacts in the emerging world.

➲ **Commoditisation of connectivity:** Low-cost connectivity is essential to enable the business case of most applications. There are many variants of connectivity including wireline and wireless technologies. The lowest cost wireless connectivity leverages license-exempt spectrum over short distance (Figure 3). Wearables, for example, leverage Bluetooth to connect with smartphones. Alternatively, some consumer devices rely on longer-range licence-exempt technologies such as Wi-Fi for greater range. Central hubs for connectivity and routing are deployed to tether over longer distances for remote control and monitoring. Where mobility is required, wireless technologies in licensed spectrum can be implemented albeit at a higher cost. Such connectivity commoditization, shall allow the deployment of new Internet broadband architectures and service models in the emerging world, with a direct implications on applications running on top.

➲ **Emergence of long-range low power wireless technologies:** We see an opportunity for very long range wireless technologies that are low power, low cost and work over long range (Figure 4). Such technologies are now on the market but are yet to prove their commercial viability. These technologies often assume the build out of a parallel IoT network to the mobile network. The IoT network is operated as a private network on a subscription model of per device/message basis for low fixed cost pricing. In specific industries such as energy, utilities, logistics and transportation, such developments shall lead to the rollout of new services with clear economic benefits.

➲ **Partnerships and alliances to win the IoT platform war:** The development of IoT solutions is inherently about the development of ecosystems around offered solutions. Such ecosystems are built via tight and lose partnerships between the various industry players. The leading players will aim at controlling the ecosystem by providing a platform that would host IoT applications, and over which IoT services will be built (Figure 5). As in any platform model, such as those in smartphones and the Internet, the key is to increase the adoption of the platform. Various models are being put in place to achieve this, via the development of open source IoT con-

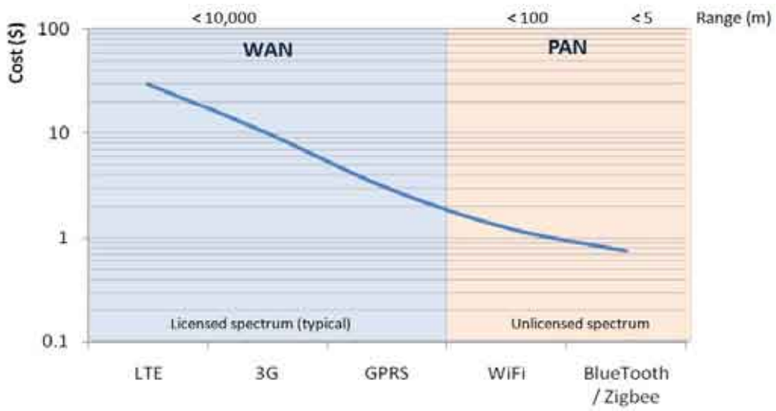


Figure 3. Commoditisation of wireless technologies

nectivity and interworking software, open APIs to plug into the platforms, and SDKs to develop services on top of the platform.

Various contenders are already in the game to achieve the control of IoT platforms, including the Internet platform players (Google, Apple, Amazon, etc.), the lead industrial players with a specific vertical focus (e.g. GE for industrial Internet), and to some extent certain mobile operators with a strategy towards Internet-scale OTT deployment. This opens up the opportunity to develop optimized platforms that would be best suited for the device and applications required for the African eco-system.

➲ **Emergence of new MNO and MVNO/OTT service models:** A key dynamic of the IoT market that needs to be highlighted is that the majority of 'value' in any IoT application lies not in the simple carriage of data, but in the provision of an overall service. For example, a wide-area wireless enabled home security system represents a significant revenue opportunity for a mobile or virtual mobile operator, including revenues from device sale, installation, and monthly service fees. However, the data traffic revenue that such a solution generates is likely to be relatively small in comparison.

In a similar fashion, a connected health solution would include the connectivity network as well as the platform to manage the solution, interfacing with the various stakeholders in the health solution value chain. The story is the same for many other IoT applications: the real opportunity for mobile operators lie in moving up the value stack and away from the simple provision of data carriage services. The mobile network operator has to provide the connectivity and IoT management for value added. IoT solution provider (either over-the-top IoT service provider or mobile service provider who offers IoT solutions) has to integrate all the components of the ecosystem for the end-to-end IoT solution. MVNO and OTT models, with the right cost structure would likely emerge to tackle specific services needs in the emerging world.

➲ **Extracting value through data sciences:** As businesses evolve to leverage the huge amounts of data assembled – mining and learning through such data as well as optimising communication between those producing it and those using it brings significant opportunities around IoT business models. As such, the desired goal is to create a solid foundation architecture that is able to provide these optimal functional capabilities and a platform to overlay data science applications. This would include the various layers in the data value chain – optimised processing through an acceleration of migrations to the cloud, scalable data management leveraging big data models and the use of customised data sciences solutions for business intelligence creation. This is complemented by a fundamental re-architecture of IT models within the businesses integrating IoT models.

We are now witnessing the emergence of enhanced (and new in some cases) set of machine learning and data mining algorithms, specifically focused on clustering and predictive modelling in high dimensional spaces based on imprecise, uncertain and incomplete information, efficient statistical data summarisation and features extraction algorithms as well as large-scale real-time data stream management. These tools will be at the core of the processing engines being commercialized or running in open source environment, and will aim, when applied to specific industry problems, at optimizing the existing business logic and augment it with new functionalities over time. Such data science models in IoT environments would form the basis for new solutions and services offering that can only benefit societies in the developing world.

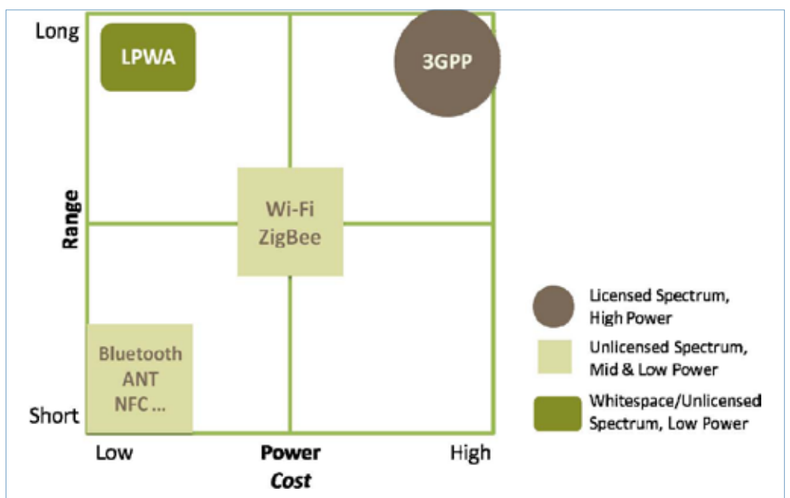


Figure 4. IoT Wireless connectivity

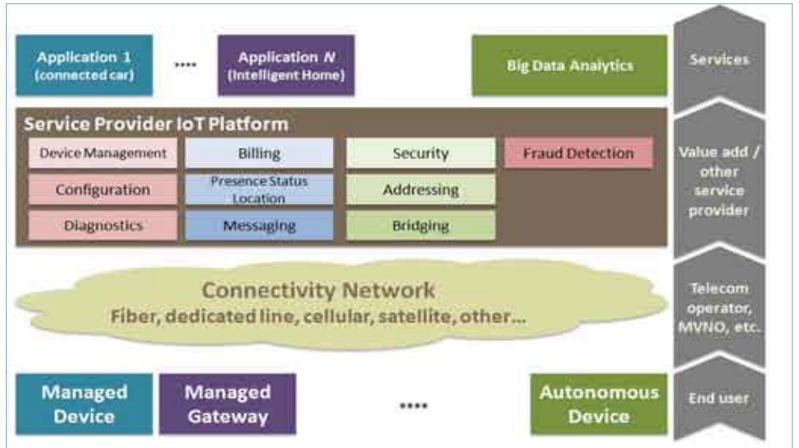


Figure 5. Value appropriation through platforms

## ➲ IoT enabled Innovations – Illustrative Use Cases in an African Context

A large number of digital solutions in various business verticals are seeing an aggressive insertion and leverage of IoT components in their value chain. This includes mobile internet, financial applications, education, energy and healthcare. Some of them are illustrated below, with applications soon to be seen in various eco-systems within Africa.

### a) Financial services

One of the impacts of IoT in financial services is that it will reduce the cost of monitoring a loan in asset-based lending especially machinery/equipment loans and inventory based financing. Asset based loans typically cost more than traditional loans and sometimes include additional audit and due diligence fees. With proper agreements and understanding between the lender and loan recipient, IoT can monitor the functional characteristics of the equipment or provide tracking of inventory. This can not only reduce the cost of monitoring for the bank but would reduce the overall risk and provide advance warnings on cash flow issues that may lead to default, triggering for instance proactive collection attempts.

Loan recipients can be incentivized with lower rates and fees to allow for opting into IoT sensors on their equipment. This is similar to what is in use today in some personal auto loans, where an IoT can assist (thereby reducing the cost) in the repossession of an automobile after a default. In auto-insurance, IoT can provide more valuable driving performance information that insurance companies can use to provide discounts to drivers.

### b) Industrial internet

Data associated with industrial Internet that is, data created by Industrial equipment such as wind turbines, jet engines, and MRI machines – holds more potential business value on a size-adjusted basis than other types of Big Data associated with social web, and consumer internet. The typical use cases of IoT in the Industrial Internet are to collect equipment performance data as part of Asset performance management. This data can be organized in the Cloud and analysed for insights that can predict breakdowns and other kinds of occurrences. Industrial companies can boost productivities of their operations and equipment by up to 30 per cent by introducing IoT and Big Data based analytics to monitor and manage their assets. Recent examples include the rollout of smart meters and sensors in water utility businesses on their various operational assets (pipes, treatment facilities), with analytics leveraged to predict critical situations such as leaks and adverse weather events. The water utility expects to save on scheduled repair and overall maintenance cost, allowing a superior business case for scalable rollouts.

### c) Health Care

Health care probably has the biggest applications of IoT. From remote tracking of patients to predict onset of acute symptoms to streamlining patients' flow through emergency department in the hospital, there are numerous applications of IoT supported by Big Data analytics. For example, sensors that snap on to an Asthma inhaler and users can voluntarily opt-in to track when and where they use their inhalers. The data collected is analysed and presented back to the Asthma patients through a mobile app to better understand triggers like pollen counts that may affect their symptoms.

The overall benefit potential is huge with early studies reducing the number of people with uncontrolled Asthma by about 50 per cent. The potential of such solutions to reduce overall health care costs is huge. Another example is an ingestible sensor that can be swallowed. An example would be a pill that gets energy by reacting to stomach acids and transmits useful information to a mobile phone through a patch worn on the body. All in all, the Internet of Things era has had various false starts, as far as mass adoption and progression to mainstream.

The recent convergence of various trends including innovation in low power and low cost devices technologies, scalable network connectivity as well as mainstream cloud and big data processing models, have opened a new window for the emergence of IoT based value add services. A specific focus on ways of taking advantage of this IoT evolution in an African context, with its specific emerged and emerging economies is analysed in this paper. It is illustrated via various real world scenarios in the areas of health, finance and logistics.

We believe that this evolution will provide the appropriate framework for new services creation, which will increase in strategic importance and becomes a major component of business competitiveness and socio-economic development moving forward.

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● ***This article is exclusive to us.***