2017

Initial Report on IoT Use Cases

IoT Egypt Forum

Initial Report on IoT Use cases - Phase 1

Revision History

Date	Version	Description	Authors
August , 2018	<0.1>	Phase 1 of the report	**IoT Use cases WG – Round 1 (July-December 2017)** • Ayman AbuSehly (Chair), *ZAS soft* • Mahmoud El Sayed Abdel Moniem (Co-chair),*ISKRAEMECO* • Ahmed Abdallah (Facilitator), *SECC* • Yasser El-Zoghby, *ALFA ELECTRONICS* • Ayman Farouk, *SEE* • Ahmad Hafez, *Telecom Egypt* • Maha Diwan, *Arab Academy for Science and Technology* • Mohamed Maher, *Sadeem* • Mohamed Gohar, *Teradata* • Mohamed Farouk, *inventa Electronics* • Mohamed Abu Baker, *Raya Integration*

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1. EXCUTIVE SUMMARY

Enterprises across the world are actively seeking to unlock the value out of their big data. Many solutions are available in the market today to facilitate them begin their journey towards Digital Transformation. Enterprises may create new revenue streams, optimize business models and accordingly decrease cost and increase efficiency by adopting IoT based solutions tailored for their specific use.

Looking into IoT ready-made solutions is not the optimal application of IoT technology. Instead, having a solution for a problem in place is the optimum way. Problems like reducing street lights without compromising on safety, real-time tracking of shipments not only location but environmental conditions like temperature and packaging material as well as monitor and optimize utilities consumption. Many industries worldwide have successfully utilized IoT to solve problems namely, energy, manufacturing, transportation, and logistics.

In this report three use cases, specifically in logistics, utility management and transportation sectors are tackled with examples in each sector. Enterprises looking to maximize the value out of their data and reap benefits are strongly recommended to apply these use cases wherever appropriate for their initial IoT deployments.

2. INTRODUCTION

Today, enterprises have huge data generated on daily basis. Enterprises can make use of their data in several applications e.g. enhance customer experience, increase work efficiency, remediate risks, or create new revenue streams. However, it is significantly complicated to acquire, reformat, aggregate, and analyze the data and then acting upon and generate useful information in an existing enterprise. To resolve these complications, Information Technology (IT) and Operations Technology (OT) functions must join forces together.

Traditionally, in enterprises, IT and OT functions were totally separate worlds. IT supported marketing, sales, procurement, human resources. decision support functions, and management with networking, infrastructure, platforms and software solutions to do their jobs. On the other hand, OT was concerned with equipment and software solutions which run and control manufacturing systems, production processes, research and development.

Consequently, OT solutions become separate “islands of automation” since data generated from sensors are usually collected and applied to make decisions. Furthermore, many OT applications are, by nature, real-time, mission critical, or specific and in case system crash there might be major consequences. OT networks usually store and analyze data at the machine level and usually are not networked with any other enterprise systems and never leave the premises. Accordingly, IT systems have limited (or no) access to most of OT systems, networks, and applications.

Today, there is an opportunity for enterprises to adopt Digital Transformation technologies to extend computation, storage, and data analysis beyond their machines and premises. Consequently, enterprises can maximize benefits. This is applicable in the oil field, the manufacturing plant, the gateway, and even all the way to the device sensor.

With the integration of OT and IT environments, enterprises can utilize data generated from OT and maximize its potential. Data analysis can be realized via new architectures where it will have the most beneficial and timely impact on the systems. “Fog Computing” or the extension of cloud computing to the “edge” of the enterprise network specifically putting data analytics closer to the actual devices and sensors. Eventually, it is essential for these new resources to be secured, manageable, scalabile, and most importantly, cost effective.

It’s essential for IT and OT functions to cooperate in order to maximize utilization of enterprise data for the best benefit of the enterprise. IT must enable infrastructure, security, and storage closer to OT equipment and devices, including ruggedized equipment for harsher environments. While OT must find a mean to generate, analyze, and relocate data where it can maximize business value whether the device, the fog, or the cloud. There should be a governance framework to manage roles and responsibilities between IT and OT and to assure smooth flow of data.

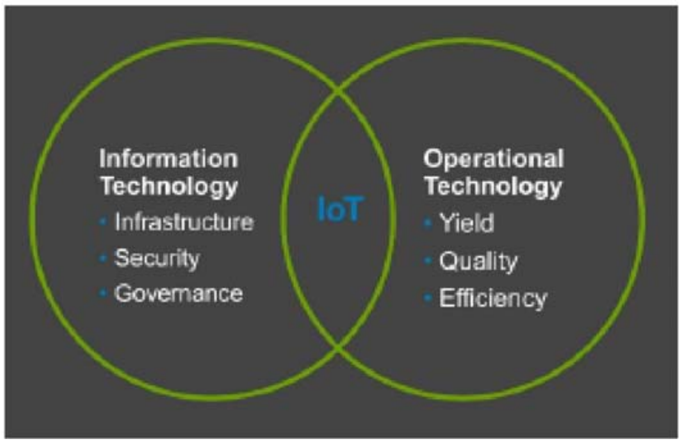

Figure 1 IoT technology [6]

Figure 2 IoT deployment [6]

3. VISION

3.1. IOT FORUM VISION

Position Egypt among top leaders in adopting and leveraging IoT technology and solutions for the overall well-being of citizens as well as boost economic growth.

3.2. MISSION

IoT forum aims at being the center of expertise of IoT technology and solutions in all fields that can serve the Egyptian economy. The forum aims also at keeping all members updated with the latest technologies in this regard.

3.3. METHODOLOGY

To achieve the forum's vision, the following methodology is adopted.

- Raise awareness of IoT use cases via different IT society channels.
- Attract new members to the forum. Members are selected based on experience.
- Regular meetings and discussions to elect the suitable use cases based on Egypt's 2030 vision, fast turn over, existing need, and society development as an election criterion.
- Following this IOT use cases are ranked and top ranked cases are selected.
- Form sub-groups of expertise to study elected use cases from different perspectives including applicability and economies of use.
- Present the use cases to stakeholders and agree on steps forward.

3.4. STRATIGIC GOALS

The forum has three main strategic goals, namely

- Innovation
- Partnership
- Member expertise

4. SMART LOGISTICS

Traditionally, factories, plants, warehouses, as well as logistics providers have been using automation and smart solutions to maximize efficiency and production levels. Yet, there will always be disruptions which promise to improve efficiency, safety, and change manufacturing and logistics forever. The two industries are constantly utilize automation more than many others. To be more specific, device connectivity and machine to machine (M2M) communication are operating via an INTRANET of Things not Internet of Things. The main reason for this is security. Manufacturing and logistics organizations are very concerned about hacking, malware, and other information theft. Consequently, they adopt an internal network unconnected to the Internet as the standard communication protocol. This will eventually change via IoT. IoT-enabled warehouses and factories will enhance security, safety, and efficiency which will eventually decrease the cargo time and consequently improve logistics efficiency as well.

Siegfried Dais, the deputy chairman of the board of management at Robert Bosch GmbH since 2004 and a limited partner at Robert Bosch Industrietreuhand KG since 2007, speaking about technology-driven changes that promise to trigger a new industrial revolution with others said *"Given the Internet of Things or Industry 4.0 as we call it when referring to manufacturing production it is highly likely that the world of production will become more and more networked until everything is interlinked with everything else. And logistics could be at the forefront of this shift"*.

Overall, IoT will result in growing the logistics and supplier network significantly complicated. Despite that lean manufacturing reduce inventories, manufacturers will certainly have to coordinate with more and more suppliers often globally, and with longer transport times, more manufacturing steps, and significantly more parties.

4.1. OVERVIEW

Improving efficiency can save shipment companies millions of dollars a year. With the introduction of connected devices as part of their supply chain, shipment companies can significantly improve operations.

In this case, we study how IoT can improve operations via fleet management, traffic management, asset tracking, and electronic toll collection.

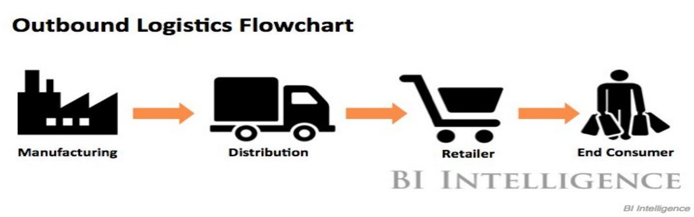

Figure 3Outbound logistics flowchart [9]

4.1.1. THE CHALLENGE

In case of traffic management, not knowing the state of current traffic control center is a major challenge which may require investment to upgrade or adopt a new state of art suite that has the capability to monitor and control traffic.

For asset tracking, several technologies can be adopted which results in several benefits. However, it's essential to investigate major challenges involved in asset tracking solutions for different industries and the best practices utilized to overcome these challenges.

Worldwide, North America is leading the market of **electronic toll collection**. The need for an effective transportation system in North America countries is mainly due to the extensive usage of four-wheelers and heavy vehicles. In APAC, as a result of the growing population and the need to have efficient transportation systems, several governmental initiatives rely on electronic toll collection systems. Consequently, APAC region is forecasted to have the highest 5-years CAGR to 2022. In India, the government has adopted several to promote electronic toll collection systems.

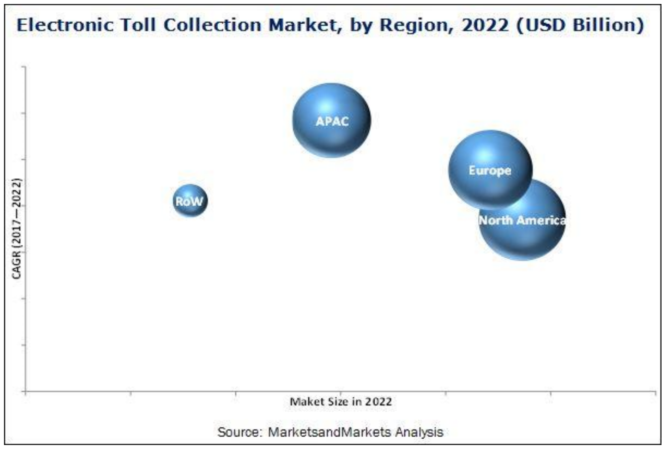

Figure 4 Electronic toll market by region [12]

The major service providers of electronic toll collection solutions are 3M (US), Xerox Corporation (US), EFKON AG (Austria), Kapsch TrafficCom (Austria), Q-Free (Norway), and Cubic Transportation Systems, Inc. (US), among others. To cater for the growing demand of electronic toll collection solutions, service providers have adopted various strategies and business models such as contracts, partnerships, continuous product launches as well as business expansions strategies.

4.1.2. OBJECTIVES

To drive adoption of smart logistics solutions, two main objectives must be fulfilled. First, recognize the change potential as opposed to the required investment. The value creation and cost reduction targets that can be achieved depending on these new systems. Supply chain and logistics enterprises often rely on traditional solutions, but, with an old mind-set and accordingly, they fail to exploit the advancements solutions were designed to offer. Second objective is to design a system with a robust algorithm and a user-friendly interface so that customers who use the system heavily and on a daily base can immediately locate problems and react to immediately without getting lost in a complex web of interdependencies.

4.2. HIGH LEVEL DEFINITION

Logistic enterprises often invest in solutions that can better manage their prime assets including vehicle fleets. Fleet management investments are optimizing commercial vehicles operation and leveraging analytics to increase efficiency.

One of the major service providers in the field of fleet-management systems is Verizon. Verizon is actively building its portfolio of fleet management solutions. In

2016 and in order to take the lead in the North American market, Verizon spent billions of US dollars to purchase two fleet-management leaders. The growing market has pushed Verizon and other major players to aggressively make big plays to guarantee big share of the market.

Figure 5 Example deployment [9]

Supply chain and logistics operators are most interested in asset tracking technologies because of the anticipated significant value that might be created from adopting new relevant technologies. Significant savings can be achieved at almost every stage of the value chain including packaging, extraction, storage, transportation, and delivery to the customer. It may also result in new revenue streams because of insights generated from the data collected and analyzed along the value chain. Tags and sensors accompanied goods can generate real time data about location whether in warehouse or in transit as well as physical conditions of shipments such as temperature, pressure, or potential damage. However, if companies don't implement relevant organizational changes and other technologies that can take instant action of real-time tracking data, companies will not gain the potential benefits and savings out of these technologies.

World Health Organization (U.S.) has recently reported that about 1.2 million people are killed in road accidents every year, and about 50 million people are injured. **Electronic toll collection** is one of the solutions of traffic management. It is a cashless tolling system which can efficiently manage the traffic on highly congested areas on highways and in urban areas. It also facilitates the tolling collection process reduces the chance of accidents near toll booths. Electronic toll collection systems relies on the latest technological solutions, such as the RFID, GPS/GNSS technology, DSRC, and video analytics. Consequently, it significantly reduces the delays on toll roads by providing an easy and quick access for vehicle drivers to pass through the tolls. The advanced toll collection systems are based on the latest technologies and help eliminate congestions on highways and in urban areas. Governments in many countries have put standards and regulations for the electronic toll collection system market.

Figure 6 Toll gate [11]

Many countries worldwide have adopted electronic toll collection systems. One of the tolling systems used on highways is open road tolling which doesn't employ toll booths. Open road tolling enables users to drive vehicles at their speeds, without having to stop at a toll booth.

Figure 7 Automatic toll lane [11]

Due to the large number of congested highways in some cities worldwide raises the need for efficient traffic management solutions which in turn, drives the growth of this market. In 2016, the largest market share of electronic toll systems was attributed to highway related applications due to the traffic congestion is often more on highways.

The ecosystem of electronic toll collection includes the suppliers and manufacturers of equipment and technology, system integrators, and operators. Equipment manufacturers worldwide include Xerox Corporation, 3M, Cubic Transportation Systems, Inc., Raytheon Company, The Revenue Markets Inc., Perceptics, LLC, TransCore in US, Q-Free in Norway, Siemens AG and Toll Collect GmbH in Germany, Thales Group and Schneider Electric SE in France, Transurban Limited in Australia, International Road Dynamics, Inc. in Canada, Far Eastern Electronic Toll Collection Co., Ltd. In Taiwan, and Xiamen Innov Information Technology Co., Ltd. In China. While software solution providers include Xerox Corporation (US), VaaaN (India), TransCore, LP (US), and GeoToll, Inc. (US). System integrators include Bangna Phaisan Co., Ltd. In Thailand, IBI Group in Canada, EFKON AG and Kapsch TrafficCom in Austria, and VaaaN in India.

The electronic toll collection market worldwide is expected to grow at a CAGR of 9.16% between 2017 and 2022 and to be valued at USD 10.57 Billion by 2022. This growth is mainly attributed to the increasing demand for electronic toll collection solutions driven by the need for efficient traffic management, toll collection, as well as accident prevention solutions.

4.2.1. Application Level Use Case Diagram

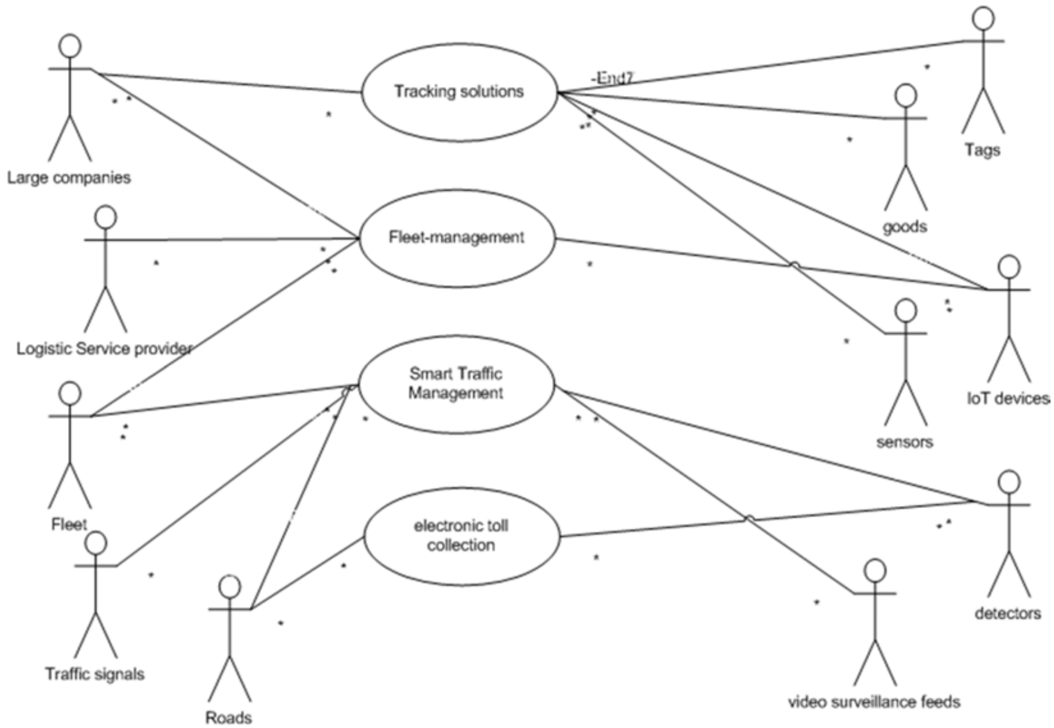

Figure 8 Use case diagram [9]

4.2.2. Actors

There are many actors involved in this case including traffic signals, fleet, roads, video surveillance feeds, detectors, sensors, tags, IoT devices, goods, companies, as well as Logs.

4.2.3. Subsystems

Systems involved are tracking, fleet management, smart traffic management, and electronic toll collection solutions.

4.2.4 Business Model Canvas

Key partners	**Key activities**	**Value Proposition**	**Customer Relationship**	**Customers Segments**

·External and Domestics goods ports ·National Logistic Warehouses ·Ministry of Interior (Traffic management) ·Financial Institutes (Payment Gateways) ·Commodity Exchanges ·IT & IoT Solution Providers ·Ministry of Communication and Information Technology ·Ministry of Supply ·Ministry Trade ·NTRA ·Media	·Install Sensors networks ·Install Tracking Devices ·Install Payment Gateways ·Design Data Security Plans ·Design & build MDM & Data Hubs ·Design & Build National Knowledge Hubs for analytics ·Integration with Current Stakeholders Enterprise systems	·Real time monitoring of Goods and Materials nationally ·National Supply planning ·Market Costing and Pricing strategy building Tool ·Risk Management Tool according to differ (place/time) events	·National Governmental Monitoring and Planning tool ·Official Data Source for Traders, media, ·Information Sources for Manufacturers ·Billing and Payment Inclusion utility	·Importers ·Exporters ·Mentioned Ministries ·Transportation Companies & Authorities
	Key Resources		**Channels**	
	·Smart Sensors networks in national ports and Logistics Centers ·Vehicle Tracking Solutions ·Ministries information systems ·Commodity Exchanges		·Command Control Centers ·Social Media ·Web portal & Mobile apps ·Media ·Call Centers	

Cost Structure	**Revenue**
IoT network s Cost (Sensors, Communications, Legalities, …) ·IT & analytics Platforms cost ·Payment & Billing Platforms cost ·Customers Services solutions cost ·Dissemination & Awareness	·Cost saving from Good Planning ·Data analytics and trade Intelligence Reporting ·B2B service (Opportunities Alerts, Shipment, Payment,) ·Metering and Sensors Device Manufacturing

5. SMART UTILITY MANAGEMENT

5.1. OVERVIEW

Electricity is essential for human development. It enables improvements in almost every aspect of life such as education, health, and commerce which in return enables economic development and advancement.

Electricity losses can cost economies significant losses that can reach to 3-5 percent of developing countries' annual GDP and about 15 percent of all electricity produced in more than 44 developing countries. Electricity stolen is valued to more than 1.5 percent of developing countries' annual GDP.

Worldwide, many factors impact utilities consumption including growing population, population density change, climate change, as well as utilities infrastructure. Aged infrastructure often leads to more system failures such as outages, components malfunction, flooding, and limitations on use. Since many of the norms in the electricity field no longer apply, it becomes more difficult to predict and model the impact of these changes on utilities infrastructure.

Electricity generation, distribution, and consumption are witnessing fast changes at an exponential rate worldwide. Moreover, other supply from wind and solar enters the overall grid at many diverse locations. In addition, the quantity of that supply will vary greatly over days and years. New unusual demands are recently risen such as electric vehicles and heat pumps which mean that the peaks and toughs of power required will become more intense. Utility management of all these demands, sources, and infrastructure in 'traditional' ways would require huge investments to cover major upgrades to the networks, which cannot be afforded, either in monetary or disruption terms. Some organizations are using Solutions like "Distribution System Operation" through which local networks, including LV, can be effectively managed. This is similar to the way transmission networks are managed both regionally and nationally.

Egypt has made a significant advancement in the field of electricity generation as well as management. Electricity generation has reached about 31M electricity meters and is expected to reach ~40M meters before 2030. The Egyptian Electricity Holding Company (EEHC) is aiming at replacing its legacy electro-mechanical meters with smart meters and deploy Advanced Metering Infrastructure (AMI). AMI will help in overcoming challenges with the legacy metering processes to reach a a smart electricity distribution grid.

Billing consumers for their electricity consumption is often the key driver to the financial stability of an energy utility. However, problems related to energy bill collection have resulted in cash flow deficits for energy utilities. Technological advancement has resulted in new drivers for a smarter energy distribution and billing. For example, a M-Bus can be used to record and communicate multi utility metering (e.g. gas and water consumption) through the electricity meter, thus, achieving a centralized smart energy utility.

To protect investment in smart utility solutions and provide a future proof non-monopolized system infrastructure, interoperable communication protocols like IDIS is a key factor in the prospected smart utility. These solutions are proven to benefit both the authority and the end consumers. It will empower the government to have a consolidated overview and insights of utility resources availability, level of consumption, consumption patterns, consumer behavior, and quality of supply among other KPIs. The smart electricity meters, M2M interconnectivity, the availability of local smart metering solution providers and local meter production facilities as well as the continuous improvement in the country's communication services will enable the government to optimize consumption while efficiently manage other stages of the value chain.

5.1.1. The Challenge

There are several challenges facing the utilities generation, consumption, as well as billing and management of the overall value chain.

Technical and non-technical losses in Electricity, Water, and Gas utilities which lead to financial losses. Technical losses in electricity may be the result of grid bad quality, bad loads, etc. Technical losses in water may be the result of old and rusty pipes leading to water leakage or broken pipes. Financial losses result from technical losses can be detected and prevented which may also save lives and prevent substantial resources losses and people injuries (e.g. Gas leakage, worn electrical insulators in substations, etc.). On the other hand, non-technical losses may result from fraud/theft of utilities, untimely collection of the utility bills, unpaid bills, etc. which applies to all utilities.

Another challenge is the lack of knowledge of consumer behavior and utilization patterns for example which may lead to inefficient utilization of energy and water resources. Furthermore, estimated utility bills which don't reflect the actual consumption of the consumer may lead to mistrust of the consumer towards the utility. In addition, lack of solid data insights results from disbursed data which lead to non-accurate demand and revenue forecasts, considerable unplanned outages, subsidization unfairness as well as inefficient utilization of human resource because of the lack of data insights.

Also, loss of control over outages and peak consumption of services may lead to financial loss. In brief, utility companies suffer from poor operational performance as well as financial instability.

5.1.2.Objectives

To overcome the challenges previously discussed, the following objectives must be tackled;

- Automation and efficient utilization of resources and consequently cost reduction.
- Accurate and timely data collection and analysis of electricity, water and gas consumption.
- Capability of post and pre-payment facilities for consumption.
- Business intelligence and analytics for demand-supply of supplied services.
- Energy balancing solutions for electricity services.
- Improve billing and collection services, leveraging more frequent and accurate meter readings transmitted through the AMI System to increase revenues by reducing non-payments and delayed payments, eliminating a high volume of estimated readings. Improved collection capabilities will improve working capital through the reduction of receivable days.
- Fraud and theft detection and control will reduce financial losses.
- Basic peak load management: reduce peak loads during emergencies.
- Advanced load management implementing Time of Use tariffs for electricity and smarter Gas and Water tariffs that reflect actual cost of resources.
- Quality of supply improvement reducing number of outages and their durations.
- Optimize human resources used in operation and maintenance basic activities and focus on skilled resources for smart activities.
- multiple tariff options, outage management improvement, and new services based on consumer behavior will lead to increased customer satisfaction.
- Advanced demand management: reduce peak loads via load control.
- Renewable energy integration: Integrate net metering functionalities.
- Multi-purpose billing services: unify data collection for electricity, water, and gas utilities

5.2. HIGH LEVEL DEFINITION

A smart utility management solution for water, gas, and electricity which is fully automated and combined with data analytics tools must have the following components as illustrated in the hereunder diagram

Figure 9 System basic components

The solution must support capabilities like fair meter production and renewables and micro-generation utilities. It should ensure revenue protection and prevent financial losses as much as possible as well as tools for commissioning operational cost reduction.

Furthermore, the solution must also increase consumer awareness via consumer friendly initiatives which will result in consumer confidence in the utility and accordingly a more rational consumption of energy resources.

Lastly, it should provide capabilities of interoperability and interchangeability of the solution via interoperable communication protocol-stack (like IDIS) which may be required for future proof investment protection.

The roadmap for Smart Utility Management

1. Assess current standards, specifications, regulations, and processes and suggest modifications and additions. This includes:
   - 1.1. Operational processes and procedures for all utilities.
   - 1.2. Technical Specifications and Standardization of meters, communication infrastructure, integration, interoperability, etc.
   - 1.3. Communication policies and regulations.
   - 1.4. Financial KPIs and benchmarking data (current vs. target KPIs).
2. Unified smart utilities entities:
   - 2.1. Establish a communication utilities consortium for Gas, Electricity, water, and other renewable utilities to govern the unified smart utility.
   - 2.2. Unified decision making and implementation authority election/assignment
   - 2.3. Central view over all utilities appointment.
3. Interconnectivity solution:
   - 3.1. Communication hub design and implementation with help of national telecommunication companies.
   - 3.2. Standard communication protocols/channels for data transmission
   - 3.3. Security solutions provisioning.
4. Implementation of a modular utilities management platform:
   - 4.1. Platform initial modules customization
   - 4.2. Operational procedures
   - 4.3. Support center organization
   - 4.4. Demand-side management
5. Modular Integration of additional value-added services
   - 5.1. Payment hubs integrations
   - 5.2. Financial authorities' integration
   - 5.3. Energy and water subsidization

5.2.1. APPLICATION LEVEL USE CASE DIAGRAM

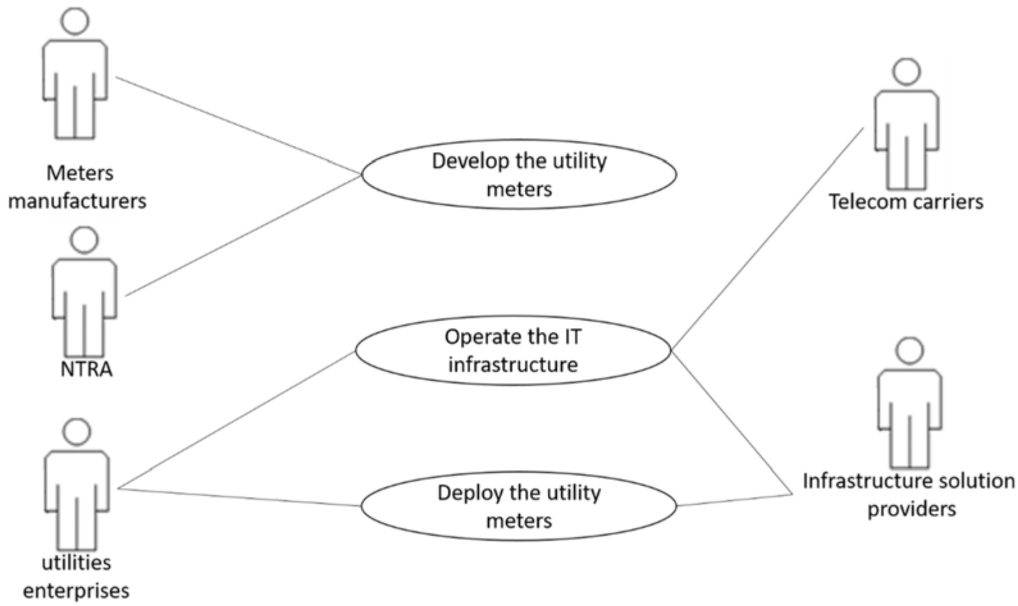

Figure 10 Application usecase diagram

5.2.2. Actors

Actors of a smart utilities management solution include utilities enterprises of gas, water, and energy, manufacturers and solution providers of smart meters, high security authorities, NTRA, telecom carriers and ISPs, as well as IT infrastructure solution providers.

5.2.3. Subsystems

Subsystems include

- Smart Meters and last-mile communication subsystems
- Backhaul communications subsystem
- Headend System
- Meter Data Management System
- Storage and processing infrastructure (physical, virtualized, cloud computing subsystem, disaster recovery, etc.)
- Data Analytics and AI systems
- Enterprise applications ecosystem.

5.2.4. Business Model

<table>
<tr><th>Key Partners</th><th>Key Activities</th><th>Value Proposition</th><th>Customer Relationship</th><th>Customer Segments</th></tr>
<tr><td rowspan="3">• Meters Manufacturers
• IT Solutions Providers
• Telecoms & ISPs
• Banks & Payment Gateways
• Regulatory Authorities</td><td>• Install electricity smart meters infrastructure
• Integrate with Water and Gas Meters
• Build MDM and analytical solution
• Build unified billing system
• Integrate with payment gateways</td><td rowspan="5">Integrated Smart Utility Management

Better utilization of the utilities grid

Integrated Billing and Collection

Better allocation of government subsidies</td><td>• Reactive and proactive actions with the smart utility system (reduce power, fix breakdown, report issues)
• Bill monitoring and payment
• Customized utility profiles and target marketing</td><td rowspan="3">• Home and residential customers
• Commercial customers
• Industrial
• Public utilities and street lighting</td></tr>
<tr><th>Key Resources</th><th>Channels</th></tr>
<tr><td>• Smart meters installation teams
• Technology platform
• Communication platform
• Data Scientists
• Commercial team
• Engineering & Maintenance team
• Customer services team</td><td>• Utility Portal and mobile app
• Social networks
• Call center
• Customer service</td></tr>
<tr><th colspan="2">Cost Structure</th><th colspan="2">Revenue Stream</th></tr>
<tr><td colspan="2">• Smart meters infrastructure building
• Communications costs
• Technology solutions costs
• Customer services and support costs
• Invoicing and billing systems costs</td><td colspan="2">• Installation fees
• Pre-paid and postpaid revenue collection
• Government subsidy
• Cost saving due to better utilization of the grid
• Marketing fees on the online channels</td></tr>
</table>

5.3. SUB-USE CASES

The workgroup has identified a potential set of sub-use-cases with direct benefits to Egypt as illustrated hereunder.

1) Sub-use case 1: Smart utilities meters integration

Having a smart electricity meters will come with further benefits, including but not limited to; the interconnectivity support to sub-utility meters for a unified service point, two-way billing of energy for microgeneration support, the connection to smart appliances, and power quality analysis for a better energy grid as well as more efficient energy supply.

The integration of the smart electricity meter with other meters like that of water and gas at the same service point (apartment, shopping outlet, etc.) is a basic step towards a smart utility. The integration should employ wired and wireless M-bus technology. The wired versus wireless approach should be determined for each deployment area based on the available communication infrastructure, location of the meters, and the distances between them. Data loggers can be used to count the measured units by old mechanical water or gas meters to avoid high costs for the replacement of recently deployed water and gas meters if they are functioning properly; the data loggers will then be connected to the smart electricity meters.

2) Sub-use case 2: Measure and control loss in the utilities distribution

Smart meters will enable measuring and controlling the loss in utilities distribution channels like discovery electricity theft, water leakage, etc.

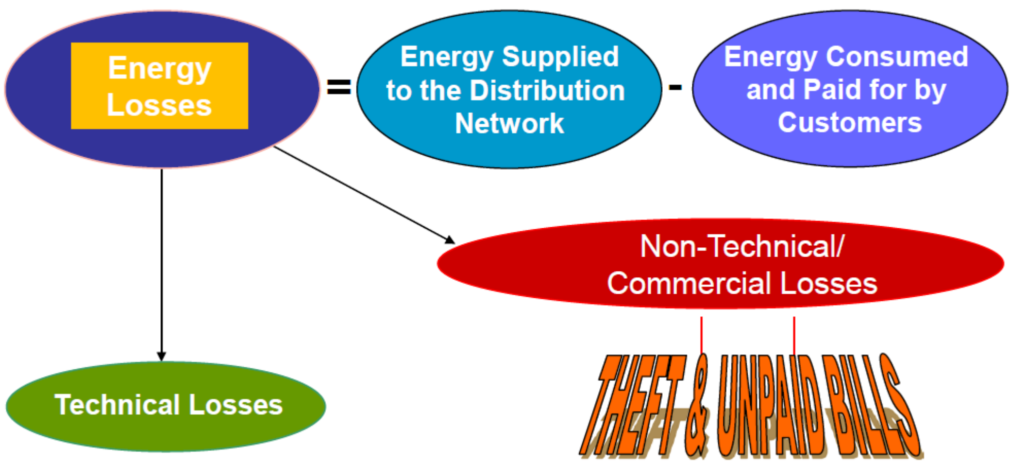

Figure 11 Electricity theft discovery

3) Sub-use case 3: Unify revenue collection method

Interconnected solution will unify the revenue collection method of different utilities through one bill that can be paid via different payment solutions; Internet, ATMs, payment gateways, etc.

4) Sub-use case 4: Smart government subsidies based on analytics

The usage of smart data analytics resulted from smart utility meters will enable the government to better allocate the subsidies to the needed citizens in smarter and fair way.

6. INTELLIGENT TRANSPORTATION SYSTEMS

6.1. OVERVIEW

With the growing population in Egypt, transportation sector currently faces many problems including, but not limited to, crowded roads and buses, shortage of transportation means in some areas and governates. Recent studies show that some of these problems can be solved via IoT technology and big data. Cloud computing can be leveraged to store transportation big data so as to be easily accessible from anywhere for analysis, insights and accordingly rigorous decision making.

6.1.1. THE CHALLENGE

One of the challenges which faces Egypt in adopting IoT is regulations. Laws are not mature enough to deal with big data and IoT technology related applications. There are some restrictions on importing IoT wireless components and we don't have the know-how and experience to manufacture these components locally. Gathering information within the big data framework must be regulated and used wisely and anonymously while respecting people's privacy and security issues. In addition, cybercrimes laws must also be formulated to protect the data in the cloud computing arena.

6.1.2. OBJECTIVES

This use case addresses transportation problems related to highways and railways in Egypt and proposes IoT related solutions for these problems.

6.2. HIGH LEVEL DEFINITION

ITS stands for Intelligent Transportation System which includes land transport (highways, railways, subways, streets, etc.), air transport and maritime transport.

6.2.1. APPLICATION LEVEL USE CASE DIAGRAM FOR RAILWAYS EXAMPLE

The hereunder figure illustrates some of IoT applications in the railways divided into 3 main applications which are the train itself, tracks, and stations.

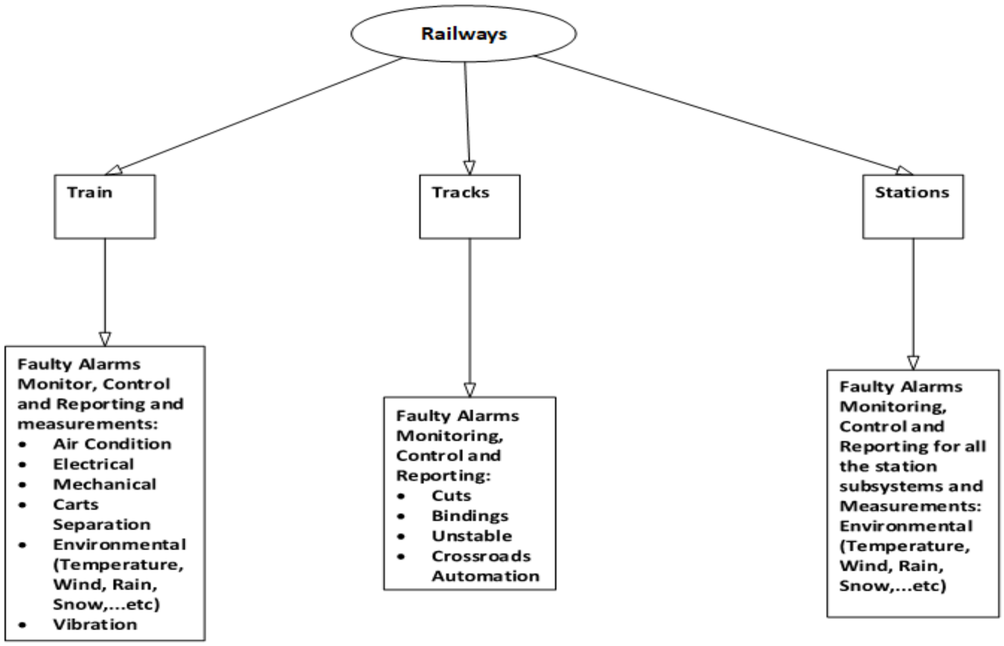

Figure 12 Railways applications

6.2.2. RAILWAY ACTORS

In this case, actors include NTRA, high security authorities, customs, ITU-R, private sector, mobile operators (Telecom Egypt, Vodafone, Orange, Etisalat), ISPs, database developers, data scientists, cloud computing service providers, universities, and public sector.

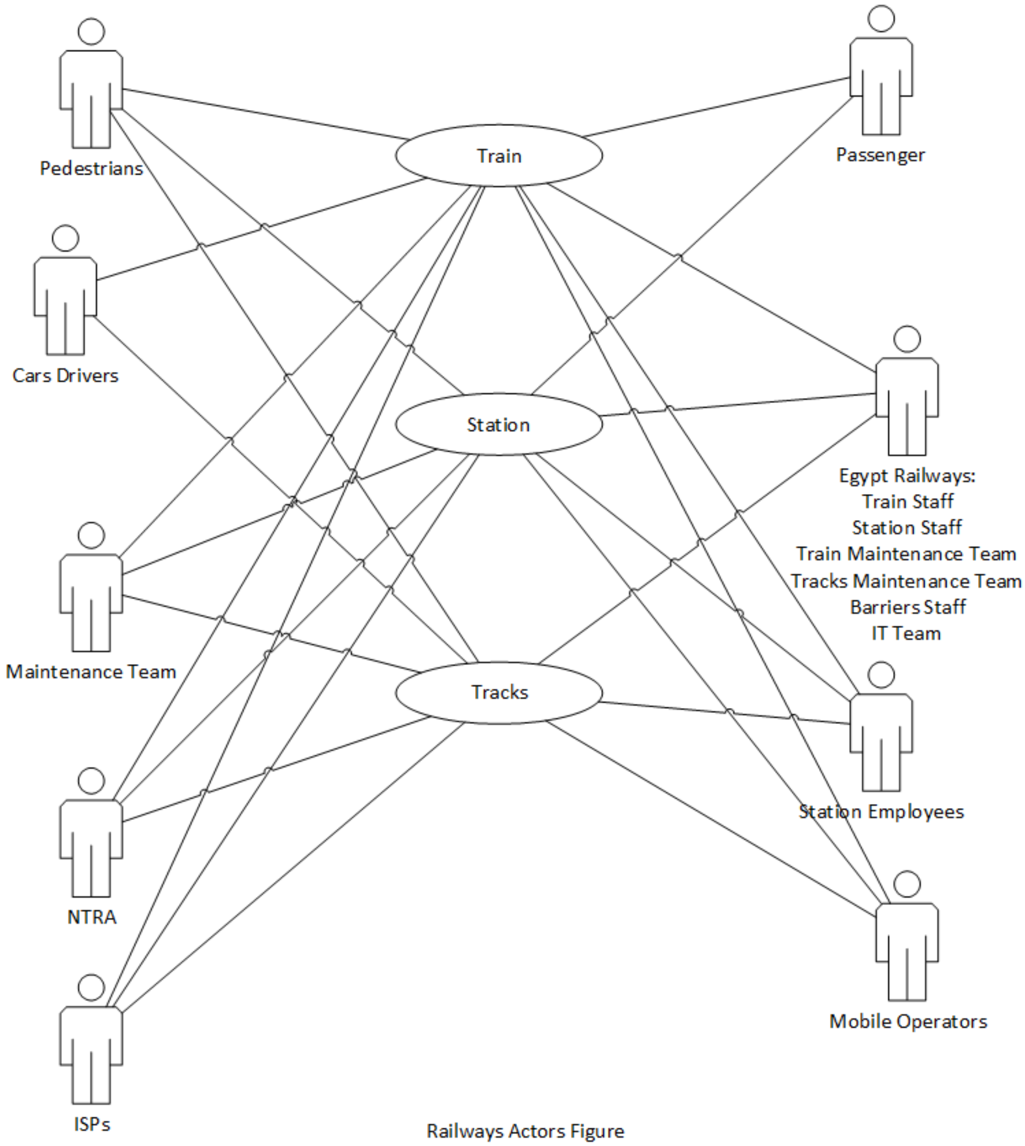

Figure 13 Railways actors

6.2.3. Subsystems

Subsystems include Automatic Vehicle Number-Plate Recognition, Traffic Flow Optimization. Real-time train tracking and control, Detection, Reporting and Alarming of Environmental Problems on roads, Services Detection and Reporting, Sensing Subsystem, Power Supply subsystem, Communications subsystem, Storage subsystem, Processing subsystem, and Cloud computing subsystem.

6.3. SUB-USE CASES

In this study, we focus on two use cases in the ITS which we think they have the most significant problems; namely highways and railways.

6.3.1. Detection, Reporting And Alarming of Environmental PROBLEMS ON Roads

Detection, Reporting and Alarming of Environmental Problems such as bumps and road holes, floods, road collapses, rocky collapses, and weather (rain, fog, dust, wind, etc.)

This can be achieved by implementing IoT solutions in 2 dimensions. First, via on-site cameras and weather sensors on all target roads and connections. The locations of the cameras and sensors are determined based on several factors like critical areas and nature of the roads/areas.

Second, via embedding IoT boxes in target vehicles like public buses, heavy trucks, governmental fleet, taxis, bus of interested corporates to report road conditions like bumps and holes with the corresponding GPS location.

Actors involved in this case are Ministry of Interior, Ministry of Transportation, Roads and Bridges Authority.

The data will be collected in near real-time mode via the mobile network to a centralized location via cloud computing. Then advanced analytics techniques, Artificial Intelligence, and image processing techniques can be employed to detect, report and create alarms of environmental problems. The entity responsible of crisis management and decision makers should have access to the generated alarms in order to take the appropriate decision in case of emergencies.

The solution design should facilitate multiple communication channels like GPS, SMS, cell broadcast, etc. in order to report serious roads and environmental issues as soon and as accurate as possible.

Furthermore, it is recommended to partner with OTT players like Google to get the benefits of their advanced and powerful services like Google maps.

6.3.2. Traffic Flow Optimization (Smart Traffic Management)

In Smart Traffic management system, traffic signals and sensors, which are centrally-controlled, regulate the flow of traffic along a certain area. All the signals on the main roads in a city can be upgraded and integrated which will result in;

- Reducing congestion and traffic Jams markedly. In addition, the system can be pre-programmed to handle a sudden increase in traffic on any of its ten radials.
- Reducing pollution throughout the city.
- Enabling a much more effective response to traffic incidents.
- Traffic data can be collected, analyzed, and insights generated via installing monitoring equipment along the roads.

- Reducing congestion and accordingly journey time will save time and fuel money as well as vehicles maintenance for the citizens.

Involved actors are Ministry of Interior, Ministry of Transportation, as well as all vehicles drivers.

The main components of a traffic management system are on-site cameras, wireless connectivity, Artificial Intelligence Software solution which can process images, analyze situations, and abstract number-plate data of the relevant vehicles in addition to a backend database.

The following diagram illustrates an example of a traffic management system.

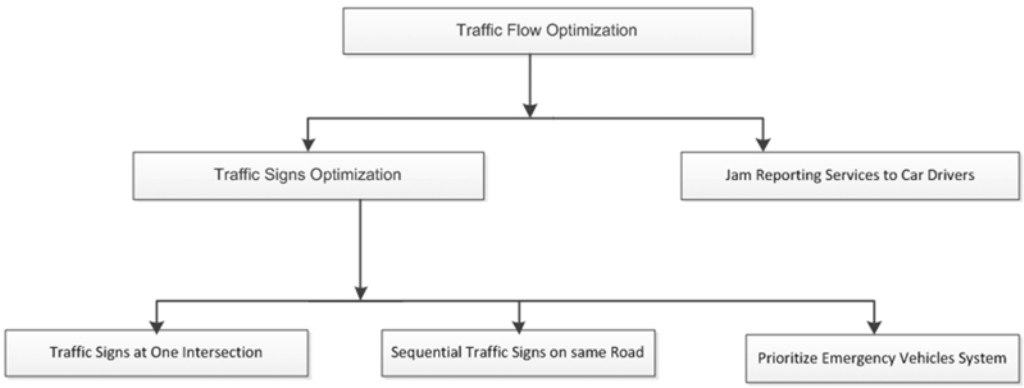

Figure 14 Traffic management system

Traffic signs at One Intersection: this kind of signs are added at road intersection to control vehicles flow via cameras and AI software. Traffic status of an intersection can be analyzed at real time, then, the timing of each traffic sign can be set dynamically. For example, if Road-A is crowded while Road-B is relatively un-crowded, then Green light for Road A can be set to 2 minutes while for Road B only 30 seconds while it could be the opposite in other time and so forth.

Sequential Traffic Signs on same Road: This kind of signs can be connected together using a wireless connectivity protocol such as Wi-Fi or GSM. Then, via using a suitable software algorithm, the timing of each traffic sign can be correlated to the timing of the predecessor traffic signs to allow the most optimal Green light time for all the vehicles. Accordingly, total commute time of all vehicles can be minimized.

Prioritize Emergency Vehicles System: Time is very crucial for ambulance and fire-fighting vehicles. They can be supplied by wireless identification advertisers (for example Bluetooth iBeacons as well as traffic sign sensors. As such, they can be detected while they are moving across the road and traffic signs can be optimized accordingly to give them the highest priority.

Jam Reporting Services to Car Drivers: To avoid congested roads and traffic jam, alternate roads can be reported instantaneously to car drivers. so as they can look for alternate roads. This can be done via a mobile application or simply via SMS.

6.3.3. SERVICES DETECTION AND REPORTING

This includes services like empty parking areas, rest areas, gas stations, and car maintenance shops. Implementing IoT solutions in these areas can be used to monitor and report on;

1) Number and location of empty spots e.g. in a parking area.
2) Available capacity e.g. in a car maintenance shop in addition to other any other relevant information.
3) Amount of available fuel in a gas station as well as working/pause hours.
4) Location of nearest rest areas and available services nearby.

Collecting such data in a near real-time via mobile network for example into a centralized data center and make it accessible over the internet via a portal or a mobile application is a perfect example of data monetization. Integration with OTT players e.g. Google to make use of their advanced and powerful services like Google maps.

Actors in this case include local private and public business e.g. gas stations and parking facilities, Ministry of Interior, Ministry of Transportation, and Councils of local authority.

6.3.4. AUTOMATICS VEHICLE NUMBER-PLATE RECOGNITION

Automatic Vehicle number-plate recognition is an IoT technology that uses AI optical character recognition on images to read vehicle registration plates.

The system consists of an on-site camera, wireless connectivity, AI software solution which process images, analyze situations, and abstract number-plate data of the relevant vehicles, as well as a backend database.

Actors include Ministry of Interior, Ministry of Transportation, in addition to car owners of both personal and Business cars.

The following diagram illustrates some of the relevant applications.

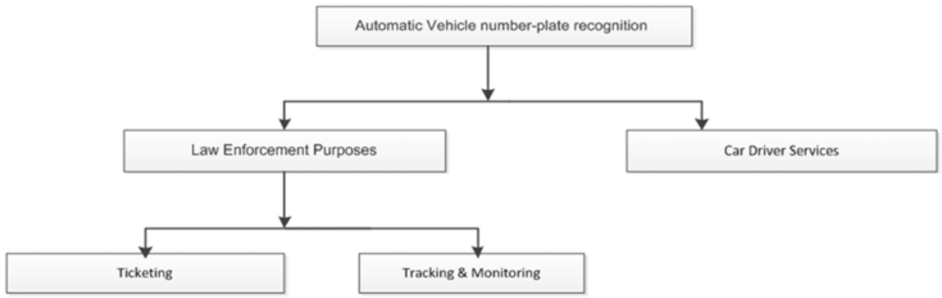

Figure 15 Example applications

Examples of ticketing cases includes over speed ticketing, parking in prohibited areas, violation of traffic signs, and expired driving license.

Tracking and monitoring include stolen cars detection, detecting and chasing criminals in cars, detection of unregistered /counterfeited numbers, and detecting any manipulation activities like adding some paint to numbers to misguide policemen.

Car Driver Services include automatic toll collections on roads and parking lots and sending SMS to remind car owners with about to expire driving/car licenses.

6.3.5. Secure Railway Rod

Railway rod are roads with very long distance of more than 9000 KM (x1) which are often desert roads totally away from population such as western rods and new valley rods. Thieves are active on these rods which results in lost money and goods.

Main system components in this case are connectivity sensors and a GIS solution.

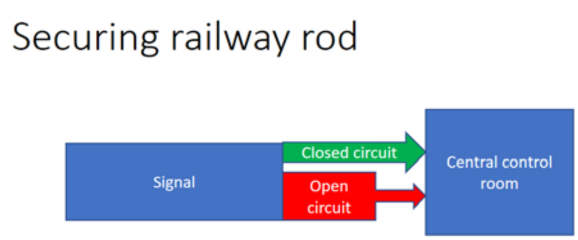

Figure 16 Main system components

Actors include Railway agency (train driver, crossroad operator and health and safety department in railway) and Ministry of interior.

The following diagram illustrates how the system works in this case.

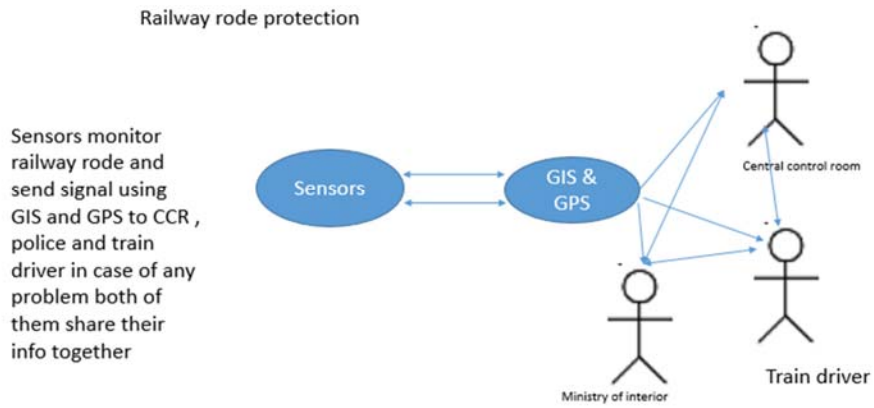

Figure 17 System interactions

Sensors, built on the rods, are connected to the GIS system so that in case of any issue (unusual move or objects e.g. bomb, cutting road, etc.), sensors send alarms to the control room which in return can direct police officers to the target location.

6.3.6. System To Alarm Pedestrian Crossing Railway Bar

Egyptian Railway cover the road from Alexandria near Mediterranean Sea up to Aswan near Sudan border. Most of the railway road are surrounded by very crowded residential areas and accordingly pedestrians, vehicles, and animals (in villages) often cross the railway rod (crossroads) anytime during the day which is very risky and causes many severe accidents. Hence, it is crucial to find an effective solution to alert people and vehicle that a train is coming, and it's prohibited to cross the road at the time being. This solution will certainly save souls and cost of losing vehicles and animals as well as reduce the cost of train tip and time.

Main system components are in-train sensors which send a signal when train approaches a pre-defined distance (example 4 Kilometers) from a certain determined location, and an auto-mechanical alarms located along the road to close and open railroads according to received signal.

Actors include Railway agency (train driver, crossroad operator and health and safety department in railway), Ministry of interior.

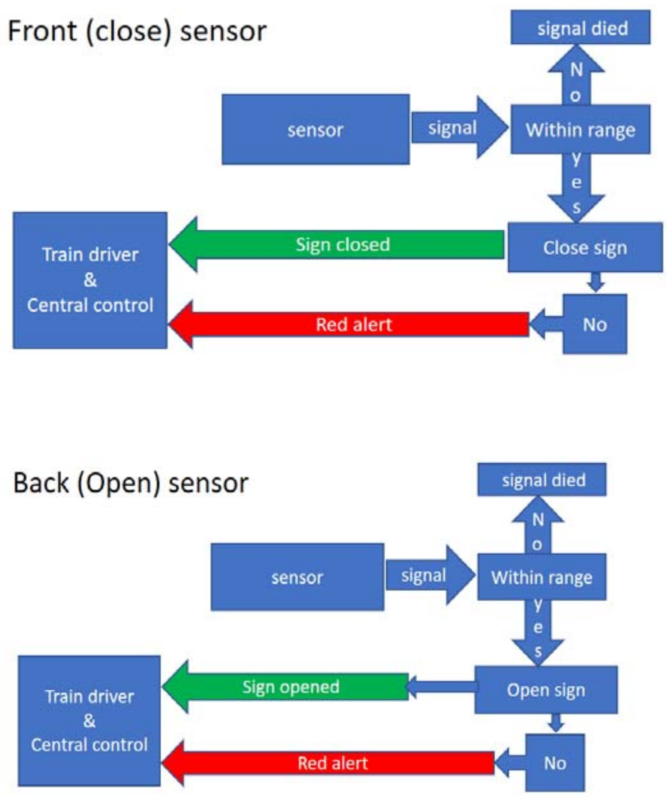

Figure 18 Sensor types

The hereunder diagram illustrates a typical scenario. When train moves, the sensor in train will send a signal for a predefined distance e.g. 4 Kilometers. This signal will be received by a sensor in an alarm within the 4 kilometers range. When sensor in alarm received the signals, alarm will be operated to give alert (sound and light alert) to pedestrians and vehicles. When no signal this will make alarm stopped then pedestrian can move safely.

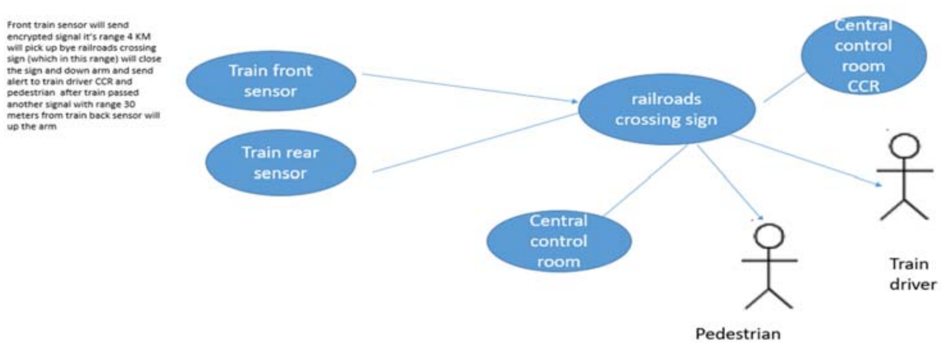

Figure 19 Working scenario

6.3.7. Real Time Train Tracking And Control

Railway rods long 9000 Kilometers from Alex to Sudan border without knowing the actual current train location is very dangerous. Collision between two trains or a train and vehicles may happen. Knowing the actual location for train at any moment is very important to plan all railway rod usage and avoid accidents as well as reducing mean time of travelers waiting for the train to arrive at a station.

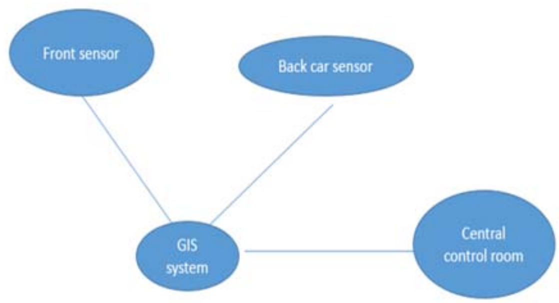

Figure 20 System Components

Main system components in this case are two sensors one in train tractor and another one in the last car both are connected to a GIS system and GPS Connection system.

Actors are Railway agency (train driver, crossroad operator and health and safety department in railway) and Ministry of interior.

A typical scenario in this case is illustrated in the hereunder diagram. Every train will contain two sensors connected to GIS system. The sensors will send the actual current location of the train. The first sensor is located at the front of train and the second one at the last car. The first sensors will send the location of train tractors while the second sensor will send location of the last car. The readings (which should be identical) are sent to the central control room. In case there is a big difference between the two sensors readings this means one or more cars are separated from the train. So, an alarm will send an alert to the driver and central control room.

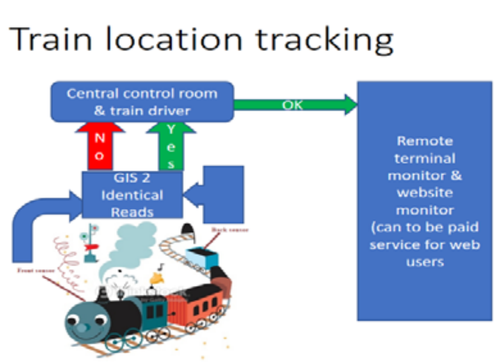

Figure 21 System overview

7. CONCLUSION AND RECOMMENDATIONS

7.1. RECOMMENDATIONS

It is highly recommended to piloting all the three use cases discussed in this study which will then accelerate the discovering of the on-ground real challenges to go further and expand the rollout of the proposed model.

Governmental stakeholders for each of the uses cases as well as economic and financial experts should be consulted during building the rollout and implementation plans. ICT and IoT experts should also be consulted from the early beginning and along the implementation phases. This is crucial to assure realistic, economic and rigorous plans are put into action.

7.2. NEXT STEPS

Use cases studied in this report need to be further discussed with all stakeholders and industry experts in a more detailed context including;

- Security issues and data/privacy protection
- Regulatory and Governance challenges
- Environmental and cultural change management
- Infrastructure and technology standardization and direction

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