

# **IOT APPLICATIONS FOR RUMINANT PROFILING AND DISEASE MONITORING**

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## **ABSTRACT**

*The livestock industry in Malaysia comprises of ruminants and non-ruminants. Currently, the ruminant sector which consists of beef and dairy cattle, dairy buffaloes, sheep, and goats are still raised in small-scale. The national level of meat production is still low at around 23%. Therefore, Malaysia has to import more than 70% of national meat needs. Malaysia imports most of the needs of beef, mutton and dairy products from India, Australia and New Zealand. Favorable progress has been observed in recent years, including modernizing the livestock industries in Malaysia to fulfill the local demand. The Internet of Things (IoT) has begun to shape the future of various industries, which help to increase the effectiveness and reducing the cost of business operations. Radio-Frequency Identification (RFID) technology has been used to provide part of the IoT physical layer for ruminant profiling in smart environments through low-cost and disposable sensors. The system was developed for breeding management and disease control activities. RFID chips have been implanted under the skin of caudal fold section of the livestock and data can be read within 2-5 seconds. User-friendly software with security features was developed for managing livestock profiles. An encryption option for permanent disease marking was also introduced for law enforcement agency. All livestock must be registered in the National Ruminant Database. The goal is to establish digital inventory control and to monitor livestock performance. The developed system is environmental-friendly using lead-free inert material which is ideal for livestock.*

**Keywords:** Ruminants, internet of things, sensors, radio-frequency identification, profiling

## **INTRODUCTION**

Malaysia's livestock industry is one of the important industries in the country's agricultural development. It provides lucrative employment, supplies the domestic requirements of meat, milk and dairy products to the population. The development of the industry will ensure the food security in the country and reduces dependency on meat imports. In 2013, the livestock sector has contributed about 12.4% of the total agricultural gross domestic product (GDP) (Shanmugavelu, 2014). The poultry sub-sector is a major contributor to livestock GDP with the rate at 62.9% whereby the ruminant sub-sector contributes the least at 12.1% (Shanmugavelu, 2014). This industry also employs around 20% of the country's agricultural sector labor-force. It contributes substantial earnings to households through sale of livestock and livestock products; and provides raw material for agro-industries. As Malaysia is experiencing rapid economic and human population growth, it has led to an increase in the demand-driven consumption of livestock products. Based on the Malaysian National Agro-food Policy 2011-2020 (NAP), the demand and production for meat are expected to increase. The demand is expected to increase from 1.4 million MT in 2010 to 1.8 million MT in 2020 with a growth of 2.4% per annum while meat production is forecast to increase from 1.6 million MT to 2.1 million MT respectively with a growth of 2.7% per annum in the same period. The demand increase is also expected for other livestock products such as milk and eggs.

Livestock industry in Malaysia comprises of ruminants and non-ruminants. Currently, the ruminant sector which consists of beef and dairy cattle, dairy buffaloes, sheep and goats are still raised in small-scale (Mohamed, 2007). A positive progress has been observed in recent years, but it is still

unable to meet the local demand. Thus, Malaysia imports most of the needs of beef mutton and dairy products from abroad especially India, Australia and New Zealand to cater for the shortage. In 2014, the levels of self-sufficiency (SSL) for beef, mutton and milk were 24.84%, 13.10% and 12.93% respectively (Table 1). The lag in this ruminant sector is normally associated with several factors such as the lack of land resources, high feed price, cheaper import substitutes, poor private-sector involvement (Shanmugavelu, 2014), disease prevention and control (Mohamed, 2007), and lack of quality breeds, expertise and workforce (National Agro-food Policy 2011-2020).

Table 1. Self-sufficiency levels of livestock products, 2006 – 2014 (%)

Commodity	2006	2010	2014 <sup>Estimate</sup>
Beef	21.78	30.12	24.84
Mutton	8.99	12.13	13.10
Poultry	98.85	95.36	93.87
Eggs	124.94	105.55	104.87
Pork	109.06	114.63	120.55
Milk	4.66	8.49	12.93

Source: Department of Veterinary Services, Malaysia

In contrast, the non-ruminant sub-sector such as poultry (broilers and eggs) and swine is well developed in terms of production capacity and technology. It has achieved high level of self-sufficiency (Table 1). The sub-sector has achieved production scale and mostly commercially operated by large multi-national integrators. Nevertheless, there are also commercialized domestic producers and integrators who are also important players in the industry. Technology transfer and adoption have made it possible for non-ruminants to develop rapidly. Both poultry and swine are dominating the local livestock and internationally competitive for export and simultaneously decreasing the balance of trade for food commodities. This industry will continue to be emphasized and further developed so that the competitiveness and sustainability of the industry is increased.

## INTERNET OF THINGS IN MALAYSIA

Malaysia has launched its National IoT Strategic Roadmap in year 2015 with the aims to make Malaysia a regional IoT development hub and to create a national ecosystem for the proliferation of use and industrialization of IoT as a new source of economic growth. IoT has been touted as one of the technologies at the forefront of the Fourth Industrial Revolution (IR 4.0). The initial IoT economic potential for Malaysia will be RM9.5 billion of gross national income (GNI) creation by 2020 and it is expected to experience exponential growth beyond 2020 and reach RM42.5 billion (Figure 1). Technology opportunities can be created by IoT in Malaysia with forecast technology opportunities for; application and services amounting to RM34 billion in 2025 compared to RM7.5 billion for 2020 and device producers at RM1.0 billion and RM4.3 billion for years 2020 and 2025 respectively.

IoT is not only about smart homes and cities or manufacturing but open huge opportunities in other sectors especially in agriculture. In conventional practices, farmers have had to monitor manually the condition of their crops, livestock, environment or agricultural produce. And this is difficult and not practical for a large-scale agriculture farm. The IoT is helping change the way that farmers work through precision farming, a farm management concept that uses sensors, data, and network communication to tailor the farming system to the specific conditions of each field (Telit.com). In Malaysia, the implementation of IoT in agriculture sector is mainly for rice precision farming, plant factory and vertical farming and fertigation. In the livestock sector the use of IoT is relatively new and is still being developed.

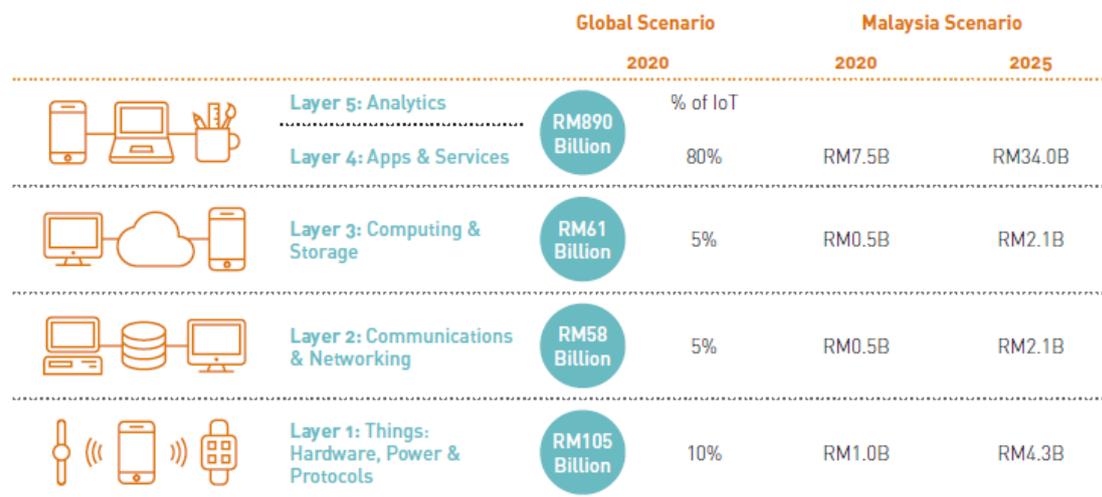


Figure 1. Malaysia: IOT technology opportunities  
Source: National Internet of Things (IoT) Strategic Roadmap, MIMOS 2015

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There are some issues with conventional method where the ear tags were used for profiling. The ear tags were subjected to loss and difficult to re-identification of selected ruminants and also subjected to adulteration and animal theft. The conventional method is difficult to handle and to read under field conditions. Traceability is the most important aspect in ruminant profiling which is very difficult to rely on the conventional method because lack of foolproof. Therefore, MARDI has introduced a ruminant profiling and disease monitoring system. The technology developed by MARDI consists of (Figure 2);

- i. Passive RFID chip
- ii. Chip inserter
- iii. Digital scale
- iv. Wireless Bluetooth reader
- v. Livestock profiling software

Passive of 13.56 MHz RFID chip is suitable for use under fluid and tissue environment. The technology has been patented with both anti-slip features and custom chip inserter. It is also ISO compliant. With its tamper-proof condition, it is designed to be inserted under skin (sub-dermal) with encrypted data entry option as shown in Figure 3. It comes in a miniature 4mm x 20 mm dimensions. The technology is matched with custom 13.56 MHz, 1 Watt Bluetooth handheld reader custom tuned to designed RFID chip. A user-friendly livestock profiling software with security features has also been developed.

Besides its permanent and tamper -proof animal ID, it also records animal weight automatically with error free data which will avoid manual entry errors. It provides rapid execution with relatively about 2 sec for ID and 5 sec for weight and has rapid chip insertion of 5 minutes reading per animal. The chips are designed to be reusable and sterilizable. It also provides an encryption option for permanent disease marking which is to be used or monitored by the enforcement agents.

The developed technology will increase productivity and efficiency and also acts as disease early warning system. The system creates permanent ownership ID which is preventable to animal loss and theft. Moreover, it provides global recognition via implementation of animal traceability. Department of Veterinary Services (DVS), Malaysia will be responsible as national enforcement agent in managing national animal database provided with RFID encryption for disease early warning system. The IoT system is currently been developed to monitor and identify each animal for their profiling and health conditions. Figure 4 shows how the system is being implemented.



Figure 2. System components of ruminant profiling and disease monitoring



Figure 3. Implanted RFID chip and system field test

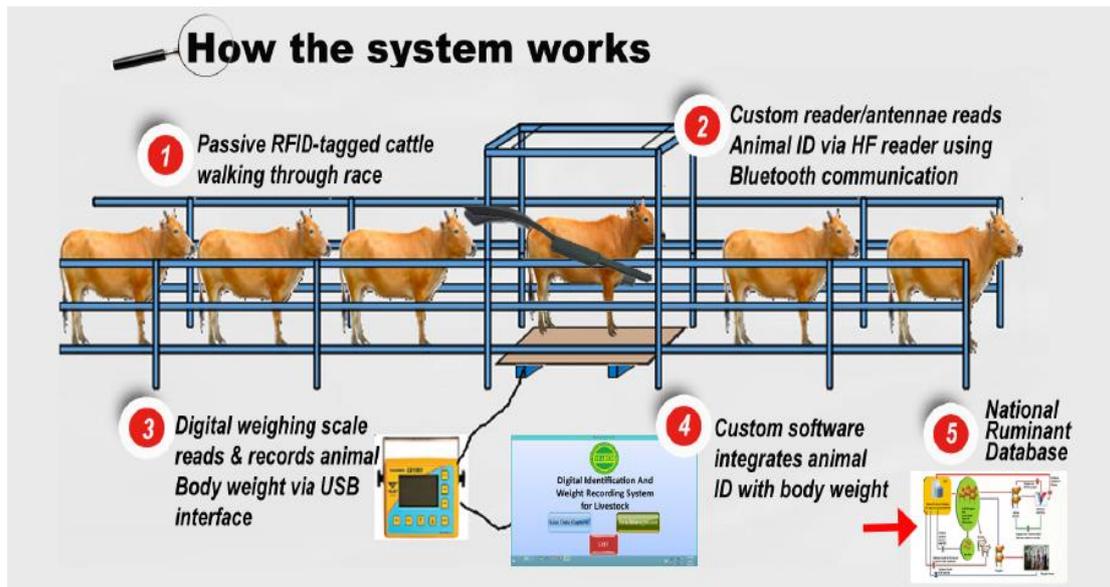


Figure 4. How the system works

## CONCLUSION

The use of IoT in livestock sector in Malaysia is relatively new and is still being developed. MARDI has developed a ruminant profiling system for animal registry and database for inventory control and animal performance monitoring. The database is also very useful to gather animal information such as breeding, disease and management activities. The IoT system is currently being developed for a smart system to operate and monitor animal farm remotely.

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