IoF2020 - the Internet Of Meat: towards applications of Internet of Things in the meat supply chain

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Abstract

To enable all actors in the meat supply chain to monitor, manage and optimise their production process, Internet of Things applications create multiple opportunities. In the IoF2020 project (Internet of Food and Farm 2020), starting early 2017, 11 partners from five countries focus on large-scale implementations of IoT via three use cases in the meat supply chain: pig farm management, poultry chain monitoring and meat transparency and traceability. Farmer's lack of accessibility to information to monitor their production on a continuous basis will be addressed by installing and integrating IoT sensors for environmental and animal monitoring. In addition, early warning systems will be developed, linking different data-streams to provide valuable feedback to the farmer, as well as information transfer to other stakeholders. Doing so, preventive or corrective actions for diseases, boar taint, bird mortality, feed waste, environment, etc. can be taken. Further, also EPCIS-based tracebility from farm to fork will be enabled, so that consumers receive reliable information on meat origin and quality. The current progress of these three use cases, as well as the planned developments will be presented. By addressing several technological and business challenges, as well as EU-wide dissemination, IoF2020 aims to contribute to the digital revolution in Smart Farming.

Keywords: Internet of Things, meat, pigs, poultry, traceability, IoF2020

Introduction

The meat production sector is undoubtably an important part of the European agricultural sector. Looking at EU statistics, there are almost 7 million livestock farms in the EU which is more than half of the total number of farms (Marquer & Forti, 2015). The economic relevance of animal production is 43.1% of the EU agricultural output, of which 57.5% is animal output (slaughter, herd renewal or further growing and fattening) and the rest is animal products (milk, eggs, wool etc.). The different meat categories are (Marquer & Forti, 2015):

- Pig meat – 23.5% of EU farms – 9% of EU agricultural output
- Bovine (cattle, buffalo, veal, etc.) – 21.4% of EU farms – 8.1% of EU agricultural output
- Broilers – 18.7% of EU farms – 5.5% of EU agricultural output
- Sheep & goats – 12.1% of farms – 1.4% of agricultural output

With an increase in world consumption and production, it is essential that aspects as sustainability, welfare, environment, quality and traceability receive the maximum of attention. To solve challenges like resource efficiency, disease and risk management, it is important for the meat production sector to stay on top of their production process, monitoring and if needed controlling every part of it. One of the innovations that can help achieve this is a technological innovation to bring Internet of Things (IoT) to the agricultural domain. This is what the newly started project IoF2020 (Internet of Food and Farm, *iof2020.eu*, 1/1/2017-31/12/2020) is about. With over 70 partners in total, IoF2020 aims to accelerate the uptake of IoT technologies in the European farming and food chains, with a primary focus on 5 trials (arable, dairy, fruit, vegetables and meat).

The Meat trial consists of three use cases, two vertical use cases aim to support the meat value chain through knowledge-based livestock production systems with smart sensors and data integration, in pig and poultry. The third horizontal use case concentrates on meat tracebility and transparency.

Use case 1: Pig production management

This use case will work on combining data across the value chain in order to provide the pig farmers with crucial information to effectively steer their management to reduce boar taint, health problems, productivity problems, etc. This information is currently lacking, fragmented or collected only post-hoc. In a next step, this data could enable valuable information transfer to other relevant stakeholders as well (breeders, food processors, feed suppliers, veterinarians, consumers, etc.).

Short description

The main goal of this use case is to enable a revolution in the management of pig farms via optimal use of data throughout the chain. This use case will work on collecting crucial information automatically and linking data to provide feedback to the farmer via an easy to use interface (data dashboard). In addition, a cooperation will be set up with the horizontal use case related to meat traceability and transparency. By providing management information to the pig farmer focussing on opportunities to improve his management, several goals are combined:

- Sustainable production (e.g. animal welfare and use of feed ingredients)
- Optimisation on supply chain level (instead of optimisation on farm level)
- Creating maximum added value, regarding intrinsic product quality (e.g. reduce boar taint in meat) as well as extrinsic product characteristics (e.g. animal welfare, carbon footprint)

Partners involved in the use case are ILVO (Belgium), Porphyrio NV (Belgium), VION (the Netherlands), ZLTO (the Netherlands) and ISMB (Italy). The use case will be deployed on five fattening pig farms, covering both conventional and organic farms.

Use case specific challenges

In the use case the automated gathering of production data and problem detection during growing-finishing phase will be deployed and improved, using direct feedback of the farmers. This will be done using group level data (based on Porphyrio NV Business Intelligence Dashboard), but also using individual level data (based on the PigWise project (Maselyne,

2016; Scalera, 2013a, b)). There is a large variation in productivity between farms and the last decades the main improvements were made at the level of the breeding (sow productivity), whereas fattening pig productivity has stagnated recently (van der Peet-Schwering et al., 2009). One of the reasons could be that information is most often only collected post-hoc (at the slaughterhouse) and only on batch level (Maselyne, 2016). Data streams are also not sufficiently linked for the farmer to be able to take the correct actions. The economic impact of health problems can therefore accumulate quickly, for example the cost of clinical ileitis is €8.7 per present pig and the cost of clinical circovirus is €6.6 per present pig (Boehringer Ingelheim, 2010; Holyoake et al., 2010). If this can be reduced by 10%, this is already a gain of €1.5 per present pig, or €369 million in the EU.

By linking data across the supply chain, the challenges of optimization of pig production on supply chain level and boar taint reduction (Aluwé, 2012; Van der Peet-Schwering, 2013) are also being targeted. At the moment 3-4% of the boar carcasses (25-30% of the slaughtered pigs) are devalued by about €25. With over 246 million slaughtered pigs at EU level, this corresponds to a loss of about €54 million yearly. A reduction of boar taint by 20% by preventive measures on the farm and in the genetics could thus lead to a reduction of losses of €10.8 million and improve general market acceptation of boar production. Finally, through a consumer survey, there will be investigated how consumers differentiate and evaluate their meat, and especially how they look towards the use of technology in pig farming.

<u>Use case specific outcomes</u>

Recent technological developments have led to large possibilities that are not fully exploited on the pig farms at the moment. This use case aims to change that. The first step is to collect and link data of individual animals or animal groups on the farm (a.o. via sensors) and at other places in the value chain (slaughterhouse, breeders). Then, this data is processed to get:

- Management info for the farmer for the purpose of better and more market-aimed production, via a Business intelligence dashboard including:
  - Boar taint prevalence & related analysis (linked to genetics, feed type, etc.)
  - Slaughterhouse performance & related analysis (linked to genetics, feed type, etc.)
  - Sensor data analytics & early warning systems (feed, water, growth, etc.)
- (New) knowledge on relations between:
  - Animal data (genetics, feed, growth, age, weight, etc.)
  - Farm management (a.o. housing, hygiene, health level)
  - Meat quality (a.o. boar taint)
  - Added value for the customer/consumer

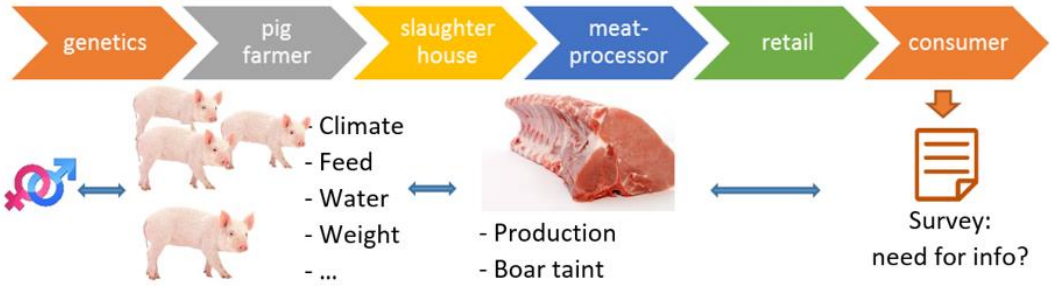

Figure 1: Diagram of the use case Pig farm management

Use case 2: Poultry chain management

The end goal of the use case Poultry chain management is to have efficient growth of poultry, with respect to animal welfare, to a desired and accurate end weight required by the processing plant. This will be enabled via sensor networks and improved sensor technologies so that online information of critical parameters in the poultry growing process, during logistics and at the slaughtering plant can be collected.

Short description

This use case will work on improvement of the poultry production, logistics and processing processes, necessary to arm the European poultry meat sector on the competitive world market. Technology will play an important role to achieve this. This use case pretends to improve the performance of the poultry production chain processes through IoT driven technologies, focusing mainly on controlling the growing process of the poultry, reducing birds' mortality, and improving their physical condition as well as welfare. Partners in the use case are IK4-Tekniker (Spain), Porphyrio NV (Belgium), SADA p.a SA (Spain) and Exafan (Spain). The use case will be deployed on four broiler farms in Spain.

Use case specific challenges

Three critical points define the efficiency and product quality of the poultry meat, starting from the broiler farm to the processing plant. In each step, IoT technology brings value, and moreover, linkage between these steps adds the second level of value:

- Farm level: Monitor and combine different aspects in the farm such as environmental conditions (such as temperature, humidity, etc.) and/or birds intake behaviours (feed and water consumption) for an efficient growth of poultry, regarding welfare, for the final aim of getting a uniformed end weight of birds, crucial for the processing in the slaughterhouse.
- Logistics: Monitor and optimize broiler handling and transport environmental conditions to reduce negative impacts (such as broken wings or hematomas due to sudden bird load to transport cells) on the poultry and increase comfort levels.
- Processing plant: Optimize slaughtering and improve rendability and product-market fit, with traceability from all stages.

In numbers, the impact on the European market is potentially very large. When birds for roast are below a threshold of weight, these are dismissed. In Europe the production of broilers for roast is around 1560 million, thus improving the uniformity of the flock by 10% (which is a key performance indicator of the use case) will allow to reduce the number of dismissed birds with 78 million (125.97 million €). Broiler deaths during the production phase and transport is currently on average 6% and 0.2% (personal communication, SADA p.a SA). With the system of the pilot, including better monitoring of the ambient parameters and early warning systems, there is expected to lower the birds mortality by a 15% in transport and 10% in farms, leading to a reduction of 33.85 million at EU level, with a total save of 160.797 million €. Also the impact of improving the bird's physical condition and the indirect economic impact quickly lead to high gains, so the total revenue for the European market would be near 400 million € with a reduction of 137.85 million birds dismissed.

Use case specific outcomes

Collect and link interoperable and traceable IoT devices data in critical meat chain points through smart data analytics, within a big data platform, to give valuable business analytics back to the farmer and other partners in the chain through:

- Poultry Growing Early Warning system aimed to support an optimal birds breeding process
- Bird Manipulation Monitoring system aimed to assess the manipulation process and its impact in animal physical condition and welfare
- Environmental Monitoring system to measure the impact of the transport in animal physical and welfare conditions
- Meat Quality Assessment and Production Management chain-assistants, based on the whole data gathered through IoT devices in the main critical chain points

New knowledge will be also generated in terms of:

- Animal breeding related data
- Farm management (a.o. housing, hygiene, health level)
- Meat quality (a.o. hematomas, broken wings)
- Added value for the customer/consumer

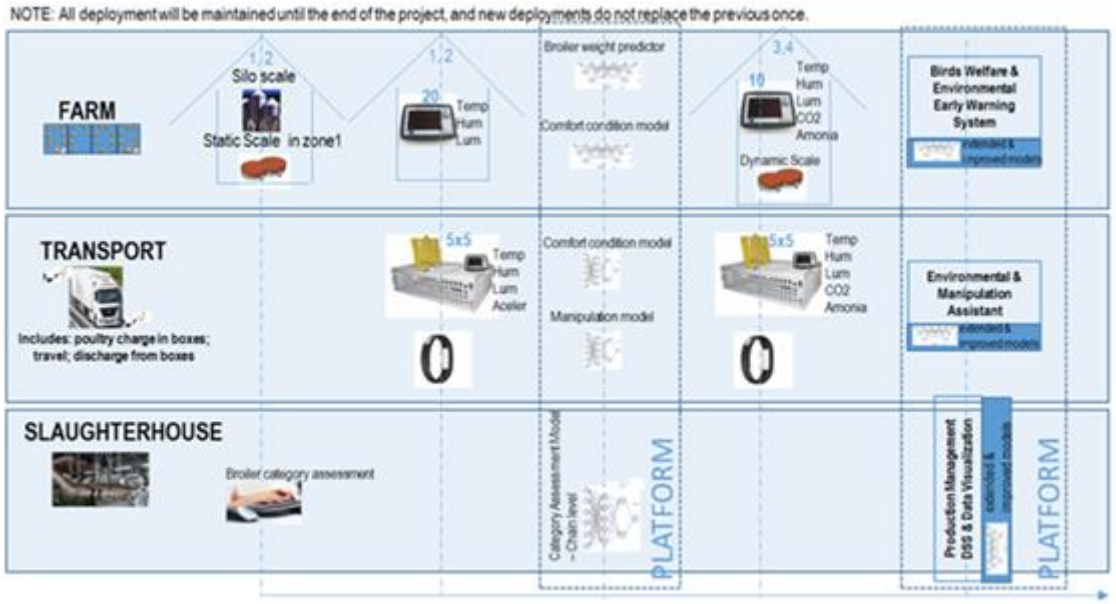

Figure 2: Diagram of the technical solution of the use case Poultry chain management.

Use case 3: Meat transparency and traceability

This use case aims to improve transparency and traceability in the pig supply chain, by developing an ICT solution for collect and share meat-related quality data and traceability data. The use case builds on top of the EPCIS standard, and will further develop the IoT and meat quality dimensions. By employing a widely adopted standard as EPCIS, meat transparency and traceability solutions can be further integrated with existing systems down in the supply chain, including logistics, retailers and eventually consumers.

Short description

The use case will implement a EPCIS infrastructure for capturing and storing all relevant event data in pork supply chains. These will include information on quality aspects of the supply chain partners or their business processes and give access to those data down the pork supply chain. This enables sharing information and optimising business process, while the consumer at the end of the supply chain is informed on all pork related aspects that they consider as important for their health and ethical well-being. Objects passing the pork supply chain undergo all kind of events of which the *what*, *when*, *where* and *why* are captured and stored conform the EPCIS standard, which will be further extended to incorporate sensor information from pig farms. Partners in the use case are Wageningen University (the Netherlands), GS1 Germany GmbH (Germany) and the European EPC Competence Center (Germany). Relevant data collected on the farm or at the slaughterhouse by the use case 1 will be transformed to EPCIS events and stored in an EPCIS repository.

Use case specific challenges

This use case will demonstrate IoT-enabled transparency and traceability in meat supply chains, where farmers to communicate their practices to retailers and consumers. This could include sharing information about animal friendliness, sensory information collected at the farm level, or the use of certain medication. While improved transparency can contribute to higher margins, it may also allow the detection of problems across the chain, potentially leading to higher product quality and reduced overall waste.

Use case specific outcomes

The use case infrastructure consists of several parts, see Figure 3. First one or more EPCIS repositories will be realized. On top of the EPCIS repositories, several apps, developed in FIspace's MIP trial, add functionality to the infrastructure. A *connector* will be developed to transform farm events into EPCIS. The other events will be captured directly from a farm management system, or ERP. Key aspects of the architecture for the infrastructure are (1) the use of the global standard for event information exchange, i.e. EPCIS (EPC Information Services), (2) the use of global identification standards such as GTIN, SGTIN and GLN and (3) the use of the Core Business Vocabulary.

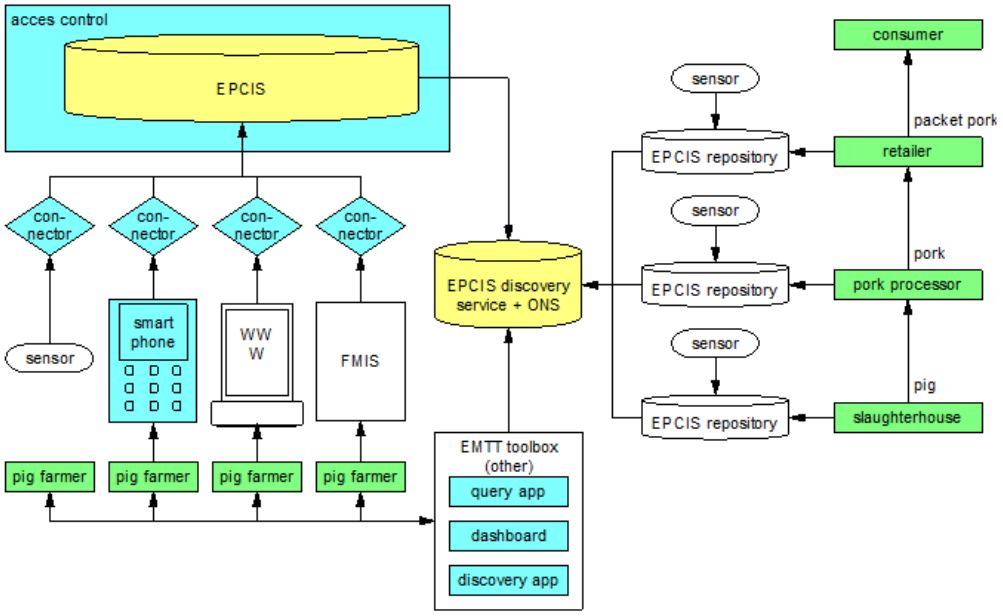

Figure 3: Diagram of the technical solution of the use case Meat transparency and traceability

Conclusions

The project IoF2020 consists of three use cases focussing on meat production: pig and poultry management and meat transparency and traceability. These use cases support our vision of *The Internet of Meat in 2020*, or how IoT technologies can contribute to the meat sector. Technology providers, end-users and research institutes are involved in each use case, aiming at practical implementations to ensure the best uptake of IoT in farming. In the meat trial the main focus will be on using sensor data, in the meantime enhancing the impact of sensor data and combining data of several sensors on the farm, during transport and at the slaughterhouse to give valuable business analytics back to the farmer and other partners in the chain. Besides that, standardization work will enhance the meat transparency and traceability in the meat chain using the EPCIS standard. Work will focus on installation of components during the first year of the project, after which a lean multi-actor approach will lead to further improvements of the systems.

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