

# EFFICIENT TRACEABILITY OF AQUATIC PRODUCTS ON THE COLD SUPPLY CHAIN MANAGEMENT VIA IoT AND ARTIFICIAL NEURAL NETWORKS

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# Facts & Challenges for Aquatic Food Traceability

- With the 178/2012 directive, EU has placed responsibility for ensuring safety and high quality on aquatic product producers and retailers.
- Aquatic products and first produce have to be preserved in **optimum temperature** and **relative humidity** to keep the desired freshness.
- Market experience has shown that **controlled conditions are not always maintained** during aquatic product transportation especially at transit points

# Solution

- Food tracking and monitoring systems utilized the RFID etiquette technology via WSN.
- We claim that these systems can optimize aquatic product surveillance, can implement just-in-time inventory and therefore prevent delivery of spoiled products to customers.
- Using this methodology, RFID readers collect stored information about:
  - transportation path (GPS coordinates are written periodically)
  - package internal temperature time series,
  - internal relative humidity time series,
  - external air temperature time series,
  - time intervals at journey transit sites

# Our Proposal

- We propose a WSN composed by GPS and sensor nodes where each node monitors the package external and internal conditions during the transportation of aquatic products.
- The system can be easily implemented using an **Arduino board** for controlling all sensors and providing data acquisition, synchronization and centralization.
- Processing of data is two-fold:
  - towards controlling the progress of the package within the supply chain sharing the information of all nodes to all other sites via the Xbee and Zigbee protocols and
  - towards the implementation of prediction algorithms that take over in making a product lifeline decision policy when either outlier information is stored or lack of link sharing in the supply chain occurred.

**Internet of Things, (IoT):** is the technology of physical device networking including embedded items with

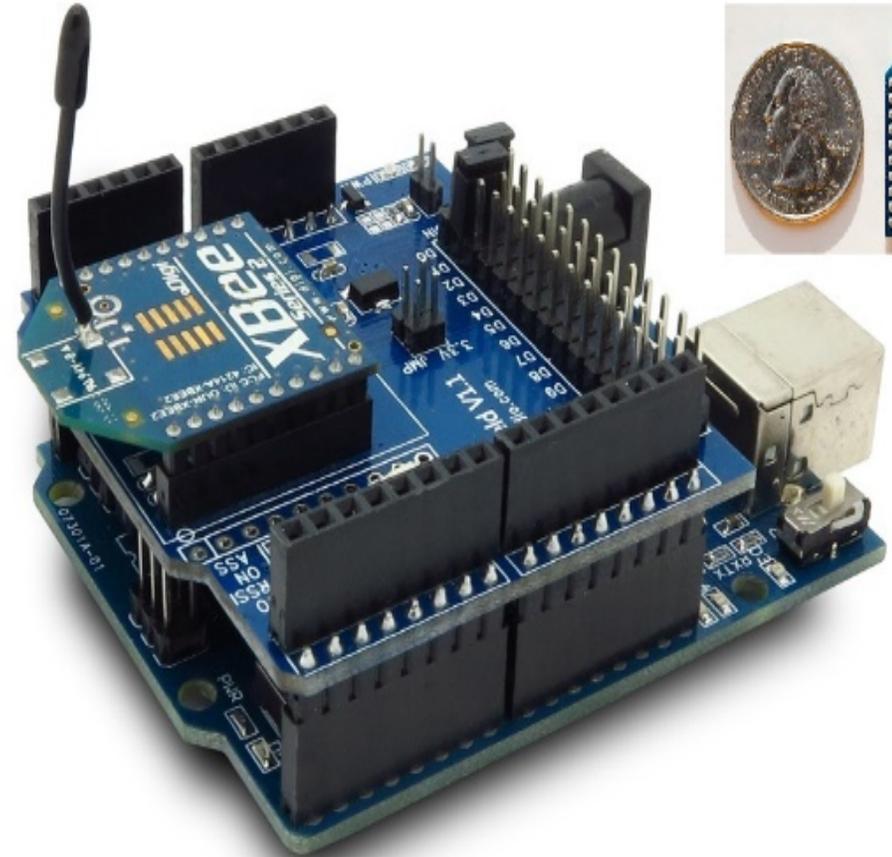
- electronics,
- software,
- sensors,
- actuators, and
- connectivity

which enables these things to connect and exchange data. This technology allows the direct integration and simulation of the physical world into a computer-based platform.

# Technologies Used

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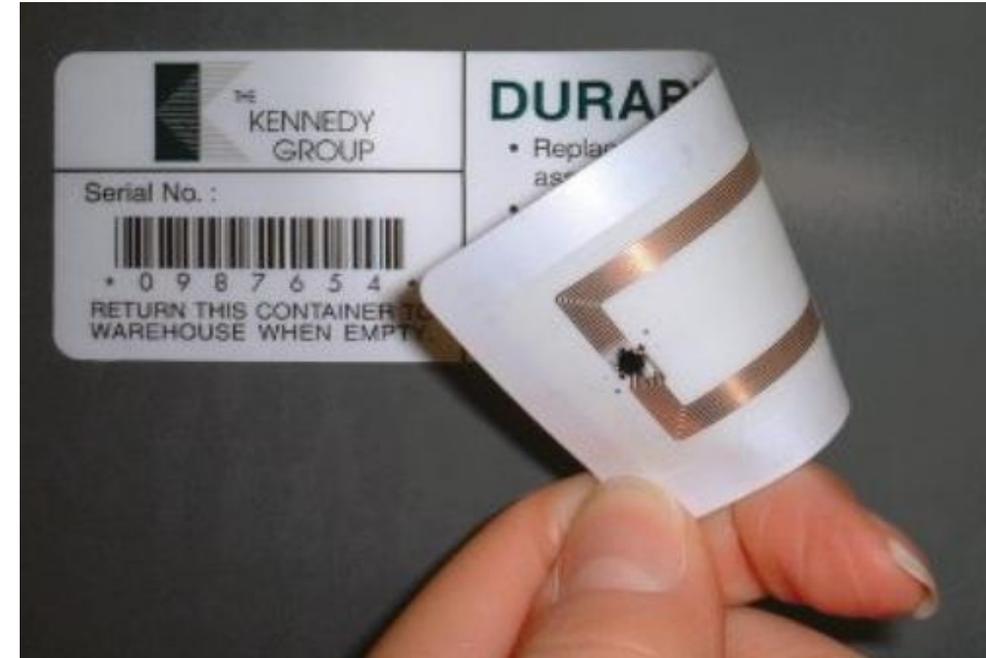
**Arduino, Xbee:** Arduino is an open source computer hardware and software technology of single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world.



# Technologies Used

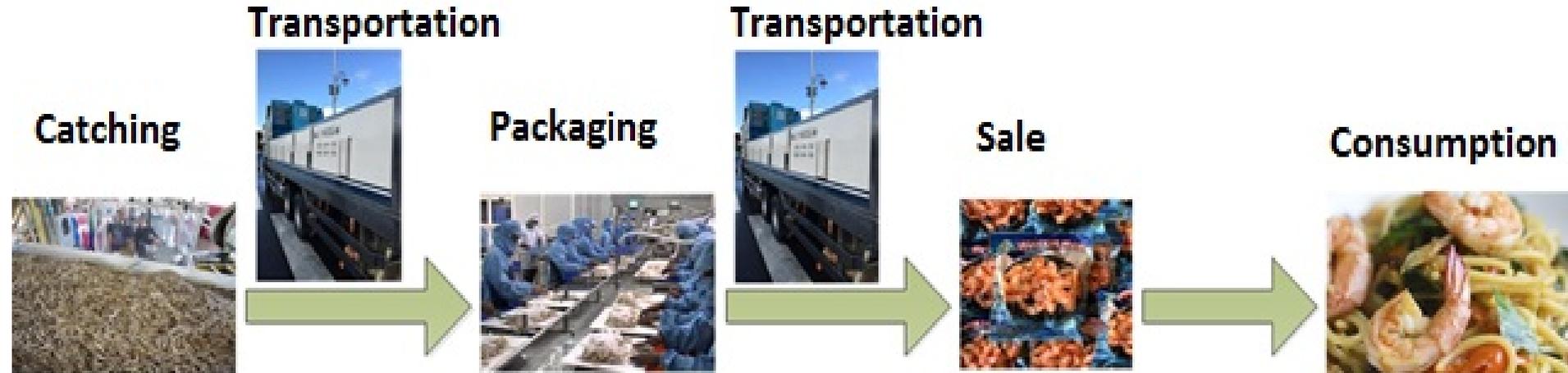
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- **Radio Frequency Identification (RFID):** is a technology that uses electromagnetic fields to identify and monitor tags that are attached to objects and carry multilevel stored information.
- We can have passive or active RFID tags.
- Applications of RFID tags mainly track the progress of materials or objects and give valuable information about the condition of the carrier.

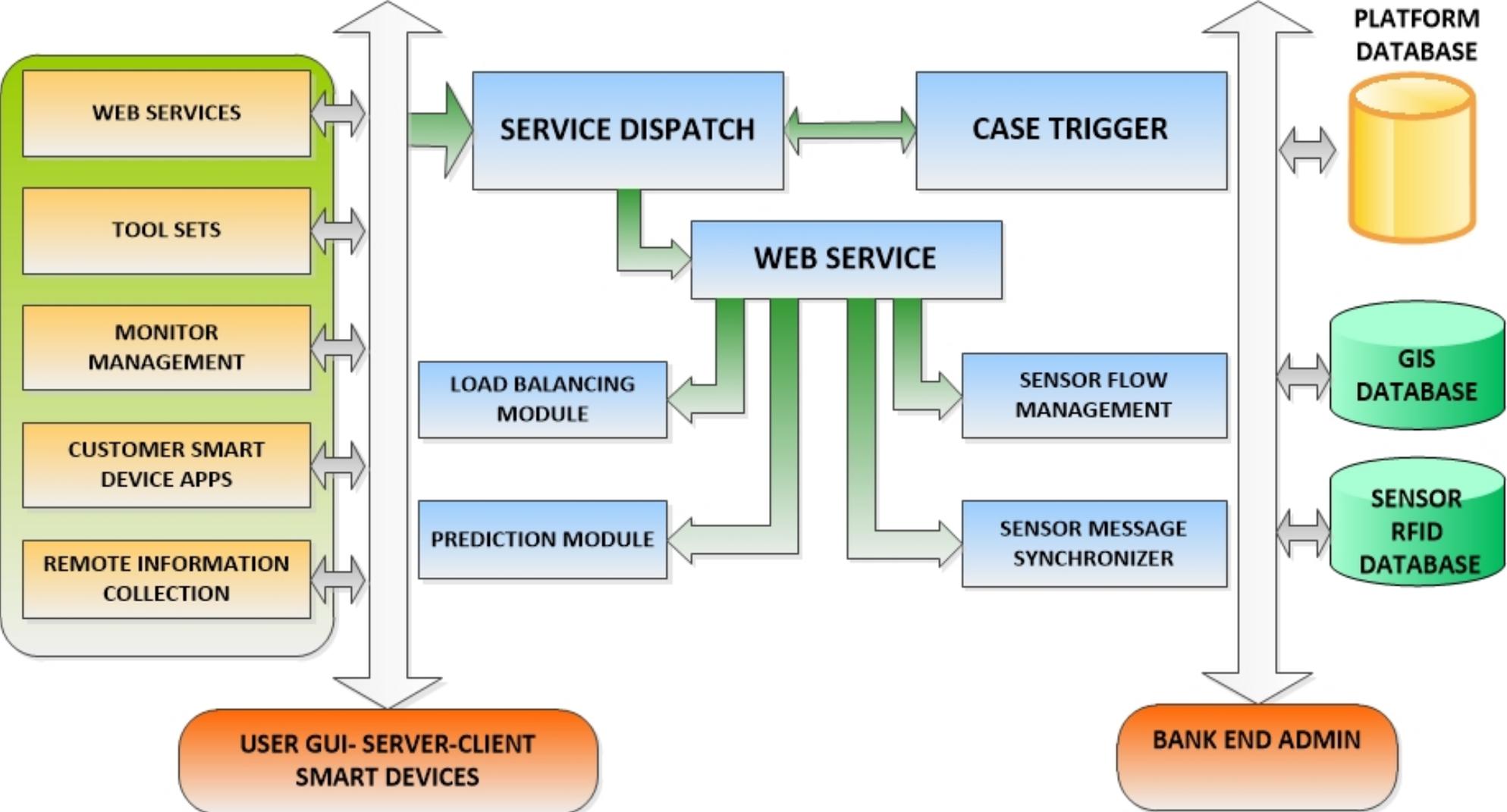


# Cold supply chain management steps

- Fishing in the catch area → Send fish to processing plants.
- Processing divided into two categories: (a) **without segregation of the catch**; and (b) **by segmentation of the catch**.
- Storing aquatic products in refrigerated chambers under suitable temperatures.
- Transfer the products to retail outlets.
- Sale of products and consumption by the customers.



# Logical architecture of the monitoring of cold supply chain management

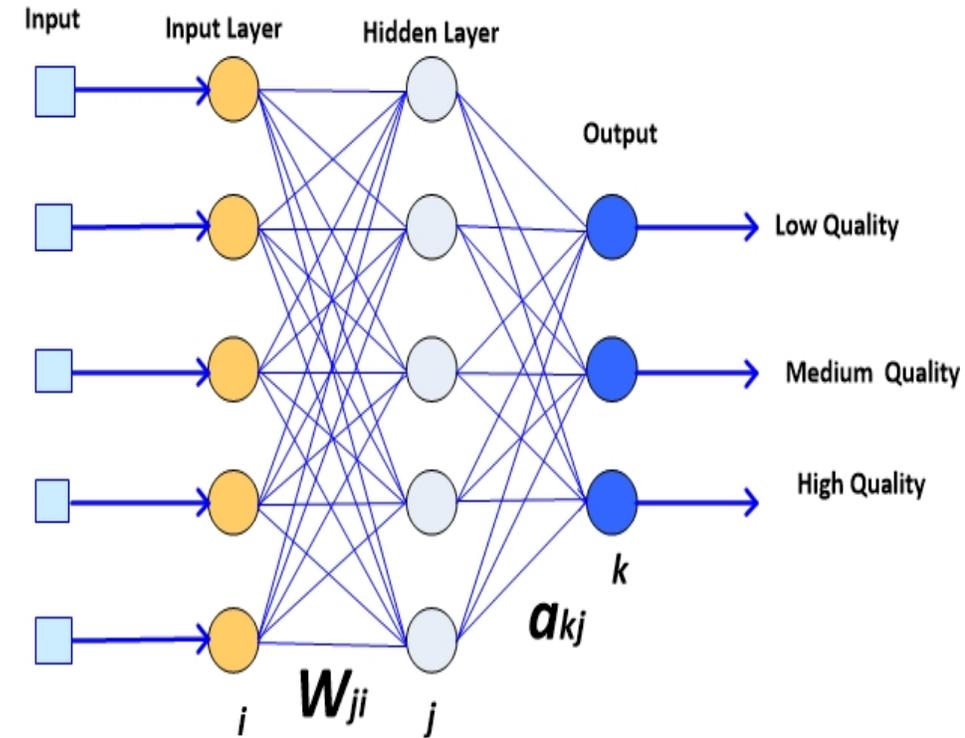


# Evaluation of Aquatic Product traceability using ANN

- We consider effective traceability methods focusing on the **quality evaluating function** for the aquatic products.
- Our primary goal is two-fold:
  - assist the shipping and food processing companies to maintain high levels of food quality
  - improve the customer satisfaction as to be able to identify quality and fresh products.
- We introduce an **Artificial Neural Network algorithm (ANN)** to improve traceability of aquatic products within the cold chain processes.
- This method focuses on **fuzzy classification** to achieve forward tracking and diverse tracing for specific RFID packages.
- **Innovation**: the results produced by fuzzy classification are constantly compared to the information recorded in the traceability platform to evaluate the product quality. While fuzzy classification is used to evaluate the food quality, the ANN at the end determines through a metric (let's say a grade) the quality.

# Fuzzy Classification and ANN prediction

- Fuzzy classification method produces results in each stage of quality evaluation.
- Using the above results as inputs, we make an ANN to compute the final evaluation of the aquatic product quality as a metric or a grade.
- The grade is also at fuzzy level. We determine three levels of product quality: (a) **low**, (b) **medium** and (c) **high** quality.
- The ANN we use is a well-known multilayer feed forward neural network consisting of an input layer, one or more hidden layers and one output layer.



# Milestone achieved

The proposed system can provide consumers, transporters and sellers with a set of smart device tools that give accurate traceability information.

## Challenge

- Not too many people bother to use these tools either when they buy the aquatic products as consumers or when they transport or sell them as professionals.
- Inexperienced consumers think that these applications are worthless thinking that they are not able to predict the quality of the products and grade them accordingly.
- Importance to convince people about the improved ability of the artificial neural networks to accurately predict the quality level of the products.