Wireless sensor networks and real time monitoring in precision agriculture

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Introduction section: an integrated view on precision smart farming

- The grand challenges that agriculture and our world are currently facing:
  1. world's population will surpass 9.0 billion people by year 2050 (FAO, 2009).
  2. limited resources
  3. less skilled labour,
  4. limited amount of arable land
  5. changing climate
  6. Irrigation
  7. Nutrients
  8. and pesticides among others

Precision agriculture (PA)

- Precision agriculture (PA) presents itself as one among many solutions to the grand challenges that agriculture and our world are currently facing.
- Over the years, PA has grown worldwide and is slowly embracing newer technologies that are autonomous, disruptive and data-intensive.
- The first decade of PA had focus on Global Navigation Satellite Services (GNSS) and om locating and quantifying spatial variability in soils.
- The second decade focused on tractor automation and developing technologies that allowed precision management of inputs, such as crop nutrients.
- Now, in its third decade, focus is on collecting of location-based agricultural data via suite of sensors and sensing devices.

Precision agriculture (PA)

Acording the International Society of Precision Agriculture (ISPA) the top ranked definition of PA is:

'Precision Agriculture is a management strategy that gathers, processes and analyses temporal, spatial and individual data and combines it with other information to guide site, plant or animal specific management decisions to improve resource efficiency, productivity, quality, profitability and sustainability of agricultural production'.

Agriculture as a cyber-physical system (CPS)

- Agriculture was once a highly mechanical system and now it is becoming a dynamic cyber-physical system (CPS) that combines the cyber or digital domain with the physical domain.

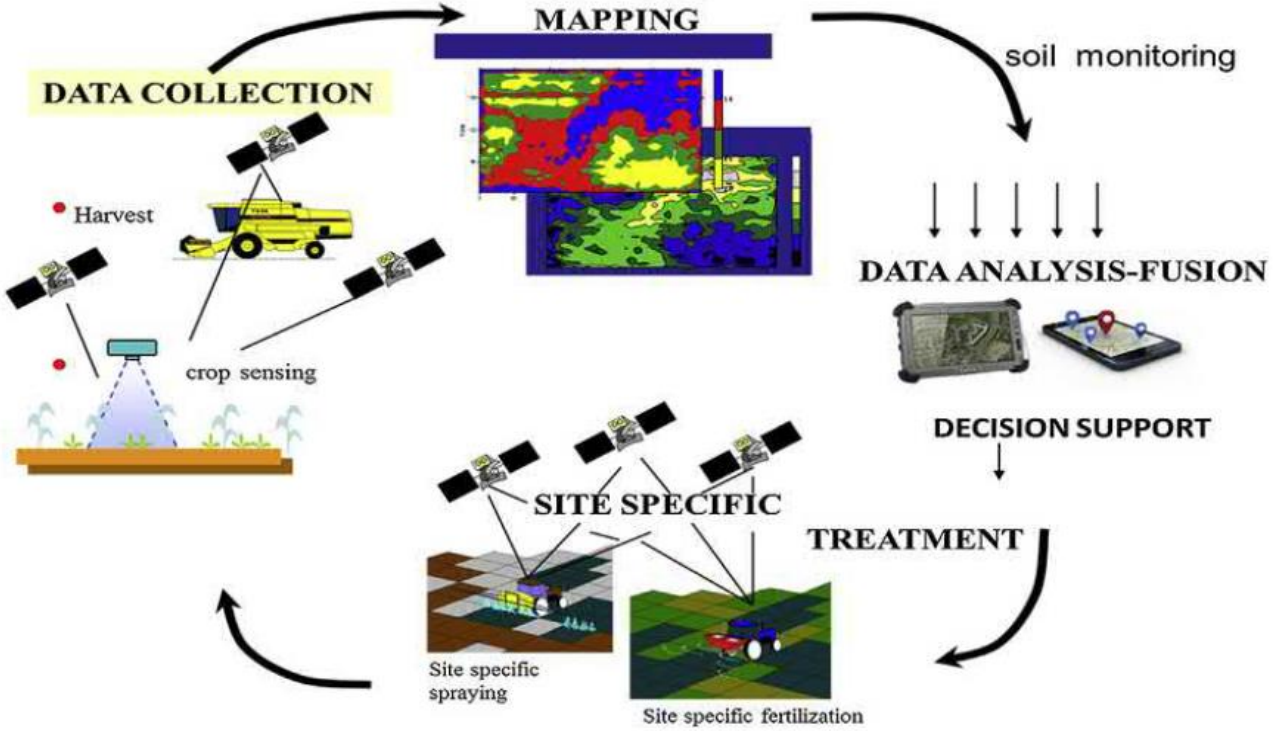

FIGURE 1.1 Precision farming as a cyber-physical system.

Agriculture as a cyber-physical system (CPS)

- The concept of precision farming as a CPS consists of the following:
  - wireless sensor networks (WSNs) (IoT),
  - information and data fusion,
  - decision support intelligence and
  - actuators for applications of inputs.

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Agricultural internet of things model.

- To overcome the limitations of spatially scarce data, advances in proximal sensing technology and data processing techniques are now able to provide information on soil, crops and associated environmental properties. These sensors will produce large volumes of data that have to be collected, stored, shared, processed, analyzed, fused and interpreted for translating data into new knowledge and action .

FIGURE 1.2 Agricultural internet of things model.

Internet of things architectures and paradigms.

- The IoT paradigm is based on the concept of a pervasive network capable of connecting not only people but also objects and systems.
- Within the IoT paradigm, a connected object is also defined as Smart, if, in some way, it is able to process its state or the world around it and consequently make decisions, which can be very simple (sorting data) or even complex (DSS).

CISCO internet of things (IoT) reference model

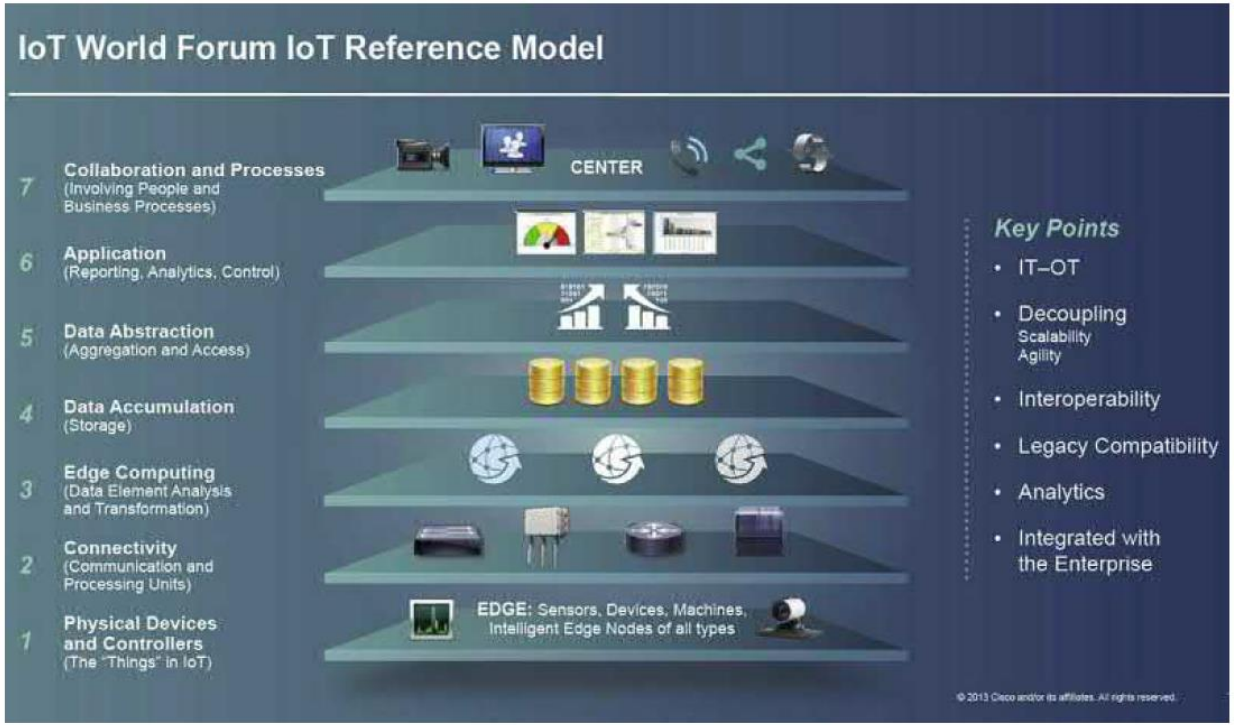

FIGURE 1.3 CISCO internet of things (IoT) reference model – IoT world forum.

Open source internet of things platforms

- Implementing precision irrigation or smart fertigation means making a series of measurements in the field, adding other useful data and making them available, in real time, to a decision-maker (DSS) that, when certain conditions occur, schedules the spreading of agronomic inputs, i.e., water and/or fertilizer.
- What has been described could be outlined with a loop like the one shown in Figs. 1.4 and 1.5.on next slide

Open source internet of things platforms

FIGURE 1.4 The decision support system process.

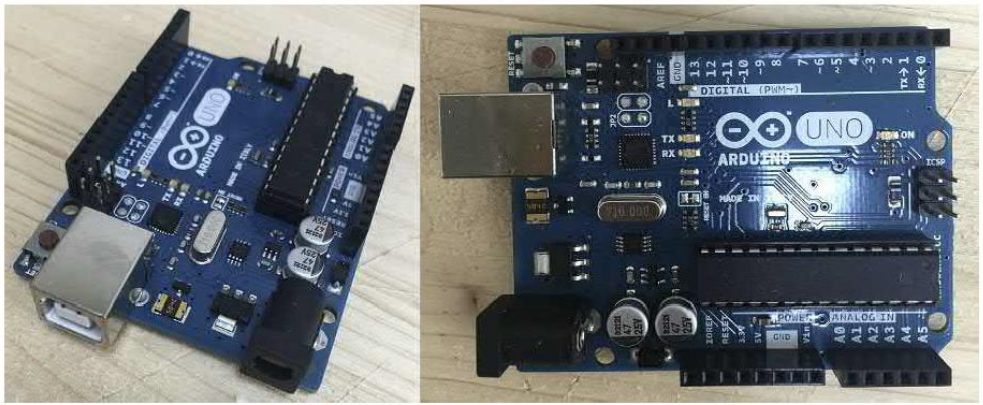

FIGURE 1.5 The Arduino UNO device.

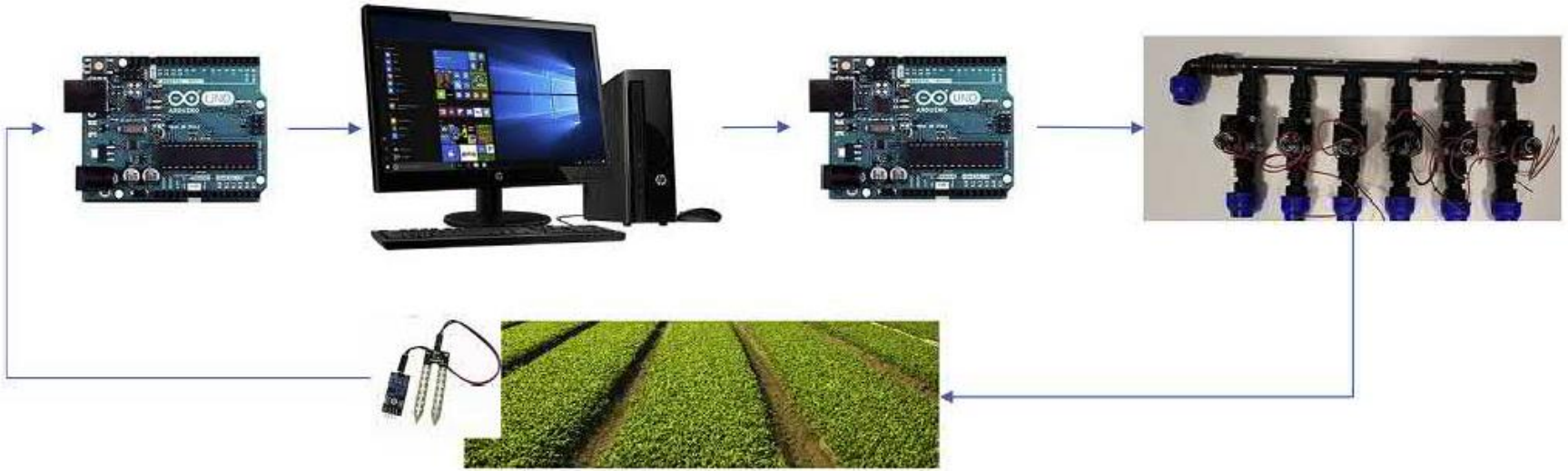

FIGURE 1.6 Arduino UNO integration schema for internet of things irrigation/fertigation

Session Q&A