IoT Academy

Digital Transformation: Enhancing IoT-driven Solutions for Smart Islands

IIoT and Industrial developments in smart islands

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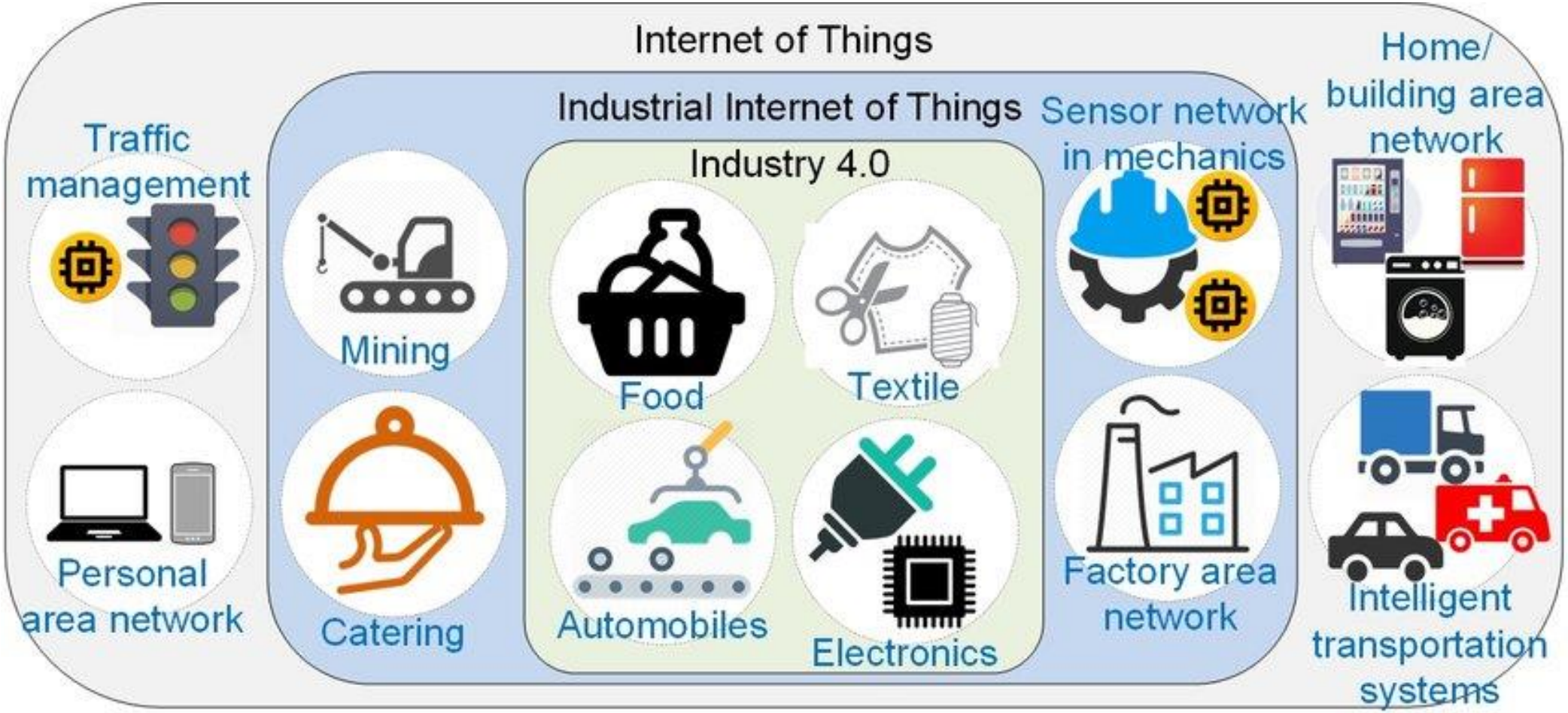
- CEO of IoT Academy (ITU Academia Member & ITU IoT Center of Excellence in Asia-Pacific)
- Faculty Member in ICT Research Institute
- International Internet of Things (IoT) Speaker & Lecturer
- International Telecommunication Union (ITU) Expert
- Chairman of The corresponding ISO/IEC JTC1 SC41 (Internet of Things and related technologies Standards) in Iran
- Chairman, Member of the founding board and the board of trustees of Non-Commercial Institute (as a NGO) of “Promoting the Internet of Things and data science” at national level.
- Doctor of Business Administration from the University of Tehran, MBA, M.Sc in Electrical Engineering-Telecommunication systems, B.Sc in Electrical Engineering- Electronics.

Other Records:

- Counselor of the Director of ICT Research Institute
- Superintendent of IT Faculty in Iran Telecom Research Center
- Deputy of IT Faculty in Iran Telecom Research Center
- Head of Multimedia Systems Research Group in Iran Telecom Research Center
- Project Manager, Consultant and Observer of more than 50 Regional and National ICT related Projects.

Internet of Things and Industry 4.0



The fourth industrial revolution

Digitization of products and production

Networking of the manufacturing working environment

Decentralization of processes

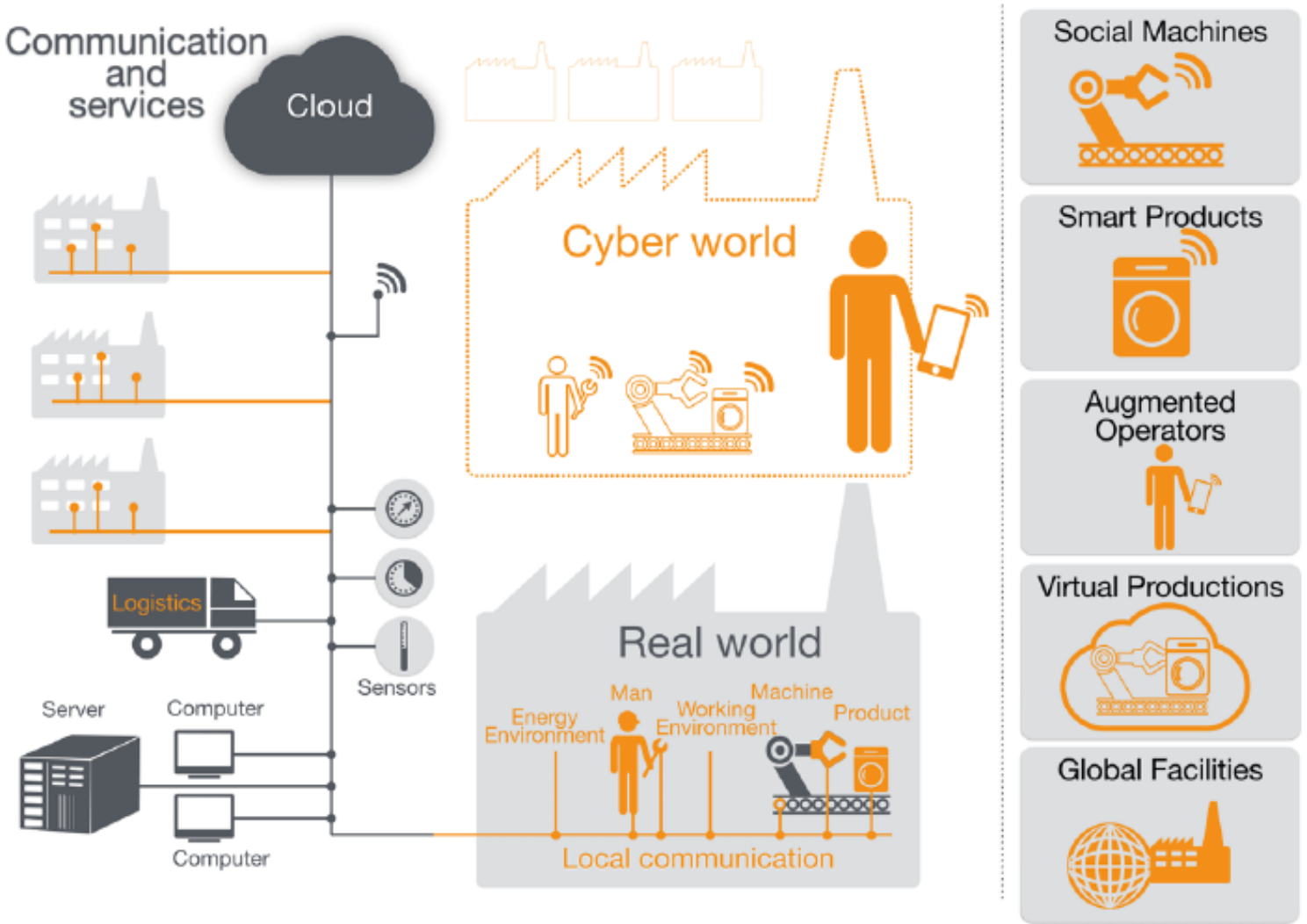
Decentralization of decision-making structures

Intelligent/smart factory

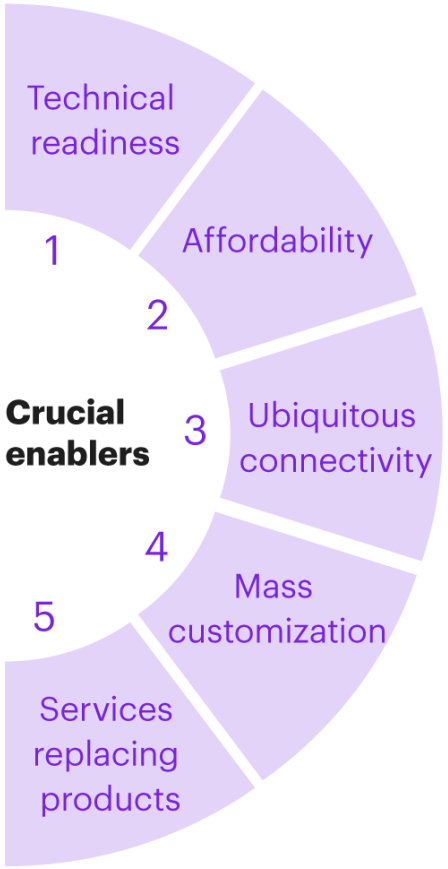
Cyber-physical systems

1. **Mechanization**
   Mechanical production
   Industry 1.0
   End of the 18th century
2. **Industrialization**
   Mass production
   Industry 2.0
   Beginning of the 20th century
3. **Automation**
   Electric automation
   Industry 3.0
   Early 1970s
4. **Cyber-physical systems**
   Integrated automation
   Industry 4.0
   Today

Week 1-6 IIoT and Industrial developments in smart islands



Five factors are accelerating the Fourth Industrial Revolution



1

- Ease of implementation and use of technologies are improving.
- Industry 4.0 technologies are quickly moving from research and development toward mass deployment.

2

- The unit selling price of technologies has declined by 50 to 75 percent along with reducing implementation costs.
- Worker training costs are decreasing.

3

- The Internet of Things is connecting production assets more rapidly.
- About 40 percent of equipment is connected.

4

- Production processes are more flexible with interchangeable tooling options enabling product customization.

5

- The huge capex required for such technologies is being mitigated through service-focused models.
- 3D printing on demand and “robot on rent” models are replacing the need to buy new technology.

Source: Kearney analysis


Please check the axes within the next two days.
Mr. Smith order is ready.
Maintenance is scheduled for tomorrow at 9.
I have space for Mr. Smith's order.
I'm ready for collection.
Economy
Ecology
Flexibility
Time-to-Market

The Industry 4.0 Strategy is based on three Pillars

Technology

- Intelligent components
- Modularity
- Networked systems
- Innovative solutions for functional integration and microsystems

People

- Human-machine interaction
- Adaptive and intelligent technology
- Simple, intuitive operation

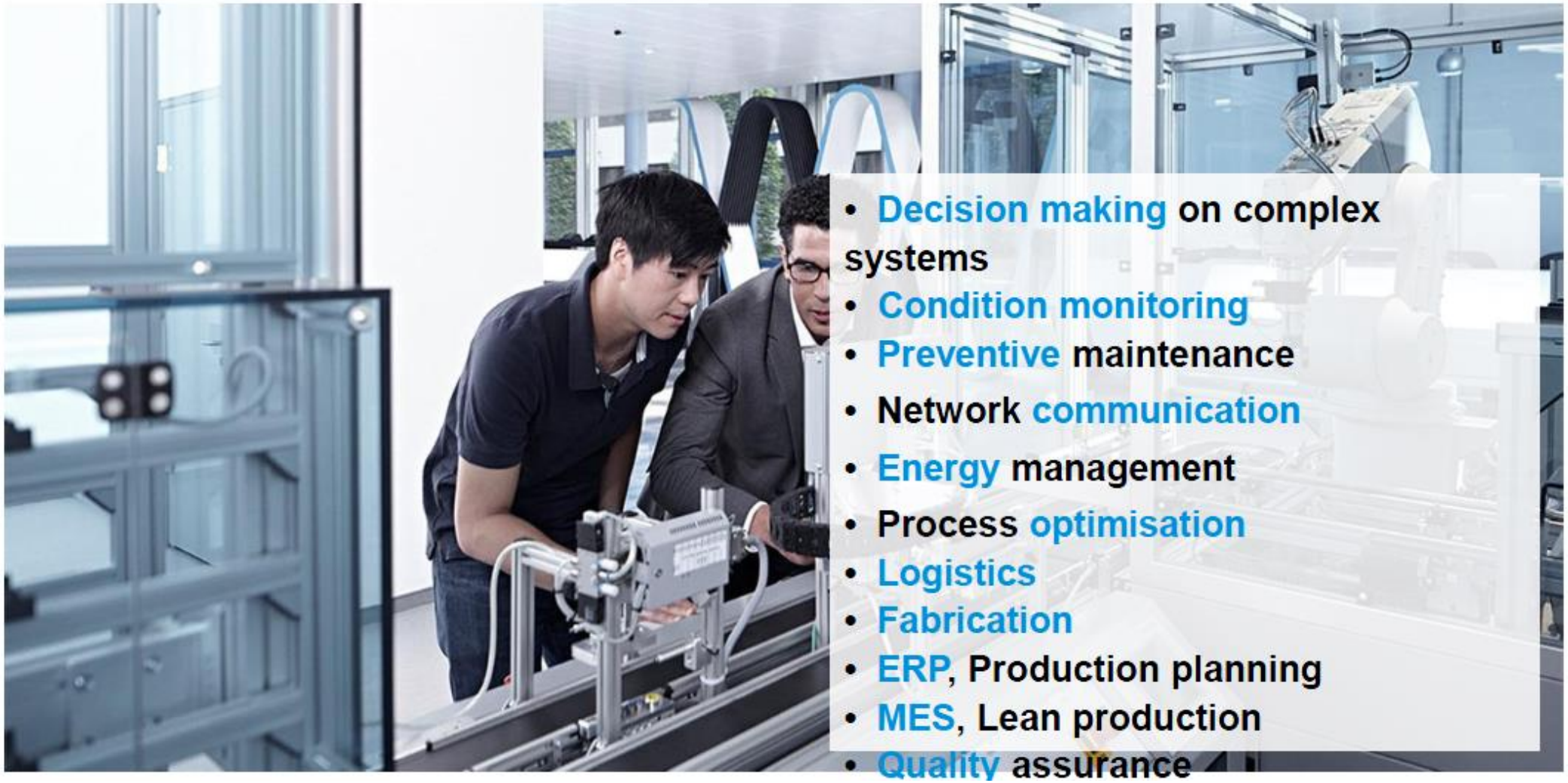
Qualification

- Training the new generation of workers
- Employee qualification
- Learning systems by Festo Didactic


• Intelligent products for adaptive production
• Modularity
• Networked overall systems
• Innovative integration and miniaturisation solutions
• Consistent software solutions
• Cyber-physical systems

Focus on People

Focus on Qualification 4.0



Fundamental paradigm shift in Industry 4.0

3.0

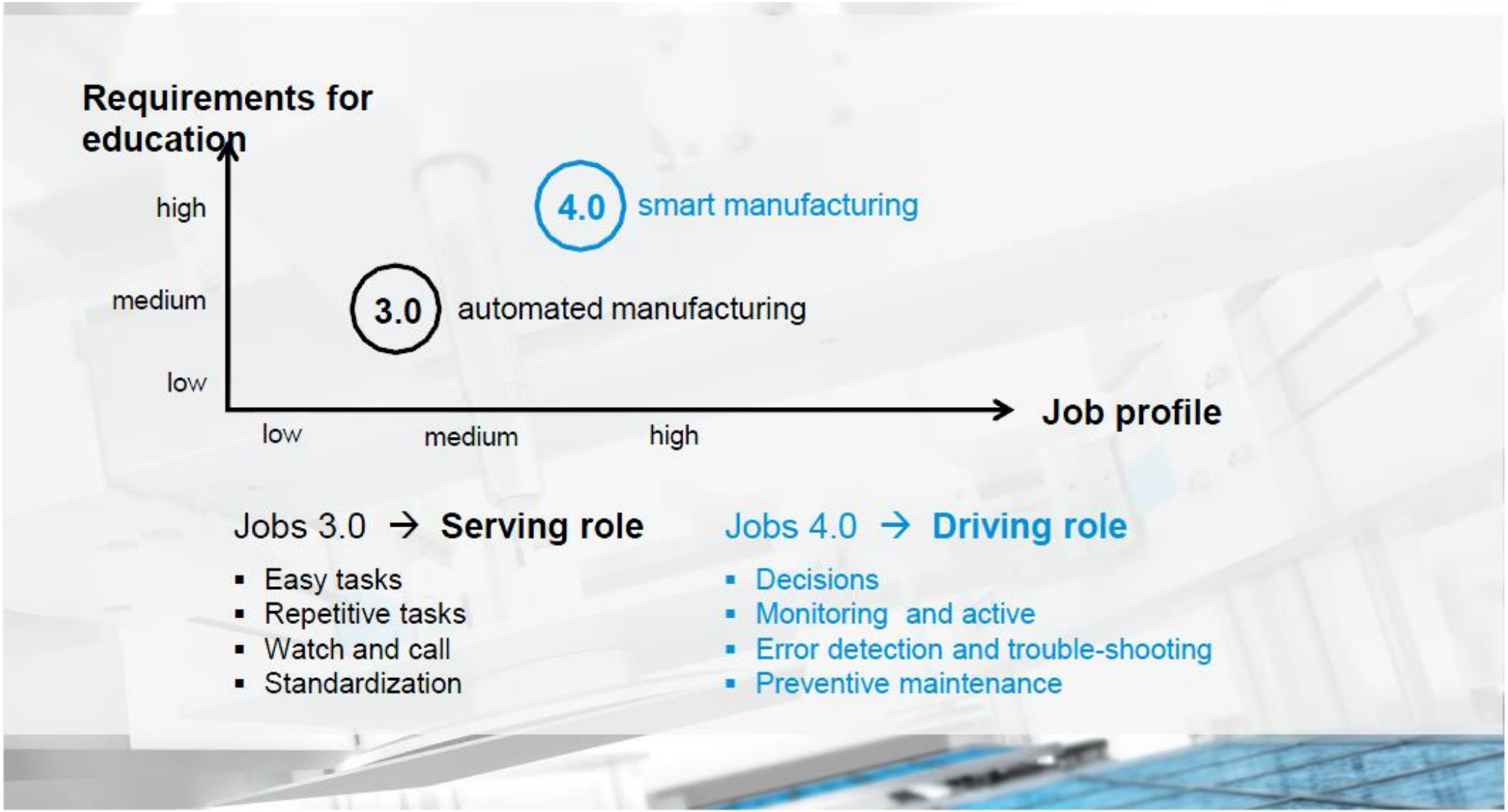
Third industrial revolution
The use of computers and robots leads to greater production automation.

4.0

Fourth industrial revolution
Industry 4.0 describes the networking of people, machines, and products – in real time, via the Internet.

- Hierarchical central control
- Established value chains
- Production system operation is planned in advance
- Products are passive objects in the processing operation

- Decentralized self-organization through ad-hoc networking
- Virtual ad-hoc organizations
- Autonomous, self-organizing production units
- Active production process supported by intelligent products


Requirements for education
high
medium
low
4.0
smart manufacturing
3.0
automated manufacturing
low
medium
high
Job profile
Jobs 3.0 → Serving role
Easy tasks
Repetitive tasks
Watch and call
Standardization
Jobs 4.0 → Driving role
Decisions
Monitoring and active
Error detection and trouble-shooting
Preventive maintenance

"Livestock sector is one of the fastest growing parts of the agricultural economy, contributing 40% of the global value of agricultural output and support the food security of 1.3 billion people"

Food & Agriculture Organization

Approach

We approach our solutions to be powered by AI + IoT, end to end

IoT is about automated data collecting,
storing, visualisation, and reacting, in massive scale

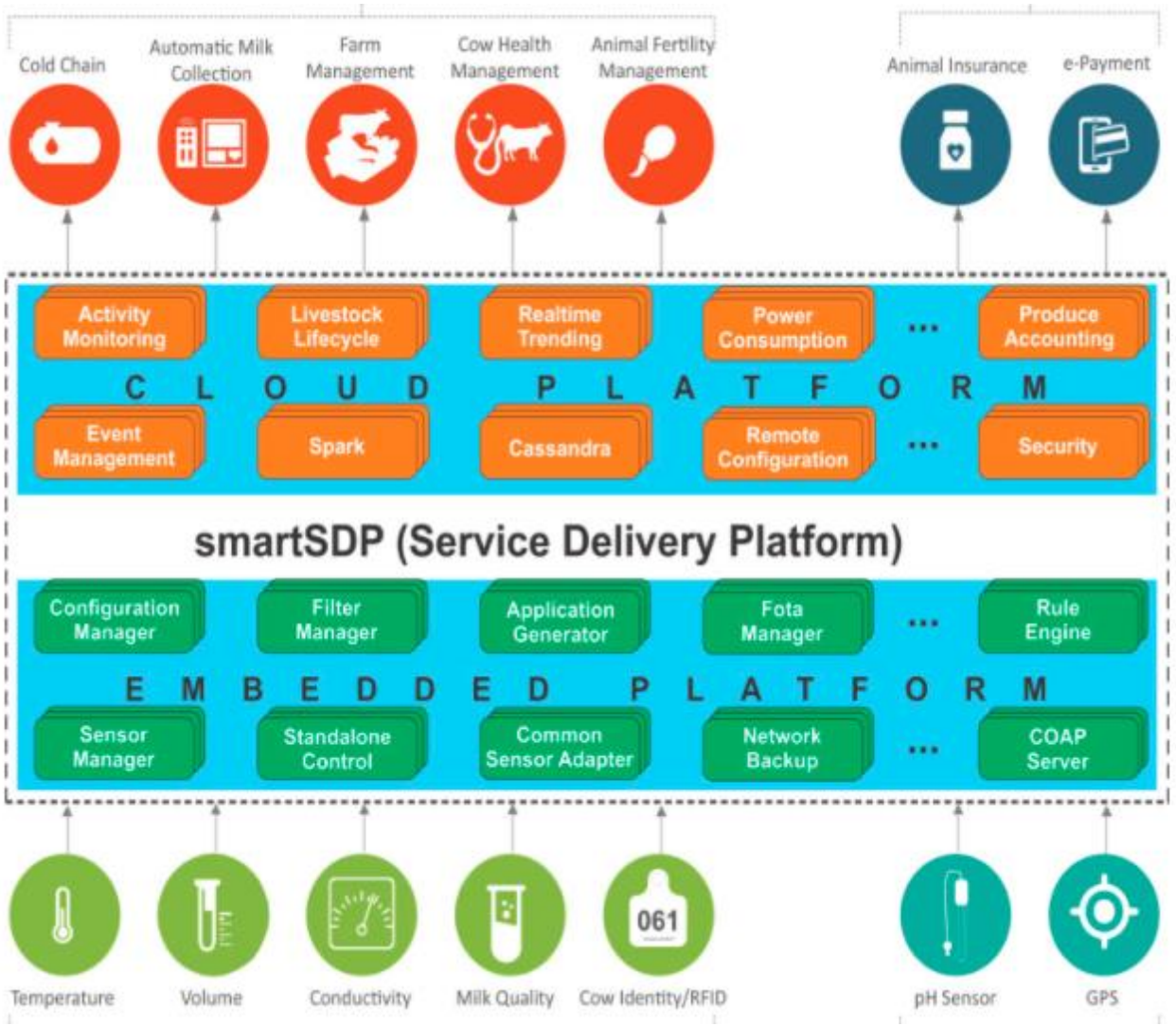
"Data Supplier"

AI is about making sense of the massive data,
providing insights & recommendation,
and predicting the future outcome

"Data Miner"

Combining AI + IoT (AIoT) enables a lot of opportunities!

Data acquisition and recording is the first step towards creating measurable value in any supply chain. While automated, IoT based acquisition ensures Data integrity, the ability to plug-in sensors and applications on the fly ensures agility in catering to multifarious supply chains. Data synthesis across the Rural-Agri supply chain will undoubtedly result in innumerable use cases and can help unlock unprecedented value on a very large scale. Click on the images to get a feel of these tools and our smart Service Delivery Platform.

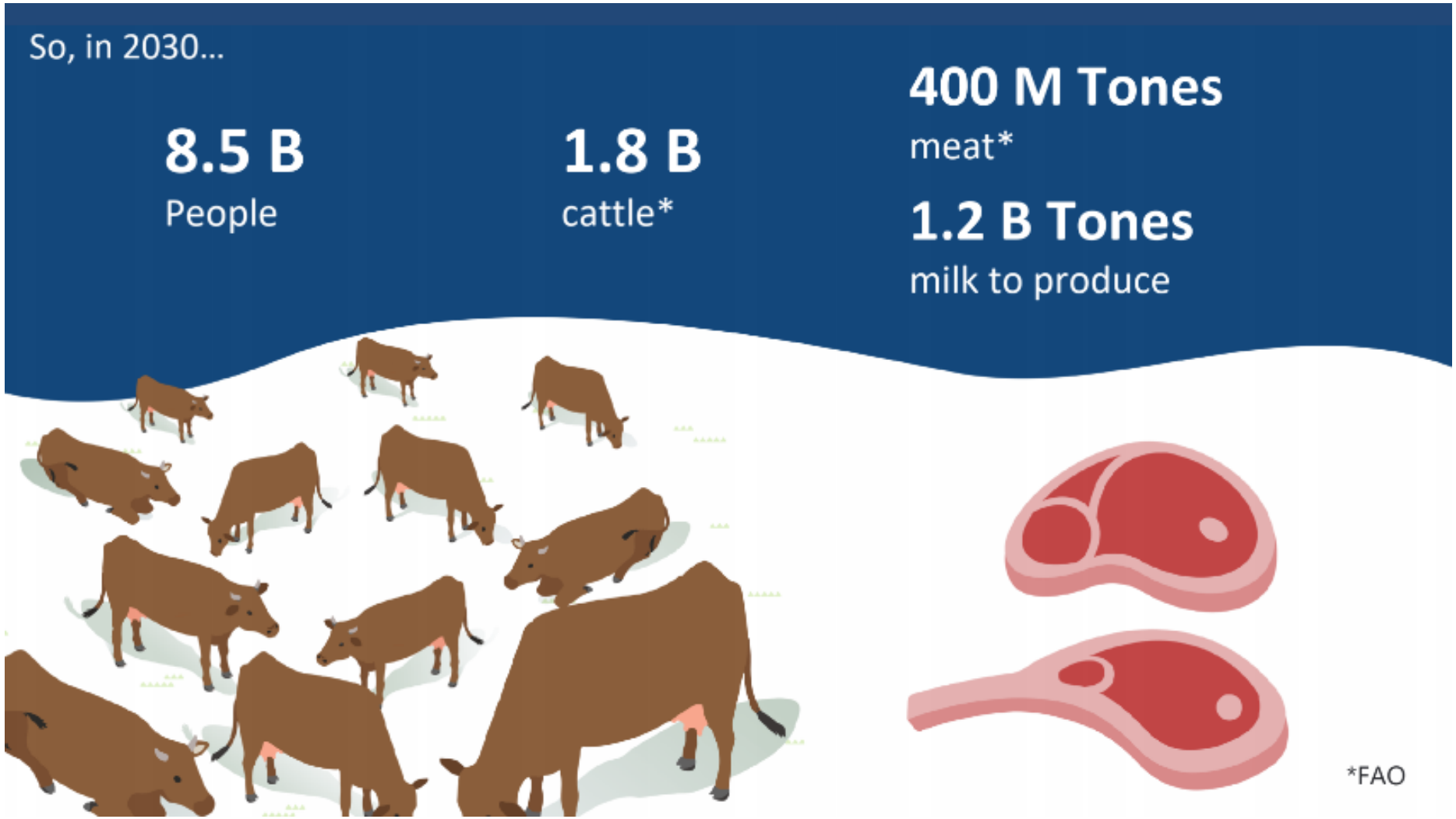

Cold Chain
Automatic Milk Collection
Farm Management
Cow Health Management
Animal Fertility Management
Animal Insurance
e-Payment
Activity Monitoring
Livestock Lifecycle
Realtime Trending
Power Consumption
Produce Accounting
CLOUD PLATFORM
Event Management
Spark
Cassandra
Remote Configuration
Security
smartSDP (Service Delivery Platform)
Configuration Manager
Filter Manager
Application Generator
Fota Manager
Rule Engine
EMBEDDED PLATFORM
Sensor Manager
Standalone Control
Common Sensor Adapter
Network Backup
COAP Server
Temperature
Volume
Conductivity
Milk Quality
Cow Identity/RFID
pH Sensor
GPS


The Internet of Things (IoT) helps companies collate huge volumes of data easily!

Livestock - Poultry – Fish

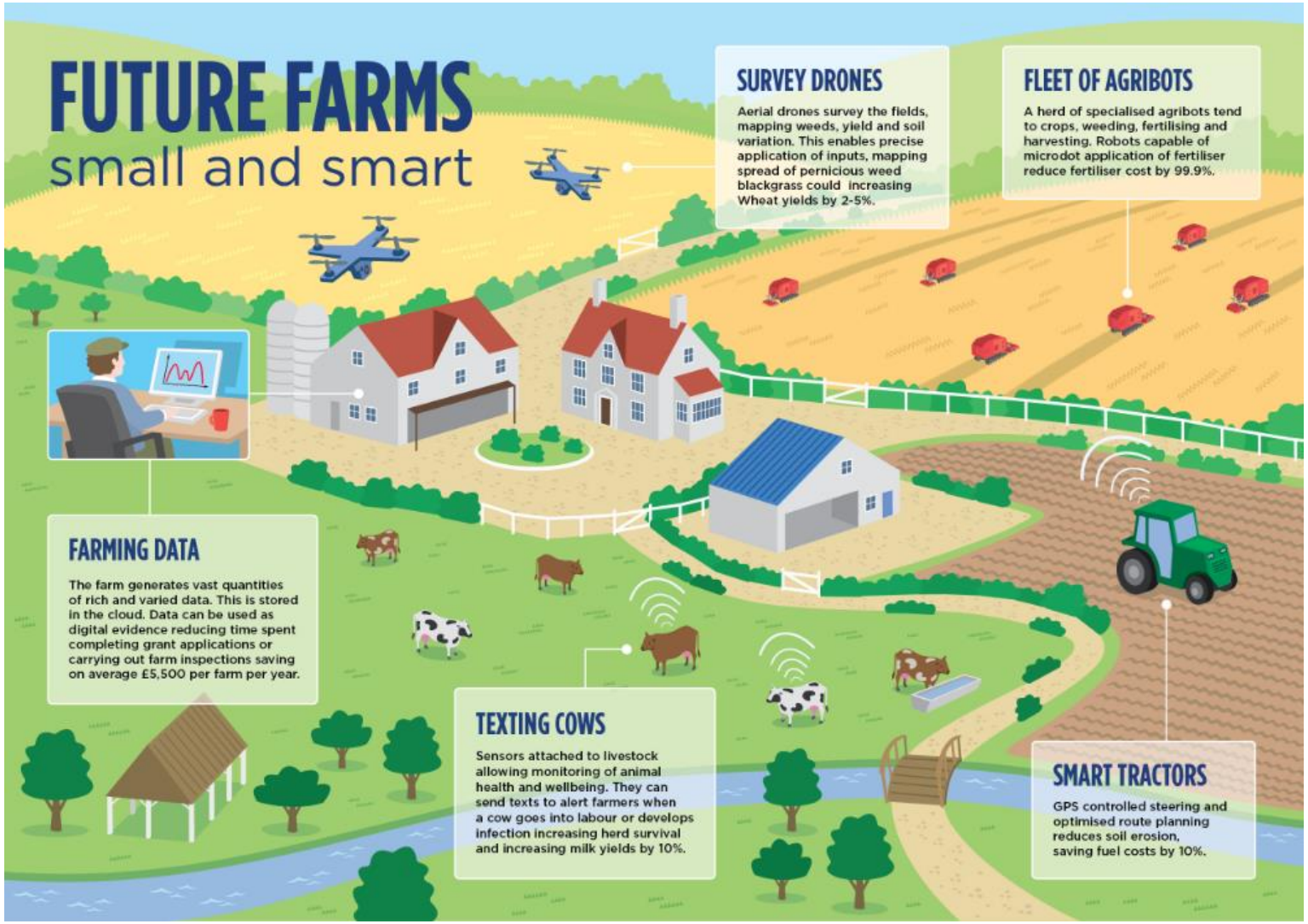
- Identification and tracking
- Feeding
- Grouping
- Behavior
- Environmental control
- Weather monitoring

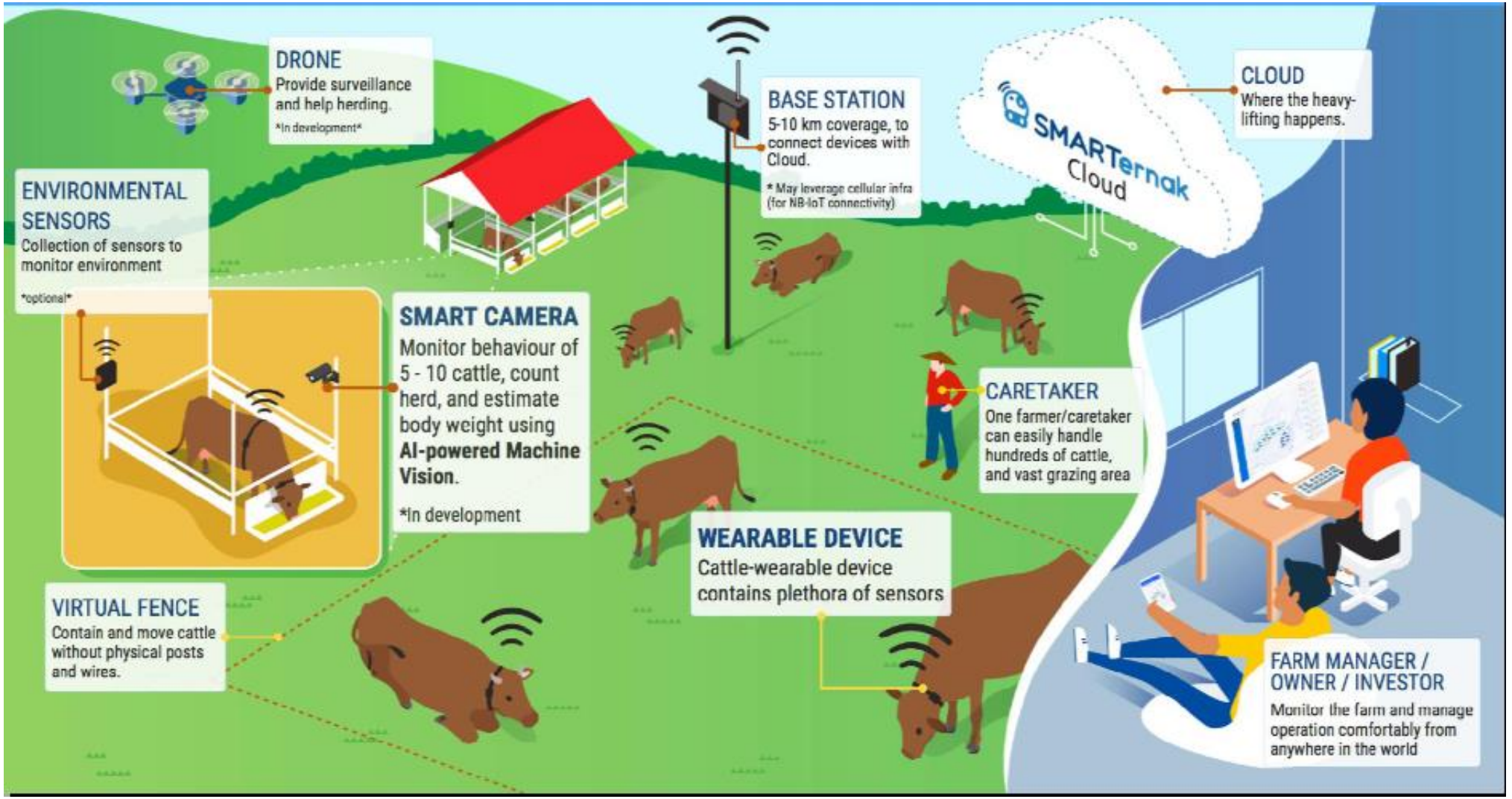
…

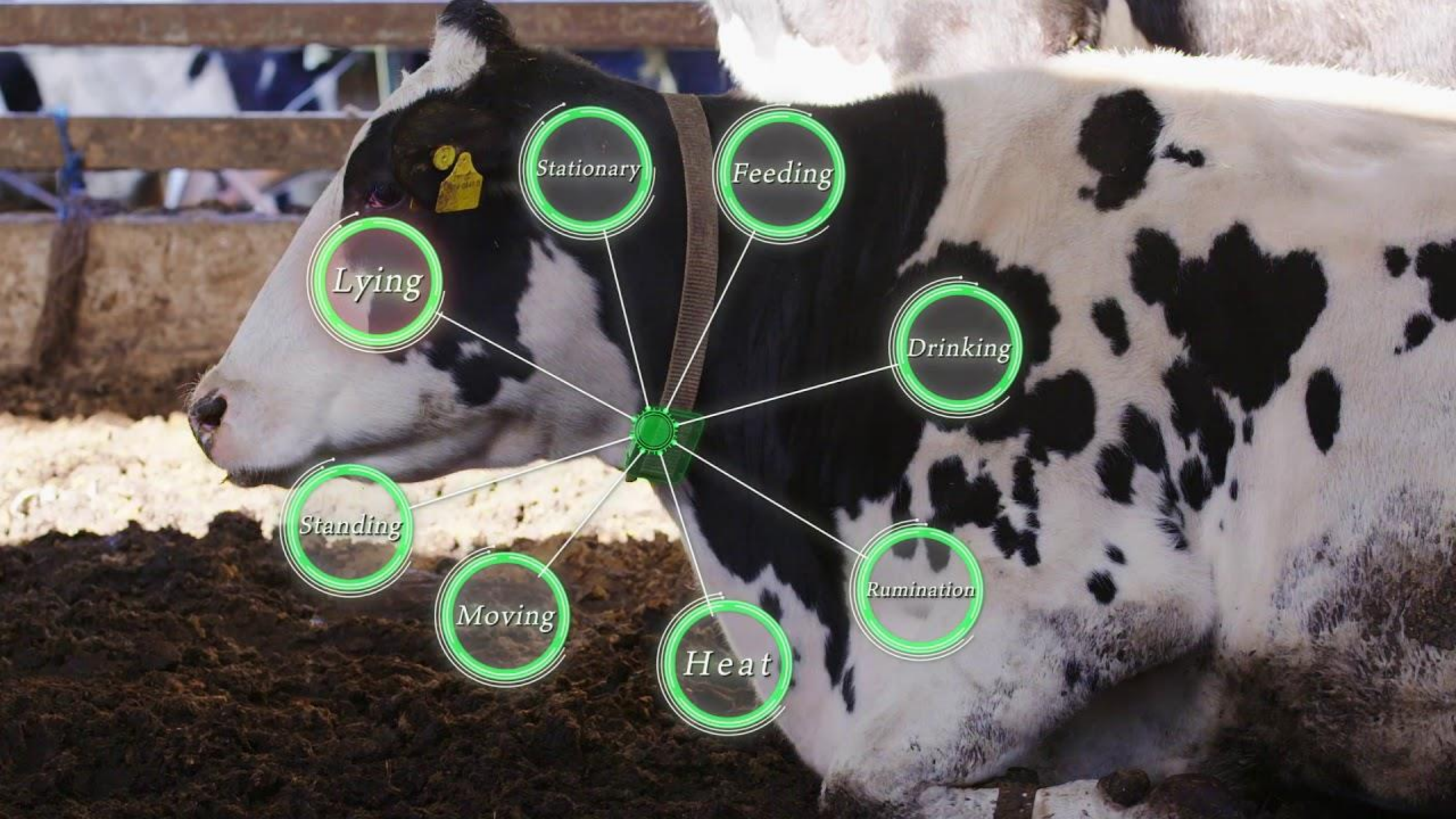

So, in 2030...
8.5 B
People
1.8 B
cattle*
400 M Tones
meat*
1.2 B Tones
milk to produce
*FAO

Precision Livestock Farming

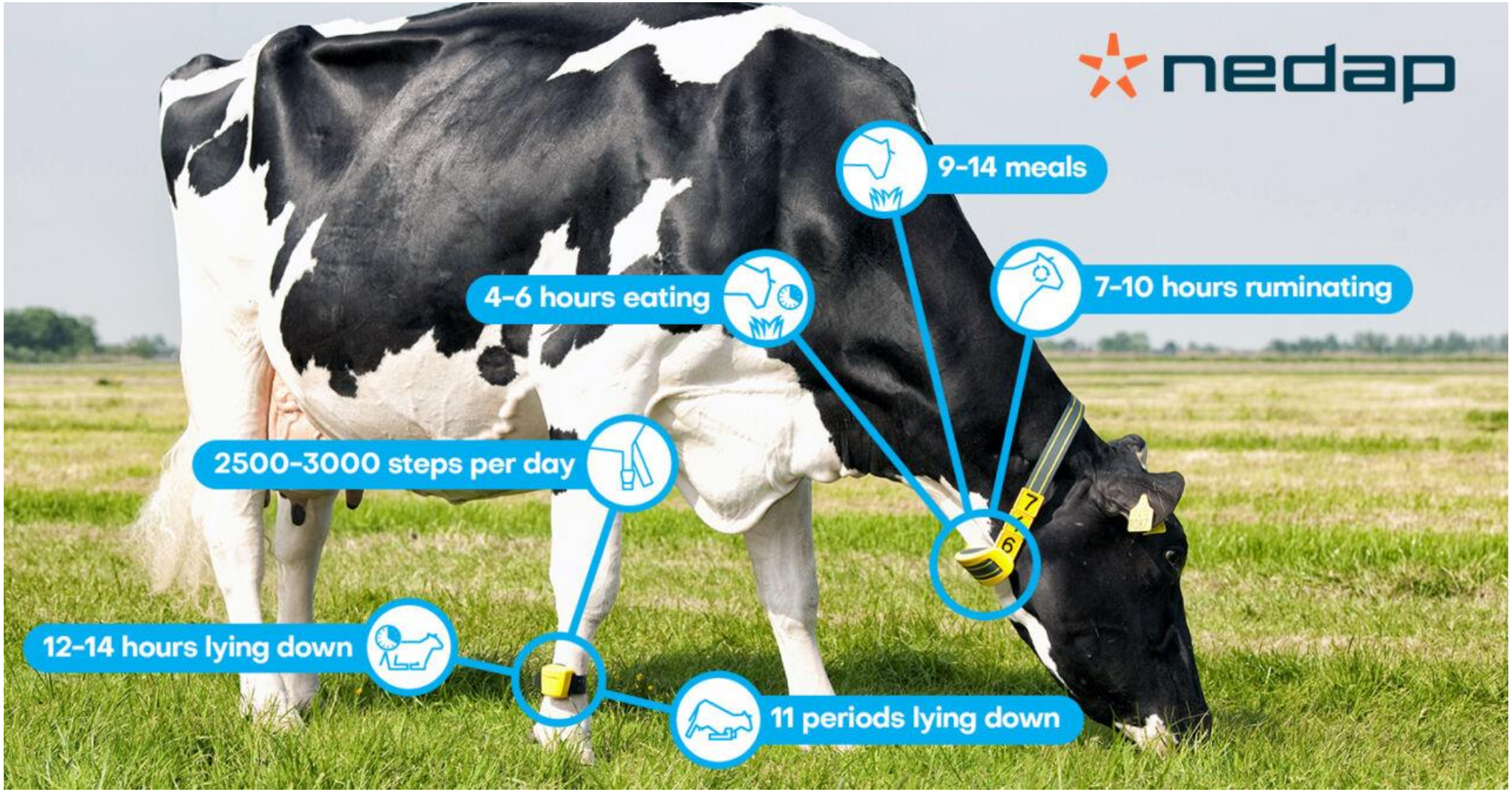
Data-driven management of livestock by continuous automated real-time monitoring of production/reproduction, health and welfare of livestock and environmental impact.




DRONE
Provide surveillance and help herding.
In development
BASE STATION
5-10 km coverage, to connect devices with Cloud.
* May leverage cellular infra (for NB-IoT connectivity)
SMARTernak Cloud
CLOUD
Where the heavy-lifting happens.
ENVIRONMENTAL SENSORS
Collection of sensors to monitor environment
optional
SMART CAMERA
Monitor behaviour of 5 - 10 cattle, count herd, and estimate body weight using AI-powered Machine Vision.
*In development
CARETAKER
One farmer/caretaker can easily handle hundreds of cattle, and vast grazing area
WEARABLE DEVICE
Cattle-wearable device contains plethora of sensors
VIRTUAL FENCE
Contain and move cattle without physical posts and wires.
FARM MANAGER / OWNER / INVESTOR
Monitor the farm and manage operation comfortably from anywhere in the world


Stationary
Feeding
Lying
Drinking
Standing
Rumination
Moving
Heat

Cattle-wearable Device


nedap
9-14 meals
7-10 hours ruminating
4-6 hours eating
2500-3000 steps per day
12-14 hours lying down
11 periods lying down

Wearable Device Internals

Electronic board is 100% designed in-house, mass-produced in Indonesia, by 100% Indonesian

Dual IoT Connectivity

Short Range: 1 km WiFi, Bluetooth v4.2, BLE
Mesh-supported. High speed, e.g. for firmware update

Long Range: **NB-IoT,**
for low power yet long range coverage

Powerhouse

Low Power, Dual Core Microcontroller
with on device Machine Learning inference

Actuators

Audio Alert/Speaker
LED

Packed with Sensors

GPS / GNSS
Accelerometer, Gyroscope
Body Temperature
Ambient Temperature & Humidity
Barometric Pressure
Ambient Light
MLMS Microphone
Device Removal Detector

Smart Energy Management

Battery Monitoring
Solar Energy Harvesting
Smart Switching Between
Main & Backup Battery
Firmware-optimised
power consumption

To watch the video of this slide, refer to the video presentation.

Monitoring & Insights

Monitor cattle where-about & well-being
Provide insights - powered by AI farmer doesn't really care about (raw) data

Environmental Sensors:
Monitor ambient temperature, humidity, and air quality in barn

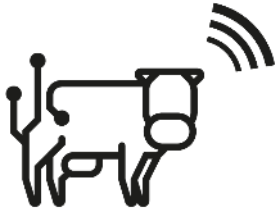
On-farm Smart Camera:
Monitor activity of 5 - 10 cattle - focus on group activity
Count herd & movement
Estimate weight

Cattle-wearable device:
Precisely monitor each cattle for: Location (latitude, longitude, movement speed, direction) Body temperature Ambient temperature & humidity Ambient light & sound Movement (linear acceleration, angular velocity, direction) Device removal status Battery voltage & capacity

To watch the video of this slide, refer to the video presentation.

Wireless communication

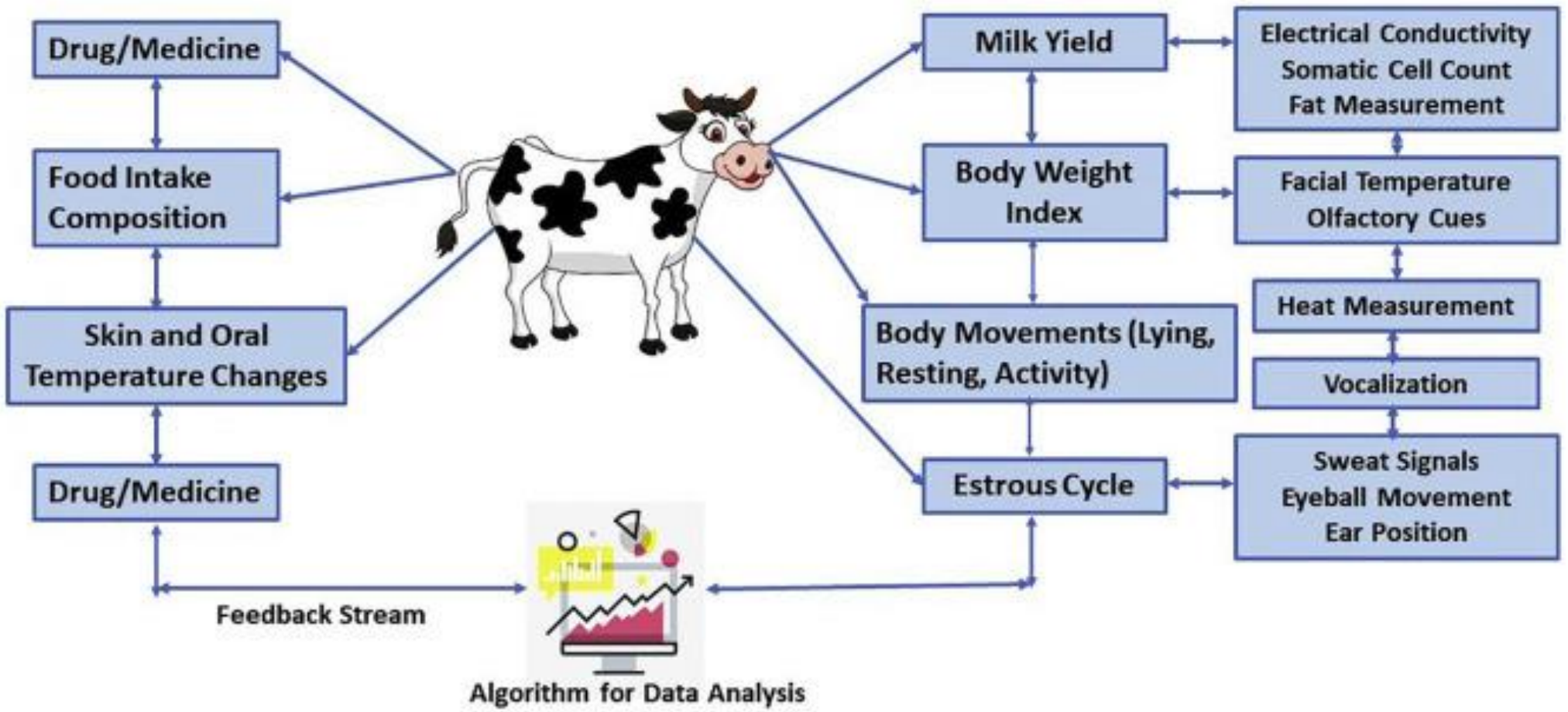
Data-Driven Sustainable Farming



With LoRaWAN® technology, whose long-range, low-power wireless sensors can send data from the farm to the Cloud, via private or public networks, farmers have easy access to a host of information for improving their businesses, with a distinct advantage over satellites and drones. Such high value data can be transmitted over distances of up to 15 km from sensors with batteries lasting up to 10 years, resulting in lower maintenance and operating costs along with greater operational visibility, which in turn empower farmers to scale their businesses.

For example, recurrent tasks on the field can be replaced by automatized modes of monitoring and maintenance. The benefits are two-fold: farmers are able to detect irrigation necessities based on weather recording and forecast, plant estimated needs , soil moisture, etc. while detecting defaults in the irrigation system. This avoids time consuming checking of the systems on the field, it optimizes efficiency of irrigation and avoids potential loss of crops.

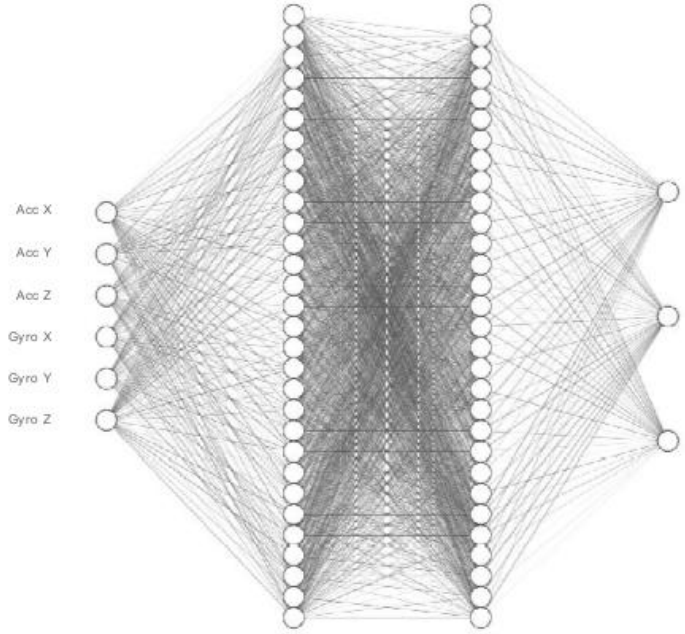
Individual monitoring of high value animals (cattle, horses…) or environmental monitoring of mass production animals (poultry, swine…) improves reproduction, grow factors and animal welfare while reducing the use of medication thanks to early detection of disease. This results in better milk quality and decreased environmental pollution.


Drug/Medicine
Food Intake Composition
Skin and Oral Temperature Changes
Drug/Medicine
Feedback Stream
Milk Yield
Body Weight Index
Body Movements (Lying, Resting, Activity)
Estrous Cycle
Electrical Conductivity
Somatic Cell Count
Fat Measurement
Facial Temperature
Olfactory Cues
Heat Measurement
Vocalization
Sweat Signals
Eyeball Movement
Ear Position
Algorithm for Data Analysis

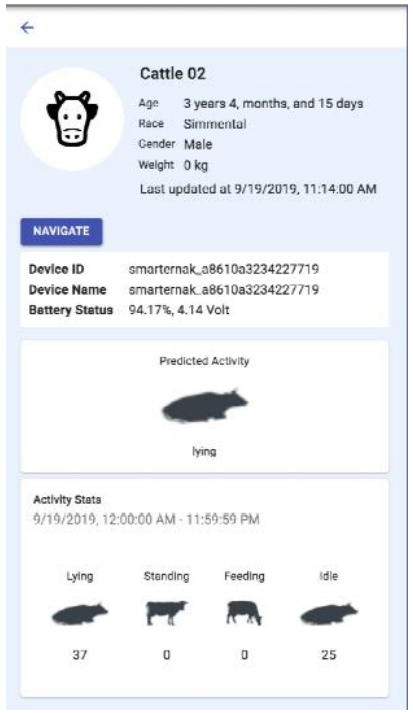
Artificial Intelligence at The Edge

Learn & det etc. cattle behavior's to tailor actionable insights & recommendation based on sensor data with the help of on-device Artificial Intelligence

Motion captured by Inertial Measurement Unit (IMU) sensor inside cattle-wearable device



Deep Neural Network



Predicted activity (standing, lying-dow n, feeding, and more)

Real-Time Location System (RTLS) for Indoor Tracking

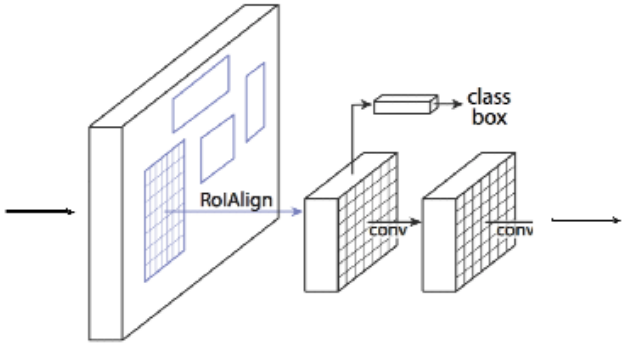
The sensors operate at a frequency of 2.4ghz, tracking the animals every second. It has a range indoors of 30-100 meters and outside 500 meters. It will tell you where an animal is to within 1.2 meters.

To watch the video of this slide, refer to the video presentat

On-farm Smart Camera

Cattle Counting & Behaviour Analysis using on-farm camera with the help of Machine Vision & on-device Artificial Intelligence

Image/video stream from camera



Deep Neural Network (Instance Segmentation)

Detected cows and predicted activity (standing, lying-down, feeding, …)

To watch the video of this slide, refer to the video presentation.

Smart Poultry

The word poultry refers to the rearing and breeding of avian species like ducks, chickens, turkeys, geese and guinea-fowls that have been domestic. They are the most excellent converters of feed into animal protein compared to another livestock. Chickens are the most general poultry enterprises. Chickens alone take up 90% of the net poultry.

Smart Poultry

In most of the countries, the demand of poultry meat is increasing progressively because of high protein, low energy and low cholesterol meat. The high production of chicken depends on the environment, breeding process and the active operations. To monitor and control the farm actively, in most cases sufficient manpower is required, however in turn it increases the production cost significantly. So it requires a mechanism that may manage the poultry farm easily for better improvement in the production with lower cost. Usually, the poultry farms are located in suburbs, away from populated areas. There can be more than one poultry farm nearby, and it requires a lot of manpower (labor) to manage each poultry farm. The advancement that has been made in the technologies now make it possible for remote monitoring and controlling system and thus reduces the manpower cost and enhances the production

Smart Poultry

By utilizing the internet of things (IoT) system, this goal can be achieved easily. IoT can be defined as many physical objects (having capability of sensing something from environment) connected to a WAN (Wide Area Network) network to collect, share and convey information for some analysis. With the help of these small network connected sensors or objects we can easily control a certain system . There is a great extent of using IoT like smart hospital, smart home and smart traffic. Smart poultry farm system can be a good implementation of IoT system.

IoT can help the poultry farm owners to enhance production while lowers the cost substantially. The size of poultry farm is generally 60 x 120 meters. Different type of controller and monitoring devices are used to maintain the temperature, humidity, feeding and watering inside poultry farm, that may be controlled remotely. In some developing countries, there are certain issues, such as lack of water, hard weather conditions, lack of infrastructure and transport facilities.

Smart Poultry

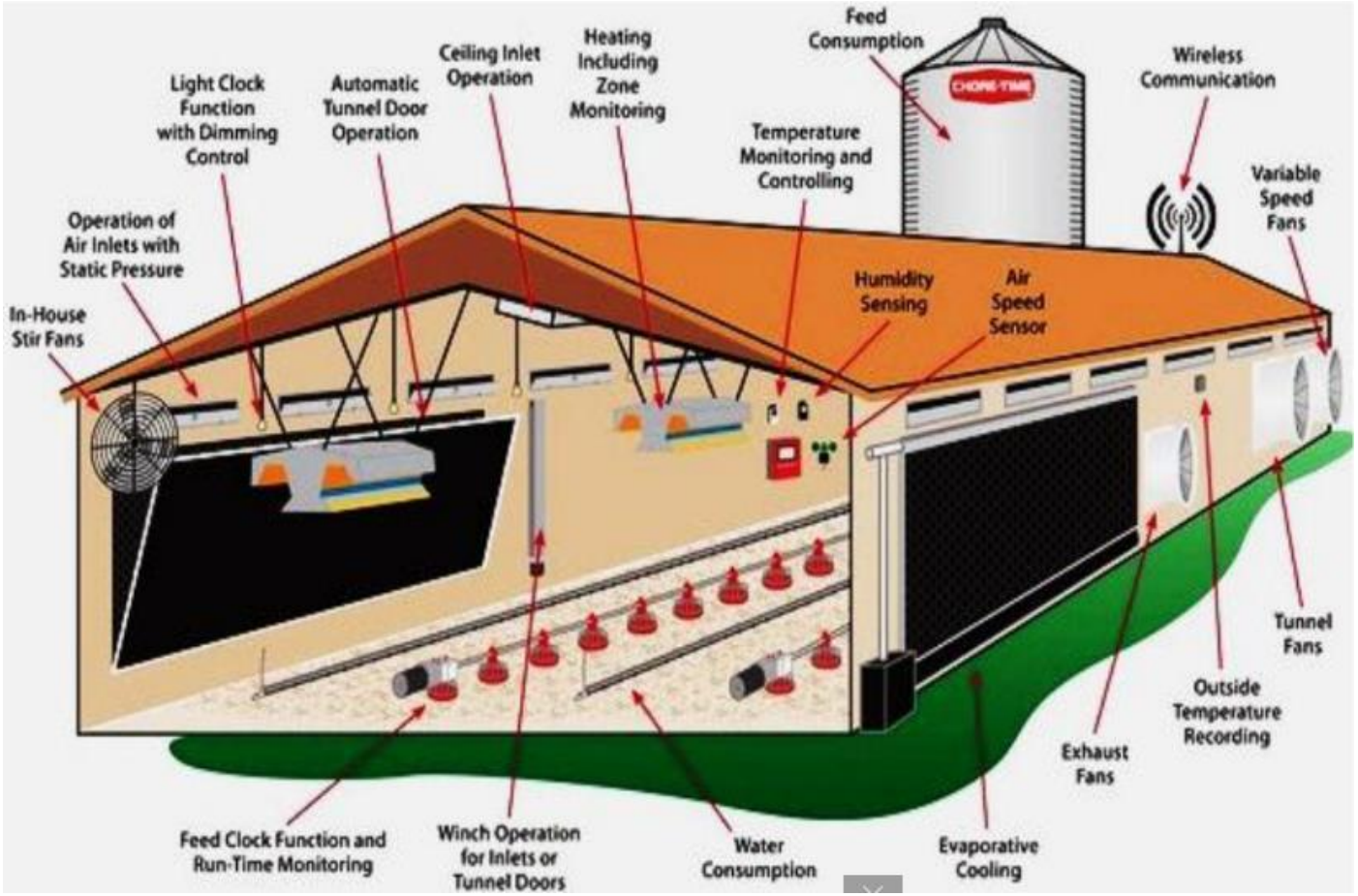
For such countries an IoT based smart poultry farming may help to resolve these issues up to some extent.

As discussed earlier, there can be environmental monitoring and controlling system which can be controlled remotely. These monitoring and controlling system are often based on wireless network . Wireless communication is steadily grows in recent years and it can be easily implemented in a places, that are located in remote areas with hard weather conditions and without complete communication infrastructure. For these reasons, wireless network has advantage over wired network, and seen as a best candidate to avoid the cable layouts and its management . In a wireless communication, the Wireless sensor network (WSN) is most suitable for such type of environments.

Smart Poultry

It provides connectivity to different sensors while inter connected with internet using a wide area network (WAN).The WSN is consisting of small sensor nodes, coordinator and internet gateway (WAN access). Sensor node has low processing and power capabilities than a coordinator. A coordinator is a powerful device which has more processing capabilities and a good battery life.

An internet gateway can be a cellular network or any other internet access point. An overview of wireless connectivity of typical poultry farm is depicted in Figure .



To watch the video of this slide, refer to the video presentation.

Smart Fish Farming

SMART means to have Fish Farm one click away!

Live Monitoring
Online access to the actual parameter values of each tank, from any device connected to the Internet.
Alerts
Instant alerts by e-mail or SMS when the pre-set parameters` values are exceeded.
Control
Remote switching on and off the automate installations of oxygen and tank water circulation.
Graphs
Display one or more parameters within the monitored tanks in progress graphs.
Records
Online records with recorded values for parameters monitored within different time periods.
Automate Control
Integral automation of the farm for automate control of parameters in accordance with the values recorded.

Smart Fish Farming

Online management means efficiency!
The high density of fish in aquaculture tanks leads to the acceleration of water quality degradation and requires permanent attention to parameters adjustment.

- **Real-time** online monitoring of temperature, pH, dissolved oxygen, and other relevant water tank parameters such as ammonia, conductivity and turbidity from any computer, tablet, or smartphone connected to the Internet.
- **Receive** alerts via e-mail or SMS when pre-set values are exceeded for any monitored parameter in order to quickly control any situation.
- **Analyze** records and graphs with values recorded during different time periods, by simply clicking on them, in order to improve production planning.
- **Send** parameter adjustment commands from any computer, tablet or smart phone , at any time, from anywhere.
- **Complete fish farm automation**, Automation of oxygen pumps, water circulation valves and fish feeders can be done according to the actual values of the parameters.

Deep learning for smart fish farming

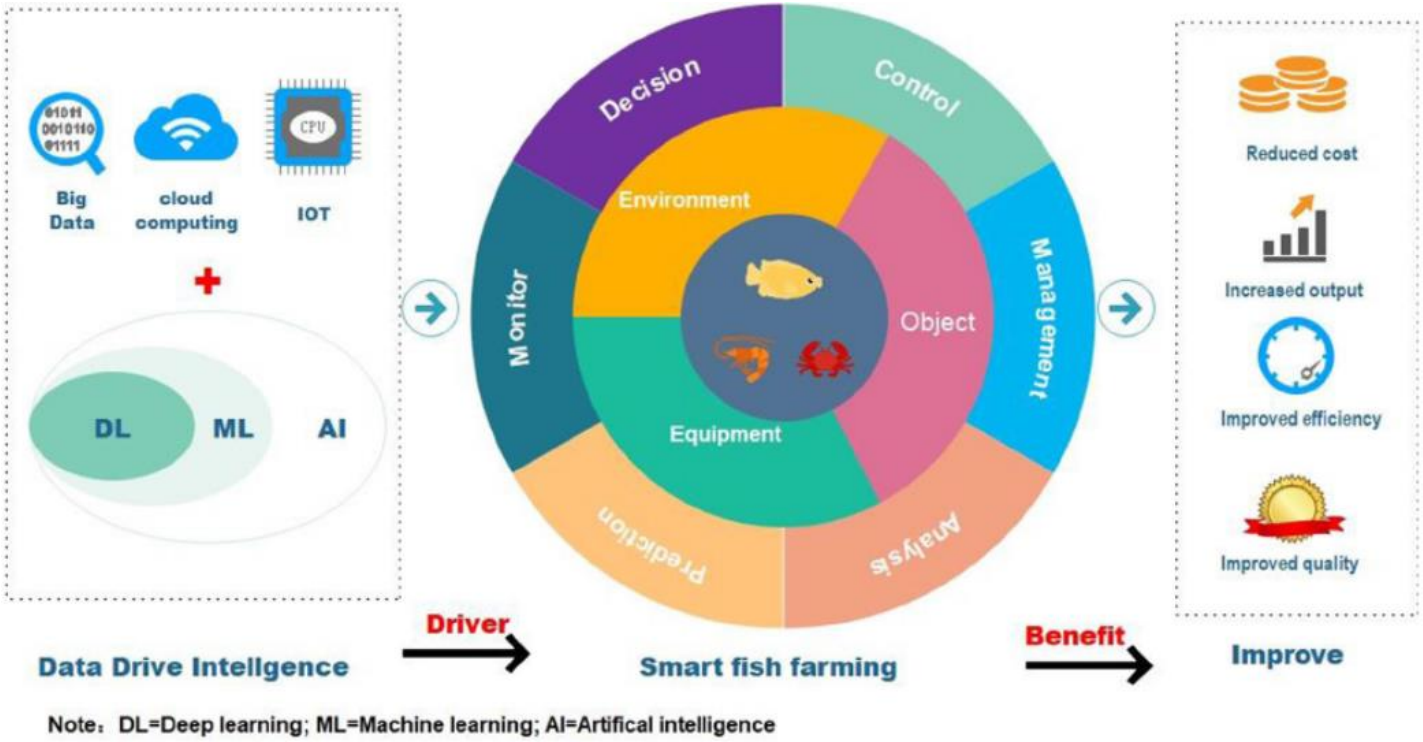
In 2016, the global fishery output reached a record high of 171 million tons. Of this output, 88% is consumed directly by human beings and is essential for achieving the Foodland Agriculture Organization of the United Nations(FAO)'s goal of building a world free from hunger and malnutrition (FAO 2018). However, as the population continues to grow, the pressure on the world's fisheries will continue to increase .

Smart fish farming refers to a new scientific field whose objective is to optimize the efficient use of resources and promote sustainable development in aquaculture through deeply integrating the Internet of Things (IoT), big data, cloud computing, artificial intelligence and other modern information technologies.
Furthermore, the real-time data collection, quantitative decision-making, intelligent control, precise investment and personalized service have been achieved, finally forming a new fishery production mode.
In smart fish farming, data and information are the core elements. The aggregation and advanced analytics of all or part of the data will lead to the ability to make scientifically based decisions.

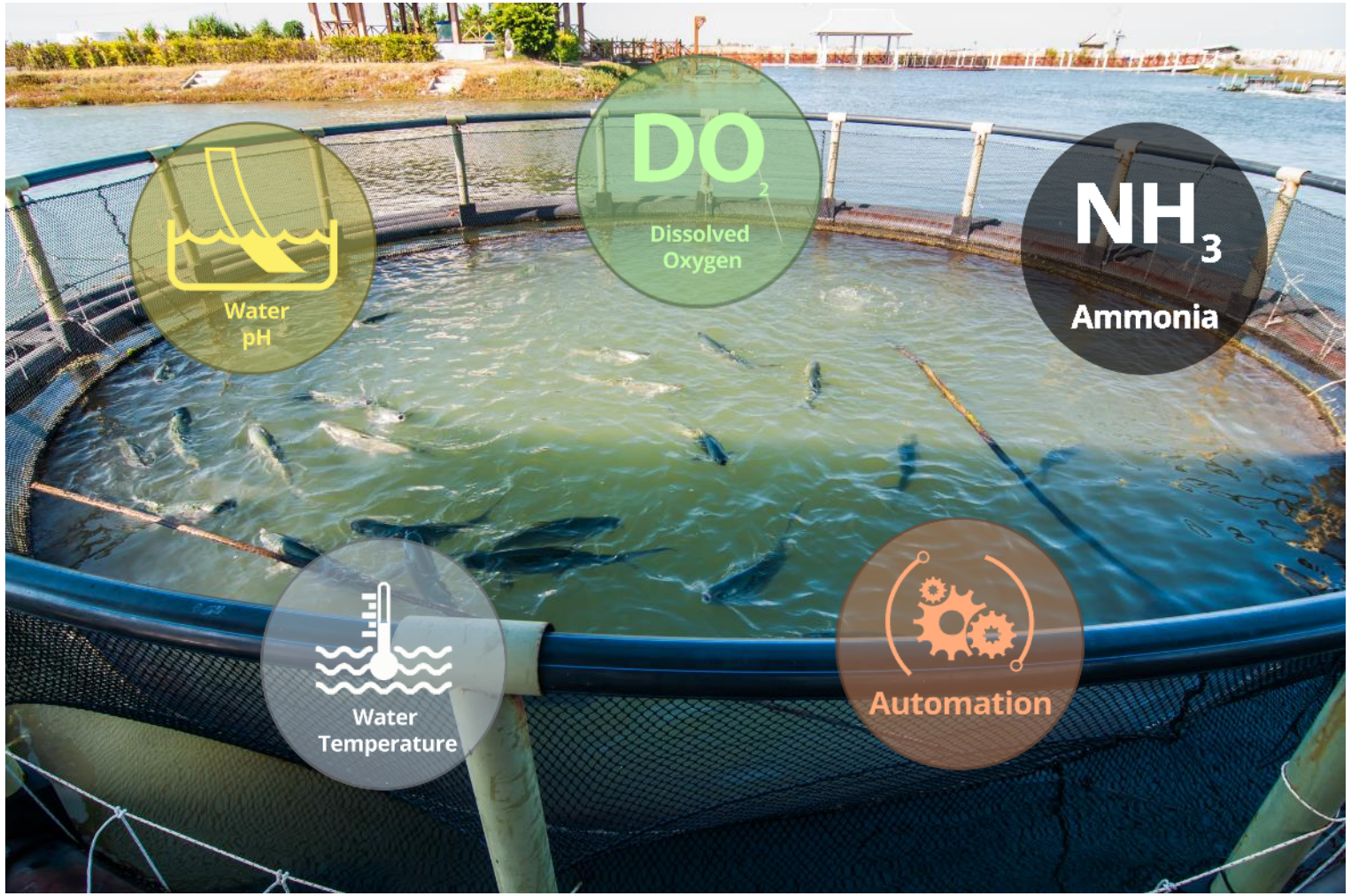
Deep learning for smart fish farming

However, the massive amount of data in smart fish farming imposes a variety of challenges, such as multiple sources, multiple formats and complex data. Multiple sources include information regarding the equipment, the fish, the environment, the breeding process and people. The multiple formats include text, image and audio.

The data complexities stem from different cultured species, modes and stages. Addressing the above high-dimensional, nonlinear and massive data is an extremely challenging task.



Note：DL=Deep learning; ML=Machine learning; AI=Artifical intelligence


Water
pH
DO2
Dissolved
Oxygen
NH3
Ammonia
Water
Temperature
Automation


thank you
danke
gracias
merci
obrigado
teşekkür ederim
go raibh maith agat
спасибо
dziękuje
sukriya
kop khun krap
terima kasih
grazie
arigatô
dakujem
mochchakkeram
ngiyabonga
bedankt
tapadh leat
dank je
мерси
хвала
рахмат
Баярлалаа
감사합니다
ありがとう
謝謝
ευχαριστώ