RFID solutions for dairy farmers

Nedap Cattle Management

Vital element for growth

*nedap

1. Introduction

1.1. Nedap

Nedap N.V. was founded in 1929 and is based in Groenlo in the Netherlands. The company has more than 700 employees worldwide. Nedap is quoted on the Amsterdam Stock Exchange (NYSE Euronext). At our modern headquarters we have combined our research, development, production and marketing activities, ensuring an efficient and reliable solution to customer requirements. Nedap is a solution-oriented, knowledge-based organization with a wide portfolio of products, systems and services and is an innovative and entrepreneurial partner. For more than 80 years, we have built our success on our highly successful co-operation with our customers, enhanced by our expertise in EID (Electronic Identification) and electronics. Our EID systems are used in various markets to offer the end-user the ultimate solution in secure and reliable identification. The capability to integrate and combine these various technologies affords a high level of flexibility. Nedap is a truly unique organization with several subsidiaries and a network of business partners all over the world.

Nedap Livestock Management

For over 35 years Nedap's Business Unit Nedap Livestock Management has been heavily involved in agriculture, one of the world's most essential industries. Producing safe quality food at an affordable price is the challenge facing the global agricultural community. Now that both the number of people and their welfare is rising, one of the oldest sectors in the world is challenged to double her production without exhausting the limited resources of our planet. This is one example of how Nedap Livestock Management has been contributing to this industry. By automating vital processes in animal husbandry, (feeding and milking, for example), Nedap Livestock Management enables farmers to make efficient use of their input. Nedap Livestock Management was the first to introduce individual animal feeding based on electronic identification for both dairy cows and sows. It develops, produces and markets its products worldwide either as complete solutions or integrated as sub-systems. Nedap's Livestock Management division can make use of the extensive automation knowledge Nedap has drawn from its wide range of activities. Its proven experience in applying electronics and software within agricultural environment assures the robust products demanded by this specific market. Nedap Livestock Management is the world's market leader in the electronic identification of livestock.

Contents

1.2 Nedap's track record with RFID

One of Nedap's first cow feeding stations.

Nedap's RFID solutions for the agricultural market are based on many decades of practical experience. We launched our first RFID technology based cow feeding station in 1977. Since then, Nedap has continued to develop management applications for dairy farmers including milk yield recording, central separation and heat detection.

The key to all of this is RFID technology, which takes the reliability, accuracy and efficiency of individual animal management in the milking parlor to an ever higher level. Besides applications for dairy farmers, Nedap also offers identification and automation solutions for pig, goat and sheep farmers.

2. RFID

2.1 What is RFID?

RFID (**R**adio **F**requency **Id**entification) is a technology that enables you to **identify unique products, people and animals** fully automatically and wirelessly. It is all done with radio signals. RFID can be used to make all kinds of processes more efficient, secure and more effective. The technology is used in a wide range of processes and applications: in logistics processes for registering incoming and outgoing goods, stock control,

anti-shoplifting, security, library automation and even for delivering information in museums - to mention but a few.

A basic RFID system always consists of:
• **an RFID label**
• **an RFID reader (antenna)**
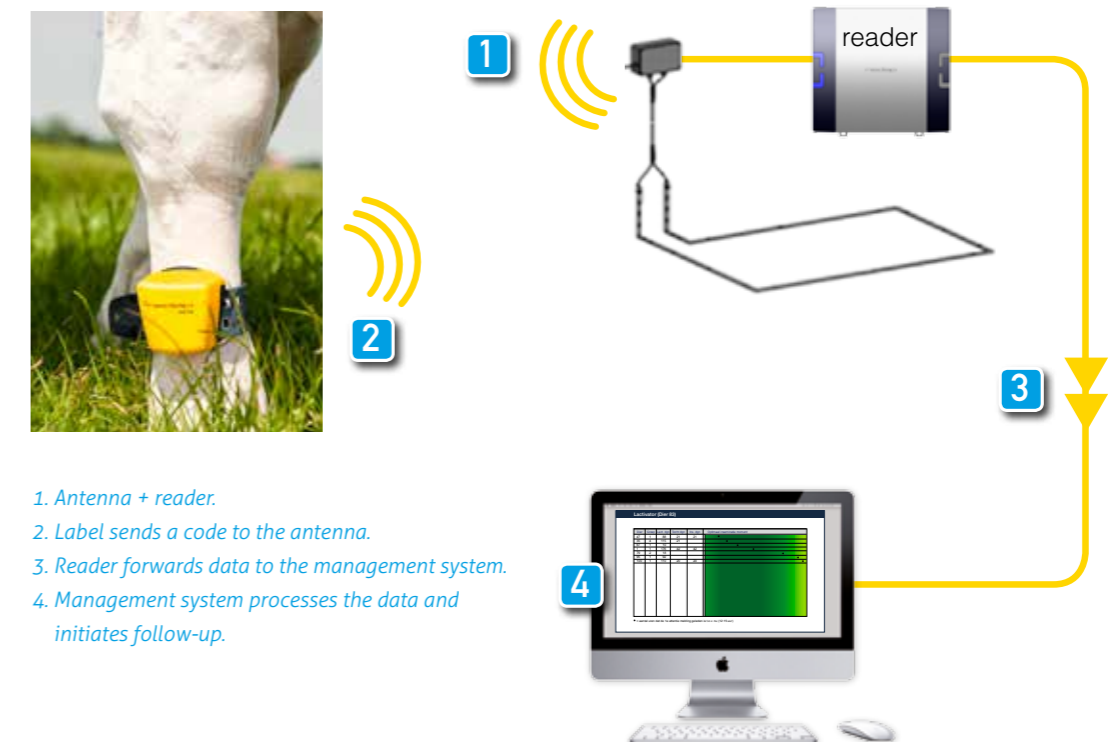• **a system for processing the RFID data.**

2.2 How RFID works in a milking parlor

An RFID system for a milking parlor also consists of RFID labels, antennas and an RFID data processing system.

1. The antenna transmits a magnetic field.
2. The labels use the energy from the magnetic field to send a code back to the antenna.
3. The antenna receives the code and forwards this data to the management system.
4. The management system processes the data it has received and initiates any necessary follow-up, such as indicating the animal's whereabouts in the milking parlor and assigning milk production data, or separating animals.

1. Antenna + reader.
2. Label sends a code to the antenna.
3. Reader forwards data to the management system.
4. Management system processes the data and initiates follow-up.

The label and antenna can communicate with each other in various ways. With RFID systems in the milking parlor, communication can take place with FDX (Full Duplex) and HDX (Half Duplex). See paragraph 2.3.2 (Technical aspects of RFID: ISO 11785) for more information.

2.3 ISO standard for livestock RFID

ISO in a nutshell

ISO is the acronym of the International Organization for Standardization. It also refers to the Greek word 'isos' which means 'equal'. And that is precisely what this organization does: it sets **international standards** for products and processes which businesses and industry can use. ISO standards are arrived at by mutual agreement within business and industry, so they are not the result of government legislation. These mutual agreements are made in order to **guarantee quality** and **security** for products and processes. But above all, they also ensure **compatibility**. Companies can choose whether or not to make their products or processes ISO compliant - it is not compulsory.

An example: The USB stick.
Many producers offer USB sticks: they are a handy way of storing data and copying it to various media like computers, laptops, tablets, or even MP3 players, cars and many other devices or equipment that store, use or generate data. To enable the consumer to connect a USB stick to any media or device and exchange data with it, the technology that enables the data to be stored and exchanged via the USB stick needs to be standardised. If no standards had been agreed for this, we would have ended up with a large number of different data carriers - such as USB sticks - for every medium or device, or even for every brand of medium or device.

ISO for livestock RFID

In short, ISO standards are standards that businesses and industrial companies have agreed among themselves and that guarantee quality and security. The same is true for RFID for livestock. Compatibility also became more and more important:
• **for dairy farmers**, to ensure that they are not tied to one system;
• **for system integrators**, to ensure that they can select and combine the best possible systems.

Key aspects of RFID are the unique animal numbers and the way the technology works. So the code structure and the technical aspects of RFID have been laid down in an ISO standard.

Benefits for RFID through ISO standards

Worldwide standard for RFID animal identification enables automatic national and international registration of origin and movement of animals:
• Less labor and administration
• Prevention of abuse of subsidy
• Fast response and tailored measures in case of outbreaks of infectious animal disease. Tailored and controlled prevention of animal diseases
• Improvement of consumer confidence

2.3.1 The livestock RFID code structure: ISO 11784

To enable every unique animal to be identified, **a unique identification code** *(animal number) is needed. This code needs to contain enough space and information to enable animals to be identified and to ensure international compatibility. ISO 11784 defines the structure of the RFID identification code for farm animals.*

The standard describes the code structure of a 64 bit[*1] identification code that is transmitted by the label, enabling unique identification. The code in the electronic identification device is split up into a number of code fields[*2]. Each of these code fields has its **own meaning** and transmits **specific information**.

The number of bits in the code fields determines the **number of possible combinations** and therefore the **amount of information** and the number of unique numbers that can be contained in a code field. The ISO 11784 code structure is described in the following table.

Table: Code structure at the 64 bit identification code for farm animals

| Bit no.	Information	Number of combinations
1	Information about animal or non-animal application.	2
2-15	Reserved code field for future use or additional manufacturer information.	16.384
16	Information about the existence of a data Block or no data Block. This indicates if additional data is to be received measured by a device which combines identification and monitoring. This bit is not used.	2
17-26	Unique country code. This code is a three-digit country code between 000 and 900, defined in ISO 3166. In addition, this code field[*2] can be used to specify a unique manufacturer code. This three-digit manufacturers code is between 901 and 999. The manufacturer code is used if the identification code has not been issued by an official body but by a manufacturer.	1.024
27-64	National identification code.	274.877.906.944

*1   Bit: The smallest amount of information in digital or information technology
*2   Code field: Group of bits in the identification code with a specific meaning.

Numeric animal number

The 64-bit code structure is ideal for creating a unique identification code that contains enough space and information to identify animals. The code is transmitted digitally by the label. This code structure is not really suitable for use as an animal number **that can be written down** however.

So a **numeric abbreviation** was created, consisting of the three-digit country code or manufacturer code and the 12-digit national identification code. This results in a **unique 15-digit numeric animal number**. This number, or part of it, can often be found on labels or in management programs.

Example: numeric animal number

984 000000725567

12-digit national identification code

3-digit country or manufacturer code
984 is Nedap's unique manufacturer code.
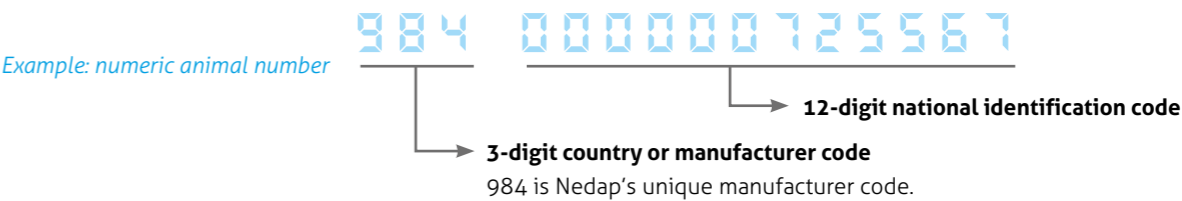
2.3.2 Technical aspects of livestock RFID: ISO 11785

The technical operation of RFID in the animal shed can differ in terms of how the label and the antenna communicate with each other. This can happen in two ways: with **FDX** *(Full Duplex) and* **HDX** *(Half Duplex). There are two differences between these: firstly, they differ in terms of how a label is activated to transmit information, and secondly,* **how the stored label information is sent** *to the antenna. The operation of both FDX and HDX technology is defined in ISO 11785.*

FDX

With Full Duplex, the antenna constantly transmits a magnetic field which energizes the label. As soon as the label has received enough energy it starts to 'reply' (i.e. transmit the stored code). The antenna 'hears' the answer while continuing to transmit an magnetic field. The label stops replying when it leaves the magnetic field.
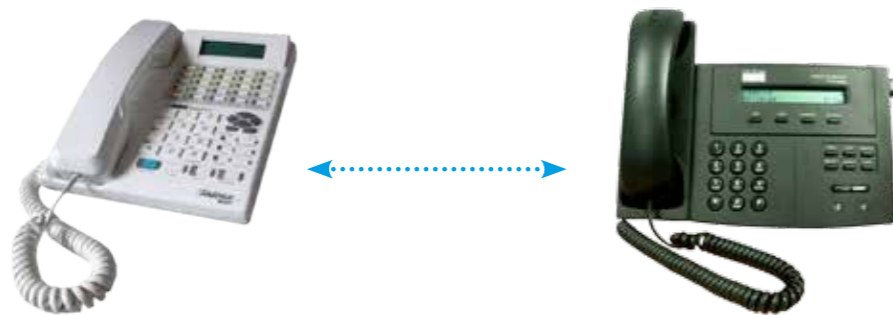
Communication between the label and the antenna in FDX can be compared with a telephone call, where the two parties remain connected to each other throughout the communication.

HDX

With Half Duplex, the antenna transmits a magnetic field to provide the label with sufficient energy. The antenna then stops transmitting the magnetic field. As soon as the charged label starts 'replying', the antenna 'listens'. Then the antenna reactivates the magnetic field to re-charge the label. At that point the label stops 'replying'.
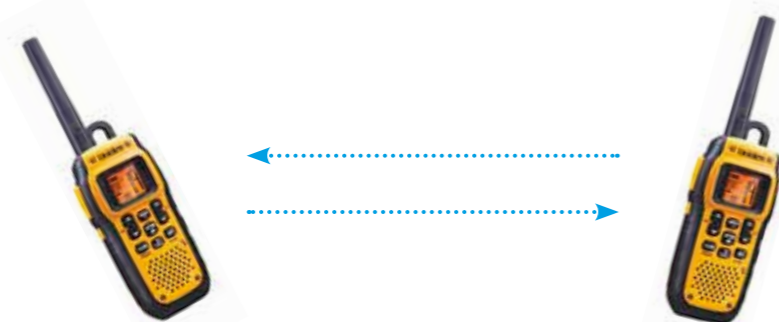
Communication between the label and the antenna in HDX can be compared with a conversation on a walkie-talkie, where the two parties communicate with one another in turn.

3. Use of RFID in the milking parlor

3.1 RFID for management and tracking & tracing

RFID farm animal identification is used for various reasons: for **management purposes** in the milking parlor and for **tracking and tracing**.

By RFID for **management** purposes we mean the **frequent** and **intensive use** of the identification on the livestock farm itself. The identification is used for monitoring individual animals and activating feedings, sorting, etc. The use of RFID for **tracking and tracing** is about tracking animals through the **entire production line**. All stakeholders in this production line must be

able to use this (livestock farmers, auction houses, abattoirs, retail, vets, government authorities, etc.), but this usage is generally **less frequent** and **less intensive**. So the requirements for the performance of these labels are less stringent.

The various uses of RFID for identifying farm animals call for different labels with different features and characteristics. The differences are shown in the table below.

| Segment	Application	Tags
Management	Production monitoring Individual programmed feeding Sorting, routing Weighing Heat detection	Relatively large Collar or leg mounted Strong signal Reliable identification
Tracking & Tracing	Mandatory schemes Voluntary use	Relatively small Ear tags or boluses Less reliable identification

3.2 Nedap solutions for using management labels in the milking parlor

For the use of management labels in the milking parlor, Nedap offers solutions with a walk through and a walk over antenna.
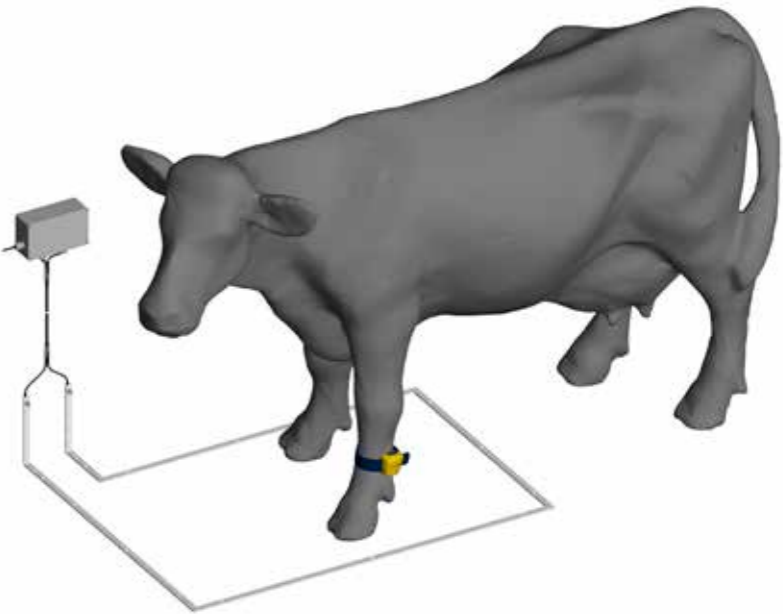
3.2.1 Walk through antennas

- For neck-mounted tags
- Easy to install
- Autotuning (optional)
- Flexible, fits all types of stalls
- 99.9% identification
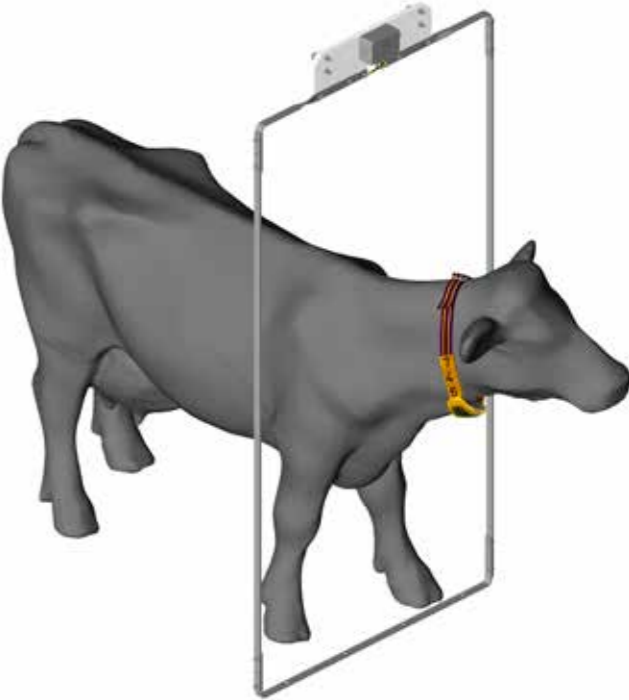
3.2.2 Walk over antennas

- For leg-mounted tags
- Easy to install
- Autotuning (optional)
- Flexible, fits all types of stalls
- 99,9% identification

3.3 Nedap solutions for using ear tags and boluses in the milking parlor

Ear tags and boluses are labels that are ideal for tracking and tracing, as they are **easy to fit**, they have a **long service life**, they are fraud-proof and they are **relatively cheap**. But in some cases these labels are also used for management purposes. Because the signal from these labels is much weaker than management labels, a key requirement for their use for management purposes is that they must be of extremely good quality. The rule of thumb for the quality of ear tags is: the bigger the tag, the better the quality of the ear tag. This enables them to receive more energy and return a stronger signal.

For the use of ear tags and boluses for management purposes in the milking parlor, Nedap offers several solutions.

3.3.1 Walk past antennas

- **Easy to install**
- **Flexible, fits all types of stalls**
- **Made of high quality HMPE (High Modulus Polyethylene)**
  - Extremely tough
  - High impact strength
  - Low coefficient of friction
  - Resistant to abrasion
    (15 times higher than carbon steel!)
  - Odorless, tasteless, non toxic
- **Automatic tuning**
  - Plug-and-play installation
  - Automatically retunes after any change in the environment
  - Switch on/off function for auto-tuning to avoid constant retuning due to opening/closing of (entry) gates
- **Easy mounting by drilling holes on site in designated area of the antenna**
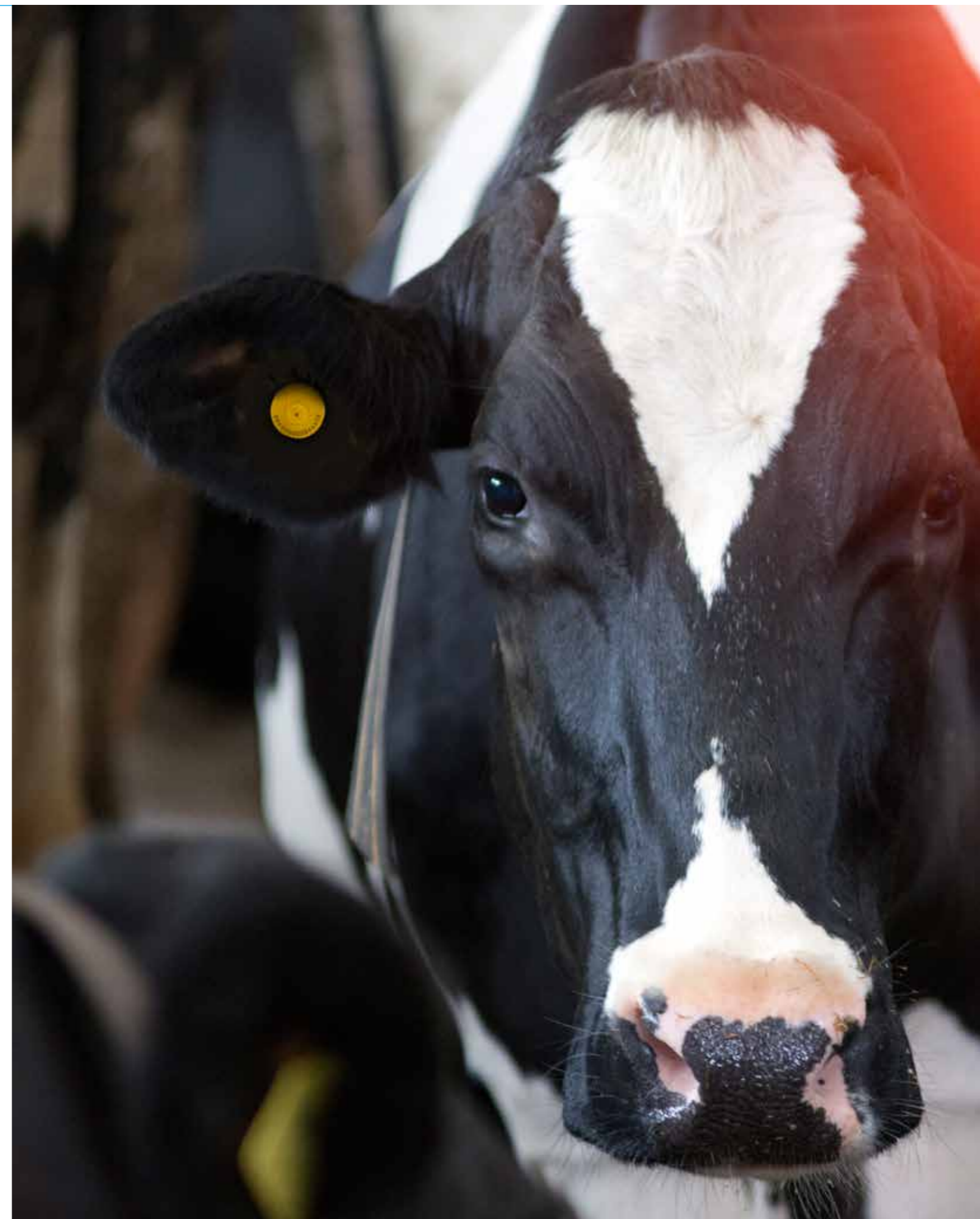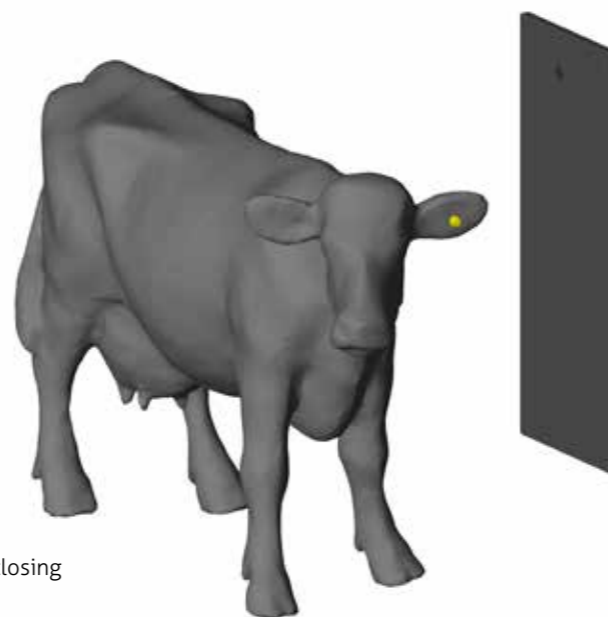
# 4. RFID in the large milking parlor

4.1 Milking parlor Identification state-of-the-art solutions for today's dairyman

Individual animal RFID (Radio Frequency Identification) has been the key to dairy automation in general and to milking parlor automation in particular. Milk yield recording, heat detection, weighing, drafting and any other sensor/actuator in, on or near the animal or the milk produced by the animal can only provide added value to the dairyman when it can be assigned to the right animal.

When focusing on milking parlor automation RFID has really opened up the market for electronic milk meters, in-line milk sensors and, last but not least, fully automated milking. For many years most of the in-parlor identification systems consisted of walk

through, walk past or walk-over (in case of leg activity tags) antennas and readers, located at the entry of (each side of) the milking parlor and smart software, assigning the identified animals in the correct sequence to their stall in the parlor.

This combined with relatively strong neck of leg mounted RFID Management tags (Transponders) provided the dairyman with a highly reliable ID system enabling him to collect and assign individual milking data of his herd. In general, any exceptional failed identification could be corrected manually by using in-parlor control panels.
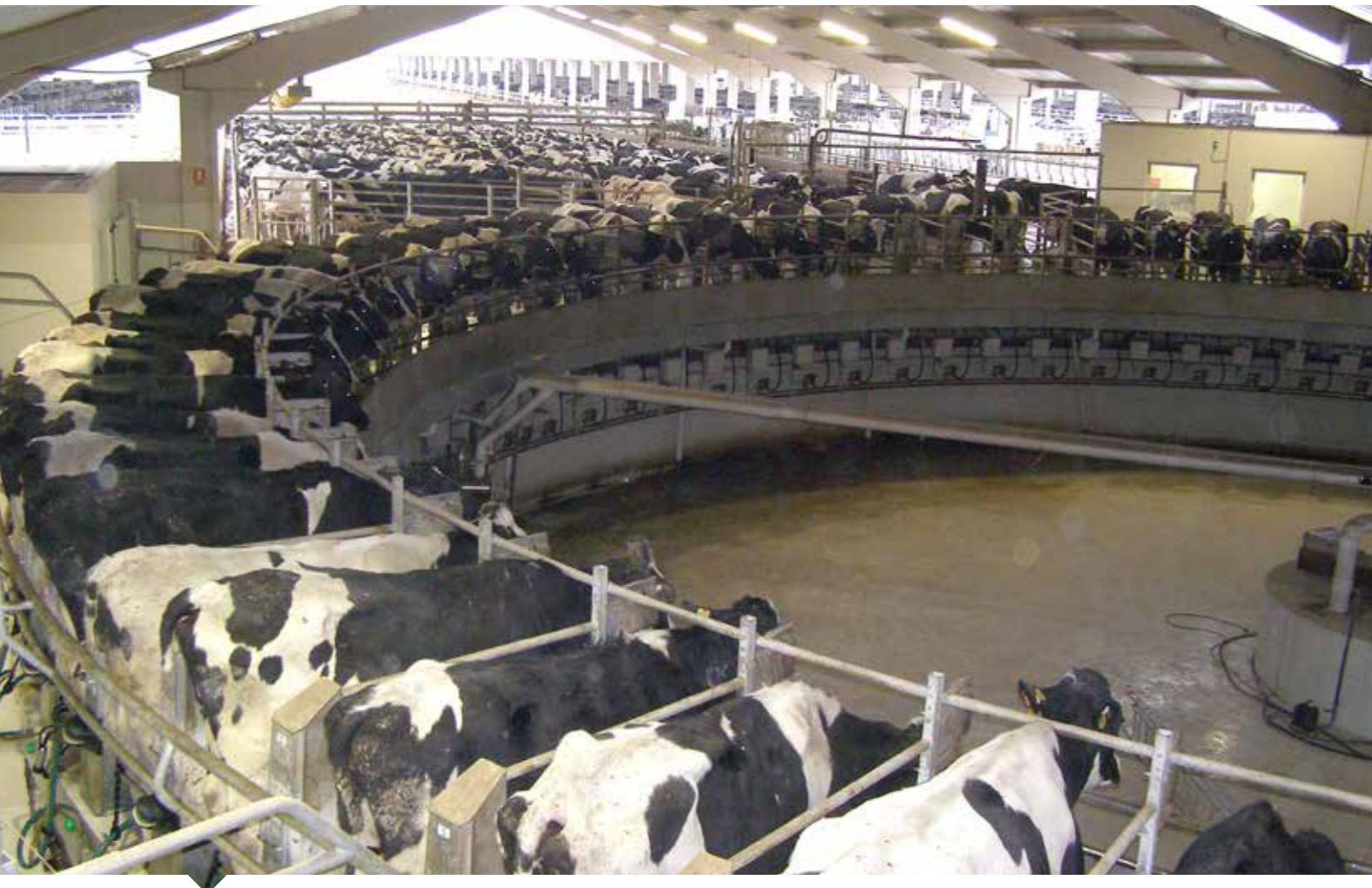
In modern dairy farming however, two major factors have significantly changed and requirements for in-parlor identification systems have increased:
• Strong increase of herd size
• Shift from strong management tags (transponders) to cheap, weak ear tags and boluses

Herd size is rapidly increasing word wide. From tens of cows to hundreds and even thousands on industrial dairies.

For in-parlor RFID, increased herd size has several important consequences:
• **Emphasis shifts from individual cow management to herd management and even people (staff) management:**
  It is no longer a matter of course that all animals wear a working tag (newly arrived animals, lost tags, etc).
• **Increased herd size coincides with increased parlor size:**
  - Less or no possibilities to correct/enter

unidentified cows.
  - Heavier consequences of failing identification for whatever reason of one particular animal for the rest of the animals in a row on one side of the parlor (many animals identified allocated to the wrong stall).

Second factor, the use of cheap RFID ear tags, has even more influence on the requirements for in-parlor identification systems.

Due to their reduced size compared to management tags, ear tags perform far less than management tags which leads to reduced reading ranges. On top of this, the relatively low performance of ear tags has to "compete" with environmental electrical noise which can further deteriorate ID performance. Management tags are less susceptible for noise as in most cases their performance is much stronger than the environmental noise.
Nedap Livestock Management has taken on these

new challenges and can offer the dairyman a reliable, tailor made RFID solution for any herd size, type of parlor or type of tag:

• **Further improvements to carefully designed walk past, walk through and walk-over antennas and smart DSP readers**
• **Individual Per Point IDentification (PPID)**
• **Vision technology to identify animals entering the parlor passing without being identified (faulty or lost tag)**
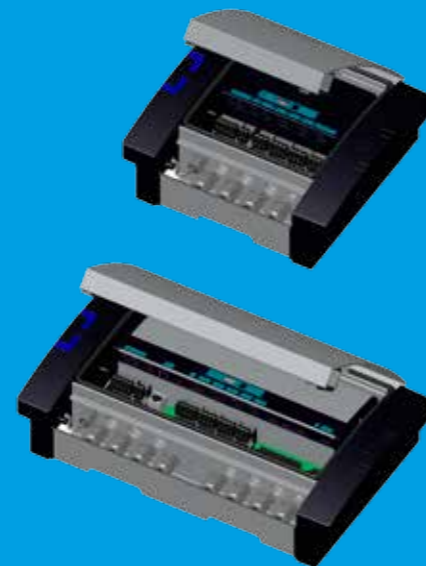
PPID is the ultimate solution for ear tag identification in large batch type and rotary parlors. Due to the relatively small antennas, environmental noise hardly affects ID performance and any not identified animal does not affect reliability of datasets of any other cow. Depending on the type of stalls, per point antennas and readers can work autonomously for just one milking point or antennas can be multiplexed using one reader per eight milking points.

Obviously, multiplexing is a more economic solution than a reader per milking point. In some cases however, the "window for tag reading" is limited to just the moment the animal is entering her stall. In that case reading cannot be interrupted but needs to be fully and full time active until the animal is read.

4.2   Nedap RFID solutions in the large milking parlor

4.2.1   PPID (Per Point Identification)

• For neck, leg and ear mounted tags
• For Rotary and Side-by-Side stalls
• Not sensitive for environmental noise
• Maximum correct cow-bail assignment, even with failing or lost tags
• The most reliable solution for large parlors

4.2.2   Camera supported walk past and walk through antennas

• For neck, leg and ear mounted tags
• For Herringbone and Side-by-Side stalls
• Not sensitive for environmental noise
• Less sensitive for tag position
• Maximum correct cow-bail assignment, even with failing or lost tags
• Cost efficient
• Easy to install

Advanced and up-to-date barn automation: Digital Signal Processing

Individual electronic identification is the cornerstone of barn automation. Conventional identification systems use analogue signalling technology - a method that identifies animals reliably but can also be affected by external interference or the use of ear tags with a less strong signal. To tackle this problem, Nedap has developed solutions using Digital Signal Processing, such as a digital sender/receiver (Nedap VP 1910 DSP Reader), and will continue to invest in offering the very latest innovative technology going forward.
This advanced digital technology filters out other frequencies that interfere with identification. The digital sender/receiver also generates a very strong antenna field in which the use of ear tags presents less of an obstacle to reliable identification. The result: optimal identification in difficult circumstances.
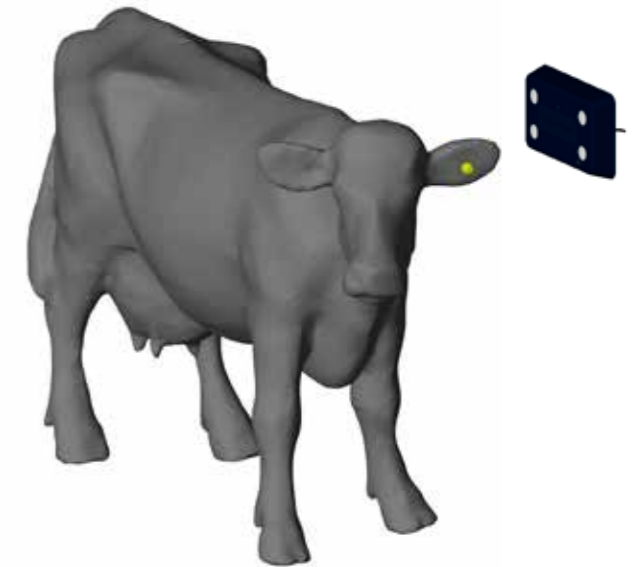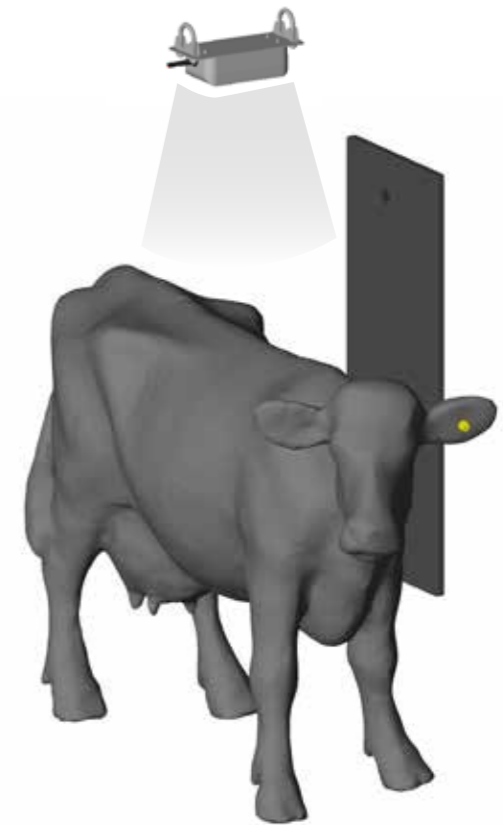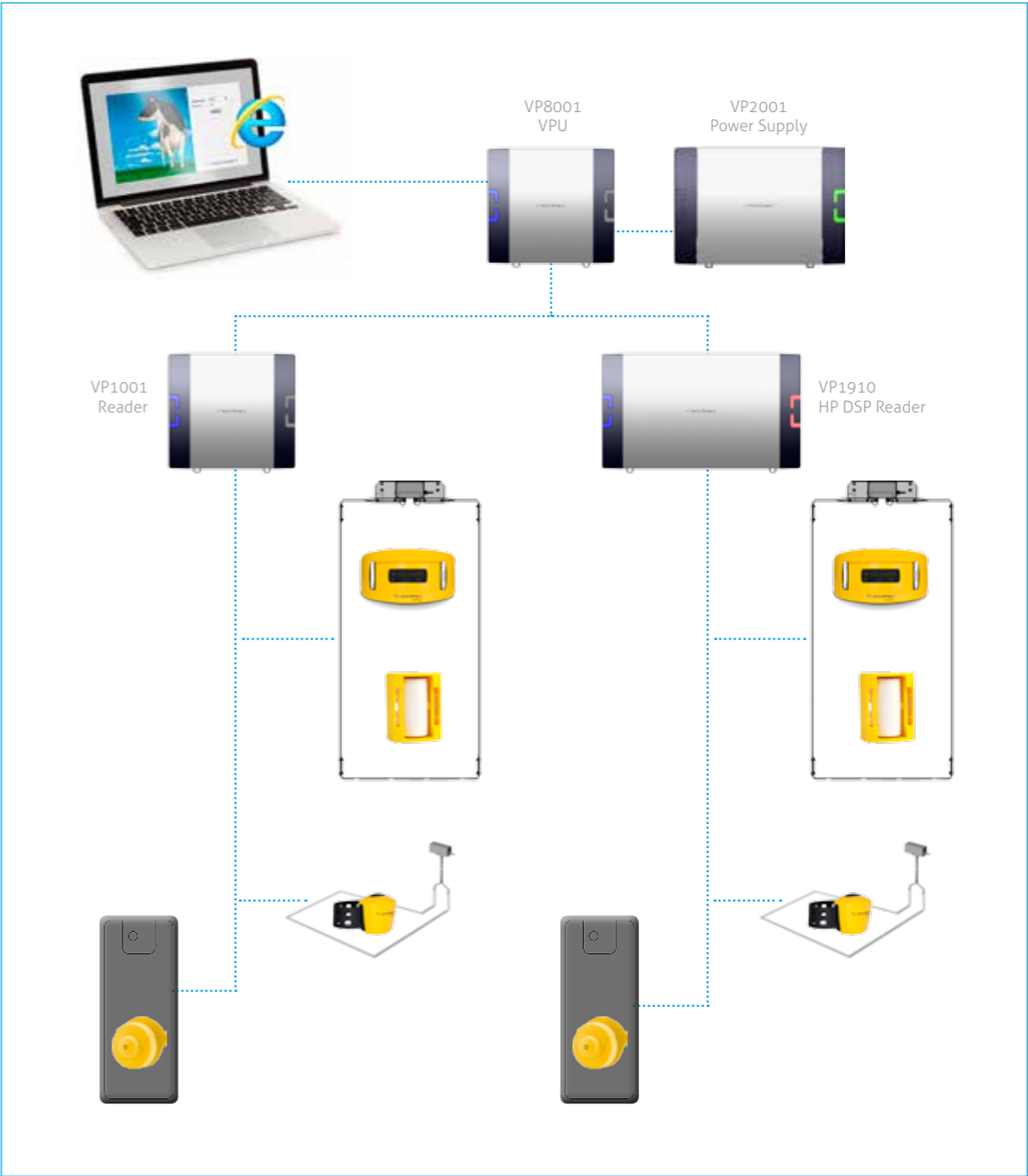
Nedap VP1001 I/O Control (analog)

Nedap DSP Reader (digital)
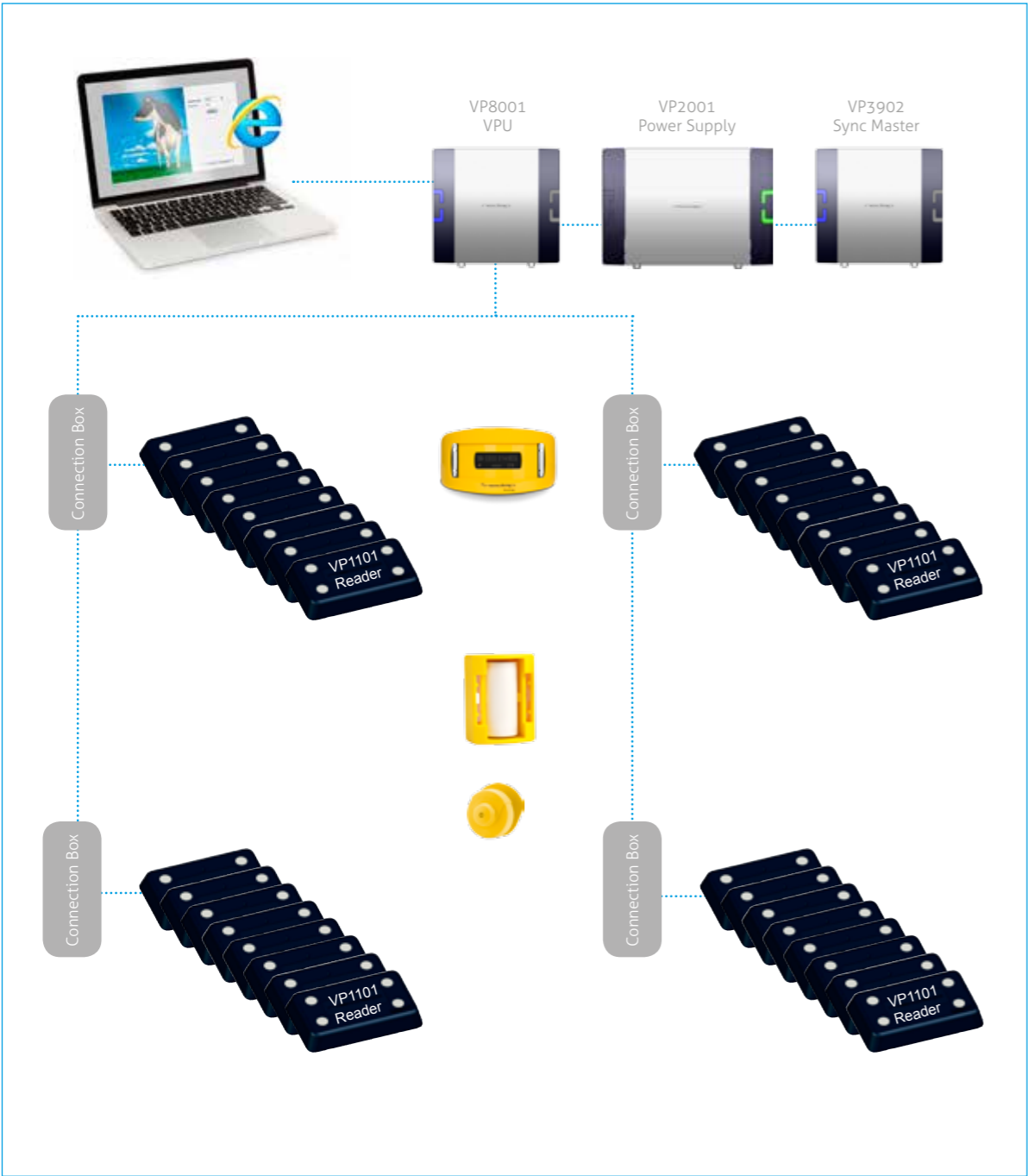
5. Nedap solutions for the milking parlor, a complete overview

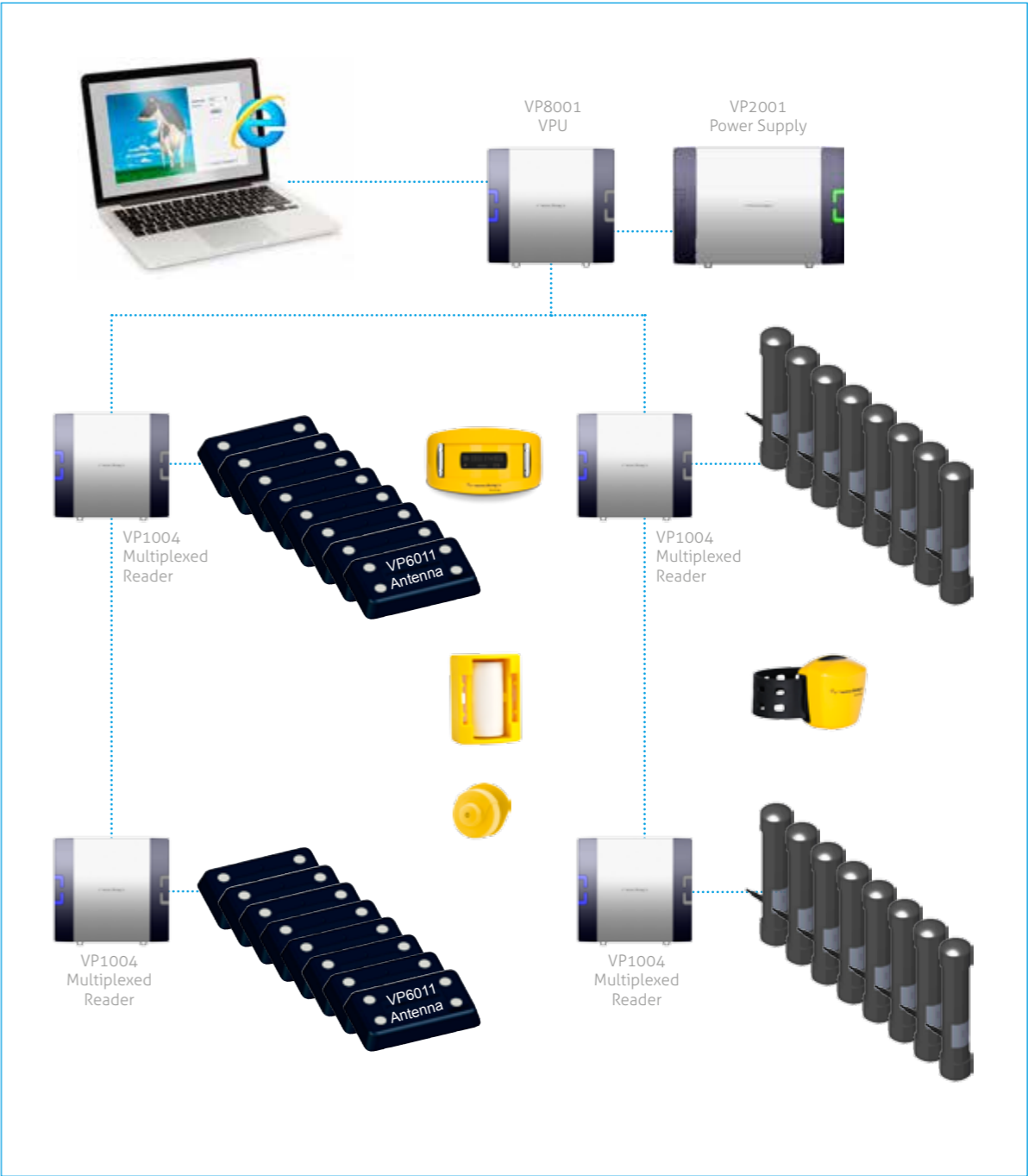## 5.1 Walk through, walk over, walk past ISO FDX/HDX identification

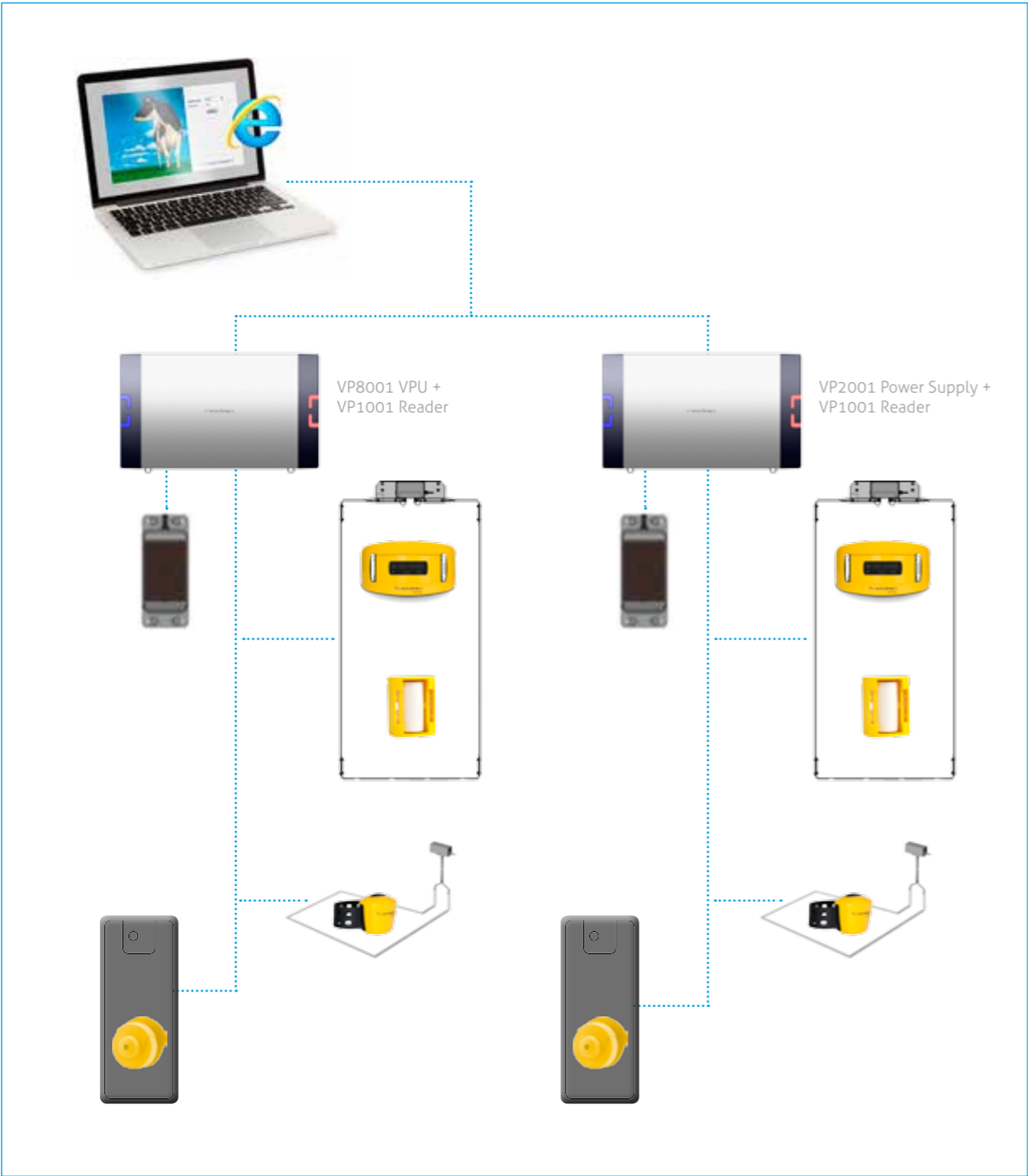## 5.2 Per Point ISO FDX/HDX identification with reader per point

VP8001
VPU

VP2001
Power Supply

VP3902
Sync Master

Connection Box

Connection Box

Connection Box

Connection Box

VP1101
Reader

VP1101
Reader

VP1101
Reader

VP1101
Reader

5.3 Per Point ISO FDX/HDX identification with multiplexed antennas

VP8001
VPU

VP2001
Power Supply

VP1004
Multiplexed
Reader

VP1004
Multiplexed
Reader

VP1004
Multiplexed
Reader

VP1004
Multiplexed
Reader

VP6011
Antenna

VP6011
Antenna

5.4 Camera supported walk through, walk over, walk past ISO FDX/HDX identification

VP8001 VPU +
VP1001 Reader

VP2001 Power Supply +
VP1001 Reader

5.5 Some of the Nedap RFID products

VP8001: Processing Unit

VP2002: Power Supply
25VDC/2.5A

VP2001: Power Supply 25VDC/9A
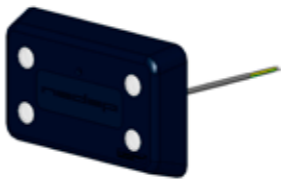
VP1101: ISO Reader / Antenna
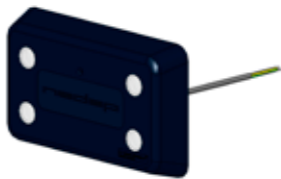
VP6011: ISO Antenna

VP6050: V-Sense Antenna

VP1001: Standard
FDX/HDX Reader

VP1910: High Performance
DSP FDX/HDX Reader

VP6020: V-Sense stick Antenna

VP3902: ISO Sync Hub

VP6201: Camera