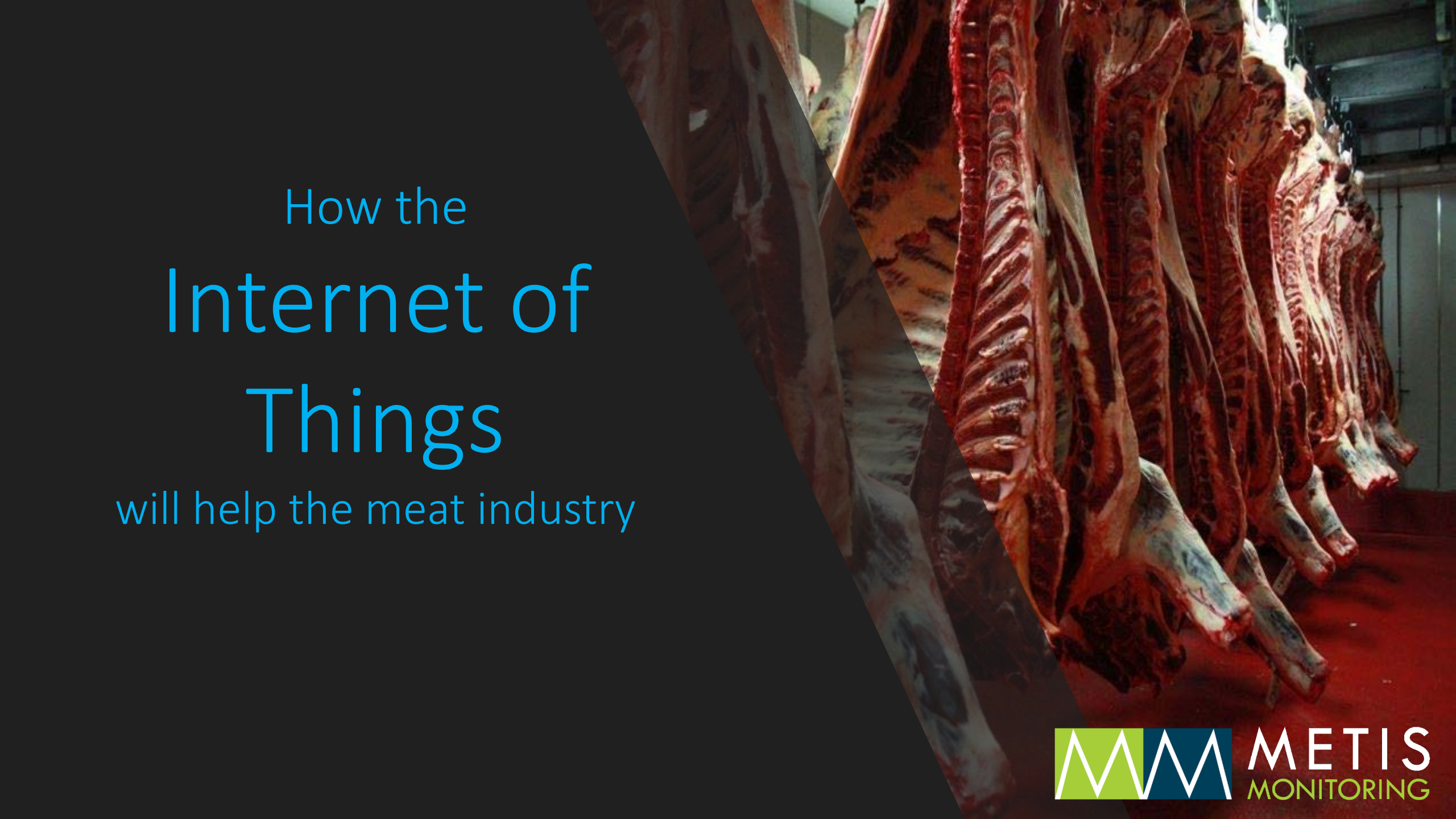
How the

Internet of Things

will help the meat industry



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The **Internet of Things** (**IoT**)
is the network of physical devices, vehicles,
home appliances and other
items embedded with electronics, software,
sensors, actuators, and connectivity which
enables these objects to connect and
exchange data.

Source: Wikipedia

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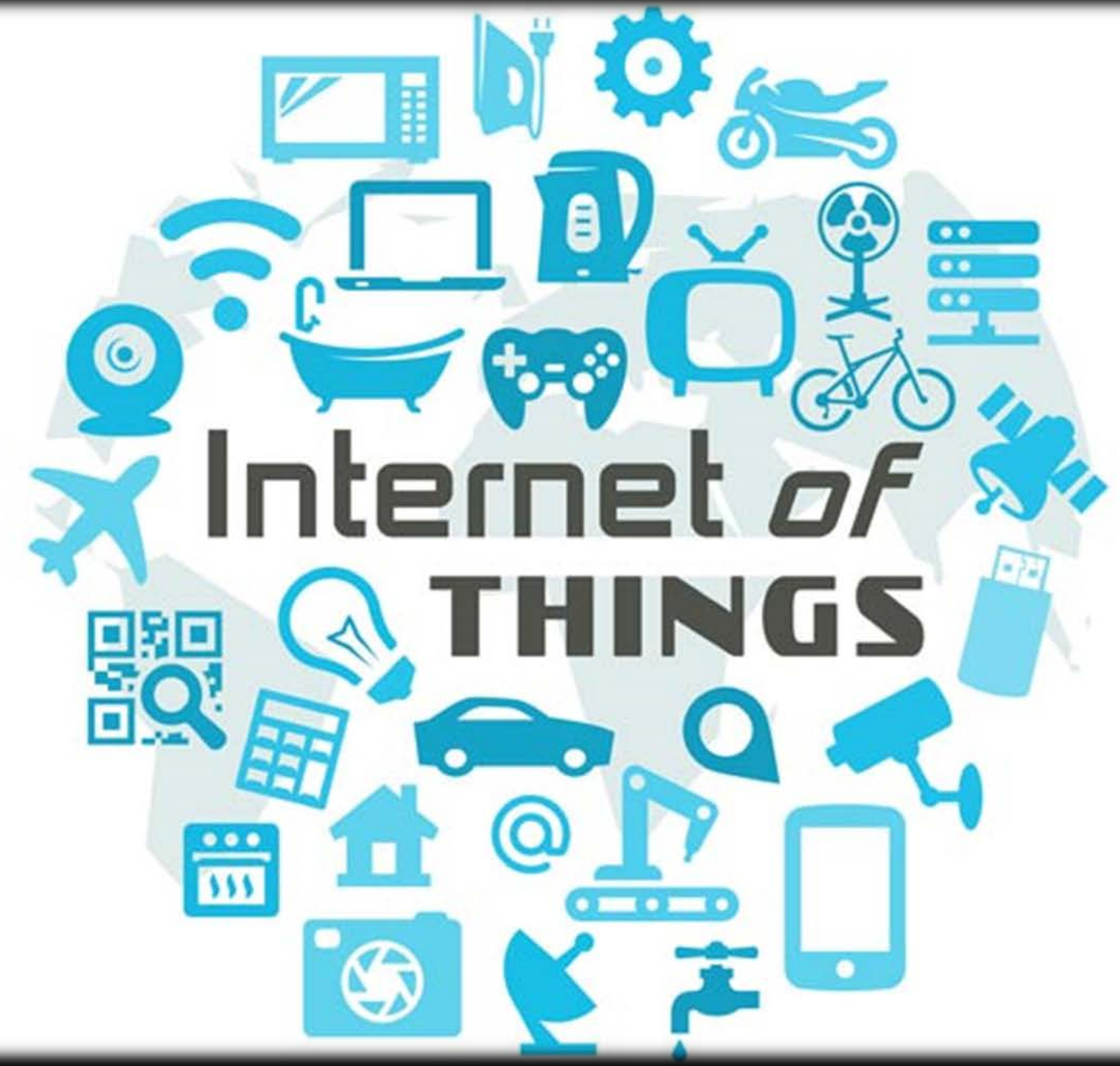

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IoT Is Gaining Momentum

Medication adherence

Health monitoring

Pet tracking

Behavior modification

Object tracking

Child and elder monitoring

Sports and fitness

Smart lighting

Indoor navigation

Beacons and proximity

Trip tracking and car health

COMMUTE

HOME

WORKPLACE

COMMUTE

HOME

Smart appliances

Food and nutrition tracking

Identity

Office equipment

Smart vending machines

Bike ride stats and protection

Sleep tracking

Air conditioning and temperature control

Environmental sensors

Information capture

Control

Home security

Home automation

Leak detection

Garden, lawn and plant care

New devices and sensors

Entertainment systems

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Table 1: IoT Units Installed Base by Category (Millions of Units)

Category	2016	2017	2018	2020
Consumer	3,963.0	5,244.3	7,036.3	12,863.0
Business: Cross-Industry	1,102.1	1,501.0	2,132.6	4,381.4
Business: Vertical-Specific	1,316.6	1,635.4	2,027.7	3,171.0
Grand Total	**6,381.8**	**8,380.6**	**11,196.6**	**20,415.4**

Source: Gartner (January 2017)

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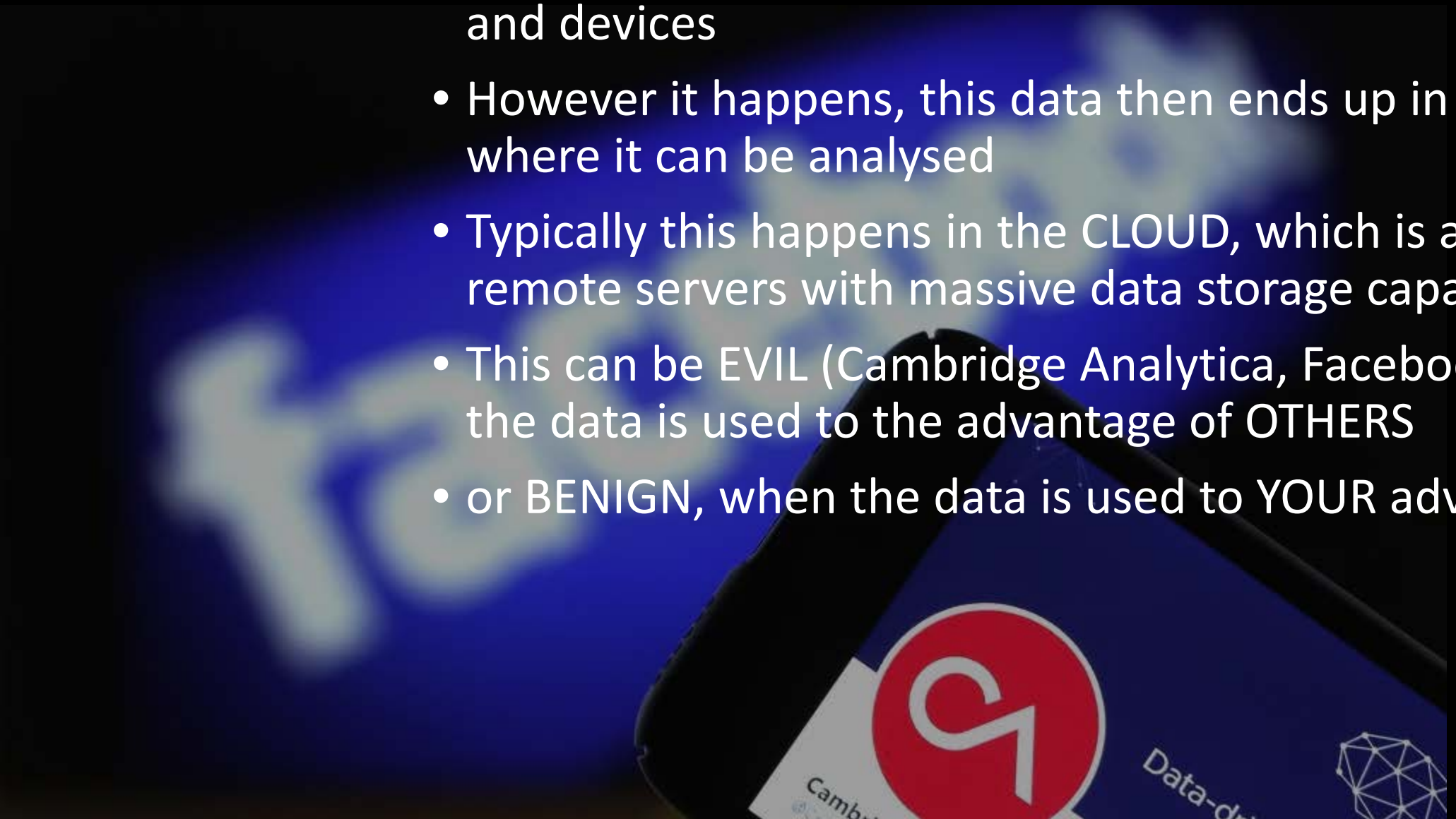
Big Data

- IoT is all about DATA!!
- Data comes from files and software, but also from sensors and devices
- However it happens, this data then ends up in one place where it can be analysed
- Typically this happens in the CLOUD, which is a set of remote servers with massive data storage capacity.
- This can be EVIL (Cambridge Analytica, Facebook) - when the data is used to the advantage of OTHERS
- or BENIGN, when the data is used to YOUR advantage



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"Your recent Amazon purchases, Tweet score and location history makes you 23.5% welcome here."

Sourced from Wikimedia Commons under CC 2.0
Image by Thierry Gregorius

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So how can IoT and Big Data help me and my business?

Answer: *By employing analytics on my data to help me save time and money*

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Analytics?

- Artificial intelligence
- Machine learning
- Pattern detection
- Anomaly detection
- Data mining
- Statistical regression
- Etc

Machine learning is a field of computer science that uses statistical techniques to give computer systems the ability to "learn" with data, without being explicitly programmed.

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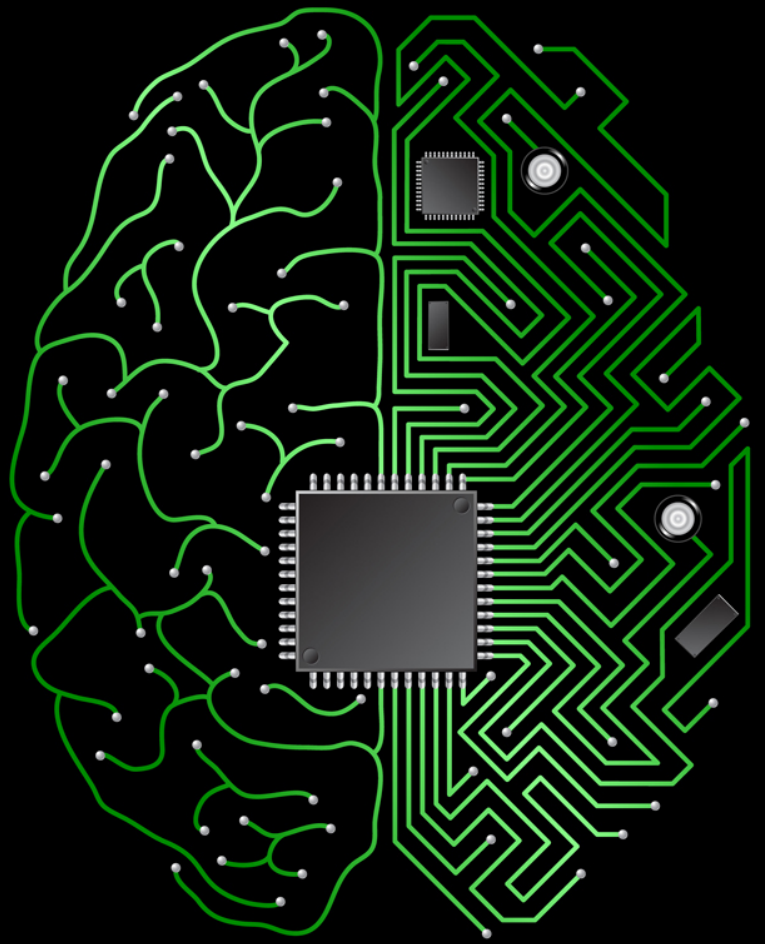
Machine Learning

Learning to predict behaviour or operation

- Learn “normal” behaviour and detect deviations from it (anomaly detection)
- *Use trained symptom detection to detect specific issues (pattern detection)*
- Ability to detect even very brief errors invisible to human examination
- *Ongoing algorithm improvement for ever increasing accuracy and precision*
- Create intelligent and predictive alerts, rather than fixed threshold alarms



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Maintenance

If not maintained, equipment may

- Become less reliable and fail, causing a loss or inconvenience
- Become damaged and need early replacement
- Not work as well as it should or could
- Use more energy than needed
- Cause a workplace hazard
- etc

However

- Maintenance can be costly!

Equipment maintenance

- Breakdown / Reactive
  - Do nothing until the system fails
  - Risk of product loss and high cost of a/h service work
  - Risk of high power costs
  - Reliance on fast response and good service by service provider
- Pro-active / Preventative
  - Service the equipment according to a schedule and replace items pre-emptively
  - Reduced risk at high cost of often unnecessary service work
  - Wasteful
- Predictive
  - Use analytics to predict problems and fix them before they occur, just in time.
  - Minimize both risk of loss and service costs

PROBLEM:

Refrigeration servicing is mostly reactive. It wastes time, energy, and money through inefficient servicing, often after-hours, and leads to avoidable system failures and product loss

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SOLUTION:

By applying IoT techniques to upload sufficient sensor data, predictive fault diagnosis using machine learning can significantly reduce losses and maintenance costs.

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The more sensors – the better the diagnostic

Diagnosable Faults (Increasing diagnostic Precision ↑)	Sensor configurations				
	Condenser Air Temperatures	+ Conditioned Space Temperatures	+ Motor Current	+ Refrigerant Temperatures	+ Refrigerant Pressures
Evaporator Blockage					✓
Dirty Condenser					✓
Refrigerant Blockages					✓
Pressure Safety Trip					✓
Refrigerant Leak					✓
Evaporator Ice Up				✓	✓
Evaporator Fan Issue			✓	✓	✓
Short Cycling			✓	✓	✓
Power Consumption			✓	✓	✓
Evaporator Issue		✓	✓	✓	✓
Room Temp Deviation		✓	✓	✓	✓
High Condenser Ambient	✓	✓	✓	✓	✓
Condenser Fan Issue	✓	✓	✓	✓	✓
Condenser Issue	✓	✓	✓	✓	✓

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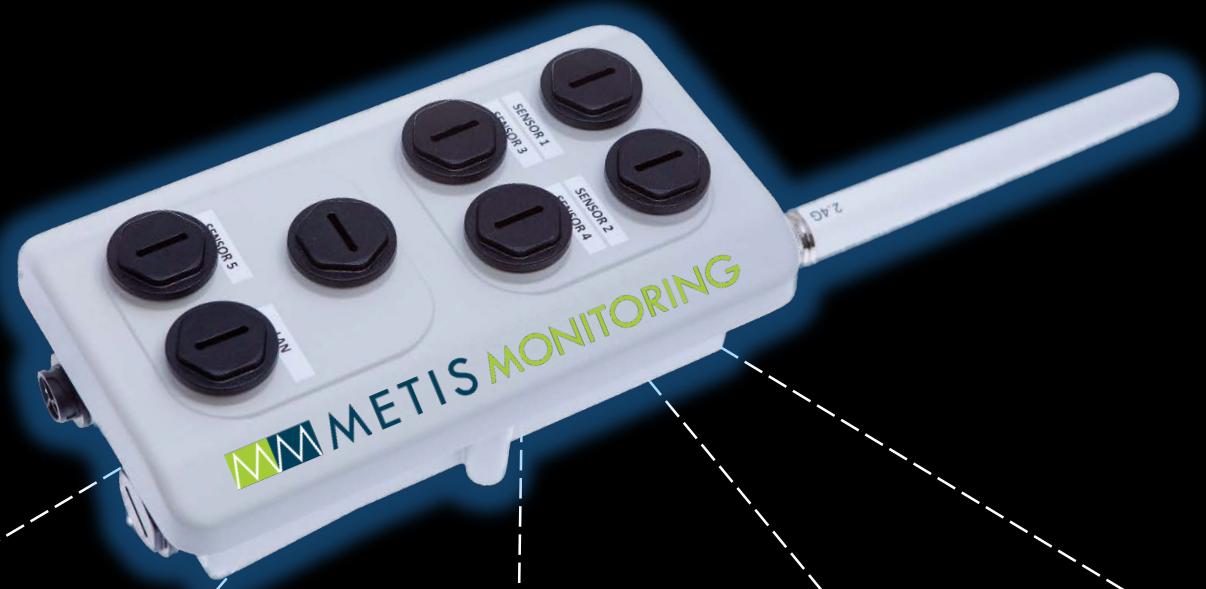
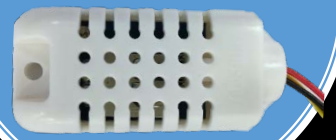
COMPREHENSIVE DATA GATHERING

CLOUD-BASED
DATA
COLLECTION



PRESSURE

TEMP &
HUMIDITY



CURRENT

LINE TEMP

MODBUS

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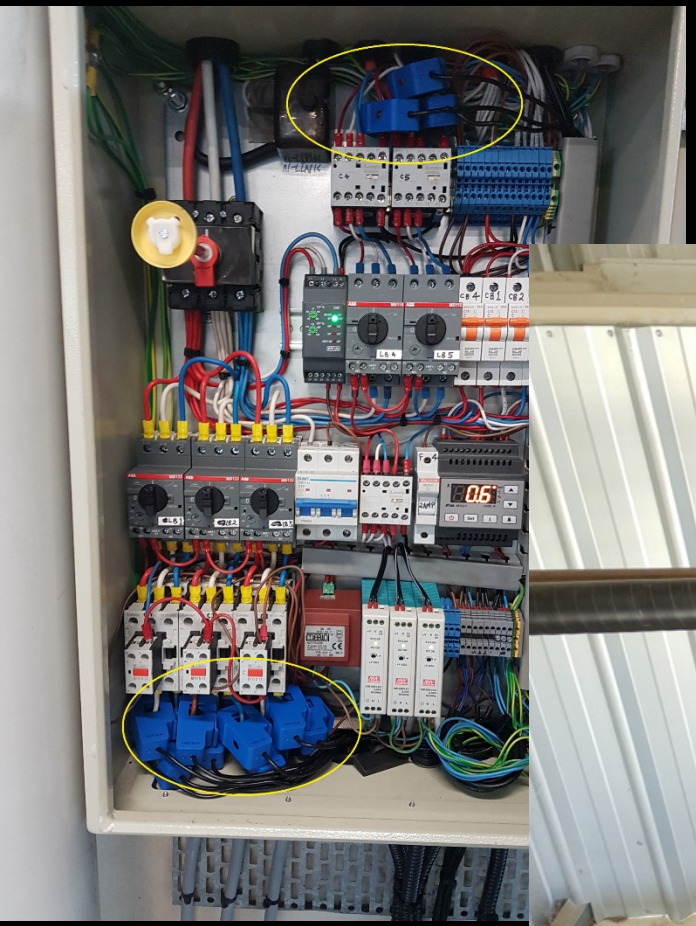
Installation examples



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What happens to the data in the cloud?

- Made visible using Web User Interface and Smartphone Apps
- *Crunched to yield more useful data*
- Fault diagnosis routines applied
- *Alerts generated for current or predicted faults*

Data storage is permanent and can be accessed even when the system is turned off.

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Search...

Show more filters

Units Nodes

- AWM Coolroom 1 Evaporator - Cur...
- AWM Coolroom 2 Evaporator - Cur...
- AWM Coolroom 3 Evaporator - Cur...
- AWM Coolroom 4 Evaporator - Cur...
- AWM Coolroom 1 Defrost - Current
- AWM Coolroom 2 Defrost - Current
- AWM Coolroom 3 Defrost - Current
- AWM Coolroom 4 Defrost - Current
- AWM Compressor Compressor 3 P...
- AWM Coolroom 4 Air-On B - Temp...
- AWM Coolroom 4 Air-On A - Temp...

DAILY VIEW LIVE DATA

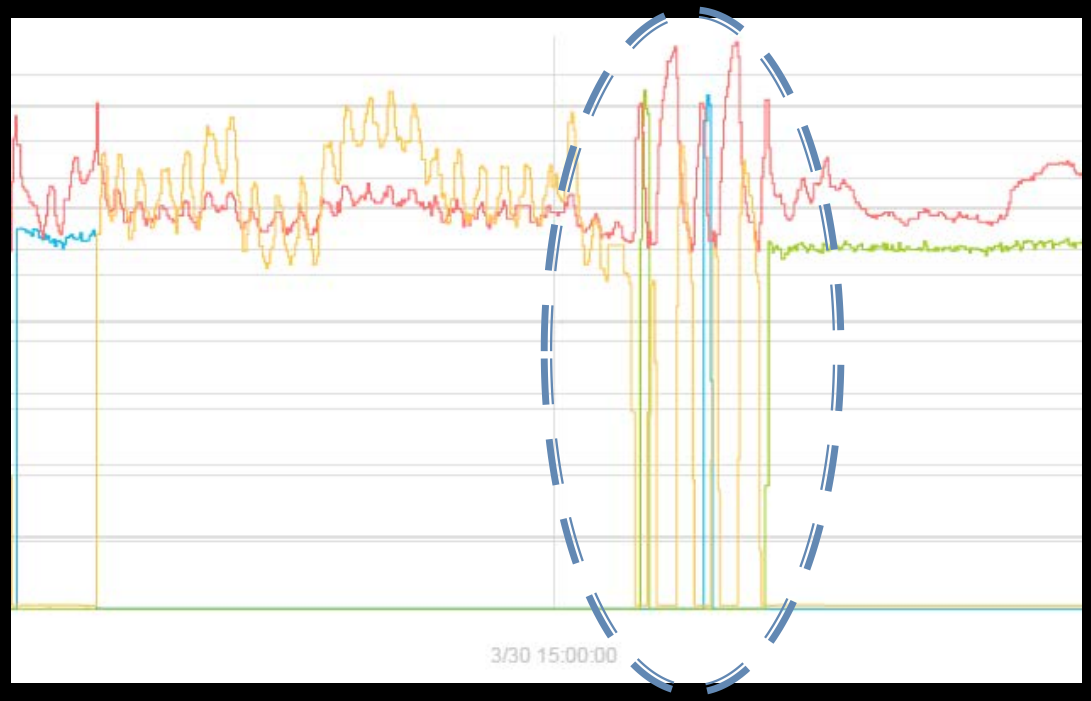
TIMEZONE

VERTICAL CURSOR CREATE FAULT

0 - BASED MAX SCALE 4 WEEKS 1 WEEK DAY HOUR 15 MIN RANGE

Fault recognition

- Recognition of normal operation and deviations from normal
- Intelligent alerts and remote diagnosis
- Predictive / early alarms for:
  - Refrigerant loss
  - Evaporator ice-ups
  - Short cycling of compressors
  - Condenser or evaporator fan failure
  - Expansion or solenoid valve failure/blockage
  - Compressor wear or valve leakage
  - Compressor, evaporator, condenser deterioration detection
  - Any unusual operation - high currents, temperature, pressures



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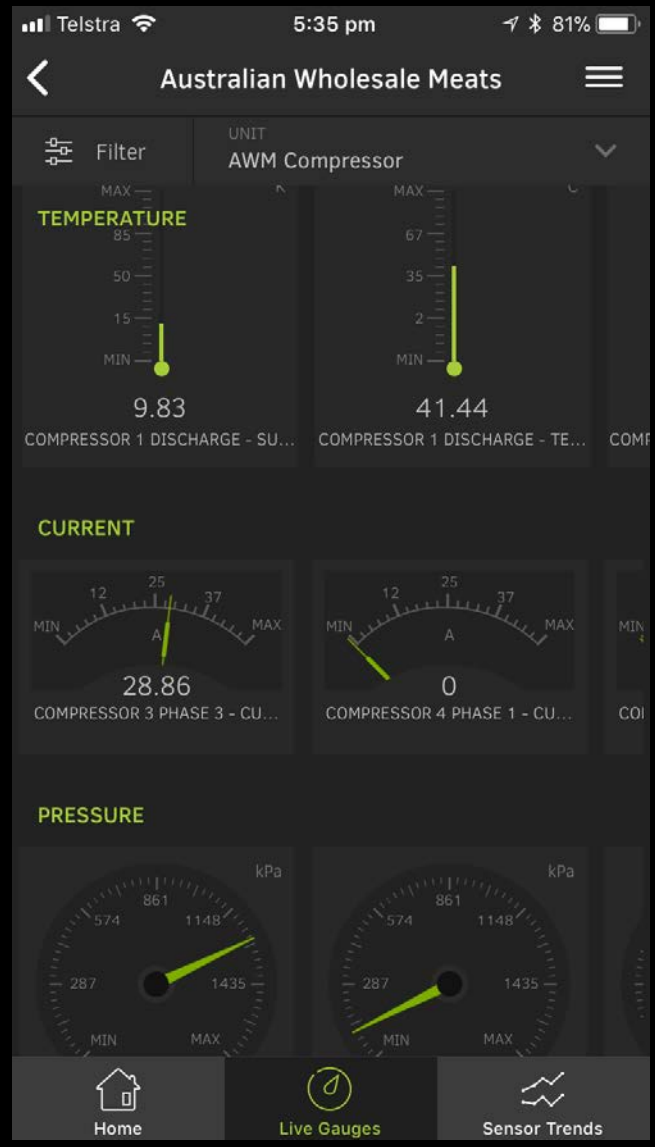
Smartphone App - Technician

- Better tools yield better results.
- Historical sensor data can be examined to pin-point potential and past problems.
- The technician now has complete service history at his finger tips.

✓Detailed sensor trends and sensor fusion: Real-time, Hourly, Daily, Weekly and Monthly.
✓Full alert management and history.
✓Annotated pictorial service history.
✓Export to external applications.



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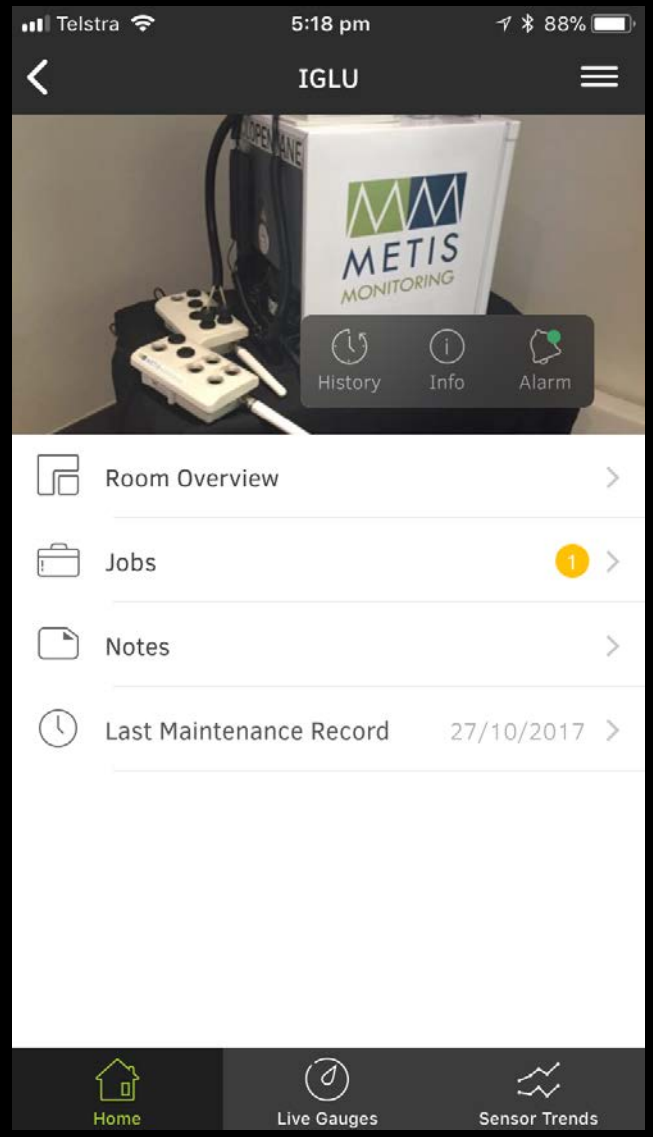
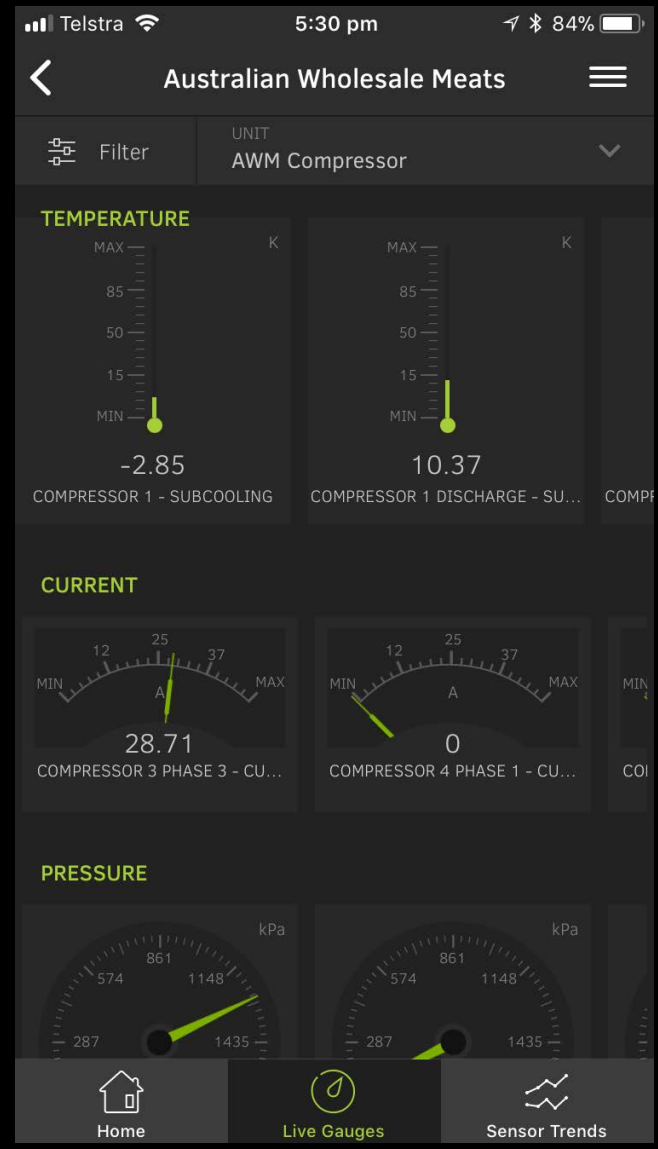
Smartphone App – user

- Full access to the overall status of the system.
- Receive detailed alerts when the refrigeration system needs attention.

✓See any temperature deviation
✓Track real-time power consumption.
✓Know system & temperature history.





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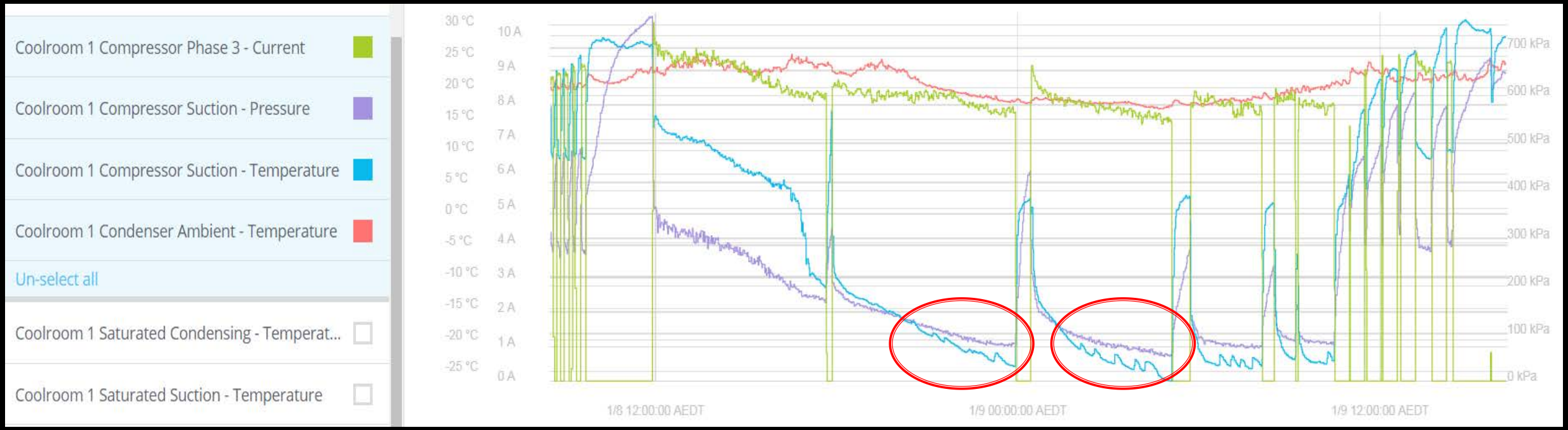
ICE-UP



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TX Valve Malfunction

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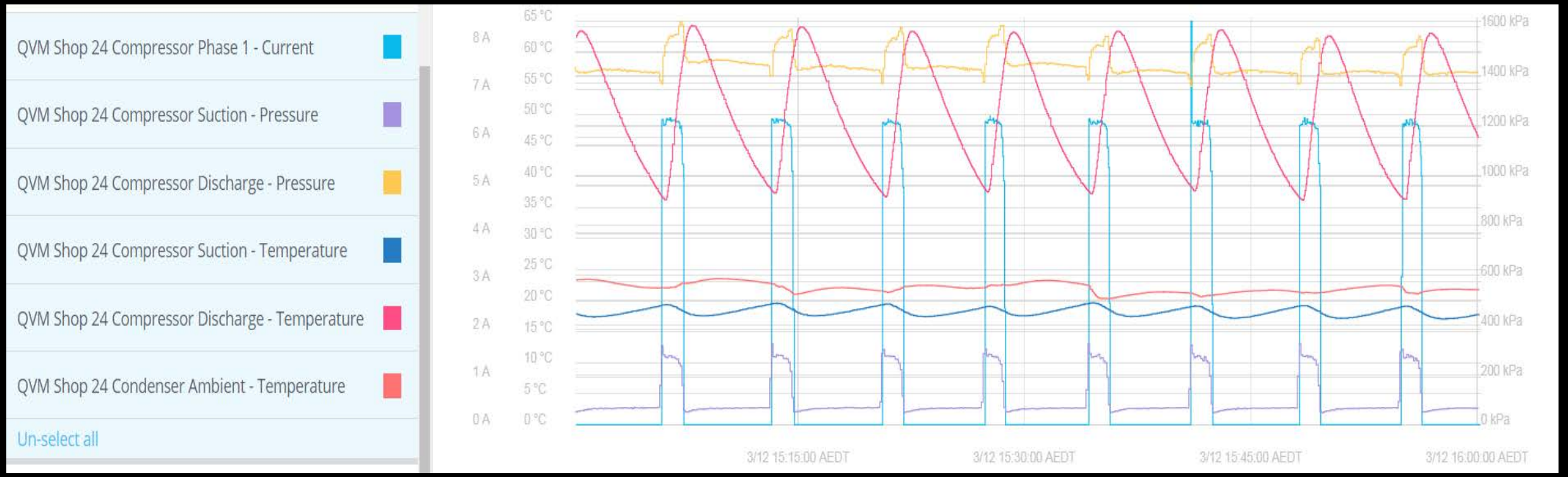
Short Cycling



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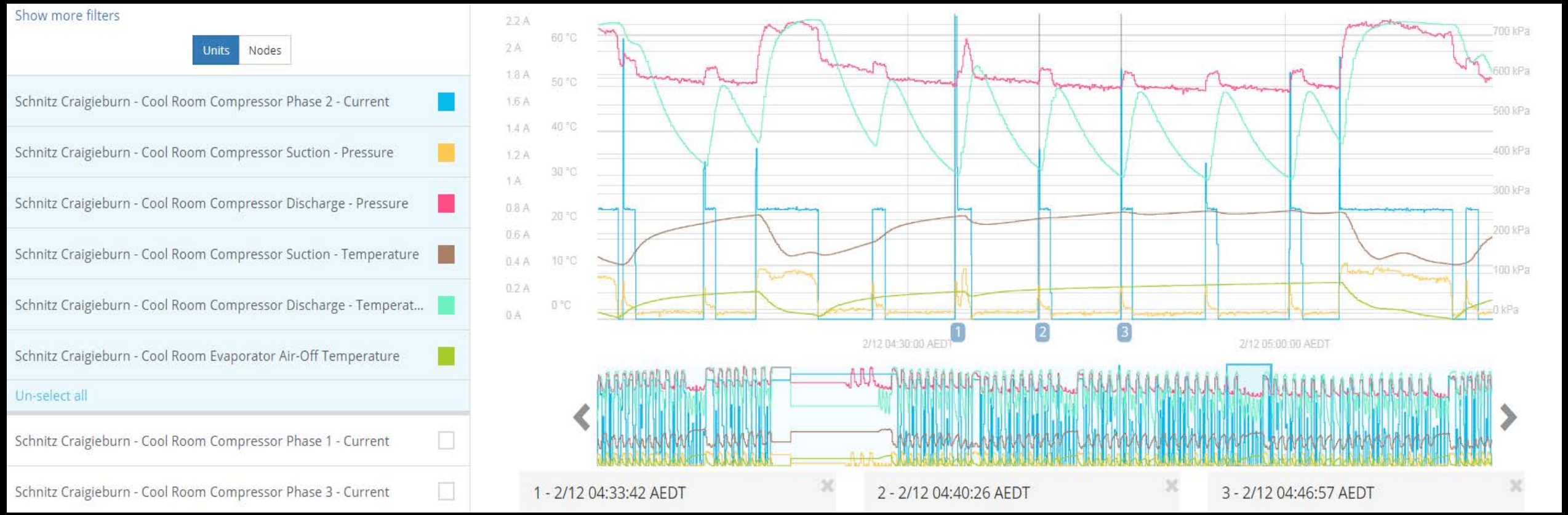
Unnecessary Starts, Compressor Refrigerant Bypass



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Summary

- IoT is not just a catchword – it is an inevitable and useful technology!
- Applications in the meat industry are going to be very wide, literally from Paddock to Plate – on the farm, at the processor, at the butcher.
- Most industrial IoT applications are seeking to save costs, by reducing resource and energy use, and labour.
- The Metis Monitoring application will change the way refrigeration plants are maintained, increasing their reliability and reducing service costs.

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