

Introduction to Danfoss **Condition Monitoring (CBM)**

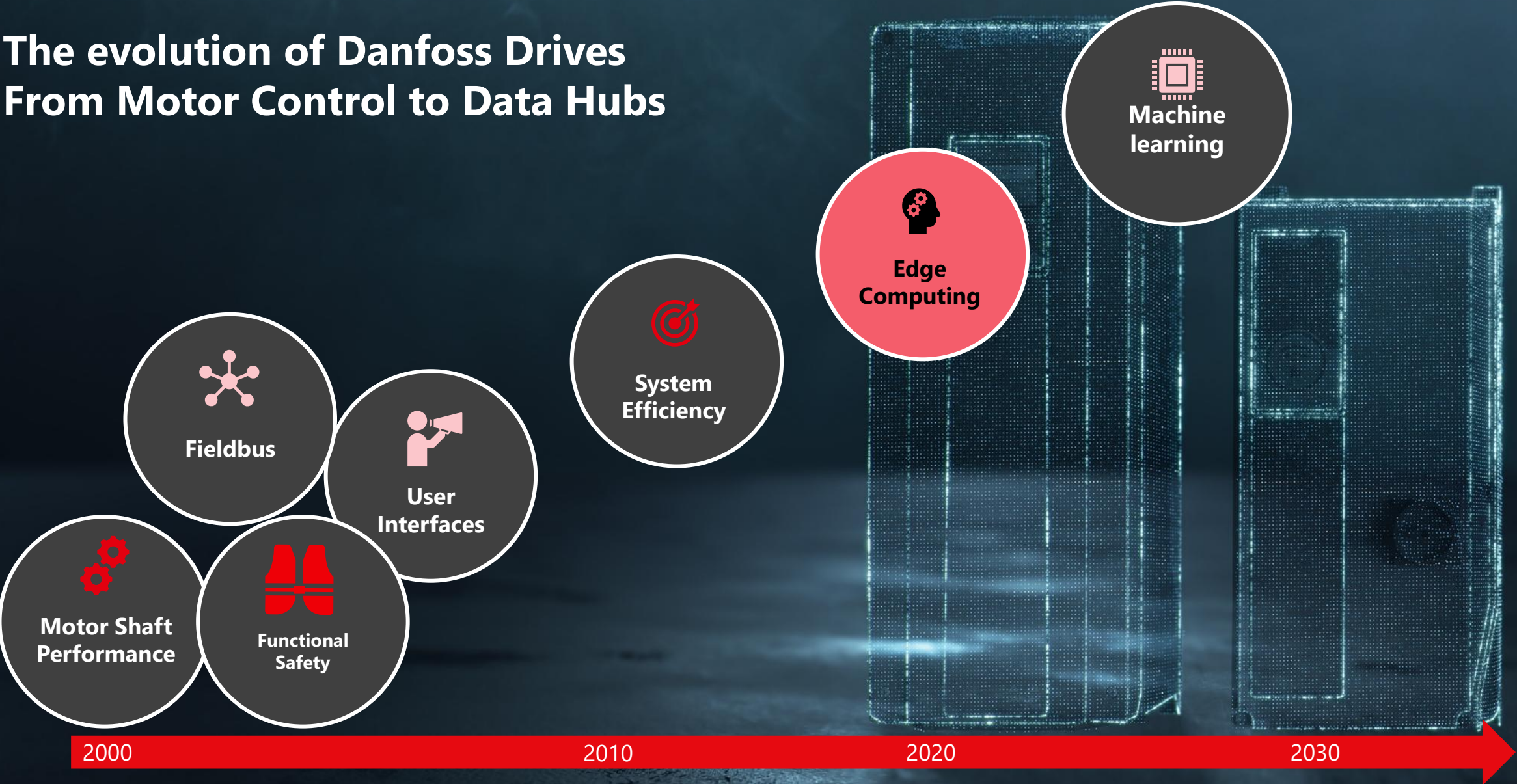


Virgil Lupu

- Product founder of Condition Monitoring in Danfoss VLTs
- Senior Business Developer in F&B team
- 20 years with Danfoss Drives
- 25 years in the drive market
- Background in Electrical Engineering
- Based out of Gråsten, Denmark
- Contact: lupu@danfoss.com
- [Condition monitoring with VFDs | Danfoss](#)



The evolution of Danfoss Drives From Motor Control to Data Hubs



Condition-based maintenance benefits using Data



TRADITIONAL
PREVENTIVE
MAINTENANCE



MAINTENANCE
COSTS



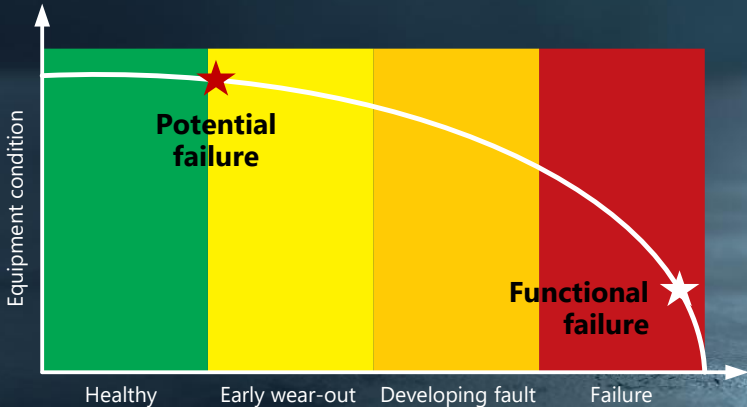
PRODUCTION



DOWNTIME



BREAKDOWNS



Source: February 2021 – Preparatory study for the Ecodesign and Energy Labelling Working Plan 2020-2024 – On behalf of the **European Commission**

Intelligent drives VLT – VACON – iC7



Condition-based Monitoring

- Without external sensor:
 - Motor: stator winding monitoring
 - Application: load envelope (torque)
 - New: 2025: cavitation detection/control
 - New: 2025: sinus filter capacitor lifetime
- With external sensor:
 - Motor: vibration monitoring
 - Bearings: wear-out monitoring
 - Application: sensor monitoring (i.e. pressure)

Suitable for new and/or installed drives



Factory-enabled License code

1

Using Danfoss Drives Configurator/Product Store



Enclosure *		ⓘ
RFI Filter *		
Brake - Safe Stop *		
LCP	(G) Graphical Loc. Cont. Panel	↔
Coating PCB *		
Mains Option *		
Adaptation A	(X) Standard Cable Entries	↔
Adaptation B	(X) No adaptation	↔
Software Release	(SXXX) Latest release std. SW.	↔
Software Language Pack	(SXXX) Latest release std. SW. (LXX1) Cascade controller 2.0 (LX1X) Condition-based Maintenance	↔
A Option		ⓘ



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A Option		↔



Upgrade License code

2

Using online MyDrive Suite Unique code: ABCD-0123X-YZAB-CFGH Or Site License for 50/100 drives

SELECT WORK MODE

 Dimension	 DC/DC	 AFE/uGRID (Beta)	 Key	 DCGuard
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Insert in LCP / MCT-10 par. 50-01

1069RPM	7.144	100
License	50-**	
50-01 License Code		
0000-0000-0000-0000		

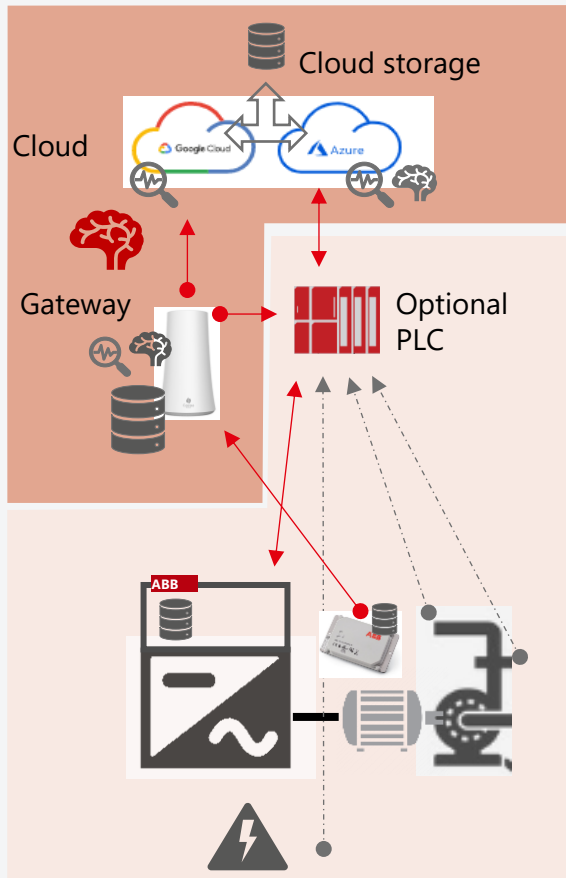
See Programming guide
for full description

Danfoss EDGE Condition Based Monitoring

Fundamentally different



Competitor setup (ABB, Siemens, Rockwell, etc.)



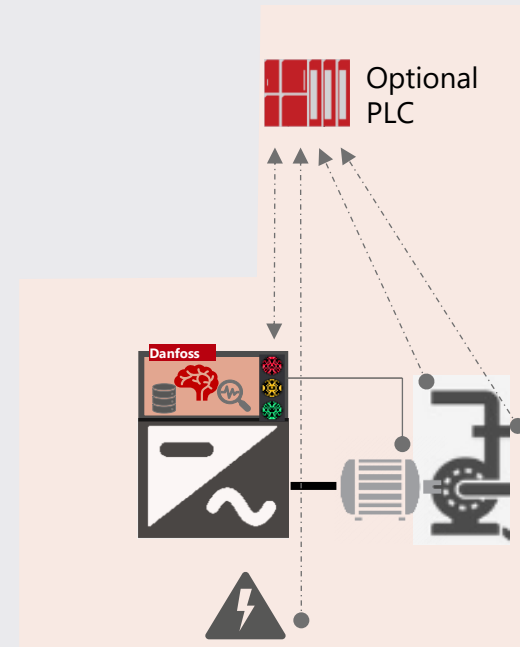
Cloud analytics:

- Algorithms in cloud
- Data collection
- Infrastructure
- Specialist

Operational facts:

- Monthly cloud cost -> €
- Data transfer cost -> €
- Data security risk
- Need IT approval to get started

Danfoss setup



Edge analytics:

- Data collection in drive
- Data storage in drive
- Data analytics in drive
- Optional DrivePro® Service

Benefits:

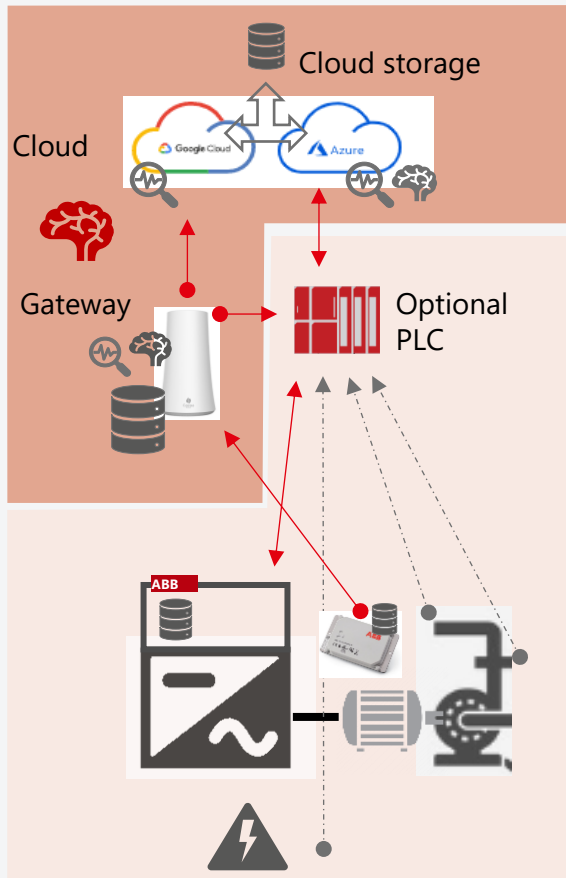
- Works without remote data transfer, storage and processing
- Integrate well into existing PLC/SCADA
- Time critical data is synchronized
- No monthly fee
- Very high security (no data leaks)
- No need for specialist

Danfoss EDGE Condition Based Monitoring

Fundamentally different



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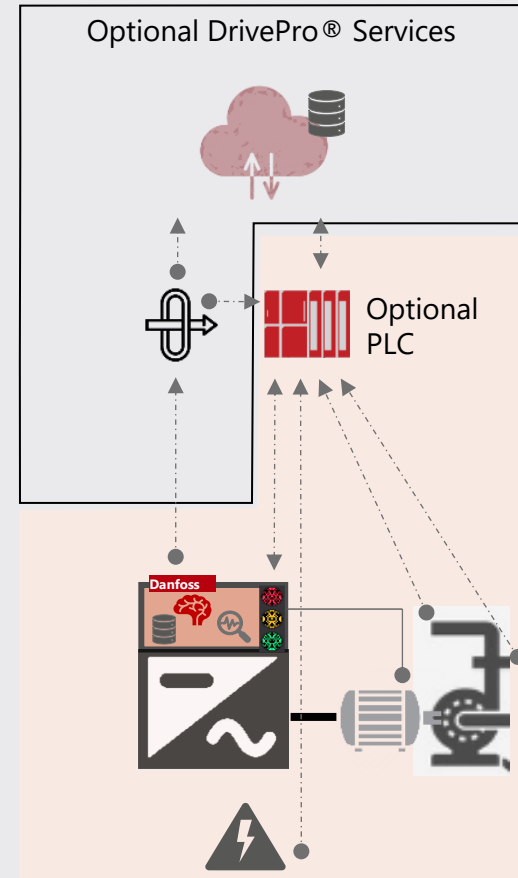
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CBM as Unique Selling Point for Danfoss Drives since 2020



Cost



Relevance



Upgrades



EDGE

Heineken: Success Story with Cavitation Detection



- Location: Heineken Den Bosch brewery, The Netherlands
- Pain Point: repeated damage to main water supply pumps (\$\$\$\$)
- Danfoss installed CBM with **Cavitation detection** and DrivePro Remote Monitoring on all FC302s used on process pumps for water supply
- Cavitation fault signaled immediately after Online Baseline (2 weeks)
 - **Software bug or real fault detection?**
- KSB analyzed data from 3 weeks of operation, confirmed cavitation due to turbulence and suggested improvements
- **Heineken** Savings: 56.000€ in total
 - 12.000€/pump
 - 20.000€/year in energy savings
 - Ability to adjust process based on FC302 data



Maintenance strategies to increase uptime

Failure

Corrective
maintenance

Time

Preventive
maintenance

Data

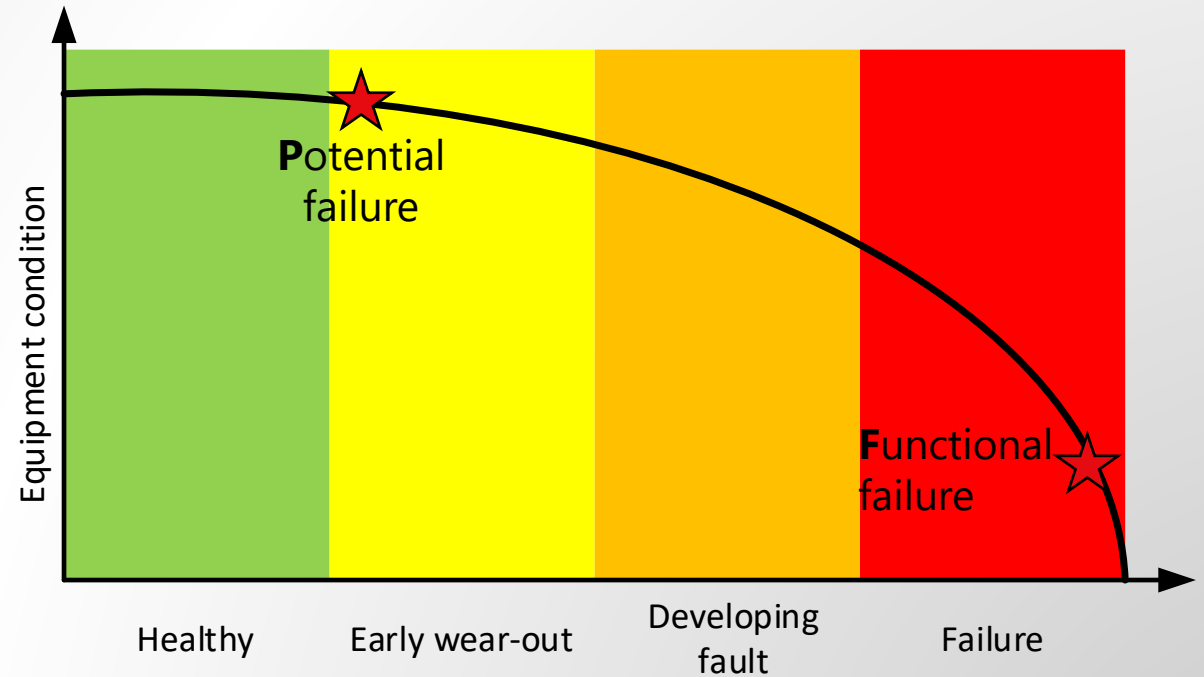
Condition-based
maintenance



Condition monitoring

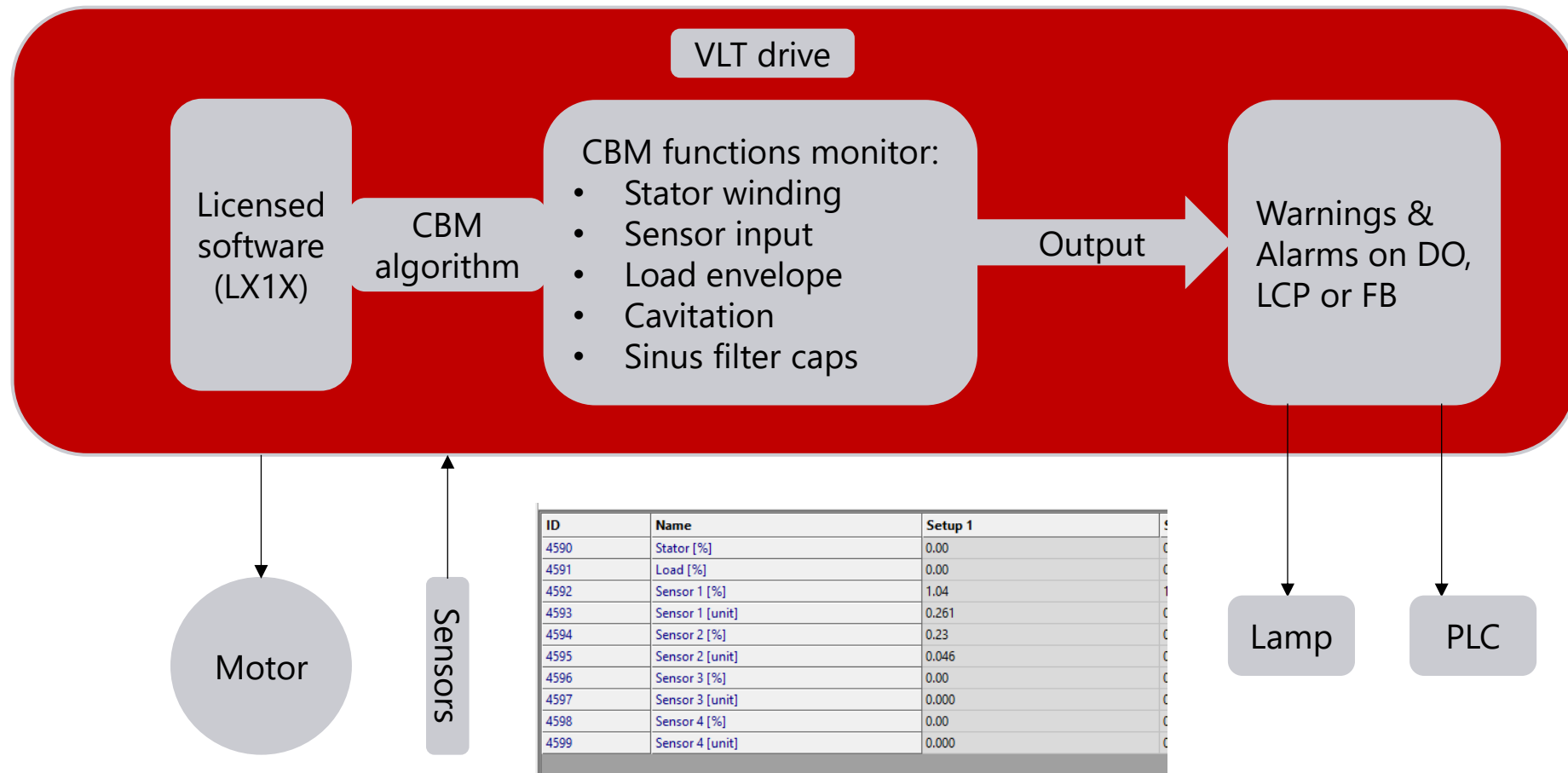
the right information at the right time

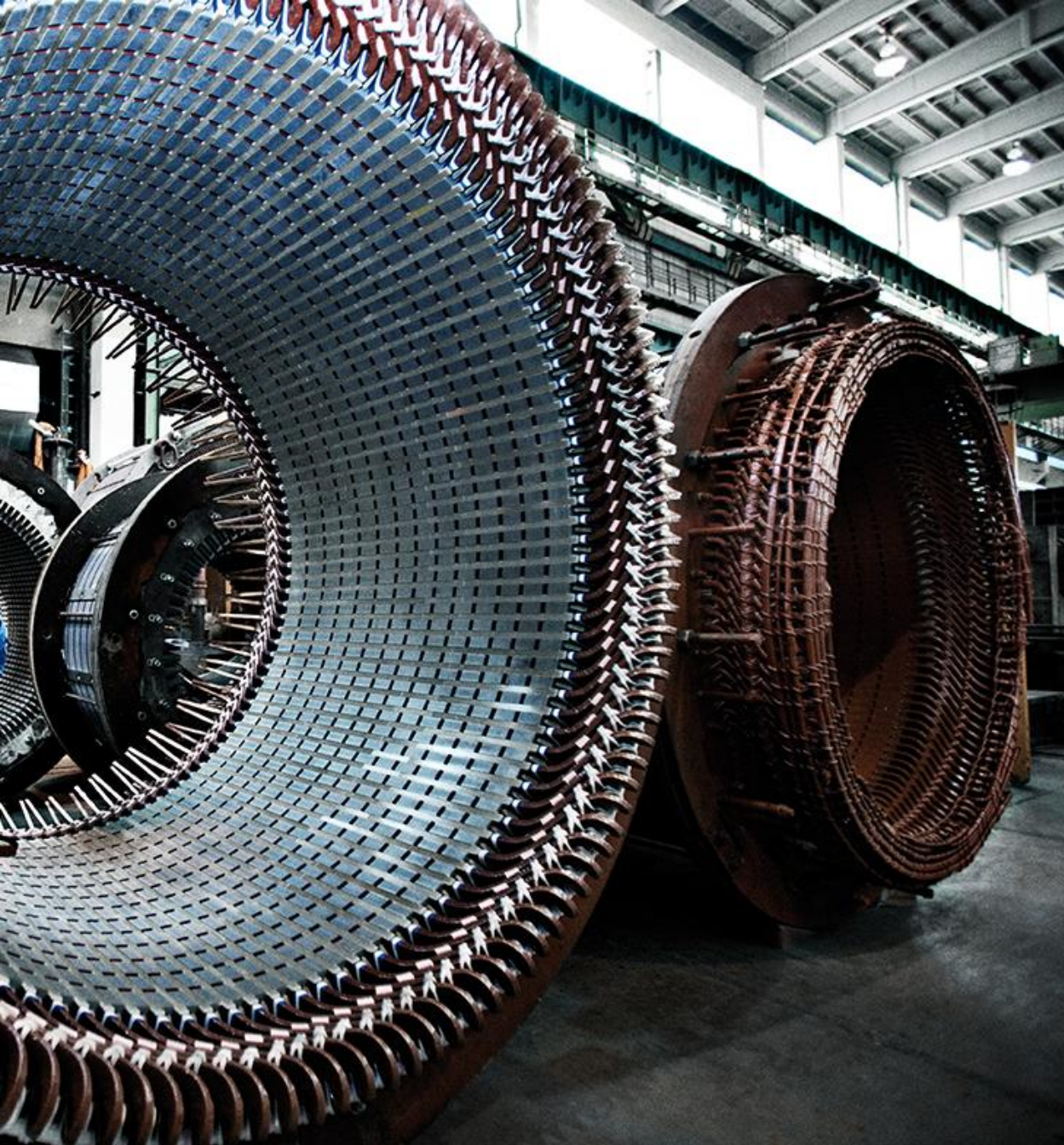
- Follows the p/f curve
- The development of the curve depends on the fault's nature
- Danfoss CBM is only a tool, the insight belongs to local maintenance



What is Condition Monitoring (CBM)

– VLT as a sensor?





Motor stator winding monitoring



- Danfoss VSDs provide early detection and user notification of motor isolation faults
- External sensors not needed: VLTs have embedded current transducers (3)
- **Customer value:** avoid "sudden death" of motor based on early fault detection



Vibration monitoring



- External 4-20mA sensor needed
- The function is useful for detecting mechanical faults such as:
 - unbalance and eccentricity
 - looseness
 - misalignment
 - mechanical resonance
- **Customer values:**
 - 3rd party "box" not needed
 - Four channels 4-20mA RMS/velocity
 - Motor speed correlated with vibration
 - Permanent monitoring
- **Hansford Sensors**
 - Available from DK stock



Bearing wear-out monitoring

- Thanks to Hansford **g-peak sensors**, the VSDs can detect and notify on early bearing wear-outs
- Limitation: the functions do not offer diagnose/root cause analysis
- **Customer values:**
 - Plan bearing maintenance based on data
 - Increase uptime



Load envelope



- The function is useful fault detection in various applications with passive load:
 - Fouling, sanding, broken impeller or wear-out of pumps
 - Clogged filters and leakages in ventilation systems
 - Friction in machines
- **Customer values:**
 - Machine "health" status data
 - Confined areas are now "visible"
 - Maintenance based on data



System independence



Users are free to chose the CBM data interface:

- LCP102 graphical or LCP103 WiFi displays
- RS485/Modbus serial comms
- Fieldbus options (ProfiNet, EtherNet, etc)
- DrivePro® Remote monitoring
- PC Tool MCT10 (CBM plug-in/easy start-up)

The embedded drive functions protect your application by processing direct data, and display status via different user interfaces.

Sinus filter (SWF) monitoring



- Capacitors have a defined End-of-Life (EOL) with irreversible internal changes
- At EOL, Capacitor degradation can pose risks to installations
- SWF monitoring continuously tracks changes within the sine-wave filter

Customer value

- Provides timely notifications to prevent breakdowns and hazards
- Requires no external sensors, simplifying installation and maintenance
- Easily commissioned for new and existing sine-wave filter setups
- Ensures seamless integration and enhanced operational reliability

Cavitation Detection in Centrifugal Pumps



- Sensor-less detection
- VLT as a sensor and current signature analysis in the drive
- Pump cavitation has a specific fault pattern that is different from winding faults but co-exists well together in the CBM package.
- When the fault occurs, the pump will make an audible noise that is also visible in the current signature.

Danfoss 1st mover with real use of AI Lubrication fault detection OGD



Significant Innovation in **Drive Technology!**

Co-creation with Heineken and Molson Coors

- Embedded in drives firmware (iC7, VLT), EDGE
- Uses licensed EDGE software library from
- Danfoss fault detection algorithm based on current signature
- Builds neural network and trains while running to learn healthy application behavior
- Sensor less
- **Detects lubrication loss in OGD as first step**



Customer values: higher **conveyor uptime** due to early poor lubrication alerts, allowing time to **plan maintenance** actions





Customer values using Danfoss Condition Monitoring

- Simple cost-effective way of obtaining machine data for smart maintenance decisions
 - CBM specialist not needed
 - Upgrade installed base with new software
 - Existing user interfaces are supported
 - Full power size and wide application range
 - Cloud-independent (edge computing in drive)
- Helps increasing your machine's uptime:
 - Early drive warnings allow time for actions:
 - Damaged motor windings
 - Increasing vibration levels (RMS)
 - Squealing bearings
 - Unusual torque values (high or low)
 - Cavitating pumps

