



THE NEXT GENERATION ICE DETECTION SYSTEM

Control System Integrated Software Solution for Substantial Cost
Optimization

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1. Motivation “Cut the Costs”
2. Field-proven Ice Detection System
3. Innovative Controller Integration
4. Realizable Cost Reduction Potential
5. Conclusions & Outlook

Why do we drive this innovation process?



Industry trend to eliminate number of third party systems and interfaces (whenever possible) to drop LCoE



New business models put the emphasis increasingly on the data analysis and data mining



Availability of highly-performant industrial PCs based on PLCnext technology are the technological backbone



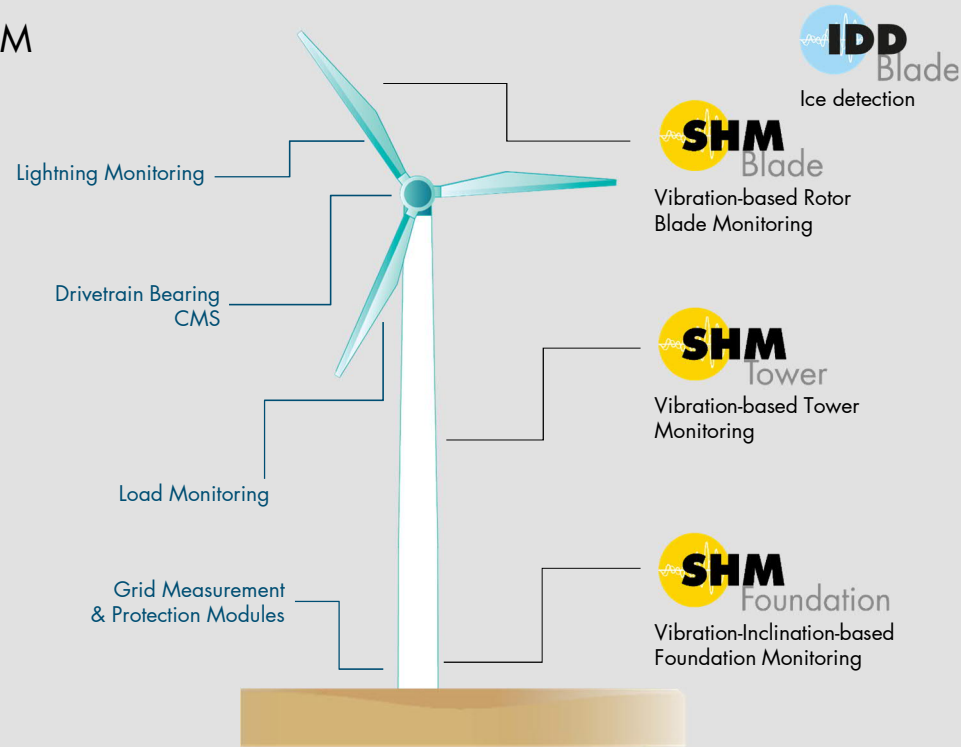
Multiple CPU cores usable to separate WTG control and SHM functionalities safely and with allocable resources

CPU = Central Processing Unit
LCoE = Levelized Cost of Energy
WTG = Wind Turbine Generator
SHM = Structural Health Monitoring

Phoenix Contact and Wölfel partner up for holistic SHM

- Driven by technology advancement and possibilities for cost reduction
- Wölfel brings in in depth structural health monitoring data analysis knowledge
- Phoenix Contact has expertise in lightning, drivetrain monitoring and grid modules

→ Outcome: One system for all requirements



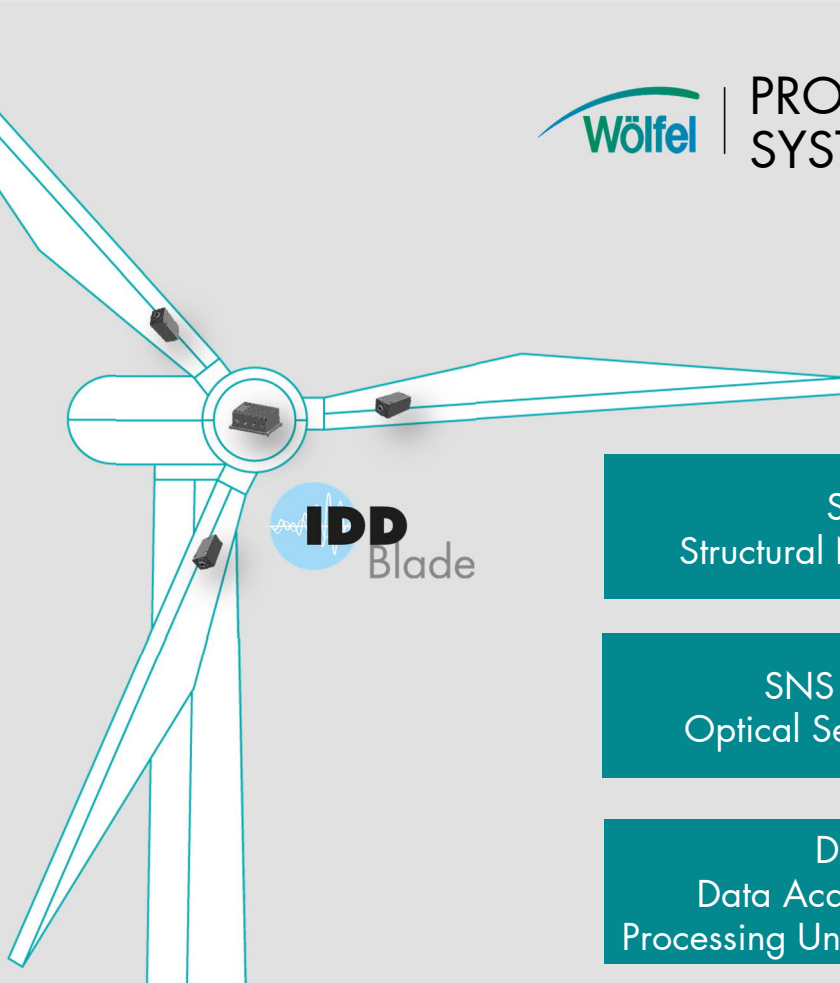
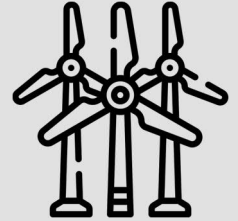


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PROVEN TECHNOLOGY WITH 1.000+ SYSTEMS IN THE FIELD

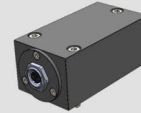


IDD
Blade

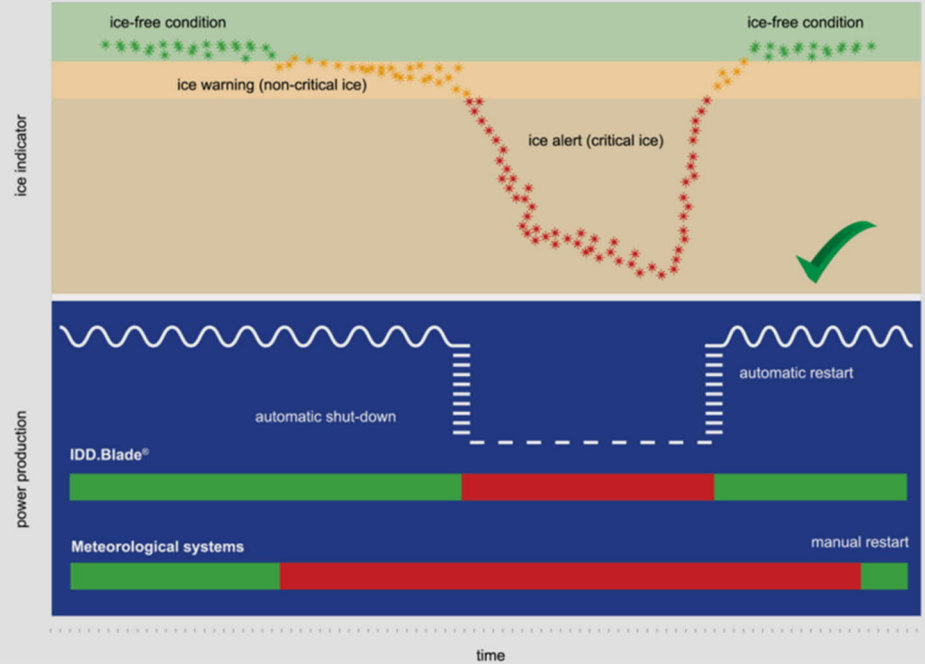
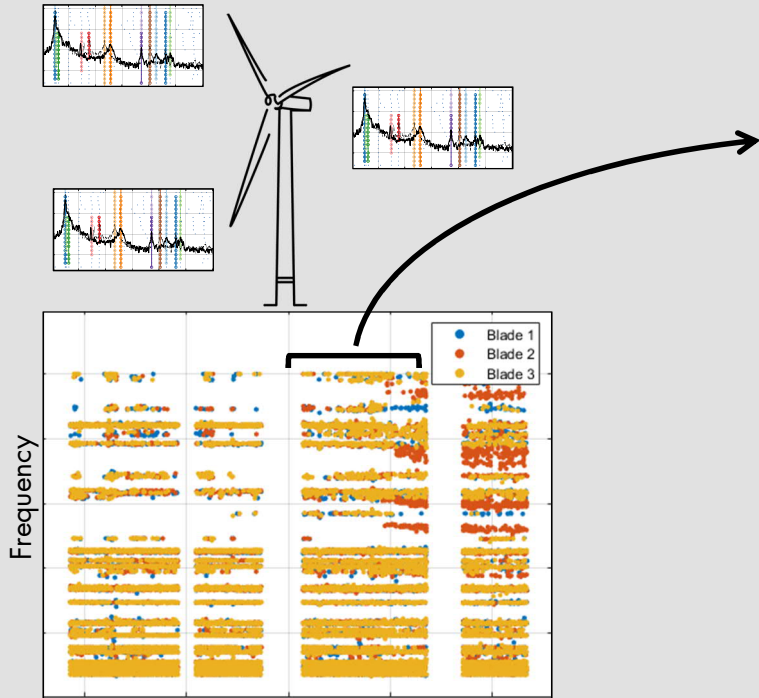
SNS
Structural Noise Sensor

SNS - DAPU
Optical Sensor Cables

DAPU
Data Acquisition and
Processing Unit – Interface PLC



TEMPORAL ANOMALIES INDICATE ICE ACCRETION





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- **ENERCON** develops a new control systems for more efficient and cost effective turbines
- The heart is one central industrial controller for the power plant with more than sufficient computational resources
- **Phoenix Contact** provides PLCnext BoxPC and sensor hardware, integration of control algorithms
- Advanced software use the standardised interface and accesses directly the turbine data
- **Wölfel** software evaluates the data and outputs the critical KPI indicators for rotor blade icing and damages

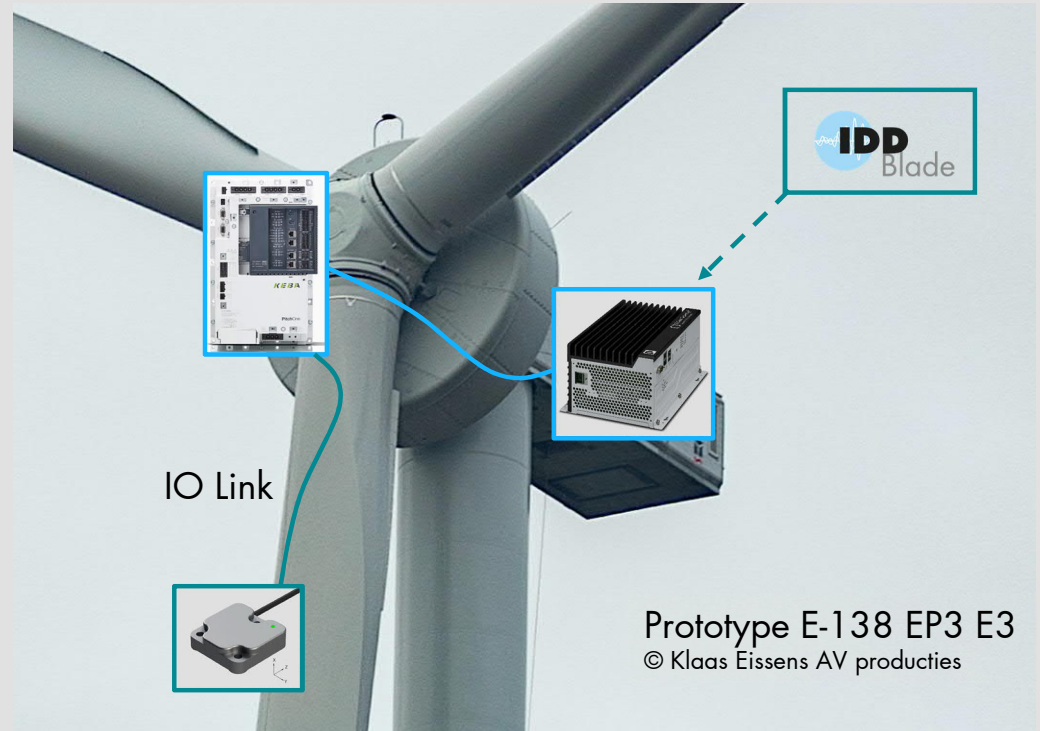


WÖLFEL APPLICATION IS A MODULE IN THE NEW PLATFORM INTEGRATED CONTROL SYSTEM OF ENERCON

System architecture of the new ice detection device includes

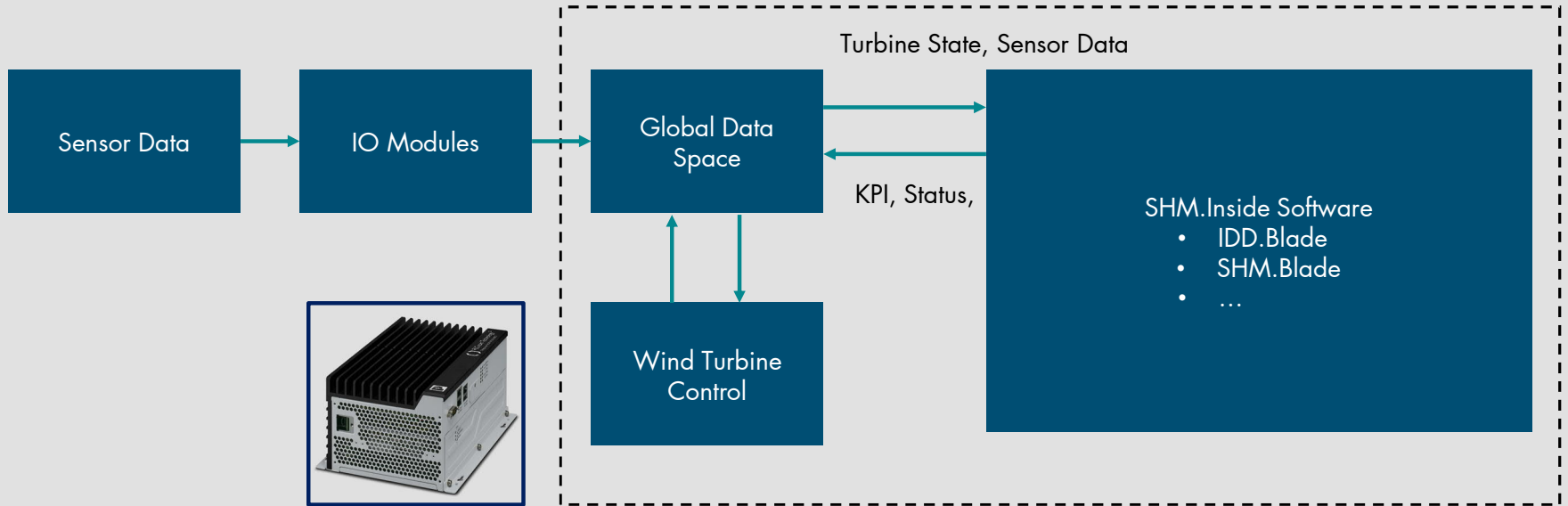
- the **standard components**
- and **additional components for ice detection with IDD.Blade**

→ This is the conceptual design to detect reliably ice accretion



ARCHITECTURE TO FIT THE NEEDS OF OEM & OPERATORS

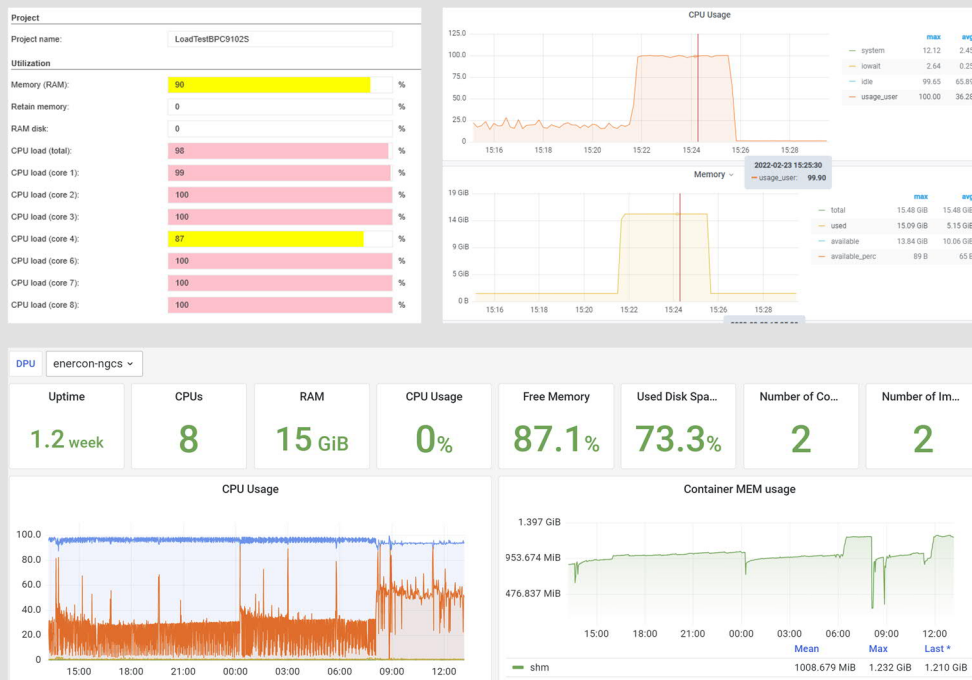
Communication and processing with software container



1. Proof of Concept



2. Prototype Software



✓ Initial acid stress test, pushes the PLCnext to its limits in order to know them

✓ Prototype software shows decent performance on BPC target

1. Proof of Concept



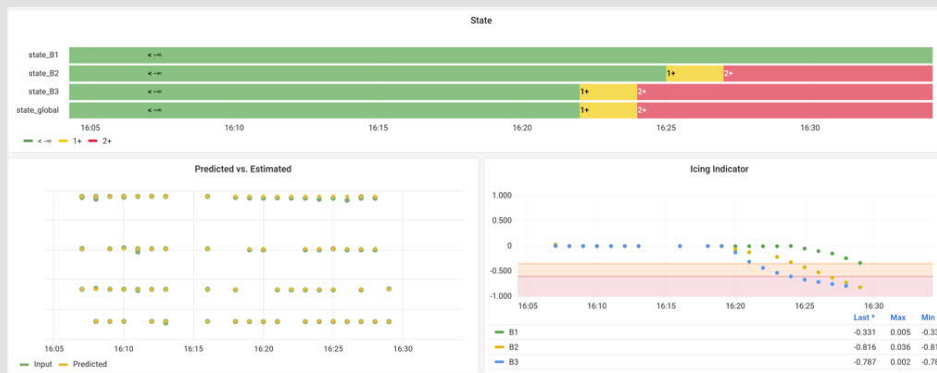
2. Prototype Software



3. Product Software

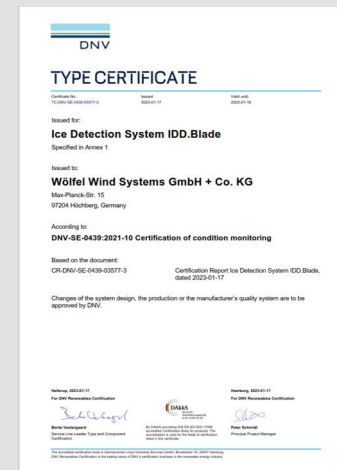


4. Certified Software



✓ Ice detection functionality fully integrated into software architecture

✓ IDD.Blade successfully certified by DNVGL as next generation ice detection system (01/2023)



- Fully integrated software container with advanced SHM functionality
- Performant hardware is deliberately restricted to use only one CPU core
- Certification process successfully completed
- Roll-out in first turbines

- Solution is available for the following turbine types:
 - E-138 EP3 E3 → 2023
 - E-115 EP3 E4 → 2023
 - E-160 EP5 E3 R1 → 2023/24



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1. Classical ice detection systems

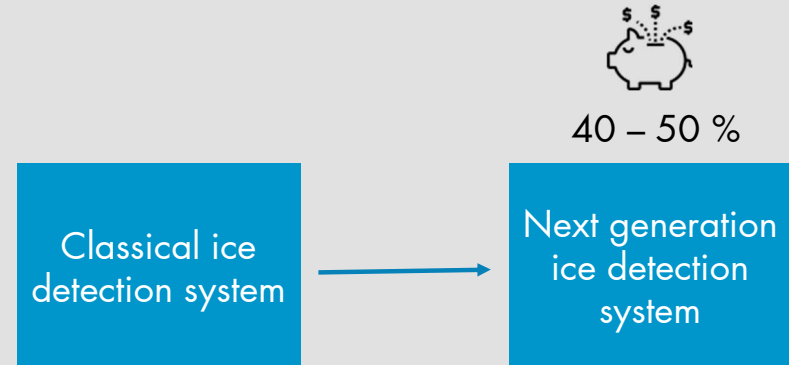
- 1x Data Processing Unit (Cabinet)
- 1x Interface Connection to the WTG
- 3x Structural Noise Sensor (SNS)
- 3x Sensor Cable
- Software + License
- Advanced communication protocol (etc. Modbus)
- Service and spare parts

2. Next generation ice detection system

- 3x Structural Noise Sensor (SNS)
- 3x Sensor Cable
- Software + License
- Simple communication via global data space

COST OPTIMIZATION COMPARED TO TODAY'S ICE DETECTION

- Substantial drop in costs for the ice detection system
- Plus additional savings due to
 - reduced maintenance costs
 - less hardware-related costs
 - reduced costs for device and patch management (software updates)
 - increased revenues "after sales" (simpler retrofit solution)





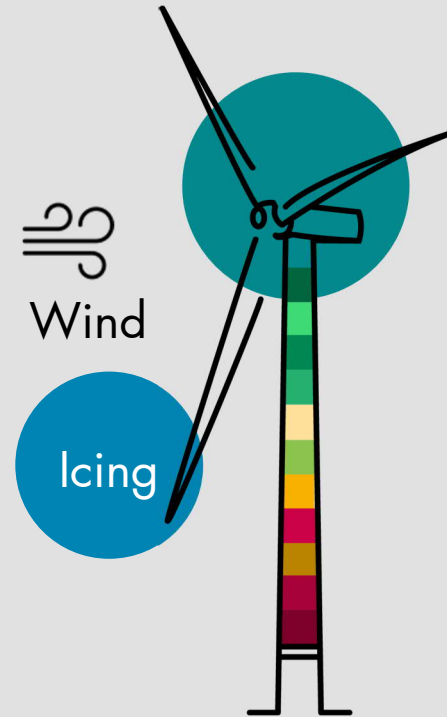
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Final conclusions:

- Direct integration in control hardware eliminates the need for separate data processing unit
- This leads to reduced efforts for installation, maintenance, spare parts and documentation
- And to increased IT security due to lack of communication protocols between third party systems
- Easily maintainable software through firmware and software updates on a regular basis

→ Summarized this is the next generation ice detection system





THANK YOU FOR YOUR INTEREST



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A long-exposure photograph of a starry night sky, showing curved light trails from stars. The top half of the image is dark blue with many fine, curved white and light blue lines. The bottom half shows a dark silhouette of a forest along a body of water, which reflects the star trails.

Wölfel