Novel Approaches for Vibration Monitoring by a Cloud-supported System Architecture

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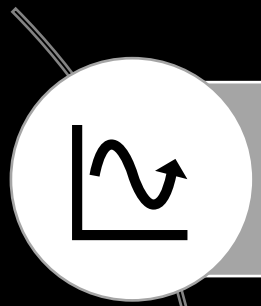
OUTLINE



What are the requirements for a torsional vibration monitoring system?

How to design a state-of-the-art monitoring on-site?

How to design a state-of-the-art monitoring including backend solutions?

TORSIONAL VIBRATION MONITORING

- Example: Torsional vibration monitoring of a steel spring damper

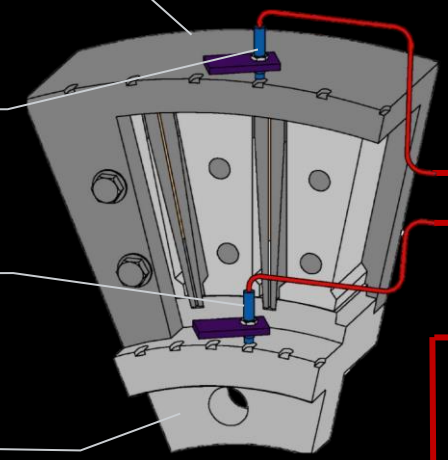
Damper outer member

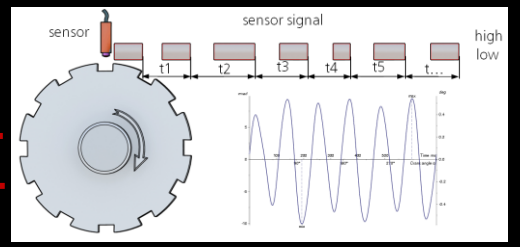
Outer sensor

Inner sensor
(Engine free end)

Damper innerstar

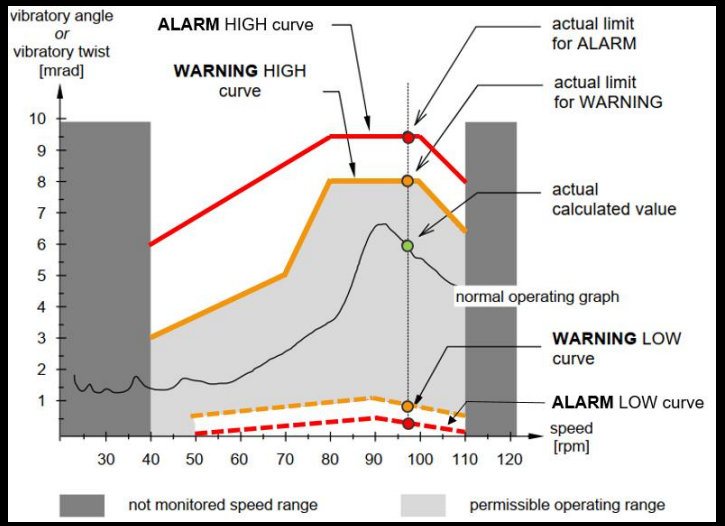
Oil parameter monitoring T, p in oil supply





Data processing covering short time horizon

Benchmarked against pre-defined limit values & normal operation based on simulations and parameter variations



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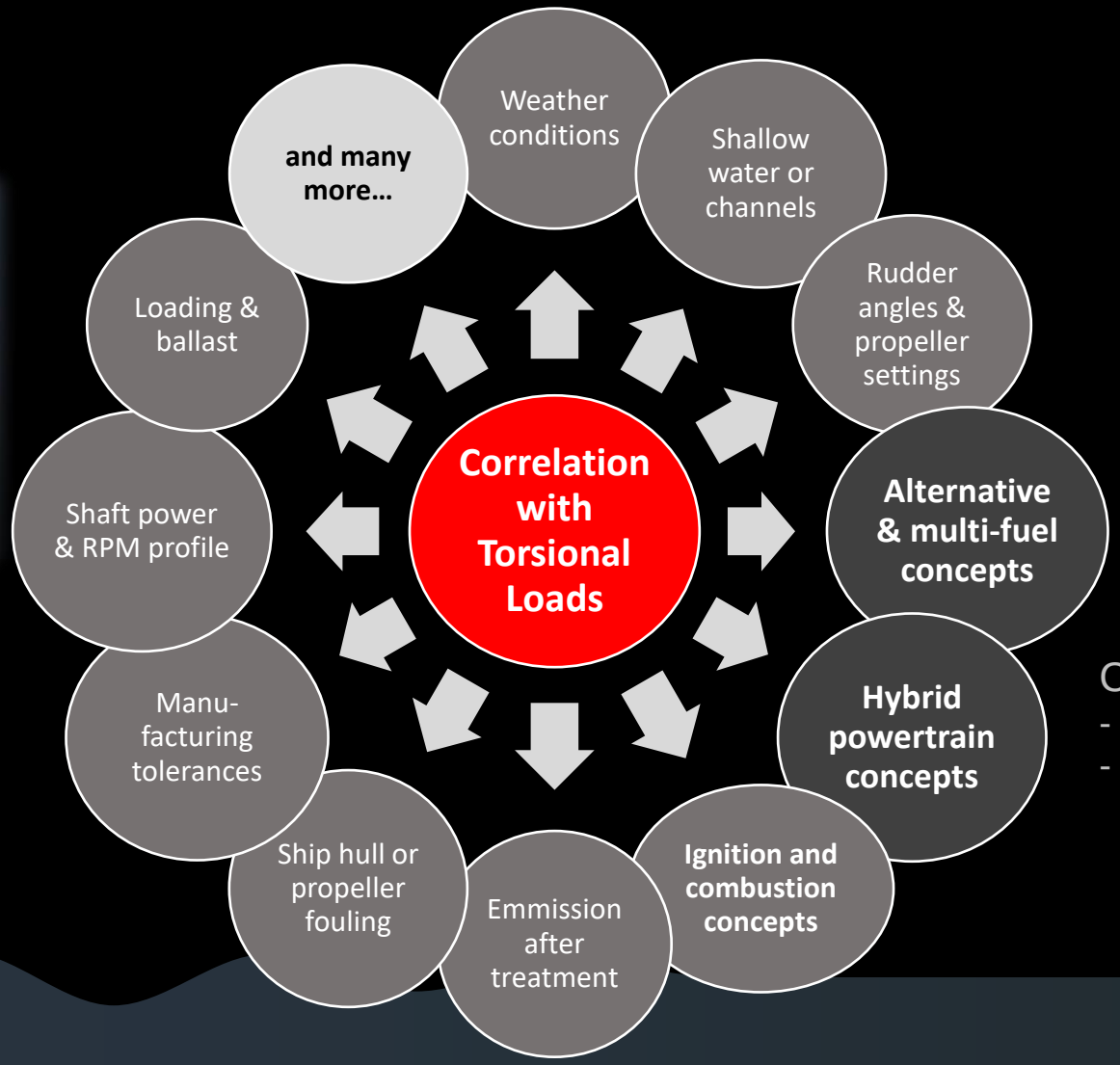
IMPACTS ON TORSIONAL VIBRATIONS

Example:
Marine application



- Demand for a lot of context information
- New system architecture and monitoring design requirements
- Condition monitoring vs. Business Intelligence

CIMAC Cascades 2021
- Green fuels
- Hybridization in large engine application

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TORSIONAL VIBRATION & FUELS

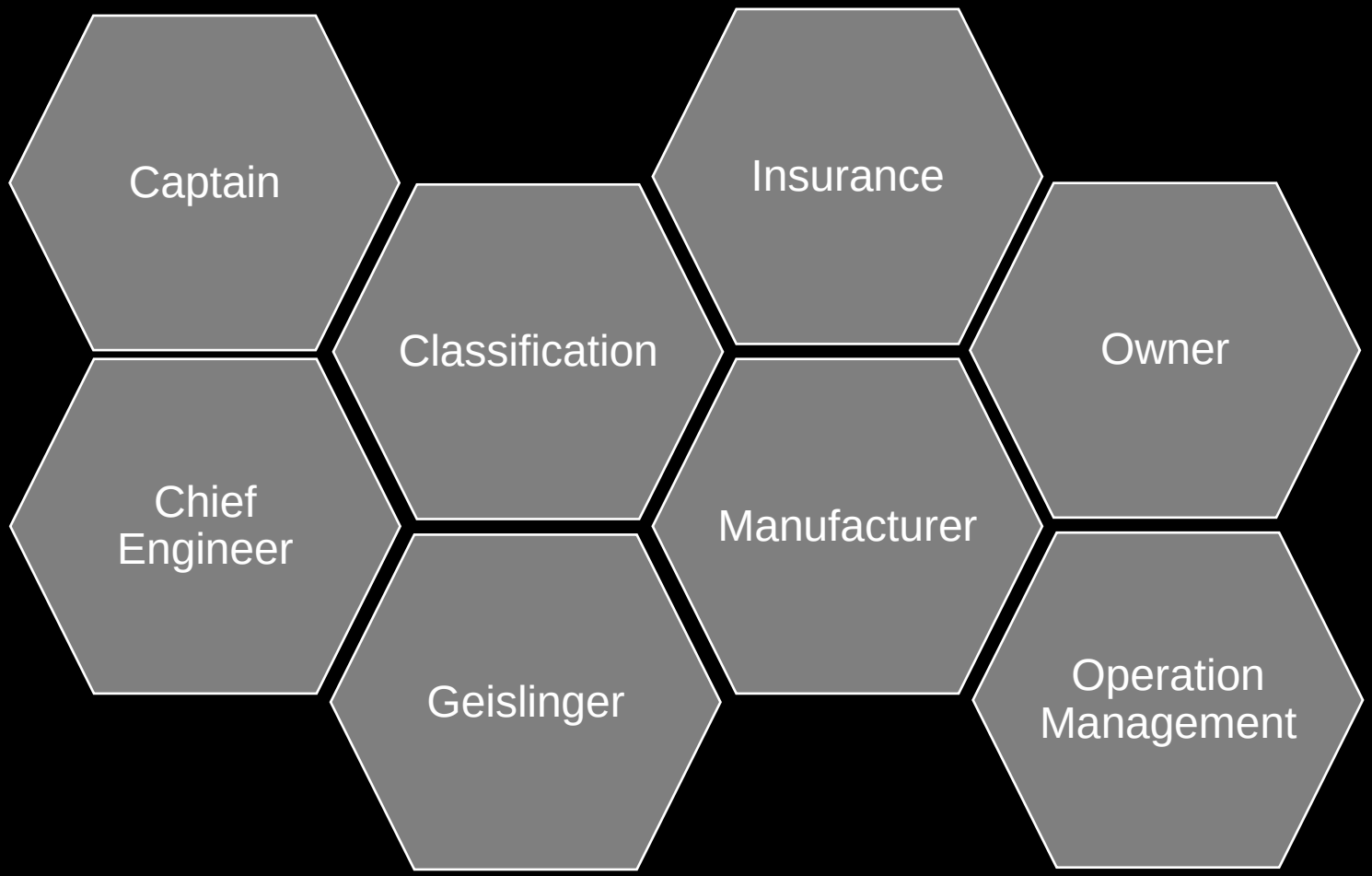
Fuel Types		Torsional Vibration Impact
Fossil Diesel Fuel	DI	0
Natural Gas, LNG, CNG	DI	↗
	Pre-mixed	↗
LPG	DI	↗
	Pre-mixed	↑
Methanol	DI	↗
Ammonia	DI	↗
e-MDO	DI	→
Biodiesel	DI	→
H2: Ottocycle		↑

Effect Legend	
↑	Strong impact
↗	Impact
→	unchanged

Properties	Torsional Vibration Impact
Power Density	↗
Ignition Energy Request	→
Ignition Stability	↗
Combustion Stability	↑
Peak Pressure Level	↑
Temperature Level	→
Knocking Sensitivity	↗
Mechanics & Tribology	↗

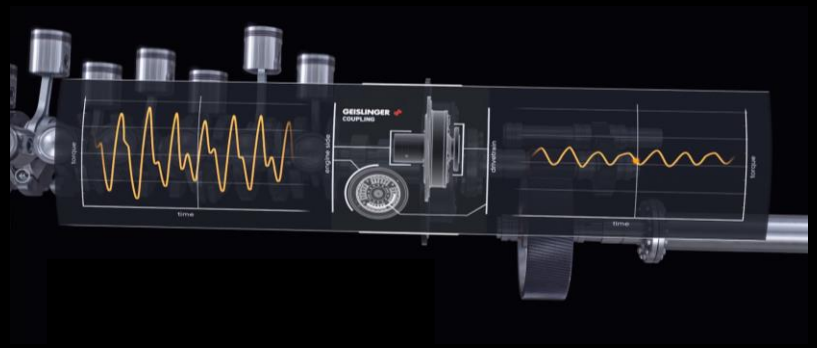
Prenninger K., Mühlberger C., Eicheldinger S., Wachtmeister G., Impact of Emission Reduction Strategies on Torsional Vibrations, TVS 2021, Salzburg, 2021

BENEFICIARIES

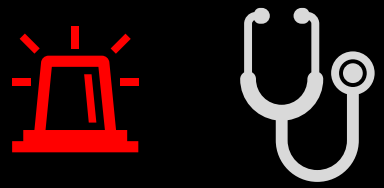


BENEFICIARIES ON-SITE

- Monitoring of torsional vibration in the powertrain



- Alarming and diagnosis in case of faulty behaviour



Captain

Chief Engineer

Classification

Geislinger

Insurance

Manufacturer

Owner

Operation Management

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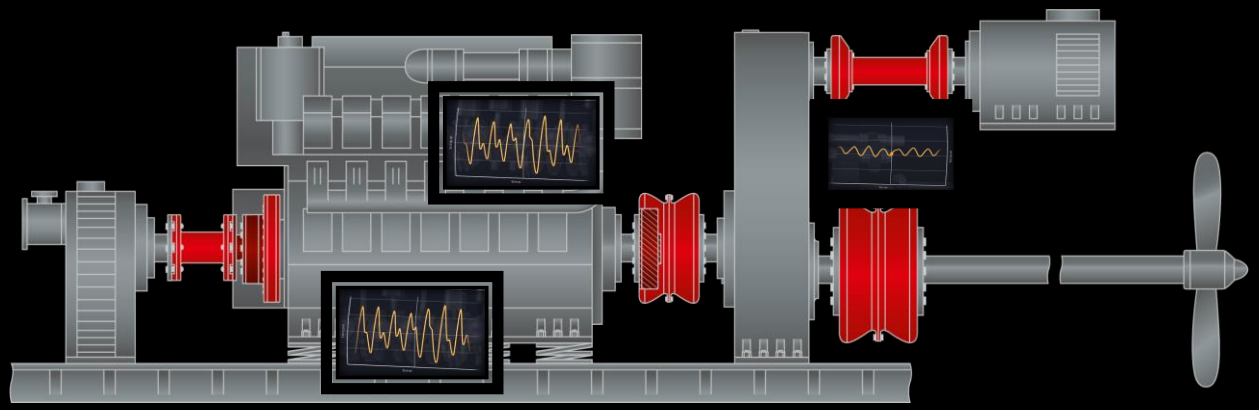
SYSTEM ARCHITECTURE ON-SITE

- Torsional vibration monitoring of a powertrain



- Modular and robust hardware
  - Necessary certification
  - Process powertrain sensor data
  - Possibility of retrofit options
- HMI for on-site monitoring
- Alarming in case of detected overloads
  - Audible feedback
  - Visual feedback

SYSTEM ARCHITECTURE ON-SITE

On-site service prerequisites

- Possibility for data recording (e.g. USB)
- Possibility for software updates (e.g. USB)

3rd party system integration

- Improve condition monitoring through larger data base

Missing standards

- High integration efforts
- Diversity of requirements
- Problems identified late
  - cost increase

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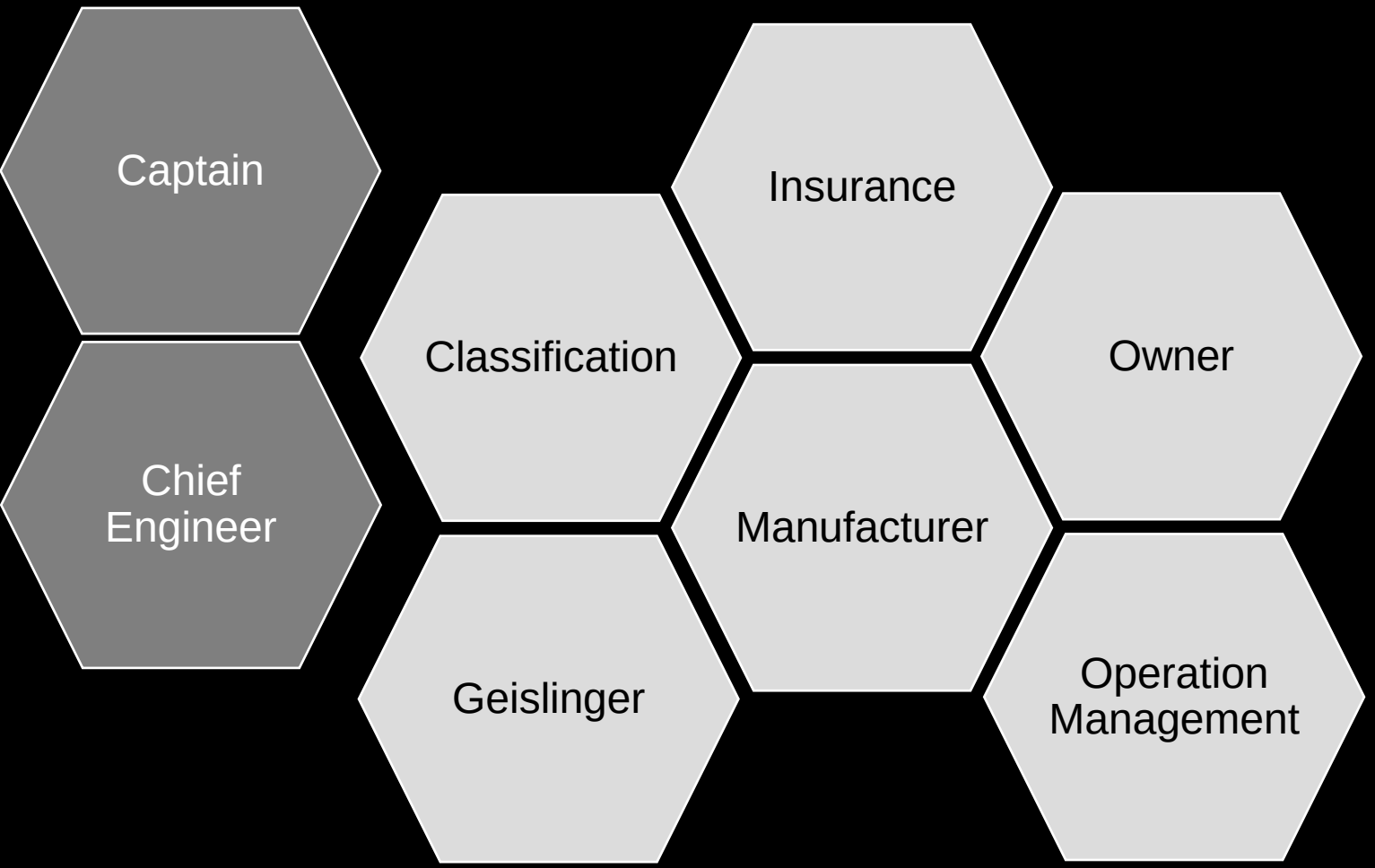
BENEFICIARIES BEYOND ON-SITE



Even more demands…

- Reduction of unplanned downtimes
- Additional operational safety

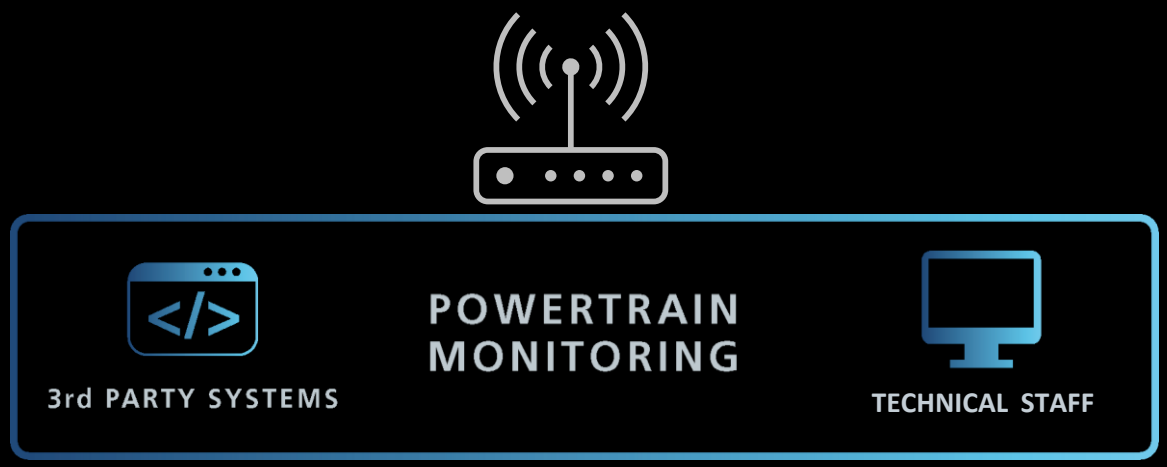
- Reports for classification and insurance

- Learn about product behaviour
- Build Digital Twin of product

- Cost savings

Hardly possible to fulfill on-site

GETTING READY FOR INTERNET CONNECTION

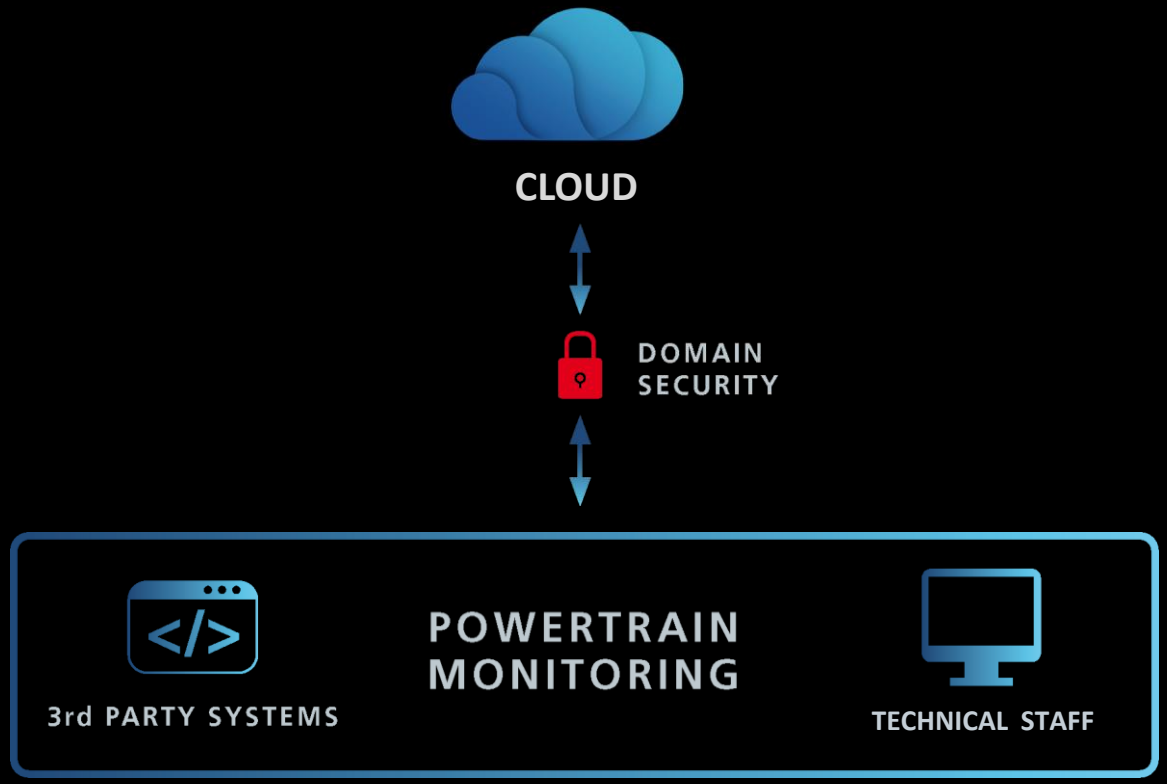


Preparation for internet connectivity

- Hardware requirements
  - Disc space for data backup
  - Physical interfaces
- Network settings
- Device identification

ECOSYSTEM – CLOUD PUSH

Purpose:
Collect historic TV data



SECURITY

Overall goal
- Provide a secure solution

IT department demands
- Small modifications of firewall settings
- Limit number of ports and protocols

Remote Service demands
- Accessible from outside

ECOSYSTEM – CLOUD PUSH

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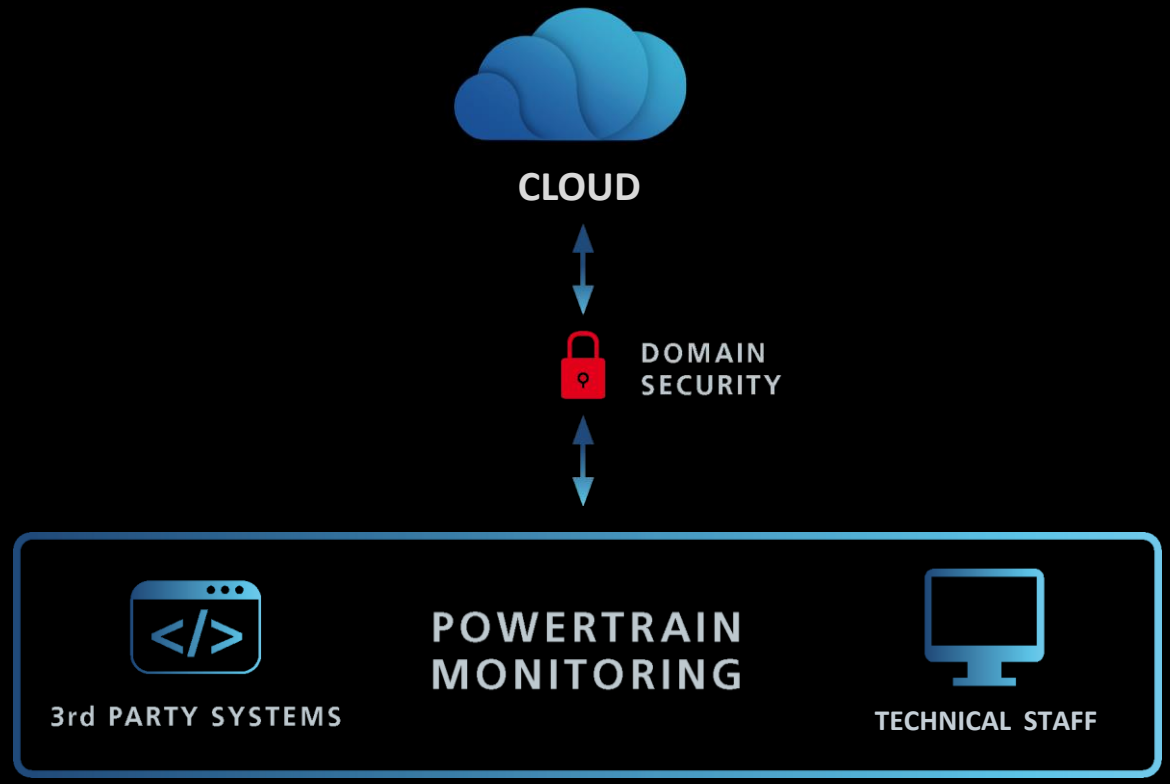
Collect historic TV data



CONNECTIVITY

- Expensive
- Availability
- Tradeoff between memory usage and continuous data flow
- Provide offline solution with manual data upload

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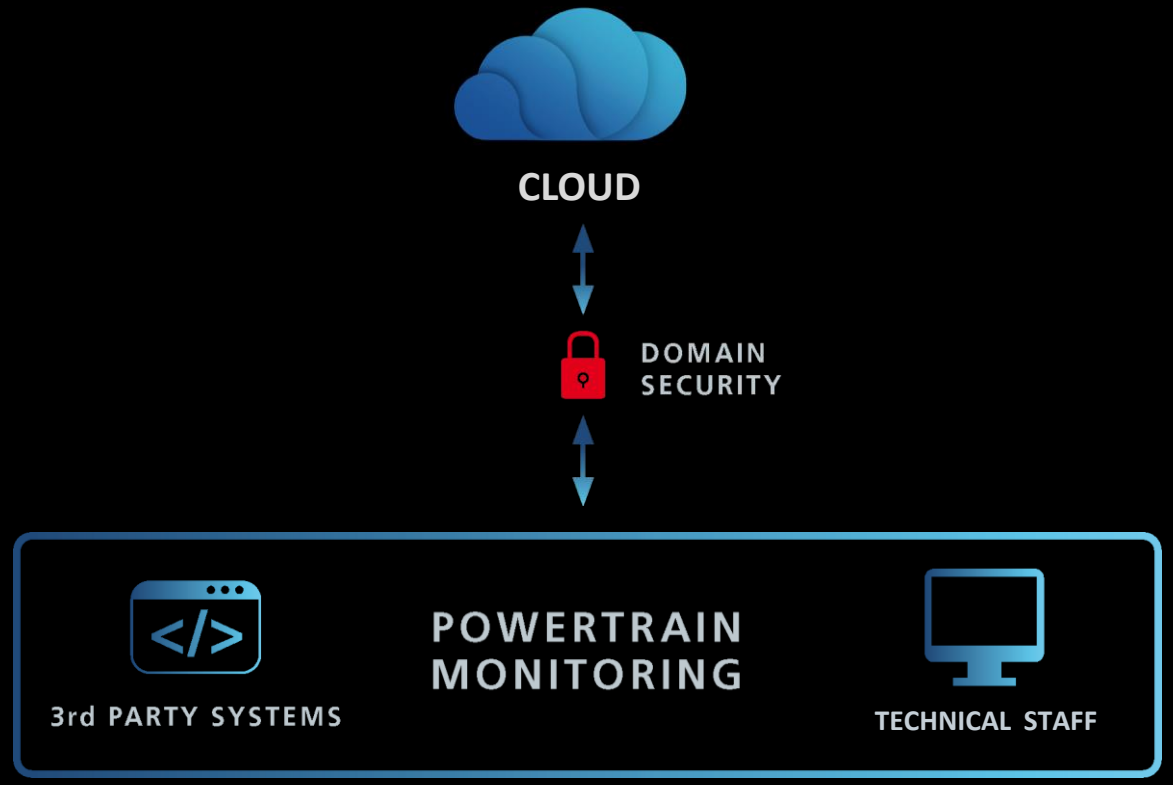

§ DATA OWNERSHIP

- Who owns the data?
  - GDPR
  - Terms and conditions
  - User requested data deletion

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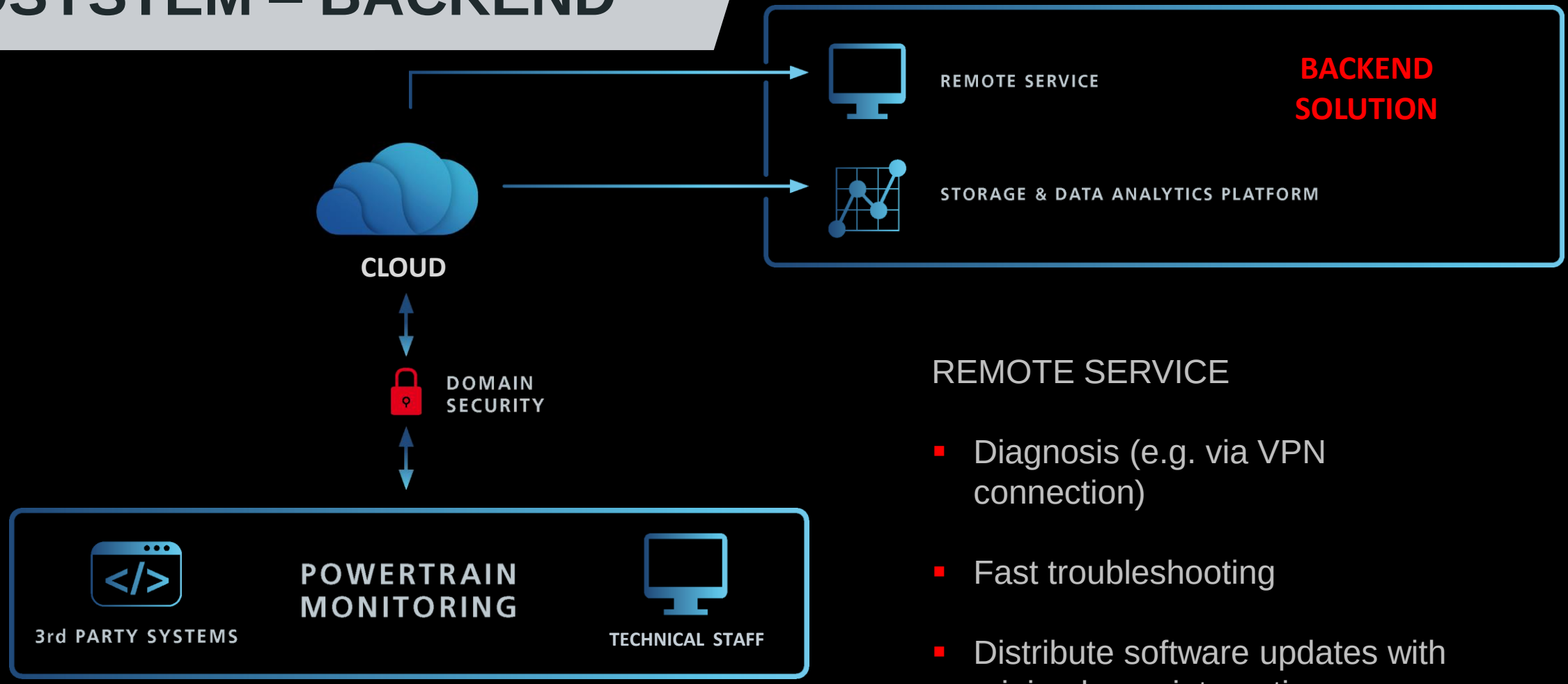
ECOSYSTEM – BACKEND



REMOTE SERVICE

- Diagnosis (e.g. via VPN connection)
- Fast troubleshooting
- Distribute software updates with minimal user interaction

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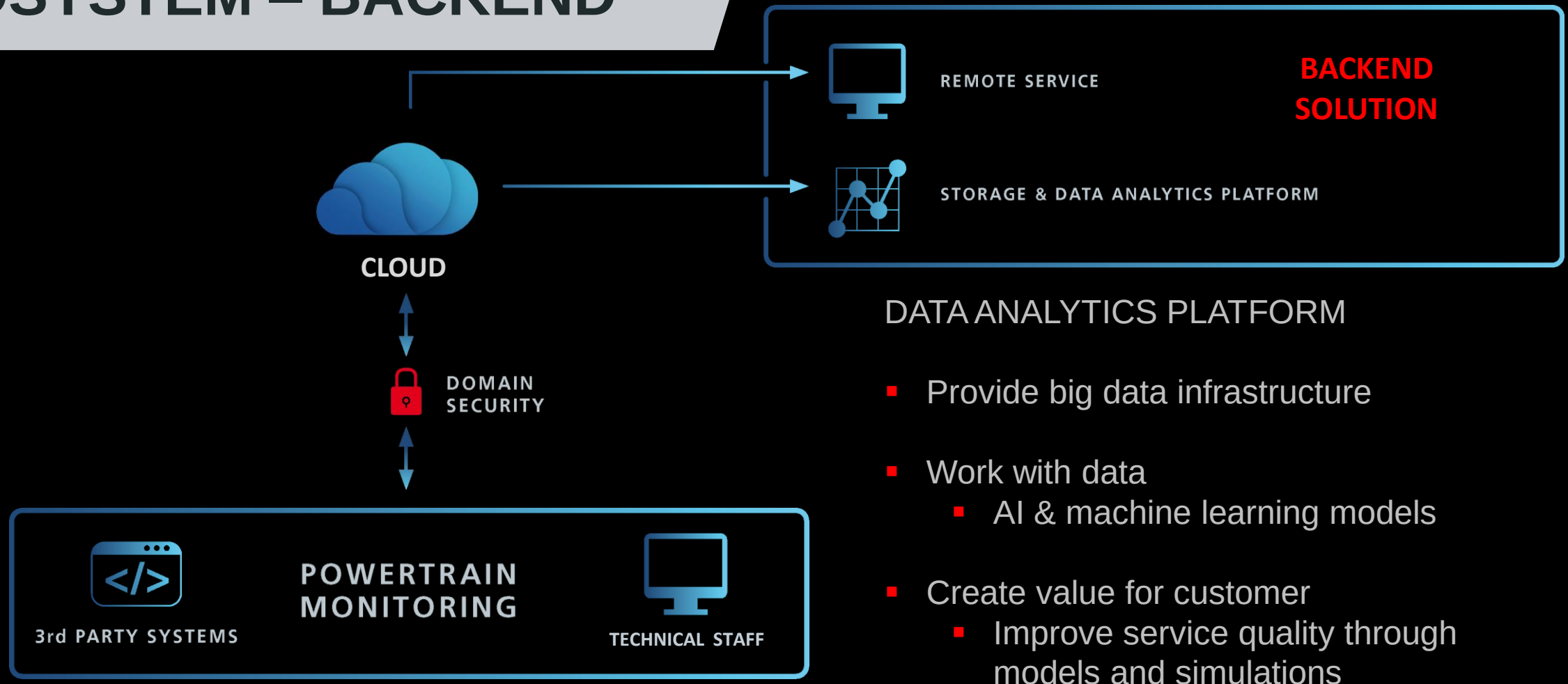
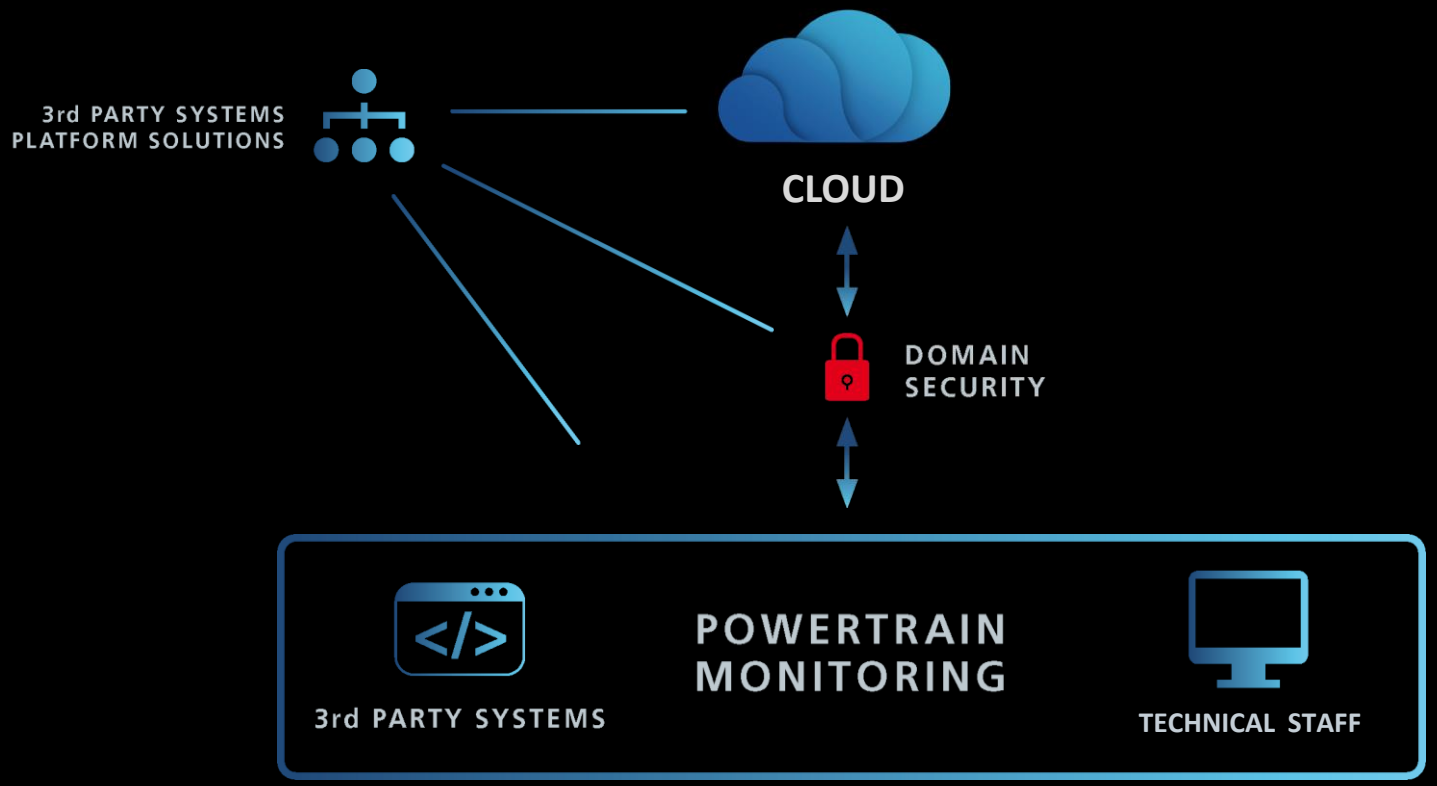
ECOSYSTEM – BACKEND



DATA ANALYTICS PLATFORM

- Provide big data infrastructure
- Work with data
  - AI & machine learning models
- Create value for customer
  - Improve service quality through models and simulations
  - Adapt service intervals

ECOSYSTEM – 3rd PARTY



Market feedback:
Customer wants to have fast and easy insights to all data & services

3rd PARTY INTEGRATION

- All information in a single solution
  - Being part of larger platforms adds *sometimes* more value to customer
- Enlarge context data
- Use own infrastructure for data processing (domain knowledge) and share KPIs backend-2-backend

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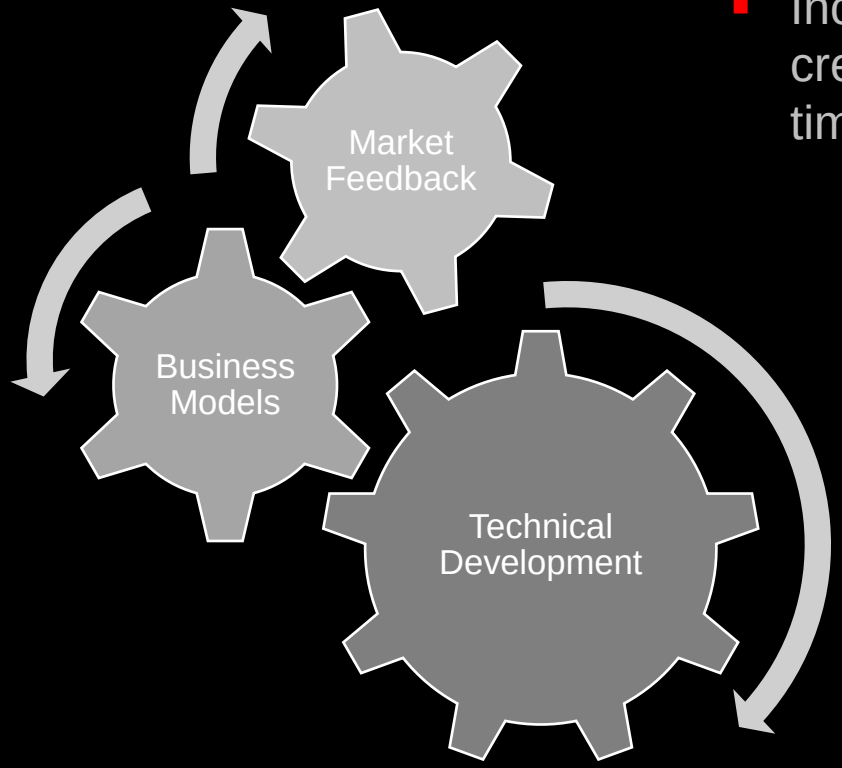
AGILE DEVELOPMENT PROCESS

- Include market feedback to create MVPs with short time-to-market



- Not only technical issue, but also commercial challenge

- Stay modular and agile in development process

Geislinger Monitoring System Mark6

Geislinger Digital Services

Geislinger Analytics Platform

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