

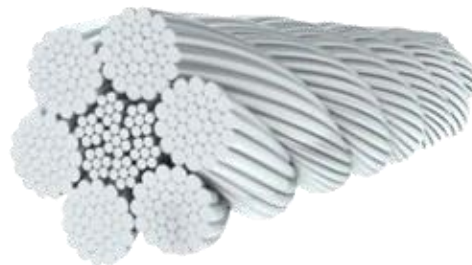
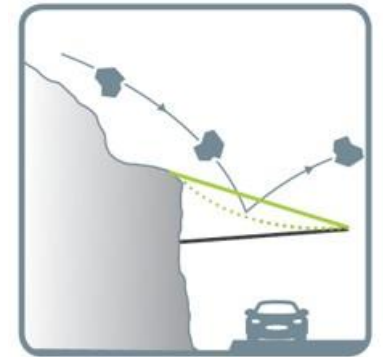
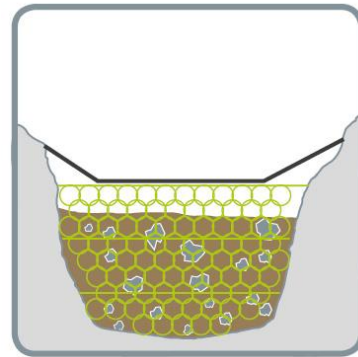


Subcommittee on Geotechnical Asset Management (GAM)
Manuel Eicher

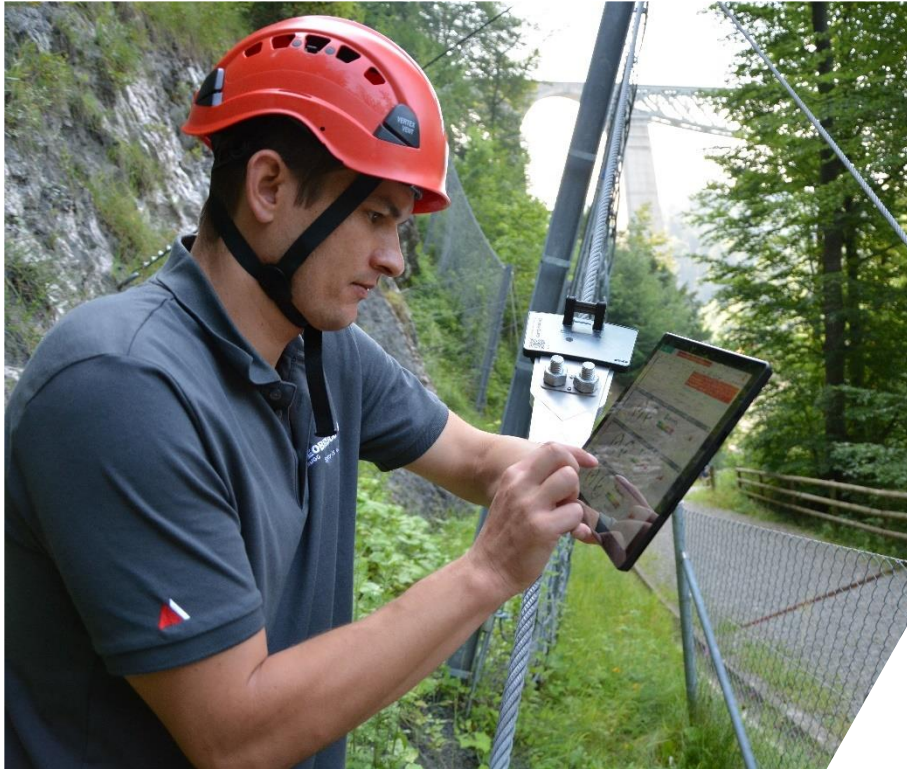
ASSET MANAGEMENT / GUARD

An IoT device for remote monitoring of flexible protection systems against natural hazards

Made for different systems / not limited to Geobrugg Systems



Asset Management with GUARD



1. STANDARDS
2. IMPLEMENTATION AND CHALLENGES IN THE FIELD
3. FUNCTION OF THE GUARD
4. INSPECTION MANAGEMENT WITH THE GUARD



STANDARDS

Rail Ways



Regions



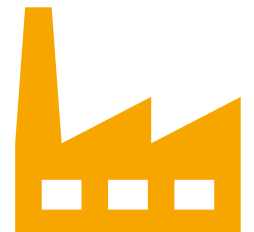
Countries



Roads



Manufacturer



There are no harmonised standards for the inspection and maintenance of protection structures against natural hazards.



Example: SBB Swiss Federal Railways

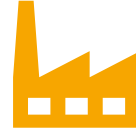
Hauser, M., Künzli, B., Sperisen, R., Haesler, S., & Hofstetter, F. (2016). Überwachungsrichtlinie für Schutzbauten gegen Naturgefahren. Bern: SBB CFF FFS

Inspections

A difference is made between:

- Regular inspection (according to the cycle of protection structures)
 - Intermediate inspections (ongoing observations)
 - Special inspections (after events)
- ▶ Intermediate inspections (ongoing observations)
 - During and after extraordinary meteorological events (e.g.: heavy precipitation, thunderstorms, snowy winters).
 - At locations with increased risk (e.g.: after documented events, at protection structures with reduced or unknown protective effect, construction sites).





Example: Geobrigg Maintenance Manual

Roduner, A., Lanter, A., & Sennhauser, M. (2019). Maintenance Manual RXE-, GBE- and ATT-series. Romanshorn, Geobrigg AG

3.1 Regular inspections

3.1.1 Interval for regular inspections

The appropriate interval depends primarily on the following parameters:

- Frequency of rockfall
- Corrosion class of the area
- Vegetation

3.1.2 Minimum number of inspections

Under normal environmental conditions, two checks a year are sufficient. If frequent rockfall occur, more inspections are appropriate. These should be carried out before the start of winter and after winter has ended.



TOP 2

IMPLEMENTATION AND CHALLENGES IN THE FIELD

IMPLEMENTATION AND CHALLENGES IN THE FIELD

Challenges which owners have

- ▶ Too few resources
- ▶ Poorly accessible protection structures
- ▶ No possibilities for visual inspections



Picture: Visual inspection of a rockfall barrier visible from the road / 21.06.2021

AVERAGE NUMBER OF HEAVY PRECIPITATION PER YEAR

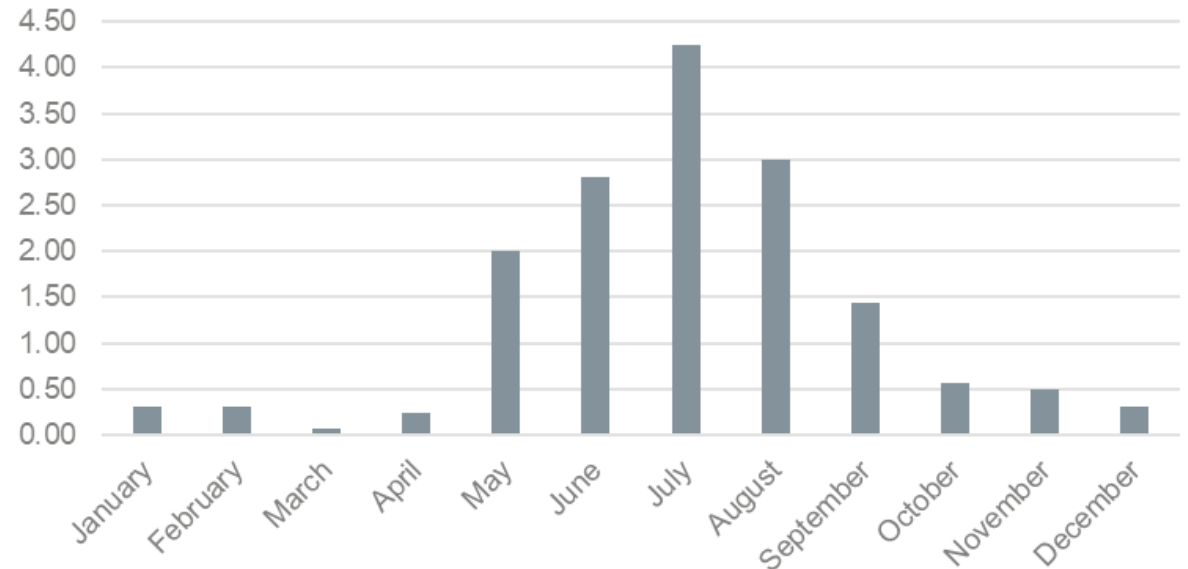
Total over all month's 15.81 heavy precipitation per Year in Germany

Definition heavy precipitation:

- ▶ Rainfall amounts 15 to 25 l/m² in 1 hour or 20 to 35 l/m² in 6 hours (severe weather warning)
- ▶ Rainfall amounts > 25 to 40 l/m² in 1 hour or > 35 l/m² to 60 l/m² in 6 hours (severe weather warning)
- ▶ Rainfall > 40 l/m² in 1 hour or > 60 l/m² in 6 hours (extreme weather warning)

<https://www.dwd.de/DE/service/lexikon/begriffe/S/Starkregen.html>

Average number of heavy precipitation per Year (Data base 2001-2017)



<https://de.statista.com/statistik/daten/studie/899077/umfrage/starkregenereignisse-in-deutschland-nach-monaten/>

IMPLEMENTATION AND CHALLENGES IN THE FIELD

Rough assessment Inspection / Maintenance			
Spring / All year	Heavy precipitation	Storm	Winter
Min. 1x / year	15.8 x / year	?x / year	1x / year

In practice, these requirements can hardly be implemented.

How can it be ensured that an owner can fulfil his responsibility?

IMPLEMENTATION AND CHALLENGES IN THE FIELD

An option is to use cost-effective remote monitoring systems

If you can permanently monitor the condition of a structure:

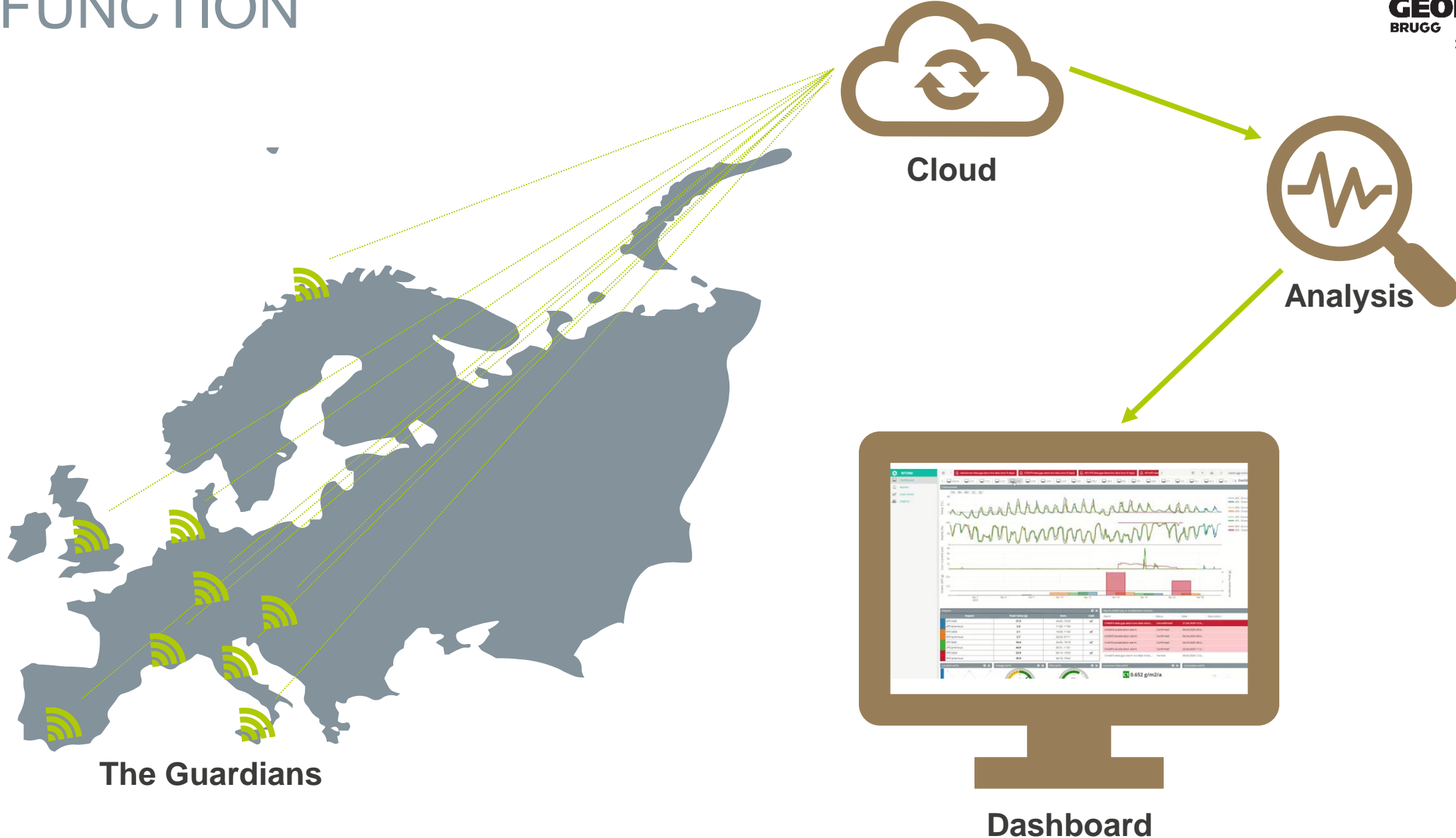
- controls can be prioritised after an event
- postponing an inspection after e.g., heavy rainfall
- on-site inspections take place more need-based
- the standards are fulfilled





FUNCTION OF THE GUARD

FUNCTION



GEOBRUGG GUARD / SENSOR CONCEPT

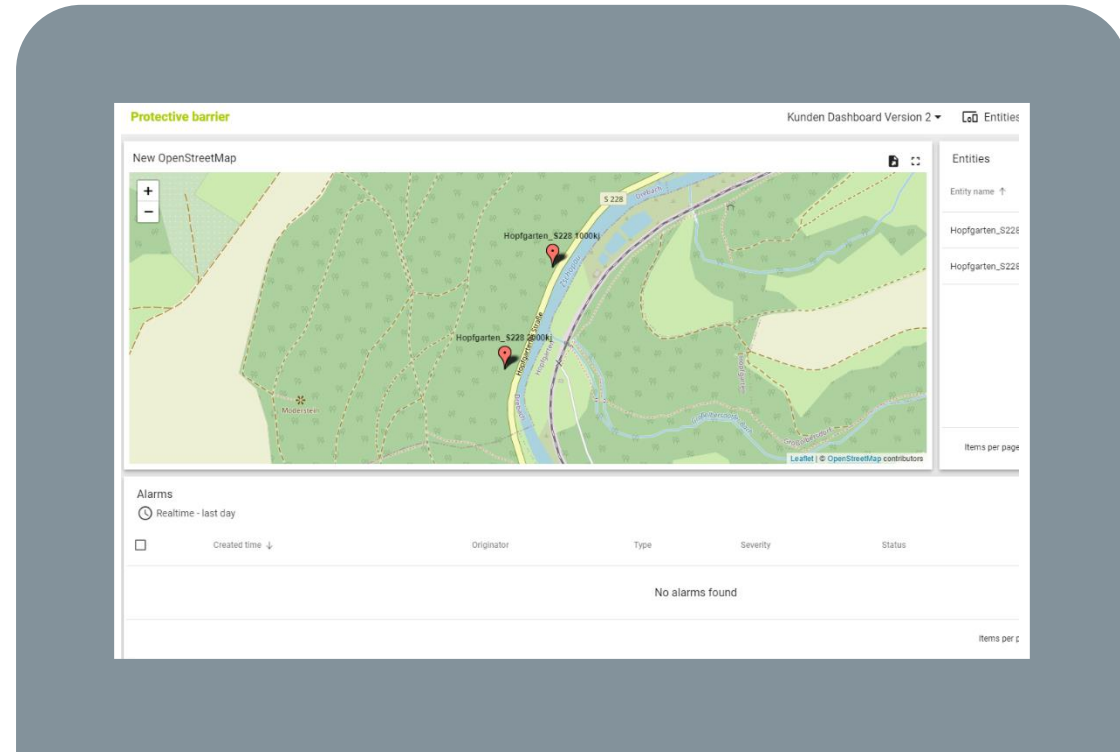
	Dynamic load cases	Static load cases	Corrosion / Zinc reduction
Problem	<ul style="list-style-type: none"> • Rockfall • Impact through trees • Debris flow • and more... 	<ul style="list-style-type: none"> • Snow pressure • Slow debris flow • Rubble • and more... 	<ul style="list-style-type: none"> • Humidity • Salt • Air pollution • other location factors...
Problem identification	Acceleration sensor	Rope force sensor	Corrosion sensor
Urgency	High impact → Immediately Low impact → Weeks	Day / Weeks	Months / Years
Notification	SMS and/or E-Mail	E-Mail, Dashboard or Report	Dashboard or Report
Measures to maintain the level of safety	Replacing elements such as brake elements, net, support ropes, ...	Replacing elements such as brake elements, net, support ropes, ...	Replace parts or add corrosion protection



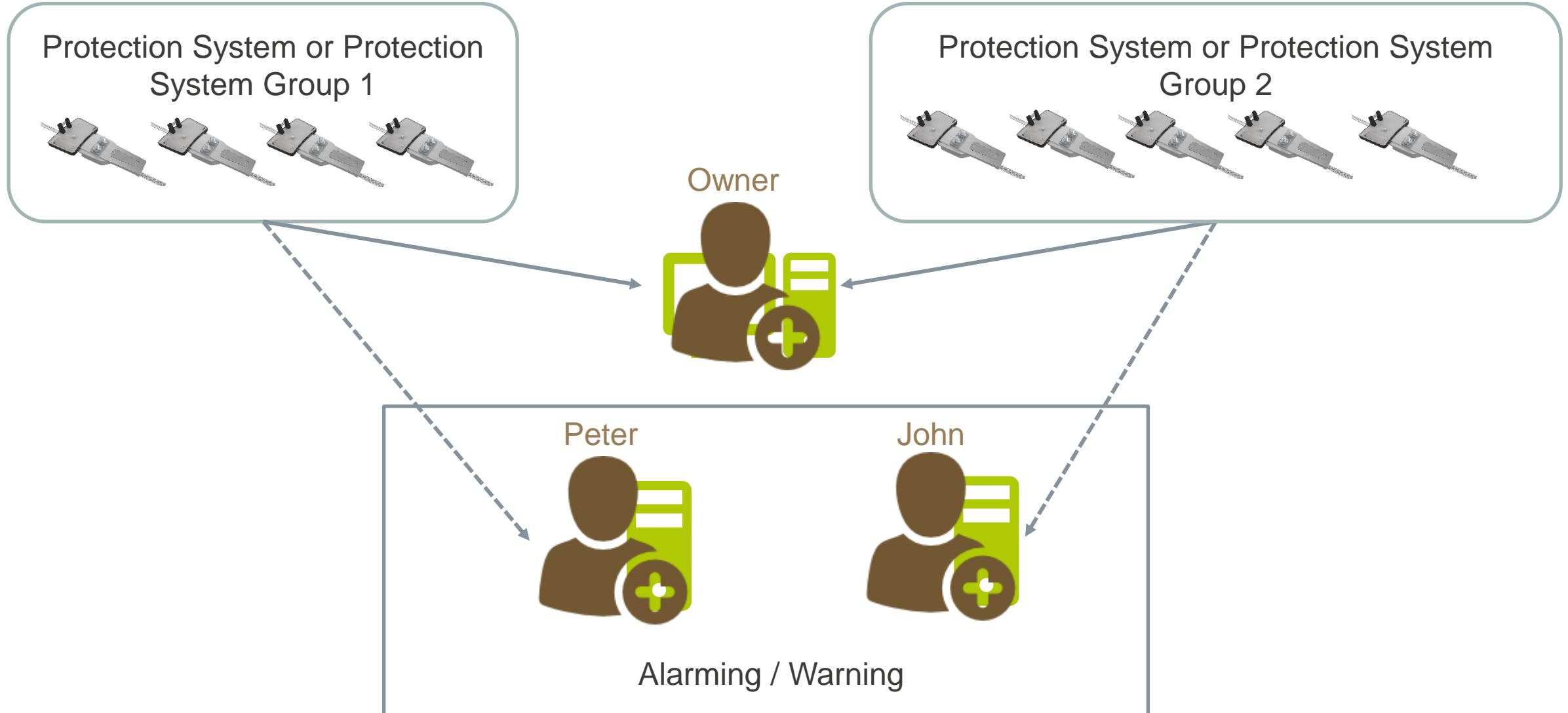
INSPECTION MANAGEMENT WITH THE GUARD

Manage the platform **independently**

- ▶ Management of logins and users
- ▶ Management of alarm and warning process via cell phone (SMS) or E-mail
- ▶ Installing and assigning protection structures to persons (also third parties)

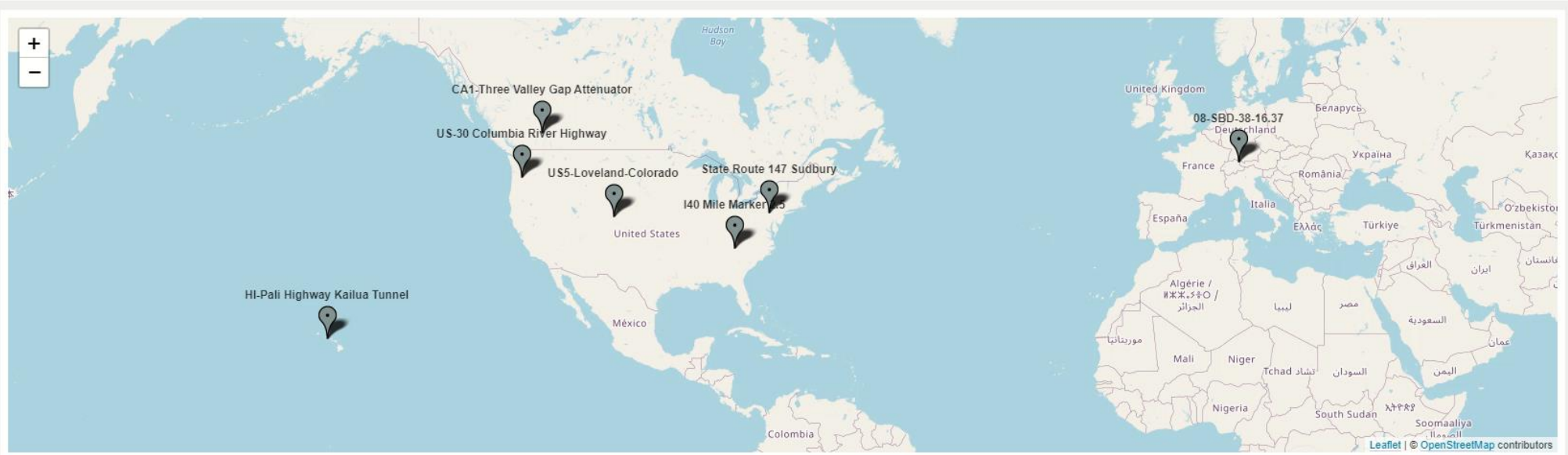


INSPECTION MANAGEMENT WITH THE GUARD



- Home
- Alert List
- Edit Asset
- Edit Device
- Add User
- Add Alert Receiver

Protection System



Date picker
11 Dec 2021 - 10 Jan...

Step size
Month

<input type="checkbox"/>	Protection System	Device ID	Alert Type	Status	Alert Time ↓	Acknowledged Time	Peak [g]	Classification	
<input type="checkbox"/>	State Route 147 Sudbury	tl3l-qw72-wys4-tsc2	Impact	Cleared Unacknowledged	2022-01-09 19:17:47		12.15		... ✓ ✎
<input type="checkbox"/>	State Route 147 Sudbury	tl3l-qw72-wys4-tsc2	Impact	Cleared Acknowledged	2022-01-09 19:17:47	2022-01-10 13:29:16	12.15	False Alert	... ✓ ✎
<input type="checkbox"/>	CA1-Three Valley Gap Attenuator	t4sx-31d7-8m8n-xl4k	Impact	Cleared Acknowledged	2022-01-07 17:31:11	2022-01-10 13:29:24	3.50		... ✓ ✎
<input type="checkbox"/>	CA1-Three Valley Gap Attenuator	q632-6wlz-5kb6-dzup	Impact	Cleared Acknowledged	2022-01-07 03:20:46	2022-01-10 13:29:27	11.44		... ✓ ✎

RECENT EXAMPLES

OREGON / US-30 COLUMBIA RIVER HIGHWAY

Last week / Tuesday 4th of January 2022



- ▶ 6g acceleration
- ▶ at 01:09:20 UTC



STATE ROUTE 147 SUDBURY

What happened yesterday?



- ▶ 12g acceleration
- ▶ at 18:17:47 UTC



THANK YOU FOR YOUR ATTENTION

