

## **Alarm Pattern Recognition**

**IPSW 2023 Problem Topic Briefing** 



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## Why do alarms in power grids matter?



Renewable capacity must grow **4x more** than it is today



Electrical car sales are expected to increase **18x the level today** 



In industry, \*emissions must drop **20% by 2030** and 90% by 2050



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\*IEA's Net Zero by 2050 report





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Papua New Guinea

East Timor

Australia

People's Republ

... and are exposed to all

Bolivia

ACTUALITÉS

Incendie de forêt

Open Infrastructure Map https://openinframap.org/

La centrale La Grande-3 à nouveau évacuée, situation tendue à la Baie-James

Éinland



or ENTSOE: https://www.entsoe.eu/





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## Where do the alarms go?





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https://nyiso.com

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## Where do the alarms go?

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## Where do alarms come from?





https://pksafety.com/blog/the-importance-of-arc-flash-protection

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## Some of the alarms in our dataset

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#### Alarm overload a persistent issue

TABLE IIIa. Average severity of difficulties encountered at the Central or National Level, ranked on a scale of 1 to 5.



#### Standards hard to achieve



Transmission Control Center Alarm Management Practices – Observations Report #3002009925 (**2017**) EPRI, Electric Power Research Institute

#### Active long-standing research topic

- Alarm 'floods' or 'avalanches' (hundreds of alarms in a short period of time)
  - overwhelm operators' capacity to respond
  - can distract and impede response
- · More alarms continue to be added
- Standards guides advise how to manage alarms, but take **significant effort** to adopt



### Alarm overload challenges today's operators; pattern recognition could help

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#### What is in the dataset

- A real transmission system operator's data
  - 8 months, many many alarms
- 2000 near-simultaneous "Alarm Floods"
  - Some un-related coincident alarms
- Redacted data describing
  - When (to the nearest ~second)
  - Where (more or less)

Public

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- Who (specific signal & 'kind of thing')
- What (status change happened)

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• How (important do engineers think it is)

#### What would be interesting to find

**Possible questions:** 

- How to summarize?
- Initiating or "root cause"?
- Patterns of alarms which happen together?
- Surprise? Underlying process changed?
- 'Missing' or 'extra' alarms?
- Mathematic formulation(s) which are:
  - Fast & medium-memory
  - · Incrementally updated as alarms arrive
  - Tolerant of (or useful to find) bad data

#### What makes it tricky

- Timestamp not perfectly accurate (A -> B, B -> A?)
  - · Some alarms could be delayed
- Not everything recorded
- Relationships between objects changes
  - Network is reconfigured, maintained
  - Logic is changed, conditional
  - Scope of influence varies widely
- Data engineering not perfect
  - "Alarm Subtype" often generic
- Mistakes very expensive

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## Real customer data so process required

- 1. Sign NDA
- 2. Access a shared OneDrive link
- 3. Data in Python ".pickle" format plus one in .CSV as an example
- 4. Delete data at end of workshop





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