SnT 2023
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE
HOFBURG PALACE - Vienna and Online
19 TO 23 JUNE

Downtime Statistics and Failure Analysis of International Monitoring System Seismic, Hydroacoustic and Infrasound Stations

Yacine Sid Ahmed
CTBTO Preparatory Commission

CTBTO PREPARATORY COMMISSION

INTRODUCTION

This study is performed on a recurring basis since November 2011 with the objective to trigger actions reducing data losses due to station failures.

METHODS/DATA

Data Availability Unauthenticatied (DAU) is the metric used to quantify station Data Loss (DL).

Data Losses are identified and categorized using IMS Reporting System (IRS) Problem Reports (PRs) logging troubleshooting details at stations.

The categorization of failure causes are standardized using a pre-defined Station Model.

START

RESULTS

Stations meeting and not meeting the 98% DAU criteria are identified.

Main failure causes impacting DAU are identified, and their impact is quantified.

Station Subsystems contributing the most to DL are identified, and their impact is quantified.

Engineering projects aiming to reduce DL are initiated and closely monitored.

CONCLUSION

This study is crucial to monitor the status and evolution over time of station failures, and the adequacy of current engineering projects in support to stations' robustness to downtime

This contributes to the IMS Network's sustainability.

Some limitations are inherent to the available data set.

Ad-hoc further analysis can be performed on identified priorities (e.g. power issues)

Leave empty – QR code will be overlayed on touchscreen

P4.1-722

Disclaimer: The views expressed on this poster are those of the author and do not necessarily reflect the view of the CTBTO

Introduction & Objectives

The computation of failure statistics and the failure analysis of IMS stations are on performed on a recurring basis since November 2011 in support of the following objectives:

- triggering the required maintenance and engineering activities,
- verifying that the implemented engineering and maintenance solutions led to improvements in reliability,
- initiating further technical analysis when needed (i.e., root cause analysis), and
- supporting the earliest identification of possible future failures.

For seismic, hydroacoustic and infrasound (SHI) stations, Data Availability Unauthenticated (DAU) status and variation over time are studied for each station to identify the main failures impacting DAU, especially for stations not reaching 98% DAU (requirement derived from the Operational Manuals).

The results of this study are presented on a yearly basis to CTBTO Member States during WGB sessions. This ePoster presents a brief overview of the approach taken and some examples of the results obtained.

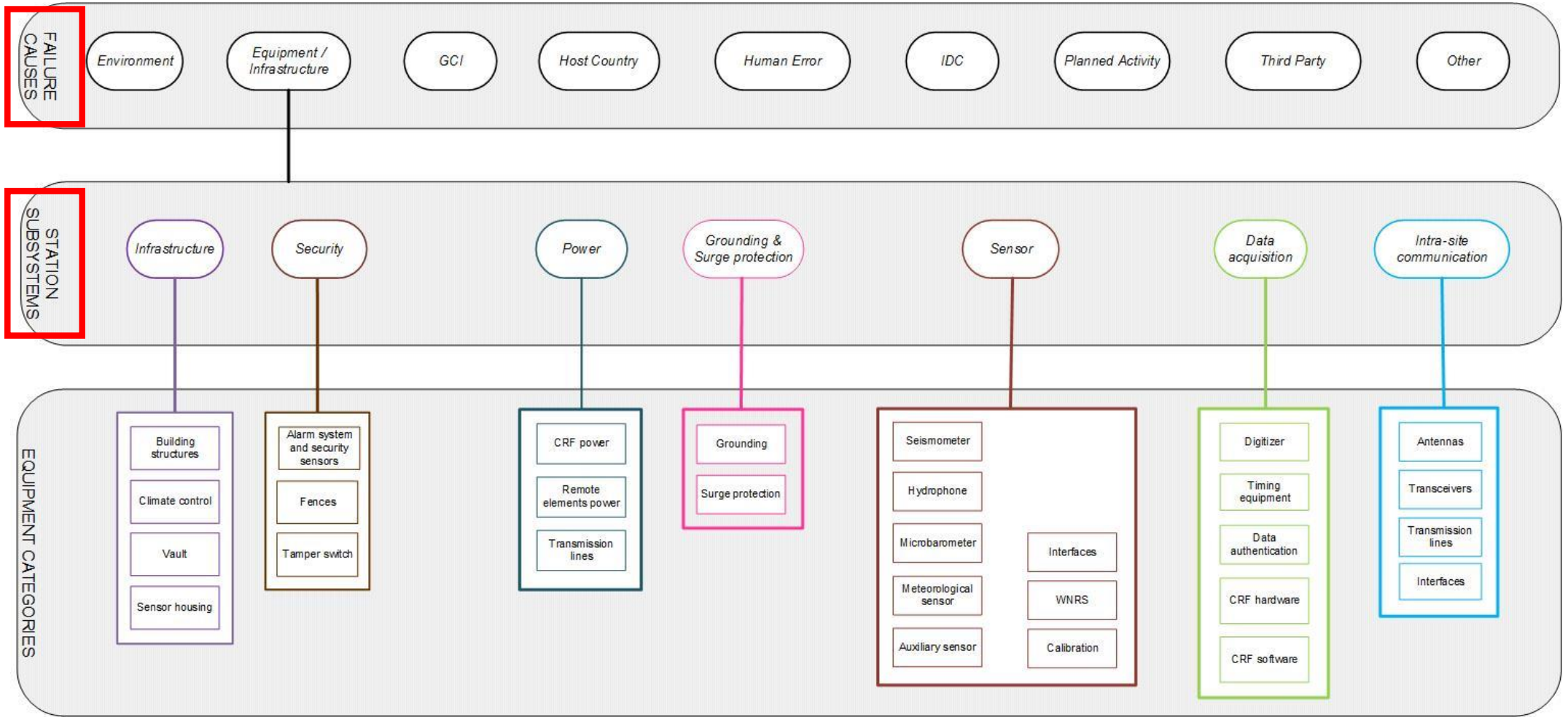
INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

P4.1-722

Leave empty – QR code will be overlayed on touchscreen

SHI Station Model

- The categorization of issues is made at the **Failure Cause** and **Station Subsystem** levels described in the Station Model below:



Definition of Failure Cause categories are detailed in the last slide.

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

Leave empty – QR code will be overlayed on touchscreen

Data sources & Method

Data Sources:

- DAU computed from cdtools
- IMS Reporting System (IRS) Problem Reports (PR) describing station issues and troubleshooting.

Method:

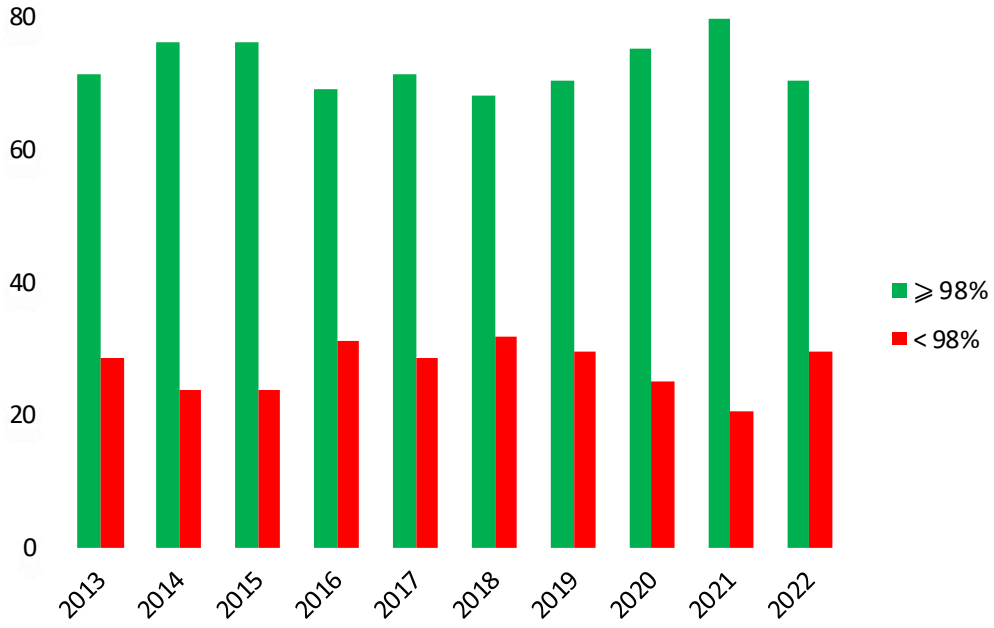
- Identification of stations DLs
- Identification of IRS PRs potentially related to DLs (~1000 PRs identified per year)
- PRs review and failures categorization according to the SHI Station Model
- Correspondence between DLs and Failure Causes / Station Subsystems
- Graphical representation and analysis

P4.1-722

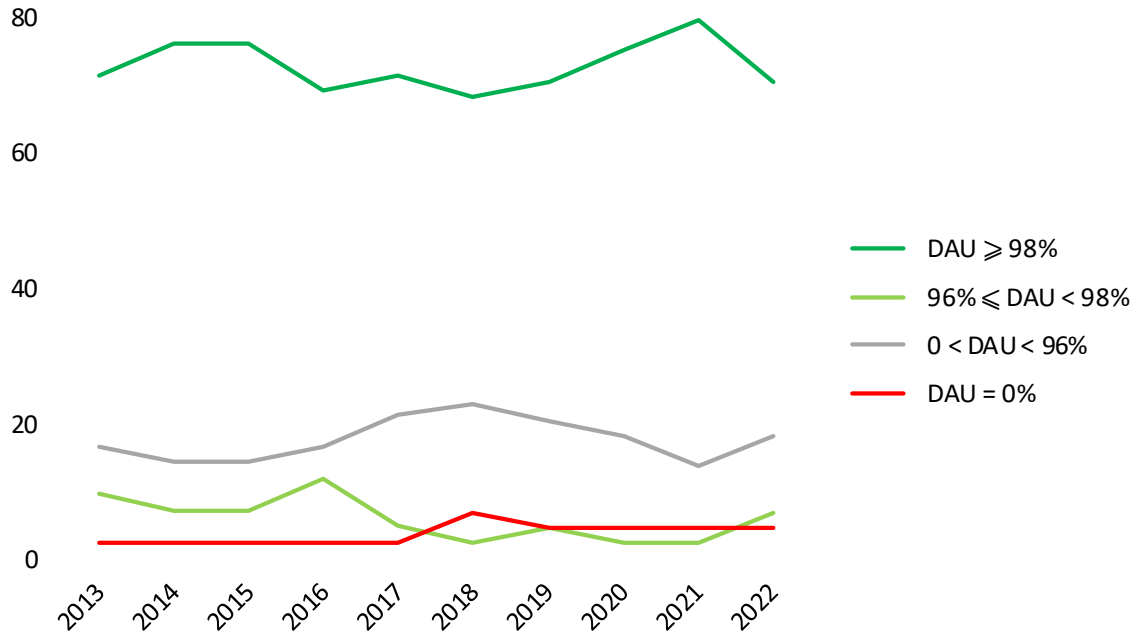
Leave empty – QR code will be overlayed on touchscreen

Results: example for Primary Seismic stations (PS) - DAU

Percentage of PS stations meeting (green) and not meeting (red) 98% DAU



Percentage of PS stations with different DAU levels



- % of stations with DAU > 98% are overall stable since 2013 (~73%)

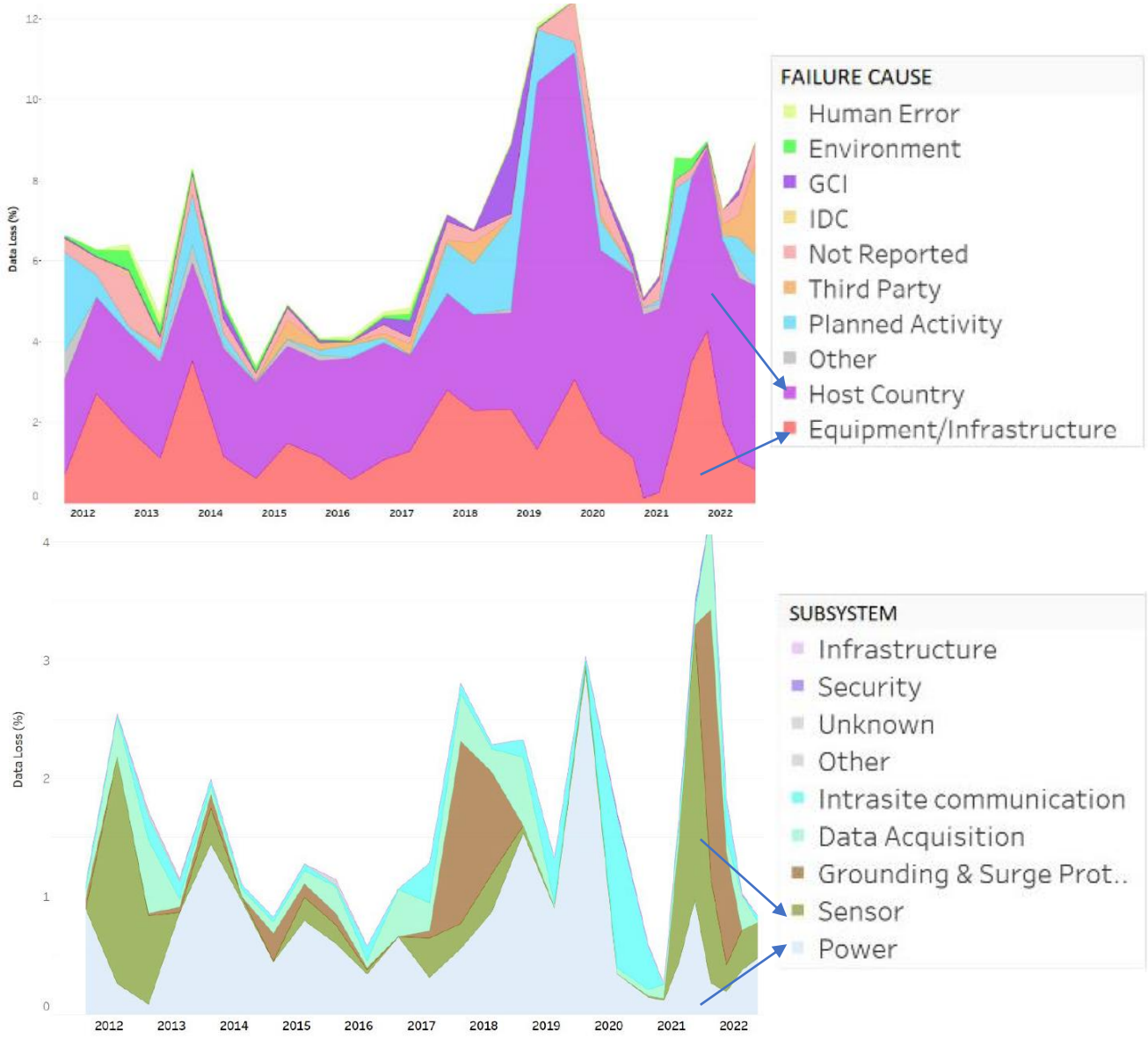
- % of stations with different DAU levels are all overall stable since 2013.

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

P4.1-722

Leave empty – QR code will be overlayed on touchscreen

Results: categorization of DL (example for PS stations)



For PS stations:

- Issues categorized as **Host Country** impact DAU significantly over time as such (non-technical) issues often need long discussions as a pre-requisite for their resolution.
- Issues categorized as **Equipment** is the second main contributor to DL.
- Within the **Equipment** category, the main Station Subsystems impacting DAU are **Power**, **Sensor** and **Data acquisition**.

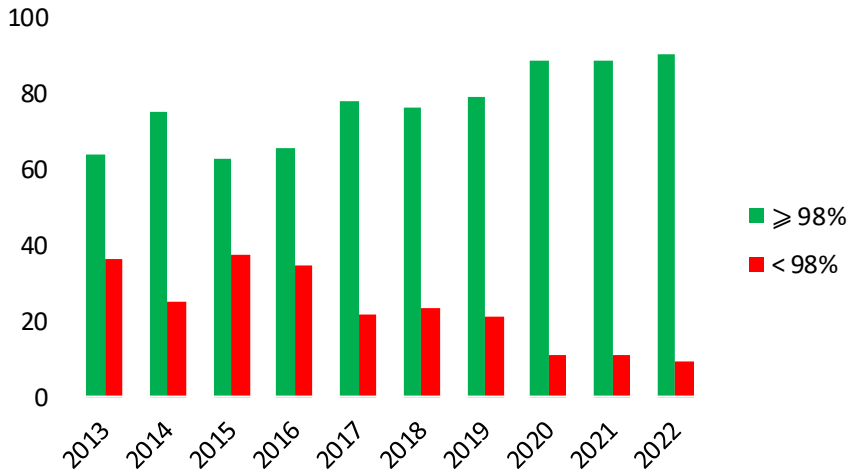
INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

P4.1-722

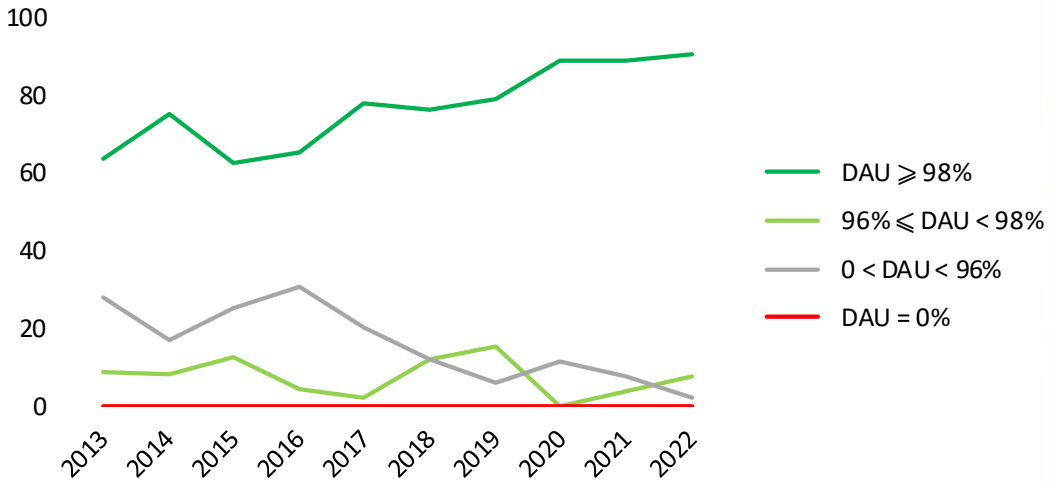
Leave empty – QR code will be overlayed on touchscreen

Results: example for Infrasound stations (IS) - DAU

Percentage of IS stations meeting (green) and not meeting (red) 98% DAU



Percentage of IS stations with different DAU levels



- Continuous increase of % of stations with DAU above 98% DAU (> 90% in 2022)

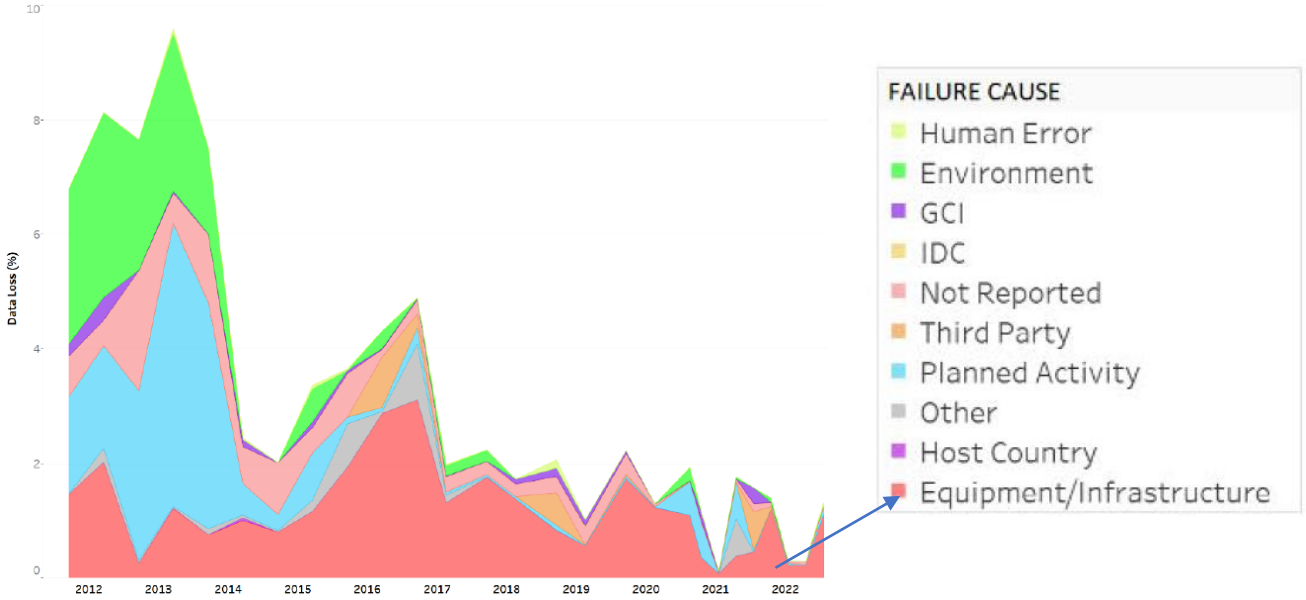
- This can be explained by different factors, such as:
  - the certification of relatively new IS stations (e.g., IS60 in 2016, IS20 in 2017, IS03 in 2018, IS01 in 2019, IS25 in 2020) showing consistent high DAU performances over time, and
  - successful major station upgrades and recapitalizations (e.g., IS13, IS31, IS41, IS36, IS47) performed during the recent years.

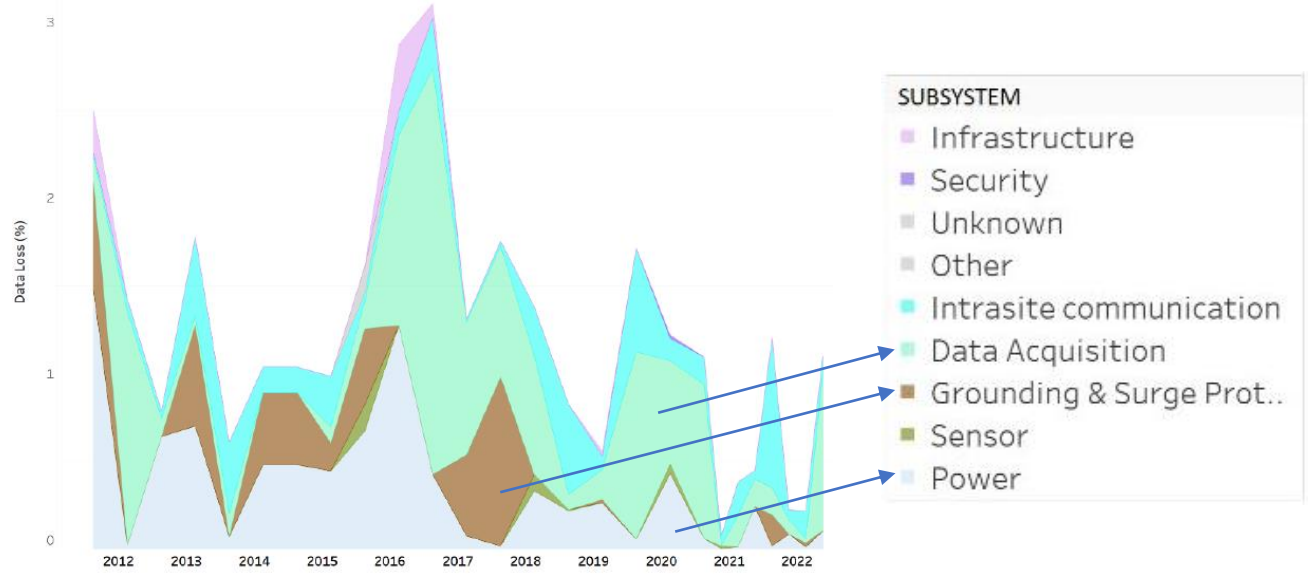
INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

P4.1-722

Leave empty – QR code will be overlayed on touchscreen

Results: categorization of DL (example for PS stations)





For IS stations:

- Issues categorized as **Equipment** is the main contributor, but levels remain very low (typically <2%).

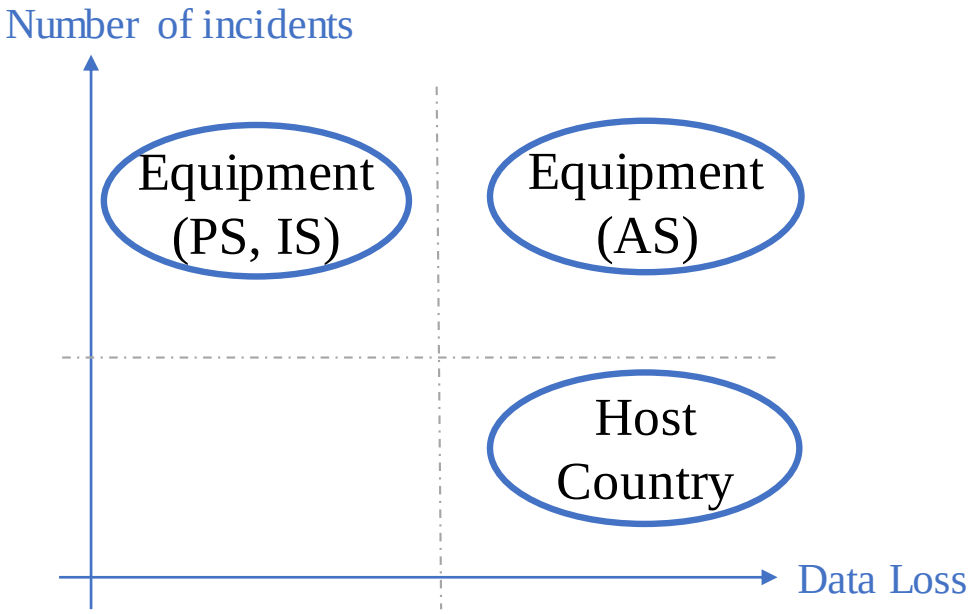
- The main Station Subsystems impacting DAU are **Power**, **Data acquisition**, and **Lightning and surge protection**. The impact remains low for each of these subsystems (often <1%).

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

Leave empty – QR code will be overlayed on touchscreen

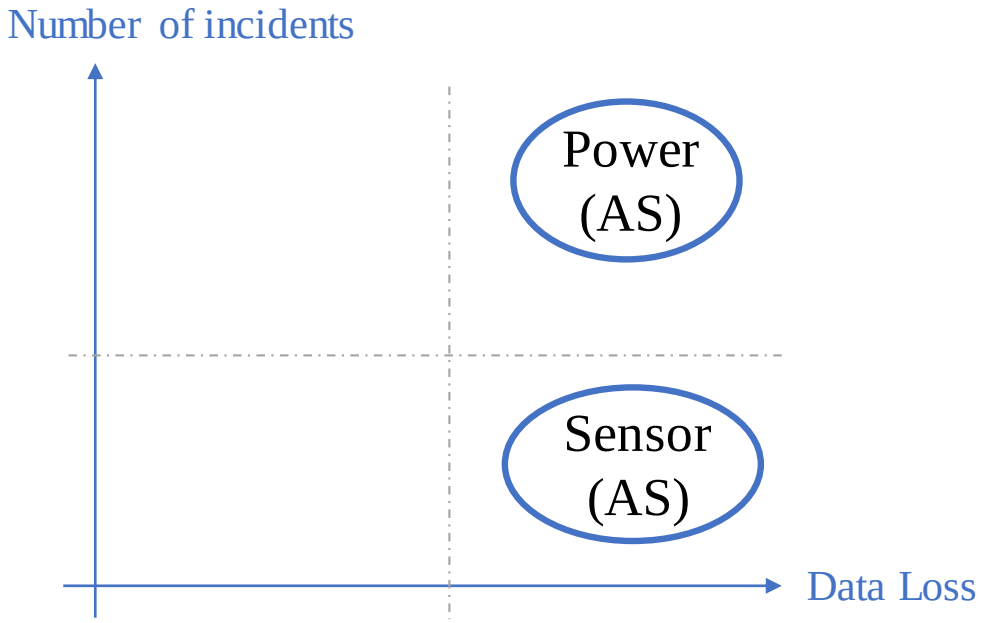
Results: Severity Matrix
(overview of recurrent DL contributors in the past years)

Failure Cause



- High number of failures categorized under **Equipment** have:
  - Low impact on PS and IS stations DAU
  - High impact on AS stations DAU (e.g. financial constraints)
- Few failures categorized as **Host Country** have a high impact on DAU.

Station Subsystem



- Few **Sensor** failures have a high impact on AS stations DAU
- High number of **Power** failures have a high impact on AS stations DAU

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

Leave empty – QR code will be overlayed on touchscreen

Conclusion

The study is used to trigger and maintain relevant engineering projects to increase stations' robustness to failures, as well as promoting mechanisms for prompt station recovery following downtime.

This study faces known challenges / limitations, such as:

- The usable data source: PRs are not meant to contain comprehensive information for root cause analysis
- The heterogeneity of stations: a wide variety of equipment combination, interfacing and configuration
- The interpretation in the case of multiple causes of failure
- The interpretation of the existence of root cause(s) vs. cause(s) preventing station recovery in expected delays

However, this study allows observing that main contributors to station downtime are:

- Failure Causes categorized under **Host Country**, and **Equipment** categories, and
- **Sensor** and **Power** issues, especially in the case of AS stations.

Going further, this study can be completed by ad-hoc analysis to further focus and investigate on the main issues identified at stations (e.g., power issues).

P4.1-722

Leave empty – QR code will be overlayed on touchscreen

References: documents and definitions

Documents:

- CTBT/WGB/TL-11,17/15/REV.7
Operational Manual for Seismological Monitoring and the International Exchange of Seismological Data

- CTBT/WGB/TL-11,17/16-REV.7
Operational Manual for Hydroacoustic Monitoring and the International Exchange of Hydroacoustic Data

- CTBT/WGB/TL-11,17/17-REV.7
Operational Manual for Infrasound Monitoring and the International Exchange of Infrasound Data

Definitions:

Failure Cause:	*Definition:*
Environment	Environmental conditions (e.g. flood, tsunami, fire, hurricane)
Equipment / Infrastructure	Station equipment or infrastructure
GCI	Global Communication Infrastructure, Independent Sub Network
Host Country	Political, financial, customs, human resources
Human Error	Mishandling or misconfiguration of equipment, absence of personnel at the station
IDC	International Data Center data processing pipeline, station testing
Planned Activity	Preventive maintenance and engineering planned activities
Third Party	Action of a third party (e.g. long absence of mains power supply, suppliers deficiencies, vandalism)
Other	Unspecified cause or any cause not specified in current categorization
Not Reported	Failure not reported in the IRS

P4.1-722

Please do not use this space, a QR code will be automatically overlayed

CTBTO PREPARATORY COMMISSION