Advancement of SHM systems

Practical considerations for long term monitoring systems
Research to reality

14th ANSHM Workshop

EngAnalysis

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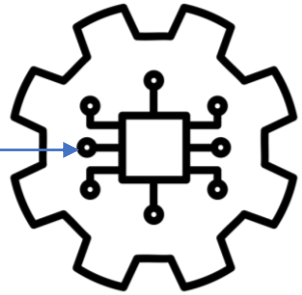
Introduction

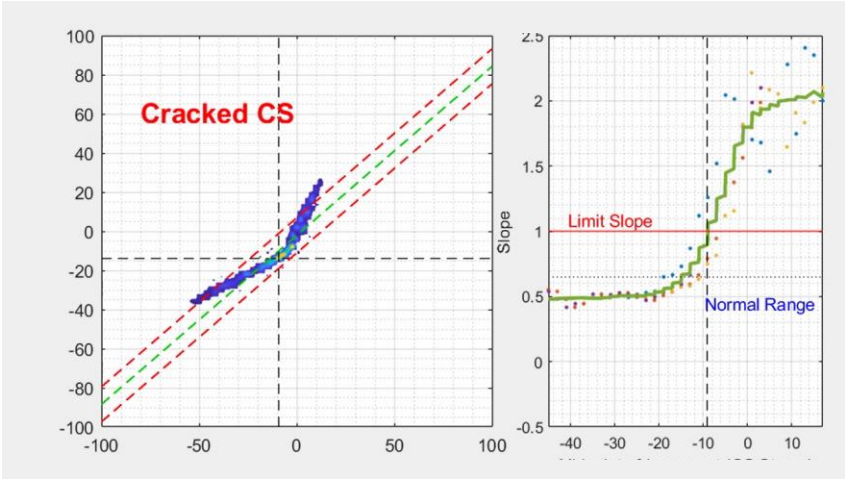


- Motivation for this topic
  - Share lessons learnt and provide considerations for: implementing long-term measurement systems, writing SOW
- Contents:
  - Objectives and actions
  - System/experiment design
  - System build – hardware and software, infrastructure requirements
  - Reporting – communication of results
  - Operations and maintenance
  - Conclusion

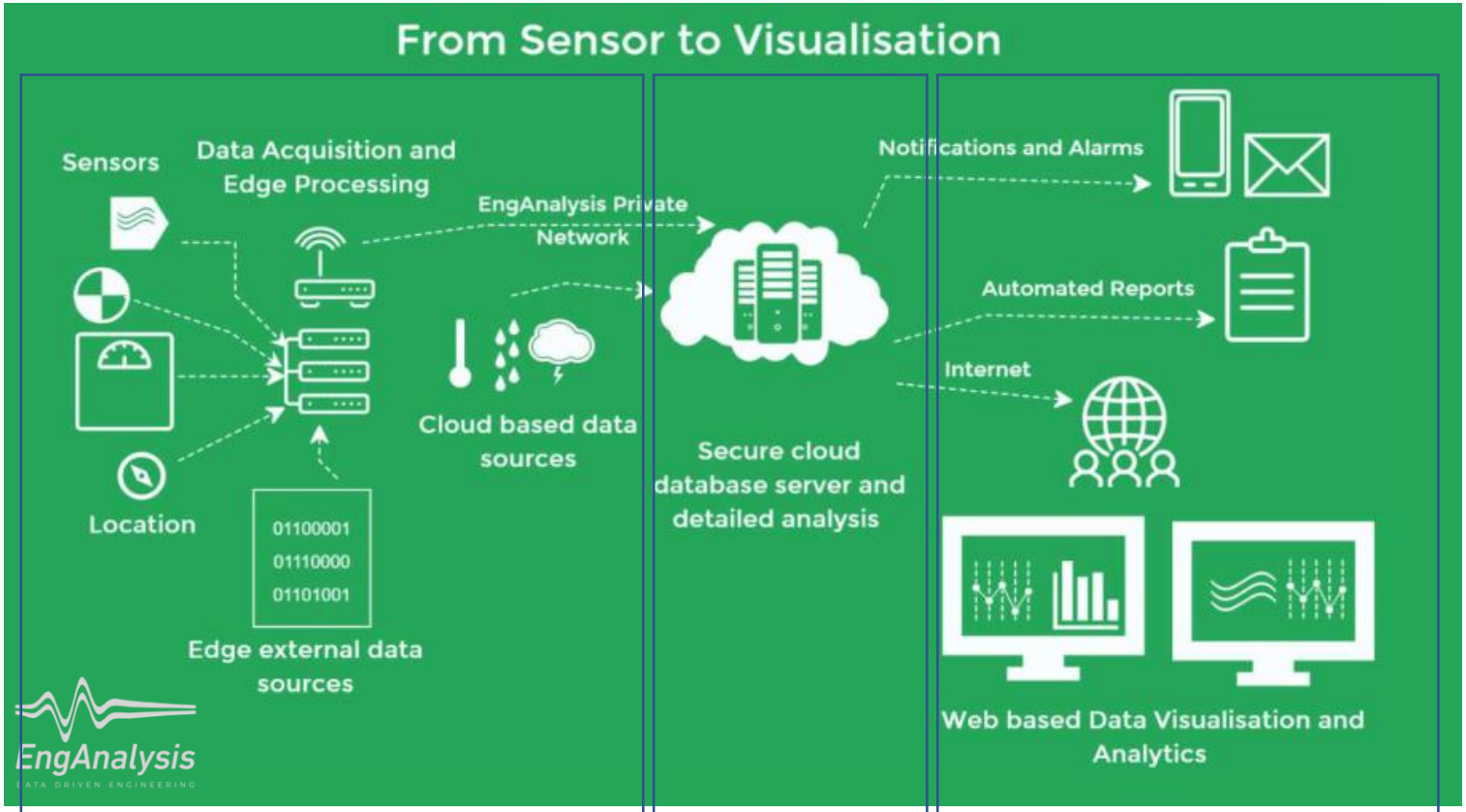
Research & Development	Long term tests, Monitoring system development	Monitoring system operations & maintenance
New and novel ideas Development Manual inputs / supervised	Less supervision required, but it still makes some questionable decisions Unsupervised, independent, still good to check in on occasionally	

Objectives and Actions

- What is the problem being addressed?
  - Design of experiment to focus on the problem
- Is SHM required?
  - Is more data required to make informed decisions?
- Approach:
  - Short term data acquisition and analysis
  - Long term monitoring
- Actions:
  - When a problem is found, then what?
  - Action plan
    - Inspections, manual review of data, stop work



System Design - Components



Field – sensors, DAQ, computing	Storage, Processing, Analysis	Reporting

System Design – On Site

Strain gauges
- Resistance based foil
- Resistance based transducer
- Vibrating wire
- FBG optical
- Distributed optical
- Weld on / glue
- Etc.

- Sensors
  - Type (durability, cost, measurement type, protection, wiring, fastening/adhesives, maturity, difficulty, frequency response)
  - What is being measured? What are the limitations?
  - How many?
  - Redundancy, fault tolerance – if there are failures can the system still meet functional requirements
  - Temperature (and environmental variables)

- DAQ & Computing Equipment Selection
  - Sensor type
  - Suitable sample rates, filtering and processing capability
  - Data transmission

- Alternative / External Data Sources
  - Site operations or asset data
  - Weather, other online accessible data

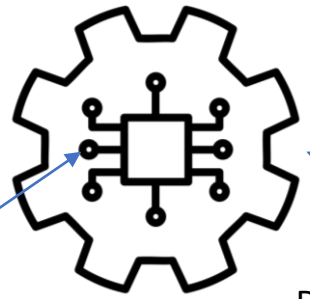
- Data Communications & Power
  - Reliability and security
  - How much to send?
    - Is all the data required?
    - Edge processing?
    - Local storage

Different sites/environments = different requirements

System Design – Storage and Analysis

- Preparation: Cleaning / pre-processing
  - Noise, erroneous data, environmental variables, power issues, damage
  - Planned space in the analysis/processing for filtering and cleaning

- Data storage – sensible database choice and structure (ease and speed of write/read to suit requirements)
- Mechanism for checking different stages of analysis and output of results
- Operate unsupervised

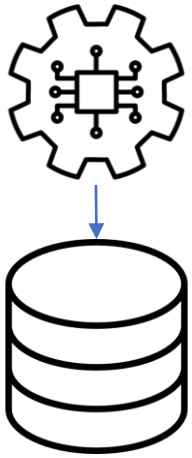


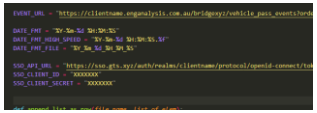
Model/research output

Monitoring system
Data pipeline, preparation, monitor, inspections, QA…

Reporting and Access to Data

- Different stakeholders, different requirements
  - Executive level, asset manager – often want the visualized results, green light, all ok
  - Analysts and Engineers – as above + often want the raw or processed data for their own analysis and reporting
  - You – inspection/checks, improvements





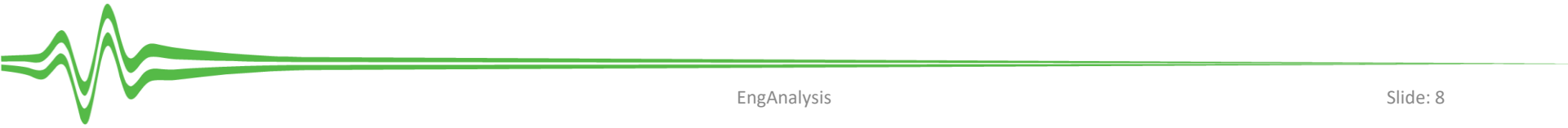
Raw or processed data, analysis outputs

Custom analysis and visualizations, internal reporting

Operations and Maintenance

System deployed, commissioned and working

- Unexpected data
  - Interpret results, and explain why
  - QA – look back and be able to report that everything was checked and working
  - Ability to assess if it is real or a result from an erroneous data or unexpected input to the analysis
- Transparency - Ability to see final outputs, intermediate and raw data
- Improvement cycle
  - Fix problems, improve outputs
- Plan for growth
  - New requirements, changes



Conclusion

- Research vs implementation
- Objectives and Actions
- Robust design – sensors/DAQ, communication, analysis, reporting
- Storage, preprocessing/preparation
- Reporting – accessible data in multiple forms
- Operations and maintenance – ability to check, maintain, improve

- Questions?
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