Progress Towards a Unified Storage Solution for Remote Emissions Sensing Data

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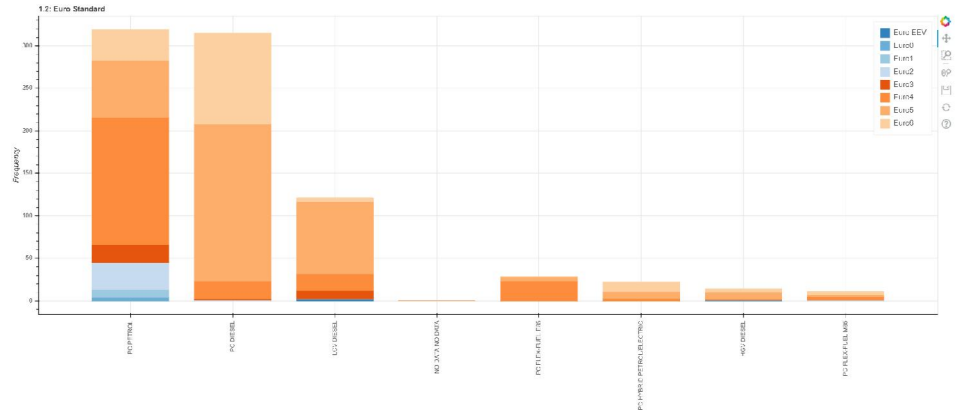
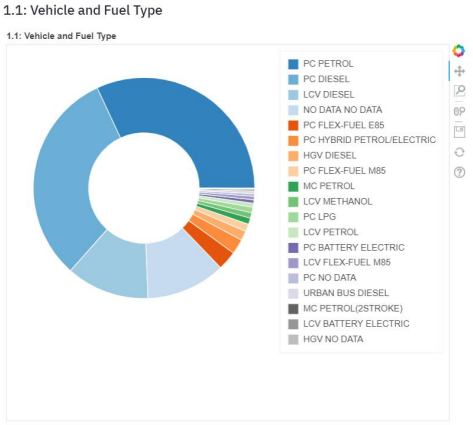
CITY AIR REMOTE EMISSION SENSING





Current Practice

Conventional Vehicle Emission Remote Sensing

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Measurement Data (Flat):

As provided by commercial RS providers (fixed format?)

e.g. CSV file format.

Straight-forward data solution / sharing.

Relational Database:

Fixed schema forces conformity but lacks flexibility.

e.g. MySQL is a well understood enterprise level database solution.

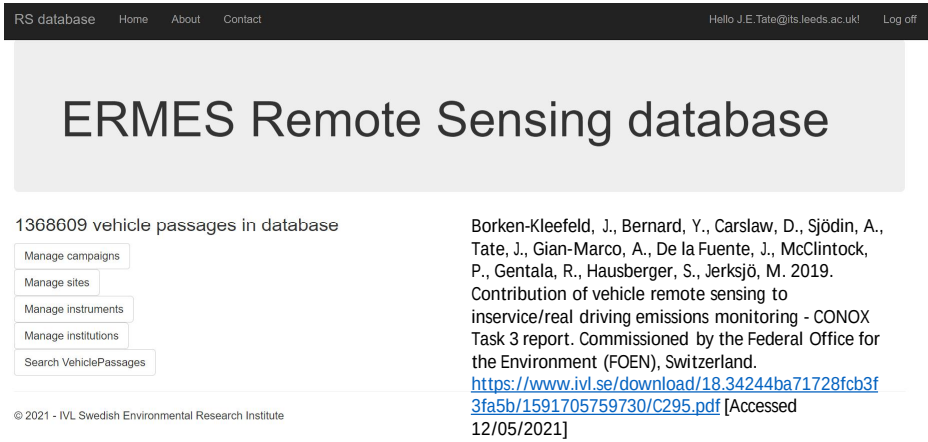
CONOX:

Comprehending

Combining

COmparing Real Driving Emissions

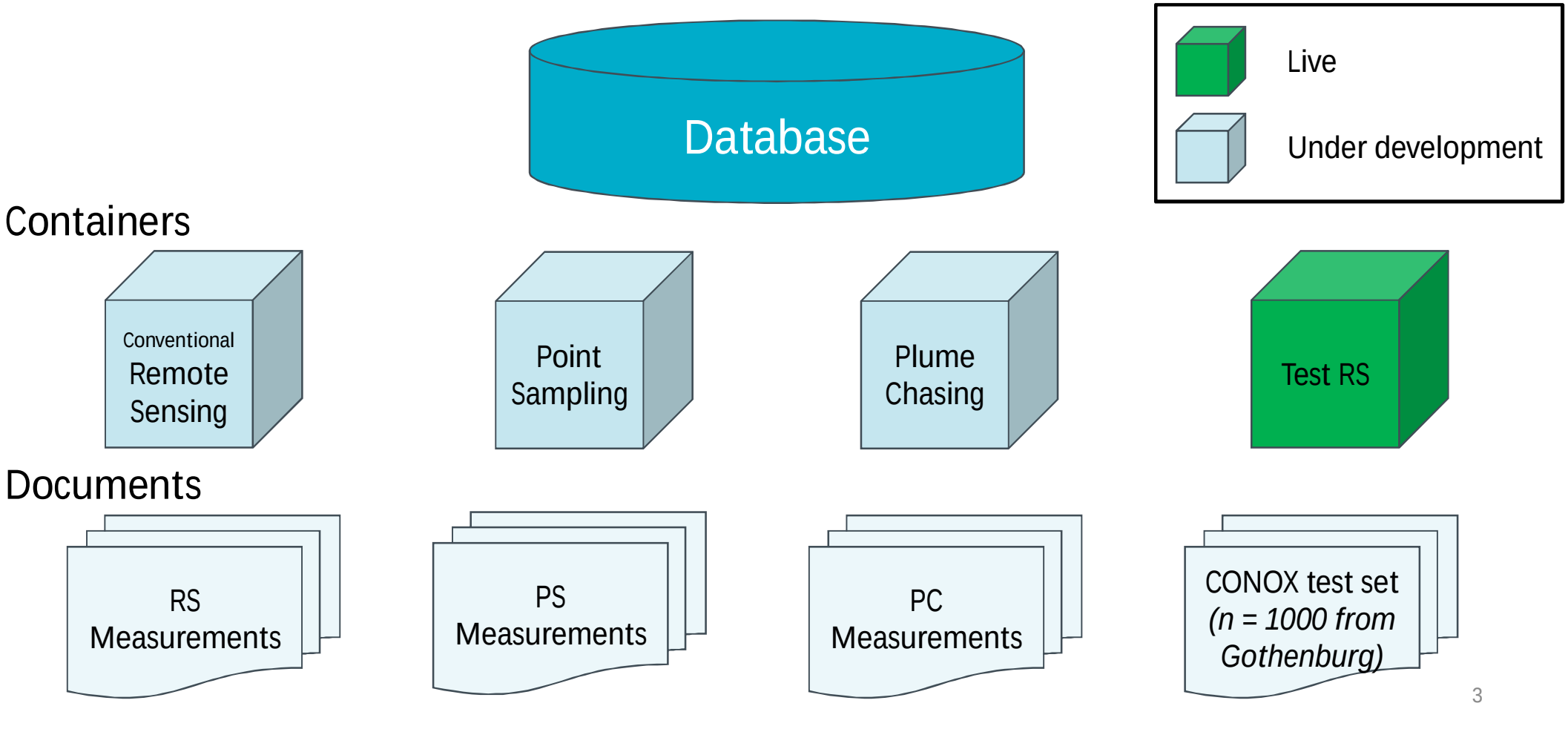
COllaborating on NOx RDE and Remote Sensing measurements.



Borken-Kleefeld, J., Bernard, Y., Carslaw, D., Sjödin, A., Tate, J., Gian-Marco, A., De la Fuente, J., McClintock, P., Gentala, R., Hausberger, S., Jerksjö, M. 2019. Contribution of vehicle remote sensing to inservice/real driving emissions monitoring - CONOX Task 3 report. Commissioned by the Federal Office for the Environment (FOEN), Switzerland. https://www.ivl.se/download/18.34244ba71728fcb3f3fa5b/1591705759730/C295.pdf [Accessed 12/05/2021]

CARES Project

The data infrastructure challenge



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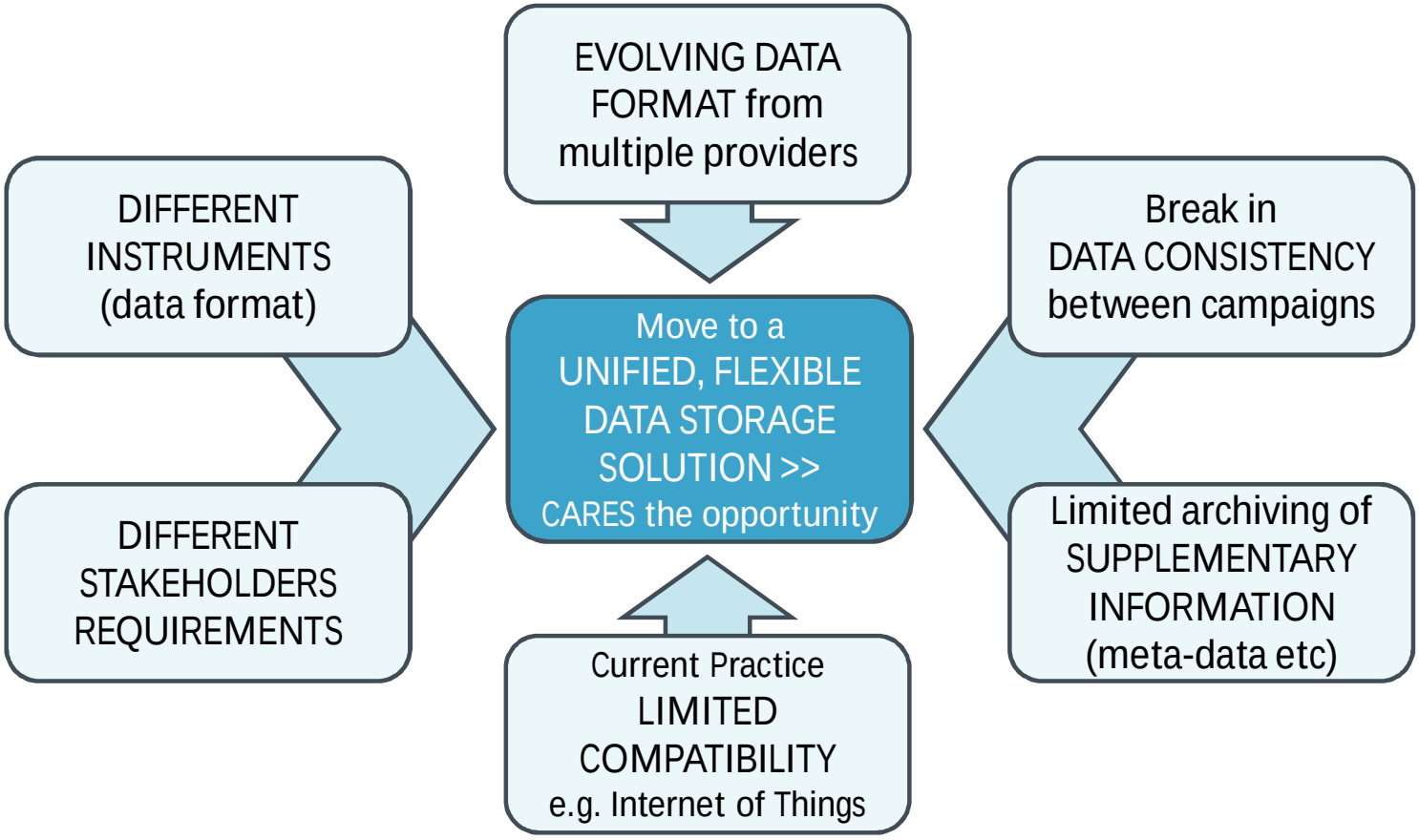
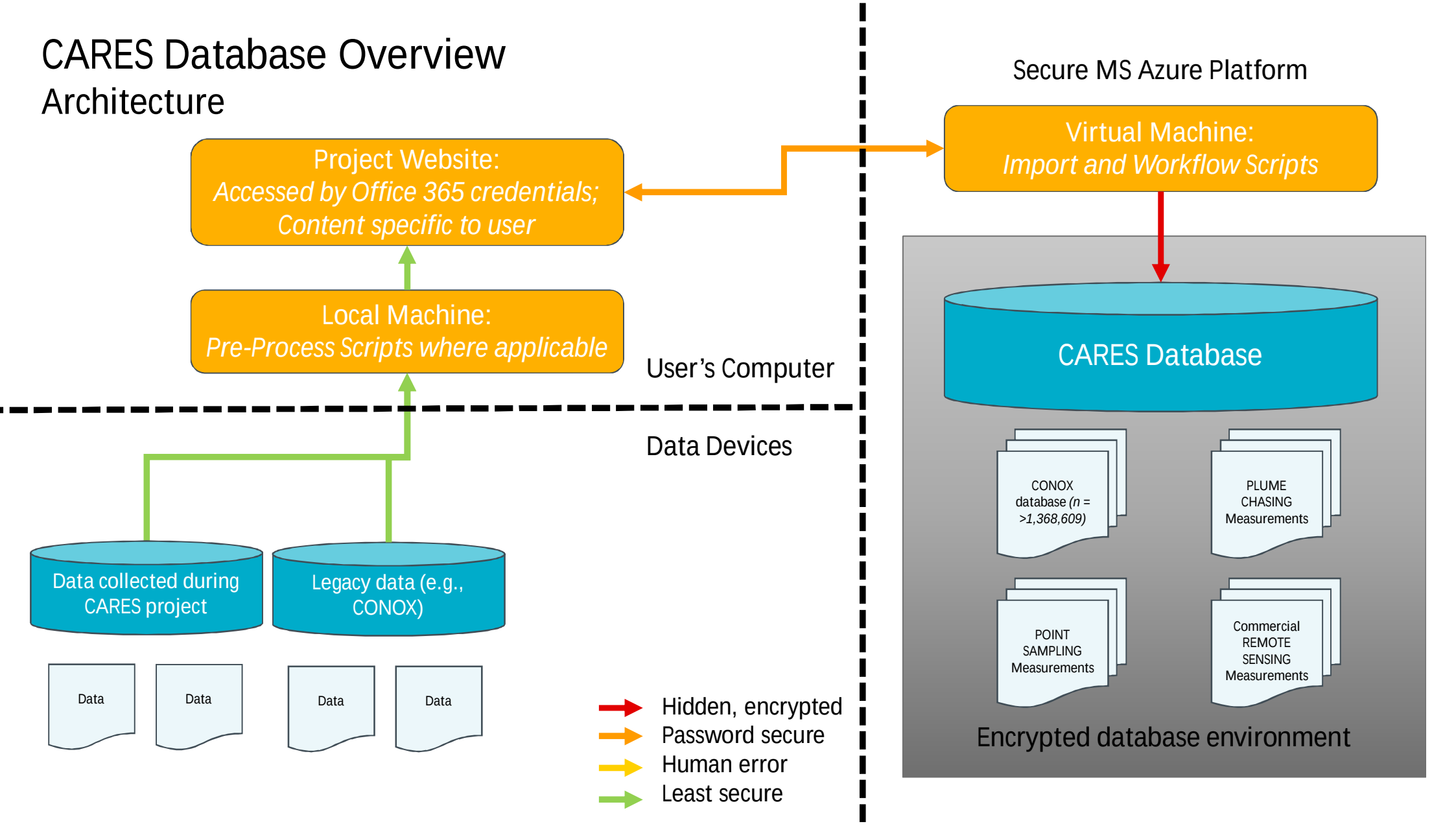
The data infrastructure challenge

The need for a unified, flexible solution



CARES Database Overview
Architecture



Data Journey

Traditional Remote Sensing

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Tasks performed before handover

Tasks performed between handover and retrieval

Post-retrieval analysis

Remote sensing deployment data collected

Initial data sense check

Data added onto database

Data quality control functions applied

Queried data set accessed

Data Collection → *Handover* → *Storage* → *Query* → *Analyse*

- Data collected using normal procedures
- Initial sense checks of data to be performed offline, including:
  - *Data exists in the file*
  - *Data is in the correct format*
- Some data checks available in GUI
  - *Prioritization of headers for checking*
  - *Headers updated to standard form*
  - *Ranges of data match CONOX or reference values already in database*
- Data set converted into database format
- Data is ready to be uploaded

- Data is received by the database
- Data is added to the database *in the form it was delivered*
- Data is stored on the database and remains encrypted
- Data retrieval request is received subject to permissions
- Quality control functions (*Deliverable 2.2 etc*) are applied to queried data
- Data is ready to be retrieved

- Data access controlled by Azure platform
- Security based on institution standards
- All actions auditable
- Anonymous *read-only* queries for some users
- Download for selected users
- User interface via *streamlit*
- Data is ready to be analyzed

Demonstration of the

DEVELOPMENT CARES DATABASE INTERFACES

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Data Interface

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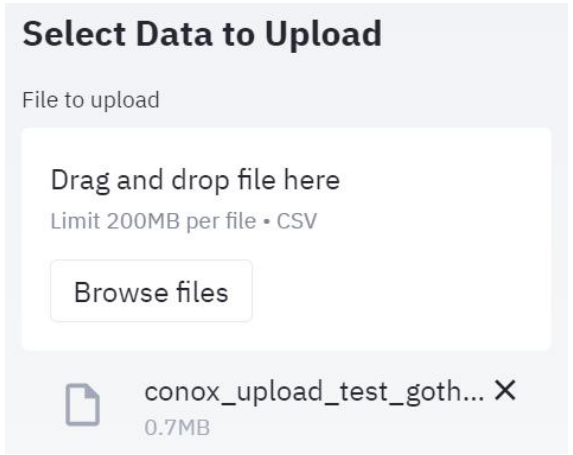
- Data can be uploaded from a local file using familiar operating system file browsing systems
- Headings are updated to standard form using pre-configured templates
- Manual heading transformation is implemented but is very time consuming to use
- Basic statistics are applied to the data set comparing it to the data already in the database
  - Midpoint ratio checks that the data is broadly aligned
  - Kolomogorov - Smirnov (K-S) test for two samples applied
  - Thresholds are determined and applied



Variable	Midpoint Ratio	KS-Statistic	p-value	Overall RAG
Euro 3 Petrol PC				
NO:CO2	1	0.31	0.13	Green
HC:CO2	1	0.07	1	Green
CO:CO2	1	0.14	0.93	Green
Euro 5 Diesel PC				
NO:CO2	1	0.18	0	Amber
HC:CO2	1	0.05	0.85	Green
CO:CO2	1	0.07	0.52	Green
Fleet Dynamics				
Speed	0.97	0.08	0	Amber
Acceleration	-3.91	0.15	0	Red
VSP	1.58	0.07	0	Amber

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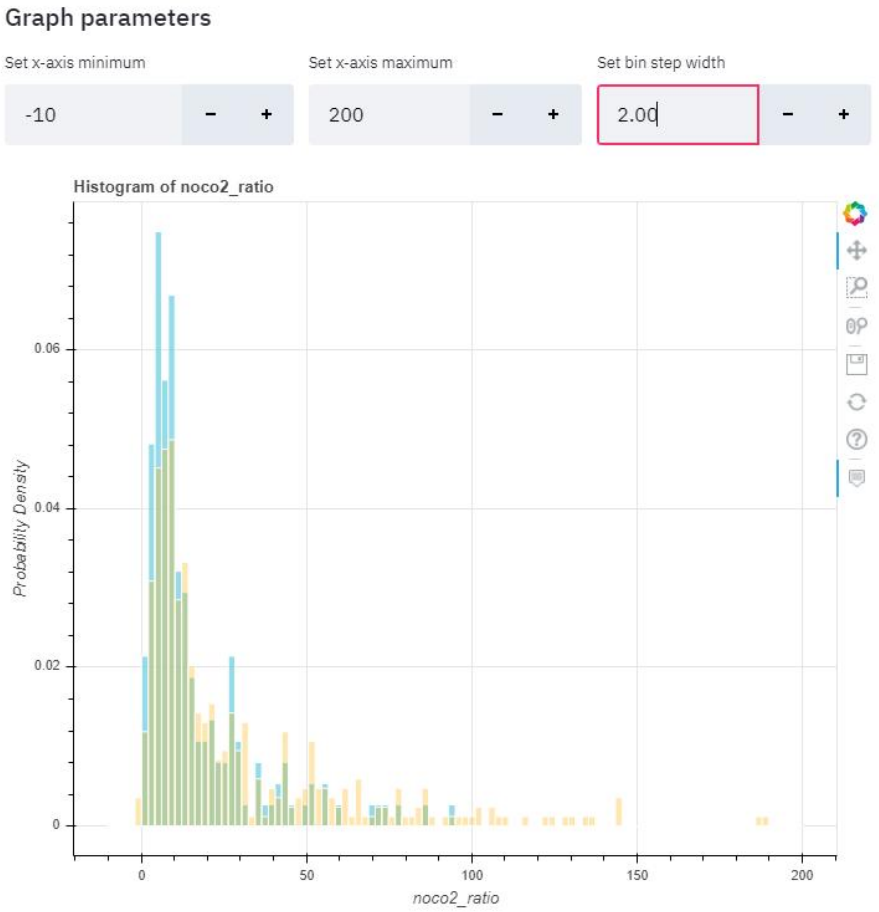
- The NO:CO2 ratio in the sample data set only met Amber conditions
- We can investigate this using a built in data viewer
- Test data (yellow) is different from reference data (blue) but an eyeball confirmation tells us that they are likely equivalent
- Data that is added to the database will still have amber status attached to it
- Future users can determine whether they accept amber or red rated data
- These tests can be performed for all pollutants
- Graphics can be easily saved directly from the interface



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- The acceleration parameter did not meet the amber or green criteria
- Data viewer shows us that there are more lower and negative acceleration values in the test data set
- User decision must be made as to whether this is caused by test location or by some error in the data
- If data is added to the database without modification it will be flagged as red.

Future outlook and closing remarks

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Future Work – Remote Sensing

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- Adding functionality to current web platform:
  - *Improving scientific basis for upload decision*
  - *Improving the user interface for easier interaction*
  - *Include Office 365 authentication*
  - *Publish to online platform using Azure App Service*
- Increasing the content of the database
  - *Currently a small segment of CONOX*
  - *Plan to include all CONOX data*
  - *CARES characterisation and city demo data as available*
- Integrate data quality control checks
  - *Basic functions already developed as part of WP2*
  - *Investigate using natural language processing to improve quality of text based fields (e.g. standardised naming conventions)*
  - *Sense checking Euro standard*

Work Beyond CARES

Future Work – More New Methods

- Closer integration of database with instruments
  - *IoT connectivity*
  - *Increased stakeholder access*
  - *Larger instrument networks*
- Improved collaboration space
  - *Azure platform offers huge potential to work collaboratively*
  - *New tools can be developed to take advantage of new data handling approach*
  - *Secure environment to test new ideas*
  - *Bespoke dashboards for different stakeholders*