OIL & GAS

Introduction of MECADA Joint Industry Project

Metering & Calibration Data Analytics

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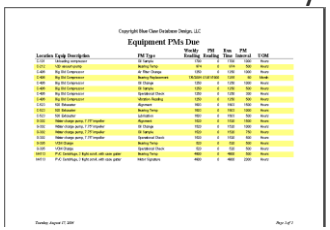
Challenge's of today flow metering expert

Metering diagnostics

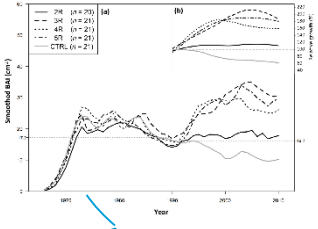
Maintenance history



Standards & Contracts

Knowledge on field conditions

History of events

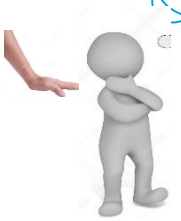


Certificates

Calibration & testing

- *When should we calibrate ?*
- *Can we postpone and save cost ?*
- *What is the risk of mis-measurement ?*
- *Are we still compliant*

Reduction in OPEX !!



Metering Engineer

MECADA

(internal) clients and stakeholders

Why start the MECADA Joint Industry Project-1-?

CALIBRATION AND RECALIBRATION of Flow meters

- Calibration and recalibration of flow meters is necessary to assure accuracy and control field uncertainty and financial risk.
- Calibration and recalibration also form substantial part of CAPEX and OPEX costs and therefore operators are considering several means to reduce these costs:
  - Extension of recalibration intervals
  - Potential options to use lower pressure gas or air calibrations as lower cost alternatives
  - Use of field validation instruments to prove, that field uncertainty is still within acceptable levels and recalibration is not needed.
- Questions to be asked in doing this:
  - What is the risk? E.g. what is the real drift of flow meters in field environment
  - Is the drift different for different technologies and manufacturer solutions?
  - What is the uncertainty/ risk when calibrating at conditions different from field conditions (pressure/ medium)?
  - What is the real performance/ uncertainty of calibration facilities across the globe?

Why start the MECADA Joint Industry Project-2-?

Additional role of METER DIAGNOSTICS

- Every individual flow meter with diagnostics can be monitored in the field and detect its own issues.
  - But how do we learn whether these diagnostics work properly?
- If diagnostics indicate issues, how big will the flow measurement error become?
  - Do we stay within contractual limits?
- How do manufacturers know that their diagnostics work in real life field applications? Do they evaluate field performance with large datasets?
  - And if so, do you trust the manufacturer to asses the performance?

Why start the MECADA Joint Industry Project-3-?

Across Grid performance

- If the installed base of a certain type of meter is 1000 worldwide, how can we profit from all this field performance data when these meters belong to dozens of different operators?

Introduction MECADA Joint Industry Project

- MECADA = Metering & Calibration Data Analytics

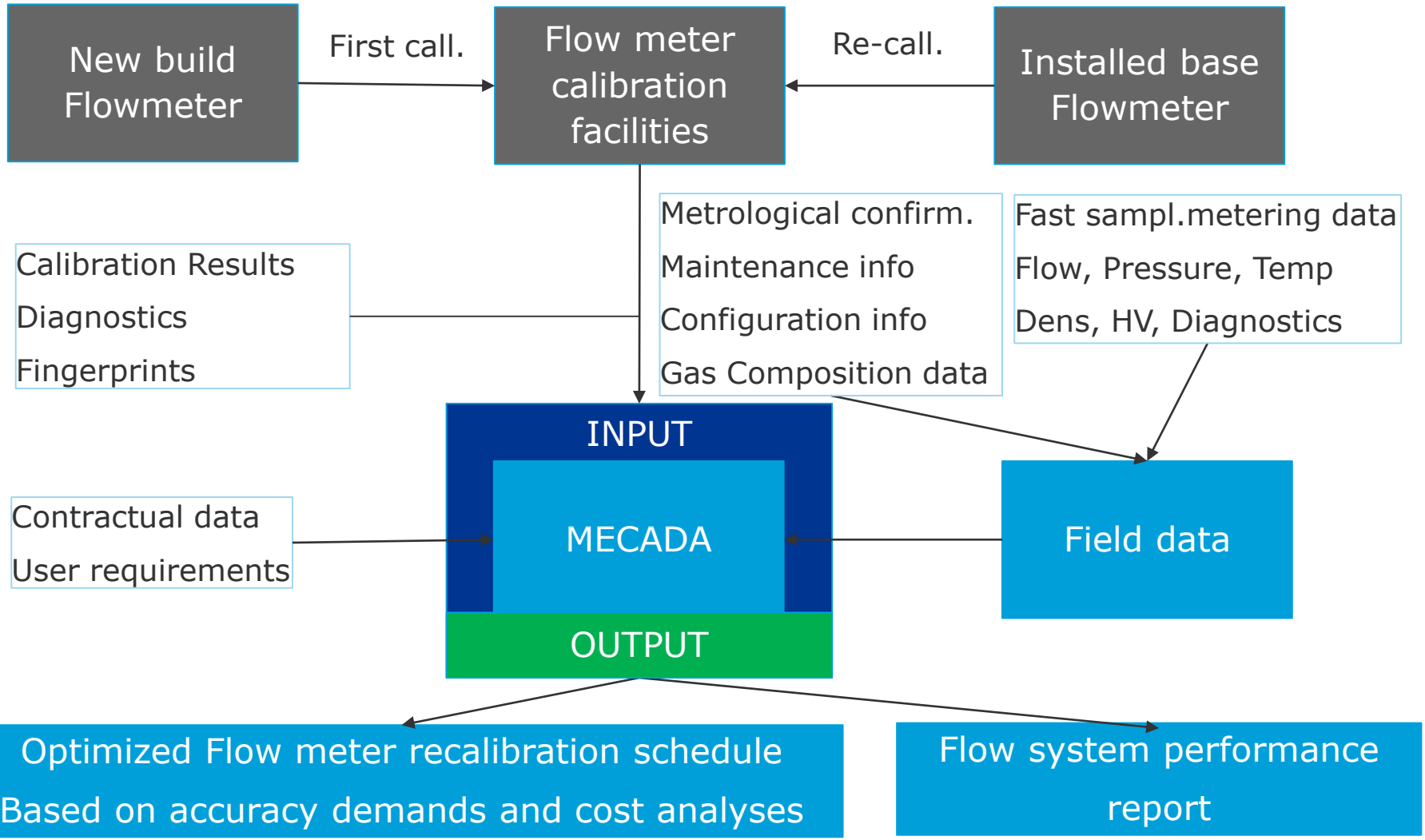
- DNV GL proposes to collect and analyse metering flow data and diagnostic data, to develop a data-driven performance assessment based on real field data
  - **DNV GL builds a field data based model** through machine learning algorithms, based on the performance data of all participants
  - The model is accessible to each of the participants (operators) through the open platform
  - The models performance is based on much more data than any individual participant could have done on their own
  - DNV GL's dedicated senior flow metering professionals and data scientists work together to improve model performance.
  - Operators can also develop and run own analysis scripts or ask other (third) parties to make models for the data (only their own data)
  - Model performance keeps improving, the more data comes in.

Introduction MECADA Joint Industry Project

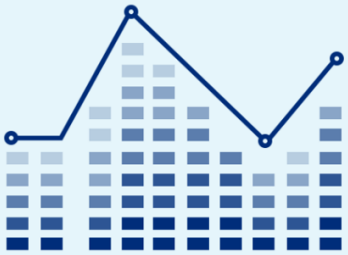
- MECADA = Metering & Calibration Data Analytics

- DNV GL proposes to collect and analyse metering flow data and diagnostic data, to develop a data-driven performance assessment based on real field data
  - Data is collected, stored and analysed securely in DNV GL's VERACITY open industry data platform
  - VERACITY analytics can be employed by DNV GL but also by participant
  - DNV GL performs data cleansing and anonymizes all data to build the models
  - As DNV GL is a trusted and independent third party: data stored in VERACITY will never be accessible by or revealed to other parties
  - DNV GL creates the models to quantify measurement errors and recommend optimal recalibration intervals
  - JIP participants only see their own data, none from the other participants

Relation diagram between Flow calibration, field data and MECADA



VERACITY Introduction



CREATING VALUE FROM DATA

Marketplace for digital services, data and analytics

SECURE SHARING AND TRADING OF DATA

Functionality to securely share your data container

YOUR DATA

Functionality to create a data container for your data

Technical setup of MECADA
Metering & Calibration Data Analytics

- Setup of VERACITY Data Analytics platform (in Microsoft Azure Cloud) containing all available relevant data: initial calibration, recalibration, dry (air) calibration, field verifications, flow measurement data, diagnostics, etc.

- **Trust your data**
  - By combining our independent industrial domain expertise, algorithms and data management experts we assess the quality of your data so that you know if you can trust the data and use it for analytics and insights

- **Enrich your data**
  - Keep ownership and control while leveraging your data by integrating, sharing or bench-marking it from one secure place

MECADA Goals

- **First goal** is **offline** meter performance assessment
  - How well does this meter perform compared to hundreds of the same type of meters around the world?
  - How do the diagnostics compare to the total population of installed meters?
  - How large is the meter error for recalibrated similar meters with similar diagnostic readings?
  - Use the data to determine optimum calibration and recalibration intervals

- **Second goal** is **online** meter performance assessment
  - Is the meter drifting or is performance deteriorating
  - Combined with P/T meter run and station data: error detection in flow metering

- **Ultimate goal** is moving from qualitative to **online** quantitative diagnostics
  - Determine the **live in-field meter error** based on DNV GL's flow meter models

MECADA Main benefits

- **Benchmark** operator's meter population against same type of meters installed at dozens of other operators worldwide. Is performance on the same level or should improvements be made?

- **Offline meter error prediction** in field situation:
  - Error found: Operator may be under-measuring and missing revenues. Early warning to take the meter out and recalibrate the meter
  - No significant error found: Operator may leave the meter in operation for an extended period, saving recalibration cost

- **Online meter error prediction** in field situation:
  - Same as offline, but live instead of weekly/monthly.
  - Continuously monitor and confirm whether the field error / uncertainty is still within contractual limits

- And more: the maturing MECADA models will provide more benefits as the data collection grows

MECADA Secondary benefits/spin-off

- Apart from using diagnostic data and generic models, data of complete metering stations may be used: P, T, Flow and GHV for each meter run
  - Detect issues for individual stations: live, weekly basis, monthly basis, etc.

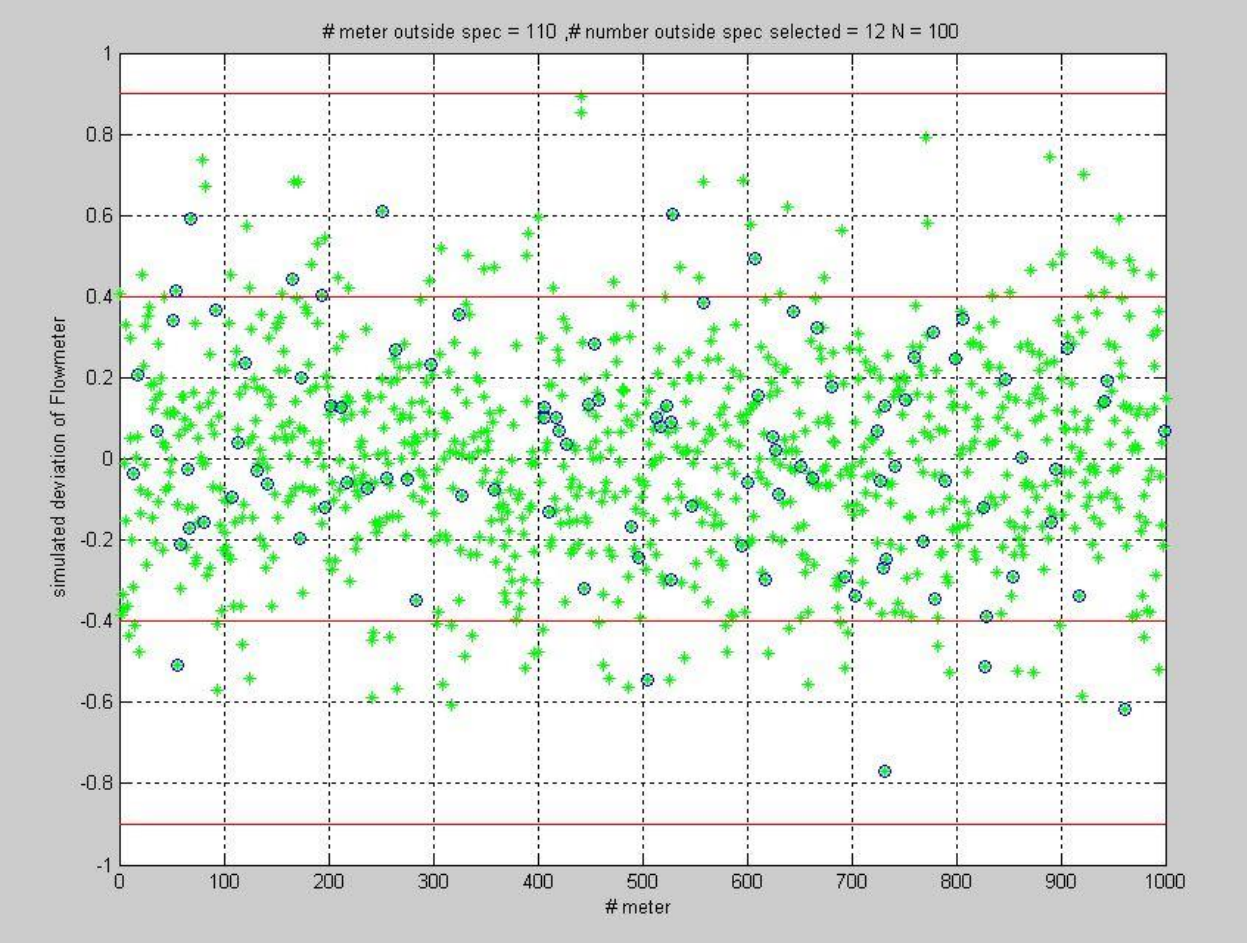
- Detect differences in meter run performance, for example:
  - Pressure fluctuations in meter run 1 consistently higher than meter run 2: pressure regulator instability
  - Flow measurements in meter run 1 consistently higher than meter run 2 despite a stable process: possible indication of meter errors

- Detect flow computer issues by consistency checks, for example:
  - Meter run 1 registers zero flow and temperature of 5 degrees
  - Meter run 2 registers zero flow and temperature of 20 degrees
  - Outside temperature is 20 degrees
  - Detection: meter run 2 truly has zero flow, but meter run 1 fails to register any flow as is detected by the too high temperature difference

MECADA Joint Industry Project approach and start-up

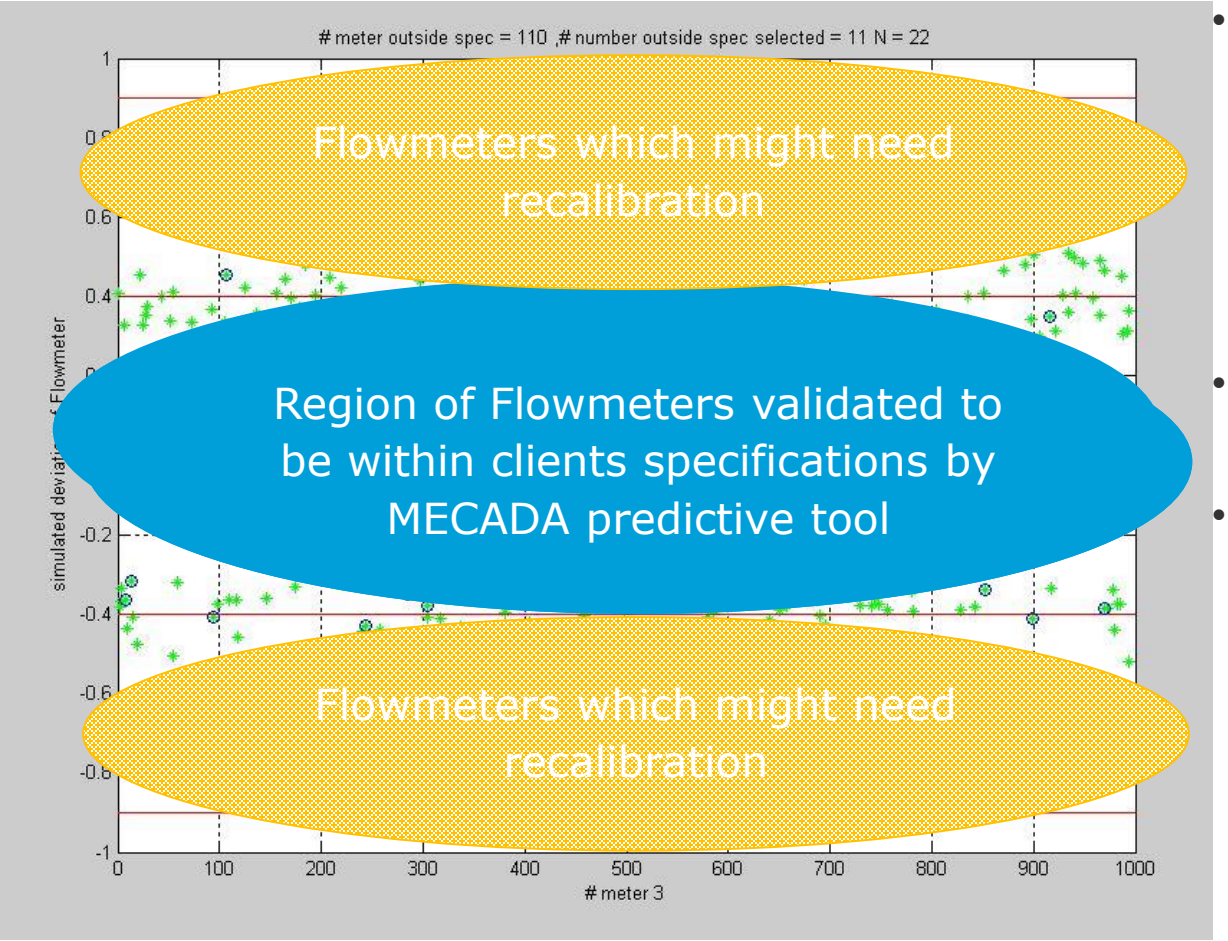
- Operators and Meter owners are encouraged to bring their data in
  - Meter's initial calibration certificate
  - Meter's recalibration certificate
  - Field verifications outcome
  - Flow and Diagnostics field data
- Meter manufacturers are also encouraged to bring their data in such as dry calibration data, diagnostics, etc.
- Models will be developed for all types of technologies
  - Turbine meters
  - Ultrasonic Meters
  - Rotary meters
- Project starts with focus on Ultrasonic and Turbine meter data (most abundant)

MECADA, Example of possibilities / flow error prediction 1



- Assume an installed base of 1000 flow meters with a normal distributed error somewhere between +/- 1%
- Error's between +/-0.4% are acceptable
- Randomly select 100 flow meters for recalibration
- Resulting in only 12 flowmeter actually being out of spec. after calibration
- 88 flow calibrations shows the meters are within specs

MECADA, Example of possibilities / flow error prediction 2



- Use MECADA to pre select flow meters that are likely to be out of spec (with an uncertainty level) out of 1000
- Randomly select 22 flow meters for recalibration
- Resulting in 11 flowmeter actually being out of spec.

MECADA – Joint Industry Project information -1-

- Official MECADA project launch Oct-Nov 2017
- Pilot with first client Q4- 2017 (model development pilot)
- The intention is to start the JIP-project by Q1 2018
- The project duration is 18 months
- Participants 6-10 (TSO and manufacturers)
- Each partner is investing 30 – 50 kEuro (depending on how many partners are joining)
- After data insertion into DNV GL's Veracity system the JIP partner is provided with a secured access code (unique data security key) for his or her data container.
- After cleansing the data and improving the data quality (first step in the project) the first visualization algorithms will be developed and deployed for use of the participants

MECADA – Joint Industry Project information -2-

- Project phases
  - 0 Contracting and Initiation
  - 1 Kickoff and data collection – cleansing and setup of data container
  - 2 Model development and first results (each owner on own data)
  - 3 Benchmarking – across owner results
  - 4 Finalisation - Reporting
- Project deliverables
  - Development and use of data models on own data
  - Free use of data models for new live data during the project timeline (18 months)
  - Reduced fee for use of data models after project timeline
  - Comprehensive Report with benchmarking analysis
- Note: Exact results can not be predicted at this stage

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