DNV·GL

OIL & GAS

OIL & GAS Metering

Paper FORCE workshop – June 2017 Vejen-Denmark

Calibration and recalibration actions; a balancing act between costs and risks

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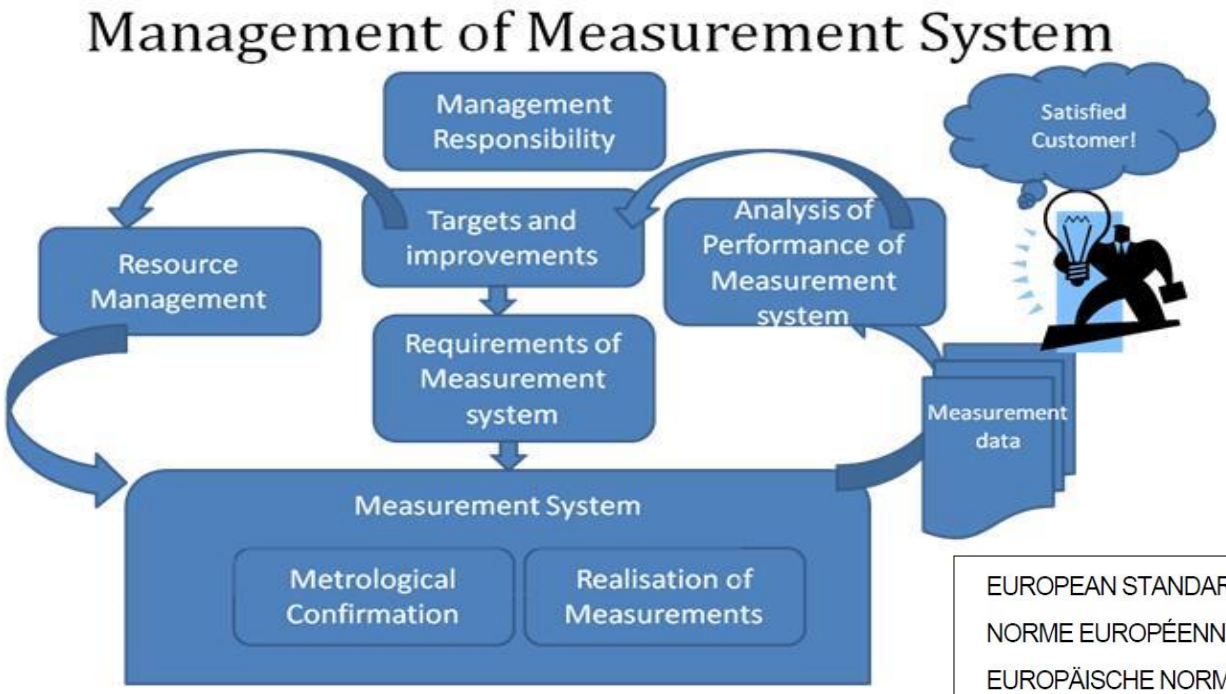
Balancing Cost and Risks in Calibration and Recalibration

1. Introduction Cost and Risk Control in gas metering
2. DUAL meters with online comparison – Recalibration cost reduction possible, but is the metrological risk acceptable?
   a) German legal metrology scheme
   b) Technology Qualification Scheme

3. MECADA: Big Data Analytics Platform will provide the answers to key questions about recalibration, role of meter Diagnostics, and Flow Error Monitoring
4. Summary and Conclusion

Management of Measurement systems (ISO 10012)



EUROPEAN STANDARD **EN ISO 10012**

NORME EUROPÉENNE

EUROPÄISCHE NORM April 2003

ICS 03.120.10; 17.020 Supersedes EN 30012-1:1993

English version

Measurement management systems - Requirements for measurement processes and measuring equipment (ISO 10012:2003)

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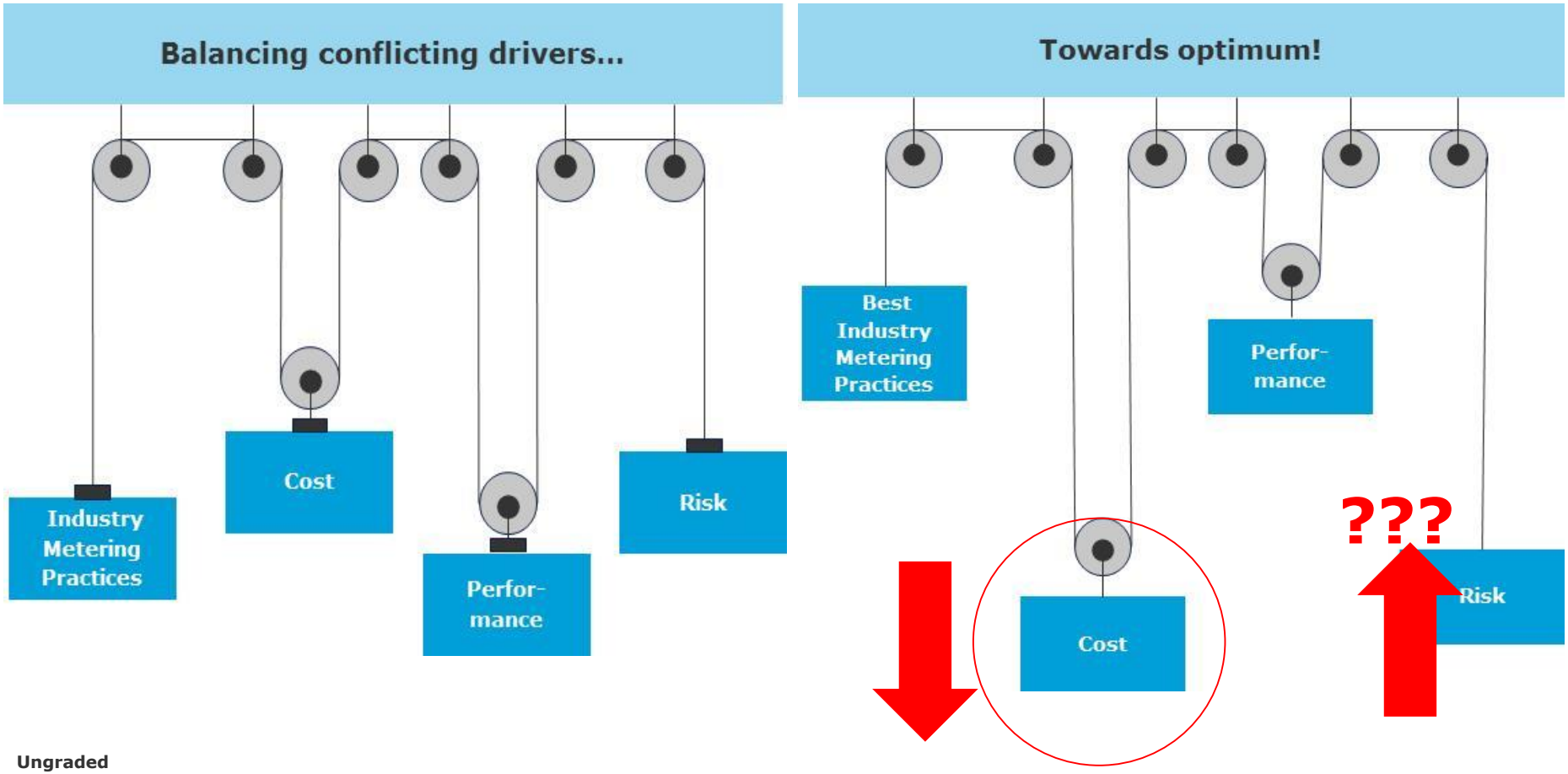
Metering Management / ISO10012 is a balancing act

Metering Management is balancing conflicting drivers towards optimum!



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Advise based on balance between costs and risk!

DNV GL classification for fiscal metering of gas						
Accuracy class	Economic trading value	Advised uncertainty flow	energy	Advised Recalibration frequency	Calibration conditions medium	pressure Reynolds
I-AAA	> 100 million euro	0.3%	0.6%	3-5 years	NG only	within 10%
I-AA	10M-100M euro	0.5%	0.8%	5-8 years	NG only	within 25%
I-A	1-10M euro	0.7%	1.0%	8-12 years	NG, other with proof	within 50%
I-B	0.1M-1M euro	1.0%	1.5%	---	air	

E.g. for Turbinemeters: typical financial risk/ added uncertainty:

- 0.4% after 5 years of no recalibration
- 0.6% after 10 years of no recalibration
- {compare with Energienet.. 0.72% after 8 years}

DUAL meters and recalibration

German Metrology Scheme allows DUAL meters with online comparison to be used to extend recalibration intervals

But is it really cost effective and a controlled risk for high-end fiscal systems?

Online Comparison (OLC) or periodic series testing as a tool to extend recalibration -1-

Real-time on-line comparison:

OLC is the on-line difference between Meter 1 and Meter 2

OLC= (Q1-Q2) / Q1 (in %)

Note: OLC is used in current legal metrology schemes in relation to recalibration intervals.

- E.g. German metrology scheme based on PTB G18 and expressed in "Mess und Eichverordnung" 2014-11-12 Anlage 7 Ordnungsnr. 5.6.7

  Drehkolbengaszähler, Turbinenradgaszähler, Wirbelgaszähler und Ultraschallgaszähler im geschäftlichen Verkehr zwischen gleichbleibenden Partnern mit einem maximalen Durchfluss von mindestens 1 600 m3/h gas im Betriebszustand, wenn ein Vergleichszähler eingebaut ist, der zu Vergleichsmessungen in Reihe geschaltet werden kann, oder wenn in Dauerreihenschaltung ein Vergleichszähler mit unterschiedlichen physikalischen Messverfahren eingebaut ist oder zwei Ultraschallgaszähler mit unterschiedlicher Reaktion auf Strömungseinflüsse eingebaut sind, unter der Voraussetzung, dass Vergleichsmessungen bei der ersten Inbetriebnahme und nachfolgend mindestens einmal jährlich ausgeführt werden, deren Ergebnisse keine Veränderungen der Abweichungen von mehr als der Hälfte der Eichfehlergrenzen gegenüber den bei der Inbetriebnahme festgestellten Abweichungen zeigen

Online Comparison (OLC) or periodic series testing as a tool to **extend recalibration** -2-

*Rotary Meters, Turbine meters, vortex meters and ultrasonic meters which measure either **continuously in series** or can be checked **at least once a year against each other** do not need to be recalibrated if the intercomparison of the meters show a difference of less than 50% of the calibration limits in relation to the reference difference which was established at commissioning of the meters*

In German legal metrology schemes

- *Legal metrology calibration limits (in German: Eichfehler grenze) in normal ranges (Q_t – Q_{max}) are **1%***
- *Legal metrology reference in real life field applications (Verkehrsfehlergrenze) is **2%** ,*
- *On the contrast for high-end custody transfer typical requirements in flow are < **0.5%** (e.g. class I-AA)*

Conclusion/warning

- *the applied metrology scheme **does not match** with normal high-end custody transfer requirements*
- ***No experimental evidence** has been provided to support the metrology scheme(s) for certain meter combinations*

DUAL meters and recalibration

Technology Qualification scheme

to control risk for high-end fiscal systems

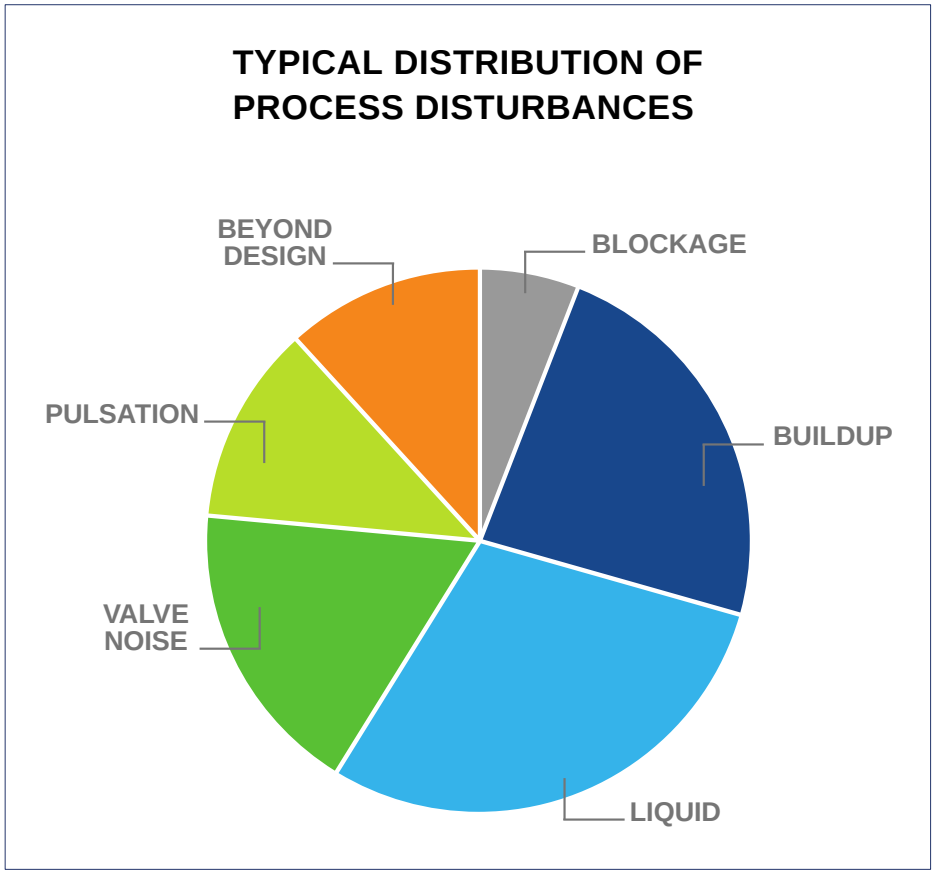
Third-Party Analysis of Actual Field Robustness

Field errors/ Bad meter performance is mostly

- meter related = 25%
- Process related = 75%

Process related metering errors can be due to:

- Process conditions beyond design
- Presence of dust and liquids
- Buildup of dirt on piping
- Flow conditioner blockage
- Dynamic flow processes (pulsations)
- Noise (e.g. valves)



Metering Risk Table for Verification of Technology Qualification

Meter performance is mainly determined based on **meter deviation** on one hand and **detection and diagnostic ability** on other hand in a risk matrix

Metering Risk Table for Technology Qualification					
	Flow Meter Detection and Diagnostic Ability				
Flow Meter Deviation	HIGH ←		MEDIUM	→	LOW
NON-SIGNIFICANT	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**
LOW	**PASS**	**PASS**	**PASS**	**PASS**	**FAIL**
MEDIUM	**PASS**	**PASS**	**PASS**	**FAIL**	**FAIL**
HIGH	**PASS**	**PASS**	**FAIL**	**FAIL**	**FAIL**
VERY HIGH	**PASS**	**FAIL**	**FAIL**	**FAIL**	**FAIL**

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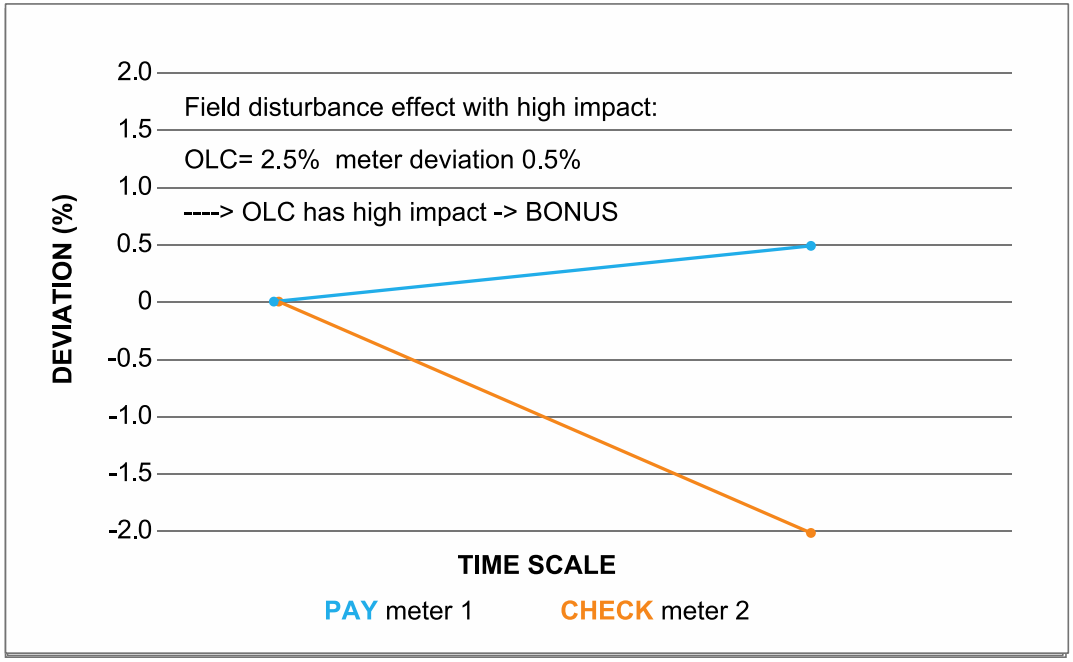
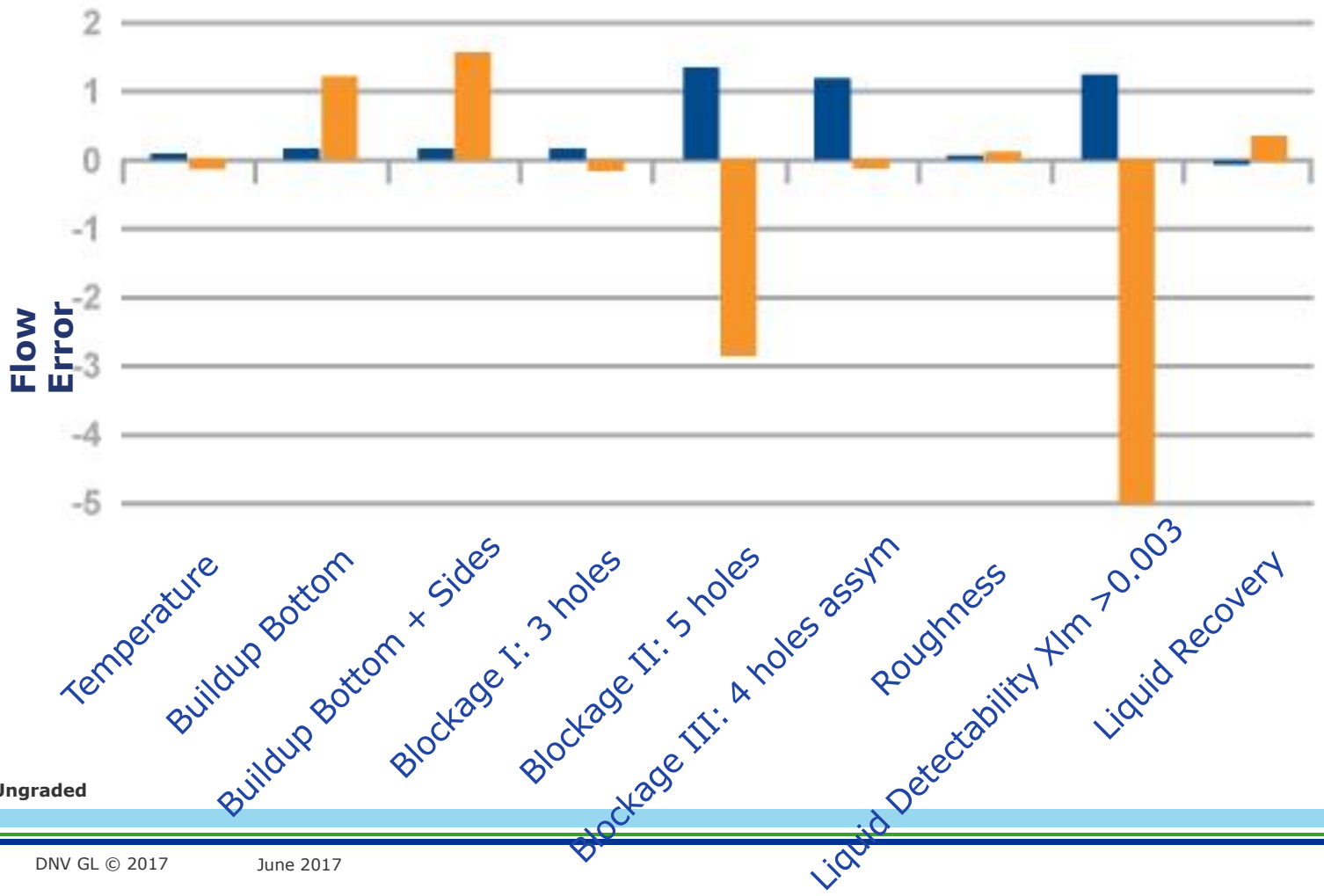
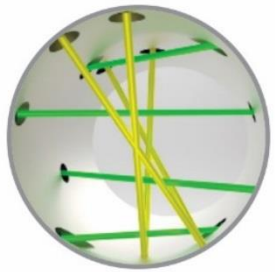
On-Line Comparison of Dual-Configuration Meters: Bonus Points or Penalties in Detection Ability



Summary of DNV GL Technology Qualification of Daniel 3416 Ultrasonic Flow Meter

Comparison of Pay and Checkmeter Affect on Operational Distortions





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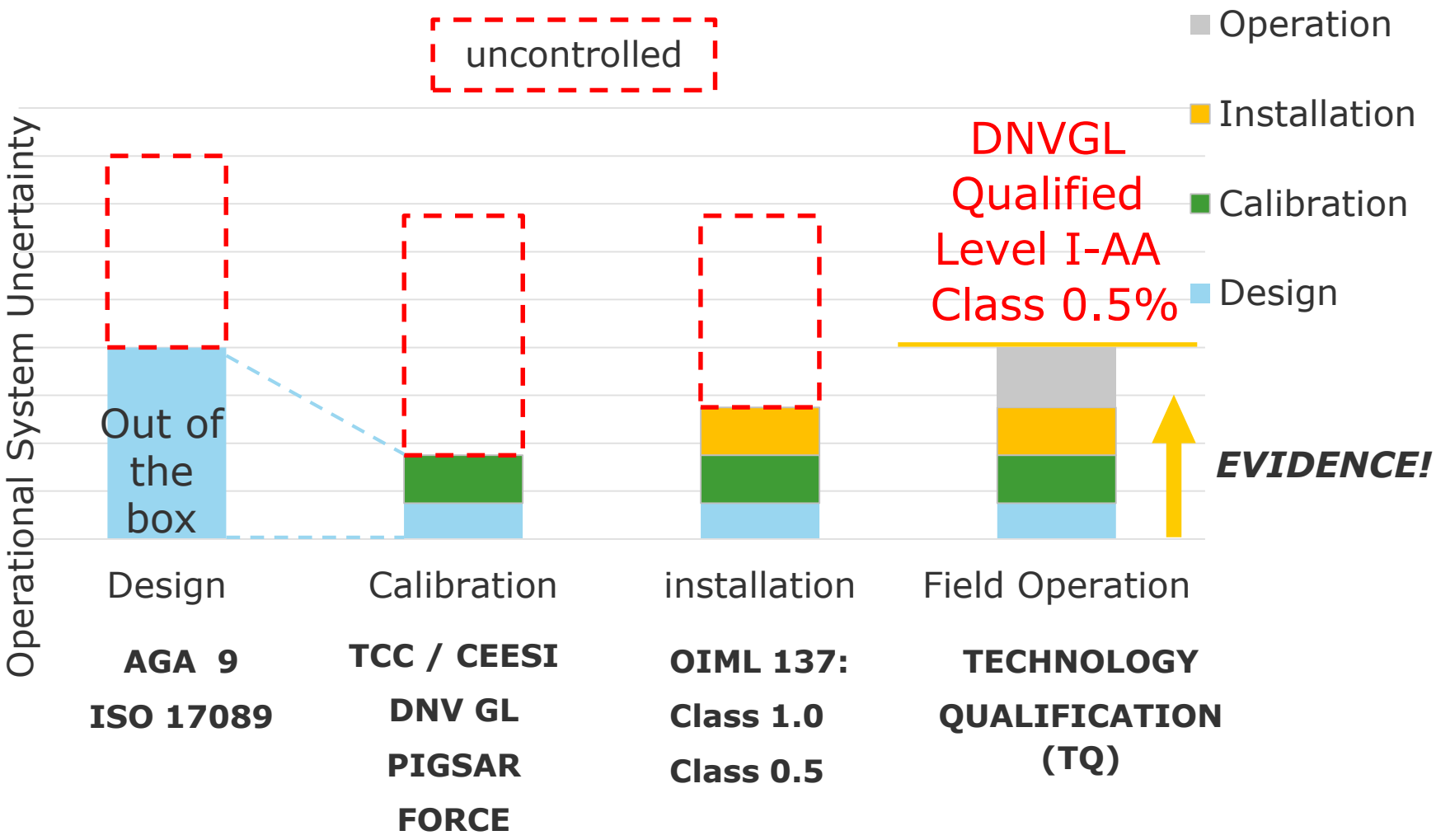
Technology Qualification as a tool to extend recalibration



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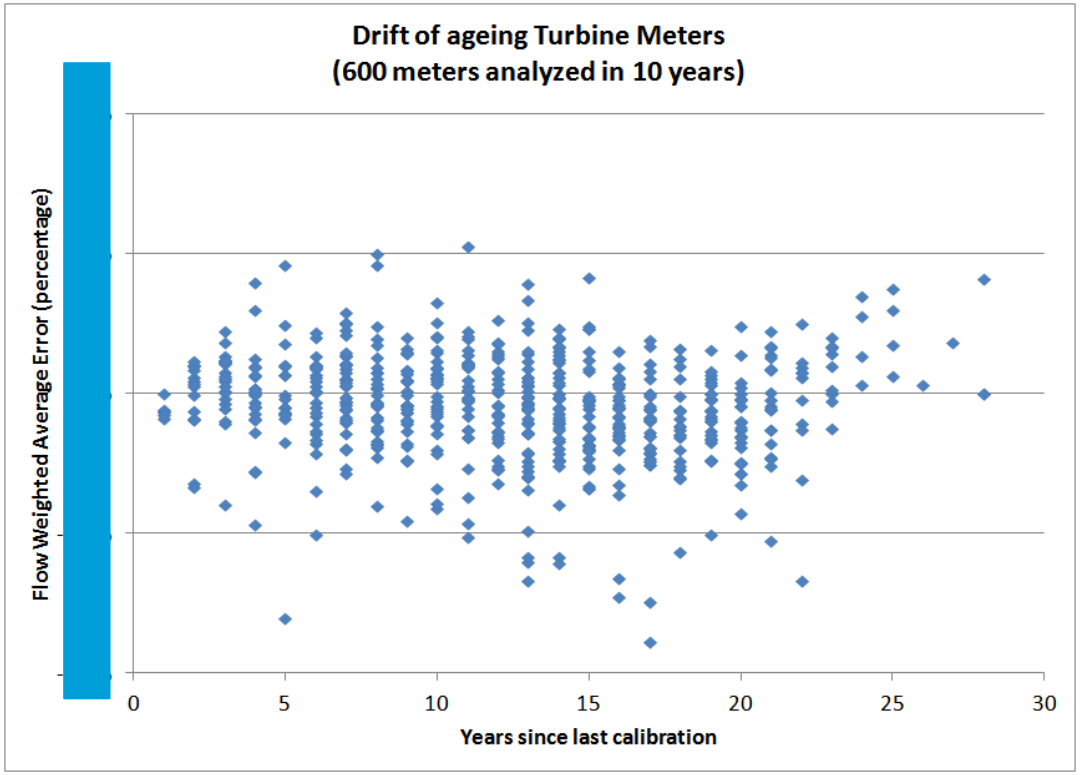
Way forward: Make smart use of all our metering and calibration and field data!

Metering Analytics and Combined Sensor Diagnostics help in track, trace and cure field errors and help in extension of recalibration intervals

Metering Analytics & Combined Sensor Diagnostics -1-

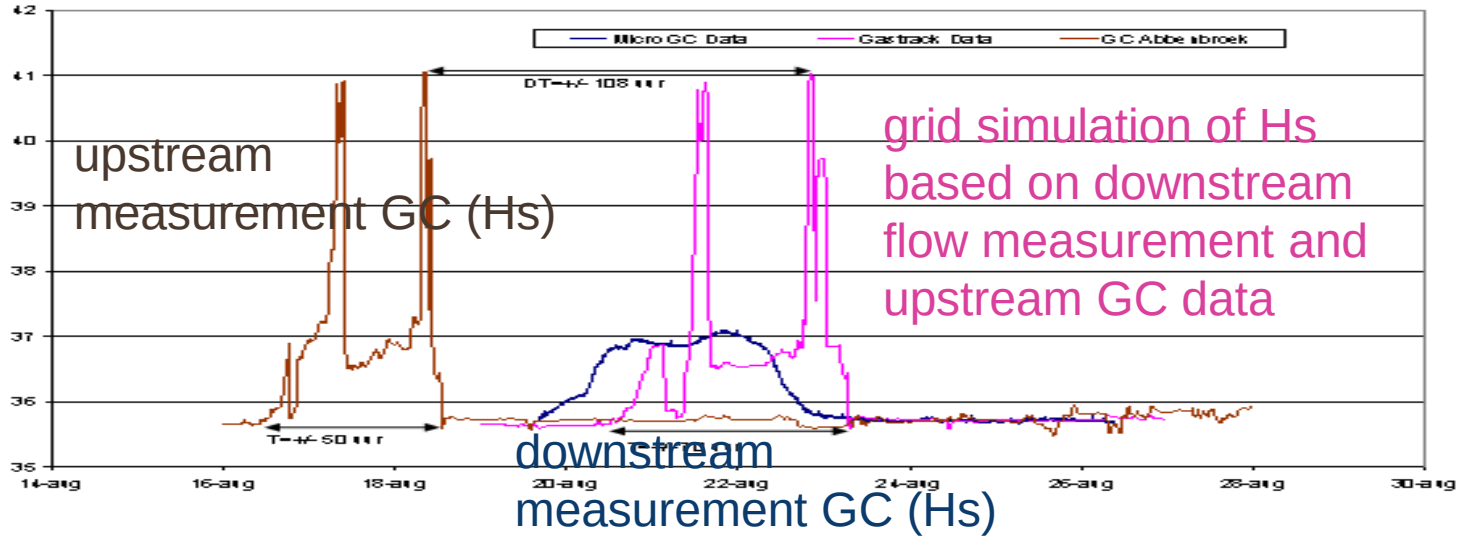
What if you could detect drift by combining all historic evidence?

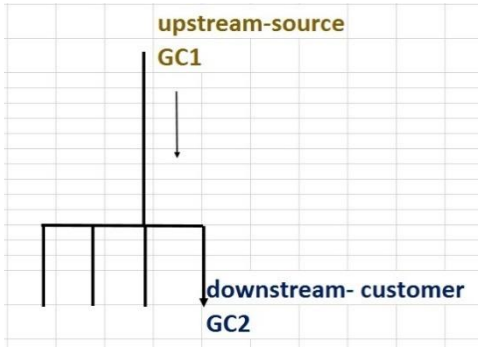


Metering Analytics & Combined Sensor Diagnostics -2-

What if you could use information in a grid to validate flow meters?

- Gas quality variation reveals flow deviation (like a tracer):





- Conclusion:
  - Transit time difference 20% ->
  - Error in flow meter about -20%!
  - Gas quality variations can act as a tracer (Time-of-flight)

Why start the MECADA Joint Industry Project-1-?

CALIBRATION AND RECALIBRATION

- 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-?

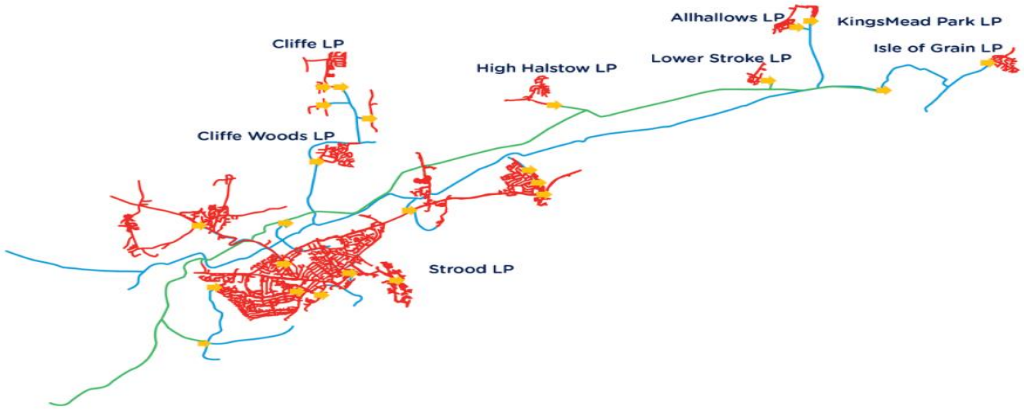
Additional role of METER DIAGNOSTICS

- 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

- A grid operator usually controls an installed base of TM or US meters > 1000 worldwide,
  - Can the operator in his grid create a set of (simple) virtual flow meter to check each flow measurement system?
  - Can the operator profit from all this field performance data to get optimum levels of gas losses (UFG< 0.1%) and maintenance cost?
  - Can you trace any fraudulous activities in metering (and calibration) practices?



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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 get access to their own data, like in Cloud. Data from other participants is only visible through the models in a general way, e.g. for trending or benchmarking purposes.

VERACITY Introduction Video

Link to the video:

https://www.dnvgl.com/data-platform/index.html

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

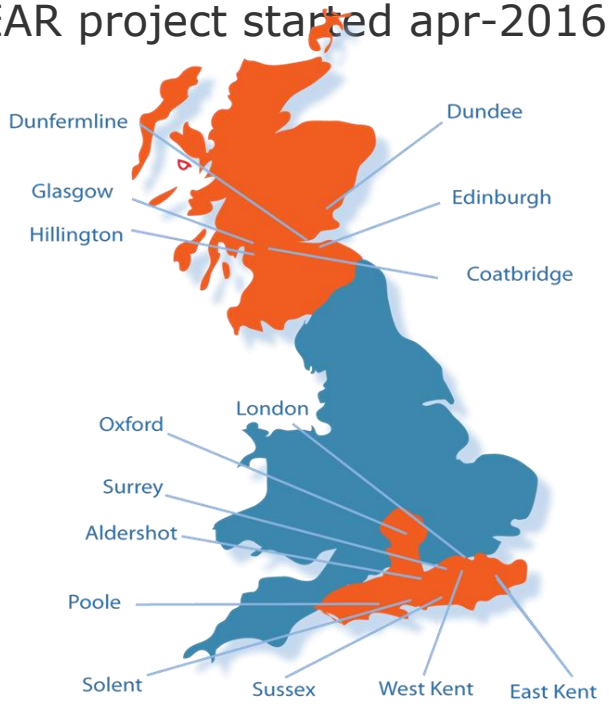
- **Enrich your data**
  - Keep ownership and control while leveraging your data by integrating, sharing or bench-marking it from one secure place

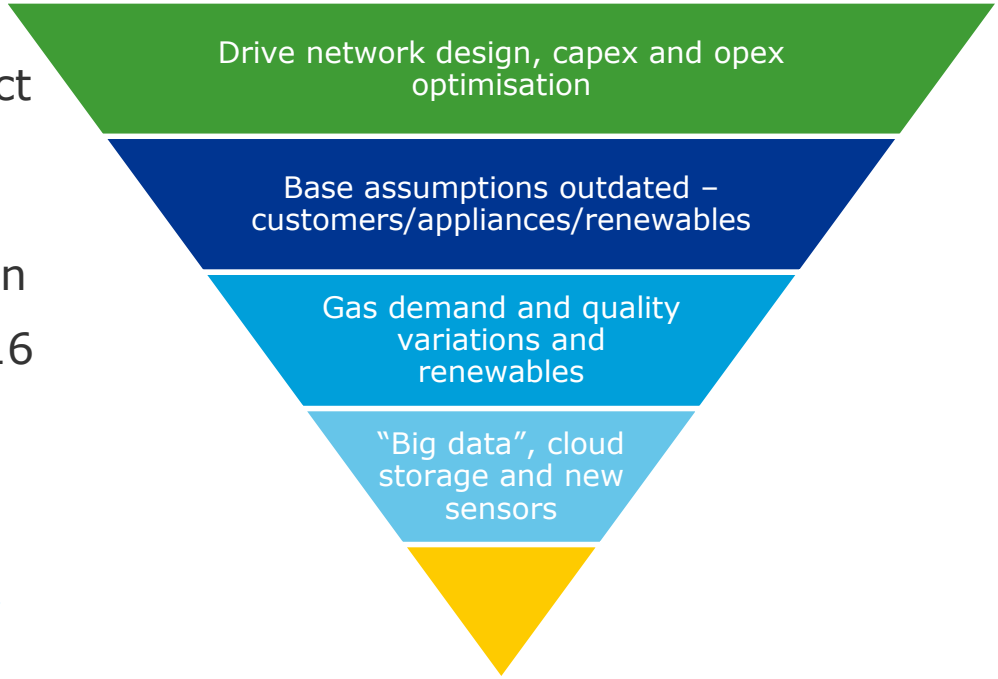
Example of Data Analytics project of DNV GL in UK

DNV GL supports SGN (Scotia Gas Networks) in a large project Network Analysis

AIM: CAPEX and OPEX optimisation, demand prediction

3-YEAR project started apr-2016





REAL-TIME NETWORKS

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MECADA goals and benefits

- The maturing model will provide more benefits as the data collection grows
- **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 Joint Industry Project approach and startup

- 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.

- Project starts with focus on Ultrasonic and Turbine meter data (most abundant calibration data), but can later be extended to other types

MECADA Joint Industry Project Timeline

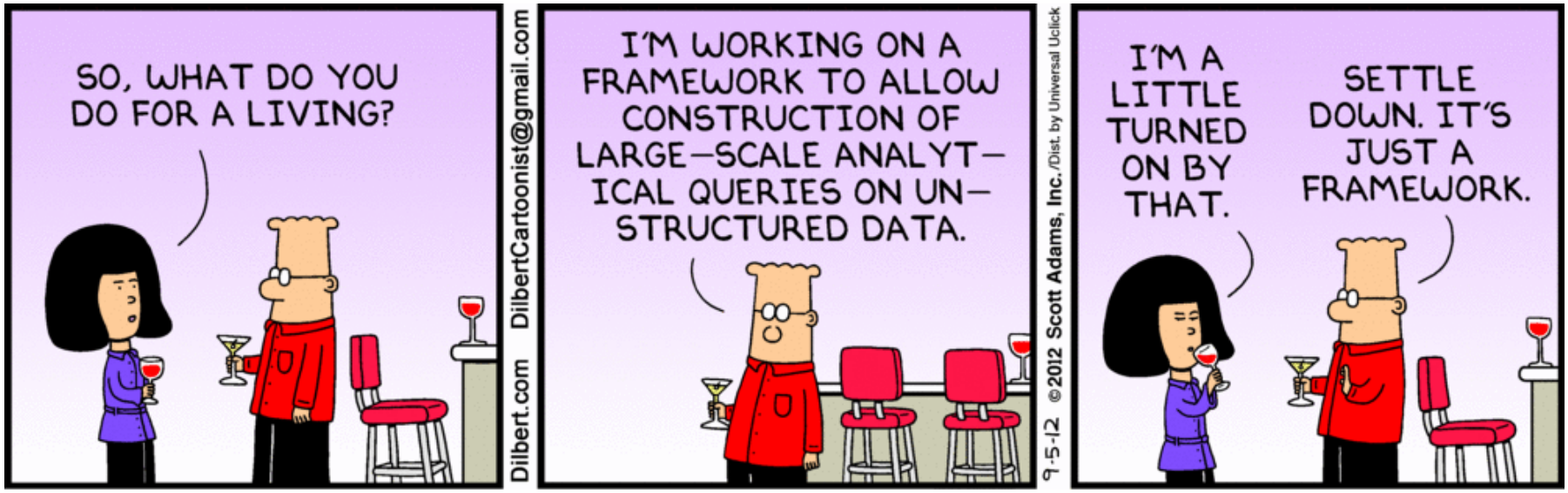
- Q3/Q4 2017 official LAUNCH
  - First Phase: Proof-of-principle
  - Participating company in first phase can participate by bringing in their calibration data, their diagnostic data and as much as possible also their field data
  - DNV GL will develop algorithms to see how the goals as described in this presentation can be met (and maybe include additional goals)
  - DNV GL is sponsoring the project in first phase, so no out-of-pocket money required for participating companies
- Q2 2018 Based on the outcome of First phase project is evaluated and the next steps are determined
- Ultimate ambition: create the largest data analytics platform for metering, (re)calibration and field data

MECADA poll {results poll between brackets}

1. Do you think there is more value in your metering, calibration and diagnostic data then you currently are using or extracting?
   1. YES {50%} / No {0%}

2. Are you interested to participate with your metering and calibration data in an open platform like MECADA?
   A. Yes, this will really be helpful for me/ my company {0%}
   B. Yes, provided data security, and confidentiality has been arranged {10%}
   C. Maybe, as our company policies on data security and confidentiality are strict {20%}
   D. Maybe, but more information and examples is needed to convince me {50%}
   E. No, I do not see any value {0%}

MECADA at the bar.....



Calibration and Recalibration, a balancing act between costs and risk

Summary & Conclusions

- Markets drive too much on cost reduction. Individual risks are either unknown (limited awareness) or socialised among trading parties
- Use German metrology scheme and tracing of meter difference is okay only when evidence/ verification of combined flow system behaviour and field robustness has been provided
- TQ testing scheme developed by DNV GL can help to obtain quick necessary evidence for field robustness
- Future option/ project: Make smart use of all our data! Data Analytics and combined sensor diagnostics can be used to trace errors, get early warnings and reduce maintenance cost.
- **First step in this direction?** ***JIP proposal MECADA***
- Welcome to join the discussion and align your and our thoughts. Stay updated by sending an email or leaving your contact info

Thank You!

More info: contact

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