Usage of an explicit Taxonomy and CC Services in a DCC

Enhancing the interoperability of Calibration Certificates

February | FORUM-MD | Diego Nahuel Coppa, Marcos Bierzychudek, Andrés Torán, Héctor Laiz

Instituto Nacional de Tecnología Industrial
INTI

Ministerio de Economía Argentina
Secretaría de Industria y Desarrollo Productivo

Instituto Nacional
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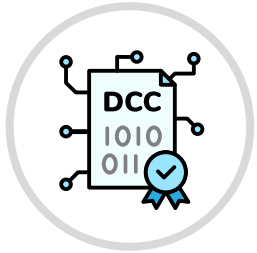
Why? What? How?

Why?, What? How?

Motives, Improvements & base for the proposal



Why?

- Increase in the interoperability between Calibration Certificates.
- Facilitate the adoptability of the DCCs. (Simpler software)
- Increase the usefulness of the Calibration Certificates.

Why?, What? How?

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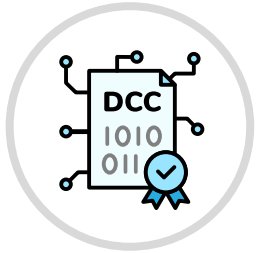

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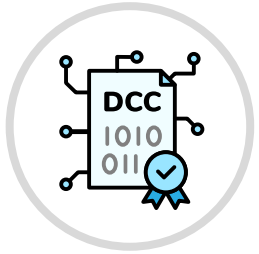

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How?

- Use a classification that already exists. (Consultive Comitees's Services)
- Link the DCC to the SI Reference Point.
- Use a structurization that is already accepted by Metrological Communities. (NCSLI MII Taxonomy)

  https://github.com/NCSLI-MII/measurand-taxonomy/
  https://www.metrology.net/multical/metrology-taxonomy/

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Case of study:
Calibration Certificate in the QI

Case of study: Calibration Certificate

MRA & KCDB


Reconnaissance mutuelle
des étalons nationaux de mesure
et des certificats d'étalonnage et de mesurage
émis par les laboratoires nationaux de métrologie
Paris, le 14 octobre 1999
Supplément technique révisé en octobre 2003 (pages 17-20)
ΜΕΤΡΩ ΧΡΗ
Mutual recognition
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Mutual Recognition of Calibration Certificates issued by NMIs

www.bipm.org/en/cipm-mra/cipm-mra-documents

Case of study: Calibration Certificate

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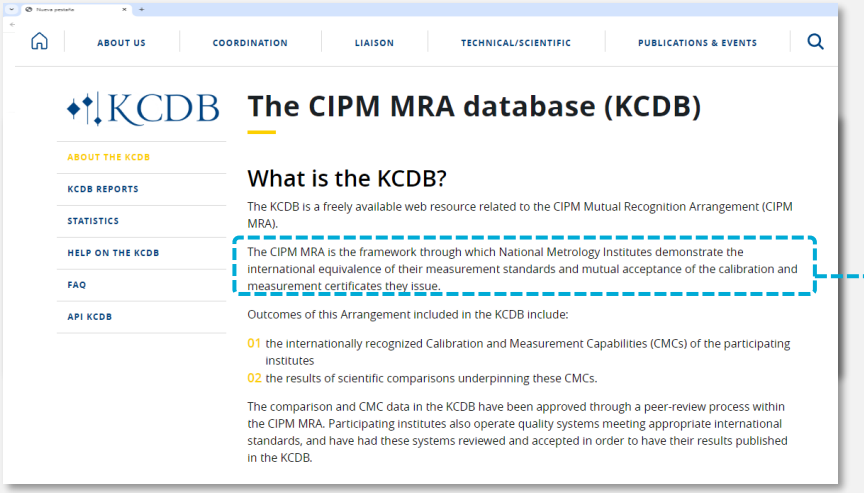


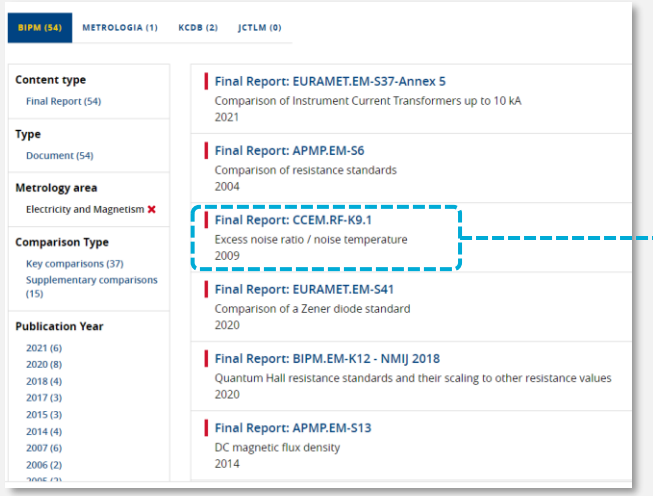
The Key Comparison Data Base (KCDB) is the framework through which NMIs demonstrate the mutual acceptance of the Calibration Certificate they issue.

www.bipm.org/en/cipm-mra/cipm-mra-documents

www.bipm.org/en/cipm-mra/kcdb

Case of study: Calibration Certificate

KCDB Reports & Classification of Consultive Comitees's Services (CC Services)



Analog reports to support the CMCs.
(Digitalization on the way)

www.bipm.org/kcdb/cmc/advanced-search

Case of study: Calibration Certificate

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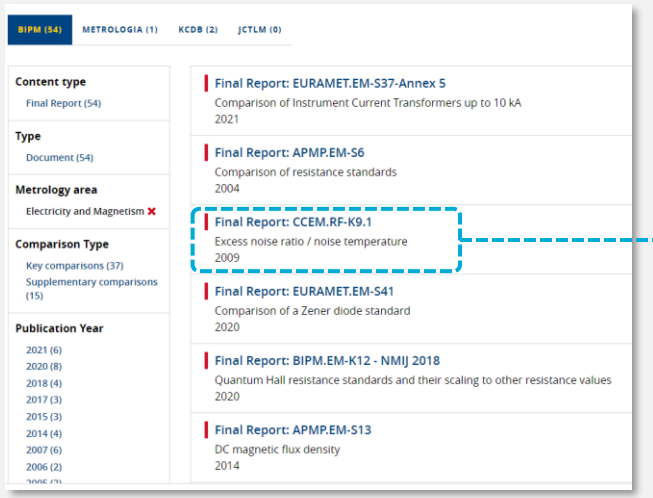

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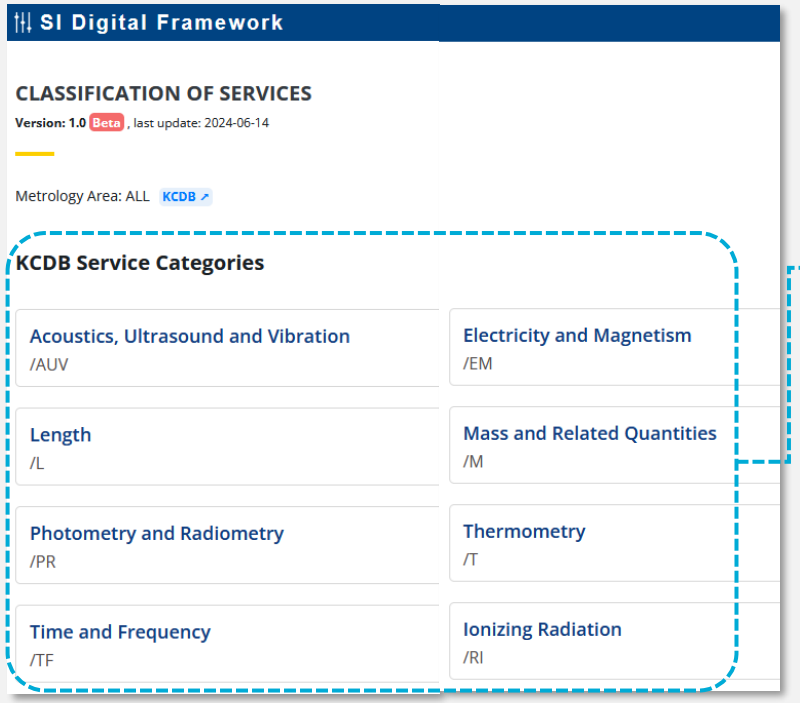

Digital classification of CC Services

www.bipm.org/kcdb/cmc/advanced-search

si-digital-framework.org/kcdb-sc/

Case of study: Calibration Certificate

Classification of Consultive Committee's Services (CC Services)

Classification of CC Services in:

ELECTRICITY AND MAGNETISM

BRANCH: AC VOLTAGE, CURRENT, AND POWER

5. AC voltaje (up to the MHz range)

5.2. AC voltaje up to 1100 V

5.2.1. Sources: multifunction calibrator.
SIRP: EM/AC-5.2.1 Sources

5.2.2. Meters: AC voltmeter, multimeter, multifunction transfer standard.

SIRP: EM/AC-5.2.2 Meters

MASS AND RELATED QUANTITIES

BRANCH: FLUID FLOW

9. Fluid Flow

9.10. Fluid Flow

9.10.1. Liquid Flow.

9.10.2. Gas Flow

9.10.3. Quantity of Fluid

9.10.4. Flow Speed (...)

ACOUSTICS, ULTRASOUND AND VIBRATION

BRANCH: Vibration

21. Linear Vibration

21.3. Acceleration measuring chain / accelerometer

21.3.1. Charge sensitivity

21.3.1.1 Modulus: frequency

21.3.1.2. Phase: frequency

THERMOMETRY

BRANCH: TEMPERATURE

2. Temperature – Items used for disseminating ITS-90 and PLTS 2000

2.2. Resistance thermometers

2.2.2. Industrial platinum resistance thermometers (IPRTs).
SIRP: T/T-2.2.2 Platinum resistance thermometers (PRTs)

LENGHT

CLASS: 2. Linear Dimensions

2.4. Diameter standards

SERVICE CATEGORY	INSTRUMENT OR ARTIFACT	MEASURAND
2.4.1	external cylinder (plug, piston, pin, wire)	diameter
2.4.2	internal cylinder (ring)	diameter
2.4.3	sphere (ball)	diameter

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Case of study: Calibration Certificate

CMC linked to a CC Service – EM Services – item 5.2.2 – Case of Study

Calibration and Measurement Capability (CMC)

Data Base for humans (Digitalization on the way)

GROUP ID	SERVICE PROVIDER	INSTITUTE SERVICE CODE	COMMENTS	BRANCH	SERVICE	QUANTITY
	Argentina **INTI**	INTI/102.02.04.05.10.001		AC voltage, current, and power	AC voltage (up to the MHz range)	AC voltage (up to the MHz range): AC voltage ratio up to 1100 V, real component (or modulus)

INSTRUMENT OR ARTIFACT UNDER STUDY	INSTRUMENT TYPE OR METHOD APPLIED	VALUE CMC	EXPANDED UNCERTAINTY CMC	PARAMETERS	APPROVAL DATE
AC voltmeter, multimeter, multifunction transfer standard	AC/DC transfer	[0.06 to 1000] V	[1.0E1 to 3.0E2] µV/V Uncertainty table	Frequency : 10 Hz to 1 MHz	2013-08-06

www.bipm.org/kcdb/cmc/advanced-search

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Case of study: Calibration Certificate

AC Voltage for Multimeters – 5.2.2 Service – Case of Study

Lab #1

RANGE	NOMINAL VALUE	MODIFIER	ERROR	UNCERTAINTY K=2; 95%
200 mV	100 mV	0.04 kHz	0.000 mV	0.011 mV
200 mV	100 mV	1 kHz	-0.003 mV	-0.011 mV
200 mV	100 mV	20 kHz	0.002 mV	0.011 mV

Lab #2

RANGE	REFERENCE VALUE	MODIFIER	DEVIATION	MEASURED VALUE	UNCERTAINTY K=2; 95%	All Dev	Ut of All Dev
200 mV	100.000 mV	0.04 kHz	0.000 mV	100.000 mV	0.011 mV	±0.21 mV	5 % pass
200 mV	100.000 mV	1 kHz	-0.003 mV	99.997 mV	0.011 mV	±0.21 mV	6 % pass
200 mV	100.000 mV	20 kHz	0.002 mV	100.002 mV	0.011 mV	±0.21 mV	6 % pass

Lab #3

RANGE	NOMINAL VALUE	MODIFIER	ERROR	MEASURED VALUE	UNCERTAINTY K=2; 95%
200 mV	100 mV	40 Hz	0.000 mV	100.000 mV	0.011 mV
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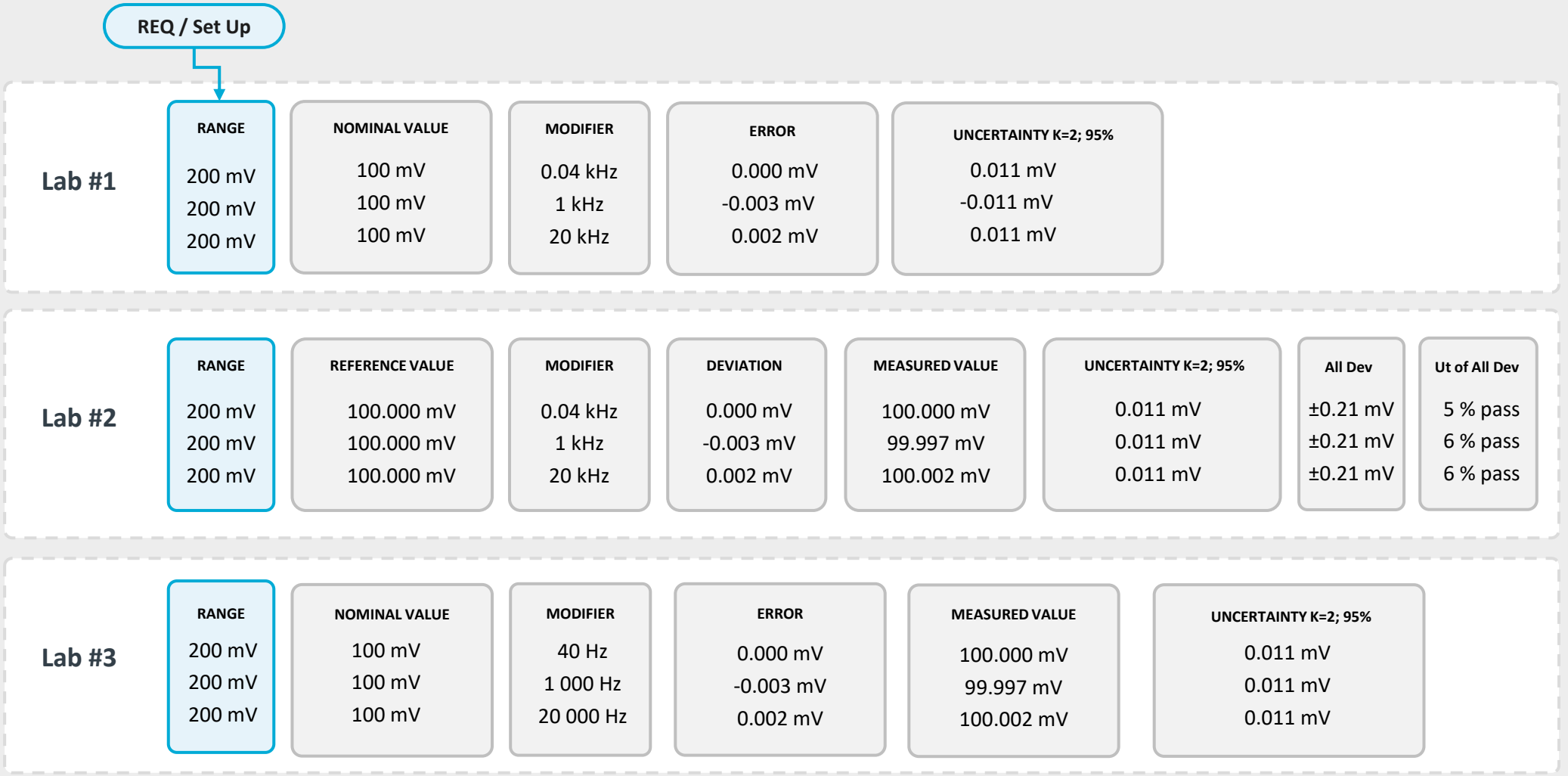
200 mV	100 mV	20 000 Hz	0.002 mV	100.002 mV	0.011 mV

Case of study: Calibration Certificate

AC Voltage for Multimeters – 5.2.2 Service – Case of Study



Case of study: Calibration Certificate

AC Voltage for Multimeters – 5.2.2 Service – Case of Study

REQ / Set Up

REQ-OPT

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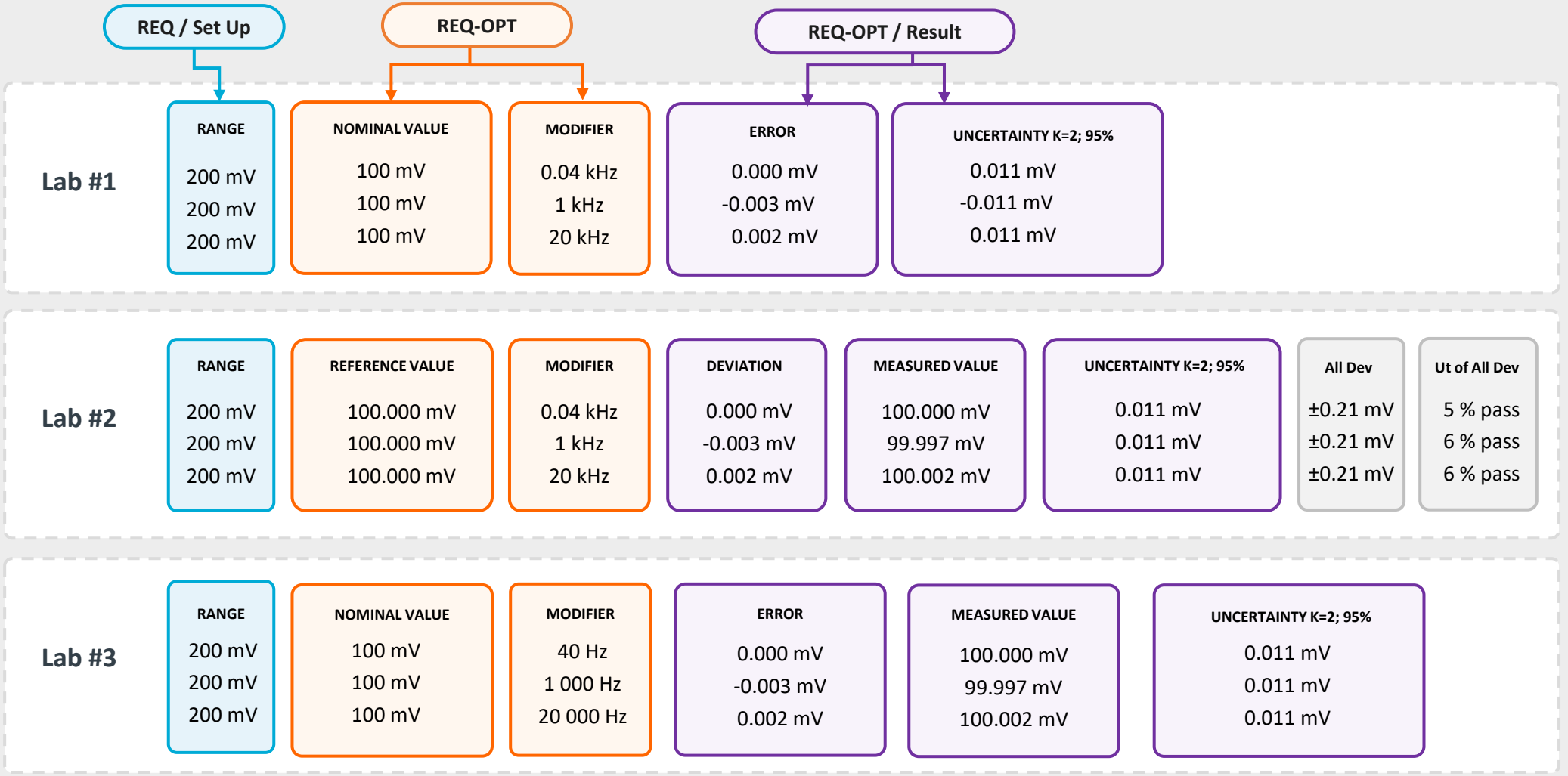

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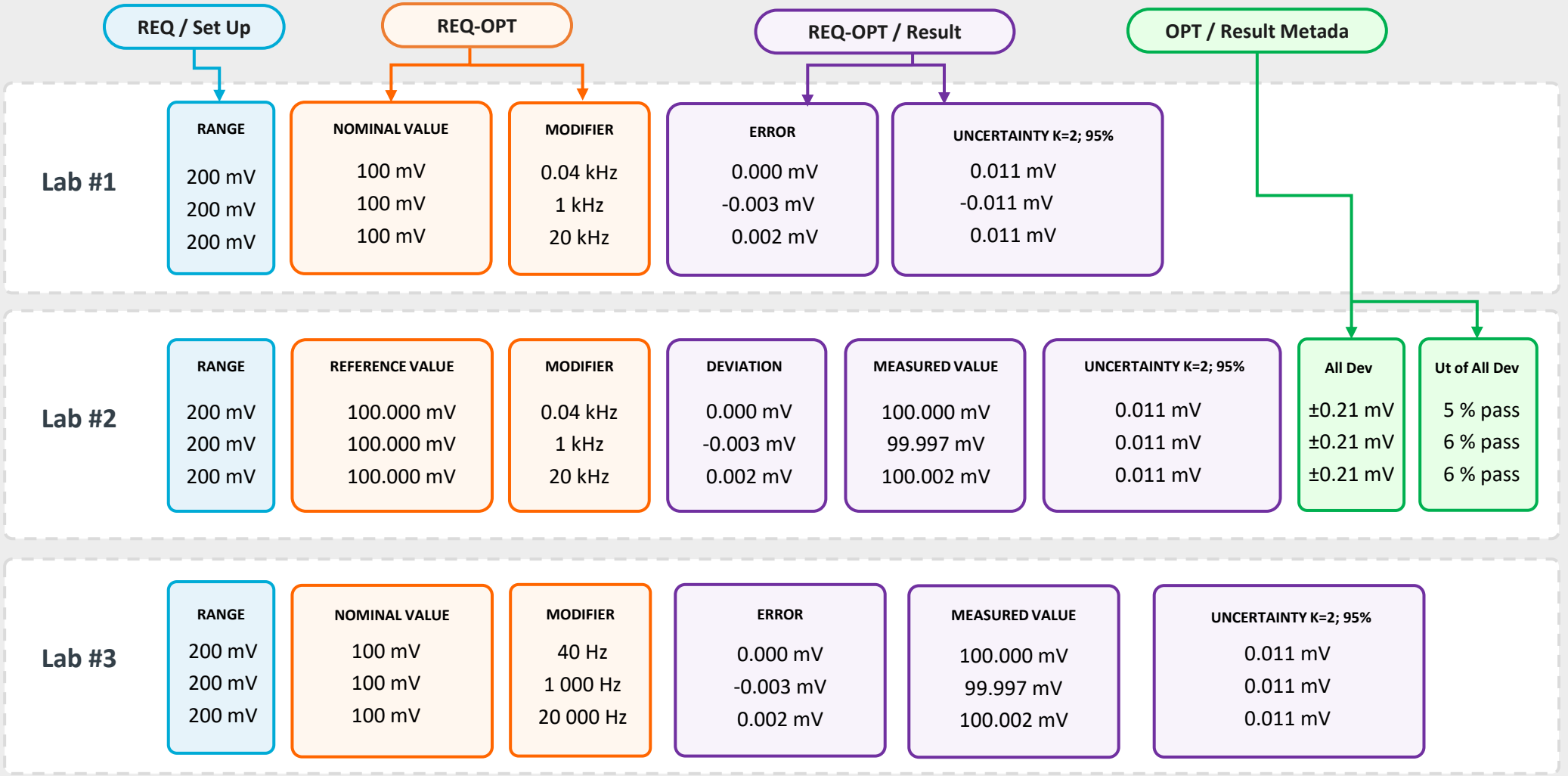
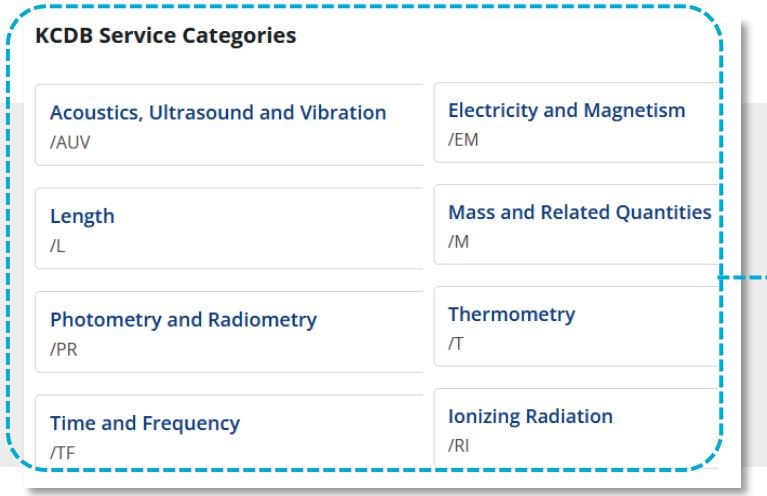


Case of study: Calibration Certificate

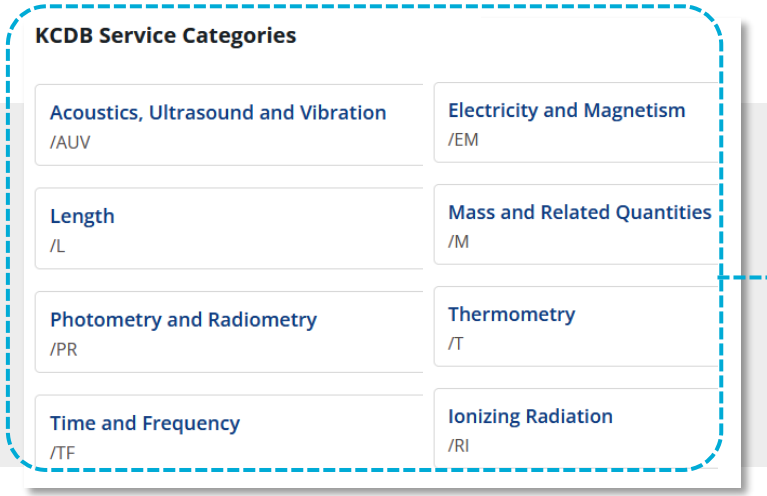
Case of study: Conclusions



Calibration Certificates can be classified by Consultive Committees's Services (CC Services) even without CMCs involved

Case of study: Calibration Certificate

Case of study: Conclusions



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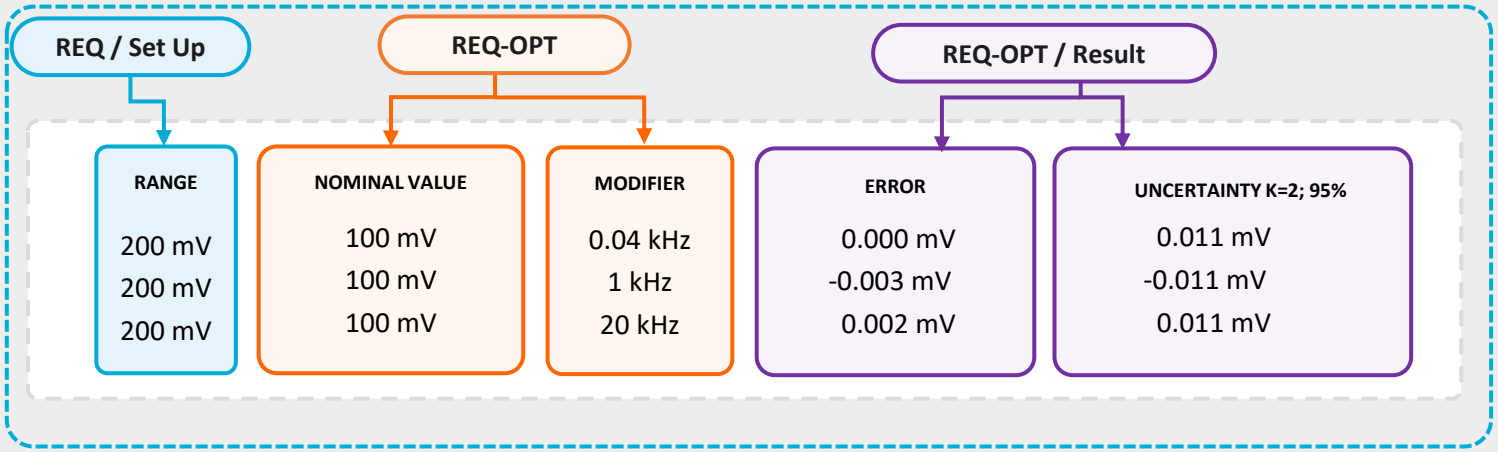


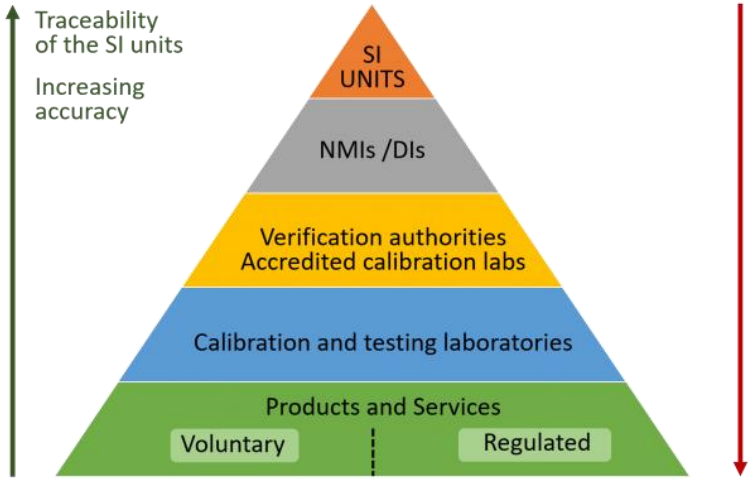
Harmonization of DCC structures is possible based on CC services

Case of study: Calibration Certificate

Discussion

Further discussion

- **Should the Consultive Committees Service be extended and clarified to be used for the Calibration Certificates?**
- **Should there be services in different levels like BIPM, RMO and NMI?**



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Case of study: Taxonomy

From analog to digital

Introducing a Taxonomy

Taxon to explain a CC Service

Classification of services in electricity and magnetism

BRANCH: AC VOLTAGE, CURRENT, AND POWER

5. AC voltaje (up to the MHz range)

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TOKEN	DEFINITION
MEASURE	DUT is an equipment that measures the Quantity
SOURCE	Implies that the DUT is a generator of the Quantity
VOLTAGE	[qk] concept described in ISO 80000 or elsewhere
AC	Alternating current nature of Voltage

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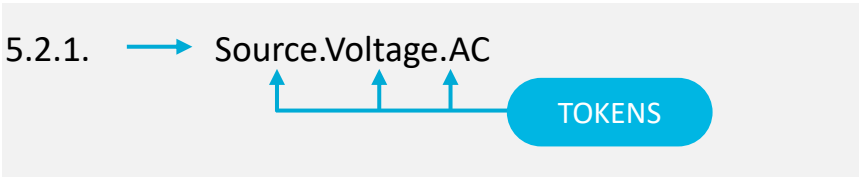
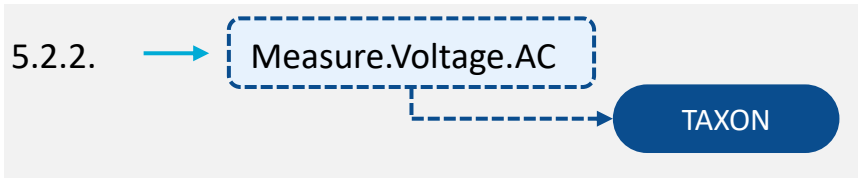
The Taxon is not about the method, the technique, or the procedure; it is about the Measurand

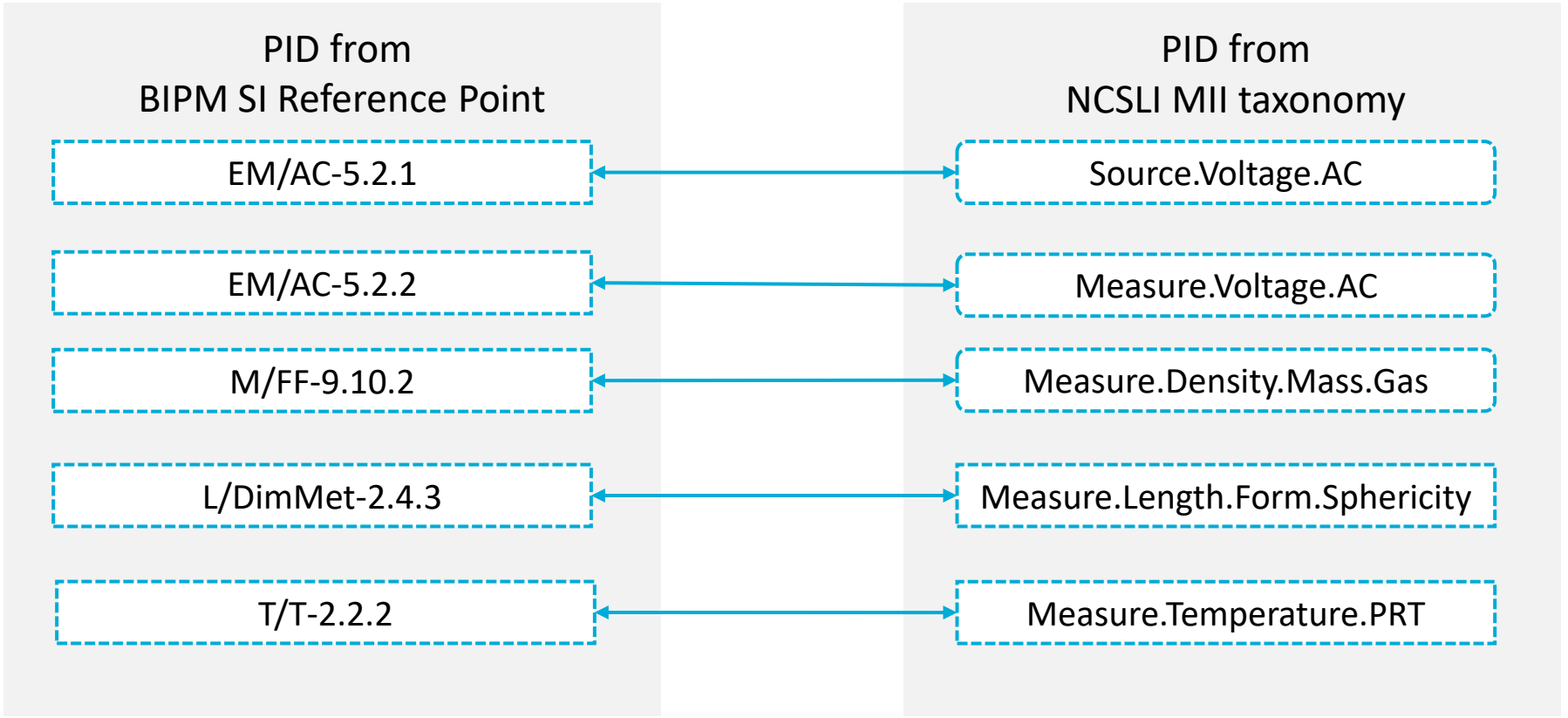




Introducing a Taxonomy

SIRP vs Taxonomy

Examples:



https://si-digital-framework.org/sc-quantities

NSCLI-141 Measurement Information Infrastructure & Automation Committee

www.metrology.net/mii-approved-taxonomies/

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D-SI and DCC

From analog to digital

Analyzing a DCC

refTypes in a DCC

XML example GP - DCC (not exactly):

XML

```
<dcc:list>
  <dcc:quantity refType="electric_CalPointVoltageDC">
     <si:valueXMLList>100 200 300 400 500</si:valueXMLList>
     <si:unitXMLList>\volt</si:unitXMLList>
  </dcc:quantity>
<dcc:quantity refType="electric_Error_measureVoltageDC ">
     <si:valueXMLList>0.1 0.2 0.4 0.2 0.4</si:valueXMLList>
     <si:unitXMLList>\volt</si:unitXMLList>
     <si:expandedUncertainty>
       <si:valueXMLList>0.1 0.2 0.1 0.1 0.2</si:valueXMLList>
         <si:covFactor>2</si:covFactor>
         <si:covProb>0.95</si:covProb>
       </si:expandedUncertainty>
  </dcc:quantity>
</dcc:list>
```

Multimeter DC Voltage

NOMINAL VALUE		ERROR	UNCERTAINTY K=2; 95%
100	V	0.1 V	0.1 V
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Hackel, S.; Schönhals, S.; Doering, L.; Engel, T.; Baumfalk, R. **The Digital Calibration Certificate (DCC) for an End-to-End Digital Quality Infrastructure for Industry 4.0**. *Sci* 2023, *5*, 11. https://doi.org/10.3390/sci5010011

Analyzing a DCC

refTypes in a DCC

XML example GP - DCC (not exactly):

XML

```
<dcc:list>
  <dcc:quantity refType="electric_CalPointVoltageDC">
     <si:valueXMLList>100 200 300 400 500</si:valueXMLList>
     <si:unitXMLList>\volt</si:unitXMLList>
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PTB DCC with Taxons

refTypes with an explicit Taxonomy

CC Services would provide a way of comparison between DCCs

XML

```
Measure.Voltage.DC->CC service EM 1.2.2 in BIPM
CalibrationPoint->Calibration Point concept
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Multimeter DC Voltage
CC Service EM 1.2.2

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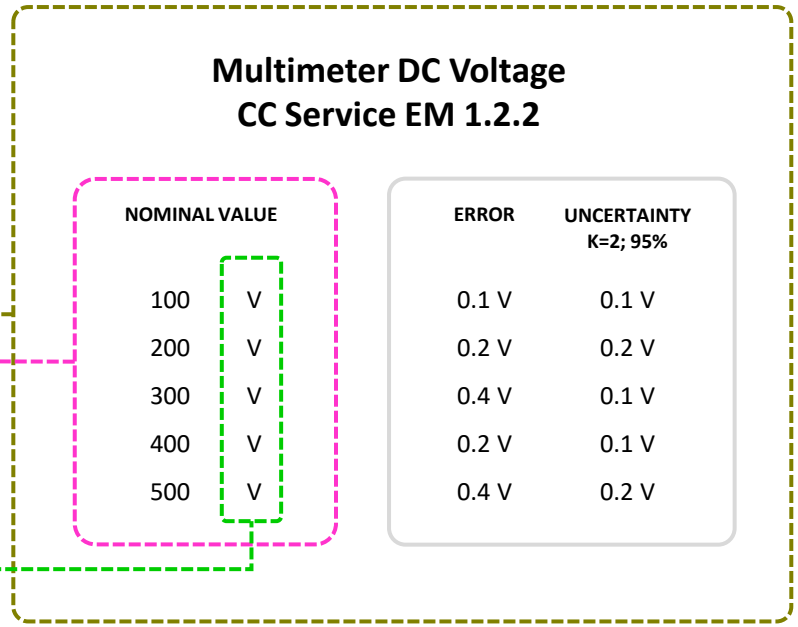

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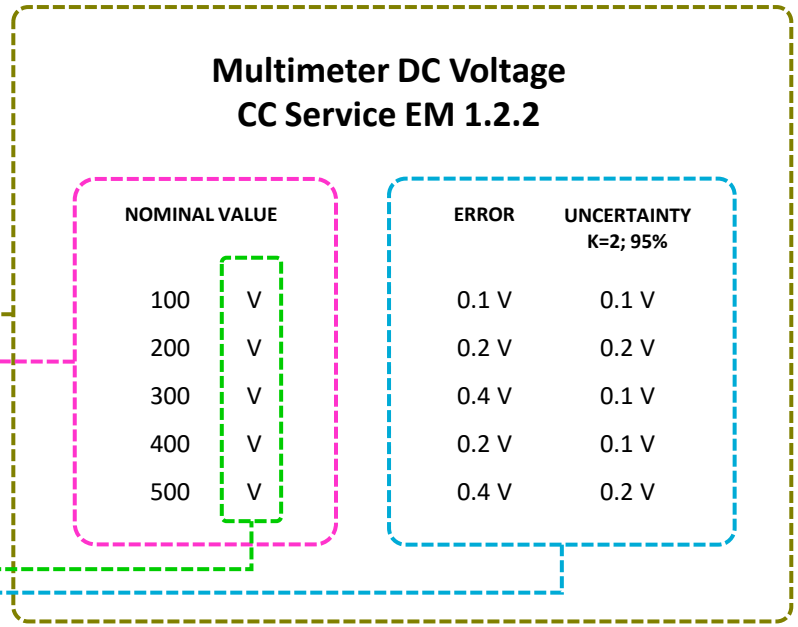

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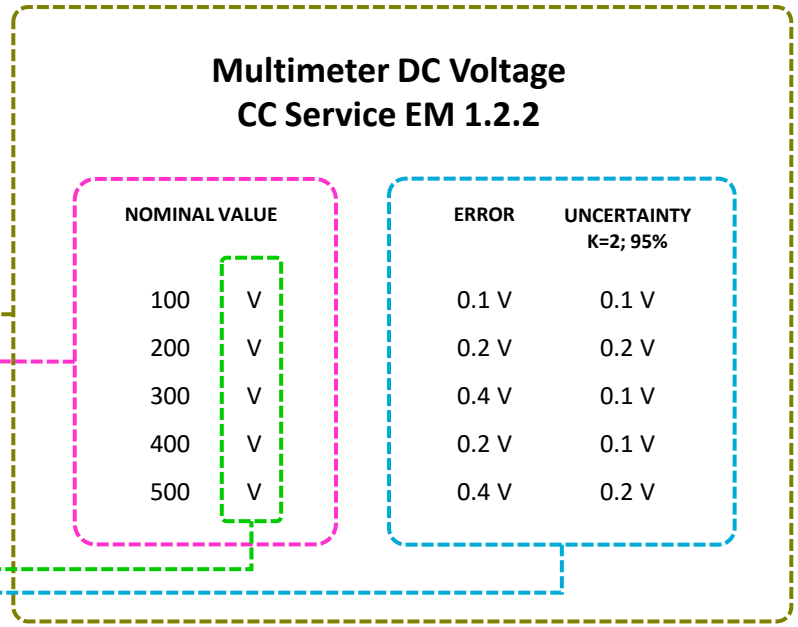

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Case of study: Taxonomy

Conclusions

XML

```
<dcc:list refType="Measure.Voltage.DC">
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...
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CC Service EM 1.2.2

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A well-designed taxonomy may enable the modeling of reality.
In other words, a taxonomy could enable the semantics of certificates that explain the result of a calibration.

CC services can be the foundation of the model of DCCs

Instituto Nacional
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INTI

The envisioned future

DCC

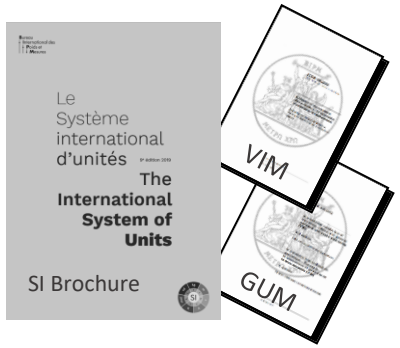
The envisioned Future of DCC

KCDB e-services compatible

- Services
- CMCs
- Key Comparison

A FAIR DCC

QI Conformed and ISO/IEC 17025 Accredited



Interoperable = M2M, interpretable for humans, easy to adopt = easy software

Not dependent on a system of digital units and quantities

josephwright/
siunitx
A comprehensive (SI) units package for LaTeX

Multi-format portability

such as XML, JSON, YAML or CSV

Thanks!

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Argentina

Secretaría de Industria
y Desarrollo Productivo