

The SI in the process of Digital Transformation that our world is experiencing

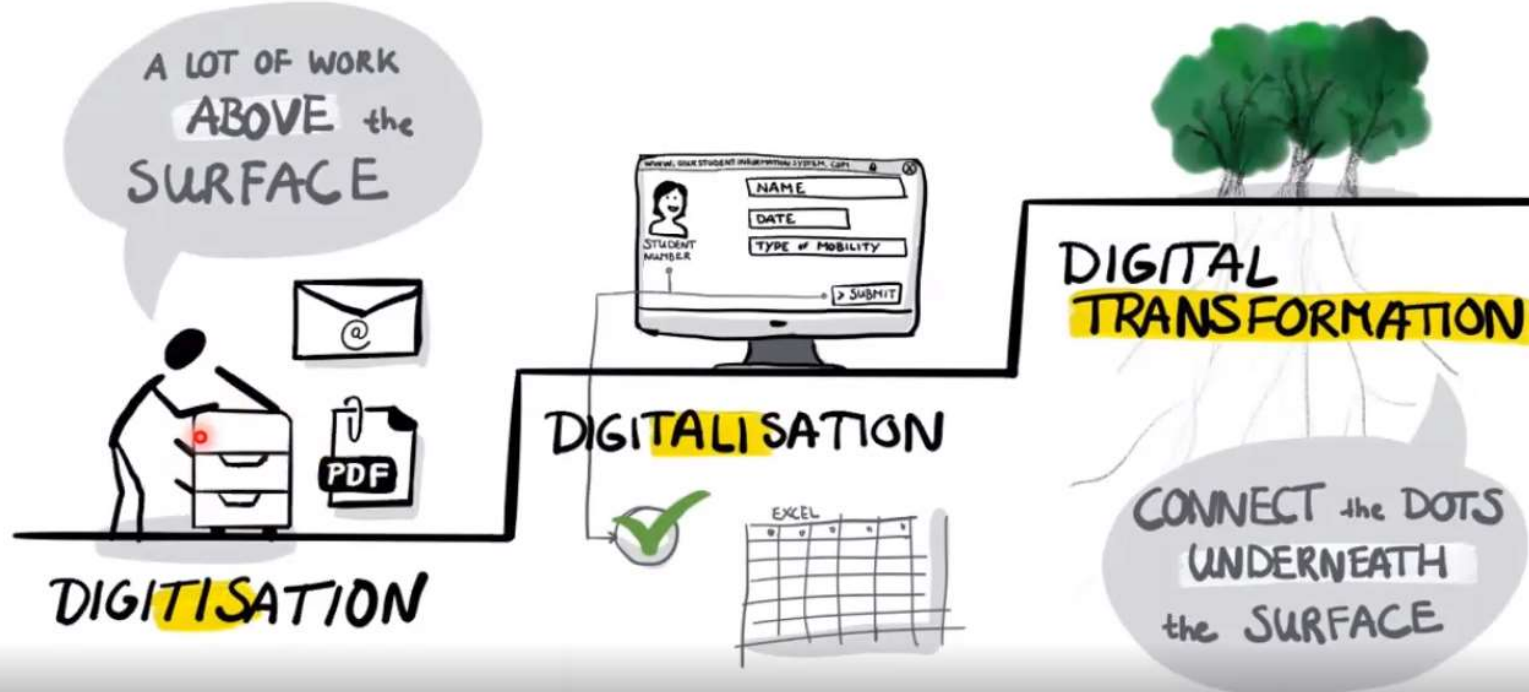


Diego, Eduin, Francisco,
Mauricio and Olman

From digitization to Digital Transformation

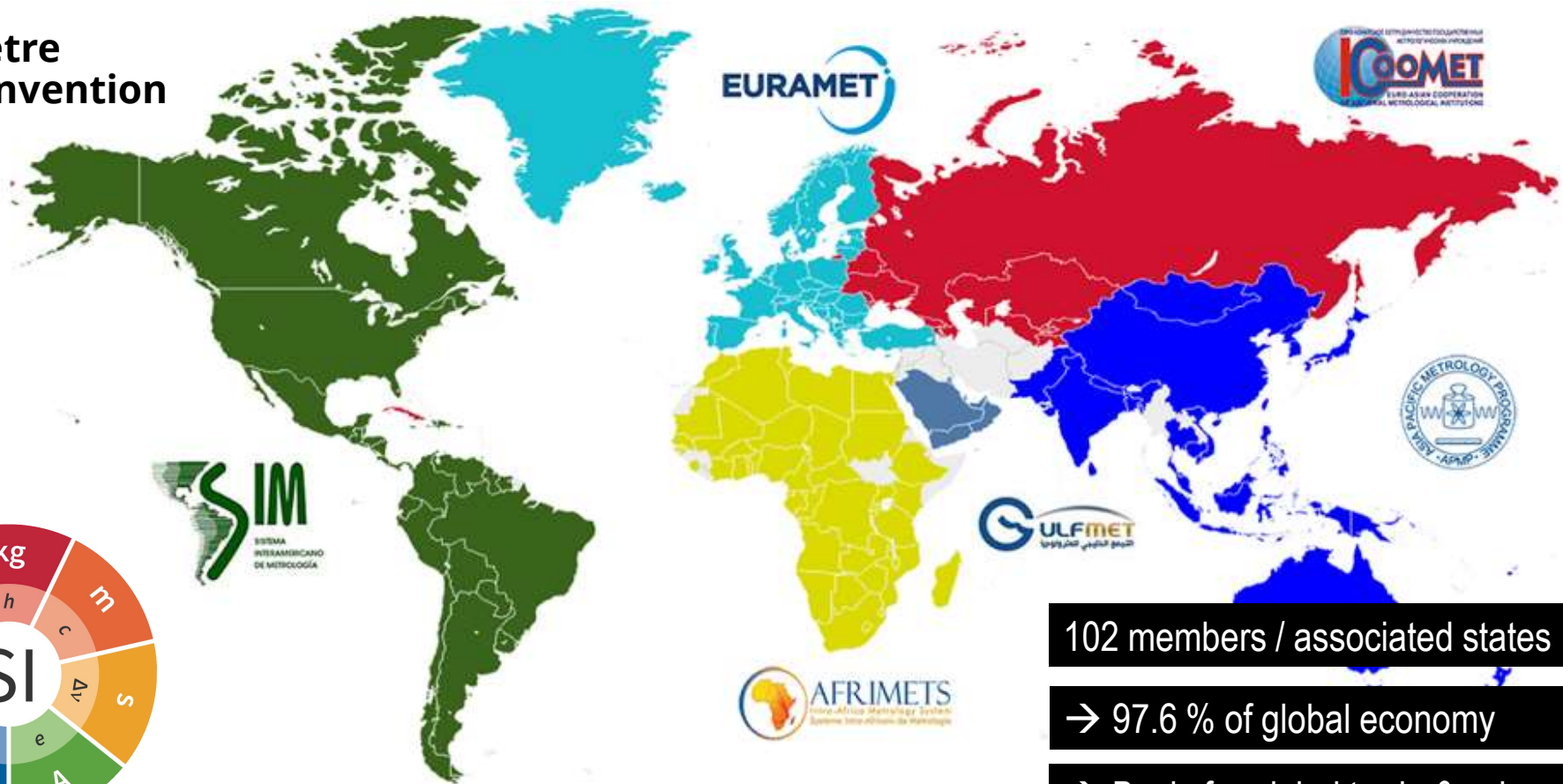
the **DIGITALISATION THREE STEP** in Higher Education

by Esther Rinders
July 2020



Metrology and Digital Transformation

Metre Convention



102 members / associated states

→ 97.6 % of global economy

→ Basis for global trade & science

FAIR

2003



2009

Concept
Web
Alliance

From a list of 23 “required to archive” a Data FAIRPORT the FAIR principles emerged

2014 Data FAIRPORT



Through consideration of these core requirements
The acronym FAIR was subsequently coined by Barend
breaking these requirements into the categories of:

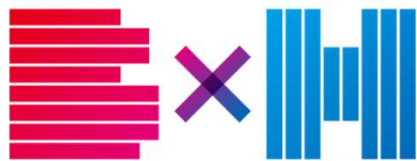
Findability
Accessibility
Interoperability
Reusability

FAIR

2015



ABOUT ▾ COMMUNITY ▾ CODE OF CONDUCT GROUPS RESOURCES ▾ N



**BioHackathon 2015
in Nagasaki**

2016



FINDABLE

→ Unambiguous identifiers supported by searchable metadata

ACCESSIBLE

→ Clearly-defined access protocol, preferably machine-actionable

INTEROPERABLE

→ Use shared vocabularies/ontologies in machine-accessible format

REUSABLE

→ Contextual information, allowing proper interpretation
→ Rich provenance information facilitating accurate citation

FAIR

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FAIR

2016



G20



2017



New mission of the CIPM

A new project “International System of Units” (SI) in the digital world under the Meter Convention (BIPM)



Mission of the D-SI Task Group:

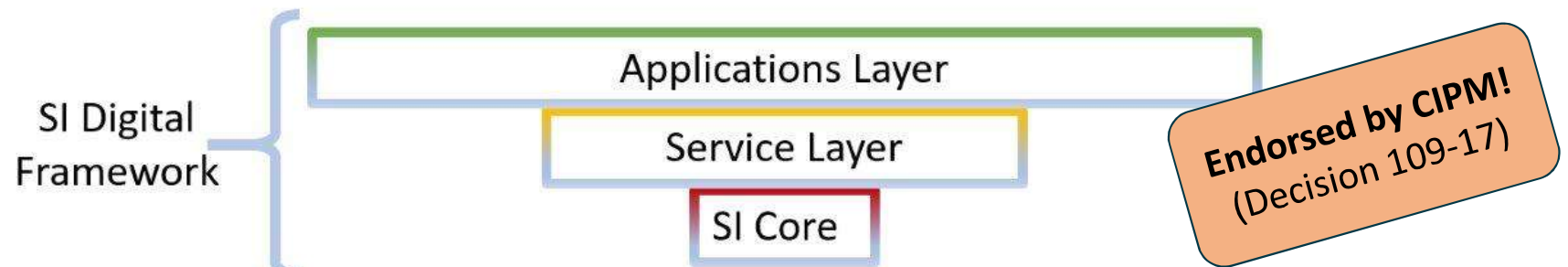
- World-wide **agreed, uniform, unambiguous, authoritative** and **dependable** data exchange framework **based on the International System of Units (SI)**
- **Coordinating this effort with all stakeholders**
- **Suggestions to make the SI Brochure machine readable**

**Grand Vision
SI Digital Framework**

**International Workshop
Feb 2021**

Grand Vision: SI Digital Framework

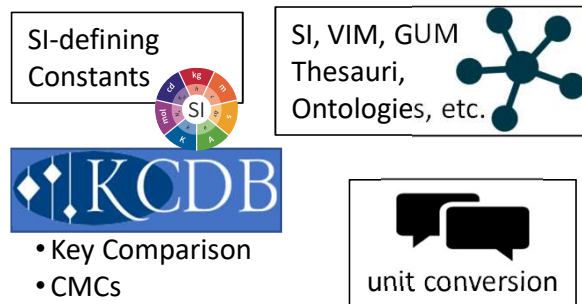
Sustainable framework for the SI in a digital world



value, unit, kind of quantity, uncertainty



various data, services and tools



all aligned with FAIR principles



Grand Vision: SI Digital Framework

Make metrological data ready for...

- **The emerging challenges of digitalization in industry and research**
 - Facilitating reproducible data science and Artificial Intelligence
- **A profound transition for metrological applications in a digital world**
 - Machine-actionable SI is fundamental in the Digital Knowledge Domain
 - Machine-readable Digital Certificates (e.g., calibration)
 - Digital twins of measuring devices and equipment, etc.

Overcome existing limitations in digital data usage due to diversity of formats and approaches

- **SI units and metrological concepts (e.g., uncertainty) as anchors for reliable and secure data with a low risk of misinterpretation of meaning**

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- **Coordinating this effort with all stakeholders**
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<https://www.bipm.org/en/committees/ci/cipm/wg/cipm-tg-dsi>

**Grand Vision
SI Digital Framework**



**International Workshop
Feb 2021**



International Workshop Feb 2021



The diagram shows the seven base SI units arranged in a circle around the central 'SI' logo. Starting from the top and moving clockwise, the units are: kg (red), m (orange), s (yellow), A (green), K (blue), mol (purple), and Cd (dark purple). Each unit is accompanied by its symbol and a small icon representing its domain: kg (mass), m (length), s (time), A (electricity), K (temperature), mol (chemistry), and Cd (physics).

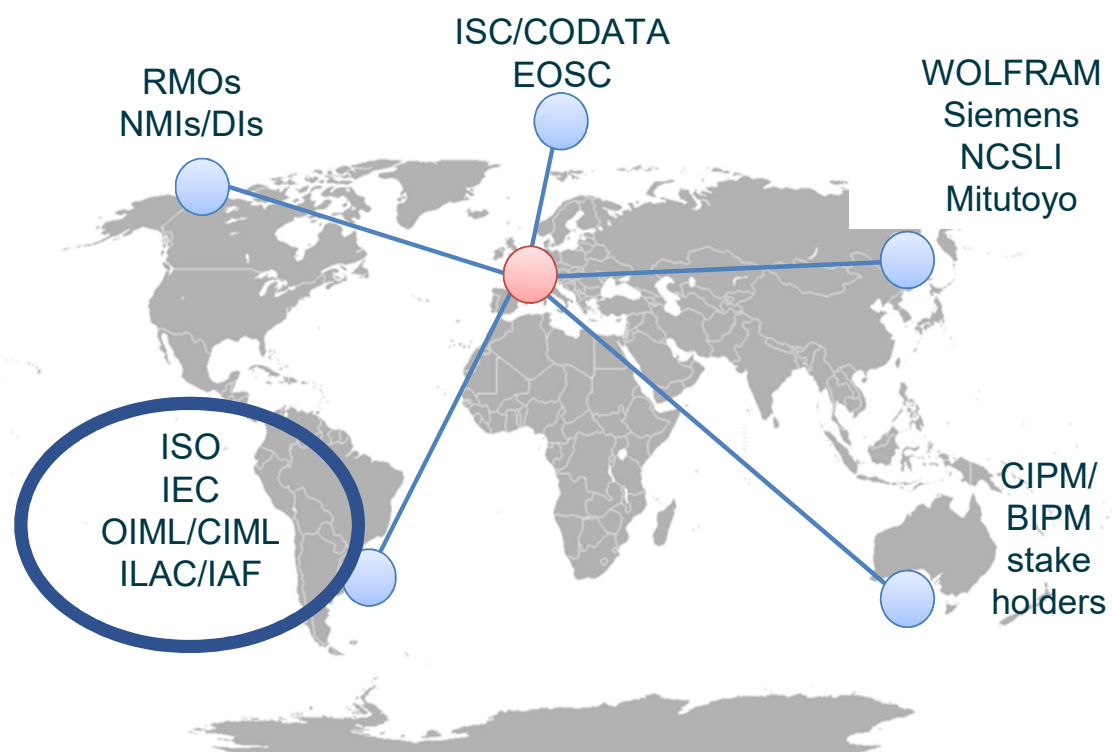
The International System of Units in FAIR digital data

The International System of Units (SI) in **FAIR** digital data.

Prof. Dr. Joachim Ullrich
CIPM Vice President
CCU and TG "Digital SI" Chair
22 February 2021

- International Unions
- Global Science

International Workshop Feb 2021



International Workshop Feb 2021

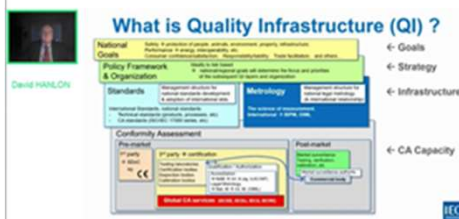
Leslie Pendrill – Chair ISO/TC 12
Mike Glickman – Chair ISO/TC 215
Quantities and units in e-health



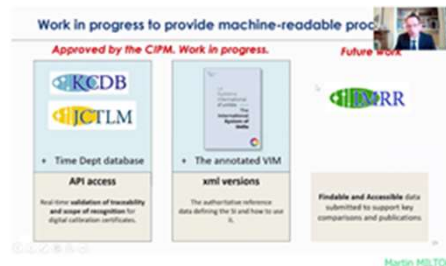
International Quality Infrastructures



David Hanlon
IEC Conformity Assessment Board
DT Impacts Scenarios on QI



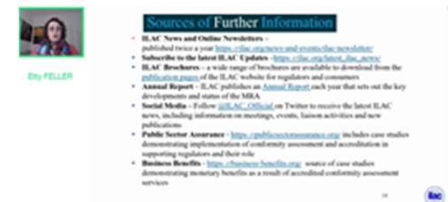
Martin Milton
Director of BIPM
**Comparable Measurement for a
digital world**



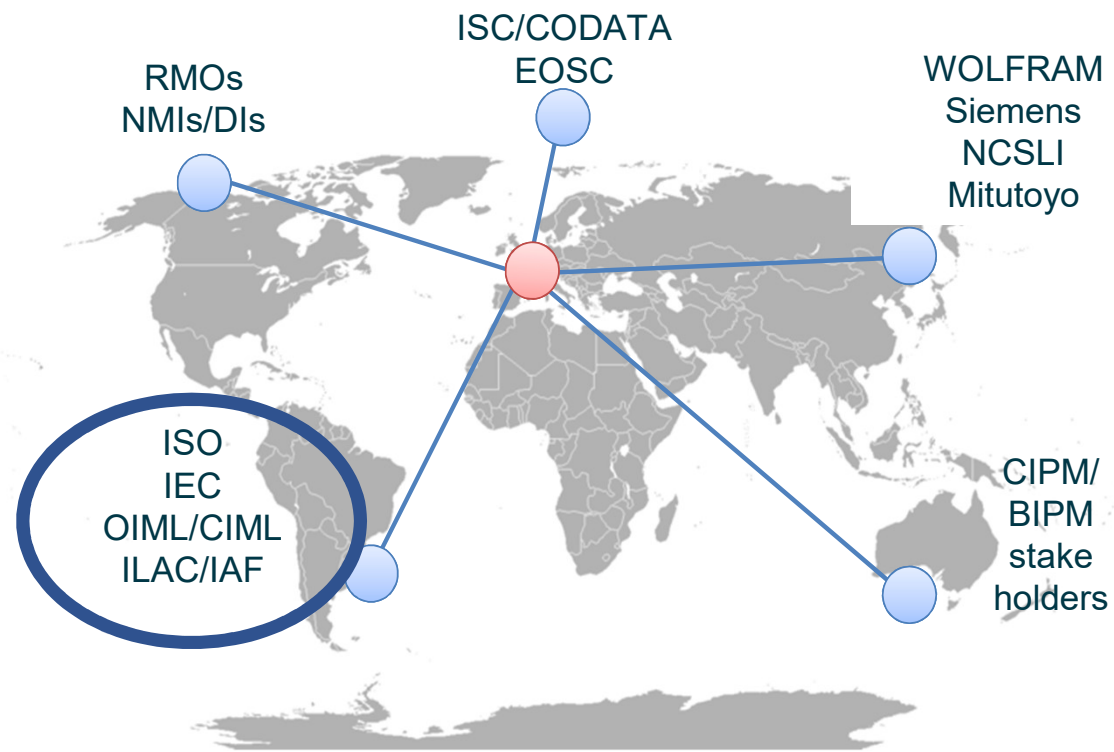
Roman Schwartz
President of CIML (OIML)
Digital Transformation of legal metrology processes



Etty Feller
President of ILAC
**Digital Transformation for
acreditation**



International Workshop Feb 2021



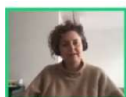
International Workshop Feb 2021 (Open Global Science - ISC/CODATA, EOSC)

Summary

- Several existing machine-processable systems
- Most claim full generality, but each has distinct history & community
- Parsimonious/generative vs inventory spectrum
- Alignment efforts underway – based on UCUM and QUDT



Simon COX



Sarah JONES

What is EOSC?

A web of FAIR data and services

Federation of infra and research infrastructures

Environment in which data can be brought together with services to perform analyses and address societal challenges



"FAIR is 90% Metadata"

December 2020
- Mark Wilkinson, Universidad Politécnica de Madrid
- Mark Musen, Stanford University

<https://www.nature.com/articles/sdata201618>

Box 2 | The FAIR Guiding Principles

To be Findable:
F1. (metadata) are assigned a globally unique and persistent identifier
F2. data are described with rich metadata (defined by R1 below)
F3. metadata clearly and explicitly include the identifier of the data it describes
F4. (metadata) are registered or indexed in a searchable resource

To be Accessible:
A1. (metadata) are retrievable by their identifier using a standardized communications protocol
A1.1 the protocol is open, free, and universally implementable
A1.2 the protocol allows for an authentication and authorization procedure, where necessary
A2. metadata are accessible, even when the data are no longer available

To be Interoperable:
I1. (metadata) use a formal, accessible, shared, and broadly applicable language for knowledge representation.
I2. (metadata) use vocabularies that follow FAIR principles
I3. (metadata) include qualified references to other (metadata)

To be Reusable:
R1. (metadata) are richly described with a plurality of accurate and relevant attributes
R1.1. (metadata) are released with a clear and accessible data usage license
R1.2. (metadata) are associated with detailed provenance
R1.3. (metadata) meet domain-relevant community standards

Erik Schultes

Scalable FAIR metadata: Smart reuse of vocabularies and templates

BioPortal
ZonMw
COVID-19
Program
vocabulary
November-February

Project Admin Metadata
<https://cedar.metadatascenter.org/templates/edit/https://repo.metadatascenter.org/templates/1c645834-e593-479e-9a2a-0206a55c8b5a7?folderId=https:%2F%2Frepo.metadatascenter.org%2Ffolders%2F8c5c1001-1864-46df-8888-8f0b9e96deb>

Project Content Metadata
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Not yet finalized

Generic Dataset Metadata
<https://cedar.metadatascenter.org/templates/edit/https://repo.metadatascenter.org/templates/dd6231ef-5890-48cb-9621-04c5b5577c1e7?folderId=https:%2F%2Frepo.metadatascenter.org%2Ffolders%2F19822c6-0828-41e5-8767-22ab78be384>
Not yet finalized

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Semantic use case



A rare disease researcher is seeking clinical data that match the study population and variables to reach the population size needed



Search metadata catalogue to find candidate datasets



Search semantic artefacts based on domain metadata to check relevant variables are present



Agree subset of data to reuse



“FAIR is 90% Metadata”

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Scalable FAIR metadata: Smart reuse of vocabularies and templates



November-February



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Project Content Metadata

<https://cedar.metadatascenter.org/templates/edit/https://repo.metadatascenter.org/templates/3258a592-a0a0-4822-9eda-5cd757e28926?folderId=https://%2F%2Frepo.metadatascenter.org%2Ffolders%2F8c5c1001-1864-46df-8888-8f60b9e96deb>

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International Workshop Feb 2021(EOSC)



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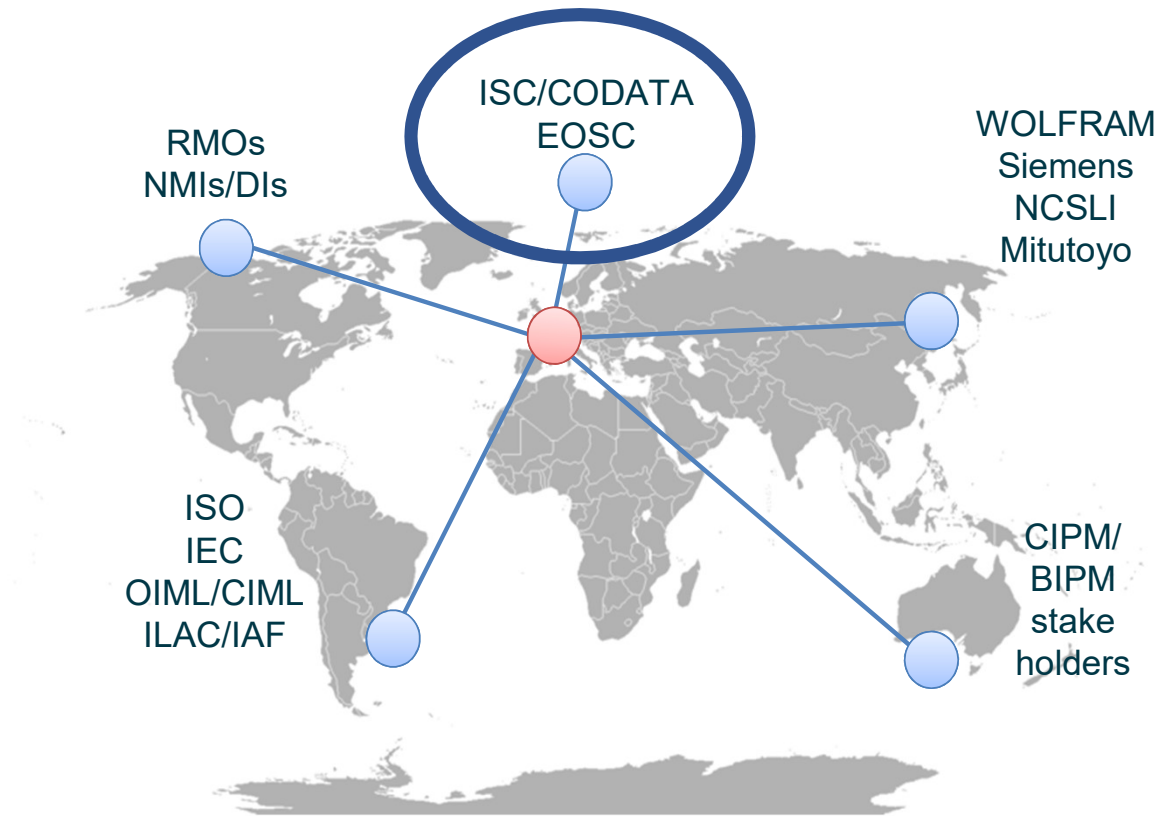


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Agree subset of data to reuse

International Workshop Feb 2021



International Workshop Feb 2021

DIGITAL REPRESENTATION OF UNITS - DSI

Representation String: m^3

String	Format
m^3	ascii
$m³$	html
$\text{\textit{m}}^{\text{\textit{3}}}$	latex
$\text{\textit{si}}(m^{\text{\textit{3}}})$	siunitx
$\text{\textit{si}}(\text{meter}^{\text{\textit{cubed}}})$	siunitx
m^{**3}	ivoa

Instrument data reported without units – microscopy data

Experiment activity 1

Activity contents: STEM imaging

Search:

Setup Parameter	Value
Microscope	Titan80-300_03084
Name	FEI Techna Remote
Operation Mode	SCANNING
Operator	Andrew Harding
Specimen	STEM
Stage Position Z	-40.101600000000000
Stage Position α	-0.36648788999997004
Voltage	300000.0

Missing metadata? No units are reported for Z, alpha

01_rot90_5,1Mx_13.6mrad_100mm_zus_HAADF.dms

Search:

Metadata Parameter	Value
Creation Time	2020-10-22 11:05
Data Dimensions	(2048, 2048)
Field of View (μm)	0.02540320967741935
Indicated Magnification	5100000.0
Stage Position X	5.3625
Stage Position Y	7.2705
Stage Position Z	-57.6535
Stage Position β	0.21999975051197246

Missing metadata?

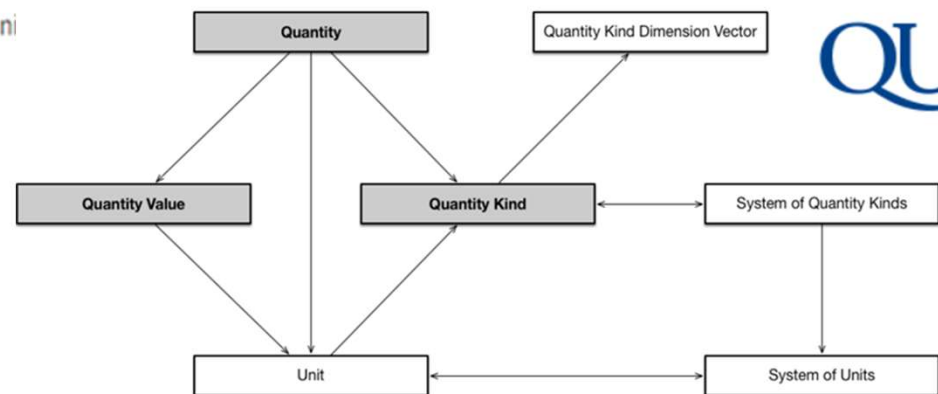
Products of **Quantity** objects with compatible units will heuristically determine the result unit

```
In[1]:= qa = Quantity[1, "Kilometers"];
qb = Quantity[3000, "Meters"];
CompatibleUnitQ[qa, qb]
```

Out[1]= True

```
In[2]:= qa * qb
```



Out[2]= 3 km^2



QUDT

A estos sistemas de representación de unidades, lo que les falta ser Interoperables (FAIR)

International Workshop Feb 2021 (Industrial Digital Infrastructure)





Maxime LEFRANÇOIS

Summarizing the polarized view of the community

- **consensus**
 - datatype for quantity values, and support in SPARQL engines, would be the way to go
 - datatype support in RDF/SPARQL engines can be a plus, but should remain optional
 - a standard is urgently needed
 - `cod:ucum` is appropriate use of RDF datatyping
 - UCUM terms of use are scaring out people – AFAIK soon to be revised
- **divergences**
 - unit inside the lexical form as in `cod:ucum` vs unit encoded in the datatype IRI
- **raised requirements**
 - operator extensions, and extension functions, need to be defined
 - need casting conversions, canonical unit, unit ladder mechanisms
 - would need some kind of web services to compare/convert/manipulate literals

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Proposal → UCUM: Unified Code
for Units of Measure



Thomas ENGEL

Conclusion - Summary

Data in the digital quality infrastructure for Industry 4.0 needs to be



- **F**indable
- **A**ccessible
- **I**nterpretable
- **R**eusable ... and traceable - by nature!

The GEMIMEG-II project is aiming for a standardized, secure and traceable implementation - from sensor to cloud / application.
Partners and contributors are highly appreciated and welcome!

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GEMIMEG – II, SIEMENS.com

MII Measurements Information Infrastructure

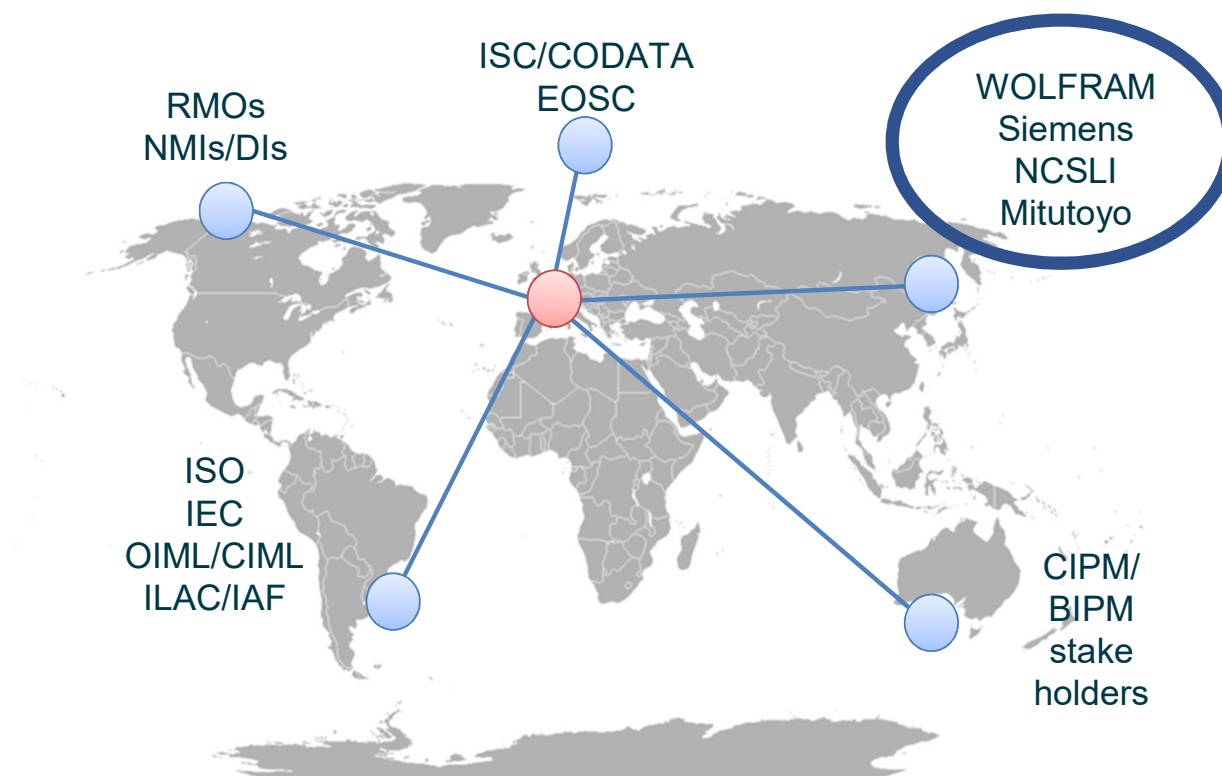


Mark KUSTER

D-SI Discussion Topics

- Measurand taxonomy reference?
- Reusable quantity-value structure from which to build measurement results, influence quantities, etc.?
- Celsius temperature ≠ thermodynamic temperature
- Preserve exact unit conversions?
- Arbitrary-precision numerics for future proofing?
- Uncertainty distribution parameters?

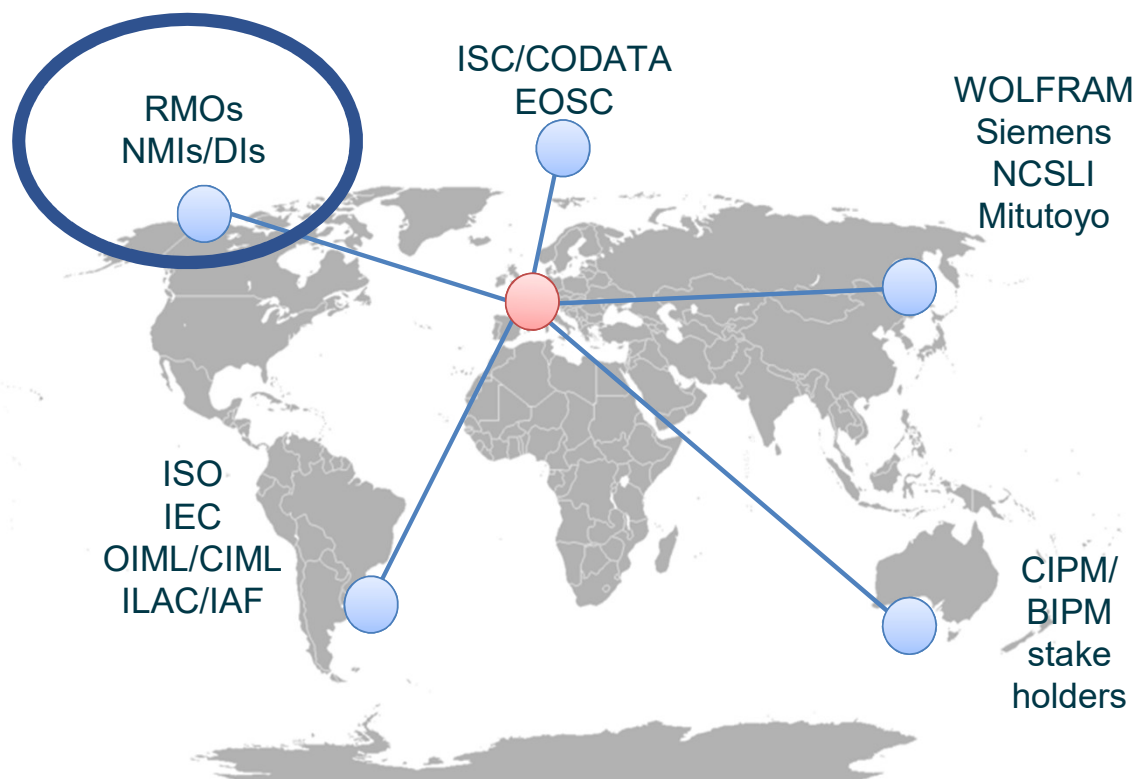
International Workshop Feb 2021



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BIPM-WS- digital-SI/Draft Statement

Towards a joint effort...

Given that

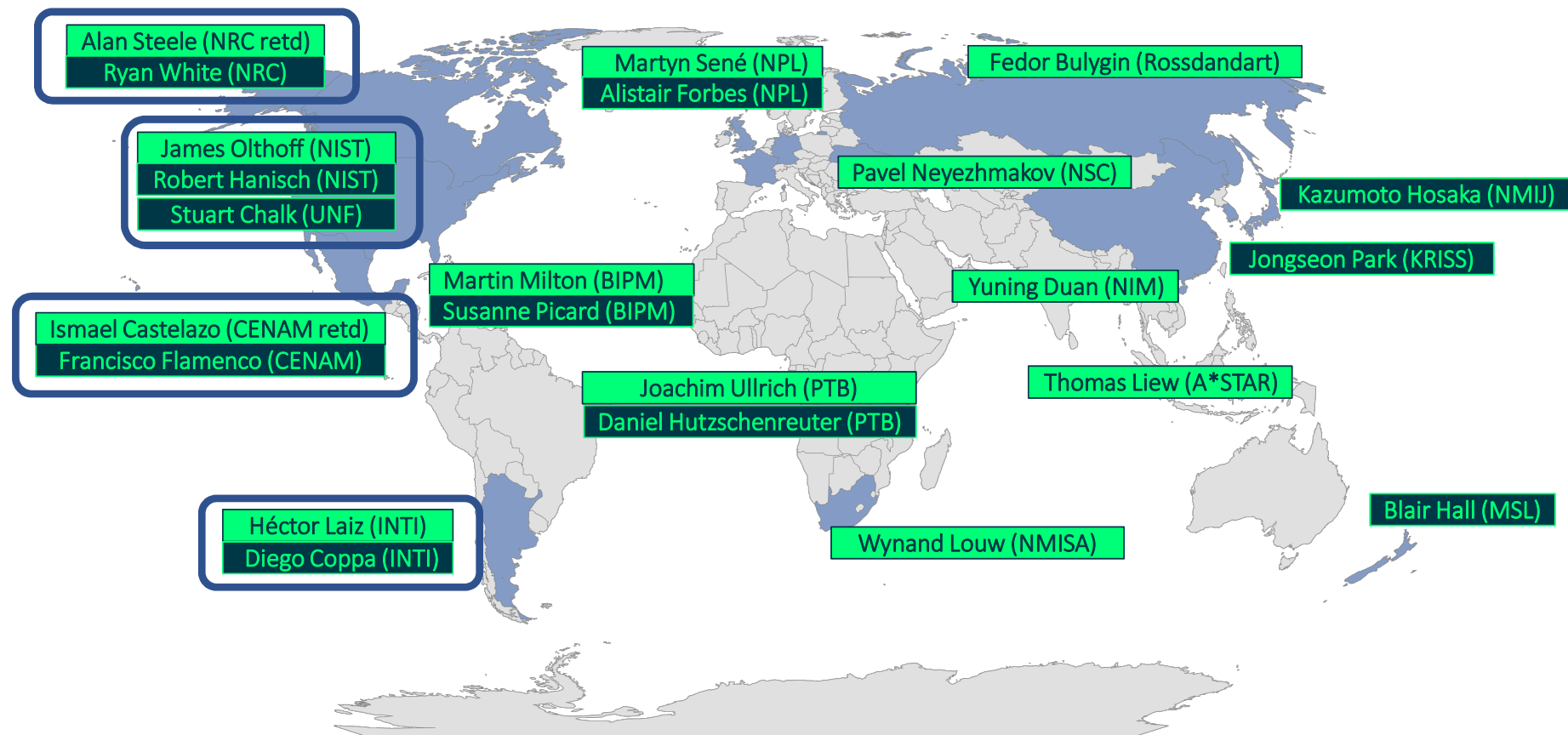
- The International System of Units (SI) underpins all measurements in industry, trade, legal metrology, and science;
- Its transformation into a fully digital representation is necessary to facilitate efficient processes within industry, the quality infrastructure and its organizations, in modern research and development globally;
- Such a digital representation relies upon robust, unambiguous, and machine-actionable digital representations of units of measurement;
- The breadth of potential applications is extensive and likely to grow; and
- Progress on global challenges requires participation and critical thinking from diverse communities;

Representatives from OIML and CODATA have already indicated their cooperation and collaboration with CIPM in the pursuit of the SI Digital Framework and its propagation in compliance with the FAIR principles.

**The CIPM very much invites all organizations
helping to shape and to join the effort!**

Our Team @ Metre Convention

SI Digital
Framework
CIPM



CIPM Task Group contributions

CIPM Expert Group contributions

BIPM support: Andy Henson, Romain Coulon, Johanne Flament, Celine Fellag