Bureau International des Poids et Mesures

Bureau International des Poids et Measures

Industrial and scientific metrology: road to a developed NMI

Andy Henson
Director of International Liaison and Communications

April 2014

Bureau International des Poids et Mesures

The BIPM

- Is the **International Bureau des Poids et Measures**
- Established by the 1875 Metre Convention
- Has 56 Member States and 39 Associates
- Is based near Paris, France. It is financed jointly by the Member States and Associates, and operates under the exclusive supervision of the CIPM.
- Its mandate is to provide the basis for a single, coherent system of measurements throughout the world, traceable to the International System of Units (SI).
  - This task takes many forms, from direct dissemination of units (as in the case of mass and time) to coordination through international comparisons of national measurement standards (as in length, electricity and ionizing radiation).
- It maintains laboratories in areas of:
  - mass, time, electricity,
    ionizing radiation, and chemistry.
- It has an international staff of around 75.
- Its budget for 2014 is around thirteen million euros.

Content:

- **Introduction to metrology and traceability to SI**
- Metrology and trade: economic benefits of metrology
- Status, needs and key challenges of NMIs in the region
- The role of BIPM worldwide and in the region

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Introduction to metrology

Metrology is a very broad field and may be divided into three subfields:

- Scientific or fundamental metrology concerns the establishment of measurement units, unit systems, the development of new measurement methods, realization of measurement standards and the transfer of traceability from these standards to users in society.
- Applied or industrial metrology concerns the application of measurement science to manufacturing and other processes and their use in society, ensuring the suitability of measurement instruments, their calibration and quality control of measurements.
- Legal metrology concerns regulatory requirements of measurements and measuring instruments for the protection of health, public safety, the environment, enabling taxation, protection of consumers and fair trade.

BIPM

The BIPM, established in 1875 by the Metre Convention (a diplomatic treaty between 51 nations), ensures worldwide uniformity of measurements and their traceability to the International System of Units (SI).
www.bipm.org

OIML

The OIML, established in 1955, is an intergovernmental organization whose principal aim is to harmonize the regulations and metrological controls applied by the national metrology services of its national members.
www.oiml.org

Introduction to metrology

Why Measure?

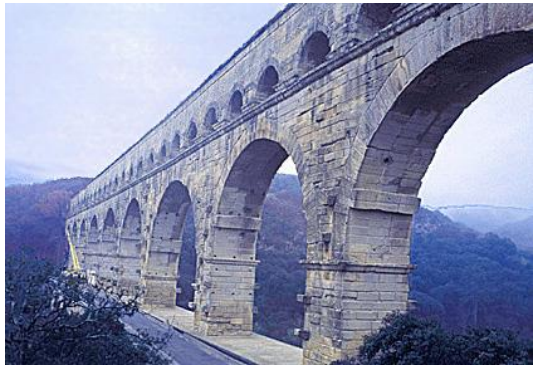
Measurement requirements grew from the need to locally trade commodities.

Egyptians

Greeks

Romans

Medieval



but…… for the Egyptians and Romans building construction was also important - a reliable measure of the cubit was essential!

Pont du Gard: The Aqueduct

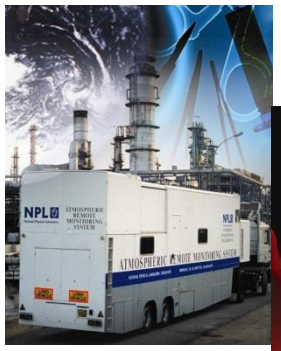
Built ~2000 years ago to bring water 50 km to Nîmes down a total gradient of only 17 metres (a gradient of 1:3000!!).

Measurement in the 20th Century

The Industrial Revolution introduced many new measurement challenges which continue to be of importance in the 21st century

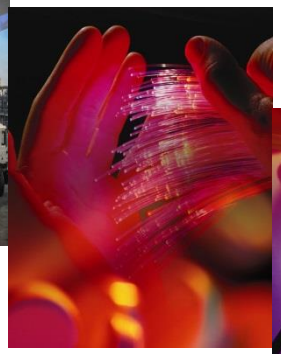
Introduction to metrology

Today's growing demands for better measurements



Industry

Environment

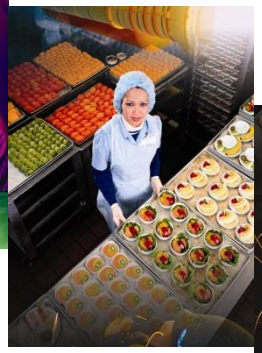


Science

Communications

Doctors

Healthcare

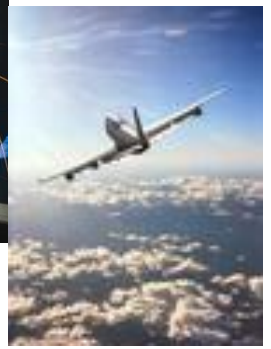


Regulators

Food

Health & safety

You and I



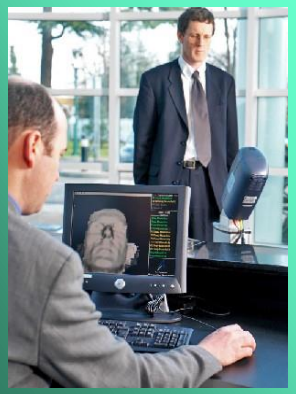
Transport

It is estimated that in Europe today we measure and weigh at a cost equivalent to 2%-7% of GDP.

Metrology influences, drives and underpins much of what we do and experience in our everyday lives, though often unseen. Industry, trade, regulation, legislation, quality of life, science and innovation all rely on metrology to some extent.

Grand challenges for sustainable development

Climate change



Security

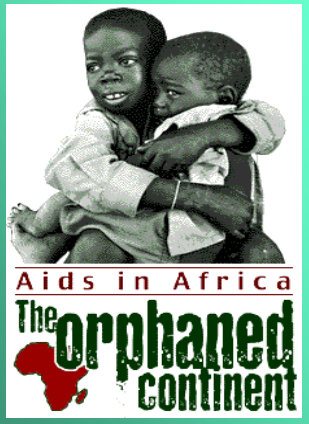
Reducing poverty

A few of today's grand challenges

Globalisation

Healthcare

Energy security



AIDS

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Importance of measurement traceability

Health

Traceable to SI

Meas. Instr.

Laboratory in medicine

Traceable measurements

Insulin for diabetics

Chemical therapy for treatment of cancer

Overdose

+

Dose

−

No results

Human Health

Industry

Meas. Instr.

Traceable measurements

Components manufactured in different countries

Interchangeable/interoperable components

Science

Research

Meas. Instr.

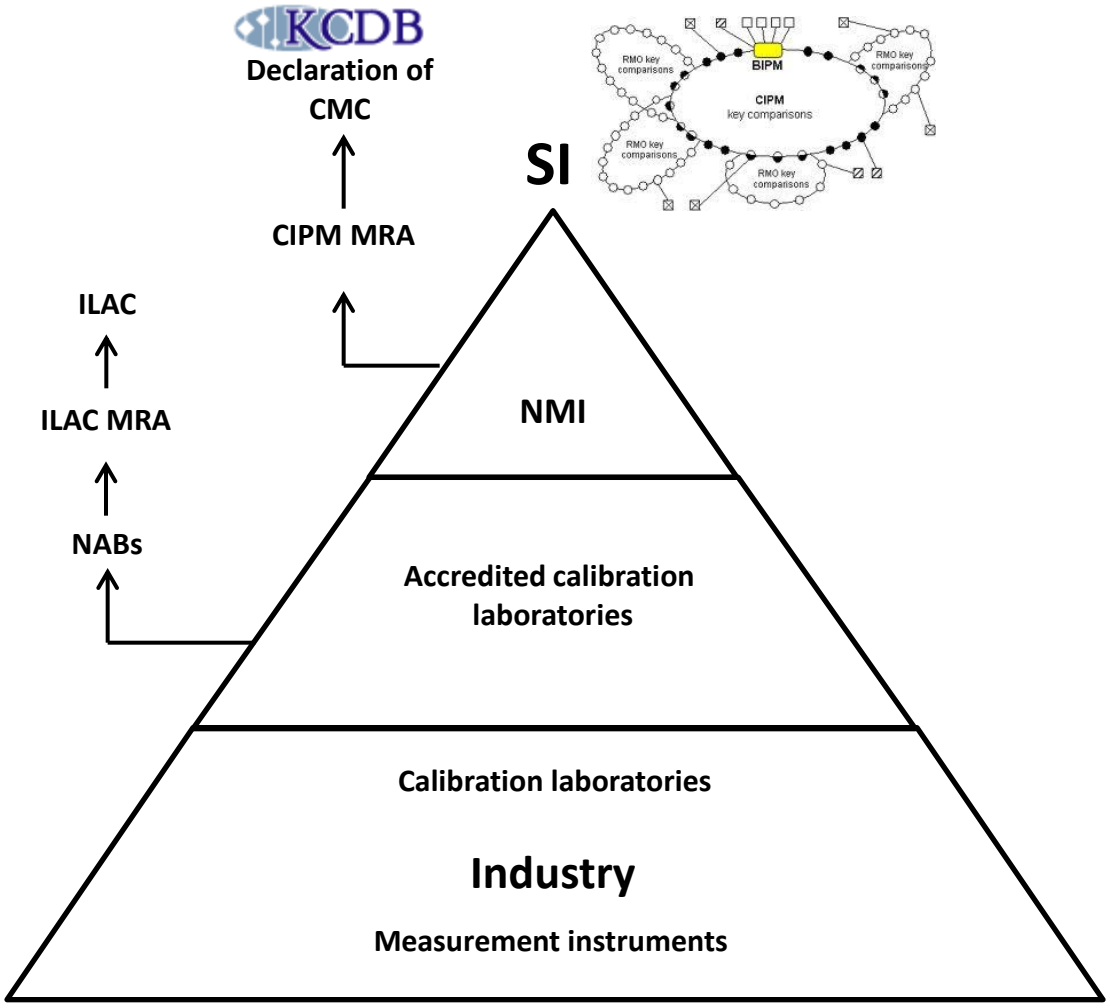
Traceable measurements

Internationally recognized technical evidebce

Results of science

Innovation

Importance of measurement traceability



Metrology is of fundamental importance in industry and trade – not only from the point of view of the consumer but also for those involved in manufacturing. Both groups must have confidence in the accuracy and reliability of the measurements upon which they depend. Within the manufacturing process, to ensure the accuracy of measuring instruments, it is essential that they should be periodically calibrated against more accurate standards, which in turn should have their calibration traceable to even more accurate national measurement standards at the national level and, eventually, the international level. When these various levels of calibration have been documented, a **chain of traceable calibrations** is created.

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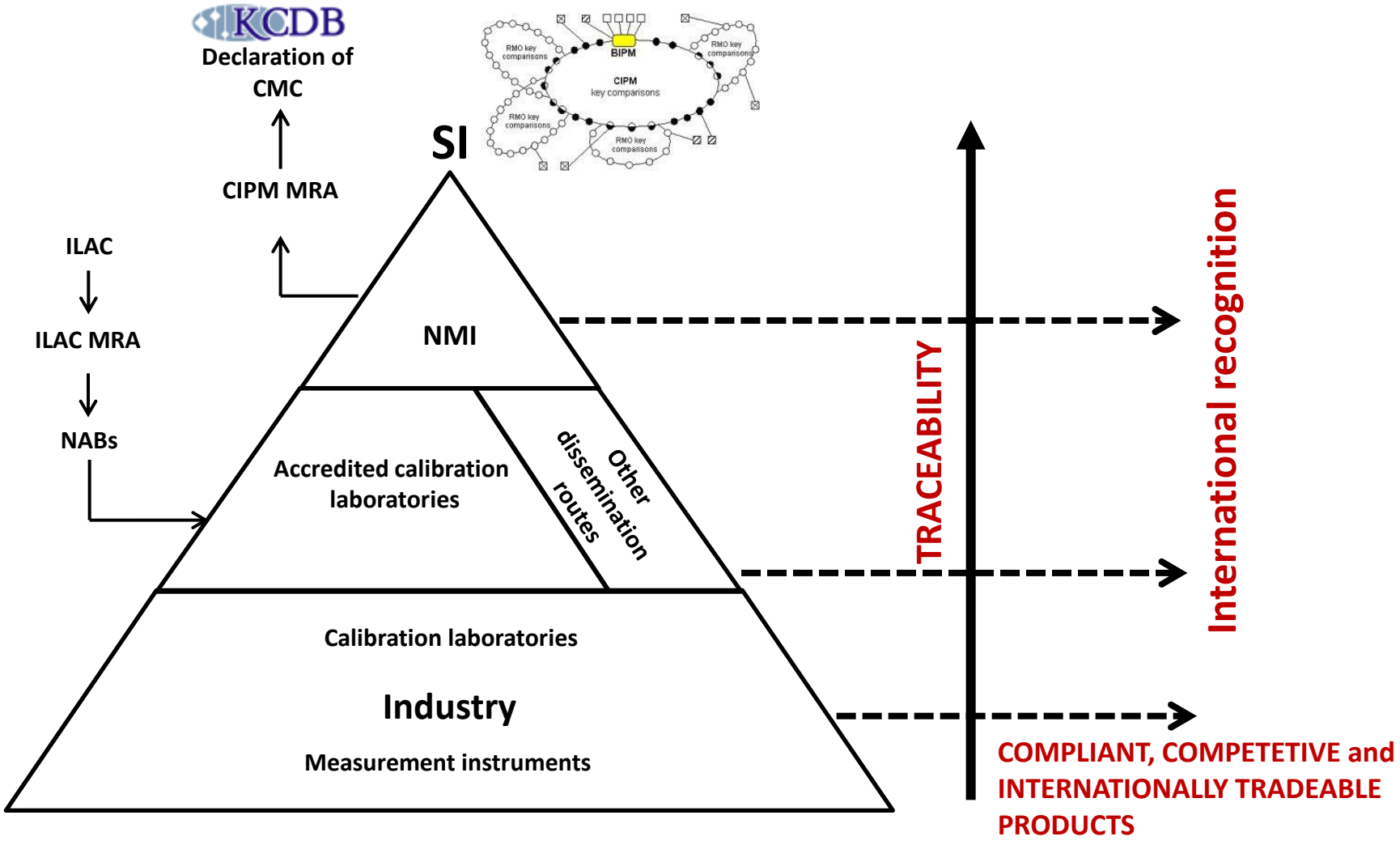
Importance of measurement traceability



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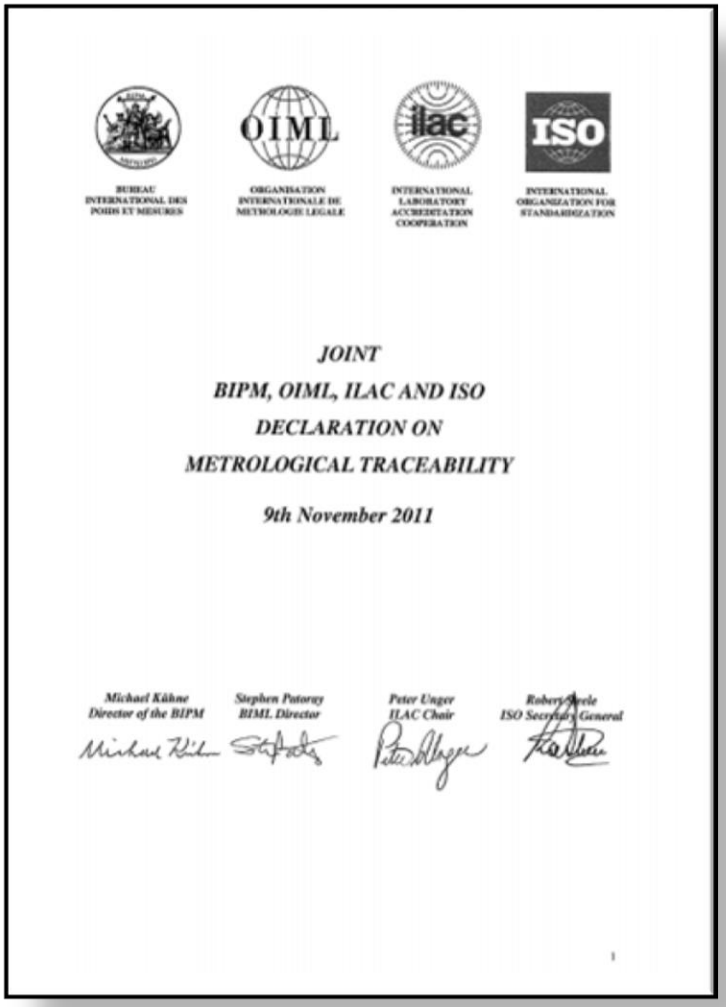
Importance of measurement traceability

Joint BIPM, OIML, ILAC и ISO declaration on measurement traceability

(http://www.bipm.org/utils/common/pdf/BIPM-OIML-ILAC-ISO_joint_declaration_2011.pdf)



BUREAU INTERNATIONAL DES POIDS ET MESURES

ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE

INTERNATIONAL LABORATORY ACCREDITATION COOPERATION

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

JOINT

BIPM, OIML, ILAC AND ISO

DECLARATION ON

METROLOGICAL TRACEABILITY

9th November 2011

Michael Kühne
Director of the BIPM

Stephen Patoray
BIML Director

Peter Unger
ILAC Chair

Robert Steele
ISO Secretary General

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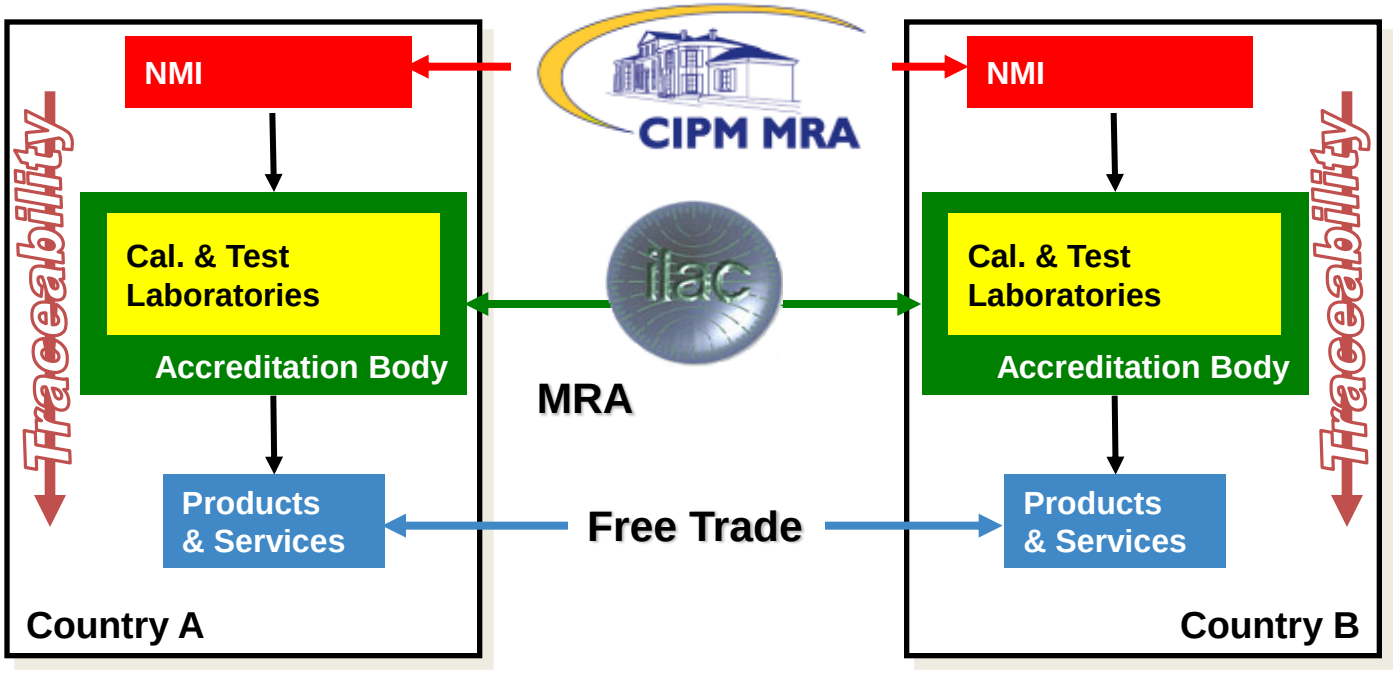
The importance of measurement

A sound measurement system is fundamental in fields of science, production of goods and services, health, commerce, communications,…It creates the framework in which suppliers of products and services can demonstrate compliance with specifications within an internationally standardized system.



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Metrology impacts your economy

Measurement technologies

Measurement methods

Nationally and internationally aligned standards

Generate, optimise and assure confidence in the technical data innovators need to -

- Validate new ideas
- Reduce new product time to market
- Accelerate processes
- Improve process efficiency
- Reduce waste/downtime
- Increase reliability
- Extend the operating envelope
- Meet standards/regulation

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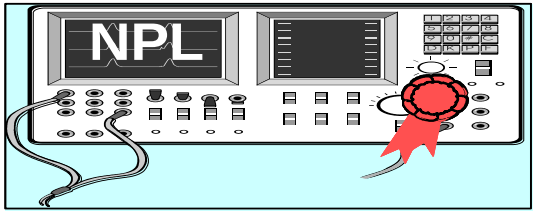
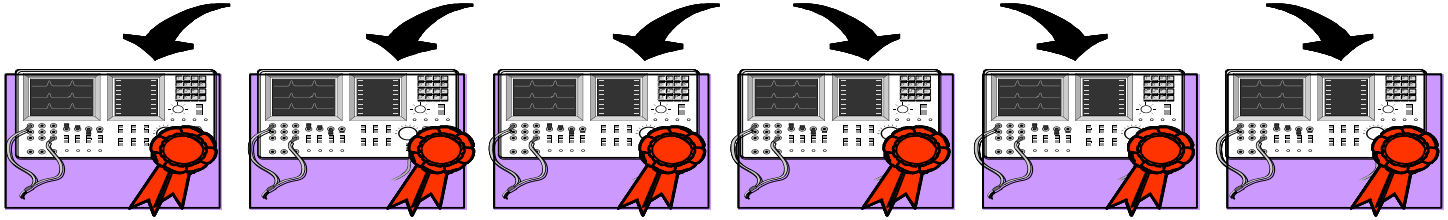
The cost of technical barriers to trade

- Developed and G22 countries lose 1%-15% of trade because of lack of compliance with standards etc whereas developing and LDCs lose between 10% and 40%
- 70% of the burden on developing countries' manufactured exports comes from trade barriers erected by other countries
- The EU single market reduced trade costs of the pre-expansion EU by 2.5% by using "harmonised" standards
- New Zealand exporters pay 5%-8% of exports to overcome TBTs

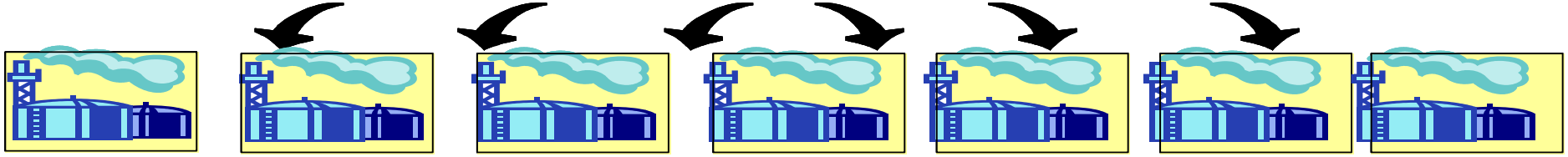
National "fan out"



National Laboratory
>5,000 calibrations pa



~400 UKAS Accredited Laboratories
>700,000 calibrations pa



Industry and Other Users
1,000,000,000s of traceable measurements pa

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National measurements systems

BIPM

Accuracy

NPL,UK

NIST, USA

PTB, GERMANY

WORLD TRADE, INTERNATIONAL HEALTHCARE etc etc

Measurements for Industry, science, health and commerce

Number of measurements

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Understanding "quality" in trade terms - some basic concepts

Why do we want "quality"?

- Because "quality" is the term we use to to describe the ability of a product or service to meet the "customer" expectations
- Note that some expectations are explicit expectations, some are implied expectations
- Some quality expectations are differentiators,
  - When you choose whether to by a car from company A or company B your choice will be influenced by your judgment regarding the relative merit and value of the offerings defined in the specification
  - You will have an implied expectation that either company will provide a working car
  - You will have an implied expectation that either company will provide a regulatory compliant car

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Trade: Quality of Life & Regulation

- Trade and quality of life are intimately linked
- Quality of life is protected by regulation
- Trade access depends on meeting regulation, and being able to demonstrate that regulation is met in a way that is acceptable to the importing country

Expectations of “quality”

Why do we want “quality”?

- The expectation (in developed economies) is that:
  - The goods or services will meet any relevant regulatory requirement that may exist
  - The goods or services will “do what is says on the tin” in terms of performance

- Over and above this expectation we make judgements on perceived quality, which wraps up issues such as value for money, brand value, utility to the user, etc etc

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The role of Quality in trade

One way of looking at quality in trade - single market

The role of Quality in trade

Many:

-Regulations

-Directives

-Written standards

require measurements/ tests which need to be correct and international acceptable (traceable to the SI or if this is not yet practical to other internationally recognized reference standards)!!!

Success in trade

A very important lesson:

- Compliance with regulatory requirements gives you potential access to markets
- It does not, on its own, persuade anyone to actually buy your goods or services!
- Whilst MAS-Q to demonstrate compliance is an essential, alone it is often not enough!

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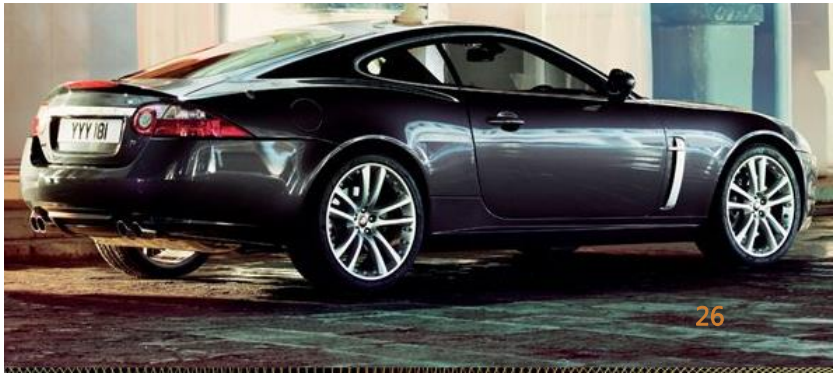
Expectations of "quality"

- Regulatory compliance is often invisible to the the user/consumer
  - If "it" doesn't comply, "it" is not on the market
- So when it comes to choosing your product over a competitor's product quality will be assessed on "value for money". The interpretation of value for money will vary from person to person (or organisation to organisation)



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MAS-Q and Trade

Metrology is the **building block** for all of these elements, if you cannot measure:

- You cannot generate reliable data
  - **You cannot demonstrate compliance**
  - **You cannot add quality**

….and if you cannot comply…

- **you have no market**

….and if you cannot add quality……

- **you cannot add value**

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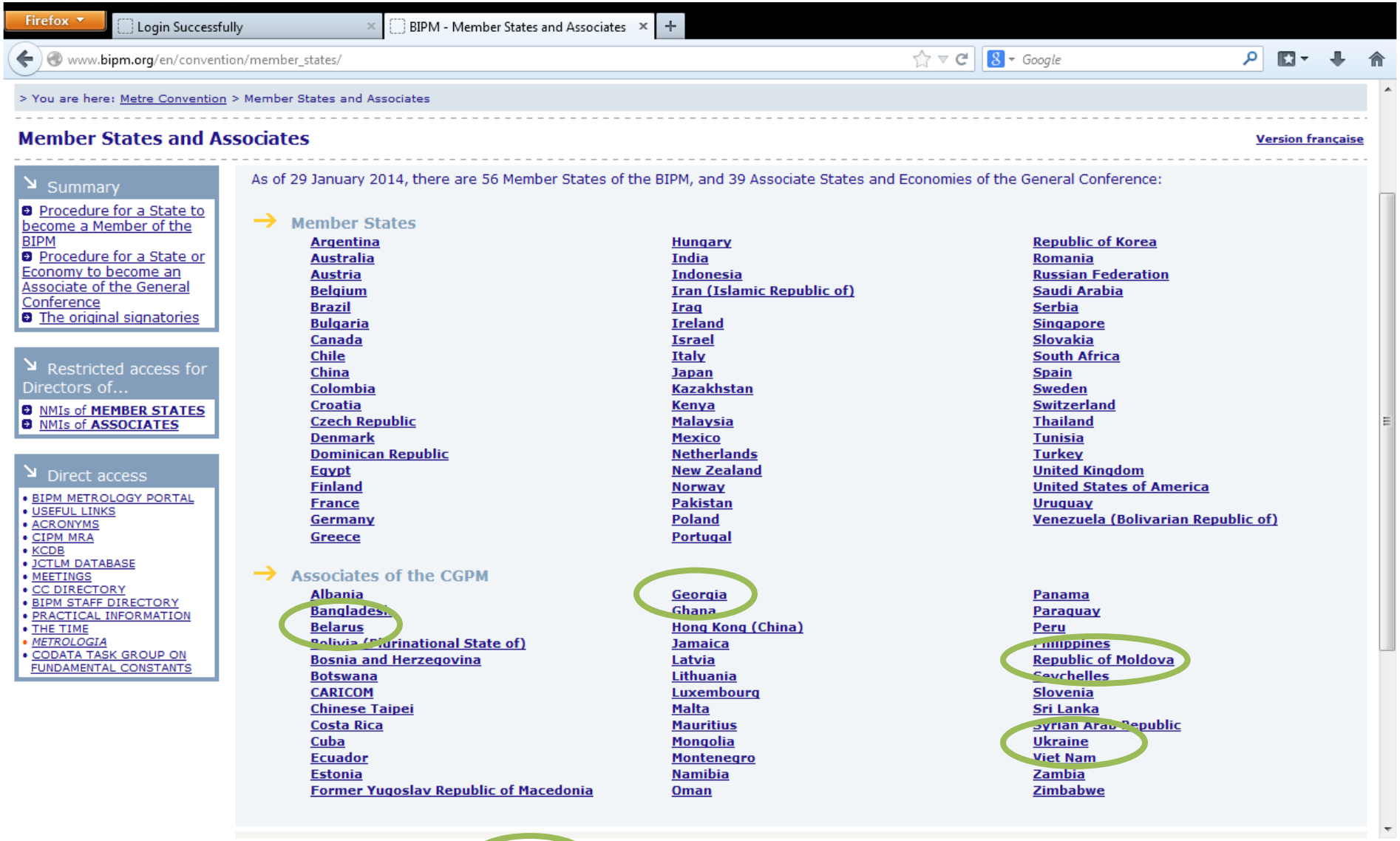

Azerbaijan well on the way to becoming an Associate – *hi Rahima*!

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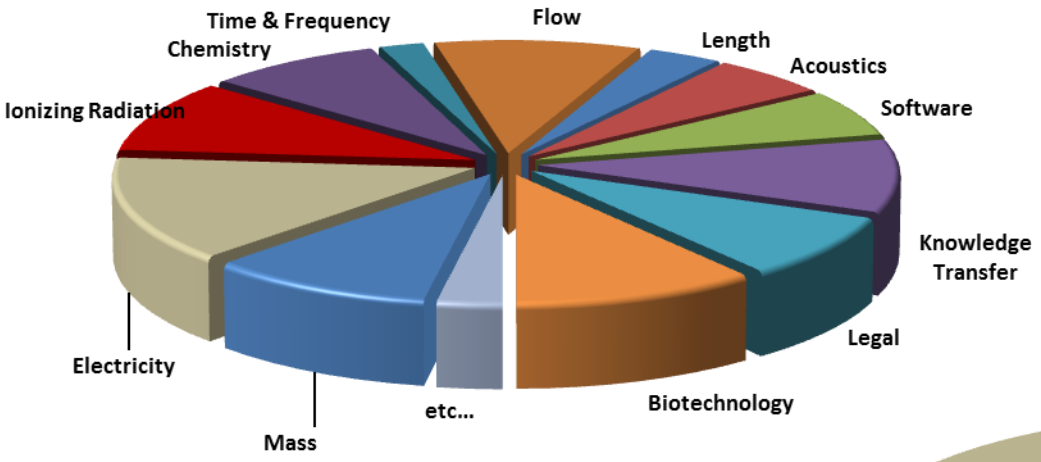
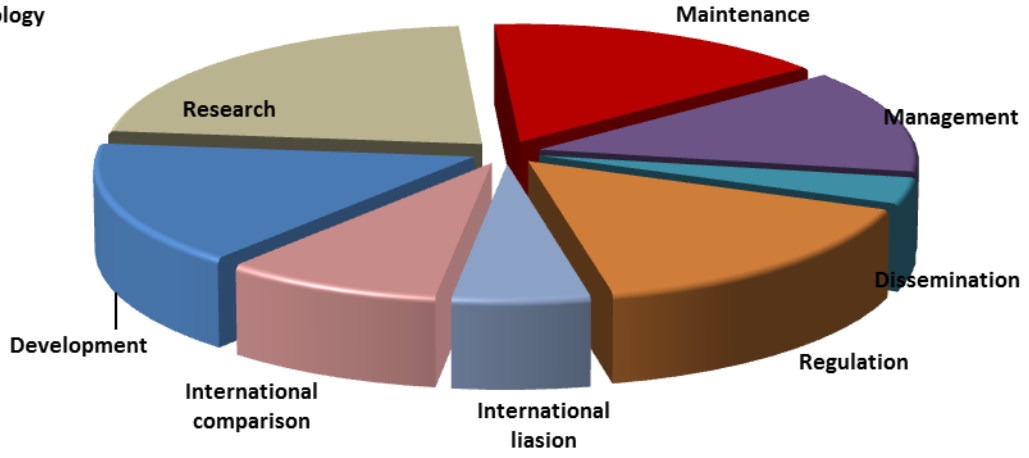
All NMIs have to decide

where to focus their resources



….and their activities



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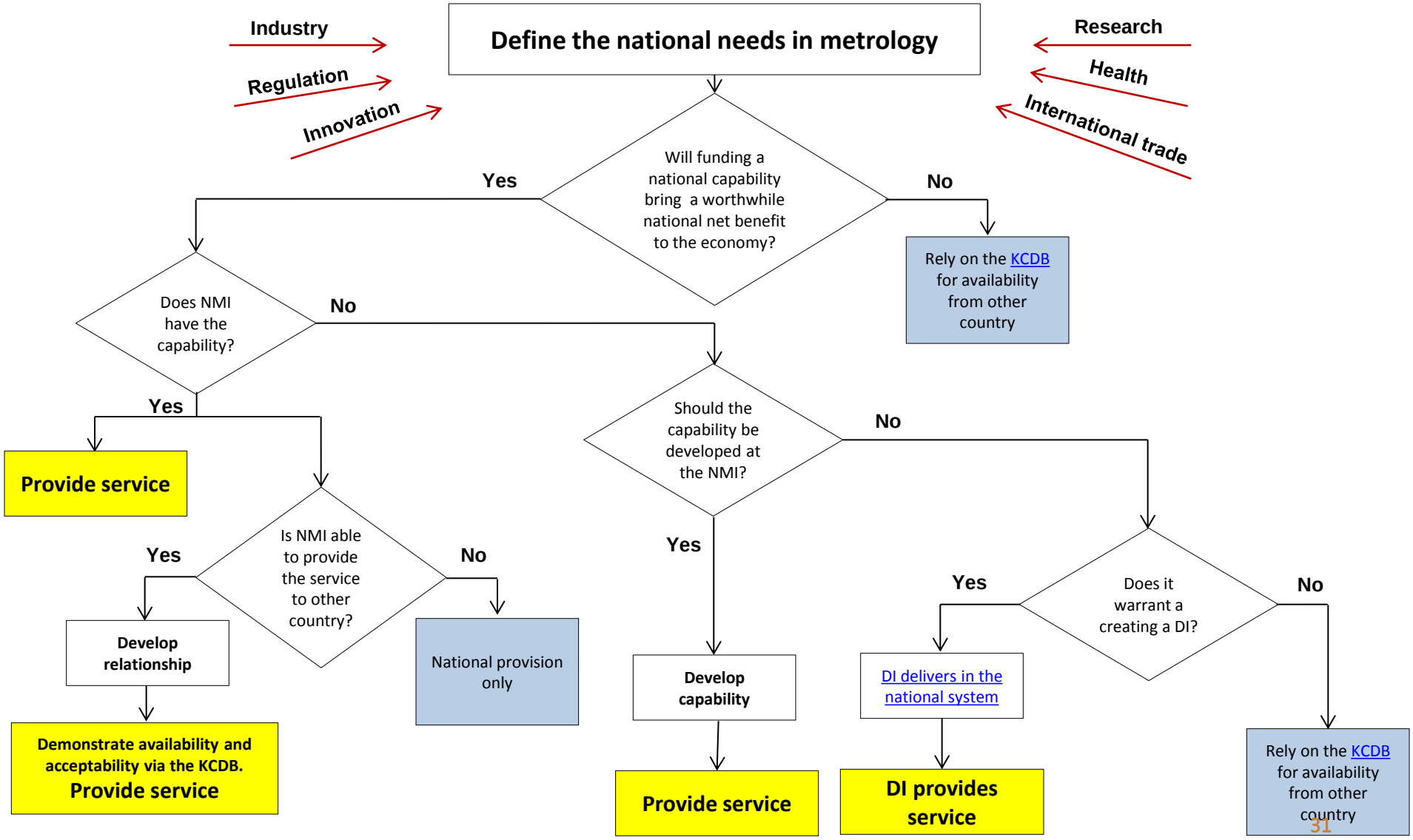
Decision Analysis Tree



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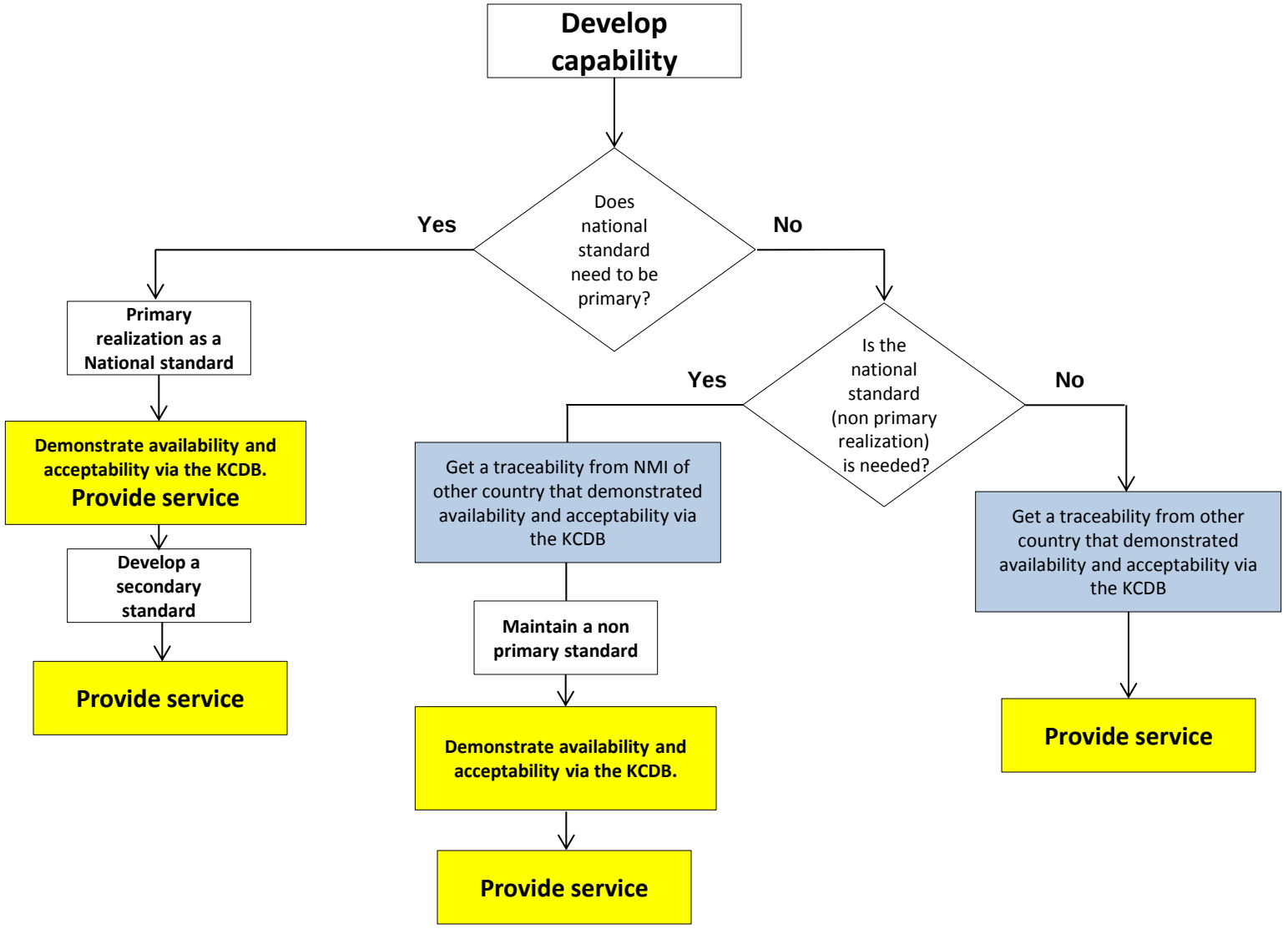
Decision Analysis Tree



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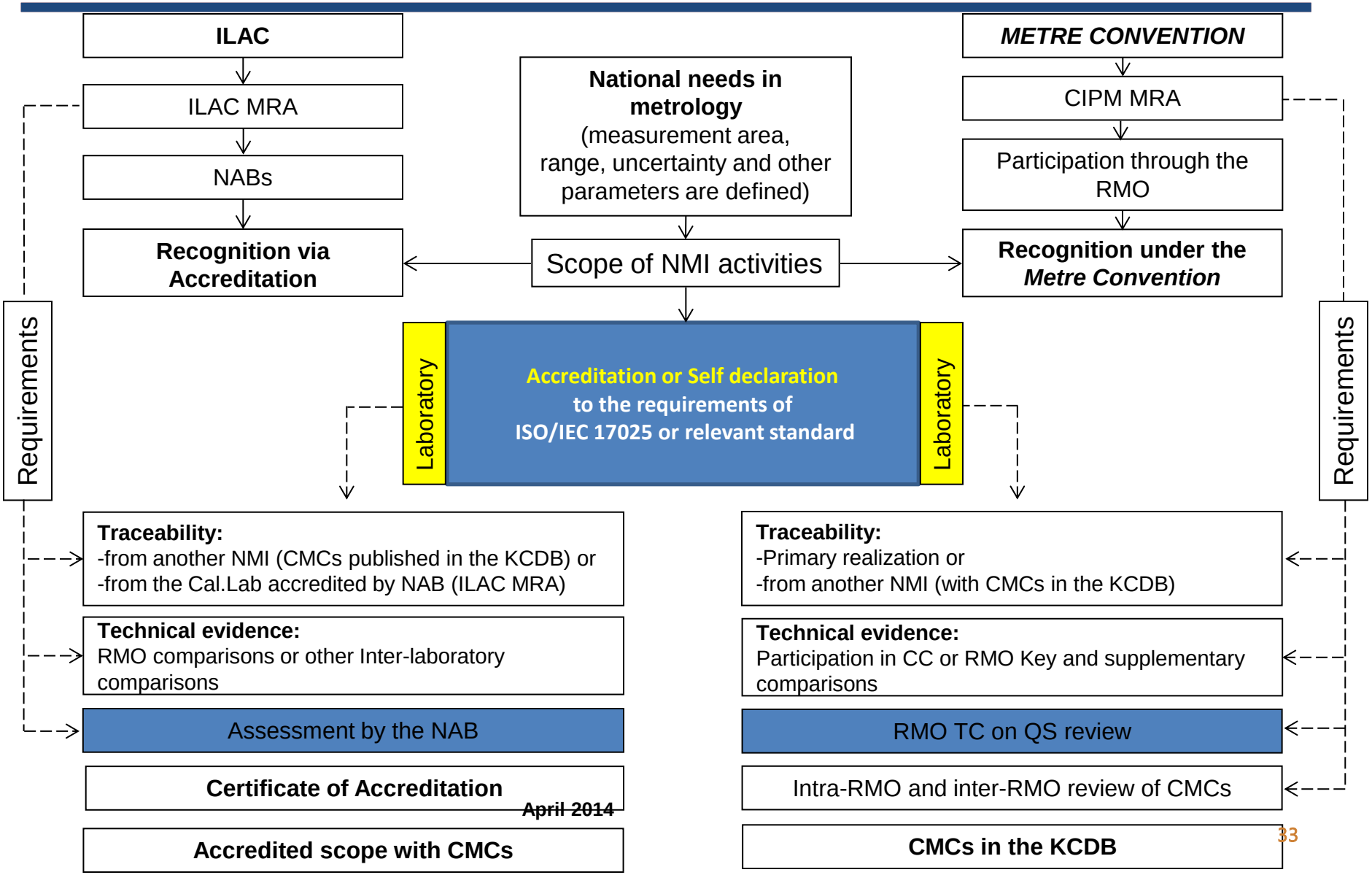
Options for NMIs providing traceable services



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Conclusion: Key challenges for the NMIs in the region

- **Establishing and maintaining an NMI that:**
- Operates a quality management system ISO/IEC 17025
  - and if relevant for reference materials ISO Guide 34
- Has national standards (primary realization or not as appropriate) for the highest priority national needs with the right balance of benefit verses cost.
  - Very low uncertainties are very expensive
  - Not realistic to provide every possible capability
  - Must align with real national downstream needs
  - Human resource is critical
- Participates in accreditation and/or *Metre Convention* (CIPM MRA) to demonstrate capability and ensure international acceptability
- Disseminates traceability from the national standards to customers via calibration services and/or reference materials
- Provides advice to stakeholders/ customers related to the calibration services and other measurement challenges
- Provides advice to stakeholders/ customers on where to obtain internationally accepted traceable services when not provided by the NMI

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THE METRE CONVENTION

The *Metre Convention* was signed on May 20, 1875 by representatives of 17 states.

From the text:

"Desiring the international uniformity and precision in standards of weight and measure…"

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THE METRE CONVENTION

THE METRE CONVENTION

International Convention established in 1875 with 55 Member States in 2013. The institutional foundation of the International System of Units (now the SI).

CGPM – Conférence Générale des Poids et Mesures

Composed of Member State representatives. Typically meets every 4 years to decide on matters pertaining to the Metre Convention and the SI

CIPM – Comité International des Poids et Mesures

18 individuals of different nationalities appointed by CGPM. Supervises BIPM and generally supplies chairs to Consultative Committees.

BIPM – Bureau International des Poids and Mesures

Research institute founded by the Metre Convention. Administers interlaboratory comparisons and provides measurement services to member NMIs.

Consultative Committees (CCs)

CCAUV – Acoustics, US & Vibration
CCEM – Electricity & Magnetism
CCL – Length
CCM – Mass and related
CCPR – Photometry & Radiometry
CCQM – Amount of substance
CCRI – Ionizing Radiation
CCT – Thermometry
CCTF – Time & Frequency
CCU - Units

Bureau International des Poids et Mesures

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- It maintains laboratories in areas of: mass, time, electricity, ionizing radiation, and chemistry.
- It has an international staff of around 75.

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Mission of the BIPM

The BIPM is an intergovernmental organization established by the *Metre Convention*, through which Member States act together on matters related to measurement science and measurement standards.

The mission of the BIPM is to ensure and promote the global comparability of measurements, including providing a coherent international system of units for:

- Scientific discovery and innovation,
- Industrial manufacturing and international trade,
- Sustaining the quality of life and the global environment.

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BIPM'S GLOBAL ROLE

Working with Governments, National Metrology Institutes, and the accreditation community so as to maintain confidence in the world measurement system for science and trade.

To address the common interest of the NMIs of States Parties to the Metre Convention in dealings with international and intergovernmental bodies such as the World Meteorological Organisation, World Health Organisation, the International Federation of Clinical Chemistry, International Laboratory Accreditation Co-operation, International Organisation for Legal Metrology etc. as the occasion arises.

World Meteorological Organization

FAO

USP

ilac

IAEA.org International Atomic Energy Agency

WORLD ANTI-DOPING AGENCY

World Health Organization

WORLD TRADE ORGANIZATION

OIML

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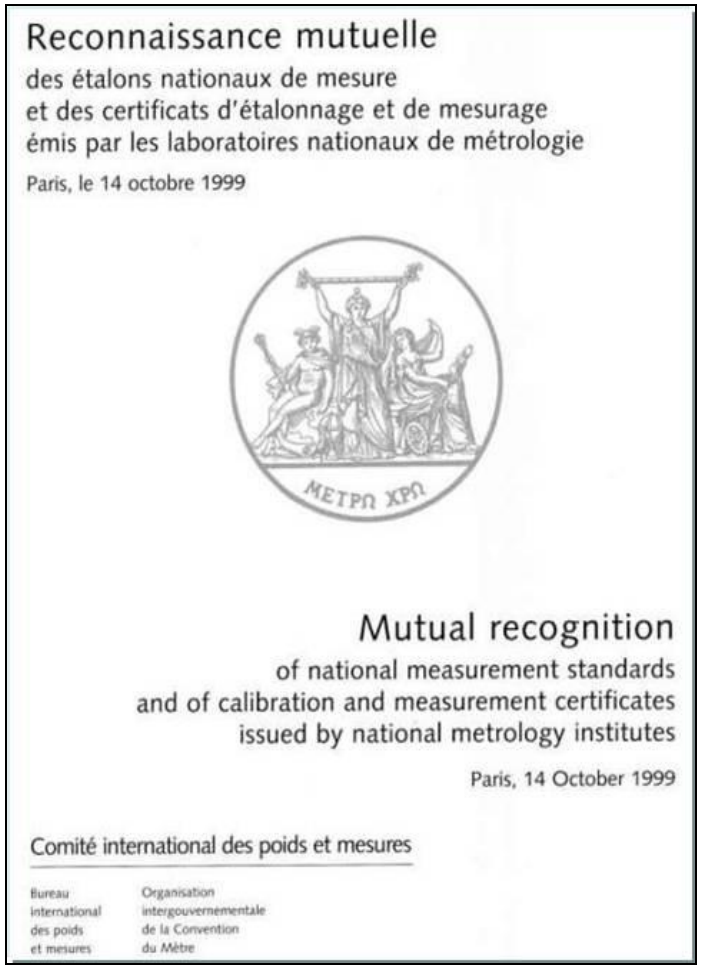
The CIPM Mutual Recognition Arrangement



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

ΜΕΤΡΩ ΧΡΩ

Mutual recognition

of national measurement standards
and of calibration and measurement certificates
issued by national metrology institutes

Paris, 14 October 1999

Comité international des poids et mesures

Bureau international des poids et mesures

Organisation intergouvernementale de la Convention du Mètre

The CIPM Mutual Recognition Arrangement (CIPM MRA) was signed on 14 October, 1999 by the Directors of the National Metrology Institutes of 38 States signatories to the Metre Convention and two international organizations.

The essence of the CIPM MRA is that it provides the institutional and technical framework (the "what", "who" and "how") for NMIs to recognize each others' measurement standards and calibration certificates.

CIPM MRA

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CIPM MRA: Engagement

The objectives of the CIPM MRA are stated as:

- to establish the degree of equivalence of national measurement standards maintained by NMIs
- to provide for the mutual recognition of calibration and measurement certificates issued by NMIs
- thereby to provide governments and other parties with a secure technical foundation for wider agreements related to international trade, commerce and regulatory affairs

The objectives of the CIPM MRA are to be achieved through:

- International comparisons of measurements, to be known as key comparisons
- Supplementary international comparisons of measurements
- Quality systems and demonstrations of competence by NMIs

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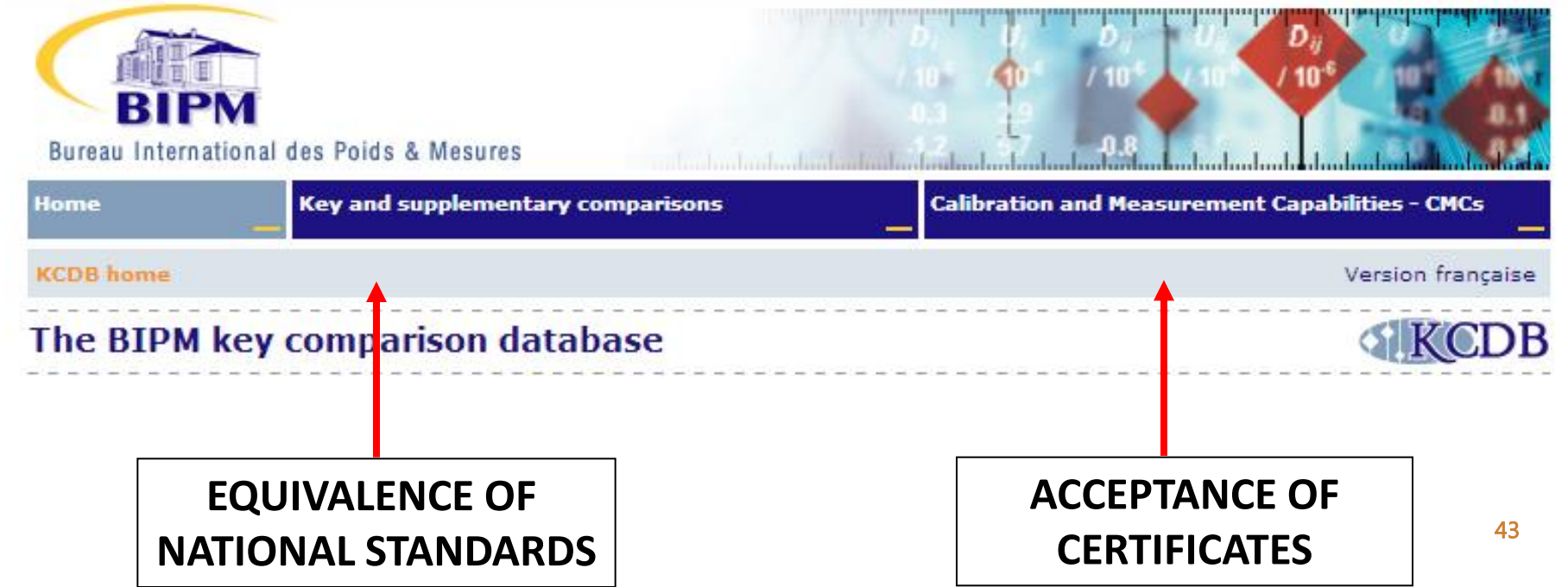
CIPM MRA: Outcome

The outcome of the CIPM MRA processes are statements of the internationally recognized calibration and measurement capabilities (CMCs) of each NMI published in the database maintained by the BIPM and publicly available online.

http://kcdb.bipm.org/



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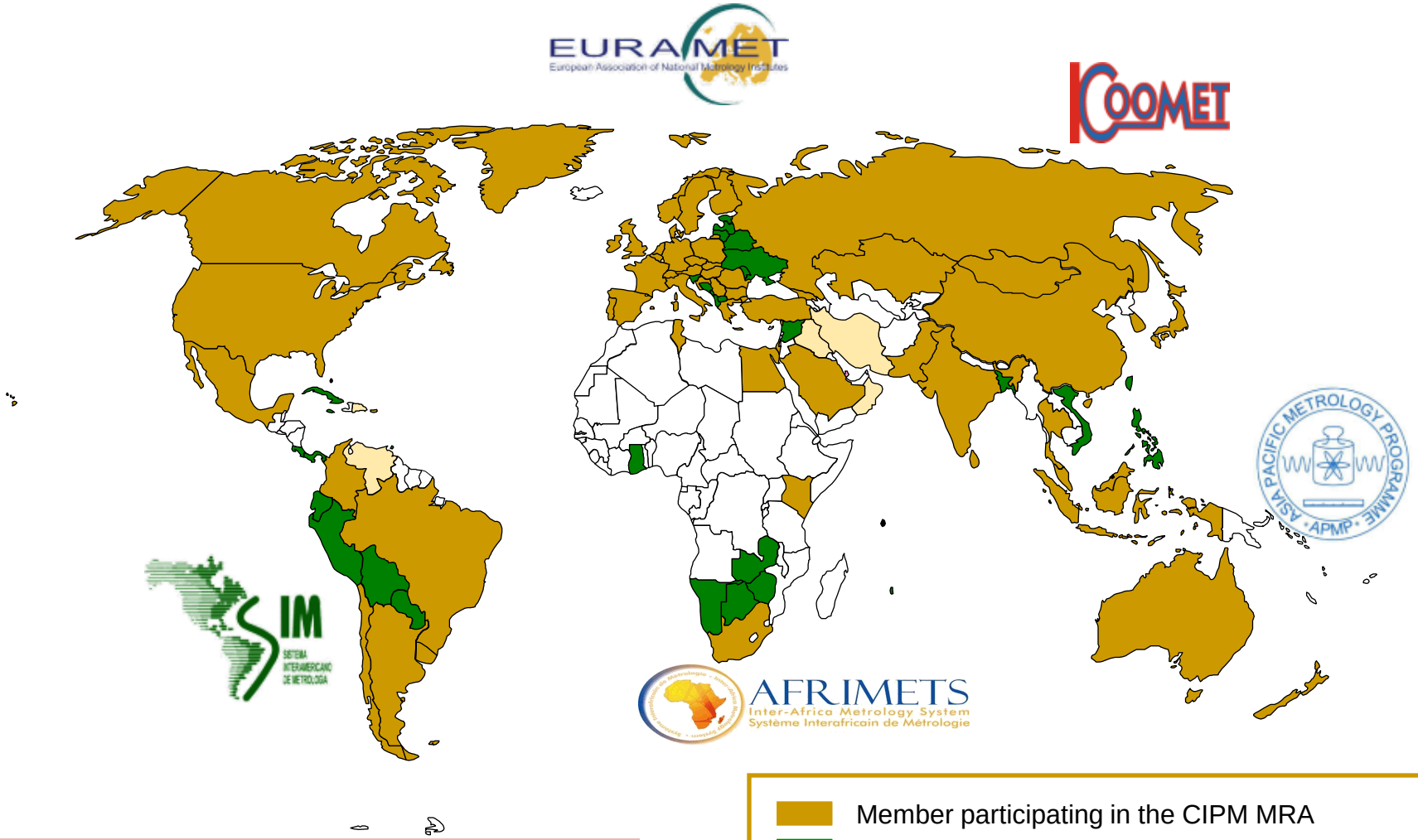
CIPM MRA Participation



The CIPM MRA has now been signed by the representatives of 93 institutes – from 52 Member States, 37 Associates of the CGPM, and 4 international organizations – and covers a further 150 institutes designated by the signatory bodies.

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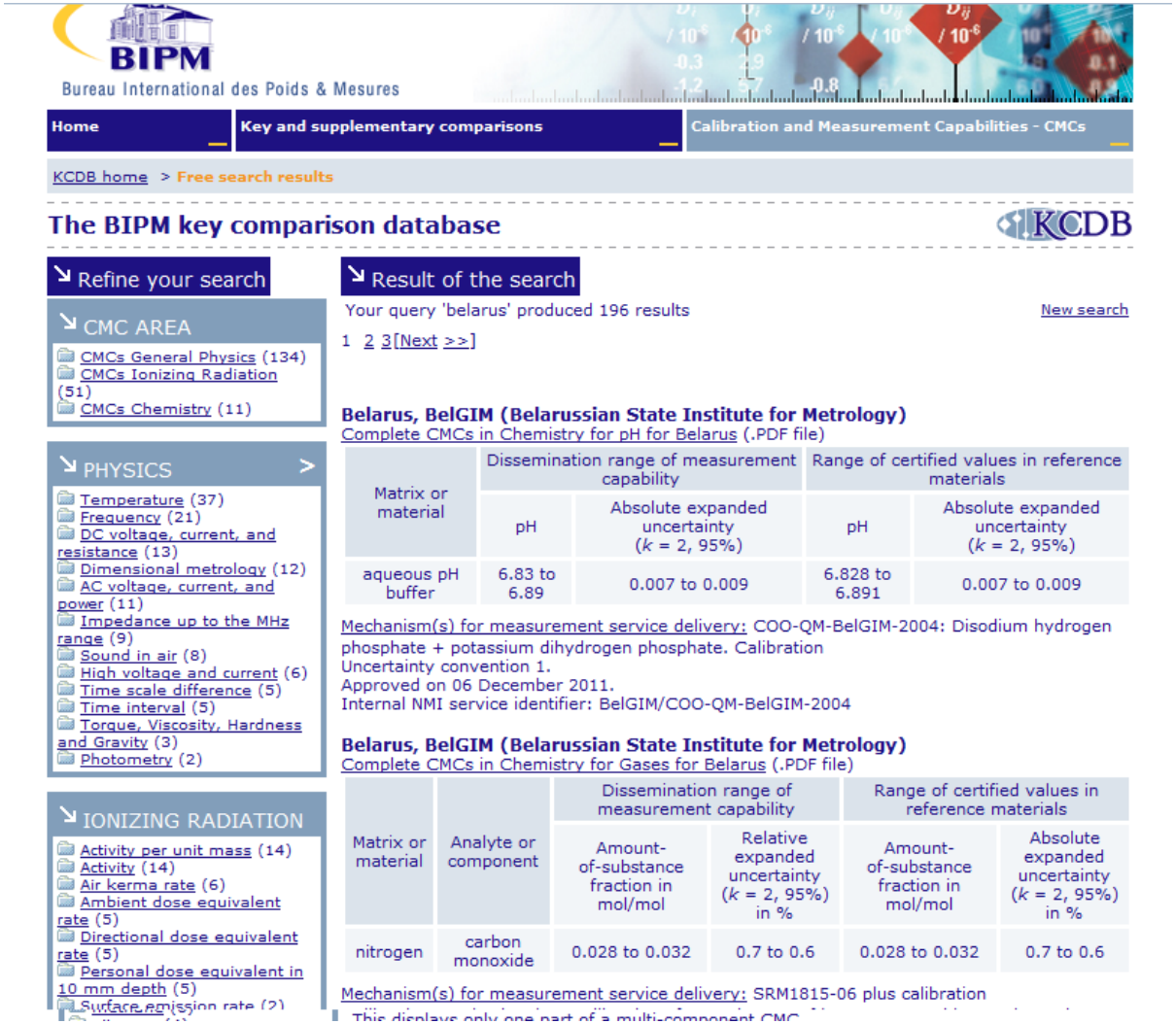
CIPM MRA: Engagement



BIPM
Bureau International des Poids & Mesures

Home | Key and supplementary comparisons | Calibration and Measurement Capabilities - CMCs

KCDB home > Free search results

The BIPM key comparison database

KCDB

Refine your search

CMC AREA

- CMCs General Physics (134)
- CMCs Ionizing Radiation (51)
- CMCs Chemistry (11)

PHYSICS

- Temperature (37)
- Frequency (21)
- DC voltage, current, and resistance (13)
- Dimensional metrology (12)
- AC voltage, current, and power (11)
- Impedance up to the MHz range (9)
- Sound in air (8)
- High voltage and current (6)
- Time scale difference (5)
- Time interval (5)
- Torque, Viscosity, Hardness and Gravity (3)
- Photometry (2)

IONIZING RADIATION

- Activity per unit mass (14)
- Activity (14)
- Air kerma rate (6)
- Ambient dose equivalent rate (5)
- Directional dose equivalent rate (5)
- Personal dose equivalent in 10 mm depth (5)
- Surface emission rate (2)

Result of the search

Your query 'belarus' produced 196 results

New search

1 2 3 [Next >>]

Belarus, BelGIM (Belarussian State Institute for Metrology)

Complete CMCs in Chemistry for pH for Belarus (.PDF file)

Matrix or material	Dissemination range of measurement capability		Range of certified values in reference materials	
	pH	Absolute expanded uncertainty (k = 2, 95%)	pH	Absolute expanded uncertainty (k = 2, 95%)
aqueous pH buffer	6.83 to 6.89	0.007 to 0.009	6.828 to 6.891	0.007 to 0.009

Mechanism(s) for measurement service delivery: COO-QM-BelGIM-2004: Disodium hydrogen phosphate + potassium dihydrogen phosphate. Calibration
Uncertainty convention 1.
Approved on 06 December 2011.
Internal NMI service identifier: BelGIM/COO-QM-BelGIM-2004

Belarus, BelGIM (Belarussian State Institute for Metrology)

Complete CMCs in Chemistry for Gases for Belarus (.PDF file)

Matrix or material	Analyte or component	Dissemination range of measurement capability		Range of certified values in reference materials	
		Amount-of-substance fraction in mol/mol	Relative expanded uncertainty (k = 2, 95%) in %	Amount-of-substance fraction in mol/mol	Absolute expanded uncertainty (k = 2, 95%) in %
nitrogen	carbon monoxide	0.028 to 0.032	0.7 to 0.6	0.028 to 0.032	0.7 to 0.6

Mechanism(s) for measurement service delivery: SRM1815-06 plus calibration

This displays only one part of a multi-component CMC

The BIPM key comparison database

Refine your search

CMC AREA

CMCs General Physics (9)

PHYSICS

Temperature (9)

GEOGRAPHIC LOCATION

COOMET (9)
Georgia (9)

Result of the search

Your query 'georgia' produced 9 results

Ne

Georgia, GEOSTM (Georgian National Agency for Standards, Technical Regu and Metrology)

Complete CMCs in Thermometry for Georgia (.PDF file)

Temperature. Water triple point cell, **0.01 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **0.25**
Direct comparison
Thermostat: ice bath
Approved on 14 March 2014
Internal NMI service identifier: GEOSTM/1

Temperature. Tin cell, **231.928 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **2.6**
Direct comparison
Temperature-controlled furnace: 3-zone
Approved on 14 March 2014
Internal NMI service identifier: GEOSTM/2

Temperature. Long-stem standard platinum resistance thermometer, **0.01 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **0.3**
Calibration at water triple fixed point
Thermostat: ice bath
Approved on 14 March 2014
Internal NMI service identifier: GEOSTM/3

Temperature. Long-stem standard platinum resistance thermometer, **231.928 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **3.5**
Calibration at tin fixed point
Temperature-controlled furnace: 3-zone
Approved on 14 March 2014
Internal NMI service identifier: GEOSTM/4

Temperature. Industrial platinum resistance thermometer, **0 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **10**
Calibration at ice melting point
Thermostat
Hysteresis uncertainty for IPRT must be added to uncertainty quoted in calibration repo
Approved on 14 March 2014

Bureau International des Poids et Mesures

CIPM MRA: Engagement

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CIPM MRA: Engagement

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Home | Key and supplementary comparisons | Calibration and Measurement Capabilities - CMCs

KCDB home > Free search results

The BIPM key comparison database

KCDB

Refine your search

CMC AREA
- CMCs General Physics (171)
- CMCs Chemistry (21)
- CMCs Ionizing Radiation (1)

PHYSICS
- Temperature (35)
- Dimensional metrology (23)
- Sound in air (23)
- Frequency (20)
- Radio frequency measurements (15)
- AC voltage, current, and power (13)
- Impedance up to the MHz range (12)
- High voltage and current (9)
- Time scale difference (7)
- Fluid flow (3)
- DC voltage, current, and resistance (3)
- Time interval (3)

IONIZING RADIATION
- Activity per unit volume (1)

CHEMICAL MATERIAL
- natural gas (7)
- aqueous pH buffer solution (6)
- nitrogen (4)

Result of the search

Your query 'ukraine' produced 193 results — New search

[<< Prev]3 4 5[Next >>]

Ukraine, NSC IM (National Scientific Centre "Institute of Metrology")

Complete CMCs in Thermometry for Ukraine (.PDF file)

Temperature. Long-stem standard platinum resistance thermometer, **0.01 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **0.20**
Water triple fixed point
Thermostat: ice bath
Approved on 06 September 2013
Internal NMI service identifier: NSC IM/26

Temperature. Long-stem standard platinum resistance thermometer, **0.01 °C to 29.7646 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **0.20 to 0.35**
Calibration at fixed points
Fixed points: TPW, Ga
Approved on 06 September 2013
Internal NMI service identifier: NSC IM/27

Temperature. Long-stem standard platinum resistance thermometer, **0.01 °C to 156.5985 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **0.20 to 1.1**
Calibration at fixed points
Fixed points: TPW, In
Approved on 06 September 2013
Internal NMI service identifier: NSC IM/28

Temperature. Long-stem standard platinum resistance thermometer, **0.01 °C to 231.928 °C**
Absolute expanded uncertainty (k = 2, level of confidence 95%) in mK: **0.20 to 1.3**
Calibration at fixed points
Fixed points: TPW, In, Sn
Approved on 06 September 2013
Internal NMI service identifier: NSC IM/29

Temperature. Long-stem standard platinum resistance thermometer, **0.01 °C to 419.527 °C**
This displays only one part of a multi-component CMC

Bureau International des Poids et Mesures

Some Facts

DSME, Korea – BP, USA [2002]

Claim

- Offshore plant order by BP,USA.
- **Calibration traceable to NIST required.**

Solution

- DSME, accredited by KOLAS, a member of ILAC MRA.
- DSME keeps traceability of its standards traceable to KRISS.
- KRISS and NIST are all signatory to the CIPM MRA.
- NIST confirmed that **"traceability to KRISS is equivalent to traceability to NIST"** via the CIPM MRA.
- **BP accepted** accreditation by KOLAS and calibration certificates issued by KRISS.

< DSME offshore plant >

Benefit

- **US$ 11 million saved**
- US$ 30,000 Invested for calibration

- recalibration at NIST; US$ 1 million
- penalty of 2 month delay; US$ 10 million

Bureau International des Poids et Mesures

Some Facts

SHI - SEIC, Russia [2003]

- ***SHI : Samsung Heavy Industry***
- *SEIC : Sakhalin Energy Investment Company*

Claim

- SHI constructing an offshore platform ordered by SEIC, Russia.
- **All the measuring instruments installed in the platform required to be traceable to NMS of Russia.**

Solution

- KRISS and VNIIMS participate in the CIPM MRA.
- KRISS and VNIIMS concluded a protocol recognizing the equivalence of NMS of both countries.
- **SEIC approved** all the measuring instruments of SHI **traceable to KRISS as traceable to VNIIMS**.

Benefit

- **US$ 16 million saved**
- US$ 150,000 Invested for calibration

< The dimensions of the platform is approximately 95 m x 130 m x 120 m >

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Some Facts

POSCO – India, Mexico [2004]

• ***POSCO: Pohang Steel and Iron Company***

Claim

- Mexican manufacturer of automobile parts demanded the proof of reliability of POSCO steel.
- Indian buyer of POSCO steel **required the certification from BIS(Bureau of India Standard).**

Solution

- POSCO's testing laboratory had been accredited by KOLAS.
- KOLAS is a member of APLAC and signatory to the ILAC MRA.
- **POSCO has a traceability to KRISS participating in the CIPM MRA**.
- POSCO's steel accepted without being retested in India and Mexico.

Benefit

- **US$ 5 million saved**
- US$ 70 000 Invested for calibration

ROI 70 times

< POSCO steel plant >

Thank you for your attention

http://www.bipm.org

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