Standardization and accreditation in digital quality infrastructure: a measurement science perspective

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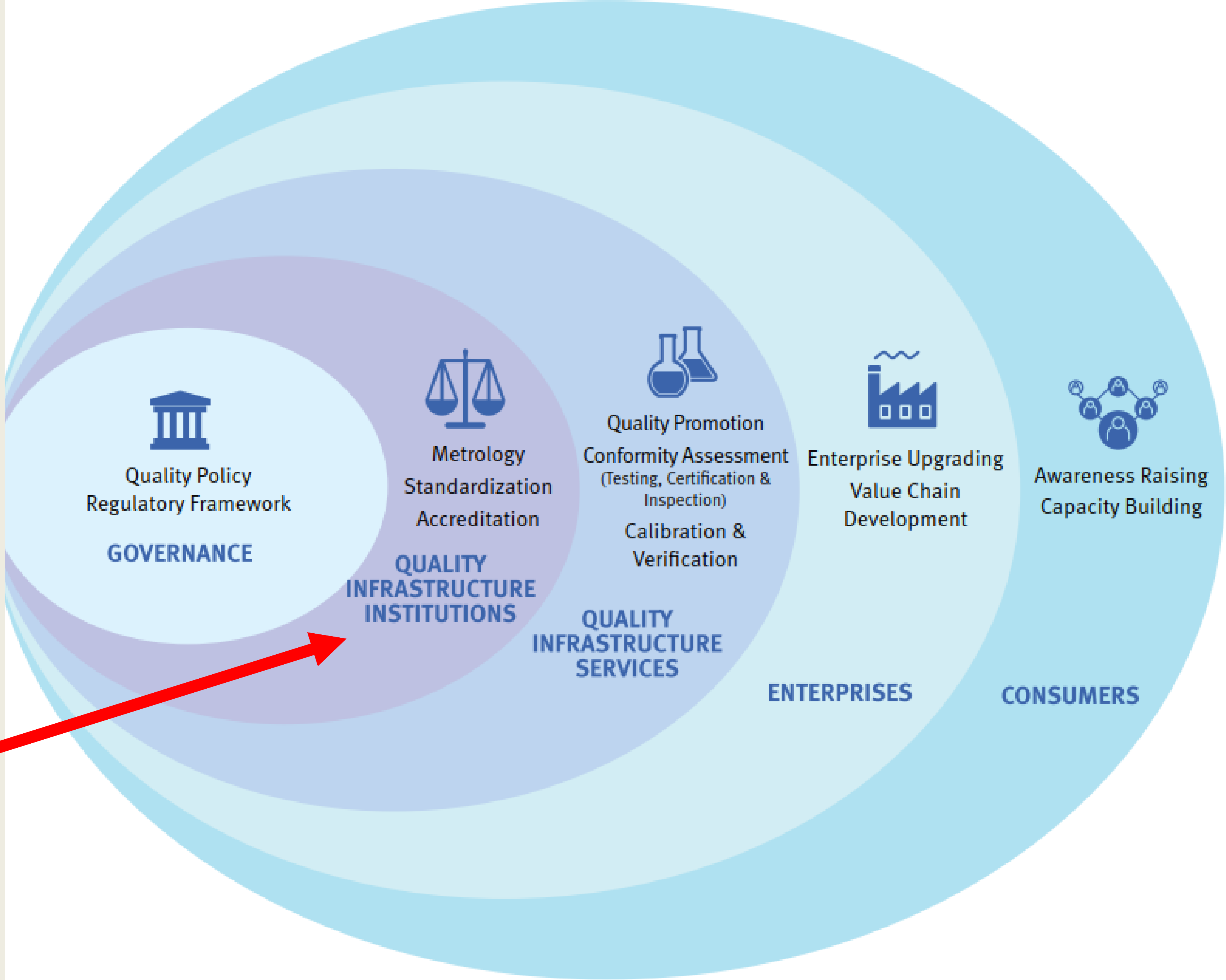
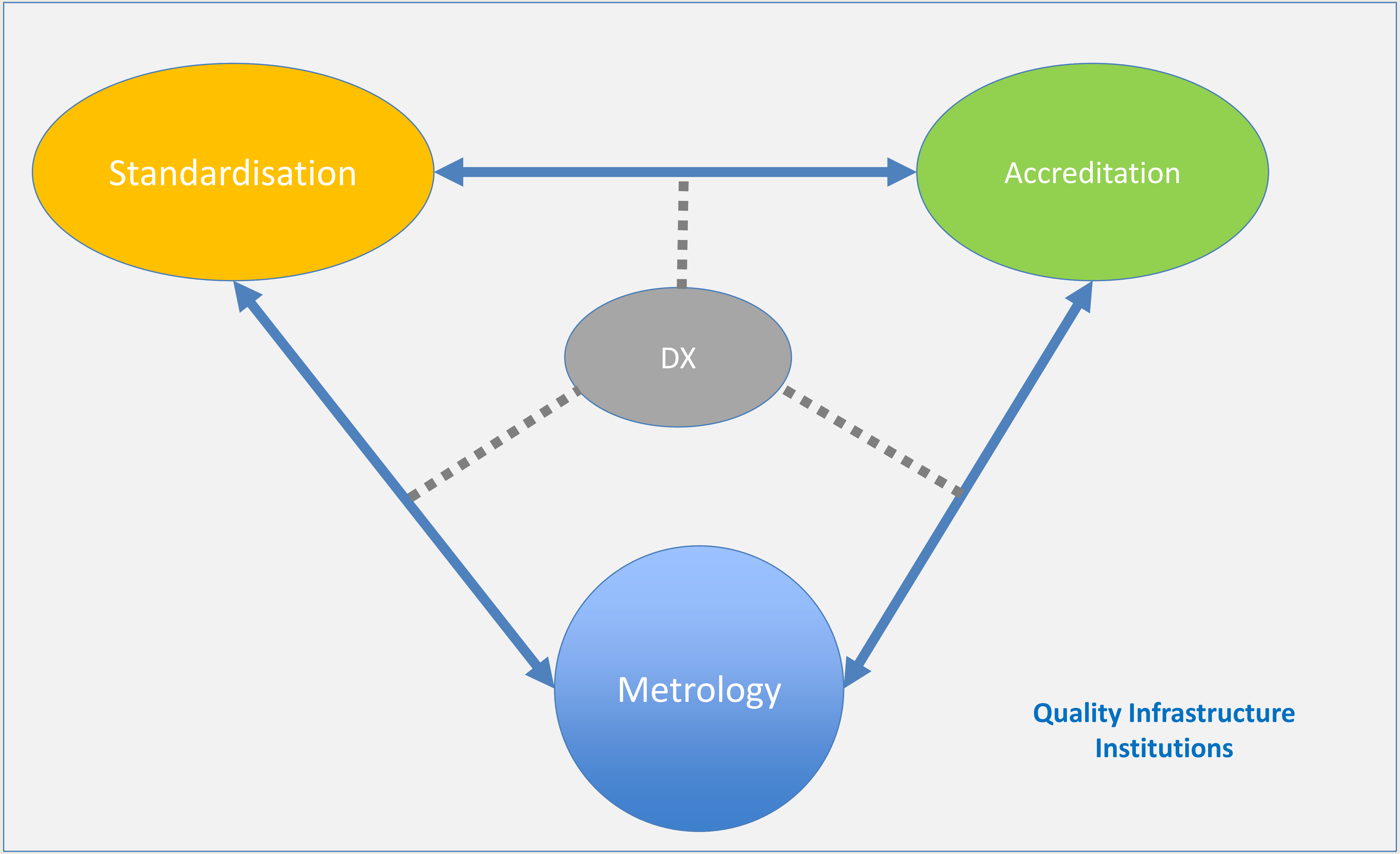
Quality infrastructure:

a complicated system



Metrology
Standardisation &
Accreditation

UNIDO, Implementing ISO/IEC 17025:2017, 2020


Standardisation
Accreditation
DX
Metrology
Quality Infrastructure
Institutions

Standardisation

- Standardisation establishes **rules** for activities or the results of activities.
- Using standards can achieve a level of **uniformity** to ensure activities or results are **fit for purpose**.
- Standards can incorporate **scientific knowledge** (e.g., in regulatory compliance for health, safety, the environment, etc.)
- Standardisation can support **interoperability** (e.g., manufacturing)

Quality assurance and 3rd party accreditation

- The International Organization for Standardization developed the ISO 9000 series in the 1980’s.

- Accreditation (e.g., ISO/IEC 17025 – formerly Guide 25) requires **independent assessment** of competency. (quality standards are now integrated in laboratory accreditation)

- Compliance with standards like 17025 means that measurements are standardised
(formally specified and expertly reviewed)!

Accreditation bodies are "providers of trust"

Trust is not a word you will find in a dictionary of physical science.

You will, however, find definitions for '**reliability**'.

Reliability relates to the consistency and dependability of measurement results

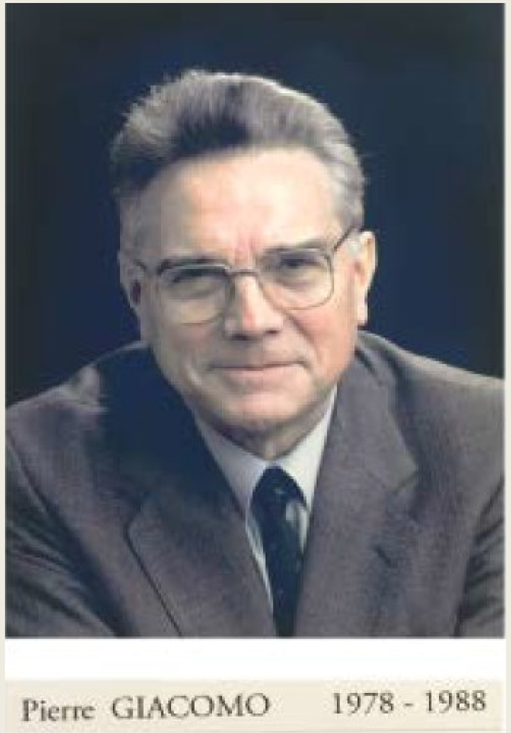
Accreditation evaluates the reliability of work produced by a laboratory

If a consumer trusts the endorsement of an accreditation body, they can use results more **efficiently** (without independently evaluating the reliability).

Metrology

“A dictionary will tell you that metrology is the science of measurement, which is not much of an explanation.”

“… **metrology is the science that allows us to give a meaning to measurements**“



Pierre Giacomo
(BIPM Director 1978-88, and
Chair of the joint working group for the VIM 1st edition)

The **meaning** of measurement data is critical to the success of worldwide digital transformation of quality infrastructures.

- **Interoperability:** unambiguous interpretation => shared understanding
- **Integrity:** of meaning is preserved across platforms and applications
- **AI-driven analysis:** data must have precise and consistent meaning
- **Legal and regulatory:** the meaning of results—what they represent and their compliance with standards—must be admissible in legal and regulatory contexts.
- **Metrological traceability:** to preserve meaning, traceability must be captured

What does the international quality infrastructure need?

Joint BIPM,OIML, ILAC and ISO declaration on metrological traceability, 2018

We assert that international **consistency and comparability of measurements** are **required** if the missions of our Organizations are to be achieved. In particular, measurement comparability is an **essential characteristic** of an international system within which measurement results can be universally accepted. This international consistency and comparability can only be guaranteed if measurement results are **metrologically traceable** to internationally recognized references.

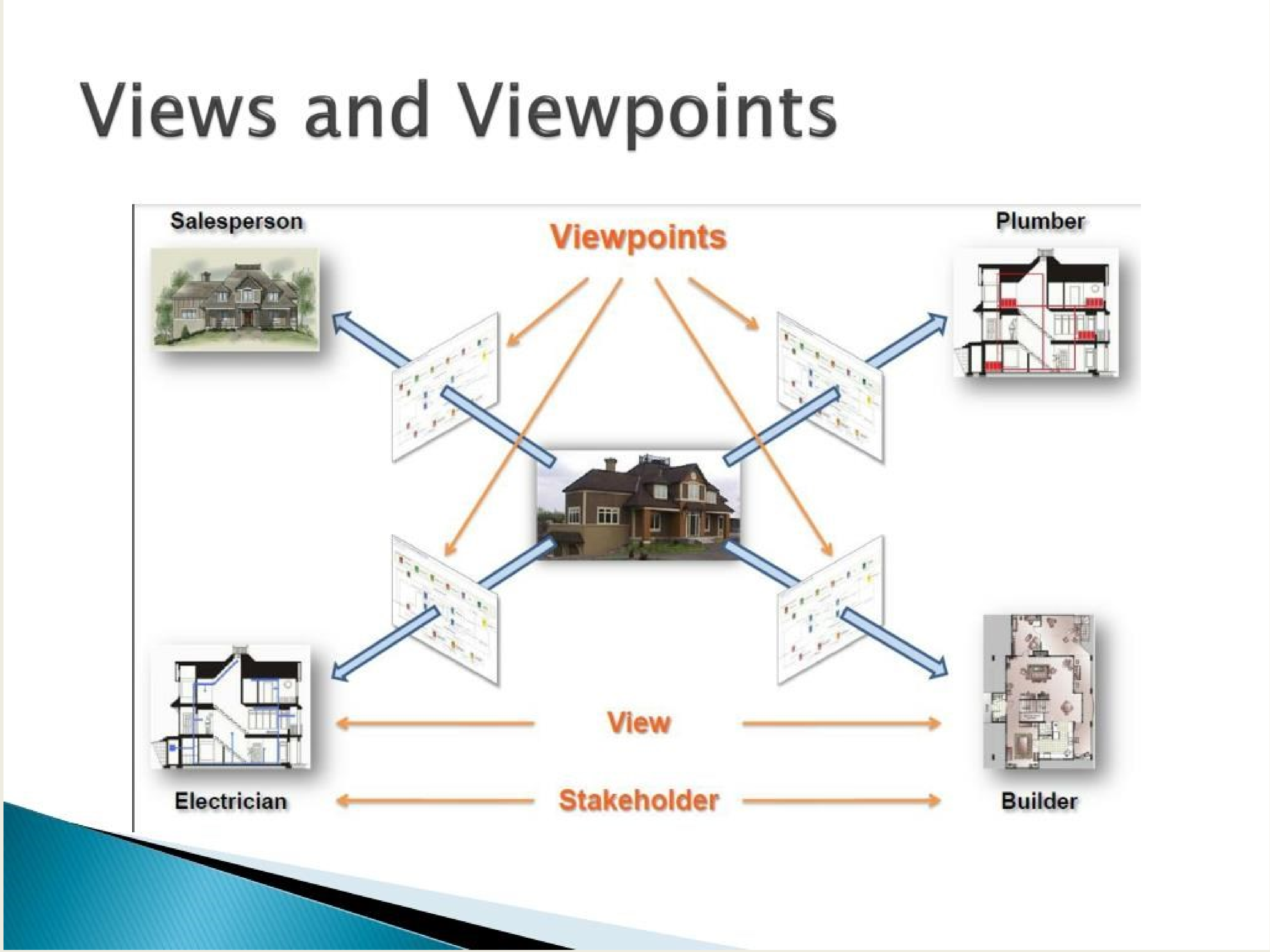
Complexity

Stakeholders include

- Owners
- Vendors
- Regulators
- Maintainers
- Builders
- Designers

Different concerns

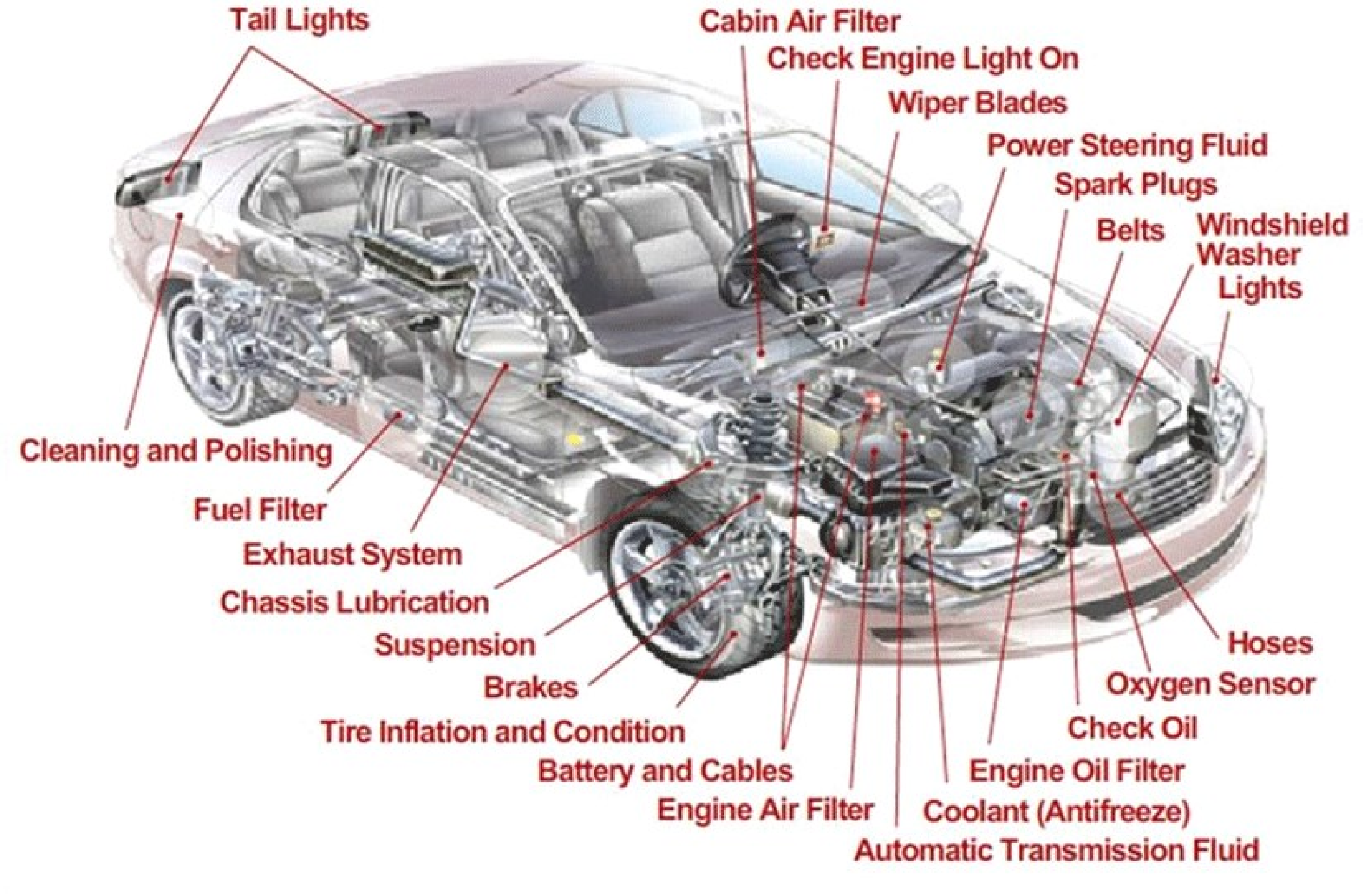
Different points of view



What is a car? (engineering)

A self-propelled vehicle, typically consisting of a chassis, four wheels, and a cabin with seating for passengers.

Cars are equipped with features such as steering mechanisms, brakes, headlights, and turn signals.



What is a car? (socio-economic)

A vehicle used to transport people and goods.

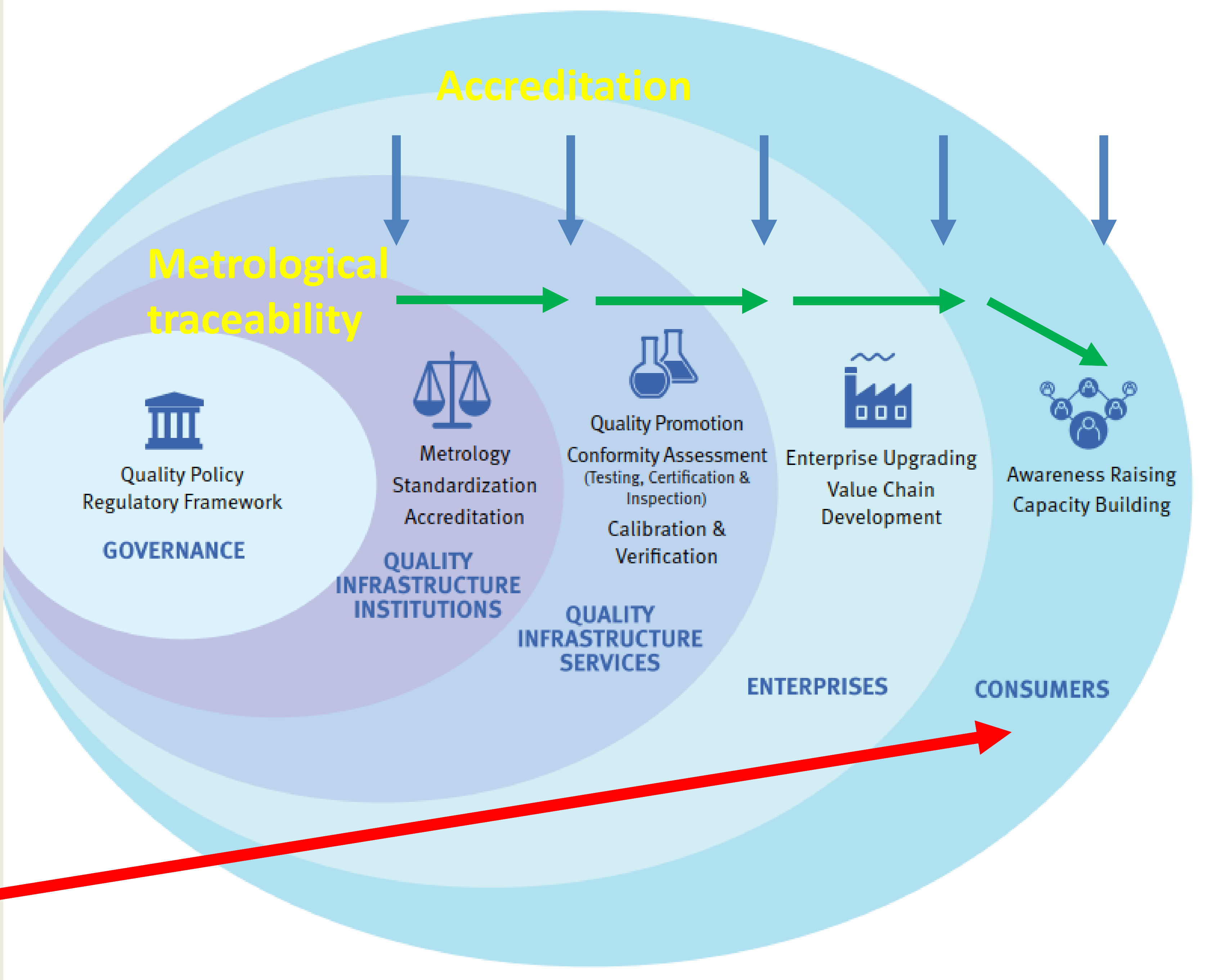
It provides a convenient means for individuals and small groups to move from one place to another.

Supported by considerable investment in infrastructure.

Stakeholders include:

- Consumers (society)
- Governance (NGOs, IGOs, governments)
- Operators (metrologists, regulators)
- Maintainers (metrologists, ABs & TEs, regulators)
- Builders & Designers (metrologists, regulators)

Critical consumer decisions in society



UNIDO, Implementing ISO/IEC 17025:2017, 2020

An internal (operational) view of traceable measurement

[…] can be related to a **reference** through a documented unbroken chain of **calibrations**, each contributing to the **measurement uncertainty**

—VIM 2012
(with 8 accompanying notes)

An external (consumer) view of traceable measurement

For quantities to be ***meaningfully compared***, they must be expressed on a metrologically traceable measurement scale.

The traceability principle enables comparison and verification of measurements made by different instruments and laboratories, ensuring consistency and reproducibility.

Traceability is essential to ***inform critical decisions*** *based on physical data*

Metrological traceability: science or quality assurance?

"The property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national of international standards, through an unbroken chain of comparisons all having stated uncertainties.

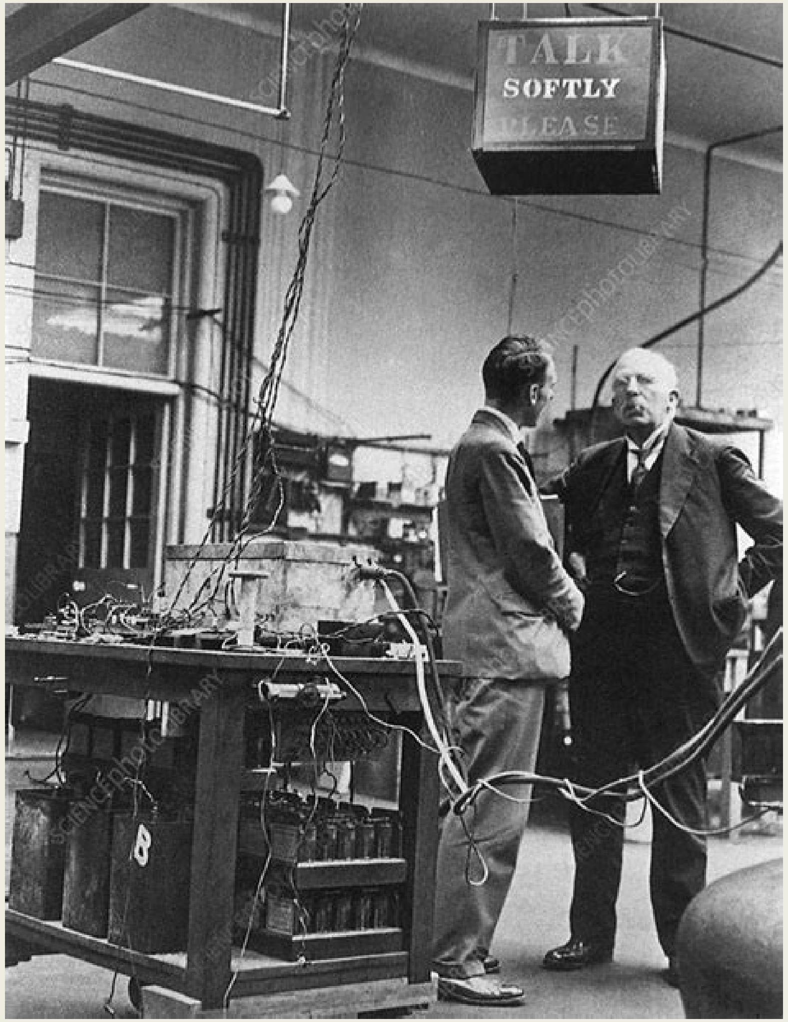
It is noted that traceability **only** exists when scientifically rigorous evidence is collected on a continuing basis showing that the measurement is producing documented results for which the total measurement uncertainty is quantified."

Dr. Robert E. Hebner
Calibration Traceability: A summary of NIST's view (Feb, 1996)
(Acting Deputy Director of NIST)

Digitalisation of meaning: classification and modelling

“All science is either physics or stamp collecting”

- Ernest Rutherford



Models describe mathematical relationships between quantities.

Modelling is necessary (modelling –> uncertainty and traceability)

Quantities can be classified, but not their values (expressed on scales).

Modelling uses scientific principles (physical laws), whereas cataloguing and classification are discrete and descriptive.

Both modelling and classification are needed to represent the meaning of measurement results.

Classification (stamp collecting) may apply to ….

- ✓ **Compliance** with quality standards (essentially check lists with documented evidence)

- ✓ **Units** of measure (uniquely identifiable; but widely misunderstood)

- ➢ **Quantities** – ok in principle but complicated in practice.

  A measurement estimates the value of a property (not always a quantity) of an object under specific circumstances. Quantity classifications are generally much broader.

  For example, for the same nominal ‘quantity’, different standardised methods can produce results that are not comparable (and so should be classified separately).

  So, the **meaning and purpose** of a measurement must be known (can this be classified?)

Modelling (not the stamp collecting)

Quantitative assessment of accuracy => modelling the effect of measurement errors

The whole (unbroken chain) traceability chain must be modelled

Measurement begins with the reference standards and ends when a result does not propagate to another measurement stage (instead, it informs a decision).

No model information is being reported along traceability chains!!!

Summary

Metrology, standardisation, and accreditation are intwined

Standardisation encapsulates expert knowledge and scientific principles => reliability

Accreditation independently assesses reliability => efficiency

Metrology provides meaning => interoperability, automation, data integrity, etc.

- ✓ **Metrological principles are embedded in QI activities and workflows**
- ✓ **Standardisation ensures that correct and reliable results *can* be obtained.**
- ✓ **Accreditation ensures that correct and reliable results *are* being obtained.**

Complexity and meaning are challenges we face

Architectural approach

- Recognise stakeholders, their concerns, viewpoints, etc.
- Design fit-for-purpose digital representations and views of information

Classification

- Capture important conceptual elements (e.g., vocabularies and taxonomies)
- Describe relationships (logical modelling)

Measurement modelling (measurement science)

- Address underlying issues: why are models not being reported?
- Raise awareness about metrological principles (models can tell us things)
- Develop digital representations for measurement models

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Thank you

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