METROIND4.0&IoT

2020 IEEE INTERNATIONAL WORKSHOP ON
METROLOGY FOR INDUSTRY 4.0 & IoT
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IEEE

A Measurement Information Infrastructure's Benefits for Industrial Metrology and IoT

Mark Kuster, Consultant, *Texas*, *USA*

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Chair, NCSLI 141 MII & Automation Committee

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Managing Editor, NCSLI Measure: The Journal of Measurement Science

SECTION 1

Io[Measuring]T Problems

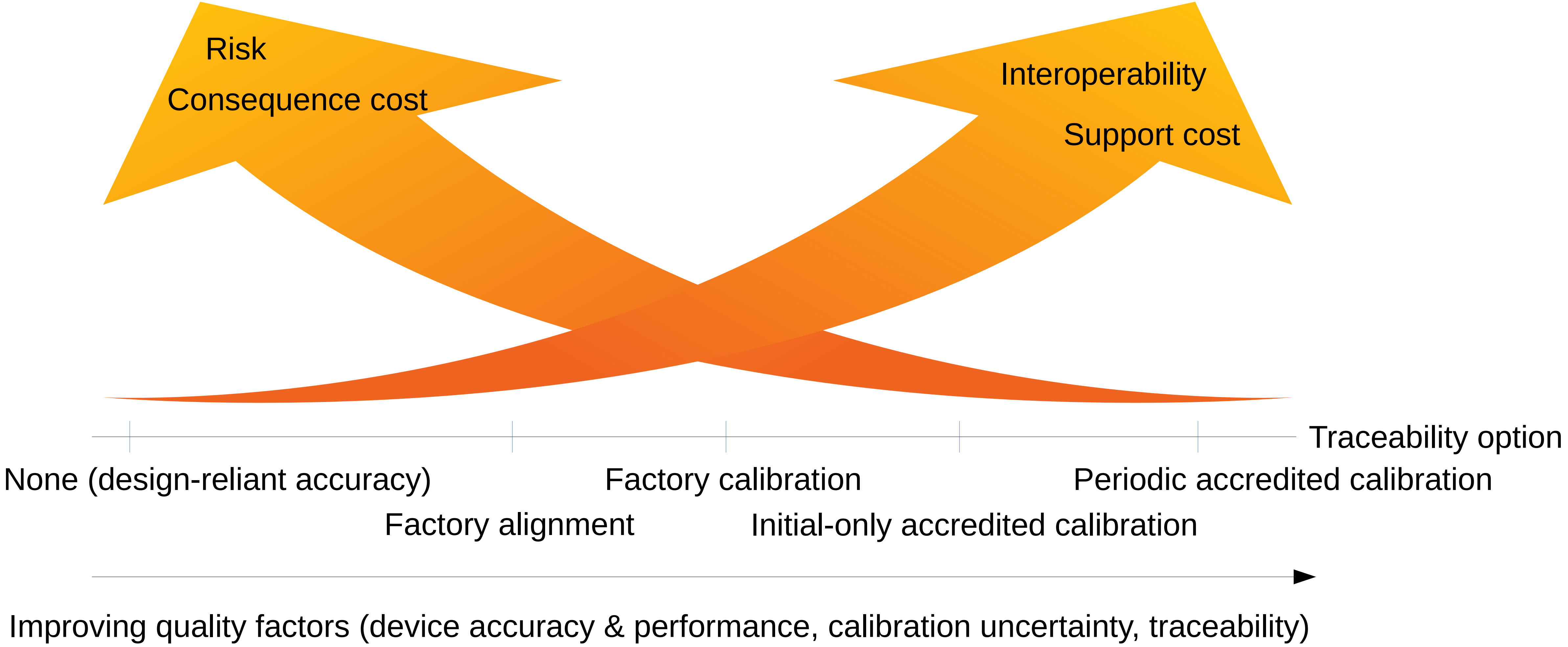
IoT Risks

- IEEE *IT Professional* (vol. 21, no. 3)
  - 2017 Gartner study: Enterprise IoT adoption will rise from 30 % to more than 65 % by 2020.
  - 2018 Cisco study: 64 % of IoT adopters experienced problems.
- IoT measuring instruments (IoMeasuringT) add traceability issues on top of functional issues.
- IEEE May 2020 *I&M Magazine*: Both Io[M]T and Big Data will underperform when users don’t apply sound metrological principles.

IoMT Interoperability

- Data quality → provenance
- Measurement data quality → traceability to the SI
- Known and fit-for-purpose measurement uncertainty
- Known measurand (unambiguous metadata)
- At a price, the international quality structure (IQI) provides:
  - Data confidence, reduced measurement decision risk
  - “Plug and play” measurement interchangeability
  - Trade efficiency—source and use instruments and measurement data anywhere

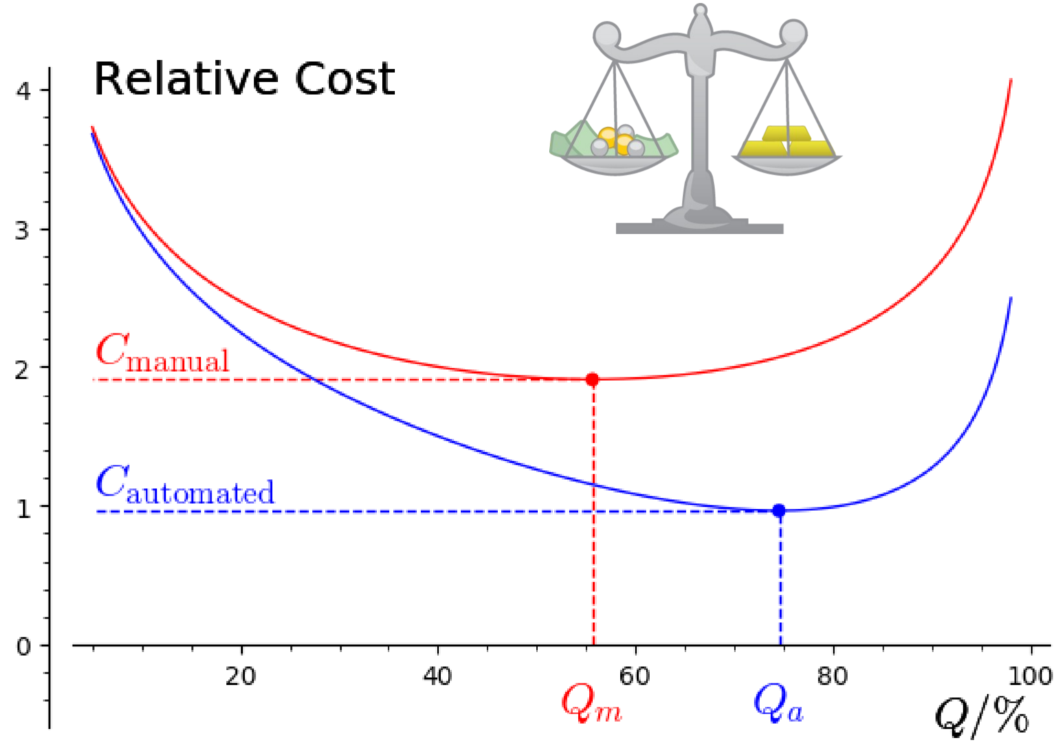
Interoperability Options



The Balancing Act

- High interoperability cost drives down data quality.
- Poor metadata does likewise.
- Cheap IoMT devices deployed in large numbers amplify the problem.
- The IQI requires an improved cost-risk operating curve.

Total Support & Consequence Costs



SECTION 2

IoMT Solutions

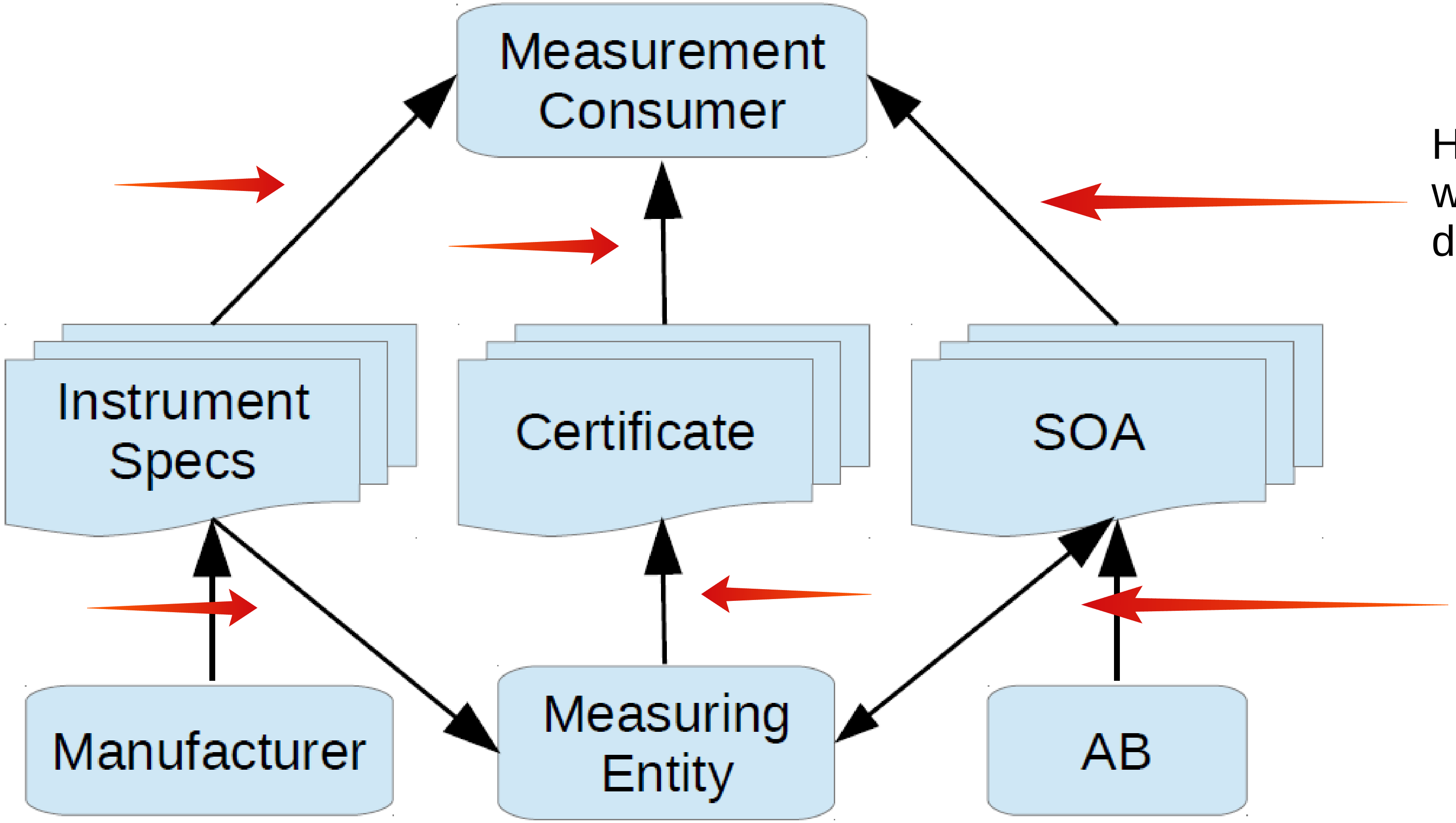
Cost Solutions for IoMT

- IQI cost reductions abound as a normal course of business.
  - Process improvements, e.g., batch calibration, automated measurement
  - Instrument improvements, e.g., digital interfaces
- Disruptive changes also occur, e.g., embedded SI (ESI)
  - Onboard intrinsic standards (traceability) obviate calibration.
  - Cost, size and quality requirements barriers delay this solution for IoMT.
- Artifical intelligence? Still too inaccurate.
- We propose instead a measurement information infrastructure (MII).
  - Standardize, interconnect and automate!

A Measurement Information Infrastructure (MII)

- MII – set of normative standards that unambiguously define data structures, taxonomies, service protocols and security for locating, communicating and sharing measurement information
- Such an MII would eliminate manual processing and transform the IQI into an automated measurement-information-exchange network, much like the IoT itself.
  - Drives down IQI labor costs and enriches measurement data.
  - Machine processing releases value from detailed traceability data, correlations, bias correction functions, etc.
  - The IoMT with its inherent network and large numbers would naturally and easy benefit.

MII (Digital) Documents



Human and paper walls block every data exchange.

MII Design Properties

- Standardization—The SI and other norms should inform its models.
- Interoperability—machine-readable measurand metadata
- Data Completeness—data retention for downstream computation
- Identity—a unique identity code for every reusable element
- Extensibility—backward and forward version compatibility
- Authentication and Authorization—security protection features
- Revocation—mechanisms to revoke documents when appropriate

MII Core Metadata

Metadata Modules	Submodules and Data Elements
administrative data	organizations, services, localization, identifiers, authentication, approvals, registrations, configuration management
instrument data	measurement functions, measuring ranges, influence quantities, input quantities, measurement model, automation commands
operating conditions	rated, reference, storage, transportation, and operation quantity value intervals
measurement data	measured, nominal and reference values, traceability, bias correction parameters, measurement quality metrics, environmental conditions
uncertainty data	coverage intervals and probability, distributions, degrees of freedom, correlations, Monte Carlo results

An Example IoMT Metadata Packet

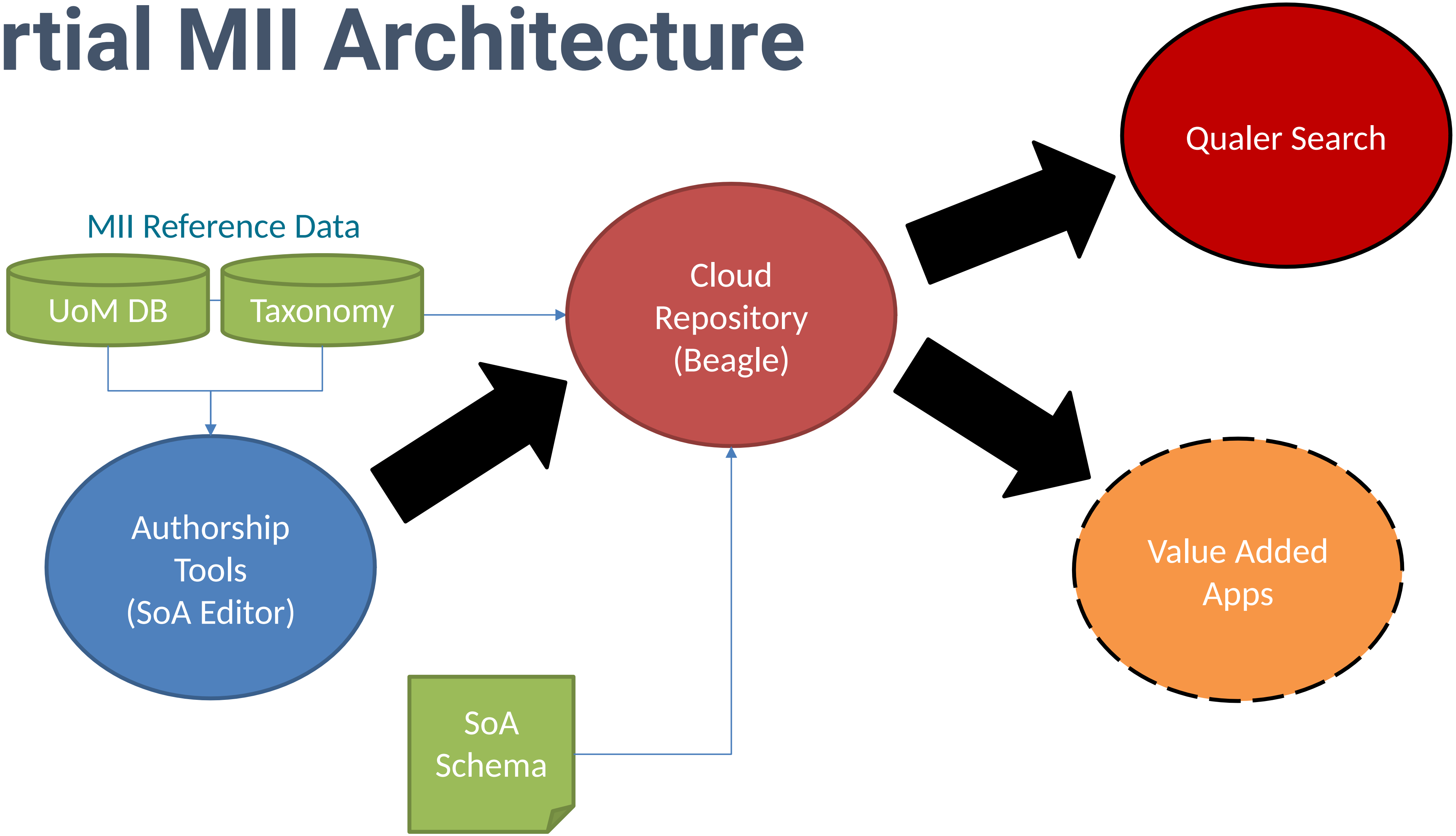
Data Element	Comment
Device Identifier	device dependent, e.g., UUID
...	device-dependent data packet
Measurement Result	quantity value
Measuring Range ID	UUID
MII Instrument Specification Identifier	optional URI
MII Calibration Certificate Identifier	optional URI, if calibrated

- IoMT devices may store references to full MII documents.
- MII-aware software or services may accept authorized requests and the unique range identifier, and respond with the desired interoperability data.

IoT Progress

- High-level document data models
- XML schemas for quantities & units, CMCs and the SoA
- Quantities and units database editor
- Intelligent SoA search demonstration sites (see paper)
- Measurand taxonomy in progress (> 150 drafted)
- SoA editor in progress
- NCSLI MII specification document in progress

Partial MII Architecture



Taxonomy—Metadata for Interoperability

- A single unique taxon to encode every measurand and process
- Each process defines output, input & influence quantities, property parameters, measuring range, operating conditions, aliases, etc.
- See paper for structure rules
- Example taxons:
  - Measure.Pressure.Pneumatic.Absolute.Static
  - Source.Current.AC.SineWave
  - Source.Temperature.Simulated.RTD
  - Measure.Resistance.Insulation

Collaboration

- An appropriate consensus of independent pursuits seems fruitful.
- Besides NCSLI, other organizations pursue metrology digitization:
  - BIPM: SI measurement data exchange
  - PTB: Legal metrology digitization and more
  - MSL: Digital traceability and interoperability
  - ATS Metrology, Fluke Corporation: Calculable instrument specifications
  - Multiple organizations: Digital certificates
- Let’s collaborate!

Acknowledgments

- Thanks to . . .
  - MetroInd4.0&IoT 2020
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  - NCSLI 141 MII & Automation Committee members
  - Cherine Marie-Kuster
- Thank You for your time!
- Questions?
- Collaborations?