

Metrology Information Infrastructure Open Forum

History, Inception and Vision



Toward a Metrology Information Infrastructure

Inception and Motivation

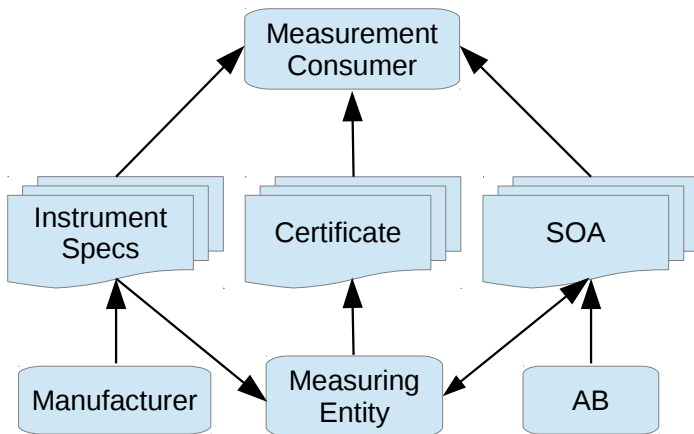
World-wide, people have created many puzzle pieces for decades. A hundred scattered conversations began to coalesce ca. 2011-12. Enter Linda Stone, NCSLI Media Coordinator

NCSLI Metrologist started a conversation in 2013:

- The measurement world automates test & calibration.
- Much other metrology software exists
 - Lab management systems
 - Enterprise management systems
 - Analytical software for uncertainty, etc.
- Many local benefits
- ... but the systems by and large do not communicate.

Why haven't we automated the bigger picture?

Measurement Information Flow



Small excerpt from a vast network

Typical Manual Information Processing Tasks

- Search for information
 - Acquire candidate spec sheets from vendors
 - Analyze specifications to select instruments
 - Search AB web sites to obtain SOAs
 - Examine CMCs to find suitable MEs
- Validate information
 - Validate certificates against SOAs
 - Reconcile certificate content against requisitions
 - Verify measurement results vs. specifications
 - Initiate non-conformance notices

Typical Manual Information Processing Tasks

- Maintain information
 - Augment SOAs as they expire
 - Copy calibration results to measurement software
 - Update data files and uncertainty budgets
 - Summarize measurement results on certificates
 - Send certificates to customers
 - Transfer test results to software systems
 - Archive and retrieve documents
- Analyze information
 - Determine calibration or verification points
 - Transform uncertainty analyses into SOA CMCs

Accredited Lab Search Example

Search A2LA Directory of Accredited Organizations

Search For

Commercial Status

Certificate #

Organization Name

City

State

Country

Zip

Accreditation Field

Sort Order

Accredited Lab Search Example

Your query returned 24 records

Certificate#	Organization	Contact	City, State	Country	Phone	Comm Code	Field	Standard	Expiration
1009.01	Accu-Check Instrument Service, Inc.	Robert Vaughan	Lancaster, OH	United States	740 654 0500	C1	Calibration	ISO/IEC 17025:2005	07/31/2016
2171.01	ACR Technical Services, Inc.	Richard Hogan	Newport News, VA	United States	757 890 0460	C1	Calibration	ISO/IEC 17025:2005	10/31/2016
3467.01	Al Hoty Calibration Services - A Branch of Al Hoty Co. Ltd.	Wendell Arevalo	Al Khobar 31952,	Saudi Arabia	00966 3 864 4150	C1	Calibration	ISO/IEC 17025:2005	08/31/2017
2260.01	Alpha Controls & Instrumentation Inc.	Slava Pecurov	Markham, Ontario L3R 3V8,	Canada	905 477 2133 x228	C1	Calibration	ISO/IEC 17025:2005	01/31/2017
71.05	Bowser-Morner, Inc.	Robin Wolfe	Dayton, OH	United States	937 236 8805 x 226	C1	Calibration	ISO/IEC 17025:2005	01/31/2016
3781.01	Cal-Tec, Inc.	Chris Grevemberg	Broussard, LA	United States	337 839 0450	C1	Calibration	ISO/IEC 17025:2005	05/31/2017
2147.01	ENI Labs	Andrew Burd	Fort Wayne, IN	United States	260 471 6775	C1	Calibration	ISO/IEC 17025:2005	03/31/2016
2496.01	Eustis Co., Inc./Pyrocom Calibration Lab	Bill LeMesurier	Lynnwood, WA	United States	425 423 9996	C1	Calibration	ISO/IEC 17025:2005	10/31/2016

Accredited Lab Search Example

Searching for “Dry well”

Liquid-In-Glass Thermometers ³	32 °F	0.6 °F	Comparison to digital thermometer in water bath at fixed point (32 °F)
	(68 to 662) °F	0.52 °F	Dry block calibrator

Accredited Lab Search Example

Searching for "Dry well"

Calibration of Thermocouple Wires ³ – Type J,K,T,E,R,S,C,U,N	32 °F	0.61 °F	Ice bath/precision thermometer CMART 25 calibrator, Fluke 5502A
Type J	(91) °F to (660) °F	0.43 °F	Fluke metrology well CMART 25 calibrator
Type K	(91) °F to (660) °F	0.43 °F	Fluke 5502A
Type T	(91) °F to (400) °F	0.43 °F	
Type R	(91) °F to (662) °F	0.43 °F	
Type S	(91) °F to (662) °F	0.43 °F	
Type E	(91) °F to (662) °F	0.43 °F	
Type C	(91) °F to (662) °F	0.43 °F	
Type U	(91) °F to (662) °F	0.43 °F	
Type N	(91) °F to (662) °F	0.43 °F	

Accredited Lab Search Example

Searching for "Dry well"

<p>Indirect Verification of Rockwell Hardness Testers³ –</p> <p>Rockwell and Portable Rockwell</p>	<p>HRA: (60.5 to 69) HRA (70 to 79) HRA (80 to 92) HRA</p> <p>HRBW: (0 to 59) HRBW (60 to 79) HRBW (80 to 100) HRBW</p> <p>HRC: (20 to 35) HRC (35 to 60) HRC (60 to 80) HRC</p>	<p>0.42 HRA 0.41 HRA 0.29 HRA</p> <p>1.5 HRBW 0.92 HRBW 0.66 HRBW</p> <p>0.59 HRC 0.51 HRC 0.47 HRC</p>	<p>Indirect verification per ASTM E18, E110</p>
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Accredited Lab Search Example

- 24 scopes to search
- Too often fruitless
- Many other possible search terms
- With several ABs, the USA multiplies the difficulty.
- International operations also use multiple ABs.
- Makes your lab a needle in the haystack
- Similar problem for instrument searches
- No fun!

An Easier Way

Flights

Round-trip One-way Multi-city

Dallas (DFW) 2 travelers, Economy

Include nearby

Exact dates

Depart

Return

Well defined search parameters

Taxonomy

- AKL Auckland, **New Zealand** - Auckland Intl
- CHC Christchurch, **New Zealand** - Christchurch
- WLG Wellington, **New Zealand** - Wellington
- ZQN Queenstown, **New Zealand** - Queenstown Intl
- DUD Dunedin, **New Zealand** - Dunedin
- NSN Nelson, **New Zealand** - Nelson
- ROT Rotorua, **New Zealand** - Rotorua

Show airports on map

Standards and automation behind the scenes: Open Travel Alliance

Search hundreds of travel sites to find the right flight.

MII

Why not apply similar technology to accredited lab searches?
What about instrument specs? Certificates with embedded traceability, uncertainty, error corrections, . . . ?

Definition

Measurement Information Infrastructure—a set of normative standards that define data structures, taxonomies, service protocols and security for locating, communicating and sharing measurement information

Motivation

An MII realization would empower developers to incorporate MII features into measurement-related software, streamlining many tedious and error-prone tasks, improving traceability, engendering new service opportunities, and generally increasing the value and quality of testing, calibration and measurement.

Automated Possibilities

- Publish machine-readable information
 - OEM software creates spec sheets for vendors to post.
 - Lab software writes and posts CMCs
 - AB software generates and posts SOAs.
- Find information
 - A user enters measurement requirements into MII SW.
 - User software locates suitable instruments and labs.
 - The user selects the instrument and lab.
 - Software writes purchase orders and transmits requirements.

Automated Possibilities

- Validate and use information
 - Lab software creates test points from the requirements and MII certs for its equipment.
 - Lab software generates an automated measurement procedure.
 - Lab software tests the instrument and issues a calibration cert.
 - User software validates the certificate.
 - User software initiates any non-conformance actions.
 - User software updates systems with corrections & uncertainty.
 - Software validates data at every step.

Measurement Information Vehicles

- Instrument data sheets (specifications)
 - Designed and warranted performance
 - Manufacturers → potential customers & instrument users
 - Manufacturers, re-specifiers, vendors, specifiers, users
- Certificates (test, calibration, etc.)
 - Measured performance
 - MEs → instrument users
- Statements of accreditation (SOAs)
 - A measuring entity's (ME) accredited services
 - CIPM MRA, unaccredited "scopes of capability"
 - MEs → accreditation body (AB) → MEs, instrument users
- Measurement information circulates through these documents.

Centered on Measurement Data

Absolute Uncertainty Specifications

± 5 °C of Calibration Temperature

Voltage Range	Frequency Range	Absolute Uncertainty			
		AC/DC Transfer Mode ± ppm 2 Years	Measurement Mode ± (ppm of Reading + μV)		
			90 Days	1 Year	2 Years
2.2 mV	10 Hz - 20 Hz		1700 + 1.3	1700 + 1.3	1700 + 1.3
	20 Hz - 40 Hz		740 + 1.3	740 + 1.3	740 + 1.3
	40 Hz - 20 kHz		420 + 1.3	420 + 1.3	420 + 1.3
	20 kHz - 50 kHz		810 + 2.0	810 + 2.0	820 + 2.0
	50 kHz - 100 kHz		1200 + 2.5	1200 + 2.5	1200 + 2.5
	100 kHz - 300 kHz		2300 + 4.0	2300 + 4.0	2300 + 4.0
	300 kHz - 500 kHz		2400 + 6.0	2400 + 8.0	2600 + 8.0
500 kHz - 1 MHz		3200 + 6.0	3500 + 8.0	5000 + 8.0	

Similar information

- Measured quantity (electric potential difference)
- Influence quantities (frequency)
- Quantity values (ranges, MPE, results, uncertainty)

Centered on Measurement Data

Parameter/Range	Frequency	CMC ^{2,4,5,6,7} (\pm)	Comments
AC Voltage – Generate, Fixed Points			
2 mV	10 Hz, 20 Hz, 100 Hz, 1 kHz, 10 kHz, 20 kHz, 50 kHz 100 kHz	0.02 % 0.022 %	Fluke 792 AC/DC Transfer Standard with AC Divider

Similar information

- Measured quantity (electric potential difference)
- Influence quantities (frequency)
- Quantity values (ranges, MPE, results, uncertainty)

Centered on Measurement Data

Calibration Data					
Parameter	Nominal Value	Measurement Result	Limits of Error		Expanded Uncertainty
			Lower Limit	Upper Limit	
INPUT 1 ABSOLUTE AC ERROR					
2.2mV Range, 2mV Applied					
1 Year Specification Limits shown					
0.0 $\mu\text{V/V}$ @ 10 Hz	0.00	XXX.X	-2350.0	2350.0	200 $\mu\text{V/V}$
0.0 $\mu\text{V/V}$ @ 20 Hz	0.00	XXX.X	-1390.0	1390.0	200 $\mu\text{V/V}$
0.0 $\mu\text{V/V}$ @ 100 Hz	0.00	XXX.X	-1070.0	1070.0	200 $\mu\text{V/V}$

Similar information

- Measured quantity (electric potential difference)
- Influence quantities (frequency)
- Quantity values (ranges, MPE, results, uncertainty)

MII Technology Elements

- Semantic data structures—old hat
 - *VIM, ISO 80000-x*: ontological foundation & taxonomies
 - SysML, ATML (*IEEE 1671.x*), MIMOSA infrastructure
- File formats
 - XML (eXtensible Markup Language) for one
 - Many others: JSON, YAML, etc.
- Communications Protocols
 - SOAP (Simple Object Access Protocol)
 - REST (Representational State Transfer)
- Security
 - Public certificates to verify signatures & logos
 - Encryption for confidentiality if required
- Norms (standards)
 - Metrology & commerce revolve around them.
 - Up front consensus or defacto development

MII Forward Action

Plenty of MII work proper . . .

- Identify and involve stakeholders
- Identify useful ISO, IEEE, etc. standards
- Research metrology taxonomies
- Refine and implement MII document models
 - Instrument specifications
 - Accreditation scopes
 - Test and calibration certificates
 - Available on the MII Community page at ncsli.org
- Research web services options
- Design web service protocols for MII documents
- Draft MII-specific standards, recommended practices

MII Support Work

... and plenty of enabling development work.

- Software development
 - Demo MII document editors
 - Demo MII-aware applications
 - Demo MII web site(s)
 - Standard APIs for interfacing any software to the MII
- Metrology enhancements—more accurate data to practitioners
 - Automation changes the economics, creates opportunities
 - Makes manually impractical refinements practical
 - METAS: traceability structure with upstream correlations
 - GTC: propagates *uncertain numbers* via scripting
 - METBENCH: arbitrary instrument spec equations, parameters bound to measurement results at cal time
 - Instrument modeling, measurement model libraries

Conclusion

The requisite systems and technology already exist.
We only lack applying them within a consensus framework.

Volunteers? Contact us!

MII community page at ncsli.org

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