47: Internet Calibration

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1 USE OF INTERNET TO CONDUCT CALIBRATION

Regular instrument calibration is an essential part of today's quality driven measurement environment, and a traceable link to a national or international standard should be present. Achieving traceability requires a laboratory to periodically send their standards to be calibrated at a National Measurement Institute (NMI), acquiring a certificate and correction values. The standards are measured under carefully controlled conditions at the NMI, but there is no guarantee that these conditions will be reproduced when the standards are used at the remote laboratory. Furthermore, in some cases, the value of the standards can be affected by transport leading to an uncertainty component, which is difficult to assess.

The downtime experienced by laboratories fulfilling calibration schedules can be extremely disruptive and costly while the equipment is sent away. On the equipment's return, system checks, paperwork, and the update of soft or hard calibration figures compounds the delays. Implementation of remote calibrations using the Internet as a data transmission medium has emerged as a solution to all of the transportation, environmental, downtime, and cost issues present in current calibration schemes. Additional benefits emerge in the dissemination of measurement techniques and good practice equally to all laboratories using an Internet service.

The use of the Internet to assist in metrology has taken a number of forms. In the simplest case, the Internet acts as a means of exchanging information between two remote sites with human operators at each end using video or interactive links (Filipski, 1999).

The second stage of development was remote monitoring of sensors (Lee and Schneeman, 1999 and O'Dowd *et al*., 1997).

However, services are emerging that are truly remote calibrations. These allow a laboratory to log on to a site, perform an accredited measurement and create a full uncertainty evaluation instantly (Dudley and Ridler, 2000, 2001).

Services that offer online standard or instrument calibration have become known as *Internet Calibration Services* or iCals.

2 TYPE OF MEASURAND SUITED TO INTERNET CALIBRATION

Clearly, Internet calibration is not applicable to all metrology areas, because physical constraints or human interaction are essential for some measurements.

However, measurements that rely on a standard issue instrument, on artifact, or are distinctive in the software developed as part of the calibration process, are open to Internet implementation. The implementation of remote calibration via the Internet varies considerably with each

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measurement example but some general rules are that the system must have one of the following:

- Stable calibration artifact with easily verified performance check.
- Easily transported measurement artifact from which the calibration is derived.
- Unique software for calibration and uncertainty calculation.

3 PROCEDURES FOR CARRYING OUT AN INTERNET CALIBRATION

A laboratory undertaking an Internet-based calibration observes a number of advantages during the measurement process compared to a conventional method. Once a computer has been connected to the measurement system, typically through GPIB (General Purpose Interface Bus) or RS-232 ports, the laboratory only needs to log on to their calibration service provider.

Once connected to the system, the measurement system, standards, and instrumentation are known by the iCal service. It instructs the operator, in the correct order, to perform the measurements.

Effectively, the iCal system provides the operator with a soft procedure to perform the measurements assuming, of course, the operator is skilled and has been accredited with using the system.

Once the measurement procedure is completed, the iCal system generates the required final data with uncertainties ascertained from the measured and database information, providing the operator with a certificate if applicable.

During the measurement process, there is potential for the iCal system to provide measurement assistance screens with video or procedural details for specific parts of the process. In no way does an iCal system 'de-skill' the calibration operator; instead, it provides the maximum assistance to ensure an accurate and efficient calibration.

In addition, the iCal service provides the administration with any measurement procedural changes through new international standards and ensures all groups are following common guidelines. Finally, data warehousing and historical records are automatically kept on the iCal service Web site and can be accessed and checked with minimal demands on the service users.

4 EXAMPLE OF AN INTERNET CALIBRATION SERVICE

The first true iCal service was developed by the UK's National Physical Laboratory (NPL), (Dudley and Ridler, 2000, 2001). It combines the technology of remote monitoring, remote control, and NMI calibration techniques for application in a microwave frequency measurement system called *vector network analysers* (VNA).

VNAs provide a swept frequency measurement of the transmission and reflection coefficients for an electrical network. Calibration is performed using instrument firmware and a set of standard devices, all of which are assumed to be ideal and are available as standard items from the VNA manufacture.

Correction of the measurement data to that of the NMI comes via precision verification artifacts, air-spaced transmission lines, attenuators and terminations, whose properties change little over time. An external computer, running a specially designed code, controls the calibration and evaluates the uncertainty in measurement. The extension of control across the Internet is ideal for this particular system.

A calibration procedure under non-Internet conditions requires the client to send the calibration laboratory their precision verification artifacts for periodic calibration. The NMI returns the verification device plus certificate and correction data, Figure 1(a). The client must then implement their measurements using the verification information and introduce their own uncertainty budget. It should be noted that typically a 1 to 18 GHz calibration for a VNA results in several thousand correction values being generated. The majority of VNA firmware does not allow inclusion of these correction values and a client will usually have to resort to creation of proprietary control software or use a spreadsheet to correct measured data using the calibration information.

The Internet version, while not removing the need for physical movement between sites of the instrument's standard reference, does simplify the process, Figure 1(b).

When the NMI receives the client standard, all correction factors are stored in an online database. The standard is returned, but now all a client needs to do to measure a device with traceability is to connect their control PC to the service Web pages.

While online, the client enters the required measurement parameters and is offered options based on the knowledge the NMI has about the client's equipment. From this point, the entire measurement process is controlled by NMI and the need for clients to assess their own uncertainty budget is removed.

There exists great potential for many new applications of Internet calibration and metrology. Applications are being investigated in the medical and optical networks markets. The optical communications network provides a method of a real standard transfer for wavelength measurements.

If telecommunications networks were all-optical – they are presently a combination of optical and electrical – it would be possible for an NMI to distribute a wavelength

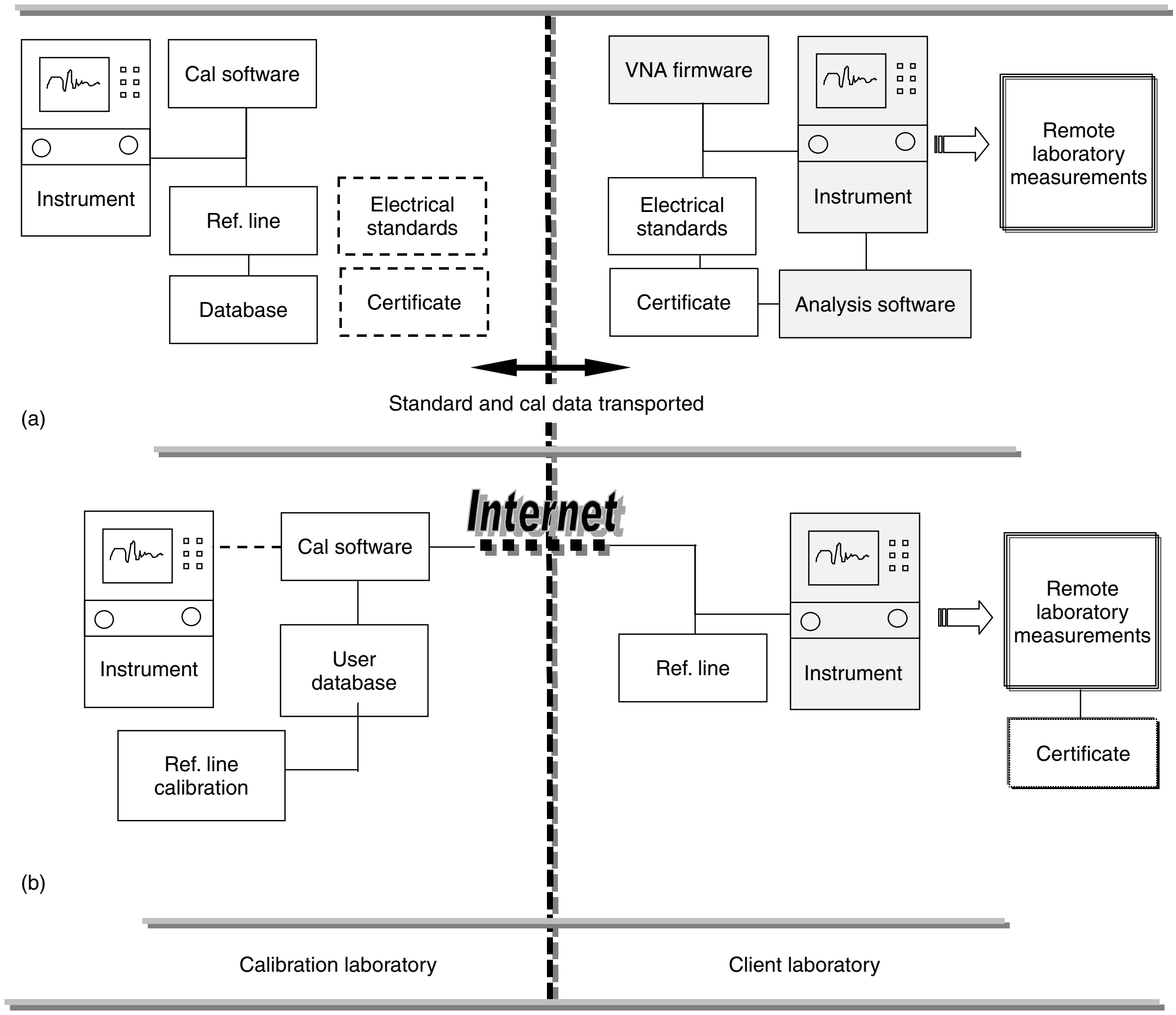

Figure 1. (a) Basic components of Internet calibration system: artifacts, instrument and control firmware, producing a certificate for the remote laboratories' artifacts. (b) The Internet system removes the need for traveling verification artifacts by allowing direct access to the calibration software and client historical database.

standard into the network creating a 'real' international standard artifact.

Other possibilities such as frequency, noise, and possibly time stamping could be placed on the back of the wavelength standard for added value. Futher information is found on http://www.internetcalibrations.com.

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