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Title: **INTEGRATED REVIEW SOFTWARE ADVANCES AT LOS ALAMOS**

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Integrated Review Software Advances at Los Alamos

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Abstract

Since 1988, Los Alamos National Laboratory (LANL) has been developing software for unattended monitoring systems. These systems are composed of three categories of software: acquisition, collection and review. The data acquisition software is contained in modular instrumentation distributed throughout facilities to continuously acquire data from devices ranging from radiation detectors to cameras to binary switches. The data collection software runs on computers connected to the instruments and offloads and stores the acquired data. The review software enables the end user to quickly and easily examine the data collected from these different systems and compare the results to declared operator activities. This paper addresses the review software.

The original standalone review software processed only radiation data. This software was expanded to include new programs (tools) to display and correlate video and operator declarations and added an interface to the standard neutron coincidence counter analysis program. This expanded review software containing multiple review tools is referred to collectively as the Integrated Review Software (IRS). The IRS continues to expand and evolve. Two primary IRS developments will be described in this paper.

First, the IRS was expanded to include review tools to display and analyze new data types. Position Review was developed to display Global Positioning System (GPS) location data to aid in tracking radiation movements. Isotopic Review is being developed to provide a link to the standard gamma isotopic analysis software. In addition significant enhancements are being added to the existing review tools such as Operator Review, Radiation Review and Digital Video Review.

A second IRS development is to produce standardized components with published interfaces enabling other parties to produce custom components that plug into review software. It is anticipated that there will be four primary types of components that could be developed by any party: import, analysis, display and report. In addition there are some common manager components that perform the same task for all the IRS review tools. Several import components as well as two manager components have been developed and are now being used in the latest version of the IRS.

Introduction

The unattended monitoring system developed by the LANL Safeguards Science and Technology group has been developed primarily in support of International Atomic Energy Agency (IAEA) safeguards to be used in facilities where continuous coverage is required. The system has been in development since the late 1980s and is composed of orthogonal hardware and software building blocks.[1,2,3] For each facility, an appropriate subset of the hardware and software building blocks are

deployed as required to meet the safeguards needs at the facility. Because the building blocks are orthogonal, individual components can be upgraded or replaced without affecting other components in the system. As the building blocks are upgraded, care is taken to maintain backwards compatibility. The original instruments used in the systems were instruments developed for attended use. As these instruments were upgraded to better perform unattended measurements, complete instruments were replaced in the system. Currently individual integrated circuit boards are updated, rather than replacing entire instruments. As computers have evolved, it has become possible to create software with greater capabilities. The number of collection programs has been reduced by providing one data collection program that can interface to all instruments rather than a separate data collection program for each instrument type. The original review programs to display and analyze data coming from single instruments have been combined into a single review program while maintaining backwards compatibility so that data acquired in 1988 can still be reviewed with 2004 software. As the need for integrating radiation data with other types of data, such as operator declarations, binary switches or video images, arose, new review programs have been written to handle the display of these new data types in conjunction with the radiation data.

The unattended monitoring software is broken into three groups: acquisition, collection and review. The divisions are based on where the software performing the tasks is running and also the timeliness of when the information is needed.

Acquisition: The firmware that runs in the various instruments acquires data from the detectors and makes all real-time decisions, such as signaling that a threshold has been exceeded. The firmware in each instrument is completely capable of running standalone and requires no interaction with an external program other than occasionally getting its data off-loaded.

Collection: The data collection software runs on the computer connected to the instruments and it performs tasks that do not have real-time processing requirements. It downloads data from the instruments and provides information on the state-of-health of the system; in some systems this state-of-health information is transmitted to IAEA headquarters on a daily basis. It is necessary that the data collection software run only as often as state-of-health is desired or downloading instrument data is required.

Review: The review software is used on a less frequent interval, usually in terms of days or even months. Its primary purpose is to provide an easy, quick way to review what has happened at the facility since the last time the review software was run and to help reconcile the activities observed by the unattended monitoring system with the declarations provided by the facility operator. It is only necessary to run it as often as the data need to be reviewed.

IRS Review Tools

The Integrated Review Software (IRS) is composed of several different programs, called review tools, each review tool being associated with a specific type of data. At the present time, there are 7 review tools that comprise the IRS. Radiation Review, IAEA Neutron Coincidence Counter code (INCC), Digital Video Review, Operator Review, and Integrated Review have been reported on previously.[3] Position Review and Isotopic Review were recently added. Anytime two or more of these review tools are used to review a data set, the combination of the review tools being used is referred to as the IRS. For any given facility, only the review tools that are needed for the facility data are used. Thus each facility may have a unique subset of the IRS review tools installed.

There are special requirements that a software program must meet in order to be considered to be part of the IRS:

- It accepts commands (start, exit, import, setup, review, reanalyze) from a main controlling review tool to perform tasks (mainly in an automated fashion) and responds in a pre-defined manner at conclusion of the task.
- It supports time-matching messages with other review tools. Upon receiving a time matching request, the review tool shows its data in a format appropriate to the data type it is designed to display. Also, any review tool can send a request to another review tool to display its time-matched data.
- Output files produced by any individual review tool are written in an agreed-upon format so that other review tools can read them.

By supporting these capabilities, the IRS provides end users with a way to automate tasks that are repeated often. Also with systems where other types of data are integrated with the radiation data, the IRS allows the user to easily view the associated data to help define more clearly what has happened at a particular location and time.

These capabilities are implemented via each review tool including common code referred to as the IRS Upper Layer. The IRS Upper Layer allows each review tool to conform to the above requirements and to operate in a stand-alone, paired, or hierarchical configuration. In stand-alone mode, the review tools just perform their basic functions. When used in any combination mode (part of an IRS), the review tools are linked together and allow users to easily navigate various review tools to view data based on time. When the review tools are installed in a hierarchical configuration, Integrated Review (reconciliation) becomes the commander and orchestrates the actions. Using a single review tool as a commander presents the user with an interface that makes it look like all the individual review tools are part of a single, integrated data review application.

The following paragraphs give brief descriptions of the various review tools:

Radiation Review (RAD)

Radiation Review[4] displays and analyzes radiation data that was collected by Multi-Instrument Collect (MIC). The primary functions of RAD are to import data from various instruments, perform integrity checks on the data, perform specialized analysis of the data, display data and results on a highly flexible time-based strip-chart graph, and produce summary reports. In addition to supporting data from Gamma Ray and Neutron Detector (GRAND), MiniGRAND, Jomar Shift Register (JSR) 11/12s, Advanced Multiplicity Shift Register (AMSR) and MiniAnalog to Digital Converter (MiniADC) instruments, RAD has added support for binary and VXI Integrated Fuel Monitoring (VIFM) data. Also, another significant advance is the inclusion of the powerful, easy-to-use Facility Manager to specify the facility instruments and detectors.

IAEA Neutron Coincidence Counter (INCC)

INCC[5] is the standard IAEA software used for neutron analysis of data acquired from shift-register instruments either in attended or unattended mode. The attended mode program was modified to include the IRS Upper Layer as well as including capability to automatically import data from measurement runs identified using Radiation Review and subsets of operator declarations from Operator Review. This information is then used to calculate the mass value of the measurement and

compare results to the operator declaration. As new analyses are added to INCC, they become available for end users to use in either attended or unattended modes.

Digital Video Review (DVR)

Digital Video Review[6] displays digital images through an interface similar to a VCR (play forward, play reverse, stop, etc.). The intention of DVR is to provide users with the capability to display images which can provide additional information in determining what has happened with a radiation movement detected by RAD; it is not intended to perform the classical surveillance video review. DVR contains the IRS Upper Layer allowing correlation of images with radiation events displayed in RAD. The software design separates the video control panel (containing the IRS Upper Layer) from the video display panel that could be specific to a digital camera system. This allows each digital video vender to easily supply a video display panel that is appropriate to their specific digital video format. Display panels have been provided by the Aquila Technologies Group, Inc. (ATG) for the Gemini-N and the Neumann DCM-14 camera system. The original DVR supported reviewing relatively few images in a near-real-time basis (hours or days). A second generation version of DVR is being developed by LANL and ATG to support display of large numbers of images collected over long periods of time and to provide the end user with more flexibility in which images are displayed.

A previous video review tool called Time Lapse Recorder Review (TLR) was used with a specific VCR that is no longer used by any IAEA facilities. Support for this review tool has been dropped.

Operator Review (OP)

Operator Review[7] displays facility declarations that have been provided by a facility operator in a table format. The user can scroll through the table to view all declarations and highlight table cells as needed. Currently, these declarations are written in a text file in facility-specific formats which require a unique facility-specific program to interpret each facility declaration. It has been proposed to upgrade Operator Review to be more flexible in the formats of declarations and to eliminate the need for unique facility-specifc conversion programs. Multiple file formats with user-defined columns would be supported.

Integrated Review (IR)

Integrated Review[8] is used to command other review tools to run in automated mode to perform data import and analyses, display the data summaries produced, and determine whether the disparate data matches according to facility-specific-rules that can be defined within IR. The rules include which columns are to be compared and the allowable data tolerances, if applicable. Results of the comparison are indicated in the summary table by both color and text (R = Reconciled, P = Partially reconciled, U = Unreconciled). The end user can further investigate the data by requesting time matches to other review tools.

Position Review (POSR)

Position Review displays the latitude/longitude location on a user-selected map. In some systems where the irradiated material is expected to move a significant distance, GPS latitude/longitude coordinates are recorded every x minutes as the material is moved. POSR imports the GPS data recorded and displays it on a user-selectable map. The user can display the location information in a manner similar to images with a VCR-like control to play the location forward in time, backwards

in time, etc. Configuration of instruments at facilities is handled by using the common Facility Manager component. There is also the capability to display the raw data points in tabular format. A map manager capability allows the user to select the map on which the data are to be displayed, to calibrate the map and to specify the definition of colors used on the map display. Figure 1 shows time-matching data from POSR, DVR and RAD.

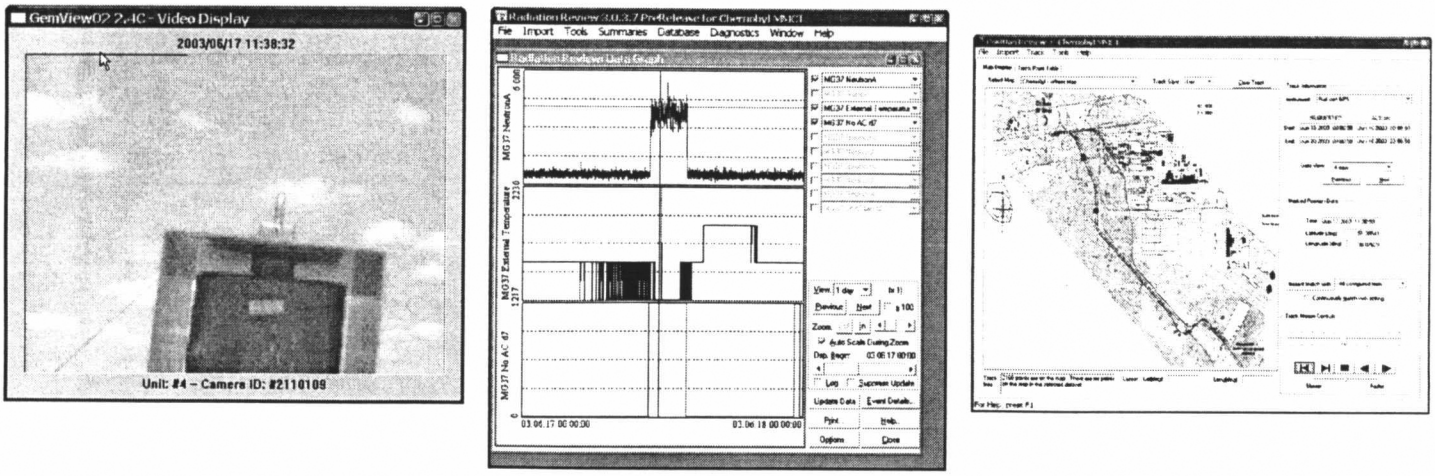

Figure 1 Data at a common time displayed by multiple review tools. The radiation data for a time span is shown on the RAD graph with the red cursor indicating a specific time. Supporting information is provided by a video image from DVR and the coordinates showing location on a map by POSR for the same time indicated by the RAD graph cursor.

Isotopic Review (ISO)

Isotopic Review[9,10] is used to provide a link to the standard gamma spectral analysis package, Stand-alone Fixed energy Response function Analysis with Multiple efficiencies (SFRAM), into the IRS. ISO contains the IRS Upper Layer which handles all communication with other review tools. In addition it performs facility-specific analysis and summaries. For example, summary displays comparing measured and declared isotopic information might be provided.

IRS COM components

The original approach with the IRS review tools was to develop a review tool for each data type. This supported the orthogonal approach. As data types were added to the system existing review tools did not have to be modified. As the review tools evolved several observations were made:

- Third-party vendors - When the IAEA standardized on the IRS as its common review software, the capability for other support programs and vendors to be able to add their data types and algorithms to the IRS became necessary. Contributions from other vendors were not easily supported in the original design.
- Adaptability – The IRS was constantly evolving with new data types and review analyses, displays, or reports being added. Some review tools, particularly RAD and INCC, were large programs and integrating new capabilities into these programs required the subject-matter specific software experts at Los Alamos.
- Lack of Common "Look and Feel" - Many review tools contained common functionality, such as importing data, but there was not a common "look and feel" to the process.

- Configuration – Setting up any facility was difficult because of the need to keep all the orthogonal components in data acquisition, collection and review synchronized with respect to instruments present, channels used, etc.
- Maintenance – Minor updates required full reinstallation of review tools being used.

Clearly, a new approach that provided more flexibility was needed. Increased flexibility would potentially yield shorter turn-around time on of requests, reduced costs, eased maintenance tasks, and increased capability for third-party contributions. Newer technology than the original IRS could employ some contemporary software principles (i.e. Plug and Play). However, in keeping with the principles of the evolution of the unattended monitoring system, an approach had to be found that allowed an evolutionary approach so that the many person-years of work that had gone into the existing system could be re-used as the basis for the new approach.

After evaluating different technologies available, it was decided that an approach based on the Component Object Model (COM) technology was the best way to provide the new flexibility needed. The advantages of a defined COM interface specification include: components could be language-independent, Windows-standard methods for versioning, upgrades, and system registration, individual components could be developed in parallel, components could be tested stand alone prior to integration, and components could be reused and shared among the suite of review tools.

The existing review tools were analyzed and it appeared that the functionality could be captured in 4 types of COM components:

- Import – reading raw data files, storing the data in a component-specific manner and providing a common method for other components to access the data
- Analysis – retrieving data from various Import COMs, analyzing the data, storing results and providing a common method for other components to access the results
- Displays – providing a method so that data from Import or Analysis components can be displayed in ways that make sense for the data (i.e. on a graph or as an image or as a point on a map or a line of results in a table),
- Reports – summarizing results (on a screen, printer or saving to file) from the other components in a common manner.

In addition to the components that did the import, analysis, display or reports, it was also necessary to provide components that provided the management of these types of components, these are called managers. The managers provide functions such as holding all the facility configuration data, linking together all the import or analysis components, etc.

To test the approach that looked good on paper, two prototypes were developed. Concerns included: could existing IRS review tools be evolved to the COM approach and would COM technology make actions such as importing large amounts of data so slow as to be unacceptable. The first Import COM component developed was for importing GRAND data into Radiation Review. The existing code to import GRAND data was removed from Radiation Review and re-wrapped in a COM component. Timing tests could be performed using identical data sets with the traditional Radiation Review and the new COM-based Radiation Review. The tests showed that the import speed was essentially equal and that it was possible to easily integrate the COM technology with the older Radiation Review code. A second prototype, Facility Manager, was created that

addressed some of the configuration issues of the IRS, and also provided a component that multiple review tools could use, eliminating duplication of common data across tools. There was no existing code to support configuration so Facility Manager was written as a new component but it had to support existing configurations "rules" and "axioms" developed over the past 15 years. By developing these capabilities as COMs, two independent programmers worked on the project in parallel.

Based on these results, it was decided that as new import or analysis capabilities were added to existing review tools or as new review tools were developed, additions would be made by adding COM components whenever practical. At this time several COM components have been developed and are included in the various review tools as shown in Table 1. As funding becomes available, all the IRS review tools will be evolved to be based on COM components. In the near future, the first release of the COM interfaces for managers and import and analysis COM components will be published.

Table 1 COM Components for IRS

COM	RAD 3.0.3	POSR 1.0	ISO 1.0
Binary Import	X		
GPS Import		X	
GRAND Import	X		
Spectral Import			X
VIFM Import	X		
Time Align Import	X		
Import Manager		X	X
Facility Manager	X	X	X

Future developments include defining the interfaces for all the components, developing prototypes to test the interfaces and expanding the Facility Manager COM to contain the configuration for all data acquisition, collection and review parts of a system. The user would then have to enter information for a facility in only one place and then all programs needing that information would retrieve it from Facility Manager.

Summary

The IRS continues to add new review tools that display new types of data that are being integrated into the unattended monitoring systems and to add new data capabilities to existing review tools. A major evolution in the system is taking place as the individual review tools are being converted to a COM-based philosophy with the goals of opening up the architecture to others and reducing costs to add new capabilities to existing review tools.

References (Rita, do we do it differently after things have been published – I copied these from the original papers before proceedings were published)

1. J. K Halbig, S. F. Klosterbuer, R. F. Parker, M. E. Abhold, J. M Audia, Y. Bai, S. C Bourett, S. E. Buck, W. J. Hansen, K.D. Ianakiev, H. O Menlove, D. G. Pelowitz and M. R. Sweet, "Integrated Monitoring System – An Overview" (published in EASRDA 21st proceedings) LA-UR-99-2109

2. R. F. Parker, J. K. Halbig, S. F. Klosterbuer, M. E. Abhold, J. M. Audia, Y. Bai, S. C. Bourett, W. J. Hansen, K. D. Ianakiev and M. R. Sweet, "Integrated Monitoring Hardware Developments at Los Alamos", (published in EASRDA 21st proceedings) LA-UR-99-2053
3. S. F. Klosterbuer, S. E. Buck, D.G. Pelowitz, R. F. Parker, W. C. Harker, J. K. Halbig, and M. E. Abhold, "Integrated Monitoring Software Developments at Los Alamos", (published in EASRDA 21st proceedings) LA-UR-99-2109
4. S. F. Klosterbuer, "Radiation Review User Manual", February 13, 2004, LA-UR-99-1655 (rev.2), RAD-UM-003.001
5. W. C. Harker, M. S. Krick, "INCC Software Users Manual, May 1999, LA-UR-01-6761
6. S. E. Buck, "Digital Video Review User Manual", January 25, 2000, LA-UR-99-2206 (Rev 3), UM-DVR-016.004
7. S. E. Buck, C. M Schneider, "Operator Review User Manual", August 2003, LA-UR-99-2205 (Rev)
8. S. E. Buck, M. E. Abhold, S. F. Klosterbuer, "Integrated Review User Manual, Version 1.32", May 1999, LA-UR-99-1290
9. C. M Schneider, H. A. Nordquist, "Isotopic Review User Manual, Version 0.1", February 2003, LA-UR-03-1517
10. T. E. Sampson, T. A. Kelley, "PC/FRAM, Version 4.2 User Manual", March 2003, LA-UR-02-5268