THE TECHNICAL INFORMATION DATABASE FOR SYSTEMS MONITORED BY THE TCR

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Abstract
A database containing information pertaining to different technical systems monitored by the Technical Control Room (TCR) has been in operation since the conversion of the BBC surveillance system to the LEP control system. This database contains all data that are of interest to monitoring applications such as the alarm system, the TDS, the equipment controllers and the surveillance of installations through mimic diagrams and data logging. It is important that the quality of this data is high so that an accurate picture of the systems being monitored is available at all time to both operators and equipment specialists. The information in this database is related to other data handled by ST Division such as equipment data used in the computerized maintenance system, location and personnel information; it is important that coherence between these systems is observed, if not rigorously implemented. This paper explains the role and implications of this database for the Division.

1 BACKGROUND

1.1 Technical Infrastructure Monitoring in the TCR

TCR operators monitor a wide range of systems essential to the proper working of CERN. These systems are all very different in nature and are under the responsibility of different parts of the Organization. An operator must react quickly and efficiently to randomly occurring events, and often needs to pass on information of a problem detected to a service that can fix the problem.

Since the overwhelming majority of the information available to operators is computer based, the nature of the information appearing through computer applications will have a significant bearing on the service provided by the TCR. These applications are principally the alarm screen, displaying information on problems detected in the various installations, the mimic diagrams, showing the detailed state of an installation, and the data logging system, showing the evolution of measurements.

1.2 Evolution of the TCR

The TCR has evolved in just a few years from the surveillance of around 5000 data points (alarms, measurements, states and commands) using a stand alone “off the shelf” industrial package, to a heterogeneous system incorporating in-house and commercial systems, monitoring up to 100,000 points, covering a more varied and complex spectrum of equipment than before.

Furthermore, the operators have become more transient, so that whereas in the past, knowledge could be accumulated through many years experience, much routine information concerning the installations monitored must now be rapidly available when required.

1.3 The data issue

When reacting to an event detected in the TCR, an operator, and later those contacted to resolve a problem, must be confident that the information they are consulting corresponds exactly to what has been detected in the installation. This can be illustrated by the diagram below:

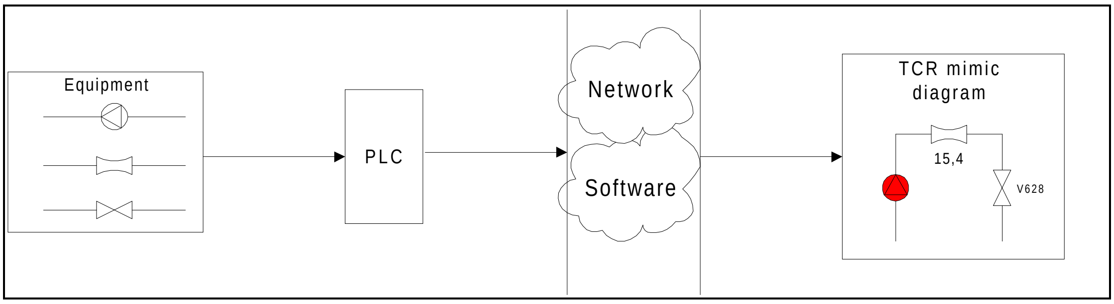

Fig. 1 Example

In the above example the operator, consulting the mimic diagram of a monitored installation, must be certain that the pump whose state has changed has in fact failed (indicated on the screen by a red color). Similarly, the units of the flow value of 15.8 should be known (liters per second or cubic meters per hour); moreover, this value should have had any conversion factor required by the PLC applied to it. Lastly, if asked to take action to close valve V628, the label on the mimic diagram should correspond to the appropriate valve in the installation.

2. THE TECHNICAL SERVICE REFERENCE DATABASE

2.1 The Data Driven Principle

The applications used in monitoring are data driven. This means that the programs rely on parameters that determine how they behave. This design is adopted so that the changes occurring in the monitoring environment do not necessitate software modifications.

2.2 Content of the Monitoring Reference Database

The majority of the data on this database relates to the “points” being monitored. A point is anything in the monitoring environment that can be identified. It covers states (a pump on or off), measurements (temperature of water in a circuit), and commands (open or close a valve).

Basic data such as the description, location, classification, person responsible, physical address, supervision system, etc., is held for each point; additional data is stored depending on the type of point: priority, receiver, and operator help information for alarms; units, upper and lower values for measurements. Other data on the database mainly concerns the configuration of the software modules used in monitoring and the domains used to enforce data validation rules.

2.3 Role of the Monitoring Reference Database

The data supplied to the monitoring applications is held in a database known as TDRefDB. This is an Oracle database running on CERN centrally maintained machines. The data required by each program is downloaded to a file read at execution time. The diagram below shows the relationship between the TDRefDB and the monitoring software.

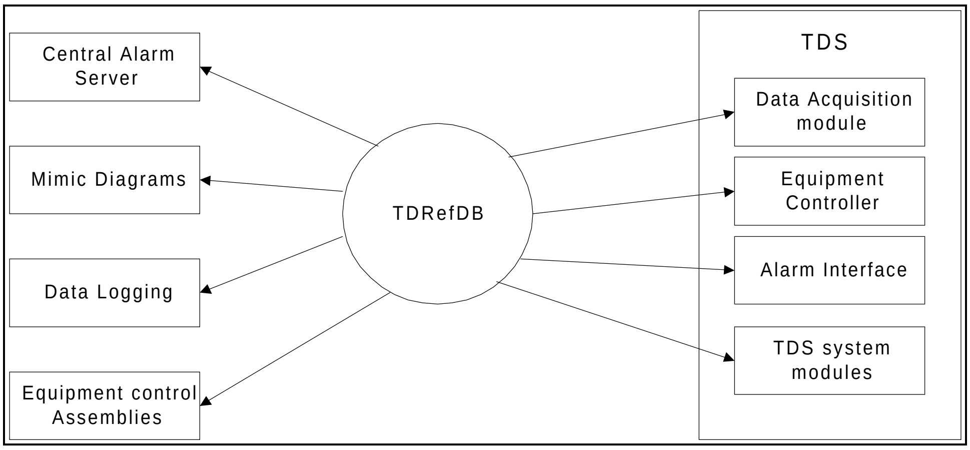

Fig. 2 Relationship between the TDRefDB and the monitoring software.

2.4 Data Usage by Monitoring Applications

2.4.1 The Technical Data Server (TDS)

The TDS was instigated to improve the reliability, performance of data transfer from the equipment level to the operator's applications. It basically gathers data from the diverse equipment connected to the monitoring system and distributes it to client applications used in operation. It is a completely data driven system and each module relies on information from the database to know what to monitor and how to treat the changes that have been detected.

The TDS allows alarm inference and filtering to prevent alarm avalanches; the rules for determining these operations are held on the database and supplied to the program analyzing alarm information.

2.4.2 The Equipment Interface

The equipment interface is responsible for detecting change and transmitting it to the next layer of the monitoring system (it is also but less frequently used for making a change received from the above layer). The high level monitoring applications cannot use the low level equipment hardware addresses as they differ in structure across equipment; there is no guarantee that duplicate addresses will be avoided.

A correspondence between a unique point identifier and the equivalent local hardware address is held on the database. This information is downloaded to the equipment interface so that the appropriate message can be sent to the higher levels of the monitoring system.

2.4.3 The Alarm System

The alarm system will send a message to the operator when a point defined as an alarm has changed state. All the information that is at the operator's disposal for dealing with the alarm, including its possible causes and consequences, will have originated from the database. The nature of the change of state, (from 0 to 1 or 1 to 0) indicating a new or terminated alarm, as well as the control room to which the information should be sent, is taken from the database.

2.4.4 The Mimic Diagrams

By consulting the contents of the database, a mimic diagram developer is able to select the points that will appear on the diagram. The selection will be made based on criteria understandable to the developer, such as the description of the point, its location, the name of the equipment affected, etc. When executed, the mimic diagram program will read a file containing codes of the points dealt with.

2.4.5 *The Data Logging System*

The selection of points to be logged is done in exactly the same way as above. In addition, the logging parameters of a point (frequency for polling or change value for event logging, and data retention period) are also held on the data base. Furthermore, the logging graph display selection interface uses data originating from the database to allow users to chose points for display on the basis of the commonly used classifications and descriptions.

3 DATA QUALITY

3.1 Effect on Operation

As should be clear from the above, any erroneous data entered in the database will find its way to a monitoring application. The effect of this can vary from the annoying, to the catastrophic, where an alarm has been incorrectly defined and therefore goes undetected. Incorrect or ambiguous data will undermine the trust that the operators (and other users) place in the monitoring system and can adversely affect both motivation and job satisfaction.

Whereas significant resources have been invested in building a fast and robust network to transport monitoring information around the site, and efforts have been made to improve software reliability by adopting software engineering methods, very little attention has been devoted to ensuring the data being handled by the monitoring system is correct. Unfortunately, the quality of the network and the software are irrelevant to the results of a computer system if the data input are incorrect.

3.2 Factors Determining Data Quality

The following factors will affect the quality of the data used in the monitoring system (they are examined in more detail below):

(i) Design and reliability of the database holding the monitoring data;

(ii) Definition of standards for the data entered;

(iii) Procedures for entering and maintaining data;

(iv) Appropriate allocation of responsibilities for data maintenance.

3.3 Database Design and Reliability

The database must be able to handle the different types of equipment connected to the monitoring network. It needs to be flexible in order to adapt the requirements of new systems and new applications. The appropriate interfaces must be available to permit loading of data describing a new system to be monitored as well as periodic updating of information. Validation rules should also be implemented on the database to prevent the storing of incoherent or absurd data. The database is backed up regularly so that data is not lost through any malfunction.

3.4 Data standards

Standards are desirable since they enable similar attributes of points to be presented to operators and other users in a consistent way, thereby reducing the risk of misunderstandings and ambiguity. Some standards are the result of the adoption of certain software products, such as the central alarm server requiring alarms to be defined in terms of a “fault family”, “fault member” and “fault code”.

Few standards are currently applied to the monitoring data: there is always a danger of standardizing attributes that may be inherently different across systems, thus introducing inaccuracies in the data. Implementing standards requires agreement between the different people using them, as well as a body officially defining them. Moreover, once a standard has been defined, adherence to it becomes a precondition of using the monitoring system.

3.5 Data Input Processes

The main changes to data occur when new installations are taken on by the monitoring system; this can result in the definition of hundreds of new points. With such a large amount of data being entered into the database the scope for inputting errors is obviously quite large.

By clearly defining the processes that make up data entry, and monitoring their progress, errors can be reduced. The following model subdivides data input into five phases and describes the tasks to be accomplished at each phase.

3.5.1 The Data Definition Phase

This consists of an analysis of the system to be monitored under the responsibility of the equipment specialists as only they have the knowledge of the system. It requires the collaboration of TDS and database administrators and a representative of the TCR. The aim of this phase is to produce the following:

1. The list of points (alarms, states, measures and commands) that will be used in the new monitoring application;
2. The domains of the points in the new system;
3. The data necessary for the functioning of the TDS, and other monitoring applications;
4. The necessary database structure changes (if any);
5. The data requirements of the TCR/SCR monitoring tasks, covering alarm information and data mimic diagrams and logging.

3.5.2 The Data Preparation Phase

Once the definition phase is complete, the equipment specialists can prepare a list of all new data points with the appropriate parameters. Operations staff should be consulted when assigning descriptions and codes since these must be meaningful to users of the surveillance tools.

With large volumes of data to be input, an Excel program is provided for the transcription of the points parameters. This can speed up data transcription and facilitate data verification by highlighting points that are missing or have inappropriate parameters.

The person responsible for monitoring system will produce a list of any new data that needs to be included to enable the new points to be accepted onto the database.

3.5.3 The Data Capture Phase

The database will first be updated by the monitoring system responsible with all new monitoring data since the new point data may depend on them for validity. When dealing with large quantities of data, database loading programs based on the predefined Excel documents will be used to input the data, otherwise the equipment specialist can use a Human Computer Interface (HCI) to enter small quantities of data. This interface is designed to guide the user through the correct steps in data entry and offer help in completing parameters with acceptable values.

Reports are available so that a final check can be made on the new data by the people interested.

3.5.4 The Data Maintenance Phase

This phase covers the changes that need to be made to the database, due to modifications in the installations monitored, error correction and the addition of supplementary information.

The HCI mentioned in the data capture phase will allow these changes to be made. This HCI must ensure that only the appropriate people can make changes to the data. The database administrator will have the responsibility of ensuring that each user can only access their own data, for example each equipment specialist can only modify his own data, similarly only operators and the TDS administrator can modify mimic diagram information and monitoring configuration data respectively.

The production of reports from the database detailing what is monitored can help in the maintenance activity.

3.5.5 The Data Destruction Phase

This phase concerns the removal of a point no longer monitored, or when a system or large part of a system is decommissioned. It is essential to remove unused data as this can speed up database performance and prevent obsolete data from being sent to applications that will no longer treat it. Similarly, this data will not clutter reports on the systems monitored.

3.6 Data Responsibilities

The database administrator is responsible for ensuring that the database structure, and data describing the monitoring system, are adapted to the installations monitored and the application programs depending on it.

Each equipment specialist is responsible for ensuring that the data on the database accurately reflects the monitoring requirements of the installations for which they are responsible.

The TCR Operation Section is responsible for ensuring that their applications are using the appropriate points for monitoring the different installations.

4. CONCLUSION

Errors on the database can lead to errors or inefficiency in operation. It is very important to ensure the highest quality for data on this database. Since the data rarely changes once input, the main effort in ensuring the quality of the data used must be put into the initial data capture processes.

The data relating to an installation monitored is the responsibility of the organizational unit responsible for the installation itself. It follows that this organizational unit must control the quality of the data being entered into the monitoring system database. Clear procedures must be followed for data entry when a new system involving a large amount of data is being taken on.

The data that will be displayed or otherwise used by operators must be formally approved by those responsible for the installations monitored. A regular check on this data by the installation supervisors should be instigated, so that any errors found can be rectified.