For exercising control and taking action, data is always essential. This data can be either present status, past history or trends.

In the central control room (CCR) of any industry, status of various drives and process is monitored continuously along with some key parameters critical to the process. For electrical control system, such parameters can be current, power, healthiness of protective circuit and so on. Monitoring alarms and faults to respond quickly to the situation and avoid damage to the process is the prime responsibility of CCR. Large mimic panels, multiple window annunicators, huge control desks with control and metering units usually constitute a common sight in CCR in any process plant.

Advent of microprocessor-based systems has not only reduced the number of devices in the electrical protection and control systems, but has also impacted the typical layout of a CCR. All the data desired by the CCR is made available in a simple, user friendly format.

It is well known that any data can be represented in simple tabular form. But it is also known that use of graphical presentation helps in immediate focussing and faster interpretation.

That is why Graphical User Interface (GUI) is the most desired form of a Man-Machine Interface (MMI) between Intelligent Electronic Devices (IEDs) in switchgear or field and the central control room. The essential part of Graphical User Interface is the capability of IEDs to communicate continuously with the CCR and update parameters and status on the data bus with simultaneous execution of controls. Such an MMI not only reduces cabling and equipments in CCR but it also reduces engineering, commissioning and testing time. Added to this is the flexibility, the user gets to modify the monitoring parameters even after commissioning of the plant.

In this issue of L&T Current Trends, we bring you information on Man-Machine Interface. This type of interface simplifies data viewing, perception and integrates multiple functions on a common data bus, without sacrificing speed to a great extent.

With proper design, such a system can eliminate the need to preserve a hard copy of electrical drawings for routine operations. It can also eliminate the tedious job of keeping various maintenance logs.

Once a plant is operational, parameterisation (setting) of IEDs is not required to be done frequently. Hence, Data Acquisition System, which remains continuously in operation for on line monitoring, should be regarded as separate from the parameterisation system.

Customising the MMI to make it user friendly requires understanding of the operation and detailed engineering between the supplier and the user. However, with the flexibility of modifying the data structure in the field, users can have more meaningful control and data acquisition in the CCR.
So far, in previous articles, we have seen how Intelligent Electronic Devices (IEDs) can be used in the process plants and how they can be networked.

Many issues arise:
- How to achieve networking and data acquisition for continuous process plants?
- Whether other plants/industries also need to go for such systems?
- What data should be acquired?
- How this data can be effectively used?
- How data acquisition can be user friendly?
- What should be considered in the ‘Man-Machine Interface’ (MMI)?

In this article, we have tried to address these issues – pertaining to the electrical parameters.

**Whether to opt for continuous data acquisition and monitoring system?**

It is well known that decisions based on study and analysis of acquired data are more logical and are more likely to be correct. Thus data acquisition becomes a tool, helping proper decision-making.

Also, in the years to come, more and more plants – whether continuous process plants or otherwise – have to adopt increasing automation for controlling their running costs. This can be facilitated only by continuous data acquisition and monitoring systems. Efficiency of the operations/process/energy consumption can be improved with the analysis of acquired data.

**What all data should be acquired?**

This question gets addressed by the application the user has in his mind.

For centralised control, drive availability (healthiness of all interlocks/permisssives) and status is important. Since current drawn indicates utilisation of process capacity, it is also required to be monitored. These three parameters are monitored by a DCS continuously. In case a drive is not available, it needs to be analysed, which permissive is "not healthy". This can be concluded when the status of all the interlocks is monitored and reported – individually, e.g. in the central control room, if status of auto/manual switch (located on switchboard) in “Manual” mode or local stop push button (near Motor) “Open” is made available, why the drive is not permitted to start from control room can be realised immediately.

Plants desiring effective utilisation of energy by switching over from grid to installed captive generation need to monitor power/energy consumption continuously, along with Peak Demand.

Statistical data such as the total number of hours of run of a particular drive, the number of hours it has completed after the last close/start command, how many ON-OFF operations the drive has seen, how many faults/trips the drive has gone through is acquired to develop comprehensive maintenance logs.

Certain IEDs (such as Motorvision relays from L&T) give further diagnostic information like starting time, starting current, thermal capacity consumed during starting for every start of the motor in addition to running thermal capacity. This data is invaluable for preventive maintenance.

Parameters at the time of fault/alarm and the reason for fault/alarm are also required in system analysis.

**How to use the data more effectively?**

Well organised data directly leads to a better control of the system. Knowledge about status of all permissive/interlocks in the control room helps trouble shooting. Take example of a 400-meter long conveyor belt. If it sways in a particular location and the drive trips, it is very difficult to assess exact reason and exact location. If such a conveyor is provided with 3 or 4 belt-sway switches, making 4 zones, and status data of each of the switch is captured in the control room, the problem zone is identified instantaneously. Digital input status available in the IED can be captured on the data bus and displayed in the control room, as described in the Fig.1. Capability of the IED to accept Digital Input data not only enhances speed of action but also Fig.1.
makes comprehensive data acquisition easy. Power, power factor, energy, maximum demand related data is very useful for trending and effective load management system. Peak loads can be identified and suitable steps can be taken to carry out some operations/activities at non-peak hours so as to reduce maximum demand.

Statistics and maintenance logs available from IEDs eliminate need of manual logs. In many plants, routine maintenance is carried out periodically. Since “hours run” or “number of operations” data is not available at that time, routine maintenance checks are applied to all drives, entire switchgear. In the process, devices which are not used frequently and which have not undergone wear and tear also get the same attention as the devices which are in regular use. Data such as “hours run” or “number of operations” or “number of trips” if maintained by IEDs, is more accurate and gives information for prioritising the maintenance checks. This reduces pressure on the maintenance team during shutdown hours. Specially when they are running out of time. To have an advance intimation, maintenance log from IEDs can be programmed for alarm using proper MMI.

**How data acquisition can be user friendly?**

Normally, any data is presented in tabular form. When the data is vast, it is recommended to use multiple tables, so that the user can see specific data which he is interested in. Till such time, generally important data is displayed.

When IEDs like Integrated Protection Controllers are used for data acquisition (along with protection, control, metering and annunciation application), large data is made available to the user by a single device. This can be broadly grouped under subheadings like “Electrical parameters”, “Statistics and maintenance”, “Dig-in and output status”, “Fault and alarm data”, “Controls” and “Trends”. The specific data acquired under each subheading can be viewed by the user whenever desired. All important parameters can be displayed on one common screen with single line diagram.

Typical screens for data acquisition are shown in Fig.2 (Single Line Diagram), Fig.3 (Parameters), Fig.4 (Pre-Trip Values).

As seen in these screens, the data displayed on the graphical display is user friendly. For such data acquisition systems, the IEDs should have a protocol, which permits Graphical User Interface (GUI). This enables trending of electrical parameters.

Alarms are very important and need to be watched for continuously. Process alarms in the form of digital inputs and electrical system alarms are generated by IEDs and are monitored in the central control room. Data displayed on the monitor normally has facility to display latest 2/3 alarms which can be acknowledged. A detailed screen of all alarms for the given period can be made available separately – for analysis and facilitating alarm log.

Apart from data acquisition, if the monitoring system has capability of controls (start/stop/reset), it becomes a simple Supervisory Control And Data Acquisition (SCADA) system. Such integrated system replaces separate control desks, annunciation panels and reduces control cables drastically between switchboard and central control room.

Panorama 2000 software offered by L&T for data acquisition with supervision series relays is such SCADA system, which offers all the above mentioned features to the user. It permits data acquisition monitoring and control of all supervision relays, hooked up to the communication network.
What all should be considered in an MMI?

When the needs are not clearly specified, there can be a vast gap between the system supplied and desired.

To specify the MMI, the user should indicate his desired functions such as “Electrical Parameters Display – Current, Voltage, Power factor, Power, Energy, Max. Demand etc.”, “Input/Output Status Display”, “Fault Data”, “List of Alarms “, “Control for Start/Stop/Reset”, ”Maintenance log such as total run time, number of operations, number of trips, starting time, starting peak current”.

Graphical SCADA systems permit active SLD and Bill of Materials (BOM) on the interactive screen, thereby eliminating need of hard copy of drawings.

It would be desirable to set the relays from the PC. However, this can cause delay in the data acquisition for continuously monitored process. Hence, it is advisable to set the relays only on a serial link when they are off.

The overall system configuration should be such that it can be possible to integrate such a system with higher level Distributed Control System (DCS) or Electrical Data Management System (EDMS).

Sum-up:
From this series of articles, it can be realised that when Intelligent Switchgear system is desired, it is not adequate to specify merely numerical relays or micro processor based relays with communication port.

A Comprehensive Intelligent System has four basic elements :

1) Numerical relays with integrated protection, control, metering, annunciation and data acquisition capability

operations, number of trips, starting time, starting peak current”.

Advantages offered by such a Comprehensive Intelligent System are:

- Reduction in device count, hence fewer failures, less maintenance and less inventory
- Reduction in control wiring/cabling
- Reduction in cost of DCS I/O
- Reduction in civil costs
- Standardisation of circuits, lower system design costs
- Faster installation and commissioning
- Data available for analysis
- Ready interface with higher level automation.

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Fig.4

2) Data integration network and interface system

3) Monitoring PC

4) User friendly, graphical software – such as Panorama 2000 SCADA system. It facilitates easy interpretation of data acquired and provides simple controls.

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