" STFS BASED TIME SYNCHRONIZED REAL TIME LOAD DESPATCHING IN WESTERN REGION"

Anjan Roy*	**M.G.Raoot***	**P.Pentayya***
Addl. General Manager	Dy. General Manager	Chief Manager

1.0 INTRODUCTION

Western Regional Load Despatch Centre located in Mumbai is responsible for real time load despatching of Western regional power grid (India) which comprises the States of Madhya Pradesh, Gujarat, Maharashtra, Goa, Chhatisgarh and Union Territories of Daman, Diu and Dadra & Nagar Haveli. The peak demand met in the region is of the order of 22,000 MW with installed capacity of 30,000 MW. Western regional power grid is meeting the highest peak demand amongst all the regions in the country.

2.0 LOAD DESPATCHING FACILITIES IN WESTERN REGION

2.1 The task of real time monitoring and control of such a vast grid with its inherent complexity is accomplished through a computer based SCADA system installed at State Load Despatch Centres in the States of Madhya Pradesh, Gujarat & Maharashtra and at Regional Load Despatch Centre located in Mumbai. These computer based SLDCs are transmitting data in real time mode to Regional Load Despatch Centre. SLDCs in respective States acquire data through number of Microprocessor based Remote Terminal Units (RTUs) primarily located at important nodes in the grid viz., power stations, sub-stations etc. These RTUs are sending station related information through standard protocols to computer centre at SLDC. SLDC computers then further transmit the data to WRLDC. A leased communication network (provided by BSNL) is deployed to form a WAN to complete the total SCADA system for the Western Region.

2.2 While data to the tune of 2000 Analog points and 5000 digital points is acquired at WRLDC in real time environment through the SCADA network, the complexity of managing this data to produce useful and effective information to the Load Despatcher is nonetheless significant. This task of providing timely and right information to the operator (through MMIs) is accomplished through various station-wise, state-wise and regional graphic displays and generation of required events and alarms. Besides above, report generation facility provides system behaviour pattern for post-mortem analysis to derive inputs for operational planning.

2.3 Load despatching functions basically cover monitoring of grid parameters and corrective actions to maintain these parameters within safe limits. The grid security has to be ensured by way of not allowing vital system parameters to deviate from its range and ensuing central sector generation share to beneficiaries. The information made available by SCADA system helps the operator to take various decisions during normal, alert, emergency and restoration states of power system operation. A well

* Power Grid Corporation of India Limited,
Western Regional Load Despatch Centre.

conceived SCADA system makes the job easier for the operator to effectively manage the safe and secured grid operation.

3.0 NEED FOR TIME SYNCHRONIZATION OF EVENTS

3.1 Over the years, it is our experience that a good SCADA system alone is of no consequence unless the monitoring of a large power network like that of Western region is carried out without a uniform time-frame. It is required to ensure uniform time frame for logging of various events / alarms in the grid especially during periods of grid disturbances. It is extremely important to establish a clear demarcation between initiating cause and compounding events (based on the time of occurrence) to effectively analyse a grid disturbance. Unless grid disturbances are properly analysed, strategies for future avoidance cannot be evolved. It has been experienced through many test cases that a uniform time frame logging of power system events helps in a long way in systematically and accurately analysing the grid disturbances. It may be worthwhile to highlight here that a SCADA system acquiring 5000 digital points (status indications) needs to have chronological logging of events and alarms to establish the exact cause of disturbance or cascading. In a power system network, the events occur within 20-30 milliseconds timeframe and when a cascading phenomenon takes place where number of events are generated at different geographical locations in the region, the task of putting these events in order of their occurrences is practically impossible unless the SCADA system itself is integrated at all levels of hierarchy with a common time signal to provide uniform time base. This need and requirement has been strongly felt in the operation of power system networks in India.

3.2 Requirement of accurate recording of time and time synchronization during normal and alert states of power system operation needs no emphasis. In case of sudden loss of generation, step change in frequency would occur. To counteract the frequency decay, turbine governors provided on the generating sets would respond after around two seconds and pick up generation from the stored energy (thermal) of the boiler and this instantaneous response from generators is vital to arrest the steep frequency decline and avoid a major contingency. As such, various generators in the grid are assigned to provide instantaneous generator response. The Regional Load Despatch Centres (RLDCs) have to monitor the compliance of generator response and the duration of availability of this response. Since the generators are situated all around the region over a widespread area, without time synchronization facilities, it would be difficult to examine the adequacy and promptness of governor operation.

3.3 The generators also provide reactive power support. In response to sudden voltage dips, the reactive power of various generators has to be increased at a faster rate and in the event of close-in faults, field forcing occurs making the generators pick up reactive power generation at very fast rate. To ensure compliance of this vital function, close monitoring of reactive power pick up vis-à-vis voltage dip need to be done which is possible only if the recording instruments at both the locations (location of voltage dip and location of the generators) are synchronized to a common timeframe.

3.4 In order to analyze the system disturbances with fair degree of accuracy, the events that occurred during the disturbance needs to be sequenced with respect to a common

* Power Grid Corporation of India Limited,
Western Regional Load Despatch Centre.

timeframe. Further, disturbance recorders and recording and indicating instruments provided at various sub-stations and generating stations also need to be time synchronized with a common timeframe. Lack of reliable time synchronized information would be an impediment to proper analysis. As such, it is recommended that the disturbance recorders, recording and indicating instruments at sub-stations and generating stations need to be time synchronized by providing STFS system locally. Further, the time stamping of events need to be done at RTU level. Presently, at some of the sub stations, this facility has been already provided in the Western region. However, the RTUs get time from the master computers at SLDCs. In the event of communication (PLCC) failure between RTU and SLDC or in the event of failure of master computer at SLDC, RTU clocks can not be synchronized to a common timeframe. Thus, it is essential to have STFS systems installed locally.

3.5 The transmission utilities have to maintain high level of availability of their lines which has commercial implications to the utilities. Precise recording of tripping times and charging times of lines is required. Further, tripping of lines (subsequently as a compounding event) due to tripping of lines of other utilities due to faults needs correct sequence of recording as the lines tripping subsequently need not be treated as "outage" for availability computations.

3.6 In the modern relaying applications, the phasor mesurements at both ends of the line are compared to take a decision for tripping or to block tripping. Unless protective relays at both ends are not time synchronized, comparison requiring decision could lead to maloperation.

3.7 Using the STFS system installed at WRLDC, an independent frequency monitoring system was developed. One of the RS-232 ports of STFS have been used to supply time and frequency information to a stand alone PC to record "two second" frequency samples. These samples have been used to compute df/dt (rate of change of frequency) frequency variation index (FVI) and Unscheduled Interchange (UI) price. These are displayed to help in real time load despatching. This system called "Computer based Frequency Analysis System (COMFAS)" is also used to independently check the Automatic Under Frequency Load Shedding Scheme (AUFLS) of Western region. The COMFAS system is also independent of SCADA system which is an added advantage.

4.0 STFS SYSTEM

4.1 In order to provide a common time base to SCADA events, the standard and reliable time source has to be integrated with the SCADA system. To meet this requirement successfully in Western region, the NPL designed STFS system which acquires time and frequency signals through Indian National satellite (INSAT) is found to be best suited to power system requirement. Accordingly, in Western Region NPL designed STFS were provided at all the five control centres. These (STFS) systems installed at WRLDC and SLDCs / ALDC provide Indian Standard Time (IST) to host computer. The integration of time signals with the host SCADA computer then provides an uniform time base for logging of various power system events. Considering the accuracy of the STFS, the various power system events that occur in a dynamic grid (during normal operation) and burst of events (during system disturbance) gets chronologically logged in the database along with a time tag. This time tagged data

* Power Grid Corporation of India Limited,
Western Regional Load Despatch Centre.

alongwith data acquired from local SCADA, DRs and recording instruments at remote locations, provide an easy way to analyse the various grid disturbances and to accurately establish the sequence of events to clearly find out the causes and effects. Based on such analysis of the grid disturbances, the remedies could be worked out for aversion of similar occurrences in future.

4.2 In addition to providing a uniform and accurate time base for logging of various events in the grid, the STFS system also provides for a system frequency measurement through RS-232 communication ports which is fairly accurate and provides high resolution measurement. Based on this frequency measurement (which has also commercial implication in the new tariff system being implemented shortly in India) the system operator can take suitable decision to control the grid.

4.3 There are different ways to integrate time signals with SCADA System. Earlier in W.R. Patek-Philippe make time centre was integrated only with WRLDC host computer and time synchronisation of SLDC system was achieved through time signal transfer on computer-computer link. This arrangement has a disadvantage in the event of failure of communication link between two control centres. However presently, the NPL supplied STFS is provided at all the control centres thereby bringing in the additional reliability. The configuration of the old SCADA system without time synchronization facilities is shown at Exhibit-I while the upgraded SCADA system with time synchronization facilities is shown at Exhibit-II

5.0 CASE STUDIES

5.1 Three case studies involving major grid disturbances have been briefly described here along with the sequence of events recorded by the SCADA system. These occurrences took place during 1991 and 1992 when time synchronization facilities were not fully implemented. In all the three occurrences, inadequacy is sequencing the events relative to time has become a major handicap in analysis of the occurrences. The recorded events corresponding to these occurrences are enclosed as Annexure.(only relevant extracts included).

5.2 Case Study – 1

The sequence of trippings recorded by the SCADA system during the occurrence on 25.10.91 in Western region are enclosed. During 1991-92, the computers at SLDC, Kalwa (Maharashtra) and RLDC, Mumbai were not time synchronized. The computers at SLDC, Kalwa were lagging behind by 2 seconds as per the weekly observations done by SLDC and RLDC. However, exact correction on the day of occurrence can not be worked out due to uncertain drifting rates of the clocks during this span of a week. The sequence of trippings have been made by correcting the events at SLDC by adding two seconds. However, the initiating cause of the disturbance has a time stamp of 105109 (220kV Kalwa-Trombay) whereas the events related to bus fault at Karad which occurred subsequently is shown as the initiating cause. Further number of trippings have time stamps in the wrong sequence making the analysis further difficult.

* Power Grid Corporation of India Limited,
Western Regional Load Despatch Centre.

5.3 Case Study –2

Another occurrence took place while restoring the collapsed grid in the morning on 25.10.91. This occurrence got initiated with tripping of ICT at Asoj at 220316 hours, In the sequence of trippings enclosed, AE.Co'F' (230251) tripped prior to tripping of Wanakbori-Soja- I (230309) which was not correct. The unit has tripped on under frequency following the islanding of Gujarat grid which will happen only after tripping of Wanakbori-Soja-I.

5.4 Case Study-3

During grid occurrence on 31.3.1992, the sequence of trippings recorded once again indicate the subsequent compounding effects as the initiating causes. During this occurrence also, the time lags between computers at SLDC, Kalwa and RLDC, Mumbai are corrected based on monitoring time of both the computers once in a week. The trippings of Kalwa-Khaldalgaon S/C which initiated the occurrence appears as event No.10 while the first five events have only compounded the extent of occurrence due to tripping on "power swing".

All the three case studies reveal that the recordings from SCADA system without time synchronization facilities are creating confusion and coming in the way of proper analysis.

6.0 CONCLUSIONS

Restructuring and reforming in power sector are also beginning to take place in India making the grid operation complex. Various players and service providers in the evolving power structure will provide different products which are to be evaluated based on the exact time of need for such products and compliance in providing such services need to be monitored to commercially compensate the providers for such services. Thus, more need for time synchronization to a common time frame on the entire power system is needed. All the Enquiry Committees on grid disturbances and Central Electricity Regulatory Commission (CERC) have also stressed the need for time synchronization. Further, Indian Electricity Grid Code (IEGC) also stipulates for time synchronization facilities.

In conclusion, no large electric power network could be effectively managed without having a common time synchronized event logging facility since all the events during normal operation or during occurrences and restoration needs proper analysis for appropriate control actions.

****

* Power Grid Corporation of India Limited,
Western Regional Load Despatch Centre.