Kalkitech
Enabling the Smart Grid

Case Study

Disturbance Data Collection Solution Using SYNC 3000 and SYNC 4000

Client/Project Background

Client:
Major Indian Transmission Utility Company

Industry:
Disturbance Data Collection Solution

Solutions

- Remote Accessibility System
- Automated Fault Analysis System

Products

- PSES
- SYNC 3000
- SYNC 4000

Business Case

The Client was one of the largest transmission utility company in the world, with more than 95,000km Transmission network and more than 200 EHV / HVDC substations, planned to set up a Remote Access and Automatic Fault Analysis System from each of its substation spread across an area of 2.5Mn sq.kms. The main functionalities of the system was to include the automatic remote collection of the Disturbance Recording (DR) files, as well as Event Logs (EL) from the various devices / IEDs in the substations, and subsequent download to a central National Transmission Management Center, through nice Regional Asset Management Centers spread across the country. The Utility was able to remotely view, configure devices, collect disturbance and event data – hence, making it possible for the substations to be unmanned and operated / maintained remotely. The project involved almost all of the client's 200EHV substations, and more than 3000 relays / IEDs, and was the largest such asset monitoring project executed in the country's transmission network.

Apart from the scale, the complexity of the project was magnified as the data was to be collected from various IED manufacturer, hence was necessary to have a large protocol conversion capability at the collector end. The absence of Ethernet ports in all relays also made it necessary to use terminal servers, for enabling remote configuration for all the existing devices in the substations.

Solution

Kalkitech proposed a de-centralized architecture where a redundant Kalkitech SYNC 3000 was provided in every substation that acted as Substation Disturbance Record (DR) collector. The disturbance data was captured from the IEDs using proprietary/ standard protocols and then converted to COMTRADE (refer last page on more information regarding COMTRADE file format) files by SYNC 3000 at the substation and sent to Kalkitech's SYNC 4000 server at National Asset Management center, via a secure communication channel. COMTRADE files in SYNC 4000 at the management center were mirrored to SYNC 4000 at a back-up site when new DR files were generated.

The SYNC 4000 also acted as a server to numerous enterprise applications and clients, including the Automatic Fault Analysis System, SCADA and DR Monitoring and Analysis Applications. Hence the SYNC 4000 also had various adaptors that facilitated data transfer, including ICCP, ODBC, SMB.CIFS and proprietary adaptors.

KALKITECH SYNC 3000 Data Concentrator was widely used in substation data concentrator and protocol converter, which was designed for gathering of real-time data and files from IEDs, Event Loggers installed in transmission and distribution substations. SYNC 3000 communicated with substation devices and managed the collection, processing and presentation relating to faults and disturbances at each substation. The communication was established with drivers/adaptors which enabled communication with many different types and brands of devices, including ABB, Siemens, Areva and SEL. The drivers collected disturbance data from various protocols including ABB SPA, Alstom Courier, IEC103, IEC61850, Fast Message Protocol from SEL, as well as various custom Modbus implementations.

For Remote Accessibility of relays with serial (RS232/422/485) commutation interface, Kalkitech's SYNC 2000 was used as terminal servers. SYNC 2000 offered 6 serial ports connected to IEDs and provided connectivity over TCP/IP.

Data Acquisition Using SYNC 3000 and SYNC 2000

The SYNC 3000 station data concentrator was configured in a Primary - Standby modes such that the complete functionality of the RAS was available even in case of failure of one. The data (disturbance records / files / logs / database changes /updates) were synchronized between the two data concentrators by the Hot Standby (HSB) module in SYNC 3000. SYNC 3000 also had IEC 61850-3 substation ruggedness compliance with 6 Ethernet and 12 serials ports, for direct connection of Relays and Event Loggers.

For substation where more than 12 serial ports were needed for DR collection, Kalkitech's SYNC 2000 Terminal server with 6 serial ports was used such that not more than 5 relays were connected on one serial loop. SYNC 2000 terminal servers were used in a pass through mode while DR collection drivers and conversion to COMTRADE format was executed in SYNC 3000. SYNC 3000 Data Concentrator (DC) also had two or six Ethernet port option, connected to the Station Ethernet network, configuration LAN and SAS LAN fetched data from IEDs connected in substation.

For field devices with RS232 serial ports, a Fall Back Switch was used to provide connectivity of the serial link to primary and standby SYNC 3000 data concentrators. For field devices with serial ports that were multi-dropped (such as SPA, Courier) the RS485 loop were connected to both active and stand-by SYNC 3000 units.

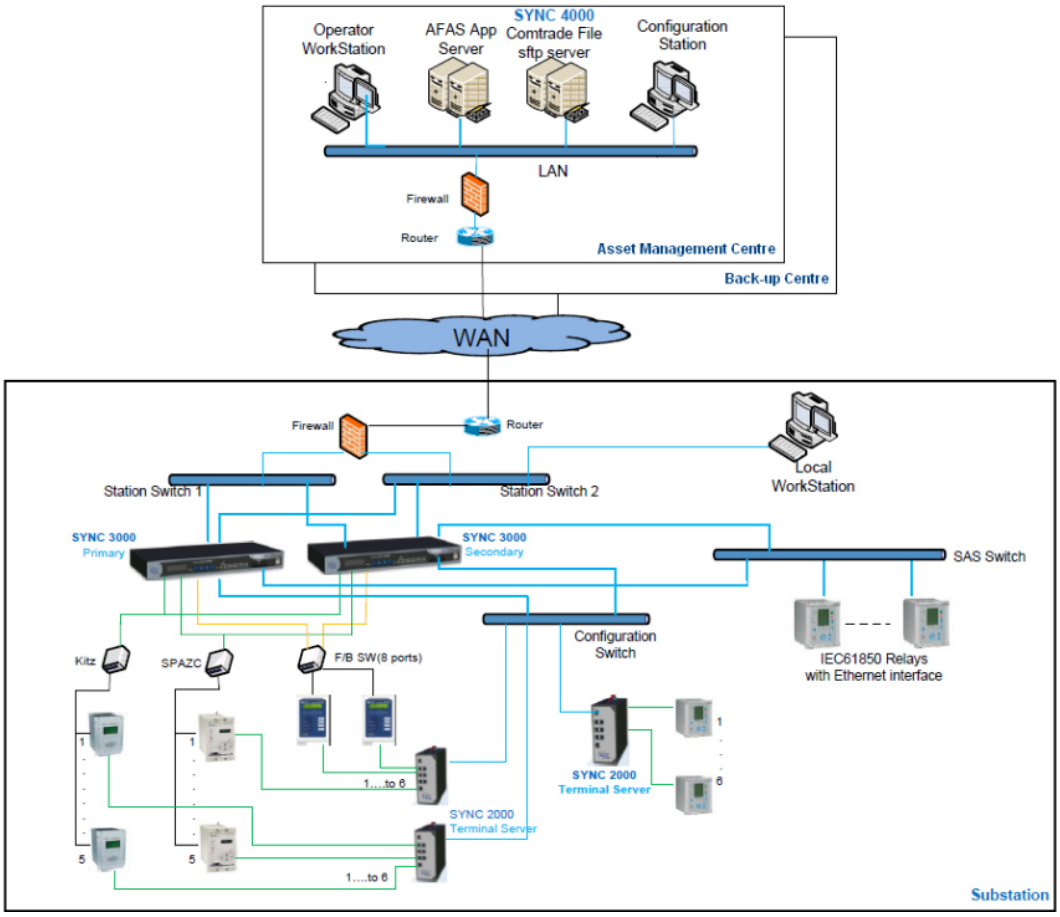

Fig 1: Architecture Diagram

SYNC 3000 DC also supported data acquisition through scheduled polling, device (DR/IEDs) initiated transfer as well as on demand from the SCADA/EMS system. SYNC 3000 also initiated polling when occurrence of DR was reported by the relay itself as in case of SEL protocol and IEC 61850. SCADA system intimated the Data Concentrator at the substation an event such as CB trip or Protection relay operation for initiation of polling of the corresponding relay. Proprietary DR file format were also converted into the standard COMTRADE Binary format in the SYNC 3000.

Apart from Disturbance data collection, the SYNC 3000 captured event logs from the standalone event loggers, collated these events as ".txt" files and sent it to the remote servers located at the National Asset Management center using secure FTP file transfer. These remote servers (SYNC 4000) then transferred these to the Information Storage & Retrieval (ISR) servers of the SCADA/EMS system using an ODBC interface.

SYNC 4000 as Control Center Server

Kalkitech's SYNC 4000, installed at the Asset Management center, managed secure communication to Station DC and provides remote access for configuration. It also supported an interface to ISR and SCADA system and accepted DR collection trigger as well as, sent stored event data from Event loggers in ISR. SYNC 4000 hardware proposed with Dual LAN, 8 GB RAM expandable to 32GB RAM, 320 GB HDD (expandable to 640GB), with RAID 5 storage for long term storage (with each Server).

SYNC 4000's DR collection system user interface came with functionalities to perform configuration change, view status of DR collection, view alarms or events in the communication system. Option was also provided for manual DR collection triggered to initiate DR transfer from the substations to the central asset management center.

COMTRADE File transfer from SYNC 3000 DC to SYNC 4000 at the Asset Management Centre was using Secure File Transfer Protocol (SFTP), with SYNC 3000 acting SFTP server whereas SYNC 4000 was SFTP client. The client- server communication was encrypted using SSL. The data exchange between SYNC 3000 and SYNC 4000 was compliant to NERC CIP requirements. SYNC 4000 logs all user initiated activities performed along with necessary information such as time-stamp and user/administrator comments needed as part of maintaining audit trails. It also created communication logs to identify communication errors.

Interfaces to Enterprise Applications

Interface to Fault Analysis System

COMTRADE files were maintained in a file system in SYNC 4000 server. These files were shared to the automatic Fault Analysis software using Server Message Block (SMB), also known as Common Internet File System (CIFS), which operated as an application-layer network protocol mainly used to provide shared access to files between nodes on a network. It also provided an authenticated inter-process communication mechanism. DR files from each relays were stored in separate folders grouped under each substation folder. The SYNC 4000 made the DR files available as and when the DR files were created, with the fault analysis application programmed to monitor the SYNC 4000 folders on a periodic basis.

Interface to SCADA / EMS

SYNC 4000 also had an ICCP interface connected to SCADA / EMS systems. The DR collection trigger from the SCADA system was configured using this ICCP link. Whereas link was used to DR trigger transfer as well as any data exchange, the Event Logger files were populated to ISR servers using an ODBC interface.

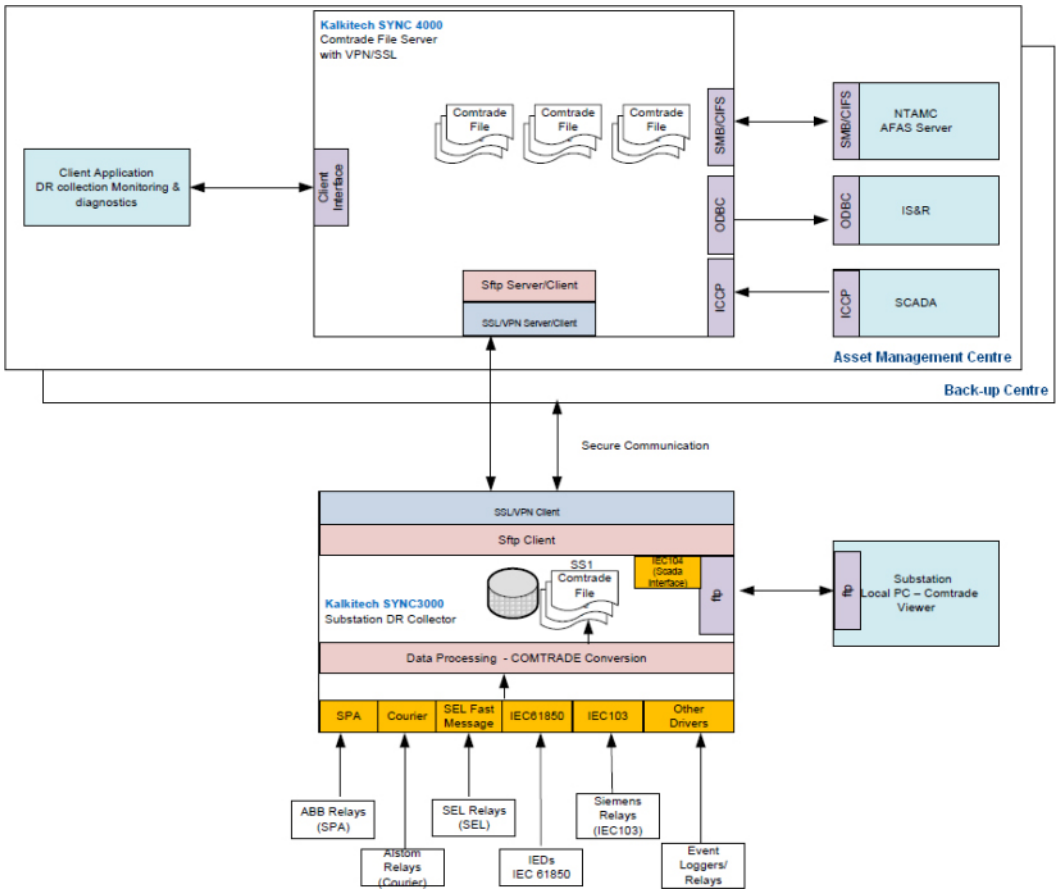

Fig 2: Disturbance Data Collection and Event Logging – Data Flow

Key Features

Enhanced Security

- NERC/CIP compliant security
- User management in Configuration utility to prevent unauthorized configuration
- End to end SSL encrypted VPN to avoid tampering of data transferred in the network

Integration of Protection and Control IEDs in the substation was carried out in a secured manner in compliance with relevant NERC CIP Cyber Security standards particularly CIP-005-1 (Electronic Security). Remote Access to the IEDs in the substation was restricted through a single point by the Substation Firewall provided by the System Integrator; it created an electronic perimeter that protected all the electronic devices e.g. IEDs/ Relay/ DR /EL from unauthorized access. It also performed authentication with user name and password authorization by assigning users to groups with well defined privileges, Encrypted all pass-thru connections that spanned the WAN connection.

Large Protocol and Multiple IED vendor support

SYNC 3000 supported industry standard protocol drivers and communicated with IEDs and event loggers. Kalkitech SYNC gateways supported extensive range of substation protocols for data transfer such as IEC61850, IEC 60870-5-103, SEL fast message protocol for SEL 4xx and 3xx, DNP3, SPA, Courier. Kalkitech's expertise in driver development and substation communication protocols ensured that proprietary protocol support was attained, as a customization project. This particular case study project integrated 10 IED manufacturers including major vendors like ABB, Siemens, Areva / Alstom, SEL and supported nearly 50 model variants.

SYNC 3000 also supported SNTP protocol for time synchronization, which was used to synchronize the Data Concentrator clock to the reference GPS source.

Remote Accessibility System (RAS)

RAS software supported multiple versions of the configuration tools of various vendor relays so that the same could be easily managed from the central system.

RAS software had a database associated for storing the latest configuration files which were automatically uploaded from the specific relay. The version management of these files were one of the key features of RAS software.

It also had a DR viewer and analysis system associated with the same which used the COMTRADE files retrieved from the SYNC 3000 and stored in the central DB.

Data Storage in DC

SYNC 3000 stored DR files and Event Logs for at least 1 month in non volatile memory considering one DR file per day from each connected Relay and 1000 event logs per day in each Event Logger. All status and configuration information that was to be retained during power failure was stored in non volatile memory.

Alarms and Event parameters

SYNC 3000 read all configuration parameters from configuration XML file at start up. A GUI configuration utility was also available for users to create new configuration or edit existing configuration. The tool generated a configuration in the form of XML file which was then transferred to SYNC 3000 using the WAN network, and stored in non-volatile memory.

WHAT IS COMTRADE? ***

COMTRADE (Common Format for Transient Data Exchange for power systems) is a standard file format for oscilloscope / fault data, that was being using my many IED manufacturers for recording fault / disturbance signals in high voltage substations. COMTRADE file format had been standardized by the IEEE, under IEEE C37.111-1999, which defined the format for files containing transient waveform and event data collected from power system models.

Each COMTRADE record had up to four files associated with it:

- Header (xxx.HDR)
- Configuration (xxx.CFG)
- Data (xxx.DAT)
- Information (xxx.INF)

The Configuration file itself was an ASCII text file, while the Data file contained the value for each input channel captured for each sample in the record. Hence, these two files were mandatory for analysis.

Kalki Communication Technologies Pvt. Ltd.
"The Address", 17/1, 4th Floor, Kadubeesanahalli,
Outer Ring Road, Bangalore 560103, India
Telephone: +91-80670 21900 | Email: sales@kalkitech.com

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