TRANSIENT DATA REPOSITORY

By

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INTRODUCTION:

Advances in technology have had a great impact on the design of electrical power measurement and protection devices. The microprocessor is now at the heart of each device providing ample processing power, lots of memory, and open connectivity. Microprocessor based devices are called Intelligent electronic devices (IEDs). These devices store various types of useful time sequence data (TSD) including but not limited to transient, load, and status data. IEDs are currently being used worldwide and all of the data that we have always wished for is actually being measured, calculated and archived by IEDs.

State of the art communication technologies are also being used to provide point-to-point connectivity between the Office and the remote IEDs. Data is being gathered in real time, simultaneously from multiple IEDs. Old dreams of integrated designs are being realized. A host of new applications such as remote energy management, advanced SCADA, integrated protection and remedial action systems are being developed. These are very exciting times.

Clearly, data overload is a visible problem. Automatically collecting, filing and managing large volumes of IED data is not a simple task. The nature of the data is complex and requires the use of specialized management tools and new filing standards in order to achieve the goal of housing the data in a single repository. Building a repository of IED data is the main subject of this paper. The paper presents a survey of the latest in IED integration and TSD management tools. A brief review of the latest in communication technologies is provided and the latest trends in communications and recording are discussed. The main intent of the authors is to provide a broad outline for IED integration and TSD management.

REQUIREMENTS:

The term “repository” is used specifically to avoid the use of the term “database”. The science of databases is vast and does not follow the KISS principle. The term repository is defined as a directory of files or as the simplest form possible for a database. The requirements for building a repository of IED data are:

1) Work with various types of connections.
2) Communicate using various types of protocols.
3) Manage data from various types of IEDs.
4) Archive legal data records in their original raw form.
5) Handle the various implementations of the COMTARDE format.
6) Provide a browser to quickly search and find specific data.
7) Provide a universal viewer with graphical plots and specialized editors.
8) Provide advanced analysis functions.
9) Provide concurrent access to multiple users.
10) Provide interfaces to energy management and short circuit analysis applications.

BACKGROUND:

There are three questions commonly asked when trying to access an IED: 1) what kind of connection, 2) which type of communication protocol, and 3) where is the end-user software? In what follows a brief tutorial is presented on accessing and networking various types of IEDs.

Devices are networked using a multi-drop or a star topology. The difference is that in the multi-drop case you communicate with the devices one at a time, whereas in the star topology case you can communicate with the devices simultaneously (as shown in Figure-1). The most common type of physical connection available today is the serial port (RS232, 422 and 485). New IEDs are equipped with Ethernet ports (10/100 Base-T) which can provide high speed access to the company network. Serial connections are established by using dial-up links, null cables, radio modems, fiber modems and so on.

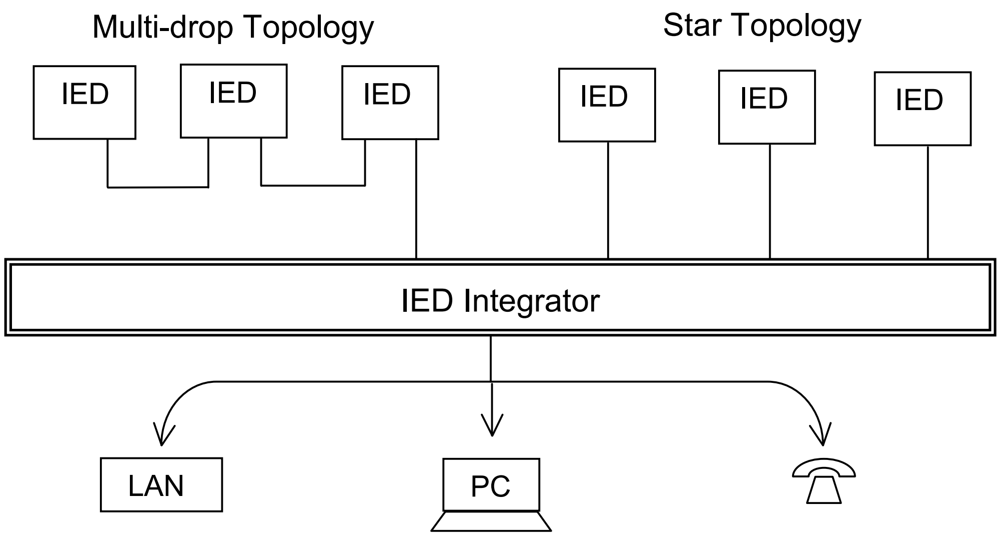

Figure-1: IED Network Schemes

Once a physical connection is established to the IED then any type of communication software can be used as long as the same protocol is supported on both ends. The most common type of communication protocol used today is proprietary ASCII. Other types of protocols include but are not limited to ZMODEM, DNP and MODBUS. New devices support a variety of communication protocols that can be used simultaneously from separate ports. The latest in protocols is UCA (utility communication architecture) which is gaining popularity among manufacturers of power systems equipment.

The end-user software is used to view and manage IED data. The software deciphers the storage formats of the originating IED and provides display and analysis capabilities. There are many types of proprietary storage formats. No standard format currently exists. However, the standard COMTRADE format which was initially defined as a common transient data exchange format is rapidly gaining acceptance and may become the standard. The latest in TSD management tools is the naming convention from the IEEE's Power System Relaying Committee (PSRC – H8 Working Group). The convention defines a common way of naming files where key information about the contents is placed in the filename.

Typically, each manufacturer provides a different type of communication and end-user software that is designed to work with their own type of devices. The result is a large number of programs with a variety of operating nuances producing disconnected islands of power system information. New software applications are being produced in order to solve these problems. These applications automatically extract and manage data from various types of IEDs over a hybrid of physical connections. The result is a well-managed repository of historical and real-time system information that is accessible to authorized users from anywhere in the world (refer to Figure-2).

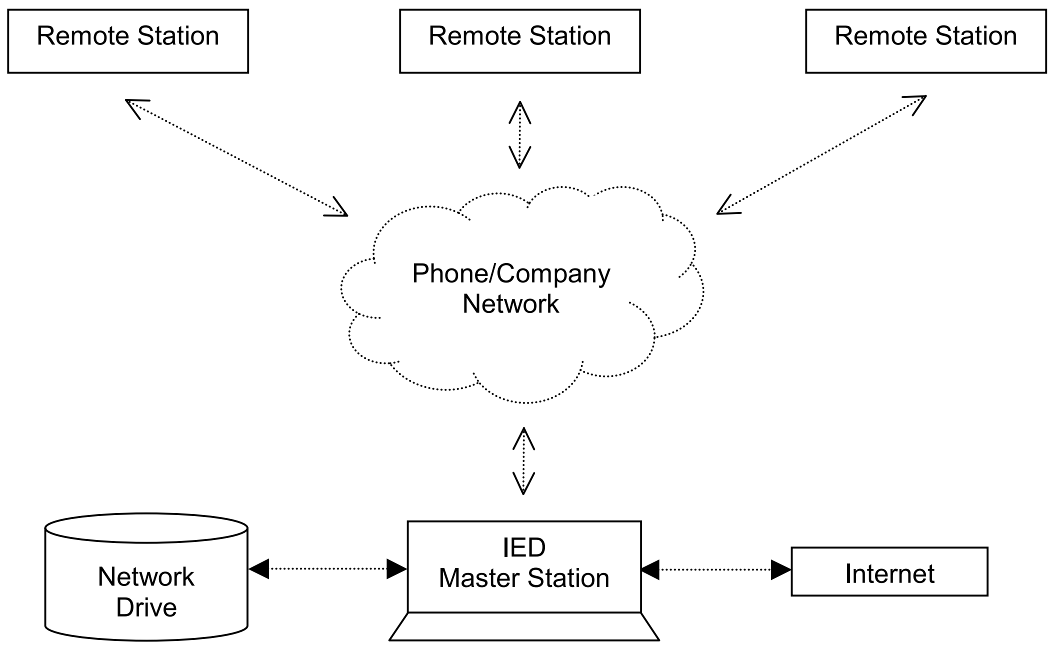

Figure-2: Remote Station Integration Schemes

BUILDING A REPOSITORY OF IED DATA:

There are two categories of IED data: 1) configuration data, and 2) system data. Configuration data includes but is not limited to settings, scale factors, and maintenance logs. System data includes but is not limited to transient, load, status and summary data. The data formats vary depending on the manufacturer. Examples of various types of transient formats are shown in Figure-3. Many software applications for dealing with data from various types of IEDs are currently commercially available. These applications provide common interfaces for viewing and analyzing system data as shown in Figure-4.

Now, assume that you have just finished integrating all of your IEDs onto a common system and that you are about to turn the system on. Expect to wait a long time after power-up because the system will initially have to receive all of the archived data from each of the integrated IEDs. Later on, when the system is operational and a storm passes through expect to add many more data records to your repository. Many additional volumes of useful data resulting from polling, testing and maintenance operations will also have to be housed in the same repository.

The business of filing all of this data can quickly become a hinder. The good news is that the PSRC naming convention for TSD can be used to uniquely tag and identify each piece of data in the repository. An example of the TSD filename format follows:

"EventDate,Time,TimeCode,StationName,DeviceName,CompanyName.Extension"

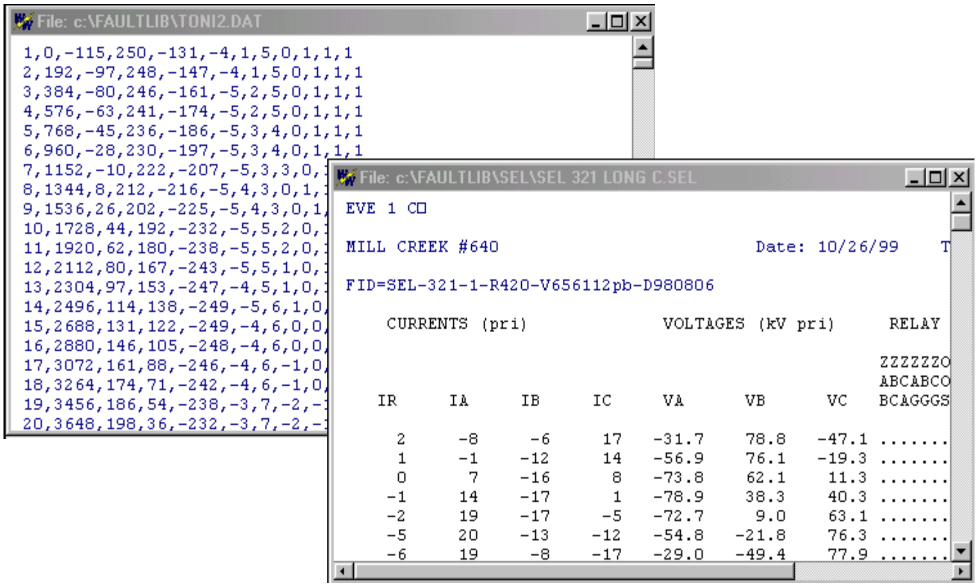

Figure-3: Various Types of Transient Record Formats

There are many applications that can be realized given a unique, informative file naming system. Possible suggested applications are: time-line manager, TSD manager, universal viewer and analysis system, global/international data bank for TSD files and so on. Among the main beneficiaries of the proposed convention are the utilities and the emerging global and local energy regulatory commissions (NERC, FERC & SERC). These utilities and commissions can now realize the benefits of sharing a common electronic file system. Take any TSD file from any device anywhere on the planet and just seamlessly file it in your own repository. The net effect of combining the latest in communication technology with a solid naming convention results in a well managed repository. You can collect it from anywhere, file it, and then access it from anywhere (office, home, or road).

THROUGHTPUT AND MEMORY REQUIREMENTS:

Communication speed and availability depend on the type of physical link available at the IED. For a dialup system, speed is around 9600 baud (many devices are at 1200 baud), and only one number can be dialed at a time (multi-drop topology). Dial-up systems are typically used to poll on a daily basis or upon request. For a fiber network, speeds of 10 Mbps and above can be easily attained and the connection is always available (star topology). With such power you can continuously poll the entire system and provide a base for remote energy management.

The memory requirements for the repository will vary depending on the type and the total number of integrated devices. A high-end estimate of the memory requirements for storing transient data can be calculated by knowing that a typical proprietary record is about 100 Kbytes in size and that a COMTARDE ASCII record is 1 Mbyte. Assuming that a total number of 10,000 proprietary records and 1000 COMTRADE records are generated each year then the maximum memory requirements is 2 Giga bytes per year. However, if load and status data are also extracted from each of the integrated device then the memory requirements will dramatically increase as a function of the polling frequency.

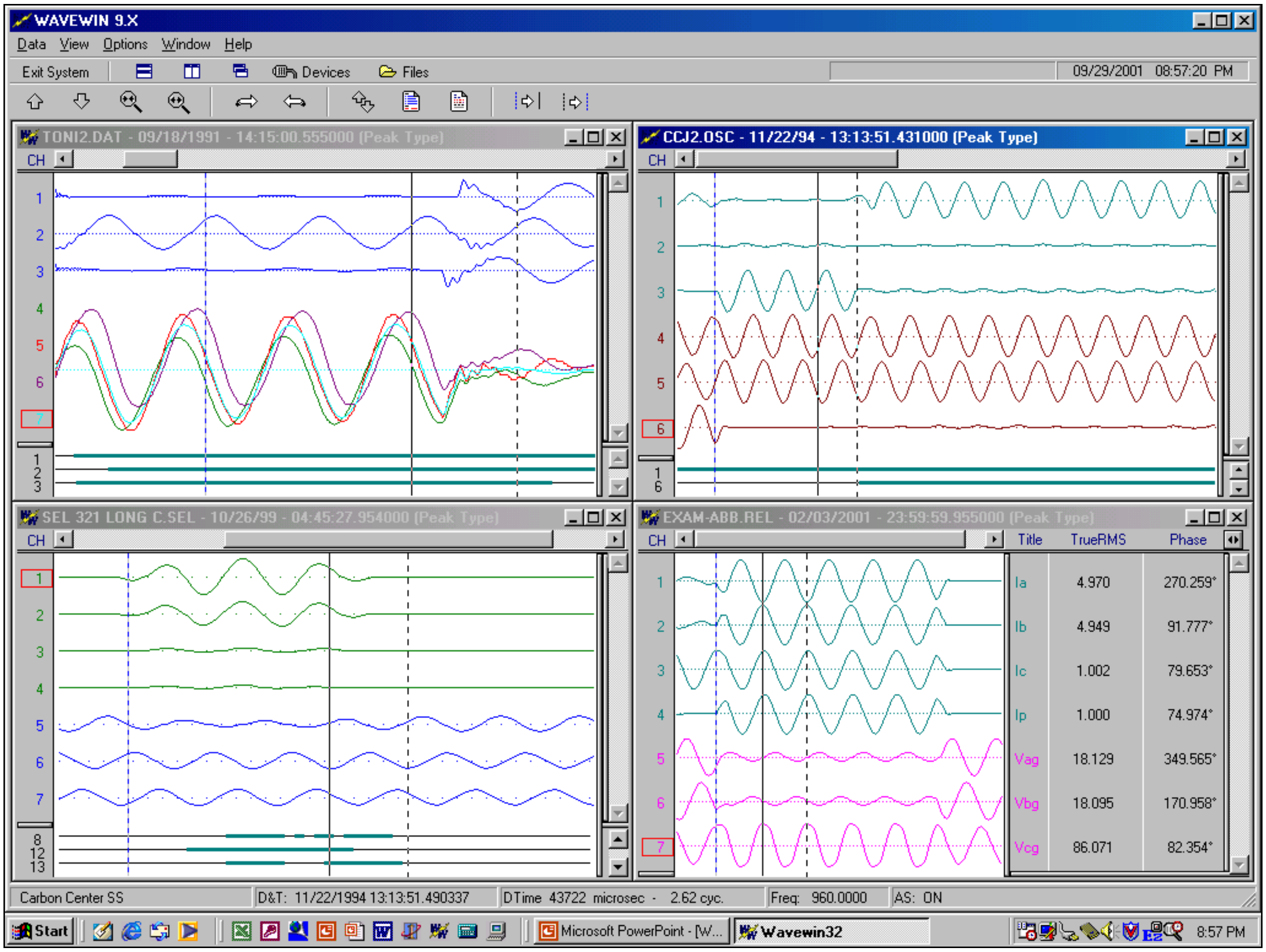

Figure-4: Universal Viewer

TECHNOLOGY TRENDS:

Advances in technology over the past decade have changed the way IEDs are designed in two fundamental waves. First was the microprocessor-based technology and embedded systems wave. This wave brought us digital devices that can internally store historical records of data and can serially communicate via dial-up or direct link. Then came the second wave, which was the communications technology wave. All of a sudden, IEDs can be easily integrate using a single desktop computer. You can collect power system information in real-time. Save the collected system information to a network drive so that anyone can have access to this information from any point on the network. Better yet, automatically e-mail summaries, reports or alarms to the proper personnel anywhere in the world. Print the information or fax it. Build a web site and populate it with real-time information. You can provide advanced analysis tools for detecting trends in system behavior (refer to Figure-5) and that's only the tip of the iceberg.

The old way was to physically go to the IED for readings and reset operations. This is still the typical way of doing business today. However, utilities are replacing aging infrastructure with state of the art digital equipment and that's not an easy task. Crews have to go to the location of the old devices in order to dismantle them and replace with new IEDs. For the crew to quickly mount and wire the new IEDs then they must have matching dimensions and connections as the old devices did. Now think about thousands of substations with existing infrastructure that need to be upgraded. The task is monumental, but utilities are rapidly gaining ground.

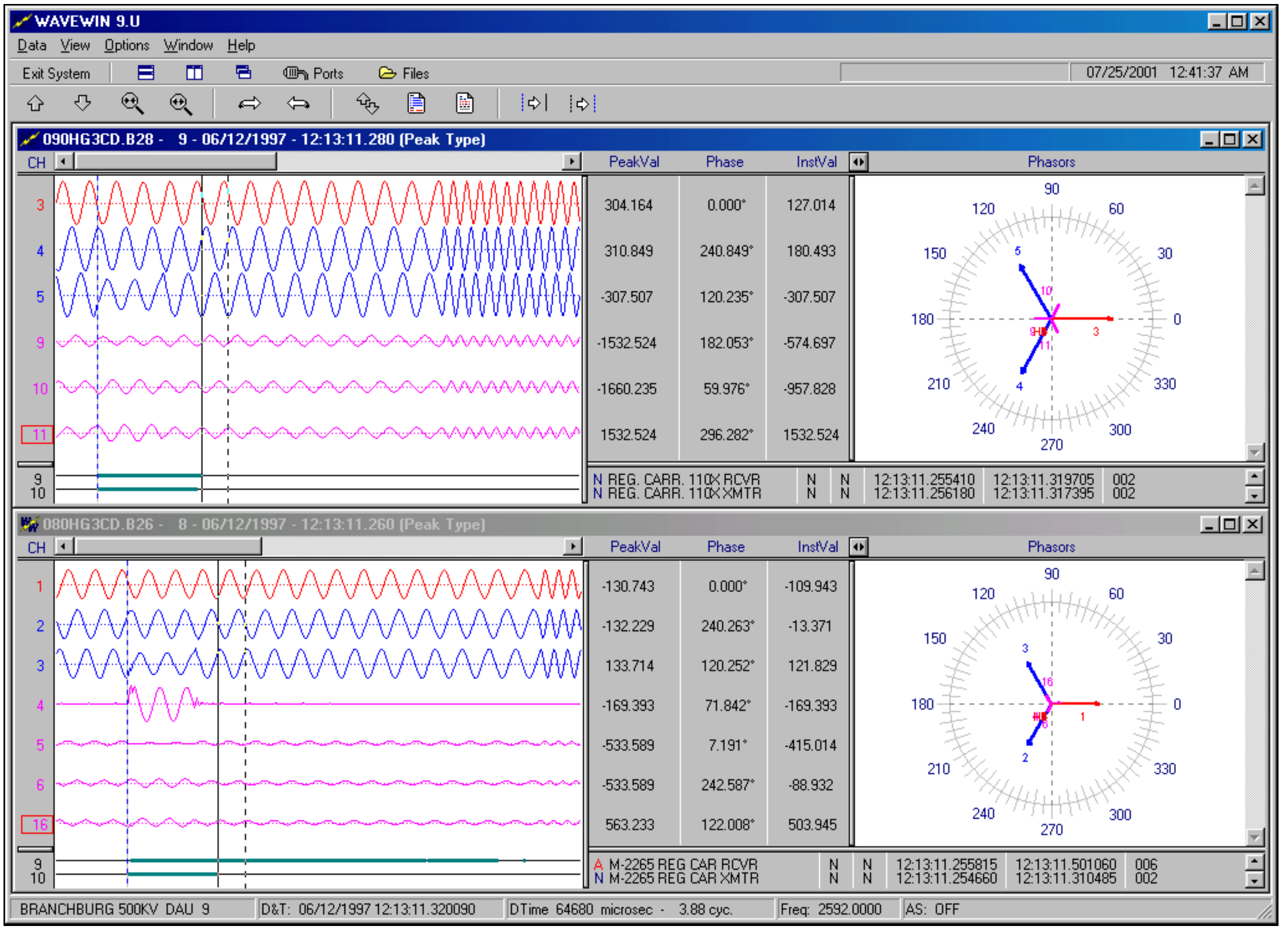

Figure- 5: TSD Display and Analysis

New exotic types of information systems are now being realized. Chief among these dreams is to automatically report to the proper personnel the faulted phase and location. A remedial action system (RAS) is another dream currently being piloted by a number of brave utilities. The RAS measures the state of the power system and compares with pre-stored values. When the proper conditions are met then the proper contingencies are executed. Other dreams include the linking of relay records and digital fault records and then cataloging by power system disturbance. The links will open the path for implementing advanced expert system designs and concepts.

Today, when you go out and buy a new IED, expect to get plenty of storage, many analog and digital channels, and lots of useful measurements and calculations. You can expect to get serial and Ethernet connectivity too. Remember to look for expandable applications in order to seamlessly integrate new devices. Use the TSD naming convention to provide the operators with the choice of using the best type of equipment for the proper type of application. The future for communications and IEDs is very promising.

BIOGRAPHY:

Amir Makki, M.S.E.E., is a graduate of Tennessee Technological University, Cookeville, Tennessee. In 1986, Amir received a presidential scholarship from Temple University, Philadelphia, Pennsylvania to help develop a Ph.D. program in Engineering. In 1991, Amir helped Co-found SOFTSTUF an automation and process control company based in Philadelphia. Amir is currently the Chairmen and Chief Engineering Officer.

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