GeoWatch

December 2002, Issue 17

GeoSIG

Table of contents

Foreword from the CEO

Another busy year comes to an end. During the year 2002 we have performed major logistical improvements both in our headquarters at Glattbrugg as well as in our production site at Cugy. Persisting as a leading company in the field of geophysical monitoring systems demands frequent renovation and enhancement of logistical resources and arrangement.

Instrumentation projects usually, if not always, require quite complex systems that integrate standard products with case dependent custom solutions. Thus, in addition to the experience and fundamental know-how on the measuring and recording units, many other themes have to be addressed to in bringing such projects to life. In GeoSIG, we consistently put our best effort to achieve the best result and optimum solution for each and every job and perceive this as a challenging task.

In this GeoWatch we present two examples from the nuclear power industry, which is one of our numerous areas of application, and where security and quality are most demanding factors. Also with this issue, a series of technical articles starts, which we believe will provide not just an overview but also some detailed insight on measuring solutions.

I would like to express my sincere thanks to all of our clients and to all the GeoSIG team for the fruitful cooperation and hard work during 2002. I hope that you find the opportunity to rest and to enjoy yourself as much as you need during the coming Christmas and holiday time and wish you all the best for the year 2003.

Christoph Kündig

GeoSIG Provides Seismic Instrumentation for Beznau NPP, Switzerland

The Beznau nuclear power plant is Switzerland's first NPP, which consists of two identical units: Beznau I and Beznau II, with outputs of 365 and 357 MW, which went into operation in 1969 and 1971, respectively. Operated by the Nordostschweizerische Kraftwerke (NOK), which is a joint stock company of the cantons of Northeast Switzerland, the plant is located next to the Aare River near the town of Böttstein, approximately 15 km west of Zurich.

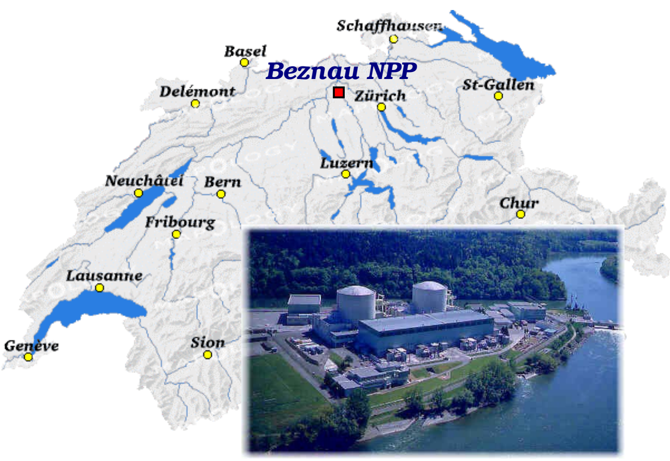

Figure 1. Location and general view of Beznau NPP

The system consists of a central processing unit and several distributed sensors with recorders. In order to achieve a certain level of redundancy, the storage of the motion signals from the sensors takes place first in the recorders.

The seismic instrumentation is continuously running during normal operation and during event downloading. The substantial components of the seismic instrumentation are equipped with appropriate power supply, emergency power supply (sensors with registration units), or 24-VDC supplies provided by the customer.

The six triaxial measuring sensors (AC-23 Sensor) and recorders (GSR-18 Strong Motion Recorder) have self-monitoring and testing facilities for periodic tests of the entire measurement chain. For each measuring channel, the recording threshold and the alarm limit values can be set individually.

The local GSR-18 has sufficient storage capacity for the complete recording of an event; i.e., mainshock and aftershocks. In order to analyze weak-motion signals as well, the data are acquired with a resolution of 1:131'000 (18 Bit).

The alarm transmission and communication between the recorders and the central processing unit take place via fiber-optic (FO) cable. After an event, the locally registered data are taken over automatically by the central processing unit where our state-of-the-art Data Acquisition Software, GeoDAS, is utilized for reliable system operation.

Furthermore, it is also possible to retrieve data with a laptop PC directly from the local recorders. In the case of a recording, the system starts automatically a pre-defined evaluation. The results of this high-speed evaluation are stored in the PC of the central processing unit in defined files and printed out automatically.

The central processing unit is inserted in an earthquake-safe cabinet, including specific accessories. The sensors, recording units, and FO converters are supplied in housings adapted to the respective site conditions. GeoSIG supplies also a comprehensive documentation and training of the customer's personnel.

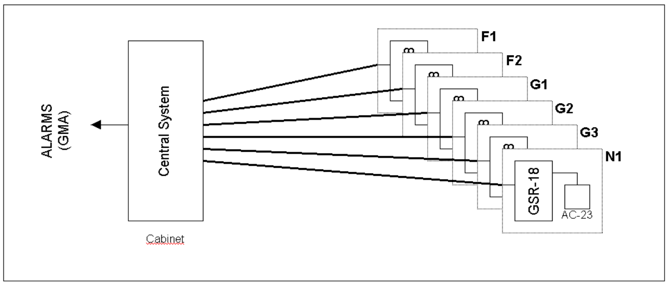

Figure 2. Overview of Seismic Instrumentation of Beznau NPP

Units 5 and 6 of Kozloduy NPP in Bulgaria are Protected by GeoSIG Seismic Instrumentation

The Kozloduy NPP is located 4 km from the Danube River, 5 km west of the town of Kozloduy, in Bulgaria. The activation of the NPP consists of three stages. GeoSIG equipment is installed in units 5 and 6, which were completed in September 1988 and December 1993, respectively.

Figure 3. Location of and views from Kozloduy NPP

Seven AC-23 sensors are installed for the NPP as illustrated in Figure 4. The SMS structural monitoring system in the center consists of two cabinets, which acquire and process the data. The cabinets are equipped with a sophisticated data acquisition unit, an integrated industrial computer, interfaces for two remote-status displays, and alarms to the main control room.

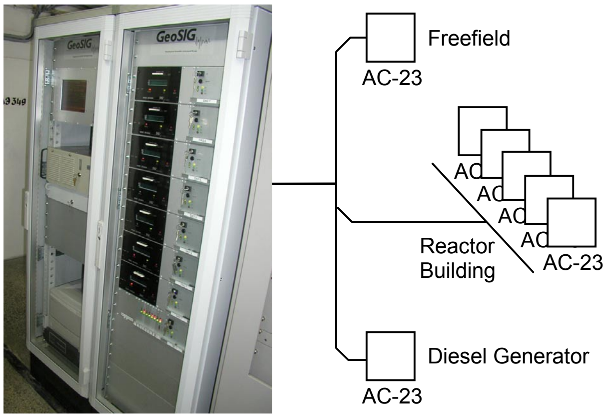

Figure 4. Overview of Seismic Instrumentation of Kozloduy NPP

Ivan Zanin, Electrical Engineer, Joins GeoSIG Family

Ivan Zanin, 31, has recently joined the GeoSIG Engineering Team, reinforcing our design and research-and-development capabilities.

Mr. Zanin is an electrical engineer specialized in microelectronics, with 10 years of experience in the field. He has significant expertise with microcontrollers, microprocessors, and design and development tools. He is well experienced with assembly language and firmware development, as well as computer programming.

Ivan Zanin is mainly performing Development, Production, and Testing tasks on our Engineering Team. While providing support for our customers, which is one of the highest priority tasks for GeoSIG, he is also assisting with project management issues.

We warmly welcome Ivan.

Strong Motion Instrument Networks

Abstract

Whenever more than one Strong Motion Instrument is implemented in the same structure, the question of the Network principle arises. There are three principle Network configurations:

a. Independent Recording Network
b. Interconnected Recording Network
c. Central Recording Network

For each of the above principles, the specifications and advantages are pointed out and typical applications are shown. The different system parameters are discussed in terms of the following modules: Sensor, Recorder, Center and Interconnection. The parameters of common triggering, common timing, modem communication, and time synchronization are explained.

Introduction

For most applications, one or more recording stations are placed at different sites to obtain information about the vibrations occurring at each site. The three basic approaches are:

a. Independent Recording Stations
b. Interconnected Recording Stations
c. Central Recording Station

Every approach has its advantages and disadvantages. The final decision about the network approach to be implemented has to be made by the user. To demonstrate the three basic approaches of instrumentation, we will consider a dam with six sensor sites on or near the dam: 3 at the crest, 2 at the basement, and one in the free field.

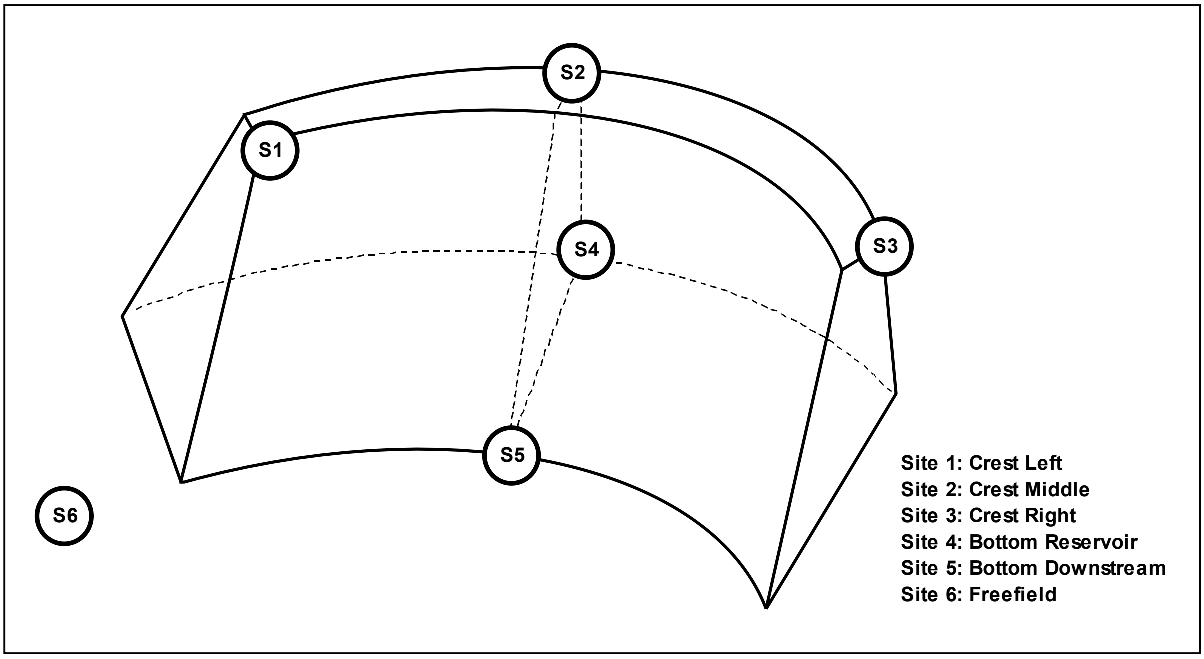

Figure 5. A sample site arrangement in a dam instrumentation

Different physical implementation possibilities or limitations and project specifications (e.g., common triggering and common timing) usually lead to one preferable solution.

Independent Recording Network

This is a Local Recording case in which recording takes place at each station. One or more independent recorders with internal or external sensor are placed on site, as illustrated in Figure 6.

In case of an event, each recorder records independently the time history of the event. An exact correlation between the individual recordings can be provided only if each of the recorders is connected to a common time reference, such as a GPS receiver, in which case common timing would be based on UTC time.

There is no common triggering between the different recorders, therefore false triggering caused by local human-induced noise may occur.

The parameter settings and data retrieval have to be performed locally on the site of each recorder.

Error and warning messages are visible on the display of the recorder at each station, which make the detection of a malfunction possible whenever an on-site check is done.

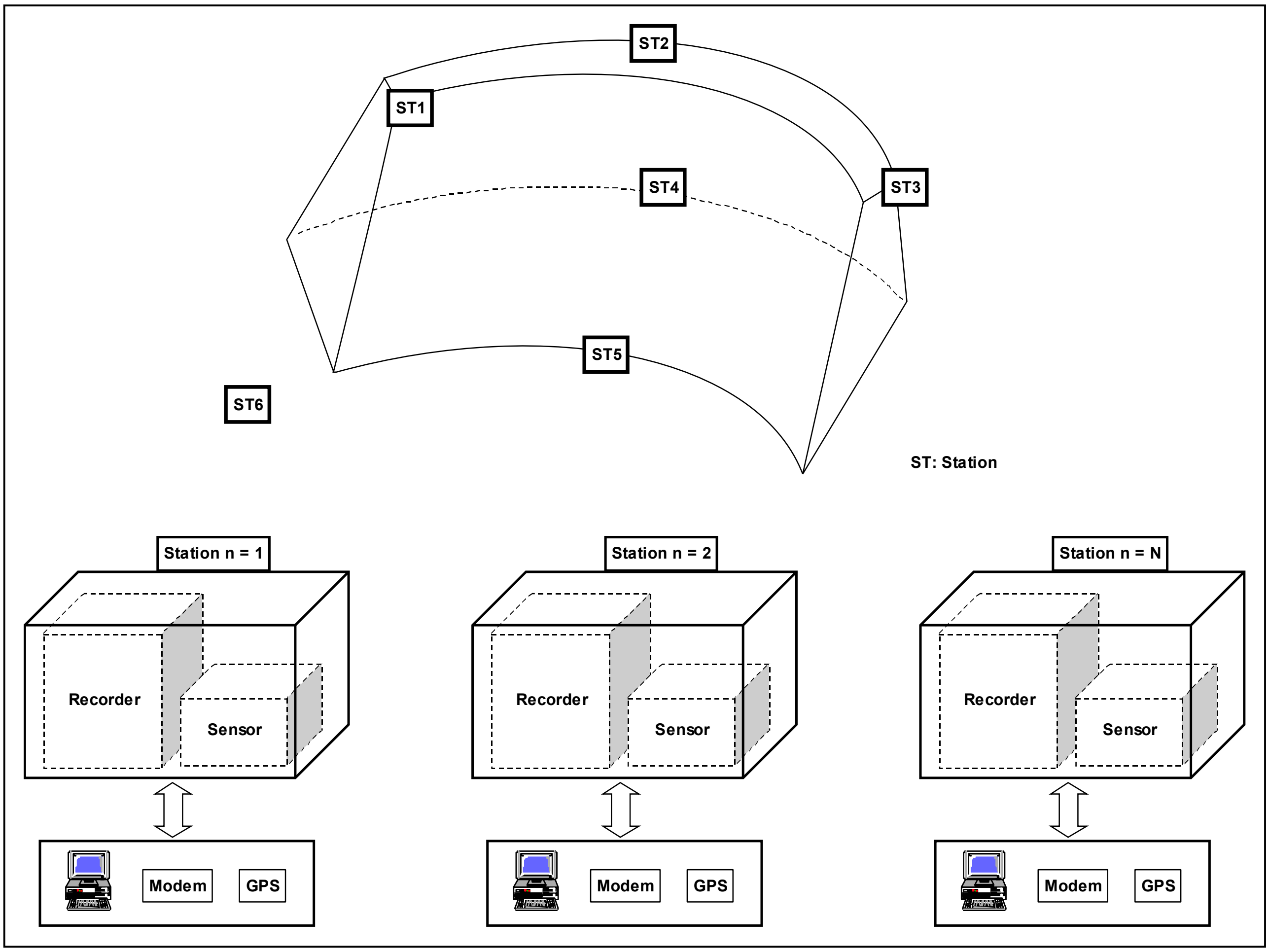

Figure 6. Topology of the Independent Recording Network

Interconnected Recording Network

Another version of Local Recording is the Interconnected Recording Network. When interconnection is involved, more options are available in terms of connections, data flow and accessibility, and cost. The three options that are supported by GeoSIG are illustrated in Figure 7 and described here. A brief functional comparison is also presented in Table 1.

Common Funtionality

Several recorders with internal or external sensors are placed on site and are interconnected with one cable while galvanically isolated from each other. For convenient cabling external junction box(es) are used. The interconnection between the stations can be carried out in ring, star, or net topology. Distances between the stations can be as much as 1 km. This is a favorable and cost effective solution for many applications.

One of the interconnected recorders (commonly referred to as the Timing Master) is enabled to synchronize and update the internal clock of each of the other recorders via the network to achieve Common Timing. A GPS time source connected to the Timing Master can also be used to achieve the time synchronization of the whole array, which would allow easier correlation with recordings made by other arrays or recorders.

The Common Trigger function in the Interconnected Recording Network is achieved by setting the necessary parameters in each recorder as follows:

- enable/disable self trigger
- enable/disable sending trigger to network
- enable/disable accepting trigger from network

An output for Local Communication is available at each recorder for local data retrieval and setting of parameters.

The reliability of the monitoring network is high, because a malfunction of a recorder would affect only the location of malfunction in the array.

If the network is interrupted, each of the recorders will perform as a stand-alone recorder by recording whenever the instrument's event-recording trigger level is reached.

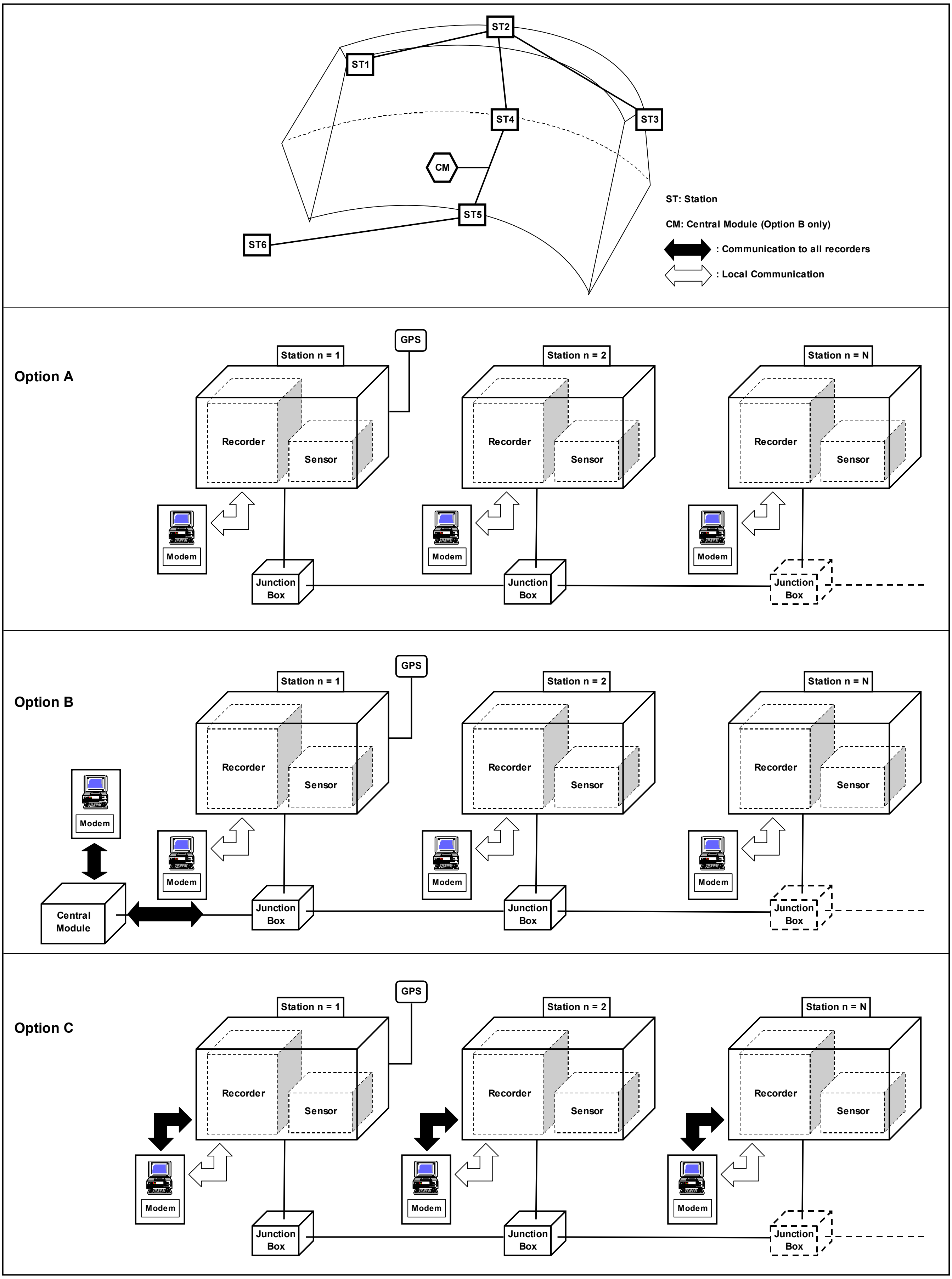

Figure 7. Topology of the Interconnected Recording Network Options

Option A: CCL (Common Time, Common Trigger, Local Communication)

This type of array enables common triggering and common time in the simplest form. The data are stored locally in every recorder and have to be retrieved locally from each recorder separately, due to the availability of Local Communication only. Similarly, the setting of parameters of each recorder have to be performed on the site of each recorder.

Option B: CCC (Common Time, Common Trigger, Central Communication)

A central communication module is utilized in this option. The module is connected to the network as a central, from which all of the recorders can be accessed for data retrieval and setting of the parameters.

Option C: CCM (Common Time, Common Trigger, Multinode Communication)

The data of every recorder can be accessed and retrieved from any of the recorders in the array. Similarly the parameters of each recorder is adjustable from any of the accessed recorders. This provides an extremely versatile system to operate.

Comparison of options

Option	Common Timing	Common Triggering	Communication from: Local Recorder – To Local Recorder	Communication from: Local Recorder – To Every Recorder	Communication from: Central Module – To Every Recorder
CCL	✓	✓	✓		
CCC	✓	✓	✓		✓
CCM	✓	✓	✓	✓	

Table 1. Functional comparison of interconnected network options

Central Recording Network

For this type of network, sensors installed at several locations are connected to the Network Center where a central recording equipment takes place as illustrated in Figure 8. Central recording is available in two options depending on the required ease of accessibility to data, storage space, versatility in network administration and cost.

The signal of every sensor in the network is transmitted through its own connection (star topology), continuously to the central recorder (optionally via a ±5 V differential voltage transmission or a 0-20 mA current-loop).

Option A: GNC-CR Central Recorder

Digitizer and Recorder Module Cards within the GNC-CR digitize and record the incoming data. Thus, all the data is stored in the network center.

The operation mode of the GNC-CR is event recording as trigger levels are reached.
The on-line surveillance, common triggering, and time synchronization for the network is accomplished by GNC-CR, which as well displays the status of each sensor on-line.

An optional Alarm Output can be defined in a way similar to selecting the event-recording trigger, thereby enabling the user to be informed immediately of the occurrence of an event or of a warning or error. Lightning and overvoltage protection is used for the sensors, and Network Center. Other options for the GNC-CR include a GPS Receiver, and a modem.

Option B: CR-4 PC Based Central Recorder

Digitizer Module Cards within the CR-4 digitize the incoming data from the sensors. The digitized data then are recorded on an integrated industrial PC in the CR-4.

The operation mode of the CR-4 is event recording as trigger levels are reached, plus permanent recording into the ringbuffer taking the advantage of the integrated PC.

By monitoring continuously the sensors, CR-4 detects events depending on the software settings on the PC, generates associated alarms and automatically processes the recorded data.

The CR-4 can distinguish between warnings and errors. Warnings are malfunctions of the instrument, while it is still running and capable to record data as well as generate alarms. Errors on the other hand, effect the function of the recorder such that it may not record or generate any alarm. Warnings and errors can be displayed on the screen (if connected) or sent to a data center by modem (user selectable).

The utilization of a PC greatly improves task handling, data storage, communication and interaction capabilities as well as allows easy update of software, without reprogramming the firmware in the DSP.

Common Functionality in Instrumentation Networks

Optional features for each recorder in the Independent and Interconnected Recording Networks are a GPS Receiver, which can obtain accurate real time (UTC), and a modem, which can enable automatic dialing capability and allow external access and control of the system through a Network Center. Integration of one or more recorders in the local safety system (e.g. for generation of an alarm) is also possible.

Many of the functions (processor, time update, A/D conversion, etc.) of an instrument network are permanently and automatically checked internally. Other functions (sensor link, filter response, memory, etc.) may be checked periodically by the user. The system can be programmed to execute this periodic test automatically at periodic intervals or to disable it.

The optional Data Analysis Package of Windows-based GeoDAS software can be used to perform several functions using data obtained by any of these networks.

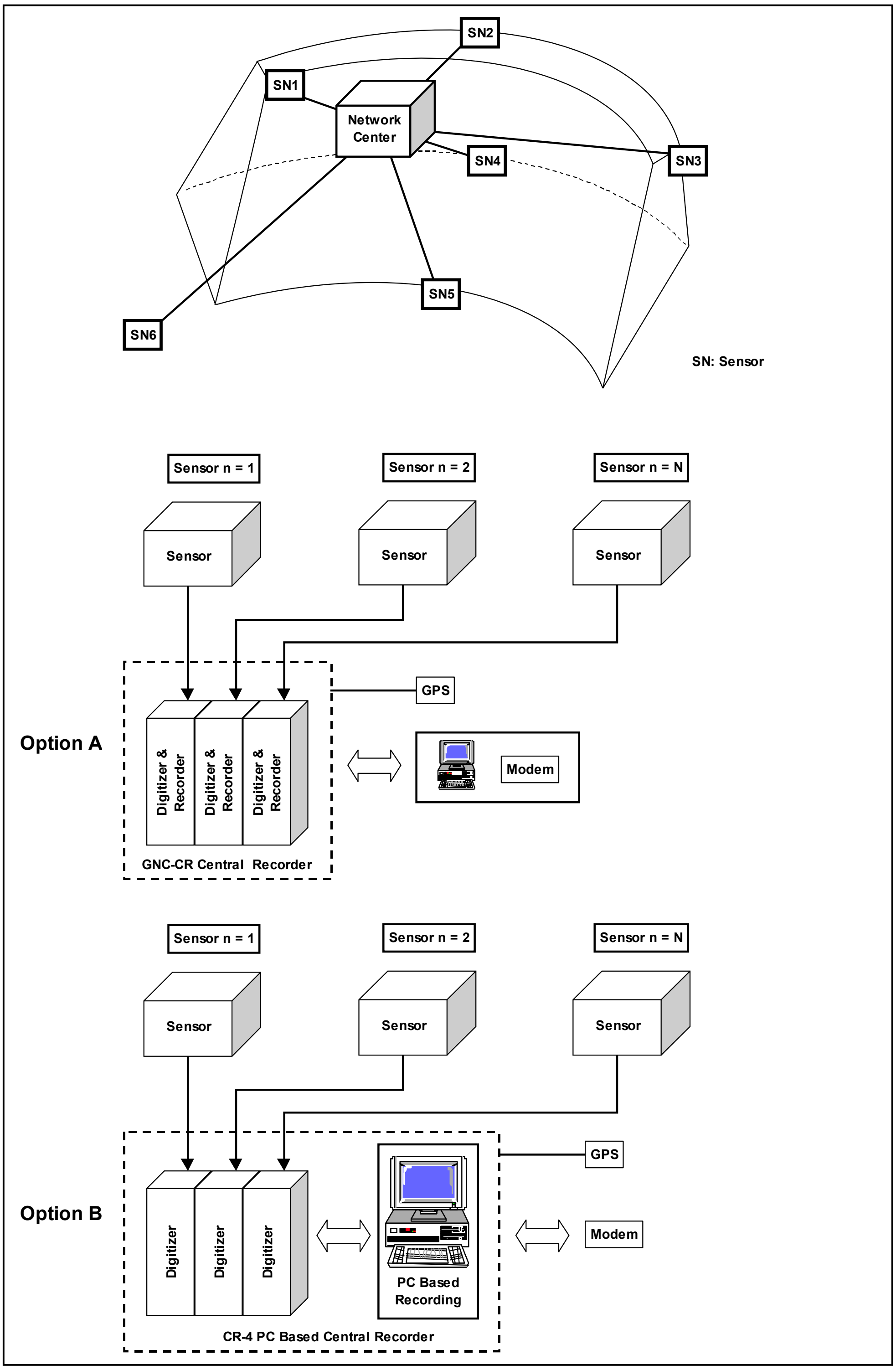

Figure 8. Topology of the Central Recording Network

This technical note has been prepared by GeoSIG Engineering Department, based on professional know-how and experience on Strong Motion Instrumentation Networks.

to be continued:
Structural Monitoring and National Building Codes

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We would like to take this opportunity to announce that our annual winter holiday will be from the 23rd of December 2002 to the 3rd of January 2003,
And Wish You a Happy and Prosperous New Year