HYDROMETEOROLOGICAL TELEMETRY NETWORK OF ALBERTA 1/ 635-78

By

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Introduction

The planning for an Hydrometeorological Telemetry Network began in early 1974. The network was designed with three independent systems: remote hydrometeorological network, communication network and central computer and user's terminals (see Figure 1).

Presently, the only meteorological instrument with telemetry is the Fischer-Porter precipitation gauge. The electronics needed to interface between the absolute position shaft encoder and the telephone system were developed and manufactured locally. Each interface unit is capable of handling up to eight separate inputs. The Hydrometric Telemetry Network consists of 33 Leupold-Stevens Telemarks which are operated by Water Survey of Canada.

The second section is the communication system. Presently the Alberta Government Telephone System (A.G.T.) is used to transmit the data from the field into the office. Alternative means of communications are currently being investigated.

The Central Computer Facilities consists of a mini-computer, auto dialer and the telemark reformater. The computer and auto dialer were purchased and the telemark reformater was designed and manufactured locally. The software for this system was written with maximum flexibility. A very general program was needed to accommodate not only Flow Forecasting's needs but also those needs of the Air and Water Quality Branches. The computer performs scheduling, interrogating, editing, data storing and general management functions.

Automatic Collection of Data

Traditionally, automatic weather stations have tended to be complex devices with all their peripheral devices clustered around a source of power and set of communication lines. Two recent developments have allowed that traditional view to be challenged. CMOS technology has decreased power requirements for electronics circuitry by orders of magnitude, until power is now a relatively minor consideration, The second important development has been the extension of the switched telephone network throughout the populated, and even the relatively unpopulated areas of Alberta. These two factors have made the concept of a distributed network of sensors feasible.

In the process of searching for a precipitation gauge suitable for use with an automated weather station the Federal Atmospheric Environment Service and Alberta Environment decided on the Fischer-Porter precipitation gauge. This instrument has been used by the Atmospheric Environment Service for several years to collect data in remote areas. Most of the problems in siting and operating these gauges have been overcome. However, the data collected by these gauges has been of little direct use to the operational meteorologist and hydrologist because this data was not available in realtime.

A Baldwin absolute position shaft encoder was chosen to interface with the precipitation instrument. When properly installed, the shaft encoder had virtually no effect on the normal operation of the data collection portion of the gauge, and allowed direct electronic access to the gauge. Near the time that this was done, a small, inexpensive, electronic device called DARDC or LADS II became available that could automatically answer a

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standard telephone and transmit the data applied to its input ports as a short teletype message. This teletype message was transmitted as a pair of audio tones, representing marks and spaces, and all that was required to receive them was a teletype machine or other teletype based devices connected to an acoustic coupler, or a telephone modem leased from the telephone company.

It was a simple wiring job to interconnect the shaft encoder with the DARDC. The first unit was installed in the Pembina River Basin near Mayerthorpe, Alberta to demonstrate the principle. This unit operated there for about six months with a remarkably good maintenance record.

Alberta Environment and the Atmospheric Environment Service jointly modified and installed a series of these gauges in southern Alberta. The gauges were modified by a local machine shop, and a contract was let to a local firm to construct the electronic components. The electronics were assembled from a virtually off-the-shelf locally designed and manufactured data system, which was being used in process control and monitoring in the oil and allied chemical industry. The equipment built under that contract has not been as trouble-free as desired but the problem appears to have been traced to the telephone coupler which is connected to the telephone lines installed by the Alberta Government Telephones. Some of these lines were noisier than anticipated and caused the rechargeable battery used in the unit to run down sooner than expected. These data collection systems use CMOS logic in conventionally designed circuitry.

The next set of telemetry interface units was designed with wide temperature range microprocessor technology. These units are proving to be a much superior design. Test data shows that the battery life (12.5 V gel cell) will operate these units up to 3 years at four interrogations per day. The first of these units was installed over one year ago. To date there has not been any missing data due to failure of this unit, or any of the other four units currently in operation.

Sufficient capacity has been built into the field units to accommodate up to 7 additional inputs. At some climatic sites data such as temperature, snow-water equivalent, wind speed and direction, and radiation will be transmitted as well as precipitation totals. These modifications can be made by the simple installation of an additional input board into the card cage.

Transmission of the Collected Data

All the precipitation and water level data is being transmitted to Alberta Environment Headquarters in Edmonton via the A.G.T. switched network. At present, each remote site is connected with individual line service thereby insuring no interference from other users. Originally in 1974 the cost of installing individual line service was relatively inexpensive. Since then, however, these costs have increased considerably.

Two areas of difficulty were encountered with connecting the telemetry units to the switched network: 1) the passive data coupler supplied by A.G.T. was designed for A.C. power supply only, therefore D.C. battery driven units had to be designed and built, and 2) telephone line noises caused the telemetry unit to be continuously activated, therefore draining the battery within 36 hours. A.G.T. anticipated strength of signal problems with one gauge which was to be located 40 miles from the telephone exchange, however the telemetry unit was easily activated upon testing and is working successfully.

Receiving, Storing and Editing Data

The master station is centered around a data general S230 computer which is operated by the Systems & Computing Branch of Alberta Environment. The main functions of this in-house computer are to control the interrogation schedule, to interpret the incoming signals, to perform various calculations and editing functions, and to execute several report writing tasks.

The signals produced by the remotes are in two forms. The precipitation remotes signal is digital and therefore is directly accepted by the computer. Those produced by the water level monitors (Leupold-Stevens Telemark) are analogue (voice) signals. A local consultant firm was hired to design a device to convert these signals to digital. The resulting telemark reformater was designed using "phase lock loops" and has currently been working with approximately 80 percent reliability. The two main problems which had to be overcome were: (a) many lines contained excessive noise (high frequency high energy signals), (b) all telemarks did not produce the same signal frequency. It was discovered that the telemarks fell into three separate frequency bands, therefore three separate loops had to be designed to accommodate all currently operating telemarks.

The computer software is fairly complex therefore a general program was written to handle the needs of all users. The following paragraphs outline the main modules of the system (see Figure 2).

Details Control Program Module

This program is used to create a file which contains the details for an individual remote. The station number, name, phone number, conversion file and standard file are contained in this file. No conversion or standard files have been developed for any stations as yet. An example of a conversion file would be the rating curve for a particular station. The "Standards file" is a file containing a basic program which will perform several checks. This file would check whether a certain rate of change or a certain predetermined flood stage was exceeded. If a critical value was exceeded then a warning could be printed out or a phone call initiated to the forecaster on duty.

The Scheduling System

The scheduling program is the heart of the Environmental Monitoring System and is itself composed of several modules: the master schedule itself, a command system which is used to create, examine and modify the schedule, and several "task" modules which are executed at various times under the control of the master scheduler.

A scheduling file was created containing the following information: station number, polling schedule, priority and a printing and/or storing code. The station numbers for the hydrometric stations correspond to the Water Survey of Canada station numbers and the station numbers for the precipitation gauges were derived using a similar system. The scheduling for the polling of each station can be specified three ways: (a) identifying an exact date and time, (b) identifying a pattern, which must be matched by the date and time, or (c) specifying an interval (in minutes) between executions.

Each station is given a priority code. Therefore, if two stations are to be polled at the same time, then the one with the highest priority will be polled first. Once polled, the information will be either stored, printed out immediately, or both.

The Editing and Report Writing System

This program is again composed of several modules. Subprograms allow the raw data to be verified and errors to be corrected. It also gives the operator the control to recopy the data into more concise files. The second part of this system is the report writing tasks. Several programs have been written so that the data can be called from storage, total differences, etc. can be calculated and then a report written. Several types of reports may be written: (a) daily reports containing all interrogated values (raw data) for any period specified, (b) monthly reports containing the daily values for any month specified and a summary of that month, and (c) yearly reports containing the daily values for any year specified and a summary for that year.

Further Expansion

The need for an alternative communication system was recognized in that many of the prime flood producing areas of Alberta are not serviced by the A.G.T. switched network. Although technically feasible to install land lines to many of these sites, the cost of doing so is prohibitive. A detailed Communications Study was undertaken by Bristol Aerospace Ltd. of Winnipeg. The consultant was to analyze present communication alternatives with respect to cost, operating characteristics and constraints, reliability, flexibility, availability of proven hardware, etc. This study showed that only two different systems are presently feasible. These systems are (1) a combination of GOES telemetry and

FIGURE 1

DATA ACQUISITION SYSTEM

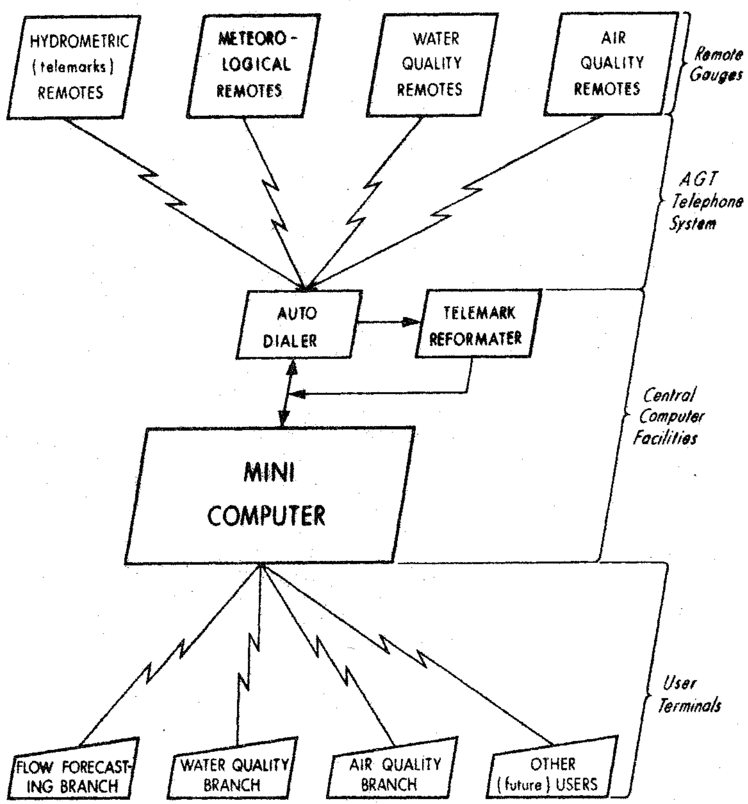
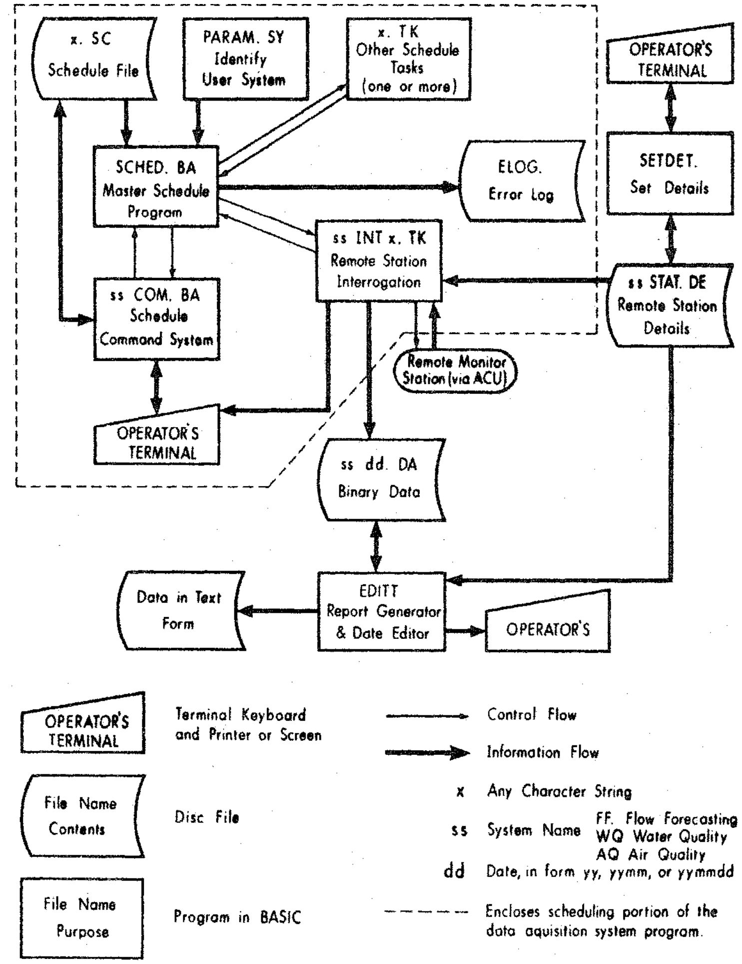


FIGURE 2

CENTRAL COMPUTER FACILITIES



land lines, and (2) Meteor Burst telemetry and land lines. Land lines would be used when the installation cost is under $2,000. Both systems are able to satisfy all our requirements. The estimated cost of both systems were very competitive. The next phase of this project will be to procure monies and go out for competitive bids. It has not yet been decided which system to tender on or whether to tender on both. Alberta Environment is also looking into less expensive (but equally reliable) instrumentation and interface equipment.

Uses

Most of the major flood events in Alberta are caused by heavy precipitation in the East Slopes at a time when rivers are already high from mountain snowmelt. Because many of the major Alberta centers are located in close proximity to this area of heavy runoff there is very little lead time in which to prepare for an impending flood. Our present network consists mainly of reports from the Alberta Forest Service. These readings are taken twice daily (at most stations) at 7:30 in the morning and 1:30 in the afternoon. Therefore, precipitation could be reported as much as 18 hours after the event occurred. For these reasons the need for a Hydrometeorological Telemetry Network was realized.

With a realtime system such as this, the rainfall and river stages can be monitored automatically 24 hours a day, seven days a week at any scheduled time interval. If rain is forecasted for a certain area then gauges in that area would be rescheduled to report more frequently.

Temperature, precipitation intensity, snowfall and soil moisture conditions play a very important role in the forecasting of flood events. Sensors reporting from these areas enable the forecaster to determine (a) where precipitation is falling as rain and at what elevation it is snow, (b) the rate of evaporation or sublimation, (c) the melt rate, (d) the time distribution of the event, (e) the intensity of the event, and (f) basin conditions prior to the storm.

The above information would be available on a realtime basis without having personnel in the field continuously.

The information obtained from this system is not only beneficial for the primary purpose of flood forecasting but also in the following areas: (a) Improve Water Supply Forecasting - knowing daily melt rates, precipitation amounts and evaporation/sublimation losses would permit more accurate forecasts to be produced and updated more frequently, (b) Recreation - sites which are located adjacent to skiing facilities would be useful in forecasting avalanche potentials. Backpackers, hikers and canoeists would also find this type of information valuable, (c) Agriculture - will benefit from more accurate water supply forecasts and improved flood warning would reduce agricultural and livestock losses, and (d) Hydrology - better knowledge of the hydrology of the East Slopes will be gained from the increased use of continuous recording gauges.

Summary

Currently only a small network of telemetry stations are located strategically throughout Alberta consisting of seven (7) precipitation sites and thirty-three (33) hydrometric sites (see Figure 3). A major network expansion is currently underway in Alberta (see Figure 4). One of the major hurdles of course is to choose a reliable communication system

The present telemetry network using land lines works exceedingly well. This system is very flexible and reliable but is very limited as to economically feasible locations where this network can be expanded.

REFERENCES

Falk, Alfred, September 1977. Environment Monitoring System: Users' Manual, Computek Ltd., Edmonton, Alberta, Canada.

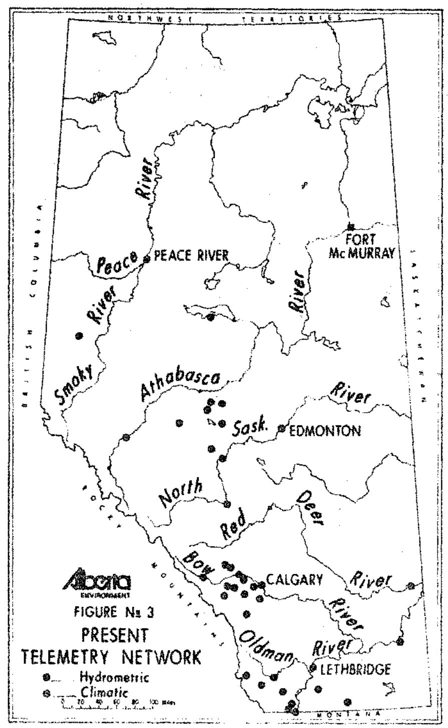


FIGURE № 3
PRESENT TELEMETRY NETWORK

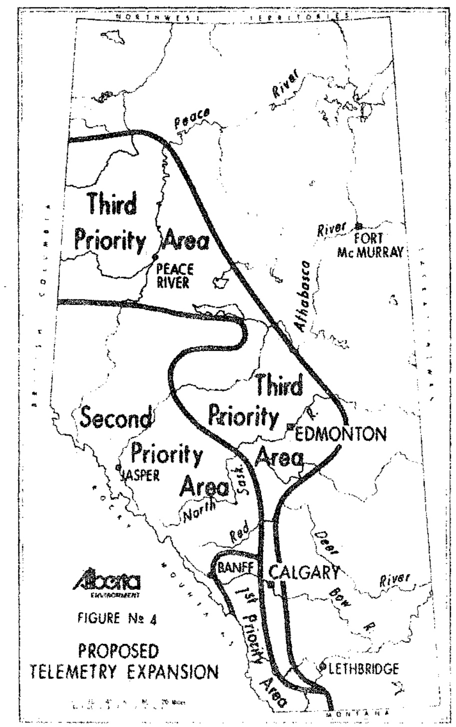


FIGURE № 4
PROPOSED TELEMETRY EXPANSION