METEOR BURST DEMONSTRATION PROJECT

Interim Report

by

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INTRODUCTION

The Alaska Department of Transportation and Public Facilities (ADOTPF) has become involved in remote monitoring of state facilites for the purpose of operation and maintenance, especially for those buildings in locations where well-trained maintenenance personnel are not available. Several schemes have been proposed for instrumenting facilities and transmitting operating data back to a central maintenance location where such factors as equipment use, energy efficiency, hazardous conditions and impending failures can be monitored. One of the most promising techniques for data transmission is a network of meteor burst remote stations which use the brief ionized trails of meteors as a medium for relaying information back to a master station. The information is sent in coded "bursts" and is decoded by a computer located in the master station. The meteor burst techniques has been described in a previous report*.

The project described in this interim report is a demonstration project for evaluating the feasibility of meteor burst technology in State of Alaska applications. It consists of two phases:

1. Calibration and testing of sensors and remote station on the University of Alaska, Fairbanks campus.

*LOW DATA RATE DIGITAL TRANSMISSION TECHNIQUES FOR ALASKAN APPLICATIONS, T.D. Roberts, R.P. Merritt and K.J. Kokjer, ADOTPF Report AK RD 81-6 (1981).

2. Installation and evaluation of performance under severe operating conditions at a remote facility.

Phase one has been sucessfully completed and phase two is underway.

SITE SELECTION AND CHOICE OF INSTRUMENTATION

In November, 1980, a proposed site at the repeater location on Caribou Mountain, North of the Yukon River on the Haul road, was inspected and evaluated for suitability as a test location. Two small buildings containing a generator and VHF transmitting gear are located here, as well as a transmitting tower. The site is subjected to severe winds and temperatures. The radio horizon is good, but from the standpoint of signal propagation, the signal path is close to the worst case, so that ionospheric disturbances will have the greatest effect on system reliability. The site was judged to be suitably "remote" yet reasonably accesible for experimentation, while providing harsh and unfavorable operating conditions.

Physical parameters selected for monitoring were indoor and outdoor air temperatures, generator oil temperature, line voltage, and wind speed and direction.

REMOTE STATION CHARACTERISTICS

The remote station is a protoype unit manufactured by Meteor Communications Consultants and consists of a 300 watt transceiver and a microprocessor controlled data acquisition unit which periodically reads and stores the data from six sensors. The unit is an improved version of units presently in use by federal agencies in Alaska. There is a 4K memory on board, with 16K available optionally. A 300 baud interface allows data readout using an RS232 standard printing terminal. Short messages may also be sent and received without the need for units such as the unit required on the federal stations. Sampling times are selectable by simple wiring connections. The Caribou mountain unit samples temperature, wind, and voltage data every ten minutes. The station is polled every hour by the master station and the data is recorded on a permanent computer file accessible from the University of Alaska Computer Network. Data from a period immediately after installation is shown in the accompanying figure. The data is in decimal, unprocessed form and may be interpreted with the aid of the following equations:

GENERATOR VOLTAGE

$$V = .0545(d1) + 33.5 \quad \text{rms volts}$$

INSIDE AIR TEMPERATURE

$$T = .100(d2) - 60.4 \quad \text{degrees Fahrenheit}$$

WIND DIRECTION

$$D = .136(d3) \quad \text{degrees from true North}$$

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zas,811740704,1579,1354,2000,0664,0029,0690
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zas,811760902,1515,1355,1757,1091,0377,1624
zas,811761010,1441,1342,1936,1114,0339,1659
zas,811761102,1500,1351,1869,1128,0272,1659
zas,811761203,1479,1346,1787,1129,0502,1675
zas,811761302,1475,1346,1809,1129,0387,1687
zas,811761407,1495,1352,1793,1124,0425,1719
zas,811761507,1491,1349,1964,1126,0378,1748
zas,811761607,1445,1361,1866,1117,0446,1770
zaf,811761402,0064,0256,0896,3057
zal,811761602,0064,0256,0896,2977
zas,811761707,1490,1356,1377,1100,0486,1802
zas,811761800,1458,1350,1914,1098,0565,1795
zas,811761907,1459,1343,1653,1091,0432,1739
zas,811762007,1470,1341,1730,1087,0362,1718
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zas,811770405,1461,1288,0980,0996,0296,1651
zas,81177  5,1529,1284,1168,0997,0352,1662
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FIGURE 1

Computer print-out of data from Caribou Mountain site coded "zas". The 9-digit number refers to the year, day and time. For example, the first entry refers to day #174 of 1981 at 0704 hours.

The next set of six 4-digit numbers are coded decimal outputs referring to the sensor data. (See text.) From left to right, the outputs represent Generator voltage, inside air temperature, wind direction, outside air temperature, wind speed, and generator oil temperature.

Incomplete data strings represent errors in transmission or propagation.

The arrow points to the first entry after the station was installed at the Caribou Mountain site; data before the arrow is test data obtained from the Duckering Building location.

OUTSIDE AIR TEMPERATURE

$$T = .134(d4) - 89.14 \quad \text{degrees Fahrenheit}$$

WIND SPEED

$$S = .0378(d5) \quad \text{miles per hour}$$

GENERATOR OIL TEMPERATURE

$$T = .127(d6) - 13.4 \quad \text{degrees Fahrenheit}$$

Here d1 through d6 are sensor decimal outputs from the data acquisition unit. Using these relations and the data from the first log-in from the Caribou Mountain site it is seen that on the 175th day of 1981 at 1933 hours (7:33 PM on June 24 1981) the following conditions were observed:

GENERATOR VOLTAGE: 110.2 volts rms

INSIDE AIR TEMPERATURE: 65.9 degrees Fahrenheit

WIND DIRECTION: 275.3 degrees from true North

OUTSIDE AIR TEMEPRATURE: 63.8 degrees Fahrenheit

WIND SPEED: 17.2 miles per hour

OIL TEMPERATURE: 208.7 degrees Fahrenheit

After the Caribou Mountain station logged on, and after some initial station adjustments were made, the station responded hourly to the interrogation signal from the master station. Unlike the federal remote stations, which may be inoperative for several hours after transmitting, the Caribou mountain station remains on line after the ten minute data sampling period. Hence, the time of transmission which appears on the computer printout is also a good indicator of the system response time to the polling signal from the master station. Preliminary results from the first few days suggests that the average waiting time for the first few days of operation was of the order of three or four minutes.

The antenna in use is a three element Yagi which has been modified to operate at 40 MHz. The radio horizon at the Caribou Mountain site is clear, and summer operation appears to be quite reliable at this writing (June 30, 1980).

FUTURE WORK

The major portion of the field work is now over, with the establishment of a functioning remote station at Caribou mountain. The remainder of the project will consist of analysis and evaluation including accuracy of the data, adaptability of the technique to other sites and other problems, hardware reliablility over the 1-year test period, and hardware servicability. The inclusion of Meteor Data, Inc. as a subcontractor has undoubltedly helped keep maintenance and installation problems to a minimum so far.

Since the master station polling schedule begins on the hour and continues until an error-free response is received, it is relatively straightforward to obtain the message delay time, and the variation of the delay time with season and propagation conditions. A computer program will be written which will keep weekly records of typical and unusual data, mean delay time, propagation conditions, and data limits for the period. The data will be analyzed and typical performance indices will be established for the system, along with best case and worst case performance characteristics. The work will conclude with an exhaustive final report.