EFFECTIVE STATUS MONITORING
THROUGH
HIERARCHICAL DISTRIBUTED PROCESSING

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ABSTRACT

As cable systems continue to grow in complexity and length a good status monitoring system capable of reducing down time is a must. Such a system should be able to detect a problem before an outage occures and be expandable to meet the future needs of the system.

As the power of micro computers increases and the cost continues to fall a multiple processor status monitor system becomes a cost effective tool for the system operator. The multiple processor system will decrease detection time while increasing reliability and future expandability.

This paper will disribe the advantages of such a system in detail and try to show what could be done in the near future by using the power of the micro-computer.

INTRODUCTION

Up until recently status monitoring has been a luxury rather than a necessity. Down time has always been a major concern but now with more and more systems caring data the system operator needs to find problems before the outage occurs. Sensors to measure exact levels, voltages and temperature need to be combined with error free data transmission to and from the computer. The operating console needs to be easy to use and the software should be written with future expandability in mind.

By having multiple levels of processing power the data can be concentrated at each level so that the data flow will be minimized at the higher levels (Reference Figure 1). The operator control computer (OCC) is located at the headend or billing office. It collects data from the remote polling controller (RPC) by polling them one at a time. The data is then used for trend analysis and the printing of alarm status. The operator can quickly examine any problem using the user friendly menus.

Communications between the OCC and the RPC's is done using standard RS-232 with data rates of 300 to 9600 baud. Data in both directions is checked using 16 bit cylindrical redundacy checking (CRC-16).

The RPC keeps track of all the data from the remote status modules (RSM) including limits and alarms. In fact, all the operator console would have to normally do would be to issue a "Is there anything wrong" command. The lower level proccessing would take care of polling and limit checking. In this way the operator console (OCC) could use low speed data lines such as phone modems to allow the OCC to be located anywhere. This would also allow the remote polling controller (RPC) to be located at a remote hub site and if multiple hubs existed they could be physically located miles apart.

A typical system would consist of the following:

1) Transponders
2) Remote polling controllers (RPC)
3) Operator command console (OCC)

The following is a description of each level of processing in detail.

TRANSPONDERS

The transponders are located at the device to be monitored. Their job is to carry out commands from the RPC and send back data when instructed to do so. Features to look for in a transponder are:

1) Number of stations that can be addressed.
2) Number of inputs and outputs.
3) Data speed and error checking.
4) Dynamic range of RF modem.
5) Power requirements.
6) Future expandability.

The Jerrold advanced status monitor tranponder is refered to as an RSM or remote status module. It uses a state of the art micro-computer IC that has on board read only memory (ROM), random access memory (RAM), serial port and input/output ports (Reference Figure 2). This is a big advantage because of the space savings and powerful data error checking that can be done.

The number of stations that can be addressed is an important concern. If there are too few addresses then not all devices in the system can be monitored. If there are too many then the response time to find a failure incresses. In a multi-processor enviroment the work load can be divided between several computers. In the Jerrold advanced status monitor we allow 1000 addresses for the transponders. At a data speed of 19.2 Kbits per second and a total transmission word length of 47 bytes this gives a polling time of under 60 seconds. If more stations are needed another remote polling controller can be added. A maxiumin of 16 remote polling controllers can be in one system thus giving a total of 16,000 monitored stations and a maximum response time of under 60 seconds. An example of the advantage of distributed processing would be if the system had 1,600 stations to be monitored. If 16 RPC's were used to distribute the work load and each polled 100 stations, then the response time for a complete system poll would be under 6 seconds.

The RF modem is built into the transponder itself thus allowing installation in either a trunk amp, remote power supply or anywhere on the 2 way cable system. The RF modem is designed with a dynamic range of over 40 db thus allowing it to receive data in very weak signal conditions as found in the case of a failed trunk amp. FM modulation was chosen since it gives a 6db S/N improvement over AM. Data is transfered using standard 8 bit asynchronous format with one start bit, eight data bits and one stop bit with a baud rate of 19.2 Kbits per second.

Error checking on all data to and from the transponder is done by using a 16 bit cylindrical redundacy check (CRC-16). This the the type of error checking done by most of the advanced communication programs and would be extremly difficult to do without the micro-computer.

Power requirements are an important specification to look for in any piece of cable equipment. The micro-computer replaces the function of many IC's and by using CMOS technogoly both current and heat are reduced. In the Jerrold advanced status monitor transponder we were able to keep the power requierment under 150 ma @ 24VDC.

Future expandability is provided by sending a type code along with the data stream. The micro-computer in the transponder then looks at this code to determine what system configurization it is to be used in. We are currently using seven different types leaving 249 additional types to be used in the future.

Additional expandability is provided by an op-code that is sent to the RSM (Reference Figure 3). Op-code zero instructs the RSM to return its analog and digital data while op-code eight instructs it to load limits and alarms. A simple re-programming could be done to add many more commands.

Analog HI and LOW limits are compared in the transponder itself. This saves computer time in the polling computer thus providing a faster polling time.

The computer also controls the return RF level. The RPC measures the return RF level from the RSM and then can command it to increase or decrease its return level. By using the closed loop architecture between the two computers an adjustment free system has been realized that is nearly independent of reverse amplifier set-up gain.

Remote Polling Controller

The remote polling controller has two basic tasks. The first task is to poll the transponders connected to it and store this information in memory. The second task is to receive commands from the operator control console and send back requested information.

The Jerrold advanced status monitor RPC is baised around the IBM PC computer. To be as flexible as possible all of its software is uploaded to it from the operator control console computer thus allowing future software updates with NO hardware changes. Since its software is running out of random access memory no disk drives, keyboard or video monitor are needed for this computer there-by increassing reliability.

To get the maximum polling speed another micro-computer IC is installed on a plug-in card in the remote polling computer. The job of this status monitor interface board is to take data from the RPC and send it in a serial format on a radio frequency to the transponders. Once the RPC sends a command to this board it is free to handle commands from the operator control console and waits for the board to tell it that it's ready. In the Jerrold advanced status monitor there are four levels of processing that the data flows through.

THINGS TO COME

The multiple processor environment frees up each computer to handle a bigger task. I see the day coming when there will be computer controlled stations, not just computer monitored. Imagine a trunk amplifier that all that was necessary to set it up was to turn it on. The micro-processor could measure the pilot levels, control the slope and gain, adjust for outside temperature and send back a report of system flatness at its location. Total amplifier failure could be bypassed and previous amplifier levels increased to compensate for it.

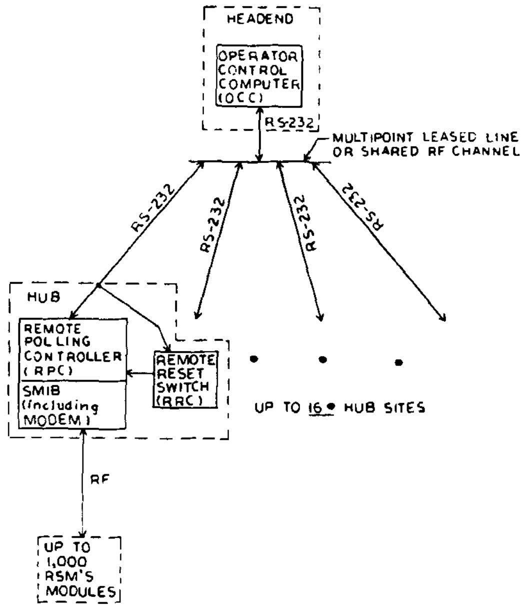

FIGURE 1: SYSTEM DIAGRAM

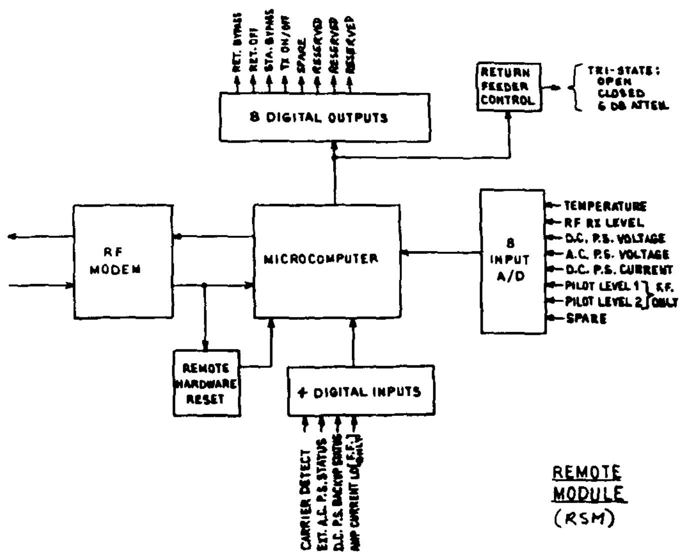

FIGURE 2: REMOTE STATUS MODULE

COMMAND: Return Alarms and Values

OPCODE: HEXØ, BINARY ØØØØ

DESCRIPTION: Report all alarms and all analog and digital values.

F O R W A R D   T R A N S M I S S I O N   F O R M A T:

4	4	8	16
OP-CODE	ADDRESS		CRC-16 CHECKSUM

4	4	8	8	8	8	8	8
OP-CODE	ADDRESS		ANA-LOG HI ALARMS	ANA-LOG LO ALARMS	DIG-ITAL IN-PUTS	ANA-LOG VALUE 8	ANA-LOG VALUE 7

8	8	8	8	8	8	16
ANALOG VALUE 6	ANALOG VALUE 5	ANA-LOG VALUE 4	ANA-LOG VALUE 3	ANA-LOG VALUE 2	ANA-LOG VALUE 1	CRC-16 CHECKSUM

B I T   F O R M A T S:

ANALOG HI ALARMS								ANALOG LO ALARM								DIGITAL INPUTS							
AHA8	AHA7	AHA6	AHA5	AHA4	AHA3	AHA2	AHA1	ALA8	ALA7	ALA6	ALA5	ALA4	ALA3	ALA2	ALA1	DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1

FIGURE 3