WIYN Project

Wisconsin-Indiana-Yale-NOAO

MEMORANDUM

TO: Distribution Date: July 2, 1992
FROM: Matt Johns
SUBJECT: Science Instrument Interface Requirements

Enclosed is a first draft of the WIYN Project Science Instrument Interface Requirements. I hope it provides a context for our discussion in Madison.

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Title: Science Instrument Interface Requirements for the WIYN 3.5 Meter Telescope

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1. Scope

The purpose of this document if to define the requirements for the interface between the WIYN control system and science instruments (SIs) that attach to the system. Specifications for the interface will be contained in an interface control document (ICD).

The scope of this document includes the hardware and software being developed for the WIYN project by the University of Wisconsin Controls Group that comprise the Science Instrument interface including (a) system configuration, (b) network protocols, (c) message transport layer, (d) commands, (e) telemetry, (f) image processor interface, and (g) timing signals.

2. Configuration

The primary science instrument interface to the control system is through the Observatory LAN. In the current design, the Observatory LAN has three legs: (a) Telescope Controls, (b) Engineering Data System, and (c) Science Instruments. The SI leg is provided for (a) instrument controllers, (b) data reduction and archiving workstations, (c) scientist workstations, (d) shared disks and (e) a printer. The ports and cabling for these instruments will be provided as part of the control system. The actual instruments are the responsibility of instrument developers. Figure 1 shows the system configuration.

A bridge/router separates the local SI traffic from traffic on the other two legs. Messages from SIs to the rest of the observatory control system pass through the bridge/router in a manner transparent to the software running in the connected peripherals. The bridge/router also connects the Observatory LAN to the Mountain LAN providing a gate to the Internet.

Science instruments may have subnets of their own for instrument control and data storage. No restrictions are specified in this document for subnets, instrument cabling or the internal design of instrument controllers. Developers must coordinate their instrument controls design with the WIYN Observatory. The Observatory does not guarantee that all configurations of controller location, cabling, communications links, etc., can be accommodated.

The real time control of telescope motions is carried out by 68000 based single board VME-bus computers (SBCs) running VXWORKS attached to the Telescope Controls leg of the Observatory LAN. A software router (NB. need a different name to distinguish between this and hardware bridge/router) controls the transmission of commands and telemetry between the real-time controllers and control workstations, Engineering Data System, SIs, etc.. There is no provision for connecting SIs directly to the real-time systems.

SIs attached to the Instrument Adapter (IA) at the WIYN port will use the acquisition and guide system provided with the IA to track the telescope. Instruments that will provide guide information independent of the IA will be able to do so (a) by sending guide commands to the control system or (b) by providing a video signal to the Instrument Adapter System (IAS) image processor as described below. Examples of instances where this may be necessary are guiding off a spectrograph slit and SIs attached to the other ports.

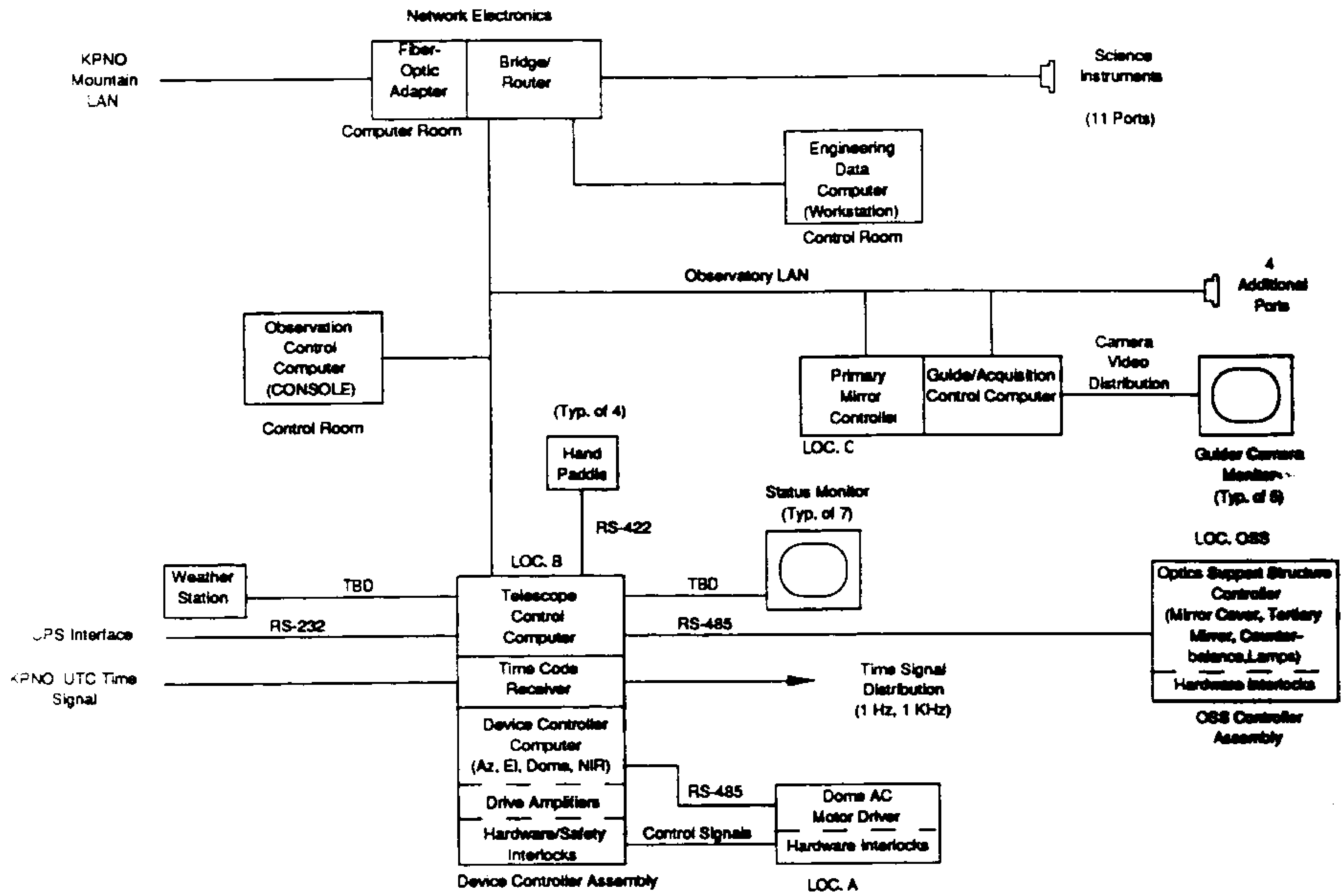

Figure 1. WIYN Control System Block Diagram

3. Observatory LAN

The Observatory LAN is a resource that is shared between the telescope controls, science instruments, and local scientist and staff workstations. The LAN consists of three legs as described under "Configuration". Access to the NOAO network and Internet is provided through a connection to the Mountain LAN.

The Observatory LAN backbone uses thick-wire 10base5 Ethernet and TCP/IP. Twisted-pair 10baseT extensions of the LAN may be implemented in locations where wiring access is limited.

Instrument developers planning to use the network need to submit an estimate of the bandwidth and timing requirements for their instrument before finalizing the design. Advance approval is required from the Observatory to assure adequate resources will be available.

3.1 Science Instrument subLAN

SIs will attach to the Science Instrument leg of the Observatory LAN. These will include (a) instrument controllers, (b) data reduction workstations, (c) shared peripherals such as disks, tape drives, and printers, and (d) scientist workstations. Ports will be provided in the following locations:

a. Spectrograph laboratory (1)

b. Computer room (3)

c. Instrument shop (1)

d. Enclosure second floor (1)

e. Control room (3)

f. Scientist's office (1)

g. Observing floor (1)

3.2 Telescope Control subLAN

The real-time controllers for the telescope and dome will be attached to the Telescope Control leg of the Observatory LAN. The Observation Control Computer (OCC) will also be connected to this leg. The SIs will interact with the real-time controllers by passing messages through router software running on the OCC. The exceptions to this rule are (a) video input from the SIs to the image processor, (b) guide/acquisition frames from the image processor, and (c) time signals from the WWV time base to the SIs as described below.

3.3 Engineering Data subLAN

Engineering data is defined in Section 5. The engineering data archiver will be connected to the Engineering Data leg of the Observatory LAN. SIs will be able to access archives using standard UNIX network tools (rlogin, telnet, ftp, etc.).

3.4 Kitt Peak Mountain LAN

SIs will connect to the Kitt Peak Mountain LAN through the bridge/router and Whisperlan® fiberoptic link. The Mountain LAN will provide T1 service to the Tucson NOAO LAN and through it to the Internet.

The Mountain LAN and T1 link to the downtown NOAO network are shared with the other telescopes and observatories on Kitt Peak. Traffic restrictions may be imposed at various points in the net if demand exceeds the capacity of the system.

4. Network Protocols

The high level control subsystems including the SIs communicate over thick-wire (10base5) Ethernet using the TCP/IP protocols. Telemetry between the SIs and the real-time controls is based on a client/server model in which commands and data are encapsulated in messages that are passed between processes using software socket connections. The messages are encoded in a machine and network independent format and are not restricted to connections on the local networks. Message formats are described in the Message Handler Manual available from the project.

The format for passing guide/acquisition and wavefront sensor images is to be determined (TBD).

The guiding philosophy of the top level control system design is that information is exchanged as telemetry over the network rather than being embedded in rlogin or xwindow sessions. Software running locally at the control sites to processes the telemetry and runs terminal sessions and displays. This reduces the network traffic and transmission delays for remote clients but does require that each node be a workstation. The hardwired display providing telescope/dome position and status at the observatory is the exception.

4.1 Software Standards

The top level software standards for the WIYN control system are UNIX and C. WIYN will provide instrument developers with C subroutines for interfacing to the Engineering Data System (EDS) and Command and Control System (CCS). These will include procedures for: (a) connecting to the EDS and CCS, (b) message formatting, and (c) miscellaneous utilities.

A command line interpreter will also be available.

4.2 Communication with Real-time System

SIs will communicate with the real-time telescope controls using the message passing protocols described in this section. Messages will pass through the router software running on the OCC that will (a) validate access privileges, (b) determine single or multiple recipients, and (c) transmit the message accordingly. Engineering data from the SI to the EDS will also be handled by the router.

4.3 UNIX tools

SIs will have available the standard UNIX network tools (rlogin, telnet, ftp, etc.) for communicating over the network with the Engineering Data System and remote workstations.

5. Engineering Data System

Engineering data includes all control system messages not classified as commands or control. Examples of engineering data are positions, velocities, temperatures, voltages, currents, target names, program ID's, and so on. Command and control messages also become engineering data after they have been acted upon by the appropriate subsystem. Engineering data allow the observatory operators to monitor the real-time status and performance of the observatory and allow non-real time archival analysis for trending and troubleshooting. Engineering data will be used by remote stations for generating operator displays.

The EDS is not intended to handle science data but will process engineering data associated with science instruments. Examples of engineering data produced by the instrument are instrument configuration, exposure start/stop time, detector temperature and so on. Instruments will be both generators and consumers (ie. servers and clients) of engineering data. As an example of the later, FITS headers produced by the instrument controller will include telescope position and time information obtained from the EDS.

Engineering data messages are initiated at the subsystem level. The content and timing of messages are determined by processes running at this level, for example, in the telescope control computer. Science instruments would generate their own engineering data and send it to the EDS server. The server routes the messages to subscribing clients. These will include other subsystems, science instruments, control stations and the archiver.

The format for engineering data messages is specified in "WIYN Control System: Message Handler Software Programmer's Guide".

6. Command and Control System

Command and control messages have the same structure as EDS messages. A command and its arguments are encapsulated together in the same message. Two examples of commands are (a) moving the telescope to a new position and (b) turning on a bank of calibration lamps. Examples of control are (a) requesting position telemetry and (b) inhibiting a motion command.

The Command and Control System (CCS) has a single entry point called the CCS socket server running under the router. Users connect to this server using standard TCP/IP sockets. The server accepts commands and dispatches them to the appropriate subsystem. The CCS sends command messages to the real time subsystems over UNIX socket connections.

(Note: is the concept of the socket server still requires or has it been incorporated into the router?)

SIs will be able to send commands to and/or receive commands from the CCS socket server if they are connected to the LAN and implement this feature in their software. The socket server will validate command permission and transmit the command message to the appropriate subsystem. All system commands are potentially available to the SI under this system.

The format for command and control messages is specified in "WIYN Control System: Command and Control System User's Guide".

7. Image Processor

The image processor is provided as part of the Instrument Adapter System (IAS) at the WIYN port. In addition to providing a mount for instruments at that port, the IAS contains acquisition and guide cameras for tracking the telescope. The image processor will accept video signals from SIs mounted on any port.

7.1 Description

Video signals from the cameras in the Instrument Adapter go to the IAS Image Processor. The image processor (a) captures frames for target acquisition, (b) integrates multiple frames to improve signal-to-noise, (c) displays raw and integrated images, (d) adds cursor and other graphical information to the display, and (d) calculates star centroids to obtain guide errors for tracking the telescope axes. The format for video signals between the cameras and the image processor is RS170.

Additional camera inputs will be provided in the IAS for those science instruments that require some or all of the capabilities of the IAS and can use the same hardware and software. Reconfiguration between the IAS and SI cameras will be handled in the IAS software in response to operator commands.

7.2 Guide function

TBR.

7.3 Frame store

Image frames from the IAS will be sent to the SI in TBD format. SIs will initiate the transmission by sending a command to the IAS. Bandwidth and timing restrictions will apply to this operation.

8. Time Signals

Buffered 1 Hz and 1 kHz signals synchronized to WWV will be distributed throughout the observatory for use by instrument developers. The signals will be carried on separate coaxial cables in digital logic levels.

System time is available asynchronously as EDS telemetry over the Observatory LAN.