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Gemini Controls Group Interface Control Document

ICD 2 — Systems Status and Alarm Interfaces

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This document describes how principal systems within the Gemini Control System provide status and generate alarm conditions.

1.0 Introduction

1.1 Purpose

This ICD document specifies the principal system software interface for alarms and system status.

In detail it:

1. Describes the nature and behavior of the alarm and status software interface.
2. The mechanisms and functionality that will be provided by the principal systems developers to support alarms and status.

The Gemini Control System software is described in detail in [1].

1.2 Scope

This document defines the mechanisms and software that will be used and provided as part of the status/alarm principal system interface. The description of status and alarms and their role in the control system is defined.

The software interface covering system commands is the subject of ICD/1 [6].

1.3 Applicable Documents

[1] SPE-C-G0037, *Software Design Description*, Gemini 8m Telescopes Project.

[2] GSCG.grp.005, *Gemini System Interfaces*, Gemini 8m Telescopes Project.

[3] GSCG.grp.006, *Overview of System Interfaces*, Gemini 8m Telescopes Project.

[4] SPE-C-G009, *Software Programming Standards*, Gemini 8m Telescopes Project.

[5] GSCG.kkg.005, Version 003, 28/6/94, *Baseline Major Systems Interface*, Gemini 8m Telescopes Project.

[6] GSCG.kkg.009, *ICD1a - The System Command Interface*, Gemini 8m Telescopes Project.

[7] GSCG.grp.024, *ICD1b - The Baseline Attribute/Value Interface*, Gemini 8m Telescopes Project.

[8] gscg.grp.008, *ICD 4 — Logging Interface*, Gemini 8m Telescopes Project.

[9] *Channel Access Reference Manual*, Jeffrey O. Hill, EPICS Group, Los Alamos National Laboratory.

[10] *EPICS Release Four Channel Access Functional Specification* (DRAFT - 23 September, 1994), Jeffrey O. Hill, EPICS Group, Los Alamos National Laboratory.

[11] *Alarm Handler User's Guide*, Martin Kraimer, Ben-Chin K. Cha, Mark Anderson, Janet Anderson, September, 19, 1991, Los Alamos National Laboratory.

[12] *Alarm Configuration Tool and Alarm Handler* User Interface System Requirements Definition (DRAFT), Janet Anderson, Ben Chin-Cha, August 30, 1993. Lost Alamos National Laboratory.

[13] EPICS *Alarm Configuration Tool and Alarm Handler User Interface System Requirements Definition (DRAFT)*, Janet Anderson, Ben Chin-Cha, August 30, 1993. Los Alamos National Laboratory.

[14] *EPICS IOC Record Reference Manual*, Janet B. Anderson, Martin R. Kraimer, October, 1992, Los Alamos National Laboratory.

[15] EPICS *Archiving Reference Manual* (DRAFT), Roger Cole, Los Alamos National Laboratory. [N.B. This document is in preparation. The Gemini project has a draft copy. Contact the author for up to date information].

[16] *Definition of the Flexible Image Transport System* (FITS), June 18, 1993, Standard NOST 100 1.0.

[17] *Gemini Record Reference Manual*, Gemini 8m Telescopes Project.

1.4 Abbreviations and Acronyms

A&G	Acquisition and Guiding
AVL	Attribute/Value Layer
DHS	Data Handling System
EPICS	Experimental Physics and Industrial Control System
GCS	Gemini Control System
ICD	Interface Control Document
ICS	Instrument Control System
IOC	Input Output Controller
OCS	Observatory Control System
SAD	Status/Alarm Database

SIR	Status/Information Record
SDD	Software Design Description
TBP	To Be Provided
TCS	Telescope Control System

1.5 Glossary

Alarms — Alarms are the asynchronous notification of occurrences in the control system that are critical or important to proper operation. For example, an alarm should occur if a power supply fails in the A&G system. Like the power supply example, the items monitored by alarms are often not directly related to the observing activity but can have a profound effect on observing. Alarms can have *warning* or *failure* severity.

Attribute — An attribute is a textual description of some part of a Gemini based hardware or software system. An attribute has an associated value.

Health — Health is the highest level of status presented by the visible interface. It is defined to be a component's well-being as determined by the component itself. Health can have one of three values: *good* means *I am normal, everything is okay*; *warning* means *I'm operating but not normally*; and *bad*, which means *I'm not operational*. Health should be viewed as a predefined mandatory type of alarm.

Health is defined recursively—a component is in good health only if all the components that it manages and relies upon are healthy too. By logically combining the health of all systems it is possible to find out if the entire telescope system is healthy.

Principal System — At the highest level in the GCS software decomposition, the software system is divided into four kinds of software systems called principal systems. The four types are called: the Data Handling System, the Observatory Control System, the Telescope Control System, and the Instrument Control System. There may be up to four concurrently executing Instrument Control Systems.

Severity — Alarms and errors can have one of two severity levels in the GCS. *Warnings* are alarms or errors that subsystems feel are important and should be brought to the attention of the user. A component should be able to continue working in spite of any events that cause warnings. Warnings can be acknowledged by users allowing operations to continue.

A *failed* severity indicates that a component is in a state that will not allow it to continue operations. The user or operator must solve the problem before continuing operations. Failed alarms or errors will not go away when acknowledged.

Status — Status consists of the values various hardware and software devices present to the other hardware and software systems. A component's *state* includes the attributes related to the purpose of the component, but will also include system related status attributes such as its operational state (busy, done).

Value — The value is the data associated with a particular attribute.

1.6 Stylistic Conventions

Program text is shown in the `Courier` typeface.

2.0 Overview

The Gemini Control System (GCS) is made up of principal software systems: the Telescope Control System (TCS), the Data Handling System (DHS), the Observatory Control System (OCS), and up to four Instrument Control Systems (ICS).

Each system in the GCS must provide information describing its state and health to the other principal systems. The primary status information client is the OCS that uses the status in the following ways.

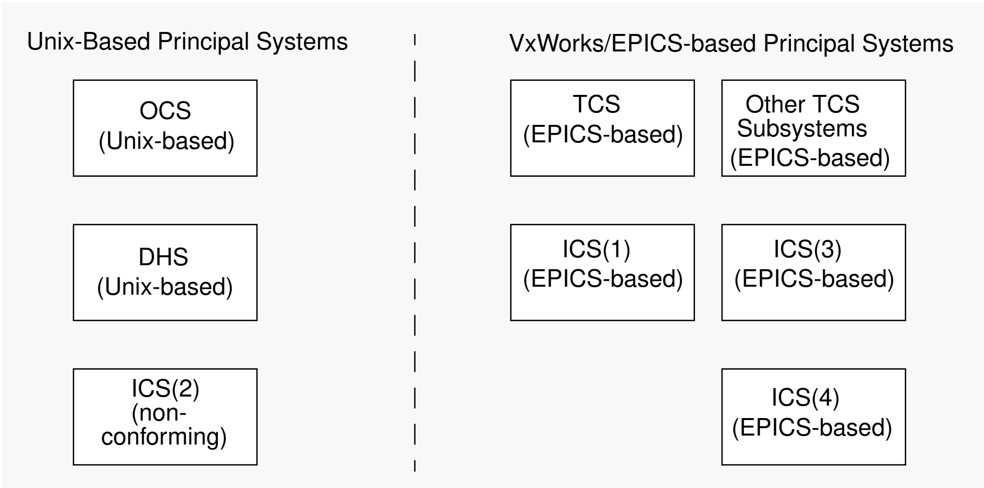
- It must coordinate the inclusion of status data in the science data headers.
- It must update the Science Program record with information that is part of the system status.
- It must keep the observer and operator control screens up to date.

Additionally, all systems need to have access to a general mechanism for reporting alarm conditions to the operator and observers.

2.1 System Hardware Architecture

The Gemini Control System is a distributed system executing on machines of different types and operating systems. The real-time principal systems software, executing in the Telescope Control System and the facility Instrument Control Systems, is based on a combination of VxWorks and EPICS. Figure 1 shows how the principal systems would typically be distributed between VxWorks/EPICS systems and Unix-based systems.

FIGURE 1. Typical Gemini Principal Systems Hardware Arrangement



The Data Handling System and some visitor instruments may not be EPICS based, but the principal systems alarm/status interface must allow all systems to raise alarms and provide status and health to the other principal systems in a uniform way.

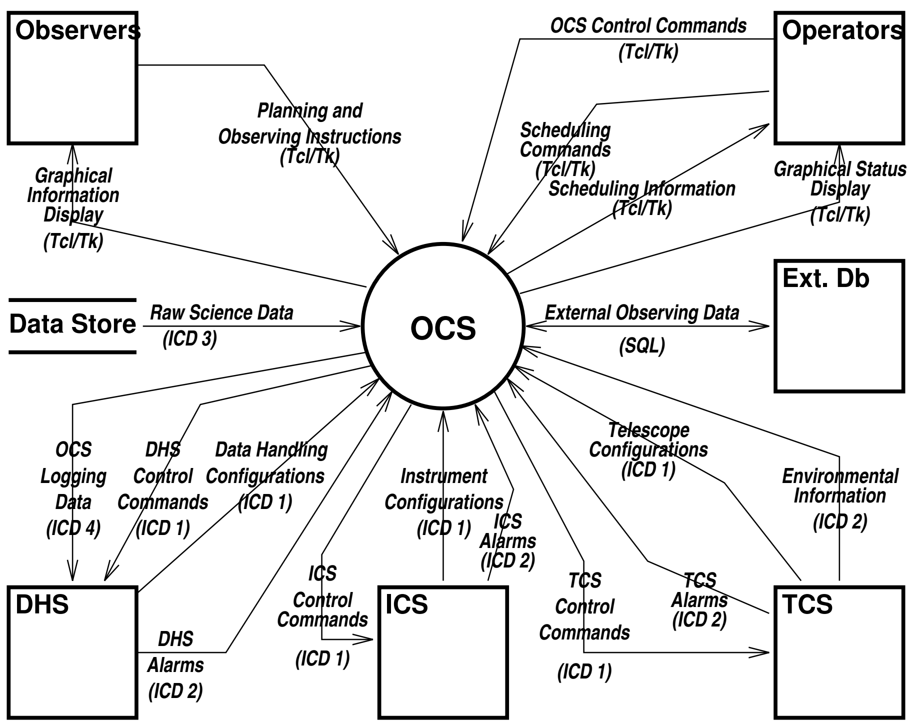
2.2 Communication Architecture

The distributed alarm/status system is built upon the facility Control Local Area Network. There are no alarm/status specific communication requirements. All systems provide and obtain status and alarms using EPICS Channel Access over the Control Local Area Network. Channel Access is based upon TCP/IP and UDP.

2.2.1 Context Diagram

Figure 2 shows the relationship between ICD/2 and the principal systems in a software context diagram.

FIGURE 2. The ICD2 Context Diagram



2.2.2 Events and Responses

Table 1 on page 6 shows the set of events and responses covered in this ICD.

TABLE 1. Events and Responses in ICD/2.

Event	Response
A status device that is part of a principal system updates a status item.	All other principal systems monitoring the value of the status item are notified of the changed value. They respond to the notification in their own way.
A status device that is part of a principal system moves to a state where one or more of its status items are in an improper state generating an alarm condition.	All other principal systems monitoring the status item are notified of the alarm condition in the status item.
A principal system acknowledges an outstanding alarm condition.	The status device generating the alarm is pacified by the acknowledgment.

2.3 The Services Component of the Interface

This interface provides a uniform interface to the use and production of principal system status and alarm information.

2.3.1 Communication Services and Protocols

Communication takes place by means of TCP/IP messages communicated on the Control Local Area Network. The messages are managed using EPICS Channel Access Protocol [9].

2.3.2 Host Support Services

A host can expect to use this interface to provide the GCS with alarm and status information.

2.3.3 Target Support Services

A target system can use this interface to monitor the status of another principal system and to be alerted when an alarm occurs in another principal system.

3.0 Behavior

Chapter 5 of the SDD [1] defines the kinds of information that must be provided by principal systems including: health, errors, alarms, and status. Errors are tied to commands and are covered in ICD/1a [6], the Systems Command Interface. The remaining information items are defined here and their role within the system is discussed.

The following sections are build upon the detailed definitions of status, alarms, severity, and health in the Glossary in Section 1.5 on page 3.

3.1 Status and Alarm Groundwork

This section describes the behavior of status values and alarms in the GCS.

In this document, a *status device* is a piece of hardware or software that has state or information that is of interest to *status clients,* other parts of the software system that wish to monitor status. A *status item* is one piece of information provided by a status device, the *owner* of the status item. Status items are read-only; they can not be modified by any system entity other than the owner of the status item. A status item is part of the status device's *public status interface* if it is available to any status client in the control system. A status device's *private status* is the set of status items that are available only to a subset of possible status clients. For example, the TCS may have status items that are only readable by its subsystems.

FIGURE 3. Relationship between items and definitions in section 3.1.

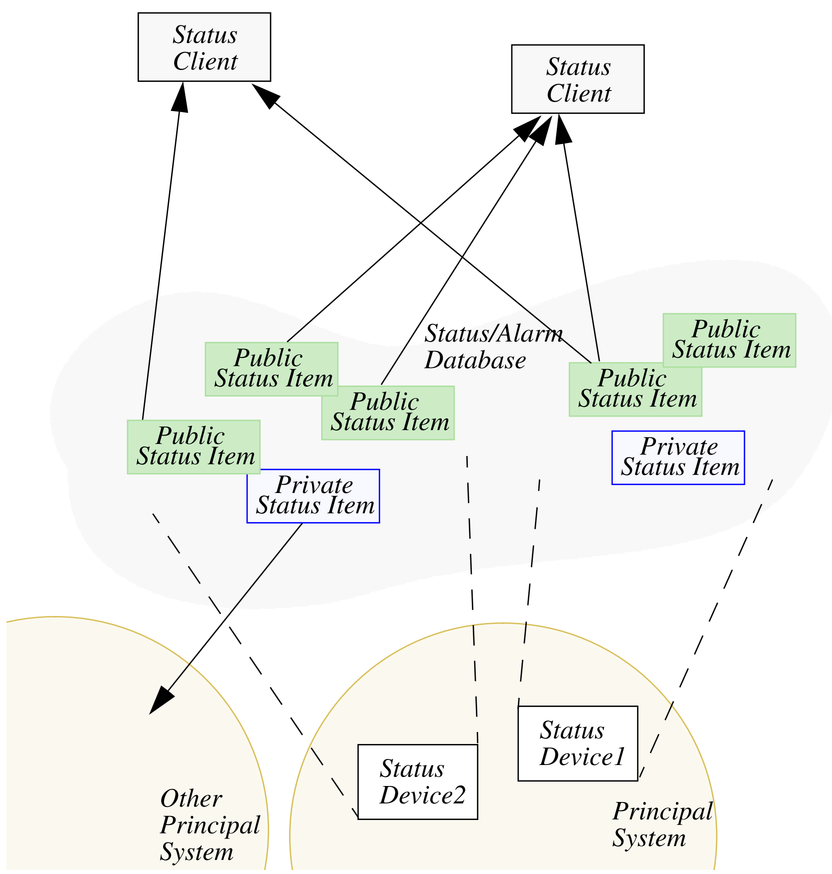


Figure 3 shows the relationship between the terms and entities just defined. Each of the two status devices in the principal system owns a set of public and private status items indicated by the dotted boundary emerging from the status device. Each of the status devices keeps its set of status items up to date. Public status items can be monitored by any program in the system. Private status items can only monitored by systems allowed by the owner.

3.1.1 The Relationship between health, alarms, status, and errors.

Health, alarms, status, and errors are not always independent although the GCS attempts to isolate them as much as possible. For instance, a component's health is related to alarms. The A&G health would be *bad* if a wave-front sensor power supply failed and generated an alarm. However, a component can be healthy and still generate a command error. If an A&G probe is requested to move to a position and it can't get there, it may produce a *failure* command error, but still be in good health.

To simplify the overall design, a health alarm must be defined in terms of the available set of status items. In other words, a bad or failed health determination must be traceable to one or more status items that are probably in an alarm state. This is not a limitation on the system; it merely means that all contributors to a system's health must be present as status items.

The details of these relationships are application specific. The developers of principal systems should use the definitions of health, alarms, and status as a guide to providing the OCS with information.

The actual status items for each principal system will be defined as part of each principal system Work Package and will be based on the control system needs and the kinds of information that must be available to operators and observers.

3.2 Status Behavior

The following items define what status items are and how they can be used.

- A status item consists of an attribute name that describes the information in the status item and a value which is the information in the status item.
- A status item attribute name must allow a status client to infer what information is in the status item.
- The value of a status item consists of one or more values of the same, simple type. The baseline set of types is the set available in an EPICS IOC database: string, integer, short integer, float, enumeration, character, long, and double.
- Status items are *indivisible* meaning a status item is the smallest piece of status information in the system. A status item can not consist of multiple unrelated values.

  For instance, a status item called **system:info** containing the telescope azimuth, the wind speed, and dome temperature would be a forbidden abuse of the status system. Although the items are all of the same type, the items are unrelated and the attribute name gives no indication of the item's content.

  A status item named **neDomeTemp** containing the dome temperature as measured by the north east sensor is simple and indivisible.

The following items define the important aspects of the behavior of the GSC status system.

- Any status item that is part of a device's public interface is available at all times to any status client through a common status software interface.
- It is the responsibility of the owner of a status item to keep its public and private status items up to date; always reflecting the correct state of the status device.
- Status clients can read the value of status items at any time, but the primary way clients keep abreast of the values of status items is through a *monitor mechanism.* Status clients register interest in a status item and are notified when that item is changed by its owner.

3.3 Alarm Behavior

Alarms are built upon the functionality of the status system. An alarm is a notification of an unusual, abnormal, or failure condition in a status device. The act of notifying status clients of abnormal conditions is called *raising an alarm*.

The following items define the important aspects of the behavior of the GCS alarm system.

- Developers of alarm devices should make sure that alarms are raised as near in time to the system event that generates the abnormal condition as possible.
- The owner of a status item determines when the status item is in an alarm state and what the severity of the alarm is.
- The status monitor functionality of the previous section provides the means for alerting users of alarm conditions.
- The alarm mechanism should also provide notification of a failure of the alarm system. For instance, it should be possible to determine the difference between an alarm in the status device and a loss of all information from the status device as in a power failure.

3.4 Health Behavior

The GCS views the health information as a pre-defined kind of alarm that all systems must provide. Health is a global indication of the overall operational status of a particular status device or group of status devices. The health status device is recursively defined in terms of the health of all the status devices that are part of the parent status device.

Health can have three values (**good**, **warning**, and **bad**) and what determines whether the system can continue operations in the warning state shall be determined by the Work Package groups.

4.0 Implementation

This section defines how status, alarms, and health will be implemented in the GCS and how the implementation provides the required behavior. The alarm/status software interface is presented.

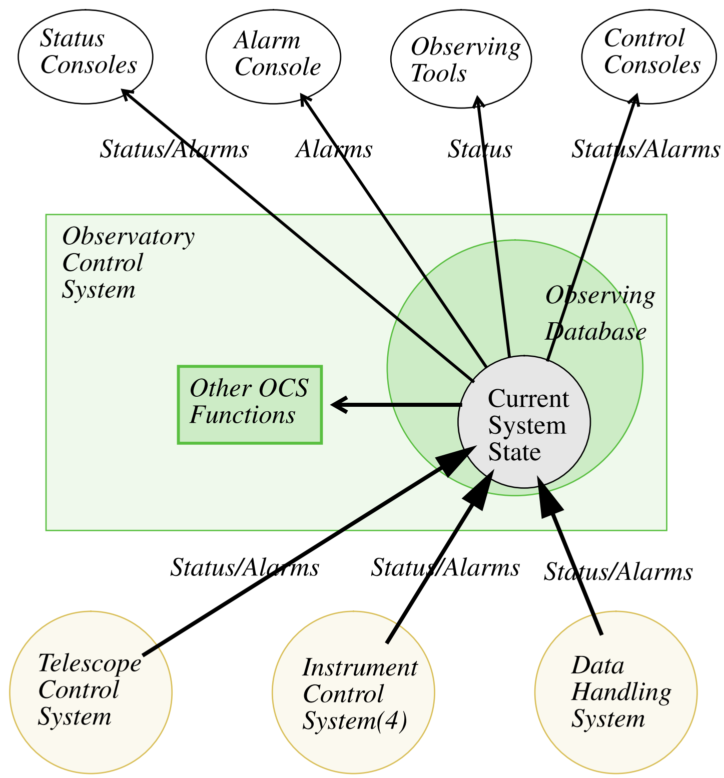
The principal system alarm/status system must span the multi-system GCS environment –the DHS and OCS are Unix-based and the TCS and ICS(s) are VxWorks/EPICS-based. In ICD1a-The System Command Interface [6], an layered interface for commands and responses is specified that is independent of EPICS and Channel Access providing the ability to send commands between any two principal systems. Using a message-based, layered approach to status and alarms is also a reasonable approach to providing status and alarm functionality that is will work with any Gemini principal system.

The baseline implementation and interface to the status/alarms functionality does not use this approach. The primary reason for using a higher-level principal system command layer interface was that EPICS/Channel Access was not deemed capable enough for the command requirements of the GCS by the design group. This has not found to be true for the EPICS alarm and status functionality. The EPICS alarm/status system/interface provides an adequate status/alarm environment for the GCS; therefore, the baseline alarm/status functionality is based on EPICS and Channel Access. The separation of commands and the status/alarm system in the GCS design has made this possible.

4.1 The OCS Alarm/Status Environment

Figure 4 shows the relationship between the principal systems and the Observatory Control System and the flow of status information in the system.

FIGURE 4. The Flow of Status Information in the Gemini Control System



Within the OCS is the Observing Database and part of the Observing Database is the current system state, which is the union of all public status items of all status devices in the principal systems. Status information is used by the OCS to update the various kinds of interface screens, to properly control the execution of observations, and to update the Science Programs as their observations execute. Alarms and health also flow up from the principal systems through the OCS to the observers and operator screens.

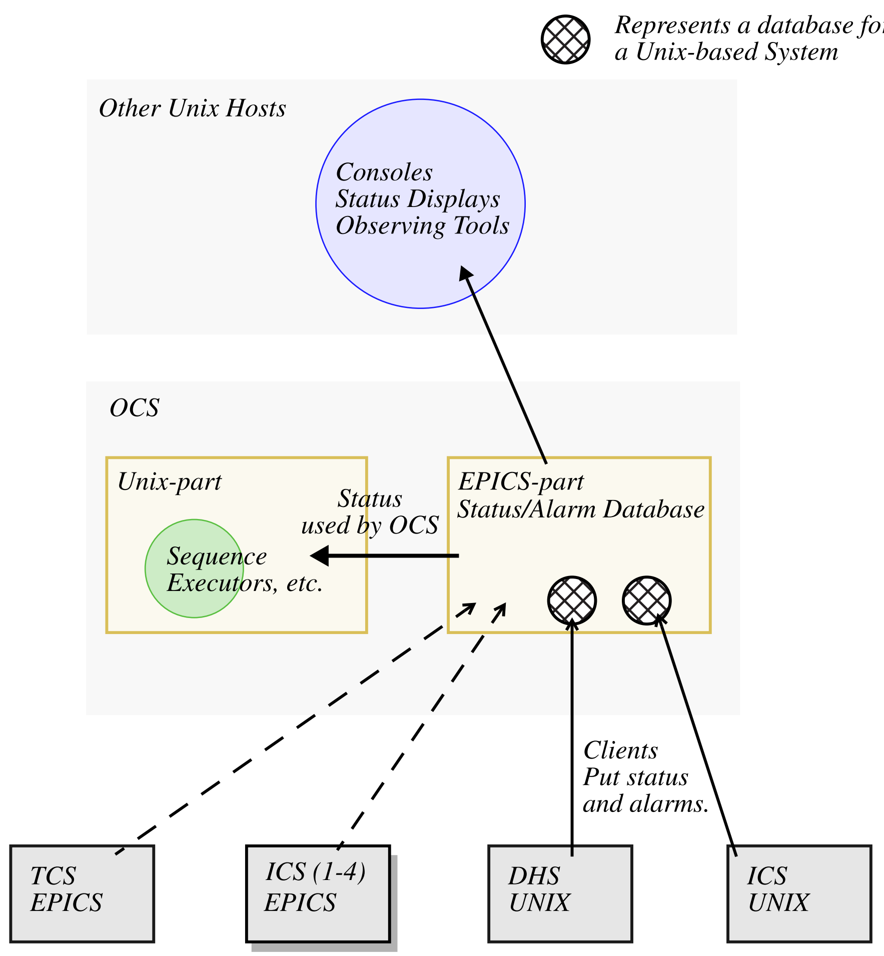
The following are reasons for including an EPICS system in the OCS to process alarms and status.

- EPICS is already in use within the real-time systems making the integration of the OCS and real-time systems simpler.
- EPICS supports asynchronous monitoring of database values.
- EPICS already supports alarms of various types.
- Allows simple integration of status with the standard EPICS archive programs.
- Status and alarms will be generated by the same set of EPICS records for both the engineering and operation phase interfaces.

4.2 EPICS as the Alarm/Status Environment

The GCS status/alarm functionality is based on that provided by the EPICS database. To provide non-EPICS systems with the alarm/status capability of section 3.0, the OCS will provide an EPICS system dedicated to status and alarms (EPICS-based principal systems can also use it if they choose). The **Current System State** in Figure 4 is implemented as one or more EPICS databases in the OCS Status/Alarm Database (SAD). The implementation of Figure 4 is shown in Figure 5.

FIGURE 5. Distribution of OCS Functions by Hardware System



There is no requirement for a host-level Channel Access server. Non-EPICS principal systems are clients of the OCS SAD and can put values into their status items. EPICS systems may also decide to centralize their status items in the SAD, but this is not a requirement at this time.

The Functional Specification for Release Four of Channel Access [10] indicates that the functionality of the OCS SAD can eventually move to from a VxWorks system to a UNIX host. This move is a long-term goal since it would reduce hardware costs and cause no impact or change to the behavior or implementation of the status/alarm system.

4.3 Implementing Status/Alarm Databases during development

Although the OCS IOC is the ultimate repository for status and alarm information, developers of component systems need to provide development Status/Alarm Databases. Each system should implement this development SAD as an EPICS database that is separate from any other EPICS databases used by that system. This makes moving the development SAD into the OCS IOC a simple matter. Note that this implies that all access to a SAD must be through EPICS Channel Access. The EPICS UAE environment simplifies the process of loading the development SAD into the development IOC along with any other EPICS databases. Naming conventions for process variables and records within a SAD are identical to the naming conventions used for other EPICS databases, see [4] for details.

4.4 The Implementation of Status/Alarms and Health within EPICS

There are two interface issues related to the EPICS implementation: how does EPICS provide the status/alarm functionality, and how is status represented in the SAD. The second issue will be covered in the next section. The following sections will tie the terminology of the behavior section to the EPICS implementation.

4.4.1 The Implementation of Status in the OCS/EPICS SAD

Records are used to represent status items in an EPICS database (see section 4.5.) A status device may have many status items in its EPICS database. EPICS status item records contain a number of fields that can be written into by their owner and monitored for change by status client applications. The default set of EPICS record types contains a number of fields that are common to all record types including the record's name, a description, and several alarm related fields.

One unique attribute of EPICS status item records is that the records are read-only and are not tied to processing as with typical EPICS database records (other than monitoring and raising alarms).

The behavior of status as specified in section 3.0 is provided by the core EPICS system. Status clients will read and write status item fields using Channel Access. Status clients can monitor the status item field values using Channel Access monitors (through ca_add_event).

Status values in the SAD should not be updated at a rate faster than 1 Hz, to help decrease the load on the network. How a system chooses to present information that naturally changes at a faster rate is determined by that system.

4.4.2 The Implementation of Alarms in the OCS/EPICS SAD

The alarm behavior of section 3.0 and the Software Design Description is within the capabilities of the EPICS alarm system. The EPICS alarm system consists of IOC support and the user/operator alarm handler application (covered in a later section). All of the standard EPICS record types contain alarm related fields.

- STAT - the current alarm status. The alarm status is a standard value that indicates the kind of alarm being raised by the record.
- SEVR - the current alarm severity. EPICS alarms can have one of four severity levels that map closely to the severity of alarms presented in the OCS section of the SDD. The following table shows how EPICS alarms are to be mapped to OCS alarms.

TABLE 2. Mapping of OCS Alarm Kinds to EPICS Alarm Severities

EPICS Alarm Severity	OCS Alarm Severity	Comment
NO_ALARM	OK	No alarm
MINOR_ALARM	Warning	System is not operating to specification, but it can continue to operate.
MAJOR_ALARM	Failure	The status device is in an alarm state that requires correction before observing can continue.
INVALID_ALARM	Invalid	This is not in the original SDD, but is a useful concept. This means the alarm system can not determine the value of the specific alarm because of a system failure.

- NSTA - new alarm status. A new alarm has occurred that must be merged with the current status.
- NSEV - new alarm severity.
- DISS - disable alarm severity. Severity issued by the status item when it is disabled.

The determination of which alarm severity is appropriate in a situation should be based on the usage of alarms as specified in the Gemini SDD, not the EPICS documentation.

Status clients use the Channel Access event facility to monitor the STAT and SEVR alarm fields of a status item. Alarms are delivered whenever the status device changes the alarm severity/status fields.

4.4.3 The Implementation of Health in the OCS/EPICS SAD

As stated in section 3.0, health is a predefined alarm status item indicating the general operational state of a status device. The determination of a systems health must be a function of its set of status items.

There are two ways a principal system can implement health in the OCS/EPICS SAD and both can be used within a single principal system.

Health Status Item. A health status item has alarm status that represents the operational health of the principal system or a subset of the principal system. It must follow the recursive nature of health and reflect the operational state of all the parts of the system it depends on.

Health as a Group. The EPICS alarm manager program [11] [12] implements the concept of alarm groups that will be propagated into any alarm manager program that might be used in the Gemini Control System. An alarm group presents an alarm for a user-determined set of related status items or other groups. Health can be implemented as a group alarm and the recursive nature of health can be implemented by building a tree of health groups. This approach maps well to the health concept but requires groups to develop alarm handler configuration files.

The preferred approach to implementing health is as health status items with the group health approach as a backup.

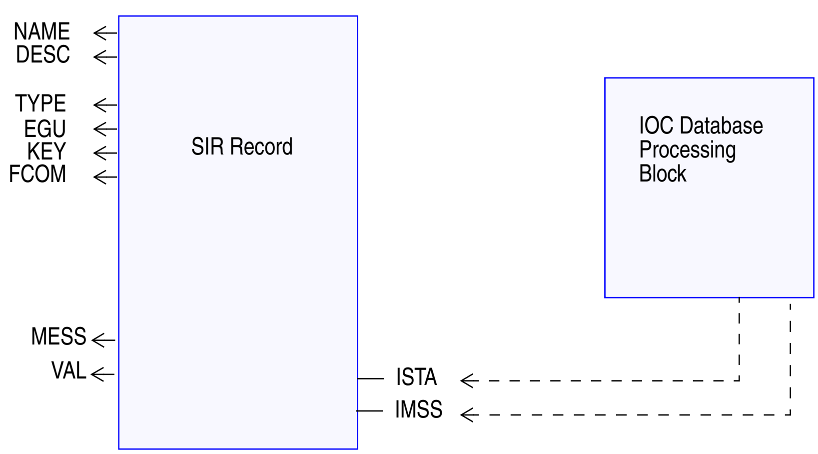
4.5 The Representation of Status in EPICS

In a standard EPICS process control environment, OPI applications monitor record fields of IOC database records responding to changes in the value fields and alarm fields. The status and control fields are all within the same database record, typically they are the same field (the VAL field). Because the OCS/EPICS SAD must provide support for non-EPICS systems that do no processing in their databases, this ICD defines a standard EPICS status item record (SIR) that must be used by non-EPICS systems and should be used by EPICS principal systems to provide status in the GCS. EPICS principal systems are not required to use the status item record, but they must provide the functionality of this record in their own database if they choose not to use status item records.

The Status Item Record (SIR) is an extension of the EPICS Stringout record ([14], page 147) and is described in the Gemini Record Reference Manual[17].

Figure 6 shows the SIR record fields that appear as the interface for status information.

FIGURE 6. SIR Record in an IOC Environment



4.6 The Alarm Tool

The standard EPICS Alarm Handler Tool provides the baseline user interface to the alarm/status system. Through consultation between Work Package groups, the status items required to operate and monitor the telescope will be agreed upon.

Principal system developers will write an Alarm Handler configuration file that will allow checkout of their status/alarm system.

The OCS Work Package group may augment the EPICS alarm handler or design their own to more adequately present GCS alarms using the features of the SIR.

All Gemini alarm handler applications will support the concept of groups as defined in the EPICS Alarm Handler Tool.

5.0 Error, Alarm and Logging System

5.1 Error System

Errors may be reported in the following ways:

- By reporting events via the EPICS alarm handler, as described in [11]. This method is particularly useful for reporting spontaneous events that do not have to be connected with a command.
- By detecting and reporting changes in a system's health. All Gemini systems must provide a Status/Information record called "health" which contains a brief representation of the their health. Changes in this "health" record are monitored. Allowed values are:
  - GOOD — good health;
  - WARNING — a warning has been issued but the system can continue to operate;
  - BAD — the system cannot continue to operate without outside action.
- By rejecting a command through the "Accept/Reject" and "Message" fields in an EPICS CAD record, or by reporting the failure of a command through the "Status" and "Message" fields of an EPICS CAR record, as described in ICD/1b, [6].
- By logging error messages using the standard Gemini logging system, as described in ICD/4, [8], and [15]. This mechanism can be used to elaborate on an error reported using the other two methods (especially in a debugging mode), but it should *not* be used alone.

5.2 Alarm System

This is provided by the EPICS system. See [11] and [12].

The status of the Control LAN interface is monitored by the EPICS channel access software and is communicated to the higher level EPICS software using the standard EPICS Alarm/Severity mechanisms.

5.3 Logging System

The interface should have the capability of logging the messages sent. Each message should be logged with a time stamp and a title.

Principal systems can log messages using the standard Gemini logging system described in ICD/4, [8]. Engineering data and status can be logged by the EPICS system, as described in [15].

6.0 Compulsory SIR records

The following SIR records are compulsory for every Gemini system:.

TABLE 3. Compulsory Status Information

SIR record (system prefix +)	FITS keyword	FITS included?	Type	Units	Comments
name	INSTRUME * or TELESCOP * etc...	Start	string		System name
state	xxSTATE[a] •		string		System state [BOOTING | INITIALISING | RUNNING | CONFIGURING]
health	xxHEALTH •	Start	string		System health [GOOD | WARNING | BAD].
historyLog		TBD	string		System log messages.
heartbeat	N/A	Never	integer		Continuously changing variable used to detect whether the system is still alive.

a. Where “xx” is a 2 character code for the system in question (IN=Instrument; TL=Telescope).

In addition to the above list, a science instrument Detector Controller must provide the following status information.

TABLE 4. Science Instrument Detector Controller Status Information

SIR record (instrument prefix +)	FITS keyword	FITS included?	Type	Units	Comments
dc:preacq	N/A	Never	boolean		Flag to indicate that the Detector Controller is preparing to acquire data (e.g. the detector is preflashing, or it is waiting for the chopper to reach the right phase).
dc:acq	N/A	Never	boolean		Flag to indicate that the Detector Controller is acquiring data (i.e. the detector is integrating opn the sky). The instrument mechanisms should not be reconfigured during this period
dc:postacq	N/A	Never	boolean		Flag to indicate that the Detector Controller has stopped acquiring data and is now reading out the data. The instrument may reconfigure its mechanisms but the detector cannot observe again until this flag goes false.

7.0 The Programmatic Interface

The programmatic interface will be designed by the OCS Work Package group, but within the confines of the design defined in this document.

7.1 General Structure

Status and Alarms will be based on the functionality, libraries, and applications provided by EPICS.

8.0 Debugging

Debugging of the baseline status and alarm system will be facilitated by the EPICS archiver programs and the alarm configuration file development tools.

9.0 Development and Test Factors

9.1 Project Control

The project has control over the standard set of commands and parameters used for this interface. New commands and data structures should only be added after consultation with the project.

Any new commands or parameters should be added to this document after a change control process which involves a period of time for general comment.

9.2 Deliverables

9.3 Acceptance Testing

Gemini systems must be able to run in a mode which allows their communication with other Gemini systems to be tested. The simulator should mimic the behavior of this interface