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Gemini Controls Group Interface Control Document

ICD 11 — Event Bus

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This document defines the interface into the system event bus.

1.0 Introduction

1.1 Purpose

An overview describing all the interfaces in the Gemini system is given in document "GSCG.grp.005, Gemini System Interfaces, Gemini 8m Telescopes Project." (which is reference [3] as listed on page 2).

This document (ICD 11- Event Bus) specifies those interfaces in the Gemini system that direct event information. The interfaces involved are:

- The transfer of event signals from the Instrument Control System (ICS) to the Telescope Control System (TCS).
- The transfer of event signals from the Instrument Control System (ICS) to the M2 Control subsystem of the TCS.
- The transfer of event signals from the Telescope Control System (ICS) to the Instrument Control System (TCS).
- The transfer of event signals from the Telescope Control System (ICS) to the M2 Control TCS subsystem.
- The transfer of event signals from the M2 Control TCS subsystem to the Telescope Control System.
- The transfer of event signals from the M2 Control TCS subsystem to the Instrument Control System (ICS).

1.2 Scope

This document covers the event movement between the TCS, the M2 Control TCS subsystem, and the ICS.

Both conforming and non-conforming instruments are considered here.

1.3 Applicable Documents

The following documents should also be consulted:

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

[2] SPE-I-G0009, *Software Programming Standards,* Gemini 8m Telescopes Project.

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

[4] The EPICS documentation, most notably the *EPICS:IOC Application Developers Guide*

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

[6] *Trade Study: EPICS Event Bus Driver*, Gemini 8m Telescopes Project

[7] GSCG.grp.013, *ICD 1 - The System Command Interface*, Gemini 8m Telescopes Project.

[8] GSCG.grp.014, *ICD 2 - Systems Status and Alarm Interfaces*, Gemini 8m Telescopes Project.

[9] GSCG.grp.017, *Glossary,* Gemini 8m Telescopes Project

[10] *The Global Event System,* Argonne National Laboratory

1.4 Abbreviations and Acronyms

See document [9] *Glossary* for a complete list of acronyms used by the Gemini ICDs.

1.5 Glossary

See document [9] *Glossary* for a complete list of terms used by the Gemini ICDs.

2.0 Overview

The Software Design Description, [1], describes the Gemini Control System.

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. Some visitor instruments may not be EPICS based, but the event bus interface must allow communication between the all interested systems regardless of their operating environment.

2.1.1 The Instrument Control Systems (ICS)

A “conforming” ICS is VME-based running VxWorks and EPICS.

A “non-conforming” ICS is assumed to be Unix-based without access to EPICS or VxWorks.

No other ICS architectures are supported.

2.1.2 The Telescope Control System (TCS)

The TCS is distributed across multiple VME-based VxWorks/EPICS systems, one for the TCS proper and one for each TCS subsystem.

2.1.3 The M2 Control TCS Subsystem

The control of the secondary mirror is accomplished with a VME-based VxWorks/EPICS system that interfaces to a contractor-supplied local control system.

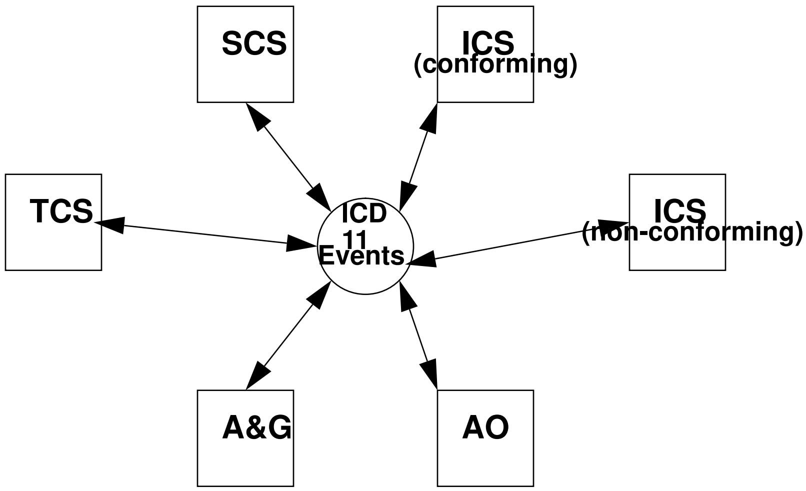
2.2 Communication Architecture

The design of the Gemini event system is subject the following requirements:

- Event information must be provided with less than a 1 microsecond jitter RMS.
- The event bus must present an interface easily usable by non-conforming instruments. The non-conforming instruments must have access to both the generation and receiving of system events.
- It must be possible to select a specific source of a given event via software and to prevent other sources from generating events.

2.2.1 Context Diagram

FIGURE 1. Context Diagram



2.2.2 Events and Responses

The events which may happen on the event interface, and the responses to those events, are shown in the following table. Refer to section 3.0 for information on what causes these events.

Event	Response
Select Chop Event Source	The subsystem responsible for the chop events is enabled.
Select Nod Event Source	The subsystem responsible for the nod events is enabled.
Shutter Is Open	None required (informational only).
Shutter Is Closed	None required (informational only).
Move To Next Chop Position	The M2 Control Subsystem starts a move to a next chop position.
Chopper Is In Position	The ICS initiates an exposure (and perhaps opens its shutter).

Event	Response
Move To Next Telescope Position	The TCS commands the Mount Control Subsystem to move to the next position.
Telescope Is In Position	TBD.

2.3 The Services Component of the Interface

2.3.1 Communication Services and Protocols

2.3.2 Host Support Services

N/A. In this case there is no host or target.

2.3.3 Target Support Services

N/A. In this case there is no host or target.

3.0 Behavior

3.1 Event Control Events and Responses

3.1.1 Select Chop Event Source <subsystem>

Valid values for <subsystem> are A&G, AO, TCS, SCS, and specific ICSs (instruments).

The global event system will render all but the named <subsystem> incapable of generating of the ‘Move To Next Chop Position’ event.

3.1.2 Select Nod Event Source <subsystem>

Valid values for <subsystem> are A&G, AO, TCS, SCS, and specific ICSs (instruments).

The global event system will render all but the named <subsystem> incapable of generating of the ‘Move To Next Telescope Position’ event.

3.2 Instrument Control (ICS) Events and Responses

3.2.1 Shutter Is Open

The ICS will cause the ‘Shutter Is Open’ event to be generated. This event occurs simultaneously with the start of an exposure.

3.2.2 Shutter Is Closed

The ICS will cause the ‘Shutter Is Closed’ event to be generated. This event occurs simultaneously with the end of an exposure.

3.2.3 Move To Next Chop Position

The ICS will cause the ‘Move To Next Chop Position’ to be generated when it desires the chopper to be moved and it is the currently enabled source for this event.

3.3 M2 Control Events and Responses

3.3.1 Move To Next Chop Position (generate)

The TCS will cause the ‘Move To Next Chop Position’ to be generated when it desires the chopper to be moved and it is the currently enabled source for this event.

3.3.2 Chopper Is In Position

This event will be generated when the M2 controller has signalled the secondary mirror control system that the mirror is now ‘in-position’.

3.3.3 Move To Next Chop Position (receive)

The secondary mirror control system will command the M2 controller to move the mirror to the next chop position.

3.4 Telescope Control (TCS) Events and Responses

3.4.1 Move To Next Chop Position

The TCS will cause the ‘Move To Next Chop Position’ to be generated when it desires the chopper to be moved and it is the currently enabled source for this event.

3.4.2 Telescope Is In Position

This event will be generated when the Mount Control Subsystem has signalled the TCS that the mirror is now ‘in-position’.

3.4.3 Move To Next Telescope Position

The TCS will command the Mount Control Subsystem to move the telescope mount to the next position.

4.0 Implementation

A trade study concerned with EPICS support for the use of the Event Bus is part of the Gemini Project’s Standard Instrument Controller Work Package currently underway at RGO.

One possible implementation is the global event hardware and software system in use at the Advanced Photon Source. Although this solution is based around EPICS and VME-bus hardware it does allow an interface for non-conforming ICSs. This is described below in section 4.4.2 [Interface to Non-Conforming Instruments].

4.1 Overview

The APS Global Event system consists of the APS event generator and receiver boards and four new EPICS record types.

4.2 General Hardware Characteristics

4.2.1 Event Transmission

- Fiber Optic links (820 nm)
- 10 M events/sec
- Star or Daisy Chain topology
- Based on TAXI chips

4.2.2 Event Types

- Normal events - 128 possible codes
- Trigger events

4.2.3 Event Generator

- Event Sources:

1. 8 External signals (positive edge ~3.5V into 50 Ohms)
2. 2 RAM-based sequences (32K long)

   These are initiated either by an external clock (upto 1 MHz) or by an external trigger.
3. VME processor initiated

- May be cascaded
- Normal events are priority based

4.2.4 Event Receiver

- All outputs in response to received events are positive true, ~3.5V into 50 Ohms.
- 7 Level outputs
- 14 100ns pulse outputs
- 4 programmable delay and width outputs

4.3 Records

4.3.1 EG Records

The EG record type is used to select the options of a specific generator card. This record’s purpose is only to specify the operating modes of the event generator.

4.3.2 EGEVENT Records

The EGEVENT record is used in conjunction with an EG record in order to specify a single event that is to be placed into a sequence RAM. The event code and its time displacement from the trigger are specified in this record.

4.3.3 ER Records

The ER record type is used to select the options of a specific event receiver card. This record’s purpose is only to specify the operating modes of the event receiver.

4.3.4 EREVENT Records

The EREVENT records are used to specify what bits are to be set in the event receiver mapping RAM. The use of these bits depend on which outputs are enabled on the event receiver card. Additionally, this record type is used to select the VME interrupt and time-latch options.

4.4 Does It Meet Our Requirements?

4.4.1 Jitter

The jitter for events out of the sequence RAM is primarily dependent on the clock frequency chosen for the sequence. The design specification called for a maximum event sequence clock rate of 1Mhz but they have been run at 2-3MHz in the field. With a 1MHz sequence RAM clock a peak to peak jitter of ~1.1 microseconds can be expected.

If one of the event generator’s external inputs are used to generate the event then the peak to peak jitter can be reduced to ~0.1 microseconds.

Typically, the logic in the event hardware runs without communicating with the VME processor. If software intervention is required then the following quantities must be noted:

1. VxWorks Interrupt Latency - 3 microseconds (M68020)
2. VxWorks Context Switch - 30 microseconds (M68020)
3. EPICS Record Processing - ~60 microseconds (M68040)
4. EPICS Record Processing Jitter - ~10-100 microseconds depending on nature of VxWorks tasks (M68040).

The first two quantities will have to dealt with when considering using any VxWorks application. The latter two are incurred by using EPICS record processing.

4.4.2 Interface to Non-Conforming Instruments

Non-conforming instruments can cause a properly-configured event generator card to generate the desired system event codes by supplying the required 50 Ohm, ~3.5V signal. The event code will be generated upon receipt of the positive edge.

A single generator card can transmit 8 distinct system event codes from these inputs (one per physical connection). The exact codes generated are defined as part of the board configuration.

Non-conforming instruments can receive signals from a properly configured event receiver card by accepting either one of the seven 50 Ohm 3.5V Level Outputs, one of the fourteen 50 Ohm 3.5V 100 nanosecond pulsed outputs, or one of 50 Ohm 3.5V programmable delay/width outputs.

The mapping between received event codes and which outputs are generated is defined as part of the board configuration.

The programming and set-up of the event generator and receiver cards would take place during the configuration of the instrument. It is quite possible that a specific set of event hardware would be used for interfacing to non-conforming instruments.

4.4.3 Software Selection of Event Source

There are two mechanisms for forcing an event generator card to stop transmitting a specific event.

1. Disable the complete operation of the card by clearing the ENAB (Master Enable) field of the associated EG record.
2. Reconfigure the card. The Sequence RAM modes must be ‘Off’ or ‘Alternate’ for configuration to take place. The trigger event inputs can be explicitly disable and/or the output event codes can be redefined.

Both of the above procedures require the VME processor running either a low-level VxWorks task or EPICS record processing.

5.0 The Programmatic Interface

5.1 General Structure

The programmatic interface for this ICS is based on the EPICS channel access library.

5.2 Major System Commands

The major system commands should follow the conventions defined in [2].

5.3 Attributes

6.0 Debugging

6.1 Compiling Programs for Debugging

See [4] for information on compiling and linking programs which use EPICS.

See [2] for information on how to compile and link Gemini software for debugging.

6.2 Debugging Modes

6.3 The Debug Mode

6.4 Booting and Starting

7.0 Error, Alarm and Logging System

7.1 Error System

The event bus device driver will perform periodic test of the event bus state, and report this and other error conditions to the higher level EPICS software using the standard EPICS Alarm State/Severity mechanism.

7.2 Alarm System

See the above section, 7.1.

7.3 Logging System

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

8.0 System Attributes

8.1 Maintainability

8.1.1 Interface Design Recommendations

8.1.2 Adaptability and Enhancement Potential

It should be easy to add new classes of event as needed, with the consent of the Gemini project office.

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

The interfaces described in this report are all directly implemented using EPICS. Consequently, applications of this interface should provide the appropriate EPICS database, a full description of the functionality accessible through the interface, and any support routines that are required.

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.