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Operational Scenarios relevant to CDS

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1 ABSTRACT

This note collects ideas about LIGO operational scenarios which may have some relevance to CDS. It needs to be read in conjunction with the note on CDS building considerations (T940002-05)

This is the first attempt at the subject. In order to get early feedback it is distributed in a very early state. Please feel free to criticize, correct, suggest, improve, ...

2 KEYWORDS

Operational Scenario, Installation, Commissioning, Operation, CDS

3 OVERVIEW

Activities at the remote Facilities ("sites") are different during the installation/commissioning (I/C) phases from the activities during regular operation (RO). As installation/commissioning of the different systems and interferometers is phased, installation/commissioning activities may take place in parallel with regular operation activities.

3.1. Definitions

3.1.1. Detector System

A detector system is a complete set of (art least) one interferometer, and the corresponding part of the data acquisition and the data handling systems

3.1.2. Regular operation

Regular operation of LIGO in this context is the coordinated, technically correct operation of all subsystems of a LIGO detector together with all necessary CDS systems (like data acquisition); it does not mean in this context that the interferometers are necessarily locked or that the observatory works at full sensitivity.

3.1.3. Installation and Commissioning

The Installation and commissioning phases cover all activities required to get a detector system into the operational phase.

4 CABLING

All cabling activities will take place during Installation and Commissioning phases.

4.1. Cabling in the Operation Support Building[1]

4.1.1. Types of cables

Cabling in the operation support building falls into different categories (see LIGO-T940002)

Table 1: CDS cable categories in the OSB

type	*uses*	*installation notes*
armoured, multiple fibre optic cable	Ethernet Fibre Channel Remote Diagnostic Links Diagnostic TV	only used for connections to other buildings (including BTE and LVEA)
multiple, reinforced fibre optic cable	Ethernet Fibre Channel Remote Diagnostic Links Diagnostic TV	only connects equipment inside the same station building: control area rooms, computer room, ETMA
single, reinforced fibre optic cable	Ethernet Fibre Channel Remote Diagnostic Links Diagnostic TV Timing System	only connects equipment inside the same station building: control area rooms, computer room, ETMA
Thin Ethernet cable	Ethernet	all rooms[a]
other signal cable	TBD	should only be used locally

a. except bathrooms, corridors, etc.

4.1.2. Installation of cables

All cables are to be installed in easily accessible cable trays inside the buildings. The topology has to be agreed upon. For the fibre optic connections and (most likely) the Ethernet connections a star-structured scheme will be adopted. The main hub of the star structure will be placed in the computer room.

The indoors fibre type proposed cannot be pulled into trays, it needs to be placed. This requires easy access to all cable trays in the building.

Armoured fibre optic cables may need to be split up upon entering the OSB in order to connect to different locations inside the OSB.

4.1.2.1 Cable installation procedure in the OSB

Cable installation follows the following procedure:

1. who has the budget for the "CDS" cabling for the building (except control/computer area and ETMA) ???

- prepare cable database
- pull cable / lay fibre optic cable
- label cable at both ends
- terminate cable (except spares to be left unterminated)
- inspect cable terminals
- check cable continuity / check for correct wiring in multiple cables / measure fibre optic loss (with the exception of unterminated spares cables)
- enter measurement results in database

Initial cabling should be installed as part of the building cable installation process (telephones etc.).

4.1.2.2 Cable spares policy in the OSB

It is good practice to install spare cables, especially when runs are long and/or difficult to access.

As it can be expected that all runs in the OSB are relatively easily accessible, the only place where spares are necessary are additional fibre-optic connections between the Control Rooms and the Computer room, and between the other buildings (including LVEA) and the OSB. These spares should fully terminated and tested.

4.2. Cabling in the BTEs

4.2.1. Types of cables

CDS cables in the BTE fall into the categories shown in the next table.:

Table 2: Cable categories in the BTEs

type	*uses*	*installation notes*
multiple, armoured fibre optic cable	Ethernet Fibre Channel Remote Diagnostic Links Diagnostic TV	runs connect only station buildings and mid-pumping stations
multiple, armoured fibre optic cable[a]	industrial I/O	connects all 250m additional pumping stations

a. maybe the same cable type as above

4.2.2. Installation of cables

Armoured fibre optic cables can stand rough handling.

They are to be installed into the cable trays which are pre-installed in the BTEs. Armoured cable is typically supplied on reels of 2000m length. Handling is similar to heavy power cabling as it is relatively stiff (minimum bending radius typically 250mm).

5 SCENARIOS IN THE CONTROL ROOMS

5.1. People in the Control Rooms during I/C phases

During the I/C phase the facility control room (FCR) serves as communication hub for all people working on site.

For this purpose the Installation Engineer/Scientist in Charge (ESC) should be permanently located in the FCR as long as no regular operation takes place. When parts of the facility become operational, one may consider to move him to another location.

(At least) one operator is permanently present in the FCR as long as people are working on the site. His tasks include:

- logging the access of people to the restricted access areas
- watch the facility monitor and control screen
- serve as telephone switchboard operator (as he knows who is where)

5.2. People in the Control Rooms during RO phases

All components of the LIGO facility which are under computer control (i.e. operate with CDS support, or are monitored by the Facility Control and Monitoring System or by the Particulate Measurement System) are operated from the LIGO control rooms at the site. Control Rooms are:

- Facility Control Room
- Diagnostics Control Room

A tentative scenario for the manning of the Control Rooms is given in the table below.

Table 3: Routine manning of control rooms

room	*number*	*function*	*notes*
FCR	2	operator	24 hours
FCR	1	interferometer scientist	daytime
DCR	1	interferometer scientists	daytime

During RO phases the facility control room (FCR) serves as communication hub for all people involved in the LIGO operation at the site.

Please note, that the Engineer/Scientist in Charge (ESC) is not permanently present in the Control Rooms during normal operation. He might even be at one of the other sites.

5.3. Flow of materials through the Control Rooms

There is no regular flow of materials through the control rooms with the exception of paper documentation.

5.4. People flow through the Control Rooms during I/C phases

The following matrix illustrates the people flow through the Control Rooms. Control Rooms here are both the facility Control Room and the Diagnostic Control Room. Local traffic between these two rooms is not considered

Table 4: People flow involving the Control Rooms

Room	*to*	*from*	*notes*
Computer Room	x	x	occasional
Tape Room	x	x	occasional
LVEA	x	x	all people going into the LVEA have to report in person or by phone to the facility control room. I assume that the corresponding paperwork will be handled there as well
Conference Room or other break-out room	x	x	frequent on-the-spot meetings will be required near to the control rooms, to avoid that discussions disturb the operation.

5.5. Installation of CDS Equipment in the Control/Computer Area

5.6. Maintenance of CDS Equipment in the Control/Computer Area

5.6.1. Scheduled maintenance

CDS equipment in the Control Rooms does not require scheduled hardware maintenance.

Computing equipment (especially tape units) may be subject to scheduled hardware maintenance.

All computer equipment is subject to occasional shutdown due to software maintenance.

5.6.2. Troubleshooting

Computing equipment in the control rooms and in the computer room should be covered by on-call maintenance contracts by external contractor. Computer system software troubleshooting normally takes place via remote access.

6 SCENARIOS IN THE EMTA

6.1. Activities in the EMTA during I/C phases

Activities in the EMTA during I/C phases include:

- testing electronic modules in pre-configured test stands (VME crates) using computing workstation
- testing electronic modules in ad-hoc set-ups
- execute minor repairs on electronic modules
- assemble and test cable sets (incl. fibre optics)
- assemble and cable complete electronic cabinets
- testing complete pre-cabled cabinets under computer control

6.2. Activities in the EMTA during RO phases

Activities in the EMTA during RO phases include:

- testing electronic modules in pre-configured test stands (VME crates) using computing workstation
- testing electronic modules in ad-hoc set-ups
- execute minor repairs on electronic modules
- test and repair cable sets (incl. fibre optics)

6.3. People in the ETMA

ETMA provides

- permanent desks for two technicians
- a "glass cage" office for an engineer
- a number of electronic workbenches (increasing with time) for use by the "permanent residents" of the ETMA and by temporary users.

6.4. Flow of materials through the ETMA

6.4.1. Cleaning

All equipment leaving the ETMA for a clean area (mainly the LVEAs) requires cleaning before it leaves.

Where is this cleaning done?.

The items to be cleaned are:

- cable sets
- electronic modules
- crates (full and empty)
- complete pre-cabled cabinets (with or without electronic modules)
- measurement instruments (oscilloscopes etc.)
- tools
- (paper) documentation

6.4.2. Categories of materials

The following table lists the materials categories which enter and leave the ETMA during I/C phases.

Table 5: CDS equipment going through the ETMA

	description	*from*	*to*[a]
a	empty 19" equipment cabinets	supplier long-term store	n.a.
b	pre-cabled 19" equipment cabinets	contractor long-term store	LVEAs Store[b]
c	VME crates	supplier LVEAs store(s)	LVEA Store[c] supplier (repair)
d	Electronic modules	supplier LVEAs	LVEAs supplier (repair)
e	Instruments	supplier LVEAs	LVEAs supplier (repair)
f	small electronic components & accessories	supplier	n.a.
g	paper documentation	LVEAs other sites	LVEAs other sites

a. all items which go to the LVEA have to undergo cleaning
b. most likely these items need cleaning and wrapping before being put into the store
c. most likely these items need cleaning and wrapping before being put into the store

6.4.3. People flow involving the ETMA during I/C phases

The following table illustrates the people flow through the ETMA.

Table 6: People flow involving the ETMA

Room	*to*	*from*	*notes*
Control rooms	x	x	all people going into the LVEA have to report in person or by phone/intercom to the facility control room. I assume that the corresponding paperwork will be handled there

7 SCENARIO IN THE LVE AREAS

7.1. Installation of CDS Equipment in the LVEAs

7.1.1. Cable Trays

- all cables are routed in cable trays
- cable trays fall into two classes
  - •• main highways
  - •• local connections
- Main highways contain system cables and long distance signal cables
- local connections connect individual electronic cabinets (or groups of cabinets to the highway trays. They contain system cables and signal cables for the local cabinet
- Highway trays are typically pre-installed at the beginning of the installation phase
- Local connections are installed together with the installation of the corresponding electronic cabinet(s)

7.1.2. Cabinets, Crates, Modules

Electronic cabinets arrive pre-cabled at the remote sites.

Pre-cabling covers all cabling which connects points inside the same electronic cabinet. It may be considered that pairs of cabinets arrive as pre-wired units at the sites.

Pre-wired cabinets normally contain VME crates, isolation transformer. Normally all modules and module-type equipment will be installed at the site when the cabinet is in its final position. Cabinets are inspected prior to installation in the EMTA. They are then cleaned for installation in the LVEA. If they are not immediately installed, they are wrapped and stored in the long-term store.

Electronic cabinets are suitable for transportation by hydraulic dolleys or by overhead crane.

Cabinets are placed in position and then mechanically connected to the cable trays. They do not need to be bolted to the floor.

Electrical power is then connected via individual, permanent electrical connections to the corresponding distribution board. Every cabinet has a separate circuit breaker on the panel.Electrtical power cables do not share cable trays with CDS cables.

7.1.3. System Cabling

Cable types:

- fibre optic
- thin Ethernet

Long-range system cables, especially fibre optic cables are installed ahead of the actual usage, i.e. spares are installed generously, required cables are installed ahead of the installation of the corresponding "user" cabinets.

Ideally system cables are all installed in one batch after the installation of the tray highways.

Fibre optical cables are field-terminated and tested in batches.

Long-distance copper cables (including LAN cables) are field-terminated and tested in batches.

Short distance system cables (fibre optic and copper) will be installed pre-terminated using standard-length cables from stock. Installation takes place after the installation of the corresponding cabinets. This applies typically to connections between VME crates in the same cabinet or in adjacent cabinets.

Long-distance signal cables are few, they are treated in the same way as long distance system cables.

7.1.4. Signal Cabling

Cable types

- signal coax
- twisted pair
- multiple twisted-pair
- coaxial TV

(Local) signal cables are installed after the installation of the corresponding electronic cabinets.They are typically connected to terminal blocks in the (pre-wired) cabinet. A small number of signal cables may be connected directly to the destination electric components without being routed through terminal blocks.

Long-distance signal cables are few, they are treated in the same way as long distance system cables.

7.2. Commissioning of CDS Equipment in the LVEAs

The commissioning scenario for CDS equipment is by far not yet defined in addition it is closely intertwined with the commissioning of the corresponding IFO components.

The following is patchy list of ideas and suggestions.

7.2.1. Commissioning activities without computer support

The operations mentioned below do not involve the CDS control, monitoring and data acquisition software. They would profit, but do not depend upon, on-line, local access to the (CDS) cable database. Ideally a hand-held data entry station should be available.

7.2.1.1 Cable checking of long distance cables

The following operations are executed by two people using a point-to-point-intercom connection:

- Fibre optic cables are checked by applying a calibrated light source at one end and by measuring the light intensity at the other end. The result of the measurement is entered in the cable data base.
- long-distance copper cables (if there are any at all!) are checked for continuity by using wire pairs on the same run

7.2.1.2 Cable checking of local cables

Local cables are checked in a similar way as long distance cables, but no intercom is required.

7.2.2. Commissioning activities with computer support

All other CDS-related commissioning activities require at the location of the equipment under commissioning:

- a local CDS console (=workstation)
- a telephone connection
- network connection

This implies that CDS consoles (computer workstations) need easily be transported from one location to another in the building. For this purpose it may be required that these Mobile Consoles be compatible with transportation by overhead crane. This is technically possible by buying rack-mounted computing equipment and mounting it in a suitable electronics rack.

Telephone and network outlets could easily be provided in each CDS cabinet; alternatively outlet boxes could be mounted near all CDS cabinet locations

Many computer-based commissioning activities will require that the facility control room be manned in order to provide coordination between the activities of different crews and in order to keep the CDS system running.

Entry and exit to the LVEAs are closely monitored from the facility control room where the entry permit procedure is handled.

7.3. Maintenance of CDS Equipment in the LVEAs

7.3.1. Scheduled maintenance

- regular visual and acoustic (hissing fans!) inspection of cabinets
- filter cleaning (if cabinets are fitted with air filters)

7.3.2. Troubleshooting

Troubleshooting is the most difficult-to-predict scenario. It may involve anything between a software check from a console to a full commissioning scenario as sketched above. The main problem here will most likely be the flexibility of the procedure to take items into the controlled areas. Items which spring to my mind here are:

- measurement instrument (oscilloscopes)
- spare electronic modules
- cable assemblies
- tools
- paper documentation
- portable computers
- complete workstations

If cleanliness requirements make it necessary, some equipment may need to be duplicated and one set permanently be parked in the LVEA. (This only works for the corner station LVEA)

Troubleshooting always requires the facility control room to be manned.

8 SCENARIO IN THE BT ENCLOSURES

8.1. Installation of CDS Equipment in the BTEs

8.1.1. System Cabling

CDS system cables in the BTE are exclusively armoured fibre-optic cables. They can be treated like power cables.

In the present scenario (no CDS services available for the BT baking and characterization) the installation of the CDS system cables in the BTEs takes place after all station buildings are available.

Cable handling is similar to the one described for the LVEAs above.

8.1.2. Signal Cabling

Signal cabling in the BTEs falls in two categories:

- cabling in the 250m "stations"
- cabling in the BTE proper

If the 250m stations are separated from the BTEs and are properly protected from rodents, signal cabling there is the same as in the LVEAs.

Signal cabling in the BTEs outside the 250m stations requires precautions against rodents (armoured cable)

8.1.3. Cabinets, Crates, Modules

If the 250m stations are separated from the BTEs and are properly air conditioned and protected from rodents, the handling of cabinets, crates, and modules is identical to the handling in the LVEAs.

8.2. Commissioning of CDS Equipment in the BTEs

Same considerations as for the LVEAs apply.

8.3. Maintenance of CDS Equipment in the BTEs

8.3.1. Scheduled maintenance

Same considerations as for the LVEAs apply.

8.3.2. Troubleshooting

Same considerations as for the LVEAs apply.

9 DELIVERIES AND STORAGE AT THE REMOTE SITES

9.1. CDS components delivered to the sites

The flow is different for the different items.

Table 7: CDS equipment delivered to the remote sites

	description	*size/weight*	*comment*
a	cable on drums		I/C phases only
b	fibre optic cable on drums		I/C phases only
c	empty 19" equipment cabinets		I/C phases only
d	pre-cabled 19" equipment cabinets		I/C phases only
e	VME crates		

Table 7: CDS equipment delivered to the remote sites

	description	*size/weight*	*comment*
f	Electronic modules		
g	computing equipment		
h	cable trunking materials		I/C phases only
j	instruments		
k	paper documentation		
l	empty tapes		
m	small electronic components & accessories		

9.1.1. Large items

For large items (a, b, c, e) the sequence is as follows:

- unpacking in the shipment/receiving area
- computer registration (where?)
- transport to the long-term storage or ETMA

9.1.2. Electronic Modules

For small electronic items (f) the sequence is as follows:

- unpacking in the shipping and receiving
- "registration" in the ETMA
- temporary storage in the ETMA
- acceptance testing (if applicable) in the ETMA
- cleaning (where?)
- packaging in sealed envelopes (where?)
- transport to store (most likely inside the ETMA)

9.1.3. Pre-cabled cabinets

For item d the sequence is as follows:

- unpacking in the shipping/receiving area
- computer registration (where?)
- transport to the ETMA
- inspection, testing in the ETMA
- cleaning (where?)
- (possibly?) sealing
- transportation to the long-term store or to the final destination (LVEA), as applicable

9.1.4. Computing Equipment, Instruments[1]

For items g, j the sequence is:

- unpacking in the shipping/receiving area
- computer registration (where?)
- transportation to the final destination:
  - computer room for compute servers and tape/disk units
  - Facility control room, diagnostic control room, user control room or individual office for workstations/desktop computers
  - ETMA for instruments

9.1.5. Small items

Sequence:

- registration in the shipping/receiving area
- delivery to the end user
- unpacking by the end user

9.2. Deliveries from the sites

Table 8: CDS equipment shipped from the remote sites

	description	*size/weight*	*comment*
a	VME crates		for repair, to other site
b	Electronic modules		for repair, to other site
c	computing equipment		for repair, to other site
d	paper documentation		to other sites
e	full tapes		to archives site

Some categories of items may require shipping from the sites during I/C.

9.2.1. VME crates, Electronic modules, computing equipment

VME crates, electronic modules, computing equipment (a, b, c, d) may need shipping for repair off-site or for use at another site. The sequence is as follows:

- transport from location (store or actual installation location) to the ETMA
- preparation for shipping (ETMA)

1. small computing accessories are handled as small electronics (electronic Modules) or other small items.

- de-register (where?)
- transport to shipping/receiving area
- packaging (shipping and receiving area)

9.2.2. Tapes

The present scenario provides for a complete set of tape copies to be shipped to the data analysis site on a daily basis once the facility is operational. During RO about 15 tapes will be produced per running interferometer per day. During I/C some data tapes will be produced; the number will be lower than in the operational phase.

9.2.3. Storage

The following table lists the types of equipment to be stored at the remote sites. It indicates for each category in which store they are expected to be kept.

Table 9: CDS equipment stored at the remote sites

	description	*size/weight*	*location*[a]
a	cable on drums		LTS
b	fibre optic cable on drums		LTS
c	empty 19" equipment cabinets		LTS
d	pre-cabled 19" equipment cabinets		ETMA or LTS[b]
e	VME crates		LTS[c]
f	Electronic modules		ETMA[d]
g	computing equipment		normally not stored
h	computing peripherals (tape and disk units)		normally not stored
j	cable trunking materials		LTS
k	paper documentation		ETMA
l	empty tapes		Tape Room, Computer Room

a. LTS: Long-Term Store
b. wrapped and sealed after cleaning
c. wrapped and sealed after cleaning
d. wrapped in sealed envelopes after cleaning

10 OVERALL COMMISSIONING SCENARIO

The overall commissioning scenario in the sense of the sequence of the systems has not yet been considered.

There are however some obvious necessities:

Control room and CDS networks need to be install before any of the "user" systems can be commissioned.

The first CDS system to be commissioned is the Vacuum Controls system.

the sequence of the interferometer systems requires further elaboration

11 CONTRACTUAL ASPECTS OF CDS INSTALLATION

It has been envisaged that many tasks of the installation of CDS equipment be subcontracted. The following is a list of activities which are candidates for sub-contracting:

- assembly and standard pre-cabling of electronic cabinets:
  - assembly of cabinet frame
  - installation of isolation transformer and of 120V wiring
  - installation of ground wiring
  - installation of temperature sensing
  - testing
- signal pre-cabling of electronic cabinets:
  - installation of VME crates
  - installation of terminal blocks
  - installation of cabling between terminal blocks and electronics
  - installation of temperature sensing
  - testing
- installation of cable trays
- installation of cabinets and connection to cable trays (local connection) and to 120V

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intentionally (empty)