BBDev Memo 029.0

Brief report on Integration and Automation Workshop Haystack Observatory 2009 Feb 23-25

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2009/03/12

1. Introduction

A workshop was held at Haystack Observatory on 2009 Feb 23-25 to discuss what is needed for a VLBI2010 site, ranging from the control room to the antenna, and including all ancillary equipment. A major topic was monitoring/command/control/communications.

2. Objectives

The following topics were considered as a starting point for the first two days:

- Can we come up with a model and requirements for a VLBI2010 site that operates "mostly unattended"?
- The model might encompass the entire chain from scheduling, through observation, through correlation, to analysis.
- The main considerations should be:
  - what is required at the VLBI2010 site in terms of hardware so an accurate assessment can be made of cost, feasibility, and potential extent of "unattended operation", and
  - what are the personnel requirements? at the site? related places, such as remote control room (should we consider this?)?

The following guidelines were suggested to focus the discussions of the workshop.

Curbing our enthusiasm

What decisions need to be made to allow continued technical development?
What topics are we best suited to address?
What would we really like to discuss?
What can we accomplish in two days?

Other guidelines for the meeting, and the list of participants, are included in the Appendix.

3. Discussion

A principal action was to diagram the components of a VLBI2010 site and their connections. (This and other discussion in the workshop was documented in a PowerPoint document.) Other major topics were

- how to maintain information needed from a site either for operations or for data analysis. Valuable input was provided (over telephone) by VLBA personnel (Craig Walker, Jon Romney, Walter Briskin, Peggy Perley, and Steven Durand).
- operations requirements (again important VLBA input from their experience)
- site ties
- communications (LabView as interface?)

- the interaction of the DBE2 with the rest of the system (especially 1 pps, gain control, and calibration control)

(The notes are included at the end of the document).

4. Summary

1. See powerpoint for framework.
2. At least 2 fte are needed per site.
3. Monitor everything. Probably use a database system. A database designer is needed.
4. Centralized control is desirable. One location seemed desirable (i.e. not several distributed around the world.
5. Intrasite communication should be done over Ethernet. Modem should be available as backup from outside world.
6. DBE requirements were elaborated (see summary ppt).
7. Site ties
   a. Observations of GPS cannot be used to obtain ground ties with sufficient accuracy (VLBI to ground to GPS). Uncertainties 1-2 mm horiz and 15 mm vert)
   b. A good candidate for ground ties is a small antenna (!2 m) as reference antenna for both VLBI and GPS. Classical survey to GPS from ref and VLBI, then use 2 m for GPS phase corrections (as for AMCS).
   c. Holography setup – investigate value as a tool for evaluating antennas and improving site ties.

Appendix

Two other sections were included in the final announcement before the meeting. I include them here because they serve as a reminder of topics not to be forgotten.

The list of participants is attached.

Framework

Monitor and control
- What needs to be monitored? recorded?
  - How often? e.g.
    - met-sensors every 10 minutes
    - T_sys at beginning of every scan
    - power-line voltages and currents ?
    - antenna position – 5 seconds?
    - building environmental conditions
  - To where reported or stored?
    - local disk (met data)
    - remote control center
    - local site manager?
- What needs to be controlled?
  - How often?
    - e.g.
  - From where?
  - By what?
    - Field system
    - How are different M&C points and paths implemented, i.e. what hardware, software? (this is what I thought would be the main thrust when we first discussed having a meeting)

Communications to/from outside world
- Observation control (equipment setup, schedules)
- Data
  - VLBI bits (disk/module shipping, network for real-time and near real-time transfer)
  - Ancillary information
    - monitor and control information (above)
    - safety (power, environment at all sites; has the NCC operator had a heart attack?)

What provisions should be made to enable accurate site ties?
- Basic markers
  - Local footprint
    - How many?
    - Where?
  - Regional footprint
    - How many?
    - How far away?
- Antenna tie to local network
  - How (conventional survey; small antenna; GPS, other)?

How often?

How should maintenance and spare parts be handled?

Each agency?

Pool of like equipment?

e.g.

Antenna

Data chain (Dewar/feed/cal_inst/LNAs, UDC/LO, DBE, recorder)

More details

1. Building and grounds (infrastructure?)
    1. Control building
    2. Power requirements
    3. Environment (heating, A/C, water)
    4. Safety (
2. Antenna
    1. Pad
    2. Electrical
    3. Network connections
    4. RF/5 MHz connections
    5. Environment in pedestal, base, and front end
3. Site

Instrumentation

H-maser

Cable measurement

Timing system

Meteorology sensors

RFI monitoring

etc

Test equipment

Monitoring system and equipment required

What needs to be recorded, how often, accessible to whom/when? stored where?

e.g. Tsys, rx temps, met data, phase cal, Dewar temps, tower height, DBE power levels, (just examples)

automated notification of alarms

Network connection requirements

Local ties to SLR/GPS/monuments

Requirements for remote antenna control (e.g. if the array is operated from a centralized control center)

Storage area

Spares

Maintenance requirements

Allowed down-time

Participants

Haystack
- AEER
- AEN
- CJB
- ARW
- BEC
- AAH
- RJC
- MAP
- Mike T
- KAD
- Chet
- DLS
- Ken Kokado

GSFC/NVI/HTSI
- Chopo Ma
- John Gipson
- Ed Himwich
- Tom Clark
- Irv Diegel
- Jim Long

DRAO
- Bill Petrachenko

NRAO (by phone)
- Craig Walker
- Jon Romney
- Walter Brisken
- Peggy Perley
- Steven Durand

Questions for VLBA

- Most useful monitoring.
  - How often
- Why XML?
- Why database
- How does AGC work for DBE
- What do site techs do when not repairing?
  - What about general maintenance? (HV, mow)
- Are things site-techs have to do make system work?
  - Change disks, reset buttons, etc?

VLBA Answers

- What to monitor, and how often.
  - Depends. Different things for different uses.
  - For startup, some things are especially useful.
    - Phase cal
    - Switched power
  - Some people say: not useful to look at historical info.
  - File at each station that sets up what is monitored.
    - Only change if have special request.
    - Eg., GPS measured every 1024 seconds.
  - Some elements (Tsys) under schedule control.
  - Normally use default unless specifically called out for some test.
  - Monitor several 100 items.
    - Everything an engineer would want to look at.
  - Are there points you wish you had included?
    - Probably.

Why XML and/or Database

- Use XML for eVLA.
  - VLBA uses binary.
- XML way to move data around. Then store in database.
- A lot are monitored. But not all are stored.
  - Some are used only in real time by loggin onto station computer.
  - Because of space limitations, did not store everything.
    - If had to do it over, would store it all.
  - Settings of switches are not logged. Log commands that set the switches, but not the results.
- Same monitor screens at stations are available remotely.
- Can look at trends. Use for diagnosing problems. Not currently used to anticipate problems.
- History:
  - Use database because Barry Clark and J. Romney thought a good idea.
  - Wanted to be able to extract things easily.
  - Not sure if we got all the benefits
  - Started with SyBase, now Oracle
- May use extended Vex to get other information.
- Working with monitored data brings own set of problems
  - Time interval
  - Latency

Databases

- VLBA's db administrator says what they do is "not particularly compicated".
  - May not need high level person.
- Nice because do structured queries.
- VLBA specifically hired someone to do their dB.
- Use a commercial package called MainSaver to track maintenance.
- DBA spends 80% on DB related tasks, but covers several organizations.
- In spite of problems, find maintenance database worthwhile.
  - Can use to look and see when their were similar problems.
  - Forces entering info in consistent fashion.
  - On the whole, positive, rather than negative.

VLBA Site Techs

- Site techs do everything.
  - Inventory, track system
  - Mow lawns
  - Module repair for VLBA, builds for eVLA
  - Hancock does BBCs
  - 25-30% on repair.
  - 1-2 scheduled maintenance days week.
  - Additional maintenance because of failures.
  - Maintenance list produced weekly for each site.
    - Allow 1 day to do. If can't be done in 1 day, need to scrounge additional time.

VLBA Maintenance

- Tiger teams…
  - Special container with all tools
  - If one site is down, may do other sites at the same time.
  - "timing is everything".

Site Techs what do they have to do.

- Security checks
- Insert/remove disk packs
- Weather issues.
  - Hurricanes, lots of snow, e.g.
- Receive shipping
- On call 24/7.
  - Circuit breaker trips
  - Insert stow pins
- Origin of call for action:
  - Most is (remote) operated triggered
  - Each site also will call tech in case of fire, power out, etc.
- Call outs.
  - Operators will make decision about what to do based on severity, how much observing time is left, etc.
- Most things will come up on their own.
  - But it took a while to get there.
  - Sometimes still need site-techs to "kick" something.

VLBA Experience

- Station Control System queries monitor points.
  - Uses RS232 based bus.
- Station control software packages up responses with time tag, code.
- Sent over narrowband WAN to AOC.
- All display-able on operators console.
- Displays error messages: Out of range, etc.
  - Color coded.
- How do you disk conditioning?
  - At correlator.

VLBA continued

- Station receives schedule via internet. Can operate autonomously in case of outage.
- Monitor messages buffered and kept at station.
- AOC also keeps copy.
- Monitor Points:
  - System temperature.
  - Mechanical readback (pointing, sub-reflector)
  - Pulse Cal.
  - GPS clock offset (every 1024 points).

V LBA (3) Improvements

- Now send binary, would send xml or flexible text based.
- Do reconciliations for lost data on 24, recommend do per project.
- Store raw data (not derived parameters) in database.
- Fundamental architecture not flexible, hard to modify.

eVLA

- Use XML, write to central databases.
- MIBS (module interface board) write status data for each monitor point.
- Sent via multi-cast. Different modules can listen.

VLBA Safety

- Chatterbox
  - Can shut things down (ie, high winds)
  - Will call site tech
  - These conditions may break communication to Socorro. (This is why it calls site tech.)
- Modem backup to site in case normal internet goes down.
- Backup power:
  - Backup generators. Basically stow antenna, keep maser, cryo cold, some computers.
  - Have 75 sec UPS, ~several hours full power diesel.

VLBA Site Staff

- 2 people per site.
  - 8 hour day.
  - At the same time.
- What ever operational plan you want to eventually have, start out that way. Hard to change.
- Each site (is supposed to be) responsible for some sub-set of equipment maintenance.
  - If a site can't fix, is supposed to send someplace else.
- Site techs workshop
  - Less than annual because of budget constraints.
- All site techs are full time NRAO.
- Design schedule to minimize overtime.
- Have head of site tech group at Socorro.

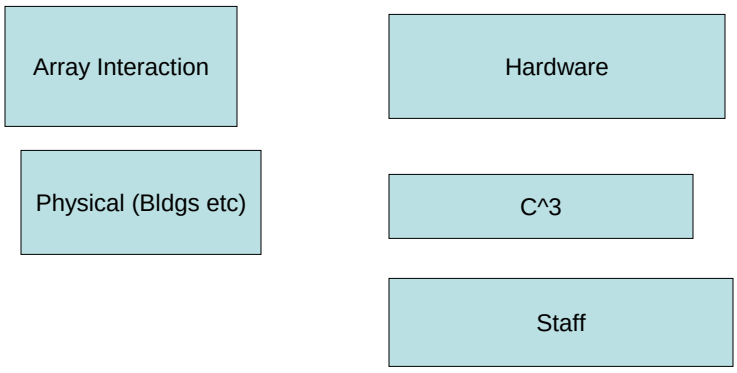
VLBA (misc)

- Maintenance database
  - Site techs log instrumental failures.
  - Every ticket tagged & reviewed and kept track of until cleared.
  - Correlator hardware in system.
- Have complete set of equipment (w/o antenna) at AOC. Allows testing, etc.
- Monitor database is used to produce cal files which are added after correlation.
- Once a week have maintenance day.
- Once a month, double maintenance day.
- Security issues:
  - Worried a lot initially, but not a lot problems.
  - Some sites placed out of the way so you can not see.
  - Compound is locked.
- Operators run both correlator and stations.
  - Need 5 operators. Operate 24/7.
  - Hourly.
- Analysts set up Correlator job, review schedules, etc.

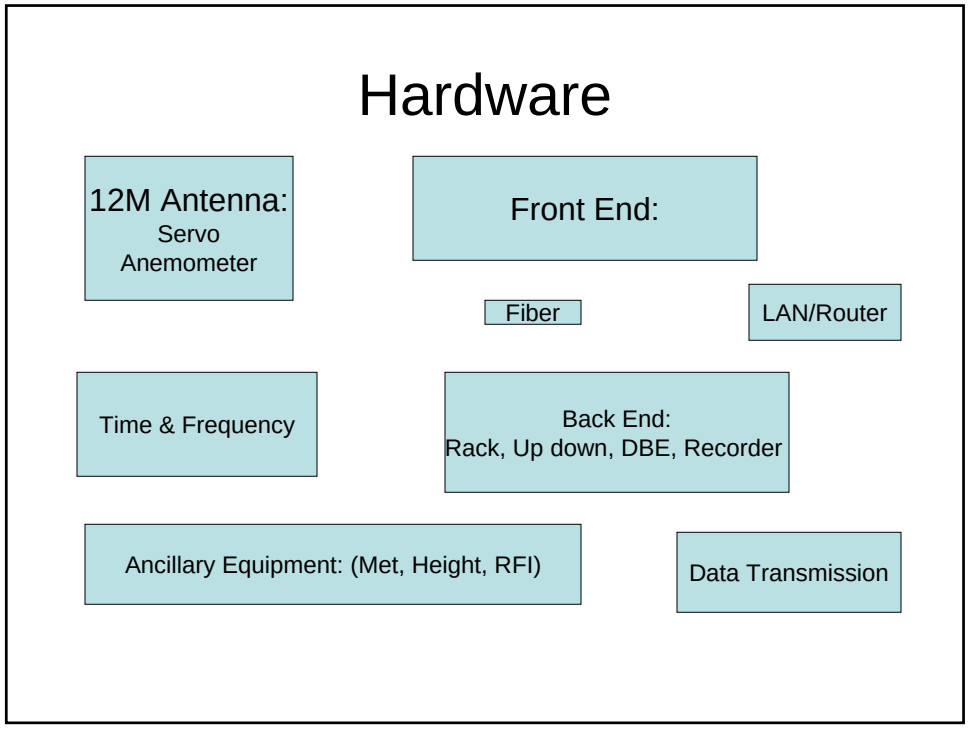
VLBA Misc

- What facilities:
  - Restroom
  - Kitchen
  - Control building is RFI shielded.
  - No windows
- Maser has own room.
  - Additional shielding
  - Vibration isolating pad
  - Temperature control
- Video cameras:
  - Mostly look at antenna.

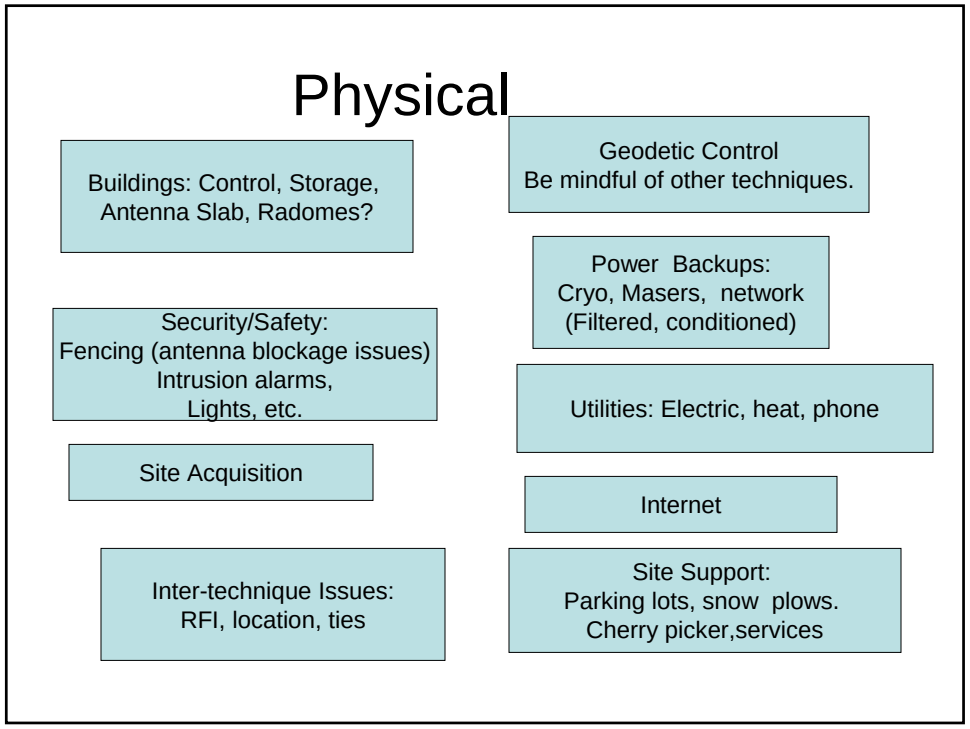
Major Pieces VLBI 2010 Station



Hardware



Physical



Command Control Commun.

Field System:
Schedule, Antenna Control
Operator Interface

Instrument Control & Logging
(Met, …)

Human Interaction

Modem for backup communication

External Communications:
Firewall/Authentication

Non-Internet:
Alarms, Fire, Video Cameras,…

Internal Connections:
General &Instrument Only vs
General

Ant. Pointing System

Local Staff

Operations:
Disk conditioning?

Repair

Scheduled Maintenance

Call outs:
Local
To AOC

Qualifications

Training

Array Interaction

Coordination Center:
Media, schedules, correlation

Depot Maintenance (parts):
Distributed or local or combo?

Remote Operations Center(s)

Engineering Support
Troubleshooting
Hardware

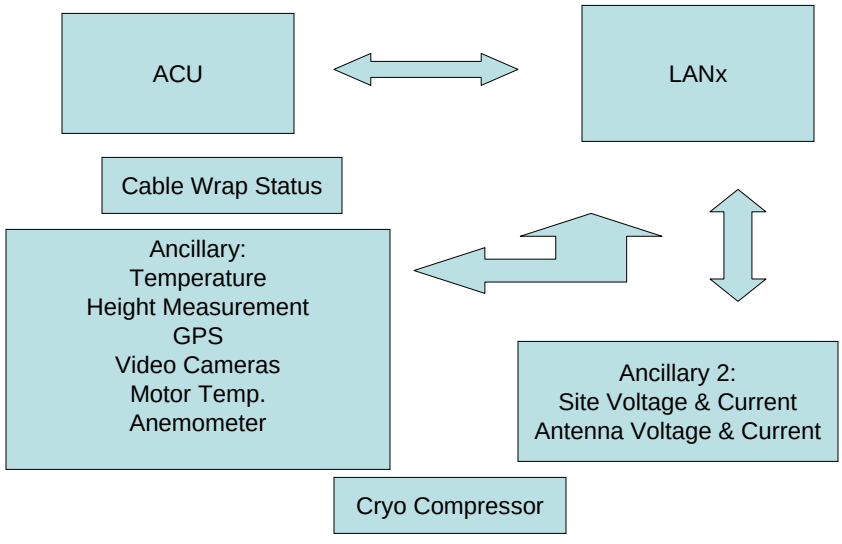
Correlator

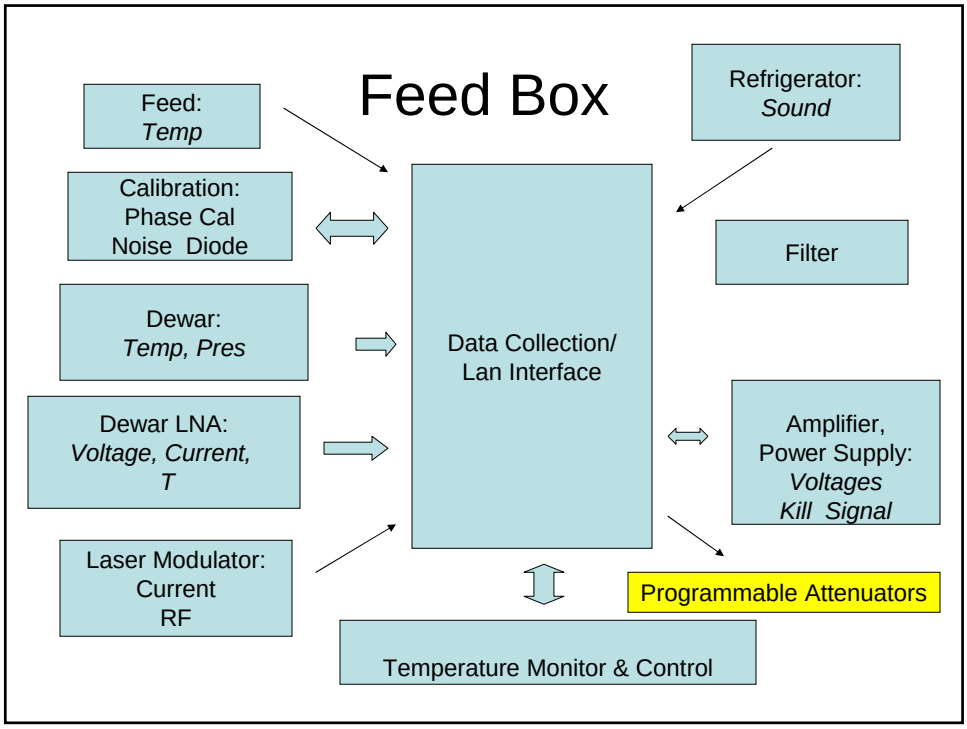
Physical Network

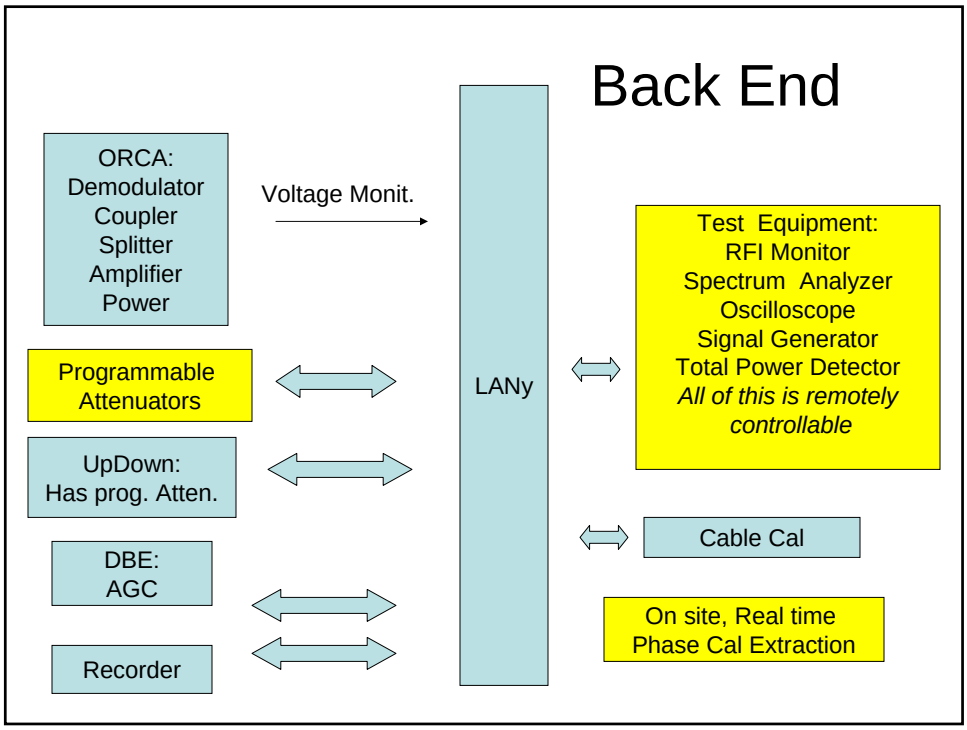
Training (e.g., TOW)

Equipment/Repair database?

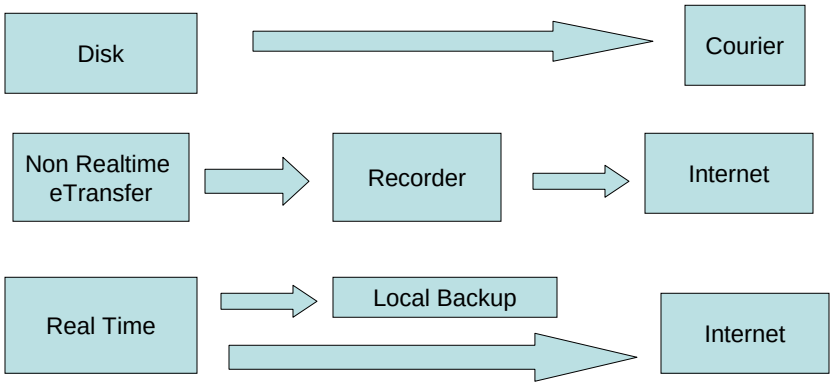
12M Antenna




Feed Box
Feed:
Temp
Refrigerator:
Sound
Calibration:
Phase Cal
Noise Diode
Filter
Dewar:
Temp, Pres
Data Collection/
Lan Interface
Dewar LNA:
Voltage, Current, T
Amplifier,
Power Supply:
Voltages
Kill Signal
Laser Modulator:
Current
RF
Programmable Attenuators
Temperature Monitor & Control

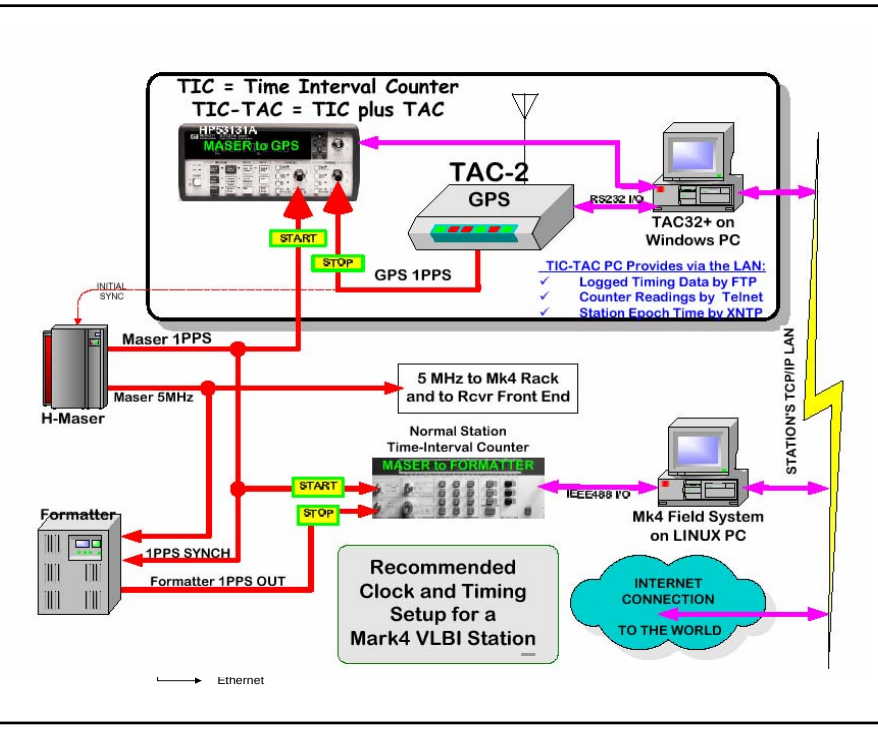

Back End
ORCA:
Demodulator
Coupler
Splitter
Amplifier
Power
Voltage Monit.
LANy
Test Equipment:
RFI Monitor
Spectrum Analyzer
Oscilloscope
Signal Generator
Total Power Detector
All of this is remotely controllable
Programmable Attenuators
UpDown:
Has prog. Atten.
Cable Cal
DBE:
AGC
On site, Real time
Phase Cal Extraction
Recorder

Data Transmission



If you want to do 24/7 operation eTransfer, then need to have internet rate same as average data rate.

Correlators may need to store data.



Timing & Frequency

- 1 PPS Distribution
- 5/10 MHz Dist.
- Maser
- Data acquisition computer
- GPS timing NTP server
- GPS and DOT counters

Ancillary Equipment

- Met Sensor(s) An array(?) anemometers
- Height/3D
- Tiltmeters, Extensionometers, etc.
- Multiple Antenna T. Concrete, piers, etc.
- Surveying marks, etc on Ant
- WVR:
- Small Antenna(?)
- GPS (for real time local site tie)
- Audio/Video monitoring
- Holography Equipment
- Seismometer, etc.
- Way to turn off X-Band SLR

Labview

- Local access & control
- How to interface to non-GPIB instruments?
- Linux distribution RedHat.
- Can labview operate our hardware, and at what level?

Client/Server