Architecture Walk-through
Outline

• Overview.

• Board descriptions.

• System design issues.
OVERVIEW
Antennas: Receivers, Samplers, Fibre WDM

Station Board
- MCB Interface Module
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Fibre-Optic Receiver Module
- DELAY
- FIR Filter Bank
- Timing

Fibre WDM Demodulators
- FOTS

Wideband Autocorrelator
Station Board

- FIR Filter Bank
- Delay
- Fibre-Optic Receiver Module

Sub-band Distributor Backplane

- Master
- Slave 1
- Slave 2
- Slave 3

Fibre WDM Demodulators

TIMECODE Generator Box (TGB)

- Reference Clock
- Reference Time Tick

Antennas:
- Receivers, Samplers, Fibre WDM

- TIMECODE + CLOCK

- FOTS

- Wideband Autocorrelator
Baseline Board
- 8 x 8 Correlator Chip and LTA Controller Matrix
- 8 'Y' Recirculation Controllers

Station Board
- FIR Filter Bank
- DELAY
- Fibre-Optic Receiver Module

Baseline Entry Backplane

Sub-band Distributor Backplane
- Master Slave 1 Slave 2 Slave 3
- Retiming/Drivers

Phasing Board
- 8 Sub-array 2nd-Stage Adders

TIMECODE Generator Box (TGB)
- Reference Clock
- Reference Time Tick

TIMECODE(s) + CLOCK(s)

Fibre WDM Demodulators

TIMECODE Box (TGB)

Antennas: Receivers, Samplers, Fibre WDM

8 'Y' Recirculation Controllers

B. Carlson, 2001-Nov-02

EVLA Correlator Conceptual Design Review
STATION BOARD
Each Station Board handles one baseband pair (2 x 2 GHz = 4 GHz), 4 bits/sample.

- 8 bits/sample possible with 1/2 bandwidth.

- Two banks of 18 poly-phase FIR filters: each one independent in width and placement in the baseband.

- Input 64-bit, 256 Ms/s “data highway” could be reassigned to multiple basebands.

- Generates all timing, dump control, delay, and phase for downstream processing.

- Use SDRAM for >10k km baselines.

- Output switch for flexibility.
SUB-BAND DISTRIBUTOR
BACKPLANE
200-pin type E male headers (opposite side)

-48VDC main power connectors

48VDC blind-mate headers (opposite side)

TIMECODE + CLOCK entry header

80-pin MDR headers (sub-band data out x 18)
Each MDR-80 connector contains one sub-band from all 8 basebands (8 x 4-bits).

(+ TIMECODE + DUMPTRIG, + PHASEMOD, + DELAYMOD + CLOCK)
STATION DATA FANOUT BOARD
Station Data Fanout Board

- Fans data out to Baseline Boards within a Baseline Rack.
- For 32 stations, a fanout of 4 is required, 40 stations requires a fanout of 5, 48 stations a fanout of 6.
- Also fans data out to Phasing Boards, and expansion boards.
1.8V and 3.3V DC-DC power supplies

- Input MDR-80 Header (opposite side)
- LVDS Receivers
- Retiming FPGA
- LVDS Drivers
- Output MDR-80 Headers
- Opposite side holes for expansion output
- Sub-band breakout headers for Phasing Boards

**DATEL UNR-3.3/8-D5**
(3.3V @ 8A)

**DATEL UNR-1.8/2-D5SM**
(1.8V @ 2A)

**XCV60E-FG256C**

Dimensions:
- 3.5" height
- 8" width
• Straw-man concept for hot-swapping the SDFB.
• Mount SDFB to plate, that can be unfastened from the back panel of the Baseline Rack.
• Guide posts allow extraction of SDFB plate without short circuit worry.
• Remove cables, install new plate assembly...
• Alternative is to use a set of blind-mate MDR-80 sockets on PCB that mounts permanently to back panel. Higher cost...
BASELINE ENTRY
BACKPLANE
• Feeds sub-band (MDR-80) data through to the Baseline Board.

• Blind-mate with Baseline Board.

• Single board design permits flexibility in mixing Baseline Boards and Phasing Boards in the same sub-rack.

• Many pins using 200-pin (hm 2.0, 8 row) connectors, yields high insertion force (~100 lbs).

• hm 2.0 connectors should be ok for 256 Mbits/sec.
BASELINE BOARD
• FPDP is a simple protocol to handle with an FPGA, with no CPU interaction.

• Alternate solutions (Firewire) possible…as long as controlled by FPGA.
PHASING BOARD
ENTRY BACKPLANE
• Feeds up to 48 stations, 1 sub-band \textit{pair} into a Phasing Board.

• Each connector contains two, 4-bit data paths, timing, delay, and phase.

• Use GORE “quietzone” cables / connectors (12 pairs).
PHASING BOARD
- Phases 1 sub-band pair, from up to 48 stations.
- “Phasing granularity” of 4 stations to prevent excessive connection problems.
- 5 sub-arrays.
- Sub-sub-band filtering for more efficient narrowband data recording.
- All digital.
- 8-bit output for expansion >48 stations
TIMECODE GENERATOR BOX
• Generates “TIMECODE” for use by correlator.
• 4 TIMECODES generated. Each Station Board “quad” can select any of the 4. This permits mixed real-time and tape-based VLBI operation.
• 48 outputs to go to up to 48 Sub-band Distributor Backplanes.
• Requires input clock and reference time tick.
SYSTEM DESIGN ISSUES
Sub-rack Design

- 24” wide to allow 8 boards, with 2.5” width per board (3 full VME slots per board).
- Fresh (cool) air supply for each sub-rack (crate) of boards.
- Requires hot-swappable fan (tray).
- Requires more vertical rack space...
Station Rack Design

- Cool air entry from bottom.
- Each sub-rack has own cool air.
- Probably only fit two sub-racks per rack (7’).
- Estimated power dissipation: 200W/board $\approx$ 2kW/sub-rack $\approx$ 4kW/rack.
Baseline Rack Design

- Must hold up to 256, ~3 m 80-wire GORE cables.
- Extra 3’ depth, with rear and side-panel access.
- “Grid routing” to organize cabling.
- Will build full mock-up to test feasibility.
Remote Power M&C

- DC-DC converters have power monitor and control line.
- Route via terminal block and DB25-pin connector to external control computer.
- Individual power-cycle and monitor capability for each board in the system.
Correlator (48-station) Floor Plan

- 45 x 50 ft.
- Center Station Racks because of cabling.
- 360° access to baseline racks (intra-rack cabling).
- 48 VDC mains supply Single-point failure, hot-swappable boards and modules.
(One idea of the) Computing Environment

- Use Linux PCs for non-real-time “sophisticated” M&C computing (e.g. model generation)
- Use Linux PC Beowulf clusters for back-end data processing.
- Other solutions being proposed...
Summary

- 32 delivered stations expandable to 48+ stations.
- A few modules need to be developed.
- Baseline Board and correlator chip conceptual design is quite advanced.
- Station Board design straightforward, but not as advanced as the Baseline Board.
- System design (racks etc.) fairly conservative. High cabling density in Baseline Rack requires mock testing.
- Full remote control capability, can hot-swap all modules with semiconductors.
- Ideas for computing environment, but not decided...