Coherent Dedispersion Backends: CGSR2 and GASP

Bryan Jacoby (NRL/NRC)
Motivation

Challenge: Coherent dedispersion offers very high time resolution for precision timing and other applications. However, wide-bandwidth voltage recorders produce impractically large data volumes.

Solution: Integrate computing power with backend to process data at time and place of observation, eliminating need for large-scale data storage and transport.
Dedispersion Techniques

PSR B0535+28

J1800−3053
Post-detection Dedispersion

J1800−3053
Coherent Dedispersion
CGSR2 Overview

Wide-bandwidth voltage sampler and (semi-)real-time coherent dedispersion engine

- One custom Fast Flexible Digitizer (FFD) board
- Inputs: $4 \times 64$ MHz analog channels, sampler clock, 1 PPS, serial control
- Outputs: $4 \times 2$-bit or $2 \times 4$-bit, real sampled, to $2 \times$ EDT PCI CD60
- On-board gain control, bit packing, etc.
- 21-node computer cluster linked by Gb Ethernet:
  - $2 \times$ primary (data acquisition) nodes
  - $18 \times$ secondary (data processing) nodes
  - $1 \times$ gateway / archiver node
Schematic

Fast Flexible Digitizer II

- IF Ch. 0
- IF Ch. 1
- IF Ch. 2
- IF Ch. 3

Amplification and A/D Conversion

Output Drivers

EDT PCI-CD60
1 GB RAM Buffer

Primary Nodes

Gb Ethernet Switch

Secondary Nodes

Archive Collection Node

To Outside World

Coaxial Input Cable
EDT LVDS Cable
Ethernet Cable
Serial Cable
Internal Connection
Physical Component
Function or Group
Fast Flexible Digitizer
Crate and Cluster
Observing
Data Processing

- Usual mode: dedispersion/folding with PSRDISP
- Of order real time for reasonable $DM$ at L-band
- Secondary analysis: PSRCHIVE
- Other packages exist or can be implemented for searching, single pulse work, etc.
- Versatile, modular: can do anything with the voltage sampled data.
Processing
The Future

- Scalability: can do more bandwidth by adding more nodes, software is already written.
- BUT: big clusters are a lot of work to maintain.
- Question: cluster or FPGA approach for the next generation backend?