Using the ID-1 Digital Tape Recorder to Collect Radio Telescope Data

DATATAPE Incorporated

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Agenda

- Project Overview
- What is a Pulsar?
- What can we learn from studying pulsars?
- How pulsar data is collected using the DATATAPE LP 400 ID-1 recorder
- How pulsar data is analyzed using the Intel Paragon supercomputer and the ID-1 recorder

Project Overview

- Funding from National Science Foundation's Grand Challenge Applications Program
- Caltech, Intel, DATATAPE Incorporated
- Multi-year project to collect and analyze pulsar data
- Principles
  - Dr. Tom Prince Caltech
  - Dr. Steve Unwin Caltech
  - Rick Jenet Caltech
- Radio telescopes at Owens Valley Radio Observatory in California and Parkes Observatory in Australia

What is a Pulsar ?

- Pulsars are highly magnetic neutron stars that represent the remains of a star after it dies
  - Spin at up to 1000 revolutions/sec
  - Very accurate clocks
  - Neutron stars start out approx 1.5 times the mass of the sun and compact to about the size of Pasadena Calif.
- Emit regular bursts of radio waves
- Millisecond pulsars found in globular clusters
  - Some of the oldest constituents of our galaxy
- Questions:
  - How do they form ?
  - Why do pulsars seem to evolve by spinning down and then spinning up again ?

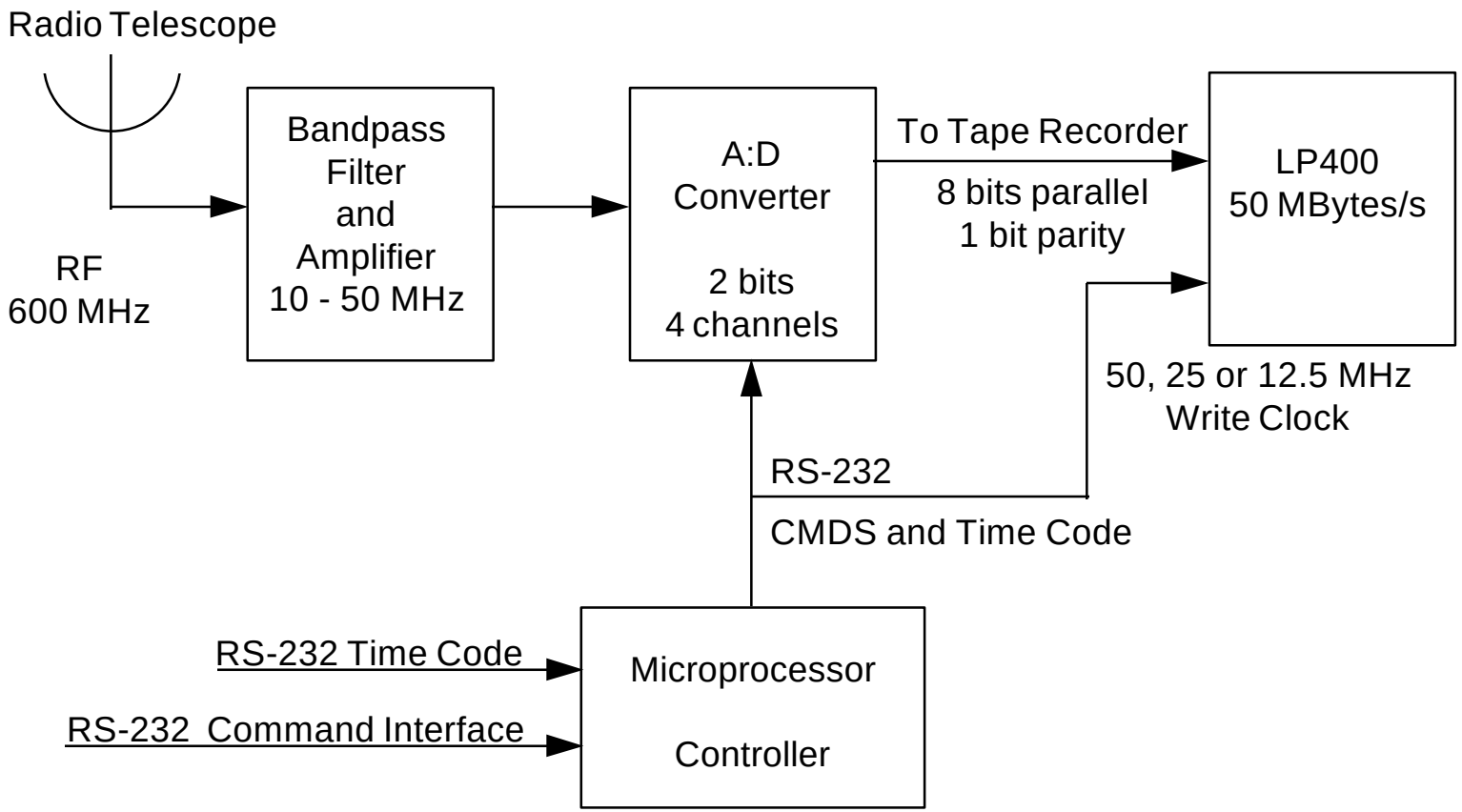
What Can We Learn from Studying Pulsars?

- Achieve a better understanding of the behavior of nuclear matter in very dense situations
  - Pulsars' surfaces spin at close to the speed of light
  - An understanding of how fast they can spin will clarify how dense nuclei can become
- Verify portions of Einstein's theory of relativity
  - Fundamental test of physics
  - Understand gravitational waves by two objects in orbit
- Pulsars are the most accurate clocks known
  - Why are they so accurate and predictable?

How Pulsar Data is Collected Using the ID 1 Recorder

- Collection of pulsar data requires sensitive radio telescopes that capture radio signals
- Continuous data is received by the radio telescope
- Bandwidths range from 10 - 50 MHz
- The data is bandpass filtered and amplified
- The data is converted from RF to digital
- The digital data is recorded on the ID-1 recorder at 50 and 25 MBytes/sec

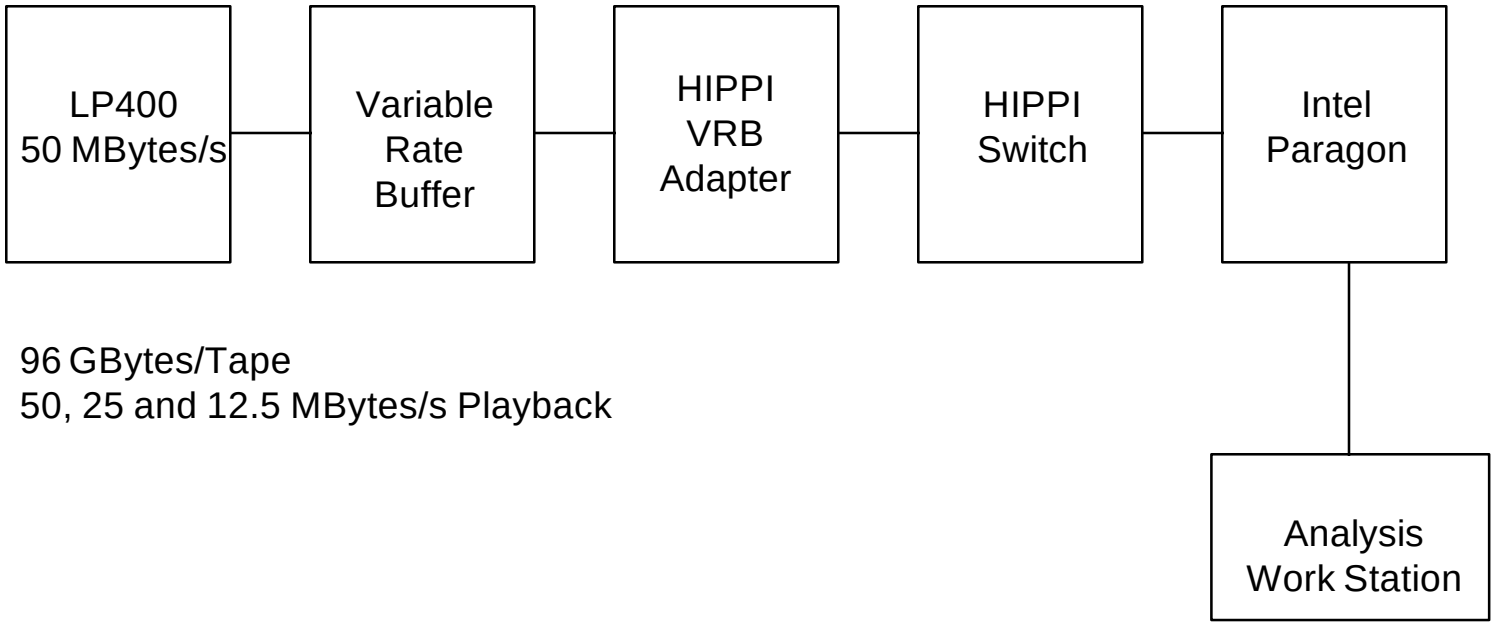
Pulsar Data Collection Block Diagram (Record)



How Pulsar Data is Analyzed Using the Intel Paragon Supercomputer and the ID-1 Recorder

- The study of pulsars is a signal processing application
  - Dispersion must be corrected by complex computational algorithms
- Requires high performance computing similar to medical diagnostic imaging, seismic data processing, or environmental impact studies
- Intel Paragon filters and analyzes the data
  - checks data integrity, data reduction, and signal de-dispersion
- Data is analyzed to determine if pulsar activity is detected
- Over 10 Terabytes of data was collected over 2 weeks in July of 1995 (analysis ongoing)

Pulsar Data Analysis Block Diagram (Playback)



96 GBytes/Tape
50, 25 and 12.5 MBytes/s Playback

Summary

- Supercomputing application using COTS equipment and standard interfaces
  - ID-1 digital tape recorder
  - HIPPI connected
  - Intel Paragon
  - High transfer rates (up to 50 Mbyte/s)
  - Large tape capacity (up to 98 Gbytes/cassette)
- Same technology can be used for instrumentation, data analysis, data warehousing, SAR imagery, and image rendering applications