A Real-Time Recording System using DSP-based Multiprocessor Technology

Fabio Ancona*, Flemming Christensen‡, Alain Nguyen§

Sundance Multiprocessor Technology Limited, Chiltern House, Waterside Chesham, Buckinghamshire, HP5 1PS, United Kingdom
Tel.: +44 1494 793167 Fax: +44 1494 793168
*FabioA@Sundance.Com ‡FlemmingC@Sundance.Com § AlainN@Sundance.Com

* Corresponding author

Abstract

Introduction

Sundance Multiprocessor Technology Ltd. has a leading role in the research and development of sophisticated products which meet the myriad requirements of system builders. Sundance is a Texas Instrument's Third Party and it allows us to develop advanced technology in the high-performance embedded processing market [1].
The paper describes a new real-time recording system for 10MHz based-band radio applications. The product is made by a modular and complex parallel architecture using concurrent real-time software and it achieves high performance at a low cost.

The System

Software

The system is organised with a DSP-based multi-processor architecture where a concurrent software design guarantees real-time performance. The user controls the system from the host by a Graphical User Interface (Fig. 1) running on an Intel platform both under WinNT and under Win9x. A custom device driver, built using the SMT6010 [2] (WinDriver for WinNT) or using the SMT6020 [3] (WinDriver for Win9x), allows data transfers from the system to the host and vice versa: high performance has been reached using the SMT6015 [4], which is a WinServer developed by Sundance. The main functions under the user's control are a single or a multi-file record on SCSI disks (the size of the sampling file and the sampling frequency are input parameters) and the backup both on SCSI Tape and on the host's harddisk. It is possible to backup a single file, or part of it, or several files. All the files are organised in a directory showing the main features for each file.

A multi- tasking, parallel and symmetric software has been designed for the Embedded System (ES) with two 10Mbytes/sec digital channel hardware architecture: sophisticated synchronisation techniques enable high system efficiency.
In particular, the record process, which is the most complex function of the system and the only one where real-time performance is essential, needs 5 concurrent tasks and two processors per channel: one channel is used to record the even 1Mbytes data frames onto a SCSI disk and the other is for the odd ones on the second SCSI disk.

Hardware

One analogue channel is sampled and recorded on two 9Gbytes SCSI disks at a rate of up to 20Mbytes/sec: the file size can be maximum 18Gbytes. The backup from the 2 disks to the tape is at a rate of up to 4Mbytes/sec and the backup from the 2 disks or the tape to the host is at rate of up to 10Mbytes/sec.
The system is based on Sundance's OEM products, is symmetric and is composed of 2 channels working in parallel: Figure 2 shows the picture of the system and Figure 3 is the picture of the ES. The hardware of the ES is composed of the SMT320 [5], which is a PCI TIM carrier, mounting 4 TIMs: the SMT359 [6] (a single width TIM-40 compliant module consisting of a single channel 40MHz, 12-Bit ADC), the SMT315 [7] (a dual processor SRAM TIM) and two SMT307 [8] (fast wide SCSI-2 TIMs). The above TIMs are all based on Texas Instruments's DSPs (TMS320C4x) and on re-configurable computing hardware (Altera's FPGA or XILINX's FPGA) guaranteeing a flexible system design.
The most relevant FPGA design is on the SMT359 that implements two main functions: the Samples Processing (SP) on the ADC module and the Linear Feedback Shift Register (LFSR) Pseudo-Random (PN) Data Generator (Fig. 4). In the SP the 12-bit ADC converts the analogue input into 12-bit samples. The FPGA then truncates samples from 12 bits to 8 bits, packs the samples in 32-bit words and interleaves the words in two 10Mbytes/sec digital channels using a 2Kbytes FIFO. The PN generator is used for the Data Integrity Test that checks if there are any data losses in the sampling and backup process.
The SMT307 consists of a Texas Instruments's TMS320C44 ('C44) with 4MBytes of Enhanced Dynamic RAM (EDRAM). The TIM module uses an NCR53C720 SCSI–2 I/O processor, C720, to provide a peak transfer rate to SCSI-2 devices of 20MBytes/s synchronously and 10MBytes/s asynchronously. The SCSI processor is capable of processing NCR SCRIPT codes in the EDRAM without intervention from the 'C44. The board can access 68-way 16-bit wide SCSI drives. Very complex multi-tasking software allows the processor's local bus and two DMA lines (on two C44's comm-ports respectively) to work concurrently guaranteeing the real-time performance required. In other words, the processor can get 1Mbytes data frame and write the previous one to the SCSI disk in the meantime.
The SMT315 is a dual processor TIM with two 'C44 and 4Mbytes of SRAM. The two processors work in parallel on the two different channels and they have an important role on the recording process because they guarantee a real-time data flow from the ADC module using sophisticated multi-tasking software.

Conclusions and future work

This research describes a novel technology design of a real-time recording system used for radio applications. At present, the system is a product, called SMT8001 [9], and it has been sold to the Military Research Centre (M.O.D.) of Israel, which has been using it extensively in some of their research projects.
Future work will be focused in increasing the recording capacity from 18Gbytes up to 72Gbytes and in getting the system working with more flexible hosts both in terms of platform and O.S..

References

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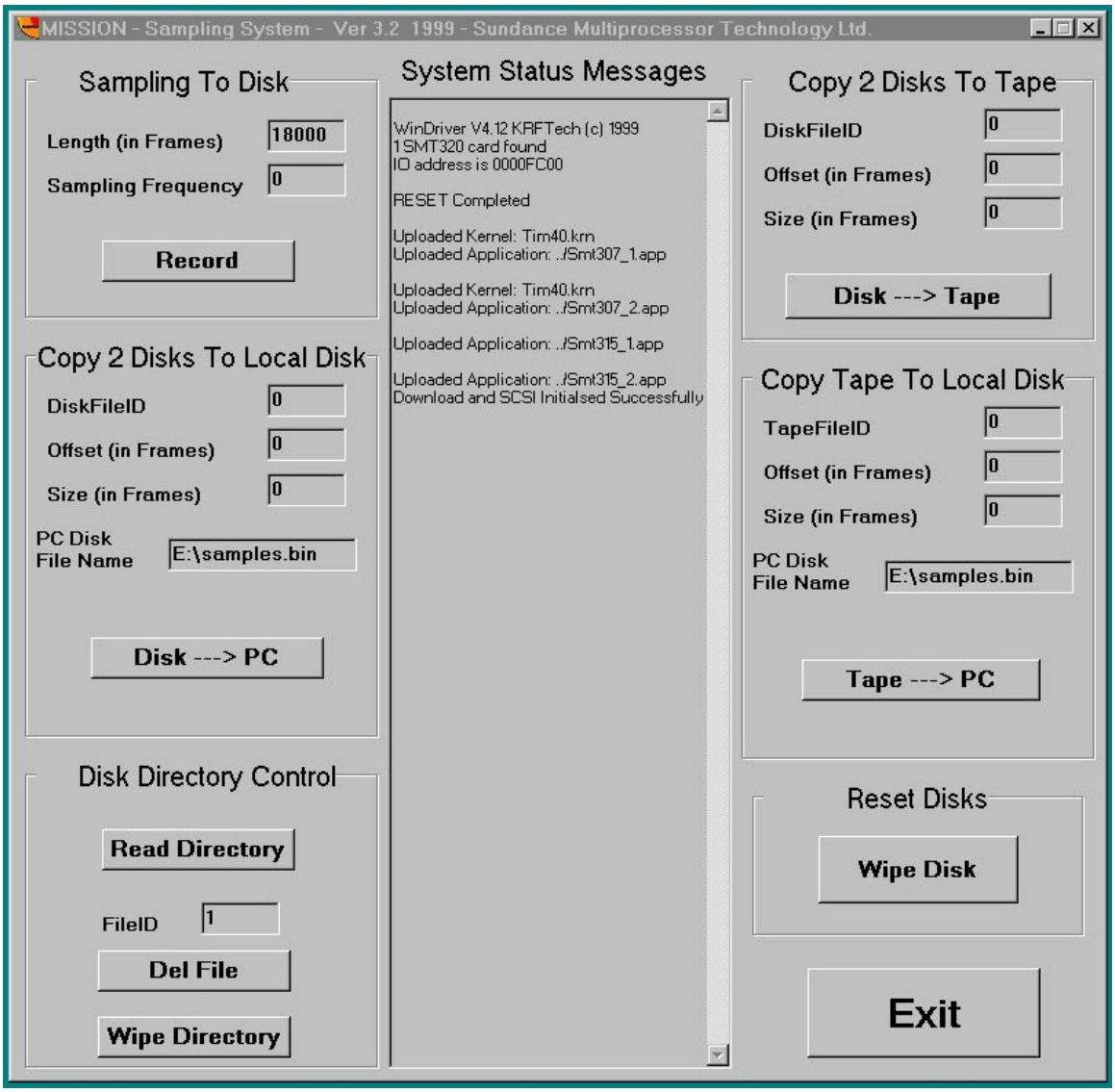

Fig. 1 – The Graphical User Interface.

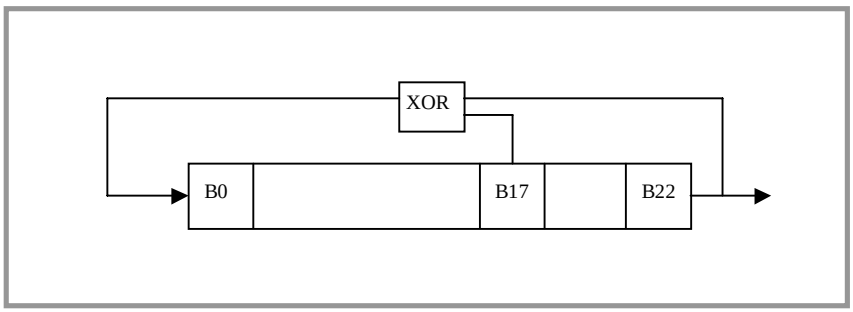

Fig. 4 – The LFSR PN Data Generator.

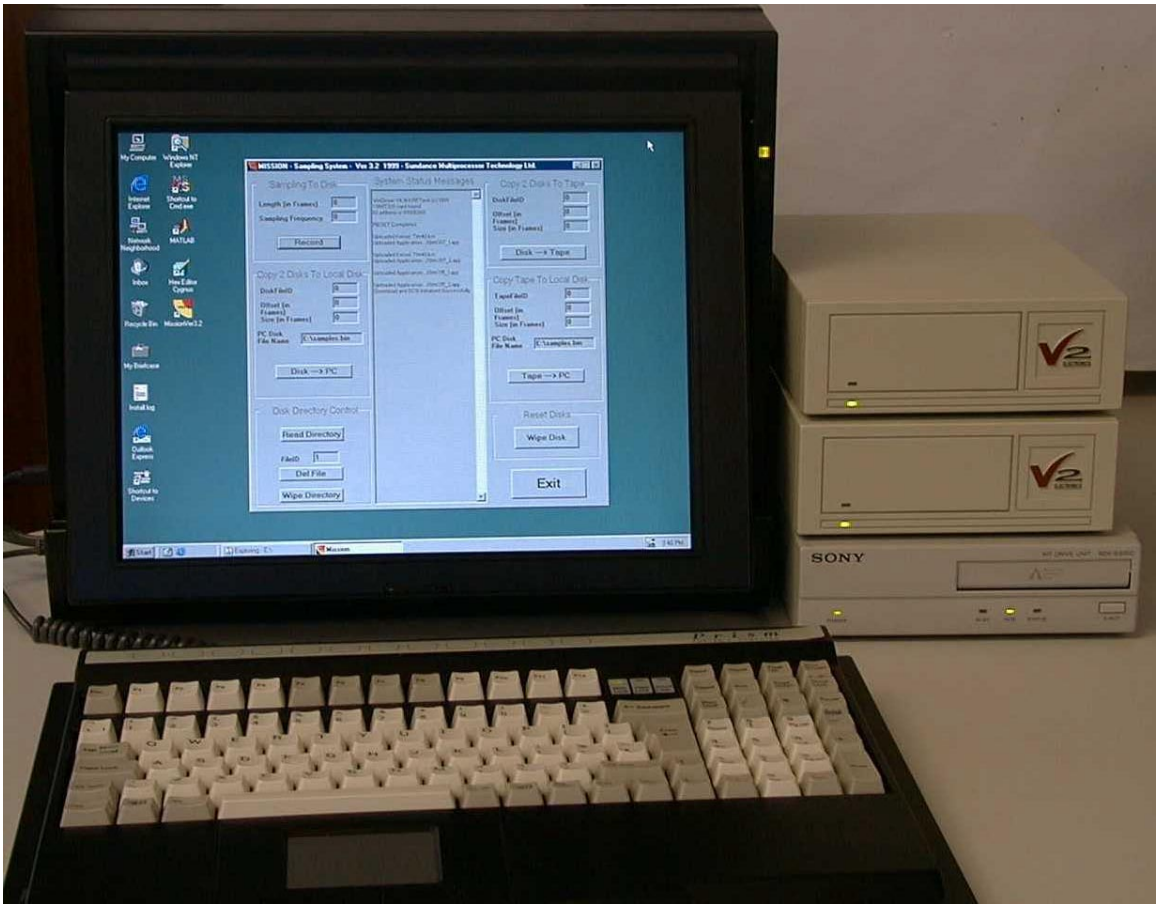

Fig. 2 - The Picture of the System.

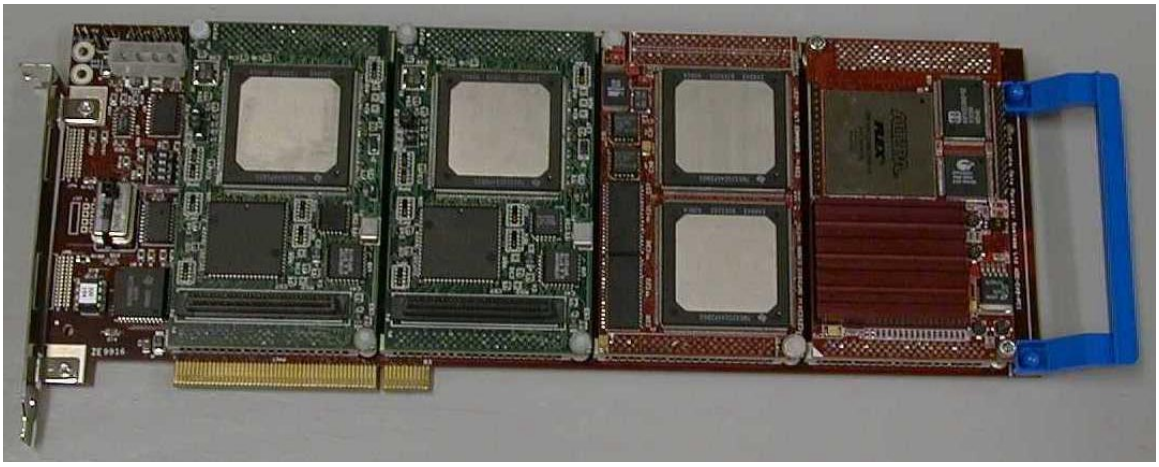

Fig. 3 - The Picture of the Embedded System.