DEFENCE DÉFENSE

Migration of DIINS to PowerPC/VxWorks and Intel/Win32

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Defence Research Establishment Ottawa

Defence R&D Canada
DEFENCE RESEARCH ESTABLISHMENT OTTAWA

TECHNICAL MEMORANDUM
DREO TM 2001-046
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Canada

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Aerospace Radar and Navigation Section

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Abstract

This report documents the results of work required to migrate the DIINS (Dual Inertial Integrated Navigation System) software from its former platform, consisting of a unix-based Sparc host system and Motorola 68030 VME target system under a Telesoft Ada83 compiler and run-time executive, to a new Green Hills Ada95 NT development environment and two new run-time platforms: a PowerPC604 VME target system running VxWorks 5.4, and a generic personal computer running Windows NT 4.0. The migration is not entirely complete, though both new run-time platforms are running satisfactorily to a great extent. This document records the status of the migration, presents some results of the systems in real-time laboratory trials, and identifies issues that need to be explored more fully if the migrated DIINS systems are to be deployed in operational environments.

Résumé

Ce rapport fait état des résultats des travaux nécessaires à la migration du logiciel DIINS (Dual Inertial Integrated Navigation System) de son ancienne plate-forme, c'est-à-dire un système hôte Sparc tournant sous Unix et un système cible Motorola 68030 VME doté d'un compilateur et d'un programme d'exécution run-time Ada83 de Telesoft, à un nouvel environnement de développement Ada95 NT de Green Hills et deux nouvelles plates-formes run-time, soit un système cible PowerPC604 VME tournant sous VxWorks 5.4 et un micro-ordinateur générique tournant sous Windows NT 4.0. La migration n'est pas encore terminée, mais les deux nouvelles plates-formes run-time fonctionnent en général assez bien. Le présent document consigne l'état de la migration, présente certains résultats produits par les systèmes pendant les essais en temps réel en laboratoire et dresse la liste des questions qu'il faudra étudier plus à fond si la migration des systèmes DIINS est déployée en milieu opérationnel.

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Executive summary

This report documents the results of work required to migrate the DIINS (Dual Inertial Integrated Navigation System) software from its former platform, consisting of a unix-based Sparc host system and Motorola 68030 VME target system under a Telesoft Ada83 compiler and run-time executive, to a new Green Hills Ada95 NT development environment and two new run-time platforms: a PowerPC604 VME target system running VxWorks 5.4, and a generic personal computer running Windows NT 4.0. The migration is not entirely complete, though both new run-time platforms are running satisfactorily to a great extent.

Originally DIINS had been targeted for the Halifax Class ships of the Canadian Navy, as a subsystem of their new electronic chart systems known as SHINNADS (Shipboard Integrated Navigation and Display). More recently, it has become evident that DIINS may be used in other applications including those of foreign navies. Thus a decision was taken to migrate the software to more readily available and supportable hardware, including general purpose PC's. This document summarizes the efforts that have been conducted in that regard. It is intended primarily to be used as a reference for future development of DIINS or its adaptation to different classes of ships.

First a brief background of the DIINS project and the initial migration contract results are presented and followed by an outline of the new system configuration and administration. Instructions for running DIINS on the new PC and VME platforms and procedures for rebuilding the source are also summarized. An outline of some recent debugging and migration work is followed by a list of remaining migration issues identified but not yet fully resolved and which need to be explored further if the migrated DIINS systems are to be deployed in operational environments. Finally, some real-time lab trial results of the new platforms are presented to show that the systems are both running fairly well and executing the core DIINS input/output and Kalman filtering algorithms correctly.

Bird, J.S., 2001. "Migration of DIINS to PowerPC/VxWorks and Intel/Win32," DREO TM 2001-046, Defence Research Establishment Ottawa.

Sommaire

Ce rapport fait état des résultats des travaux nécessaires à la migration du logiciel DIINS (Dual Inertial Integrated Navigation System) de son ancienne plate-forme, c'est-à-dire un système hôte Sparc tournant sous Unix et un système cible Motorola 68030 VME doté d'un compilateur et d'un programme d'exécution run-time Ada83 de Telesoft, à un nouvel environnement de développement Ada95 NT de Green Hills et deux nouvelles plates-formes run-time, soit un système cible PowerPC604 VME tournant sous VxWorks 5.4 et un micro-ordinateur générique tournant sous Windows NT 4.0. La migration n'est pas encore terminée, mais les deux nouvelles plates-formes run-time fonctionnent en général assez bien.

Au début, le DIINS avait été prévu pour les navires de classe Halifax de la Marine canadienne, à titre de sous-système de leur nouveau système électronique de visualisation des cartes marines SHINNADS (Shipboard Integrated Navigation and Display). Dernièrement, il est devenu évident que le DIINS peut être utilisé dans d'autres applications, notamment celles des forces de la marine étrangères. Par conséquent, nous avons décidé d'installer le logiciel sur un appareil plus courant et dont le soutien est plus facile à assurer, notamment le PC à usages multiples. Ce document résume les travaux que nous avons réalisés dans cette optique. Nous espérons qu'il servira de document de référence pour tout projet ultérieur de développement du DIINS et tout projet visant à l'adapter à d'autres classes de navires.

Le document contient d'abord une brève mise en contexte du projet du DIINS et les résultats du premier contrat de migration. Vient ensuite un aperçu de la nouvelle configuration et des nouvelles méthodes d'administration du système. Le document fournit ensuite des instructions permettant d'exécuter le DIINS sur les nouvelles plates-formes PC et VME, et donne la procédure à suivre pour reconstruire la source. Le document présente ensuite des données générales sur des travaux de débogage et de migration réalisés récemment, suivies d'une liste des problèmes de migration qui ont été répertoriés mais qui ne sont pas encore entièrement réglés. Ces problèmes devront être examinés plus attentivement si on décide de déployer les systèmes DIINS en milieu opérationnel. Enfin, on présente les résultats de certains tests en laboratoire réalisés en temps réel sur les nouvelles plates-formes pour démontrer que les deux systèmes fonctionnent assez bien et qu'ils exécutent correctement les algorithmes centraux d'entrée et de sortie du DIINS et les algorithmes de filtrage Kalman.

Bird, J.S., 2001. Migration du DIINS à PowerPC/VxWorks et à Intel/Win32, DREO TM 2001-046, Centre de Recherches pour la Défense, Ottawa.

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1. DIINS Migration Background

1.1 Introduction

This report documents the work that was required to migrate the DIINS (Dual Inertial Integrated Navigation System) software from its former platform, consisting of a unix-based Sparc host system and Motorola 68030 VME target system under a Telesoft Ada83 compiler and run time executive, to two new run-time platforms:

- a PowerPC604 VME target system running VxWorks 5.4; and
- a generic personal computer running Windows NT 4.0.

For both platforms, the host development system is a Windows NT 4.0 PC running the Green Hills Ada95 AdaMulti development environment, with both a native compiler for the Windows run-time platform and a PowerPC cross complier for the VME PowerPC runtime platform.

The migration is not entirely complete, though both new run-time platforms are running satisfactorily to a great extent. This document records the status of the migration, presents some results of the systems in real-time laboratory trials, and identifies issues that need to be explored more fully if the migrated DIINS systems are to be deployed in operational environments.

1.2 Structure of this Document

First a brief background of the DIINS project and the initial migration contract results are presented in the remainder of Section 1.

An outline of system configuration and administration is in Section 2.

Instructions for running DIINS on the new PC and VME platforms are included in Section 3. This document does not explain the details of the DIINS configuration files (simsetup.cfg) or Kalman filter parameter files. It is assumed the reader is familiar with those.

Procedures for rebuilding the source is at Section 4. Source code version reconciliation is briefly discussed in Section 5. Section 6 summarizes the debugging and migration work by DREO after the initial migration contract was complete. During this phase, a number of issues were identified, but have not yet been fully resolved. These are summarized in Section 7. Section 8 reviews some real-time lab trial results of the new platforms.

1.3 DIINS Background

The following text is taken from [1] and describes the overall DIINS system.

"The Defence Research Establishment Ottawa has been developing a highly fault-tolerant, integrated navigation system for the Canadian Navy's dual-INS equipped ships for a number of years. The system, called DIINS (Dual Inertial Integrated Navigation System), has undergone extensive sea trials and is now being prepared for fitting on the vessels. Externally, DIINS provides best estimates of ownship navigation data for an ECDIS (Electronic Chart and Display Information System) on the bridge, and for the ship's command and control system. Internally DIINS implements multiple, cooperating Kalman filters to enable the application of sensitive Failure Detection, Isolation and Reconfiguration (FDIR) techniques and to provide high system reliability and navigation accuracy. The sensors being integrated include two inertial navigation systems (INS's), GPS (PPS, SPS and/or differential), speed log, and Loran-C. The application of multiple parallel filters and precise statistical error tests to redundant inertial navigation systems has been very limited until the most recent generations of microprocessors. Such a system is significant in that the design has been optimized for automatic failure detection and reconfiguration and to provide navigation information in decreasing but known accuracy as sensors fail; thus the operator can always be confident that the best remaining sensors are being used to navigate. Such a complex and comprehensive integrated navigation system is quite unique among the world's navies."

Further references on the design, implementation, and results of the original DIINS system include [2] through [8].

1.4 Initial DIINS Migration

Late in fiscal year 99/00, DREO obtained year-end contract funds to complete the DINS Advanced Development Model and to begin the "Evolved DIINS." With these funds, two contracts were initiated with Prior Data Sciences (now called "xwave solutions") to commence the migration. These contracts were:

W7714-9-0291 "DIINS Migration and Enhancements"

W7714-9-0322 "DIINS Input-Output Redesign"

The total value of these two contracts was approximately $140,000. With these funds Prior Data Sciences procured the new hardware and software environments, which included:

Two Motorola PowerPC604 VME Single Board Computers ($17,000);

WindRiver Tornado VxWorks run-time operating system for PowerPC ($37,500);

Two licences for Green Hills Ada95 (each with native win32 and PPC cross compilers) ($43,000).

The remaining contract funds were for labour. In addition to these resources, DREO provided the following:

Two personal computers for software development – a desktop machine called "SNOW" and a notebook called "NTNAVNOTE1";

Two new VME serial I/O cards from SBS GreenSpring and associated third party VxWorks driver software from Compware Systems; and

The original DIINS ADM software Version 3.3 written for the Telesoft Ada83 system on the old 68030 processor and Force serial I/O VME cards, hosted on the unix-based Sparc systems.

Prior made the initial modifications to previous version of the DIINS source code software that was developed under the old development environment in order to compile it under the new Green Hills Ada95 compiler. Fortunately, due to the substantial universality of Ada, relatively minor modifications were required for the non-hardware specific routines, including all the navigation, Kalman filtering and failure detection routines.

More substantial modifications were required for the input-output subsystem. These were essentially entirely re-written since the old serial I/O card from Force Computer system was no longer available. New I/O functionality had to be created for both platforms, and since the I/O of the VME system and the PC system is significantly different, the resulting DIINS I/O routines are quite different as well. This has resulted in two slightly different versions of the DIINS source code and will be explained in more detail later.

Because of the tight time constraints of the contracts, the work was extremely rushed, but still was very successful. In relatively short order, the source code was recompiled for both new platforms, new device driver I/O routines were written and the VxWorks environment for the VME PowerPC system was constructed and made functional. At the time of contract delivery, both platforms were able to read data from the navigation sensors (through their new I/O facilities), process the data through the DIINS internal Kalman filters exactly as the former ADM system did, and provide the results to the navigation electronic chart system. However it was evident that there were numerous issues that needed attention in order to bring the systems to acceptable levels of functionality. However, since the contract funds had been exhausted and new funding was not imminent, DREO carried on the migration and has succeeded in bringing the new systems to a reasonable level of functionality.

2. The New DIINS Platforms – Configuration and Adminstration

2.1 The Intel/Win32 Platform

The native Ada compiler purchased with the Green Hills Ada95 compiler allowed the build of the DIINS source code to run under Windows NT4.0 on a standard PC. In order for this computer to read the sensor serial data, a multi-port serial port expansion card was required. The following table details the specific PC used for this configuration:

Table 1. *Configuration of PC used for Intel/win32 DIINS*

FEATURE	DETAIL
Computer Type	Generic Desktop PC
Host name	"snow"
IP Address	131.136.36.20
Workgroup	"DIINS"
Development Account	"diins"
DREO Asset No.	21984
Processor	Pentium III 450 Mhz
RAM	128 MB
Hard Disk	8GB
O.S.	Windows NT 4.0, SP6a
Multiport Serial Card	Rocketport PCI 8 (Model 95760-7), with RS232/422 Surge Interface Box (Model 970507) providing 8 additional DB25 male serial ports (Com3-Com10)

A photograph of this equipment is shown in Figure 1, and close-up of the RS-232/422 interface for the RocketPort 8 port serial port expansion card is shown in Figure 2.

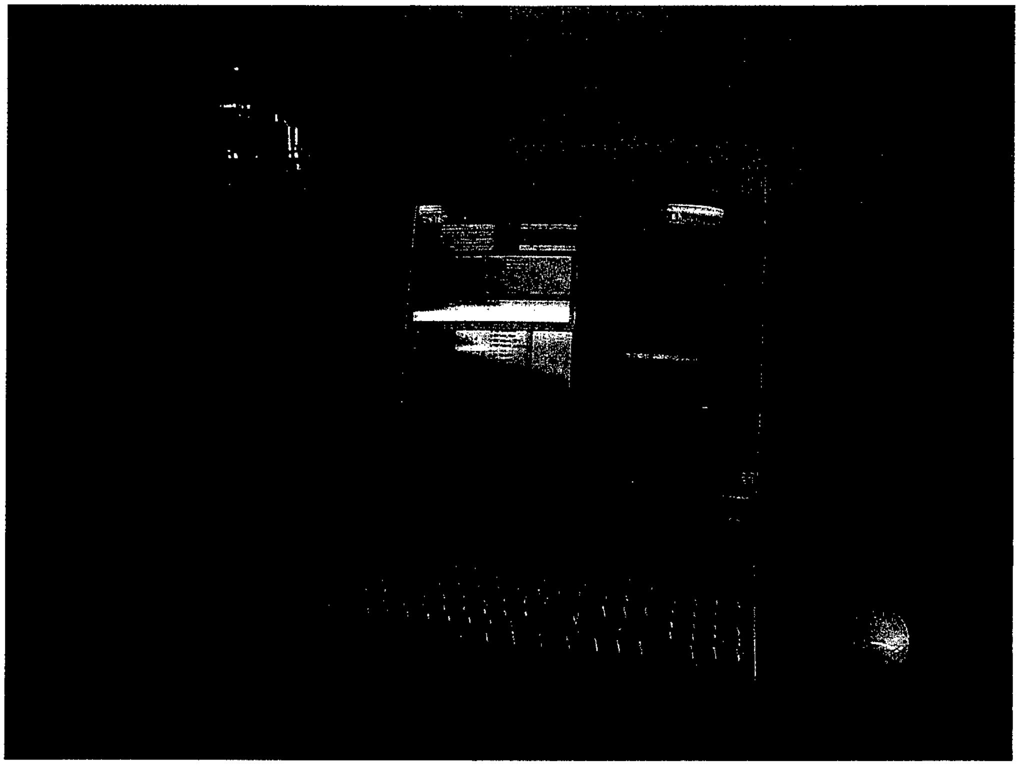

Figure 1. *The PC-based DIINS system*

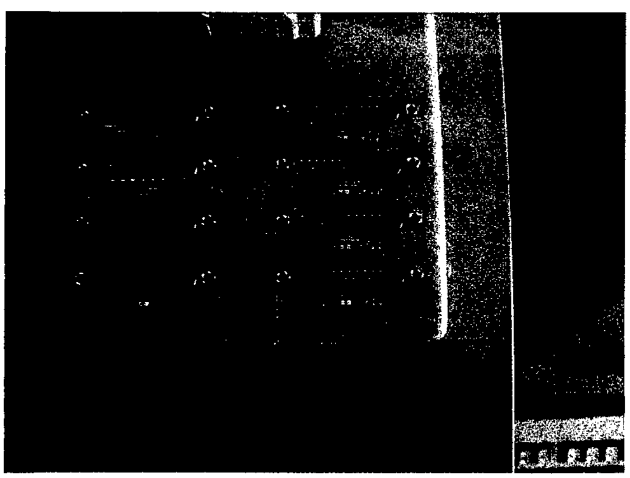

Figure 2. *The RocketPort Serial Interface box for the PC version of DIINS*

2.2 The PowerPC/VxWorks Platform.

There are two components to this platform: the host development PC and the run-time VME target computer.

The host development PC is a notebook computer called "ntnavnote1". A notebook was chosen to provide more flexibility for the deployment, debugging and data logging requirements of the VME target system. The host system holds the source code and the cross compiler which creates the downloadable code for the target VME computer. At present the compiled code is transferred to the target system at run-time via an Ethernet connection. In addition the VxWorks operating system is loaded from the notebook via the Ethernet link when the VME system is powered up. In the future, both VxWorks and the DIINS run-time code will be held in the flash ROM on the VME card. The configuration of the PC used as the host development system is:

Table 2. *Configuration of Notebook used as host for VME PowerPC/VxWorks System*

FEATURE	DETAIL
Computer Type	Eurocom Notebook PC, Model 2100C
Host name	"ntnavnote1"
IP Address	131.136.36.21
Workgroup	"DIINS"
Development Account	"diins"
DREO Asset No.	21696
Processor	Celeron 400 Mhz
RAM	128 MB
Hard Disk	6GB
O.S.	Windows NT 4.0, SP6a

A photograph of this computer is shown in Figure 3.

Figure 3. *The VME-based DIINS system and host development notebook PC*

The second component of this platform is the VME target system. This is also shown in the photograph in Figure 3, and the details of the cards used in this chassis are as follows:

Table 3. *Configuration of VME PowerPC/VxWorks Target System*

FEATURE	DETAIL
Processor Board	Motorola MVME2604-4341 (with MVME712 A/B Transition module)
Host name	"harpo"
IP Address	131.136.36.22
Processor	PowerPC604, 333MHz
RAM	64 MB

Flash ROM	9 MB (1MB socketed and 8MB soldered)
Transition Module	MVME712A/B with AUI Ethernet, SCSI and serial console port connections.
Serial Card	SBS GreenSpring four slot 6U VME Carrier card (model VIPC616), loaded with four IP-MP-Serial IndustryPacks, each with 2 high-speed EIA-232/422/485 serial ports (for a total of 8 ports). Front panel ribbon connectors and cables attach to eight DB25 male connectors (ports 1-8)

2.2.1 Configuring a new MVME2604 Board with VxWorks boot kernel

The VME processor boards must be configured to work with the VxWorks operating system and the host development PC. See Annex A for an outline of what was done for the board used in the DREO laboratory. More details are found in the product documentation, references [9], [10], [11], and [12]. The procedures in the Annex need only be done once for each new card or after a network configuration change. The results are stored in non-volatile RAM on the processor card. Note that these procedures are intended to simply flash the processor board ROM with a VxWorks boot kernel, which will load the rest of VxWorks from the host PC at power-up over the Ethernet connection, and which in turn will allow the download and execution of the DIINS program over the Ethernet connection. Procedures to flash the ROM with the full bootable VxWorks/DIINS executable have not yet been tested.

Whenever the VME system reboots, it requires a valid FTP server running on the PC that will accept a connection from a user name "diins" with password "diins99ppc". The program that is currently set up on the notebook PC that provides this service is called WFTP32 and automatically loads at start up (or can be started with a desktop shortcut). It will then let the VME download the rest of the VxWorks operating system (residing at a specified filename) over the Ethernet connection via ftp. The run-time VxWorks image can be re-built if necessary by using Tornado and opening, editing and rebuilding the corresponding workspace (presently D:\DIINS\DIINS.WSP).

After the VxWorks run-time image has loaded on the board, communication with it is provided through the Tornado target server facilities. Annex B outlines the procedures used to configure the Tornado target server for the VME board. The DIINS executables are loaded through this Tornado facility.

2.2.2 Configuring the SBS GreenSpring Serial I/O Board

All ports were set to RS-232 from the default RS-422. See Section 3.2.1 for an outline of what was done for the board used in the DREO laboratory.

2.3 Network Administration

All of the computers in this report have been networked together to enable easy file access and sharing. All machines are equipped with AUI or 10baseT ports and an 8 port 10baseT hub is used to connect them together. The machines all have 131.136.36.xx addresses and are all in the "DIINS" workgroup under Microsoft Windows networking. The following table summarizes the IP addresses used. Note that all the Windows PC's have these addresses entered into the "hosts" file (at \WINNT\SYSTEM32\DRIVERS\ETC\HOSTS) since DNS (Domain Name Services) are not available on this network.

Table 4. *IP Addresses used in the "DIINS" Workgroup*

COMPUTER	IP ADDRESS
"snow" (main desktop PC, Asset 21984)	131.136.36.20
"ntnavnote1" (notebook PC, Asset 21696)	131.136.36.21
"harpo" (first MVME2604 PowerPC card)	131.136.36.22
"groucho" (second MVME2604 PowerPC card)	131.136.36.23
"sleet" (supporting PC, Asset 20918)	131.136.36.24
"hail" (supporting PC, Asset 19488)	131.136.36.25

3. Running DIINS

This section outlines the procedures needed to run DIINS as it currently stands on both the PC and the VME platforms. Note that this document may refer to the PC version as the Intel or win32 version interchangeably. Equivalently, it may refer to the VME version as the VxWorks, PowerPC or PPC version.

3.1 DIINS Execution – PC Version

The PC version is simpler to run so it is described first.

3.1.1 Connecting the sensors to the PC

The PC COM port numbers for each sensor are defined in the SIMSETUP.CFG file used for each DIINS run. By default this file (located in d:\diins\cfg\realtime\win32) has the sensor-port configuration shown in Table 5.

Table 5. *Default Com port sensor connections – PC version*

PC COM PORT	ROCKETPORT PORT NO.	SENSOR
1	-	(Spare)
2	-	(Spare)
3	1	GPS1
4	2	GPS2
5	3	Output to Display
6	4	HCI Control Interface
7	5	Loran
8	6	(Spare)
9	7	INS1
10	8	INS2

The physical locations of ports 3-10 are on the RS-232/422 interface box attached to the RocketPort multiport serial card. This card and interface box has both RS-232 and RS-422 capabilities selected by a switch on each port. At present they are all selected as RS-232. Some of the sensors in the lab have RS-422 output. These are run through RS-422 to RS-232 converters and connected to the Rocketport interface. In the end-use system it will be more practical to connect the RS-422 sensors directly to the interface box and select the RS-422 switch position. This has not yet been tested. The pinout of the DB25 RocketPort interface connections when in RS-422 node is given in [16] and repeated in Table 6.

Table 6. *Pinout of DB25 Connector of RocketPort Interface in RS-422 mode*

PIN	SIGNAL
7	Signal Ground
15	RXD+
17	RXD-
19	TXD+
25	TXD-

3.1.2 Program Execution - PC

To run DIINS, there is only one step needed. Simply run the DIINS executable from a windows command prompt. The default location of this executable is:

D:\diins\mainwin32\diins.exe

Note. Experiments with running DIINS as a high priority or real-time task have been conducted. This may be necessary if the PC may be performing other tasks at the same time as running DIINS. This can be done with the Windows NT priority options in the "start" command from a command prompt:

start /high d:\diins\Mainwin32\diins.exe

start /realtime d:\diins\Mainwin32\diins.exe

There are shortcut icons on the Windows desktop that accomplish this.

DIINS will prompt for the location of the configuration file name. The user may simply hit Enter to accept the default or may type a new path and file name.

To stop and restart DIINS execution, simply hit "`ctrl-c`" and restart as above.

3.1.3 Data Logging – PC Version

Data logging on the PC, while functional, is not intuitive to set up. This is a consequence of the various DIINS configurations over the years and different sea trial requirements. However the following procedure will work:

Do not use the HCI to set up a logging run, but rather use a simsetup.cfg file that is similar to the one shown here in Table 7. The important parameters are in bold, namely BIG_FILE LOCAL_DISK in line 2, and the lines at the bottom of the file that specify that all the filter data should go in files in the D:\DIINS\RESULTS directory. Not that the data will all go to one big file named D:\DIINS\RESULTS\Styyyy_ddd-hhmm.DAT (unfortunately the path is hard-coded and is not related to the names of the files at the end of the simsetup.cfg file).

Some of the data extraction tools that were used on the old Sparc system have been ported to the PC to extract the data from this file, notably "extract_data", "extract_pure_sensor_data", "bin2ascii" and "ascii2bin". Annex F demonstrates the use of these programs. The port of the sensor extraction utilities was complicated by the big endian / little endian issue (different internal byte storage order for numeric variables in Intel vs. Motorola processors). See the file "Standard.h" in D:\DiinsUtils\Extract_data for details.

Table 7. *Sample simsetup.cfg file for PC data logging (7 filters)*

```
REALTIME
BIG_FILE LOCAL_DISK
SPERRY_MK29_INS1 INSTALLED          1.28        9   BAUD_9600 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE    RS_232
0.00         0.00       0.0   METRES
SPERRY_MK49_INS1 UNINSTALLED        1.28        0
LITTON_LTN90_INS1UNINSTALLED        1.00        0
SIM_SD_INS1        UNINSTALLED      1.00        0
SIM_GIM_INS1       UNINSTALLED      1.00        0
SPERRY_MK29_INS2 INSTALLED          1.28        10  BAUD_9600 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE    RS_232
0.0          0.00       0.0   METRES
SPERRY_MK49_INS2 UNINSTALLED        1.28        0
LITTON_LTN90_INS2UNINSTALLED        1.00        0
SIM_SD_INS2        UNINSTALLED      1.00        0
SIM_GIM_INS2       UNINSTALLED      1.00        0
ASHTECH_XII_GPS    UNINSTALLED      1.00        0
TRIMBLE_TANS_PY_TIPY_GPS1 UNINSTALLED       1.00        0
NMEA_GPS1          INSTALLED        1.00        3   BAUD_4800 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE RS_232
USEMYCLOCK     PPS  0.0        0.0      0.0   METRES
UOFC_DGPS1         UNINSTALLED      1.00        0
SIM_GPS1 UNINSTALLED        1.00        0
TRIMBLE_TANS_PY_TIPY_GPS2 UNINSTALLED       1.00        0
NMEA_GPS2          INSTALLED        1.00        4   BAUD_4800 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE RS_232
DontUseMyClock     DGPS     0.0         0.0      0.0  METRES
UOFC_DGPS2         UNINSTALLED      1.00        0
```

```
TRIMBLE_VECTOR_GPS          UNINSTALLED         1.00            0
SIM_GPS2 UNINSTALLED          1.00          0
INTERNAV_LC360_LORAN        INSTALLED            1.00            7    BAUD_2400 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE
          RS_232      0.0          0.0       0.0    METRES
SIM_LORAN         UNINSTALLED         10.00          0
SIM_SPEED_LOG     UNINSTALLED          1.00          0
PREFILTER_TASK       1.28           0
FDI_TASK    1.28          0
ASF_TASK 300.00          0
OSL_TASK    0.00          5    BAUD_19200 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE RS_232
HCI_TASK    0.00          6    BAUD_9600 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE RS_232
    7
200000.00
d:\diins\cfg\realtime\s12.cfg
d:\diins\cfg\realtime\s1n1n2.cfg
d:\diins\cfg\realtime\s2n1n2.cfg
d:\diins\cfg\realtime\s1n1.cfg
d:\diins\cfg\realtime\s2n1.cfg
d:\diins\cfg\realtime\s1n2.cfg
d:\diins\cfg\realtime\s2n2.cfg
d:\diins\cfg\realtime\slog.dat
d:\diins\cfg\realtime\slograte.dat
d:\diins\cfg\realtime\finimeas.dat
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
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temp.bin
d:\diins\cfg\realtime\fopval.dat
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d:\diins\cfg\realtime\fopval.dat
d:\diins\results\Disp_LT2001_1.bRes d:\diins\results\State_LT2001_1.bRes d:\diins\results\Res_LT2001_1.bRes
d:\diins\results\Disp_LT2001_2.bRes d:\diins\results\State_LT2001_2.bRes d:\diins\results\Res_LT2001_2.bRes
d:\diins\results\Disp_LT2001_3.bRes d:\diins\results\State_LT2001_3.bRes d:\diins\results\Res_LT2001_3.bRes
d:\diins\results\Disp_LT2001_4.bRes d:\diins\results\State_LT2001_4.bRes d:\diins\results\Res_LT2001_4.bRes
d:\diins\results\Disp_LT2001_5.bRes d:\diins\results\State_LT2001_5.bRes d:\diins\results\Res_LT2001_5.bRes
d:\diins\results\Disp_LT2001_6.bRes d:\diins\results\State_LT2001_6.bRes d:\diins\results\Res_LT2001_6.bRes
d:\diins\results\Disp_LT2001_7.bRes d:\diins\results\State_LT2001_7.bRes d:\diins\results\Res_LT2001_7.bRes
d:\diins\results\Setup_LT2001_1.cfg
d:\diins\results\Setup_LT2001_2.cfg
d:\diins\results\Setup_LT2001_3.cfg
d:\diins\results\Setup_LT2001_4.cfg
d:\diins\results\Setup_LT2001_5.cfg
d:\diins\results\Setup_LT2001_6.cfg
d:\diins\results\Setup_LT2001_7.cfg
d:\diins\results\FDI-LT2001.log
```

To conduct a run with no data logging, use a setup file similar to the following as shown in Table 8. Note that line 2 now has NONE specified for data logging and that the filenames at the bottom have all been replaced by the special string "NUL".

Table 8. *Sample simsetup.cfg file for **no** data logging (7 filters)*

```
REALTIME
BIG_FILE       NONE
SPERRY_MK29_INS1        INSTALLED        1.28        9 BAUD_9600 BITS_8 PARITY_NONE STOP_1
HANDSHAKE_NONE     RS_232 0.00     0.00    0.0 METRES
SPERRY_MK49_INS1        UNINSTALLED      1.28        0
LITTON_LTN90_INS1       UNINSTALLED      1.00        0
SIM_SD_INS1     UNINSTALLED      1.00        0
SIM_GIM_INS1    UNINSTALLED      1.00        0
SPERRY_MK29_INS2        INSTALLED        1.28        10 BAUD_9600 BITS_8 PARITY_NONE STOP_1
HANDSHAKE_NONE     RS_232 0.0      0.00    0.0 METRES
SPERRY_MK49_INS2        UNINSTALLED      1.28        0
LITTON_LTN90_INS2       UNINSTALLED      1.00        0
SIM_SD_INS2     UNINSTALLED      1.00        0
SIM_GIM_INS2    UNINSTALLED      1.00        0
ASHTECH_XII_GPS         UNINSTALLED      1.00        0
TRIMBLE_TANS_PY_TIPY_GPS1       UNINSTALLED      1.00        0
NMEA_GPS1       INSTALLED        1.00        3 BAUD_4800 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE
RS_232 USEMYCLOCK    PPS  0.0     0.0     0.0 METRES
UOFC_DGPS1      UNINSTALLED      1.00        0
SIM_GPS1        UNINSTALLED      1.00        0
TRIMBLE_TANS_PY_TIPY_GPS2       UNINSTALLED      1.00        0
NMEA_GPS2       INSTALLED        1.00        4 BAUD_4800 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE
RS_232 DontUseMyClock    DGPS     0.0     0.0     0.0 METRES
UOFC_DGPS2      UNINSTALLED      1.00        0
TRIMBLE_VECTOR_GPS      UNINSTALLED      1.00        0
SIM_GPS2        UNINSTALLED      1.00        0
INTERNAV_LC360_LORAN    INSTALLED        1.00        7 BAUD_2400 BITS_8 PARITY_NONE STOP_1
HANDSHAKE_NONE RS_232     0.0     0.0     0.0 METRES
SIM_LORAN       UNINSTALLED     10.00        0
SIM_SPEED_LOG   UNINSTALLED      1.00        0
PREFILTER_TASK    1.28      0
FDI_TASK          1.28      0
ASF_TASK        300.00      0
OSL_TASK          0.00      5  BAUD_19200 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE RS_232
HCI_TASK          0.00      6  BAUD_9600 BITS_8 PARITY_NONE STOP_1 HANDSHAKE_NONE RS_232
    7
200000.00
d:\diins\cfg\realtime\s12.cfg
d:\diins\cfg\realtime\s1n1n2.cfg
d:\diins\cfg\realtime\s2n1n2.cfg
d:\diins\cfg\realtime\s1n1.cfg
d:\diins\cfg\realtime\s2n1.cfg
d:\diins\cfg\realtime\s1n2.cfg
d:\diins\cfg\realtime\s2n2.cfg
d:\diins\cfg\realtime\slog.dat
d:\diins\cfg\realtime\slograte.dat
d:\diins\cfg\realtime\finimeas.dat
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
```

```
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp_a.bin temp_v.bin temp_p.bin
temp.bin
temp.bin
temp.bin
temp.bin
temp.bin
temp.bin
temp.bin
temp.bin
temp.bin
temp.bin
temp.stn temp.bin
temp.stn temp.bin
temp.bin
d:\diins\cfg\realtime\fopval.dat
d:\diins\cfg\realtime\fopval.dat
d:\diins\cfg\realtime\fopval.dat
d:\diins\cfg\realtime\fopval.dat
d:\diins\cfg\realtime\fopval.dat
d:\diins\cfg\realtime\fopval.dat
d:\diins\cfg\realtime\fopval.dat
NUL NUL NUL
NUL NUL NUL
NUL NUL NUL
NUL NUL NUL
NUL NUL NUL
NUL NUL NUL
NUL NUL NUL
NUL
NUL
NUL
NUL
NUL
NUL
NUL
NUL
```

3.2 DIINS Execution – VME Version

3.2.1 Connecting the sensors to the VME

The port numbers for each sensor are defined in the SIMSETUP.CFG file used for each DIINS run. By default this file (located in d:\diins\cfg\realtime\PPC) has the following sensor-port configuration shown in Table 9.

Table 9. *Default port sensor connections – VME version*

SERIAL PORT	SENSOR
1	INS1
2	INS2
3	GPS1
4	GPS2
5	Output to Display
6	HCI Control Interface
7*	LORAN
8*	(Spare)

* Ports 7 and 8 are non-functional at this time. See [15, p.8] for details

The physical locations of ports 1-8 on the SBS GreenSpring card are incorporated in four 50-pin connectors on the front of the card. Ribbon cables were constructed with 50 pin connectors on one end and dual DB25 male connectors on the other to allow connections to standard RS-232 cables (see Figure 3). The physical locations of each port on the card are as in Figure 4.

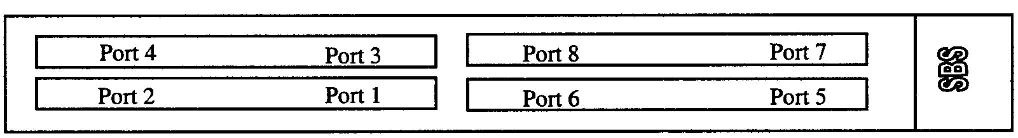

Figure 4. *Locations of serial ports on SBS GreenSpring serial card front panel*

The SBS GreenSpring serial card has both RS-232 and RS-422 capabilities, but changing from one to the other requires the removal the IndustryPack modules from the board and the removal of terminating resistors from the packs. Table 10 (from [14, page 2]) summarizes the two configurations. At present all ports on the card used in the lab are configured as RS-232. Some of the sensors in the lab have RS-422 output. These are run through RS-422 to RS-232 converters and then connected to the DB25 connectors attached to the serial card interface. In the end-use system it will be more practical to connect the RS-422 sensors directly to the card and select the RS-422 configuration on the corresponding IndustryPack ports. This has not yet been tested. The pinouts of the DB25 GreenSpring interface connections when in RS-422 mode are given in [14, p. 52] and repeated in Table 11.

Table 10. *SBS GreenSpring IndustryPack Resistor packs for RS232 or RS-422 operation*

SERIAL MODE	RESISTORS INSTALLED	RESISTORS REMOVED
RS-232	RP1 and RP2	RP3, RP4, and RP5
RS-422	RP3, RP4, and RP5	RP1 and RP2

Table 11. *Pinout of DB25 Connector of SBS GreenSpring VME Interface in RS-422 mode*

PIN	SIGNAL
7	Signal Ground
16	RXD+
3	RXD-
11	TXD+
14	TXD-

3.2.2 Program Execution – VME

At present, the DIINS executable is downloaded from the host development PC via the Tornado development environment.

- First, ensure the VME card and the host development notebook PC are connected via Ethernet.

- Ensure that the WFTP32 ftp server is running on the host PC

- Power on (or reset) the VME system

- Start Tornado on the host PC (there is a desktop icon).

- In Tornado select "Tools|Target Server|Harpo"

- In the dropdown box, select "HarpoServer@ntnavnote1"

- Click on the "->i" icon to start a new target shell

In the target shell window, at the -> prompt, type

```
< d:\diins\diins_setup_and_run.scr
```

(This script file mounts the required NFS shares, downloads the DIINS executable code from the PC to VME memory and runs it.)

DIINS runs as usual, prompting for a configuration file name in the console window.

Of particular note in the above script file, there is a command as follows:

nfsMount("ntnavnote1", "D:\DIINS", "D:\\DIINS")

This is important because in the DIINS source code and configuration files, there are several references to files in the "D:\DIINS" directories. This command mounts the D:\DIINS directory on ntnavnote1 (which has been shared by the NFS sharing utility "DiskShare") as a logical drive "D:\\DIINS". In previous version of the DIINS code, the logical share was called NFS_DIINS. This was renamed to D:\\DIINS to improve compatibility with the PC version of DIINS (which has direct access to its D:\DIINS directories).

To stop and restart program execution, the following procedure has been found to be the quickest and most reliable:

- Hit the reset ("RST") button on the processor card

- Wait 10-20 seconds for VxWorks to reboot

- Type something (anything) in the Tornado shell window

- Wait for the console window to re-open

- Then reload and restart DIINS by typing in the above command again in the Tornado shell (or using the shell's command line recall functions: <ESC> "k" "k").

3.2.3 Data Logging – VME Version

Data logging is not yet functional on the VME. It should be possible to use the NFS mounted D:\DIINS drive and log the data to the NFS disk as a LOCAL_DISK, but although it logs the first few seconds correctly, it soon detects a Device Error exception and terminates logging.

4. Compiling the DIINS Source Code

The procedure for compiling the DIINS source code is the same for either platform, there being only small differences in the build files. The compiler is called AdaMulti 1.8.9.b from Green Hills software and has been installed on both the desktop PC "snow" to compile primarily the native Intel/win32 version of DIINS, and on the notebook "ntnavnote1" to compile primarily the cross platform version to download and run on the PowerPC VME card under VxWorks. There are no limitations preventing a native compile on the notebook or a cross compile on the desktop, in fact both have been done. Full details on running the AdaMulti program are found in [17].

4.1 Compiling Natively to run on the PC

There is shortcut on the desktop PC called "DIINS_Win AdaMulti". Executing this will start the Green Hills AdaMulti compiler in the D:\DIINS\MAINWIN32 directory, which holds all the object and executable files for the native win32 version of DIINS. This shortcut has been customized to tell AdaMulti to begin with the "default.bld" file found in that directory.

Once AdaMulti has started, it will load the specified default.bld file. This file references three other files that hold the names of all the DIINS source code files. These files are

```
D:\diins\part1_win32.bld
D:\diins\part2_win32.bld
D:\diins\part3_win32.bld
```

To recompile DIINS, simply select "Build | Build All" from the AdaMulti Menu.

4.2 Cross-compiling to run on the MVME-2604 under VxWorks

There is shortcut on the notebook PC called "DIINS_PPC AdaMulti". Starting this will start the Green Hills AdaMulti compiler in the D:\DIINS\MAINPPC directory, which holds all the files for the PowerPC/VxWorks cross-compiled version of DIINS. This shortcut has been customized to tell AdaMulti to begin with the "default.bld" file found in that directory.

Once AdaMulti has started, it will load the specified default.bld file. This file references three other files that hold the names of all the DIINS source code files. These files are

```
D:\diins\part1_ppc.bld
D:\diins\part2_ppc.bld
D:\diins\part3_ppc.bld
```

To recompile DIINS, simply select "Build | Build All" from the AdaMulti Menu.

4.3 Variations in the Build files of the two versions

There are some difference in the two versions of the build files, due to the differences in the Intel PC/win32 and the PowerPC/VxWorks version. When the systems were first delivered from Prior Data after the initial migration, there were many differences mainly because different software team developers were working on each migration separately. The author took significant effort to reconcile the various versions of the source files and build files and to reduce the difference in the two versions to a minimum. Table 12 through Table 15 below show the contents of the different versions of the build files and highlight the differences.

Any files that are different either have a "win32" or "PPC" in their filenames, or they are in ..\win32\.. or ..\PPC\.. subdirectories.

In future development, care should be taken to try to keep the two versions as similar as possible. This will allow a common framework for both the PC and VME versions.

***Table 12.** Contents of default.bld files*

INTEL/WIN32 VERSION `\DIINS\MAINWIN32\DEFAULT.BLD`	**VME PPC/VXWORKS VERSION** `\DIINS\MAINPPC\DEFAULT.BLD`	**COMMENTS**
#!build default: program :check=nobounds :check=noassignbound :check=nonilderef :check=noswitch :check=nozerodivide :check=nousevariable :check=novariant :check=nowatchpoint :check=noreturn :dependency=nodepend :memcheck=none ***:target=win32***	#!build default: program :language=c :language=ada :optimize=nostandard :optimize=nomemory :optimize=noalgorithmic :optimize=nosmall :optimize=novector :optimize=noinline :optimize=noloop :optimize=noexpression :minoroptimize=nopeep :minoroptimize=nocse :minoroptimize=noconstprop :minoroptimize=nounroll :minoroptimize=nominmax :minoroptimize=nopipeline :minoroptimize=nostrcpy :minoroptimize=notailrecursion :minoroptimize=nounroll8 :minoroptimize=nounrollbig :minoroptimize=noautoregister :minoroptimize=nooverload :check=nobounds :check=noassignbound :check=nonilderef :check=noswitch :check=nozerodivide :check=nousevariable :check=novariant :check=nowatchpoint	Most of these are minor differences created automatically by the AdaMulti environment when different targets are selected. The main differences of note are the target OS and processor (in bold)

:temp_dir=D:\TMP ***:outputname=diins.exe*** :ada_main_program=taskmaster ***:adalibdirs=epath=d:\green\win32_ada bindings***	:check=noreturn :dependency=nodepend ***:target_os=vxworks*** ***:processor=ppc*** ***:ppc_cputype=ppc604*** :ada_listing=always :ada_list_format=continuous :debuglevel=multi :temp_dir=D:\TMP ***:outputname=TaskMaster*** :ada_main_program=TaskMaster ***:remote=tornserv HarpoServer@ntnavnote1***	
D:\Green\win32ada.lib library	D:\GREEN\vx_adabindings\ghs_vx_types.ads Ada D:\GREEN\vx_adabindings\vx_io.ads Ada D:\GREEN\vx_adabindings\vx_sigevent.ads Ada D:\GREEN\vx_adabindings\vx_time.ads Ada	Platform specific components required by the compiler
D:\diins\part1_win32.bld subproject ***D:\diins\part2_win32.bld*** subproject ***D:\diins\part3_win32.bld*** subproject	***D:\diins\part1_ppc.bld*** subproject ***D:\diins\part2_ppc.bld*** subproject ***D:\diins\part3_ppc.bld*** subproject	Subproject files (See next 3 tables)

Table 13. Contents of PART1 Build Files

INTEL/WIN32 VERSION \DIINS\PART1_WIN32.BLD	VME PPC/VXWORKS VERSION \DIINS\PART1_PPC.BLD	COMMENTS
#!build	#!build	
default:	default:	
subproject	subproject	
:debuglevel=multi	:debuglevel=multi	
D:\diins\UTILITIES\System_Error.spc	D:\diins\UTILITIES\System_Error.spc	
Ada	Ada	
D:\diins\UTILITIES\System_Error.ada	D:\diins\UTILITIES\System_Error.ada	
Ada	Ada	
D:\diins\UTILITIES\Standard.spc	D:\diins\UTILITIES\Standard.spc	
Ada	Ada	
D:\diins\UTILITIES\Standard_Win32.ada	**D:\diins\UTILITIES\Standard_PPC.ada**	←- Little Endian / Big Endian
Ada	Ada	
D:\diins\UTILITIES\Standard_Math.spc	D:\diins\UTILITIES\Standard_Math.spc	
Ada	Ada	
D:\diins\UTILITIES\StandardIO.spc	D:\diins\UTILITIES\StandardIO.spc	
Ada	Ada	
D:\diins\UTILITIES\StandardIO.ada	D:\diins\UTILITIES\StandardIO.ada	
Ada	Ada	
D:\diins\UTILITIES\BinaryStandardIO.spc	D:\diins\UTILITIES\BinaryStandardIO.spc	
Ada	Ada	
D:\diins\UTILITIES\BinaryStreamIO.spc	D:\diins\UTILITIES\BinaryStreamIO.spc	
Ada	Ada	
D:\diins\UTILITIES\BinaryStreamIO.ada	D:\diins\UTILITIES\BinaryStreamIO.ada	
Ada	Ada	
D:\diins\UTILITIES\String.spc	D:\diins\UTILITIES\String.spc	
Ada	Ada	
D:\diins\UTILITIES\String.ada	D:\diins\UTILITIES\String.ada	
Ada	Ada	
D:\diins\UTILITIES\Scientific.spc	D:\diins\UTILITIES\Scientific.spc	
Ada	Ada	
D:\diins\UTILITIES\Scientific.ada	D:\diins\UTILITIES\Scientific.ada	
Ada	Ada	
D:\diins\UTILITIES\FileUtilities.spc	D:\diins\UTILITIES\FileUtilities.spc	
Ada	Ada	
D:\diins\UTILITIES\FileUtilities.ada	D:\diins\UTILITIES\FileUtilities.ada	
Ada	Ada	
D:\diins\UTILITIES\Conversion.ada	D:\diins\UTILITIES\Conversion.ada	

Ada	Ada	
D:\diins\LIBRARY\MathUtilities.spc	D:\diins\LIBRARY\MathUtilities.spc	
Ada	Ada	
D:\diins\LIBRARY\MathUtilities.ada	D:\diins\LIBRARY\MathUtilities.ada	
Ada	Ada	
D:\diins\LIBRARY\MathUtilities.SparseMxMult.ada	D:\diins\LIBRARY\MathUtilities.SparseMxMult.ada	
Ada	Ada	
D:\diins\LIBRARY\MathLibraryExtension.spc	D:\diins\LIBRARY\MathLibraryExtension.spc	
Ada	Ada	
D:\diins\LIBRARY\MathLibraryExtension.ada	D:\diins\LIBRARY\MathLibraryExtension.ada	
Ada	Ada	
D:\diins\UTILITIES\REALTIME\TimeUtilities.spc	D:\diins\UTILITIES\REALTIME\TimeUtilities.spc	
Ada	Ada	
D:\diins\UTILITIES\REALTIME\TimeUtilities_Win32.ada	***D:\diins\UTILITIES\REALTIME\TimeUtilities_PPC.ada***	←- Different Realtime hardware clock functions
Ada	Ada	
D:\diins\LIBRARY\Assign.ada	D:\diins\LIBRARY\Assign.ada	
Ada	Ada	
D:\diins\LIBRARY\MakeDCM.ada	D:\diins\LIBRARY\MakeDCM.ada	
Ada	Ada	
D:\diins\LIBRARY\LeverArmCorrections.ada	D:\diins\LIBRARY\LeverArmCorrections.ada	
Ada	Ada	
D:\diins\LIBRARY\GeodeticLibrary.ada	D:\diins\LIBRARY\GeodeticLibrary.ada	
Ada	Ada	
D:\diins\LIBRARY\NavCorrect.spc	D:\diins\LIBRARY\NavCorrect.spc	
Ada	Ada	
D:\diins\LIBRARY\NavCorrect.ada	D:\diins\LIBRARY\NavCorrect.ada	
Ada	Ada	
D:\diins\LIBRARY\ChiSquaredFailureDetection.ada	D:\diins\LIBRARY\ChiSquaredFailureDetection.ada	
Ada	Ada	
D:\diins\LIBRARY\KalmanLibrary.spc	D:\diins\LIBRARY\KalmanLibrary.spc	
Ada	Ada	
D:\diins\LIBRARY\KalmanLibrary.ada	D:\diins\LIBRARY\KalmanLibrary.ada	
Ada	Ada	
D:\diins\LIBRARY\PropagateTheStateVector.ada	D:\diins\LIBRARY\PropagateTheStateVector.ada	
Ada	Ada	
D:\diins\LIBRARY\PropagateTheP_Mx.ada	D:\diins\LIBRARY\PropagateTheP_Mx.ada	
Ada	Ada	
D:\diins\LIBRARY\DeFactor.ada	D:\diins\LIBRARY\DeFactor.ada	
Ada	Ada	
D:\diins\LIBRARY\F_ToPhi.ada	D:\diins\LIBRARY\F_ToPhi.ada	
Ada	Ada	
D:\diins\LIBRARY\PhiMxUD_MxMult.ada	D:\diins\LIBRARY\PhiMxUD_MxMult.ada	
Ada	Ada	
D:\diins\LIBRARY\PropagatePhi.ada	D:\diins\LIBRARY\PropagatePhi.ada	
Ada	Ada	

D:\diins\LIBRARY\Update.ada Ada D:\diins\LIBRARY\UD_Factor.ada Ada D:\diins\LIBRARY\LinearSolverLibrary.spc Ada D:\diins\LIBRARY\LinearSolverLibrary.ada Ada D:\diins\LIBRARY\LinearSolverLibrary.BackSolver.ada Ada D:\diins\LIBRARY\LinearSolverLibrary.CholeskiDecomp.a da Ada D:\diins\LIBRARY\LinearSolverLibrary.ComputeApproxCon dNum.ada Ada D:\diins\LIBRARY\LinearSolverLibrary.ComputeNormMxInv .ada Ada D:\diins\LIBRARY\LeastSquares.ada Ada	D:\diins\LIBRARY\Update.ada Ada D:\diins\LIBRARY\UD_Factor.ada Ada D:\diins\LIBRARY\LinearSolverLibrary.spc Ada D:\diins\LIBRARY\LinearSolverLibrary.ada Ada D:\diins\LIBRARY\LinearSolverLibrary.BackSolver.ada Ada D:\diins\LIBRARY\LinearSolverLibrary.CholeskiDecomp.a da Ada D:\diins\LIBRARY\LinearSolverLibrary.ComputeApproxCon dNum.ada Ada D:\diins\LIBRARY\LinearSolverLibrary.ComputeNormMxInv .ada Ada D:\diins\LIBRARY\LeastSquares.ada Ada	

Table 14. *Contents of PART2 Build Files*

INTEL/WIN32 VERSION \DIINS\PART2_WIN32.BLD	VME PPC/VXWORKS VERSION \DIINS\PART2_PPC.BLD	COMMENTS
#!build default: subproject :debuglevel=multi	#!build default: subproject :debuglevel=multi	
D:\diins\DDT\REALTIME\Adalan-stub.spc Ada	D:\diins\DDT\REALTIME\Adalan-stub.spc Ada	
D:\diins\DDT\REALTIME\Display.spc Ada	D:\diins\DDT\REALTIME\Display.spc Ada	
D:\diins\DDT\REALTIME\DisplayDataTask.spc Ada	D:\diins\DDT\REALTIME\DisplayDataTask.spc Ada	
D:\diins\SYSTEM\REALTIME\ATEX_Mailbox_Manager.spc Ada	D:\diins\SYSTEM\REALTIME\ATEX_Mailbox_Manager.spc Ada	
D:\diins\SYSTEM\REALTIME\ATEX_Mailbox_Manager.ada Ada	D:\diins\SYSTEM\REALTIME\ATEX_Mailbox_Manager.ada Ada	
D:\diins\DLT\CollectData.ada Ada	D:\diins\DLT\CollectData.ada Ada	
D:\diins\DLT\DataLogger.spc Ada	D:\diins\DLT\DataLogger.spc Ada	
D:\diins\SYSTEM\RawSensors.spc Ada	D:\diins\SYSTEM\RawSensors.spc Ada	
D:\diins\SYSTEM\LoranStationData.ada Ada	D:\diins\SYSTEM\LoranStationData.ada Ada	
D:\diins\SYSTEM\SimTypes.spc Ada	D:\diins\SYSTEM\SimTypes.spc Ada	
D:\diins\SYSTEM\MeasGlobal.spc Ada	D:\diins\SYSTEM\MeasGlobal.spc Ada	
D:\diins\SYSTEM\SimConfig_Win32.spc Ada	***D:\diins\SYSTEM\SimConfig_PPC.spc*** Ada	←- Different default CFG file
D:\diins\LIBRARY\LoranPositions.ada Ada	D:\diins\LIBRARY\LoranPositions.ada Ada	
	D:\diins\DCT\REALTIME\SERIAL\PPC\vxWorks_IPMPSerial_Driver_Interface.spc Ada ***D:\diins\DCT\REALTIME\SERIAL\PPC\vxWorks_IPMPSerial_Driver***	← Third party (Compware) drivers for SBS GreenSpring card

D:\diins\DCT\REALTIME\SERIAL\win32\ISIO_Definitions.spc Ada ***D:\diins\DCT\REALTIME\SERIAL\win32\ISIO_Definitions.ada*** Ada D:\diins\SYSTEM\Install.spc Ada D:\diins\SYSTEM\Simconfig.ada Ada D:\diins\SYSTEM\ReadDataRates.ada Ada D:\diins\SYSTEM\WriteSimConfig.ada Ada D:\diins\SYSTEM\WriteDataRates.ada Ada D:\diins\SYSTEM\SimulationConfig.ada Ada D:\diins\SYSTEM\BBuffer.spc Ada D:\diins\SYSTEM\BBuffer.ada Ada D:\diins\SYSTEM\PreInstanBBuffer.spc Ada D:\diins\SYSTEM\SystemIndexGeneric.ada Ada D:\diins\SYSTEM\SystemConfigGeneric.spc Ada D:\diins\SYSTEM\FDI_Pkg.spc Ada D:\diins\UTILITIES\REALTIME\CPU_Usage.ada Ada D:\diins\SYSTEM\EnableFlagSetupLibrary.ada Ada D:\diins\SYSTEM\OutputResults.spc Ada D:\diins\SYSTEM\OutputResults.ada Ada D:\diins\DLT\datalogger.ada Ada D:\diins\NMEA\REALTIME\ISIO_OSL_Driver.spc Ada D:\diins\NMEA\REALTIME\ISIO_OSL_Driver.ada Ada D:\diins\DCT\REALTIME\SERIAL\TrimbleTANS_PY_DefinitionsAnd	***_Interface.ada*** Ada ***D:\diins\DCT\REALTIME\SERIAL\PPC\ISIO_Definitions.spc*** Ada ***D:\diins\DCT\REALTIME\SERIAL\PPC\ISIO_Definitions.ada*** Ada D:\diins\SYSTEM\Install.spc Ada D:\diins\SYSTEM\Simconfig.ada Ada D:\diins\SYSTEM\ReadDataRates.ada Ada D:\diins\SYSTEM\WriteSimConfig.ada Ada D:\diins\SYSTEM\WriteDataRates.ada Ada D:\diins\SYSTEM\SimulationConfig.ada Ada D:\diins\SYSTEM\BBuffer.spc Ada D:\diins\SYSTEM\BBuffer.ada Ada D:\diins\SYSTEM\PreInstanBBuffer.spc Ada D:\diins\SYSTEM\SystemIndexGeneric.ada Ada D:\diins\SYSTEM\SystemConfigGeneric.spc Ada D:\diins\SYSTEM\FDI_Pkg.spc Ada D:\diins\UTILITIES\REALTIME\CPU_Usage.ada Ada D:\diins\SYSTEM\EnableFlagSetupLibrary.ada Ada D:\diins\SYSTEM\OutputResults.spc Ada D:\diins\SYSTEM\OutputResults.ada Ada D:\diins\DLT\DataLogger.ada Ada D:\diins\NMEA\REALTIME\ISIO_OSL_Driver.spc Ada D:\diins\NMEA\REALTIME\ISIO_OSL_Driver.ada Ada D:\diins\DCT\REALTIME\SERIAL\TrimbleTANS_PY_DefinitionsAnd	← Different OS I/O(read/write), etc. calls

Defaults.spc Ada	Defaults.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\TrimbleTANS_PY_DefinitionsAndDefaults.ada Ada	D:\diins\DCT\REALTIME\SERIAL\TrimbleTANS_PY_DefinitionsAndDefaults.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_TrimbleTANS_PY_TIPY_Driver_1.spc Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_TrimbleTANS_PY_TIPY_Driver_1.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_TrimbleTANS_PY_TIPY_Driver_1.ada Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_TrimbleTANS_PY_TIPY_Driver_1.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_TrimbleTANS_PY_TIPY_Driver_2.spc Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_TrimbleTANS_PY_TIPY_Driver_2.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_TrimbleTANS_PY_TIPY_Driver_2.ada Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_TrimbleTANS_PY_TIPY_Driver_2.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\TrimbleTANS_PY_TIPY_Auto_Prompter_1.ada Ada	D:\diins\DCT\REALTIME\SERIAL\TrimbleTANS_PY_TIPY_Auto_Prompter_1.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\TrimbleTANS_PY_TIPY_Auto_Prompter_2.ada Ada	D:\diins\DCT\REALTIME\SERIAL\TrimbleTANS_PY_TIPY_Auto_Prompter_2.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_NMEA_Driver_1.spc Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_NMEA_Driver_1.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_NMEA_Driver_1.ada Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_NMEA_Driver_1.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_NMEA_Driver_2.spc Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_NMEA_Driver_2.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_NMEA_Driver_2.ada Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_NMEA_Driver_2.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_MK29_Driver_1.spc Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_MK29_Driver_1.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\win32\ISIO_MK29_Driver_1.ada Ada	***D:\diins\DCT\REALTIME\SERIAL\PPC\ISIO_MK29_Driver_1.ada*** Ada	Big Endian / Little Endian
D:\diins\DCT\REALTIME\SERIAL\ISIO_MK29_Driver_2.spc Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_MK29_Driver_2.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\win32\ISIO_MK29_Driver_2.ada Ada	***D:\diins\DCT\REALTIME\SERIAL\PPC\ISIO_MK29_Driver_2.ada*** Ada	Big Endian / Little Endian
D:\diins\DCT\REALTIME\SERIAL\ISIO_LC360_Driver.spc Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_LC360_Driver.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_LC360_Driver.ada Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_LC360_Driver.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\ISIO_HCI_Driver.spc Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_HCI_Driver.spc Ada	

D:\diins\DCT\REALTIME\SERIAL\ISIO_HCI_Driver.ada Ada	D:\diins\DCT\REALTIME\SERIAL\ISIO_HCI_Driver.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\MotherOfAllInterruptHandlers.spc Ada	D:\diins\DCT\REALTIME\SERIAL\MotherOfAllInterruptHandlers.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\win32\MotherOfAllInterruptHandlers.ada Ada	***D:\diins\DCT\REALTIME\SERIAL\PPC\MotherOfAllInterruptHandlers.ada*** Ada	← Calls to different Serial I/O handler and temporary check for RS232/422 flag
D:\diins\NMEA\REALTIME\NMEA.spc Ada	D:\diins\NMEA\REALTIME\NMEA.spc Ada	
D:\diins\NMEA\REALTIME\NMEA.ada Ada	D:\diins\NMEA\REALTIME\NMEA.ada Ada	
D:\diins\HCI\HRData.spc Ada	D:\diins\HCI\HRData.spc Ada	
D:\diins\HCI\HRData.ada Ada	D:\diins\HCI\HRData.ada Ada	
D:\diins\HCI\HRDataTask.spc Ada	D:\diins\HCI\HRDataTask.spc Ada	
D:\diins\HCI\HRDataTask.ada Ada	D:\diins\HCI\HRDataTask.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\Trimble_TIPY_1_TransformRawRecord.spc Ada	D:\diins\DCT\REALTIME\SERIAL\Trimble_TIPY_1_TransformRawRecord.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\Trimble_TIPY_1_TransformRawRecord.ada Ada	D:\diins\DCT\REALTIME\SERIAL\Trimble_TIPY_1_TransformRawRecord.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\Trimble_TIPY_2_TransformRawRecord.spc Ada	D:\diins\DCT\REALTIME\SERIAL\Trimble_TIPY_2_TransformRawRecord.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\Trimble_TIPY_2_TransformRawRecord.ada Ada	D:\diins\DCT\REALTIME\SERIAL\Trimble_TIPY_2_TransformRawRecord.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\NMEA_1_TransformRawRecord.spc Ada	D:\diins\DCT\REALTIME\SERIAL\NMEA_1_TransformRawRecord.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\NMEA_1_TransformRawRecord.ada Ada	D:\diins\DCT\REALTIME\SERIAL\NMEA_1_TransformRawRecord.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\NMEA_2_TransformRawRecord.spc Ada	D:\diins\DCT\REALTIME\SERIAL\NMEA_2_TransformRawRecord.spc Ada	
D:\diins\DCT\REALTIME\SERIAL\NMEA_2_TransformRawRecord.ada Ada	D:\diins\DCT\REALTIME\SERIAL\NMEA_2_TransformRawRecord.ada Ada	
D:\diins\DCT\REALTIME\SERIAL\win32\MK29_1_TransformRawRecord.spc Ada	***D:\diins\DCT\REALTIME\SERIAL\PPC\MK29_1_TransformRawRecord.spc*** Ada	← Big Endian / Little Endian
D:\diins\DCT\REALTIME\SERIAL\win32\MK29_1_TransformRawRecord.ada	***D:\diins\DCT\REALTIME\SERIAL\PPC\MK29_1_TransformRawRecord.ada***	

Ada ***D:\diins\DCT\REALTIME\SERIAL\win32\MK29_2_TransformRawReco rd.spc*** Ada ***D:\diins\DCT\REALTIME\SERIAL\win32\MK29_2_TransformRawReco rd.ada*** Ada D:\diins\DCT\REALTIME\SERIAL\Loran_TransformRawRecord.spc Ada D:\diins\DCT\REALTIME\SERIAL\Loran_TransformRawRecord.ada Ada D:\diins\DCT\REALTIME\SERIAL\SensorSpecificFunctions.spc Ada D:\diins\DCT\REALTIME\SERIAL\SensorSpecificFunctions.ada Ada D:\diins\DCT\REALTIME\SERIAL\GenericSensor.spc Ada D:\diins\DCT\REALTIME\SERIAL\GenericSensor.ada Ada D:\diins\DCT\REALTIME\SERIAL\InstantiatedSensors.spc Ada D:\diins\HCI\HCI_SystemConfigController.spc Ada D:\diins\SYSTEM\TaskMaster.ada Ada :ada_main_program=taskmaster D:\diins\ASF\ASF_Locals.ada Ada D:\diins\ASF\ASF_Task.ada Ada D:\diins\ASF\ASF.ada Ada D:\diins\FDI\FDI.ada Ada D:\diins\FDI\SensorSort.ada Ada D:\diins\FDI\HardSensorFailureIsolation.ada Ada D:\diins\FDI\CheckSensorStatus.ada Ada D:\diins\FDI\SoftSensorFailureIsolation.ada Ada D:\diins\FDI\ChangeSensorStatusSoftFailure.ada Ada D:\diins\FDI\FilterAnalysis.ada	Ada ***D:\diins\DCT\REALTIME\SERIAL\PPC\MK29_2_TransformRawRecord .spc*** Ada ***D:\diins\DCT\REALTIME\SERIAL\PPC\MK29_2_TransformRawRecord .ada*** Ada D:\diins\DCT\REALTIME\SERIAL\Loran_TransformRawRecord.spc Ada D:\diins\DCT\REALTIME\SERIAL\Loran_TransformRawRecord.ada Ada D:\diins\DCT\REALTIME\SERIAL\SensorSpecificFunctions.spc Ada D:\diins\DCT\REALTIME\SERIAL\SensorSpecificFunctions.ada Ada D:\diins\DCT\REALTIME\SERIAL\GenericSensor.spc Ada D:\diins\DCT\REALTIME\SERIAL\GenericSensor.ada Ada D:\diins\DCT\REALTIME\SERIAL\InstantiatedSensors.spc Ada D:\diins\HCI\HCI_SystemConfigController.spc Ada D:\diins\SYSTEM\TaskMaster.ada Ada :ada_main_program=taskmaster D:\diins\ASF\ASF_Locals.ada Ada D:\diins\ASF\ASF_Task.ada Ada D:\diins\ASF\ASF.ada Ada D:\diins\FDI\FDI.ada Ada D:\diins\FDI\SensorSort.ada Ada D:\diins\FDI\HardSensorFailureIsolation.ada Ada D:\diins\FDI\CheckSensorStatus.ada Ada D:\diins\FDI\SoftSensorFailureIsolation.ada Ada D:\diins\FDI\ChangeSensorStatusSoftFailure.ada Ada D:\diins\FDI\FilterAnalysis.ada	

Ada D:\diins\FDI\ReconfigureFromFDI.ada Ada D:\diins\FDI\ID_BestFilterForDisplay.ada Ada D:\diins\FDI\ID_BestSensorForDisplay.ada Ada D:\diins\FDI\FindFiltersForSFI.ada Ada D:\diins\FDI\FindFiltersForHFI.ada Ada D:\diins\DCT\REALTIME\NFS\UofC_dGPS_1_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_GPS_2_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_INS1_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_INS2_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_LOG_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_Loran_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_GPS_1_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\UofC_dGPS_2_DCT.ada Ada D:\diins\HCI\HCISysConfig.spc Ada D:\diins\HCI\HCISysConfig.ada Ada D:\diins\HCI\NMEA_Encoder.spc Ada D:\diins\HCI\NMEA_Encoder.ada Ada D:\diins\DDT\REALTIME\Display-stub.ada Ada D:\diins\DDT\REALTIME\DisplayDataTask.ada Ada D:\diins\HCI\Decoder.spc Ada D:\diins\HCI\Decoder.ada Ada D:\diins\HCI\SimSetupData.spc Ada	Ada D:\diins\FDI\ReconfigureFromFDI.ada Ada D:\diins\FDI\ID_BestFilterForDisplay.ada Ada D:\diins\FDI\ID_BestSensorForDisplay.ada Ada D:\diins\FDI\FindFiltersForSFI.ada Ada D:\diins\FDI\FindFiltersForHFI.ada Ada D:\diins\DCT\REALTIME\NFS\UofC_dGPS_1_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_GPS_2_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_INS1_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_INS2_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_LOG_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_Loran_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\Sim_GPS_1_DCT.ada Ada D:\diins\DCT\REALTIME\NFS\UofC_dGPS_2_DCT.ada Ada D:\diins\HCI\HCISysConfig.spc Ada D:\diins\HCI\HCISysConfig.ada Ada D:\diins\HCI\NMEA_Encoder.spc Ada D:\diins\HCI\NMEA_Encoder.ada Ada D:\diins\DDT\REALTIME\Display-stub.ada Ada D:\diins\DDT\REALTIME\DisplayDataTask.ada Ada D:\diins\HCI\Decoder.spc Ada D:\diins\HCI\Decoder.ada Ada D:\diins\HCI\SimSetupData.spc Ada	

D:\diins\HCI\SimSetupData.ada Ada D:\diins\SYSTEM\ReadFilterInitData.ada Ada D:\diins\HCI\WriteFilterInitData.ada Ada D:\diins\HCI\SetupHCI.spc Ada D:\diins\HCI\SetupHCI.ada Ada D:\diins\HCI\HCI_SystemConfigController.ada Ada	D:\diins\HCI\SimSetupData.ada Ada D:\diins\SYSTEM\ReadFilterInitData.ada Ada D:\diins\HCI\WriteFilterInitData.ada Ada D:\diins\HCI\SetupHCI.spc Ada D:\diins\HCI\SetupHCI.ada Ada D:\diins\HCI\HCI_SystemConfigController.ada Ada	

Table 15. Contents of PART3 Build Files

INTEL/WIN32 VERSION \DIINS\PART3_WIN32.BLD	VME PPC/VXWORKS VERSION \DIINS\PART3_PPC.BLD	COMMENTS
#!build default: subproject :ada_listing=always :ada_list_format=continuous D:\diins\UNIFILTER\Prefilter.ada Ada D:\diins\UNIFILTER\AllocateMemory.ada Ada D:\diins\UNIFILTER\UnitsListInit.ada Ada D:\diins\UNIFILTER\GPS_Modelling.spc Ada D:\diins\UNIFILTER\InitMeasSparseMx.ada Ada D:\diins\UNIFILTER\DecorrelationRoutines.ada Ada D:\diins\UNIFILTER\MeasInit.ada Ada D:\diins\UNIFILTER\InitContinuousQ_Mx.ada Ada D:\diins\UNIFILTER\InitDynamicsMx.ada Ada D:\diins\UNIFILTER\InitGPS_MarkovSD.ada Ada D:\diins\UNIFILTER\FormDynamicsMx.ada Ada D:\diins\UNIFILTER\FormContinuousQ_Mx.ada Ada D:\diins\UNIFILTER\FilterInit0.ada Ada D:\diins\UNIFILTER\FilterInit1.ada Ada D:\diins\UNIFILTER\FilterInit2.ada	#!build default: subproject :ada_listing=always :ada_list_format=continuous D:\diins\UNIFILTER\Prefilter.ada Ada D:\diins\UNIFILTER\AllocateMemory.ada Ada D:\diins\UNIFILTER\UnitsListInit.ada Ada D:\diins\UNIFILTER\GPS_Modelling.spc Ada D:\diins\UNIFILTER\InitMeasSparseMx.ada Ada D:\diins\UNIFILTER\DecorrelationRoutines.ada Ada D:\diins\UNIFILTER\MeasInit.ada Ada D:\diins\UNIFILTER\InitContinuousQ_Mx.ada Ada D:\diins\UNIFILTER\InitDynamicsMx.ada Ada D:\diins\UNIFILTER\InitGPS_MarkovSD.ada Ada D:\diins\UNIFILTER\FormDynamicsMx.ada Ada D:\diins\UNIFILTER\FormContinuousQ_Mx.ada Ada D:\diins\UNIFILTER\FilterInit0.ada Ada D:\diins\UNIFILTER\FilterInit1.ada Ada D:\diins\UNIFILTER\FilterInit2.ada	No Differences in Part3

Ada D:\diins\UNIFILTER\FactorDiscreteQ_Mx.ada Ada D:\diins\UNIFILTER\TransformRawData.ada Ada D:\diins\UNIFILTER\ChiSquaredFilterTest.ada Ada D:\diins\UNIFILTER\ChiSquaredTestInit.ada Ada D:\diins\UNIFILTER\ComputeLoranTD_Var.ada Ada D:\diins\UNIFILTER\ReadData.ada Ada D:\diins\UNIFILTER\ReconfigNewLoran.ada Ada D:\diins\UNIFILTER\ChangeGPS_Mode.ada Ada D:\diins\UNIFILTER\FilterTheMeasurements.ada Ada D:\diins\UNIFILTER\ApplyINS_InternalFix.ada Ada D:\diins\UNIFILTER\AdjustQ_MxWithExternalData.ada Ada D:\diins\UNIFILTER\GPS_Modelling.ada Ada D:\diins\UNIFILTER\MK29_VelocityDampStatus.ada Ada D:\diins\UNIFILTER\NavBestEstimates.ada Ada D:\diins\UNIFILTER\PreprocessPrimaryINS.ada Ada D:\diins\UNIFILTER\PreprocessSecondSensors.ada Ada D:\diins\UNIFILTER\INS1_INS2_Vel_Meas.ada Ada D:\diins\UNIFILTER\INS_GPS_Pos_Meas.ada Ada D:\diins\UNIFILTER\INS_GPS_Vel_Meas.ada Ada D:\diins\UNIFILTER\INS_LOG_Meas.ada Ada D:\diins\UNIFILTER\INS_Loran_TD_Meas.ada Ada D:\diins\UNIFILTER\INS1_INS2_Att_Meas.ada Ada	Ada D:\diins\UNIFILTER\FactorDiscreteQ_Mx.ada Ada D:\diins\UNIFILTER\TransformRawData.ada Ada D:\diins\UNIFILTER\ChiSquaredFilterTest.ada Ada D:\diins\UNIFILTER\ChiSquaredTestInit.ada Ada D:\diins\UNIFILTER\ComputeLoranTD_Var.ada Ada D:\diins\UNIFILTER\ReadData.ada Ada D:\diins\UNIFILTER\ReconfigNewLoran.ada Ada D:\diins\UNIFILTER\ChangeGPS_Mode.ada Ada D:\diins\UNIFILTER\FilterTheMeasurements.ada Ada D:\diins\UNIFILTER\ApplyINS_InternalFix.ada Ada D:\diins\UNIFILTER\AdjustQ_MxWithExternalData.ada Ada D:\diins\UNIFILTER\GPS_Modelling.ada Ada D:\diins\UNIFILTER\MK29_VelocityDampStatus.ada Ada D:\diins\UNIFILTER\NavBestEstimates.ada Ada D:\diins\UNIFILTER\PreprocessPrimaryINS.ada Ada D:\diins\UNIFILTER\PreprocessSecondSensors.ada Ada D:\diins\UNIFILTER\INS1_INS2_Vel_Meas.ada Ada D:\diins\UNIFILTER\INS_GPS_Pos_Meas.ada Ada D:\diins\UNIFILTER\INS_GPS_Vel_Meas.ada Ada D:\diins\UNIFILTER\INS_LOG_Meas.ada Ada D:\diins\UNIFILTER\INS_Loran_TD_Meas.ada Ada D:\diins\UNIFILTER\INS1_INS2_Att_Meas.ada Ada	

D:\diins\UNIFILTER\INS1_INS2_Pos_Meas.ada Ada D:\diins\UNIFILTER\INS_GPS_Att_Meas.ada Ada D:\diins\UNIFILTER\MK29_Synthetic_Vel_Meas.ada Ada D:\diins\UNIFILTER\StateVectorUpdate.ada Ada D:\diins\UNIFILTER\StateOutputCorrections.ada Ada D:\diins\UNIFILTER\StateObserved.ada Ada D:\diins\UNIFILTER\ReconfigureMeas.ada Ada D:\diins\UNIFILTER\RendezvousWithFDI.ada Ada D:\diins\UNIFILTER\Kalman.ada Ada D:\diins\UNIFILTER\GPS_Level2_MeasReconfig.ada Ada D:\diins\UNIFILTER\INS_Level2_MeasReconfig.ada Ada D:\diins\UNIFILTER\MeasFailureDetection.ada Ada	D:\diins\UNIFILTER\INS1_INS2_Pos_Meas.ada Ada D:\diins\UNIFILTER\INS_GPS_Att_Meas.ada Ada D:\diins\UNIFILTER\MK29_Synthetic_Vel_Meas.ada Ada D:\diins\UNIFILTER\StateVectorUpdate.ada Ada D:\diins\UNIFILTER\StateOutputCorrections.ada Ada D:\diins\UNIFILTER\StateObserved.ada Ada D:\diins\UNIFILTER\ReconfigureMeas.ada Ada D:\diins\UNIFILTER\RendezvousWithFDI.ada Ada D:\diins\UNIFILTER\Kalman.ada Ada D:\diins\UNIFILTER\GPS_Level2_MeasReconfig.ada Ada D:\diins\UNIFILTER\INS_Level2_MeasReconfig.ada Ada D:\diins\UNIFILTER\MeasFailureDetection.ada Ada	

5. Version 3.3.1 Reconciliation

This section requires a bit of explanation. When Version 3.3 of the DIINS source code was delivered to Prior to begin the migration, DREO was still using it on the older hardware during sea trials on HMCS Calgary. As a result of those trials, a number of improvements were identified and implemented by Dale Arden Consulting in parallel with the migration efforts underway at Prior [8]. As a result, these changes (which were known as Version 3.3.1) were not included in the migrated software eventually delivered by Prior to DREO. Consequently DREO identified all the files that were changed in Version 3.3.1 and incorporated those changes into the migrated version 3.3, effectively bringing them to the same level of functionality as 3.3.1. A software tool called "Beyond Compare" proved to be invaluable in this process, helping to identify line-by-line where files differed. Though it proved to be a fairly laborious process, it was deemed worthwhile because of the features added in Version 3.3.1

This section lists the files that were modified in Version 3.3.1. All of the important modifications have been migrated and tested on both new platforms.

Table 16. *Files Modified for Version 3.3.1*

FILE	
DIINS/UTILITIES/REALTIME/TimeUtilities.spc DIINS/UTILITIES/REALTIME/TimeUtilities.ada DIINS/SYSTEM/RawSensors.spc DIINS/SYSTEM/MeasGlobal.spc DIINS/SYSTEM/REALTIME/SimConfig.spc DIINS/DCT/REALTIME/SERIAL/ForceISIO_NMEA_Driver_1.spc DIINS/DCT/REALTIME/SERIAL/ForceISIO_NMEA_Driver_1.ada DIINS/DCT/REALTIME/SERIAL/ForceISIO_NMEA_Driver_2.spc DIINS/DCT/REALTIME/SERIAL/ForceISIO_NMEA_Driver_2.ada DIINS/DCT/REALTIME/SERIAL/Trimble_TIPY_1_TransformRawRecord.ada DIINS/DCT/REALTIME/SERIAL/Trimble_TIPY_2_TransformRawRecord.ada DIINS/DCT/REALTIME/SERIAL/NMEA_1_TransformRawRecord.ada DIINS/DCT/REALTIME/SERIAL/NMEA_2_TransformRawRecord.ada DIINS/DCT/REALTIME/SERIAL/MK29_1_TransformRawRecord.ada DIINS/DCT/REALTIME/SERIAL/MK29_2_TransformRawRecord.ada DIINS/DCT/REALTIME/SERIAL/GenericSensor.ada DIINS/SYSTEM/TaskMaster.ada DIINS/FDI/HardSensorFailureIsolation.ada DIINS/FDI/FindFiltersForHFI.ada DIINS/DCT/REALTIME/NFS/Sim_INS1_DCT.ada DIINS/DCT/REALTIME/NFS/Sim_INS2_DCT.ada DIINS/DCT/REALTIME/NFS/Sim_LOG_DCT.ada DIINS/HCI/NMEA_Encoder.ada DIINS/HCI/HCI_SystemConfigController DIINS/UNIFILTER/Prefilter.ada DIINS/UNIFILTER/TransformRawData.ada DIINS/UNIFILTER/ApplyINS_InternalFix.ada DIINS/UNIFILTER/RendezvousWithFDI.ada DIINS/UNIFILTER/ChangeGPS_Mode.ada DIINS/UNIFILTER/PreprocessSecondSensors.ada	

6. Debugging Efforts

After the new DIINS platform were delivered by Prior after the initial migrations, the author continued to debug and reconcile the new versions. Table 17 in this section simply documents some of the debugging changes for potential future reference. Annex C documents some of the initial changes made by Prior.

Table 17. *Bugs fixed by DREO after delivery*

BUG	FIX
PC could not use serial port above COM9	The call to the Windows API routine CreateFile (in ISIO_Definitions.ada) needed to specify COM ports with this syntax: `\\\\.\\COM10` (See Microsoft Article Q115831)
PC version would not start up correctly in November 2000	This was traced to a bug in the AdaMulti native win32 compiler. If the system date was in a November of a leap year, calls to the "Calendar" package would return a date one less than the correct date. This bug was reported to Green Hills software and a fix was supplied. A new "adarts.lib" file was received and installed which corrected the problem
Numerous "FDI_Constraint" errors on the PC at startup	Prior had defined a temporary variable in RendezvousWithFDI.ada called TMP := Config.AllGenericINS(i). This variable was not being used properly and was found to be unnecessary. It was removed and the version of the file used on the VME system was found to work correctly.
GPS SPS Variances too large	Since the removal of GPS Selective availability, the accuracy of SPS GPS has improved dramatically. The noise parameters in GPS_Modelling.spc were modified. Initial testing found them to be acceptable, though more thorough verification may be in order.
Crash if a GPS was specified as DGPS in the simsetup.cfg file, but it was only providing SPS data at system startup.	A temporary fix was established, but a better fix was available in the 3.3.1 versions of "ChangeGPS_Mode.ada, PreProcessSecondSensor,ada, and TransformRawData.ada" prepared by Dale Arden Consulting (see Section 5).
When less than 2 INS's were providing data, the system would crash several 10's of minutes or perhaps several hours after the loss of the INS data. The filters would stop running (but the raw sensor data was still being output), and rapid-fire "GPS1_BB: Full" messages would flash on the console screen.	This was a very difficult bug to find and took substantial effort and analysis. To summarize, the root of the problem turned out to be in a much different area than where the effects were being manifested. The problem was in the Data Collection Tasks (DCT's), at the point they called the "Enqueue" function that sends the raw sensor data to the bounded buffers to be read by the filters. In SensorSpecificFunctions.ada (and also in the old sensor DCT's in the pre-Prior versions) there is a snippet for each sensor like ... select BBUFFERS.INS2_BoundedBuffer.QBuffer.ENQUEUE(SensorData); return; else TIO.Put_Line("INS2 Sensor Instance: BB not Talking"); end select;

	It was eventually evident that one of these messages from the unplugged INS2 DCT was being printed every time the INS1 unifilter fell behind by a step. As to why the Bbuffer was not ready to enqueue sensor data at the point the sensor DCT made this Select statement call, is unknown. Since this is select-without-wait, it did not wait around for BBuffer to rendezvous with it. When this was replaced with a selective rendezvous-with-wait, like this, it works better.... select BBUFFERS.INS2_BoundedBuffer.QBuffer.ENQUEUE(SensorData); return; or delay 1.00; TIO.Put_Line("INS2 Sensor Instance: BB not Talking"); end select; The one second (max) wait may not necessarily be the most appropriate, but initial tests seem to indicate that it gives the Bbuffer task time to rendezvous with its calling DCT. There are a multitude of differences from the old system to the new ones that might account for this timing problem - the new Ada95 compiler, the new hardware (both PowerPC and Intel Pentium processors), different operating systems (vxWorks and Windows NT) with different tasking priority mechanisms, new serial drivers (Windows32 API and Compware SBS serial drivers), etc. However since nearly identical behaviour was evident on both systems (the Intel/win32 setup and the PowerPC/VxWorks setup) it is suspected that the reason lies in the main common element of the two - the Greenhills Ada95 compiler/cross-compiler. Perhaps they implement the selective rendezvous differently than the old Telesoft compiler.
"Flaky" NMEA GPS time stamps: When an NMEA GPS receiver was unplugged from DIINS and then reconnected some time later, numerous "GPS Time Flaky: messages were printed	The problem occurred only when the receiver was disconnected during the time at which DIINS was trying to reset its internal clock to GPS time (which by default is every 30 minutes). It was eventually determined that if the sensor was unplugged halfway through the $GPZDA NMEA sentence, and then reconnected sometime later, DIINS would try to use this old partial data sentence which, instead of being discarded, was being added to the beginning of the new data, e.g. $GPZDA,182214,04,04,2001$GPZDA183017,04,04,2001,000,000,*BF The root of the problem is that the NMEA checksums were not being tested on the sentences that reset the internal clock. This was fixed in the NMEA DCT's (ISIO_NMEA_DRIVER_1(2).ada with a call to the "CheckSumOK" routine before setting the clock. Note that this bug was probably in the previous versions of DIINS but had not been manifested.
Output data stream mods	A few minor mods/fixes were made to improve the data in the DIINS output data stream. Latitude and Longitudes are now output to 4 decimal places in (arc minutes) instead of 3. The Course Made Good (CMG) is set to 0 for very slow speeds (less than 0.1 m/s) in NMEA.ADA (in procedures Encode_NMEA_VTG, and CopyDIINS_Covariance_to_OSL). Similarly in Prefilter.ada, if there are no valid filters and only GPS is being output, set the heading to 0 if the speed is less than 0.1 m/s.
Data Logging	Some improvements were made, but this is still not functional on the VME, and not intuitive to use on the PC.

7. Fixes and improvements identified but not yet implemented

Though the core DIINS code runs and runs fairly well on the two new platforms, a number of minor bugs remain and a few other improvements should be made before the system can be declared 100% migrated. This section attempts to document these.

- The VME cannot use Serial Ports 7 and 8 (it can only use 1-6). This seems to be a limitation of the Compware drivers procured for the SBS GreenSpring I/O card and are related to the number of available VME bus interrupts [15, p.8].
- The HCI (Human Computer Interface) does not fully function with the migrated DIINS.
  - Any changes made via the HCI do not seem to get written back to the DIINS configuration files.
  - There are some new parameters in the configuration files that are not read or displayed by the HCI (notably RS232/RS422).
  - The HCI was written for OS/2 to communicate over a serial link with DIINS. It should be ported to Window NT and the ability to communicate with DIINS via internal files or messages, in the case of the PC version of DIINS, should be added.
- Data logging is not functional on the VME. It should be possible to use the NFS mounted D:\\DIINS drive and log the data to the NFS disk, but although tests indicate it logs the first few seconds correctly, it soon detects a Device Error exception and terminates logging.
- The name of the pathname of the file to which to log the DIIINS data is hard-coded as "D:\DIINS\RESULTS\ST…" (the Julian day and time and a .DAT extension is added at file creation time). This should probably be moved to the setup configuration file (simsetup.cfg)
- Data logging on the PC, while functional, is not intuitive to set up. This is a consequence of the various DIINS configurations over the years and different sea trial requirements. The whole data logging process should be re-addressed
- Procedures to flash the MVME2604 ROM with the full bootable VxWorks/DIINS executable have not yet been developed or tested.

- Loran processing does not seem to function correctly. On the VME the displayed latitude and longitude are incorrect, and on the PC numerous "VincentyInverse" errors arise from Loran_TransformRawRecord.ada.

- The Post-processing and Simulation modes have not been tested. In fact post-processing in the later versions of DIINS on the previous Sparc/unix platforms was not fully functional. Some efforts were made to rectify this prior to the migration to the new platforms, but were not completed.

- New sensor models, such as for different inertial systems, have not been implemented. A placeholder for the Litton-Sperry MK-49 has been introduced, but not fully developed.

8. Static Lab-Trial Real-time Results

This section presents some real-time results from the new platforms. It is intended to show that the new DIINS systems are functional and successfully integrating dual INS and dual GPS data.

8.1 Trial Setup

8.1.1 Data Sources

The source of data for this experiment is as shown in the following table. Live feeds were used for the SPS and DGPS data and previously recorded static MK-29 lab trial data was played back in real time to simulate the inertial system data.

Table 18. *Sensor Data used for Static Lab Trial*

SENSOR DATA	SOURCE
INS1	Sperry MK29 raw 2-hour data file "m2941014.bin" recorded at DREO in 1994. Played back on supporting PC "sleet" via the command `C:> mk29out m2941014.bin COM2 47 47`
INS2	Same as above (i.e. a split feed to both DIINS INS inputs)
GPS1	Trimble Tasman NGN receiver, SPS mode, NMEA output, 4800 baud
GPS2	Trimble Lassen SK8, with Trimble DGPS beacon receiver, DGPS mode, NMEA output 4800 baud

All data sources were split with appropriate RS232 splitter devices and fed to both DIINS platforms (the PC version and the VME version) simultaneously. Seven filter configurations were run on both platforms. The simsetup.cfg files used were those shown in Table 7 (for the PC version) and Table 8 (for the VME version). Note that data logging was turned on for the PC version and off for the VME version.

8.1.2 Filter Configurations

The seven filters run by each system are as in Table 19 below.

Table 19. Filter Configuration – static lab trial

FILTER NUMBER AND CONFIG FILE	SENSOR SUITE INCULDED IN FILTER
1. – s1s2.cfg	INS1, INS2
2. – s1n1n2.cfg	INS1, GPS1, GPS2
3. – s2n1n2.cfg	INS2, GPS1, GPS2
4. – s1n1.cfg	INS1, GPS1
5. – s2n1.cfg	INS2, GPS1
6. – s1n2.cfg	INS1, GPS2
7. – s2n2.cfg	INS2, GPS2

8.1.3 Logging Setup

Data logging was not enabled on the VME version because it has not been fully debugged. However full logging was enabled on the PC version. In order to get some data from the VME system for analysis, the DIINS ASCII output stream (that would normally be sent to the electronic chart) was captured (via a terminal emulator program – Hyperterm) from both platforms and was used to compare them. Also, some screen captures (from the prototype DIINS display program "OSLNMEA") of the two platforms were taken at frequent intervals and show that the two platforms are operating essentially identically.

8.2 Results

8.2.1 Screen Captures

Both the VME and the PC systems were started (close to) simultaneously, and two support PC's were setup side-by-side each running the "OSLNMEA" prototype display program, and with each displaying the output of the two separate and independently running DIINS systems. Figure 5 through Figure 8 show a sequence of photographs of the two systems, taken a few seconds apart. The display of the data from the VME system is shown on the screen in the left of each photograph and the display of the data from the PC system is shown on the screen on the right. It can be seen that they are essentially identical. The VME system was started 3-4 seconds behind the PC system, so the values of the R95 and north and east DIINS position error standard deviation estimates are slightly higher in the first few seconds of the run (as the Kalman filter variances decline), but they soon both converge on the same steady state solution.

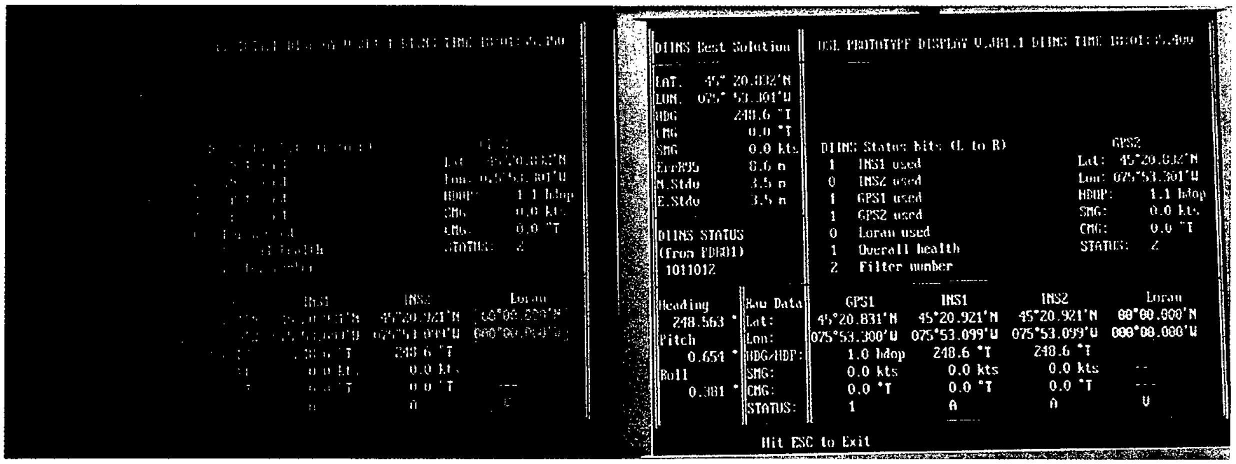

Figure 5. *VME (left) and PC (right) displays at t=t_0*

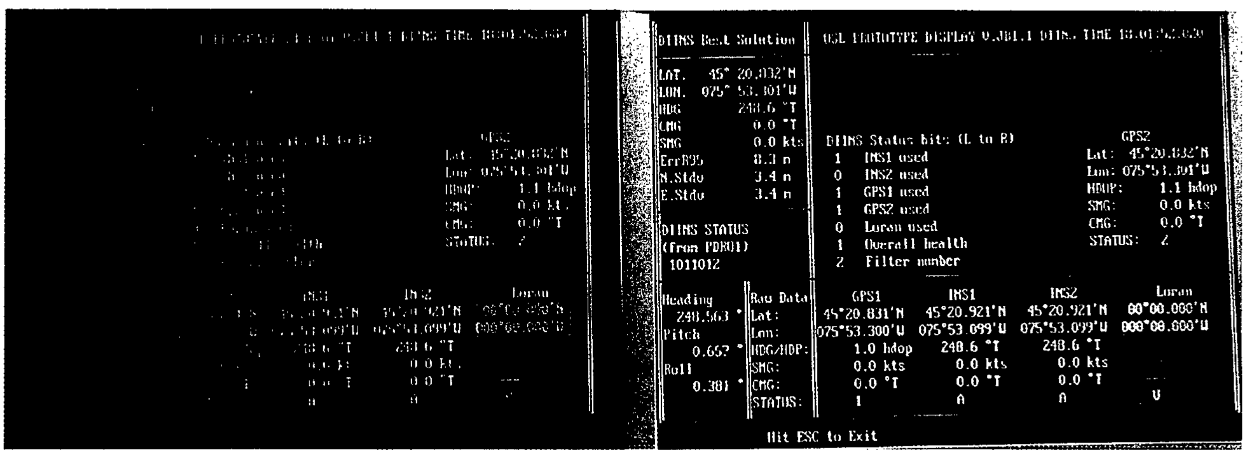

Figure 6. *VME (left) and PC (right) displays at t=t_0+17 sec*

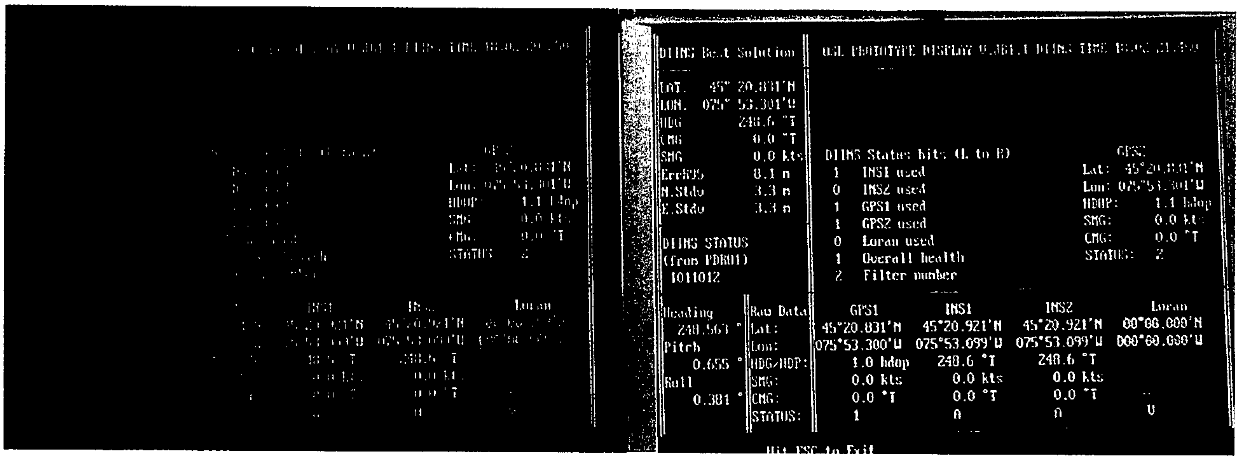

Figure 7. *VME (left) and PC (right) displays at t=t$_0$+45 sec*

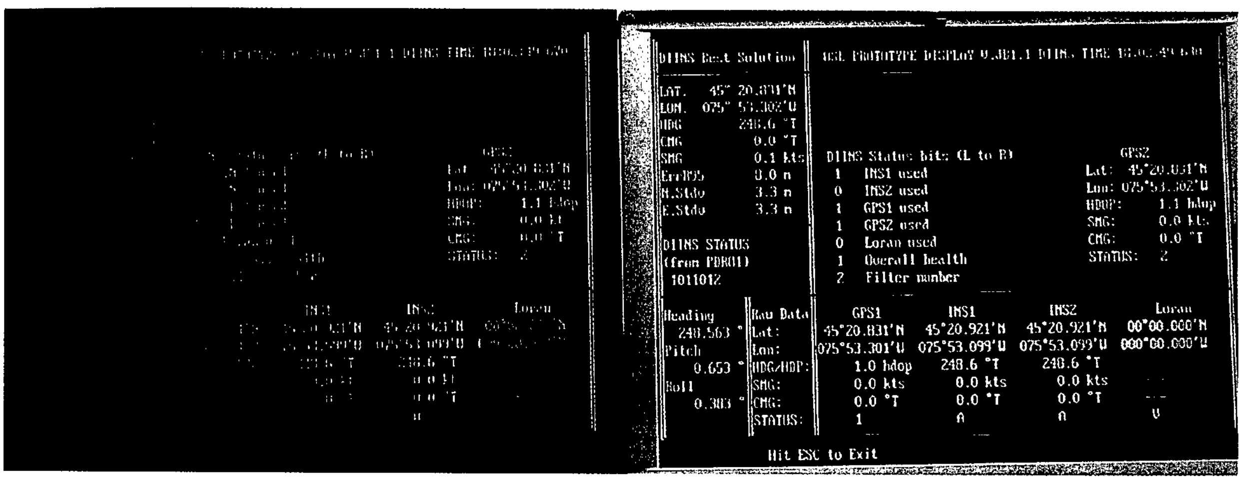

Figure 8. *VME (left) and PC (right) displays at t=t$_0$+79 sec*

The next figure (Figure 9) shows the response of the two DIINS systems when the INS's both suffer a hard failure. It is seen that both switch immediately to the DGPS (GPS2) sensor.

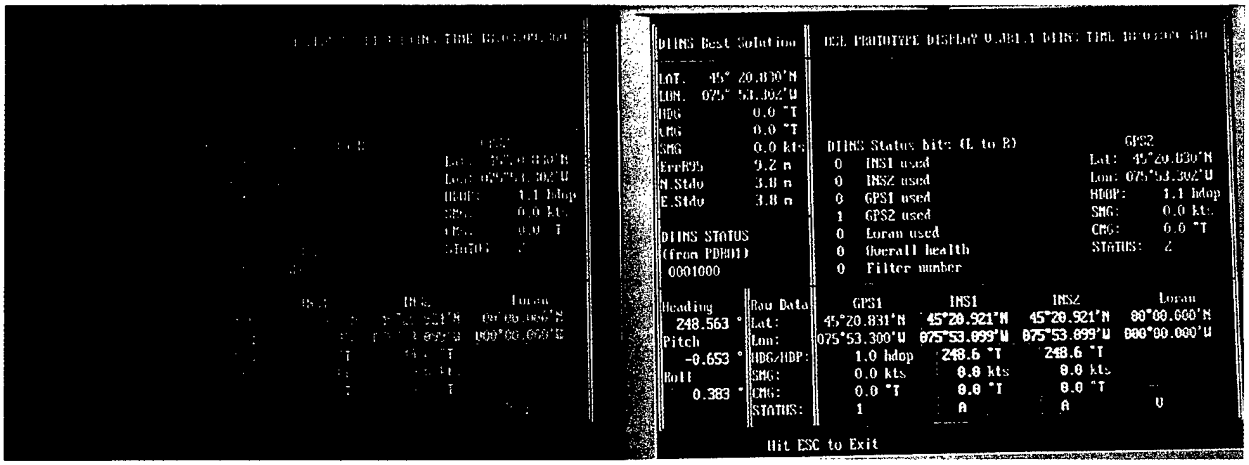

Figure 9. VME (left) and PC (right) displays after both INS's fail

The final photograph (Figure 10) shows a subsequent loss of the DGPS (GPS2) sensor. Both immediately switch to the last good sensor, the SPS GPS1.

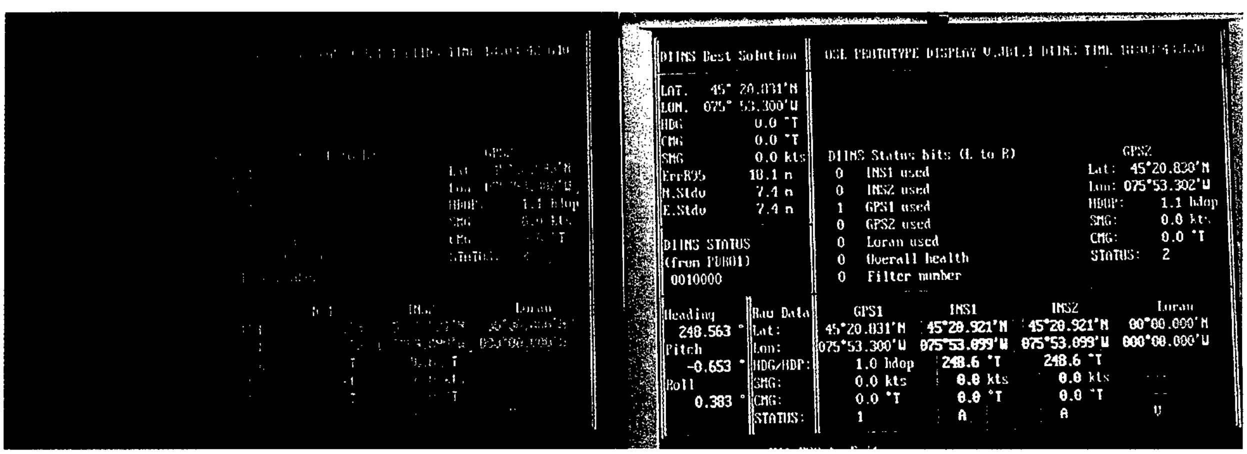

Figure 10. VME (left) and PC (right) displays after subsequent GPS2 failure

8.2.2 ASCII Output Streams

The data that was displayed on the screens photographed in the previous section was also captured using a dumb terminal program (hyperterminal), to further aid in the comparison of the VME with the PC system. The first nine seconds of the data streams from both systems is shown in Annex E. For aid in understanding the data streams, see [1, Appendix A].

The DIINS Latitude and Longitude estimates from the two systems are shown in Figure 11 and Figure 12 respectively. It is seen that they are near identical and give a good indication that port of the two systems was successful.

Finally, in Figure 13, the R95 (95 percentile estimate) from the $PDR01 output sentences of the two DIINS systems are shown. There is good agreement and the two plots are coincident at the resolution of the output data (0.1m).

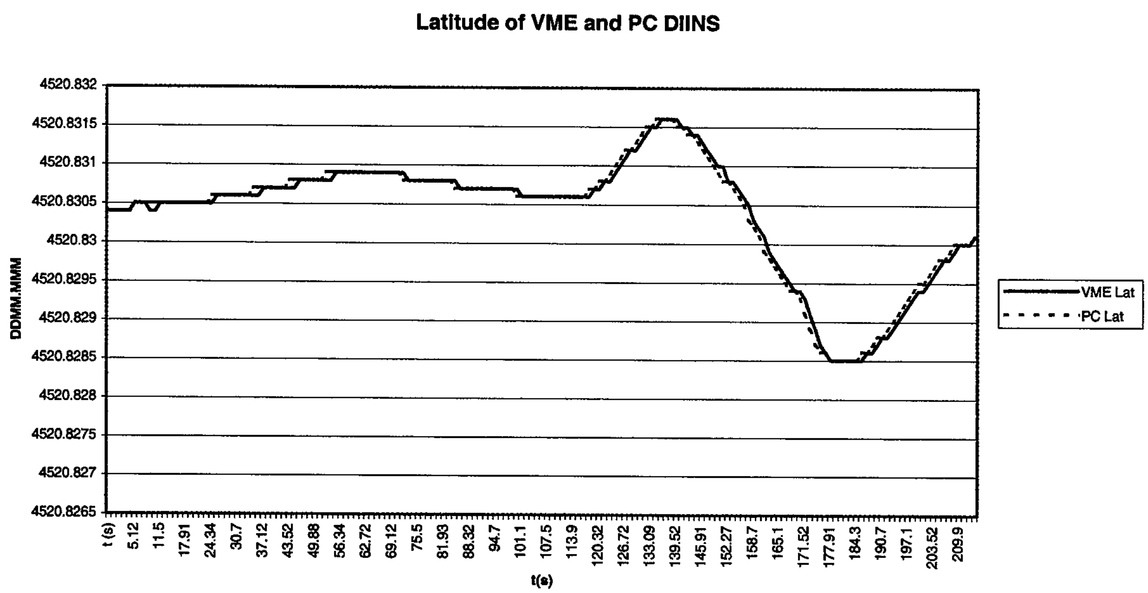

Figure 11. DIINS Latitude (from $INGLL of VME and PC Systems)

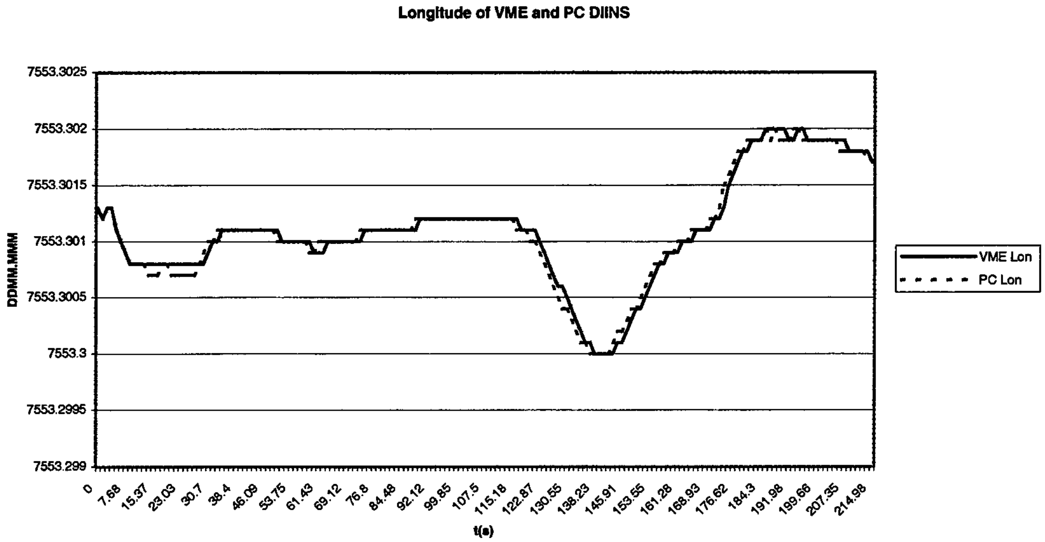

Figure 12. DIINS Longitude (from $INGLL of VME and PC Systems)

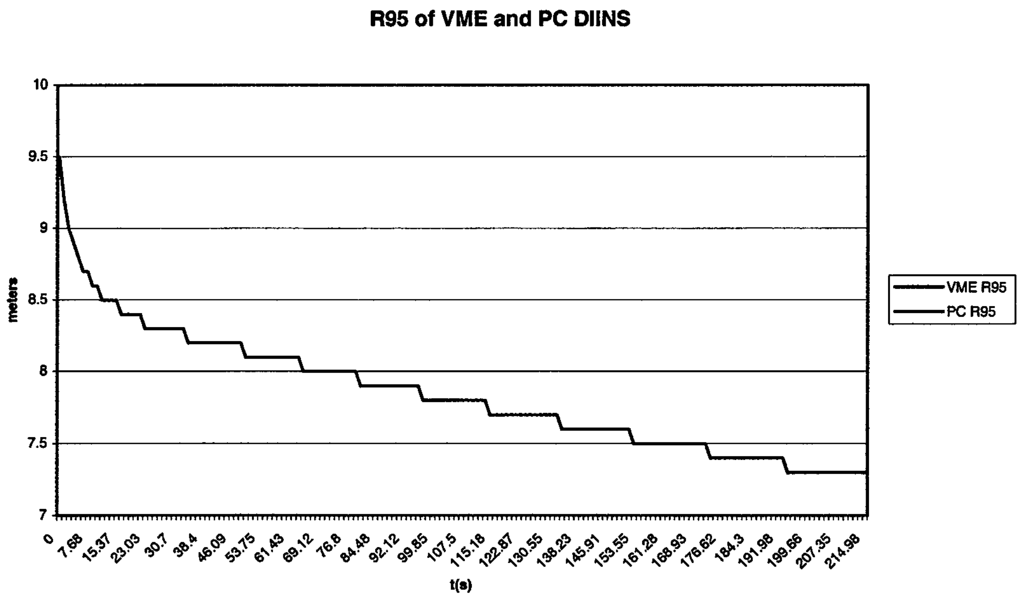

Figure 13. R95 Error Estimates (from $PDR01 of VME and PC Systems)

8.2.3 Binary Data Logged by PC Version

Since binary data logging of the PC version works, and since some of the data extraction tools have been ported from the old Sparc system to Windows NT, we are able to analyze data collected by the PC in more detail. A new data logging run was started for this section.

The file that was generated was called `ST2001_114-1457.dat`, indicating Julian day 113 of year 2001, at time 18:13 GMT. Note that DIINS automatically starts new data files after every 2 hours, each with a similar naming convention. The file was placed in `D:\DIINS\RESULTS`.

The data was then extracted with the programs "extract_data" and "extract_pure_sensor_data." Details on the procedures involved in using these programs to extract raw sensor data and Kalman filter integration data are given in Annex F.

A few representative results are shown below. Figure 14 and Figure 15 show the latitude and longitude outputs from the INS1 unifilter state output date file. These are similar to the results shown in the previous section, though somewhat different since it is a different run. Figure 16 shows the corresponding standard deviation estimate from the same filter for the X position state (the Y state is similar) These agree with the R95 plots shown in the previous section, keeping in mind that the R95 value is the combination (essentially 2.45σ) of the X and Y position error standard deviations from the filter.

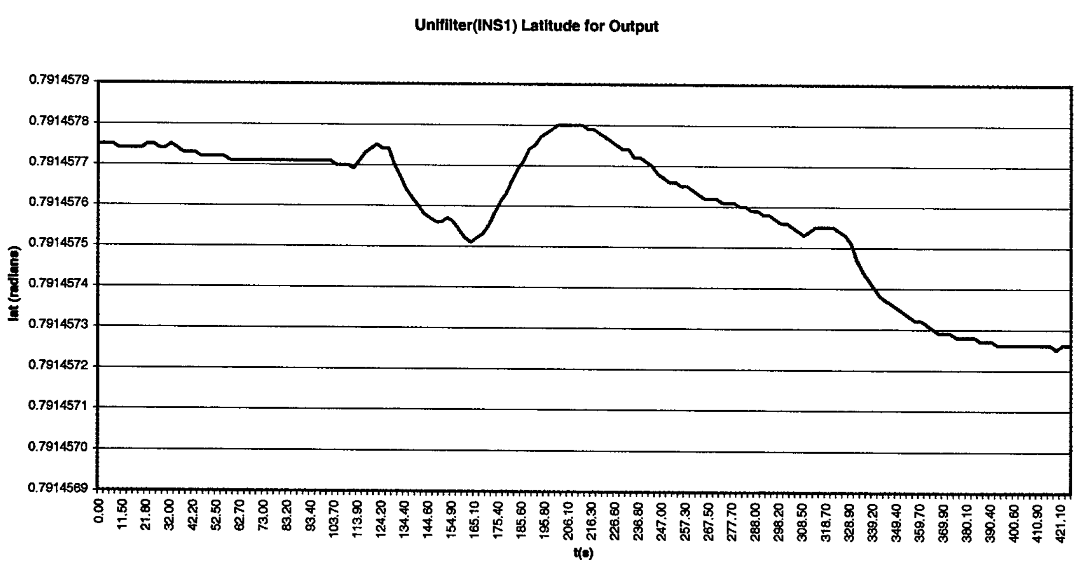

__Figure 14.__ Latitude output from INS1 Unifilter

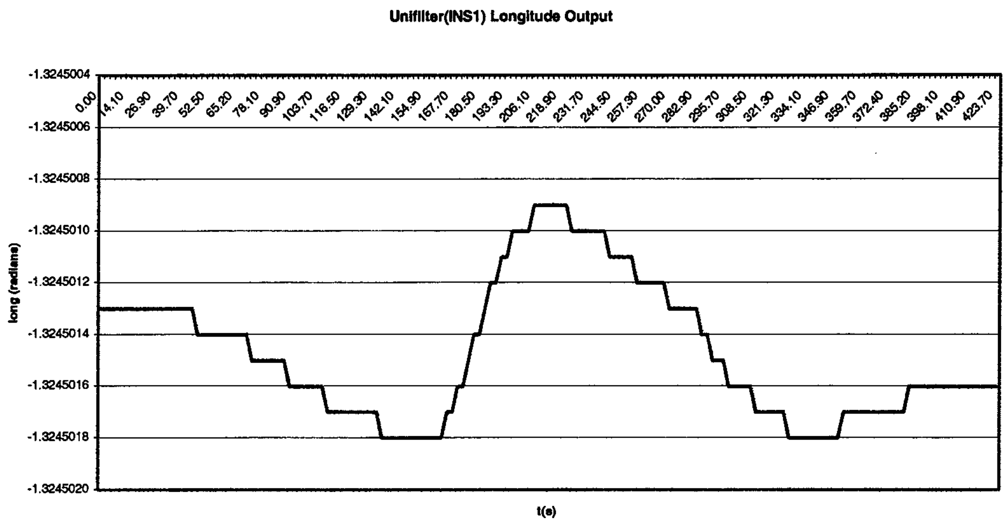

Figure 15. Longitude output from INS1 Unifilter

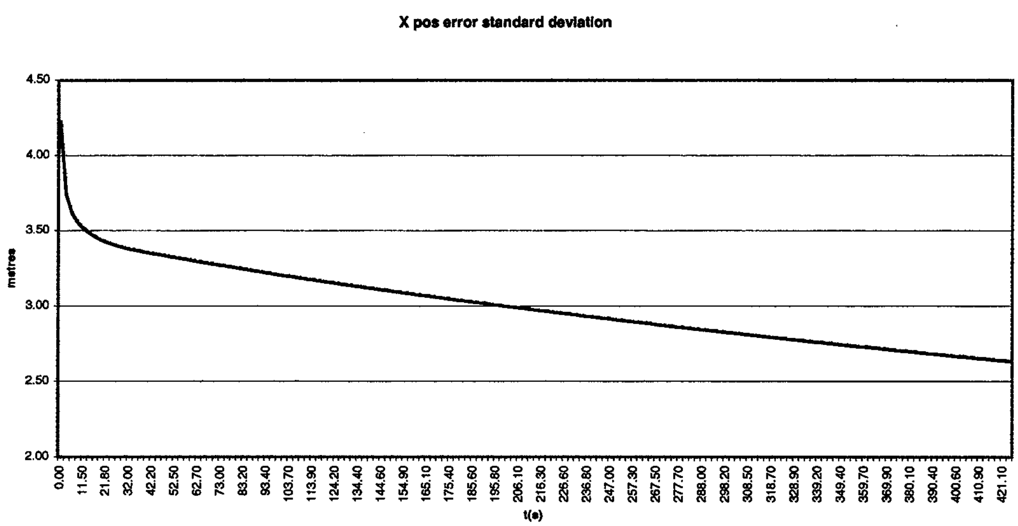

Figure 16. X position error standard deviation estimate from INS1 Unifilter

8.3 Screen Shots of PC DIINS driving an Electronic Chart

This section shows screen shots of the SHINNADS (Shipboard Integrated Navigation and Display System), from Offshore Systems Ltd. displaying the PC DIINS data. This screen shot was taken during Dec 2000 when the SHINNADS system was at DREO and OSL had released its latest software version with the latest DIINS displays. Figure 17 shows the "DIINS Detailed" screen which displays the integrated solution as well as all the individual sensor data, and Figure 18 shows the "DIINS Simplified" display which omits the raw sensor data to leave more room for the chart.

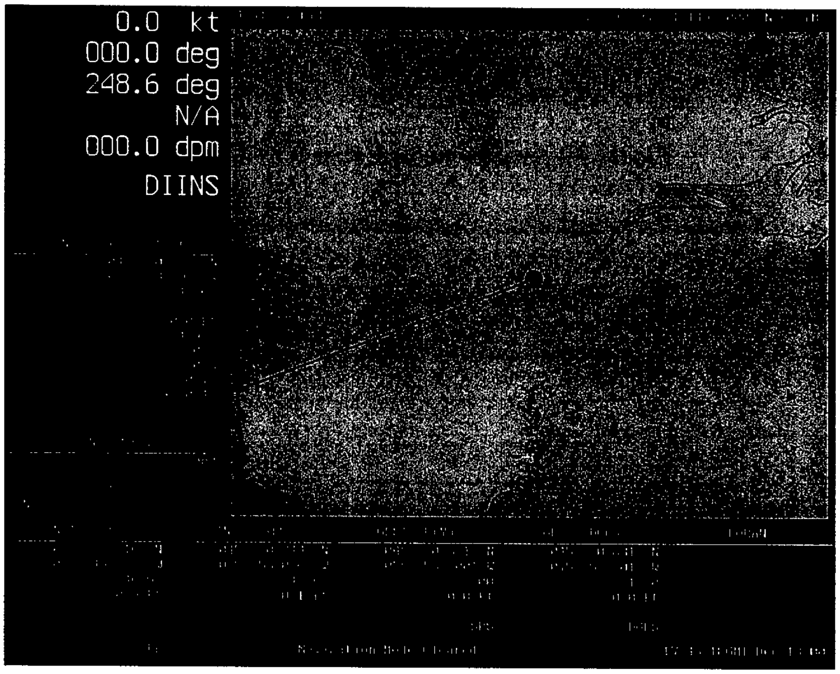

Figure 17. *DIINS Detailed Display on the SHINNADS Electronic Chart*

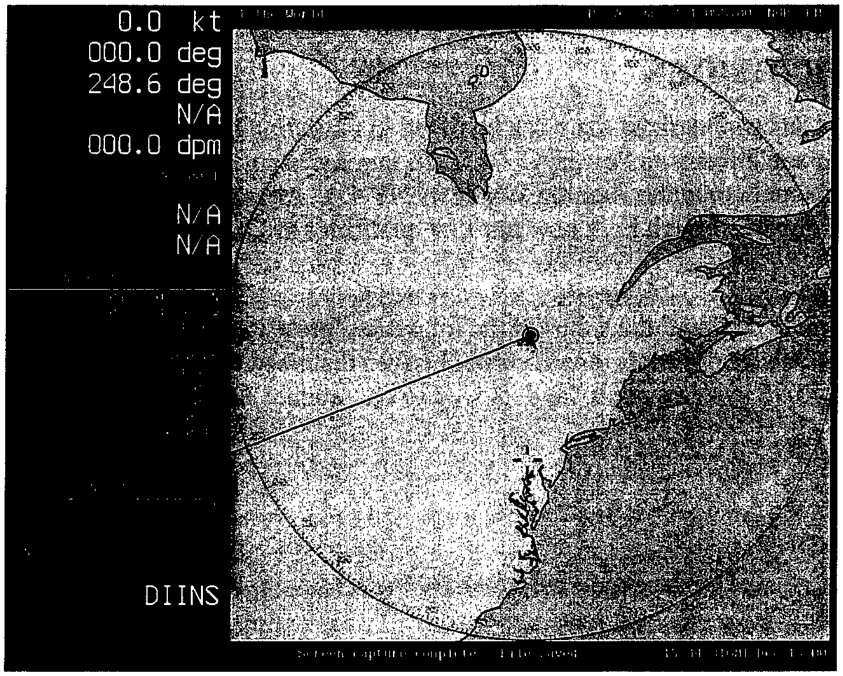

Figure 18. *DIINS Simplified Display on the SHINNADS Electronic Chart*

8.4 Processor Loading Comments

No formal tests of processor loading were conducted, since it is not thought to be an issue with the class of processors (Intel Pentium 450Mhz and PowerPC 333 Mhz) used in the new DIINS platforms. Casual observations reveal that both platforms can easily run 15 Kalman filters, each at a 1.28s update rate, with no apparent problem. In fact, in the PC version the Windows NT Task Manager reports that DIINS uses no more than 16% of the available CPU time when running 15 filters, and 8% when running 7 filters.

9. Conclusions

This report has summarized the work involved in migrating the DIINS software to two new run-time platforms: a PowerPC604 VME target system running VxWorks 5.4, and a generic personal computer running Windows NT 4.0. As was shown the migration is not entirely complete, though both new run-time platforms are running satisfactorily to a great extent.

This document recorded the status of the migration, presented some results of the systems in real-time laboratory trials, and identified issues that need to be explored more fully if the migrated DIINS systems are to be deployed in operational environments

10. References

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Annex A: Configuring a new MVME2604 Board with VxWorks boot kernel:

The VME processor boards must be configured to work with the VxWorks operating system and the host development PC. This section outlines what was done for the board used in the DREO laboratory. More details are found in the product documentation, references [9], [10], [11], and [12]. This procedure needs only be done once for each new card or after a network configuration change. The results are stored in non-volatile RAM on the processor card. There are 3 main steps to this procedure, and each is outlined here.

Note that these procedures are intended to simply flash the processor board ROM with a VxWorks boot kernel, which will load the rest of VxWorks from the host PC over the Ethernet connection, and which in turn will allow the download and execution of the DIINS program over the Ethernet connection. Procedures to flash the ROM with the full bootable VxWorks/DIINS executable have not yet been tested.

1. Prepare the Vxworks boot kernel. (See also [11, p. 13].)

- There is a batch file that will do this at:
  `\tornado\target\config\mv2604\create_new_bootrom.bat`

- copy the resulting `boot.bin` file to `\tftpboot\boot.bin`

- start the tftp server on the host PC by running

  `\tornado\host\x86-win32\bin\tftpd32.exe` (there is a shortcut to this on the Winows desktop).

2. Burning the VxWorks boot kernel in MVME2604 board soldered flash. (See also [11, p. 14])

- Power down the VME chassis and slide out the processor card

- Select Socketed flash (set J10 on the lower-front portion of the board to 2-3)

- Connect a null modem cable from VME console to PC serial port (9600 8N1)

- Start a suitable PC communication program

- Power up board

- At the "PPC1-Bug" prompt, issue the following commands:

"set mmddyyhhmm" (to set date time)

"niot" (to set network addresses…

Contoller LUN 0
Device LUN 0
Client IP Address 131.136.36.22 (e.g. for harpo VME card)
Server IP Address 131.136.36.21 (e.g. for ntnavnote1 PC)
Gateway Address 131.136.36.1
"Y" to update the non-volatile RAM

"niop" (to download the boot.bin file…)

Contoller LUN 0
Device LUN 0
Get/Put G
FileName boot.bin
Memory Address 00004000
Length 0
Byte Offset 0

(Wait for boot.bin file to be transferred. This can be monitored in the TFTP window)

"PFLASH 4000:FFF00 FF000100 (to flash the soldered ROM)

- When finished, power off the board, restore Jumper J10 back to 1-2 (to select the newly burnt soldered flash with the new VxWorks boot kernel)

3. Configuring the Vxworks boot kernel. (See also [9, p. 38-45].)

- Connect a null modem cable from the VME console to PC (now at 38400, 8N1)

- Power on the VME system

- Hit any key to stop the autoboot process and get to the [VxWorks Boot] prompt.

- 'c' to configure:

Boot Device	dc0
Processor number	0
Host name	ntnavnote1 (or as appropriate)
File name	D:\DIINS\DIINS_VX_CONFIG\DEFAULT\VXWORKS
Inet on Ethernet	131.136.36.22 (the VME card)
Inet on backplane	<cr>
Host inet	131.136.36.21 (the host PC, e.g. ntnavnote1)

Gateway inet	131.136.36.1
User	diins
Password	diins99ppc
Flags	0
Target name	harpo (for example)
Startup script	<cr>
Other	<cr>

- On the host PC, start the WFTP server via

\tornado\host\x86-win32\bin\wftpd32.exe (there is a desktop shortcut)

- Reboot the VME system

When the system reboots, it will require a valid FTP server running on the PC that will accept a connection from a user name "diins" with password "diins99ppc". The program that is currently set up on the notebook PC that provides this service is called WFTP32 and automatically loads at start up (or can be started with a desktop shortcut). It will then let the VME download the rest of the VxWorks operating system (residing at the specified filename) over the Ethernet connection. This run-timeVxWorks image can be re-built if necessary by using Tornado and opening and editing the corresponding workspace

Annex B: Configuring the Target Server for Tornado on "ntnavnote1"

The Tornado development environment provides for what is known as a Target Server which is necessary to handle communications to and from the VME target processor board. This section outlines how the target server for "harpo" was configured on the "ntnavnote1" notebook host PC. Complete details on how to fully manage the Tornado Target Server can be found in [9, Chapters 1 and 5].

In Tornado, select "Tools | Target Server | Configure"

For Target Server Name, enter "`HarpoServer`"

Turn on the check box for "Add description to menu"

For Target Name/IP Address, enter `131.136.36.22`

Under Target Server Properties | Back End:

Select "wdbrpc and enter `2` and `10` for TimeOut and Re-try respectively

Under Target Server Properties | Memory Cache Size: Specify `5000` Kbytes

Under Target Server Properties | Target Server File System:

Turn on the check box for "Enable File System"

Specify the Root as "`d:\`" and select "Read/Write"

Under Target Server Properties | Console and Redirection

Turn on the check boxes for "Redirect Target I/O" and "Create Console Window"

(This last step allows any communication that would normally occur over the VME serial port console to instead be redirected over the Ethernet interface and appear in a text window on the PC, thus alleviating the need for another serial cable and console terminal.)

Annex C: Modifications documented by Prior

The requirement and available time for documentation during the initial Prior migration was minimal. The following is extracted from a brief document that was prepared by one of the developers and list some of the changes they had implemented during the migration. Some of this information may no longer be applicable here, but it is included for completeness, and may be a useful future reference

MEMO: DIINS Software on NT

April 4, 2000

(File location references updated 8 Jan 2001 & 20 Feb 2001)

File Location

The working directory for DIINS NT version is d:\diins\mainwin32
The project file is d:\diins\mainwin32\default.bld which contains three subprojects:

d:\diins\part1_win32.bld
d:\diins\part2_win32.bld
d:\diins\part3_win32.bld

Most of the NT-specific packages are in their original locations. The main program is d:\diins\system\taskmaster.ada.

DIINS configuration files are in d:\diins\cfg\realtime\win32.

Logon

User name: diins
Password: (See author)

Start AdaMulti

Double Click the shortcut to adamulti in d:\diins\mainwin32 directory or the icon on the desktop. Upon startup, AdaMulti automatically loads the default.bld project in d:\diins\mainwin32 which in turn contains part{1,2,3}_win32.bld.

In AdaMulti, double click default.bld to show the subprojects. Click the arrows on the right end of the subprojects to fold or unfold the subprojects. Double click an ada file will open the file with the AdaMulti editor.

The main program is specified in AdaMulti Builder by selecting the project (default.bld) and the menu Option/Ada/MainProgramName.

Use Build menu or Build button on the tool bar to build the project. See AdaMulti manual Getting Started for Windows for adding, deleting files from the project, and for building and debugging the project.

Debug

Click Debug button on AdaMulti window to open the debug window. Start running the program with Go button or Step/Next buttons. Click the green dot on the left of the source lines to toggle the breakpoints.

Main Changes Made

- ISIO_Definition in d:\diins\dct\realtime\serial\win32 is the serial interface for NT.

- Motorola and Intel chips store data in different orders in the memory. Conversion has been introduced to isio_mk29_driver_1 and isio_mk29_driver_2, and mk29_1_TransformRawRecord and mk29_2_TransformRawRecord packages.
  Pragma Bit_Order use System.High_Order_First is added for the data blocks defined in TransformRawRecord packages. As a result the size of the data blocks has to be adjusted. Sperry_MK29_Rec is now 36 bytes. Sperry_MK29_Rec.Block starts from the byte 16 instead of byte 15. Xfer.buffer size has been increased to 36 to match to Sperry_MK29_Rec. One dummy byte is added to the buffer after 15th byte of sensor data. Bytes swapping routine is added to the TransformRawRecord and is called before converting Xfer.buffer to Sperry_MK29_Rec.

- The package Display is stubbed.
- Epoch_year is now 2001
- Set System Time stubbed to PC time (Otherwise pre-recorded GPS data resets PC Clock) **** NOTE **** This stub has been removed. PC time is now set to the GPS date and time (taking the time zone into effect). If no GPS time or date, the PC time will be set to 00:00 1 Jan 2001. If GPS time is available but no date, then the PC time be set to the GPS time of day and the date will default to 1 Jan 2001.
- Fixed a bug in TimeUtilities.YYYYDDDHHMMSS routine.
- Removed LumDebug.
- In ReadDataRates, added DontUseMyClock to ClockEnum to read the setup file properly.
- In SimConfig, tempBuffer size is reduced to 128.
- In SimConfig, replace some of the loop variable I with J.
- In Assign package a local variable MyStateEnable is defined and is a copy of the StateEnable parameter upon initialization. This is because the assign routines seem to get wrong stateenable values and cause exception.
- In TaskMaster and Prefilter, Prefilter ID is passed as parameter when the TaskMaster creates prefilters, instead of using a global variable. Delay between creation of prefilters seems still necessary to properly initialize the prefilters.
- DataLogger is only using LOCAL_DISK.
- DataLogger Writer Task may start to access mailbox before the mailbox initialization is completely done. Added delay at the begining of the Writer task.

- In FDI add ReconfigurationRequired := FDI_TaskType.ReconfigurationRequired; Otherwise prefilter gets a bad SensorStatusHasChanged from FDI which invokes exception.

- In FDI.ada Initialize MostAccAidInFilterArr (to 1) and LeastAccAidInFilterArr (to 0) to avoid the exception from ID_BestFilterForDisplay when ReconfigFDI is called for the first time.

Language and Compiler related changes

- In MatheLibraryExtension, Atan is replaced by Actan.
- Numeric_Error exception is handled by Constraint_Error, handler is removed.
- File_Utilities package cannot be found, replaced by TIO (in WriteSimConfig, WriteFilterInitData, SimSetupData).
- Math_Library.Math is replaced by Numerics.Generic_Elementary_Functions.
- Add Pragma Elaborate_Body in Scientific, StandardIO, SystemIndexGeneric.
- No Set_Time package. SetCalendarTime is added to TimeUtilities.
- Ada Calendar.Clock returns local, not UTC time. Added a Get_Time routine instead that uses the Win32 API call to GetSystemTime to get the current UTC time.
- Pragma Images is not supported and is no need any more.
- Pragma Preserve_Layout is not supported. Removed.
- Storage_Size attribute for tasks is obsolete and is replaced by Pragma Storage_Size.

Compiler issues

- In D:\DIINS\MAINWIN32\ADA.LIB added the lines:
```
PATH
        ELABPATH  d:\green\win32_adabindings
        PATHNAME d:\green\win32_adabindings
        ELABPATH  d:\green\adalib
ENDPATH
```
-

Annex D: Move of Green Hills compiler:

At one point it was necessary to move the Ada compiler from c:\green to d:\green. Rather than remove and re-install the program, the following steps were found to be sufficient:

- Copy c:\green to d:\green

- Change all shortcuts on the desktop and Start menu

- In the Windows registry, change all c:\green to d:\green

- In Control Panel, stop the Elan Licence manager and rename the directory of the licence keys from c:\green to d:\green, and restart

- In any and all DIINS *.bld compiler build files, change c:\green to d:\green

- In \DIINS\MAINPPC\ADA.LIB file (and/or \diins\mainwin32\ada.lib) change c:\green to d:\green.

- Rebuild DIINS

Annex E: Sample of ASCII output of VME and PC DIINS Systems running simultaneously

The following Table is a sample of the first few seconds of ASCII output data taken from the two DIINS systems (the VME and the PC platforms) when simultaneously processing the same sensor data. (See Section 8.2.2 for more details.) The beginnings of the streams have been edited out. The sequences are shown beginning with the first integrated output sentence ($INGLL) from DIINS, and ending with the 7th $INGLL sentence some 9 seconds (7x1.28) seconds later.

***Table 20. Sample** ASCII output of the two DIINS systems*

OUTPUT OF VME DIINS	OUTPUT OF PC DIINS
$INGLL,4520.8304,N,07553.3013,W,181422.25,A*04	$INGLL,4520.8304,N,07553.3013,W,181422.32,A*02
$INHDT,248.563,T*2B	$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.015,M,3.9,N,3.9,E,9.5,C,1011012*51	$PDRO1,0.000,T,0.015,M,3.9,N,3.9,E,9.5,C,1011012*51
$PDRO2,248.563,-0.659,0.378*1C	$PDRO2,248.563,-0.659,0.378*1C
$PDRO2,248.563,-0.659,0.381*1A	$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.656,0.384*10	$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.558,-0.656,0.376*15	$PDRO2,248.558,-0.656,0.376*15
$PDRO2,248.563,-0.665,0.381*15	$PDRO2,248.563,-0.665,0.381*15
$PDRO2,248.558,-0.656,0.384*18	$PDRO2,248.558,-0.656,0.384*18
$HESTN,01*69	$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181423.53,A*00	$HEGLL,4520.9196,N,07553.1024,W,181423.62,A*02
$HEHDT,248.560,T*22	$HEHDT,248.560,T*22
$HEVTG,0.000,T,,M,0.014084,N,0.026084,K*7B	$HEVTG,0.000,T,,M,0.014084,N,0.026084,K*7B
$HESTN,02*6A	$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181423.53,A*00	$HEGLL,4520.9196,N,07553.1024,W,181423.62,A*02
$HEHDT,248.560,T*22	$HEHDT,248.560,T*22
$HEVTG,0.000,T,,M,0.014084,N,0.026084,K*7B	$HEVTG,0.000,T,,M,0.014084,N,0.026084,K*7B
$PDRO2,248.563,-0.656,0.384*10	$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.656,0.384*10	$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.656,0.381*15	$GPSTN,01*73
$GPSTN,01*73	$GPGGA,181423.00,4520.8310,N,07553.3000,W,1,,1.0,,,,,,*4C
$GPGGA,181423.00,4520.8310,N,07553.3000,W,1,,1.0,,,,,,*4C	$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60	$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.659,0.373*17	$PDRO2,248.563,-0.659,0.373*17
$PDRO2,248.563,-0.659,0.381*1A	$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.656,0.384*10	$PDRO2,248.563,-0.656,0.384*10
$GPSTN,02*70	$GPSTN,02*70
$GPGGA,181423.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*40	$GPGGA,181423.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*40
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60	$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.384*1F	$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.656,0.384*10	$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.558,-0.656,0.384*18	$PDRO2,248.558,-0.656,0.384*18
$PDRO2,248.563,-0.656,0.378*13	$PDRO2,248.563,-0.656,0.378*13
$PDRO2,248.563,-0.656,0.384*10	$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.656,0.381*15	$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.659,0.384*1F	$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.656,0.381*15	$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.381*15	$GPSTN,01*73
$GPSTN,01*73	$GPGGA,181424.00,4520.8310,N,07553.3000,W,1,,1.0,,,,,,*4B
$GPGGA,181424.00,4520.8310,N,07553.3000,W,1,,1.0,,,,,,*4B	$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60	$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.384*10	$PDRO2,248.563,-0.656,0.384*10
$HESTN,01*69	$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181424.82,A*0B	$HEGLL,4520.9196,N,07553.1024,W,181424.90,A*08
$HEHDT,248.566,T*24	$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.008735,N,0.016177,K*75	$HEVTG,0.000,T,,M,0.008735,N,0.016177,K*75
$HESTN,02*6A	$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181424.82,A*0B	$HEGLL,4520.9196,N,07553.1024,W,181424.90,A*08
$HEHDT,248.566,T*24	$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.008735,N,0.016177,K*75	$HEVTG,0.000,T,,M,0.008735,N,0.016177,K*75
$PDRO2,248.563,-0.659,0.381*1A	$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.558,-0.659,0.381*12	$PDRO2,248.558,-0.659,0.381*12
$GPSTN,02*70	$GPSTN,02*70
$GPGGA,181424.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*47	$GPGGA,181424.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*47
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60	$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.656,0.381*15	$INGLL,4520.8304,N,07553.3012,W,181423.62,A*07
$INGLL,4520.8304,N,07553.3012,W,181423.53,A*05	$INHDT,248.563,T*2B
$INHDT,248.563,T*2B	$PDRO2,248.563,-0.656,0.381*15

```
$PDRO1,0.000,T,0.012,M,3.7,N,3.7,E,9.2,C,1011012*51
$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.656,0.376*1D
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.659,0.381*1A
$GPSTN,01*73
$GPGGA,181425.00,4520.8310,N,07553.3000,W,1,,1.0,,,,,,*4A
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.656,0.384*10
$GPSTN,02*70
$GPGGA,181425.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*46
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8304,N,07553.3013,W,181424.82,A*0F
$INHDT,248.558,T*23
$PDRO1,0.000,T,0.007,M,3.7,N,3.7,E,9.0,C,1011012*57
$PDRO2,248.563,-0.656,0.381*15
$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181426.09,A*0A
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.014084,N,0.026084,K*7B
$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181426.09,A*0A
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.014084,N,0.026084,K*7B
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.569,-0.662,0.381*18
$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.384*10
$GPSTN,01*73
$GPGGA,181426.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*48
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.659,0.378*1C
$PDRO2,248.563,-0.656,0.376*1D
$GPSTN,02*70
$GPGGA,181426.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*45
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8304,N,07553.3013,W,181426.09,A*0E
$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.005,M,3.6,N,3.6,E,8.9,C,1011012*5D
$PDRO2,248.563,-0.662,0.381*12
$PDRO2,248.558,-0.656,0.387*1B
$PDRO2,248.563,-0.662,0.384*17
$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181427.37,A*06
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.011049,N,0.020462,K*75
$PDRO2,248.563,-0.656,0.384*10
$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181427.37,A*06
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.011049,N,0.020462,K*75
$PDRO2,248.563,-0.656,0.378*13
$PDRO2,248.563,-0.659,0.376*12
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.656,0.387*13
$GPSTN,01*73
$GPGGA,181427.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*49
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.659,0.376*12
$PDRO2,248.563,-0.665,0.384*10
$GPSTN,02*70
$GPGGA,181427.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*44
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8304,N,07553.3011,W,181427.37,A*00
$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.075,M,3.6,N,3.6,E,8.8,C,1011012*5B
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.657,0.387*12
$HESTN,02*6A
```

```
$PDRO1,0.000,T,0.012,M,3.7,N,3.7,E,9.2,C,1011012*51
$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.656,0.376*1D
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.659,0.381*1A
$GPSTN,01*73
$GPGGA,181425.00,4520.8310,N,07553.3000,W,1,,1.0,,,,,,*4A
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.656,0.384*10
$GPSTN,02*70
$GPGGA,181425.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*46
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8304,N,07553.3013,W,181424.90,A*0C
$INHDT,248.558,T*23
$PDRO1,0.000,T,0.007,M,3.7,N,3.7,E,9.0,C,1011012*57
$PDRO2,248.563,-0.656,0.381*15
$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181426.17,A*05
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.014084,N,0.026084,K*7B
$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181426.17,A*05
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.014084,N,0.026084,K*7B
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.569,-0.662,0.381*18
$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.381*15
$PDRO2,248.563,-0.656,0.384*10
$GPSTN,01*73
$GPGGA,181426.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*48
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.659,0.378*1C
$PDRO2,248.563,-0.656,0.376*1D
$GPSTN,02*70
$GPGGA,181426.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*45
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8304,N,07553.3013,W,181426.17,A*01
$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.005,M,3.6,N,3.6,E,8.9,C,1011012*5D
$PDRO2,248.563,-0.662,0.381*12
$PDRO2,248.558,-0.656,0.387*1B
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.656,0.384*10
$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181427.45,A*03
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.011049,N,0.020462,K*75
$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181427.45,A*03
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.011049,N,0.020462,K*75
$PDRO2,248.563,-0.656,0.378*13
$PDRO2,248.563,-0.659,0.376*12
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.656,0.387*13
$GPSTN,01*73
$GPGGA,181427.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*49
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.656,0.384*10
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.659,0.376*12
$PDRO2,248.563,-0.665,0.384*10
$GPSTN,02*70
$GPGGA,181427.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*44
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8304,N,07553.3011,W,181427.45,A*05
$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.075,M,3.6,N,3.6,E,8.8,C,1011012*5B
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.665,0.384*10
$PDRO2,248.563,-0.657,0.387*12
$PDRO2,248.563,-0.657,0.384*11
```

```
$HEGLL,4520.9196,N,07553.1024,W,181428.66,A*0D
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.012353,N,0.022877,K*74
$PDRO2,248.563,-0.657,0.384*11
$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181428.66,A*0D
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.012353,N,0.022877,K*74
$GPSTN,01*73
$GPGGA,181428.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*46
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.657,0.379*13
$PDRO2,248.563,-0.657,0.381*14
$GPSTN,02*70
$GPGGA,181428.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*4B
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.379*1D
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.659,0.384*1F
$GPSTN,01*73
$GPGGA,181429.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*47
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.381*14
$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181429.93,A*06
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.008735,N,0.016177,K*75
$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181429.93,A*06
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.008735,N,0.016177,K*75
$PDRO2,248.563,-0.654,0.381*17
$PDRO2,248.558,-0.657,0.381*1C
$GPSTN,02*70
$GPGGA,181429.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*4A
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8305,N,07553.3010,W,181428.66,A*0B
$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.094,M,3.6,N,3.6,E,8.7,C,1011012*5B
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.558,-0.657,0.387*1A
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.378*12
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.657,0.378*12
$PDRO2,248.563,-0.659,0.384*1F
$GPSTN,01*73
$GPGGA,181430.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*4F
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.657,0.376*1C
$GPSTN,02*70
$GPGGA,181430.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*42
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8305,N,07553.3009,W,181429.93,A*08
$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.099,M,3.5,N,3.5,E,8.7,C,1011012*56
```

```
$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181428.74,A*0E
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.012353,N,0.022877,K*74
$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181428.74,A*0E
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.012353,N,0.022877,K*74
$GPSTN,01*73
$GPGGA,181428.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*46
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.657,0.379*13
$PDRO2,248.563,-0.657,0.381*14
$GPSTN,02*70
$GPGGA,181428.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*4B
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.379*1D
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.563,-0.662,0.384*17
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.563,-0.657,0.384*11
$GPSTN,01*73
$GPGGA,181429.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*47
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.381*14
$HESTN,01*69
$HEGLL,4520.9196,N,07553.1024,W,181430.01,A*05
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.008735,N,0.016177,K*75
$HESTN,02*6A
$HEGLL,4520.9196,N,07553.1024,W,181430.01,A*05
$HEHDT,248.566,T*24
$HEVTG,0.000,T,,M,0.008735,N,0.016177,K*75
$PDRO2,248.563,-0.654,0.381*17
$PDRO2,248.558,-0.657,0.381*1C
$GPSTN,02*70
$GPGGA,181429.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*4A
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8305,N,07553.3010,W,181428.74,A*08
$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.094,M,3.6,N,3.6,E,8.7,C,1011012*5B
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.558,-0.657,0.387*1A
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.378*12
$PDRO2,248.563,-0.657,0.384*11
$PDRO2,248.563,-0.657,0.378*12
$PDRO2,248.563,-0.659,0.384*1F
$GPSTN,01*73
$GPGGA,181430.00,4520.8310,N,07553.2990,W,1,,1.0,,,,,,*4F
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$PDRO2,248.563,-0.659,0.381*1A
$PDRO2,248.563,-0.657,0.381*14
$PDRO2,248.563,-0.659,0.384*1F
$PDRO2,248.563,-0.657,0.376*1C
$GPSTN,02*70
$GPGGA,181430.00,4520.8303,N,07553.3014,W,2,,0.9,,,,,,*42
$GPVTG,0.000,T,,M,0.000000,N,0.000000,K*60
$INGLL,4520.8305,N,07553.3009,W,181430.01,A*0B
$INHDT,248.563,T*2B
$PDRO1,0.000,T,0.099,M,3.5,N,3.5,E,8.7,C,1011012*56
```

Annex F: Use of "extract_data" to extract sensor and DIINS filter data

There are two versions of the extract_data program. One will extract raw sensor data stored exactly as broadcast by the sensor ("extract_pure_sensor_data"). The other will extract formatted sensor and filter data tagged with DIINS time stamps. Each is described via example in this section.

Extraction of data from a 7 filter DIINS data logging run is demonstrated this section. The file that was generated was called `ST2001_114-1457.dat`, indicating Julian day 113 of year 2001, at time 18:13 GMT. Note that DIINS automatically starts new data files after every 2 hours, each with a similar naming convention. The file was placed in `D:\DIINS\RESULTS`.

F.1 Extracting Pure Sensor Data

To extract absolutely raw sensor data (bit for bit exactly as it was recorded, but with no timing information), one can use the PC ported version of "extract_pure_sensor_data", which currently resides at

D:\DIINSUTILS\EXTRACT_DATA\extract_pure_sensor_data.exe

When this program is used without arguments it displays the usage syntax

```
Syntax: extract_pure_sensor_data [-MK29-1] [-MK29-2] [-GPS_NMEA-1] [-GPS_NMEA-2]
      <filename>Display off (-v), , SplitFiles off (-s), No Multiple files (-f),
      No Compressed (-z)
```

To extract the raw data from the four sensors used in the test in Section 8.2.3, use:

```
d:\diinsutils\extract_data\extract_pure_sensor_data -MK29-1 ST2001_114-1457.dat
d:\diinsutils\extract_data\extract_pure_sensor_data -MK29-2 ST2001_114-1457.dat
d:\diinsutils\extract_data\extract_pure_sensor_data -GPS_NMEA-1 ST2001_114-1457.dat
d:\diinsutils\extract_data\extract_pure_sensor_data -GPS_NMEA-2 ST2001_114-1457.dat
```

These will create the following raw sensor data files:

```
Rgps_nmea-1_ST2001_114-1457.bin
Rgps_nmea-2_ST2001_114-1457.bin
Rmk29-1_ST2001_114-1457.bin
Rmk29-2_ST2001_114-1457.bin
```

These files are useful for verifying proper sensor operation and recording, and can be used in the PC-based sensor data spewers "GPSOUT" and MK29OUT".

F.2. Extracting Formatted Sensor and Kalman Filter Data

To extract data that has timing information and that has been formatted in columns for ease of use in plotting and other software packages, use the PC ported version of "extract_data", which currently resides at

D:\DIINSUTILS\EXTRACT_DATA\Extract_Data.exe

When this program is used without arguments it displays the usage syntax:

```
Syntax: extract_data [-TANS] [-GPS_TIPY-1] [-GPS_TIPY-2] [-GPS_NMEA-1] [-GPS_NMEA-2]
                [-MK29-1] [-MK29-2] [-LC360] [-PRES] [-PDIS] [-PSTA] <filename>
                Display (-v), Binary (-b), SplitFiles (-s), Multiple files (-f),
                Compressed Output (-z/-gz), -use_gps_time [-DIINS_FORMAT]
Assumes ($R0=GPS_NMEA-1), ($R1=MK29-1), ($R2=MK29-2), ($R3=LC360)
        ($R4=GPS_NMEA-2), ($R5=GPS_TIPY-1), ($R6=GPS_TIPY-2), ($R7=TANS)
```

F.2.1. Formatted Sensor Data

To extract the formatted sensor data with timing information, use the following commands:

```
d:\diinsutils\extract_data\extract_data -MK29-1 ST2001_114-1457.dat
d:\diinsutils\extract_data\extract_data -MK29-2 ST2001_114-1457.dat
d:\diinsutils\extract_data\extract_data -GPS_NMEA-1 ST2001_114-1457.dat
d:\diinsutils\extract_data\extract_data -GPS_NMEA-2 ST2001_114-1457.dat
```

(Note that these write ASCII versions of the files. The use of the "-b" will extract binary formatted files which can be converted to ASCII with the "bin2ascii" utility).

The files created from the above commands are:

mk29-1_ST2001_114-1457_a.asc	(INS1 attitude)
mk29-1_ST2001_114-1457_p.asc	(INS1 position)
mk29-1_ST2001_114-1457_s.asc	(INS1 status)
mk29-1_ST2001_114-1457_v.asc	(INS1 velocity)
mk29-2_ST2001_114-1457_a.asc	(INS2 attitude)
mk29-2_ST2001_114-1457_p.asc	(INS2 position)
mk29-2_ST2001_114-1457_s.asc	(INS2 status)
mk29-2_ST2001_114-1457_v.asc	(INS2 velocity)
gps_nmea-1_ST2001_114-1457.asc	(GPS1 Position)
gps_nmea-2_ST2001_114-1457.asc	(GPS2 position)

The fields in these data files are as shown in Table 21.

Table 21. *Fields in Sensor data files created by "extract_data"*

FILE	FIELD	DATA
INS POSITION FILE	1	INS_Pos.DIINS_Time,
	2	INS_Pos.status,
	3	INS_Pos.latitude,
	4	INS_Pos.longitude,
	5	INS_Pos.Depth,
	6	INS_Pos.InternalFix,
	7	INS_Pos.InternalLatCorrection,
	8	INS_Pos.InternalLonCorrection,
	9	INS_Pos.InternalHdgCorrection,
	10	INS_Pos.InternalLatStdDev,
	11	INS_Pos.InternalLonStdDev,
	12	INS_Pos.InternalHdgStdDev,
	13	INS_Pos.Internal_X_GyroBiasCorr,
	14	INS_Pos.Internal_X_GyroDriftCorr,
	15	INS_Pos.Internal_Y_GyroBiasCorr,
	16	INS_Pos.Internal_Y_GyroDriftCorr,
	17	INS_Pos.Internal_Z_GyroBiasCorr,
	18	INS_Pos.Internal_Z_GyroDriftCorr,
	19	INS_Pos.Internal_Z_GyroRampCorr
INS VELOCITY FILE	1	INS_Vel.DIINS_Time,
	2	INS_Vel.stat1us,
	3	INS_Vel.vn,
	4	INS_Vel.ve,
	5	INS_Vel.vd,
	6	INS_Vel.vn_rate,
	7	INS_Vel.ve_rate,
	8	INS_Vel.vd_rate
INS ATTITUDE FILE	1	INS_Att.DIINS_Time,
	2	INS_Att.status,
	3	INS_Att.roll,
	4	INS_Att.pitch,
	5	INS_Att.heading,
	6	INS_Att.roll_rate,
	7	INS_Att.pitch_rate,
	8	INS_Att.heading_rate
INS STATUS FILE	1	INS_Status.DIINS_Time,
	2	INS_Status.PerformanceDegraded,
	3	INS_Status.FineAlignSettled,
	4	INS_Status.InertialWellSettled,
	5	INS_Status.Mode,
	6	INS_Status.DampingMode,
	7	INS_Status.Damped,
	8	INS_Status.SKOR_Mode,
	9	INS_Status.SKOR_Status,
	10	INS_Status.FixSource,
	11	INS_Status.LogFailure,
	12	INS_Status.SystemFailure,
	13	INS_Status.SystemOnInternalBattery,
	14	INS_Status.VREF_Source,
	15	INS_Status.DocksideMode
NMEA GPS POSITION FILE (from GGA record)	1	GPS_NMEA_GGA.DIINS_Time,
	2	GPS_NMEA_GGA.UTC,
	3	GPS_NMEA_GGA.Latitude,
	4	GPS_NMEA_GGA.Longitude,
	5	GPS_NMEA_GGA.Quality,
	6	GPS_NMEA_GGA.NumPrn,
	7	GPS_NMEA_GGA.HDOP,
	8	GPS_NMEA_GGA.AntennaHeight,
	9	GPS_NMEA_GGA.GeoidalHeight);

F.2.2. Formatted Kalman Filter Data

To extract the Kalman filter's State, Residual and Display data with timing information, use the following commands:

```
d:\diinsutils\extract_data\extract_data -PSTA ST2001_114-1457.dat
d:\diinsutils\extract_data\extract_data -PRES ST2001_114-1457.dat
d:\diinsutils\extract_data\extract_data -PDIS ST2001_114-1457.dat
```

(Again, these write ASCII versions of the files. The use of the "-b" will extract binary.)

The files created from the above commands are:

psta1_ST2001_114-1457.asc psta2_ST2001_114-1457.asc psta3_ST2001_114-1457.asc psta4_ST2001_114-1457.asc psta5_ST2001_114-1457.asc psta6_ST2001_114-1457.asc psta7_ST2001_114-1457.asc	(Kalman state estimates for filters 1-7)
pres1_ST2001_114-1457.asc pres2_ST2001_114-1457.asc pres3_ST2001_114-1457.asc pres4_ST2001_114-1457.asc pres5_ST2001_114-1457.asc pres6_ST2001_114-1457.asc pres7_ST2001_114-1457.asc	(Kalman residuals for filters 1-7)
pdis1_ST2001_114-1457.asc pdis2_ST2001_114-1457.asc pdis3_ST2001_114-1457.asc pdis4_ST2001_114-1457.asc pdis5_ST2001_114-1457.asc pdis6_ST2001_114-1457.asc pdis7_ST2001_114-1457.asc	(Kalman filter display values for filters 1-7)

The fields within each of these State, Residual, and Display files vary for each filter, because each filter has a different sensor suite, and thus a different state vector. As part of the data logging process, DIINS writes out header files (as specified in the simsetup.cfg file) at run time that tell what fields are in these Kalman output data files.

These header files are typically called

```
State_LT2001_n.bRes.p
Res_LT2001_n.bRes.p
Disp_LT2001_n.bRes.p
```

and contain the fields in the State, Residual and Display files for filter *n*. We are usually most interested in the two DIINS unifilters (each which integrate one of the INS's with all available aids). These are usually filters numbered 2 and 3. The fields of the State, Residual and Display Kalman filter files for the INS1 unifilter are shown in Table 22.

Table 22. Fields in INS1 Unifilter (filter 2) Kalman data files created by "extract_data"

FILE	FIELD	DATA
State file `State_LT2001_2.bRes.p`	1	Time
	2	State(X_POS_ERR)
	3	State(Y_POS_ERR)
	4	State(X_VEL_ERR)
	5	State(Y_VEL_ERR)
	6	State(X_ATT_ERR)
	7	State(Y_ATT_ERR)
	8	State(Z_ATT_ERR)
	9	State(X_ACCEL_BIAS_ERR)
	10	State(Y_ACCEL_BIAS_ERR)
	11	State(X_GYRO_BIAS_ERR)
	12	State(Y_GYRO_BIAS_ERR)
	13	State(Z_GYRO_BIAS_ERR)
	14	State(X_GPS1_POS_ERR)
	15	State(Y_GPS1_POS_ERR)
	16	State(X_GPS2_POS_ERR)
	17	State(Y_GPS2_POS_ERR)
	18	State(X_LOG_VEL_ERR)
	19	State(Y_LOG_VEL_ERR)
	20	P_Mx(X_POS_ERR)
	21	P_Mx(Y_POS_ERR)
	22	P_Mx(X_VEL_ERR)
	23	P_Mx(Y_VEL_ERR)
	24	P_Mx(X_ATT_ERR)
	25	P_Mx(Y_ATT_ERR)
	26	P_Mx(Z_ATT_ERR)
	27	P_Mx(X_ACCEL_BIAS_ERR)
	28	P_Mx(Y_ACCEL_BIAS_ERR)
	29	P_Mx(X_GYRO_BIAS_ERR)
	30	P_Mx(Y_GYRO_BIAS_ERR)
	31	P_Mx(Z_GYRO_BIAS_ERR)
	32	P_Mx(X_GPS1_POS_ERR)
	33	P_Mx(Y_GPS1_POS_ERR)
	34	P_Mx(X_GPS2_POS_ERR)
	35	P_Mx(Y_GPS2_POS_ERR)
	36	P_Mx(X_LOG_VEL_ERR)
	37	P_Mx(Y_LOG_VEL_ERR)
	38	ChiSq
Residual File `Res_LT2001_2.bRes.p`	1	Time
	2	Residual(X_GPS1_POS_MEAS)
	3	Residual(Y_GPS1_POS_MEAS)
	4	Residual(X_GPS2_POS_MEAS)
	5	Residual(Y_GPS2_POS_MEAS)
	6	Residual(X_LOG_VEL_MEAS)
	7	Residual(Y_LOG_VEL_MEAS)
	8	ResVar(X_GPS1_POS_MEAS)
	9	ResVar(Y_GPS1_POS_MEAS)
	10	ResVar(X_GPS2_POS_MEAS)
	11	ResVar(Y_GPS2_POS_MEAS)
	12	ResVar(X_LOG_VEL_MEAS)
	13	ResVar(Y_LOG_VEL_MEAS)
Display File `Disp_LT2001_2.bRes.p`	1	Time
	2	Latitude
	3	Longitude
	4	Height
	5	VelG_X
	6	VelG_Y
	7	VelG_Z
	8	Roll
	9	Pitch
	10	Heading
	11	WanderAngle

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This report documents the results of work required to migrate the DIINS (Dual Inertial Integrated Navigation System) software from its former platform, consisting of a unix-based Sparc host system and Motorola 68030 VME target system under a Telesoft Ada83 compiler and run-time executive, to a new Green Hills Ada95 NT development environment and two new run-time platforms: a PowerPC604 VME target system running VxWorks 5.4, and a generic personal computer running Windows NT 4.0. The migration is not entirely complete, though both new run-time platforms are running satisfactorily to a great extent. This document records the status of the migration, presents some results of the systems in real-time laboratory trials, and identifies issues that need to be explored more fully if the migrated DIINS systems are to be deployed in operational environments.

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DIINS; Dual Inertial Integrated Navigation System

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