

Rapid Application Development of a Demonstrator Radar Signal Processor Using Gedae



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Automatic Code Generation Session

ESS 2004

Presentation Content

- Introduction
- The Gedae toolset
- History of AMS' evaluation of Gedae
- Development of demonstrator radar signal processor for HF Surface Wave Radar
- Conclusions

Defence Software Development

- Typical modern defence products require complex software applications to be deployed on multiprocessor platforms.
- A typical process to develop complex software has:
 - A document driven sequence of manual translations
 - Rigorous verification at each translation to prevent defects
 - Fragmented teams, responsible for different stages
 - Expensive maintenance to keep work products aligned

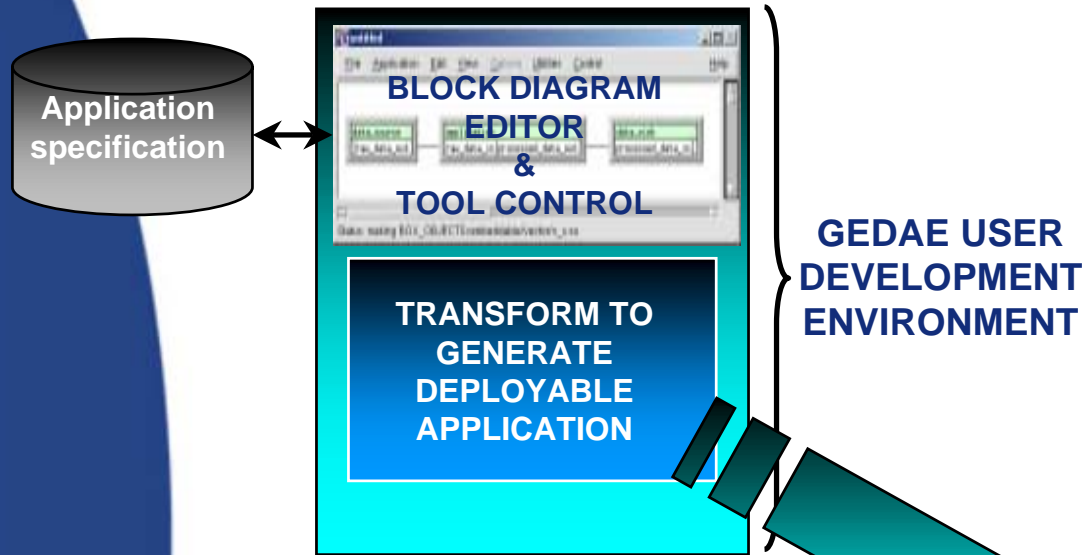
A Solution

- An integrated development environment which:
 - Abstracts the application from the final target
 - complex functionality is more easily represented
 - Allows a single representation of the application to evolve rapidly to final deployment
 - Merges development stages
 - Removes costly translations and maintenance
 - Unifies the development team
- Gedae rated as the 'Best in Class' rapid application development tool available (by The ESPADON^[1] Programme)
- Gedae - (Graphical Entry Distributed Application Environment)
Gedae, Inc.'s rapid application development toolset.

[1]The ESPADON Consortium, Madahar, B. et al. 'Technical Seminar. Embedded Systems Show 17th May 2001, Rapid Prototyping and Virtual Prototyping.' ExCel ESS 2001 16-17 May, 01. London UK



The Gedae Toolset Enables

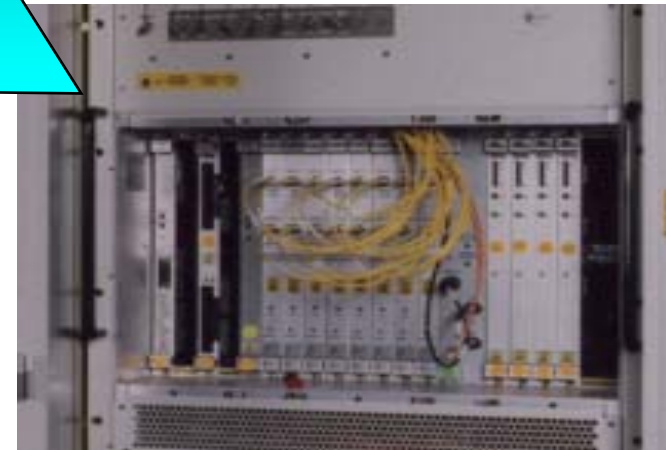


Graphical programming of application specifications using a block diagram language to capture:

- Signal processing,
- Data processing,
- Application control.

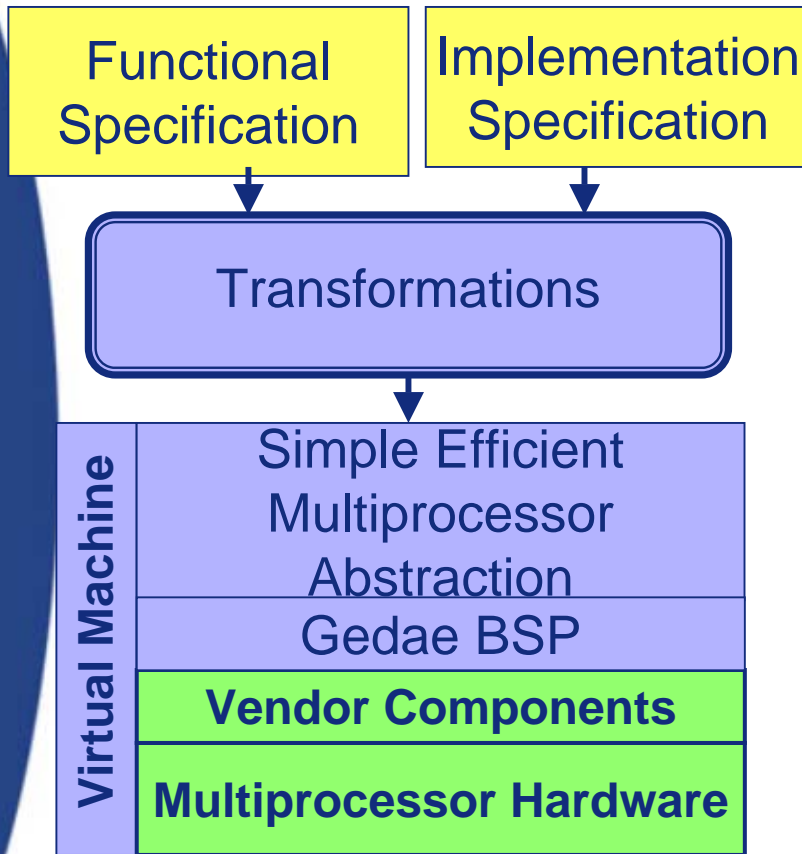
Transformation of the application specification , under user control, to give an executable implementation on:

- A single workstation,
- Networked workstations,
- Embedded multiprocessor systems,
- Heterogeneous systems (RISC/DSP/FPGA).

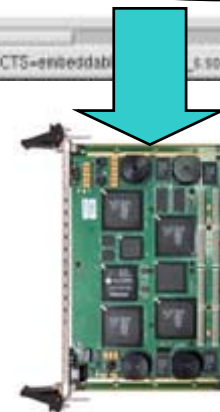
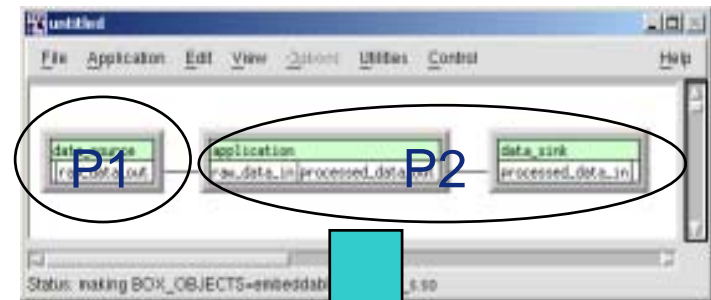


The Gedae Toolset Structure

Application Specification



5) A Gedae Board Support Package (BSP), using vendor's optimised maths and comms libraries, enables efficient deployment of the application specification to target hardware



The Gedae Toolset

- The graphical application specification generated **IS** the executable:
 - platform independence
 - execution / test on both host and embedded target platforms
 - specification changes automatically reflected in the executable
 - layered toolset structure gives an efficient executable for the chosen platform
 - no need to write inter-processor communications code
 - no costly embedding and inter-processor integration / debugging effort
- A single workproduct (the application specification) is maintained throughout, (not separate documents and source code)

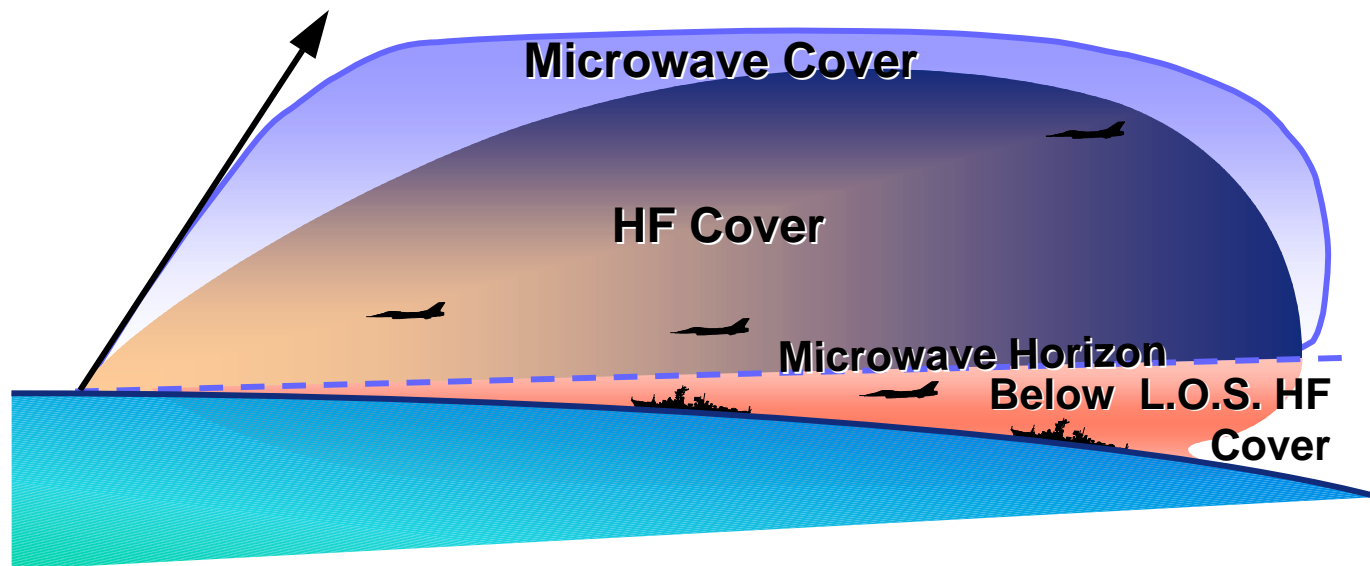
History of AMS' Gedae Evaluation

- 1998-2000
 - Graphical application modelling
 - Workstation simulation and execution.
 - Automatic code generation.
 - Embedded execution on multiprocessor COTS.
- 2001
 - Custom primitives
 - Real time peripheral control (ADC)
 - Stand-alone executable creation
- 2002
 - Mode control of 'real' application
 - HCI building
 - Multi-engineer group project working / change management

Suitability of Gedae for a 'real' SPU?

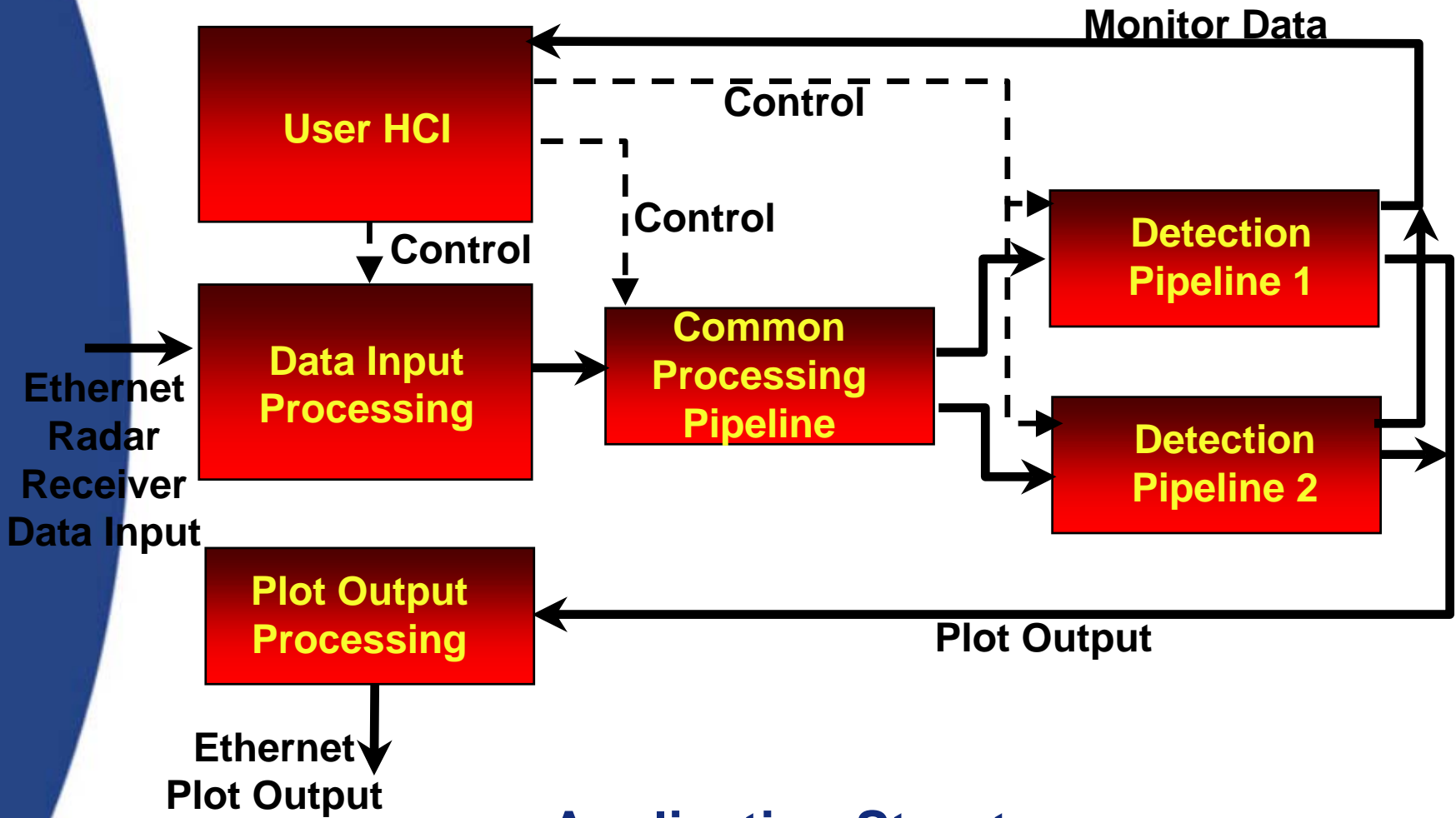
- 1998 to 2002 evaluation proved Gedae is good for producing pure application executable prototypes
- An executable specification for a 'real' SPU must also implement the following SPU support functionality:
 - Peripheral I/O control
 - Error Handling
 - Application control (by user and / or external non-Gedae software)
 - Calibration
 - Monitoring
 - Diagnostics/BIT/reconfigurability
 - Trials recording
- Must also meet performance and reliability requirements

2002 to Present – Real time Gedae signal processing unit developed for HF Surface Wave Radar (HFSWR) demonstrator



- HFSWR - Over the horizon target detection and tracking
- AMS HFSWR Customer Demonstrator Facility
- Evaluation of performance of a Gedae SPU in a real application

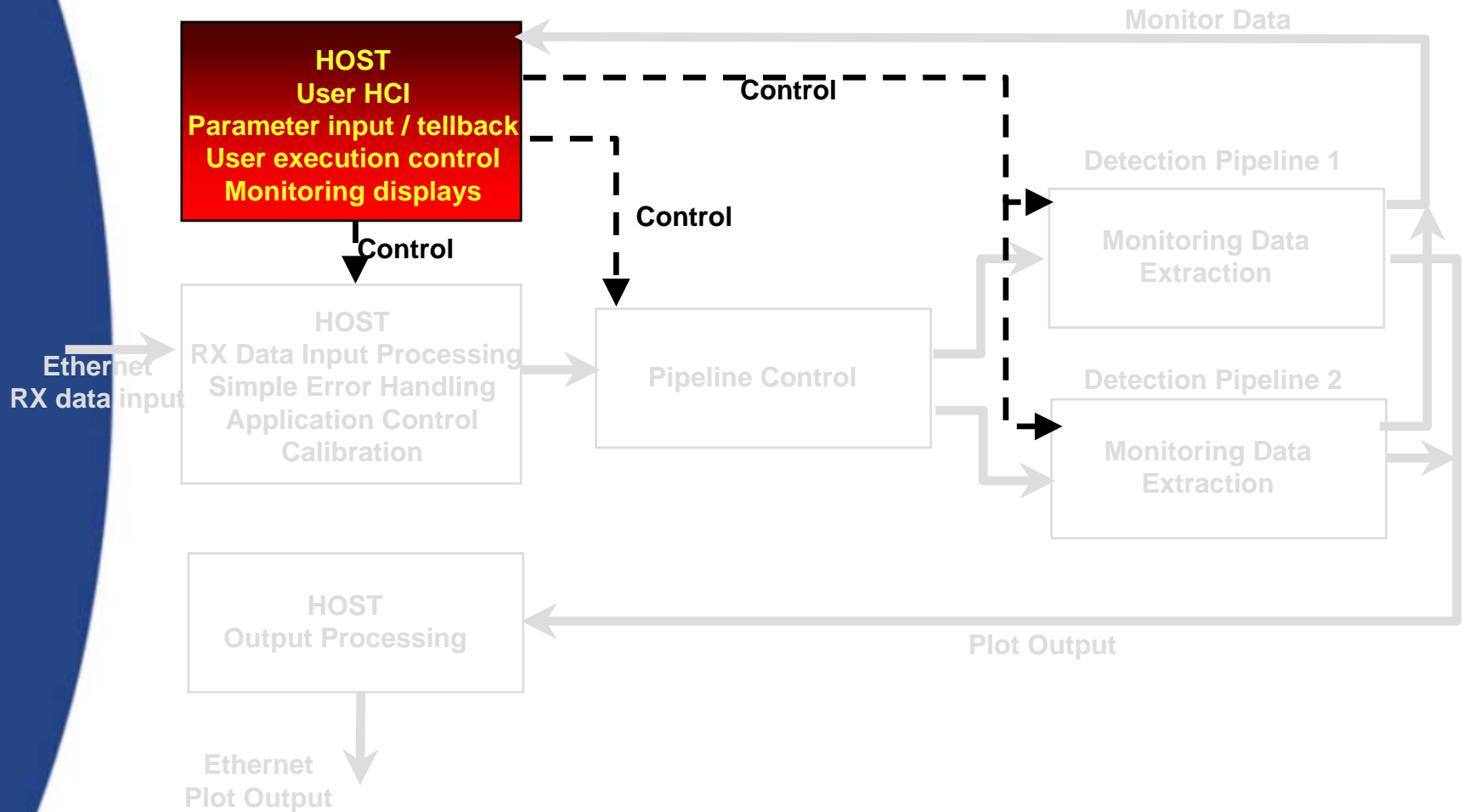
HFSWR Demonstrator Gedae SPU Application



Application Structure



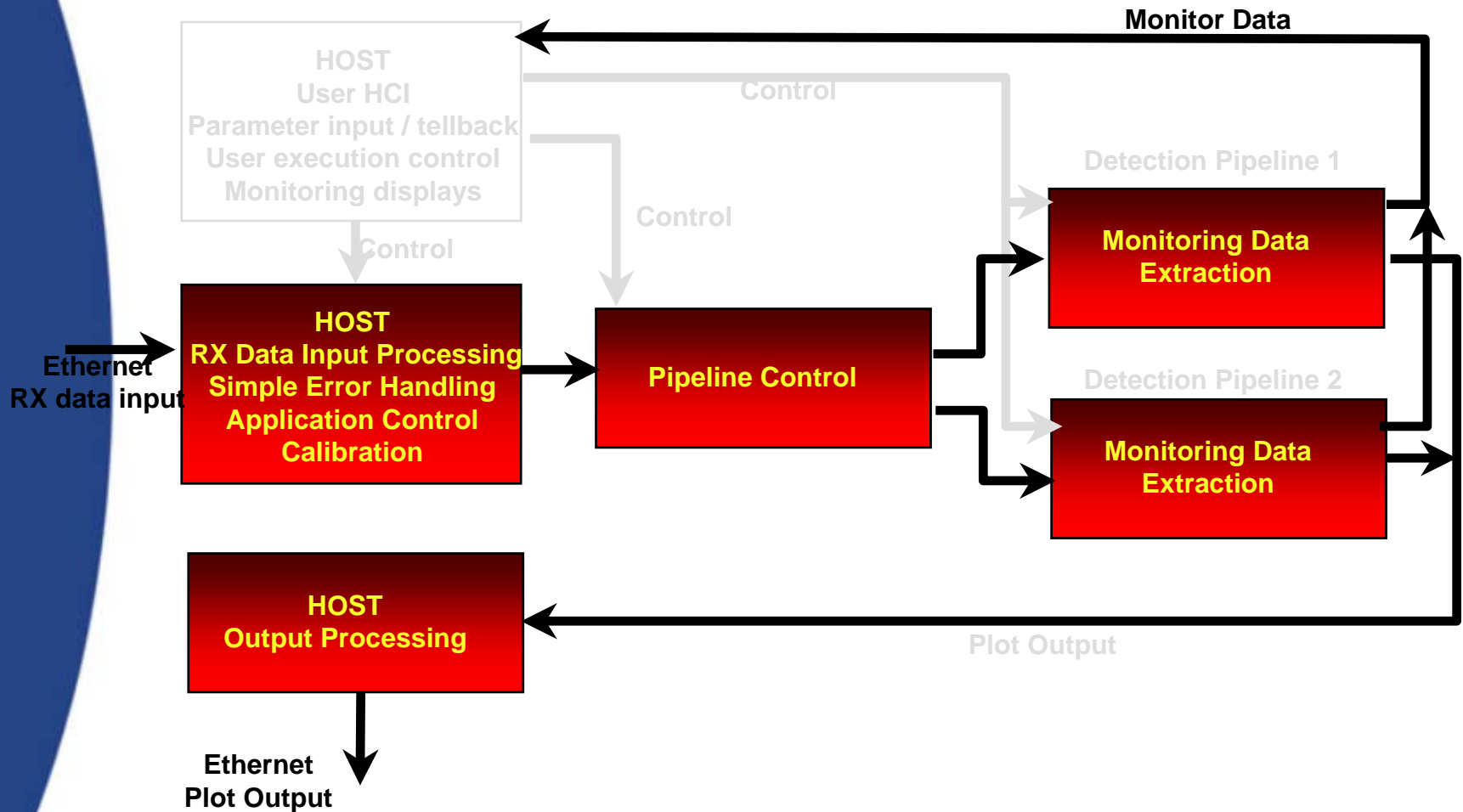
HFSWR Demonstrator Gedae SPU Application



User HCI



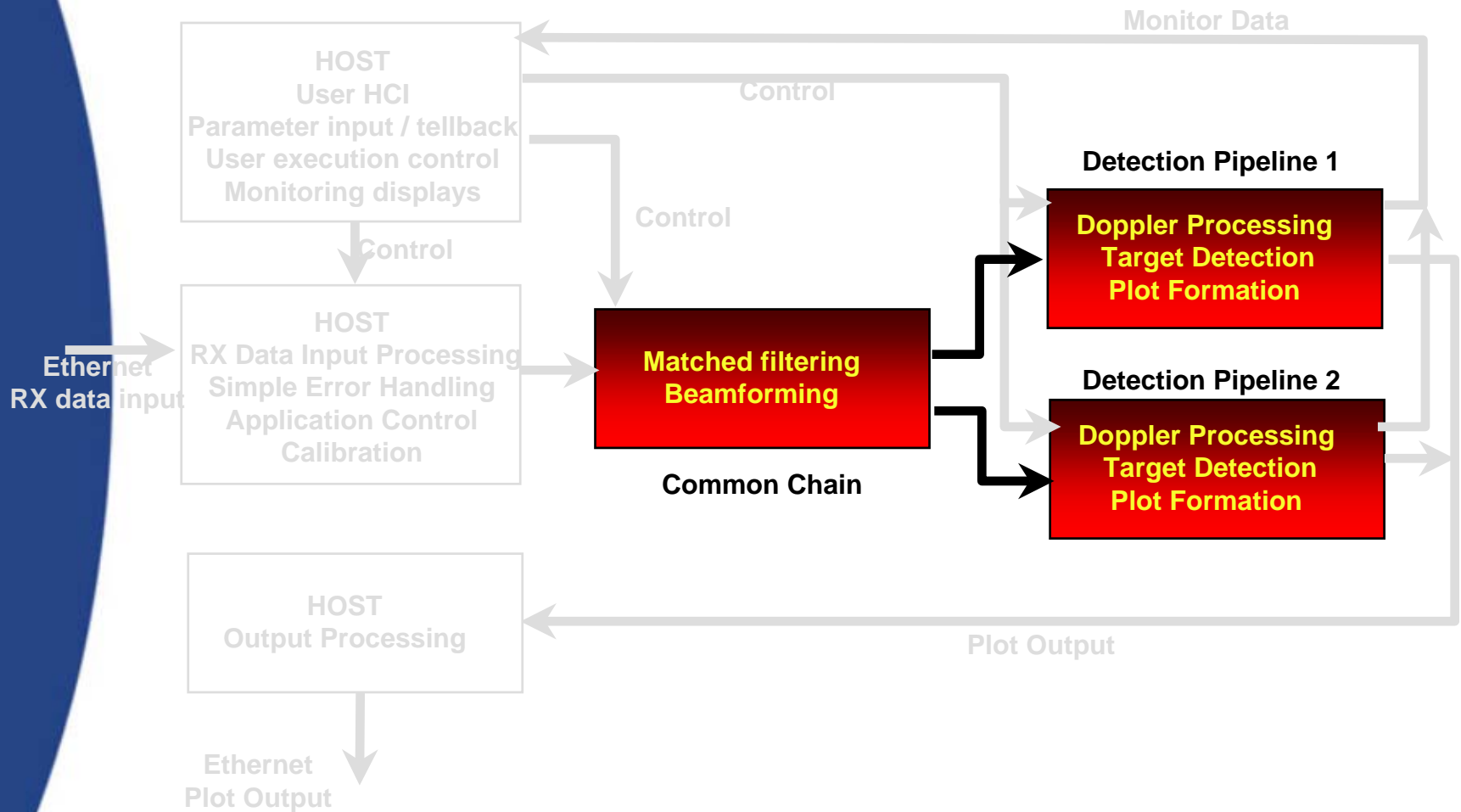
HFSWR Demonstrator Gedae SPU Application



Infrastructure



HFSWR Demonstrator Gedae SPU Application



Signal Processing



Integrated at HFSWR Customer Demonstration Facility

Transmit / Receive Buildings



Console



Amplifiers



Signal Processor Unit



Transmit / Receive Antenna Array



Receivers / WFG



Support Functionality

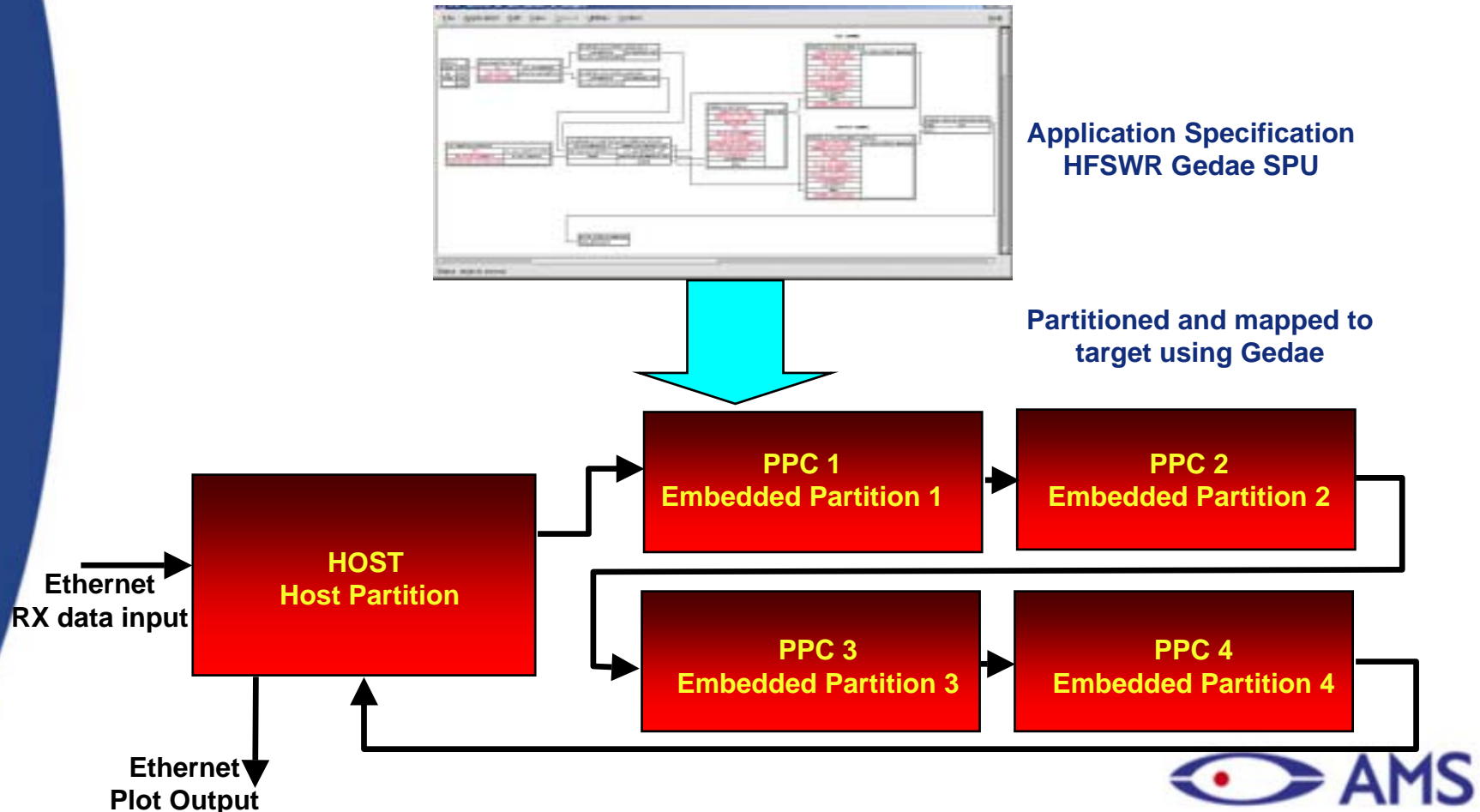
- Development of the HFSWR Demonstrator Gedae Signal Processor Unit has enabled
 - exploration of Gedae capability in support functionality areas.
 - use of an iterative development process
- Iterations completed to date have proven Gedae can implement:
 - Peripheral I/O control
 - Simple error handling & recovery
 - Application control (by user and/or external non-Gedae software)
 - Calibration
 - Monitoring

Automatic Code Generation

- HFSWR SPU application contains a total of 153 primitive functions (each used 1 to N times)
- 125 primitives from Gedae library
- A degree of hand coding is necessary:
 - 28 custom primitive functions (1705 'C' source lines hand written)
 - Majority of hand coding for data flow control only, no hardware platform dependence. Although peripheral I/O control uses API to suitable device drivers
 - No embedded processor hardware specific code written - Application is totally portable
- Gedae provides all inter-processor communications code
- No costly embedding and inter-processor integration / debugging effort

Performance of HFSWR Gedae SPU

- Real-time operation achieved using COTS hardware with minimum optimisation effort:
 - Solaris host and 4 x 7400 PPC (AltiVecs) 333MHz



Tool Maturity

- Gedae released as product in 1997 by Lockheed Martin
- Gedae Inc. formed 2001
- Current development staff have been developing the tool since late 1980's
- Now at Version 4.5.2
- Documentation is limited but improving
- Reliable embedded executables generated
- Vendor is developing further useful toolset functionality:
 - Removal of few remaining development environment bugs
 - Further development of Gedae FPGA/System on Chip capability
 - Future qualification of the toolset

Productivity gains from from rapid application development

- Graphical programming:
 - enabled good communication and reuse between developers. Monitoring display components reused with minimal rework
- Single workproduct (graphical application specification):
 - maintained throughout – not separate documents and source code
- Controlled rapid iterations implemented:
 - easy host/embedded test of prototypes alongside firm design
- Early test and verification of SPU components:
 - minimum defects found to date during integration activities at site
- Small development team:
 - Complete HFSWR SPU application produced by 2 engineers
 - 7 months from start of SPU development to integration at site

Conclusions

- Gedae is still the 'Best in Class' rapid application development tool available, for multiprocessor SPU applications.
- Application workproducts developed using Gedae are executable graphical specifications:
 - Allows effective communication of concepts
 - Manual translation stages, used in traditional hand code development, are removed
 - Gedae's software structure means application workproducts are independent of the target platform
- Final executable is suitable for deployment in deliverable systems

Conclusions

- Gedae's integrated development environment for autocoding multiprocessor applications enables:
 - rapid controlled development iterations
 - simple embedding to target, providing a very fast path to working prototypes and proof / demonstration of concepts
- Use of Gedae on the HF Demonstrator SPU development has shown:
 - Gedae can implement real SPU functionality/performance
 - Productivity benefits are realised: integrated real-time SPU operating at AMS' Customer Demonstrator Facility in months
- Some technical capabilities still to be exercised

Further Work.

- Gedae technical areas:
 - Real time peripheral control: Interfacing with high bandwidth I/O
 - Gedae BIT / system reconfiguration
 - Trials data recording in Gedae embedded real-time application

AMS' Use of Gedae in Signal Processor Product Development

- Small project using Gedae for development of deliverable embedded signal processing application for 3D surveillance radar emulator
- Currently two major project radar developments using Gedae for:
 - Algorithm development
 - Production of executable algorithm specification / functional reference models, to drive hand coded development of deliverable
 - Generation of Gedae test harnesses for hand coded deliverable
 - Execution benchmarks & hardware sizing
- One of AMS' major projects will incorporate Gedae automatically generated code as part of deliverable application – Subject of our second presentation by Richard Hunt





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