ERC32 Tools

SPACEBEL INFORMATIQUE s.a.

ERC32 Products Day
SPACEBEL Informatique Tools

Commercial Availability

Target Simulator

☞ *Schedulability Analyser*

☞ *Scheduler Simulator*

John Reynolds

ERC32 Target Simulator (SPARC)

ERC32 Scheduler Simulator

ERC32 Schedulability Analyser

ERC32 Tools

SPACEBEL INFORMATIQUE s.a.

The Hard Real-Time Toolset

- A **Schedulability Analyser** that provides an assessment of the schedulability of a task set
- A **Scheduler Simulator** that provides a textual and graphical representation of scheduling behaviour
- ADA Compilation System that compiles ADA 83 programs that conforms to Hard Real Time
- ADA Runtime System that provides ADA 83 Runtime support
- A Worst Case Execution Time Estimator that provides a high level description of execution profiles and task interactions

ERC32 Target Simulator (SPARC)

ERC32 Scheduler Simulator

ERC32 Schedulability Analyser

Schedulability Analyser - Goals

- Verification that the real-time temporal characteristics of an ADA task set are attainable
  - Deadlines are achievable or not achievable
- Verification is analytic and takes place before execution
  - Provision of a complete assessment of Schedulability
- Product constraints
  - Minimisation of pessimism
  - Configurability

ERC32 Tools

SPACEBEL INFORMATIQUE s.a.

Task Scheduling Analysis

- Worst Case Response time - the longest time required by a task to respond after its release
  - Schedulability - the principal result
- Worst Case Computation time - the maximum processor time required to execute a task
- Maximum blocking time - the maximum time a Task may be blocked due to another Task accessing shared resources
- Margin of sensitivity - the latitude involved in Schedulability
- Utilisation factors

ERC32 Target Simulator (SPARC)

ERC32 Scheduler Simulator

ERC32 Schedulability Analyser

The Application Model- Entities

- Tasks

  Task Classification

  – Cyclic tasks - fixed time intervals
  – Sporadic tasks - random condition for release - minimum interval time
  – Interrupt Sporadic task

- Protected Objects (Critical Region)
  – Resource Object - data exchanged
  – Synchronisation Object - release of other threads

The Application Model - Tasks

Task Characteristics

- Deadline
  - The maximum allowable time from a thread release to its completion
- Periodicity/Inter-arrival time
- Criticality
  - Hard, Soft, Non-critical
- Task Profile - Worst Case Execution Path
  - Worst Case Execution Time Statements
  - Worst Case Computation Time
  - Blocking

The Computation Model

- Defined to support Scheduling Theory
  - Priority Pre-emptive Scheduling
  - Deadline Monotonic Scheduling
  - Arbitrary Deadline Scheduling
  - Blocking Protocols for Protected Objects
    - Immediate Priority Ceiling Inheritance - IPCI
    - Inhibit Interrupts - INHIB
    - No System Deadlocks
- Determinism in runtime interactions
  - Deterministic Blocking Times
- The Logical view of the ADA Runtime Kernel

ERC32 Tools

SPACEBEL INFORMATIQUE s.a.

Schedulability Analyser Output

ERC32 Products Day - Estec - 01/10/96

Sch	Th#	Criticality	Deadline	Prio	WCCT FR	WCCT SR	Period MIAT	Response Time	Blocking Time	Blocking Origin	Utilisation Factor	Margin Analysis
yes	5	INTERRUPT	600	123	111	N/A	1000	317	103	PO # 1	1.26360E-01	-2.34E+01
yes	8	HARD	3500	15	413	N/A	3500	735	108	PO # 2	2.44360E-01	-2.15E+01
yes	1	HARD	9000	14	445	N/A	50000	1288	108	PO # 2	2.53260E-01	N/A
yes	6	HARD	9700	11	1357	N/A	9700	3416	608	PO # 5	3.93157E-01	-1.82E+01
yes	7	HARD	9700	7	2264	N/A	9700	6368	508	PO # 4	6.26559E-01	-1.09E+01
yes	3	HARD	17000	6	2335	N/A	200000	9474	508	PO # 4	6.38234E-01	-5.28E+01
yes	2	HARD	20000	5	2360	N/A	20000	17285	508	PO # 4	7.56234E-01	-1.75E+01
-NO	4	HARD	50000	3	9736	N/A	200000	55522	0	RTS	8.04914E-01	-1.27E+01

ERC32 Target Simulator SPARC

ERC32 Scheduler Simulator

ERC32 Schedulability Analyser

Scheduler Simulator - Goals

- To provide a complementary approach to the formal approach used by Schedulability Analyser
- To provide the designer with a means of investigating system behaviour
  - To provide visualisations of scheduling activity
  - Tightness of schedules
  - ADA runtime system interaction
- To provide highly interactive interface to promote speed of system behaviour scrutiny

ERC32 Target SPARC Simulator

ERC32 Scheduler Simulator

ERC32 Schedulability Analyser

Task Execution Behaviour

Schedulability Simulator provides

- Presentation of task scheduling behaviour through
  - Gantt Diagrams
  - Textual output
- System Statistics of both the task set and runtime System
- Investigation and post processing of historic simulations
- Configuration of release patterns for Interrupts to investigate Scheduling under different system loads

ERC32 Target Simulator SPARC

ERC32 Scheduler Simulator

ERC32 Schedulability Analyser

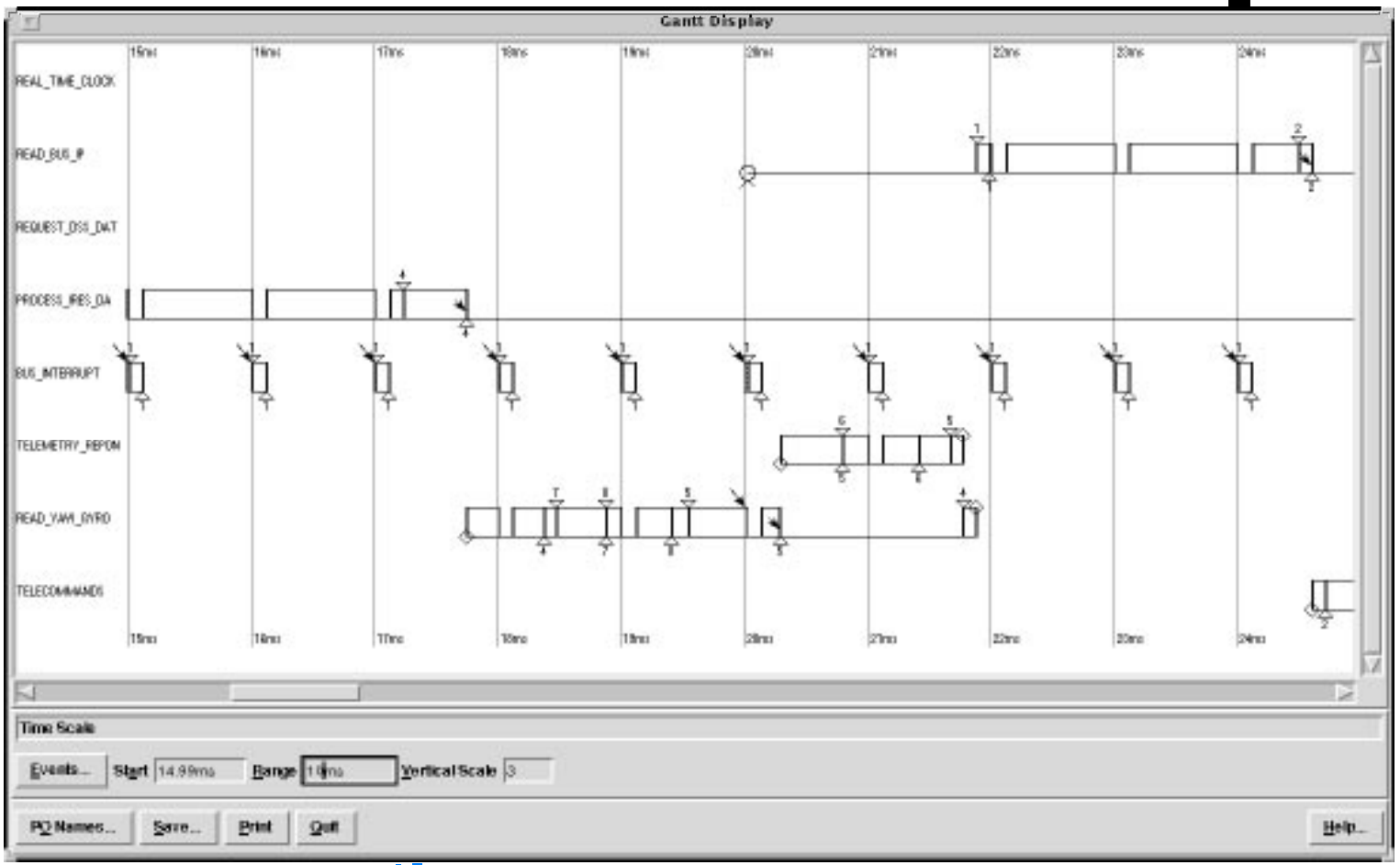
Task Progression

- Gantt and Textual output displays
  - Thread priorities
  - Task release and associated deadline
  - Start and completion of each thread
  - Suspension and resumption of tasks
  - Entry and Exit to critical regions
  - *Missed deadlines* for Threads
- Postscript output for inclusion in technical reports

ERC32 Tools

SPACEBEL INFORMATIQUE s.a.

Scheduler Simulator Output



ERC32 Products Day - Estec - 01/10/96

ERC32 Target Simulator

ERC32 Scheduler Simulator

ERC32 Schedulability Analyser

Conclusions

- Practical Industrial strength tools using state of the art scheduling techniques
- Fully integrated Hard Real Time Tools to be used throughout the software life cycle and on real projects
  - Reduction in Pessimism of the Analysis performed by the Schedulability Analyser
  - Complementary Toolset Analyser/Simulator
- HRT Toolset to be used in several ESA programs

ERC32 Target Simulator SPARC

ERC32 Scheduler Simulator

ERC32 Schedulability Analyser