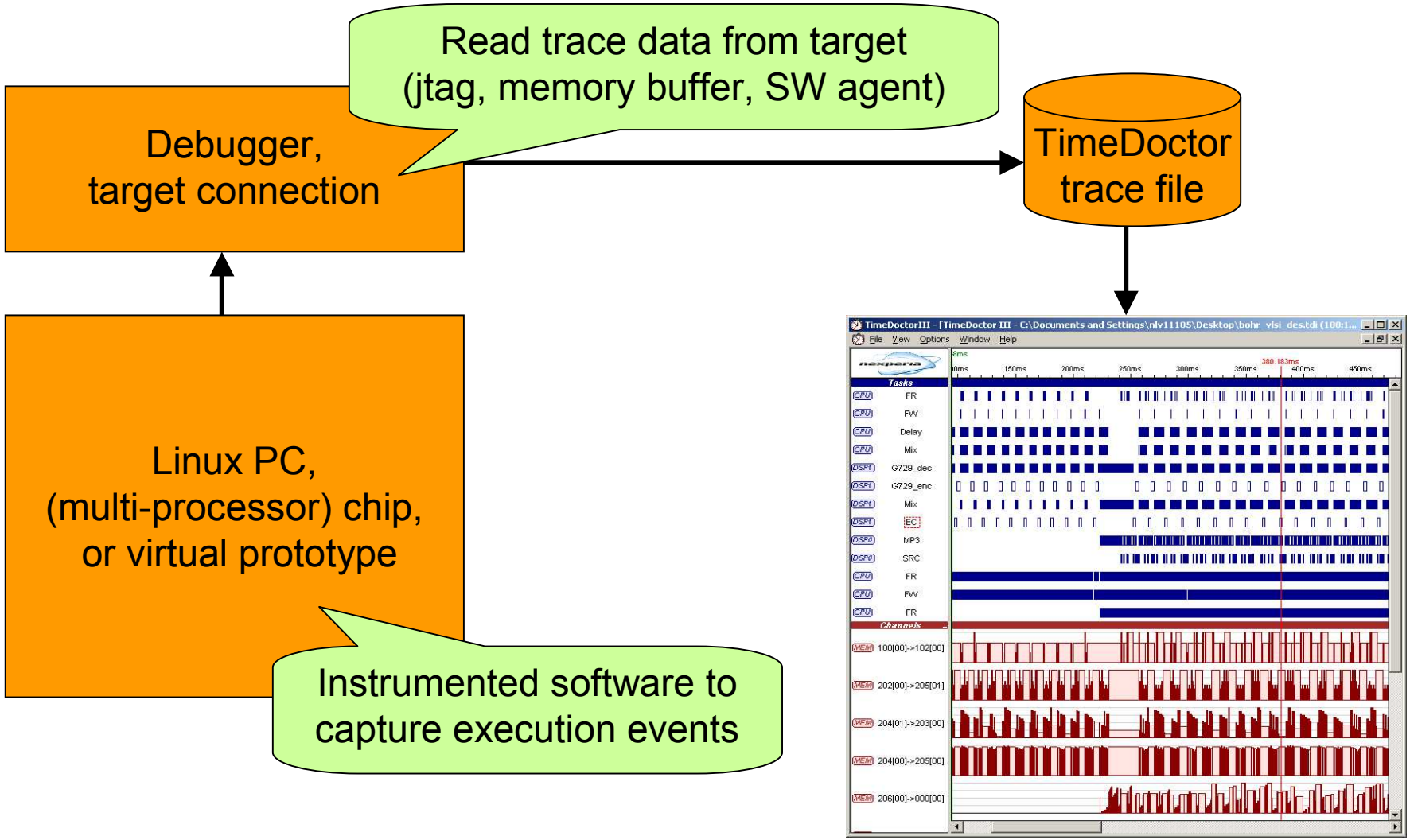
TimeDoctor

Use the Strength of Eclipse to Visualize (Multi)Processor Execution Behavior

Ruud Derwig (NXP Semiconductors)
Stuart Fullmer & Klaas van Gend (Monta Vista)

TimeDoctor – display execution traces

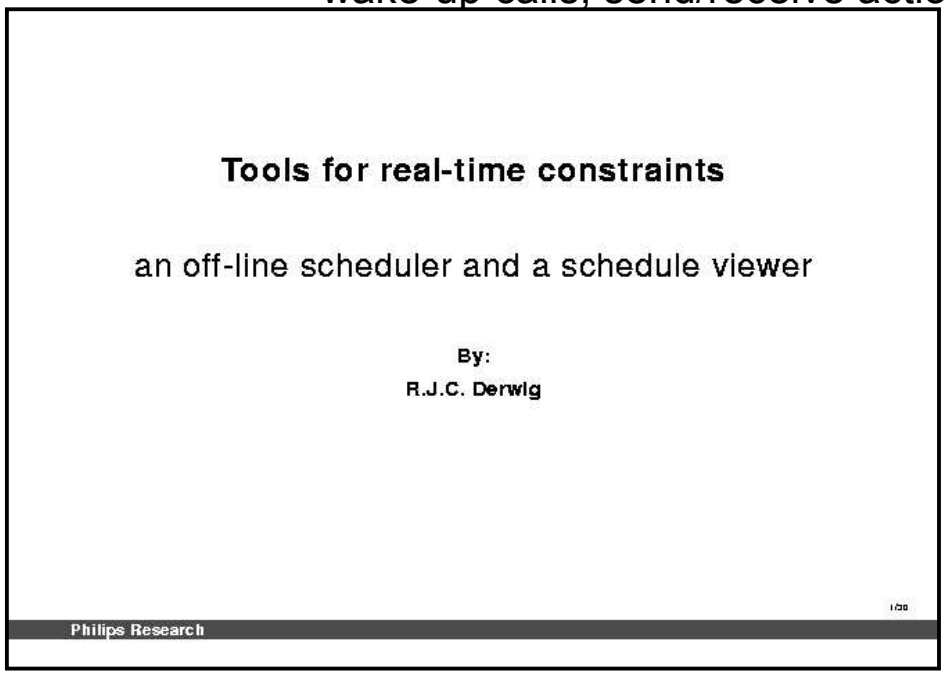


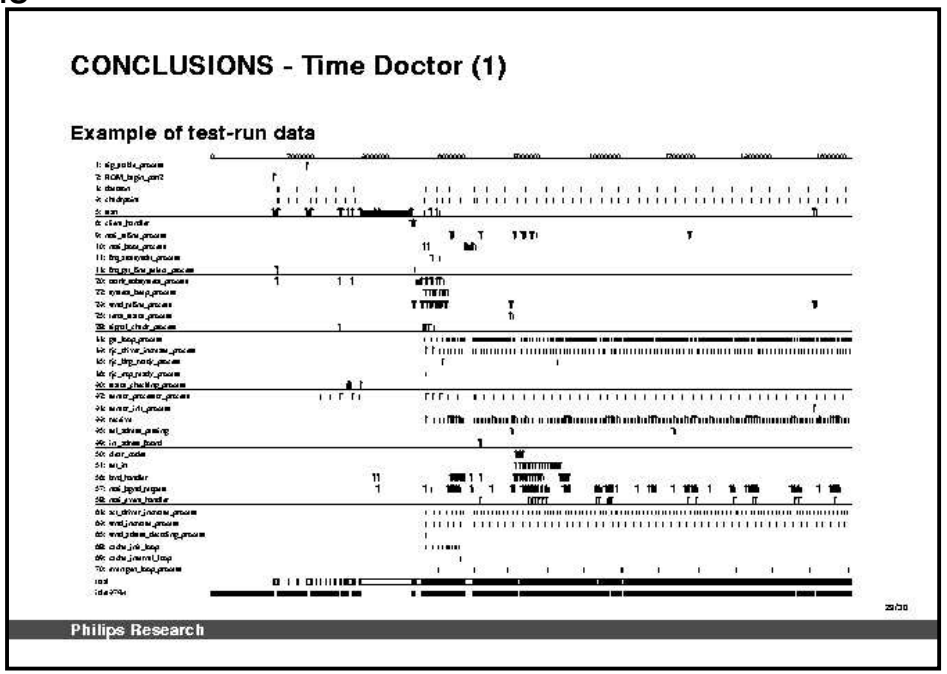
Contents

- What is it: demo
- Why
  - history
  - goals, requirements
- How – part 1
  - TimeDoctor Eclipse based architecture
  - TimeDoctor input format
  - Instrumentation & logging
- How – part 2
  - TimeDoctor & Linux
  - LTTng: getting & converting trace data
- Conclusions
  - status
  - plans

Why TimeDoctor?

- A pictures says more than a thousand words
- TimeDoctor started as a side-result of a student assignment in 1994
  - visualize schedules and additional information
    - release times & deadlines
    - wake-up calls, send/receive actions





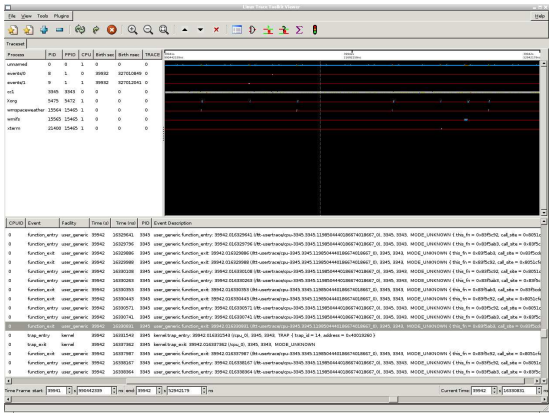
History of TimeDoctor

Generation & date	host OS & toolkit	language	kLoCs	new features
0, 1994	Unix, Motif	C++	2.5	schedules, events
1, 1999	Windows, GDI	Visual Basic C++	0.75 (VB) 3 (C++)	queues, semaphores, counters
2, 2003	Windows, .NET	C#	10	colors, statistics, agents
3, 2007	Linux + Windows, Eclipse SWT	Java	10	Eclipse integration

TimeDoctor – Eclipse plug-in objective

- Objective: make TimeDoctor available under Linux and Windows
  - Existing version is Windows only (written in C#)
- Solution: port the existing TimeDoctor version to Eclipse/Java
  - Eclipse supports both Linux and Windows
  - Align with NXP Eclipse policy
- Objective: attract a community of TimeDoctor users and developers
  - Customers can add specific features
  - NXP internal users can easily contribute
- Solution: donate TimeDoctor to open source
  - First cleanup the code to allow further extensions
  - Actively contribute with new features

TimeDoctor – related work

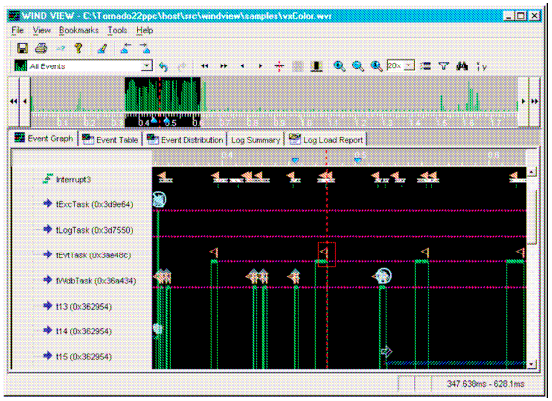


Linux Trace Toolkit
Next Generation

- Trace generation implemented in Linux
- Binary file format with extension options
- Visualization tool : LTTV

→ TimeDoctor may be used to visualize LTT trace files

- Eclipse plug-in from montavista™



WindRiver® WindView

- Based on LTTng
- Implemented as Eclipse plug-in

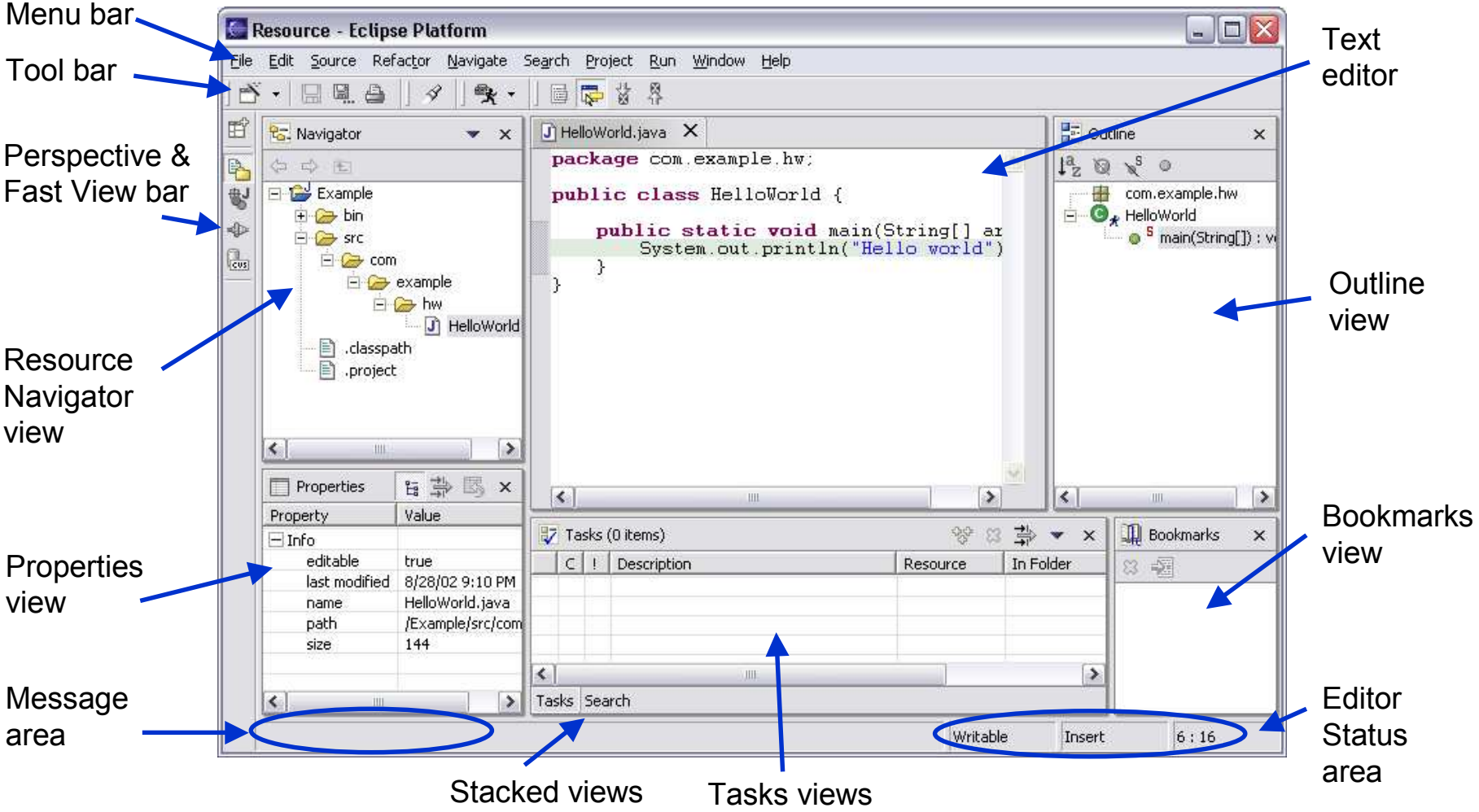
Main TimeDoctor requirements & features

- Visualization
  - Display the usage of CPU (or CPU's) in a graph over time: threads, ISRs, agents
  - Show events and OS objects that influence scheduling: semaphores, queues, etc.
    - tailored for 'streaming' applications like e.g. media processing: queue sizes
  - Support performance analysis: counters for e.g. cache misses, bus cycles, etc.
  - Support multi-core systems: indicate core for tasks and ISRs
  - Visualize user defined events/notes and additional descriptions/information
  - Provide statistical information: nr. of context switches, CPU load, etc.
  - Show sample properties and additional information when mouse hovers over
- Other
  - Linux and Windows development host environments
  - Stand-alone and Eclipse IDE plug-in
  - Good performance: quick layout and response time to the user
  - Efficient memory usage: deal with trace files of 10's of MBytes
  - Support measuring time intervals by setting baseline and distance to current mouse
  - Zooming and easy navigation through the trace set

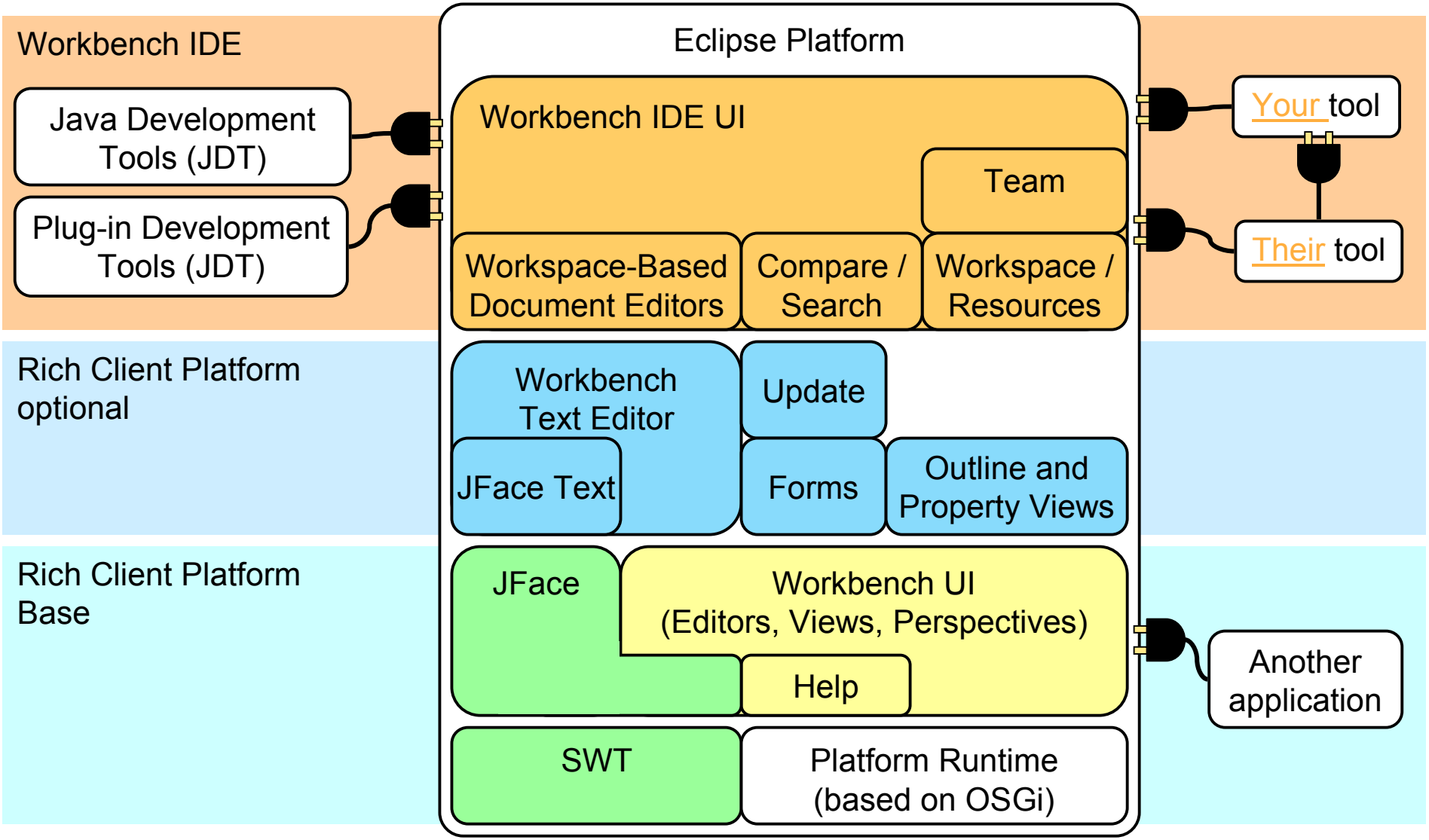
Contents

- What is it: demo
- Why
  - history
  - goals, requirements
- **How – part 1**
  - **TimeDoctor Eclipse based architecture**
  - **TimeDoctor input format**
  - **Instrumentation & logging**
- How – part 2
  - TimeDoctor & Linux
  - LTTng: getting & converting trace data
- Conclusions
  - status
  - plans

Eclipse development environment



Eclipse architecture



TimeDoctor Eclipse plug-in

TimeDoctor menu and toolbar

TimeDoctor help, preference pages, update site

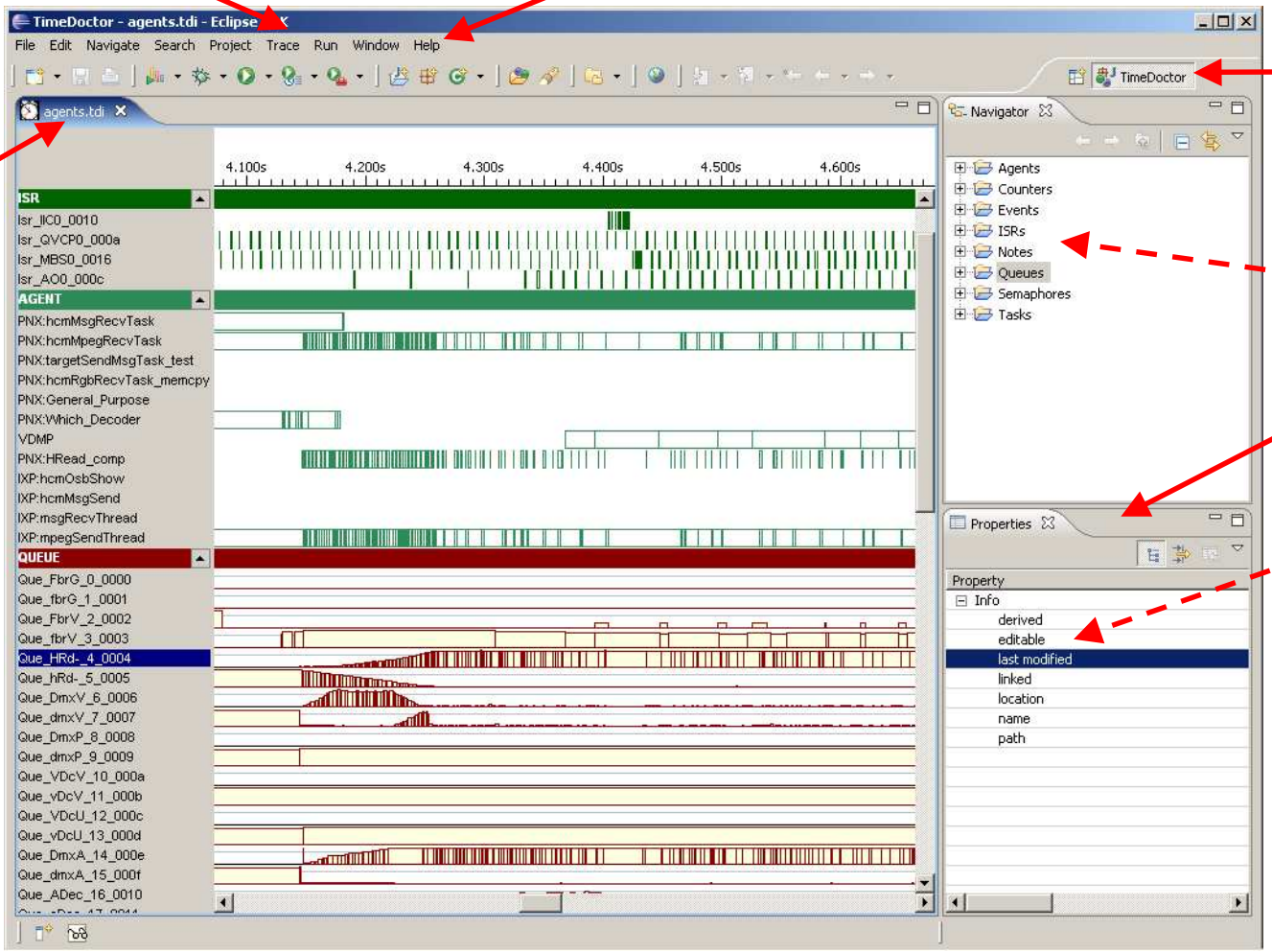
Trace editor

TimeDoctor perspective

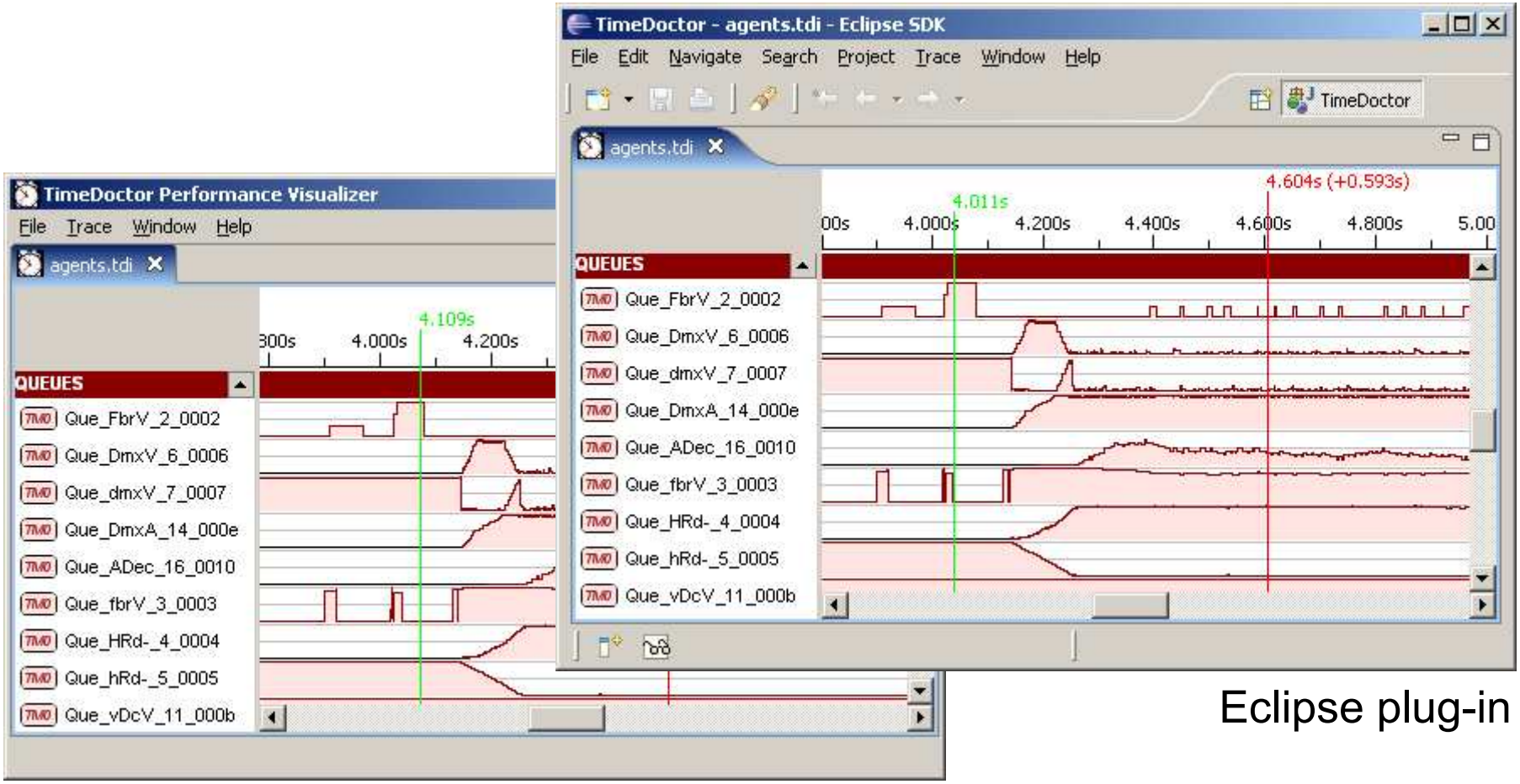
Visible trace lines outline view

Statistics view

Property view: values of the selected sample



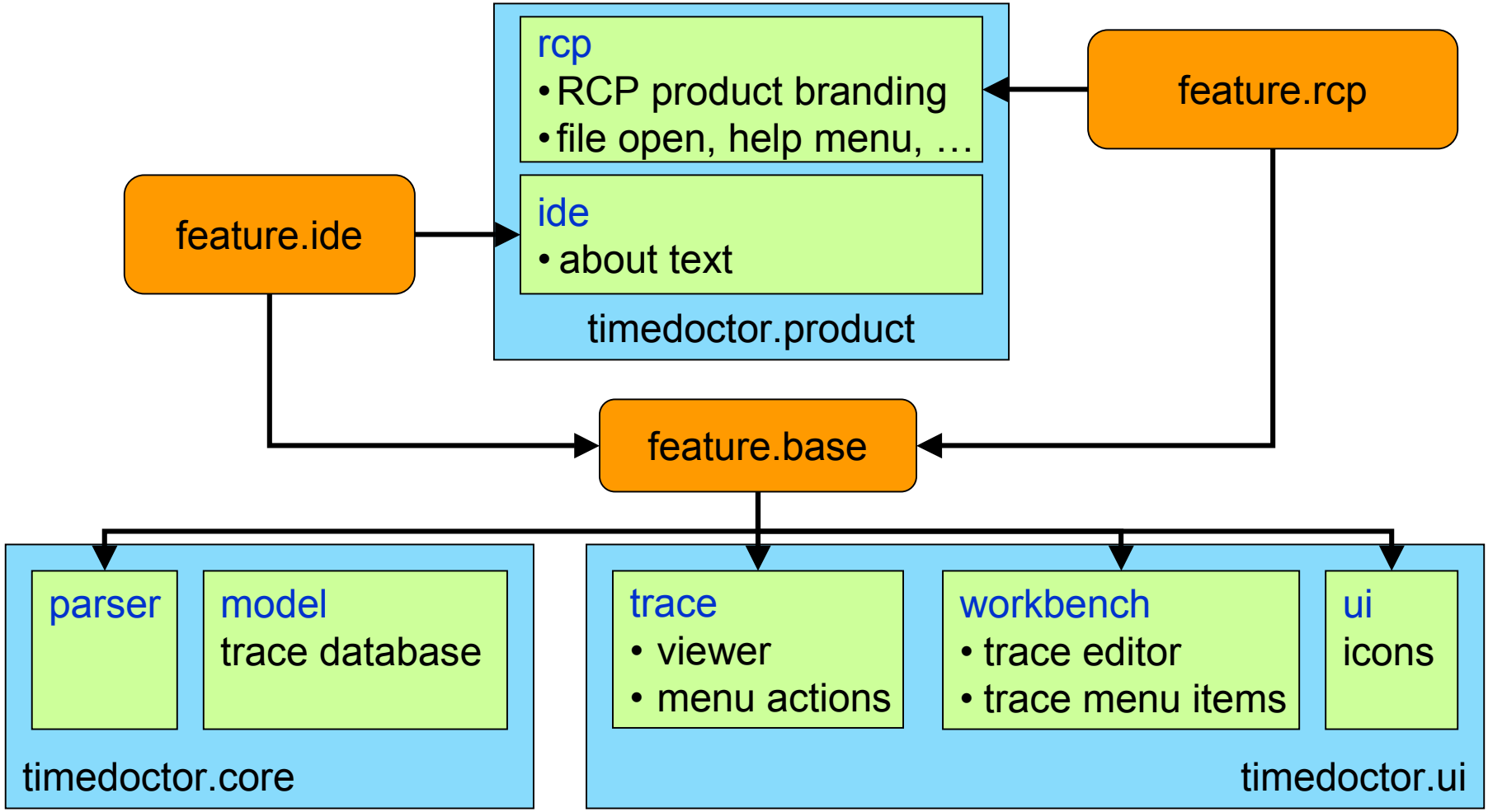
Stand-alone application & Eclipse plug-in



Eclipse plug-in

Stand-alone (RCP) application

TimeDoctor architecture – plug-ins & features



TimeDoctor trace file format

- Setup
  - CPU <id> <name>
  - SPEED <CPU clocks per sec>
  - MEMSPEED <memory clocks per sec>
  - TIME <time ticks per sec>
- Creation/delete
  - CRE <type> <id> <time> [<…>]
  - DEL <type> <id> <time>
- Events
  - STA <type> <id> <time> [<size>]
  - STO <type> <id> <time> [<size>]
  - OCC <type> <id> <time>
  - TIM <time>
  - VAL <type> <id> <value>
- Descriptions
  - DSC <type> <id> <value>
  - DNM <type> <id> <name>
  - NAM <type> <id> <name>

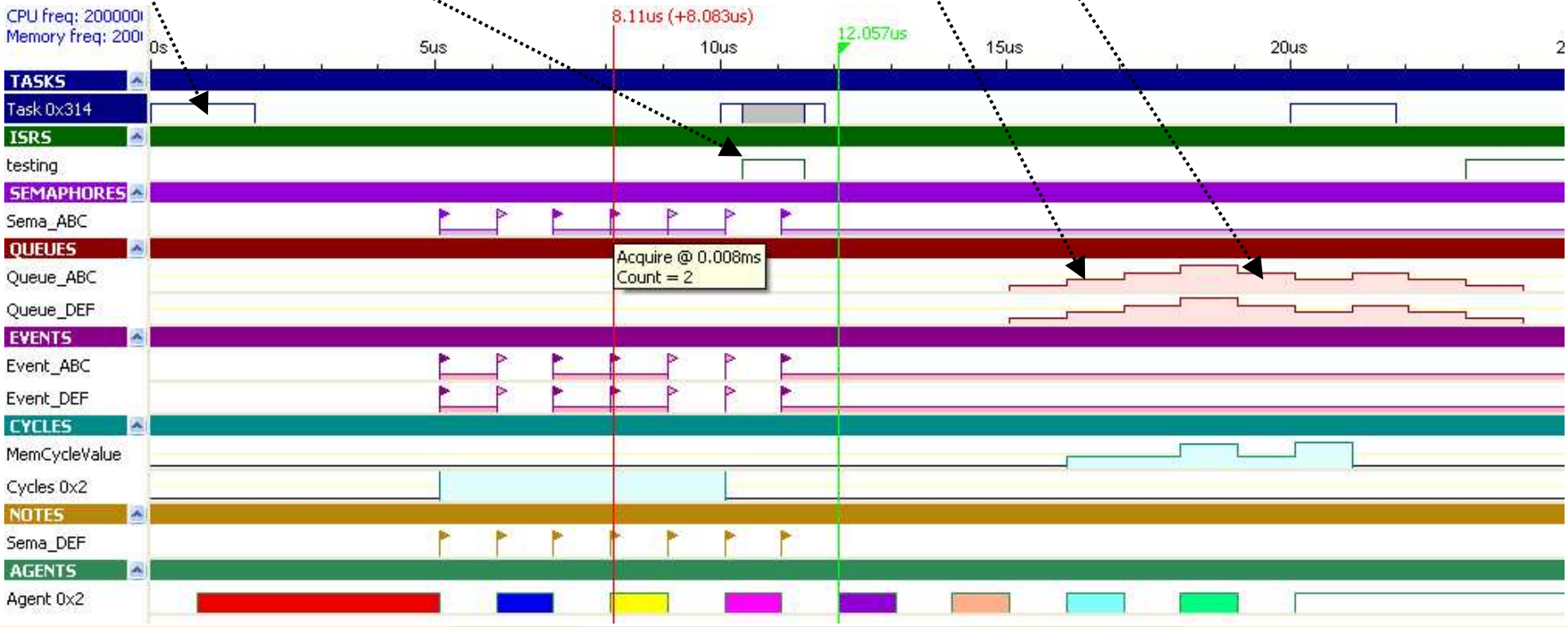
Event types	ID
– Task	0
– Interrupt service routine	1
– Agent	8
– Semaphore	2
– Queue	3
– Message event	4
– Value count	5
– Cycle count	6
– Memory cycle count	9
– Notes	7

Description types	ID
– String	0
– Number	1
– Time	2
– Color	3

TDI example – 1/2

STA 0 788 9493	*start task 788 at 9403*
STO 0 788 9676	*stop task 788 at 9676*
STA 0 788 10493	…
STA 1 1 10530	*start ISR 1 at 10530*
NAM 1 1 testing	*name of ISR 1 is "testing"*
STO 1 1 10640	…
STO 0 788 10676	*etc.*
STA 0 788 11493	…

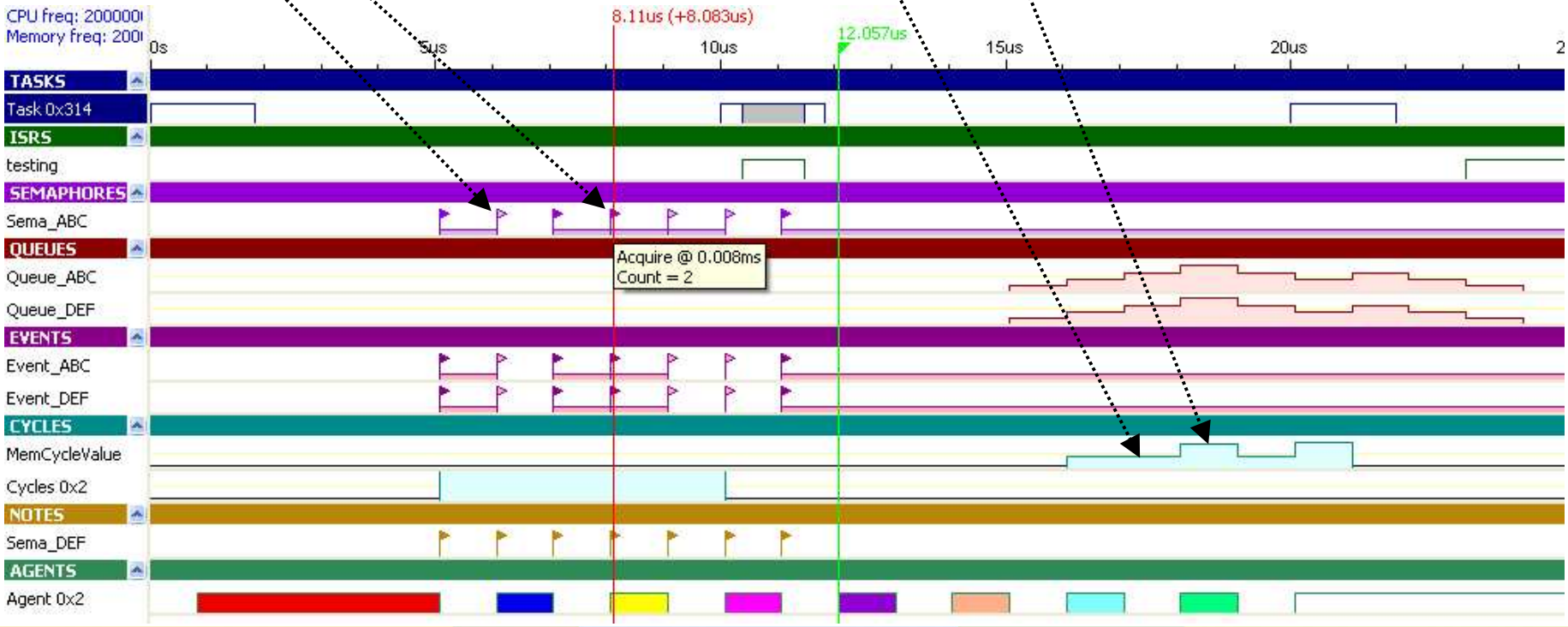
NAM 3 1 Queue_ABC	*name of queue 1 is "Queue_ABC"*
STA 3 1 11000	
STA 3 1 11100	*send a message to queue 1 at 11100*
STA 3 1 11200	
STA 3 1 11300	…
STO 3 1 11400	*receive from queue 1 at 11400*
STO 3 1 11500	
STA 3 1 11600	



TDI example – 2/2

NAM 2 1 Sema_ABC	*name of semaphore 1 is "Sema_ABC"*
STA 2 1 10000	
STO 2 1 10100	*release sem. 1 at 10100*
STA 2 1 10200	*…*
STA 2 1 10300	*acquire sem. 1 at 10300*
STO 2 1 10400	*…*
STO 2 1 10500	
STA 2 1 10600	

NAM 6 234 MemCycleValue	*define name*
TIM 11200	*set time for next sample*
VAL 6 234 100	*set value for counter 234*
STA 3 1 11300	*counter value uses time*
VAL 6 234 200	*from previous event*
TIM 11400 …	
VAL 6 234 400	*next value, delta is shown*
STO 3 1 11500	



Instrumentation & logging

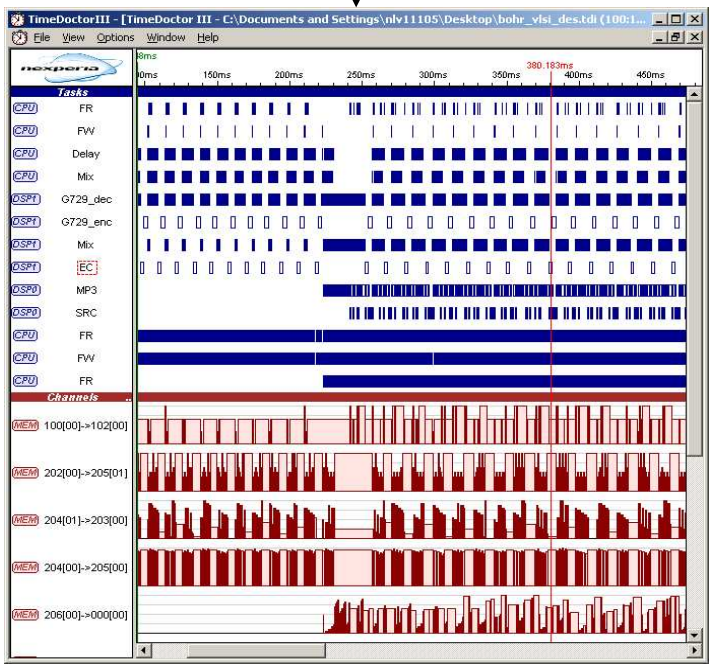
Read trace data from target
(jtag, memory buffer, SW agent)

Debugger,
target connection

TimeDoctor
trace file

Linux PC,
(multi-processor) chip,
or virtual prototype

Instrumented software to
capture execution events



Instrumentation & logging

- For NXP's TriMedia processor family (not running Linux) the infrastructure software has been fully instrumented
  - context switches
  - interrupts
  - performance counters
  - queues
  - etc.

- For MIPS & ARM running Linux, a simple logging module was written, and the kernel was instrumented
  - context switches & interrupts only
  - not suited for community, just a quick hack

- Logging module
  - Sysfs interface
    - start/stop/reset
    - read sample data
  - kernel logging functions
    - phStbLog_task_create()
      phStbLog_task_switch()
    - phStbLog_interrupt_enter/exit()
    - phStbLog_Info()
- Instrumented Linux files
  - fork.c
    - create task; CRE
  - sched.c
    - context switch; STA/STO
  - irq.c
    - enter/exit: STA/STO
- Perl script for conversion to TDI format
  - get process names etc.

Switching speakers

Klaas van Gend - MontaVista

Contents

- What is it: demo
- Why
  - history
  - goals, requirements
- How – part 1
  - TimeDoctor Eclipse based architecture
  - TimeDoctor input format
  - Instrumentation & logging
- **How – part 2**
  - **TimeDoctor & Linux**
  - **LTTng: getting & converting trace data**
- Conclusions
  - status
  - plans

montavista™

A single Eclipse-based IDE for development, debugging and system profiling

Using TimeDoctor as LTTng viewer

- 4.0 Editions: MontaVista authored proprietary Eclipse plug-in to view LTT tracefiles.

- 5.0 Editions no longer use LTT but switch to LTTng
  - Yet, LTTng visualiser doesn't run on Windows nor Solaris
  - Improving the existing plugin would be a lot of work
  - Adding another backend to TimeDoctor appeared to be a good alternative

- LTTng usage doesn't change
- Just a different viewer

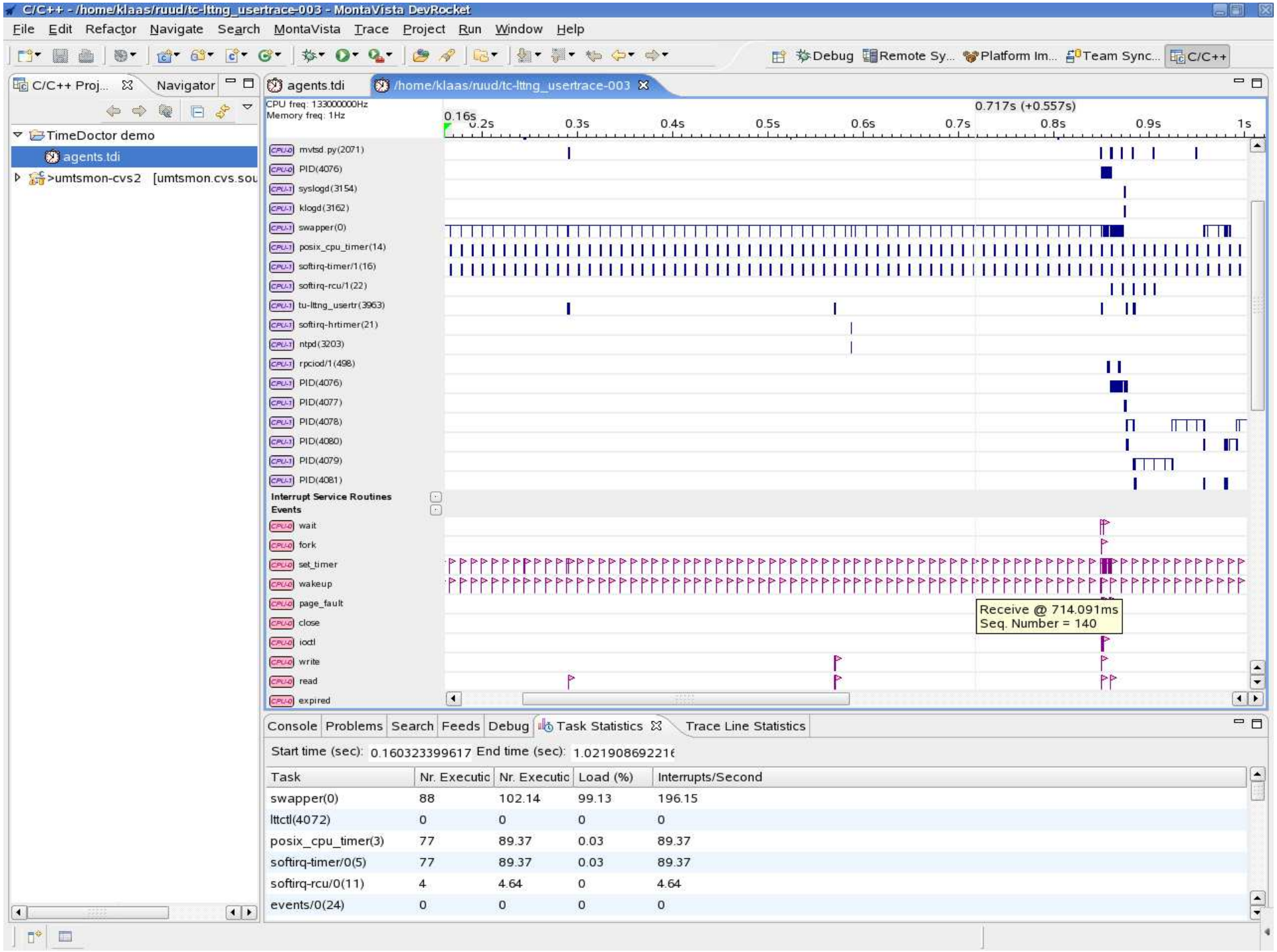
montavista™

Parsing LTTng files

- Problem: LTTng is a binary format that is very flexible and very complicated.

- First attempt: a script to convert LTTng to TimeDoctor
- Second attempt: a parser – required new hooks in TimeDoctor

montavista™


C/C++ - /home/klaas/ruud/tc-lttng_usertrace-003 - MontaVista DevRocket
File Edit Refactor Navigate Search MontaVista Trace Project Run Window Help
Debug Remote Sy... Platform Im... Team Sync... C/C++
C/C++ Proj... Navigator
TimeDoctor demo
agents.tdi
>umtsmon-cvs2 [umtsmon.cvs.sou
agents.tdi
/home/klaas/ruud/tc-lttng_usertrace-003
CPU freq: 133000000Hz
Memory freq: 1Hz
0.16s
0.717s (+0.557s)
0.2s 0.3s 0.4s 0.5s 0.6s 0.7s 0.8s 0.9s 1s
mvtsd.py(2071)
PID(4076)
syslogd(3154)
klogd(3162)
swapper(0)
posix_cpu_timer(14)
softirq-timer/1(16)
softirq-rcu/1(22)
tu-lttng_usertr(3963)
softirq-hrtimer(21)
ntpd(3203)
rpciod/1(498)
PID(4076)
PID(4077)
PID(4078)
PID(4080)
PID(4079)
PID(4081)
Interrupt Service Routines
Events
wait
fork
set_timer
wakeup
page_fault
close
ioctl
write
read
expired
Receive @ 714.091ms
Seq. Number = 140
Console Problems Search Feeds Debug Task Statistics Trace Line Statistics
Start time (sec): 0.160323399617 End time (sec): 1.02190869221
Task | Nr. Executic | Nr. Executic | Load (%) | Interrupts/Second
swapper(0) | 88 | 102.14 | 99.13 | 196.15
lttctl(4072) | 0 | 0 | 0 | 0
posix_cpu_timer(3) | 77 | 89.37 | 0.03 | 89.37
softirq-timer/0(5) | 77 | 89.37 | 0.03 | 89.37
softirq-rcu/0(11) | 4 | 4.64 | 0 | 4.64
events/0(24) | 0 | 0 | 0 | 0

Issues with the current TimeDoctor (and wish list)

- No raw event view
- TimeDoctor wants all trace data in memory
  - Imposes size limit on tracefiles
  - Streaming not possible
- Events, IRQs and syscalls are in separate items – contrary to the LTT viewer.
  - Determining what causes a context switch is more difficult
- Synchronizing various data streams
  - Add data from syslogd

montavista™

Switching speakers

Ruud Derwig – NXP Semiconductors

Contents

- What is it: demo
- Why
  - history
  - goals, requirements
- How – part 1
  - TimeDoctor Eclipse based architecture
  - TimeDoctor input format
  - Instrumentation & logging
- How – part 2
  - TimeDoctor & Linux
  - LTTng: getting & converting trace data
- **Conclusions**
  - **status**
  - **plans**

Status – TimeDoctor

- Current version 1.3.0-Alpha
  - Basic visualization of trace data
  - Both IDE and RCP support
  - Acceptable performance for large trace files
  - Help documentation
- Next release: 1.3.0
  - April/May
  - Outline view to select trace lines
  - Preference pages
- First fully functional version planned for June 2007
  - at least same feature level as TimeDoctorII
- To do list
  - Task/ISR/Queue statistics export to CVS, Excel
  - Graphical display of statistics
  - Property view
  - Many small UI features

Status – sourceforge

- NXP donated TimeDoctor to open source
  - Released under Eclipse public license (EPL)
  - Active contribution and project management by NXP
  - Project “TimeDoctor” hosted on sourceforge

http://sourceforge.net/projects/timedoctor

- MontaVista plans to release LTTng parser as open source
  - first version shipped to customers proprietary

- To do list
  - Advertise on Eclipse plugin central and others

Plans

- Complete TimeDoctorII features

- Many new ideas
  - real-time sample data feed
  - statistics graphs instead of text
  - new representations
    - events in same traceline as task instead of own traceline
      - same representation as LTT
      - configurable
    - highlight samples above/below a certain watermark
  - support for very large tracesets (GBytes)
  - synchronized scrolling of multiple trace windows
    - and other support for comparing traces
  - user annotations
  - saving/restoring configuration data (freeze view)
    - for sharing/analysing with others
  - specific Linux extensions?

Conclusions

- A picture says more than a thousand words !
- Eclipse is powerful, but has a steep learning curve
  - lot's of functionality for free
  - but many standard widgets not adequate for specific TimeDoctor purposes
- Changing from a proprietary model to Open Source works
  - what if you could: Linux was started by a student, and v1.0 was also released in 1994 …

Help us make TimeDoctor in Eclipse a success
➔ Use & Contribute to TimeDoctor 🡐