Analysis of AIX traces with Paraver

Judit Gimenez, Jesus Labarta (CEPBA-UPC)

Terry Jones (LLNL)

Technology Transfer User Support Education HPC Facilities

Research

Training

Mobility of Researchers Parallel Expertise

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- Motivation
- AIXtrace2paraver
- Some Examples
- Conclusions



Motivation

AIX Trace @ LLNL

- Very detailed information
- Generate tons of ASCII reports
 - \checkmark Scripts to extract some info
 - ✓ Lot of details "lost"

Paraver

- High potential of analysis
 - \checkmark qualitative and quantitative
 - ✓ detailed analysis
- no semantics neither on the tool, nor on the trace format

Objective

• Analyze with Paraver the information captured with AIX Trace

- good!
- not so good!



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Motivation

■ AIXtrace2paraver

- Approach
- Information emitted
- Other features
- Some Examples
- Conclusions



Approach: step 1 - AIXtracelauncher

This step is OPTIONAL

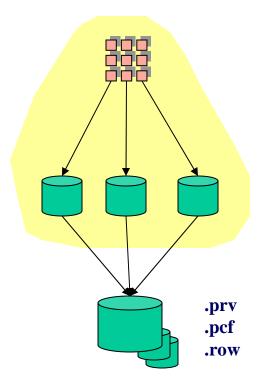
• Not required by the translator

Binary starting the AIX Trace Facility

- To simplify the launch of the tool
- To read the AIX events that we translate

Three modes:

- Trace node during n seconds
- Trace node during the execution of an application
- Sample mode: trace intervals





Approach: step 2 - AlXtrace2prv

Translator from AIXtrace binary format to Paraver format.

Emit to the .prv trace:

- All processes in node
- Only selected processes from node
- All processes, mark selected ones as "My application"
- Only selected processes from different nodes

Other options

- User events mapping
- Software counters
- Print list of processes



.prv .pcf

.row

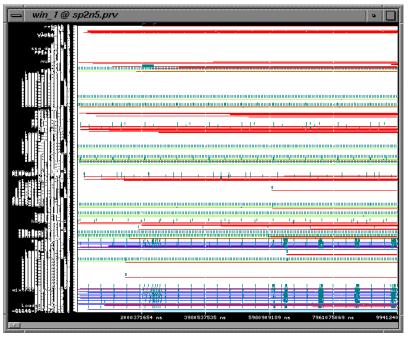
Information emitted to the Paraver trace

Per thread information:

• States and context switches:

✓ Not created, no info, running, blocked, stopped, ready, yield

- \checkmark On which processor
- Events:
 - ✓ System calls
 - ✓ Arguments to system call: fd, size
 - ✓ Return values of system calls
 - ✓ Sockets
 - ✓ SCSI driver calls
 - strategy, bstart, iodone
 - ✓ User events





Other features

Traces from multiple nodes

- Synchronized reading the switch clock
- Same configuration files

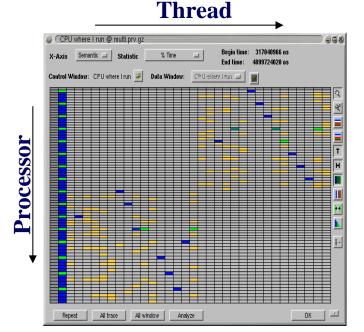
Software counters

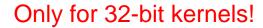
- When high frequency of system calls
 - ✓ large traces
 - ✓ no need for the details of each call
- Summarization:
 - ✓ at periodic intervals
 - ✓ how many calls of each type

Process classification

- My application, Other appl, System procs
- Text file to define system procs names

Remove threads with no info







Changes in Paraver

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Configuration files

- Some interesting views captured
- Provided in two major directories
 - Node: analyses applicable to all the processes of the node
 - ✓ resources allocation, process mapping, system calls, disk activity, sockets primitives....
 - Application: applicable to the user application only
 - ✓ few generic views
 - ✓ most specific for each application analyzed:
 - aggregate, barrier, NAS-BT



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Motivation

AIXtrace2paraver

Some Examples

- System interferences
- Analyzing MPI behavior
- IRS run @ LLNL

Conclusions



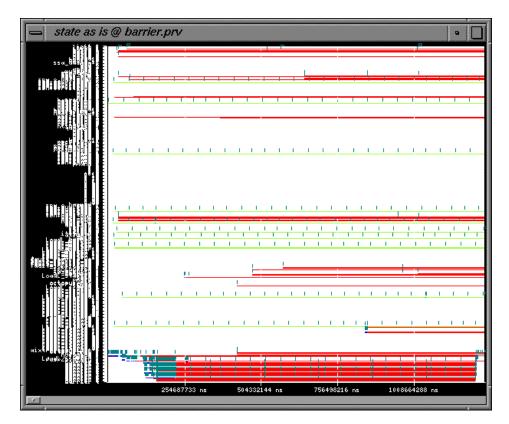
System interferences

Environment

• Very fine grain application

✓ Loop barrier - computation

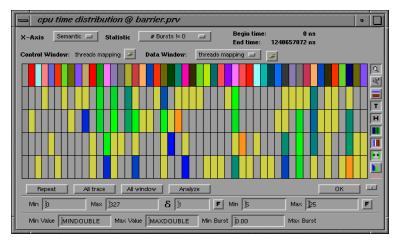
- 4 tasks in a 4-way node
- No other users

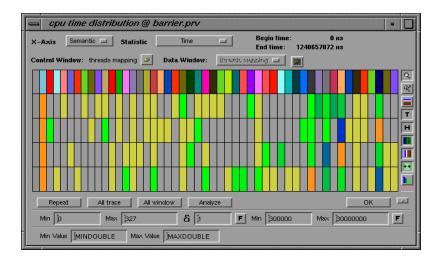


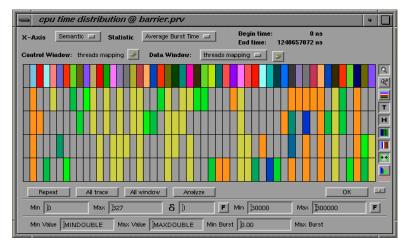


System interferences – CPU time distribution

- Mapping many processes run on most of the processors
- System processes -Typical runs of few tens of us





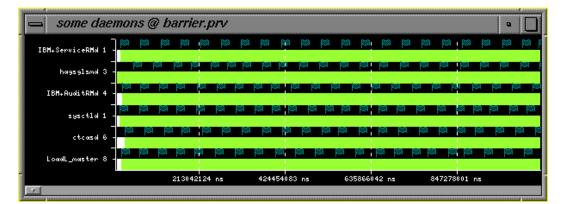




System interferences – system daemons

- Similar behavior
 - Yields for \cong 46.4 ms
 - Run \cong 21us

Most run on many CPUs



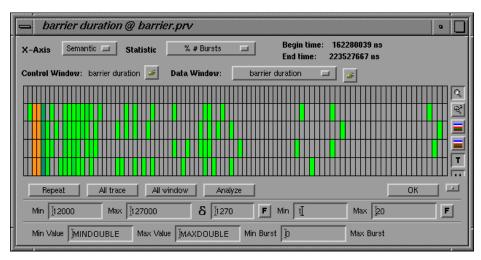
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trol Window: some daemons 🥃 Data Window: some daemons 💷 🗾	threads mapping @ barrier.prv
RUN READY YIELD M.ServiceRMd 1 20,817.23 ns 9,877.54 ns 46,938,875.08 ns hagsglsmd 3 20,679.14 ns 10,100.57 ns 45,837,105.78 ns IBM.AuditRMd 4 20,098.57 ns 12,511.43 ns 46,744,334.46 ns	X-Axis Semantic Statistic Average Burst Time Begin time: 0 ns Control Window: selected daemons mapping Image: Control Window: selected daemons ma
sysotld 1 21,699.26 ns 11,239.41 ns 45,288,404.15 ns ctcasd 6 21,456.31 ns 9,982.46 ns 46,558,374.77 ns LoadL_master 8 21,278.77 ns 10,113.54 ns 46,889,077.54 ns	Processor 1 Processor 2 Processor 3 Processor 4 IEM.ServiceRMd 1 21,308.00 ns 20,517.33 ns -
126,029.28 ns 63,824.95 ns 278,256,171.77 ns Average 21,004.88 ns 10,637.49 ns 46,376,028.63 ns Maximum 21,699.26 ns 12,511.43 ns 46,938,875.08 ns Minimum 20,098.57 ns 9,877.54 ns 45,288,404.15 ns	LoadL_master 8 25,232.00 ns - 19,584.00 ns 20,718.61 ns
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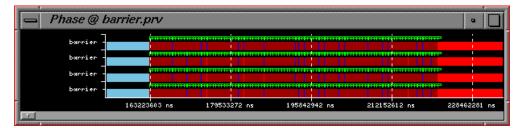
Analysis of AIXtraces with Paraver - ScicomP 9

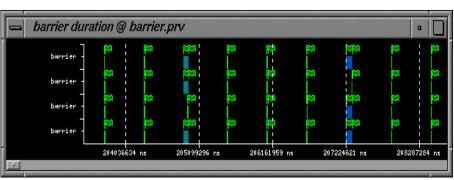
System interferences – impact on the appl.

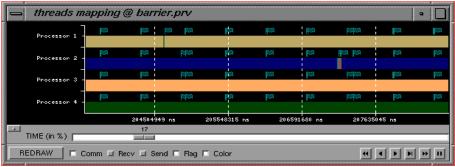
User events

- Some "Very large" barriers
 - ✓ Typical 14us
 - ✓ Large range 66-93us
- The cost is paid by all the tasks
 - \checkmark 1 task delayed by the system
 - ✓ 3 tasks wait in the barrier











Analysis of AIXtraces with Paraver - ScicomP 9

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Motivation

AIXtrace2paraver

Some Examples

- System interferences
- Analyzing MPI behavior
- IRS run @ LLNL

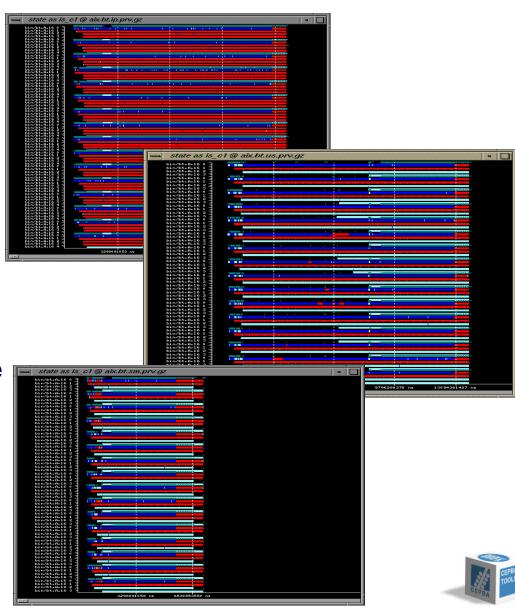
Conclusions



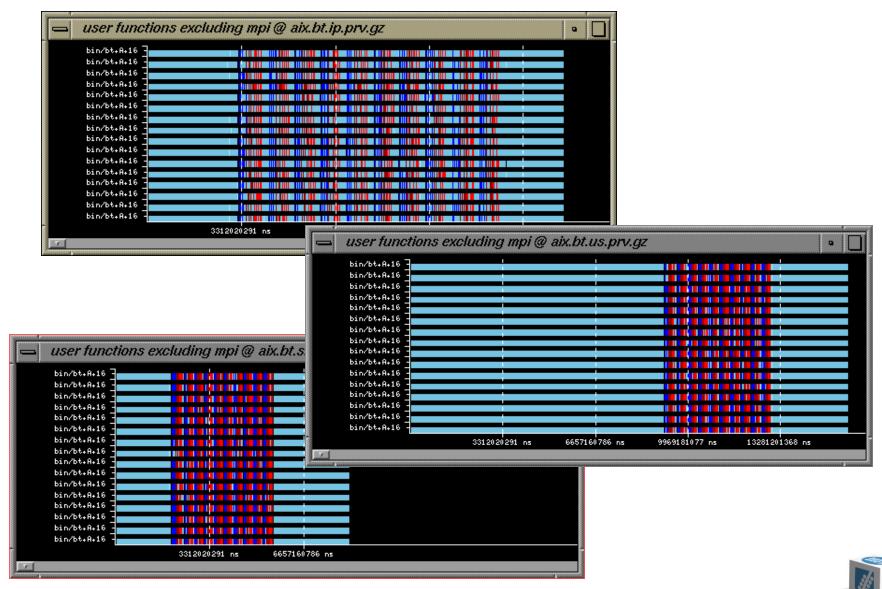
Analyzing MPI behavior

Environment

- NAS-BT, class A
- Modified source code to instrument
 - ✓ Some user functions
 - \checkmark All mpi calls
- 16 tasks in a16-way node
- 3 runs: SM, US, IP



Analyzing MPI behavior – user functions



Analysis of AIXtraces with Paraver - ScicomP 9

Analyzing MPI behavior – time distribution

user functions excluding mpi @ aix.bt.ip.prv.g	8Z 🔷		
X-Axis Semantic I Statistic Time I	Begin time: 3135.57 ms End time: 12446.89 ms		
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		<u> </u>	
Total 90,727.79 ms 18,309.84 ms 17,312.34 ms 5,670.49 ms 1,144.36 ms 1,082.02 ms	17,913.31 ms 3,615.34 ms 1,102.40 ms 1,119.58 ms 225.96 ms 68.90 ms		
Maximum 5,769.03 ms 1,355.16 ms 1,261.59 ms	1,312.01 ms 249.19 ms 82.15 ms		
Minimum 5,086.53 ms 1,098.79 ms 1,031.87 ms	1,057.42 ms 208.68 ms 60.08 ms	T	
stdev 155.58 ms 56.92 ms 49.44 ms	59.17 ms 11.86 ms 6.33 ms		
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	389.06 ms	16,546.05 ms 15,293.38 ms 15,558.28 ms 1,034.13 ms 955.84 ms 972.39 ms	200.92 ms 51.23 ms
	Maximum 452.01 ms	1,074.95 ms 980.86 ms 991.55 ms	206.61 ms 55.72 ms
		937.07 ms 949.87 ms	174.60 ms 48.61 ms
user functions excluding mpi @ aix.	bt.us.prv.gz	12.58 ms	7.29 ms 1.99 ms
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	537.67 ms 15,804.49 ms 3,393.31 ms 807.31 m		
	971.10 ms 987.78 ms 212.08 ms 50.46 m		
	985.52 ms 1,038.70 ms 215.83 ms 53.44 m 953.00 ms 966.59 ms 209.58 ms 48.20 m		
stdev 30.67 ms 10.46 ms	11.30 ms 16.88 ms 1.79 ms 1.61 m		
C.V. 0.05 ms 0.01 ms	0.01 ms 0.02 ms 0.01 ms 0.03 m		
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Min Value MINDOUBLE Max Value MAXDOUBL	.E		
,			3/2

Analysis of AIXtraces with Paraver - ScicomP 9



Analyzing MPI behavior – system calls

🥧 system calls @ aix.bt.sm.prv.gz		system calls @ aix.	bt.us.prv.gz	•
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Control Window: system calls 🥃 Data Window: system calls 💷 🗾		Control Window: system calls	Data Window: system calls	
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bin/bt.A.16 3 1 bin/bt.A.16 0 31 182 112 87 81 32	50 44 25 A	bin/bt.A.16 3 - bin/bt.A.16 0 182	1 32 112 87 81	SBRK THREAD_UNLOCK KFCNTL SIGACTION THR - <t< td=""></t<>
bin/bt.A.161	12	bin/bt.A.16 1 -		7
bin/bt.A.16 2 - 1 42		bin/bt.A.16 2 1	96	
bin/bt.A.16 3 1 bin/bt.A.16 0 23 182 112 87 81 32	50 44 25 T	bin/bt.A.16 3 - bin/bt.A.16 0 182	1 32 112 87 81	
bin/bt.A.16 1	12	bin/bt.A.16 0 182 bin/bt.A.16 1 -	<u>32 112 87 81</u>	57 50 44 25 12
bin/bt.A.16 2 - 1 42		bin/bt.A.16 2 1	96	
bin/bt.A.16 3 1		bin/bt.A.16 3 -	1	
bin/bt.A.16 0 275 182 112 87 81 32	50 44 25 12	bin/bt.A.16 0 182	32 112 87 81	57 50 44 25
bin/bt.A.16 2 - 1 42		bin/bt.A.16 1 - bin/bt.A.16 2 1	93	12
bin/bt.A.163 1		bin/bt.A.16 3 -	1	57 50 44 25 - - 12 - - 12 - - - 57 50 44 25
bin/bt.A.16 0 427 182 57 87 81 31	50 44 15	bin/bt.A.16 0 182	32 112 87 81	57 50 44 25
bin/bt.A.16 1	12	bin/bt.A.16 1 -		
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297 92 109 87 81 25 Maximum 1,211 183 112 89 81 42	X-Axis Semantic 💷 Statistic #Burs		/37571507 ns	50 44 22
Maximum 1,211 183 112 89 81 42 Minimum 23 1 57 87 81 1	Control Window: system calls 🜽 Data Window:	system calls 💷 🍙		51 45 137 50 44 7
stdev 341 91 13 0 0 17				
c.v. 1 1 0 0 1	bin/bt.A.16 3	KLSEEK _NSLEEP TROGENT THREAD	D_UNLOCK GETSOCKOPT _SIGA	
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	bin/bt.A.164			H H
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	bin/bt.A.16 2 42 10 -	- 71 -		
	bin/bt.A.16 3			
	bin/bt.R.16 4 bin/bt.R.16 0 20,903 3,009 178	 112 22 81	 50 49	
	bin/bt.A.16 1			
	bin/bt.A.16 2 53 17 -	- 71 -		
	bin/bt.A.163			
	bin/bt.A.164			
		1,680 1,494 1,296	805 784	
	9,142 1,511 190	112 47 81	47 49	
	Maximum 32,602 3,071 198 Minimum 31 6 178	112 71 81 112 21 81	51 49 1 49	
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			×	
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s of AIXtraces with Paraver – ScicomP 9	Min Value MINDOUBLE Max Value MAXDO	JBLE Min Burst 0.00	Max Burst MAXDOUBLE	CÉPBA
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Analyzing MPI behavior – system calls

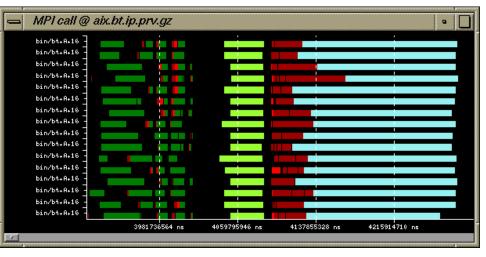
MPI call @ aix.bt.sm.prv.gz	MPI call @ aix.bt.us.prv.gz
X-Axis Semantic Statistic #Bursts = 0 Begin time: 2 End time: 7	266869015 ns X-Axis Semantic Statistic # Bursts != 0 Begin time: 0 ns 7539049675 ns End time: 15698976181 ns
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Statev 13 345 1 1 1 0	C X-Axis Semantic Image: Statistic # Bursts = 0 Begin time: 0 ns 0
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Min Value MinDOUBLE Max Value MAXDOUBLE Min Burst jo	bin/bt.A.16 1,022 754 704 194 10,800 2,475 331 14 87 4 148 bin/bt.A.16 1,022 754 704 194 10,800 2,475 332 114 87 4 148 bin/bt.A.16 1,002 894 704 194 10,800 2,475 332 114 87 4 148
	bix/bt.a.16 1,000 706 1,762 1,952 1,100 1 <t< td=""></t<>
	Repeat All trace All window Analyze OK
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nalysis of AIXtraces with Paraver – ScicomP 9	Min Value Max Value Max Value Max DOUBLE Min Burst D Max Burst MAXDOUBLE

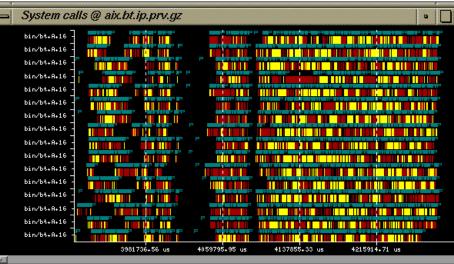
Analyzing MPI behavior – internals of MPI

IP implementation

• MPI calls

• System calls







Analysis of AIXtraces with Paraver - ScicomP 9

state as is c1@ aiv bt us prugz

MPI internal daemons

	state as is_c1 @ aix.bt.us.prv.gz
= state as is_c1@ aix.bt.sm.prv.gz •	
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	RUN BLOCKED STOPPED READY NOT_CREATED bin/bt.A.16 73.85 9.95 7.24 3.86 5.10
Control Window: state as is_c1 🥖 Data Window: 🥵 🖾 🖾 🌌	bin/bt.A.16 1 0.08 % 85.31 % 7.23 % 0.01 % 7.37 %
RUN BLOCKED STOPPED READY YIELD NOT_CREATED	bin/bt.R.16 2 0.06 % 0.01 % 10.70 % 78.98 % 10.25 %
bin/bt.R.16 0 55.01 % 24.50 % 13.61 % 1.29 % 0.00 % 5.59 %	A DHI/DC.R. 16 3 0.01 % - 7.25 % 33.31 % 53.46 %
bin/bt.A.16 1 0.07 % 80.06 % 13.60 % 0.02 % - 6.26 %	bin/bt.A.16 0 74.53 % 9.83 % 7.28 % 3.22 % 5.14 %
bin/bt.A.16 2 0.18 % 0.01 % 20.20 % 59.39 % - 10.22 %	bin/bt.R.16 1 0.08 % 85.32 % 7.23 % 0.02 % 7.34 %
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bin/bt.R.16 0 55.82 % 23.03 % 13.61 % 1.93 % - 5.62 % bin/bt.R.16 1 0.14 % 78.85 % 13.59 % 0.14 % - 7.27 %	bin/bt.R.16 3 0.00 % - 7.23 % 39.31 % 53.45 % bin/bt.R.16 0 75.09 % 9.93 % 7.27 % 2.54 % 5.17 %
bin/bt.A.16 1 0.14 % 78.85 % 13.59 % 0.14 % - 7.27 % bin/bt.A.16 2 0.13 % 0.01 % 20.16 % 69.28 % - 10.41 %	bin/bt.A.16 1 0.09 % 85.32 % 7.22 % 0.01 % 7.35 %
bin/bt.A.16 3 0.02 % - 13.58 % 70.14 % - 16.26 %	bin/bt.A.16 2 0.06 % 0.01 % 10.70 % 79.54 % 9.68 %
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bin/bt.A.16 2 0.11 % 0.02 % 20.14 % 69.05 % - 10.69 %	bin/bt.A.16 1 0.06 % 85.35 % 7.22 % 0.01 % 7.36 %
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bin/bt.R.16 2 0.11 % 0.02 % 20.15 % 69.1	orv.gz
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	. 68 % 5. 22 % 4. 51 % 3. 49 %
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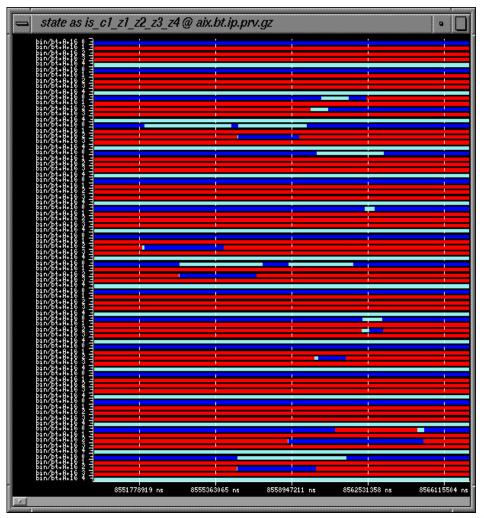


Analysis of AIXtraces with Paraver - ScicomP 9

Analyzing MPI behavior – internals of MPI

MPI internal daemons

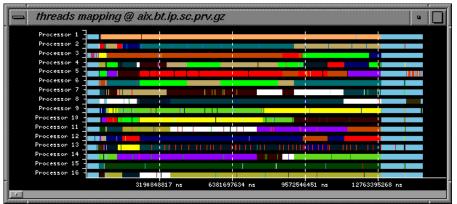
- Sometimes interfere their own MPI task
- Sometimes interfere other MPI task

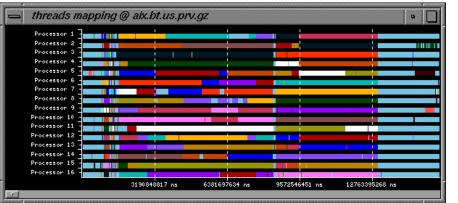


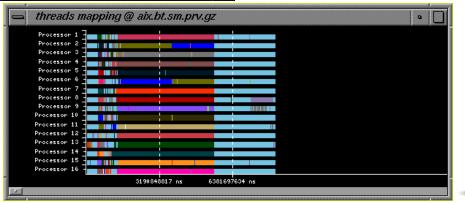


Analyzing MPI behavior - thread mapping

- Process migration
 - Initially very high
 - Not many in stable region





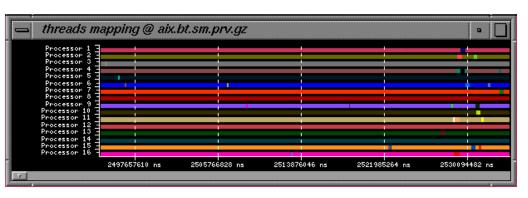


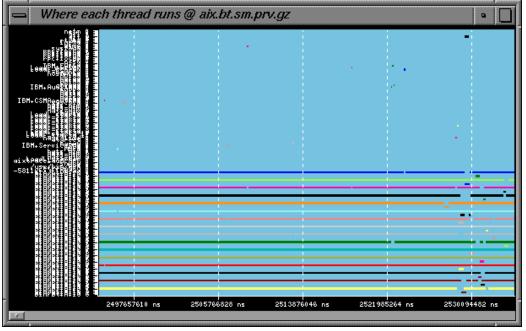


Analyzing MPI behavior - preemptions

Zooming into stable zone of SM run

Who ?







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Motivation

AIXtrace2paraver

Some Examples

- System interferences
- Analyzing MPI behavior
- IRS run @ LLNL

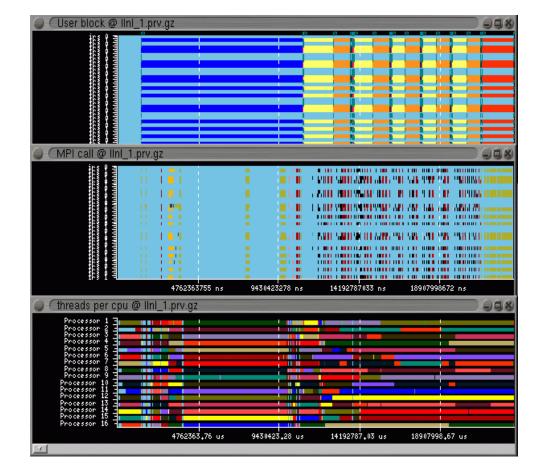
Conclusions



IRS run @ LLNL

Environment

- IRS run on 22 nodes @ LLNL
- Trace obtained
 - ✓ without aixtracelauncher
 - ✓ without dumping switch clock
- Different mapping of the user events

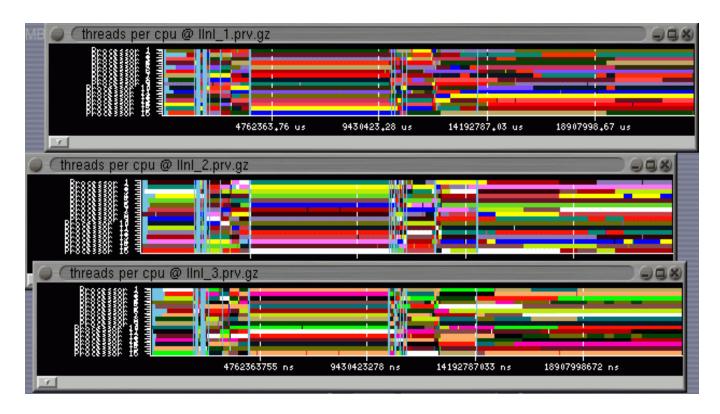




IRS run @ LLNL

Multiple nodes view

- with manual alignment
- Synchronized scheduling effects ?





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- Motivation
- AIXtrace2paraver
- Some Examples
- Conclusions



Conclusions

- Description of the translator AIXtrace2prv developed under support from LLNL (Contact: Terry Jones)
- Shown the huge potential of combining
 - The extraordinary amount of data captured by AIX trace
 - The extraordinary flexibility and processing power of Paraver to extract information from raw performance data
- Porting to 64-bit kernels...?
- Mechanism to automatically insert user events...
- Available to Paraver users or trough an evaluation license (www.cepba.upc.es/paraver)

