Performance Visualization with Vampir: How to get Insight

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Outline

- Introduction
  - Vampirtrace and OTF
  - Vampir Server Architecture and Performance
  - Vampir / Vampir NG: Some Usability Improvements
  - Vampir Displays and Features
  - Summary
Vampir History

- PARvis at Research Center Jülich
- Vampir at Research Center Jülich

- Vampir at ZIH, TU Dresden
  - Was commercially available via Pallas GmbH, later via Intel
  - Vampir (GUI) was developed by ZIH, Dresden
  - Vampirtrace was developed by Pallas/Intel

- Successor Vampir NG (next Generation)
  - client/server architecture
  - Distributed storage, more scalable

Vampir Versions

Vampir+Vampirtrace 3.0
Vampir+Vampirtrace 4.0 /
Intel Trace Analyzer 4.0+
Intel Trace Collector 4.0
Vampir+Vampirtrace 5.0
Vampir Server+Client 1.0
Intel Trace Analyzer 6.0
Intel Trace Collector 6.0
**Vampir Literature**


- Vampir User Guide
- Soon: PhD of Holger Brunst

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**Vampir: Technical Components**

- 1. Trace generator
- 2. Classical Vampir viewer and analyzer
- 3. Vampir client viewer
- 4. Parallel server engine
- 5. Conversion and analysis tools
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Many Trace Formats to choose from ...
OTF Features

- Fast and efficient sequential and parallel access
- Platform independent
- Selective access to
  - Processes
  - Time intervals
- API / Interfaces
  - High level interface for analysis tools
    - Read/write complete traces with multiple files
    - Supports filtering and parallel I/O
  - Low level interface for trace libraries

Relative File Size

- Relative File Size
- SMG 98 (18MB)
- IRS (1.8 GB)
- SMG2000 (2.3 GB)
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Vampir Server Workflow

Parallel Program

File System

Analysis Server

Visualization Client

Parallel I/O

Monitor System

Event Streams

Timeline with 16 visible Traces

768 Processes Thumbnail

Segment Indicator

Internet

Master

Worker 1

Worker 2

Worker m
**Organization of Parallel Analysis**

![Diagram of parallel analysis organization with labels for Worker, Master, Session Threads, Analysis Module, Event Databases, Trace Format Driver, N Session Threads, Visualization Client, Traces, and Message Passing.]

**Scalability - sPPM Analyzed on Origin 2000**

- **sPPM ASCI Benchmark**
  - 3D Gas Dynamic
  - Data to be analyzed
  - 16 Processes
  - 200 MByte Volume

<table>
<thead>
<tr>
<th>Number of Workers</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>16</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Time</td>
<td>47.33</td>
<td>22.48</td>
<td>10.83</td>
<td>5.43</td>
<td>3.01</td>
<td>3.16</td>
</tr>
<tr>
<td>Timeline</td>
<td>0.10</td>
<td>0.99</td>
<td>0.98</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
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<tr>
<td>Summary Profile</td>
<td>1.32</td>
<td>0.70</td>
<td>0.38</td>
<td>0.26</td>
<td>0.17</td>
<td>0.17</td>
</tr>
<tr>
<td>Process Profile</td>
<td>1.26</td>
<td>0.57</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.25</td>
</tr>
<tr>
<td>Com. Matrix</td>
<td>1.32</td>
<td>0.70</td>
<td>0.38</td>
<td>0.26</td>
<td>0.17</td>
<td>0.17</td>
</tr>
<tr>
<td>Stack Tree</td>
<td>2.57</td>
<td>1.39</td>
<td>0.75</td>
<td>0.44</td>
<td>0.25</td>
<td>0.25</td>
</tr>
</tbody>
</table>
A Fairly Large Test Case

- IRS ASCI Benchmark
  - Implicit Radiation Solver
- Data to be analyzed:
  - 64 Processes in 8 Streams
  - Approx. 800,000,000 Events
  - 40 GByte Data Volume
- Analysis Platform:
  - Jump.fz-juelich.de
  - 41 IBM p690 nodes (32 processors per node)
  - 128 GByte per node
- Visualization Platform:
  - Remote Laptop

Vampir NG Server Features

- Distributed server architecture
- Distributed storage of trace data
  - No main memory size restrictions
  - Distributed evaluation
- MPI communication across nodes
- pthread parallelism for concurrent tasks
- Support for multiple clients per server
- Successfully processed traces > 40GB!
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Vampir (old)
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Vampir NG Displays

- Global Timeline
- Process Timeline
- Summary Chart
- Summary Timeline
- Counter Timeline
- Process Profile
- Call Tree
- Message Statistics
- Navigator
- Global Filters
- OpenMP

Vampir NG Displays - Global Timeline

- Show temporal behavior for
  - Processes
  - Functions resp. function groups
  - Messages
  - Collective ops
  - I/O activities
- Context information on click
- Zoomable
- Control actual time interval for other displays
Vampir NG Displays
Global Timeline with Thumbnail

Zoomed

Vampir NG Displays
Global Timeline with Thumbnail

Further Zoomed
Vampir NG Displays - Process Timeline

- Timeline for single processes
- Unfolded call stack in vertical dimension
- Shows:
  - Functions/function groups
  - Messages, collective communication
  - I/O activities
  - Performance counter values
- Zoomable in time
- Context display
Vampir NG Displays
Process Timeline further zoomed

Vampir NG Displays
Process Timeline further zoomed II

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Vampir NG Displays - Counter Timeline

- Statistical overview over functions resp. groups of functions
- As bar chart, pie chart or table
- Global (all processes) or local (single process)
- Exclusive/inclusive time, occurrences
- Absolute or logarithmic scale
- Absolute values or percentages
- Zoomable
- Respect the current time interval (according to timeline)
Vampir NG Displays - Summary Chart

Grouped / Comprehensive Function Statistics

Vampir NG Displays - Summary Chart

Grouped / Comprehensive Function Statistics
Vampir NG Displays - Summary Chart

Alternative Representation

Vampir NG Displays - Summary Timeline

- Summary Chart over time
- Same functionality
- Zoomable
Vampir NG Displays: Summary Timeline

Vampir NG Displays - Summary Timeline
Vampir NG Displays - Process Profile

- Profile for function/group of functions per process
- Similar to results of regular profiling
- But now available for arbitrary time intervals
**Vampir NG Displays - Process Profile**

![Vampir NG Displays - Process Profile](image)

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**Vampir NG Display - Process Profile (MPI)**

![Vampir NG Display - Process Profile (MPI)](image)

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Vampir NG Displays - Call Tree

- Shows function call hierarchy
- Provide callers & callees
- Call count
- Min/max run time
- Fold/unfold
- Search
Vampir NG Displays - Message Statistics

- Sender-receiver matrix
- Zoomable, for > 1000 processes
- Show message properties:
  - Length, rate
  - Duration
  - Count
- Optionally as:
  - min, max, avg, sum
- (Message length histogram)
Vampir NG Displays - Message Statistics

- Find occurrences of certain kinds of events
- Show frequency by color scale
- Filter functions by
  - Functions, function groups, caller
  - Duration interval
- Filter messages by
  - Sender, receiver processes
  - Message length, duration or speed
  - MPI communicator or tag
- Zoomable in time
Vampir NG Displays - Navigator

Event Navigator for Function Group (MPI)

Vampir NG Displays - Navigator

Event Navigator for Function (MPI_Bcast)
**Vampir NG Displays - Navigator**

Event Navigator for Messages

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**Vampir NG Displays - Navigator**

Navigator's Message Selection Dialog

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**Vampir NG Displays - Global Filters**

- Ignore certain items globally
- Processes/threads or groups of them
- Messages
  - By communicator or by tag
- Collective operations
  - By communicator or by type
- I/O events
  - By communicator
  - By file
  - By read/write access

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**Vampir NG Displays - Global Filters**

![Event Filter Dialog](image)

Event Filter Dialog

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Vampir NG Displays - Global Filters

Process Filter Dialog

Configurable OpenMP and MPI Profiles
OpenMP Barrier Synchronization

Summary

- Vampir/Vampir NG offers
  - Comprehensive performance analysis environment
  - Demonstrated scalability to 5000 processors
  - Perfect solution for large centers with remote users and a variety of platforms

- Vampir Future Developments
  - I/O Analysis
  - One sided communication
Software Tools to Support Programming and Optimization on HPC Systems

ISC Tutorial
June 2006

Vampir

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Credits

This work has been a collaborative effort of
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- Matthias Jurenz
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