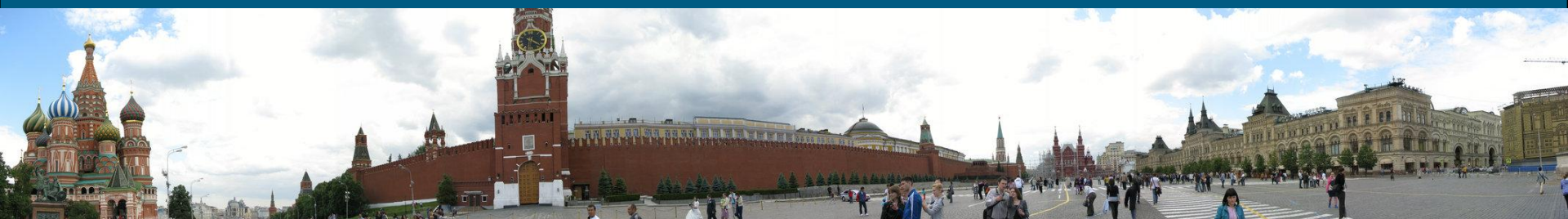


Profile Analysis with CUBE

Bernd Mohr, Jülich Supercomputing Centre

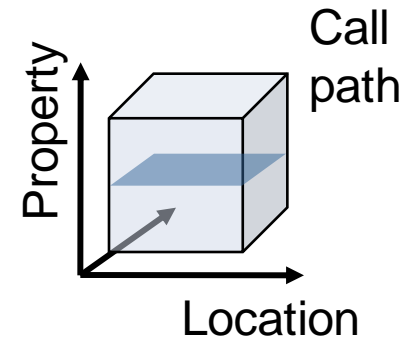


- Parallel program analysis report exploration tools
 - Libraries for CUBE XML report reading & writing
 - Algebra utilities for report processing
 - GUI for interactive analysis exploration
 - requires Qt4
- Originally developed as part of Scalasca toolset
- Now available as a separate component
 - Can be installed independently of Score-P, e.g., on laptop or desktop
 - Latest release: CUBE 4.1.3 (November 2012)

Analysis presentation and exploration



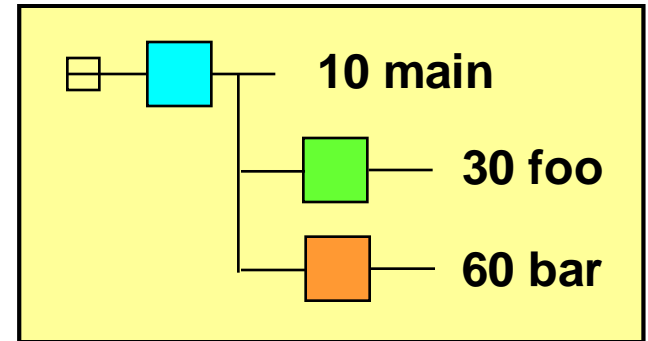
- Representation of values (severity matrix) on three hierarchical axes
 - Performance property (metric)
 - Call-tree path (program location)
 - System location (process/thread)
- Three coupled tree browsers
- CUBE displays severities
 - As value: for precise comparison
 - As colour: for easy identification of hotspots
 - Customizable via display mode
 - Inclusive value when closed & exclusive value when expanded



Analysis presentation and exploration (II)



- Each node displays severity
 - as colour
 - as value
- Dependent on state



Collapsed

- **Inclusive** time
- Entire time spent in the function

Expanded

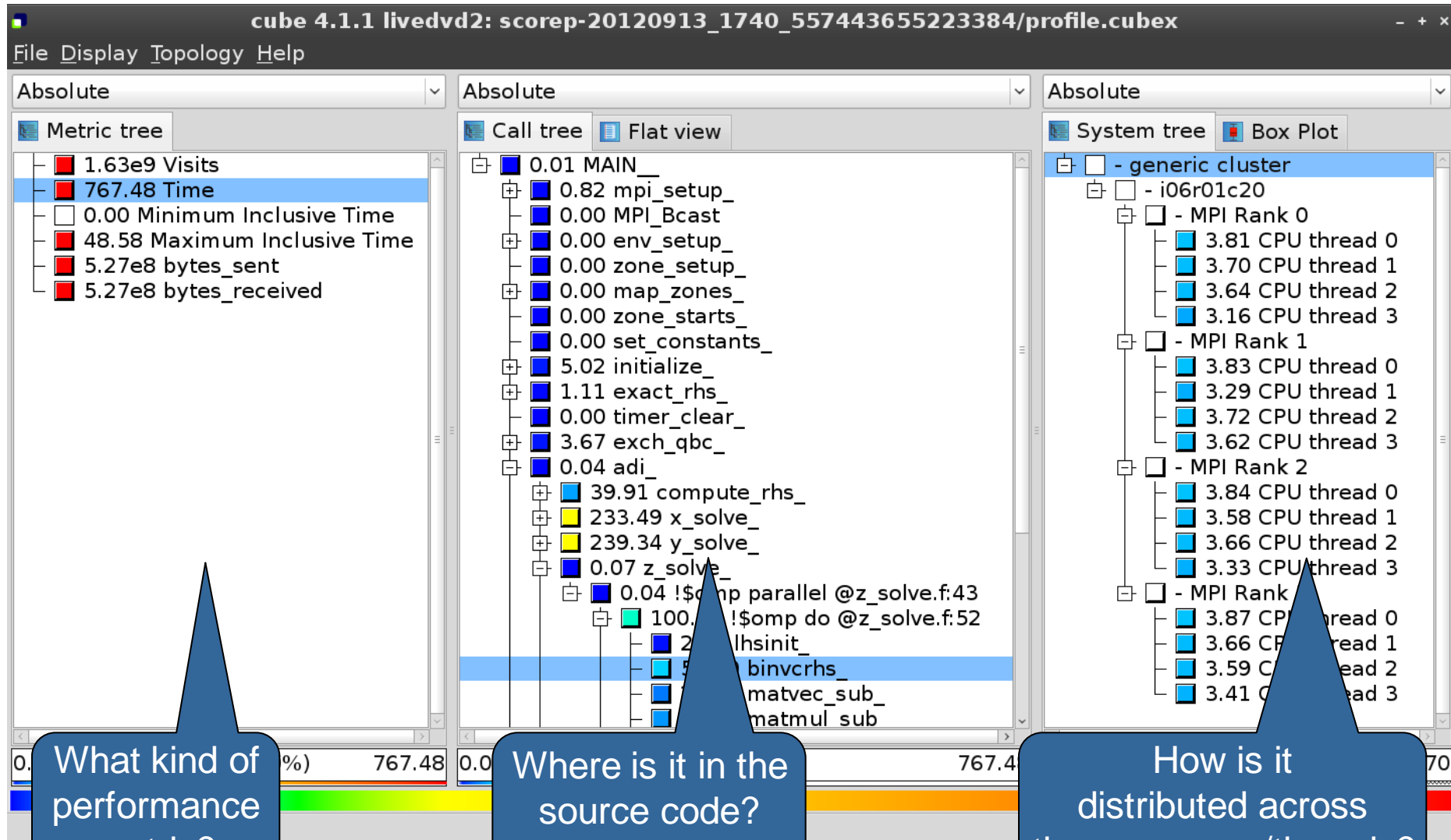
- **Exclusive** time
- Time spent in the function without taking calls to children into account

inclusive duration

exclusive duration

```
int main()
{
  int a;
  a = a + 1;
  foo();
  bar();
  a = a + 1;
  return a;
}
```

Analysis presentation



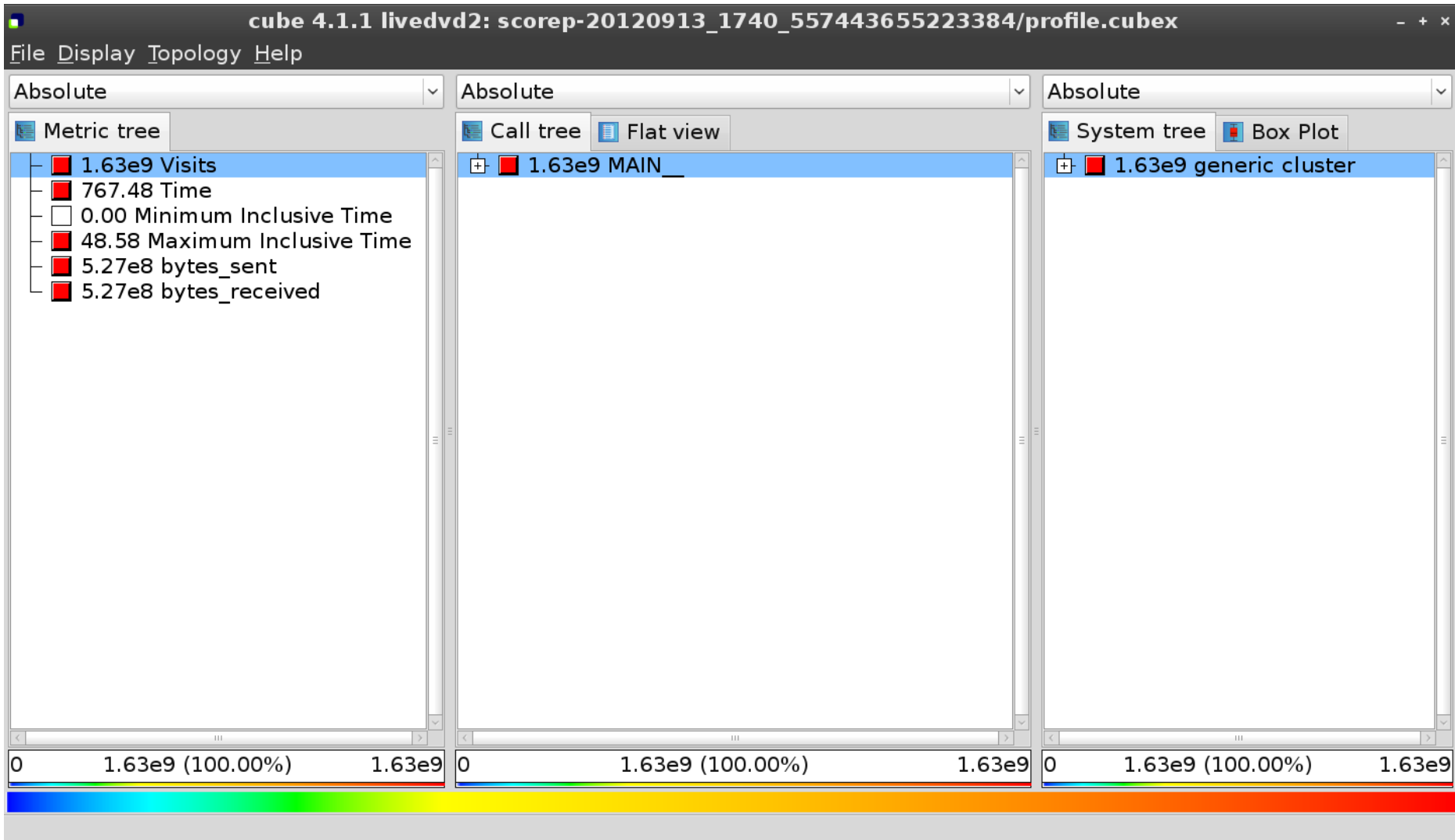
- Creates experiment directory `./scorep_bt-mz_B_4x4_sum` containing
 - a record of the measurement configuration (`scorep.cfg`)
 - the analysis report that was collated after measurement (`profile.cubex`)

```
% ls  
bt-mz_B.4  scorep_bt-mz_B_4x4_sum  
% ls scorep_bt-mz_B_4x4_sum  
profile.cubex  scorep.cfg
```

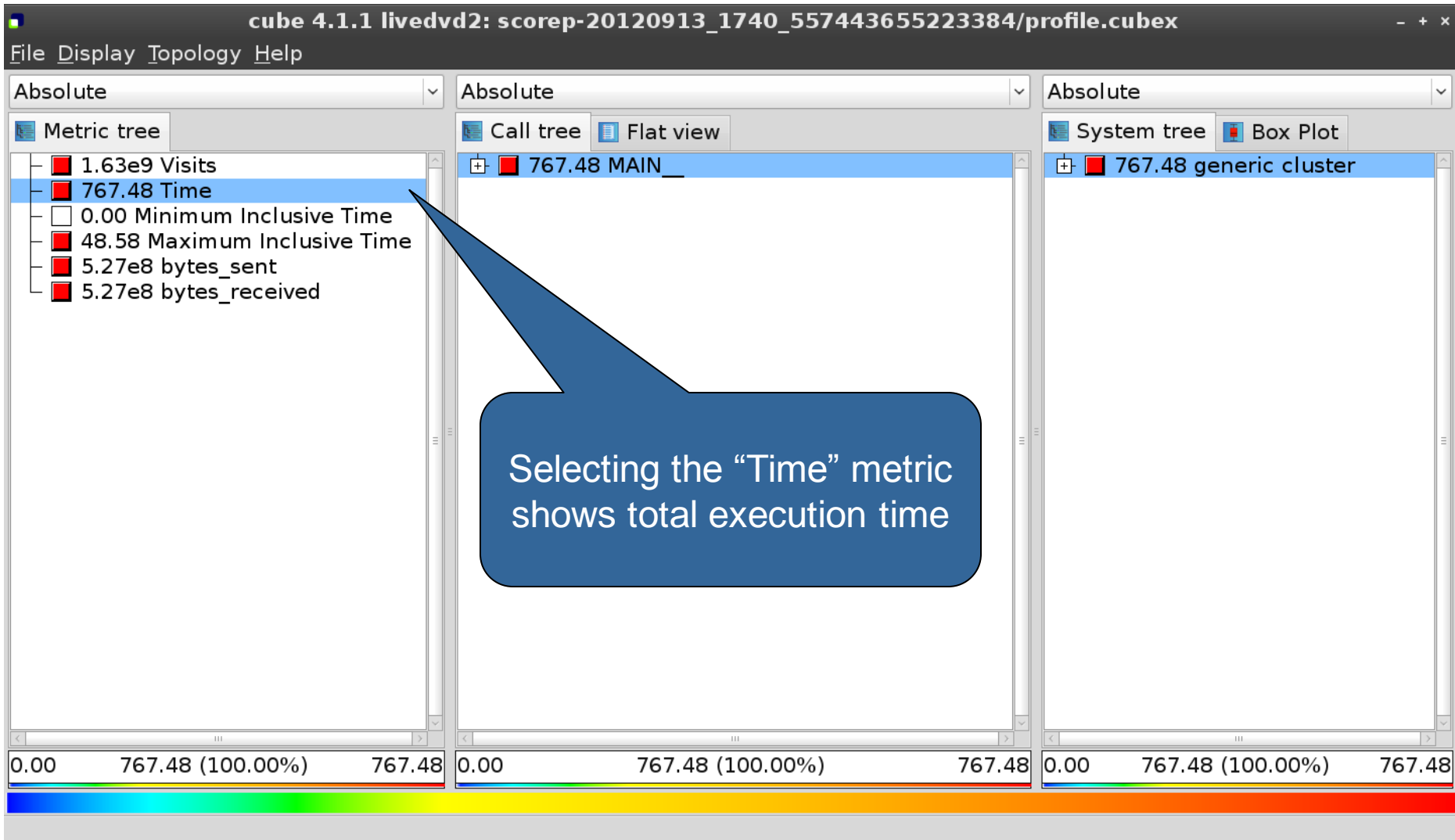
- Interactive exploration with CUBE4

```
% cube scorep_bt-mz_B_4x4_sum/profile.cubex  
  
[CUBE GUI showing summary analysis report]
```

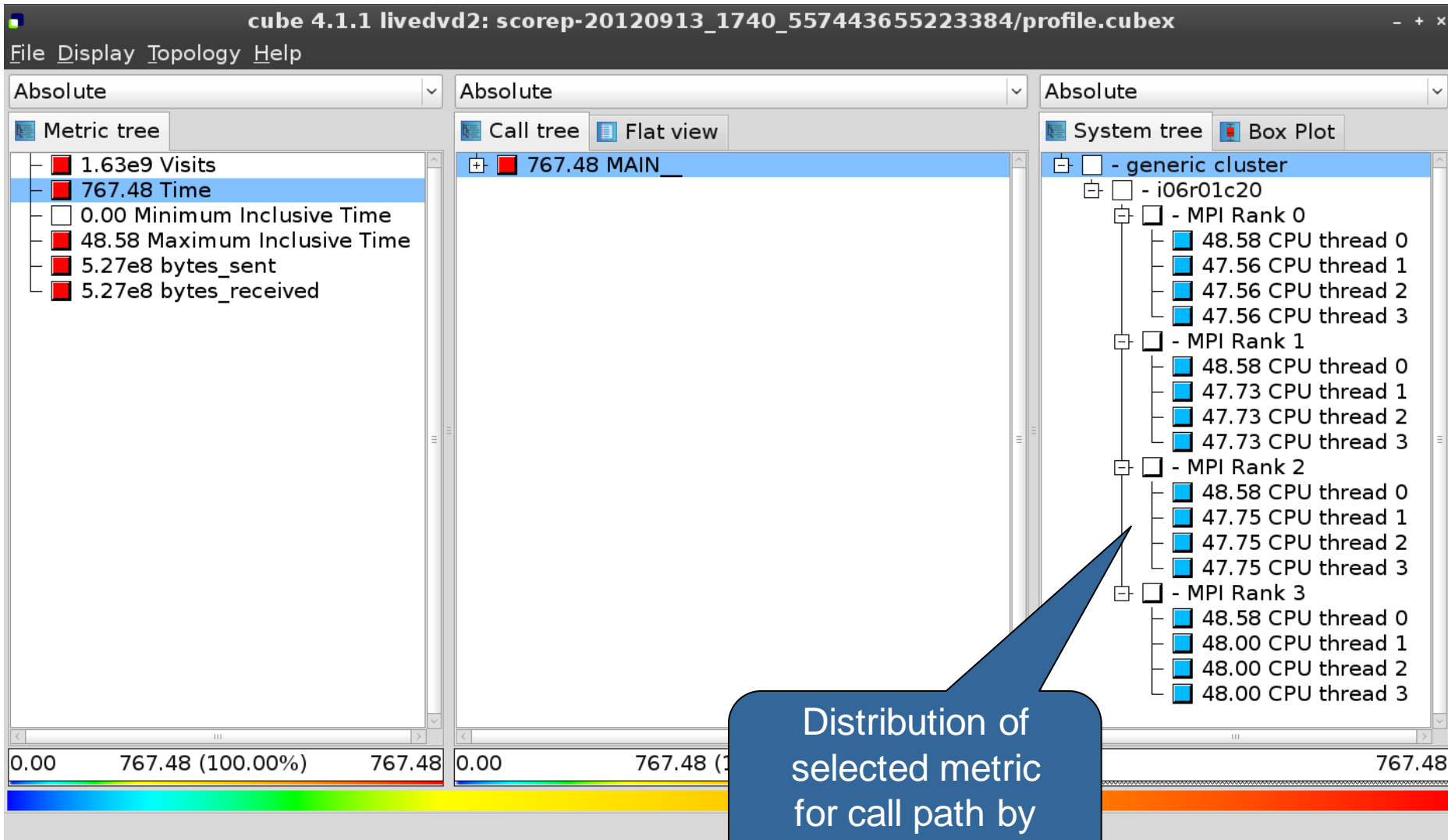
Analysis report exploration (opening view)



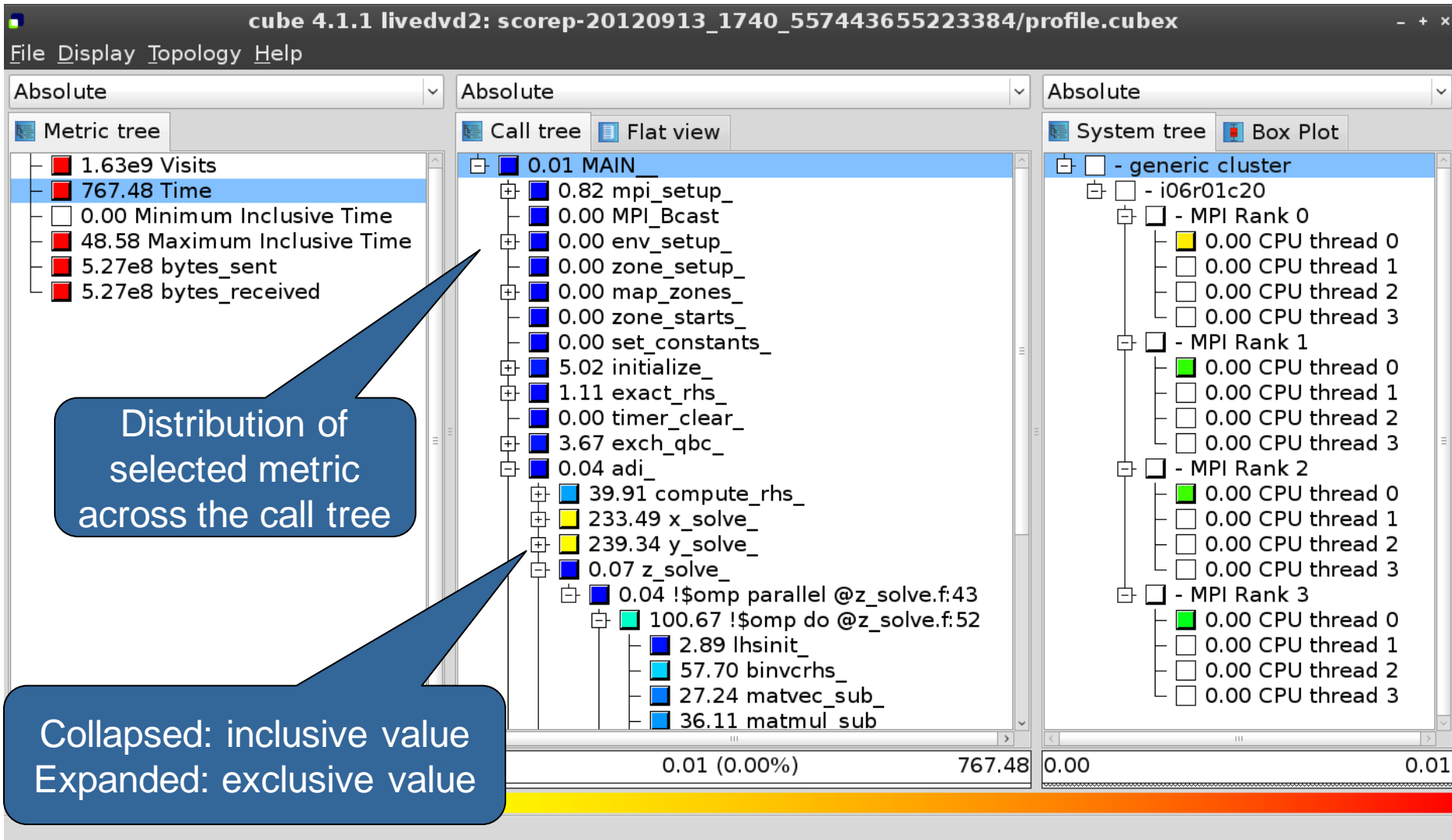
Metric selection



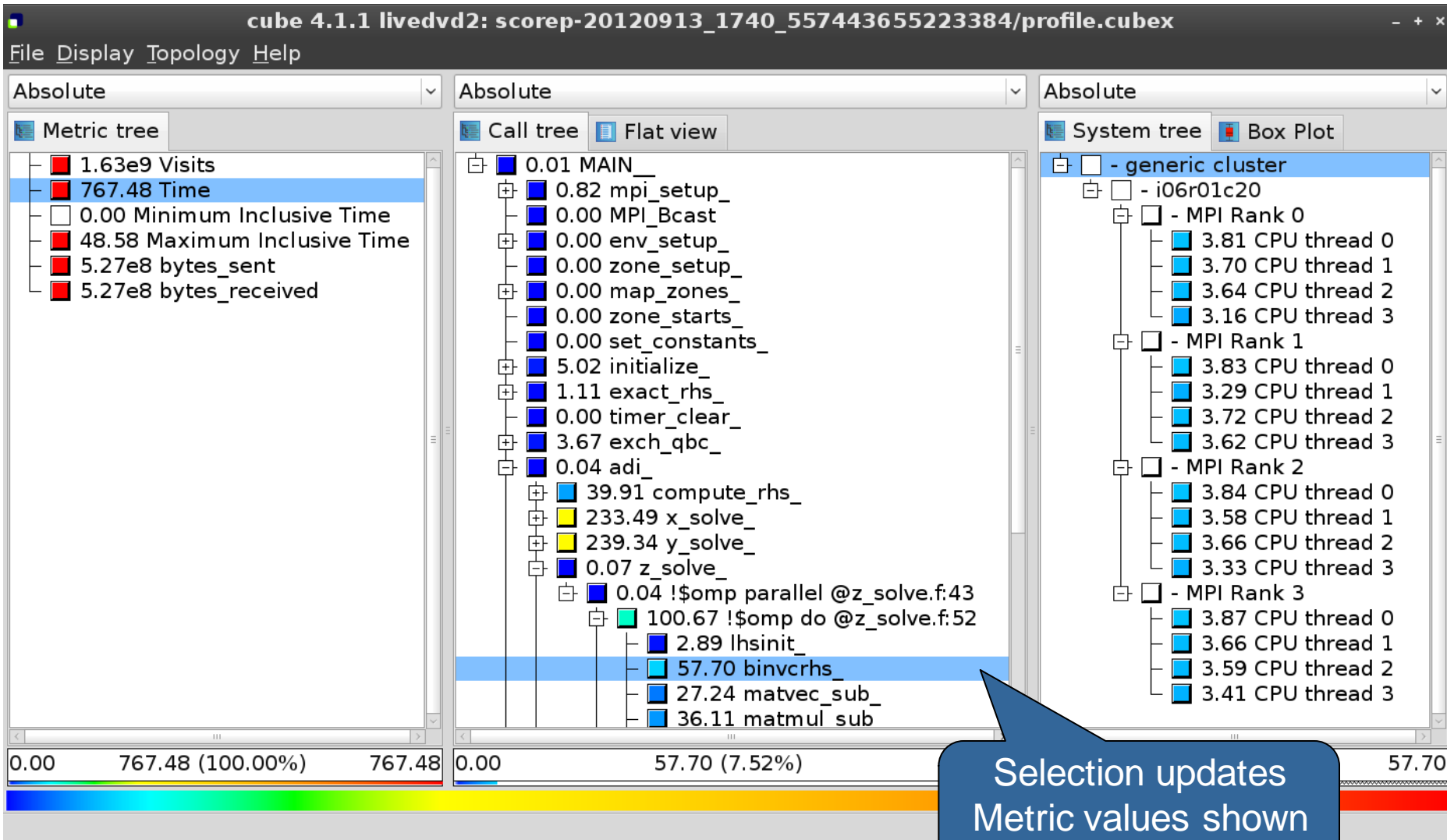
Expanding the system tree



Expanding the call tree



Selecting a call path



Source-code view via context menu



The screenshot displays the 'cube 4.1.1' interface with three main panels: 'Metric tree', 'Call tree', and 'System tree'. The 'Call tree' panel is in 'Call tree' view and shows a hierarchical structure of function calls. A context menu is open over the '57.70 binvcrhs' node, listing options such as 'Call site', 'Called region', 'Expand/collapse', 'Hiding', 'Cut call tree', 'Find items', 'Find Next', 'Clear found items', 'Copy to clipboard', and 'Min/max values'. The 'Source code' option is highlighted. A blue callout box at the bottom center contains the text 'Right-click opens context menu'. The bottom status bar shows a color-coded progress bar and numerical values: '0.00 767.48 (100.00%) 767.48' and '0.00 57.70'.

Source-code view



```
subroutine binvrhs( lhs,c,r )
C-----
C-----
C-----
C
C-----

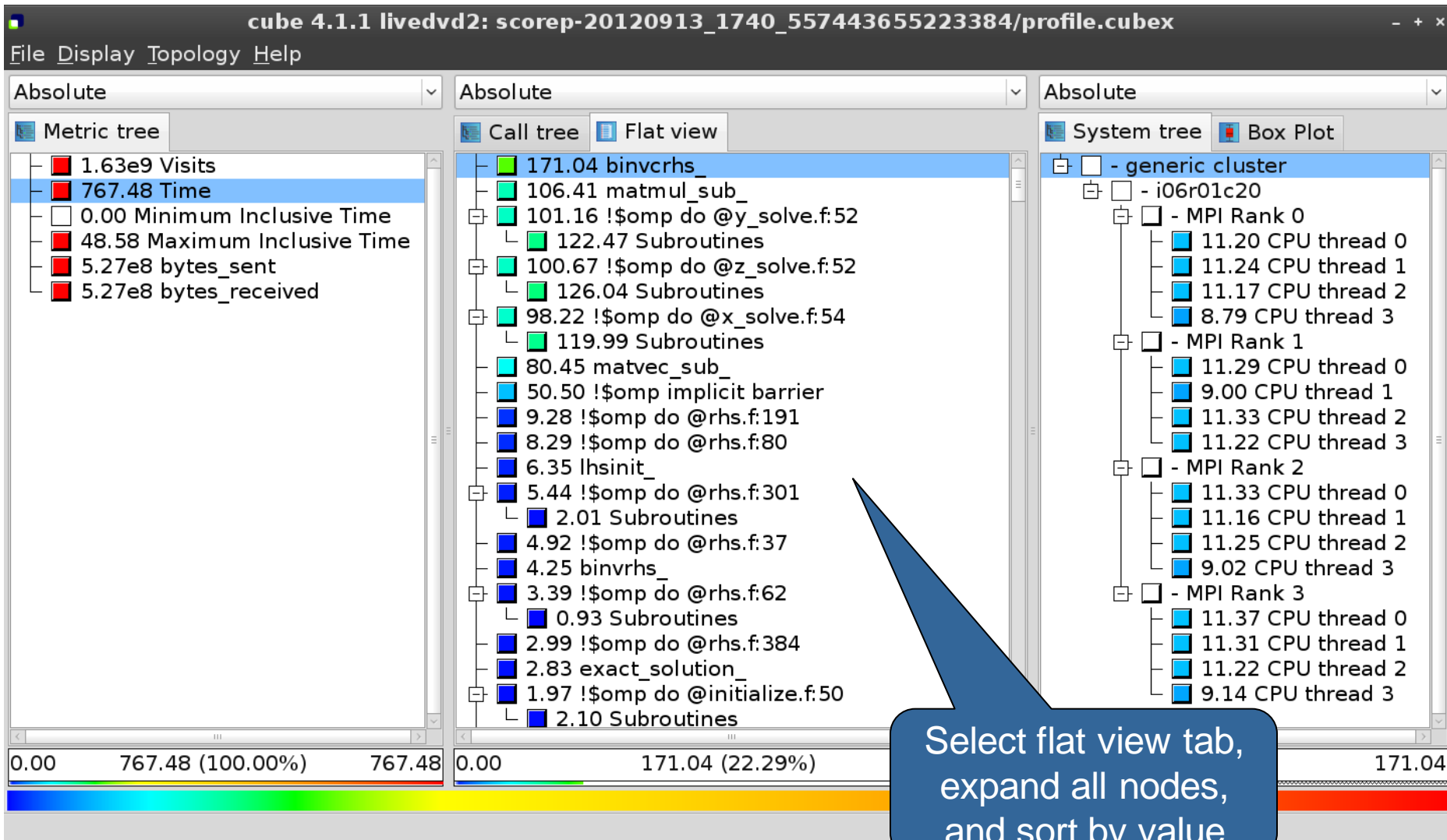
implicit none

double precision pivot, coeff, lhs
dimension lhs(5,5)
double precision c(5,5), r(5)

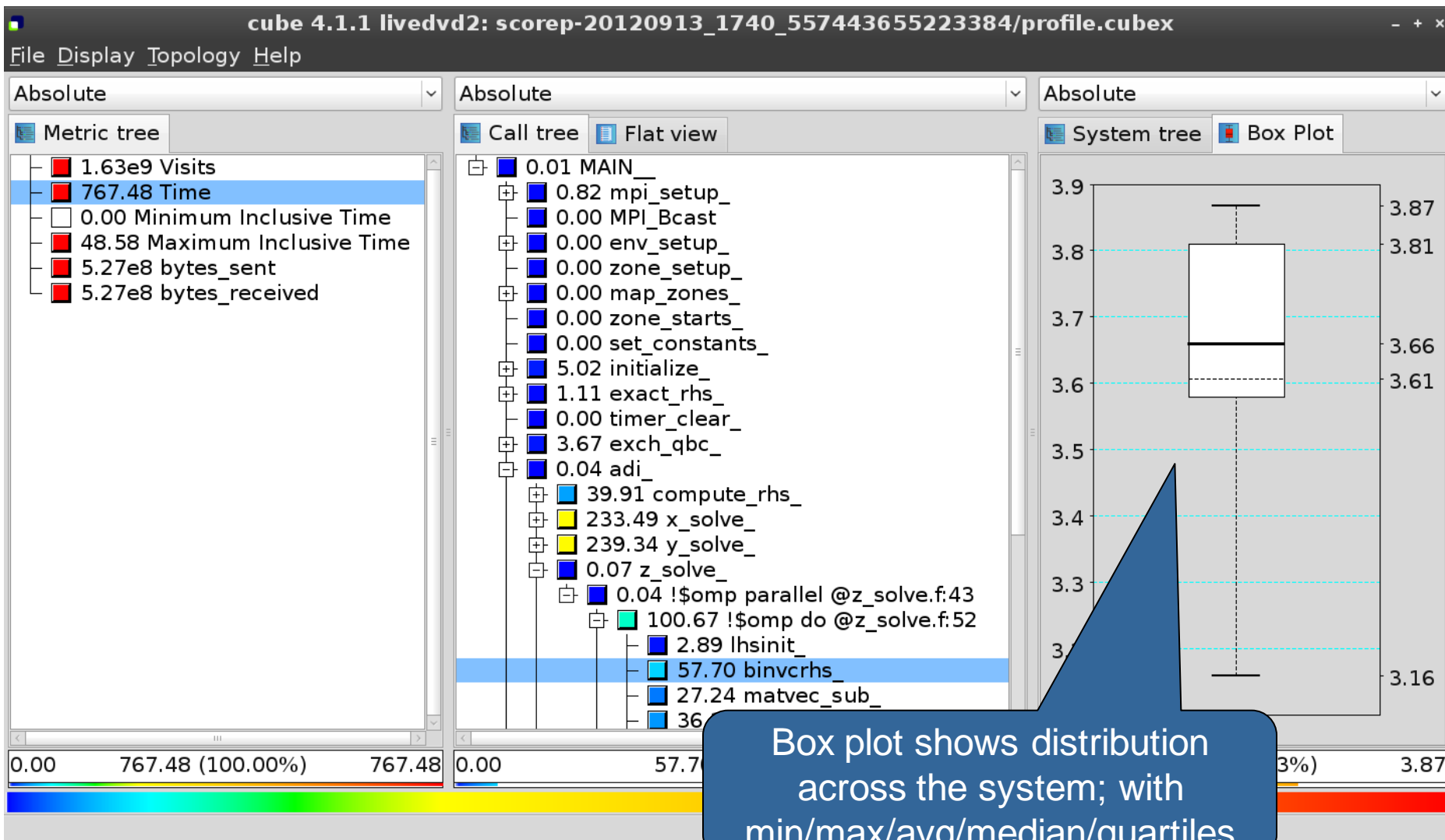
C-----
C
C-----

pivot = 1.00d0/lhs(1,1)
lhs(1,2) = lhs(1,2)*pivot
lhs(1,3) = lhs(1,3)*pivot
lhs(1,4) = lhs(1,4)*pivot
lhs(1,5) = lhs(1,5)*pivot
c(1,1) = c(1,1)*pivot
c(1,2) = c(1,2)*pivot
c(1,3) = c(1,3)*pivot
c(1,4) = c(1,4)*pivot
```

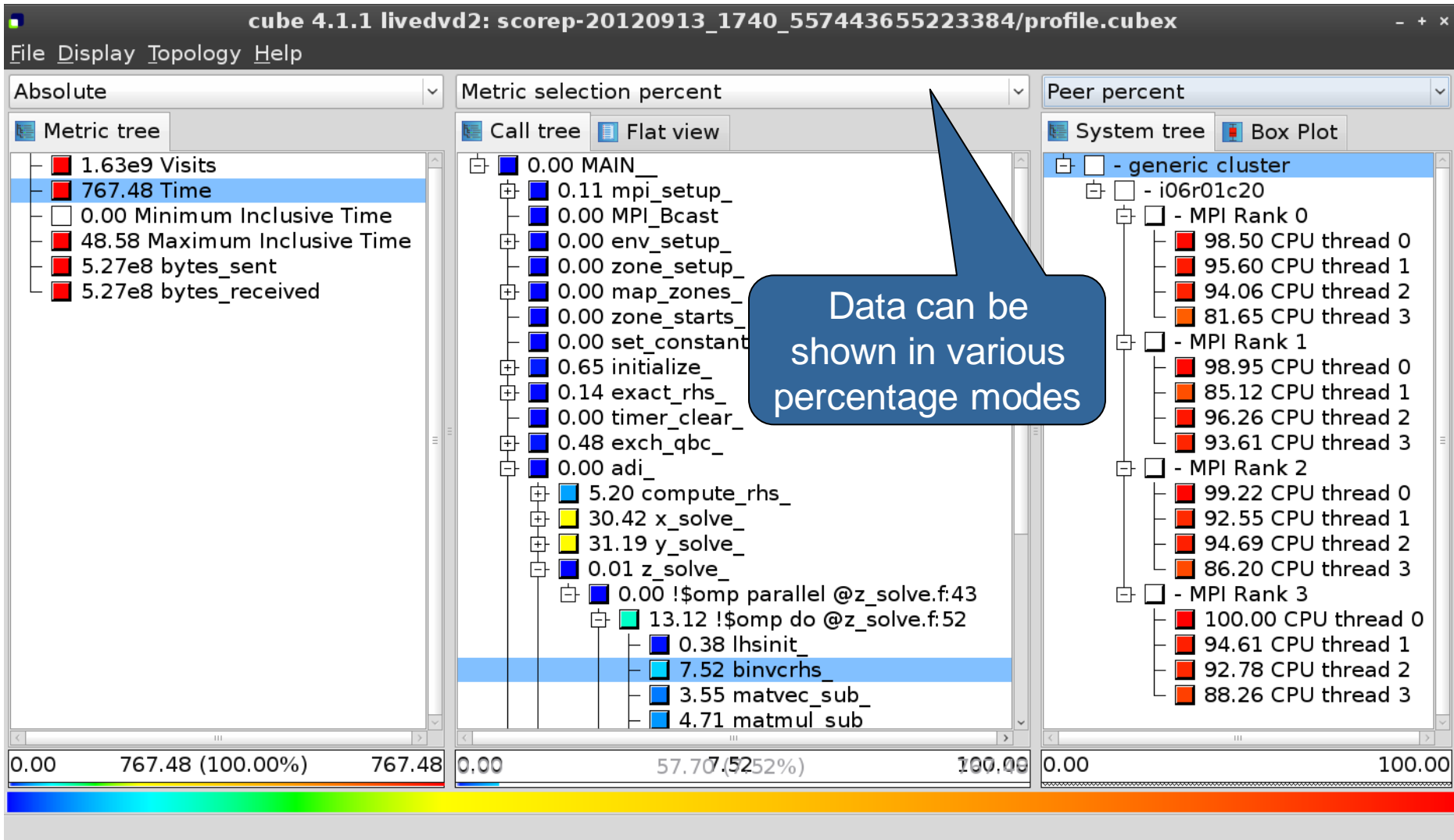
Flat profile view



Box plot view



Alternative display modes



Important display modes



- Absolute
 - Absolute value shown in seconds/bytes/occurrences
- Selection percent
 - Value shown as percentage of the value of the selected node “on the left” (metric/call path)
- Peer percent (system tree only)
 - Value shown as percentage relative to the maximum peer value

Multiple selection



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

File Display Topology Help

Absolute Metric tree Absolute Call tree Flat view Absolute System tree Box Plot

1.63e9 Visits
767.48 Time
0.00 Minimum Inclusive Time
48.58 Maximum Inclusive Time
5.27e8 bytes_sent
5.27e8 bytes_received

0.04 adi_
39.91 compute_rhs_
0.07 x_solve_
0.04 !\$omp parallel @x_sol
218.21 !\$omp do @x_sol
15.18 !\$omp implicit bar
0.07 y_solve_
0.04 !\$omp parallel @y_sol
223.63 !\$omp do @y_sol
15.60 !\$omp implicit bar
0.07 z_solve_
0.04 !\$omp parallel @z_sol
226.71 !\$omp do @z_sol
14.79 !\$omp implicit bar
1.86 add_
0.01 MPI_Barrier
0.00 timer_start_
0.00 timer_stop_
0.00 timer_read_
0.60 verify_
0.00 MPI_Reduce
0.00 print_results

- generic cluster
- i06r01c20
- MPI Rank 0
44.10 CPU thread 0
43.94 CPU thread 1
43.58 CPU thread 2
34.36 CPU thread 3
- MPI Rank 1
44.48 CPU thread 0
35.09 CPU thread 1
44.18 CPU thread 2
43.71 CPU thread 3
- MPI Rank 2
44.47 CPU thread 0
43.49 CPU thread 1
43.86 CPU thread 2
35.18 CPU thread 3
- MPI Rank 3
44.74 CPU thread 0
44.00 CPU thread 1
43.73 CPU thread 2
35.64 CPU thread 3

0.00 767.48 (100.00%) 767.48 0.00 48 0.00 668.54

Select multiple nodes with Ctrl-click

Context-sensitive help



The screenshot shows the 'cube 4.1.1' application window. The title bar reads 'cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex'. The menu bar includes 'File', 'Display', 'Topology', and 'Help'. The 'Help' menu is open, showing options: 'Getting started', 'Mouse and keyboard control', 'What's This? (Shift+F1)', 'About', 'Selected metrics description', and 'Selected regions description'. A blue callout box points to the 'What's This?' option with the text: 'Context-sensitive help available for all GUI items'. The main window is divided into three panes: 'Metric tree' on the left, a central tree view, and 'System tree' on the right. The 'Metric tree' shows metrics like '1.63e9 Visits' and '767.48 Time'. The central tree view shows a hierarchical structure of operations with values like '218.21 !\$omp do @x_solve' and '223.63 !\$omp do @y_solve'. The 'System tree' shows a 'generic cluster' with four MPI Ranks, each containing four CPU threads. At the bottom, there are three progress bars and a status bar that reads 'Change into help mode for display components'.

- Extracting solver sub-tree from analysis report

```
% cube_cut -r '<<SMG.Solve>>' scorep_smg2000/profile.cubex  
Writing cut.cubex... done.
```

- Calculating difference of two reports

```
% cube_diff scorep_smg2000/profile.cubex cut.cubex  
Writing diff.cubex... done.
```

- Additional utilities for merging, calculating mean, etc.
 - Default output of `cube_utility` is a new report `utility.cubex`
- Further utilities for report scoring & statistics
- Run utility with “-h” (or no arguments) for brief usage info

Further information



CUBE

- Parallel program analysis report exploration tools
 - Libraries for XML report reading & writing
 - Algebra utilities for report processing
 - GUI for interactive analysis exploration
- Available under New BSD open-source license
- Documentation & Sources:
 - <http://www.score-p.org>
- User guide also part of installation:
 - ``cube-config --cube-dir`/share/doc/CubeGuide.pdf`
- Contact:
 - [mailto: scalasca@fz-juelich.de](mailto:scalasca@fz-juelich.de)





Questions?