Analysis report examination with CUBE

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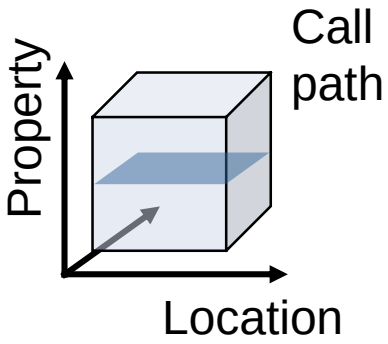
CUBE

- Parallel program analysis report exploration tools
  - Libraries for 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 4.3.0 (January 2015)

Analysis presentation and exploration

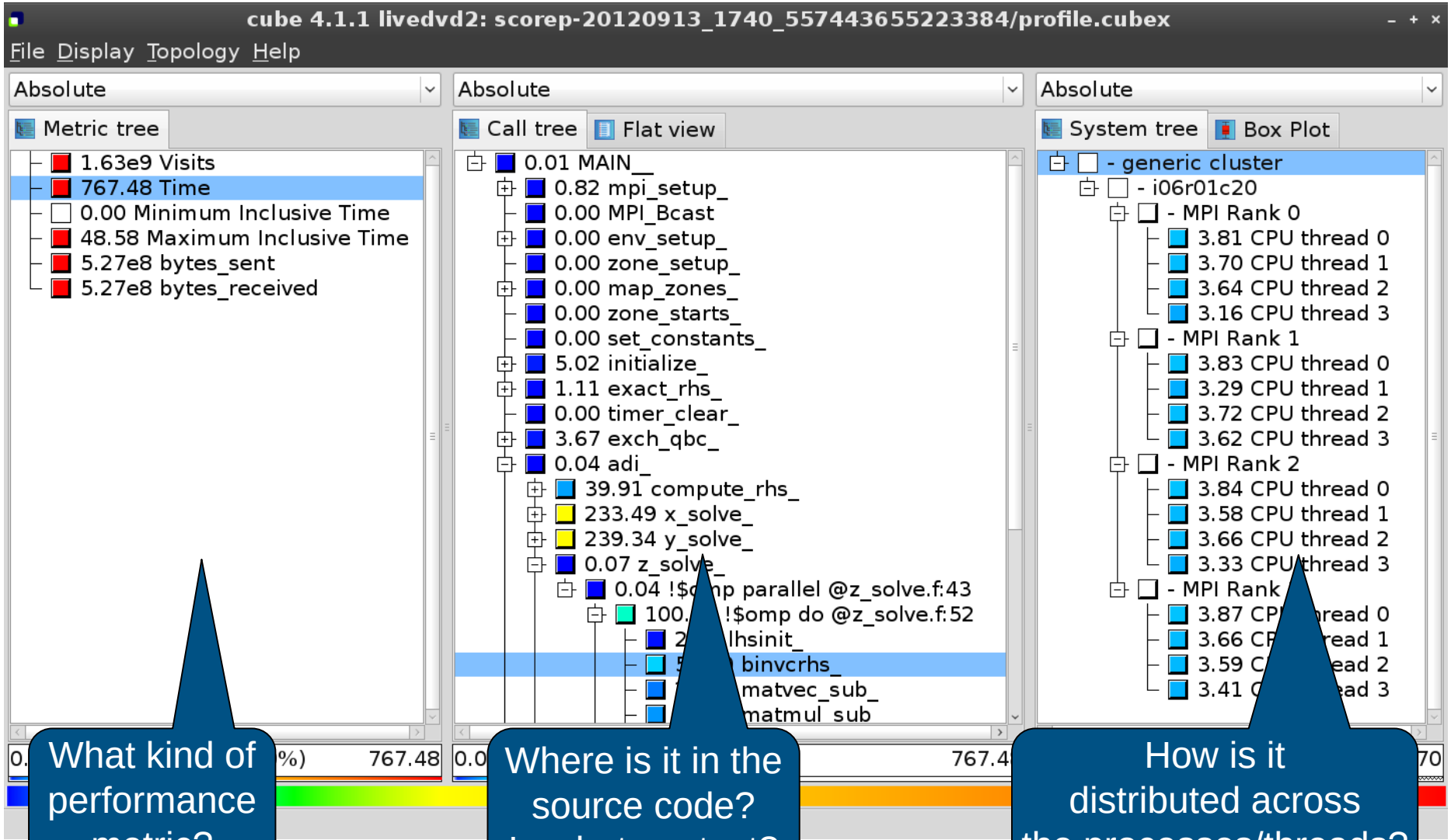
- Representation of values (severity matrix) on three hierarchical axes
  - Performance property (metric)
  - Call path (program location)
  - System location (process/thread)



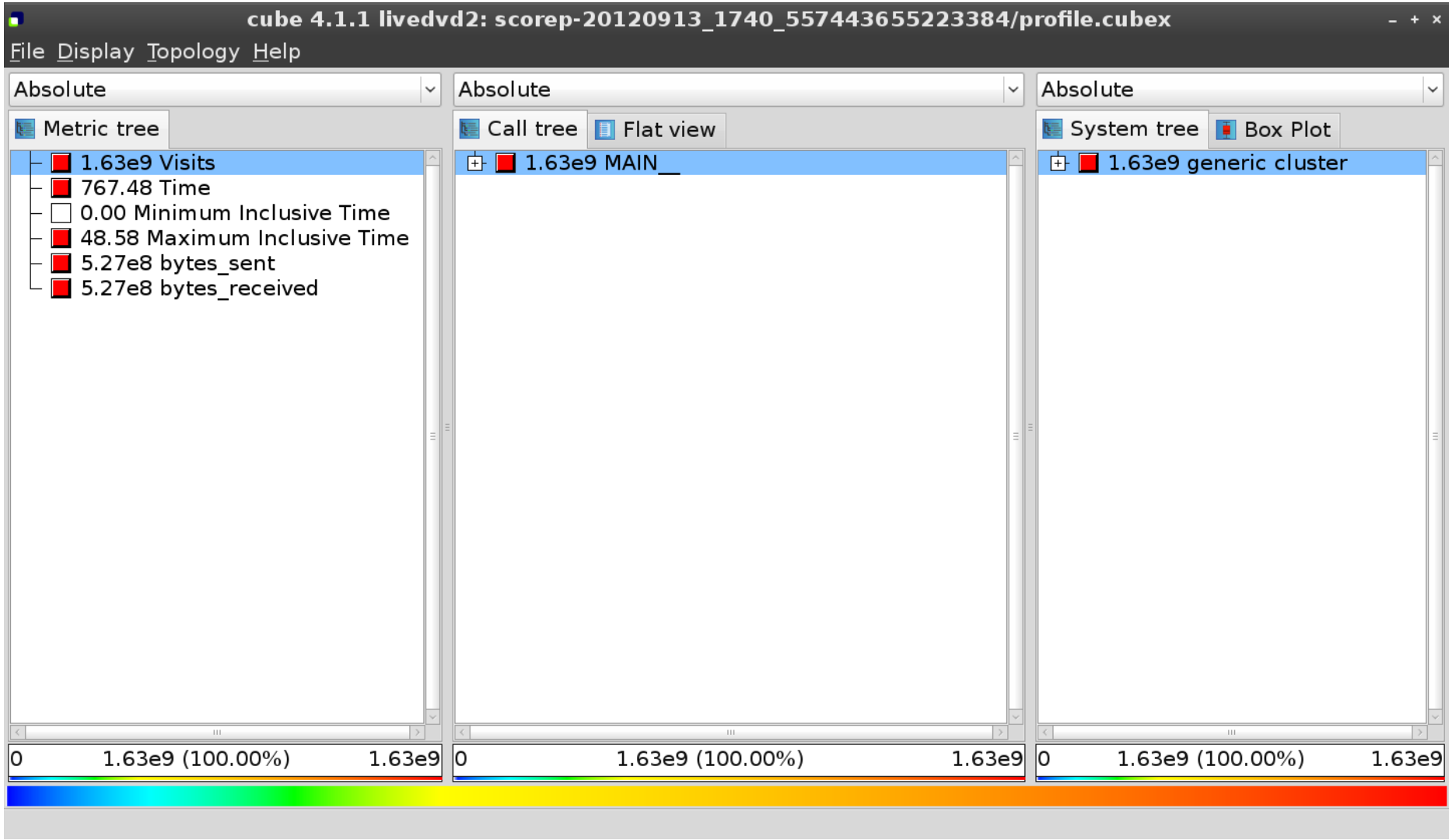
- Three coupled tree browsers

- CUBE displays severities
  - As value: for precise comparison
  - As colour: for easy identification of hotspots
  - Inclusive value when closed & exclusive value when expanded
  - Customizable via display modes

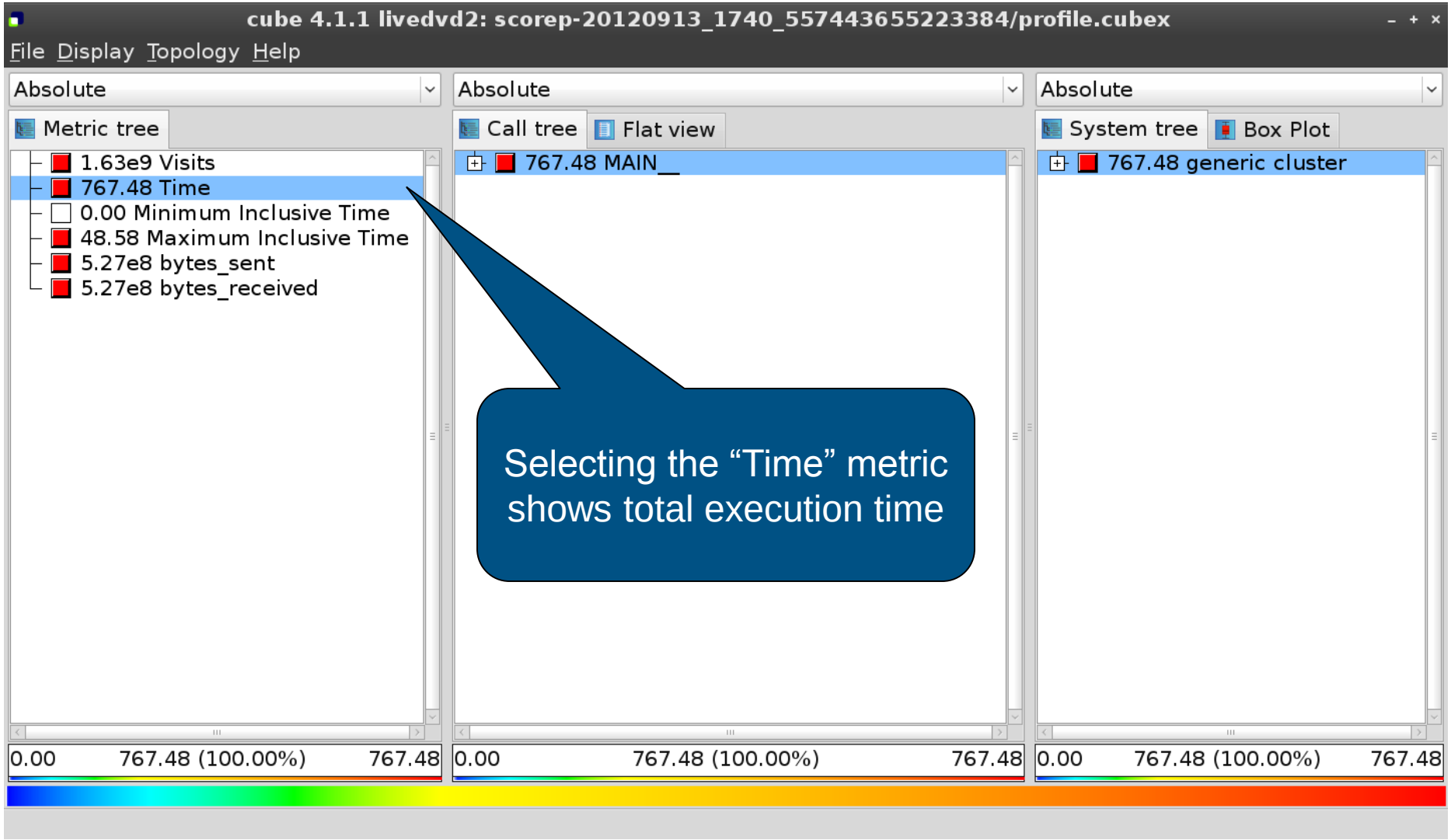
Analysis presentation



Analysis report exploration (opening view)



Metric selection



Expanding the system tree

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

File Display Topology Help

Absolute | Absolute | Absolute

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

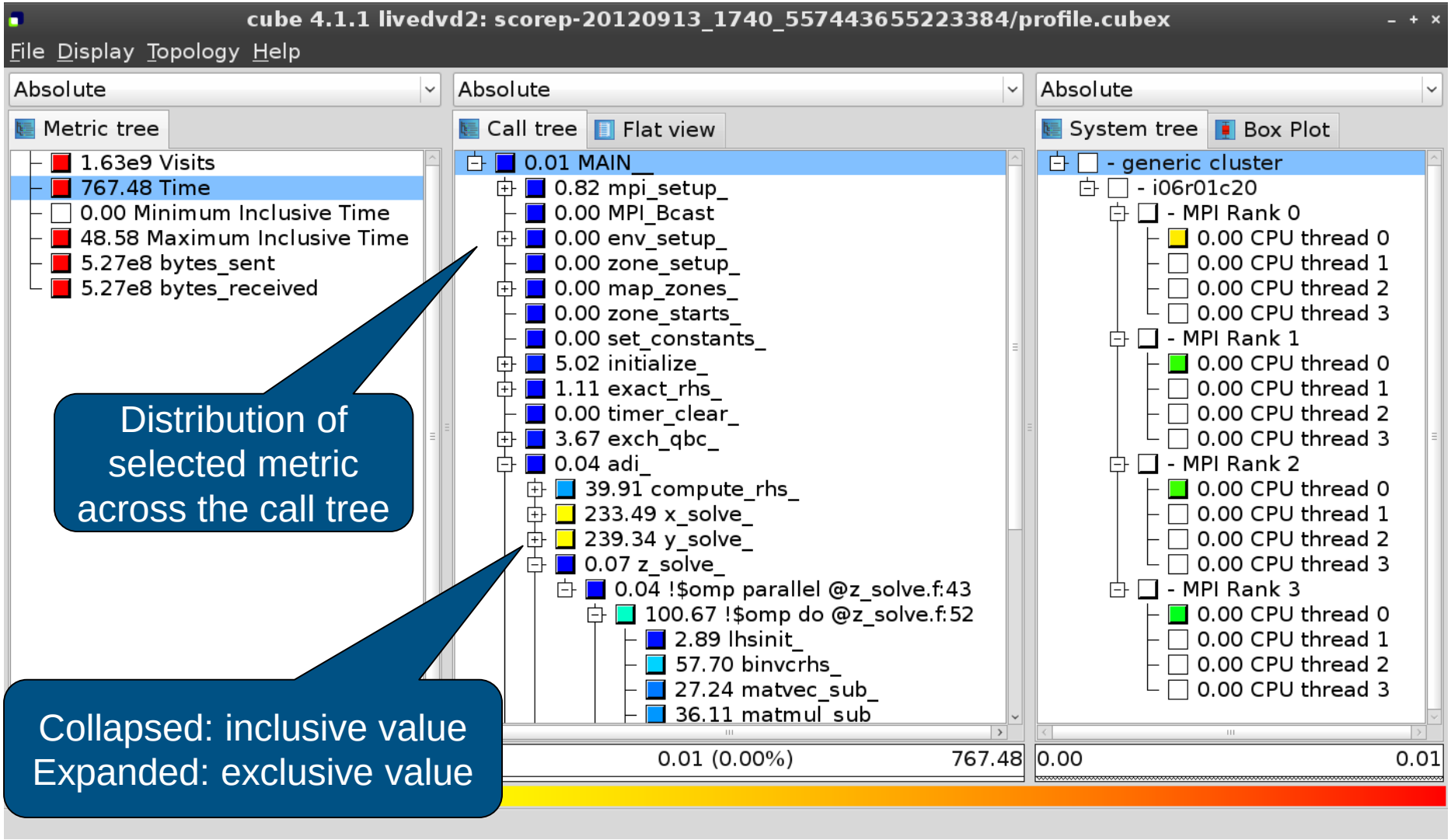
Call tree | Flat view
- 767.48 MAIN__

System tree | Box Plot
- generic cluster
  - i06r01c20
    - MPI Rank 0
      - 48.58 CPU thread 0
      - 47.56 CPU thread 1
      - 47.56 CPU thread 2
      - 47.56 CPU thread 3
    - MPI Rank 1
      - 48.58 CPU thread 0
      - 47.73 CPU thread 1
      - 47.73 CPU thread 2
      - 47.73 CPU thread 3
    - MPI Rank 2
      - 48.58 CPU thread 0
      - 47.75 CPU thread 1
      - 47.75 CPU thread 2
      - 47.75 CPU thread 3
    - MPI Rank 3
      - 48.58 CPU thread 0
      - 48.00 CPU thread 1
      - 48.00 CPU thread 2
      - 48.00 CPU thread 3

0.00 767.48 (100.00%) 767.48 | 0.00 767.48 (| 767.48

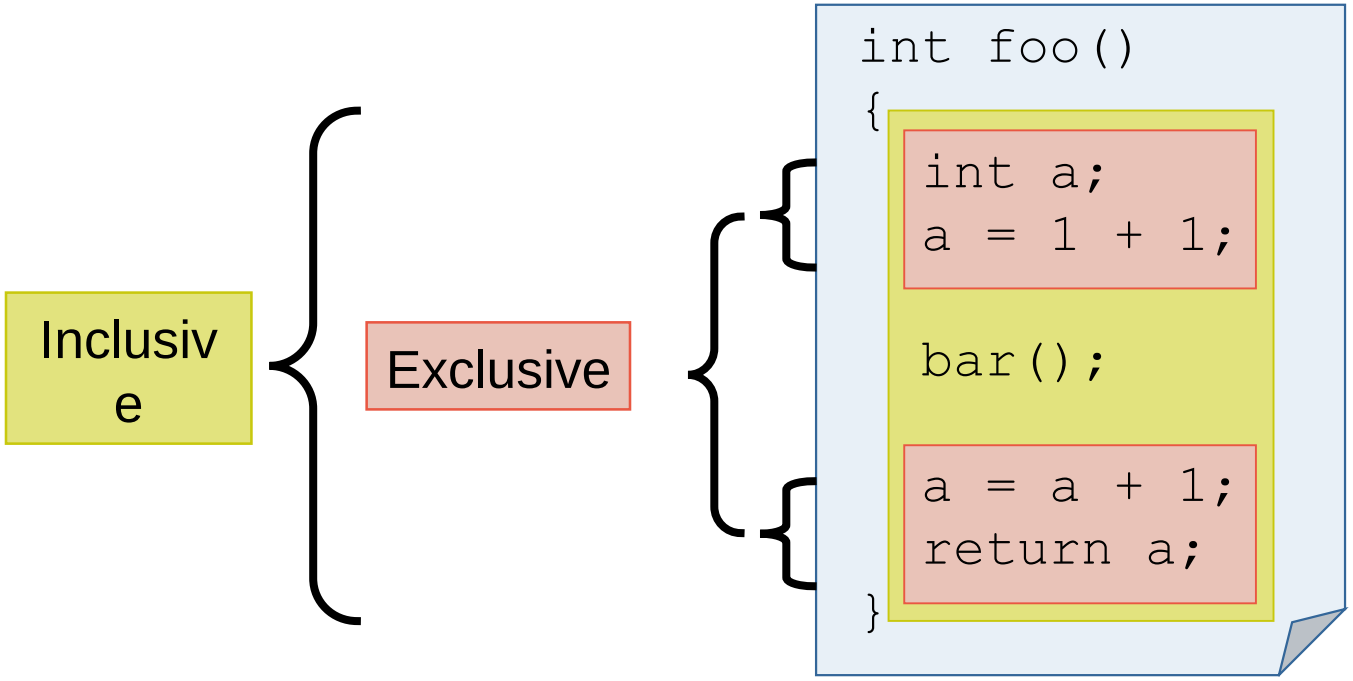
Distribution of selected metric for call path by process/thread

Expanding the call tree



Inclusive vs. Exclusive values

- Inclusive
  - Information of all sub-elements aggregated into single value
- Exclusive
  - Information cannot be subdivided further



Selecting a call path

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

File Display Topology Help

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- 5.27e8 bytes_received

0.00 767.48 (100.00%) 767.48

Call tree | Flat view

- 0.01 MAIN__
  - 0.82 mpi_setup_
  - 0.00 MPI_Bcast
  - 0.00 env_setup_
  - 0.00 zone_setup_
  - 0.00 map_zones_
  - 0.00 zone_starts_
  - 0.00 set_constants_
  - 5.02 initialize_
  - 1.11 exact_rhs_
  - 0.00 timer_clear_
  - 3.67 exch_qbc_
  - 0.04 adi_
    - 39.91 compute_rhs_
    - 233.49 x_solve_
    - 239.34 y_solve_
    - 0.07 z_solve_
      - 0.04 !$omp parallel @z_solve.f:43
        - 100.67 !$omp do @z_solve.f:52
          - 2.89 lhsinit_
          - 57.70 binvcrhs_
          - 27.24 matvec_sub_
          - 36.11 matmul_sub

0.00 57.70 (7.52%) 57.70

System tree | Box Plot

- generic cluster
  - i06r01c20
    - MPI Rank 0
      - 3.81 CPU thread 0
      - 3.70 CPU thread 1
      - 3.64 CPU thread 2
      - 3.16 CPU thread 3
    - MPI Rank 1
      - 3.83 CPU thread 0
      - 3.29 CPU thread 1
      - 3.72 CPU thread 2
      - 3.62 CPU thread 3
    - MPI Rank 2
      - 3.84 CPU thread 0
      - 3.58 CPU thread 1
      - 3.66 CPU thread 2
      - 3.33 CPU thread 3
    - MPI Rank 3
      - 3.87 CPU thread 0
      - 3.66 CPU thread 1
      - 3.59 CPU thread 2
      - 3.41 CPU thread 3

Selection updates metric values shown in columns to right

Source-code view via context menu

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

File Display Topology Help

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Call tree | Flat view
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  - 0.00 zone_starts_
  - 0.00 set_constants_
  - 5.02 initialize_
  - 1.11 exact_rhs_
  - 0.00 timer_clear_
  - 3.67 exch_qbc_
  - 0.04 adi_
    - 39.91 compute_rhs_
    - 233.49 x_solve_
    - 239.34 y_solve_
    - 0.07 z_solve_
      - 0.04 !$omp paralle
        - 100.67 !$omp d
          - 2.89 lhsinit_
          - 57.70 binvcrhs_
          - 27.2 atvec_sub_
          - matmul_sub

Call site
Called region
Expand/collapse
Hiding
Cut call tree
Find items
Find Next
Clear found items
Copy to clipbaord
Min/max values

Info
Online description
Location
Source code

System tree | Box Plot
- generic cluster
  - i06r01c20
    - MPI Rank 0
      - 3.81 CPU thread 0
      - 3.70 CPU thread 1
      - 3.64 CPU thread 2
      - 3.16 CPU thread 3
    - MPI Rank 1
      - U thread 0
      - U thread 1
      - U thread 2
      - U thread 3
      - 2
      - 3.84 CPU thread 0
      - 3.58 CPU thread 1
      - 3.66 CPU thread 2
      - 3.33 CPU thread 3
    - MPI Rank 3
      - 3.87 CPU thread 0
      - 3.66 CPU thread 1
      - 3.59 CPU thread 2
      - 3.41 CPU thread 3

0.00 767.48 (100.00%) 767.48 | 767.48 | 0.00 57.70

Shows the source code of the clicked ite

Right-click opens context menu

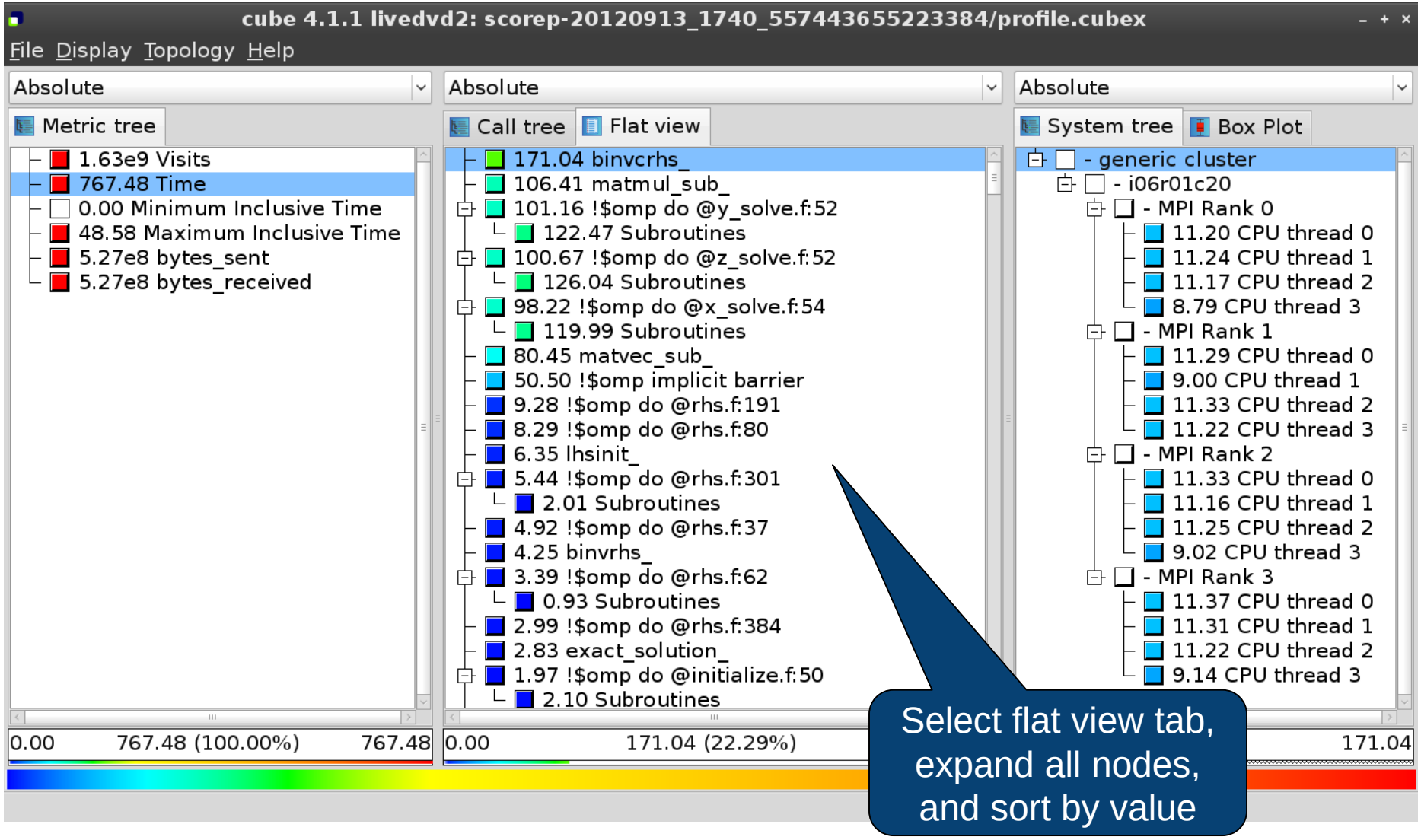
Source-code view

/home/geimer/Projects/Tests/NPB3.3-MZ-MPI/BT-MZ/solve_subs.f

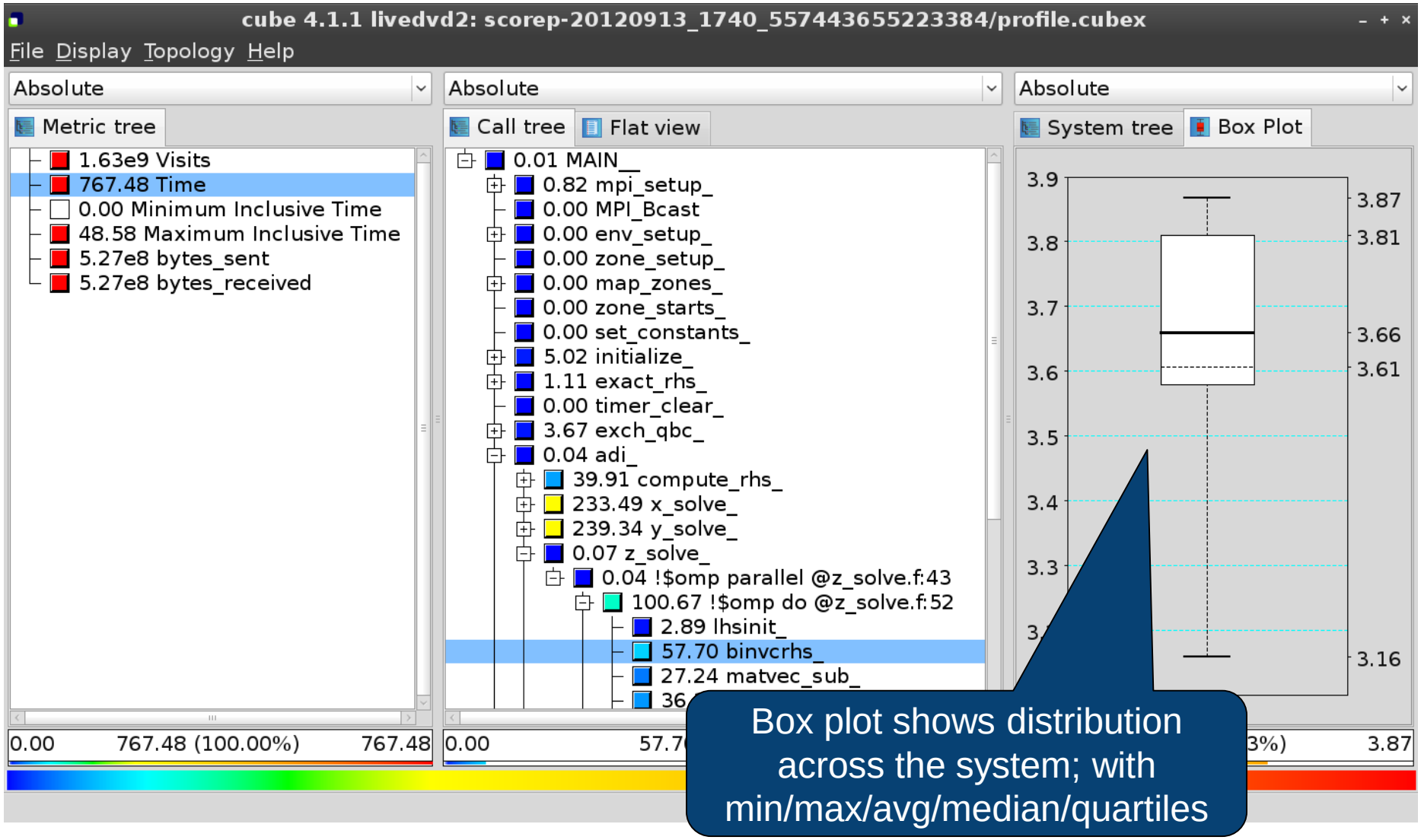
```
      subroutine binvcrhs( lhs,c,r )

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
```

Read only | Save | Save as | Font... | Close

Flat profile view

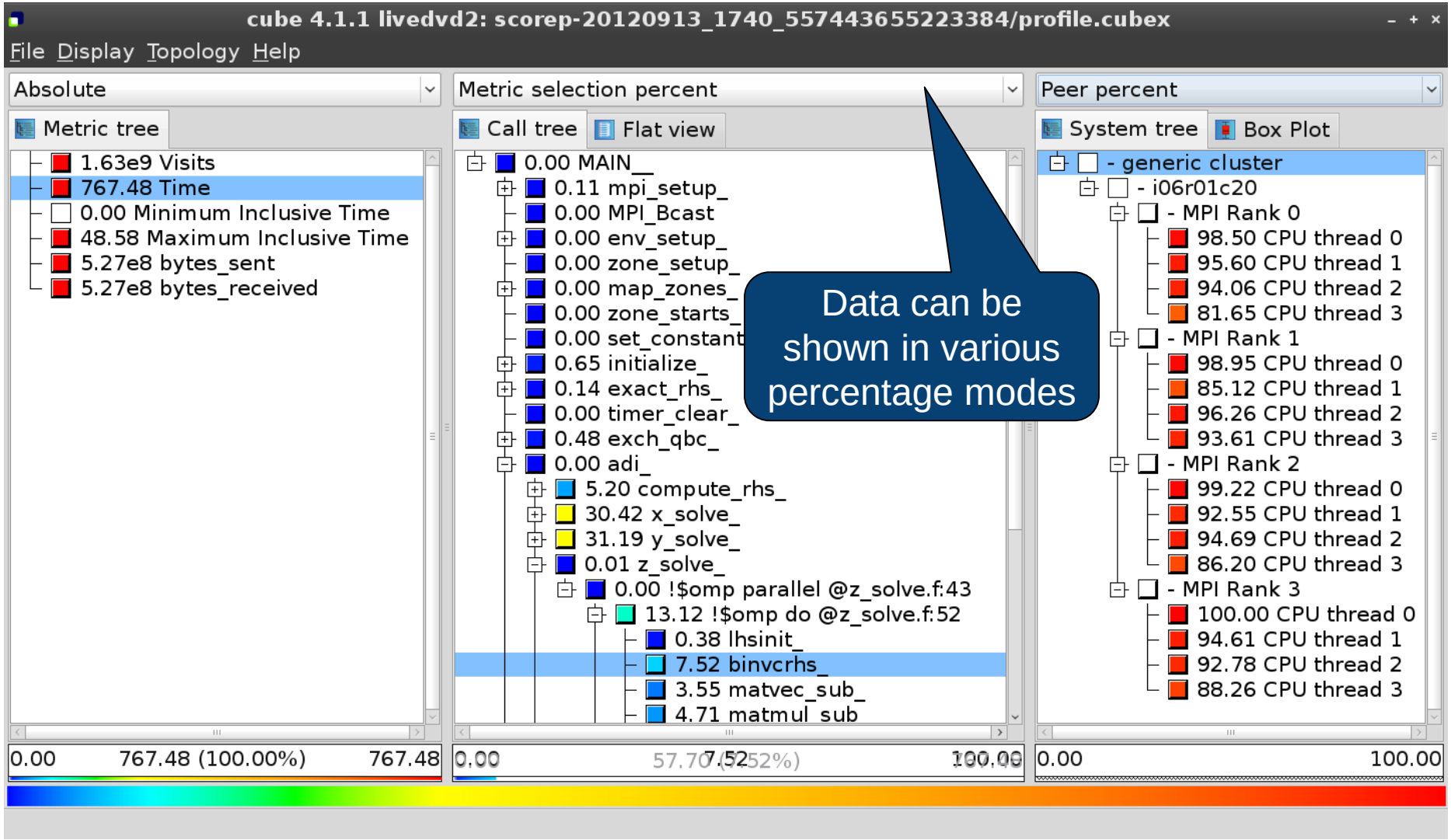


Box plot view



Box plot shows distribution across the system; with min/max/avg/median/quartiles

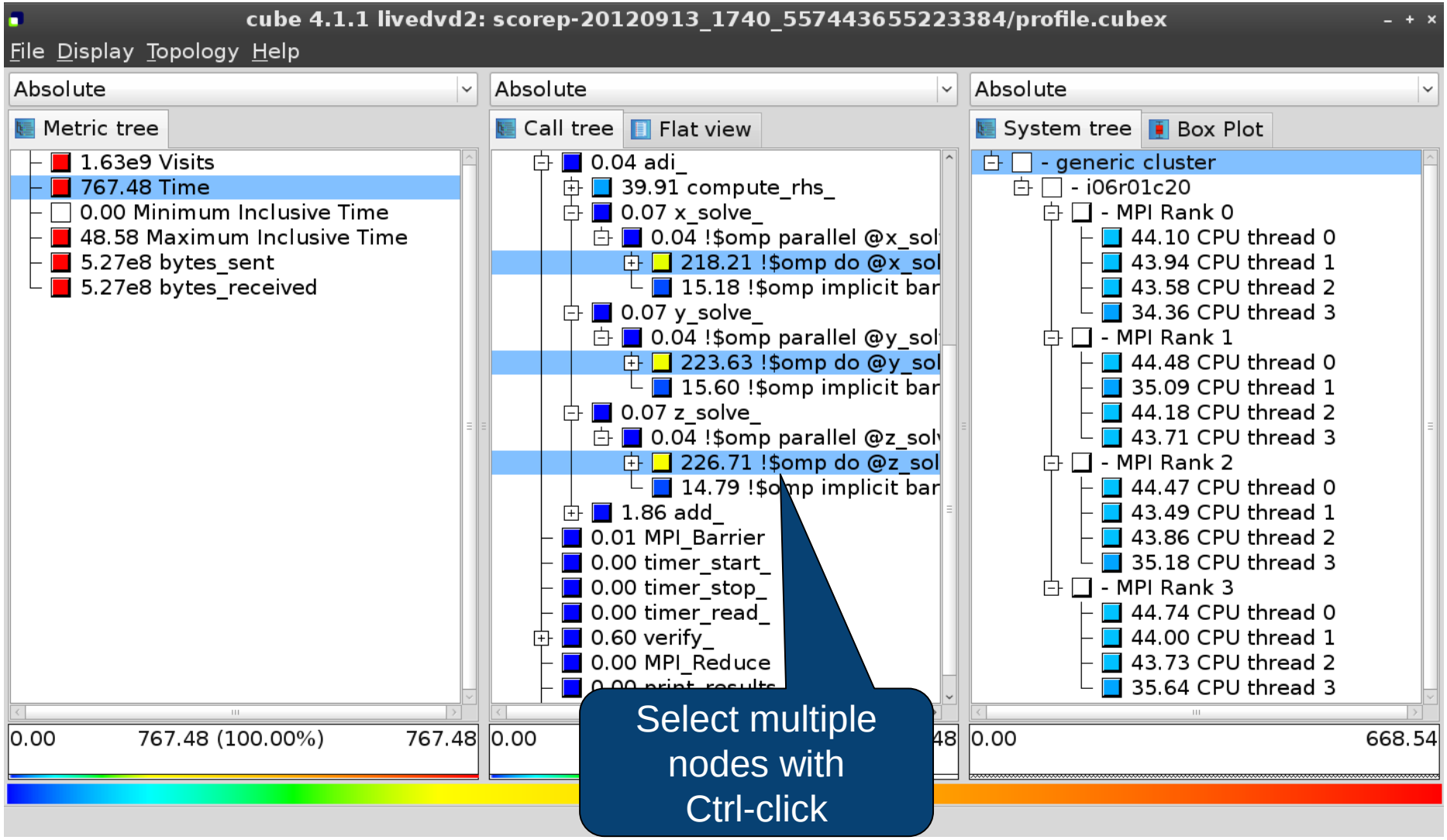
Alternative display modes



Important display modes

- Absolute
  - Absolute value shown in seconds/bytes/counts
- Selection percent
  - Value shown as percentage w.r.t. 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



Derived metrics in Cube

- Value of the derived metric is not stored, but **calculated** on-the-fly
- One defines an *CubePL* expression, like

metric::time(i)/metric::visits(e)

- Types of derived metrics:
  - **Prederived**: evaluation of the *CubePL* expression is done before the aggregation
  - **Postderived**: evaluation of the *CubePL* expression is performed after the aggregation
- Examples:
  - "Average execution time"

  Postderived metric with an expression:

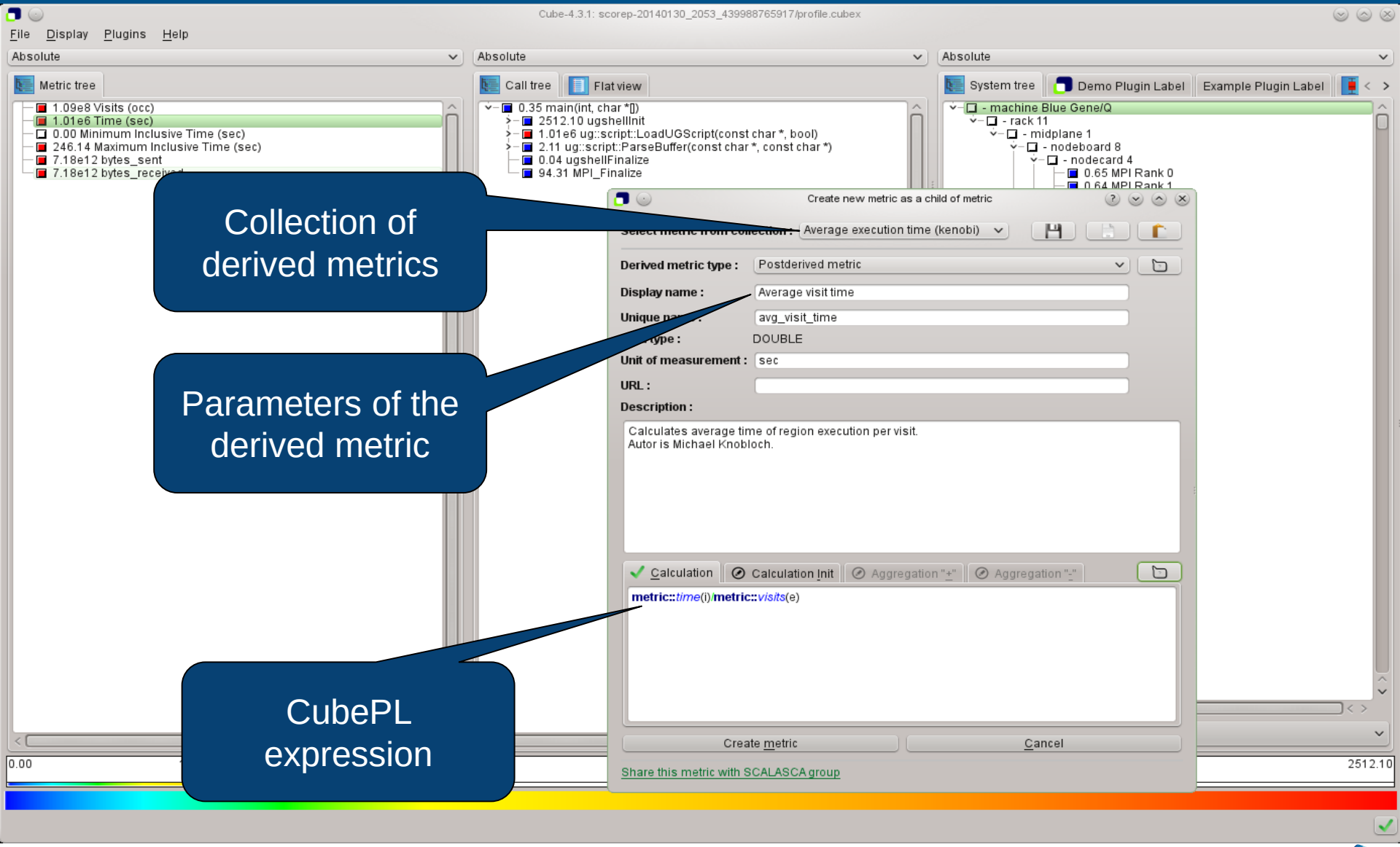
metric::time(i)/metric::visits(e)

  - "Number of FLOP per second"

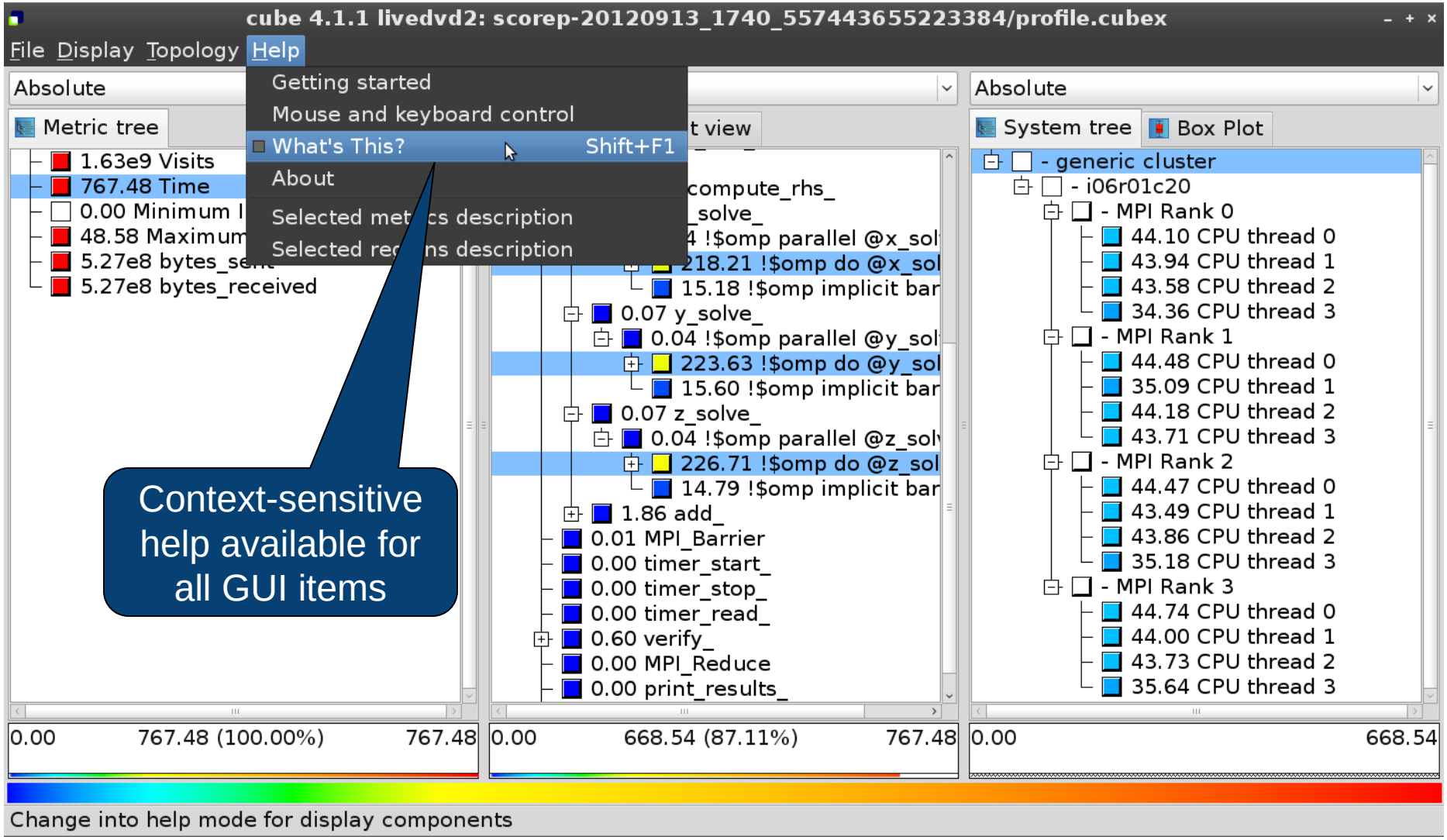
    Postderived metric with an expression:

metric::FLOP()/metric::time()

Derived metrics in Cube GUI



Context-sensitive help



Context-sensitive help available for all GUI items

CUBE algebra utilities

- Extracting solver sub-tree from analysis report

```
% cube_cut  -r '<<ITERATION>>'  scorep_bt-mz_W_4x4_sum/profile.cubex
Writing cut.cubex... done.
```

- Calculating difference of two reports

```
% cube_diff  scorep_bt-mz_W_4x4_sum/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.scalasca.org
  - User guide also part of installation:
    - `cube-config --cube-dir`/share/doc/CubeGuide.pdf
  - Contact:
    - mailto: scalasca@fz-juelich.de