Interoperability of OCM-Based On-line Tools

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Outline

1. OMIS specification and the OCM monitoring system
2. DETOP debugger and PATOP performance analyzer
3. Interoperability of DETOP and PATOP
4. Conclusions

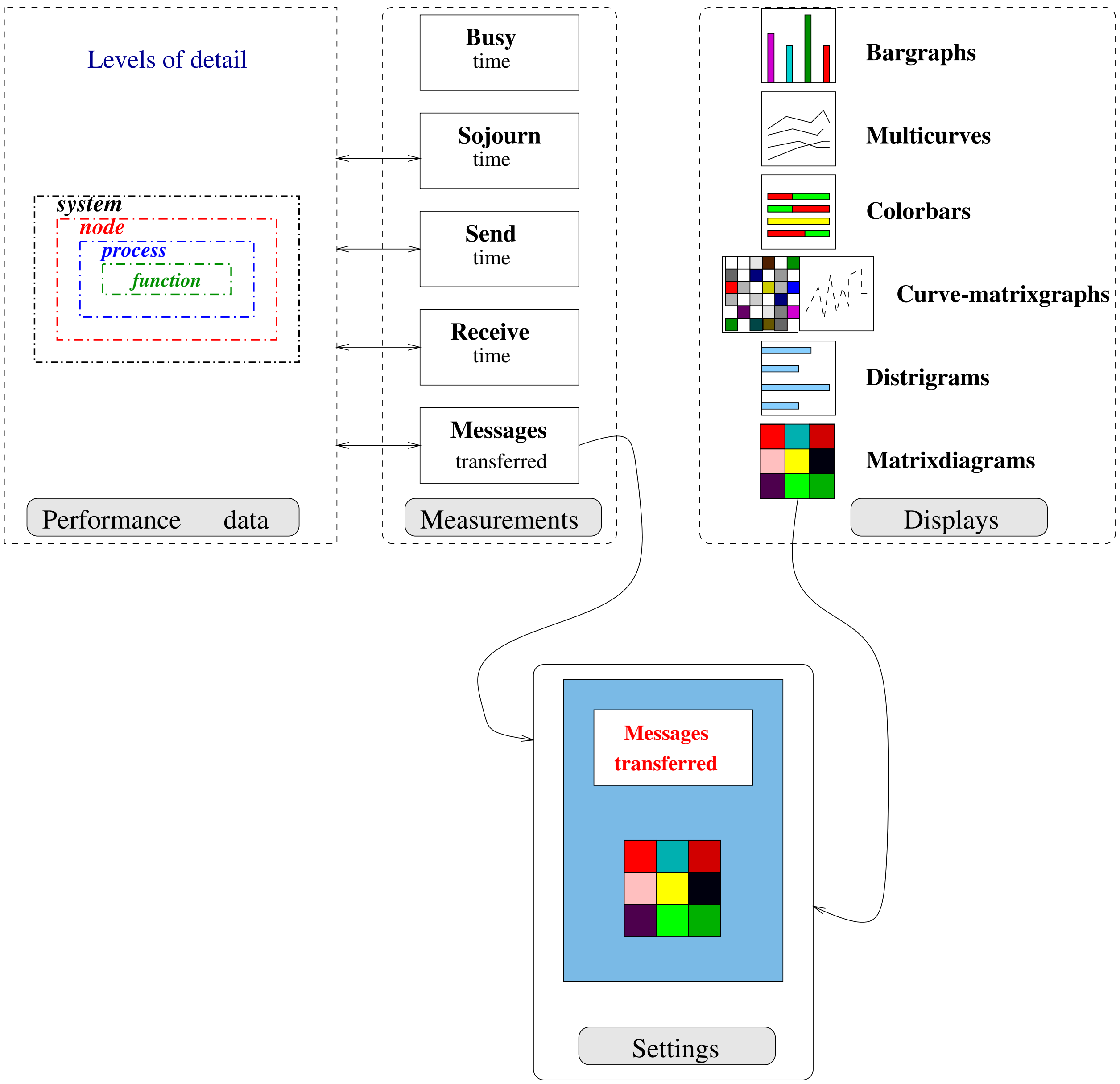
Why on-line monitoring ?

- Necessity to influence a running parallel program
- On-line monitoring can be used for “more dynamic” activities, e.g., debugging, load balancing, etc.
- Common properties of on-line monitoring:
  - event-driven mechanism
  - distributed low level components
  - central analysis component and user interface
- More problems about on-line monitoring compared to off-line:
  - more difficult to implement
  - minimizing efforts results in incompatibility of monitoring systems and of tools

A Tour about PATOP

- On-line performance analysis tool, developed at LRR-TUM (Munich)
- Allows to analyse applications running under PARIX environment on Parsytec systems
- Provides reasonably rich sets of available measurements and display diagrams

A Tour about PATOP ...



A Tour about PATOP ...

Available displays:

- bargraphs, multicurves, colorbars, curve-matrixgraphs, distrigrams, matrixdiagrams

Available measurements:

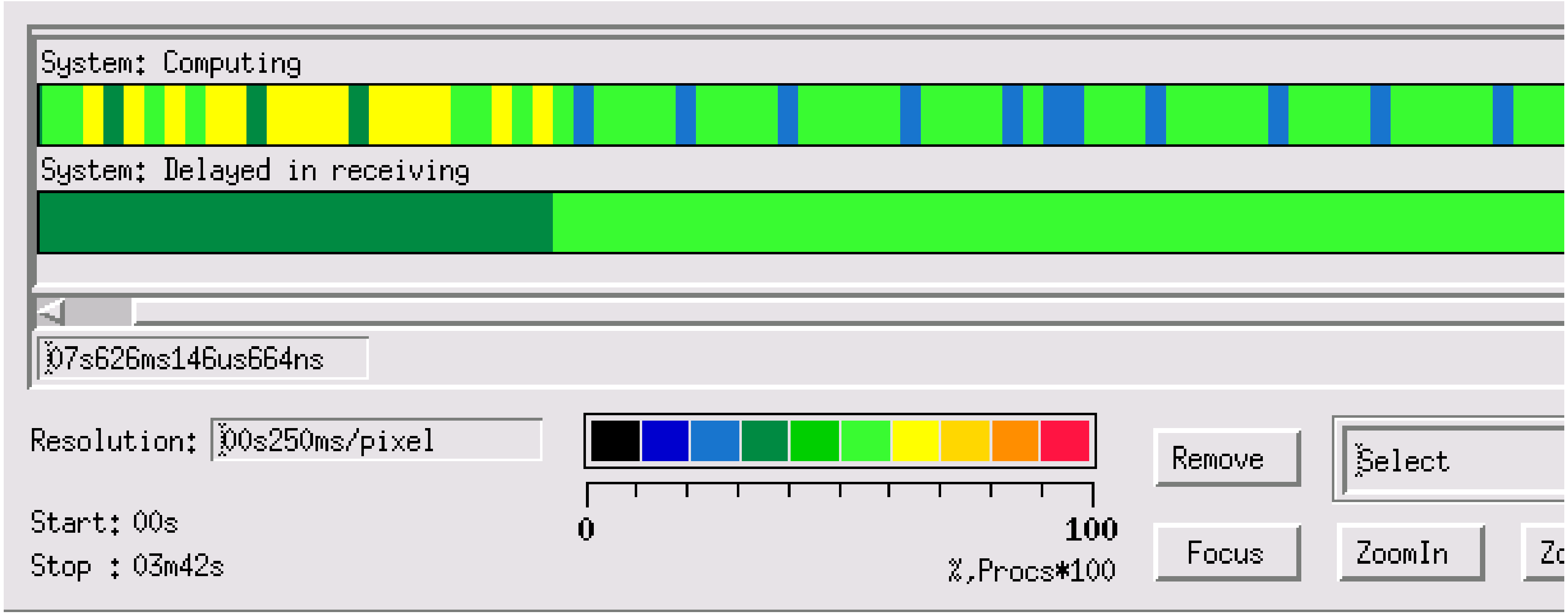
- busy and sojourn time
- delay in sending and receiving
- data volume sent and received

Various levels of detail:

- whole system, individual nodes, individual processes, user functions

Sample performance display in PATOP

- computing and receive delay time across the system visualized with bargraph display



DETOP

- Parallel debugger for PARIX system developed at LRR-TUM (Munich)
- Offers common debugging capabilities:
  - step-by-step execution
  - breakpoints
  - inspection of variables
  - etc.

DETOP ...


File Global Windows Help
Tasks
p1 (-1,/net/r
File: timing.c
71 at1 = 0;
72
73 /* pack buffer */
74
75 pvm_initsend(ENCODING);
76 pvm_pkint(&stid, 1, 1);
77
78 puts(" N uSec");
79 for (n = 1; n <= reps; n++) {
80 gettimeofday(&tv1, (struct time
81
82 if (pvm_send(stid, 1)) {
83 fprintf(stderr, "can't
84 goto bail;
85 }
86
87 if (pvm_recv(-1, -1) < 0) {
STOP
----> Breakpoint #1 at timing.c:88 (enabled)
Tasks: p1
Action: stop task
88 fprintf(stderr, "recv e
89 goto bail;
90 }
91
92 gettimeofday(&tv2, (struct time
93
94 dt1 = (tv2.tv_sec - tv1.tv_sec)
Stop New Tasks:
Command line
State
State of task p1:
State: STOPPED
Calls:
Output
> tasks [p1]
> break [p1] timing.c:88 stop task
breakpoint #1 set at timing.c:88

On-line Monitoring Interface Specification

- Main goal:
  - provide a uniform monitoring interface for a range of tools, regardless of their design peculiarities
- reduced effort to implement tools
- prerequisite for compatibility
  - not only “static”, but also “dynamic”
  - implies a kind of interoperability

OMIS ...

Common hierarchy of objects:

- nodes
- processes and threads
- messages and message queues

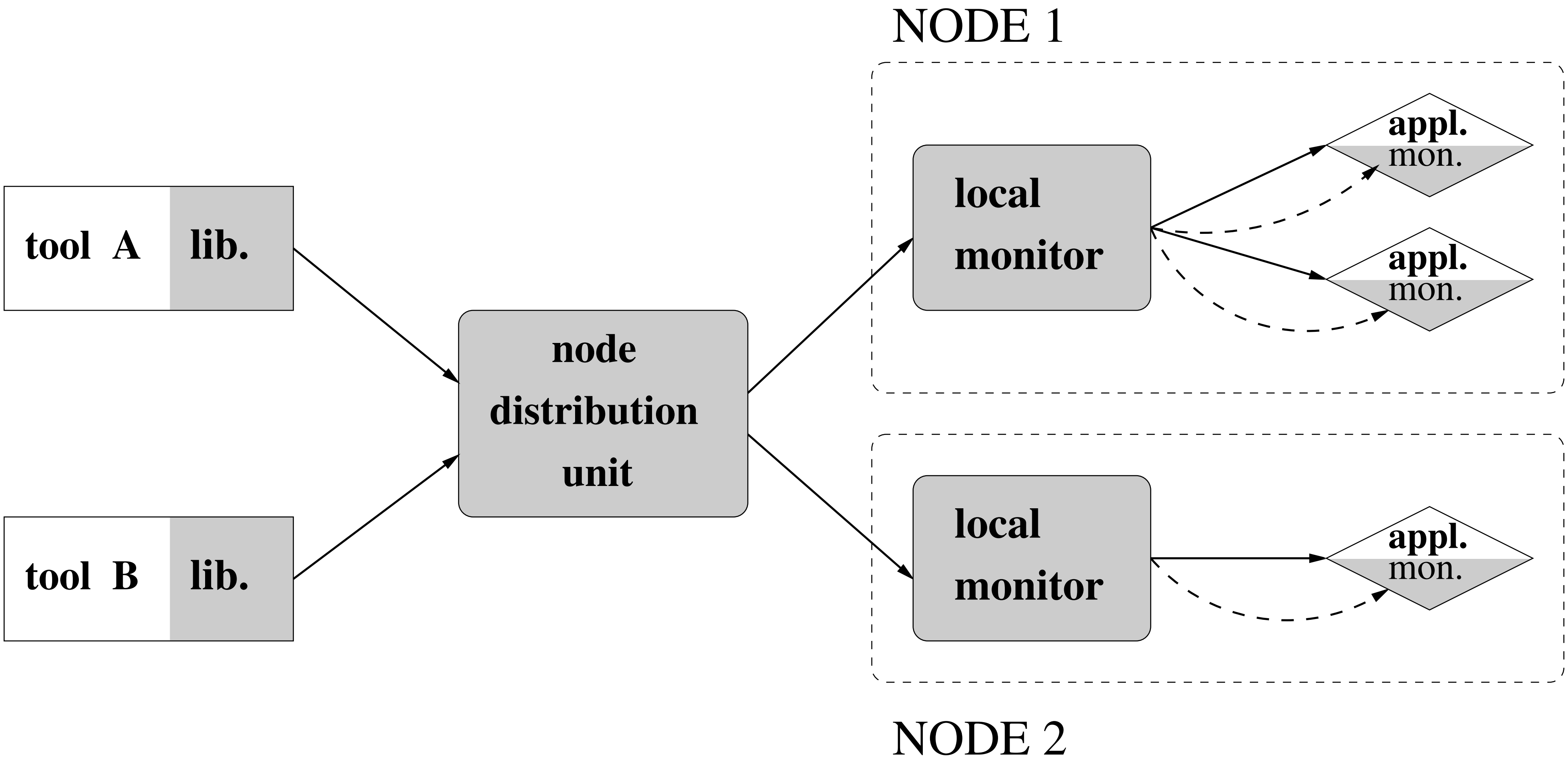
Operations to be performed on objects:

- information services, to acquire data
- manipulation services, to influence the execution
- event services, to decide when to start an action

Is the basic set of objects and operations always sufficient?

- No, but new objects and operations can be added.

Architecture of the OCM



Interoperability

Definition: (in the context of on-line tools)

- Capability to run multiple tools concurrently and apply them to the same application

Motivation:

- concurrent use of tools for different tasks
- combined use can lead to additional benefits
- enhanced modularity

Problems

- Structural conflicts: due to incompatible monitoring modules
- Logical conflicts: e.g. a tool modifies the state of an object while another tool still keeps outdated information about it

Interoperability of DETOP and PATOP

- PATOP provides a high-level performance visualization
- DETOP provides a source code level debugging
- Possible scenarios:
  - Erroneous behaviour observed via PATOP
    - suspend application with DETOP, examine source code
  - Measurement of execution parts
    - start/stop measurement at breakpoint
  - Measurement on dynamic objects
    - start measurement at breakpoint when object is created

Interoperability of DETOP and PATOP ...

- New OCTET tool
  - handles concurrent running of the application and tools
  - provides tools with relevant information
- Consistency conflicts occur if:
  - the application is started with DETOP;
    PATOP does not start the measurements
  - the application's execution is suspended with DETOP;
    PATOP does not stop the measurements

Interoperability of DETOP and PATOP ...

- Possible solutions:
  - extend ULIBS with a new module intended for resolving the consistency problems (used in the work)
  - insert pieces of code to handle conflicts dynamically via mechanism of run-time instrumentation
- Dynamical insertion of code - more general yet more complicated and less portable than the solution with a special module in ULIBS

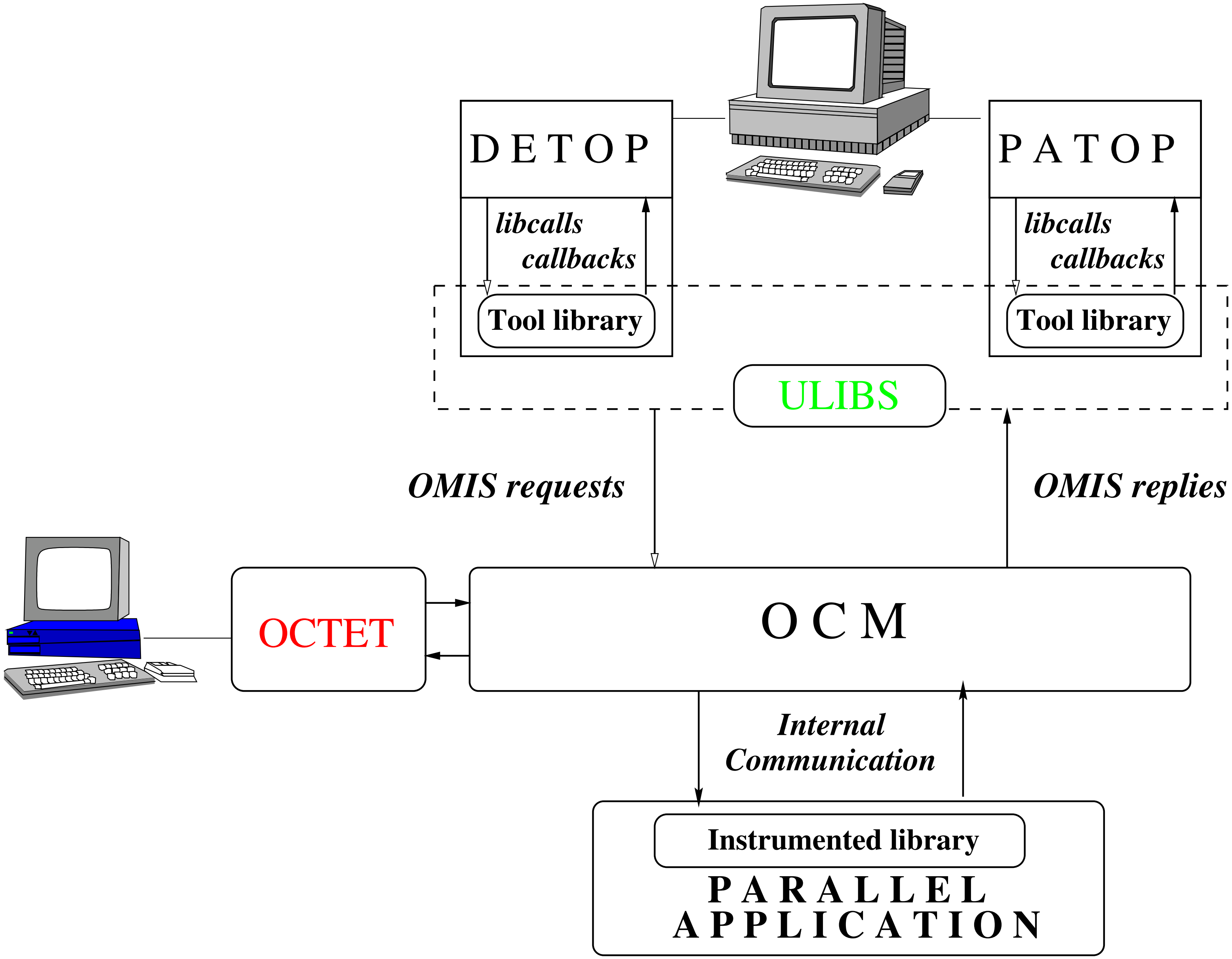
OCTET

- New top-level tool to coordinate the environment start-up and provide tools with relevant information
- Implemented as console application communicating directly with the OCM
- Main goals:
  - Enable to run the application and the tools concurrently
  - Provide the tools with information on the application processes, esp. *node* and *pid*
  - Pass to tools information on which other tools are running to enable resolving consistency conflicts

Interoperability module in ULIBS

- ULIBS - library of interface functions
- New module designed to resolve logical conflicts between the tools
- Each tool linked to a specific interoperability library
  - Separate library for each tool
  - Single interface function `io_init()` for initialization
  - Each library contains code to handle all possible tool scenarios
  - Proper actions performed, based on information obtained from the OCTET tool

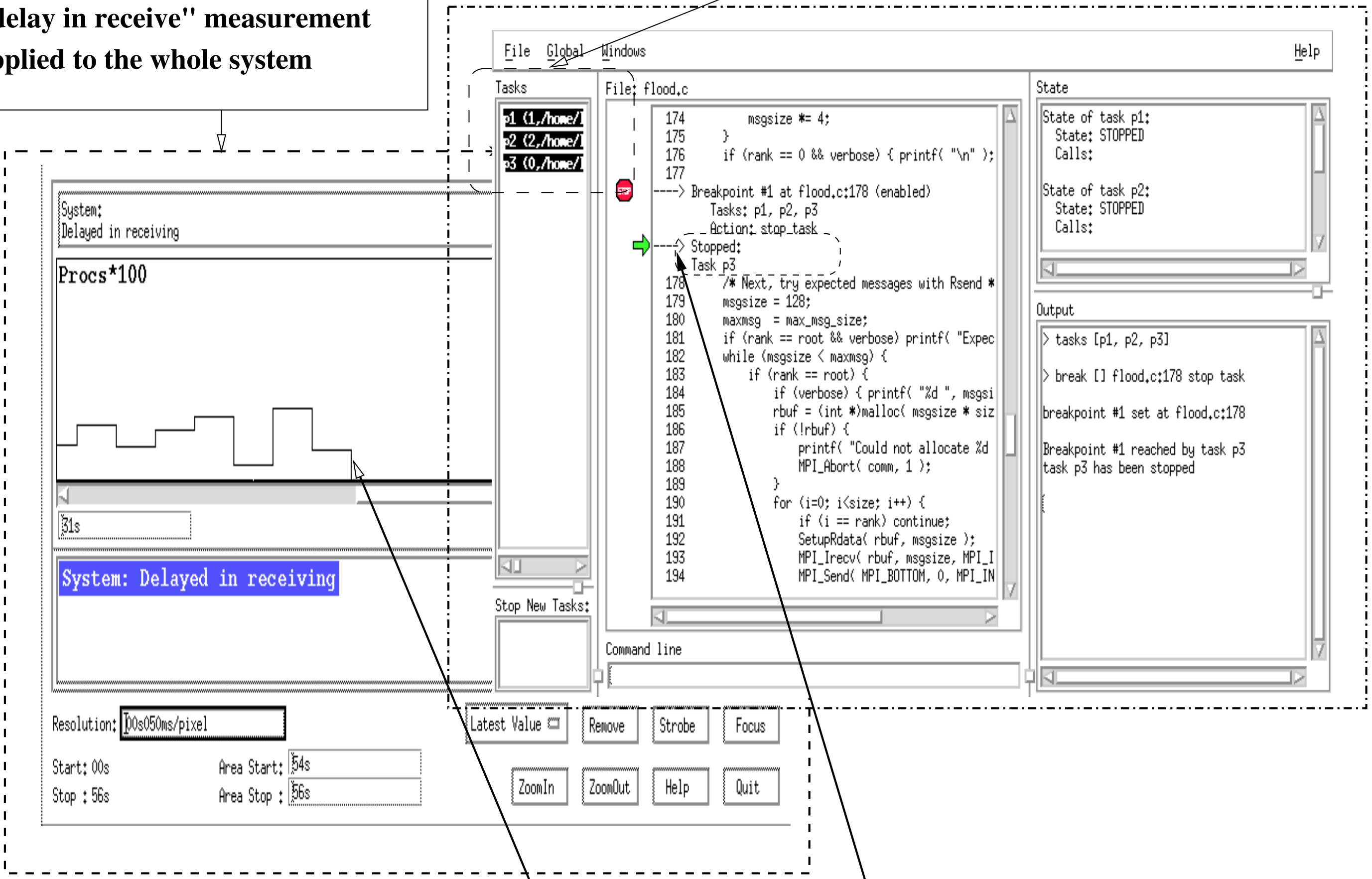
System Architecture



The System in Action

DETOP window:
all the processes
selected to be debugged

PATOP window:
"delay in receive" measurement
applied to the whole system



Measurement is suspended

Tasks arrived at a breakpoint

Summary

- Interoperability of tools is a desirable quality of a tool environment
- Cooperation of DETOP and PATOP is beneficial but several problems had to be overcome
- The OCM enables the tools to run concurrently
- The tool environment was extended to handle the concurrent execution of tools and provide mechanisms to resolve logical conflicts between the tools
- OCTET was developed to manage the startup of the environment and enable interactions between the tools
- New module was added to ULIBS to handle logical conflicts between tools