# pallas

Gesellschaft für Parallele Anwendungen und Systeme mbH

## OpenMP Tools — Assure

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## Overview: Assure and AssureView

- Assuref77/f90: OpenMP compliant, restriction in usage of OMP library (in particular: OMP_GET_THREAD_NUM)

- Use as normal compiler, but not for getting performance (small input data set)

- Multithreaded run is simulated sequentially, all memory accesses verified

- Run AssureView to visualize error breakdown. When "No Errors" are reported, multithreaded run is assured free of semantical errors as explained below, but only in the branches touched by the simulation run.

## What can be detected: invoke Assure

- Compile code with yet another compiler:

  assuref90 [options] -o myprog myprof.f90

- Execute (but don't expect performance!!)

  ./myprog

- Visualize

  assureview
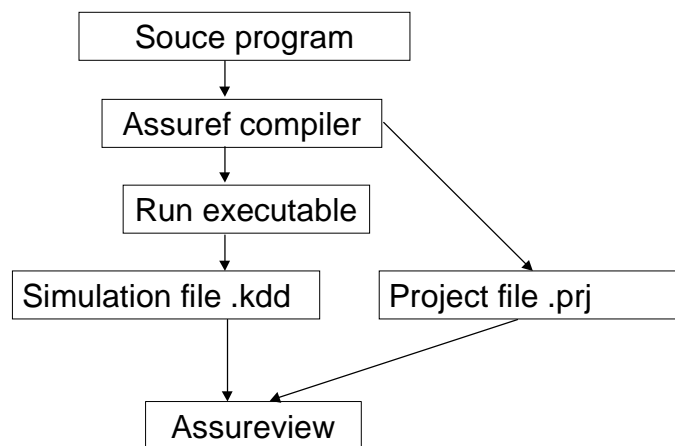
## Assure

The Assure process

```
              ┌──────────────────┐
              │  Souce program   │
              └──────────────────┘
                       │
                       ▼
              ┌──────────────────┐
              │ Assuref compiler │──────────┐
              └──────────────────┘          │
                       │                     │
                       ▼                     ▼
              ┌──────────────────┐          │
              │  Run executable  │          │
              └──────────────────┘          │
                       │                     │
                       ▼                     ▼
        ┌──────────────────┐   ┌──────────────────┐
        │Simulation file .kdd│   │ Project file .prj │
        └──────────────────┘   └──────────────────┘
                       │                     │
                       ▼                     ▼
                   ┌──────────────────┐
                   │   Assureview     │
                   └──────────────────┘
```

## What can be detected: Conflicts

```fortran
real:: a(0:N), b(N)
a(0) = 0.
!$OMP PARALLEL
!$OMP DO
DO i=1,N
   a(i) = 1./i
   b(i) = a(i-1)+a(i)
ENDDO
```

**Whats wrong ??**

## What can be detected: Conflicts

## What can be detected: Conflicts



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## Assure: Error Types

Write-Read conflicts

```
!$OMP PARALLEL DO
DO i=1,N
      a = b+c(i)
      d(i) = a+e(i)
```

The 2 statements inside the loop have to be executed in that (Write-Read) order, which is not guaranteed in a multithreaded run (a is shared by default).

Repair: private(a)

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## Assure: Error Types

Read-Write conflicts

```
!$OMP PARALLEL DO
DO i=1,N
      d(i) = a+e(i)
      a = b+c(i)
```

Repair: private(a)

## Assure: Error Types

Write-Write conflicts

```
!$OMP PARALLEL DO
DO i=1,N
      a = b+c(i)
```

Repair: private(a)

## Assure: Error Types

Private symbol, used outside loop

```
!$OMP parallel do private(a)
DO i=1,N
      a=c(i)
      d(i) = a*a
ENDDO
PRINT*, a
```

Repair: lastprivate(a)

## Assure: Error Types

Uninitialized private

```
firstiter = .TRUE.

!$OMP parallel do private(firstiter)
DO i=1,N
  IF( firstiter ) THEN ...
ENDDO
```

Repair: firstprivate(firstiter)
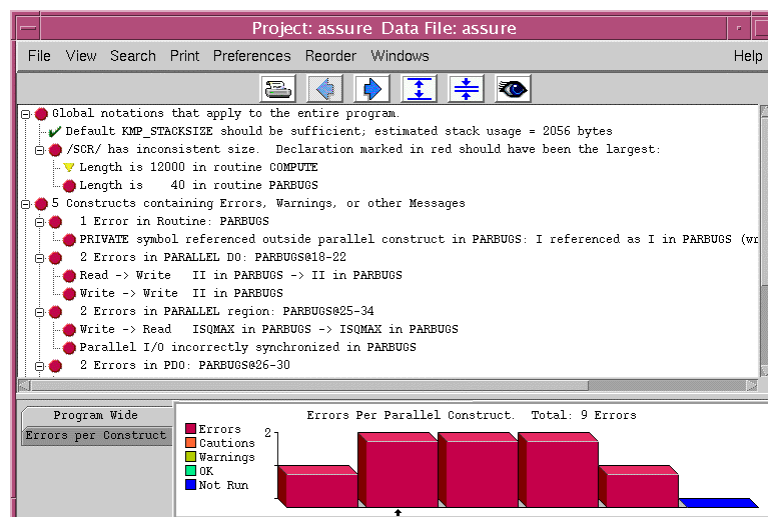
## Assureview: Displays

Main

- Main error list
    - Clickable button for each error
        Click to get precise diagnostics

    - Overview chart showing statistics of bugs, different severities

- Call Tree

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## Assureview: Displays



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## Assureview: Displays

Reading the diagnostics

Click the "+" buttons to get into the diagnostics

Finally the code sections are shown containing the error locations, (source and sink), both clearly marked.

## AssureView: Displays

Inside code windows

- Show Search: normal string search menu

- Show Stack:  show the calling sequence for arriving at the
                    location.

## Assureview: Displays

Other buttons

### View

Select display of the error list

### Search

Normal search menu, inside error list

### Print

Self explaining

## Assureview: Displays

### Preferences

Miscellaneous settings. In particular:
source code locations ("finding files")

### Reorder

.. error list by different criteria

8. &mdash; Assure - Detection of OMP race conditions &mdash; 8.

8-9

**Thanks for your attention!**

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