The background of the slide is a light blue gradient. On the right side, there is a large, semi-transparent image of a clock face with hands. On the left side, there is a semi-transparent silhouette of an airplane in flight, angled upwards.

AbsInt

Products and Research Interests

HiPEAC2 Cluster Meeting

Dr. Daniel Kästner, CTO

AbsInt Angewandte Informatik GmbH

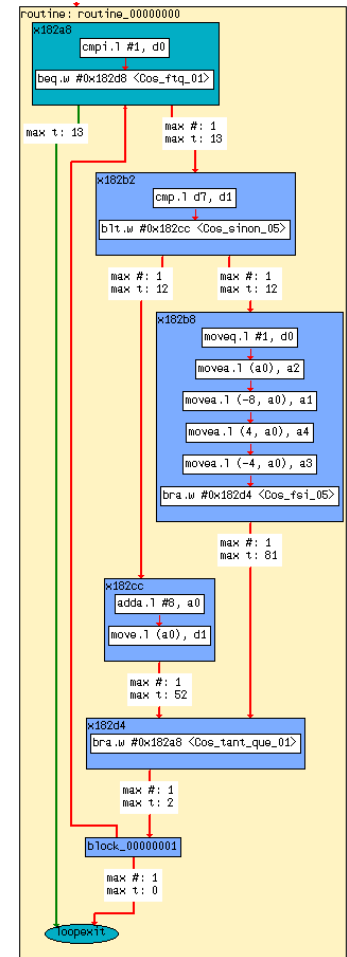
AbsInt Angewandte Informatik GmbH

The Company

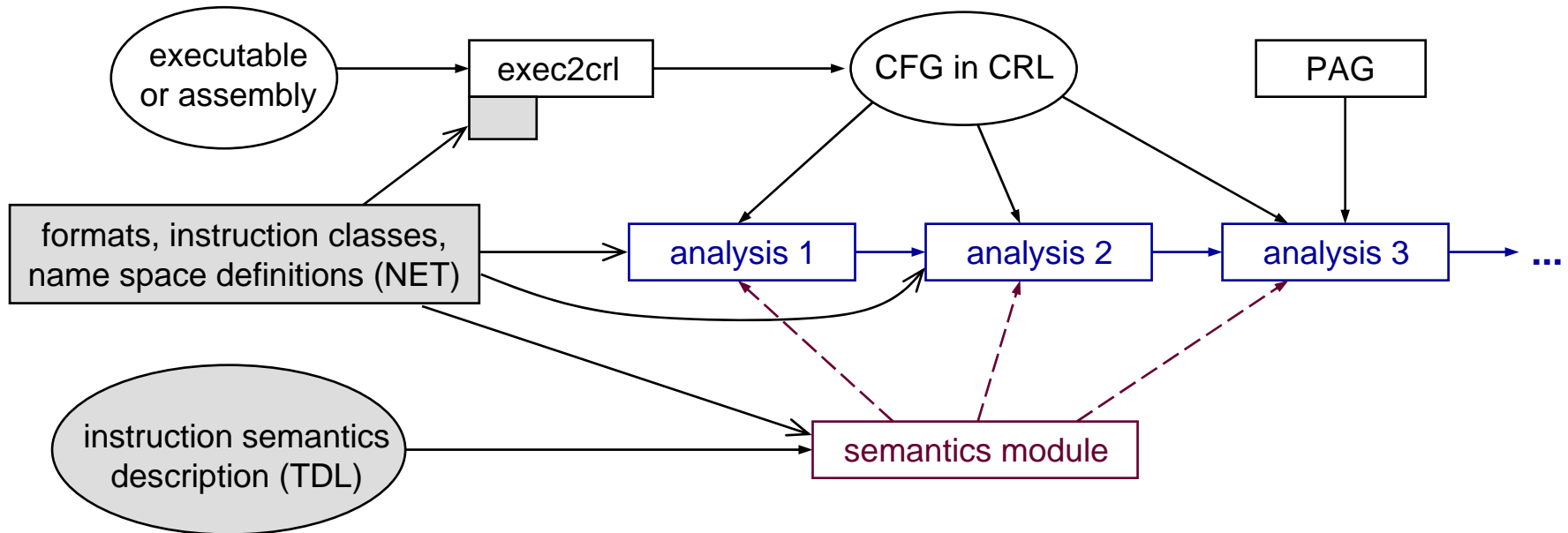
- Spin-Off of the Laboratory of Compiler Construction and Programming Languages at Saarland University (Prof. Reinhard Wilhelm), Germany; founded 1998.
- AbsInt provides advanced development tools for embedded systems, and tools for validation, verification of safety-critical software.
- Main products:
 - aiT Worst-Case Execution Time Analyzer
 - StackAnalyzer
 - aiPop Postpass Optimizer

A Generic Postpass Program Optimization and Analysis Framework

- Framework was developed and extended at Saarland University and AbsInt Angewandte Informatik GmbH in DFG Transfer Project #14, IST project DAEDALUS, BMBF project VERISOFT, NoE ARTIST 1/2, ...
- Consists of tools and data formats to analyze and transform machine code on assembly/executable level
- The tools are generic and can be adapted to different kinds of processors



Overview of the Framework



NET Names for exec2crl and TDL

→ Names

TDL Target Description Language

→ Semantics

CRL Control Flow Representation Language

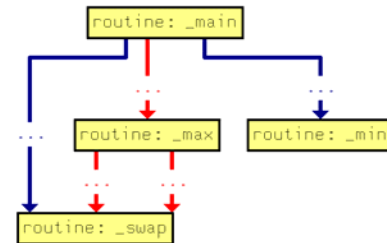
→ Control Flow

aiT WCET Analyzer

- In real-time systems correctness depends on the correct timing behavior. A prerequisite for timing validation is knowledge of the tasks' worst-case execution times.
- aiT WCET analyzer determines safe upper bounds on the **Worst-Case Execution Time** of tasks in real-time systems.
- Key Methodology: **Static Program Analysis by Abstract Interpretation**
 - Semantics-based methodology for program analysis.
 - Automatic generation of analyzers: PAG.
 - Support of correctness proofs.
 - Approximation
- Implementation: combines
 - global program analysis at the machine code level by **abstract interpretation** for **microarchitecture analysis** (caches, pipelines, ...), and for value analysis with
 - **integer linear programming** for **path analysis**.



Worst Case Execution Time: 886



aiT WCET Analysis Input/Output

Application Code

```
void Task (void)
{
  variable++;
  function();
  next++;
  if (next)
    do this;
  terminate()
}
```

Specifications (*.ais)

```
clock 10200 kHz ;
loop "_codebook" + 1 loop exactly 16 end ;
recursion "_fac" max 6;
SNIPPET "printf" IS NOT ANALYZED AND TAKES MAX 333 CYCLES;
flow "U_MOD" + 0xAC bytes / "U_MOD" + 0xC4 bytes is max 4;
area from 0x20 to 0x497 is read-only;
```

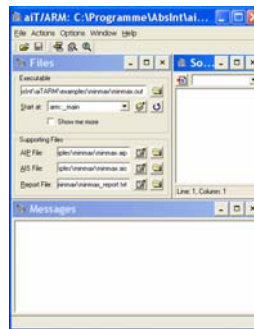
Entry Point 

Compiler
Linker

aiT

Executable (*.elf / *.out)

```
a =€@€
a€T
@€ .@€ .p K
y0.y
€y0%€2)
C@y"€(8
H#€y" €(
```



- Worst Case Execution Time
- Visualization, Documentation



aiT WCET Analyzer: Supported Targets

- Motorola HCS12/STAR12
- Infineon C16x / ST10
- Renesas M32C/85
- ARM7
- Intel i386
- TI TMS320C33
- MPC 68020
- MPC555/565
- MPC755
- Infineon TriCore

- In development:
 - MPC 5566
 - MPC 603

Research Topics

- Main interest: real-time systems
- Predictable performance
 - modelling of memory hierarchy
 - modelling of multi-core platforms
 - task switching costs
 - Virtualization and WCET
- Control flow graph reconstruction
 - Indirect jumps/calls
(function pointers, virtual calls, dispatch tables, ...)
 - Loop bound analysis
- Combination of binary with source-level program analyses.
- Postpass optimizations at the object code/binary level.
- Translation validation