



Space Systems Finland and the Bound-T tool

Overview

- Who we are
- What we are doing, and why
- Future plans



Who we are

- *Space Systems Finland founded in 1988:*
 - Space-related software development and system design
 - Currently about 30 people
 - ESA subcontracts (Astrium, Alcatel, Alenia, ...)
 - Nationally funded space projects
- *SSF staff involved in WCET work:*
 - Niklas Holsti (PhD, computer science)
 - Thomas Långbacka (PhD, computer science)
 - Sami Saarinen (working on MSc thesis)
 - and others part-time.



Why we started with WCET

- *On-board flight software*
 - hard real-time, concurrent, embedded
 - very constrained by computer power
 - under 1 MIPS processors in the 1990's
 - now flying 5 - 20 MIPS
- *Example: GOMOS Instrument Application SW*
 - 100's of timing test cases, 1000's of measured times
 - 50-page Excel table to compute final results
- *ESA interest*
 - Hard-Real-Time methodology, HRT-HOOD
 - WCET tools: York U., TLD Ada, Aonix Ada



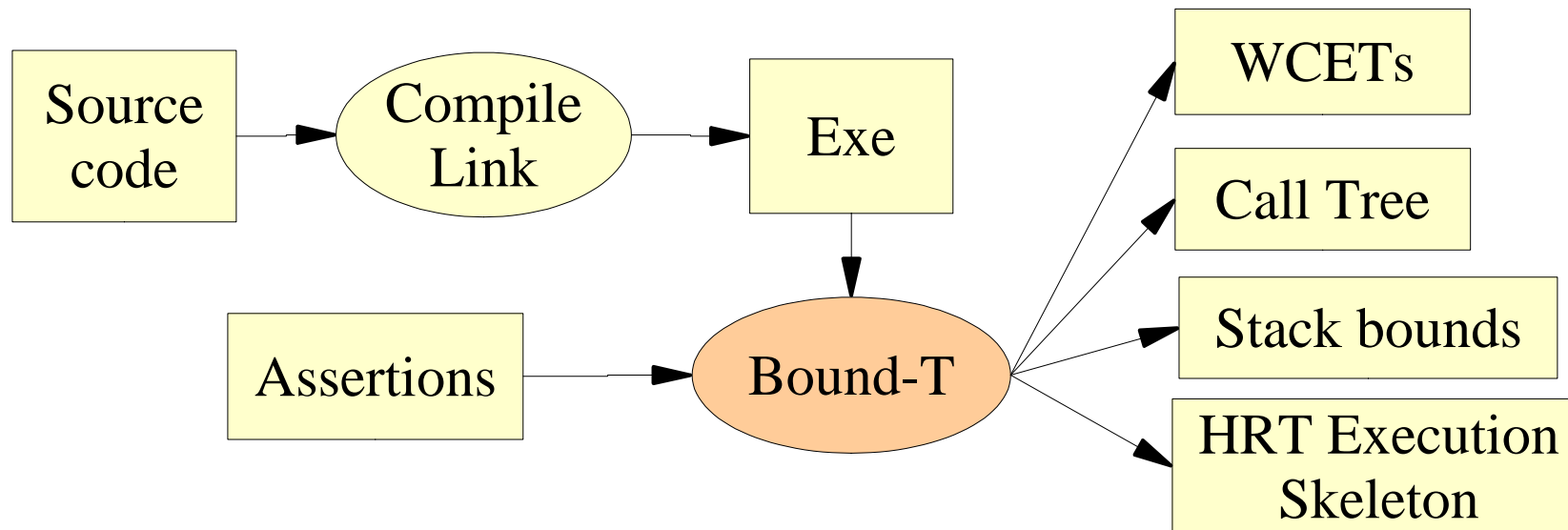
The Bound-T project

- *ADSP/TSC21020 processor*
 - Radiation-resistant DSP developed for ESA by TEMIC
 - Also used for complex control software, therefore need for HRT analysis
- *SSF develops WCET tool: Bound-T*
 - Aim at commercial product
 - ESA funds tool for 21020 and ERC32 (SPARC)
 - Other funding for other targets (Intel 8051)
- *Status*
 - 21020 and 8051 versions ready for pilot applications
 - ERC32 in progress (ready by Oct 2001)



Bound-T features

- *Reads executable binaries (compiled, linked)*
- *Automatically bounds counted loops*
- *Uses assertions for other loops and to set scenarios*





Some implementation details

- *Control-flow analysis*
 - May include more program-sequencing state than the "program counter": instruction pipeline, zero-overhead loops, ...
- *Finding and bounding loop counters*
 - Flow graphs must be reducible
 - Modeling integer calculations with Presburger Arithmetic
 - Solving with the Omega tool (Kelly, Maslow, Pugh, ...)
- *Finding the worst-case path*
 - Using Integer Linear Programming (lp_solve, Berkelaar)
- *User interface*
 - Command-line input, textual and graphical output
 - Graphics with DOT, part of GraphViz (Bell Labs)



Future plans for Bound-T

- *Marketing to space and non-space users*
- *New target processors*
 - ERC32 (SPARC V7), ADI SHARC (2106x)
 - Medium-sized mass-market embedded processors
- *Technical improvements*
 - Better aliasing (points-to) analysis
 - Cache analysis
- *Problems foreseen*
 - Convincing customers that WCET is useful & reliable
 - Popular targets are hard to model precisely (e.g. PowerPC)
 - New processors may be poorly documented for WCET



Future of WCET analysis: challenges

- *Keeping up with the processors*
 - Convince processor builders to document WCET
 - Perhaps using a common "standard" set of models
- *Keeping up with the programs to be analysed*
 - Convince programmers to make programs analysable
 - Object orientation => increased run-time dynamism
 - Increasing size and complexity
- *Combining info from source code and object code*
 - Convince compiler writers to export info for WCET
 - Static analysis tools (ASIS for Ada; ? for C/C++)
 - Define standard formats (ELF extension? XML?)