R-Stream: Compiler Technology for Next Generation HPEC
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Role in Tool Chain
R-Stream is a source-to-source compiler intended to augment an existing single processor tool chain.

C + first-class arrays
Streamit

R-Stream Compiler

C + Streaming Virtual Machine API
C + architecture-specific library

Single Processor Compiler
BinaryExecutable

Compiler Tech. for HPEC
R-Stream compiler technology automatically maps applications to HPEC architectures with:
- Multiple processor cores
- Distributed on-chip memories w/ DMA
- Reconfigurable processors and memories
R-Stream optimizes the whole application, e.g. reducing memory traffic between kernels, unlike using a library alone.
R-Stream maps one C program to multiple targets, for faster, cheaper, more reliable development than mapping by hand.

Early Results
Early results show efficient mappings over a wide range of architectural parameters:

Prototype 2.0 Mapper
1. Transform loops for locality, determine granularity
   - Goal is maximizing data that can live in local memory or local memories
   - Interchange and partially fuse parallel outer loops
   - Classify communications as local memory, inter-processor, or global memory
   - Single-processor grains contain local memory communication
   - Multi-processor grains contain communication between local memories

2. Multiprocessor scheduling
   - Modulo scheduling with parallel loops and chunks of code as “operations” and processors as “ALUs”
   - Overlaps computation and DMA
   - Smooth spectrum from time to space multiplexed

3. Memory allocation and DMA insertion
   - Tile parallel outer loop(s) around inner loops
   - Inner loopnest produces and consumes blocks of data
   - Memory allocator places these blocks in 2D space
   - Tiles alternate between half-buffers within local memory

Innovative 3.0 Technology
R-Stream prototype 3.0, currently in development, will produce even more efficient mappings for a wider range of applications by leveraging:
- SRE-based internal representation to eliminate false dependences
- Affine partitioning framework to discover maximum degrees of parallelism in application
- Unified/constraint-based mapping to avoid phase-ordering.

Supports Diverse Architectures
R-Stream prototype supports a large class of architectures via a flexible machine model, including:
- MIT RAW
- ISI/Raytheon Monarch
- UT Austin TRIPS
- Stanford Smart Memories