Data Flow Based System Level Design of Concurrent Image Processing Applications

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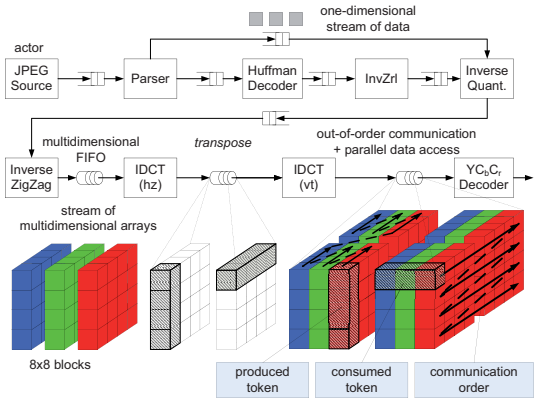
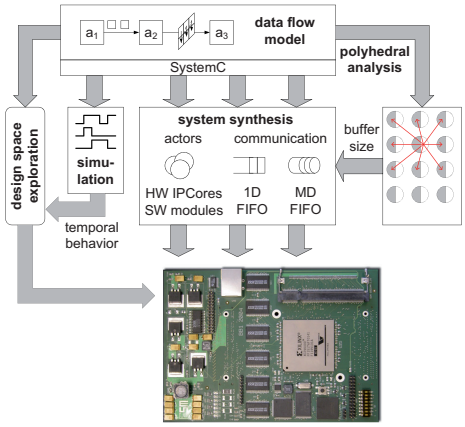
Motivation

- Image processing applications operate on **both one-dimensional and multidimensional streams** of data
- Include **regular static** algorithms (IDCT, YCbCr decoder) and **data dependent** operations (Huffman Decoder, InvZrl)

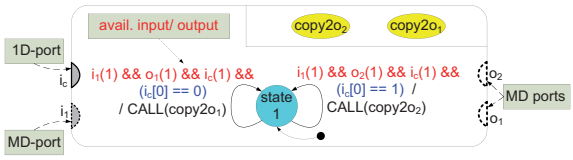


- Complexity requires new design methodologies that offer a higher level of abstraction
- Well known approaches such as SystemC or Simulink are restricted to one-dimensional streams of data
- Multidimensional methodologies are still in their infancy
- Proposition of a novel design methodology that **unifies both one- and multidimensional data flow**
- Combines the advantages of data flow based design with polyhedral analysis and synthesis
  - Block-diagram-like system specification
  - Efficient system level analysis such as automatic buffer size determination
  - Synthesis of high-speed communication primitives and actors

SystemCoDesigner Flow

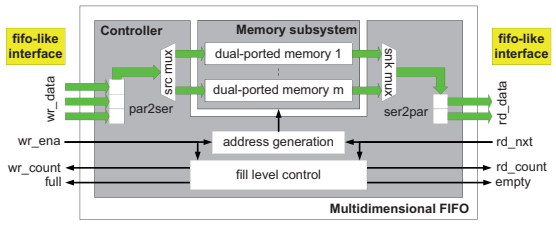


Structured Actor Specification in SystemC

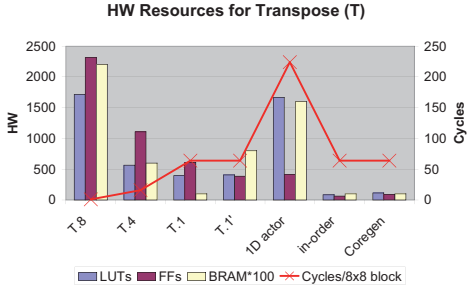


- **Ports** can be connected to one- and multidimensional FIFOs
- **Finite state machine** controls communication
- Flow control by checking availability of input tokens/windows and free space for output tokens
- Data dependency by **guards**
- Permits **classification** of static and data-dependent algorithms

Communication Synthesis



- **FIFO-like interface** for simple system integration
- **Automatic generation** from data flow specification by static compile-time analysis in order to reduce run-time overhead
- Parameterized with read and write orders
- Tracks the current read and write position
- Provision of a memory subsystem that allows to **read and write several data elements per clock cycle**
- Parallel to serial conversion allows **trading throughput against required hardware resources**
- **High clock frequencies** (up to **400Mhz** for a Virtex4 FPGA) by pipelining
- Sufficient for real-time processing of images in digital cinema resolution
- Permits for **faster communication with less resources** compared to behavioral synthesis of one-dimensional actors



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