DESIGN METHODOLOGY MANAGEMENT FOR SYSTEM-LEVEL DESIGN

Asawaree Kalavade

Edward A. Lee

Ptolemy Miniconference

March 10, 1995.

Abstract

System-level design is characterized by a behavioral specification and heterogeneous hardware/software implementations. Exploring the design space is essential for good design. Specifying and managing complex design flows, tracking dependencies and tool invocations, and maintaining consistency of design data and flows are key issues that enable efficient design space exploration.

We present a framework that manages these complex issues in the design process, transparent to the user. The framework, called DesignMaker, is implemented within the Ptolemy environment. The features of DesignMaker are illustrated with reference to an example design flow for multiprocessor synthesis. The end-objective is to embed the DesignMaker under a system-level codesign assistant.

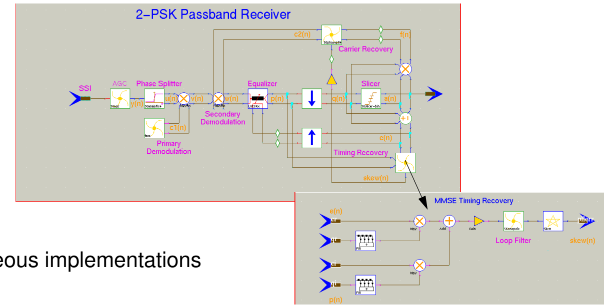
A. Kalavade, J. Pino, E. A. Lee, “Managing Complexity in Heterogeneous System Specification, Simulation, and Synthesis”, to appear: *Proc. of Intl. Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, Detroit, MI, May 1995.

Outline

- ***Motivation for systematic management of the design methodology***
- ***Design Methodology Management (DMM) infrastructure***
- ***Implementation***
- ***Examples***

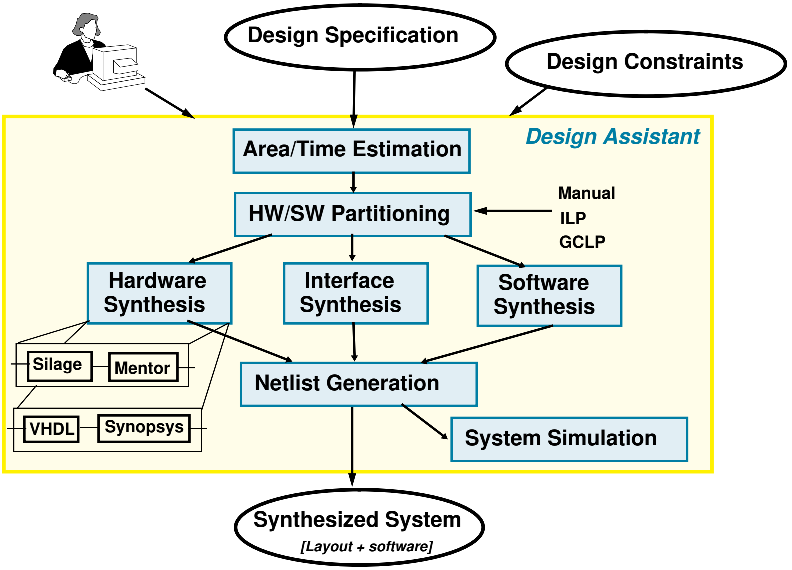
System-level Design

— Behavioral specification

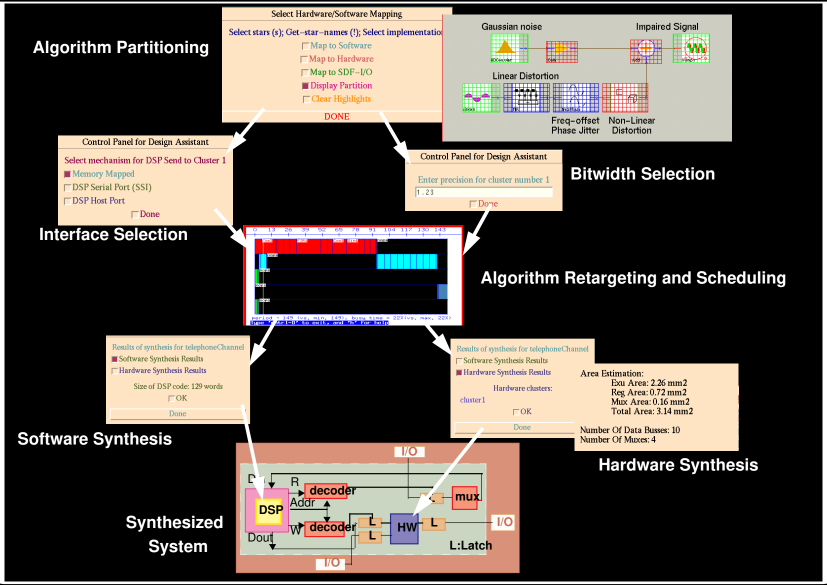


— Heterogeneous implementations

A Typical Design Flow for Hardware/Software Codesign



Design Assistant: version 1



Limitations of the Design Assistant-v1

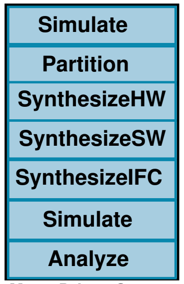
Sequential Design Flow: cannot re-run isolated design steps

Inflexible Design Flow: hardwired design methodology and tools

A possible solution: Menu Driven Approach

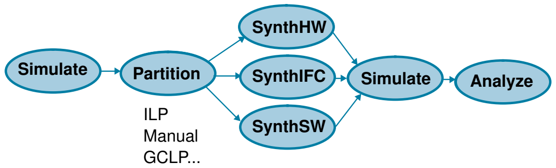
— Solves the sequential flow problem; but hardwired

— No automatic dependency analysis and tool invocation



Menu-Driven System

Desired:



➡ ***Need a mechanism to manage the design Methodology, Flow, and Data.***

Design Space Exploration

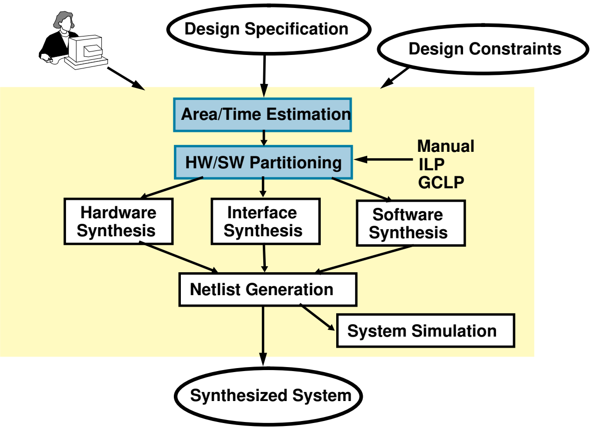
Managing the complexity of the design process is non-trivial.

Requirements:

- *Modular and configurable **flow specification** mechanisms*
- *Mechanisms to systematically **track tool dependencies** and automatically determine the **sequence of tool invocations***
- *Managing **consistency** of design data, tools, and flows*

Flow Specification

Does a feasible partition exist?

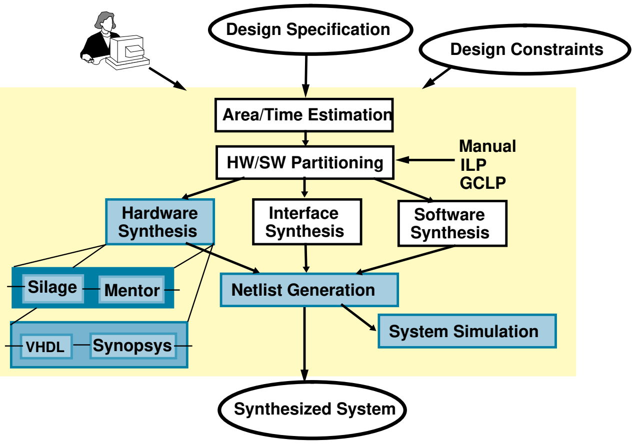


— Need a configurable methodology

— Flow constructs such as conditionals and iterations required

Tool Dependencies and Invocations

Change hardware synthesis mechanism



— Only “affected” tools should be re-run

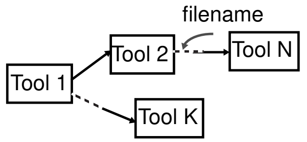
— Automatically resolve dependencies, invoke flow execution

Outline

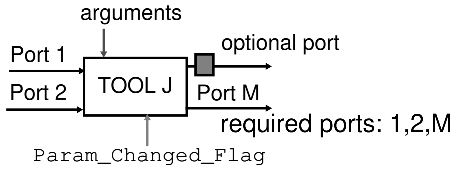
- ***Motivation for systematic management of the design methodology***
- ***Design Methodology Management (DMM) infrastructure***
- ***Implementation***
- ***An example***

Flow, Tool, and Data Model

FLOW MODEL



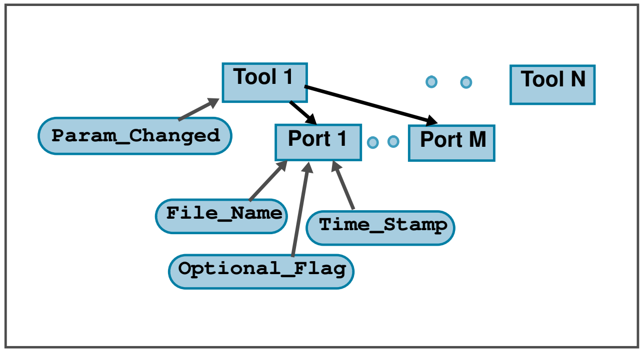
TOOL MODEL



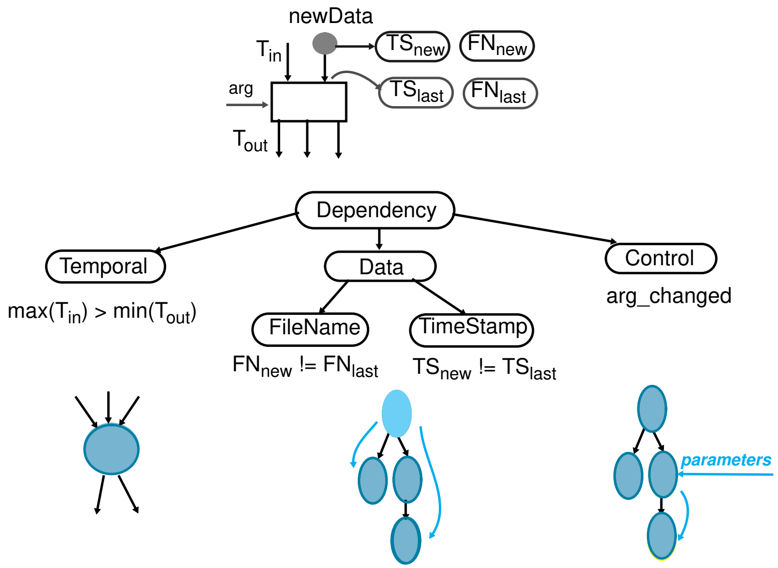
DATA MODEL

Representation

Distributed datastructure



Dependencies Used for Tool Management



Flow Management

Tool is enabled: when all “required” input ports have data

Tool is invoked: when at least one of its dependencies is alive

Tool is executed: generates data on all required outputs, conditionally on all optional ports.

Flow invocation mechanisms

data driven *demand driven*

Outline

- ***Motivation for systematic management of the design methodology***
- ***Design Methodology Management (DMM) infrastructure***
- ***Implementation***
- ***An example***

DMM Domain in Ptolemy

Design flow: specified as a graphical netlist

Tools: encapsulated within basic blocks (Star)

— have “*required*” and “*optional*” ports, parameters

Flow definition: supports conditionals, iterations, hierarchy (Galaxies)

Tool encapsulation: involves writing scripts to call “programs”

— Ptolemy functions

— stand-alone programs (with their own GUIs)

— programs on remote filesystems

DMM attributes: stored in Oct database

Flow Manager: Target (called DesignMaker)

— supports data-driven and demand-driven flow execution

— resolves tool dependencies, automatically invokes tools

Scheduler: Combination of dataflow and event-driven semantics

— detects deadlocks

DMMCodeGenerator.pl

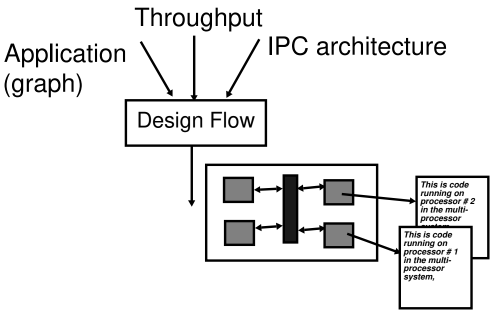
```
defstar {
        name {CodeGenerator}
        domain {DMM}
        input { name {graph}          type {message} }
        input { name {numProcs}       type {message} }
        output{ name {codeFileNames}  type {message} }
        go {
          graphName = graph.getFileName();
          name = getName(graphName);
          domain = getDomain(graphName);
          handle = getHandle(graphName);

          procFileNm = numProcs.getFileName();
          fp = fopen(procFileName,"r");
          fscanf(fp,"%d",&numberProcs);

          // run tcl command for code gen.
          Tcl_VarEval(ptkInterp,"ptkGenCode", name,domain,han-
dle,numberProcs);
          // generate output file names
          codeFileNames.putFileName(fout);
```

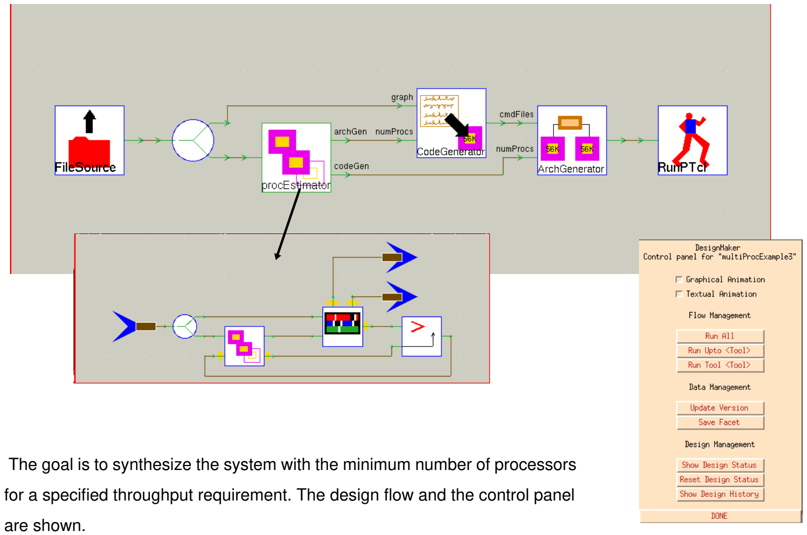

Examples

Multiprocessor synthesis



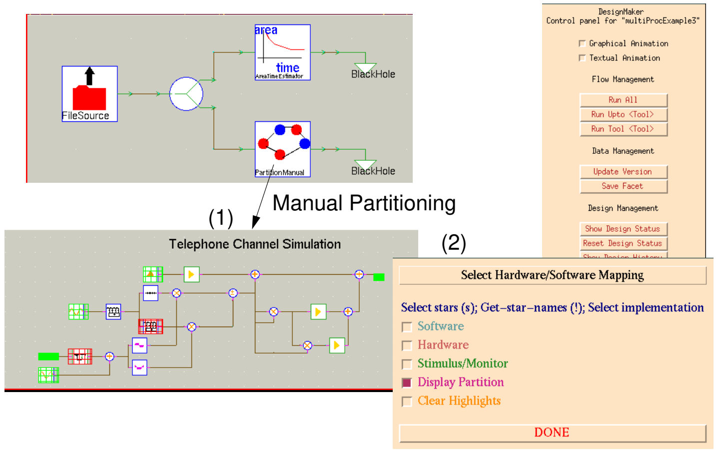
Hardware/software codesign

An Example Design Flow: Multiprocessor Synthesis



The goal is to synthesize the system with the minimum number of processors for a specified throughput requirement. The design flow and the control panel are shown.

An Example Design Flow: Components for Codesign



When the partitioning tool is invoked, it brings up the graph to be partitioned (1), and a control panel (2) that allows for manual partitioning. The area/time estimator returns the execution time and implementation area values by invoking specific tools on remote filesystems. Automated partitioning and synthesis tools have also been developed.

Conclusions

- Design space exploration is a key to system-level design
- Critical Issues:
  - Specifying and managing complex design flows
  - Tracking tool dependencies
  - Automated flow invocations
  - Maintaining consistency of design data and flows
- DMM: an infrastructure for design methodology management
- Current work:
  - Implement the codesign system in this framework