ELC 4438: Embedded System Design

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Specifications and Modeling

1. Modeling

2. Features of a Model

3. Models of Computation

Modeling

- *Models* provide an abstract view of the design at any given time, representing certain aspects of reality while hiding others that are not relevant or not yet known.

- Design models at each level of abstraction provide the basis for applying
  - analysis,
  - synthesis, and
  - verification techniques

Modeling

- *Synthesis* is the process of generating the description of a system in terms of related lower-level components from some high-level description of the expected behavior.

Modeling

- System behavior is generally described as a set of concurrent, hierarchical processes that operate on and exchange data via variables and channels.
- We have to define models for each component as well as for the whole system.
- We discuss concepts and techniques for modeling of systems at various levels of abstraction.

Features of a Model

- Hierarchy
    - Behavioral hierarchies – state, event, signal
    - Structural hierarchies – processor, memories, register, multiplexer
- Component-based design
- Concurrency
- Synchronization and communication
- Timing-behavior

Features of a Model

- State-oriented behavior
- Event-handing
  - Due to the reactive nature of some embedded systems
- Exception-oriented behavior
- Presence of programming elements
- Executability
- Support for the design of large systems

Features of a Model

- Domain-specific support
- Readability
- Portability and flexibility
- Termination
- Support for non-standard I/O devices
- Non-functional properties
  - size, weight, expected lifetime, power consumption, etc.
- Dependability
- Efficiency

Models of Computation

- Models of Computation are the basis for both humans and automated tools to reason about behavior and the requirements and constraints of computations to be performed.

Models of Computation

Components Procedures, processes, functions, finite state machines are possible components.

- Include the organization of computations in such components

Communication protocols These protocols describe methods for communication between components.

- Asynchronous message passing and rendezvous based communication are examples of communication protocols.

Models of Computation

- Relations between components can be captured in graphs.
- We refer to the computations also as processes or tasks.
- Accordingly, relations between these will be captured by *task graphs* and *process networks*.

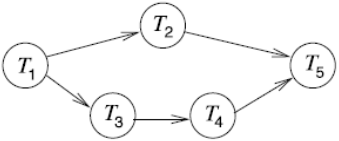
Models of Computation

- The most obvious relation between computations is their causal dependence:

  Many computations can only be executed after other computations have terminated.

- This dependence is typically captured in *dependence graphs*.

Dependence Graph


T_1
T_2
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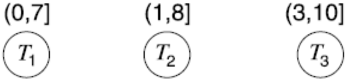
T_5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T_1
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