Quinn Roemer

Dr. Herbert G. Mayer

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Homework #2

List some (at least 5) unique, key characteristics of SW, that need to be considered during SW development.

- SW is malleable
- SW directly depends on the hardware
- SW doesn't wear out but will deteriorate
- SW solutions require unusual rigor
- SW has a discontinuous operational nature
- SW is intangible and hard to measure
- SW construction is human-intensive

Explain key phases of the 6-phase Software Product Life Cycle.

- Requirements Gathering
    - Gather the necessary requirements to outline your project.
- Requirements Specification
    - Specify the requirements needed for your project.
- Architecture Design
    - Create a base structure for your project using the gathered/specified requirements.
- Detailed Design
    - Further clarify, and outline your design.
- Implementation
    - Create your project using the necessary techniques (programming).
- Validation & Verification
    - Validate your project meets the defined requirements and verify its correct functionality.

List some (at least 5) key points of SW ethics.

- Public
    - SWE shall act consistently with the public interest.
- Client & Employer
    - SWE's shall act in a manner that is in the best interests of the client, employer. Consistent with the public interest.
- Judgment
    - SWE's shall maintain integrity and independence in their professional judgment
- Management

    - SWE managers shall subscribe to and promote an ethical approach to development and maintenance.
- Profession
    - SWE's shall advance the integrity and reputation of the profession consistent with the public interest.

List key architecture characteristics and constraints of pipelined CPU, Vector CPU, and Multiprocessor.

- Pipelined
    - ALU split into sequentially connected units in a pipeline. Each unit is a stage.
    - The time at which an action is done is the stage. Each stage can be initiated once per cycle.
    - Can execute multiple instructions at one moment on a single uniprocessor
    - Branching can cause issues if the next instruction is not sequential. Effectively stalling the pipeline.
    - Subject to data dependences. Cannot execute the next instruction if it relies on a result from the previous.
- Vector
    - Contains vector registers (arrays) that can load/store blocks of contiguous data.
    - Can perform multiple operations of the same kind on whole contiguous blocks of operands.
    - Number of steps to load/store vector register dependent on the width of the bus.
    - Subject to data dependences.
- Multiprocessor
    - Multiple CPU cores on a single chip.
    - Only one CPU can access system memory. Simultaneous accesses are not supported.
    - Subject to data dependences.

Name and explain the well-known four architectures, described by M. Flynn.

- SISD - Single Instruction, Single Data Stream
    - Typical on pure uniprocessors.
- SIMD - Single Instruction, Multiple Data Stream
    - Typical on Vector-based processors.
- MISD - Multiple Instruction, Single Data Stream
    - Typical on Pipelined, VLIW, and Superscalar processors.
- MIMD - Multiple Instruction, Multiple Data Stream
    - Typical on multiprocessors.

Describe systolic array architecture. Why don't we see many systolic machines to date?

A multiprocessor architecture where each processor has private memory and is connected via a network defined by a systolic pathway that may be bi-directional. These networks can either be defined by 2D or 3D topologies. Very rare these days due to the architecture being highly

specialized and expensive.

Which key problem will a SWE have to identify and then to efficiently program a multi-processor CPU?

> The max speedup of a program is dominated by its sequential portion. Therefore, to efficiently program a multiprocessor the sections of the program that can be parallelized must be identified and separated from the sequential sections so as to promote efficiency.

Name and briefly explain the various (about 5) Waterfall Model Phases that are common in large SW projects.

- Requirements Analysis & Definition
    - Understanding project requirements and function/purpose.
- System & Software Design
    - Specify HW system requirements and define overall system architecture.
- Implementation & Unit Testing
    - Develop project (program) and test individual units.
- Integration & System Testing
    - Integrate units into a system and perform testing.
- Operation & Maintenance
    - Deploy, maintain, update.

Which business- and technical goals must a SW engineer consider during the development of a large SW product? List at least 5.

- Cost
- Portability
- Legality
- Robustness
- Legal & Ownership Issues
- Reliability & Performance

Many SW problems have been solved before, usually with similar but rarely identical specifications. Thus, past SW solutions could provide a strong starting base for new solutions to the current problem. Argue, whether such reuse is possible, is meaningful, would be used by you, would be objectionable.

> SW reuse is not only possible but highly encouraged if the right conditions are met. These conditions being does it exist, can it be acquired legally, is it well documented, and is it cost-effective. SW reuse, when done correctly can cheapen and shorten the process of making SW. This process would definitely be used by myself as it can greatly enhance a SW project.