Lecture 23

- Assurance
  - Life cycle and assurance
- Threats
- Reference Monitors
- Policy and requirements
  - Specifications and their precision
  - Justifications

Life Cycle

- Conception
- Manufacture
- Deployment
- Fielded Product Life

Conception

- Idea
  – Decisions to pursue it
- Proof of concept
  – See if idea has merit
- High-level requirements analysis
  – What does "secure" mean for this concept?
  – Is it possible for this concept to meet this meaning of security?
  – Is the organization willing to support the additional resources required to make this concept meet this meaning of security?

Manufacture

- Develop detailed plans for each group involved
  - May depend on use; internal product requires no sales
- Implement the plans to create entity
  - Includes decisions whether to proceed, for example due to market needs

Deployment

- Delivery
  - Assure that correct masters are delivered to production and protected
  - Distribute to customers, sales organizations
- Installation and configuration
  - Ensure product works appropriately for specific environment into which it is installed
  - Service people know security procedures

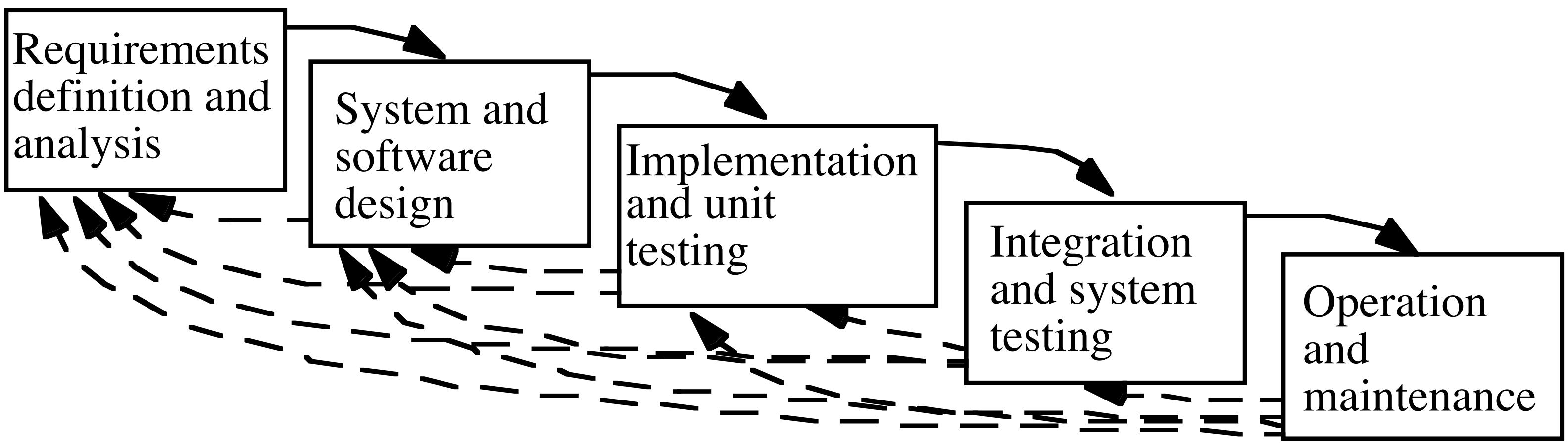
Fielded Product Life

- Routine maintenance, patching
  - Responsibility of engineering in small organizations
  - Responsibility may be in different group than one that manufactures product
- Customer service, support organizations
- Retirement or decommission of product

Waterfall Life Cycle Model

- Requirements definition and analysis
  - Functional and non-functional
  - General (for customer), specifications
- System and software design
- Implementation and unit testing
- Integration and system testing
- Operation and maintenance

Relationship of Stages



Models

- Exploratory programming
  - Develop working system quickly
  - Used when detailed requirements specification cannot be formulated in advance, and adequacy is goal
  - No requirements or design specification, so low assurance
- Prototyping
  - Objective is to establish system requirements
  - Future iterations (after first) allow assurance techniques

Models

- Formal transformation
  - Create formal specification
  - Translate it into program using correctness-preserving transformations
  - Very conducive to assurance methods
- System assembly from reusable components
  - Depends on whether components are trusted
  - Must assure connections, composition as well
  - Very complex, difficult to assure

Models

- Extreme programming
  - Rapid prototyping and "best practices"
  - Project driven by business decisions
  - Requirements open until project complete
  - Programmers work in teams
  - Components tested, integrated several times a day
  - Objective is to get system into production as quickly as possible, then enhance it
  - Evidence adduced *after* development needed for assurance

Key Points

- Assurance critical for determining trustworthiness of systems
- Different levels of assurance, from informal evidence to rigorous mathematical evidence
- Assurance needed at all stages of system life cycle

Threats and Goals

- *Threat* is a danger that can lead to undesirable consequences
- *Vulnerability* is a weakness allowing a threat to occur
- Each identified threat requires countermeasure
  - Unauthorized people using system mitigated by requiring identification and authentication
- Often single countermeasure addresses multiple threats

Architecture

- Where do security enforcement mechanisms go?
  - Focus of control on operations or data?
    - Operating system: typically on data
    - Applications: typically on operations
  - Centralized or distributed enforcement mechanisms?
    - Centralized: called by routines
    - Distributed: spread across several routines

Layered Architecture

- Security mechanisms at any layer
  - Example: 4 layers in architecture
    - Application layer: user tasks
    - Services layer: services in support of applications
    - Operating system layer: the kernel
    - Hardware layer: firmware and hardware proper
- Where to put security services?
  - Early decision: which layer to put security service in

Security Services in Layers

- Choose best layer
  - User actions: probably at applications layer
  - Erasing data in freed disk blocks: OS layer
- Determine supporting services at lower layers
  - Security mechanism at application layer needs support in all 3 lower layers
- May not be possible
  - Application may require new service at OS layer; but OS layer services may be set up and no new ones can be added

Security: Built In or Add On?

- Think of security as you do performance
  - You don’t build a system, then add in performance later
    - Can “tweak” system to improve performance a little
    - Much more effective to change fundamental algorithms, design
- You need to design it in
  - Otherwise, system lacks fundamental and structural concepts for high assurance

Reference Validation Mechanism

- *Reference monitor* is access control concept of an abstract machine that mediates all accesses to objects by subjects
- *Reference validation mechanism* (RVM) is an implementation of the reference monitor concept.
  - Tamperproof
  - Complete (always invoked and can never be bypassed)
  - Simple (small enough to be subject to analysis and testing, the completeness of which can be assured)
    - Last engenders trust by providing assurance of correctness

Examples

- *Security kernel* combines hardware and software to implement reference monitor
- *Trusted computing base* (*TCB*) is all protection mechanisms within a system responsible for enforcing security policy
  - Includes hardware and software
  - Generalizes notion of security kernel

Adding On Security

- Key to problem: analysis and testing
- Designing in mechanisms allow assurance at all levels
  - Too many features adds complexity, complicates analysis
- Adding in mechanisms makes assurance hard
  - Gap in abstraction from requirements to design may prevent complete requirements testing
  - May be spread throughout system (analysis hard)
  - Assurance may be limited to test results

Example

- 2 AT&T products
  - Add mandatory controls to UNIX system
  - SV/MLS
    - Add MAC to UNIX System V Release 3.2
  - SVR4.1ES
    - Re-architect UNIX system to support MAC

Comparison

- Architecting of System
  - SV/MLS: used existing kernel modular structure; no implementation of least privilege
  - SVR4.1ES: restructured kernel to make it highly modular and incorporated least privilege

Comparison

- File Attributes (*inodes*)
  - SV/MLS added separate table for MAC labels, DAC permissions
    - UNIX inodes have no space for labels; pointer to table added
    - Problem: 2 accesses needed to check permissions
    - Problem: possible inconsistency when permissions changed
    - Corrupted table causes corrupted permissions
  - SVR4.1ES defined new inode structure
    - Included MAC labels
    - Only 1 access needed to check permissions

Requirements Assurance

- *Specification* describes of characteristics of computer system or program
- *Security specification* specifies desired security properties
- Must be clear, complete, unambiguous
  - Something like "meets C2 security requirements" not good: what *are* those requirements (actually, 34 of them!)