Design Category:
Trust with Reluctance

Trust with Reluctance (TwR)

- **Whole system security** depends on the **secure operation of its parts**
  - These parts are **trusted**

- So: **Improve security by reducing the need trust**
  - By using a better design
  - By using a better implementation process
  - By not making unnecessary assumptions
    - If you use third party code, how do you know what it does?
    - If you are not a crypto expert, why do you think you can design/ implement your own crypto algorithm?

- **Categories**: Prevention and mitigation

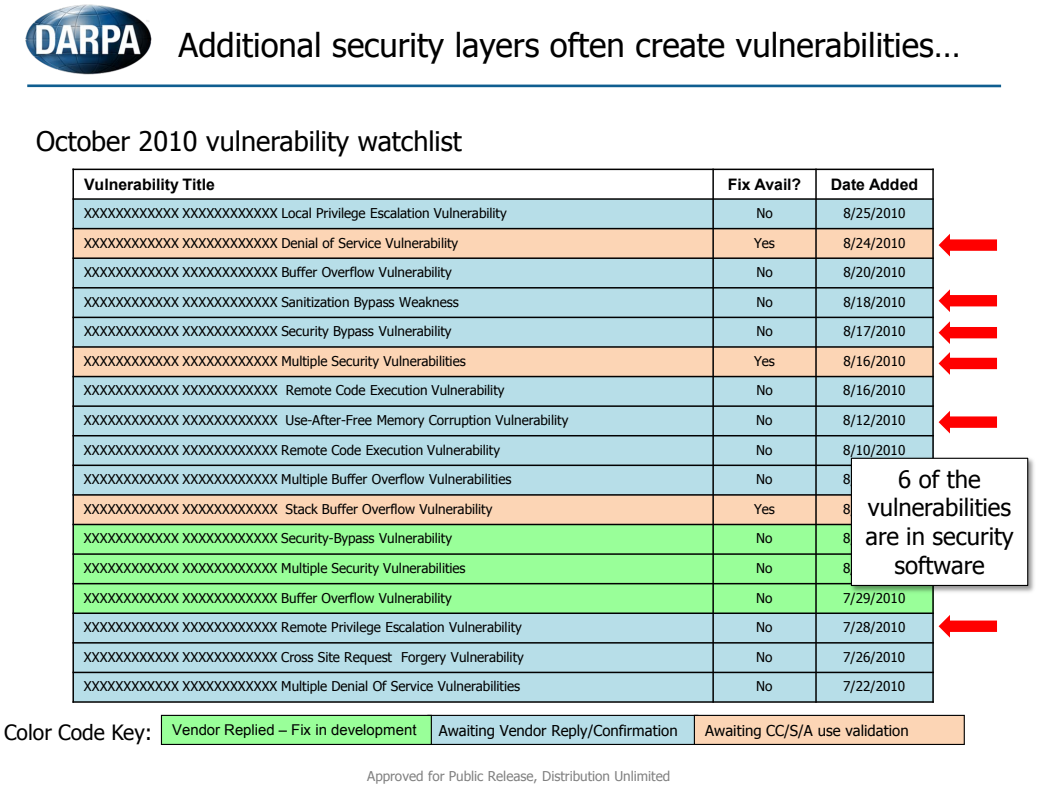
TwR: Small TCB

- Keep the **TCB small** (and simple) to **reduce overall susceptibility to compromise**
  - The trusted computing base (TCB) comprises the system components that *must* work correctly to ensure security
  - **Category**: Prevention

- **Example**: **Operating system kernels**
  - Kernels enforce security policies, but are often millions of lines of code
    - Compromise in a device driver compromises security overall
  - Better: Minimize size of kernel to reduce trusted components
    - Device drivers moved outside of kernel in micro-kernel designs

Failure: Large TCB

- **Security software** is part of the TCB
- But as it grows in size and complexity, it becomes vulnerable itself, and can be bypassed



http://www.darpa.mil/WorkArea/DownloadAsset.aspx?id=2147484449

TwR: Least Privilege

- Don't give a part of the system more privileges than it needs to do its job ("*need to know*")
  - **Category**: Mitigation

- **Example**: Attenuate delegations
  - Mail program delegates to editor for authoring mails
    - `vi, emacs`
  - But many editors permit escaping to a command shell to run arbitrary programs: too much privilege!
  - Better Design: Use a restricted editor (pico)

Lesson: Trust is Transitive

- **If you trust something, you trust what it trusts**
  - *This trust can be misplaced*

- **Previous e-mail client example**
  - Mailer delegates to an arbitrary editor
  - The editor permits running arbitrary code
  - Hence the mailer permits running arbitrary code

Rule: Input validation

- Input validation is a **kind of least privilege**
  - You are **trusting a subsystem** only **under certain circumstances**
  - *Validate that those circumstances hold*

- Several **examples** so far:
  - Trust a given function *if* the range of its parameters is limited (e.g., within the length of a buffer)
  - Trust a client form field *if* it contains no `<script>` tags (and other code-interpretable strings)
  - Trust a YAML-encoded string *if* it contains no code

TwR: Promote Privacy

- A good overall system goal is to **restrict flow of sensitive data** as much as possible
  - Doing so promotes privacy by *reducing trust/privilege*
  - **Category**: Mitigation

- **Example**: A student admission system receives (sensitive) letters of recommendation as PDF files
  - A typical design would allow reviewers to download these files for viewing on their local computers
    - But then compromise of these computers leaks private information
  - Better: PDFs only viewable in browser; no data downloaded to client machine.

TwR: Compartmentalization

- **Isolate a system component** in a compartment, or **sandbox**, reducing its privilege by making certain interactions impossible
  - **Category**: Prevention and Mitigation

- **Example**: Disconnect student records database from the Internet
  - Grant access only be direct terminals

- **Example**: `Seccomp` system call in Linux
  - Enables compartments for untrusted code

SecComp

- Linux system call enabled since 2.6.12 (2005)
  - Affected process can subsequently **only perform `read`, `write`, `exit`, and `sigreturn` system calls**
    - No support for `open` call: Can only use already-open file descriptors
  - **Isolates a process by limiting possible interactions**

- Follow-on work produced **seccomp-bpf**
  - **Limit process to policy-specific set of system calls**, subject to a policy handled by the kernel
    - Policy akin to *Berkeley Packet Filters (BPF)*
  - Used by *Chrome*, *OpenSSH*, *vsftpd*, and others

Idea: Isolate Flash Player

- Receive .swf code, save it
- Call **`fork`** to create a new process
- In the new process, open the file
- Call **`exec`** to run Flash player
- Call **`seccomp-bpf`** to compartmentalize