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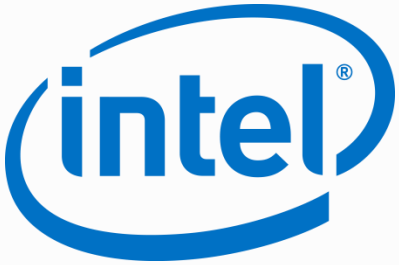


Threat Modeling for Modern System Firmware

Robert P Hale, Vincent Zimmer
Intel® Corp.

Agenda

- Introducing threat modeling
- The big BIOS assets
- Next steps

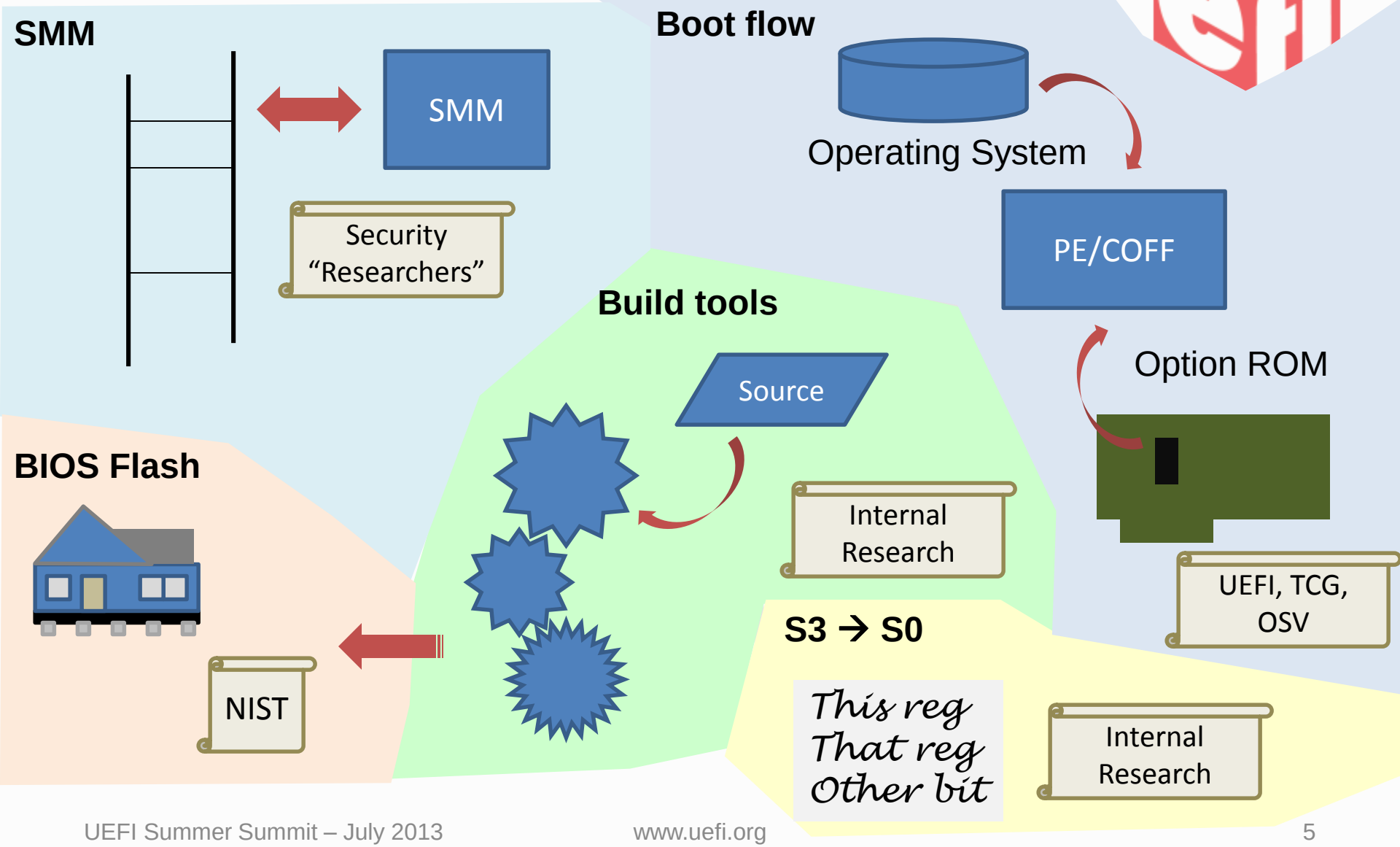
Why a threat model?

- "My house is secure" is almost meaningless
  - Against a burglar? Against a meteor strike? A thermonuclear device?
- "My system is secure" is almost meaningless
  - Against what? To what extent?
- Threat modeling is a process to define the goals and constraints of a (software) security solution
  - Translate user requirements to security requirements
- In this presentation we summarize the results of the threat modeling effort for our UEFI / PI codebase
  - We believe the process and findings are applicable to driver implementations as well as UEFI implementations in general

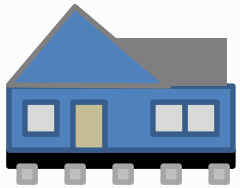
Defining, using a threat model

- A Threat Model (TM) defines the security assertions and constraints for a product
  - Assets: What we're protecting
  - Threats: What we're protecting it against
  - Mitigations: How we're protecting our Assets
- Use TM to narrow subsequent mitigation efforts
  - Don't secure review, fuzz test all interfaces
  - Select the ones that are critical
- TM is part science, part art, part experience, part nuance, part preference
  - Few big assets vs lots of focused assets

We don't always get to choose our Assets



Flash**

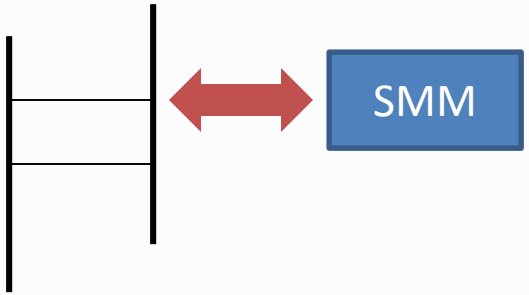


- NIST SP800-147 says
  - Lock code flash except for update before Exit Mfg Auth
  - Signed update (>= RSA2048, SHA256)
  - High quality signing servers
  - Without back doors (“non-bypassability”)
- Threats
  - PDOS – Permanent Denial of Service
    - System into inefficient room heater
  - Elevation of privilege
    - Owning the system at boot is an advantage to a virus
- Known attacks
  - CIH / Chernobyl 1999-2000
  - Mebroni 2010
- Mitigations include
  - Reexamining flash protection methods – use the best even if its new
  - Using advanced techniques to locate and remove (un)intentional backdoors

Make core flexible enough for a variety of hardware-based protections

** or tomorrow’s equivalent NV storage

SMM



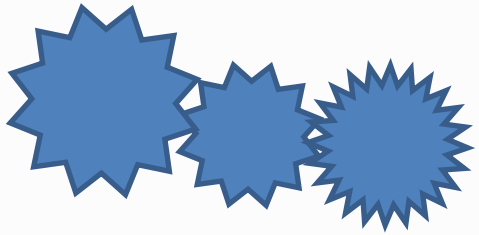
- SMM is valuable because
  - It's invisible to Anti Virus, etc
  - SMM sees all of system RAM
  - Not too different from PCI adapter device firmware
- Threats
  - Elevation
    - View secrets or own the system by subverting RAM
- Known attacks
  - See e.g. Duflot's *Security Issues Related to Pentium System Management Mode* **
- Mitigations include
  - Validate "external" / "untrusted" input
  - Remove calls from inside SMM to outside SMM

** CanSecWest 2006

Resume from S3

- ACPI says that we return the system to the S5→S0 configuration at S3→S0
  - Must protect the data structures we record the cold boot config in
- Threats
  - Changing data structures could cause security settings to be incorrectly configured leaving S3
  - Reopen the other assets' mitigated threats
- No known attacks
- Mitigations include
  - Store data in SMM -or-
  - Store hash of data structures and refuse to resume if the hashes don't compare

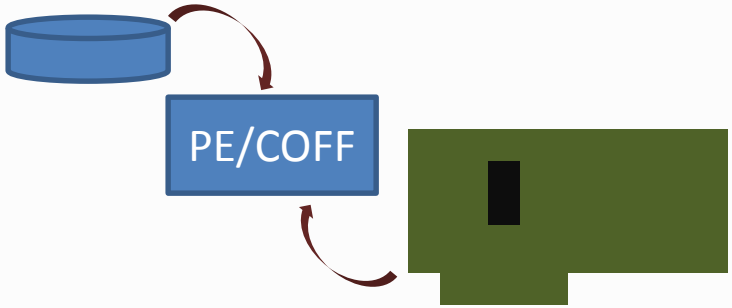
Tool chain



- Tools create the resulting firmware
  - Rely on third party tools and home grown tools
  - Incorrect or attacked tools leave vulnerabilities
- Threats
  - Disabled signing, for example
- Known attacks
  - See e.g. *Reflections on Trust*, Ken Thompson**
- Mitigation
  - Difficult: For most tools, provided as source code
  - Review for correct implementation
  - Use static, dynamic code analysis tools
    - PyLint for Python, for example

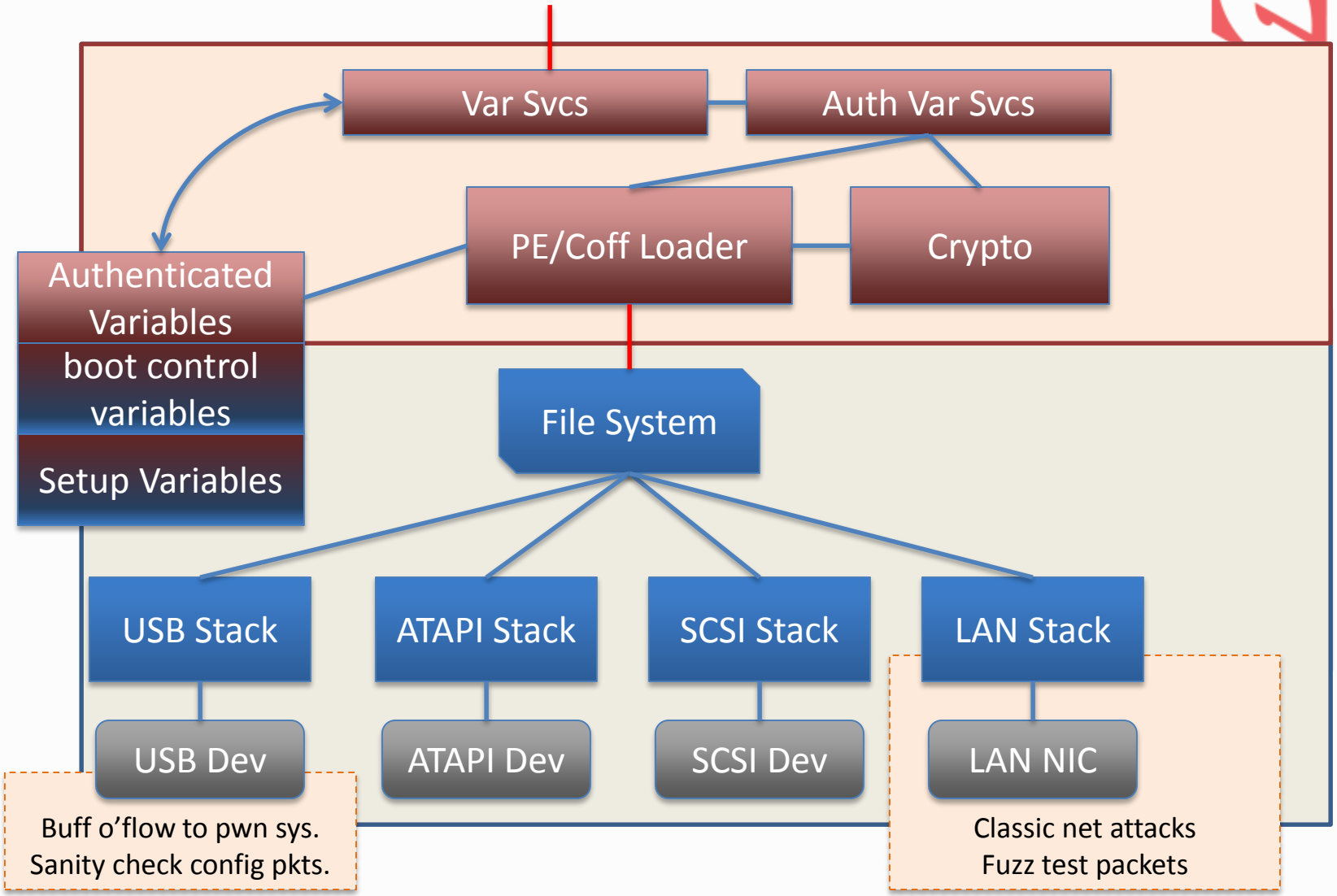
** CACM, Vol 27, No 8, Aug, 1984, pp. 761-763

Boot flow



- Secure boot
  - Authenticated variables
  - Based on the fundamental Crypto being correct
  - Correct location for config data
- Threats
  - Run unauthorized op roms, boot loaders
  - PDOS systems with bad config variables
- Known attacks
  - Researchers
- Mitigations include
  - Sanity check config vars before use, use defaults
  - Reviews, fuzz checking, third party reviews, etc.

TM to Modules: Boot flow



Assets or not?

- Variable content sanity checking?
  - If you randomly fill in your Setup variables, will your system still boot?
  - Fit in as a part of boot flow
- ACPI? We create it but don't protect it
- TPM support? We fill in the PCRs but don't use them

Quality ≠ Security

Call to action

- What are your assets?
  - How will they attack you?
  - How will you mitigate their attacks?
  - How will you verify that you've done your job well?
- If you use someone else's code you are implicitly using their threat model
  - Does their threat model match yours?
- For more info, see
  - Books, e.g. *Threat Modeling*, Swiderski and Snyder, Microsoft Press
  - Presentations from e.g. CanSecWest, Blackhat
  - Websites, e.g. Microsoft's SDL site**

** http://www.microsoft.com/security/sdl/default.aspx

Thanks for attending the
UEFI Summerfest 2013

For more information on
the Unified EFI Forum and
UEFI Specifications, visit
http://www.uefi.org

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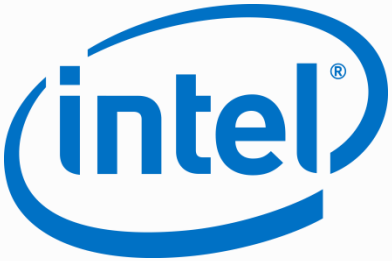

Backup

Context

- Secure Development Lifecycle must be a part of any modern firmware project
- Threat modeling is the first major activity and drives the rest of SDL
- This presentation is the result of the ongoing Threat Modeling activity Intel does on its UEFI/PI codebase
- The results are, we believe, applicable to UEFI implementations in general
- The methodology has proved useful to e.g. driver implementations as well

Assets or not?

- ACPI? We create it but don't protect it
- TPM support? We fill in the PCRs but don't use them
- Variable content sanity checking?
  - If you fuzz your setup variables, will your system boot?
  - Fit in as a part of boot flow

System firmware assets

- We don’t always have a choice as to the assets to protect
- NIST says protect your flash
- Researchers say protect your SMM
- TCG, OSVs say protect your boot flow
- Our research says protect your S3 script
- Build tool chain