# Beyond the TPM: Other Trusted Computing Technologies

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Day 1

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# What We'll Be Covering

- The Roots of Trust for Measurement (RTMs)
- Trusted Network Connect
- What else is out there (in brief)

# Core Concept: Chain of Trust

Measurements in trusted computing are based on the idea of a *chain of trust*.

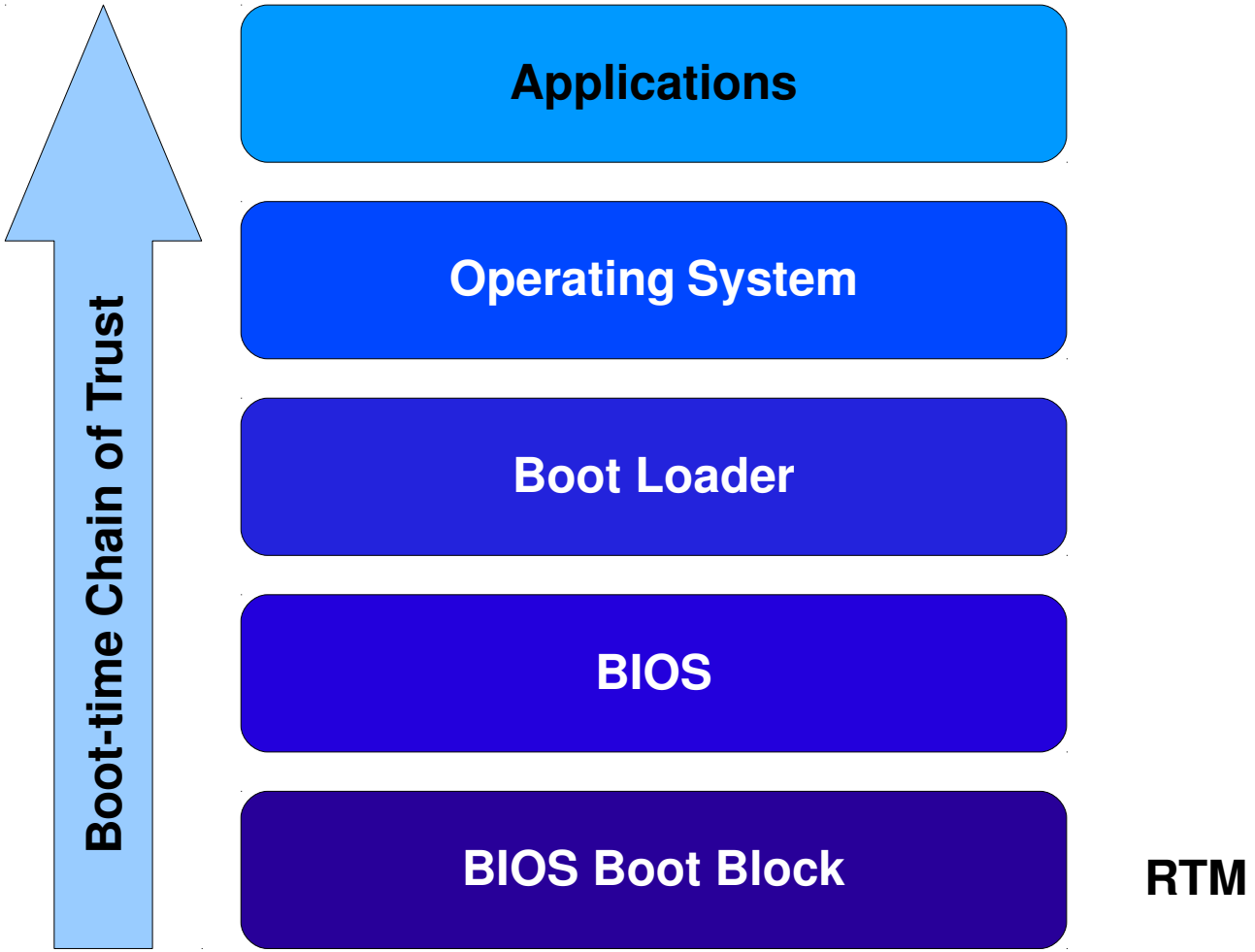
- Component A measures component B; stores that measurement
- Component A then launches component B
- Verifier: "If I trust A, then I can believe the measurement of B is accurate, and use the measurement to decide if I trust B."
- Chains: A measures B, B measures C, C measures D....

# The Two RTMs

There are two Roots of Trust for Measurement:

- Static
  - Part of BIOS
  - Runs automatically as part of system boot
  - Used to create "boot-time" chain of trust
- Dynamic
  - Part of CPU (signed code from manufacturer)
  - Run by entering special secure CPU mode
  - Used to create "late-launch" chain of trust
  - Can be used to measure and launch anything!

# Static RTM Chain of Trust



# Static RTM Tradeoffs

Pros:

- Already there, already working
- Free, no need to change any software

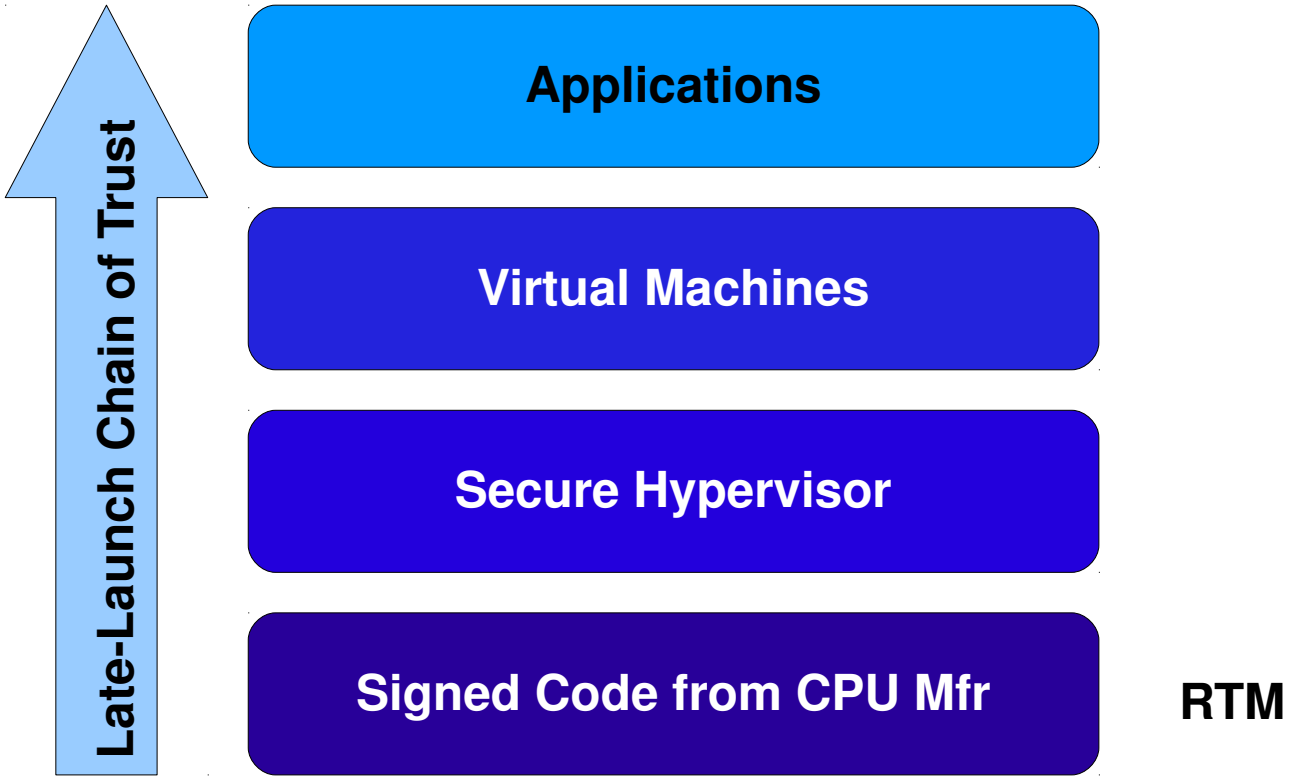
Cons:

- How much do you trust your BIOS? Your BIOS vendor?
- Today, measurements are *extremely* variable and cryptic
  - Work ongoing on standardizing, but not rolled out yet
- BIOS "bootkits" exist.

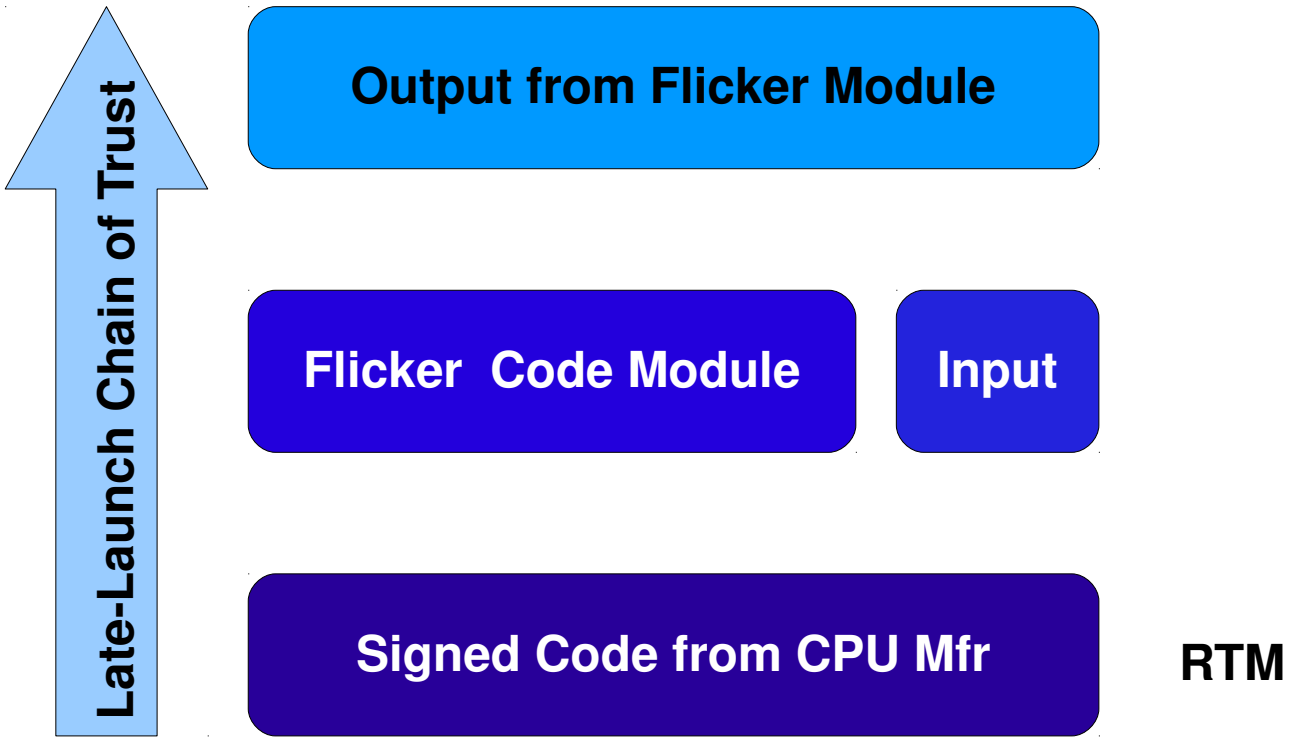
# DRTM: How It Works

- Special command sent to processor, along with designated region of memory
  - SINIT (Intel's TXT) or SKINIT (AMD's SVM)
- All processing on machine shut down except for special code module
  - Stored in firmware, signed by CPU manufacturer
  - Signature verified before execution
- Code module (DRTM) hashes contents of memory region, stores in TPM
  - Memory region may include both data and executables
- Passes control to specified location in memory
- Direct chain of trust from CPU root to any program user chooses
- Has special locality, and PCRs only it can write to
  - Can also be used to constrain keys or data
- Often referred to as *Late Launch*

# DRTM Example: Virtualization Chain of Trust



# DRTM Example: Flicker Chain of Trust



# DRTM Tradeoffs

Pros:

- Very flexible; measure anything you need to
- Trust CPU, not BIOS or boot loader
- Much shorter chains of trust

Cons:

- Requires non-trivial implementation

Mixed:

- Can be done repeatedly; only most recent verifiable

# When Should You Care About RTMs?

System design or integration:

- You want your system to be remotely evaluatable via TPM.

Application:

- You want your app to be measurable.
  - Unless using Flicker-style application-specific DRTM, you just need to know which component should measure your app.
- You are evaluating another system's trustworthiness, and thus need to know which RTM they use.
- That's it! Otherwise, you can pretty much ignore.

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# Trusted Network Connect Overview

- TCG's architecture for network access control (NAC)
- Not really a technology; a suite of protocols and architectures
- Probably the most supported TCG product
- **Does not actually require use of the TPM**
  - Part of the reason adoption has been rapid
  - Architecture flexible and abstract– roots of trust optional!
  - **Not all implementations of TNC can meaningfully be trusted**
- Uses fairly standard NAC abstractions

Core idea: Machines seeking network access present evidence about their state, which is evaluated based on policy before the machine is admitted.

# TNC Vocabulary

AR **Access Requestor**: machine seeing network access

PEP **Policy Enforcement Point**: Gateway, or other resource that can allow or deny access

PDP Policy Decision Point: Machine which evaluates access requests

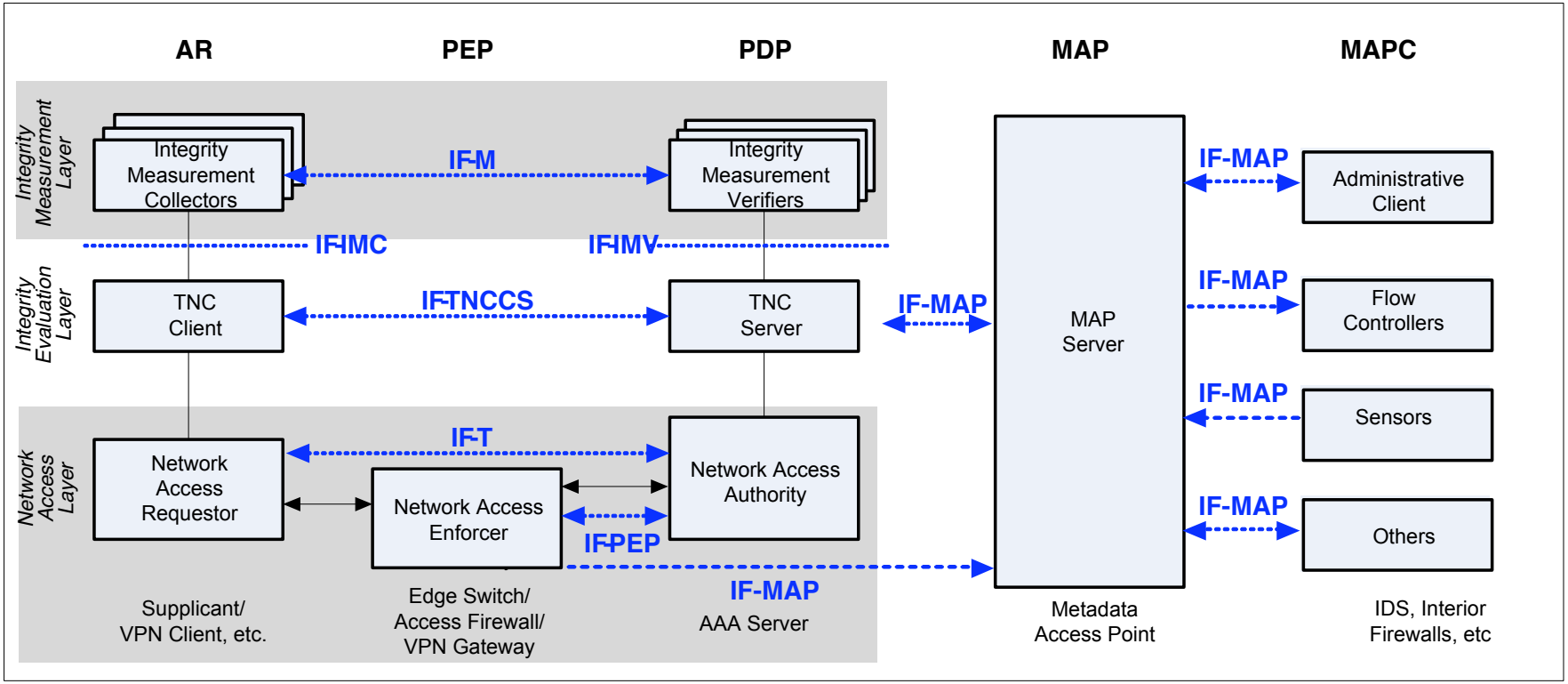
MAP Metadata Access Point: Stores and provides information about ARs

MAPC MAP Client: Clients which read or write MAP state data about ARs

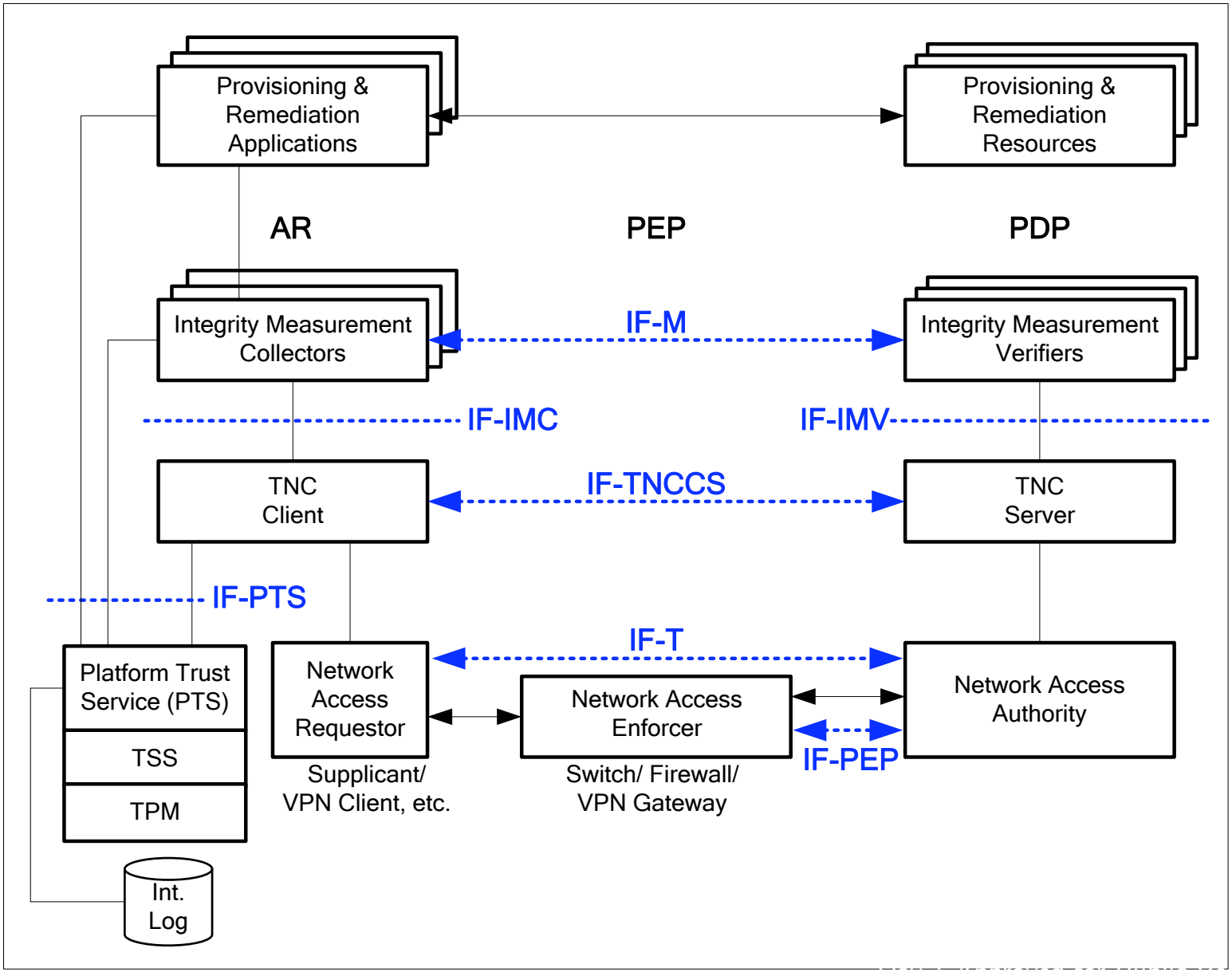
PTS Platform Trust Services: AR software interfacing between TNC and TPM.

Only bold roles actually required.

# TNC High-Level Visual



# TNC: Where the TPM Fits In



# Some Words of Warning

- The TNC protocol designers were not TPM experts.
  - **It is not safe to deploy their PTS to IF-M binding in an enterprise that plans to use any other attestation technologies.**
  - There is a **man-in-the-middle attack** if quotes are used elsewhere on the network.
- TNC alone does not give you real trust; it defines how components communicate
- You can buy TNC products today; always ask whether they use the TPM, and if so, how.

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# Other Trusted Computing Technologies: Storage

- High-security drives designed with trusted computing in mind
- Self-encrypting
  - Designed for high speed encryption and decryption
- Generally support user authentication
- Future possibilities: machine authentication or attestation

# Other Trusted Computing Technologies: Protocols

Generally, TCG's protocols are focused on taking advantage of low-level technologies.

- Integrate TPM quotes into high-level reporting standards
- Certify TPM keys and trusted platforms
- Add TPM data to various handshakes or channel establishments
- **Not all TCG protocols are appropriate for enterprise use!**
  - Serious flaws have been found in at least one TCG protocol (PTS Binding to IF-M)
  - Assumed it would be the *only* protocol on the network using the TPM
  - All TCG protocols should be evaluated against enterprise needs before use

# Other Trusted Computing Technologies: Near Future

- Mobile Trusted Module
  - Streamlined TPM-like functionality for cellphones
  - Allow providers more ability to control, verify software
  - Support cellphone-as-wallet usecase with real security
- TPM 2.0
  - Next version of TPM
  - Much like today's, but more flexible and more capable
  - Better crypto algorithms
  - More standards-compliant
- Trusted Virtualized Platform
  - Using TPMs to establish trust in virtualized workstation or cloud
  - Virtual TPMs for identifying VMs and protecting VM data