We have to watch and listen to everything that people are doing so that we can catch terrorists, drug dealers, pedophiles, and organized criminals. Some of this data is sent unencrypted through the Internet, or sent encrypted to a company that passes the data along to us, but we learn much more when we have comprehensive direct access to hundreds of millions of disks and screens and microphones and cameras.
This talk explains how we’ve successfully manipulated the world’s software ecosystem to ensure our continuing access to this wealth of data. This talk will not cover our efforts against encryption, and will not cover our hardware back doors.

Making sure software stays insecure

Daniel J. Bernstein

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Some important clarifications:

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This talk is actually a thought experiment: how could an attacker manipulate the ecosystem for insecurity?
Distract managers, sysadmins, etc.

Identify activities that can’t produce secure software but that can nevertheless be marketed as “security”.

Example: virus scanners.

Divert attention, funding, human resources, etc. into “security”, away from actual security.
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\textbf{People naturally do this.} Attacker investment is magnified. Attack discovery is unlikely.
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“Cybersecurity threats exploit the increased complexity and connectivity of critical infrastructure systems, placing the Nation’s security, economy, and public safety and health at risk. . . . The Framework focuses on using business drivers to guide cybersecurity activities and considering cybersecurity risks as part of the organization’s risk management processes.”
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  e.g. coordinate with CERT.
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  e.g. install an IDS.
- “Respond.”
  e.g. coordinate with CERT.
- “Recover.”
  e.g. “Reputation is repaired.”
Categories inside “Protect”:

- “Access Control”.
- “Awareness and Training”.
- “Data Security”.
  e.g. inventory your data.
- “Information Protection Processes and Procedures”.
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Subcategories in Framework: 98.
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This is how the money is spent.
Distract users

e.g. “Download only trusted applications from reputable sources or marketplaces.”

e.g. “Be suspicious of unknown links or requests sent through email or text message.”

e.g. “Immediately report any suspect data or security breaches to your supervisor and/or authorities.”

e.g. “Ideally, you will have separate computers for work and personal use.”
Distract programmers

Example: automatic low-latency software “security” updates.
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Marketing: “security” is defined by *public security holes*. Known hole in Product 2014.06? Update now to Product 2014.07!
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To help the marketing, publicize actual attacks that exploit public security holes.

Reality: Product 2014.07 also has security holes that attackers are exploiting.
Distract researchers

Example:
When researcher finds attack showing that a system is insecure, create a competition for the amount of damage.

“You corrupted only one file?”

“How many users are affected?”

“Do you really expect an attacker to use 100 CPU cores for a month just to break this system?”
Distract researchers

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⇒ More attack papers!
Discourage security

Tell programmers that
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Hide/dismiss/mismeasure security metric #1.
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Tell programmers that “defining security is impossible” so it can’t be implemented.

Hide/dismiss/mismeasure security metric #1.

Prioritize compatibility, “standards”, speed, etc. e.g.:
“An HTTP server in the kernel is critical for performance.”
What is security?

Integrity policy #1: Whenever the computer shows me a file, it also tells me the source of the file.

E.g. If Eve creates a file and convinces the computer to show me the file as having source Frank then this policy is violated.

I have a few other security policies, but this is my top priority.
The trusted computing base

1987: My first UNIX experience. Low-cost terminals access multi-user Ultrix computer.

Picture credit:
terminals.classiccmp.org/wiki/index.php/DEC_VT102
I log in to the Ultrix computer, store files labeled Dan, start processes labeled Dan.

Eve logs in, stores files labeled Eve, starts processes labeled Eve.

Frank logs in, stores files labeled Frank, starts processes labeled Frank.

Eve and Frank cannot store files labeled Dan, start processes labeled Dan. (Of course, sysadmin can.)
How is this implemented?

OS kernel allocates disk space:

<table>
<thead>
<tr>
<th></th>
<th>system files</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dan</td>
<td>my files</td>
</tr>
<tr>
<td>Eve</td>
<td>Eve’s files</td>
</tr>
<tr>
<td>Frank</td>
<td>Frank’s files</td>
</tr>
</tbody>
</table>

OS kernel allocates RAM:

<table>
<thead>
<tr>
<th></th>
<th>kernel memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dan</td>
<td>my processes</td>
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<td>Frank’s processes</td>
</tr>
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</table>
CPU hardware enforces **memory protection**: a user process cannot read or write files or RAM in other processes without permission from kernel.

Kernel enforces various rules. When a process creates another process or a file, kernel copies uid. Process is allowed to read or write any file with the same uid, but not with different uid.
Assume the hardware works. How do we verify that Eve can’t write Dan’s files?

1. Check the code that enforces these rules.
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2. Check the code that allocates disk space, RAM; and user-authentication code.
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1. Check the code that enforces these rules.

2. Check the code that allocates disk space, RAM; and user-authentication code.

3. Check all other kernel code. Bugs anywhere in kernel can override these rules. Memory protection doesn’t apply; language (C) doesn’t compensate.
The code we have to check is the trusted computing base.

Security metric #1: TCB size.

Eve can’t write Dan’s files unless there’s a TCB bug.

Eve’s actions: irrelevant.
Other software: irrelevant.
Millions of lines of code that we don’t have to check.

Do we need an audit log? No.
Keep computers separate? No.
Limit software Eve can run? No.
File sharing

So far have described complete user isolation.

But users want to share many of their files: consider the Web, email, etc.

I want to be able to mark a file I own as readable to just me; or also readable to Frank; or to Eve+Frank; or to a bigger group; or to the general public.
Say Frank creates a file, makes it readable to me.

I save a copy.

Later I look at the copy.

Remember integrity policy #1: Whenever the computer shows me a file, it also tells me the source of the file.

⇒ Computer has to tell me that Frank was the source.

I own the copy but Frank is the source.
Obvious implementation:

The OS kernel tracks source for each file, process.

When my copying process opens the file from Frank, the OS kernel marks Frank as a source for that process.

When process creates file, the kernel copies source.

Typical OS kernels today don’t even try to do this.
More complicated example: Eve and Frank create files, make them readable to me. I have a process that reads the file from Eve, reads the file from Frank, creates an output file.
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I have a process that reads the file from Eve, reads the file from Frank, creates an output file.

Integrity policy #1 ⇒ The OS kernel marks both Frank and Eve as sources for the process, then sources for the file.
Web browsing

Frank posts news-20140710 on his web server. My browser retrieves the file, shows it to me.

Integrity policy #1 ⇒ My computer tells me that Frank was the source.

A modern browser tries to enforce this policy. But browser is a massive TCB, very expensive to check, full of critical bugs.
What if I instead give Frank a file-upload account on my computer?

Frank logs in, stores a file news-20140710. I start a process that looks at the file.

If OS tracks sources then it tells me that Frank was the source.
Why should this be manual?

Browser creates process that downloads news-20140710 from Frank’s web server.

("Creating a process is slow."
—Oh, shut up already.)

OS automatically adds URL as a source for the process.

Process shows me the file.
OS tells me the URL.
Closing thoughts

Is the community even *trying* to build
a software system
with a small TCB
that enforces integrity policy #1?

If software security is a failure,
does this mean that
security is impossible,
or does it mean that
the community isn’t trying?