Handling Long-Term Keys

- Where do cryptographic keys come from?
- How should they be handled?
- What are the risks?
- As always, there are tradeoffs

Public/Private Keys

- Who generates the private key for a certificate?
- The server may have better random number generators
- Only the client needs the key
- (Does the corporation need a copy of the key?)
- If the server generates the key, how does it get to the client securely?
- (How does the public key get to the CA securely?)

Secret Keys

- Who generates secret keys?
- The problem is harder — both parties need to know them
- Again, how are they communicated securely?

Communication Options

- Channel authenticated by other means
- Public-key protected channel
- Hard-wired contact
- Out-of-band communications
- Note: process matters!

Out-of-Band Communications

- Telephone
- SMS text message
- Postal mail

What are the Enemy's Powers?

- Steal letters from a mailbox?
- Fake CallerID with an Asterisk PBX?
- Burglary, bribery, blackmail?

Tamper Resistance

- Keys are safer in tamper-resistant containers — they can't be stolen
- See "the three Bs" above
- Note well: tamper-*resistant*, not tamper-*proof*
- The availability of tamper-resistant hardware changes the tradeoffs

Online vs. Offline

- Does the key generator need to be online?
- A CA can be offline, and accept public keys via, say, CD
- That may be riskier than having it generate the private key — what if there's a buffer overflow in the read routine?
- For secret keys, the server can't be offline; rather, some copy of the key has to be online, to use it

Putting it All Together

- Let's look at some relatively simple privileged programs
- How do they combine the different mechanisms we've seen?
- What are the threats? The defenses?

The “Passwd” Command

- Permits users to change their own passwords
- In other words, controls system access
- Very security-sensitive!
- How does it work?

Necessary Files

- **`/etc/passwd`** — must be world-readable, for historical reasons
  - ☞ Maps numeric UID to/from username
- Historical format:

  `root:8.KxUJ8mGHCwq:0:0:Root:/root:/bin/sh`
- Fields: username, hashed password, numeric uid, numeric gid, name, home directory, shell
- Numeric uid/gid is what is stored for files
- Password is two bytes of salt, 11 bytes of encryption output
- Encoded in base 64 format: A-Za-z0-9./

Storing the Hashed Password

- Better not make it world-readable
- Store in a *shadow password* file
- That file can be read-protected

File Permissions

```
$ ls -l /etc/passwd /etc/shadow
-rw-r--r--   1 root  root  671 Oct  3 10:42 /etc/passwd
-r--------   1 root  root  312 Oct  3 10:42 /etc/shadow
```

Must Be Owned by Root!

- Ownership of that file is equivalent to root permissions
- Anyone who can rewrite it can give themselves root permissions
- Cannot use lesser permissions
- Note: adding a line to that file (often with a text editor) is the first step in adding a user login to the system

Implications of the Numeric UID/GUID

- Assigning a UID to a username grants access to that UID's files
- In other words, anyone with write permission on **`/etc/passwd`** has access to all files on the systm
- Consequence: even if we changed the kernel so that root didn't have direct access to all files, this mechanism provides indirect access to all files
- Conclusion: Cannot give root control over UID assignment on secure systems

What Else Shouldn't Root Be Able to Change?

- The user's password!
- Attack: change the user's password to something you know
- Windows XP does not give Administrator either of these powers

The Passwd Command

- Clearly, must be setUID to root
- Must be carefully written. . .

Authenticating the User

- Passwd program has real UID
- Demand old password — why?
- ☞ Guard against someone doing permanent damage with minimal access
- Root can change other user's passwords

Where Does the Salt Come From?

- Passwd command generates random number
- Need this be true-random?
- No — “probably different” will suffice.
- Seed ordinary pseudo-random number generator with time and PID

Restricting Access

- Suppose only a few people were allowed to change their own passwords
- Take away other-execute permission; put those people in the same group as “passwd”

Front Ends

- What about the help desk, for forgotten passwords?
- Have a setUID root front end that invokes passwd
- Validate: make sure they can only change certain users' passwords
- Log it! (Much more later in the semester on logging)

Making a Temporary Copy

- Must copy password file to temporary location and back to change a password
- Watch out for race condition attacks!
- Actual solution: put temporary file in **`/etc`** instead of **`/tmp`**; avoid whole problem
- Secondary benefit: use temporary file as lock file, and as recovery location in case of crash

Update in Place

- Password changes could overwrite the file in place
- Doesn’t work for use add/delete or name change
- Still need locking

Passwords on the Command Line?

- Bad idea — **`ps`** shows it
- Bad idea — may be in shell history file

```
$ history 12
12      date
13      man setuid
14      ls -l ‘tty‘
```

- Your terminal isn’t readable by others:

```
$ ls -l ‘tty‘
crw--w----  1 smb tty 136, 5 Oct 26 14:24 /dev/pts/5
```

Changing Your Name

- Chsh is like passwd, but it lets you change other fields
- Ordinary users can change shell and human-readable name; root can change other fields
- *Much* more dangerous than passwd

Input Filtering

- What if user supplies new shell or name with embedded colons? Embedded newlines? Both?
- Could create fake entries!
- Must filter for such things

Features Used

- Access control
- Locking/race prevention
- Authentication
- Privilege (setUID)
- Filtering

Security Analysis: Internet Thermostats

- I recently decided to investigate Internet thermostats
- Control and monitor my house temperature remotely
- Are there security risks?

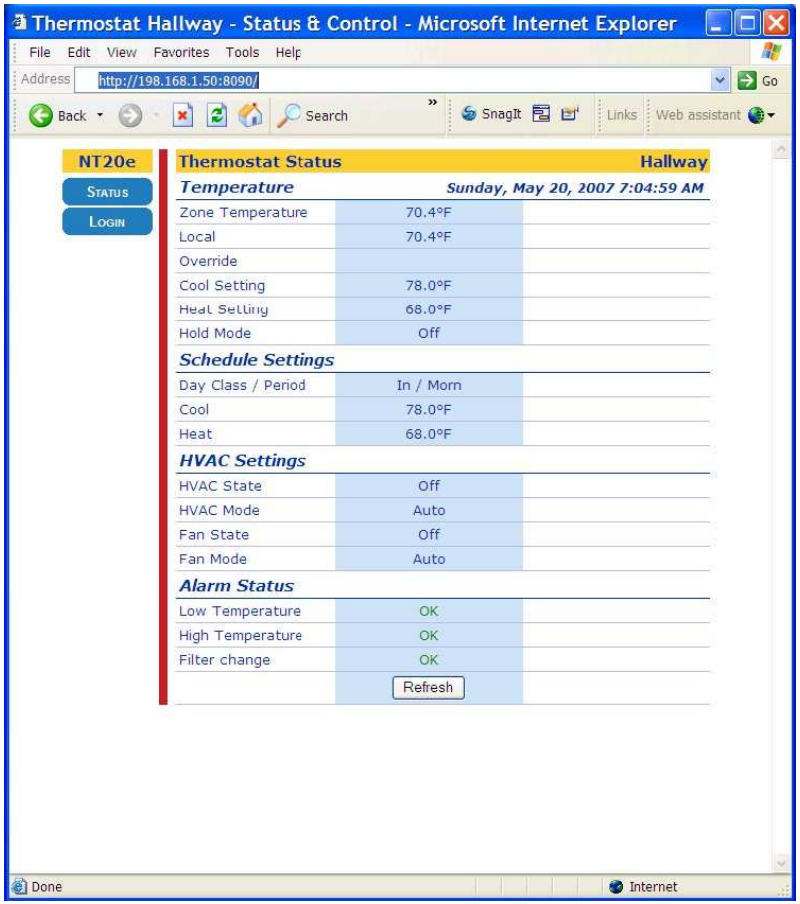
One Popular Brand

- Thermostats have built-in web servers
- Simplest mode: direct connection to thermostat
- Alternate mode: thermostat and user connect to company's web site; company can generate alert emails

What's at Risk?

- Turning off someone's heat in the middle of winter?
- Turning on the heat in the summer?
- Run heat and air conditioning simultaneously?

Local Management



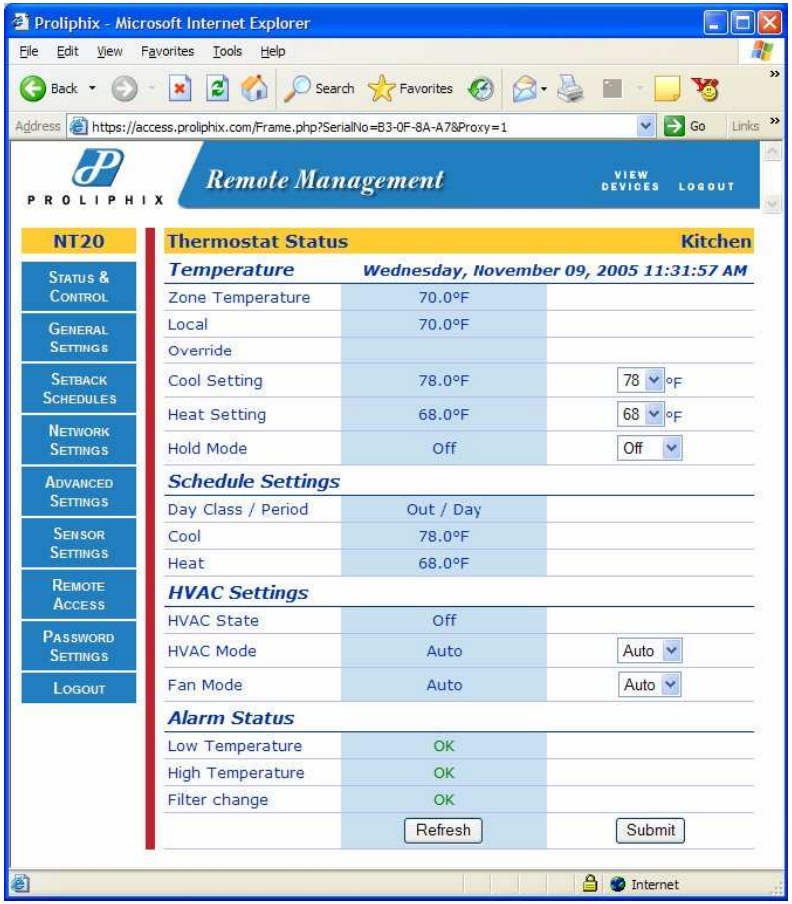
Local Problems

- No https — people can eavesdrop
- Uses “Basic Authentication”:

  “The most serious flaw in Basic authentication is that it results in the essentially cleartext transmission of the user’s password over the physical network.. . .

  “Because Basic authentication involves the cleartext transmission of passwords it SHOULD NOT be used (without enhancements) to protect sensitive or valuable information.”
- No read-only mode

Remote Management



Remote Problems

- Https — but only to the server
- Unencrytped traffic from the server to the thermostats
- Passwords are sent in the clear across the Internet
- Passwords are stored in bulk on the server

Privacy Issues

- Energy consumption patterns
- Al Gore's thermostat setting? Japanese office thermostat settings?
- Vacation schedules (burglary risk?)

Defenses

- Can’t touch thermostat software
- Add layering — access controls on top of built-in controls
- Use crypto tunnels
- Filter setting change requests

Last-Ditch Defenses

- Add a low-limit heat switch in parallel
- Add a high-limit heat switch in series
- These are hardware devices, not software
- Protect against bugs
- What if they fail?
- Independent failure modes; protect against each other

How to Analyze This?

- Hard to *know* all the threats
- Approach: see what is made available, and ask who might want it
- Reason by analogy and effect
- Check the “gold standard” (Au): **Au**thentication, **Au**thorization, **Au**dit