Rethinking Passwords

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Intel’s rules

- The password must be at least 8 characters long.
- The password **must** contain at least:
  - one alpha character [a-zA-Z];
  - one numeric character [0-9];
  - one special character from this set:
    ` ` ! @ $ % ^ & * ( ) - _ = + [ ] ; : ' " , < . > / ?
- The password **must not**:
  - contain spaces;
  - begin with an exclamation [!] or a question mark [?];
  - contain your login ID.
- The first 3 characters cannot be the same.
- The sequence of the first 3 characters cannot be in your login ID.
- The first 8 characters cannot be the same as in your previous password.
- Passwords are treated as **case sensitive**.
Golden Rule Health

PASSWORD RULES (Please note the password is case sensitive)

Must contain at least 8 characters.

Must include a number and a letter.
No more than two consecutive characters may be the same.

Passwords must be changed at least every 180 days.

No password may be re-used for a period of 1 year.

3 invalid attempts to login will result in a 30 minute lockout.
Wachovia (now Wells Fargo)

Passwords must be 7-20 characters
Must include at least one letter and one number, with no spaces
Semi-colons cannot be part of a Password
Passwords are case sensitive
Do not use your User ID as your Password
Dartmouth

- It should be **eight characters long** using only numbers and upper- and lower-case letters. **Note**: Passwords longer than eight characters will not work to authenticate you with some applications used at Dartmouth, such as Kerberos and Oracle Calendar.
- There can be **no more than four characters in sequence** (e.g., `12345` or `abcde` are not allowed).
- It must contain at least **five different characters** (e.g., `2a3a2a3a` only contains three different characters so is not allowed).
- It cannot be a word found in the dictionary, including foreign languages (e.g., `password`).
- It cannot be a reversal of a word found in the dictionary (e.g., `drowssap`).
- It cannot be a word found in the dictionary, plus one additional character either before or after the word (e.g., `xalgebra` or `algebrax`).
- It cannot be a word found in the dictionary with numbers substituted for look-alike letters (e.g., `passw0rd` or `pa55word`).
- It cannot be a word found in the dictionary minus any punctuation, symbols, or numbers (e.g., `oclock` or `soninlaw`).

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<table>
<thead>
<tr>
<th></th>
<th>length</th>
<th>case sens.</th>
<th>A-Z</th>
<th>a-z</th>
<th>0-9</th>
<th>sym</th>
<th>OK</th>
<th>not OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel</td>
<td>&gt;=8</td>
<td>Yes</td>
<td>R</td>
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<td>Golden Rule</td>
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</tbody>
</table>
Fillet of a fenny snake,  
In the cauldron boil and bake;  
**Eye of newt** and toe of frog,  
Wool of bat and tongue of dog,  
Adder's fork and blind-worm's sting,  
Lizard's leg and howlet's wing,  
For a charm of powerful trouble,  
Like a hell-broth boil and bubble.

-- Macbeth, Act 1, Scene 1
Use A Different Password on each System
Change Your Password Frequently
Don’t Reuse Passwords
Don’t Write Your Password Down
This is a usability nightmare!

Who’s responsible for this?
Well, I am, a Little
CSC-STD-002-85: DOD Password Management Guideline

• The “green book”.
• A variety of mostly-excellent security suggestions
<table>
<thead>
<tr>
<th>Scheme</th>
<th>Cracked in</th>
<th>Change time</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 character, full alphanumeric</td>
<td>6.72 mins.</td>
<td>0.40 ms.</td>
</tr>
<tr>
<td>8 character, EoN</td>
<td>9.25 days</td>
<td>31.19 ms.</td>
</tr>
<tr>
<td>11 character, EoN</td>
<td>20,390 years</td>
<td>7.4 days</td>
</tr>
<tr>
<td>13 character, full alphanumeric</td>
<td>906,123 years</td>
<td>331 days</td>
</tr>
<tr>
<td>12 character, Eye-of-newt</td>
<td>1,896,229 years</td>
<td>692 days</td>
</tr>
</tbody>
</table>
Those that accept advertising, purchase sponsored links, or user has a choice have weakest password requirements

Strongest passwords: .gov, then .edu
These rules come from the Deep Past in computing and security

- Time sharing terminals in public places
- Attacks on the login interfaces on network services
- Network eavesdropping was often trivial
- The stakes were usually much lower
- Institutionalized passwords on, say, telephone switches
- Changing passwords: lost military crypto gear
Dictionary Attacks

• Have a computer try as many password guesses as possible
• The required effort is called the “work factor”, and the resistance to attack is often (incorrectly) called the “entropy” of the password.
• These attacks can be directed at online authentication services, or against stolen hashed password files.
mail.coastal.cheswick.com login failures:
Sep 21 03:11:03 mail sshd[90325]: Invalid user cgi from 219.139.108.134
Sep 21 03:11:15 mail sshd[90335]: Invalid user oracle from 219.139.108.134
Sep 21 03:11:18 mail sshd[90337]: Invalid user tomcat from 219.139.108.134
Sep 21 03:11:47 mail sshd[90361]: Invalid user nagios from 219.139.108.134
Sep 21 04:50:29 mail sshd[54849]: Invalid user devtest from 58.213.48.82
Sep 21 04:50:33 mail sshd[54851]: Invalid user rede from 58.213.48.82
Sep 21 04:51:49 mail sshd[54895]: Invalid user anja from 58.213.48.82
Sep 21 04:51:55 mail sshd[54897]: Invalid user anja from 58.213.48.82
Sep 21 04:51:59 mail sshd[54899]: Invalid user platinum from 58.213.48.82
Sep 21 04:52:03 mail sshd[54901]: Invalid user plcmspip from 58.213.48.82
Sep 21 04:52:06 mail sshd[54903]: Invalid user teamcity from 58.213.48.82
Sep 21 04:52:13 mail sshd[54905]: Invalid user teamspeak from 58.213.48.82
Sep 21 04:59:33 mail sshd[55143]: Invalid user addr from 58.213.48.82
Sep 21 04:59:37 mail sshd[55145]: Invalid user adempiere from 58.213.48.82
Sep 21 04:59:40 mail sshd[55147]: Invalid user admin2 from 58.213.48.82
Sep 21 04:59:43 mail sshd[55149]: Invalid user admin from 58.213.48.82
Sep 21 04:59:57 mail sshd[55157]: Invalid user admin from 58.213.48.82
Sep 21 05:00:02 mail sshd[55159]: Invalid user admin from 58.213.48.82
Sep 21 05:00:05 mail sshd[55177]: Invalid user adminf with from 58.213.48.82
Sep 21 05:00:08 mail sshd[55179]: Invalid user adminhelp from 58.213.48.82
Sep 21 05:00:12 mail sshd[55181]: Invalid user admin from 58.213.48.82
Sep 21 05:00:15 mail sshd[55183]: Invalid user admin from 58.213.48.82
The Dictionary Attack Arms Race

- Moore’s Law: 12 doublings since 1990
- And multi-core CPUs are perfect for password cracking
- Can a human choose and remember a password that a computer can’t guess when limited only by computer speed and time available?
- Guessing rates can be $8 \times 10^9$ guesses per second per CPU!
A note on Grandma
What are the most common current threats

• Keystroke loggers
• Phishing attacks
• Password database compromise
• NOT DICTIONARY ATTACKS!
None of these are grandma’s fault!

It is simply poor engineering to expect people to select and remember passwords that are resistant to dictionary attacks.
Results

• People violate many of these rules routinely, for usability reasons
• Stringent rules increase use of fall-back systems, which are usually less secure, or more expensive
• The rules don’t make most things more secure in the face of most current threats
Some Password Ideas

From academia, and me
For a complete survey, see

from Dirik, Memon, Birget; SOUPS 2007

28 of about 93
Welcome to Passfaces, Please Log On

Click on your passface to logon

(go on!)
My passfaces

Meet your passfaces...

Here are your passfaces...

Press Next
(Don't worry about remembering your passfaces at this stage)

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Deja Vu (Recognition-based)
Draw a Secret

Lin, Dunphy, et al. SOUPS 2007
Use Your Illusion (SOUPS 2008)

Please memorize the three distorted images shown above.

OK
Can Something You Know Be Saved?

Can “something you know be saved?”

- I think so
- and, we don’t have a choice in most cases
- security and convenience: tradeoff?
- It is going to be one of the authentication factors
  - something you know
  - something you have
  - something you are
  - where you are
  - .....
Better Solutions

#1: Getting out of the game
A login from my distant past

RISC/os (inet)

Authentication Server.

Id? ches
Enter response code for 70202: 04432234

Destination? cetus
$

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SecureID

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RSA Softkey

Enter PIN

Passcode

8621 1490

27 sec remaining

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Great Things about the Softkey

• You always have your iPhone with you
• A bad PIN simply gives the wrong answer
• That means that the program doesn’t know the right answer
• That means that forensics can’t run a dictionary attack on it with having an observed login
• That means that a lost iPhone isn’t an authentication disaster
Challenge/Response passwords

- Gets us out of the game
- Sniffing is not useful
- Man-in-the-middle can still be used
- Pretty much nothing to forget
- A PIN is helpful to make two-factor authentication
- Surprisingly cheap
Why aren’t these ubiquitous?

- Cheap devices available before 1990
- People hate:
  - Having to carry the device
  - Entering the challenge (why SNK lost)
  - Entering the response
  - Carrying multiple devices
- **BUT**: You carry keys to use your car. Why not to authenticate on your computer?
Better Solutions

#2: Limiting guesses
Limiting guesses

• This has worked for ATM PINs since the early 1970s!
• It requires an authentication server, or some means to shut off the card/account
• It replaces the eye of newt rules with...
An Engineering Goal: Non-moronic password rule!

Pick something a friend, colleague won’t guess in a few tries, and they can’t figure out while watching you type it.
Summary solution

- Limited guesses and lock the account
- Non-moronic passwords
- Make locked accounts less painful
Grandma can understand and comply with this rule

- It makes sense
- Now, dictionary words are okay
- Simpler passwords are easier to remember
- You probably don’t have to write them down
Less painful account locking

- Don’t count duplicate password attempts
  - they probably thought they mistyped it
- Make the password hint about the primary password, and don’t have a (weak) secondary
- Allow a trusted party to vouch for the user, so he can change his password
- Lock the account in increasing time increments
- Remind the user of password rules
Better Solutions?

#3: Grasping the “passphrase” nettle
Still Want Your Strong Passwords?

Okay, fine. But let’s make them fun, or at least easier to type (and tap)
A Very Short Course on Work Factor
$$2^{10} = 1024$$ of the most common British words

the of and a in to it is to was for that you he with on by at are not this but had they his from she that which or we an were as do been their has would there what will all if can said who one so up as them some when could him into its then two out time my about did your now me no other only just more these also people know any first see very new may well should like than how get way one our made got after think between many years er those go being down yeah three good back make such on there through year over must still even take too more here own come last does oh say no work where erm us government same man might day yes however put world over another in want as life most against again never under old much something why each while house part number out off different went really thought came used children always four where without give few within about system local place great during although small before look next when case end things social most find group quite mean five party every company women says important took much men information per both national often seen given school fact money told away high point night state business second need taken done right having thing looked area perhaps head water right family long hand like already possible nothing yet large left side asked set whether days mm home called development week such use country power later almost young council himself of far both use room together tell little political before able become six general service eyes members since times problem anything market towards court public others face full doing war car felt police keep held problems road probably help interest available law best form looking early making today mother saw knew education work actually policy ever so at office am research feel big body door let name person services months report question using health turned million main though words enough child less book period until several sure father for level control known society major seemed around began itself themselves minister economic wanted upon areas after therefore woman city community only including centre gave job among position effect likely real clear staff black kind read provide particular became line moment international action special difficult certain particularly either open management taking across idea whole age process act around evidence view better off mind sense rather seems believe morning third else half white death sometimes thus brought getting church ten shall try behind heard table change support back sort whose industry ago free care so order century range gone yesterday training working ask street home word groups history central all study usually remember trade hundred programme food committee air hours experience rate hands indeed sir language land result course someone everything certainly based team section leave trying coming similar once minutes authority human changes little cases common role true necessary nature class reason 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natural live future rest project greater feet meet simple died for happened added manager computer security near met evening means round carried hear heart forward sent above attention story structure move agreed nine letter individual force studies movement account per call board success following considered current everyone fire agreement please boy capital stood analysis whatever population modern theory books stop in legal material son received model chance environment finally performance sea rights growth authorities provided nice whom produced number talk turn built final east talking fine worked west parties size record red close property myself example space giving normal nor reached buy serious quickly along plan behaviour recently term previous couple included pounds anyway cup treatment energy total thank director prime levels significant issues sat income top choice away costs design pressure scheme change a list suddenly continue technology hall takes ones details happy consider won defence following parts loss industrial activities throughout spent outside teachers generally opened floor round activity hope points association nearly allow rates sun army sorry wall hotel forces contract dead stay reported as hour difference meant summer county specific numbers wide appropriate husband top played relations figures chairman set lower product colour ideas look arms obviously unless produce changed season developed unit appear investment test basic write village reasons military original successful garden effects each aware yourself exactly help suppose showed style employment passed appeared page hold suggested continued offered products popular science window expect beyond resources rules professional announced economy picture okay needs doctor maybe events a direct gives advice running circumstances sales risk interests dark event thousand involved written park returned ensure fish wish opportunity commission oil sound ready lines shop looks immediately worth in college press fell blood goods playing carry less film prices useful conference operation follows extent designed application station television access response degree majority effective established wrote region green ah western traditional easily cold shows offer though statement published forms down accept miles independent election support importance lady site jobs needs plans earth earlier title parliament standards leaving interesting houses planning considerable girls involved increase species stopped concern public means caused raised through glass physical thought eye left heavy walked daughter existing competition speak responsible up river follow
the of and a in to it is to was for that you he with on by at are not this bit had them her from she that which or we an were as do been their has would there what will all if can said who one so up as them some when could him into its then two cut time they about did your now me no other only just more these also people know any first see very new may well should like than how get way one our made got after think between many years er those go being down yeah three good back make such on there through year over must still even take too more here own come last does oh say no work where ern us government same man might day yes however put world over another in want as life most against again never under old much something why each while house part number out off different went really thought came used children always four where without give few within about system local place great during although small before look next when case end things social most find group quite mean five party every company women says important took much men information per both national often seen given school fact money told away high point night state business second need taken done right having thing looked area perhaps head water right family long hand like already possible nothing yet large left side asked set whether days mm home called development week such use country power later almost young council himself of far both use room together tell little political before able become six general service eyes members since times problem anything market towards court public others face full doing war car felt police keep held problems road probably help interest available law best form looking early making today mother saw knew education work actually policy ever so at office am research feel big body door let name person services months report question using health turned million main though words enough child less book period until several sure father for level control known society major 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Two random choices = 20 bits

the of and a in it to is to was for that you he with on by at are not this but had they his from she that which or we an were as do been their has would there what will all if can said who one so up as them some when could him into its then two out time my about did your now me no other only just more these also people know any first see very new may well should like than how get way one our made got after think between many years er those go being down yeah three good back make such on there through year over must still even take too more here own come last does oh say no work where erm us government same man might day yes however put world over another in want as life most against again never under old much something why each while house part number cut off different went really thought came used children always four where without give few within about system local place great during although small before look next when case end things social most find group quite mean five party 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20 bits = $2^{20} = 1,048,576$

- “example early”
- to guess our two words, requires:
  - $1,048,576/2$ guess, on average
- 6 random words would be $2^{60}$
  - $1.15 \times 10^{18}$
- 8 random words gives you Avogadro’s number, a mole of work to do!
Good stuff!

- The list of words isn’t secret
- so spelling checker is okay!
  - so is error correction! In a password!
- easy words to type
- on an iPhone, pick words where the “tappos” give the word you wanted

57 of about 93
Required entropy, according to Florêncio and Herley

- Facebook, Twitter, etc. are a minimum of \( \sim 20 \) bits
- Banks are in the 30s
- Government in the mid 40s and up
iPhone-Friendly? (40 bits)

- grade likes jokes guess
- goes joke gold gods rode fire rows
- votes mines bored alike yard
- what knit bomb unit star grow
- actor agent above angel abuse
- honey learn least lemon links
www.cheswick.com/ches/insults.html

You grim-faced pipe of pleuritic snipe sweat
You dire chiffonier of foul miniature poodle squirt
You teratic theca of pathogenic moth dingleberry
You worrying pan broiler of bilious puff adder slobber
You vile wok of tumorigenic aphid leftovers
You baneful reliquary of pneumonic miller stumps
You atrocious terrine of harmful Virginia deer vomition
You excruciating pony of septic redstart eccrisis
You blotted kibble of unhygenic wild sheep spittle
You hard-featured fistula of podagric macaque flux
If you really need “high entropy” passwords

- Not user-chosen, but user can veto, waiting for a “good one”
  - User-chosen phrases have much lower entropy
- They are going to write it down, for a while
- For daily use: who’s going to remember this over a year?
(105 demo)
problems sharing workshop holy legend
gen equation

monitor crooks cutter artagquette enchanting
decanted

marechal hobbler aurochs grinagog petiolar

Pick another key

Pick another key

Pick another key
can evening reach political applied whole without needs door member i

building award days county rome why external ran states

blokes hodgepodge melissa jannequin vyng fha horseflesh

Pick another key

Pick another key

Pick another key
Use one Really Strong password to lock your password wallet

• You are not going to remember it immediately
• You will learn it after a while
• You don’t have to change it
• $2^{105}$ bits means average work factor of $20,282,409,603,651,670,423,947,251,286,016 = 20 \times 10^{30} = 33$ million times Avogadro’s number
Frankly, I am sick of this!

Several solutions that work
Current threats vs. better passwords

• Keystroke loggers
  - needs strong, reliable clients. OS!
• Phishing attacks
  - some usability hacks would help
• Password database compromise
  - up to the pros. Need stiffer sentences.
People, we have to do better than this

- The Bad Guys are getting much better
- Our computer systems are getting much more important to us
- Security has to be thought about, and reviewed
Dangerous browsing

- *All Your IFRAMES Point to Us*, Provos and Mavrommatis (Google), Rajab and Monrose (JHU); Usenix Security 2008
Dangerous patches

- **Automatic Patch-Based Exploit Generation is Possible: Techniques and Implications.** Brumley and Poosankam (CMU), Song (Berkeley), Zheng (Pitt); Proceedings of the IEEE Security and Privacy Symposium, May 2008.
Provably-hidden malware

COTS CPUs dangerous?

Stuxnet

• The pros are very good at this sort of thing
Rethinking Passwords

Bill Cheswick
ches@cheswick.com
Visiting scholar, U. Penn.
Our Digital House
Our digital house

- Many weekend projects over the past 25 years
  - lots of pieces, not a clean package
- Many features have been pleasant or useful over the years
Equipment: Home intercom
Equipment: intercom connected to a networked computer (now a Raspberry Pi running text-to-speech)
Equipment: voice modem connected to computer and landline
X10 controller connected to house wiring and the computer
X10 motion sensors, inside the mailbox and elsewhere
Webcams, wired and wireless
Other sensors, via X10

- Garage door position
- Water detector under the garage
- Circuit detector connected to a hacked smoke detector
- Front door bell voice announcement and circuit report
Features: intercom + computer

• Morning announcements
  - weather, news, planets, trash day, recycling day
  - birthday and anniversary reminders

• Telephone
  - caller ID announcements, some crank call processing

• Time/events
  - Top-of-the-hour chimes (including Big Ben at noon)
  - Dusk, turning on outside lights and Christmas lights

• Announcements from special email
Features: intercom + computer
More time/events

• Garage door open/close
• International Space Station passes
  - interrupts parties
• Iridium flares
• Eclipses and occultations
• Stock market results on closing
• You have real mail!
Video monitoring and motion sensing: beehives
Video monitoring: home sweet home

Wed Mar 19, 17

90 of about 93
### Web services: summary of things

**Summary for ches, Wednesday, Mar 19, 10:59**

- Up 36 days, 25 mins, 1 user, 0.15, 0.14, 0.10

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**Tuesday**

- Terry is calling 16:5 917
- Terry 14:31 925 51 SHE
- Terry 10:59 719 SU 20
- Terry 10:08 Dorothy wooden leg is calling 002

**Weather**

Today A chance of sprinkles before 1pm, then a slight chance of rain. Precipitation is 30%. Little or no snow accumulation expected. 

Tonight Showers, mainly before 2am. Low around 36.

Thursday Mostly sunny, with a high near 55. West wind.

Thursday Night Mostly clear, with a low around 25. West wind.

Friday Sunny, with a high near 51. West win.

Friday Night A slight chance of rain. Mostly cloudy, with a high around 45.

Saturday A chance of rain. Mostly cloudy, with a high around 49.

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Summary

• It has enriched our lives
• We miss it when we are in a vacation home
• This is not an easy package to assemble and sell
• Microsoft standard house?
Our Digital House