Big numbers as safety belt in cookies

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for
KNF-Kongress, Nuernberg, Germany 11/2016

There is something wrong when you see a lot of dwarfs with green caps!
How does a server in a web-environment know a user?
Cookies in web applications

- A server is talking to a lot of different users
- A user should be recognized in a secure way
- Also when being mobile
- Also when being behind a proxy server
- …
Cookies how I use them

• The user’s web-browser gets a cookie, this is a variable with some content in it
• reader_cookie_id = 14
• Variable name „reader_cookie_id“ << always the same
• 14 << for every web browser a different number
Cookies, what I do not do do

- **Cookie-Pinning** to a client’s ip address
  
  - because mobile IP changes when user is moving
  
  - because IPv6 changes frequently
  
  - an enterprise-proxy serves many users (Siemens, cable provides with not enough ipv4-addresses)
A view behind the curtain

• Managing readers (of a public library) in the web-application in a database

<table>
<thead>
<tr>
<th>reader_cookie_id</th>
<th>status</th>
<th>reader_passport_nr</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>unknown</td>
<td>-1</td>
</tr>
<tr>
<td>15</td>
<td>reader</td>
<td>15006</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A view behind the curtain

A. Server gets no cookie from user -> create new cookie in the database and send that with the server’s answer to the user (problem: many write-access to the database, many many cookies for users who do not accept cookies)

B. Server gets no cookie from user, wrong name or already invalid because of time -> A
The fear of the server

• What if the user know how the system works and manipulates it?

• User gets cookie-value 14 and sends 15 back with the next request -> change his identity (see internal database table 2 slides before)

• solution: a (1) very big (2) random number as value for the cookie -> a hash value
What is a hash-value?

• A hash value is a very big number, for example MD5-hex

• 28 fe 14 b3 00 46 22 28 00 01 46 ... 28 46

• The nice things about a hash value
  1. always the same length (32 characters for md5/hex), nice to save in a database
  2. defined characters (0-9, a-f)
  3. little changes in the input value create completely different hash-values
  4. „relative“ collision-free (do I trust the hash-algorithm? rc4, md5, sha256, …)
When all is done well the server knows every user by it’s „hash“-hat easily.
Perfect!
But how do we create different hashes for each user?
PID as hash-seed

• in my development environment there is a new process id (PID) for every request. PID is always different

• 1004 -> ab:cd:12:34:…

• 1005 -> 45:67:90:12:…

• 1006 -> 94:3f:5b:29:…
Checking reality #1

PID as hash-seed - development environment
Perfect!

Every user gets a different cookie-hash because PID is always different
Checking reality #2

PID as hash-seed - production environment
NOT Perfect!
Long-living processes give their long-living PID as cookie-hash to the user
Problem: PID as hash-seed

• Problem: there are only three long-living Fast-CGI-Processes in production environment which are having their PID for a long to (decreasing startup-time-lag)

• Problem: there are only 65,536 PIDs, then the operating system starts from „0“ again.

• The seed of the hash is not “random” enough
„A hash is a recipe to calculate something. A defined input gives always the same output.“
**Time as hash-seed**

- How can we have an input which is more different all the time?

- Time! 2016-12-31 14:18:32 << changes every second

- Hash: a small change in the seed changes the hash-output very much:
  - 2016-12-31 14:18:32 → ab:cd:…
  - 2016-12-31 14:18:33 → 45:12:…
Checking reality #3
Time as hash-seed - a user from time to time
Perfect!
Every user gets a different cookie-hash because time is always different.
Checking reality #4

Time as hash-seed - clumps of users
NOT Perfect!
Long-living processes give their long-living PID as cookie-hash to the user
Problems: time as hash-seed

- Time is not changing fast enough. A resolution in seconds is too rough.
- With a big quantity of users (a whole country, world-wide) also a finer granularity is not enough.
- There is a time which repeats: changing local time from summer-time to winter-time in Europe. Can you test this?
  - 30.10.2016 2:00 … summer-time
  - 30.10.2016 2:01
  - …
  - 30.10.2016 2:59
  - 30.10.2016 2:00 !!!! winter-time, uh, oh, local time repeats!!!!
A counter as hash-seed

• Can I have something that changes continuously?

• A persistenter counter, for example a number in a database-table cookie_seed

<table>
<thead>
<tr>
<th>number(int)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14600</td>
</tr>
</tbody>
</table>
Checking reality #5

counter as hash-seed - little number
Perfect!

Every user gets a different cookie-hash because counter always increases.
Checking reality #6

counter as hash-seed - max int
NOT Perfect!
Counter does not increase when reaching max(int)
A counter as hash-seed

<table>
<thead>
<tr>
<th>number(int)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.147.483.646</td>
</tr>
</tbody>
</table>

- update cookie_seed set number=number+1
- select number from cookie_seed
- gives 2.147.483.647
- increase -> gives 2.147.483.647
- increase -> gives 2.147.483.647
- increase -> gives 2.147.483.647
Problems:
counter hash-seed

- All numbers have a maximum value on your computer depending on processor, operating system, database. You have to find out what happens when you reach that number
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