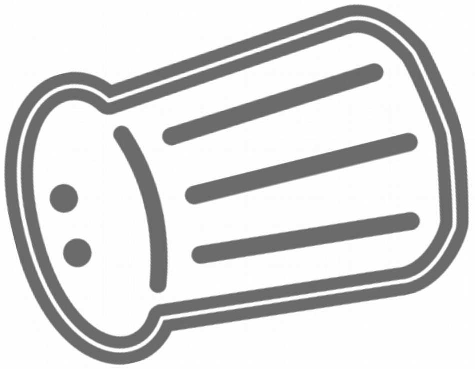
Time-efficient assessment of open-source projects for Red Teamers

Pass the Salt 2019



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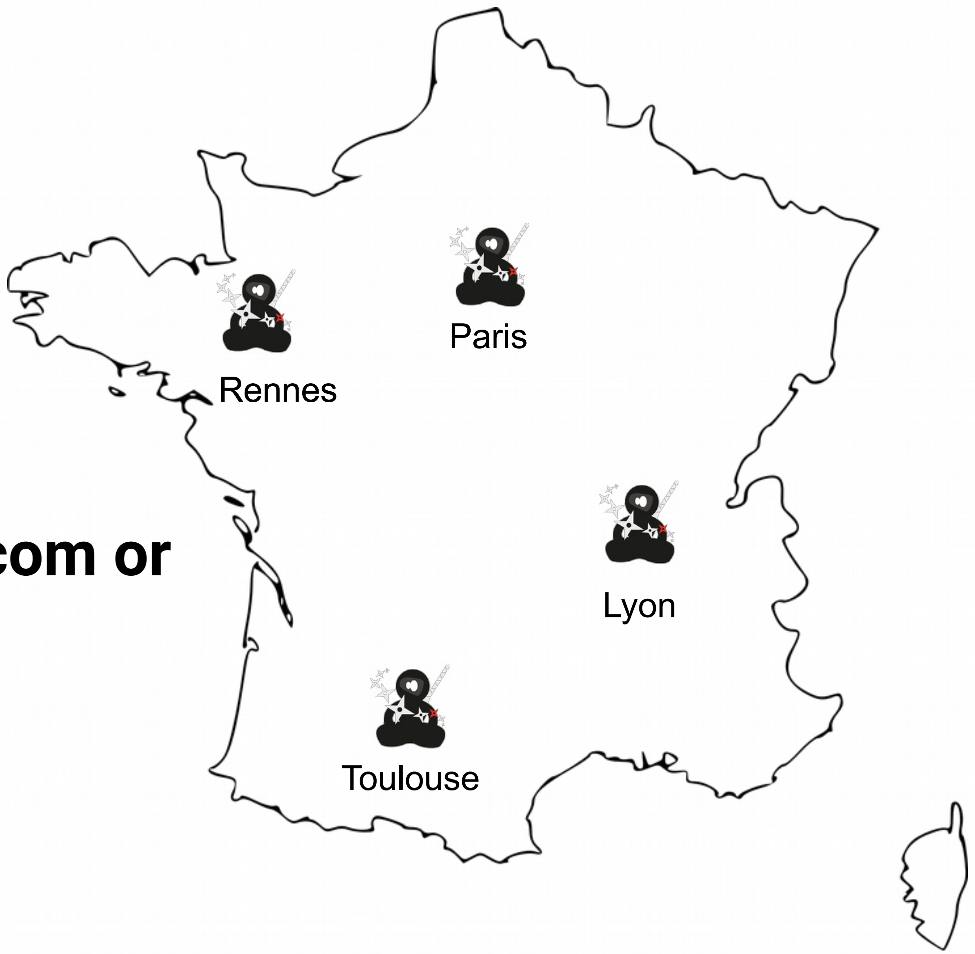
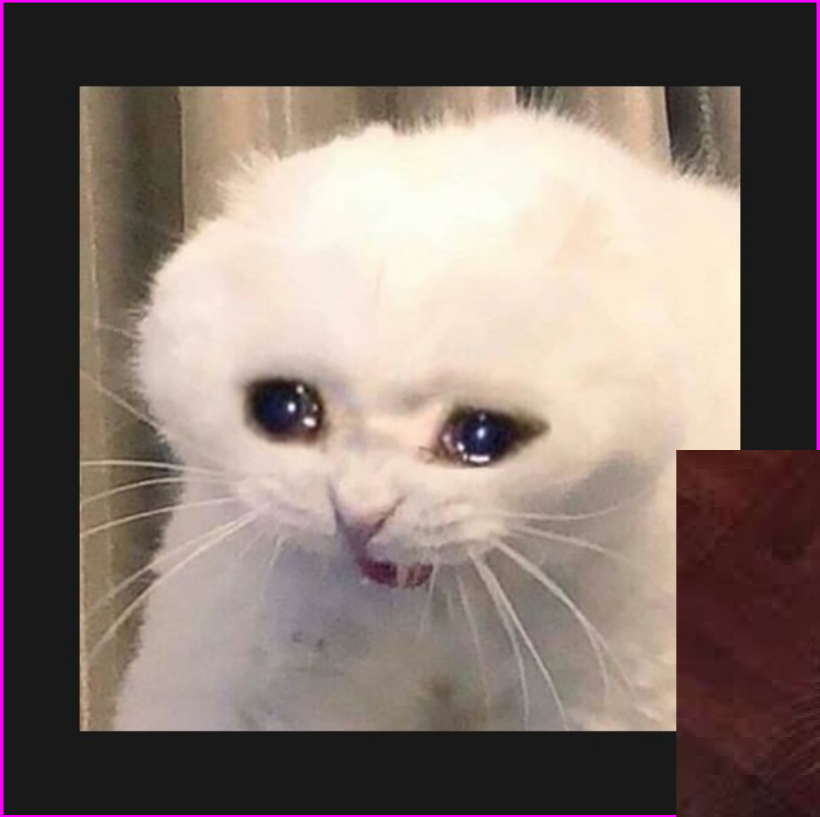
Agenda

Introduction

$(id)

- **Synacktiv is a French company focusing on offensive security: manual assessment, source code review, reverse engineering...**
- **Three teams**
  - Pentest
  - Reverse engineering
  - Development
- **We are remote-friendly**
- **Reach us at apply@synacktiv.com or at the social event**





WE NEED A SYSADMIN

Context

- **Red team assessment: only a fashionable term for “real-world” pentest?**
- **Big scopes!**
  - Limited effort per exposed asset
  - We need to reach the internal network as fast as we can
- **Facing the Blue Team**
- **OSS is not less secure than proprietary software but:**
  - Easier to get and deploy in a lab
  - Quicker to assess than an obfuscated / closed product

Case study

- **This talk aims at presenting our (sort of) methodology and findings in GLPI**
- **Hopefully didactic enough to be interesting to people not working in infosec**
- **Discovered issues were patched several months ago**
  - Make sure you're at least on 9.4.1.1
  - Don't expose it publicly
- **Identified the first day of a 2-weeks Red Team engagement**
  - Gave us a good insight on the target's internal network

GLPI ?

"GLPI ITSM is a software for business powered by open-source technologies. Take control over your IT infrastructure: assets inventory, tickets, MDM" (glpi-project.org)

- **Mostly supported by Teclib', editor of Armadito and Uhuru, under GPLv2**
- **Plugins help adding various features**
  - Inventory
  - MDM
    - Software deployment
    - Configuration

GLPI

- **Telemetry shows it's commonly used in France and Brazil**
  - 28K pingbacks last year
  - 9K from French IP addresses
- **You can add yourself on the website to show you like the project**
  - C.N.A.M.T.S, 130K computers and 90K users (2007)
  - Police Nationale, 100K computers (2012)
  - Various government departments
- **Seems like an interesting target in our context: let's break it :-)**

Considerations

- **During regular pentests, you can be loud and intrusive**
  - Exhaustive rather than opportunistic
- **During Red Team engagements, the goals change**
  - Get a foot in the door ASAP
  - Remain undetected
  - Deep compromise
  - A single entry point is enough
- **Time constraint**

Methodology

Considerations

- **What is a good Red Team vulnerability?**
  - Forget everything about client-side attacks in the first place (except for phishing campaigns)
  - No destructive actions
  - Low forensic/detection footprints
  - No feature breaking or raised exceptions (Sentry is quite popular nowadays)
  - Reproducible in our lab first

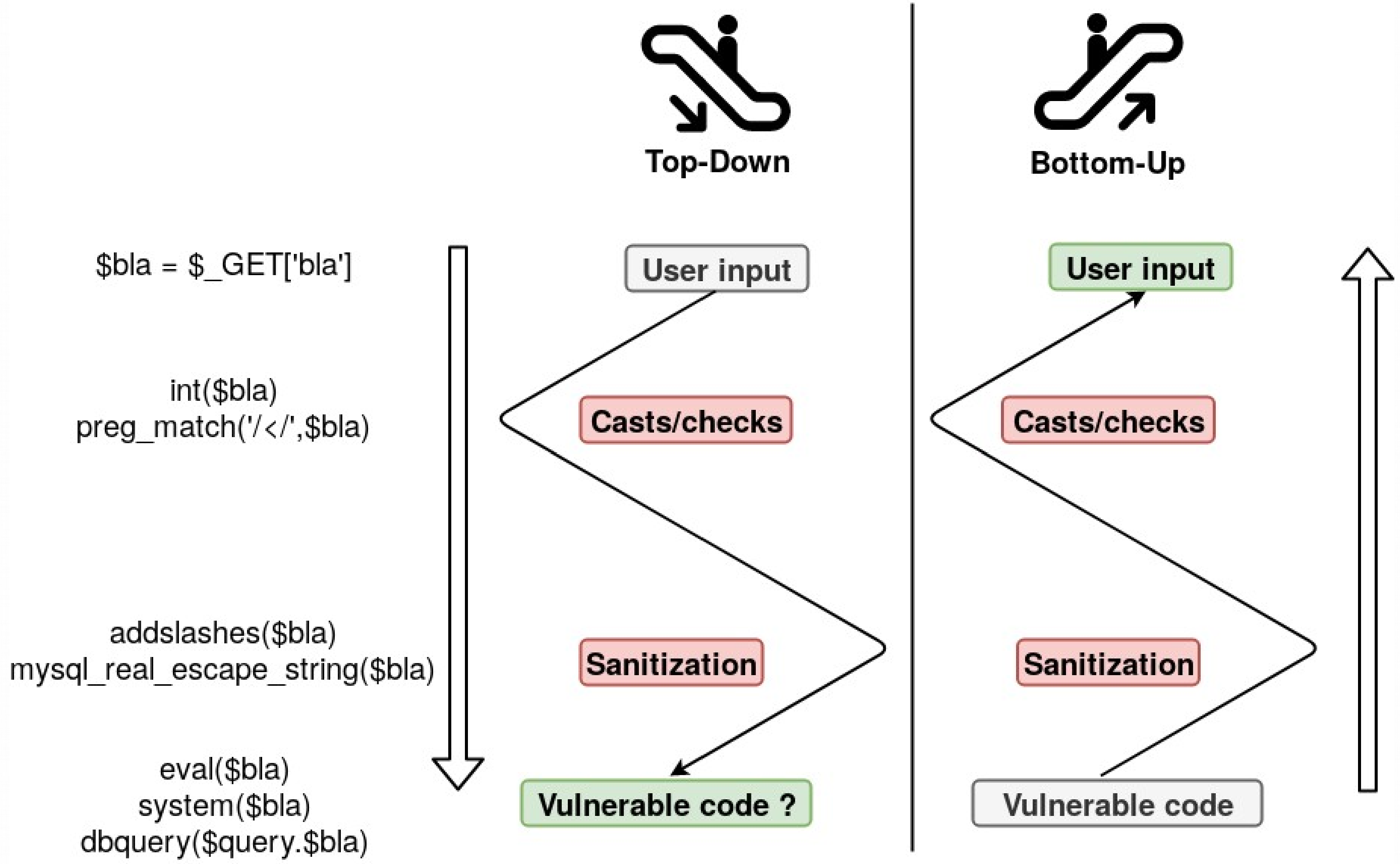
Replicating the environment

- **When assessing OSS, you are never really in blackbox**
- **Try to replicate an accurate environment**
  - HTTP server
  - CGI’s version
  - Product version
- **It will be very helpful to**
  - Avoid early detection
  - Abuse specific configurations, vulnerabilities or behaviour
- **Any information leak is valuable**

Assessing the attack surface

- **We are only interested in unauthenticated code paths**
- **PHP applications not using frameworks will often have several scripts directly reachable**
- **Prevented by**
  - Ensuring a given constant is defined
  - User has a session with a given value, etc
- **In real life, these checks are always forgotten at least once**

Assessing the attack surface



Assessing the attack surface

- **In practice, we tend to use a hybrid approach when reading source code**
  - Find vulnerabilities quickly
  - No need to be exhaustive
- **The lab allows performing dynamic analysis and using our blackbox skillset**

Assessing the attack surface

- **Our colleague @Tiyeuse developed a tool to find reachable files “doing things”**
  - Not only declaring classes and functions
  - Not exiting after checking for a constant declared in another file
  - Possibility to add custom patterns to exclude authentication checks
- **GLPI had several pre-authenticated vulnerabilities in such files**
  - Less code to read
  - Less things to understand
  - Happier auditor :-)

Other tools and tricks

- **We don’t have semantic tooling**
  - PHP-Parser can still help create a “smart grep”
- **RIPS scanner is awesome**
  - But a bit expensive for everyday use
- **Dumping every DB query to a log file**
  - Harder to miss SQL errors (injections)
  - Easier to debug PoCs
- **Instrument low-level PHP functions to search for specific behaviours**
  - Unbalanced quotes?
- **Profilers: fracker, xhprof**

Assessing the attack surface

- **Create a wrapper around $_GET and $_POST :**

```
class ObjectAccess implements ArrayAccess {
// ...
        public function offsetExists($key) {
                echo $this->name." -> isset: ".$key."\n";
                return isset($this->items[$key]);
        }

        public function offsetGet($key) {
                echo $this->name." -> get: ".$key."\n";
                return $this->items[$key];
        }
// ...
```

- **No need to browse all the includes to find accepted parameters**

Approach

- **After isolating access control functions, a quick run of *debroussailleuse* gave us the list of reachable files**
  - Still ~400 files left (excluding *vendors/*)
- **In theory, files in */scripts/* are protected by a *.htaccess***
- **Our target uses *nginx***
  - It's in the official documentation
  - *AllowOverride* is set to *None* since *Apache* 2.3.9

Findings

Information leak

- **Accessing *ajax/telemetry.php* discloses**
  - GLPI version
  - GLPI modules
  - PHP version
  - PHP modules
  - Operating system
  - HTTP server
- **Enough to start creating a lab**

DEMO

SQL injection in *compute_dictionnary.php*?

- **Digging in *scripts/* yields interesting results**
  - *scripts/compute_dictionnary.php*

```
if (isset($_GET["dictionnary"])) {
 $rulecollection = RuleCollection::getClassByType($_GET["dictionnary"]);
 if ($rulecollection) {
  if ($_GET["dictionnary"]=='RuleDictionnarySoftware' [...])) {
   $rulecollection->replayRulesOnExistingDB([...], $_GET["manufacturer"]);
[...]
   }
```

SQL injection in *compute_dictionnary.php*?

```
function replayRulesOnExistingDB([...], $params = []) {
[...]
 if (count($items) == 0) {
 //Select all the differents software
  $sql = "SELECT DISTINCT `glpi_softwares`.`name`,
[...]
  if (isset($params['manufacturer']) && $params['manufacturer']) {
   $sql .= " AND `glpi_softwares`.`manufacturers_id` = '"
         . $params['manufacturer'] . "'";
  }
  if ($offset) {
    $sql .= " LIMIT " . intval($offset) . ",999999999";
  }
```

SQL injection in *compute_dictionnary.php*?

- **But it doesn’t work! :-S**

SQL injection in *compute_dictionnary.php*?

- **The reason lies in *inc/includes.php***

```
// Security system
if (isset($_POST)) {
    [...]
    $_POST = Toolbox::sanitize($_POST);
}
if (isset($_GET)) {
    $_GET = Toolbox::sanitize($_GET);
}
if (isset($_REQUEST)) {
    $_REQUEST = Toolbox::sanitize($_REQUEST);
}
```

SQL injection in *compute_dictionnary.php*?

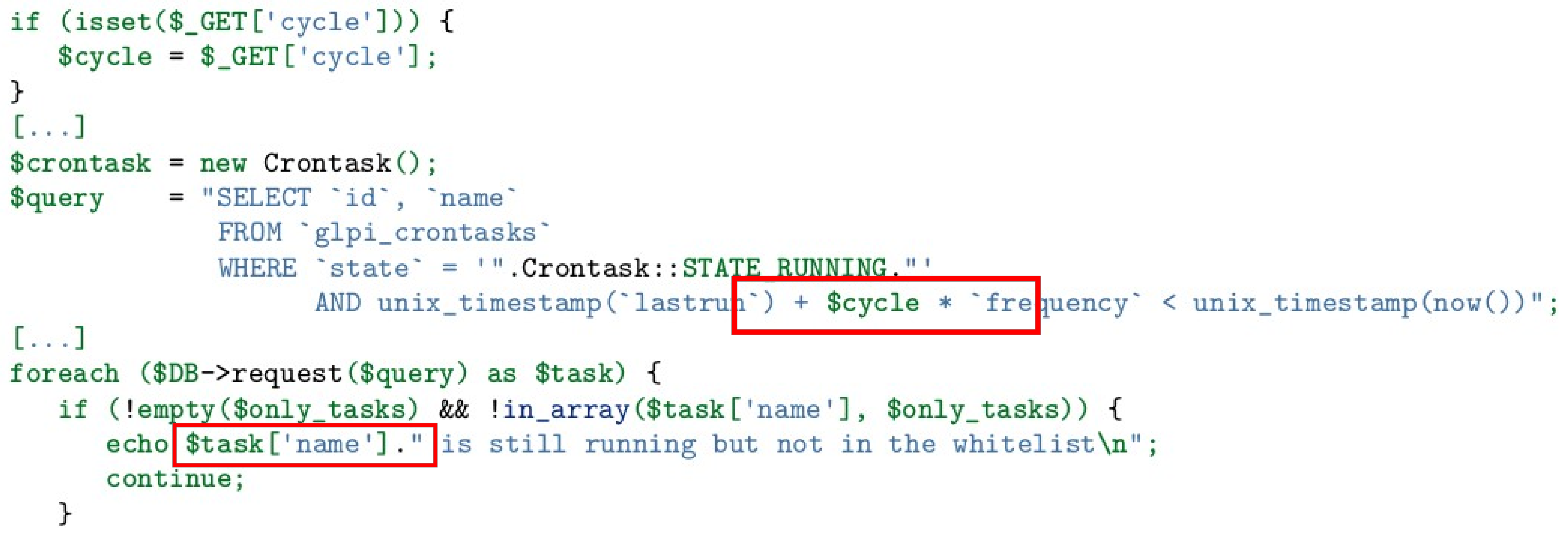
- ***Toolbox::sanitize()* is implemented this way**

```
static public function sanitize($array) {
        $array = array_map('Toolbox::addslashes_deep', $array);
    $array = array_map('Toolbox::clean_cross_side_scripting_deep', $array);
    return $array;
}
```

- ***addslashes_deep()***
  - Recursive *mysql_real_escape_string()*
- ***clean_cross_side_scripting_deep()***
  - Replaces < > by their HTML entities
- ***sanitize()* will fail in several cases (it's regex time)**

SQL injection in *unlock_tasks.php*

- **A hit was found in *scripts/unlock_tasks.php***
  - CVE-2019-10232



```
if (isset($_GET['cycle'])) {
   $cycle = $_GET['cycle'];
}
[...]
$crontask = new Crontask();
$query    = "SELECT `id`, `name`
             FROM `glpi_crontasks`
             WHERE `state` = '".Crontask::STATE_RUNNING."'
                   AND unix_timestamp(`lastrun`) + $cycle * `frequency` < unix_timestamp(now())";
[...]
foreach ($DB->request($query) as $task) {
   if (!empty($only_tasks) && !in_array($task['name'], $only_tasks)) {
      echo $task['name']." is still running but not in the whitelist\n";
      continue;
   }
```

DEMO

SQL injection in *unlock_tasks.php*

- **However...**
  - The injection doesn't allow creating users
  - Passwords are hashed with *bcrypt*
    - *PHP_PASSWORD_BRCRYPT_COST = 10*
  - Our 8 1080 Ti GPUs will hardly be enough
- **Need to find another way to get in—let's inspect the table *glpi_users***
  - *name*
  - *password*
  - *last_login*
  - *password_forget_token*
  - *personal_token*
  - *api_token*

SQL injection in *unlock_tasks.php*

- **The *Remember me* feature is enabled by default and uses the *personal_token* value**

  ["2","$2y$10f10tNcc[...]wmVSUIi"]

  [user_id, hash(personal_token)]

- **Several hash algorithms supported**
- **Leaking a token is enough to log in**
- **We could also use the API key or reset users' password**
- **Any data allowing to authenticate is a *secret*, they should be stored in the database the same way**

DEMO

Abusing the *Remember me* feature

- **While looking *Remember Me* feature, its implementation seemed weird**

```
if ($CFG_GLPI["login_remember_time"]) {
 $data = json_decode($_COOKIE[$cookie_name], true);
  if (count($data) === 2) {
   list ($cookie_id, $cookie_token) = $data;
```

- **Thanks to *json_decode()*, we can play with types of**
  - *$cookie_id*
  - *$cookie_token*

Abusing the *Remember me* feature

```
$ php -a
php> var_dump(json_decode('["1", 1, null, {}, true, false]'));
array(5) {
  [0]=>  string(1) "1"
  [1]=>  int(1)
  [2]=>  NULL
  [3]=>  object(stdClass)#1 (0) {}
  [4]=>  bool(true)
  [5]=>  bool(false)
}
```

Abusing the *Remember me* feature

- **Then, our values are used this way**

```
$user = new User();
$user->getFromDB($cookie_id);
$token = $user->getAuthToken();
if ($token !== false && Auth::checkPassword($token, $cookie_token)) {
   $this->user->fields['name'] = $user->fields['name'];
   return true;
} else {
   $this->addToError(__("Invalid cookie data"));
}
```

- ***$user→getAuthToken()* creates a new *personal_token* if it doesn't exist**

Abusing the *Remember me* feature

- **The *personal_token* is then compared with the hash provided in the cookie**

```
static function checkPassword($pass, $hash) {
  $tmp = password_get_info($hash);
  if (isset($tmp['algo']) && $tmp['algo']) {
     $ok = password_verify($pass, $hash);
  } else if (strlen($hash)==32) {
     $ok = md5($pass) == $hash;
  } else if (strlen($hash)==40) {
     $ok = sha1($pass) == $hash;
  } else {
     $salt = substr($hash, 0, 8);
     $ok = ($salt.sha1($salt.$pass) == $hash);
  }
  return $ok;
}
```

Abusing the *Remember me* feature

- **The *personal_token* is then compared with the hash provided in the cookie**

```
static function checkPassword($pass, $hash) {
  $tmp = password_get_info($hash);
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    $ok = sha1($pass) == $hash;
  } else {
    $salt = substr($hash, 0, 8);
    $ok = ($salt.sha1($salt.$pass) == $hash);
  }
  return $ok;
}
```

Abusing the *Remember me* feature

- **The hashed value to compare is controlled by the attacker (CVE-2019-10233)**

```
static function checkPassword($pass, $hash) {
  $tmp = password_get_info($hash);
  if (isset($tmp['algo']) && $tmp['algo']) {
     $ok = password_verify($pass, $hash);
  } else if (strlen($hash)==32) {
     $ok = md5($pass) == $hash;
  } else if (strlen($hash)==40) {
     $ok = sha1($pass) == $hash;
  } else {
     $salt = substr($hash, 0, 8);
     $ok = ($salt.sha1($salt.$pass) == $hash);
  }
  return $ok;
}
```

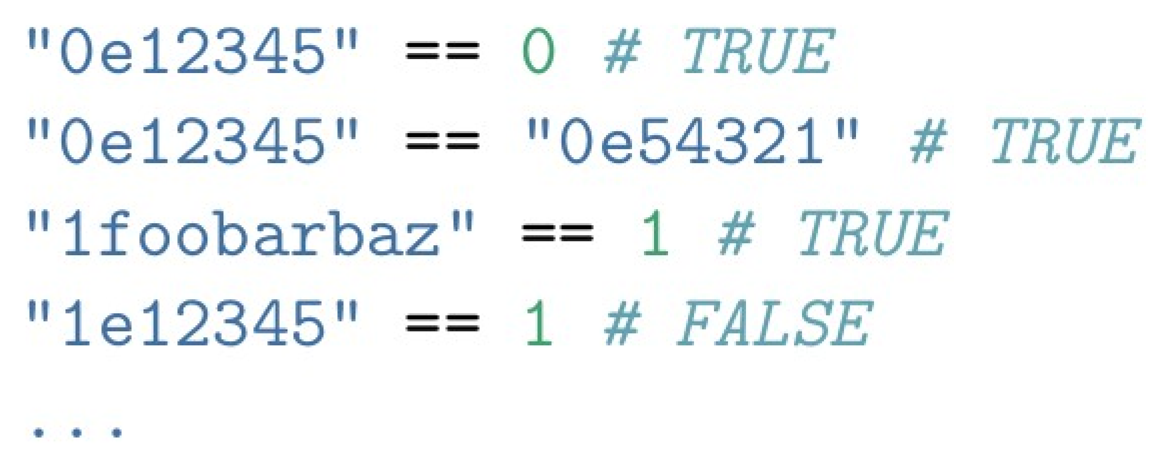
Abusing the *Remember me* feature

- **If the provided hash doesn't match any well-known algorithms, we need to talk about PHP comparisons**

```
static function checkPassword($pass, $hash) {
  $tmp = password_get_info($hash);
  if (isset($tmp['algo']) && $tmp['algo']) {
     $ok = password_verify($pass, $hash);
  } else if (strlen($hash)==32) {
     $ok = md5($pass) == $hash;
  } else if (strlen($hash)==40) {
     $ok = sha1($pass) == $hash;
  } else {
     $salt = substr($hash, 0, 8);
     $ok = ($salt.sha1($salt.$pass) == $hash);
  }
  return $ok;
}
```

Abusing the *Remember me* feature

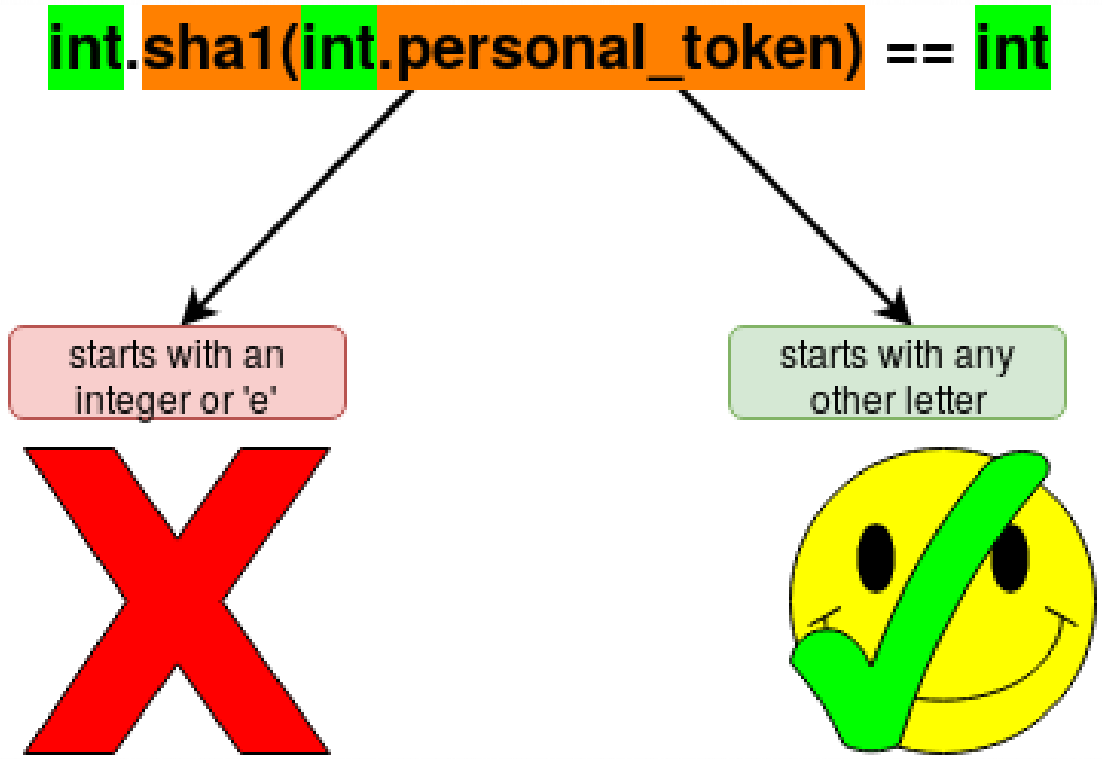
- **Quick reminder about PHP loose comparisons...**



```
"0e12345" == 0 # TRUE
"0e12345" == "0e54321" # TRUE
"1foobarbaz" == 1 # TRUE
"1e12345" == 1 # FALSE
...
```

Abusing the *Remember me* feature

- **Thus we can make the code compare**


int.sha1(int.personal_token) == int
starts with an integer or 'e'
starts with any other letter

- **We are likely able to find an int producing a suitable SHA-1 output within a few tries**

Abusing the *Remember me* feature

- **@bitcoinctf brought to our attention that it is also possible to do this...**

```
$salt = substr(true, 0, 8);
// returns 1
$ok = ($salt.sha1($salt.$pass) == $hash);
// 1.sha1(1.$pass) == true
```

- **No more need to iterate over a few integers, a single request is enough**

DEMO

Going deeper

- **We are admin on the solution (or any other user)**
  - But the goal is still to compromise the infrastructure
  - We need to find something else on the authenticated part
- **Time to compromise the underlying server**
- **Old vulnerabilities are patched**

Fusion Inventory

- **While gathering technical details about the target's infrastructure using regular features ...**

```
GET /plugins/fusioninventory/front/send_inventory.php?
itemtype=PluginFusioninventoryInventoryComputerComputer
&function=sendXML
&items_id=machine.xml
&filename=toto HTTP/1.1
```

- **Back to the good old blackbox reflexes, a wild LFI appears**

```
&items_id=../../../../../../../../../../../../etc/passwd
```

Fusion Inventory

- **It works and this is pretty cool but we found nothing valuable on the server, let's take a look at the code of the plugin**

```
$itemtype = $_GET['itemtype'];
$function = $_GET['function'];
$items_id = $_GET['items_id'];
header('Cache-control: private, must-revalidate'); /// IE BUG + SSL
header('Content-disposition: attachment; filename='.$_GET['filename']);
header('Content-type: text/plain');
call_user_func(['PluginFusioninventoryToolbox', $function],
               $items_id, $itemtype);
```

- **Unexpected**
  - Does the *PluginFusioninventoryToolbox* class implement more interesting functions?

Fusion Inventory

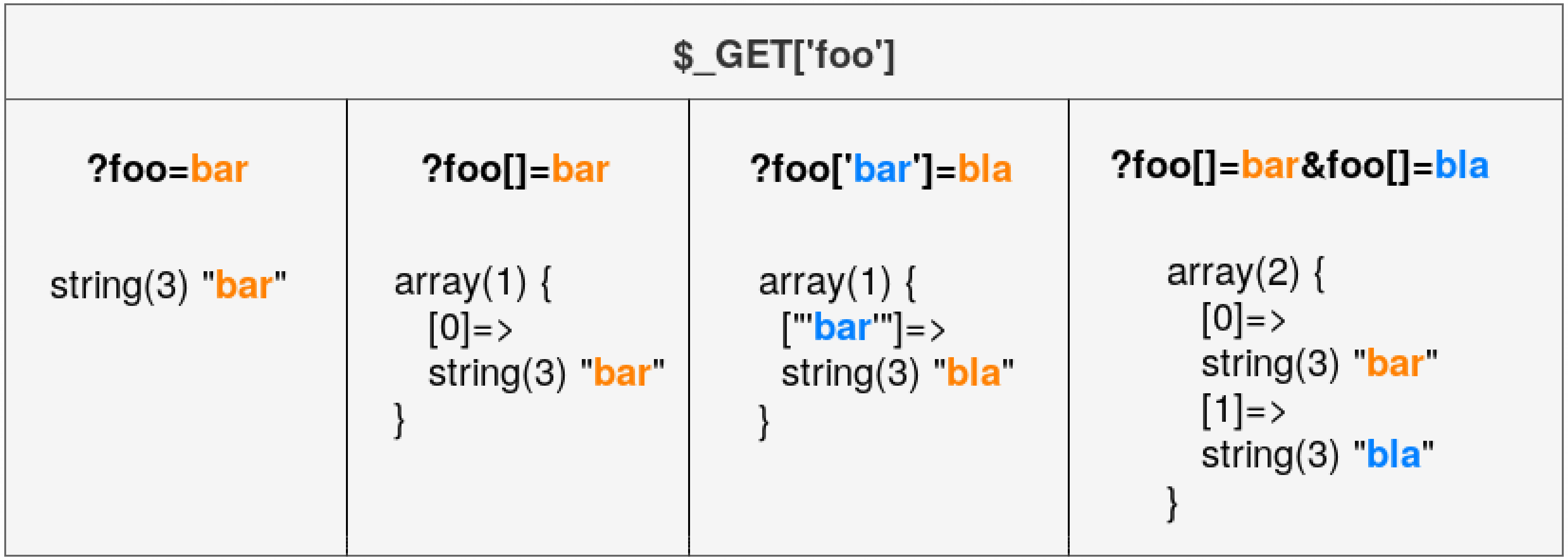
- **Yes it does!**

```
function executeAsFusioninventoryUser($function, array $args = []) {
[...]
  // Execute function with impersonated SESSION
  $result = call_user_func_array($function, $args);
[...]
  //Return function results
```

- **Only 1 requirement**
  - *$args* has to be an Array

Fusion Inventory

- **Fair enough, PHP allows playing with parameters**



$_GET['foo']			
?foo=bar	?foo[]=bar	?foo['bar']=bla	?foo[]=bar&foo[]=bla

string(3) "bar"	array(1) {
	[0]=>
	string(3) "bar"
	}
		array(1) {
		["'bar'"]=>
		string(3) "bla"
		}
			array(2) {
			[0]=>
			string(3) "bar"
			[1]=>
			string(3) "bla"
			}

- ***call_user_func_array* can be used in this situation**
  - CVE-2019-10477

Fusion Inventory

- **One last thing**

```
$itemtype = $_GET['itemtype'];
$function = $_GET['function'];
$items_id = $_GET['items_id'];
header('Cache-control: private, must-revalidate'); /// IE BUG + SSL
header('Content-disposition: attachment; filename='.$_GET['filename']);
header('Content-type: text/plain');
call_user_func(['PluginFusioninventoryToolbox', $function],
                $items_id, $itemtype);
```

- **There's no mention of a session or cookie at any moment**
  - That's ok, you can remove it
  - This code is reachable without authentication :-)

DEMO

Disclosure

Disclosure

- **Timeline**

Date	Event
Early February	Issues reported
Early March	Issues fixed publicly on GitHub
March 15th	Release of 9.4.1
April 11th	Release of 9.3 backports (9.3.4)
Late April	Advisories publication
Early July	Here we are

- **The disclosure process was smooth and efficient**
- **Maintainers responded and shipped patches in a timely manner; thanks again!**

Do people patch?

- **Telemetry is not very reliable**
  - Old/test instances aren't removed after some time
  - All instances might not have access to the Internet
- **3 days after patches came out, 30 instances were up-to-date**
- **3 months later (end of June)**
  - 8046 have been upgraded
  - 26807 remain vulnerable
- **Digitemis created GLPIScan to check your instances**
  - https://github.com/Digitemis/GLPIScan/

Conclusion

Conclusion and next steps

- **Useless in this case but we now hunt for GLPI in internal pentests**
- **Indirectly, companies contribute to OSS security by including such products in pentest scopes**
- **We need more**
  - Collaborative tools to review code
  - “Smart” static scanners
  - QL
- **GLPI and MDM agents are cool targets for Red Teams and they need more attention/security contribution**

TIME FOR QUESTIONS

THANKS FOR YOUR ATTENTION!

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