

Automated Detection of HPP Vulnerabilities in Web Applications

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Roadmap

- ▶ Introduction
- ▶ HTTP Parameter Pollution
 - ▶ Client-Side
 - ▶ Server-Side
 - ▶ Other Uses
- ▶ Detection
 - ▶ Approach
 - ▶ Tool
 - ▶ Demo
- ▶ Experiments
- ▶ Results
- ▶ Prevention



Who am I?

- ▶ From Bergamo (IT) to the French Riviera
- ▶ MSc in Computer Engineering
- ▶ PhD at EURECOM
- ▶ 8+ years experience in IT Security
- ▶ Engineer and consultant for different international firms
- ▶ Co-founder of BGLug, Applied Uni Lab, (ex) SPINE Group, Nast, etc...

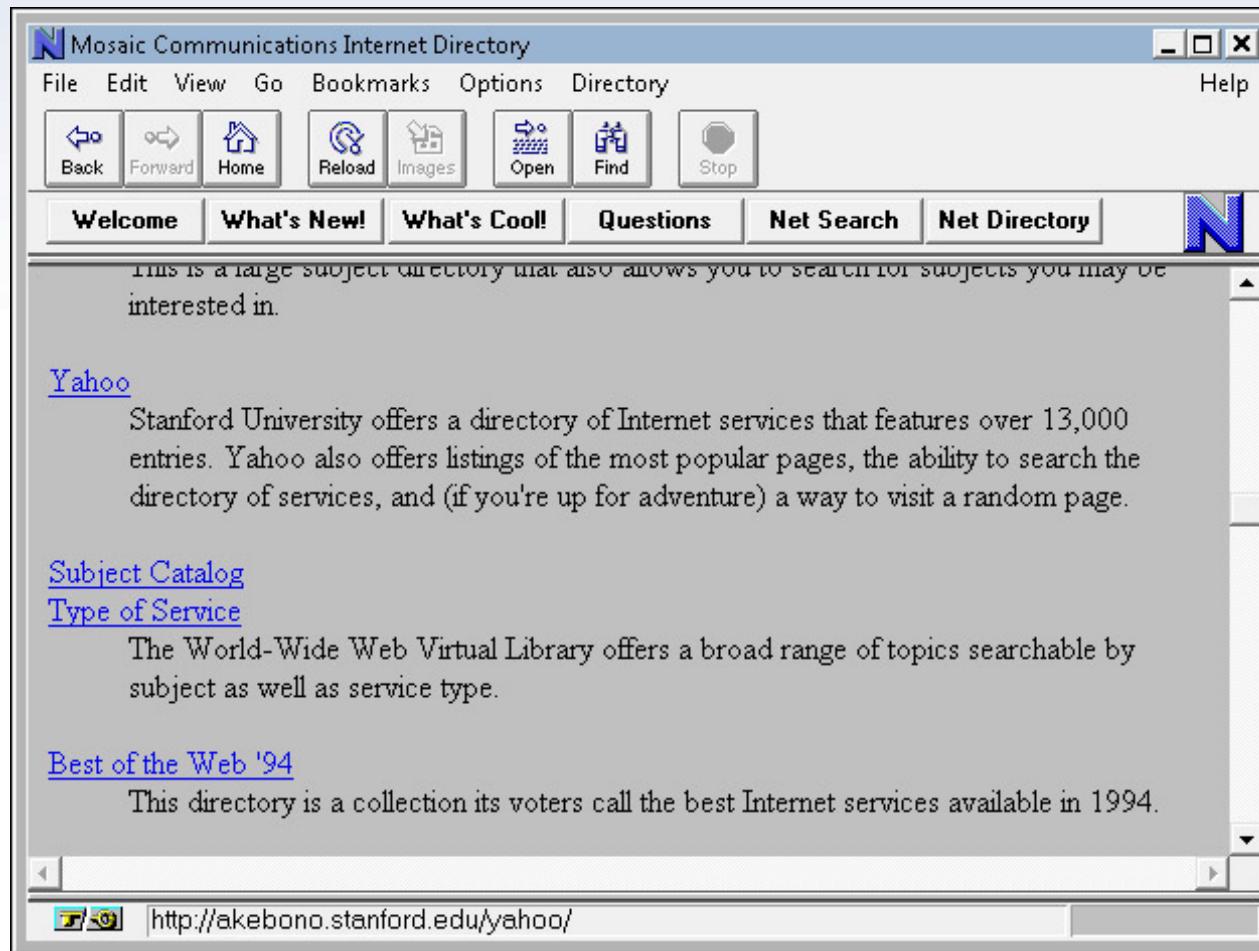
- ▶ [http://www.iseclab.org/people/
embyte](http://www.iseclab.org/people/embyte)



The Web as We Know It

- ▶ Has evolved from being a collection of simple and static pages to fully dynamic applications
- ▶ Applications are more complex than they used to be
- ▶ Multi-tier architecture is the normal
- ▶ Many complex systems have web interfaces

The Web before



Now

Google wave

Navigation

- Inbox
- Active
- All
- By Me
- History
- Spam
- Settings
- Trash

SEARCHES

- To Do's
- Triathlon

FOLDERS

- Apartment

Contacts

- Anna-Christina
drinkin' coffee
- Search...
- Gregory

Inbox 1 - 14 of 21

New Wave in:inbox

Archive Mute Read Unread Folder

Chess times = fun times – It's on!

Dinner and board games – Who's up for dinner and board games next week?

Snapshots! – ... They make me want to go on vacation Seriously, what a

BBQ on Sunday! – Our house, 6pm Let us know if you can come! What

Sushi time? – Hey Dan and Jens, I think its time for our monthy sushi -

Hey Steph, – Wanna get coffee tomorrow? We can met by the palm

Wayward music player? – Looking to return Hey, I think your music player

See what turned up on my front lawn yesterday! – It's fairly late in

It's Movie Time!!!! – ... what about "Confessions of a Shopaholic"? that

Pics from a walk in Sydney... – Just from walking around in Kirribilli /

Add participants

dan

Daniel Danilatos

Dan Peterson

Dan Kettering

Pics from a walk in Sydney...

Increased Importance of Web Security

- ▶ As a consequence:
 - ▶ Web security has increased in importance
 - ▶ OWASP, the Top Ten Project
 - ▶ Attack against web apps constitute 60% of attacks on the Internet (SANS's The Top Cyber Security Risks)
 - ▶ Application being targeted for hosting drive-by-download content or C&C servers
 - ▶ Malware targeting browsers (e.g. key and network loggers)

Increased Importance of Web Security

- ▶ A lot of work done to detect injection type flaws:
 - ▶ SQL Injection
 - ▶ Cross Site Scripting
 - ▶ Command Injection
- ▶ Injection vulnerabilities have been well-studied, and tools exist
 - ▶ Sanitization routines in languages (e.g., PHP)
 - ▶ Static code analysis (e.g., Pixy, OWASP Orizon)
 - ▶ Dynamic techniques (e.g., Huang et al.)
 - ▶ Web Application Firewalls (WAF)

HTTP Parameter Pollution

- ▶ A new class of Injection Vulnerability called HTTP Parameter Pollution (HPP) is less known
 - ▶ Has not received much attention
 - ▶ First presented by S. di Paola and L. Carettoni at OWASP 2009
- ▶ Attack consists of injecting encoded query string delimiters into existing HTTP parameters (e.g. GET/POST/Cookie)
 - ▶ If application does not sanitize its inputs, HPP can be used to launch client-side or server-side attacks
 - ▶ Attacker may be able to override existing parameter values, inject a new parameter or exploit variables out of a direct reach

Research Objectives

- ▶ To create the first automated system for detecting HPP flaws
 - ▶ Blackbox approach, consists of a set of tests and heuristics
- ▶ To find out how prevalent HPP problems are on the web
 - ▶ Is the problem being exaggerated?
 - ▶ Is this problem known by developers?
 - ▶ Does this problem occur more in smaller sites than larger sites?
 - ▶ What is the significance of the problem?

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HTTP Parameter Handling

- ▶ During interaction with web application, client provides parameters via GET/POST/Cookie
- ▶ HTTP allows the same parameter to be provided twice
 - ▶ E.g., in a form checkbox
[http://www.w3schools.com/html/tryit.asp?
filename=tryhtml_form_checkbox](http://www.w3schools.com/html/tryit.asp?filename=tryhtml_form_checkbox)
- ▶ What happens when the same parameter is provided twice?
 - ▶ <http://www.google.com/search?q=italy&q=china>
 - ▶ <http://www.site.com/login?user=alice&user=bob>

Google example

 http://www.google.com/search?q=italy&q=china

[Video](#) [Maps](#) [News](#) [Libri](#) [Gmail](#) [altro ▾](#)



italy china

Circa 784.000.000 risultati (0,08 secondi)

► [Fondazione Italia Cina](#) -

La Fondazione promuove la realizzazione di una Cabina di Regia con riferimento al garantire un efficace raccordo tra pubblico e privato e dare ...

[Contatti](#) - [Chi Siamo](#) - [CV Online](#) - [Il Presidente](#)

italychina.org/ - Copia cache - Simili

[Zhongguo Cina :: Associazione Italia-Cina](#)

Presenta informazioni sull'associazione, notizie sulla **Cina**, appuntamenti, pagine sul turismo.

italiacina.org/ - Copia cache - Simili

Yahoo example

http://search.yahoo.com/search;_ylt=AjjaXqxBy_VBz8JmVbmegebvZx4?p=italy&p=china

Sign In | Help

Web Images Video Local Shopping News More ▾

HOO!

Apps

Search Pad

Search - On

10 results for

Also try: [china ambassador](#), [china airlines](#), [china ufo](#), ...

China - Wikipedia, the free encyclopedia

[Etymology](#) | [History](#) | [Territory and environment](#) | [Economy](#)

With nearly 4,000 years of continuous history, **China** is one of the world's oldest civilizations. Prior to the 19th century, it possessed one of the most advanced societies and economies...

en.wikipedia.org/wiki/China - [Cached](#)

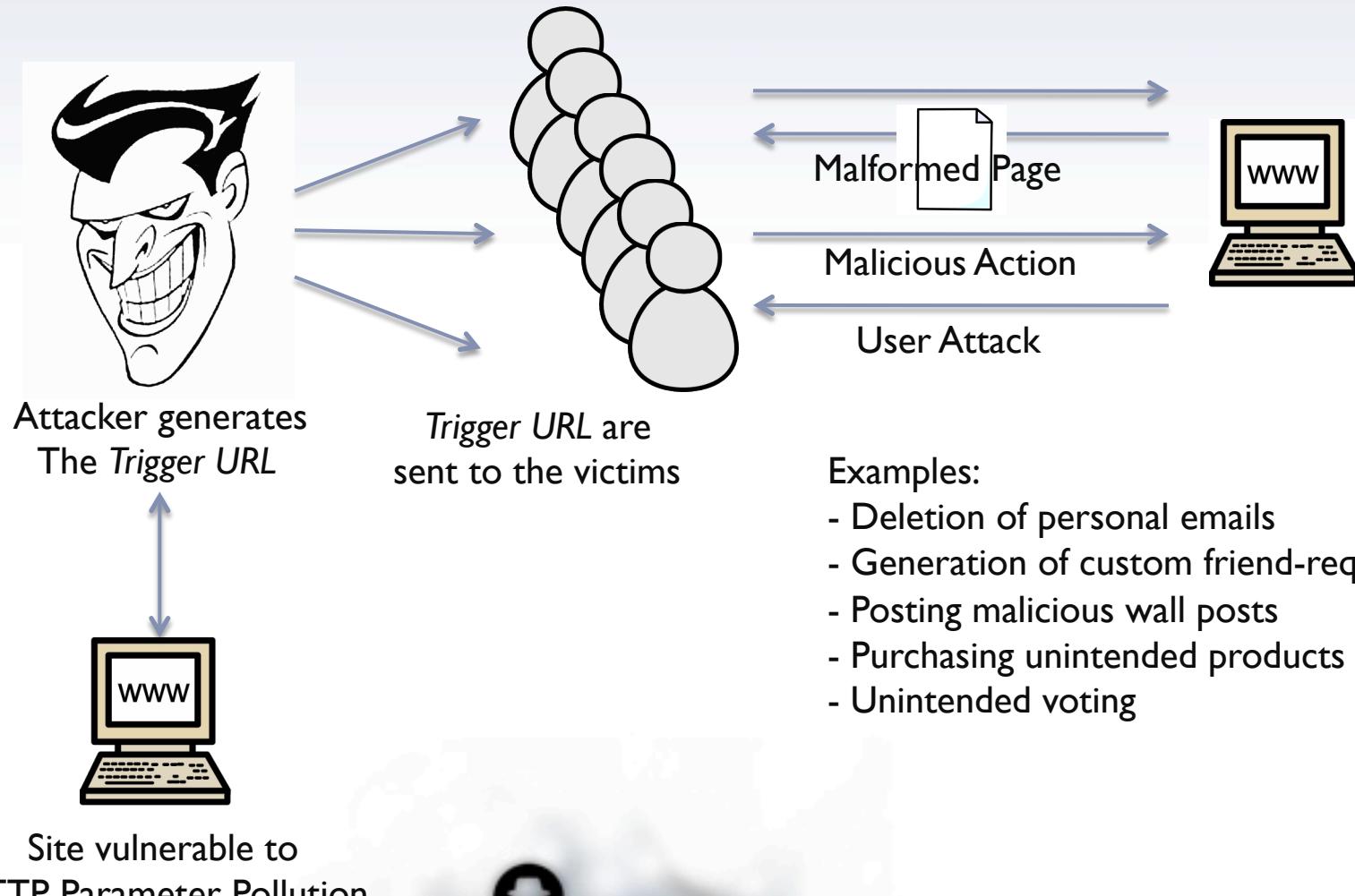
HTTP Parameter Handling

- ▶ We manually tested common methods of 5 different languages

Technology/Server	Tested Method	Parameter Precedence
ASP/IIS	Request.QueryString("par")	All (comma-delimited string)
PHP/Apache	\$_GET("par")	Last
JSP/Tomcat	Request.getParameter("par")	First
Perl(CGI)/Apache	Param("par")	First
Python/Apache	getvalue("par")	All (List)

- ▶ There is nothing bad with it, if the developer is aware of this behavior
- ▶ Languages provide secure functions (python's getfirst())

HTTP Parameter Pollution (Client-Side)



Client-Side #1: Unintended voting

- ▶ An application for voting between two candidates
- ▶ The two links are built from the URL

```
Url : http://host/election.jsp?poll_id=4568
```

```
Link1: <a href="vote.jsp?poll_id=4568&candidate=white">  
      Vote for Mr.White </a>  
Link2: <a href="vote.jsp?poll_id=4568&candidate=green">  
      Vote for Mrs.Green </a>
```

- ▶ No sanitization

```
ID = Request.getParameter("pool_id")  
href_link = "vote.jsp?poll_id=" + ID + "&candidate=xyz"
```

Client-Side #1: Unintended voting

- ▶ **poll_id** is vulnerable
- ▶ Attacker generate a *Trigger URL* to be sent to his victims:
 - ▶ `http://host/election.jsp?poll_id=4568%26candidate%3Dgreen`
- ▶ The resulting page now contains injected links:

```
<a href=vote.jsp?pool_id=4568&candidate=green&candidate=white>  
    Vote for Mr. White </a>  
<a href=vote.jsp?pool_id=4568&candidate=green&candidate=green>  
    Vote for Mrs. Green </a>
```

- ▶ Candidate Mrs. Green is always voted!

Client-Side #2: Misleading shopping users

http://shop.history.com/detail.php?p=67760&y=aetv_show_intervention%26p%3D67765

ezer CouchSurfing Facebook wordreference BabelFish CiteULike Wiki VMWARE IlGiornale.it C

intervention Season One: Then a... +

H History Shop A&E Shop Lifetime Shop bio. Shop H Education

Newsletter Sign Up - Get 15% Off | Gift Cards | Customer Service | My

SEARCH - enter search terms - SHOP

SHOWS SUBJECTS DVDS FAN GEAR BEST SELLERS

SALE

GET SEASON 4 OF PARANORMAL STATE STEVEN SEAGAL LAWMAN GET THE COMPLETE SEASON 1 BILLY

Store Home > Store Home [Back]

 Click to enlarge

Intervention Season One: Then and Now DVD
SKU ID #67760

★★★★★ 5.0 (2 reviews)
Read 2 Reviews Write a Review

J'aime Soyez le premier de vos

Price: \$11.99
List Price: \$14.95
You Save: \$2.96 20% off

Get \$25 Off your Order of \$50 or More with SAVE25 at checkout

Quantity:

Availability: In Stock
Ships within 24 - 48 hours

Add to Cart

image

Modifica Visualizza Cronologia Segnalibri Strumenti Aiuto

ezer CouchSurfing Facebook wordreference BabelFish CiteULike

ETN Shop - My Account - Wish ... +

H History Shop A&E Shop Lifetime Shop

Newsletter Sign Up - Get

SEARCH - ent

SHOWS SUBJECTS DVDS FAN GEAR

SALE

GET SEASON 4 OF PARANORMAL STATE STEVEN SEAGAL LAWMAN GET THE COMPLETE SEASON 1 BILLY

Browse

Featured Shows:

- » Billy The Exterminator
- » Dog the Bounty Hunter
- » Paranormal State
- » Criminal Minds
- » Criss Angel Mindfreak
- » Beyond Scared Straight
- » Crime 360
- » CSI Miami
- » The First 48
- » Gene Simmons Family Jewels
- » Steven Seagal: Lawman
- » Hoarders
- » Heavy
- » Intervention
- » Storage Wars

View More Shows

Popular Subjects:

- » A&E Merchandise
- » A&E Real Life Drama

Crime 360. Welcome to \$24.95

Remove from wish list

+ 2011

Client-Side #3: Sharing components

- ▶ Sharing functionalities can be attacked
- ▶ No validation in the sharer API (Facebook, Twitter, ...)
- ▶ Injection on the customer side (e.g. blog post)
- ▶ Client-side attack
 - ▶ Posting of unintended data



Motorcycles - Email to a Friend - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Aiuto

http://motorcycles.about.com/gi/pages/shareurl.htm?PG=http://motorcycles.about.com&t=Honda Announces 2011 PCX Scooter&u=http://www.iseclab.org

share this on facebook

Motorcycles - Email to a Friend Login | Facebook

Facebook Myspace StumbleUpon

Digg Twitter Delicious

Or email it:

Recipient's email:

Separate multiple addresses with commas.
Limited to 10 recipients. We will not share
any of the email addresses on this form with
third parties.

http://www.facebook.com/sharer.php?u=http://motorcycles.about.com?r=facebook&t=Honda Announces 2011 PCX Scooter&u=http://www.iseclab.org

Login | Facebook - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Aiuto

http://www.facebook.com/sharer.php?u=http%2F%2fmotorcycles.about.com%3Fr%3Dfacebook&t=Honda Announces 2011 PCX Scooter&u=http://www.iseclab.org

share this on facebook

Motorcycles - Email to a Friend Login | Facebook

f Facebook Login

You must log in to share "Honda Announces 2011 PCX Scooter" with your friends.

Email:

Password:

Keep me logged in

Sign up for Facebook

Completato

Login **Cancel**

Facebook - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Aiuto

http://www.facebook.com/sharer.php?u=http%3A%2F%2Fwww.iseclab.org&t=Honda+Announces+2011+PCX+Scooter

share this on facebook

Motorcycles - Email to a Friend Facebook

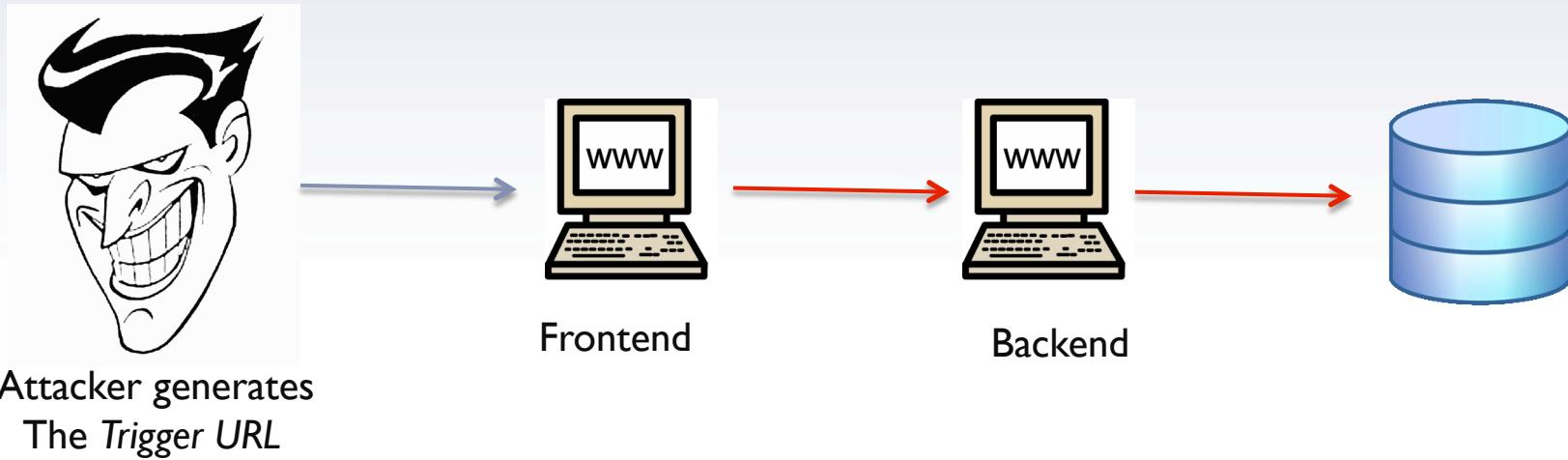
f Post to Profile

What's on your mind?

 International Secure System Lab
<http://www.iseclab.org/>
Internet security has become part of everyday life where security problems impact practical aspects of our lives. Even though there is a considerable corpus of knowledge about tools and techniques to protect networks, information about what are the actual vulnerabilities and how they are exploited is not

Completato

HTTP Parameter Pollution (Server-Side)



- ▶ Used to exploit the server-side logic of the web-application
- ▶ The attacker sends the *Trigger URL* to the vulnerable application

Server-Side #1: Payment System

- ▶ E.g., Payment system (di Paola / Carettoni)

```
void private executeBackendRequest(HTTPRequest request) {  
    String amount=request.getParameter("amount");  
    String beneficiary=request.getParameter("recipient");  
    HttpRequest("http://backendServer.com/servlet/actions", "POST",  
               action=transfer&amount="+amount+"&recipient="+beneficiary);  
}
```

Trigger URL: `http://frontendHost.com/page?amount=1000&recipient=Mat%26action%3dwithdraw`

Injected query on the backend:

```
HttpRequest("http://backendServer.com/servlet/actions", "POST",  
           action=transfer&amount=1000&recipient=Mat&action=withdraw);
```

Server-Side #2: Database hijacking

- ▶ E.g., Access the user passwords
- ▶ ASP concatenates the values of two parameters with the same name with a comma
- ▶ This permits to inject and modify the query on the database

Normal requests:

URL: printEmploys?department=engineering

Back-end: dbconnect.asp?what=users&department=engineering

Database: select users from table where department=engineering

HPP injected requests:

URL: printEmploys?department=engineering%26what%3Dpasswd

Back-end: dbconnect.asp?what=users&department=engineering&what=passwd

Database: select users,passwd from table where department=engineering

Server-Side #3: Authorization Bypass

- ▶ Google Blogger exploited by Nir Goldshlager
- ▶ Get administrator privilege over any blogger account
- ▶ Attacker uses the add authors functionality
 - ▶ The server checks the 1st blogid value but executes the 2nd blogid value of the attacker
- ▶ When the attacker is added as user to the victim's blogger, he raises his privileges to administrator

```
POST /add-authors.do HTTP/1.1
```

```
security_token=attacker_token&blogID=attacker_blogidvalue&  
blogID=victim_blogidvalue&authorsList=attacker_email&ok=Invite
```

Parameter Pollution – More uses

- ▶ 1) Cross-channel pollution
 - ▶ Override parameters between different input channels (GET/POST/Cookie)
 - ▶ Good security practice: accept parameters only from where they are supposed to be supplied
- ▶ 2) Bypass CSRF tokens
 - ▶ E.g. Yahoo Mail client-side attack (di Paola & Caretoni)
 - ▶ The user's mails get automatically deleted!

```
Url: showFolder?fid=Inbox&order=down&tt=245&pSize=25&startMid=0  
%2526cmd=fmgt.emptytrash%26DEL=1%26DelFID=Inbox%26cmd=fmgt.delete
```

```
Link: showMessage?sort=date&order=down&startMid=0  
%26cmd%3Dfmgt.emptytrash&DEL=1&DelFID=Inbox&cmd=fmgt.delete&  
.rand=1076957714
```

Parameter Pollution – More uses

- ▶ 3) Bypass WAFs input validation checks
 - ▶ Split & Join the attack payload
 - ▶ E.g., SQL injection via parameter replication
 - ▶ Exploit ASP concatenation behavior and inline comments

Standard: show_user.aspx?id=5;select+1,2,3+from+users+where+id=1-

Over HPP: show_user.aspx?id=5;select+1&**id**=2&**id**=3+from+users+where+id=1-

Standard: show_user.aspx?id=5+union+select+*+from+users-

Over HPP: show_user.aspx?id=5/*&**id**=*/union/*&**id**=*/select+*/*&**id**=*/from+users--

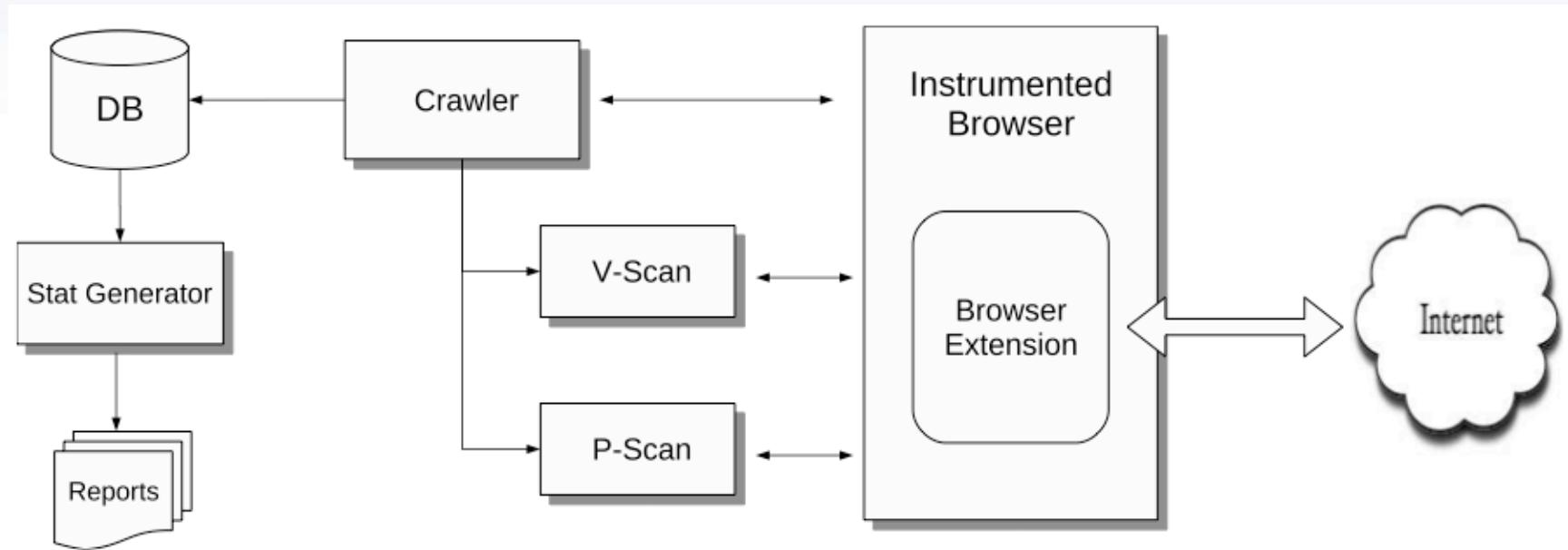
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System for HPP Detection

- ▶ Four main components: browser, crawler, two scanners



P-Scan: Analysis of the Parameter Precedence

- ▶ Analyzes a page to determine the precedence of parameters, when multiple occurrences of the same parameter are submitted
- ▶ Take parameter `par1=val1`, generate a similar value `par1=new_val`
 - ▶ Page0 (original): `app.php?par1=val1`
 - ▶ Page1 (test 1) : `app.php?par1=new_val`
 - ▶ Page2 (test 2) : `app.php?par1=val1&par1=new_val`
- ▶ How do we determine precedence? Naïve approach:
 - ▶ `Page0==Page2` -> precedence on first parameter
 - ▶ `Page1==Page2` -> precedence on second parameter

P-Scan: Problem with the naïve approach

- ▶ In practice, naïve technique does not work well
 - ▶ Applications are complex, much dynamic content (publicity banners, RSS feeds, ads, etc.)
- ▶ Hence, we perform pre-filtering to eliminate dynamic components (embedded content, applets, IFRAMES, style sheets, etc.)
 - ▶ Remove all self-referencing URLs (as these change when parameters are inserted)
 - ▶ We then perform different tests to determine similarity

V-Scan: Testing for HPP vulnerabilities

- ▶ For every page, an innocuous URL-encoded parameter (**nonce**) is injected in the page's parameters
 - ▶ E.g., ?q=italy%26foo%3Dbar
- ▶ The page is submitted (GET/POST)
- ▶ Then, the answered page is checked for containing the decoded version of the nonce (&foo=bar):
 - ▶ In links or forms (action)

Where to inject the nonce

- ▶ $P_A = P_{URL} \cap P_{Body}$: set of parameters that appear unmodified in the URL and in the page content (links, forms)
- ▶ $P_B = p \mid p \in P_{URL} \wedge p / \in P_{Body}$: URL parameters that do not appear in the page. Some of these parameters may appear in the page under a different name
- ▶ $P_C = p \mid p / \in P_{URL} \wedge p \in P_{Body}$: set of parameters that appear somewhere in the page, but that are not present in the URL

Reducing the False Positives

- ▶ E.g., one of the URL parameters (or part of it) is used as the entire target of a link

Url: index.php?v1=p1&uri=apps%2Femail.jsp%3Fvar1%3Dpar1%26foo%3Dbar
Link: apps/email.jsp?var1=par1&foo=bar

- ▶ Self-referencing links

Url: search.html?session_id=jKAmS2x5%26foo%3Dbar&q=shoes
Link: service_request.html?page=search%2ehtml%3fsession_id%3djKAmS2x5&foo=bar&q=shoes

- ▶ Similar issues with printing, sharing functionalities
- ▶ To reduce false positives, we use heuristics
 - ▶ E.g., the injected parameter does not start with http://
 - ▶ Injection without URL-encoding

Implementation – The PAPAS tool

- ▶ PAPAS: Parameter Pollution Analysis System
- ▶ The components communicate via TCP/IP sockets
 - ▶ Crawler and Scanner are in Python
 - ▶ The browser component has been implemented as a Firefox extension
 - ▶ Advantage: We can see exactly how pages are rendered (cope with client-side scripts, e.g. Javascript)
 - ▶ Support for multiple sessions (parallelization)



Implementation – The PAPAS tool

- ▶ PAPAS is fully customizable
 - ▶ E.g., scanning depth, number of performed injections, page loading timeouts, etc.
- ▶ Three modes are supported
 - ▶ Fast mode, extensive mode, assisted mode
 - ▶ In assisted mode, authenticated areas of a site can be scanned as well
- ▶ Now, as a free-to-use-service:
 - ▶ <http://papas.iseclab.org>



Possible improvements

- ▶ PAPAS does not support the crawling of links embedded in active content
 - ▶ E.g., flash
- ▶ Support additional encoding schemas (UTF-8, Double URL)
- ▶ PAPAS currently only focuses on client-side exploits where user needs to click on a link
 - ▶ HPP is also possible on the server side – but this is more difficult to detect
 - ▶ Analogous to detecting stored XSS

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Ethical Considerations

- ▶ Only client-side attacks. The server-side have the potential to cause harm
- ▶ We provided the applications with innocuous parameters (&foo=bar). No malicious code.
- ▶ Limited scan time (15min) and activity
- ▶ We immediately informed, when possible, the security engineers of the affected applications
- ▶ Thankful feedbacks

Two set of experiments

- ▶ 1) We used PAPAS to scan a set of popular websites
 - ▶ About 5,000 sites collected by the first 500 of Alexa's main categories
 - ▶ The aim: To quickly scan as many websites as possible and to see how common HPP flaws are
- ▶ 2) We then analyzed some of the sites we identified to be HPP-vulnerable in more detail

The 5,016 tested sites

Categories	# of Tested Applications	Categories	# of Tested Applications
Financial	110	Shopping	460
Games	300	Social Networking	117
Government	132	Sports	256
Health	235	Travel	175
Internet	698	University	91
News	599	Video	114
Organization	106	Others	1,401
Science	222		

Efficient assessment

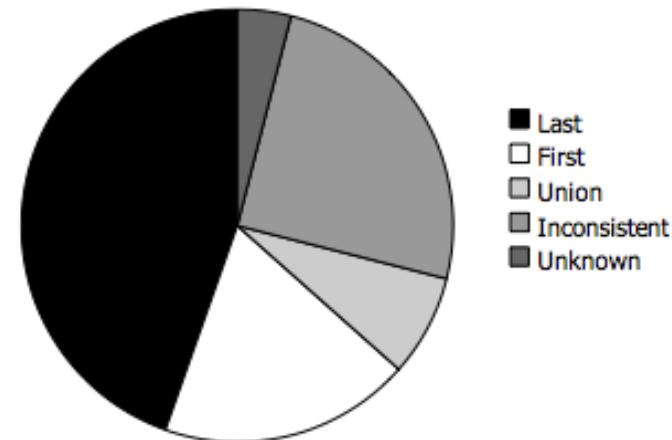
- ▶ In 13 days, we tested 5,016 sites and more than 149,000 unique pages
- ▶ To maximize the speed, the scanner
 - ▶ Crawled pages up to a distance of 3 from the homepage
 - ▶ Considered links with at least one parameter (except for the homepage)
 - ▶ Considered at max 5 instances for page (same page, different query string)
 - ▶ We disabled pop-ups, images, plug-ins for active content technologies

Evaluation – Parameter Precedence

▶ Database Errors

- ▶ Web developers does not seem conscious of the possibility to duplicate GET/POST parameter
- ▶ No sanitization is in place

Parameter Precedence	WebSites	
Last	2,237	(44.60%)
First	946	(18.86%)
Union	381	(7.60%)
Inconsistent	1,251	(24.94%)
Unknown	201	(4.00%)
Total	5,016	(100.00%)
Database Errors	238	(4.74%)



Nasa.gov: coldfusion SQL Error

The web site you are accessing has experienced an unexpected error.
Please contact the website administrator.

The following information is meant for the website developer for debugging purposes.

Error Occurred While Processing Request

The cause of this output exception was that:
`coldfusion.tagext.sql.QueryParamTag$InvalidDataException:`
`Invalid data value 23,24 exceeds maxlenlength setting 4..`

Resources:

- Enable Robust Exception Information to provide greater detail about the source of errors. In the Administrator, click Debugging & Logging > Debug Output Settings, and select the Robust Exception Information option.
- Check the [ColdFusion documentation](#) to verify that you are using the correct syntax.
- Search the [Knowledge Base](#) to find a solution to your problem.

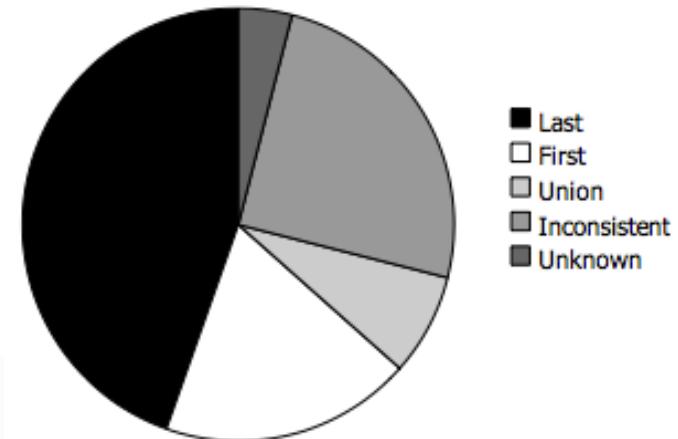
Browser	Mozilla/5.0 (X11; U; Linux i686; it; rv:1.9.2.3) Gecko/20100401 Firefox/3.6.3
Remote Address	193.253.230.214
Referrer	http://www.jpl.nasa.gov/multimedia/slideshows/index.cfm?id=23&page=1%26id%3D24
Date/Time	07-Jun-10 07:44 AM

Evaluation – Parameter Precedence

▶ Parameter Inconsistency

- ▶ Sites developed using a combination of heterogeneous technologies (e.g. PHP and Perl)
- ▶ This is perfectly safe if the developer is aware of the HPP threat... this is not always the case

Parameter Precedence	WebSites	
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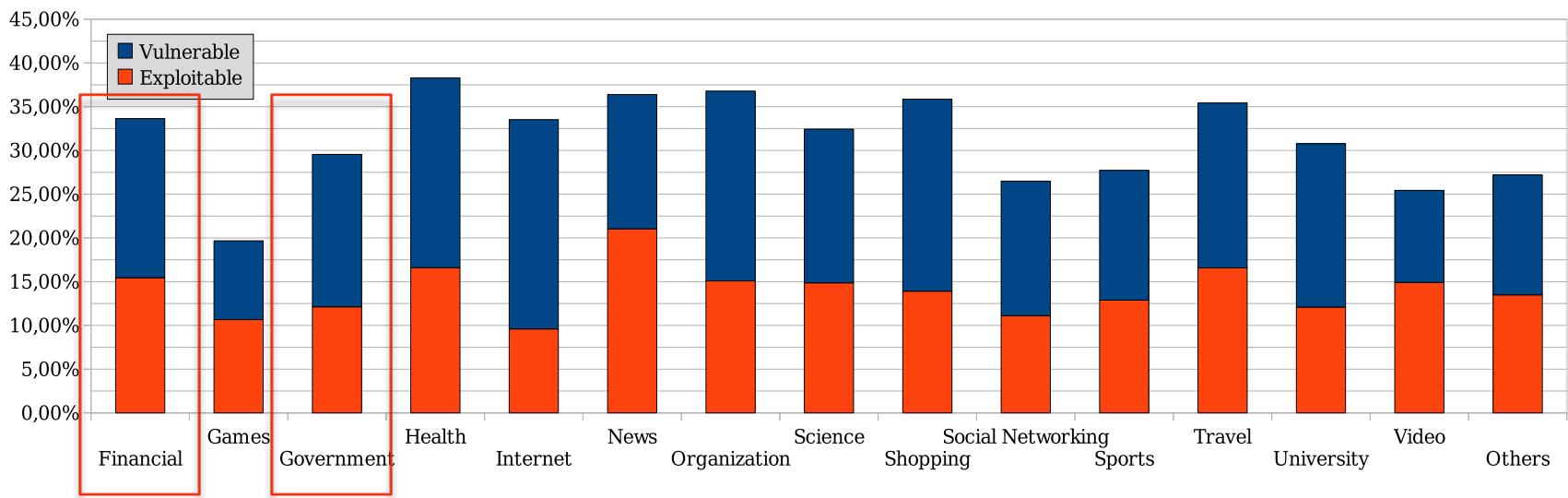
Evaluation – HPP Vulnerabilities

- ▶ PAPAS discovered that about **1,500 (30%)** websites contained at least one page vulnerable to HTTP Parameter Injection
 - ▶ The tool was able to inject (and verify) an encoded parameter
- ▶ **Vulnerable != Exploitable**
 - ▶ Is the parameter precedence consistent?
 - ▶ Can a possible attacker override existing parameter values?

Vulnerable or Exploitable?

- ▶ Injection on link
- ▶ Read a mail: `http://site.com/script?mail_id=10&action=read`
 - ▶ Parameter in the middle -> always overriding
 - ▶ `?mail_id=10&action=delete&action=read`
 - ▶ Parameter at the begin/end -> automated check via P-Scan
 - ▶ `?action=read&mail_id=10&action=delete`
- ▶ Injection on form:
 - ▶ The injected value is automatically encoded by the browser
 - ▶ Still, someone may be able to run a two-step attack (client-side) or a server-side attack
- ▶ 702 applications are exploitable (14%)

Evaluation



- ▶ More sensitive sites are equally (or even more) affected by the problem

False Positives

- ▶ 10 applications (**1.12%**) use the injected parameter as entire target for one link
- ▶ Variation of the special case we saw in previous slide (V-Scan: special cases)
 - ▶ The application applied a transformation to the parameter before using it as a link's URL

Some Case Studies

- ▶ We investigated some of the websites in more detail
 - ▶ Among our “victims”: Facebook, Google, Symantec, Microsoft, PayPal, Flickr, FOX Video, VMWare, ...
 - ▶ We notified security officers and some of the problems were fixed
 - ▶ Facebook: share component
 - ▶ Several shopping cart applications could be manipulated to change the price of an item
 - ▶ Some banks were vulnerable and we could play around with parameters
 - ▶ Google: search engine results could be manipulated

World Health Organization

The screenshot shows a web browser window with the URL <http://apps.who.int/bookorders/anglais/home1.jsp?sesslan=1&compro=mised>. The page is titled "WHO Press - Editions de l'OMS - Ediciones de la OMS". A red oval highlights the URL in the address bar. The left sidebar has links like "About us", "Search", "Just published", etc. A red circle highlights the "Search" link. Another red circle highlights the URL for the "Just published" section. The main content area shows a book cover for "Cancer affects everyone" and a note about alcohol use. A red circle highlights the URL for the book details. A red oval highlights the "In Focus" section. The bottom footer shows the URL <http://apps.who.int/bookorders/anglais/catalog1.jsp?sesslan=1&compro=mised>.

http://apps.who.int/bookorders/anglais/home1.jsp?sesslan=1&compro=mised

Deezer CouchSurfing Facebook wordreference BabelFish CiteULike Wiki VMWARE IlGiornale.it

App Search on Flickr - Application... Shine on you crazy diamond ... - WHO - Home page

WHO Home Search English Français Español

In Focus

Cancer affects everyone - the rich and poor, men, women and children - and represents a tremendous burden on patients, families and societies.

Cancer is one of the leading causes of death in the world, particularly in developing countries. Yet, many of these deaths can be avoided. Over 30% of all cancers can be prevented. Others can be detected early, treated and cured. Even with late stage cancer, the suffering of patients can be relieved with good palliative care.

To find more information on this topic, please visit the [10 facts about cancer](#).

NOTE TO BOOKSELLERS / DISTRIBUTORS

Please send your orders by email to bookorders@who.int, as this online ordering web site does not apply the discount for booksellers and distributors.

2011 WHO Agendas/Diaries

You can now purchase your 2011 WHO Diary online! [WHO Agenda Art bleu/Diary Art blue](#) and [WHO Agenda Art vert/Diary Art green](#)

Classification of Disease

To view the recent books published in the field of Classification of Disease, browse through the [Disease classification catalogue](#)

To find more information on Disease classification, visit [Family of](#)

<http://apps.who.int/bookorders/anglais/catalog1.jsp?sesslan=1&compro=mised>

Your (secured) home banking

'www.usbank.com/cgi_w/cfm/creditcards/secured/usb_secured_card.cfm?ics_src=7109%26productId%3D30

Secured Visa Credit Card offer from ... × Credit Card Services × Credit Ca

usbank.

Personal

Credit Cards

- Browse & Compare Credit Cards
- Get a Credit Card Recommendation
- Online Account Access
- Rates and Fees
- Get Saved Credit Card Application
- Accept Mail Offer

Products & Services > Credit Cards > Secure Visa Credit Card

U.S. Bank Secured Visa® Credit Card



The U.S. Bank Secured Visa® Credit Card - Safely build or re-establish your credit starting now!¹

Apply Now

A U.S. Bank Secured Credit Card is a great way to help build or

U.S. Bank Young Adult Visa® Card Application



The application process will take 5 -10 min
your Social Security Number to complete th

Our privacy policy allows personal informati
inactivity. After 15 minutes of inactivity your p
will be asked to start your application proce
this may cause you.



PayPal

Raise your account limits and get Verified

For security and legal reasons, there are initial limits on how much money customers can send, receive, and withdraw using their PayPal accounts. Confirming your card raises some of these limits and makes you a Verified PayPal member.

How do I confirm my card?

Follow the steps below unless you are confirming [domestic bank card](#).

Sample card statement

Date	Description	Amount
01/06/2009	PP1234 EXPUSE	1,50 EUR

1234

Sample PayPal code

1. Enter your card information or select an existing card and click **Continue**. We'll charge your card 1,50 EUR&EUPCCFee=500,00 USD to make sure it's yours.
2. In 2-3 days, check your bank statement (or card statement) for the unique 4-digit code that we sent along with the charge.
3. Log back in to your PayPal account and enter the code from your statement.

We'll refund the 1,50 EUR&EUPCCFee=500,00 USD charge into your PayPal account within 24 hours after you confirm your card.

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And Google ☺

C... X +

http://www.google.com/support/accounts/bin/search.py?ctx=it:searchbox&query=i+really+like+google+%20%26q%3Dclimbing%26tbs=vid:1

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Is are spelled correctly.
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i really like google climbing

About 176 results (0.22 seconds)

Search Advanced search

Climbing - Deepwater Soloing in with David Lama ...
8 min · 16 Apr 2007
one of the best and most beautyfull places in the world: i in the South
of Thailand. David Lama is showing some **really** amazing ...
google.com - Related videos

Mikes Mail EP 2
17 min · 23 Apr 2010 · Uploaded by mikebarter387
who he wants to introduce to the outdoors. I have a unit the exact same
age so I can relate to his situation. I also have units 14 ...
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8 min · 23 Oct 2005
crazy!!
google.com - Related videos

search?hl=en&q=i really like google &q=climbing&tbs=vid:1

What's next?

- ▶ Complementary approach: white-box (SCA)
- ▶ Server-Side flaws
- ▶ Technology: Pixy, RIPS
- ▶ Problems: Parsing, OOP support, Custom Sanitizations
 - ▶ PHP-Parser: <https://github.com/nikic/PHP-Parser#readme>
 - ▶ Saner
- ▶ Get in touch!



HPP Prevention

- ▶ Input validation
 - ▶ Encoded query string delimiters
- ▶ Use safe methods
 - ▶ Handle the parameter precedence
 - ▶ Channel (GET/POST/Cookie) validation
- ▶ Raise awareness
 - ▶ The client can provide the same parameter twice (or more)

Conclusion

- ▶ Presented the first technique and system to detect HPP vulnerabilities in web applications.
 - ▶ We call it PAPAS, <http://papas.iseclab.org>
- ▶ Conducted a large-scale study of the Internet
 - ▶ About 5,000 web sites
- ▶ Our results suggest that Parameter Pollution is a largely unknown, and wide-spread problem
- ▶ We hope that this work will help raise awareness about HPP!

Thanks for your attention.



I love you too, pollution!

Acknowledgments & References

- ▶ Co-joint work:
 - ▶ M. Balduzzi, C.Torrano Gimenez, D. Balzarotti, and E. Kirda.
 - ▶ NDSS 2011, San Diego, CA.
 - ▶ *Automated discovery of parameter pollution vulnerabilities in web applications*
- ▶ Minded Security Blog, S. di Paola & L. Carettoni
 - ▶ <http://blog.mindedsecurity.com/2009/05/client-side-http-parameter-pollution.html>
- ▶ I collected a bunch of resources here:
 - ▶ <http://papas.iseclab.org/cgi-bin/resources.py>