Using Machine-Learning to Investigate Web Campaigns at Large

Dr. Federico Maggi, @phretor

Joint work with Marco Balduzzi, Ryan Flores, Lion Gu and Vincenzo Ciancaglini

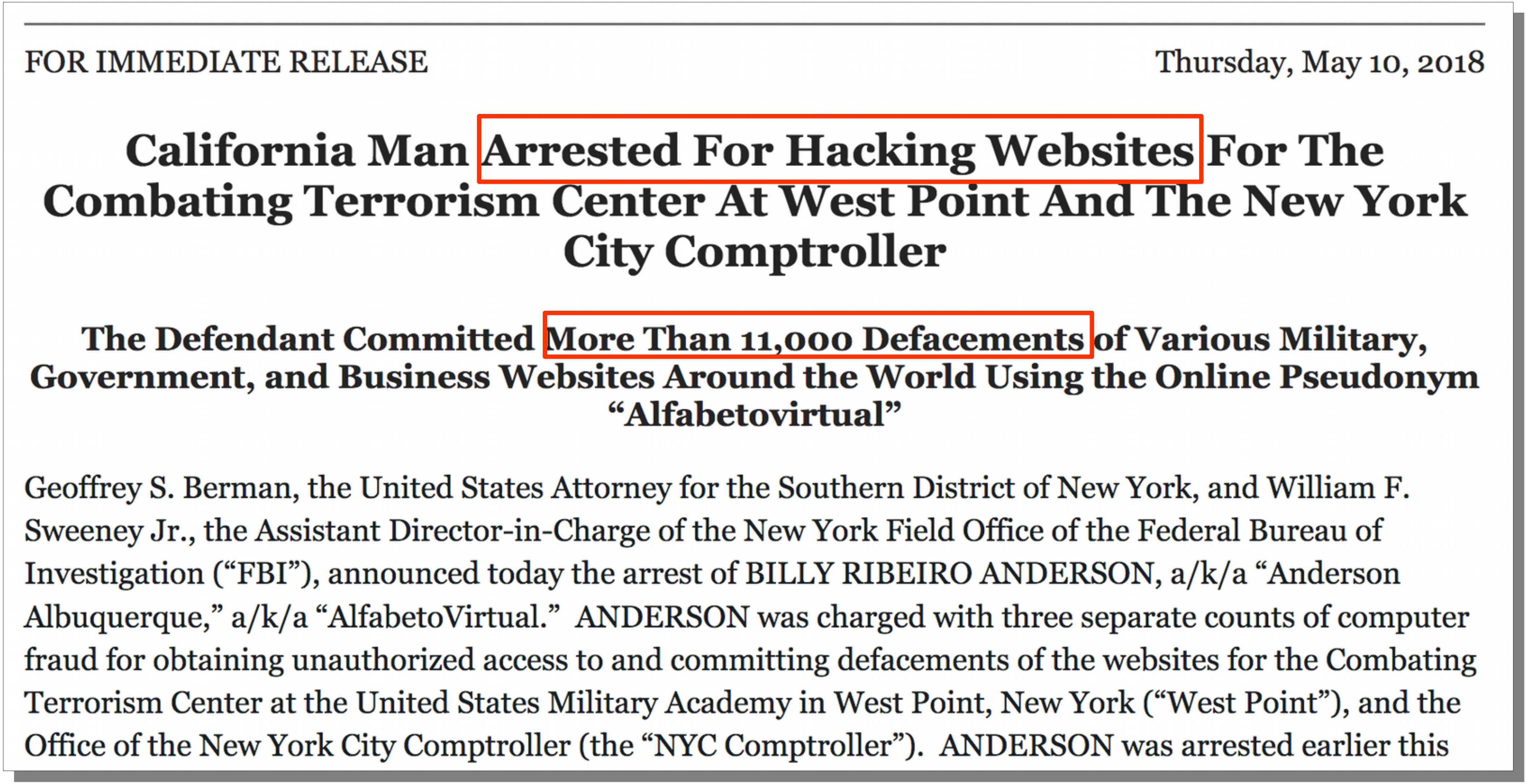
Web Defacement

=

Website Compromise

+

Homepage Alteration



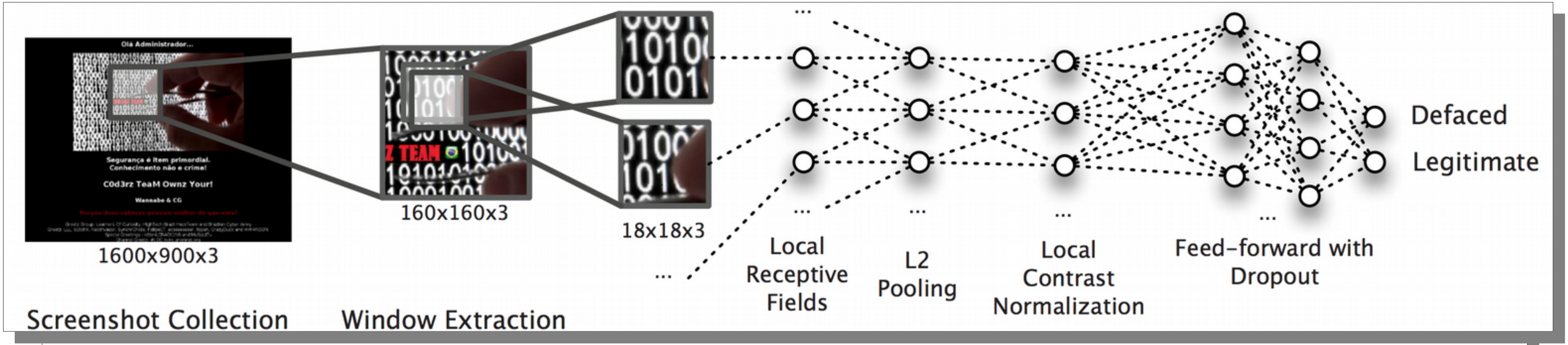
FOR IMMEDIATE RELEASE

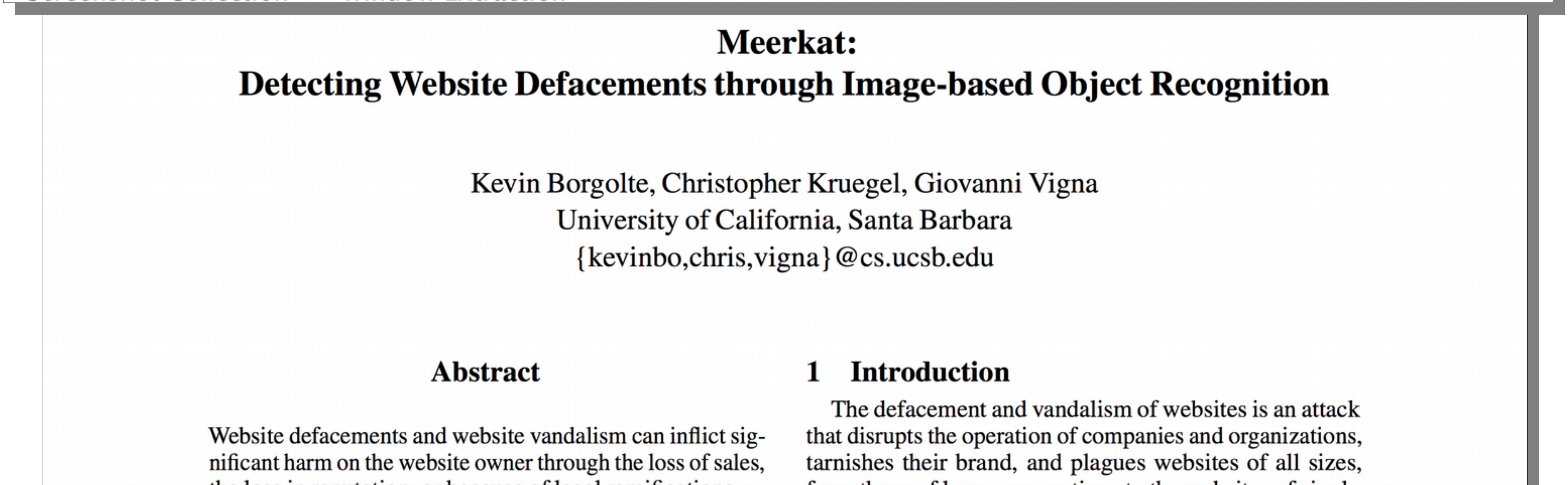
Thursday, May 10, 2018

California Man Arrested For Hacking Websites For The Combating Terrorism Center At West Point And The New York City Comptroller

The Defendant Committed More Than 11,000 Defacements of Various Military, Government, and Business Websites Around the World Using the Online Pseudonym "Alfabetovirtual"

Geoffrey S. Berman, the United States Attorney for the Southern District of New York, and William F. Sweeney Jr., the Assistant Director-in-Charge of the New York Field Office of the Federal Bureau of Investigation ("FBI"), announced today the arrest of BILLY RIBEIRO ANDERSON, a/k/a "Anderson Albuquerque," a/k/a "AlfabetoVirtual." ANDERSON was charged with three separate counts of computer fraud for obtaining unauthorized access to and committing defacements of the websites for the Combating Terrorism Center at the United States Military Academy in West Point, New York ("West Point"), and the Office of the New York City Comptroller (the "NYC Comptroller"). ANDERSON was arrested earlier this





Meerkat: Detecting Website Defacements through Image-based Object Recognition

Kevin Borgolte, Christopher Kruegel, Giovanni Vigna
University of California, Santa Barbara
{kevinbo,chris,vigna}@cs.ucsb.edu

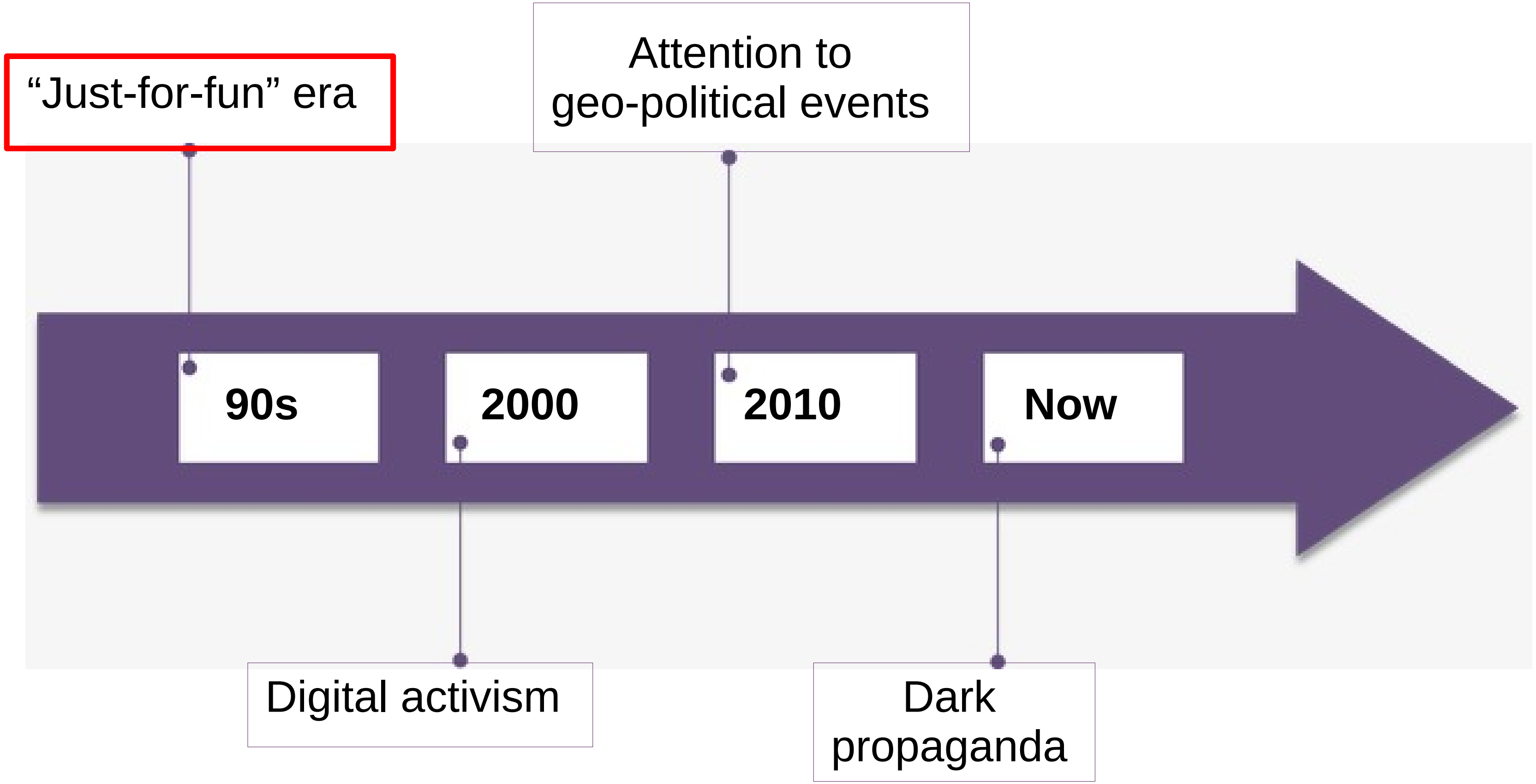
Abstract

Website defacements and website vandalism can inflict significant harm on the website owner through the loss of sales,

1 Introduction

The defacement and vandalism of websites is an attack that disrupts the operation of companies and organizations, tarnishes their brand, and plagues websites of all sizes,

Evolution



“Just-for-fun” era

Attention to geo-political events

90s

2000

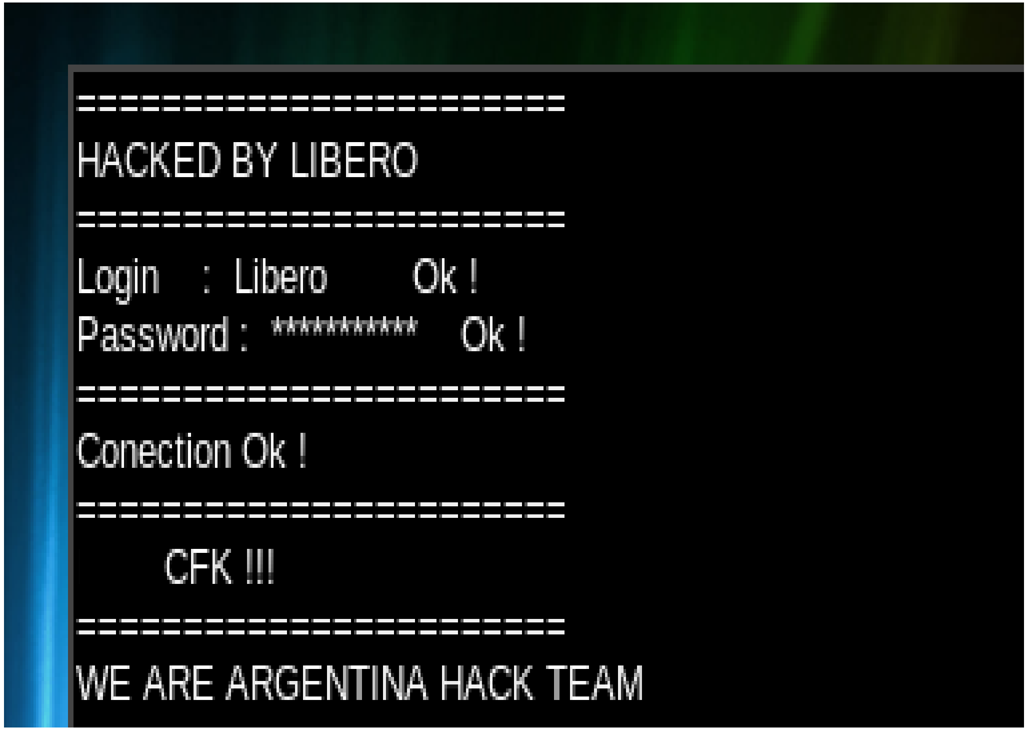
2010

Now

Digital activism

Dark propaganda

“Just-for-fun” Era



```
=======================
HACKED BY LIBERO
=======================
Login    :  Libero       Ok !
Password :  ***********    Ok !
=======================
Conection Ok !
=======================
      CFK !!!
=======================
WE ARE ARGENTINA HACK TEAM
```

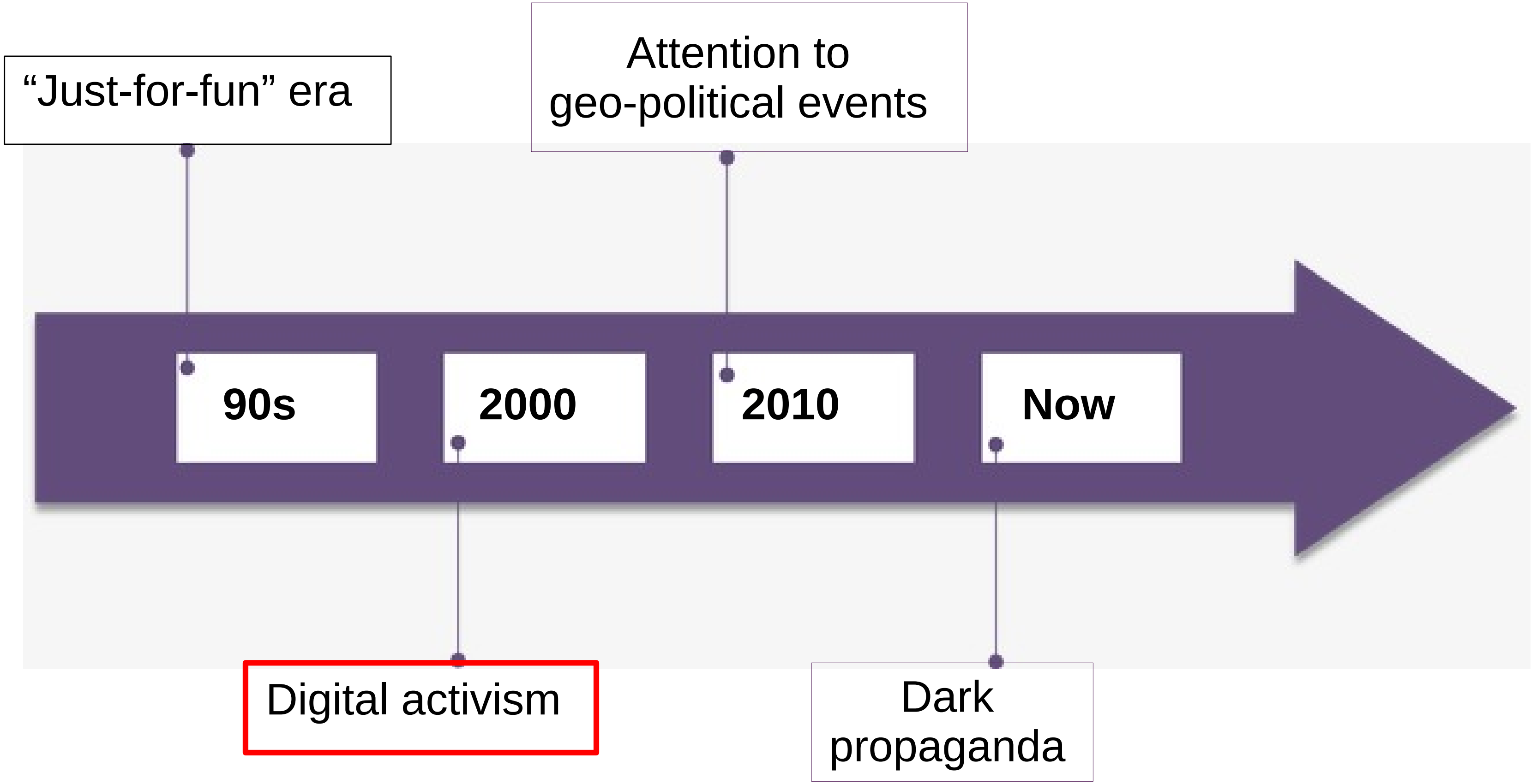
```
| owned by ssh-2 | CHILE |

uname -a;id

Linux obelix 2.6.15-1-686 #2
Mon Mar 6 15:27:08 UTC 2006
i686 GNU/Linux

uid=0(root) gid=33(www-data)
groups=33(www-data)
```

Evolution



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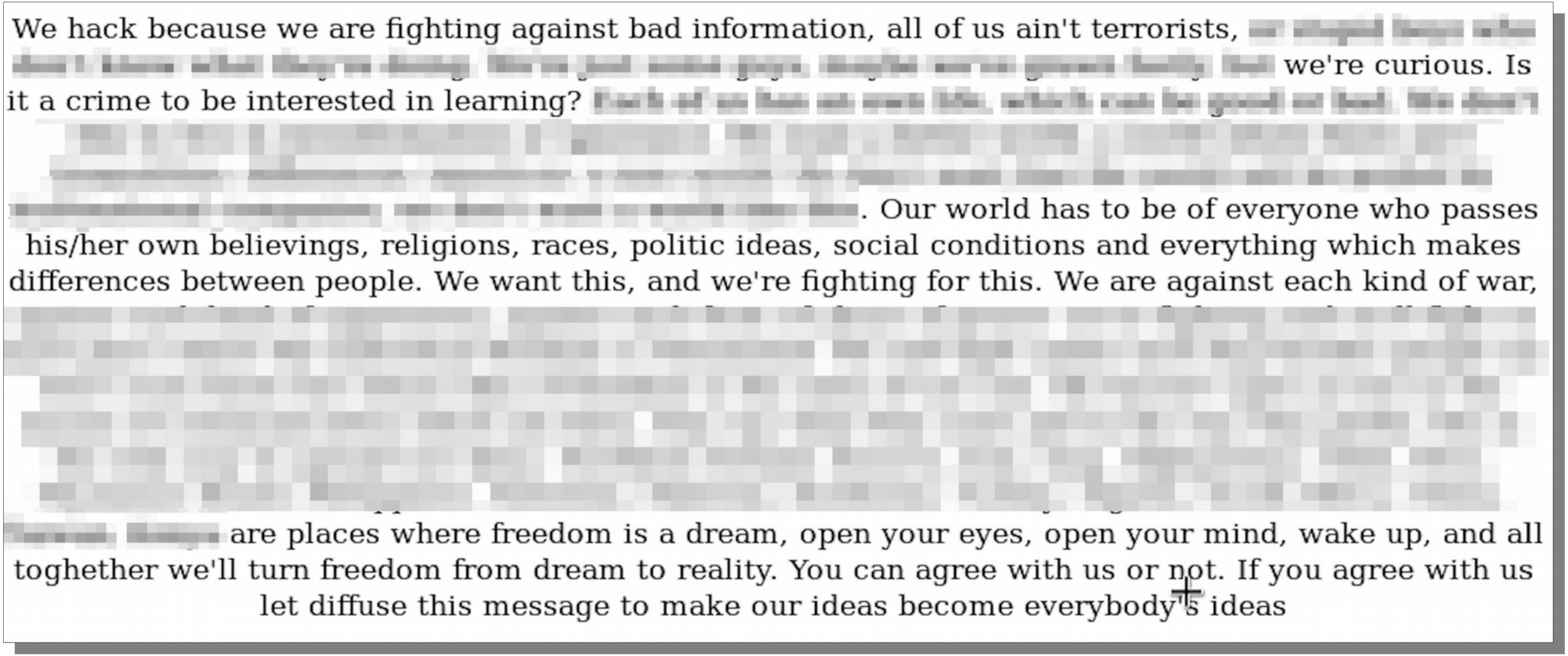
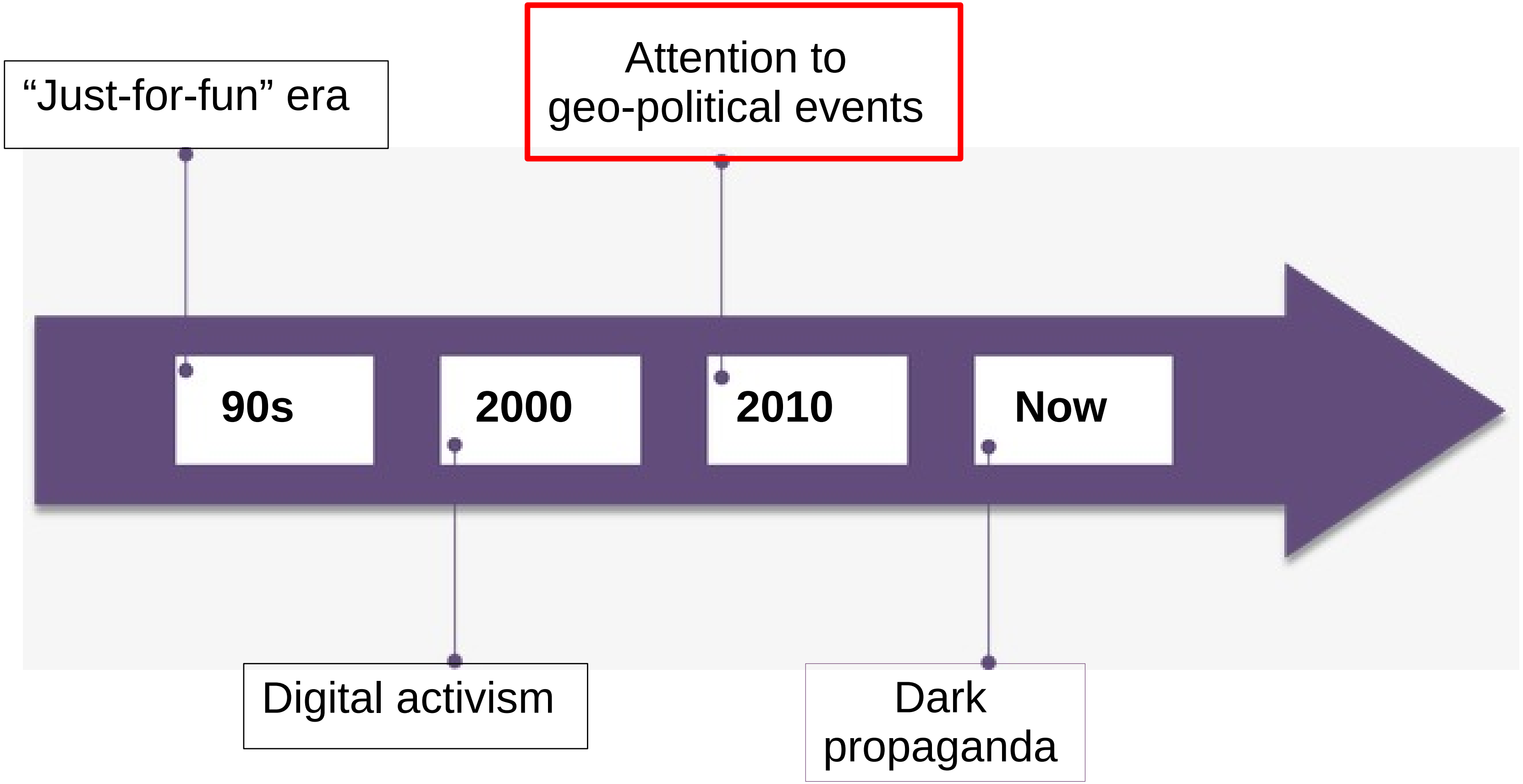
Digital Activism



We hack because we are fighting against bad information, all of us ain't terrorists, [redacted] we're curious. Is it a crime to be interested in learning? [redacted]. Our world has to be of everyone who passes his/her own believings, religions, races, politic ideas, social conditions and everything which makes differences between people. We want this, and we're fighting for this. We are against each kind of war, [redacted] are places where freedom is a dream, open your eyes, open your mind, wake up, and all toghether we'll turn freedom from dream to reality. You can agree with us or not. If you agree with us let diffuse this message to make our ideas become everybody's ideas

Evolution



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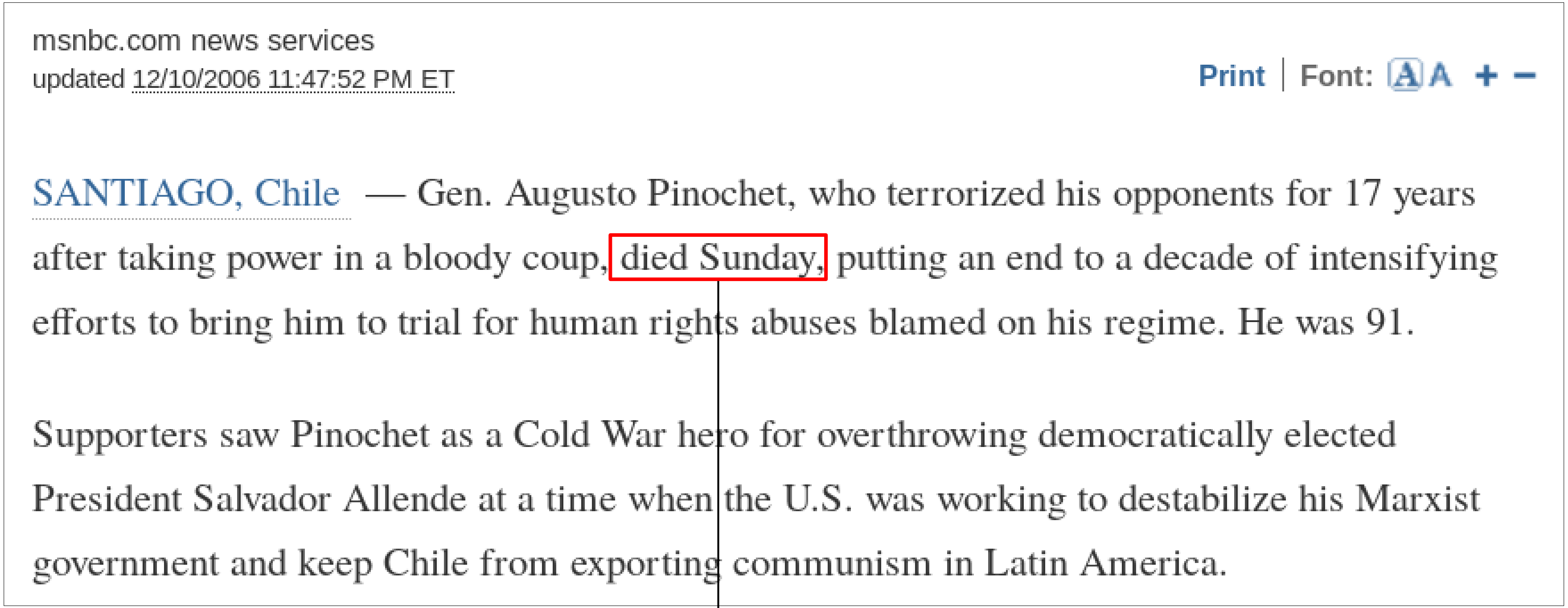
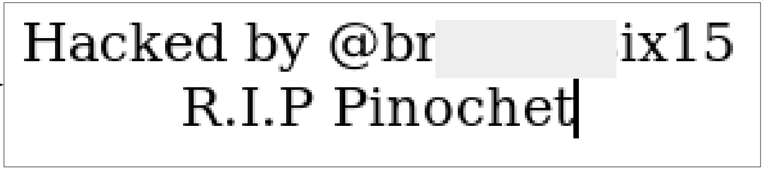


msnbc.com news services
updated 12/10/2006 11:47:52 PM ET

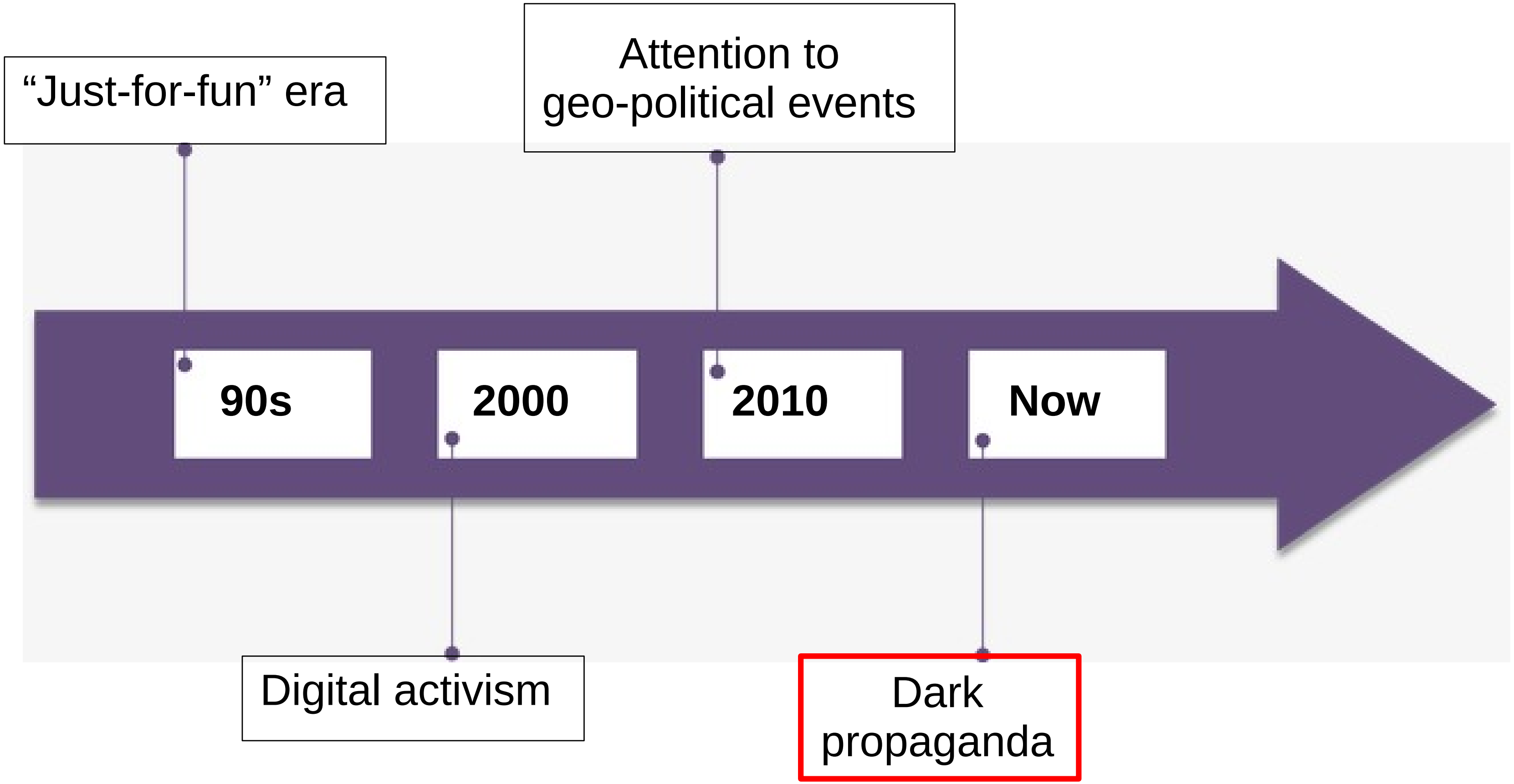
SANTIAGO, Chile — Gen. Augusto Pinochet, who terrorized his opponents for 17 years after taking power in a bloody coup, died Sunday, putting an end to a decade of intensifying efforts to bring him to trial for human rights abuses blamed on his regime. He was 91.

Supporters saw Pinochet as a Cold War hero for overthrowing democratically elected President Salvador Allende at a time when the U.S. was working to destabilize his Marxist government and keep Chile from exporting communism in Latin America.



Hacked by @br[redacted]ix15
R.I.P Pinochet

Evolution



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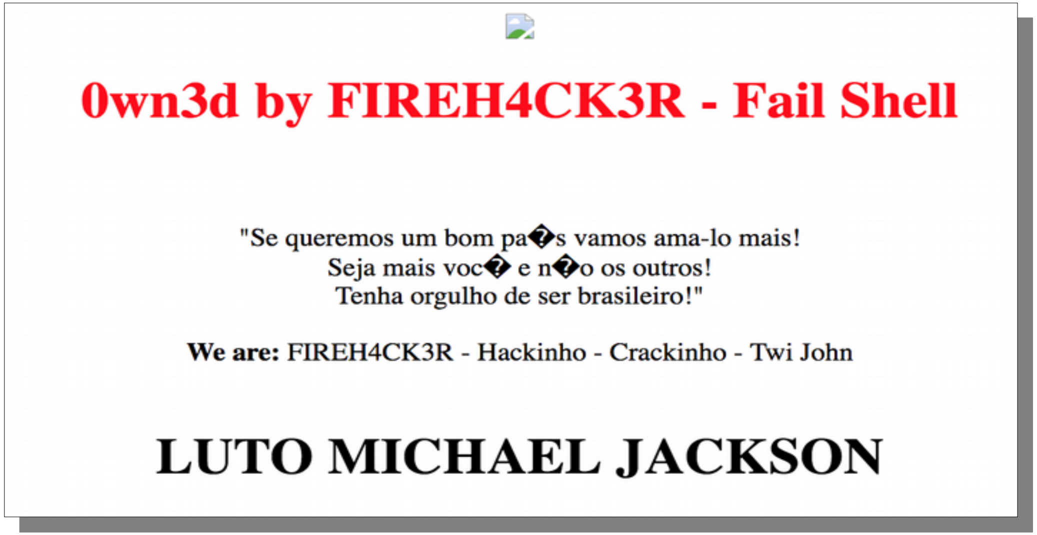
Dark propaganda

From isolated events to coordinated campaigns

- Death statement is June 25th, 2009
- Sporadic defacements: June 28th
- Campaigns: August



0wn3d by FIREH4CK3R - Fail Shell

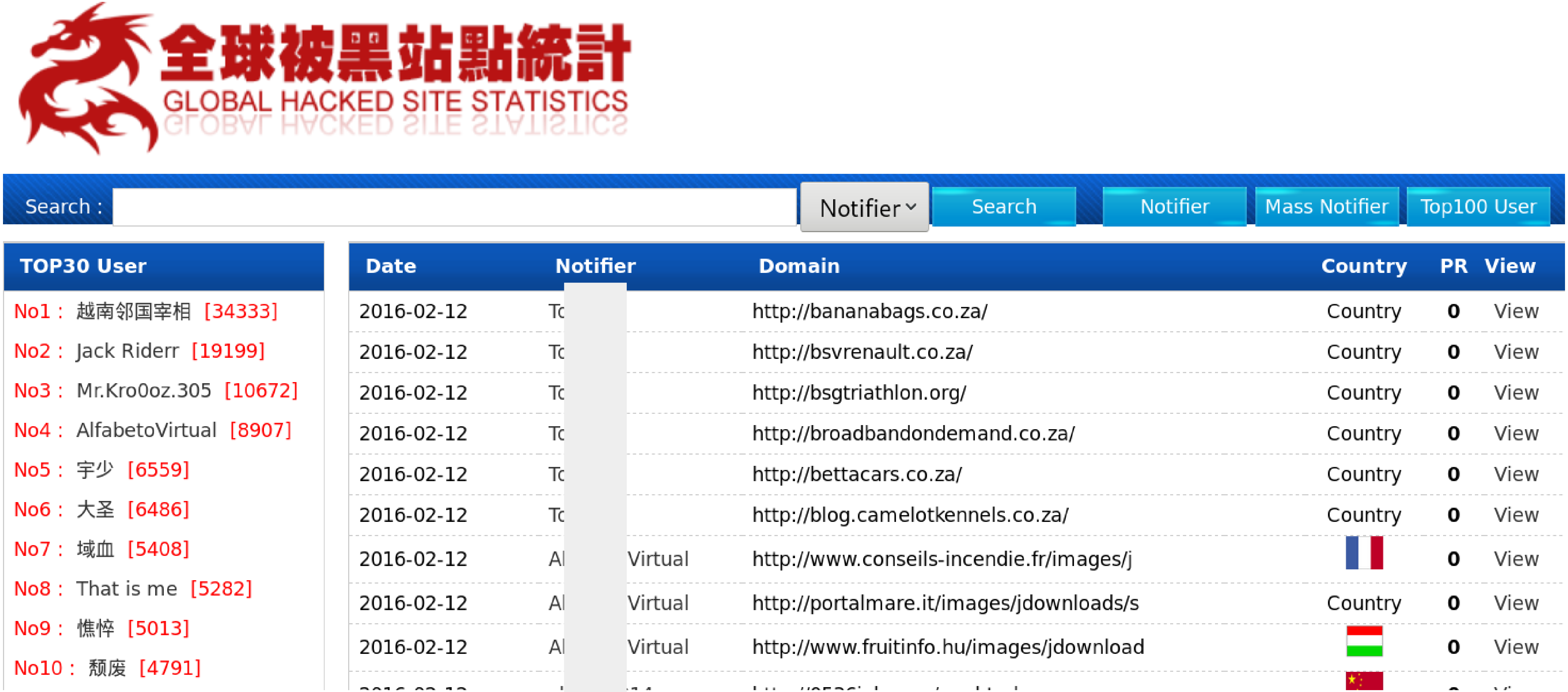
"Se queremos um bom pa�s vamos ama-lo mais!
Seja mais voc� e n�o os outros!
Tenha orgulho de ser brasileiro!"

We are: FIREH4CK3R - Hackinho - Crackinho - Twi John

LUTO MICHAEL JACKSON

That’s interesting
But how do we scale?

Public Repositories



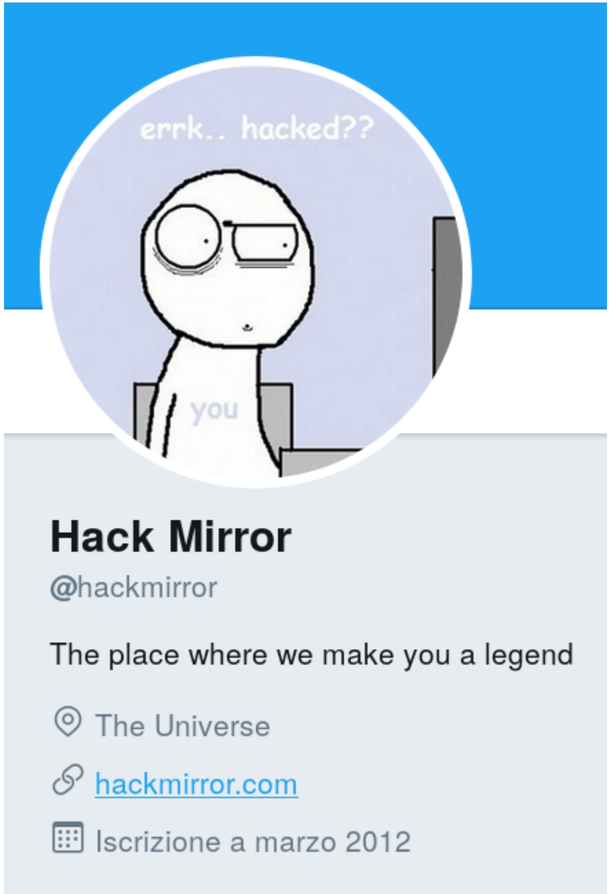
全球被黑站點統計
GLOBAL HACKED SITE STATISTICS

TOP30 User

No1： 越南邻国宰相 [34333]
No2： Jack Riderr [19199]
No3： Mr.Kro0oz.305 [10672]
No4： AlfabetoVirtual [8907]
No5： 宇少 [6559]
No6： 大圣 [6486]
No7： 域血 [5408]
No8： That is me [5282]
No9： 憔悴 [5013]
No10： 颓废 [4791]

Date	Notifier	Domain	Country	PR	View
2016-02-12	[redacted]	http://bananabags.co.za/	Country	0	View
2016-02-12	[redacted]	http://bsvrenault.co.za/	Country	0	View
2016-02-12	[redacted]	http://bsgtriathlon.org/	Country	0	View
2016-02-12	[redacted]	http://broadbandondemand.co.za/	Country	0	View
2016-02-12	[redacted]	http://bettacars.co.za/	Country	0	View
2016-02-12	[redacted]	http://blog.camelotkennels.co.za/	Country	0	View
2016-02-12	[redacted]	http://www.conseils-incendie.fr/images/j	🇫🇷	0	View
2016-02-12	[redacted]	http://portalmare.it/images/jdownloads/s	Country	0	View
2016-02-12	[redacted]	http://www.fruitinfo.hu/images/jdownload	🇭🇺	0	View

Others



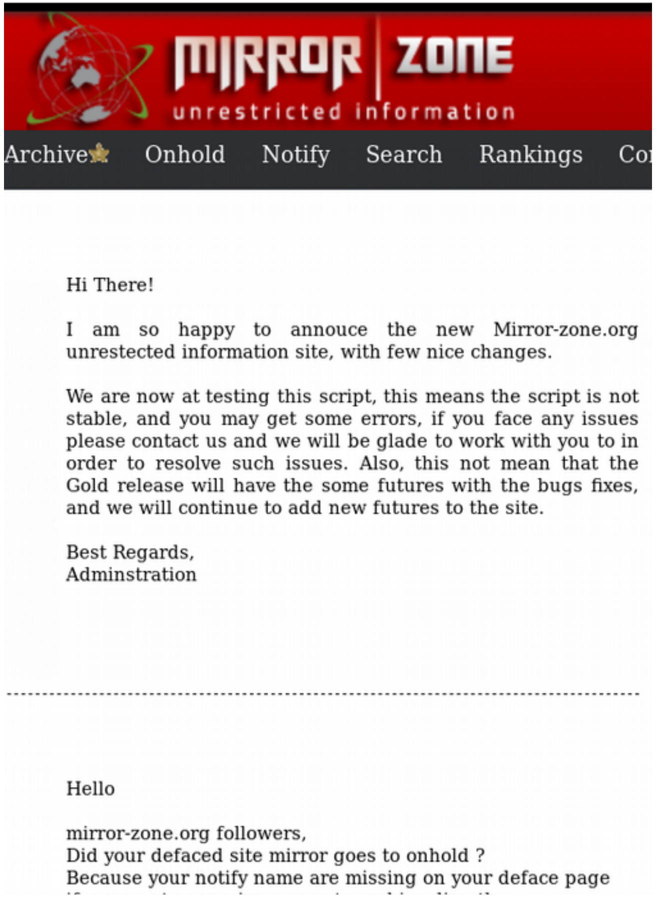
Hack Mirror
@hackmirror

The place where we make you a legend

The Universe

hackmirror.com

Iscrizione a marzo 2012



Hi There!

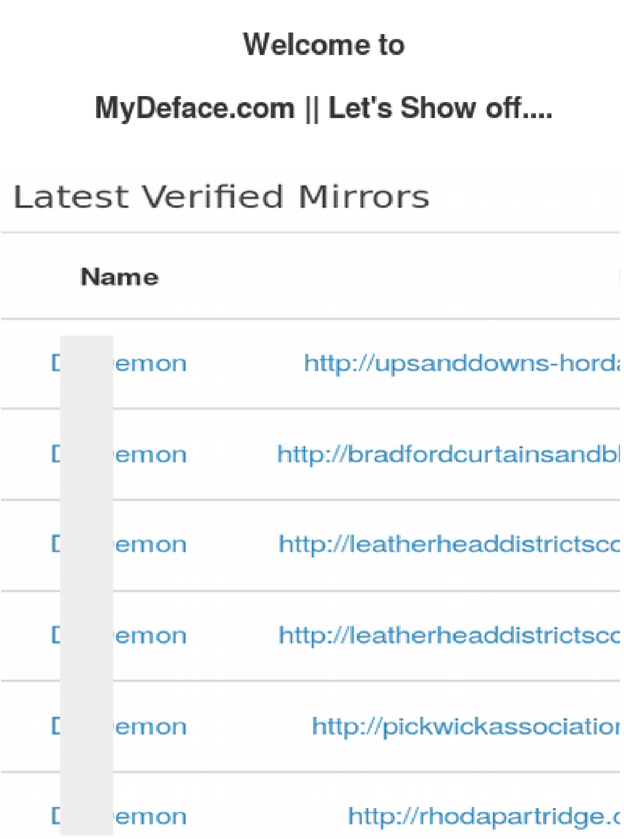
I am so happy to annouce the new Mirror-zone.org unrestected information site, with few nice changes.

We are now at testing this script, this means the script is not stable, and you may get some errors, if you face any issues please contact us and we will be glade to work with you to in order to resolve such issues. Also, this not mean that the Gold release will have the some futures with the bugs fixes, and we will continue to add new futures to the site.

Best Regards,
Adminstration

Hello

mirror-zone.org followers,
Did your defaced site mirror goes to onhold ?
Because your notify name are missing on your deface page



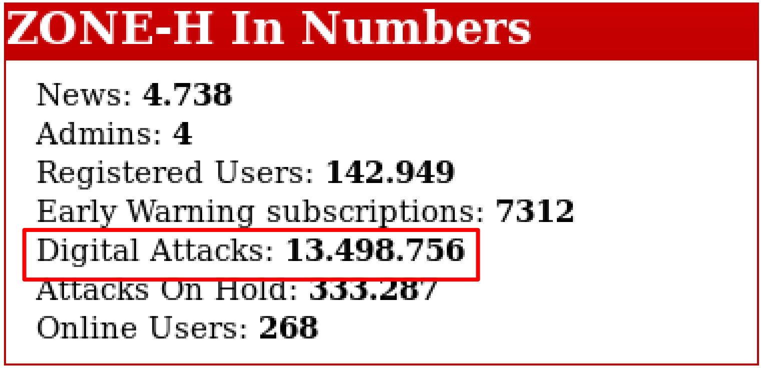
Welcome to

MyDeface.com || Let's Show off....

Latest Verified Mirrors

Name	
D[redacted]emon	http://upsanddowns-hord
D[redacted]emon	http://bradfordcurtainsandbl
D[redacted]emon	http://leatherheaddistrictsc
D[redacted]emon	http://leatherheaddistrictsc
D[redacted]emon	http://pickwickassociatio
D[redacted]emon	http://rhodapartridge.

THE site :)



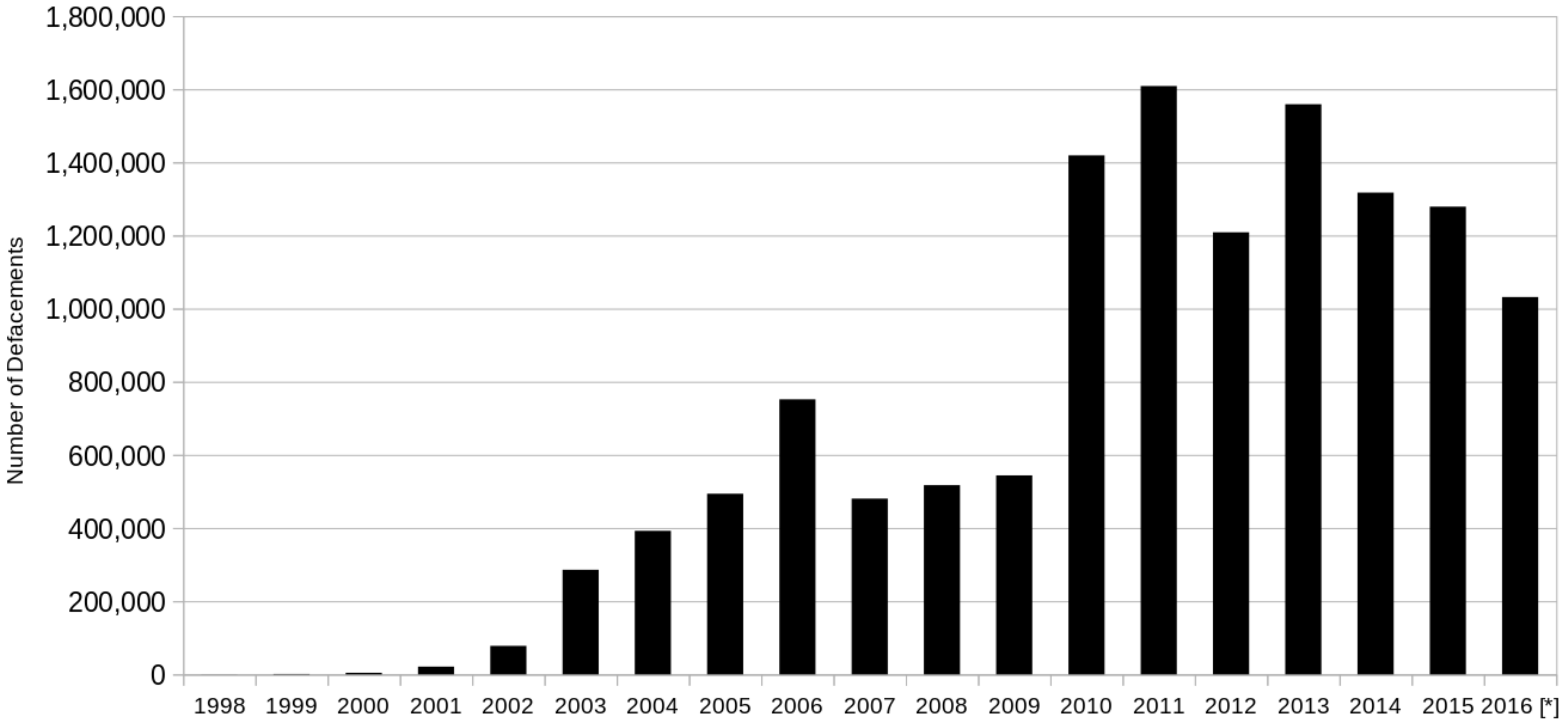
ZONE-H In Numbers

News: **4.738**
Admins: **4**
Registered Users: **142.949**
Early Warning subscriptions: **7312**
Digital Attacks: **13.498.756**
Attacks On Hold: **333.287**
Online Users: **268**

Collected Data

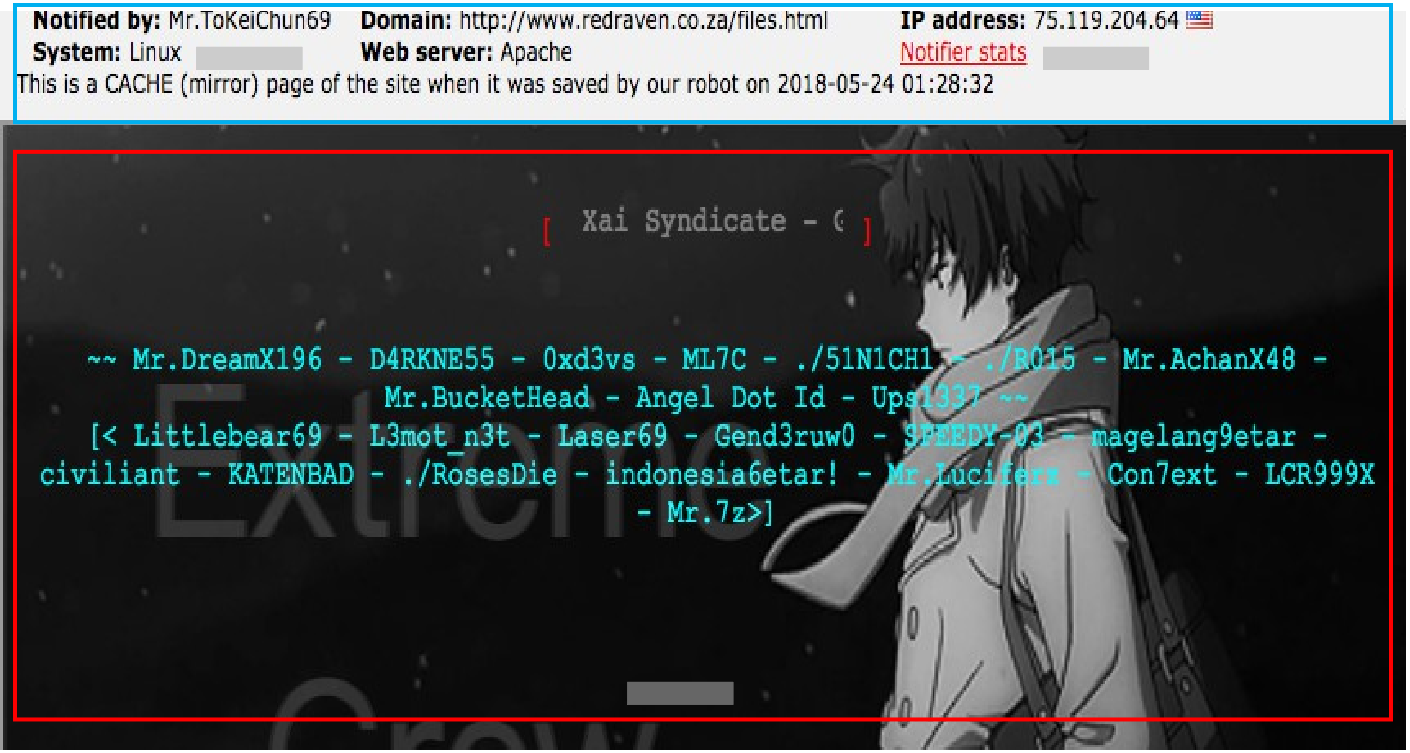
Source Name	Website URL	Acquired Records
Zone-H	`www.zone-h.org`	12,303,240
Hack-CN	`www.hack-cn.com`	386,705
Mirror Zone	`www.mirror-zone.org`	195,398
Hack Mirror	`www.hack-mirror.com`	68,980
MyDeface	`www.mydeface.com`	37,843
	TOTAL	**12,992,166**

Amount of Events Over Time



Up to September

Data Format



Metadata

Notified by: Mr.ToKeiChun69 **Domain:** http://www.redraven.co.za/files.html **IP address:** 75.119.204.64

System: Linux [redacted] **Web server:** Apache Notifier stats [redacted]

This is a CACHE (mirror) page of the site when it was saved by our robot on 2018-05-24 01:28:32

Raw content

[Xai Syndicate - ( ]

~~ Mr.DreamX196 - D4RKNE55 - 0xd3vs - ML7C - ./51N1CH1 - ./R015 - Mr.AchanX48 - Mr.BucketHead - Angel Dot Id - Ups1337 ~~

[< Littlebear69 - L3mot_n3t - Laser69 - Gend3ruw0 - SPEEDY-03 - magelang9etar - civiliant - KATENBAD - ./RosesDie - indonesia6etar! - Mr.Luciferz - Con7ext - LCR999X - Mr.7z>]

[redacted]

Data Accuracy

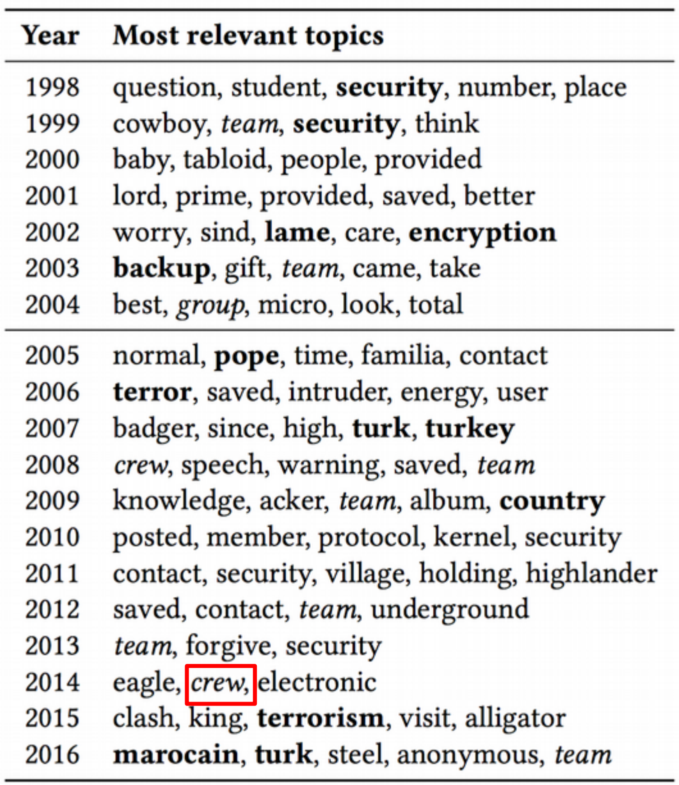
Type	Attribute	Example	Trustworthiness
Metadata	URL	`http://target.gov`	High
	Timestamp	`2010-01-02 15:00`	Medium
	Nickname	`Neo Hacker`	Medium-Low

	Webserver;
	Reason;
	Hack Mode
		`Nginx;`
		`Political;`
		`SQLi`
			Low

Raw content	Main page	HTML or TXT file	High
	Embeeded resources	Various format	High
	External resources	Various format	Medium-High

General Trends

Topics

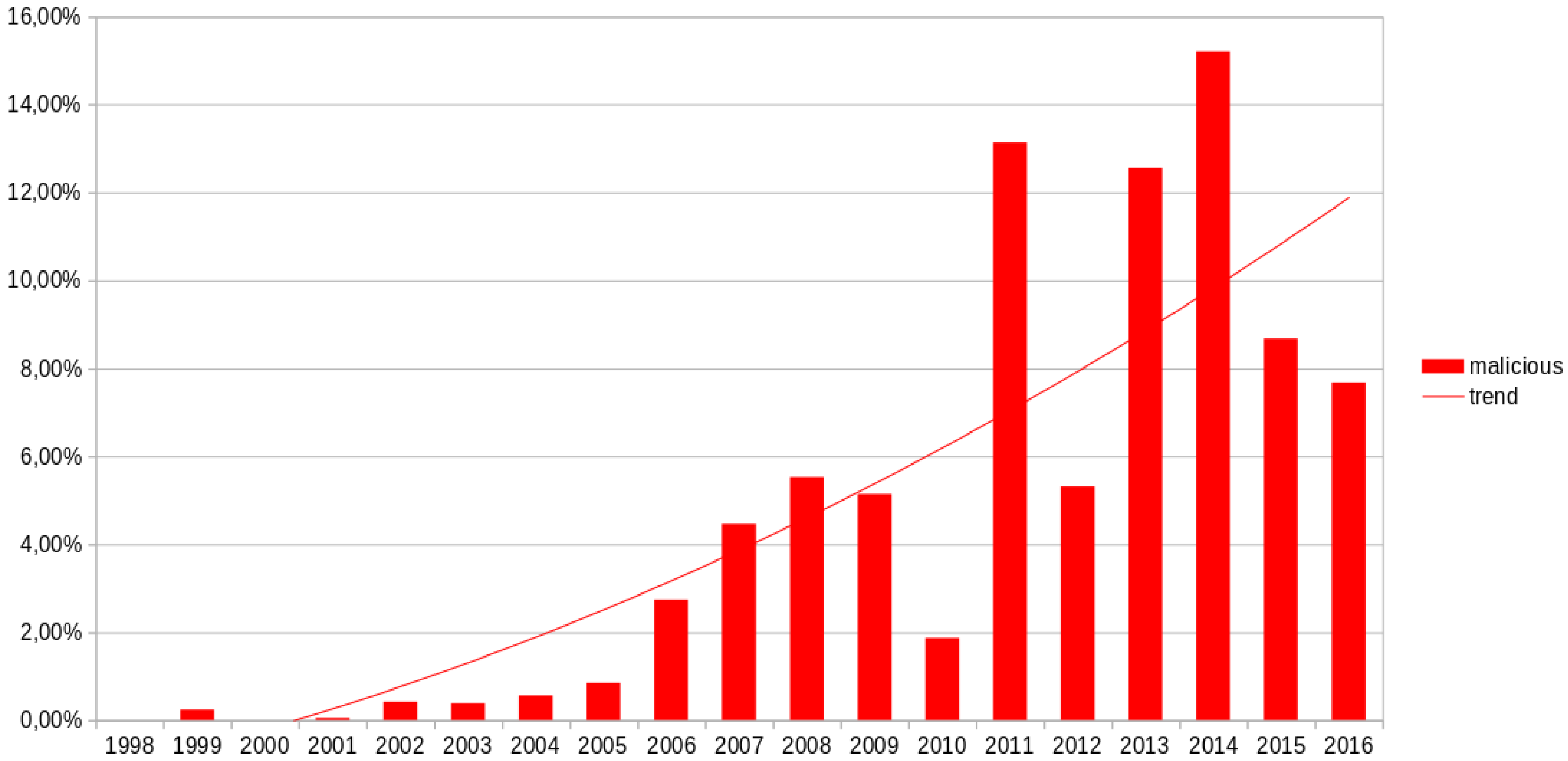


Year	Most relevant topics
1998	question, student, **security**, number, place
1999	cowboy, *team*, **security**, think
2000	baby, tabloid, people, provided
2001	lord, prime, provided, saved, better
2002	worry, sind, **lame**, care, **encryption**
2003	**backup**, gift, *team*, came, take
2004	best, *group*, micro, look, total
2005	normal, **pope**, time, familia, contact
2006	**terror**, saved, intruder, energy, user
2007	badger, since, high, **turk**, **turkey**
2008	*crew*, speech, warning, saved, *team*
2009	knowledge, acker, *team*, album, **country**
2010	posted, member, protocol, kernel, security
2011	contact, security, village, holding, highlander
2012	saved, contact, *team*, underground
2013	*team*, forgive, security
2014	eagle, *crew*, electronic
2015	clash, king, **terrorism**, visit, alligator
2016	**marocain**, **turk**, steel, anonymous, *team*

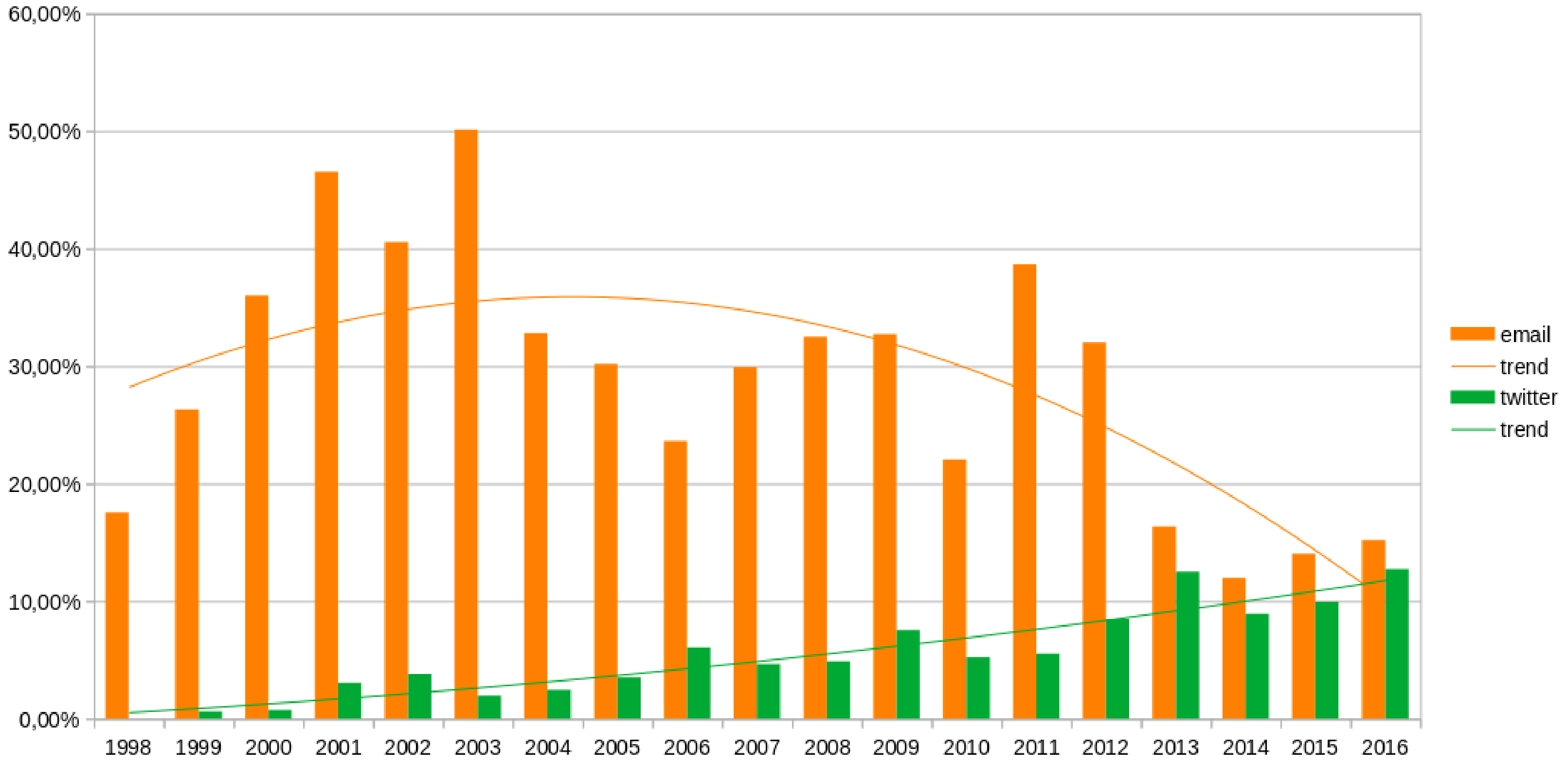
Security Problems

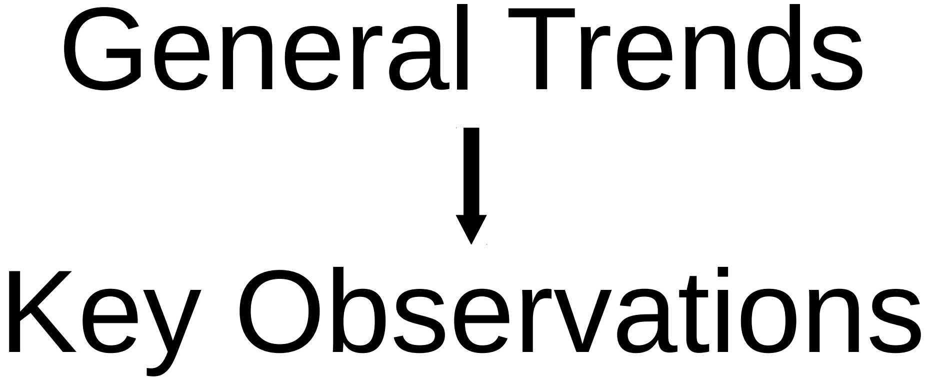
Real World Events

Adoption of Malicious Content



Adoption of email & Twitter handlers

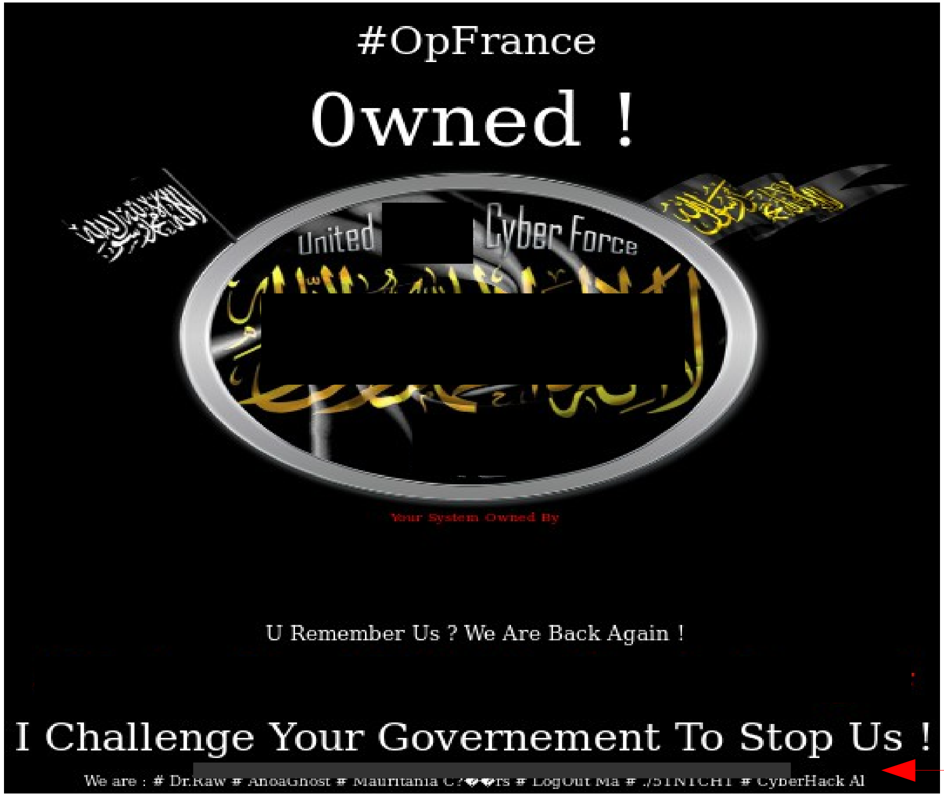




General Trends

Key Observations

Teams vs. Individuals



#OpFrance

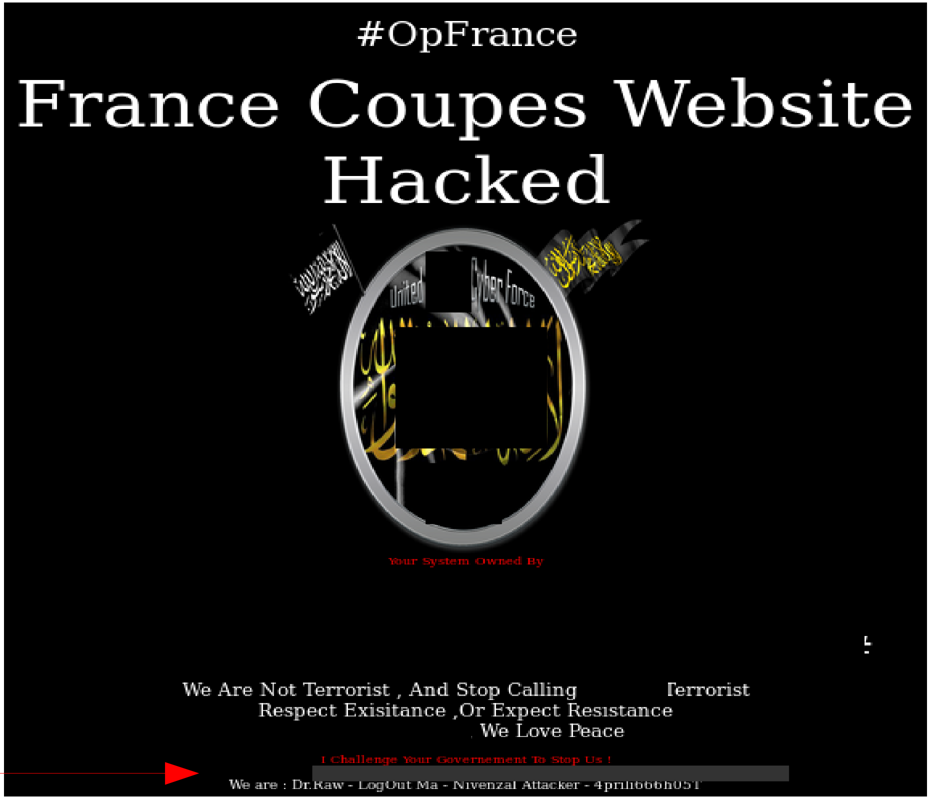
Owned !

Your System Owned By

U Remember Us ? We Are Back Again !

I Challenge Your Governement To Stop Us !

We are : # Dr.Raw # AnoaGhost # Mauritania C?��rs # LogOut Ma # ./5TNTCHT # CyberHack Al



#OpFrance

France Coupes Website Hacked

Your System Owned By

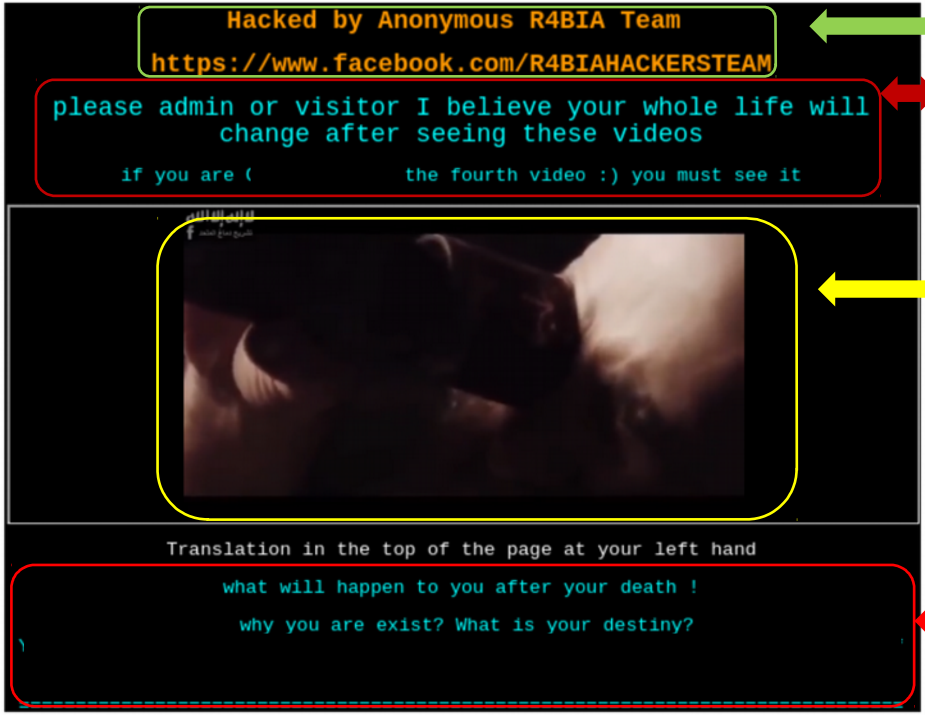
We Are Not Terrorist , And Stop Calling Terrorist
Respect Exisitance ,Or Expect Resistance
We Love Peace

I Challenge Your Governement To Stop Us !

We are : Dr.Raw - LogOut Ma - Nivenzal Attacker - 4prili666h05T

Templates & Campaigns

Template



Hacked by Anonymous R4BIA Team

https://www.facebook.com/R4BIAHACKERSTEAM

please admin or visitor I believe your whole life will change after seeing these videos

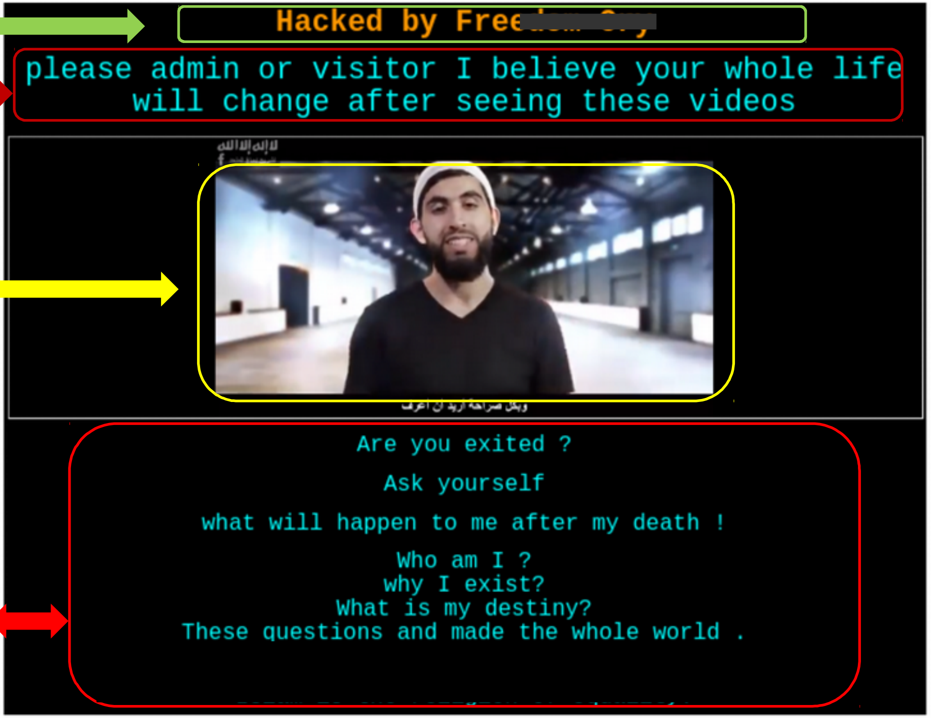
if you are (the fourth video :) you must see it

Translation in the top of the page at your left hand

what will happen to you after your death !

why you are exist? What is your destiny?

Customization



Hacked by Free[redacted]

please admin or visitor I believe your whole life will change after seeing these videos

Are you exited ?

Ask yourself

what will happen to me after my death !

Who am I ?
why I exist?
What is my destiny?
These questions and made the whole world .

Key Observations

1. Actors **cooperate** in teams

   Especially if driven by **similar, strong ideologies**

2. Defacements are organized around **campaigns**

3. Teams re-use a common **template** that each member can customize

Key Observations

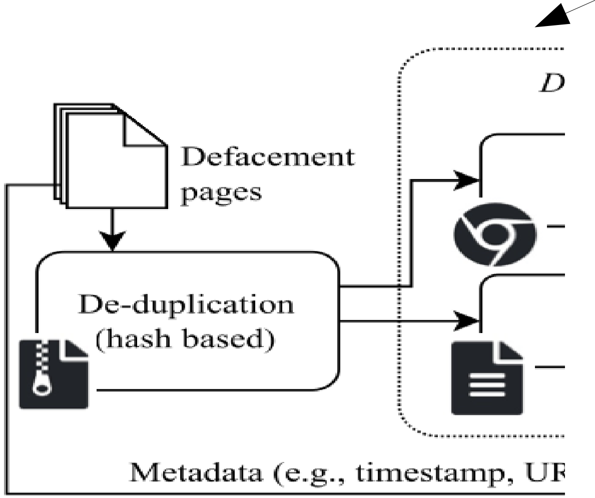
↓

Next Generation* Defacement Explorer

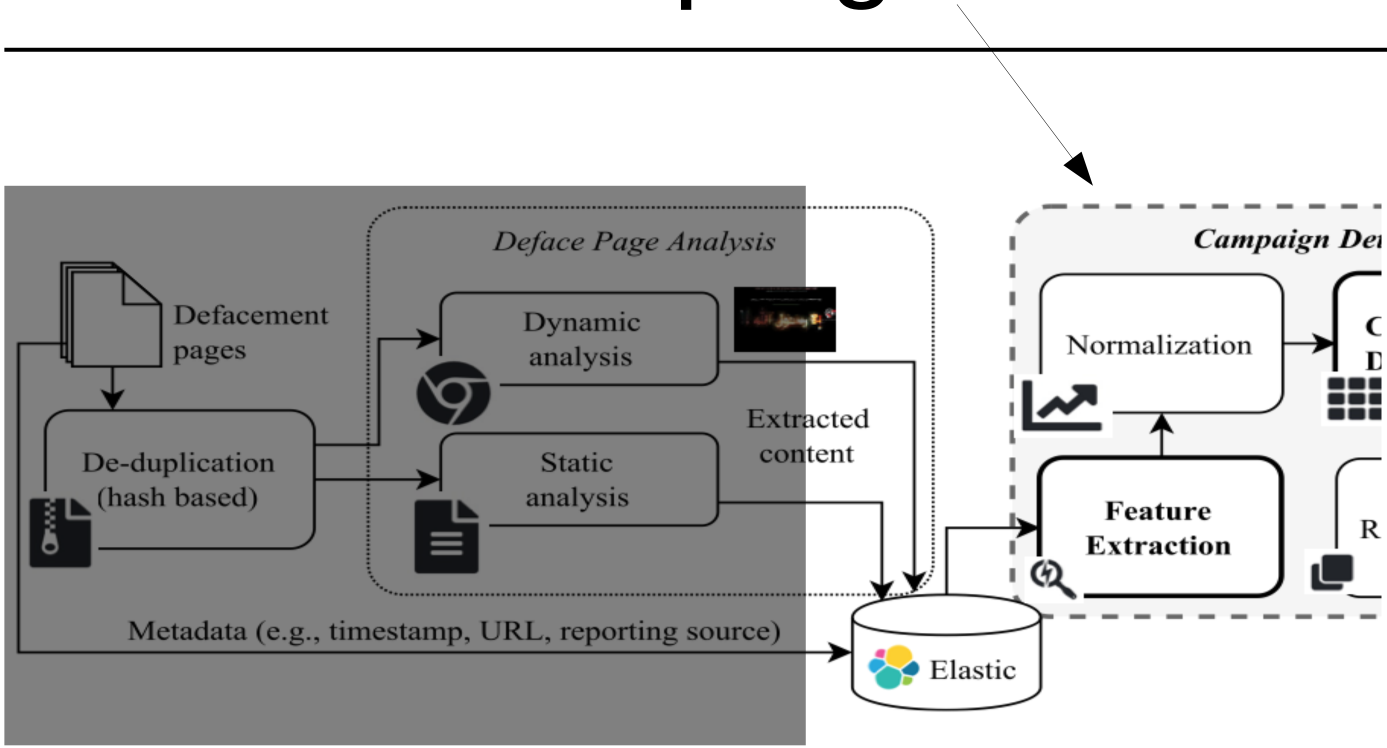
(DefPloreX-NG)

(*) 1st generation presented at BH Arsenal

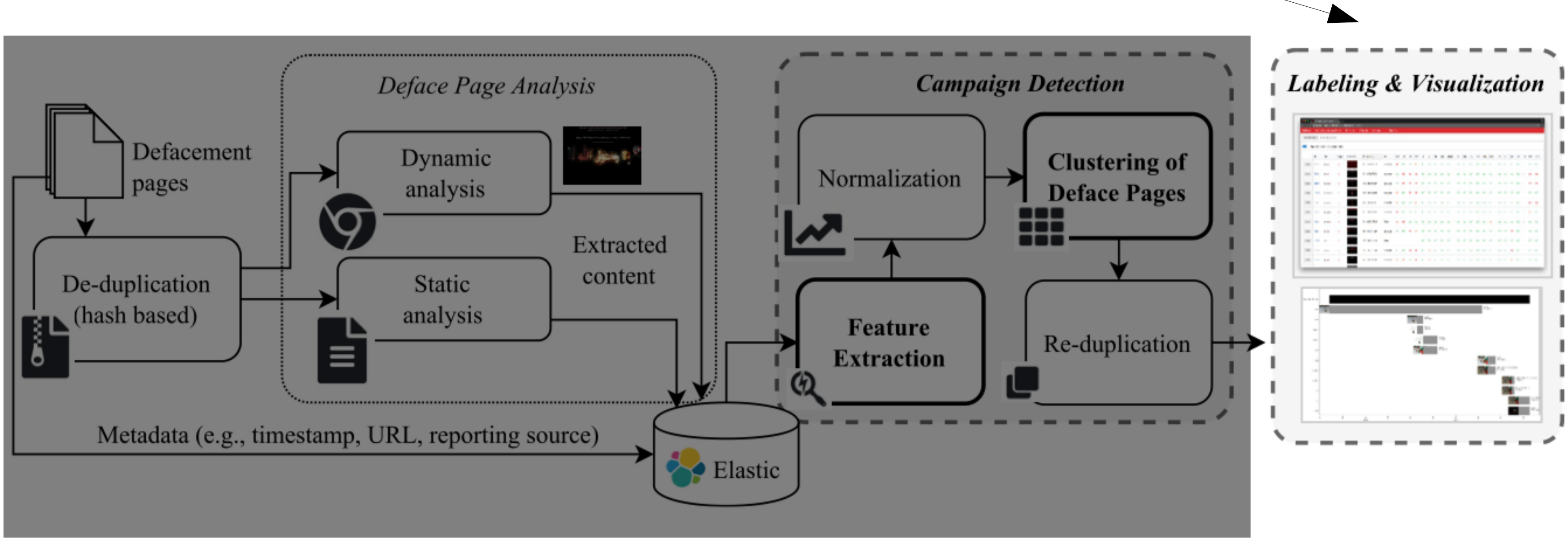
Deface Page Analysis

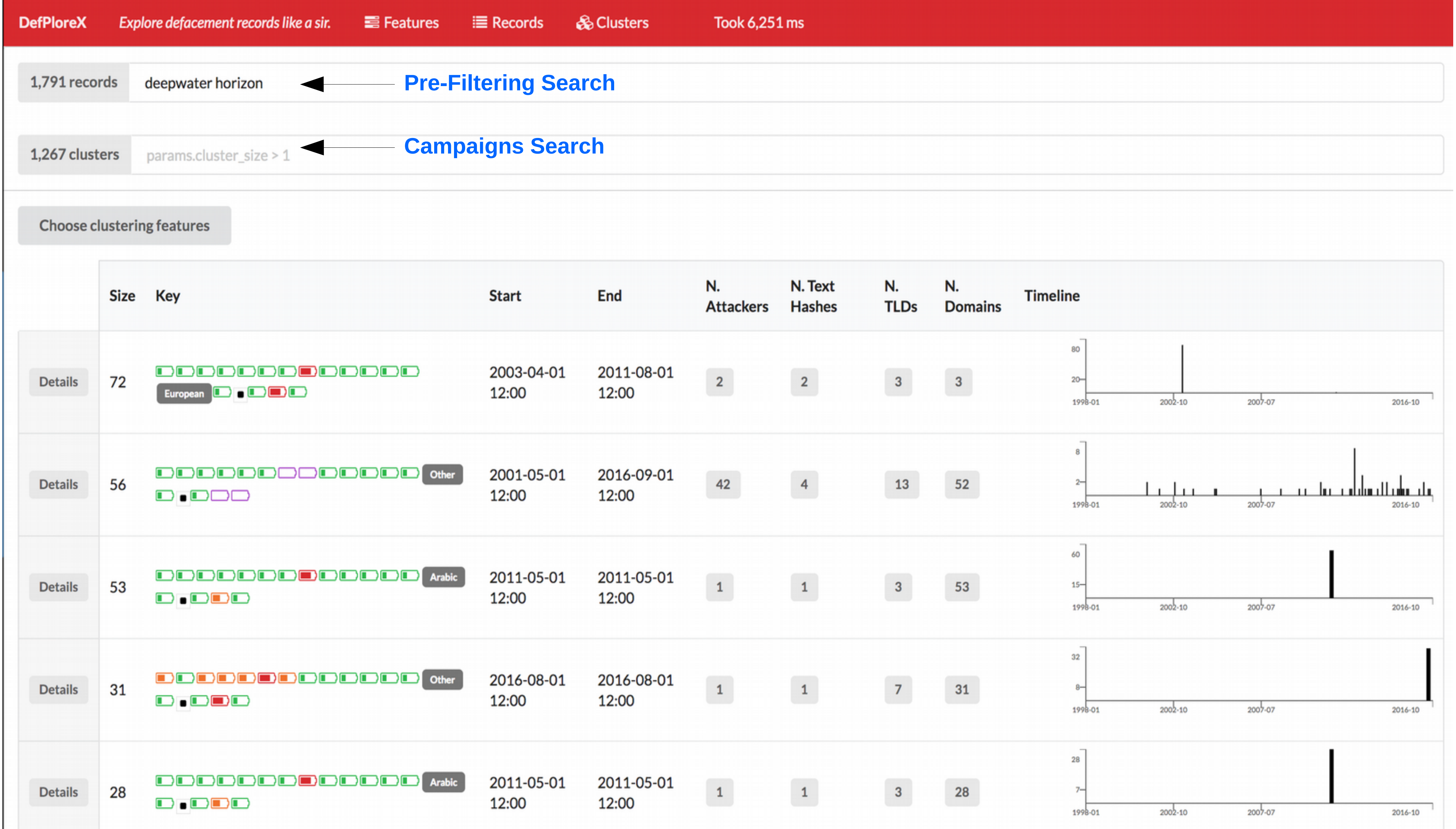


Campaign Detection



Labeling & Visualization




DefPloreX
Explore defacement records like a sir.
Features
Records
Clusters
Took 6,251 ms

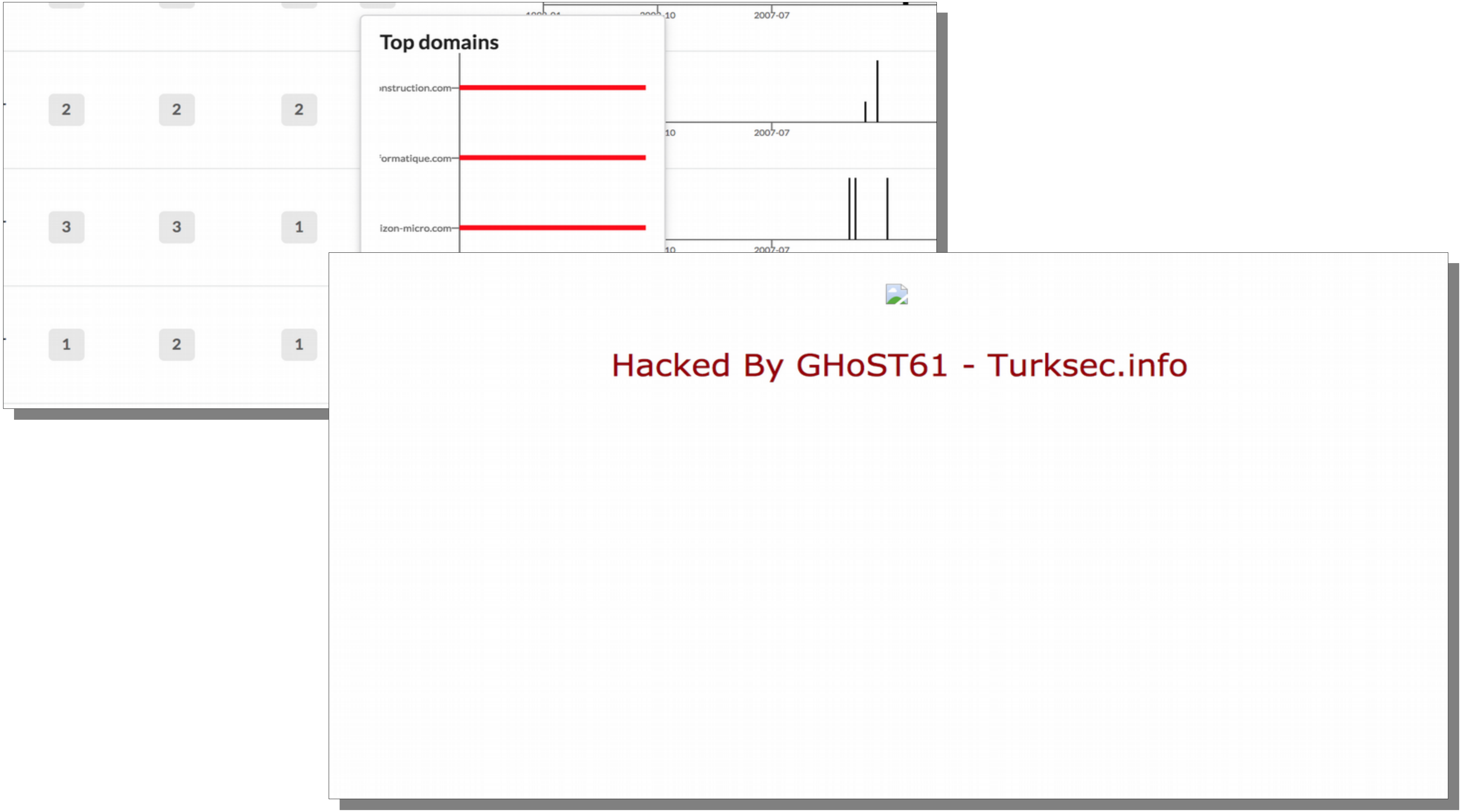
1,791 records	deepwater horizon
1,267 clusters	params.cluster_size > 1

Pre-Filtering Search

Campaigns Search

Choose clustering features

	Size	Key	Start	End	N. Attackers	N. Text Hashes	N. TLDs	N. Domains	Timeline
Details	72	🟩🟩🟩🟩🟩🟩🟩🟥🟩🟩🟩🟩🟩 European 🟩 ■ 🟩🟥🟩	2003-04-01 12:00	2011-08-01 12:00	2	2	3	3	
Details	56	🟩🟩🟩🟩🟩🟩🟪🟪🟩🟩🟩🟩🟩 Other 🟩 ■ 🟩🟪🟪	2001-05-01 12:00	2016-09-01 12:00	42	4	13	52	
Details	53	🟩🟩🟩🟩🟩🟩🟩🟥🟩🟩🟩🟩🟩 Arabic 🟩 ■ 🟩🟧🟩	2011-05-01 12:00	2011-05-01 12:00	1	1	3	53	
Details	31	🟧🟩🟧🟧🟧🟥🟧🟩🟩🟩🟩🟩🟩 Other 🟩 ■ 🟩🟥🟩	2016-08-01 12:00	2016-08-01 12:00	1	1	7	31	
Details	28	🟩🟩🟩🟩🟩🟩🟩🟥🟩🟩🟩🟩🟩 Arabic 🟩 ■ 🟩🟧🟩	2011-05-01 12:00	2011-05-01 12:00	1	1	3	28	



2	2	2
3	3	1
1	2	1

Top domains

Hacked By GHoST61 - Turksec.info

Implementation Details

Feature Engineering

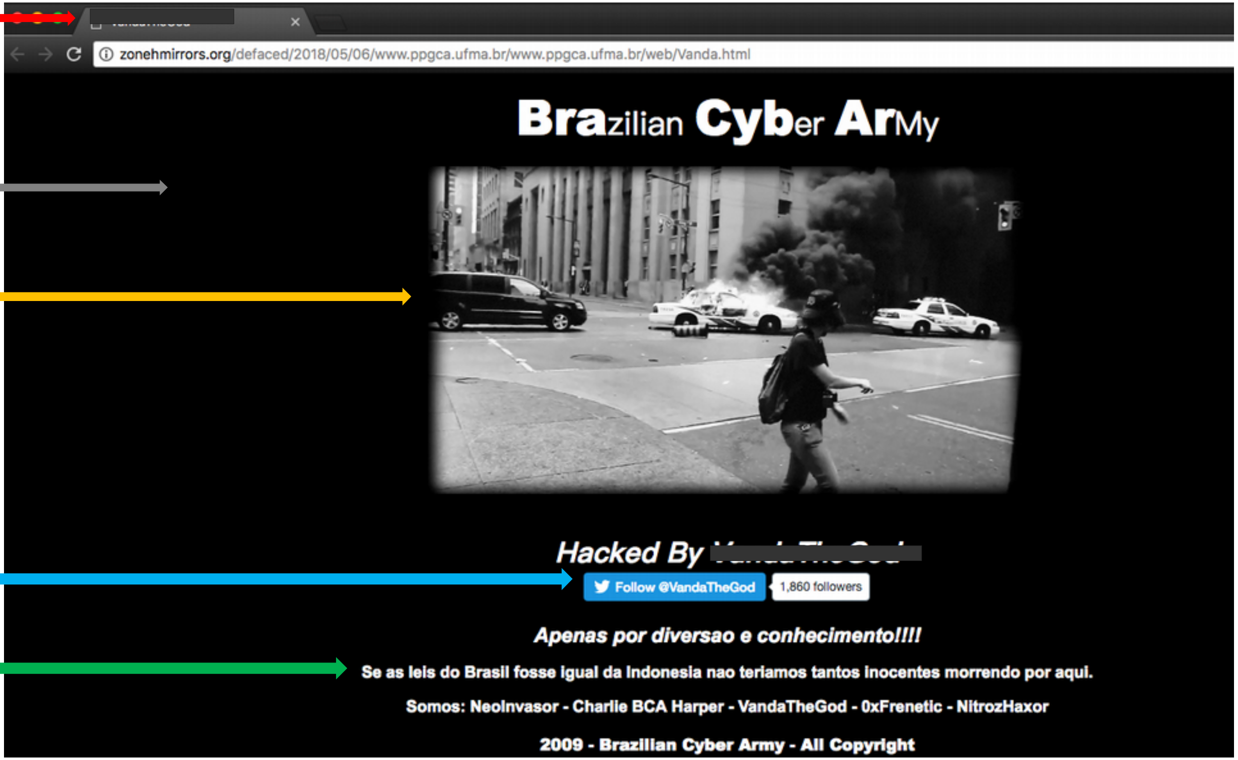
Format of Title

Visual Features (colors)

Visual Features (images)

Social Features

Structural Features



[redacted]
zonehmirrors.org/defaced/2018/05/06/www.ppgca.ufma.br/www.ppgca.ufma.br/web/Vanda.html
Follow @VandaTheGod
1,860 followers

Brazilian Cyber ArMy

Hacked By [redacted]

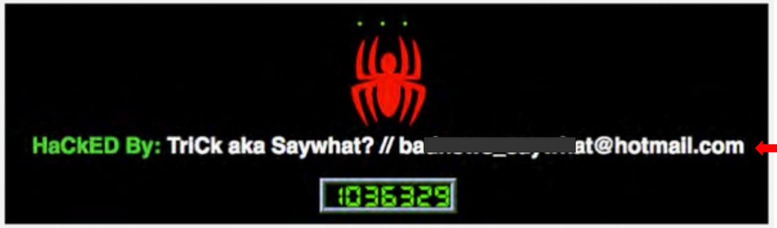
Apenas por diversao e conhecimento!!!!

Se as leis do Brasil fosse igual da Indonesia nao teriamos tantos inocentes morrendo por aqui.

Somos: NeoInvasor - Charlie BCA Harper - VandaTheGod - 0xFrenetic - NitrozHaxor

2009 - Brazilian Cyber Army - All Copyright

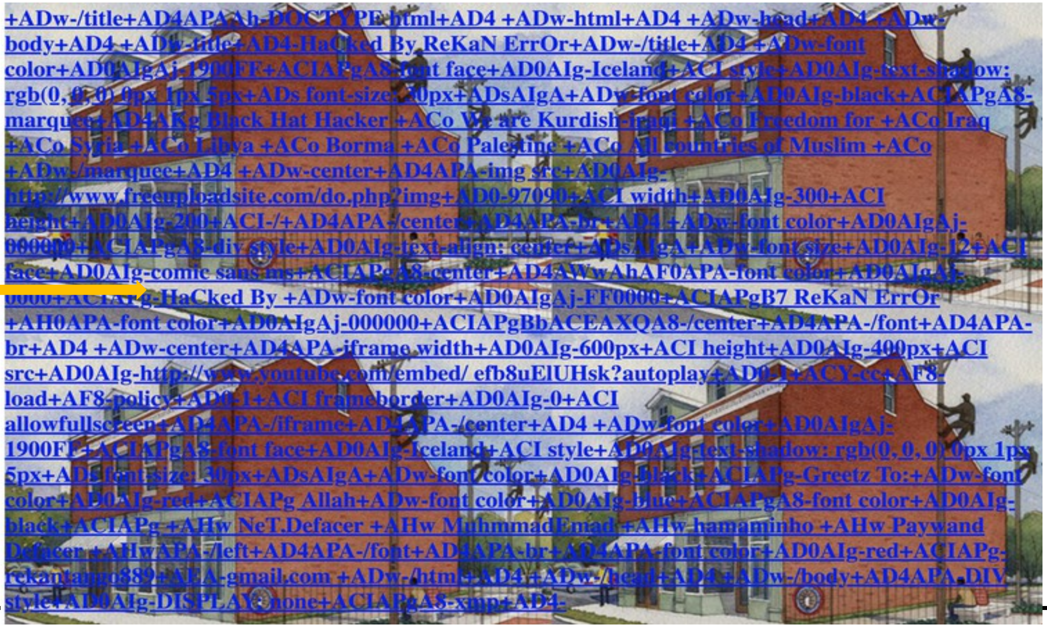
Feature Engineering



HaCkED By: TriCk aka Saywhat? // ba[redacted]at@hotmail.com

Email Addresses

Media resources and URLs



```
+ADw-/title+AD4APAAh-DOCTYPE html+AD4 +ADw-html+AD4 +ADw-head+AD4 +ADw-
body+AD4 +ADw-title+AD4-HaCked By ReKaN ErrOr+ADw-/title+AD4 +ADw-font
color+AD0AIgAj-1900FF+ACIAPgA8-font face+AD0AIg-Iceland+ACI style+AD0AIg-text-shadow:
rgb(0, 0, 0) 0px 1px 5px+ADs font-size: 30px+ADsAIgA+ADw-font color+AD0AIg-black+ACIAPgA8-
marquee+AD4AKg Black Hat Hacker +ACo We are Kurdish-iraqi +ACo Freedom for +ACo Iraq
+ACo Syria +ACo Libya +ACo Borma +ACo Palestine +ACo All countries of Muslim +ACo
+ADw-/marquee+AD4 +ADw-center+AD4APA-img src+AD0AIg-
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rekantango889+AEA-gmail.com +ADw-/html+AD4 +ADw-/head+AD4 +ADw-/body+AD4APA-DIV
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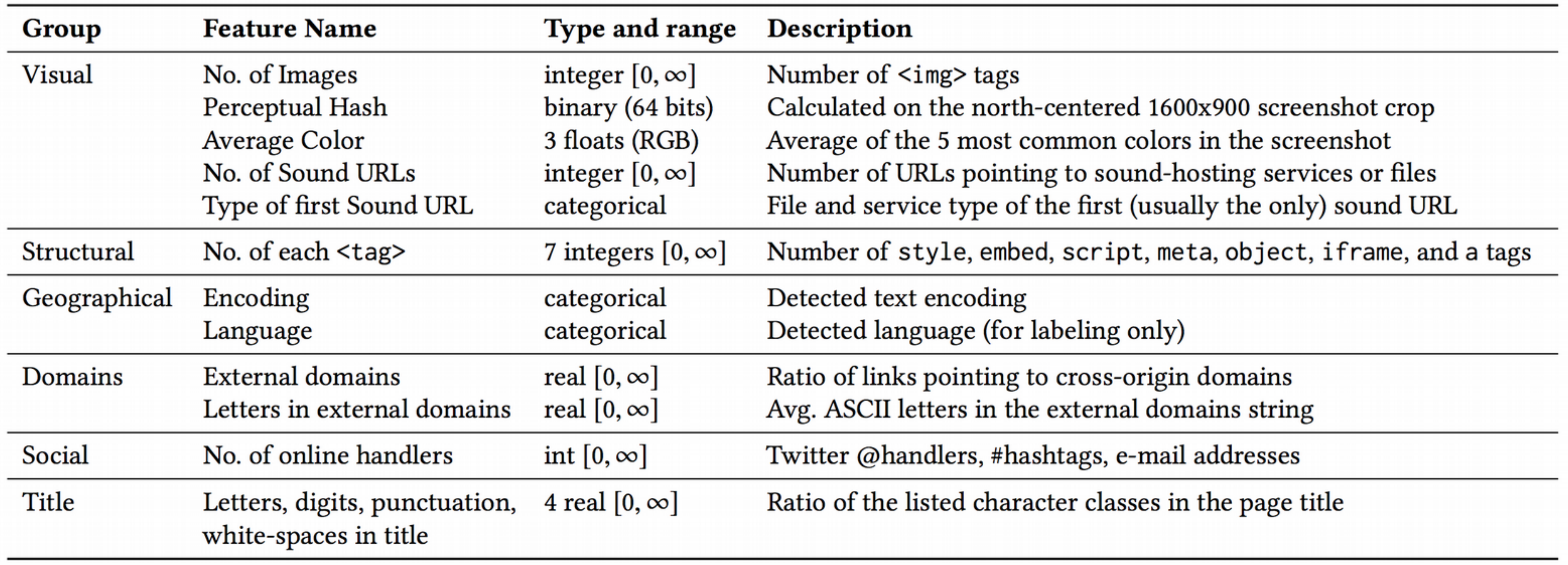
Summary of Features



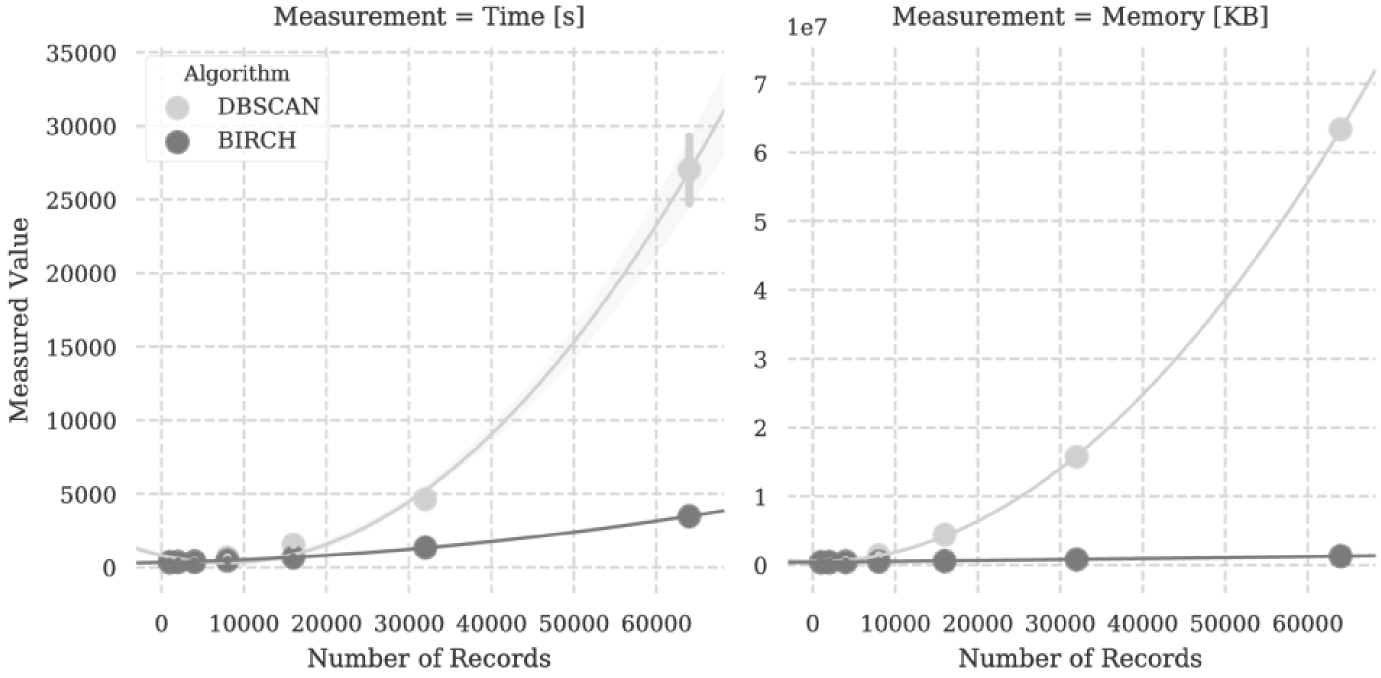
Group	Feature Name	Type and range	Description
Visual	No. of Images	integer $[0, \infty]$	Number of <img> tags
	Perceptual Hash	binary (64 bits)	Calculated on the north-centered 1600x900 screenshot crop
	Average Color	3 floats (RGB)	Average of the 5 most common colors in the screenshot
	No. of Sound URLs	integer $[0, \infty]$	Number of URLs pointing to sound-hosting services or files
	Type of first Sound URL	categorical	File and service type of the first (usually the only) sound URL
Structural	No. of each <tag>	7 integers $[0, \infty]$	Number of style, embed, script, meta, object, iframe, and a tags
Geographical	Encoding	categorical	Detected text encoding
	Language	categorical	Detected language (for labeling only)
Domains	External domains	real $[0, \infty]$	Ratio of links pointing to cross-origin domains
	Letters in external domains	real $[0, \infty]$	Avg. ASCII letters in the external domains string
Social	No. of online handlers	int $[0, \infty]$	Twitter @handlers, #hashtags, e-mail addresses
Title	Letters, digits, punctuation, white-spaces in title	4 real $[0, \infty]$	Ratio of the listed character classes in the page title

Campaign Detection: Clustering

- BIRCH
  - Balanced Iterative Reducing and Clustering Hierarchies
- Do **not** materialize the entire distance matrix
  - Statistical values are efficient to compute
  - Quickly find the closest cluster for each new data points

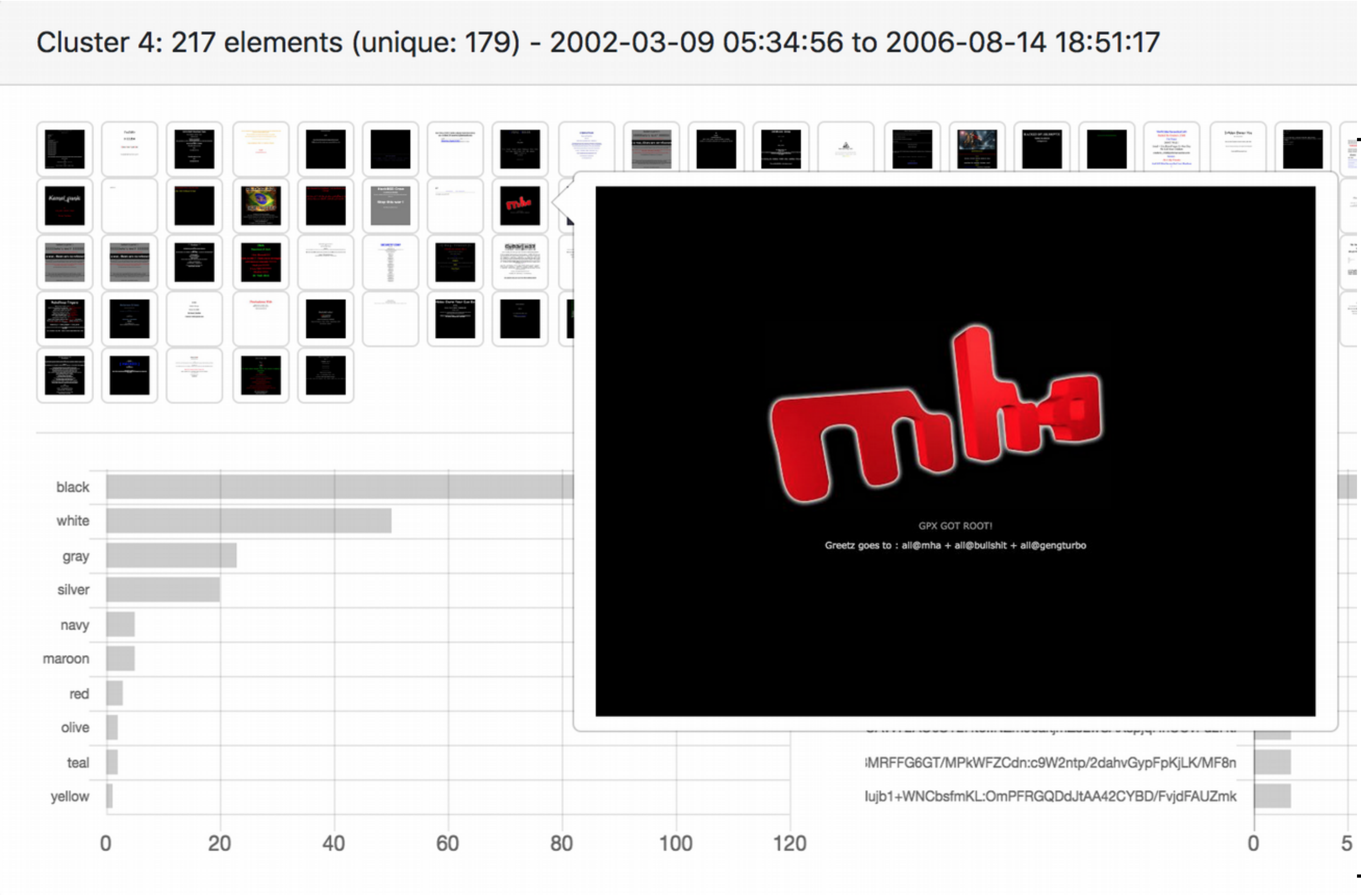
Scaling Clustering

- Scalability of BIRCH vs. DBSCAN (10 runs)



Clusters → Campaigns: Labeling

- Each cluster represented in a **succinct report**
  - **Time** span
  - Screenshot **thumbnails** (by perceptual hash)
  - Name of **actors** and **teams**
  - **Keywords** used in campaigns (e.g. #opfrance)
  - **Category** of targets (e.g, news, governmental sites)

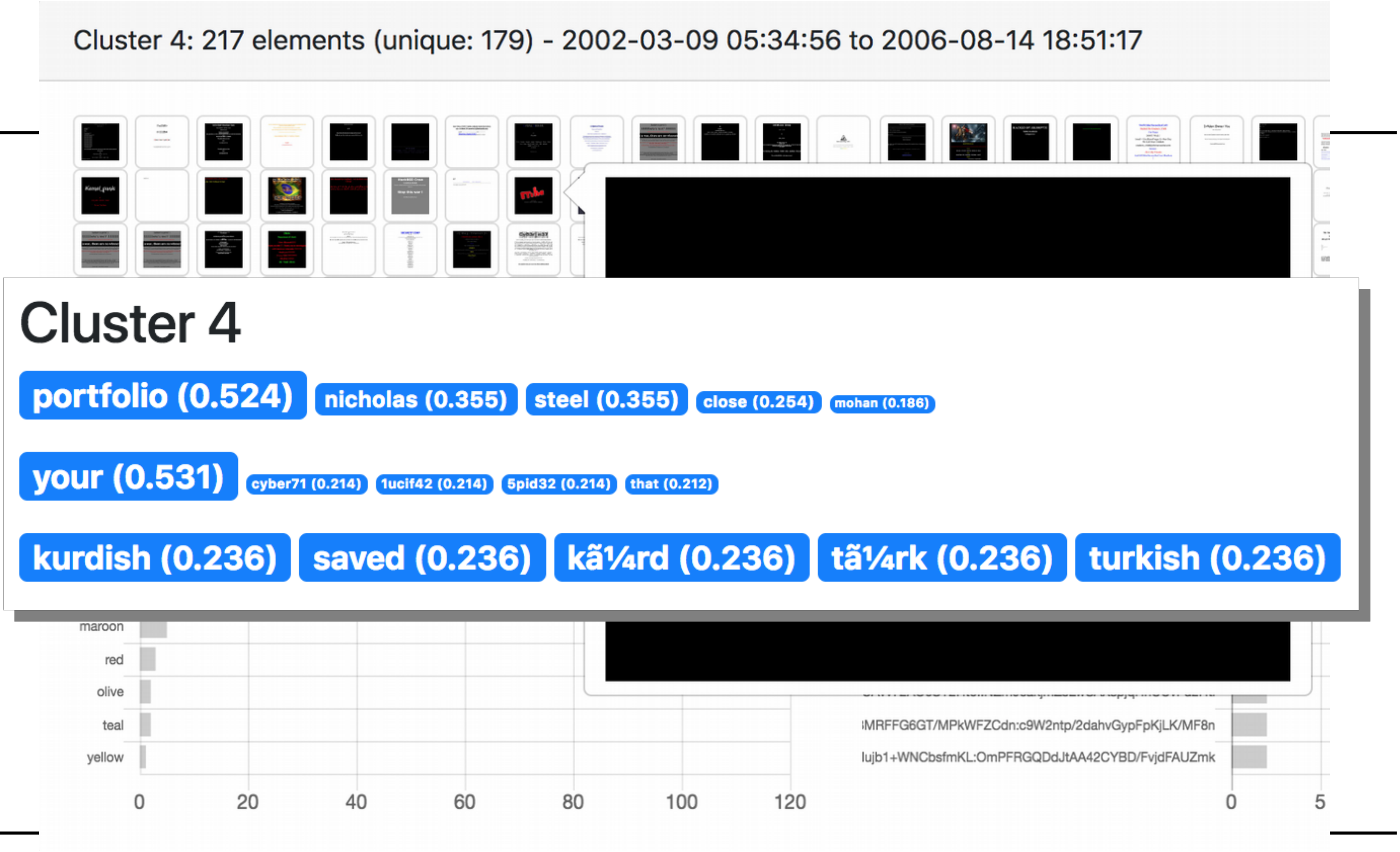


Cluster 4: 217 elements (unique: 179) - 2002-03-09 05:34:56 to 2006-08-14 18:51:17

GPX GOT ROOT!

Greetz goes to : all@mha + all@bullshit + all@gengturbo

mha
black
white
gray
silver
navy
maroon
red
olive
teal
yellow
0
20
40
60
80
100
120
MRFFG6GT/MPkWFZCdn:c9W2ntp/2dahvGypFpKjLK/MF8n
lujb1+WNCbsfmKL:OmPFRGQDdJtAA42CYBD/FvjdFAUZmk
0
5



Cluster 4: 217 elements (unique: 179) - 2002-03-09 05:34:56 to 2006-08-14 18:51:17

Cluster 4

portfolio (0.524) nicholas (0.355) steel (0.355) close (0.254) mohan (0.186)

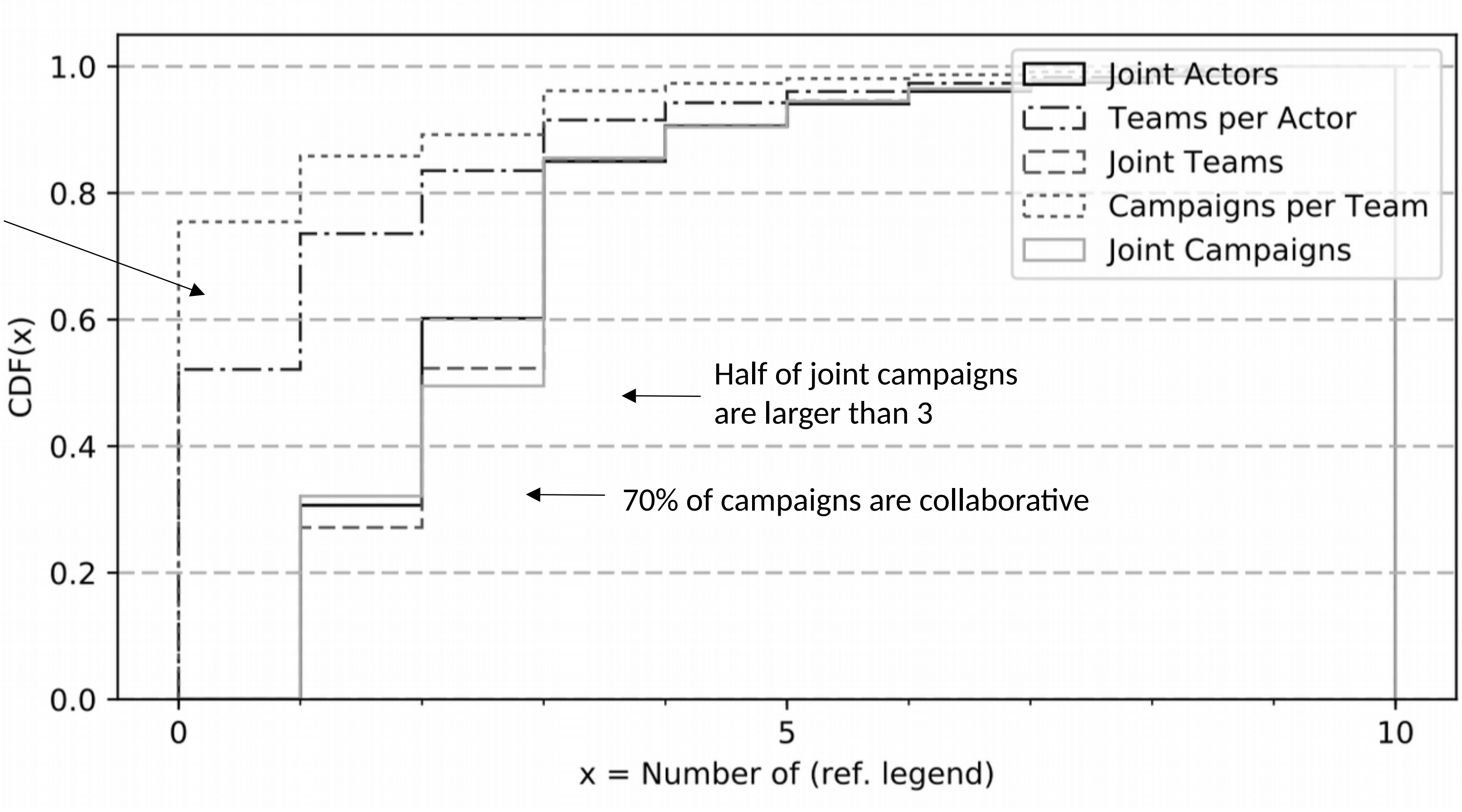
your (0.531) cyber71 (0.214) 1ucif42 (0.214) 5pid32 (0.214) that (0.212)

kurdish (0.236) saved (0.236) kã¼rd (0.236) tã¼rk (0.236) turkish (0.236)

maroon
red
olive
teal
yellow
0
20
40
60
80
100
120
MRFFG6GT/MPkWFZCdn:c9W2ntp/2dahvGypFpKjLK/MF8n
lujb1+WNCbsfmKL:OmPFRGQDdJtAA42CYBD/FvjdFAUZmk
0
5

Findings

Organization of Actors



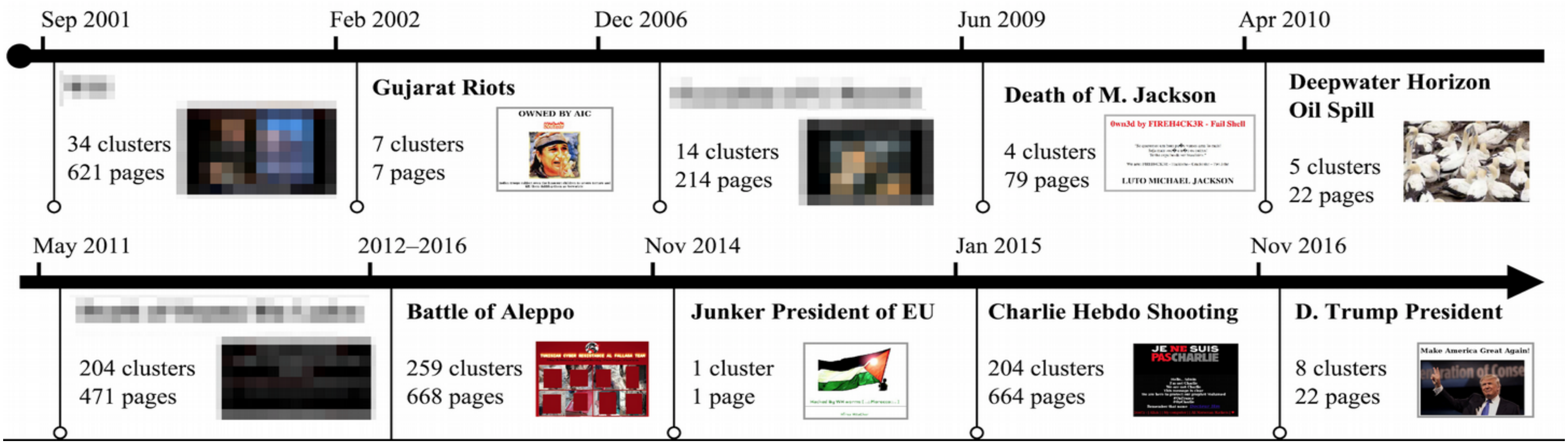
43% of actors join one team, at least

Half of joint campaigns are larger than 3

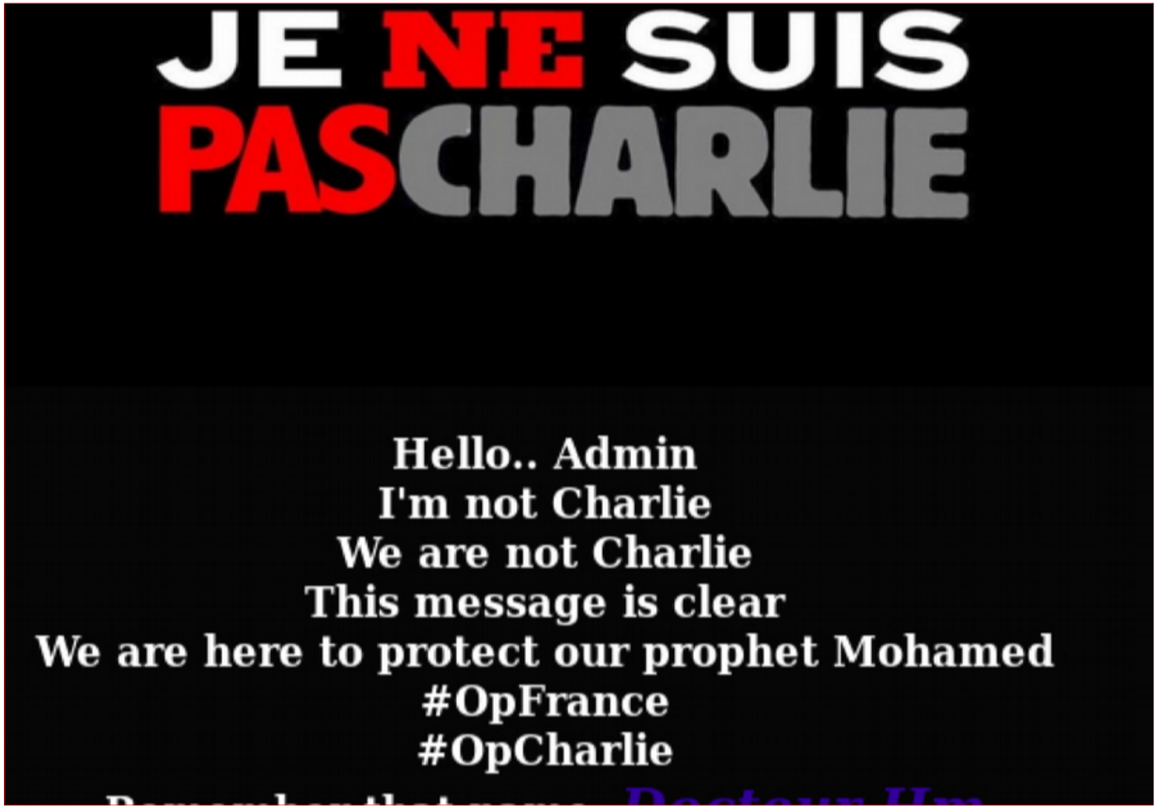
70% of campaigns are collaborative

Geopolitical Real-World Events

Successfully detected



The “Charlie Hebdo” case



JE NE SUIS PASCHARLIE

Hello.. Admin
I'm not Charlie
We are not Charlie
This message is clear
We are here to protect our prophet Mohamed
#OpFrance
#OpCharlie
Remember that name - Doctour Hm

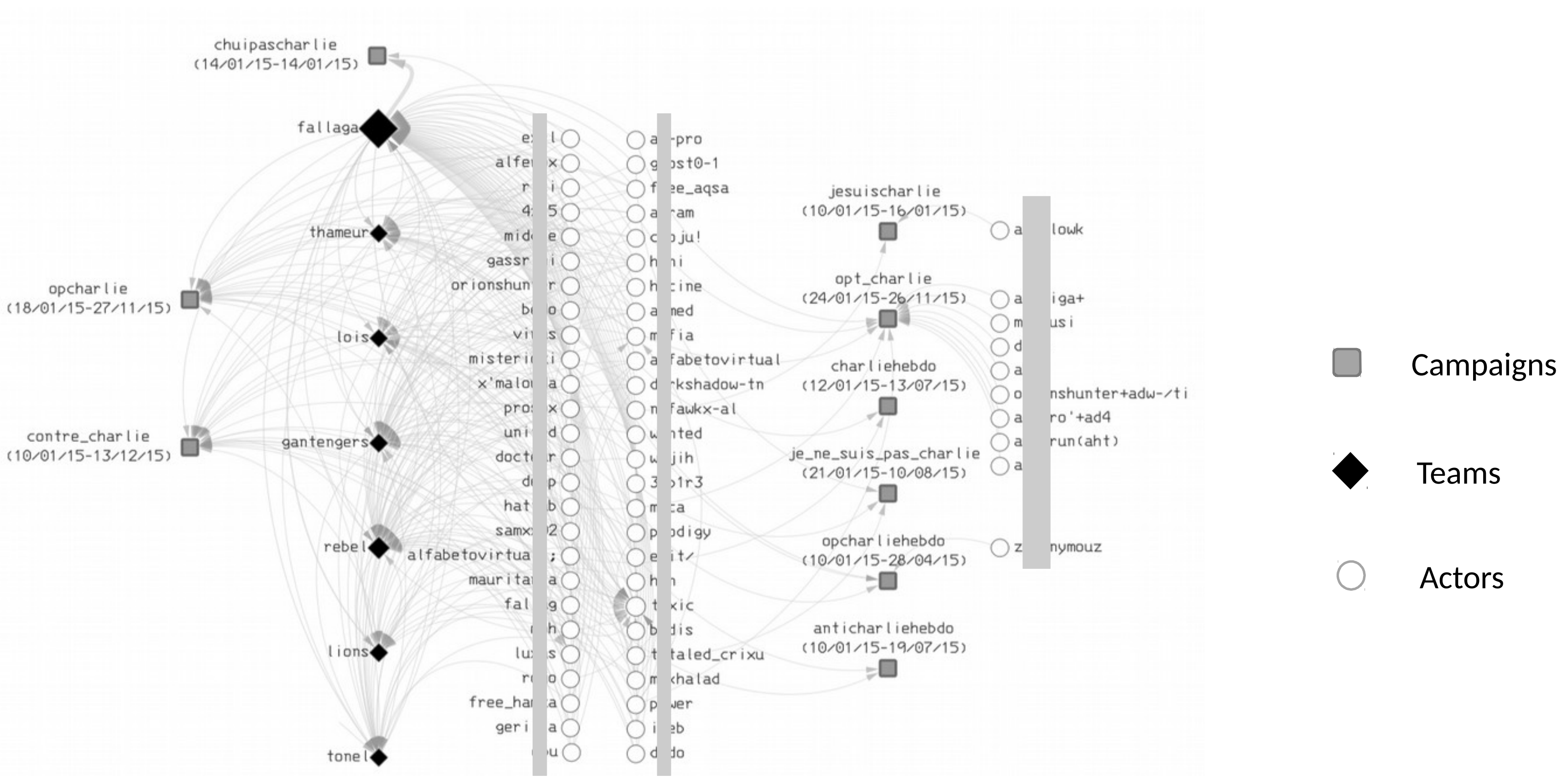
The “Charlie Hebdo” case

■ Campaigns

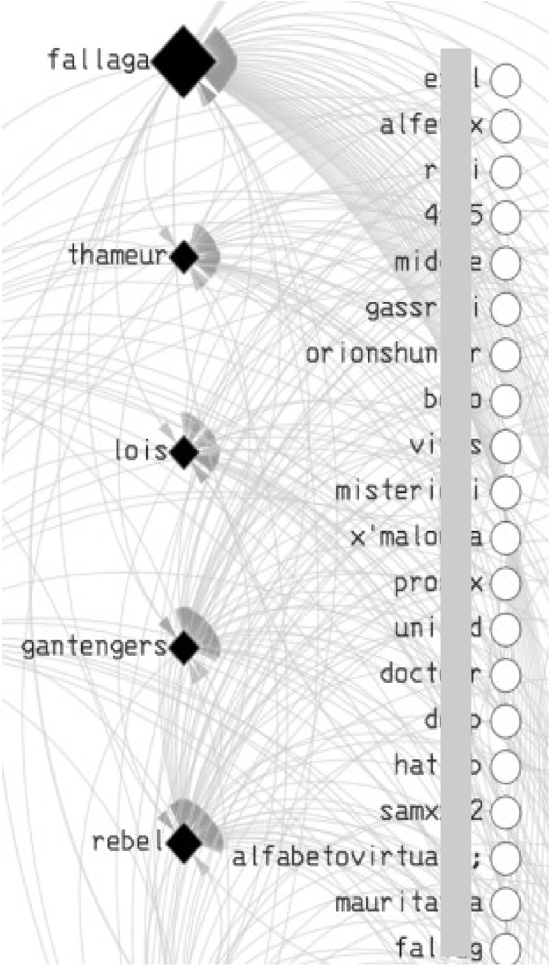
◆ Teams

○ Actors

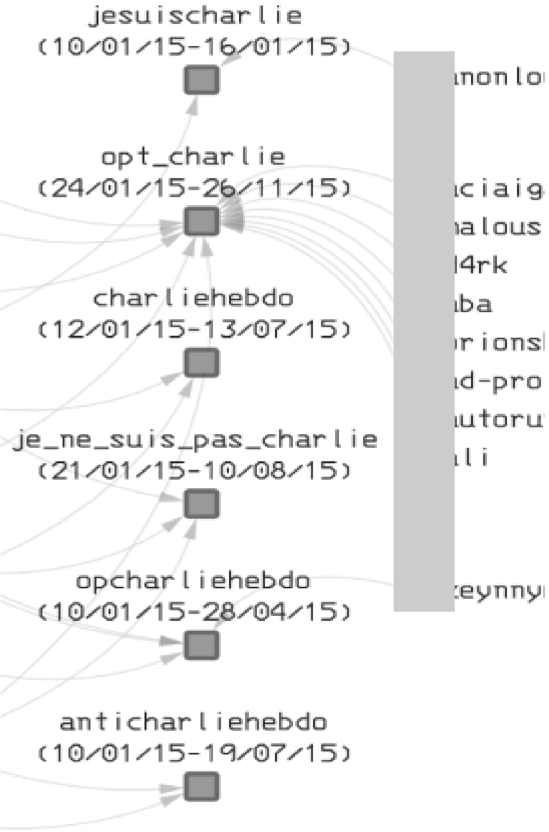
The “Charlie Hebdo” case



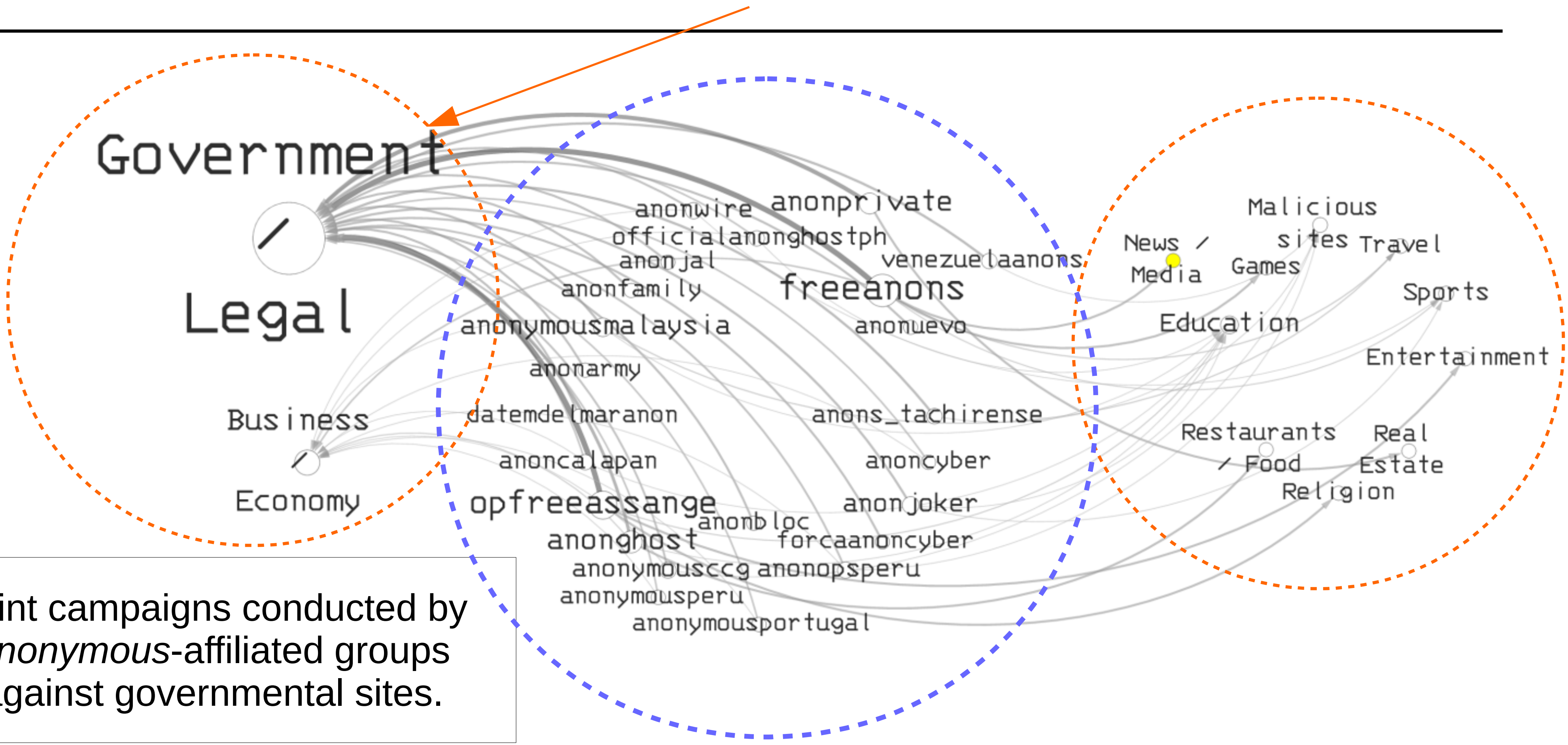
Affiliated actors



Lone wolfs



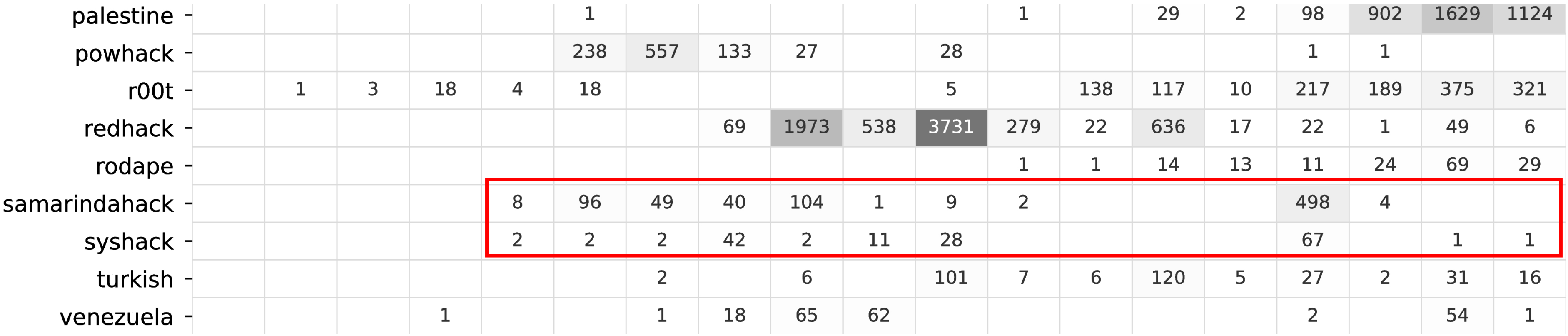
Anonymous Ops. Target Gov. Sites



Joint campaigns conducted by *anonymous*-affiliated groups against governmental sites.

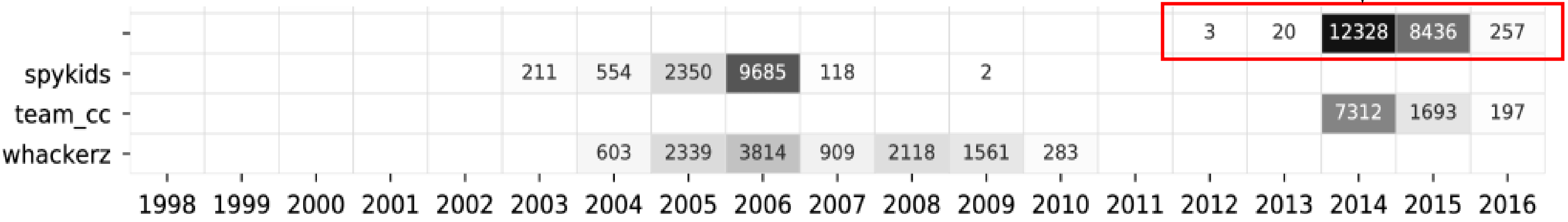
Long-Term vs. Aggressive Campaigns

Long-Term vs. Aggressive Campaigns

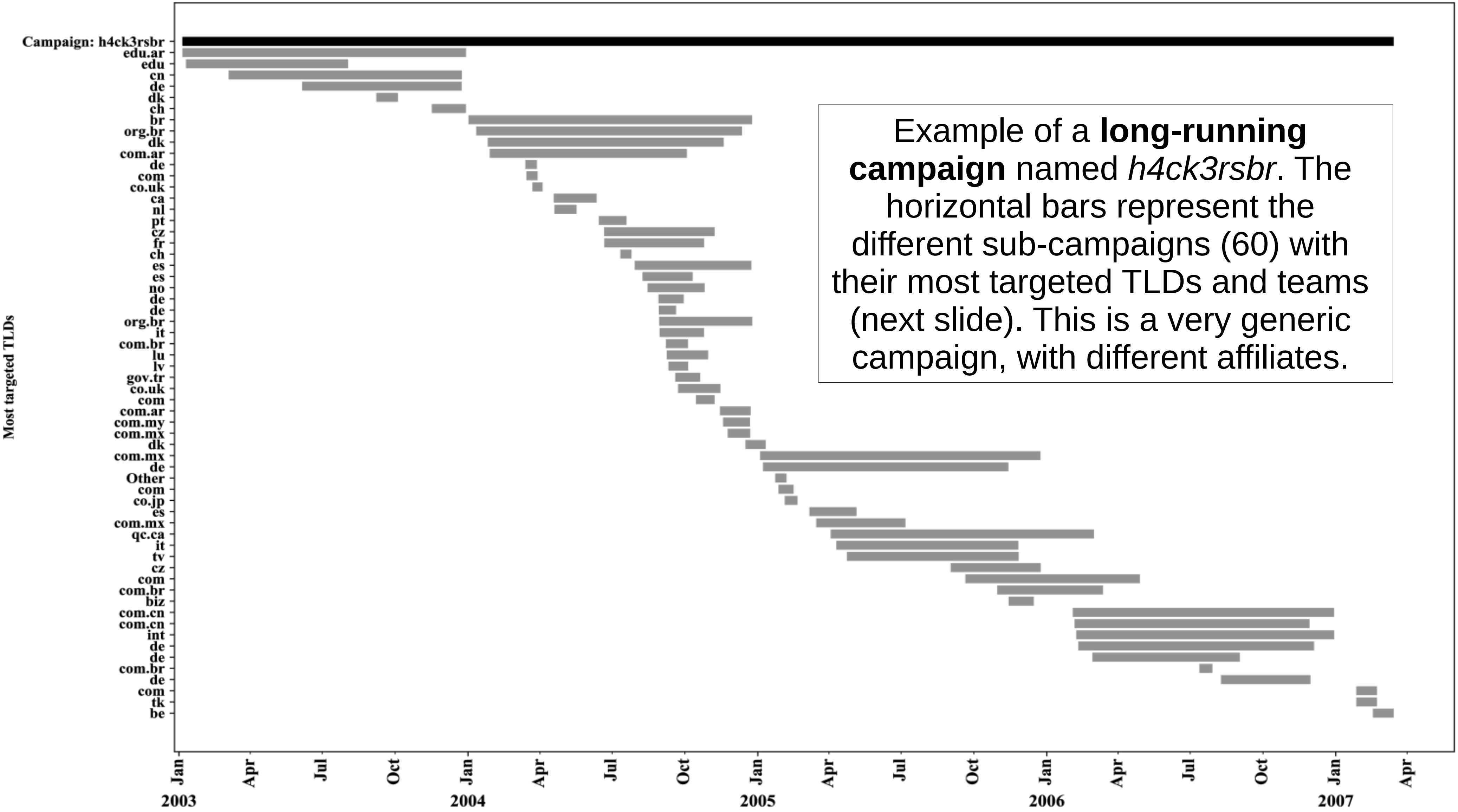


	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
palestine						1						1		29	2	98	902	1629	1124
powhack						238	557	133	27		28					1	1		
r00t		1	3	18	4	18					5		138	117	10	217	189	375	321
redhack								69	1973	538	3731	279	22	636	17	22	1	49	6
rodape												1	1	14	13	11	24	69	29
samarindahack					8	96	49	40	104	1	9	2				498	4		
syshack					2	2	2	42	2	11	28					67		1	1
turkish							2		6		101	7	6	120	5	27	2	31	16
venezuela				1			1	18	65	62						2		54	1

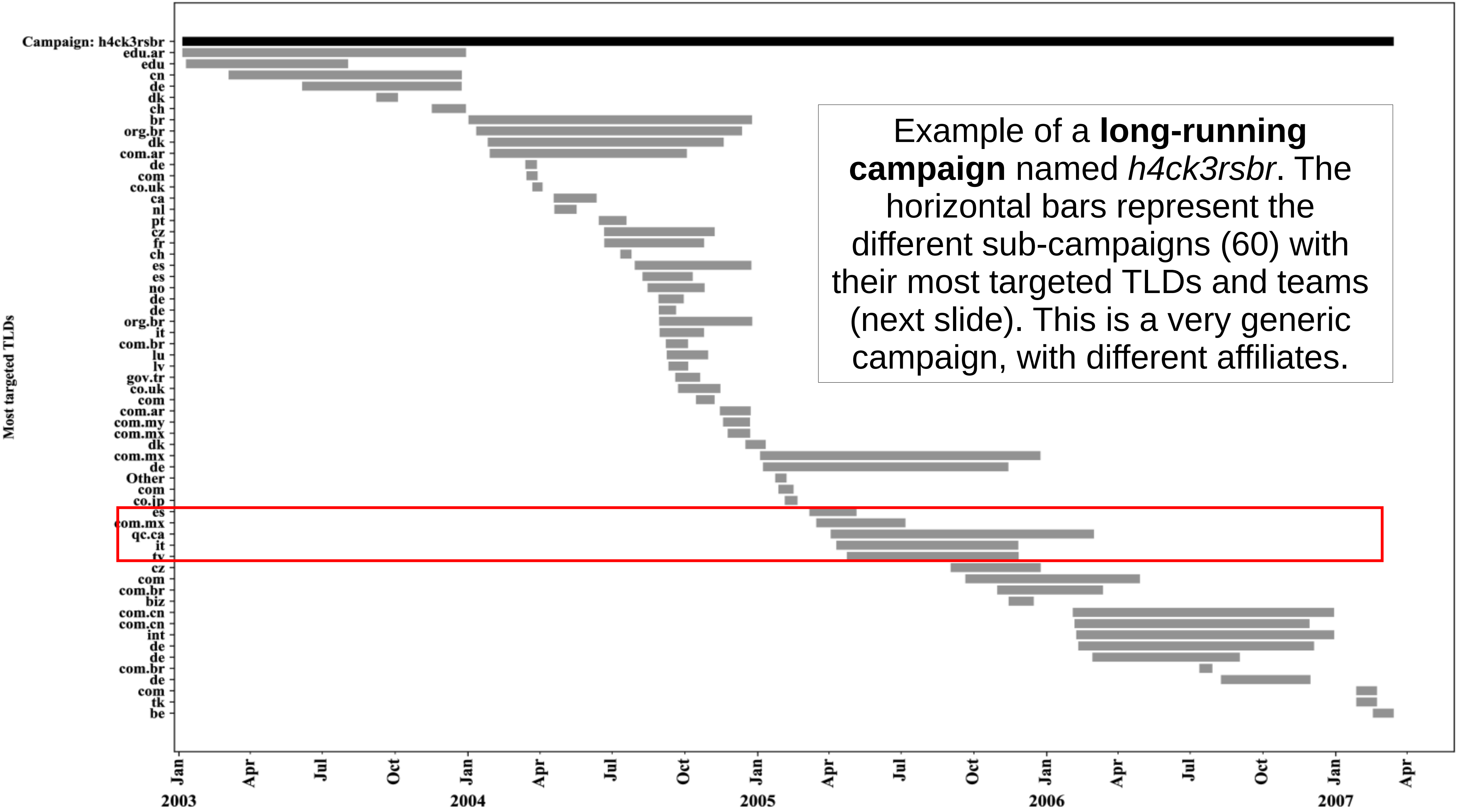
Spot, aggressive campaign in reaction to war events



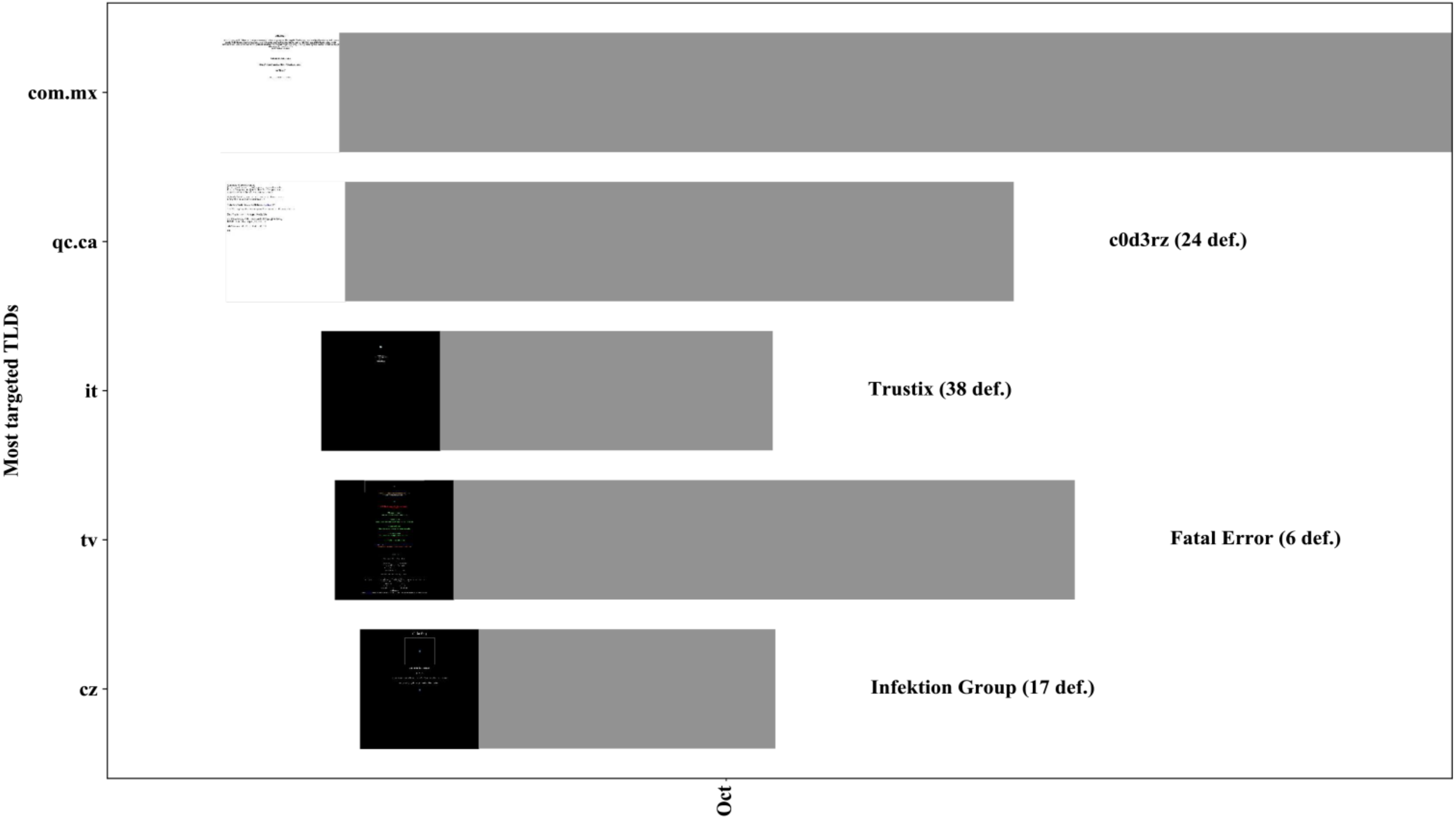
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
-															3	20	12328	8436	257
spykids						211	554	2350	9685	118		2							
team_cc																	7312	1693	197
whackerz							603	2339	3814	909	2118	1561	283						



Example of a **long-running campaign** named *h4ck3rsbr*. The horizontal bars represent the different sub-campaigns (60) with their most targeted TLDs and teams (next slide). This is a very generic campaign, with different affiliates.



Example of a **long-running campaign** named *h4ck3rsbr*. The horizontal bars represent the different sub-campaigns (60) with their most targeted TLDs and teams (next slide). This is a very generic campaign, with different affiliates.


Most targeted TLDs
com.mx
qc.ca
it
tv
cz
c0d3rz (24 def.)
Trustix (38 def.)
Fatal Error (6 def.)
Infektion Group (17 def.)
Oct

Conclusions

- Dark propaganda
- Prevailing phenomenon
- Driven by geopolitical motivations
- Key targets, influencing sites

References

- DefPloreX-NG
- GitHub: `https://github.com/trendmicro/defplorex`
- Paper*: `https://documents.trendmicro.com/assets/wp/wp-web-defacement-campaigns-uncovered-gaining-insights-from-deface-pages-using-defplorex-ng.pdf`

(*) Joint work with Marco Balduzzi, Ryan Flores, Lion Gu and Vincenzo Ciancaglini

Using Machine-Learning to Investigate Web Campaigns at Large

Dr. Federico Maggi, @phretor

Joint work with Marco Balduzzi, Ryan Flores, Lion Gu and Vincenzo Ciancaglini