ETH
Eidgenössische Technische Hochschule Zürich
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THE KNOWN UNKNOWNS

& OUTBIDDING CYBERCRIMIMALS

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Throughout history, new technologies have revolutionized crime and warfare alike

- Chariot ..
- Gunpowder ..
- Tanks ..

Criminals proofed repeatedly to be very fast adopters of new technology

Thriving Underground Market

information about

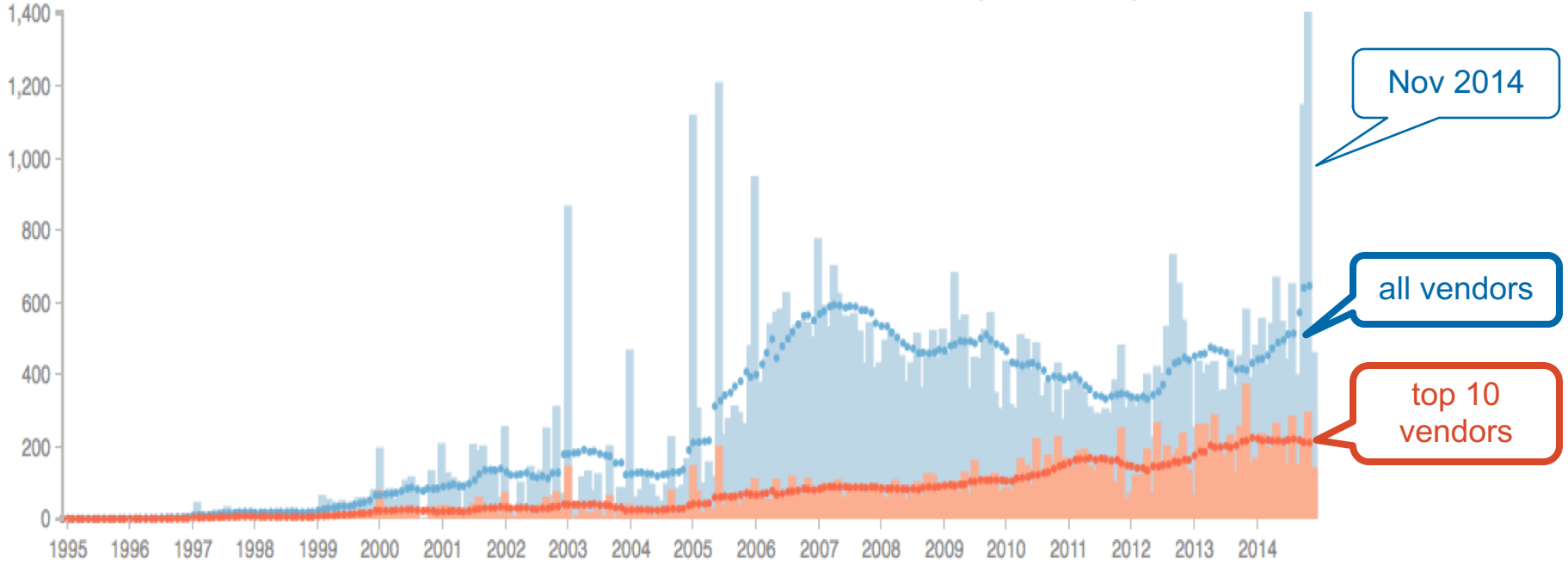
security vulnerabilities

has become a

valuable asset

Two decades of security investment ..

Vulnerabilities per month & 12 months moving average



The top ten vendors *IBM, Oracle, Cisco, Microsoft, Apple, RedHat, Google, Linux, Mozilla,* and *Adobe* account for more than 33 percent of all vulnerabilities published in the last 12 months.

Source: http://www.techzoom.net/BugBounty/SecureSoftware

Trend: five years vs. last year

#	VENDOR	HISTORY 20Y	TREND 60M	VULNS AVG 60M	VULNS LAST 12M	RISK LAST 12M
1	IBM		+103%	215	437	 high med low
2	Oracle		+48%	291	431	 high med low
3	Cisco		+94%	198	385	 high med low
4	Microsoft		+33%	267	356	 high med low
5	Apple		+5%	255	267	 high med low
6	RedHat		+152%	62	156	 high med low
7	Google		-19%	192	155	 high med low
8	Linux		+7%	123	131	 high med low
9	Mozilla		-19%	149	121	 high med low
10	Adobe		-28%	159	115	 high med low

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MAJOR VENDORS

33%

Just 10 vendors account for 33% of all disclosures in the last 12 months.

INDUSTRY TREND

+34%

Trend of the top 10 vendors comparing vulnerability disclosures of the last 12 vs. preceeding 60 months

INDUSTRY TREND

3 / 10

Only 3 of 10 vendors reduced vulnerability counts in the last 12 vs. preceeding 60 months

Software Industry

- The top ten vendors quite well represent the software industry
- These represent >80% market share of OSes, browsers, databases, plug-ins, .. in daily use

- They employ the best software engineers and have lots of funds

- After two decades, vulnerabilities do not go away

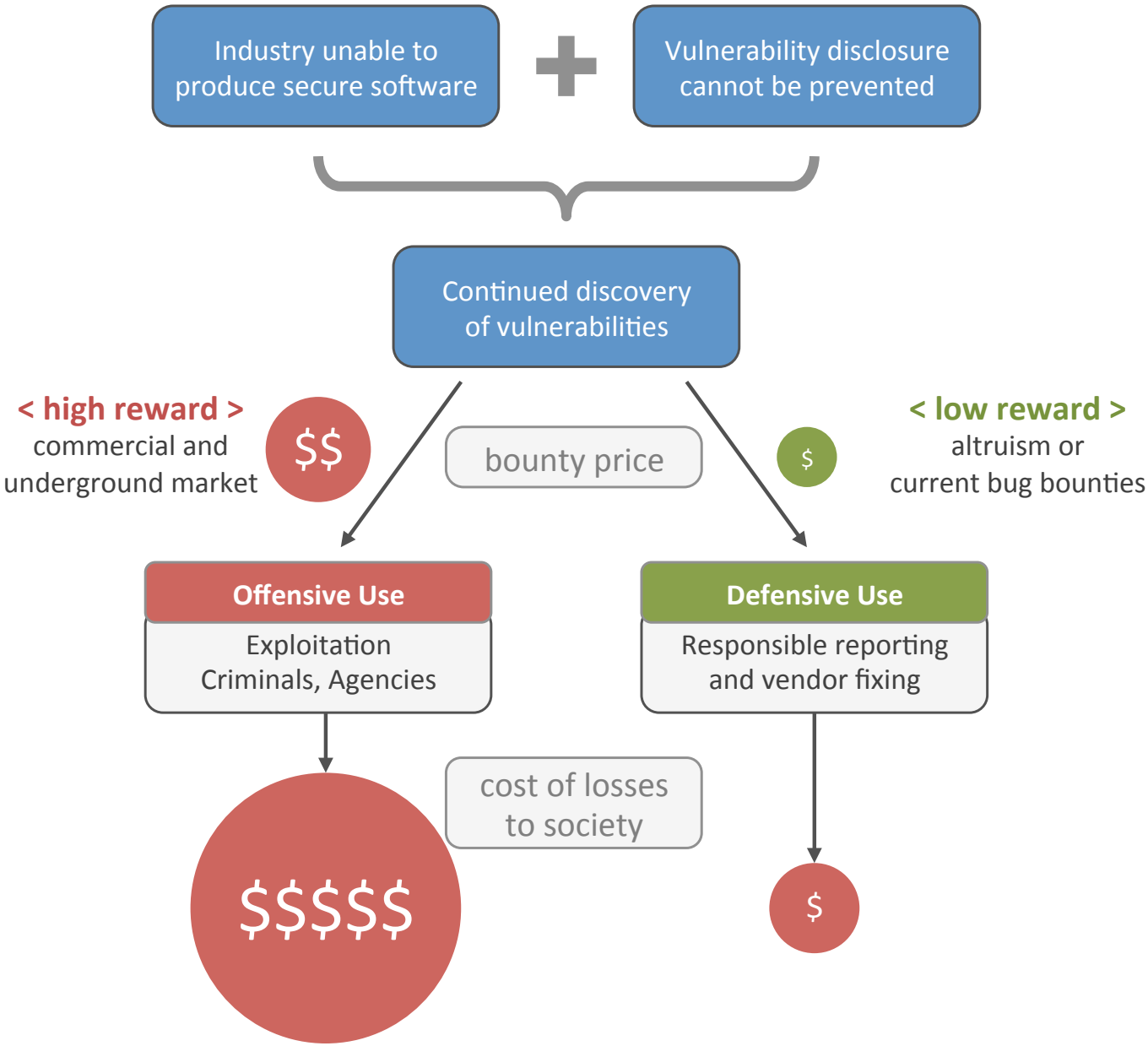
Vulnerabilities known only to
privileged closed groups
such as ..

Cyber Criminals

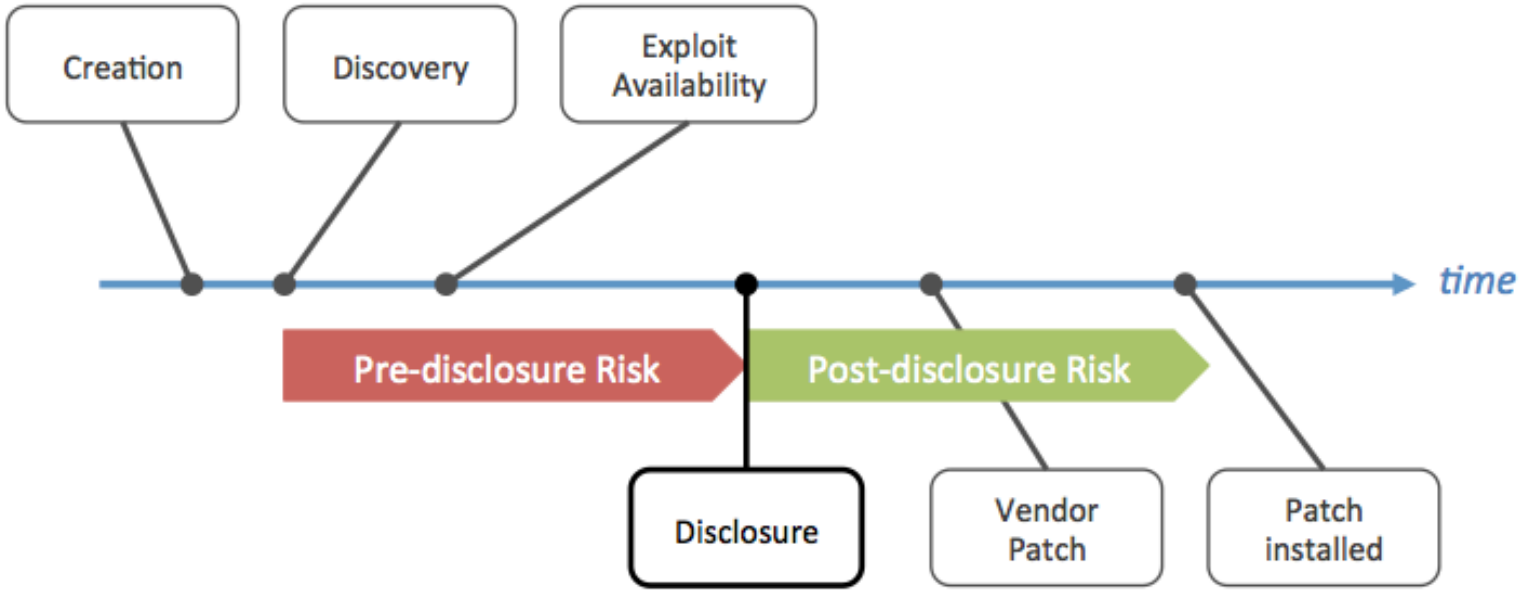
Brokers

Government Agencies

.. pose a real and present risk to all who use the affected software


Industry unable to produce secure software
+
Vulnerability disclosure cannot be prevented
Continued discovery of vulnerabilities
< high reward >
commercial and underground market
$$
bounty price
$
< low reward >
altruism or current bug bounties
Offensive Use
Exploitation
Criminals, Agencies
Defensive Use
Responsible reporting and vendor fixing
cost of losses to society
$$$$$
$

Lifecycle of a Vulnerability



The

Known Unknowns

vulnerabilities known to privileged groups only

How many?

Unknown for how long?

How to measure?

Vulnerability Purchase Programs

Data of two vulnerability purchase programs covering 1,855 vulnerabilities from 2002 - 2013 allow the reconstruction of the vulnerability lifecycle after publication

Program	Program Inception	Total Purchases	Targeted Vendors	Time To Disclosure
iDefense VCP	2002	969	195	133 days
TippingPoint ZDI	2005	1,423	92	174 days

Pre-disclosure risk

These programs coordinate vulnerability information with the software vendor!

iDefense Vulnerability Contributor Program (VCP)

TippingPoint Zero Day Initiative (ZDI)

Relevant targets, considerable exposure

#	Vendor Affected	Total Purchases VCP	ZDI	VCP+ZDI	Days Private	Vendor Share
1	Microsoft	153	237	390	181	14%
2	Apple	38	171	209	129	10%
3	HP	17	157	174	233	19%
4	Adobe	59	102	161	119	17%
5	Oracle	29	114	143	166	8%
6	Novell	30	112	142	142	10%
7	IBM	58	67	125	226	8%
8	RealNetworks	19	73	92	262	49%
9	Sun	34	26	60	159	5%
10	Symantec	20	39	59	198	18%
11	Mozilla	8	51	59	80	5%
12	CA	23	30	53	151	29%
13	EMC	11	35	46	131	38%
14	Cisco	10	20	30	229	2%
15	WebKit	13	14	27	138	5%
16	Trend Micro	15	10	25	94	24%
17	Samba	9	14	23	65	28%
18	Ipswitch	15	8	23	58	25%
19	SAP	4	10	14	143	13%
Total		**565**	**1290**	**1855**		
Average					**153**	**17%**

14%

of all Microsoft vulnerabilities reported through a purchase program

153 days

from purchase to patch availability

Purchase programs …

- cover a considerable share of a vendors' vulnerabilities
- despite offering low prices compared to the "black market"

Exposure to "Known Unknowns"

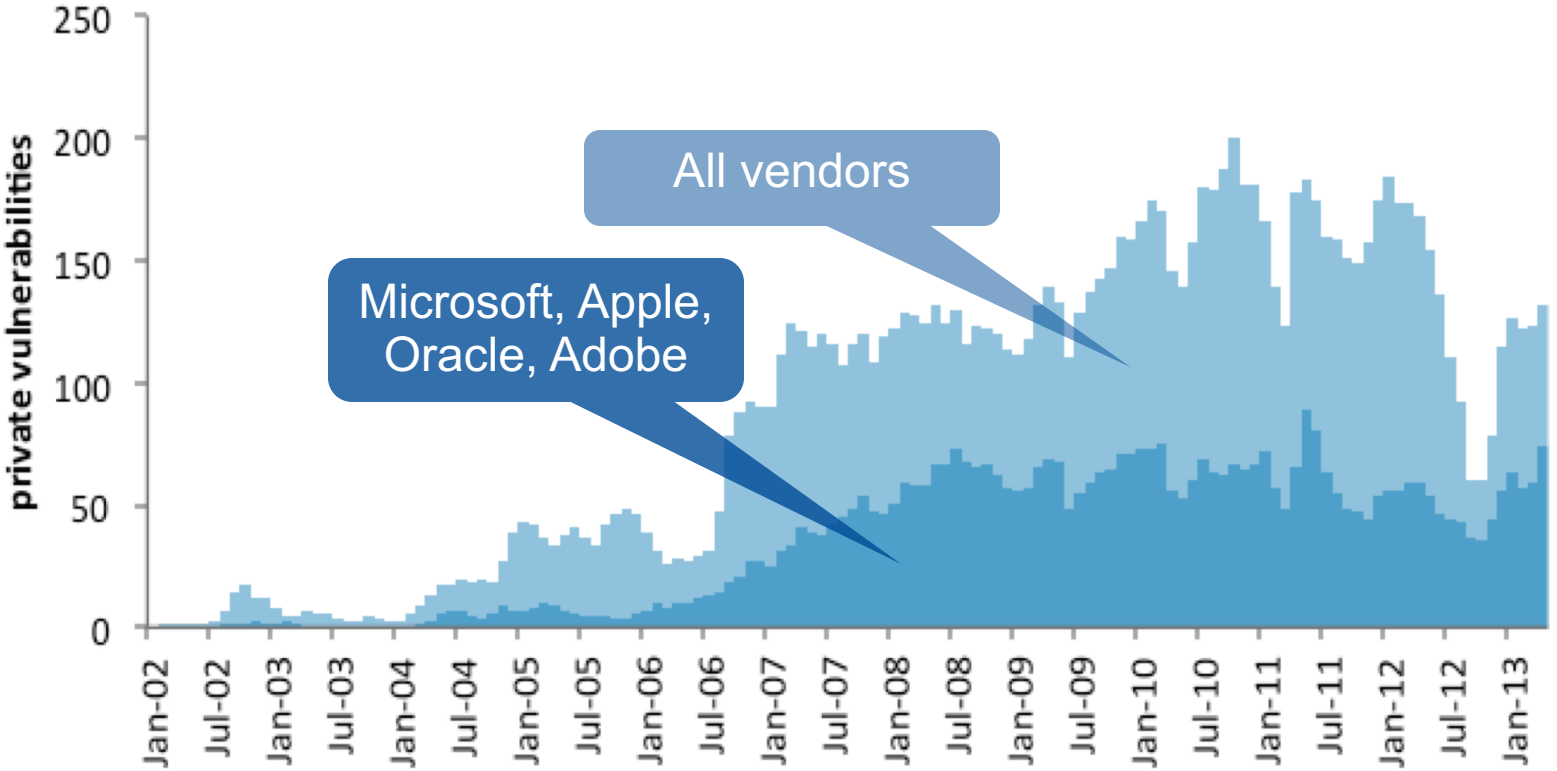
How many yet unpublished vulnerabilities are known to purchase programs exclusively ..

at any given day in the last years?

153 vulnerabilities known only to VCP and ZDI on any given day between 2010 and 2013

# of known unknowns, average per day

58 of which target Microsoft, Apple, Oracle, and Adobe



VCP & ZDI inform the vendor in order to release a patch

average exposure time: 153 days

Critical vulnerabilities are available

- in considerable quantities for private groups, for extended periods

and for a relatively low price

When the vendor is not informed about new vulnerabilities

average zero-day attack persists 312 days

The average zero-day attack persists for almost a year before it is detected

Source: Symantec Research
http://www.symantec.com/connect/blogs/zero-day-world

More Unknowns

Our measurement provides a minimum estimate of the known unknowns
(… criminals and government agencies don't share data)

What about vulnerabilities and exploits that are not publicly traded, and are definitively not coordinated with the software vendor?

- Boutique Exploit Providers
- Governments & Defense Contractors
- Commercial Security Consulting

ENDGAME. [Re]Vuln VUPEN security EXODUS INTELLIGENCE

Vulnerability & Exploit Providers

An increasing number of commercial players offer zero-day exploits for their subscribers:

- they do not reveal their clients
  (big buyers reportedly include government agencies)
- have a keen interest in a long pre-disclosure time
  (keep the zero-day private as long as possible)
- some firms restrict their clientele
  (by country, specific agencies)
- price for exploits between USD $40k and $160k

Shopping List

Maui – Zero-Day Vulnerability and CNE/CNA Program

Maui	$2,500,000 per contract year	• Minimum of 25 deliverables per year
		• Deliverable contents - Software
		  • Software CNE/CNA
		  • Metasploit module
		  • VMware image for testing
		• Deliverable contents - Documentation
		  • Vulnerability information
		  • CNE/CNA information
		  • Demo instructions
		  • Revision history

USD $2.5 million for 25 zero-day exploits per year

Software Vulnerability Packages

- Development of general and custom tools for IA and IO
- Productization for use by trained and untrained operators

.. for use by trained and untrained operators

Challenge to Society

Our security depends largely on ethical researchers reporting vulnerabilities under the practices of coordinated disclosure for free

At the same time, the black market is expanding rapidly and offering large rewards for the same information

"Never was so much owed
by so many to so few."

Winston Churchill's famous 1940 wartime speech

Cyber Crime Losses

Yearly losses due to cyber crime are estimated between

10 to 1,000 billion USD

Vulnerabilities are the root cause of considerable part of these losses

What if ..

.. we would purchase all vulnerabilities and report them to the vendor for remediation?

for USD

150,000.-

per vulnerability

with a massive **bug bounty program**?

Reasoning

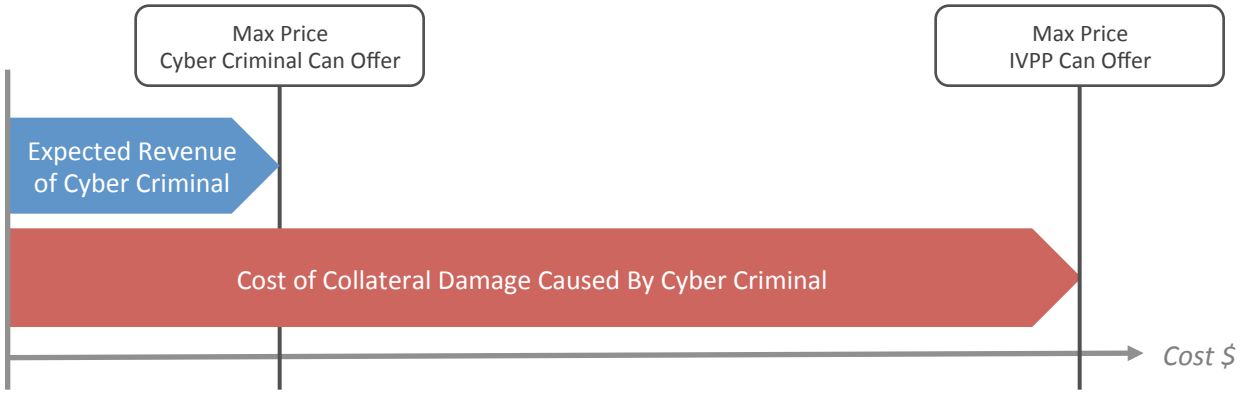
USD 150,000.-

per vulnerability

- doing nothing is not an option for the future
- we would outbid most cyber criminals
- increase research > more robust products
- validate the economics by buying all vulnerabilties regardless of criticality

We can outbid criminals

Buying vulnerabilities makes sense as long as the purchase cost is less than the cost of the prevented losses



Vulnerability abuse incurs large collateral damage, exceeding criminals revenue

International Vulnerability Purchase Program

What would it cost society to buy all vulnerabilities from all vendors for USD 150,000 each?

This includes buying all non-critical vulnerabilites

Cost of buying all vulnerabilities in 2012

		Cost in Million $				Percentage Cost of			Percentage Cost of	
	Vuln.	Cost by Risk				GDP	GDP	Revenue	Cyber Crime Estimates	
Vendors	Total	High	Med	Low	Total	US	EU	SW Ind.	10 Billion	100 Billion
All	**5,218**	265	441	76	**783**	0.005%	0.005%	0.268%	7.827%	0.783%
Top 100	**3,332**	192	257	51	**500**	0.003%	0.003%	0.171%	4.998%	0.500%
Top 50	**2,959**	176	224	44	**444**	0.003%	0.003%	0.152%	4.439%	0.444%
Top 10	**2,065**	147	134	29	**310**	0.002%	0.002%	0.106%	3.098%	0.310%

less than **0.01%** of the **GDP** of the **US** or the **European Union**

less than **1%** of the yearly cost of **cyber crime**

Software vendors buying their vulnerabilities

What would it cost software vendors to buy all their vulnerabilities for USD 150,000 each?

This includes buying all non-critical vulnerabilites

Cost of buying vendor vulnerabilities in 2012

		Cost in Million $				Revenue in Million $	
	Vuln.	Cost by Risk					
Vendor	Total	High	Med	Low	Total	Revenue	Cost in %
Oracle	427	9.8	37.4	17.0	64.1	37,120	0.173%
Apple	303	25.1	18.3	2.1	45.5	164,700	0.028%
Google	279	24.9	16.2	0.8	41.9	49,770	0.084%
Mozilla	202	18.0	11.6	0.8	30.3	n/a	
IBM	175	6.9	16.5	2.9	26.3	104,500	0.025%
Microsoft	173	18.2	7.2	0.6	26.0	72,930	0.036%
Cisco	160	13.8	9.5	0.8	24.0	46,680	0.051%
Adobe	146	19.8	2.1	0.0	21.9	4,404	0.497%
Linux	116	3.5	10.5	3.5	17.4	n/a	
HP	84	6.8	5.0	0.9	12.6	120,400	0.010%
Total w/o Mozilla, Linux	(Open Source, No Revenue)				**262.1**	**600,504.0**	**0.044%**

less than
1%
of the software vendors' **revenue**

Follow the money ...

The experience of past decades has shown that traditional approaches based on "more of the same" can not deliver adequate security

The question to ask is this:

"How much are those that bear the costs willing to pay to reduce their losses incurred as a result of cyber crime?"

Online Cost Callculat
http://www.techzoom.net/BugBounty/EconomicsGlobal

Run your price model ...

Check out the online calcluator to test your price model

- You chose price per criticality
- Calculates total cost for Top-N or all vendors
- Up-to date data from past 12 months

http://www.techzoom.net/BugBounty/EconomicsGlobal

Challenge to Society

Our security depends largely on ethical researchers reporting vulnerabilities under the practices of coordinated disclosure for free

At the same time, the black market is expanding rapidly and offering large rewards for the same information

This trend is not sustainable

Conclusion
Recommendations

Conclusion

The software industry is yet unable to produce secure code.

Vulnerabilities and exploits continue to be available for abuse, for extended periods and unknown to the public.

Conclusion

We depend on researchers following coordinated disclosure for free, while the black market offers top money,

this current approach is not sustainable

It makes economic sense to purchase vulnerabilities, and we can outbid cyber criminals

Conclusion

What is the cost of doing nothing?

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REFERENCES

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- Correlation of Detection Failures
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