



Selling 0-days to governments and offensive security companies

Maor Shwartz



About Me

Working as a vulnerability broker (~4 years)

- Q-recon
- Beyond Security

Cyber Security / Threat Intel researcher in Insurance industry

Hobbies

- Hiking
- E-games



@malltos92



Maor@qrecon.com

Agenda

- Who is this talk for?
- My Story
- Overview
- Who is selling 0-days to governments /
offensive security companies?
- The process of selling 0-days
- How to sell 0-days?
- Tips for beginners

Is this talk for you?

This is not a technical talk, this also not a deep drill down in to the brokerage world

This is meant to help researchers who are new or interested in the transactional process

Share some of my experiences and a few tricks to help you along the way

My story – The Beginning

Founded a vulnerability brokerage company called Q-recon

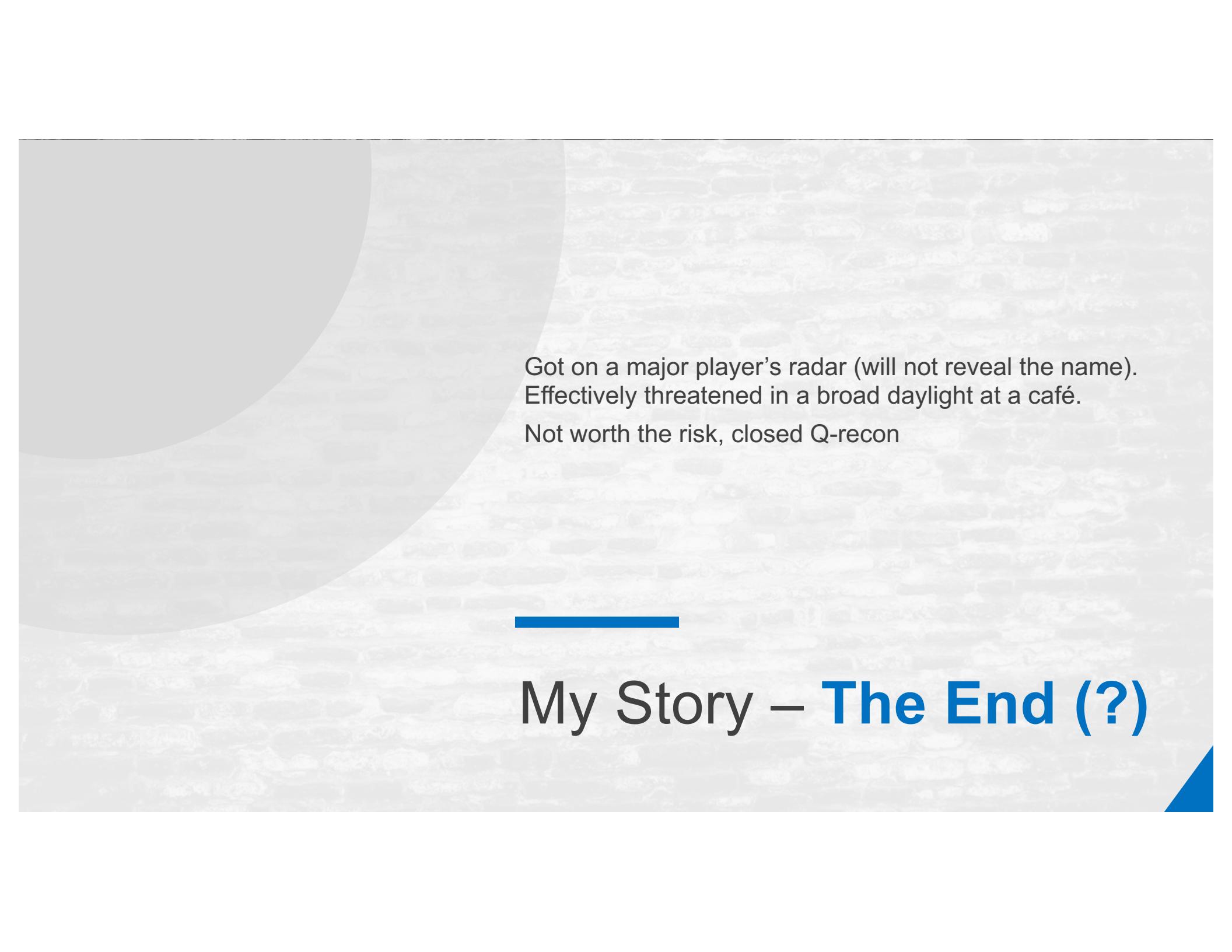
Had quite a few researchers working with me

Attained some major clients

After a few successful moves started to get attention

- Sold 0-days
- Found jobs for a few researchers





Got on a major player's radar (will not reveal the name).
Effectively threatened in a broad daylight at a café.
Not worth the risk, closed Q-recon

My Story – The End (?)

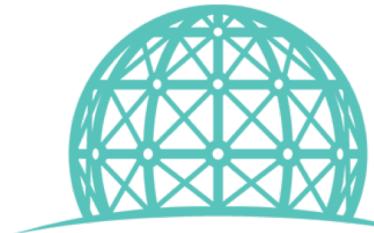
A grayscale photograph of a man in a suit and tie, sitting at a desk and gesturing with his hands while speaking. He is wearing a watch on his left wrist. On the desk in front of him is a laptop and some papers. The background is slightly blurred.

Overview

Regular Development issues

In traditional software companies:

- The problem is linear
- When the company encounters a technology problem – they hire an army of developers in order to solve that problem



The uniqueness of **vulnerabilities** research

Finding vulnerabilities is an art, not a science
(Most of the time) That's why it's a multi million
dollars industry

You can hire a lot of vulnerability researchers,
spend millions and find nothing



History

In the past 5 years the 0-day market has transformed drastically

Increase in number of:

Brokerage companies

Offensive security companies

Conferences

Competitions

Bug bounty programs

Budgets

Stepping out of
the shadows

(No more
whispering in
dark alleyways)

Who is interested in 0-days?



Cyber security
companies
(defense)

Bug bounty
programs

Bug bounty
platform



Vulnerability
brokers

Competitions
Pwn2Own /
PWNoRAMA /
Hack2Win /
Zer0Fest



Offensive
Security
Companies

Government

Criminals



**Who is buying
what?**

The community



Cyber security
companies
(defense) - PR

Bug bounty
programs

Bug bounty
platform



Vulnerability
brokers

Competitions
Pwn2Own /
PWNoRAMA /
Hack2Win /
Zer0Fest



Offensive
Security
Companies

Government

Vulnerability researchers – overview (HackerOne)

HackerOne
166,000
Registered Hackers

72,000 vulnerabilities
submitted

70% of the reported
vulnerabilities are focused
on web

What is Your Favorite Kind of Platform or Product to Hack?

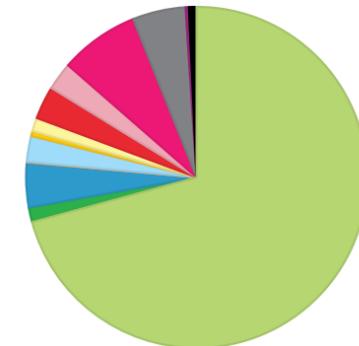
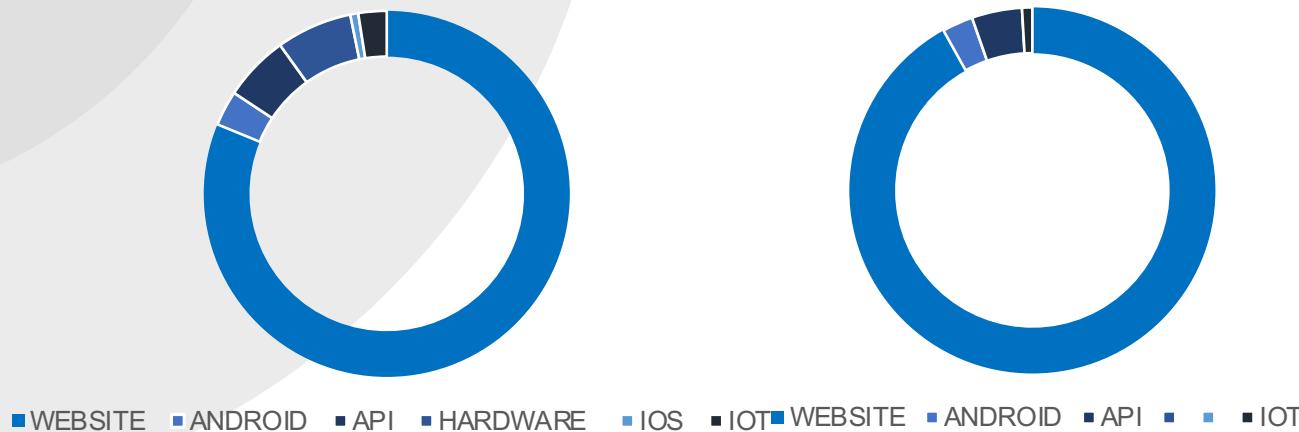


Figure 11

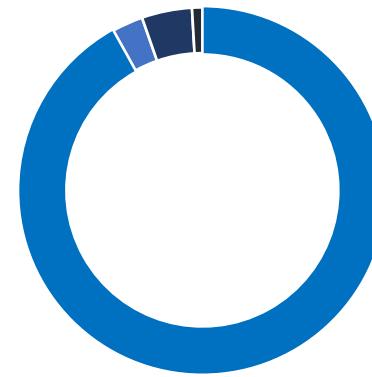
WEBSITES : 70.8%
IOS MOBILE APPLICATIONS : 1.4%
ANDROID MOBILE APPLICATIONS : 4.2%
DOWNLOADABLE SOFTWARE : 2.5%
WINDOWS MOBILE APPLICATIONS : 0.1%
COMPUTER HARDWARE: 0.5%
FIRMWARE : 1.3%
OPERATING SYSTEMS : 3.1%
INTERNET OF THINGS (WEARABLES, APPLI... : 2.6%
APIs : 7.5%
TECHNOLOGY THAT I'M A USER OF/THAT HAS MY DATA : 5.0%
SUPPLY CHAIN PARTNER THAT MY OWN TE... : 0.3%
EVALUATING THE TARGETED TECHNOLOGY TO BUY OR USE : 0.7%

Vulnerability researchers – overview (bugcrowd)

AMOUNT PAID BY TARGET



SUBMISSIONS PAID BY TARGET



■ WEBSITE ■ ANDROID ■ API ■ HARDWARE ■ IOS ■ IOT ■ WEBSITE ■ ANDROID ■ API ■ ■ ■ ■ IOT



Cross-Site Scripting (XSS) Reflected (P3), was the **top vulnerability submitted this year** via the Crowdcontrol™ platform.



The majority, **13% of all submissions paid out** last year were for vulnerabilities classified as **Cross-Site Scripting (XSS) Stored**.

There are also high-end researchers that contribute to the community

iOS 12

Released September 17, 2018

Accounts

Available for: iPhone 5s and later, iPad Air and later, and iPod touch 6th generation

Impact: A local app may be able to read a persistent account identifier

Description: This issue was addressed with improved entitlements.

CVE-2018-4322: Min (Spark) Zheng, Xiaolong Bai of Alibaba Inc.

Auto Unlock

Available for: iPhone 5s and later, iPad Air and later, and iPod touch 6th generation

Impact: A malicious application may be able to access local users AppleIDs

Description: A validation issue existed in the entitlement verification. This issue was addressed with improved validation of the process entitlement.

CVE-2018-4321: Min (Spark) Zheng, Xiaolong Bai of Alibaba Inc.

Entry added September 24, 2018



P0

Whitehats

There are a lot of
“vulnerability researchers”

Most are focused on low-hanging fruit
Quick and easy money
Bug bounties

The high-end researchers:
• (Sometimes) Ideologically motivated
• Working in Cyber security companies / research teams (PR motivated)

Who is interested in 0-days?



Cyber security
companies
(defense)- PR

Bug bounty
programs

Bug bounty
platform



Vulnerability
brokers

Competitions
Pwn2Own /
PWNoRAMA /
Hack2Win /
Zer0Fest

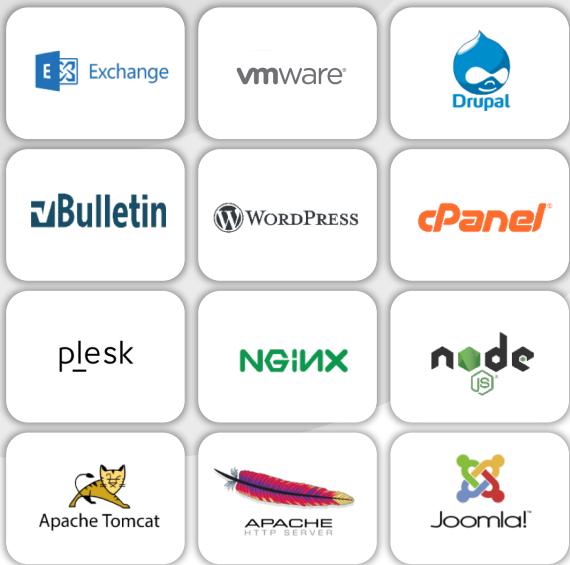


Offensive
Security
Companies

Government

Criminals

The High-End Market



*No user interaction pre-auth RCE or LPE

The High-Rollers Table

End-product

Vector

- RCE + LPE + Persistence

Vulnerabilities

- RCE | LPE | Persistence

Component (parts in a chain)

- Info leak
- Mitigation bypass

Services

Dedicated research

- Freelancing

Workshops

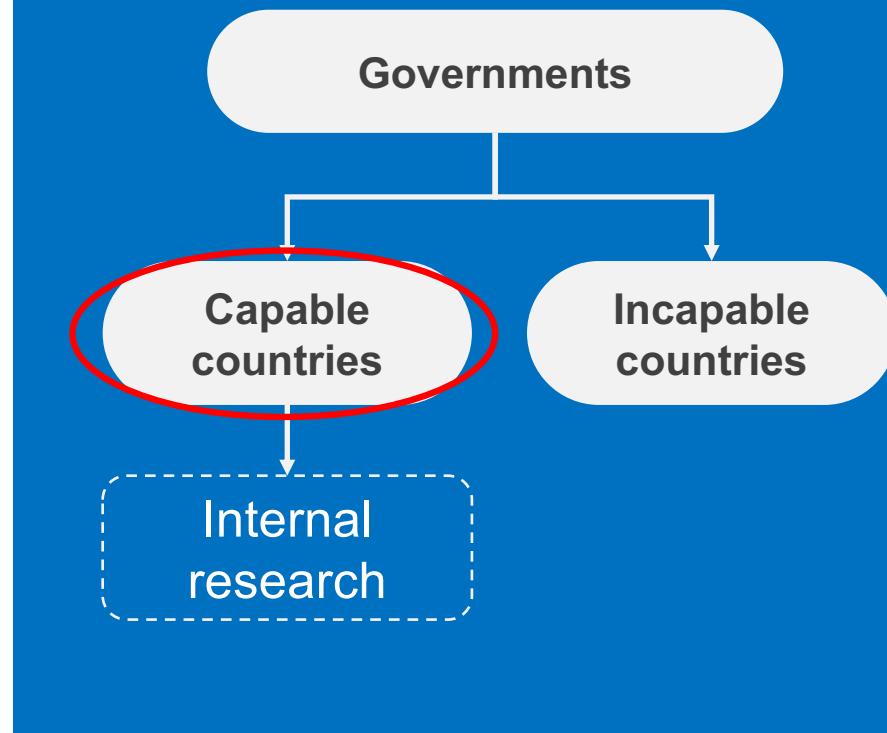
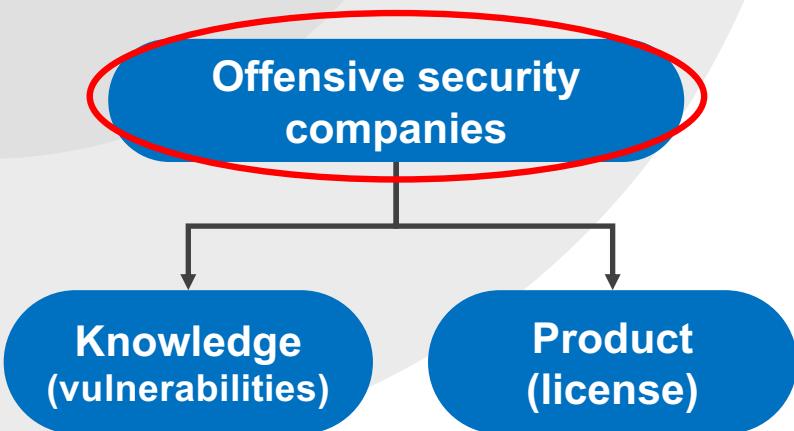
Consulting

- Validate other researchers vulnerabilities

Support

- Exploit new versions

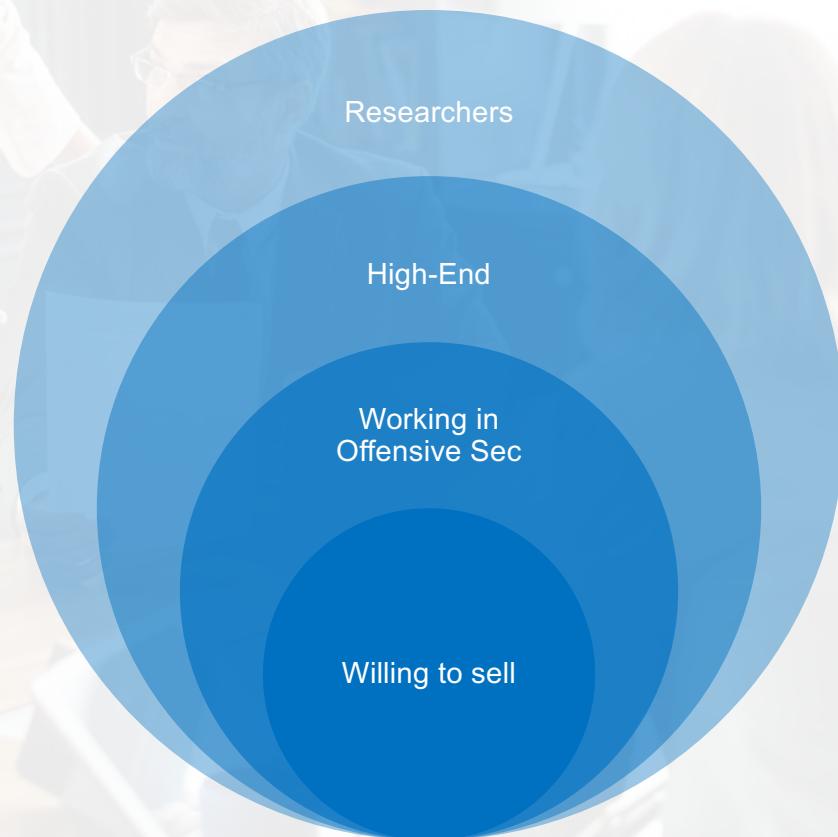
Companies vs Governments



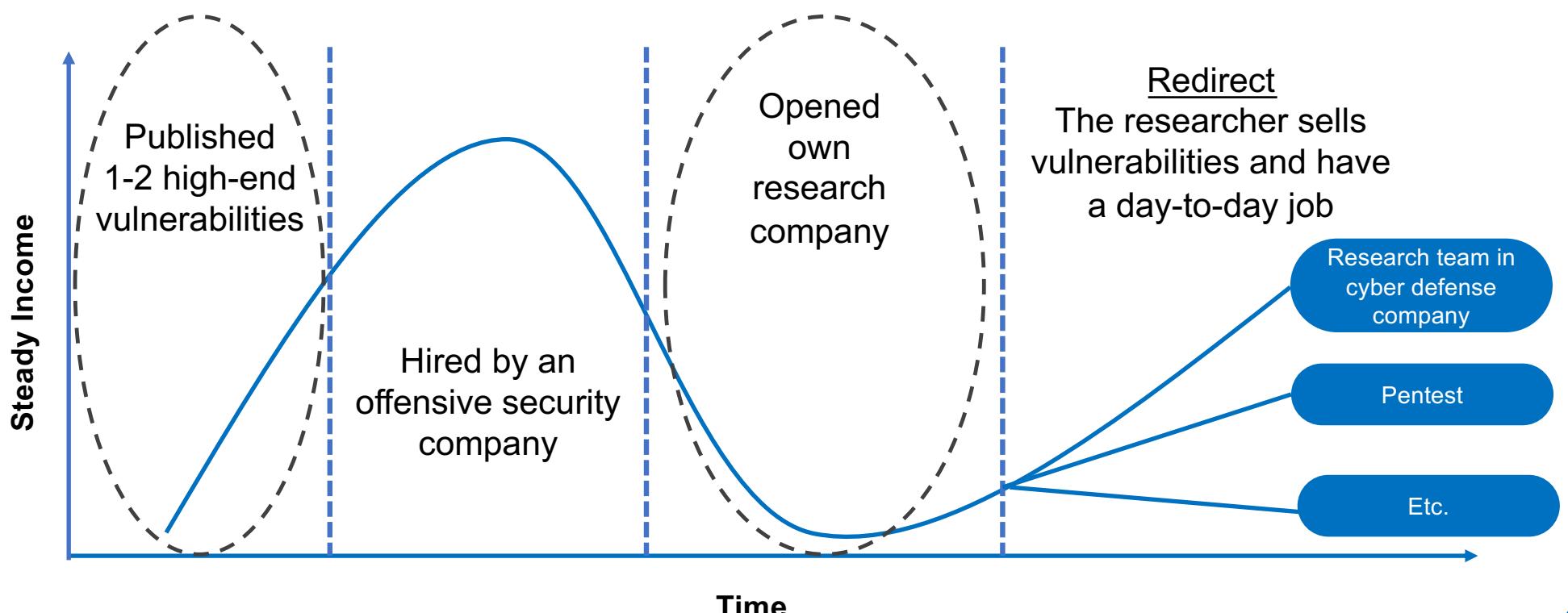
How are they
getting them
0-days



Researchers by groups



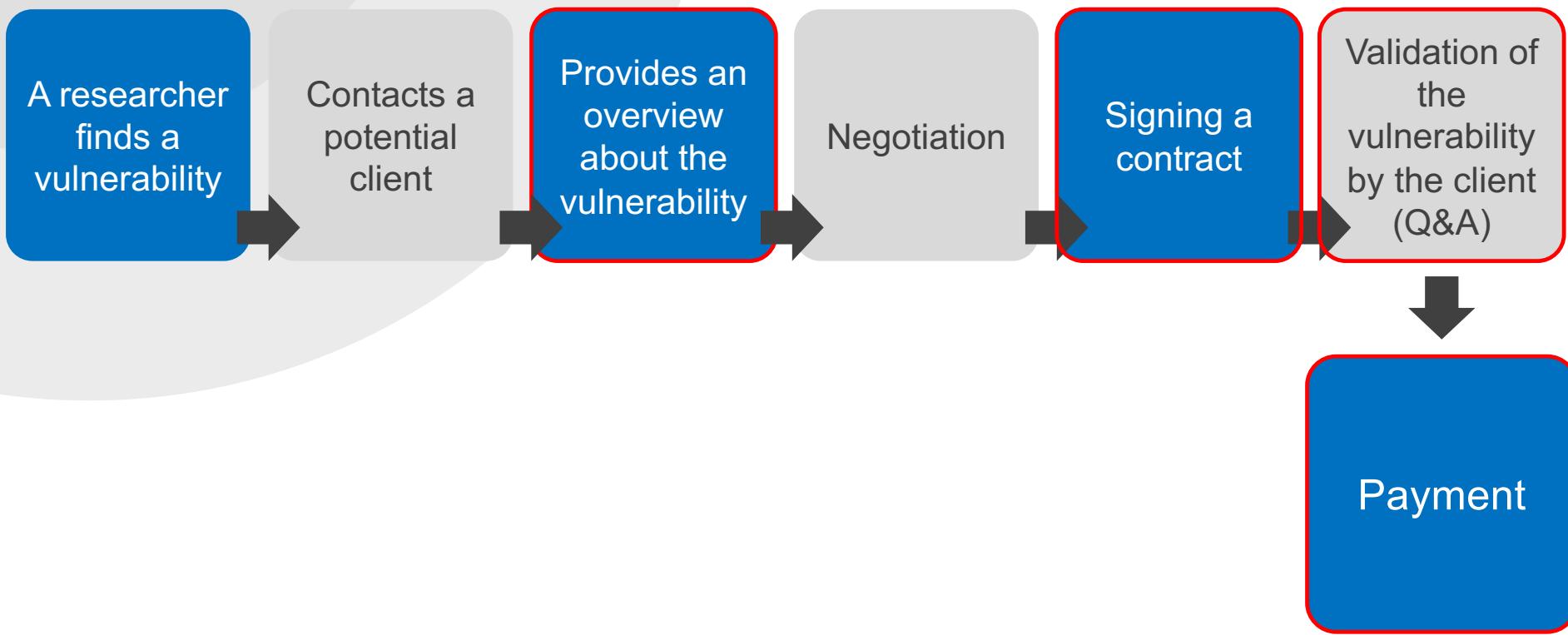
The researcher journey



A grayscale photograph of a woman with long hair, wearing a white ribbed sweater, sitting at a desk and looking at a laptop screen. She is holding a small object in her hands. The background is slightly blurred.

The Process of Selling 0-days

The sales process - overview



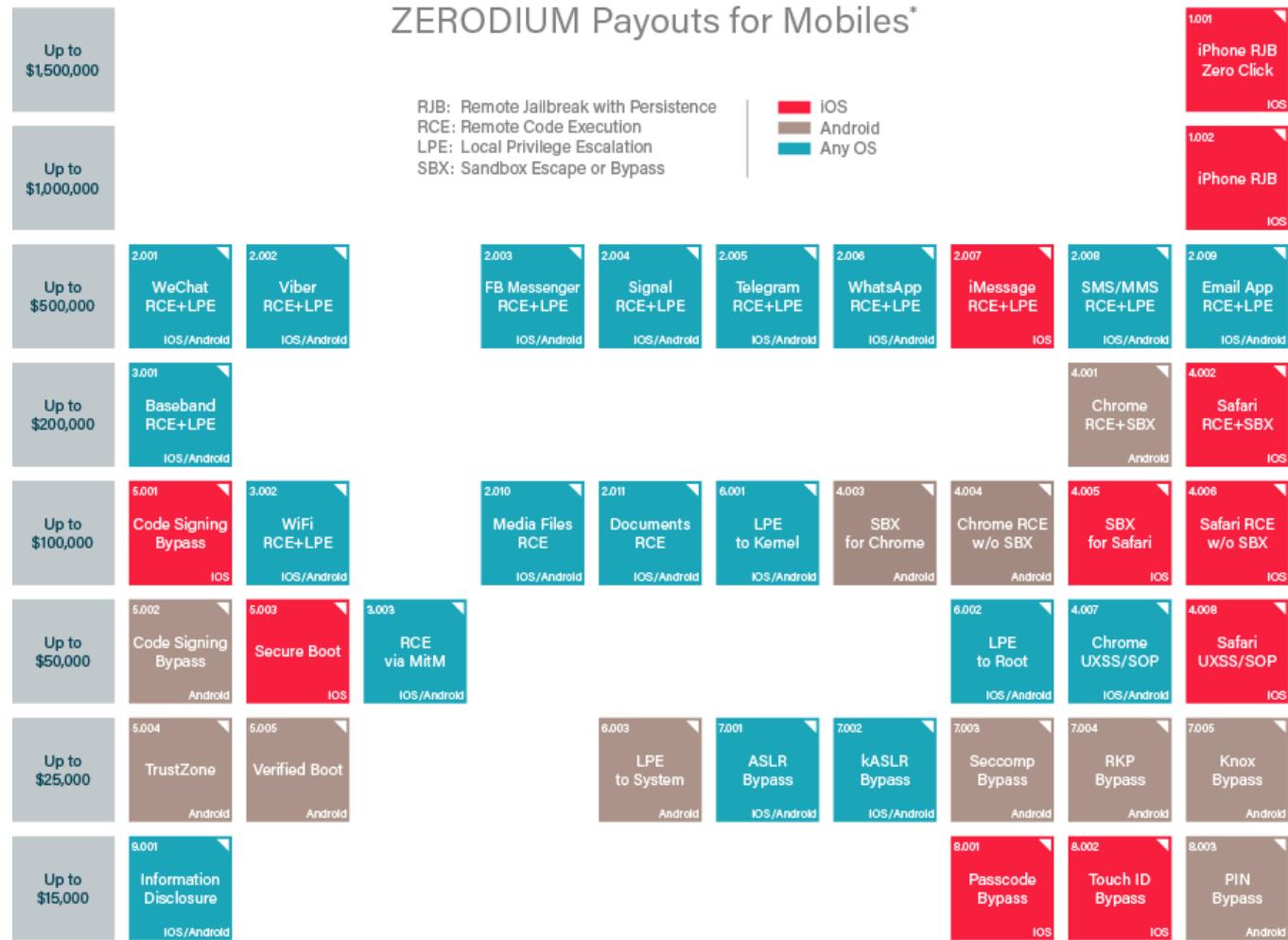
Payouts

As a researcher you expect to get paid more than the vendor bug bounty program

There is no single pricelist

- Competitions (pwn2own / PWNoRAMA)
- Rumors – other researchers that sold
- Hacking Team like incidents

Zerodium transformed the optics for 0day acquisition, devil is in the details.



*All payouts are subject to change or cancellation without notice, at the discretion of ZERODIUM. All trademarks are the property of their respective owners.

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Payouts – behind the scenes

Different entities will offer different payouts for the same vulnerability

Warranty and Seller model matters

Complexity of
the system

Mitigations

Supply and
demand

Who is the
researcher

Deliverables

Generic

Exclusive /
Nonexclusive

Payouts – behind the scenes

**WhatsApp /
Signal /
iMessage
0clicks
~1.5M\$**

**iOS /
Android PE
~400-
600k\$**

**Windows
PE
(Redstone 6)
~250-
500k\$**

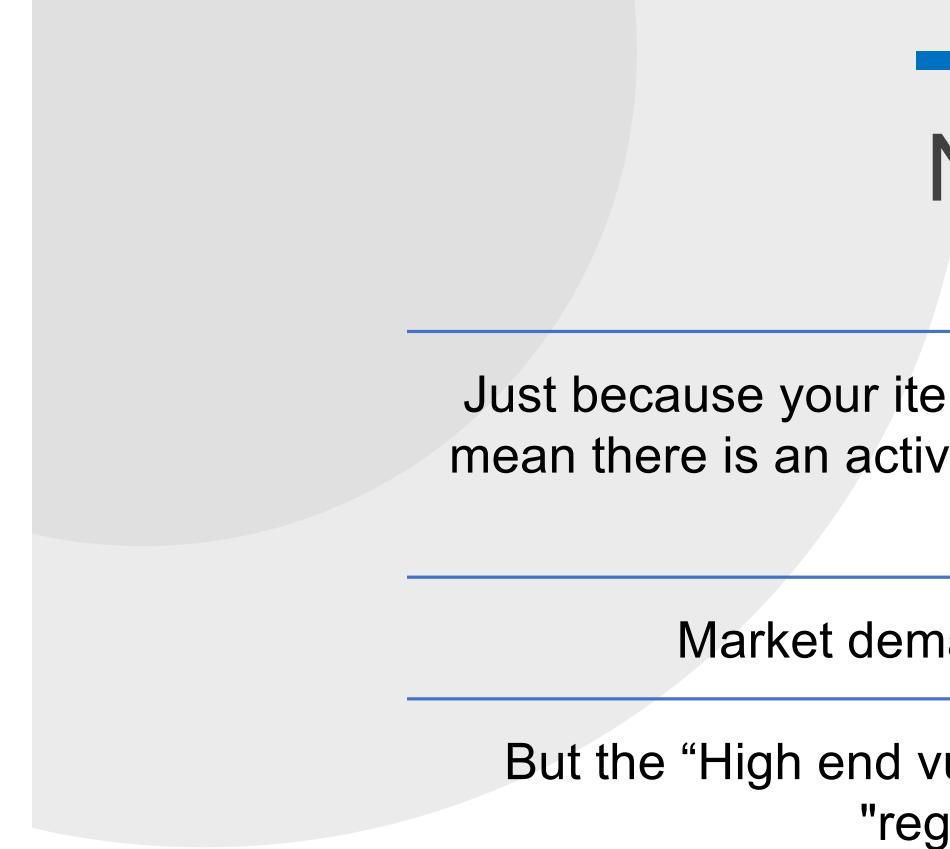
**Linux PE
~150-
400k\$**

**Chrome
RCE
(without sandbox
escape)
~300-
400k\$**

**FF RCE
~200-
400k\$**

**Edge RCE
~100-
300k\$**

*Assuming high end products with ~95% reliable, ~3 seconds execution time and generic



NOTE

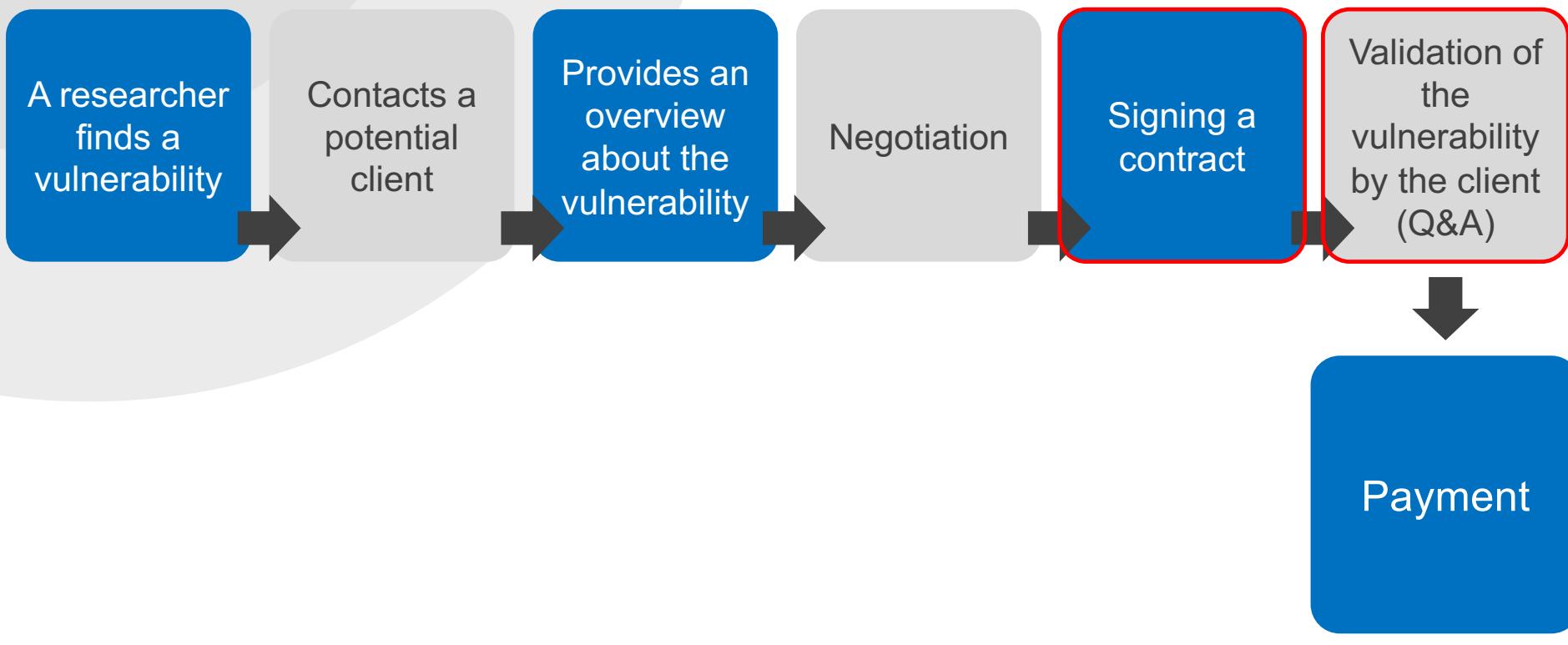
Just because your item is worth this amount, doesn't mean there is an active or captive buyer willing to pay for it

Market demand changes regularly

But the "High end vulnerabilities" are generally in "regular" demand



The sales process - overview



IMPORTANT

*I DO NOT PROVIDE LEGAL
ADVICE AND DO NOT
CREATE AN ATTORNEY-
CLIENT RELATIONSHIP.*

IANAL: I Am Not A Lawyer

Legal - Contracts

Spec

Exclusive / Nonexclusive

Delivery date

Validation period

Fees & payment

Propriety rights

Confidentiality

Support

Governing law

Export liability

SOFTWARE ACQUISITION AGREEMENT

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Spec

Bug type
Exploit result
Vector
Affected architecture
Reliability
Execution time
Mitigations bypass
Supported versions
Product configuration
Deliverables

As a researcher, you guarantee the end result of the vulnerability on a pre-defined configuration

There is some acceptable variance with your estimates (+/- 5%)



Never claim it is more reliable or capable than it is, it will end badly.

Specification

Title:
Bug type:
Exploit result:
Vecotr:
Affected architecture:
Exploit result:
Reliability:
Execution time:
Mitigation bypass:
Supported versions:

- The exploit works on the following versions:
- The vulnerability is open but not exploited on the following versions:

Process continuation:
Product configuration:
Deliverables:

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Validation Period

4. Acceptance

- 4.1. Buyer shall conduct acceptance tests of the Materials within fourteen (14) days following the delivery of the Software (the "Acceptance Date"). If before the expiration of the acceptance period the Buyer finds that the Materials do not conform to their Specification, Buyer may reject the Software by providing written notice with a description of the nonconformity to the Seller. In which case, the Seller, at its sole cost, will update the Materials to fix its failure to conform to the Specification and deliver revised Materials. Buyer will then be granted with additional seven (7) days to conduct additional acceptance tests.
- 4.2. If the Buyer uses the Software before acceptance under this clause, except for testing purposes in accordance with the acceptance tests, then the Software will be deemed to have been accepted on the date of such first use.
- 4.3. If the Buyer rejects the Software after the acceptance tests the Buyer agrees to cease all use of the Software and Materials and will promptly destroy all copies of the Software and Materials in its possession or control.

Make sure you get access to the client test environment

Where possible, consider having a VM image ready in case you need to ship the working state PoC

Ensure buyer is prepared to test the item before sending – avoid anxiety

Usually 14 days

If the client has questions
– there is an extension of
up to 7 days
(Total of 21 days)

During the validation period, the client can decline the vulnerability if it doesn't comply to the Spec

Legal - Contracts

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- 3.4. The Seller will use all reasonable endeavors to achieve delivery by any specified or requested date.

Fees & Payment

THERE IS NO SUCH THING AS ADVANCED PAYMENT

- ▲ **6. Fee & Payment Terms**
 - 6.1. The Buyer shall pay to the Seller a total sum of [REDACTED] US dollars (USD [REDACTED]), plus VAT if applicable, as a fixed compensation for the Materials to be provided as part of this Agreement. The Fee shall be payable as follows:
 - 6.1.1. an amount of [REDACTED] (USD [REDACTED]) to be paid after successful acceptance tests within seven (7) days of the Acceptance Date (the "**First Installment**").
 - 6.1.2. [REDACTED] equal monthly installments of [REDACTED] US dollars (USD [REDACTED]) each, following the date of First Installment.
 - 6.2. For the avoidance of doubt, in the event where the Software becomes either (i) part of the "public domain" due to any reason other than infringement by the Buyer of its obligations under this Agreement or misuse by Buyer's customers, or (ii) inefficient due to modifications made in the relevant software, and were implemented in a subsequent release or (iii) otherwise compromised or not functional, in whole or in part, then any remaining payment obligations of the Buyer hereunder at such time, shall be cancelled and no longer due to the Seller unless the Seller updates the Materials to fix its failure to conform to the Specification and delivers revised Materials.
 - 6.3. The Buyer will pay to the Seller the Fee which fall due under this Agreement in the amounts and at the times specified in clause 6, against a duly issued invoice. The Buyer will deduct any withholding taxes as required by law unless Seller will present an exemption from such withholding taxes.

- Split the risk approach
- 100% on validation usually below 100k
- VAT (if applicable)
- Cryptocurrency VS Fiat
- Remember - if the transaction will be in USD (standard pricing), you should have a USD account



Legal - Contracts

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Proprietary Rights

Exclusive

Buyer acquires any and all title, copyright, or other proprietary rights

Researchers - make sure you add to the contract the ability to use your vulnerability for internal research

Nonexclusive*

The researcher sells a license

Can be sold multiple times

*Non exclusive isn't as good as you may think strategically, many times its worst

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Support

Support can take many forms:

- Exploit adjustments to:
 - Product new / older versions
 - New vectors
- If the vulnerability is patched, the researcher may need to provide a different vulnerability
- Provide a workshop about the vulnerability to the client

Don't Forget – Support is worth money

if you are going to provide technical support for your sale, make sure you get paid for it

Legal - Contracts

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Governing law

Export liability

SOFTWARE ACQUISITION AGREEMENT

This Agreement describes how [REDACTED] (the "Seller"), will provide [REDACTED] and any of its affiliated companies (collectively the "Buyer") with software and documentation, which are detailed below, and how the Buyer is allowed to use the same.

1. Definitions

In this Agreement, unless inconsistent with the context or otherwise specified, the following definitions will apply:

- 1.1. "Acceptance Date" means the date on which the Software is accepted or deemed to be accepted by the Buyer pursuant to clause 4.
- 1.2. "Agreement" means these terms and conditions which shall include the Specification.
- 1.3. "Documentation" means the operating manuals, user instructions, and other related materials supplied to the Buyer by the Seller (whether physically or by electronic means) for aiding the use of the Software, including any part or copy of it.
- 1.4. "Equipment" means any hardware equipment compatible with the Software.
- 1.5. "Fee" means the fee specified in clause 6.
- 1.6. "Materials" means the Software and the Documentation.
- 1.7. "Software" means the computer programs as described in the Specification.
- 1.8. "Specification" means the specification document describing the functions of the Software provided by the Seller to the Buyer.
- 1.9. "Release" means any improved version of the Software.
- 1.10. "use the Software" means to sell or distribute the Software, or load the Software into and store, run and display the Software in accordance with the terms of this Agreement.

2. Sale of Software

- 2.1. Subject to the terms of this Agreement and in consideration of the payment to the Seller by the Buyer of the Fee, the Seller shall sell and deliver to the Buyer the Software and Documentation.
- 2.2. If and when applicable, each party will be responsible at its own expense for complying with its relevant export or import laws and regulations.

3. Delivery and Installation

- 3.1. The Seller will deliver one copy of the Software, in both object code and source code, and the Documentation by electronic means to the Buyer, within five (5) business days as of the execution of this Agreement.
- 3.2. The Buyer is responsible for ensuring that the Equipment is installed and fully operational prior to the scheduled date for delivery of the Software.
- 3.3. The Buyer is responsible for installation of the Software on the Equipment.
- 3.4. The Seller will use all reasonable endeavors to achieve delivery by any specified or requested date.

Governing law

Be mindful of where legal disputes are handled.

Make sure you have all the licenses if something goes terribly wrong.

Are there grounds for a suit?

Work with reputable buyers, they have no incentive to take bad deals that lead to legal action. Reputation matters for both sides.

Legal - Contracts

Spec

Exclusive / Nonexclusive

Delivery date

Validation period

Fees & payment

Propriety rights

Confidentiality

Support

Governing law

Export liability

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Wassenaar agreement

The **Wassenaar** agreement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies is a multilateral export control regime.

In simple words – In **some** countries you need an export license.

Each state legislates laws that represent the Wassenaar agreement differently.

Agreement



Law



Wassenaar agreement

'Vulnerability disclosure' means the process of identifying, reporting, or communicating a vulnerability to, or analyzing a vulnerability with, individuals or organizations responsible for conducting or coordinating remediation for the purpose of resolving the vulnerability.

4. E. TECHNOLOGY

4. E. 1. "Technology" as follows:

- a. "Technology" according to the General Technology Note, for the "development", "production" or "use" of equipment or "software" specified by 4.A. or 4.D.
- b. "Technology" according to the General Technology Note, other than that specified by 4.E.1.a., for the "development" or "production" of equipment as follows:
 1. "Digital computers" having an 'Adjusted Peak Performance' ('APP') exceeding 15 Weighted TeraFLOPS (WT);
 2. "Electronic assemblies" specially designed or modified for enhancing performance by aggregation of processors so that the 'APP' of the aggregation exceeds the limit in 4.E.1.b.1.
- c. "Technology" for the "development" of "intrusion software".

Note 1 4.E.1.a. and 4.E.1.c. do not apply to 'vulnerability disclosure' or 'cyber incident response'.

Note 2 Note 1 does not diminish national authorities' rights to ascertain compliance with 4.E.1.a. and 4.E.1.c.

Technical Notes

1. 'Vulnerability disclosure' means the process of identifying, reporting, or communicating a vulnerability to, or analysing a vulnerability with, individuals or organizations responsible for conducting or coordinating remediation for the purpose of resolving the vulnerability.
2. 'Cyber incident response' means the process of exchanging necessary information on a cyber security incident with individuals or organizations responsible for conducting or coordinating remediation to address the cyber security incident.

Export liability - Wassenaar

Report to vendor

No problem

Exporting
(End-product / Research
Service)

Special Marketing License

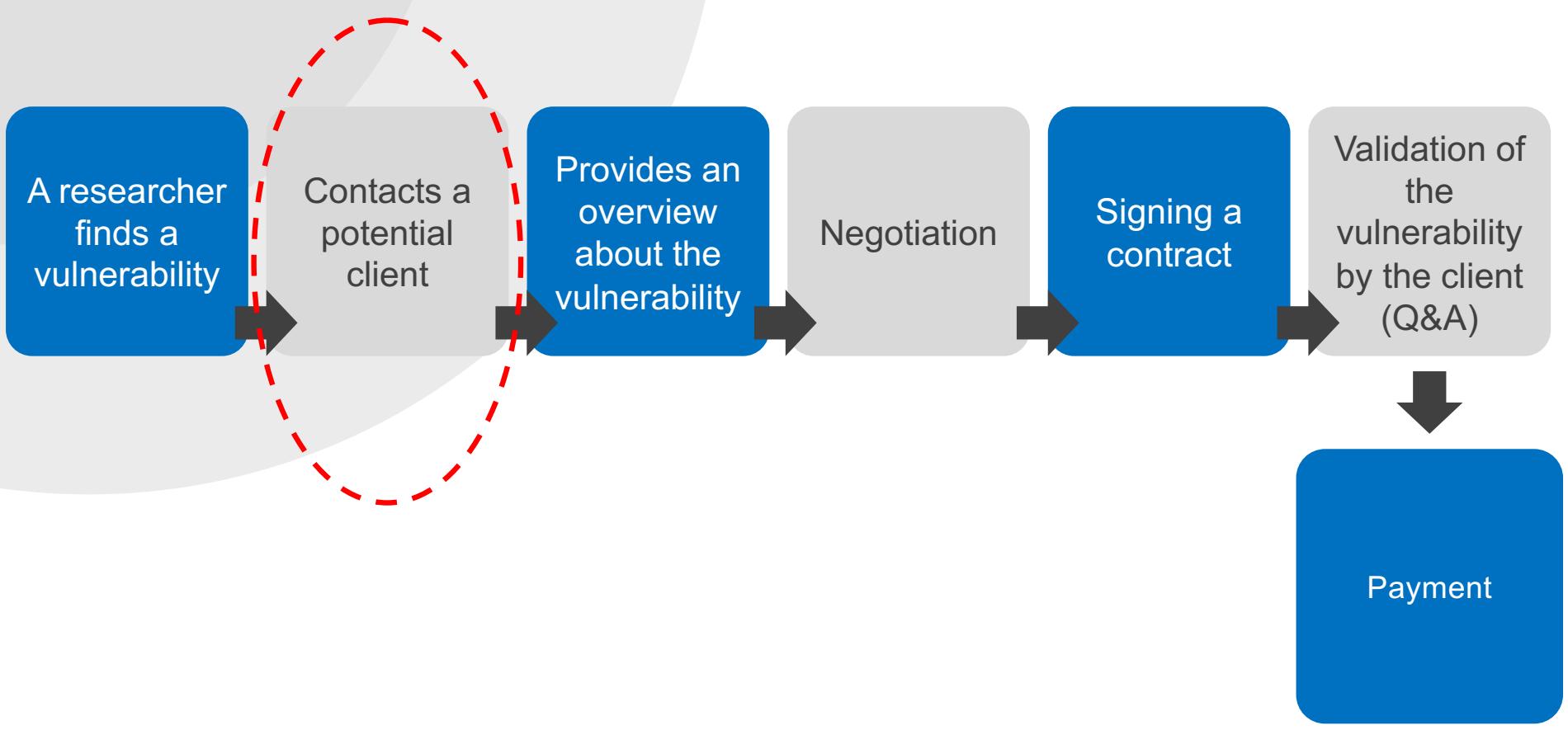
Special Selling License

Ministry Of Defense (MOD)

A blurred background image of a man in a suit sitting at a desk, looking at a laptop screen. He is wearing a grey suit jacket over a white shirt. The background is a soft-focus office or cafe environment.

Finding the Customers

The sales process - overview



Selling Vulnerabilities to Govs / Companies

Official point of contact

Vulnerability brokers

Personal connections
(govs / companies)



Official point of contact

Some governments and offensive security companies publish “official” point of contact

Conferences (business cards / emails / flyers etc.)

Direct approach (“cold email”)

As a researcher, you can email companies you think will be interested (They will probably reply)

Governments direct can be extremely time consuming

don't expect amazing terms or a timely schedule for decision making or payment

Some may be willing to engage directly unsolicited (expect significant competition)

some may be impossible to reach and need a direct relationship or introduction

Official point of contact

Pros	Cons
The researcher knows who the client is	The client (usually) knows the researcher identity
Updated in real time on the status of the deal	Limited number of potential clients (~5)
Legal (licensing)	Legal (licensing)
	The researcher might get underpaid
	Bad Contract (The client can add limiting terms before buying)
	Multiple POCs Simultaneously - Time consuming

Selling Vulnerabilities to Govs / Companies

Official point of contact

Vulnerability brokers

Personal connections
(govs / companies)



Personal connections

Pros	Cons
The researcher knows who the client is	The client (usually) knows the researcher identity
Updated in real time on the status of the deal	Limited number of potential clients (~5)
Legal (licensing)	Legal (licensing)
Full payment without worries*	The researcher might get underpaid
Trust	Bad Contract (The client can add limiting terms before buying)
	Multiple POCs Simultaneously - Time consuming

Vulnerability
broker



The 0-day broker – My experiences

Workshops

HR services
(Full / part time jobs)

On demand projects
(freelancers)



Selling end-product
(vulnerabilities / exploits)

Working with other
brokers

Helping clients to create
their own ability to buy
and sell 0-days

Benefits of working with brokers

Anonymity

Market
Landscape

Close and
intimate
relationship with
clients

Negotiation

Legal

Manage the
process

How does a broker make his money?

The broker charge the client for his services

There are couple of models:

Broker Fee - %
on top of the
initial price.

Q-recon fees
were:
• 17% from
companies
• 15% from
governments

Reseller - The
broker buys the
vulnerability from
the researcher
and sells it to
couple of clients

Subscription -
yearly or monthly
subscription fee.

Selling 0-days – In a nutshell

Don't waste too much time
in the high-end market if your
vulnerability isn't high quality

Ensure your PoC is stable and
mature and always works on
the latest sable

Just because your iOS Safari
RCE/LPE is worth XXXX
doesn't mean there is a
buyer for it

NEVER oversell a vulnerability
hoping it will lead to a
successful transaction, **IT**
WILL NOT, find better bugs

Selling 0-days – In a nutshell

Exclusive has its pros.
Juggling non-exclusive to
multiple parties is both
stressful and can easily fall
apart

DO explain if the vulnerability
is stable and deterministic, but
your exploit is just sh*t and
can be improved
(can save a deal)



If you sell non exclusive, limit
the expose to a few trusted
clients

NEVER tweet or be overt
about a transaction, it can
breach the contract
confidentiality and relationship
trust

Selling 0-days – In a nutshell

**0days lately burn a lot faster
due to p0 and such .**

Your lower offer might in fact to
be the better offer if your 0day
goes to 0\$

Always listen to feedback. If
your are skilled at Edge
Chakra and your broker tells
you to focus on V8 you should
probably consider the buyer
feedback

**Sometimes transactions just don't work out, but when they do
work out – it's definitely worth it**

Selling 0-days – In a nutshell

The going rate for any vulnerability is based purely on Demand. If the market is flooded with a capability, it doesn't matter what its worth if everyone is redundant

Exclusive might seem easy to work around or later "convert" to non exclusive. DON'T, most buyers/brokers are in the same network/circles, with real deal buyer its even a smaller world. Trust is everything in this market

Some Tips for Beginners



Don't eat yellow snow

Get Some Street Cred

Play CTFs

Go to Conferences – meet researchers and potential clients

Publish 1-2 vulnerabilities (high-end)

Get help when in doubt

Know your s*** (Never “Fake it till you make it”).

Don't worry about imposter syndrome or if you're good enough, you never know until you try



How Can I Help You on Your Journey

I closed my company, but I still want to help.
ATM, I offer my services for free, no strings attached.

A photograph of a modern office environment. In the foreground, a person with blonde hair and glasses is seen from the side, writing in a notebook. Behind them, a man stands at a whiteboard, holding a marker and gesturing towards it. Several laptops are open on desks in the background, and large windows let in natural light. A watermark "mashroom5" is visible in the upper left corner of the image.

Questions?

**Thank you
very much
for your
time**



@malltos92



Maor@qrecon.com