RSAConference2022
San Francisco & Digital | June 6 – 9

TRANSFORM

SESSION ID:

Protecting Traditional and Blockchain Virtual Economies

Adrian Bednarek

CISO
Overflow Labs, Inc.

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Me

- Adrian Bednarek
- CISO@ Overflow Labs
- Into:
  - Breaking and protecting weird stuff
    - Proprietary protocols
    - Obfuscated code
    - Digital assets/Rights management
    - ‘Blockchainy’ things
    - Virtual economies

Agenda

- My background
- Crash course in econ 101 (I'll make it quick)
- Web1, Web2, Web3 economies? What are they?
- Common economic attacks on traditional (web2) economies.
- Deep dive into a web2 economic exploit
- Common attacks on web3 economies
- Summary/Recap

Timeline

1997

2001

2002

2004

+~25 others

2017

2022

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Virtual Economy Management Platform


The Lord of the Rings Online


Ultima Online


DarkFall
Unholy Wars


Age of Conan


WildStar


Dark Age of Camelot


RIFT


Asheron's Call 2
Fallen Kings


Final Fantasy XIV
Online


The Elder Scrolls
Online


Star Wars
The Old Republic


Shadowbane


World of Warcraft


Lineage


Anarchy Online


Age of Wushu


Final Fantasy XI
Online

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TLDR/TLDL (Too long didn't listen)

95% of all virtual economies are hackable*

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Crash Course In Economics

Economy 101

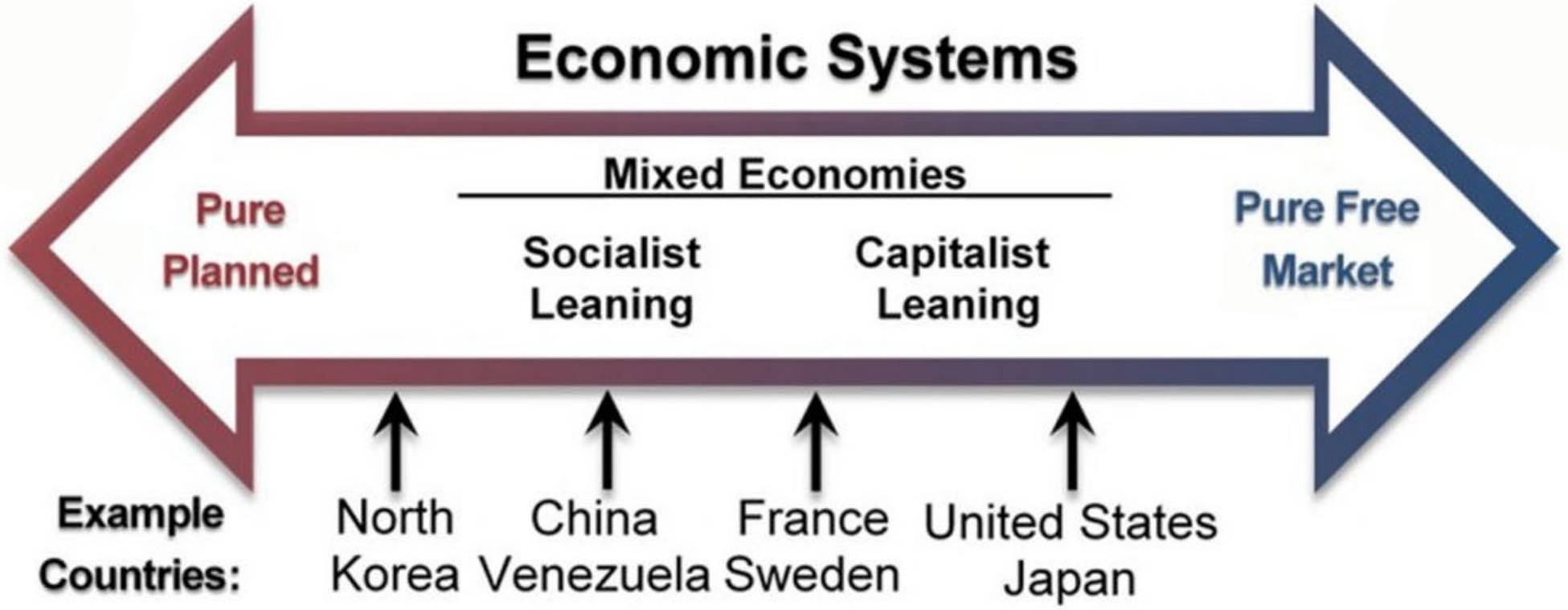
What is an Economy?

- The root of what an economy is both simple and complex
  - In a nutshell an economy is defined by the production and consumption of:
    - Goods
    - Services
  - It gets complicated since both the production and consumption of goods are influenced by:
    - Culture and values
    - Education and technological evolution
    - Social norms
    - Political structure and legal systems
    - Geographic factors and natural resource abundance

Types of Economic Systems

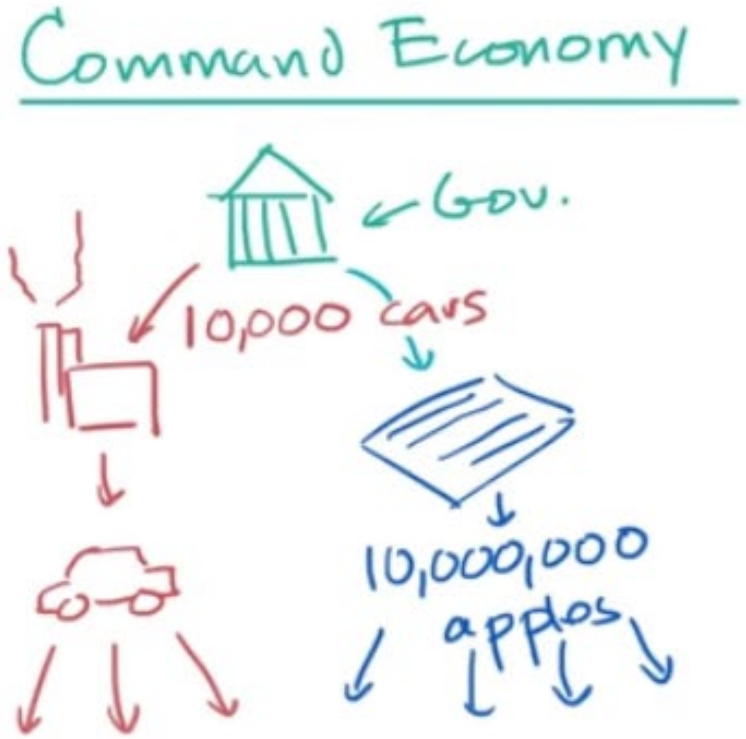
- Four main types
  1. Free Market Economy (Defined by Supply and Demand)
  2. Command Economy (Defined by a Central Government/Entity*)
  3. Traditional Economy (Developing countries, social and custom defined, barter)
  4. Mixed Economy (Typically a hybrid of free market and command)
- Goal: Minimize or control the fluctuation of goods and services availability
  - Stable Markets (prices of goods)
  - Stable Employment Levels
  - Business and Individual Prosperity

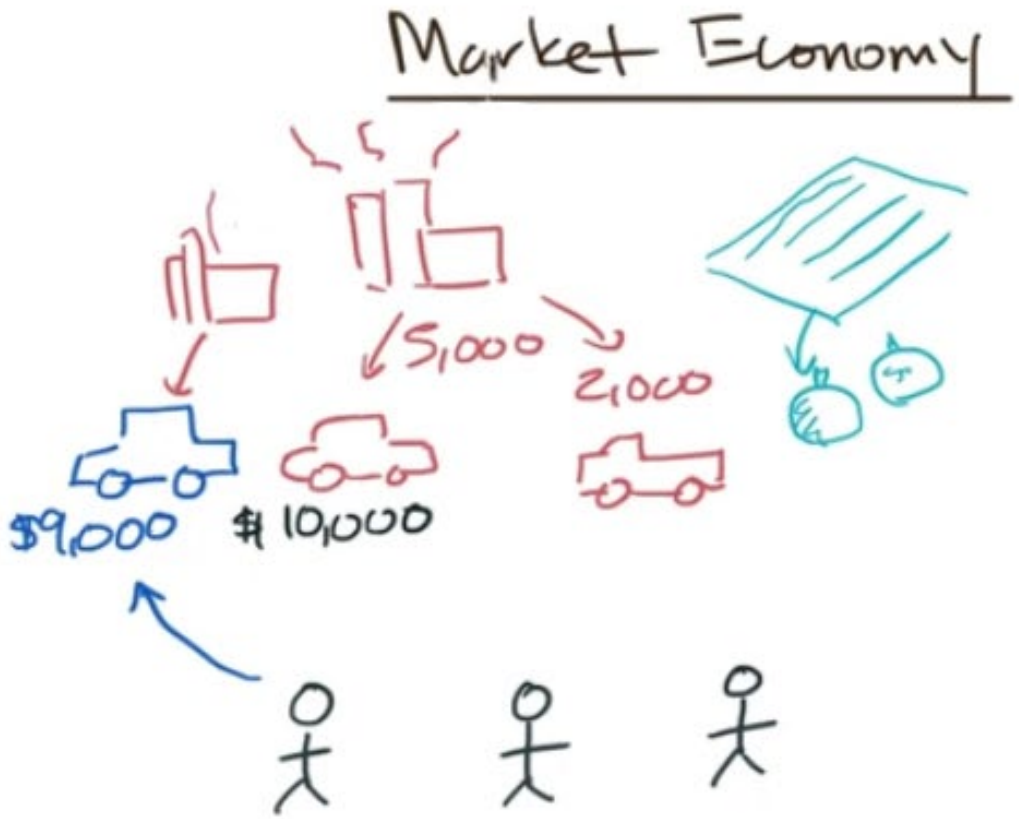
Planned-Free Market Spectrum



*source:https://www.proprofs.com/

Command vs Market Illustrated

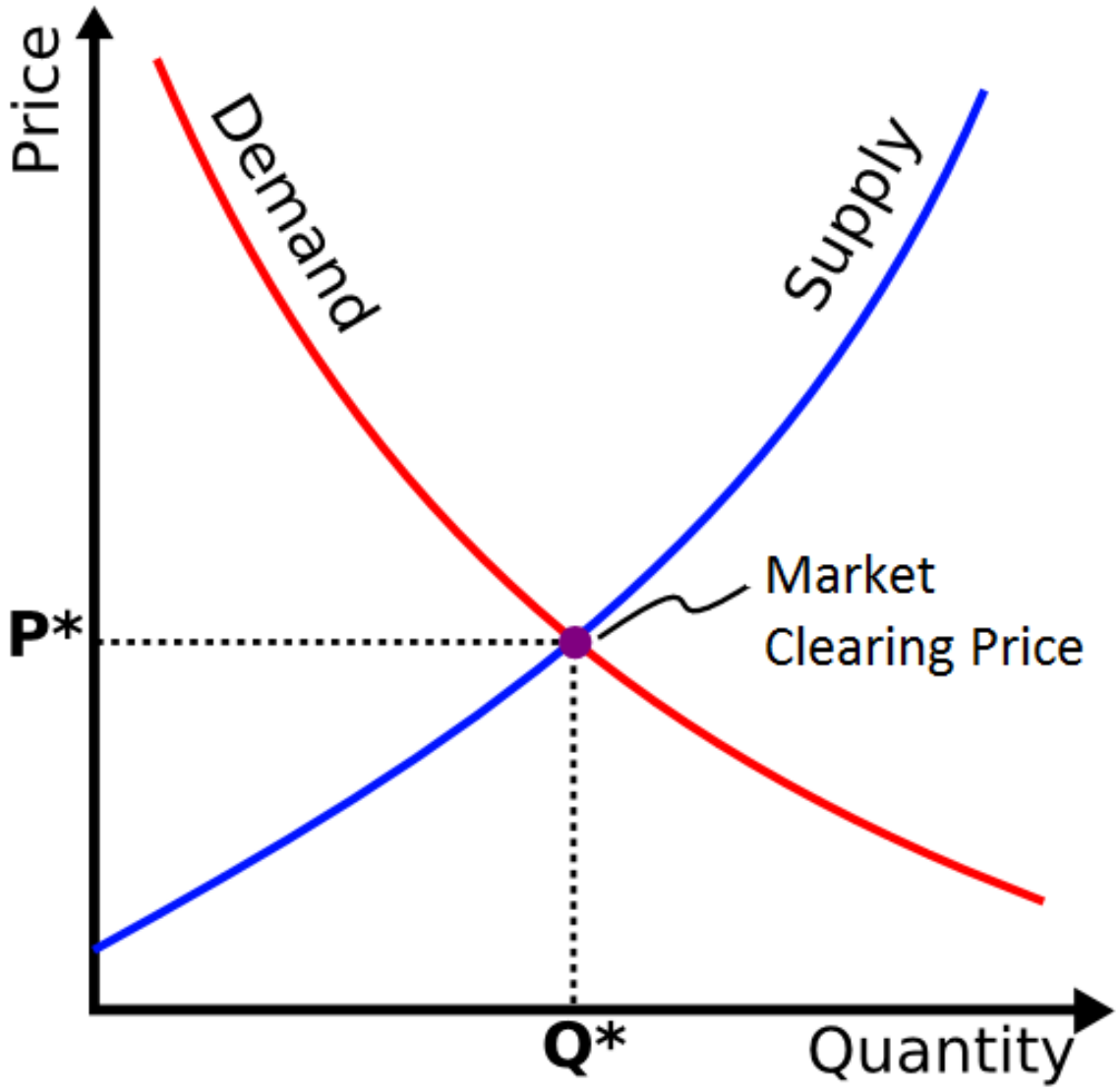




*source: https://www.youtube.com/watch?v=Ve6K10-Yx_M

Supply and Demand

- The entire field of economics is based on the idea of **“Scarcity”**



“Scarcity”

8L Banff Air

~~$32.00~~ **$25.00**

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Recap

- In a free-market people vote with their money on what goods and services should be provided
- In a command top-down designed economy a group of people in leadership mandate what goods and services should be provided
- The concept of **Scarcity** is central to economic activity
  - Scarcity must be protected?

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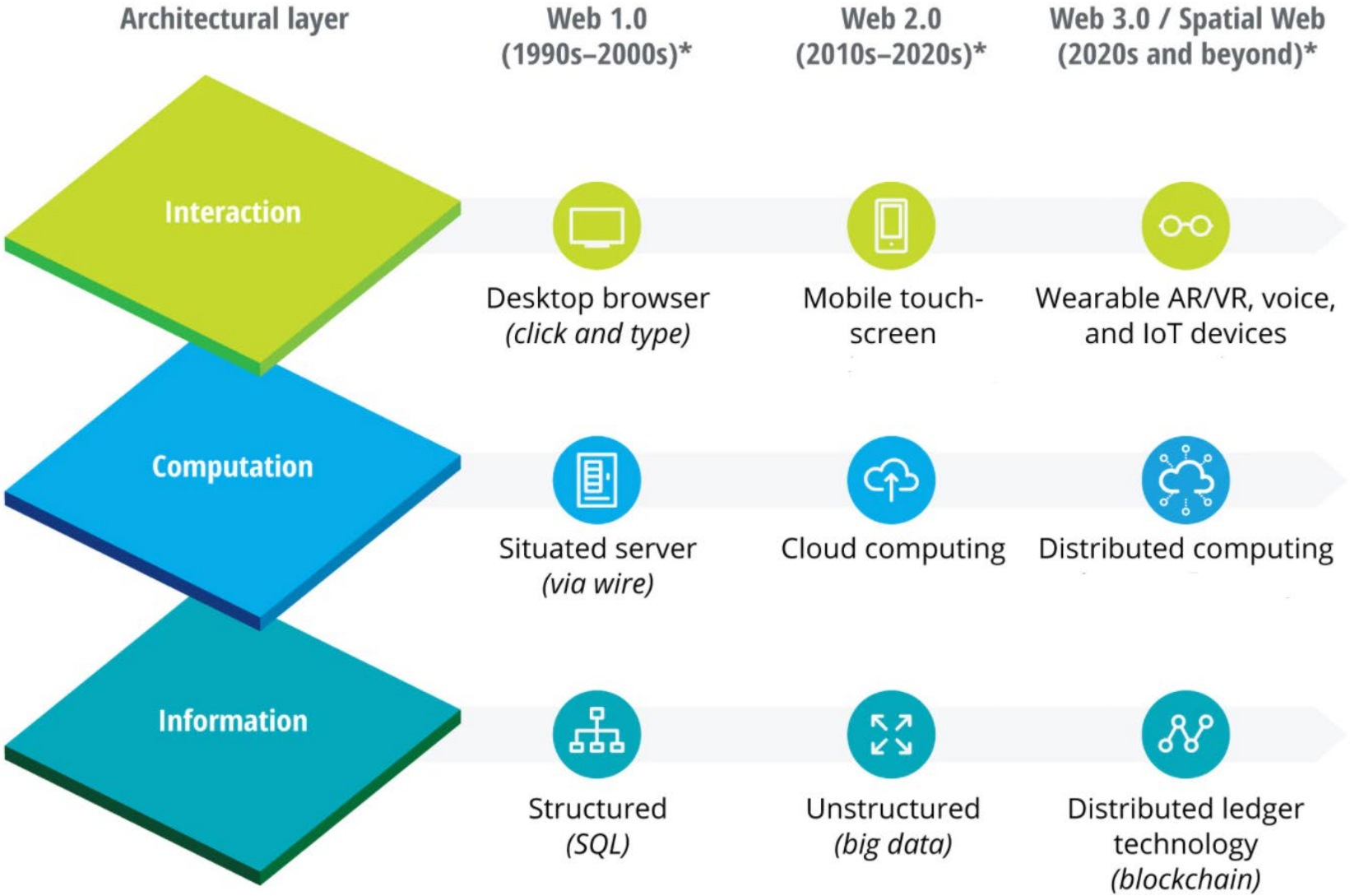
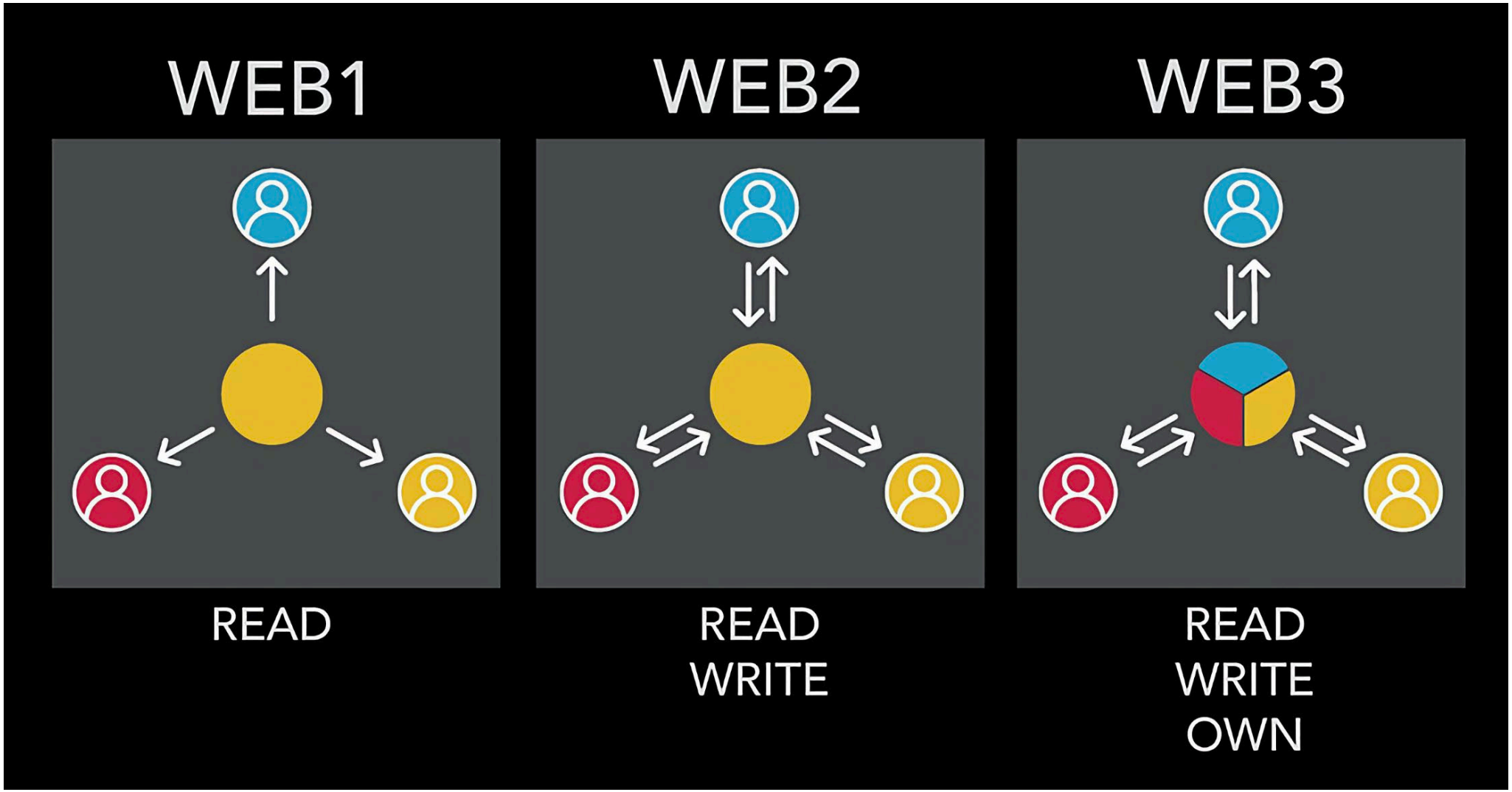
Virtual Economies

What is web1/web2, and web3?



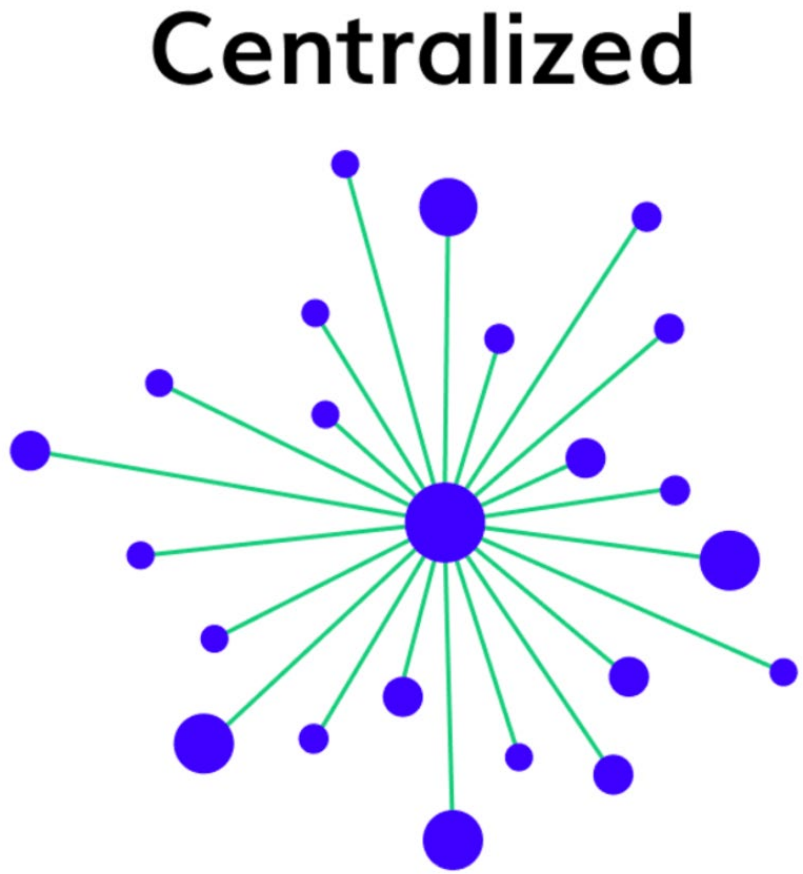
*Source:Artivatic.ai

In a Nutshell



Protecting Web 2 Economies

- Centralized data ownership issues:
  - Trust of maintainers
  - Trust of codebase
  - Trust of infrastructure
- Exploit classes:
  - OWASP TOP 10
  - Infrastructure configuration
  - Business logic
- Why? – Protect Scarcity



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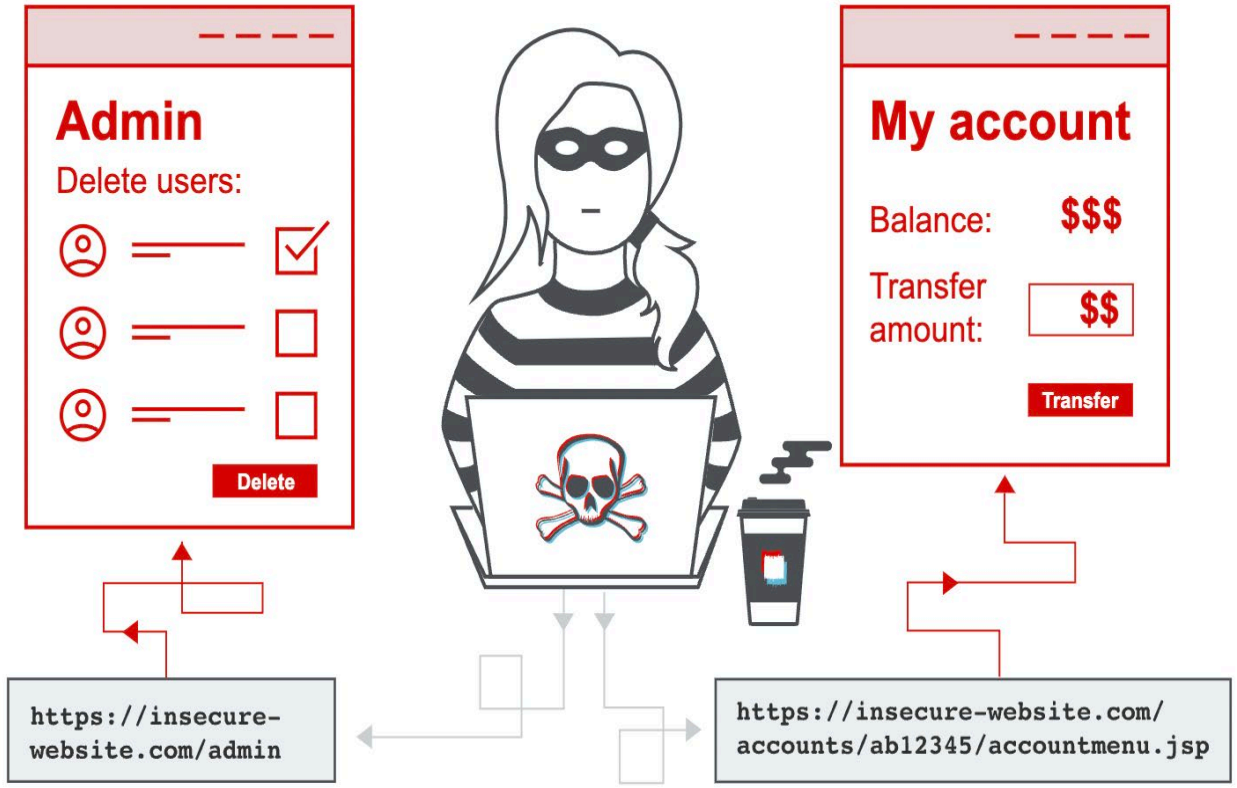
Common Types of Attacks

Integer/Data Race/Access/Authorization Issues

Access/Authorization Issues

- Insufficient access checks or enforcement



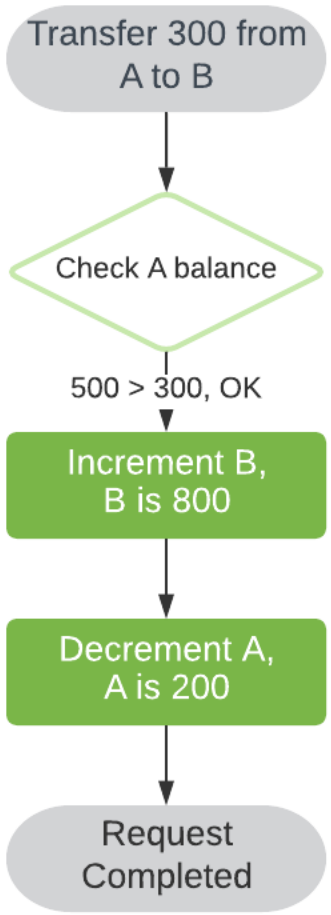
*Source: portswigger.net

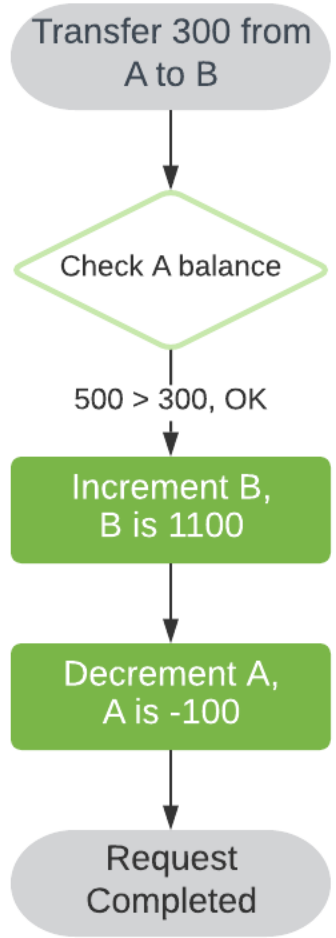
Integer Exploits

- Simpsons did it!

Race Conditions

- Complicated
- Frequent in multithreaded systems/distributed computing





*Source: baeldung.com

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Case Study

Guild Wars 2 – a ‘web 2’ era ecosystem

Guild Wars 2

- WoW type clone
- Player to player trading
- Popular
- Large feature set
  - crafting, guild banks, personal banks, auction house, vendors.. etc
- large attack surface + popular game + in game commerce


Black Lion Trading Company
Trading Post [0]
112 76 91
GET MORE GOLD
Home
Buy Items
Sell Items
My Transactions
pearl rod
Search : pearl rod
Only Show Available
Armor
Weapons
Upgrade Components
Skins
Crafting Material
Other
Inventory Bags
Delivery Box
Items: 0
Funds: 0
When you buy or sell on the Trading Post the items and funds will show up here. Speak to a Black Lion Trading Company NPC to pick them up.
Qty.
Item
Level
Price
10650 Pearl 0 1 94
27 Rodgort 80 1,974 99
202 Dire Pearl Rod 80 1 75 27
206 Rabid Pearl Rod 80 94 73
250 Magi's Pearl Rod 80 89 99
40 Giver's Pearl Rod 80 3 88 99
270 Carrion Pearl Rod 80 1 22 1


Dire Pearl Rod
Vendor Value: 2 64
Quantity: 1
Max. Price 1 75 27
Total Price: 1 75 27
Buy Instantly
Cancel
Current Buyers
Ordered
Price per Unit
2 Ordered 81 40
3 Ordered 81 39
2 Ordered 81 38
4 Ordered 81 37
2 Ordered 81 33
Current Sellers
Available
Price per Unit
Buying 1/2 1 75 27
2 Available 1 75 28
1 Available 1 81 29
1 Available 1 81 30
1 Available 1 83 33


Current Sellers
Available
Price per Unit
Buying 1/2
1 75 27
2 Available
1 75 28
1 Available
1 81 29
1 Available
1 81 30
1 Available
1 83 33
2 Available
2 4 91

AH – BUYING STUFF (via GUI)

- Listed:

2 @ 1 g 75 s 27 c

2 @ 1 g 75 s 28 c

- To buy 3 the price would be:

2* 1g 75s 27c (17527)

+ 1* 1g 75s 28c (17528)

= (17527*2) + (17528*1)

= 52582 or 5 Gold 25 silver 82 coper

AH – BUYING STUFF (INTERNALS)

- RESTFUL API – JSON
- Example buy request:

{"protocol":"Game.gw2.Trade",

"command":"Buy",

"body":{"offers":[{"UnitPrice":17527,"Quantity":2},{"UnitPrice":17528,"Quantity":1}]},"headers":{"t":"$45977","m":“<CHARID/SESSIONTOKEN GUID"},"type":"One"}

45977 is item id (https://www.gw2spidy.com/item/45977)

TLDR; The Exploit

Original Request

- *Item Number*
- "t":"$45977"
- *Array of purchase requests*

[{"UnitPrice":17527,"Quantity":2},

{"UnitPrice":17528,"Quantity":1}]

- Buyer spends 5g 25s 82c and gets all 3 items.
- The Seller gets the full 5g 25s 82c!

Modified Request

- *Item Number*
- "t":"$45977"
- *Array of purchase requests*

[{"UnitPrice":17527,"Quantity":2},

{"UnitPrice":1,"Quantity":1}]

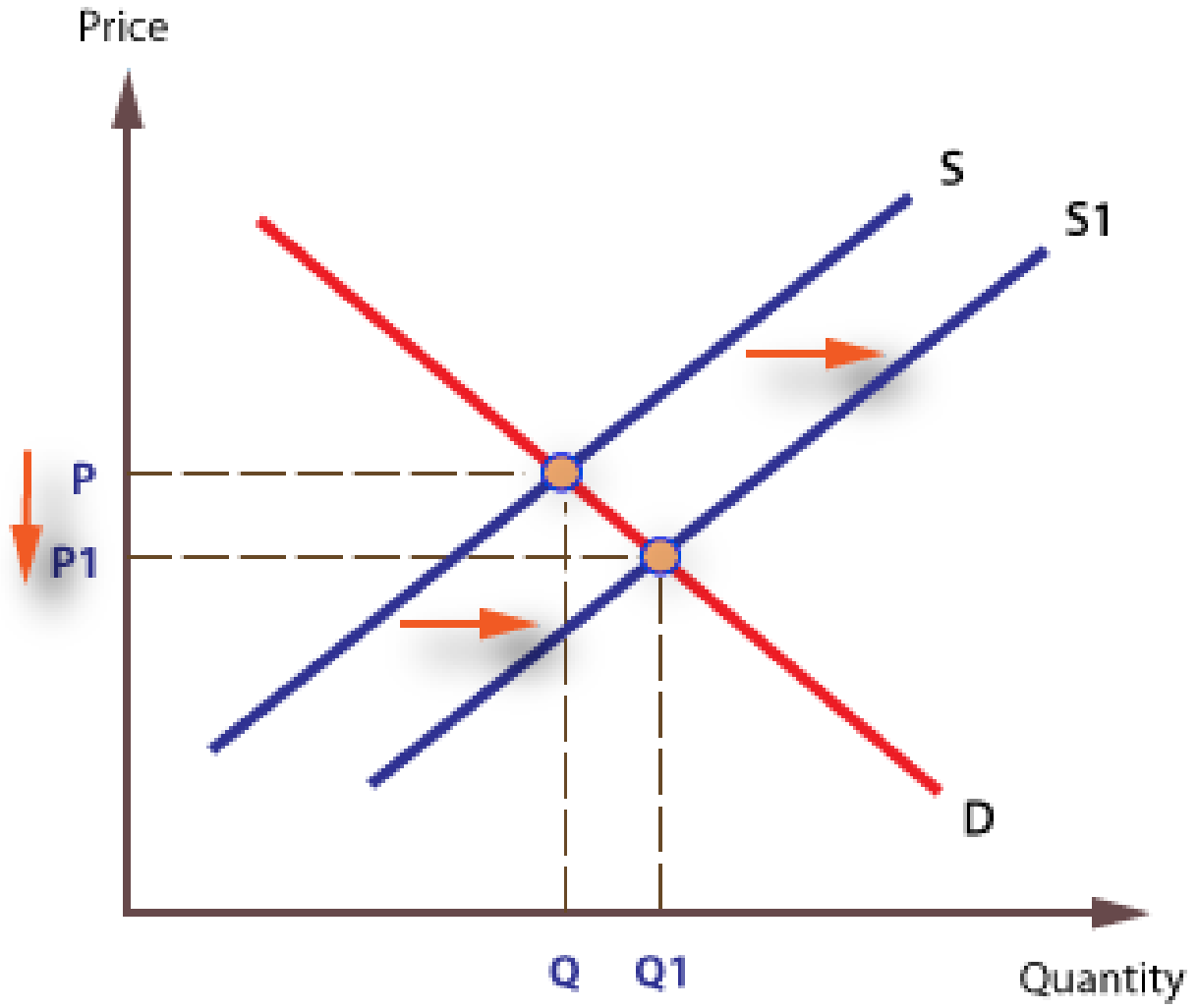
- Buyer spends 3g 50s 54c and gets all 3 items.
- The Seller gets the full 5g 25s 82c!

TLDR; The Exploit

- The buyer and seller can be the same account!
- What does this mean?
- Account 1 Lists 10 items up for sale at 1,000 gold per item
- Account 1 Buys 1 item at 1,000 gold and 9 at 1 copper in the same request:
- Account 1 now has all 10 items
- Account 1 now has a net gain of 10,000 – 1,000 gold = **9000 gold profit!** (rinse and repeat!)
- **Illusion of ”Scarcity” is at risk – if abused then the economy will be broken**

Illusion of Scarcity at Risk

- Supply shift possible
  - Worst case: to infinity



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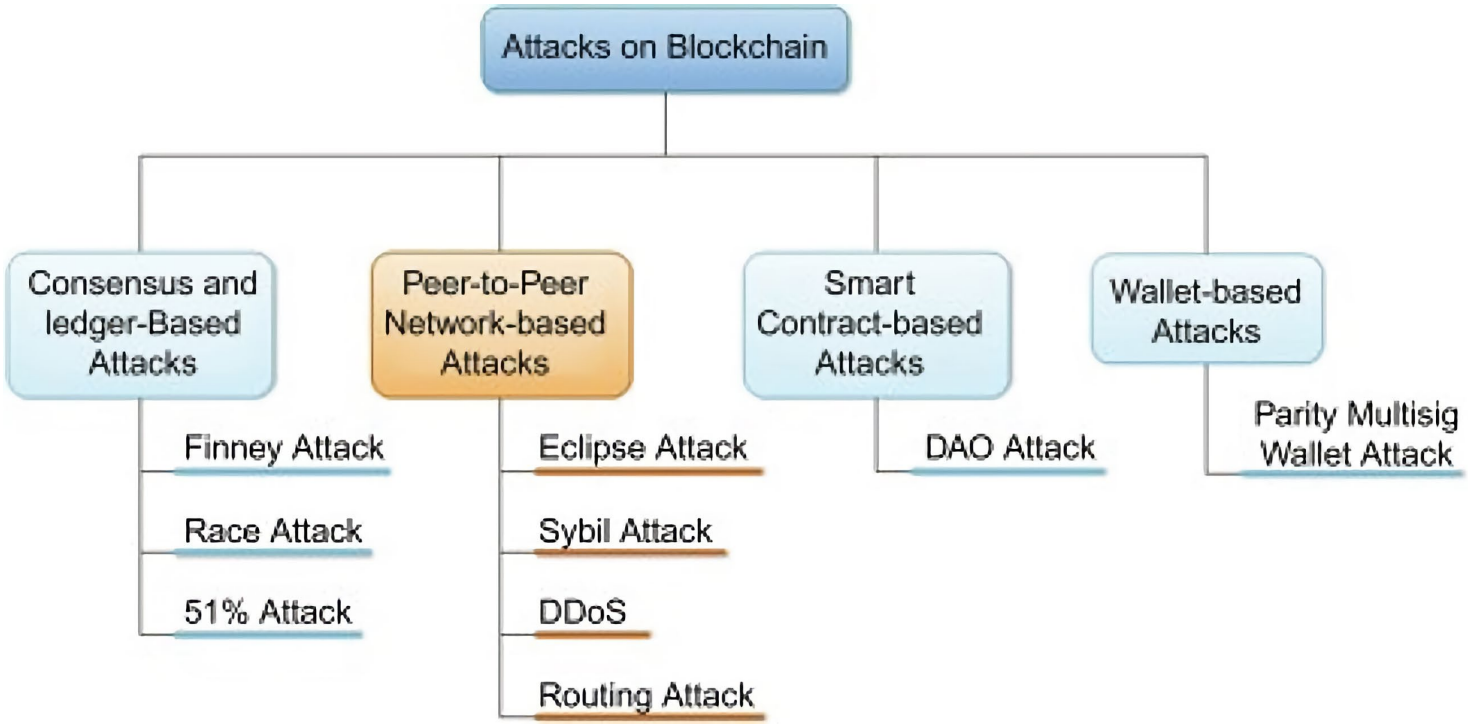
Blockchain Economy

3-10 Billion USD lost/stolen in 2019/2020/2021

Threats against blockchain economies

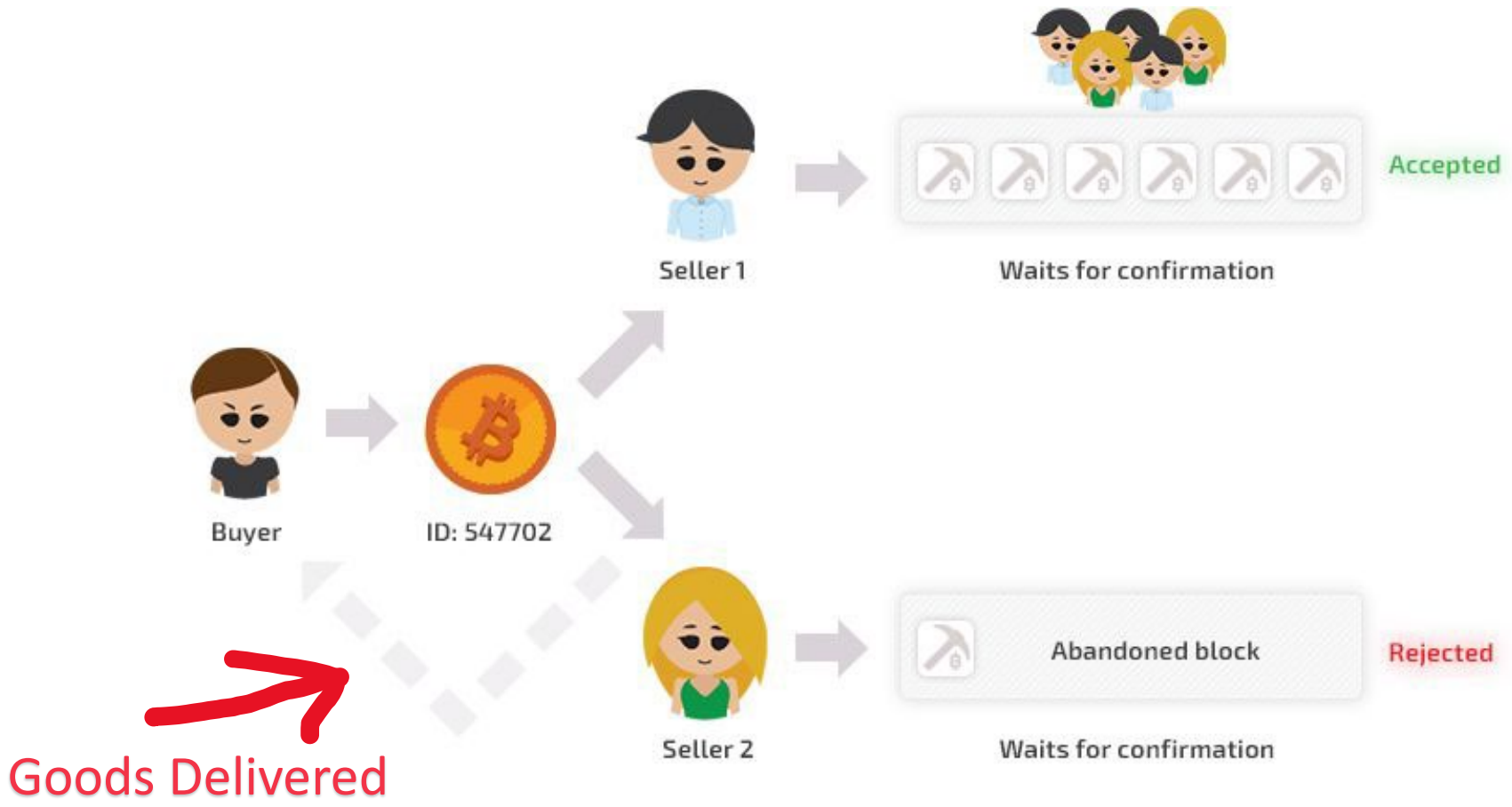
- Blockchain network itself
- User wallet attacks
- Smart contract attacks
- Cryptographic failures



Finney Attacks and Race Attacks

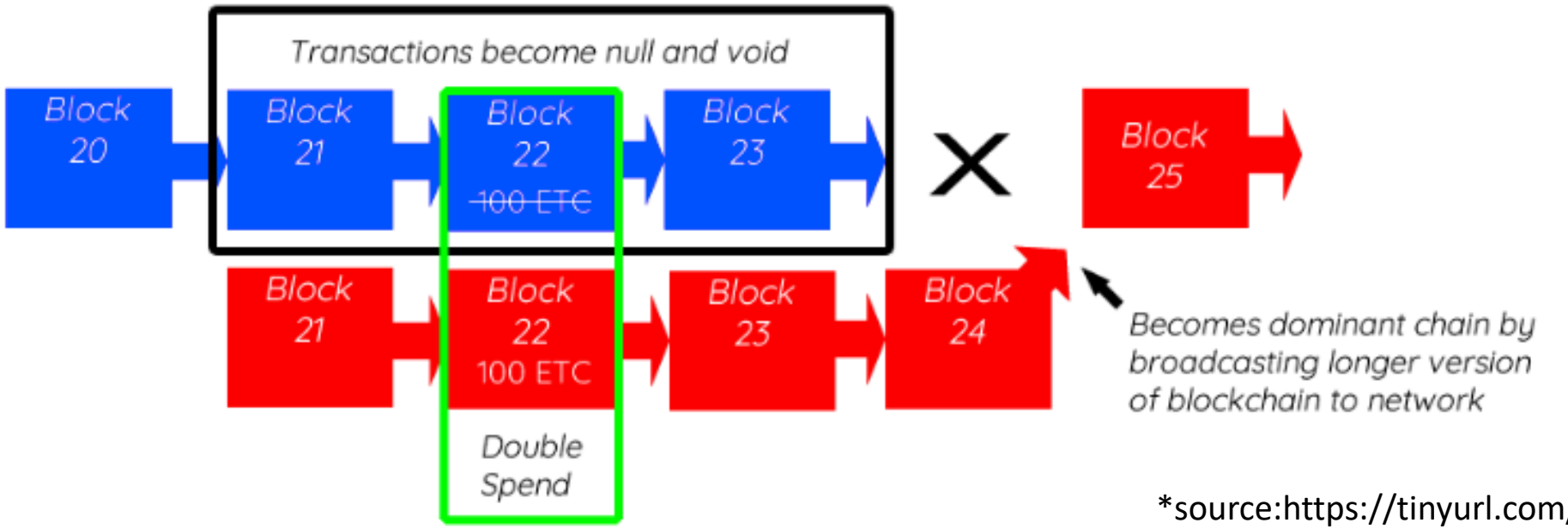
- Double Spend Attack

*source:https://www.apriorit.com/dev-blog/578-blockchain-attack-vectors



51% Attack (Blockchain Unique)

- Goal is to
  - 1: Spend Virtual Currency and Receive Goods
  - 2: Reject the transaction that spent the virtual currency

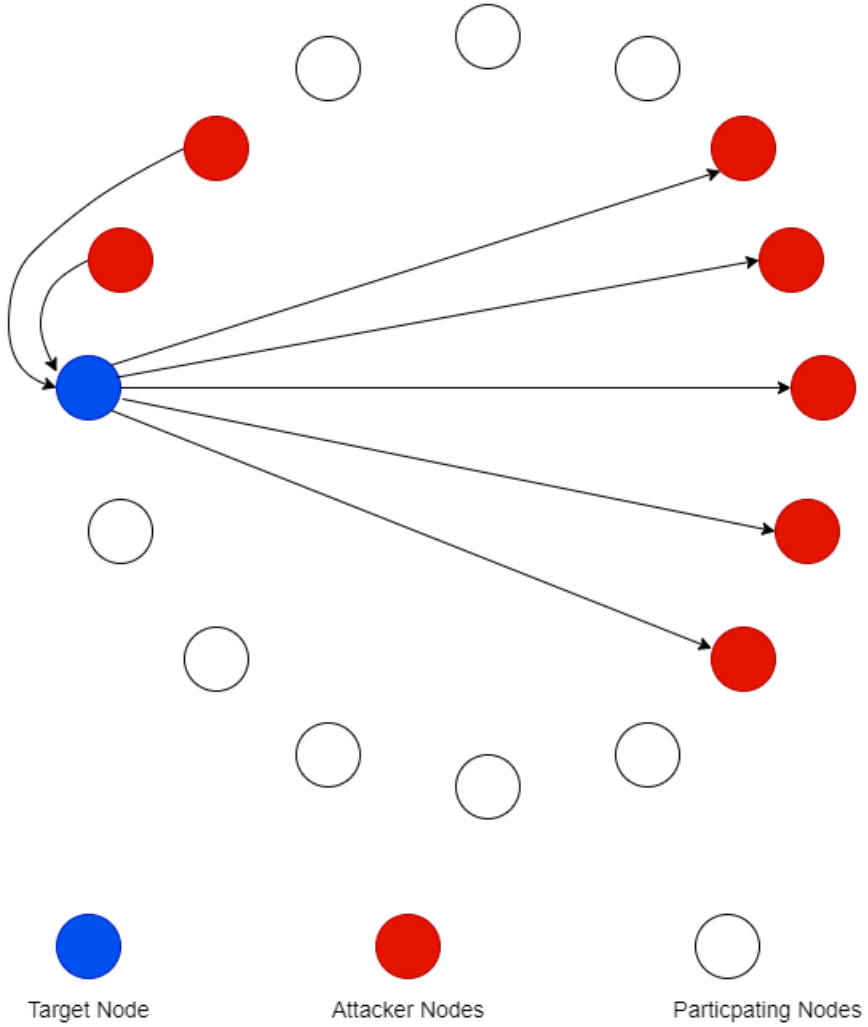


*source:https://tinyurl.com/ykj6jv29

Eclipse/Sybil/Routing Attacks

- Goal is to influence a node to fetch an alternate view of the blockchain from other attacker-controlled nodes
- This allows an attacker to:
  - Double spend to steal goods and services
  - Disrupt a blockchain network
    - Miners
    - Reputation

*source:https://www.geeksforgeeks.org/what-is-an-eclipse-attack/



DAO attacks

- What is a DAO?
  - Decentralized Autonomous Corporation
  - An entity defined by code?
  - I like to think of it as a vending machine in the cloud
    - Participants can interact with it
    - Participants can govern and alter its behavior through voting
- Popular DAO example:

UNISWAP

Wallet Attacks

- Wallets are defined by private keys
  - If someone get your private key, they can:
    - See your virtual currency balance
    - Transfer all your virtual currencies
- Popular attack vectors
  - Malware
  - Phishing
  - Fake wallet hardware and/or software

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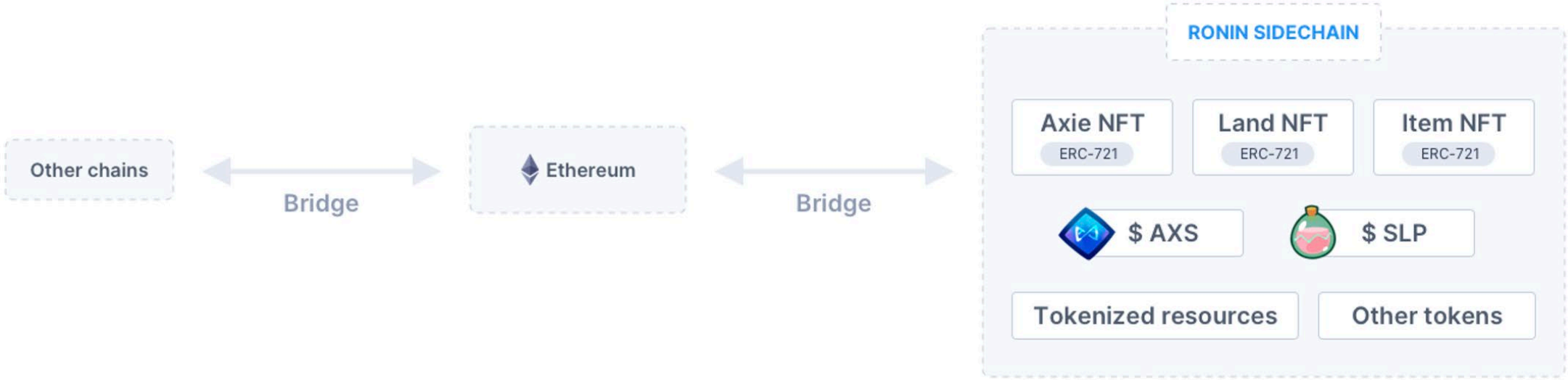
Case Study

Axie Infinity

- Blockchain game
- Has its own currency ”AXS”
  - Tradeable for Ethereum

Axie Infinity

- Sidechain structure with an Ethereum bridge
- Ethereum wallet compromised
  - Social engineering attack to steal private keys
- Result: 600,000,000$ Lost



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Web2/Web3 Summary

Web 2 Incidents

MMO	Launched	Integer	Access	Data Race
Ultima Online	1997	✓	✓	✓
Asherons Call	1999			✓
Dark Age of Camelot	2001	✓	✓	✓
Anarchy Online	2001	✓	✓	
Final Fantasy Online (XI)	2002	✓	✓	✓
Asherons Call 2	2002			✓
Shadowbane	2003	✓	✓	✓
Lineage 2	2003	✓	✓	
World of Warcraft	2004	✓	✓	
Lord of The Rings Online	2007	✓	✓	

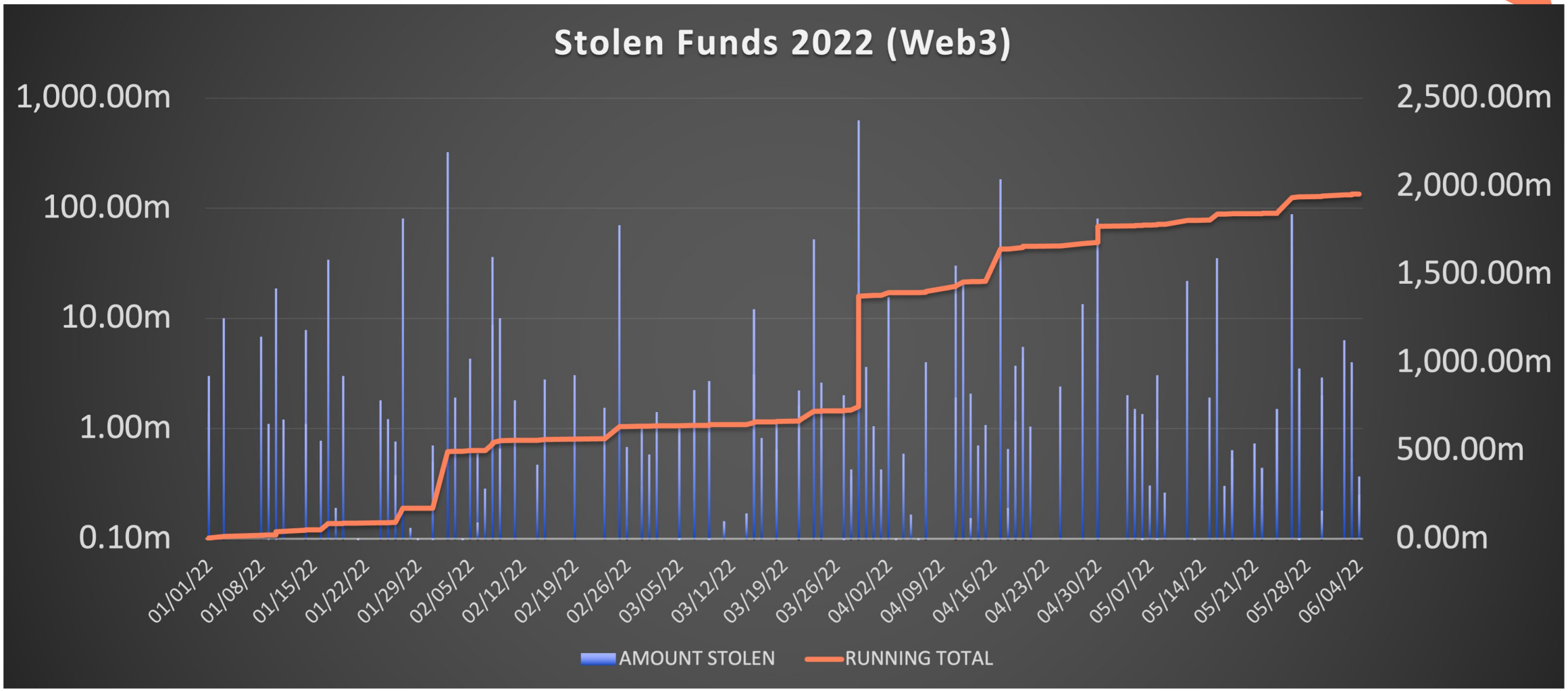
Web 2 Incidents

MMO	Launched	Integer	Access	Data Race
Age of Conan	2008	✓	✓	
Darkfall: Unholy Wars	2009	✓	✓	
Final Fantasy Online (XIV)	2010	✓	✓	✓
Star Wars the Old Republic	2011	✓	✓	
Rift Online	2011	✓		
Guild Wars 2	2012	✓	✓	
Age of Wushu	2013	✓		
Wildstar	2014	✓	✓	
Elder Scrolls Online	2014	✓	✓	

Web 2 Summary (1997-2017)

- This is from my perspective
- ~180 economic exploits found in total
- ~5-10 economy breaking exploits per game
  - Average lifespan for an exploit before detection ~2 months
    - Some have run for multiple years. (12 years for one)
- Interesting sidenote:
  - The more an economic system relied on ‘bolt-on’ anti cheat detection the more likely it was to have critical exploits

Web 3 Incidents 2022 (144 as of June 5)



*Data Source: https://web3isgoinggreat.com/

Web 3 Incidents 2022 Summary

- Average attack yield 13,580,000$
- On average there is an Attack every 26 hours
- Total value lost in 2022 ~ 2 Billion*
  - About 42 Billion if Terra/Luna is included

Protecting the Virtual Economy

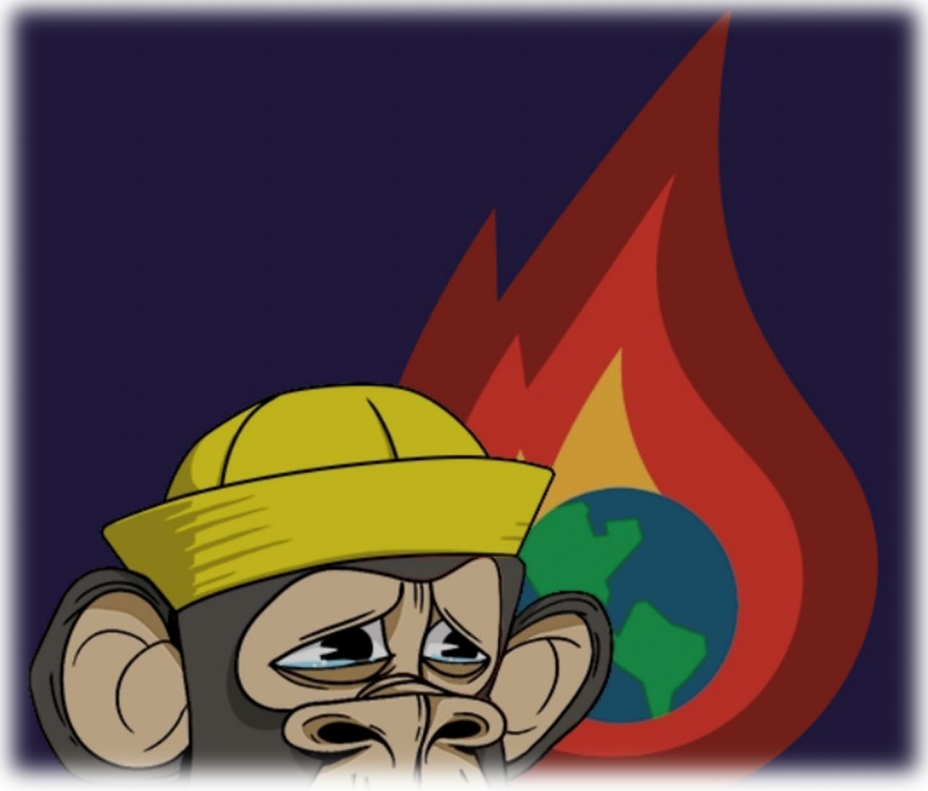
- Web 3 economic scarcity has to be maintained
- Web 2 ‘illusion of scarcity’ has to be maintained
- Violation of scarcity will lead to price crash and abandonment of economic participation by individuals

Apply What You Have Learned Today

- Next week you should:
  - Identify present or future workflows that may have interactions with internal or external virtual economies
- In the first three months following this presentation you should:
  - Catalog virtual economy items:
    - Scarce assets
    - Sources of assets and define security controls around them. Who can generate assets, how are asset generation controls enforced?
- Within six months you should:
  - Threat model and define steps to test security guarantees provided by systems that interact with ‘scarce’ assets

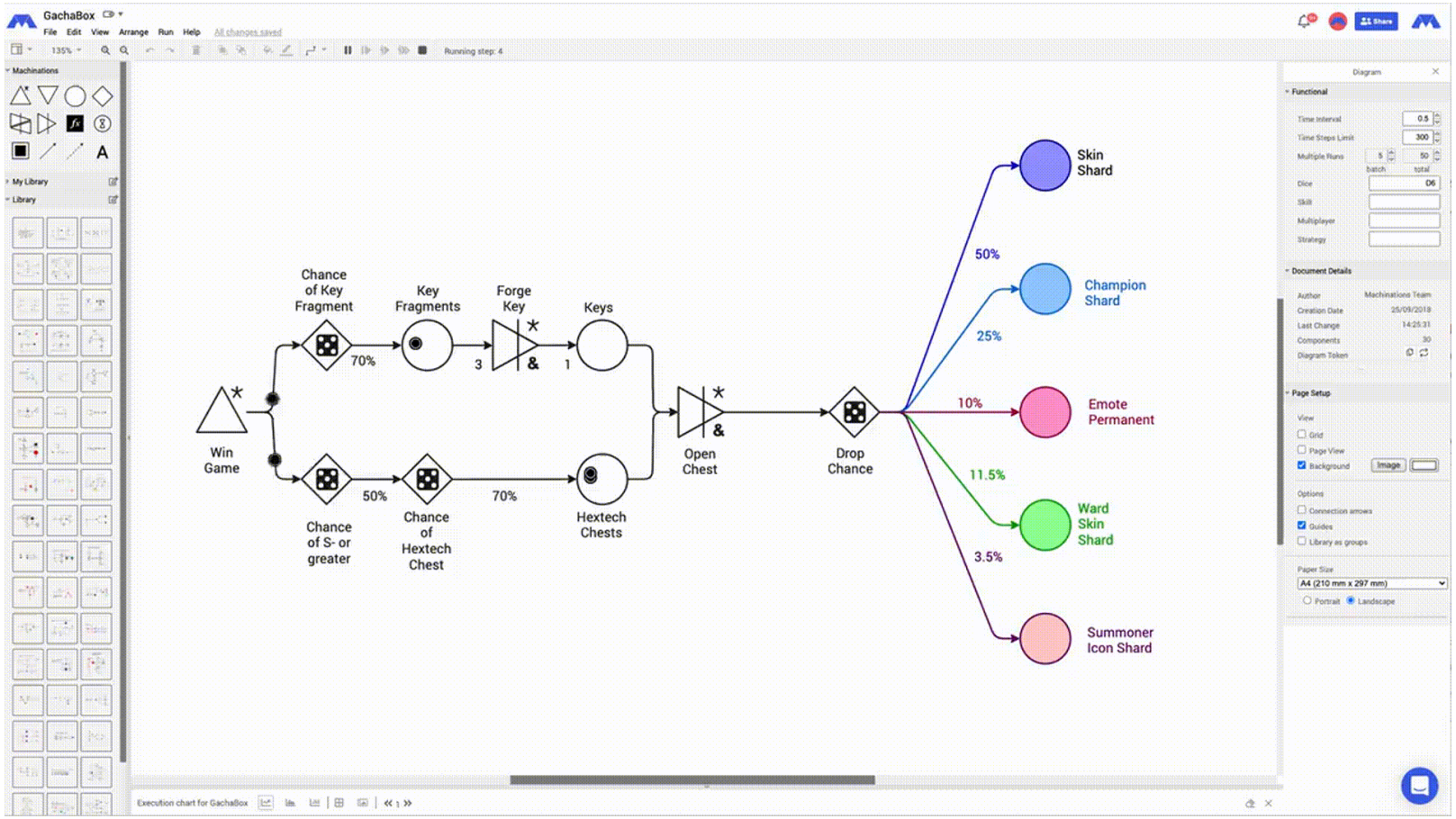
Additional Resources

- https://web3isgoinggreat.com/
- Seems like satire but its not
  - Covers the struggles of web3 as it matures



Additional Resources

- https://machinations.io/ -- Economic Modeling



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Thank You!

Adrian Bednarek

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