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ANATOMY OF EXPLOITING MMORPG'S

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Independent Security Evaluators
@ISEsecurity

Obligatory who is this guy?

- Adrian Bednarek
- Security Analyst/Researcher at ISE (Independent Security Evaluators)
- Started in the security field as a mostly ethical blackhat*
  - Creating side channel ‘in app purchase’ functionality
    - E.g. Selling gold and virtual goods on ebay, then playerauctions/wholesale
    - First sale – castle in Ultima Online
    - Over 100+ 0day virtual economy exploits in 24+ online games
- Here to talk about common exploits in MMORPG’s
  - Tools
  - Methods
  - Challenges!

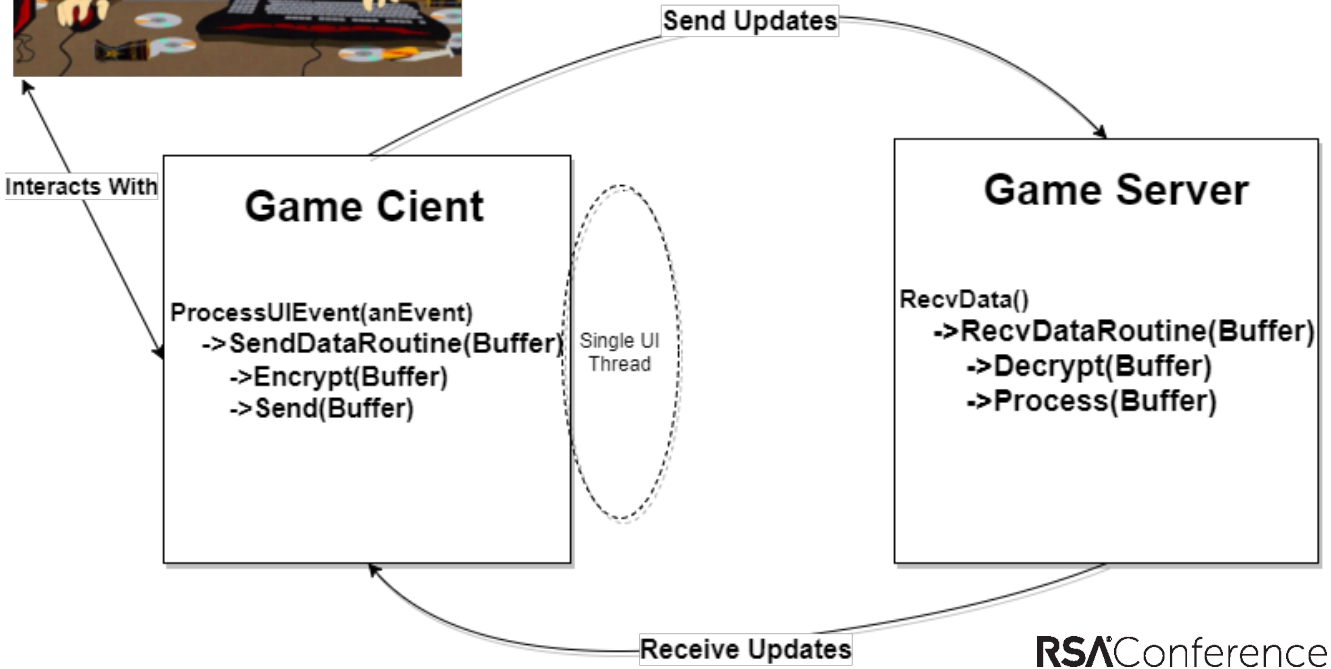
What is an MMORPG?

- Massively Multiplayer Online Role Playing Game
  - Single virtual world with multiple thousands of players interacting
- Typically used to be windows based
  - MMORPG's are highly popular on iOS/Android

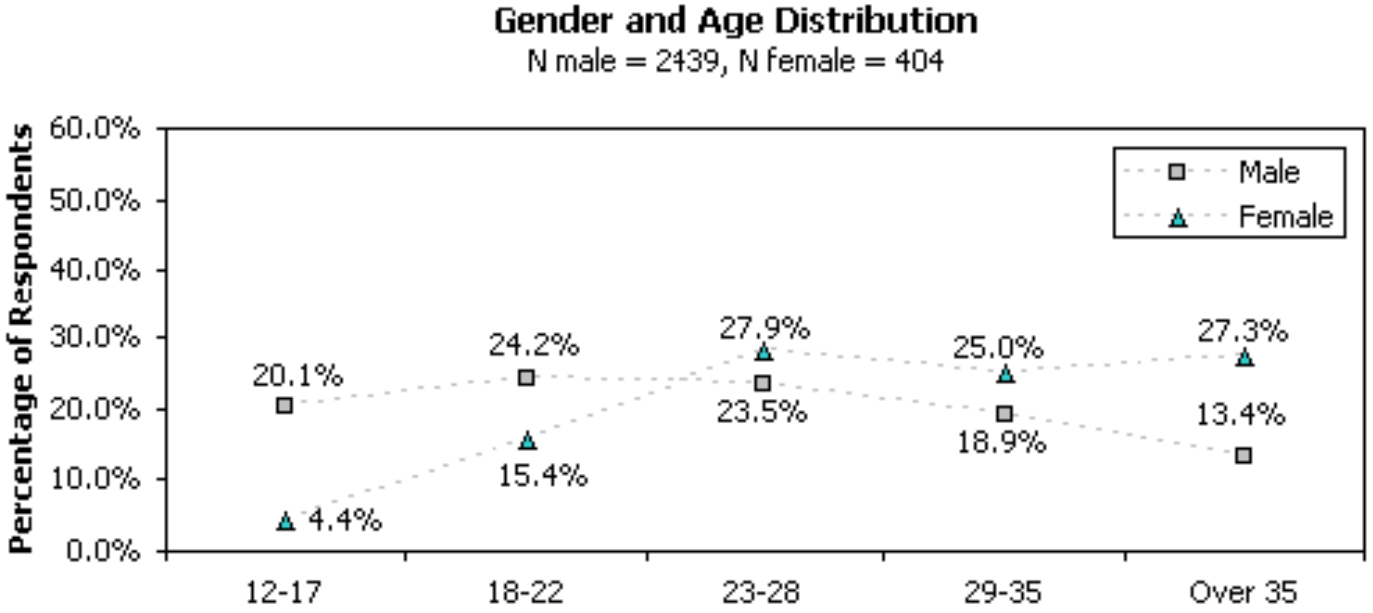
ESO

http://www.justpushstart.com/2014/04/elder-scrolls-online-guide-banished-cells-dungeon-overview/

Overly simplified game architecture



Player Demographics



https://www.gamasutra.com/view/feature/130552/unmasking_the_avatar_the_.php

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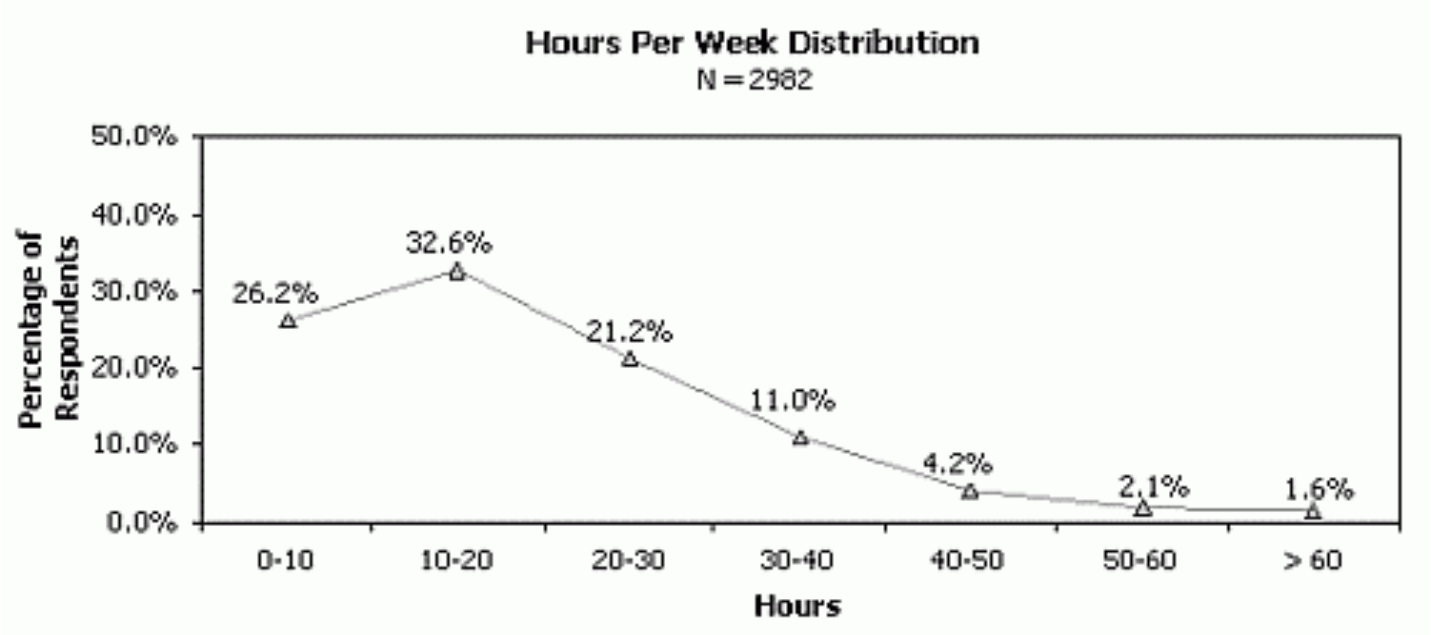

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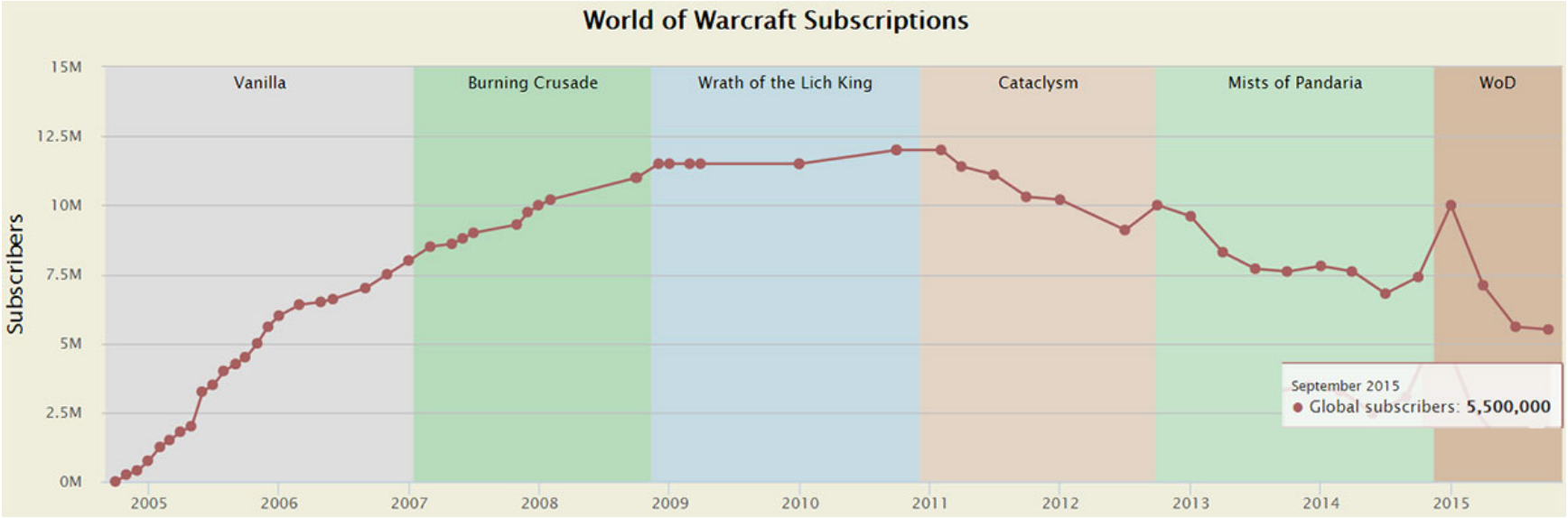
MMORPG Popularity

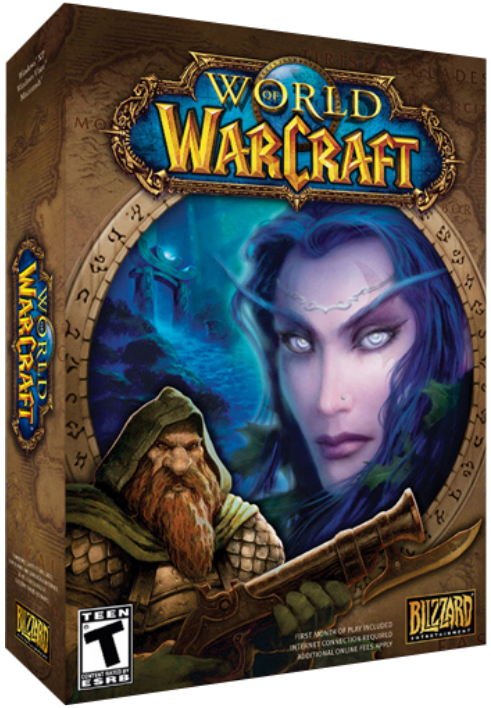
- Lots of players across many demographics!



https://inanage.com/2015/11/04/blizzards-q3-2015-report/

MMORPG Business Model

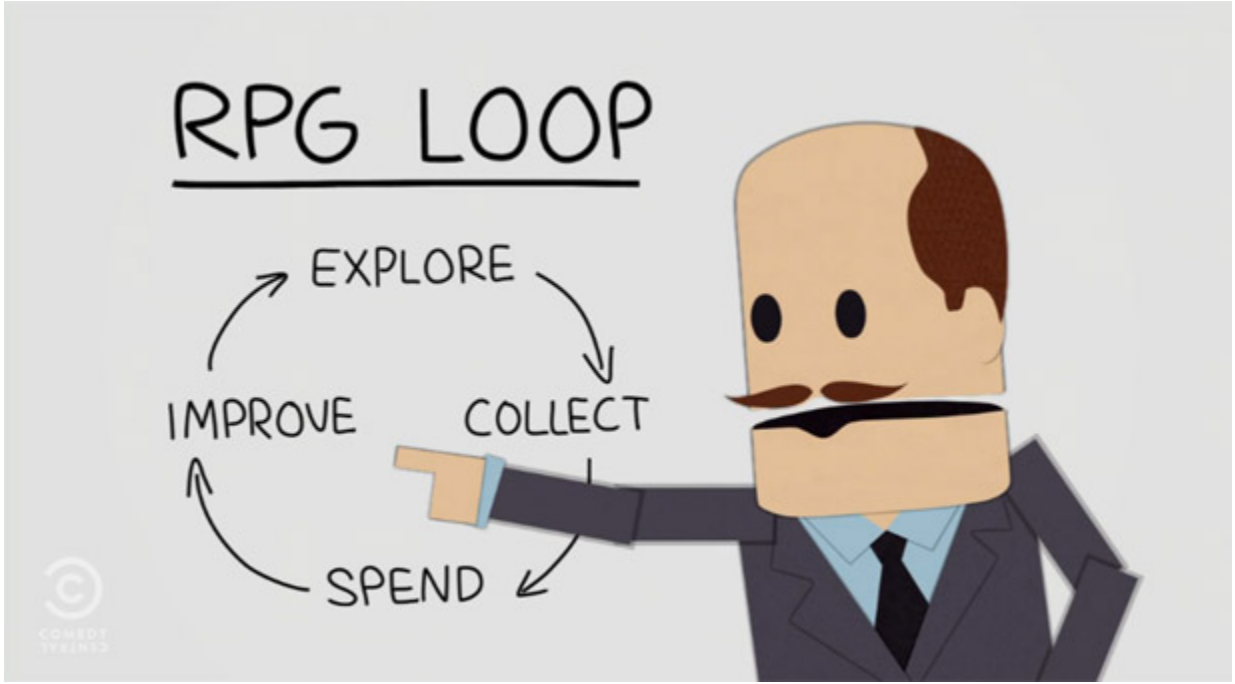
- Early Days (1990s to early 2010 years)
  - Subscription model
  - Buy a box
  - Includes 30 days of playtime
    - To continue playing you typically pay 15$ per month
      - Unlimited unrestricted play (all you can eat!)
  - Seldomly used these days



MMORPG Business Model

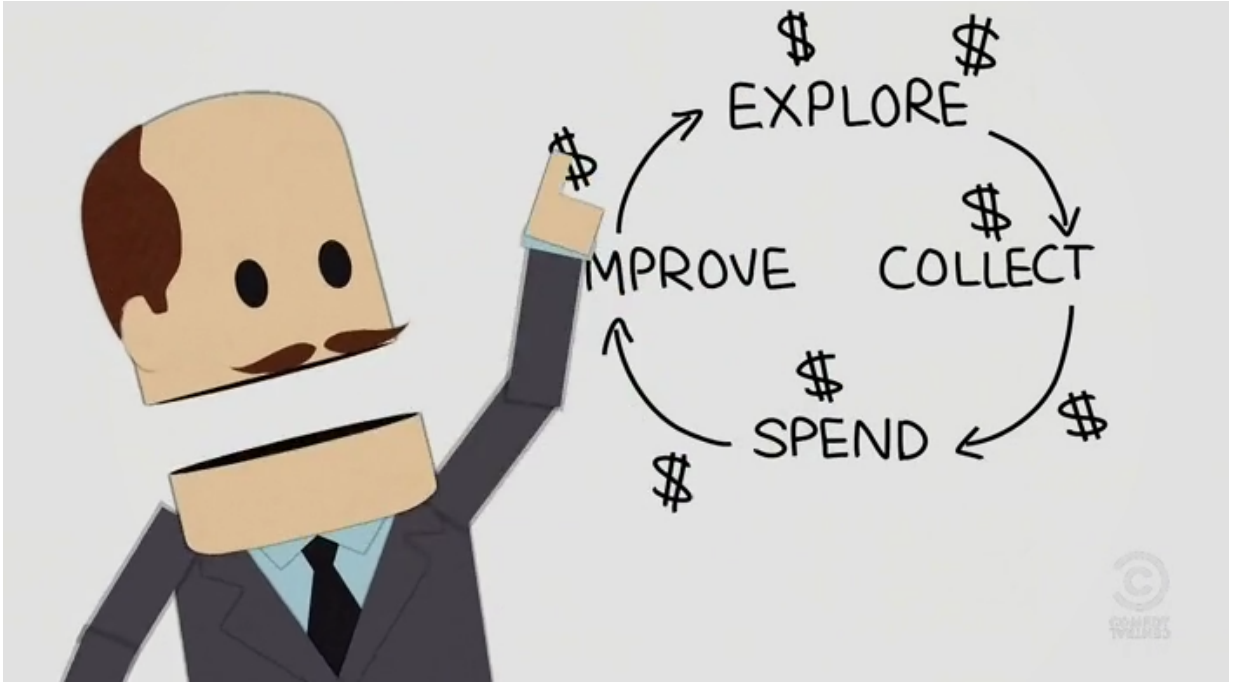
- Current
  - Free/One time fee for game
  - In app purchase model
    - Buy items that enhance gameplay
      - ‘Pay 2 Win’ complaints
        - Cosmetic items
    - Play time limit
      - To continue playing pay more
        - Or wait! (maybe*)

MMORPG Business Model



*South Park Studios – Freemium Isn't Free

MMORPG Business Model



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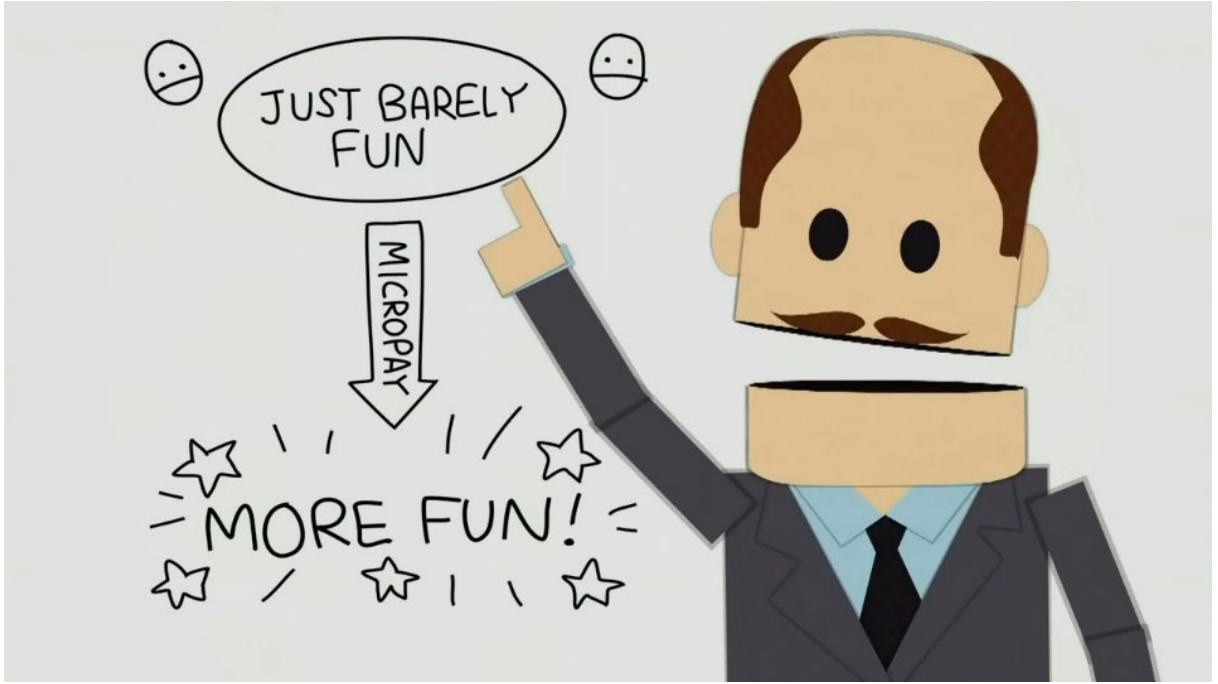
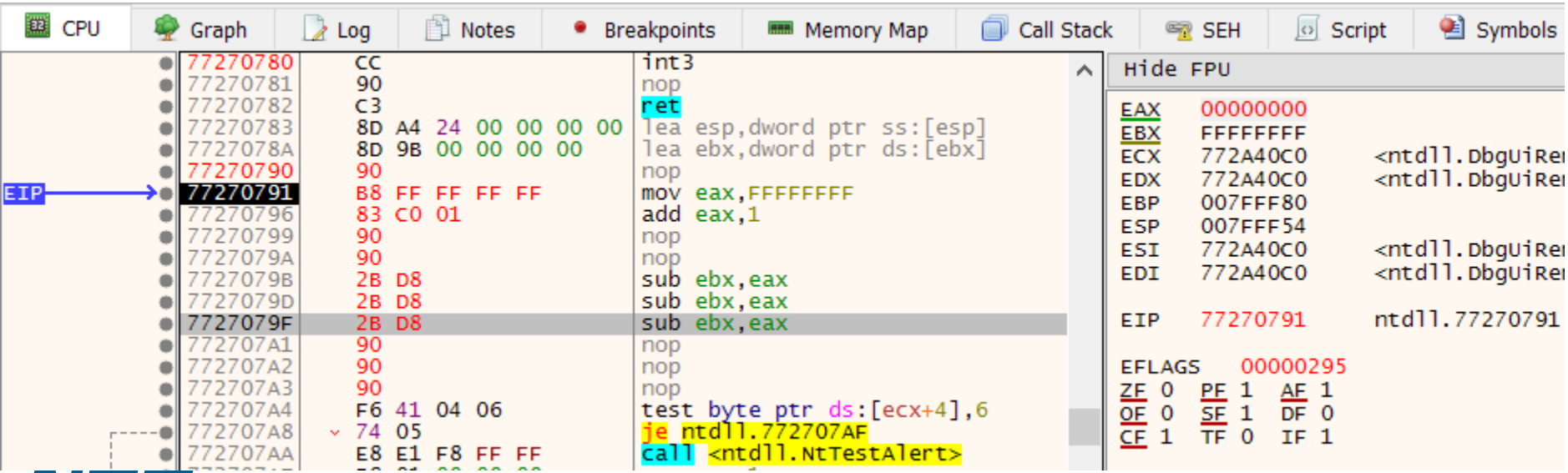


*South Park Studios – Freemium Isn't Free

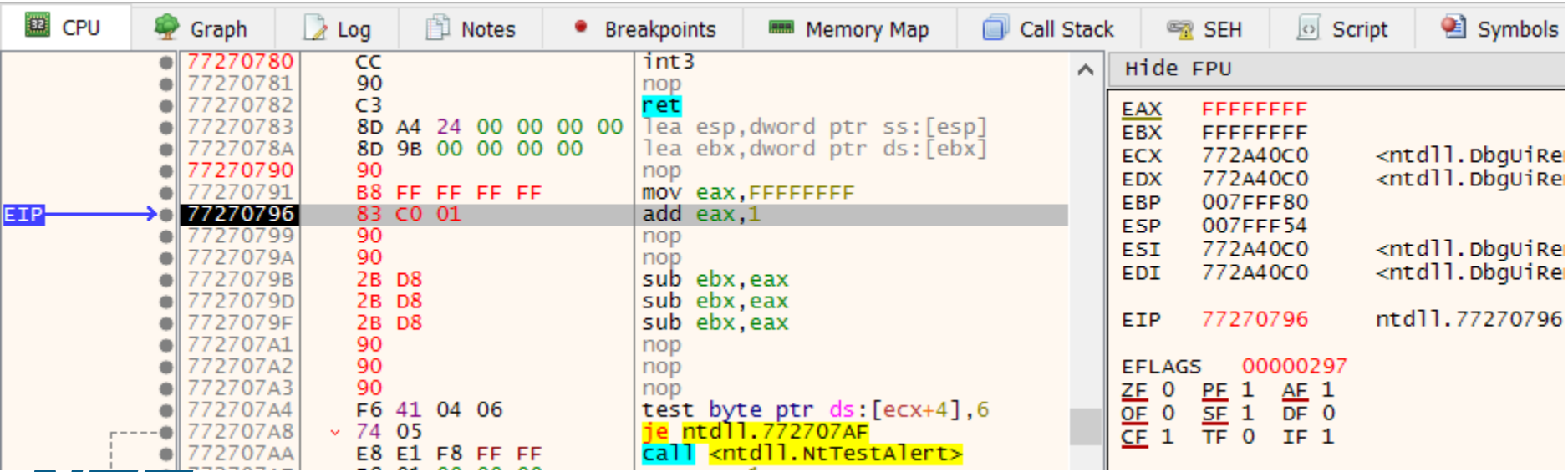
Pay for virtual game goods?

- Paying for virtual game goods
  - That's crazy talk!
  - Why not just hack it?
- But first… Integer overflows!

Integer Overflows!



Integer Overflows!



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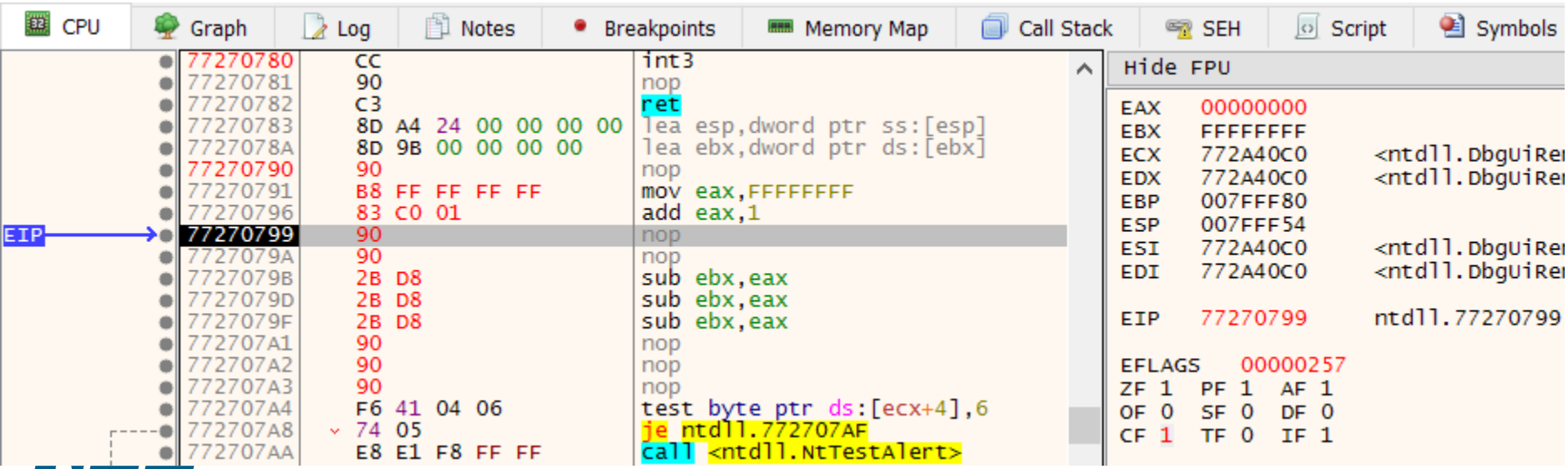


Pay for virtual game goods?

- An integer overflow in the wild:
  - Demo: WSO.flv

Pay for virtual game goods?

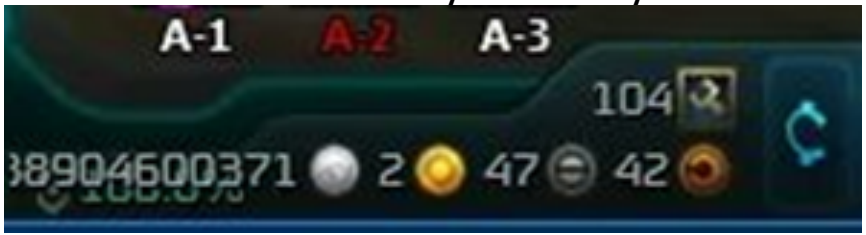
- Submit a buy order for max signed int64
  - 7FFFFFFF FFFFFFFF
  - Server adds a small fee
  - 7FFFFFFF FFFFFFFF + fee = integer roll into negative
  - >8000000 00000000
  - This then gets subtracted from the player account balance

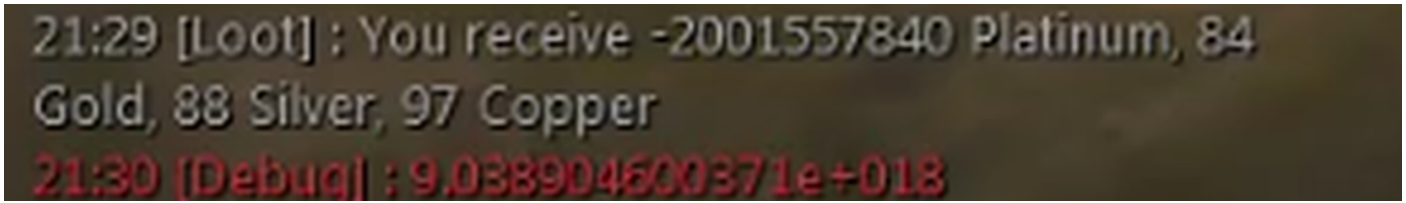
006FF6D8	000006CA
006FF6DC	006FF6F0
006FF6E0	006FFBCB
006FF6E4	0E445810
006FF6E8	006FFBCB
006FF6EC	CD5B2523
006FF6F0	00000000
006FF6F4	00000000
006FF6F8	0000490A
006FF6FC	00000001
006FF700	FFFFFFFF
006FF704	7FFFFFFF
006FF708	00000006
006FF70C	00000000
006FF710	00000001
006FF714	00000000
006FF718	00000000
006FF71C	00000000
006FF720	00000000

Pay for virtual game goods?

- Subtracting a negative number puts you in the positive
  - e.g. 5 - -8 = 13
- 9.038904600371e+018
- 9 Quintillion gold! (credits)
- (Implications later)

Player money Window:





Log + Debug command to show player money

MALICIOUS ACTORS

Hacking MMORPGs

But first…Motivation?

- 1) For the lulz:

lulz

/ləlz/

noun *informal*

fun, laughter, or amusement, especially that derived at another's expense.
"the splinter group embarked on a spree of daring cyberattacks **for the lulz**"

But first…Motivation?

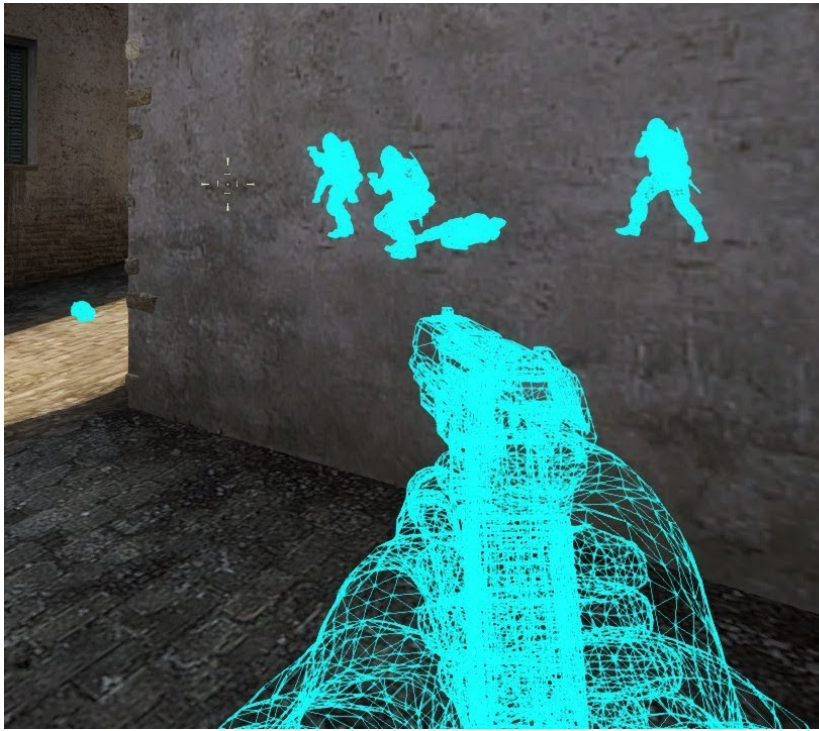
- 2) For profit:

Type 1) Adversaries/Researchers

- Researchers
  - Can I bypass client side checks
  - What kind of encryption is being used
  - What libraries are being used?
  - Can I view art/sound files?
  - How does the protocol work
  - How do they validate inputs

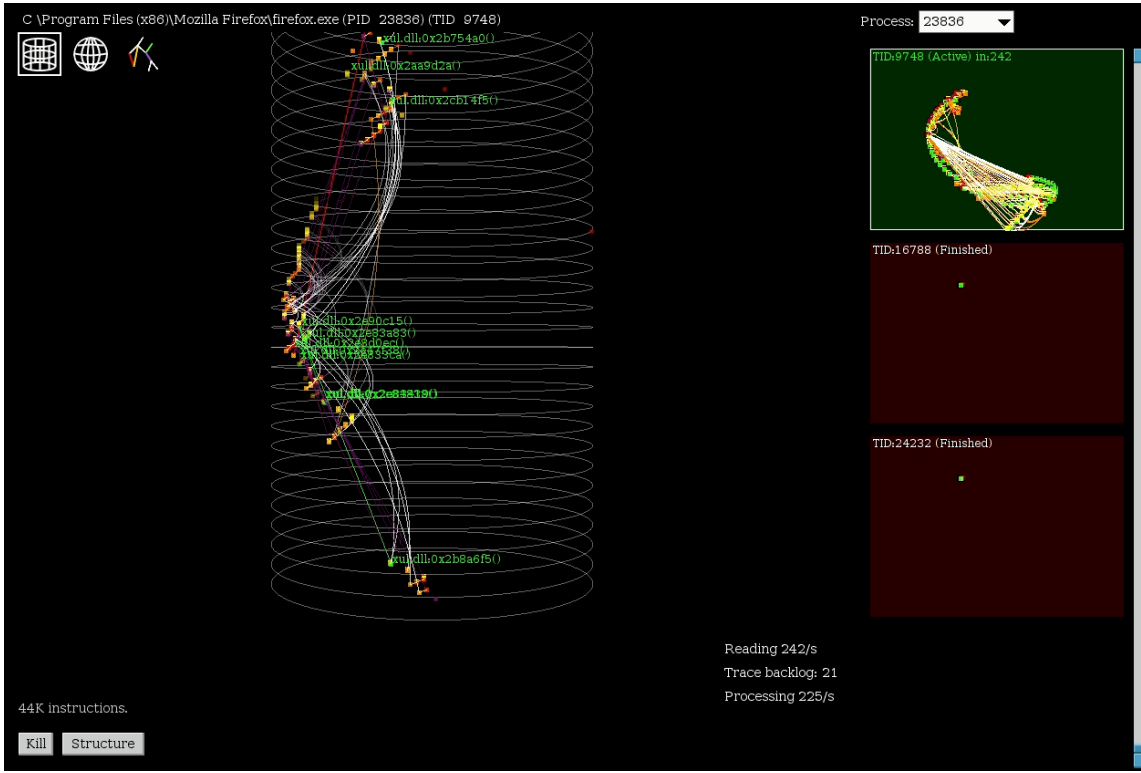
Type 2) Adversaries/Hackers

- Cheaters/Hackers (for the advantage)
  - Client RE
  - Modify game client
    - Runtime
    - Static
  - Typically to gain advantage over players
  - Disruptive
    - Upset players (ever been 360 noscoped?)



Type 3) Adversaries/Professional Hackers

- For profit
  - In game commodities
  - Tools/Bots
    - Custom
    - Off shelf
  - 0-Days
    - Server compromise
    - Client compromise
  - Countermeasure evasion
    - High level statistics
    - Client modification



*https://github.com/ncatlin/rgat

Type 4) Adversaries/Nation states

- Nation states? (*In my game?… its more likely than you think*.)
- North Korea
  - employing MMO hackers to fund government
- South Korea
  - 30 North Korean operatives
    - Bot and farm 6 million USD$ worth of digital goods (L2)

Adversaries/Nation states

- Chinese prisoners
  - Forced to farm World of Warcraft gold
  - 300 prisoners play WoW 12 hours a day
    - Generate ~800 USD$ per day

Type 5) Adversaries/Chinese Farmers

- Over 100k active farmers
- Typically
  - Bot assisted
  - Manual
- Sweatshop like conditions
- Detrimental to gameplay
  - Spawn camping
  - Resource sniping

Hacking for profit?

- What a million looks like in USD$
- Weighs about 22 lbs.

Hacking for profit

- What a million USD$ looks like in Elder Scrolls Online Currency
- < billionth of a billionth of a gram, or 0.00000000000000001g*

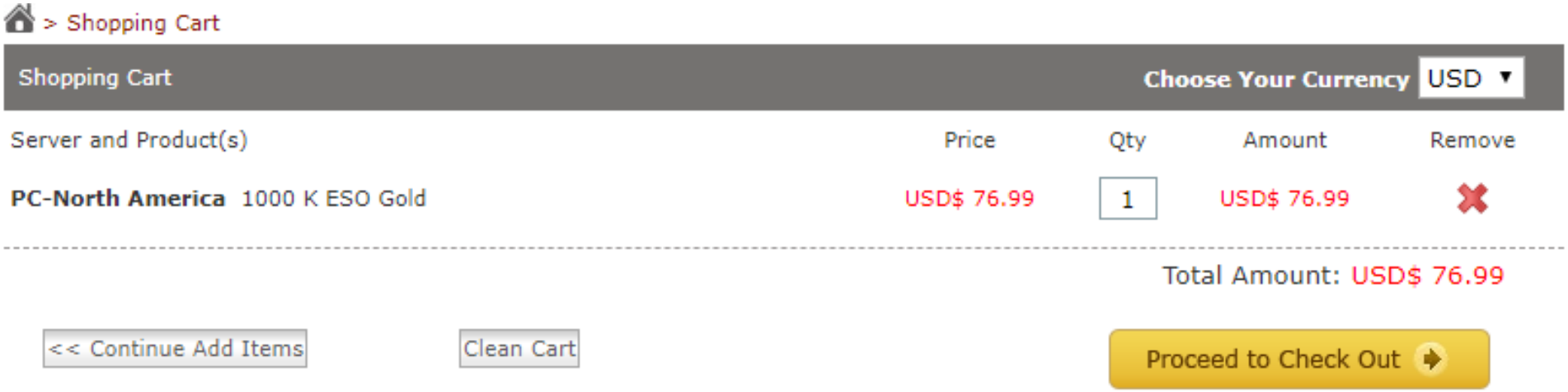
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	ANS
C0	E4	15	06	03	00	00	00									
00	00	00	00	00	00	00	00									
00	00	00	00	00	00	00	00									
00	00	00	00	00	00	00	00									
00	00	00	00	00	00	00	00									
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	

Data Interpreter

8 Bit (±):	-64
16 Bit (±):	-6,976
32 Bit (±):	102,098,112
64 Bit (±):	12,987,000,000

Hacking for profit

- 1 million ESO gold sells for about 77$



Hacking for profit?

- 77$ per million ESO gold
- 1,000,000/77 = 12,987 million units of ESO gold
- 12,987,000,000 gold
- That seems like a lot of gold!
- How easy would it be to get that much?
  - Manually – forever
  - Hacking…

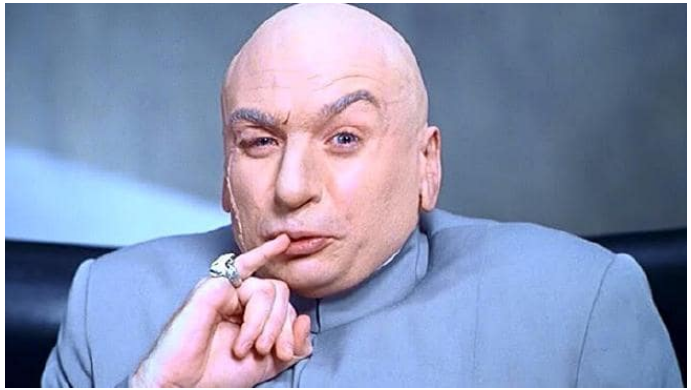

5 LEVEL
0
MAIL
0
INBOX
Guild Trader Bid Lost
Guild Trader Bid Lost
From: Guild Store
Expires In: < 1 day
Received: 10 months ago.
Item Sold
An item you listed has sold. (Little-Known Metal Weapon)
Attached is your profit, after deductions.
Sent Gold: 4,294,967,295
ATTACHMENTS
Sent Gold: 4,294,967,295
[Slays-By-Moon] zone: x
[Canniblessed] zone: Come and join <Wabbajack Warriors>!!!
We are friendly and experienced players from worldwide.

Remember WildStar?

- 5$ per million units of WildStar gold

Hacking for profit?

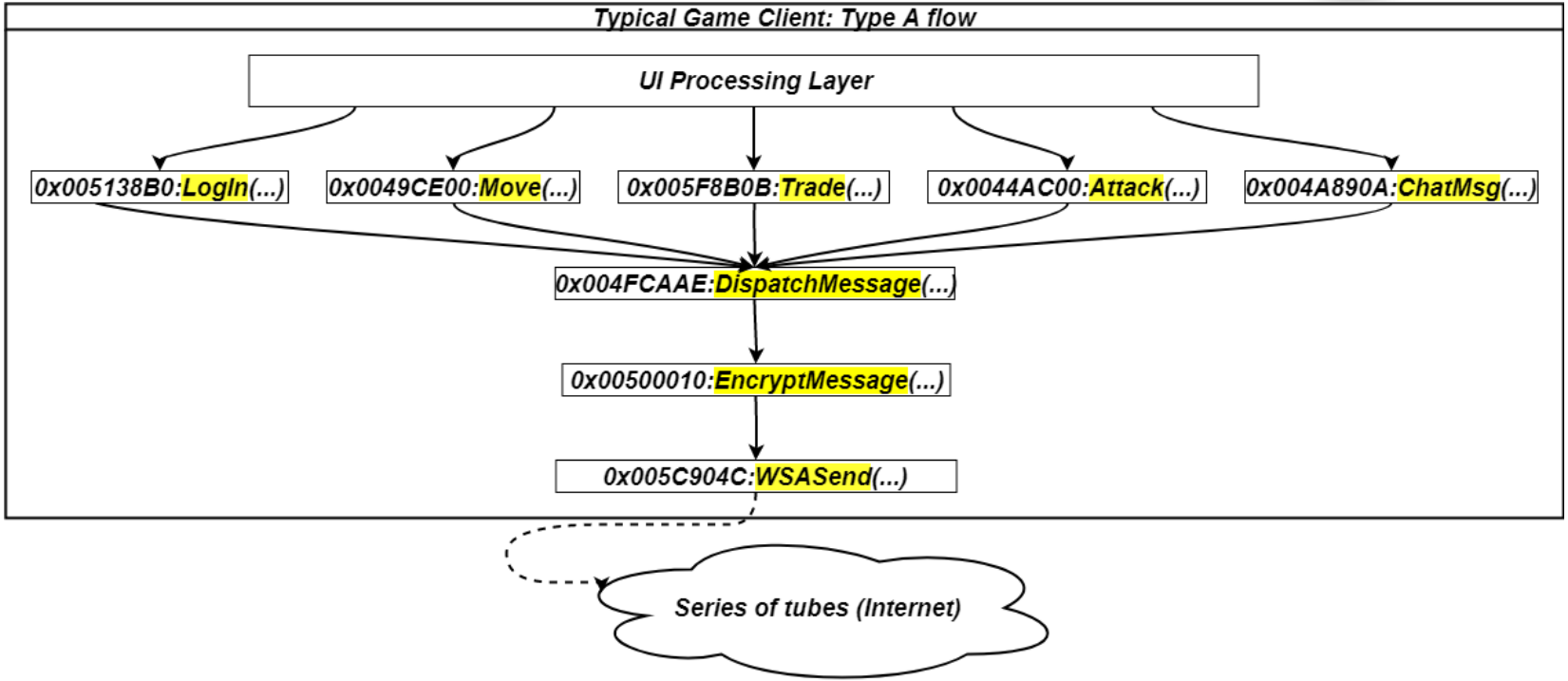
- 5$ per million WSO gold
- ~ 9 Quintillion gold
- (90389046003710000000/1,000,000)*5 = 45,194,523,001,855 USD$
- 45 Trillion Dollars



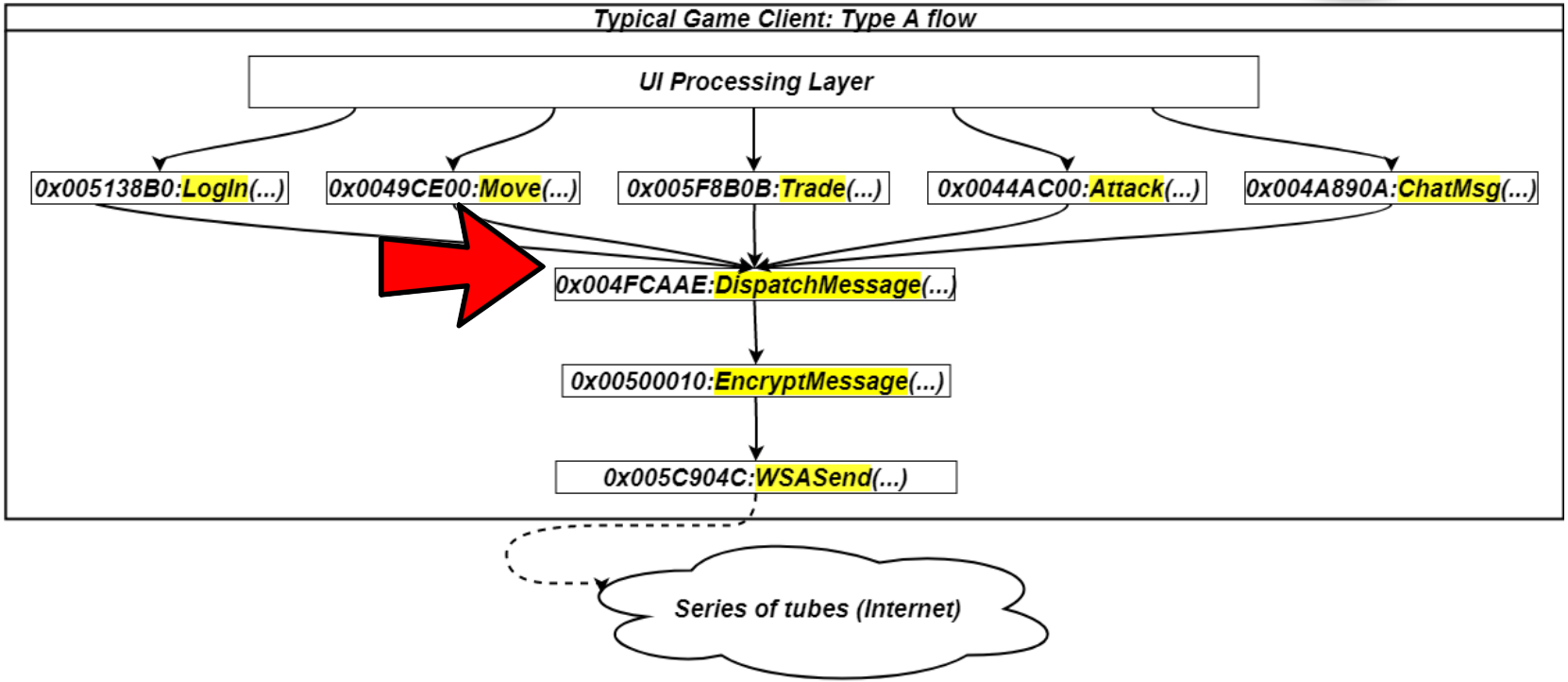
Challenges

- Countermeasures
  - Then – Nearly none
- Now – Many! (Advanced!)
  - Proprietary encryption
  - Anti Debugging
  - Packet integrity checks
  - Packet sequencing
  - Server side statistics (e.g. Sudden jumps in player wealth)
  - Client/Host machine fingerprinting
  - Code flow obfuscation!
- Advanced countermeasures help
  - adversaries

Type A Game Client (Easy)



Type A Insertion Point



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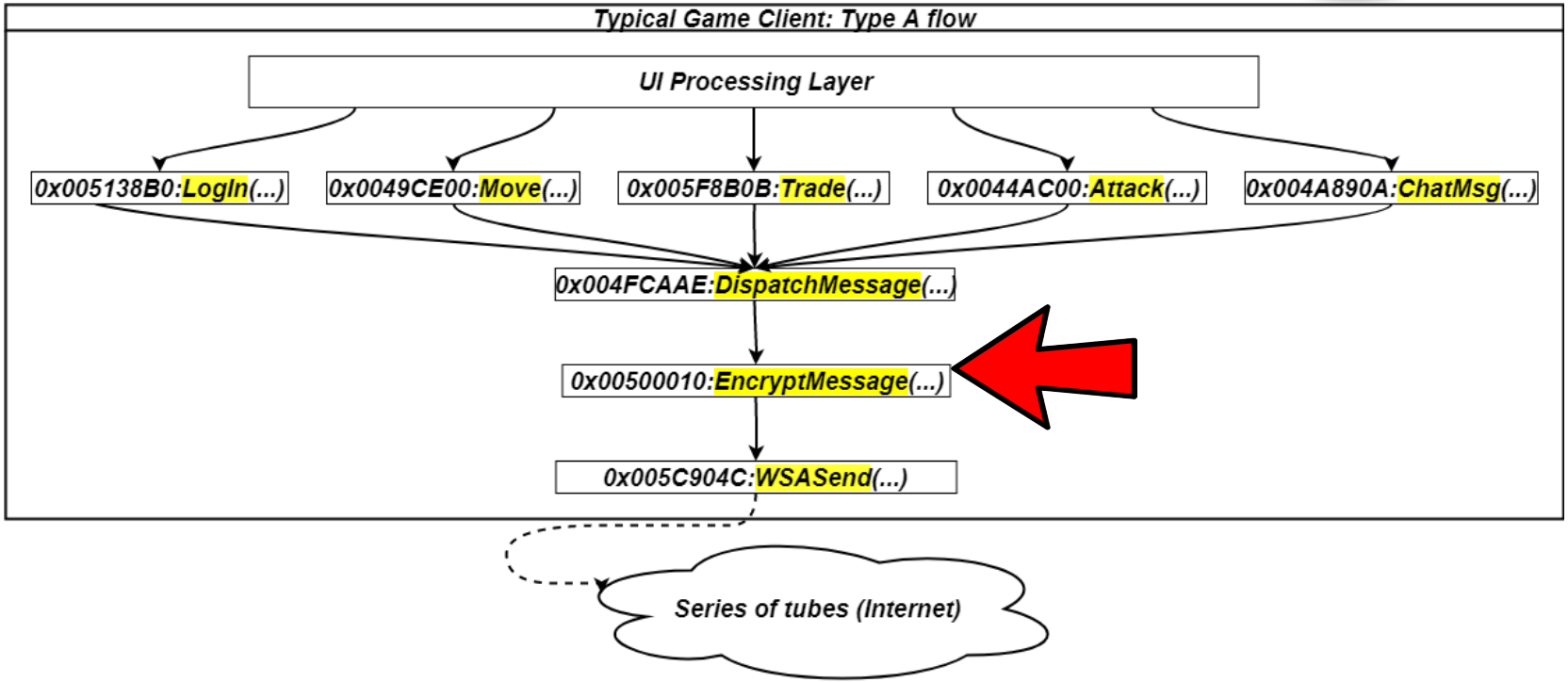

Attack Plan – Network MITM?

Pros

- Complete takeover of the incoming and outgoing client to server messages
- Data can be routed to off computer tools to analyze and modify packets.
- Cheat/Hack detection irrelevant

Cons

- Time consuming
- Must RE encryption/Negotiation
- Must RE any hashing/checksums
- Must RE and takeover any sequencing of packets
- Must have prior knowledge of message encoding structure i.e. how do you know where data for one packet begins and ends?
- Encryption/Packet structure probably will change every patch

Attack Plan – Modify Game Client?

Pros

- Modify global values that dictate gameplay behavior
  - Movement Speed
  - Character Location
  - Wall hacking (disable collision)

Cons

- Time consuming
  - RE each behavior and find where code handling it is
- Can miss a lot of hidden code features or messages being sent to server that may do more interesting things!

Attack Plan – Application Layer MITM?

Pros

- Complete takeover of the incoming and outgoing client to server messages
- Can be done pre encryption/checksum for outgoing
- Can be done post decryption/checksum for incoming messages
- Easily inject forged packets to outgoing or incoming data stream
- Automatic detection of packet boundries

Cons

- Need custom tools
- Lots of RE
- Client anti-cheat/modification detection is possible*

Methodology Demo

- Runtime binary data flow analysis
  - thread-hello.mp4

Summary

- Extreme obfuscation works in favor of the highly skilled adversaries
  - Low hanging fruits are protected
  - Typically 6-7 integer over-under exploits
- Expect to be probe and hacked
  - Honeypots in code, extreme logging offloading
- Take a wholistic approach to security (Don't focus on one area)

Summary Continued.

- Security through obscurity makes it harder to discover successful attacks
- Monitor high level characteristics
  - Look for outliers in statistical data
- Don't ignore compiler warnings!
  - They can be annoying but they do help
    - (*Usually…*)

QUESTIONS?

About tools?/Other common exploits?/Anything?

THANK YOU!

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Independent Security Evaluators
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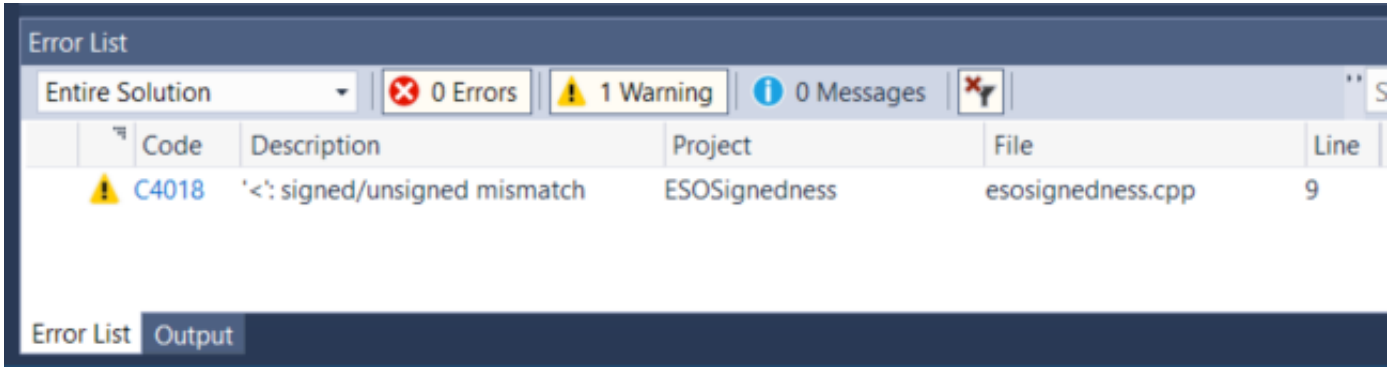
https://www.linkedin.com/in/adrianbksd/

Ew! Code at 9 AM!?

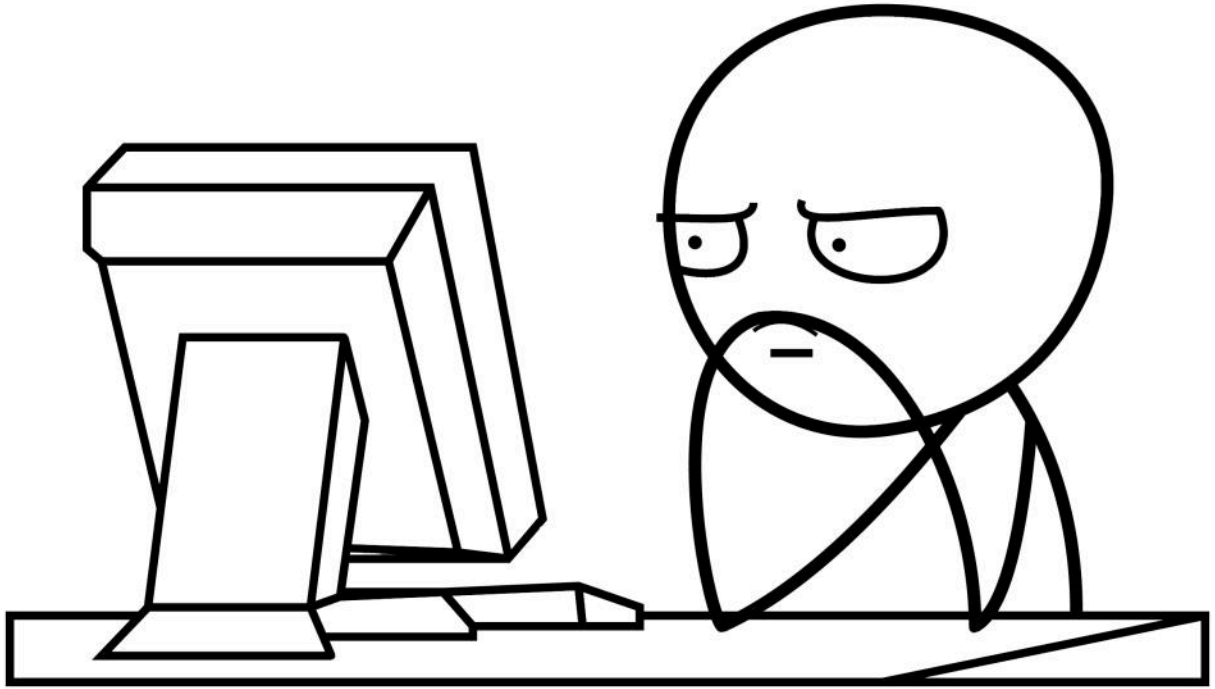

```
6   signed int playerGold = 1;
7
8   void bidOnItem(unsigned int playerBid){
9       if (playerGold < playerBid){
10          printf("Failed Bid!");
11      }
12      else{
13          printf("Successful Bid!");
14          playerGold -= playerBid;
15      }
16  }
```

It Lives!

- It compiles!
- But wait…



I don’t like warnings…compiler spam.



Easy fix!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```

COMPILED/NO WARNINGS/ALL SET/DEPLOY!

Few days/weeks later: There's some weird stuff going on. Is my server haunted?