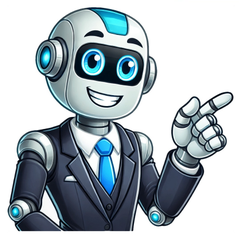
I'm not a bot



Read about our research on blockchain security and its vulnerabilities Abstract: Blockchain technology relies on public-private key pairs for secure transactions. Well-known blockchains like Bitcoin, Waves, Ripple, ZCash, Monero, and Ethereum have huge transaction volumes. The Ethereum blockchain alone boasts 345 million transactions with 47 million unique key pairs. The probability of generating a duplicate private key is incredibly low at around 1 in 2256, making it almost impossible to stumble upon an existing one. In this paper, we investigate how ISE managed to find 732 private keys and their corresponding public keys, which had committed 49,060 transactions on the Ethereum blockchain. Furthermore, we identified 13,319 Ethereum units that were sent to either invalid addresses or wallets created from weak keys worth $18,899,969 at the peak of the market. Our investigation revealed a suspicious activity where funds from these weak-key addresses are being transferred to a single destination address linked to an individual or group targeting vulnerable private keys. As of January 13, 2018, this 'blockchain bandit' had amassed 37,926 ETH valued at $54,343,407.Keywords: Blockchain security, Public key, Private key Encryption, Ethereum, Cryptography, Brute force, Entropy, Key truncation Introduction: This paper focuses on our discovery of private keys used to facilitate transactions on the Ethereum blockchain. Despite the extremely low probability of encountering a duplicate private key (1 in 2256), we developed methods to uncover keys generated through suboptimal processes, such as faulty code or random number generators.Background: The Ethereum project utilizes elliptic curve cryptography to generate public-private key pairs. A 256-bit private key is used to compute a point on the secp256k1 ECDSA curve to derive the public key. This process involves hashing using keccak256 and truncating the resulting hash to produce the public Ethereum address.The study implemented the algorithm correctly and utilized non-random private keys derived from them. Experiment Design: The Ethereum network allows users to query any address for information such as balances, transfers, and committed transactions by querying a local or remote node or using online services like Etherscan which encapsulates data through web interfaces. For instance, Etherscan can be used to query the public Ethereum address A99FDD90FF61DD08CF049155D18E086F7806641B. By navigating to etherscan.io/address/A99FDD90FF61DD08CF049155D18E086F7806641B one can see that there are no transactions for this address, as expected given the key's disclosure in this paper. However, due to the key being public and disclosed, it may have been used for transactions since then.With over 50 million public Ethereum addresses having recorded transactions on the network, it is likely to encounter keys with low randomness or weakness. One reason is key truncation where a random 256-bit private key is generated but only a small subset is used due to errors in coding or complier frameworks. For example, if a 256-bit private key of value 0x47579DA2BEA463533DBFAD6FCF8E90876C2FE9760DC1162ACC4059EE37BDDB5C is truncated to 32 bits, it would result in the following key: 0x0000000000000000000000000000000000000000000000000000000000000000037BDDB5C.In an experiment, a private key of 1 was used for no reason other than being the lower bound of possible keys and also within the range of a 32-bit truncated key. The public Ethereum address derived from this private key is 0x7e5f4552091a69125d5dfcb7b8c2659029395bdf, which has been found to have 592 transactions on it according to Etherscan.io. Given the infinitesimal probability of two users generating the same key randomly, we should expect no coincidences with another user's randomly generated key.We aimed to investigate the prevalence of weak keys in the Ethereum blockchain. Our research focused on locating and analyzing Ethereum addresses that use weak private keys. Although legitimate code paths would not produce a weak key, we hypothesized that errors during coding, operating system, device, or execution environment usage could lead to their generation.Common mistakes that may weaken 256-bit keys include logic errors, type confusion, entropy errors, random device errors, poorly handled exceptions, memory reference errors, memory corruption, seed re-use, and malware compromise. Due to computational limitations, we focused on a smaller 32-bit subset of the 256-bit key space, containing approximately 4.3 billion possible private keys.Our method involved generating an in-memory hash map of public Ethereum addresses and querying this data structure for each enumerated key. We performed bulk scanning across eight 32-bit "sub-regions" in the 256-bit key space, with a focus on the lower 32-bit portion. By leaving the remaining 224 bits set to 0x00, we identified possible regions for enumeration.We tested transaction activity on the Ethereum blockchain for each region, using specific private key ranges defined by our scan strategy.Given article text here The researchers analyzed a specific range of the 256-bit key space, which covers groups F to H. They found that despite making up only an infinitesimal part of the total key space, certain areas are vulnerable to errors or randomness issues. The study discovered 49,060 transactions involving 732 public keys, with a combined value exceeding 32 Ethereum. However, the present-day balance across these addresses was zero due to daily transfers in and out.The researchers also found that there were 60,286,012 ERC-20 based tokens held by these 732 public keys, worth different amounts. They were unable to enumerate all the transactions for these tokens as it fell outside their scope. The results are summarized in a graphical representation of the private keys used for blockchain transactions.Given article text hereThe blockchain bandit has been sending ~$1 worth of ETH to its holding address after receiving it from ISE. The 'blockchain' bandit instantly sent an outbound transaction from the weak private key address to their holding address of 0x957cd4ff9b3894fc78b5134a8dc72b032ffbc464.There have been 8772 transactions on the Parity Wallet with Empty Passphrase, which is derived from a private key of 0x4d5db4107d237df6a3d58ee5f70ae63d73d7658d4026f2eefd2f204c81682cb7 generated from an empty recovery phrase (""). This address has transferred a total of 5215.586 Ethereum and is being monitored for inbound transactions.Another Ethereum address, 0xdcc703c0e500b653ca82273b7bfad8045d85a470, was derived from a keccak256 hash performed on an empty string instead of an ECDSA public key. This address has had 815.643 ETH transferred to it over 28 transactions spanning roughly 3 years and is irrecoverably lost.The Ethereum address 0x0000000000000000000000000000000000000000, which is all zeros, has also received Ethereum erroneously transferred to it. This address has had 7289.472 Ethereum transferred to it over 1169 transactions spanning roughly three years and is irrecoverably lost.In conclusion, we have discovered 49,060 transactions spread over 732 public keys for which we have the corresponding private keys, with a total transfer amount of over 32 Ethereum. The most damaging address is the Parity-derived Ethereum address that is based on an empty string passphrase (""), which has had 5215.586 Ethereum transferred to it and is worth $730,182 USD.Between January 2020 and March 2022, a total of 8,105 Ethereum was sent to two suspect addresses: 0x0000000000000000000000000000000000000000 (a public address with no hash) and 0xdcc703c0e500b653ca82273b7bfad8045d85a470 (an empty string as a public hash). These addresses have been involved in over 1,197 transactions spanning three years. Due to the lack of corresponding private keys, any Ethereum sent to these addresses is irretrievably lost. Given current computational limitations, attempting to find matching private keys is futile. In large-scale incidents where significant amounts of Ethereum are mistakenly transferred or lost, it may be possible to lobby the Ethereum governing body for a hard fork a process that creates a new version of the blockchain reversing the effects of the error. A notable example of this occurred in 2016 during the DAO attack [3]. On January 13, 2018, at the height of the Ethereum market (when 1 Ethereum was valued at approximately $1,432), losses due to incorrect destination addresses or weak private keys totaled 13,319 Ethereum ($18.8 million). Furthermore, a hacking campaign that came to light around this time had amassed $54.3 million in Ethereum. The convergence of cryptocurrency's popularity and easy monetization with ongoing hacking campaigns suggests that systems handling private keys are at an increased risk for targeted attacks. To counter these threats, developers should implement defense-in-depth principles when designing software or systems interacting with valuable private keys. In the future, research can focus on examining public key signing algorithms like ECDSA in other blockchain implementations (e.g., Bitcoin, Waves, Ripple) and exploring source code repositories to identify potential vulnerabilities related to hardcoded private keys or poorly generated test keys that have migrated into production code. Additionally, investigating patterns between poorly generated private keys and their destinations may reveal larger-scale activities not yet documented or understood.Individuals were implicated in the theft of digital currencies. According to etherscan.io, a platform that tracks cryptocurrency transactions [1], and another resource on etherscan.io [2] that displays address activity charts, this incident is linked to The DAO (organization) [3]. Furthermore, academic research by D. G. Wood [4] and S. S. Stuart Haber [5] shed light on the concept of blockchain technology. Additionally, articles from packetlife.net [6] and TechSpot [7] provide explanations of encryption and hashing methods, as well as an overview of blockchain.

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