Storj Platform Security Assessment

Client-Facing Deliverable

STORJ

Prepared for Storj Labs Inc.
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Table of Contents

Engagement Overview

Assessment Components and Objectives

Storj Labs Inc. ("Storj") recently engaged Atredis Partners ("Atredis") to perform a Platform Security Assessment of the Storj platform. Objectives included validation that Storj infrastructure and services were developed and deployed with security best practices in mind, and to obtain third party validation that any significant vulnerabilities present in Storj's environment were identified for remediation.

Testing was performed from March 28 through April 15, 2022. Specific testing components and testing tasks are included below.

COMPONENT	ENGAGEMENT TASKS
Storj Platform Security Assessment	

Assessment Targets	• Storj Distributed Storage Platform and Related Services
	  • Multi-tenant Decentralized Data Storage
	  • Uplink Go storage client
	  • Multiple Go application services
	  • Single and Multi-tenant Gateway
	  • Satellite service
	  • Storage node service

Assessment Tasks	• Source-Assisted Penetration Testing of the Storj platform
	  • Dynamic and source driven application security testing
	  • Authentication and authorization review across services
	  • Multiple user roles and access levels
	  • Application spidering, fuzzing and fault injection
	  • Automated and runtime application testing
	  • PoC generation and validation of findings
	• Network and System Penetration Testing of Storj Platform
	  • Automated and manual network and system penetration testing
	  • Traditional penetration testing of exposed network services
	  • Targeted exploitation of identified high-risk vulnerabilities
	  • PoC generation and validation of findings

Reporting and Analysis	
Analysis and Deliverables	• Status Reporting and Realtime Communication • Comprehensive Engagement Deliverable • Engagement Outbrief and Remediation Review

The ultimate goal of the assessment was to provide a clear picture of risks, vulnerabilities, and exposures as they relate to accepted security best practices, such as those created by the National Institute of Standards and Technology (NIST), Open Web Application Security Project (OWASP), or the Center for Internet Security (CIS). Augmenting these, Atredis Partners also draws on its extensive experience in secure development and in testing high-criticality applications and advanced exploitation.

Engagement Tasks

Atredis Partners performed the following tasks, at a high level, for in-scope targets during the engagement.

Application Penetration Testing

For relevant web applications, APIs, and web services, Atredis performed automated and manual application penetration testing of these components, applying generally accepted testing best practices as derived from OWASP and the Web Application Security Consortium (WASC).

Testing was performed from the perspective of an anonymous intruder, identifying scenarios from the perspective of an opportunistic, Internet-based threat actor with no knowledge of the environment, as well as from the perspective a user working to laterally move through the environment to bypass security restrictions and user access levels. Where relevant, Atredis Partners utilized both automated fuzzing and fault injection frameworks as well as purpose-built, task-specific testing tools tailored to the application and platforms under review.

Network and System Penetration Testing

Atredis Partners performed traditional manual and automated network penetration testing against the in-scope targets, mapping out network services that are available, and confirming the security-relevant aspects of these targets and services.

Once services were mapped out and confirmed, Atredis used manual techniques along with automated network discovery and vulnerability discovery tools to assess the targets, building target-specific attack scenarios, and developing various engagement-specific tools to confirm the presence of vulnerabilities identified and reduce false positives.

Source Code Analysis

Atredis reviewed the in-scope application source code, with an eye for security-relevant software defects. To aid in vulnerability discovery, application components were mapped out and modeled until a thorough understanding of execution flow, code paths, and application design and architecture was obtained. To aid in this process, the assessment team engaged key stakeholders and members of the development team where possible to provide structured walkthroughs and interviews, helping the team rapidly gain an understanding of the application’s design and development lifecycle.

Executive Summary

Storj provided Atredis Partners with documentation, public and private code repositories, and a question-and-answer meeting during the first week of the engagement. A Slack channel for continued questions and real-time communication was maintained throughout the engagement. Live testing was performed against both locally deployed development instances and production services. The open source Storj client was used along with modifying proxies and custom-built clients to dynamically test the implementation.

Atredis Partners performed testing initially from the perspective of an unauthenticated user and mapped out the public network attack surface exposed by the infrastructure. Following enumeration activities, Atredis built test cases against each of the exposed service endpoints across protocols including HTTP and Google Remote Procedure Call (gRPC). The highest priority tasks were validating the peer-based authentication, the handling of authorization secrets in the edge services, and review of the data security of the end-to-end design.

In addition to web application security centric tasks, Atredis Partners also performed a basic network vulnerability assessment of the environment, scanning for listening ports and fingerprinting network services to identify any network security relevant issues that might present a risk to the Storj platform.

Key Conclusions

Overall, Atredis Partners found Storj's platform to be well-architected from a security perspective, with strong authentication across interfaces despite the distributed design of the platform. The cryptographic engineering produced strong guarantees around data confidentiality and integrity. The access key design at the core of the Storj Edge Services provides data loss mitigations when users export access grants beyond the endpoint. Atredis also considered attacks on the availability for each of the peer services.

Findings Summary

In performing testing for this assessment, Atredis Partners identified **one (1) critical severity**, **one (1) medium severity, and two (2) low severity** findings.

Atredis defines vulnerability severity ranking as follows:

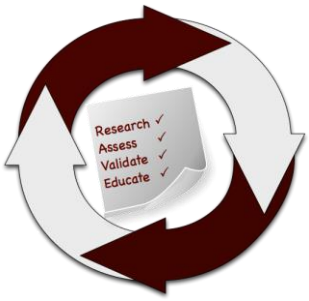
- **Critical:** These vulnerabilities expose systems and applications to immediate threat of compromise by a dedicated or opportunistic attacker or completely disable platform availability.
- **High:** These vulnerabilities entail greater effort for attackers to exploit and may result in successful network compromise within a relatively short time.
- **Medium:** These vulnerabilities may not lead to network compromise but could be leveraged by attackers to attack other systems or applications components or be chained together with multiple medium findings to constitute a successful compromise.

- **Low:** These vulnerabilities are largely concerned with improper disclosure of information and should be resolved. They may provide attackers with important information that could lead to additional attack vectors or lower the level of effort necessary to exploit a system.

Remediation

Atredis Partners has completed retesting efforts and confirmed that all identified findings have been remediated.

Appendix I: Assessment Methodology



Atredis Partners draws on our extensive experience in penetration testing, reverse engineering, hardware/software exploitation, and embedded systems design to tailor each assessment to the specific targets, attacker profile, and threat scenarios relevant to our client's business drivers and agreed upon rules of engagement.

Where applicable, we also draw on and reference specific industry best practices, regulations, and principles of sound systems and software design to help our clients improve their products while simultaneously making them more stable and secure.

Our team takes guidance from industry-wide standards and practices such as the National Institute of Standards and Technology's (NIST) Special Publications, the Open Web Application Security Project (OWASP), and the Center for Internet Security (CIS).

Throughout the engagement, we communicate findings as they are identified and validated, and schedule ongoing engagement meetings and touchpoints, keeping our process open and transparent and working closely with our clients to focus testing efforts where they provide the most value.

In most engagements, our primary focus is on creating purpose-built test suites and toolchains to evaluate the target, but we do utilize off-the-shelf tools where applicable as well, both for general patch audit and best practice validation as well as to ensure a comprehensive and consistent baseline is obtained.

Research and Profiling Phase

Our research-driven approach to testing begins with a detailed examination of the target, where we model the behavior of the application, network, and software components in their default state. We map out hosts and network services, patch levels, and application versions. We frequently use a number of private and public data sources to collect Open Source Intelligence about the target, and collaborate with client personnel to further inform our testing objectives.

For network and web application assessments, we perform network and host discovery as well as map out all available application interfaces and inputs. For hardware assessments, we study the design and implementation, down to a circuit-debugging level. In reviewing source code or compiled application code, we map out application flow and call trees and develop a solid working understand of how the application behaves, thus helping focus our validation and testing efforts on areas where vulnerabilities might have the highest impact to the application's security or integrity.

Analysis and Instrumentation Phase

Once we have developed a thorough understanding of the target, we use a number of specialized and custom-developed tools to perform vulnerability discovery as well as binary, protocol, and runtime analysis, frequently creating engagement-specific software tools which we share with our clients at the close of any engagement.

We identify and implement means to monitor and instrument the behavior of the target, utilizing debugging, decompilation and runtime analysis, as well as making use of memory and filesystem

forensics analysis to create a comprehensive attack modeling testbed. Where they exist, we also use common off-the-shelf, open-source and any extant vendor-proprietary tools to aid in testing and evaluation.

Validation and Attack Phase

Using our understanding of the target, our team creates a series of highly-specific attack and fault injection test cases and scenarios. Our selection of test cases and testing viewpoints are based on our understanding of which approaches are most relevant to the target and will gain results in the most efficient manner, and built in collaboration with our client during the engagement.

Once our test cases are validated and specific attacks are confirmed, we create proof-of-concept artifacts and pursue confirmed attacks to identify extent of potential damage, risk to the environment, and reliability of each attack scenario. We also gather all the necessary data to confirm vulnerabilities identified and work to identify and document specific root causes and all relevant instances in software, hardware, or firmware where a given issue exists.

Education and Evidentiary Phase

At the conclusion of active testing, our team gathers all raw data, relevant custom toolchains, and applicable testing artifacts, parses and normalizes these results, and presents an initial findings brief to our clients, so that remediation can begin while a more formal document is created. Additionally, our team shares confirmed high-risk findings throughout the engagement so that our clients may begin to address any critical issues as soon as they are identified.

After the outbrief and initial findings review, we develop a detailed research deliverable report that provides not only our findings and recommendations but also an open and transparent narrative about our testing process, observations and specific challenges in developing attacks against our targets, from the real world perspective of a skilled, motivated attacker.

Automation and Off-The-Shelf Tools

Where applicable or useful, our team does utilize licensed and open-source software to aid us throughout the evaluation process. These tools and their output are considered secondary to manual human analysis, but nonetheless provide a valuable secondary source of data, after careful validation and reduction of false positives.

For runtime analysis and debugging, we rely extensively on Hopper, IDA Pro and Hex-Rays, as well as platform-specific runtime debuggers, and develop fuzzing, memory analysis, and other testing tools primarily in Ruby and Python.

In source auditing, we typically work in Visual Studio, Xcode and Eclipse IDE, as well as other markup tools. For automated source code analysis we will typically use the most appropriate toolchain for the target, unless client preference dictates another tool.

Network discovery and exploitation make use of Nessus, Metasploit, and other open-source scanning tools, again deferring to client preference where applicable. Web application runtime analysis relies extensively on the Burp Suite, Fuzzer and Scanner, as well as purpose-built automation tools built in Go, Ruby and Python.

Appendix II: About Atredis Partners

Atredis Partners was created in 2013 by a team of security industry veterans who wanted to prioritize offering quality and client needs over the pressure to grow rapidly at the expense of delivery and execution. We wanted to build something better, for the long haul.

In six years, Atredis Partners has doubled in size annually, and has been named three times to the Saint Louis Business Journal's "Fifty Fastest Growing Companies" and "Ten Fastest Growing Tech Companies". Consecutively for the past three years, Atredis Partners has been listed on the Inc. 5,000 list of fastest growing private companies in the United States.

The Atredis team is made up of some of the greatest minds in Information Security research and penetration testing, and we've built our business on a reputation for delivering deeper, more advanced assessments than any other firm in our industry.

Atredis Partners team members have presented research over forty times at the BlackHat Briefings conference in Europe, Japan, and the United States, as well as many other notable security conferences, including RSA, ShmooCon, DerbyCon, BSides, and PacSec/CanSec. Most of our team hold one or more advanced degrees in Computer Science or engineering, as well as many other industry certifications and designations. Atredis team members have authored several books, including *The Android Hacker's Handbook*, *The iOS Hacker's Handbook*, *Wicked Cool Shell Scripts*, *Gray Hat C#*, and *Black Hat Go*.

While our client base is by definition confidential and we often operate under strict nondisclosure agreements, Atredis Partners has delivered notable public security research on improving the security at Google, Microsoft, The Linux Foundation, Motorola, Samsung and HTC products, and were the first security research firm to be named in Qualcomm's Product Security Hall of Fame. We've received four research grants from the Defense Advanced Research Project Agency (DARPA), participated in research for the CNCF (Cloud Native Computing Foundation) to advance the security of Kubernetes, worked with OSTIF (The Open Source Technology Improvement Fund) and The Linux Foundation on the Core Infrastructure Initiative to improve the security and safety of the Linux Kernel, and have identified entirely new classes of vulnerabilities in hardware, software, and the infrastructure of the World Wide Web.

In 2015, we expanded our services portfolio to include a wide range of advanced risk and security program management consulting, expanding our services reach to extend from the technical trenches into the boardroom. The Atredis Risk and Advisory team has extensive experience building mature security programs, performing risk and readiness assessments, and serving as trusted partners to our clients to ensure the right people are making informed decisions about risk and risk management.