A2 - COSC3P95

Members

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Contributions

Gideon contributed to the development of the client-server program using the FastAPI framework. He also implemented the auto and manual instrumentation of opentelemetry to the project. He implemented the advanced features of the client-server program, namely Encryption & Security and Compression. And he also implemented the integration with the Jaeger tool.

Hamza worked on introducing a deliberate bug in the client-server program for the purposes of implementing Statistical Debugging techniques to identify and resolve the issue, leveraging Open-Telemetry for collecting/visualizing the data. He also wrote the report and analysis on findings based on the generated OpenTelemetry data.

Report (Q1)

init.py:

Creates a FastAPI application.
Defines an endpoint /upload that accepts file uploads using FastAPI's UploadFile class.
Tracing instrumentation to trace the upload function using OpenTelemetry's tracing functionalities.
The program decodes the uploaded file content using base64 writes the decoded content to a temporary file, treating it as a ZIP file and extracts the contents of the ZIP file to a temporary directory.

client.py:

Sets up an argument parser to accept host, port, and directory inputs.
Creates a ZIP file containing all files from a specified directory.
Encrypts the ZIP file content using base64 encoding.
Sends a POST request to the /upload endpoint of the FastAPI server, uploading the encrypted file and handles the server response

Results

The server (**init**.py) receives encrypted ZIP files, decodes them, and extracts their contents to a temporary directory.
The client (client.py) prepares a ZIP file from a specified directory, encrypts it, sends it to the server, and handles the server response.

Interactions

The client and server communicate via HTTP POST requests to upload and handle encrypted ZIP files.
OpenTelemetry is used for distributed tracing in the server-side code to trace the upload function.

Security Concerns

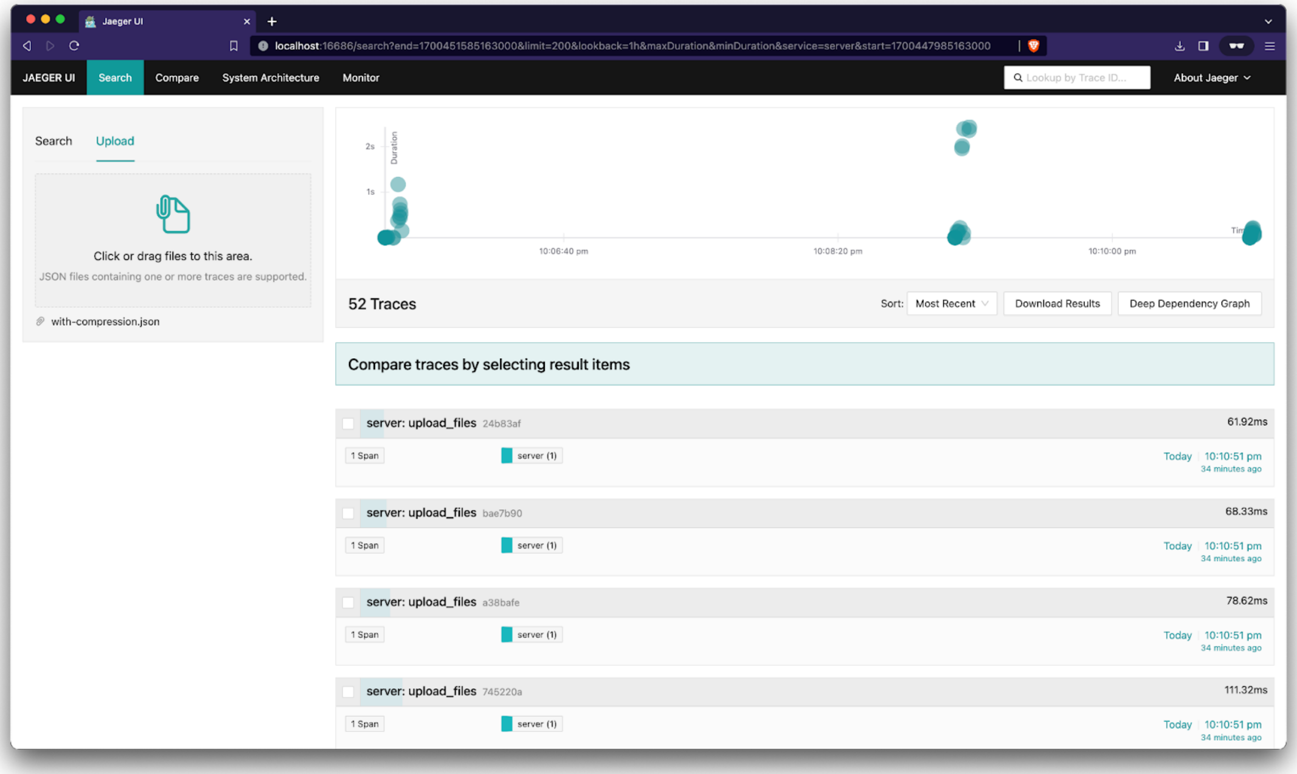
The code performs basic encryption (base64 encoding/decoding), but this is not a secure encryption method for sensitive data.
The code doesn't handle potential exceptions or errors related to file operations or network requests.

Improvements

Use secure encryption methods for sensitive data.
Implement error handling for file operations and network requests.
Enhance security practices for handling uploaded files in the server code.
Consider adding authentication and authorization mechanisms for the client-server interaction.

Sample Outputs Of Jaeger UI local host:

**


Jaeger UI
localhost:16686/search?end=1700451585163000&limit=200&lookback=1h&maxDuration&minDuration&service=server&start=1700447985163000
JAEGER UI
Search
Compare
System Architecture
Monitor
Lookup by Trace ID...
About Jaeger
Search
Upload
Click or drag files to this area.
JSON files containing one or more traces are supported.
2s
1s
Duration
10:06:40 pm
10:08:20 pm
10:10:00 pm
Time
Sort: Most Recent
Download Results
Deep Dependency Graph

with-compression.json

52 Traces

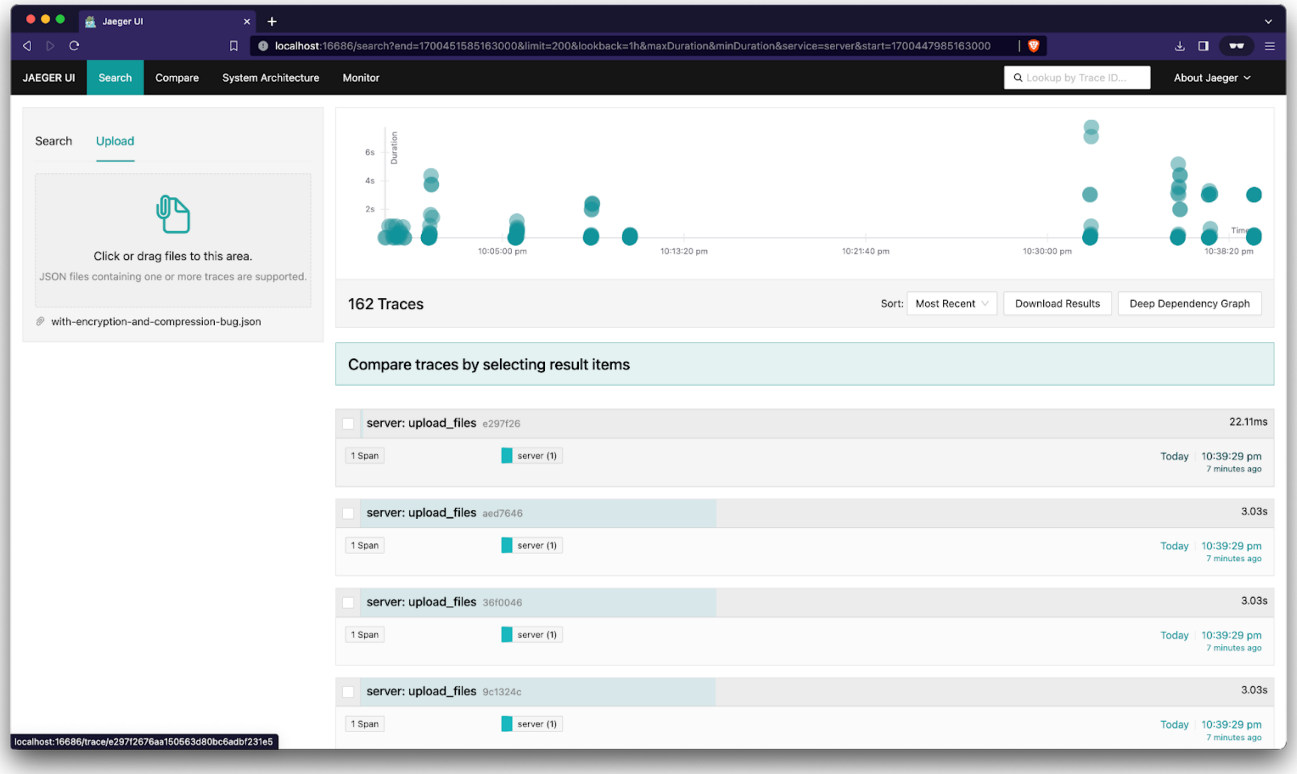
Compare traces by selecting result items

server: upload_files 24b83af — 61.92ms
1 Span — server (1) — Today 10:10:51 pm, 34 minutes ago

server: upload_files bae7b90 — 68.33ms
1 Span — server (1) — Today 10:10:51 pm, 34 minutes ago

server: upload_files a38bafe — 78.62ms
1 Span — server (1) — Today 10:10:51 pm, 34 minutes ago

server: upload_files 745220a — 111.32ms
1 Span — server (1) — Today 10:10:51 pm, 34 minutes ago



with-encryption-and-compression-bug.json

162 Traces

Compare traces by selecting result items

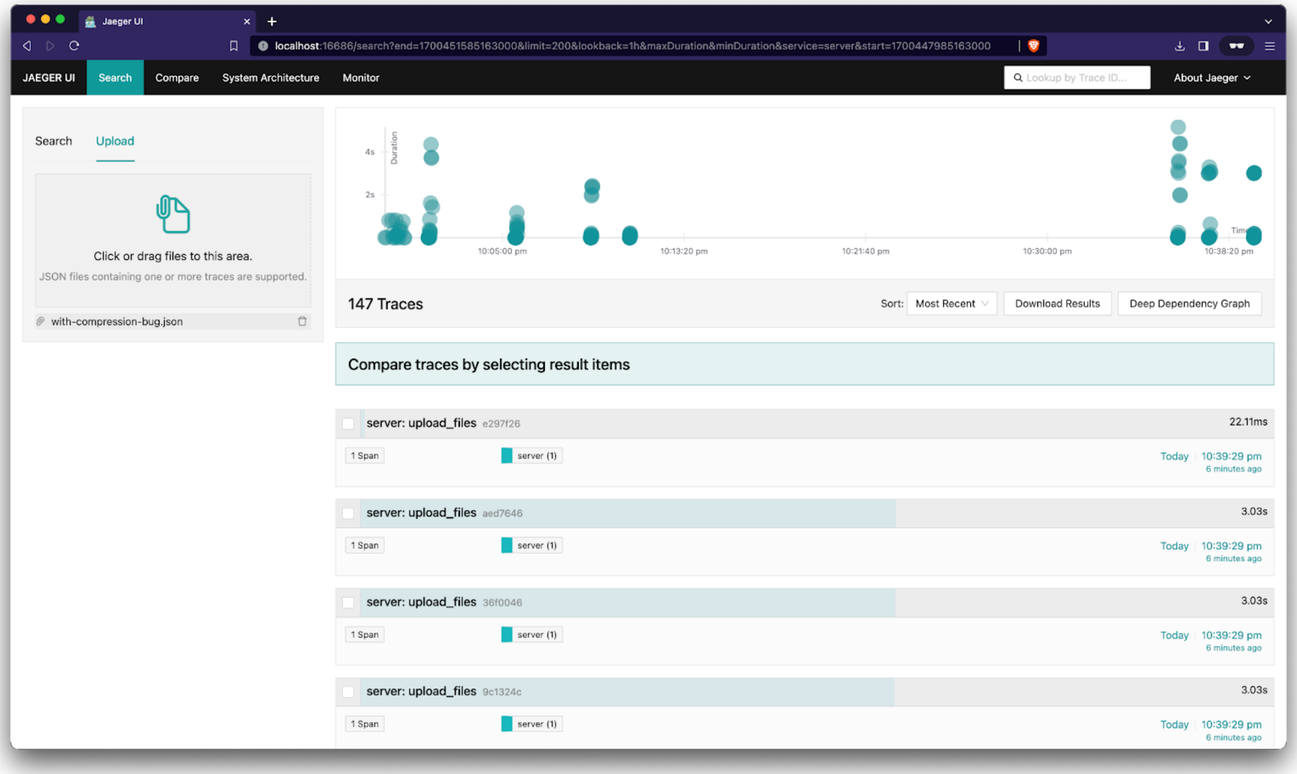
server: upload_files e297f26 — 22.11ms
1 Span — server (1) — Today 10:39:29 pm, 7 minutes ago

server: upload_files aed7646 — 3.03s
1 Span — server (1) — Today 10:39:29 pm, 7 minutes ago

server: upload_files 36f0046 — 3.03s
1 Span — server (1) — Today 10:39:29 pm, 7 minutes ago

server: upload_files 9c1324c — 3.03s
1 Span — server (1) — Today 10:39:29 pm, 7 minutes ago

localhost:16686/trace/e297f2676aa150563d80bc6adbf231e5



localhost:16686/search?end=1700451585163000&limit=200&lookback=1h&maxDuration&minDuration&service=server&start=1700447985163000

with-compression-bug.json

147 Traces

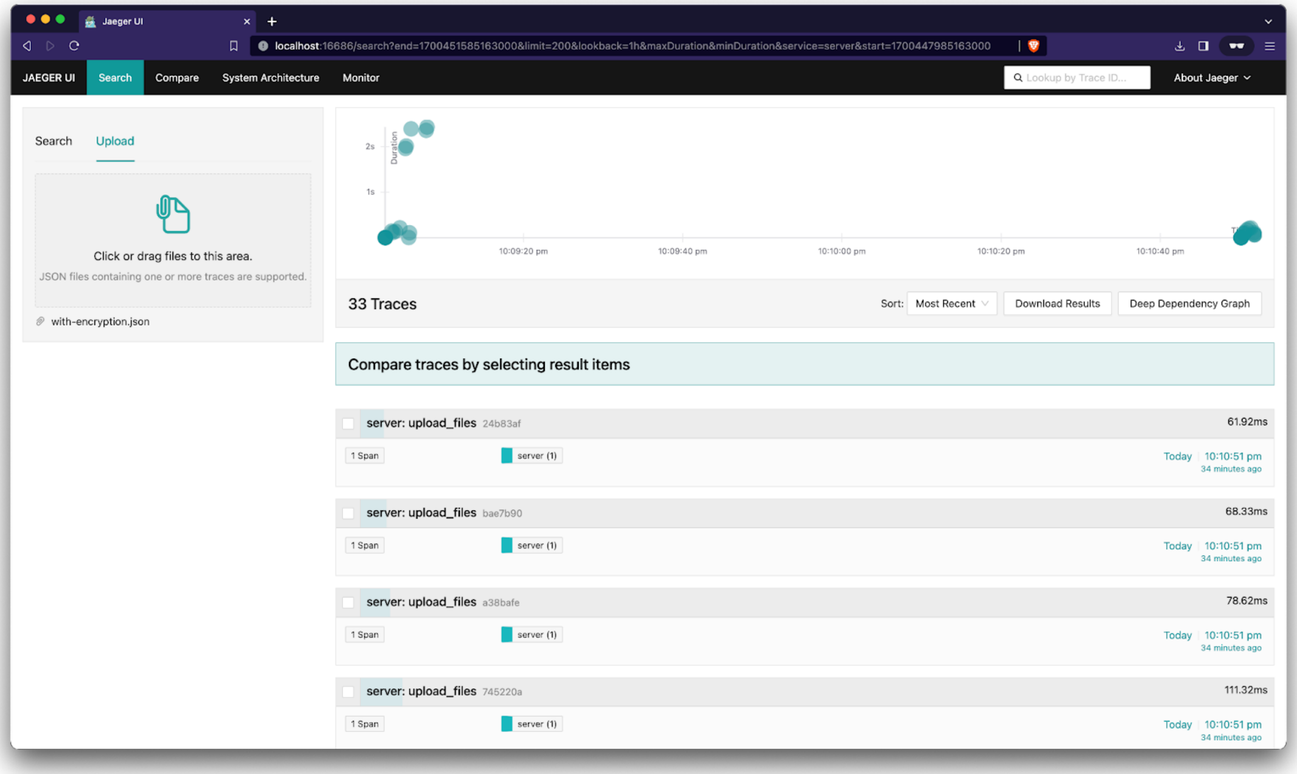
Compare traces by selecting result items

server: upload_files e297f26 22.11ms
1 Span server (1) Today 10:39:29 pm
6 minutes ago

server: upload_files aed7646 3.03s
1 Span server (1) Today 10:39:29 pm
6 minutes ago

server: upload_files 36f0046 3.03s
1 Span server (1) Today 10:39:29 pm
6 minutes ago

server: upload_files 9c1324c 3.03s
1 Span server (1) Today 10:39:29 pm
6 minutes ago



localhost:16686/search?end=1700451585163000&limit=200&lookback=1h&maxDuration&minDuration&service=server&start=1700447985163000

with-encryption.json

33 Traces

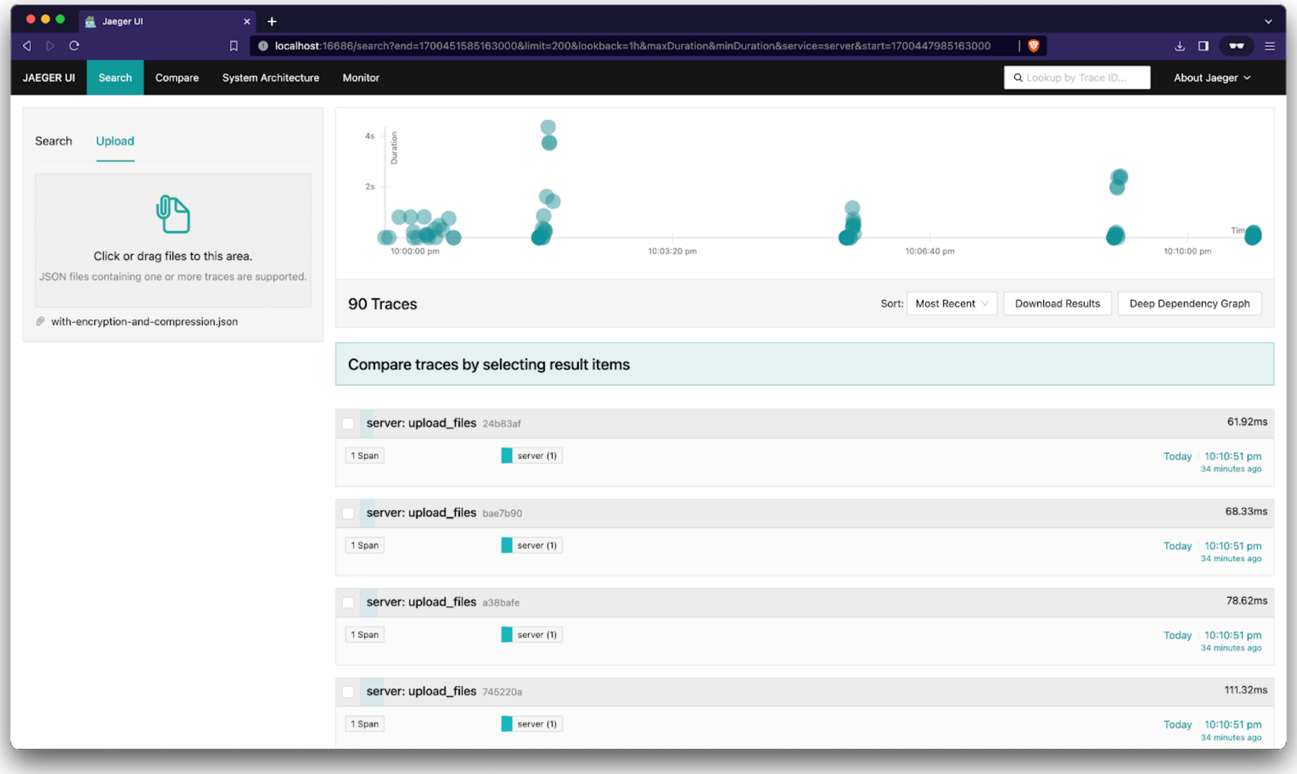
Compare traces by selecting result items

server: upload_files 24b83af 61.92ms
1 Span server (1) Today 10:10:51 pm
34 minutes ago

server: upload_files bae7b90 68.33ms
1 Span server (1) Today 10:10:51 pm
34 minutes ago

server: upload_files a38bafe 78.62ms
1 Span server (1) Today 10:10:51 pm
34 minutes ago

server: upload_files 745220a 111.32ms
1 Span server (1) Today 10:10:51 pm
34 minutes ago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with-encryption-and-compression.json
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2s
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10:00:00 pm
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10:06:40 pm
10:10:00 pm
Tim
Sort:
Most Recent
Download Results
Deep Dependency Graph

90 Traces

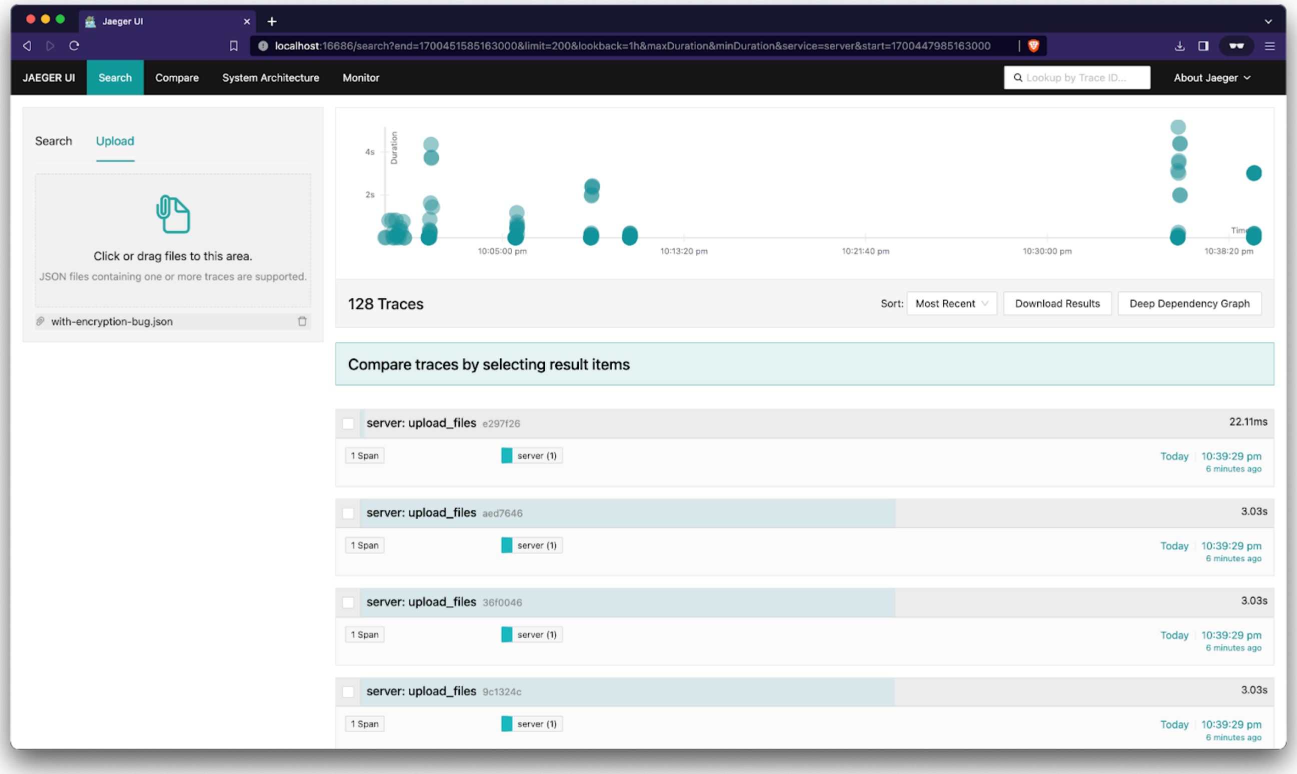
Compare traces by selecting result items

□ server: upload_files 24b83af — 61.92ms
1 Span | server (1) | Today 10:10:51 pm, 34 minutes ago

□ server: upload_files bae7b90 — 68.33ms
1 Span | server (1) | Today 10:10:51 pm, 34 minutes ago

□ server: upload_files a38bafe — 78.62ms
1 Span | server (1) | Today 10:10:51 pm, 34 minutes ago

□ server: upload_files 745220a — 111.32ms
1 Span | server (1) | Today 10:10:51 pm, 34 minutes ago



128 Traces

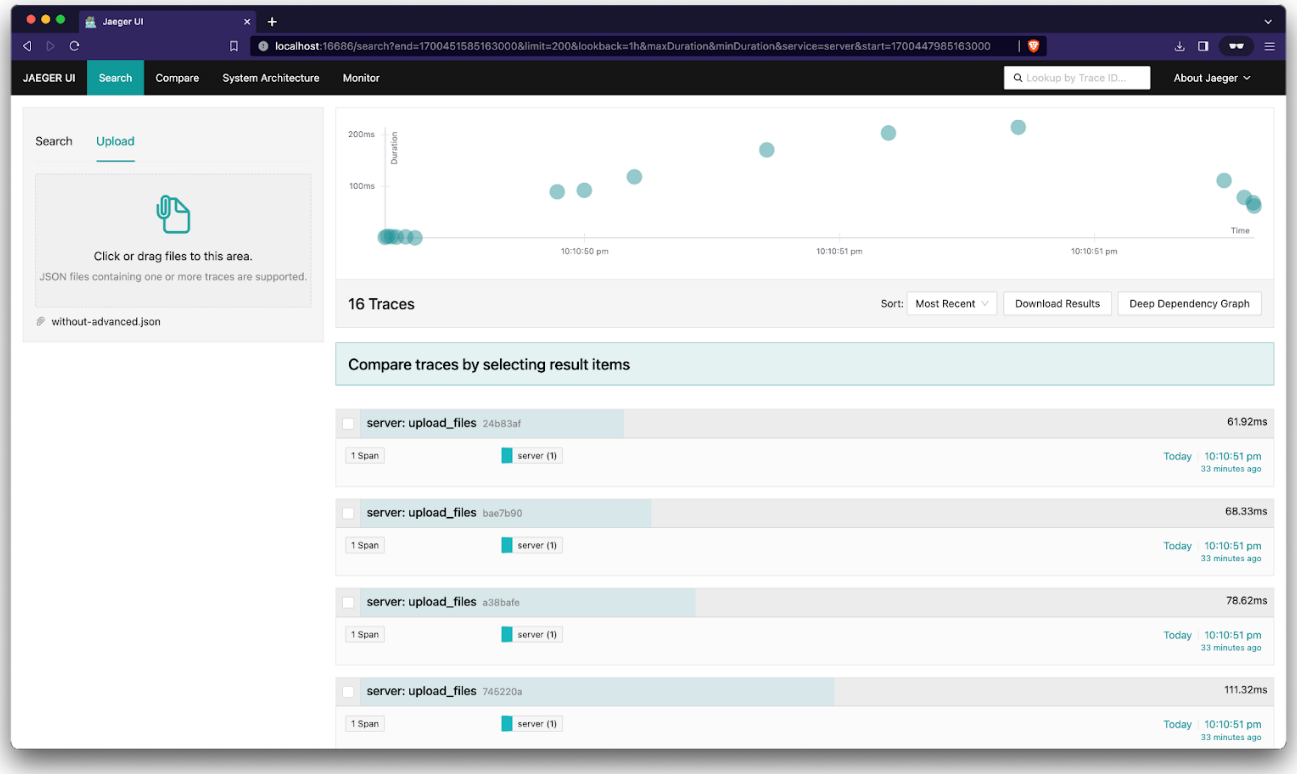
Compare traces by selecting result items

□ server: upload_files e297f26 — 22.11ms
1 Span | server (1) | Today 10:39:29 pm, 6 minutes ago

□ server: upload_files aed7646 — 3.03s
1 Span | server (1) | Today 10:39:29 pm, 6 minutes ago

□ server: upload_files 36f0046 — 3.03s
1 Span | server (1) | Today 10:39:29 pm, 6 minutes ago

□ server: upload_files 9c1324c — 3.03s
1 Span | server (1) | Today 10:39:29 pm, 6 minutes ago



localhost:16686/search?end=1700451585163000&limit=200&lookback=1h&maxDuration&minDuration&service=server&start=1700447985163000

Click or drag files to this area.

JSON files containing one or more traces are supported.

without-advanced.json

16 Traces

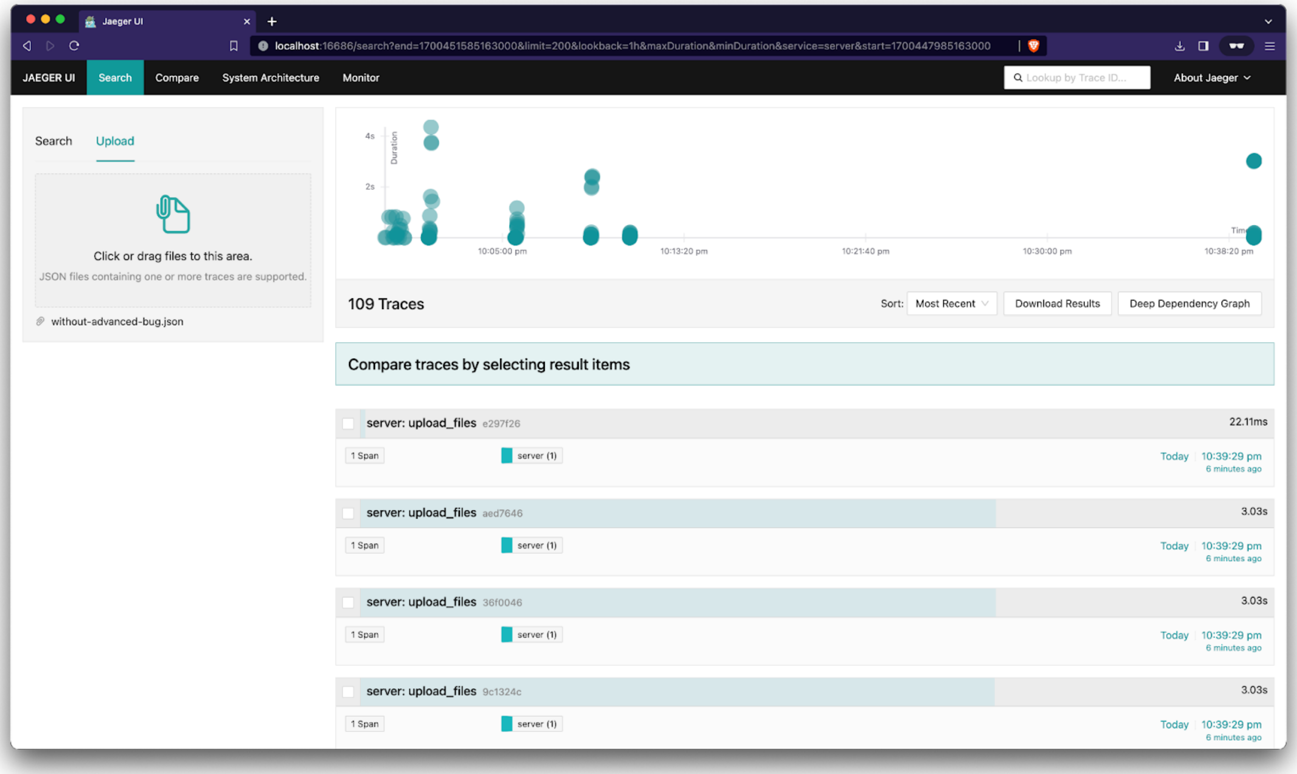
Compare traces by selecting result items

server: upload_files 24b83af — 61.92ms — 1 Span — server (1) — Today 10:10:51 pm 33 minutes ago

server: upload_files bae7b90 — 68.33ms — 1 Span — server (1) — Today 10:10:51 pm 33 minutes ago

server: upload_files a38bafe — 78.62ms — 1 Span — server (1) — Today 10:10:51 pm 33 minutes ago

server: upload_files 745220a — 111.32ms — 1 Span — server (1) — Today 10:10:51 pm 33 minutes ago



localhost:16686/search?end=1700451585163000&limit=200&lookback=1h&maxDuration&minDuration&service=server&start=1700447985163000

Click or drag files to this area.

JSON files containing one or more traces are supported.

without-advanced-bug.json

109 Traces

Compare traces by selecting result items

server: upload_files e297f26 — 22.11ms — 1 Span — server (1) — Today 10:39:29 pm 6 minutes ago

server: upload_files aed7646 — 3.03s — 1 Span — server (1) — Today 10:39:29 pm 6 minutes ago

server: upload_files 36f0046 — 3.03s — 1 Span — server (1) — Today 10:39:29 pm 6 minutes ago

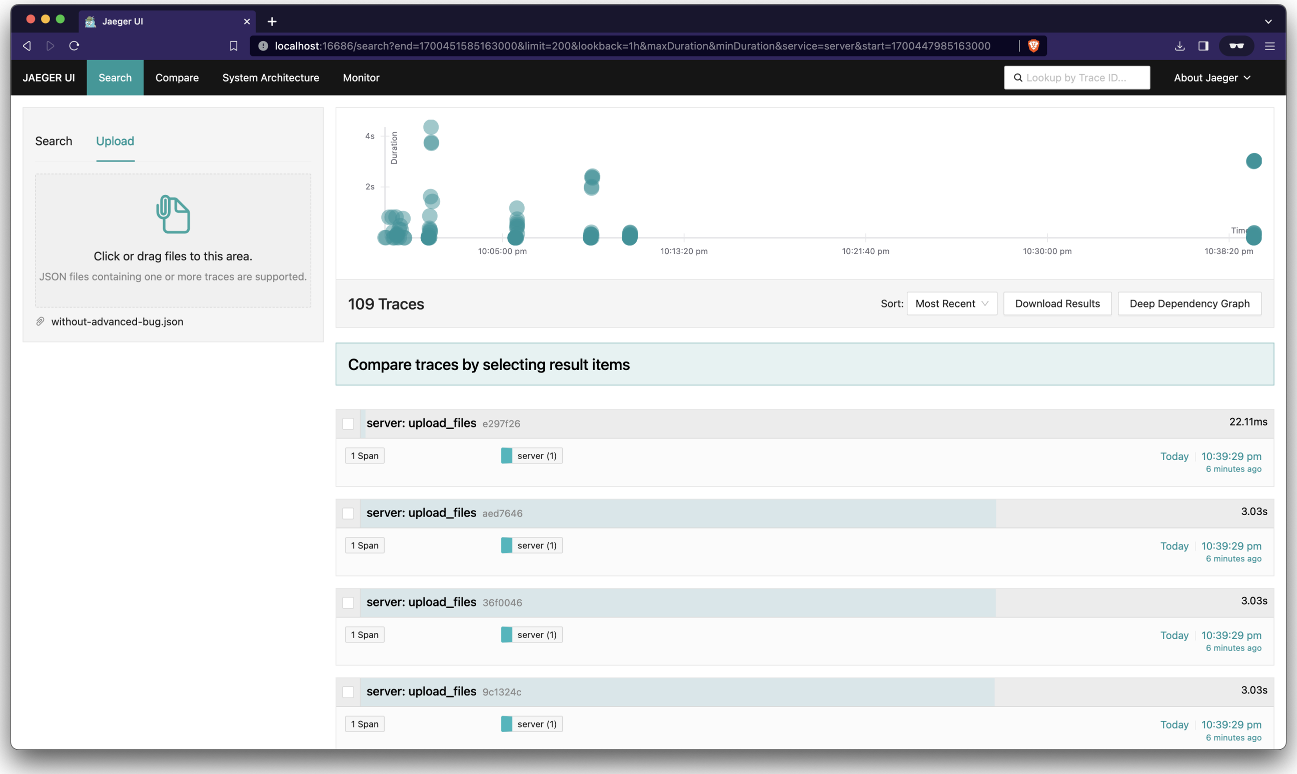
server: upload_files 9c1324c — 3.03s — 1 Span — server (1) — Today 10:39:29 pm 6 minutes ago

Report (Q2)

The Bug

The bug introduced was a `sleep` function that is triggered with a 30% probability whenever the server receives a file from the client. Whenever the bug is triggered, it would delay the execution time of the server by 3 additional seconds.

Statistical Debugging & Analysis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6 minutes ago

server: upload_files 36f0046 3.03s
1 Span server (1) Today 10:39:29 pm
6 minutes ago

server: upload_files 9c1324c 3.03s
1 Span server (1) Today 10:39:29 pm
6 minutes ago

Using the `without-advanced-bug.json` OpenTelemetry trace samples, the number of failed runs `F(P)` (i.e. the execution time took 3+ seconds) was 6. The total number of samples was 20. Therefore the $Failure(P)$ is 30%.

$$F(P) = 6$$

$$Failure(P) = \frac{F(P)}{F(P) + S(P)} = \frac{6}{20} = \frac{3}{10} = 30\%$$

The $S(Pobserved)$ is 0 because the execution time always fails (i.e. exceeds 3 seconds) whenever the predicate P (the probability that the random number is less than 30%) is true. Therefore, the $Context(P)$ is 1.

$$Context(P) = \frac{F(Pobserved)}{F(Pobserved) + S(Pobserved)} = \frac{6}{6+0} = 1$$

Therefore, the $Increase(P)$ defined as $Failure(P) - Context(P)$ is -0.7. Since the value is farther from 0, it shows that there is a high correlation between the probability conditional and the source of the bug. Therefore, we identify that the root-cause of the bug occurs in the conditional.

$$Increase(P) = Failure(P) - Context(P) = 0.3 - 1 = -0.7$$

Probability Conditional

```
if secrets.randbelow(10) < 3:
```

Bug

```
    time.sleep(3)
```

Steps to resolve issue

Knowing that the source of the bug is due to the `if-statement`, we can resolve the issue by removing the `sleep` function invocation and the `if-statement` altogether. This solves the delay in execution time for the server program.