Improving Business Insight: Observability Patterns for Software Systems

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Introduction

The complex nature of software systems makes failures inevitable. Rather than attempting to perfect a system without failures, which is incredibly difficult and expensive, it's more practical to take the necessary steps to respond and resolve failures when they occur. The term "observability" wasn't coined by software developers.

> “Observability” is a term from control theory that describes the property of a system where one can infer its internal state by inspecting its external outputs.

The same definition can be applied to enterprise software systems, where we use the following external outputs to infer the internal state of the system:

- log
- index
- track

Logs are the most common way to record the output of enterprise applications. These logs are usually stored in files and rotated after a period of time to maintain a certain storage period.

Metrics are statistics related to the behavior of your application.

Traces are very useful for gaining insight into what is happening in a system at a fine-grained level. Typically, these traces record the delivery of every message in the system.

Implementing Observability

Developers often don't prioritize implementing observability because it requires extra work during the development phase. Constrained by time pressures and other challenges, they often view it as a post-release task or a to-do item that never seems to get completed. That is, until a serious production issue arises, forcing support engineers to struggle to find the root cause. By then, the problem has already occurred, and significant time has been wasted due to a lack of observability in the system.

The four main steps to implementing observability include:

- Instrumentation
- Correlation
- automation
- Insights and predictions

Instrumentation is the first step to implementing observability, where applications need to generate necessary telemetry data from the source code so that data collectors can ingest and aggregate this data for further analysis.

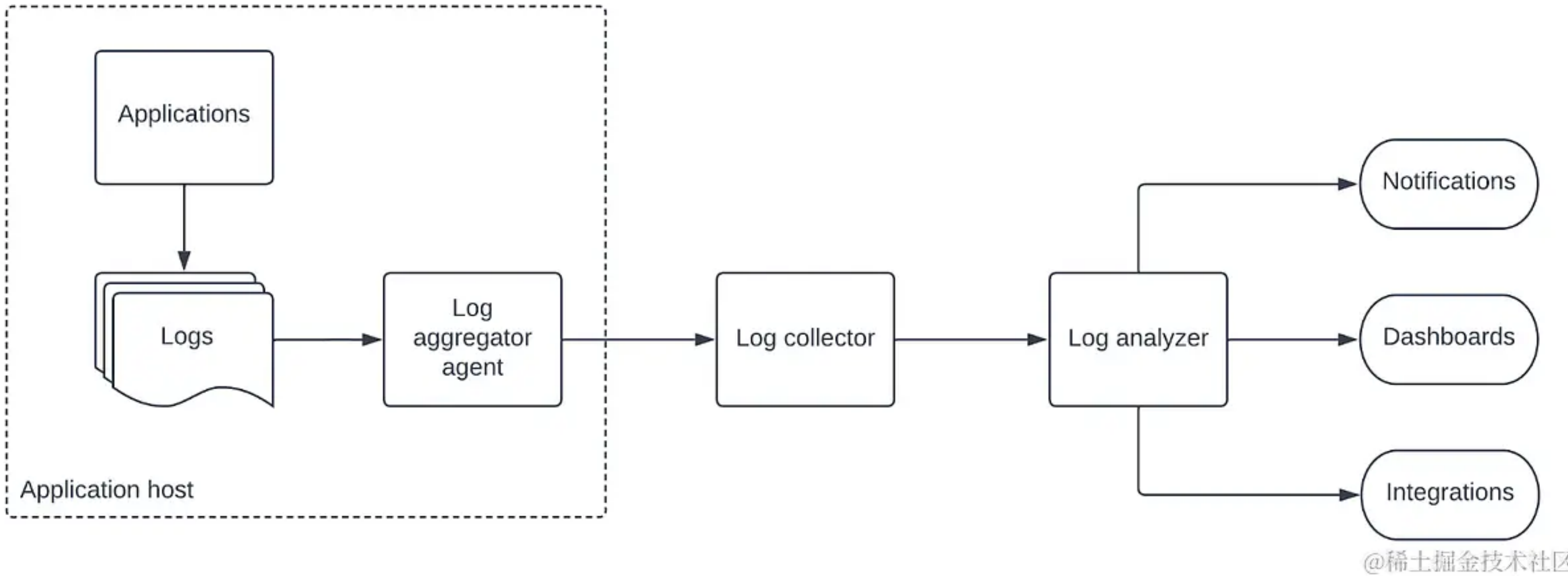
Once the data is collected and aggregated, there must be a mechanism to correlate telemetry data from different events across different applications to troubleshoot issues and identify the root cause. It is important to have a common approach across different applications to correlate these events.

Allocating resources to review every telemetry event and make decisions based on it is an impractical task. Instead, we need to automate the process of analyzing these events as much as possible, so that only those events that require attention trigger human intervention.

Furthermore, in addition to responding to critical incidents, we can also use observability data to analyze user behavior, generate insights and predictions to support business decisions to improve system performance and business.

Using logs for observability

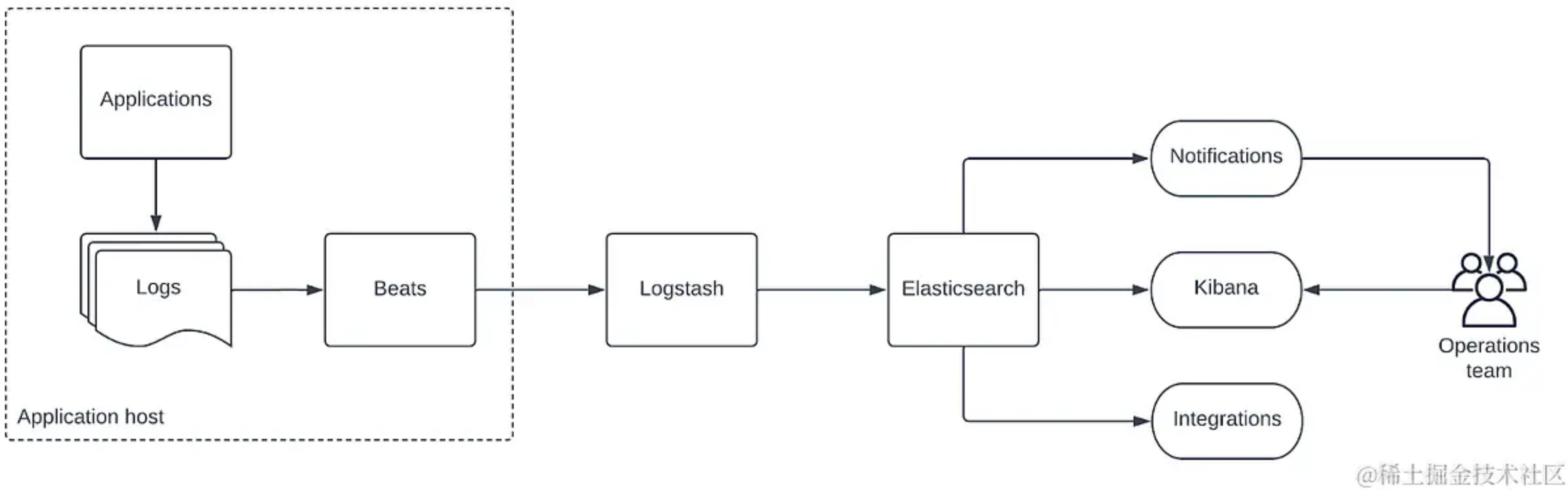
Logging is the most common and popular method for troubleshooting enterprise applications. Applications can be instrumented to output different types of log entries, such as errors, warnings, debug messages, and informational details, to these log files. The following diagram shows a typical pattern for using logs for observability.



As shown in the previous figure, different types of applications expose their internal state as external output through log entries. These logs can be aggregated or read by agents running next to the applications. The main task of these agents is to read these log entries and publish them to log collectors. Log collectors are responsible for aggregating these log entries and preprocessing them before further analysis. With log analyzers, users can choose to analyze these logs directly using a query language or use external dashboard components for analysis. Some popular log analysis tools include:

- ELK（Elasticsearch、Logstash、Kibana）
- Grafana Labs（Promtail、Loki 和 Grafana）
- Splunk
- New Relic
- Sumo Logic

We can use the ELK stack to implement the observability pattern as shown below.

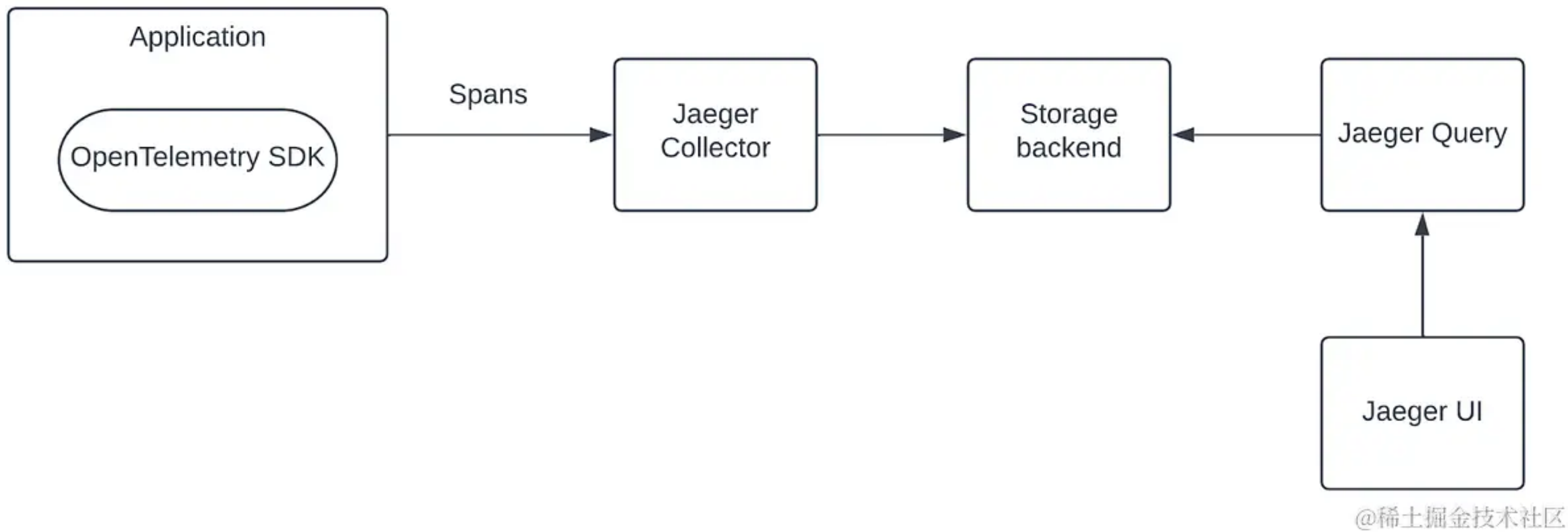


As shown in the previous figure, the Beats agent, located next to the application, reads log files and transmits these log entries to Logstash, which acts as a log aggregator. Logstash then stores these aggregated logs in its unique storage and indexes, searches, and analyzes the data in the log files. Elasticsearch is a powerful tool capable of analyzing various types of data, including structured and unstructured data, as well as numerical, textual, and geospatial data, allowing users to extract valuable insights and context from the data. Kibana allows users to interactively explore, visualize, and share insights, and monitor systems through visual dashboards.

Using tracing for observability

Tracing is another way to implement observability for enterprise applications. In this case, we use common standards such as OpenTelemetry or OpenTracing to publish detailed information about the data transmitted through the application.

Jaeger is an open-source distributed tracing platform used to implement observability solutions for modern cloud-native applications. It helps operations teams capture trace data across multiple applications and use this information to troubleshoot issues and improve system performance. The following diagram illustrates how to implement tracing observability using Jaeger.



The diagram above depicts a use case where an application is intelligently leveraging an OpenTelemetry-based SDK to instrument the application and publish telemetry data as a series of "spans" to a Jaeger collector. During this process, the Jaeger collector validates and transforms the data before storing it. Possible storage backends include in-memory storage, Elasticsearch, Kafka, or a database. Once the data is stored in the backend storage, the Jaeger query component is used to perform search and query operations to retrieve the trace data, which is then visualized in the Jaeger user interface.

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