PRESENTATION ON DISTRIBUTED DEBUGGING

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Distributed System

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OUTLINE

Debugging

Distributed Debugging

Debugging Single-Process Application vs Distributed System

Challenges of Distributed System

Types of Bugs in Distributed System

Techniques

Conclusion

DEBUGGING

Process of finding and resolving bugs in computer programs, software, or hardware.

Aims to identify and correct the root cause of an error.

Bugs can include faulty code, logic errors, or manufacturing defects.

DISTRIBUTED DEBUGGING

Ability to debug associated processes within a distributed application environment.

Problems: message loss, inconsistent state etc.

Extra functionality in debuggers such as tracing, logging etc.

DEBUGGING SINGLE-PROCESS APPLICATIONS VS DISTRIBUTED SYSTEMS

Debugging Single-Process Application

- All code runs within a single process, so easier to trace and identify issues.
- Debug with a debugger, line by line.

Debugging Distributed Systems

- Multiple processes running on different devices
- Therefore, need to debug all nodes simultaneously
- Use logging, tracing, monitoring etc.

CHALLENGES OF DISTRIBUTED SYSTEM

Challenges:

☐ Heterogeneity

☐ Concurrency

☐ Distributed state

☐ Security

☐ Partial failures.

Developing distributed systems is difficult due to the complexity of algorithms.

CHALLENGES OF DISTRIBUTED SYSTEM

Heterogeneity:

Systems consist of diverse nodes, such as mobile phones, laptops etc.

This hardware and software variations in nodes enhance system robustness.

Forces developers to manage compatibility during both development and debugging.

CHALLENGES OF DISTRIBUTED SYSTEM

Concurrency:

It enhances performance in distributed systems.

However, it may introduce race conditions and deadlocks.

It also introduces packet delay and loss in network.

CHALLENGES OF DISTRIBUTED SYSTEM

Distributed State:

Removes the central point of failures and improves scalability.

Nodes must synchronize state and maintain consistency.

Consistency challenges.

Difficulty in reconstructing global state between nodes.

Thus, Debugging and validating bugs become more complicated.

CHALLENGES OF DISTRIBUTED SYSTEM

Security:

Network vulnerabilities

Authentication and authorization risks

Data privacy concerns

Trust and identity management complexity

TYPES OF BUGS IN DISTRIBUTED SYSTEMS
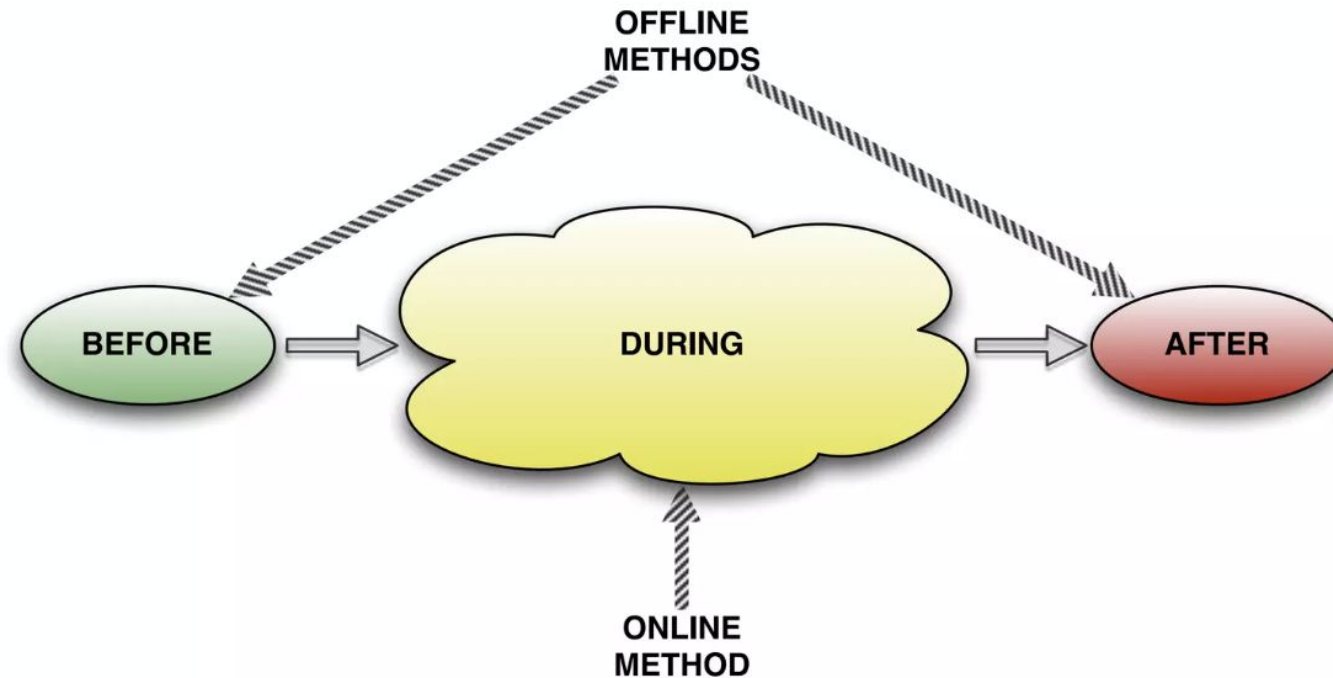
Network failures

Race conditions

Message loss

Inconsistent states

TECHNIQUES

Methods and approaches used to identify, analyze, and resolve issues

TECHNIQUES

Log Analysis

☐ Gathering log files from components involved in process

☐ Understanding the log format used by each microservice

☐ Use gathered logs to analyze and resolve

TECHNIQUES

Trace Analysis

▢ Traces are record of journey of a single request across multiple services

▢ Captures distributed traces as requests flow through the system

▢ Analyze the captured traces

TECHNIQUES

Metrics monitoring

☐ Involves collecting and analyzing various metrics in real-time.

☐ Metrics are CPU usage, memory used, network traffic, response times.

☐ Setting up centralized monitoring system

☐ Set thresholds for each metrics

☐ So system can run smoothly

TECHNIQUES

Reproducing Issues

☐ Recreating the conditions or scenarios that led to a specific problem

☐ Observe its behavior closely

☐ Collect, analyze and monitor related data

TECHNIQUES

Chaos Engineering

☐ Also called Fault Injection

☐ Intentionally injecting controlled failures

☐ To uncover vulnerabilities

☐ To improve the resilience of distributed system

CONCLUSION

Essential aspect for ensuring the robustness

Errors are challenging to resolve

Various techniques have been developed

Continuous improvement enhances system resilience

THANK YOU!!