

SE2062 – Distributed Systems

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Lab 05

Consistency Models in Distributed Systems

1. Strong Consistency:

- Ensures that after an update completes, any subsequent read will return the most recent value.
- Behaves as if there is a single, up-to-date copy of the data.
- Example: Traditional relational databases (ACID compliance).
- Advantage: Predictable and easy reasoning for developers.
- Disadvantage: High latency and lower availability in distributed systems.

2. Eventual Consistency:

- Guarantees that if no new updates are made, eventually all replicas will converge to the same value.
- Reads may return stale values temporarily.
- Example: DNS systems, Amazon DynamoDB.
- Advantage: High availability and low latency.
- Disadvantage: Developers must handle temporary inconsistencies.

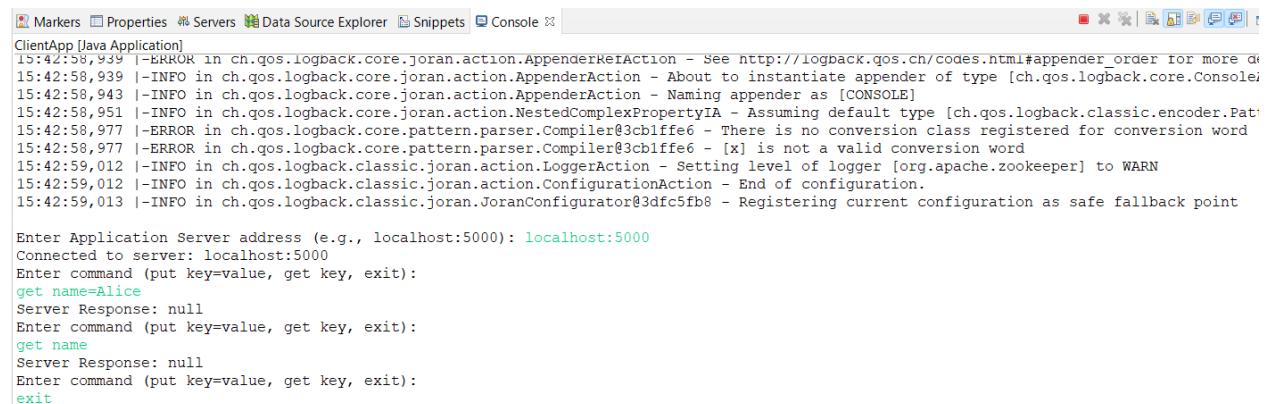
3. Sequential Consistency:

- Ensures that the result of operations is the same as if all processes executed their operations in a single sequential order.
- Operations from a single process are observed in the order issued, but there is no global real-time guarantee.
- Example: Writes appear in program order, but the interleaving across processes may vary.
- Advantage: Easier reasoning compared to eventual consistency, without the cost of strong consistency.
- Disadvantage: May still allow anomalies compared to strong consistency.

Key Difference:

- Strong consistency guarantees the most recent data always.
- Eventual consistency only guarantees convergence over time.
- Sequential consistency guarantees program order per process, but not strict real-time ordering across the system.

Outputs



The screenshot shows a Java application named "ClientApp" running in an IDE. The "Console" tab is active, displaying log messages from the application's logger. The log includes several INFO and ERROR messages related to Logback configuration, such as appender instantiation and conversion word validation. At the bottom of the console, the application prompts for a server address ("localhost:5000") and a command, demonstrating a simple key-value store interaction.

```
Markers Properties Servers Data Source Explorer Snippets Console
ClientApp [Java Application]
15:42:58,939 I-ERROR in ch.qos.logback.core.joran.action.AppenderKeiAction - See http://logback.qos.ch/codes.html#appender_order for more de
15:42:58,939 I-INFO in ch.qos.logback.core.joran.action.AppenderAction - About to instantiate appender of type [ch.qos.logback.core.ConsoleAppender]
15:42:58,943 I-INFO in ch.qos.logback.core.joran.action.AppenderAction - Naming appender as [CONSOLE]
15:42:58,951 I-INFO in ch.qos.logback.core.joran.action.NestedComplexPropertyIA - Assuming default type [ch.qos.logback.classic.encoder.PatternLayoutEncoder]
15:42:58,977 I-ERROR in ch.qos.logback.core.pattern.parser.Compiler@3cb1ffe6 - There is no conversion class registered for conversion word [x]
15:42:58,977 I-ERROR in ch.qos.logback.core.pattern.parser.Compiler@3cb1ffe6 - [x] is not a valid conversion word
15:42:59,012 I-INFO in ch.qos.logback.classic.joran.action.LoggerAction - Setting level of logger [org.apache.zookeeper] to WARN
15:42:59,012 I-INFO in ch.qos.logback.classic.joran.action.ConfigurationAction - End of configuration.
15:42:59,013 I-INFO in ch.qos.logback.classic.joran.JoranConfigurator@3dfc5fb8 - Registering current configuration as safe fallback point

Enter Application Server address (e.g., localhost:5000): localhost:5000
Connected to server: localhost:5000
Enter command (put key=value, get key, exit):
get name=Alice
Server Response: null
Enter command (put key=value, get key, exit):
get name
Server Response: null
Enter command (put key=value, get key, exit):
exit
```

```
Problems Javadoc Declaration Console X Eclipse IDE for Java Developers 2025-06 Release
ClientApp [Java Application] C:\Program Files\Java\jdk-24\bin\javaw.exe (Sep 2, 2025, 3:31:23 PM elapsed: 0:01:15) [pid: 15328]
15:31:24,370 |-INFO in ch.qos.logback.classic.joran.action.ConfigurationAction - End of configuration.
15:31:24,371 |-INFO in ch.qos.logback.classic.joran.JoranConfigurator@3c0ecd4b - Registering current configuration as safe fallback point

Enter Application Server address (e.g., localhost:5000): localhost:5000
Connected to server: localhost:5000
Enter command (put key=value, get key, exit):
put name=Alice
Server Response: Stored: name=Alice
Enter command (put key=value, get key, exit):
get name
Server Response: Value: Alice
Enter command (put key=value, get key, exit):
```

```
Registered server: localhost:5000
Application Server started on port 5000
Received: get name=Alice
```

```
Markers Properties Servers Data Source Explorer Snippets Console X
ClientApp [Java Application]
16:32:37,788 |-INFO in ch.qos.logback.core.joran.action.NestedComplexPropertyIA - type [ch.qos.logback.core.pattern.Parser$Compiler]
16:32:37,815 |-ERROR in ch.qos.logback.core.pattern.parser.Compiler@3cb1ffe ClientApp [Java Application] rsion class regi
16:32:37,815 |-ERROR in ch.qos.logback.core.pattern.parser.Compiler@3cb1ffe6 - [x] is not a valid conversion word
16:32:37,853 |-INFO in ch.qos.logback.classic.joran.action.LoggerAction - Setting level of logger [org.apache.zoo
16:32:37,853 |-INFO in ch.qos.logback.classic.joran.action.ConfigurationAction - End of configuration.
16:32:37,854 |-INFO in ch.qos.logback.classic.joran.JoranConfigurator@3dfc5fb8 - Registering current configurati

Enter Application Server address (e.g., localhost:5000): localhost:5000
Connected to server: localhost:5000
Enter command (put key=value, get key, exit):
put name=Alice
Server Response: Stored: name=Alice
Enter command (put key=value, get key, exit):
get name
Server Response: Value: Alice
Enter command (put key=value, get key, exit):
```

```
Markers Properties Servers Data Source Explorer Snippets Console X
ClientApp [Java Application]
16:37:16,142 |-ERROR in ch.qos.logback.core.pattern.parser.Compiler@3cb1ffe6 - There is no conversion class registered for conversion word [x]
16:37:16,142 |-ERROR in ch.qos.logback.core.pattern.parser.Compiler@3cb1ffe6 - [x] is not a valid conversion word
16:37:16,179 |-INFO in ch.qos.logback.classic.joran.action.LoggerAction - Setting level of logger [org.apache.zookeeper] to WARN
16:37:16,179 |-INFO in ch.qos.logback.classic.joran.action.ConfigurationAction - End of configuration.
16:37:16,179 |-INFO in ch.qos.logback.classic.joran.JoranConfigurator@3dfc5fb8 - Registering current configuration as safe fallback point

Enter Application Server address (e.g., localhost:5000): localhost:5001
Connected to server: localhost:5001
Enter command (put key=value, get key, exit):
put name=Alice
Server Response: Stored: name=Alice
Enter command (put key=value, get key, exit):
get name
Server Response: Value: Alice
Enter command (put key=value, get key, exit):
```

Summary Table

Feature	Without Vector Clocks	With Vector Clocks
Event ordering	Unknown / arbitrary	Tracks causal relationships accurately
Message delivery	May deliver out of order	Delivers only when causality is respected
State awareness	Each process knows only itself	Each process knows partial state of all others