RELIABLE GROUP COMMUNICATION

Ensuring Consistency and Fault Tolerance

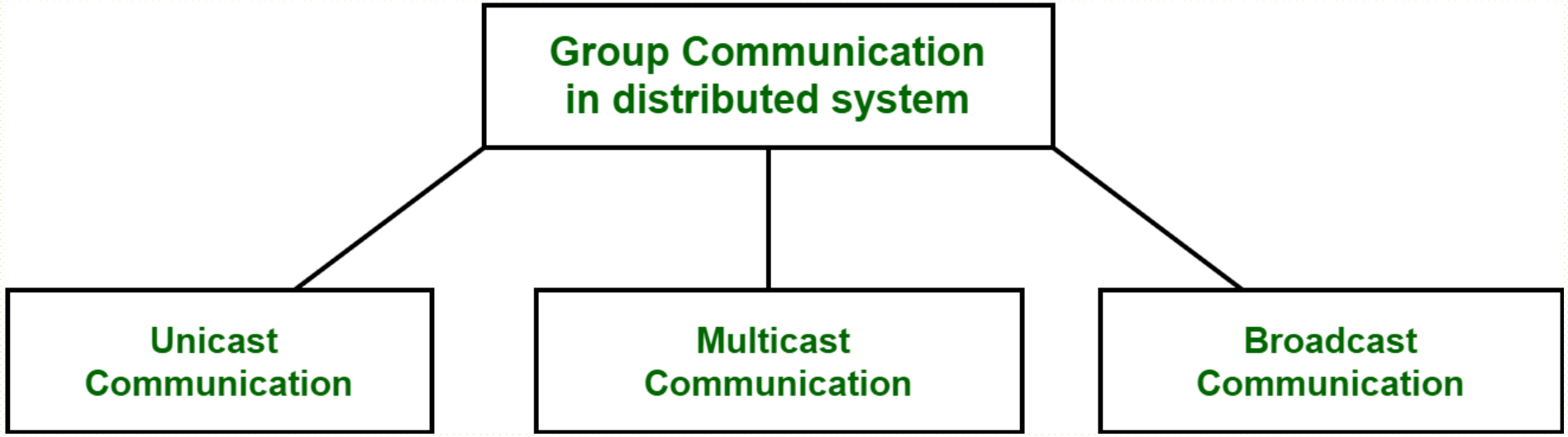
Presented by:
Kiara Raya

Contents

Introduction

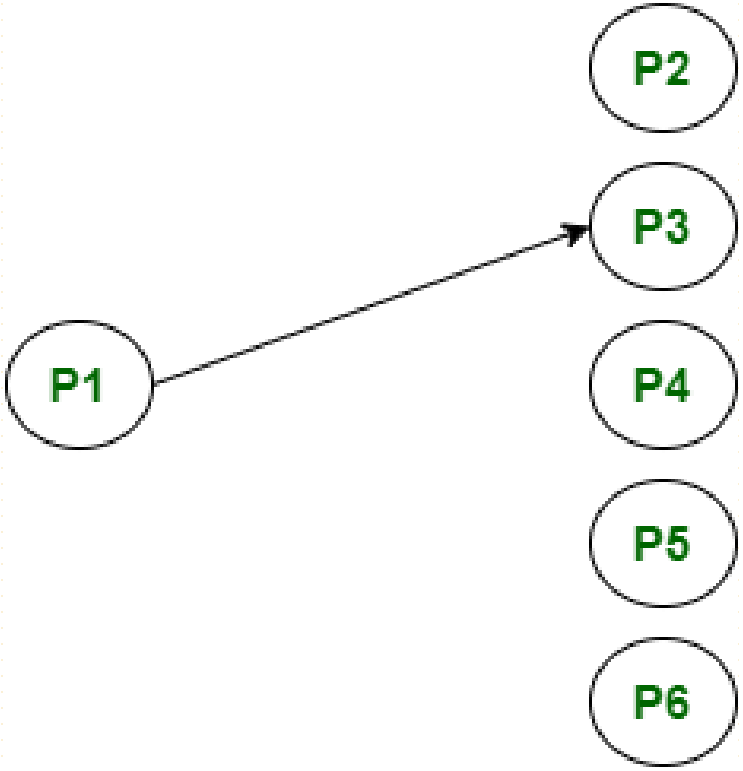
- **Communication** between two processes in a distributed system is required to exchange various data, such as code or a file, between the processes.
- When one source process tries to communicate with multiple processes at once, it is called **Group Communication**.
- A group is a collection of interconnected processes with abstraction.
- This abstraction is to hide the message passing so that the communication looks like a normal procedure call.

Types of group communication



Unicast Communication

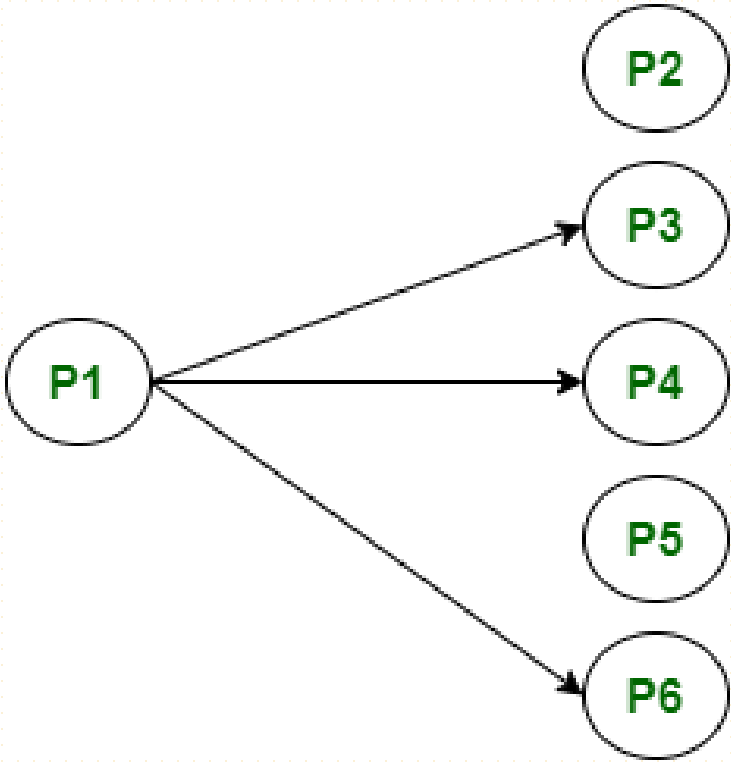
- The host process tries to communicate with a single process in a distributed system at the same time.
- This works best for two processes communicating as only it has to treat a specific process only.
- However, it leads to overheads as it has to find exact process and then exchange information/data.



A unicast communication: P1 process communicating with only P3 process

Multicast Communication

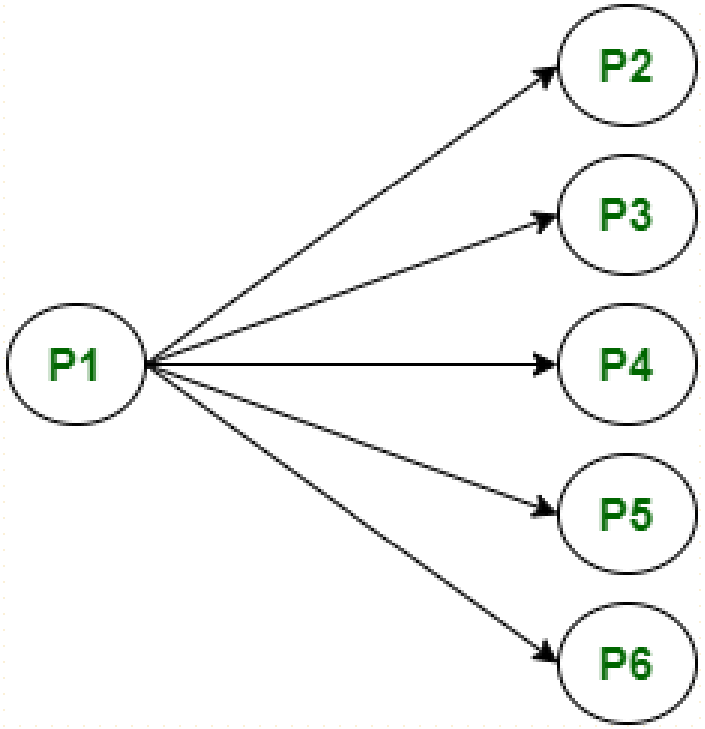
- The host process tries to communicate with a designated group of processes in a distributed system at the same time
- Mainly used to find a way to address problem of a high workload on host system and redundant information from process in system



A multicast communication: P1 process communicating with only a group of processes in the system

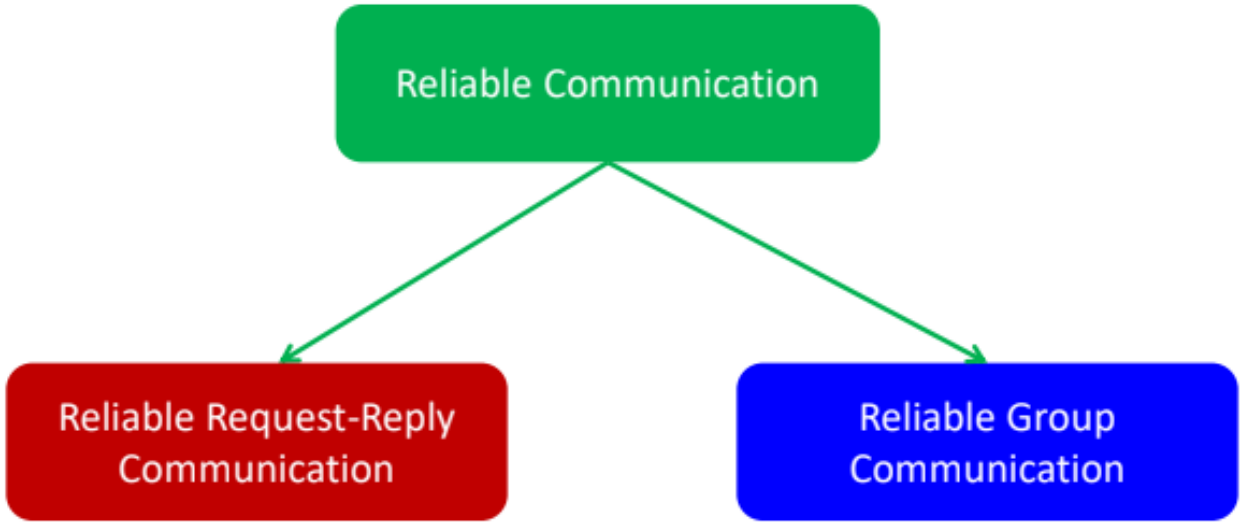
Broadcast Communication

- The host process tries to communicate with every process in a distributed system at same time.
- Useful when a common stream of information is to be delivered to each and every process in most efficient manner possible.



A broadcast communication: P1 process communicating with every processes in the system

Types of Reliable Communication



Request-Reply Communication

- Reliable request-reply communication is a communication paradigm used in distributed systems where a request is sent from a sender (client) to a receiver (server), and the receiver responds with a reply.
- The primary goal is to ensure that the request is delivered to the receiver and that the reply is delivered back to the sender reliably, despite potential failures in the network or the systems involved.

Key Characteristics of Request-Reply Communication

1. Message Delivery Guarantees:

- **At-Least-Once Delivery:** The system ensures that the request is delivered to the receiver at least once. However, this might lead to duplicate messages if the network is unreliable.
- **At-Most-Once Delivery:** The system ensures that the request is delivered to the receiver at most once, preventing duplicates but not guaranteeing delivery.
- **Exactly-Once Delivery:** The system ensures that the request is delivered exactly once, providing the highest level of reliability but typically requiring more complex mechanisms.

Key Characteristics of Request-Reply Communication

2. Acknowledgments:

- **Positive Acknowledgment (ACK):** The receiver sends an ACK back to the sender to confirm that the request has been received and processed.
- **Negative Acknowledgment (NACK):** If the request cannot be processed, the receiver sends a NACK, prompting the sender to resend the request.

Key Characteristics of Request-Reply Communication

3. Timeouts and Retries:

- **Timeouts:** The sender waits for an acknowledgment for a specified period. If no acknowledgment is received, the sender assumes the request or reply was lost and retries.
- **Retries:** The sender resends the request if an acknowledgment is not received within the timeout period. The number of retries may be limited to avoid infinite loops.

Key Characteristics of Request-Reply Communication

4. Sequencing:

- **Sequence Numbers:** To handle duplicate requests and replies, each message is assigned a unique sequence number. The receiver uses these sequence numbers to identify and discard duplicates.

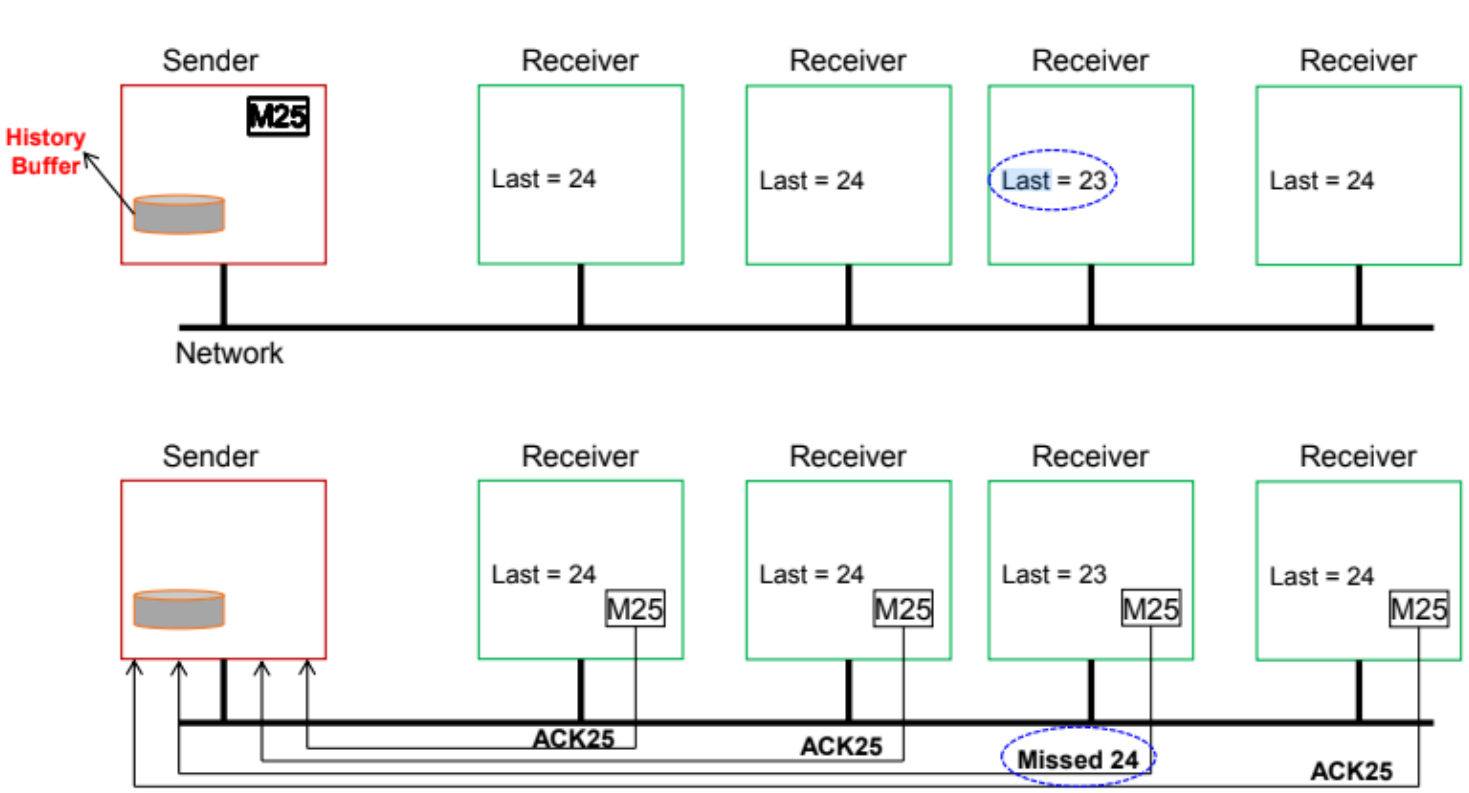
Reliable Group Communication

- This involves sending messages to multiple recipients (a group) in a way that ensures all members of the group receive the message reliably.

Reliable Multicasting with Feedback Messages

- **Reliable Multicasting with Feedback Messages** is a communication protocol used in distributed systems to ensure that messages sent to multiple recipients (a group) are delivered reliably.
- This means that every member of the group eventually receives every message, even if some messages are initially lost due to network issues or other failures.

Reliable Multicasting with Feedback Messages



Key properties of Reliable Communication

- **Atomicity:** Messages are either delivered to all nodes or none.
- **Ordering:** Ensures messages are delivered in a specific order (FIFO, causal, or total order).
- **Consistency:** All nodes see the same messages in the same order.

Importance of reliable group communication

- Ensures data consistency across nodes.
- Provides fault tolerance and system resilience.
- Critical for applications like distributed databases, cloud services, and collaborative tools.

Challenges of group communication

- Network partitions and node failures.
- Message ordering and delivery guarantees.
- Scalability and performance trade-offs.

Conclusion

- Reliable group communication is vital for the stability and consistency of distributed systems.

Thank You!