Delivery Semantics

What does it mean?

Delivery semantics describe how often a message might be delivered between the producer and the consumer, especially when failures or retries happen.

Kafka's guarantees depend on when producers retry and when consumers commit.

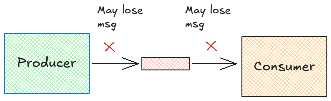
At-most-once delivery

- Producer doesn't retry on failure OR consumer commits offsets before processing

It prioritizes speed, if something fails, that's fine

Producer → Broker
1. Producer sends record.
2. Broker writes it (or maybe fails).
3. Producer does NOT retry if it doesn't get an ack.

Consumer flow:
1. Poll records from broker.
2. Immediately commit offsets (before processing).
3. Process records.
4. Crash happens during processing.



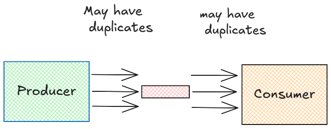
At-least-once delivery

- Producer retries if send fails
- Consumer commits offsets after processing

Default in Kafka, better to process twice than lose data. The consumer reprocess a record if it crashed before committing.

Producer → Broker
1. Producer sends record
2. Broker writes it and acks back
3. Producer never receives the ack (network glitch, crash, etc.)
4. Producer retries sending the same record

Consumer flow:
1. Poll records → process → (before commit)
2. Crash or restart before committing offset
3. On restart → re-polls the same uncommitted records

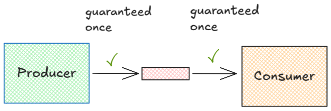


Exactly-once delivery

- Combines idempotent producer + transactional writes + careful offset commits
- Guarantees that each record is processed once and only once

Producer → Broker
1. Producer sends record with a sequence number (idempotent mode).
2. Broker appends it and tracks the sequence.
3. Ack gets lost.
4. Producer retries → broker sees same sequence → ignores duplicate.

Consumer flow:
1. Poll records.
2. Process records inside a transaction (writes + offset commit are atomic).
3. Commit transaction → both data and offsets stored together.
4. Crash before commit → Kafka rolls back transaction.



Mode	Risk	Guarantee
at-most-once	Loss	Fastest
at-least-once	Duplicates	Reliable
exactly-once	None	Precise but heavier