Apache Kafka & ZooKeeper

1. ZooKeeper Kya Hai? (The Manager)

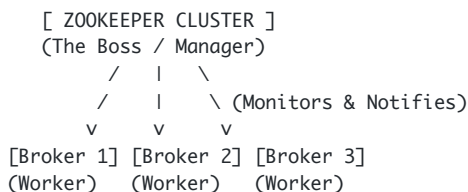Simple shabdon mein, **ZooKeeper Kafka Brokers ka Manager hai**.

- Kafka ek distributed system hai (bahut saare brokers/servers), aur in sabko coordinate karne ke liye ek external software ki zarurat hoti thi, wo **ZooKeeper** hai.
- **Legacy:** Kafka ki shuruwat se lekar aaj tak, Kafka bina ZooKeeper ke start bhi nahi ho sakta tha (Version 2.x tak).
- **Current Status:** Ye dheere-dheere "Disappear" ho raha hai (Kafka 3.x+ mein), lekin abhi bhi production mein bahut zyada use hota hai, isliye isse samajhna zaruri hai.

---

2. ZooKeeper ke Responsibilities (Kaam kya karta hai?)

ZooKeeper ka main kaam brokers par nazar rakhna aur metadata manage karna hai.

1. **Managing Brokers:** ZooKeeper active brokers ki list maintain karta hai. "Kaun zinda hai, kaun mar gaya," ye record ZooKeeper rakhta hai.
2. **Leader Election (Most Important):**
   - Agar koi Broker (jo kisi partition ka Leader tha) crash ho jaye, toh naya Leader kaun banega?
   - Ye decision lene mein ZooKeeper help karta hai.
3. **Notifications:**
   - ZooKeeper baaki brokers ko update bhejta hai jab bhi koi change hota hai.
   - *Examples:* New Topic create hua, Topic delete hua, ya koi Broker down ho gaya.
4. **Metadata Storage:** Kafka ka sara configuration aur state data ZooKeeper store karta hai.

Text Diagram: ZooKeeper managing the Cluster

```
       [ ZOOKEEPER CLUSTER ]
       (The Boss / Manager)
           /   |   \
          /    |    \ (Monitors & Notifies)
         v     v     v
  [Broker 1] [Broker 2] [Broker 3]
  (Worker)   (Worker)   (Worker)
```

---

3. ZooKeeper Architecture (Odd Numbers Rule)

ZooKeeper ko design kiya gaya hai ki wo **Odd Numbers** (Visham sankhya) mein chale.

- **Why Odd?** Majority voting (Quorum) ke liye.
- **Setup:**
  - 1 ZooKeeper (Dev/Test ke liye)
  - 3 ZooKeepers (Production minimum)
  - 5 ZooKeepers (Production standard)
  - 7 ZooKeepers (Maximum recommended)
- *Note:* Kabhi bhi even numbers (2, 4, 6) use nahi karte kyunki decision making (voting) mein tie ho sakta hai.

---

4. The Future: KRaft (Kafka without ZooKeeper)

Kafka community ab ZooKeeper ko remove kar rahi hai. Is naye mechanism ko **KRaft** (Kafka Raft) kehte hain.

- **Kafka < 3.x (Old):** ZooKeeper compulsory hai. Bina iske Kafka start nahi hoga.
- **Kafka 3.x (Current):** Aap ZooKeeper use kar sakte hain **YA** KRaft mode (No ZooKeeper) use kar sakte hain. Ye transition phase hai.
- **Kafka 4.x (Future):** ZooKeeper puri tarah hat jayega.
- **KIP-500:** Ye wo proposal hai jisne Kafka se ZooKeeper ko hatane ka plan banaya tha (Google: "KIP-500").

Text Diagram: Evolution of Kafka

```
Phase 1 (Past/Present):    [ App ] --> [ Kafka ] <--> [ ZooKeeper ]
                                          (Dependency)

Phase 2 (Future - KRaft):  [ App ] --> [ Kafka (with Internal Raft) ]
                                          (Self Managed)
```

5. Real World Example: Leader Election

Imagine kijiye ek Cricket Team (Kafka Cluster) hai.

- **Players:** Brokers.
- **Captain:** Partition Leader.
- **Coach/Umpire:** ZooKeeper.

Scenario:

1. Match chal raha hai, Broker 101 (Captain/Leader) injured ho gaya (Server Crash).
2. Team ko naya Captain chahiye immediately.
3. **ZooKeeper (Coach)** notice karta hai ki Captain gayab hai.
4. ZooKeeper decide karta hai (Broker 102 ya 103) mein se naya Captain kaun banega.
5. ZooKeeper sabko bata deta hai: "Ab se Captain Broker 102 hai."

Summary Checklist

- ☑ **ZooKeeper:** Kafka brokers ko manage karta hai.
- ☑ **Vital Role:** Leader Election perform karta hai jab broker fail hota hai.
- ☑ **Setup:** Hamesha Odd numbers (1, 3, 5, 7) mein run hota hai.
- ☑ **Future:** KRaft mode (Kafka without ZooKeeper) future hai, lekin abhi humein ZooKeeper seekhna padega kyunki purane systems mein yehi use hota hai.

Next Step: Would you like to proceed to **Start Kafka** (Installation and Setup) instructions for your specific OS (Windows, Mac, or Linux)?