In Kubernetes, the **API server** is the central management component that interacts with etcd to store and retrieve the cluster's state. Here's how the API server updates the state in etcd:

1. User/Component Sends a Request

- A user or a Kubernetes component (e.g., `kubectl`, controllers, or kubelets) sends a request to the API server.
- This request is typically in the form of a REST API call, such as `POST`, `PUT`, `PATCH`, or `DELETE`.

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2. Request Validation

- The API server validates the incoming request to ensure it adheres to the Kubernetes API schema.
- It verifies:
    - Authentication (e.g., token-based, certificate-based).
    - Authorization (e.g., RBAC rules).
    - Schema conformance (e.g., required fields, object structure).

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3. Admission Controllers

- The request passes through a chain of admission controllers, which can modify or reject the request based on specific policies (e.g., resource quotas, pod security policies).

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4. Request Processing

- Once validated, the API server processes the request. Depending on the type of request:
    - **Create (`POST`)**: The API server creates a new resource.
    - **Update (`PUT` or `PATCH`)**: The API server updates the resource's state.
    - **Delete (`DELETE`)**: The API server removes the resource.

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5. Persisting State in etcd

- The API server translates the processed request into an object in Kubernetes' internal format (e.g., Pod, Service).
- This object is serialized (typically in JSON or Protocol Buffers format) and stored in etcd as a key-value pair.
    - **Key**: The object's unique identifier (e.g., `/registry/pods/default/my-pod`).
    - **Value**: The serialized object state.
- The API server uses etcd's transactional capabilities to ensure atomic updates.

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6. Etcd Sync

- The API server interacts with etcd through the etcd client library.
- If the write to etcd succeeds, the operation is considered complete.
- If the write fails (e.g., due to a conflict or etcd error), the API server returns an appropriate error to the requester.

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7. Event Notification

- Once the state is successfully updated in etcd, the API server notifies interested components (e.g., controllers, kubelets) about the change.
- These components subscribe to changes via the API server's **watch mechanism**, enabling real-time updates.

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8. Ensuring Consistency

- Kubernetes maintains eventual consistency:
    - Changes to the cluster's state propagate to other components through watch events or periodic synchronization.
    - Controllers and kubelets reconcile their local state with the desired state stored in etcd.

Key Points about etcd and the API Server

1. **High Availability**: The API server uses etcd clusters for redundancy.
2. **Transactions**: Updates to etcd are atomic to ensure data integrity.
3. **Conflict Management**: The API server uses resource versioning to handle concurrent updates.

4. **Scalability**: etcd is optimized for high-performance reads and writes to handle large-scale clusters.

This interaction ensures that the cluster's state remains accurate and consistent across all components.