# API Protocols

## 1. REST (Representational State Transfer)

- A lightweight architectural style using **HTTP** for communication
- Follows principles like **statelessness (**Each request contains all necessary information, and the server stores **no client session state** between requests**)** and **resource-based URLs**
- Each API call is **independent** (no stored session state)
- Common HTTP methods: **GET, POST, PUT, DELETE**
- **Use Cases:** Web apps, mobile apps, public APIs (Twitter, GitHub)

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## 2. SOAP (Simple Object Access Protocol)

- A formal, protocol-driven approach relying on **XML** for messaging
- Designed for **highly structured**, secure, enterprise-level interactions
- Built-in mechanisms for **error handling** and **security** (e.g., WS-Security)
- Typically heavier and more rigid than REST

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## 3. GraphQL

- Lets clients **request exactly the data they need**
- Eliminates over-fetching and under-fetching
- All operations are served from **a single endpoint**
- Response structure is defined by the **client**
- Ideal for complex UIs needing efficient data access

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## 4. gRPC (Google Remote Procedure Call)

- A high-performance RPC framework by Google
- Uses **Protocol Buffers (Protobuf)** for compact and fast message serialization
- Runs over **HTTP/2**, enabling bi-directional streaming
- Supports multiple languages with low latency and small payloads (The payload is the **actual serialized data** (usually Protobuf messages) sent between client and server)
- Excellent for microservices and distributed systems

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## 5. WebSocket

- Provides **full-duplex (**Both client and server can **send and receive data simultaneously** over the same connection**)**, real-time communication over a single TCP connection
- No need to re-establish connections for continuous data flow
- Very low latency
- **Use Cases:** Chat apps, live dashboards, gaming, real-time updates

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# Quick Comparison Table

| Feature | REST | SOAP | GraphQL | gRPC | WebSocket |
|---|---|---|---|---|---|
| **Data Format** | JSON, XML | XML only | JSON | Protobuf | Custom frames (binary/text) |

| Feature | REST | SOAP | GraphQL | gRPC | WebSocket |
|---|---|---|---|---|---|
| **Flexibility** | High | Low | Very High | Medium | High (real-time) |
| **Performance** | Fast | Slower | Efficient | Very Fast | Very Fast |
| **Best Use Case** | Modern web APIs | Enterprise-grade systems | Dynamic client data needs | Microservices, internal APIs | Real-time apps |