API Design and Management

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Software Engineer

Outline

Course Objectives

1. Provide good Arabic content for the topic

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1. Provide good Arabic content for the topic
2. Overview of API Design and Management

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3. Role and Importance of APIs in Distributed Systems

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2. Overview of API Design and Management
3. Role and Importance of APIs in Distributed Systems
4. The best practices you should follow today

Understanding APIs

Definition *wikipedia*

Application programming interface (API) is a way for two or more computer programs or components to communicate with each other. It is a type of software interface, offering a service to other pieces of software.

Definition *ChatGPT*

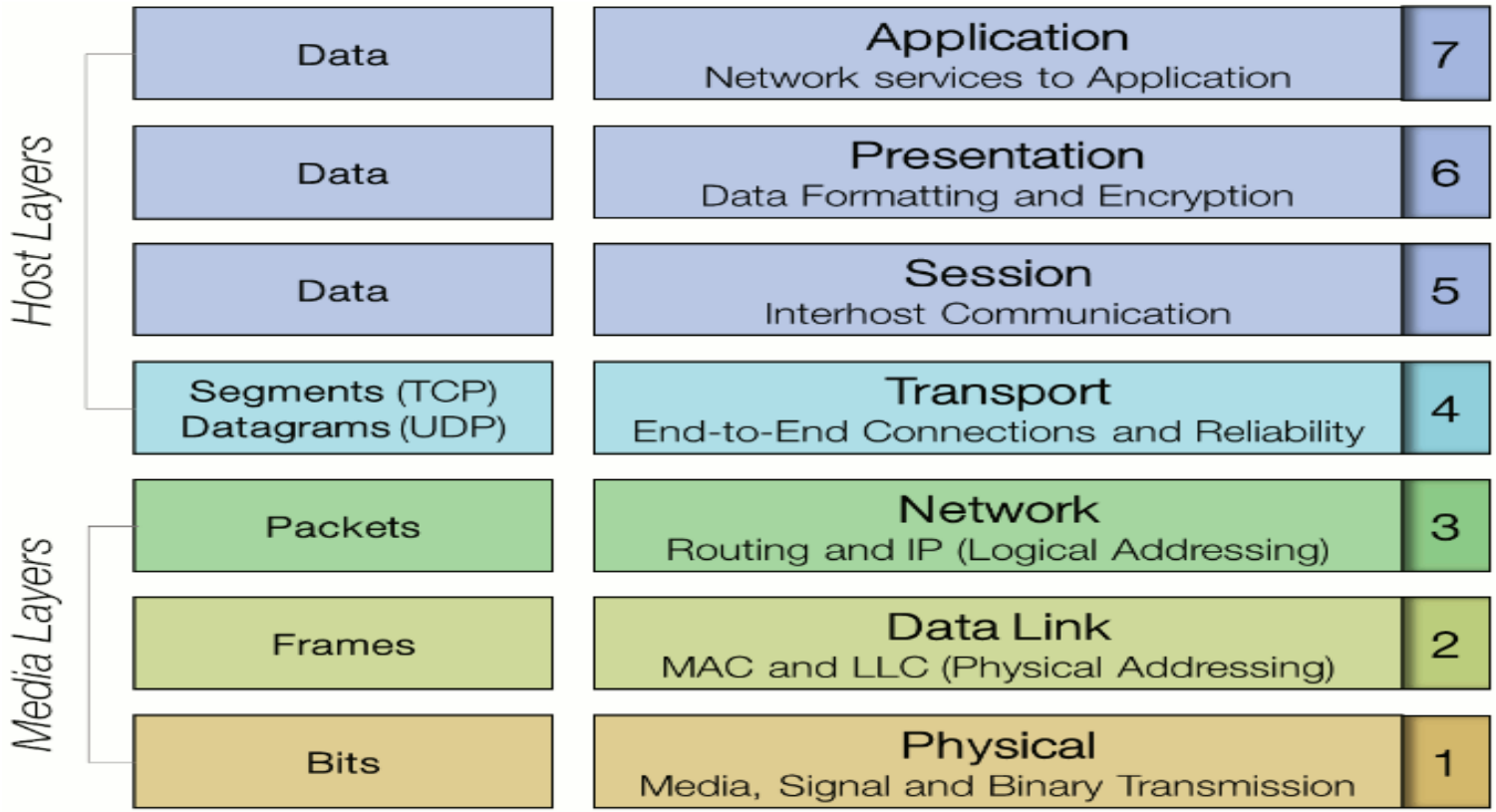
API (Application Programming Interface) is a set of rules, protocols, and tools for building software applications. It specifies how software components should interact and is used to enable the integration between different software systems.

History *wikipedia*

The term "application program interface" is first recorded in a paper called Data structures and techniques for remote computer graphics in 1968. The authors use the term to describe the interaction of an application "Graphics Program" with the rest of the computer system.

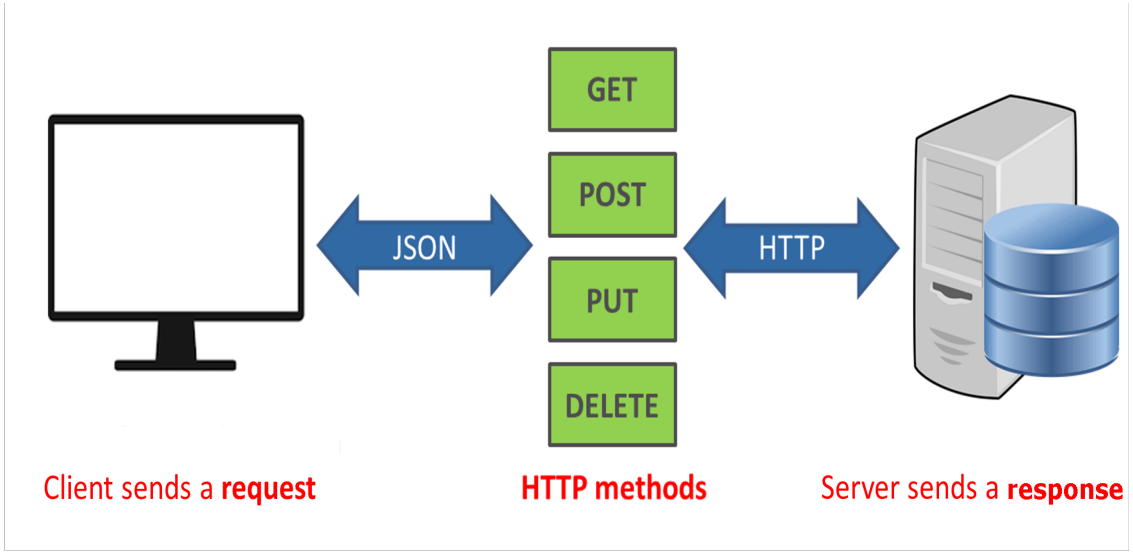
Understanding APIs *OSI Model*

The open systems interconnection (OSI) model is a conceptual model created for Standardization which enables diverse communication systems to communicate using standard protocols.



source: coengoedegebure.com/osi-model

Understanding APIs Example



source: phpenthusiast.com/blog/what-is-rest-api

Understanding APIs (API Types)

There are several types of API, each one serves specific use case.

- Public APIs (Open APIs)
  The APIs are publicly available and can be designed in various ways, taking security into account. However, the main priority is to ensure they are easily consumable by as many clients as possible.

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  Specialized interfaces that enable organizations to access data and service offerings across businesses (B2B) in order to create unique features within their own applications or services by utilizing a partner's resources.

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The types can be designed and developed using two ways

1. API Architectural Style,
2. API Standard Protocol.

Understanding APIs (API Architecture vs API Protocols)

API Architecture Style

It refers to the high-level structural design of the API. It encompasses the standards, and best practices governing how the API is developed, how it interacts with other systems, and how it exposes its functionality and data.
Example: REST

No Restrictions

Architectural style is sensitive to change and enhancement; it relies more on human experience.

API Protocol

It refers to a set of rules and standards used for communication between various software components. The protocol dictates how requests and responses are formatted and transmitted, and what are the restrictions of the communication.
Example: SOAP

Understanding APIs (SOAP API)

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- It relies on XML as its message format and usually relies on other application layer protocols, most notably Hypertext Transfer Protocol (HTTP) and Simple Mail Transfer Protocol (SMTP), for message negotiation and transmission.

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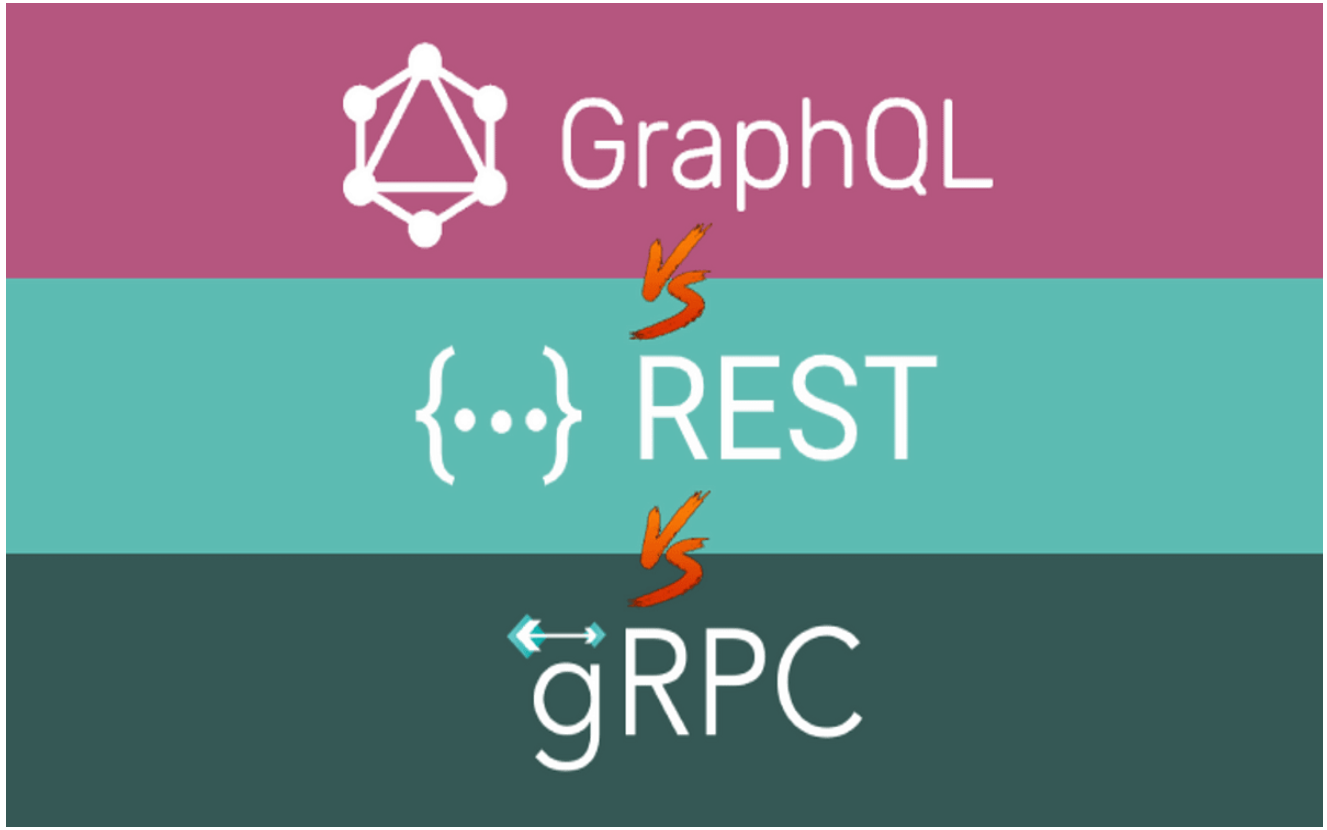
```
<?xml version="1.0"?>
<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  <soap:Header>
    <!-- header information here -->
  </soap:Header>
  <soap:Body>
    <m:GetPrice xmlns:m="http://www.example.org/stock">
      <m:StockName>IBM</m:StockName>
    </m:GetPrice>
  </soap:Body>
  <soap:Fault>
    <!-- fault information here -->
  </soap:Fault>
</soap:Envelope>
```

Understanding APIs (Other Protocols)

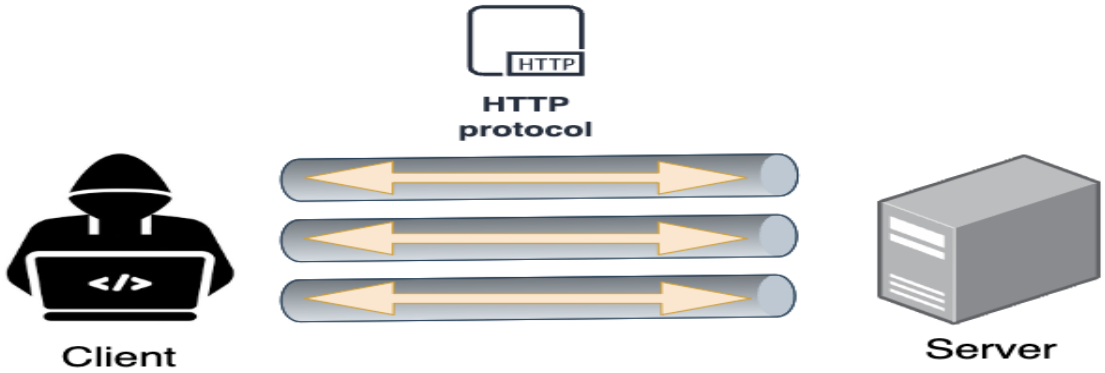
- gRPC
- REST
- GraphQL

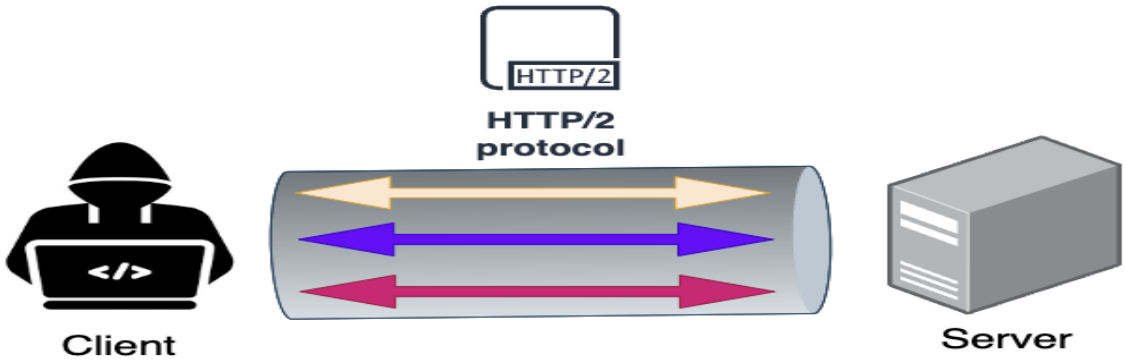


source: REST vs GraphQL vs gRPC: Comparing Three Modern API Technologies

Understanding APIs (HTTP1 vs HTTP2)

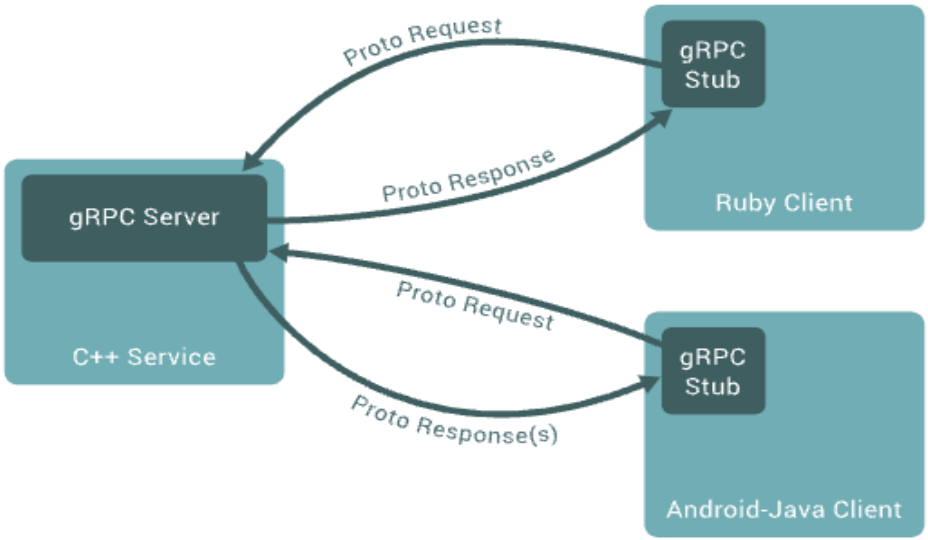
HTTP/1.1	HTTP/2
Text-Based Protocol: Data is sent in a text-based format.	Binary Protocol: More efficient binary protocol, easier to parse.
One Request Per Connection: Each TCP connection allows only one request-response cycle at a time.	Multiplexing: Multiple requests and responses can be handled over a single TCP connection in parallel.
Headers Uncompressed: Headers are sent in plain text and can be quite large.	Header Compression: Uses HPACK compression to reduce overhead.
No Push Capabilities	Server Push





Understanding APIs (gRPC Protocol)

- gRPC is a modern open source high performance Remote Procedure Call (RPC) framework that was developed in Google.
- gRPC can use **protocol buffers** as its underlying message interchange format.
- gRPC is based around the idea of defining a service, specifying the methods that can be called remotely with their parameters and return types.
- On the server side, the server implements this interface and runs a gRPC server to handle client calls.
- On the client side, the client has a stub (referred to as just a client in some languages) that provides the same methods as the server.

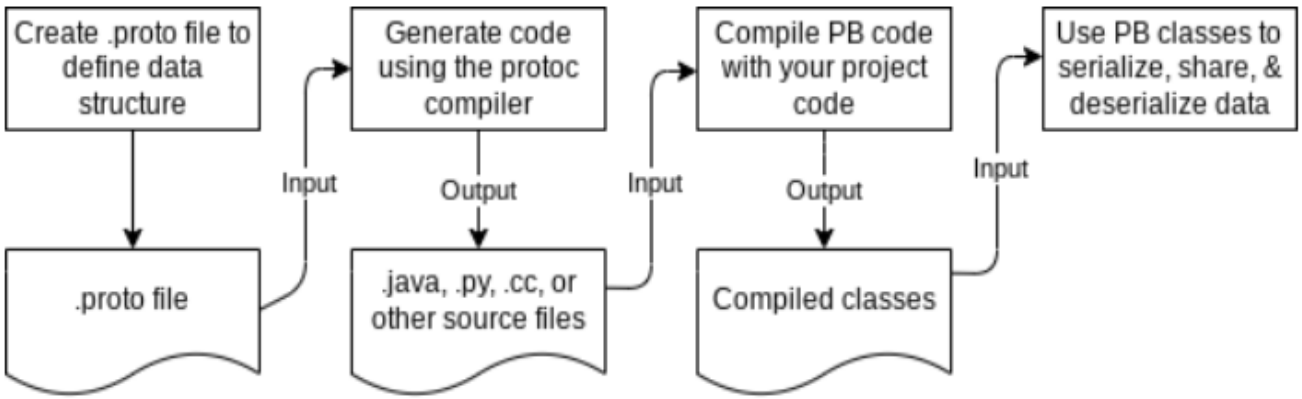


source: Introduction to gRPC

Understanding APIs (Protocol Buffers)

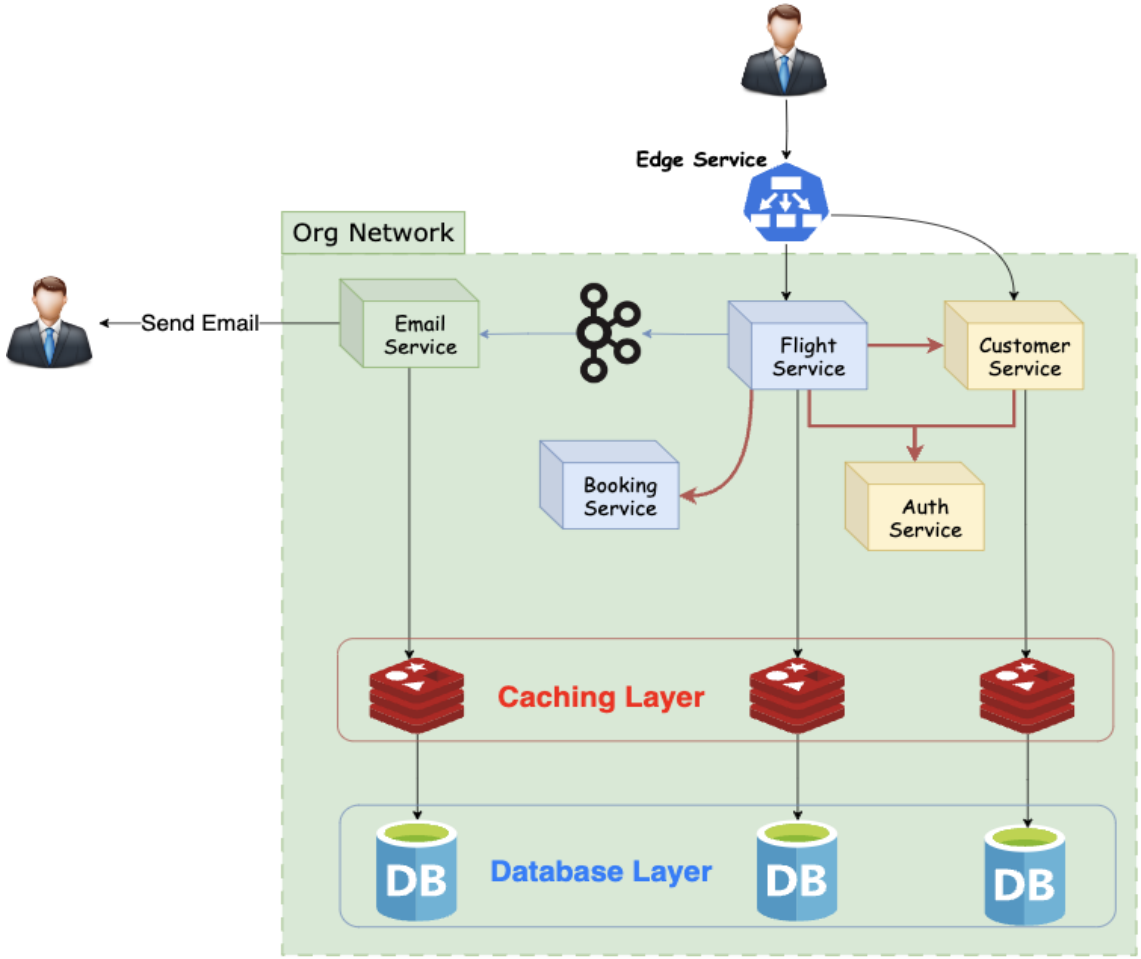
- Protocol Buffers are a language-neutral, platform-neutral extensible mechanism for serializing structured data.
- The file that includes the definition is `.proto` file

```
message Person {
 string name = 1;
 int32 id = 2;
 bool has_kids = 3;
 optional string email = 4;
}
```



source: protobuf overview

Understanding APIs (gRPC)



gRPC
Service to Service Integration

source: gRPC Offical doc

Understanding APIs (gRPC)

```
1  syntax = "proto3";
2  package observer;
3
4  service ObserverStatusService {
5      rpc getServiceStatus (SystemStatusRequest)
6        returns (SystemStatusResponse) {}
7  }
8
9  message SystemStatusRequest {
10     optional string uuid = 1;
11     string service_name = 2;
12 }
13
14 message SystemStatusResponse {
15     string uuid = 1;
16     string status = 2;
17     string component = 3;
18     optional string service_name = 4;
19 }
```

Understanding APIs (Other Protocols)

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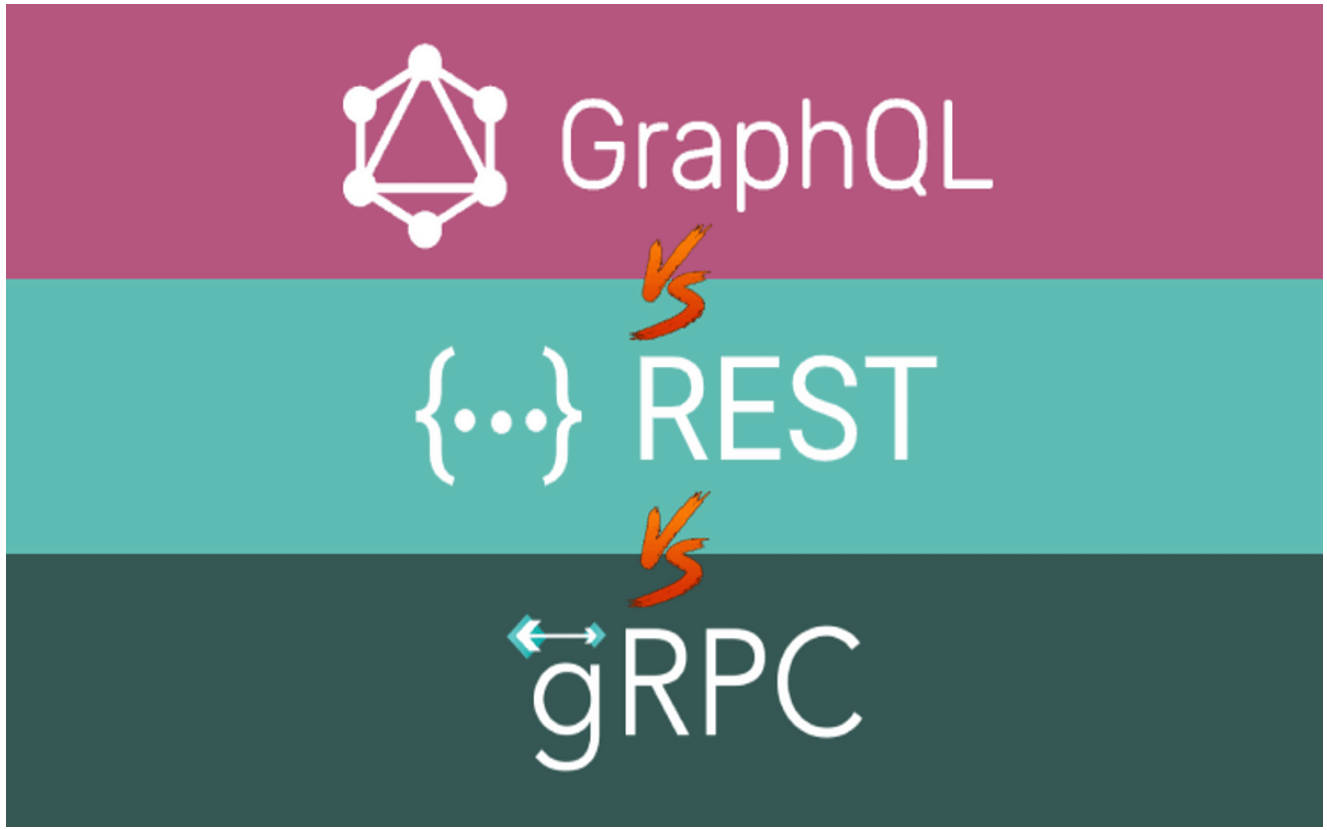

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Understanding APIs (RESTful API)

REST API

- In 2000, Roy Fielding proposed Representational State Transfer (REST) as an architectural approach to designing web services
- REST is independent of any underlying protocol and is not necessarily tied to HTTP
- REST is an architectural style for building distributed systems based on *hypermedia*

Primary Goal

REST API doesn't bind the implementation to any specific implementation, the API could be written in **Go** , and the client can use any language or tools.

Example

To **GET** an order , API URI might look like https://api-design/orders/1

Client response `{"orderId":1,"orderValue":99.90,"productId":1,"quantity":1}`

source: Microsoft: RESTful web API design

Understanding APIs (RESTful API)

It is all about *resources*

A resource is an entity that can be identified, named, addressed, or handled on the web.REST APIs expose data as resources and use standard HTTP methods to represent Create, Read, Update, and Delete (CRUD) transactions against these resources.

source: Designing Web APIs

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- HTTP methods like GET, POST, UPDATE, and DELETE inform the server about the action to be performed
- REST methods semantics "CRUD"
  - READ $\rightarrow$GET, `never change the server state`
  - CREATE $\rightarrow$POST
  - UPDATE $\rightarrow$PUT or PATCH
  - DELETE $\rightarrow$DELETE

source: Designing Web APIs

Understanding APIs (RESTful API)

`CRUD operations, HTTP verbs, and REST conventions`

Operation	HTTP verb	URL: /users	URL: /users/U123
Create	POST	Create a new user	Not applicable
Read	GET	List all users	Retrieve user U123
Update	PUT or PATCH	Batch update users	Update user U123
Delete	DELETE	Delete all users	Delete user U123

source: Designing Web APIs

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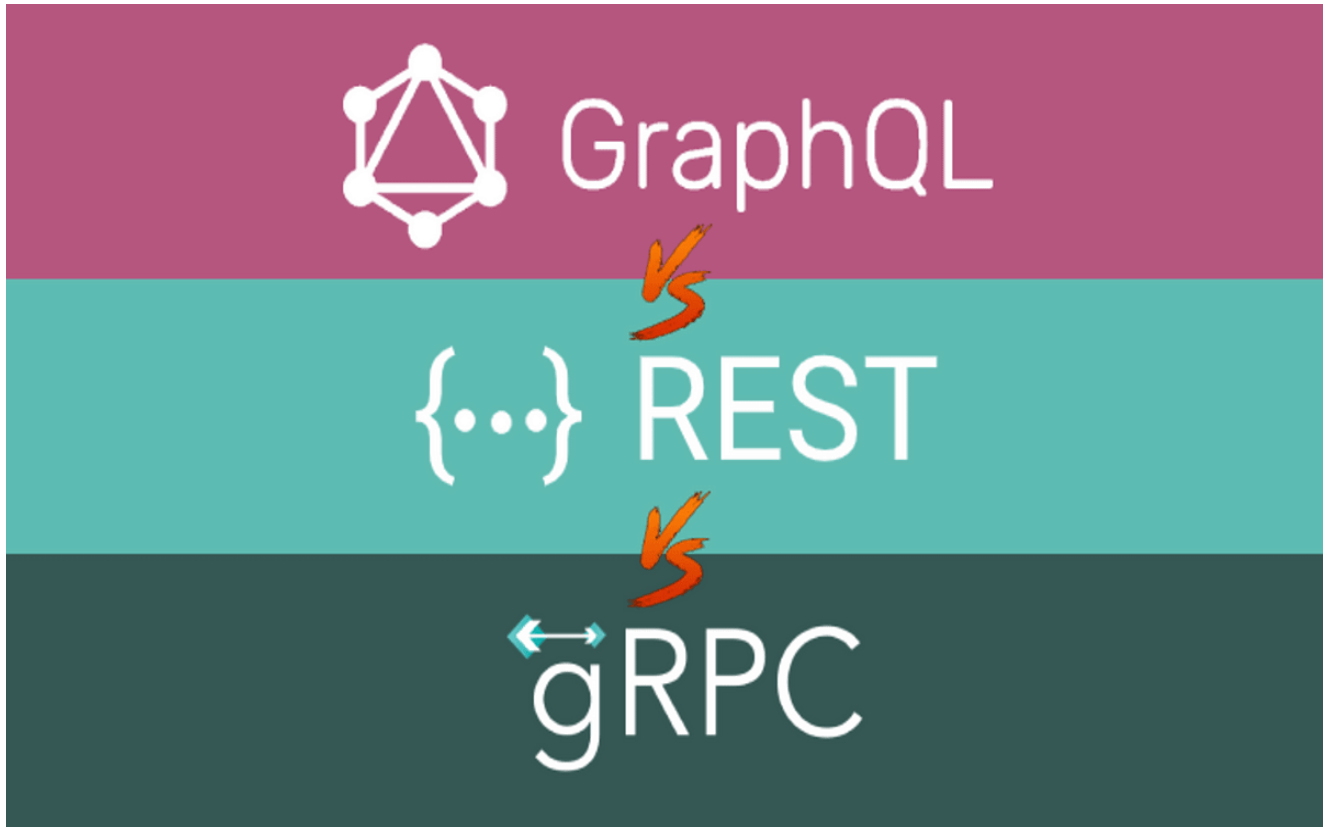

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Understanding APIs (Intro to GraphQL)

What is GraphQL?

- As shown in the name, it includes “Graph“ which means it represents a relation to some extend, you have to keep in your mind this subtle notice.

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- GraphQL is a query language for your API, and a server-side runtime for executing queries using a type system you define for your data.

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Example

A GraphQL service is created by defining types and fields on those types, then providing functions for each field on each type. For example, a GraphQL service that tells you who the logged in user is (me) as well as that user's name might look like this:

```
type Query {
  me: User
}

type User {
  id: ID
  name: String
}
```

source: Introduction to GraphQL

Understanding APIs (Intro to GraphQL "examples")

```
{
  hero {
    name
  }
}
```

```
{
  "data": {
    "hero": {
      "name": "R2-D2"
    }
  }
}
```

```
{
  human(id: "1000") {
    name
    height
  }
}
```

```
{
  "data": {
    "human": {
      "name": "Luke Skywalker",
      "height": 1.72
    }
  }
}
```

source: Introduction to GraphQL

Understanding APIs (Websockets API)

What is Websocket API?

- The WebSocket API is an advanced technology that makes it possible to open a two-way interactive communication session between the user's browser and a server.

source: WebSockets, Long polling, Server-Sent Events

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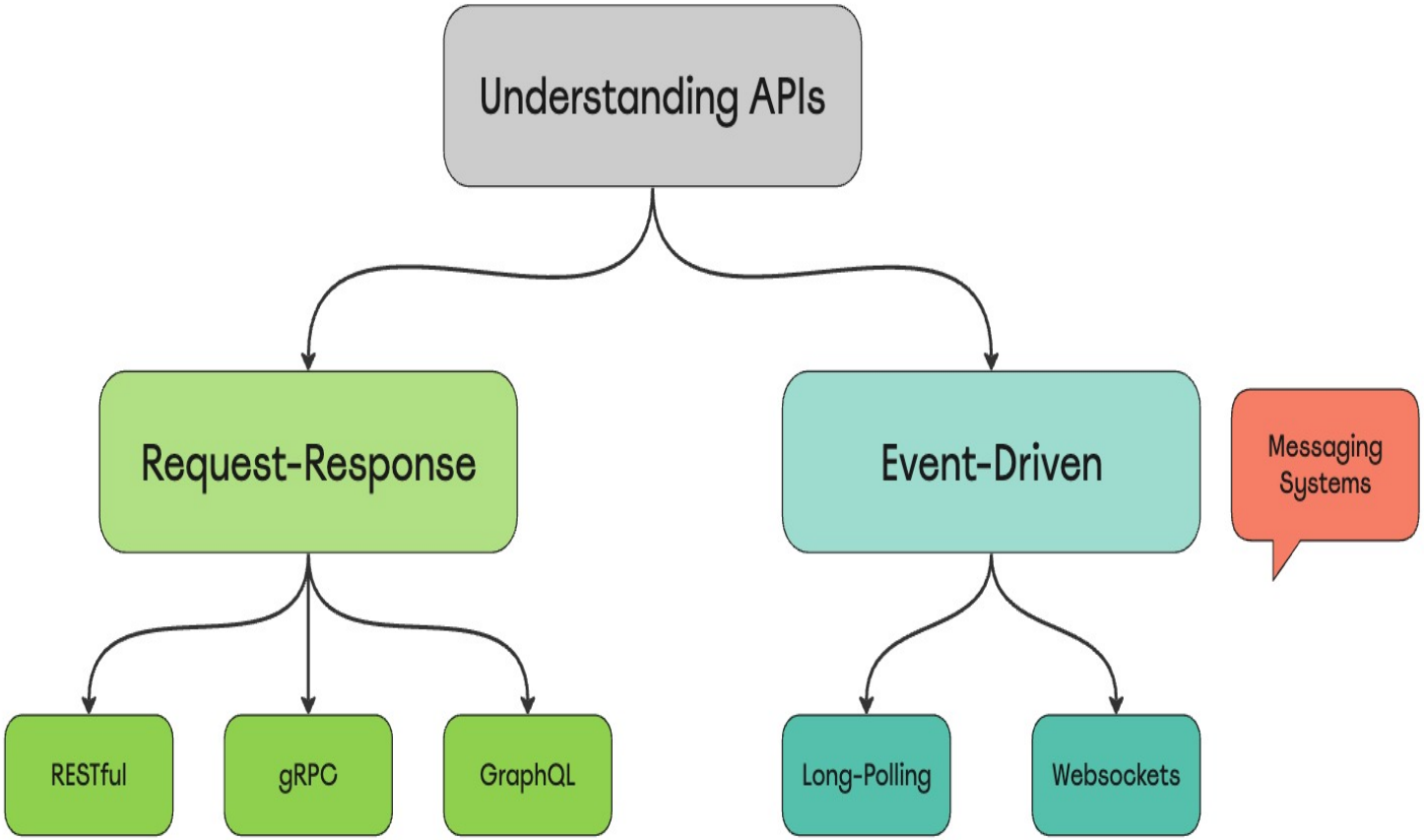
- The WebSocket API is an advanced technology that makes it possible to open a two-way interactive communication session between the user's browser and a server.
- With this API, you can send messages to a server and receive event-driven responses without having to poll the server for a reply.

source: WebSockets, Long polling, Server-Sent Events

Understanding APIs



API Design Principles

- Fundamentals of Good API Design
- Designing for Scalability and Performance
- API Versioning Strategies

RESTful API Design

- RESTful Architecture Principles
- Designing RESTful Services (Endpoints, HTTP Methods, Status Codes)
- Best Practices in RESTful API

Advanced API Protocols

- Introduction to GraphQL and Its Advantages
- Implementing gRPC for Microservices
- Comparison of Different API Styles

API Documentation and Specification

- Importance of Comprehensive API Documentation
- Tools for API Documentation (Swagger, OpenAPI Specification)
- Maintaining and Versioning API Documentation

API Security

- Authentication and Authorization Mechanisms (OAuth, JWT)
- Securing API Endpoints
- Handling Sensitive Data and Privacy Concerns

API Testing and Quality Assurance

- Writing Effective API Tests
- Tools and Frameworks for API Testing
- Performance Testing and Load Testing for APIs

API Management and Lifecycle

- The Lifecycle of API Development
- API Deployment Strategies
- Monitoring and Analytics for APIs

Conclusion

- Recap of Key Learnings
- Emerging Trends in API Development