GraphQL

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Introduction

What is GraphQL?

- Is an API Query Language developed and open-sourced by Facebook that provides a more efficient, powerful and flexible alternative to REST
- Enables declarative data fetching where a client can specify exactly the data that is needed from an API.
- GraphQL servers exposes a single endpoint

History

- Facebook started using GraphQL in 2012 for their native mobile apps
- The first time Facebook publicly spoke about GraphQL was at React.js Conf 2015
- It was believed it was a limited to use only with React
- Netflix implemented Falcor
- Coursera cancelled their project to use GraphQL

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GraphQL vs. REST

A more efficient alternative to REST

- When REST concept was developed, client application were relatively simple
- REST was a good fit for many applications
- API landscape has radically changed over the years
- Three factors that have been challenging the way APIs are designed

1. Increased mobile usage creates need for efficient data loading

- Increased mobile usage, low-powered devices and sloppy networks were the initial reasons
- GraphQL minimizes the amount of data that needs to be transferred
- Majorly improves applications operating under these conditions

2. Variety of different frontend frameworks and platforms

- Difficulty to build and maintain one API that would fit the requirements of all
- GraphQL allows each client to access precisely to the data they need.

3. Fast development & expectation for rapid feature development

- Continuous deployment has become a standard
- Rapid iterations and frequent product updates are indispensable

REST

The way data is exposed often needs to be modified

Scenario

In a blogging application, an app needs to display the titles of the posts of a specific user. The same screen also displays the names of the last 3 followers of that user.

REST

- Has become the standard for designing web APIs
- Stateless servers
- Structured access to resources
- Inflexible to keep up with the rapidly changing requirements of the clients

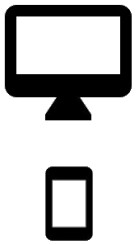
GraphQL

- Stateless
- Solves shortcomings
- More efficient

Data Fetching - REST

- Three requests to different endpoints to fetch the required data.
- Overfetching, since the endpoints return additional information that is not needed.

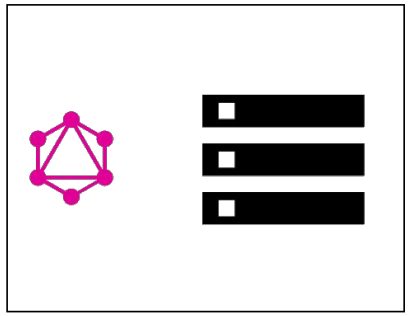
Data Fetching - GraphQL



```
query {
  User(id: "er3tg439frjw") {
    name
    posts {
      title
    }
    followers(last: 3) {
      name
    }
  }
}
```

HTTP POST

```
{
  "data": {
    "User": {
      "name": "Mary",
      "posts": [
        { title: "Learn GraphQL today" }
      ],
      "followers": [
        { name: "John" },
        { name: "Alice" },
        { name: "Sarah" },
      ]
    }
  }
}
```



- The client can specify exactly the data it needs in a query.
- The structure of the server's response follows the nested structure defined in the query.

No more Over- and Underfetching

Overfetching: when the client downloads more information than is actually required.

Underfetching:

Endpoint does not provides enough of the required information.

The client will have to make additional requests

Situation where a client needs a list of elements and one more request per element to fetch required data

Rapid Product Iterations on the Frontend

- Structure REST APIs endpoint according to the views
- Does not allow rapid iterations on the frontend
- High risk that there is more (or less) data required.

- With GraphQL, changes on client-side can be done without extra work
- Clients specify their exact data requirements
- No backend adjustments

Insightful Analytics on the Backend

- Allows you to have fine-grained insights about the data that's requested on the backend
- It can help in evolving an API and deprecating specific fields that are not requested anymore
- Low-level performance monitoring of requests.
- Instrumenting and measuring performance of resolver functions for bottlenecks.

Benefits of a Schema & Type System

- Uses a strong type system to define the capabilities of an API
- All the types that are exposed in an API are written down in a schema using Schema Definition Language (SDL)
- The Schema serves as the contract between the client and the server.
- Easy to test applications by mocking data structures

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Architecture

Architecture - Uses Cases

3 different architectures that include a GraphQL server

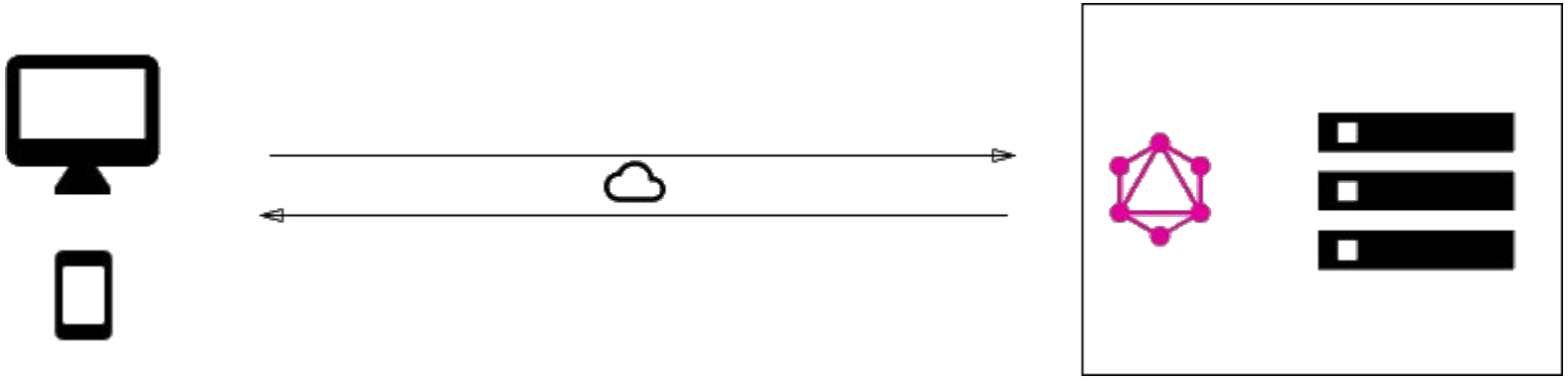
1 - GraphQL server with a connected database

2 - GraphQL server that is a thin layer in front of a number of third party or legacy systems and integrates them through a single GraphQL API

3 - A hybrid approach of a connected database and third party or legacy systems that can all be accessed through the same GraphQL API

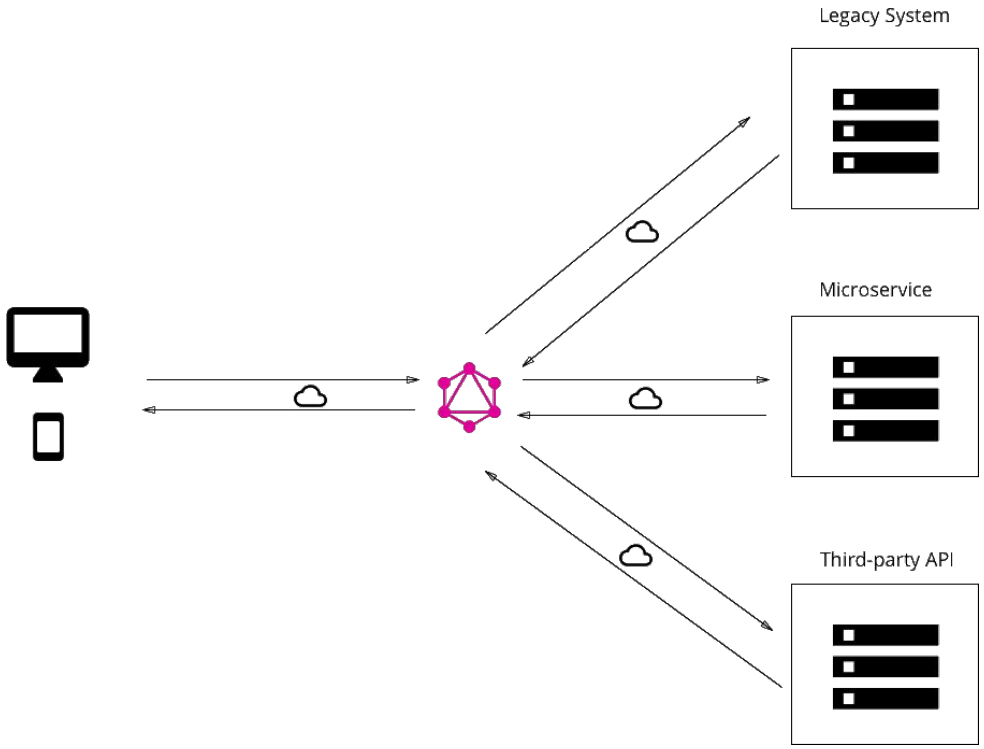
1. GraphQL server with a connected database

- Single server that implements GraphQL specification
- Server read the query's payload and fetches the information from the DB (Resolving)
- Constructs the response object and returns it to the client
- Transport-layer agnostic (TCP, WebSockets)
- Does not care about DB or stored data format



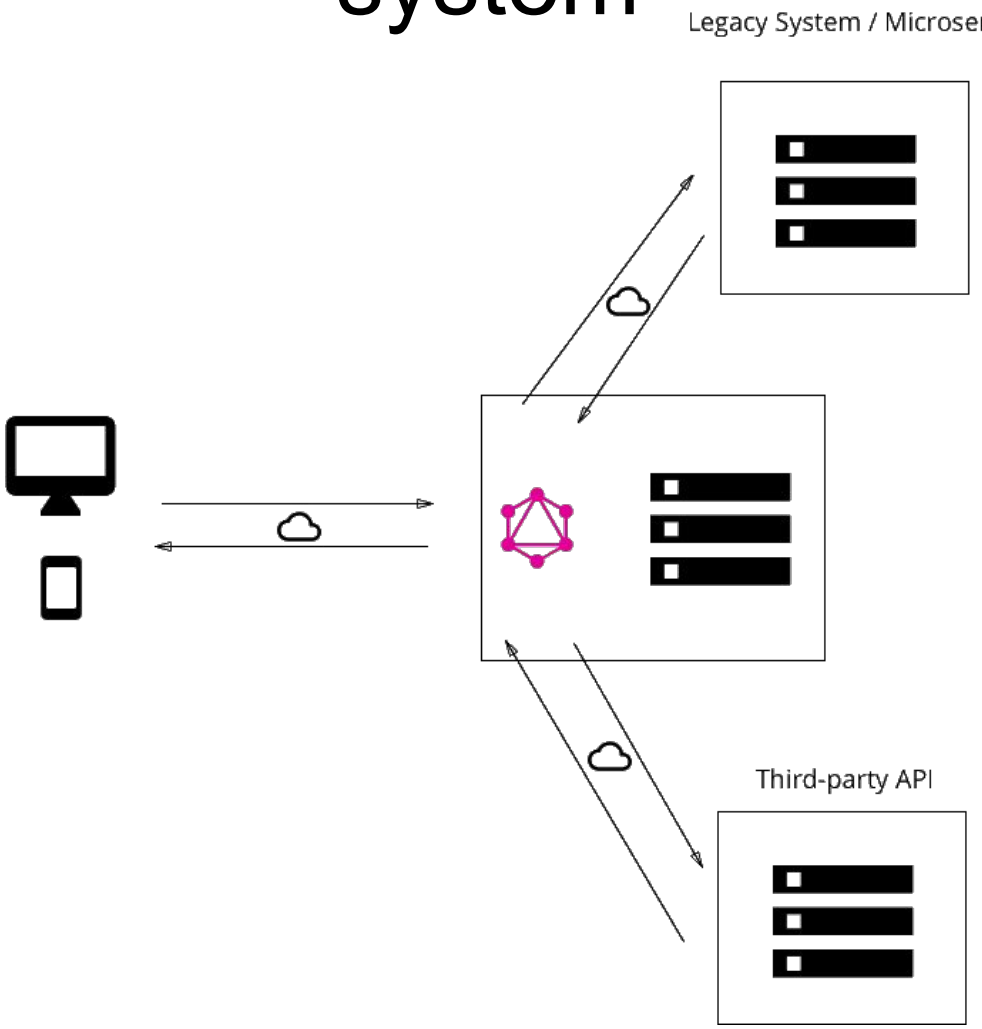
A standard greenfield architecture with one GraphQL server that connects to a single database.

2. GraphQL layer that integrates existing systems



- Legacy systems make practically impossible to build products that need access to multiple systems
- Unify systems and hide complexity behind a GraphQL API
- GraphQL does not care about the data sources to fetch needed data

3. Hybrid approach with connected database and integration of existing system



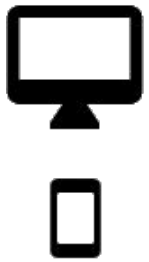
How do we gain this flexibility with GraphQL?

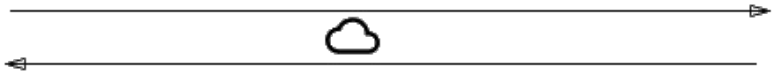
The payload of a GraphQL query (or mutation) consists of a set of fields

In the GraphQL server implementation each of these fields actually corresponds to exactly one function that's called a resolver

The purpose of a resolver function is to fetch the data for its field

Resolver Functions





```
query {
  User(id: "er3tg4sa9frj") {
    name
    followers(first: 5) {
      name
      age
    }
  }
}
```


Resolvers

```
User(id: String!): User
name(user: User!): String
age(user: User!): Int
friends(first: Int, user: User!): [User!]!
…
```

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Core Concepts

The Schema Definition Language (SDL)

GraphQL has its own type system that's used to define the schema of an API

```
type Person {
  name: String!
  age: Int!
  posts: [Post!]!
}
```

```
type Post {
  title: String!
  author: Person!
}
```

Basic Queries

Request

```
query{
  allPeople {
    name
  }
}
```

Response

```
{
  "allPeople": [
    { "name": "Johnny" },
    { "name": "Sarah" },
    { "name": "Alice" }]
}
```

Basic Queries

GraphQL also allows for naturally querying nested information

For example, loading all the posts that a Person has written:

Request

```
{
  allPeople {
    name
    age
    posts {
        title
    }
  }
}
```

Response

```
"allPeople": [
      {
        "name": "Johnny",
        "age": 23,
        "posts": [{
            "title": "GraphQL is awesome"
          }]
      },
      ...
```

Basic Queries

In GraphQL, each field can have zero or more arguments if that is specified in the schema.

For example, allPeolple field could have a “last” parameter to return a specific number of people:

Request

```
{
  allPeople(last: 2) {
    name
}
```

Response

```
"allPeople": [
        {
          "name": "Sarah"
        },
        {
          "name": "Alice"
        }
]
```

Writing data with Mutations

Three kinds of mutations:

- Create
- Update
- Delete

Mutations follow the same syntactical structure as queries, but they always need to start with the mutation keyword

Writing data with Mutations

Request

```
mutation{
  createPerson(name: “Bob”, age: 36) {
    name
       age
  }
}
```

Response

```
"createPerson": {
    "name": "Bob",
      "age": 36
}
```

Writing data with Mutations

GraphQL types have unique IDs generated by the server.

```
type Person {
  Id: ID!
  name: String!
  age: Int!
  posts: [Post!]!
}
```

Request

```
mutation{
  createPerson(name: "Alice", age: 36)
{
    id
  }
}
```

Response

```
"createPerson": {
    "id": "ck1o9omiv0c2f0"
}
```

Realtime Updates with Subscriptions

Realtime connection to the server to get informed about important events

When a client subscribes to an event, it will initiate a steady connection to the server

Unlike queries and mutations that follow a typical “request-response-cycle” subscriptions represent a stream of data sent over to the client

Realtime Updates with Subscriptions

Subscribing to an event

```
subscription{
  newPerson{
    name
    age
  }
}
```

Server sends information

```
"newPerson": {
    "name": "Jane",
    "age": 23
}
```

Defining a Schema

One of the most important concepts when working with GraphQL API.

It specifies the capabilities of the API and defines how clients can request data.

A schema is a collection of GraphQL types.

Root types:

```
type Query { ... }
type Mutation { ... }
type Subscription { ... }
```

Defining a Schema

```
type Query {
  allPeople(last: Int): [Person!]!
}

type Mutation {
  createPerson(name: String!, age:
Int!): Person!
}

type Subscription {
  newPerson: Person!
}
```

```
type Person {
  name: String!
  age: Int!
  posts: [Post!]!
}

type Post {
  title: String!
  author: Person!
}
```

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Backend

Technologies

- Graphql-yoga: Fully-featured GraphQL server built on top of Express, apollo-server, graphql-js and more.
- Prisma: replaces traditional ORMs. Use the Prisma client to implement your GraphQL resolvers and simplify database access
- GraphQL Playground: “GraphQL IDE” that allows to interactively explore the functionality of a GraphQL API

Creating a new project

- Install Yarn
- Open your terminal and run the following commands:

```
mkdir hackernews-node

cd hackernews-node

yarn init -y
```

This will create a new directory called “hackednews-node” and initializes it with configuration files.

Creating a raw GraphQL server

- Open the project in Visual Studio
- Create a folder called src
- Inside src folder create index.js

Start building GraphQL server

Let’s add a dependency to the project

```
yarn add graphql-yoga
```

Graphql-yoga y a fully featured GraphQL server. Based on Express.js

Graphql-yoga features

- GraphQL spec-compliant
- Supports file upload
- Realtime functionality with GraphQL subscriptions
- Works with TypeScript typings
- Out-of-the-box support for GraphQL Playground
- Extensible via Express middlewares
- Resolves custom directives in your GraphQL schema
- Query performance tracing
- Accepts both application/json and application/graphql content-types
- Runs everywhere: Can be deployed via now, up, AWS Lambda, Heroku etc.

Start building GraphQL server

Open index.js and type the following:

```
const { GraphQLServer } = require('graphql-yoga')

const typeDefs = `
type Query {
  info: String!
}`
```

`typeDefs` constant defines your GraphQL schema.

Start building GraphQL server

```
// 2
const resolvers = {
  Query: {
    info: () => `This is the API of a Hackernews Clone`
  }
}
```

Resolvers object is the implementation of the GraphQL schema

Start building GraphQL server

```
// 3
const server = new GraphQLServer({
  typeDefs,
  resolvers,
})
 server.start(() => console.log(`Server is running on
 http://localhost:4000`))
```

The schema and resolvers are bundled and passed to the GraphQL server.

This tells the server, what API operations are accepted and how they should be resolved.

Testing GraphQL server

In the root directory of your project run:

```
node src/index.js
```

The server will be running on `http://localhost:4000`

Open your browser and you'll see a GraphQL Playground

Send your first query

```
query {
  info
 }
```

Try updating resolver function to return null instead of `` `This is the API of a Hackernews Clone` ``

Extending the schema definition

Add a new root type called “Link” with the following fields:

- id - mandatory ID type.
- description - mandatory String.
- url - mandatory String.

Add the following in “Query”:

- Add a field “feed” to retrieve a list of all stored links, the list and Link cannot be null.

Implement resolver functions

Let's use a links variable (at least for now) to simulate DB

```
let links = [{
 id: 'link-0',
 url: 'www.howtographql.com',
 description: 'Fullstack tutorial for GraphQL'
 }]
```

Add feed in Query resolver to return links variable.

Add Link resolver

As Link has its own fields, resolver function will return them using parent argument.

I.e:

Id: (parent) => parent.id

Implement the same line for other fields

Is parent argument needed?

- Is the result of the previous resolver execution level.
- On the first level, it invokes the **feed** resolver and return data stored in links variable
- For the second level, graphQL is smart enough to invoke the resolvers of **Link** type.
- The incoming parent object is the element inside **links** list.

As the implementation is trivial, resolvers for Link can be omitted

Mutations

Let’s add a new post Mutation in the schema

```
type Mutation {
 post(url: String!, description: String!): Link!
 }
```

Update resolver

```
Mutation: {
    // 2
    post: (parent, args) => {
        const link = {
         id: `link-${idCount++}`,
         description: args.description,
         url: args.url,
        }
        links.push(link)
        return link
    }
 },
```

Testing the mutation

```
mutation {
  post(
    url: "www.prisma.io"
    description: "Prisma replaces traditional ORMs"
  ) {
    id
  }
}
```

Add the following in the Schema:

```
type Query {
  # Fetch a single link by its `id`
  link(id: ID!): Link
}

type Mutation {
  # Update a link
  updateLink(id: ID!, url: String, description: String): Link

  # Delete a link
  deleteLink(id: ID!): Link
 }
```

Implement the resolvers for each one