Feb 2023

API Styles Fundamentals

by **Lukasz Dynowski**

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GITHUB

GitHub Fundamentals—with Interactivity

Published by O'Reilly Media, Inc.

Interactive

What you'll learn Is this live event for you? Schedule

GitHub is a central hub for most open source projects, and it's the biggest hosting platform for storing source code versioned by Git. Yet it still manages to be highly underutilized. Correctly managed, GitHub can be a proven record of your work and interests, a résumé that can be used as leverage in salary negotiations, a hosting platform to promote yourself or your projects, a CI/CD platform to deliver your software to millions, and a fantastic collaborative tool for your team to facilitate communication among developers. And GitHub can also be your go-to place for solving daily programming challenges and fixations.

Join expert Lukasz Dynowski to learn everything you need to know to get started with GitHub. In a little over an hour, you'll build a complete open source project, create a web page and a wiki to promote it, and discover how to maintain and collaborate with others on your project.

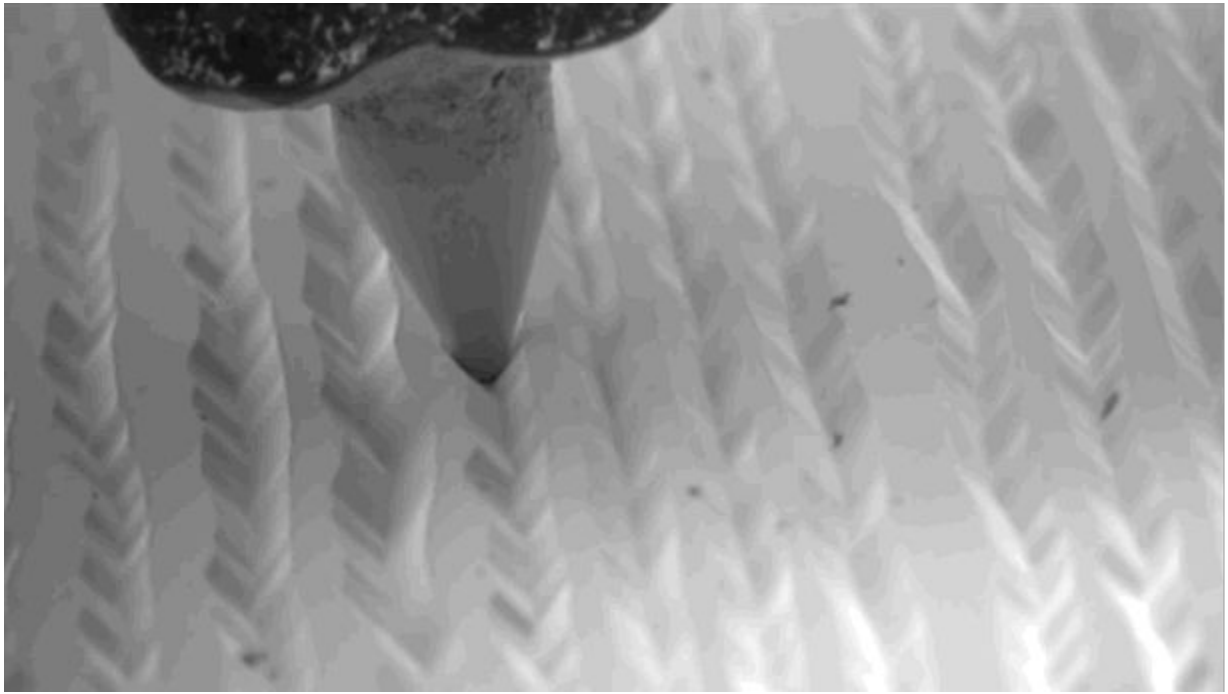
YOUR INSTRUCTOR

Lukasz Dynowski

Lukasz Dynowski is an independent consultant who in his career was involved in over 150+ projects. Counting over 10 years of experience as a software engineer Lukasz was doing Full-Stack, DevOps, Software Architecture, as well as...

Read more

Vinyl



By Applied Science - https://www.londonsoundacademy.com/blog/how-does-vinyl-work

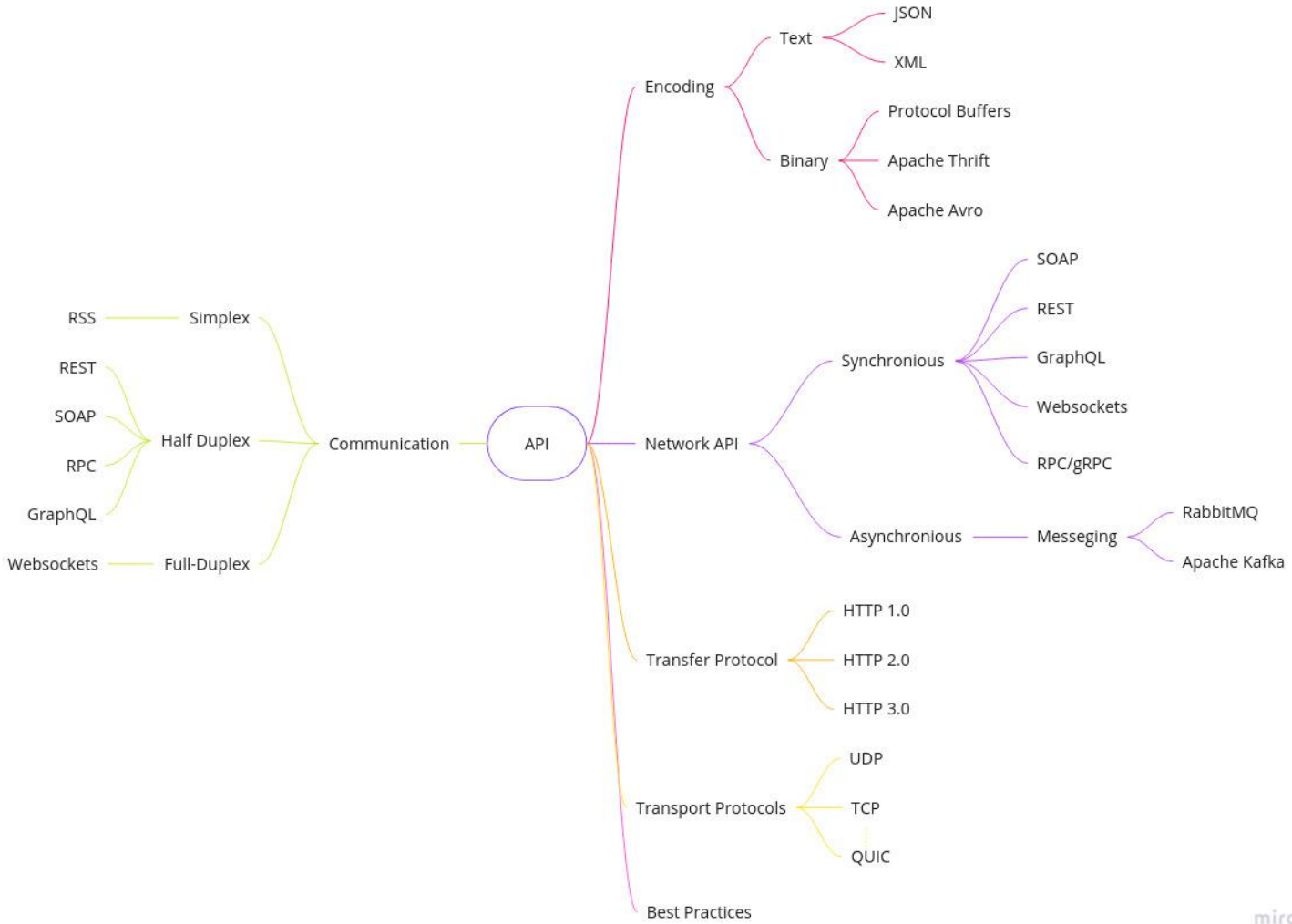
Objectives

Preliminary

- Common API styles
- Offering of each API style and its trade-offs
- The counterpart technology for every API
- When to use appropriate API style
- Characteristics of good API

Secondary

- Historical context that lead to creation of APIs
- The OSI model and telecommunication transmission models
- Common encodings used in the context of APIs


API
Communication
Simplex
RSS
Half Duplex
REST
SOAP
RPC
GraphQL
Full-Duplex
Websockets
Encoding
Text
JSON
XML
Binary
Protocol Buffers
Apache Thrift
Apache Avro
Network API
Synchronious
SOAP
REST
GraphQL
Websockets
RPC/gRPC
Asynchronious
Messeging
RabbitMQ
Apache Kafka
Transfer Protocol
HTTP 1.0
HTTP 2.0
HTTP 3.0
Transport Protocols
UDP
TCP
QUIC
Best Practices

Why API?

https://www.nginx.com/resources/library/idc-report-apis-success-failure-digital-business/

What is an interface?

Dictionary

Definitions from Oxford Languages · Learn more

interface

noun

1. a point where two systems, subjects, organizations, etc. meet and interact.
   "the **interface between** accountancy and the law"
2. **COMPUTING**
   a device or program enabling a user to communicate with a computer.
   "a graphical user interface"

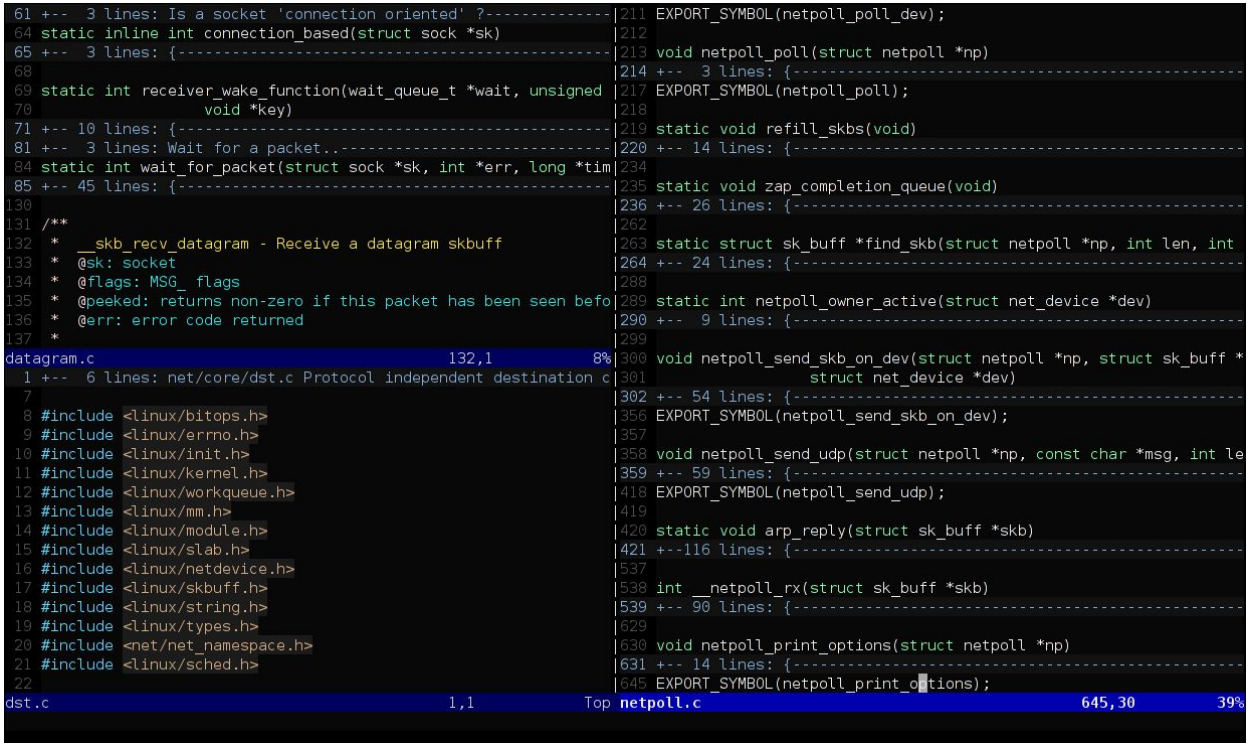
verb

1. interact with (another system, person, etc.).
   "you will interface with counterparts from sister companies"
2. **COMPUTING**
   connect with (another computer or piece of equipment) by an interface.
   "the hotel's computer system can interface automatically with the booking system"

User Interface

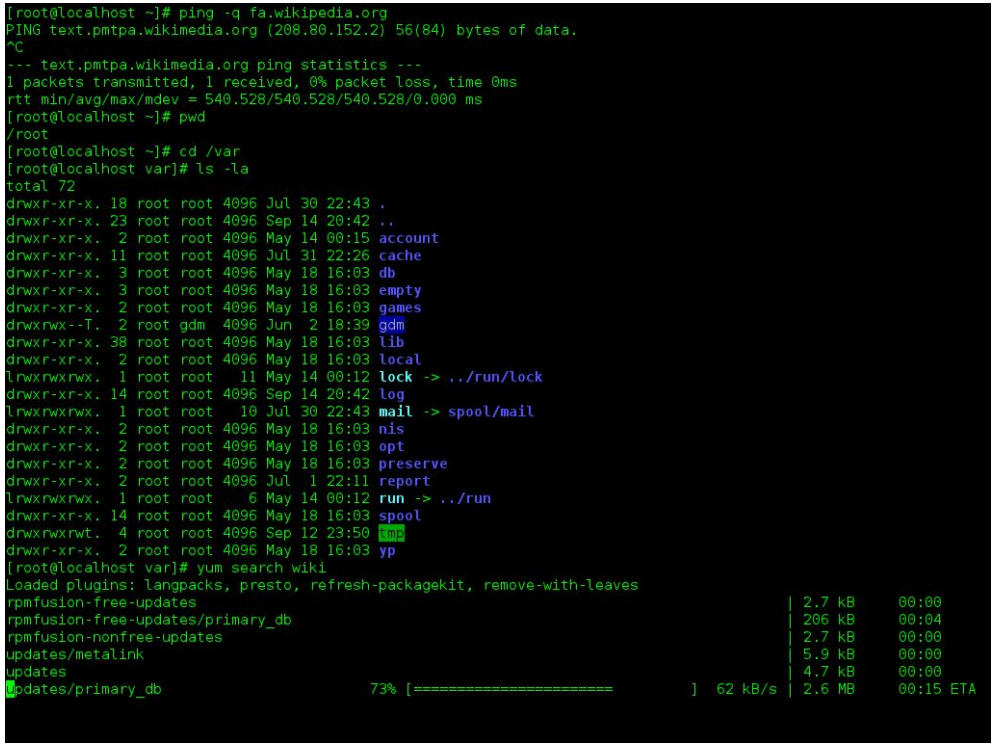
By Evan-Amos - Own work, Public Domain, https://commons.wikimedia.org/w/index.php?curid=35155956

Terminal User Interface



GPL, https://commons.wikimedia.org/w/index.php?curid=365954

Command Line Interface



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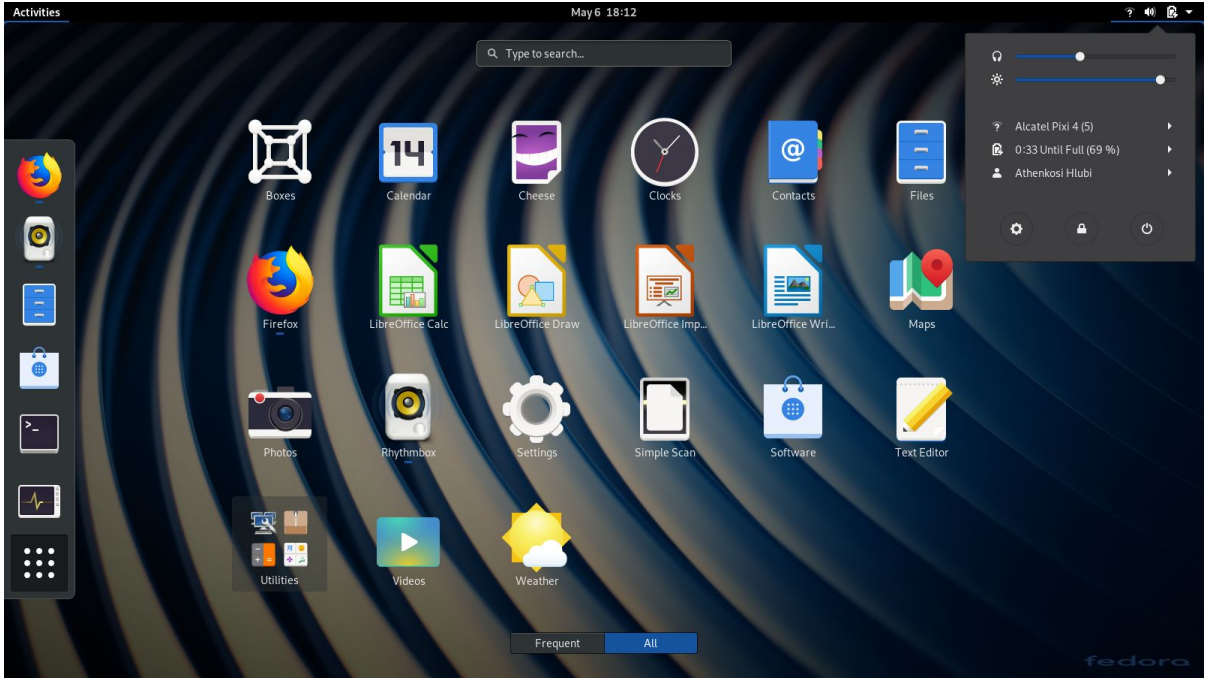
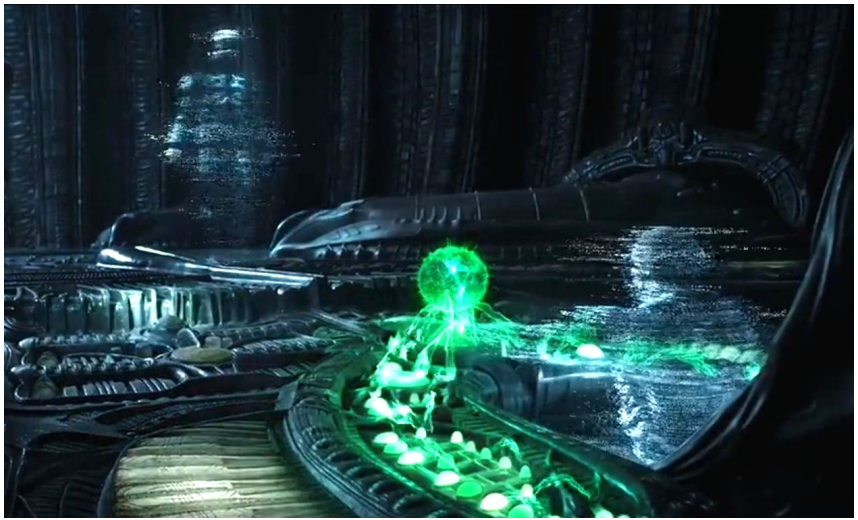
Graphical User Interface



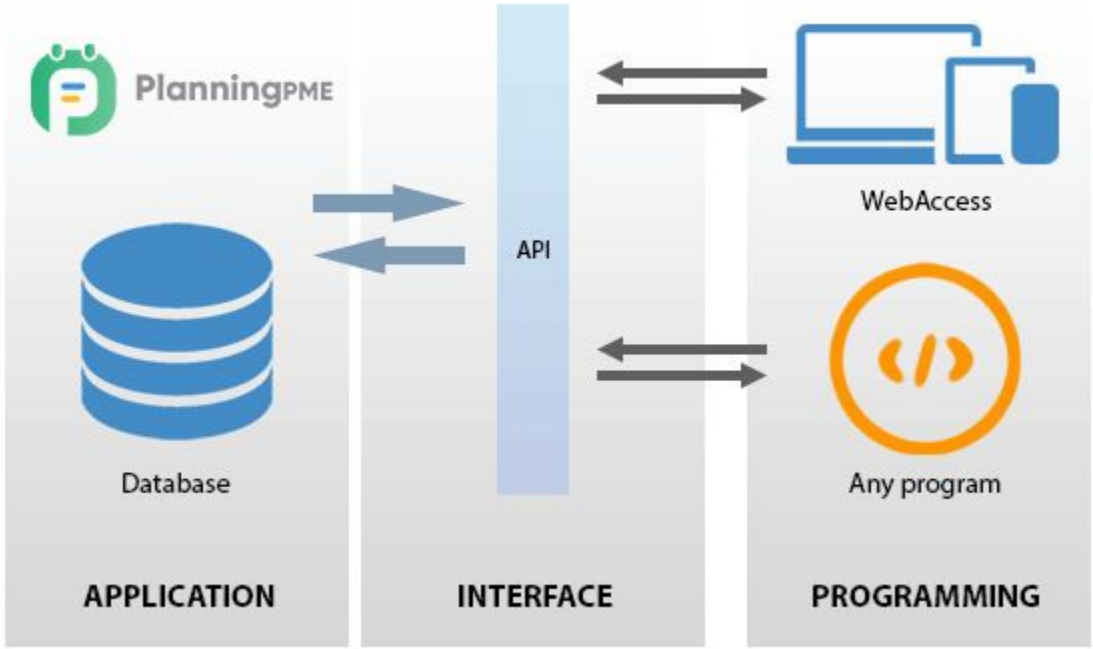
Alien Interface

Predator, 1987



Prometheus, 2012

Application Programming Interface

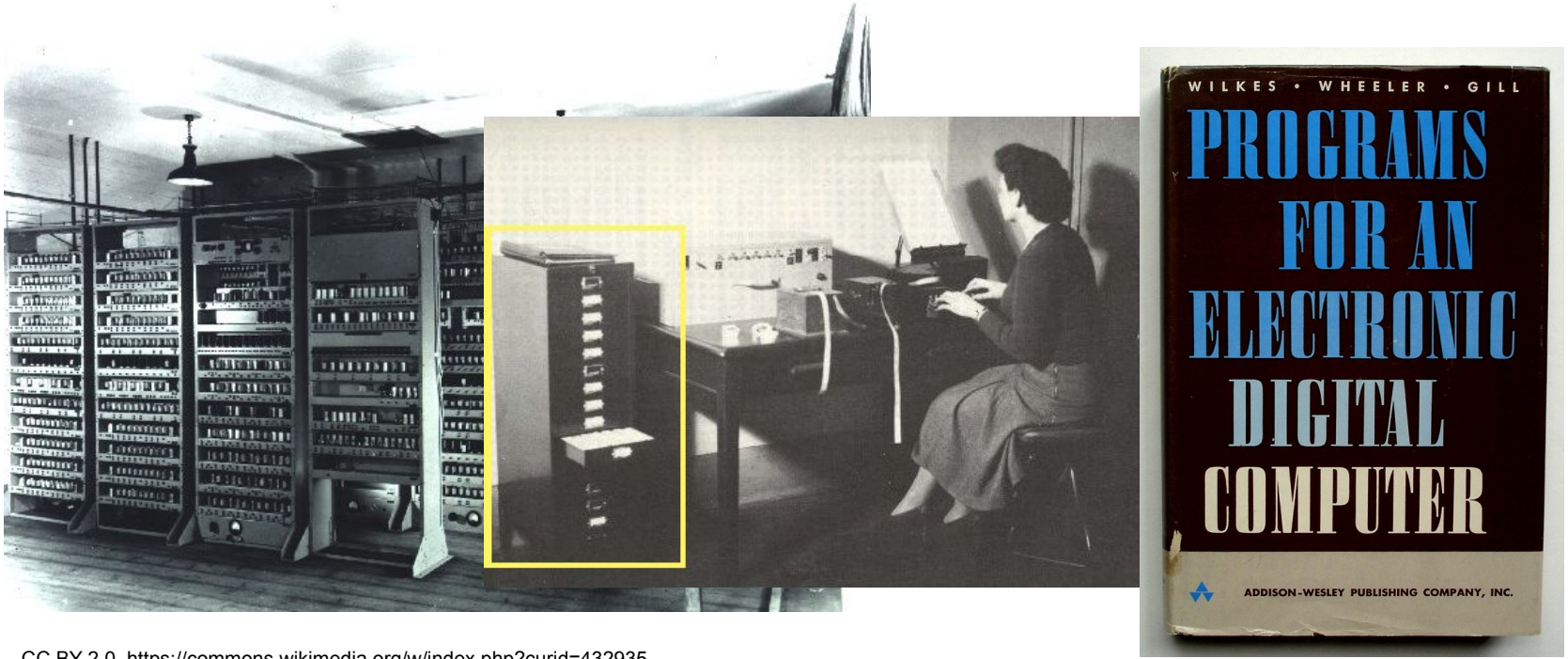


https://www.planningpme.com/img/planningpme-api.jpg

What is the purpose of an API?

- To bridge relevant applications / services.
- To hide the inner workings of a system and exposes only the parts that a programmer will find useful and keep them consistent even if the internal details of that system change later.
- To help create a standard for reusable and easily understood by the users components.
- The defined scope of API helps in the designing, testing, building, managing, and versioning of the component.

History of API - 40s EDSAC



History of API - 60s

Data structures and techniques for remote computer graphics

by IRA W. COTTON

Sperry Rand Corporation
Philadelphia, Pennsylvania

and
FRANK S. GREATOREX, JR

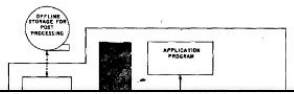
Adams Associates
Bedford, Massachusetts

INTRODUCTION

It has been adequately demonstrated[1,2,3] that computer graphics systems need not require the dedication of a large scale computer for their operation. Computer graphics has followed the trends of computing in general, where remote access, time sharing, and multiprogramming have become the key phrases. The prob-

and of relating the appearances of a picture on the tube face to its description in the data structure.

Figures 1 and 2 illustrate a typical configuration as it



trolled tools comes immediately to mind). Finally, hardware independence at the central computer means that a consistent application program interface could be maintained if that computer were replaced; this also

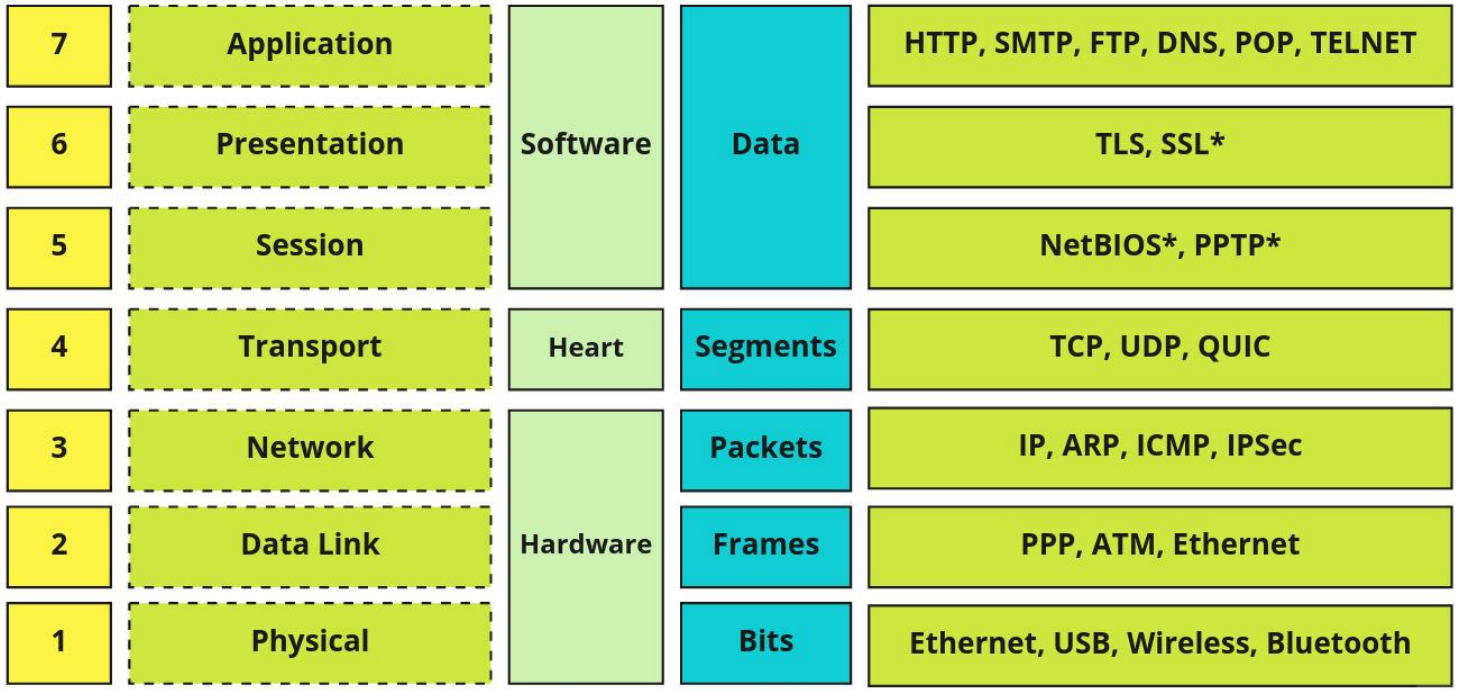
https://dl.acm.org/doi/pdf/10.1145/1476589.1476661

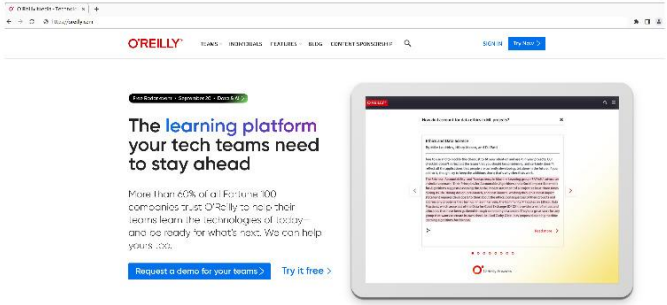
History of API - 90s and 2000s

- **90s** - Program executed on computer located elsewhere. Expanded the idea of API
- **2000s** - Roy Fielding “network-based Application Programming Interface” - Web API

https://dl.acm.org/doi/pdf/10.1145/1476589.1476661

Open Systems Interconnection (OSI)



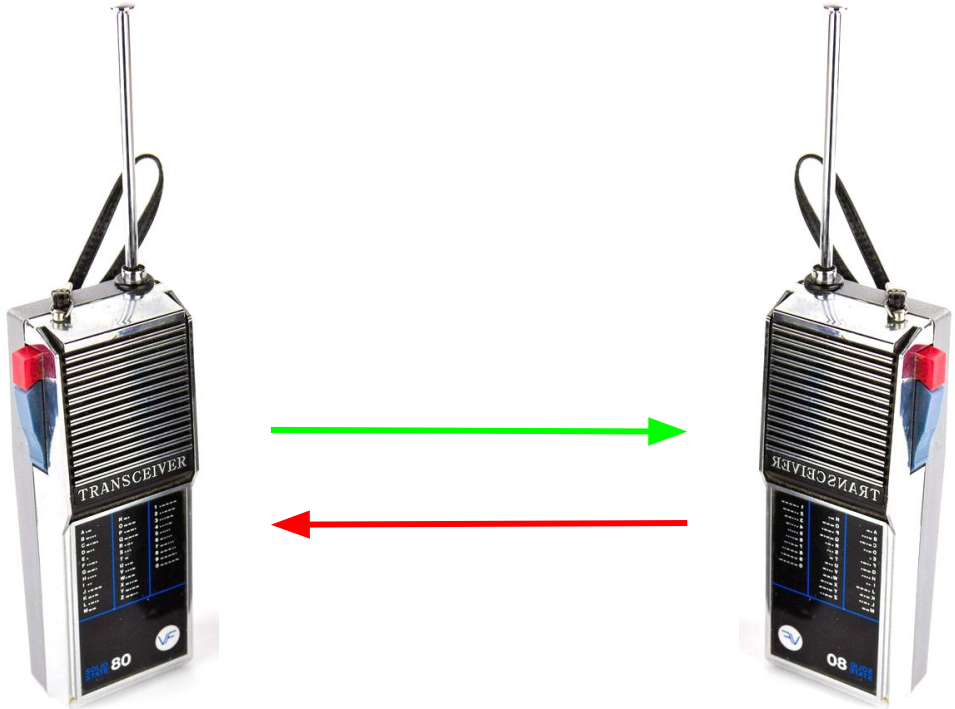


7	Application	Software	Data	HTTP, SMTP, FTP, DNS, POP, TELNET
6	Presentation			TLS, SSL*
5	Session			NetBIOS*, PPTP*
4	Transport	Heart	Segments	TCP, UDP, QUIC
3	Network	Hardware	Packets	IP, ARP, ICMP, IPSec
2	Data Link		Frames	PPP, ATM, Ethernet
1	Physical		Bits	Ethernet, USB, Wireless, Bluetooth

TRANSMISSION MODES

Simplex

Half-Duplex



Full-Duplex

When to use what?

Simplex - pull based broadcasting

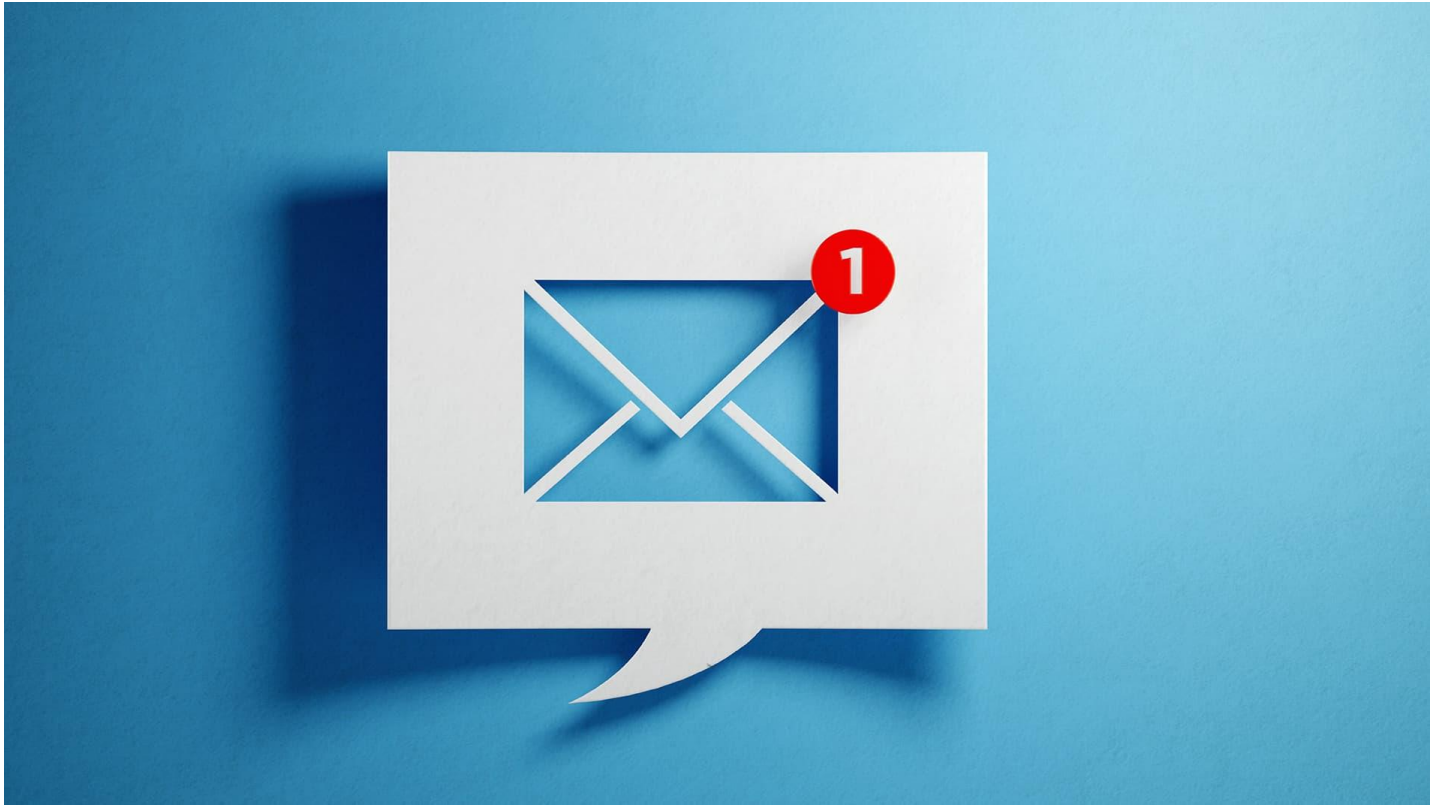
Half-Duplex - for system that can operate at worst with large latencies

Full-Duplex - for system that requires real time information exchange

COMMUNICATION STYLES

Synchronous

Asynchronous



When to use what?

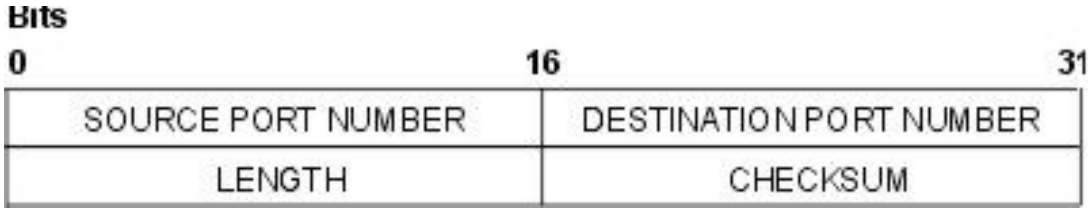
Synchronous communication is easy to reason about, but it can lead to lack of scalability, reliability, elasticity and other architectural characteristics.

Asynchronous communication benefits from performance and scale however, at the cost of data synchronization, deadlocks, race conditions, debugging, and so on.

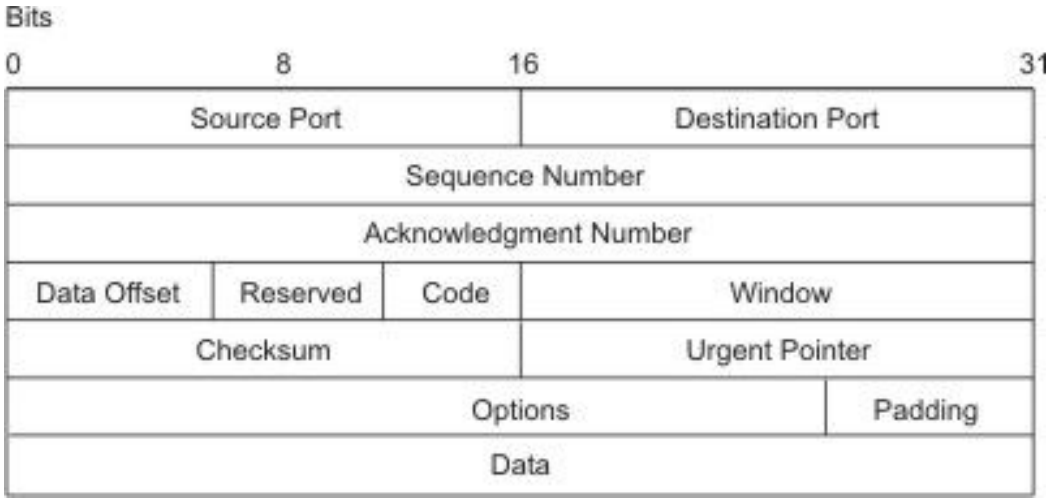
Synchronous by default, asynchronous when needed.

TRANSPORT PROTOCOLS

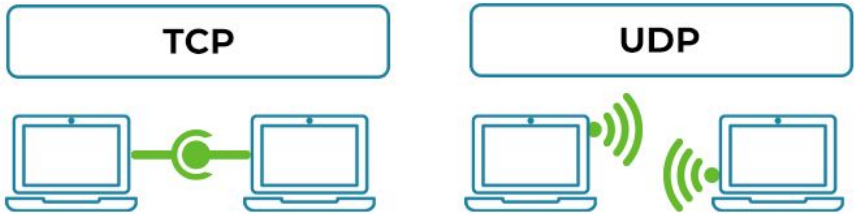
UDP


Bits
0
16
31
SOURCE PORT NUMBER
DESTINATION PORT NUMBER
LENGTH
CHECKSUM

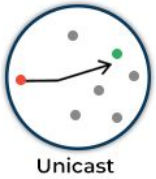
TCP


Bits
0
8
16
31
Source Port
Destination Port
Sequence Number
Acknowledgment Number
Data Offset
Reserved
Code
Window
Checksum
Urgent Pointer
Options
Padding
Data

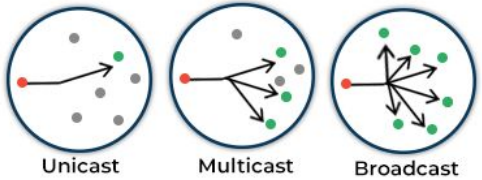
TCP vs UDP



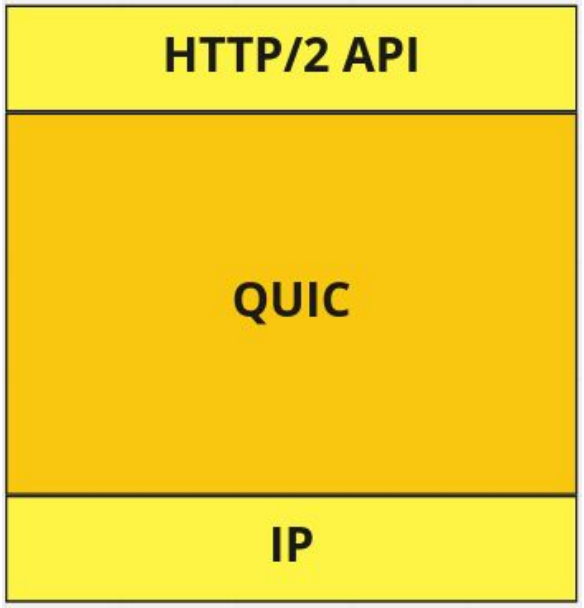
- Slower but more reliable transfers
- Typical Applications:
  - File Transfer Protocol
  - Web Browsing
  - Email



- Faster but not guaranteed transfer (“Best Effort”)
- Typical Applications:
  - Live streaming
  - Online Games
  - VoIP

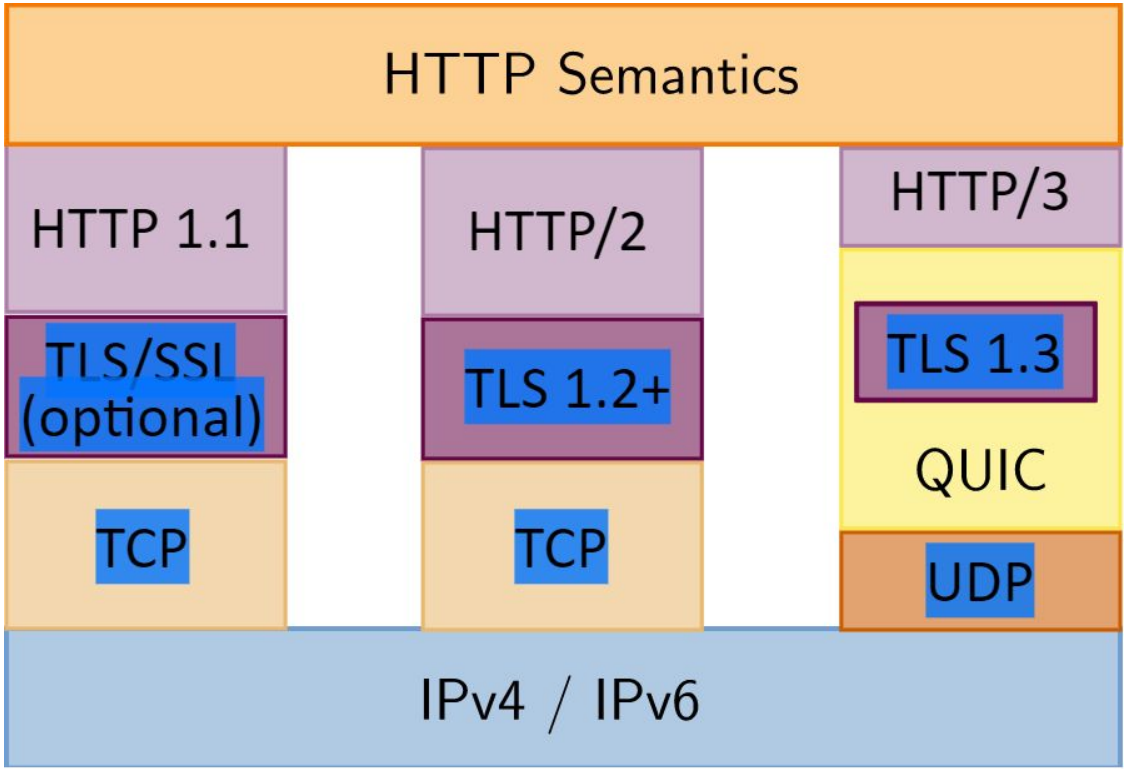


QUIC UDP



APPLICATION PROTOCOLS

HTTP


HTTP Semantics
HTTP 1.1
HTTP/2
HTTP/3
TLS/SSL (optional)
TLS 1.2+
TLS 1.3
QUIC
TCP
TCP
UDP
IPv4 / IPv6

Page Speed Insights

- HTTP/1 - Craiglist - Page Speed Insights
- HTTP/2 - Twitter - Page Speed Insights
- HTTP/3 - Google - Page Speed Insights

ENCODING AND ENCRYPTING

XML

```xml
<?xml version="1.0" encoding="UTF-8"?>
<breakfast_menu>
  <food>
    <name>Belgian Waffles</name>
    <price>$5.95</price>
    <description>Two of our famous Belgian Waffles with plenty of real maple syrup</description>
    <calories>650</calories>
  </food>
  <food>
    <name>Strawberry Belgian Waffles</name>
    <price>$7.95</price>
    <description>Light Belgian waffles covered with strawberries and whipped cream</description>
    <calories>900</calories>
  </food>
  <food>
    <name>Berry-Berry Belgian Waffles</name>
    <price>$8.95</price>
    <description>Light Belgian waffles covered with an assortment of fresh berries and whipped cream</description>
    <calories>900</calories>
  </food>
  <food>
    <name>French Toast</name>
    <price>$4.50</price>
    <description>Thick slices made from our homemade sourdough bread</description>
    <calories>600</calories>
  </food>
  <food>
    <name>Homestyle Breakfast</name>
    <price>$6.95</price>
    <description>Two eggs, bacon or sausage, toast, and our ever-popular hash browns</description>
    <calories>950</calories>
  </food>
</breakfast_menu>
```

XML

James Webb Space Telescope XML Database: From the Beginning to Today[1]

Jonathan Gal-Edd
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Greenbelt, MD 20771
301-286-2378
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Curtis C. Fatig
SAIC
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
curtis.fatig@gsfc.nasa.gov

Abstract—The James Webb Space Telescope (JWST) Project has been defining, developing, and exercising the use of a common eXtensible Markup Language (XML) for the command and telemetry (C&T) database structure. JWST is the first large NASA space mission to use XML for databases. The JWST Project started developing the concepts for the C&T database in 2002. The database will need to last at least 20 years since it will be used beginning with flight software development, continuing through Observatory integration and test (I&T) and through operations. Also, a database tool kit has been provided to the 18 various flight software development laboratories located in the United States, Europe, and Canada that allows the local users to create their own databases.

TABLE OF CONTENTS

1. INTRODUCTION
2. JWST DATABASE HISTORY
3. XML THE EARLY YEARS
4. JWST XML GROWTH
5. JWST XML TODAY
6. JWST XML COMPATIBILITY
7. REFERENCES
8. BIOGRAPHIES

JSON

```
{
    "firstName": "John",
    "lastName": "Smith",
    "isAlive": true,
    "age": 27,
    "address": {
        "streetAddress": "21 2nd Street",
        "city": "New York",
        "state": "NY",
        "postalCode": "10021-3100"
    },
    "phoneNumbers": [{
            "type": "home",
            "number": "212 555-1234"
        },
        {
            "type": "office",
            "number": "646 555-4567"
        }
    ],
    "children": [
        "Catherine",
        "Thomas",
        "Trevor"
    ],
    "spouse": null
}
```

YAML

```yaml
apiVersion: batch/v1
kind: Job
metadata:
  name: hello
spec:
  template:
    # This is the pod template
    spec:
      containers:
      - name: hello
        image: busybox:1.28
        command: ['sh', '-c', 'echo "Hello, Kubernetes!" && sleep 3600']
      restartPolicy: OnFailure
```

Protocol Buffers - Schema

```
message Person {
  string name = 1;
  int32 id = 2;  // Unique ID number for this person.
  string email = 3;

  enum PhoneType {
    MOBILE = 0;
    HOME = 1;
    WORK = 2;
  }

  message PhoneNumber {
    string number = 1;
    PhoneType type = 2;
  }

  repeated PhoneNumber phones = 4;

  google.protobuf.Timestamp last_updated = 5;
}

// Our address book file is just one of these.
message AddressBook {
  repeated Person people = 1;
}
```

Protocol Buffers - Marshaling

```
protoc -I=$SRC_DIR --go_out=$DST_DIR $SRC_DIR/addressbook.proto
```

```
book := &pb.AddressBook{}
// ...

// Write the new address book back to disk.
out, err := proto.Marshal(book)
if err != nil {
        log.Fatalln("Failed to encode address book:", err)
}
if err := ioutil.WriteFile(fname, out, 0644); err != nil {
        log.Fatalln("Failed to write address book:", err)
}
```

Protocol Buffers - Unmarshaling

```
// Read the existing address book.
in, err := ioutil.ReadFile(fname)
if err != nil {
        log.Fatalln("Error reading file:", err)
}
book := &pb.AddressBook{}
if err := proto.Unmarshal(in, book); err != nil {
        log.Fatalln("Failed to parse address book:", err)
}
```

Apache Thrift - Service

```
/**
 * Services just need a name and can optionally inherit from another service.
 */
service Calculator extends shared.SharedService {

   void ping(),

   i32 add(1:i32 num1, 2:i32 num2),
   i32 calculate(1:i32 logid, 2:Work w) throws (1:InvalidOperation ouch),

   /**
    * This method has a oneway modifier. The client only makes a request and
    * does not listen for any response at all. Oneway methods must be void.
    */
   oneway void zip()

}
```

Apache Thrift - Client

```
def main():
    # Make socket
    transport = TSocket.TSocket('localhost', 9090)

    # Buffering is critical. Raw sockets are very slow
    transport = TTransport.TBufferedTransport(transport)

    # Wrap in a protocol
    protocol = TBinaryProtocol.TBinaryProtocol(transport)

    # Create a client to use the protocol encoder
    client = Calculator.Client(protocol)

    # Connect!
    transport.open()

    client.ping()
    print('ping()')

    sum_ = client.add(1, 1)
```

Apache Avro - JSON Schema

```
{
  "namespace": "example.avro",
  "type": "record",
  "name": "User",
  "fields": [
     {"name": "name", "type": "string"},
     {"name": "favorite_number",  "type": ["null", "int"]},
     {"name": "favorite_color", "type": ["null", "string"]}
  ]
}
```

Apache Avro - Writing

```
import avro.schema
from avro.datafile import DataFileReader, DataFileWriter
from avro.io import DatumReader, DatumWriter

schema = avro.schema.parse(open("user.avsc", "rb").read())

writer = DataFileWriter(open("users.avro", "wb"), DatumWriter(), schema)
writer.append({"name": "Alyssa", "favorite_number": 256})
writer.append({"name": "Ben", "favorite_number": 8, "favorite_color": "red"})
writer.close()
```

Apache Avro - Data

```
$ od -v -t x1z users.avro
0000000 4f 62 6a 01 04 14 61 76 72 6f 2e 63 6f 64 65 63  >Obj...avro.codec<
0000020 08 6e 75 6c 6c 16 61 76 72 6f 2e 73 63 68 65 6d  >.null.avro.schem<
0000040 61 ba 03 7b 22 74 79 70 65 22 3a 20 22 72 65 63  >a..{"type": "rec<
0000060 6f 72 64 22 2c 20 22 6e 61 6d 65 22 3a 20 22 55  >ord", "name": "U<
0000100 73 65 72 22 2c 20 22 6e 61 6d 65 73 70 61 63 65  >ser", "namespace<
0000120 22 3a 20 22 65 78 61 6d 70 6c 65 2e 61 76 72 6f  >": "example.avro<
0000140 22 2c 20 22 66 69 65 6c 64 73 22 3a 20 5b 7b 22  >", "fields": [{"<
0000160 74 79 70 65 22 3a 20 22 73 74 72 69 6e 67 22 2c  >type": "string",<
0000200 20 22 6e 61 6d 65 22 3a 20 22 6e 61 6d 65 22 7d  > "name": "name"}<
0000220 2c 20 7b 22 74 79 70 65 22 3a 20 5b 22 69 6e 74  >, {"type": ["int<
0000240 22 2c 20 22 6e 75 6c 6c 22 5d 2c 20 22 6e 61 6d  >", "null"], "nam<
0000260 65 22 3a 20 22 66 61 76 6f 72 69 74 65 5f 6e 75  >e": "favorite_nu<
0000300 6d 62 65 72 22 7d 2c 20 7b 22 74 79 70 65 22 3a  >mber"}, {"type":<
0000320 20 5b 22 73 74 72 69 6e 67 22 2c 20 22 6e 75 6c  > ["string", "nul<
0000340 6c 22 5d 2c 20 22 6e 61 6d 65 22 3a 20 22 66 61  >l"], "name": "fa<
0000360 76 6f 72 69 74 65 5f 63 6f 6c 6f 72 22 7d 5d 7d  >vorite_color"}]}<
0000400 00 05 f9 a3 80 98 47 54 62 bf 68 95 a2 ab 42 ef  >......GTb.h...B.<
0000420 24 04 2c 0c 41 6c 79 73 73 61 00 80 04 02 06 42  >$.,.Alyssa.....B<
0000440 65 6e 00 10 00 06 72 65 64 05 f9 a3 80 98 47 54  >en....red.....GT<
0000460 62 bf 68 95 a2 ab 42 ef 24                       >b.h...B.$<
0000471
```

Apache Avro - Read

```
reader = DataFileReader(open("users.avro", "rb"), DatumReader())
for user in reader:
    print user
reader.close()
```

```
{u'favorite_color': None, u'favorite_number': 256, u'name': u'Alyssa'}
{u'favorite_color': u'red', u'favorite_number': 8, u'name': u'Ben'}
```

When to use what?

Text based encoding when:

- Data must be human readable
- You are at the scale of MiB or approaching a GiB limit
- Data is directly consumed by a web browser
- You aren’t prepared to tie the data model to a schema
- To make debugging easier for developers

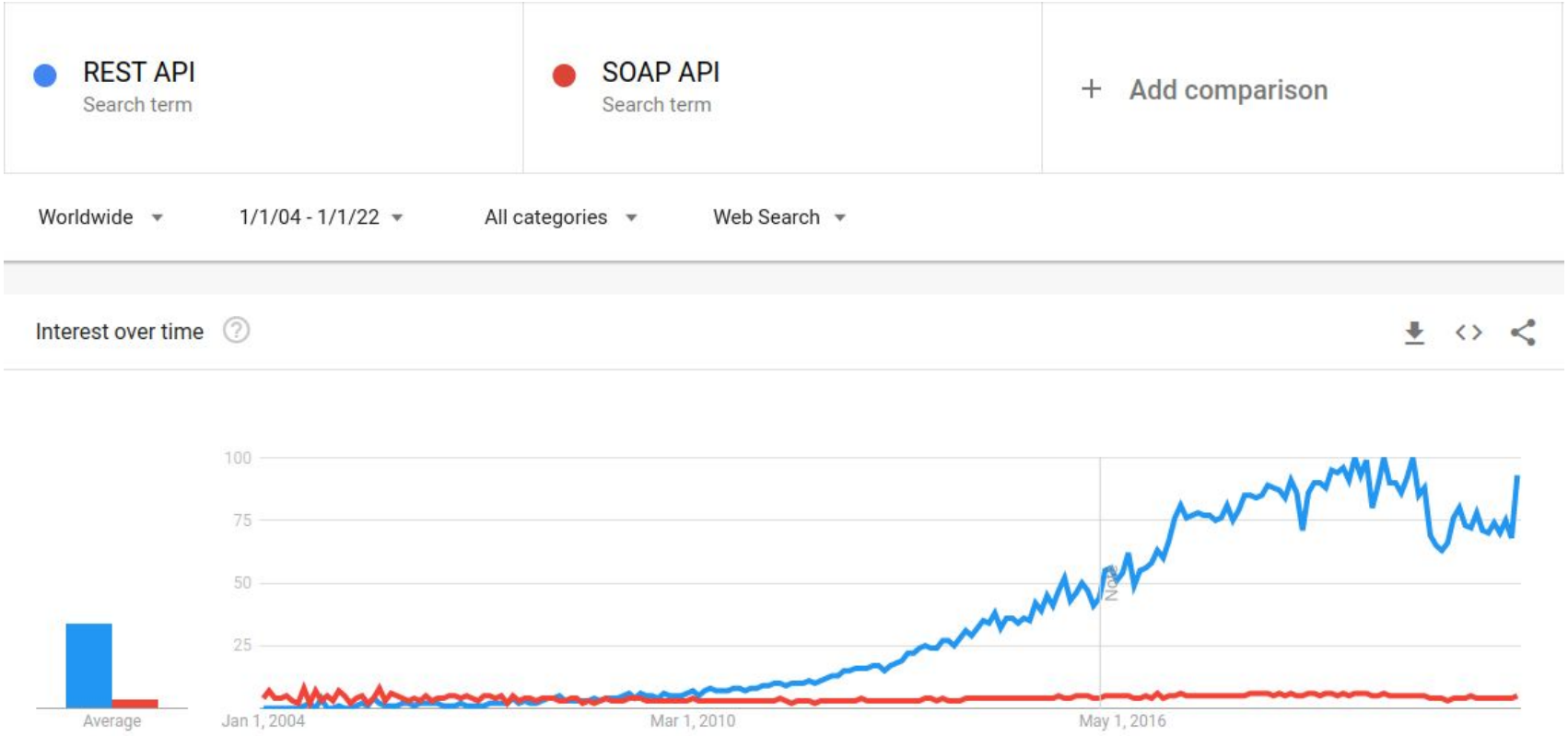
Binary based encoding when:

- You are handling GiB and beyond data
- Latency of moving data back and forth between the systems is a huge cost
- You need efficient service to service communication

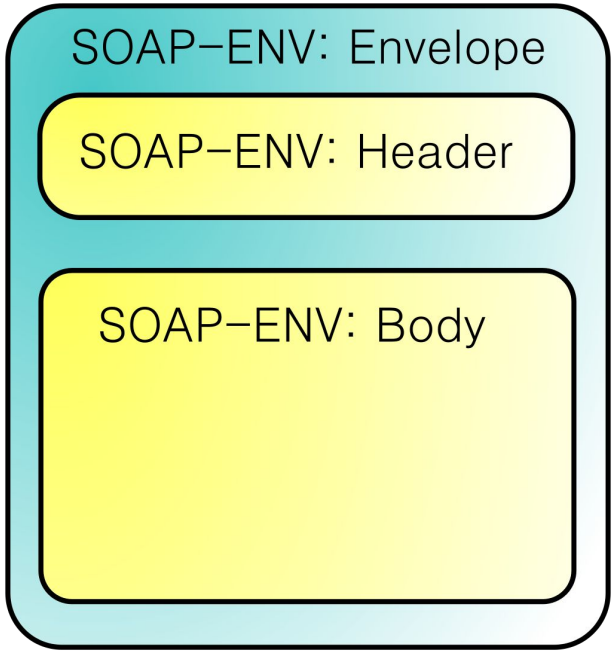
API STYLES

Simple Object Access Protocol

Simple Object Access Protocol



SOAP - Message



SOAP - Message

```
POST /InStock HTTP/1.1
Host: www.example.org
Content-Type: application/soap+xml; charset=utf-8
Content-Length: 299
SOAPAction: "http://www.w3.org/2003/05/soap-envelope"

<?xml version="1.0"?>
<soap:Envelope xmlns:soap="http://www.w3.org/2003/05/soap-envelope" xmlns:m="http://www.example.org">
  <soap:Header>
  </soap:Header>
  <soap:Body>
    <m:GetStockPrice>
      <m:StockName>T</m:StockName>
    </m:GetStockPrice>
  </soap:Body>
</soap:Envelope>
```

Pros and Cons

Advantages

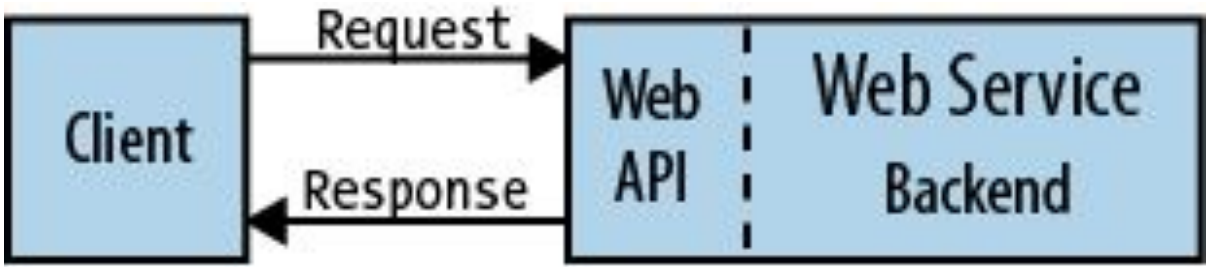
- SOAP's neutrality characteristic explicitly makes it suitable for use with any transport protocol. HTTP, SMTP
- SOAP tunnels easily through firewalls and proxies - when used with HTTP protocol

Disadvantages

- The verbosity of the protocol
- Slow parsing speed of XML messages
- Lack of a standardized interaction model
- Being protocol-agnostic, SOAP is unable to take advantage of protocol-specific features and optimizations
- When relying on HTTP as a transport protocol and not using Web Services Addressing, the roles of the interacting parties are fixed. That means that only one party (the client) can use the services of the other

REpresentational State Transfer

REST - Architecture



REST

UNIVERSITY OF CALIFORNIA, IRVINE

Architectural Styles and the Design of Network-based Software Architectures

DISSERTATION

submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in Information and Computer Science

by

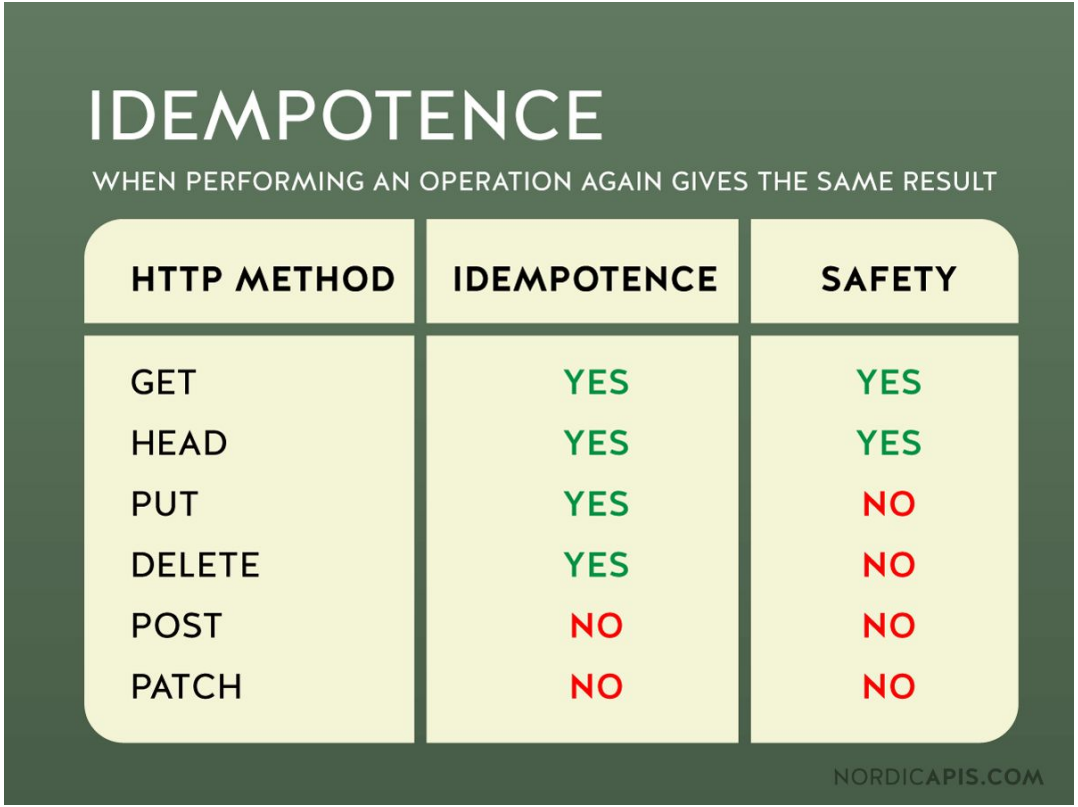
Roy Thomas Fielding

2000

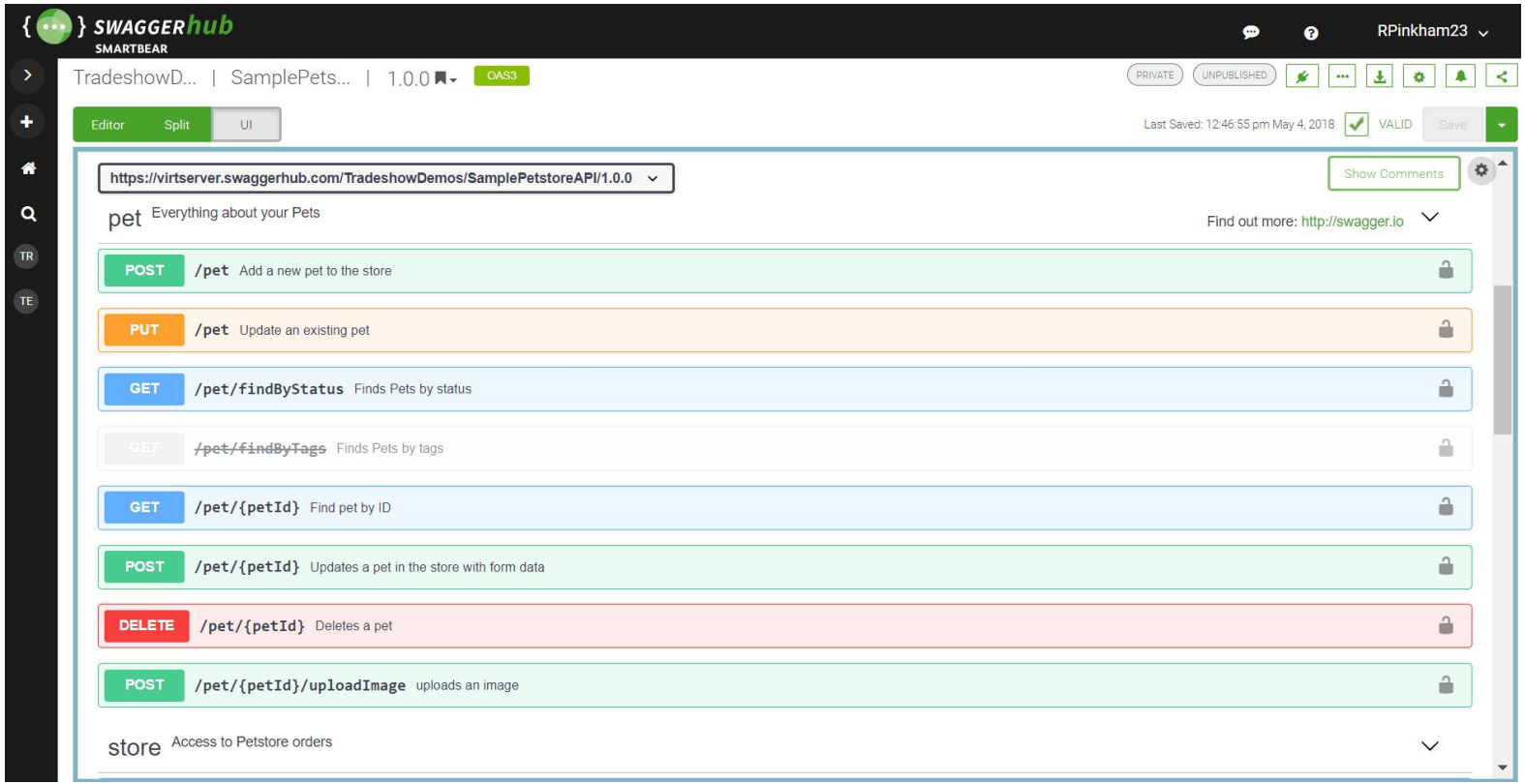
https://www.ics.uci.edu/~fielding/pubs/dissertation/fielding_dissertation.pdf

Dissertation Committee:
Professor Richard N. Taylor, Chair
Professor Mark S. Ackerman
Professor David S. Rosenblum

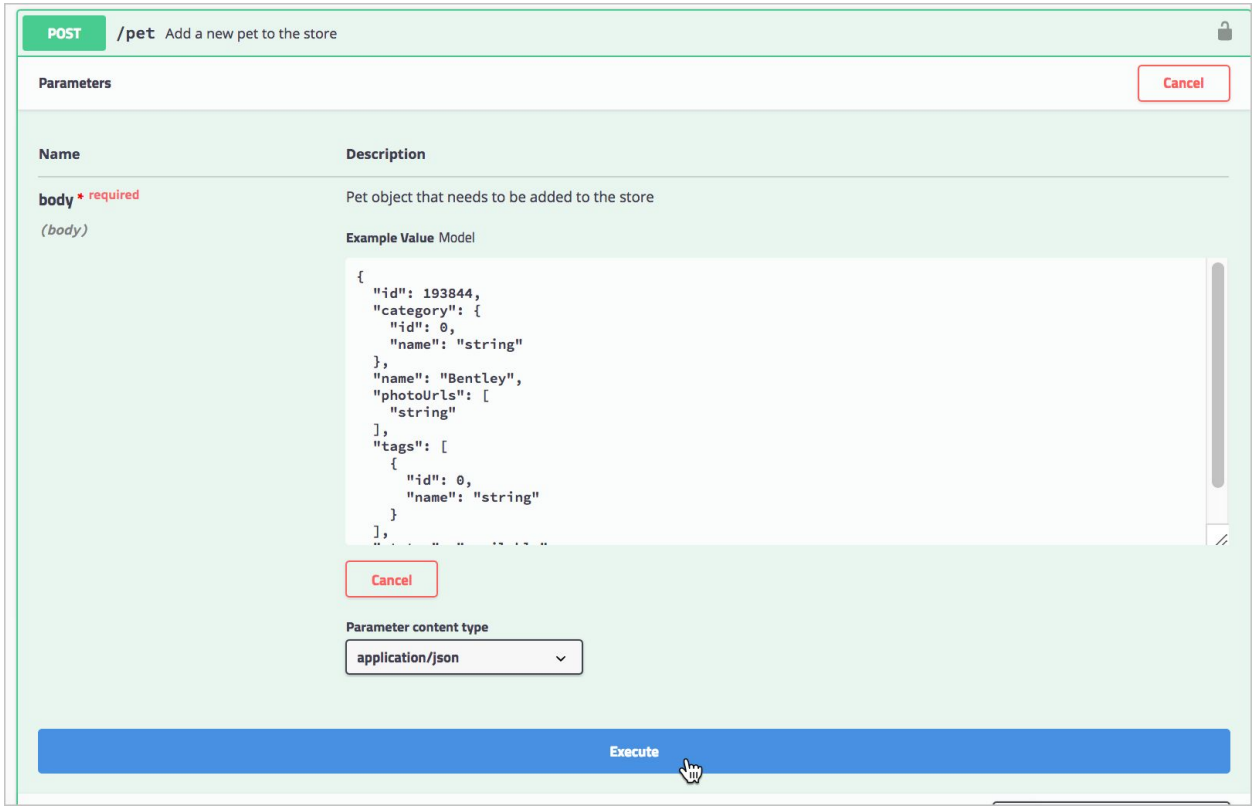
REST - IDEMPOTENT



REST - Swagger - Open API



REST - Swagger - Open API



SOAP vs REST

#	SOAP	REST
1	A XML-based message protocol	An architectural style protocol
2	Uses WSDL for communication between consumer and provider	Uses XML or JSON to send and receive data
3	Invokes services by calling RPC method	Simply calls services via URL path
4	Does not return human readable result	Result is readable which is just plain XML or JSON
5	Transfer is over HTTP. Also uses other protocols such as SMTP, FTP, etc.	Transfer is over HTTP only
6	JavaScript can call SOAP, but it is difficult to implement	Easy to call from JavaScript
7	Performance is not great compared to REST	Performance is much better compared to SOAP - less CPU intensive, leaner code etc.

REST - Advantages

- Simplicity
- REST is almost synonymous with HTTP
- Data Format
- RESTful API are stateless
- Caching
- No need for much bandwidth
- REST API uses entity-oriented models
- Debugging
- Ecosystem

REST - Disadvantage

- Security
- Data exposure
- Lack of state

When to use REST?

- You are interested in decoupled systems which are more adaptable to change.
- The core concern that you are facing is integration between many systems.
- If your API will be consumed by many external systems that you have no control over.
- You need data to be retrieved in many different formats.
- You expect a huge influx of requests.
- Long lived projects.

GraphQL

GraphQL - Query

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

```
{
  "hero": {
      "name": "Luke Skywalker",
      "height": 1.72
  }
}
```

GraphQL - Types

```
{
  hero {
    name
    friends {
      name
      homeWorld {
        name
        climate
      }
      species {
        name
        lifespan
        origin {
          name
        }
      }
    }
  }
}
```

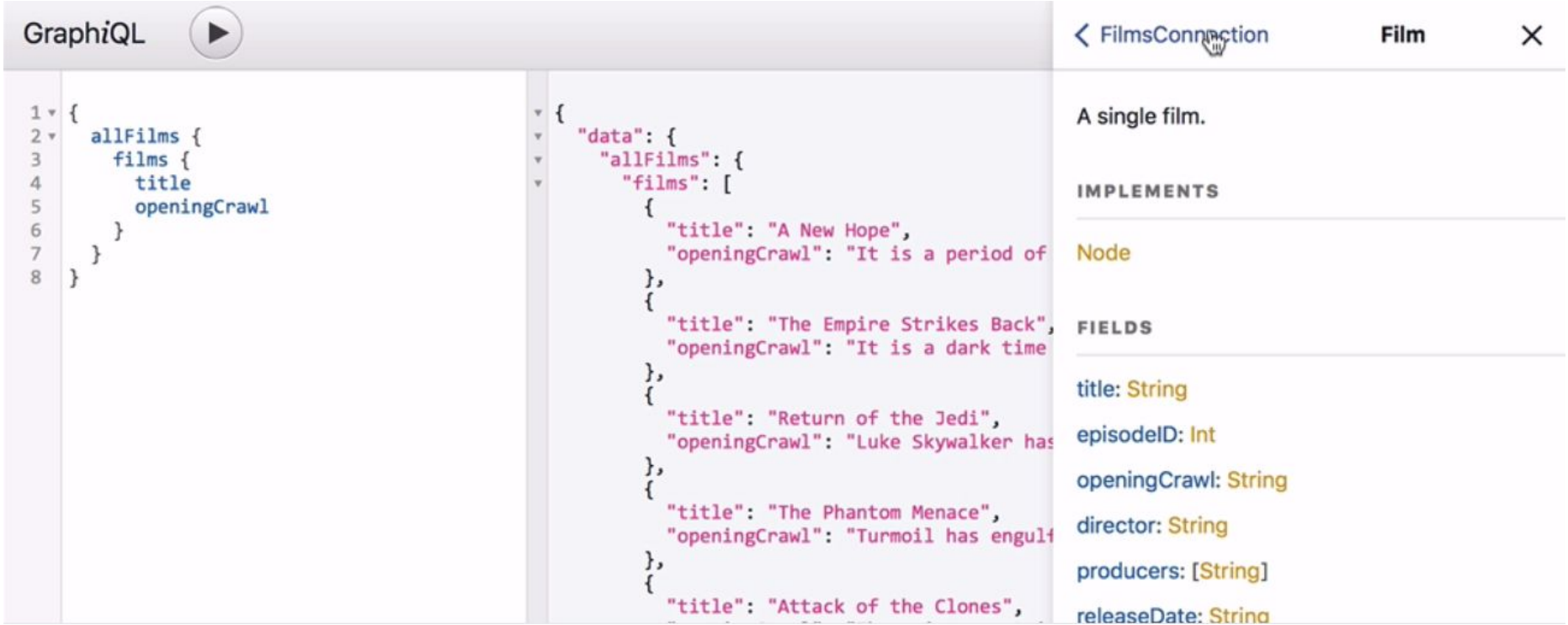
```
type Query {
  hero: Character
}

type Character {
  name: String
  friends: [Character]
  homeWorld: Planet
  species: Species
}

type Planet {
  name: String
  climate: String
}

type Species {
  name: String
  lifespan: Int
  origin: Planet
}
```

GraphQL - Docs



GraphQL - Advantages

- Each client retrieves exactly the data it needs. This can be especially beneficial in low-bandwidth environments
- JSON objects can be retrieved and used as is, without any manipulation on the client side
- clients are immune to how the APIs are defined
- GraphQL pairs perfectly with React

GraphQL - Disadvantages

- **Expensive Queries** - GraphQL allows you to query and mutate large amounts of data. A big query could very quickly bring down an entire GraphQL server.
- Ability to traverse a graph can lead to **deep recursions** that could burn valuable resources.
- GraphQL Rate Limiting - In REST API, you can specify that we allow only this amount of requests in one day", This is difficult to specify in GraphQL
- GraphQL Caching - Caching in GraphQL is very complex because each query can be different, even though it operates on the same entity.
- Files upload/download can be tricky forcing you to implement dedicated REST endpoints.
- The fact that you can allow/disallow fields makes Relational Database joins non-trivial.

GraphQL - Big Queries

```
query lotsOfData {
        allProducts
        allSKUs
        allCategories
        allCustomers
        allOrders
}
```

GraphQL - Recursive Traverse

```
query somethingMalicious {
        allProducts {
                category {
                        products {
                                category {
                                        products {
                                                category
                                        }
                                }
                        }
                }
        }
}
```

When to use GraphQL?

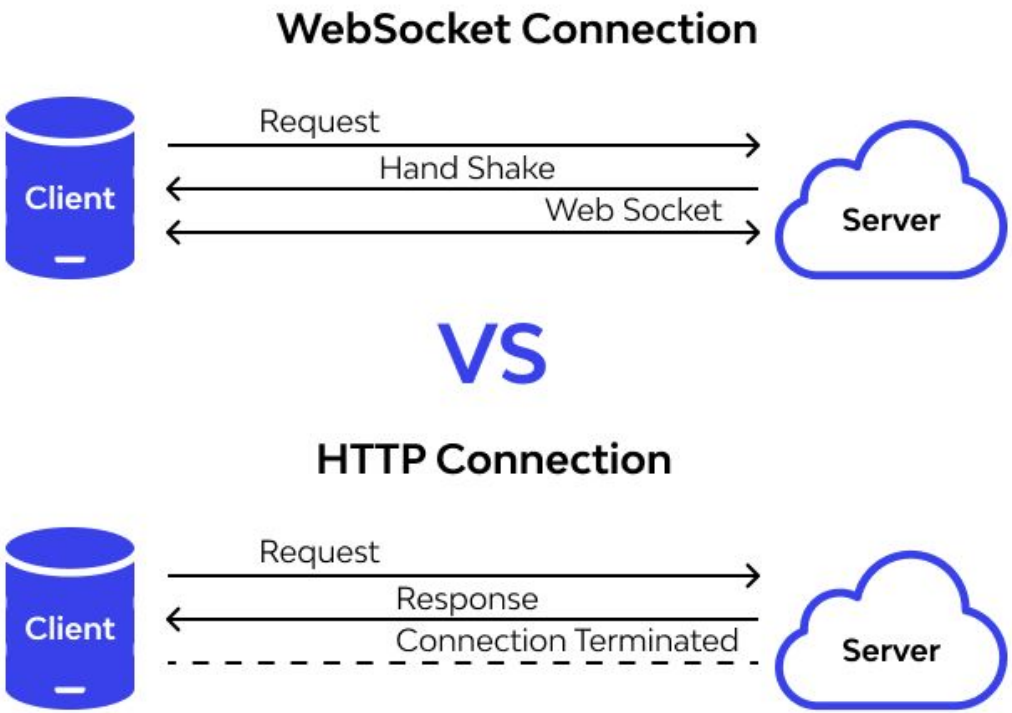
- When application bandwidth matters - mobile phones, smartwatches, IoT
- Composite pattern, where application retrieves data from multiple, different APIs
- In short lived project.

GitHub - REST and GraphQL

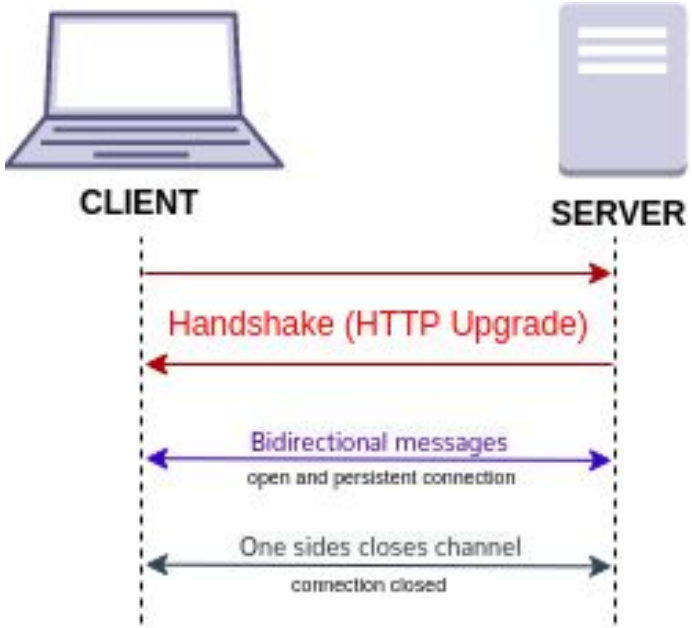
- https://docs.github.com/en/rest/repos/repos#list-public-repositories
- https://docs.github.com/en/graphql/overview/explorer

WebSocket

WebSocket - Connection



WebSocket - Upgrade



WebSocket - Protocol Switch

```
GET /chat HTTP/1.1
Host: server.example.com
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Key: x3JJHMbDL1EzLkh9GBhXDw==
Sec-WebSocket-Protocol: chat, superchat
Sec-WebSocket-Version: 13
Origin: http://example.com
```

Server response:

```
HTTP/1.1 101 Switching Protocols
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Accept: HSmrc0sMlYUkAGmm5OPpG2HaGWk=
Sec-WebSocket-Protocol: chat
```

WebSocket - Events

```
// Creates new WebSocket object with a wss URI as the parameter
const socket = new WebSocket('wss://game.example.com/ws/updates');

// Fired when a connection with a WebSocket is opened
socket.onopen = function () {
  setInterval(function() {
    if (socket.bufferedAmount == 0)
      socket.send(getUpdateData());
  }, 50);
};

// Fired when data is received through a WebSocket
socket.onmessage = function(event) {
  handleUpdateData(event.data);
};

// Fired when a connection with a WebSocket is closed
socket.onclose = function(event) {
  onSocketClose(event);
};

// Fired when a connection with a WebSocket has been closed because of an error
socket.onerror = function(event) {
  onSocketError(event);
};
```

WebSocket - Pros and Cons

Advantages

- Real time full-duplex communication
- Platforms agnostic web, desktop, mobile
- WebSocket overhead has only 2-byte compared to HTTP 2000 bytes
- WebSockets data frames can transfer text or binary data

Disadvantages

- A fully HTML5-compliant web browser is required
- Websockets do not provide intermediary caching
- Lost connection require reconnecting mechanisms
- Communication between origins - at the costs of security risks

When to use WebSockets?

- full-duplex communication
- real time constraints

https://miro.com/app/board/uXjVPZmxNVQ=/

RPC / gRPC

gRPC - .proto

```
// The greeting service definition.
service Greeter {
  // Sends a greeting
  rpc SayHello (HelloRequest) returns (HelloReply) {}
  // Sends another greeting
  rpc SayHelloAgain (HelloRequest) returns (HelloReply) {}
}

// The request message containing the user's name.
message HelloRequest {
  string name = 1;
}

// The response message containing the greetings
message HelloReply {
  string message = 1;
}
```

gRPC - code generation

```
python -m grpc_tools.protoc \
        -I../../protos \
        --python_out=. \
        --pyi_out=. \
        --grpc_python_out=. \
        ../../protos/helloworld.proto
```

- generated **request** and **response** classes
- generated **client** and **server** classes

gRPC - greeter server

```
class Greeter(helloworld_pb2_grpc.GreeterServicer):

  def SayHello(self, request, context):
    return helloworld_pb2.HelloReply(message='Hello, %s!' % request.name)

  def SayHelloAgain(self, request, context):
    return helloworld_pb2.HelloReply(message='Hello again, %s!' % request.name)
```

gRPC - greeter client

```
def run():
    with grpc.insecure_channel('localhost:50051') as channel:
        stub = helloworld_pb2_grpc.GreeterStub(channel)
        response = stub.SayHello(helloworld_pb2.HelloRequest(name='you'))
        print("Greeter client received: " + response.message)
        response = stub.SayHelloAgain(helloworld_pb2.HelloRequest(name='you'))
        print("Greeter client received: " + response.message)
```

gRPC- Pros and Cons

Advantages

- Performance
- gRPC uses HTTP/2 under the hood, but does not expose any of HTTP/2 to the API designer or API user.

Disadvantage

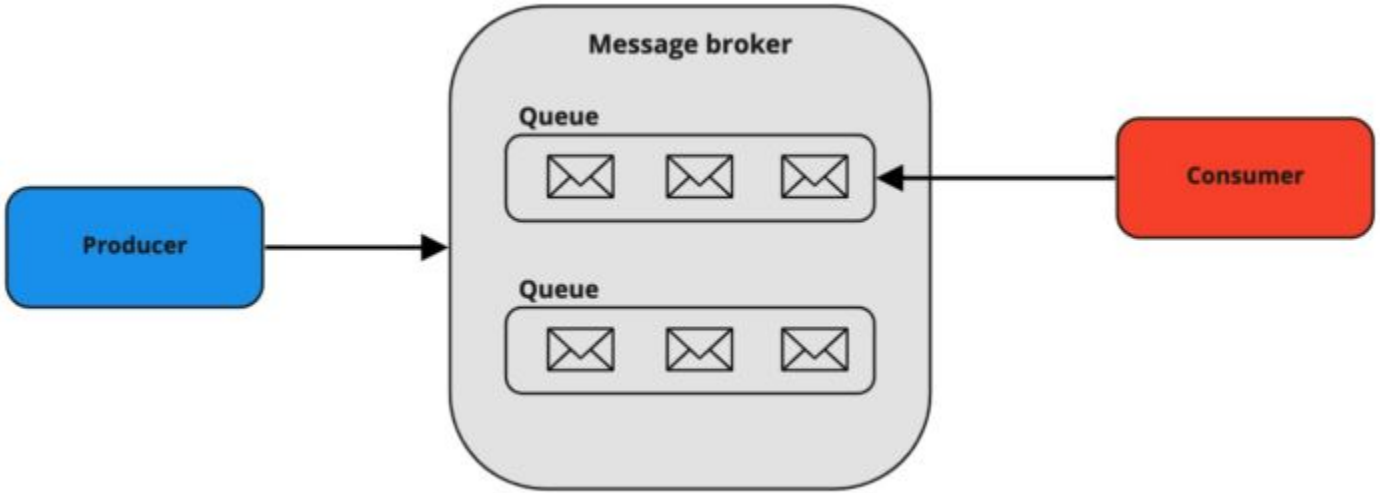
- Client and the server regeneration.
- RPC tends to bloat over time as more procedures are added.

When to use gRPC?

- When every bit matters
- When you need efficient communication between tightly coupled services that you own
- When the consumers of the API is the organization that you have control over (internal APIs)

Messaging

Messaging - Architecture

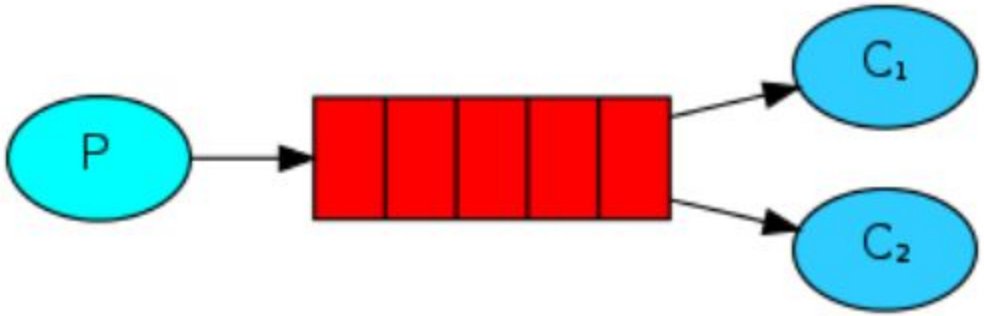


Messaging vs RPC

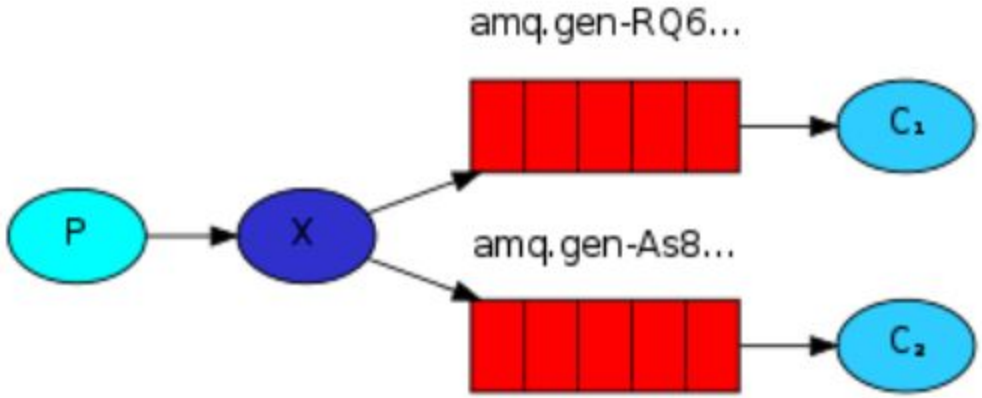
- The sender doesn’t need to know the IP address and port number of the recipient.
- If the recipient is unavailable or overloaded then the broker acts as a buffer.
- It can automatically redeliver messages to a process that has crashed.
- It allows one message to be sent to several recipients.
- It logically decouples the sender from the recipient.


Rabbit
MQ

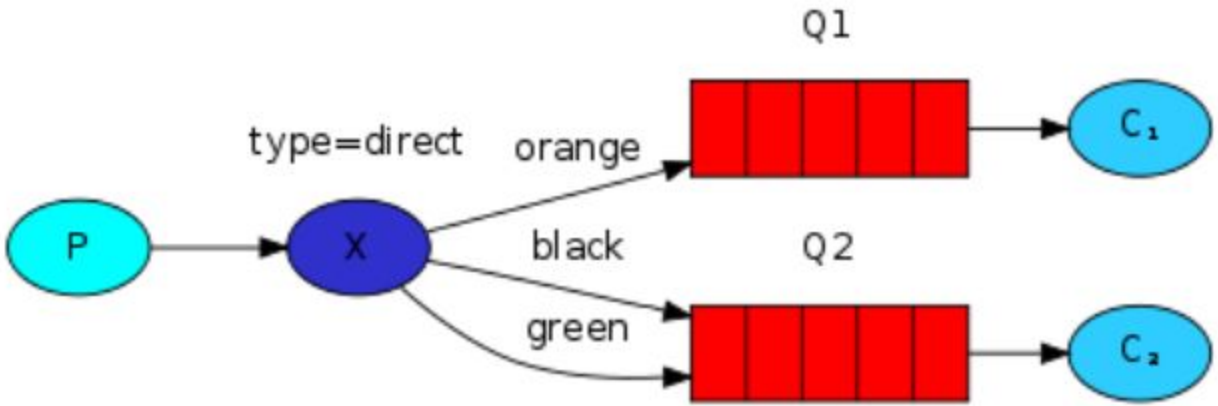
Work Queue



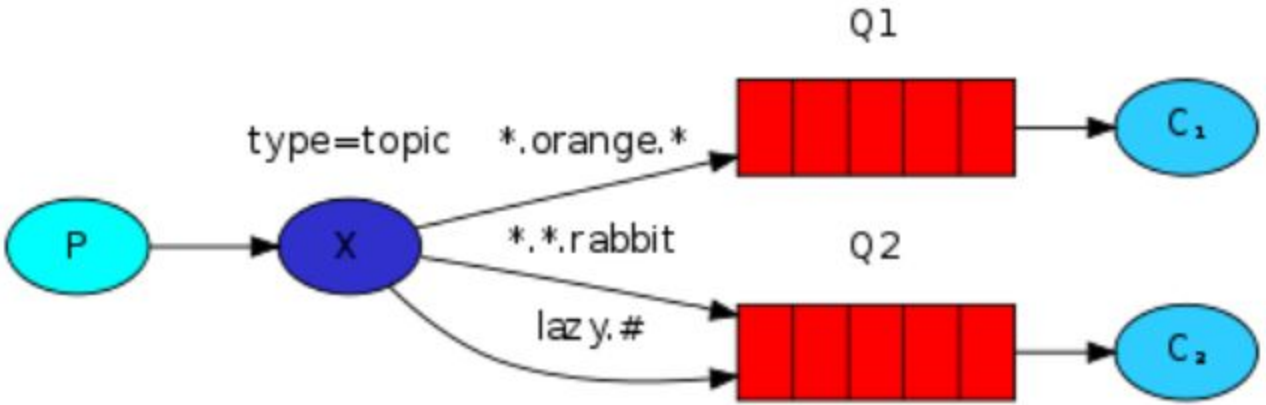
Publish / Subscribe



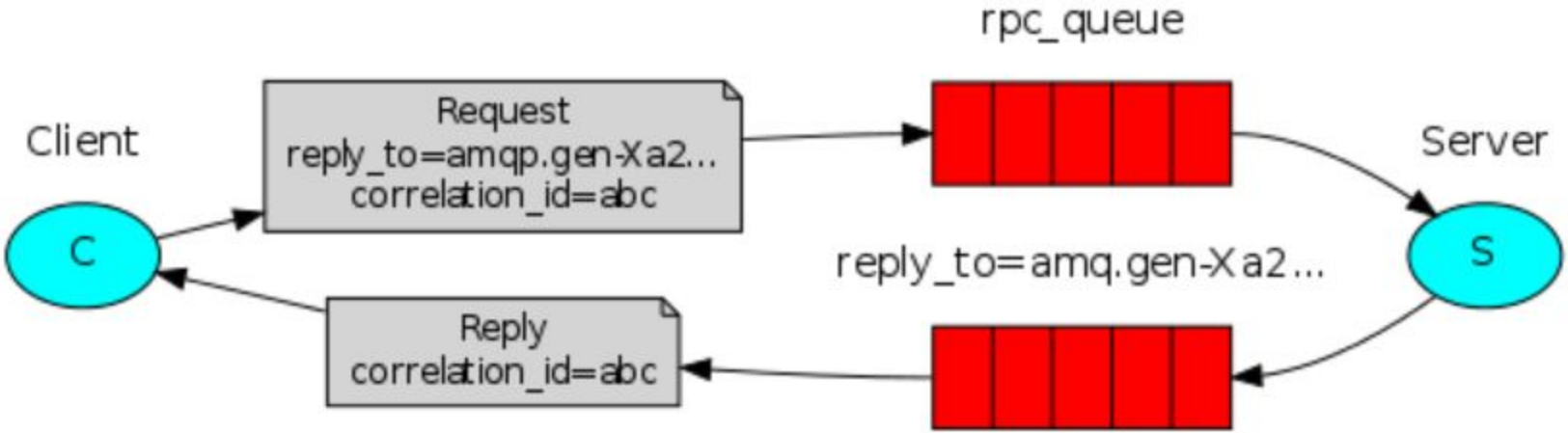
Routing



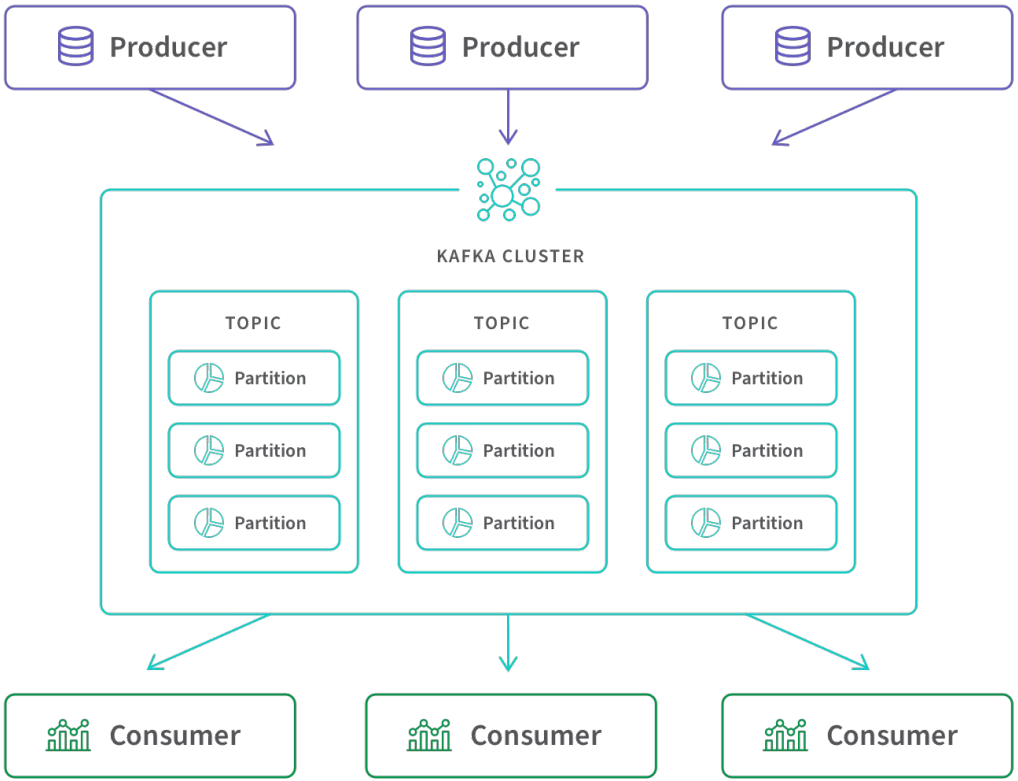
Topics



Request - Reply




APACHE
kafka®


Producer
Producer
Producer
KAFKA CLUSTER
TOPIC
Partition
Partition
Partition
TOPIC
Partition
Partition
Partition
TOPIC
Partition
Partition
Partition
Consumer
Consumer
Consumer

Kafka vs RabbitMQ

Kafka

- Users can replay messages
- Pairs well with big data systems such as Elasticsearch
- Allows topics to be split into partitions
- Performance improves with fewer, large batches of data
- Includes four primary security features

RabbitMQ

- Allows users to set sophisticated rules for message delivery
- Supports STOMP, MQTT, WebSockets, and others
- Capability to vary point-to-point, request/reply, and publish/subscribe messaging
- Strong authentication and expression-based authorization

When to use Messaging?

- Synchronous communication is not a concern
- Data delivery is a concern
- Near real time data feeds
- Decoupled systems

Characteristics of Good API

"APIs should be easy to use and hard to misuse. It should be easy to do simple things; possible to do complex things; and impossible, or at least difficult to do wrong things. Documentation matters. No matter how good an API is, it won't get used without good documentation." **Joshua Bloch**

Good API is:

- Easy to read
- Easy to learn
- Easy to maintain
- Easy to evolve
- Intuitive - easy to use even without documentation
- Hard to misuse
- Appropriate to the audience

Recap

- Historical context that lead to creation of various APIs
- The OSI model
- Transmission modes and communication styles for API
- Encoding and encryption in context of API
- Relevant protocols utilized in network based communication for API
- Understanding of common web API
- API styles trade-offs
- API style is appropriate for particular set of problems
- Characteristics of good APIs