Intro to gRPC

Phaser Deep Dive
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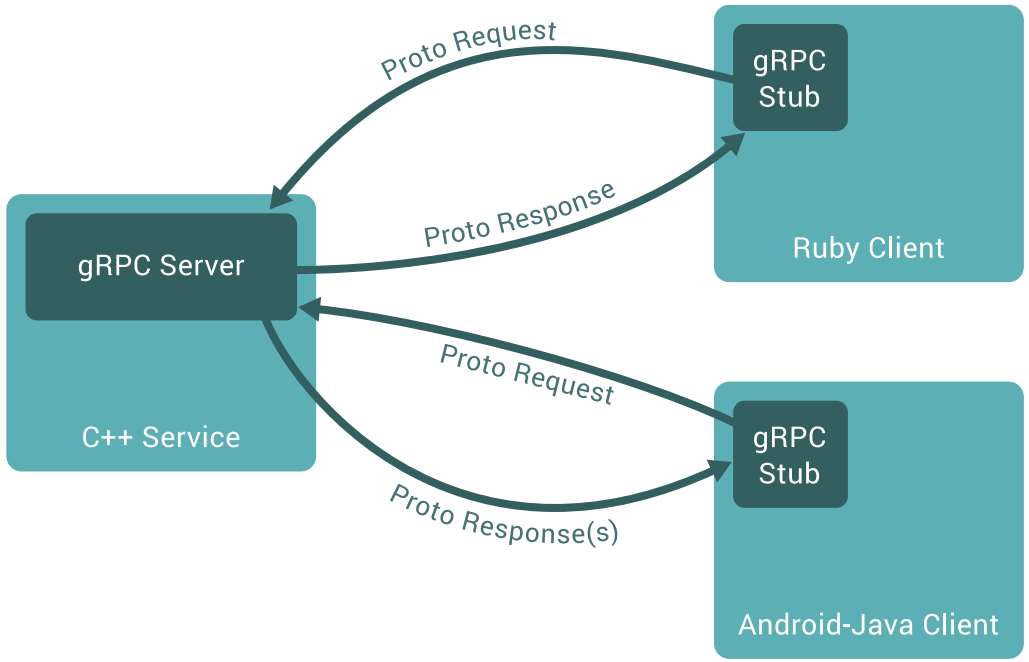
What is gRPC?

gRPC is an open source, high performance RPC framework from Google. It is cross platform and language agnostic. It is primarily used for connecting polyglot services.



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What is an RPC?

```
In distributed computing, a remote procedure call (RPC) is when a computer
program causes a procedure (subroutine) to execute in a different address space
(commonly on another computer on a shared network), which is coded as if it
were a normal (local) procedure call, without the programmer explicitly coding
the details for the remote interaction
- Wikipedia
```

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What is Protobuf?

- gRPC uses Protocol Buffers as the message format.
- Protocol buffers are a flexible, efficient, automated mechanism for serializing structured data.
- Protobufs are language neutral, platform neutral, and extensible.
- comes from Google
- open source

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Why use Protobuf?

1. Backwards compatibility

- New fields will be discarded by services with older version of `.proto` file

2. Fixed Schema

- Typed schema provides validation on serialization/deserialization

3. Space efficient (3-10x smaller)

- Binary-Encoding, varint encoding, and no field names or overhead characters

4. Faster (20-100x faster)

- Binary-Encoding is more efficiently processed than recursively parsing string-encoded message and reflecting on type (if applicable)

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How to use Protobuf?

- specify the structure of the data in a `.proto` file
- Each protobuf message is a very small (less than 1MB) logical record, consisting of a series of key-value pairs
- You distribute the `.proto` file to all the services communicating with that message
- compile it for the language of each service

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A Protobuf Message

```
syntax = "proto3";

message Contact {
    string name = 1;
    int32 id = 2;
    string email = 3;

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

    message PhoneNumber {
        string number = 1;
        PhoneType type = 2 [default = HOME];
    }

    repeated PhoneNumber phone = 4;
}
```

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How does Protobuf work?

1. Protobuf compiler generate *SerDes* code for a target language
2. When it serializes a protobuf message in code, it converts each field to its *wire type* and concatenates them together into a single byte stream, ready to send
3. The deserializer reads the byte stream sequentially, looking for a set of start bytes starting each field identifying the field, the *wire type*, and followed by the data
4. The stream is deserialized into a protobuf-compiler-generated object (for the target language)

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Protobuf Encoding

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Length Delimited Encoding

Strings are encoded as a series of bytes prefixed by a length. This goes for repeated fields, and embedded messages as well.

For Example:

```
12 07 | 74 65 73 74 69 6e 67
0x12 → Field Number = 2, type = 2
0x07 → Seven Bytes following
Message spells out "testing"
```

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Base 128 VarInt encoding

VarInt incoding is a way to serialize integers using one or more bytes.

For Example: 300

```
Encoded in VarInt
1010 1100 0000 0010
# (44034)

# Uses only lower 7 bits (base 128);
# MSB is reserved to indicate continuation.
1010 1100 0000 0010
→ 010 1100  000 0010

# All Lower 7 Bits Concatenated (Little Endian)
000 0010  010 1100
# Concat the bytes
→  000 0010 ++ 010 1100
→  100101100
→  256 + 32 + 8 + 4 = 300
```

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Fixed Encoding

- Certain types (float, fixedInt32, etc) always consume a fixed number of bytes
- Using negative `int*` will cause numbers to drop out of VarInt encoding and always consume ten bytes (Use `sint32` instead)

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Protobuf Types

Protobuf supports a bunch of scalar types:

```
Type    Meaning             Used For
0        Varint              int32, int64, uint32, uint64, sint32, sint64, bool, enum
1        64-bit              fixed64, sfixed64, double
2        Length-delimited    string, bytes, embedded messages, packed repeated fields
3        Start group         groups (deprecated)
4        End group           groups (deprecated)
5        32-bit              fixed32, sfixed32, float

Decoding: (field_number << 3) | wire_type
```

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Field Ordering

```
    string host = 1;
    string path = 2;
    string x_forwarded_for = 3;
```

- Specify order by using unique numeric tags for each field starting with 1, up to 536,870,911 (excluding 19000-19999 reserved for protobuf)
- Should keep the number of tags at 15 to use only one byte
- You can use field numbers in any order
- When serialized, the message will be in the correct order
- The sequential nature of the byte stream allows the decoder to work fast
- The decoder can also act on fields in any order.

From Protobuf to gRPC Service

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Sample gRPC Proto

```
import 'google/protobuf/empty.proto';

service Core {
    rpc Assign (AssignmentRequest) returns (PhaserResponse){}
    rpc FlushCache(google.protobuf.Empty) returns (google.protobuf.Empty){}
}

message AssignmentRequest {
    string host = 1;
    string path = 2;
    string x_forwarded_for = 3;
    string user_agent = 4;
    string referer = 5;
    string dr_orpheus_header = 6;
    string jet_api_client = 7;
    map<string,string> supplemental_headers = 8;
}

message PhaserResponse {
    string build_header = 1;
    string dr_orpheus_header = 2;
}
```

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Sample gRPC Client Implementation

```
import (
    "context"
    "log"
    "time"

    pb "go.jet.network/phaser/core-service/proto"
    "google.golang.org/grpc"
)

func main() {
    // Set up a connection to the server.
    conn, err := grpc.Dial("localhost:8080", grpc.WithInsecure())
    if err != nil {
        log.Fatalf("did not connect: %v", err)
    }
    defer conn.Close()
    c := pb.NewCoreClient(conn)
    ctx, cancel := context.WithTimeout(context.Background(), time.Second)
    defer cancel()
    r, err := c.Assign(ctx, &pb.AssignmentRequest{DrOrpheusHeader: "Dr. O: Phaser!"})
    if err != nil {
        log.Fatalf("could not assign: %v", err)
    }
}
```

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Sample gRPC Server Implementation

```
type PhaserServer struct{}

// Assign Stub
func (ps *PhaserServer) Assign(ctx context.Context,
    req *pb.AssignmentRequest) (*pb.PhaserResponse, error) {
    pd := "Some Phaser Assignment"
    return &pb.PhaserResponse{DrOHeader: pd}, nil
}

func main() {
    lis, err := net.Listen("tcp", ":8080")
    if err != nil {
        log.Fatalf("Failed to listen: %v", err)
    }
    s := grpc.NewServer()

    // this will satisfy the interface laid out in pb.go file
    var ps *PhaserServer
    // Defined in Autogenerated pb.go file
    pb.RegisterCoreServer(s, ps)
    if err := s.Serve(lis); err != nil {
        log.Fatalf("Failed to serve: %v", err)
    }
}
```

gRPC Methods

gRPC gives us four kinds of methods:

1. Unary RPC
2. Server-Streaming RPC
3. Client-Streaming RPC
4. BiDirectional-Streaming RPC

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HTTP/2

gRPC transmits data over HTTP/2 Protocol:
- Update to HTTP/1.1 Protocol
- Spec Released May 2015

Features

- Single TCP connection for multiple streams
- Server Push
- Supports **Binary Protocols**
- Multiplexed Streams
- Stream prioritization
- HPACK Stateful Header Compression

gRPC Feature Summary

- Idiomatic client libraries in 10 languages
- Highly efficient on wire and with a simple service definition framework
- Bi-directional streaming with http/2 based transport
- Pluggable auth, tracing, load balancing and health checking

Thank you

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