CSE 124
Distributed programming and Remote Procedure Calls (RPC): Apache Thrift

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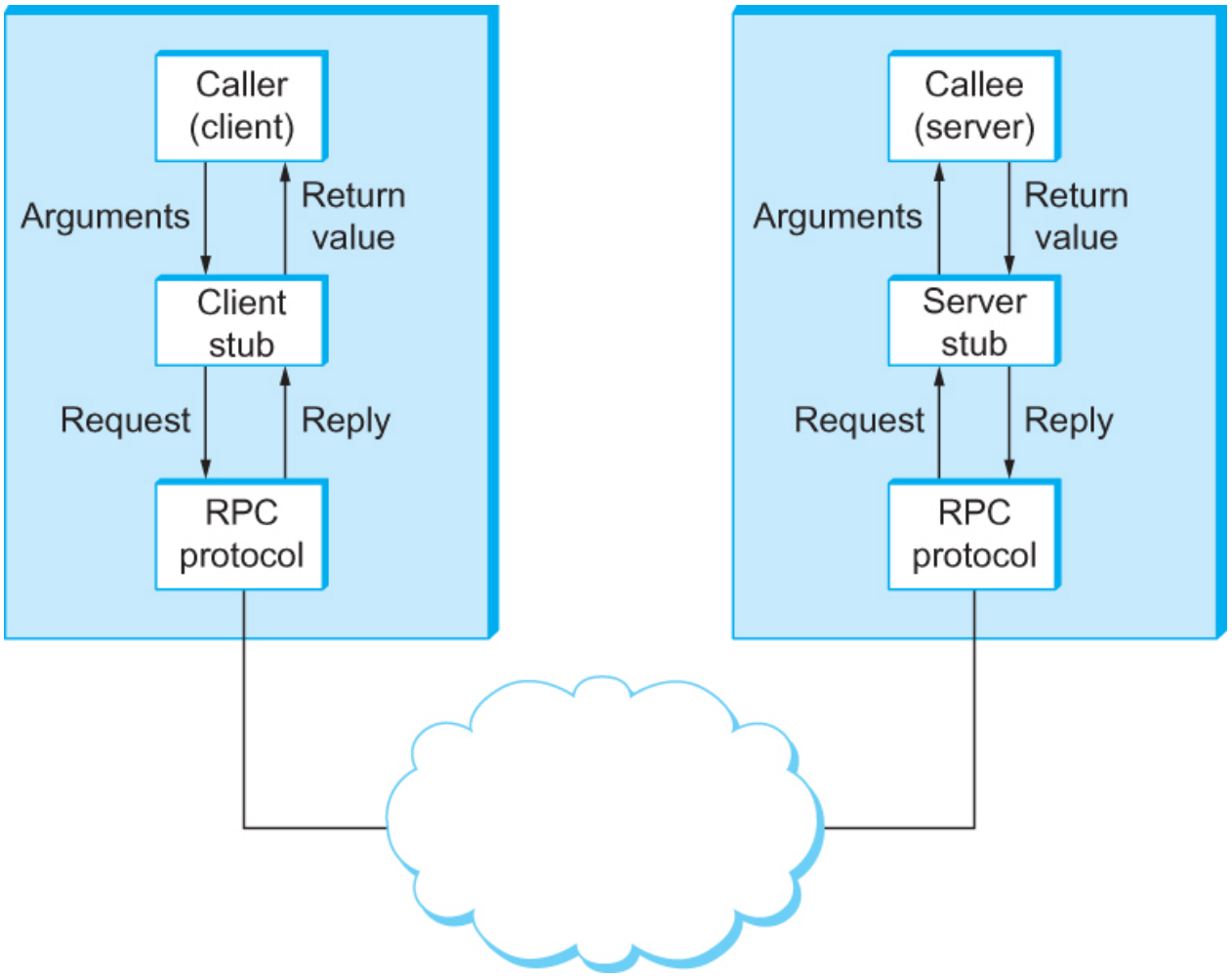
Announcements

RPC Components

- End-to-end RPC protocol
  - Defines messages, message exchange behavior, …
- Programming language support
  - Turn “local” functions/methods into RPC
  - Package up arguments to the method/function, unpackage on the server, …
  - Called a “stub compiler”
  - Process of packaging and unpackaging arguments is called “Marshalling” and “Unmarshalling”

High-level overview



Outline

- Thrift overview
- In-class development of a simple “ATM machine” service

Apache Thrift Overview

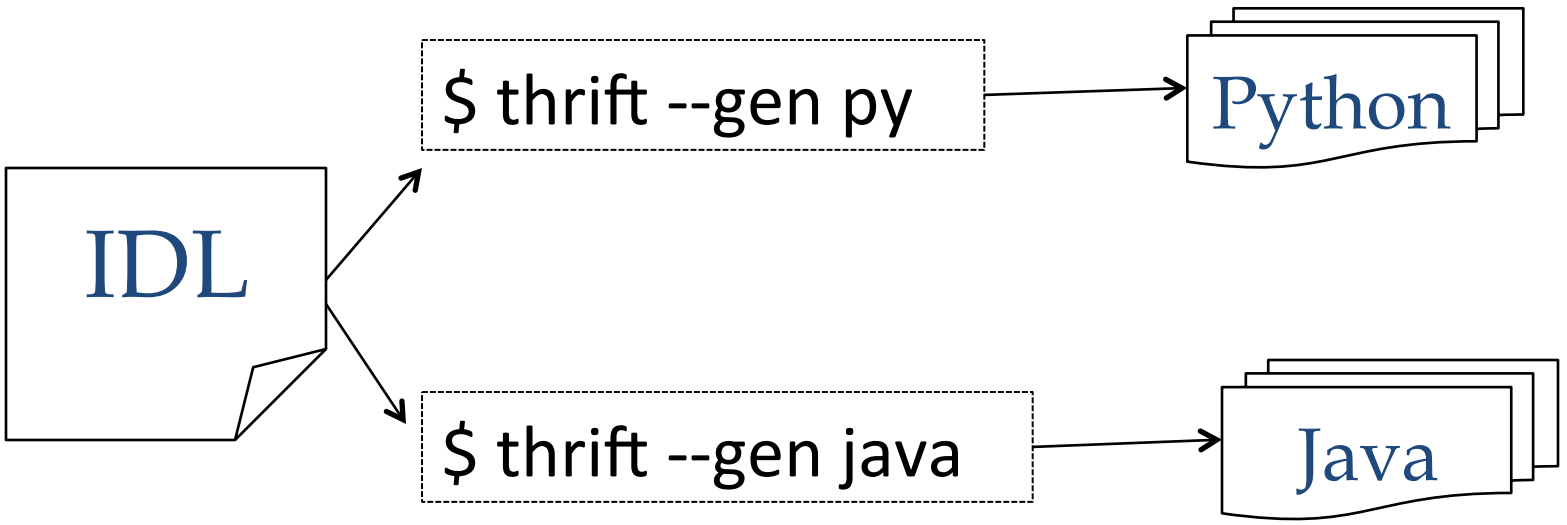
Thanks to Diwaker Gupta
http://diwakergupta.github.io/thrift-missing-guide/

Features

- Cross-platform RPC toolkit developed by Facebook
- Languages:
  - C++, C#, Cocoa, Java, OCaml, PHP, Ruby, Python, …
- Namespaces
  - (as compared to flat identifiers)
- Data types
  - Base, Structs, Constants, Enums, Containers (Set, List, …)
- Exceptions
- Services
  - The actual procedures you are remotely calling

IDL: Interface Definition Language

- Language-neutral way of specifying:
  - Data structures
  - Services, consisting of procedures/methods
- Stub compiler
  - Compiles IDL into Python, Java, etc.



IDL Base types

- bool: A boolean value (true or false)
- byte: An 8-bit signed integer
- i16: A 16-bit signed integer
- i32: A 32-bit signed integer
- i64: A 64-bit signed integer
- double: A 64-bit floating point number
- string: A text string encoded using UTF-8 encoding

IDL Containers

- `list<t1>`
  - Ordered list of type t1
- `set<t1>`
  - Unordered set of unique items of type t1
- `map<t1,t2>`
  - Map of unique keys of type t1 to values of type t2

IDL Services

- Defines procedures/methods to be invoked
- Similar to Java interfaces
  - You specify their type signature in the IDL
  - Then actually implement the methods in Java/Python/… files
    - (But Thrift helps you out by handling much of the cookie-cutter code generation)

```
service Calculator {
    i32 add(1:i32 num1, 2:i32 num2)
}
```

IDL Positional Arguments

- Why?
  - `i32 add(1:i32 num1, 2:i32 num2)`
- Instead of:
  - `i32 add(i32 num1, i32 num2)`

Making services *evolvable*

- Consider supporting multiple generations of services
  - (see optional paper on evolving services by Brewer et al.)
- Parameters can be added/dropped over time
  - `void addUser(String firstname, String lastname, i32 ID)`
- Becomes
  - `void addUser(String fullname, i32 ID, i32 phonenum)`
- Confusion results; type information not enough to differentiate old vs. new service API
- Explicit numbering allows parameter order and the existence of parameters change

Explicit Parameter numbering

- `void addUser(1:String firstname, 2:String lastname, 3:i32 ID)`
- →
- `void addUser(4:String fullname, 5:i32 phonenum, 3:i32 ID)`

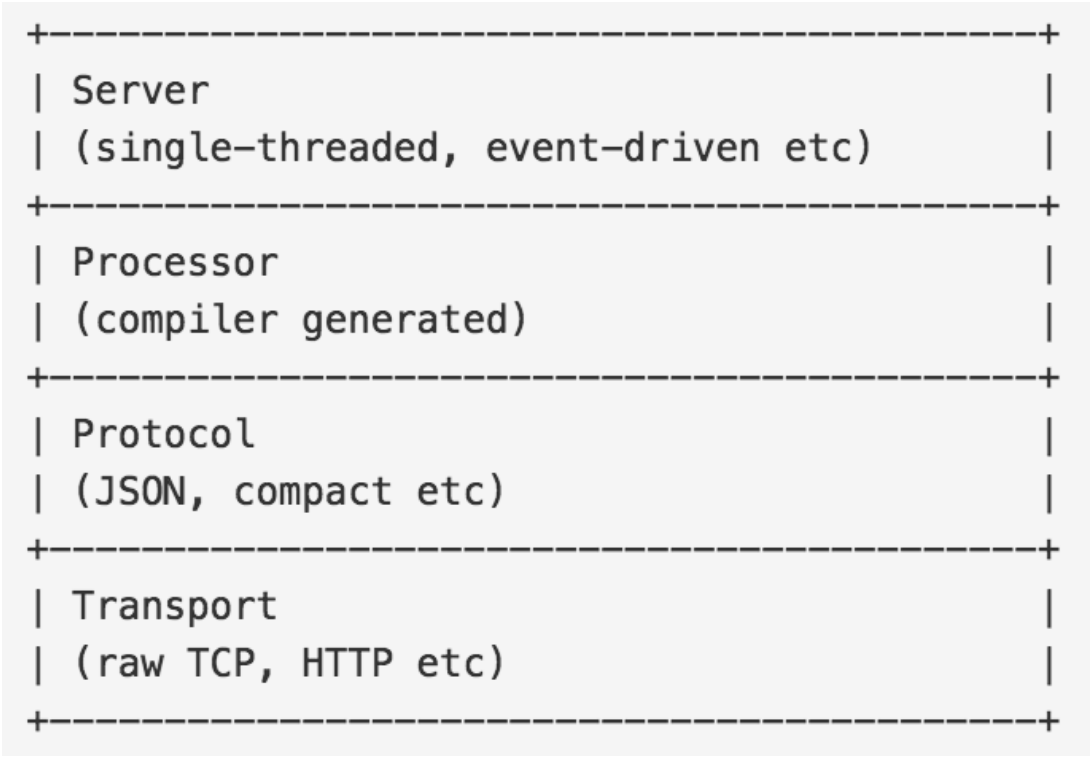
Parameter numbering and Structs

- Explicit parameter numbers applies to structures too
- Required/optional further constrains RPC interface

```
struct Location {
    1: required double latitude;
    2: required double longitude;
}

struct Tweet {
    1: required i32 userId;
    2: required string userName;
    3: required string text;
    4: optional Location loc;
    16: optional string language = "english"
}
```

Thrift's layered model



Transport Protocol

- Reading/writing to the network (or other channel)
- Can utilize TCP, or even HTTP
- Can also read and write to files on a disk
  - Facebook uses this feature to record `log()` calls in a logging system, and then "replays" them later to actually record the logs

Protocol

- Maps in-memory data structures to on-the-wire formats
- Knows how to convert each IDL data type
  - For each language
- Examples:
  - writeI32(i32)
  - readI32(i32)
  - writeString(string)
  - readString(string)
  - …
- Text-based JSON, compact binary representation, …

Processor and Server

- Processor
  - Compiler-generated “glue” between RPC protocol messages and your code
- Server
  - High-level controller of all we’ve talked about
  - Creates the transport (e.g., open TCP sockets, bind, listen, accept, …)
  - Creates input/output protocols
  - Creates a processor based on the input/output protocols
  - Wait for incoming connections and hand off to processor

ATM Server

Simple ATM Server

- Operations:
  - login
    - Account number + PIN
  - deposit
    - $$$
  - getBalance
  - logout

Simple ATM Server

- Keeping track of account + pin with "login tokens"
- After logging in, get a token
- Use token to deposit money, withdraw, transfer, …

ATM Machine Project Structure