THE PROGRAMMER'S GUIDE TO

Apache Thrift

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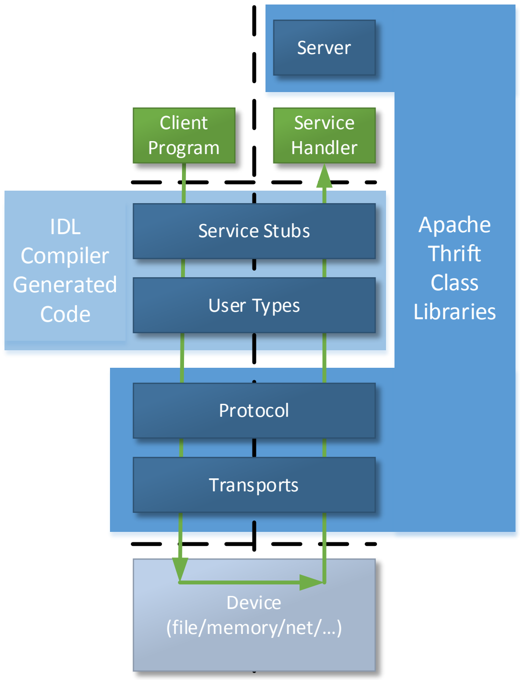
brief contents

Part 1
Apache Thrift Overview

Apache Thrift is an open source cross language serialization and remote procedure call (RPC) framework. With support for over 20 programming languages, Apache Thrift can play an important role in many distributed application solutions. As a serialization platform Apache Thrift enables efficient cross language storage and retrieval of a wide range of data structures. As an RPC framework, Apache Thrift enables rapid development of complete cross language services with little more than a few lines of code.

Part 1 of this book will help you understand how Apache Thrift fits into modern cloud based application models while imparting a high level understanding of the Apache Thrift framework architecture. Part 1 also gets you started with basic Apache Thrift setup and debugging and a look at building a simple cross language hello world service.


Server
Client Program
Service Handler
IDL Compiler Generated Code
Service Stubs
User Types
Apache Thrift Class Libraries
Protocol
Transports
Device (file/memory/net/...)

1 Introduction to Apache Thrift

This chapter covers

- Using Apache Thrift to unify polyglot systems
- How Apache Thrift simplifies the creation of networked services
- An introduction to the Apache Thrift modular serialization system
- How to create a simple Apache Thrift multilanguage application

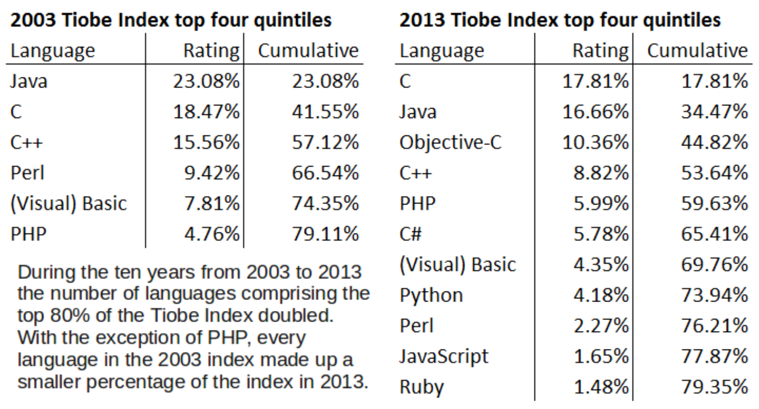
Modern software systems live in a networked world. From the tiniest embedded systems chirping away in the Internet of Things to the largest monolithic relational databases anchoring traditional three tier applications, network communications are a core competency. But how to wire all of these things together? How do we package a message from a service written in one language in such a way that any other language can read it? How do we design services that are fast enough for high performance backend cloud systems? How do we do these things in such a way that our interfaces can evolve over time without breaking existing systems? How do we do all of this in an open, vender neutral way? For companies like Facebook, Evernote and Twitter, the answer is Apache Thrift.

This chapter introduces the Apache Thrift framework. In the pages ahead we will take a look at why Apache Thrift was created and how it helps programmers build high performance cross language services. The chapter begins with a look at the growing need for multilanguage integration and examines the role Apache Thrift plays in polyglot distributed application development. Developers are faced with many choices when selecting tools which integrate software systems written in several languages, this chapter will help you know when Apache Thrift is a good solution. This chapter also includes a tutorial which will walk you through the construction of a simple Apache Thrift application, demonstrating how easy it is to create cross language networked services with Apache Thrift.

1.1 Polyglotism, the pleasure and the pain

The number of programming languages in common commercial use has grown considerably in recent years. In 2003 80% of the Tiobe Index was attributed to six programming languages: Java, C, C++, Perl, Visual Basic and PHP. In 2013 it took twice as many languages to capture the same 80%, adding Objective-C, C#, Python, JavaScript and Ruby to the list. In 2015 the Tiobe top 20 languages only added up to around 75% of the mind share. In Q4 2014 Github reported 19 languages all having more than 10,000 active repositories (http://githut.info/), adding Swift, Go, Scala and others to the list of popular languages. Increasingly developers and architects choose the programming language most suitable for the task at hand. A developer working on a Big Data project might decide Clojure is the best language to use, meanwhile folks down the hall may be doing front end work in JavaScript, while programmers upstairs might be using C and C++ with embedded systems. Years ago this type of diversity would be rare at a single company, now it can be found within a single team.

Choosing a programming language uniquely suited to solving a particular problem can lead to productivity gains and better quality software. When the language fits the problem, friction is reduced, programming becomes more direct and code becomes simpler and easier to maintain. For example, in large scale data analysis, horizontal scaling is instrumental in achieving performance. Functional programming languages like Haskell, Scala and Clojure tend to fit naturally here, allowing analytic systems to scale without complex concurrency concerns.



2003 Tiobe Index top four quintiles

Language	Rating	Cumulative
Java	23.08%	23.08%
C	18.47%	41.55%
C++	15.56%	57.12%
Perl	9.42%	66.54%
(Visual) Basic	7.81%	74.35%
PHP	4.76%	79.11%

During the ten years from 2003 to 2013 the number of languages comprising the top 80% of the Tiobe Index doubled. With the exception of PHP, every language in the 2003 index made up a smaller percentage of the index in 2013.

2013 Tiobe Index top four quintiles

Language	Rating	Cumulative
C	17.81%	17.81%
Java	16.66%	34.47%
Objective-C	10.36%	44.82%
C++	8.82%	53.64%
PHP	5.99%	59.63%
C#	5.78%	65.41%
(Visual) Basic	4.35%	69.76%
Python	4.18%	73.94%
Perl	2.27%	76.21%
JavaScript	1.65%	77.87%
Ruby	1.48%	79.35%

Figure 1.1 - The Tiobe Index uses web search results to track programming language popularity (www.tiobe.com)

New platforms drive language adoption as well. Objective-C exploded in popularity when Apple released the iPhone and Swift is following suit, most programming for Android will be biased toward Java and the Windows Phone folks will likely be using C#. Those coding for the browser will have teams competent with JavaScript. Embedded systems shops are going to have strong C programming groups and high performance GUI applications will often be written in C++. These choices are driven by history as well as compelling technology underpinnings. Even when such groups are internally monoglots, languages mix and mingle as they collaborate across business boundaries.

Many organizations who claim monoglotism make use of a range of support languages for testing and prototyping. Dynamic programming languages such as Groovy and Ruby are often used for test and behavioral driven development solutions, while Perl and Python are popular for prototyping and PHP has a long history on the server side of the web. Platforms such as the Groovy based Gradle and the Ruby based Rake provide innovative build capabilities. Thus, even firms that think they are monoglots may not be, given the proliferation of innovative language driven tools around the periphery of core application development.

The Polyglot story is not all wine and song, however. Mastering a programming language is no small feat, not to mention the tools and libraries that come with it. As this burden is multiplied with each new language, firms may experience diminishing returns. Introducing multiple languages into a product initiative can have numerous costs associated with cross language integration, developer training, and complexity in build and test. If managed improperly, these costs can quickly overshadow the benefits of a multilanguage strategy.

Figure 1.1 - The growing number of programming languages in commercial use creates important cross language interoperability challanges

There are many degrees of Polyglotism. Some go to the extreme, coding individual components of a single process in different languages, relying on a runtime layer, such as the JVM or CLR, to provide interoperability. Others are purists, sticking with a single language for everything and only dealing with other languages when forced to by partners and clients. Either way, if trends continue, only the rarest of software teams will be truly isolated within the bounds of a single programming language in the years ahead. While Polyglotism may be bane or boon, depending on your point of view, it is a condition not likely to go away. The more our programs mirror the dialog on the floor of the United Nations General Assembly, the more we will need professional translators to communicate across languages.

1.2 The Apache Thrift Framework from 30,000 feet

Apache Thrift solves two important problems associated with building cross platform applications:

- Data Normalization
- Service Implementation

1.2.1 Data Normalization

The first problem, data normalization, is fundamental to any cross platform/language exchange. Imagine an enterprise application that uses Apache QPID as a messaging system. Using the QPID message broker, Java and Python programs can send messages to queues. The question is: can the Python and Java programs read each other's messages? Python objects are represented differently in memory than Java objects. If a Python program sent the raw memory bits for a Python object to a Java program, fireworks would likely ensue.

To solve this problem we need a data normalization layer on top of the messaging platform. So why not just send everything back and forth in JSON? Using a standard format like JSON is part of a solution, however we still must answer questions like: how are data fields ordered when sending multi field messages, what happens when fields are missing, what does a language that does not directly support a data type do when receiving that datatype? These and many other questions cannot be answered by a data layout specification like JSON or XML. If you do use JSON, what happens when a text based format proves to be too slow to parse or too large to store?

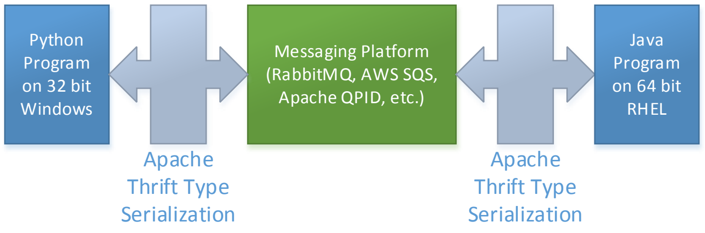

Python Program on 32 bit Windows
Messaging Platform (RabbitMQ, AWS SQS, Apache QPID, etc.)
Java Program on 64 bit RHEL
Apache Thrift Type Serialization
Apache Thrift Type Serialization

Figure 1.2 - Apache Thrift can be used to normalize data in cross platform messaging scenarios.

These questions are answered by Apache Thrift. Apache Thrift allows developers to define abstract data types in an Interface Definition Language (IDL). This IDL can then be compiled into source code for any supported language. The generated code provides complete serialization and deserialization logic for all of the IDL user defined types. Apache Thrift ensures that types written by any language can be read by any other language and generates the type serialization code for you.

Apache Thrift also provides pluggable serializers, known as protocols, allowing you to use any one of several serialization formats for data exchange, including binary for speed, compact for size and JSON for readability. Using a single serialization framework across all development languages avoids problems associated with tool integration in cross vender solutions. The open source nature of Apache Thrift also means that you can easily change or enhance functionality and push it upstream when needed (patches are always welcome at the Apache Thrift project).

1.2.2 Service Implementation

Some Apache Thrift users are only interested in the ability to consistently serialize types across languages and platforms. In such cases the data normalization features of Apache Thrift may be all that an organization requires. However, many also desire a way to construct platform and language agnostic services.

Service Oriented Architectures (SOA), or if you prefer, microservices, define applications in terms of many small composeable services. Data normalization is not enough to allow two programs to communicate directly in a client/server service model. Client programs need to be able to call functions provided by servers and, in many environments, servers need to be able to scale to support requests from thousands of clients concurrently.

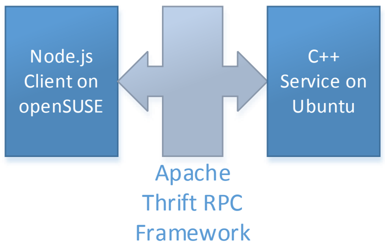


Figure 1.3 – The Apache Thrift RPC framework enables cross platform services.

Apache Thrift solves these service implementation problems by providing a complete cross language RPC framework. The Apache Thrift IDL allows services to be defined in concert with user defined data types. In this way types can be serialized to disk files, passed as messages or used in the context of service methods. The Apache Thrift framework also includes a complete library of servers, ready to use. This makes it possible for developers to define a service in IDL, code the service method implementations and leave everything else to Apache Thrift. Apache Thrift will provide client side proxies and all of the server side networking, concurrency and call routing logic.

1.3 Apache Thrift Features

There are several key benefits associated with using Apache Thrift to develop network services or perform cross language serialization tasks.

- Full SOA Implementation - Apache Thrift supplies a complete SOA solution
- Modularity - Apache Thrift supports plug-in serialization protocols and transports
- Performance - Apache Thrift is fast and efficient
- Reach - Apache Thrift supports a wide range of languages and platforms
- Flexibility - Apache Thrift supports interface evolution

Let's take a look at each of these features in turn.

1.3.1 Service Implementation

Services are modular application components which provide interfaces accessible over a network. The service facilities of Apache Thrift are Interface Definition Language (IDL) based (see Listing 1.1). Services are described using a simple IDL syntax and compiled to generate stub code used to connect clients and servers in a wide range of languages.

For example, imagine you have a C++ module which tracks and computes sailing team statistics for the America's Cup and that this module is built into a C++ GUI application. As it happens, your company's web dev team would like to use the sail stats module to enhance a client facing web application. Several challenges are presented here. Imagine the web site team builds everything in PHP and that the web application uses the Service Oriented Architecture (SOA) model. To provide the sail stats features to the web dev team in the most convenient way possible the sail stats module will need to be deployed as a network service.

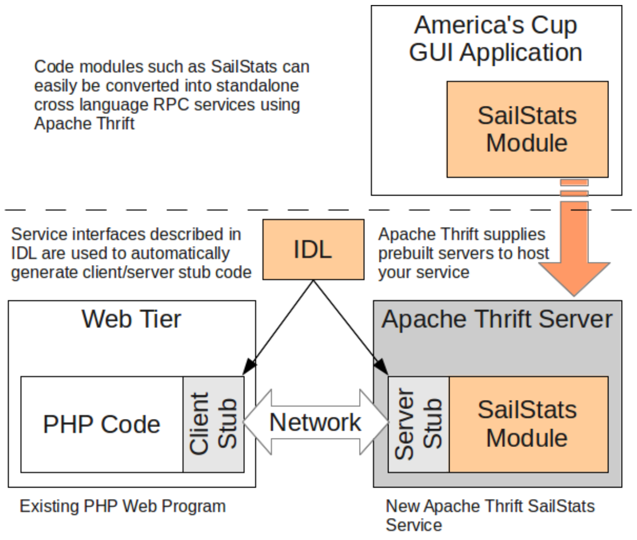

Code modules such as SailStats can easily be converted into standalone cross language RPC services using Apache Thrift
America's Cup GUI Application
SailStats Module
Service interfaces described in IDL are used to automatically generate client/server stub code
IDL
Apache Thrift supplies prebuilt servers to host your service
Web Tier
PHP Code
Client Stub
Network
Apache Thrift Server
Server Stub
SailStats Module
Existing PHP Web Program
New Apache Thrift SailStats Service

Figure 1.4 - Converting a module from a GUI application (above dotted line) into a distributed network application (below dotted line)

Microservices And Service Oriented Architecture (SOA)

The microservices and SOA approaches to distributed application design break applications down into services, which are remotely accessible autonomous modules composed of a set of closely related functions. SOA based systems generally provide their features over language agnostic interfaces, allowing clients to be constructed in the most appropriate language and on the most appropriate platform, independent of the service implementation. SOA services are typically stateless and loosely coupled, communicating with clients through a formal interface contract. SOA services may be internal to an organization or support clients across business boundaries.

Encapsulating the SailStats module in a SOA service will make it easy for any part of the company's enterprise to access the service. There are several common ways to build SOA services using web oriented technologies, however many of these would require the installation of web or application servers, possibly a material amount of additional coding, the use of HTTP communications schemes and text based data formats, which are broadly supported but not famous for being fast or compact.

Apache Thrift offers a compelling alternative. Using Apache Thrift IDL we can define a service interface with the functions we want to expose. We can then use the Apache Thrift compiler to generate RPC code for our SailStats service in PHP and C++ (and most other commercially viable languages). The web team can now use code generated in their language of choice to call the functions offered by the SailStats service, exactly as if the functions were defined locally (see Figure 1.4).

Apache Thrift supplies a complete library of RPC servers. This means that you can use one of the powerful multithreaded servers provided by Apache Thrift to handle all of the server RPC processing and concurrency matters. The C++ code generated from the IDL will make it easy to take the existing sail stats module and wire it to the service oriented interface, with network support provided by one of the prebuilt Apache Thrift RPC servers.

Listing 1.1 ~/thriftbook/hello/SailStats.thrift

```
service SailStats {
   double GetSailorRating(1: string SailorName),
   double GetTeamRating(1: string TeamName),
   double GetBoatRating(1: i64 BoatSerialNumber),
   list<string> GetSailorsOnTeam(1: string TeamName),
   list<string> GetSailorsRatedBetween(1: double MinRating,
                                       2: double MaxRating),
   string GetTeamCaptain(1: string TeamName),
}
```

To turn a code library or module into a high performance RPC service with Apache Thrift, all we need do is:

1. Define the service interface in IDL
2. Compile the IDL to generate client and server RPC stub code in the desired languages
3. On the client side call the remote functions as if they were local using the client stubs
4. On the Server side connect the server stubs to the desired module functionality
5. Choose one of the prebuilt Apache Thrift servers to host the service

In exchange for a fairly small amount of work, we can turn almost any set of existing functions into a high performance Apache Thrift service, accessible from a broad range of client languages.

1.3.2 Modular Serialization

To make a function call from a client to a server, both client and server must agree on the representation of data exchanged. The typical approach to solving this problem is to select an interchange format and then to transform all data to be exchanged into this interchange format. The process of transforming data to and from an interchange format is called serialization. In essence, taking a complex memory object and turning it into a serial bit stream.

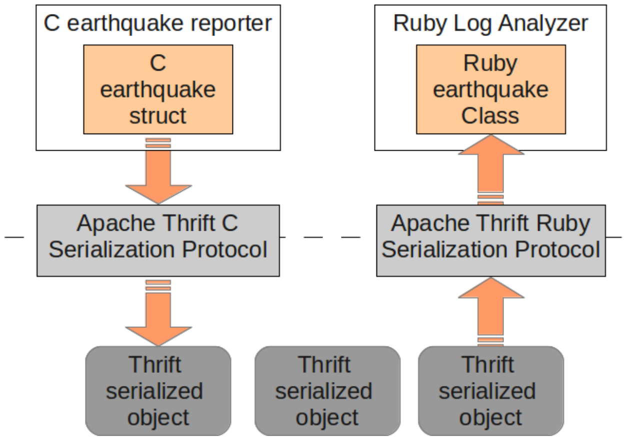


Figure 1.5 - Apache Thrift serialization protocols enable different programming languages to share abstract data types

The Apache Thrift framework provides a complete, modular, cross language serialization layer which supports RPC functionality but can also be used independently. Serialization frameworks make it easy to store data to disk for later retrieval by another application. For example, a service written in C which captures live earthquake data in a C struct could serialize this data to disk using Apache Thrift (see figure 1.6). The serialization process converts the C struct into a generic Apache Thrift serialized object. At a later time a Ruby earthquake analysis application could use Apache Thrift to restore the serialized object. The serialization layer takes care of the various differences in data representation between the languages automatically.

A fairly unique feature of the Apache Thrift serialization framework is that it is not hard wired to a single serialization protocol. The serialization layer provided by Apache Thrift is modular, making it possible to choose from an assortment of serialization protocols, or even to create custom serialization protocols. Out of the box, Apache Thrift supports an efficient binary serialization protocol, a compact protocol which reduces the size of serialized objects and a JSON protocol which provides broad interoperability with JavaScript and the web.

1.3.3 Performance

Apache Thrift is a good fit in many distributed computing settings, however it excels in the area of high performance backend services.

The choice of prebuilt and custom protocols for serialization allows the application designer to choose the most appropriate serialization protocol for the needs of the application, balancing transmission size and speed.

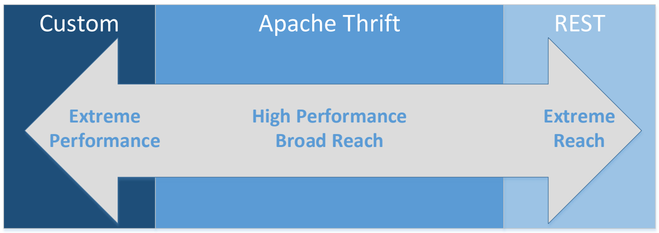


Figure 1.6 – Apache Thrift balances performance with reach and flexibility

Apache Thrift supports compiled languages such as C, C++, Java and C#, which generally have a performance edge over interpreted languages. This allows performance critical services to be built in the appropriate language while still providing interoperability with highly productive front end development languages.

Apache Thrift RPC servers are lightweight, performing only the task of hosting Apache Thrift services. A selection of servers is available in various languages giving application designers the flexibility to choose a concurrency model well suited to their application requirements. These servers are easy to deploy and load balance as standalone processes or within Virtual Machines or Containers.

Apache Thrift covers a wide range of performance requirements in the spectrum between custom communications development on one end and REST on the other (see figure 1.7). The light weight nature of Apache Thrift combined with a choice of efficient serialization protocols allows Apache Thrift to meet demanding performance requirements while offering support for an impressive breadth of languages and platforms.

1.3.4 Reach

The Apache Thrift framework supports a number of programming languages, operating systems and hardware platforms in both serialization and service capacities. Companies which are growing and changing rapidly need solutions which give teams the flexibility to integrate with new languages and platforms rapidly and with low friction. Apache Thrift can be a significant business advantage in settings such settings. Figure 1.8 illustrates the broad scope of environments within which Apache Thrift is often found.

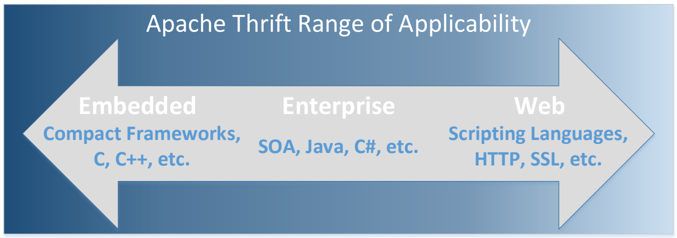

Apache Thrift Range of Applicability
Embedded
Compact Frameworks, C, C++, etc.
Enterprise
SOA, Java, C#, etc.
Web
Scripting Languages, HTTP, SSL, etc.

Figure 1.7 - Apache Thrift is an effective solution in embedded, enterprise and web technology environments

The table below provides a list of the languages supported directly by Apache Thrift 1.0. Note that support for C# enables other .Net/CLR languages, such as F#, VisualBasic and IronPython. By the same token, support for Java enables most JVM based languages to interoperate with Apache Thrift, including Scala, Clojure and Groovy. JavaScript support is provided for browser based applications and Node.js. Other projects found on the web expand this list further.

Table 1.1 - Languages supported by Apache Thrift

C	C++	C#	D
Delphi	Erlang	Go	Haskell
Haxe	Java	JavaScript	Lua
Objective-C	OCaml	Perl	PHP
Python	Ruby	Smalltalk	TypeScript

Apache Thrift supports these languages on a range of platforms including Windows, iOS, OS X, Linux, Android and many other Unix-like systems. Apache Thrift is compact and supports C/C++ and JavaME, making it appropriate for some embedded systems. At the other end of the spectrum, Apache Thrift supports HTTP[S], Webscoket and an array of web tech languages, including Perl, PHP, Python, Ruby and JavaScript, making it viable in web oriented environments. Few frameworks can supply the breadth of reach in languages and platforms offered by Apache Thrift.

1.3.5 Interface Evolution

Interface evolution is the process of changing the elements of an interface gradually over time. Modern IDL based systems like Apache Thrift make it possible to evolve interfaces without breaking interoperability with modules built around older versions of the interface.

For example, consider the previously described earthquake application where a C language program writes a C language struct to disk each time a tremor is reported. Let’s assume that the earthquake struct contains fields for the date, time, position and magnitude of the earthquake and that this struct is shared with a Ruby data analysis program. The interface evolution features of Apache Thrift allow new fields, say the earthquake’s nearest city and state, to be added to the earthquake struct without breaking the Ruby application. The Ruby program will continue to read old and new earthquake files, simply ignoring fields it does not recognize. Should the Ruby programmers require the new fields they may add support for them at their leisure, using default values when old files without the new fields are read.

Early RPC systems like SunRPC, DCE RPC, CORBA and MSRPC supplied little or no support for interface evolution. As platforms grow and requirements change, rigid interfaces can make it hard to extend and maintain RPC based services. Modern RPC systems such as Apache Thrift provide a number of features which allow interfaces to evolve over time without breaking compatibility with existing systems. Functions can be extended with new parameters, old parameters can be removed, and default values can be supplied. Properly applied these changes can be made without impacting peers using older versions of the interface.

Support for interface evolution greatly simplifies the task of ongoing software maintenance and extension, particularly in a large enterprise. Modern engineering sensibilities such as Microservices, Continuous Integration (CI) and Continuous Delivery (CD) require systems to support incremental improvements without impacting the rest of the platform. Systems which do not supply some form of interface evolution tend to “break the world” when changed. In such systems changing an interface means that all of the clients and servers using that interface must be rewritten and/or recompiled, then redeployed in a big bang. Apache Thrift interface evolution features allow multiple interface versions to coexist, making incremental updates viable. We will take an in depth look at interface evolution in later chapters.

Continuous Integration (CI) & Continuous Delivery (CD)

Continuous integration is an approach to software development wherein changes to a system are merged into the central code base frequently. These changes are continuously built and tested, usually by automated systems, providing developers with rapid feedback when patches create conflicts or fail tests. Taking CI to its logical conclusion involves migrating successfully merged code to evaluation and ultimately production systems at a high frequency. Often these processes occur multiple times per day. The goal of continuous systems is to take many small risks and to provide immediate feedback rather than taking large risks and delaying feedback over long release cycles. The longer integration is delayed the more patches are involved in the integration task, making it more difficult to identify and repair the source of conflicts and bugs.

1.4 Building a Simple Service

Now that we have covered some of the key features and benefits of Apache Thrift, let’s take a look at a very simple Apache Thrift service. If you already have a working Thrift installation on your system you can build the example as you read. If you do not have a working Thrift installation you may want to take a few minutes to setup Apache Thrift (Chapter 3 covers Apache Thrift setup).

For this example we’ll build a simple server designed to supply various parts of our enterprise with a daily greeting. Our service will expose one function which takes no parameters and returns our greeting string. To see how Apache Thrift works across languages we will build clients in C++, Python and Java.

1.4.1 Describing services with Apache Thrift IDL

Most projects involving Apache Thrift begin with careful consideration of the services that will be consumed. Service interfaces are the basis for communications between clients and servers in Apache Thrift. Apache Thrift services are defined using an Interface Definition Language (IDL) similar to C in its notation. IDL code is saved in plain text files with a “.thrift” extension.

Here is the IDL file we will use for our service.

Listing 1.2 ~/thriftbook/hello/hello.thrift

```
service HelloSvc {                #A
   string hello_func()            #B
}
```

This IDL file declares a single service interface called HelloSvc #A. HelloSvc has one function, hello_func(), which accepts no parameters and returns a string #B. To use this interface in an RPC application we can compile it with the Apache Thrift IDL Compiler. The IDL Compiler will generate stub code for both clients using the interface and servers implementing the interface. In this example we will begin by using the compiler to generate Python stubs for the HelloSvc. The IDL Compiler binary is called “thrift” on UNIX like systems and “thrift.exe” on Windows. The IDL Compiler accepts an IDL file and a target language to generate code for. Here’s an example bash shell session which generates stubs for our HelloSvc:

```
~/thriftbook/hello $ ls -l
-rw-r--r-- 1 randy randy 95 Mar 26 16:28 hello.thrift
~/thriftbook/hello $ thrift --gen py hello.thrift                    #A
~/thriftbook/hello $ ls -l
drwxr-xr-x 3 randy randy 4096 Mar 26 16:31 gen-py                   #B
-rw-r--r-- 1 randy randy   95 Mar 26 16:28 hello.thrift
```

In this example we specify Python as our target by providing the gen switch with the “py” argument #A. The IDL Compiler creates a gen-py directory to house all of the emitted Python code #B.

1.4.2 Building a Python Server

We will construct an Apache Thrift Python server to host our HelloSvc. The principle work is the implementation of the HelloSvc itself. Apache Thrift provides a range of prebuilt servers and all of the glue needed to make our service available to clients. The following is the complete listing of the implementation for our Python service:

Listing 1.3 ~/thriftbook/hello/hello_server.py

```
import sys                                                            #A
sys.path.append("gen-py")                                             #A
from hello import HelloSvc                                            #A

from thrift.transport import TSocket                                  #B
from thrift.transport import TTransport                               #B
from thrift.protocol import TBinaryProtocol                           #B
from thrift.server import TServer                                     #B

class HelloHandler:                                                   #C
    def hello_func(self):
        print("[Server] Handling client request")
        return "Hello from the python server"

handler = HelloHandler()                                              #D
proc = HelloSvc.Processor(handler)                                    #D
```

```
trans_ep = TSocket.TServerSocket(port=9095)                            #E
trans_fac = TTransport.TBufferedTransportFactory()                     #F
proto_fac = TBinaryProtocol.TBinaryProtocolFactory()                   #G
server = TServer.TSimpleServer(proc, trans_ep, trans_fac, proto_fac)   #H
server.serve()                                                         #I
```

Our listing begins with the resolution of several dependencies using Python's import statement. We use the built in Python sys module to add the gen-py directory to the Python Path. This allows us to import the IDL Compiler generated RPC stubs for our HelloSvc service #A.

Our next step is to import several Apache Thrift library packages. TSocket provides an end point network transport for our clients to connect to, TTransport provides access to buffering and framing layers, TBinaryProtocol will handle data serialization and TServer will give us access to some of the prebuilt Python server classes #B.

The next block of code implements the HelloSvc service. This class is called a handler in Apache Thrift parlance. All of the service methods must be represented in the Handler class, in our case this is just the hello_func() method #C.

Next we create an instance of our handler and use it to initialize a processor for our service. The processor is the server side stub generated by the IDL Compiler which turns network RPC messages into calls to the handler #D.

Our RPC server will need an end point transport for clients to connect to as well as a buffering layer and a serialization protocol. The Apache Thrift library offers end points for use with files, memory and various networks. The example here creates a TCP server socket end point to accept client connections on TCP port 9095 #E. The buffering layer ensures that we make efficient use of the underlying network #F. The binary serialization protocol transmits our data in a fast binary format #G.

Apache Thrift provides a range of servers to choose from, each with unique features. The server used here is an instance of the TSimpleServer class, which, as its name implies, provides basic server functionality #H. Once constructed, we can run the server by calling the serve() method #I.

The Apache Thrift Tutorial

In addition to the code examples included with this text, the Apache Thrift source tree provides a tutorial with samples in each supported language. The tutorial is based on a central IDL file defining a calculator service from which client and server samples in each language are built. This tutorial is simple but demonstrates many of the capabilities of Apache Thrift in every supported language. The tutorials can be found under the tutorial directory off of the root of the Apache Thrift source tree. Each language specific tutorial is found in a subdirectory named for the language. A Makefile is provided to build the tutorial examples in languages which require compilation.

```
~thrift-1.0.0/thrift/tutorial  $ ls
as3     cpp             d               erl             go
java    Makefile.am     ocaml           php             py.tornado
```

```
rb      shared.thrift   c_glib          csharp          Delphi
haxe    hs              js              nodejs          perl
py      py.twisted      README.md       tutorial.thrift
```

To test our server program we can run the code at the command line using the Python interpreter.

```
~/thriftbook/hello $ ls -l
drwxr-xr-x 4 randy randy 4096 Jan 27 02:34 gen-py
-rw-r--r-- 1 randy randy  732 Jan 27 03:44 hello_server.py
-rw-r--r-- 1 randy randy   99 Jan 27 02:24 hello.thrift
~/thriftbook/hello $ python hello_server.py
```

Creating a Python server took about 7 lines of code, excluding imports and the service implementation. The story is similar in C++, Java and a number of other languages. This is a very basic server but the example should give you some sense as to how much leverage Apache Thrift gives you when it comes to quickly creating cross language RPC services.

1.4.3 Building a Python Client

Next let's code up a Python client to get a feel for the client side of Apache Thrift services. Our client will simply call the hello_func() service method, display the result and exit.

Listing 1.4 ~/thriftbook/hello/hello_client.py

```
import sys
sys.path.append("gen-py")
from hello import HelloSvc                                          #A

from thrift.transport import TSocket                                #B
from thrift.transport import TTransport                             #C
from thrift.protocol import TBinaryProtocol                         #D

trans_ep = TSocket.TSocket("localhost", 9095)                       #E
trans_buf = TTransport.TBufferedTransport(trans_ep)                 #F
proto = TBinaryProtocol.TBinaryProtocol(trans_buf)                  #G
client = HelloSvc.Client(proto)                                     #H

trans_ep.open()                                                     #I
msg = client.hello_func()                                           #J
print("[Client] received: %s" % msg)                                #K
```

Our client imports the same HelloSvc module used by the server #A. We also import three modules from the Apache Thrift Python Library. The first is TSocket which is used on the client side to make a TCP connection to the server socket #B. The next import pulls in TTransport which will provide a network buffer #C. Finally we import TBinaryProtocol which will be used to serialize messages to the server #D.

Next we initialize our TSocket with the host and port to connect to #E and wrap the port in a buffer #F, which will ensure that RPC calls are sent as a unit. To transmit RPC messages we will need to serialize them using a protocol. While there are a several protocols to choose from, the binary protocol is the Apache Thrift default. To construct our binary protocol instance we pass it the top layer on the transport stack #G.

The final layer of our I/O stack is the IDL Compiler generated client stub for our HelloSvc #H. The IDL Compiler creates a Client class for each service which acts as a proxy for the remote service. After constructing the client object and supplying it with a protocol object we can make calls to the service using the client. Invoking the hello_func() method on the Client object serializes our call request with the binary protocol and transmits it over the socket to the server.

Here is a sample bash shell session running the above client. The Python server must be running in another shell to respond.

```
~/thriftbook/hello $ ls -l
drwxr-xr-x 3 randy randy 4096 Mar 26 21:45 gen-py
-rw-r--r-- 1 randy randy  386 Mar 26 21:59 hello_client.py
-rw-r--r-- 1 randy randy  535 Mar 26 16:50 hello_server.py
-rw-r--r-- 1 randy randy   95 Mar 26 16:28 hello.thrift
~/thriftbook/hello $ python hello_client.py
[Client] received: Hello from the python server
~/thriftbook/hello $
```

While a bit more work than your run of the mill hello world program, a few lines of IDL and a few lines of Python code have allowed us to create a language agnostic, OS agnostic and platform agnostic service API with a working client and server. Not bad.

1.4.4 Building a C++ Client

To broaden our perspective and demonstrate the cross language aspects of Apache Thrift we will build two more clients for the hello server, one in C++ and one in Java. Let's start with the C++ client.

As a first step we will compile our existing IDL for C++.

```
~/thriftbook/hello $ thrift --gen cpp hello.thrift                   #A
~/thriftbook/hello $ ls -l
drwxr-xr-x 2 randy randy 4096 Mar 26 22:25 gen-cpp
drwxr-xr-x 3 randy randy 4096 Mar 26 21:45 gen-py
-rw-r--r-- 1 randy randy  386 Mar 26 21:59 hello_client.py
-rw-r--r-- 1 randy randy  535 Mar 26 16:50 hello_server.py
-rw-r--r-- 1 randy randy   95 Mar 26 16:28 hello.thrift
```

Running the IDL Compiler with the "--gen cpp" switch causes it to emit C++ files roughly equivalent to those generated for Python #A. This creates headers (.h) and source files (.cpp) for our hello.thrift IDL in the gen-cpp directory. The gen-cpp/HelloSvc.h header contains the declarations for our service and the gen-cpp/HelloSvc.cpp source file contains the implementation of the RPC stub components.

Here's the code for a HelloSvc C++ client with the same functionality as the Python client above.

Listing 1.5 ~/thriftbook/hello/hello_client.cpp

```
#include <iostream>
```

```
#include <string>
#include <boost/shared_ptr.hpp>                          #A
#include <boost/make_shared.hpp>                         #A
#include <thrift/transport/TSocket.h>                    #B
#include <thrift/transport/TBufferTransports.h>          #B
#include <thrift/protocol/TBinaryProtocol.h>             #B
#include "gen-cpp/HelloSvc.h"                            #C

using namespace apache::thrift::transport;               #D
using namespace apache::thrift::protocol;                #D
using boost::make_shared;

int main() {
    auto trans_ep = make_shared<TSocket>("localhost", 9095);
    auto trans_buf = make_shared<TBufferedTransport>(trans_ep);
    auto proto = make_shared<TBinaryProtocol>(trans_buf);
    HelloSvcClient client(proto);

    trans_ep->open();
    std::string msg;
    client.hello_func(msg);                                      #E
    std::cout << "[Client] received: " << msg << std::endl;
}
```

Our C++ client code is structurally identical to the Python client code. With few exceptions, the Apache Thrift meta-model is consistent from language implementation to language implementation, making it easier for developers to work across languages.

The C++ main() function corresponds line for line with the Python code with one exception, hello_func() does not return a string conventionally, rather it returns the string through an out parameter reference #E. The Apache Thrift language libraries are generally wrapped in namespaces to avoid conflicts in the global namespace. Apache Thrift takes care of the fact that each language has its own unique namespace mechanisms. In C++ all of the Apache Thrift library code is located within the “apache.thrift” namespace. The using statements provide the namespaces for the TSocket and TBufferedTransport transports, as well as the TBinaryProtocol protocol #D.

Our C++ program uses #include to resolve compile time dependencies. The Apache Thrift library headers included provide us support for transports and protocols #B. We also include our generated service stubs which are housed in the HelloSvc.h file #C.

While Apache Thrift strives to maintain as few dependencies as possible to keep the development environment simple and portable, some things are indispensable. The Apache Thrift C++ Library relies fairly heavily on the open source Boost Library #A. In our example several objects are wrapped in boost::shared_ptr. Apache Thrift uses shared_ptr to manage almost all of the key objects involved in C++ RPC.

Those familiar with C++ will know that shared_ptr has become part of the standard library in C++11. While our example code is written in C++11, Apache Thrift supports C++98 as well, requiring the use of the boost version of shared_ptr when interacting with the Apache Thrift C++ library.

Here is a bash session which builds and runs our C++ client.

```
$ ls -l
```

```
drwxr-xr-x 2 randy randy 4096 Mar 26 22:25 gen-cpp
drwxr-xr-x 3 randy randy 4096 Mar 26 21:45 gen-py
-rw-r--r-- 1 randy randy  641 Mar 26 22:36 hello_client.cpp
-rw-r--r-- 1 randy randy  386 Mar 26 21:59 hello_client.py
-rw-r--r-- 1 randy randy  535 Mar 26 16:50 hello_server.py
-rw-r--r-- 1 randy randy   95 Mar 26 16:28 hello.thrift
$ g++ --std=c++11 hello_client.cpp gen-cpp/HelloSvc.cpp -lthrift             #A
$ ls -l
-rwxr-xr-x 1 randy randy 136508 Mar 26 22:38 a.out
drwxr-xr-x 2 randy randy   4096 Mar 26 22:25 gen-cpp
drwxr-xr-x 3 randy randy   4096 Mar 26 21:45 gen-py
-rw-r--r-- 1 randy randy    641 Mar 26 22:36 hello_client.cpp
-rw-r--r-- 1 randy randy    386 Mar 26 21:59 hello_client.py
-rw-r--r-- 1 randy randy    535 Mar 26 16:50 hello_server.py
-rw-r--r-- 1 randy randy     95 Mar 26 16:28 hello.thrift
$ ./a.out                                                                      #B
[Client] received: Hello thrift, from the python server
$
```

In this example we use the standard gnu C++ compiler to build our hello_client.cpp file into an executable program #A. Clang, Visual C++ and other compilers are also commonly used to build Apache Thrift C++ applications.

For the C++ compile phase we specify our hello_client.cpp file but must also compile the generated RPC client stub found in the HelloSvc.cpp source file. During the link phase the "–lthrift" switch tells the linker to scan the standard Apache Thrift C++ library to resolve the TSocket and TBinaryProtocol library dependencies (this switch must follow the list of .cpp files when using g++ or it will be ignored causing link errors).

Assuming the Python Hello server is still up we can run our executable C++ client and make a cross language RPC call. The C++ compiler builds our source into an a.out file which produces the same result as the Python client when executed #B.

1.4.5 Building a Java Client

As a final example let's put together a Java client for our service. Our first step is to generate Java stubs for the service.

```
~/thriftbook/hello $ thrift --gen java hello.thrift         #A
~/thriftbook/hello $ ls -l
-rwxr-xr-x 1 randy randy 136508 Mar 26 23:07 a.out
drwxr-xr-x 2 randy randy   4096 Mar 26 22:25 gen-cpp
drwxr-xr-x 2 randy randy   4096 Mar 26 23:23 gen-java
drwxr-xr-x 3 randy randy   4096 Mar 26 21:45 gen-py
-rw-r--r-- 1 randy randy    641 Mar 26 22:36 hello_client.cpp
-rw-r--r-- 1 randy randy    386 Mar 26 21:59 hello_client.py
-rw-r--r-- 1 randy randy    535 Mar 26 16:50 hello_server.py
-rw-r--r-- 1 randy randy     95 Mar 26 16:28 hello.thrift
```

The "–-gen java" switch causes the IDL Compiler to emit Java code for our interface #A. The generated Java HelloSvc class contains nested client and server stub classes.

Here is the source for a Java client which parallels the prior Python and C++ clients.

Listing 1.6 ~/thriftbook/hello/HelloClient.java

```
import org.apache.thrift.protocol.TBinaryProtocol;
import org.apache.thrift.transport.TSocket;
import org.apache.thrift.TException;

public class HelloClient {
    public static void main(String[] args) throws TException {
        TSocket trans_ep = new TSocket("localhost", 9095);
        TBinaryProtocol protocol = new TBinaryProtocol(trans_ep);
        HelloSvc.Client client = new HelloSvc.Client(protocol);

        trans_ep.open();
        String str = client.hello_func();
        System.out.println("[Client] received: " + str);
    }
}
```

This simple program uses Java style import statements and places the main() method inside a class with the same name as the file. The rest is a rehash of our previous clients. The one noticeable difference is that the Java client has no buffering layer above the end point transport, trans_ep. This is because the socket implementation in Java is based on a stream class which buffers internally, so no additional buffering is required.

Here is a build and run session for the Java client.

```
~/thriftbook/hello $ javac -cp /usr/local/lib/libthrift-1.0.0.jar:           #A
                                 /usr/local/lib/slf4j-api-1.7.2.jar:         #A
                                 /usr/local/lib/slf4j-nop-1.7.2.jar          #A
                                 HelloClient.java gen-java/HelloSvc.java     #A
Note: gen-java/HelloSvc.java uses unchecked or unsafe operations.
Note: Recompile with -Xlint:unchecked for details.
~/thriftbook/hello $ ls -l
-rwxr-xr-x 1 randy randy 136508 Mar 26 23:07 a.out
drwxr-xr-x 2 randy randy   4096 Mar 26 22:25 gen-cpp
drwxr-xr-x 2 randy randy   4096 Mar 26 23:34 gen-java
drwxr-xr-x 3 randy randy   4096 Mar 26 21:45 gen-py
-rw-r--r-- 1 randy randy   1080 Mar 30 00:04 HelloClient.class
-rw-r--r-- 1 randy randy    607 Mar 29 23:48 hello_client.cpp
-rw-r--r-- 1 randy randy    657 Mar 30 00:04 HelloClient.java
-rw-r--r-- 1 randy randy    384 Mar 29 23:48 hello_client.py
-rw-r--r-- 1 randy randy    535 Mar 26 16:50 hello_server.py
-rw-r--r-- 1 randy randy     95 Mar 26 16:28 hello.thrift
~/thriftbook/hello $ java -cp /usr/local/lib/libthrift-1.0.0.jar:
                                /usr/local/lib/slf4j-api-1.7.2.jar:
                                /usr/local/lib/slf4j-nop-1.7.2.jar:
                              ./gen-java:                                    #B
                              .                                              #B
                              HelloClient
[Client] received: Hello thrift, from the python server
~/thriftbook/hello $
```

As you can see in the session transcript, our Java compile includes three dependencies #A. The first is the Thrift Java Library jar. The IDL generated code for our service also depends on SLF4J, a popular Java logging façade. The slf4j-api jar is the façade and the slf4j-nop jar is the nonoperational logger, which simply ignores logging calls. We must generate byte code .class files for our HelloClient class as well as the generated HelloSvc class.

The unchecked warning emitted by the javac compiler is triggered by method return type casts in the Apache Thrift generated code. The Apache Thrift Java libraries are designed to work with JDK 1.5 and newer, so while the code compiles clean in older JDKs, newer JDKs produce this warnings, which can be safely ignored here.

To run our Java HelloClient class we must modify the Java class path as we did in the compilation step, adding the current directory and the gen-java directory, where the HelloClient class and HelloSvr class files will be found #B. Running the client produces the same result we saw with Python and C++.

Beyond running the standard language build tools in our respective languages, it took very little effort to produce our Apache Thrift server and the three clients. With minimal effort we have built a server which can handle requests from clients created in a number of different languages.

Now that we have seen how basic Apache Thrift programs are created, let’s take a look at how Apache Thrift fits into the overall distributed application landscape.

1.5 Apache Thrift’s role in Distributed Applications

Distributed applications are applications which have been broken down into subsystems that can be deployed on separate computers (or containers), yet still collaborate to accomplish the purpose of the application. When subsystems are autonomous and export flexible APIs, they are often called services. Compared to large monolithic systems, distributed applications benefit from smaller more focused processes which are easier to scale, reuse, maintain and test. Distributed applications generally use one or more of three key types of inter-process communications:

- **Streaming** – Communications characterized by an ongoing flow of bytes from a server to one or more clients.
  - Example: An internet radio broadcast where the client receives bytes over time transmitted by the server in an ongoing sequence of small packets.
- **Messaging** – Message passing involves one way asynchronous, often queued, communications, producing loosely coupled systems.
  - Example: Sending an email message where you may get a response or you may not, and if you do get a response you don’t know exactly when you will get it.
- **RPC** – Remote Procedure Call systems allow function calls to be made between processes on different computers.
  - Example: An iPhone app calling a service in the Cloud which returns the weather forecast.

Scalability

Scalability describes a system's ability to increase, or scale, its workload. There are two common means of scaling a system, vertical and horizontal. Vertical scaling is often referred to as scaling up and horizontal scaling is often referred to as scaling out.

Vertical scaling, in simple terms, involves buying a faster computer. Vertical scaling places little burden on the application and is an easy way to increase capacity. However, modern CPUs are no longer increasing in performance at the rates they once did, making it expensive, or impossible in many cases, to scale vertically beyond a given threshold.

Horizontal scaling involves adding more computers to a pool or cluster of systems which run an application collectively. Horizontally scaled applications take advantage of multiple CPUs and/or multiple systems to grow performance. Applications must be designed for distribution across multiple computers to take advantage of horizontal scaling. Extreme examples of horizontal scaling allow applications to harness thousands of CPUs to perform demanding tasks in very short periods of time. Apache Thrift is a tool particularly well suited to building horizontally scaled distributed applications.

These three communications paradigms can be used to tackle just about any inter-process communication task. Let's look at how Apache Thrift applies in each of these settings.

1.5.1 Streaming

Streaming systems deal in continuous flows of bytes. Streaming servers may transmit streams to one or more clients. Some streams have temporal requirements, for instance streaming movies which require frames to arrive at least as fast as they are viewed. Streaming systems are typically designed for communications where data transfers flow in one direction and are of large or undefined size.

Streaming systems are frequently low overhead in nature. They tend to be large bandwidth consumers and therefore strive for efficiency over ease of use. Unicasting is often used to eliminate connection and retransmission overhead, and in some cases multicasting is used to allow the server to send a single message to multiple clients. Streaming systems may use data compression mechanisms to reduce network impact as well.

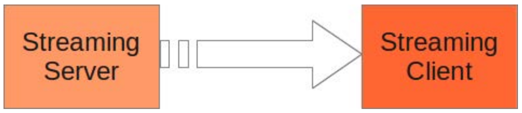


Figure1. 8 - Streaming systems are often purpose built to meet performance needs

Apache thrift does not typically play a role in streaming data services. However, control APIs used to subscribe to streams and perform other setup and configuration tasks may be a good fit for Apache Thrift services. Apache Thrift supports one way messages which may suffice to stream information from a client to a server in some applications. Apache Thrift serialization may also be useful in streaming solutions which require streaming structured data across languages.

1.5.2 Messaging

Messaging is an asynchronous communications model allowing queued communications to take place independently of the speed of the producer or consumer. Full service messaging systems support reliable communications over unreliable links with features such as store and forward, transactions, multicasting and publish/subscribe. Systems such as IBM WebsphereMQ, Apache ActiveMQ, Pivotal RabbitMQ and Java JMS fit into this category.

Lightweight messaging systems are more appropriate for messaging at high data rates with minimum latency as a design imperative. Open source systems such as LCM and ZeroMQ, and commercial systems such as TIBCO Rendezvous implement a lightweight framework supporting many standard messaging features, with performance as an overriding design goal. Such high speed messaging systems strike a balance between the performance of streaming systems and the features of heavier weight messaging systems.

Apache Thrift is not a message queuing platform but it can fulfill the serialization responsibilities associated with cross language messaging. For example, if you are interested in using RabbitMQ to send messages between a C++ and a Java application, you may need a common serialization format. User defined message types can be described in Apache Thrift IDL and then compiled to support serialization in any Apache Thrift language. A C# program could serialize a C# object and then send it as a message through the messaging system, whereupon an Objective-C application could receive the message and deserialize it into a native Objective-C object.

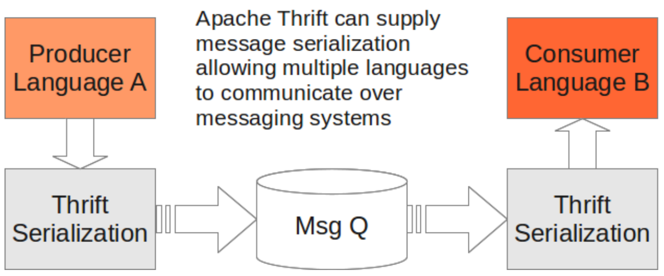

Producer Language A
Apache Thrift can supply message serialization allowing multiple languages to communicate over messaging systems
Consumer Language B
Thrift Serialization
Msg Q
Thrift Serialization

Figure 1.9 - Messaging systems can make use of Apache Thrift serialization

RPC systems, under the covers, send messages between clients and servers to make function calls and return results. Therefore it is possible to implement RPC systems on top of messaging systems. There is an experimental Apache Thrift transport in the contrib folder of the Apache Thrift repository which uses ZeroMQ as an RPC substrate.

1.5.3 Remote Procedure Calls

Making function calls to complete the work of a program is fairly natural in most languages. Remote Procedure Call systems allow function callers and function implementers to live in different processes, as demonstrated by our sample application earlier in this chapter. Systems such as Apache Thrift, JavaRMI, DCOM/COM+, DCE, SOAP and CORBA provide RPC style functionality.

Unlike messaging systems, the client and the server in an RPC exchange must be up and running at the same time. The client waits for the server's response in many RPC environments, just as if the client were calling a local function. This couples the client to the server in a much closer way than that of a messaging system. However, SOA platforms, such as Apache Thrift, lend flexibility to the client and server relationship in several ways.

Most Apache Thrift languages support asynchronous client interfaces. This allows the client to call the server and then go about other business, checking back later to see if the response is available. This is similar to the way a client and server would interact over a messaging platform.

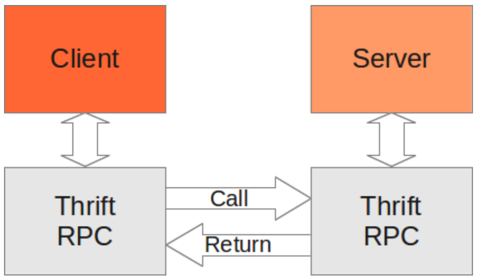


Figure 1.10 - Apache Thrift allows clients to call functions hosted in remote servers

Apache Thrift also supports one way messages. One way messages are "fire and forget" style communications, the client calls the one way function with the appropriate parameters and then goes about its business. The server receives the message but does not reply. This is akin to the way single direction messages are sent in streaming and non-queued messaging environments.

Choosing the right communications platform often involves a combination of RPC, messaging and streaming style solutions. Thrift is well suited to such hybrid environments, and can provide the IDL central to the unified serialization needs of the entire distributed application as well as the service implementation framework in client/server interactions.

1.6 The cross language communications landscape

Apache Thrift was originally developed at Facebook to address performance and functionality challenges facing programmers working with REST interfaces and the LAMP stack (an acronym for Linux, Apache [httpd], MySQL and PHP). The Facebook team examined several potential 3rd party options to use for their cross language communications system. To quote the 2007 Facebook white paper, their list of possibilities and conclusions were:

- *SOAP.* XML-based. Designed for web services via HTTP, excessive XML parsing overhead.
- *CORBA.* Relatively comprehensive, debatably overdesigned and heavyweight. Comparably cumbersome software installation.
- *COM.* Embraced mainly in Windows client software. Not an entirely open solution.
- *Pillar (Facebook internal).* Lightweight and high-performance, but missing versioning and abstraction.
- *Protocol Buffers.* Closed-source, owned by Google. Described in Sawzall paper. *

*** NOTE** Protocol Buffers, while listed in the Facebook white paper as closed source, has since been open sourced.

REST, SOAP, Protocol Buffers and the Apache Avro platform are perhaps the technologies most often considered as alternatives to Apache Thrift. Each of these technologies is unique and all have their place.

1.6.1 REST, SOAP and XML-RPC

REST is an acronym for REpresentational State Transfer and is the typical means for web browsers to retrieve content from web servers. RESTful web services use the REST architectural style in order to leverage the infrastructure of the web. The well understood and widely supported HTTP protocol gives REST based services broad reach. RESTful services most often use JSON for data interchange. REST is unique as a service communications approach in that such interfaces work with resources using various HTTP verbs, such as GET, PUT, POST and DELETE. This resource oriented approach is often dubbed Resource Oriented Architecture (ROA). ROAs produces significant benefits when scaling over the infrastructure of the web. For example, standard web based caching systems can cache resources acquired using the GET verb, firewalls can make more intelligent decisions about HTTP delivered traffic and applications can leverage the wealth of technology associated with existing Web server infrastructure.

Simple Object Access Protocol (SOAP) and XML-RPC are both RPC style SOA type systems. SOAP and XML-RPC rely on XML for carrying their payload between the client and the server and are frequently built upon HTTP, though other transports can also be used. Optimizations are available which attempt to reduce the burden of transmitting XML and there are versions of SOAP which use JSON, among other off shoots. Unlike, RESTful services, which directly utilize HTTP headers, verbs and status codes, SOAP and XMP-RPC systems tunnel function calls through HTTP POST operations, missing out on the caching and system layering benefits found in RESTful services.

The key benefit of HTTP friendly technologies is their broad interoperability. By transmitting standards based text documents (XML, JSON, etc.) over the ubiquitous HTTP protocol, almost any application or language can be engaged.

On the downside, each language, vender and, often, each company, provides their own scheme for generating stubs, and, in the case of REST, for defining service interfaces. The RESTful world offers three competing platforms for service definition and code generation: RAML, Swagger and API Blueprint. There are no guarantees that code generated from various SOAP WSDL (Web Service Description Language) or RESTful specification tools will collaborate. Another key drawback of these approaches is that they tend to underperform more native platforms in server I/O scenarios due to the high cost of text based payload serialization and HTTP overhead.

1.6.2 Google Protocol Buffers

Google Protocol Buffers and Apache Thrift are similar in performance and from a serialization and IDL stand point. Official Google Protocol Buffer language support is limited to C++, Java, and Python. Google Protocol Buffers are used by a large community of developers and many projects on the web expand the languages supported by Protocol Buffers to a selection comparable to that of Apache Thrift.

While Apache Thrift supplies a full RPC client and server framework, Google Protocol Buffers provides only message serialization, though several RPC style systems for Protocol Buffers are available in other projects.

Another difference between the platforms is support for transmission of collections. Apache Thrift supports transmission of three common containers types: lists, sets and maps. Protocol Buffers supplies a repeating field feature rather than support for containers, producing similar capabilities through a lower level construct.

Protocol Buffers are robust, well documented and backed by a large corporation which contrasts with the open source nature of Apache Thrift.

1.6.3 Apache Avro

Apache Avro is a serialization framework designed to package the serialization schema with the data serialized. This contrasts with the Apache Thrift and Protocol Buffers approach, which describes the schema (data types and service interfaces) in IDL. Apache Avro interprets the schema on the fly and Apache Thrift generates code to interpret the schema at compile time. In general, combining the schema with the data works well for long lived objects serialized to disk. However, such a model can add complexity and overhead to real time RPC style communications. Arguments and optimizations can be made to turn these observations on their head of course but most practical use of Apache Avro has been focused on serializing objects to disk.

Apache Avro supported eight programming languages at the time of this writing and offered a basic RPC framework as well. Avro supports the same containers present in Apache Thrift although Apache Avro maps only allow strings as keys. The use of dynamically interpreted embedded schemas in Apache Avro and the use of compiled IDL in Apache Thrift is the key distinction between these two platforms.

Apache Thrift Versions

The Thrift framework was originally developed at Facebook and released as open source in 2007. The project became an Apache Software Foundation incubator project in 2008, after which four early versions were released.

0.2.0	released 2009-12-12
0.3.0	released 2010-08-05
0.4.0	released 2010-08-23
0.5.0	released 2010-10-07

In 2010 the project was moved to top level status where several additional versions have been released.

0.6.0	released 2011-02-08
0.6.1	released 2011-04-25
0.7.0	released 2011-08-13
0.8.0	released 2011-11-29
0.9.0	released 2012-10-15

0.9.1	released 2013-07-16
0.9.2	released 2014-11-16
1.0.0	released ????

1.7 What Apache Thrift doesn't do

Apache Thrift is a powerful cross language serialization platform packaged with a robust RPC framework, however it is not a fit for all applications.

While the Apache Thrift type system has many nice features, including support for constants, unions, sets, maps and lists, Apache Thrift has only early stage support for self-referential structures. This means that trees, and other graphs will likely have to be reorganized to transit an Apache Thrift Service interface. With some creativity any data structure can be recomposed with lists and maps. Many experienced distributed system interface designers prefer to avoid passing uncontrolled data structures through RPC interfaces, making this shortfall a potential boon for inexperienced interface designers.

Thrift is not a good choice for transmission of large datasets. If you need to move large blocks of data between processes it may be best to consider other options. Apache Thrift RPC and serialization are designed to be fast and efficient in the context of traditional function call and messaging payloads, unit data sizes much more than a megabyte may become unwieldy. Again, this is less of an Apache Thrift failing and more of a general Messaging/RPC best practice.

Apache Thrift is not a messaging system. The Apache Thrift serialization system can be an effective vender neutral way to encode messages transmitted over commercial and open source messaging systems, however Apache Thrift RPC is not designed to provide publish/subscribe, queuing, multicast, broadcast or other messaging specific features.

If absolute performance is your goal and you have no need for serialization, the cross language and interface evolution overhead added by Thrift may be unnecessary. Apache Thrift fares well in performance comparisons with competing platforms but it will not be as fast as rigid, purpose built code.

While no platform is everything to everyone, Apache Thrift serves as an exceptionally capable back end service platform. Adding to this the ability to serialize types for messaging applications, disk storage and services in a single IDL, makes Apache Thrift a highly useful tool for building distributed systems.

1.8 Summary

Here are the most important points to take away from the chapter:

- Apache Thrift is a cross language serialization and service implementation framework
- Apache Thrift supports a wide array of languages and platforms
- Apache Thrift makes it easy to build high performance backend services
- Apache Thrift is a good fit for service oriented architectures (SOA) and microservices

- Apache Thrift is an Interface Definition Language (IDL) based framework
- IDLs allow you to describe interfaces and automate support code generation
- IDLs allow you to describe types used in messaging, long term storage and service calls
- Apache Thrift includes a modular serialization system, providing several built in serialization protocols and support for custom serialization solutions
- Apache Thrift includes a modular transport system, providing built in memory, disk and network transports and making it easy to add additional transports
- Apache Thrift support interface evolution empowering CI/CD environments