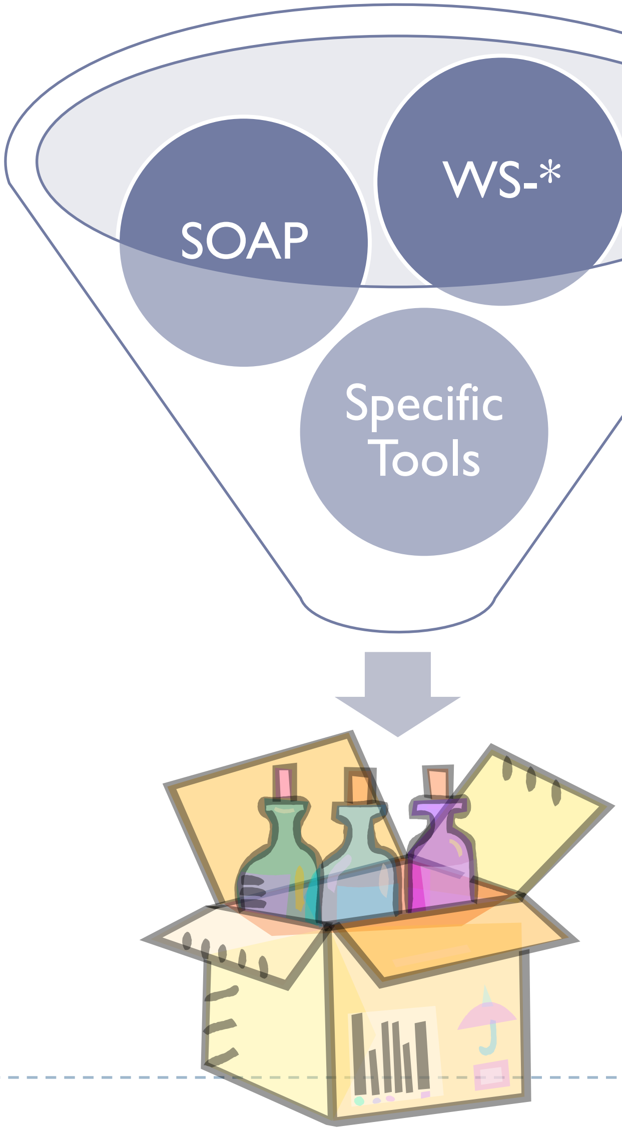
Scalable, Reliable, and Secure RESTful services

Stuff you need to know about REST and HTTP

envoisolutions

What this talk is NOT



SOAP

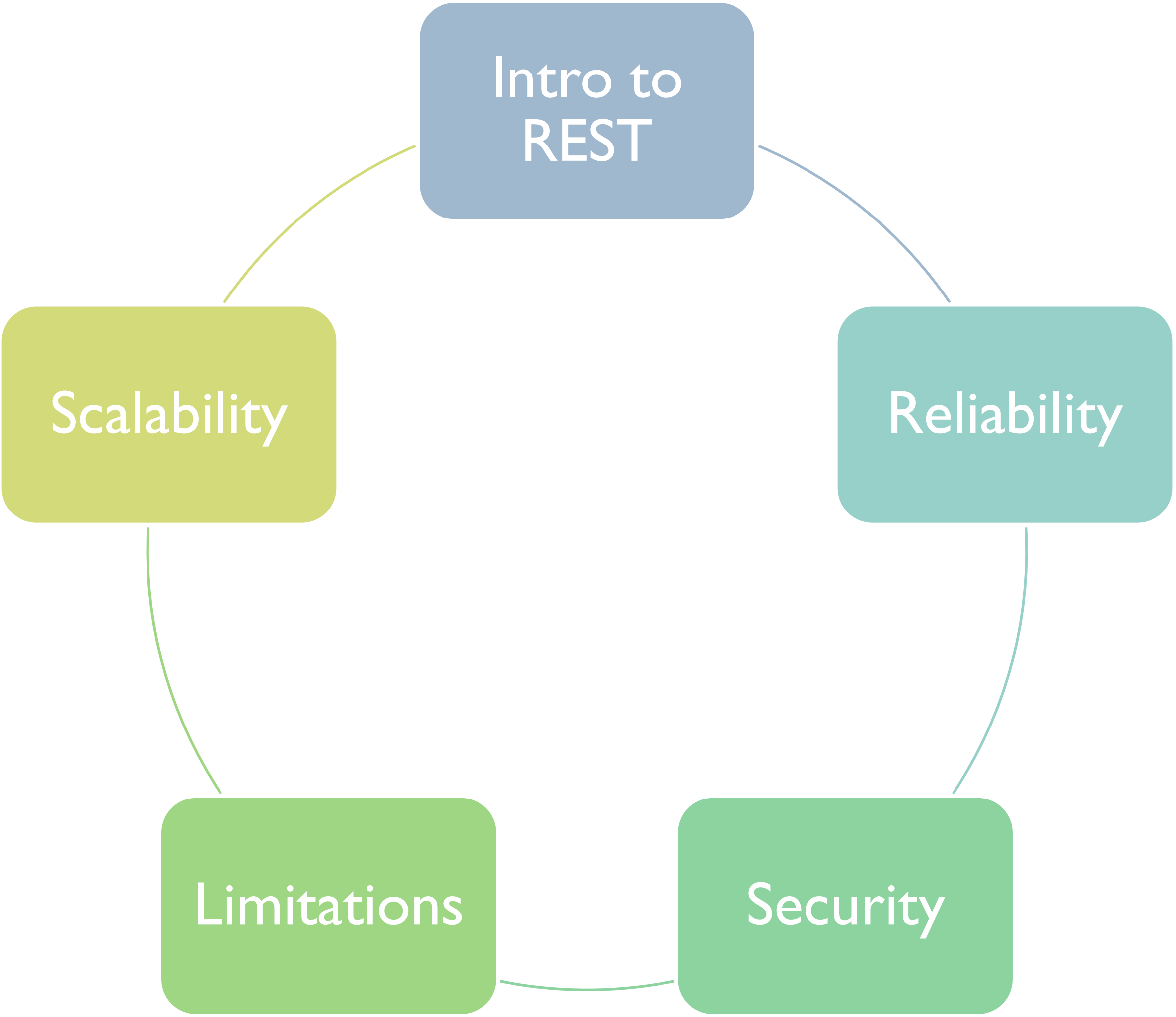
WS-*

Specific Tools

For that go to:

Navigating WS-(death?)* - 17:30

Today’s talk



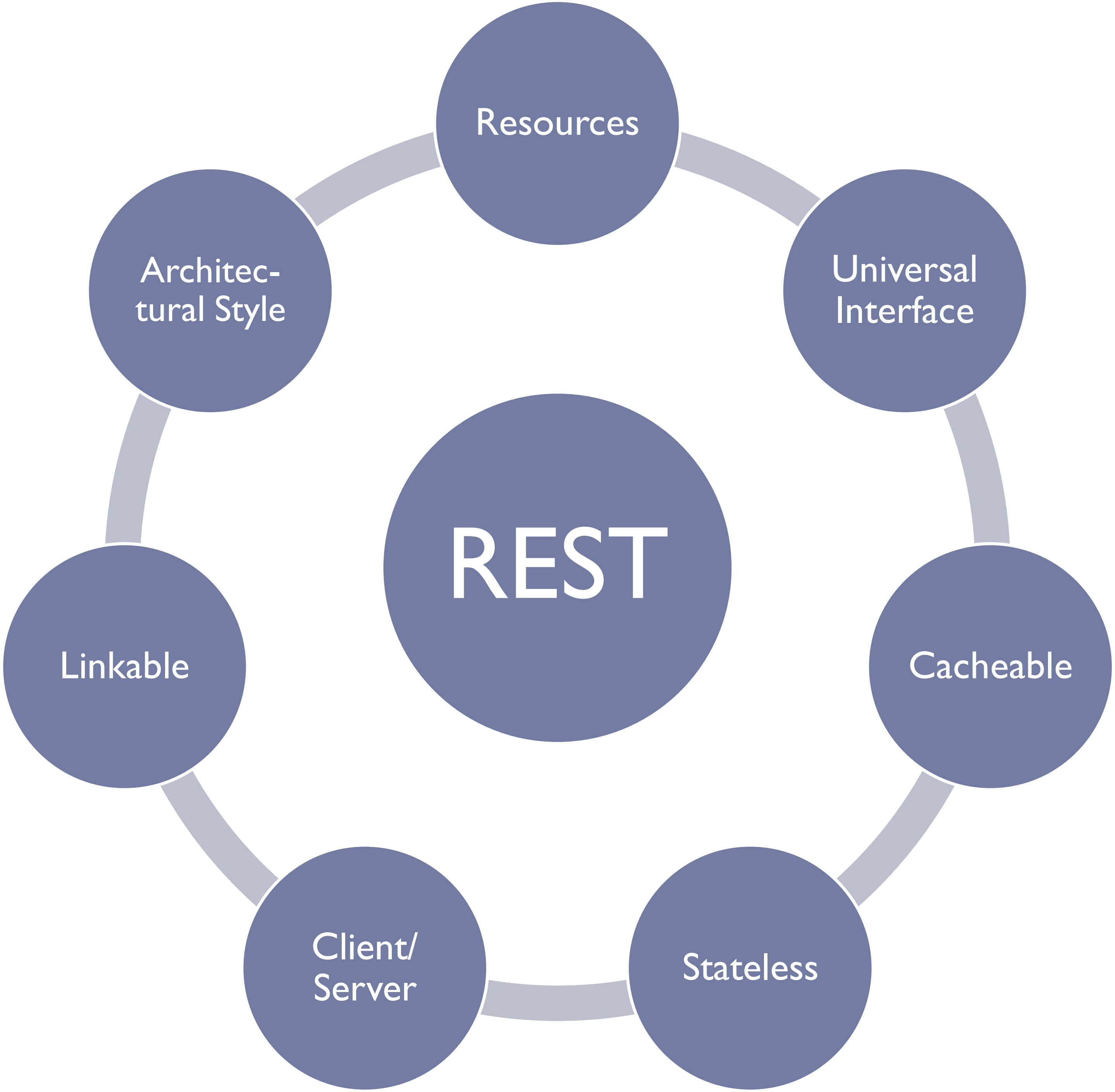
Intro to REST

Reliability

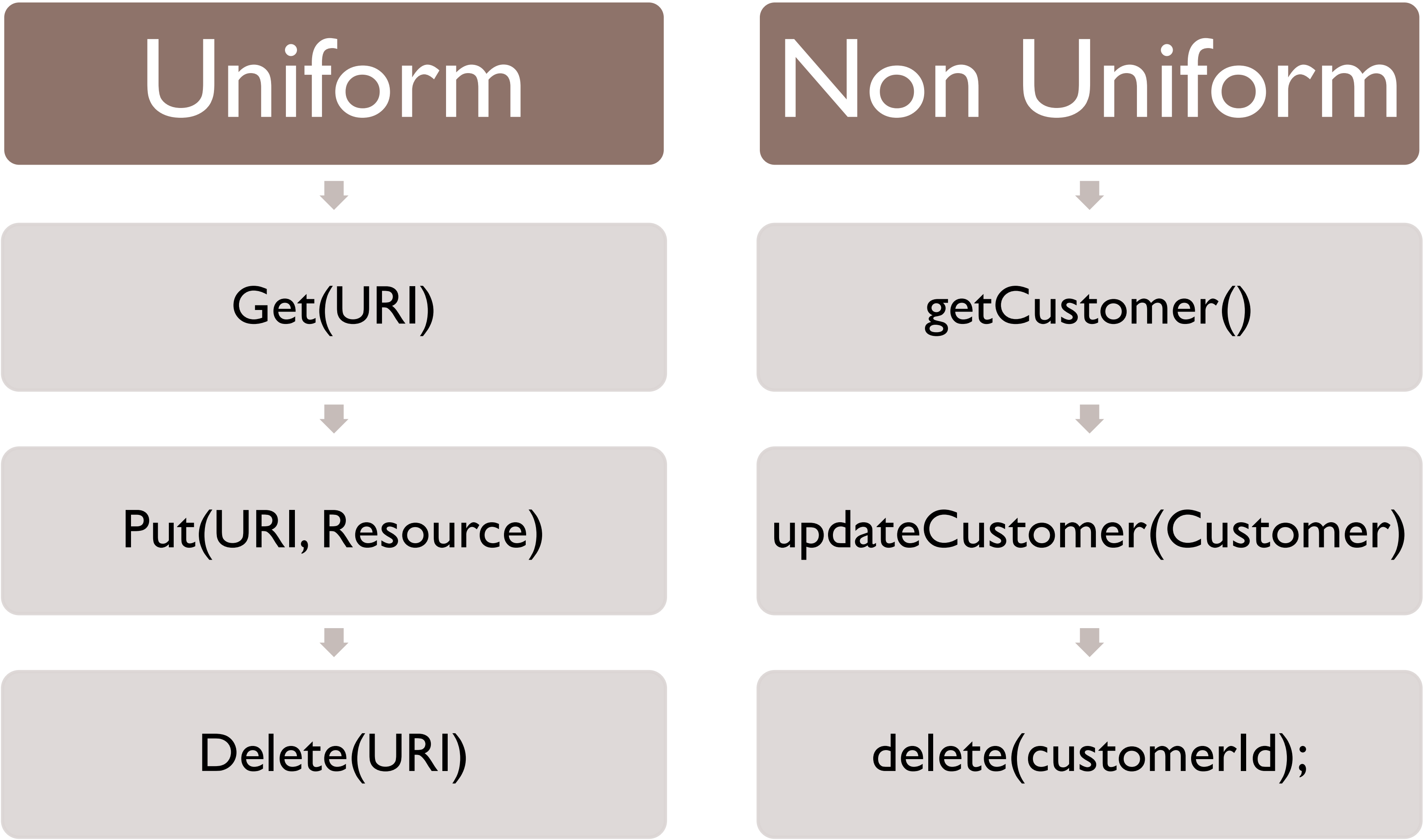
Security

Limitations

Scalability


REST
Resources
Universal Interface
Cacheable
Stateless
Client/ Server
Linkable
Architec-tural Style

The Uniform Interface



Uniform

Get(URI)

Put(URI, Resource)

Delete(URI)

Non Uniform

getCustomer()

updateCustomer(Customer)

delete(customerId);

Resources, resources, resources

- Everything is a resource
- Resources are addressable via URIs
- Resources are manipulated via verbs and the uniform interface

Hypertext and linkability

- Resources are hypertext
- We don't want "keys", we want links!
- Data model refers to other application states via links

From here on out…

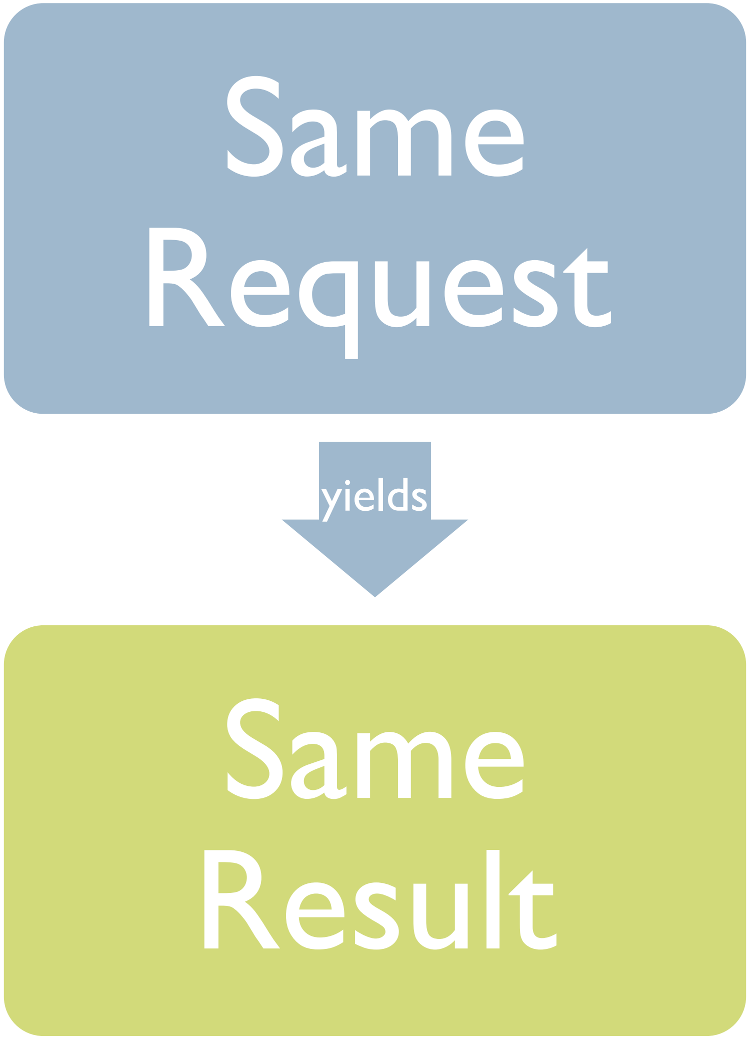
- We're talking about HTTP
- REST defines the architectural style of HTTP
- We'll discuss further RESTful principles in relation to HTTP specifically (i.e. caching, statelessness)

Reliability through Idempotency

Our Starting Point

GET	• Cacheable • SAFE – no side effects
POST	• Unsafe operations, which can’t be repeated
PUT	• Idempotent
DELETE	• Idempotent
HEAD	• SAFE – no side effects • No message body

Idempotent Operations



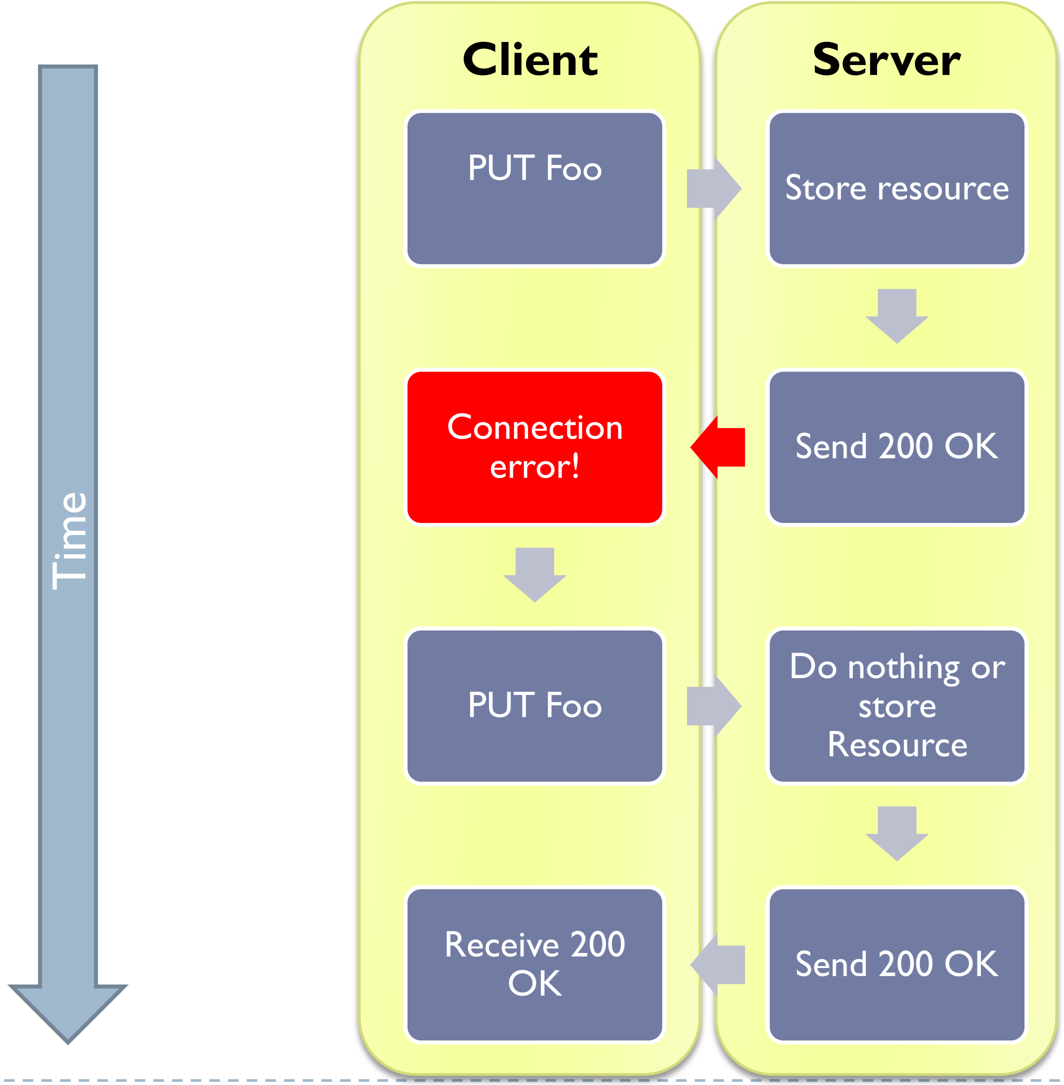
Some Basic Scenarios:

1. Getting resources
2. Deleting resources
3. Updating a resource
4. Creating a resource

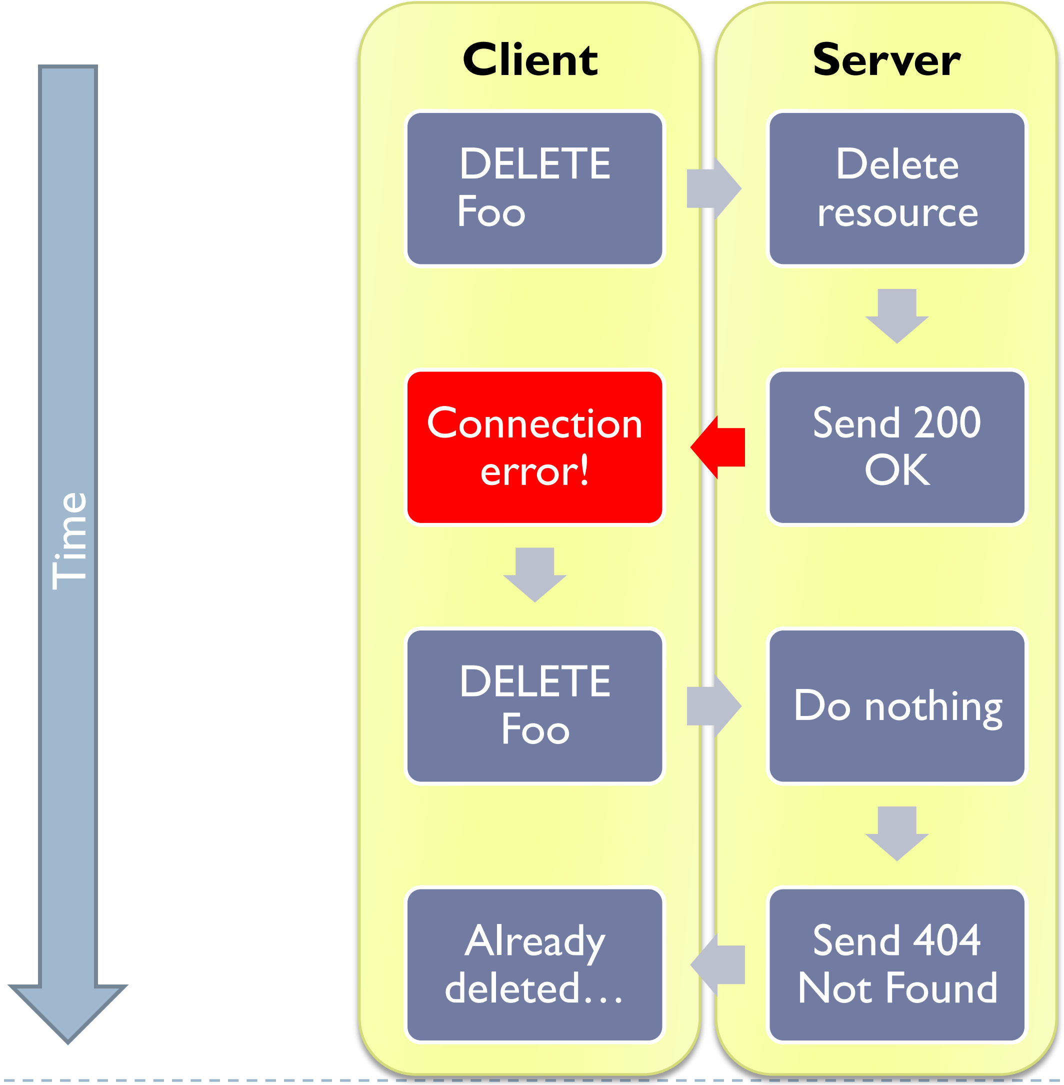
Getting a resource

- GET is SAFE
- If original GET fails, just try, try again

Updating a resource



Deleting a resource



Time

Client

Server

DELETE Foo

Delete resource

Connection error!

Send 200 OK

DELETE Foo

Do nothing

Already deleted…

Send 404 Not Found

Creating Resources

```
POST /entries
Host: acme.com
…
```

```
PUT /entries/1
Host: acme.com
Content-Type: …
Content-Length: …

Some data…
```

Client

```
HTTP/1.1 201 Created
Date: …
Content-Length: 0
Location:
  http://acme.com/entries/1
…
```

```
HTTP/1.1 200 OK
…
```

Server

Creating Resources

- IDs which are not used can be
  - Ignored
  - Expired
- Another option: have the client generate a unique ID and PUT to it straight away
  - They're liable to screw it up though

Problem: Firewalls

- Many firewalls do not allow PUT, DELETE
- You might want to allow other ways of specifying a header:
  - Google: `X-HTTP-Method-Override: PUT`
  - Ruby: `?method=PUT`

Scalability

ETags, Caching, Content-Types, URLs, and more

Statelessness

- All communication is stateless
- Session state is kept on the Client!
  - Client is responsible for transitioning to new states
  - States are represented by URIs
- Improves:
  - Visibility
  - Reliability
  - Scalability

ETag Header

- Resources may return an ETag header when it is accessed
- On subsequent retrieval of the resource, Client sends this ETag header back
- If the resource has not changed (i.e. the ETag is the same), an empty response with a 304 code is returned

ETag Example

```
GET /feed.atom
Host: www.acme.com
…
```

```
HTTP/1.1 200 OK
Date: …
ETag: "3e86-410-3596fbbc"
Content-Length: 1040
Content-Type: text/html
…
```

```
GET /feed.atom
If-None-Match:
  "3e86-410-3596fbbc"
Host: www.acme.com
…
```

```
HTTP/1.1 304 Not Modified
Date: …
ETag: "3e86-410-3596fbbc"
Content-Length: 0…
```

Client

Server

LastModified Example

```
GET /feed.atom
Host: www.acme.com
…
```

```
GET /feed.atom
If-Modified-Since:
  Sat, 29 Oct 1994
  19:43:31 GMT
Host: www.acme.com
…
```

Client

```
HTTP/1.1 200 OK
Date: …
Last-Modified: Sat, 29 Oct
  1994 19:43:31 GMT
Content-Length: 1040
Content-Type: text/html
…
```

```
HTTP/1.1 304 Not Modified
Date: …
Last-Modified: Sat, 29 Oct
  1994 19:43:31 GMT
Content-Length: 0
```

Server

Scalability through Caching

- A.k.a. “cache the hell out of it”
- Reduce latency, network traffic, and server load
- Types of cache:
  - Browser
  - Proxy
  - Gateway

How Caching Works

- A resource is eligible for caching if:
  - The response headers don’t say not to cache it
  - The response is not authenticated or secure
  - No ETag or LastModified header is present
  - The cache representation is fresh
- From: http://www.mnot.net/cache_docs/

Is your cache fresh?

- Yes, if:
  - The expiry time has not been exceeded
  - The representation was LastModified a relatively long time ago
- If its stale, the remote server will be asked to *validate* if the representation is still fresh

Scalability through URLs and Content-Types

- Information about where the request is destined is held outside the message:
  - Content-Type
    - application/purchase-order+xml
    - mage/jpeg
  - URL
  - Other headers
- Allows easy routing to the appropriate server with little overhead

Transactions

- The web is NOT designed for transactions
  - Client is responsible for committing/rolling back transactions, and client may not fulfill responsibilities
  - Transactions can take too long over the web and tie up important resources
- Much better IMO to build in confirmation/cancellation into your application
- This requires application specific means for compensation
- See the paper: *Life Beyond Transactions* by Pat Helland

Security

Question #1

- What are your goals & requirements?
  - Authentication?
  - Authorization?
  - Privacy?
  - Integrity?
  - Openness?
  - Eliminate hassles for users?

Tools at our disposal

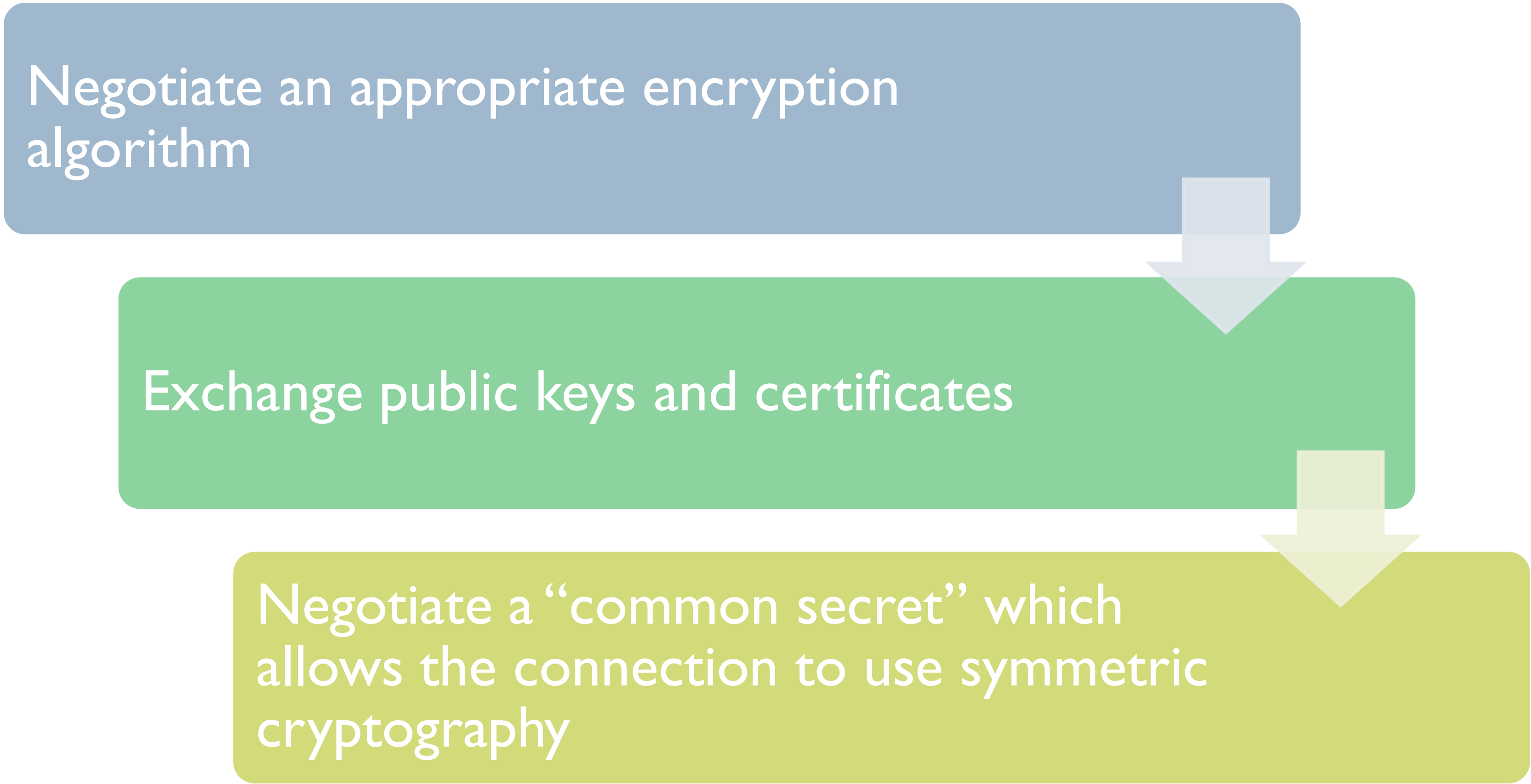
- HTTP Authentication
- SSL
- XML Signature & Encryption
- Others:
  - SAML, Cardspace, OpenID…

HTTP Authentication Basics

- Basic Authentication
  - Username & Password passed in plain text
- Digest
  - MD5 has of username & password is created
- Sent with every request
  - Remember – *statelessness?*

SSL and Public Key Cryptography

- SSL/TLS defines a process to encrypt/secure transports

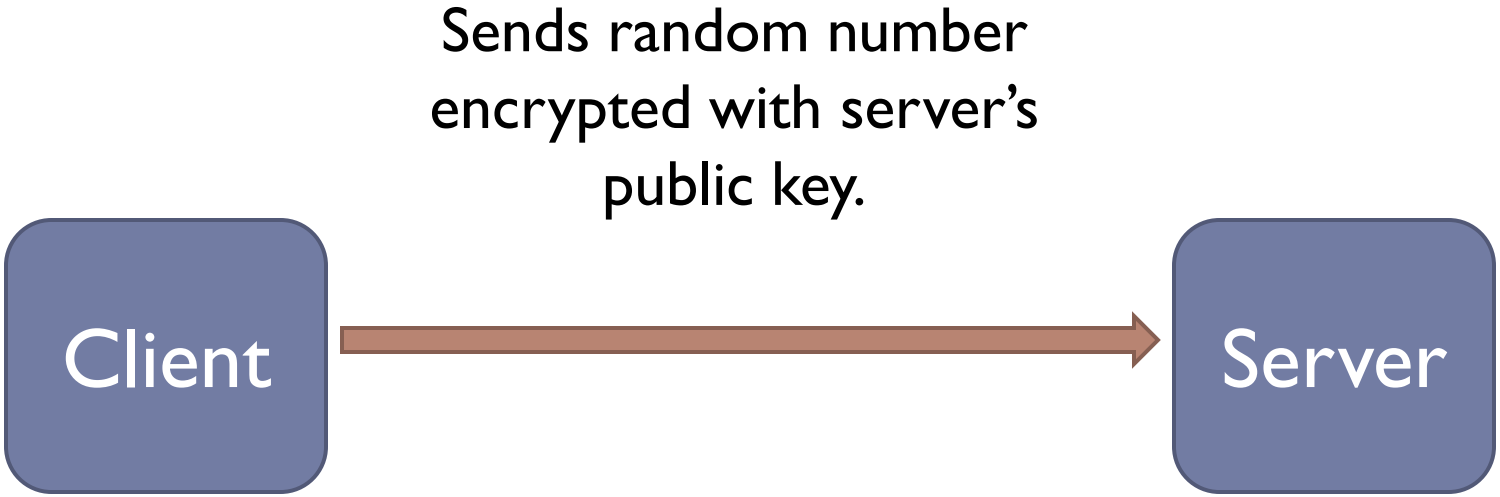


Negotiate an appropriate encryption algorithm

Exchange public keys and certificates

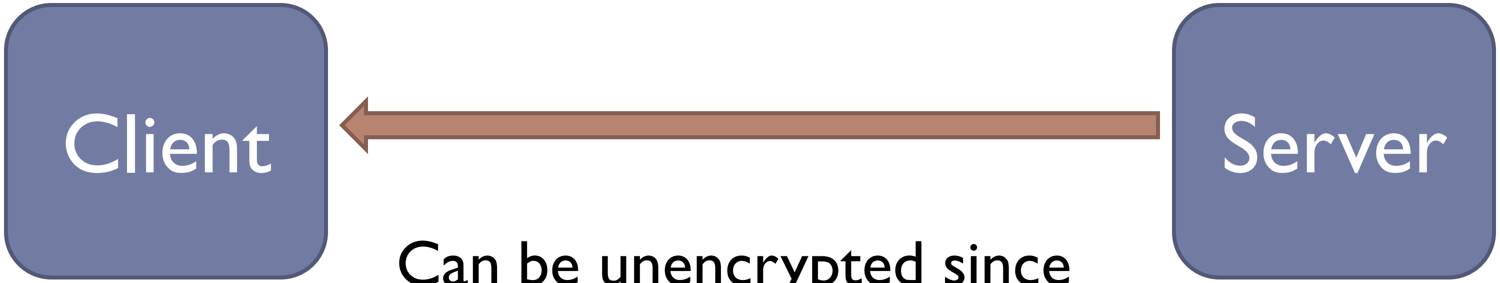
Negotiate a “common secret” which allows the connection to use symmetric cryptography

How SSL works



Sends random number encrypted with server's public key.

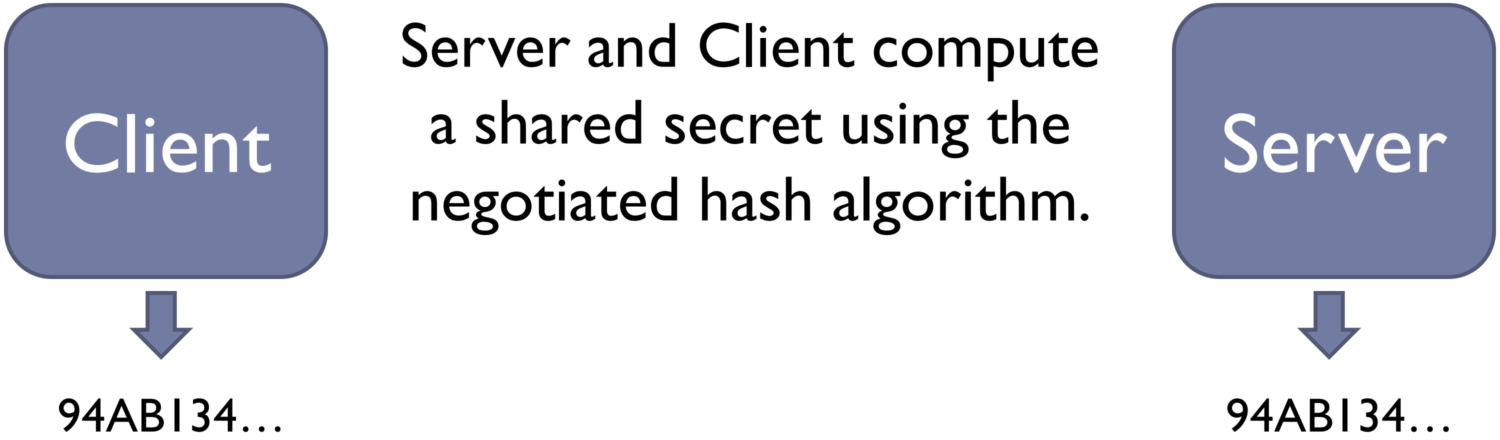
How SSL works



Server sends random number to client.

Can be unencrypted since Client may not have public key.

How SSL works



Client

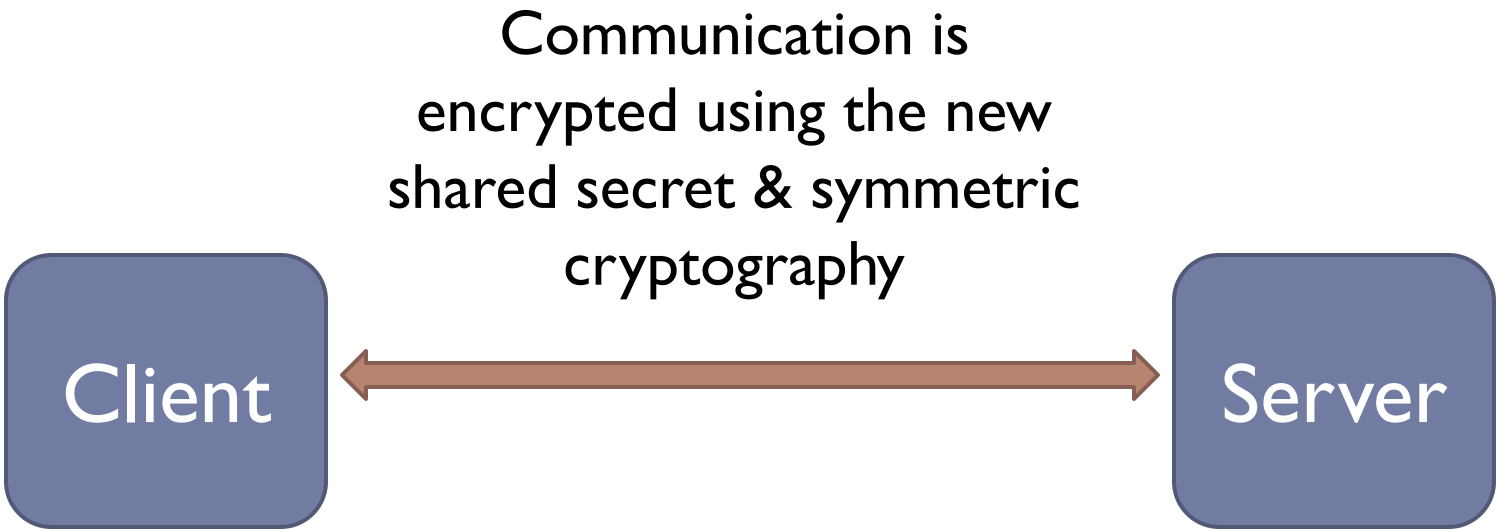
Server and Client compute a shared secret using the negotiated hash algorithm.

Server

94AB134…

94AB134…

How SSL works


Communication is encrypted using the new shared secret & symmetric cryptography

Client Authentication

- Server can authenticate the Client using it’s public key
- Requires key distribution
  - Server side must import every client public key into it’s keystore

Limitations of SSL

- Does not work well with intermediaries
  - If you have a gateway handling SSL, how do you actually get the user information?
- Limited ability for other authentication tokens beyond those of HTTP Auth
  - i.e. SAML
  - Some implementations support NTLM (Commons HTTPClient)

XML Signature & Encryption

- Provide message level security when needed
- Limited support across languages
  - Mostly Java & .NET
- Allows other types of authentication mechanisms beyond just SSL

An XML digital signature

```
<ds:Signature>
 <ds:SignedInfo>
   <ds:CanonicalizationMethod Algorithm=
      "http://www.w3.org/2001/10/xml-exc-c14n#"/>
   <ds:SignatureMethod Algorithm=
     "http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
   <ds:Reference URI="#mySignedElement">
     <ds:Transforms>
       <ds:Transform Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#"/>
     </ds:Transforms>
     <ds:DigestMethod Algorithm=
        "http://www.w3.org/2000/09/xmldsig#sha1"/>
     <ds:DigestValue>EULddytSo1...</ds:DigestValue>
   </ds:Reference>
 </ds:SignedInfo>
 <ds:SignatureValue>
   BL8jdfToEb1l/vXcMZNNjPOV...
 </ds:SignatureValue>
 <ds:KeyInfo>
 …
 </ds:KeyInfo>
</ds:Signature>
```

Building on the Atom Publishing Protocol

What is Atom?

- Atom: a format for syndication
  - Describes "lists of related information" – a.k.a. *feeds*
  - Feeds are composed of entries
- *User Extensible*
- More generic than just *blog stuff*

The Bare Minimum

```
<?xml version="1.0" encoding="utf-8"?>
<feed xmlns="http://www.w3.org/2005/Atom">

 <title>Example Feed</title>
 <link href="http://example.org/"/>
 <updated>2003-12-13T18:30:02Z</updated>
 <author>
   <name>John Doe</name>
 </author>
 <id>urn:uuid:60a76c80-d399-11d9-b91C-0003939e0af6</id>

 <entry>
   <title>Atom-Powered Robots Run Amok</title>
   <link href="http://example.org/2003/12/13/atom03"/>
   <id>urn:uuid:1225c695-cfb8-4ebb-aaaa-
  80da344efa6a</id>
   <updated>2003-12-13T18:30:02Z</updated>
 </entry>

</feed>
```

Atom retargeted for employee info

```
<?xml version="1.0" encoding="utf-8"?>
<feed xmlns="http://www.w3.org/2005/Atom">

 <title>Employees</title>
 <link href="http://acme.com/hr/employees"/>
 <updated>2003-12-13T18:30:02Z</updated>
 <author>
   <name>Acme Inc.</name>
 </author>
 <id>urn:uuid:60a76c80-d399-11d9-b91C-0003939e0af6</id>

 <entry>
   <title>John Doe</title>
   <link href="http://acme.com/hr/employees/john_doe"/>
   <id>urn:uuid:1225c695-cfb8-4ebb-aaaa-80da344efa6a</id>
   <updated>2003-12-13T18:30:02Z</updated>
   <acme:EmployeeInfo>
       …
   </acme:EmployeeInfo>
 </entry>

</feed>
```

What is the Atom Publishing Protocol?

- Create, edit, delete feeds and entries
- GET feeds
  - Includes paging support
- Properly uses HTTP so can be scalable, reliable and secure
- Implemented by a variety of clients and servers
  - Abdera, Amplee, blog stuff*, etc

Why you should use APP for our app

- There are many APP implementations and they are known to work well together
- Atom format is well understood
- You can leverage existing solutions for security
  - HTTP Auth, WSSE, Google Login, XML Sig & Enc
- Eliminates the need for you to write a lot of server/client code
  - ETags, URLs, etc are all handled for you

What other tools are available?

- Java
  - Servlets
  - Restlets
  - Spring MVC
  - CXF
  - Axis
- Ruby on Rails
- Python's Django
- Javascript's XMLHttpRequest ☺

Limitations (Constraints) of REST & HTTP

Conclusions

- HTTP Provides many tools/properties for us to build scalable, reliable, secure systems:
  - Idempotent and safe methods
  - ETags/LastModified
  - Hypertext
  - Caching
  - URLs & Content Types
  - SSL
- Beyond HTTP
  - Atom
  - XML Signatures & Encryption
  - Much more… (Open ID, SAML, RDF, etc)

Limitations

- HTTP is NOT an RPC or message passing system
  - Not good for sending event based messages
  - May have performance constraints for asynchronous messaging that JMS/others may not have
- Security Standards
  - Most people will just use SSL, but…
  - Exchanging other types of authentication tokens is not possible unless they are custom HTTP headers
  - No way to establish trust relationships beside certificate hierarchies/webs

Questions?

- Blog: http://netzooid.com/blog
- Email: dan@envoisolutions.com