Module Two: Service Message Exchange SOAP and Service Description WSDL

Our textbook for this module:

- **Ethan Cerami, Web Services Essentials, Publisher： O’Reilly， ISBN：9780596002244，**
  - Chapter 3 - SOAP
  - Chapter 6 - WSDL
- **Liang-Jie Zhang, Services Computing, Publisher: Springer， ISBN：9783540382812 -** You can find an online version of this book for free through our library webpage.
  - Chapter 3.1
  - Chapter 3.2 (without 3.2.5)

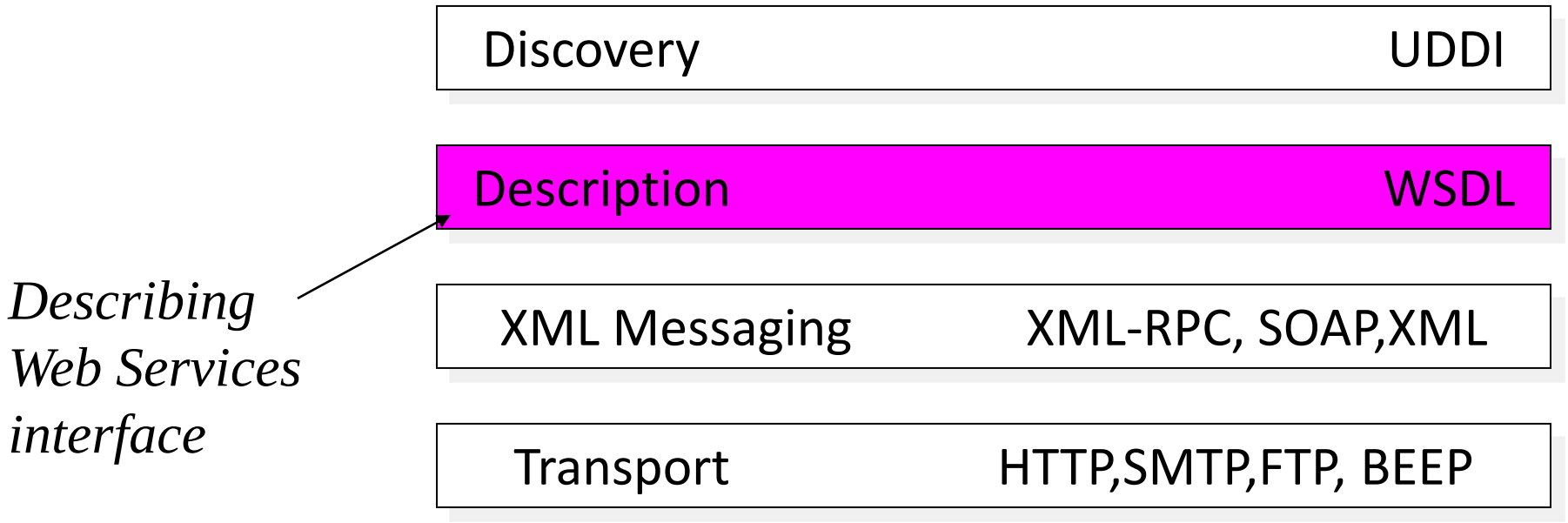
Module 2 Learning Outcomes

- Understand the basics of the SOAP protocol
- Understand the details about the SOAP XML Message specification
- Understand the SOAP encoding rules
- Understand the basics of WSDL

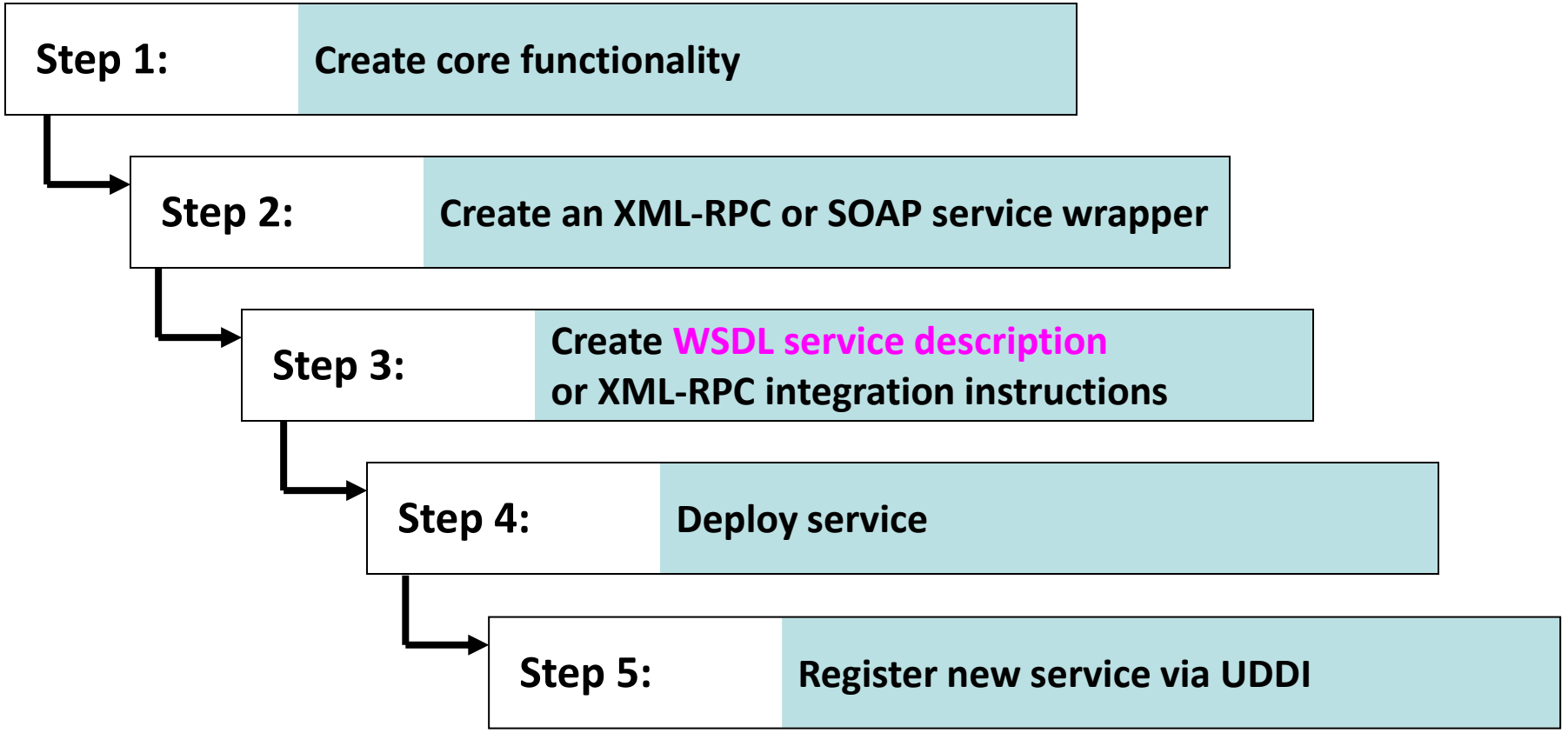
- Let’s continue where we left off on Monday

Service Description
WSDL

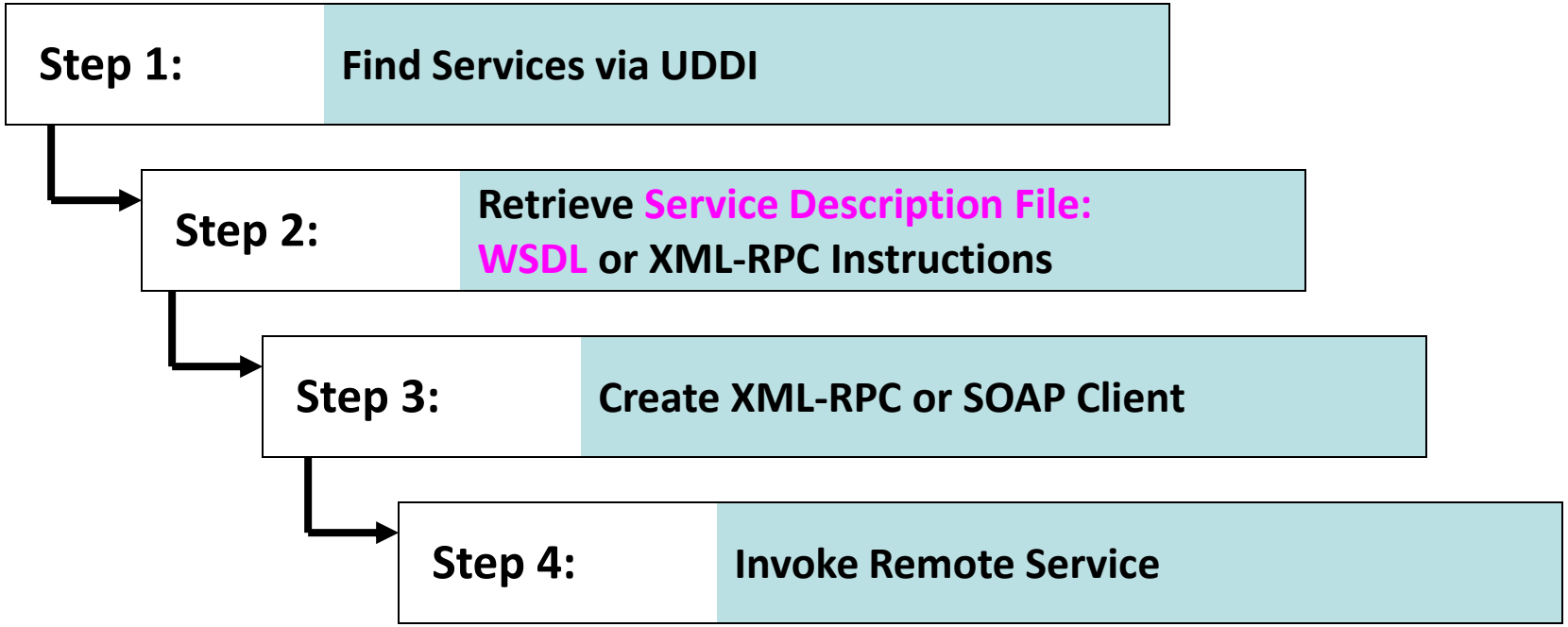
Web Service Protocol Stack



Using the Protocols Together – service provider perspective

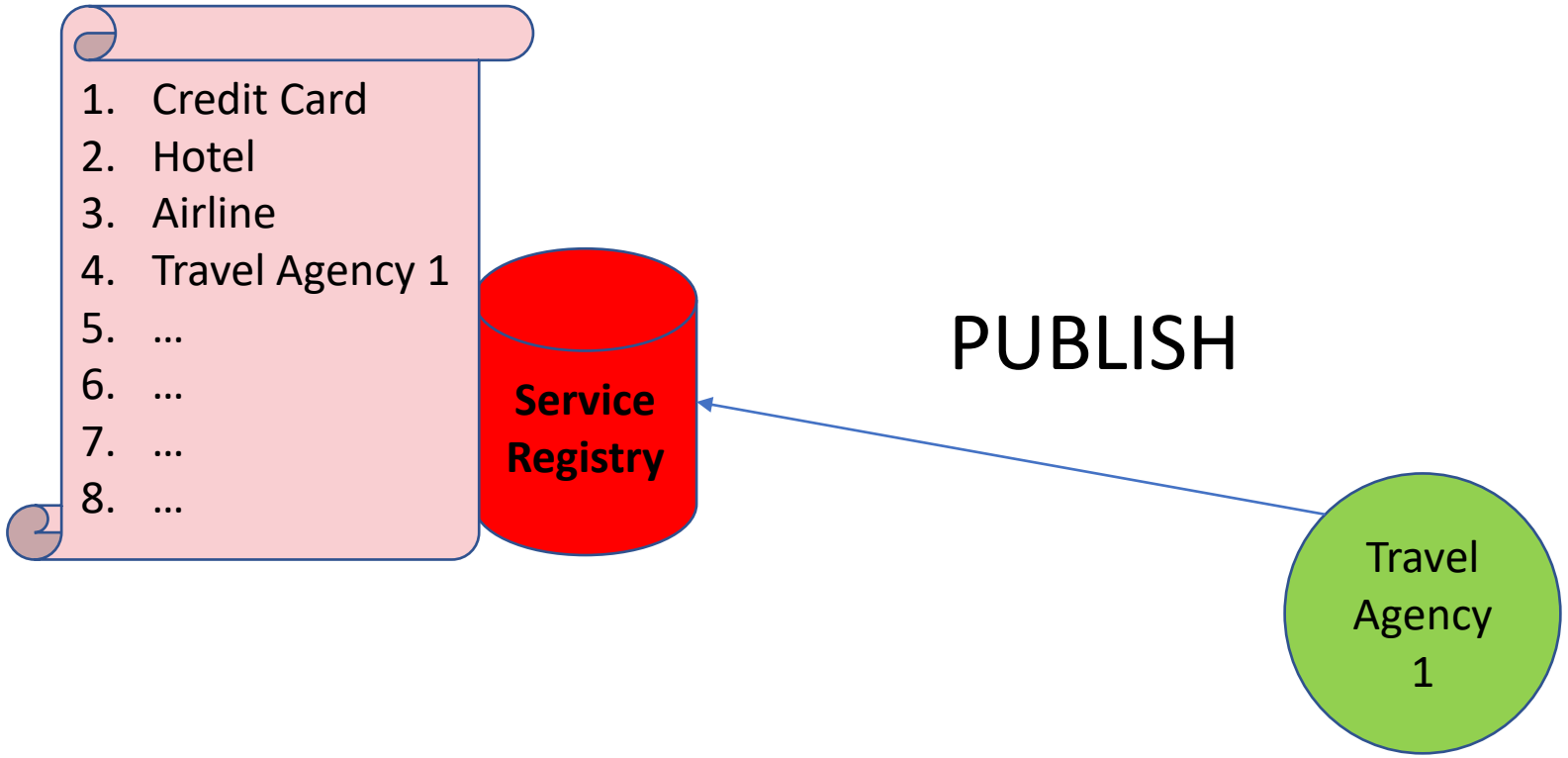


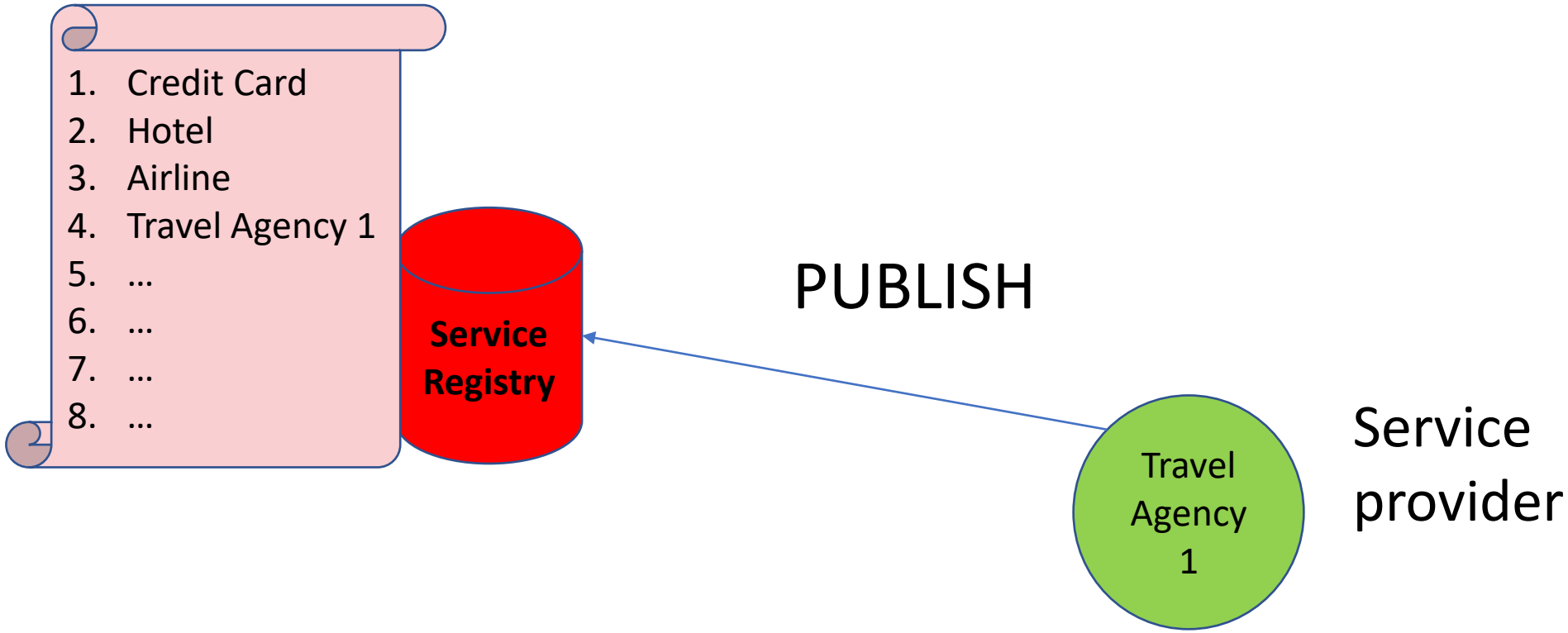
Using the Protocols Together – service request perspective



A client program reads a WSDL document to understand what a Web service can do; then it uses SOAP to actually invoke the functions listed in the WSDL document.


Travel
Agency
1


1. Credit Card
2. Hotel
3. Airline
4. Travel Agency 1
5. …
6. …
7. …
8. …
Service Registry
PUBLISH
Travel Agency 1


1. Credit Card
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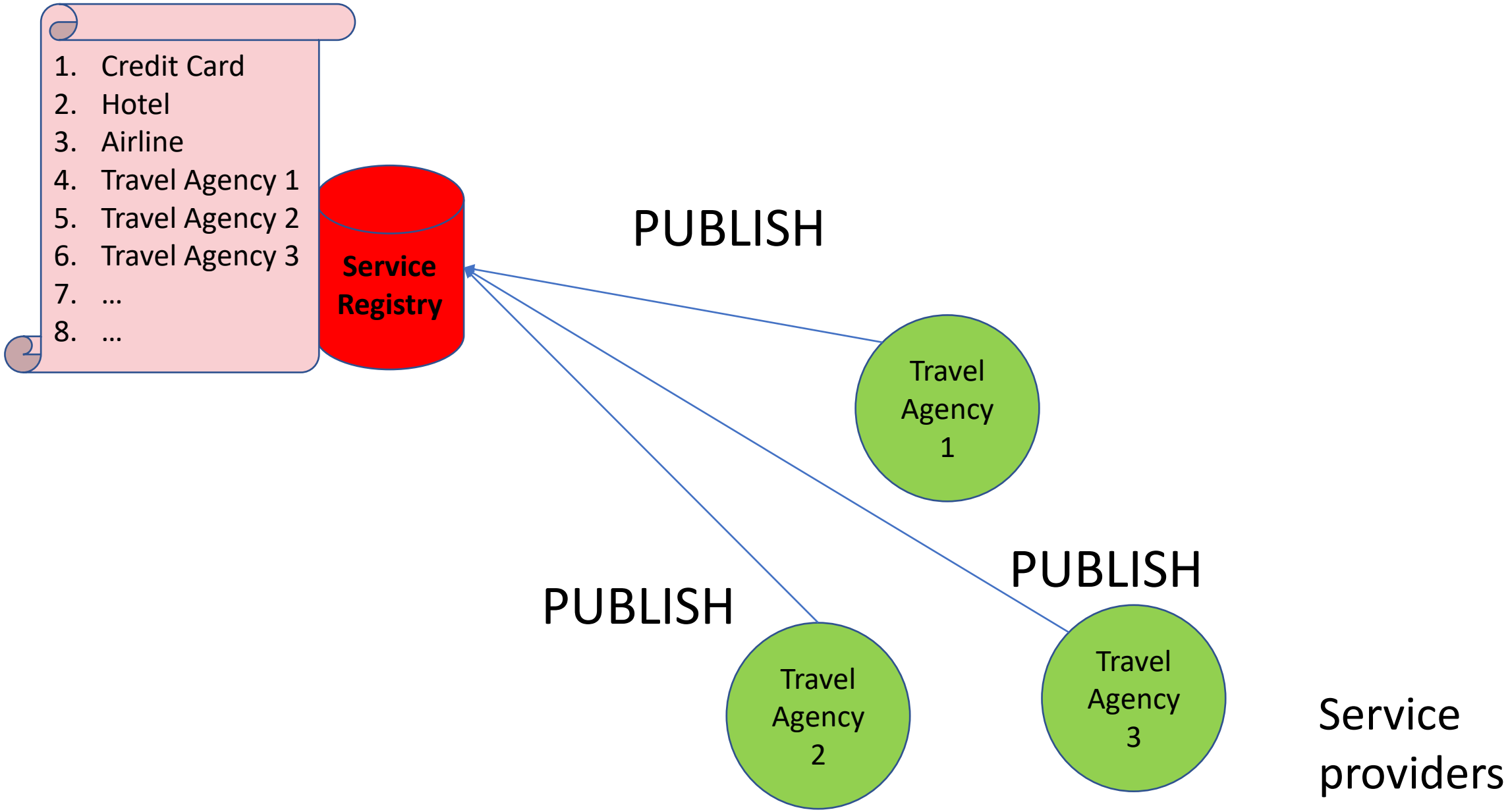
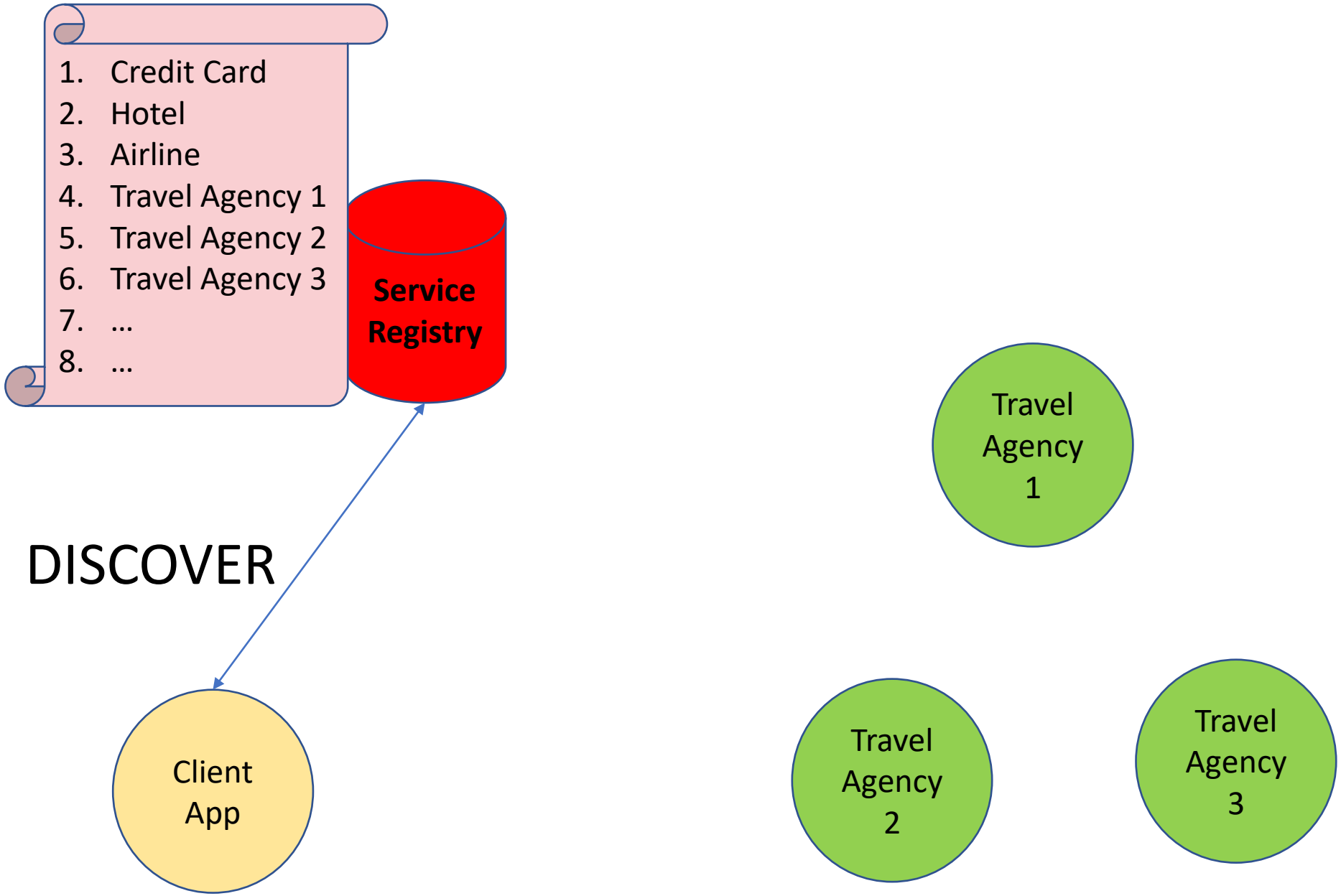
3. Airline
4. Travel Agency 1
5. …
6. …
7. …
8. …
Service Registry
PUBLISH
Travel Agency 1
Service provider


1. Credit Card
2. Hotel
3. Airline
4. Travel Agency 1
5. Travel Agency 2
6. Travel Agency 3
7. …
8. …
Service Registry
PUBLISH
PUBLISH
PUBLISH
Travel Agency 1
Travel Agency 2
Travel Agency 3
Service providers


1. Credit Card
2. Hotel
3. Airline
4. Travel Agency 1
5. Travel Agency 2
6. Travel Agency 3
7. …
8. …
Service Registry
DISCOVER
Client App
Service requestor
Travel Agency 1
Travel Agency 2
Travel Agency 3
Service providers

Travel Agency 1

Service provider

BIND

Client App

Service requestor

1. Credit Card
2. Hotel
3. Airline
4. Travel Agency 1
5. Travel Agency 2
6. Travel Agency 3
7. …
8. …

Travel Agency 1

Client App

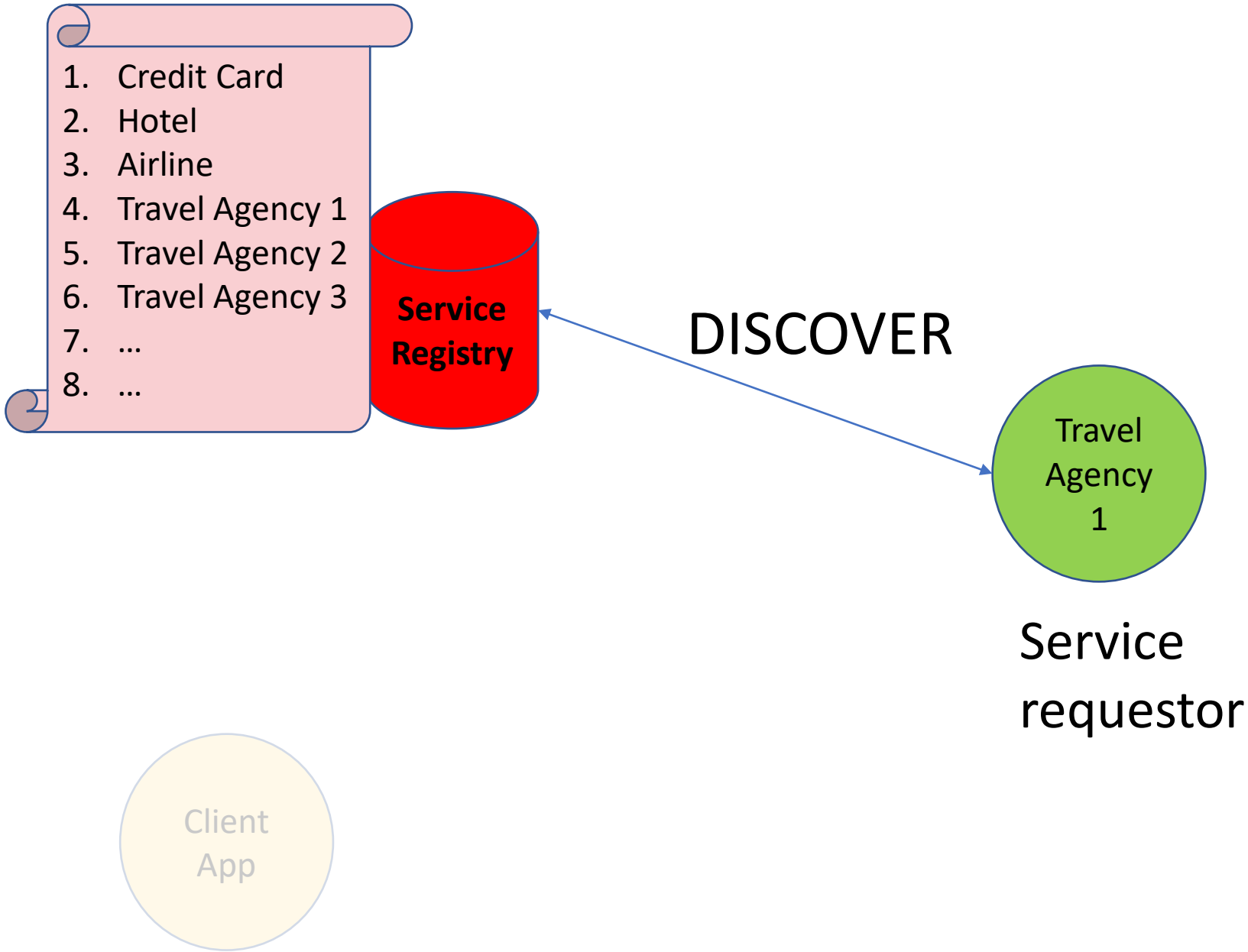
1. Credit Card
2. Hotel
3. Airline
4. Travel Agency 1
5. Travel Agency 2
6. Travel Agency 3
7. …
8. …

Service Registry

I need to find someone who provides hotel services… Also some airlines and payment services would be great

Travel Agency 1

Client App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Service Registry
DISCOVER
Travel Agency 1
Service requestor
Client App

Credit Card

Hotel

Travel Agency 1

Service requestor

Airline

Client App


1. Credit Card
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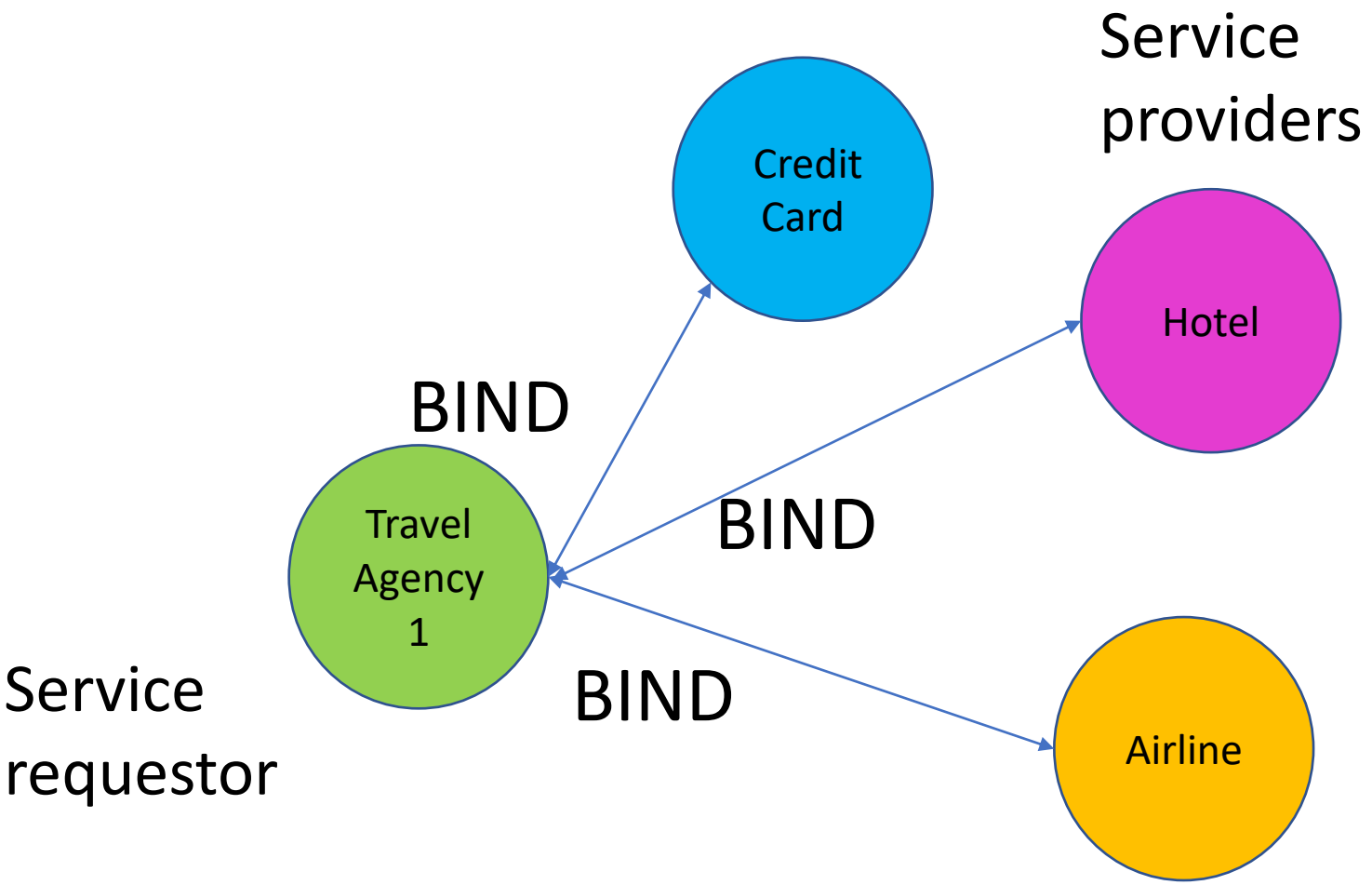
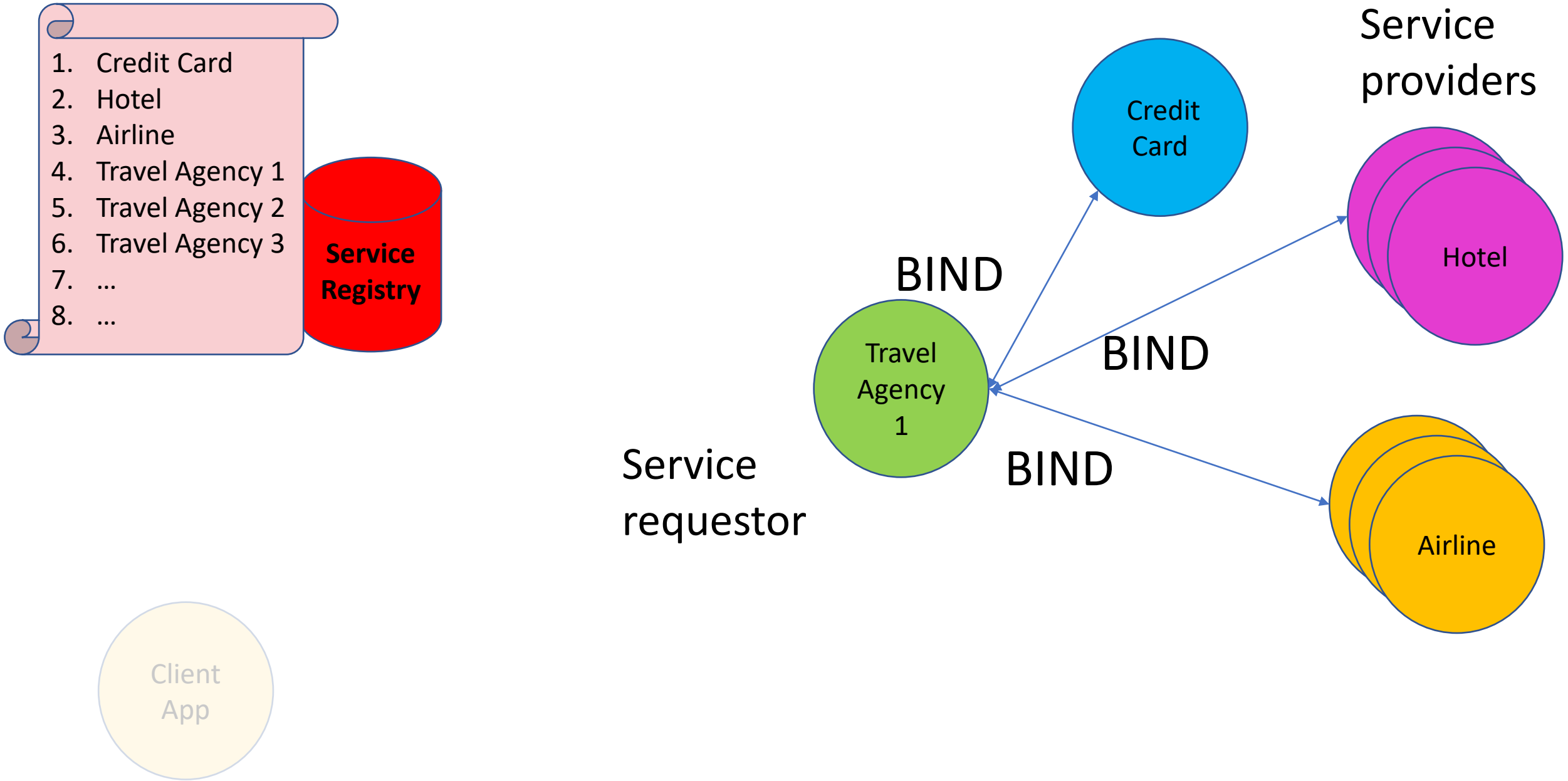
7. …
8. …
Service Registry

Client App


Service providers
Credit Card
Hotel
Airline
BIND
BIND
BIND
Travel Agency 1
Service requestor


1. Credit Card
2. Hotel
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4. Travel Agency 1
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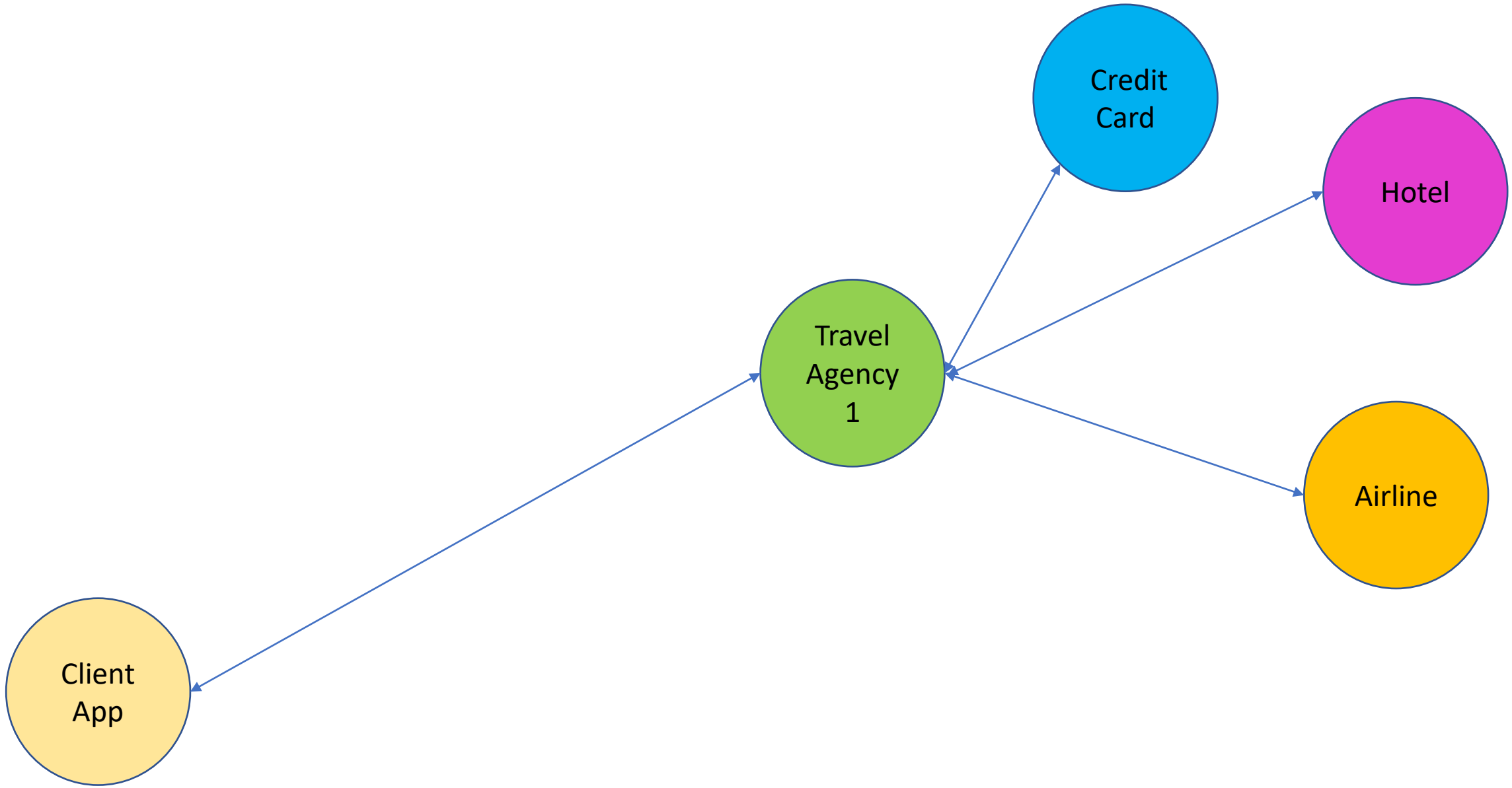
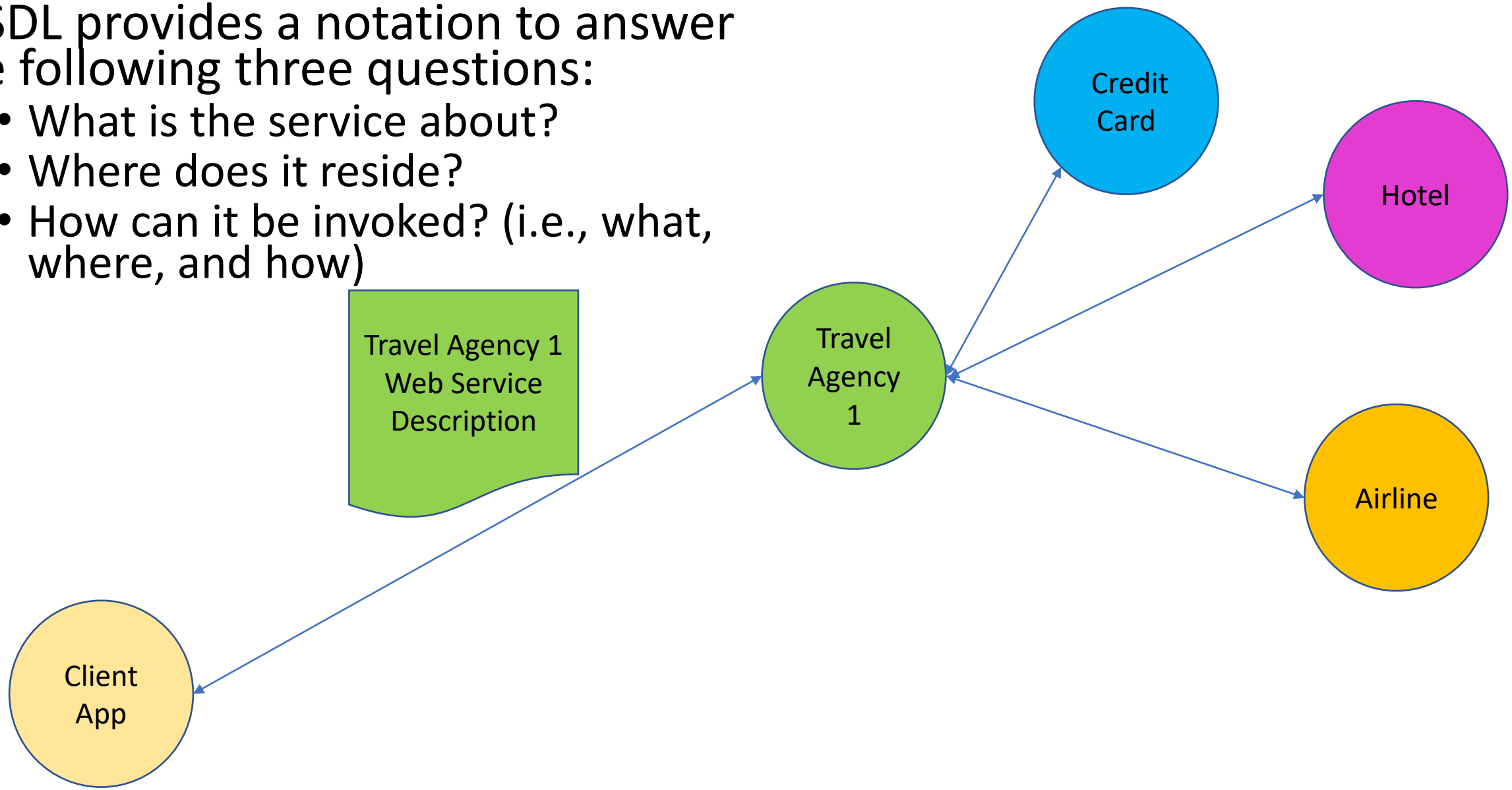
Service Registry
Service providers
Credit Card
Hotel
Airline
BIND
BIND
BIND
Travel Agency 1
Service requestor
Client App


Credit Card
Hotel
Travel Agency 1
Airline
Client App

WSDL provides a notation to answer the following three questions:

- What is the service about?
- Where does it reside?
- How can it be invoked? (i.e., what, where, and how)



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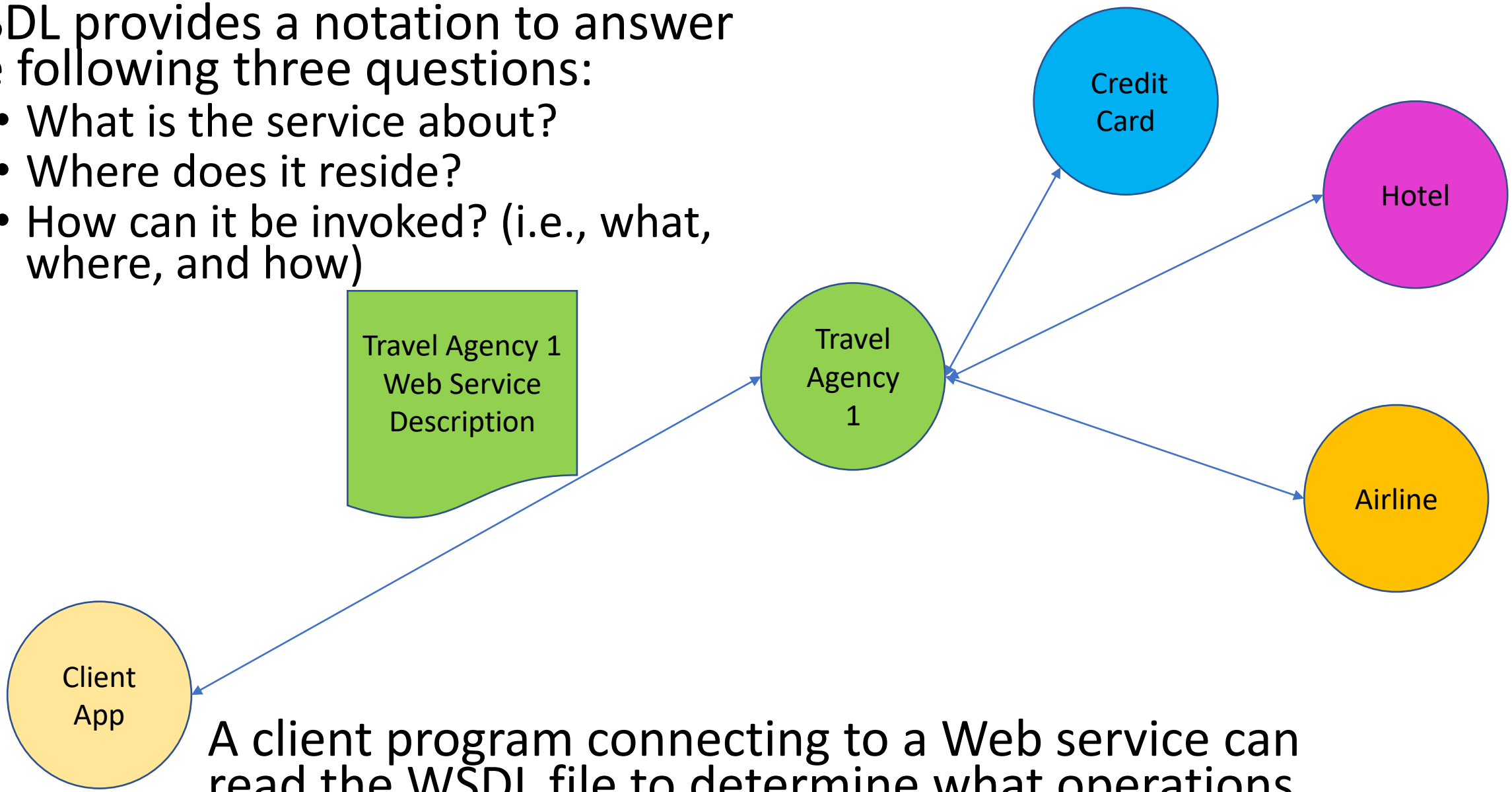
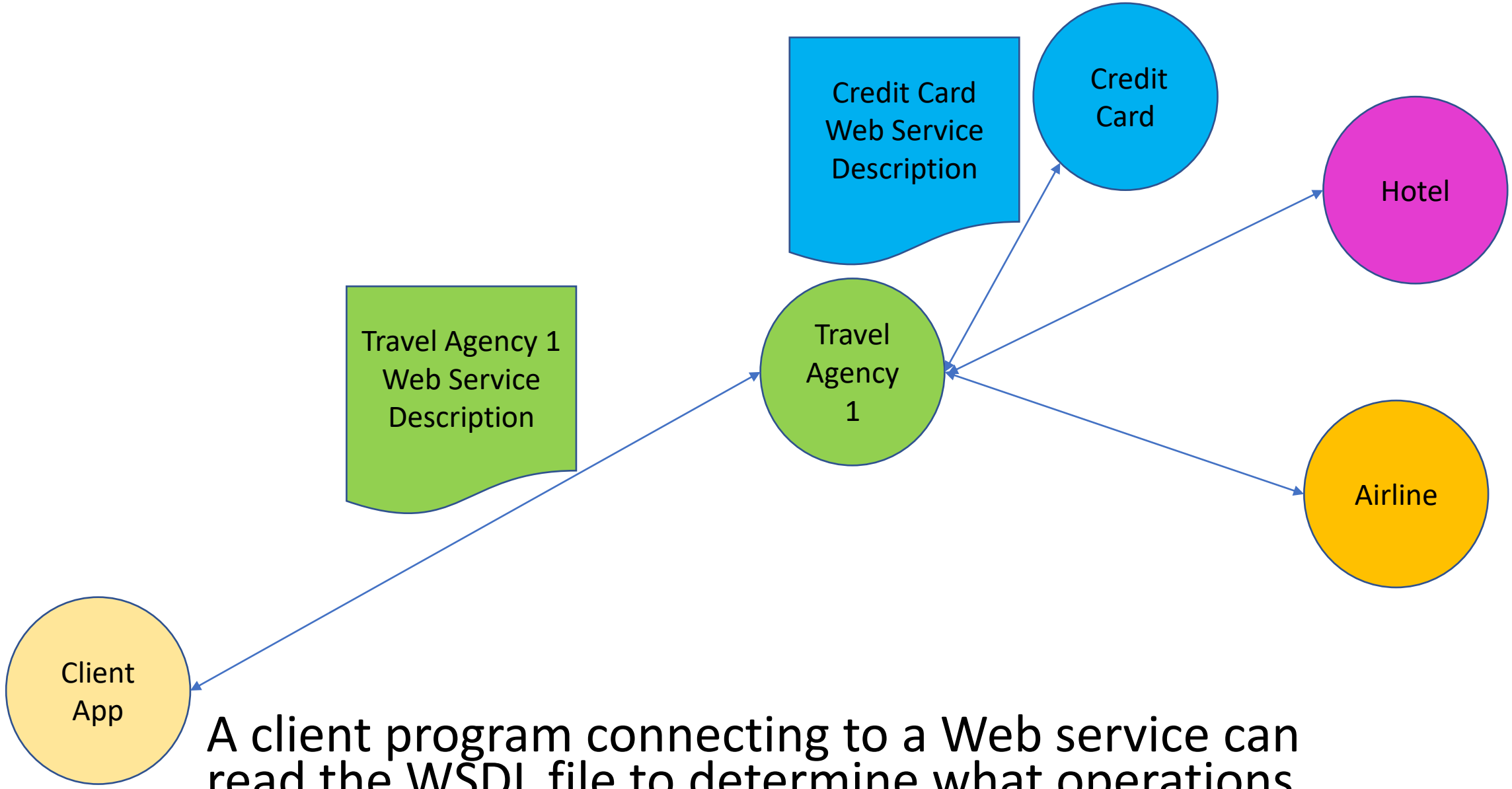


A client program connecting to a Web service can read the WSDL file to determine what operations are available on the server



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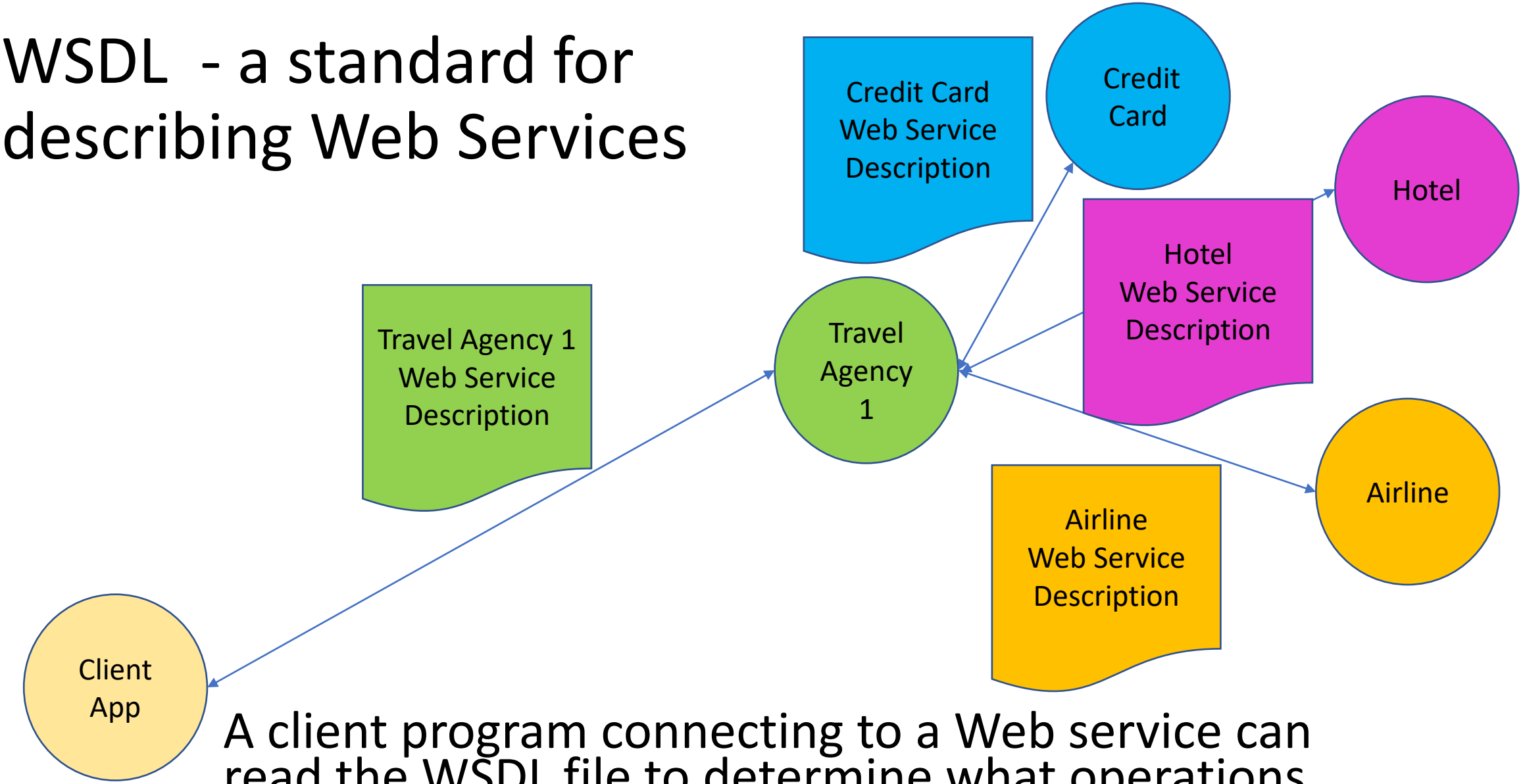
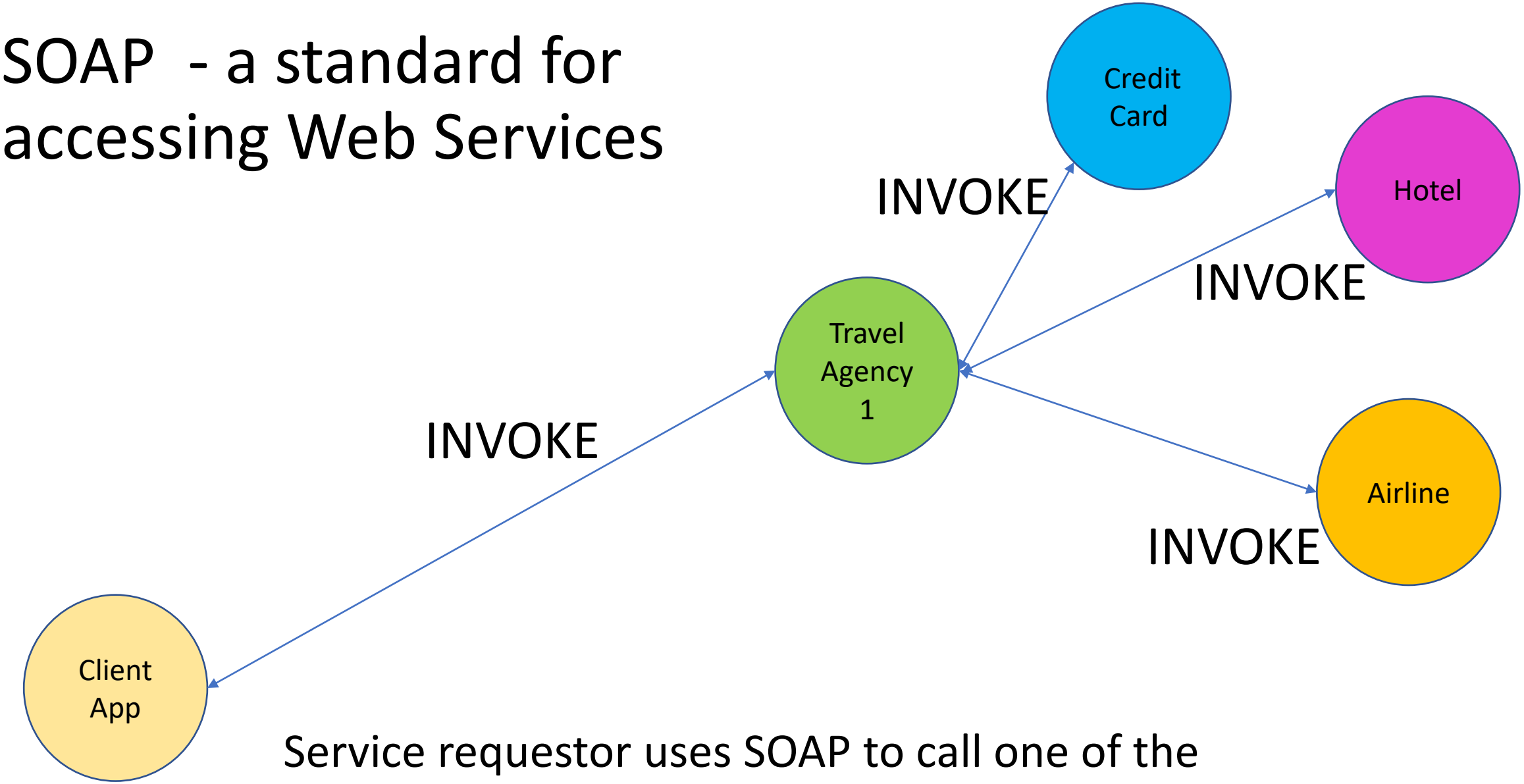
WSDL - a standard for describing Web Services



A client program connecting to a Web service can read the WSDL file to determine what operations are available on the server

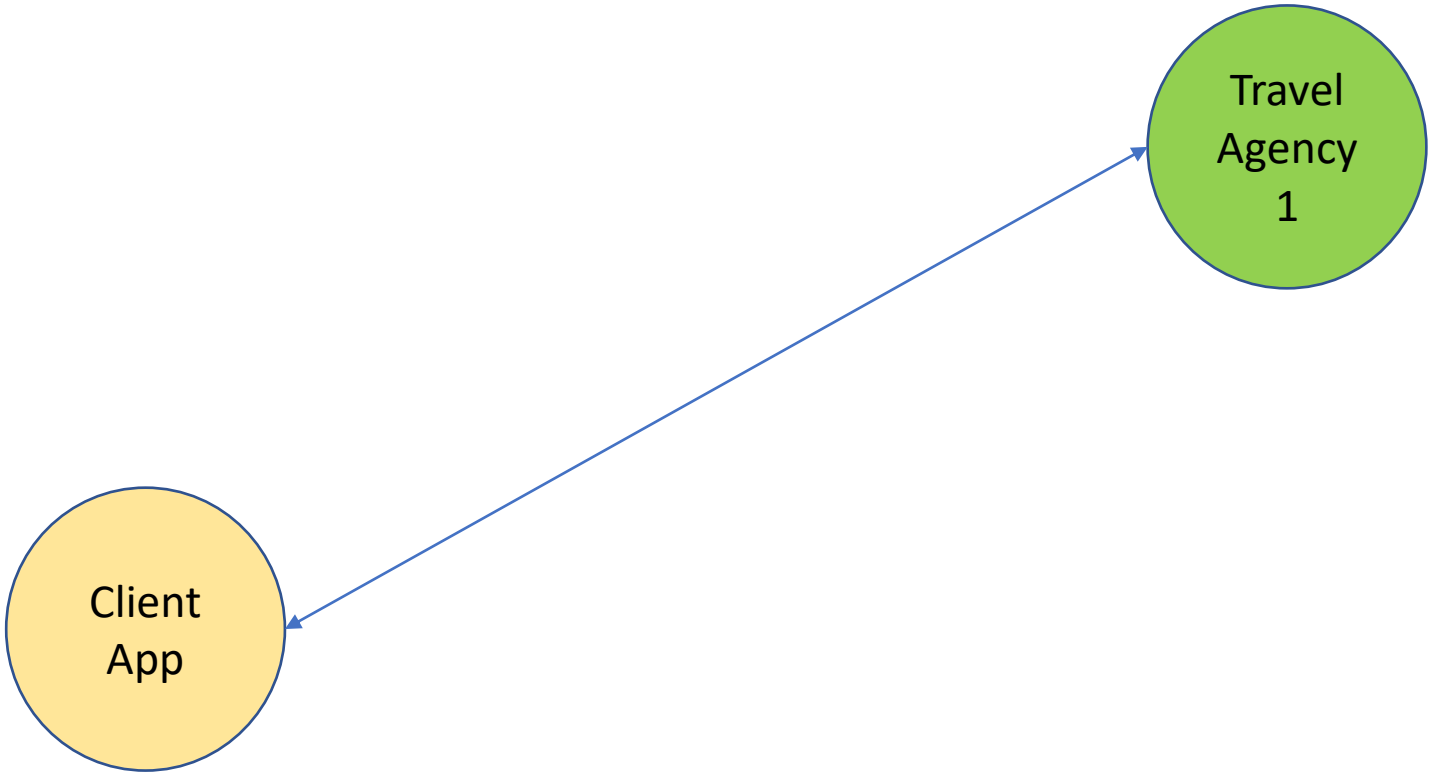
SOAP - a standard for accessing Web Services

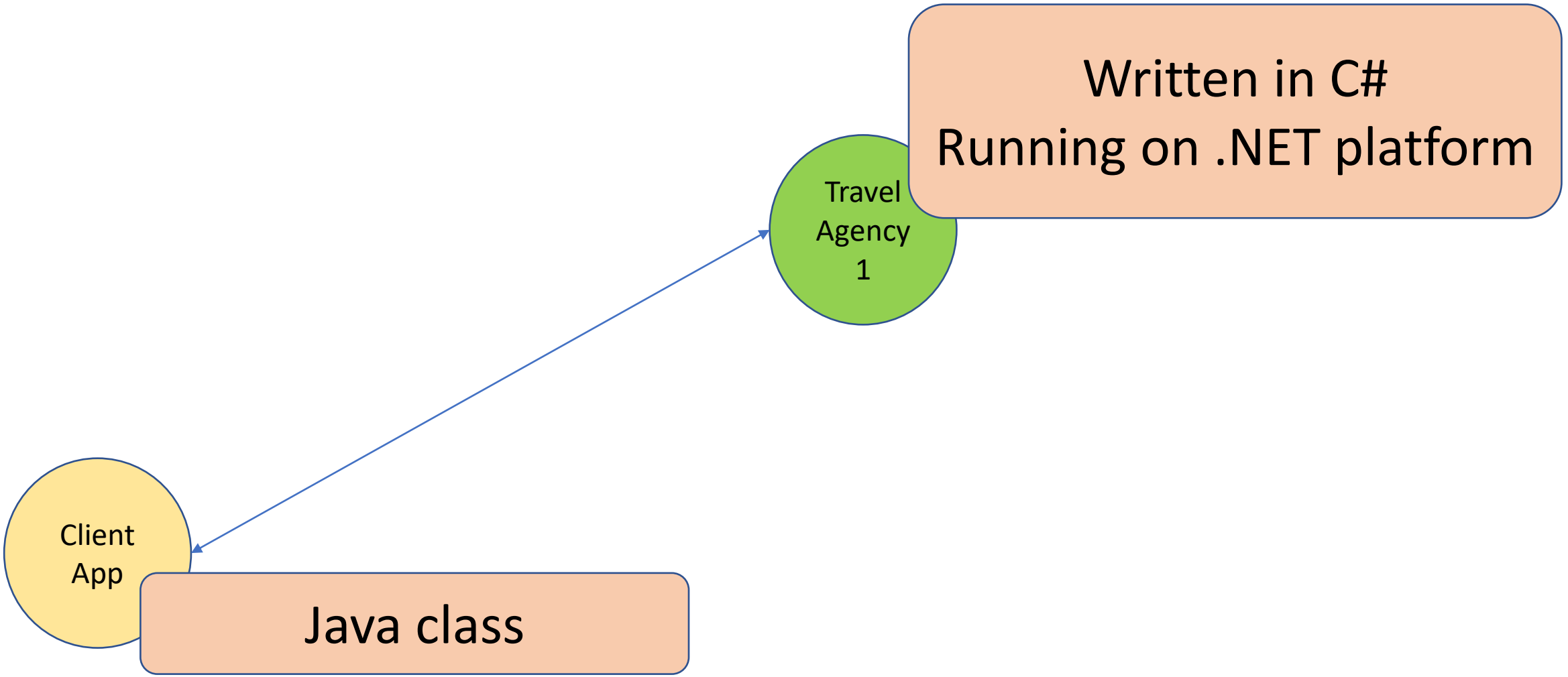


Service requestor uses SOAP to call one of the operations listed in the WSDL file

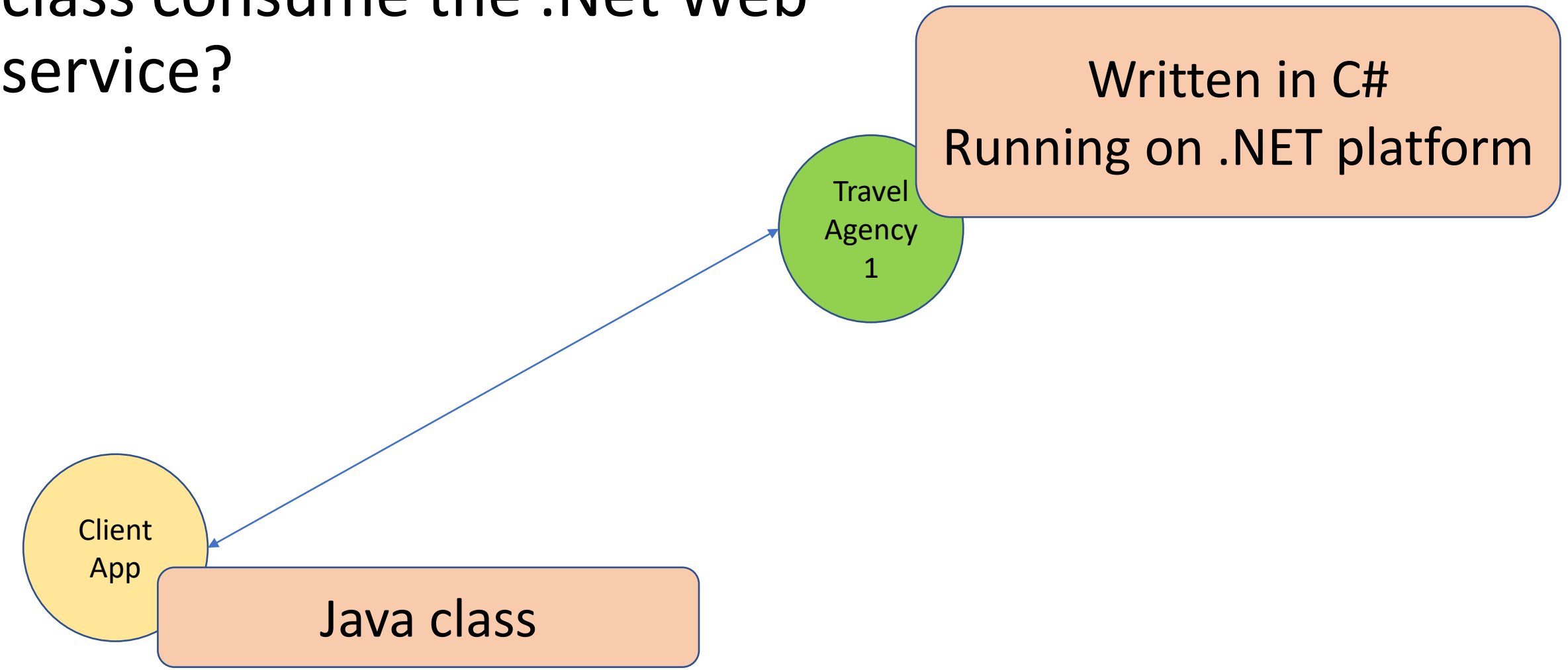
Interoperability

- Ability of services to connect and communicate with one another


Travel
Agency
1
Client
App


Written in C#
Running on .NET platform
Travel Agency 1
Client App
Java class

Interoperability - can a Java class consume the .Net Web service?



Open Question Points: 10

Setting

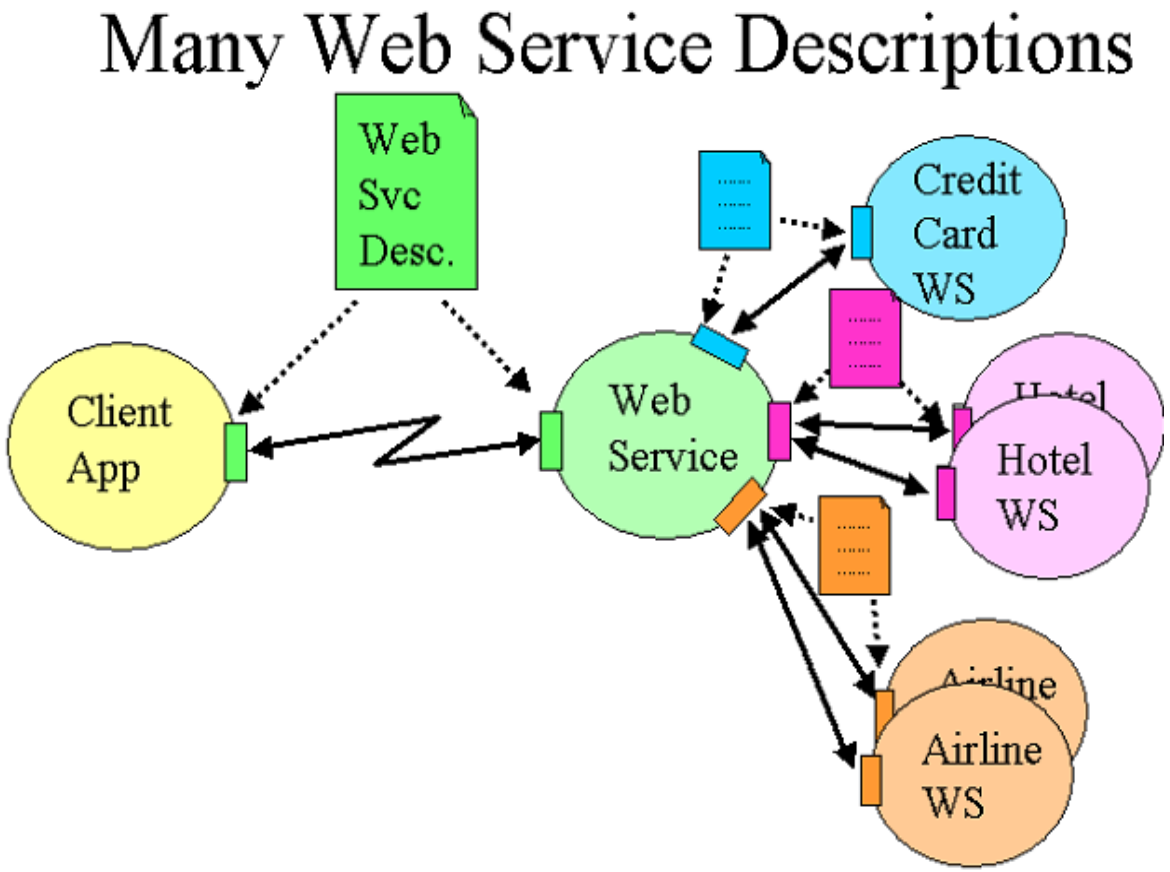
How does WSDL help achieve interoperability?

Open Question is only supported on Version 2.0 or newer.

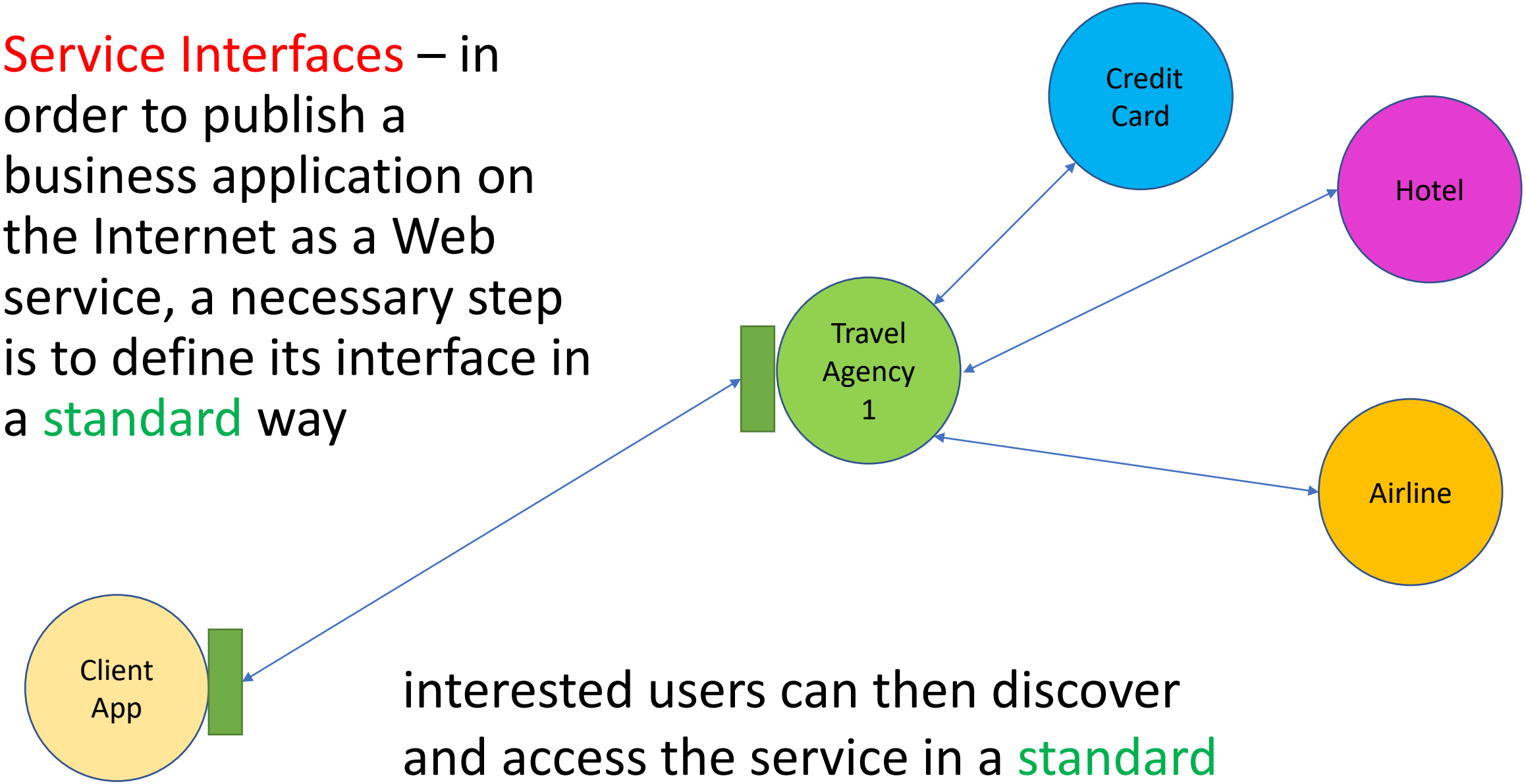
Answer

WSDL Essentials

- For services to interact, they must be aware of each other

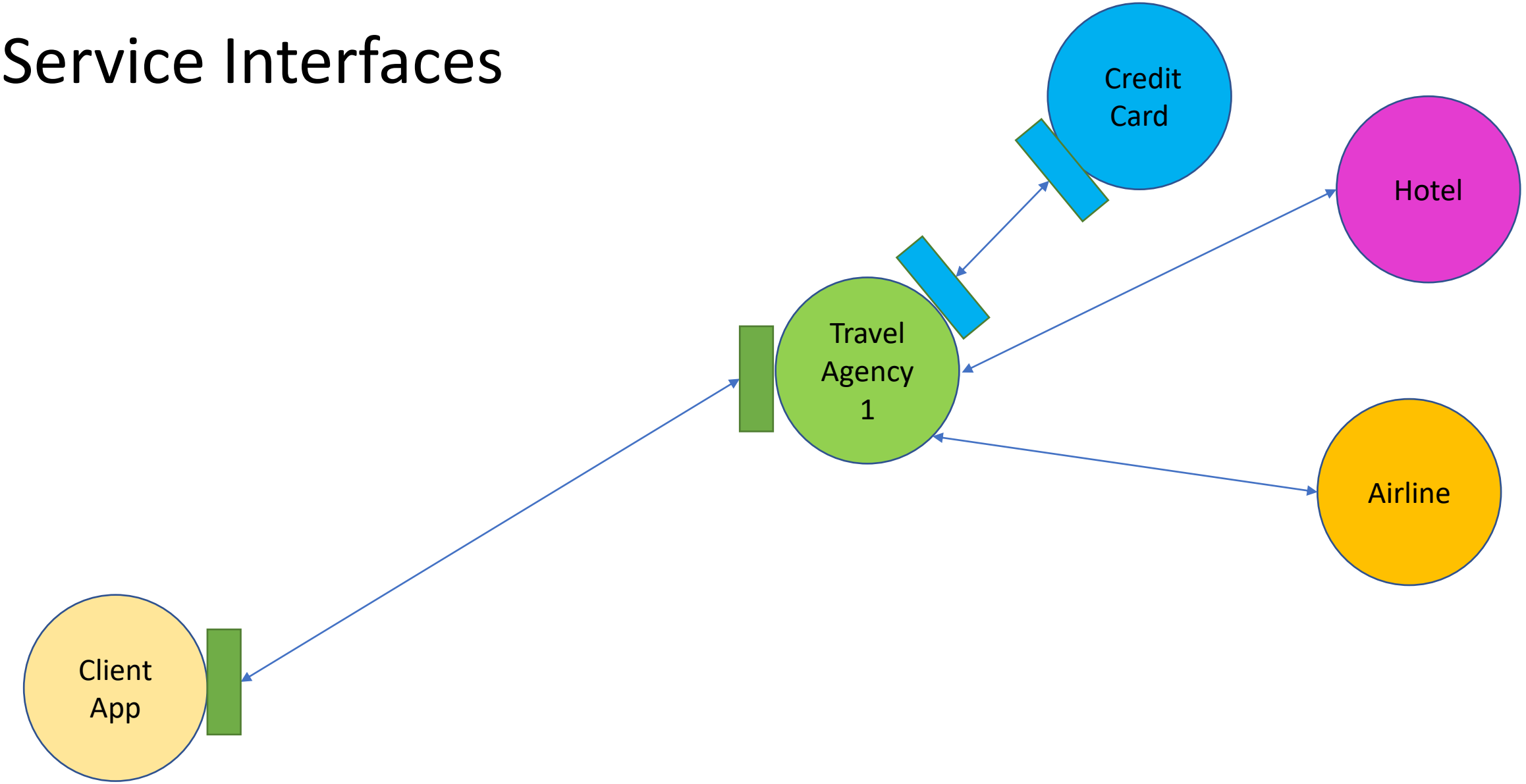


Service Interfaces – in order to publish a business application on the Internet as a Web service, a necessary step is to define its interface in a standard way

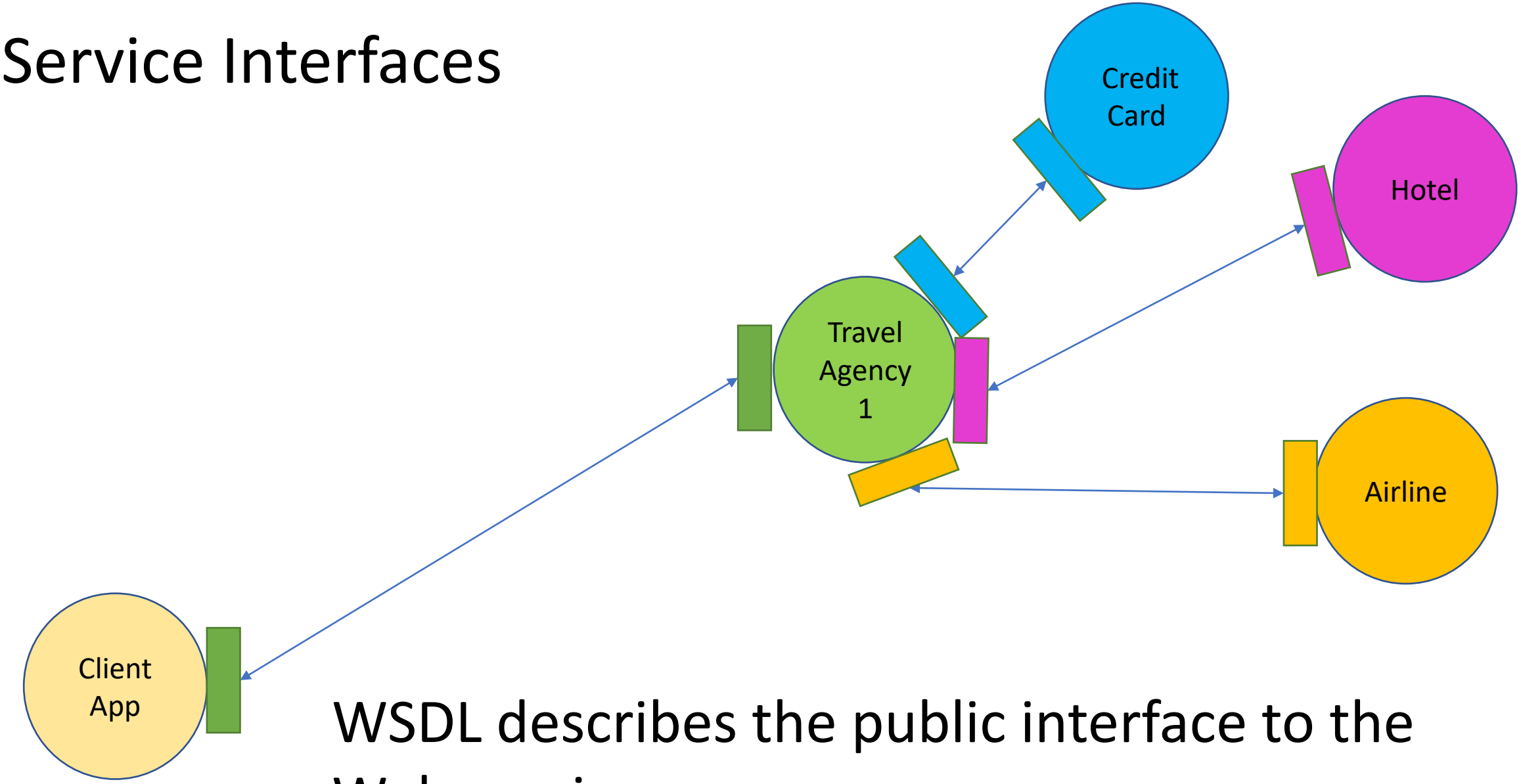


interested users can then discover and access the service in a standard manner

Service Interfaces



Service Interfaces



WSDL describes the public interface to the Web service

Interface - Web Services Interoperability

- Services interoperate based on a formal definition (WSDL) that is independent of the underlying platform and programming language

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Interface - Web Services Interoperability

- Services interoperate based on a formal definition (WSDL) that is independent of the underlying platform and programming language
- The interface definition hides the implementation of the language-specific service
- SOA-based services can function independently of development technologies and platforms (Java, .NET, etc.)

WSDL file is what binds everything together

- WSDL file is written in XML
  - XML can be read by any programming language
  - Both .Net and Java have corresponding commands that have the ability to work with XML
  - If the client application was written in .Net – it would understand the XML file
  - If the client app was written in Java – it could also interpret the WSDL file

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  - If the client application was written in .Net – it would understand the XML file
  - If the client app was written in Java – it could also interpret the WSDL file
- Web services allow multiple applications built on various programming languages to talk to each other
  - We can have a .Net web application talking to a Java application via a Web service

Open Question Points: 10

Setting

Why do you think interoperability is important for businesses?

Open Question is only supported on Version 2.0 or newer.

Answer

Web Services Interoperability

- Universal accessibility
  - Standard interface description
  - Standard communication protocols
- Can be implemented in different programming languages
- Can be implemented on different platforms

Web Services Interoperability benefits

- Facilitate B2B collaboration
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Web Services Interoperability benefits

- Facilitate B2B collaboration
  - Each organization exposes its business applications as services on the Internet and makes them accessible via standard programming interfaces
- Facilitate distributed computing and resource sharing over the Internet
  - Cross-language and cross-platform
- Cost effective way to quickly develop and deploy Web applications
  - Integrate other independently published Web service components into new business processes

Developing Web Services with WSDL

Does a Web Service need to be developed from scratch?

- Widget, Inc. makes and sells components for smartphones. Their customers are major smartphone producers.

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  - Customer submits purchase orders by sending an email
  - Widget, Inc employee enters the purchase order in their "orders application"

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- Currently, the ordering process is based on a legacy system:
  - Customer submits purchase orders by sending an email
  - Widget, Inc employee enters the purchase order in their "orders application"
- To improve their business relationships, Widget, Inc. wants to start selling parts through its website, enabling customers to directly submit purchase orders and check on order status.

Open Question Points: 10

Setting

You are a developer for Widget, Inc. You are asked to develop a Web service to expose the “order application” functions on the Internet and make it accessible to the existing and potential customers.

- Can you reuse the existing “order application” ? How?

Open Question is only supported on Version 2.0 or newer.

Answer

Does a Web Service need to be developed from scratch?

- Any existing application can become a Web Service as long as it is wrapped by a Web Services interface (WSDL) and then published in a registry.

What if we do want to develop the web service from scratch?

Open Question Points: 10

Setting

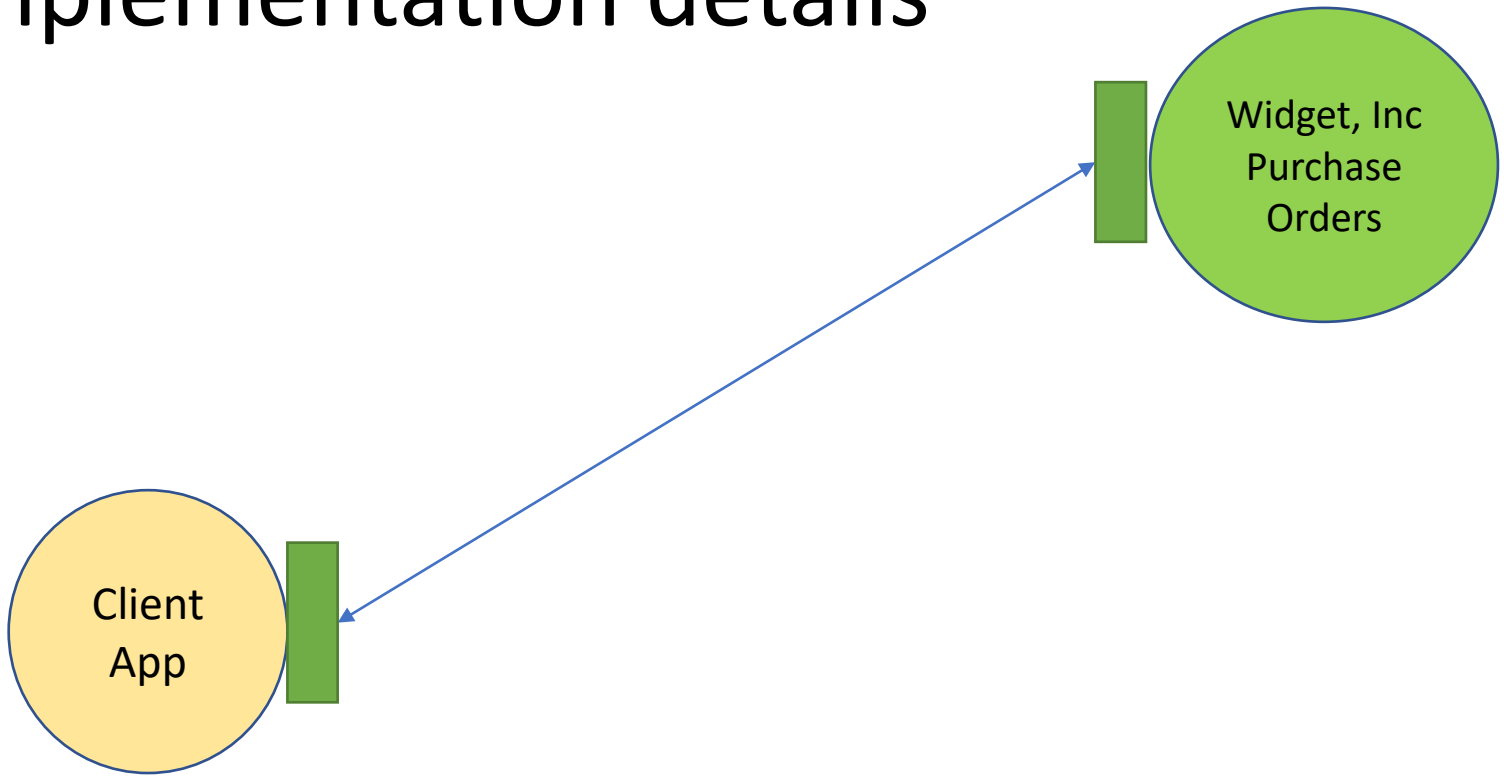
You are a developer for Widget, Inc. You are asked to develop a Web service
- If you want to develop the Web service from scratch – how do you start?

Open Question is only supported on Version 2.0 or newer.

Answer

What if we do want to develop the web service from scratch?

- Start by modelling its potential interfaces before moving to implementation details



Service reusability

Service reusability

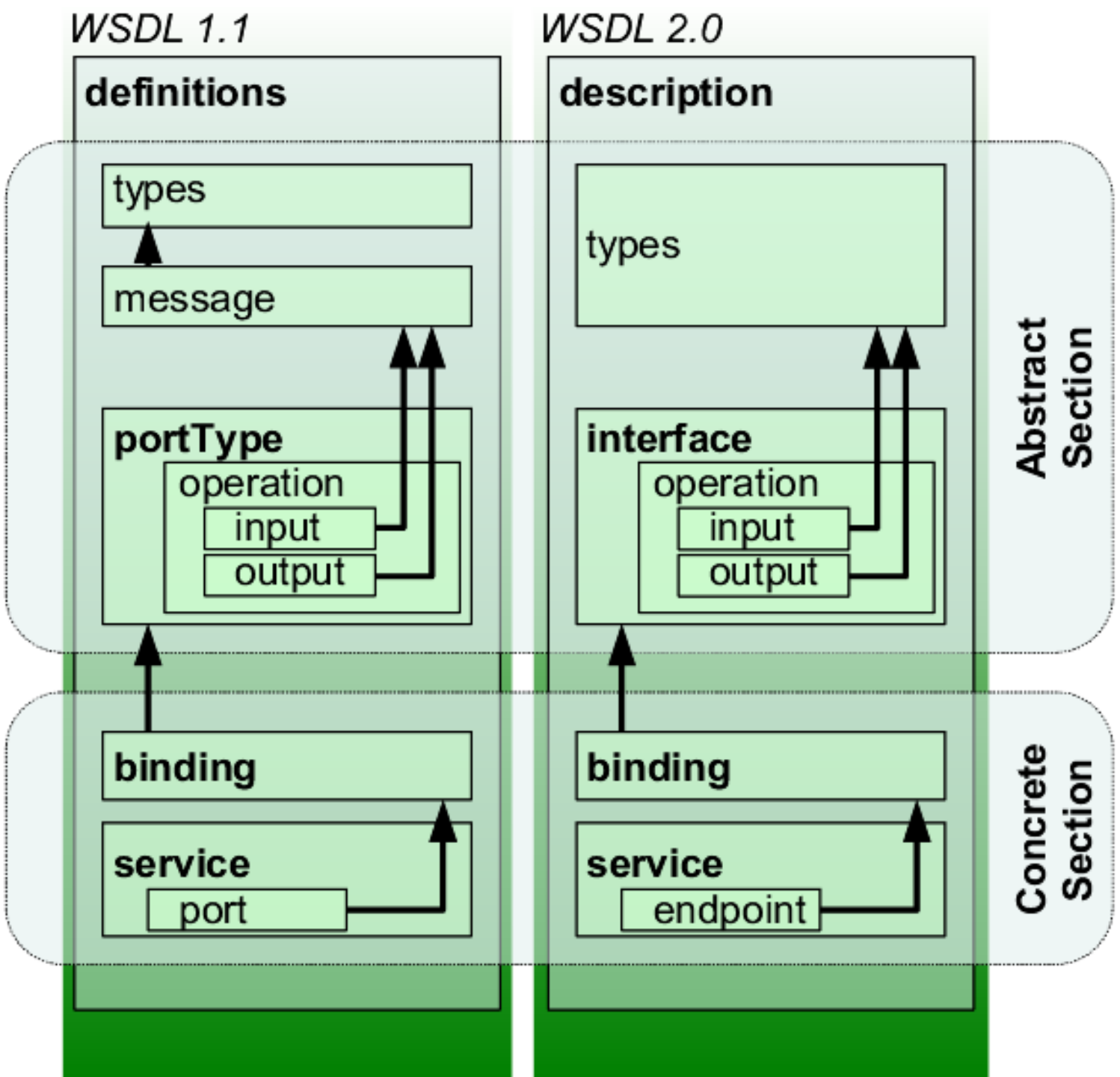
- Service reuse is often mentioned as an important aspect of SOA
- The aim is to create services that can be reused across a business
- Does WSDL help with reusability?

WSDL and reusability

- Recall the sections of WSDL document. How do you think WSDL helps with reusability of services?

WSDL

- An XML-based interface description language
- Used for describing the functionality offered by a web service
- WSDL describes services as collections of network endpoints or ports



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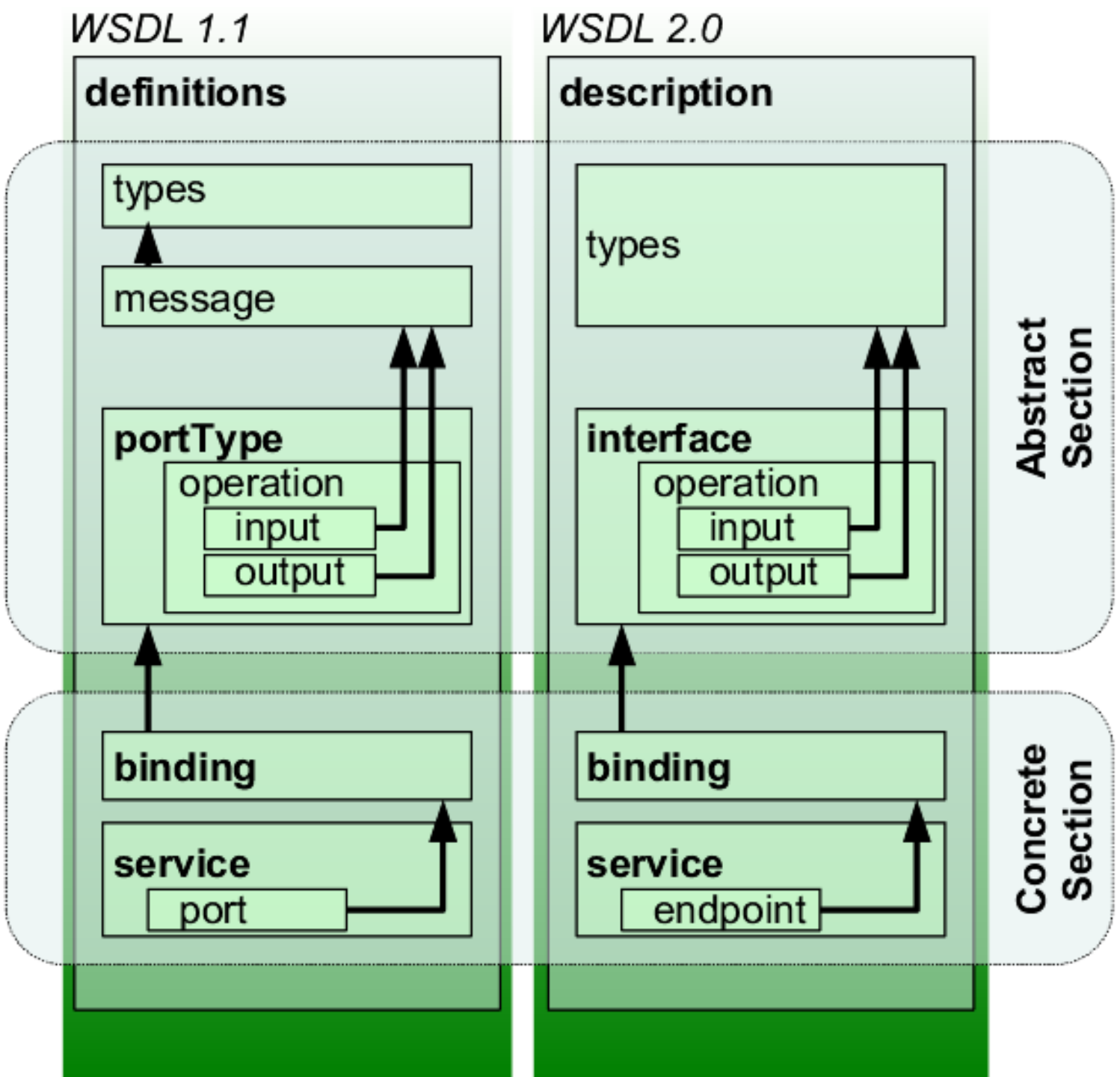


- A WSDL document can be divided into “abstract” and “concrete” portions
- The abstract definitions of ports and messages are separated from their concrete use or instance
- These portions are often defined in two or more files
  - Concrete file imports the abstract one
- Separating this sections allows for reuse

Authoring Style Recommendation

- **Reusability** and **maintainability**
- Maintain WSDL document in 3 separate parts
  - Data type definitions
  - Abstract definitions
  - Specific service bindings
- Use "*import*" element to import necessary part of WSDL document

Example7A: http://example.com/stockquote/stockquote.x

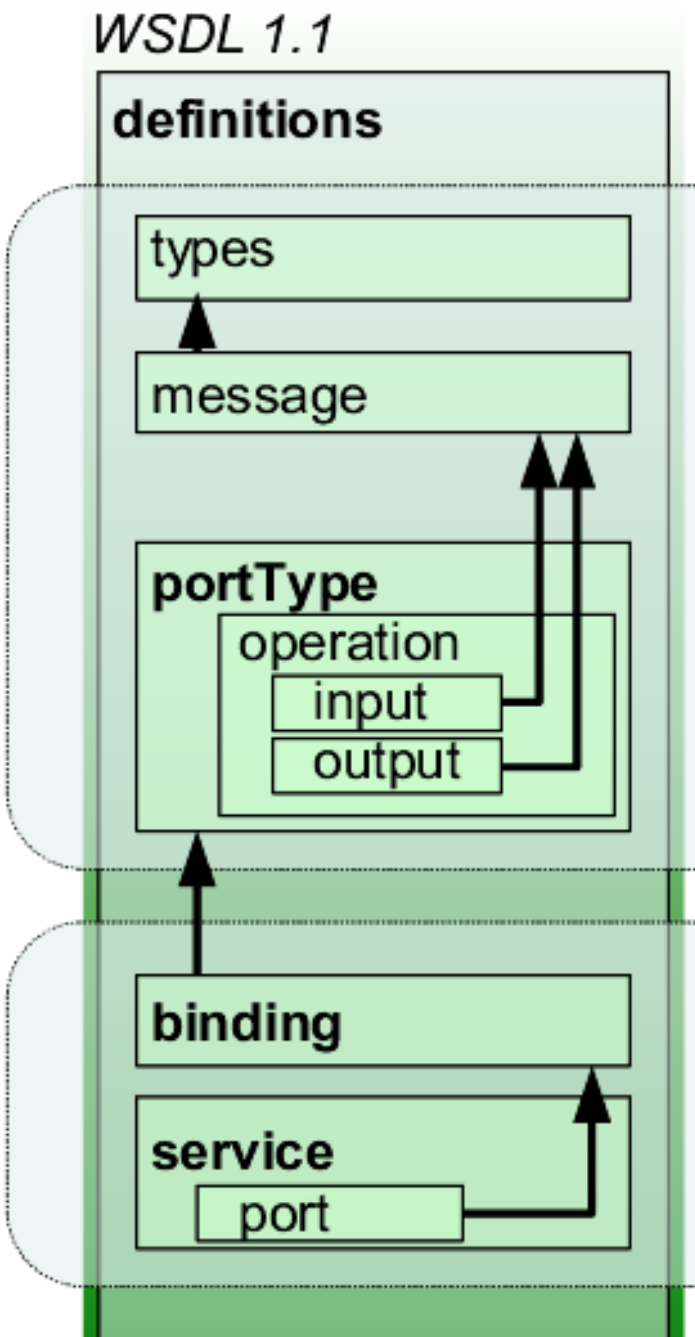
```
<?xml version="1.0"?>
<schema targetNamespace="http://example.com/stockquote/schemas"
     xmlns="http://www.w3.org/2000/10/XMLSchema">
   <element name="TradePriceRequest">
      <complexType>
         <all>
            <element name="tickerSymbol" type="string"/>
         </all>
      </complexType>
   </element>
   <element name="TradePrice">
      <complexType>
         <all>
            <element name="price" type="float"/>
         </all>
      </complexType>
   </element>
</schema>
```

Maintain WSDL document in 3 separate parts

– Data type definitions

– Abstract definitions

– Specific service bindings



Example7B:http://example.com/stockquote/stockquote.wsdl

```
<?xml version="1.0"?>
<definitions name="StockQuote"
targetNamespace="http://example.com/stockquote/definitions"
        xmlns:tns="http://example.com/stockquote/definitions"
        xmlns:xsd1="http://example.com/stockquote/schemas"
        xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
        xmlns="http://schemas.xmlsoap.org/wsdl/">
  <import namespace="http://example.com/stockquote/schemas"
         location="http://example.com/stockquote/stockquote.xsd"/>
   <message name="GetLastTradePriceInput">
      <part name="body" element="xsd1:TradePriceRequest"/>
   </message>
```

Use "*import*" element to import necessary part of WSDL document

Abstract part

```
<message name="GetLastTradePriceOutput">
   <part name="body"
element="xsd1:TradePrice"/>
</message>
<portType name="StockQuotePortType">
   <operation name="GetLastTradePrice">
      <input
message="tns:GetLastTradePriceInput"/>
      <output
message="tns:GetLastTradePriceOutput"/>
   </operation>
</portType>
</definitions>
```

- Here we just declare the expected elements of a message, but we do not really define here how the actual SOAP message matching this definition looks like

Maintain WSDL document in 3 separate parts

– Data type definitions

– Abstract definitions

– Specific service bindings

Example7C: http://example.com/stockquote/stockquoteservice.wsdl

```
<?xml version="1.0"?>
<definitions name="StockQuote"
targetNamespace="http://example.com/stockquote/service"
        xmlns:tns="http://example.com/stockquote/service"
        xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
        xmlns:defs="http://example.com/stockquote/definitions"
        xmlns="http://schemas.xmlsoap.org/wsdl/">
  <import namespace="http://example.com/stockquote/definitions"
         location="http://example.com/stockquote/stockquote.wsdl"/>
   <binding name="StockQuoteSoapBinding“ type="defs:StockQuotePortType">
     <soap:binding style="document" transport="http://schemas.xmlsoap.org/soap/http"/>
     <operation name="GetLastTradePrice">
```

Use “*import*” element to import necessary part of WSDL document

Concrete part – specific service bindings

```
 <soap:operation soapAction="http://example.com/GetLastTradePrice"/>
    <input><soap:body use="literal"/> </input>
    <output><soap:body use="literal"/></output>
  </operation>
</binding>
<service name="StockQuoteService">
  <documentation>My first service</documentation>
  <port name="StockQuotePort" binding="tns:StockQuoteBinding">
    <soap:address location="http://example.com/stockquote"/>
  </port>
</service>
```

Maintain WSDL document in 3 separate parts

– Data type definitions
– Abstract definitions
– Specific service bindings

SOAP Binding

When to use What?

Example7C: http://example.com/stockquote/stockquoteservice.wsdl

```
<?xml version="1.0"?>
<definitions name="StockQuote"
targetNamespace="http://example.com/stockquote/service"
        xmlns:tns="http://example.com/stockquote/service"
        xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
        xmlns:defs="http://example.com/stockquote/definitions"
        xmlns="http://schemas.xmlsoap.org/wsdl/">
   <import namespace="http://example.com/stockquote/definitions"
         location="http://example.com/stockquote/stockquote.wsdl"/>
    <binding name="StockQuoteSoapBinding“ type="defs:StockQuotePortType">
      <soap:binding style="document"
     transport="http://schemas.xmlsoap.org/soap/http"/>
      <operation name="GetLastTradePrice">
      <soap:operation soapAction="http://example.com/GetLastTradePrice"/>
        <input><soap:body use="literal"/> </input>
        <output><soap:body use="literal"/></output>
      </operation>
    </binding>
```

WSDL SOAP Binding style and mode

- **There are four (+1) combinations of WSDL SOAP Binding style and mode:**
  - rpc/encoded
  - rpc/literal
  - ~~document/encoded~~
  - document/literal
  - document/literal/wrapped

rpc/encoded

WSDL segment

```
<message name="myMethodRequrest">
    <part name="x" type="xsd:int">
    <part name="y" type="xsd:float">
</message>
<message name="empty"/>
<portType name="PT">
    <operation name="myMethod">
        <input message="myMethodRequrest"/>
        <output message="empty"/>
    </operation>
</portType/>
```

SOAP segment

```
<soap:envelop>
    < soap:body >
        <myMethod>
            <x xsi:type="xsd:int">5</x>
            <y xsi:type="xsd:float">5.0</y>
        </ myMethod >
    < soap:body />
</soap:envelop >
```

rpc / literal

WSDL segment

```
<message name="myMethodRequrest">
    <part name="x" type="xsd:int">
    <part name="y" type="xsd:float">
</message>
<message name="empty"/>
<portType name="PT">
    <operation name="myMethod">
        <input message="myMethodRequrest"/>
        <output message="empty"/>
     </operation>
</portType/>
```

SOAP segment

```
<soap:envelop>
    < soap:body >
        <myMethod>
            <x>5</x>
            <y>5.0</y>
        </ myMethod >
     < soap:body />
</soap:envelop >
```

document/literal

WSDL segment

```
<types>
    <schema>
        <element  name="xElement" type="xsd:int"/>
        <element  name="yElement" type="xsd:float"/>
    </schema>
</types>
<message name="myMethodRequrest">
    <part name="x" type="xElement">
    <part name="y" type="yElement">
</message>
<message name="empty"/>
<portType name="PT">
    <operation name="myMethod">
        <input message="myMethodRequrest"/>
        <output message="empty"/>
     </operation>
</portType/>
```

SOAP segment

```
<soap:envelop>
    < soap:body >
        < xElement >5</ xElement >
        < yElement >5.0</yElement >
    < soap:body />
</soap:envelop >
```

document/literal/wrapped

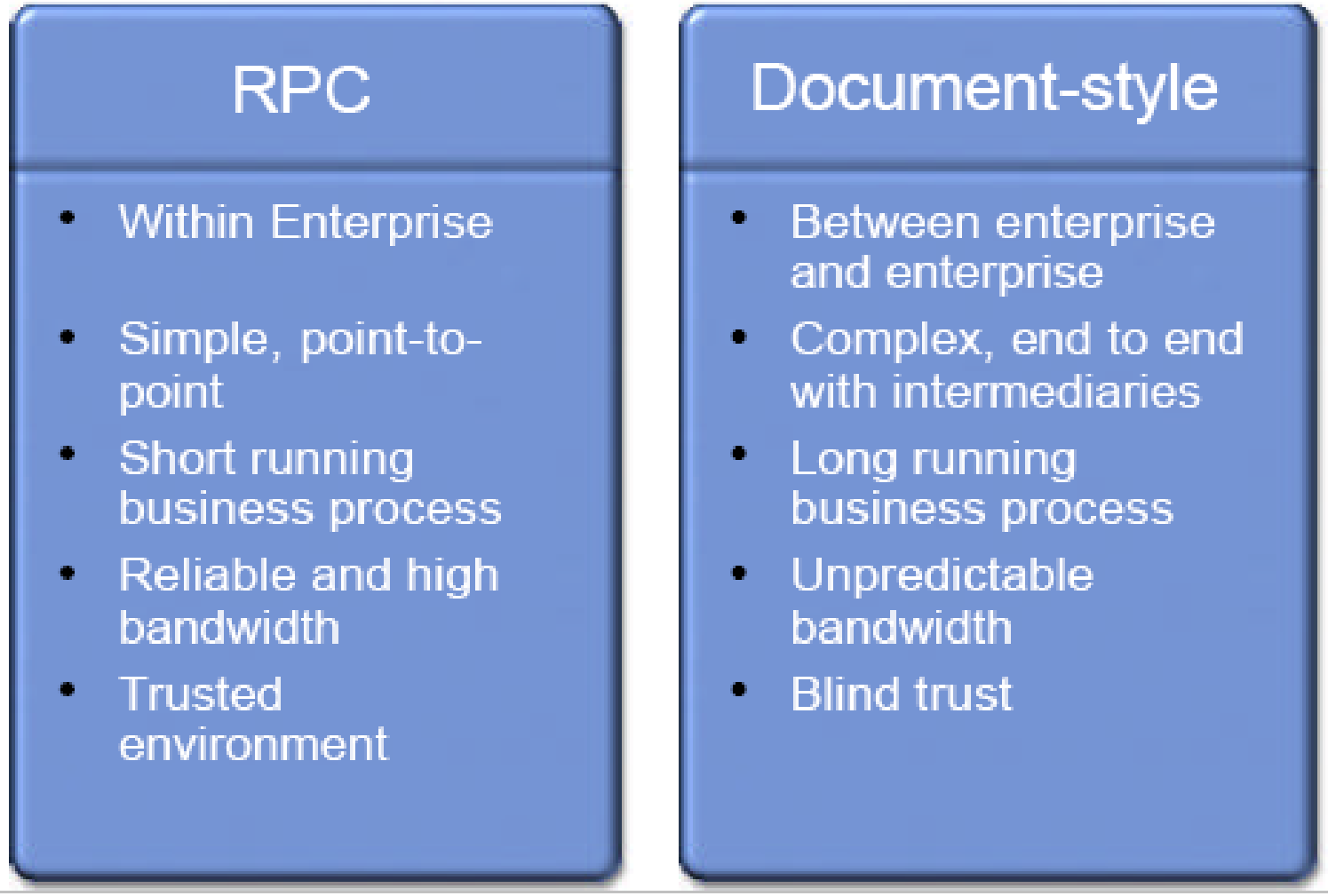
WSDL segment

```
<types>
    <schema>
        <xs:element name=" myMethodRequrest ">
            <xs:complexType>
                <xs:sequence>
                    <xs:element type="xs:int" name=" xElement " />
                    <xs:element type="xs:float" name=" yElement " />
                </xs:sequence>
            </xs:complexType>
        </xs:element>
    </schema>
</types>
<message name="myMethodRequ
    <part name="part1" type="myI
</message>
<message name="empty"/>
<portType name="PT">
    <operation name="myMethod">
        <input message="myMethodRequrestMessage"/>
```

SOAP segment

```
<soap:envelop>
    < soap:body >
        < myMethodRequrest >
            < xElement >5</ xElement >
            < yElement >5.0</yElement >
        < /myMethodRequrest >
    < soap:body />
</soap:envelop >
```

When to use Which model?



Module 2 Summary

- SOAP technology
- WSDL technology

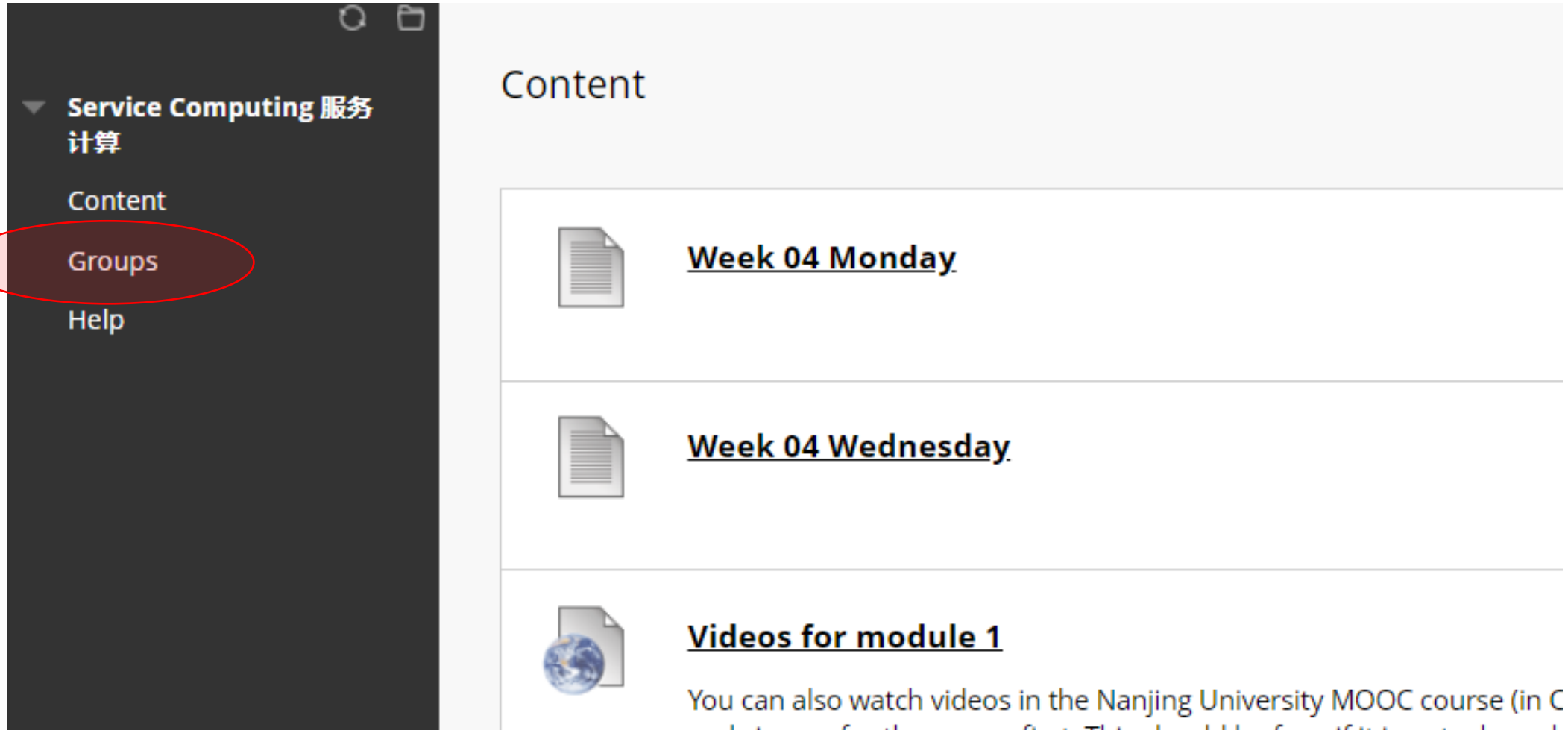
Hot topic study

- There will be 2 tasks to complete today
  - 1. form groups and sign up
  - 2. discuss the topic each group will want to study

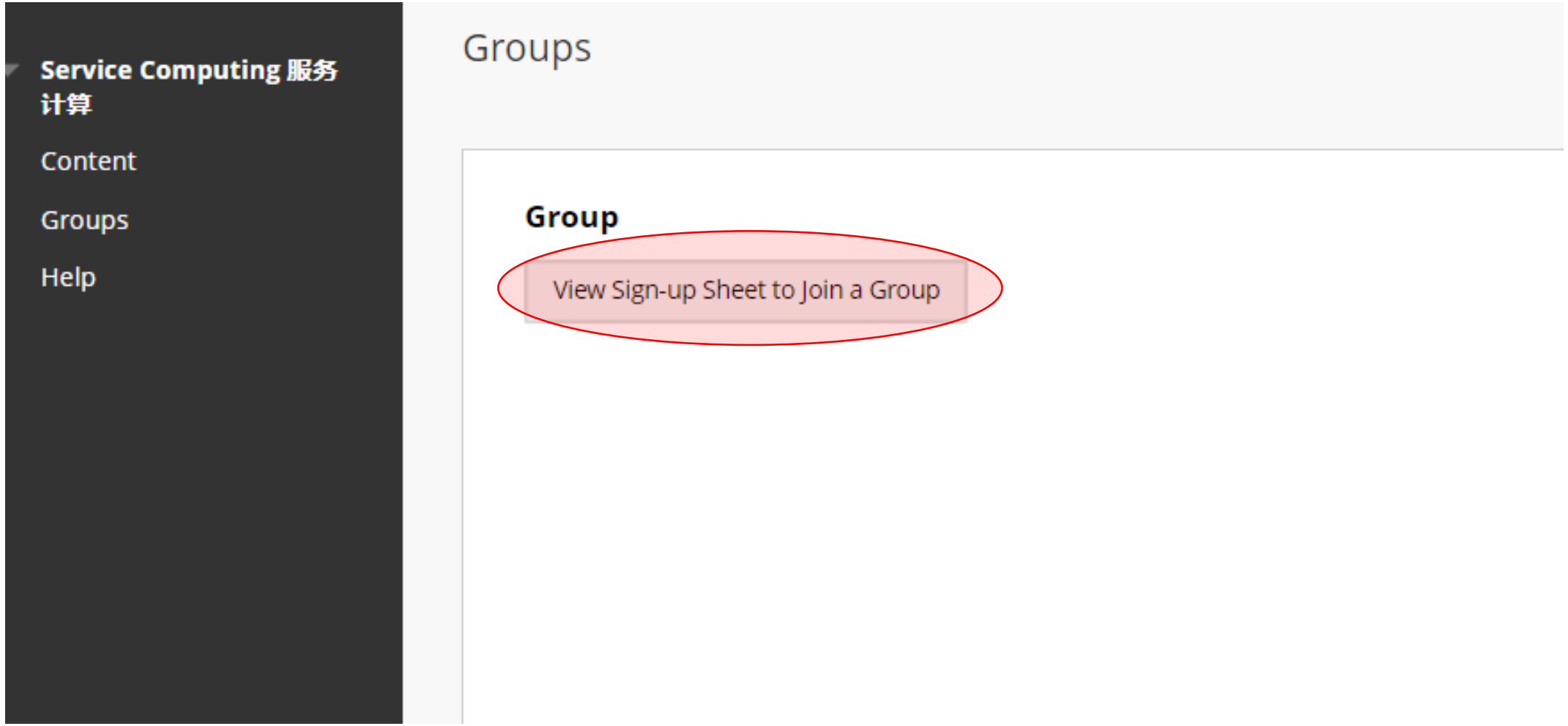
Hot topic study - groups

- We will have 5 students in a group
  - But each student will be accessed individually for their own work in the group
- You can find your own groupmates and together sign up for the same group on Blackboard

How to sign up



How to sign up



Content

Groups

Help

SignUp Sheet Name: Sign-up Sheet for group

SignUp Sheet Instructions:

Group 1

Group Members : None
Max Members Allowed : 5
Sign Up

Group 10

Group Members : None
Max Members Allowed : 5
Sign Up

Group 11

Group Members : None
Max Members Allowed : 5
Sign Up

Group 12

Group Members : None
Max Members Allowed : 5
Sign Up

Hot topic study

- For the students who will not form groups today or tomorrow, I will create groups by Friday
- By Friday, each student will know which group they work with and what is their topic

Hot topic study - possible topics

- IoT and Services
- Fog/Edge Computing and Services
- Cloud Computing
- Big Data Services
- Digital Health – services that support healthcare
- Services in Smart cities
- …..

Hot topic study - topics

- Each group area in Blackboard has tools available
- This week, use Group discussion board to discuss with your group members possible topics

“Post” time

- If you have any questions, please send a post, danmu or a Tencent Meeting message

What to do next?

- Go to the Blackboard to find
  - discussion slides with today's lecture
  - PREP slides to help you prepare for Wednesday online session
  - *Optional – you can watch the videos explaining the topics we will discuss on Monday, the videos links are in the Blackboard
- Form your groups and discuss the possible topics
- See you on Monday in Tencent Meetings/Rainclassroom!