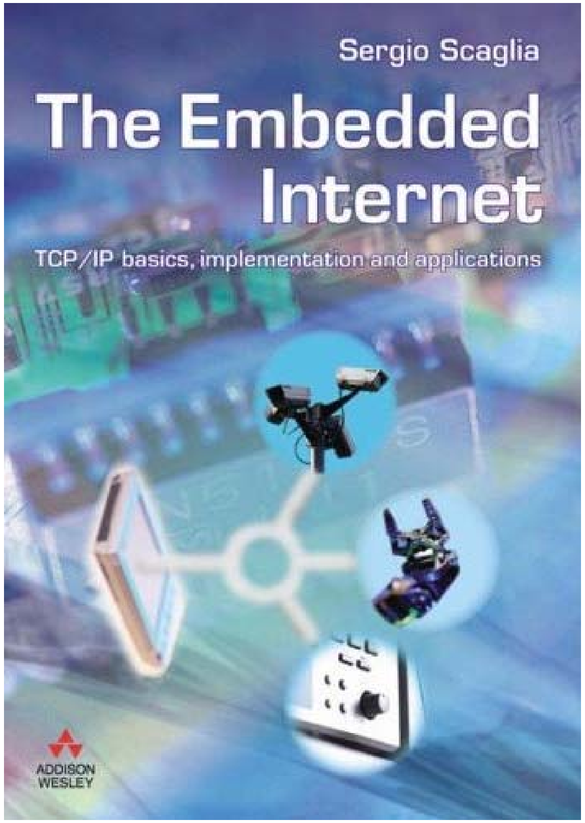
NXP founded by Philips

Enabling Embedded Systems to access Internet Resources

Enabling Embedded Systems to access Internet Resources

Embedded Internet Book



The Embedded Internet (with CD)

TCP/IP Basics, Implementation and Applications

Sergio Scaglia

Feb 2007, Paperback, 632 pages

ISBN13: 9780321306388
ISBN10: 0321306384

www.EmbeddedInternet.org

Agenda

- Enabling Embedded Systems to access Internet Resources: RATIONALE
- Web Services: INTRODUCTION
- HTTP Protocol: REVIEW
- HTTP Protocol Bindings
- Testing a Web Service
- Application Case: Using Web Services for DNS Resolution
- Implementing and Testing the Web Service
- Implementing and Testing the Embedded Application

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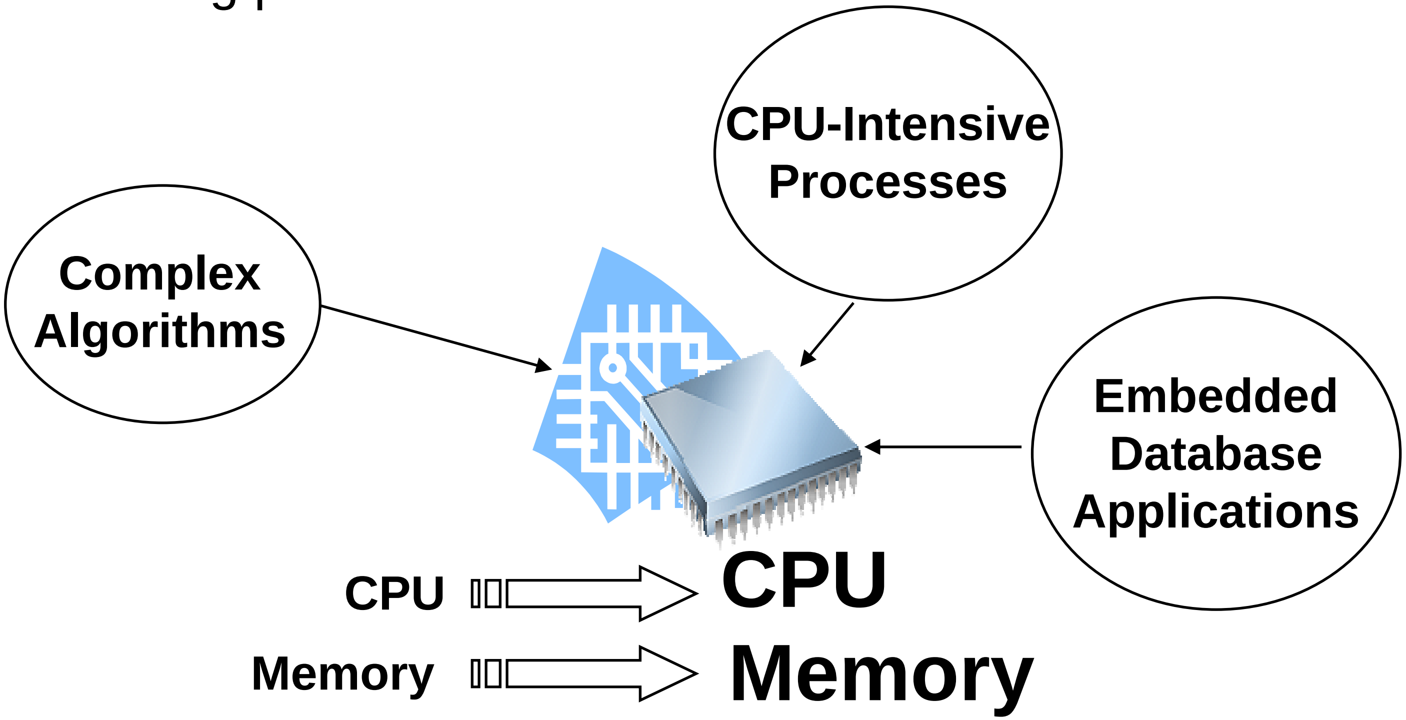
RATIONALE

- Embedded Systems have limited resources compared with PCs.
- Some applications may require large memory space and high processing power.



Complex Algorithms

CPU-Intensive Processes

Embedded Database Applications

CPU ▯▯ → CPU

Memory ▯▯ → Memory

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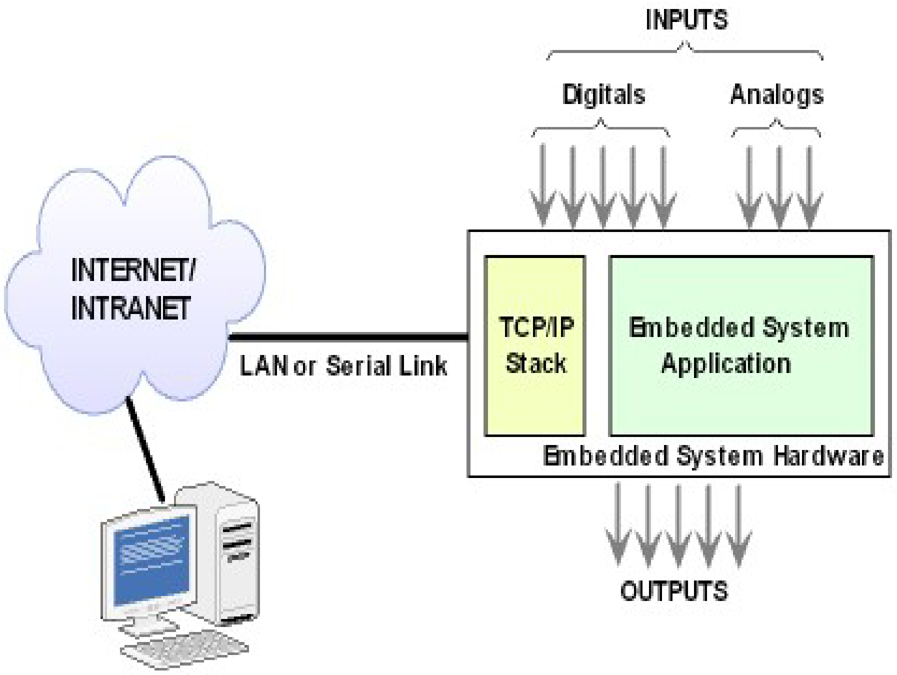
ALTERNATIVE SOLUTION

- Adding a TCP/IP Stack, Embedded Systems will have **internet-connectivity** which allows them access Internet Resources.



An Embedded System with TCP/IP Communications

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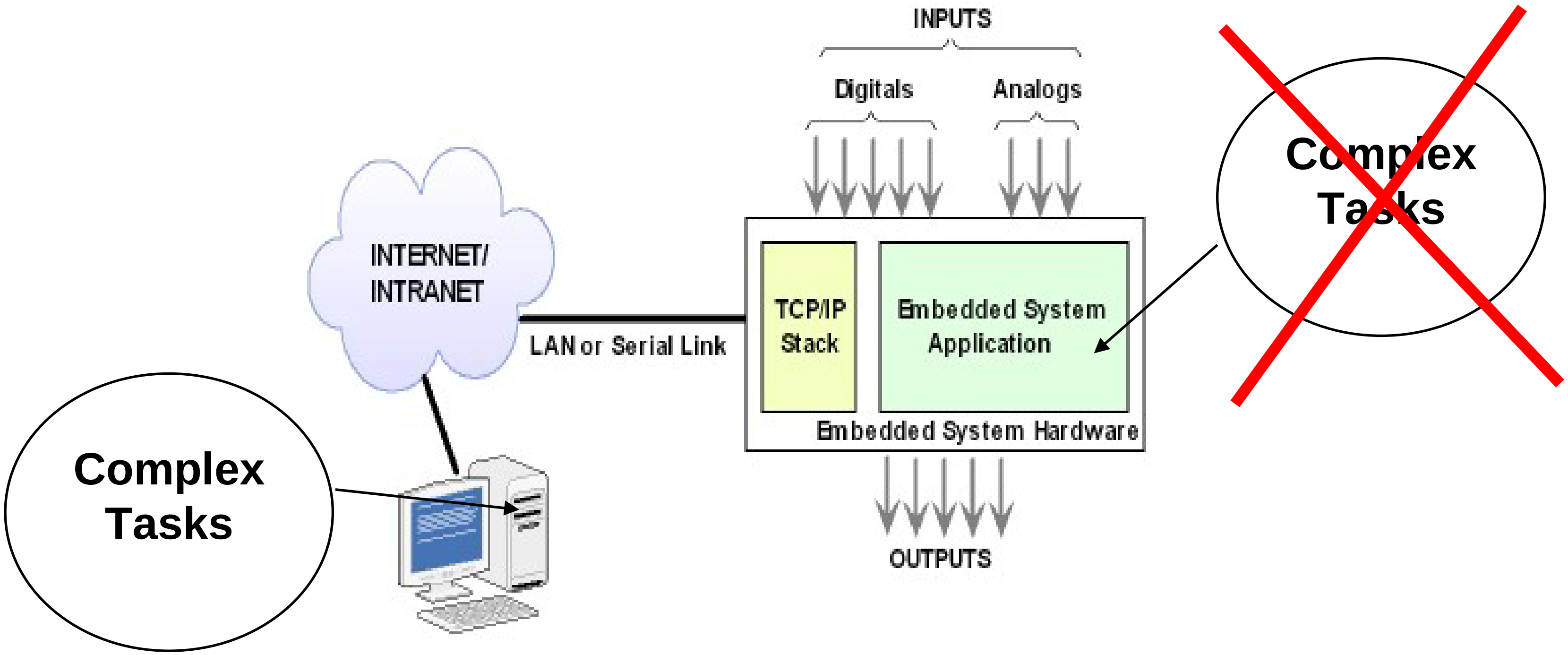
ALTERNATIVE SOLUTION

- In this scenario, complex tasks could be resolved remotely in external servers.



An Embedded System with TCP/IP Communications

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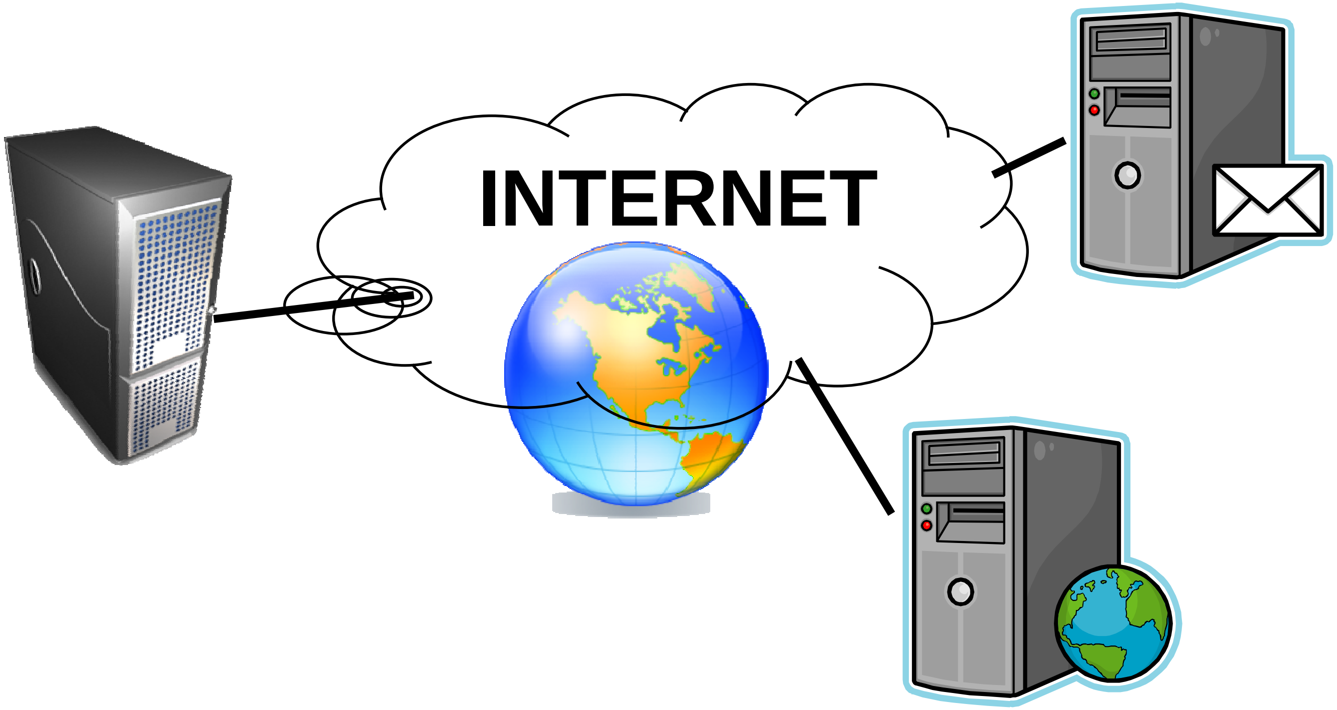
ALTERNATIVE SOLUTION

- In other words, Embedded Systems could greatly benefit from the **“external intelligence”** provided by Desktop servers connected to the Internet, without the need of additional resources.



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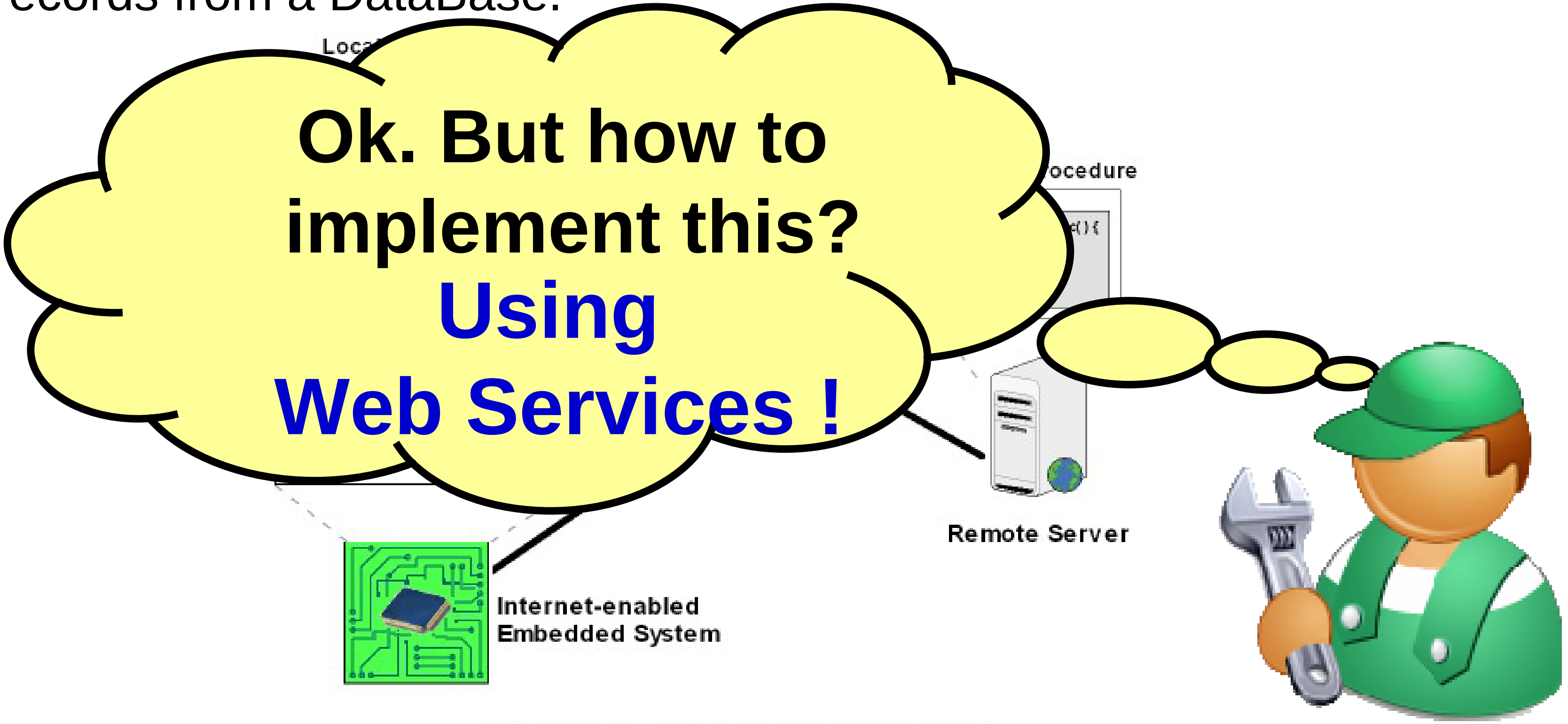
IMPLEMENTATION

- A Remote Procedure could be called in order to resolve complex tasks, such as complex algorithms, CPU-intensive calculations, or retrieve records from a DataBase.



Ok. But how to implement this?

Using Web Services !

Calling a Remote Procedure through Internet

Web Services Introduction

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WEB SERVICES - Introduction

What are Web Services?

- They are a Standardized way to call a remote procedure over the Internet.
- They allow a distributing computing schema to work independently from the technology, language, and device.
- Servers expose a piece of functionality through a Web Interface.
- Clients consume this functionality from its application, using standard Internet protocols (HTTP, SOAP, XML).
- HTTP is used as the transport protocol, to move messages between Clients and Servers - for secure transmissions, HTTPS can be used - (Advantage: most firewalls allow HTTP traffic).
- These messages formats are defined according to the SOAP protocol. The SOAP messages are encoded using XML.

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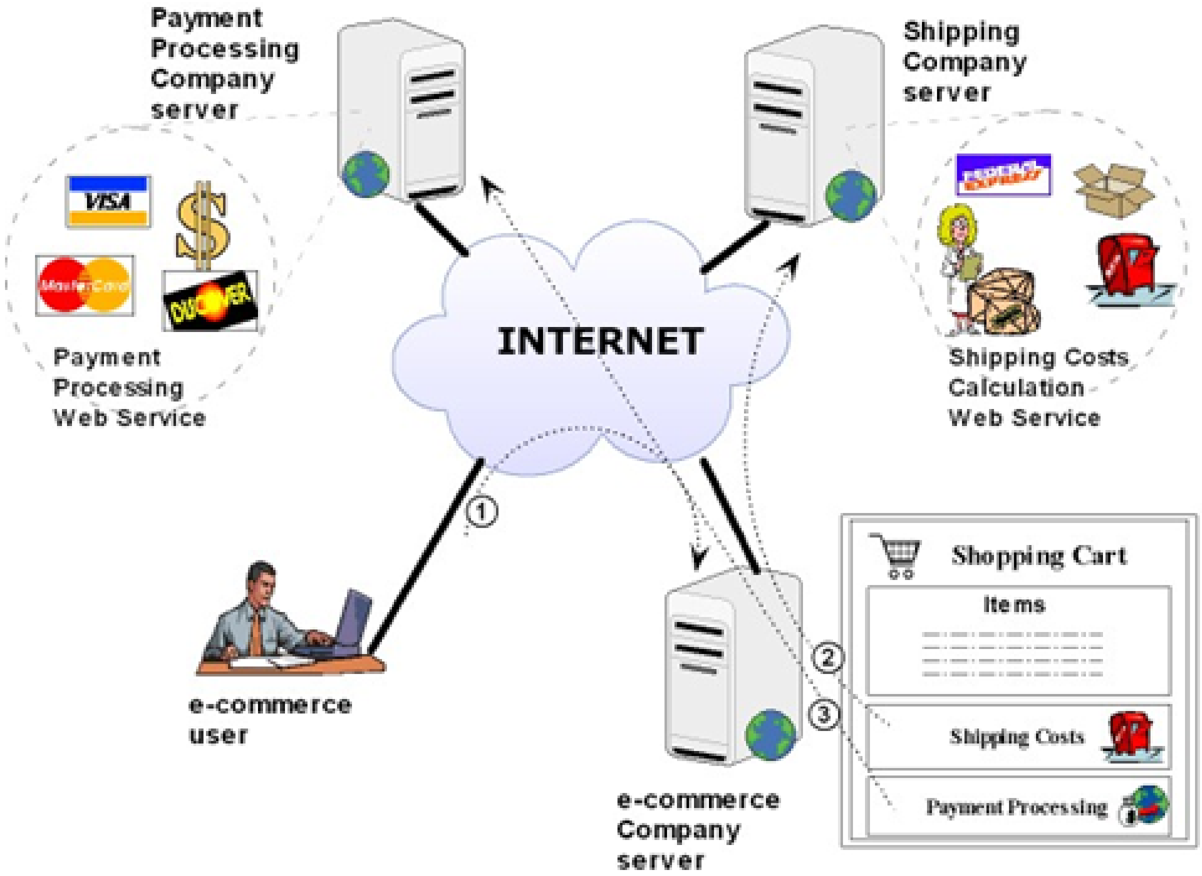
WEB SERVICES – Typical Scenario



Exposing and Consuming Web Services scenario

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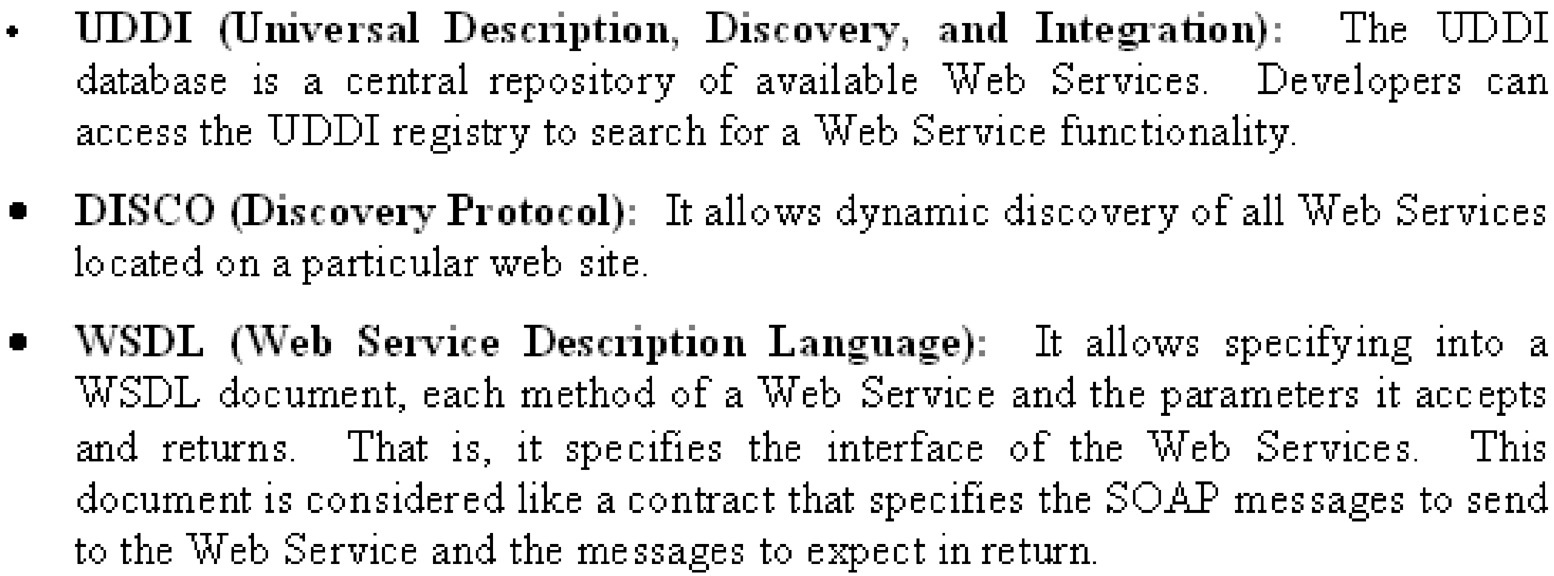
WEB SERVICES – Standards



- **UDDI (Universal Description, Discovery, and Integration):** The UDDI database is a central repository of available Web Services. Developers can access the UDDI registry to search for a Web Service functionality.
- **DISCO (Discovery Protocol):** It allows dynamic discovery of all Web Services located on a particular web site.
- **WSDL (Web Service Description Language):** It allows specifying into a WSDL document, each method of a Web Service and the parameters it accepts and returns. That is, it specifies the interface of the Web Services. This document is considered like a contract that specifies the SOAP messages to send to the Web Service and the messages to expect in return.

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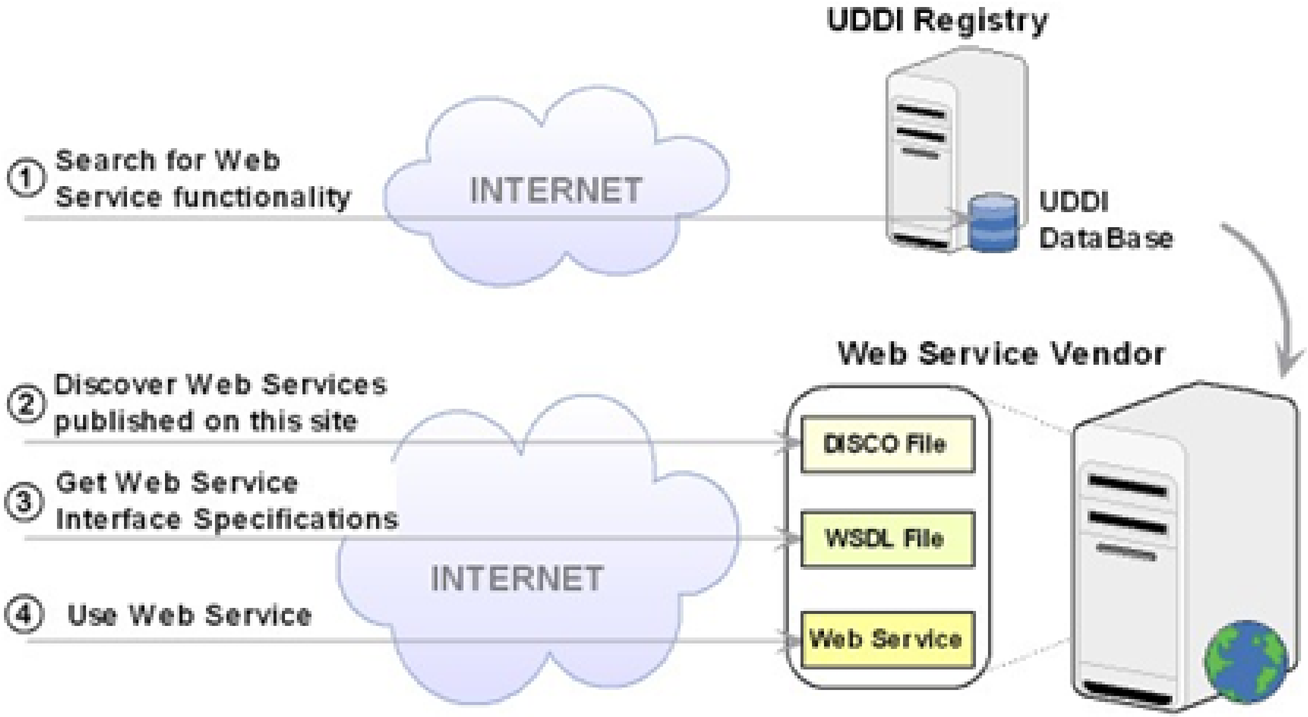
WEB SERVICES – Standards (Cont.)


UDDI Registry
1 Search for Web Service functionality
INTERNET
UDDI DataBase
Web Service Vendor
2 Discover Web Services published on this site
3 Get Web Service Interface Specifications
4 Use Web Service
INTERNET
DISCO File
WSDL File
Web Service

Web Services Standards

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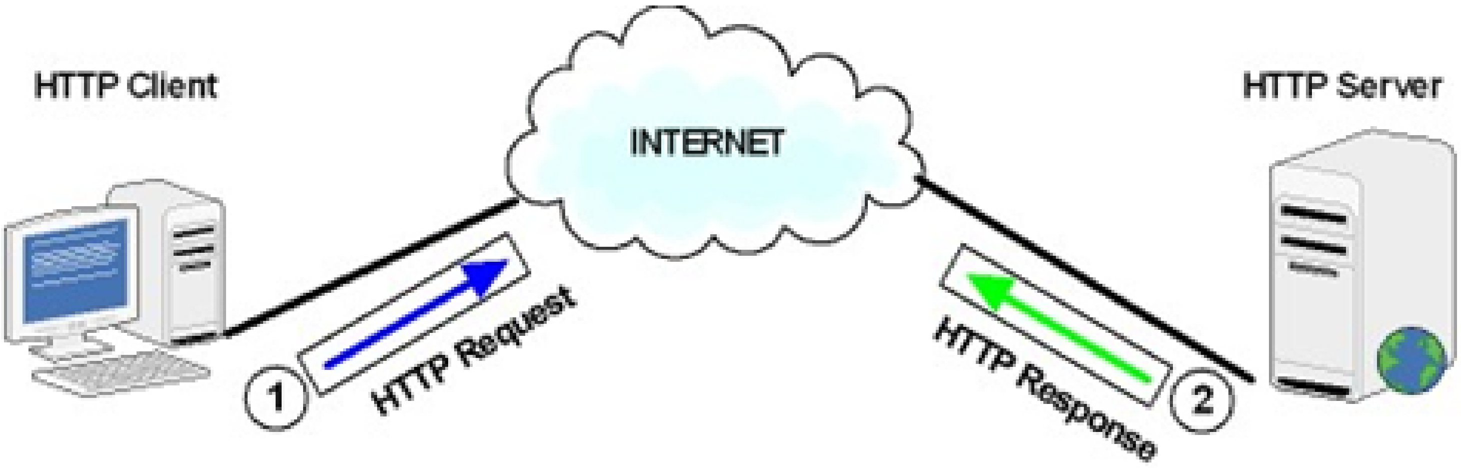
WEB SERVICES – Transport Protocol: HTTP



HTTP Client/Server Communication Model

HTTP Protocol: Review

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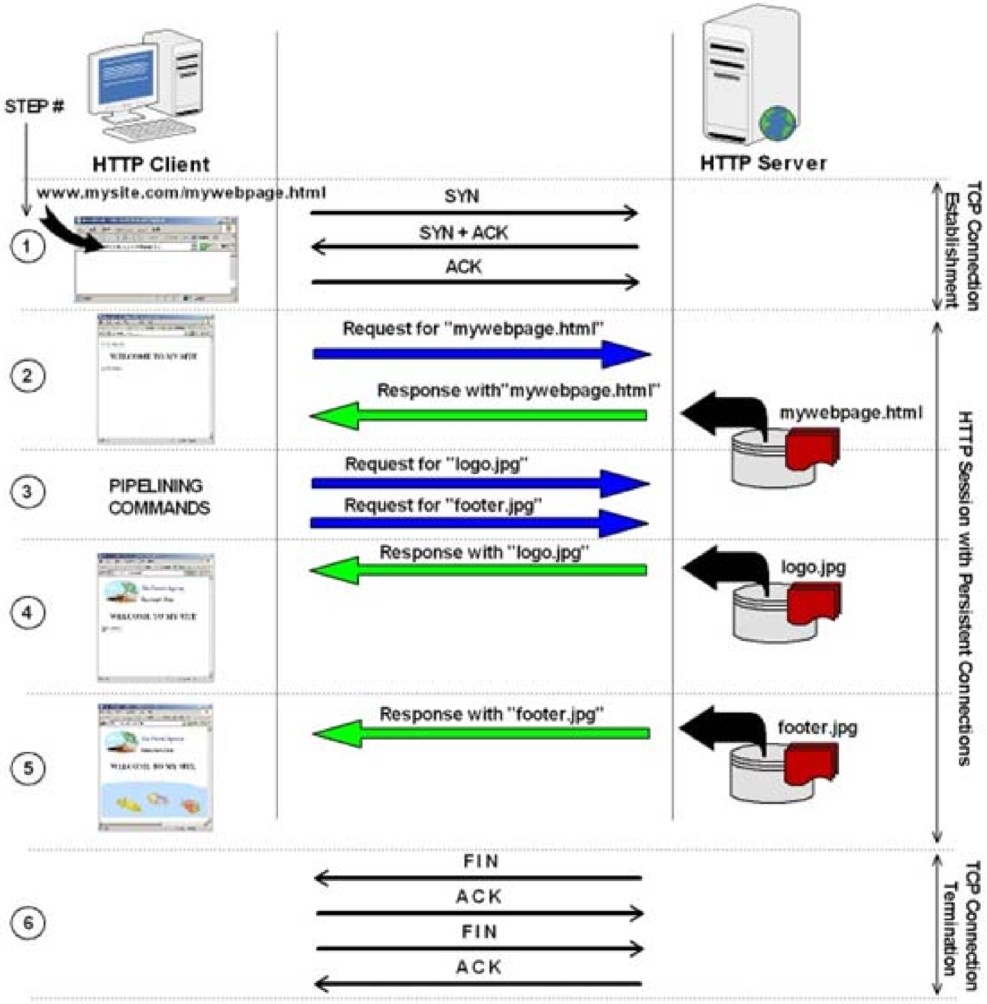
HTTP session example



STEP #
HTTP Client
HTTP Server
www.mysite.com/mywebpage.html
SYN
SYN + ACK
ACK
TCP Connection Establishment
1
2
Request for "mywebpage.html"
Response with"mywebpage.html"
mywebpage.html
3
PIPELINING COMMANDS
Request for "logo.jpg"
Request for "footer.jpg"
4
Response with "logo.jpg"
logo.jpg
5
Response with "footer.jpg"
footer.jpg
HTTP Session with Persistent Connections
6
FIN
ACK
FIN
ACK
TCP Connection Termination

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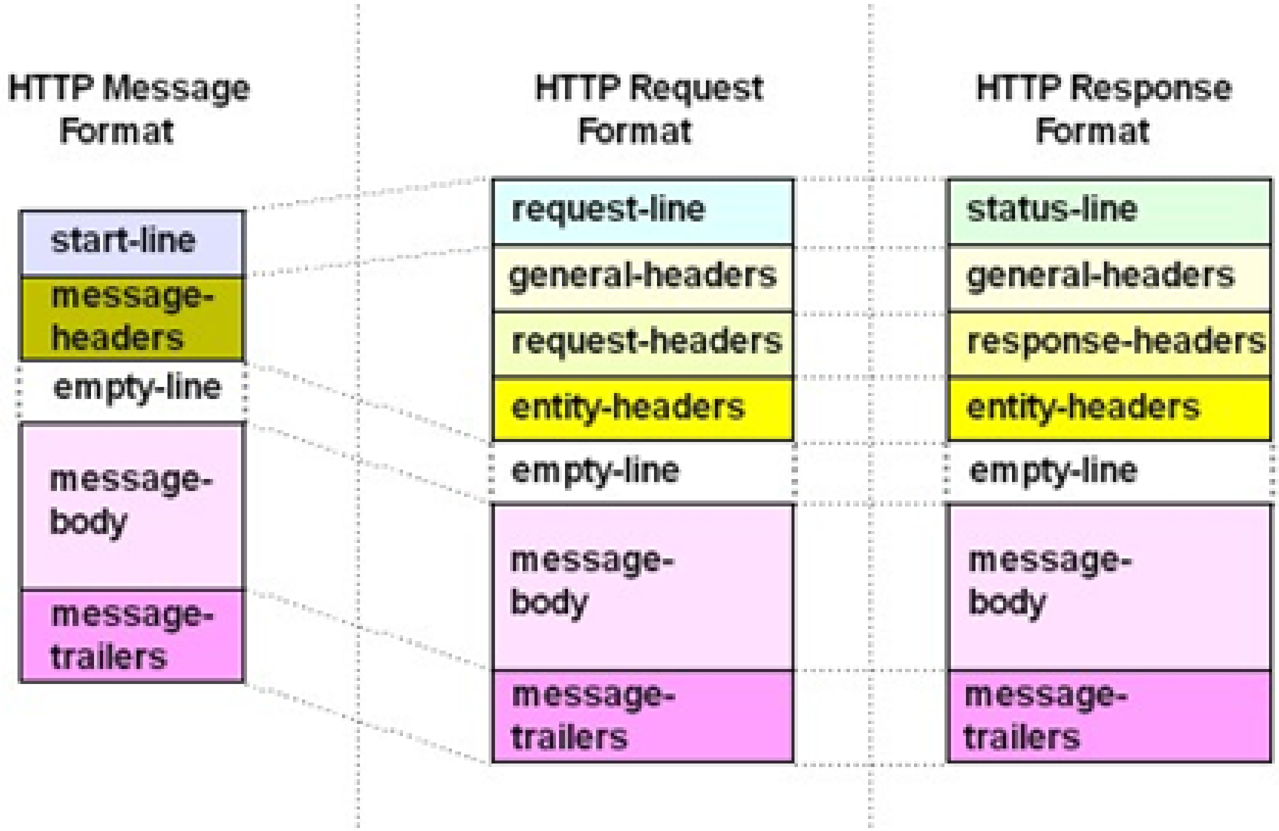
HTTP Messages Format



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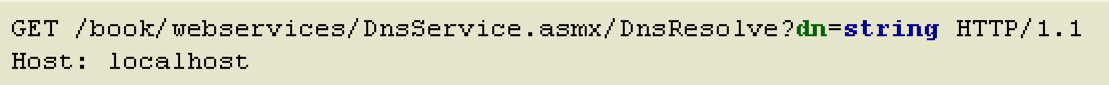
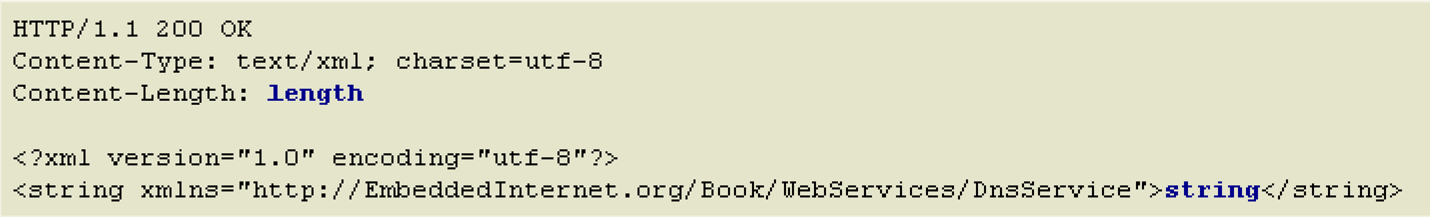
HTTP Messages Examples

Request:



```
GET /book/webservices/DnsService.asmx/DnsResolve?dn=string HTTP/1.1
Host: localhost
```

Response:



```
HTTP/1.1 200 OK
Content-Type: text/xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<string xmlns="http://EmbeddedInternet.org/Book/WebServices/DnsService">string</string>
```

HTTP Protocol Bindings

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WEB SERVICES – Protocol Bindings

- **SOAP (versions 1.1 and 1.2)**
- **HTTP POST**
- **HTTP GET (simplest - recommended for Embedded systems)**

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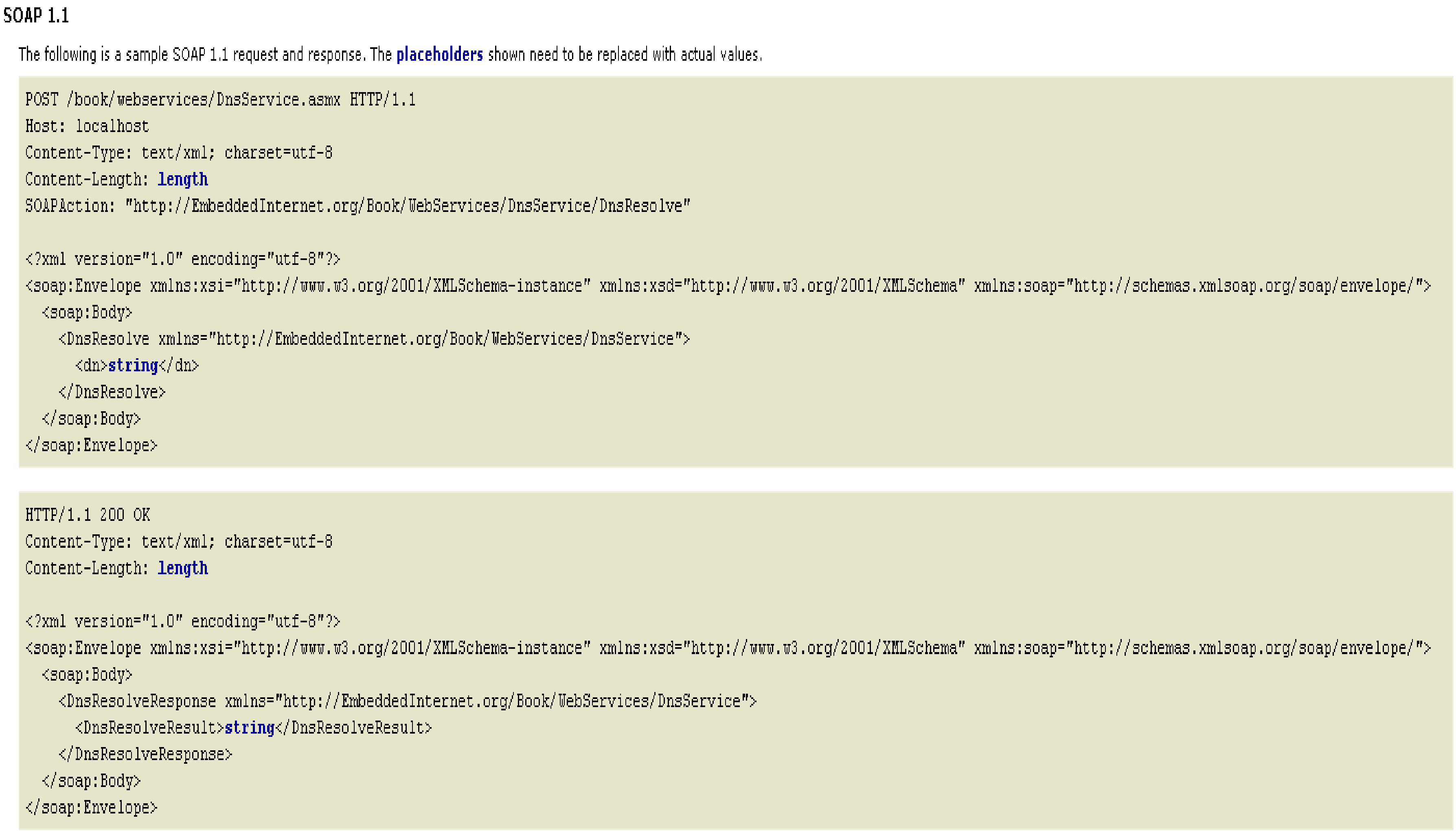
WEB SERVICES – SOAP 1.1 Binding



SOAP 1.1

The following is a sample SOAP 1.1 request and response. The **placeholders** shown need to be replaced with actual values.

```
POST /book/webservices/DnsService.asmx HTTP/1.1
Host: localhost
Content-Type: text/xml; charset=utf-8
Content-Length: length
SOAPAction: "http://EmbeddedInternet.org/Book/WebServices/DnsService/DnsResolve"

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  <soap:Body>
    <DnsResolve xmlns="http://EmbeddedInternet.org/Book/WebServices/DnsService">
      <dn>string</dn>
    </DnsResolve>
  </soap:Body>
</soap:Envelope>
```

```
HTTP/1.1 200 OK
Content-Type: text/xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  <soap:Body>
    <DnsResolveResponse xmlns="http://EmbeddedInternet.org/Book/WebServices/DnsService">
      <DnsResolveResult>string</DnsResolveResult>
    </DnsResolveResponse>
  </soap:Body>
</soap:Envelope>
```

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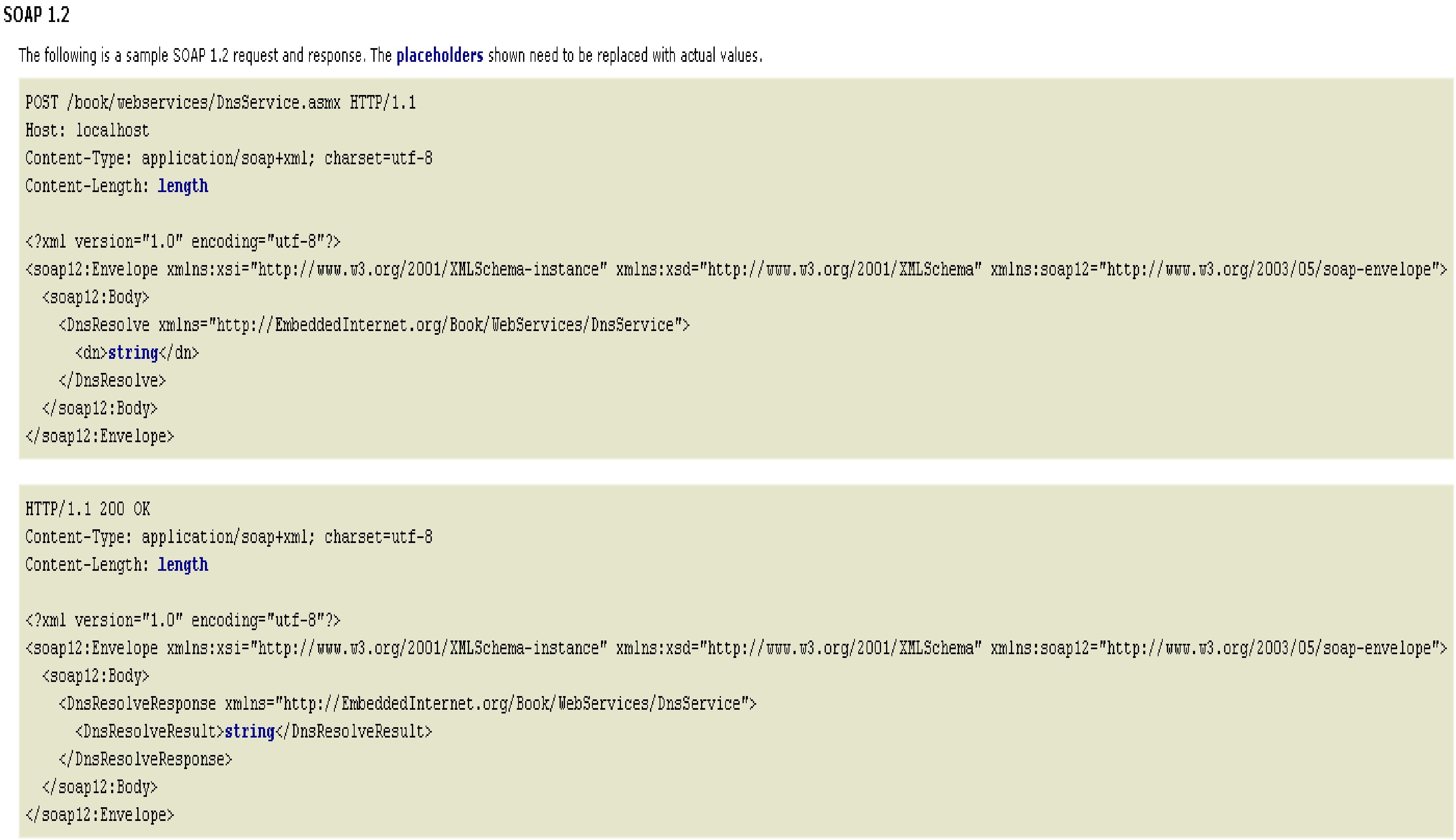
WEB SERVICES – SOAP 1.2 Binding



SOAP 1.2

The following is a sample SOAP 1.2 request and response. The **placeholders** shown need to be replaced with actual values.

```
POST /book/webservices/DnsService.asmx HTTP/1.1
Host: localhost
Content-Type: application/soap+xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<soap12:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:soap12="http://www.w3.org/2003/05/soap-envelope">
  <soap12:Body>
    <DnsResolve xmlns="http://EmbeddedInternet.org/Book/WebServices/DnsService">
      <dn>string</dn>
    </DnsResolve>
  </soap12:Body>
</soap12:Envelope>
```

```
HTTP/1.1 200 OK
Content-Type: application/soap+xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<soap12:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:soap12="http://www.w3.org/2003/05/soap-envelope">
  <soap12:Body>
    <DnsResolveResponse xmlns="http://EmbeddedInternet.org/Book/WebServices/DnsService">
      <DnsResolveResult>string</DnsResolveResult>
    </DnsResolveResponse>
  </soap12:Body>
</soap12:Envelope>
```

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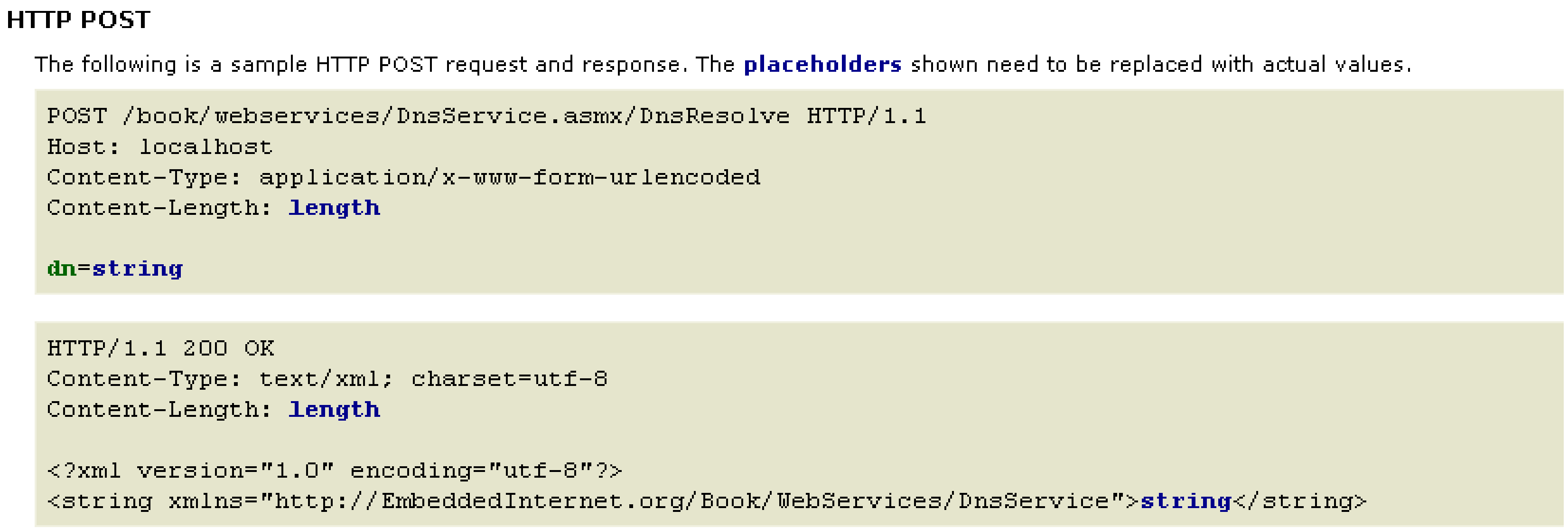
WEB SERVICES – POST Binding



HTTP POST

The following is a sample HTTP POST request and response. The **placeholders** shown need to be replaced with actual values.

```
POST /book/webservices/DnsService.asmx/DnsResolve HTTP/1.1
Host: localhost
Content-Type: application/x-www-form-urlencoded
Content-Length: length

dn=string
```

```
HTTP/1.1 200 OK
Content-Type: text/xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<string xmlns="http://EmbeddedInternet.org/Book/WebServices/DnsService">string</string>
```

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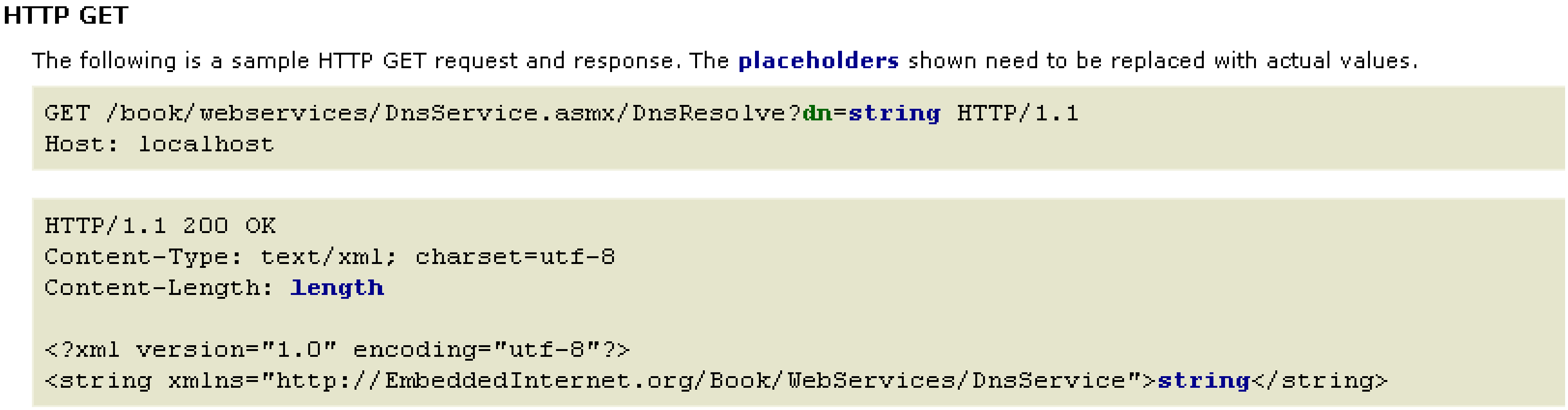
WEB SERVICES – GET Binding



HTTP GET

The following is a sample HTTP GET request and response. The **placeholders** shown need to be replaced with actual values.

```
GET /book/webservices/DnsService.asmx/DnsResolve?dn=string HTTP/1.1
Host: localhost
```

```
HTTP/1.1 200 OK
Content-Type: text/xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<string xmlns="http://EmbeddedInternet.org/Book/WebServices/DnsService">string</string>
```

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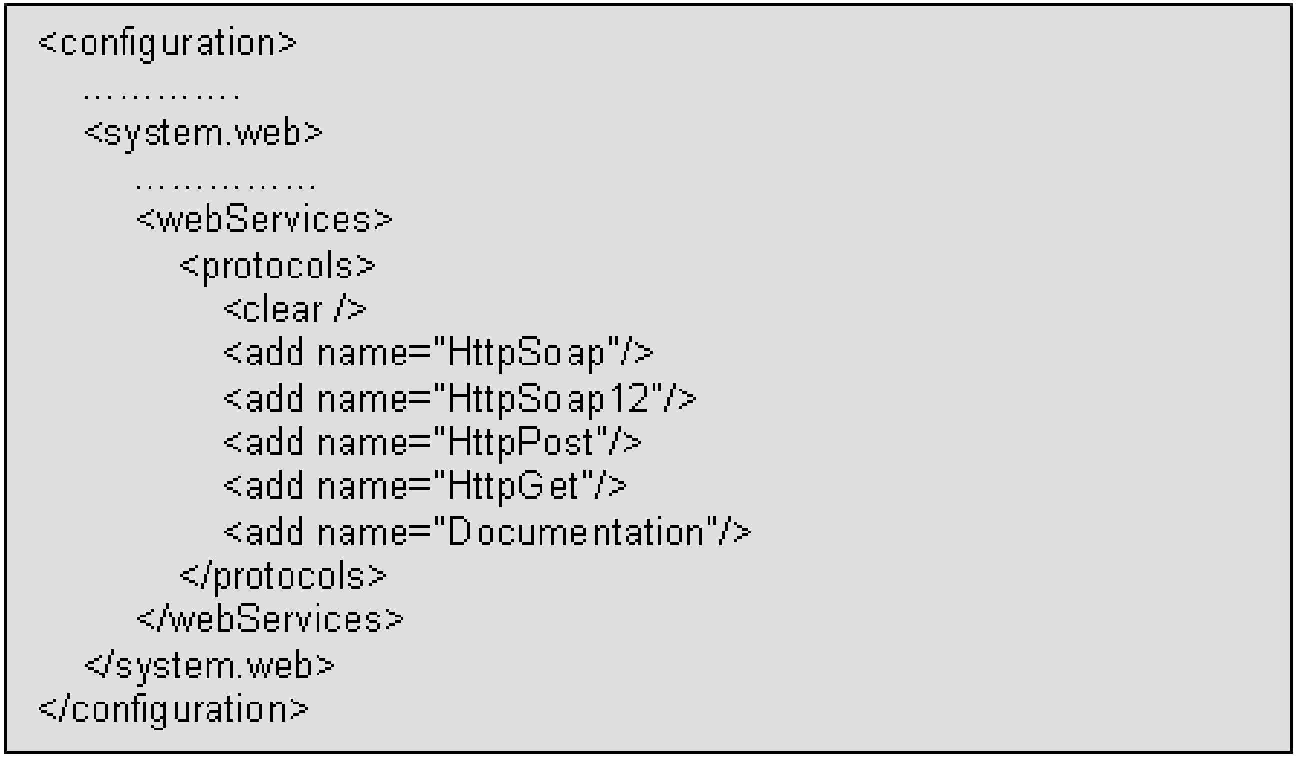
WEB SERVICES – Binding Configurations (web.config)



```
<configuration>
    .............
    <system.web>
        ...............
        <webServices>
            <protocols>
                <clear />
                <add name="HttpSoap"/>
                <add name="HttpSoap12"/>
                <add name="HttpPost"/>
                <add name="HttpGet"/>
                <add name="Documentation"/>
            </protocols>
        </webServices>
    </system.web>
</configuration>
```

Testing a Web Service

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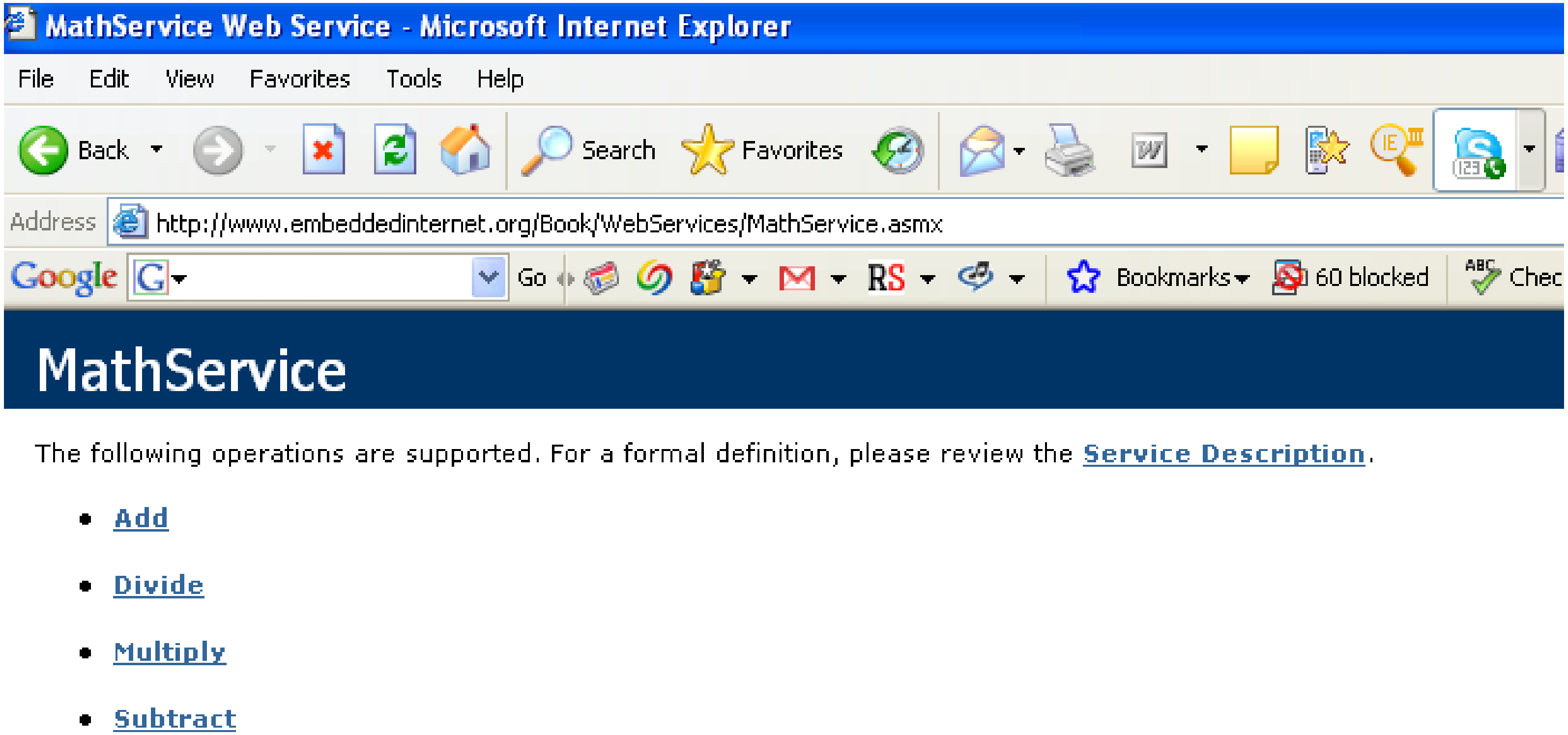
WEB SERVICES – Testing the Web Service (1/3)


MathService Web Service - Microsoft Internet Explorer
File
Edit
View
Favorites
Tools
Help
Back
Search
Favorites
Address
http://www.embeddedinternet.org/Book/WebServices/MathService.asmx
Google
Go
Bookmarks
60 blocked
Chec

MathService

The following operations are supported. For a formal definition, please review the Service Description.

- Add
- Divide
- Multiply
- Subtract

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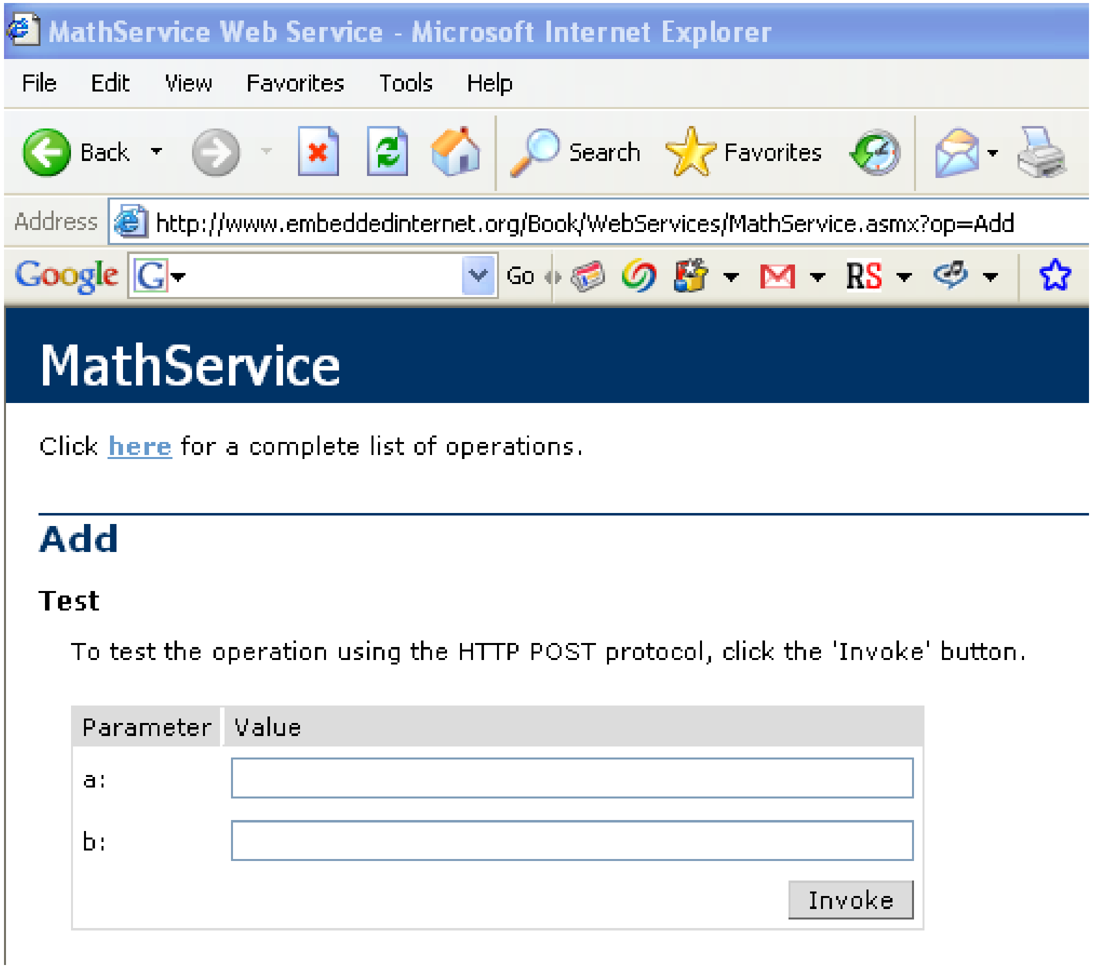
WEB SERVICES – Testing the Web Service (2/3)



MathService Web Service - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Search
Favorites
Address
Google
Go
RS

http://www.embeddedinternet.org/Book/WebServices/MathService.asmx?op=Add

MathService

Click here for a complete list of operations.

Add

Test

To test the operation using the HTTP POST protocol, click the 'Invoke' button.

Parameter	Value
a:	
b:	

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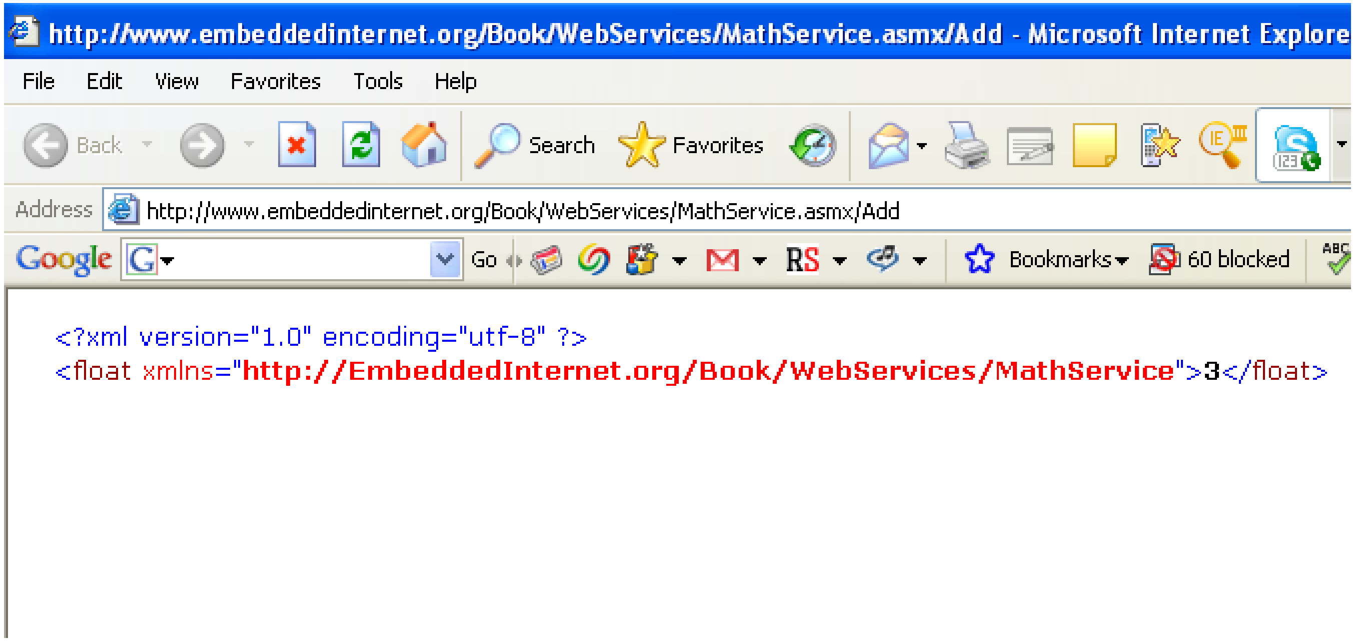
WEB SERVICES – Testing the Web Service (3/3)

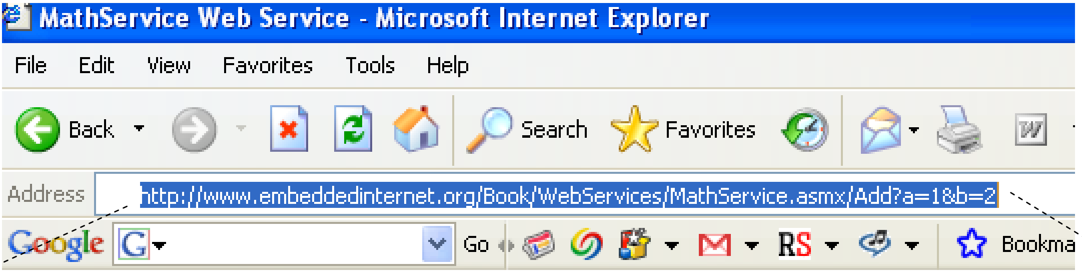

http://www.embeddedinternet.org/Book/WebServices/MathService.asmx/Add - Microsoft Internet Explore
File
Edit
View
Favorites
Tools
Help
Back
Search
Favorites
Address
http://www.embeddedinternet.org/Book/WebServices/MathService.asmx/Add
Google
Go
RS
Bookmarks
60 blocked

```
<?xml version="1.0" encoding="utf-8" ?>
<float xmlns="http://EmbeddedInternet.org/Book/WebServices/MathService">3</float>
```

Enabling Embedded Systems to access Internet Resources

WEB SERVICES – Consuming a Web Service from the Browser

- Using the Web Service through the HTTP URL syntax


MathService Web Service - Microsoft Internet Explorer

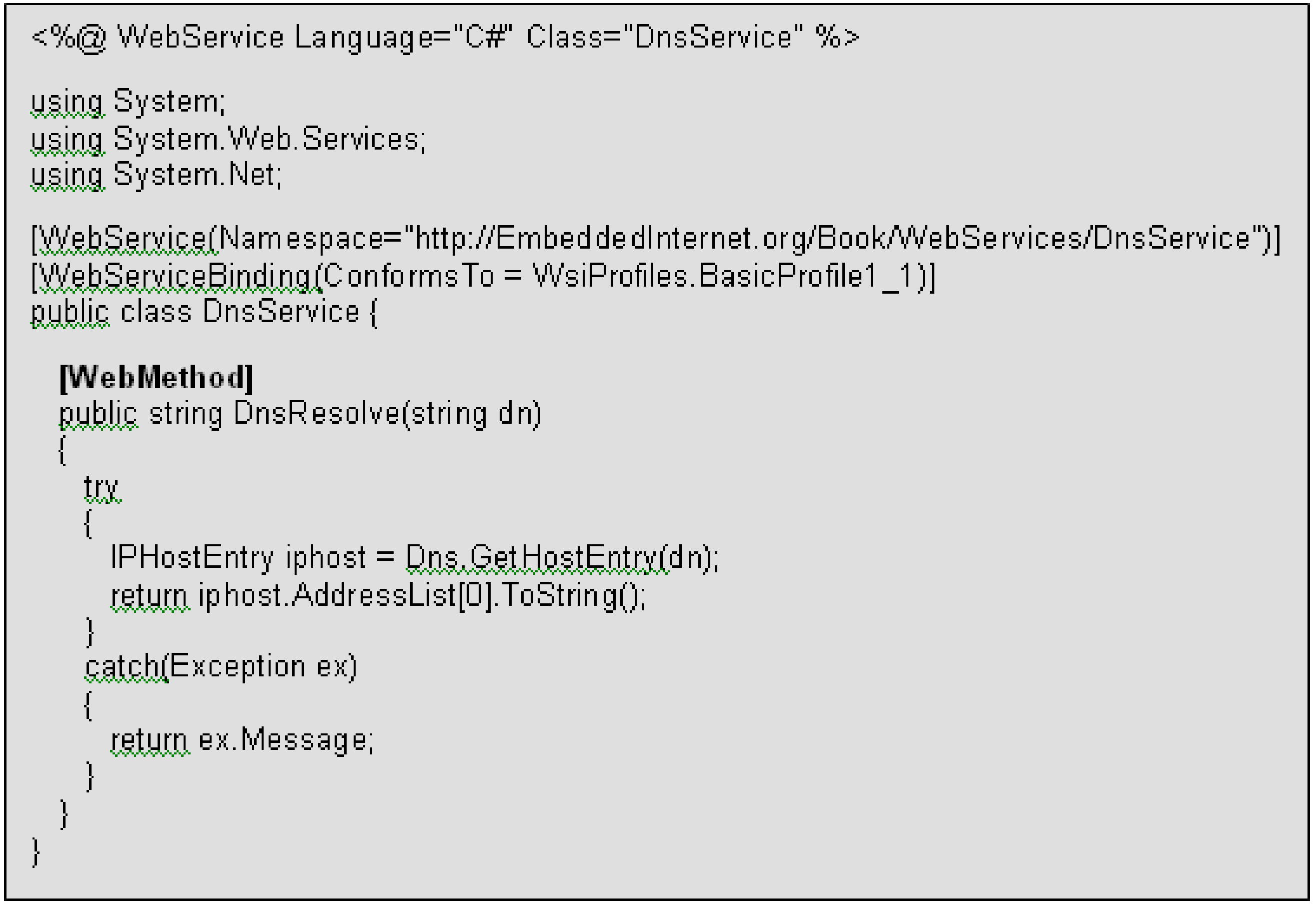
Address http://www.embeddedinternet.org/Book/WebServices/MathService.asmx/Add?a=1&b=2

http://www.embeddedinternet.org/Book/WebServices/MathService.asmx/Add?a=1&b=2

Application Case:
Using Web Services for DNS Resolution

Enabling Embedded Systems to access Internet Resources

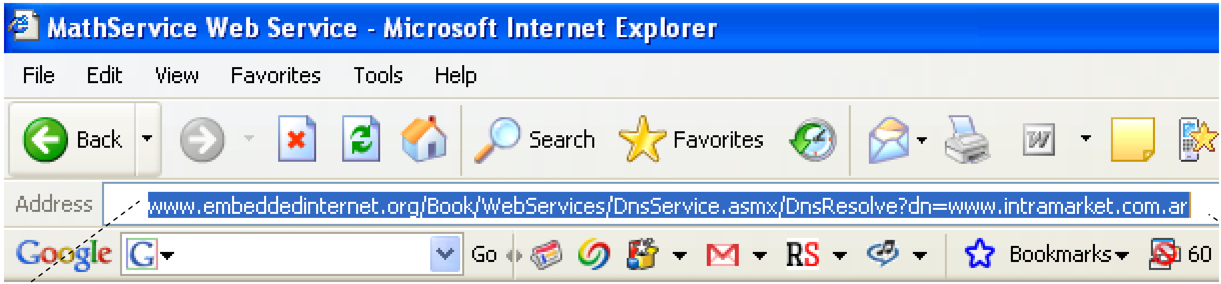
Implementing the “DnsService” Web Service



```
<%@ WebService Language="C#" Class="DnsService" %>

using System;
using System.Web.Services;
using System.Net;

[WebService(Namespace="http://EmbeddedInternet.org/Book/WebServices/DnsService")]
[WebServiceBinding(ConformsTo = WsiProfiles.BasicProfile1_1)]
public class DnsService {

  [WebMethod]
  public string DnsResolve(string dn)
  {
    try
    {
      IPHostEntry iphost = Dns.GetHostEntry(dn);
      return iphost.AddressList[0].ToString();
    }
    catch(Exception ex)
    {
      return ex.Message;
    }
  }
}
```

Enabling Embedded Systems to access Internet Resources

Testing the "DnsService" Web Service


MathService Web Service - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Search
Favorites
Address
Google
Go
Bookmarks
60

www.embeddedinternet.org/Book/WebServices/DnsService.asmx/DnsResolve?dn=www.intramarket.com.ar

www.embeddedinternet.org/Book/WebServices/DnsService.asmx/DnsResolve?dn=www.intramarket.com.ar

Enabling Embedded Systems to access Internet Resources

Consuming the “DnsService” Web Service from an Embedded System

- Create a TCP socket and open a connection to Port 80 (IP address of the server where the Web Service is published)
- Once the connection is established, create and send the Web Service Request
- When the Response is received, process the XML and extract the result
- Close the connection and the TCPsocket

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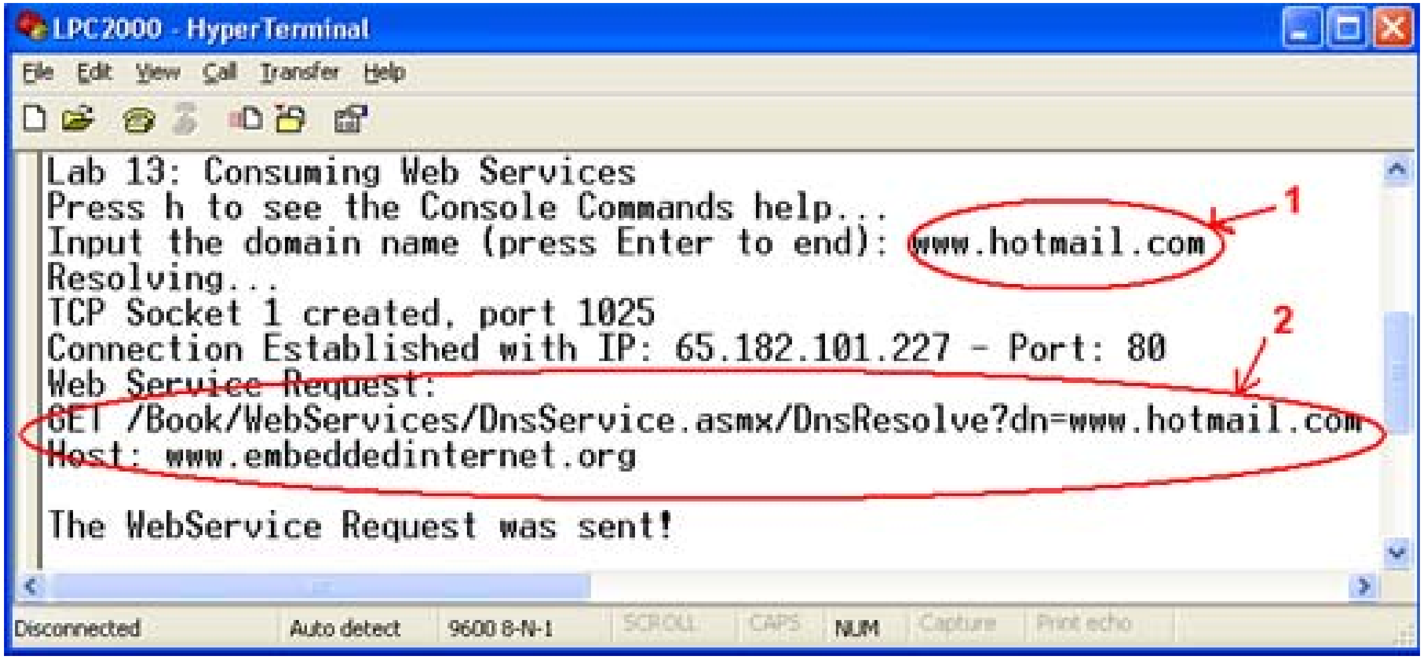
Testing the Embedded Application - Web Service Request

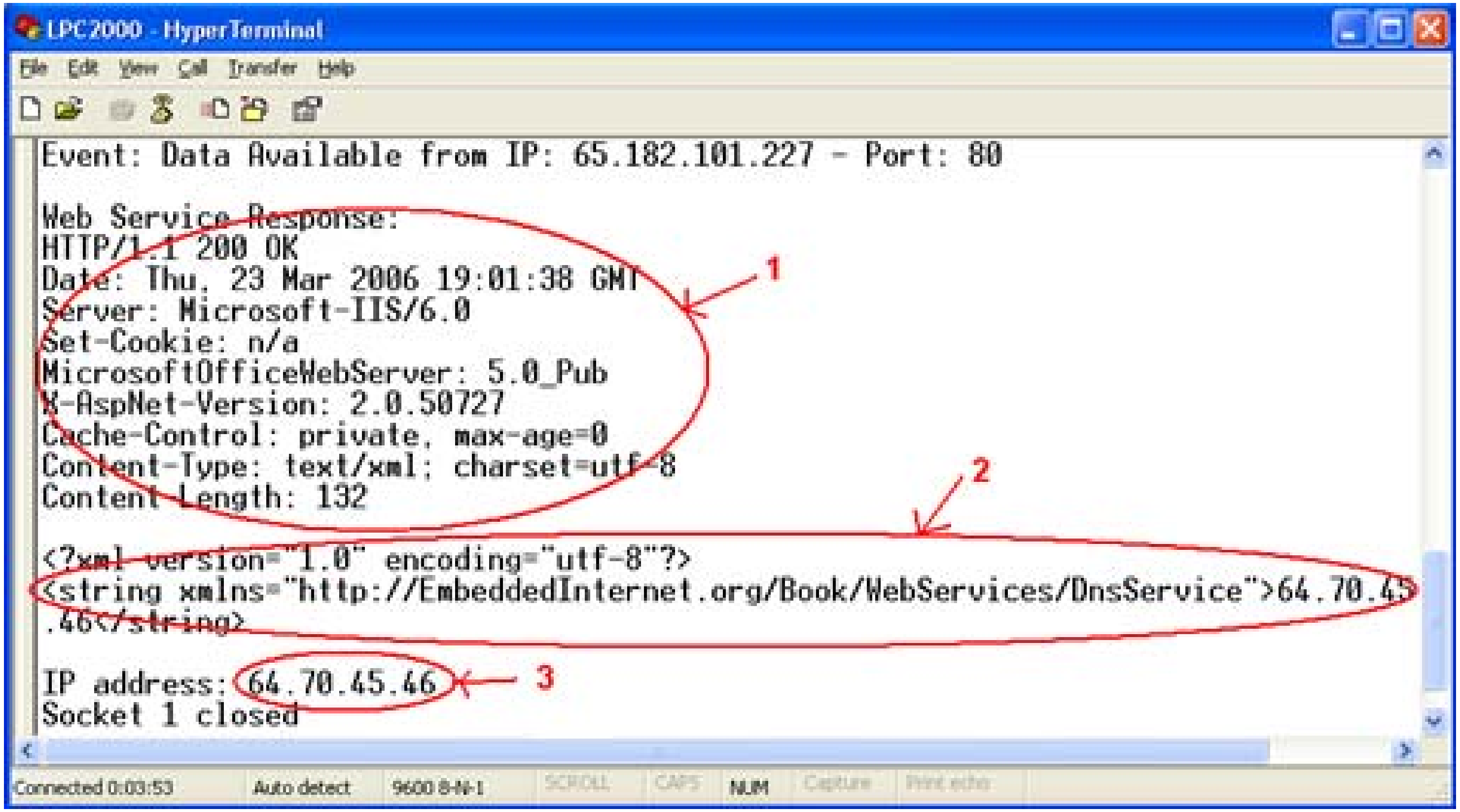


```
Lab 13: Consuming Web Services
Press h to see the Console Commands help...
Input the domain name (press Enter to end): www.hotmail.com
Resolving...
TCP Socket 1 created, port 1025
Connection Established with IP: 65.182.101.227 - Port: 80
Web Service Request:
GET /Book/WebServices/DnsService.asmx/DnsResolve?dn=www.hotmail.com
Host: www.embeddedinternet.org

The WebService Request was sent!
```

Enabling Embedded Systems to access Internet Resources

Testing the Embedded Application - Web Service Response



```
Event: Data Available from IP: 65.182.101.227 - Port: 80

Web Service Response:
HTTP/1.1 200 OK
Date: Thu, 23 Mar 2006 19:01:38 GMT
Server: Microsoft-IIS/6.0
Set-Cookie: n/a
MicrosoftOfficeWebServer: 5.0_Pub
X-AspNet-Version: 2.0.50727
Cache-Control: private, max-age=0
Content-Type: text/xml; charset=utf-8
Content-Length: 132

<?xml version="1.0" encoding="utf-8"?>
<string xmlns="http://EmbeddedInternet.org/Book/WebServices/DnsService">64.70.45
.46</string>

IP address: 64.70.45.46
Socket 1 closed
```