

WS-Discovery Protocol Overview

OASIS WS-DD TC F2F

September 16-18, 2008

Vipul Modi - Microsoft Corporation (vipul.modi@microsoft.com)

Prasad Yendluri - Software AG (Prasad.Yendluri@softwareag.com)

Dave Whitehead - Lexmark International, Inc. (david@lexmark.com)

Agenda

- Introduction
- Message Exchange Patterns
- Messages
- Protocol Binding
- Security
- Scenarios – Prasad Yendluri (Software AG)
- WS-Discovery & Lexmark - Dave Whitehead (Lexmark International, Inc.)

Introduction

WS-Discovery

- WS-Discovery is a simple, lightweight, dynamic, extensible and composable web services protocol to discover services.

Operational Mode

- Ad hoc
 - No major networking services required
 - Multicast

Example: “Mr. John Doe please pick up the white paging telephone.”
- Managed
 - Require the support of server
 - Unicast

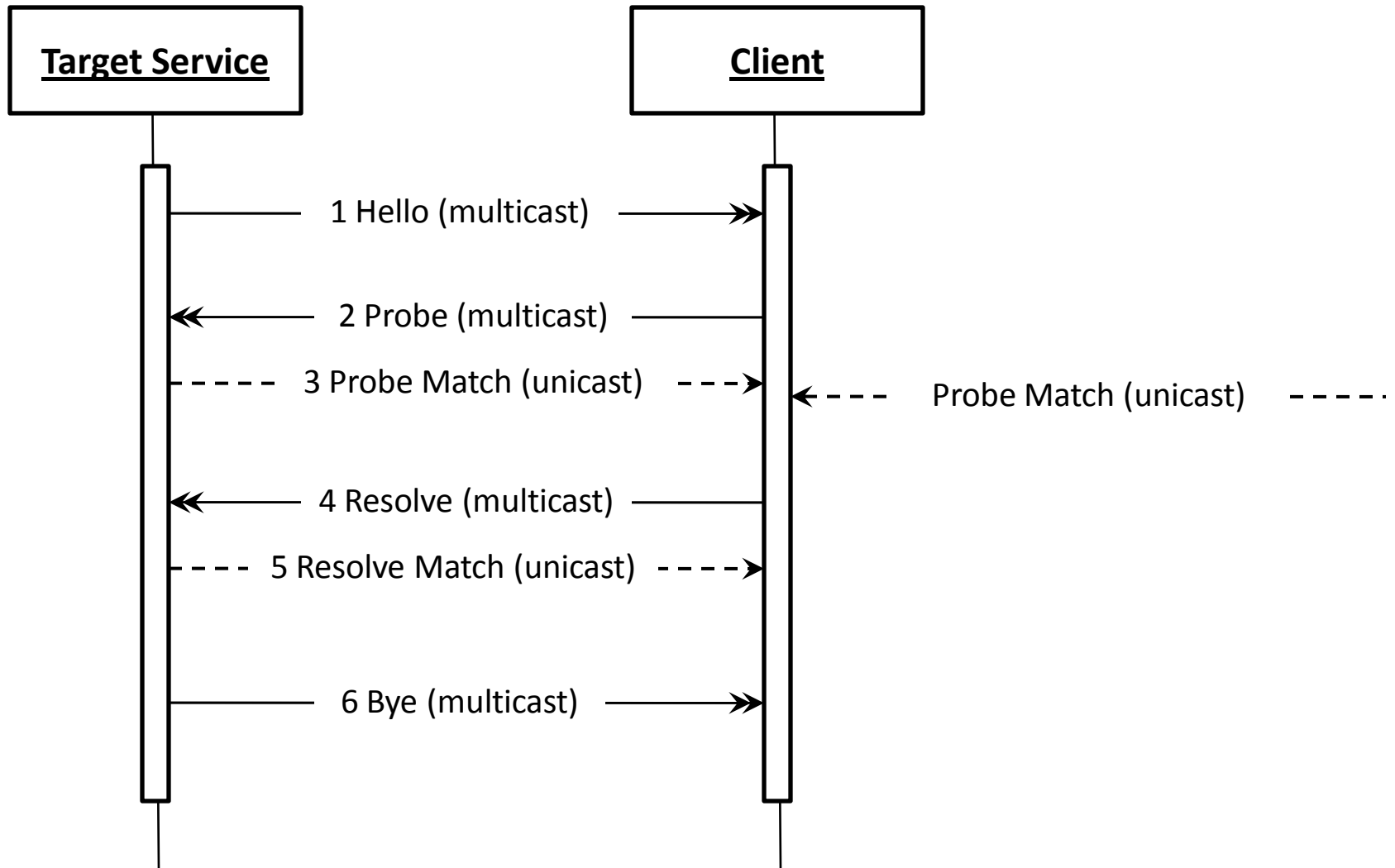
Example: “Look up whereabouts of Mr. John Doe in a timesheet.”

Terminology

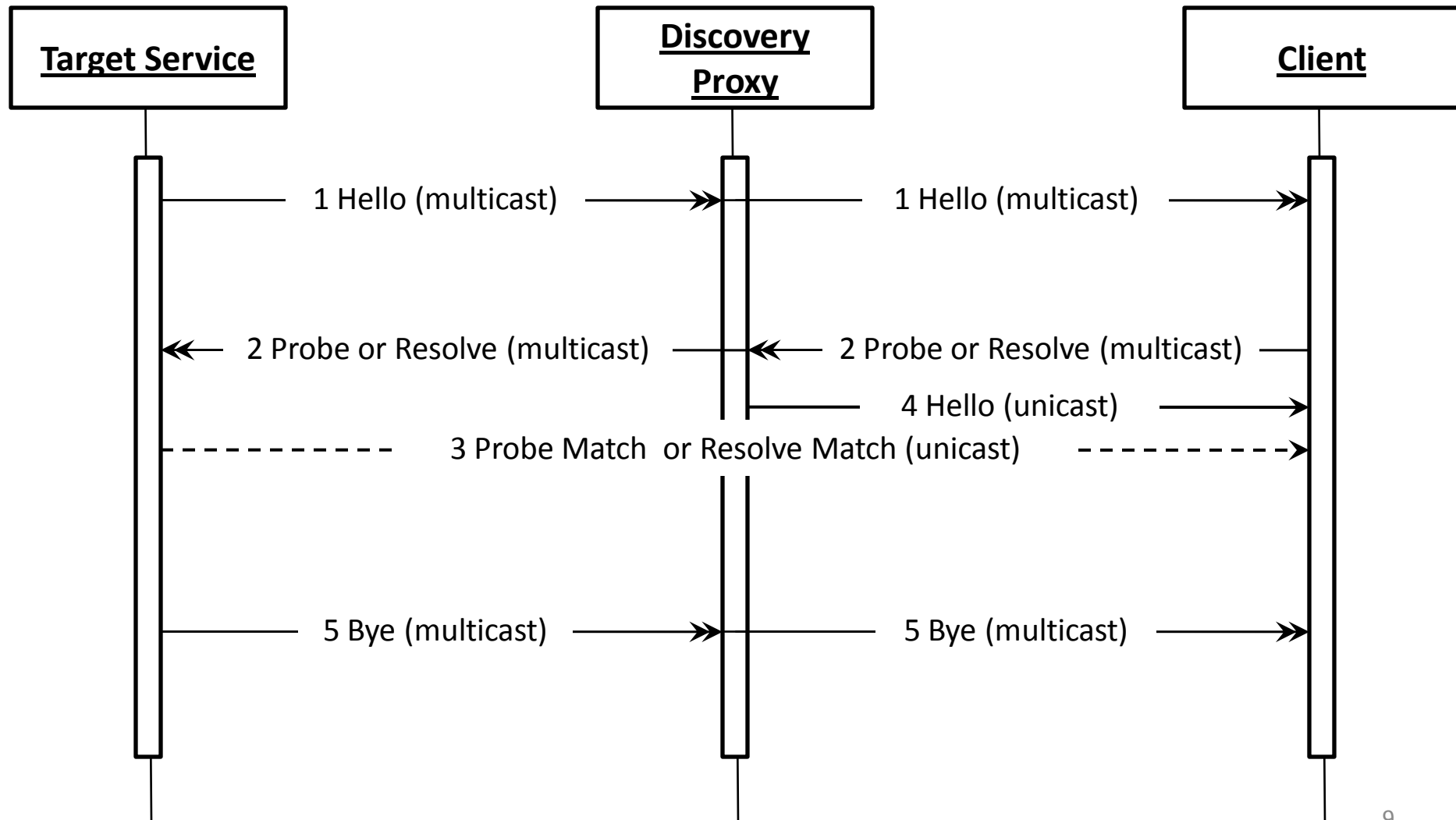
- **Target Service:** An endpoint that makes itself available for discovery.
- **Client:** The one looking for the Target Services.
- **Discovery Proxy:** An endpoint that facilitate the discovery of Target Services in managed mode.
- **Ad-hoc network:** A network in which discovery is done in an ad-hoc manner.
- **Managed Network:** A network in which discovery is done in a managed mode.

Message Exchange Patterns

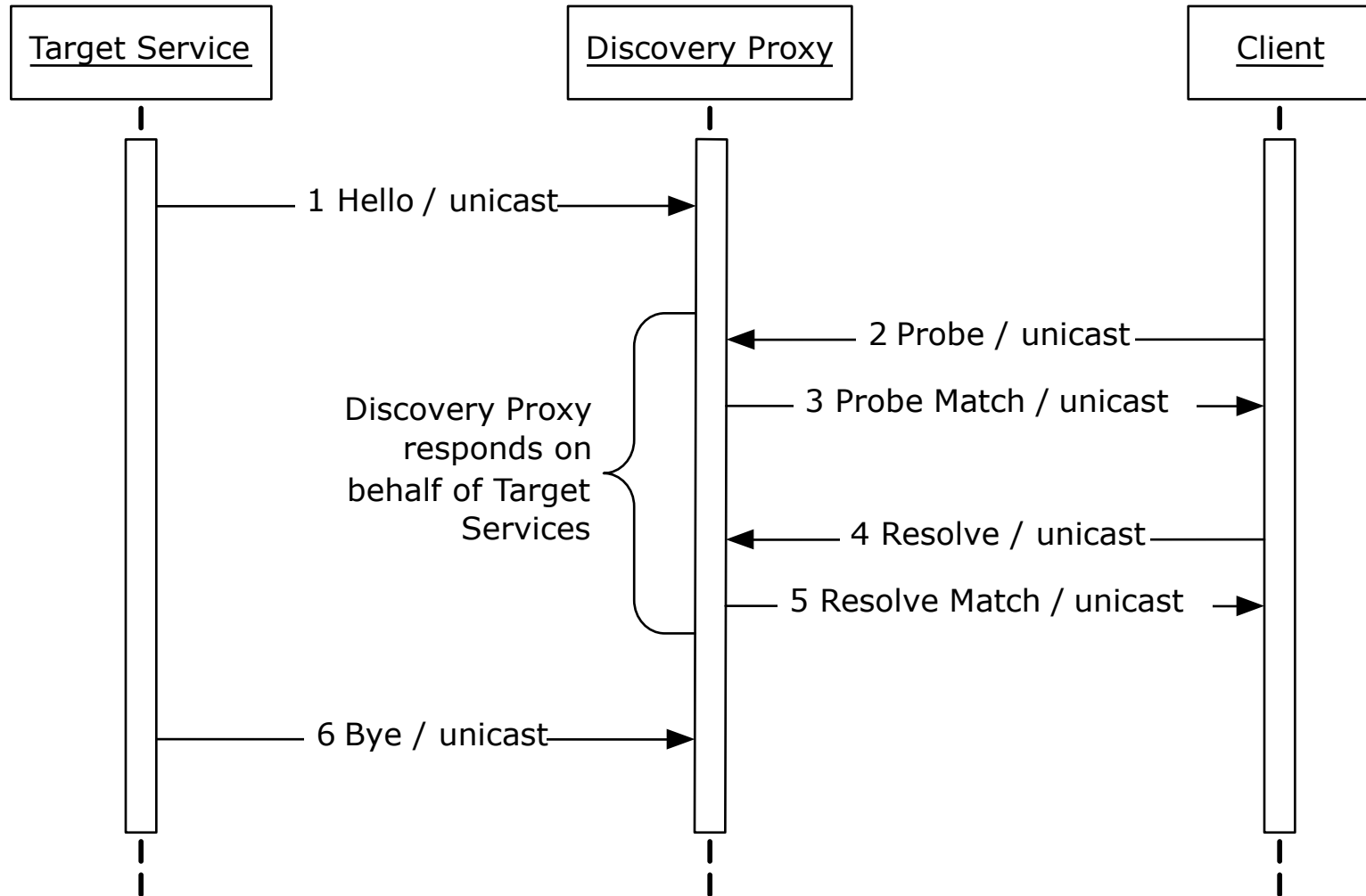
MEP – Ad hoc Mode



MEP – Multicast Suppression



MEP - Managed



Messages

Hello

- By: A Target Service when it joins the network or its metadata changes
- To:
 - Multicast on the ad hoc network
 - DP in managed mode
- Contents:
 - Discoverable metadata of the Target Service

```
<d:Hello ... >
  <a:EndpointReference> ... </a:EndpointReference>
  [<d:Types>list of xs:QName</d:Types>]?
  [<d:Scopes>list of xs:anyURI</d:Scopes>]?
  [<d:XAddrs>list of xs:anyURI</d:XAddrs>]?
  <d:MetadataVersion>xs:unsignedInt</d:MetadataVersion>
  ...
</d:Hello >
```

Example Hello Message

```
<s:Envelope
  xmlns:a="http://schemas.xmlsoap.org/ws/2004/08/addressing"
  xmlns:d="http://schemas.xmlsoap.org/ws/2005/04/discovery"
  xmlns:s="http://www.w3.org/2003/05/soap-envelope" >
  <s:Header>
    <a:Action>
      http://schemas.xmlsoap.org/ws/2005/04/discovery/Hello
    </a:Action>
    <a:MessageID>
      uuid:73948edc-3204-4455-bae2-7c7d0ff6c37c
    </a:MessageID>
    <a:To>urn:schemas-xmlsoap-org:ws:2005:04:discovery</a:To>
    <d:AppSequence InstanceId="1077004800" MessageNumber="1" />
  </s:Header>
  <s:Body>
    <d:Hello>
      <a:EndpointReference>
        <a:Address>
          uuid:98190dc2-0890-4ef8-ac9a-5940995e6119
        </a:Address>
      </a:EndpointReference>
      <d:MetadataVersion>75965</d:MetadataVersion>
    </d:Hello>
  </s:Body>
</s:Envelope>
```

Probe

- By: A Client to find Target Services based on the criteria
- To:
 - Multicast on the ad hoc network
 - DP in managed mode
- Contents:
 - Criteria to match

```
<d:Probe ... >
  [<d:Types>list of xs:QName</d:Types>]?
  [<d:Scopes [MatchBy="xs:anyURI"]? ... >list of
    xs:anyURI</d:Scopes>]?
  ...
</d:Probe >
```

Example Probe Message

```
<s:Envelope
  xmlns:a="http://schemas.xmlsoap.org/ws/2004/08/addressing"
  xmlns:d="http://schemas.xmlsoap.org/ws/2005/04/discovery"
  xmlns:i="http://printer.example.org/2003/imaging"
  xmlns:s="http://www.w3.org/2003/05/soap-envelope" >
  <s:Header>
    <a:Action>
      http://schemas.xmlsoap.org/ws/2005/04/discovery/Probe
    </a:Action>
    <a:MessageID>
      uuid:0a6dc791-2be6-4991-9af1-454778a1917a
    </a:MessageID>
    <a:To>urn:schemas-xmlsoap-org:ws:2005:04:discovery</a:To>
  </s:Header>
  <s:Body>
    <d:Probe>
      <d:Types>i:PrintBasic</d:Types>
      <d:Scopes
        MatchBy="http://schemas.xmlsoap.org/ws/2005/04/discovery/rfc2396" >
        http://example.com/us/engineering
      </d:Scopes>
    </d:Probe>
  </s:Body>
</s:Envelope>
```

Matching Probe

- “And” of criteria specified in the Probe
 - List of Types
 - All of the specified type are implemented by the service.
 - List of Scopes
 - All of the specified scope match the scopes the service is in as determined by the specified scope matching rule (MatchBy)
- Match =
Subset(Probe.Types, Service.Types) &&
Subset(Probe.Scopes, Service.Scopes)

Matching Probe – Contd.

- Matching Types
 - `T1.Name == T2.Name` and `T1.Namespace == T2.Namespace`
- Matching Scopes
 - S1 matches S2 as per the matching rules
 - Matching Rules
 - `http://schemas.xmlsoap.org/ws/2005/04/discovery/rfc2396` (default)
 - » `http://example.com/us/engineering`
matches:
 - `http://example.com/us/engineering`
 - `http://example.com/us/engineering/productA`
 - does not match:
 - `http://example.com/us/engineeringDepartment`
 - `http://schemas.xmlsoap.org/ws/2005/04/discovery/uuid`
 - `http://schemas.xmlsoap.org/ws/2005/04/discovery/ldap`
 - `http://schemas.xmlsoap.org/ws/2005/04/discovery/strcmp0`

Probe Match

- By:
 - A matching Target Service in ad-hoc mode
 - A Discovery Proxy in managed mode
- To:
 - The client that sent Probe
- Contents:
 - Discoverable metadata of the matching Target Service(s)

```
<d:ProbeMatches ... >
  [<d:ProbeMatch ... >
    <a:EndpointReference> ... </a:EndpointReference>
    [<d:Types>list of xs:QName</d:Types>]?
    [<d:Scopes>list of xs:anyURI</d:Scopes>]?
    [<d:XAddrs>list of xs:anyURI</d:XAddrs>]?
    <d:MetadataVersion>xs:unsignedInt</d:MetadataVersion>
    ...
  </d:ProbeMatch>]*
  ...
</d:ProbeMatches>
```

Example Probe Match

```
<s:Envelope ... > <s:Header> <a:Action>
  http://schemas.xmlsoap.org/ws/2005/04/discovery/ProbeMatches</a:Action>
  <a:MessageID>uuid:e32e6863-ea5e-4ee4-997e-69539d1ff2cc</a:MessageID>
  <a:RelatesTo>uuid:0a6dc791-2be6-4991-9af1-454778a1917a</a:RelatesTo>
  <a:To>http://schemas.xmlsoap.org/ws/2004/08/addressing/role/anonymous</a:To>
  <d:AppSequence InstanceId="1077004800" MessageNumber="2" />
</s:Header>
<s:Body>
  <d:ProbeMatches> <d:ProbeMatch>
    <a:EndpointReference>
      <a:Address>uuid:98190dc2-0890-4ef8-ac9a-5940995e6119</a:Address>
    </a:EndpointReference>
    <d:Types>i:PrintBasic i:PrintAdvanced</d:Types>
    <d:Scopes>
      http://example.com/us/engineering/building1/floor1/room1234
      ldap:///ou=floor1,ou=building1,ou=anytown,o=examplecom,c=us
    </d:Scopes>
    <d:XAddr>http://example.com/PRN/b1-1234-a</d:XAddr>
    <d:MetadataVersion>75965</d:MetadataVersion>
  </d:ProbeMatch> </d:ProbeMatches>
</s:Body>
</s:Envelope>
```

Resolve

- By: A Client to obtain current discoverable metadata about a known Target Service
- To:
 - Multicast on the ad-hoc network
 - DP in managed mode
- Contents:
 - EPR of the Target Service to resolve

```
<d:Resolve ... >  
  <a:EndpointReference> ... </a:EndpointReference>  
  ...  
</d:Resolve >
```

Resolve Match

- By:
 - A matching Target Service in ad-hoc mode
 - A Discovery Proxy in managed mode
- To:
 - The client that sent Resolve
- Contents:
 - Discoverable metadata of the matching Target Service(s)

```
<d:ResolveMatches ... >
  [<d:ResolveMatch ... >
    <a:EndpointReference> ... </a:EndpointReference>
    [<d:Types>list of xs:QName</d:Types>]?
    [<d:Scopes>list of xs:anyURI</d:Scopes>]?
    <d:XAddrs>list of xs:anyURI</d:XAddrs>
    <d:MetadataVersion>xs:unsignedInt</d:MetadataVersion>
    ...
  </d:ResolveMatch>]*
  ...
</d:ResolveMatches>
```

Bye

- By: A Target Service when it is about to leave the network
- To:
 - Multicast on the ad-hoc network
 - DP in managed mode
- Contents:
 - EPR of the Target Service

```
<d:Bye ... >
```

```
    <a:EndpointReference> ... </a:EndpointReference>
```

```
    ...
```

```
</d:Bye >
```

Example Bye Message

```
<s:Envelope
  xmlns:a="http://schemas.xmlsoap.org/ws/2004/08/addressing"
  xmlns:d="http://schemas.xmlsoap.org/ws/2005/04/discovery"
  xmlns:s="http://www.w3.org/2003/05/soap-envelope" >
  <s:Header>
    <a:Action>
      http://schemas.xmlsoap.org/ws/2005/04/discovery/Bye
    </a:Action>
    <a:MessageID>
      uuid:337497fa-3b10-43a5-95c2-186461d72c9e
    </a:MessageID>
    <a:To>urn:schemas-xmlsoap-org:ws:2005:04:discovery</a:To>
    <d:AppSequence InstanceId="1077004800" MessageNumber="4" />
  </s:Header>
  <s:Body>
    <d:Hello>
      <a:EndpointReference>
        <a:Address>
          uuid:98190dc2-0890-4ef8-ac9a-5940995e6119
        </a:Address>
      </a:EndpointReference>
    </d:Hello>
  </s:Body>
</s:Envelope>
```

Protocol Binding

IP Multicast Binding

- In ad-hoc mode discovery messages are:
 - sent over IP multicast
 - using SOAP over UDP with retransmission and duplicate detection
 - to following multicast group address and port
 - IPv4: 239.255.255.250
 - IPv6: FF02::C
 - Port 3702

App Sequence Header

- Provides ordering information for related messages when sent over transport that does not guarantee order delivery
 - Examples
 - Service reboots it sends Bye and then Hello. Client receives Hello first and then Bye. The client thinks that the service is offline but it is not.
 - Service sends ProbeMatch and then goes down. Bye is received first. The Client thinks that it missed Hello and service is still alive and responding but it is not.
- Transmitted as part of message header on Hello, Bye, ProbeMatch and ResolveMatch messages from a Target Service

App Sequence Header – Contd.

- Contents

```
<s:Header ...>
  <d:AppSequence InstanceId="xs:unsignedInt"
    [SequenceId="xs:anyURI"]?
    MessageNumber="xs:unsignedInt"
  ... />
</s:Header>
```

- Instance ID: Incremented every time service loses state
- Sequence ID: Identifies the set of messages that are related and require ordering
- Message Number: Monotonically increasing number

Security

Considerations

- Security in ad-hoc networks defeats the purpose of zero-configuration
- Some scenarios require Message Integrity
 - Multicast suppression
 - Message spoofing, modification and replay
 - Example: malicious Bye for a printer that you want to use.
- Challenges
 - Certificate management
 - No certificate exchange possible
 - Including full certificate in the message increases message size
 - Out of band deployment of certificate
 - IP and DNS spoofing still possible
- If full security is desired, secure application endpoints

Compact Signature

- Allows messages to be signed with minimal footprint
 - Fixed algorithms for canonicalization, transformation, digest and signature
 - <http://www.w3.org/2001/10/xml-exc-c14n#> (Canonicalization)
 - <http://www.w3.org/2000/09/xmlsig#sha1> (Digest)
 - <http://www.w3.org/2000/09/xmlsig#rsa-sha1> (Signature)
 - Pointer to existing certificate (SKI-Subject Key Identifier)

- Outline

```
<d:Security ... >
  [<d:Sig Scheme="xs:anyURI"
    [KeyId="xs:base64Binary"]?
    Refs="..."
    Sig="xs:base64Binary"
  ... />]?
  ...
</d:Security>
```

Motivation & Scenarios

Prasad Yendluri (Software AG)

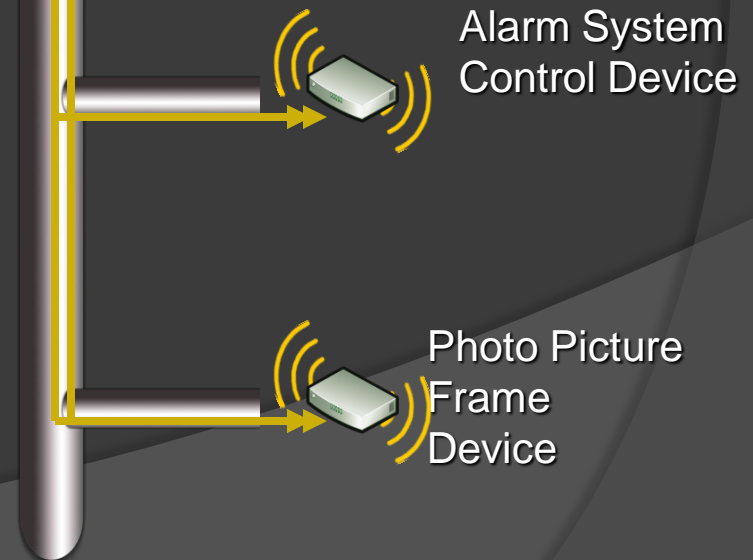
Scenario: Home network

Requirements

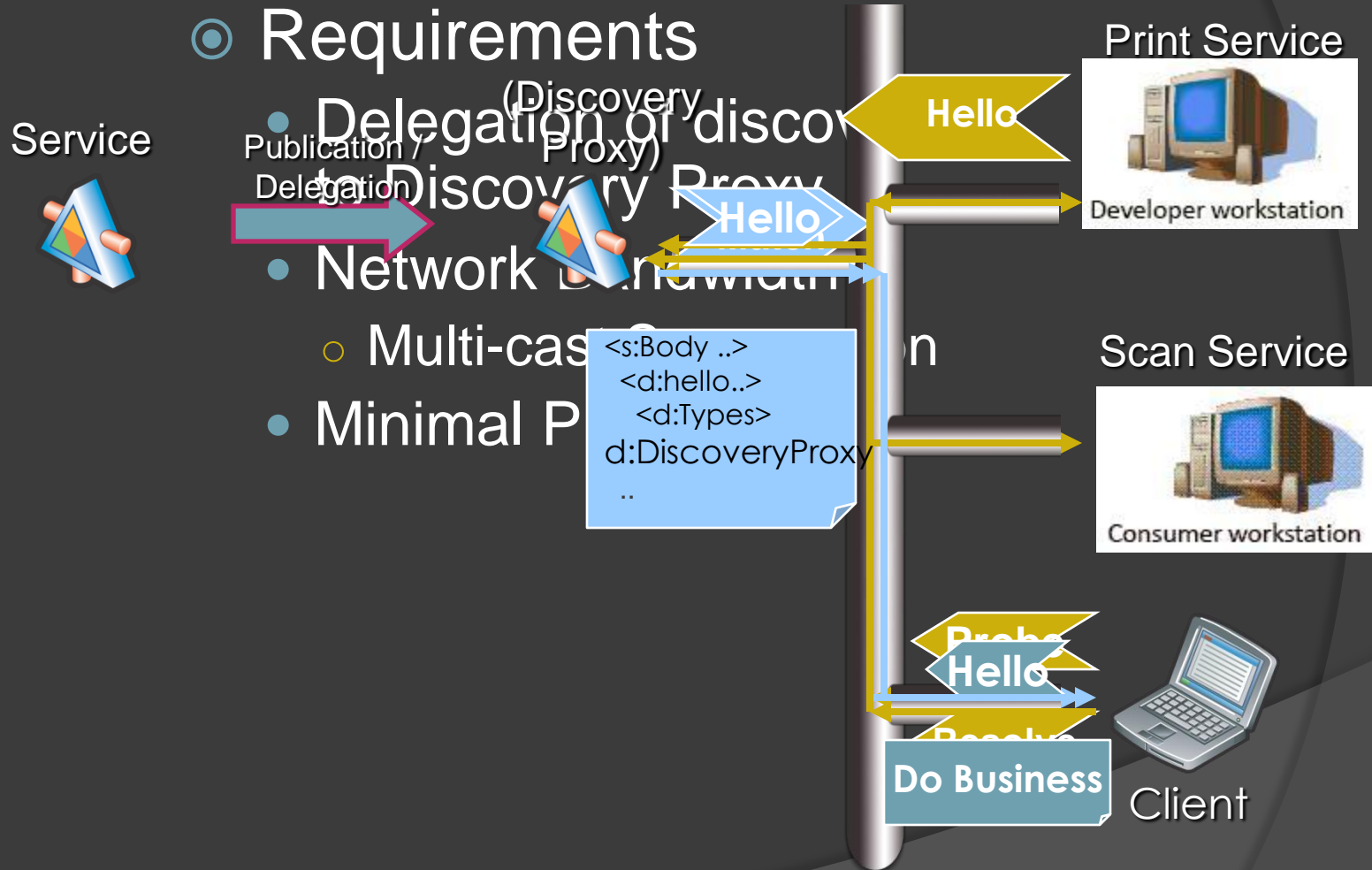
```
<s:Body>
  <d:ProbeMatch>
    <a:EndpointReference>
      <a:Address>uuid:98190dc2-0890-4ef8-90995e6119</a:Address>
      .....
    </d:ProbeMatch>
  </s:Body>
```



devices



Scenario: Enterprise network

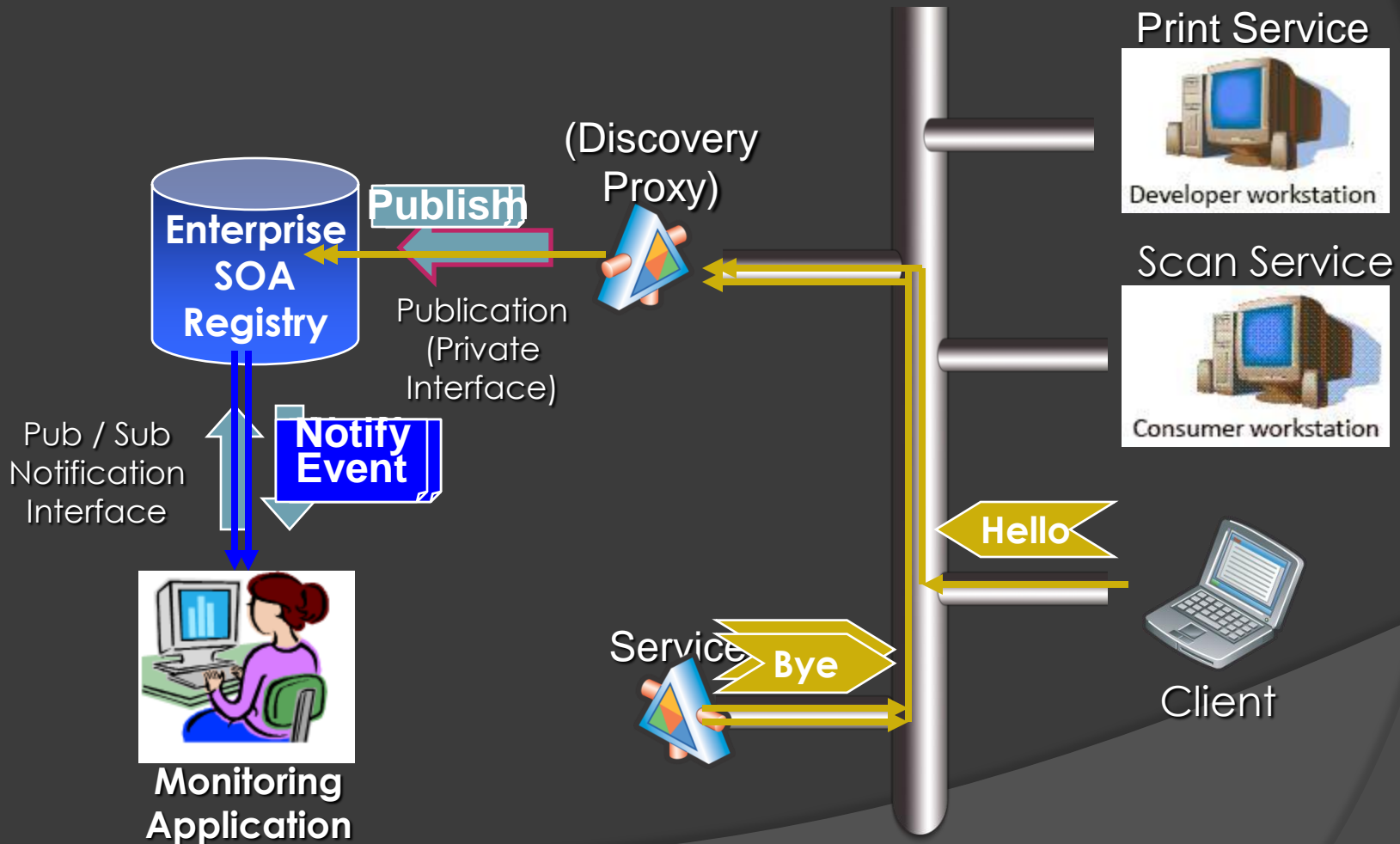


Scenario: Enterprise SOA Infrastructure Monitoring

⦿ Requirements

- Dynamically Detect Changes to Enterprise SOA Landscape
 - SOA entities joining and leaving
- Minimize Overhead on the Infrastructure (multi-cast suppression)
- Leverage Existing Infrastructure
 - Registry (UDDI) centric architecture

Scenario: Enterprise SOA Infrastructure Monitoring



WS-Discovery & Lexmark

Dave Whitehead (Lexmark International Inc.)

Why is WS-Discovery important to Lexmark?

MarkVision (Device Management)

Vista

Announcement : Hello

```
<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope
  xmlns:soap="http://www.w3.org/2003/05/soap-envelope"
  xmlns:wsd="http://schemas.xmlsoap.org/ws/2005/04/discovery"
  xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing"
  xmlns:wsdp="http://schemas.xmlsoap.org/ws/2006/02/devprof"
  xmlns:nprt="http://schemas.microsoft.com/windows/2006/08/wdp/print">
  <soap:Header>
    <wsa:Action>
      http://schemas.xmlsoap.org/ws/2005/04/discovery/Hello
    </wsa:Action>
    <wsa:MessageID>urn:uuid:26424823-7293-44d5-97db-44ca38027d82</wsa:MessageID>
    <wsa:To>urn:schemas-xmlsoap-org:ws:2005:04:discovery</wsa:To>
    <wsd:AppSequence InstanceId="293" MessageNumber="1"/>
  </soap:Header>
  <soap:Body>
    <wsd:Hello>
      <wsa:EndpointReference>
        <wsa:Address>uuid:934def7f-1b0a-42e2-994b-251d05d13aec</wsa:Address>
      </wsa:EndpointReference>
      <wsd:Types>wsdp:Device nprt:PrintDeviceType</wsd:Types>
      <wsd:XAddrs>
        http://157.184.195.202:50000/lxkWSdevice
      </wsd:XAddrs>
      <wsd:MetadataVersion>13</wsd:MetadataVersion>
    </wsd:Hello>
  </soap:Body>
</soap:Envelope>
```

Discovery : Probe

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope
  xmlns:soap="http://www.w3.org/2003/05/soap-envelope"
  xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing"
  xmlns:wsd="http://schemas.xmlsoap.org/ws/2005/04/discovery"
  xmlns:wsdp="http://schemas.xmlsoap.org/ws/2006/02/devprof">
  <soap:Header>
    <wsa:To>urn:schemas-xmlsoap-org:ws:2005:04:discovery</wsa:To>
    <wsa:Action>http://schemas.xmlsoap.org/ws/2005/04/discovery/Probe</wsa:Action>
    <wsa:MessageID>urn:uuid:520406c6-4e10-457f-9cd7-4924b8f4b92e</wsa:MessageID>
  </soap:Header>
  <soap:Body>
    <wsd:Probe>
      <wsd:Types>wsdp:Device</wsd:Types>
    </wsd:Probe>
  </soap:Body>
</soap:Envelope>
```

Discovery : Probe Match

```
<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope
  xmlns:soap="http://www.w3.org/2003/05/soap-envelope"
  xmlns:wsd="http://schemas.xmlsoap.org/ws/2005/04/discovery"
  xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing"
  xmlns:wsdp="http://schemas.xmlsoap.org/ws/2006/02/devprof"
  xmlns:wprt="http://schemas.microsoft.com/windows/2006/08/wdp/print">
  <soap:Header>
    <wsa:Action>http://schemas.xmlsoap.org/ws/2005/04/discovery/ProbeMatches</wsa:Action>
    <wsa:MessageID>urn:uuid:108a01fc-2dd6-4fb6-9e32-06a9dbf88951</wsa:MessageID>
    <wsa:RelatesTo>urn:uuid:520406c6-4e10-457f-9cd7-4924b8f4b92e</wsa:RelatesTo>
    <wsa:To>http://schemas.xmlsoap.org/ws/2004/08/addressing/role/anonymous</wsa:To>
    <wsd:AppSequence InstanceId="222" MessageNumber="4"/>
  </soap:Header>
  <soap:Body>
    <wsd:ProbeMatches>
      <wsd:ProbeMatch>
        <wsa:EndpointReference>
          <wsa:Address>uuid:01657376-4d99-442e-861e-bbd13bb18477</wsa:Address>
        </wsa:EndpointReference>
        <wsd:Types>wsdp:Device wprt:PrintDeviceType</wsd:Types>
        <wsd:XAddr>http://157.184.195.157:50000</wsd:XAddr>
        <wsd:MetadataVersion>5</wsd:MetadataVersion>
      </wsd:ProbeMatch>
    </wsd:ProbeMatches>
  </soap:Body>
</soap:Envelope>
```


UDP/IP

Internet Protocol, Src Addr: 157.184.195.202 (157.184.195.202), Dst Addr: 239.255.255.250 (239.255.255.250)

Version: 4

Header length: 20 bytes

Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)

0000 00.. = Differentiated Services Codepoint: Default (0x00)

.... ..0. = ECN-Capable Transport (ECT): 0

.... ...0 = ECN-CE: 0

Total Length: 1019

Identification: 0x0000 (0)

Flags: 0x04

.1.. = Don't fragment: Set

..0. = More fragments: Not set

Fragment offset: 0

Time to live: 1

Protocol: UDP (0x11)

Header checksum: 0x2475 (correct)

Source: 157.184.195.202 (157.184.195.202)

Destination: 239.255.255.250 (239.255.255.250)

User Datagram Protocol, Src Port: 3702 (3702), Dst Port: 3702 (3702)

Source port: 3702 (3702)

Destination port: 3702 (3702)

Length: 999

Checksum: 0x9ca8 (correct)

0000	01 00 5e 7f ff fa 00 04 00 8e 5c e6 08 00 45 00
0010	03 fb 00 00 40 00 01 11 24 75 9d b8 c3 ca ef ff
0020	ff fa 0e 76 0e 76 03 e7 9c a8

SOAP Envelope in UDP Datagram

0000	01 00 5e 7f ff fa 00 04 00 8e 5c e6 08 00 45 00	..^.....\...E.
0010	03 fb 00 00 40 00 01 11 24 75 9d b8 c3 ca ef ff@...\$u.....
0020	ff fa 0e 76 0e 76 03 e7 9c a8 3c 3f 78 6d 6c 20	...v.v....<?xml
0030	76 65 72 73 69 6f 6e 3d 22 31 2e 30 22 20 65 6e	version="1.0" en
0040	63 6f 64 69 6e 67 3d 22 75 74 66 2d 38 22 3f 3e	coding="utf-8"?>
0050	3c 73 6f 61 70 3a 45 6e 76 65 6c 6f 70 65 20 78	<soap:Envelope x
0060	6d 6c 6e 73 3a 73 6f 61 70 3d 22 68 74 74 70 3a	mlns:soap="http:
0070	2f 2f 77 77 77 2e 77 33 2e 6f 72 67 2f 32 30 30	//www.w3.org/200
0080	33 2f 30 35 2f 73 6f 61 70 2d 65 6e 76 65 6c 6f	3/05/soap-envelo
0090	70 65 22 20 78 6d 6c 6e 73 3a 77 73 64 3d 22 68	pe" xmlns:wsd="h
00a0	74 74 70 3a 2f 2f 73 63 68 65 6d 61 73 2e 78 6d	ttp://schemas.xml
00b0	6c 73 6f 61 70 2e 6f 72 67 2f 77 73 2f 32 30 30	lsoap.org/ws/200
00c0	35 2f 30 34 2f 64 69 73 63 6f 76 65 72 79 22 20	5/04/discovery"
00d0	78 6d 6c 6e 73 3a 77 73 61 3d 22 68 74 74 70 3a	xmlns:wsa="http: