Lecture 5 : Web Service for Device

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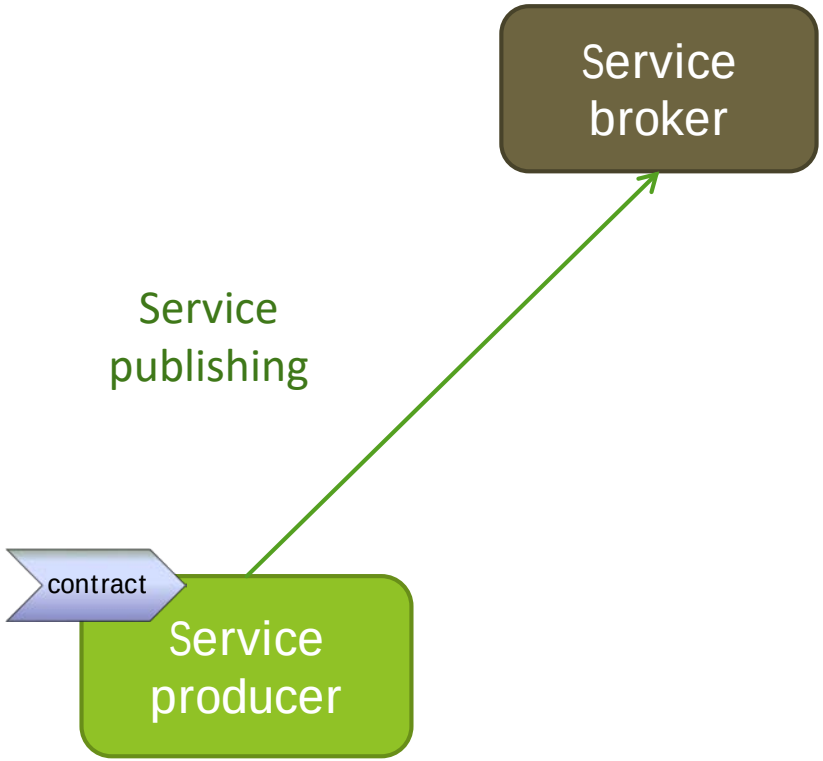
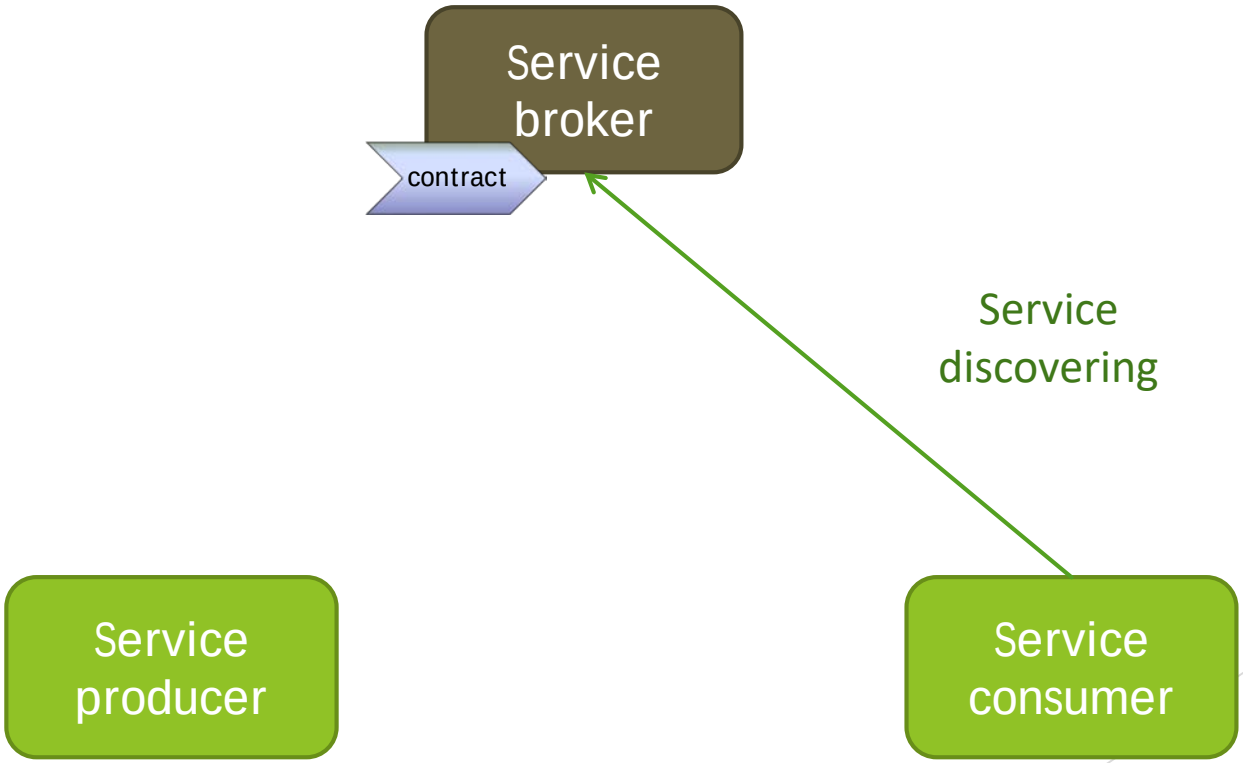
Introduction

A World of Services

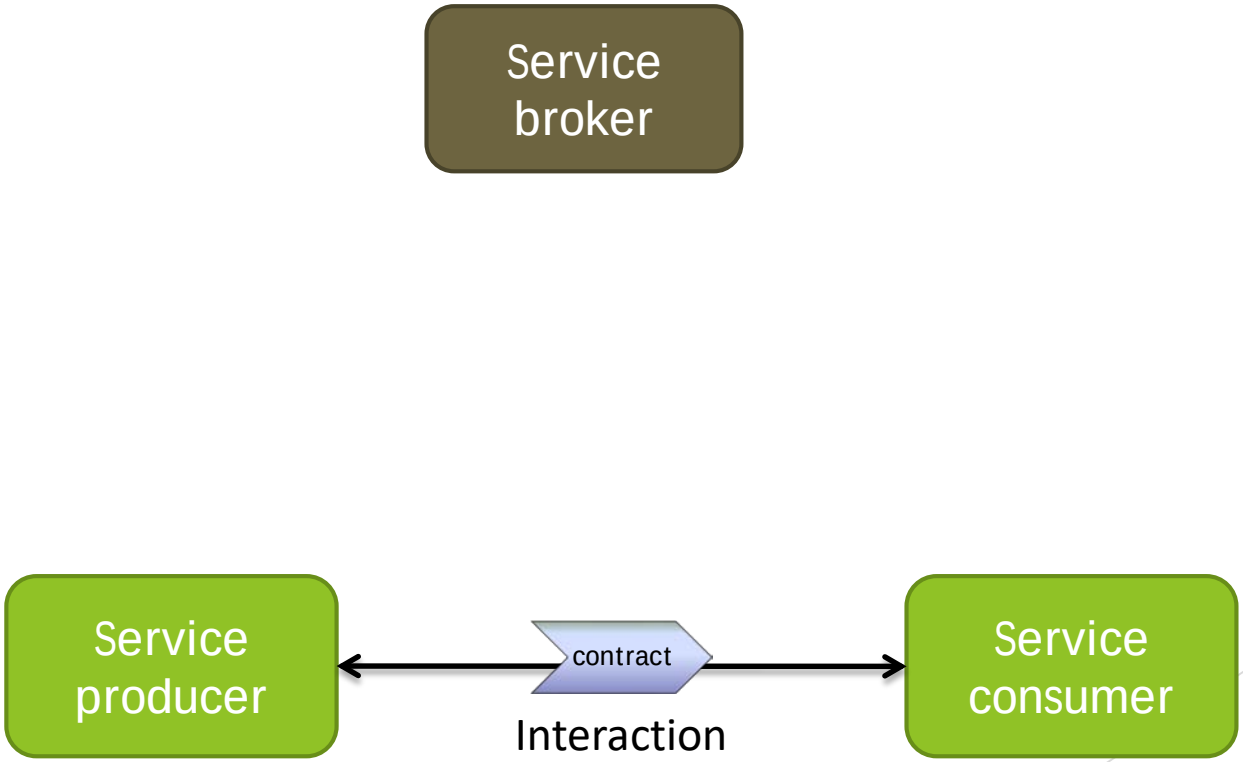
Advertising: Service Publishing



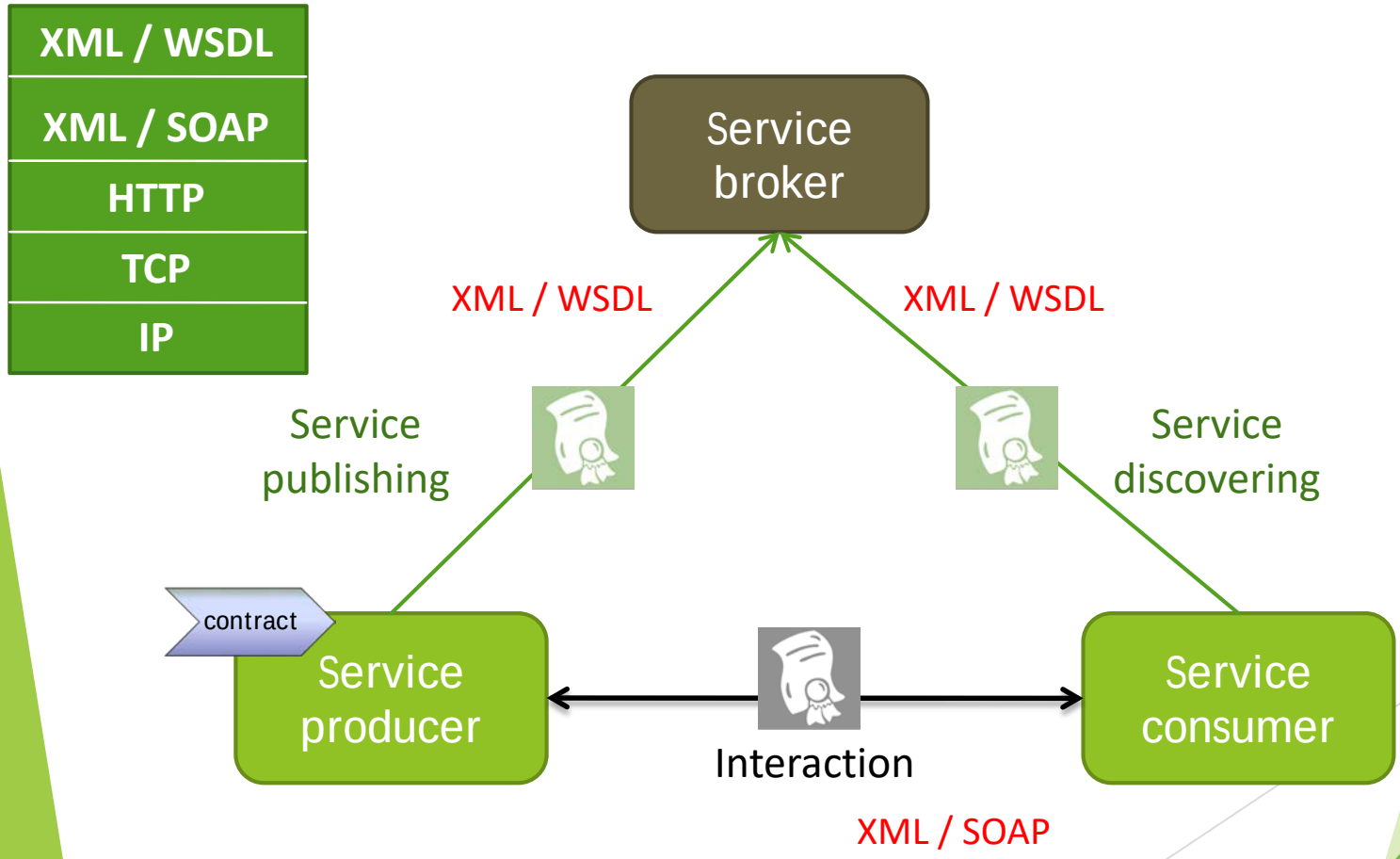
Service Discovery



Loose Coupling



Interoperability (Web standards)



From (Web) Services…

- To sum up advantages of services approach:
  - Reusability (by sharing)
  - Modularity (replacing services by another one)
  - Advertising (by publishing)
  - Discovery (by subscribing and describing)
  - Loose coupling (between entities of application)
  - Interoperability (due to Web Services)
  - Scales (from “world wide” to devices)
- But…

Lacks of Service Oriented Approach

- Remember from the lack of SoM:
  - Low level asbtraction
    - Leaves a lot to be implemented
  - Interaction pattern have to be build
    - One-to-one and request-reply provided
    - « one to many » and « many to many » ?
  - No location transparency (good or bad thing ?)

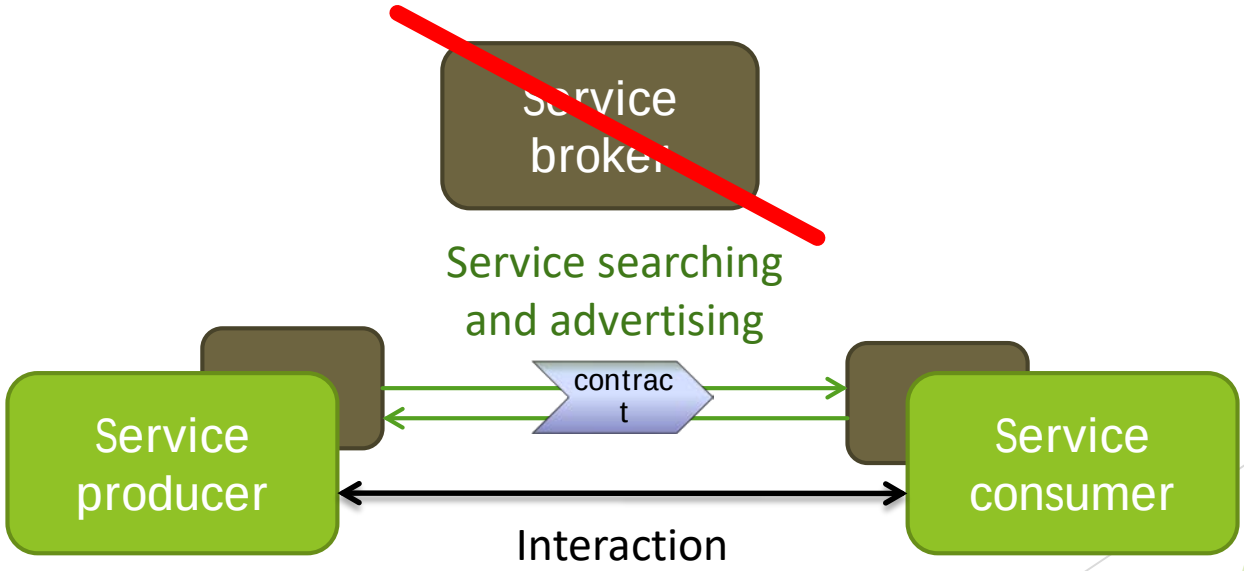
… to Web Services for Device

- Due to Ubiquitous Computing Context
  - For physical and multiple devices
  - Spontaneous Communication
    - Communications between systems not made until runtime
  - "Should compute at the right time"
- ⇨ New challenges
  - Dynamicity
    - Distributed dynamic research and discovery
  - Reactivity and Response Time
    - Evented interaction mechanism

Challenges for New Services

High Dynamicity

- Distributed dynamic Research and Discovery
  - Appearance and Disappearance management
  - Allow contextual research and discovery

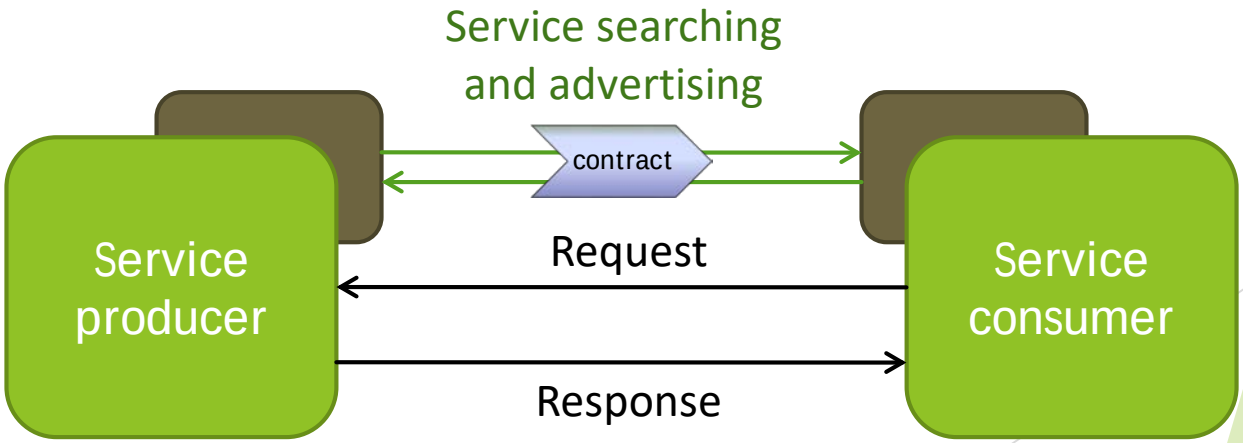


Service Discovery Protocols

- Multicast DNS/DNS-SD: Apple's protocol
  - Multicast DNS: uses API similar to unicast DNS
- SLP: IETF proposed standard
  - Supported by HP, Novell, Sun Microsystems, Oracle
- SSDP: Microsoft's protocol
  - Uses HTTP notifications (see bellow), used since Windows XP
- WS-Discovery: Defined by OASIS
  - Latest defined protocol, used in DPWS (see bellow)

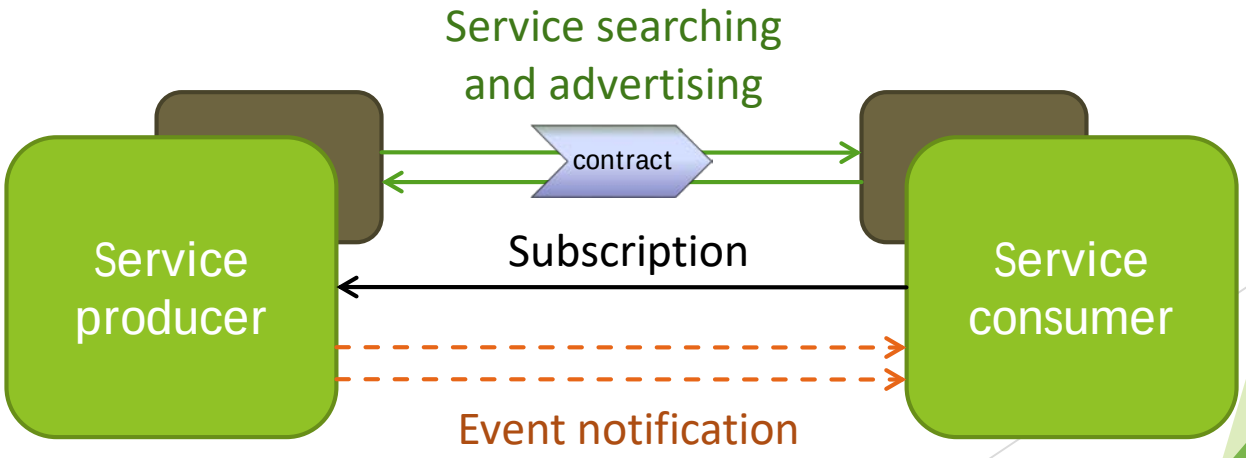
Traditional Interactions: Invocations

- "Classical" way to interact between services
  - Request-Response mechanism



Reactivity

- "New way" of interacting: Eventing interaction model
  - Based on publish/subscribe design pattern
  - Asynchronous messaging (based on push mode)



Web Services for Devices

Standards and Protocols

DPWS

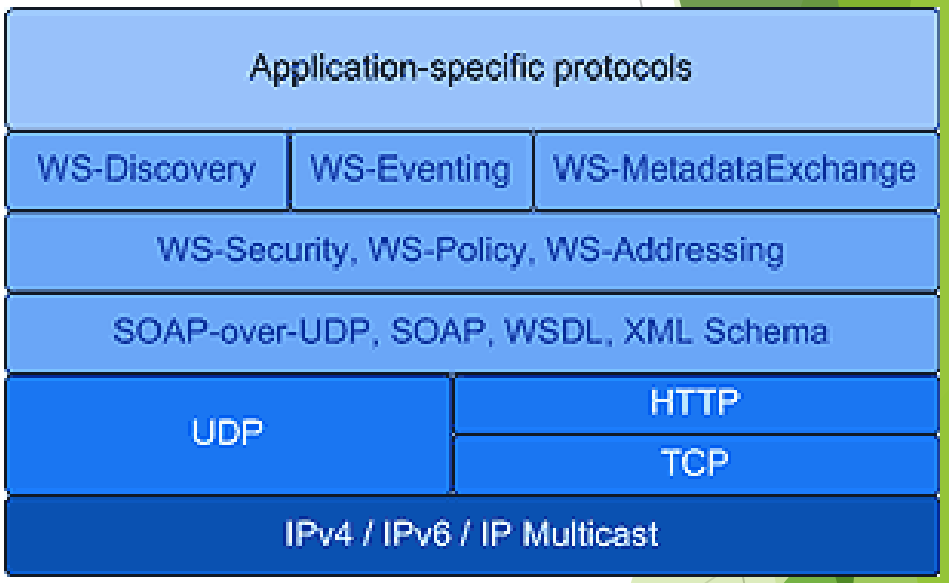
Device Profile for Web Services

Device Profile for Web Services

- Reusing standards:
  - XML Schema, SOAP, WSDL, …
- Or defining new standards:
  - WS-Discovery, WS-Eventing, …
- Approved as OASIS standard on 30, june 2009
- All or some parts of DPWS already included in Vista, Micro .NET, Windows CE, …

DPWS Stack and Protocols

- Only based on standards
  - SOAP 1.2,
  - XML,
  - XML Schema,
  - WSDL 1.1,
  - WS-Addressing,
  - WS-Transfer,
  - WS-Policy,
  - WS-Security,
  - WS-MetadataExchange,
  - WS-Discovery
  - WS-Eventing



DPWS implementations emerged with the help of Research Projects

- European Research Initiative ITEA
  - SIRENA project (2003-2005)
    - SOA4D: SOA for Devices (Java and C Stack)
    - WS4D: Web Services for Devices (Java, Java ME and C Stack)
  - SODA project (Service Oriented Device and Delivery Architecture) (2006-2008)
- EU Research Project
  - SOCRADES (2006-2009) composed by heavyweights like ABB, SAP, Schneider Electric, and Siemens

Using DPWS

- Also Microsoft implementations
  - Micro .NET framework
  - .NET framework (.NET 4.0)
  - Included since Vista (WSDAPI)
- But…
  - For the moment, the 3 main implementations (SOA4D, WS4D, Microsoft) of DPWS do not communicate with other ones…
  - So everybody is a standard !

Comparing Implementations

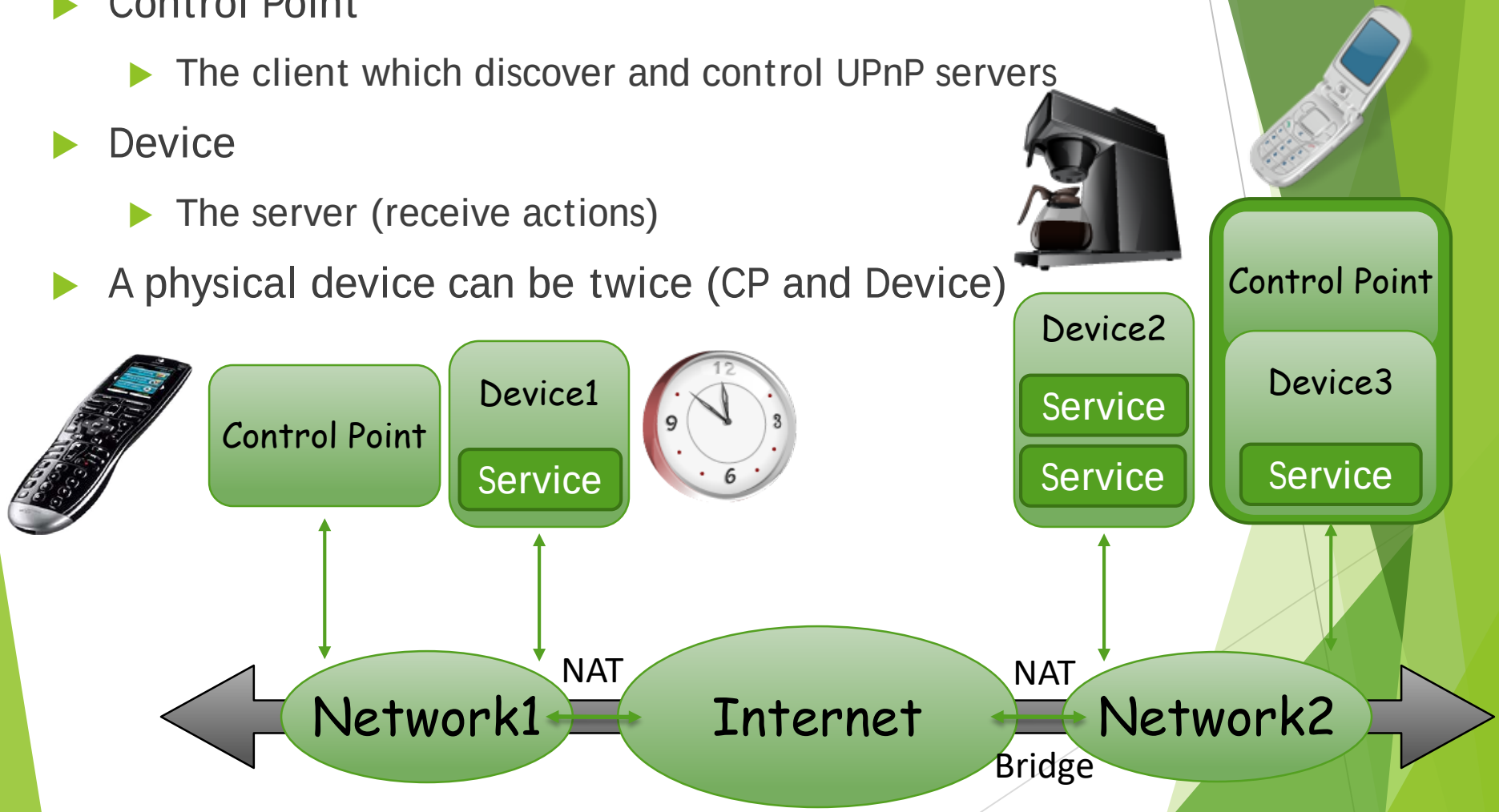
Explorer / Stack	Java Explorer	WS-Management	Hello/Bye Event Catcher Micro .NET	Hello/Bye Event Catcher WCF
WS4D - JMEDS				
DPWS Core				
Micro .NET	Exception System.Xml.XmlException			
WCF			Hello/Bye message received	

UPnP

Universal Plug and Play

Universal Plug and Play

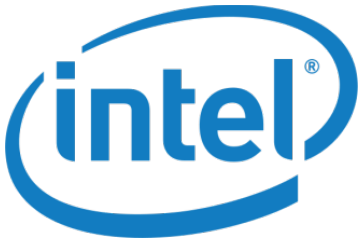
- Control Point
  - The client which discover and control UPnP servers
- Device
  - The server (receive actions)
- A physical device can be twice (CP and Device)



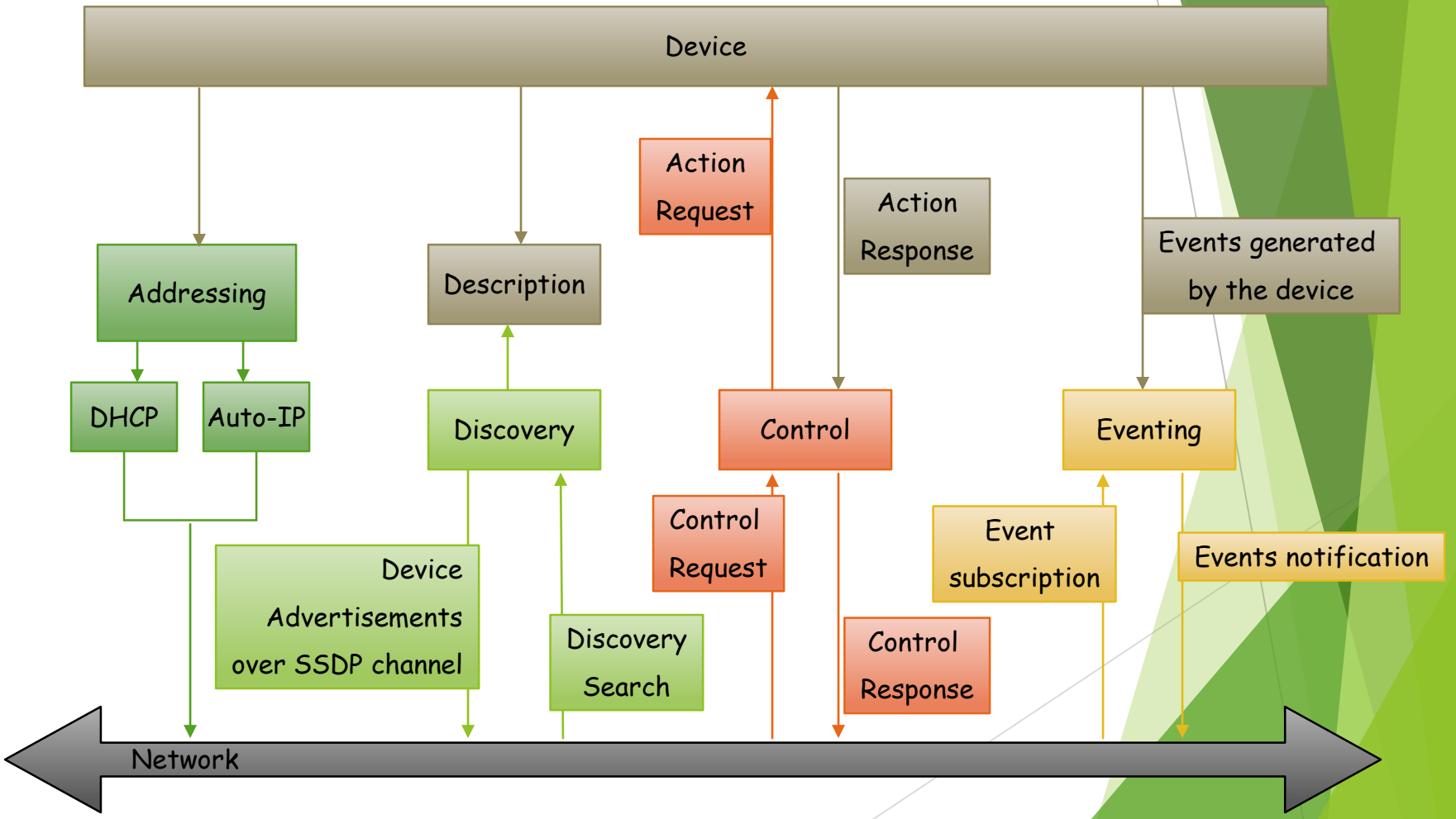
Full Tutorial of the Intel® Authoring Tools for UPnP Technologies

Ylian Saint-Hilaire

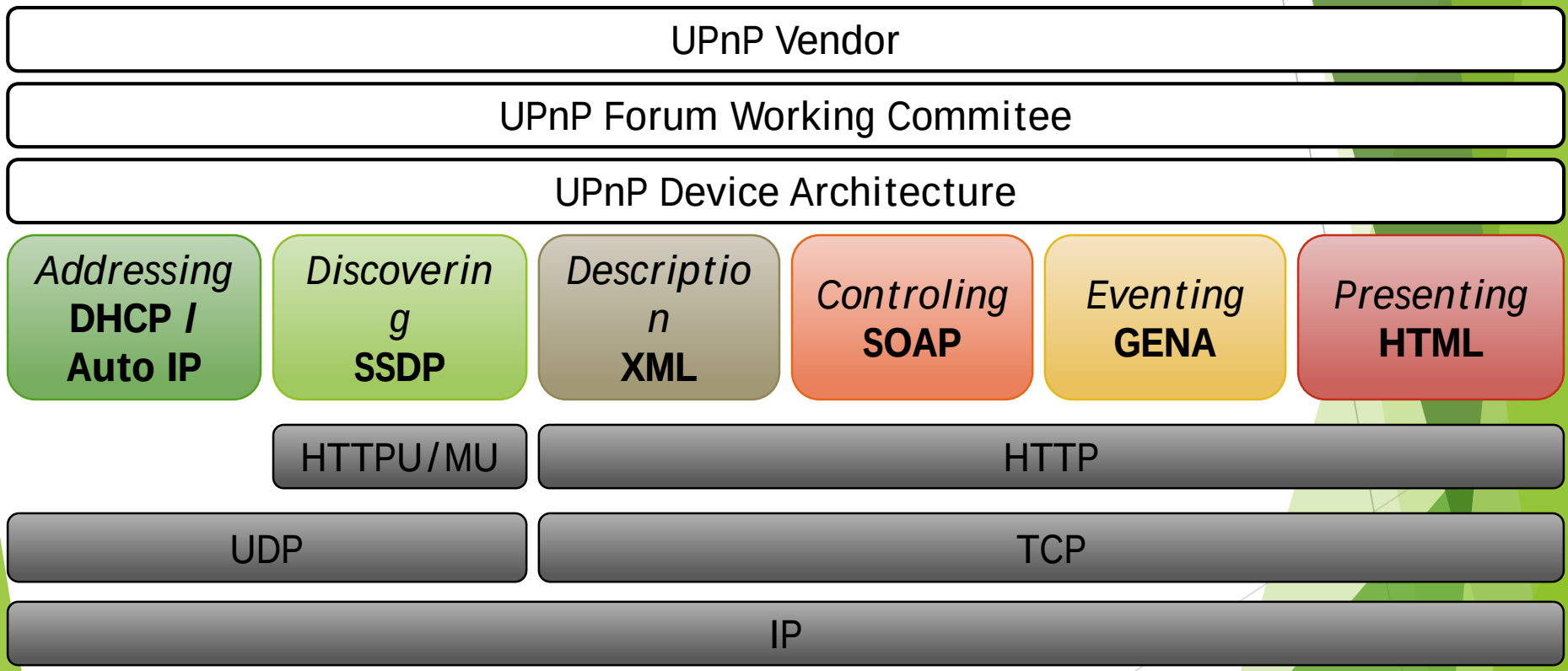
Senior Architect



Example of UPnP Device Communications



UPnP Stack and Protocols



Drawbacks of UPnP Technology

- Heavy protocol for tiny devices (web server + xml parser + soap + …): bridge solutions
- Based on non-standards protocols:
  - Discovery: SSDP over HTTPU, HTTPMU (not standardized since 2000)
  - Description: XML dialect, not standardized
  - Events: GENA (not standardized)
- No authentication protocol (security)[4]

DPWS vs UPnP

	DPWS	UPnP
Year	2009	1999
Addressing	DHCP, AutoIP	DHCP, AutoIP
Discovery	WS-Discovery	SSDP
Description	WSDL 1.1	UDA Schema
Control	SOAP 1.2	SOAP 0.9, 1.1
Eventing	WS-Eventing	GENA
Presentation	HTTP, HTML	HTTP, HTML

References

Web Service for Device

References
Web Service for Device

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2. "**Integration of Embedded Devices Through Web Services: Requirements, Challenges and Early Results**", G. B. Machado, F. Siqueira, R. Mittmann , C. Augusto, V. e. Vieira, in *Proceedings of the 11th IEEE Symposium on Computers and Communications*, pp 353-358, 2006.
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References
DPWS, UPnP

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2. "**Towards the UPnP-UP: Enabling User Profile to Support Customized Services in UPnP Networks**", T. *B. M. de Sales, L. M. de Sales, M. Pereira, H. Almeida, A. Perkusich, K. Gorgônio and M. A. de Sales*, in *Proceedings of the 2008 The Second International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies* (UBICOMM), pp 206—211, 2008.

Lecture 5 : Web of Things and Services Composition

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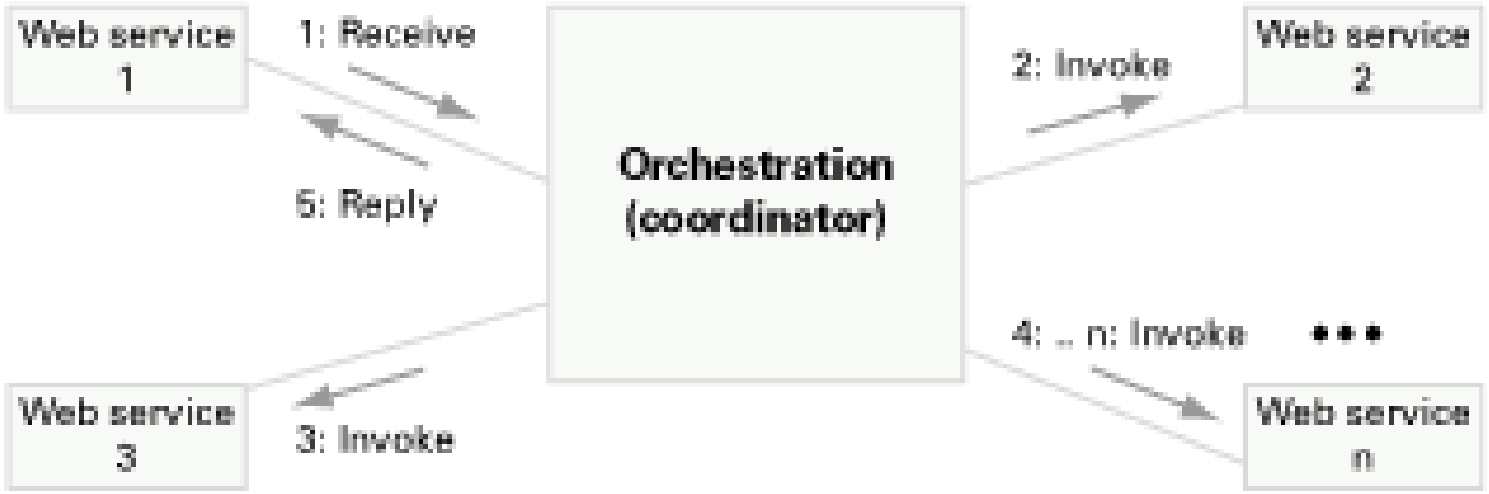
Service Composition

- Problem: more than one service might be needed to achieve a given objective
  - All such services need to interact seamlessly to achieve the objective
- Composite Web Services
  - Individual components implemented by different services and located at different locations
  - Execute in different contexts and containers
  - Need to interact to achieve an objective
- Benefits
  - Services can be reused
  - Access to high-level complex services

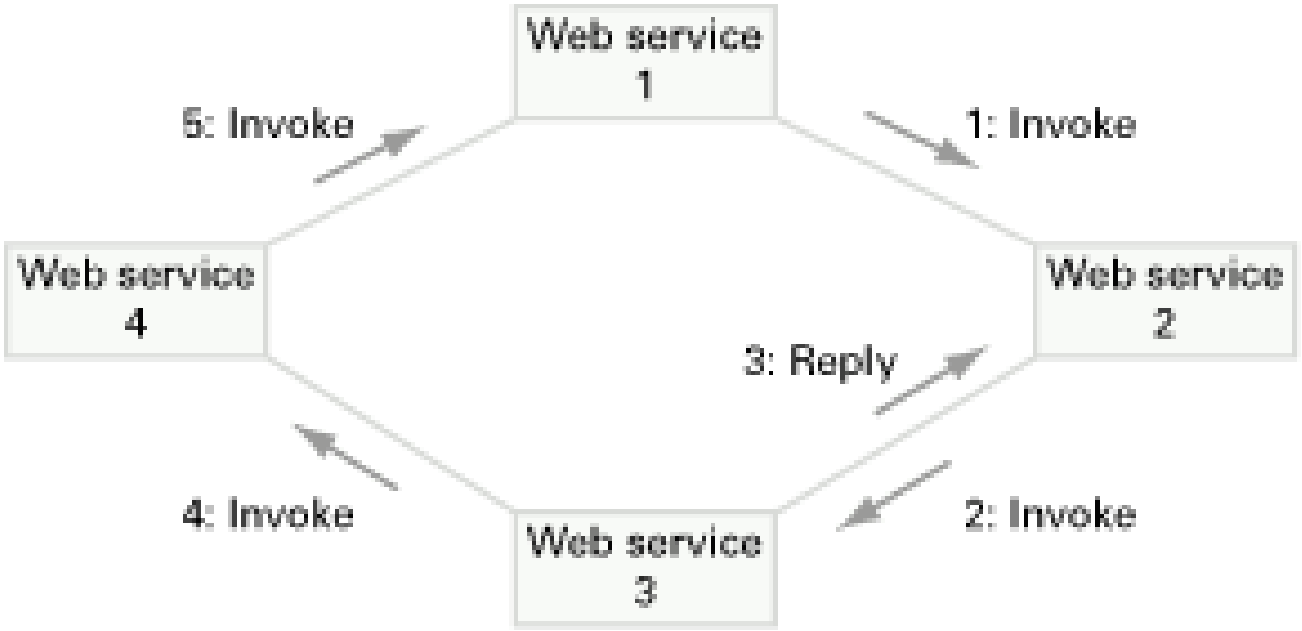
Services Composition

- Web services can be combined in two ways:
  - Orchestration
  - Choreography

Orchestration



Choreography



Service Composition

- Different Approaches

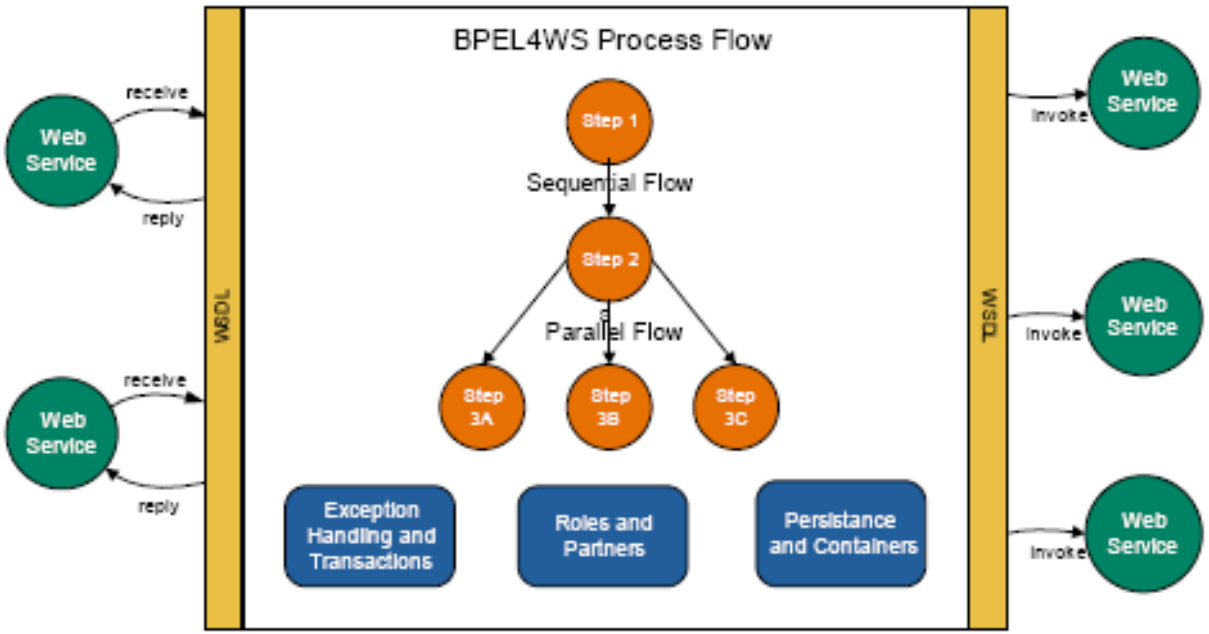
- Ad-Hoc : Mashup Static composition
  - By hand
  - BPEL4WS
- Language based (control flow) :
  - Ex : BPEL4WS
- Others for Web Service for Device :
  - Event Driven (close to Data Flow but react to event appearance)
  - Ex. : Event Driven Component based Model : LCA and SLCA (Wcomp)

Example : BPEL, a language for orchestration

BPEL - Overview

- Use Web Services Standard as a base
  - Every BPEL is exposed as a web service using WSDL. And the WSDL describes the public entry and exit points of the process
  - Interacts through WSDL interfaces with external web services
  - WSDL data types are used to describe information flow within the BPEL process

BPEL - Process Overview



BPEL - Activities

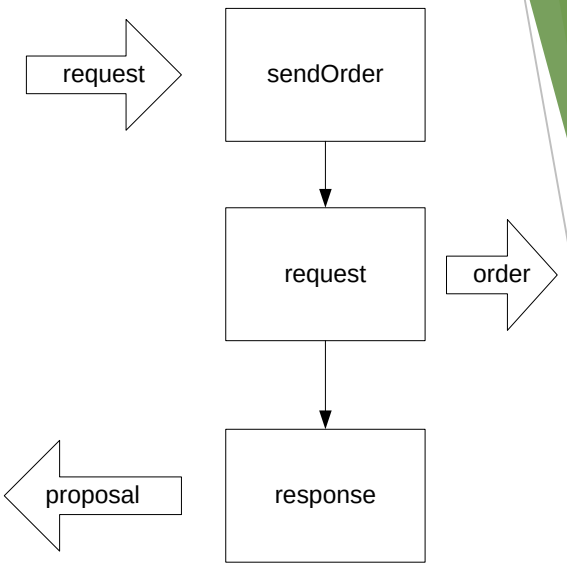
- Basic Activities:
  - Interacts with external services
    - <invoke>, <receive>, and <reply>
- Structured Activities:
  - Internal process control flow
    - sequential flow, conditional branching, looping, and etc.

BPEL - Containers and Partners

- Containers
  - Data exchanges in the message flow
    - e.g. WSDL messageType
- Partners
  - Any services that the process invokes OR any services that invokes the process

```
<partners>
        <partner name="buyer" … myRole="agent"/>
        <partner name="supplier" … myRole="requestor" partnerRole="supplier"/>
</partners>
<containers>
        <container name="request" messageType="tns:orderRequest"/>
        <container name="response" messageType="tns:orderResponse"/>
</containers>
```

BPEL - Code



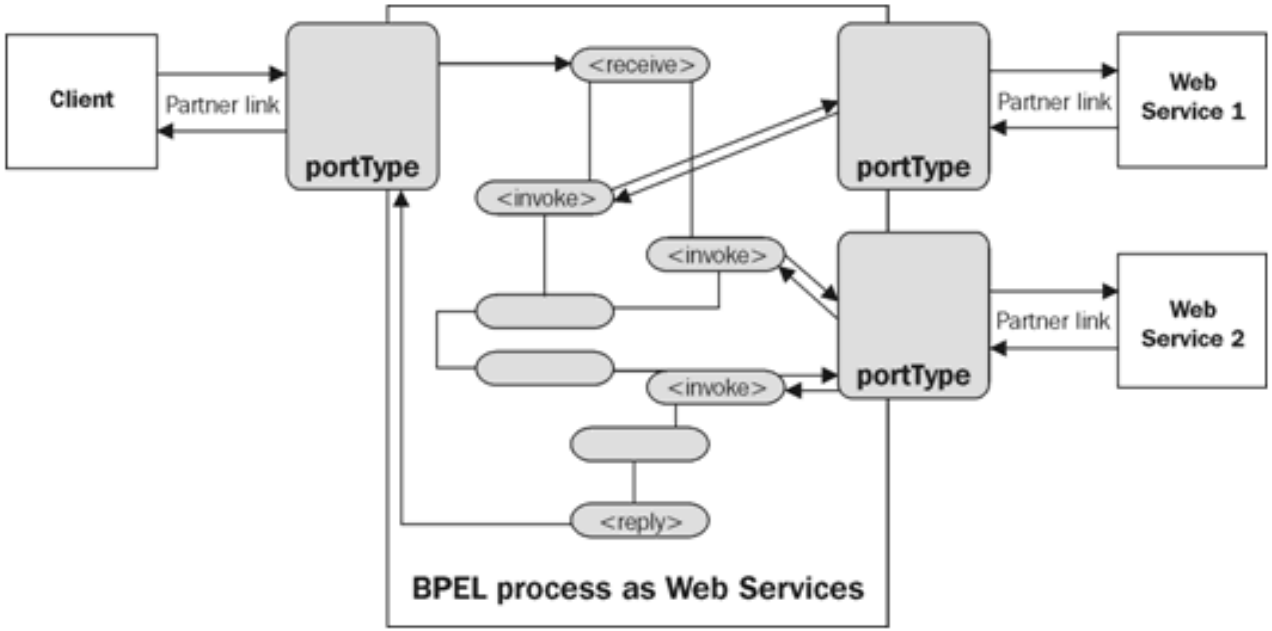
- A sequence

```
<sequence>
  <receive partner="buyer" ...
operation="sendOrder" container="request" />
  <invoke partner="supplier" ...
operation="request" container="order" />
  <reply partner="buyer" ...
operation="response" container="proposal" />
</sequence>
```

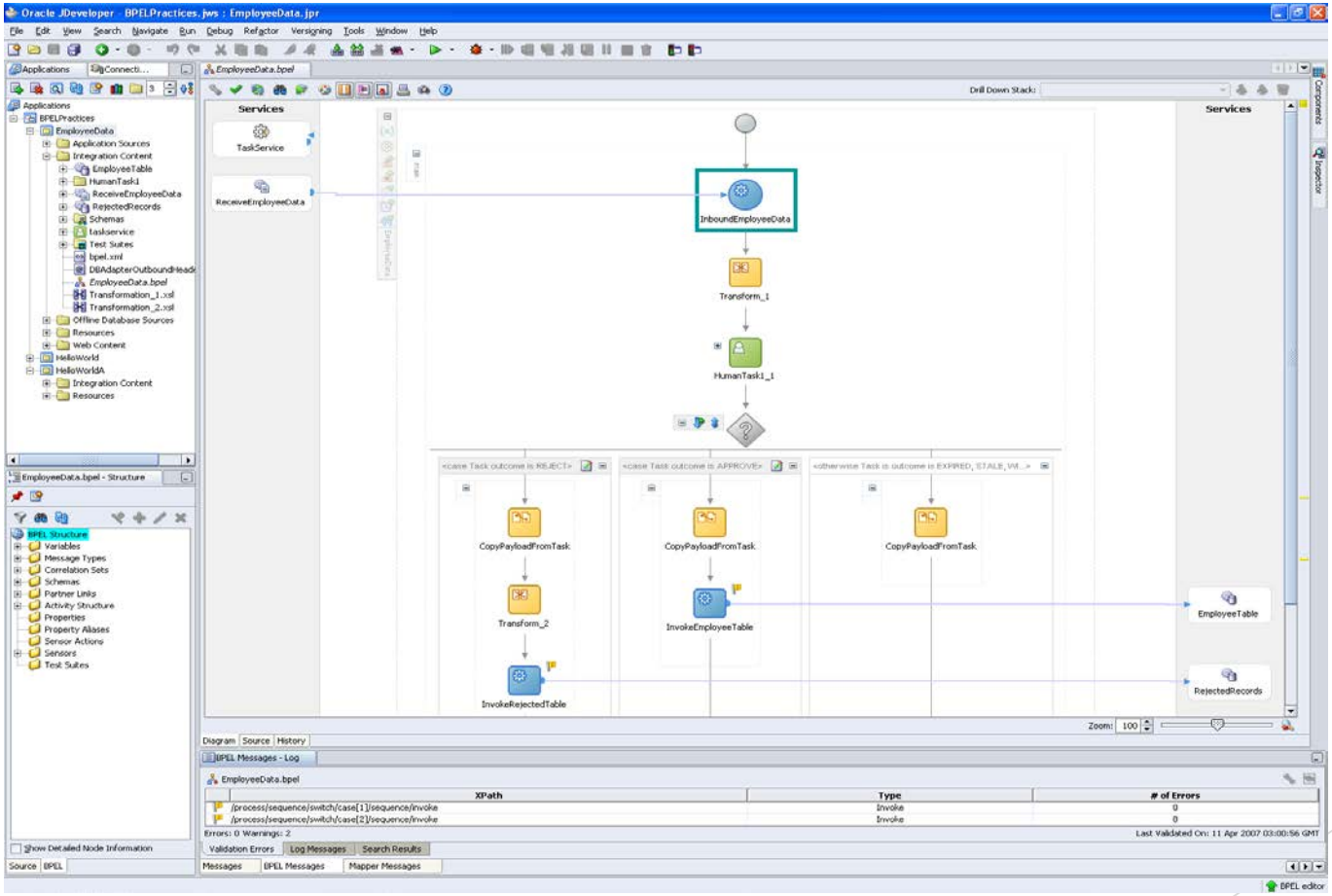
BPEL - Others

- Transactions and Exceptions
  - Building on top of WS-Coordination and WS-Transaction specifications
  - Transaction
    - A set of activities can be grouped in a single transaction through the <scope> tag
      - Can specify compensation handlers (rollback) if there is an error
  - Exception Handling
    - Through the use of throw and catch (similar to Java)

BPEL – Example Process



BPEL Process in JDeveloper



Event-driven Composition

Through Components Assemblies

Overview

- Introduction
- LightWeight Component Model
- LCA (WComp) Component Model for ubiquituous computing

What is a Component?

- "A software component is a software element that conforms to a component model, and can be independently deployed and composed without modification according to a composition standard."
- Component Model
  - Interaction Standards
    - Clearly Defined Interface
  - Composition Standards
    - Describe how components can be composed into larger structures
    - Substitutions

CBSE Definition

- Developing new software from pre-built components.
- Attempt to make an association between SE and other engineering disciplines.

- Advantages of CBSE
- Management of Complexity
- Reduce Development Time
- Increased Productivity
- Improved Quality

More on Trust

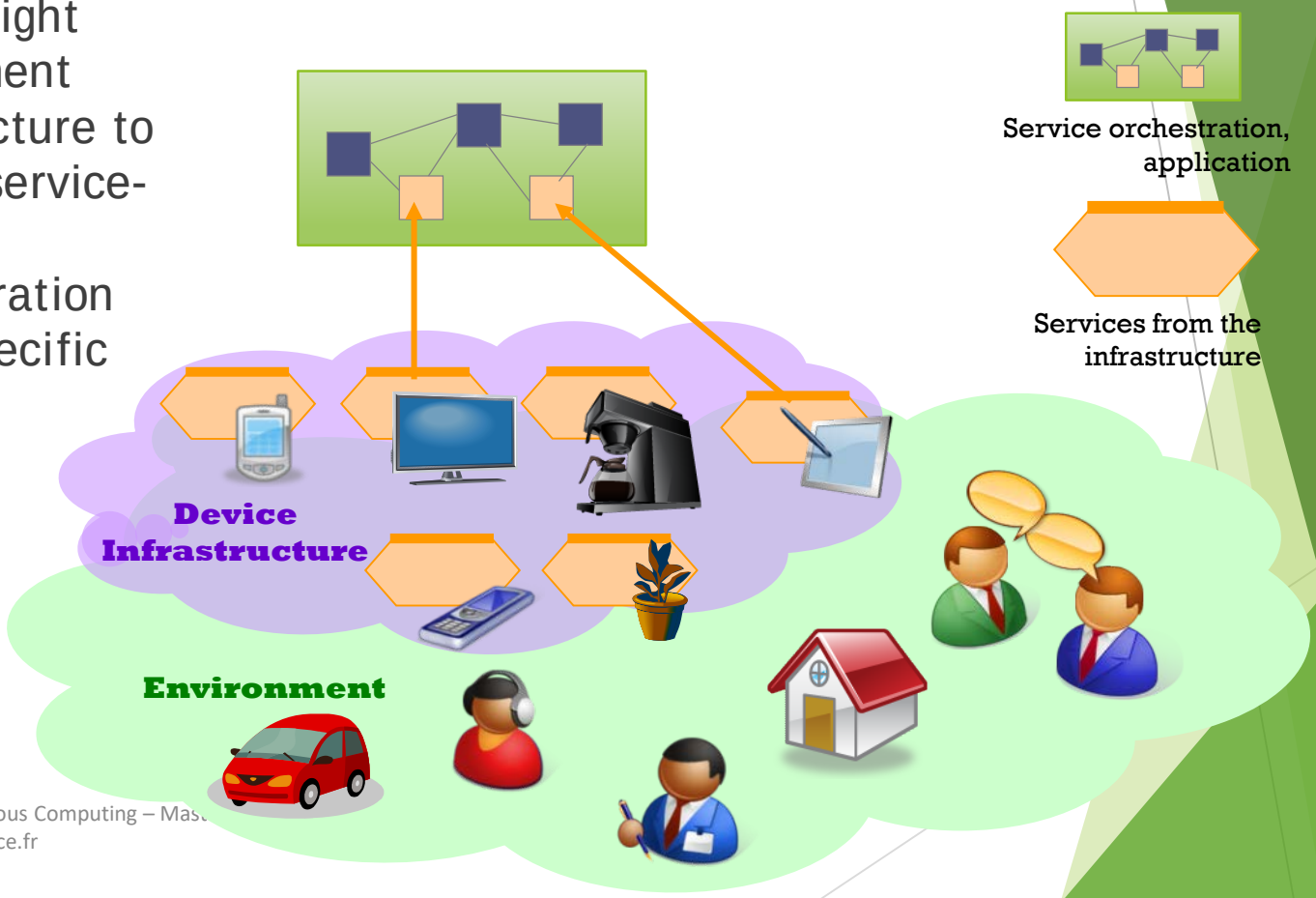
- Components come in several forms
  - Binary
  - Source Code
- Need a Certification Standard
  - Tests
  - Environments
- => Formal Validation and Model Checking is a way to do that (SCADE and synchronous programming)

A way to dynamically compose services with an event driven approach

LCA Model

LCA to compose services for Devices

- Lightweight Component Architecture to create service-based orchestration for a specific task



WComp and Local Composition (LCA)

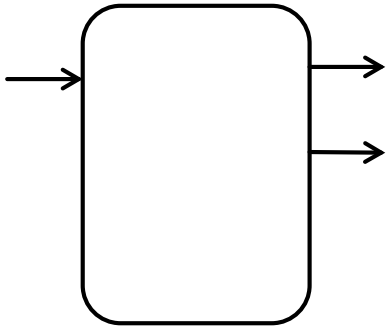
- Main requirements for ubiquituous computing :
  - Composition must be event driven
  - At runtime ….
- Solution :
  - Event based Local Composition : LCA (Lightweight Component Model) for each application execution node.

Main Features of LCA Model :

- Goal :
  - Allow to compose Services for Device between them towards a multiple devices ubiquitous application.
- Principles
  - LightWeight Components Approach :
    - Like OpenCom, JavaBeans, PicoContainer
  - On the same execution node
  - For each execution node, a container dynamically manage the assembly of components
  - Event-based interaction between components
  - Blackbox LightWeight Components

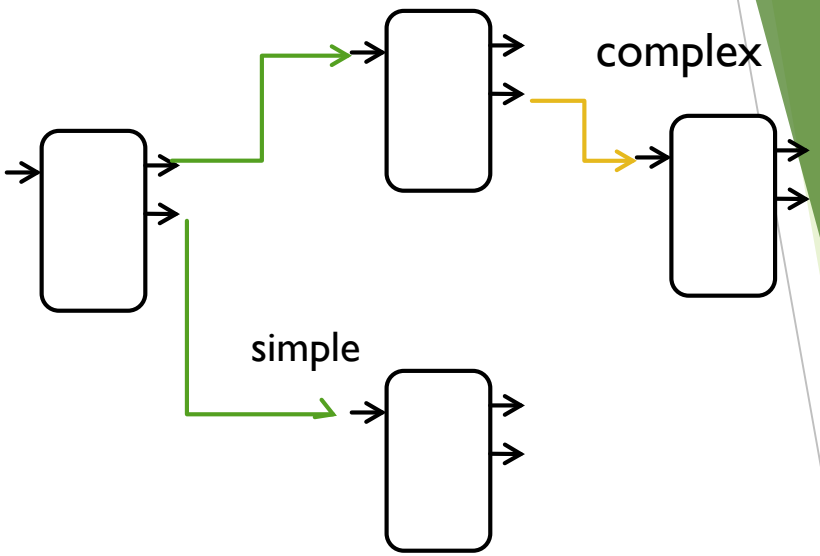
LCA Component Model

- Input : Methods
  - C2.Method (param)
- Output : Events
  - C1.Event (param)
- Internal Properties are associated with Getters and Setters
  - C2.Set<Name>(<type>)
  - <type> C2.Get<Name>()



LCA, connectors

- Demo
- (Generated source code)



Connectors

Simple Event based Connector

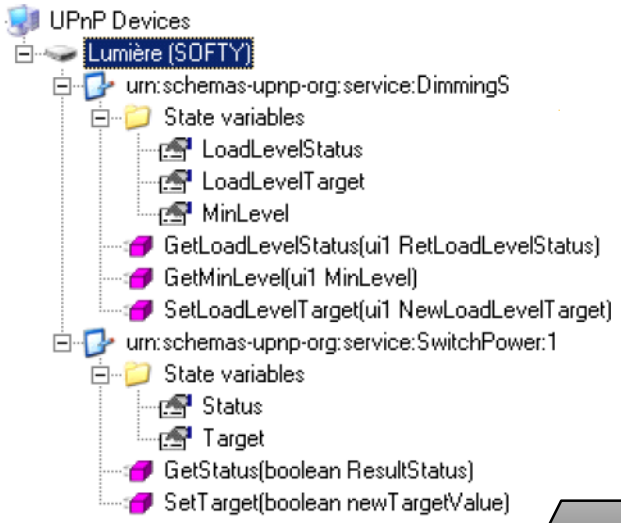
C1.Event (param) → C2.Method (param)

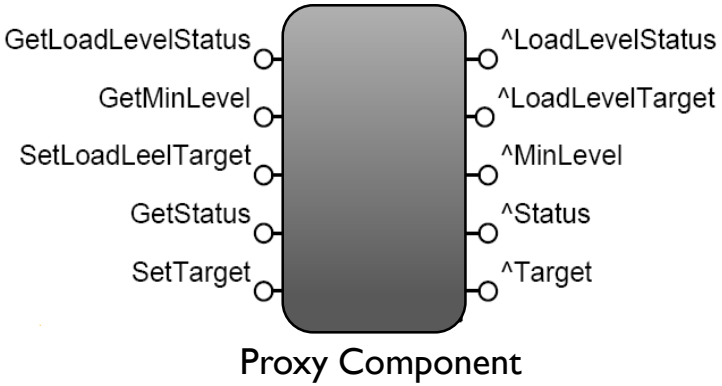
Complex Event based Connector

C1.Event (param) → C2.Method (C1.GetAProperty())

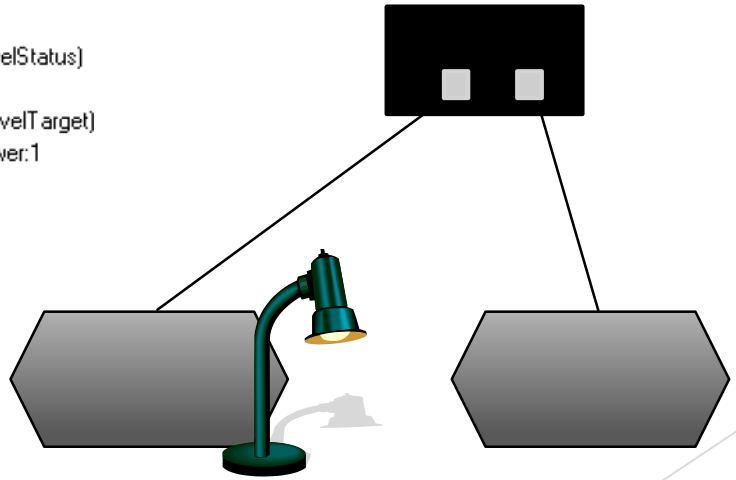
LCA Proxy components to access to Services for Devices

- Demo





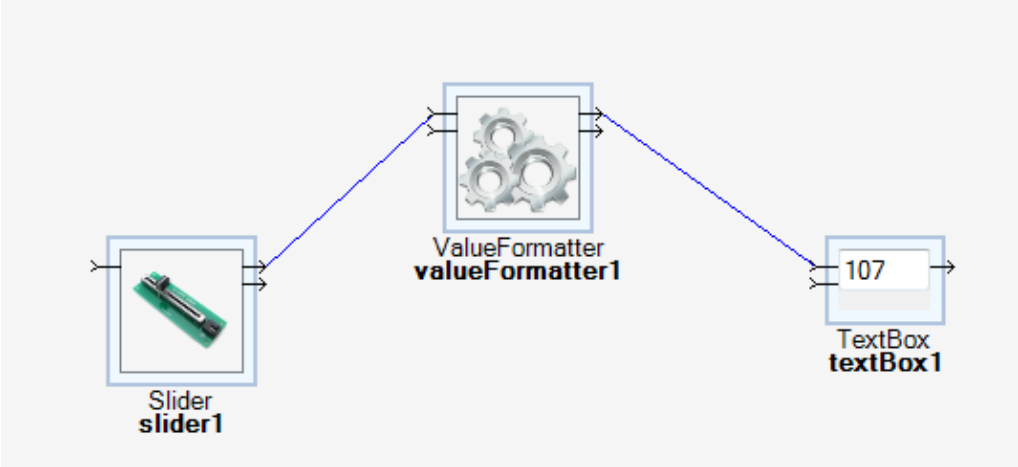
Proxy Component

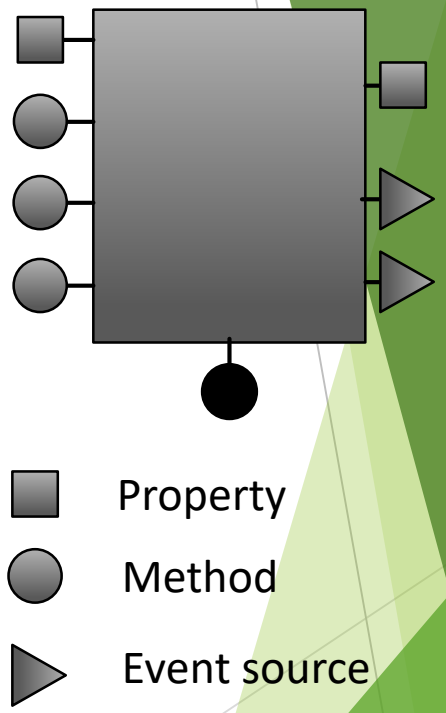


Service for Device

Build your own orchestration set of operators / beans

- Demo





- If you need If, filters, … feel free ..

Build your own component with C#

BeanWComp .Net template

- Events are based on « delegate » model (in C#)

```
using System;
using System.ComponentModel;
using WComp.Beans;

namespace Bean4
{
   /// <summary>
   /// Description rsume de Class1.
   /// </summary>
  [Bean(Category="MyCategory")]

   public class Class1
   {

// delegate implicite de void EventHandler(object sender, EventArgs e)

public event EventHandler MyEvent;

// graphiquement ce qui sera fait  :
// MyEvent += new EventHandler(func)
// avec private void func(object sender, EventArgs e)
```

Category

Event

BeanWComp .Net template

- Propriétés

```
…
// Nom de la propriété avec minuscule

// variable de sauvegarde propriété

      protected int myprop = 1;

            //meta donnée : valeur par défaut propriété
            [DefaultValue(1)]

// déclaration propriété : public <type> Nom
            public int Myprop
            {
                  get
                  {
                        return myprop;
                  }

                  set
                  {
                        if (myprop < 1)
                        {
                              throw new ArgumentException("positif !");
                        }
                        // mot clef value
                        myprop = value;
                  }
            }
…
```

Property

BeanWComp .Net template

- Méthodes

```
// méthodes

            public void MyStep(int val1, int val2)
            {
                  if (myprop >= max)
                  {
                        myprop=1;
                        MyEvent(this, null);
                  }
                  else
                        myprop++;
      }
```

Method

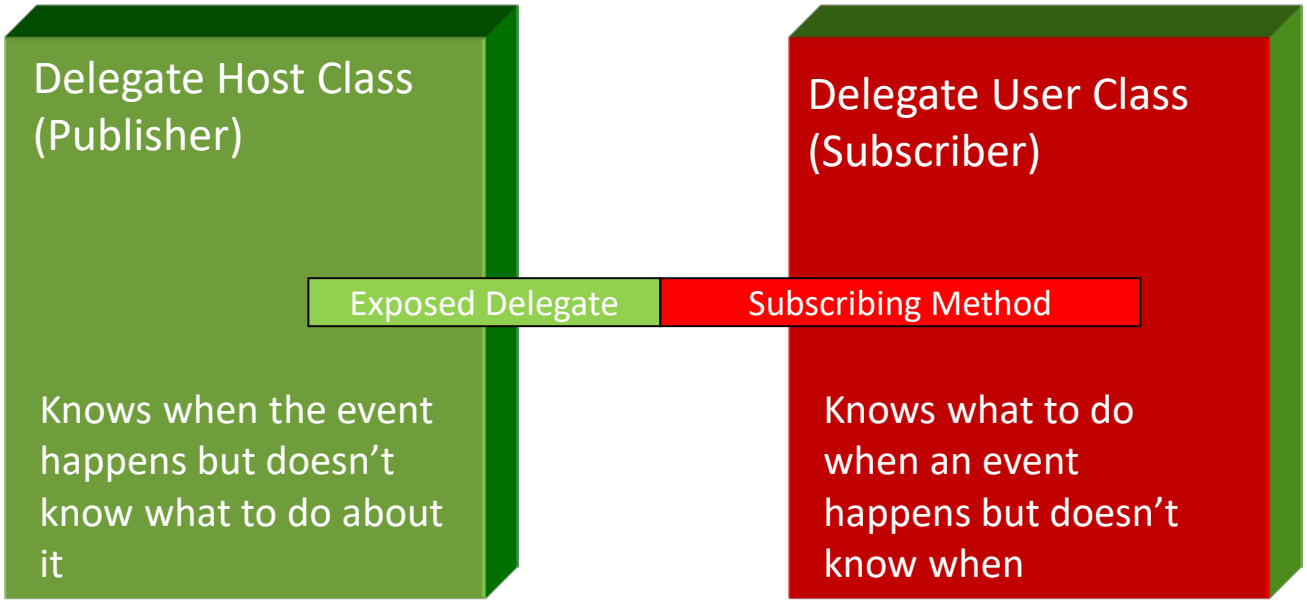
Appendix: Delegates and Events in C#

C# .NET Software Development

Delegate types

- A delegate declaration defines a new type
- Delegates are similar to function pointers
- Delegate types are derived from System.MulticastDelegate

Simple Delegate Command Pattern



The Observer Pattern or .NET Event Model

Two reasons to use Delegates

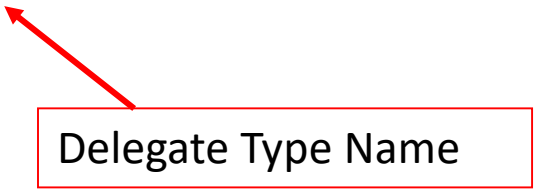
- When you're not sure what should happen when an event occurs
  - GUI events
  - Threading situations
  - Callbacks
  - Command Pattern
- To keep your interface clean
  - Looser coupling

Defining and using Delegates

- Three steps:
  - Declaration
  - Instantiation
  - Invocation

Delegate Declaration

```
namespace some_namespace
{
    delegate void MyDelegate(int x, int y);
```

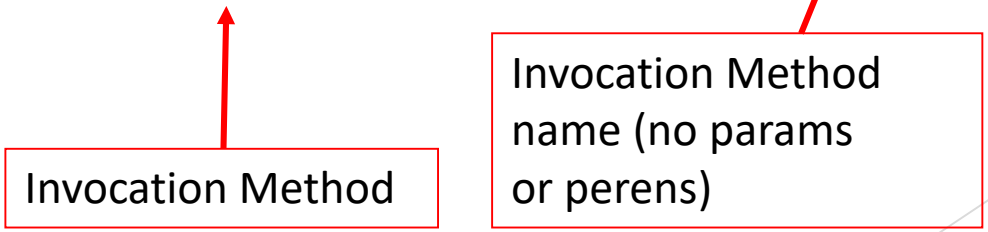


Delegate Instantiation

- delegate void MyDelegate(int x, int y);

```
class MyClass
{
   private MyDelegate myDelegate = new MyDelegate( SomeFun );

   public static void SomeFun(int dx, int dy)
   {
   }
}
```



Delegate-Method Compatibility

- A Method is compatible with a Delegate if
  - They have the same parameters
  - They have the same return type

Delegate Invocation

```
class MyClass
{
   private MyDelegate myDelegate;

   public MyClass(MyDelegate myDelegate)
   {
      this.MyDelegate = myDelegate;
   }

   private void WorkerMethod()
   {
      int x = 500, y = 1450;

      if(myDelegate != null)
         myDelegate(x, y);
   }
}
```

Attempting to invoke a delegate instance whose value is null results in an exception of type *System.NullReferenceException*.

Delegate's "Multicast" Nature

- Delegate is really an array of function pointers

```
mc.MyDelegate += new MyDelegate( mc.Method1 );
mc.MyDelegate += new MyDelegate( mc.Method2 );
mc.MyDelegate = mc.MyDelegate + new MyDelegate( mc.Method3 );
```

- Now when Invoked, mc.MyDelegate will execute all three Methods

- Notice that you don't have to instantiate the delegate before using +=
  - The compiler does it for you when calling +=

The Invocation List

- Methods are executed in the order they are added
- Add methods with + and +=
- Remove methods with - and -=
  - Attempting to remove a method that does not exist is not an error
- Return value is whatever the last method returns
- A delegate may be present in the invocation list more than once
  - The delegate is executed as many times as it appears (in the appropriate order)
  - Removing a delegate that is present more than once removes only the last occurrence

Multicast example

```
mc.MyDelegate = new MyDelegate( mc.Method1 );
mc.MyDelegate += new MyDelegate( mc.Method2 );
mc.MyDelegate = mc.MyDelegate + new MyDelegate( mc.Method3 );


// The call to:
mc.MyDelegate(0, 0);
// executes:

// mc.Method1
// mc.Method2
// mc.Method3
```

(See Delegates Demo)

Events

- Events are “safe” delegates
  - But they are delegates
- Restricts use of the delegate (event) to the target of a += or -= operation
  - No assignment
  - No invocation
  - No access of delegate members (like GetInvocation List)
- Allow for their own Exposure
  - Event Accessors

Event Accessors

```
public delegate void FireThisEvent();
class MyEventWrapper
{
   private event FireThisEvent fireThisEvent;

   public void OnSomethingHappens()
   {
      if(fireThisEvent != null)
         fireThisEvent();
   }

   public event FireThisEvent FireThisEvent
   {
      add { fireThisEvent += value; }
      remove { fireThisEvent -= value; }
   }
}
```

add and remove keywords

(See Event Demo)

Library Delegates

- ThreadStart
- TimerCallback
- ASyncCallback
- EventHandler
- KeyPressEventHandler
- KeyEventHandler
- etc.

Appendix: Delegates and Events in C#

C# .NET Software Development

Software Engineering Evolution

- In the field of Imperative programming
  - describes computation in terms of statements that change a program state
- Structured or Procedural programming
  - removing or reducing reliance on the GOTO statement (Dijkstra 1968)
- Object-oriented programming
  - data structures consisting of data fields and methods together with their interactions
- Component programming
  - separation of concerns in respect of the wide-ranging functionality available throughout a given software system
- Service-oriented programming
  - provide a loosely-integrated suite of services that can be used within multiple business domains

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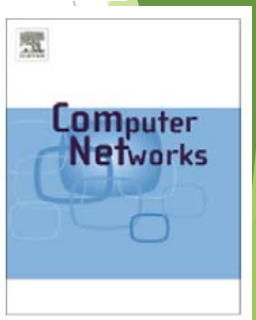

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