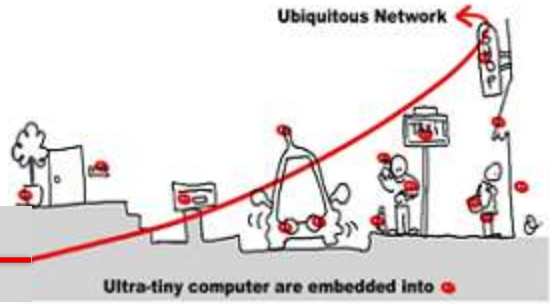

Lecture 3 : Component based middleware and ubiquitous computing

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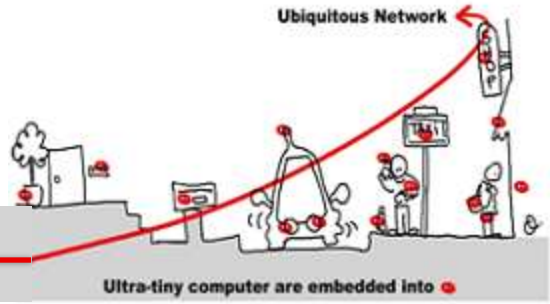
Ref : Component-based Software Engineering Ivica Crnkovic

Overview



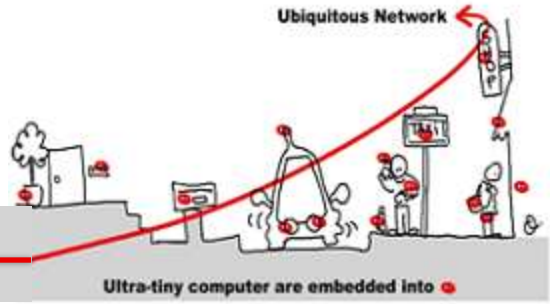
- Introduction
- ACME Architectural Description Language

- Java Bean Component Model
- COM, DCOM, MTS and COM+
- CORBA Component Model (CCM)

- .NET Component Model
- OSGI Component Model

- WComp Component Model, for ubiquituous computing

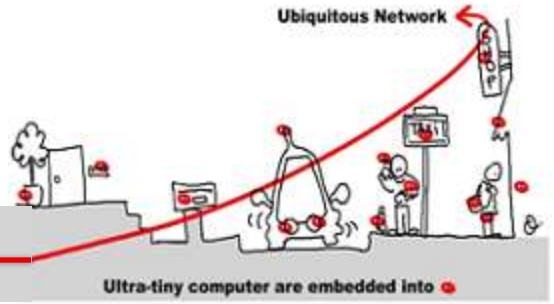
What is a Component?



- *"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."*

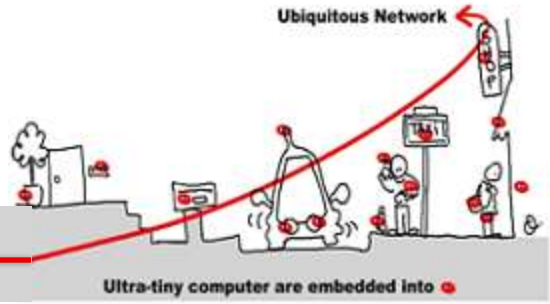
[1],[2]

What is a Component?-cont..



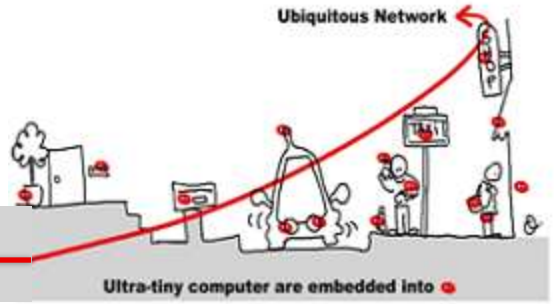
- Component Model
  - Interaction Standards
    - Clearly Defined Interface
  - Composition Standards
    - Describe how components can be composed into larger structures
    - Substitutions
- Example: COM

CBSE Definition



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

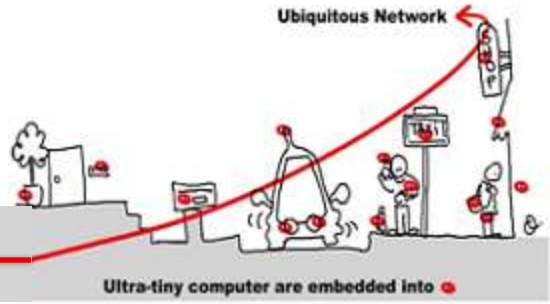
Advantages of CBSE



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

[3]

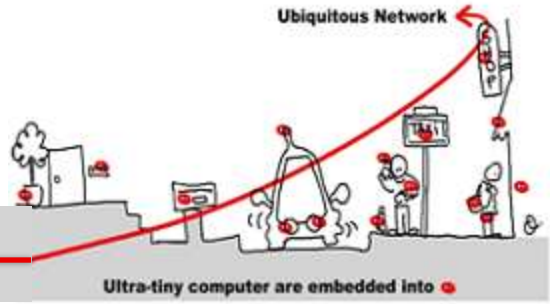
Disadvantages of CBSE



- Development of Components
- Lack of Components
- Component Maintenance Costs
- Sensitivity to changes
- Trust

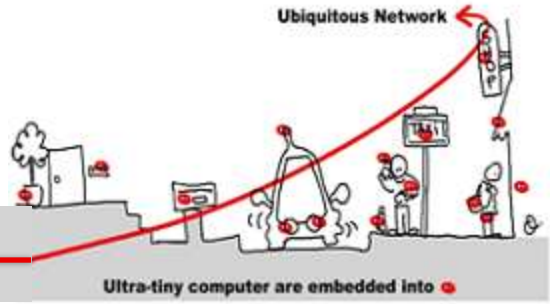
[3]

More on Trust



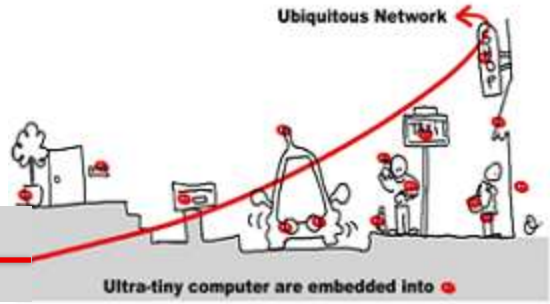
- Components come in several forms
  - Binary
  - Source Code
- Need a Certification Standard
  - Tests
  - Environments

CBSE vs. Traditional SE



- CBSE views the system as a set of off-the-shelf components integrated within an appropriate architecture.
- SE seeks to create a system from scratch.

CBSE vs. Traditional SE-cont..

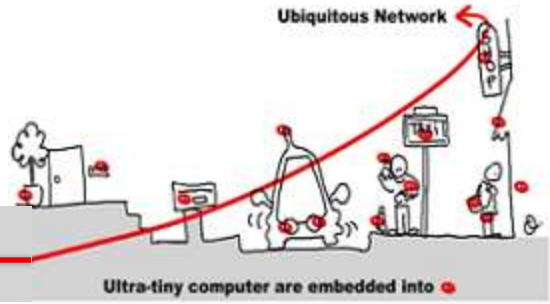


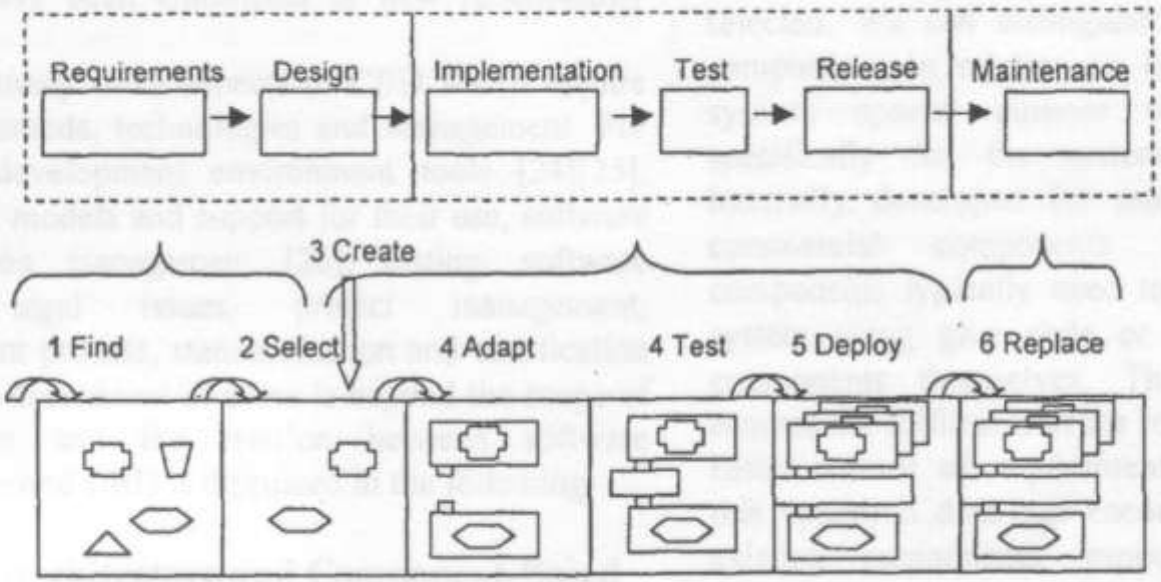
- CBSE Life Cycle is shorter.
- CBSE develops Architecture.
- CBSE is less expensive

CBSE	Waterfall
Find Select	Requirements
	Design
Adapt Test Deploy	Implementation Test Release
Replace	Maintenance

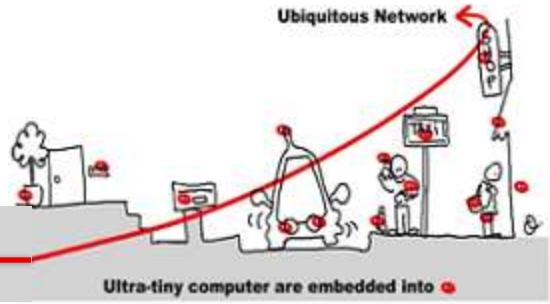
[3]

CBSE vs. Traditional SE-cont..



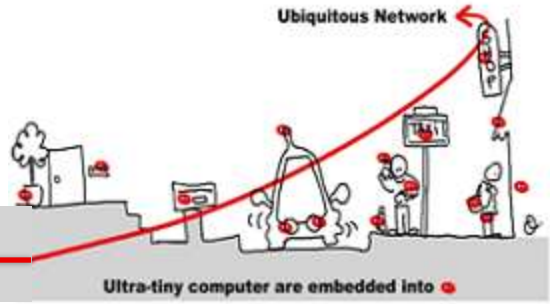


CBSE vs. Traditional SE-cont..



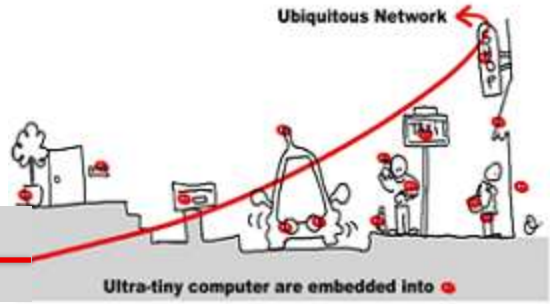
- SE can fulfill requirements more easily.
- CBSE fulfillment of requirements is based on the available components.

Consequences of CBSE



- Promote Large Scale Reuse
- Reduce Cost

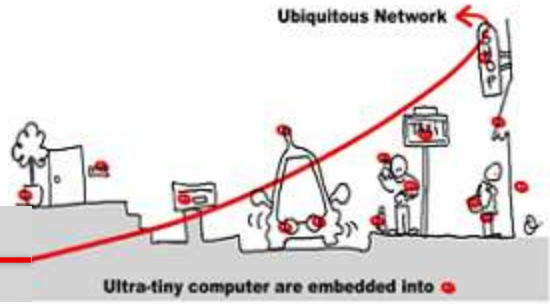
Architecture Definition Languages



- ADLs primarily address the issues related to the early phases of software engineering
  - Design
  - Analysis

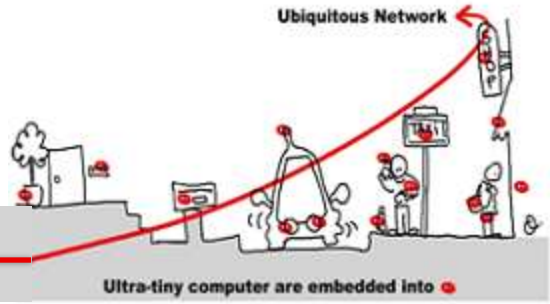
- They identify a number of concepts, such as:
  - Architecture, configurations, connectors, bindings, properties, hierarchical models, style, static analysis and behavior.

ACME Architectural Description Language

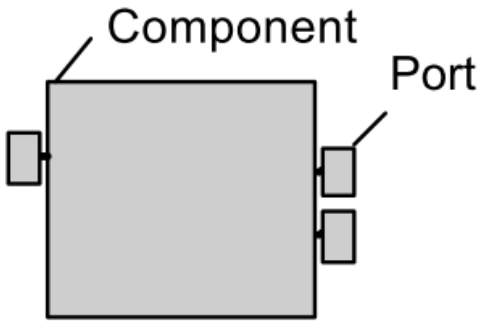


- Components and Ports
- Connectors and Roles
- Systems and Attachments
- Representations and Bindings

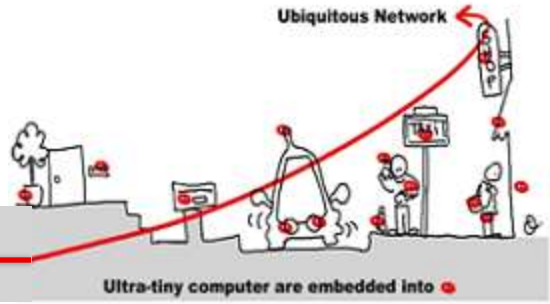
Components and Ports



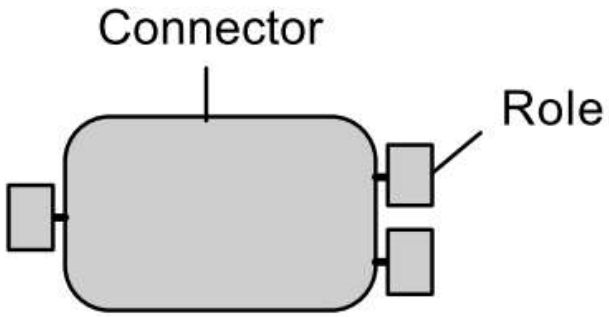
- Components
  - Represent the computational elements and data stores of a system.
- Ports
  - Are the points of interaction between a component and its environment.



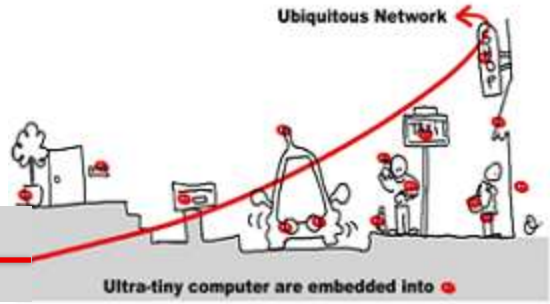
Connectors and Roles



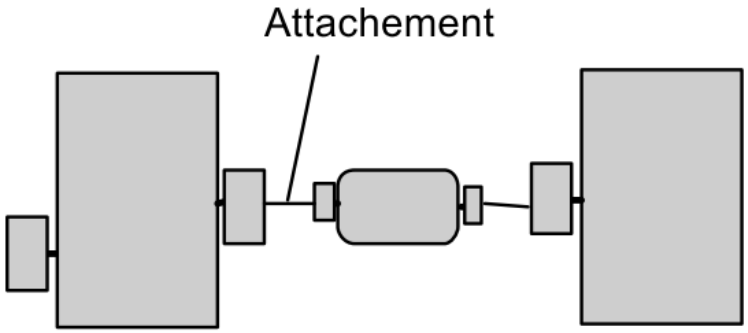
- Connectors
  - Represent interactions between components such as method calls or an SQL connection between a client and a database server.
- The interface of a connector is defined as a set of roles



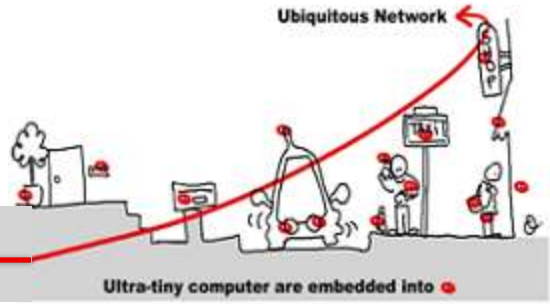
Systems and Attachments

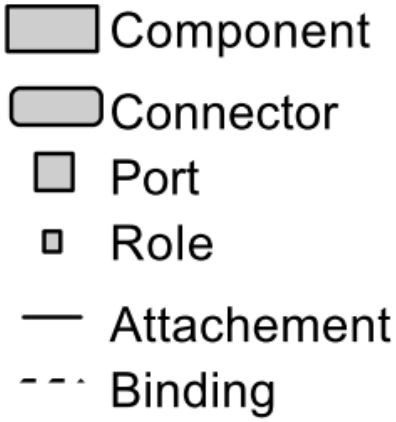


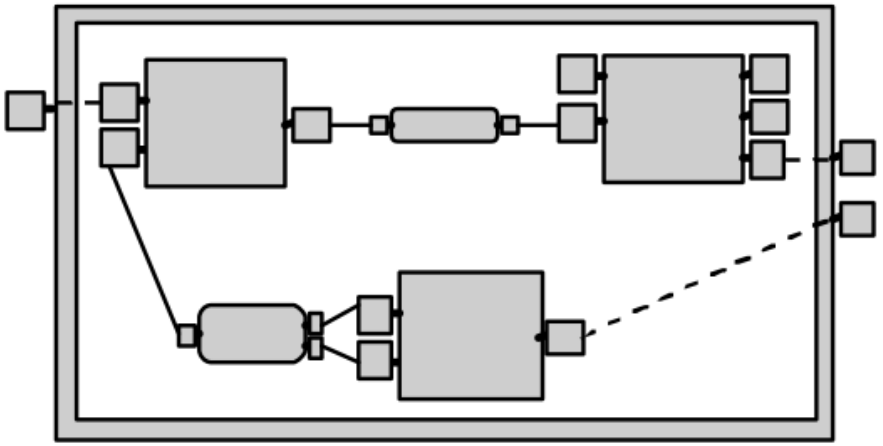
- The structure of a system is specified by a set of components, a set of connectors, and a set of attachments.
- Attachment
  - Links a component port to a connector role.



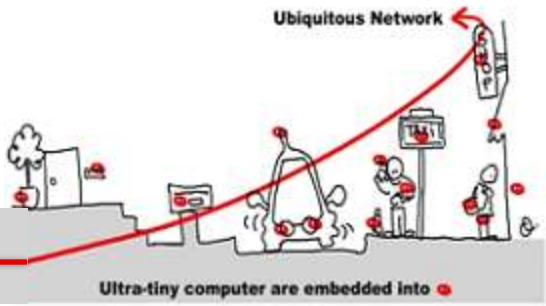
Representations and Bindings





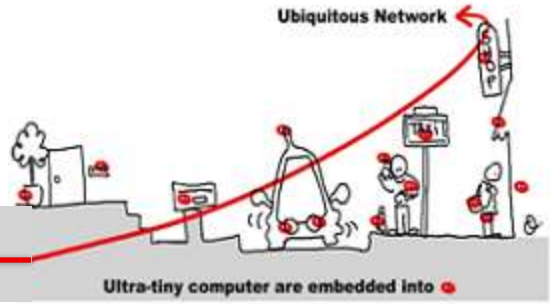


Fine-grained Component
JavaBean Model and Key Features



- "A Java Bean is a reusable software component that can be manipulated visually in a builder tool ”.
- The Java Bean was designed for the construction of graphical user interface (GUI).
- Explicitly tailored to interact in two different contexts:
  - At composition time, within the builder tool.
  - At execution time, with the runtime environment.
- Any Java class that adheres to certain conventions regarding property and event interface definitions can be a JavaBean.
- Beans are Java classes that can be manipulated in a visual builder tool and composed into applications.

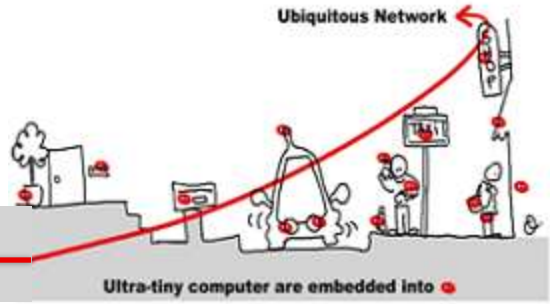
Interface of a Component



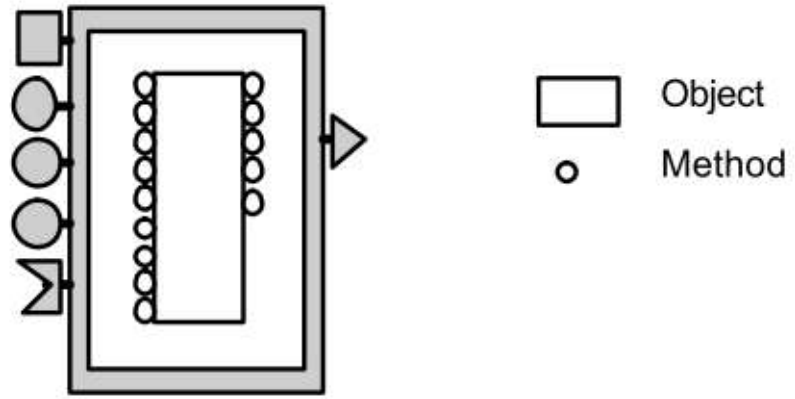
- This model defines four types of port:
  - methods,
  - properties,
  - event sources (generate an event)
  - event sinks called listeners (they receive event)

Ports

Implementation of a Component

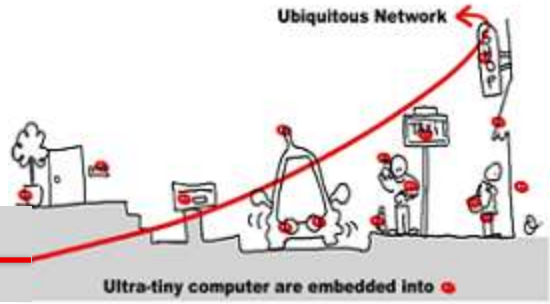


- Most bean components are implemented by a simple Java object by naming convention

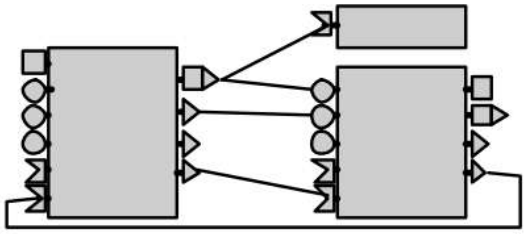


A simple implementation

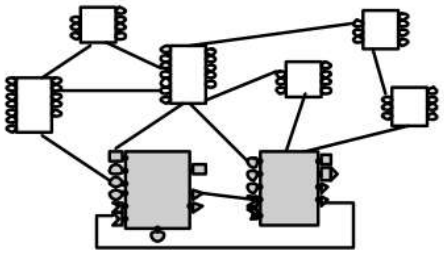
Components Assembly



- Assembly is one of the key features of Java Bean though no not specific solution is provided.
  - Composition tools (Bean Box)
  - No composition language
- Different ways of assembling components are supplied.

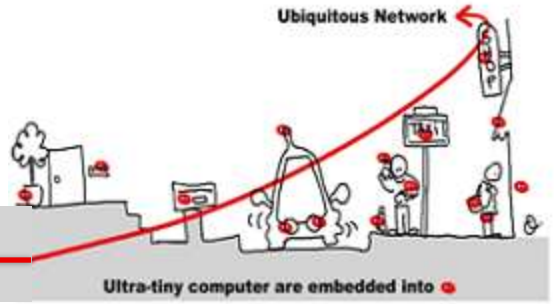


Component-based assembly



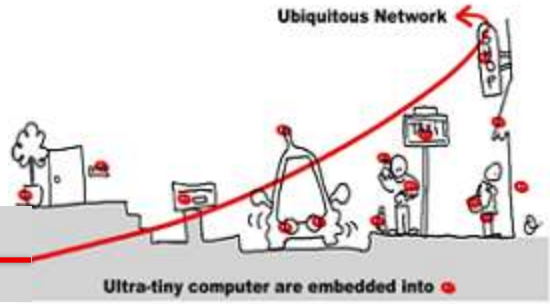
Heterogeneous assembly

Packaging and Deployment

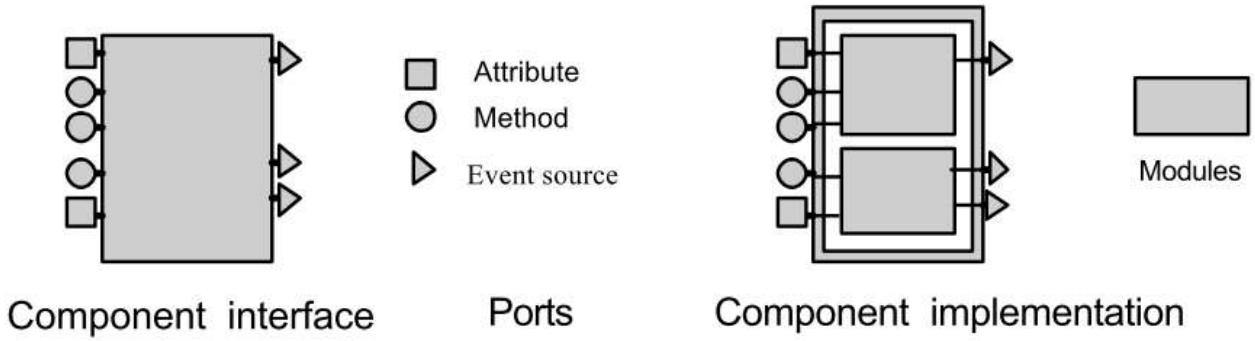


- Java Beans define a model for packaging components into archives.
  - Includes the definition of dependency relationships between the package items.
- Each package item can be marked "Design Only", so that they can be removed in a final application.

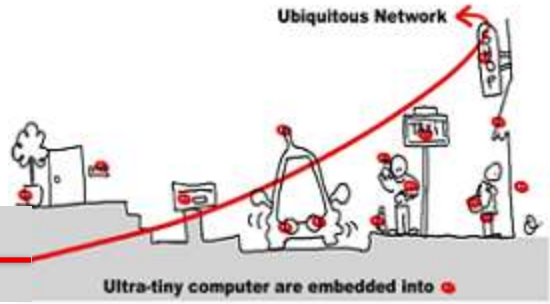
Coarse grained Component .NET Model – Implementation



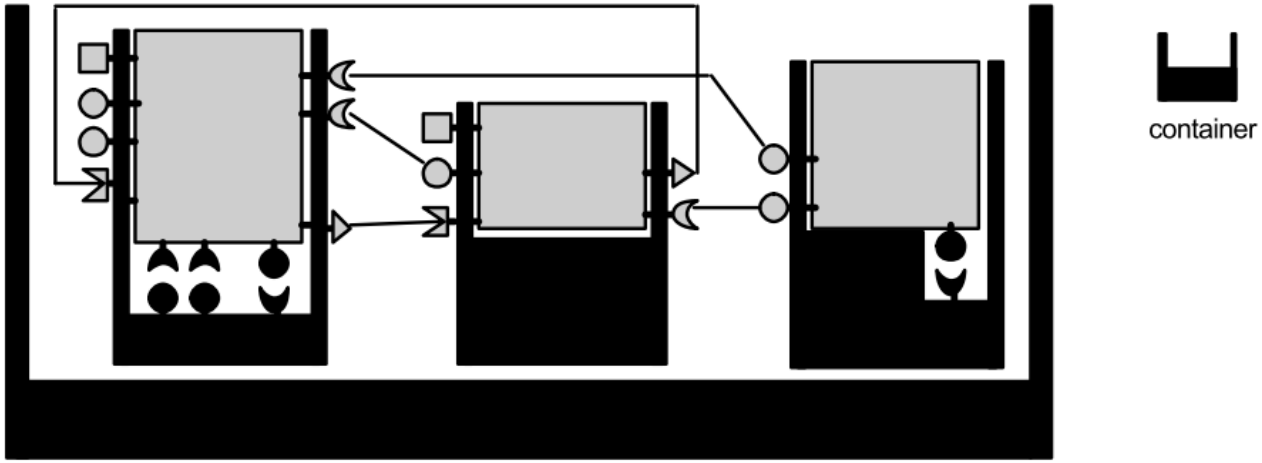
- A component (assembly) is made of modules, which are traditional executable files (DLL).
- Modules cannot be assemblies, thus the .NET model is not hierarchical.



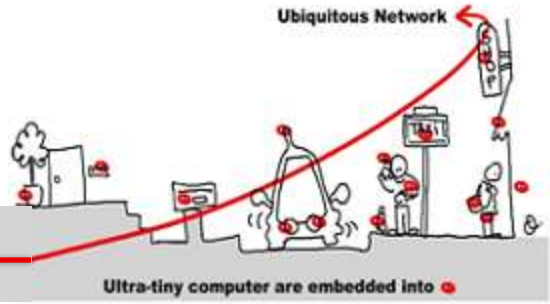
Framework : The Container Approach



- Framework – a set of containers. Containers contains components and provides a set of standard services (security, events, persistence, life -cycle support)

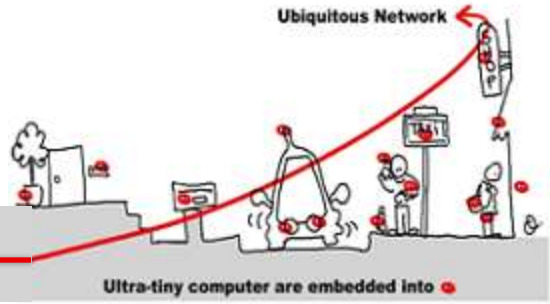


Framework



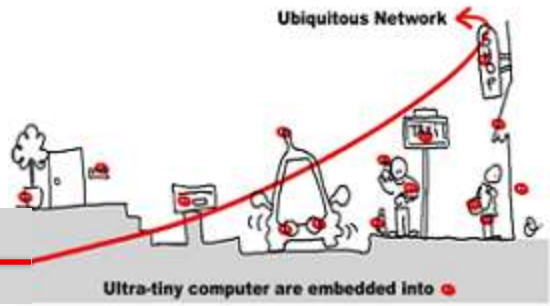
- NET relies on the traditional programming approach : the framework is seen as the language run-time support.
  - MISL – Microsoft Intermediate language (similar to Java Byte code)
  - Common Runtime Language (similar to Java Virtual Machine)

Lifecycle



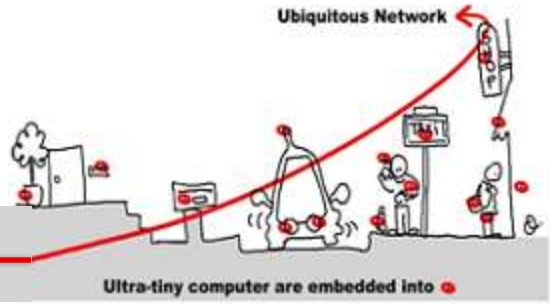
- Assemblies (and their modules) are local to an application, and thus different DLLs with same name can run simultaneously.
- Each assembly has a versioning information about itself and about the assemblies it depends on.
  - Version control is delegated to the dynamic loader, which selects the “right” version.
- Significantly improve the application packaging and deployment.

Other component model
OSGI Component Model



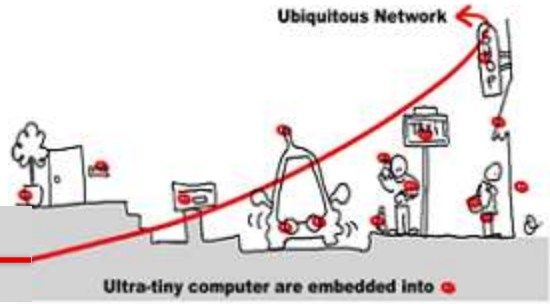
- Components
- Interface of a Bundle Component
- Assembly of Bundle Components
- Implementation of a Bundle Component

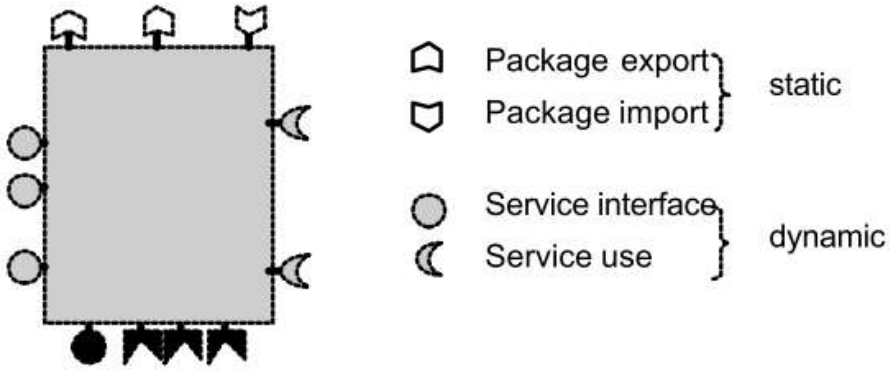
Components



- A bundle use three kinds of ports to express its interactions with
  - Traditional technology
  - Other components
  - The run-time environment
- Bundles may listen to events published by the framework such as the insertion of a new component in a system.

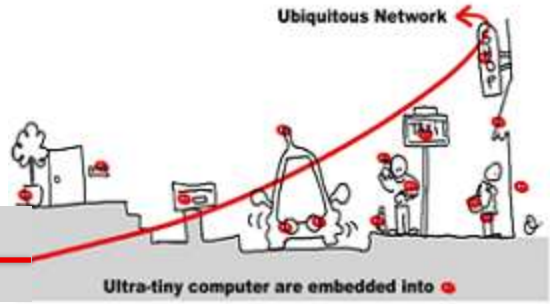
Interface of a Bundle Component





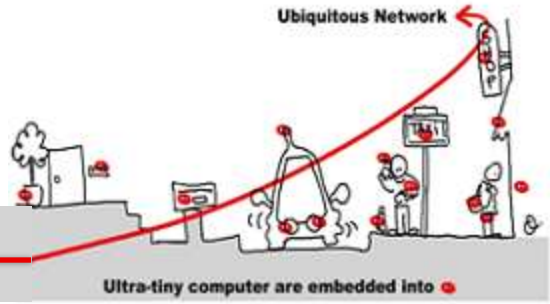
Interface of a bundle component

Assembly of Bundle Components

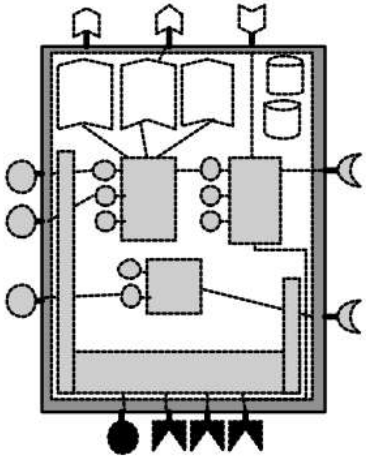


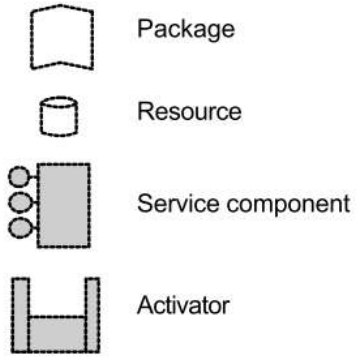
- A system is an evolving set of bundle components.
- A bundle component publishes a service interface
  - It can attach to it a set of properties describing its characteristics.
- A component requires an interface for its use,
  - It will select one via a query expression based on these properties.
- This flexibility also has its counterpart
  - There is no guarantee than the service will continue to be available

Implementation of a Bundle Component

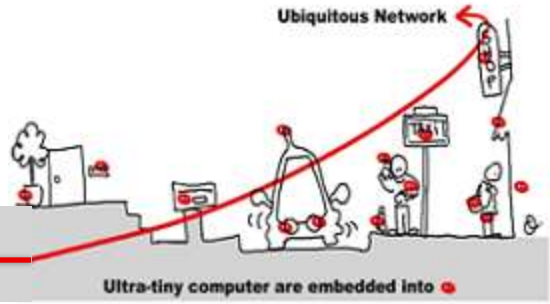


- JAR archive containing:
  - Service components
  - Java packages
  - Other resources files
- Double dependency
  - Through packages
  - Through interfaces

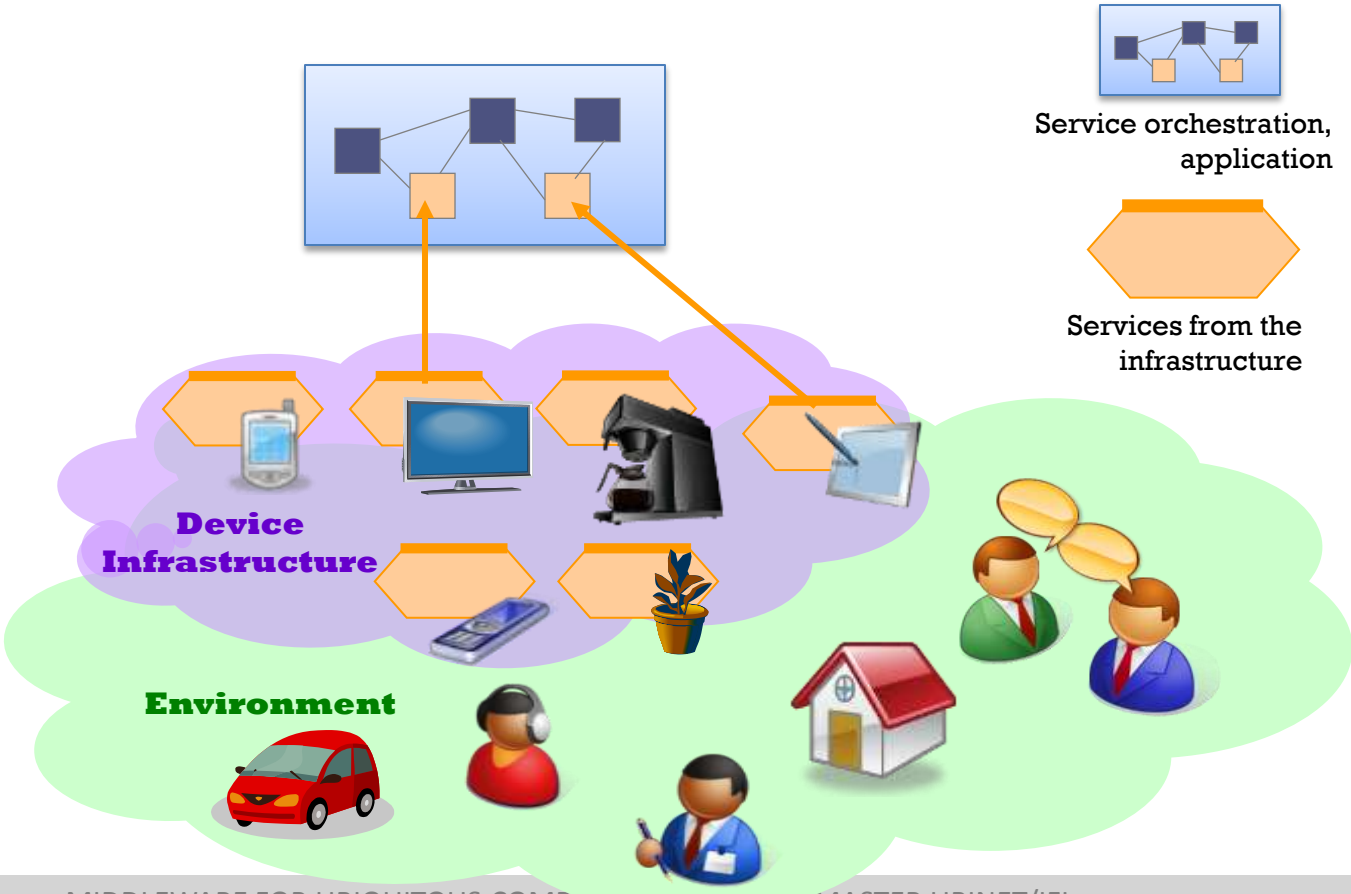




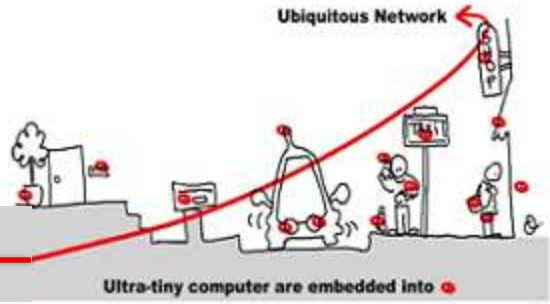
WComp and LCA to orchestrate services for Devices



- LCA create service-based orchestration for a specific task

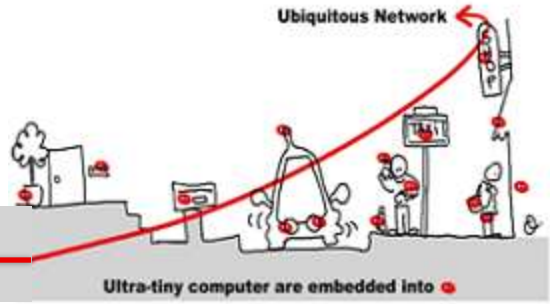


WComp and Local Composition (LCA)



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

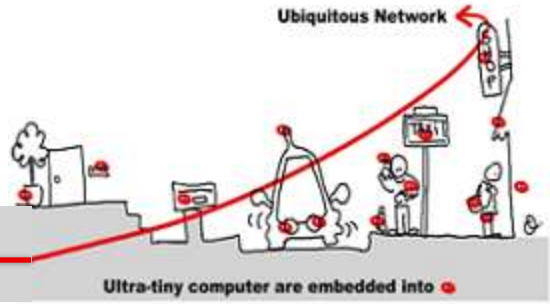
Main Features of LCA Model :



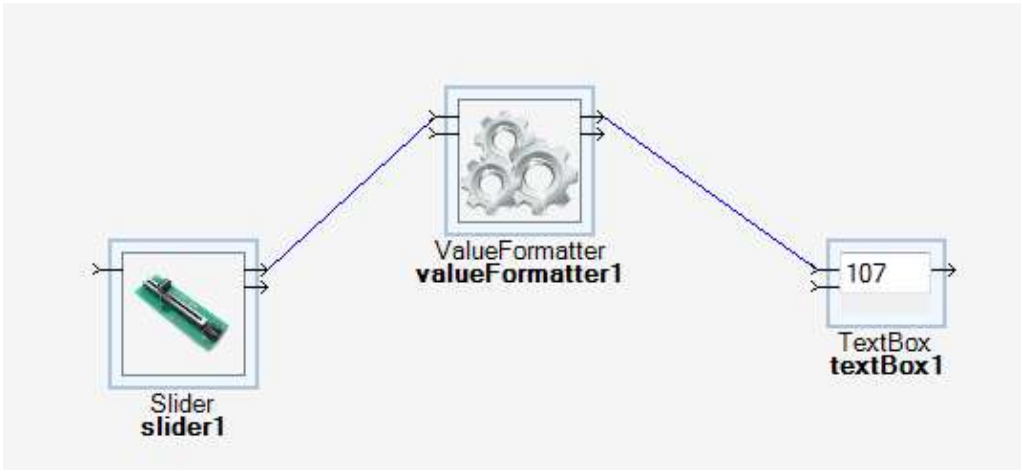
- Goal :
  - Allow to compose Services for Device between them towards a multiple devices ubiquitous application.

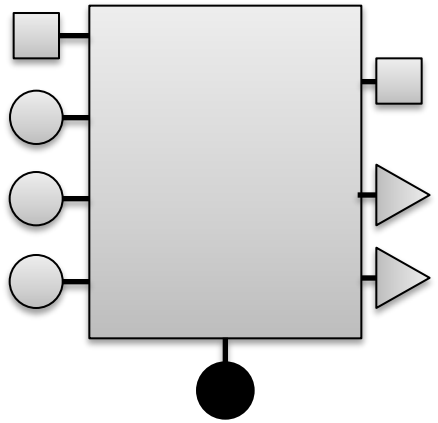
- Principles
  - LightWeight Components Approach :
    - Like OpenCom, JavaBeans, PicoContainer
  - On the same execution node
  - For each execution node, a container dynamically manage the assembly of components
  - Event-based interaction between components
  - Blackbox LightWeight Components

LCA, Bean WComp and ports



- Demo



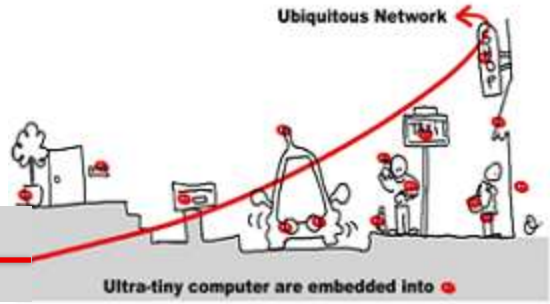


Property

Method

Event source

BeanWComp .Net template



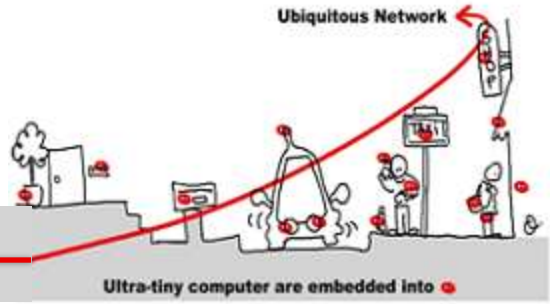
- Events are based on « delegate » model (in C#)

Category

Event

```
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)
```

BeanWComp .Net template

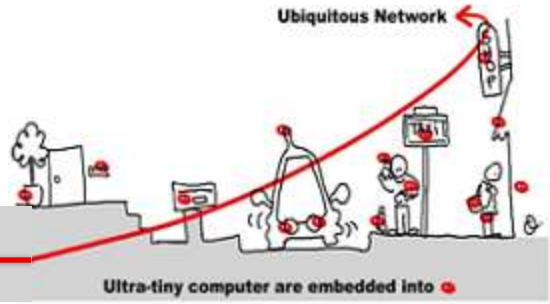


- Propriétés

Property

```
…

// 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;
                  }
            }
…
```

BeanWComp .Net template

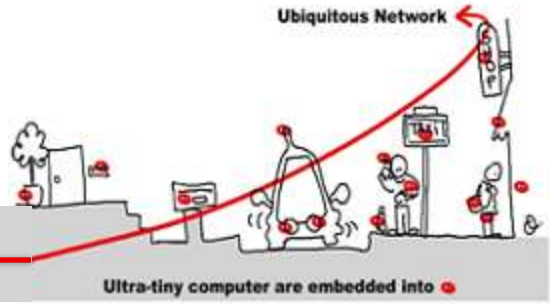


- Méthodes

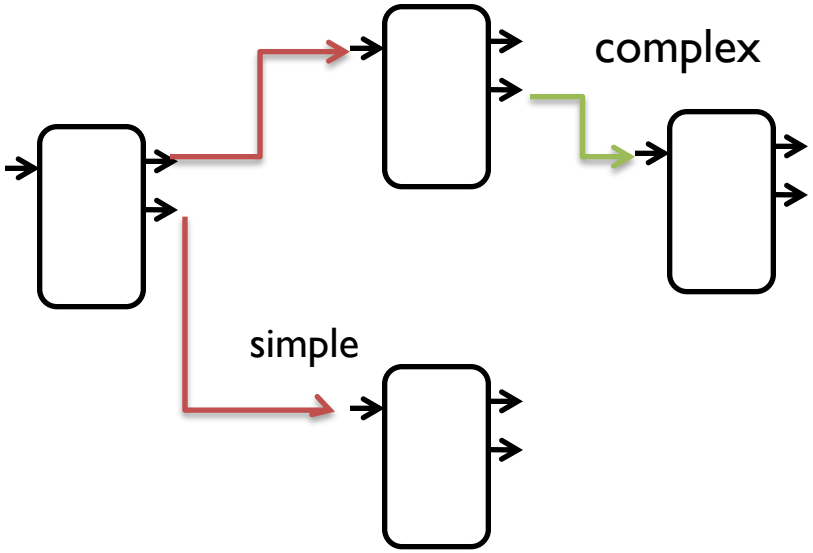
Method

```
// méthodes

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

LCA, connectors



- Demo
- (Generated source code)



Connectors

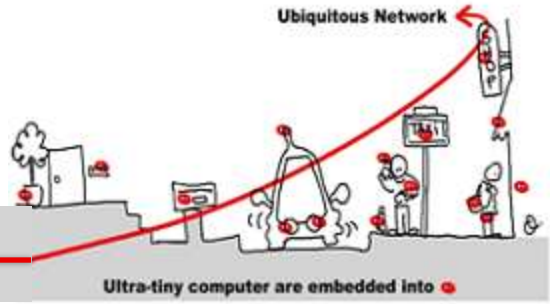
Simple Event based Connector

C1.Event (param) → C2.Method (param)

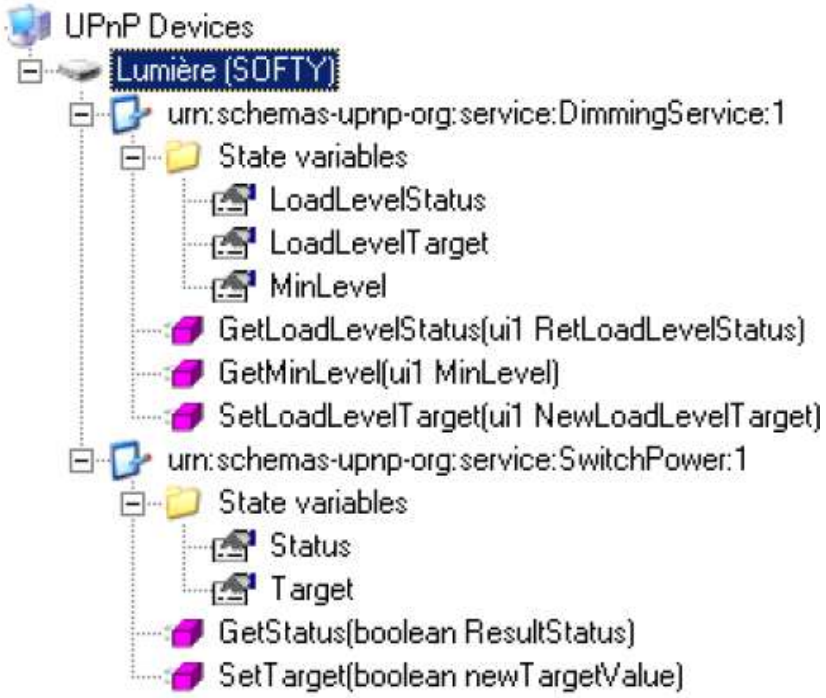
Complex Event based Connector

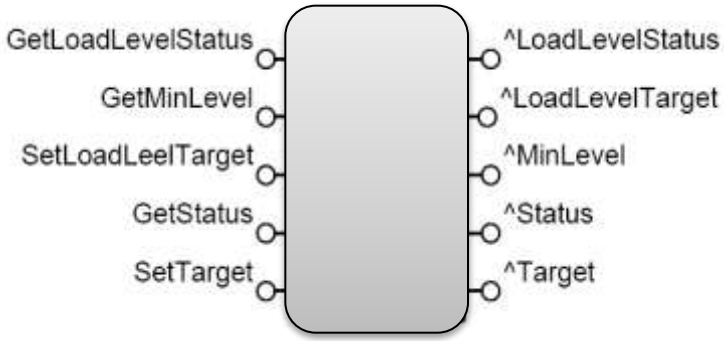
C1.Event (param) → C2.Method (C1.GetAProperty())

LCA Proxy components to access to Services for Devices

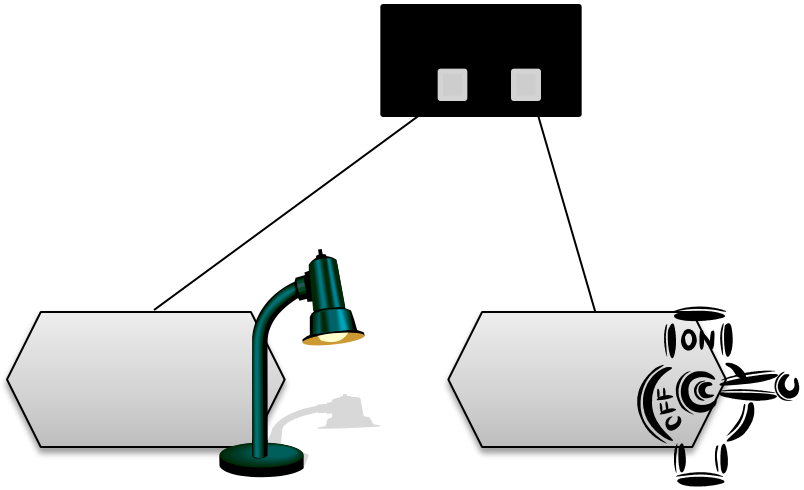


- Demo

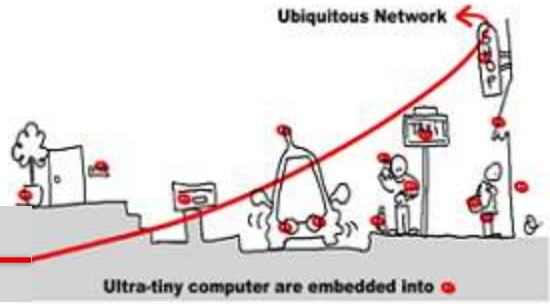




Proxy Component



Service for Device

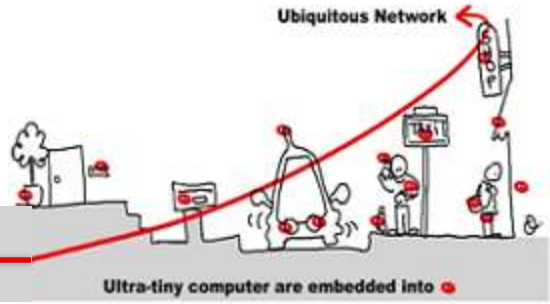


CNS 3260

C# .NET Software Development

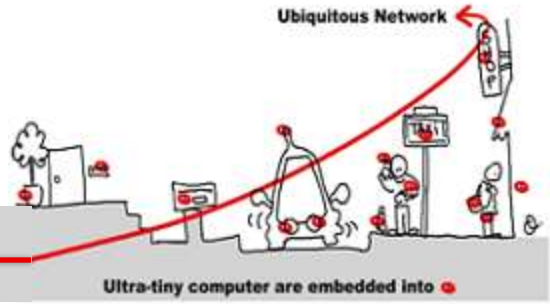
ANNEX DELEGATES AND EVENTS IN C#

Delegate types



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

The Command Pattern



Command issuer

Knows when the event happens but doesn't know what to do about it

Exposed Command Variable

Command object instance

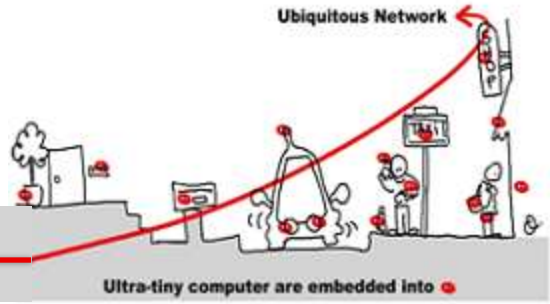
Command executor

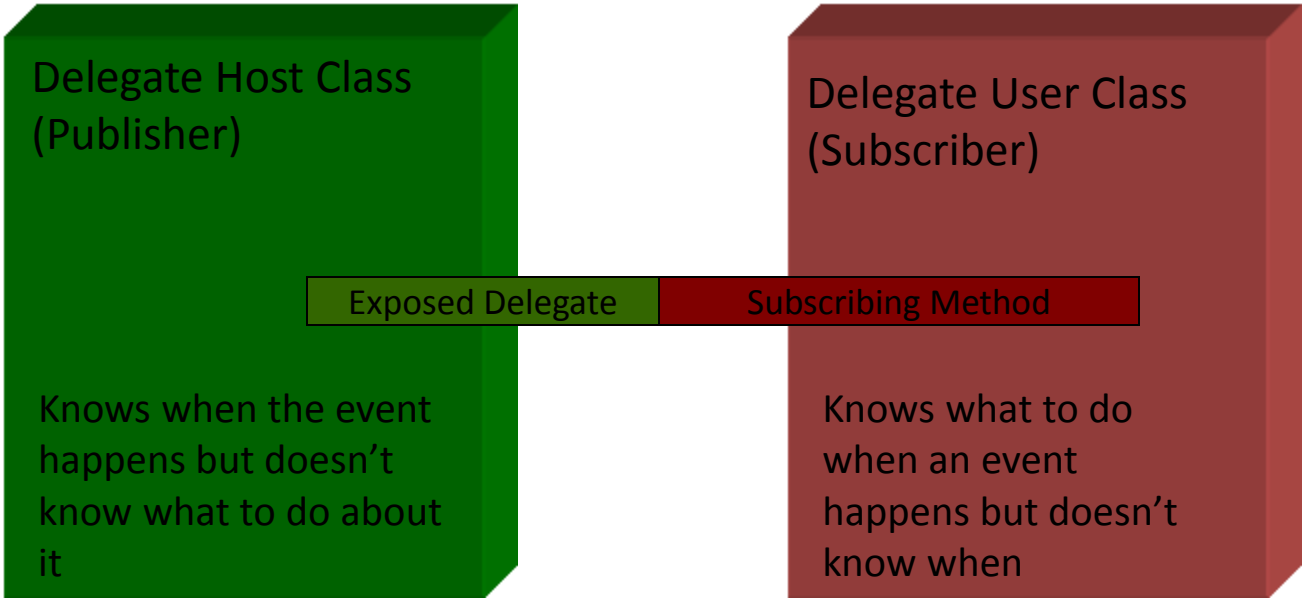
Knows what to do when an event happens but doesn't know when

Command Subclass
Execute()

Command Class
Execute()

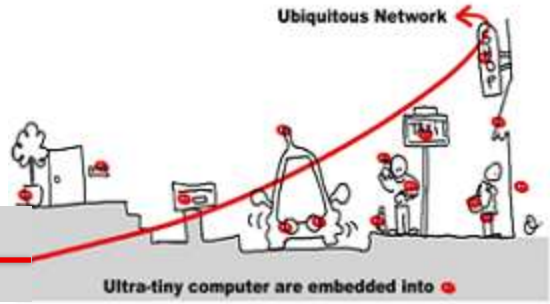
Simple Delegate Command Pattern





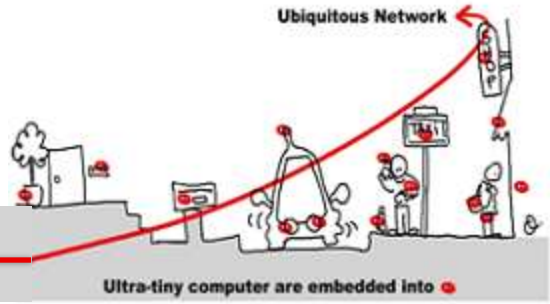
AKA: The Observer Pattern or .NET Event Model

Two reasons to use Delegates



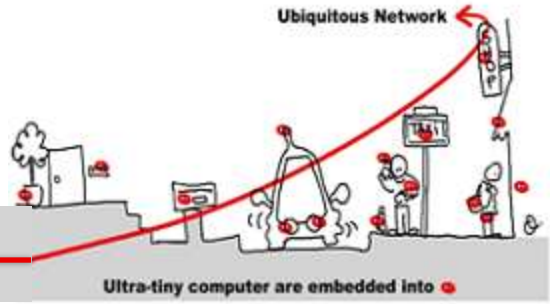
- When you're not sure what should happen when an event occurs
  - GUI events
  - Threading situations
  - Callbacks
  - Command Pattern
- To keep your interface clean
  - Looser coupling

Defining and using Delegates



- three steps:
  - Declaration
  - Instantiation
  - Invocation

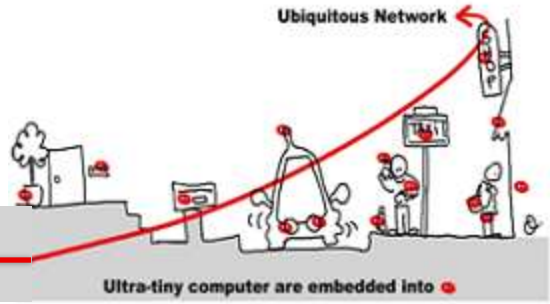
Delegate Declaration



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

Delegate Type Name

Delegate Instantiation

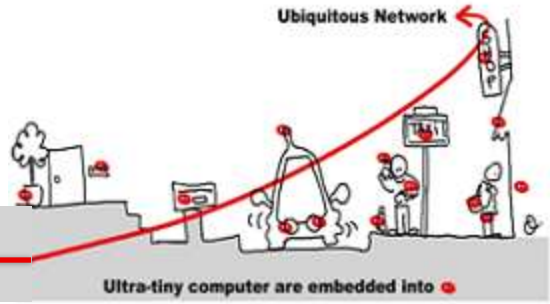



```
delegate void MyDelegate(int x, int y);

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

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

Invocation Method

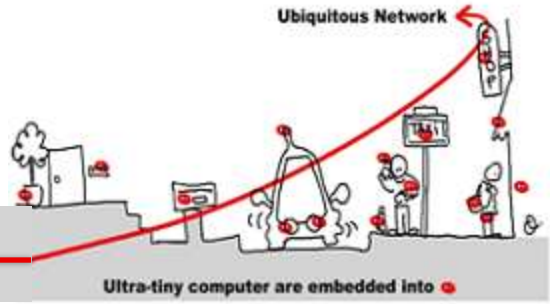
Invocation Method name (no params or perens)

Delegate-Method Compatibility



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

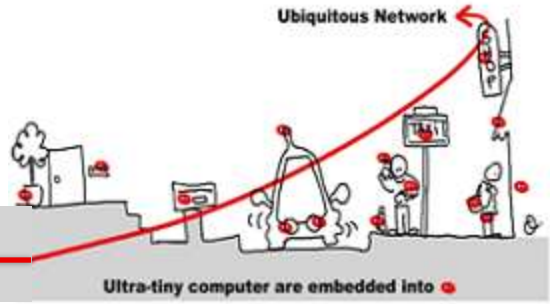
Delegate Invocation




```
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



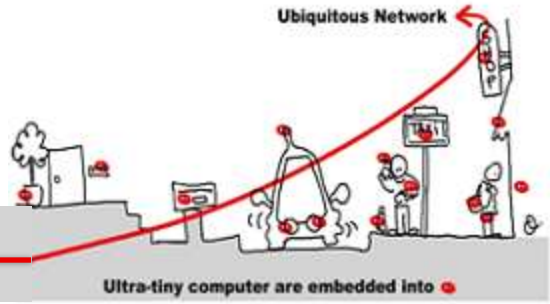
- Delegate is really an array of function pointers

```
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

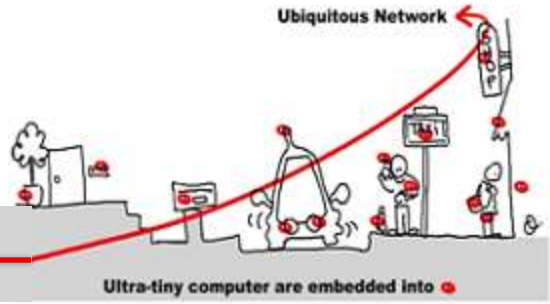
- Notice that you don't have to instantiate the delegate before using +=
  - The compiler does it for you when calling +=

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

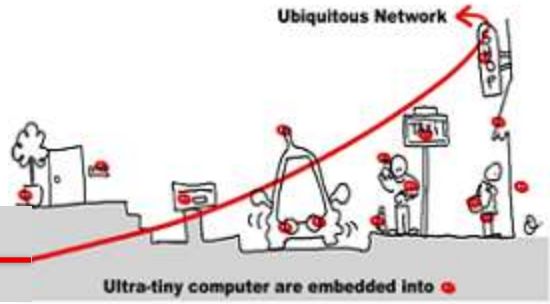
Multicast example




```
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
```

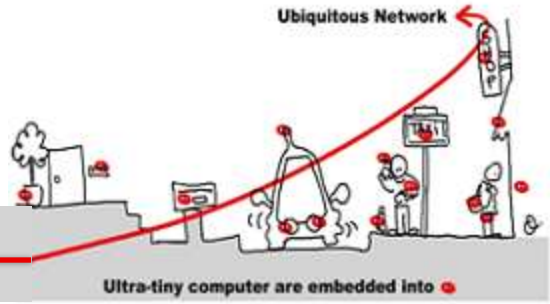
(See Delegates Demo)

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

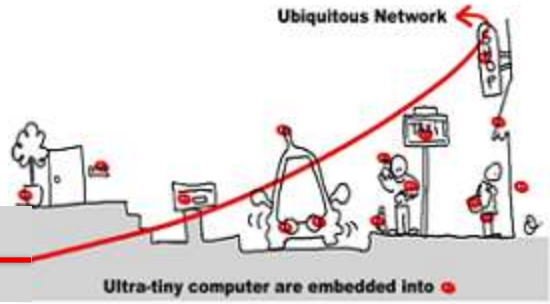



```
public delegate void FireThisEvent();
class MyEventWrapper
{
    private event FireThisEvent fireThisEvent;

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

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

add and remove keywords

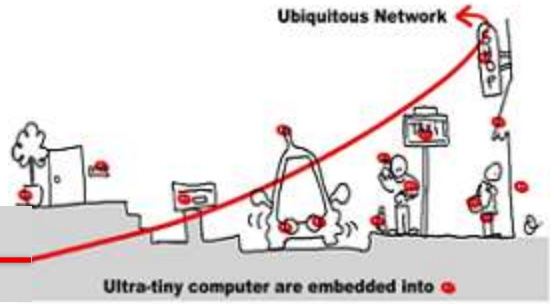
(See Event Demo)

Library Delegates



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

References



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- [2] Pour, Gilda, “Component-Based Software Development approach: New Oppurtunities and Challenges,” Proceedings of the 26th International Conference on Technology of Object-Oriented Languages and Systems, 1998.
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- [5] J.-Y. Tigli, S. Lavirotte, G. Rey, V. Hourdin, M. Riveill, “Lightweight Service Oriented Architecture for Pervasive Computing” IJCSI International Journal of Computer Science Issues, Vol. 4, No. 1, September 2009, ISSN (Online): 1694-0784, ISSN (Print): 1694-0814