Resilient Actors

A Runtime Partitioning Model for Pervasive Computing Services

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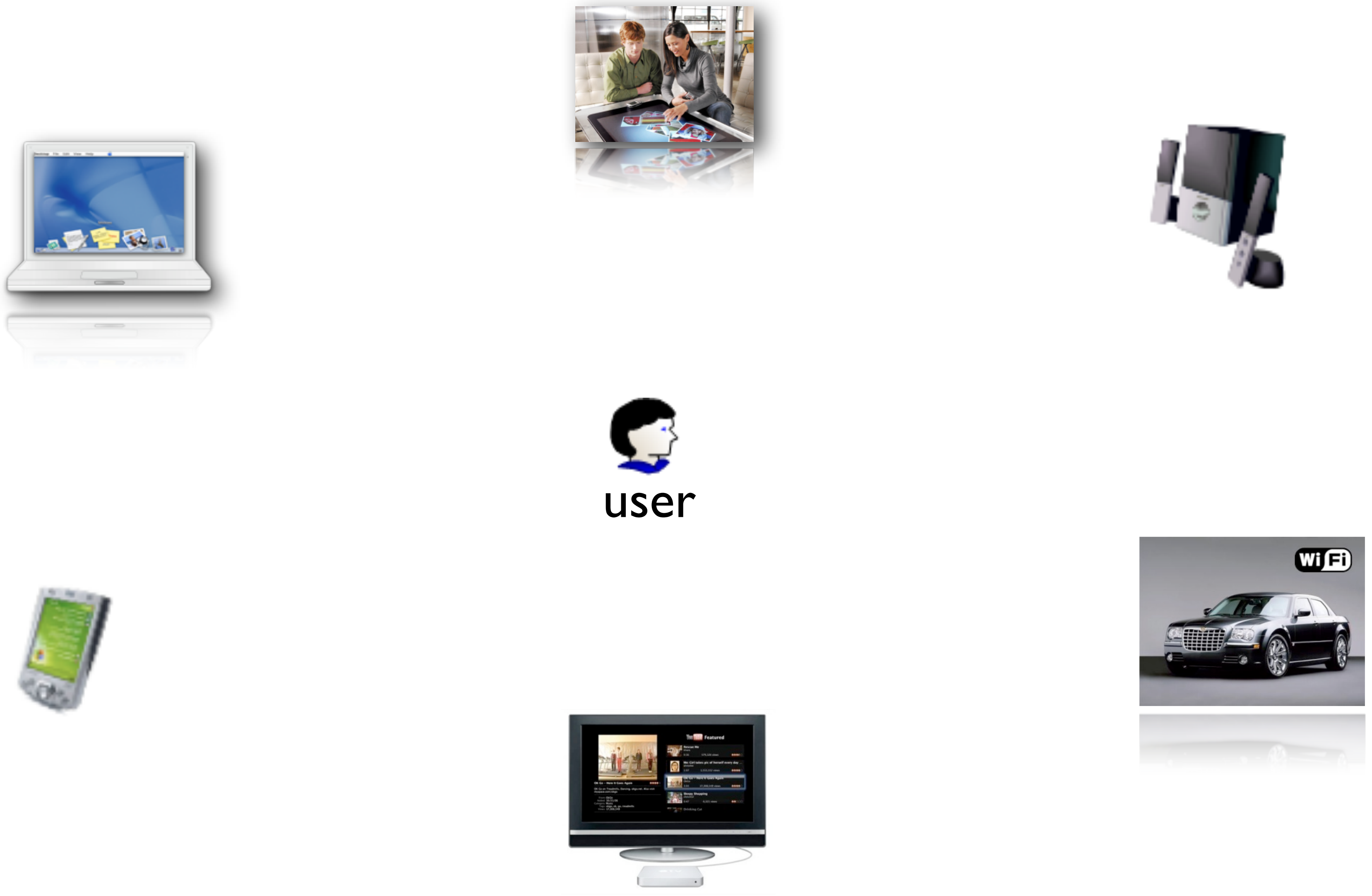
Pervasive Computing Environments

Computers integrated into everyday devices (Weiser, 1993)

Pervasive Computing Environments



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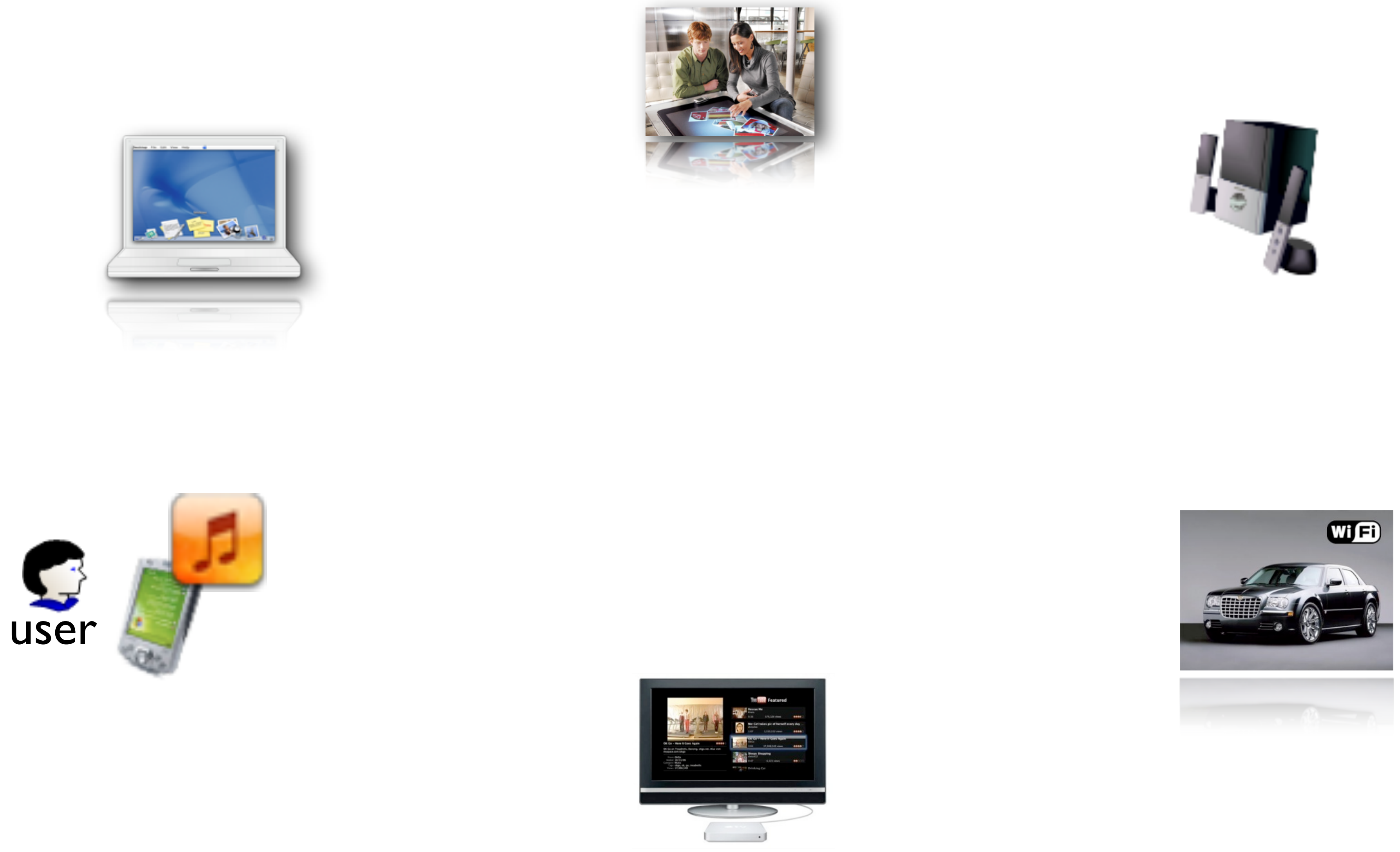

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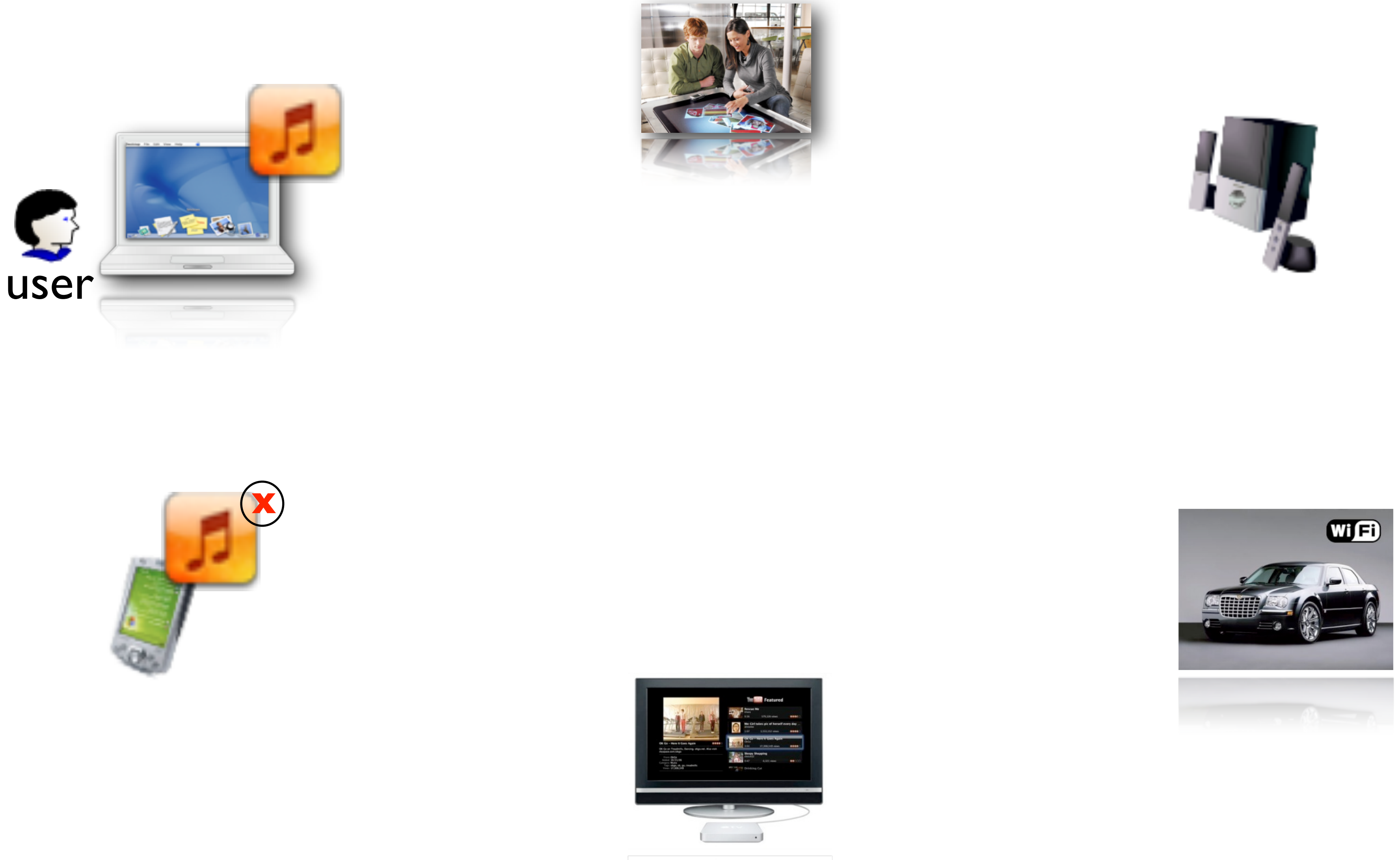

Close and start-up the application as the user roams

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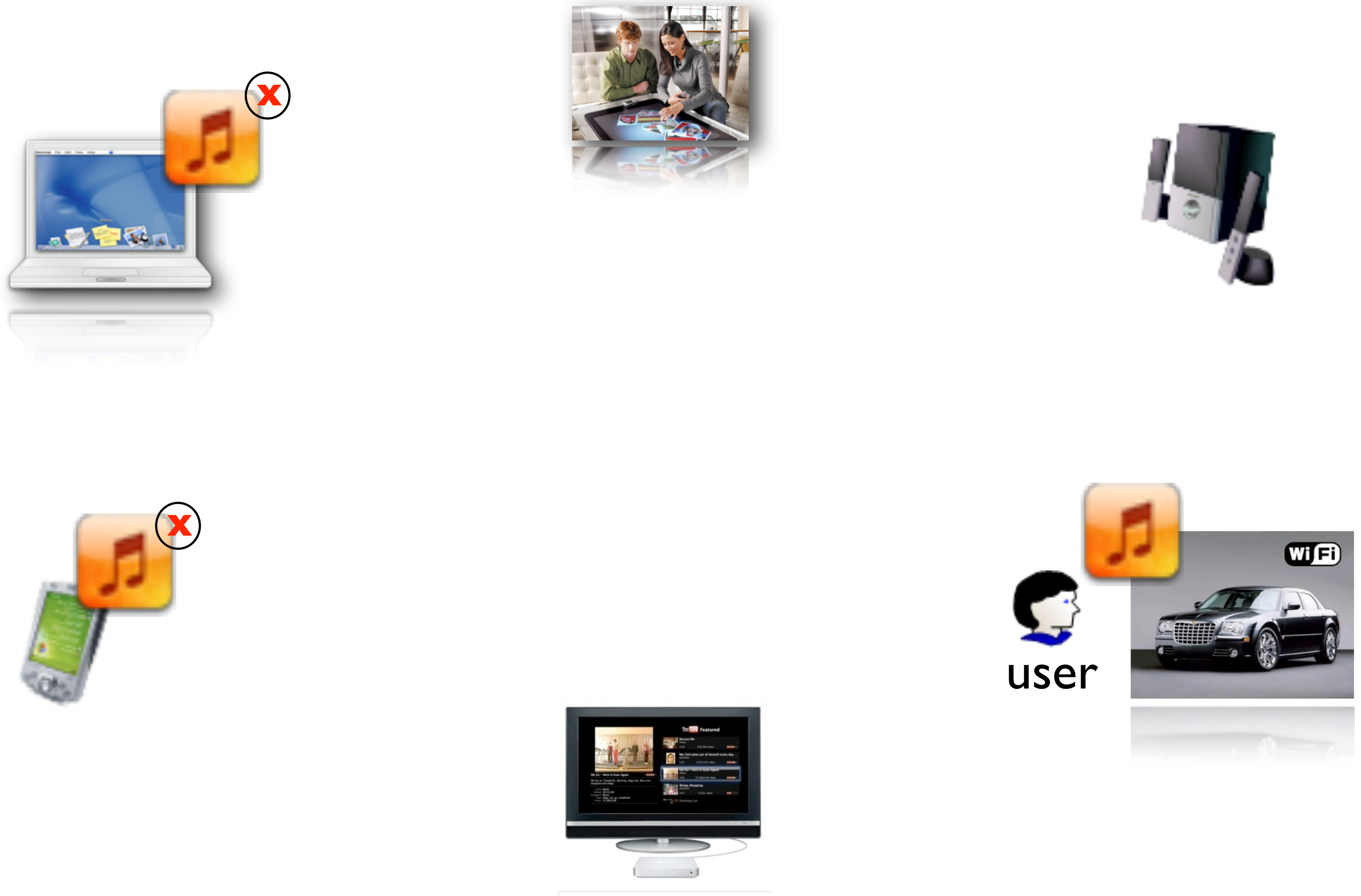

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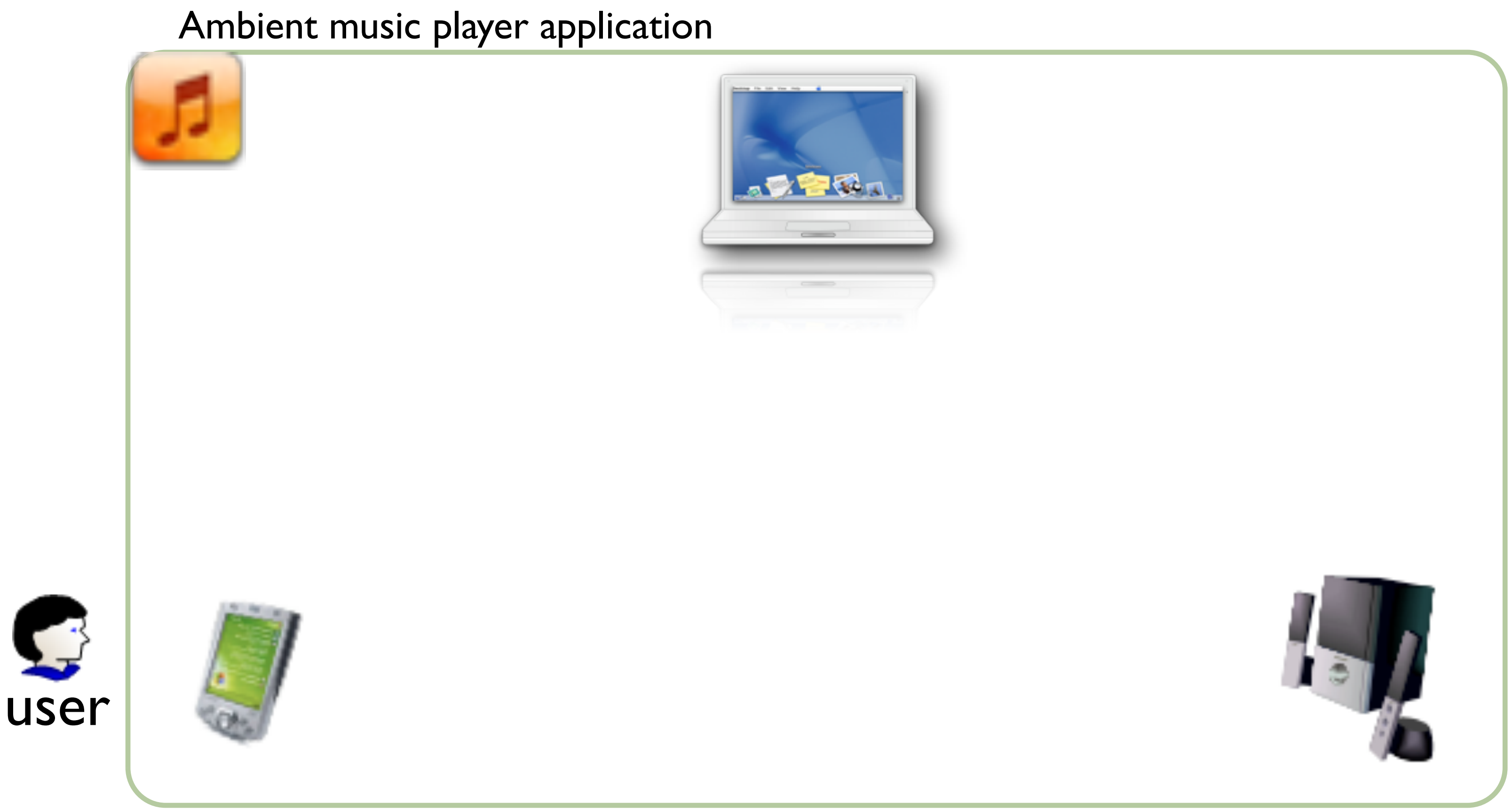
Partitioning of Pervasive Computing Services



Applications spread their functionality amongst several devices

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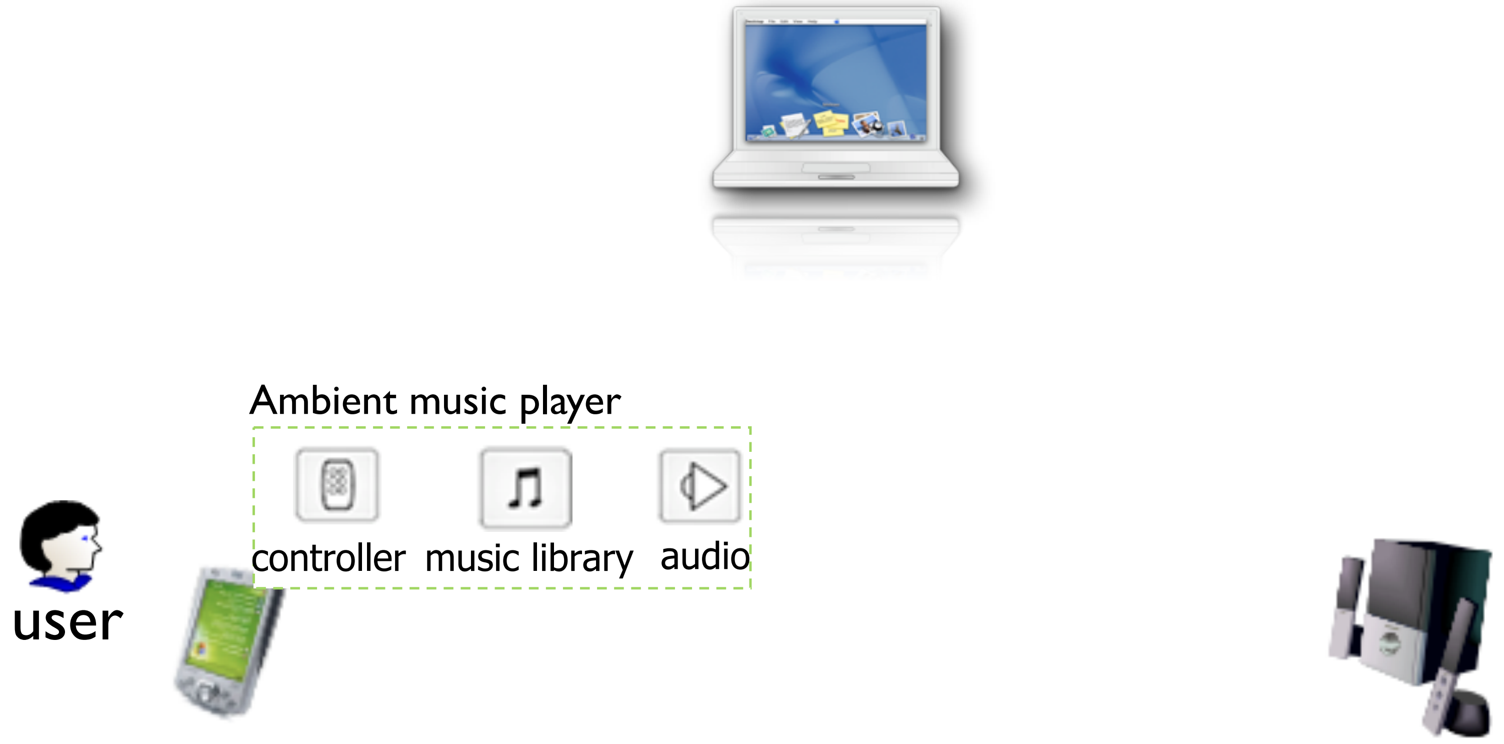

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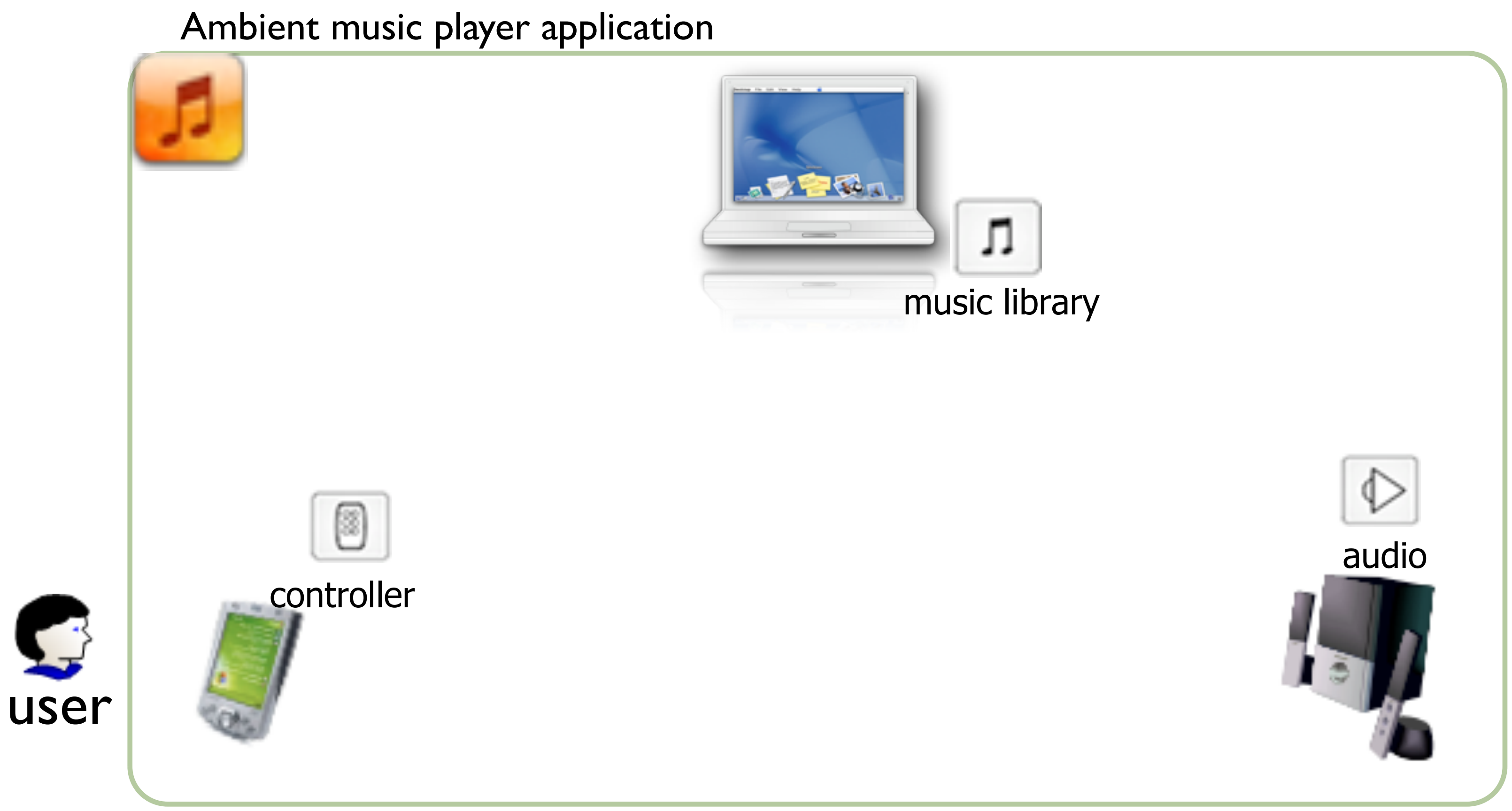
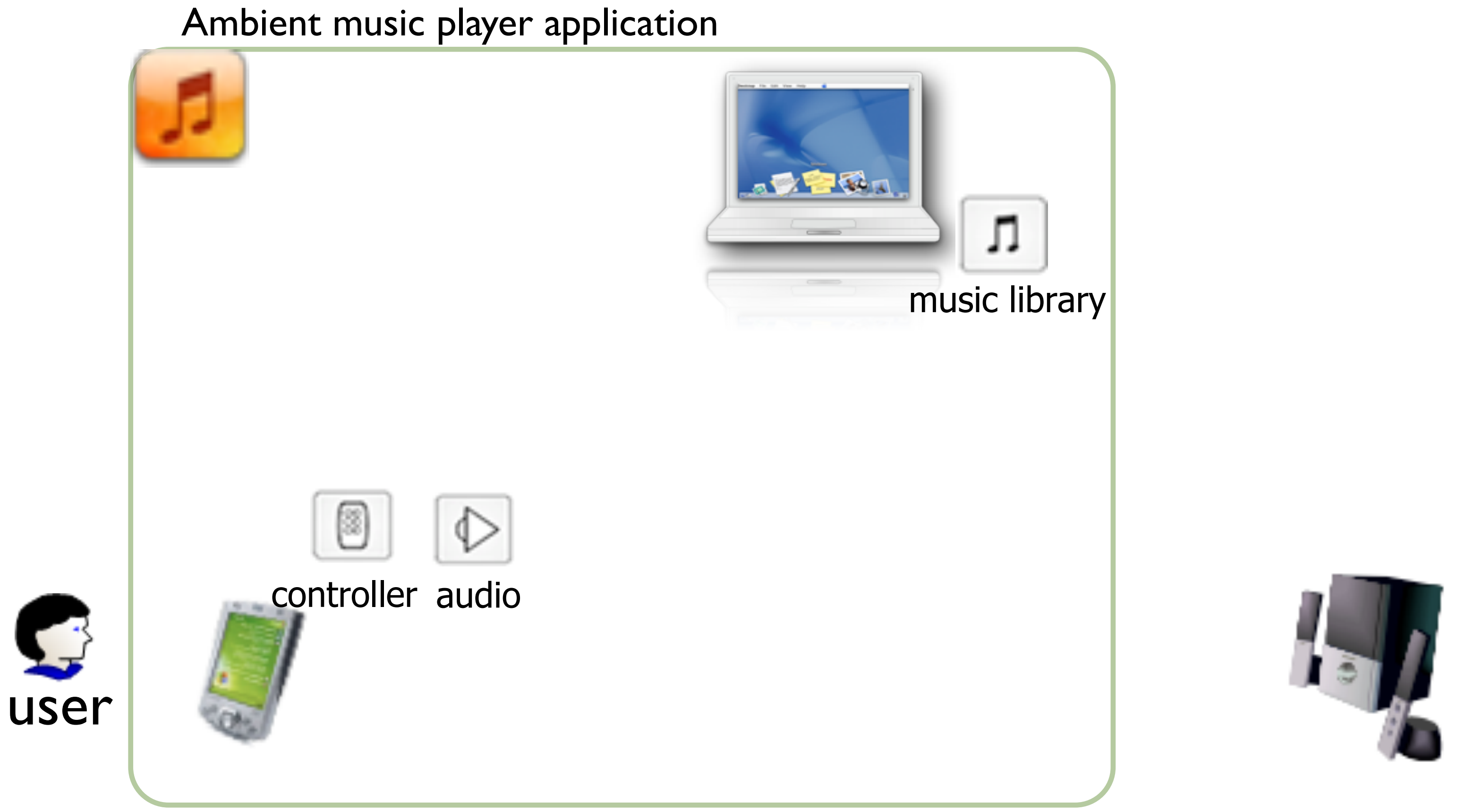


Applications are decomposed to run on multiple devices

- Runtime application partitioning

Partitioning of Pervasive Computing Services



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- Runtime application partitioning
- Retractable

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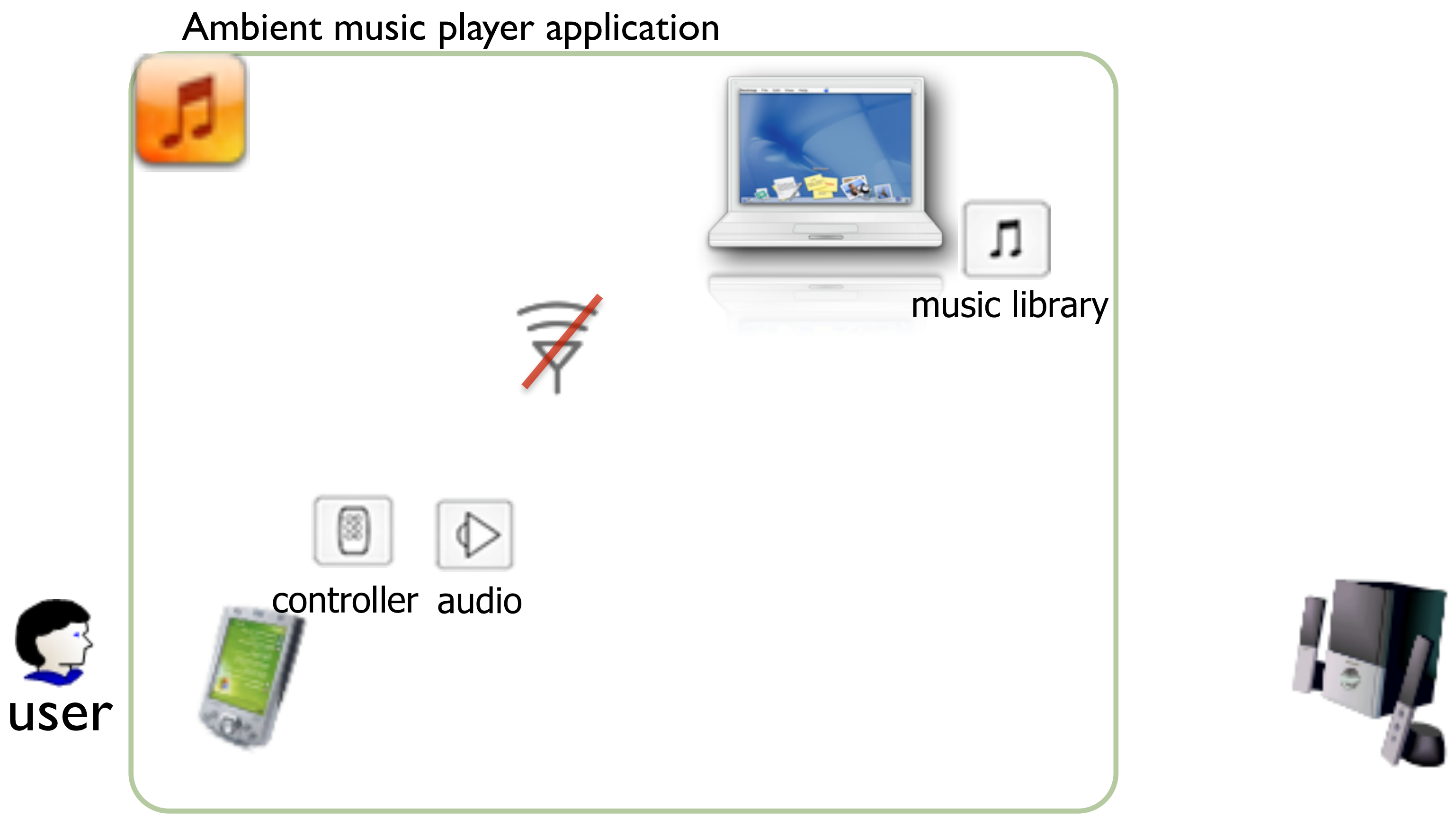

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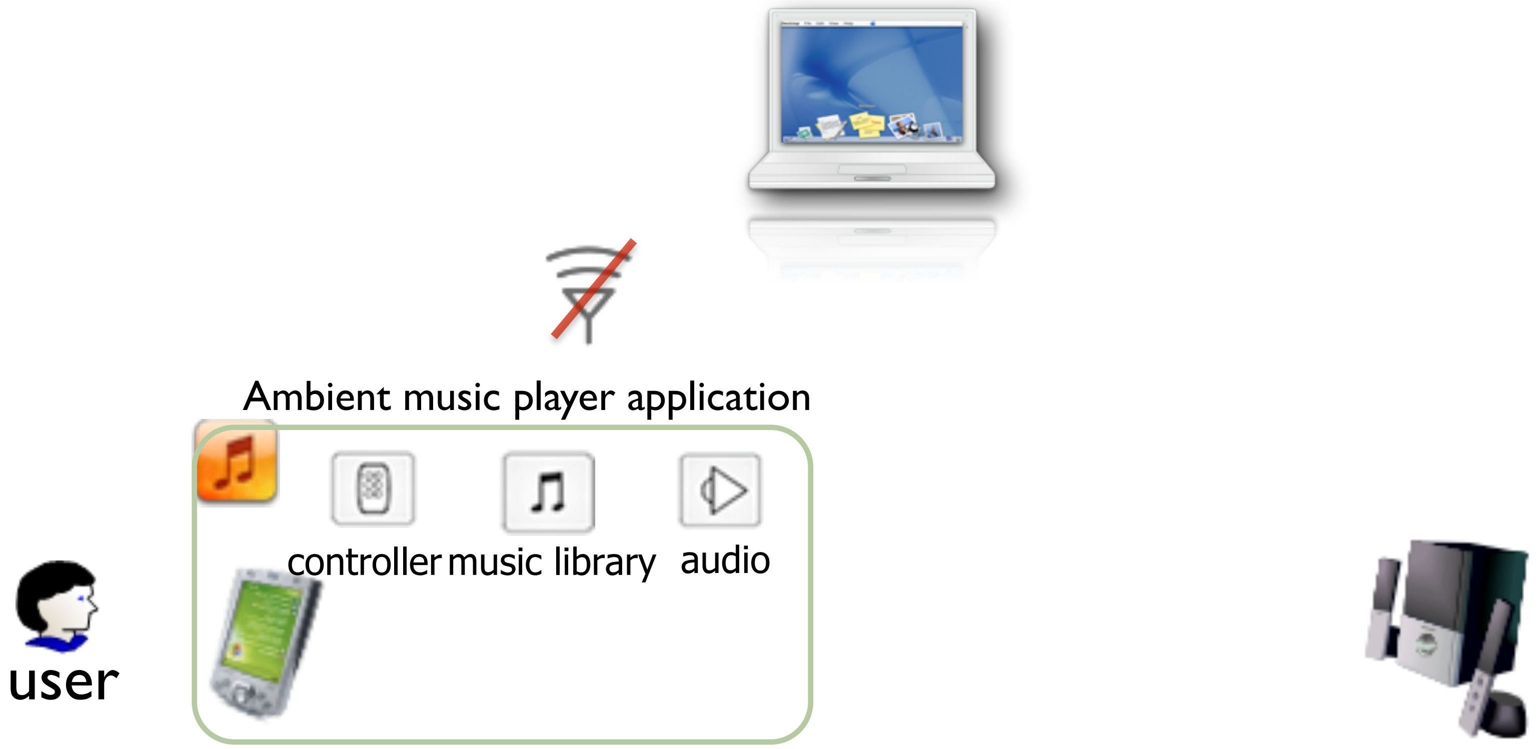

Applications are decomposed to run on multiple devices

- Runtime application partitioning
- Retractable
- Resilient to network disconnections

Existing Approaches

- Mostly static and controlled by the programmer (e.g. J-Orchestra, Addistant, ..)
- Object migration automatic or based on algorithms
- No network failure handling mechanisms

Service Partitioning Requirements

Runtime Application Partitioning

Retractable

Resilient to Network Failures

Resilient Actor Model

A resilient actor:

- A program entity that encapsulates a set of objects
- **Elastic bindings** to other actors

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Two partitioning operations

- **Stretch** - moves an actor to another device
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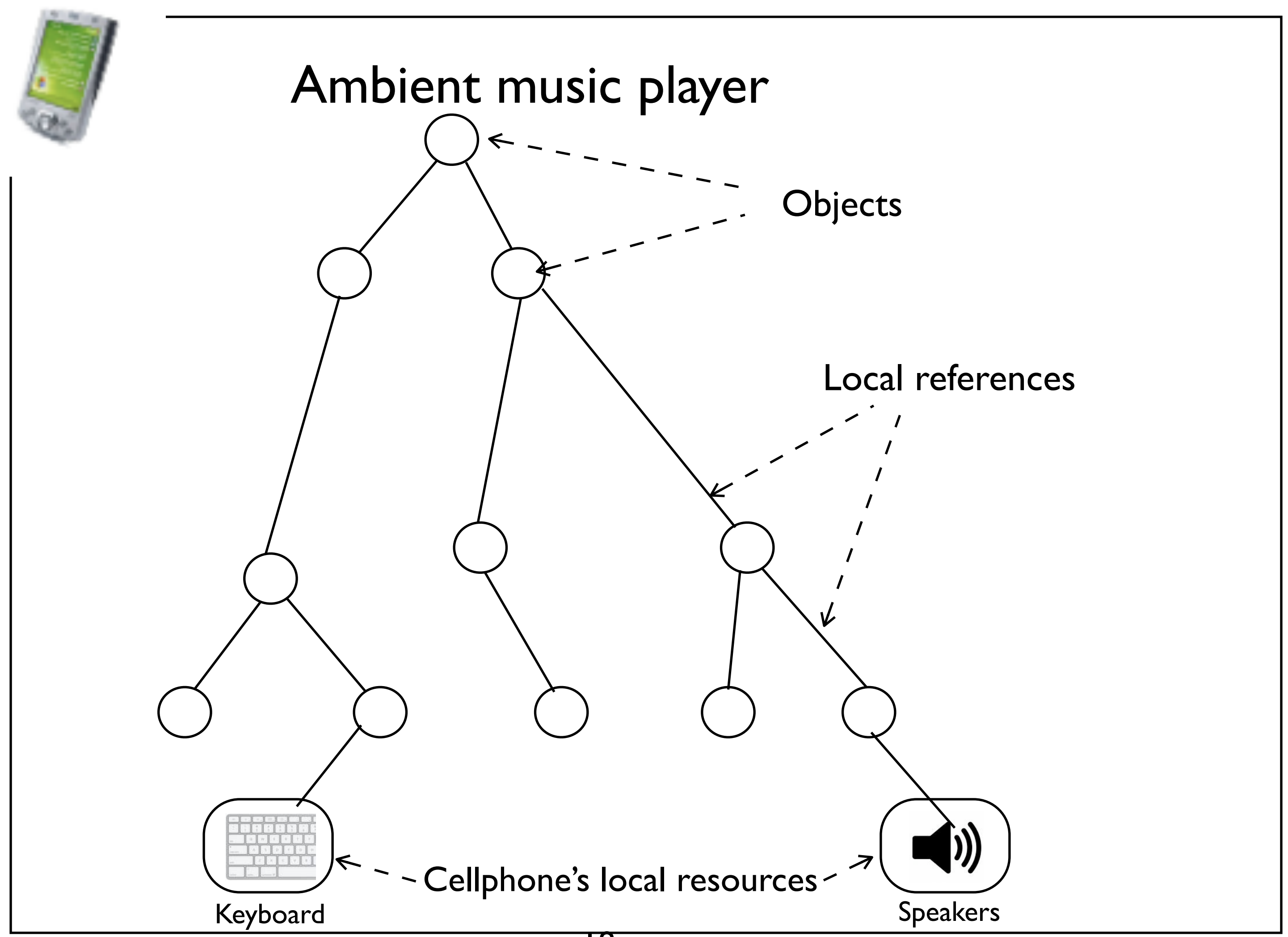
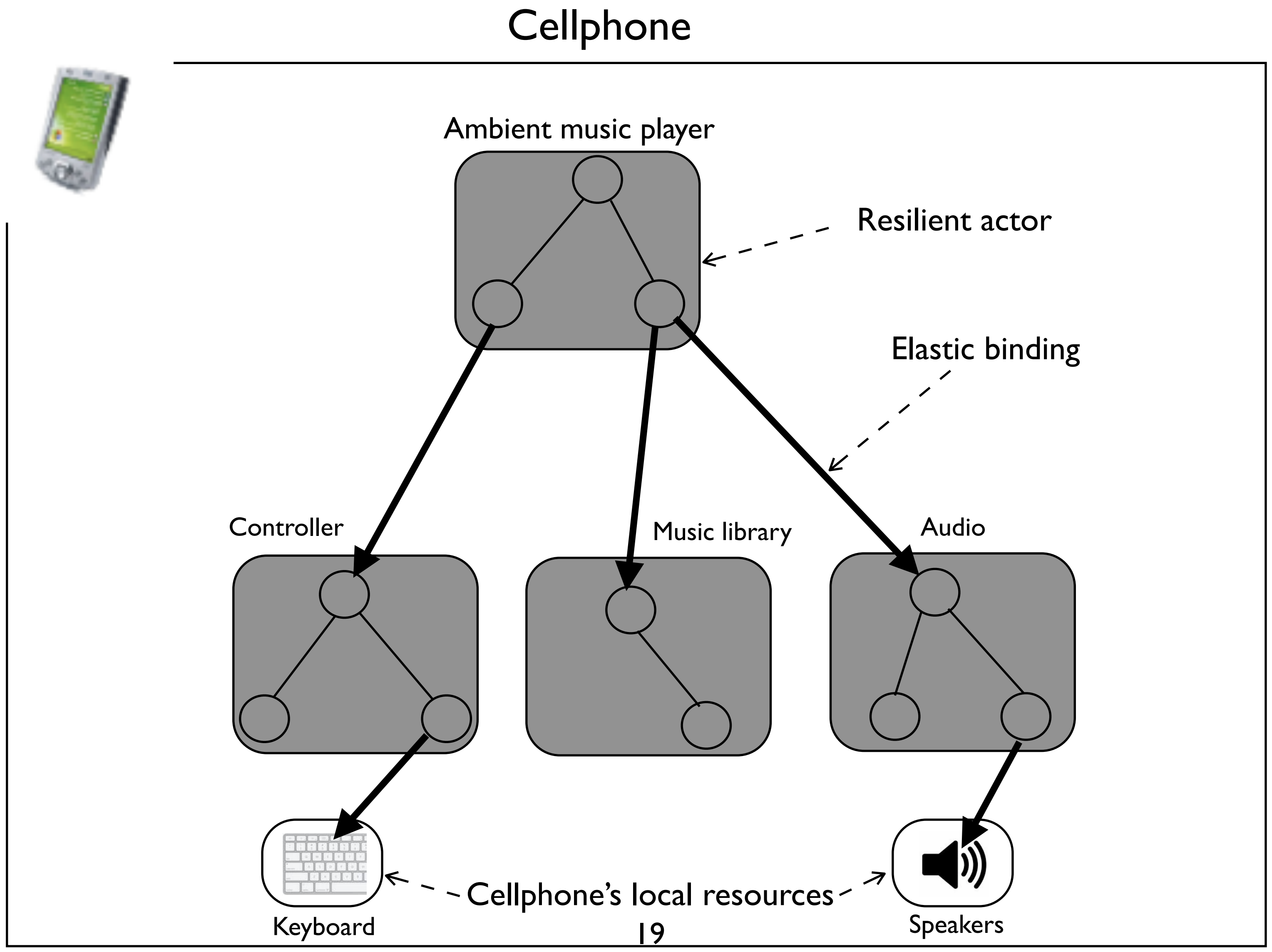
Resilience strategies (move, copy, rebind, standstill)

Service Partitioning



Service Partitioning



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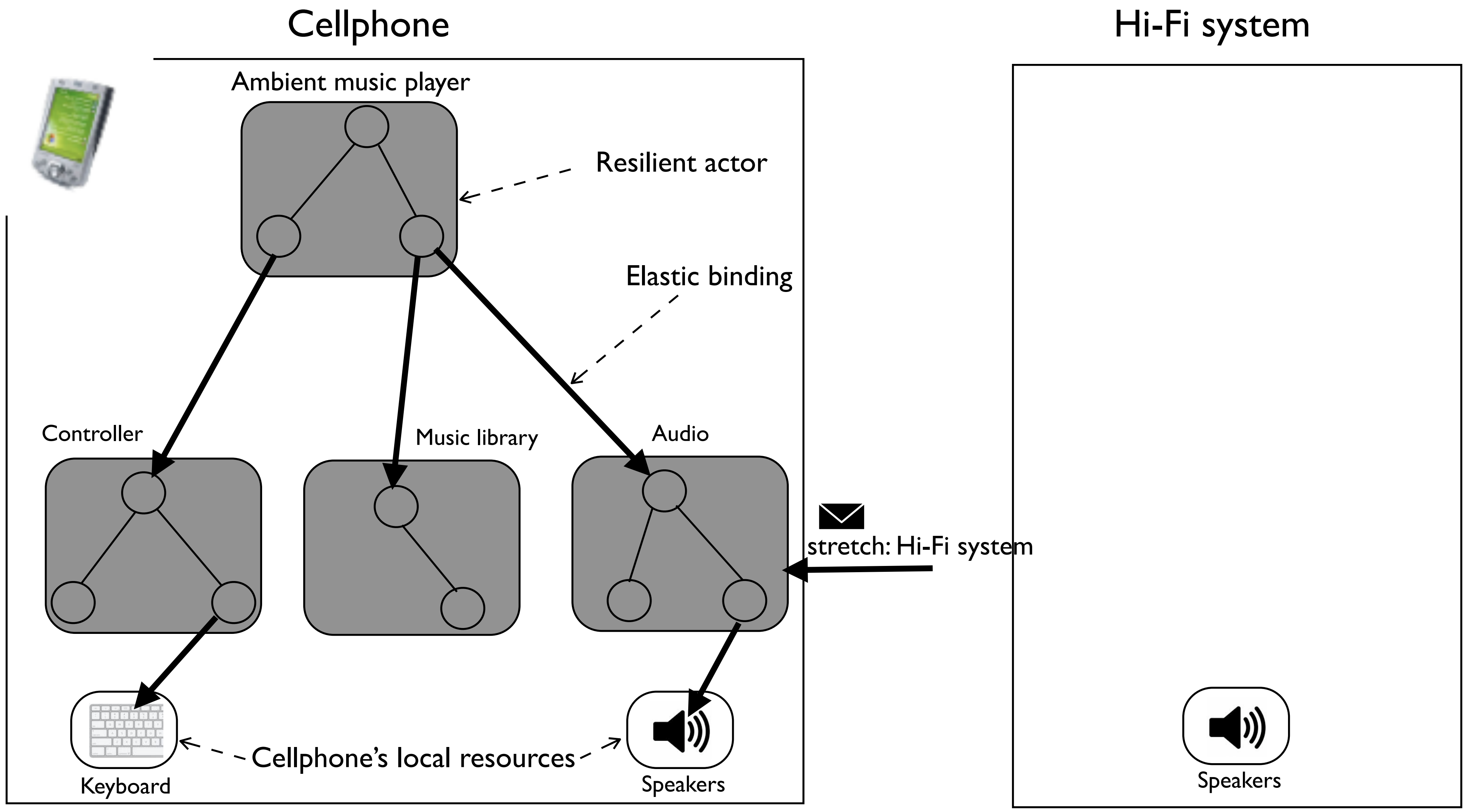

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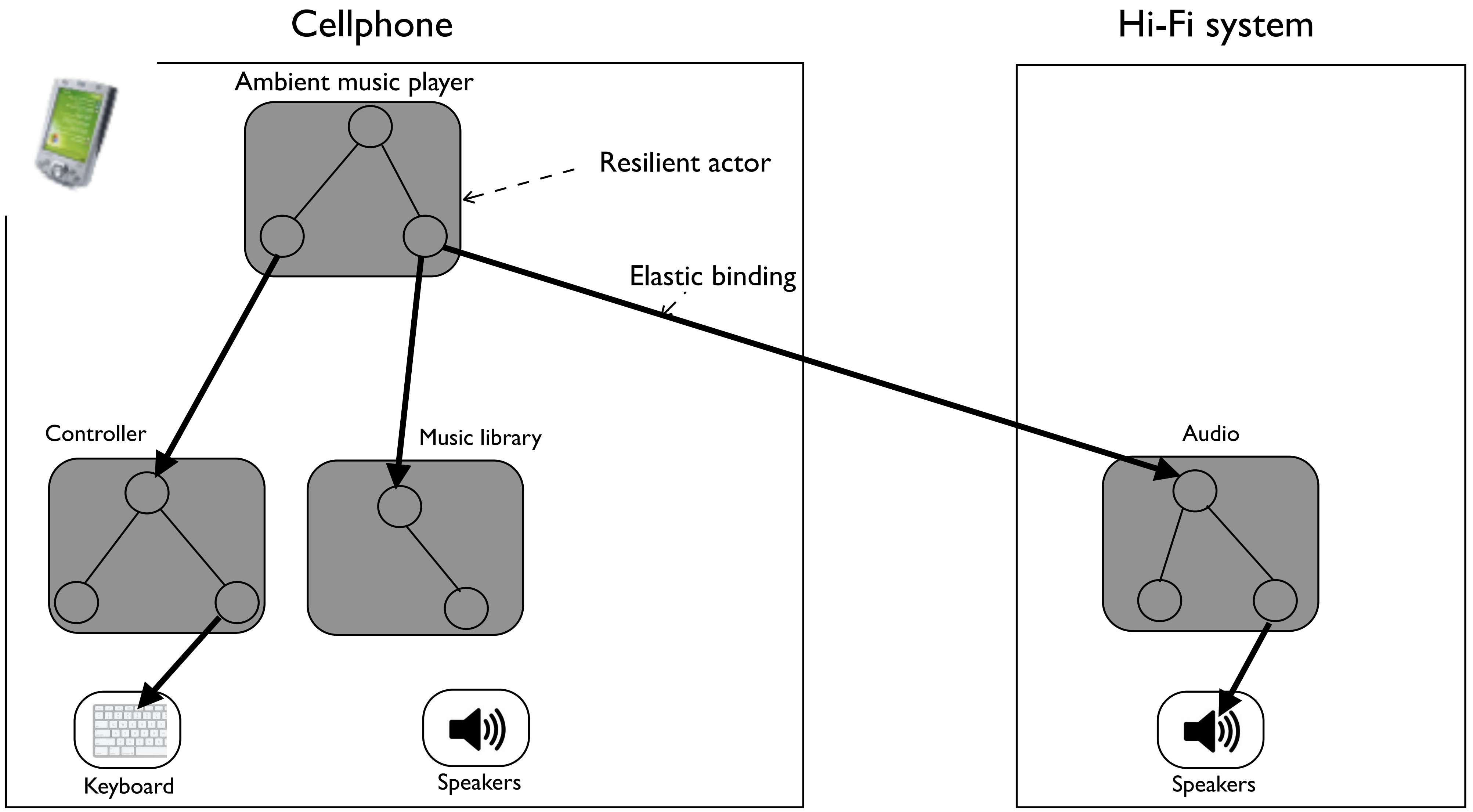
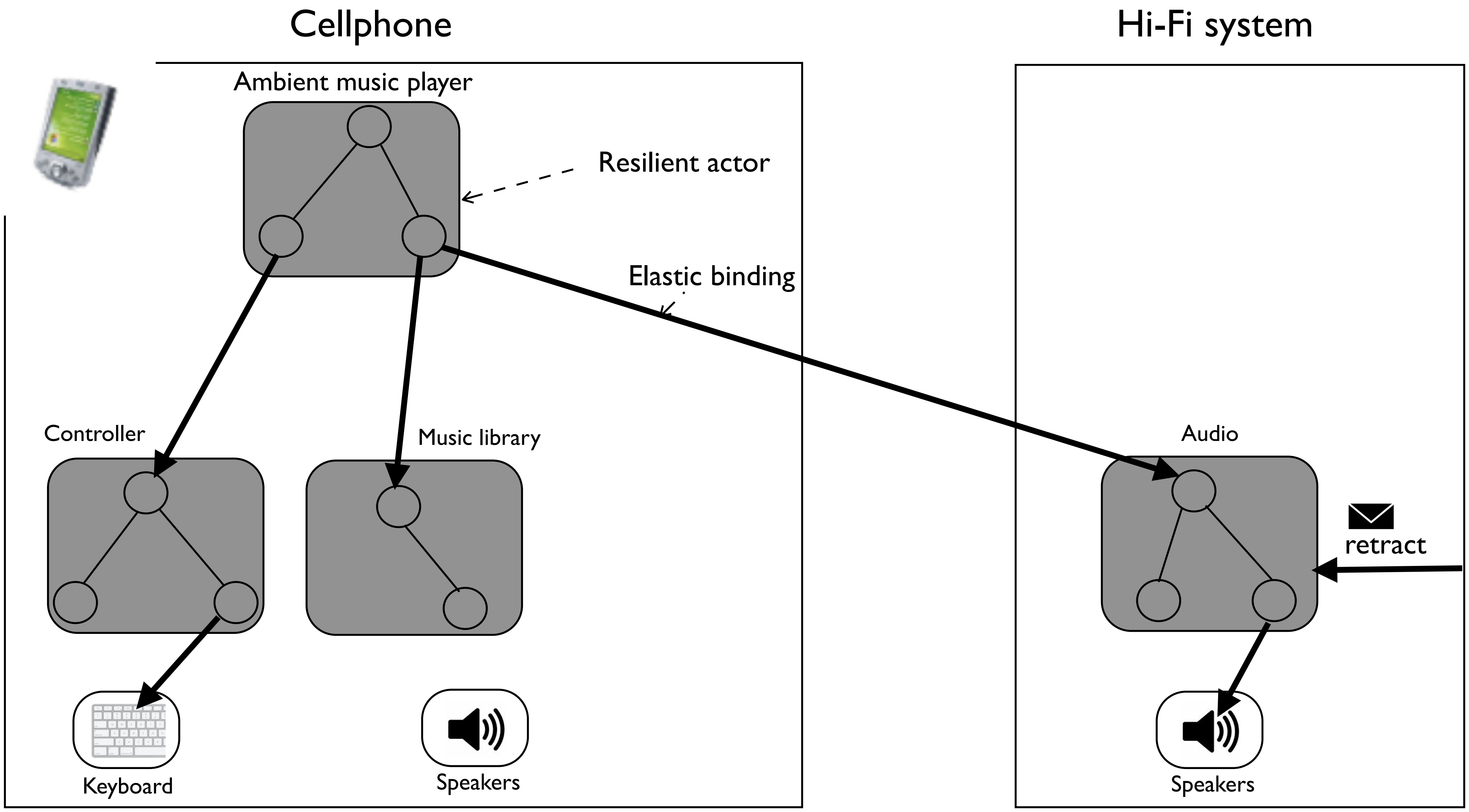
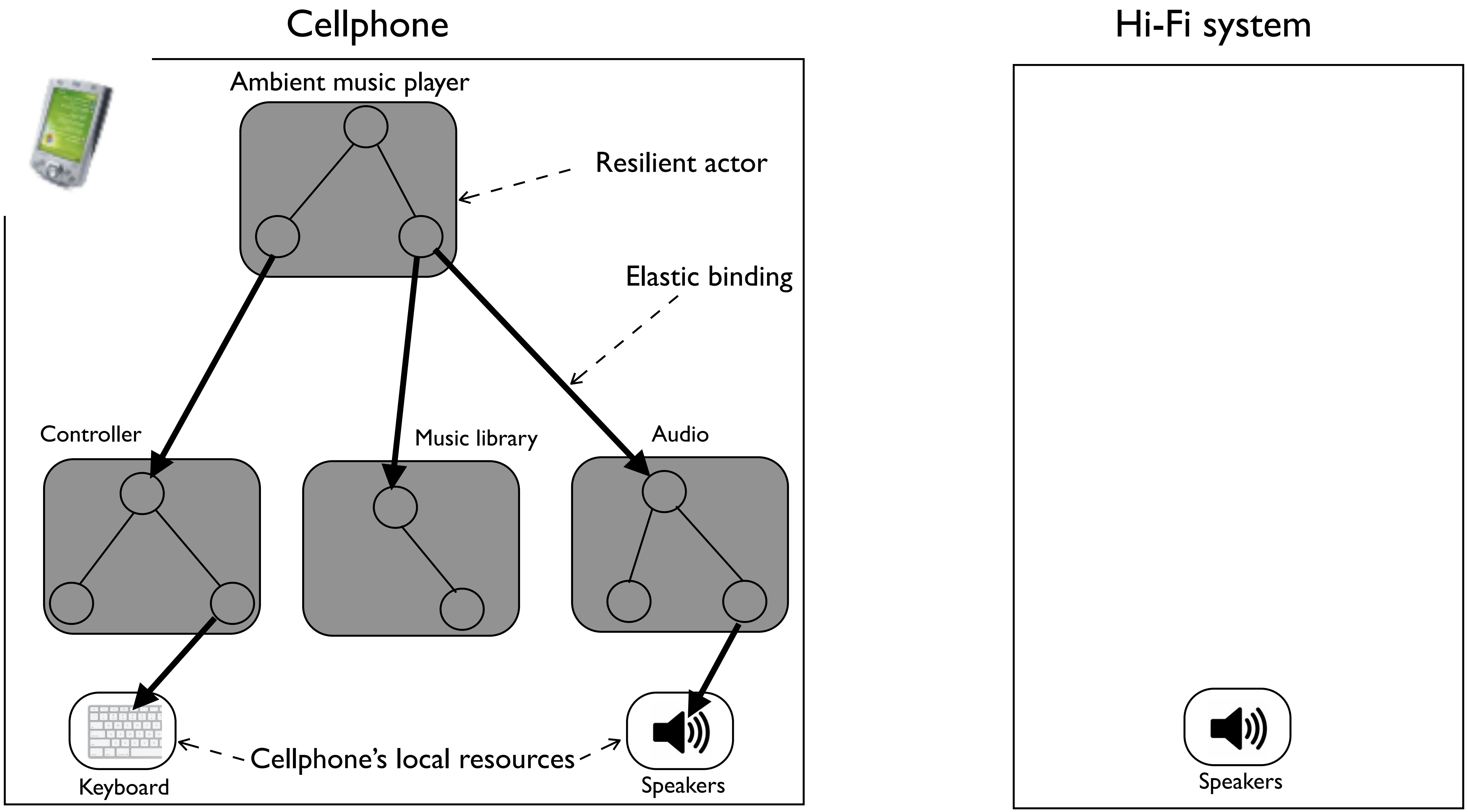


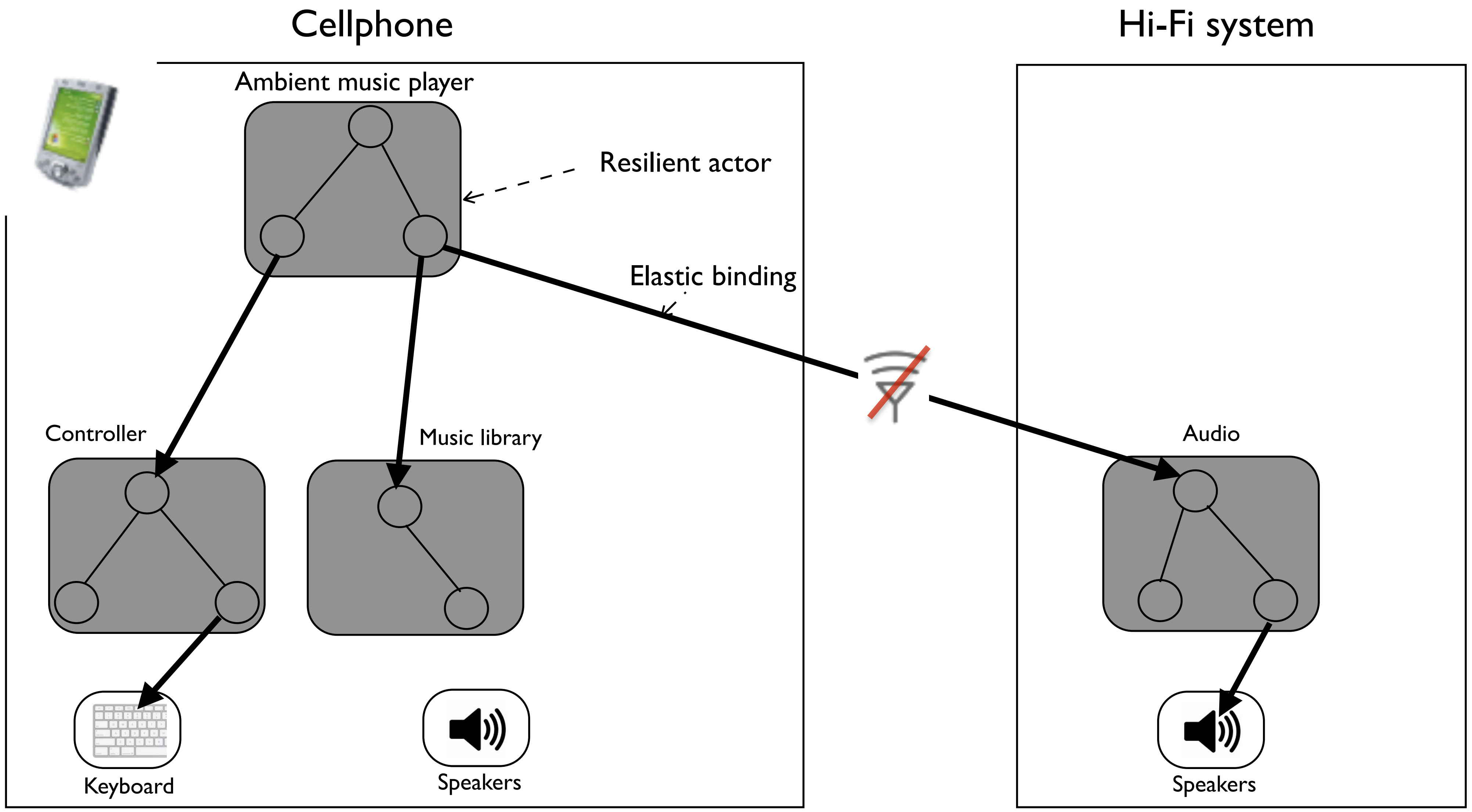
Retraction


Cellphone
Hi-Fi system
Ambient music player
Resilient actor
Elastic binding
Controller
Music library
Audio
retract
Keyboard
Speakers
Speakers

Manual Retraction



Automatic Retraction



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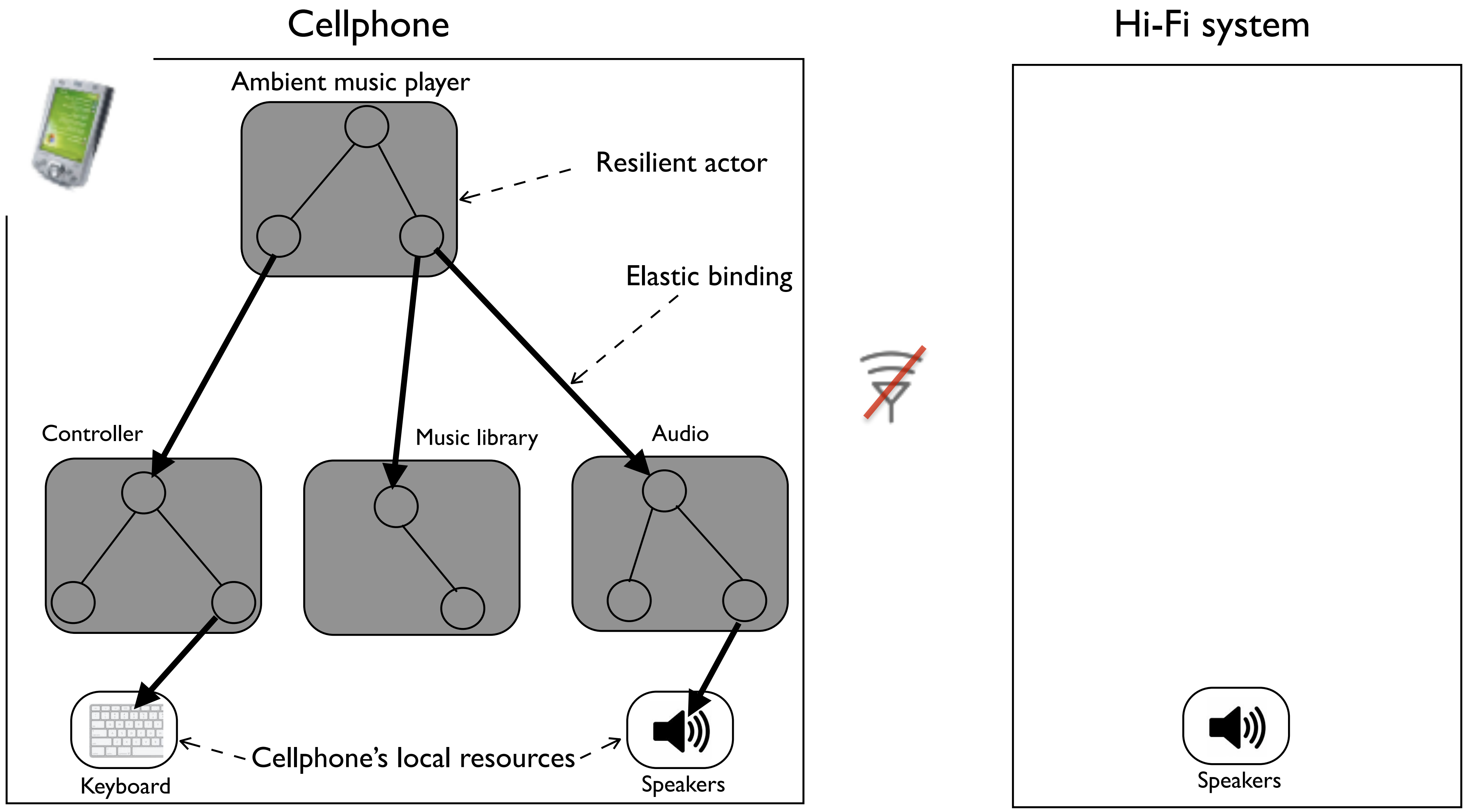
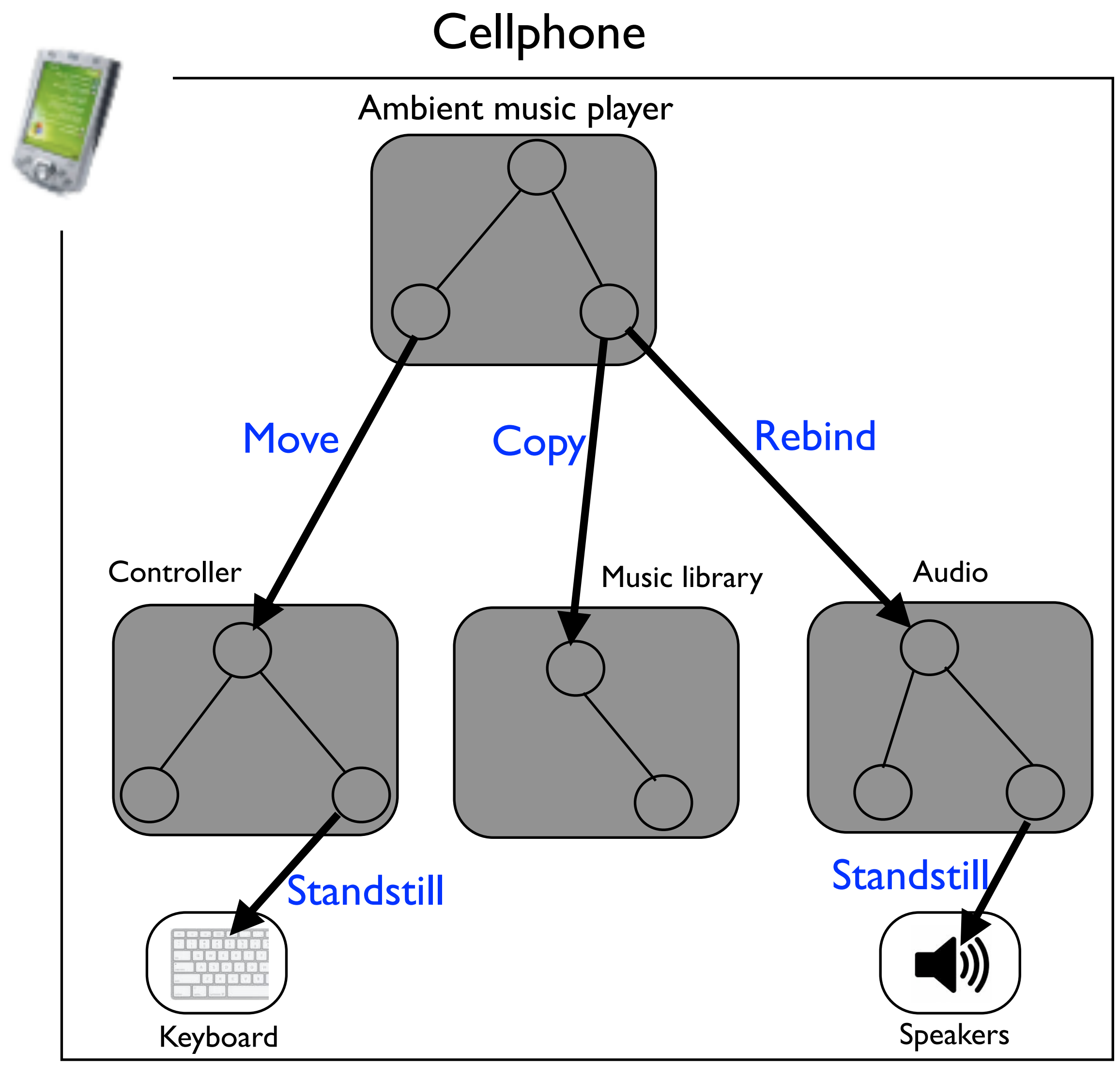
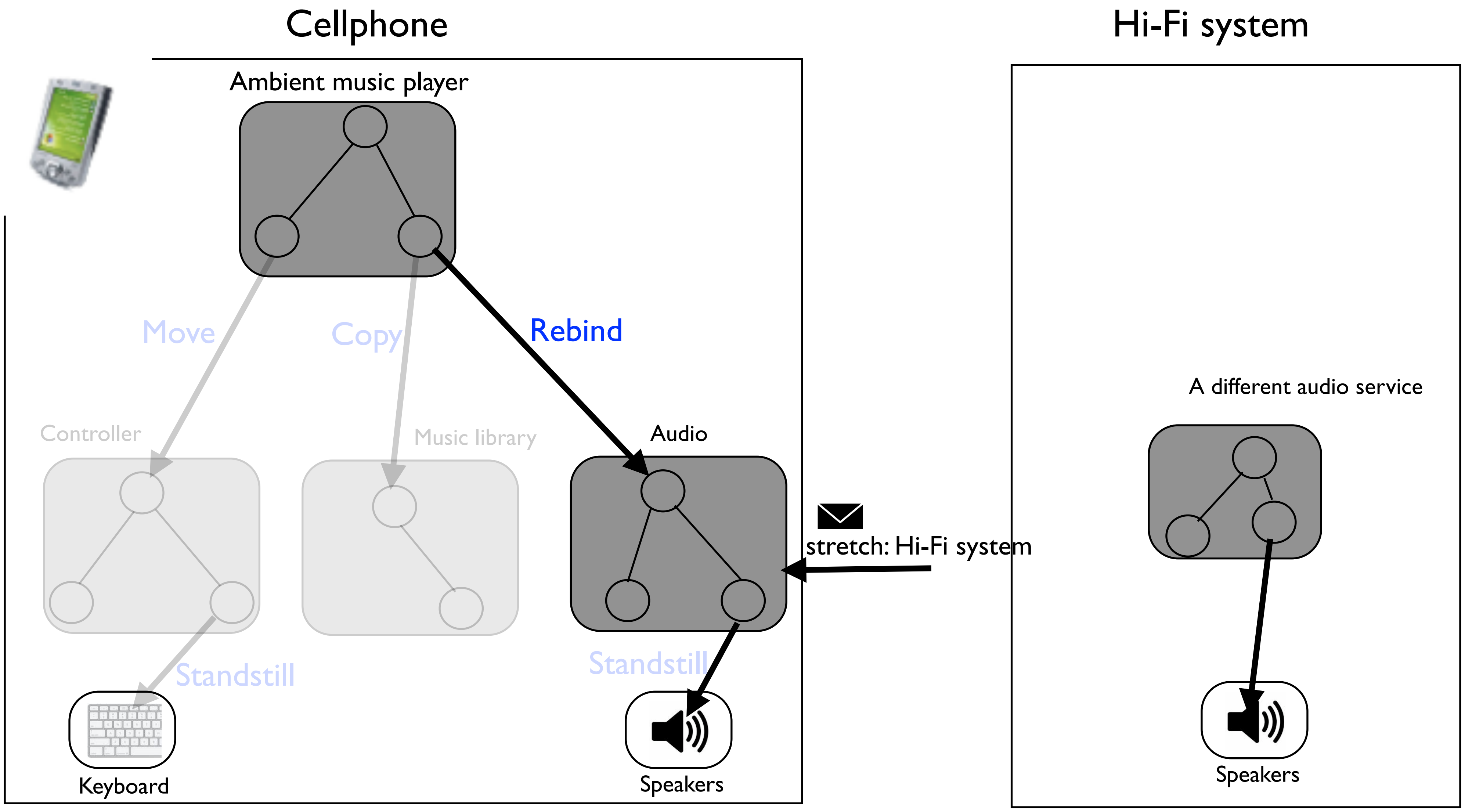


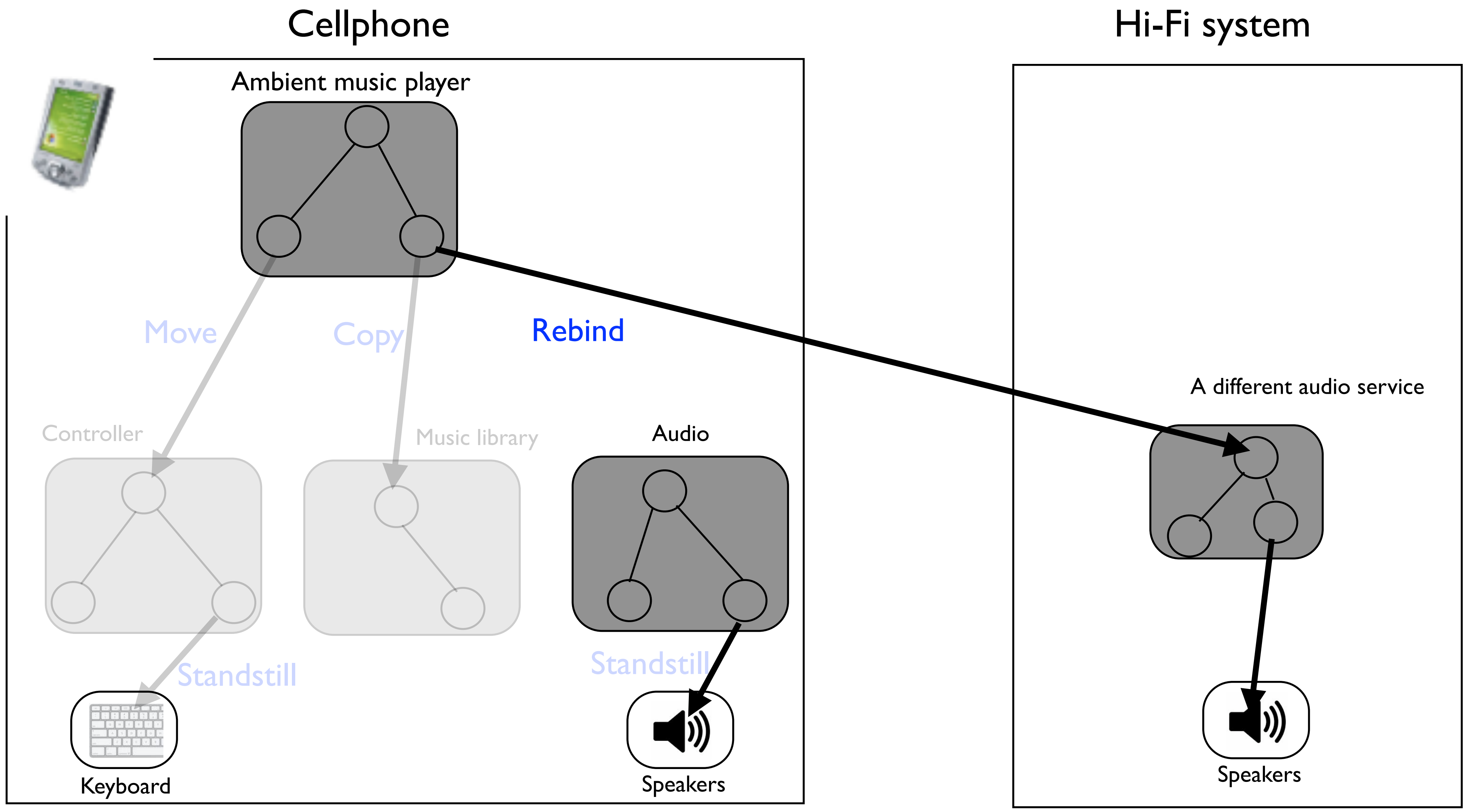
Resilience Strategies



Stretch under Rebind Strategy



Retract under Rebind Strategy



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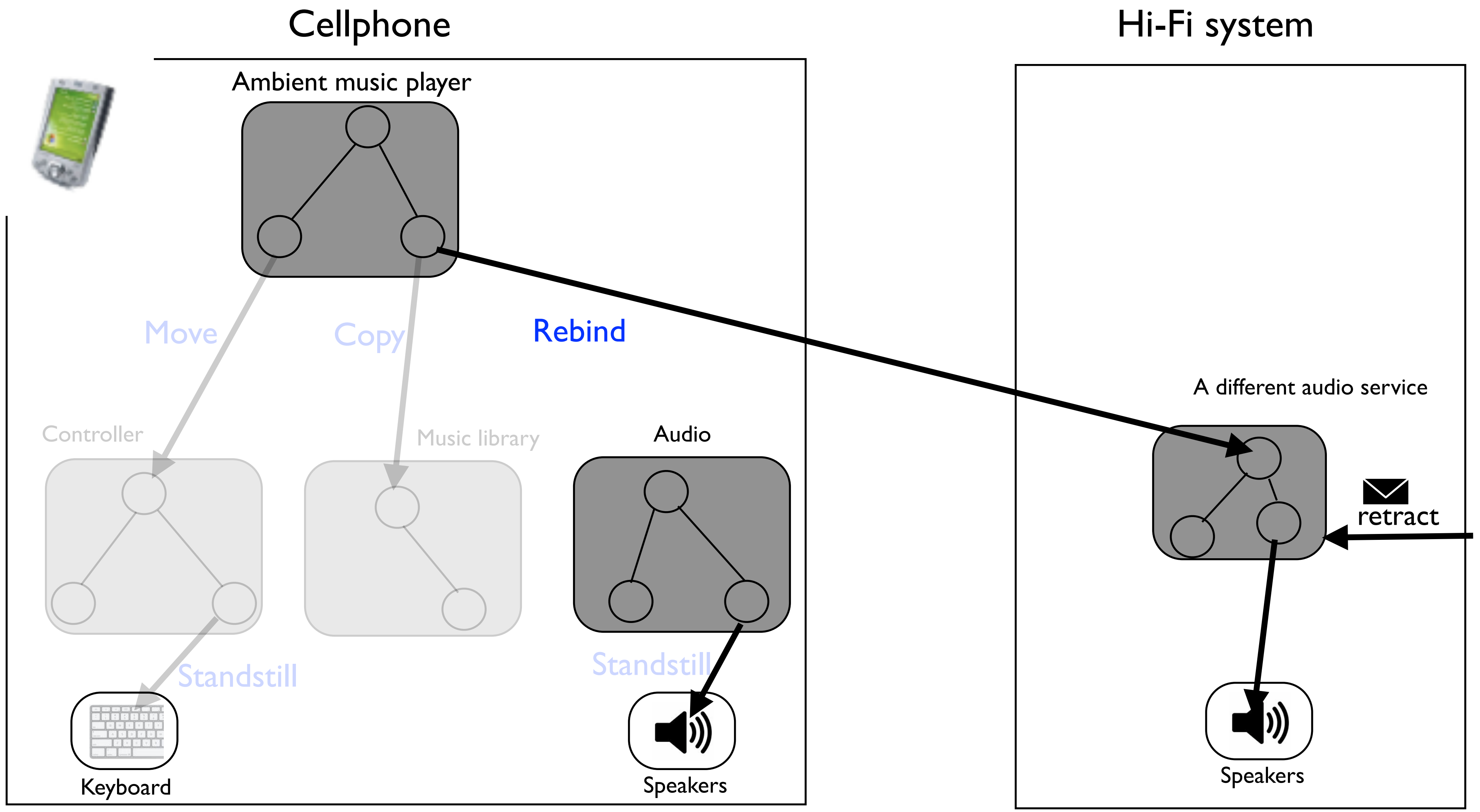

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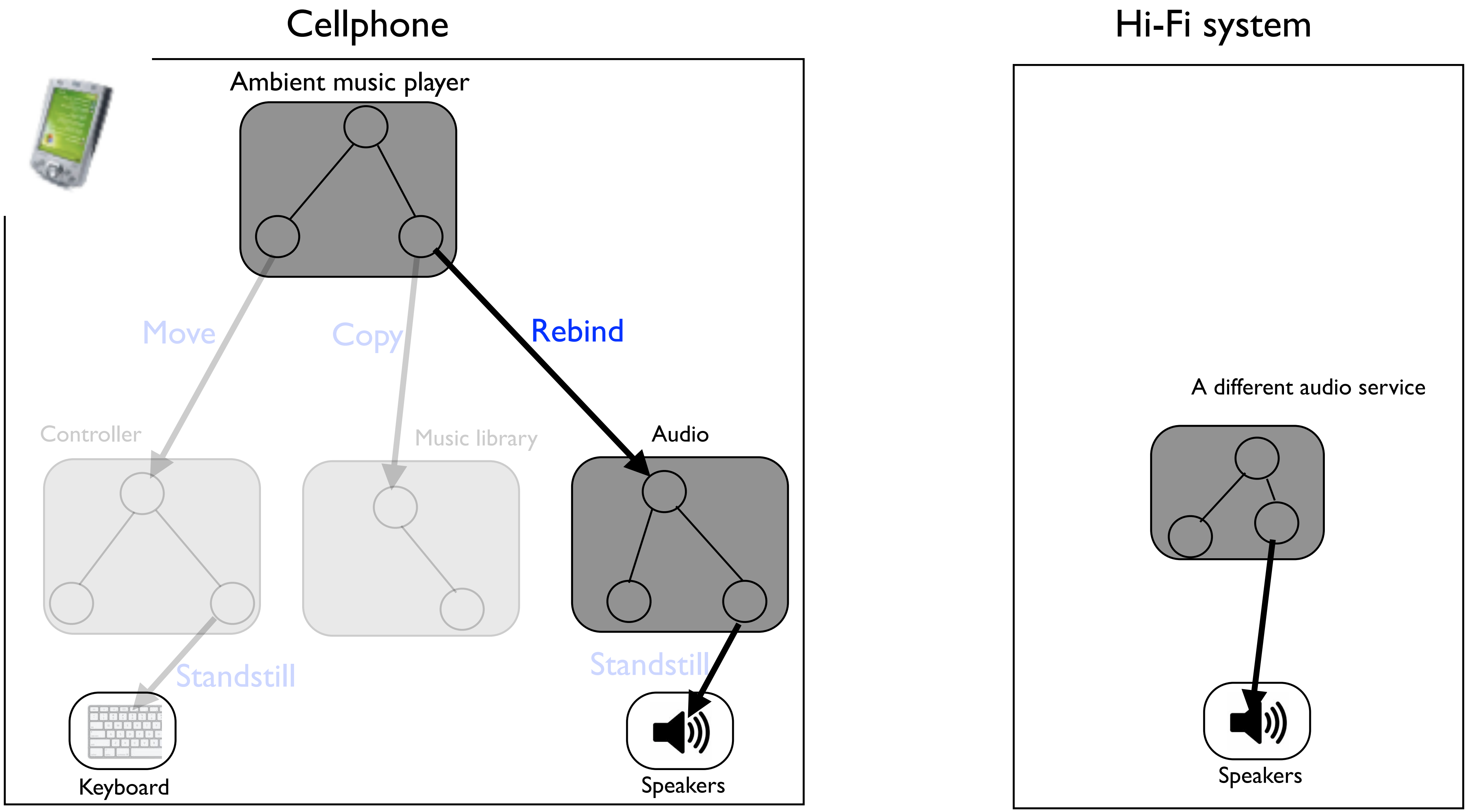
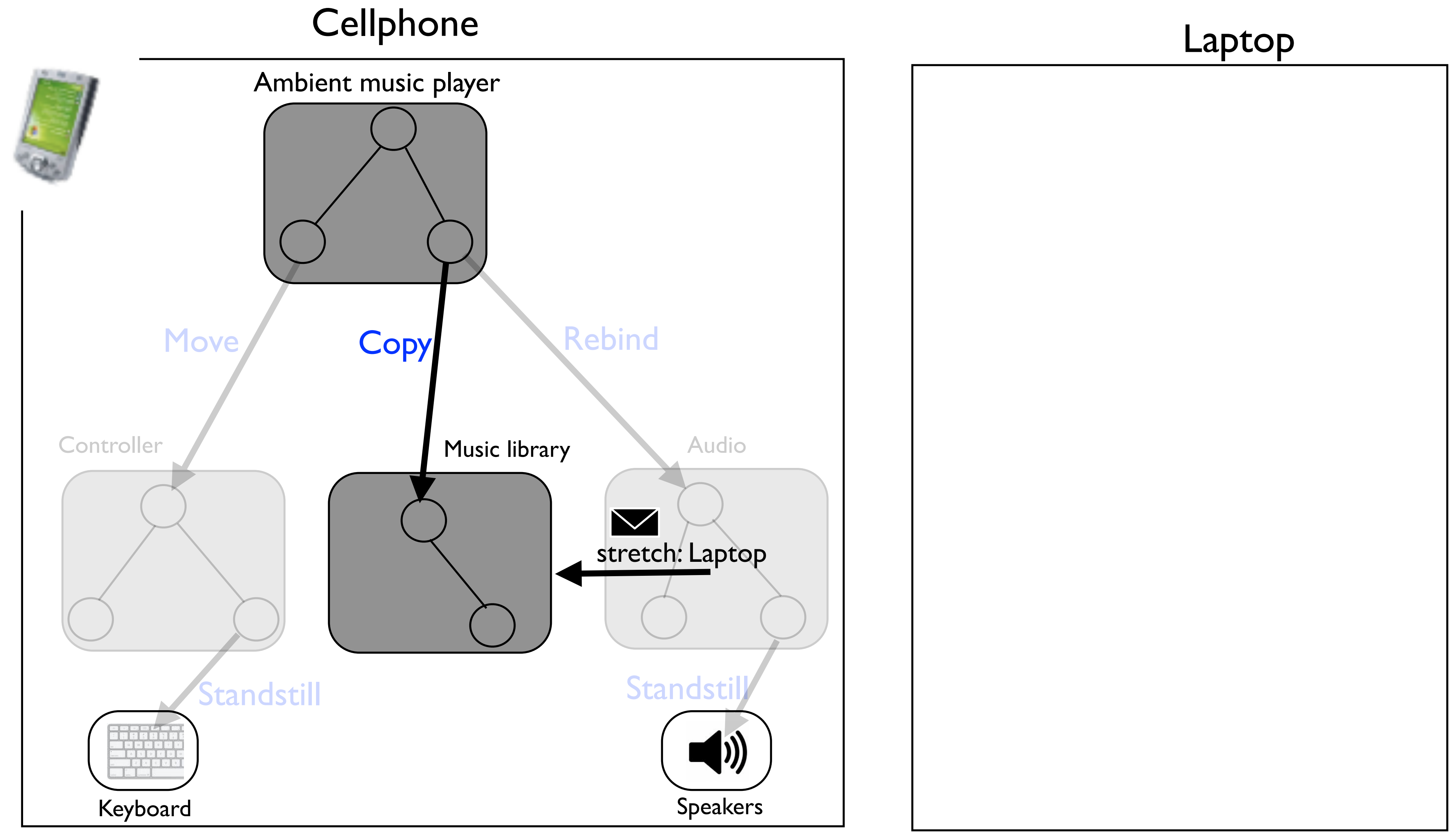


Stretch under Copy Strategy



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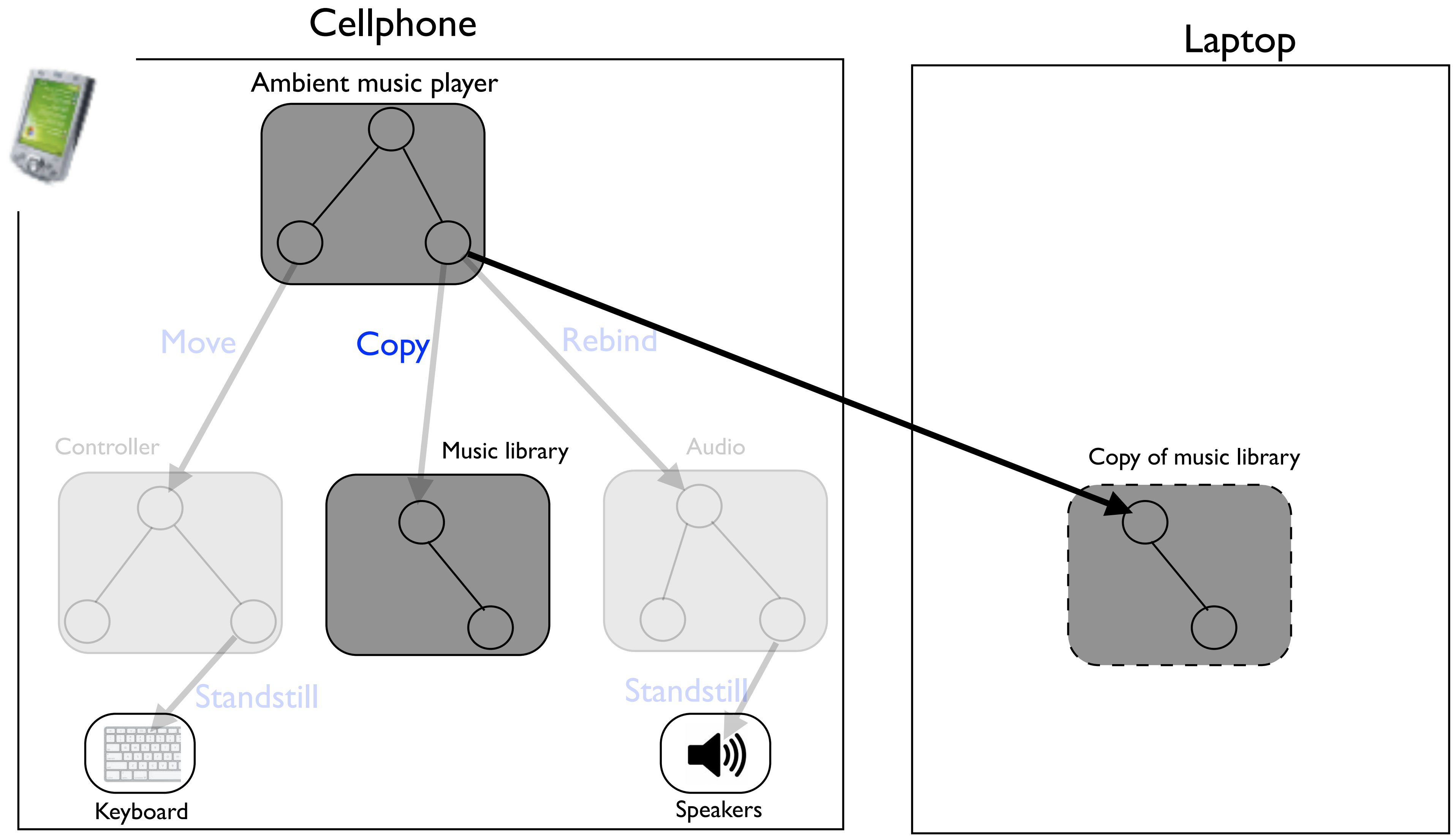
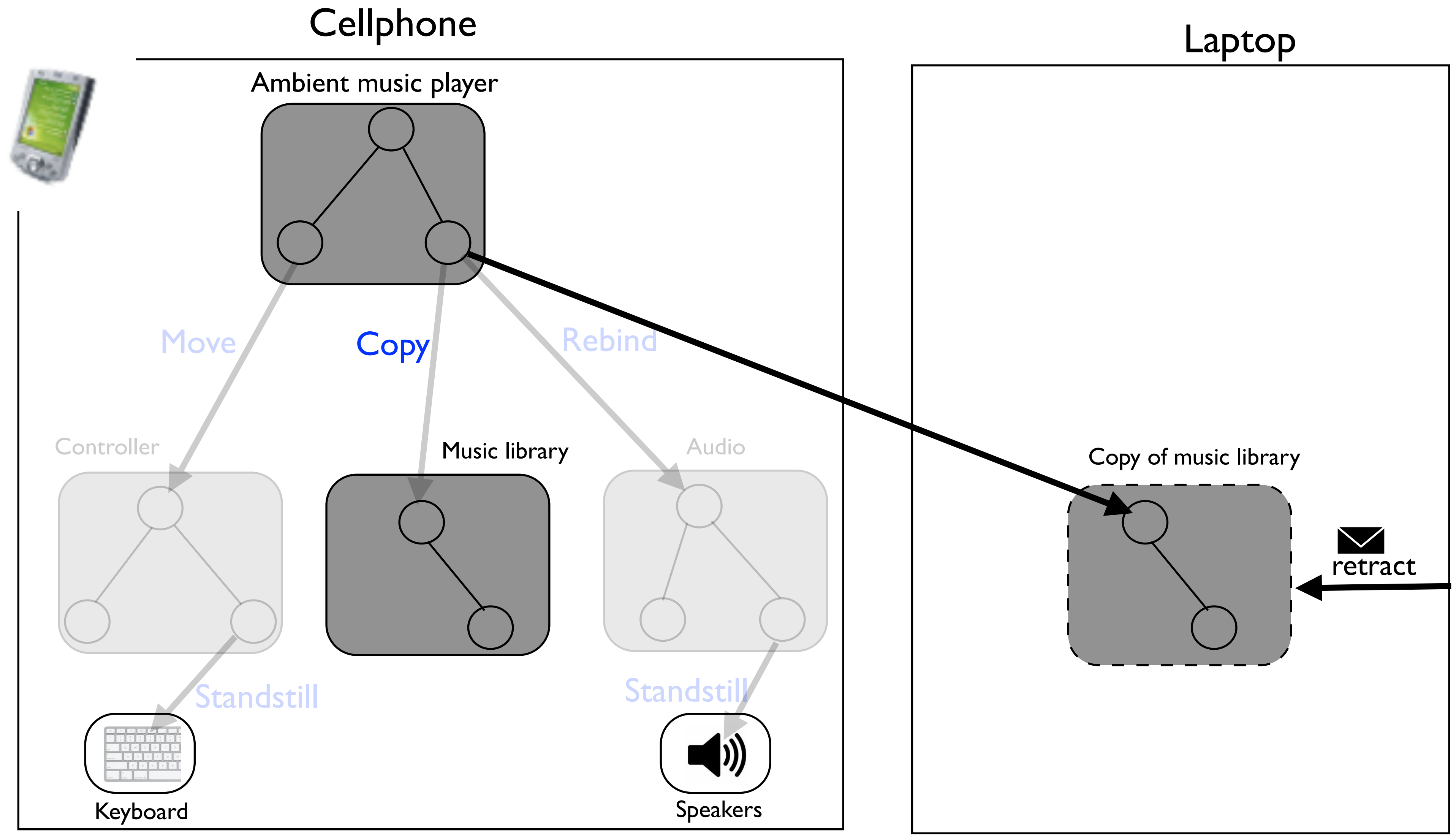
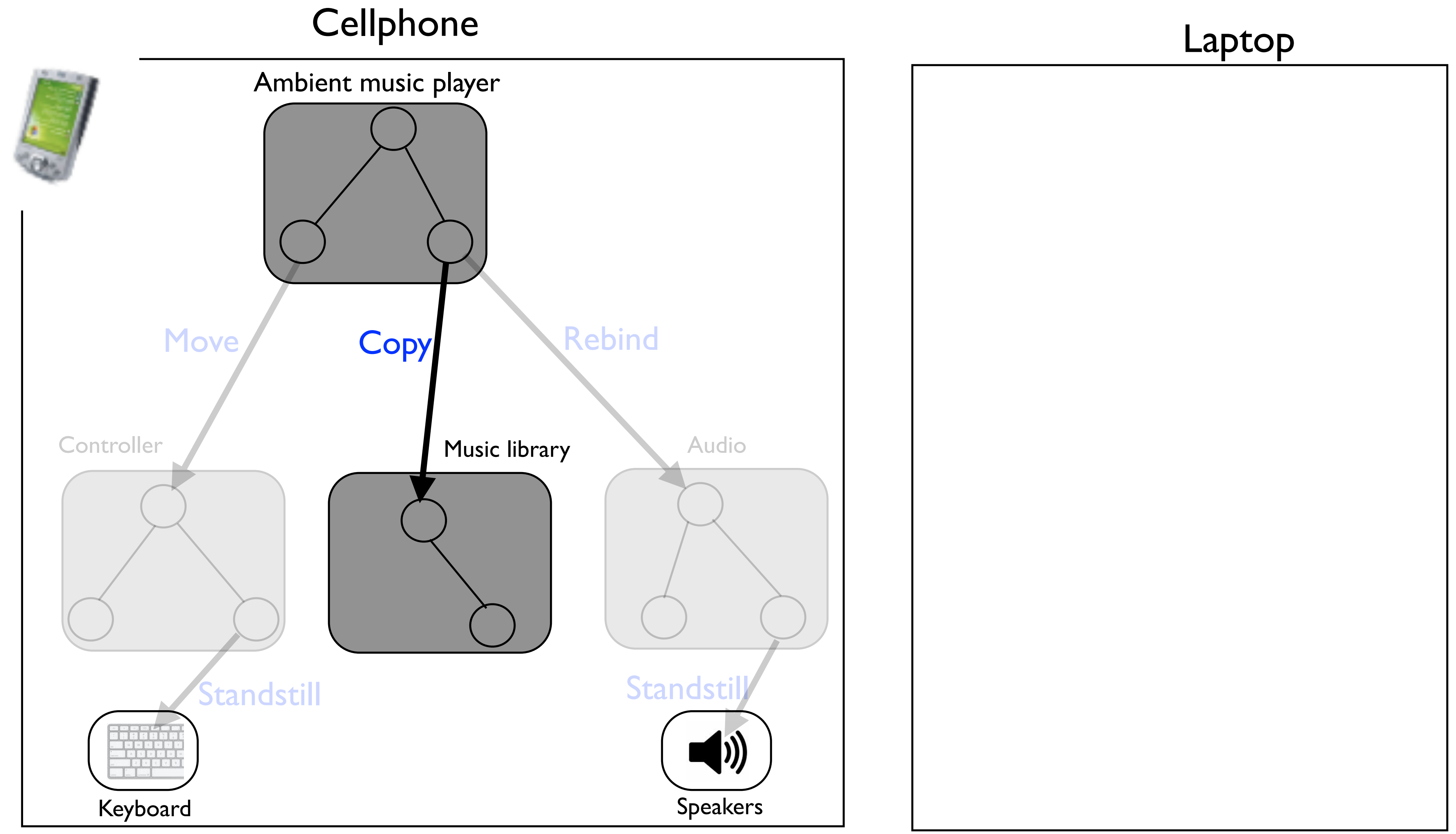


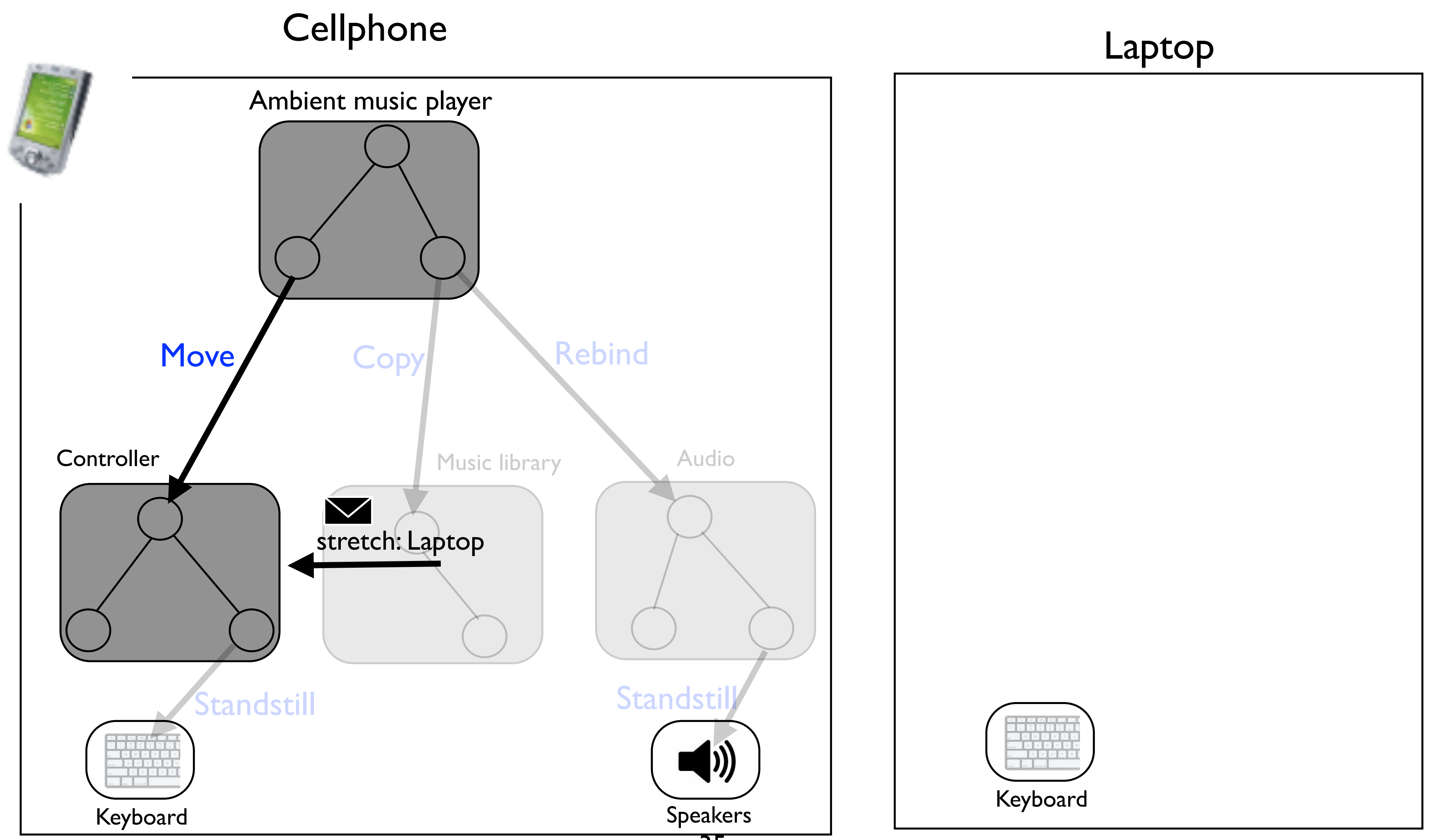
Retract under Copy Strategy



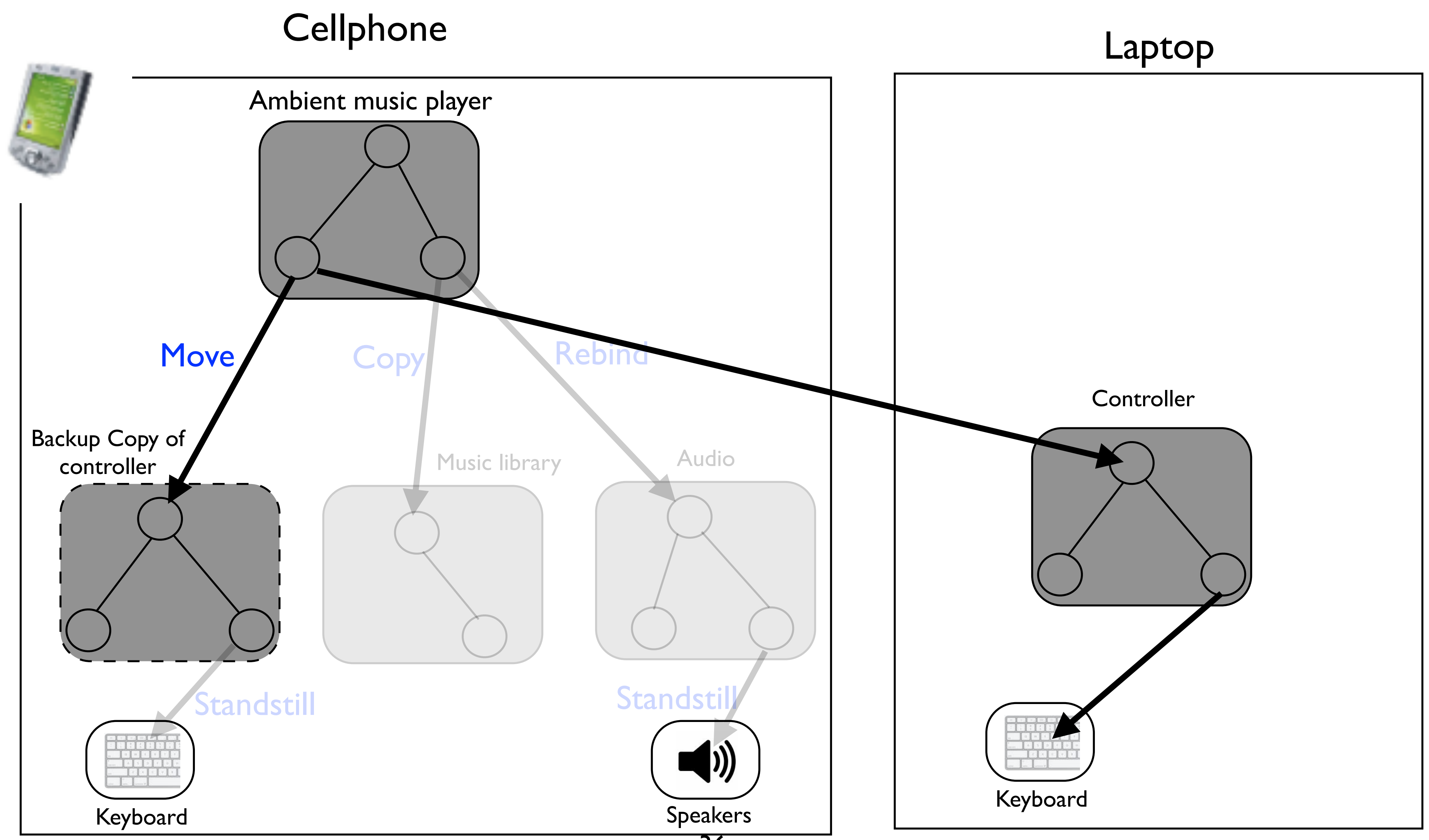
Retract under Copy Strategy



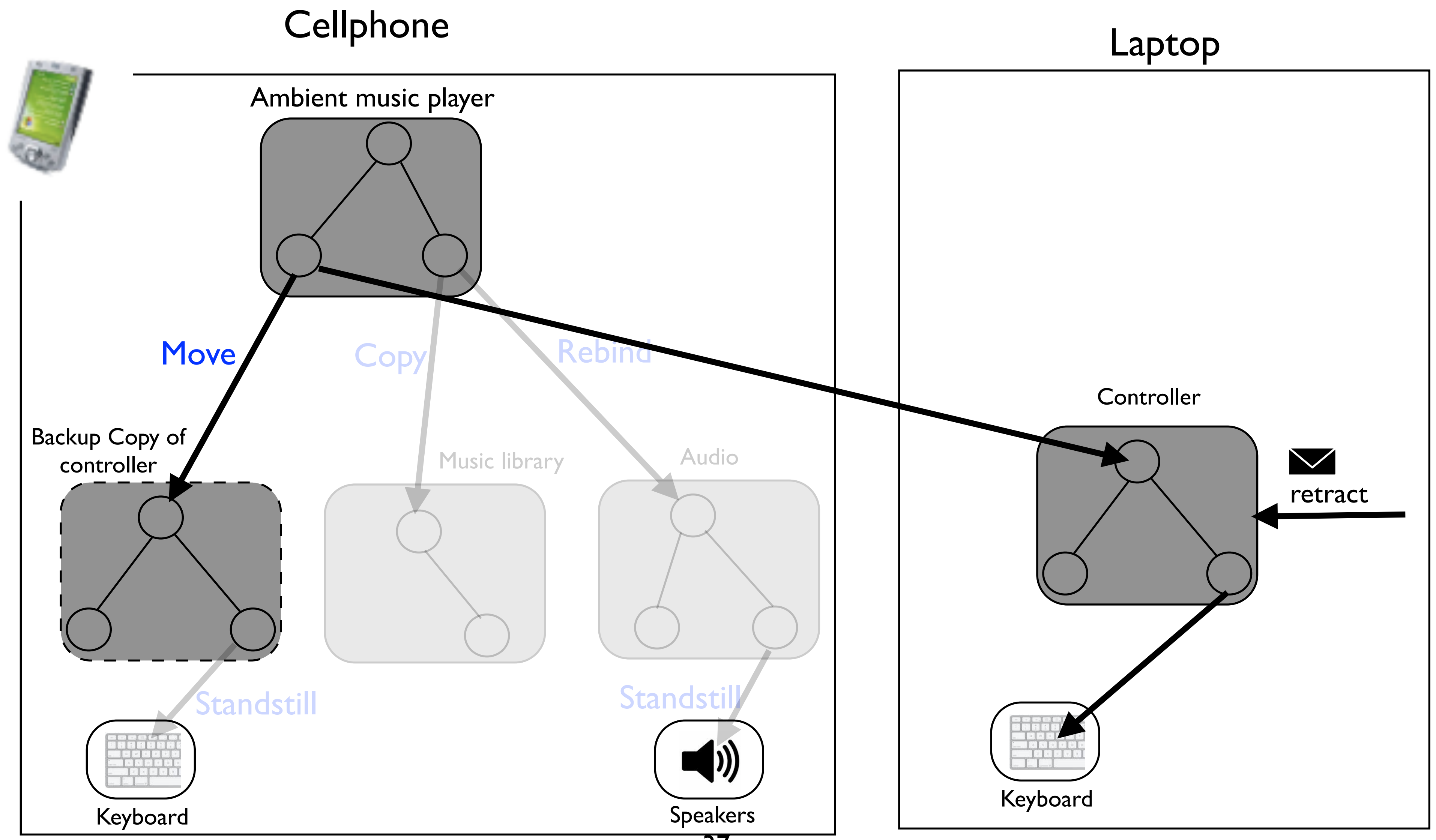
Stretch under Move Strategy



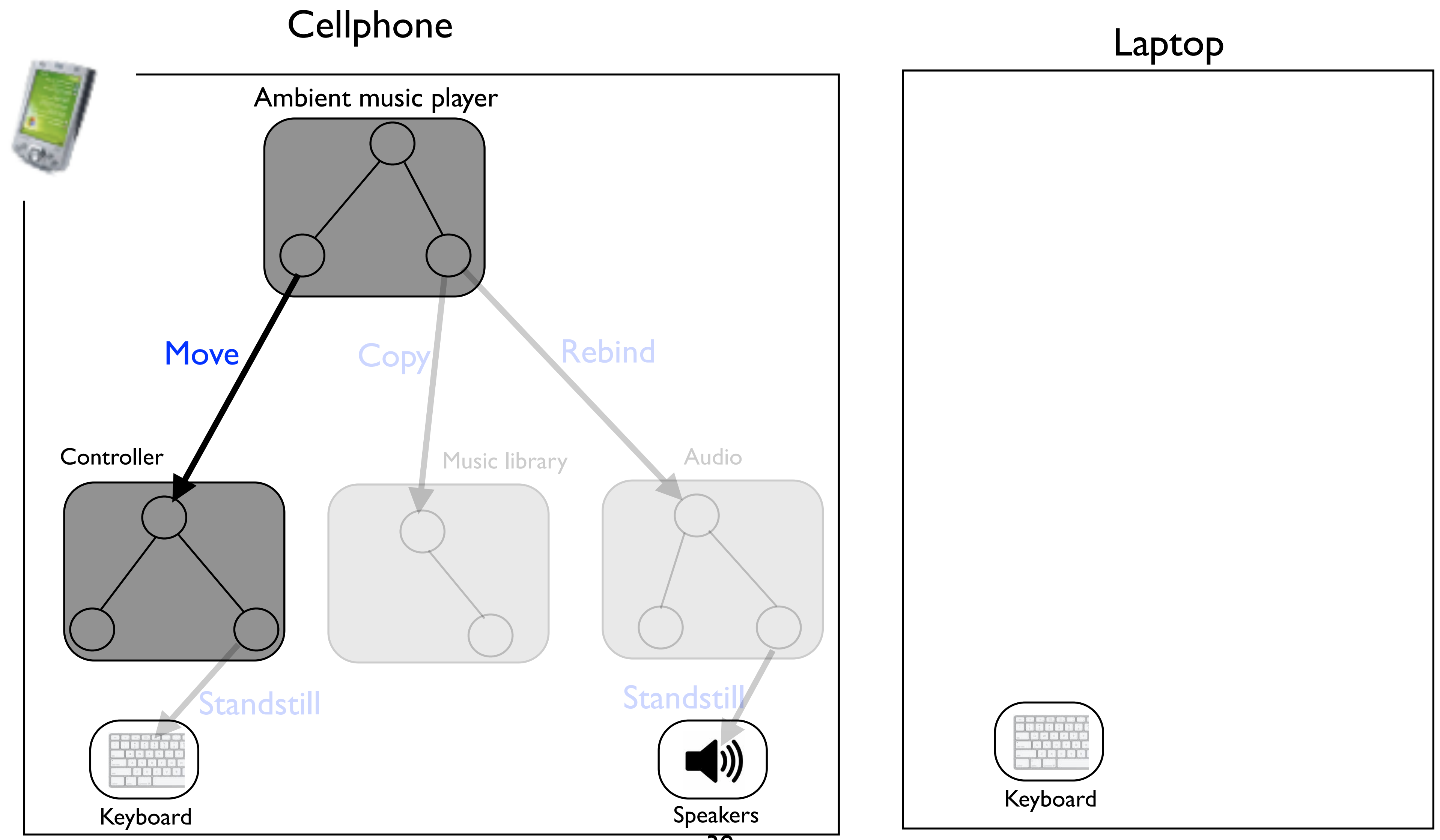
Stretch under Move Strategy



Retract under Move Strategy



Retract under Move Strategy



Resilient Actors in AmbientTalk

AmbientTalk (Van Cutsem et. al, 2007)

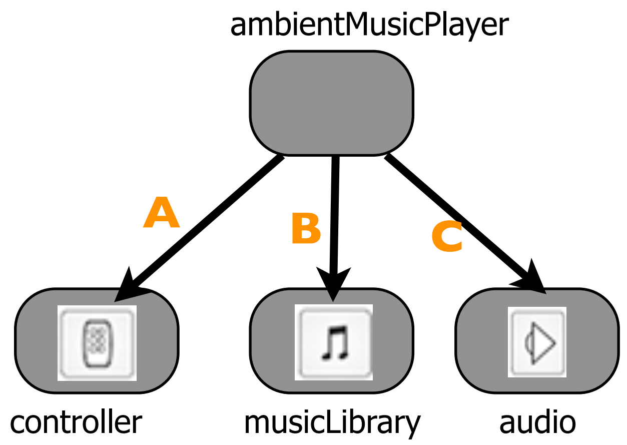
- An actor-based language for pervasive computing environments
- Publish/Subscribe service discovery
- Network failure handling mechanisms

Four language constructs for service partitioning:

actor: resilientAs: and **bindTo: resilientAs:**

stretch: and **retract:**

Example: Ambient music player



```
def controller := actor: {
   def theKeyboard := ...;
   def getInput() { ... };
   ....
} resilientAs: [move];

def musicLibrary := actor: {
   def myLib := Vector.new();
   def getPlayList(){ ... }
   ....
} resilientAs: [copy];

def audio := actor: {
    def theSpeaker := ..;
    .....
} resilientAs: [move];
```

```
def ambientMusicPlayer :=actor:{
    |controller, audio, musicLibrary|                       A
   def theController := bindTo: controller  resilientAs:[move];
                                                                  B
   def theAudio := bindTo: audio resilientAs: [rebind(audioService)];

   def theMusicLib := bindTo: musicLibrary resilientAs: [copy]; C

} resilientAs: [standstill];
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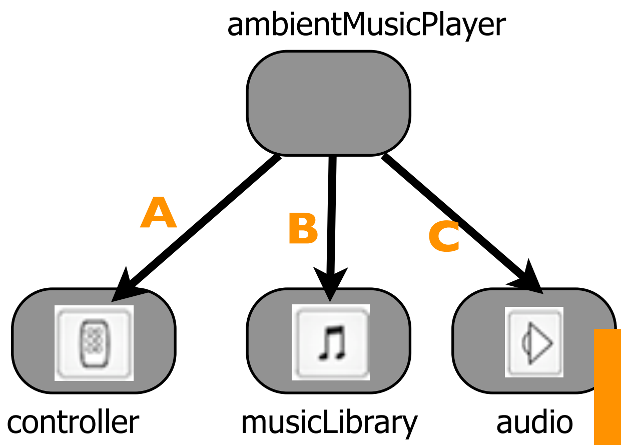

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   def theKeyboard := ...;
   def getInput() { ... };
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} resilientAs: [move];

def audio := actor: {
    def theSpeaker := ..;
    .....
} resilientAs: [move];
```

```
def Hi-FiSystem := ...//reference to a Hi-Fi system actor
audio <-  stretch: Hi-FiSystem;

audio <- retract;
```

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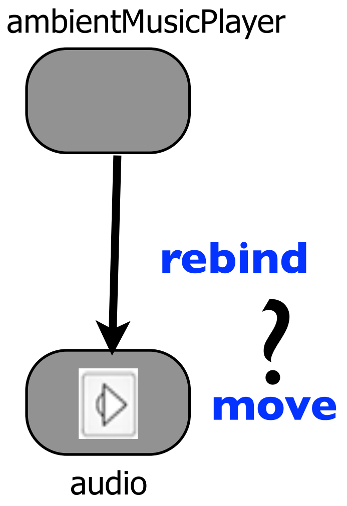
Resolution of Strategies



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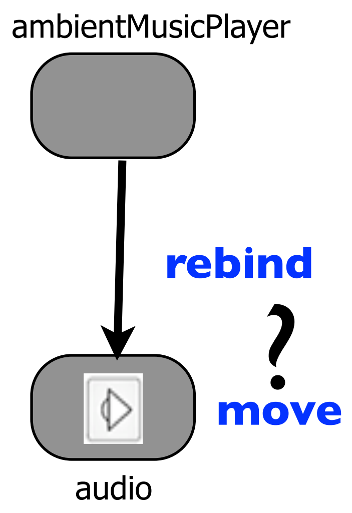

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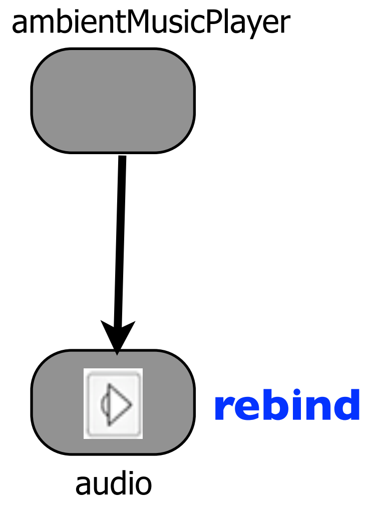
Conflict resolution mechanism

Elastic binding strategy	**Resilient actor strategy**
{rebind, standstill}	{resilience strategy}*
{move, copy}	{resilience strategy}*

Resolution of Strategies



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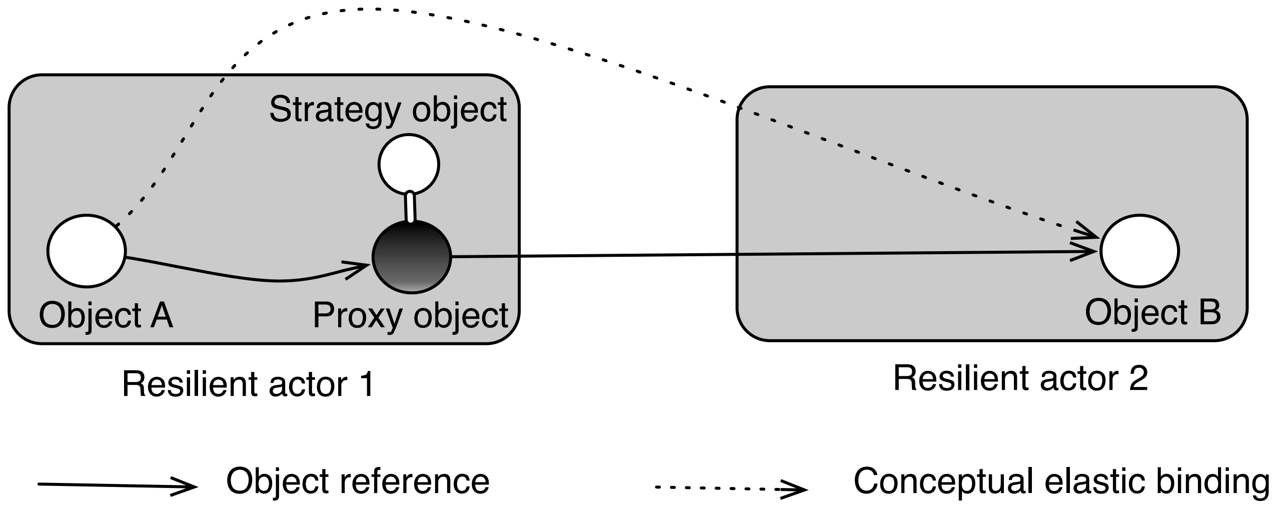
Conflict resolution mechanism

Elastic binding strategy	Resilient actor strategy
{rebind, standstill}	{resilience strategy}*
{move, copy}	{resilience strategy}*

Implementation

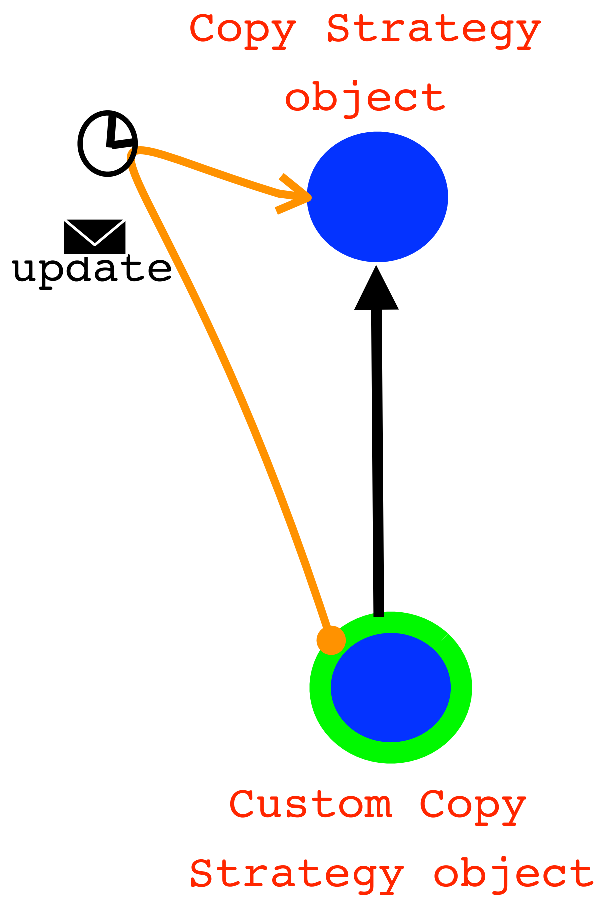
- Reflectively implemented on top of AmbientTalk
- Resilience strategies as objects
- Elastic bindings as proxy objects



Extensible Implementation

Custom Resilience Strategies

e.g Towards proactive replication



```
def copyStrategyExtension := extend:
 copyStrategy with: {
    def time := 10;
    def stretch: location {
     super^stretch: location;
      whenever: seconds(time) elapsed: {
       //...update state
       };
    };
};
```

In Summary

- Need for Resilient Partitioning of Pervasive Computing Services

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    - Resilient actors
    - Elastic bindings
    - Partitioning operations

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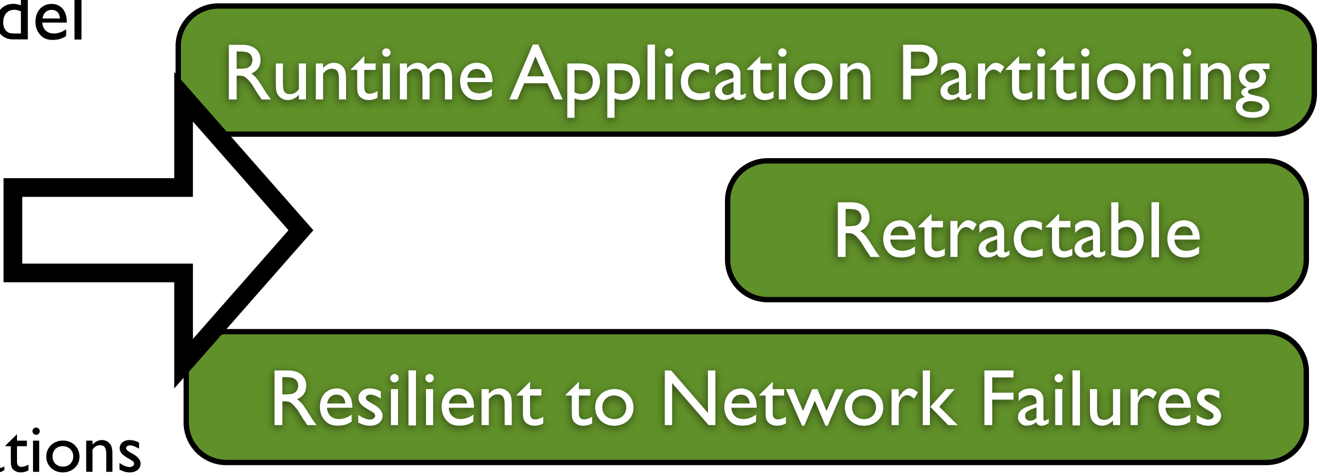
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Retractable
Resilient to Network Failures

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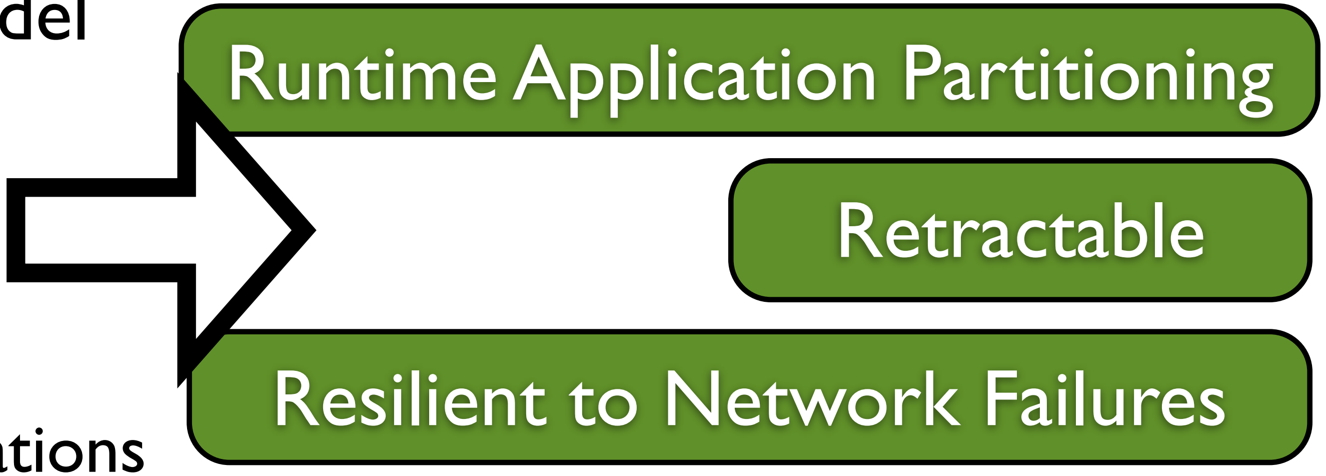
Runtime Application Partitioning
Retractable
Resilient to Network Failures

- Extensible Implementation (Resilience strategies)
- Formal Definition (see *paper*)

Thank You

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