# Tests d'intégration

# Bibliographie


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- Comment écrire du code testable, Conférence Agile France 2010, Florence CHABANOIS
- Reflexion on Software Quality and Maintenance, Alexandre Bergel, Chili
- An Introduction to Test-Driven Development (TDD), Craig Murphy
- Tests et Validation du logiciel, http://home.nordnet.fr/~ericleleu
- Test à partir de modèles : pistes pour le test unitaire de composant, le test d'intégration et le test système, Yves Letraon
- Les tests en orienté objet, J. Paul Gibson http://www-inf.int-evry.fr/cours/CSC4002/Documents
- Mocks and Stubs, Martin Fowler
- Introduction au test du logiciel, Premiers pas avec JUnit, Mirabelle Nebut
- Écrire du code testable Par Aurélien Bompard

# Tests d'intégration

✓Différents modules d'une application peuvent fonctionner unitairement, leur intégration, entre eux ou avec des services tiers, peut engendrer des dysfonctionnements.

✓Il est souvent impossible de réaliser les tests unitaires dans l'environnement cible avec la totalité des modules à disposition.

➡Les tests d'intégration ont pour objectif de créer une version complète et cohérente du logiciel (avec l'intégralité des modules testés unitairement) et de garantir sa bonne exécution dans l'environnement cible.

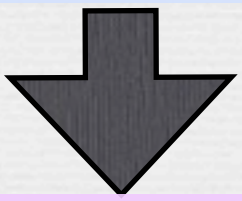
# Tests d'intégration

**Objectif**

Vérifier les interactions entre composants unitaires

**Difficultés principales de l'intégration**

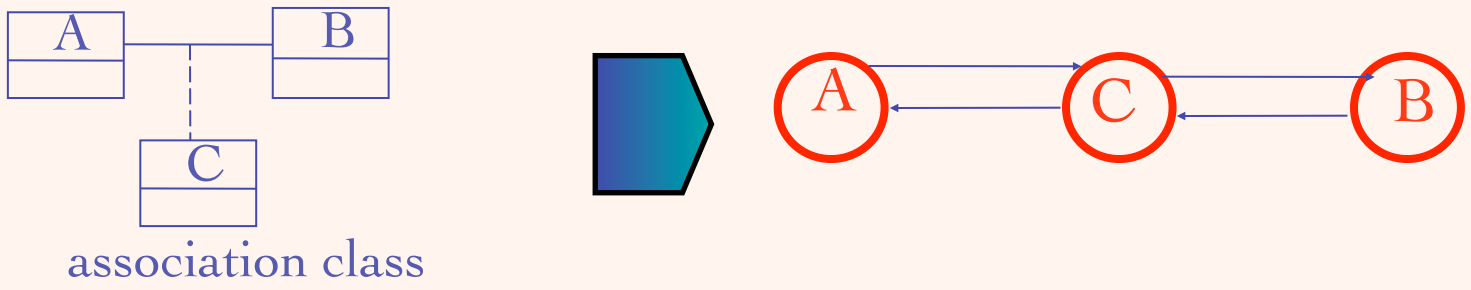
- Interfaces floues
- Implantation non conforme à la spécification
- Réutilisation de composants

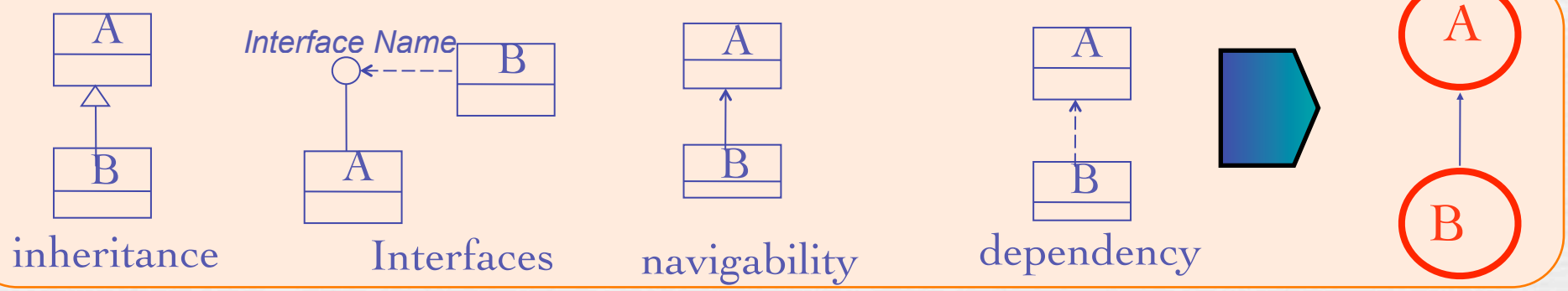


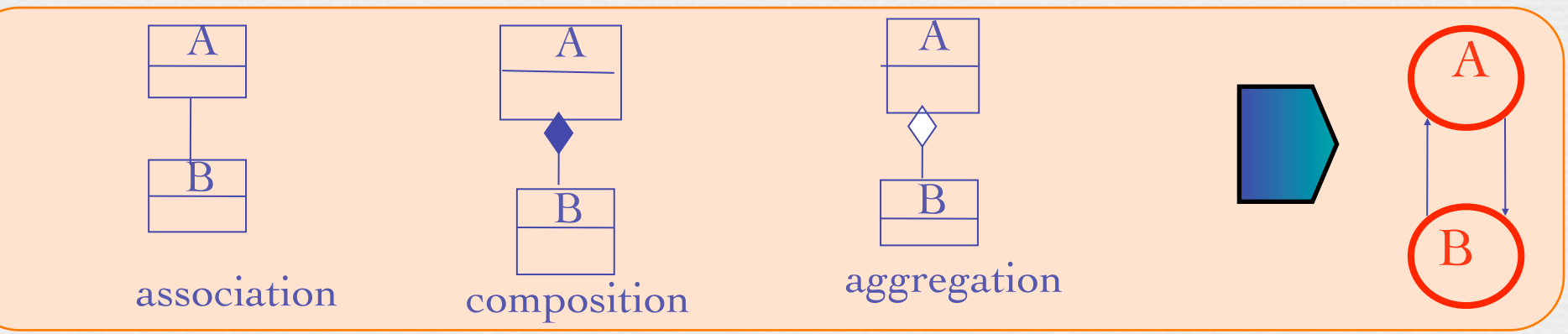
1) modéliser la structure de dépendances entre chaque composant et son environnement (graphe de dépendance des tests)

2) Choisir un ordre pour intégrer (assembler)

# Graphe de dépendance : construction



# Compilateur GNU pour Eiffel :

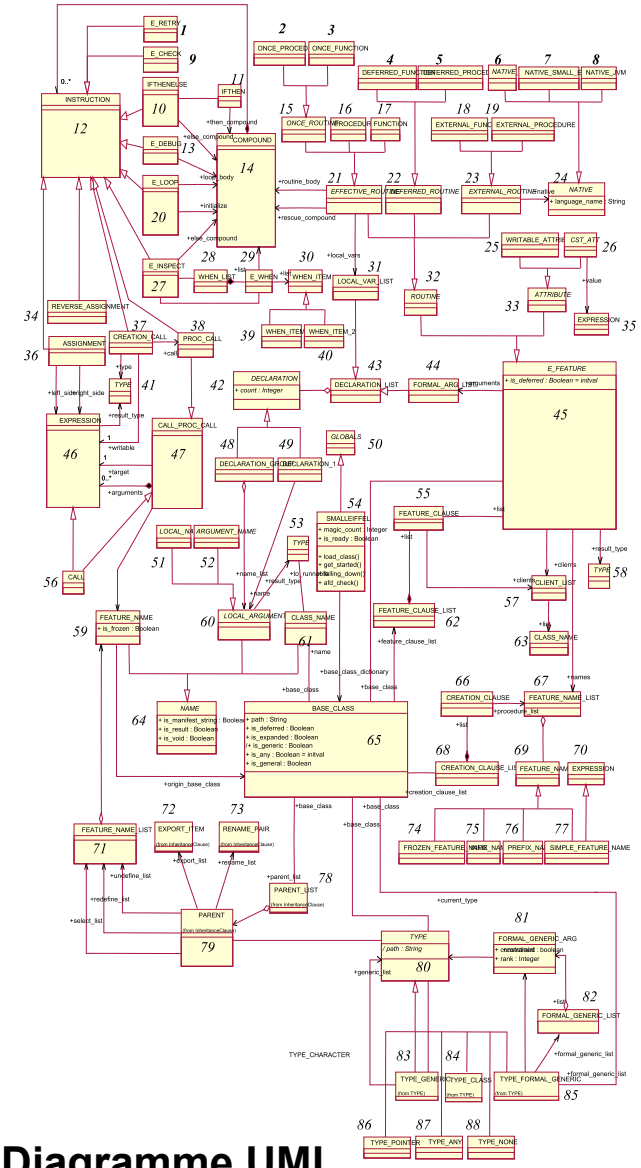
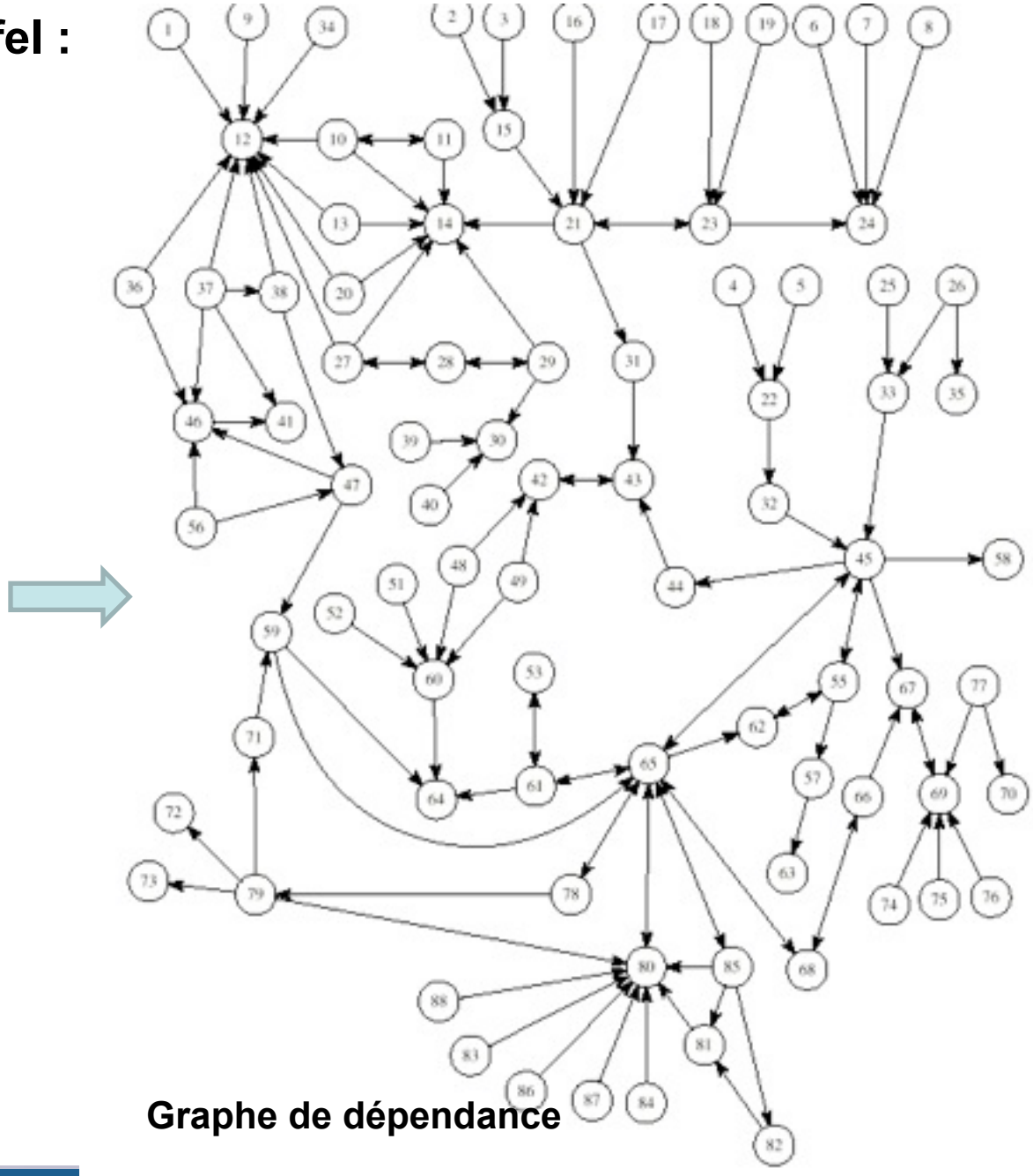


**Diagramme UML**



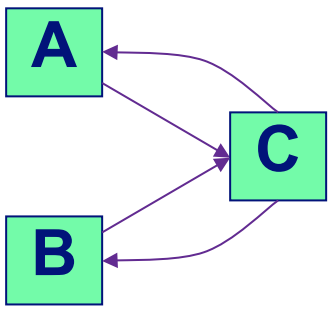
**Graphe de dépendance**

# Test d'intégration : les interdépendances

- Une solution simple consiste à contraindre le concepteur
  - pas de boucle dans l'architecture
    - c'est souvent possible
    - **mais** les optimisations locales ne sont pas toujours optimales globalement
    - **mais** concevoir des composants interdépendants est souvent naturel

# Bouchon de test

- Bouchon : une unité qui simule le comportement d'une unité

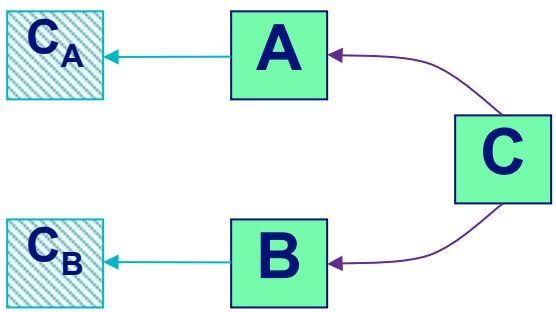



CFC

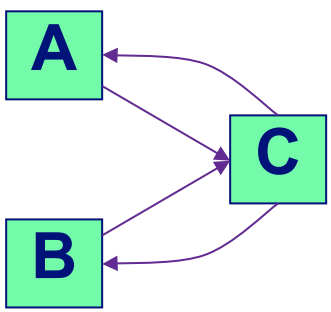
Diffusion Libre

# Bouchon de test

- Bouchon : une unité qui simule le comportement d'une unité




Bouchon spécifique

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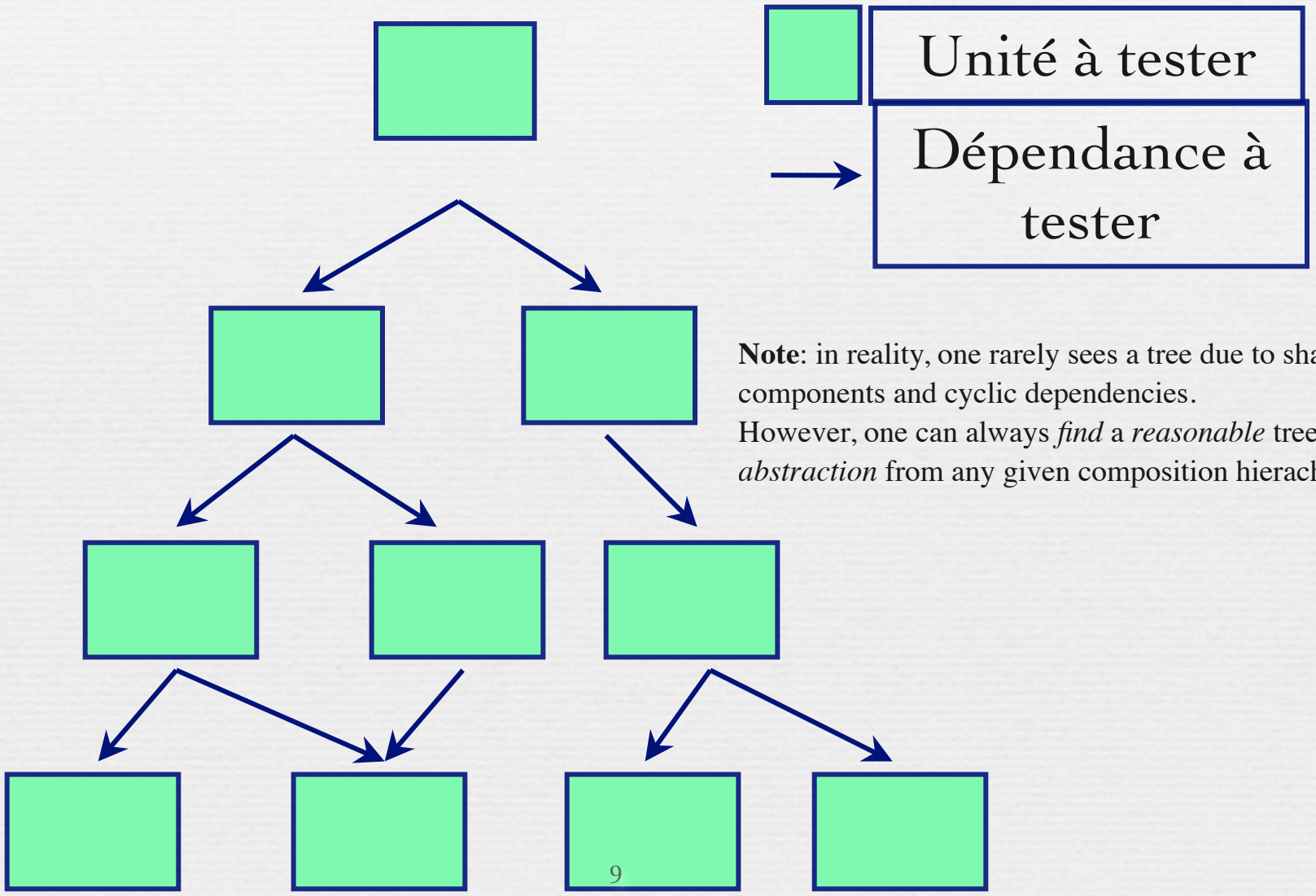
# Tests d'intégration

## ➡Architecture des dépendances

**Note**: in reality, one rarely sees a tree due to shared components and cyclic dependencies.
However, one can always *find* a *reasonable* tree *abstraction* from any given composition hierachy.

# Tests d'intégration

## ➡Architecture des dépendances



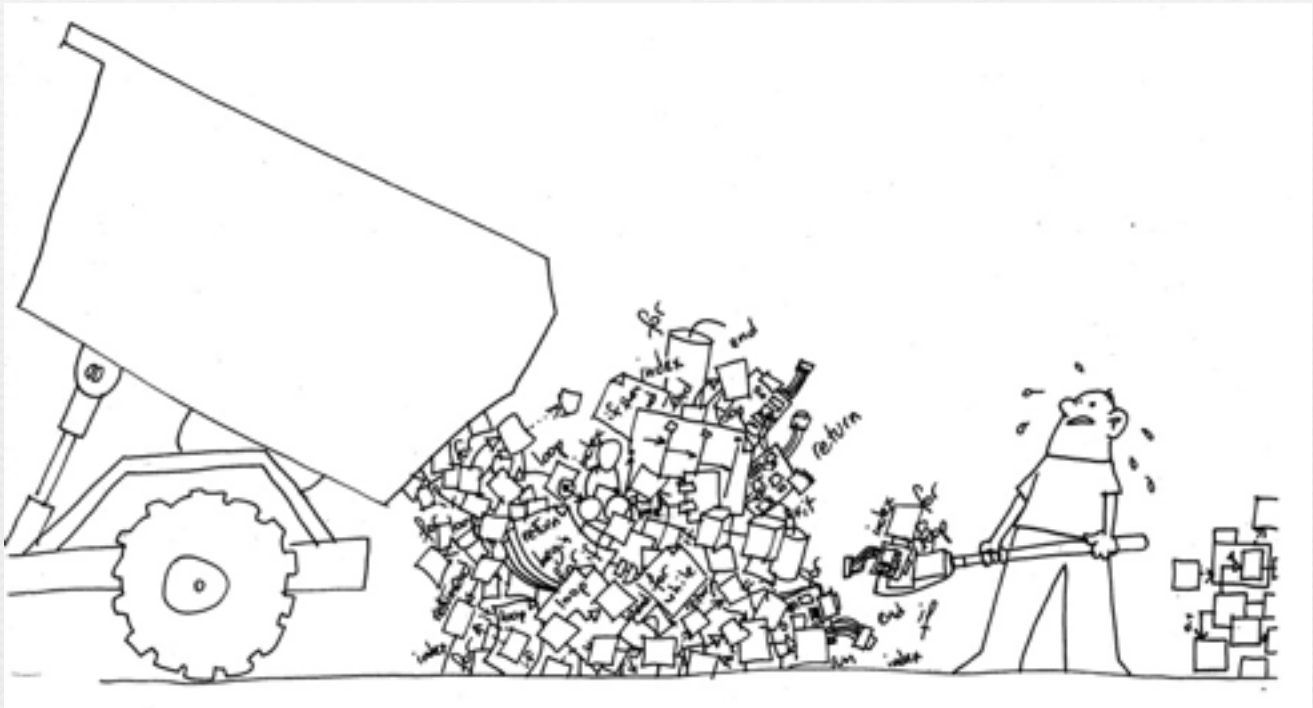

**Note**: in reality, one rarely sees a tree due to shared components and cyclic dependencies.
However, one can always *find* a *reasonable* tree *abstraction* from any given composition hierachy.

# Stratégies

- Big-bang : tout est testé ensemble (peu recommandé)
- Top-down (peu courant)
- Bottom-up (la plus classique)

# Intégration - Big-Bang

- ***Big Bang*** – Validation du système –

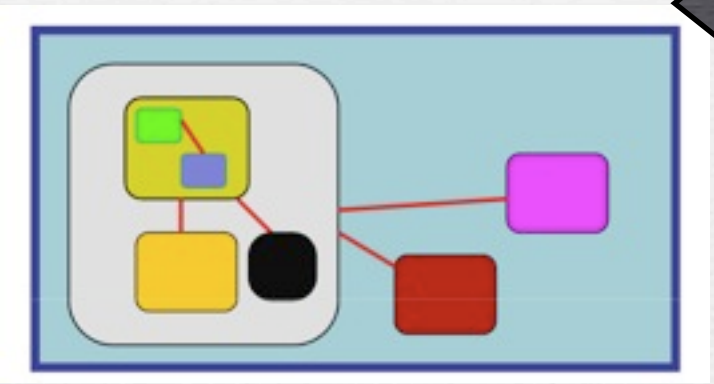


http://emmanuelchenu.blogspot.com/

# Intégration - Big-Bang

Intégration de tous les composants à tester en une seule étape. (intégration massive)

Tests à l'interface du système

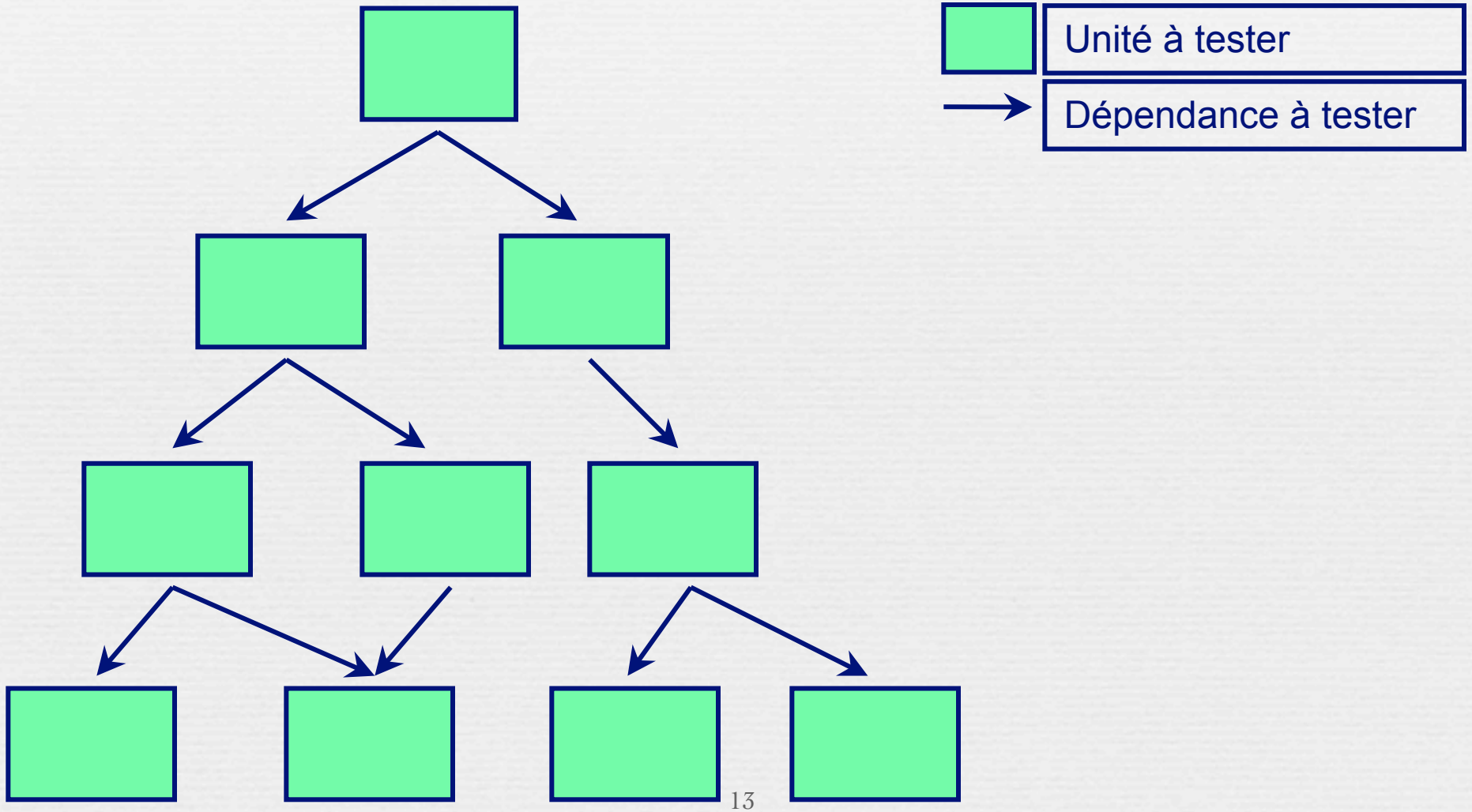


**Usage Model testing**

**Principaux Problèmes:**

- Les tests produisent des erreurs : Quelle en est la cause?
- La complexité induit des tests manquants
- Les tests ne commencent que lorsque tous les composants ont été «codés».

# Approche descendante



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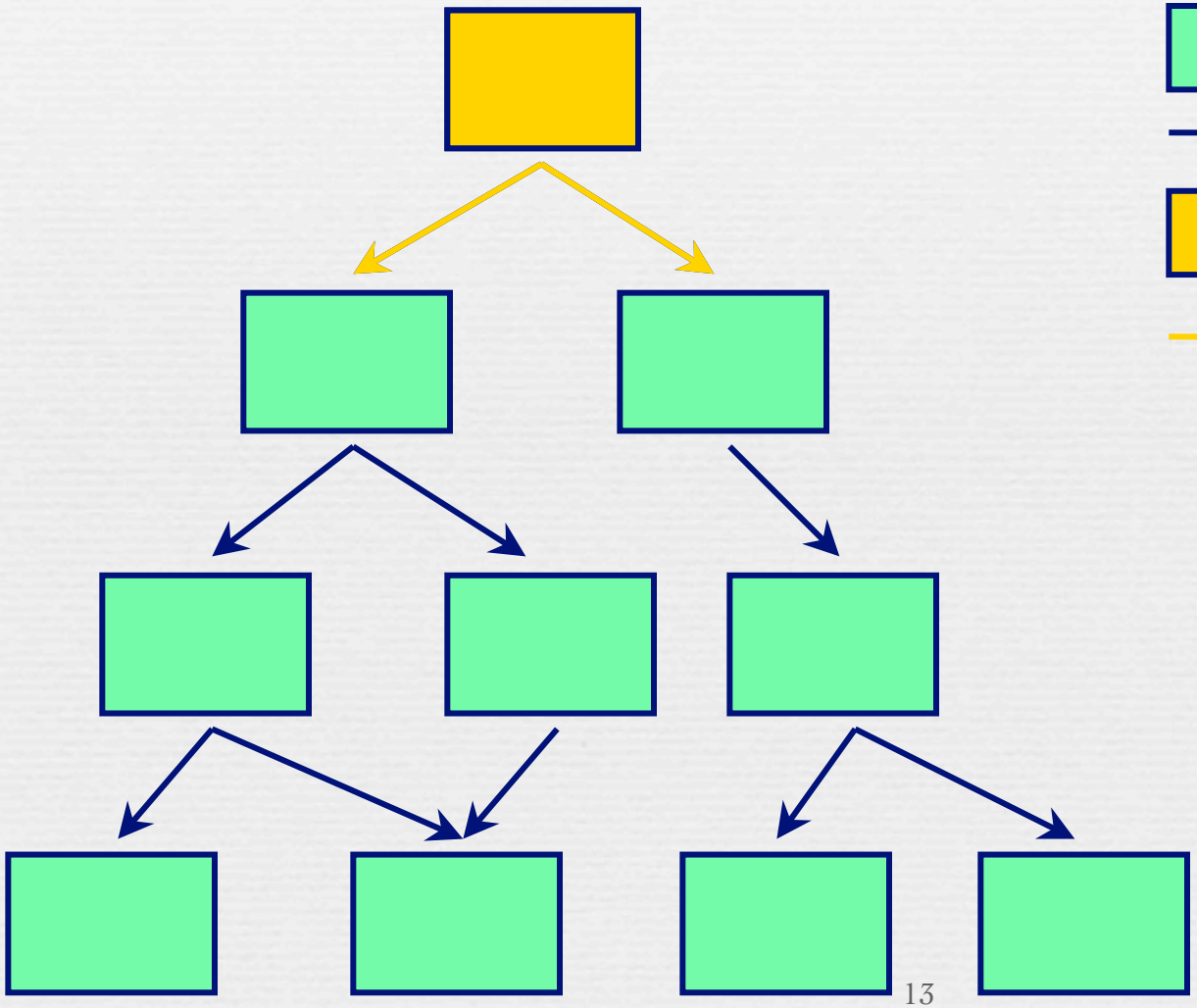

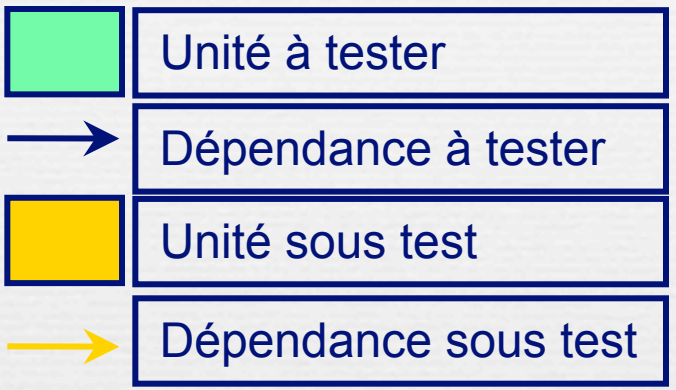

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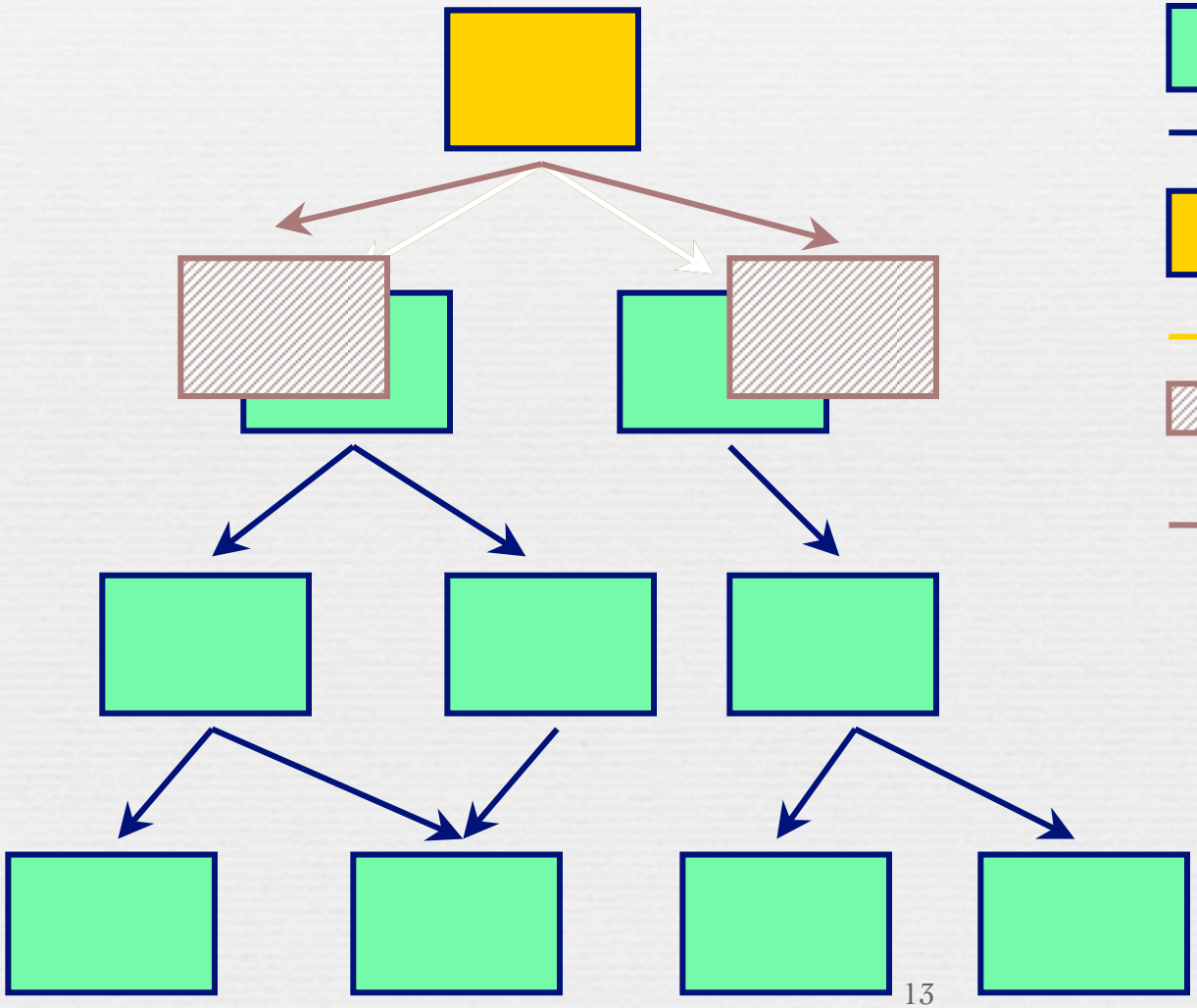

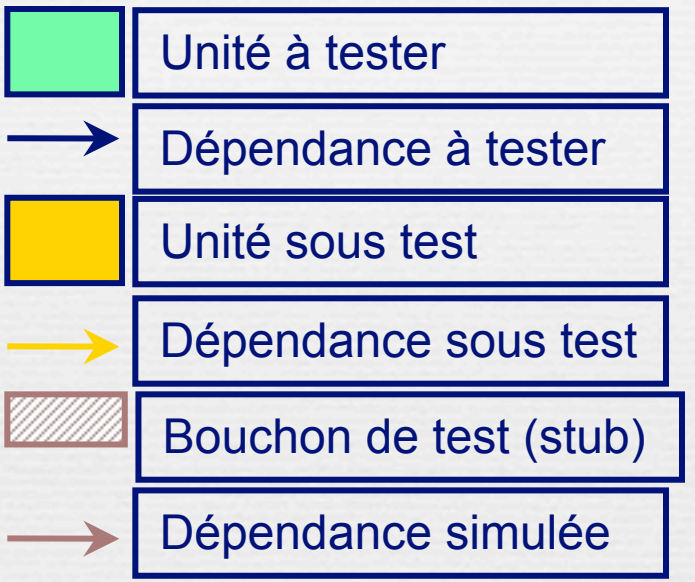

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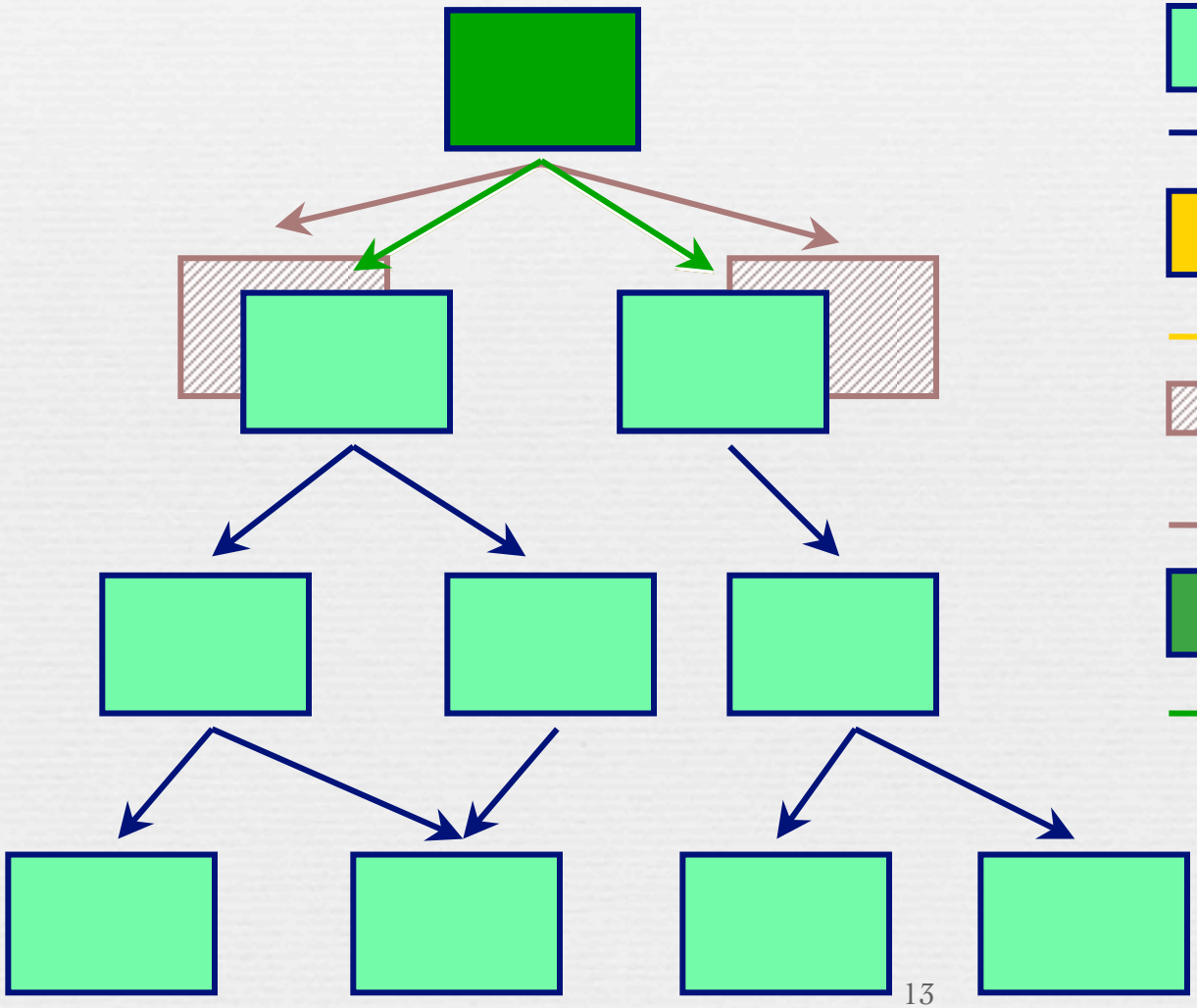

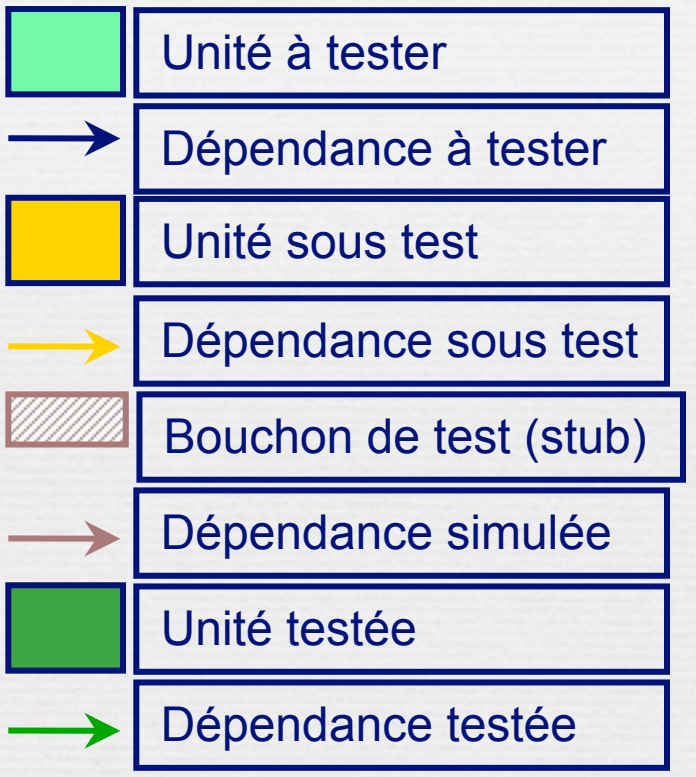

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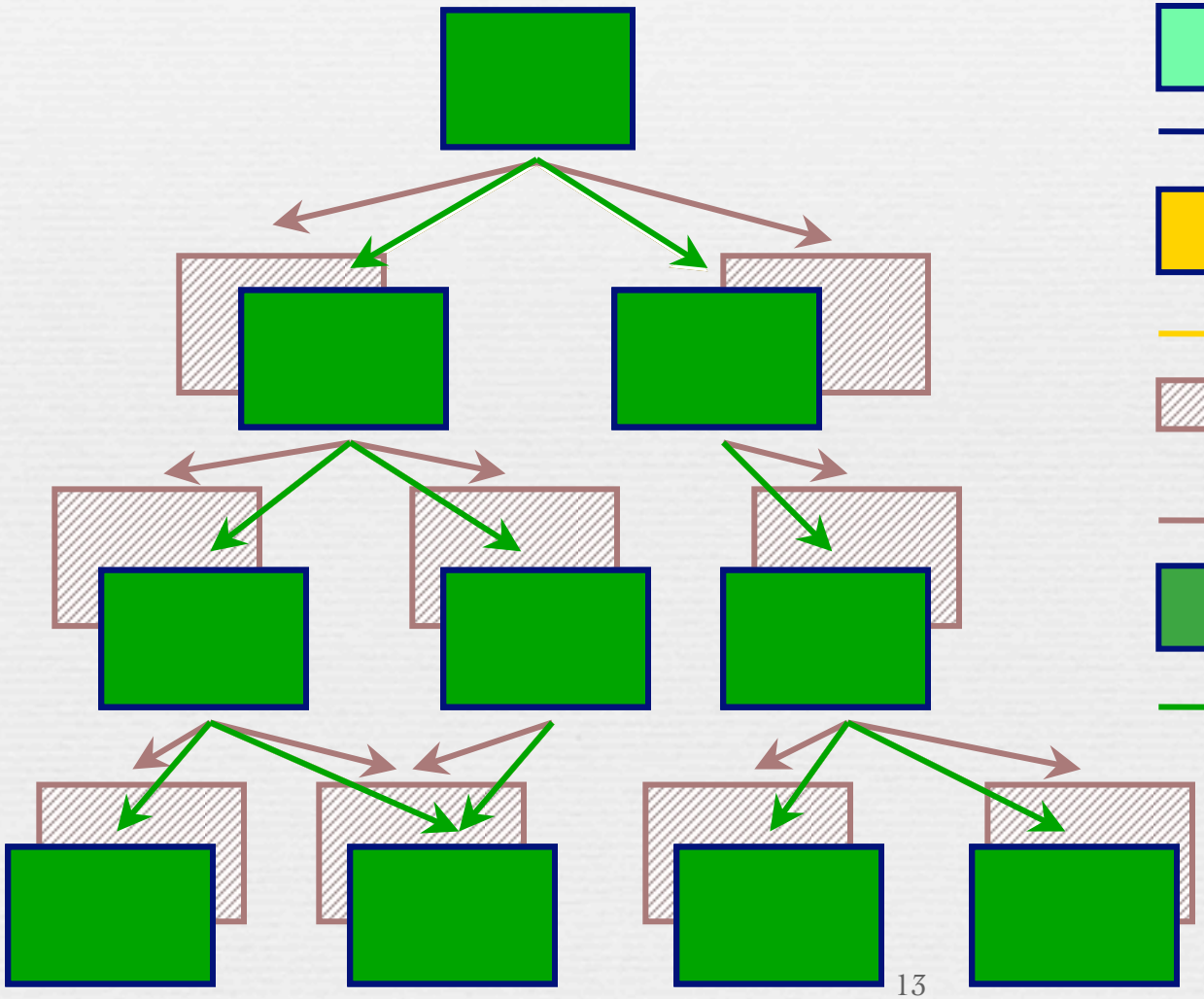
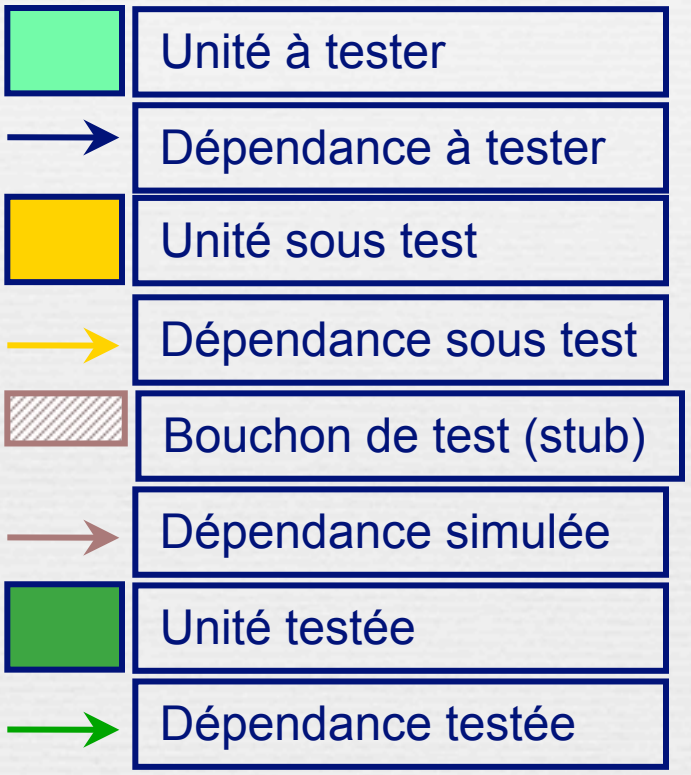


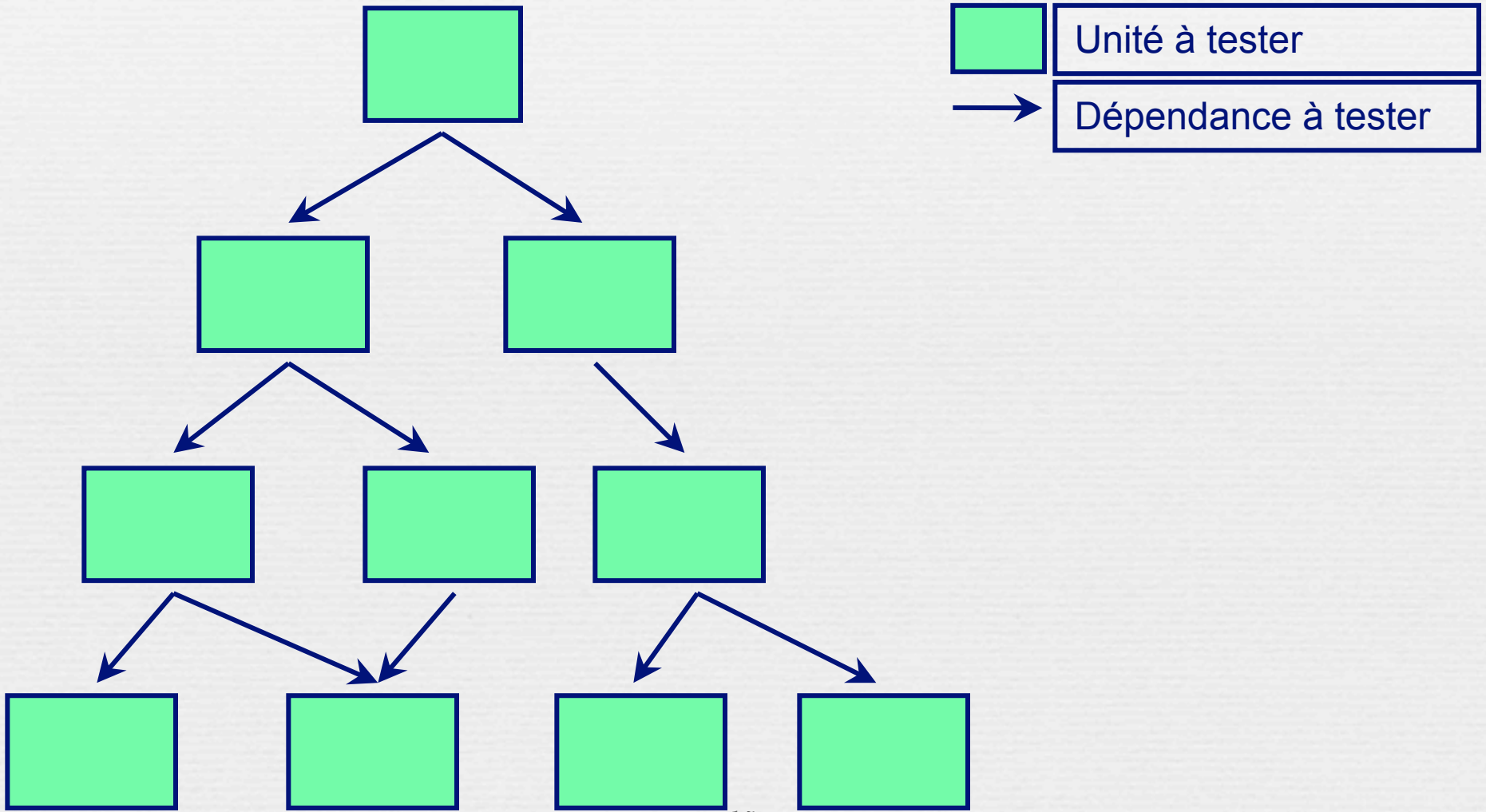


# Approche descendante

- Création de **bouchons**
- Test tardif des couches basses
- Détection précoce des défauts d'architecture

- Effort important de simulation des composants absents et multiplie le risque d'erreurs lors du remplacement des bouchons.
- La simulation par « couches » n'est pas obligatoire

# Approche Ascendante



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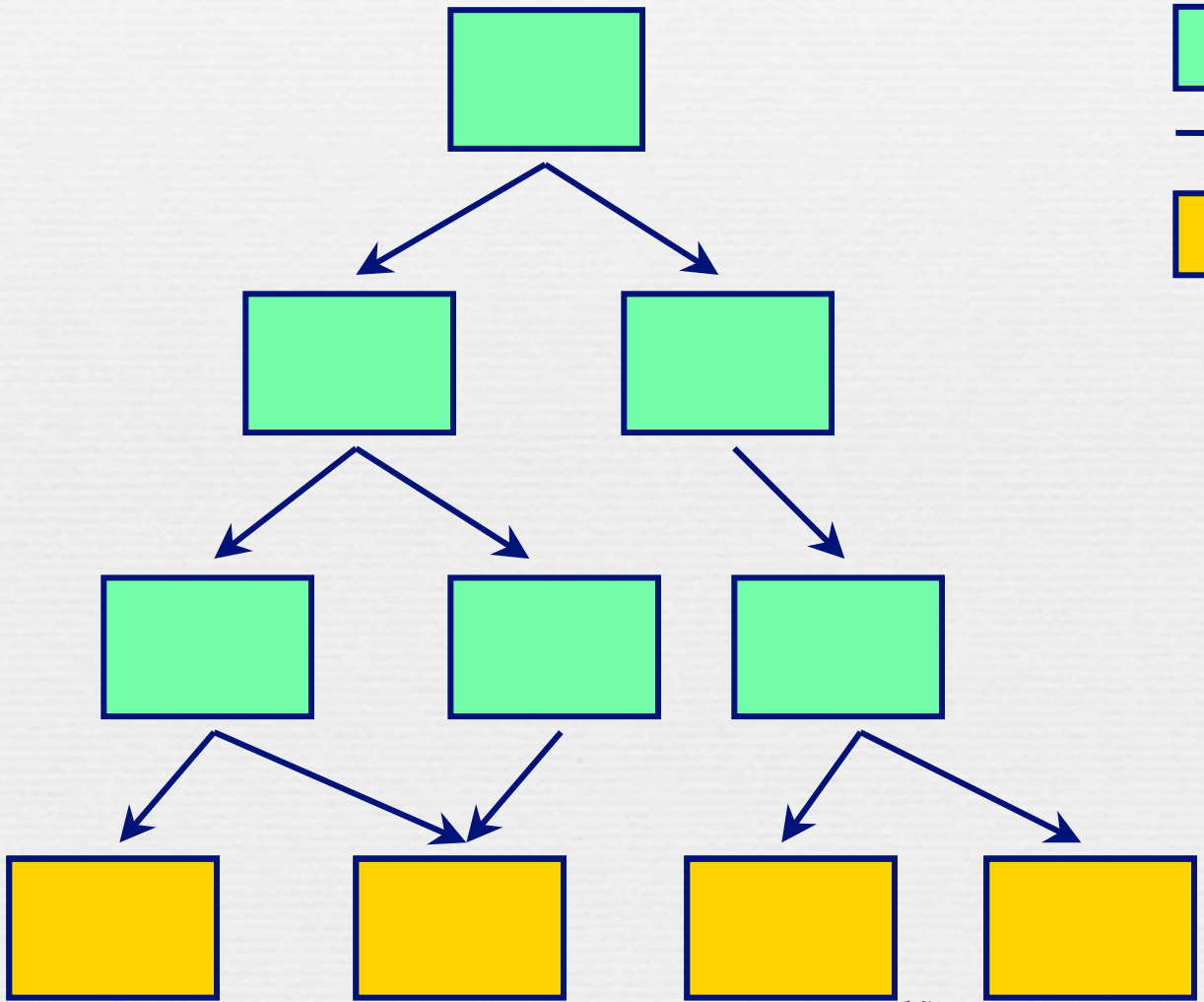

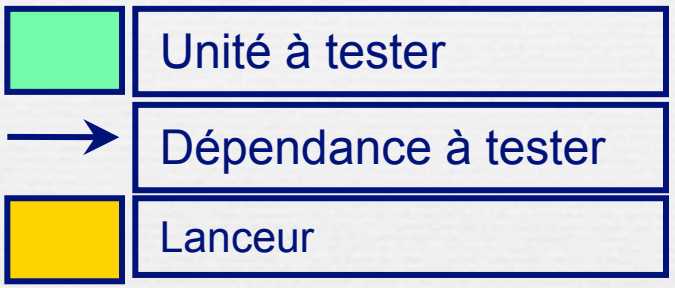

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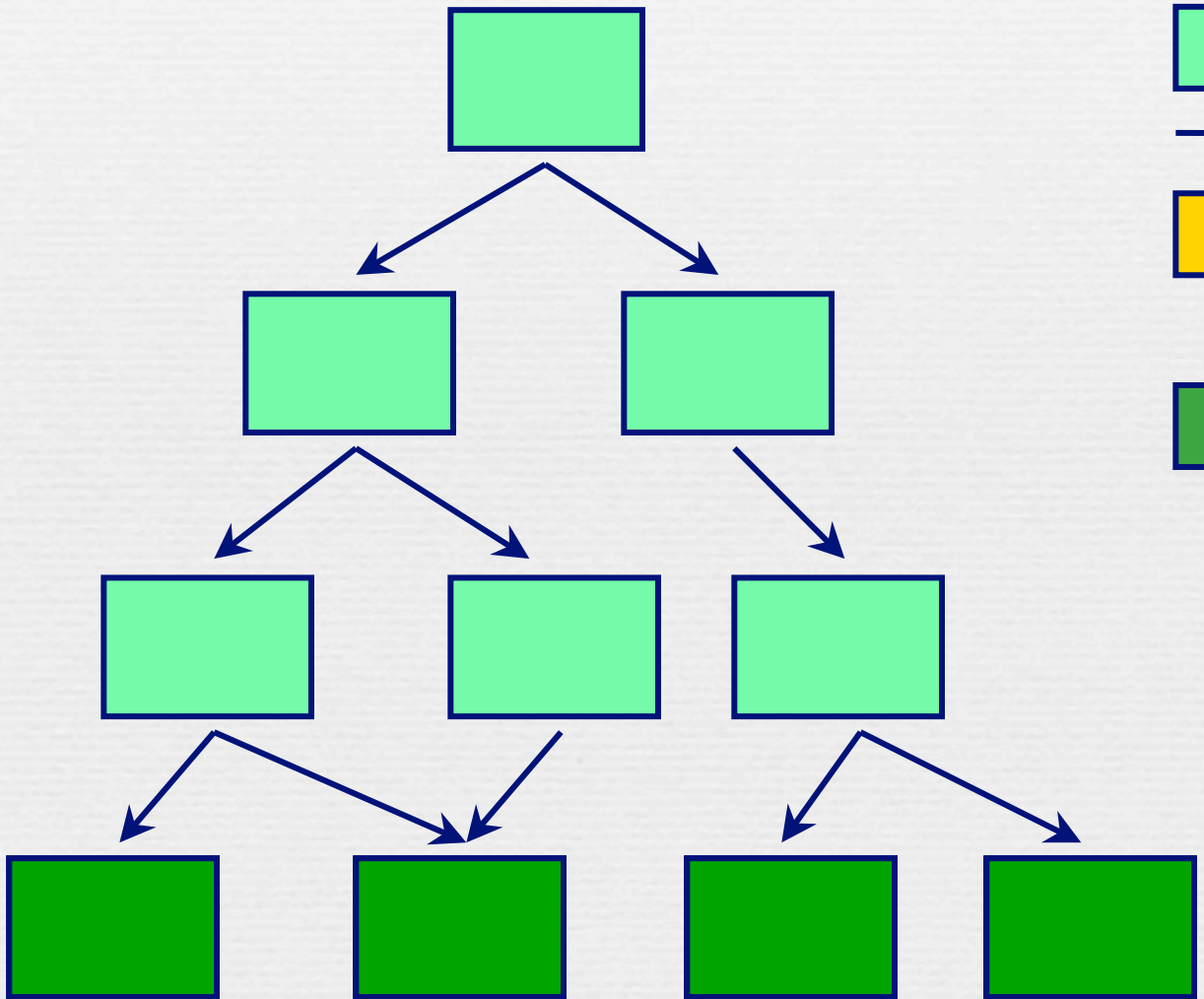

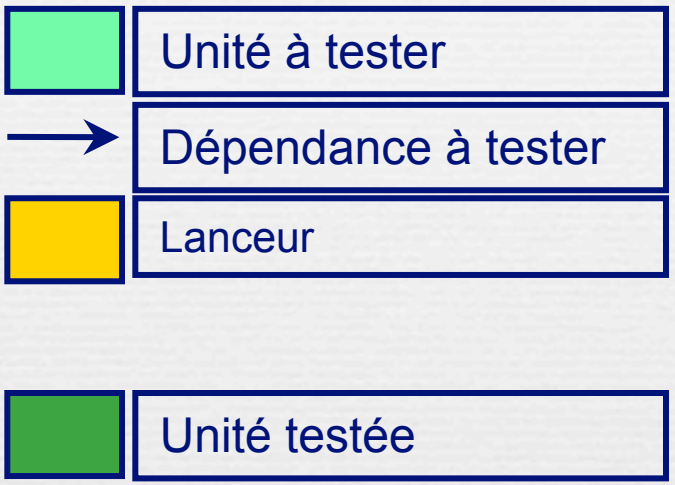

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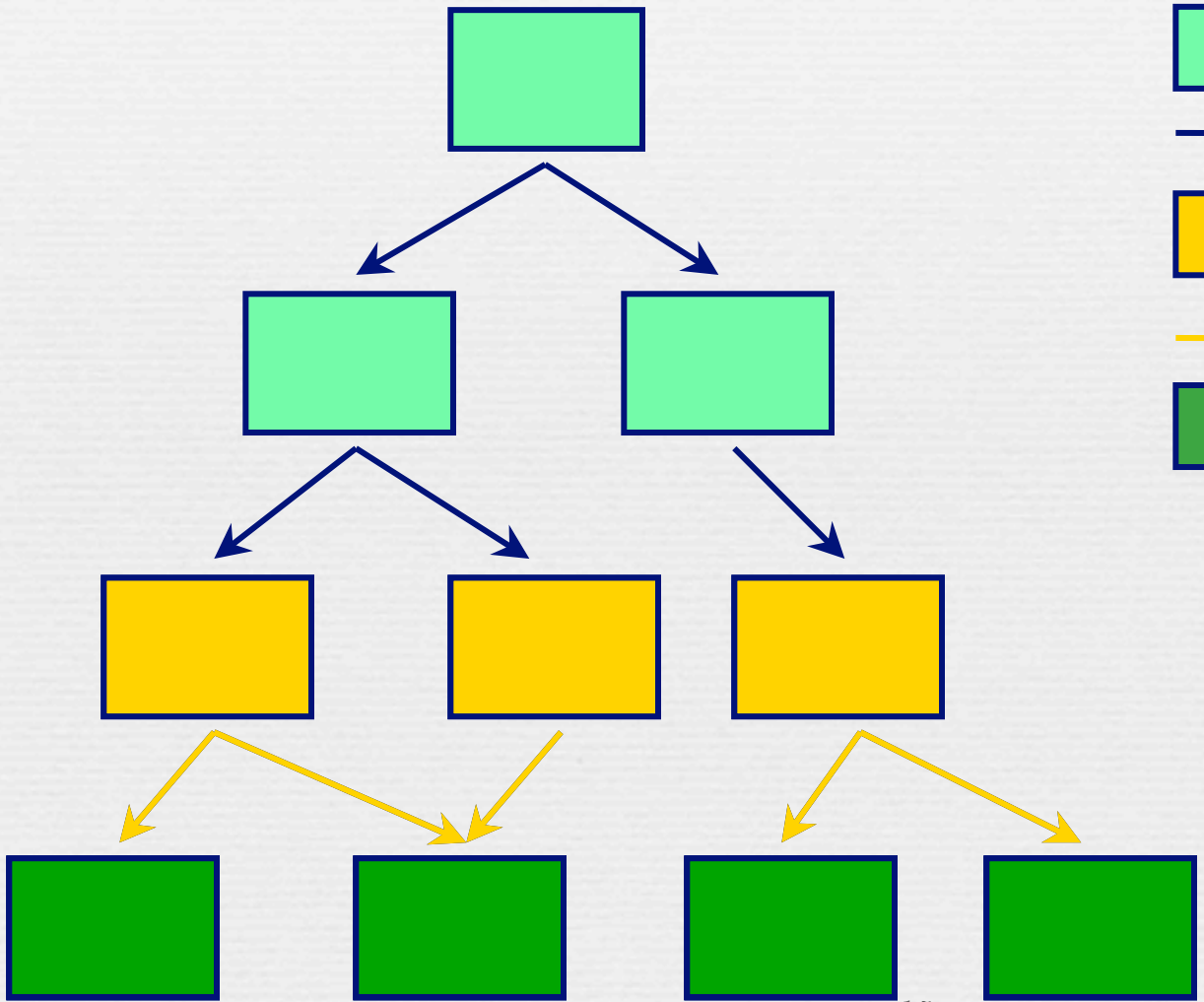

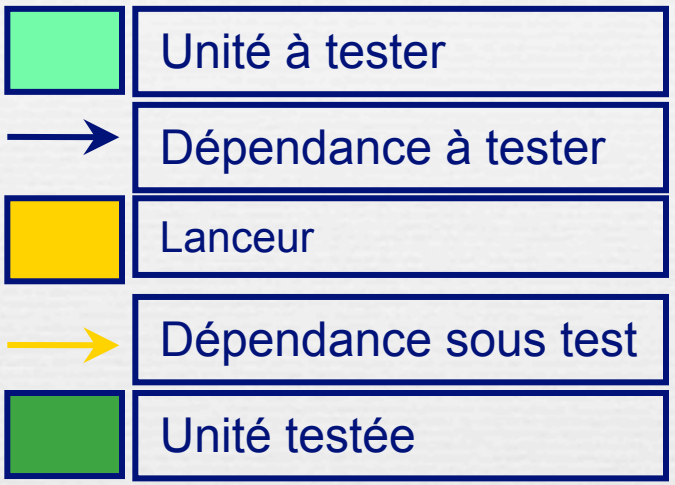

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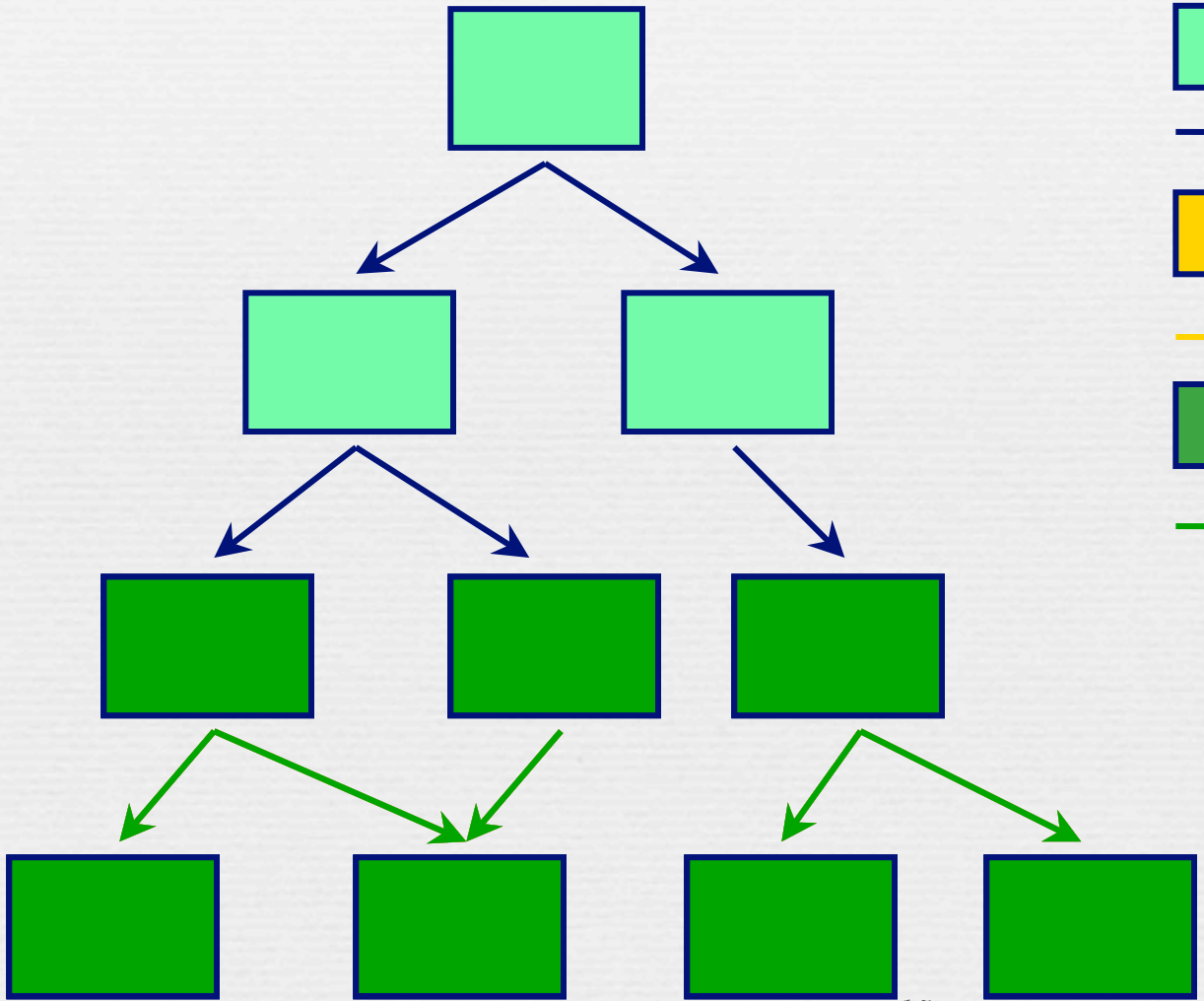

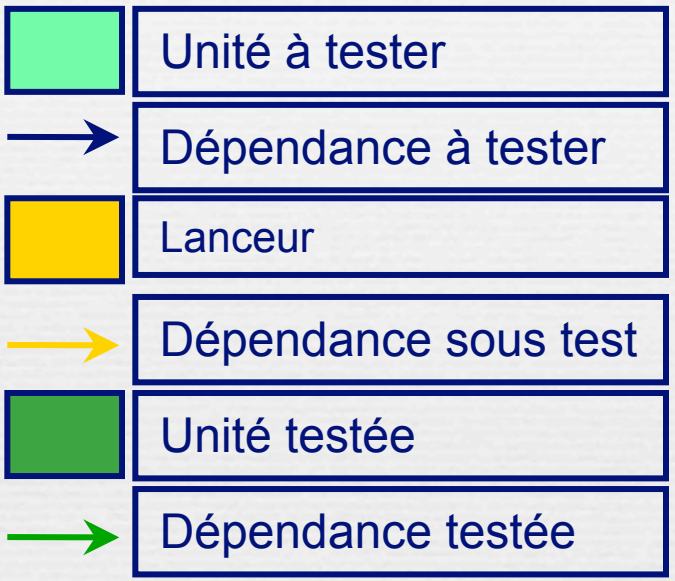

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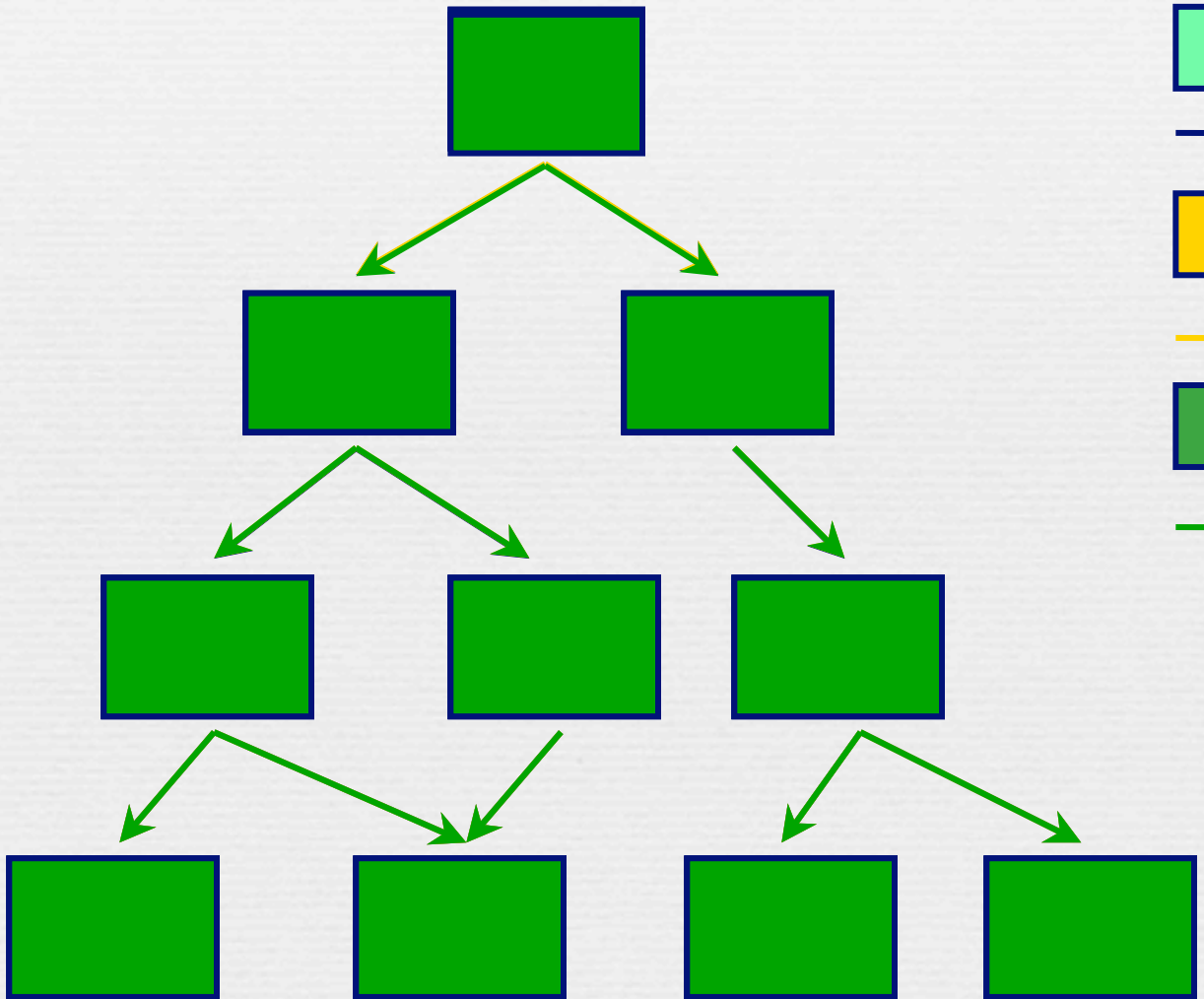
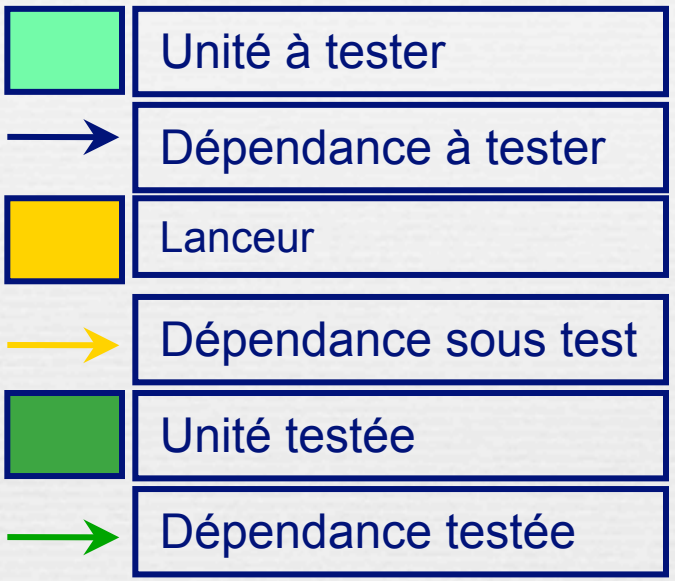




# Approche ascendante

## Avantages

- Faible effort de simulation
- Construction progressive de l'application s'appuie sur les modules réels. Pas de version provisoire du logiciel
- Les composants de bas niveau sont les plus testés,
- Définition des jeux d'essais plus aisée
- Démarche est naturelle.

## Inconvénients

- Détection tardive des erreurs majeures
- Planification dépendante de la disponibilité des composants

# Approche Mixte

- Combinaison des approches descendante et ascendante.
- **Avantages** :
  - Suivre le planning de développement de sorte que les premiers composants terminés soient intégrés en premier ,
  - Prise en compte du risque lié à un composant de sorte que les composants les plus critiques puissent être intégrés en premier.

- La principale difficulté d'une intégration mixte réside dans sa complexité car il faut alors gérer intelligemment sa stratégie de test afin de concilier les deux modes d'intégration : ascendante et descendante.

# Mocks and Stubs

**d'après** Martin Fowler –
http://www.martinfowler.com/articles/mocksArentStubs.html

Légèrement incrémenté par
M. Blay-Fornarino

# Example – Electronic Store

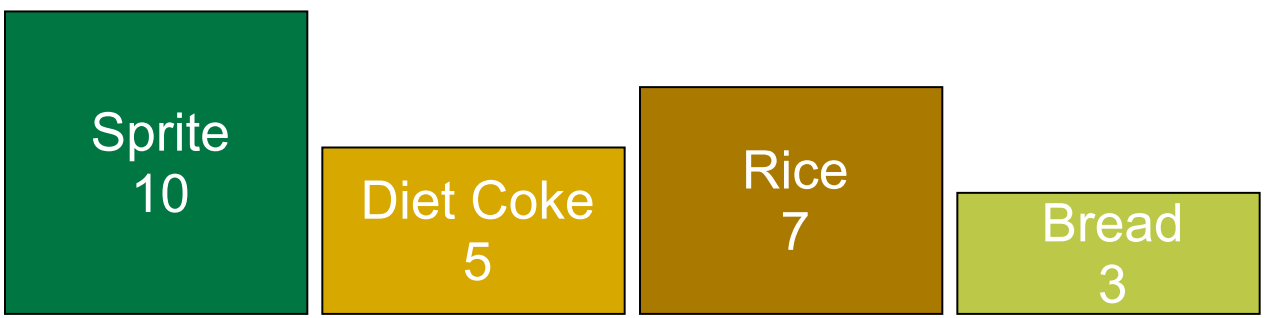
- *Orders* and a *Warehouse*

*Order1*: Diet Coke - 5

*Order2*: Diet Coke - 2

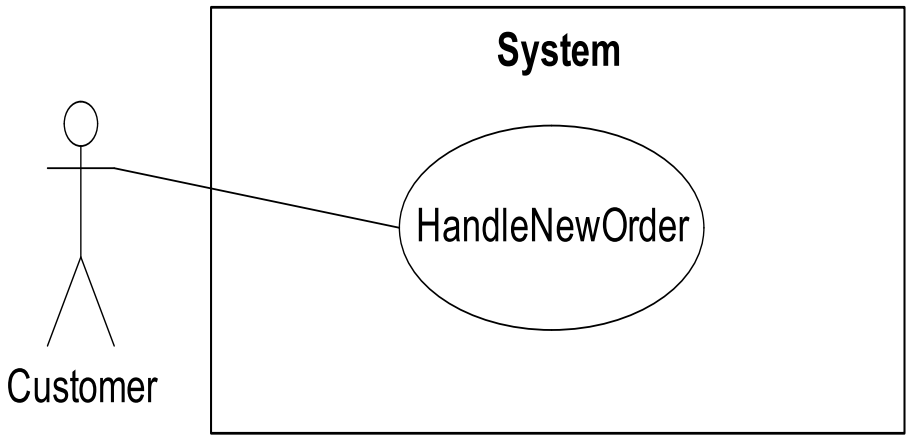
*Order3*: Sprite - 3

*Order4*: Bread - 1

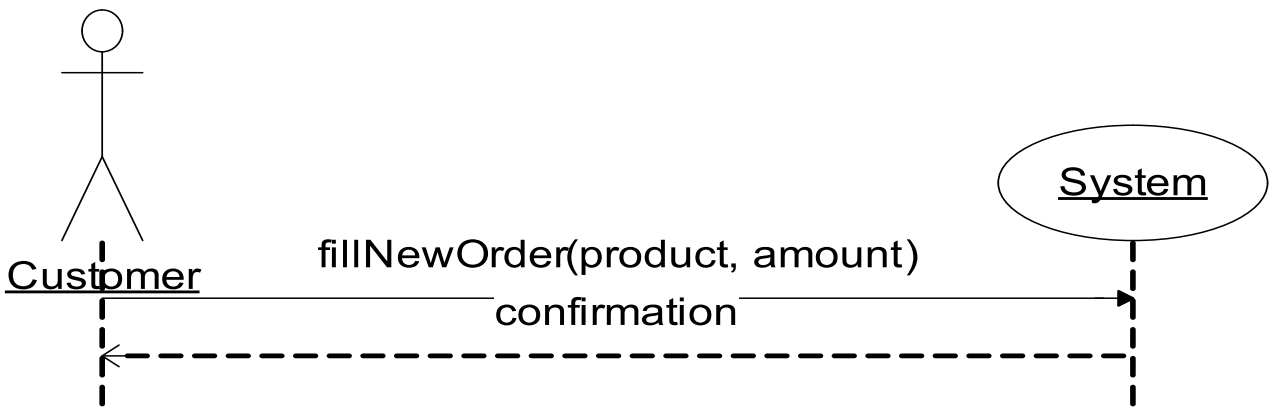


# Example – Electronic Store

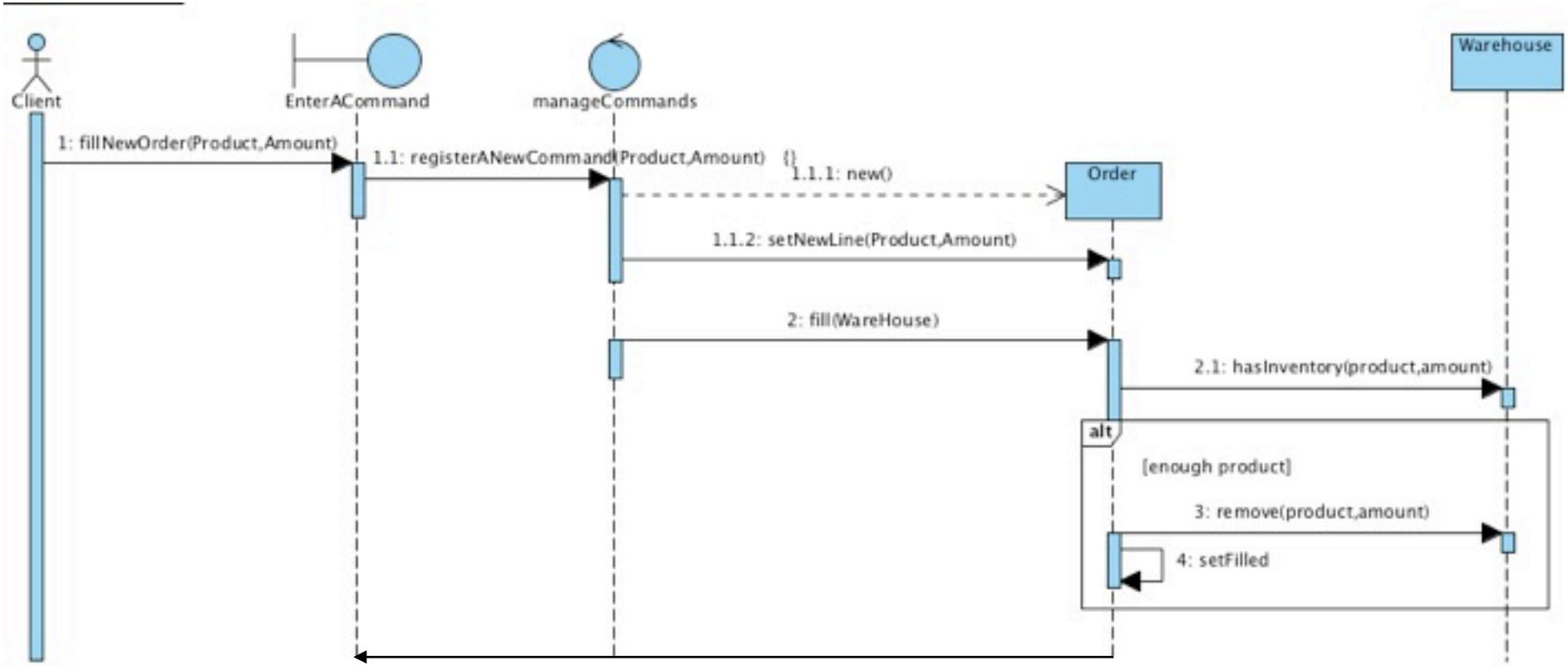
- Use Case Model




- System Sequence



# Diagramme de séquence (Conception)



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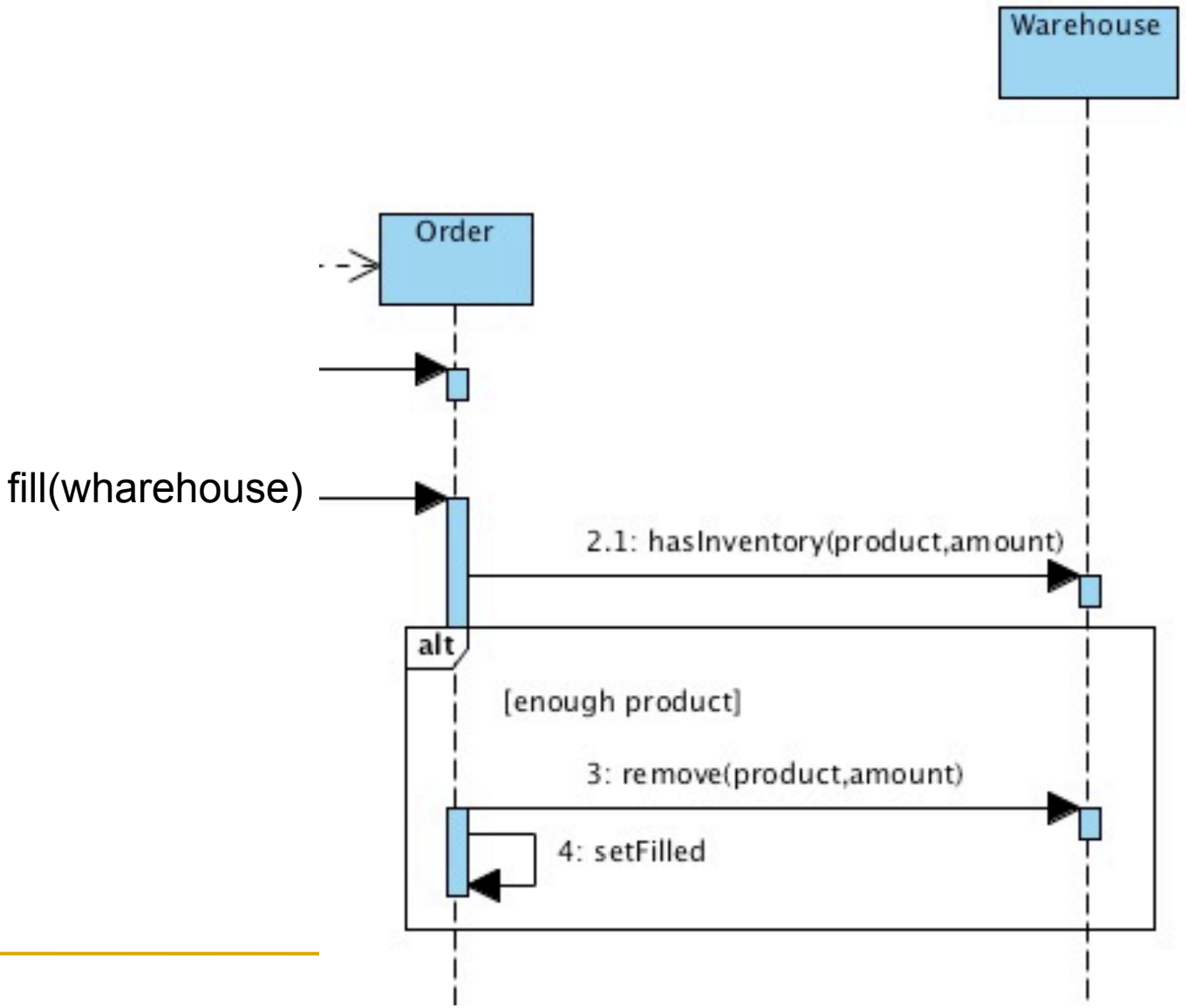
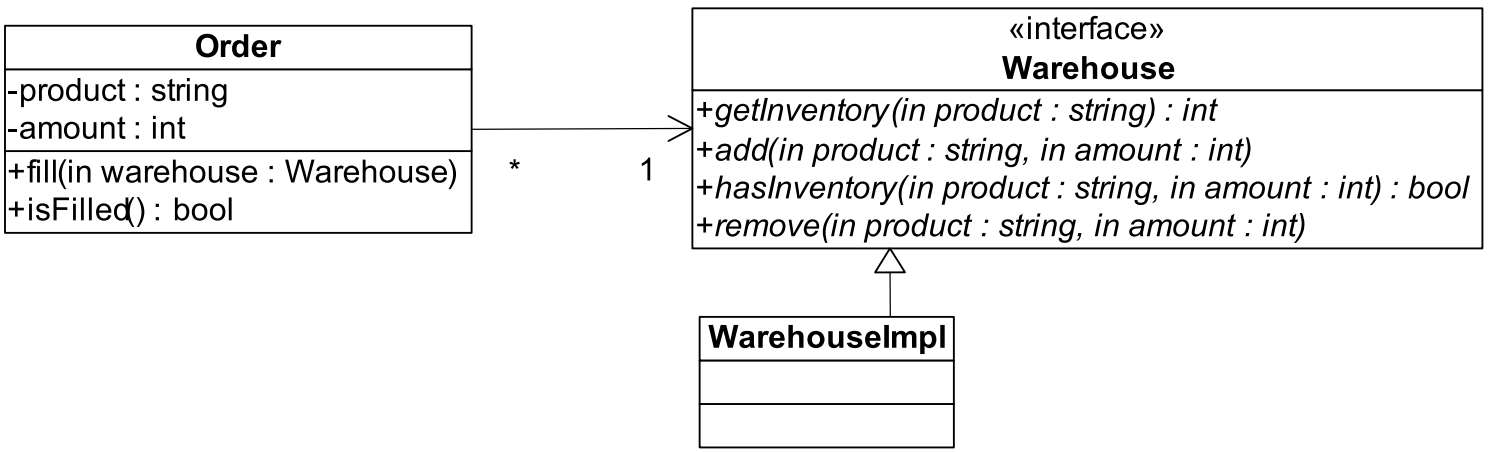
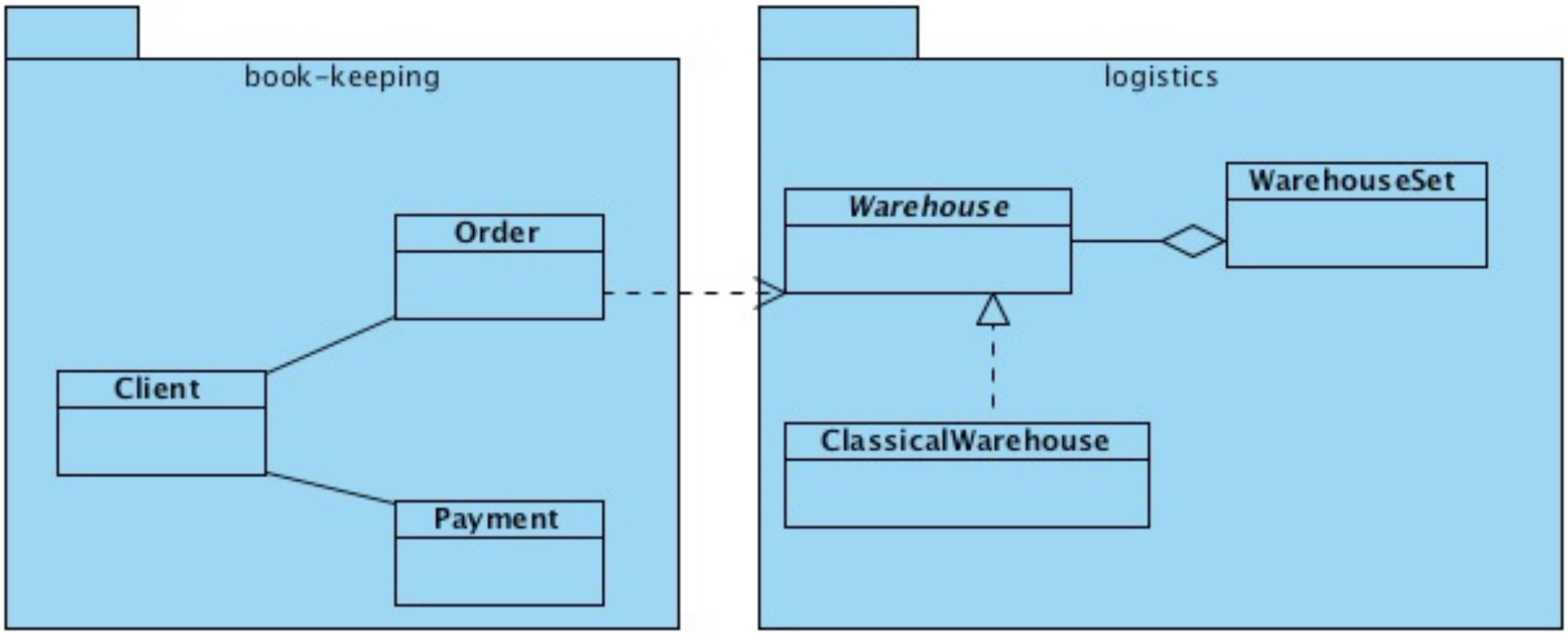


# Example – Electronic Store

- Domain Model



# Packages & Séparation des responsabilités



# Example – Electronic Store

- Testing the **Order** class

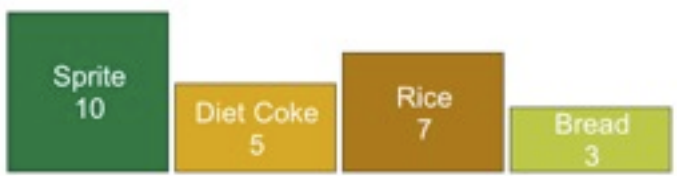
.....

```
public class Order {
        …
        public Order(String product, int i) {
                this.product = product;
                this.amount = i;
                this.isFilled = false;
        }

        public void fill(Warehouse warehouse) {
                if (warehouse.hasInventory(product,amount)) {
                        warehouse.remove(product,amount);
                        isFilled = true;
                }
        }

        public boolean isFilled() {
                return isFilled;
        }
}
```

# Example – Electronic Store

- Testing the **Order** class

```
public class OrderStateTester extends TestCase {
        …
        public void testOrderIsFilledIfEnoughInWarehouse(){
                Order order = new Order(DIET_COKE,5);
                order.fill(warehouse);
                // Primary object test
                assertTrue(order.isFilled());
                // Secondary object test(s)
                assertEquals(0,warehouse.getInventory(DIET_COKE));
        }

        public void testOrderDoesNotRemoveIfNotEnough(){
                Order order = new Order(SPRITE,11);
                order.fill(warehouse);
                // Primary object test
                assertFalse(order.isFilled());
                // Secondary object test(s)
                assertEquals(10, warehouse.getInventory(SPRITE));
        }
```



# Example – Electronic Store

- Testing the **Order** class:

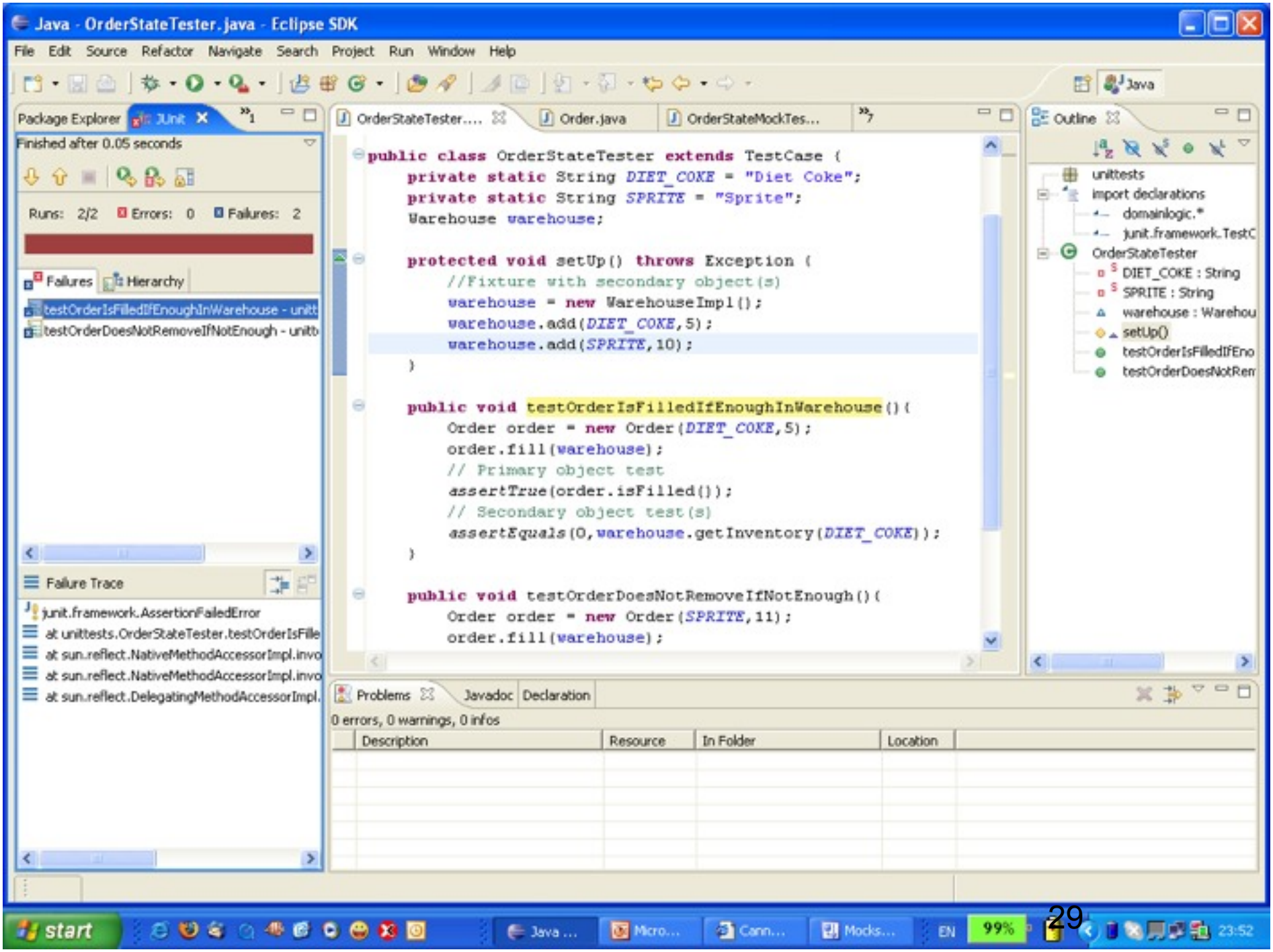
```
public class OrderStateTester extends TestCase {
        private static String DIET_COKE = "Diet Coke";
        private static String SPRITE = "Sprite";
        Warehouse warehouse;

        protected void setUp() throws Exception {
                //Fixture with secondary object(s)
                warehouse = new WarehouseImpl();
                warehouse.add(DIET_COKE,5);
                warehouse.add(SPRITE,10);
        }
        …
```

# Example – Electronic Store

Stub

- Using a *stub* to run the tests -
  - Stubs return canned data to methods calls:

```
public class WarehouseImpl implements Warehouse {

        public void add(String product, int i) {}

        public int getInventory(String product) {
                return 0;
        }

        public boolean hasInventory(String product) {
                return false;
        }

        public void remove(String product, int i) {}
}
```

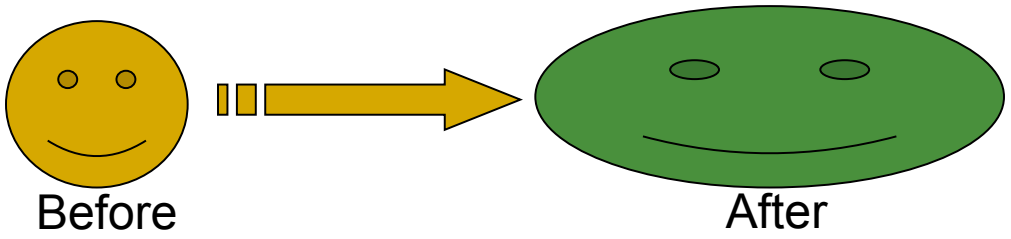

Java - OrderStateTester.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
JUnit
Finished after 0.05 seconds
Runs: 2/2
Errors: 0
Failures: 2
Failures
Hierarchy
testOrderIsFilledIfEnoughInWarehouse - unitt
testOrderDoesNotRemoveIfNotEnough - unitt
Failure Trace
junit.framework.AssertionFailedError
at unittests.OrderStateTester.testOrderIsFille
at sun.reflect.NativeMethodAccessorImpl.invo
at sun.reflect.NativeMethodAccessorImpl.invo
at sun.reflect.DelegatingMethodAccessorImpl.
OrderStateTester....
Order.java
OrderStateMockTes...
public class OrderStateTester extends TestCase {
private static String DIET_COKE = "Diet Coke";
private static String SPRITE = "Sprite";
Warehouse warehouse;
protected void setUp() throws Exception {
//Fixture with secondary object(s)
warehouse = new WarehouseImpl();
warehouse.add(DIET_COKE,5);
warehouse.add(SPRITE,10);
}
public void testOrderIsFilledIfEnoughInWarehouse(){
Order order = new Order(DIET_COKE,5);
order.fill(warehouse);
// Primary object test
assertTrue(order.isFilled());
// Secondary object test(s)
assertEquals(0,warehouse.getInventory(DIET_COKE));
}
public void testOrderDoesNotRemoveIfNotEnough(){
Order order = new Order(SPRITE,11);
order.fill(warehouse);
Outline
unittests
import declarations
domainlogic.*
junit.framework.TestC
OrderStateTester
DIET_COKE : String
SPRITE : String
warehouse : Warehou
setUp()
testOrderIsFilledIfEno
testOrderDoesNotRem
Problems
Javadoc
Declaration
0 errors, 0 warnings, 0 infos
Description
Resource
In Folder
Location
start
Java ...
Micro...
Cann...
Mocks...
EN
99%
23:52

# Example – Electronic Store

- The tests fail since the stub object – **warehouse** (secondary) misses the required functionality
- Remember: the intension is to test the behavior of the primary object - **Order**, all other objects are tested in their own corresponding tests.

- The test is only *State-Based*
  - E.g., was the *remove()* method invoked? Other methods of the warehouse object?

# Example – Electronic Store




- State Based tests:
  - All objects involved must be created – **complex fixture**
  - After the primary object was “kicked” with the behavior that is being tested, the **result** is evaluated against:
    - The primary object
    - All secondary objects
  - If the test fails, its source might be fuzzy between the primary and the secondary objects
  - No interaction is being tested!
- A possible solution – *Mock* objects

# Example – Electronic Store

- Tests basés sur les interactions
  - Les tests doivent vérifier quelles méthodes ont été appelées sur les objets secondaires.
  - Tous les objets secondaires sont remplacés par des «mocks»
  - => spécification des interfaces des objets secondaires
  - Test en Isolation: Les Bugs détectés dans les tests sont uniquement liés aux objets primaires
  - Fortement couplés avec la mise en œuvre => peuvent interférer avec la refactorisation

# Using EasyMock

- Define only the interface of the Mock object:

```
public interface Warehouse {

        void add(String product, int i);
        int getInventory(String product);
        boolean hasInventory(String product,int amount);
        void remove(String product, int i);
}
```

# Using EasyMock

- Create the Mock object:

```
protected void setUp() throws Exception {
        //Fixture with secondary object(s)
        mock = createMock(Warehouse.class);
}
```

You need to :

- Add the EasyMock jar file (easymock.jar) from this directory to your classpath
- *import static org.easymock.EasyMock.*;*

# Using EasyMock

```
public void fill(Warehouse warehouse) {
    if (warehouse.hasInventory(product,amount)) {
        warehouse.remove(product,amount)
        isFilled = true;
```

- Running tests with expectations:

```
public void testOrderIsFilledIfEnoughInWarehouse(){
    //Expectations
    expect(mock.hasInventory(DIET_COKE,5)).andReturn(true);
    mock.remove(DIET_COKE,5);
    replay(mock);

    Order order = new Order(DIET_COKE,5);
    order.fill(mock);
    // Primary object test
    assertTrue(order.isFilled());

    // Secondary object test(s)
    verify(mock);
}
```

# Using EasyMock

- Verifying Behavior
  - If the method is not called on the Mock Object

```
public void testDemo(){
        mock.remove("cola",2);
        replay(mock);

        verify(mock);
}
```

```
java.lang.AssertionError:
  Expectation failure on verify:
    remove("cola", 2): expected: 1, actual: 0
```

# Using EasyMock

- Verifying Behavior
  - If the method is not called on the Mock Object

```
public void testDemo(){
        mock.remove("cola",2);
        replay(mock);
        Order order = new Order(SPRITE,11);
        order.fill(mock);
        verify(mock);
}
```

```
java.lang.AssertionError:
  Unexpected method call hasInventory("Sprite", 11):
    remove("cola", 2): expected: 1, actual: 0
```

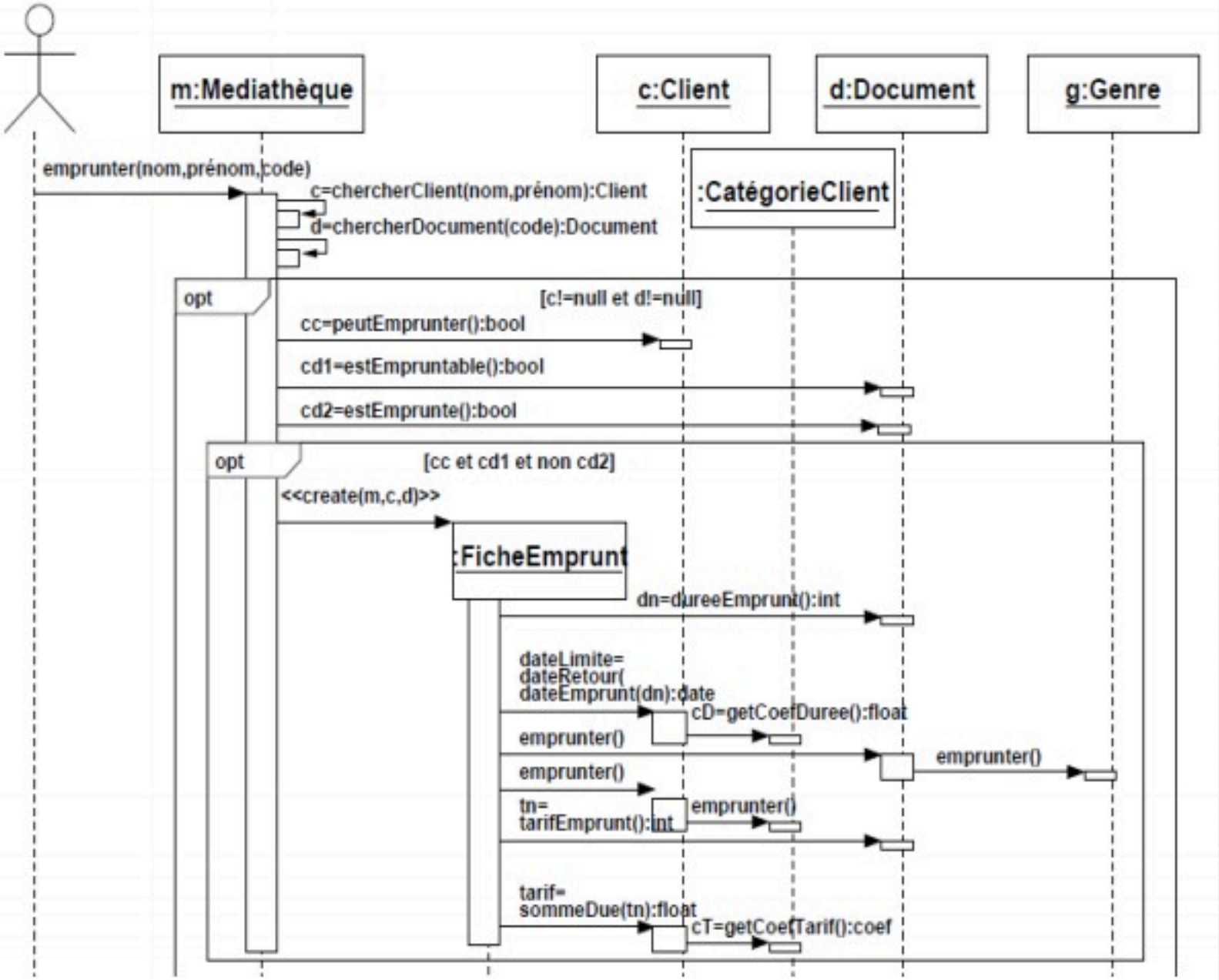
"I have not failed, I've just found ten thousand ways that won't work." – Thomas Edison

# Tests d'intégration : préparation

L'opération d'emprunter requière une coordination entre les objets : client,  médiathèque, document et ficheEmprunt.

On veut vérifier les traces de communications.
Ces tests peuvent être déduits des diagrammes de séquences.

http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf




http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf

# Integration Test1 : emprunter

➡ *Un « emprunt » n'est pas autorisé parce que le document n'est pas empruntable*

- Construct **a document**, and make it **not Empruntable**
- Construct a client
- Construct a FicheEmprunt for the client and document
- Check that:
  - 1. the system handles the exceptional case in a meaningful way
  - 2. the client and document states/statistics have not been changed

http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf

# Integration Test2 : emprunter

- Un « emprunt » n'est pas autorisé parce que le document est « emprunté »
  - Construct a document, which is empruntable and emprunté
  - Construct a client
  - Construct a FicheEmprunt for the client and document
  - Check that:
    - 1.the system handles the exceptional case in a meaningful way
    - 2.the client and document states/statistics have not been changed

http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf

# Integration Test3 : emprunter

Verify correct co-ordination by FicheEmprunt

- Integration Test 3: Emprunt is authorised
  - Construct **a document**, which is **empruntable** and not emprunté
  - Construct **a client**
  - Construct a **FicheEmprunt** for the client and document using a dummy mediatheque
  - Check that:
    - 1. the tarif and duree des emprunts are as required
    - 2. the client and document states/statistics have been updated as required

http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf

# Integration Test3 : emprunter

http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf

```
 public class IntegrationTest {
Genre g;
Localisation l;
Document d1;
CategorieClient cat;
Client c1;
@Before
public void setUp() throws Exception {
     g = new Genre("Test_nom1");
     l = new Localisation("Test_salle1", "Test_rayon1");
     d1 = new Video("Test_code1", l, "Test_titre1", "Test_auteur1",
             "Test_annee1", g, 120, "Test_mentionLegale1");
     cat = new CategorieClient("TarifReduit", 4, 25.0, 1.0, 1.0, true);
     c1 = new Client("nom1", "prenom1", "adresse1", cat, 0);
}
@After
public void tearDown() throws Exception {
     l = null;
     g = null;
     d1 = null;
     cat = null;
     c1 = null;
}
```

# Integration Test3 : emprunter

http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf

```
  @Test
  public void creationFicheEmpruntDocEmpruntable()
          throws OperationImpossible, InvariantBroken {
      // INTEGRATION TEST 3 - Emprunter - Verify correct
co-ordination by
      // FicheEmprunt
      d1.metEmpruntable();
      FicheEmprunt f1 = new FicheEmprunt(c1, d1);
      // check that the client, document and genre states
have been updated correctly
      Assert.assertEquals(1, d1.getNbEmprunts());
      Assert.assertEquals(1, c1.getNbEmpruntsEffectues());
      Assert.assertEquals(1, g.getNbEmprunts());
      // check that the duration and paiement information
are ok
      Assert.assertTrue(f1.getDureeEmprunt() == 14);
      Assert.assertTrue( f1.getTarifEmprunt() == 1.5);
  }
```

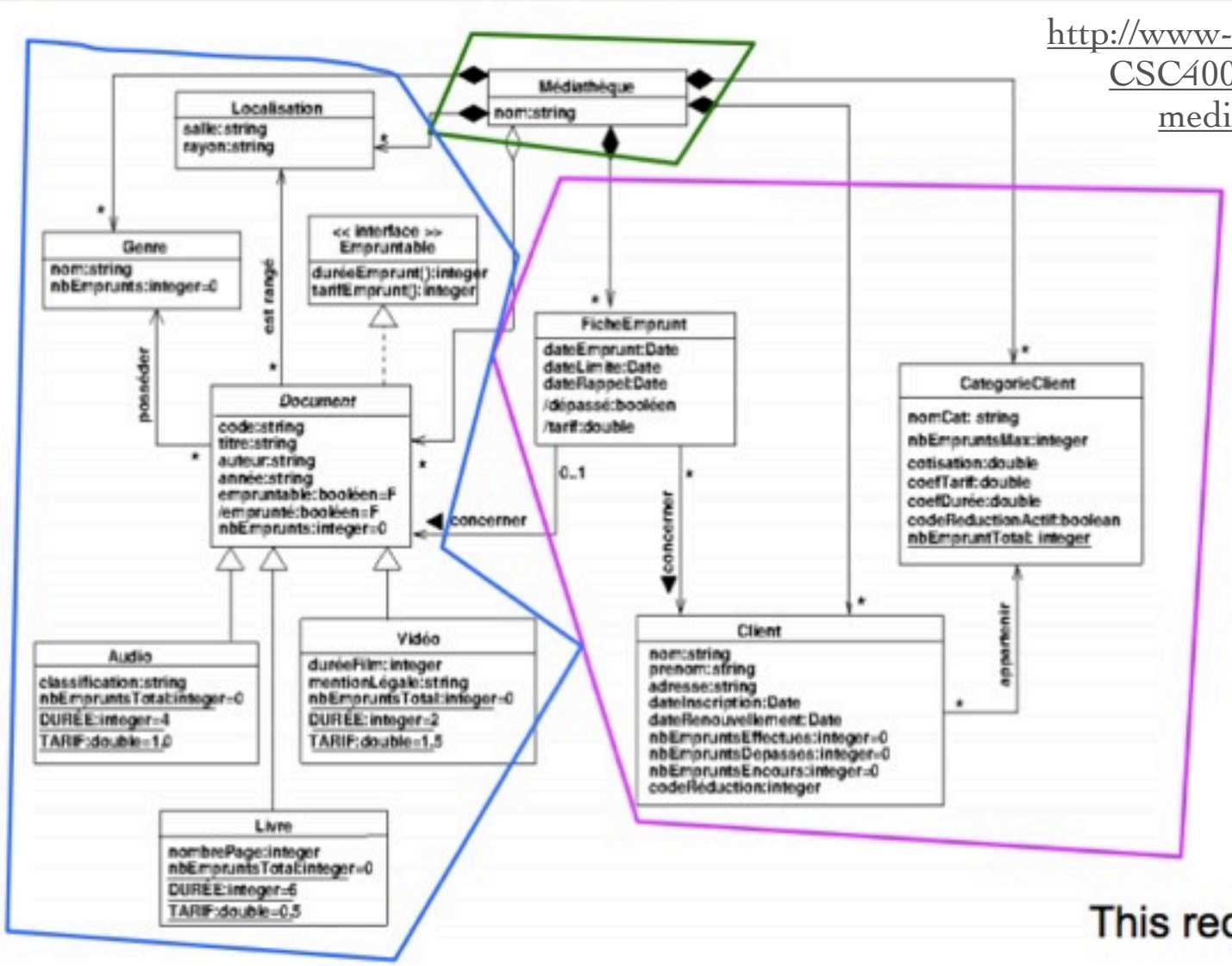
# Integration Test3 : emprunter

http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf

```
    @Test(expected = OperationImpossible.class)
  public void creationFicheEmpruntDocNonEmpruntable()
          throws OperationImpossible, InvariantBroken {
      // INTEGRATION TEST 1 - Emprunter - co-ordination
when Document not
      // empruntable
      new FicheEmprunt(c1, d1);
  }
```

# Integration Tests: Typical/ Example Development Status

http://www-inf.it-sudparis.eu/cours/CSC4002/Documents/tests-mediatheque-1pp.pdf




For exampl
Completed
Partial
Not yet
implemente

This requires further analy