Testable code

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Key rules for reusable code

- **Every implementation should derive from an interface**
  - Find the right abstractions
- **Factories (or builder)**
  - Only them are allowed to create object instances (call constructor)
  - Inject dependencies to object
  - Do not use static instances
- **(Immutability)**

How to write testable code ?

- **Find a set of practicable rules to right testable code**

- **Help developers to easily write tests**
  - Avoid test hell

Basics about test structure

- **Basic code architecture**
  - Setup
  - Test SUT (Software under test)
  - Verify
- **Styles of test (TDD - conception styles)**
  - London style (interaction style)
  - Chicago style (state based style)
- **Do not alter production code for tests by**
  - Adding specific methods for tests
  - Change visibility to public for some elements

Rule 1: Constructor does not real work

- **Coupled design**
  - Unable to change collaborators
- **Violation SRP (Object has many responsabilities)**
  - Business purpose + application wiring
- **Difficult to test**
  - Force you to setup the whole environment of production code

Violation of rule 1

- **Using “new” keyword (constructor call)**
  - Except for data
- **Using “static” keyword**
- **Logic (loop, if…) in constructor**

Rule 2: Do not dig into collaborators

- **Violation principle of least surprise**
  - Lying API: seems to ask an object for one purpose but used for another. Intent not clear
- **Brittle tests**
  - Raise your number of dependencies ⇨ more reasons to change. You depends on the object you really need + another intermediate object (coupled with its changes)
- **Code hard to read and test**
  - Force to construct a long chain of elements
  - Hard to see what really matter / obscure test

Violation of rule 2

- Do not use passed object for themselves but only to access other objects
- Law of Demeter violation: chain of getter
- Suspicious objects: context, environment...

Rule 3: Avoid global state and singletons

- **Interact with people you are not suppose to know**
  - Statically call resources which as never been set as dependencies (through constructor or methods) ⇨ Lying API
- **Spooky action at distance, unexpected interaction**
  - Force to read implementation to know what’s happened
- **Untractable code with global state**
  - Anything interact with everything
- **Interdependent tests**
  - Force tear down between each test
  - Singleton almost untestable

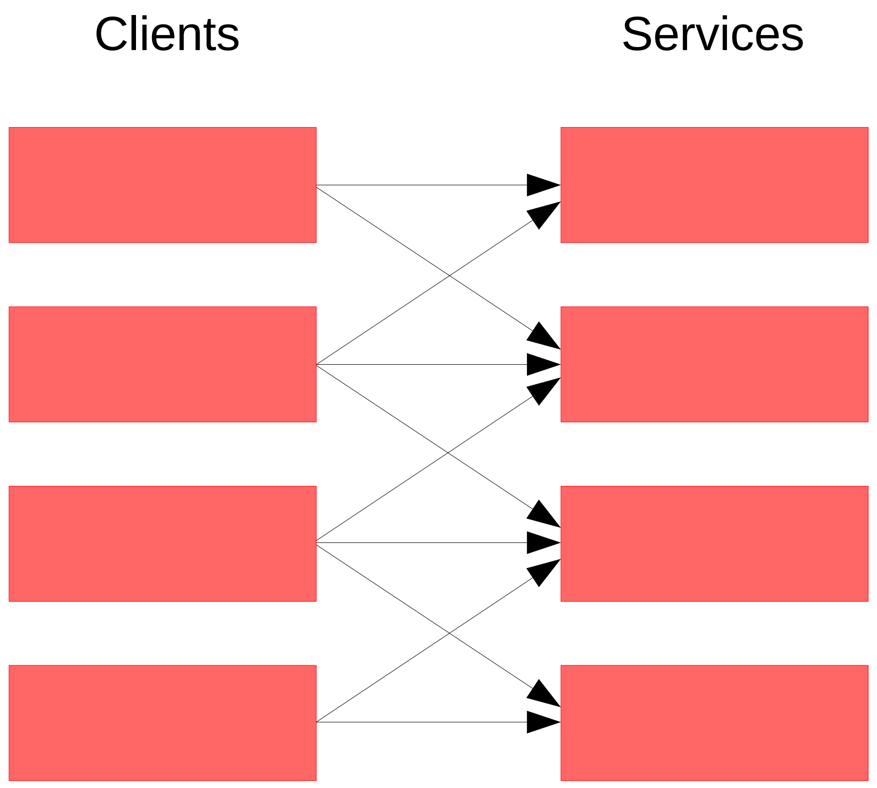
Violation of rule 3

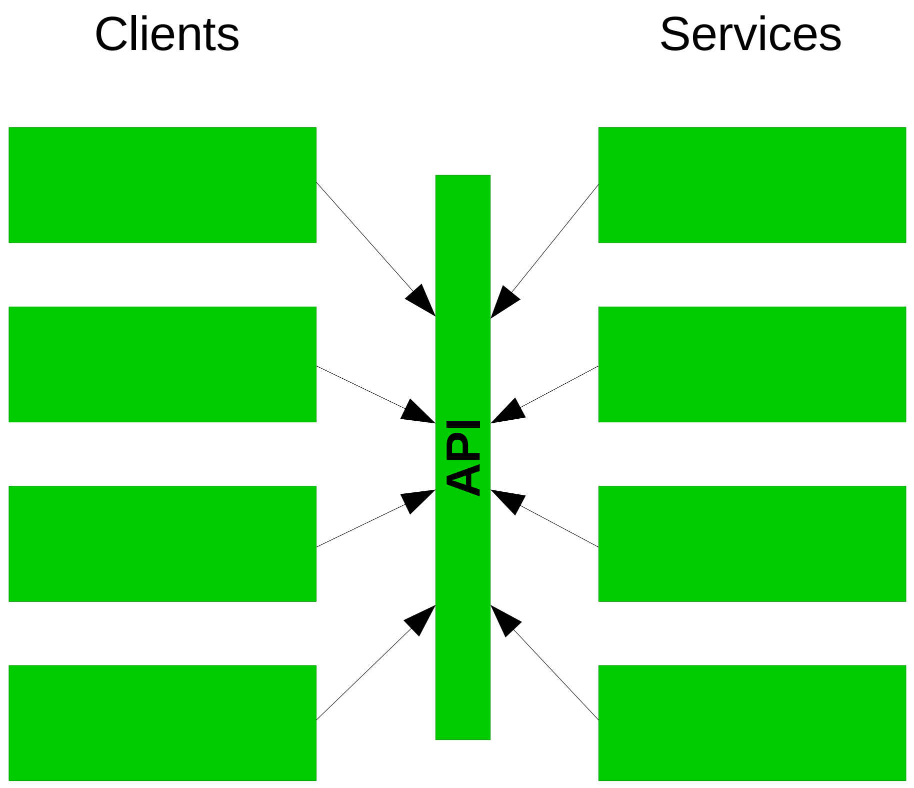
- Depend on global state
- Usage of singleton (as in GOF)
- Usage of static fields
- Usage of static methods (not private inner methods)

Reusable and testable code: same rules / Code-Test complementarity

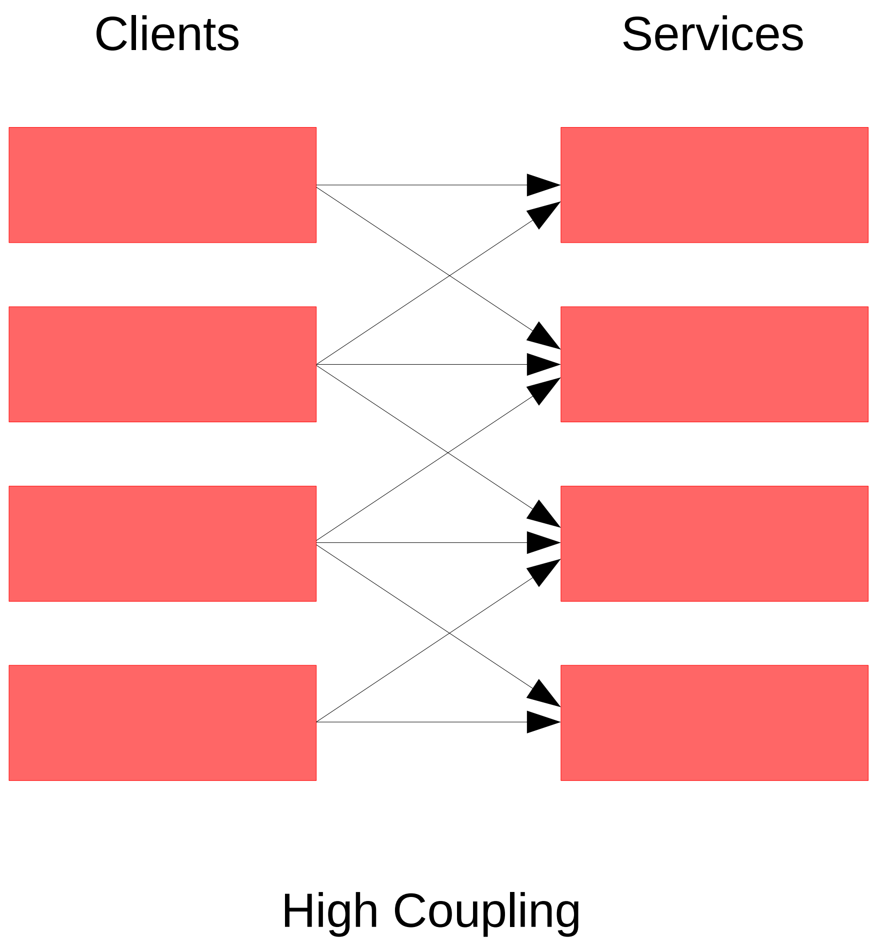
- **Tests is first case of code reuse**
  - At least one case of code reuse for tests
  - Ensure reusable and well design code
- **Test as documentation: explain usage and purpose of a software component**
  - Avoid obscure test
  - Clarify code API (how to use it)
  - Expose use cases (possible to express them in functional or acceptance tests)

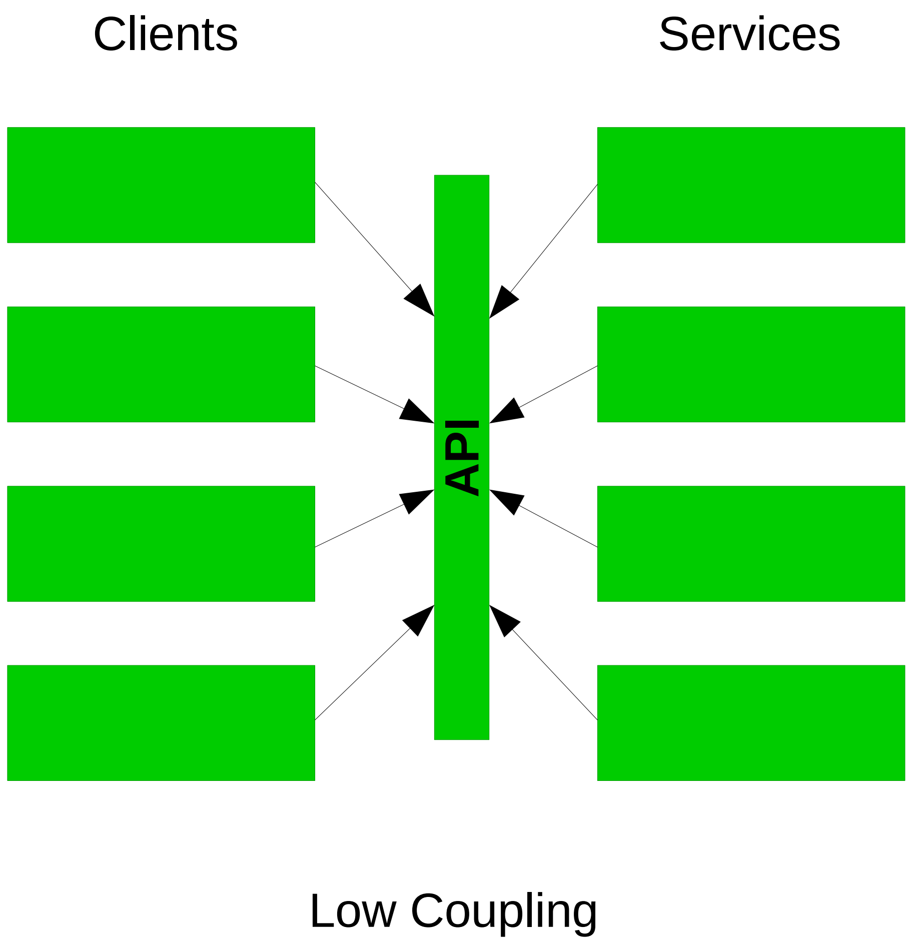
Design considerations



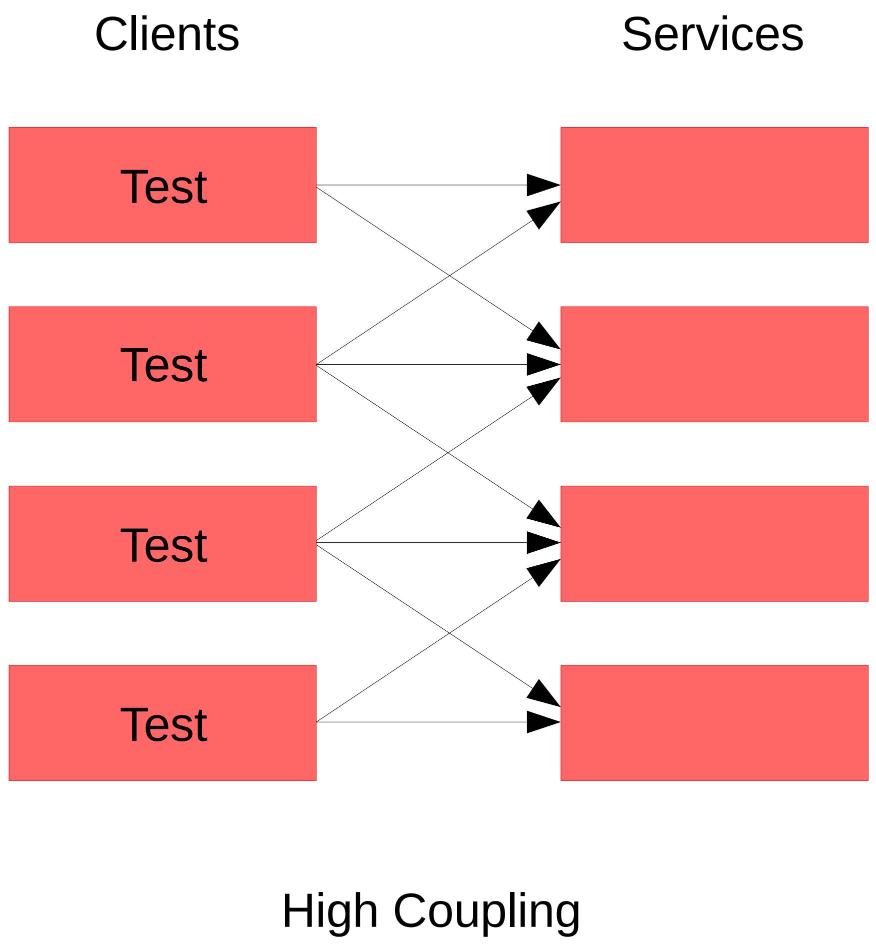


Design considerations

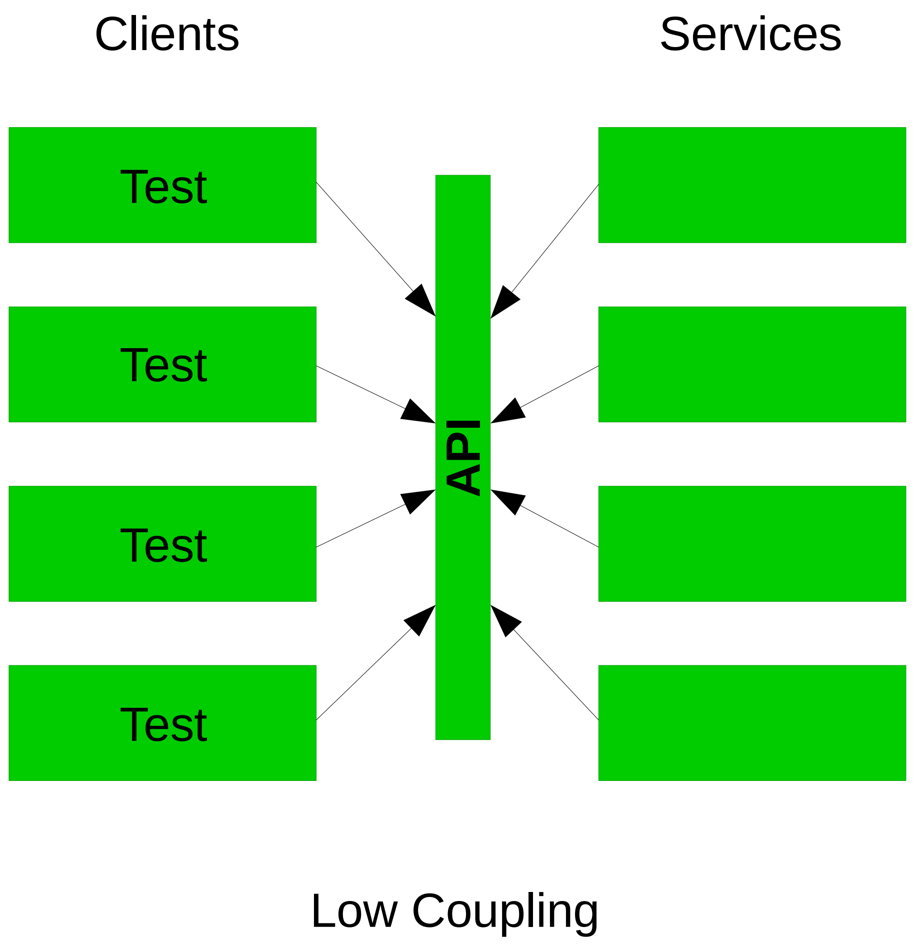




Design considerations



High Coupling



Low Coupling

Application and tests design

- **Test packages should not be an image of implementation packages**
  - Implementation class ⇔ test class (one to one correspondence)
    - Fragile tests, change on every code change
    - Production code made rigid by tests (costs of changes are too expensive or worst unpredictable)
- **Need of an architectural vision**
  - Brittle tests: reveal importance of strategic decision
    - API definition (information hiding – Parnas 1971)
    - Tests are part of the system also suffer/show design flaw
  - Test a class (or set of class) against an API that has a business value.

Tests purpose

- **Write better code with better architecture**

- **Also allow to prevent regression**

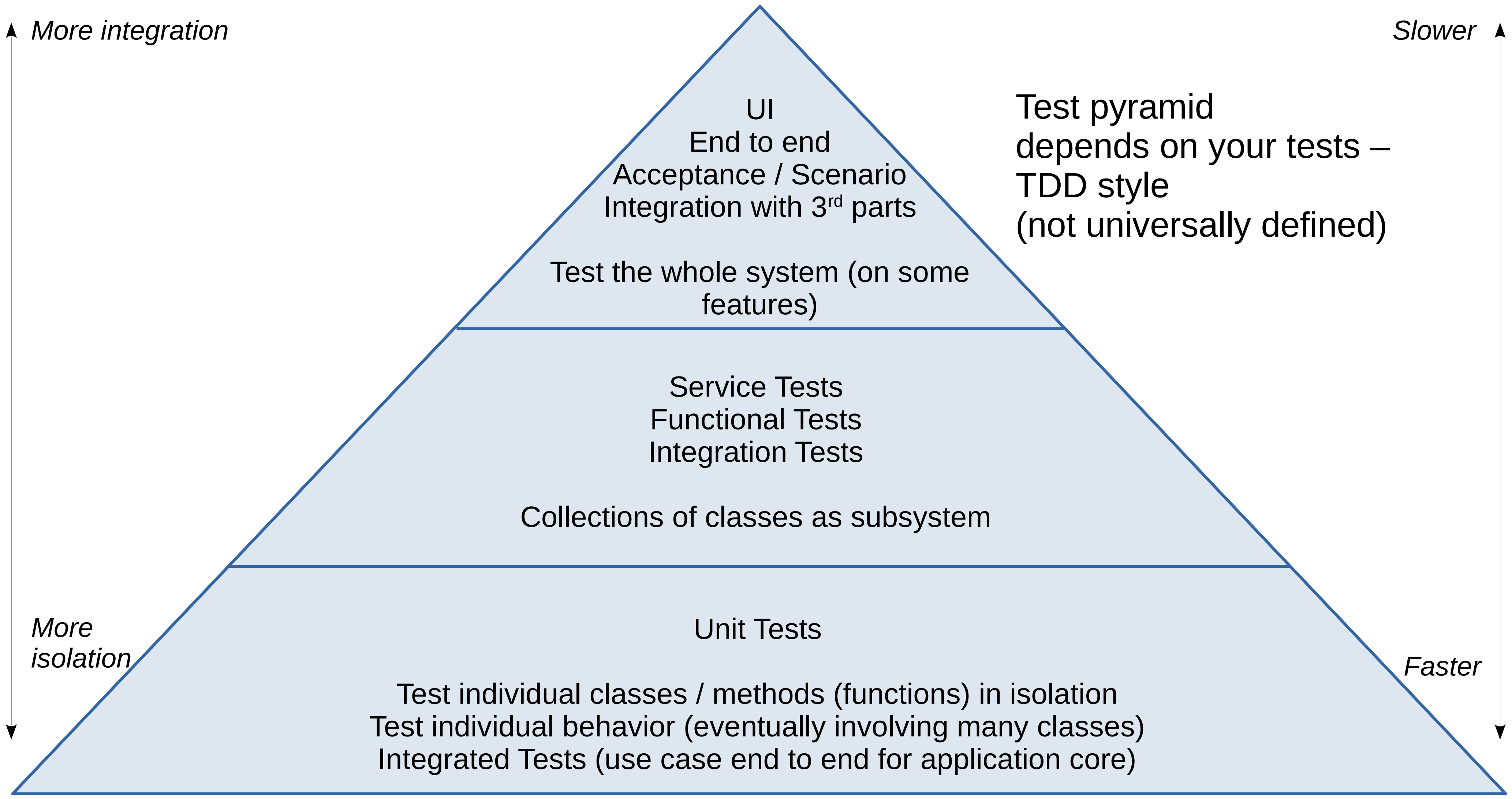
Bugs taxonomy

	Probability of occurrence	Bug detection	Fix Bug
Logic	HIGH	DIFFICULT	DIFFICULT
Wiring	MEDIUM	MEDIUM	MEDIUM
HMI	MEDIUM	EASY	EASY

Tests taxonomy

		Unit	Unit / Integration / Functional	Acceptance / Integration
		A separate part: A method, a class or a limited number of related classes	**Many parts working together**	**End to end testing: Test a complete functionality**
Isolation from Outside (DB...)	**Mock, stub external components**	Test logic, run fast	Test logic and wiring run pretty fast	Test the whole stack, could run rather fast
	Used real external component	×	Test logic and wiring, run slowly	Test the whole stack, run slowly

Test pyramid


More integration
More isolation
Slower
Faster
UI
End to end
Acceptance / Scenario
Integration with 3rd parts
Test the whole system (on some features)
Service Tests
Functional Tests
Integration Tests
Collections of classes as subsystem
Unit Tests
Test individual classes / methods (functions) in isolation
Test individual behavior (eventually involving many classes)
Integrated Tests (use case end to end for application core)

Test pyramid
depends on your tests –
TDD style
(not universally defined)

Number of tests

Test code quality

- **No copy paste / duplication**
  - Unmaintainable tests
- **F.I.R.S.T Principles of Unit Testing**
  - Fast
  - Isolated / independent
  - Repeatable
  - Self-Validating
  - Thorough

Bad tests quality:

⇨ **Throw away test**

⇨ **Software rots**

Facing complexity

Coverage	Check
Function	Every functions covered
Line	Every line covered
Decision/Branch	Every if/switch branches; every goto, break, continue, return, throw; every catch
Condition	Every condition (evaluated true and false): If (A || B) ⇨ 2 conditions A and B
MCDC (Modified condition / decision coverage)	Every decision and condition true and false, but also condition change the decision by itself (major influence) n conditions ⇨ n+1 tests
MCC (Multiple condition coverage)	Every possible combination for condition. n conditions ⇨ up to 2^n tests

Facing complexity, MCDC in details

if ((A || B) && (C || D)) {...}

4 conditions ⇨

- All combinations:
  2^4 = 16
- Reachable combinations (MCC):
  7
- MCDC (yellow):
  5

	A	B	C	D	(A||B)&&(C||D)	*MCDC*
1	F	F	_	_	F	4 - (F V)
2	F	V	F	F	F	2
3	F	V	F	V	V	3
4	F	V	V	_	V	1 - (F)
5	V	_	F	F	F	
6	V	_	F	V	V	5
7	V	_	V	_	V	

Find the best coverage compromise by combining unit, integration and functional tests.

Words about TDD

- **TDD (Test Driven Development) is not about tests but software design**
  - Emergent design

- **Demonstrations:**
  - https://www.youtube.com/watch?v=58jGpV2Cg50&list=PLmmYSbUCWJ4x1GO839azG_BBw8rkh-zOj&index=4&t=1300s
  - https://www.youtube.com/watch?v=58jGpV2Cg50&list=PLmmYSbUCWJ4x1GO839azG_BBw8rkh-zOj&index=4&t=2628s
  - https://www.youtube.com/watch?v=p_FHa0n8whQ
  - https://www.youtube.com/watch?v=TGb34TQSNKk

Next objective

- Essence of software and SOLID principles

Reference

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- https://www.youtube.com/watch?v=XcT4yYu_TTs
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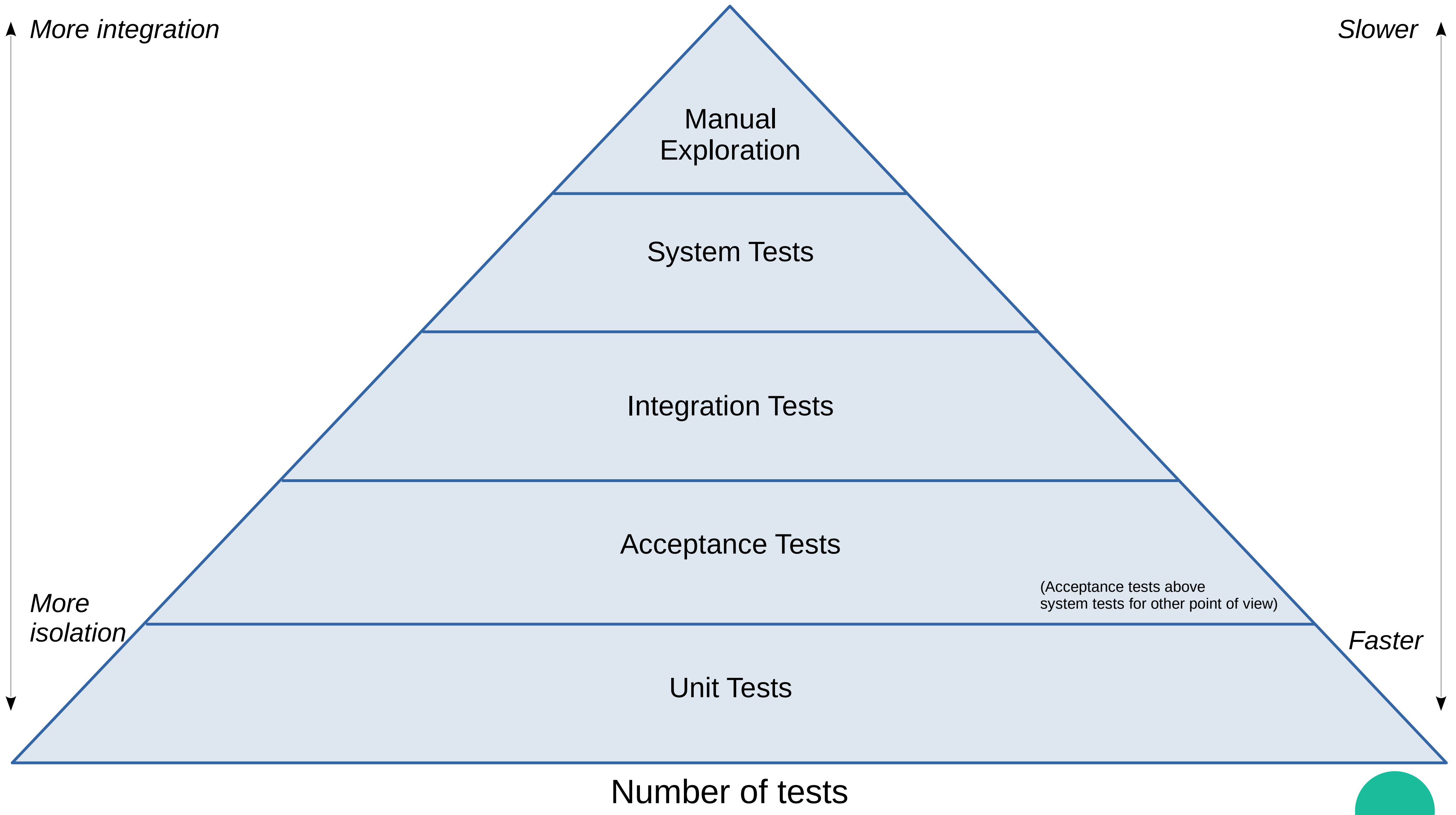
- xUnit Test Patterns, Refactoring Test Code – Gerard Meszaros
- Object-Oriented Software Engineering: A Use Case Driven Approach - Ivar Jacobson
- https://blog.cleancoder.com/uncle-bob/2017/03/03/TDD-Harms-Architecture.html
- https://site.mockito.org/
  - https://javadoc.io/doc/org.mockito/mockito-core/latest/org/mockito/Mockito.html

Test pyramid


More integration
Slower
Manual Exploration
System Tests
Integration Tests
Acceptance Tests
(Acceptance tests above system tests for other point of view)
More isolation
Faster
Unit Tests
Number of tests