what's your most difficult or challenging architecture problem?

Software Architecture by Example

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introduction

course agenda

course references

Software Architecture Fundamentals, Second Edition

★★★★★ 9 reviews

by Mark Richards, Neal Ford

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architect life

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architecture characteristics

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architecture characteristics

accessibility
accountability
accuracy
adaptability
administrability
affordability
agility
auditability
autonomy
availability
compatibility
composability
configurability
correctness
credibility
customizability
debugability
degradability
determinability
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discoverability
distributability
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extensibility
failure transparency
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fidelity
flexibility
inspectability
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integrity
interchangeability
interoperability
learnability
maintainability
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mobility
modifiability
modularity
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orthogonality
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precision
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process capabilities
producibility
provability
recoverability
relevance

repeatability
reproducibility
resilience
responsiveness
reusability
robustness
safety
scalability
seamlessness
self-sustainability
serviceability
supportability
securability
simplicity
stability
standards compliance
survivability
sustainability
tailorability
testability
timeliness
traceability
transparency
ubiquity
understandability
upgradability
usability

https://en.wikipedia.org/wiki/List_of_system_quality_attributes

architecture characteristics

feasibility

agility

elasticity

scalability

architecture katas

identifying driving characteristics

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availability reliability performance

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availability reliability performance scalability

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availability reliability performance scalability elasticity

scalability:

elasticity:

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availability reliability performance scalability elasticity (security)

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performance availability reliability

scalability elasticity i18n l10n

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performance availability reliability

scalability elasticity i18n l10n

Global Customizability Local Customizability

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performance availability reliability

scalability elasticity

Customizability { location, sales, recipe

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~~performance~~ availability reliability

scalability elasticity

Customizability { location, sales, recipe

building evolutionary architectures

Evolutionary Architecture

An evolutionary architecture supports
guided,
incremental change
across multiple dimensions.

guided

***architectural** fitness function*:

An architectural fitness function is any mechanism that provides an objective integrity assessment of some architectural characteristic(s).

guided

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maintainable?

Cyclomatic complexity < 50 for all projects

Naming conventions

Postel's Law

maintainable?

(incoming/outgoing)

Controlled afferent/efferent coupling

ArchUnit

https://www.archunit.org/

ArchUnit

https://www.archunit.org/

```java
import static com.tngtech.archunit.lang.syntax.ArchRuleDefinition.noClasses;
import static com.tngtech.archunit.library.GeneralCodingRules.ACCESS_STANDARD_STREAMS;
import static com.tngtech.archunit.library.GeneralCodingRules.NO_CLASSES_SHOULD_ACCESS_STANDARD_STREAMS;
import static com.tngtech.archunit.library.GeneralCodingRules.NO_CLASSES_SHOULD_THROW_GENERIC_EXCEPTIONS;
import static com.tngtech.archunit.library.GeneralCodingRules.NO_CLASSES_SHOULD_USE_JAVA_UTIL_LOGGING;

public class CodingRulesTest {
    private JavaClasses classes;

    @Before
    public void setUp() throws Exception {
        classes = new ClassFileImporter().importPackagesOf(ClassViolatingCodingRules.class);
    }

    @Test
    public void classes_should_not_access_standard_streams_defined_by_hand() {
        noClasses().should(ACCESS_STANDARD_STREAMS).check(classes);
    }

    @Test
    public void classes_should_not_access_standard_streams_from_library() {
        NO_CLASSES_SHOULD_ACCESS_STANDARD_STREAMS.check(classes);
    }

    @Test
    public void classes_should_not_throw_generic_exceptions() {
        NO_CLASSES_SHOULD_THROW_GENERIC_EXCEPTIONS.check(classes);
    }

    @Test
    public void classes_should_not_use_java_util_logging() {
        NO_CLASSES_SHOULD_USE_JAVA_UTIL_LOGGING.check(classes);
    }
}
```

coding rules

ArchUnit

```java
public class InterfaceRules {

    @Test
    public void interfaces_should_not_have_names_ending_with_the_word_interface() {
        JavaClasses classes = new ClassFileImporter().importClasses(
                SomeBusinessInterface.class,
                SomeDao.class
        );

        noClasses().that().areInterfaces().should().haveNameMatching(".*Interface").check(classes);
    }

    @Test
    public void interfaces_should_not_have_simple_class_names_ending_with_the_word_interface() {
        JavaClasses classes = new ClassFileImporter().importClasses(
                SomeBusinessInterface.class,
                SomeDao.class
        );

        noClasses().that().areInterfaces().should().haveSimpleNameContaining("Interface").check(classes);
    }

    @Test
    public void interfaces_must_not_be_placed_in_implementation_packages() {
        JavaClasses classes = new ClassFileImporter().importPackagesOf(SomeInterfacePlacedInTheWrongPackage.class);

        noClasses().that().resideInAPackage("..impl..").should().beInterfaces().check(classes);
    }
}
```

interface rules

Package by layer (horizontal slicing)

ArchUnit

```java
public class LayerDependencyRulesTest {
    private JavaClasses classes;

    @Before
    public void setUp() throws Exception {
        classes = new ClassFileImporter().importPackagesOf(ClassViolatingCodingRules.class);
    }

    @Test
    public void services_should_not_access_controllers() {
        noClasses().that().resideInAPackage("..service..")
                .should().accessClassesThat().resideInAPackage("..controller..").check(classes);
    }

    @Test
    public void persistence_should_not_access_services() {
        noClasses().that().resideInAPackage("..persistence..")
                .should().accessClassesThat().resideInAPackage("..service..").check(classes);
    }

    @Test
    public void services_should_only_be_accessed_by_controllers_or_other_services() {
        classes().that().resideInAPackage("..service..")
                .should().onlyBeAccessed().byAnyPackage("..controller..", "..service..").check(classes);
    }
}
```

layer dependency

ArchUnit

```java
@Test
public void third_party_class_should_only_be_instantiated_via_workaround() {
    classes().should(notCreateProblematicClassesOutsideOfWorkaroundFactory()
            .as(THIRD_PARTY_CLASS_RULE_TEXT))
            .check(classes);
}

private ArchCondition<JavaClass> notCreateProblematicClassesOutsideOfWorkaroundFactory() {
    DescribedPredicate<JavaCall<?>> constructorCallOfThirdPartyClass =
            target(is(constructor())).and(targetOwner(is(assignableTo(ThirdPartyClassWithProblem.class))));

    DescribedPredicate<JavaCall<?>> notFromWithinThirdPartyClass =
            originOwner(is(not(assignableTo(ThirdPartyClassWithProblem.class)))).forSubType();

    DescribedPredicate<JavaCall<?>> notFromWorkaroundFactory =
            originOwner(is(not(equivalentTo(ThirdPartyClassWorkaroundFactory.class)))).forSubType();

    DescribedPredicate<JavaCall<?>> targetIsIllegalConstructorOfThirdPartyClass =
            constructorCallOfThirdPartyClass.
                    and(notFromWithinThirdPartyClass).
                    and(notFromWorkaroundFactory);

    return never(callCodeUnitWhere(targetIsIllegalConstructorOfThirdPartyClass));
}
```

governance

Legality of Open Source Libraries

Penultimate

Legality of Open Source Libraries

Penultimate

Legality of Open Source Libraries

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Legality of Open Source Libraries

Penultimate

component-based thinking

component identification

as an architect, you should think about the artifacts within the architecture in terms of *components*

component:

building block of the application

well defined set of operations

well defined role and responsibility

component identification

component scope

component identification

component identification

identify initial components using core functionality

place orders → order placement

fulfill orders → order fulfillment

ship orders → order shipping

component identification

assign requirements, use cases, or user stories to a component

user story: check inventory

order placement

order fulfillment

order shipping

component identification

assign requirements, use cases, or user stories to a component

component identification

assign requirements, use cases, or user stories to a component

user story: check inventory → order placement

user story: validate order

order fulfillment

order shipping

component identification

assign requirements, use cases, or user stories to a component

component identification

assign requirements, use cases, or user stories to a component

component identification

assign requirements, use cases, or user stories to a component

component identification

component granularity

responsible for creating, deleting, and updating orders. also responsible for shipping the order and tracking the order once it has been shipped. this component is also responsible for notifying the customer each time the order status changes.

component identification

component granularity

order maintenance	responsible for creating, deleting, and updating orders.
order shipment	responsible for shipping and tracking orders
customer notification	responsible for notifying the customer when the order status changes.

architecture katas

identifying major components

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  - if nationwide auction is a success, replicate the model overseas
  - budget is not constrained--this is a strategic direction
  - company just exited a lawsuit where they settled a suit alleging fraud

Your Architectural Kata is...

I'll Have the BLT

A national sandwich shop wants to enable 'fax in your order' but over the Internet instead (in addition to their current fax-in service)

- ***Users:*** thousands, perhaps one day millions
- ***Requirements:***
  - users will place their order, then be given a time to pick up their sandwich and directions to the shop (which must integrate with several external mapping services that include traffic information)
  - if the shop offers a delivery service, dispatch the driver with the sandwich to the user
  - mobile-device accessibility
  - offer national daily promotionals/specials
  - offer local daily promotionals/specials
  - accept payment online or in person/on delivery
- ***Additional Context:***
  - Sandwich shops are franchised, each with a different owner.
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Your Architectural Kata is...

Going Going Gone!

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Your Architectural Kata is...

Going Going Gone!

Your Architectural Kata is...

Going Going Gone!

the “entity trap”

auctions

items

bids

Your Architectural Kata is...

Going Going Gone!

the “entity trap”

Your Architectural Kata is...

Going Going Gone!

the “entity trap”

Your Architectural Kata is...

Going Going Gone!

the “entity trap”

Your Architectural Kata is...

Going Going Gone!

workflow approach

create auction ⟶ find auction ⟶ sign up ⟶ watch auction ⟶ place bid

Your Architectural Kata is...

Going Going Gone!

workflow approach

Your Architectural Kata is...

Going Going Gone!

actor/action approach

bidder

auctioneer

system

Your Architectural Kata is...

Going Going Gone!

actor/action approach

bidder

auctioneer

system

view live video stream

view live bid stream

place a bid

Your Architectural Kata is...

Going Going Gone!

actor/action approach

bidder

view live video stream
view live bid stream
place a bid

auctioneer

enter live bids into system
receive online bid
mark item as sold

system

Your Architectural Kata is...

Going Going Gone!

actor/action approach

bidder

view live video stream
view live bid stream
place a bid

auctioneer

enter live bids into system
receive online bid
mark item as sold

system

start auction
make payment
track bidder activity

Your Architectural Kata is...

Going Going Gone!

bidder

view live video stream
view live bid stream
place a bid

auctioneer

enter live bids into system
receive online bid
mark item as sold

system

start auction
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Your Architectural Kata is...

Going Going Gone!

bidder

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bidder

view live video stream
view live bid stream
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auctioneer

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✓start auction
make payment
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Your Architectural Kata is...

Going Going Gone!

bidder

view live video stream
view live bid stream
place a bid

auctioneer

enter live bids into system
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mark item as sold

system

✓start auction
make payment
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Going Going Gone!

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Your Architectural Kata is...

I'll Have the BLT

Your Architectural Kata is...

I'll Have the BLT

architectural quantum

An *architectural quantum* is an independently deployable component with high functional cohesion, which includes all the synchronously coupled structural elements required for the system to function.

architectural quantum

architectural quantum?

Architectural characteristics live at the quantum level.

Your Architectural Kata is...

I'll Have the BLT

Your Architectural Kata is...

Going Going Gone!

quanta

architecture patterns

architectural quantum

Architectural characteristics live at the quantum level.

architectural quantum

Architectural characteristics live at the quantum level.

architecture patterns help define the basic characteristics and behavior of an application

microservices architecture

service-based architecture

layered architecture

event-driven architecture

pipeline architecture

microkernel architecture

space-based architecture

microservices architecture

microservices is a label, not a description

microservices architecture

architectural quantum

monolithic user interface

system level

microservices architecture

architectural quanta

partitioned user interface

sub-system level

microservices architecture

architectural quanta

micro front-end

service level

microservices architecture

drivers

- ✓ modularity
- ✓ agility
- ✓ fault-tolerance
- ✓ scalability
- ✓ testability
- ✓ deployability
- ✓ evolvability

microservices architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$

service-based architecture

service-based architecture

drivers

- ✓ modularity
- ✓ agility
- ✓ fault-tolerance
- ✓ scalability
- ✓ testability
- ✓ deployability
- ✓ simplicity / cost
- ✓ evolvability

service-based architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
	👍👍	👍👍	👍👍	👎	👍👍	👎	$$

layered architecture

layered architecture

drivers

- ✓ simplicity
- ✓ cost

layered architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
	👎	👎	👍	👎	👎	👍👍👍	$

types of monoliths

"big ball of mud"

unstructured monolith

layered monolith

modular monolith

types of monoliths

layered architecture

modular monolith

types of monoliths

technical partitioning

layered architecture

modular monolith

types of monoliths

technical partitioning

layered architecture

domain partitioning

modular monolith

layered architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
D	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
	👎	👎	👍	👎	👎	👍👍👍	$

layered architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
D	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
D	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
	👎	👎	👍	👎	👎	👍👍👍	$

layered architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
D	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
D	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
T	👎	👎	👍	👎	👎	👍👍👍	$

event-driven architecture

broker topology

mediator topology

event-driven architecture

broker topology

event-driven architecture

mediator topology

event-driven architecture

drivers

- ✓ modularity
- ✓ agility
- ✓ fault-tolerance
- ✓ scalability
- ✓ performance
- ✓ elasticity
- ✓ adaptability
- ✓ evolvability

event-driven architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
D	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
D	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
T	👎	👎	👍	👎	👎	👍👍👍	$
T	👍👍	👍👍	👎👎	👍👍👍	👍👍	👎👎	$$$

pipeline architecture

a.k.a. pipes and filters architecture

pipeline architecture

drivers

- ✓ modularity
- ✓ simplicity
- ✓ cost
- ✓ agility
- ✓ adaptability
- ✓ evolvability

pipeline architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
D	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
D	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
T	👎	👎	👍	👎	👎	👍👍👍	$
T	👍👍	👍👍	👎👎	👍👍👍	👍👍	👎👎	$$$
T	👍	👎	👍	👎	👎	👍👍	$

microkernel architecture

microkernel architecture

drivers

- ✓ modularity
- ✓ simplicity
- ✓ cost
- ✓ adaptability
- ✓ evolvability
- ✓ agility
- ✓ testability
- ✓ deployability

microkernel architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
D	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
D	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
T	👎	👎	👍	👎	👎	👍👍👍	$
T	👍👍	👍👍	👎👎	👍👍👍	👍👍	👎👎	$$$
T	👍	👎	👍	👎	👎	👍👍	$
	👍	👍	👍	👎	👎	👍	$$

microkernel architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
D	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
D	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
T	👎	👎	👍	👎	👎	👍👍👍	$
T	👍👍	👍👍	👎👎	👍👍👍	👍👍	👎👎	$$$
T	👍	👎	👍	👎	👎	👍👍	$
T D	👍	👍	👍	👎	👎	👍	$$

space-based architecture

space-based architecture

drivers

- ✓ scalability
- ✓ elasticity
- ✓ performance

space-based architecture

	agility	deployment	testability	performance	scalability	simplicity	cost
D	👍👍👍	👍👍👍	👍👍👍	👎👎	👍👍👍	👎👎👎	$$$
D	👍👍	👍👍	👍👍	👎	👍👍	👎	$$
T	👎	👎	👍	👎	👎	👍👍👍	$
T	👍👍	👍👍	👎👎	👍👍👍	👍👍	👎👎	$$$
T	👍	👎	👍	👎	👎	👍👍	$
T D	👍	👍	👍	👎	👎	👍	$$
T	👍	👍👍	👎👎👎	👍👍👍	👍👍👍	👎👎👎	$$$$

architecture katas

identifying architecture patterns

Your Architectural Kata is...

Going Going Gone!

An auction company wants to take their auctions online to a nationwide scale--customers choose the auction to participate in, wait until the auction begins, then bid during the live auction as if they were there in the room, with the auctioneer.

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  - both online and live bids must be received in the order in which they are placed
  - video stream of the action after the fact
  - bidders register with credit card; system automatically charges card if bidder wins
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Your Architectural Kata is...

Going Going Gone!

service-based architecture

space-based architecture

microservices architecture

event-driven architecture

performance

availability

reliability

scalability

elasticity

Your Architectural Kata is...

Going Going Gone!

service-based architecture

space-based architecture

microservices architecture

event-driven architecture

	service-based architecture	space-based architecture	microservices architecture	event-driven architecture
performance	👎	👍👍👍	👎👎	👍👍👍
availability	👍	👍	👍👍👍	👍
reliability	👍	👎	👎👎	👎👎
scalability	👍👍	👍👍👍	👍👍👍	👍👍
elasticity	👎	👍👍👍	👍	👍👍

Your Architectural Kata is...

Going Going Gone!

service-based architecture

space-based architecture

microservices architecture

event-driven architecture

	service-based architecture	space-based architecture	microservices architecture	event-driven architecture
performance	👎	👍👍👍	👎👎	👍👍👍
availability	👍	👍	👍👍👍	👍
reliability	👍	👎	👎👎	👎👎
scalability	👍👍	👍👍👍	👍👍👍	👍👍
elasticity	👎	👍👍👍	👍	👍👍

option 1

Your Architectural Kata is...

Going Going Gone!

Your Architectural Kata is...

Going Going Gone!

	option 1	option 2	option 3	
	service-based architecture	space-based architecture	microservices architecture	event-driven architecture
performance	👎	👍👍👍	👎👎	👍👍👍
availability	👍	👍	👍👍👍	👍
reliability	👍	👎	👎👎	👎👎
scalability	👍👍	👍👍👍	👍👍👍	👍👍
elasticity	👎	👍👍👍	👍	👍👍

Your Architectural Kata is...

Going Going Gone!

	service-based architecture	space-based architecture	microservices architecture	event-driven architecture
performance	👎	👍👍👍	👎👎	👍👍👍
availability	👍	👍	👍👍👍	👍
reliability	👍	👎	👎👎	👎👎
scalability	👍👍	👍👍👍	👍👍👍	👍👍
elasticity	👎	👍👍👍	👍	👍👍

option 2

option 3

Your Architectural Kata is...

Going Going Gone!

service-based architecture

space-based architecture

microservices architecture

event-driven architecture

	service-based architecture	space-based architecture	microservices architecture	event-driven architecture
performance	👎	👍👍👍	👎👎	👍👍👍
availability	👍	👍	👍👍👍	👍
reliability	👍	👎	👎👎	👎👎
scalability	👍👍	👍👍👍	👍👍👍	👍👍
elasticity	👎	👍👍👍	👍	👍👍

option 3

Your Architectural Kata is...

Going Going Gone!

microservices architecture

event-driven architecture

Your Architectural Kata is...

Going Going Gone!

Your Architectural Kata is...

Going Going Gone!

microservices architecture

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Your Architectural Kata is...

I'll Have the BLT

modular monolith

microkernel

microservices

event-driven

	modular monolith	microkernel	microservices	event-driven
availability	👎	👎	👍👍👍	👍👍
reliability	👍	👎	👎👎	👎👎
scalability	👎👎👎👎	👎👎	👍👍👍	👍👍👍
Customizability	👍👍	👍👍👍	👍👍👍	👍

Your Architectural Kata is...

I'll Have the BLT

modular monolith

microkernel

microservices

event-driven

availability	👎	👎	👍👍👍	👍👍
reliability	👍	👎	👎👎	👎👎
scalability	👎👎👎👎	👎👎	👍👍👍	👍👍👍
Customizability	👍👍	👍👍👍	👍👍👍	👍
simplicity	👍👍👍	👍👍	👎👎	👎

Your Architectural Kata is...

I'll Have the BLT

modular monolith

microkernel

microservices

event-driven

	modular monolith	microkernel	microservices	event-driven
availability	👎	👎	👍👍👍	👍👍
reliability	👍	👎	👎👎	👎👎
scalability	👎👎👎👎	👎👎	👍👍👍	👍👍👍
Customizability	👍👍	👍👍👍	👍👍👍	👍
simplicity	👍👍👍	👍👍	👎👎	👎
domain isomorphism	👎	👍👍	👎👎	👍👍👍

Your Architectural Kata is...

I'll Have the BLT

modular monolith

microkernel

microservices

event-driven

	modular monolith	microkernel	microservices	event-driven
availability	👎	👎	👍👍👍	👍👍
reliability	👍	👎	👎👎	👎👎
scalability	👎👎👎👎	👎👎	👍👍👍	👍👍👍
Customizability	👍👍	👍👍👍	👍👍👍	👍
simplicity	👍👍👍	👍👍	👎👎	👎
domain isomorphism	👎	👍👍	👎👎	👍👍👍

Your Architectural Kata is...

I'll Have the BLT

Your Architectural Kata is...

I'll Have the BLT

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I'll Have the BLT

Your Architectural Kata is...

I'll Have the BLT

diagramming software architecture

diagramming architecture

diagramming architecture

"…there is a proportional relationship between a person's irrational attachment to some artifact to how long it took to produce it."

Irrational Artifact Attachment

http://nealford.com/memeagora/2008/12/01/irrational_artifact_attachment.html

Your Architectural Kata is...

I'll Have the BLT

A national sandwich shop wants to enable 'fax in your order' but over the Internet instead (in addition to their current fax-in service)

- ***Users:*** thousands, perhaps one day millions
- ***Requirements:***
  - users will place their order, then be given a time to pick up their sandwich and directions to the shop (which must integrate with several external mapping services that include traffic information)
  - if the shop offers a delivery service, dispatch the driver with the sandwich to the user
  - mobile-device accessibility
  - offer national daily promotions/specials
  - offer local daily promotions/specials
  - accept payment online or in person/on delivery
- ***Additional Context:***
  - Sandwich shops are franchised, each with a different owner.
  - Parent company has near-future plans to expand overseas.
  - Corporate goal is to hire inexpensive labor to maximize profit.
  - Time to market is critical.

Your Architectural Kata is...

I'll Have the BLT

Your Architectural Kata is...

I'll Have the BLT

Your Architectural Kata is...

I'll Have the BLT

Your Architectural Kata is...

I'll Have the BLT

Your Architectural Kata is...

I'll Have the BLT

The C4 model

System Context

The system plus users and system dependencies

Containers

The overall shape of the architecture and technology choices

Components

Components and their interactions within a container

Classes (or Code)

Component implementation details

C4:

CONTAINER

No correct answers in software architecture...

...only tradeoffs.

Your Architectural Kata is...

Going Going Gone!

An auction company wants to take their auctions online to a nationwide scale--customers choose the auction to participate in, wait until the auction begins, then bid during the live auction as if they were there in the room, with the auctioneer.

- **Users**: scale up to hundreds of participants (per auction), potentially up to thousands of participants, and as many simultaneous auctions as possible
- **Requirements**:
  - bidders can see a live video stream of the auction and see all bids as they occur
  - auctions must be as real-time as possible
  - both online and live bids must be received in the order in which they are placed
  - bidders register with credit card; system automatically charges card if bidder wins
  - participants must be tracked via a reputation index
- **Additional Context:**
  - auction company is expanding aggressively by merging with smaller competitors
  - if nationwide auction is a success, replicate the model overseas
  - budget is not constrained--this is a strategic direction
  - company just exited a lawsuit where they settled a suit alleging fraud

Your Architectural Kata is...

Going Going Gone!

Your Architectural Kata is...

Going Going Gone!

Your Architectural Kata is...

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Your Architectural Kata is...

Going Going Gone!

Your Architectural Kata is...

Going Going Gone!

Your Architectural Kata is...

Going Going Gone!

quanta

documenting software architecture

architecture decisions

an architect is responsible for defining the architecture and design principles used to guide technology decisions

architecture decisions

an architect is responsible for defining the architecture and design principles used to guide technology decisions

architecture decisions

architecturally significant

"We will keep a collection of records for *architecturally significant decisions*: those that affect the structure, non-functional characteristics, dependencies, interfaces, or construction techniques."

- Michael Nygard

http://thinkrelevance.com/blog/2011/11/15/documenting-architecture-decisions

ADR

short text file

Textile

asciidoc

semantic versioning

doc/arch/adr-NNN.md

numbered sequentially

no number reused

reversed ADR kept— marked superseded

Architecture Decision Records

Title: short noun phrase

Status: `proposed`, `accepted`, `superseded`

Context: forces at play

Decision: response to forces

Consequences: context after decision is applied

justifying decisions

the scenario

justifying decisions

the requirement: you need to federate the hub

justifying decisions

the decision: dedicated broker instances?

justifying decisions

the decision: centralized broker

21. Centralized message broker for federated gateway hub

Status

Accepted

Context

The incoming gateway hub is federated into 3 separate hubs. Access to the customer information functionality in the application is only through JMS using ActiveMQ via the hub. The two options are to use a centralized broker or to use dedicated broker instances for each hub instance.

Decision

We will use a centralized message broker instance for all federated gateway hubs.

We currently have low request volumes (200 requests/sec) and anticipate this will remain stable for the foreseeable future. Therefore we do not see a performance bottleneck issue.

We will leverage the ActiveMQ failover protocol coupled with clustered ActiveMQ broker instances to address any single point of failure issues.

Consequences

The customer information application will only require a single connection to the ActiveMQ broker instance.

The gateway hubs can be expanded and consolidated without any coding changes to the application.

The application doesn’t need to be concerned about where the request came from.

adr-001.md

```
# Federating the Hub

## Context
The AcmeWidgets application currently utilizes an integration hub to allow internal applications to connect

Figure 1 illustrates the existing scenario:

![Before](adr-001-before.png) <br>
_Figure 1: Before new clients added_


New requirements require developers to add two new access types: _external_ and _b2b_.


_Considerations_:

* broker only used for hub access
* low transaction volumes expected
* application logic may be shared between different types of client applications (e.g., internal and externa

Two options exist:

### Dedicated Broker Instances

Using dedicated broker instances creates the architecture shown in Figure 2.

![dedicated](adr-001-dedicated.png)<br>
_Figure 2: dedicated broker instances_

_Identified issues to address:_

* **throughput**:
Dedicated broker instances provide better throughput because no message contention exists.
* **internal application coupling**:
```

Federating the Hub

Context

The AcmeWidgets application currently utilizes an integration hub to allow internal applications to connect to it.

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Figure 1: Before new clients added

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Using dedicated broker instances creates the architecture shown in Figure 2.

Figure 2: dedicated broker instances

Identified issues to address:

- **throughput**: Dedicated broker instances provide better throughput because no message contention exists.
- **internal application coupling**: This approach requires changes to the internal client application to "understand" the broker. Internal app must now connect to three brokers and know context of request.
- **changes to client**: additional brokers added requires additional changes to client.
- **single point of failure**: redundancy prevents a single failure from disabling all integration architecture.
- **performance**: multiple broker instances should protect against aggregated performance problems.

Centralized Broker

Using dedicated broker instances creates the architecture shown in Figure 3.

Figure 3: centralized broker

Identified issues to address:

- **throughput**: Centralized broker potentially creates a throughput bottleneck. However, developers analysed past and expected future usage, and this shouldn't create problem.
- **internal application coupling**: Loose, with only one connection; app doesn't know about broker instances. The internal application doesn't need to know where the request originated.
- **changes to client**: additional brokers do not require changes to client.
- **single point of failure**: mitigated by clustering and failover provided by tools
- **performance**: because we expect low transaction volumes, performance should be sufficient with a single queue.

Decision

We chose a **centralized broker**.

Status

proposed

Consequences

The internal applications should not have to know from which broker instance the request came from.

Only a single broker connection is needed, allowing for the expansion of additional hub instances with no application changes.

the case for Asciidoc(tor)

http://asciidoc.org

http://asciidoctor.org

the case for Asciidoc(tor)

http://asciidoctor.org/docs/asciidoctor-diagram/

the case for Asciidoc(tor)

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class DiagramBlock
class DitaaBlock
class PlantUmlBlock

BlockProcessor <|-- DiagramBlock
DiagramBlock <|-- DitaaBlock
DiagramBlock <|-- PlantUmlBlock
....
```

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_Figure 2: dedicated broker instances_

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[ditaa]
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....
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architecture katas

documenting architecture decisions

Your Architectural Kata is...

Going Going Gone!

An auction company wants to take their auctions online to a nationwide scale--customers choose the auction to participate in, wait until the auction begins, then bid during the live auction as if they were there in the room, with the auctioneer.

- **Users**: scale up to hundreds of participants (per auction), potentially up to thousands of participants, and as many simultaneous auctions as possible
- **Requirements**:
  - bidders can see a live video stream of the auction and see all bids as they occur
  - auctions must be as real-time as possible
  - both online and live bids must be received in the order in which they are placed
  - video stream of the action after the fact
  - bidders register with credit card; system automatically charges card if bidder wins
  - participants must be tracked via a reputation index
- **Additional Context:**
  - auction company is expanding aggressively by merging with smaller competitors
  - if nationwide auction is a success, replicate the model overseas
  - budget is not constrained--this is a strategic direction
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Your Architectural Kata is...

Going Going Gone!

Your Architectural Kata is...

Going Going Gone!

using async pub/sub messaging between bidding services

1. Asynchronous messaging between bidding services

Status

Proposed

Context

Decision

Consequences

1. Asynchronous messaging between bidding services

Status

Proposed

Context

The Bid Capture Service, upon receiving a bid from an online bidder or from a live bidder via the auctioneer, must forward that bid onto the Bid Streamer Service and the Bidder Tracker Service. This could be done using async p2p or pub/sub messaging or REST via the Online Auction API Layer.

Decision

Consequences

1. Asynchronous messaging between bidding services

Status

Proposed

Context

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Decision

We will use asynchronous messaging between the Bid Capture Service, Bid Streamer Service, and the Bidder Tracker Service.

The Bid Capture Service does not need any information back from the Bid Streamer Service or Bidder Tracker Service.

The Bid Streamer Service must receive bids in the exact order they were accepted by the Bid Capture Service. Using messaging and queues automatically guarantees the bid order for the stream.

Using async pub/sub messaging will increase the performance of the bidding process and allow for extensibility of bidding information.

Consequences

1. Asynchronous messaging between bidding services

Status

Proposed

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The Bid Capture Service, upon receiving a bid from an online bidder or from a live bidder via the auctioneer, must forward that bid onto the Bid Streamer Service and the Bidder Tracker Service. This could be done using async p2p or pub/sub messaging or REST via the Online Auction API Layer.

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The Bid Streamer Service must receive bids in the exact order they were accepted by the Bid Capture Service. Using messaging and queues automatically guarantees the bid order for the stream.

Using async pub/sub messaging will increase the performance of the bidding process and allow for extensibility of bidding information.

Consequences

We will require clustering and high availability of the message queues

Internal bid events will be bypassing security checks done in the API layer.

Your Architectural Kata is...

I'll Have the BLT

A national sandwich shop wants to enable 'fax in your order' but over the Internet instead (in addition to their current fax-in service)

- ***Users:*** thousands, perhaps one day millions
- ***Requirements:***
  - users will place their order, then be given a time to pick up their sandwich and directions to the shop (which must integrate with several external mapping services that include traffic information)
  - if the shop offers a delivery service, dispatch the driver with the sandwich to the user
  - mobile-device accessibility
  - offer national daily promotions/specials
  - offer local daily promotions/specials
  - accept payment online or in person/on delivery
- ***Additional Context:***
  - Sandwich shops are franchised, each with a different owner.
  - Parent company has near-future plans to expand overseas.
  - Corporate goal is to hire inexpensive labor to maximize profit.
  - Time to market is critical.

Use of Micro-kernel Architecture

Status
PROPOSED

Context
Two key requirements of the system (_promotions_ anc

The current design features a modular monolith archite

![modular monolith](fig1_modular_monolith.jpg)
Figure 1: the current state architecture

Currently, stores must specify custom behavior (produc

All local customizations reside in one service and in one

To allow stores to most easily add and customize local

![microkernel architecture](fig2_microkernel.jpg)
Figure 2: proposed microkernel architecture

The new design allows easy update of global policy (pr

Decision
The architects decided to migrate the current monolith

Consequences
The architects take advantage of the restructuring oppo

The new design also incorporates the BFF patterns, dis

The new design will greatly improve the customization

- the local store plug-in architecture certifies customizat
- promotions within threshold values go live within 15 n
- all stores work with generic workflows via the core sys
  - promotions
  - location exemptions
  - local products

quirements.

1_.

FTP. Operations must certify the JAR, leading to dela

ecome a tangled mess.

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n appropriate.

ality via plug-ins.

w occurs via messaging.

file:///Users/neal4d/Dropbox/_softarch101/OReilly%20Online

Use of Micro-kernel Architecture

Status

PROPOSED

Context

Two key requirements of the system (*promotions* and *location services*) have both global (affects all stores) and local (specific to location) requirements.

The current design features a modular monolith architecture, allowing individual stores to upload their behavior using JAR files, shown in *Figure 1*.

Figure 1: the current state architecture

Currently, stores must specify custom behavior (product specials, promotions, location exemptions) via a JAR file, uploaded to the global site via FTP. Operations mus
the JAR, leading to delays in deploying new features.

All local customizations reside in one service and in one set of tables in the master database. Over time, as new customizations accrued, it has become a tangled mess.

To allow stores to most easily add and customize local behavior, the architects propose moving to a micro-kernel architecture, shown in *Figure 2*.

Figure 2: proposed microkernel architecture

The new design allows easy update of global policy (products, inventory, promotions) while allowing local stores to selectively those choices when appropriate.

Decision

The architects decided to migrate the current monolith to become the core system for the new microkernel architecture, and build new functionality via plug-ins.

Consequences

The architects take advantage of the restructuring opportunity to localize databases to individual domains. Communication between services now occurs via messagin

The new design also incorporates the BFF patterns, discussed in 004 BFF for device independence.

The new design will greatly improve the customization workflow.

- the local store plug-in architecture certifies customizations automatically
- promotions within threshold values go live within 15 minutes
- all stores work with generic workflows via the core system, but locations can override to create custom behavior for:
  - promotions
  - location exemptions
  - local products

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summary

summary

There are no right or wrong answers in architecture; rather, it's always about ***tradeoffs***

summary

There are no right or wrong answers in architecture; ***only expensive ones***

summary

scalability

reliability

availability

business needs and ***architectural characteristics*** are what drive the architecture!

summary

every architecture decision should be accompanied with a ***technical and business justification***

more resources

nealford.com

Neal Ford | Author, ThoughtWorker, & Meme Wrangler ...

nealford.com

Abstracts/Slides Biography Books Video Writing

Architectural Katas

inspired by Ted Neward's original Architectural Katas

```
"How do we get great designers?
Great designers design,
of course."
                        Fred Brooks

"So how are we supposed to get great architects, if
they only get the chance  to architect fewer than
a half-dozen times in their career?"

                       Ted Neward
```

About

Architectural Katas are intended as a small-group (3-5 people) exercise, usually as part of a larger group (4-10 groups are ideal), each of whom is doing a different kata. A Moderator keeps track of time, assigns Katas (or allows this website to choose one randomly), and acts as the facilitator for the exercise.

The Architectural Katas started as a presentation workshop by Ted Neward. They've taken on a life of their own. *Learn more »*

Rules

Doing an Architectural Kata requires you to obey a few rules in order to get the maximum out of the activity. *Read Rules »*

Lead

Want to run the Architectural Katas yourself? There's only a few things you need to know before you do. Ted Neward, the originator of Architectural Katas, has information on his site about leading Katas exercises. *Read on the original site »*

List Katas »

Random Kata »

- Follow Neal on Twitter at *@neal4d*
- Neal works at *ThoughtWorks*, a very interesting place.
- Neal speaks frequently on the *No Fluff, Just Stuff* conference circuit.
- *Meme Agora* RSS feed.

http://nealford.com/katas/

more resources

http://evolutionaryarchitecture.com

more resources

https://www.thoughtworks.com/podcasts

more resources

codeproject.com

13,364,274 members (44,618 online) Sign in

CODE PROJECT® For those who code

home articles quick answers discussions features community help

Articles » Development Lifecycle » Design and Architecture » Application Design

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Browse Code
Stats
Revisions (7)
Alternatives
Comments

Add your own alternative version

Tagged as

Architect
Dev
Design

Stats

16.4K views
8 bookmarked

Posted 24 Jan 2017

CPOL

The C4 Software Architecture Model

Petru Faurescu, 24 Jan 2017

5.00 (12 votes) Rate this:

Is there an easy way to succinctly and unambiguously communicate the architecture of a software system? Something that could highlight the requirements, and still be brief?

The Agile Manifesto prescribes that teams should value working software over comprehensive documentation. This doesn't mean that we should not create documentation; it just means we should create documentation that provides value and at the same time does not hinder the team's progress. We can achieve this using C4 architecture model. It is a static model, that provides an easy way to communicate the design of the system to all involved, and also brings a natural narrative for exploring the architecture of a software solution. Starting from the highest level (what is the system and how does it provides value to the business), it drills into the details, until the very low level of functionality.

It could be something to next car presentation, showing the relevant details from outside to inside:

Source: Wired article (link)

This architecture model has been created by Simon Brown, and you can find more details and live presentations on his website simonbrown.je.

Why Such Architecture Model?

The C4 model is a hierarchical way to think about the structures of a software system. Why such a model would be needed, since the existence of UML, or 4 + 1 architecture views (Wikipedia link) and the others? I see the following advantages:

- **Makes the diagrams easy to read** – Usually the diagrams that design a software system are part of the context in the documents, and it is harder to get the full meaning, without reading the full specification. C4 Models encourage to write succinct description text within the diagram, making them easy to comprehend and use, even outside of a documentation. This gives a chance to be easier used by other members of the team.
- **It has a role of zoom in / zoom out**, providing the different amount of details, better suited to different persons / roles involved in the project. It starts from a **context** or general diagram, and goes into the details of **containers** (one or more containers such as web applications, mobile apps, standalone applications, databases, file systems, etc.). Each of the containers has one or more **components**, which in turn are implemented by one or more **classes**.
- **Reduces the gap between design and actual implementation** – Diagrams could be made in any tool. Even so, generating them using few lines of code, it makes possible to easier maintain them along the way the software product is developed. Here is the tool – structurizr.com

Arhitectural Kata

To try this model, I would propose to start from a simple specification, initially designed for an architectural kata sessions. In this article, I would be focused more on the way we graphically represent the system(s), rather to discuss how effectively the system is designed. In some parts, other technology selections would make more sense.

A national sandwich shop wants to enable "fax in your order", but over the Internet instead.

https://www.codeproject.com/Articles/1167140/The-C-Software-Architecture-Model

DeveloperToArchitect.com

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Developer To Software Architect

"The journey from developer to software architect is a difficult and uncharted path filled with lots of challenges, pitfalls, and confusion. The purpose of DeveloperToArchitect.com is to provide resources and training to help you along the journey to becoming an effective software architect"

Mark Richards, Software Architect, Founder of DeveloperToArchitect.com

I am a hands-on software architect with over 30 years of experience in the industry. I have experience in the architecture and delivery of Microservices Architectures, Service-Based Architectures, and Service-Oriented Architectures in a variety of platforms. I am also a published author, conference speaker, and trainer.

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Architecture by Example

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