SENG 350
- Software Architecture & Design

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Fall 2024

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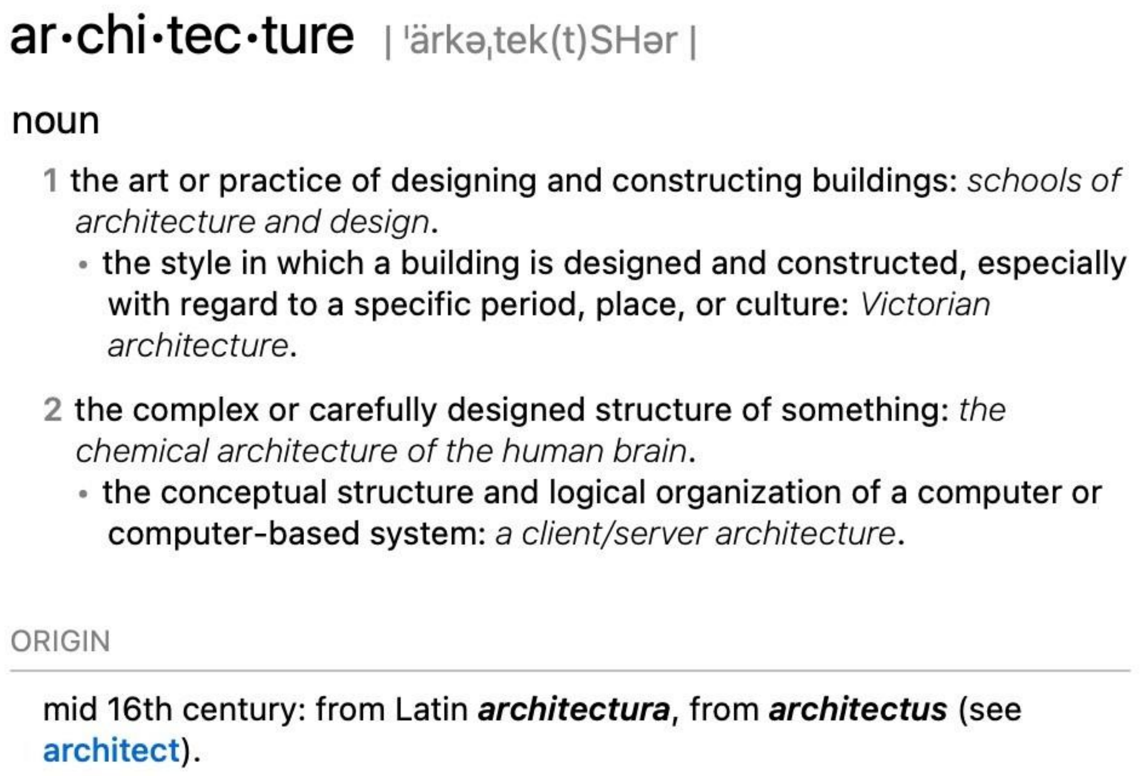
What is Software Architecture?



ar·chi·tec·ture | ˈärkəˌtek(t)SHər |

noun

1 the art or practice of designing and constructing buildings: *schools of architecture and design*.
- the style in which a building is designed and constructed, especially with regard to a specific period, place, or culture: *Victorian architecture*.

2 the complex or carefully designed structure of something: *the chemical architecture of the human brain*.
- the conceptual structure and logical organization of a computer or computer-based system: *a client/server architecture*.

ORIGIN

mid 16th century: from Latin ***architectura***, from ***architectus*** (see architect).

Definition of Software Architecture

The software architecture of a system is the set of structures needed to reason about the system. These structures comprise software elements, relations among them, and properties of both.

other definitions: “early”, “major”, or “important” decisions about a system

Course Learning Objectives

Upon completion of the course, students will be able to:

- Apply software patterns and architectural styles to solve design problems
- Understand the value of quality attributes and scenarios in testing potential designs
- Analyse architectural approaches using rigorous techniques
- Understand what decisions are the architecturally significant decisions, and which should be left to developers.
- Languages and notations, including the UML, for abstracting design models.

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Topics

- What is Software Architecture?
- Software Quality Attributes
- Architecture Description Languages
- The Unified Modeling Language (UML)
- Software Architecture Tactics and Patterns
- Quality Attribute Modeling and Analysis
- Architecture in the LifeCycle
- Documenting Architecture
- Architecture Implementation and Testing
- Architecture Reconstruction and Conformance
- Architecture Evaluation
- Architecture and Business

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Readings / Textbooks

Readings for this course will be made available online, through the learning management system.

Optional:

Software Architecture in Practice (4th ed.) Authors: Len Bass, Paul Clements, Rick Kazman Publisher: Addison-Wesley

(available online through the UVic library)

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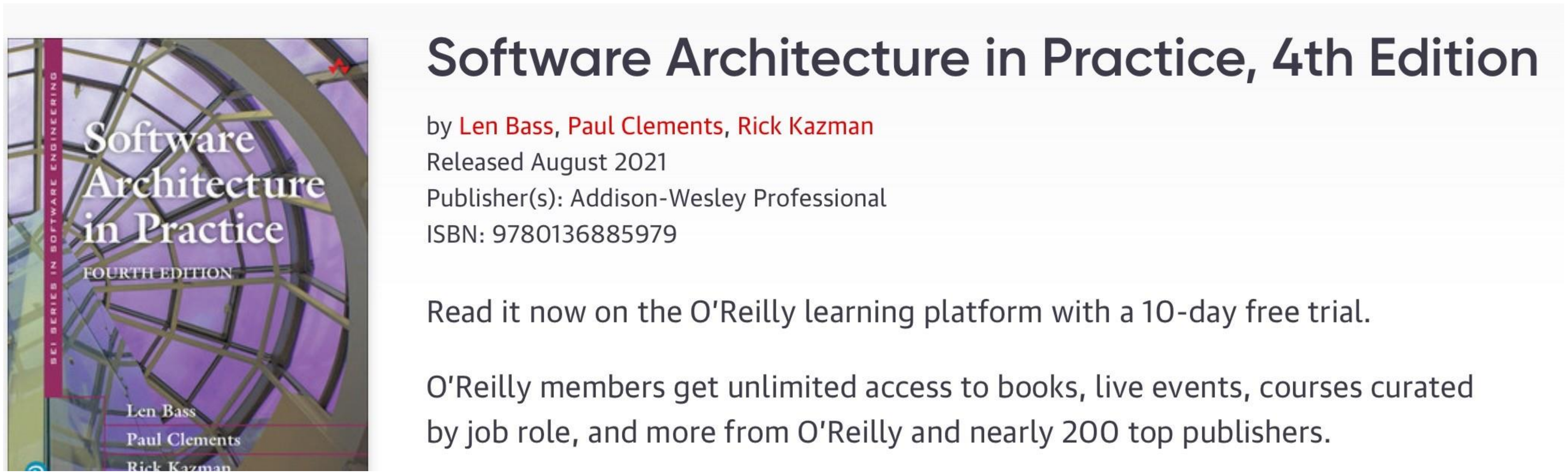
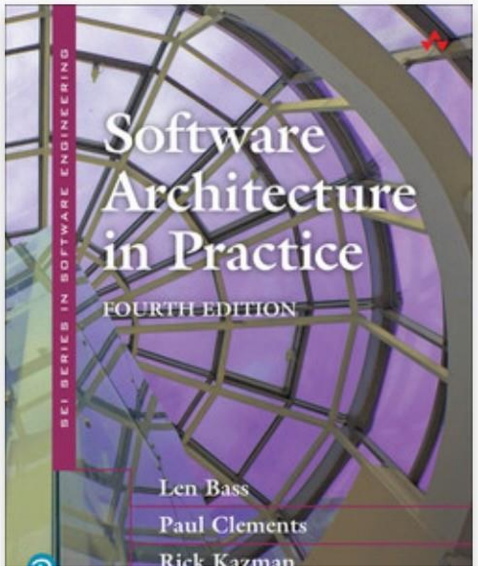
Pls. Read Chapter 1





SEI SERIES IN SOFTWARE ENGINEERING
Software Architecture in Practice
FOURTH EDITION
Len Bass
Paul Clements
Rick Kazman

Software Architecture in Practice, 4th Edition

by Len Bass, Paul Clements, Rick Kazman
Released August 2021
Publisher(s): Addison-Wesley Professional
ISBN: 9780136885979

Read it now on the O'Reilly learning platform with a 10-day free trial.

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Other Materials

Students are expected to have a laptop. The course will make use of in-class activities that require the use of a laptop. (A tablet may also work, depending on the model.)

Moreover, the course is project-based. While students will be able to use computers in the lab, it will be useful to have a laptop to work on the project from home in case students need to self-isolate because they are ill.

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Project

This course has a substantial group project, which is scheduled over four milestones worth 15% each. A tentative schedule for the milestones is provided below.

Groups will be formed in the first lab (next week, depending on your lab registration). Students are expected to attend all labs.

Milestone	Weight
Milestone 1 - Requirements	15%
Milestone 2 - Design	15%
Milestone 3 - Construction 1	15%
Milestone 4 - Documentation	15%

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Exams

The midterm exam will be a hybrid midterm exam. The first part will be a 25-minute, closed-book exam conducted during class time.

The second part will be open-book and can be completed anywhere, with students submitting their work on Brightspace.

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Course Work Overview

Item	Weight
Project	60
Lab Participation	15
Class Participation	10
Midterm	15

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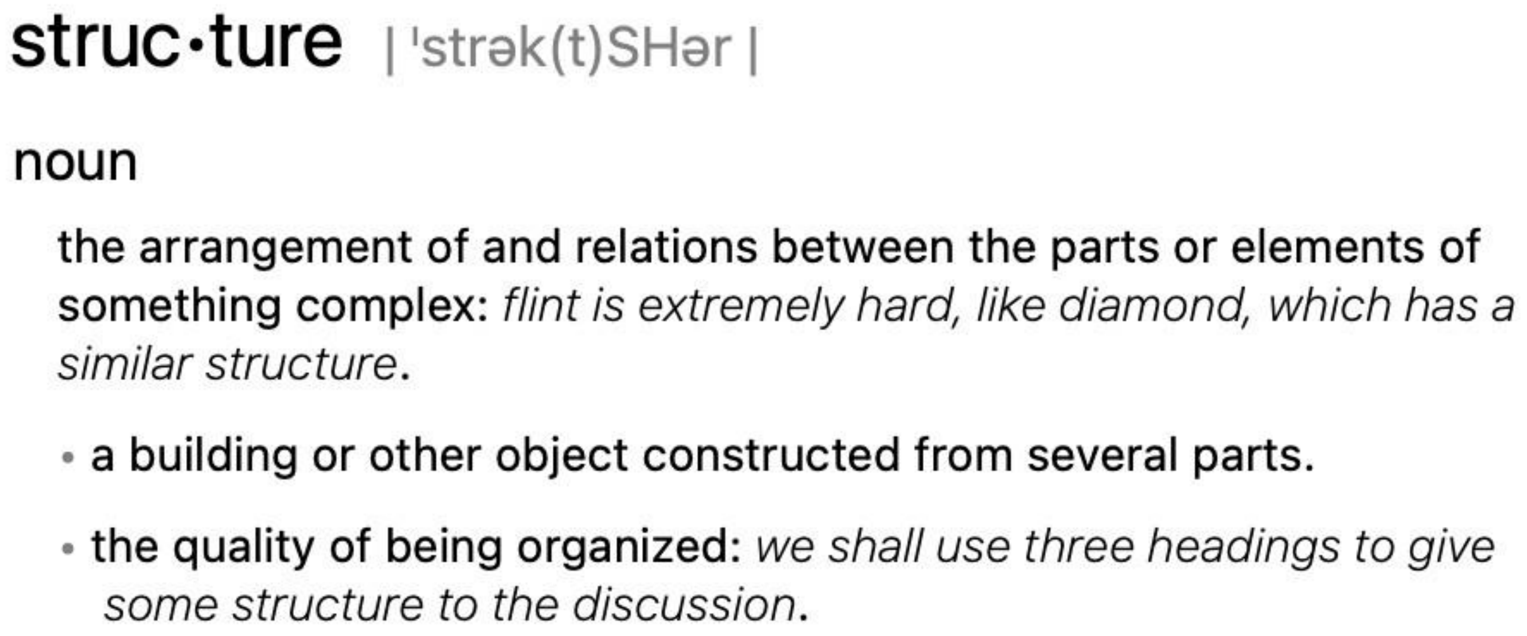
Questions about the course?

Architecture is a Set of Software Structures



struc·ture | ˈstrək(t)SHər |

noun

the arrangement of and relations between the parts or elements of something complex: *flint is extremely hard, like diamond, which has a similar structure*.

- a building or other object constructed from several parts.
- the quality of being organized: *we shall use three headings to give some structure to the discussion*.

Architecture is about reasoning-enabling structures

Find an example of a software structure that isn't architectural (i.e., that isn't reasoning-enabling)

the set of lines of source code that contain the letter "z," ordered by increasing length from shortest to longest.

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Architecture is an Abstraction

Crescent
King's Cross St. Pancras
Haggerst
ebone
Baker Street
Great Portland Street
Euston
Angel
Hoxt
Warren Street
Euston Square
Old Street
Farringdon
Regent's Park
Russell Square
Liverpool Street
Barbican
Shoredit High Stre
Goodge Street
Moorgate
ster
Bond Street
Oxford Circus
Chancery Lane
Aldgate East
St. Paul's
Marble Arch
Tottenham Court Road
Holborn
Bank
Aldgate
Covent Garden
Green Park
Leicester Square
Corner
Piccadilly Circus
Cannon Street
dge
Monument
Tower Hill
Fenchurch Street
Mansion House
Tower Gateway
Charing Cross
Blackfriars
River Thames
St. James's Park
Victoria
Temple

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Architecture vs Design

Architecture is Design

.... but not all design is architecture

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Every System has an Architecture

It may be buried, undocumented, forgotten, etc.

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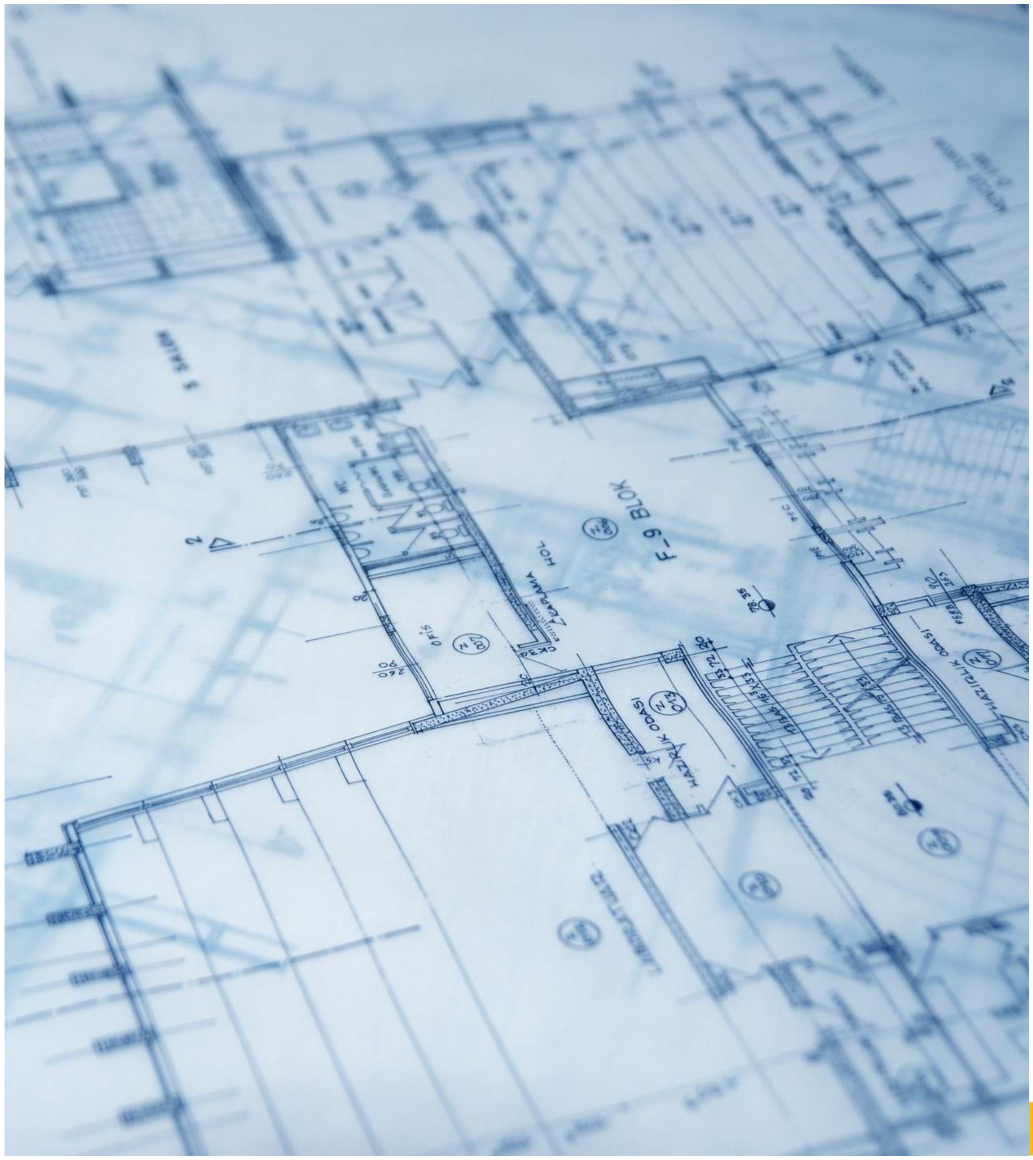
Not all architectures are good

Architecture Includes Behaviour



Related: System Architecture

- includes hardware, humans, physical infrastructure,...

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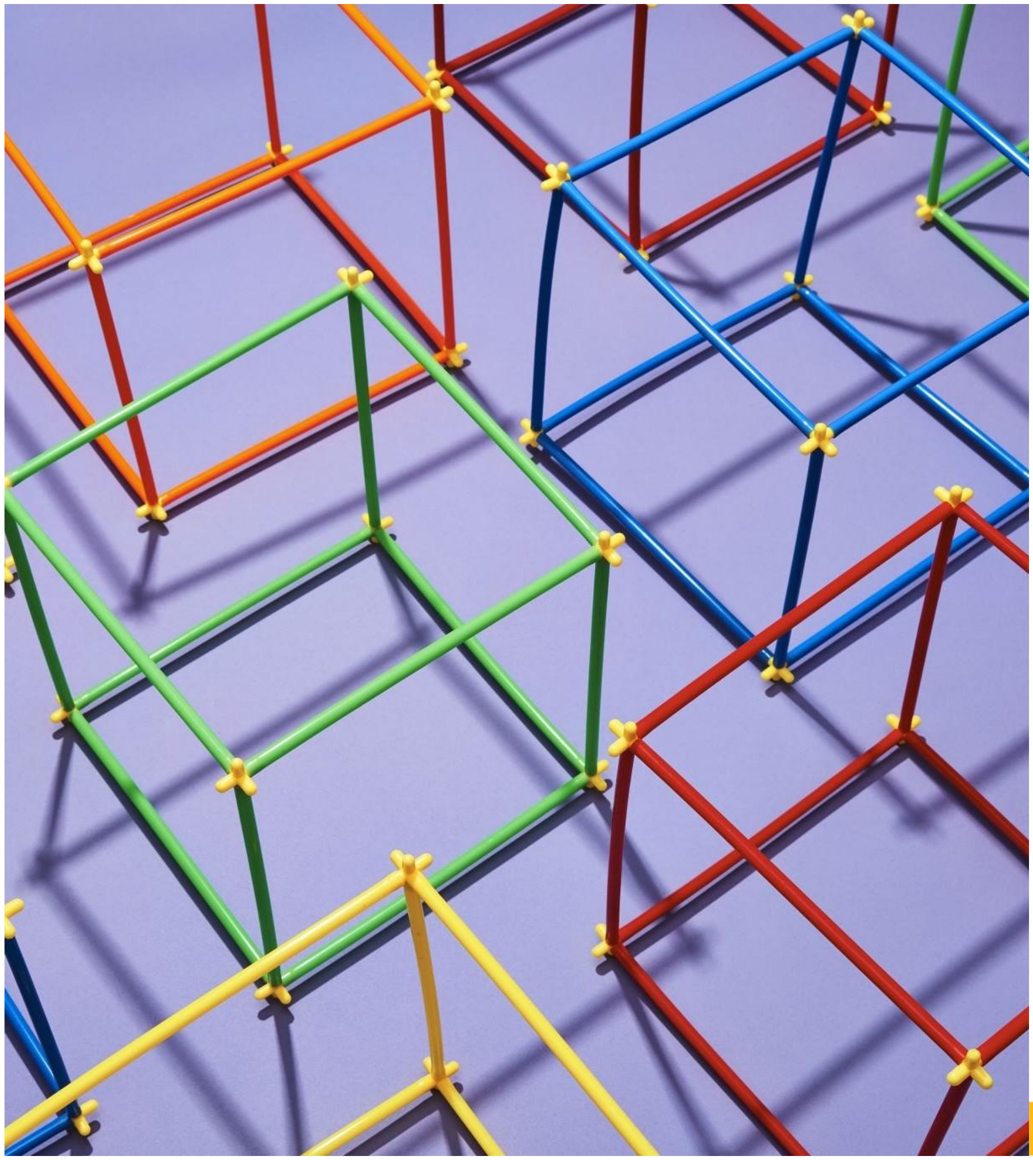

Related: Enterprise Architecture

Structure and behaviour of an organization’s processes, information flow, personnel, etc.

Discussion

What architectures have you worked with?

How can an architecture be used as a basis for decision making?

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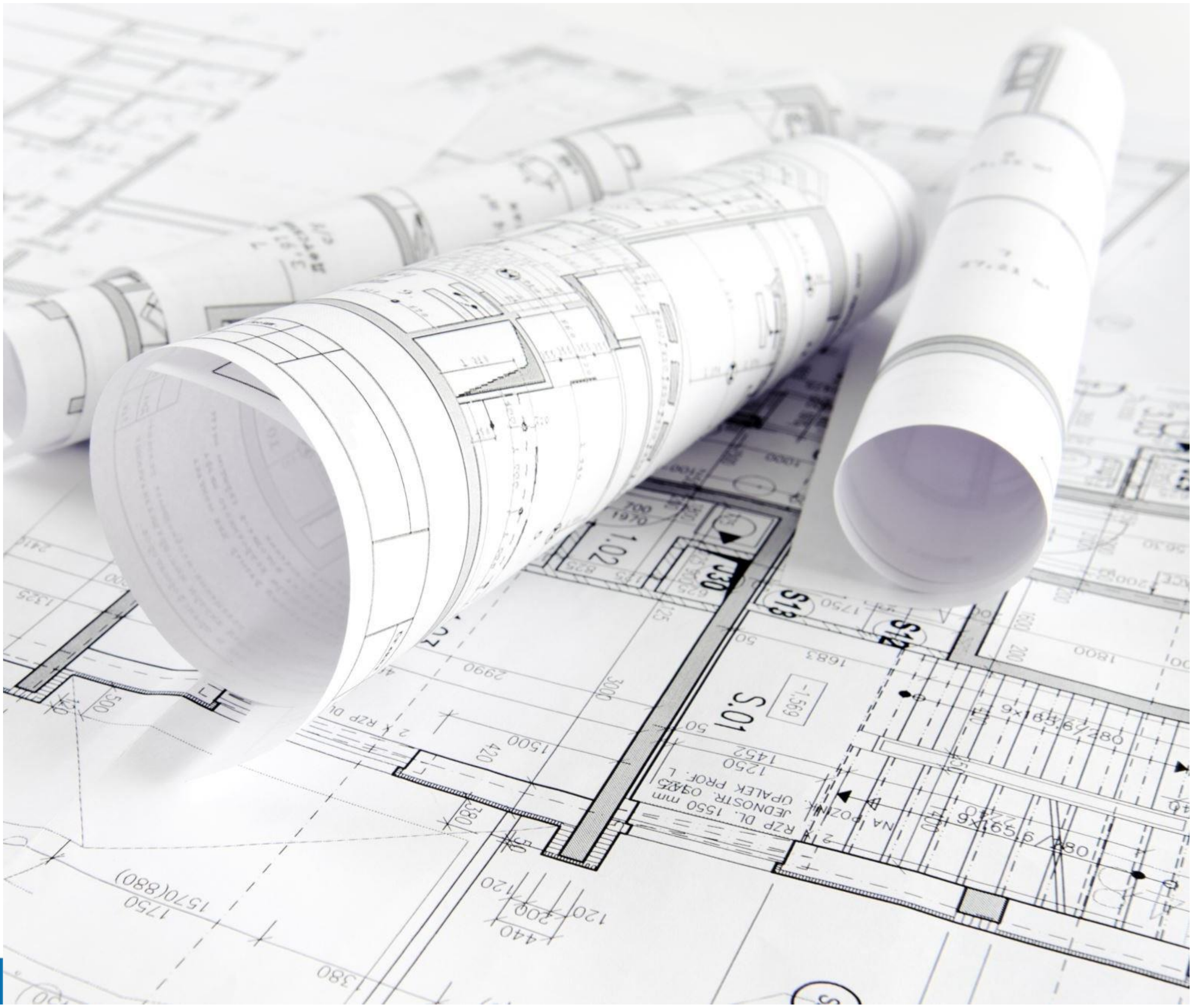
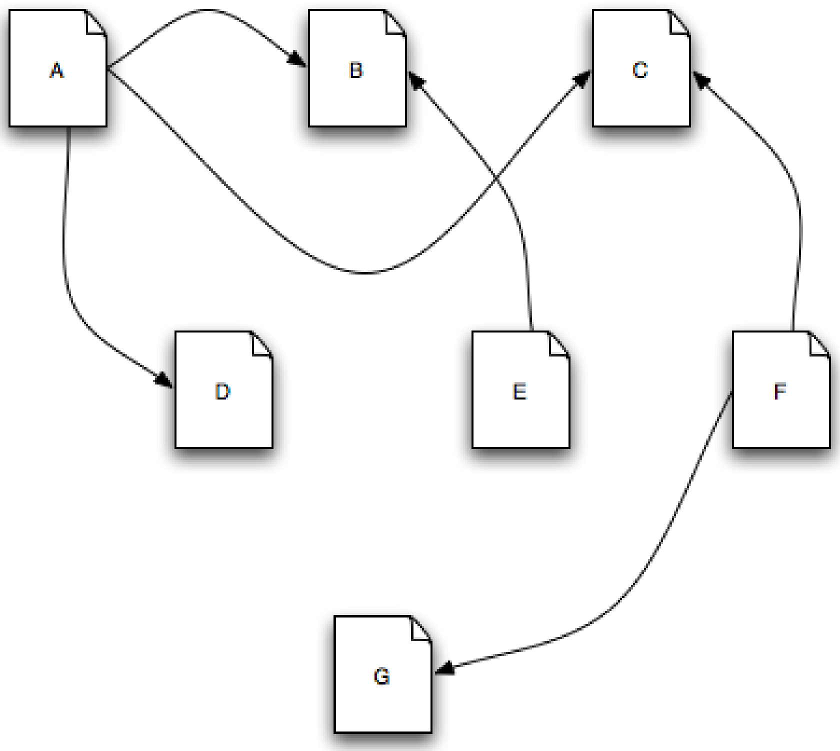


Architecture in Action: WWW

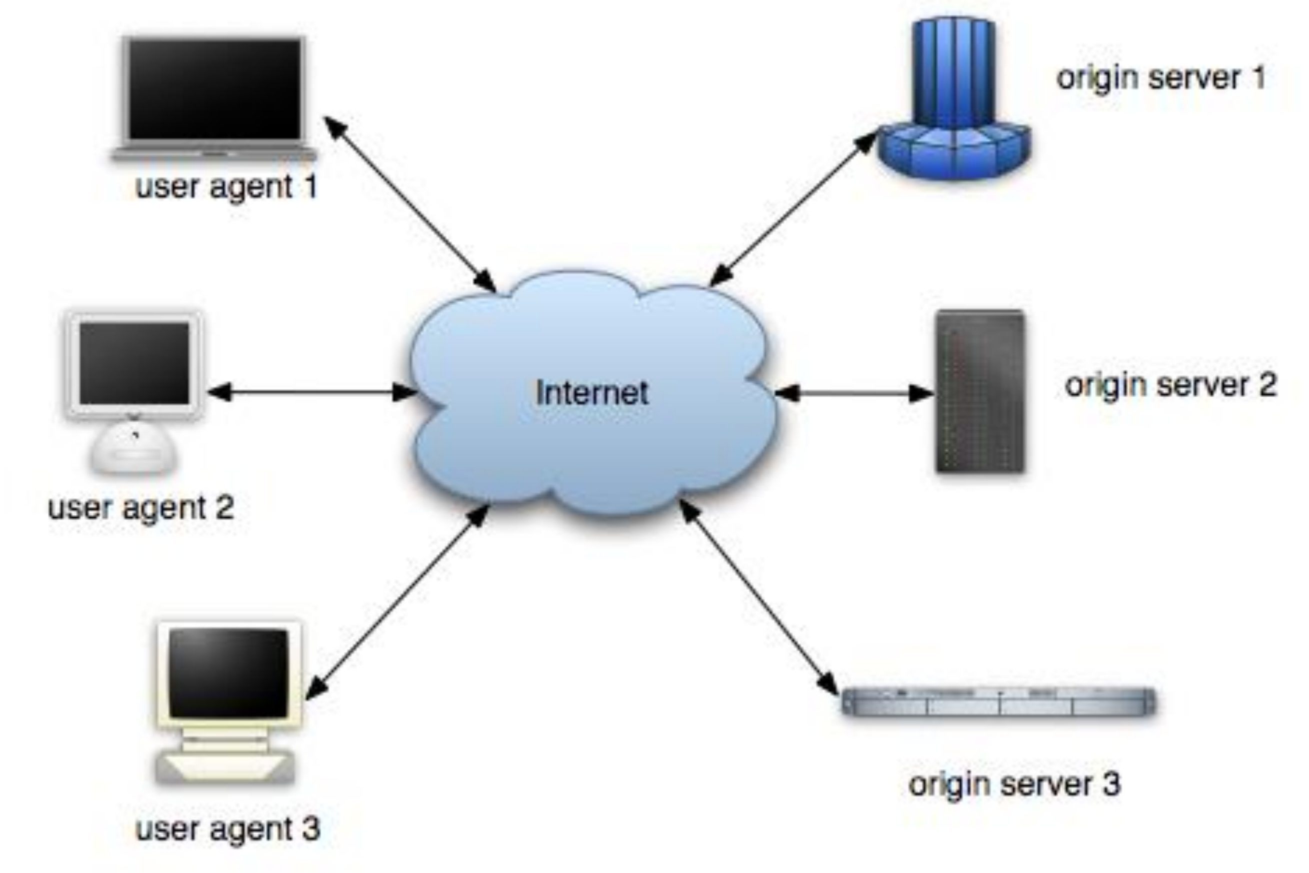
What is Web?
How do you explain it to someone?

One definition: Web is a dynamic set of relationships among collections of information



Architecture in Action: WWW

So is this



Another view: Dynamic collection of independently owned and operated machines, located around the world, which interact across computer networks

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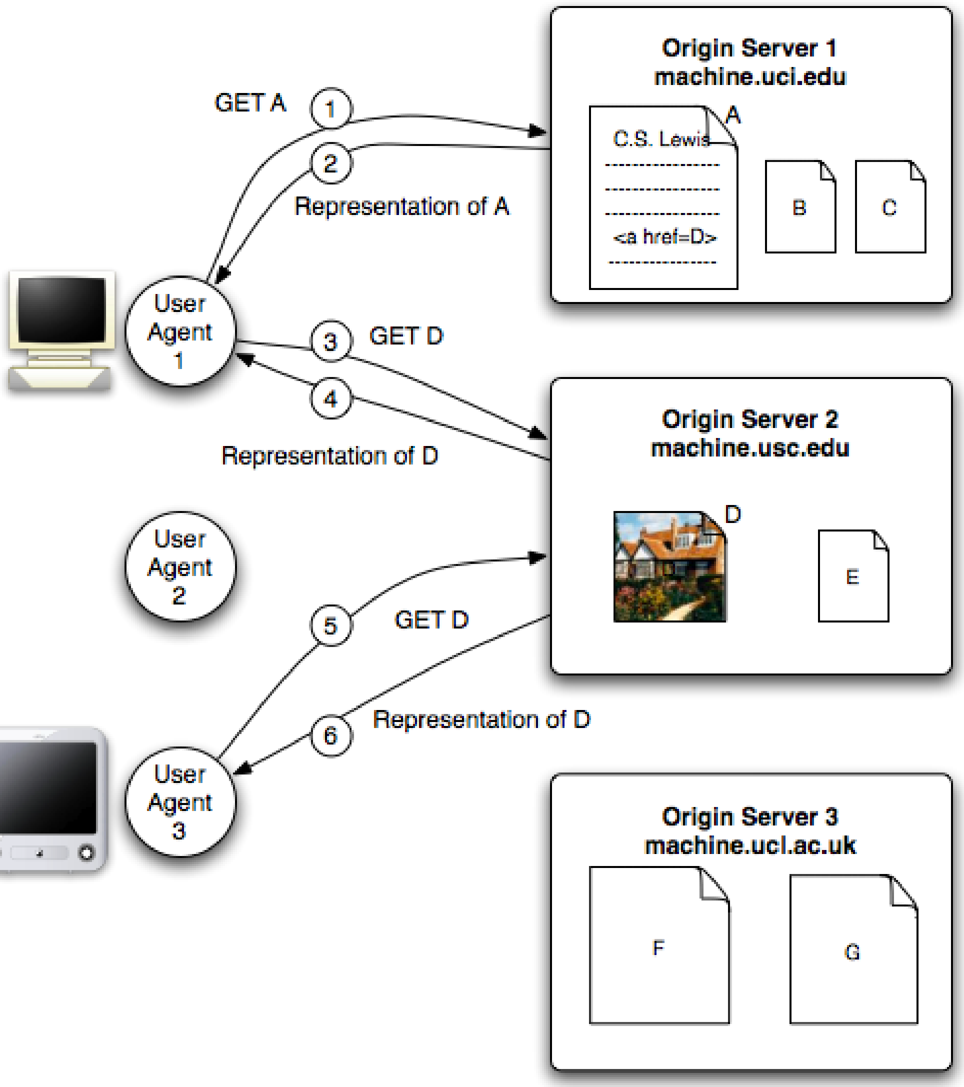
Architecture in Action: WWW

And this

Still another view: collection of independently written programs that interact with each other according to the rules specified in some standards, e.g. HTTP, HTML



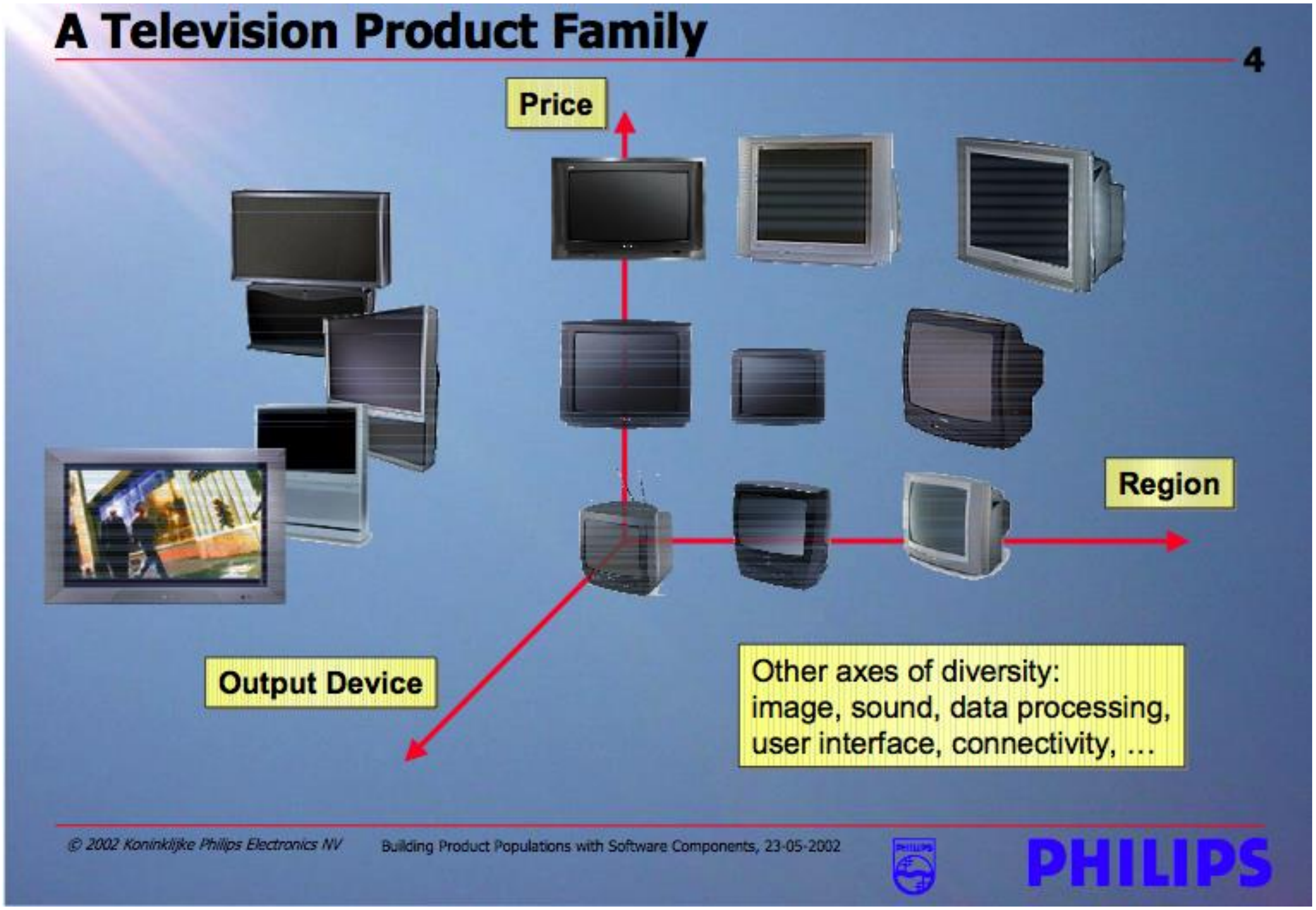
Discussion

A consumer wants a 70-inch LED with a built-in Blu-ray player for the North American market.

Architecture in Action: Product Line

- Architectures are enablers of developing product families
- Product families are sets of independent programs having significant commonality in their components/structures

Families of Related Products



A Television Product Family
4
Price
Region
Output Device
© 2002 Koninklijke Philips Electronics NV
Building Product Populations with Software Components, 23-05-2002
PHILIPS

Other axes of diversity:
image, sound, data processing,
user interface, connectivity, …

The Necessity and Benefit of Product Lines

Building these LEDs from scratch would likely put Philips out of business.

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Reusability?

Reuse as the Big Win

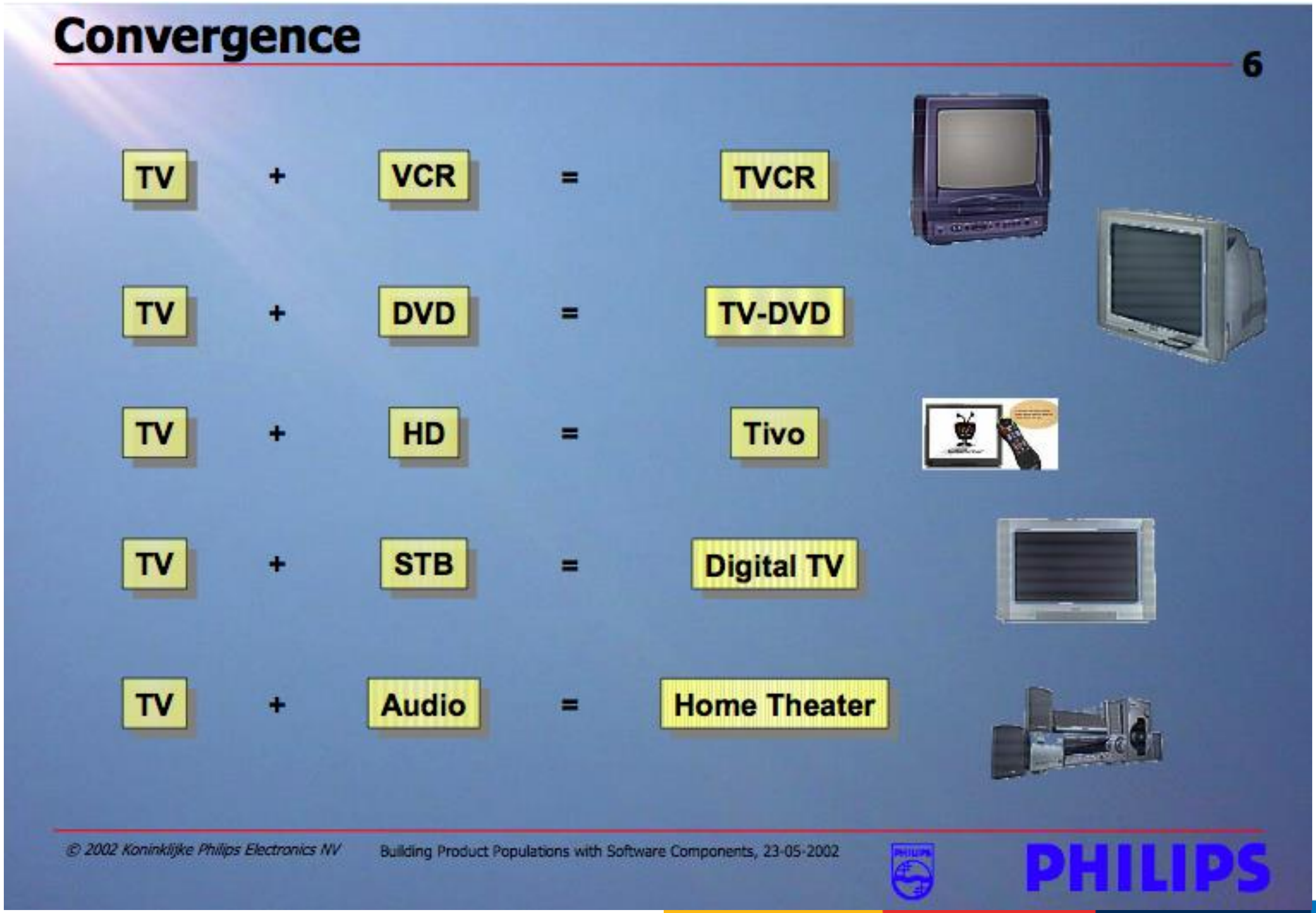
Architecture: reuse of

- Ideas
- Knowledge
- Patterns
- engineering guidance
- Well-worn experience

Product families: reuse of

- Structure
- Behaviours
- Implementations
- Test suites…

Added Benefit – Product Populations



Convergence

6

TV	+	VCR	=	TVCR
TV	+	DVD	=	TV-DVD
TV	+	HD	=	Tivo
TV	+	STB	=	Digital TV
TV	+	Audio	=	Home Theater

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Building Product Populations with Software Components, 23-05-2002

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What makes a good architecture?

What makes a good architecture?

Process recommendations

- product of a single architect (or small group) with strong connection to the dev team
- based on quality attributes (less on functionality)
- documented based on *views*
- evaluated for ability to deliver quality attributes
- allows incremental implementation

What makes a good architecture?

Structure rules of thumb

- well-defined modules (clear responsibility, interfaces, encapsulation, information-hiding)
- well-known patterns and tactics
- no dependency on particular version of commercial tool
- modules separated in data “producers” and “consumers”
- no 1:1 correspondence between modules and components
- ease of reallocation of processes to processors
- small number of simple component interactions
- specific set of resource contention areas (e.g., performance, bandwidth)

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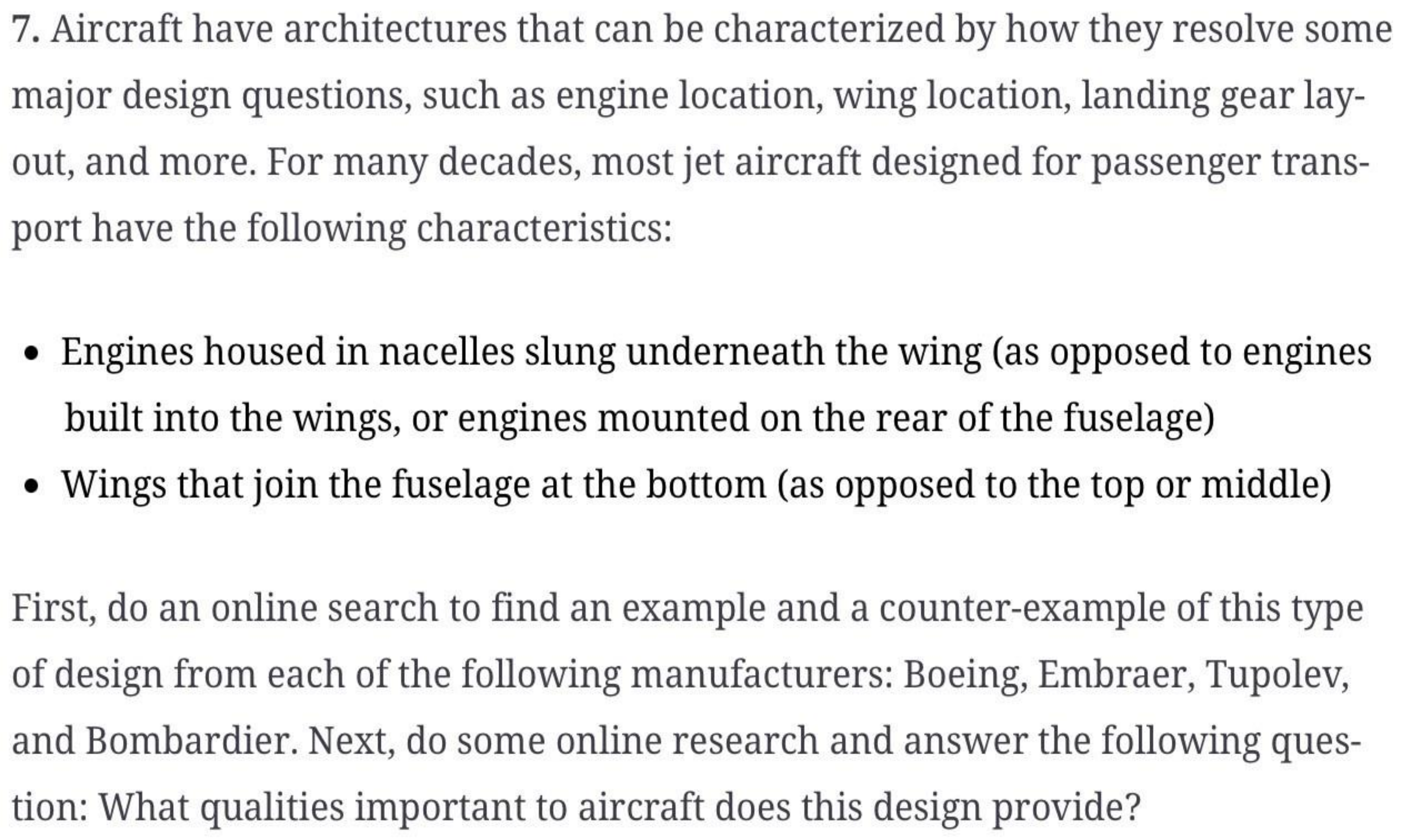
Group work (20 mins)



7. Aircraft have architectures that can be characterized by how they resolve some major design questions, such as engine location, wing location, landing gear layout, and more. For many decades, most jet aircraft designed for passenger transport have the following characteristics:

- Engines housed in nacelles slung underneath the wing (as opposed to engines built into the wings, or engines mounted on the rear of the fuselage)
- Wings that join the fuselage at the bottom (as opposed to the top or middle)

First, do an online search to find an example and a counter-example of this type of design from each of the following manufacturers: Boeing, Embraer, Tupolev, and Bombardier. Next, do some online research and answer the following question: What qualities important to aircraft does this design provide?

Submit on Teams

Make a version of your architecture for this as well.

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