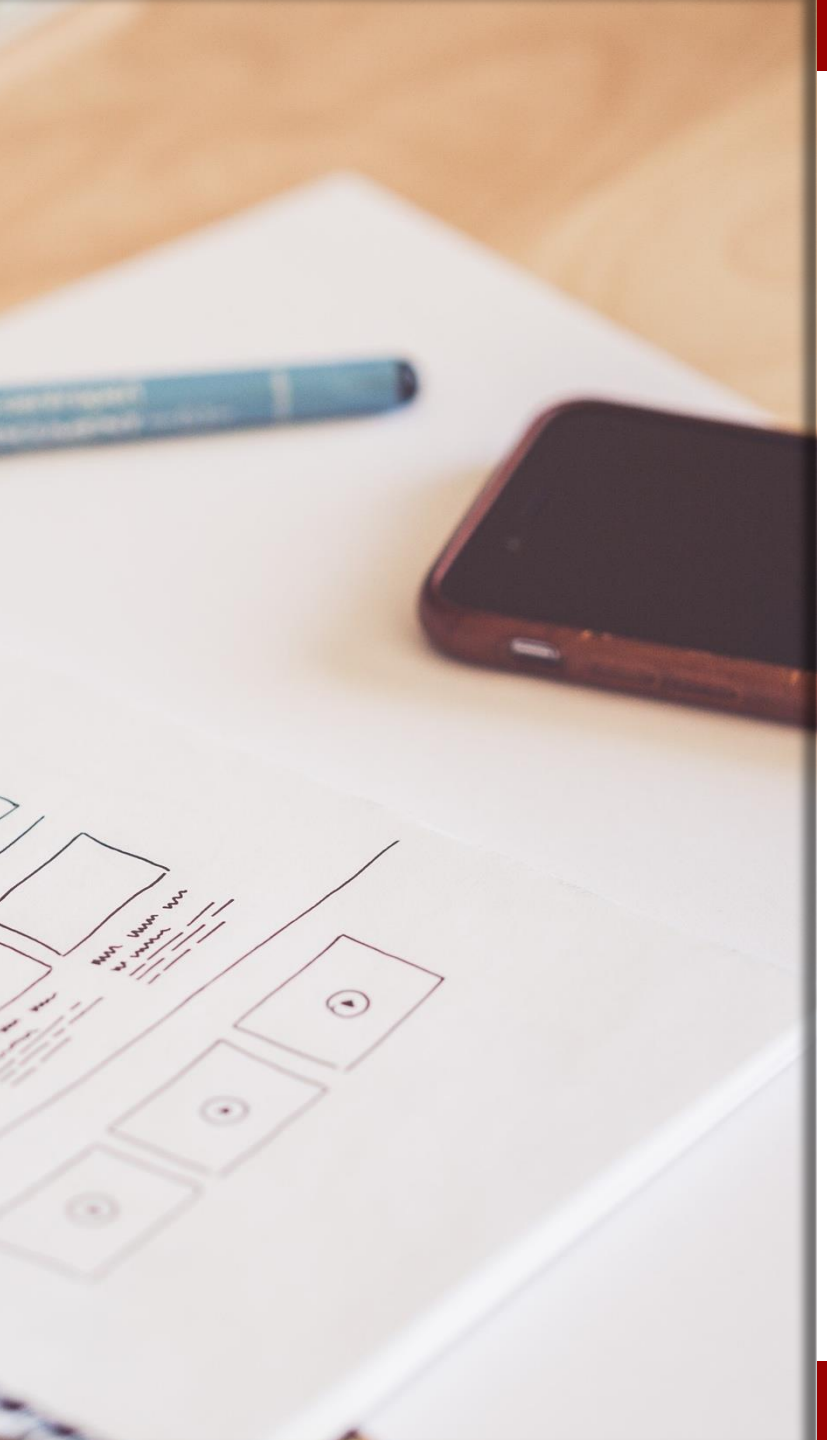


Architectural Characteristics

Rafał Włodarski
03/11/2026

ABOUT ME

Experience:

- 8 years of industry experience in software development, software project management, enterprise information systems
- Joined CMU Silicon Valley in 2022 as Assistant Professor

Teaching:

- 18-653 Software Design & Architecture
- 18-656 Functional Programming in Practice
- 18-654 Software Testing & Operations
- 18-652 Foundations of SE
- 18-351/651 Full-Stack Software Development for Engineers

Research:

- GenAI in Software Engineering Education
- Software Development Methods

LOVE: ice cream, halloween, shopping



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Defining Architectural Characteristics

- ”a measurable or testable property of a system that is used to indicate how well the system satisfies the needs of its stakeholders beyond the basic function of the system”
  - Define the success criteria of a system
  - Yet, difficult to measure
- Alternative naming:
  - *Non-functional requirements*
  - *Quality attributes*

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Identifying Architectural Characteristics

- One of the first steps in a project development lifecycle

- 3 ways to extract architectural characteristics:
  I. domain concerns,
  II. implicit domain knowledge,
  III. requirements

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Identifying Quality Attributes: domain concerns

- Collaboration with domain stakeholders drives definition of architectural characteristics:
  - surveys, workshops, meetings
- Differing languages might impede the success

Domain concern	Architecture characteristics
Mergers and acquisitions	Interoperability, scalability, adaptability, extensibility
Time to market	Testability, deployability
User satisfaction	Performance, availability, fault tolerance, security
Competitive advantage	Testability, deployability, scalability, availability, fault tolerance
Time and budget	Simplicity, feasibility

*Table source: Fundamentals of Software Architecture, Mark Richards, Neal Ford

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Identifying Quality Attributes: domain knowledge

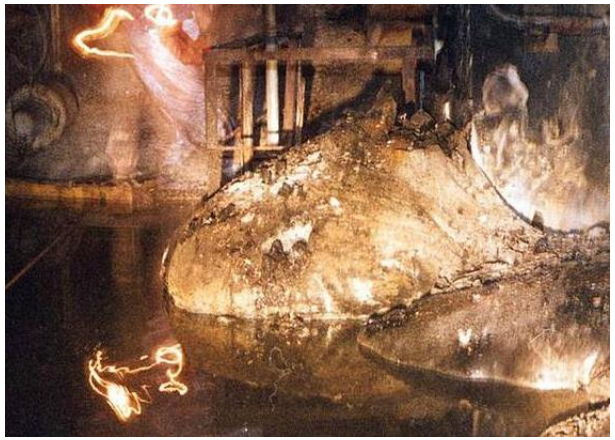
- Some quality attributes are implicit to a given domain

Availability	Downtime/Year
99.0%	3 days, 15.6 hr
99.9%	8 hr, 0 min, 46 sec
99.99%	52 min, 34 sec
99.999%	5 min, 15 sec
99.9999%	32 sec

financial systems

safety critical systems



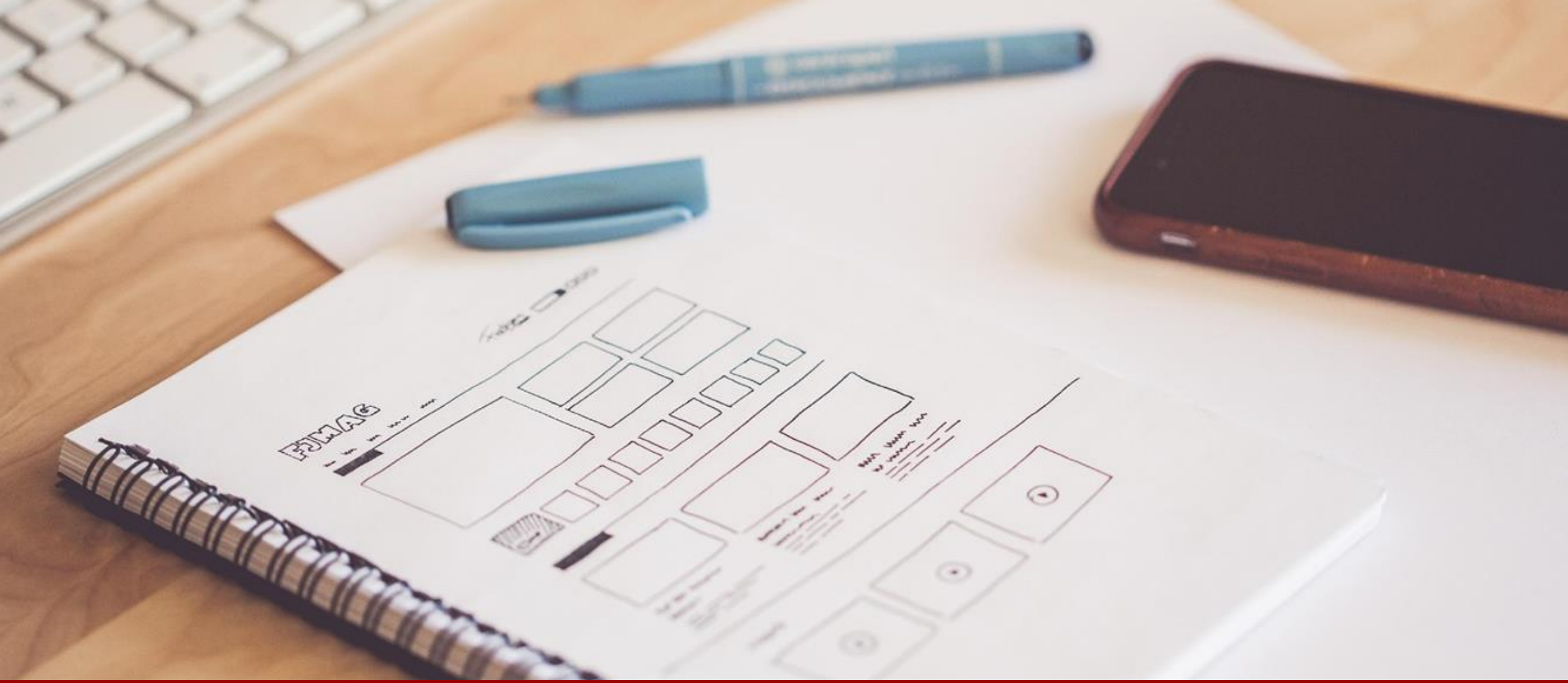


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Identifying Quality Attributes: requirements

- Sometimes explicitly stated in requirements documents
  - e.g. expected numbers of users
- More often, the architect has to read *between the lines*:
  - "*Due to regulatory requirements, it is imperative that we complete end-of-day fund pricing before 5am.*"
    - Performance, Recoverability
- Each part of the requirement might contribute to one or more aspects of architecture, *many will* not

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Architectural Kata

Architectural Katas

"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*

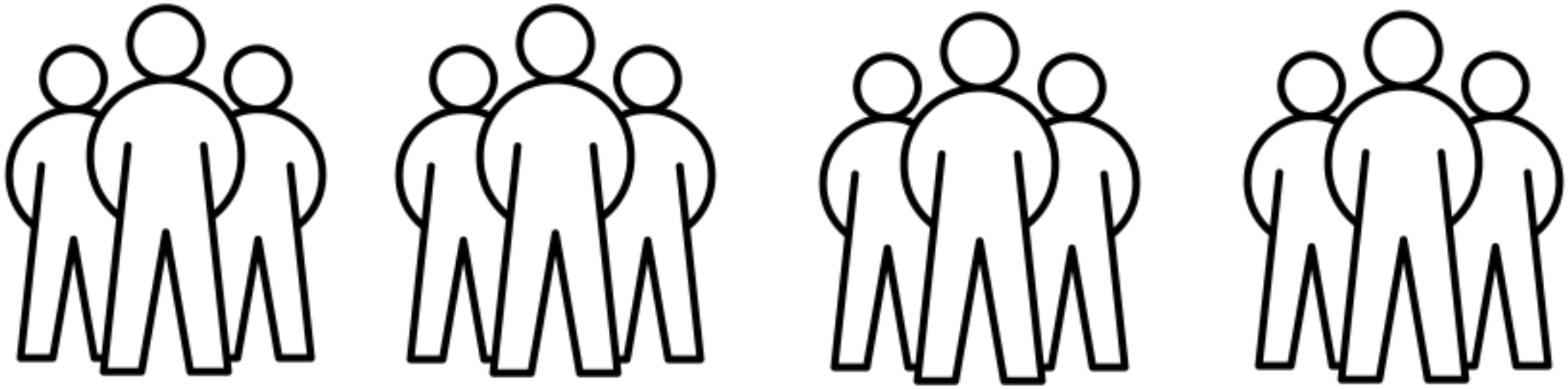
- Architectural Katas[1]
  - Small-group exercise
  - Practice deriving architecture characteristics

1. http://nealford.com/katas/; in martial arts, an individual training exercise, where the emphasis lies on proper form and technique

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Step 1: Create Groups & download activity handout

- *4 to 6* members per group
- Remember your team number



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Step 2: Identifying the quality attributes (15min)

- Based on Silicon Valley Sandwiches case study & List of common architectural characteristics
- Derive 3 Architectural Characteristics (rank them) with reasoning
- Domain expert (ME) answers teams' questions

architecture team





*SME: Subject Matter Expert

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Step 3: Share the Architectural Characteristics

- Teams share the identified characteristics & rationale
  - Submit the 3 prioritized characteristics
  - Explain *why* the characteristics are suitable for the system/domain
  - Goal: prove their relevance

https://forms.gle/rPyrHhKJMmbxP8FG8

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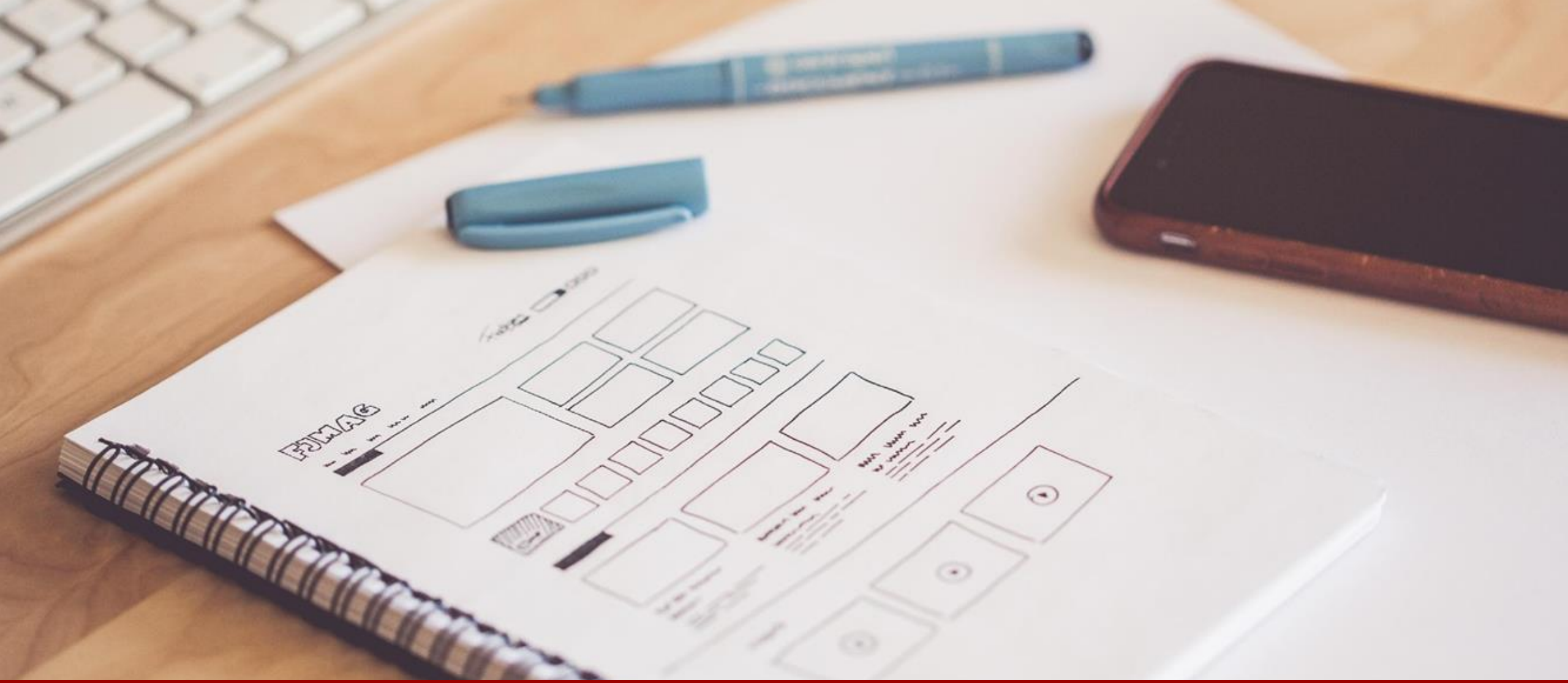
Architectural Characteristics

Your view:

- Scalability: 6
- Compatibility: 5
- Adaptability: 2
- Security: 3
- Learnability:
- Availability: 5
- Modifiability:
- Elasticity: 4
- Usability:
- Performance: 2
- Efficiency:
- Extensibility:

The “right” solution:

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Architectural Characteristics - discussion

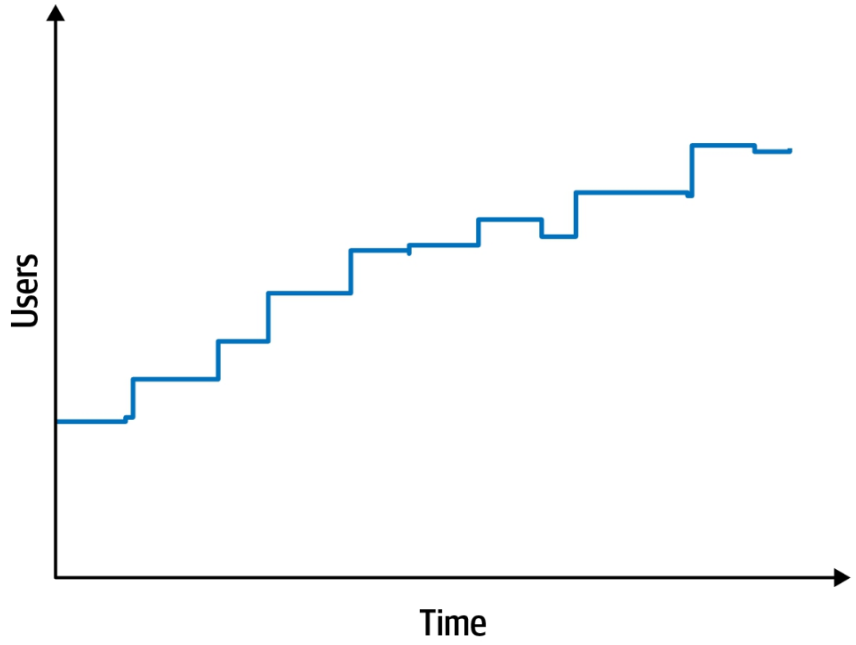
Scalability and Elasticity

- Architects must often decode domain language into engineering equivalents.
- Number of users: currently thousands, perhaps one day millions
  - *Scalability*: the ability to handle a large number of concurrent users without important performance degradation.
- *Elasticity*: the ability to handle bursts of requests.
  - Crucial for success, identified with domain knowledge

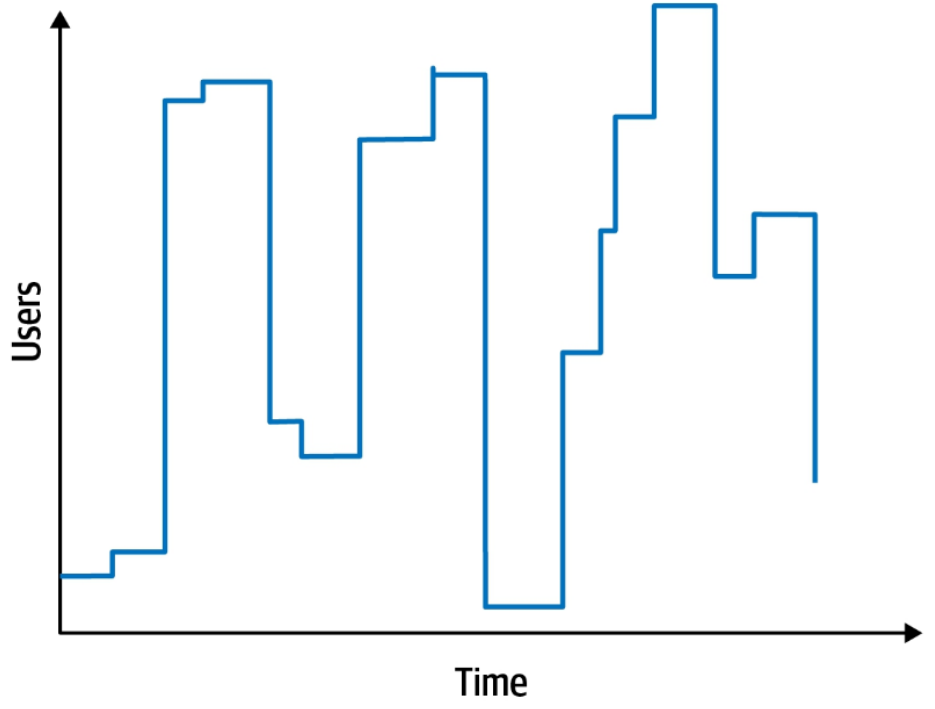
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Scalability and Elasticity

- Some systems are scalable but not elastic
  - Hotel reservation system → Scalability
  - Concert ticket booking system → Elasticity



Scalability



Elasticity

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Learnability

- ”*Degree to which a product or system enables the user to learn how to use it with effectiveness, efficiency*”
- Non-skilled workers - likely not familiar with technology – are part of the corporate strategy.

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Security – what constitutes a quality attribute?

- Architectural characteristics *influence some structural aspect of the design*
- Third-party payment API:
  - No special structural considerations, security hygiene is enough (encryption, hashing)
- In-application payment processing:
  - a specific module/component/service,
  - isolates the security concerns structurally.

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Architect role: analyzing trade-offs

- Thinking like an architect is about identifying & analyzing trade-offs to determine the best solution.

"We need lightning-fast response time to gain competitive edge"



"Over time, we expect our overseas branches to use this system"

"We plan to acquire a handful of startups in the upcoming 5 years"

- Applications can only support **a few architectural characteristics**: choose them wisely!

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References

Tactics and patterns that target selected QAs

- *Suggested further reading*: ***Software Architecture in Practice, 4th Edition (part II).*** Len Bass, Paul Clements, Rick Kazman. Addison-Wesley Professional.
- *Fundamentals of Software Architecture.* Richards, Mark; Ford, Neal. O'Reilly Media. Kindle Edition.
- *Software Architecture: Foundations, Theory, and Practice,* by Richard N. Taylor, Nenad Medvidovic, and Eric M. Dashofy, John Wiley & Sons.

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