

# **SOFTWARE ARCHITECTURES: AN INTRODUCTION**

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- Definitions
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# INTRODUCTION

Nowaday...

Software  
Systems



# INTRODUCTION

## Application Domains



<http://disney.com>



<http://www.zx.com/>



<http://www.nasa.gov/>



<http://www.siemens.co.za/>



<http://jquerymobile.com/>



<http://www.coficpolo.com.br/>

# INTRODUCTION

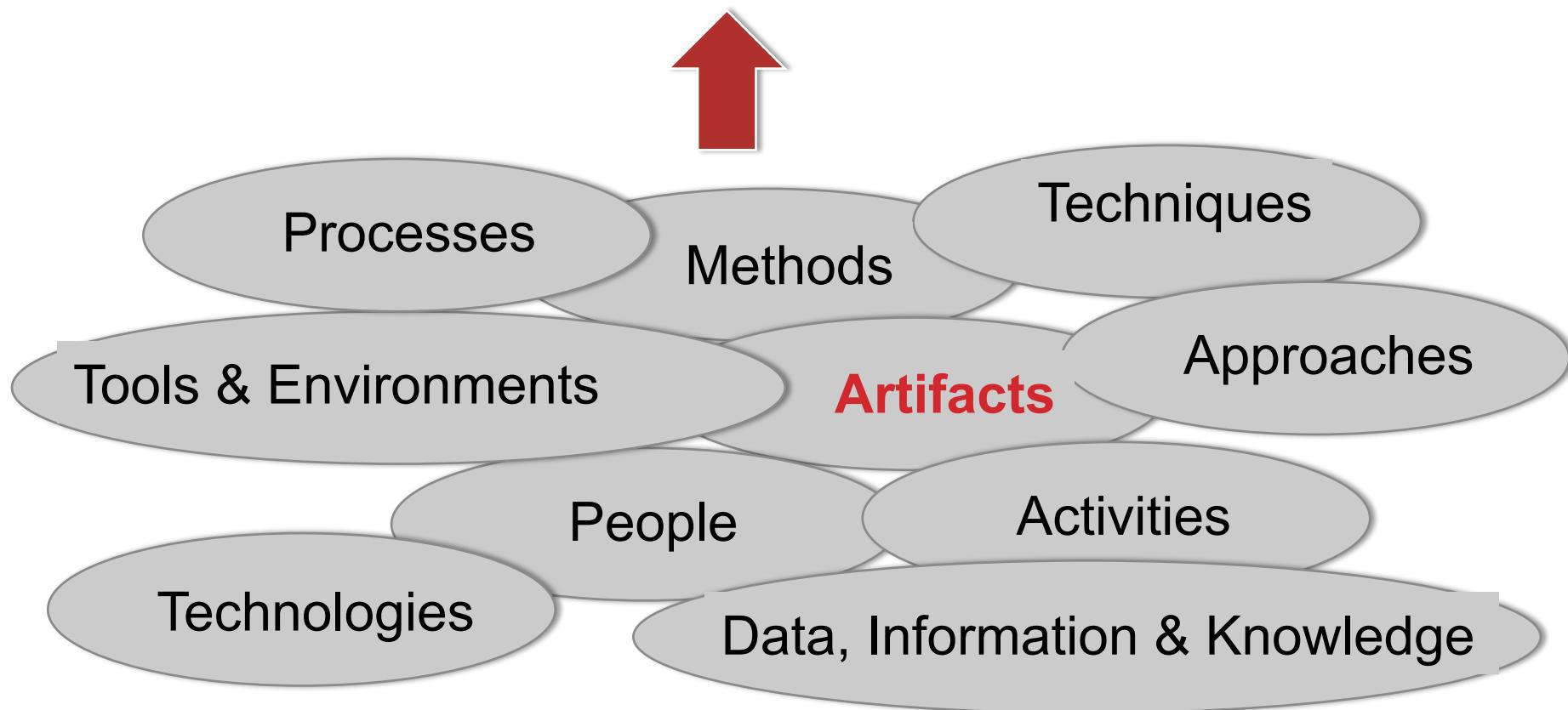
Changes in the

- **Complexity**
- **Diversity**
- **Scope**
- **Size**

of software systems.

# INTRODUCTION

## Software Systems



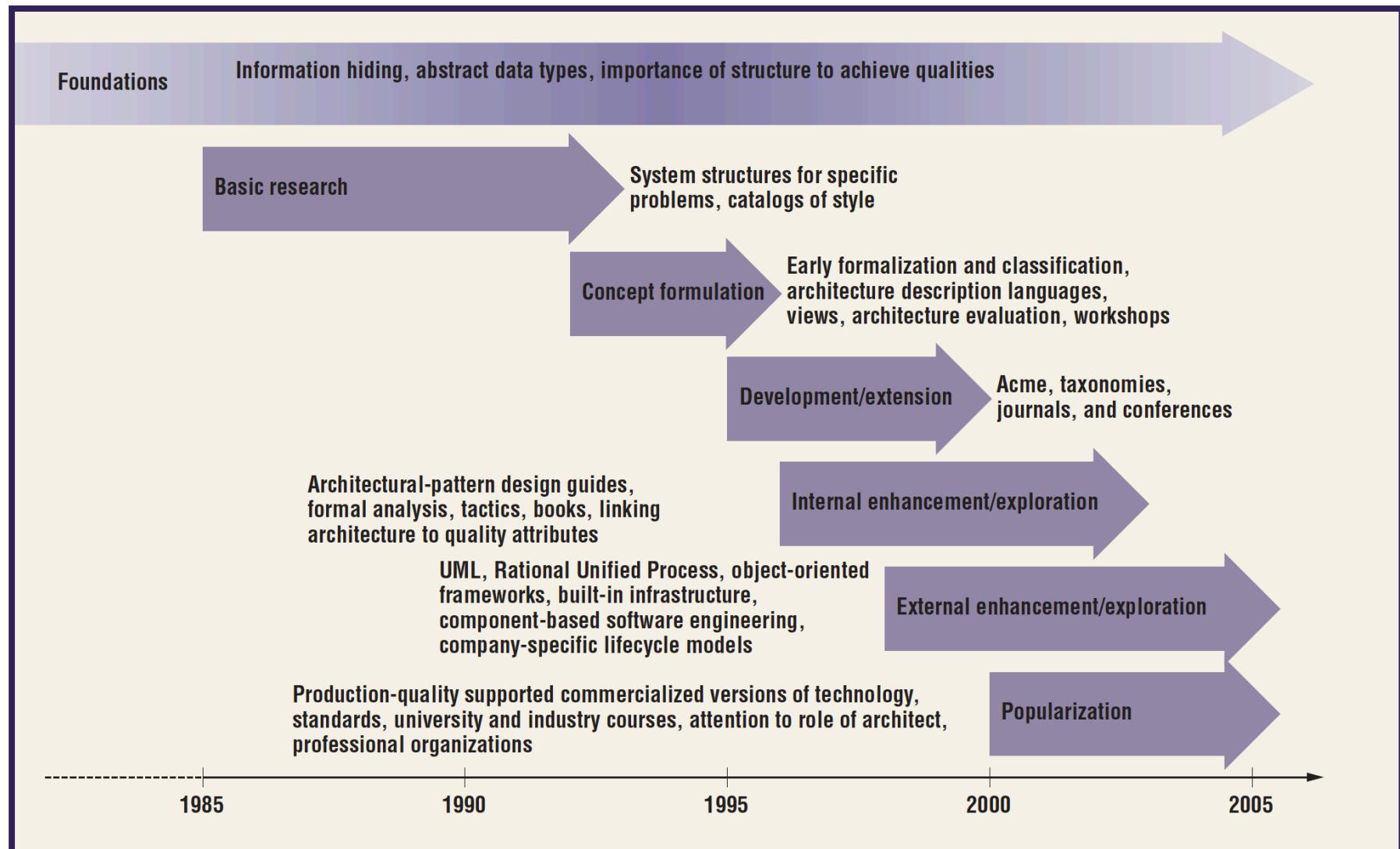
# **INTRODUCTION**

Software Systems



Software Architecture

# BRIEF HISTORY ON SOFTWARE ARCHITECTURE



# **HISTORY: ORIGIN OF THE FIELD “SOFTWARE ARCHITECTURES”**

1992 – Dwayne Perry and Alexander Wolf “Foundations for the Study of Software Architectures” in Software Engineering Notes

1993 – David Garlan and Mary Shaw “An Introduction to Software Architecture” in Advances in Software Engineering and Knowledge Engineering

1994 – Special Issue on Software Architecture in IEEE Transactions on Software Engineering

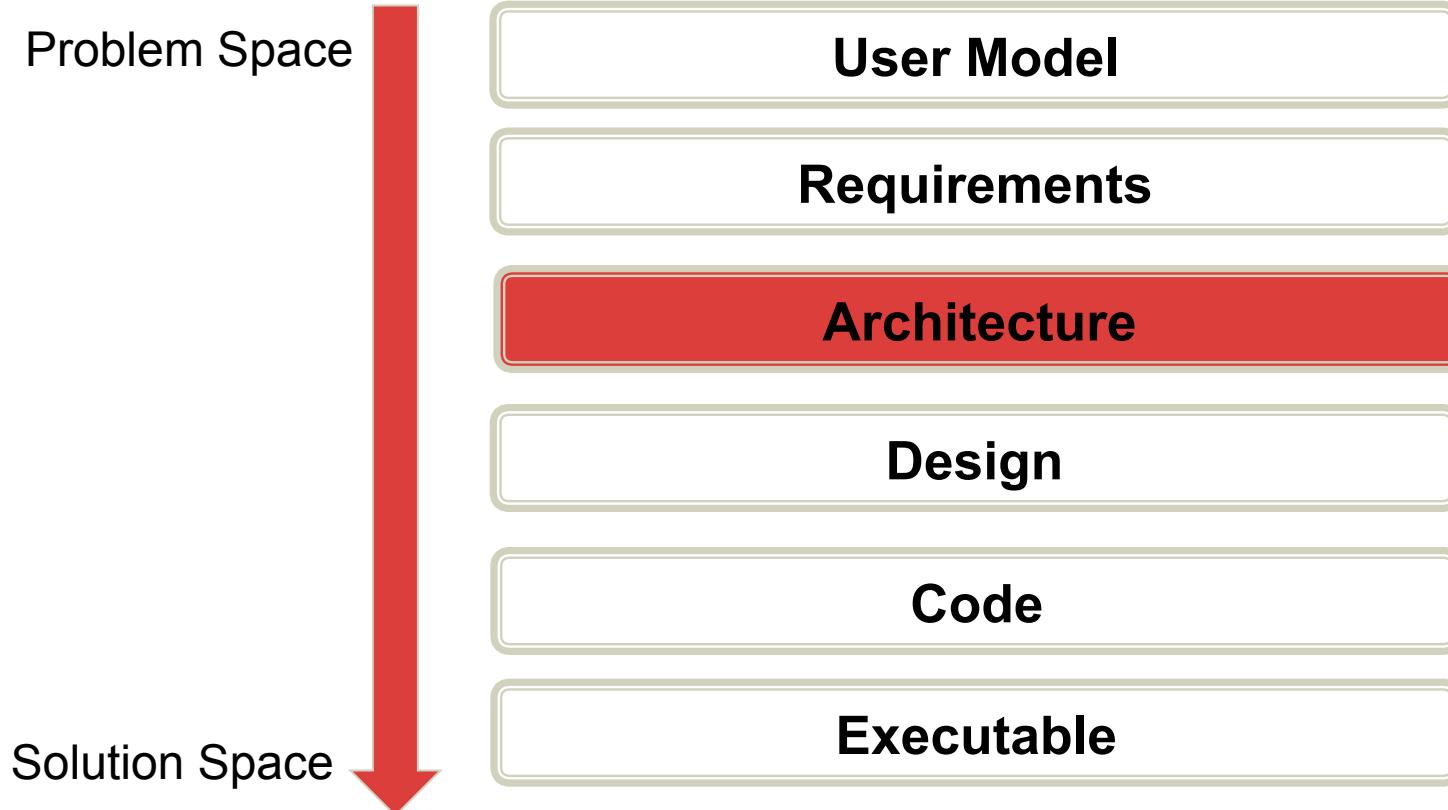
1995 – Special Issue on Software Architecture in IEEE Software

2006 – Special Issue on Software Architecture in IEEE Software (in the 10<sup>th</sup> anniversary of the 1995 special issue).

# **TODAY – VERY ACTIVE AND ESTABLISHED FIELD**

- Dedicated conferences/symposiums/workshops:
  - WICSA (Working Conference on Software Architecture)
  - ECSA (European Conference on Software Architecture)
  - QoSA (Quality of Software Architecture)
  - SBCARS (Brazilian Symposium on Components, Architectures and Reuse)
  - Workshops associated with most software engineering conferences
- Permanent Section on Architecture, e.g., in JSS
  - [http://www.journals.elsevier.com/journal-of-systems-and-software/  
call-for-papers/special-issue-on-sustainability-and-longevity-of-  
systems/](http://www.journals.elsevier.com/journal-of-systems-and-software/call-for-papers/special-issue-on-sustainability-and-longevity-of-systems/)
- Major buzzwords and trends related to the architectural field:  
SOA, MDA, IoT, ADL, UML, ...

# ROLE OF SOFTWARE ARCHITECTURE



# SEVERAL DEFINITIONS

- “The fundamental organization of a system embodied in its components, their relations to each other, and to the environment, and the principles guiding its design and evolution.” [ISO/IEC/IEEE 42101]
- “The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them.” [Clements, 2003]

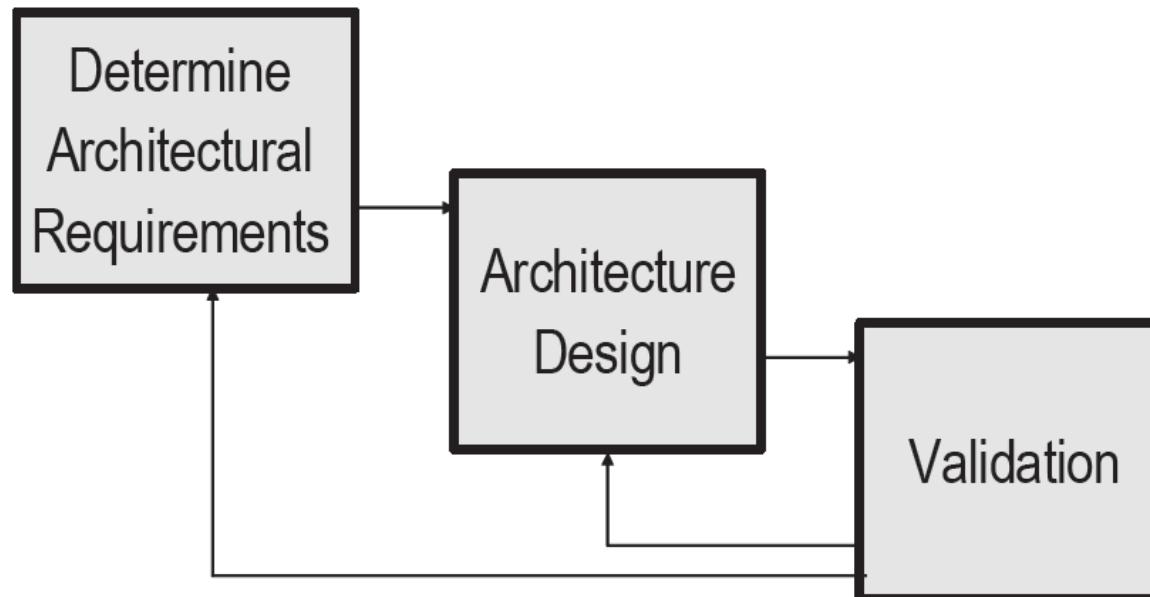
# SEVERAL DEFINITIONS

- “A software system’s architecture is the set of principal design decisions made about the system”. [Taylor, 2009]
- “Architecture is what you get before you start adding detail to the design.” [Clements et. Al]
- More than 10 definitions widely adopted.
- Discussion on software architecture definitions:
  - <http://www.sei.cmu.edu/architecture/start/glossary/published.cfm>

# QUALITY X SOFTWARE ARCHITECTURE

- Software Architecture
  - **Backbone** for any successful software-intensive system
  - Fundamental role in determining the system **quality**
- ISO/IEC 25000:2014 (Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- Guide to SQuaRE)
- **IMPORTANT: Trade off among quality attributes!!**

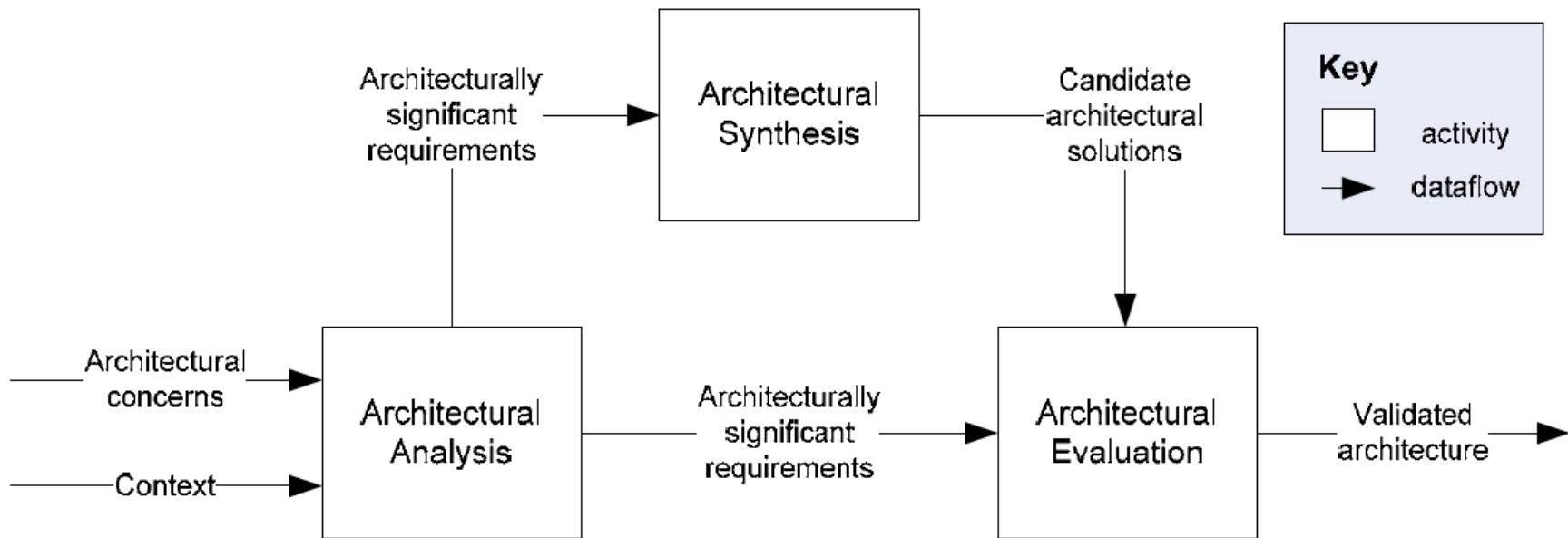
# ARCHITECTURE DESIGN PROCESS



**Fig. 36.** A three step architecture design process

[Gorton 2006]

# GENERAL ARCHITECTURING PROCESS

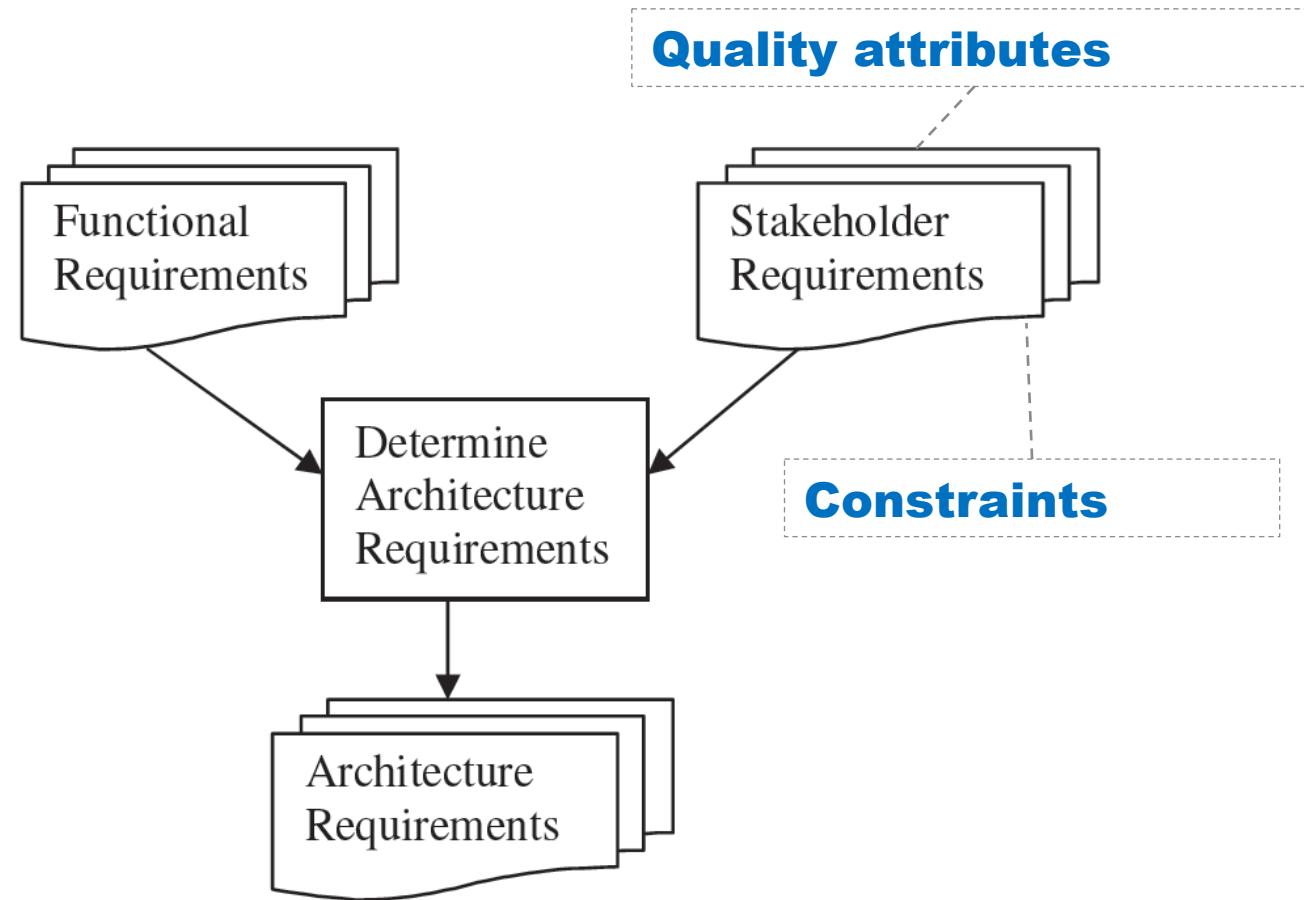


[Hofmeister, 2005]

# ARCHITECTURAL ANALYSIS

- Architectural analysis articulates architecturally significant requirements (ASRs) based on the architectural concerns and context.
- Example of ASDs:
  - A typical architecture requirement concerning **reliability of communications** is:
    - “Communications between components must be guaranteed to succeed with no message loss”

# ARCHITECTURAL ANALYSIS



**Fig. 37.** Inputs and outputs for determining architecture requirements

[Gorton 2006]

# ARCHITECTURAL SYNTHESIS

- Architectural synthesis results in candidate architectural solutions that address these requirements.
- ISO/IEC 42010 (its previous version IEEE 1471)
  - provide a widely accepted conceptual definition of architectural views, viewpoints and models
- Architectural/design decision
  - Radar of practitioners and researchers since the early days of software architecture.
- Architecture patterns
  - support design of the entire system and dictate a particular high-level modular decomposition of the system.
- Use of Architectural Description Languages (ADL)
  - Formal or semi-formal

# ARCHITECTURAL SYNTHESIS

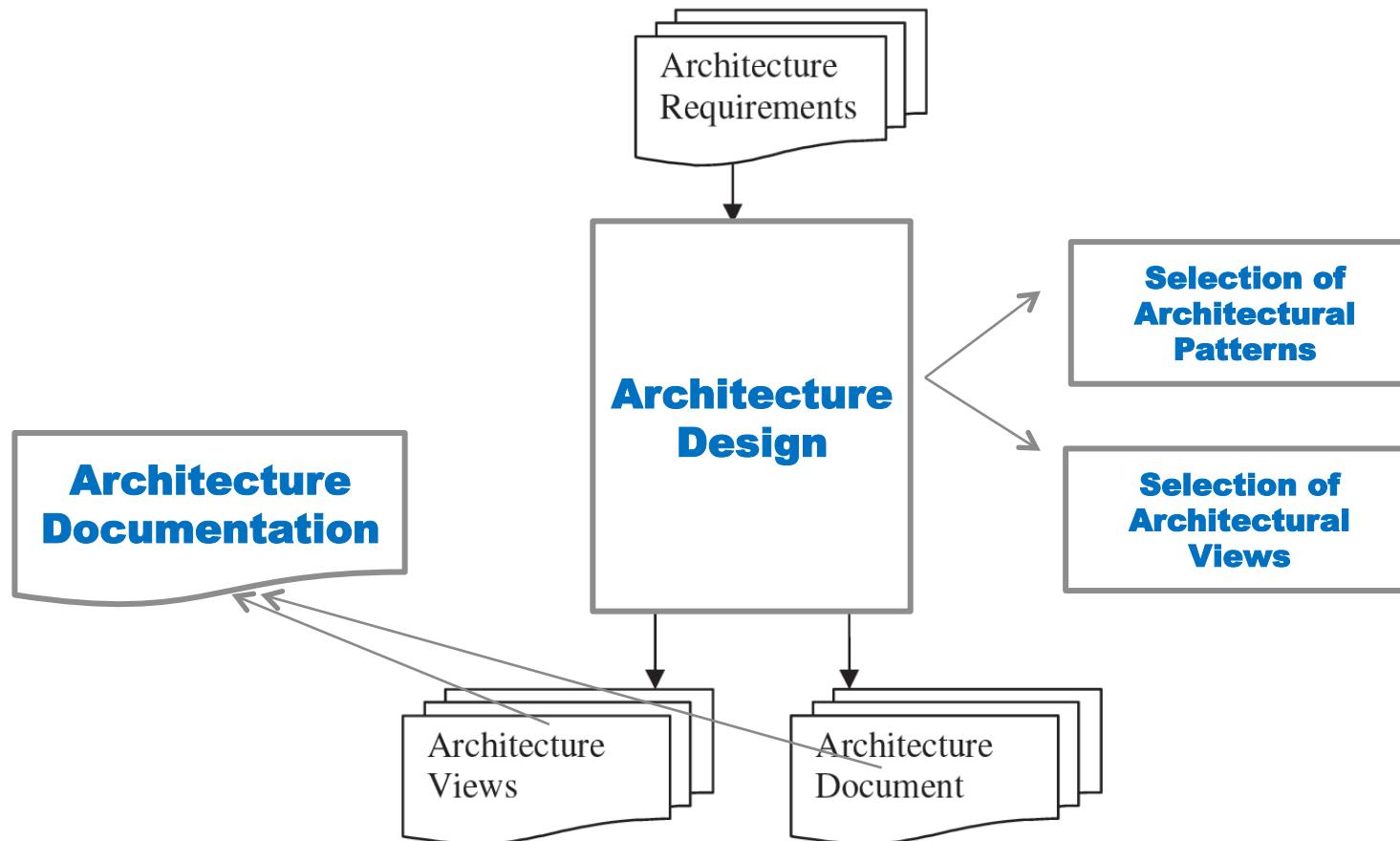


Fig. 38. Inputs and outputs of architecture design

[Gorton 2006]

# ARCHITECTURAL EVALUATION

- Architectural evaluation ensures that the architectural decisions used are the right ones.
- Architecture reviews (or evaluations) are independent examinations of the software architecture to identify potential architecture problems.
- Architectures are not inherently good or bad, they are only well-suited or not with respect to a particular set of goals.

Architecture Evaluation

Checks

Architectural-significant decisions

Against

Architectural-significant requirements

# ARCHITECTURAL EVALUATION

- **Examples:**
  - Scenario-Based Architecture Analysis Method (SAAM)
  - Architecture Tradeoff Analysis Method (ATAM)
  - Active Reviews for Intermediate Design (ARID)
  - Architecture-Level Modifiability Analysis (ALMA)
  - Architecture-Level Prediction of Software Maintenance (ALPSM)
  - Scenario-Based Architecture Reengineering (SBAR)
  - Design Decision Architecture Review Method (DCAR)
  - ...

# REFERENCE ARCHITECTURE

- "A reference architecture refers to an architecture that encompasses the knowledge about how to design concrete architectures of systems of a given application domain; therefore, it must address the business rules, architectural styles (sometimes also defined as architectural patterns that can also address quality attributes in the reference architecture), best practices of software development (for instance, architectural decisions, domain constraints, legislation, and standards), and the software elements that support development of systems for that domain. All of this must be supported by a unified, unambiguous, and widely understood domain terminology." [Nakagawa, 2011]

# **STATE OF THE ART/RESEARCH**

- **Sustainability of software architectures**
- **Variability in software architectures**
- **Software architecture for SoS, CPS, CES,...**
- **Multi Software Product Line (MSPL)**
  - MSLP for SoS, CPS, ...
- **Reference architectures**
  - Building process
  - Variability
  - Sustainability
- ...