Why Architecture Conformance Matters for Software Systems

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Why Architecture Conformance Matters

Terminology

- Architecture
- Conformance

Problem Definition

Improving Your Practices

Automation Challenges

Research – Early Results

Architecture

A system's architecture is defined by its significant design decisions, where in my experience, "significant" is measured by the cost of change.

- Grady Booch

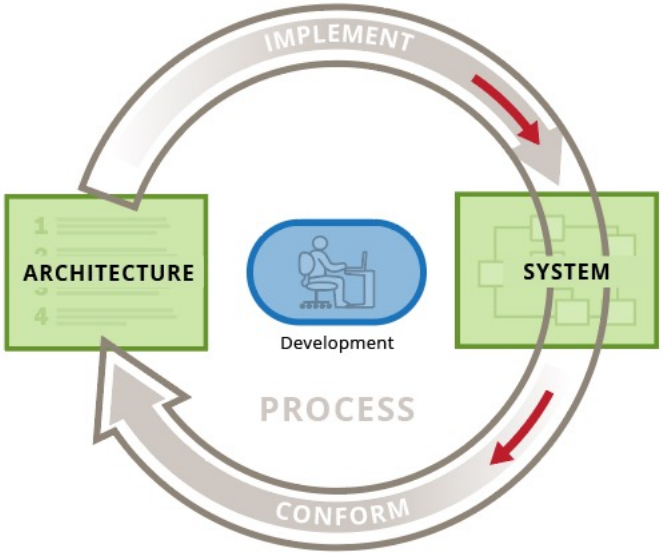
A system's ability to meet its desired (or required) quality attributes is substantially determined by its architecture. If you remember nothing else from this book, remember that.

- Len Bass, Paul Clements, and Rick Kazman

Grady Booch. Architectural Organizational Patterns. *IEEE Software*, 25(3):18–19, May/June 2008. doi:10.1109/MS.2008.56.

Len Bass, Paul Clements, and Rick Kazman. *Software Architecture in Practice*. Addison-Wesley, 4th edition, 2022.

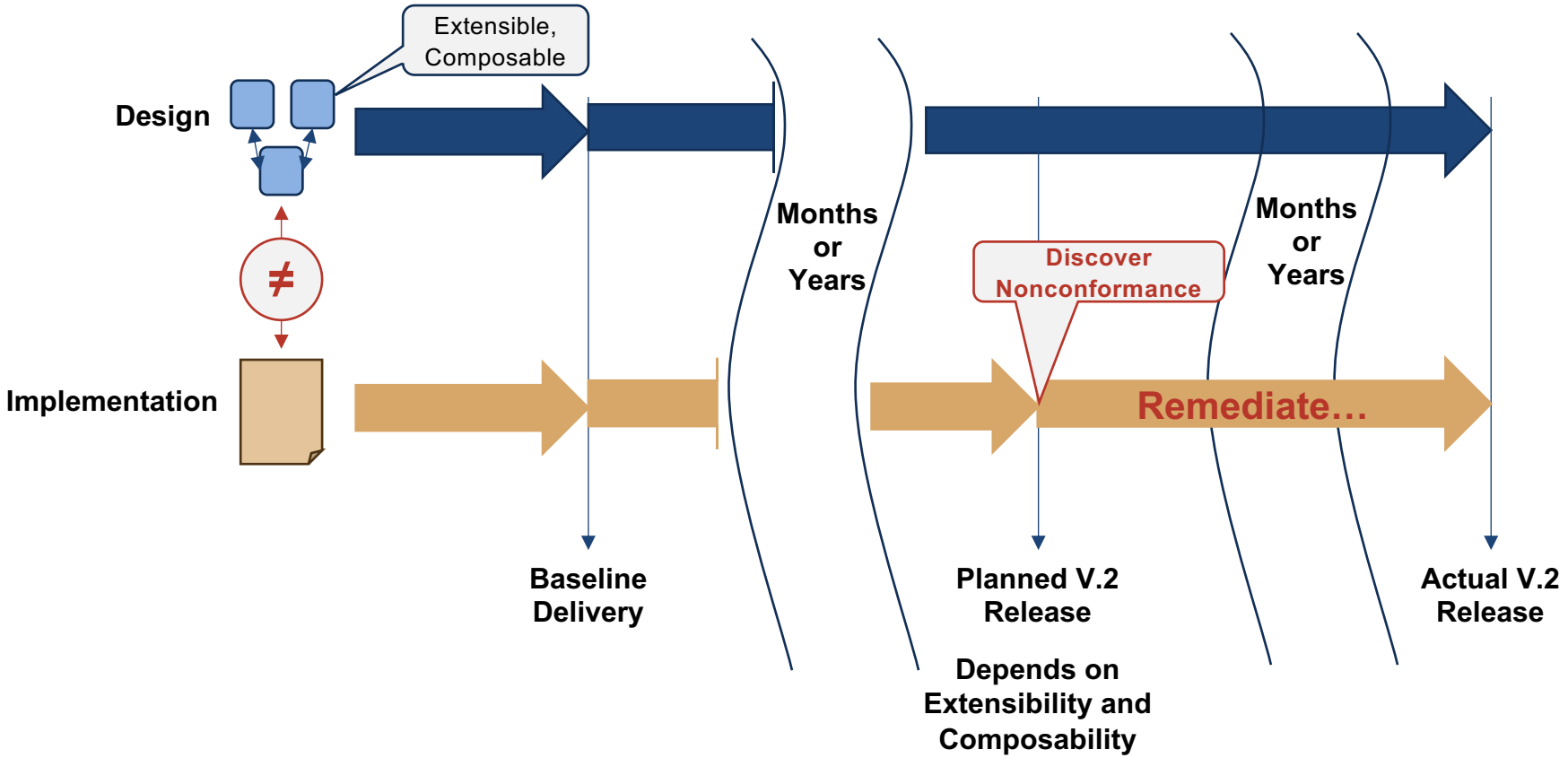
Implications for the System



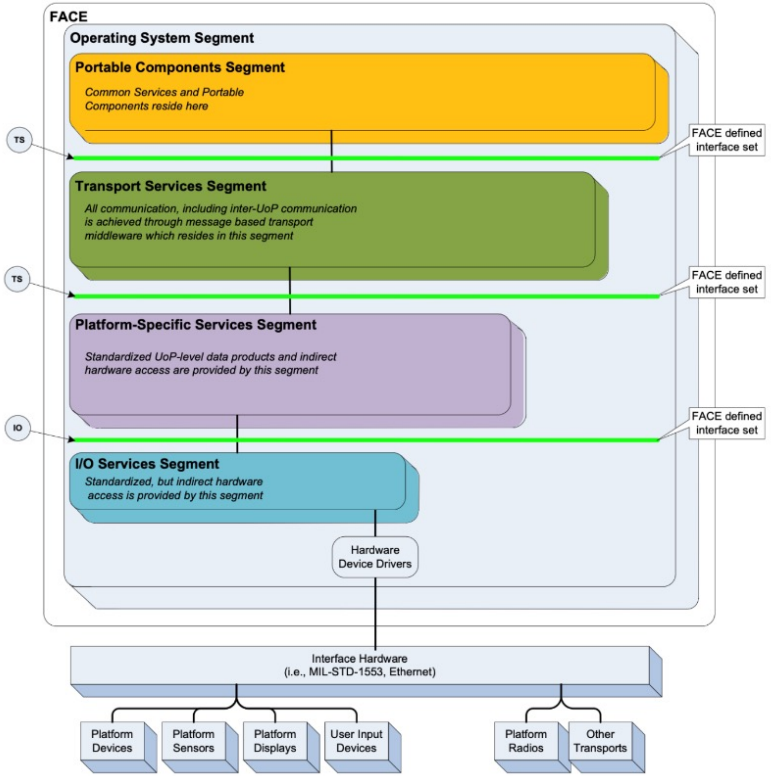
Architecture can only permit, not guarantee, any quality attribute.

For the implementation to exhibit the quality attributes engineered at the architectural level, it must conform to the architecture.

Typical Nonconformance Scenario



Challenges in Software Conformance



Modular Open Systems Approach (MOSA)

- technical and business strategy
- affordable and adaptable systems

Technical Standards, e.g., FACE

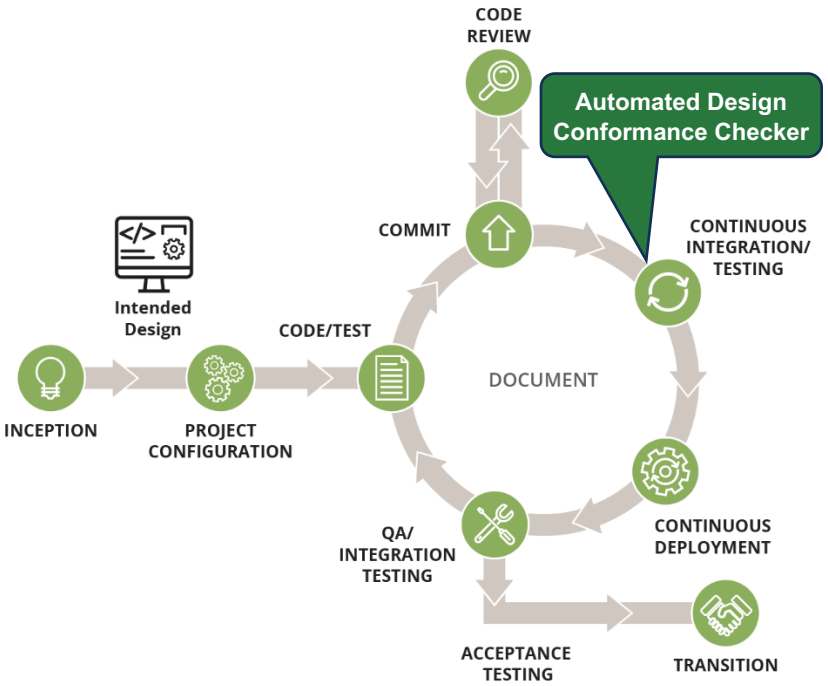
- conformance verification matrix
  - 487 items, 194 are inspection of design
- component-level standard

FACE-conformant systems may encounter integration problems.

The Open Group (2017). Reference Architecture, *FACE (Future Airborne Capability Environment) Technical Standard, Edition 3.0*.

S. Frerking & S. Foley. *Addressing the Behavioral Aspects of Integration Beyond Data Modeling*. The Open Group FACE™ Army TIM Paper, 2021.

Improve Conformance of Implementations to Architectures



An automated design conformance checker integrated into a continuous integration (CI) workflow

- exposes nonconformances at time of commit instead of months later
- promotes conversation whether code or architecture needs to change
- allows remediation before violations become fixed in the implementation
- enables program managers to hold developers accountable

State of the Art in Software Conformance

Tools based on static analysis

- E.g., Understand™, Structure101, Lattix

Code quality metrics are weakly correlated to nonconformance, but may be indicative

Dependency structure analysis can detect nonconformance for some architecture styles, e.g., Layers

Effective use requires tuning of out-of-the-box configuration

https://www.scitools.com
https://structure101.com
https://www.lattix.com

System-specific ad hoc tests

- E.g., fitness functions

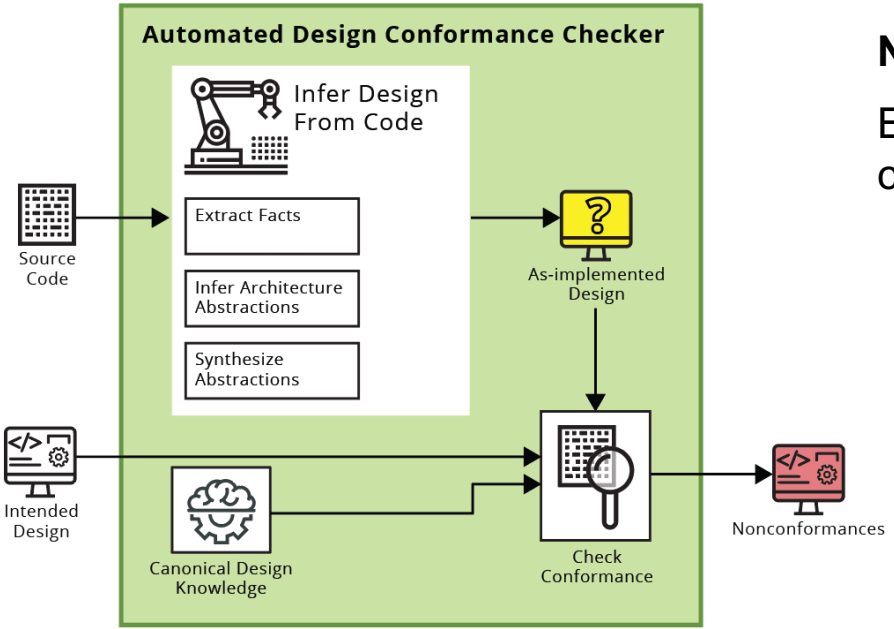
Implement using unit test framework like CppUnit or JUnit

Tests could be developed to check conformance to any architecture style

As the architecture and/or the implementation evolves, the tests related to those changes may become brittle over time and need to be maintained

Neal Ford, Mark Richards, Pramod Sadalage, and Zhamak Dehghani. *Software Architecture: The Hard Parts*. O'Reilly Media, 2021.

Goal – Automatically Inferring Design from Code



Need to bridge the model-code gap

Essential challenges to detecting design constructs

- imprecise definitions of abstractions
- variation in implementation
- limits of fact gathering analyses
- alignment or correlation of extracted design fragment to intended design fragment

James Ivers, Ipek Ozkaya, and Robert L. Nord. Can AI close the design-code abstraction gap? In *34th IEEE/ACM Int. Conf. on Automated Software Eng. Workshop (ASEW)*, pages 122–125, 2019. doi:10.1109/ASEW.2019.00041.

Steps You Can Take Today to Improve Conformance

Capture (parts of) the intended design – structures and observable principles that allow the system to satisfy the high priority quality attribute requirements

Adopt (and refactor to) an *architecturally-evident coding style* to bridge the model-code gap in the parts of the intended design that you have captured

Check conformance to the key parts of your intended architecture at commit time or incremental release or major release or gate review…but do it!

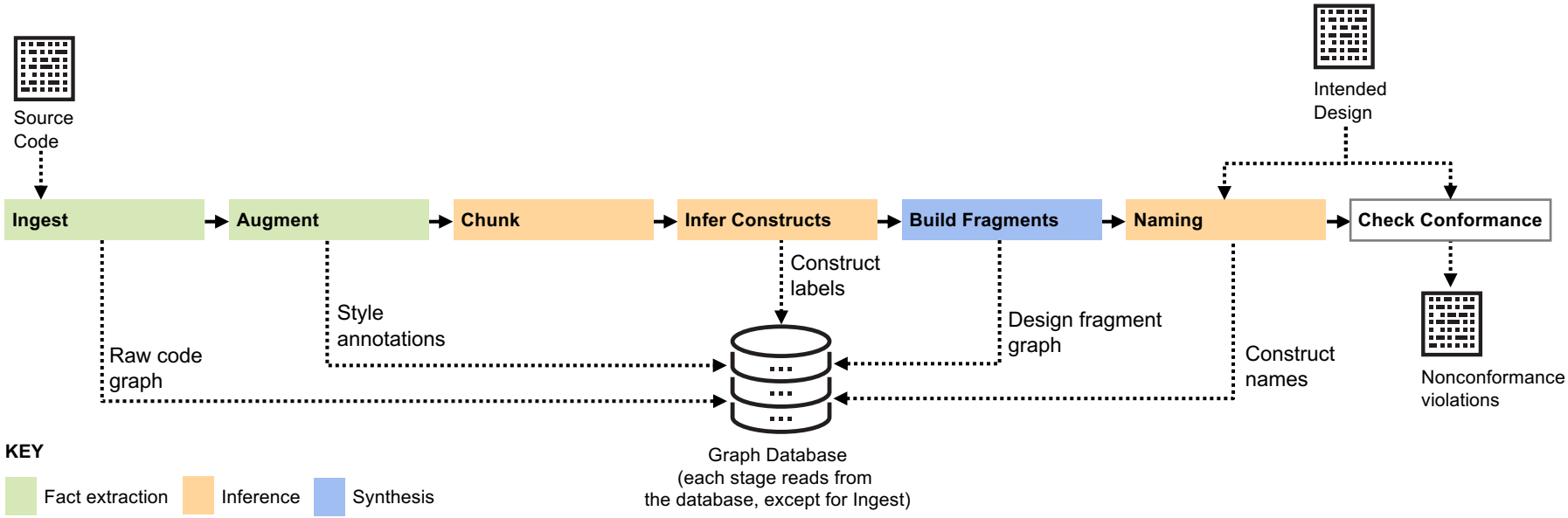
- Manual checks – in peer reviews
- Automated checks – tailor rules in off-the-shelf tools and/or ad hoc tests

John Klein and Robert L. Nord. Why architecture conformance matters for evolvable systems. *CrossTalk,* pages 19–24, July 2022. https://community.apan.org/ wg/crosstalk/m/documents/420393

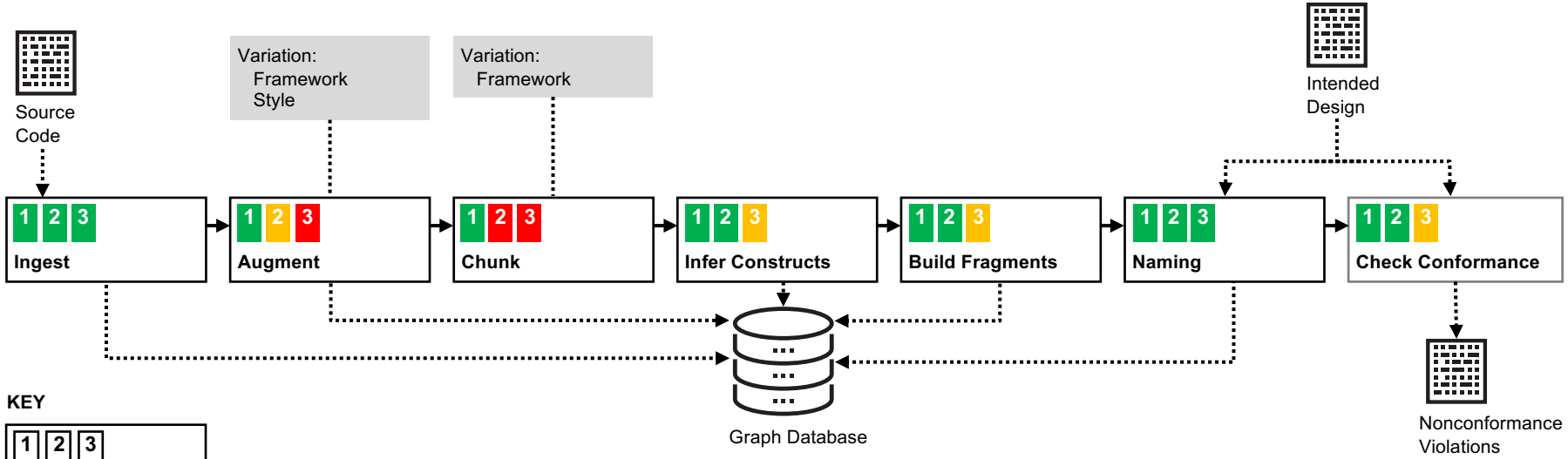
George Fairbanks. *Just Enough Software Architecture: A Risk-Driven Approach*. Marshall & Brainerd, 2010. (Ch. 10 – Arch-evident coding style)

Towards Generalized Automation: Prototype Conformance Checker

Developed at SEI in 2022



What Is Involved in Applying the Approach



We have learned how to **customize** the approach for a particular **framework-**based system and architecture **communication style**.

What Practical Problems Does the Approach Solve?

	State of Practice		Design Conformance
	Code Quality	**Architecture Quality**	
Design concepts	Classes, packages, files	Modules, dependencies	Architecture **communication styles**
Bridging code and design	Logical and physical element composition	Dependency clusters (semi-automated)	**Automated** rules (framework-based systems)
Conformance	ISO standards, maintainability	Modularity, dependencies, design paradigms	**Intended** architecture and canonical design knowledge

Conformance checking is **feasible** today using a **rules-based** approach to extract design information from **framework-based** systems.

The approach recovers a broader range of architecture views and supports checking a broader range of criteria under conformance.

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