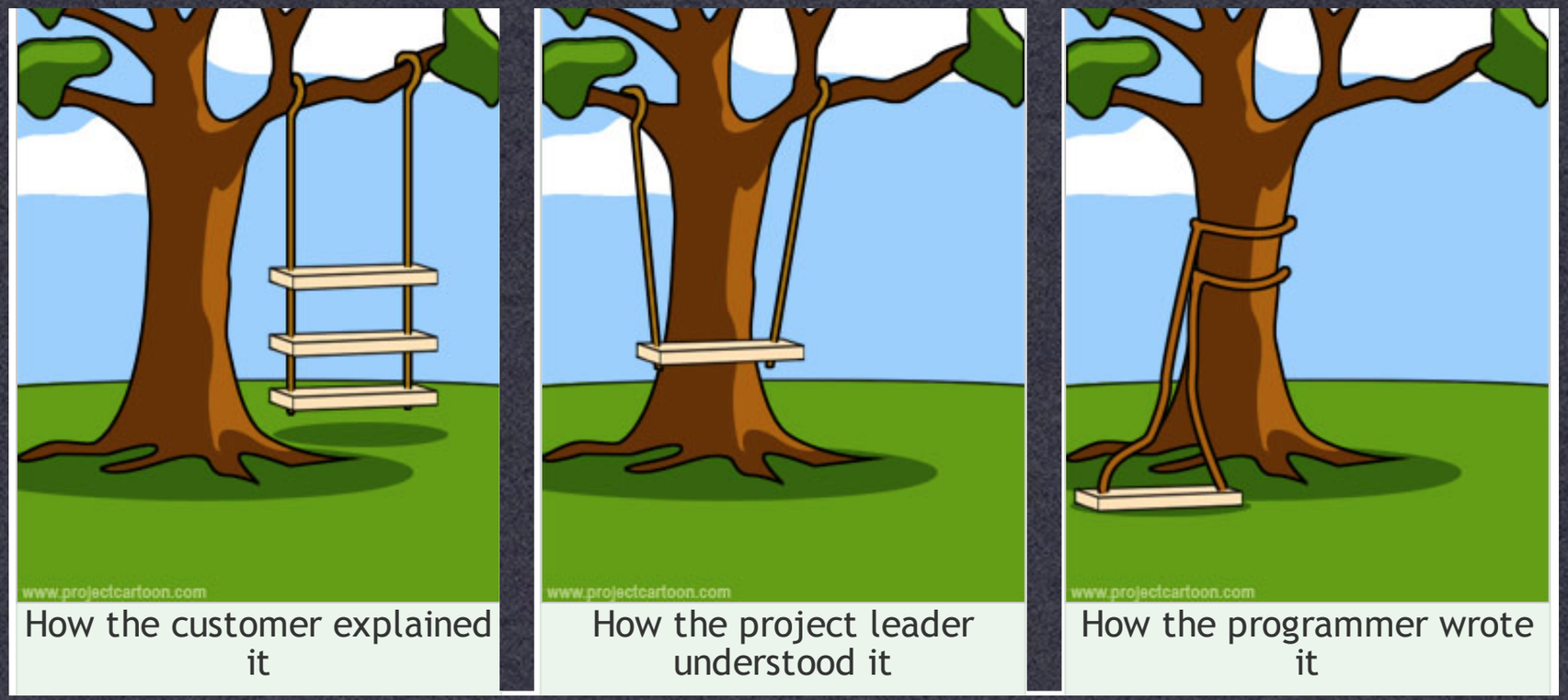


Intro graphic:
[http://projectcartoon.com]

Non-Functional Properties

Reid Holmes

System Stakeholders

- Architectural documents are used by a variety of system stakeholders:
  - Developers
  - Managers
  - Sales
  - Testers
  - Support
  - Maintenance
  - DevOps
  - Customers

Stakeholder Questions

- Management: are we on schedule?
- Developers: who is responsible for what?
- Sales: can we claim it can do this task?
- QA: what teams do we talk to about defects?
- DevOps: where should this component be deployed?
- Support: which QA team signed off on this?
- Maintenance: how can we add this feature?

Stakeholder Conflicts

- System requirements fall into two broad categories:
  - Functional Properties: what the system is supposed to do ('the system shall ***do*** X').
  - Non-Functional Properties: what the system is supposed to be ('the system shall ***be*** Y').
- Each stakeholder will have their own opinion about what NFPs matter most:
  - e.g., the development team will care about maintainability more than the customer
  - e.g., QA will be more interested in the testability of the application than sales

[Tailor et al.]

NFPs

- NFPs are constraints on the manner in which the system implements and delivers its functionality.
  - E.g.,
    - Efficiency
    - Complexity
    - Scalability
    - Heterogeneity
    - Adaptability
    - Security
    - Dependability
    - Testability
    - Usability
    - Performance

[Tailor et al.]

FP vs NFP

- Products are sold based on their FPs.
  - e.g., Cell phone, Car, Tent.
- However, NFPs play a critical role in perception.
  - “This program keeps crashing”
  - “It doesn’t work with my [...]”
  - “It’s too slow”

[Tailor et al.]

Design guidelines for NFPs

- Provide guidelines that support various NFPs.
- Focus on architectural level:
  - Components
  - Connectors
  - Topologies

[Tailor et al.]

NFP: Efficiency

- Efficiency is a quality that reflects a system's ability to meet its performance requirements.
- Components:
  - Keep them "small".
  - Simple and compact interfaces.
  - Allow multiple interfaces to the same functionality.
  - Separate data from processing components.
  - Separate data from meta data.
- Connectors:
  - Carefully select connectors.
  - Be careful of broadcast connectors.
  - Encourage asynchronous interaction.
  - Be wary of location/distribution transparency.
- Topology:
  - Keep frequent collaborators "close".
  - Consider the efficiency impact of selected styles.

[Tailor et al.]

NFP: Complexity

- Complexity is a property that is proportional to the size of a system, its volume of constituent elements, their internal structure, and their interdependencies.
- Components:
  - Separate concerns.
  - Isolate functionality from interaction.
  - Ensure cohesiveness.
  - Insulate processing from data format changes.
- Connectors:
  - Isolate interaction from functionality.
  - Restrict interactions provided by each connector.
- Topology:
  - Eliminate unnecessary dependencies.
  - Use hierarchical (de)composition.

[Tailor et al.]

NFP: Scalability /

- Scalability: The capability of a system to be adapted to meet new size / scope requirements.
- Heterogeneity: A system's ability to be composed of, or execute within, disparate parts.
- Portability: The ability of a system to execute on multiple platforms while retaining their functional and non-functional properties.

[Tailor et al.]

NFP: Scalability /

- Components:
  - Keep components focused
  - Simplify interfaces
  - Avoid unnecessary heterogeneity
  - Distribute data sources
  - Replicate data
- Connectors:
  - Use explicit connectors
  - Choose the simplest connectors
  - Direct vs. indirect connectors
- Topology:
  - Avoid bottlenecks
  - Place data close to consumer
  - Location transparency

[Tailor et al.]

NFP: Evolvability

- Evolvability: The ability to change to satisfy new requirements and environments.
- Components:
  - Same as for complexity.
    - Goal is to reduce risks by isolating modifications.
- Connectors:
  - Clearly define responsibilities.
  - Make connectors flexible.
- Topology:
  - Avoid implicit connectors.
  - Encourage location transparency.

[Tailor et al.]

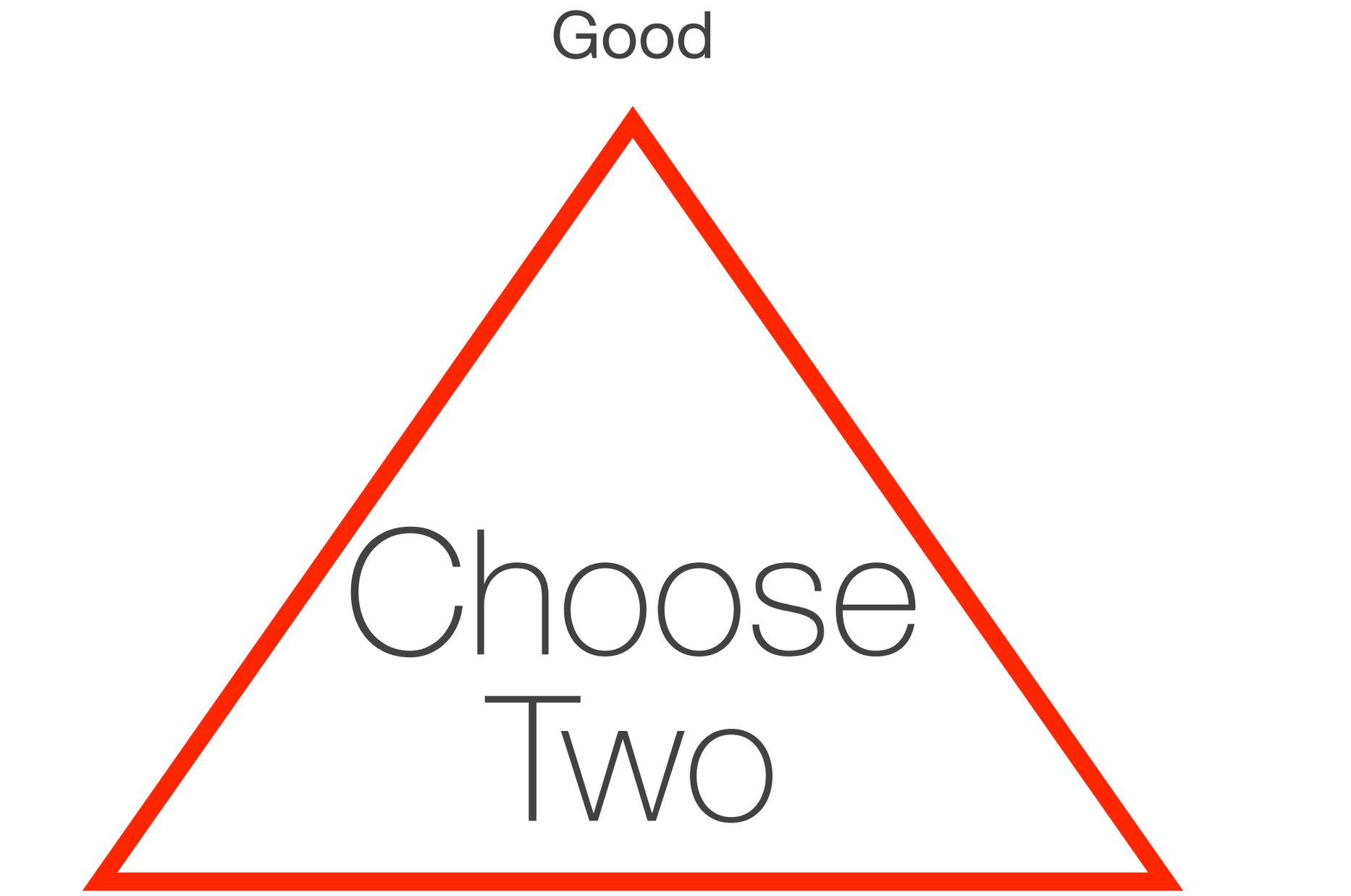
NFP: Dependability

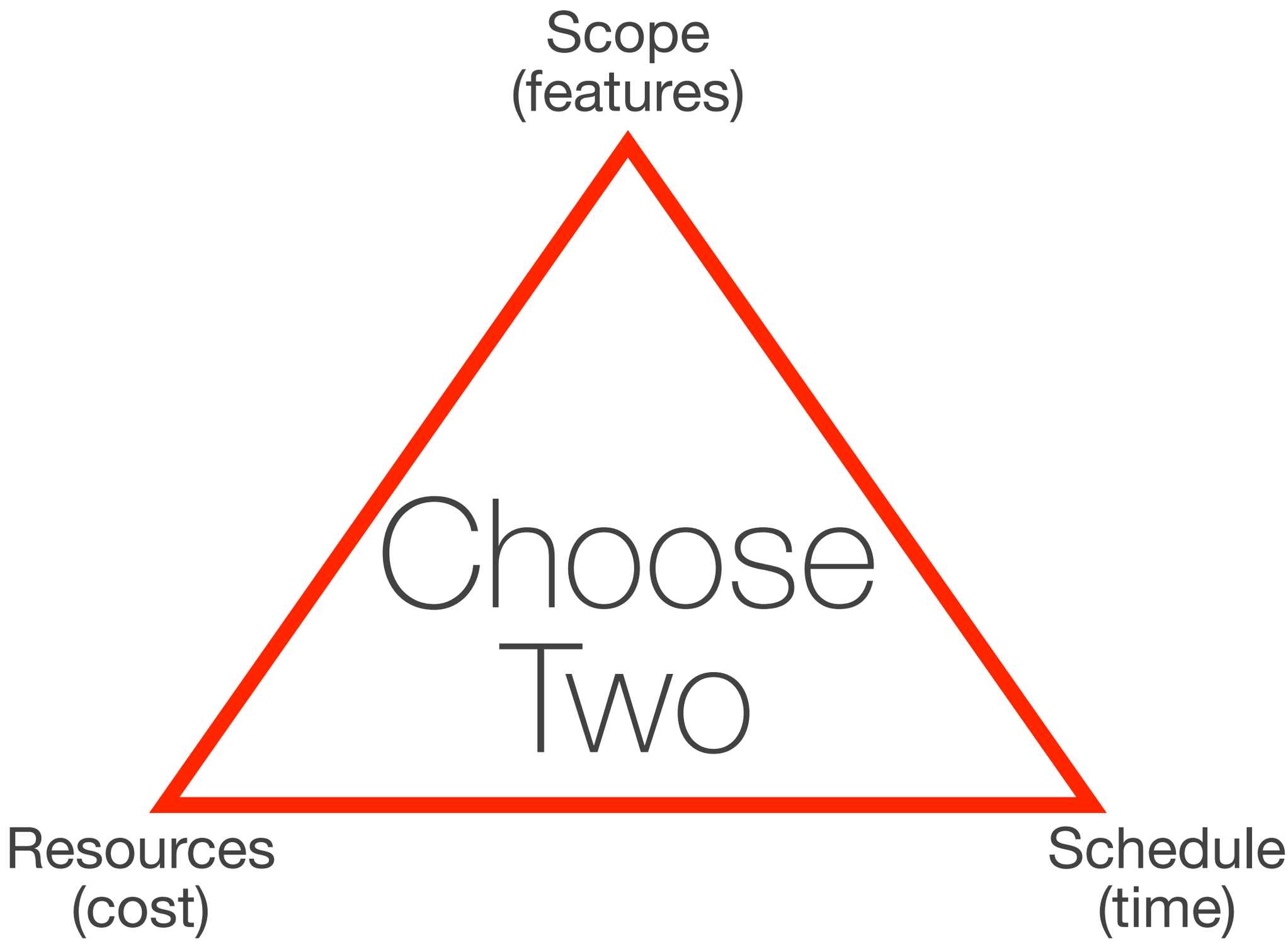
- Reliability: The probability a system will perform within its design limits without failure over time.
- Availability: The probability the system is available at a particular instant in time.
- Robustness: The ability of a system to respond adequately to unanticipated runtime conditions.
- Fault-tolerance: The ability of a system to respond gracefully to failures at runtime.
  - Faults arise from: environment, components, connectors, component-connector mismatches.
- Survivability: The ability to resist, recover, and adapt to threats.
  - Sources: attacks, failures, and accidents.
  - Steps: resist, recognize, recover, adapt.
- Safety: The ability to avoid failures that will cause loss of life, injury, or loss to property.

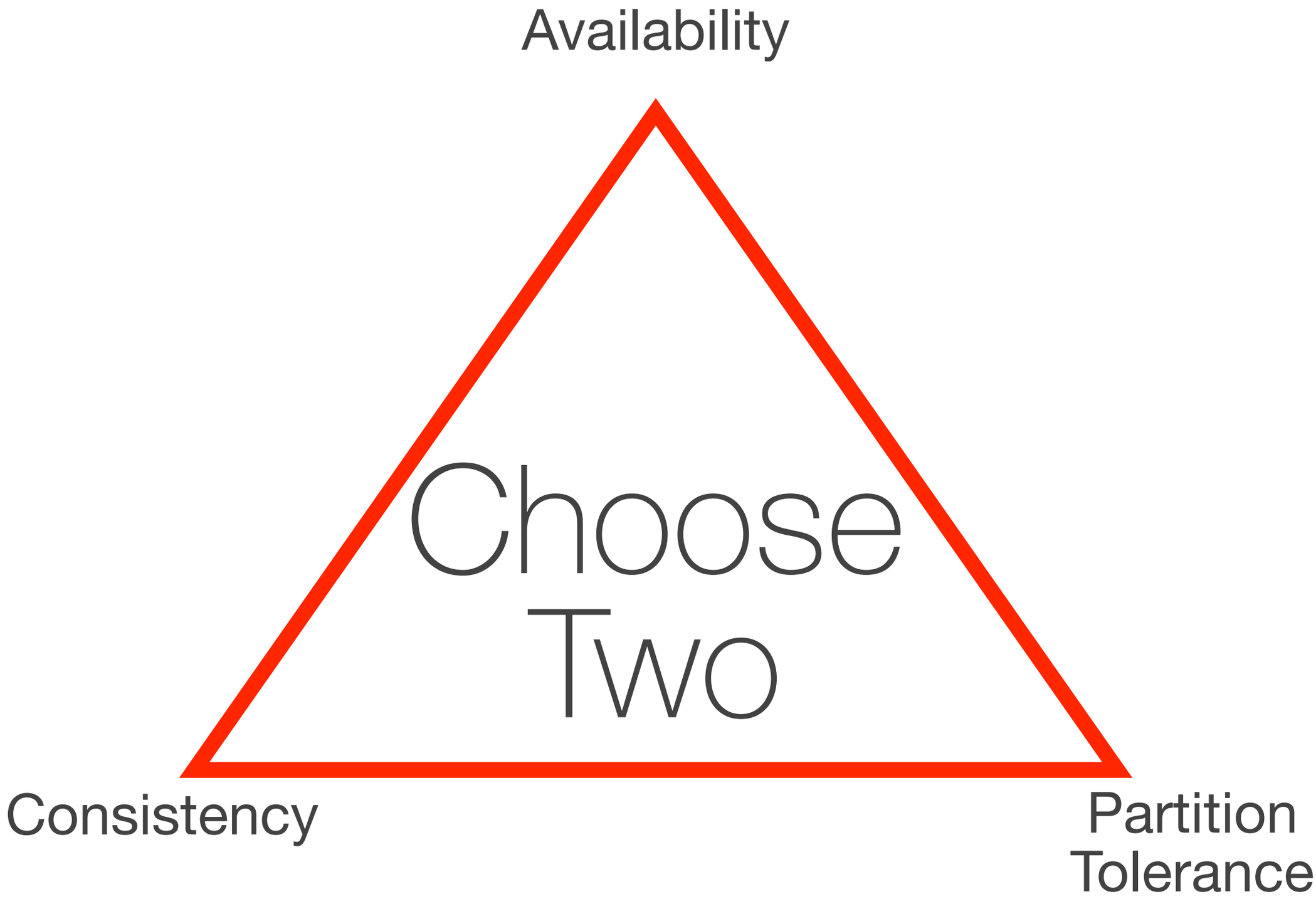
[Tailor et al.]

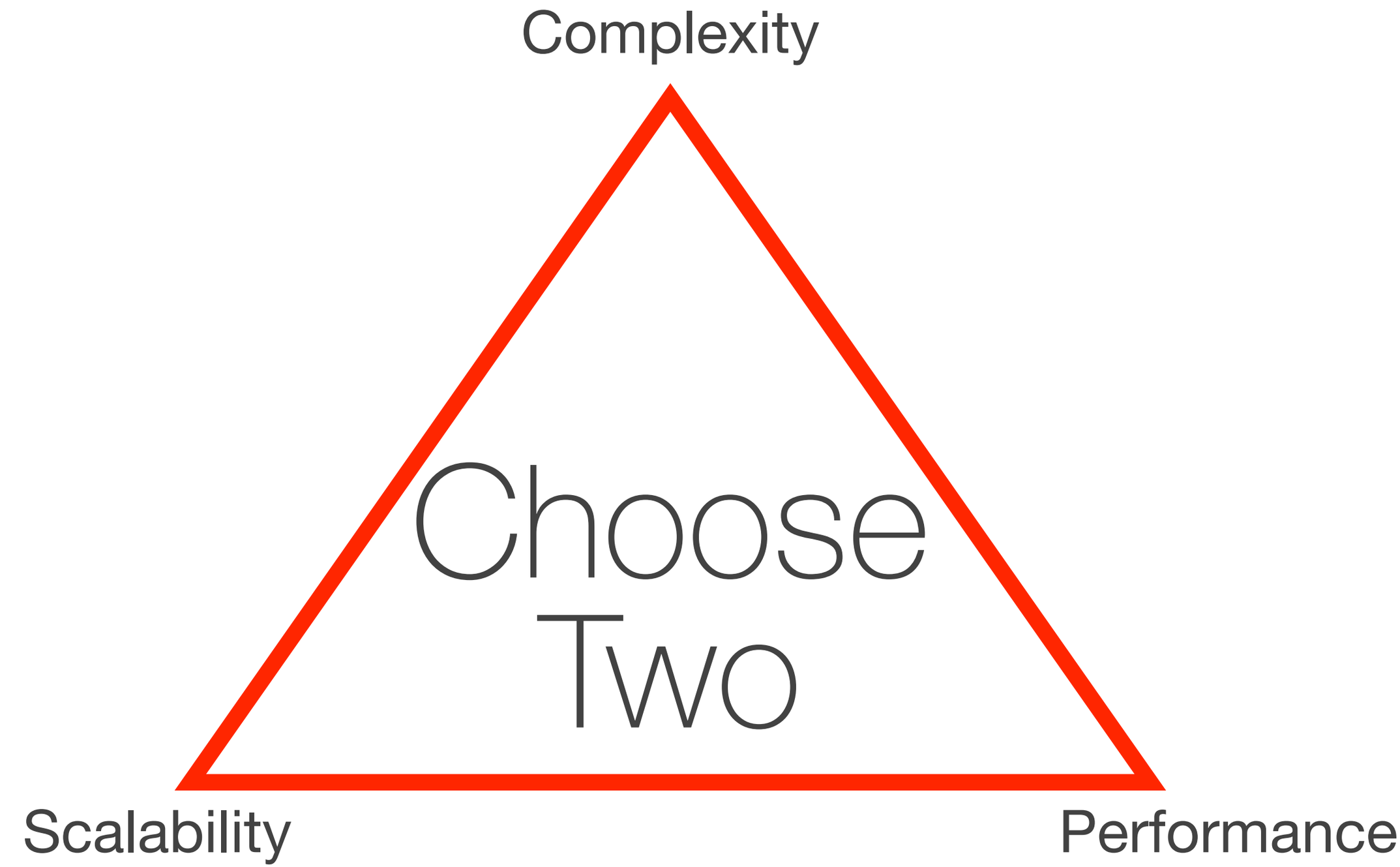
NFP: Dependability

- Components:
  - Control external component dependencies.
  - Support reflection.
  - Support exception handling.
- Connectors:
  - Use explicit connectors.
  - Provide interaction guarantees.
- Topology:
  - Avoid single points of failure.
  - Enable back-ups.
  - Support system health monitoring.
  - Support dynamic adaptation.


Good
Choose
Two
Fast
Cheap


Scope
(features)
Choose
Two
Resources
(cost)
Schedule
(time)


Availability
Choose
Two
Consistency
Partition
Tolerance


Complexity
Choose
Two
Scalability
Performance

NFP Tradeoffs (small number of examples)

- complexity <-> scalability
- availability <-> performance
- performance <-> portability
- testability <-> understandability
- usability <-> security
- scalability <-> portability
- dependability <-> heterogeneity
- deployability <-> testability
- portability <-> usability