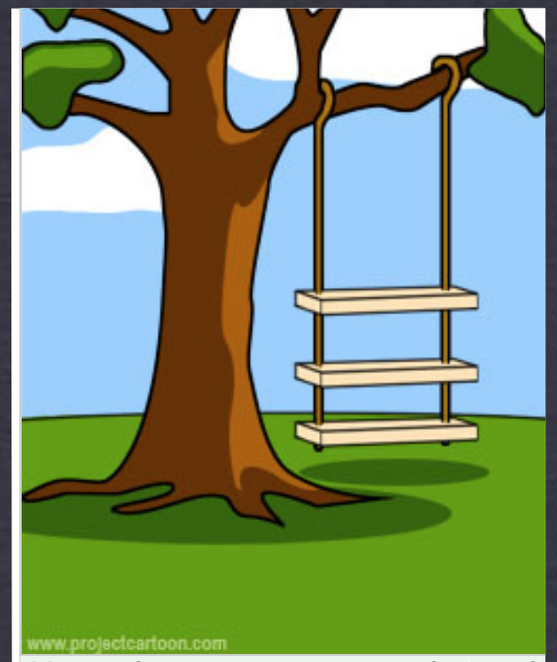
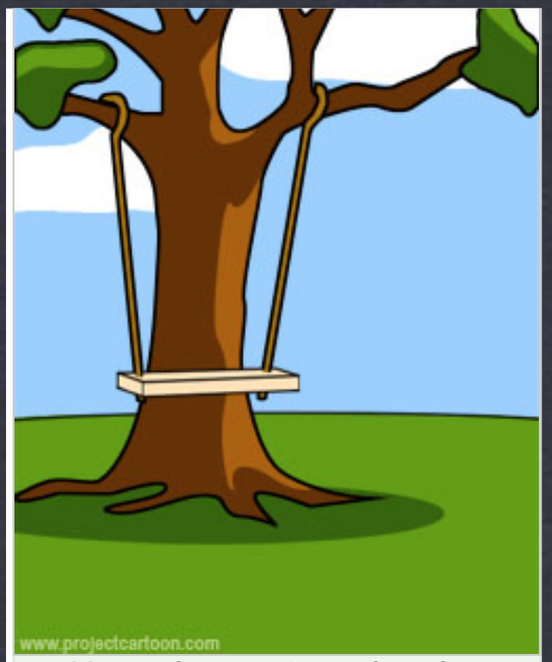
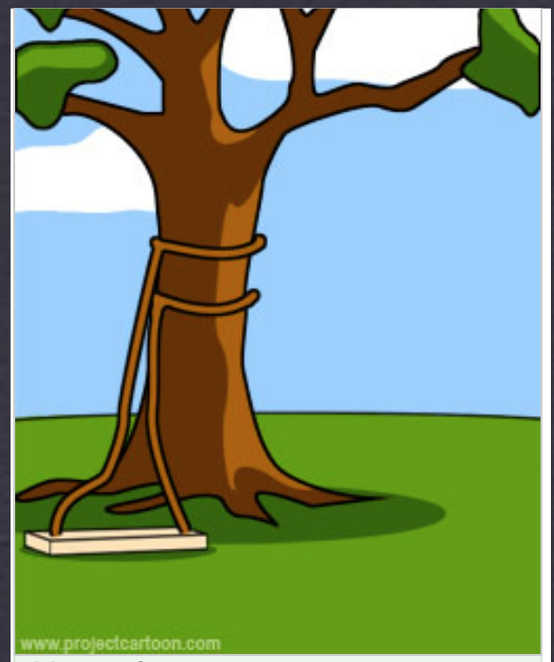


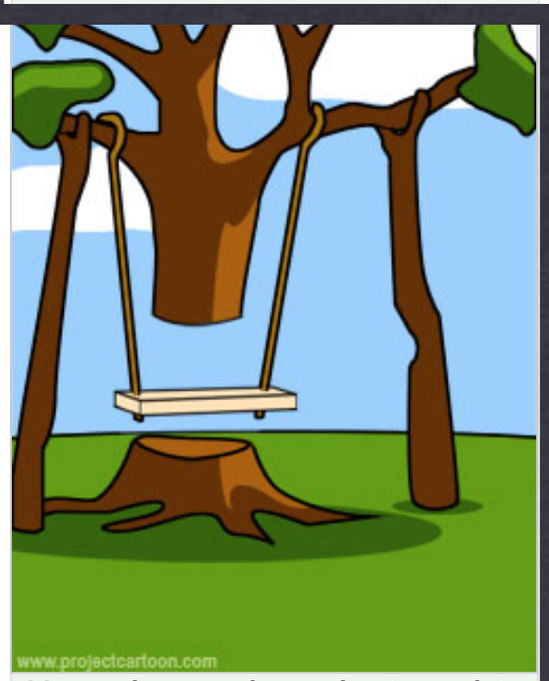
How the customer explained it



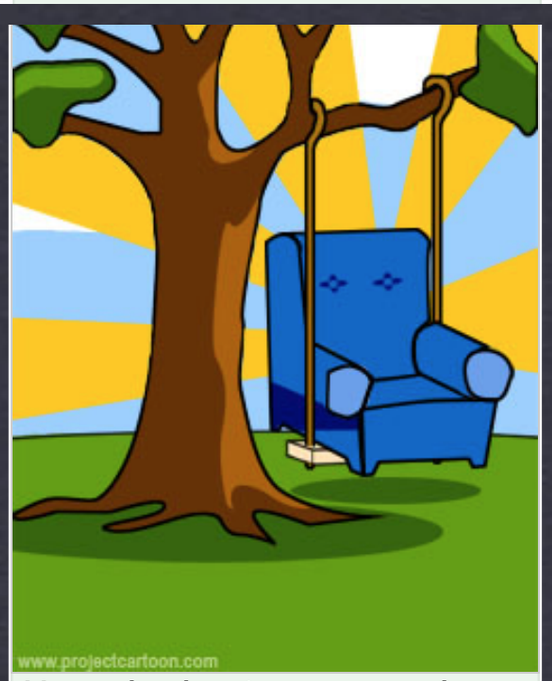
How the project leader understood it



How the programmer wrote it



How the analyst designed it



How the business consultant described it

What the customer really needed

Material and some slide content from:
- Software Architecture: Foundations, Theory, and Practice
- Elisa Baniassad
- Reid Holmes

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

Non-Functional Properties

Mei Nagappan

System Stakeholders

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

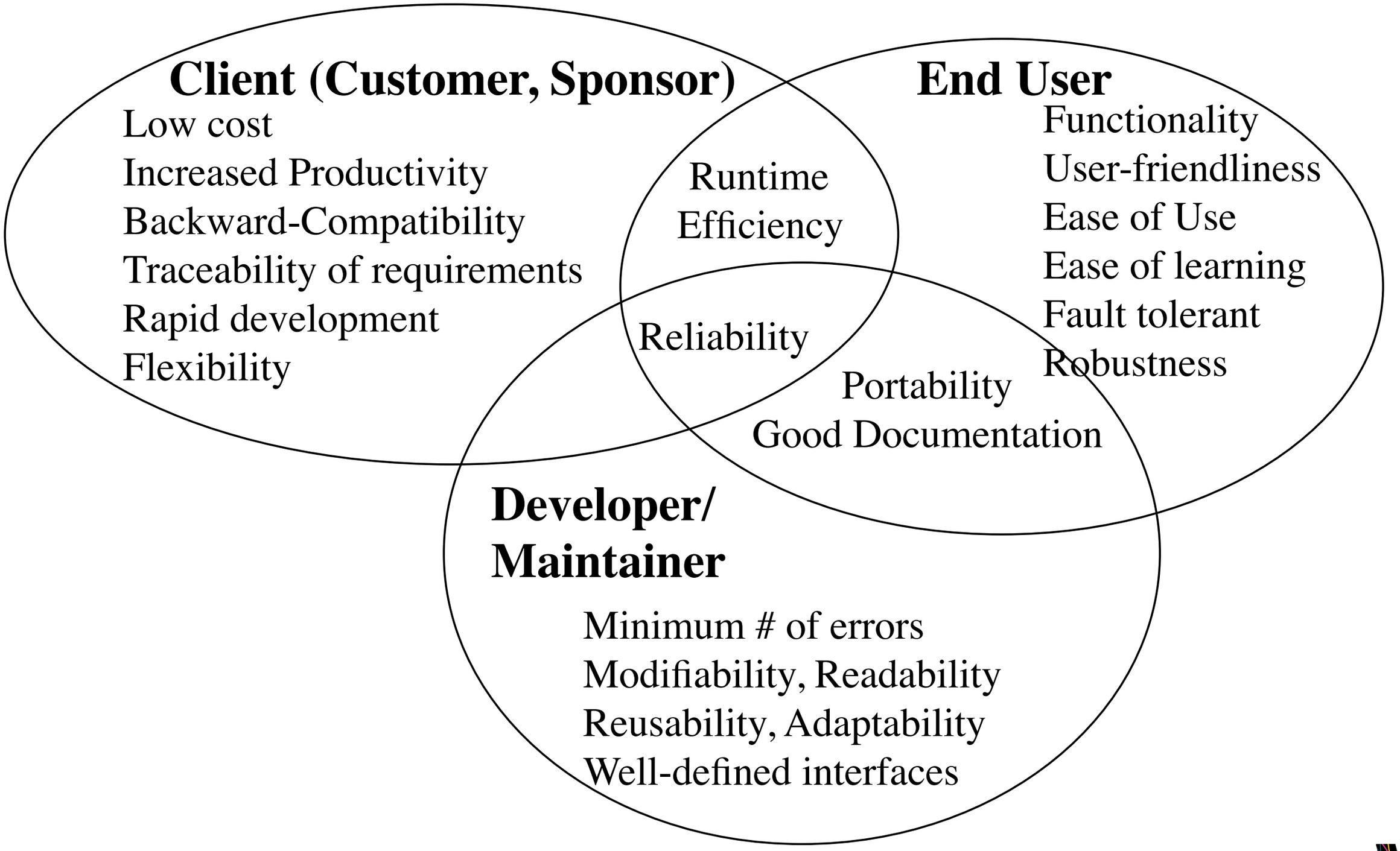
Stakeholder Questions

- 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

Tradeoffs


Client (Customer, Sponsor)
Low cost
Increased Productivity
Backward-Compatibility
Traceability of requirements
Rapid development
Flexibility
End User
Functionality
User-friendliness
Ease of Use
Ease of learning
Fault tolerant
Robustness
Runtime Efficiency
Reliability
Portability
Good Documentation
Developer/ Maintainer
Minimum # of errors
Modifiability, Readability
Reusability, Adaptability
Well-defined interfaces

Typical tradeoffs

- functionality vs. usability
- cost vs. robustness
- efficiency vs. portability
- dev velocity vs. functionality
- cost vs. reusability
- backward compatibility vs. readability

NFPs

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

[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”

Design guidelines for NFPs

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

Evaluating NFPs

- It is tempting to treat NFPs abstractly
- Thinking about NFPs concretely means thinking about how they might be measured
- If you do not do this, it is hard to validate whether a design / arch decision supports or inhibits an NFP

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.

NFP: Scalability / Heterogeneity

- 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.

NFP: Scalability / Heterogeneity

- 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

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.