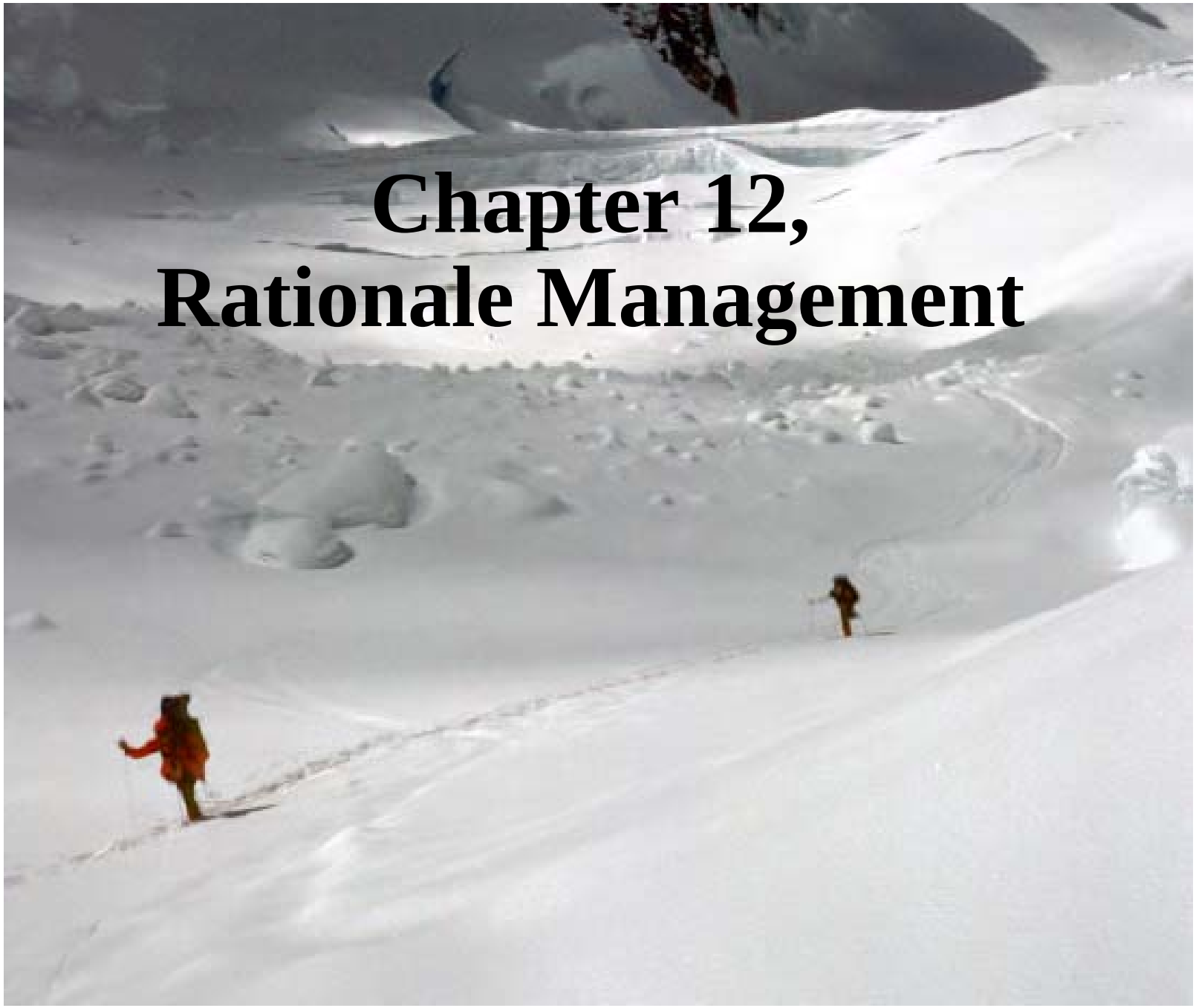
**Object-Oriented Software Engineering**
Using UML, Patterns, and Java



# Chapter 12, Rationale Management

# *An aircraft example*

A320

- First fly-by-wire passenger aircraft
- 150 seats, short to medium haul


A319 & A321

- Derivatives of A320
- Same handling as A320

Design rationale

- Reduce pilot training & maintenance costs
- Increase flexibility for airline

# *An aircraft example (2)*

A330 & A340

- Long haul and ultra long haul
- 2x seats, 3x range
- Similar handling as A320 family

Design rationale

- With minimum cross training, A320 pilots can be certified to fly A330 and A340 airplanes

Consequence

- Any change in these five airplanes must maintain this similarity

# *Overview: rationale*

- What is rationale?
- Why is it critical in software engineering?
- Centralized traffic control example
- Rationale in project management
  - **Consensus building**
  - **Consistency with goals**
  - **Rapid knowledge construction**
- Summary

# *What is rationale?*

***Rationale*** is the reasoning that lead to the system.

Rationale includes:

- the ***issues*** that were addressed,
- the ***alternatives*** that were considered,
- the ***decisions*** that were made to resolve the issues,
- the ***criteria*** that were used to guide decisions, and
- the ***debate*** developers went through to reach a decision.

# *Why is rationale important in software engineering?*

Many software systems are like aircraft:

They result from a large number of decisions taken over an extended period of time.

- Evolving assumptions
- Legacy decisions
- Conflicting criteria

-> high maintenance cost

-> loss & rediscovery of information

# *Uses of rationale in software engineering*

- Improve design support
  - **Avoid duplicate evaluation of poor alternatives**
  - **Make consistent and explicit trade-offs**
- Improve documentation support
  - **Makes it easier for non developers (e.g., managers, lawyers, technical writers) to review the design**
- Improve maintenance support
  - **Provide maintainers with design context**
- Improve learning
  - **New staff can learn the design by replaying the decisions that produced it**

# *Representing rationale: issue models*

Argumentation is the most promising approach so far:

- More information than document: captures trade-offs and discarded alternatives that design documents do not.
- Less messy than communication records: communication records contain everything.

Issue models represent arguments in a semi-structure form:

- Nodes represent argument steps
- Links represent their relationships

# *ATM Example*

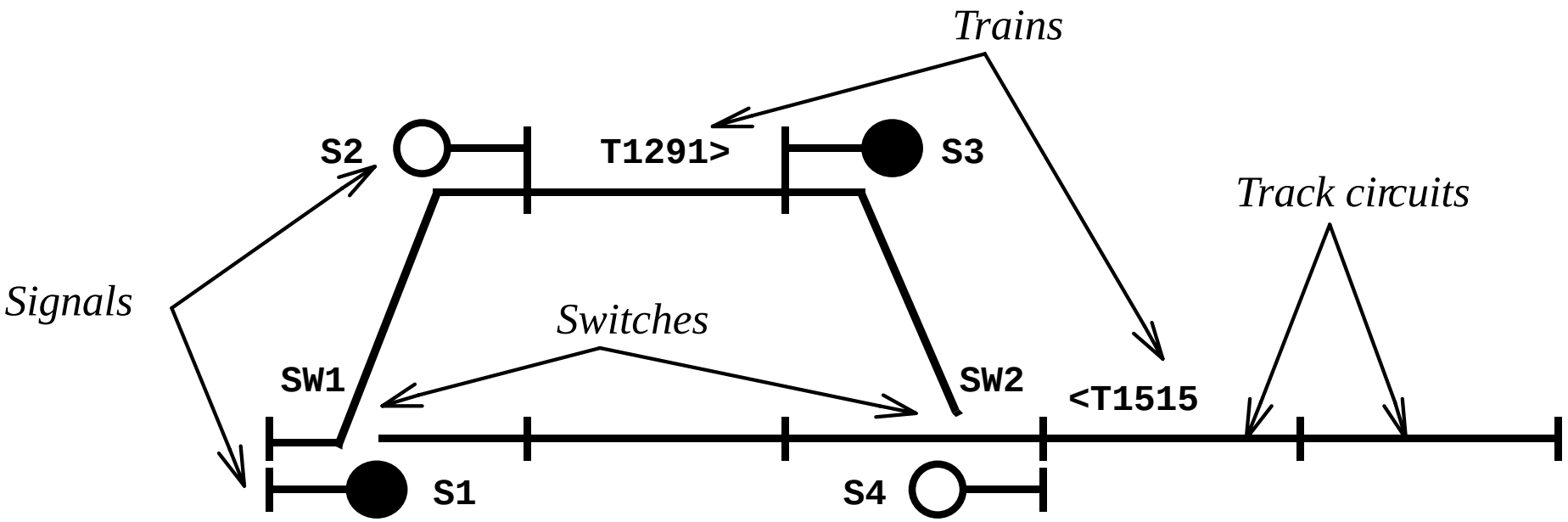
**Question:** Alternative Authentication Mechanisms?

**References:** Service: Authenticate

**Decision:** Smart Card + PIN

| | **Criteria 1:** ATM Unit Cost | **Criteria 2:** Privacy |
|---|---|---|
| **Option 1:** Account number | + | – |
| **Option 2:** Finger print reader | – | + |
| **Option 3:** Smart Card + PIN | + | + |

# *Centralized traffic control*




- CTC systems enable dispatchers to monitor and control trains remotely
- CTC allows the planning of routes and replanning in case of problems

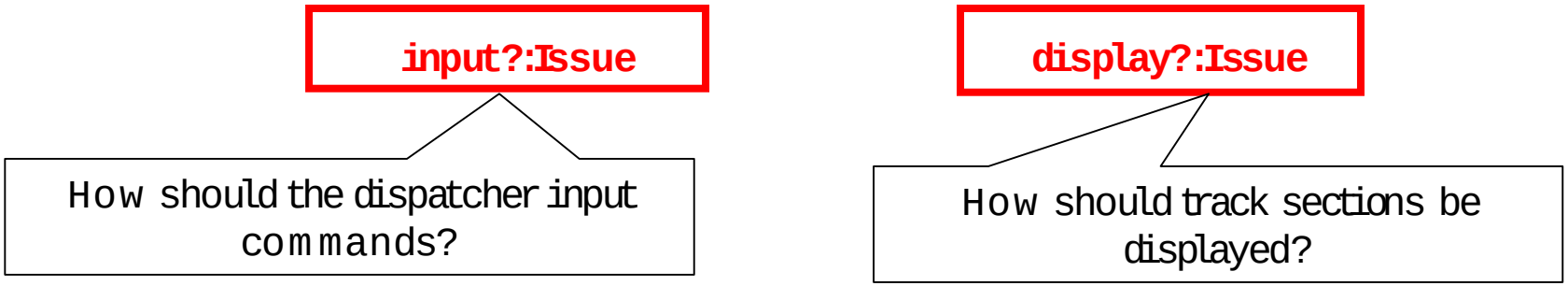
# *Centralized traffic control (2)*

CTC systems are ideal examples of rationale capture:

- Long lived systems (some systems include relays installed last century)
  - **Extended maintenance life cycle**
- Although not life critical, downtime is expensive
  - **Low tolerance for bugs**
  - **Transition to mature technology**

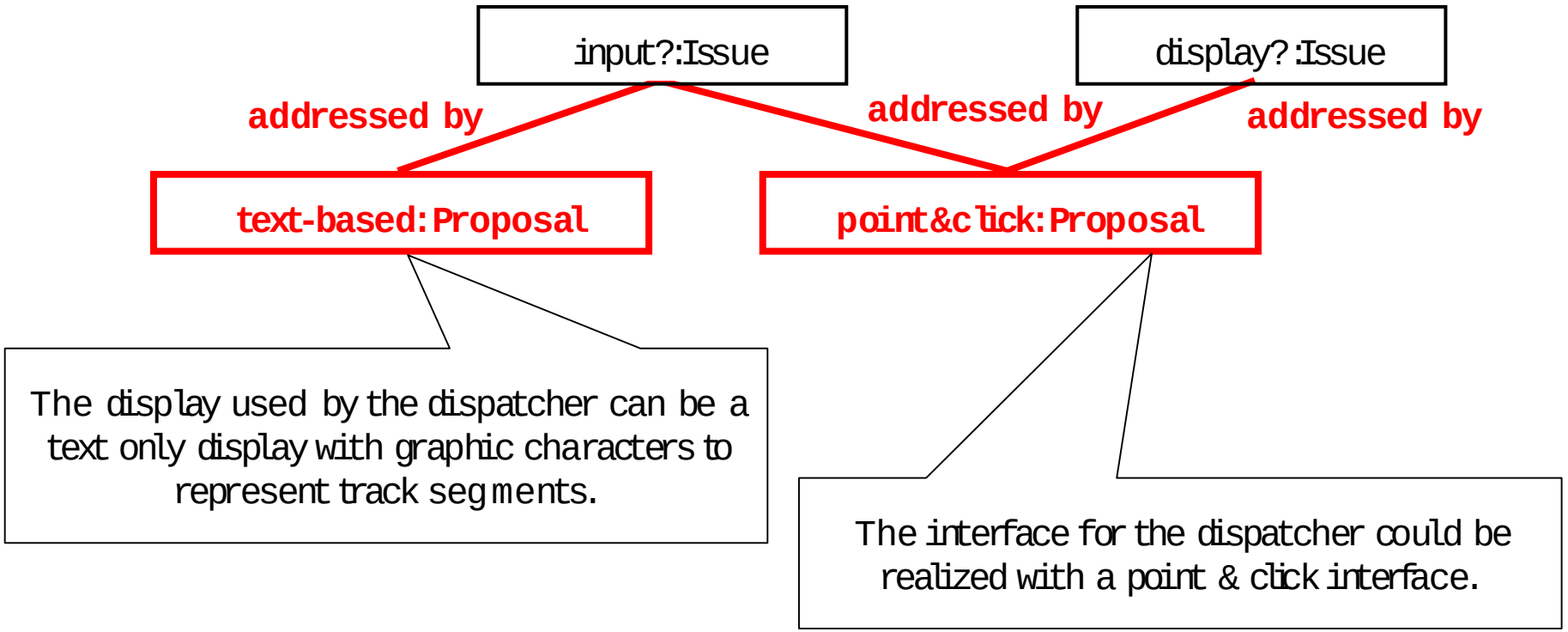
# *Issues*

- Issues are concrete problem which usually do not have a unique, correct solution.
- Issues are phrased as questions.



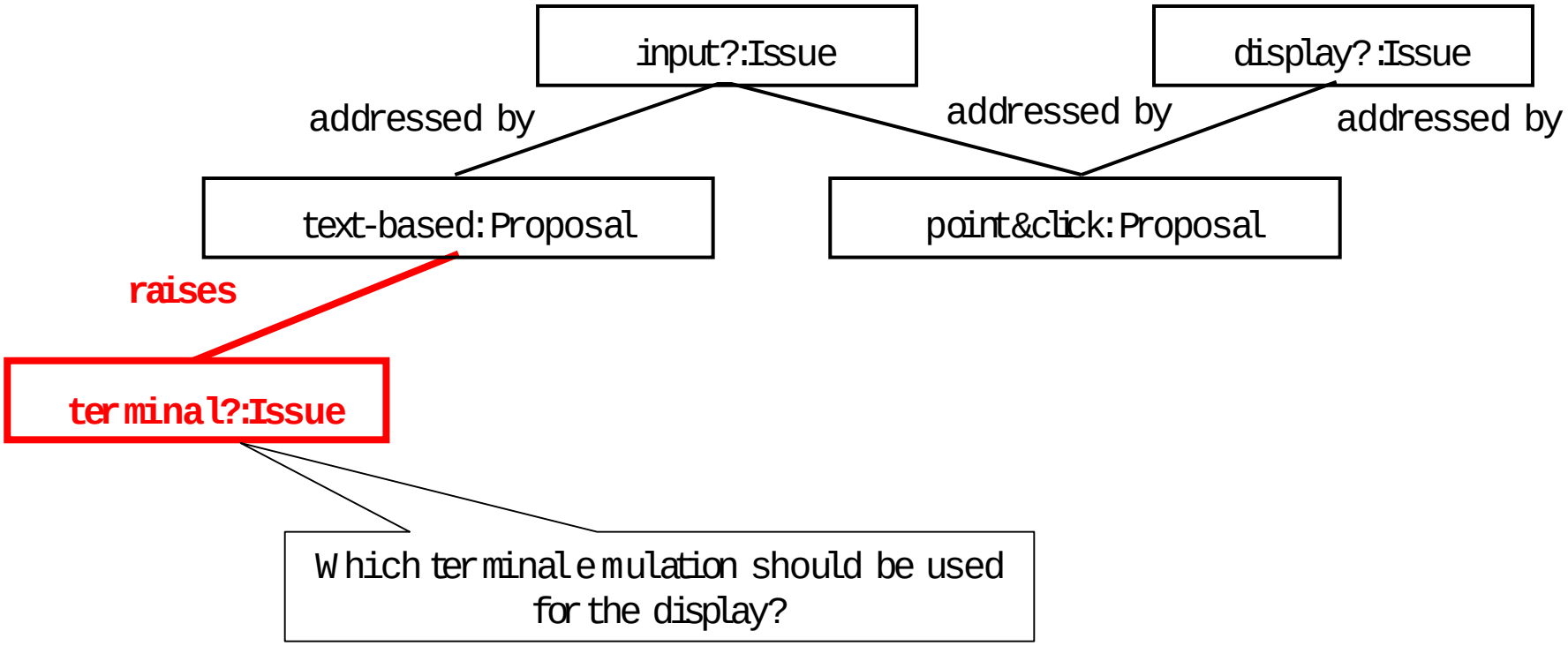
# *Proposals*

- Proposals are possible alternatives to issues.
- One proposal can be shared across multiple issues.



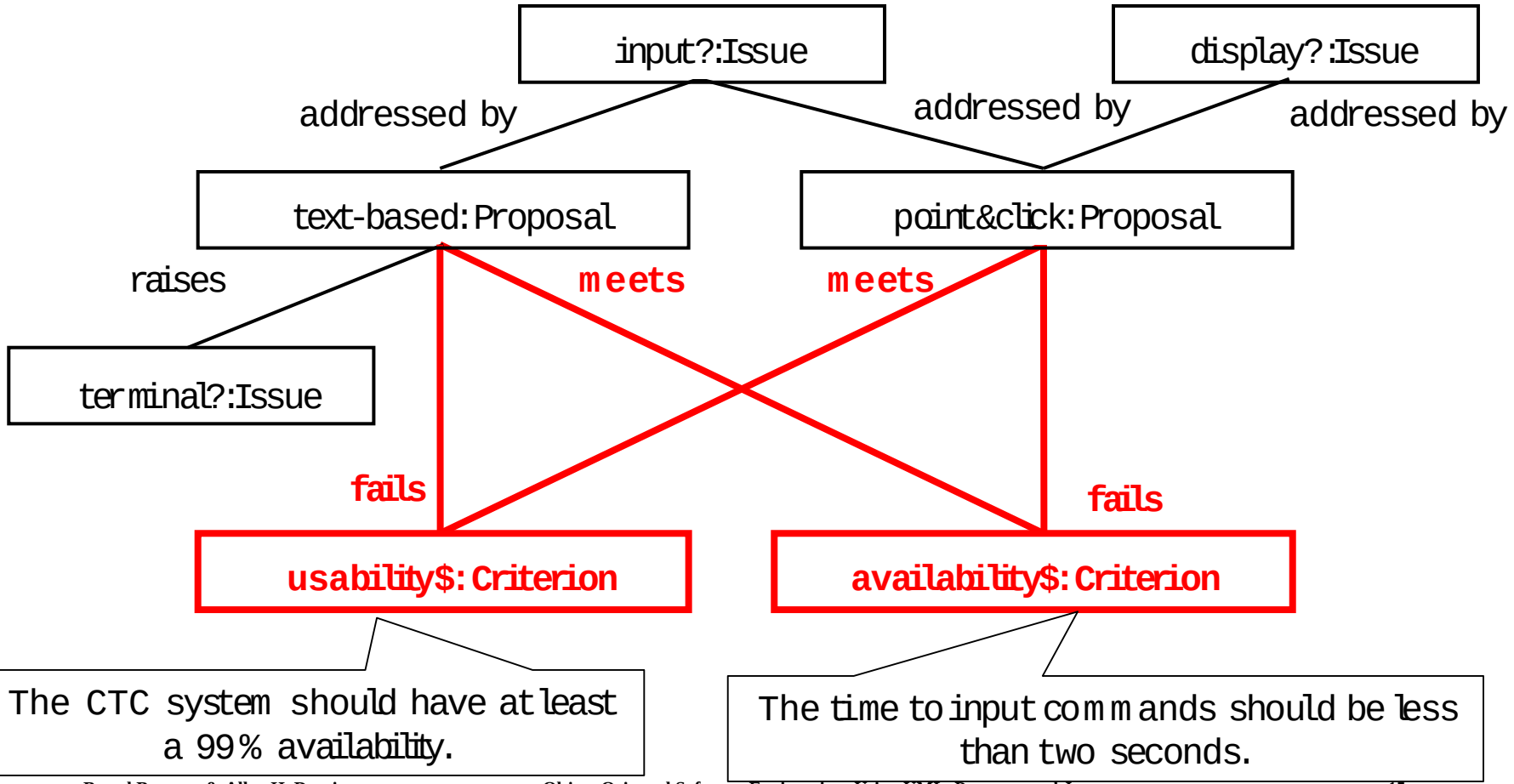
# *Consequent issue*

- Consequent issues are issues raised by the introduction of a proposal.



# *Criteria*

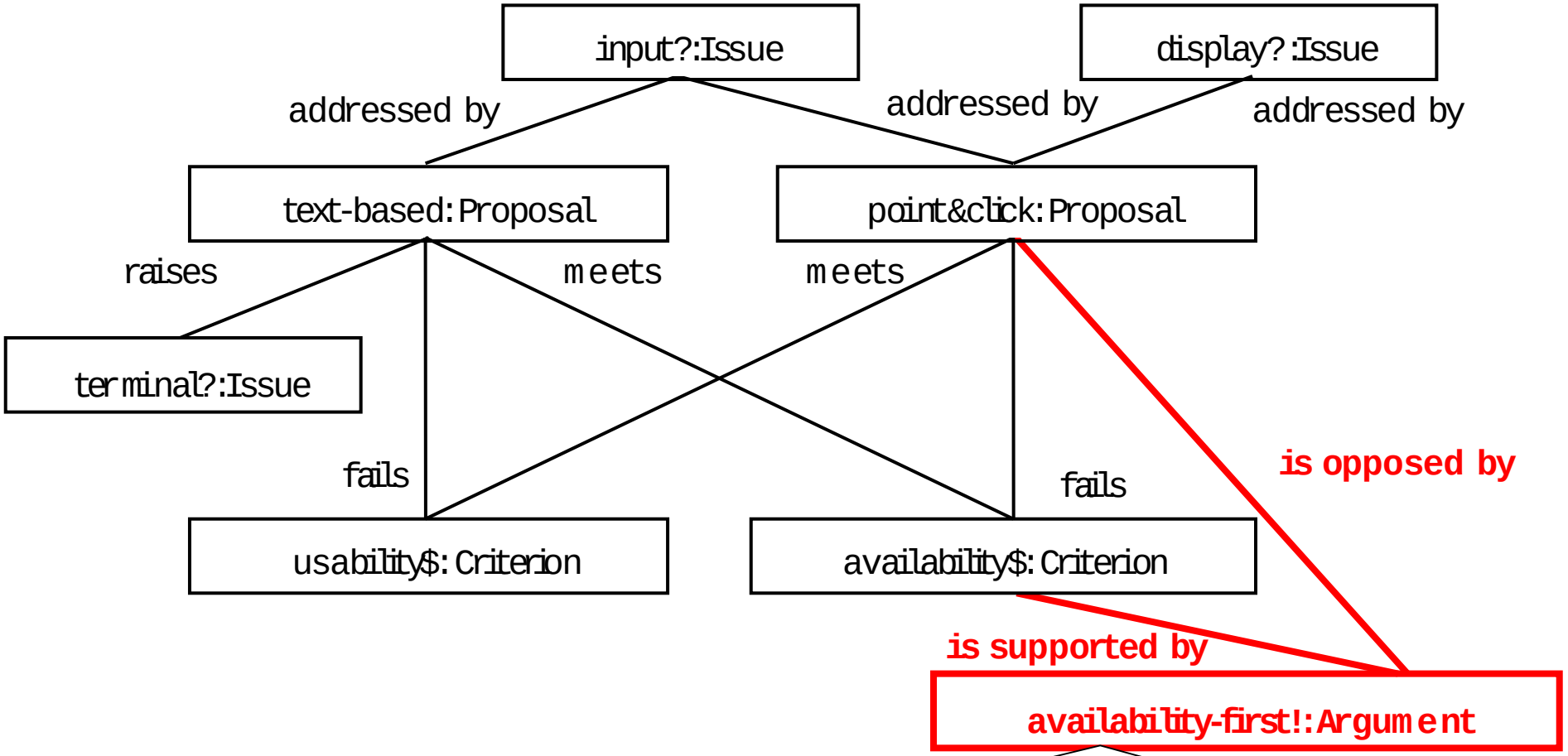
- A criteria represent a goodness measure.
- Criteria are often design goals or nonfunctional requirements.



# *Arguments*

- Arguments represent the debate developers went through to arrive to resolve the issue.
- Arguments can support or oppose any other part of the rationale.
- Arguments constitute the most part of rationale.

# *Arguments (2)*

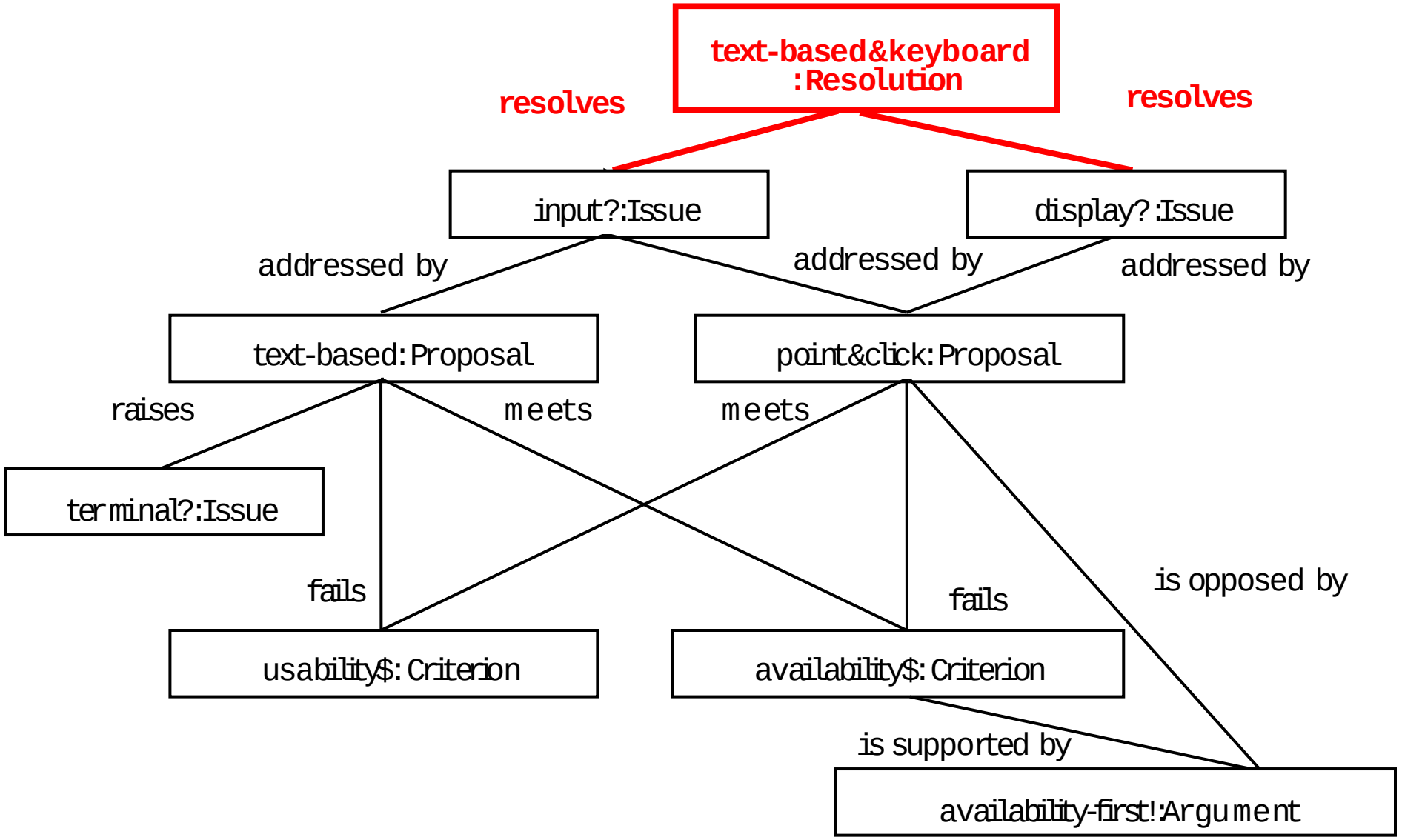



Point&click interfaces are more complex to implement than text-based interfaces. Hence, they are also more difficult to test. The point&click interface risks introducing fatal errors in the system that would offset any usability benefit the interface would provide.

# *Resolutions*

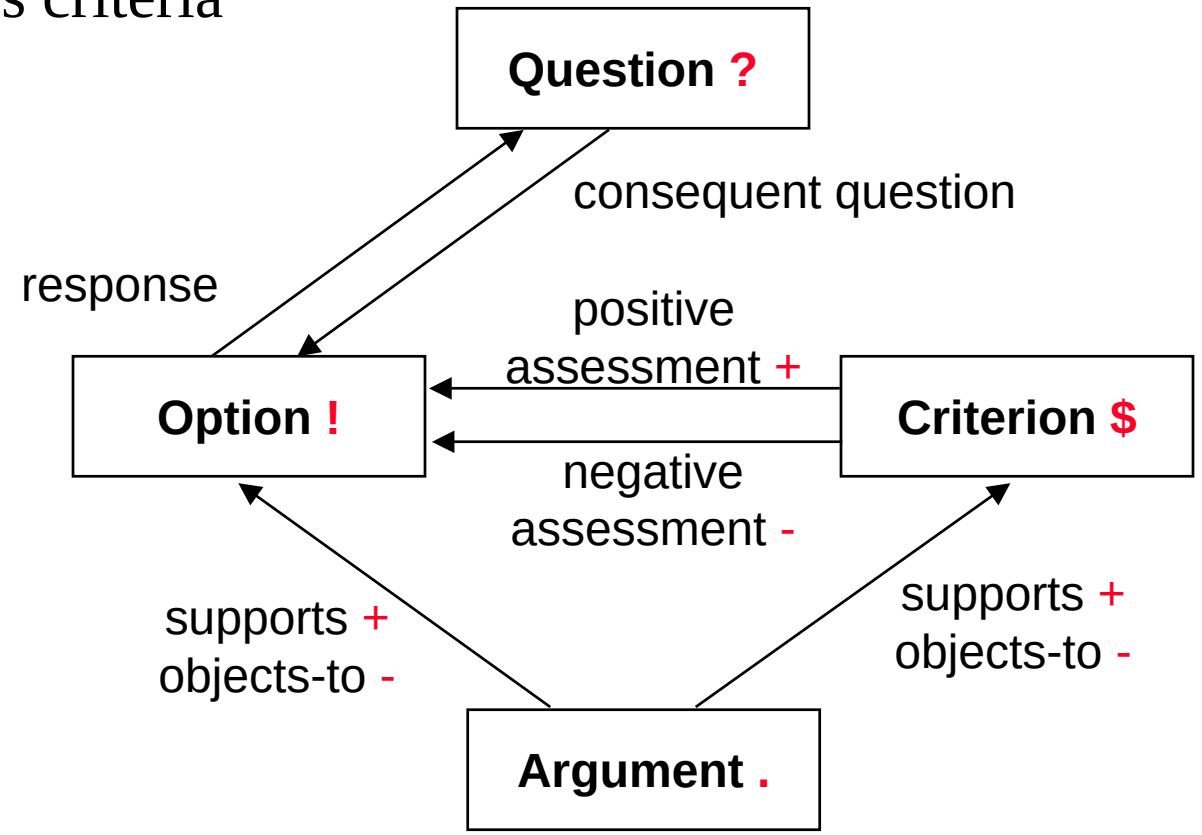
- Resolutions represent decisions.
- A resolution summarizes the chosen alternative and the argument supporting it.
- A resolved issue is said to be closed.
- A resolved issue can be re-opened if necessary, in which case the resolution is demoted.

# *Resolutions (2)*

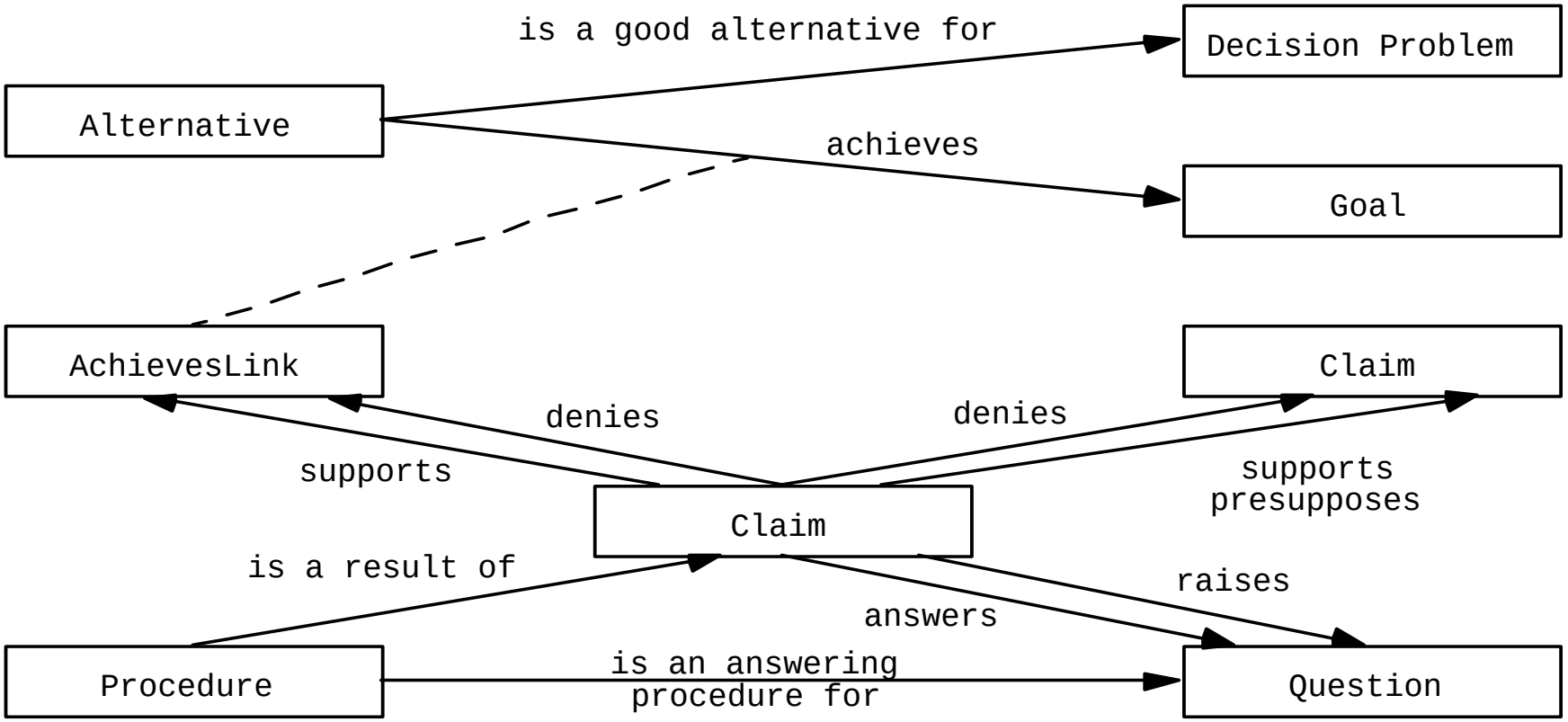


# *Questions, Options, Criteria*

- Designed for capturing rationale after the fact (e.g., quality assessment).
- QOC emphasizes criteria



# *Other issue models: Decision Representation Language*



# *Overview: rationale*

- What is rationale?
- Why is it critical in software engineering?
- Centralized traffic control example
- Rationale in project management
  - Consensus building (WinWin)
  - Consistency with goals (NFR Framework)
  - Rapid knowledge construction (Compendium)
- Summary

# *Consensus building*

Problem

- Any realistic project suffers the tension of conflicting goals
  - **Stakeholders come from different background**
  - **Stakeholders have different criteria**

Example

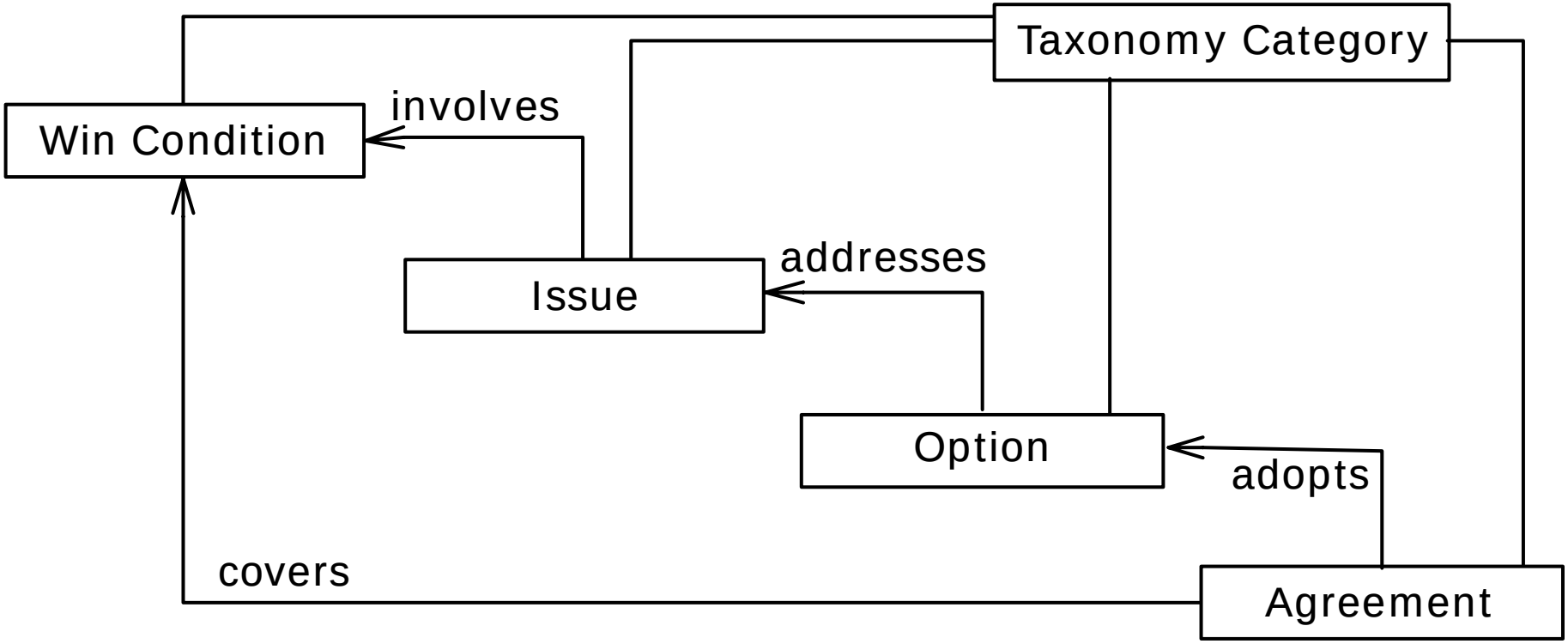
- Requirements engineering
  - **Client: business process (cost and schedule)**
  - **User: functionality**
  - **Developer: architecture**
  - **Manager: development process (cost and schedule)**

# *Consensus building: WinWin*

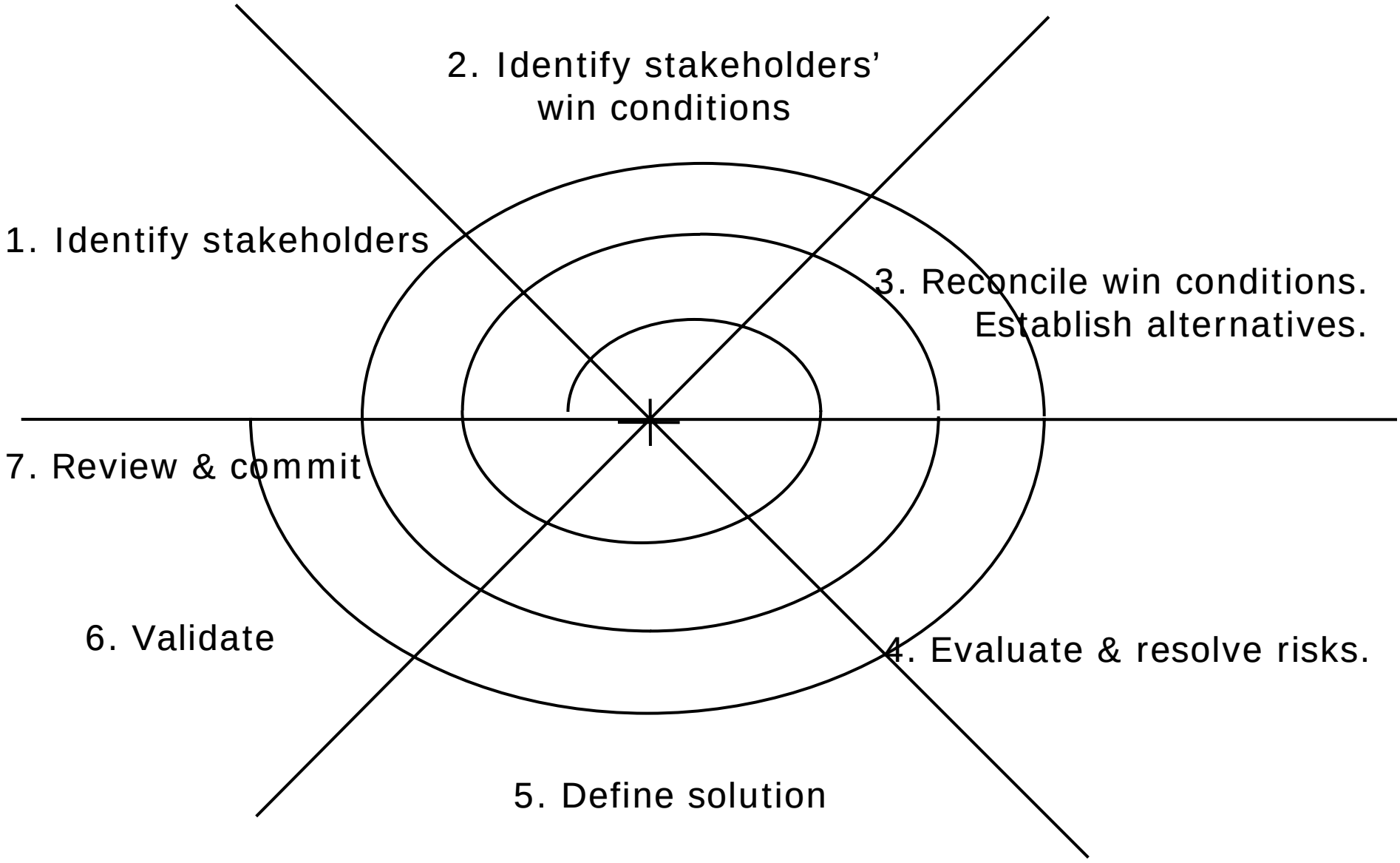
- Incremental, risk-driven spiral process
  - **Identification of stakeholders**
  - **Identification of win conditions**
  - **Conflict resolution**

- Asynchronous groupware tool
  - **Stakeholders post win conditions**
  - **Facilitator detects conflict**
  - **Stakeholders discuss alternatives**
  - **Stakeholders make agreements**

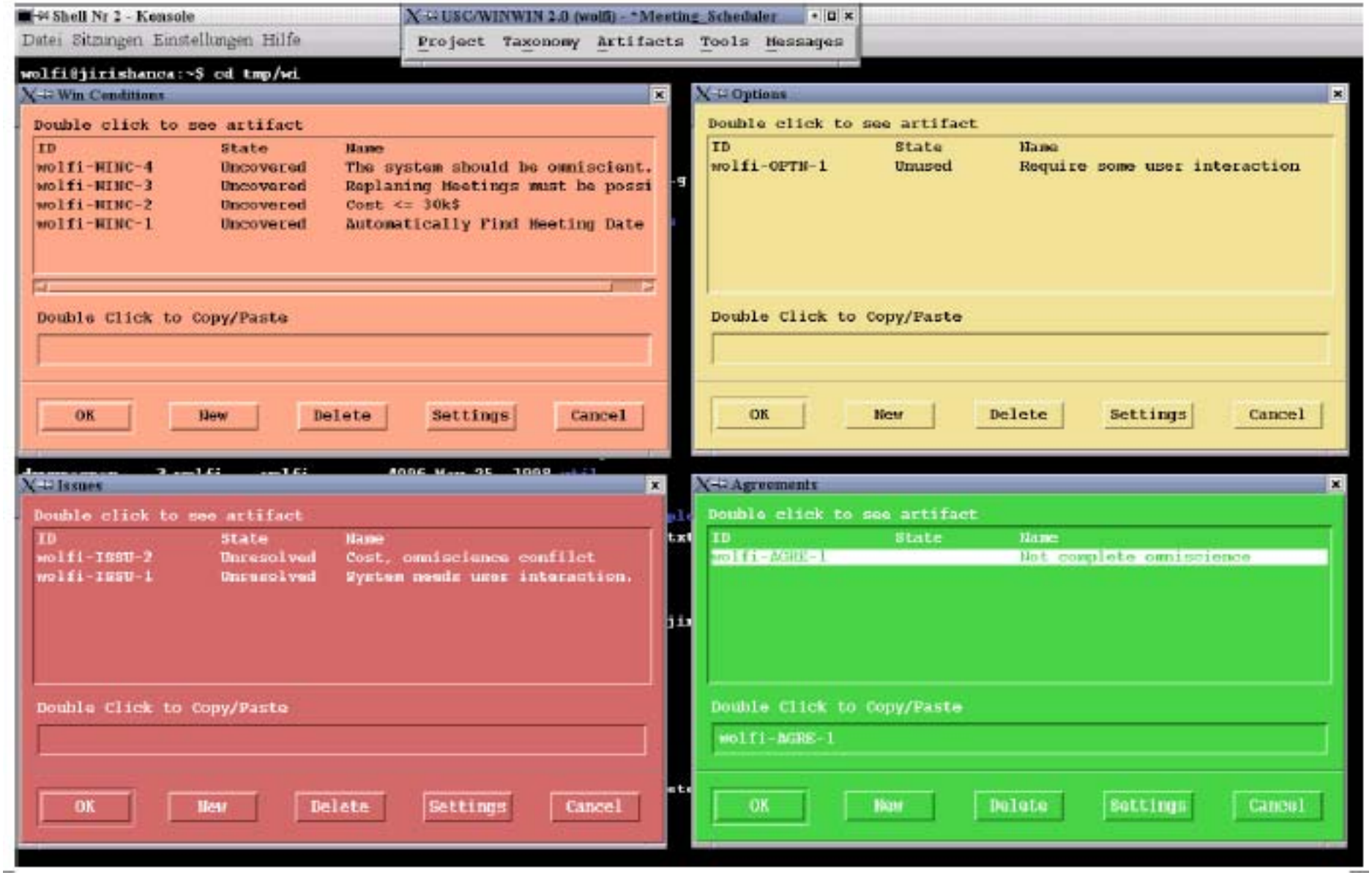
# *Consensus building: Model*



# *Consensus building: Process*



# *Consensus building: WinWin tool*



# *Consensus building: Experiences*

Context

- Initial case studies used project courses with real customers
- Used in industry

Results

+ Risk management focus
+ Trust building between developers and clients
+ Discipline
– Inadequate tool support

# *Consistency with goals*

Problem

- Once multiple criteria have been acknowledged
  - **Find solutions that satisfy all of them**
  - **Document the trade-offs that were made**

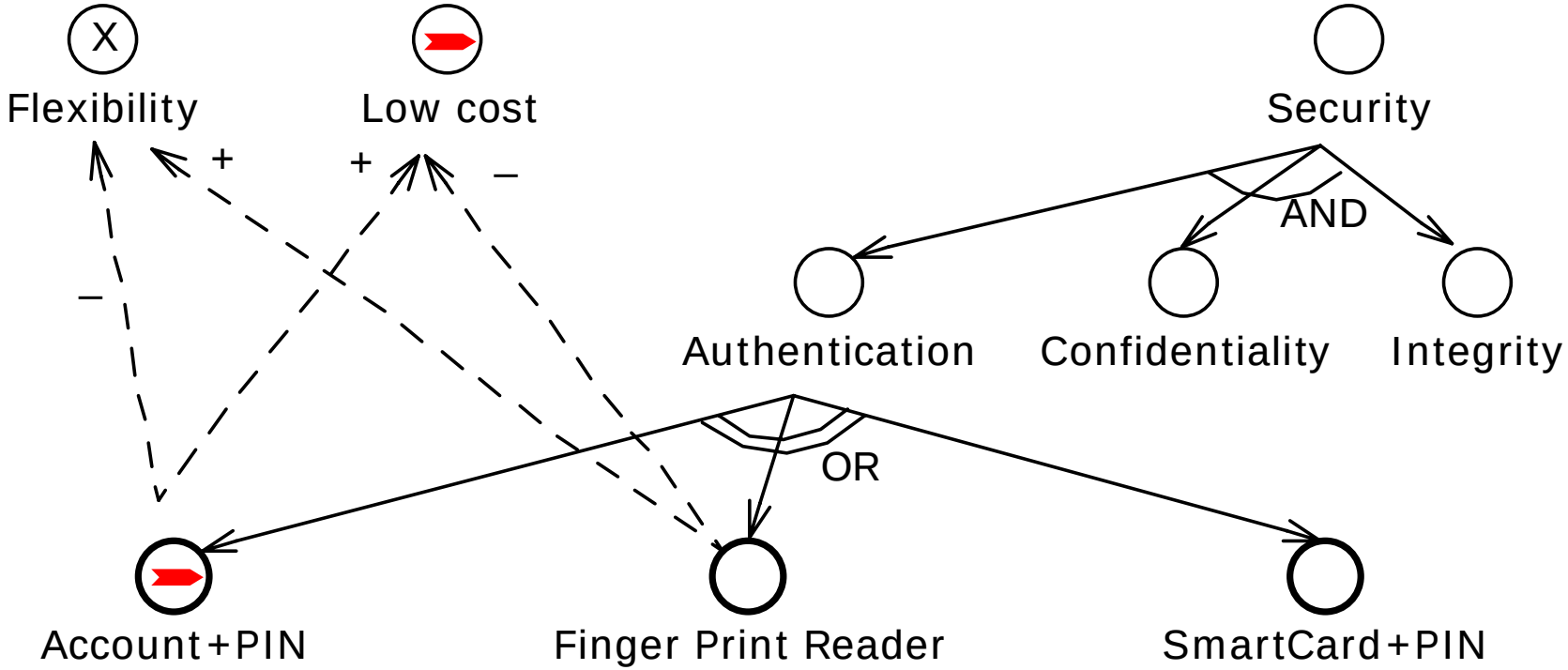
Example

- Authentication should be ***secure***, ***flexible*** for the user, and ***low cost***.

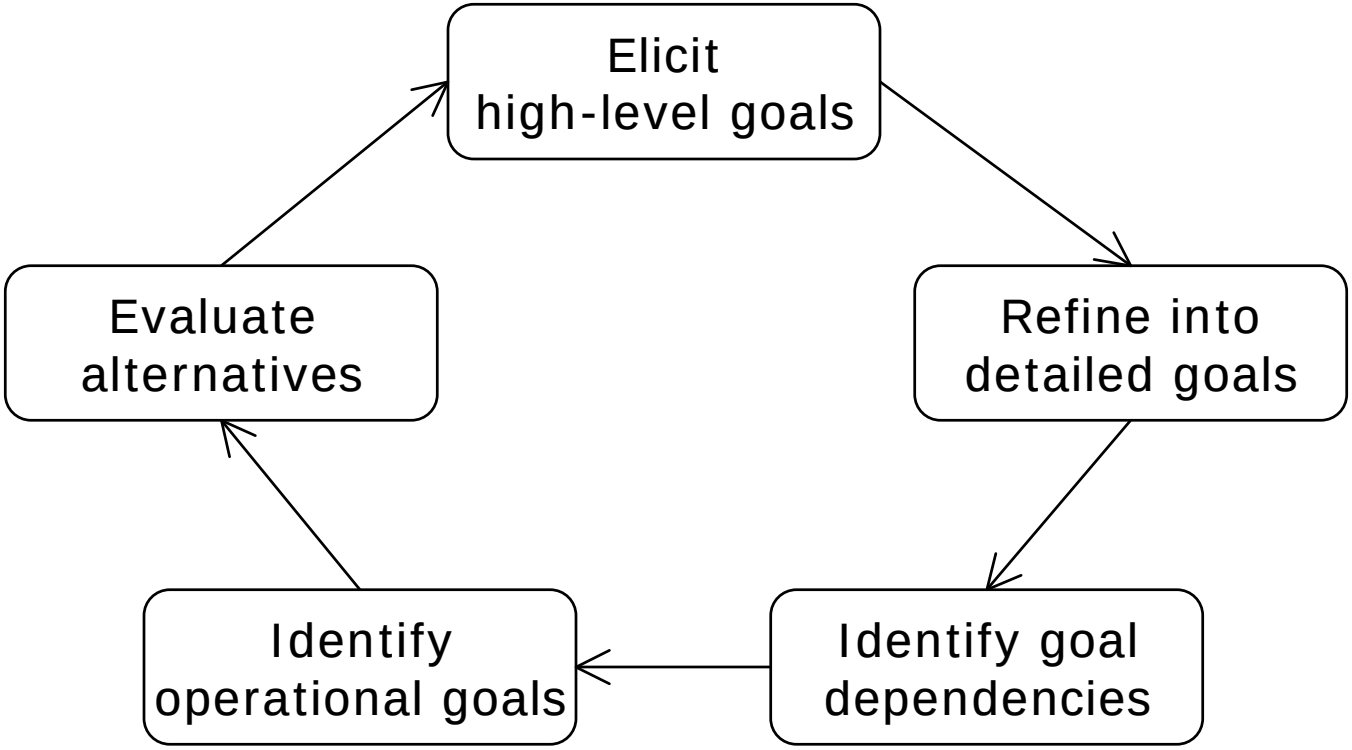
# *Consistency with goals: NFR Framework*

- NFR goal refinement
  - **NFRs are represented as goals in a graph**
  - **Leaf nodes of the graph are operational requirements**
  - **Relationships represent “help” “hurt” relationships**
  - **One graph can represent many alternatives**
- NFR evaluation
  - **Make and break values are propagated through the graph automatically**
  - **Developer can evaluate different alternatives and compare them**

# *Consistency with goals: Model*



# *Consistency with goals: Process*



# *Consistency with goals: Experiences*

+ Case studies on existing systems lead to clearer trade-offs
+ Research into integrating NFR framework and design patterns
  - **Match NFRs to design pattern "Forces"**
  - **Link NFRs, design patterns, and functional requirements**

– Tool support important

# *Rapid knowledge construction*

Problem

- When a company is large enough, it doesn't know what it does.
  - **Knowledge rarely crosses organizational boundaries**
  - **Knowledge rarely crosses physical boundaries**

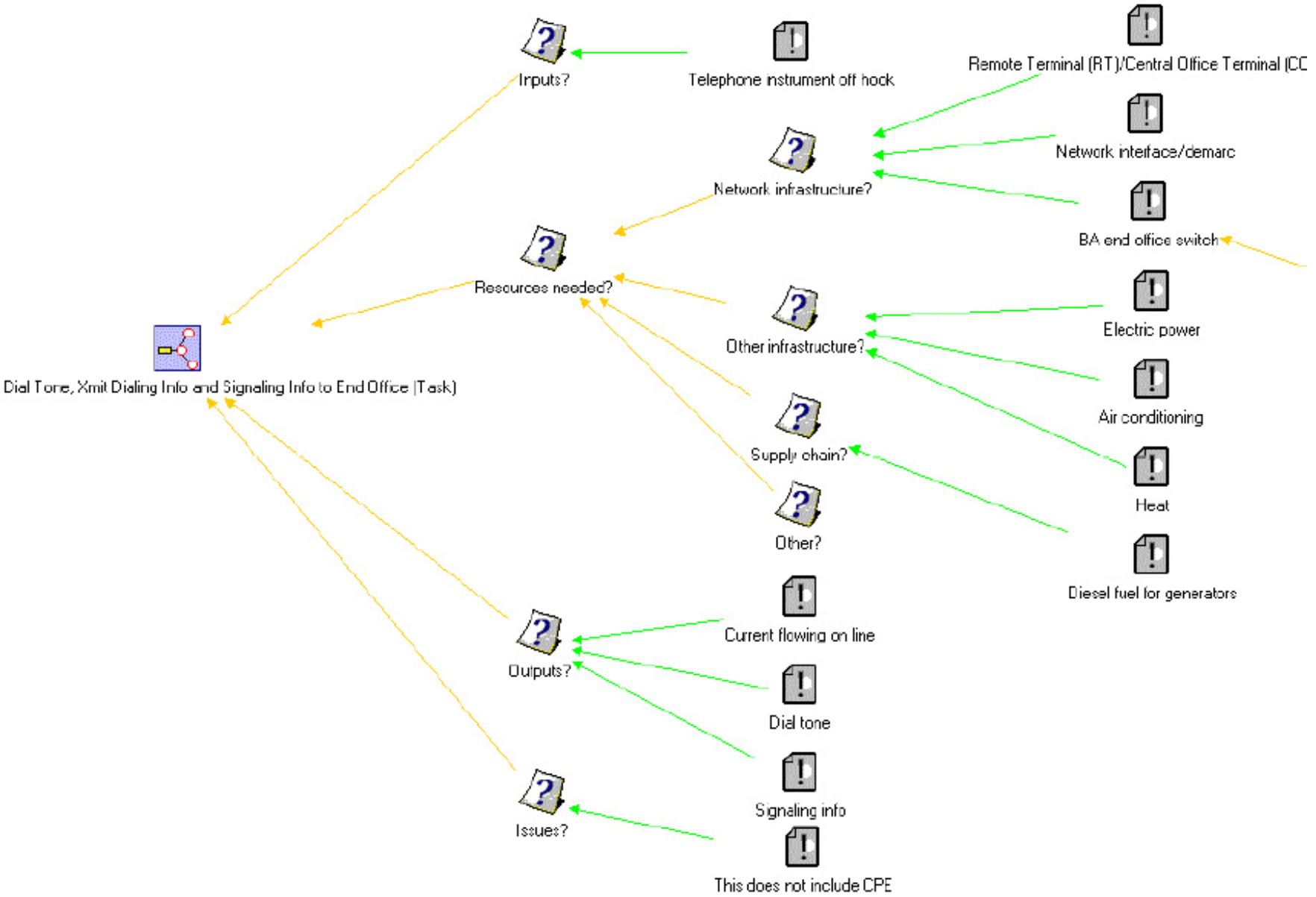
Example

- Identify resources at risk for Y2K and prioritize responses.

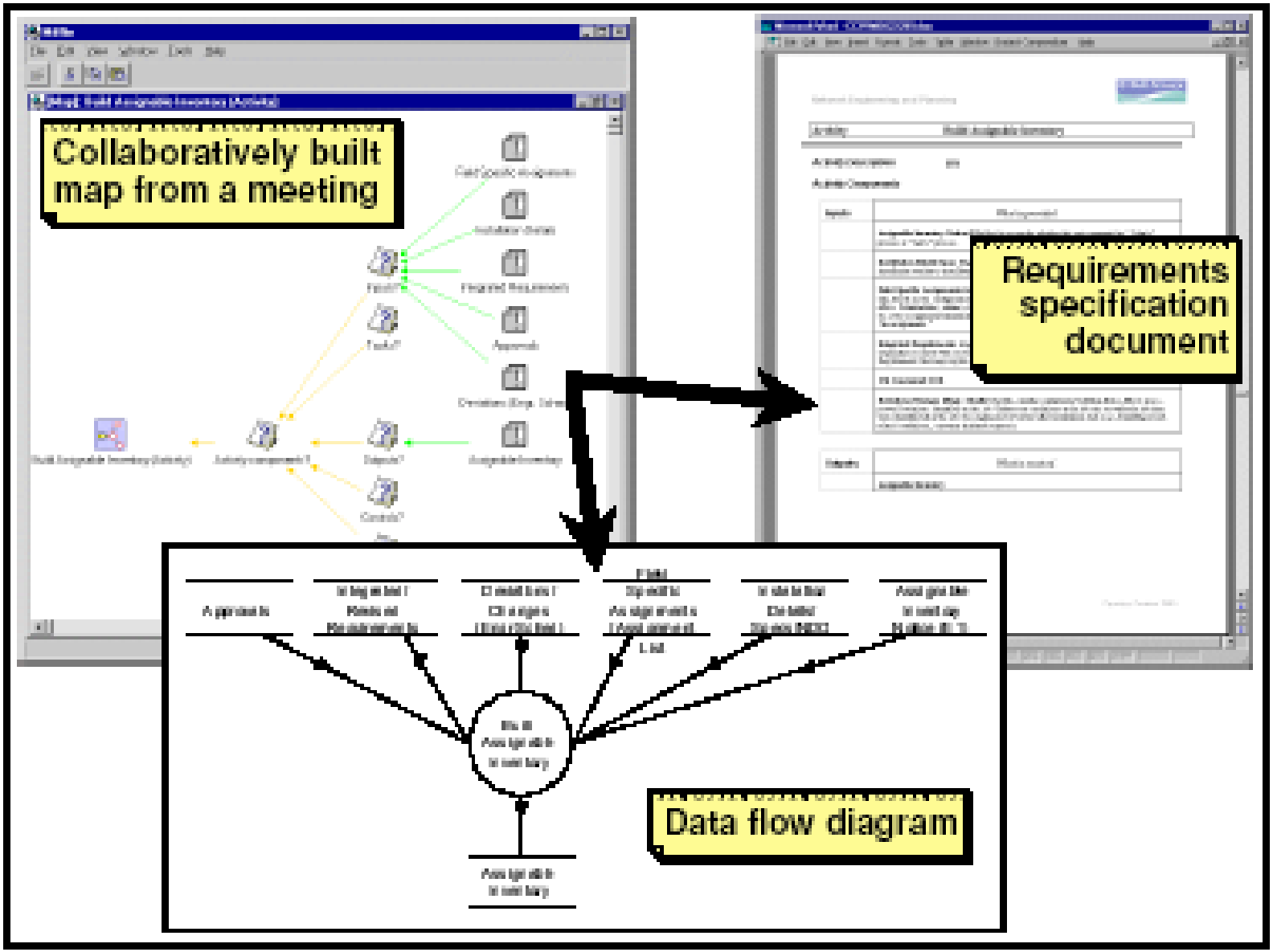
# *Rapid knowledge construction: Compendium*

- Meeting facilitation
  - **Stakeholders from different business units**
  - **External facilitator**
- Real-time construction of knowledge maps
  - **The focus of the meeting is a concept map under construction**
  - **Map includes the issue model nodes and custom nodes (e.g., process, resource, etc.)**
- Knowledge structuring for long term use
  - **Concept map exported as document outline, process model, memos, etc.**

# Rapid knowledge construction: Model



# *Rapid knowledge construction: Process example*



# *Rapid knowledge Construction: Experiences*

Context

- Several industrial case studies, including Y2K contingency planning at Bell Atlantic

Results

- Increased meeting efficiency (templates are reused)
- Knowledge reused for other tasks

# *Summary*

- Rationale can be used in project management
  - **To build consensus (WinWin)**
  - **To ensure quality (NFR Framework)**
  - **To elicit knowledge (Compendium)**
- Other applications include
  - **Risk management**
  - **Change management**
  - **Process improvement**
- Open issues
  - **Tool support**
  - **User acceptance**