PRIPARE

PReparing **I**ndustry to **P**rivacy-by-design by supporting its **A**pplication in **RE**search

Design and Evaluation of PEARS Privacy Enhancing ARchitectures

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Outline

- PEARs: Privacy Enhancing Architectures
- Using ATAM for Privacy-by-design
  - Architecture Trade-off Analysis Method
- Using CBAM for Privacy-by-design
  - Cost Benefit Analysis Method
- Conclusion

Possible Definitions of Architecture

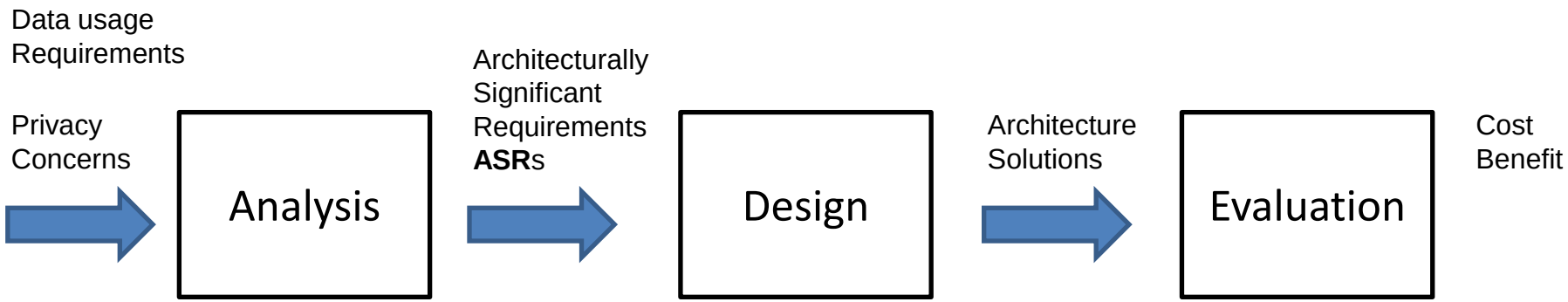
- High level structure of a system
- Documentation of this high level structure
  - e.g. ISO/IEC/IEEE 42010 Systems and software engineering — Architecture description (replaces IEEE 1471)

- Discipline of creating such a high level structure

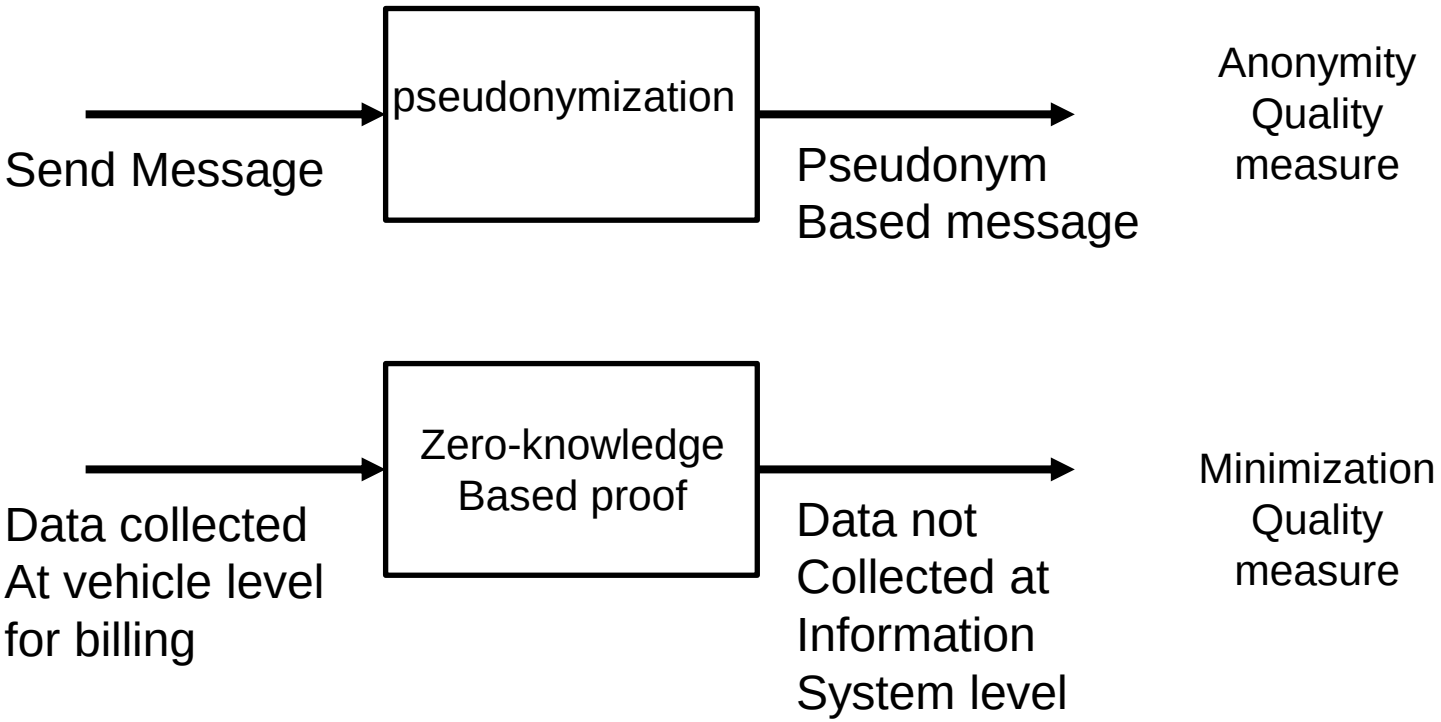
PEAR: Privacy Enhancing ARchitecture

- Discipline of creating a high level structure integrating privacy

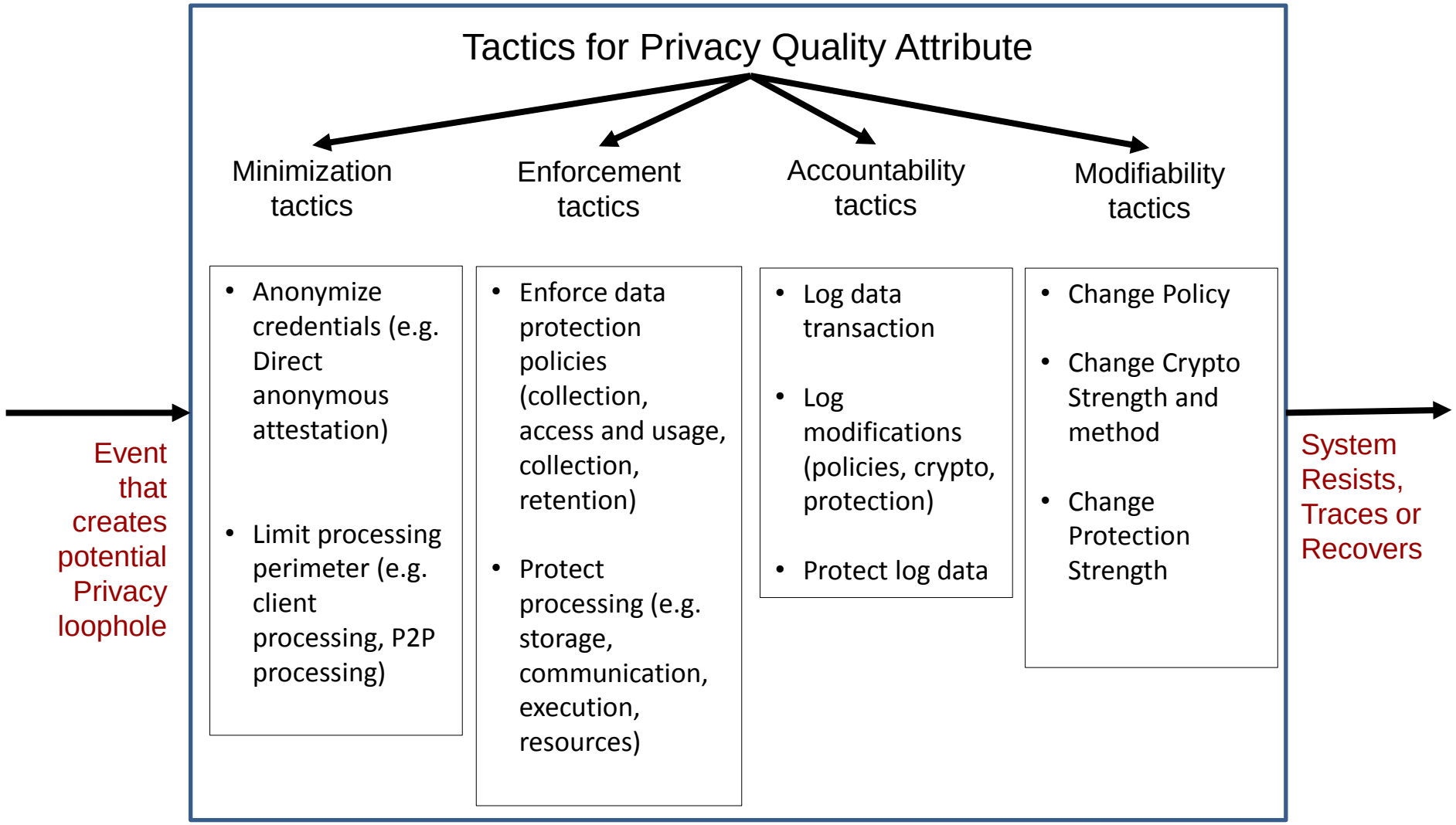
- Includes the following phases
  - Architecture analysis
  - Architecture design
  - Architecture evaluation



Architecture Tactics Examples

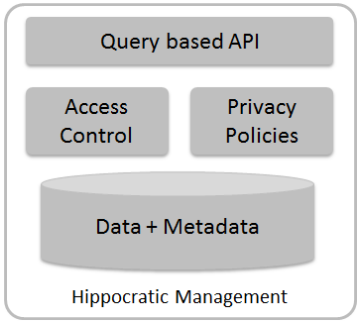


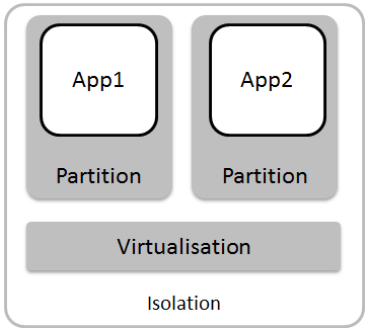
Tactics for Architecture Design



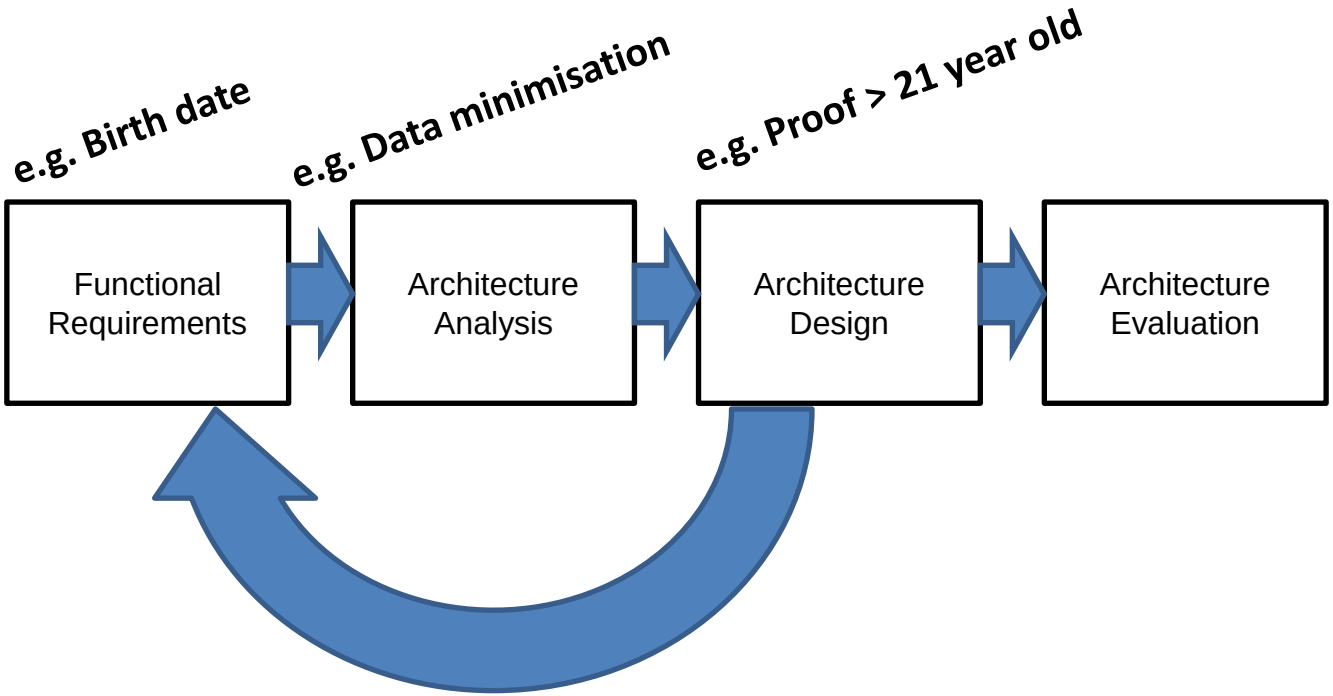
Examples of Solutions (Patterns)

- user data confinement pattern
  - Minimisation
- hippocratic management
  - Enforcement
- Isolation
  - Enforcement





Architecture tactics can change functional requirements

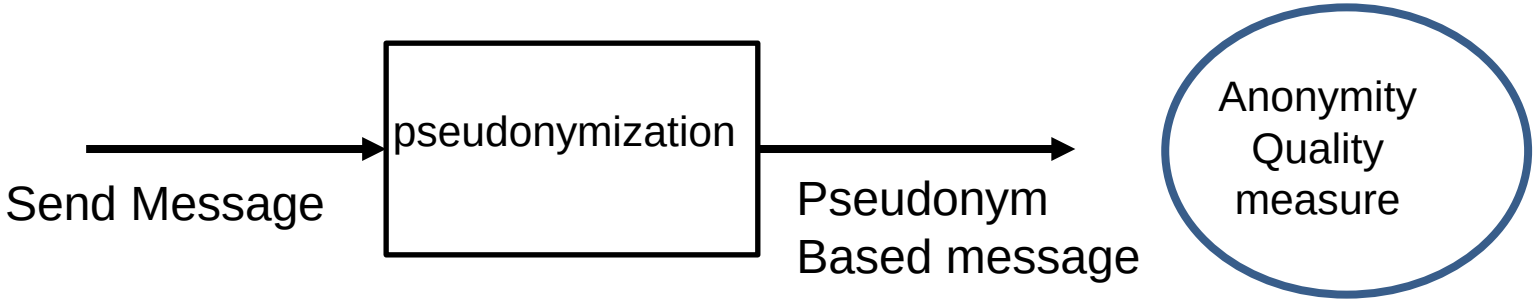


ATAM

- Architecture Tradeoff Analysis Method
  - Relies on **quality models**
  - Relies on **utility trees**
  - Relies on **attribute driven design method**

Quality Models

- Functions to predict the response measure



- Two approaches
  - Analytic models (support quantitative analysis)
    - Availability: markov models/statistical models.
    - Performance: queuing theory/scheduling theory
  - Check lists/Guidelines
    - Security: e.g. common criteria, TVRA
    - Safety: e.g. safety integrity level

Utility Trees

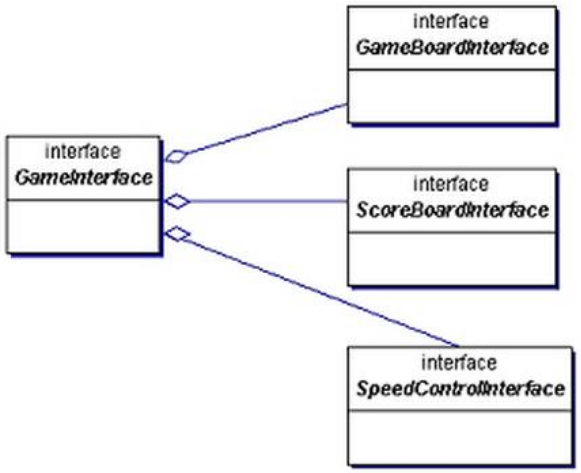
- Level 1: Quality attributes
  - e.g. minimisation
- Level 2: Attribute refinements
  - e.g. amount of data revealed
- Level 3: Definition of Architecturally Significant Requirements
  - Scenario
    - system can provide a proof that user is above 21 instead of transmitting birthdate.
  - Business value (high, medium, low)
  - Architecture impact (high, medium, low)

Attribute Driven Design Method

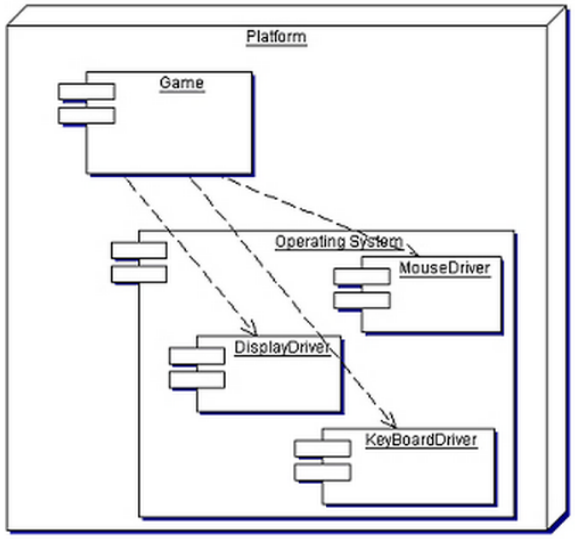
- Iteration-based
  - Choose an element of the system to design
  - Identify ASRs for that part
  - Generate a design solution (architectural views)
  - Inventory of remaining requirements and selection of input for the next iterations

Example of architectural views

- Module views



- Allocation views



ATAM Output

- Concise presentation of architecture
  - Views (e.g. static, dynamic, deployment)
  - Quality attributes and Tactics (e.g. minimization and attribute based credential)
- Business goals (e.g. financial, market position, legal, competitive, quality, …)
- Utility trees
- Risks (e.g. privacy leaks)
- Sensitivity points
  - architectural decisions affecting some quality attribute measure (e.g. data better protected)
- Tradeoff points
  - architectural decisions affecting several quality attributes measures, some positively and some negatively (e.g. data better protected but response time is not as good)

ATAM

- Participants
  - Evaluation team
  - Project decision makers
  - Architecture stakeholders
    - Do not participate to entire exercise
- Phases
  - Evaluation phase 1
    - Involves project decision makers and evaluation team
  - Evaluation phase 2
    - + Architect stakeholders

ATAM Steps

- Phase 1
  - Step 1 - Present ATAM
  - Step 2 - Present Business Drivers
  - Step 3 - Present Architecture
  - Step 4 - Identify Architectural Approaches (list patterns and tactics)
  - Step 5 - Generate Quality Attribute Utility Tree
  - Step 6 - Analyze Architectural Approaches
    - Focus on higher ranked scenarios
- Phase 2
  - Step 7 - Brainstorm and Prioritize Scenarios
  - Step 8 - Analyze Architectural Approaches
  - Step 9 – Present results

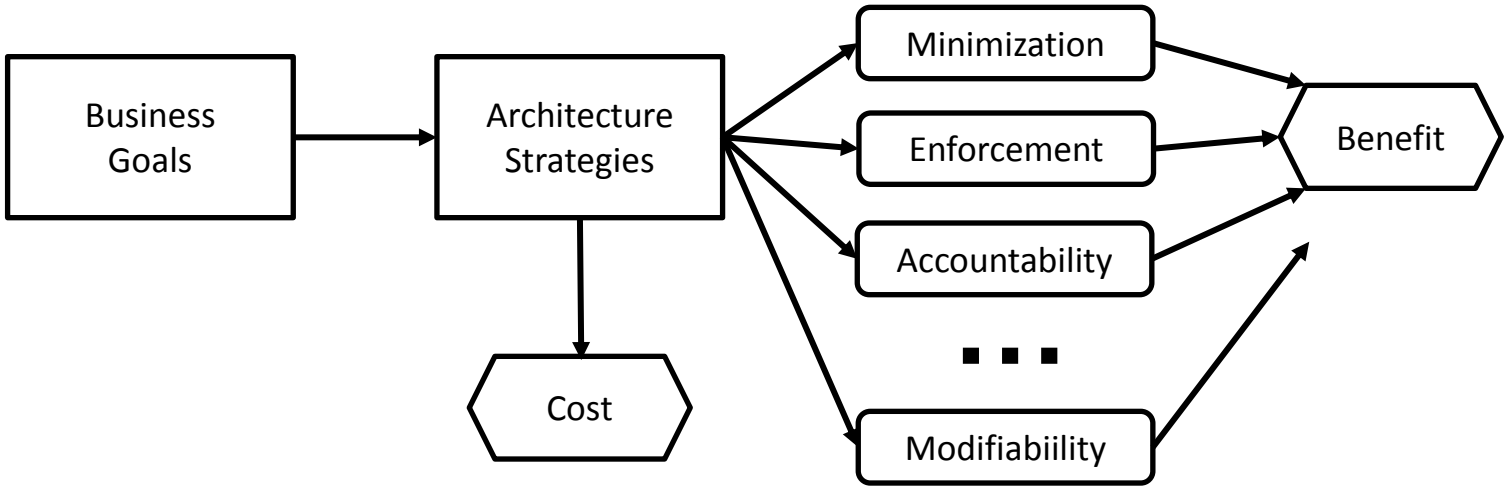
Scenario

Analysis of Architectural Approach				
Scenario #: 1	**In-house non authorised access**			
Attribute(s): **Protection enforcement**				
Environment: **SMS data base of mobile phone operator**				
Stimulus: **Attempt to access SMS log of a celebrity**				
Response: **Access denial**				
Architectural Decisions	Sensitivity	Tradeoff	Risk	Nonrisk
Access control	**S1**	**T1**	**R1**	**N1**
Reasoning: **Non authorised accesses are detected**.				

Sensitivity Points	Description
S1	**SMS log better protected**
Tradeoff Points	Description
T1	**Affects flexibility of access and sometimes customer services**
Risks	Description
R1	**Access control may be attacked**
Non-risks	Description
N1	**SMS data base encryption means slower access**

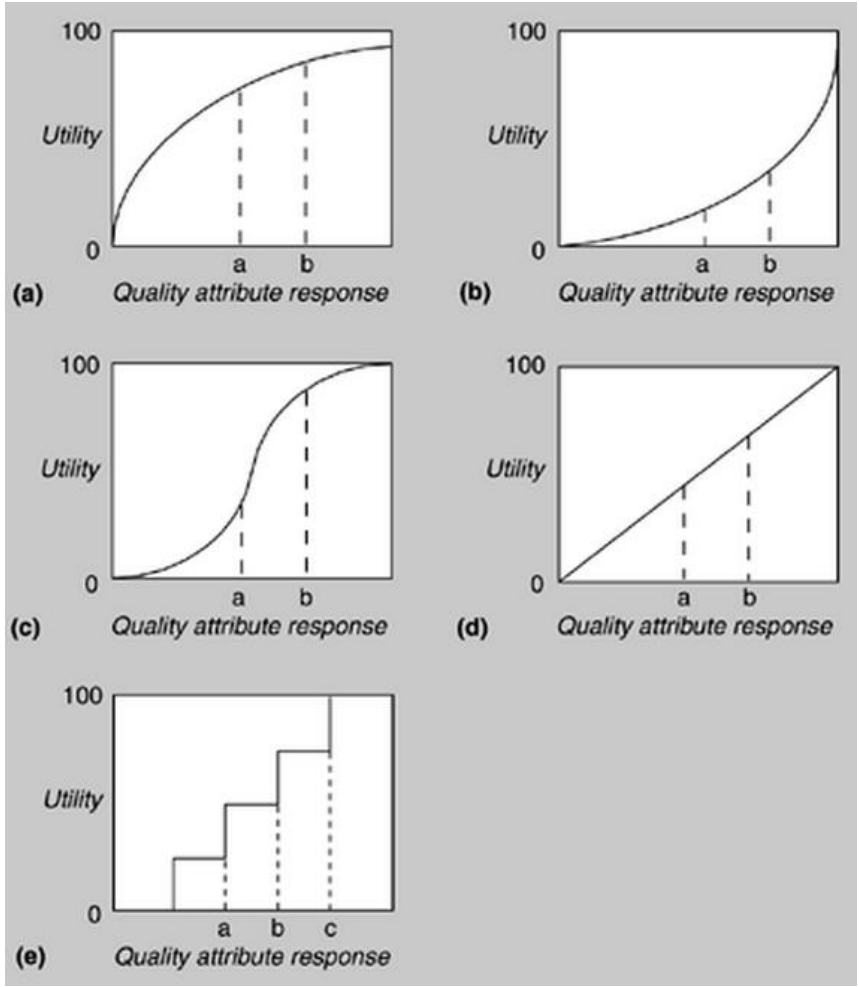
CBAM (Cost Benefit Analysis Method)

- Takes place after ATAM
- Maximize difference between
  - benefit derived from system
  - and cost of implementing the design



CBAM: Utility-Response Curves

- For each quality create a utility-response curve
- Exemple anonymity quality:
  - Case a
    - Response: K-anonymity 1
    - Utility 0
  - Case b
    - Response: K-anonymity 3
    - Utility 50
  - Case c
    - Response: K-anonymity 6
    - Utility 90



CBAM: Some Metrics

- Overall Benefit of an Architectural Strategy
  - B_i: benefit of architectural Strategy i
  - Strategy i described through j scenarios
  - W_j: weight of scenario j
  - b_{ij}: change in utility caused by scenario j: $U_{expected} - U_{current}$
  - $B_i = \Sigma_j(b_{ij} \times W_j)$
- Value for cost (VFC)
  - C_i: cost of implementing architecture Strategy i
  - $VFC = B_i / C_i$

CBAM Steps

- Step 1: collate scenario
  - Choose the top third
- Step 2: refine scenario
  - Worst case, current, desired, best case QA response level for each scenario
- Step 3: prioritise scenarios
- Step 4: assign utility for step 3 scenarios
  - Worst case, Current, Desired, Best Case
- Step 5: identify architectural strategies and associated scenarios. Determine their expected QA response level
- Step 6: Determine the utility of the expected QA response levels by interpolation
- Step 7: Calculate total benefit obtained from an architectural strategy
- Step 8: Select architectural strategy base on VFC (compatible with cost and schedule constraints)
- Step 9: confirm results with intuition

For more information, visit the PRIPARE website:
http://www.pripareproject.eu

Thank you for your attention

QUESTIONS?

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