Architecture Evaluation

Cost Benefit Analysis Method (CBAM)

Overview

Architecture Analysis

- **questioning techniques**
  - what?
    - any project area
    - any state of completeness
  - types
    - questionnaires
      - open questions
        - process
        - product
      - apply to all architectures
    - checklists
      - detailed questions
        - based on experience
        - usually domain-specific
    - scenario-based methods
      - scenario = description of interaction with system from point of view of stakeholder
      - (Quality Attribute Workshops (QAWs))
      - Architecture Tradeoff Analysis Method (ATAM)
      - Software Architecture Analysis Method (SAAM)
      - Active Reviews for Intermediary Design (ARID)
      - Survivable Network Analysis method (SNA)
      - Cost Benefit Analysis Method (CBAM)
    - quality-based methods
      - architectural Software Quality Assurance (aSQA)

- **measuring techniques**
  - what?
    - need artifact to do measures on
    - focus on specific quality attributes
  - types
    - metrics
      - quantitative interpretations
      - based on particular observable measurements
    - simulations, prototypes, experiments
    - automated tools/ADLs
    - adapted techniques
      - Rate-Monotonic Analysis

A set of architectural approaches/decisions/ tactics/… can be applied

– Add a redundant Web server?

– Manage event rate towards Inventory?

– Adhere to standard SQL?

Resources for implementing decisions are finite

– We need to choose?

– Criteria?

Cost Benefit Analysis Method (CBAM)

Economics-based approach to architecture decision analysis
- Benefit of an architectural strategy, Bi
  - Weighted and summed individual utility of strategy
- Cost of architectural strategy, Ri

- Return On Investment (ROI) for each strategy

$$R_i = \frac{B_i}{C_i}$$

- Prioritize based on Ri

May follow an ATAM evaluation
- Uses a number of artefacts produced in an ATAM evaluation
  - Business drivers
  - Scenarios
  - Architectural approaches

CBAM Steps

1: Collate Scenarios

2: Refine Scenarios

3: Prioritize Scenarios

4: Assign Utility

5: Develop Strategies

6: Determine Utility

7: Calculate Benefit

8: Choose Strategies

9: Confirm Results
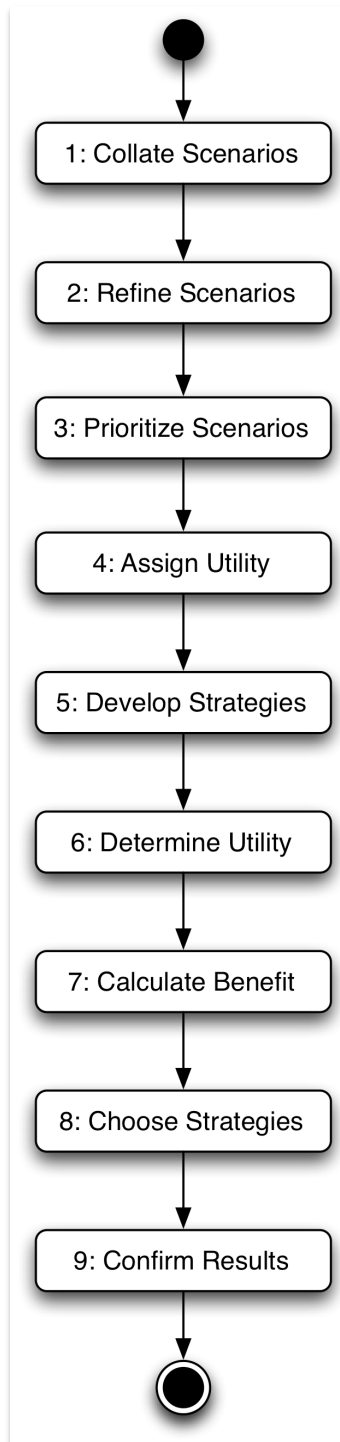
1. Collate Scenarios

– Collect a set of scenarios (e.g., from ATAM)
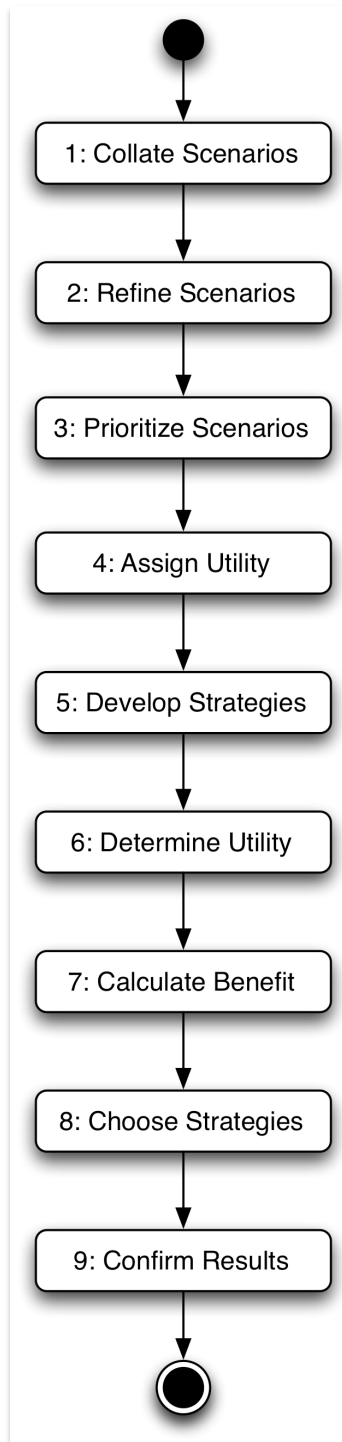– Choose 1/3 based on importance according to business goals

2. Refine Scenarios

– Focus on stimulus-response measures
– Elicit worst-case, current, desired, and best-case response levels for each scenario

3. Prioritize Scenarios

– 100 votes for each stakeholder for scenarios
– Top scenario is assigned weight 1.0 – the rest a weight relative to that

4. Assign Utility

– Determine utility for each quality attribute response level for scenarios
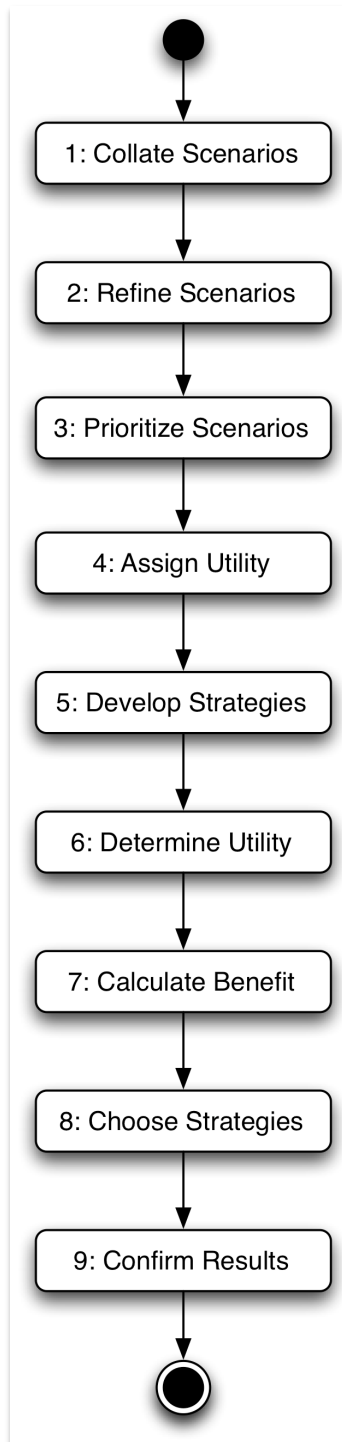
5. Develop Strategies

– Develop strategies that address scenarios

– Determine expected resulting response level

6. Determine Utility

– Determine utility for strategy based on extrapolation

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7. Calculate Benefit

– Normalize utility increase with weights of scenarios to get benefit

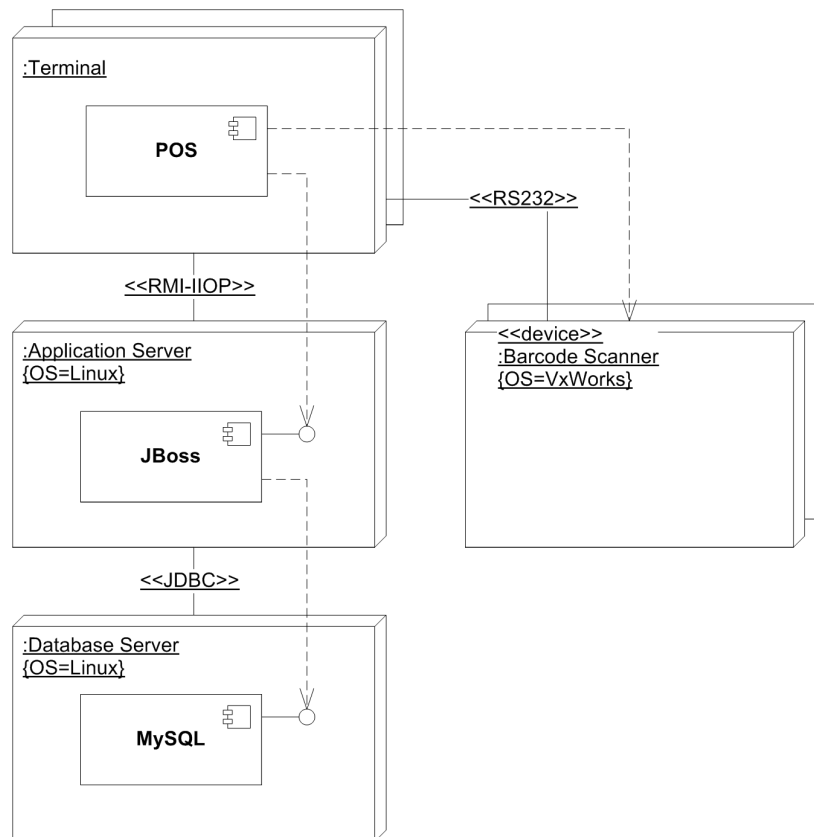– Sum benefits for each scenario to get total benefit of strategy

8. Choose Strategies

– Determine cost and schedule implications of each strategy

– Calculate ROI as a ratio between benefit and cost

– Choose strategies according to rank

9. Confirm Results
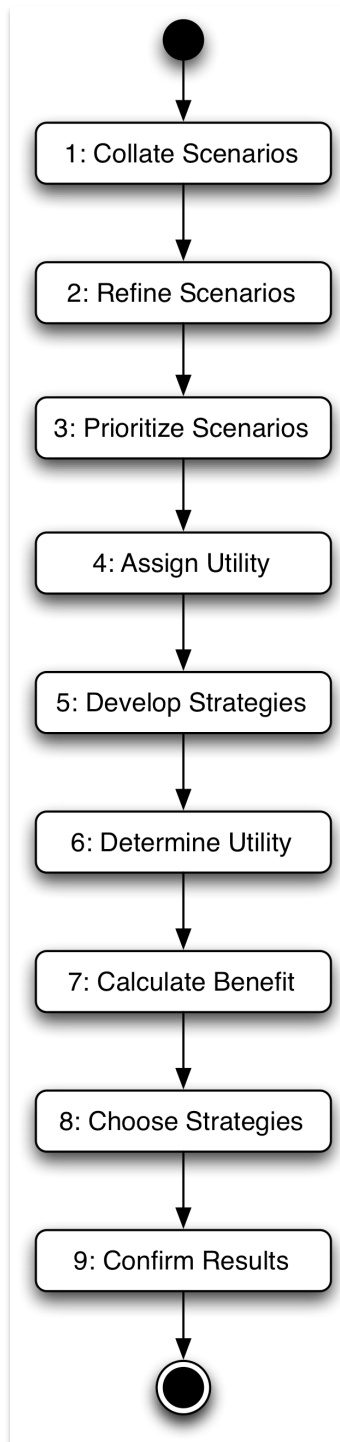
– Consider alignment with business goals

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1. Collate Scenarios

Flowchart:
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| Scenario	Scenario Description
1	The barcode scanner fails; continue in degraded mode
2	The inventory system fails and the failure is detected
3	The POS system should be extended to handle "supermarket" domains as well as "small shop" domains
4	The POS systems scans a new item; item is looked up, price updated

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2. Refine Scenarios

Flowchart (activity diagram):

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- ◉ (end)
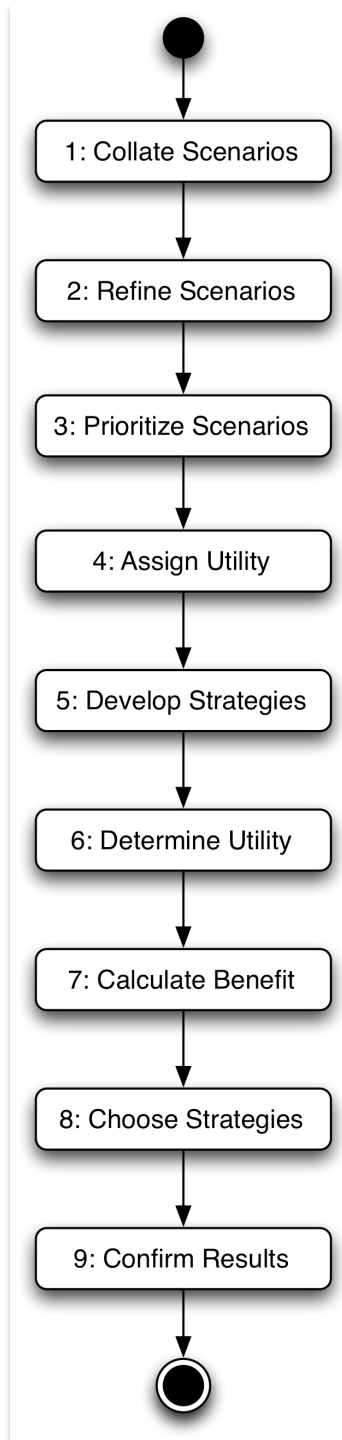
Response Goals				
Scenario	**Worst**	**Current**	**Desired**	**Best**
1	0 sec	0 sec	5 min	60 min
2	Never	Never	3 sec	2,5 sec
3	2 years	1 year	6 months	2 months
4	20 sec	4 sec	2 sec	0,5 sec

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3. Prioritize Scenarios
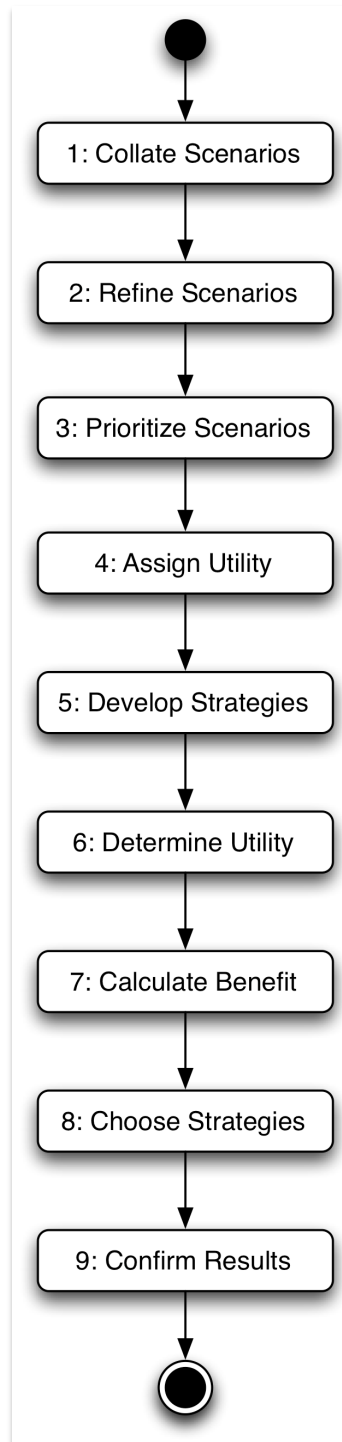
Response Goals					
Scenario	**Votes**	**Worst**	**Current**	**Desired**	**Best**
1	75	0 sec	0 sec	5 min	60 min
2	50	Never	Never	3 sec	2,5 sec
3	100	2 years	1 year	6 months	2 months
4	75	20 sec	4 sec	2 sec	0,5 sec

Activity diagram (left margin):

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4. Assign Utility

Utility Scores					
Scenario	**Votes**	**Worst**	**Current**	**Desired**	**Best**
1	75	10	10	60	100
2	100	0	0	85	100
3	50	10	40	80	90
4	75	0	20	90	100

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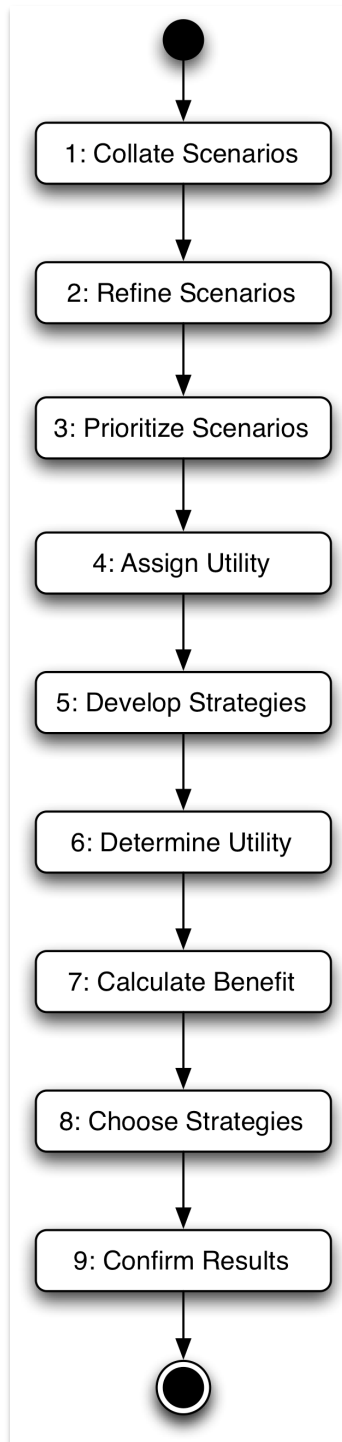
5. Develop Strategies

Strategy	Name	Scenarios Affected	Current Response	Expected Response
1	Heartbeat and cache	1	0 sec	5 min
		2	Never	3 sec
		4	4 sec	1 sec
2	Virtual machine	3	1 year	3 months
		4	4 sec	6 sec
3	Concurrency	4	4 sec	2 sec

Activity diagram:

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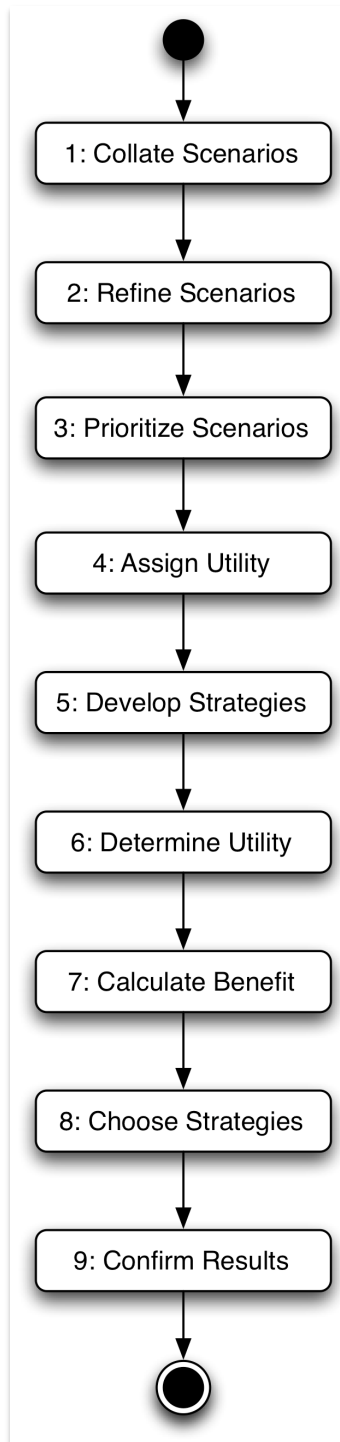
6. Determine Utility

Strategy	Name	Scenarios Affected	Current Utility	Expected Utility
1	Heartbeat and cache	1	10	60
		2	0	100
		4	20	90
2	Virtual machine	3	40	95
		4	20	10
3	Concurrency	4	20	85

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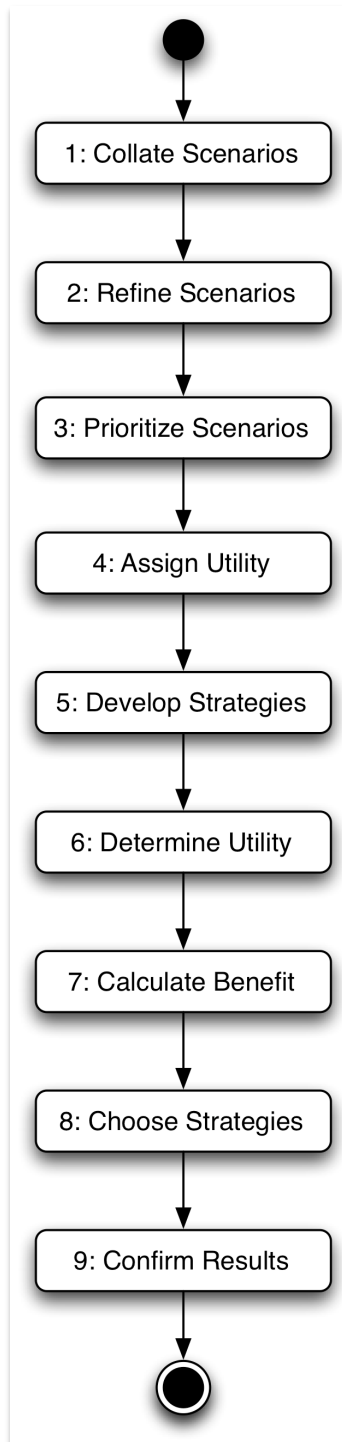
7. Calculate Benefits

Strategy	Scenario Affected	Scenario Weight	Benefit	Normalized Benefit	Total Benefit
1	1	75	50	3750	
	2	50	100	5000	
	4	75	70	5250	14000
2	3	100	55	5500	
	4	75	-10	-750	4750
3	4	75	65	4875	4875

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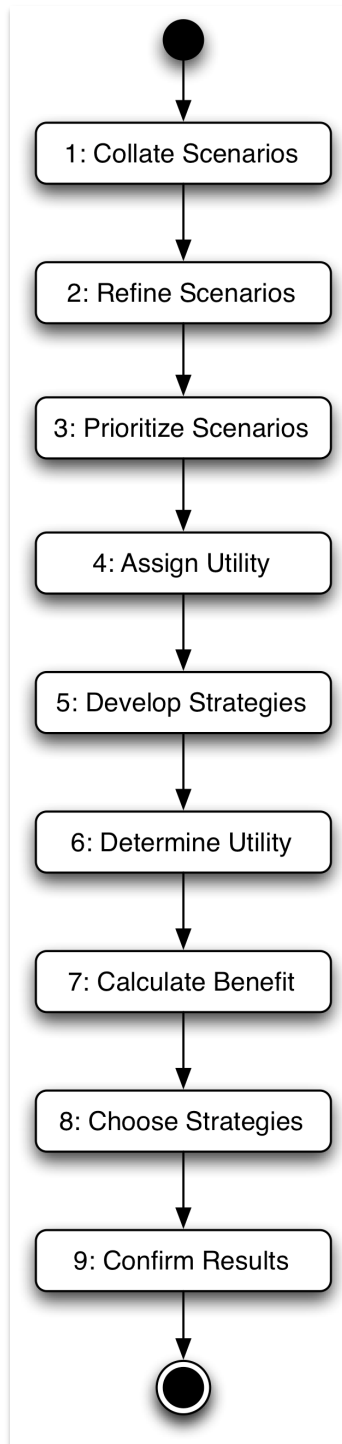
8. Choose Strategies

Strategy	Strategy Cost	Total Benefit	Strategy ROI	Strategy Rank
1	200	14000	70	2
2	1200	4750	3,96	3
3	40	4875	121,86	1

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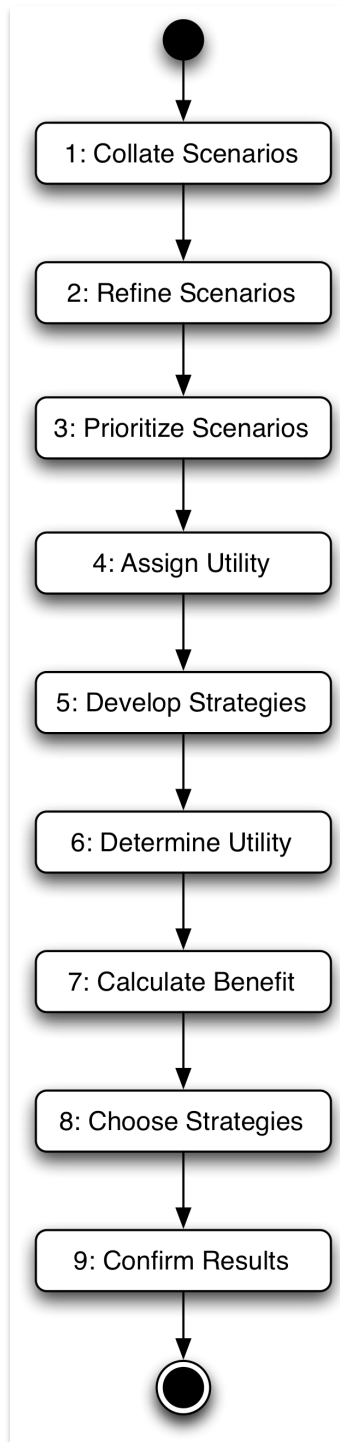
A ranking of design decisions with respect to ROI

Provides support for structured decision making

Side effects

– Discussions of costs and benefits

– Clarification of scenarios and requirements

Summary

Economy-based approach to evaluation of architectural strategies

– Architectural strategy = set of design decisions

Requires

– Business drivers
– Precise scenarios
– Architectural strategies
– Cost model

Result

– Ranking of architectural strategies according to ROI