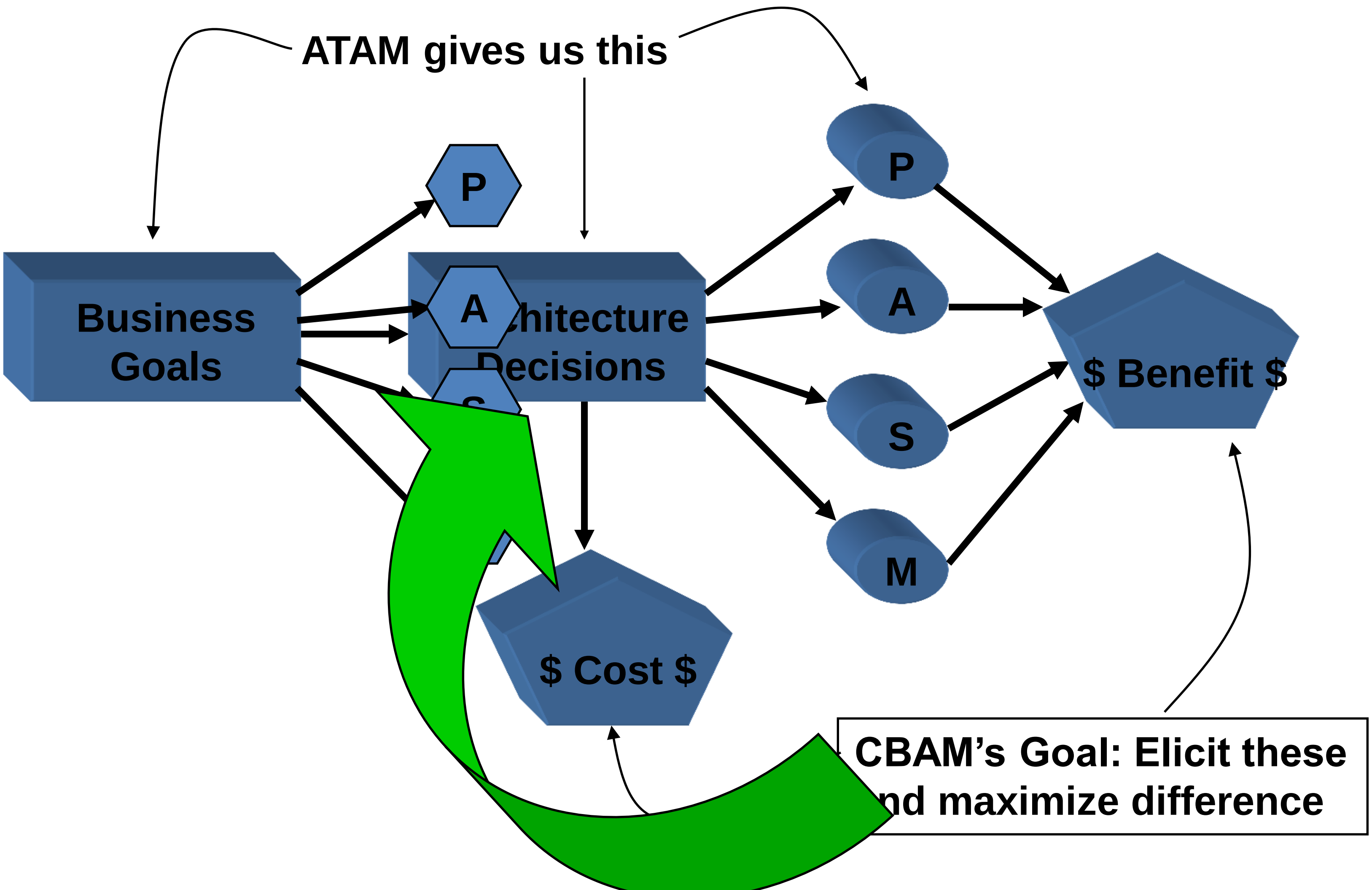
The CBAM

Cost Benefit Analysis Method

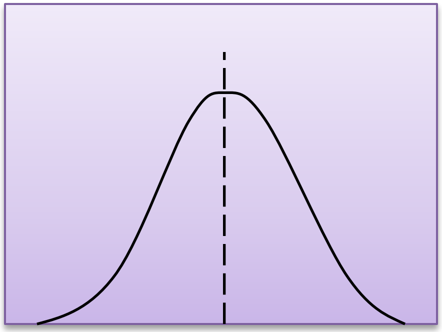
A Quantitative Approach to Architecture Design Decision Making

Context for the Work

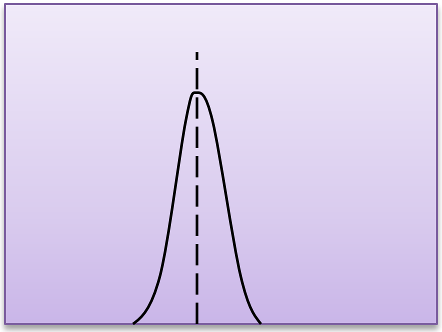


Example

	Design A	Design B
Avg Latency	500 ms.	200 ms.
Availability	99.9%	99%
Cost	3000	2500
Benefit	6000	5000
Profit	3000	2500



3000



2500

The aim of CBAM

1. Each architectural strategy provides specific level of utility (benefit).
2. Each strategy also has a cost and takes time to implement.
3. CBAM, aids in choosing strategy based ratio of benefit to cost.

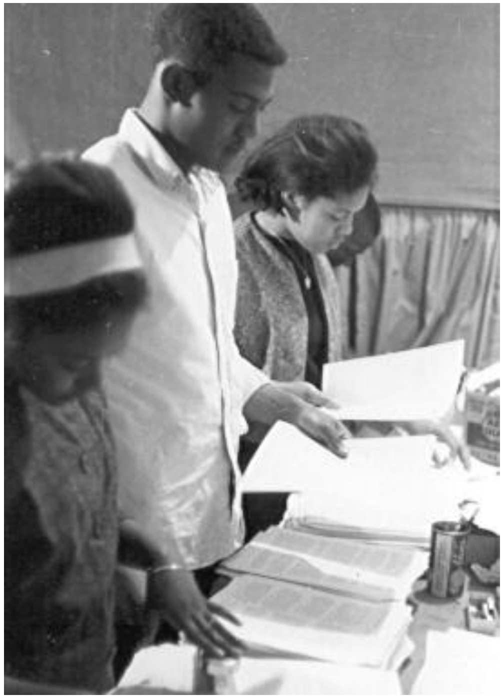
Building Upon ATAM results

1. The system's architecture-level design.
2. The prioritized business goals of the system.
3. The technical and business constraints.
4. A ranking of the scenarios.
5. The identification of the technical architectural decisions that are sources of uncertainty/risk in the existing architecture.

Cost Benefit Analysis Method

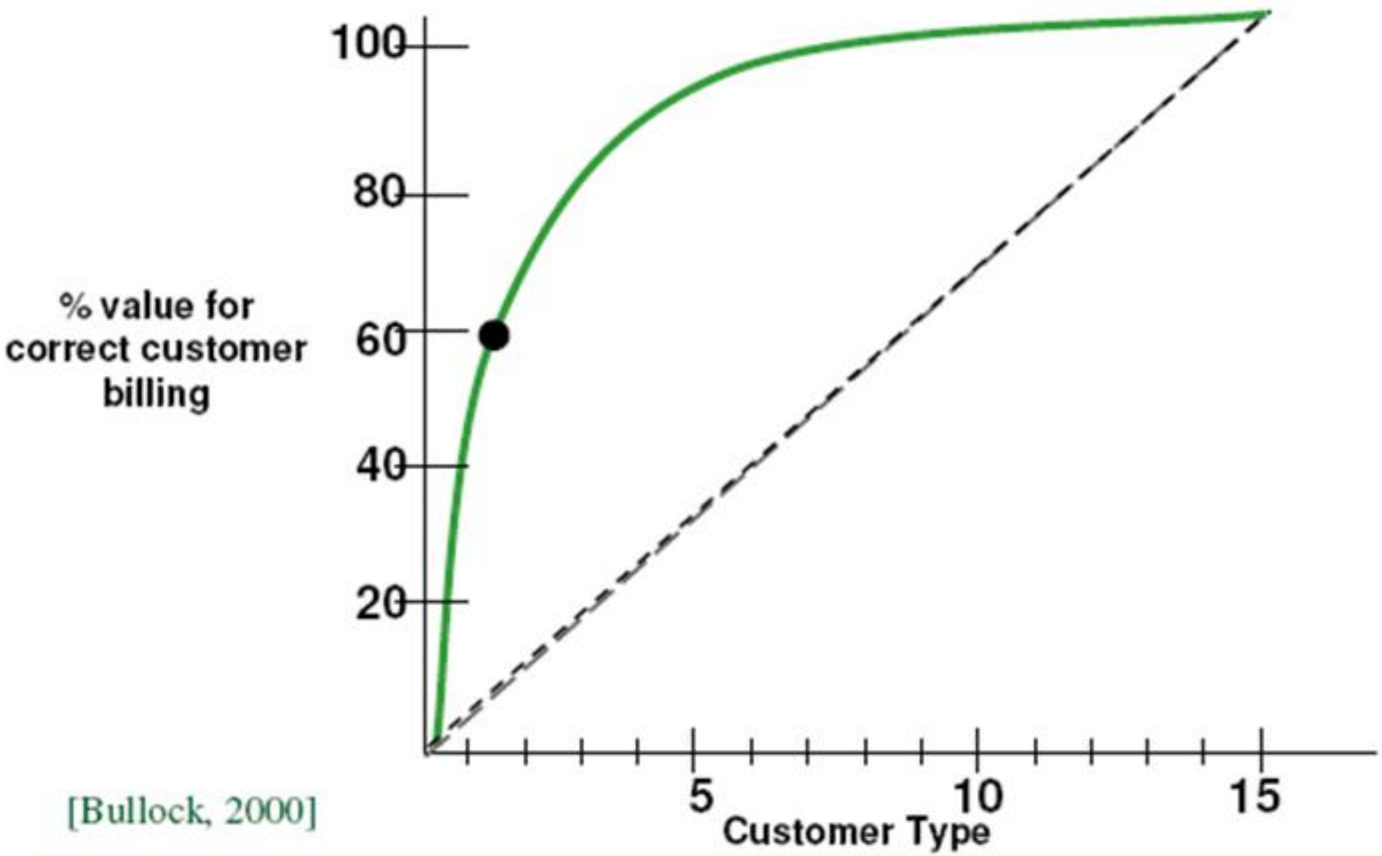
1. **Collate, Refine & Prioritize scenarios**
2. Assign Intra-Scenario Utility
3. Develop architectural strategies & its utility value
4. Calculate an Architectural Strategy’s Benefit & Cost

Collate Scenarios



Collate the scenarios elicited during the ATAM exercise. Prioritize based on satisfying the business goals of the system and choose the top 1/3 for further study. (n/3)

20% of Features Provide 80% of Value



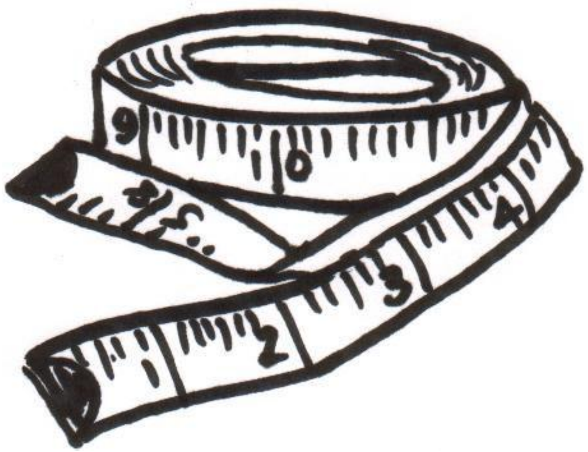
[Bullock, 2000]

Example Collate Scenarios

- S22: After 24 hours of downtime, operations re-prioritizes workload to ensure tasks are worked off in priority order.
  - S/R: System able to re-prioritize 1000 orders in 20 minutes by user class, data types, media type, destination or user (and work off backlog in accordance with these priorities).
- S25: Increase the workload up to and beyond max load. Do not degrade throughput & response time for registered users.
  - S/R: Maintain 24 hour response time for high priority orders while supporting a 2-fold data volume over 90 days without operations intervention.
- S28: Workload from one provider exceeds its rated input. System handles variations in data arrival from with max throughput and minimal operator intervention.
  - S/R: Able to support 2X spike in data volume without operations intervention and work off in priority order.

Refine Scenarios

Elicit the worst, current, desired and best quality attribute (QA) level for each scenario.



Worst Case	Current Case	Desired Case	Best Case
120 min	40 min	20 min	10 min

*F*or S22 Backlog Management; system can re-prioritize 1000 orders in:

Prioritize Scenarios

Allocate 100 votes to each stakeholder and have them vote on the scenarios. Total the votes and choose the top 50% of the scenarios for further analysis. (n/6)

Scenario	# of Votes
22	34
25	18
18	12
36	12
19	10
4	8

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Assign Intra-Scenario Utility

How do we compare the various scenarios?
Convert from technical measures to generic (Utility) measures

Worst Case	Current Case	Desired Case	Best Case
0	80	90	100
120 min	40 min	20 min	10 min

Utility Scores (0: no utility, 100: most utility)

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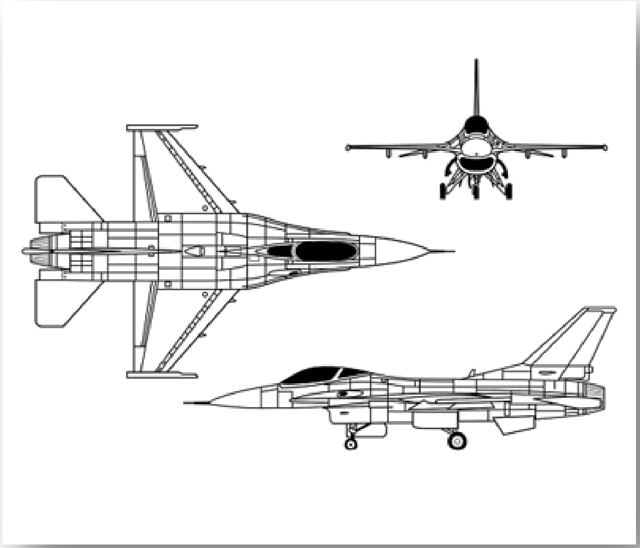
Develop architectural strategies

Scenario	AS
22	RM80
25	RM80
18	RM80
4	RM20
19	RM20
28	RM120
36	RM100

Develop ASs that address the chosen scenarios.



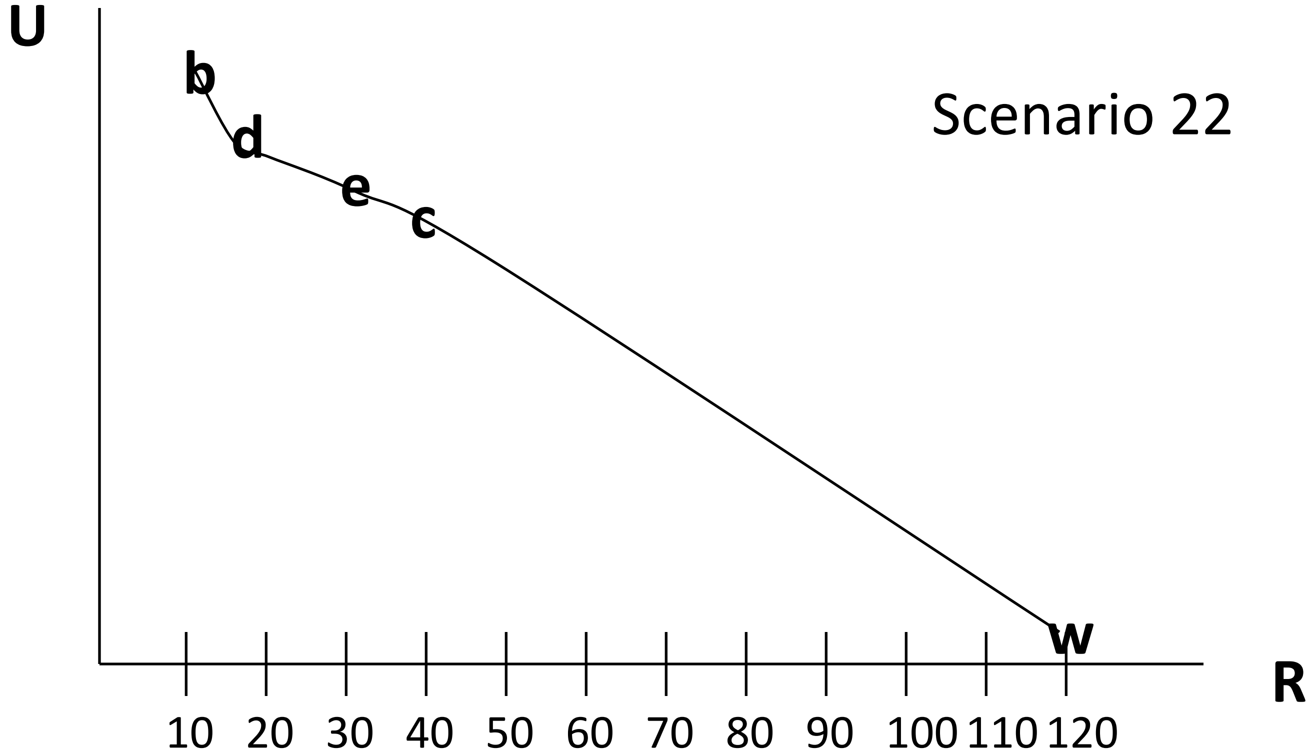
Determine the utility value

Determine the expected response levels that result from implementing these ASs.

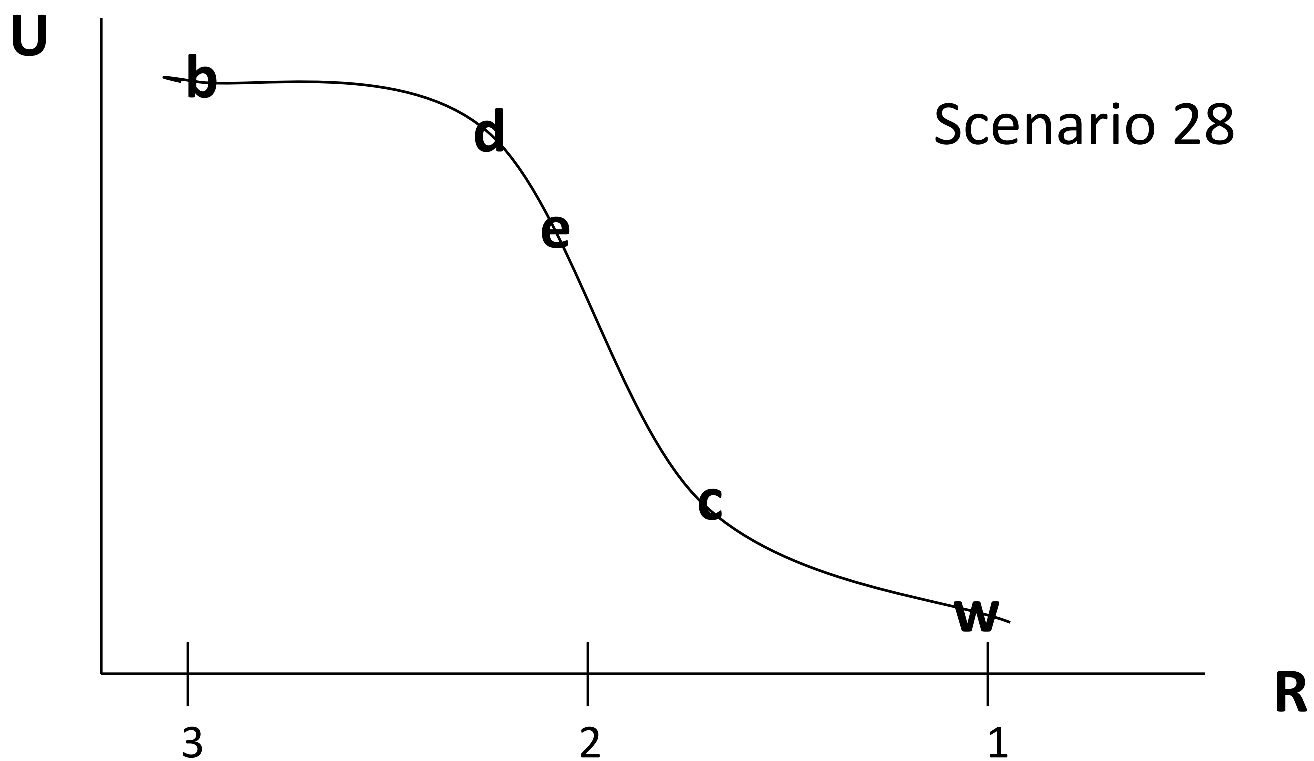
Arch Strategy	Worst Case	Current Case	Expected Case	Desired Case	Best Case
RM80	120	40	32.5	20	10

Utility-Response Graph

Strategy	Worst	Current	Expected	Desired	Best
RM80	120	40	32.5	20	10



Utility-Response Graph



Cost Benefit Analysis Method

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Calculate an Architectural Strategy's **Benefit**

For each scenario where AS_i is used:

- *calculate* the relative improvement in utility as the difference between the 'current' level and the 'expected' level.
  - **benefit = $\text{Utility}_{expected}$ - $\text{Utility}_{current}$**
- *normalize* this benefit amount using the votes collected in step 1
  - **Normalized benefit = benefit x Weight**
- *sum* these normalized values
  - **Total Benefit = Sum(Normalized benefit)**

Calculate an Architectural Strategy's **Benefit**

AS	Scenario	Benefit	Votes	Normalized Benefit	Total Benefit
RM80	22	7.5	34	255	
RM80	25	8.0	18	208	
RM80	18	3.75	12	45	508
RM20	4	5.0	8	40	
RM20	19	16.5	10	165	205
RM120	28	31.0	6	186	186
RM100	36	12.0	12	144	144

Calculate an Architectural Strategy's **Cost & Schedule**

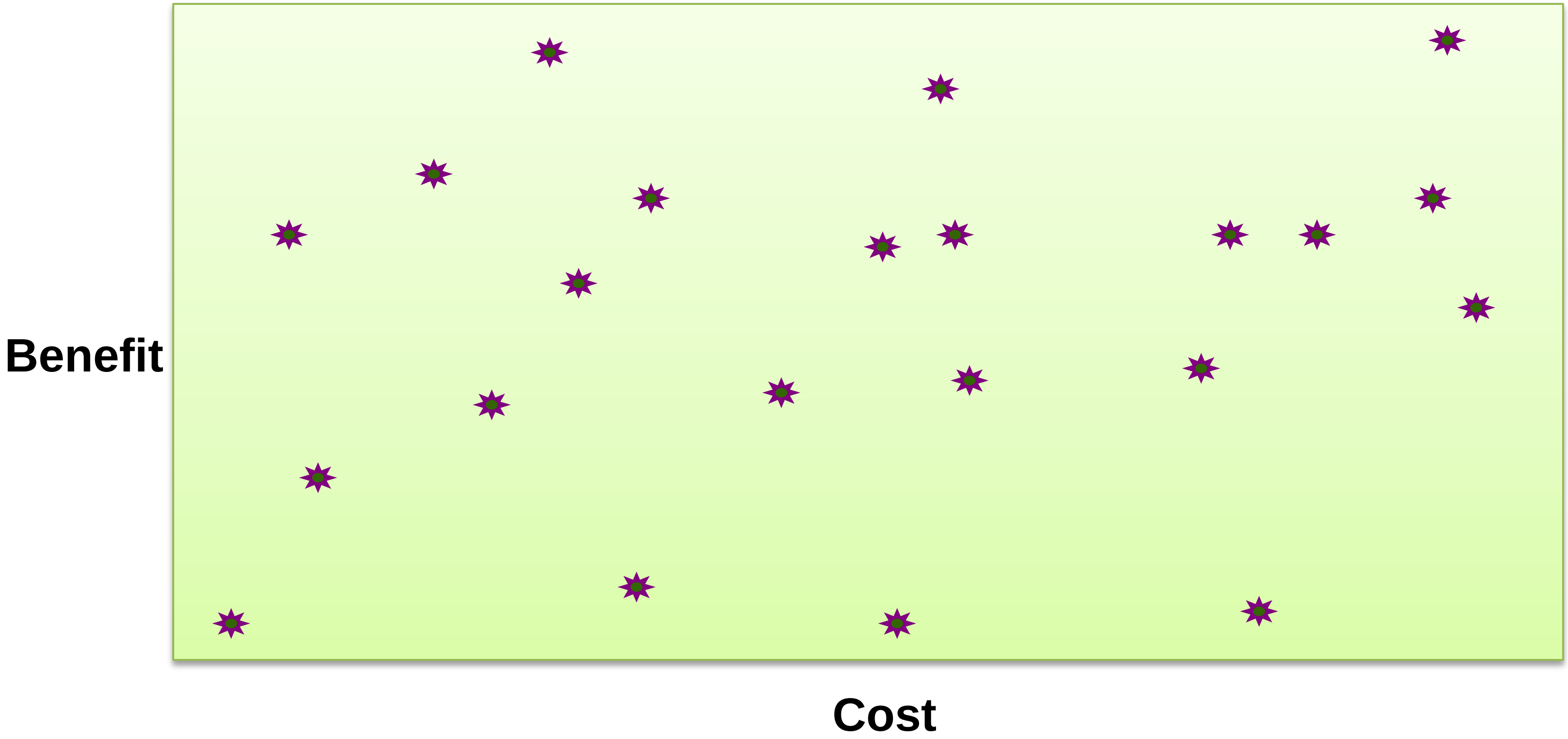
AS	Benefit	Cost (Person months)	ROI $R_i = \frac{B_i}{C_i}$
RM80	508	120	4.83
RM20	205	40	5.12
RM120	186	85	2.19
RM100	144	110	1.31

Rank Architectural Strategy's

AS	Benefit	Cost	ROI	Rank
RM80	508	120	4.83	2
RM20	205	40	5.12	1
RM120	186	85	2.19	3
RM100	144	110	1.31	4

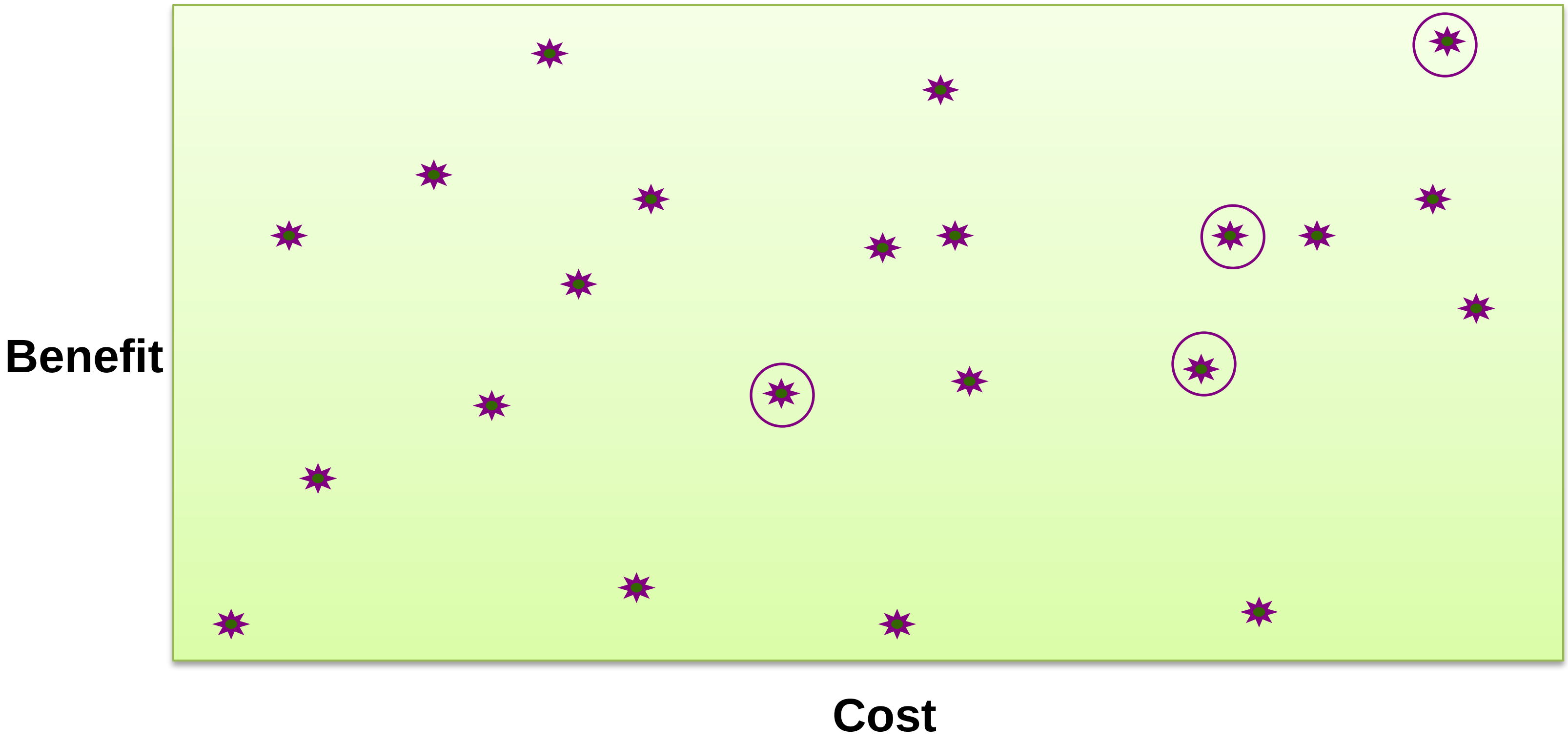
Make Decisions

The benefits and costs can now be plotted.



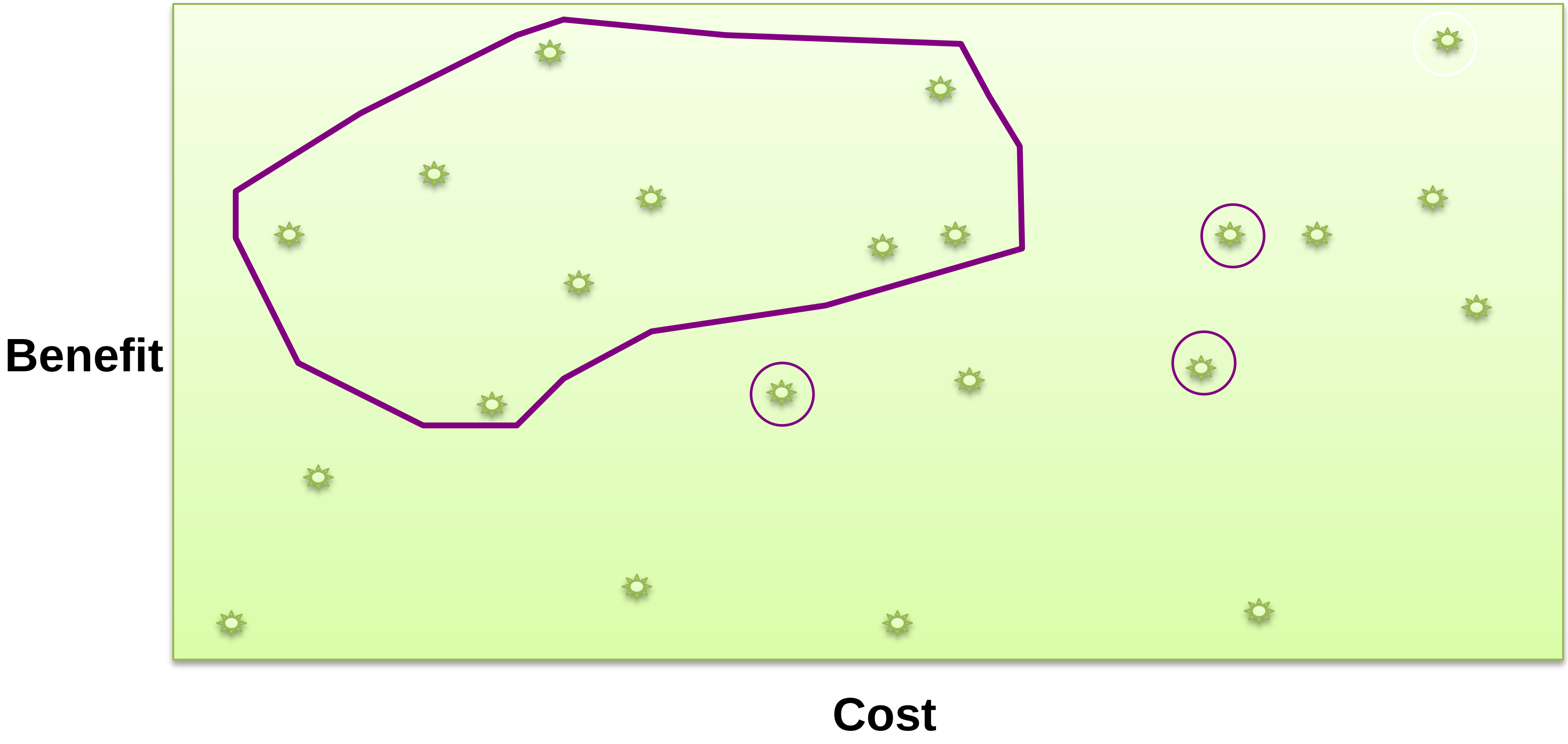
Make Decisions

Some ASs *must* be chosen. Remove these from consideration.



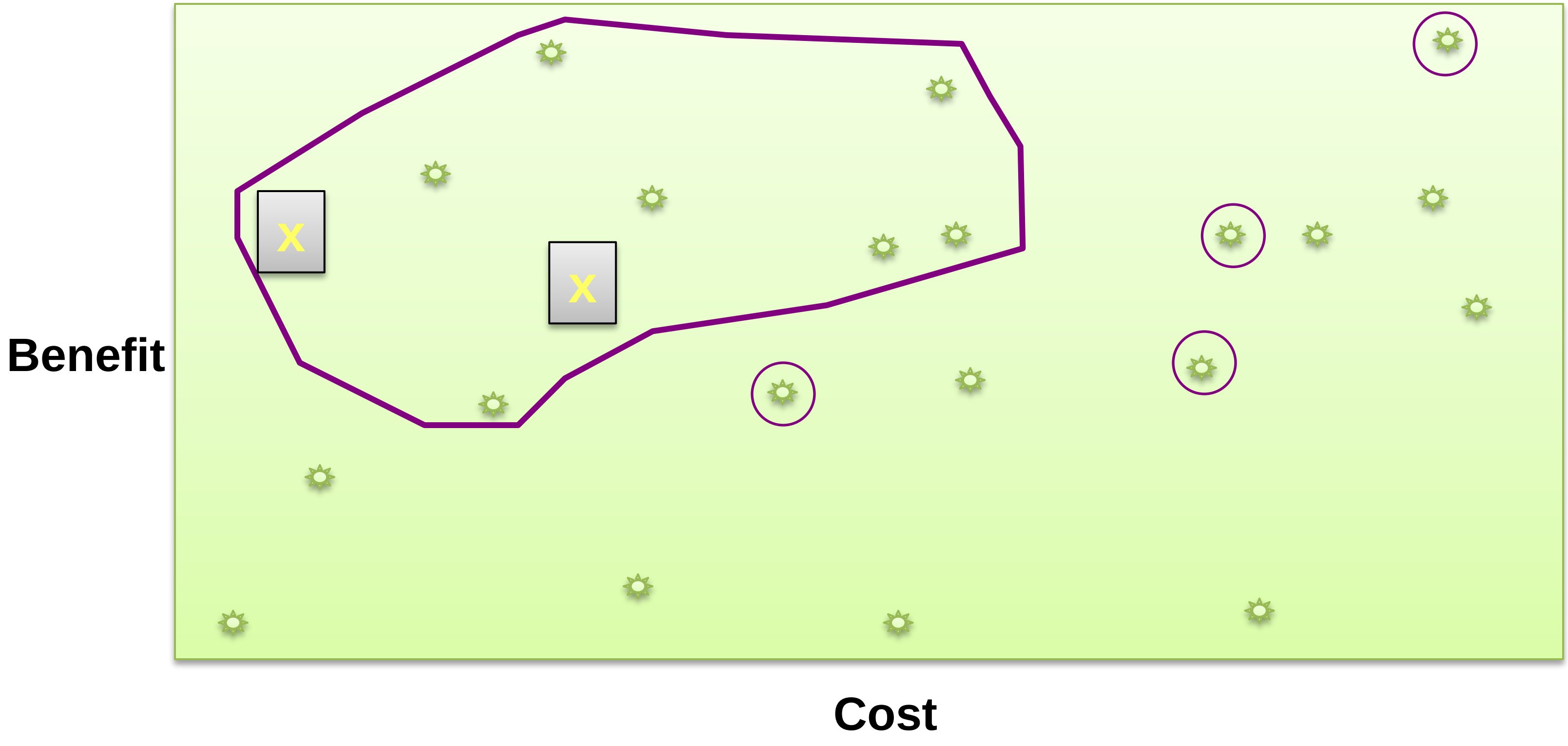
Make Decisions

Now consider the set of high benefit, low cost ASs.



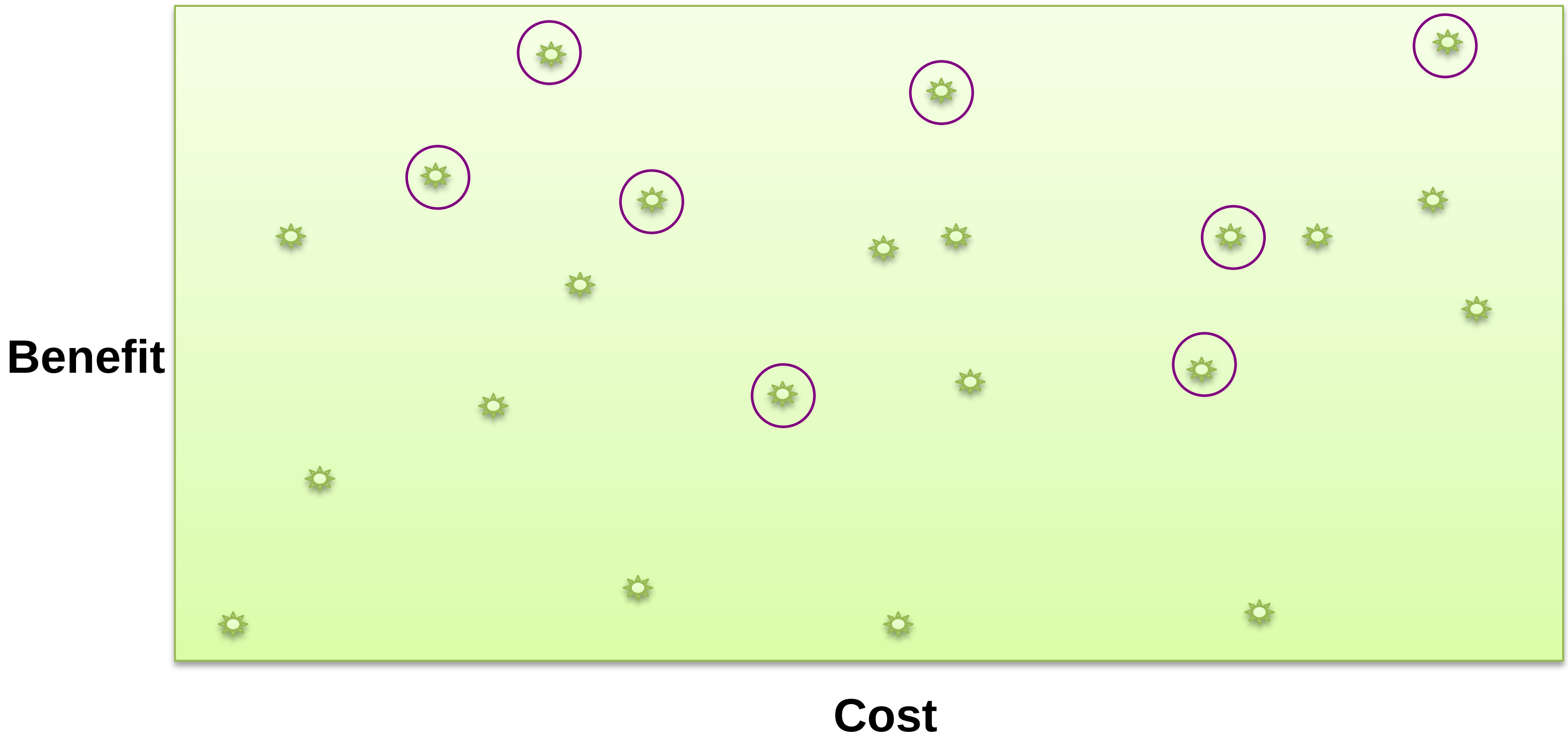
Make Decisions

Some of these may be excluded because of resource or time-to-market conflicts.



The Final Result

Choose a final set. Some decisions may be in/excluded because of dependencies.



Cost Benefit Analysis Method

1. Collate scenarios (N)
2. Refine scenarios (N/3)
3. Prioritize the scenarios (N/3)
4. Assign utility (N/6)
5. Develop architectural strategies
6. Determine the expected utility value
7. Calculate total benefit
8. Choose architectural strategies
9. Confirm results with intuition

Case study: The NASA ECS Project

- NASA's EOSDIS (Earth Observing System Data Information System) project, an enormous Web based scientific information system:
  - **1.1 million lines of custom code**
  - **12,000 modules**
  - **50 COTS products**
  - **http://eospso.gsfc.nasa.gov/**

- The EOS is a constellation of satellites that gathers data about the earth for the U. S. Global Change Research Program.