Metric-Oriented Quality Model (MoQaMo) For Architecture Tradeoff Analysis Method (ATAM)

Presented by

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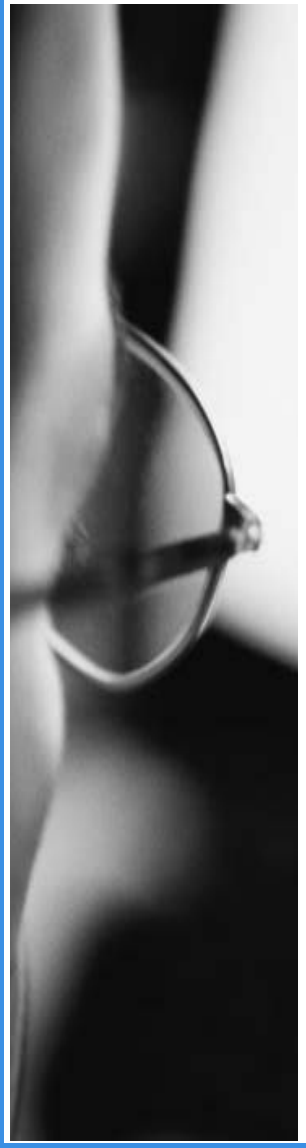
Agenda



- Introduction
- Literature Survey
- Problem Definition
- Conceptual Model
- Application of MoQaMo Model to Case Study
- References

Introduction

- Quality & Quality Model: A quality model represents an interaction between a set of characteristics and sub-characteristics and serves as a foundation for specifying quality requirements for assessing quality [2].
  McCall , Boehm and ISO are the examples of Quality Models.

- Current Research observes:

  - Current research observes lack of proper guidelines; standard and a well defined approach in generation of quality attributes utility tree.

  - Architectural evaluation methodology (ATAM) proposed by Software Engineering Institute, Carnegie Mellon University needs to be improved.

  - Software architectural evaluation methods are not sufficiently producing complete, accurate and verifiable results to support architectural decisions.

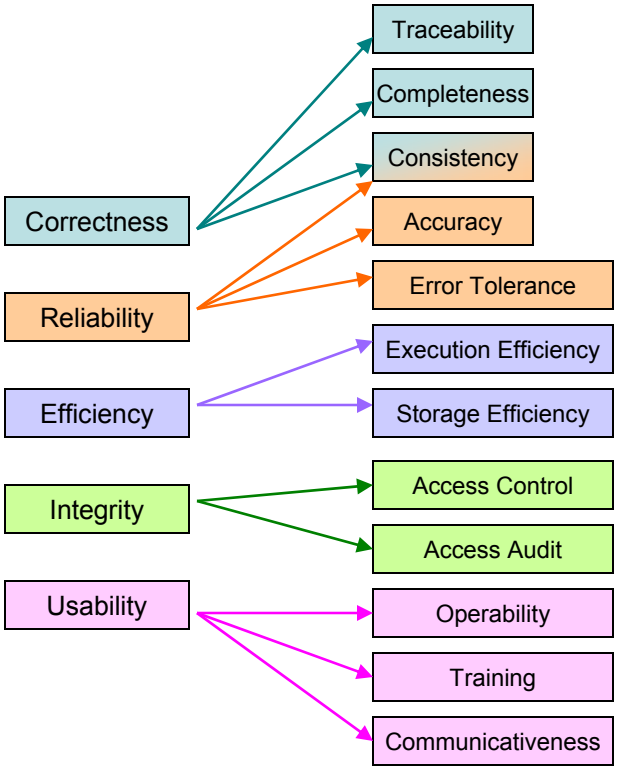
- We have proposed a quality model to cover above points

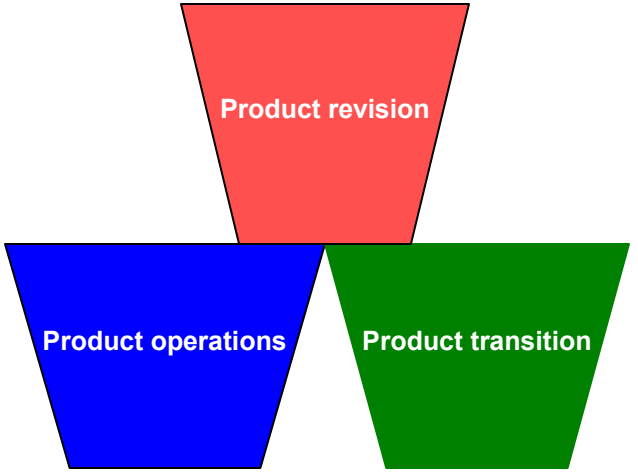
McCall Quality Model. (1977)

Back

- Focuses on the three perspectives for defining and identifying the quality of software product.

(i) Product Revision (ii) Product Operation (iii) Product Transition

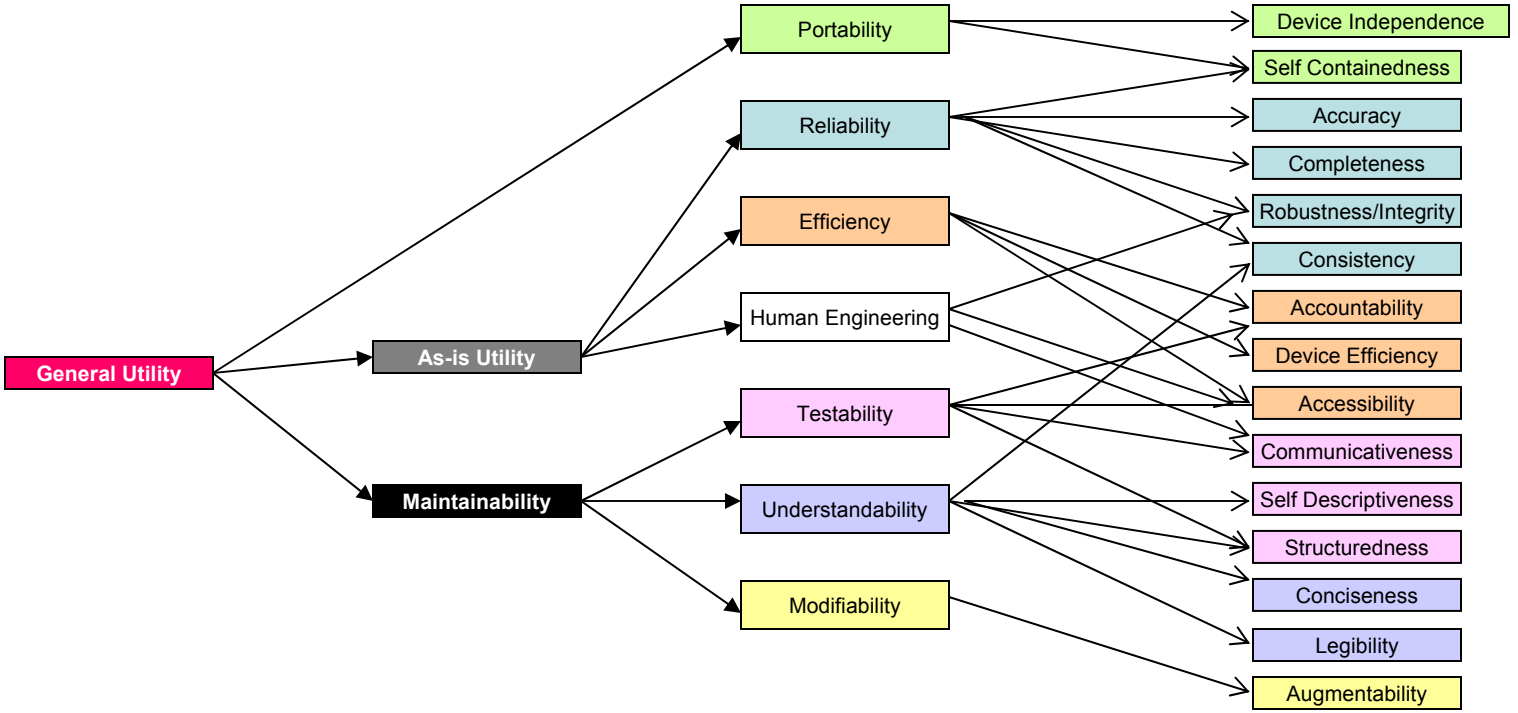




Boehm Quality Model (1978)

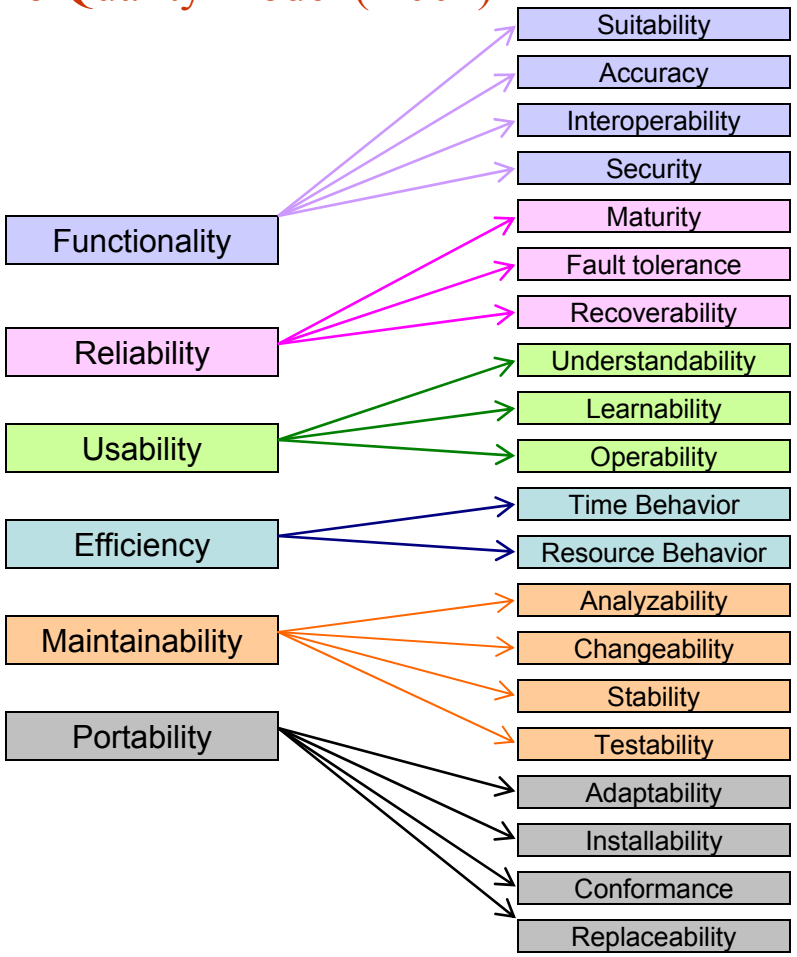
Back

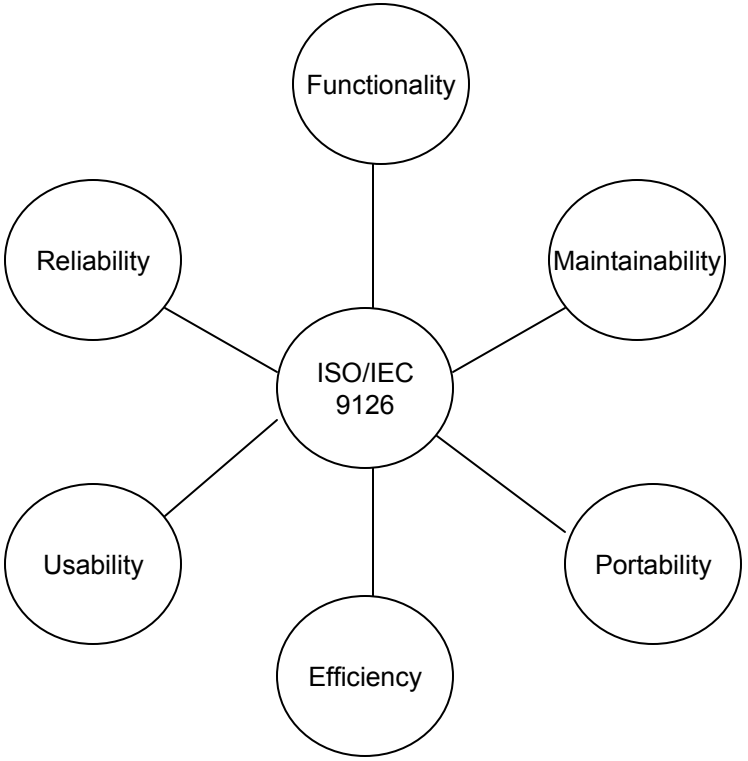
It also presents a hierarchical quality Model structure around high-level characteristics, intermediate level characteristics and primitive characteristics.



Boehm Model does not give any suggestion about measuring the quality characteristics, so we observe that there is an absence of coordination among metrics, sub-characteristics and super characteristics

ISO 9126 Quality Model (2001)





Maryoly O et all (2002) states that the downside of this model is as how these aspects can be measured [13].

Losavio F et al. (2003)

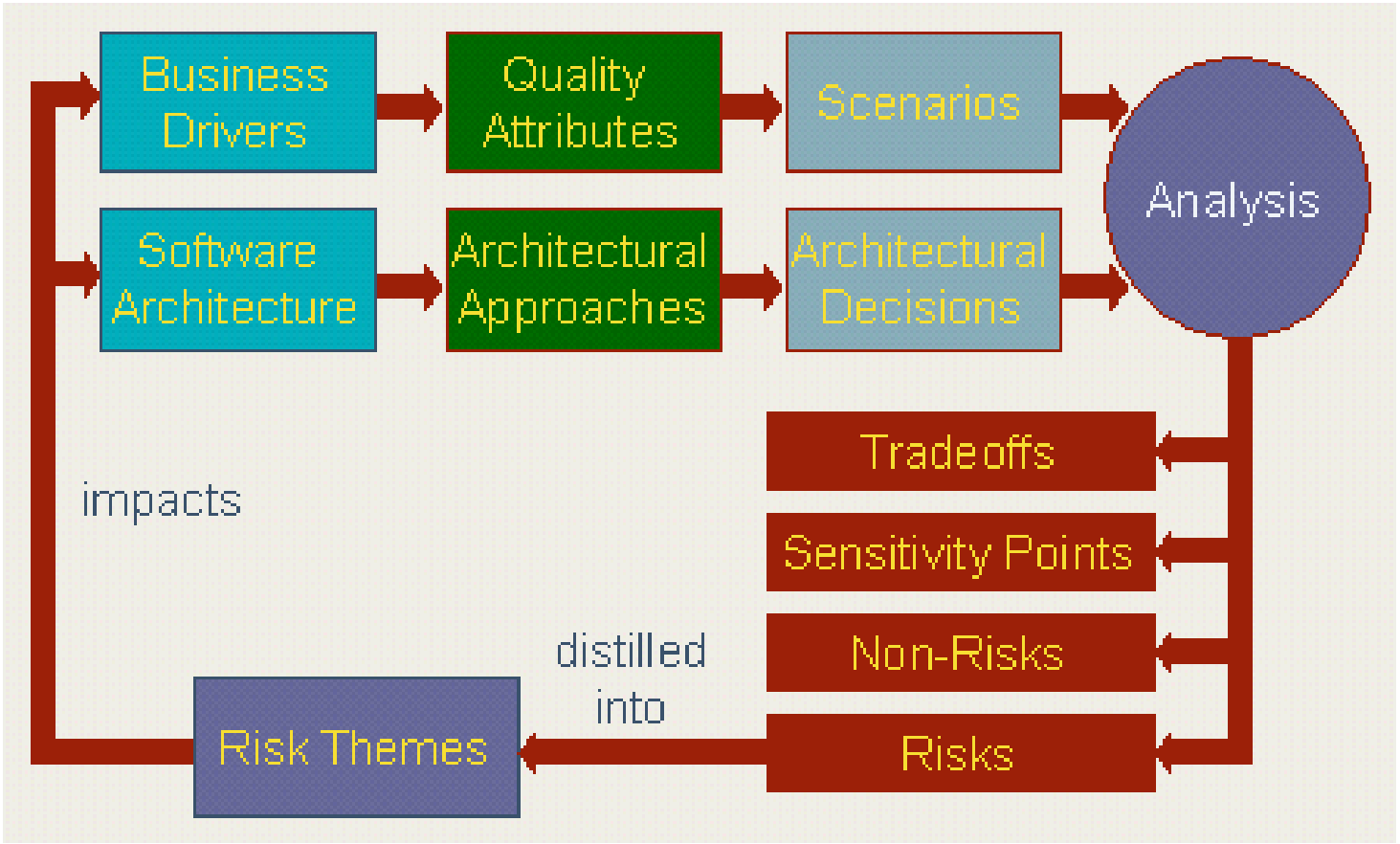
The main goal of Losavio's work is to propose an ISO 9126-1 based technique to specify the relevant quality characteristics, refined until the attribute level or measurable items, involved in the architectural design process [5].

Victor B et al (1980)

GQM is a top-down approach to establish a goal-driven measurement system for software development

- the team starts with organizational goals,
- defines measurement goals
- poses questions to address the goals
- identifies metrics that provide answers to the questions.

Architecture Tradeoff Analysis Method (ATAM)



Conceptual flow of the ATAM

Problem Definition

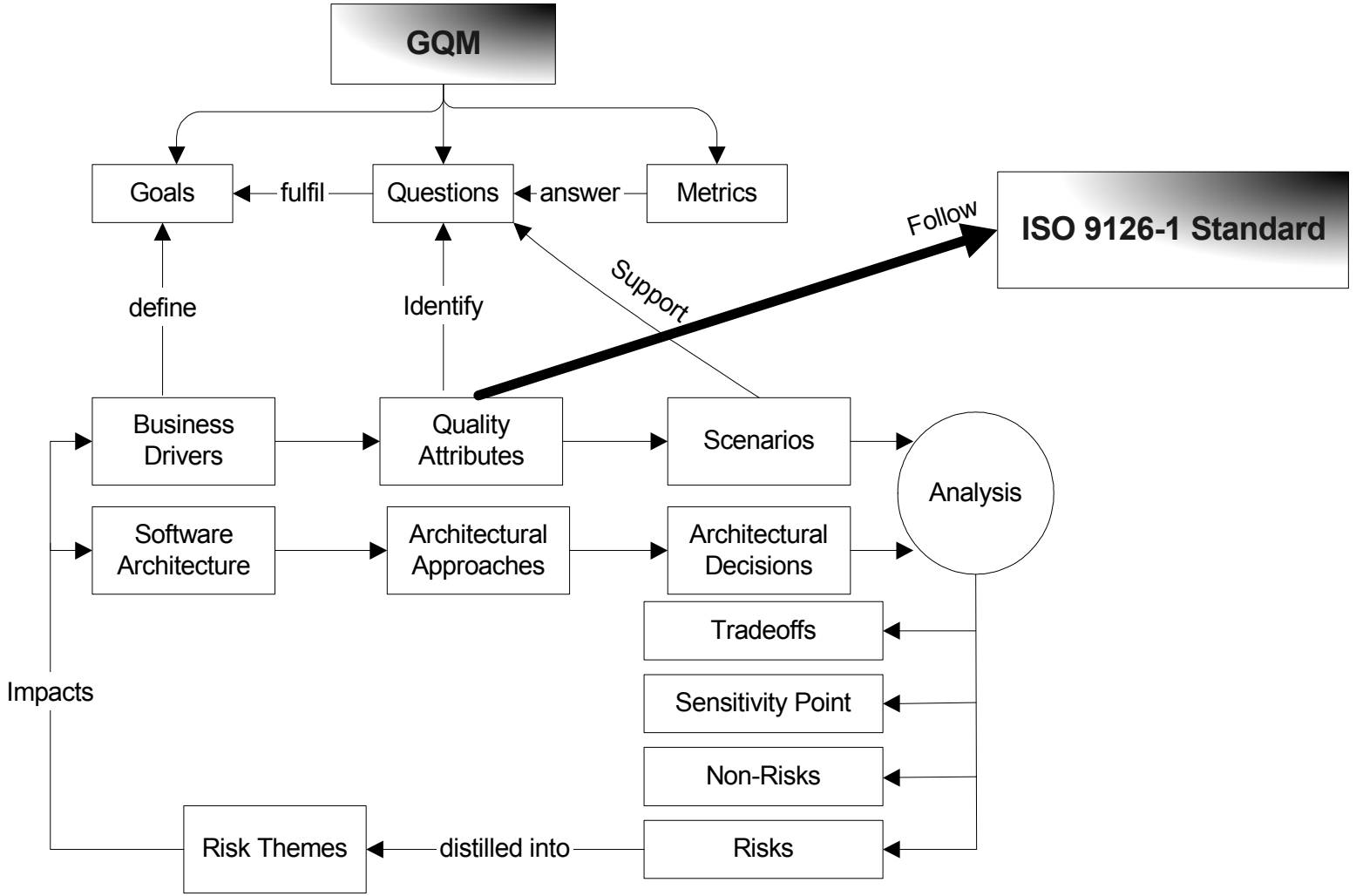
- ATAM (Architecture Tradeoff Analysis Method) uses one level of quality characteristics. However there is not any specific guideline to define the utility tree.

- Expression of quality view and the reason for one level of refinement is ambiguous [5]. Attributes defined in the utility tree are measured in terms of stimuli, parameters and responses [15].

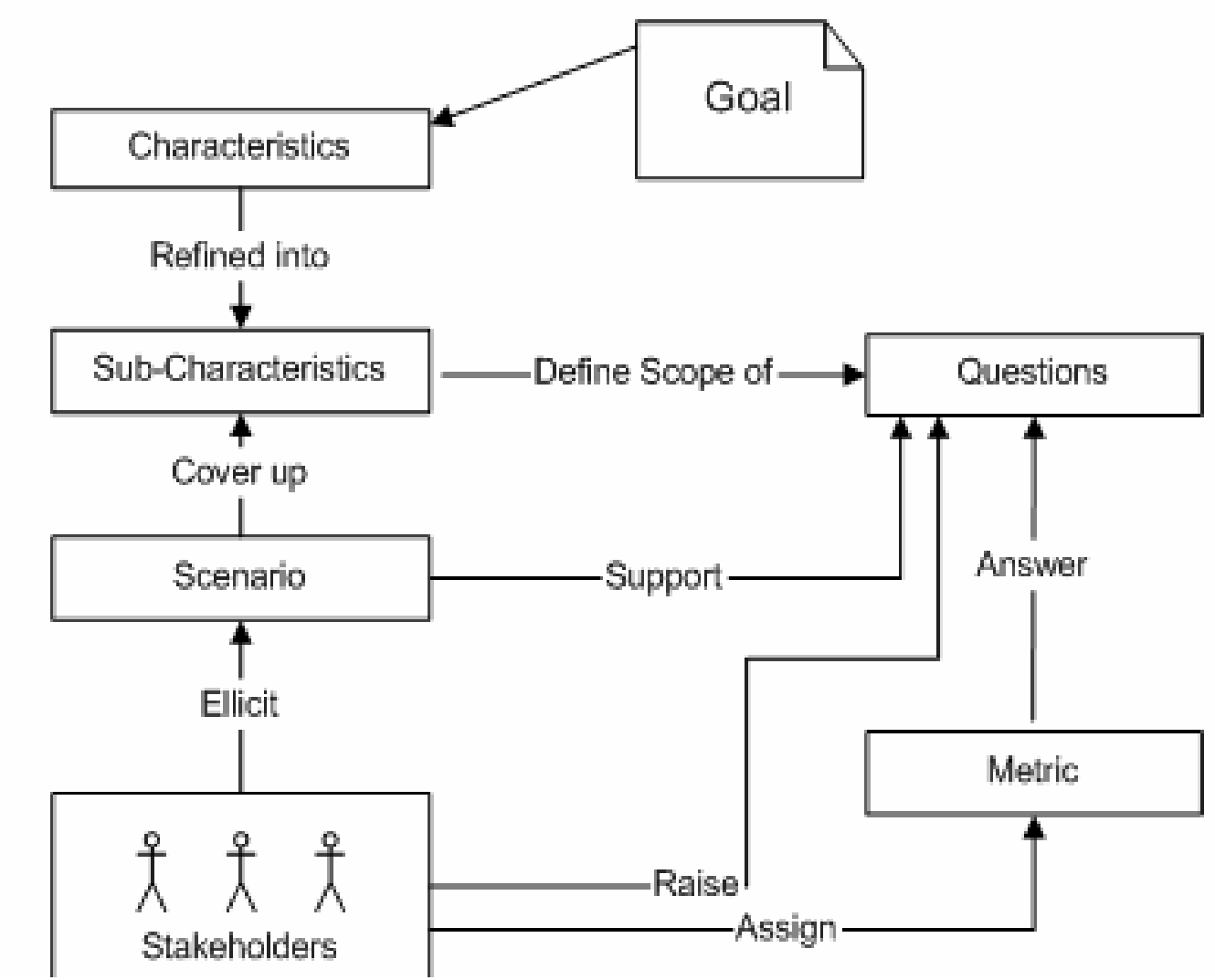
- After having a utility tree, we see that there is a lack of coordination among quality characteristics; their refined attributes and resulting scenarios which also attempt to specify measure to attributes.

- According to SEI Software Architecture Technology User Network (SATURN) Workshop April 25-26, 2006 [14], it is found difficult to come up with a quality attribute utility tree. Furthermore, its preparation is time consuming and tedious. Without clear guidelines, there occurs obstacles in building up such a tree.

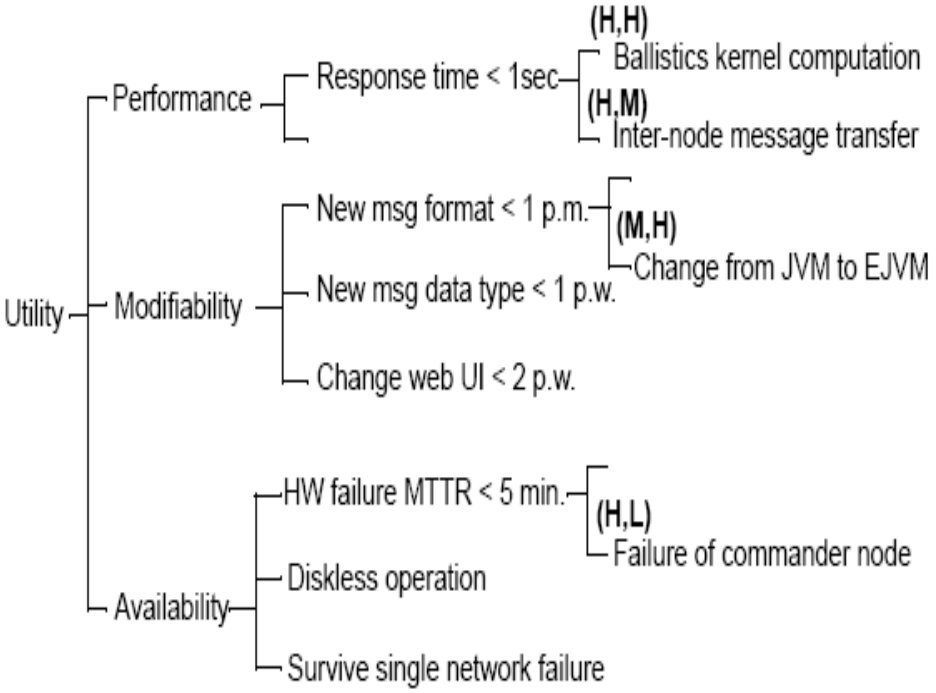
MoQaMo (Conceptual Model w.r.t ATAM)



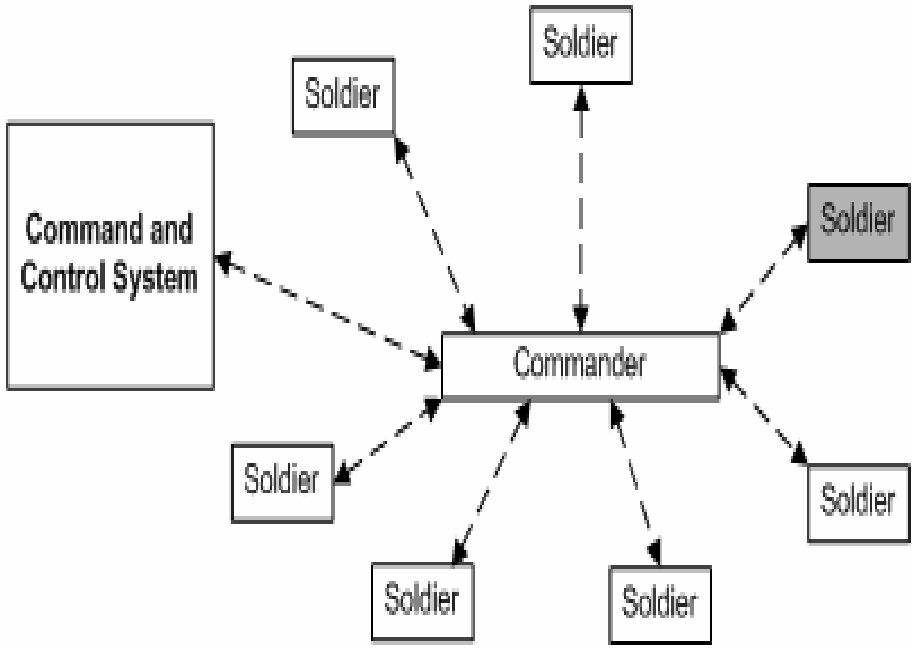
MoQaMo (Conceptual Model w.r.t GQM)



Case Study- Battlefield Control System (BCS)



A Portion of BCS Utility Tree



A System View of BCS

Characteristic/Goal	Increase the *Reliability* of the System from an evaluation team's viewpoint.		
Sub-Characteristics	Recoverability/Availability	Maturity	Fault-Tolerance
Availability			
S-1	*Failure of the commander node. (H,H)*		
Q-1	What is the failure rate of the commander?		
M-1	Unknown		
Q-2	What is the repair rate of the commander?		
M-2	10 sec		
Q-3	What is the repair rate of the backup?		
M-3a M-3b	5 min 300 sec		
Q-4	What is the number of backup soldiers in current battlefield?		
M-4	24		
Q-5	What is the number of acknowledging backups and passive backups?		
M-5	15 acknowledging backups and 9 passive backups		
Q-6	How is the failure of the commander detected?		
M-6	The backup soldier has employed "Pull Heart Beat" mechanism to see the health status of the commander.		
Q-7	Which availability tactic is used to achieve Availability?		
M-7	"Fail Over Cluster Pattern"		

High-Level Quality Characteristic (Goal): Reliability
Quality Attribute: Recoverability/Availability
Scenario S1 (Failure of the Commander node)
Stimulus: Commander Death
Downtime: 10 sec (M2)
Number of Acknowledging backups = 15 (M-5)
Number of Passive Backups = 9 (M-5)
Repair Rate of the Backup = 300 sec (M-3b)

Architectural Decisions	Risks	Sensitivity Points	Tradeoff Points
Failover Cluster (M-7)		S1	
Pull Heart Beat (M-6)		S2	T1
Ping/Echo			T2
Hot Standby (M-8)		S4	
Transaction Log	R1		
Backup Network Channel (M-10)	R2		
Acknowledging Backups	R3	S6	
Passive Backups		S7	

Risks, sensitivity and tradeoff points

R1	The transaction log mechanism, which requires the commander to update its status in its own database, is a risk if commander fails, as its status would also be lost.
R2	The shared communication channel between commander and soldiers is a major risk in case of communication channel breakdown.
R3	A high number of acknowledging backups can negatively affect availability due to high resource demands (high communication bandwidth could result in system hang status)
R4	The transaction log mechanism though would tend to improve efficiency by reducing message transmission within nodes but it is a risk if commander fails, as its status would also be lost.
S1	Failover cluster pattern is aimed to achieve the availability. This involves switching of a backup soldier to the commander.
S2	Pull HeartBeat mechanism requires the backup soldiers to monitor the status of the commander periodically.
S4	Hot Standby technique gives the availability of commander's state in real-time manner.
S6	Acknowledging and passive backups assure availability as these support multiple backups switchover to show a high state of readiness.

Benefits

- Architecture Evaluation Method (ATAM) will be based on a Quality model.
- The model highly supports the involvement of stakeholders. A clear exploration of users' requirements in different contexts helps to approach right software architecture.
- Architecture Evaluation process following MoQaMo model is easily understood, manipulated and applied in different teams as well as different organizations.
- The model allows producing objective and subjective metrics.
- Architecture Tradeoff Analysis Method (ATAM) following MoQaMo model gives the right set of architectural decisions and hence resulting in quality product.
- Quality of a software product can be assured at a very early stage of software development life cycle.

References

(I of 2)

1- Kazman R., Klein M., Clements P. “ATAM: Method for Architecture Evaluation” (2000), C MU/SEI-2000-TR-004,ESC-TR-2000-004

2- Khosravi K., Gu´eh´eneuc, Y. “On Issues with Software Quality Models”(2005), 19th European Conference on Object-Oriented Programming SECC

3- Bosch J. “Design and Use of Software Architecture”(2000), ACM Press, Harlow, England

4- Dobrica L., Niemela E., “A Survey on Software Architecture Analysis Methods”(2002), IEEE Transactions On Software Engineering

5- Losavio F., Chirinos L., Lévy N., Ramdane-Cherif A. “Quality Characteristics for Software Architecture”(2003), Journal Of Object Technology

6- ISO/IEC 9126 Software engineering – Product quality Part1: Quality model, International Organization for Standardization, June 2001.

7- ISO/IEC FCD 9126-1.2: Information Technology – Software Product Quality. Part 1: Quality Model, draft (1998).

8- Khosravi K, Guéhéneuc Y., “A Quality Model for Design Patterns. Technical report 1249, University of Montreal, September 2004.

9- Barbara K, Shari Lawrence P., “Software quality: The elusive target. IEEE Software, 13(1): 12{21}”, January 1996.

10- KAN Stephen H., “Metrics and Models in Software Quality Engineering”(2003) , Pearson Education Singapore

11- McCall, J. A., Richards, P. K., and Walters, G. F., "Factors in Software Quality", Nat'l Tech. Information Service, no. Vol. 1, 2 and 3, 1977

12- Boehm, B, W., Brown, J. R., Kaspar, H., Lipow, M., McLeod, G., and Merritt, M., “Characteristics of Software Quality”, North Holland, 1978.

References

13- Maryoly O, Maria A. Perez, Teresita R. “A systemic quality model for evaluating software products”. Laboratorio de Investigacin en Sistemas de Informacin, 2002.

14- Boucke N, Holvoet T, Lefever T, Sempels R, Schelfthout K, Weyns D, Wielemans T, “AVG case study Applying the Architecture Tradeoff Analysis Method (ATAM) to an industrial multi- agent system Application”, SEI Software Architecture Technology User Network (SATURN) Workshop April 25-26, 2006

15- Marta L., “An Evaluation Theory Perspective of the Architecture Tradeoff Analysis Method (ATAM)”, (2000), Technical Report CMU/SEI-2000-TR-012 ESC-TR-2000-012

16- Bass L., Clements P. and Kazman R., “Software Architecture in Practice (2003)”, Addison Wesley

17- Basili, Victor R.; Caldiera, Gianluigi; Rombach, H. Dieter, “The Goal Question Metric Approach”, Encyclopedia of SoftwareEngineering, J. Marcinak (editor), Wiley, 1994.

18- Trendowicz A, Punter T, “Quality modeling for software Product Lines”, 7th ECOOP Workshop on Quantitative Approaches in Object-Oriented Software Engineering (QAOOSE'2003) Darmstadt, July 2003

19- Losavio, F “Quality Models to Design Software Architecture”(2002), Journal of Object Technology

20- Manuel F, Bertoa y Antonio Vallecillo “Quality Attributes for COTS Components”(2002), 6th ECOOP Workshop on Quantitative Approaches in Object-Oriented Software Engineering.

Questions & Answers

MANY THANKS & GOOD WISHES

TO ALL OF YOU

FROM

THE PEOPLE OF PAKISTAN