Quality Attributes of Systems-of-Systems: A Systematic Literature Review

ICSE 3rd Workshop on Software Engineering for System-of-Systems (SESoS)

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Agenda

- Contextualization
- Motivation
- Goals
- Results
- Discussion
- Conclusion

Contextualization

- Systems-of-Systems
  - It can be identified in several domains;
  - Besides interoperability, several other quality attributes are critical (e.g., performance, reliability, security); and
  - Achieve quality in SoS is very difficult due its emergence behavior characteristic.
- Quality Models
  - Intends to make the software quality better understandable and manageable;
  - ISO/IEC 25010 quality model:
    - It is based on the fact that the software product quality can be specified and evaluated using a hierarchical structure of quality attributes.

Motivation

- Research on SoS applications are migrating from traditional military domains to other domains (e.g., smart home, integrated health systems, crisis management systems.);
- Quality attributes must be properly addressed by the quality models considering this variety of domains;
- However, there is not a clearly decomposition criteria that determines how the complex concept “quality” should be handled for SoS; and
- So, we can say that assure quality management of SoS is a task that has not yet been overcome by the classical software engineering.

Goals

- Though a Systematic Literature Review, to present a panorama about the current state-of-the-art on quality attributes in the SoS context considering all the application domains; and
- Analyse the coverage of the well established quality model ISO/IEC 25010 on the SoS quality attributes identified in this study.

Protocol

Search String:

("system-of-systems") AND ("quality attribute" OR "non functional requirement" OR "quality requirement" OR "quality characteristic" OR "quality criteria" OR "non functional property" OR "non functional characteristic" OR "quality model")

Search Sources:

- ACM Digital Library: http://dl.acm.org;
- IEEE Xplore: http://ieeexplore.ieee.org;
- Scopus: http://www.scopus.com; and
- Web of Science: http://apps.webofknowledge.com.

Protocol

- Studies retrieved: 116;
- Studies after apply Inclusion and Exclusion Criteria: 40;
- Papers included by suggestion of the reviewers: 12; and
- Total studies included: 52.

56 quality attributes identified

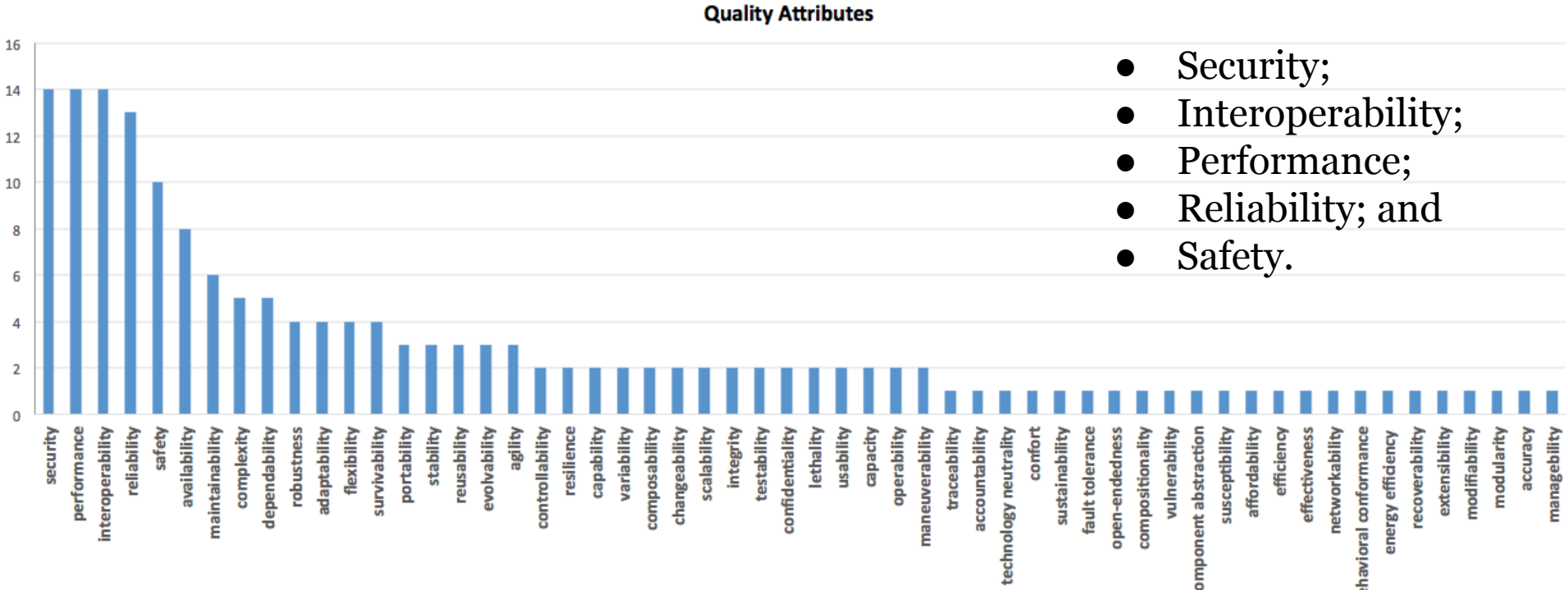
Results

Research question (RQ):

- (i) RQ1: Which are the most common quality attributes for SoS?;
- (ii) RQ2: Which are the most common application domains considered for SoS?; and
- (iii) RQ3: Which are the quality attributes established for each SoS domains?

Results

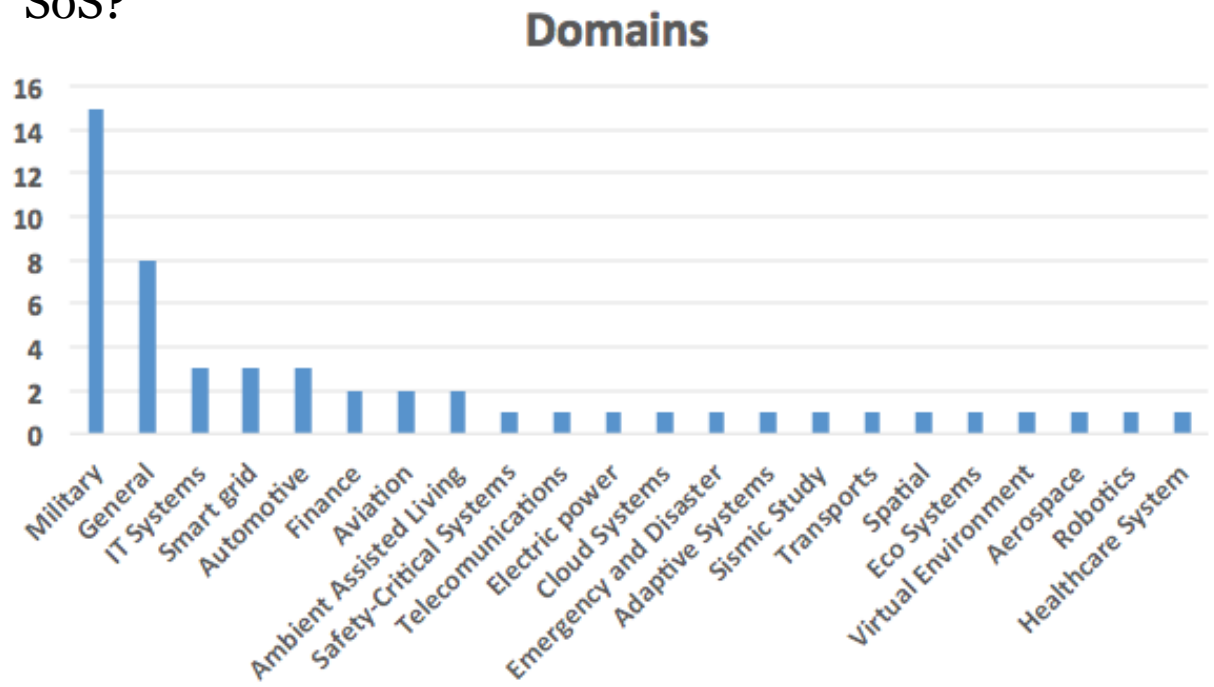
(i) RQ1: Which are the most common quality attributes for SoS?



- Security;
- Interoperability;
- Performance;
- Reliability; and
- Safety.

Results

(ii) RQ2: Which are the most common application domains considered for SoS?



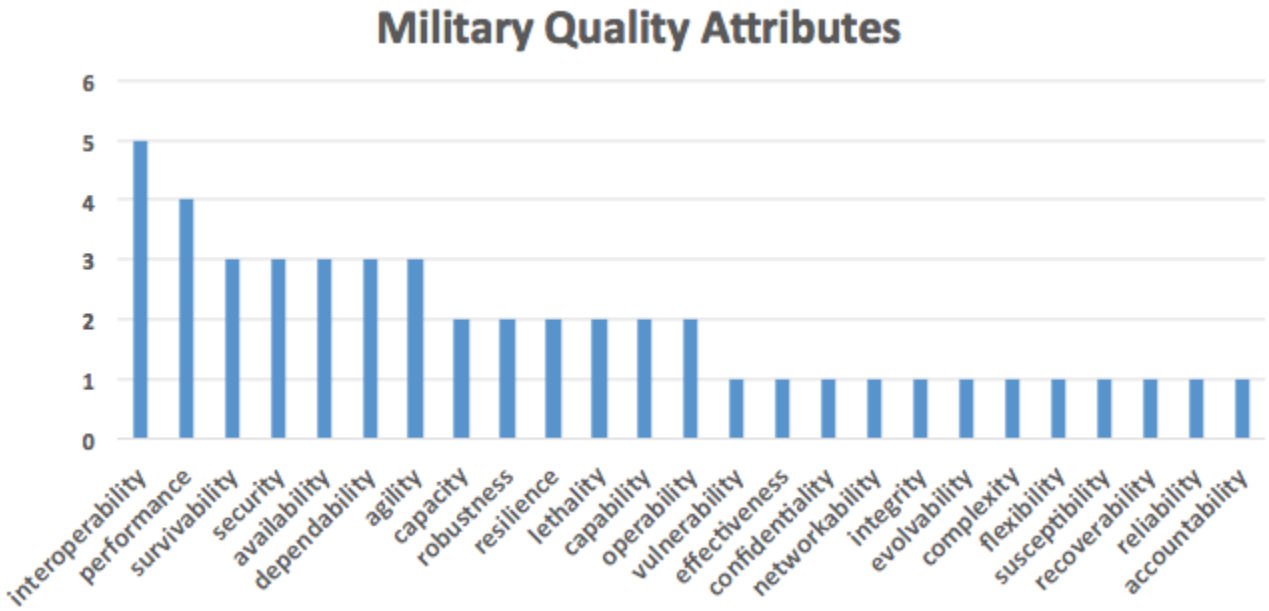
- Military;
- Smart Grids;
- Automotive; and
- IT Systems.

Results

(iii) RQ3: Which are the quality attributes established for each SoS domains?

Military:

- Interoperability;
- Performance;
- Survivability;
- Security; and
- Availability.

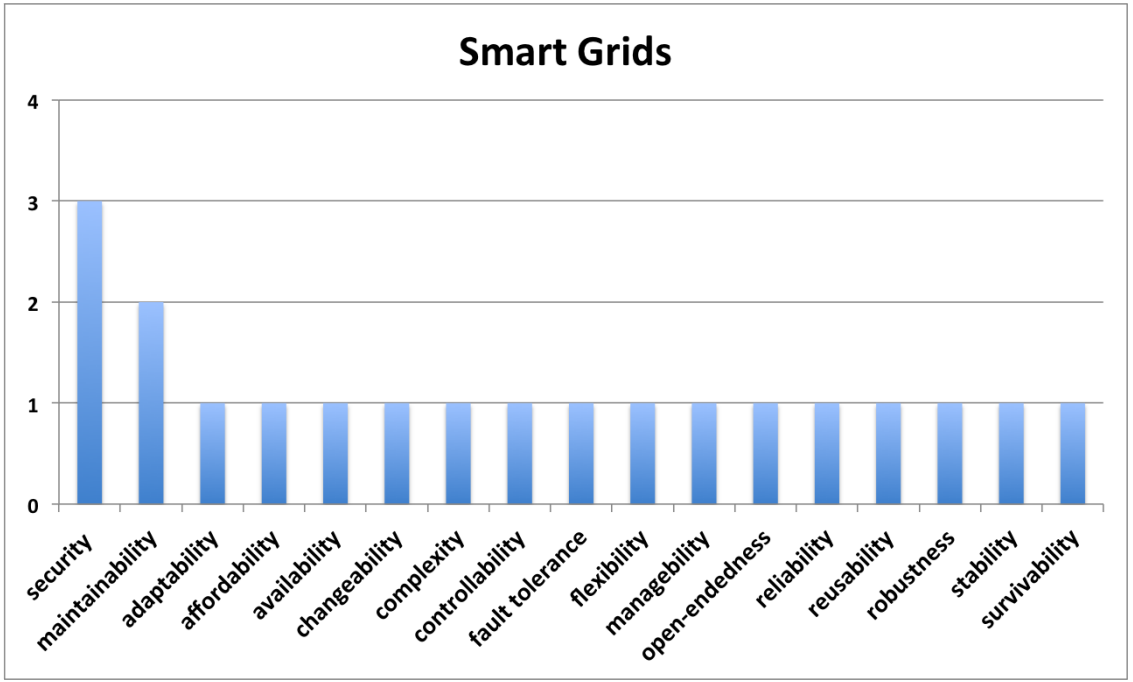


Results

(iii) RQ3: Which are the quality attributes established for each SoS domains?

Smart Grids

- Security; and
- Maintainability.

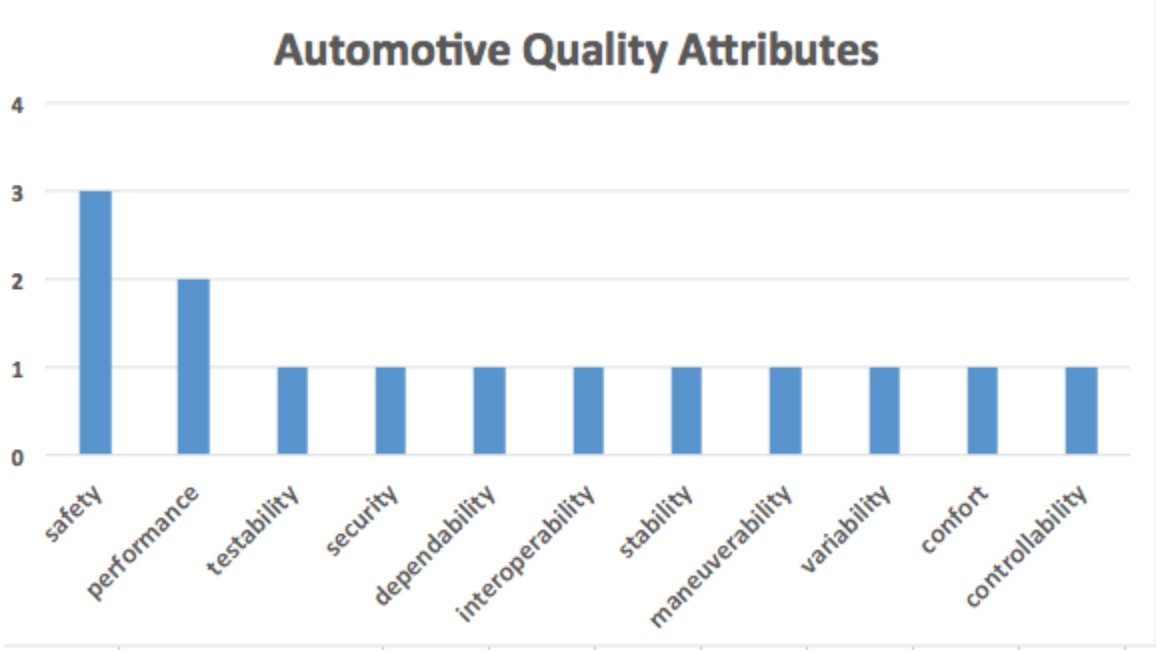


Results

(iii) RQ3: Which are the quality attributes established for each SoS domains?

Automotive:

- Safety; and
- Performance.

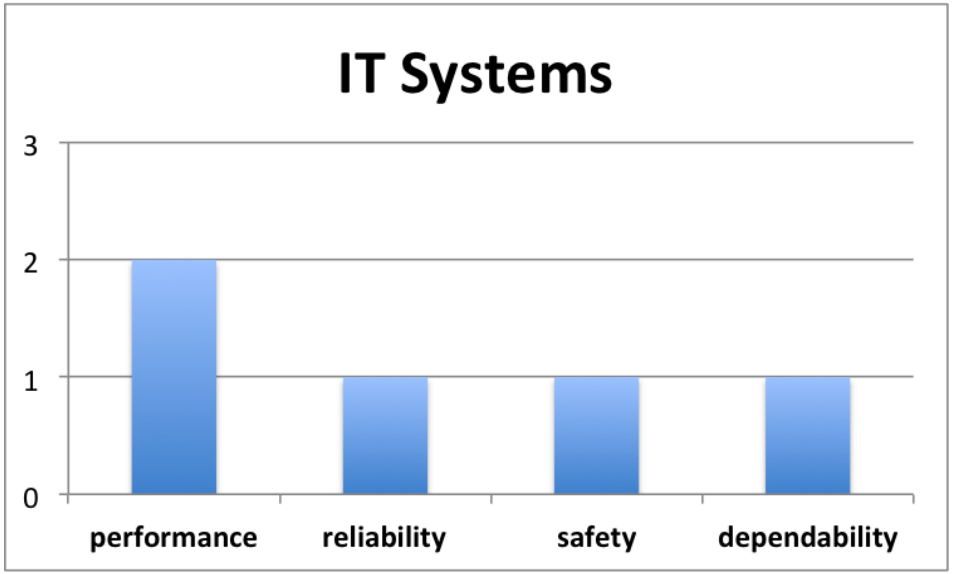


Results

(iii) RQ3: Which are the quality attributes established for each SoS domains?

IT Systems:

- Performance;
- Reliability;
- Safety; and
- Dependability.



Discussions

- It is difficult to achieve quality properties for the constituent systems without address quality for the whole SoS;
- Some well established quality attributes definitions, such as reliability, can not be fully applied in the SoS context due to the dynamic nature of these systems;
- SoS quality attributes have complex interdependencies, relationships and trade offs that are not properly translated in the hierarchical structure found in ISO/IEC 25010 and other quality models; and
- Finally, this work reports that 48% of the quality attributes commonly considered in SoS are not addressed by ISO/IEC 25010.

Conclusion

SoS have been developed without considering some important criteria on quality attributes evaluation that were not been properly addressed by the known standardized quality models.

Future Work

- To perform a detailed analysis about the concepts, definitions and interdependencies of the quality attributes found in this work;
- To propose a suitable quality model for SoS; and
- With that, we intend that issues related to quality attributes interdependencies can be properly addressed during development, maintenance, and even evolution of SoS.

Thank you!
Questions?