Introduction

Thank you for your participation in this online survey in context of my bachelor thesis.
Your responses will be kept in confidence and will be used for the purpose of our research only. We do not collect identifying information such as your name, email address or IP address.
The survey questions will be from the work field of requirements engineering.
Before the user test starts you get a short overview about requirements an the requirements domains, you will find in this user test.
Please try to answer the questions without interruption. It should take approximately 35-45 min to answer the questionnaire.

If you have any questions on the survey or want to be informed about the results pleased contact christianbraun@uni-koblenz.de or grosser@uni-koblenz.de.

* Required

Requirements

According to ISO/IEC/ IEEE 24765 Systems and software engineering Vocabulary, a requirement is: "A condition or capability that must be met or possessed by a system, system component, product, or service to satisfy an agreement, standard, specification, or other formally imposed documents".

In context of this survey, requirements of embedded systems engineering are used. The used requirements are on system abstraction level.

Requirements domains

The requirements used in this user test belong to two different domains:

Some requirements are from the 'European Aviation Safety Agency (EASA)'. EASA is an agency of the European Union with responsibility for civil aviation safety. The selected requirements belongs to the 'Certification Specification for Engines (CS-E)'. CS-E defines what must be achieved in order for an aero engine to achieve certification. In particular requirements concerned with the 'Engine Control System' (ECS) are used.

The other part of the requirements are from the 'European Cooperation for Space Standardization (ECSS)'. ECSS is an initiative established to develop a coherent, single set of user-friendly standards for use in all European space activities. The selected requirements belongs to the standard of 'Satellite attitude and orbit control system (AOCS)'. This standard specifies a baseline for the attitude and orbit control system requirements to be used in the project requirements document for space applications.

Previous experience

Please complete a short questionnaire about your occupation and your previous experience.

When you finished this short questionnaire please enter the current time in the field 'Start time' to make possible to measure the overall time to complete the user test. At the end of the last section you are also asked to fill in the 'End time'.

1. **What is your occupation?** *
   Mark only one oval.

   ( ) Student

   ( ) Scientific Assistant / Researcher

   ( ) Industry Professional

2. **Did you know what a requirement was before you opened this survey?** *
   Mark only one oval.

   ( ) Yes

   ( ) No

   ( ) I don't know

3. **Do you have experience with Requirements Template Systems?** *
   Mark only one oval.

   ( ) Yes

   ( ) No

   ( ) I don't know

4. **Do you have experience with the Requirements Template Systems MASTER (SOPHIST)?** *
   Mark only one oval.

   ( ) Yes

   ( ) No

   ( ) I don't know

5. **Do you have experience with the Requirements Template Systems EARS?** *
   Mark only one oval.

   ( ) Yes

   ( ) No

   ( ) I don't know

6. **Are you used to reading requirements?** *
   Mark only one oval.

   ( ) Yes

   ( ) No

   ( ) I don't know

7. **Are you used to writing requirements?** *
   Mark only one oval.

   ( ) Yes

   ( ) No

   ( ) I don't know

8. **Have you been trained to write requirements?** *
   Mark only one oval.

   ( ) Yes

   ( ) No

   ( ) I don't know

9. **Start time (current time):** *

   _____

   Example: 8:30 AM

Reading requirements

In this section you have to evaluate different phrasings of requirements.
Please give each proposition a score between 5 for the "most appropriate" requirement(s) – i.e. the clearest/least ambiguous one(s) – and 1 for the "worst" requirement(s).
Please give the highest score (5) to at least one of the variants of every requirement (even though you do not consider them as perfect), and rate the others by comparison.

Abbreviations:
ECS - Engine Control System
LOTC - Loss Of Thrust Control
LOPC - Loss Of Power Control

Requirement 1

10. **As soon as a control mode change happens, the ECS shall maintain the engine within approved operational limits.** *

    Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

11. **When the ECS changes operational mode, the ECS shall maintain the engine within approved operational limits.** *

    Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

12. **It must be demonstrated that, when a fault or failure results in a change from one control mode to another, the change occurs so that the engine does not exceed any of its operating limitations.** *

    Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

Requirement 2

13. **The ECS shall enable selected values of relevant control parameters to be maintained and the engine kept within the approved operating limits over changing atmospheric conditions in the declared flight envelope.** *

    Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

14. **The ECS shall be designed in a way, that the engine can be operated within approved operating limits and relevant control parameters are maintained at changing atmospheric conditions in the declared flight envelope.** *

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

15. **It must be substantiated by tests, analysis or a combination thereof that the ECS performs the intended functions in a manner which enables selected values of relevant control parameters to be maintained and the engine kept within the approved operating limits over changing atmospheric conditions in the declared flight envelope.** *

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

Requirement 3

16. **The ECS must be designed and constructed so that in the full-up configuration, the system is essentially single fault tolerant for electrical and electronic failures with respect to LOTC/LOPC events.** *

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

17. **As long as the ECS is in the state full-up configuration, the ECS shall be single fault tolerant to LOTC/LOPC events.** *

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

18. **While in a full-up configuration, the ECS shall be essentially single fault tolerant with respect to LOTC/LOPC event.** *

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

Requirement 4

19. **As soon as single failure lead to deficient aircraft-supplied data, the ECS shall prevent a hazardous engine effect. ***

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

20. **Single failures leading to loss, interruption or corruption of aircraft-supplied data, must not result in a hazardous engine effect for any engine. ***

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

21. **If a single failure leads to deficient aircraft-supplied data, then the ECS shall not cause a hazardous engine effect. ***

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

Requirement 5

22. **The satellite on-board ephemeris table shall not require an update from ground more frequently than once every 15 days. ***

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

23. **Satellite on-board ephemeris table (e.g. earth, sun, stars) shall not require an update from ground more frequently than once every 15 days. ***

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

24. **The update interval of the satellite on-board ephemeris table shall be >= 15 days. ***

Mark only one oval.

	1	2	3	4	5	
worst	◯	◯	◯	◯	◯	most appropriate

Requirements quality

In this section you will find different phrasing variants of requirements.

Please check if the wording of the requirements meet the following quality criteria:

vague:
Is the wording of the requirement free of vagueness?
Requirements should have only one possible interpretation by the reader. The requirement should be written in a simple and straightforward language of the user domain and subjective words should be avoided. Check if the wording allows more than one possible interpretation. If this is not the case, the requirement is considered to be vague.

incomplete:
Is the wording of the requirement complete?
The requirement should completely describe every part of the functionality to be delivered. If this is not the case, the requirement is considered to be incomplete.

incorrect:
Is the wording of the requirement correct?
The requirement should accurately describe the functionality to be delivered. If this is not the case, the requirement is considered to be incorrect.

inconcise:
Is the wording of the requirement concise?
The requirement should be marked by brevity of expression or statement and be free from all elaboration and superfluous detail. If this is not the case, the requirement is considered to be inconcise.

If you think the requirement meets all four quality criteria you do not have to select a type of error.

Abbreviations:
ECS - Engine Control System
LOTC - Loss Of Thrust Control
LOPC - Loss Of Power Control

Requirement 1

25. **The ECS shall enable selected values of relevant control parameters to be maintained and the engine kept within the approved operating limits over changing atmospheric conditions in the declared flight envelope.**

Check all that apply.

- [ ] vague
- [ ] incomplete
- [ ] incorrect
- [ ] inconcise

26. **It must be substantiated by tests, analysis or a combination thereof that the ECS performs the intended functions in a manner which enables selected values of relevant control parameters to be maintained and the engine kept within the approved operating limits over changing atmospheric conditions in the declared flight envelope.**

Check all that apply.

- [ ] vague
- [ ] incomplete
- [ ] incorrect
- [ ] inconcise

27. **The ECS shall be designed in a way, that the engine can be operated within approved operating limits and relevant control parameters are maintained at changing atmospheric conditions in the declared flight envelope.**

Check all that apply.

- ☐ vague
- ☐ incomplete
- ☐ incorrect
- ☐ inconcise

Requirement 2

28. **Single failures leading to loss, interruption or corruption of aircraft-supplied data, must not result in a hazardous engine effect for any engine.**

Check all that apply.

- ☐ vague
- ☐ incomplete
- ☐ incorrect
- ☐ inconcise

29. **As soon as single failure lead to deficient aircraft-supplied data, the ECS shall prevent a hazardous engine effect.**

Check all that apply.

- ☐ vague
- ☐ incomplete
- ☐ incorrect
- ☐ inconcise

30. **If a single failure leads to deficient aircraft-supplied data, then the ECS shall not cause a hazardous engine effect.**

Check all that apply.

- ☐ vague
- ☐ incomplete
- ☐ incorrect
- ☐ inconcise

Requirement 3

31. **The satellite on-board ephemeris table shall not require an update from ground more frequently than once every 15 days.**

Check all that apply.

- ☐ vague
- ☐ incomplete
- ☐ incorrect
- ☐ inconcise

32. **The update interval of the satellite on-board ephemeris table shall be > 15 days.**

Check all that apply.

☐ vague

☐ incomplete

☐ incorrect

☐ inconcise

33. **Satellite on-board ephemeris table (e.g. Earth, Sun, Stars) shall not require an update from ground more frequently than once every 15 days.**

Check all that apply.

☐ vague

☐ incomplete

☐ incorrect

☐ inconcise

Requirement 4

34. **As long as the ECS is in the state full-up configuration, the ECS shall be single fault tolerant to LOTC/LOPC events.**

Check all that apply.

☐ vague

☐ incomplete

☐ incorrect

☐ inconcise

35. **The ECS must be designed and constructed so that in the full-up configuration, the system is essentially single fault tolerant for electrical and electronic failures with respect to LOTC/LOPC events.**

Check all that apply.

☐ vague

☐ incomplete

☐ incorrect

☐ inconcise

36. **While in a full-up configuration, the ECS shall be essentially single fault tolerant with respect to LOTC/LOPC event.**

Check all that apply.

☐ vague

☐ incomplete

☐ incorrect

☐ inconcise

Writing requirements (EARS)

In this section you should write requirements by using the Requirements Template System EARS.

Requirements template systems

A requirements template is a blueprint that defines the syntactic structure of a single requirement. Requirements templates specify the syntax of the requirement and the requirements engineer only needs to define the necessary semantics. The templates are extended by additional objects and conditions. Finally you get the possibility to build semantically and syntactically correct requirements. Define the necessary semantics by filling the template gaps with domain specific terms.

Start time:

To measure the processing time please enter the start and end time of this task.

37. **Current time:** *

Example: 8:30 AM

EARS template system

The template for ubiquitous requirements and the template for optional features are required to solve this task.

The words without any bracket represent the template fixed values and the words with angle brackets < > represent the attributes that have to be filled in.

Ubiquitous requirements

An ubiquitous requirement defines a fundamental property of the system and has no preconditions or trigger.

Example: "The control system shall prevent engine overspeed."

Optional feature

Optional requirements are invoked only if the system includes a special feature.

Example: "Where the control system includes an overspeed protection function, the control system shall test the availability of the overspeed protection function prior to aircraft dispatch."

Task

This task provides two free text requirements. Please rewrite the requirements by using the EARS templates.

38. **Free text: "Means for shutting down the Engine rapidly must be provided." EARS:** *

_____

_____

_____

_____

_____

39. **Free text: "When over-speed protection is provided through hydromechanical means, it must be demonstrated by test or other acceptable means that the over-speed function remains available between inspection and maintenance periods." EARS:** *

_____

_____

_____

_____

_____

40. **End time (current time):** *

_____

Example: 8:30 AM

Writing requirements (MASTER)

In this section you should write requirements by using the Requirements Template System MASTER.

Requirements template systems

A requirements template is a blueprint that defines the syntactic structure of a single requirement. Requirements templates specify the syntax of the requirement and the requirements engineer only needs to define the necessary semantics. The templates are extended by additional objects and conditions. Finally you get the possibility to build semantically and syntactically correct requirements. Define the necessary semantics by filling the template gaps with domain specific terms.

Start time:

To measure the processing time please enter the start and end time of this task.

41. **Current time:** *

_____

Example: 8:30 AM

MASTER template system

The (detailed) FunctionalMASTER and the TimeMASTER are required to solve this task.

The uppercase words represent the template fixed values and the lowercase words with angle brackets < > represent the attributes that have to be filled in. Optional attributes are represented by squared brackets [ ].

FunctionalMASTER

The FunctionalMASTER template is used to specify functional requirements.

After the modal verb, the FunctionalMASTER allows to distinguish three types of system activity autonomous (-), user interaction (provide <actor> with the ability to) and interface (be able to).
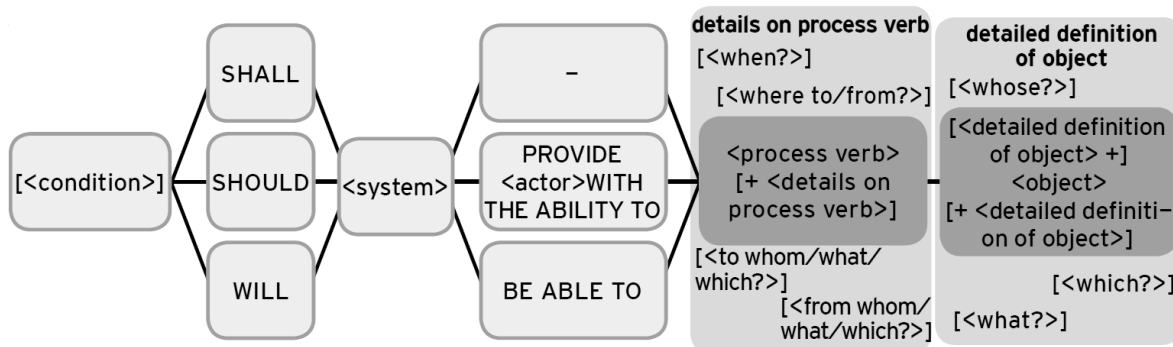
Example: "The system shall provide the user with the ability to search items."
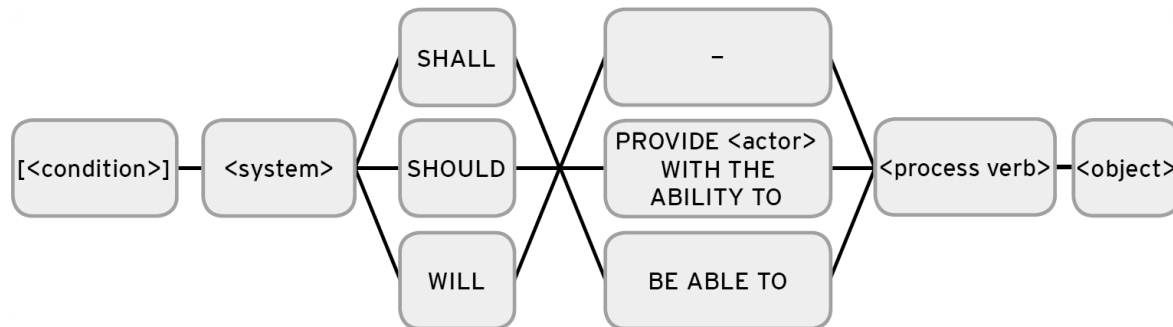
Detailed FunctionalMASTER

In the detailed FunctionalMASTER template both components <object> and <process verb> can be specified in detail.

Example: "The system shall provide the registered user with the ability to search customer related items."

TimeMASTER

The TimeMASTER defines a specific type of condition to be used with the main clause templates like the Functional Master. The TimeMASTeR template is used to specify a certain period of time when a system or object may have temporary behaviors. The requirement holds only as long as the temporary condition is valid.

Example: "As long as the system is in the state active, the system shall provide the user with the ability to search items."
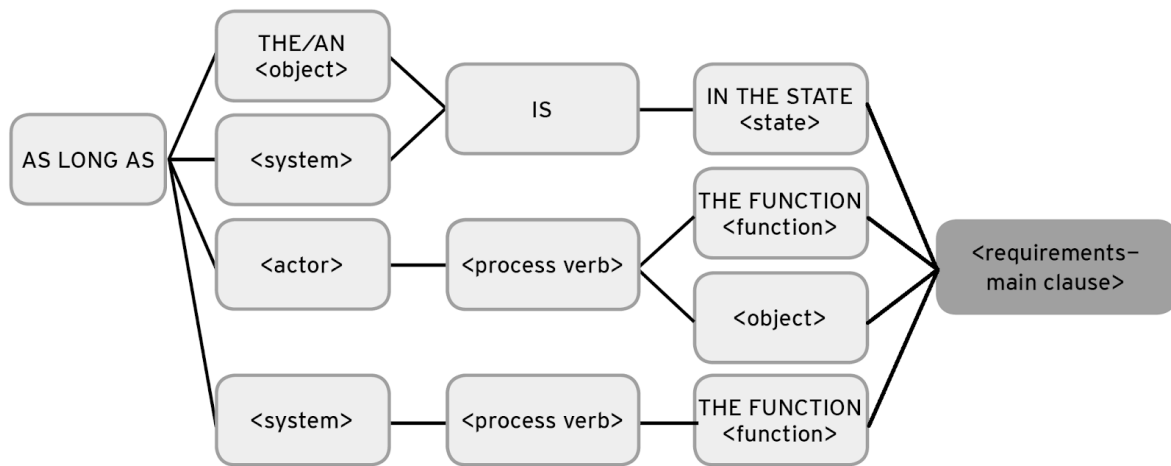
Task

This task provides two free text requirements. Please rewrite the requirements by using the MASTER templates.

42. **Free text: "Means for shutting down the Engine rapidly must be provided." MASTER:** *

_____

_____

_____

_____

_____

43. **Free text: "When over-speed protection is provided through hydromechanical means, it must be demonstrated by test or other acceptable means that the over-speed function remains available between inspection and maintenance periods." MASTER:** *

_____

_____

_____

_____

_____

44. **End time (current time):** *

_____

Example: 8:30 AM

Evaluation
How strongly do you agree with the following subjective statements? Please give your own impressions. There are no right or wrong answers.

45. **Writing** *
Mark only one oval per row.

	strongly disagree	partially disagree	partially agree	strongly agree
'It is easy to write requirements in EARS.'	⬭	⬭	⬭	⬭
'It is easy to write requirements in MASTER.'	⬭	⬭	⬭	⬭
'It is easy to write requirements in free text.'	⬭	⬭	⬭	⬭

46. **Learning effort** *
Mark only one oval per row.

	strongly disagree	partially disagree	partially agree	strongly agree
'It needs a lot of time to learn to write requirements by using MASTER.'	⬭	⬭	⬭	⬭
'It needs a lot of time to learn to write requirements by using EARS.'	⬭	⬭	⬭	⬭

47. **Understanding** *
Mark only one oval per row.

	strongly disagree	partially disagree	partially agree	strongly agree
'EARS requirements are easy to understand.'	⬭	⬭	⬭	⬭
'Free text requirements are easy to understand.'	⬭	⬭	⬭	⬭
'MASTER requirements are easy to understand.'	⬭	⬭	⬭	⬭

48. **Completeness** *
Mark only one oval per row.

	strongly disagree	partially disagree	partially agree	strongly agree
'MASTER requirements are complete.'	⬭	⬭	⬭	⬭
'Free text requirements are complete.'	⬭	⬭	⬭	⬭
'EARS requirements are complete.'	⬭	⬭	⬭	⬭

Comparison
Please answer the final questions that allowing a comparison of MASTER, EARS and free text requirements.

49. **How difficult do you think is it to write requirements in ... ?** *
Mark only one oval per row.

	very easy	easy	difficult	very difficult
Free text	⬭	⬭	⬭	⬭
MASTER	⬭	⬭	⬭	⬭
EARS	⬭	⬭	⬭	⬭

50. **How much learning effort do you think is needed to learn to write requirements in ... ?** *

Mark only one oval per row.

	very low	low	high	very high
Free text	◯	◯	◯	◯
MASTER	◯	◯	◯	◯
EARS	◯	◯	◯	◯

51. **How easy do you think it is to read requirements written in ... ?** *

Mark only one oval per row.

	very easy	easy	difficult	very difficult
Free text	◯	◯	◯	◯
MASTER	◯	◯	◯	◯
EARS	◯	◯	◯	◯

52. **For writing requirements I would prefer ...** *

Mark only one oval per row.

	strongly disagree	partially disagree	partially agree	strongly agree
Free text	◯	◯	◯	◯
MASTER	◯	◯	◯	◯
EARS	◯	◯	◯	◯

53. **End time (current time):**

_____

Example: 8:30 AM

Thank you for your participation in this online survey.

If you have any questions on the survey or want to be informed about the results pleased contact christianbraun@uni-koblenz.de or grosser@uni-koblenz.de.

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