Architecture Assessments; Needs and Experiences.

White Paper Resulting from Architecture Forum Meeting

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1. Introduction

According to literature Architecture Assessments are generally undertaken as a risk reduction measure to ensure that the current architectural approach and design is aligned with needs and objectives of its critical stakeholders. Some of the benefits claimed by SEI (http://www.sei.cmu.edu/architecture/tools/atam/index.cfm) are: *Identification of risk early in the life-cycle, clarified quality attribute requirements, improved architecture documentation, documented basis for architectural decisions, and increased communication among stakeholders.*

The Architecting Forum members discussed architecture assessments based on the following questions:

1. Does your company have a need for architecture assessments?
2. Why, what triggers this need?
3. What scope do architecture assessments cover?
4. Who is doing the assessment? E.g. internal or external assessors.
5. What does your company do with the assessment outcome?

This discussion provided a baseline of the state of practice of architecture assessments. The next step was to elaborate, by using a hypothetical case to study preferred assessment format, duration, and required assessors and participants. The following questions are explicitly addressed:

1. What Process, Method, or Techniques do you propose? E.g. TOGAF [TOGAF 2009], ATAM[Kazman 2000], ARID [Clemens 2002], …
2. What are you looking **at**?
3. What are you looking **for**?
4. What is the assessment result?

A list of assessment questions was generated after reflection on the hypothetical case. This list is a starting point to create assessment checklists.

2. From assessment trigger to outcome

All participants answered the questions formulated in the introduction, for their part of the company. We have processed these answers to consolidate the current state of practice of architecture assessments.

Needs and triggers

The members, who were present, all indicated a need for architecture assessments. Companies typically want to know:

- Is our current architecture fit for future needs?
- Is the architecture still well aligned with strategic objectives?
- Can our architecture adapt to occurring changes or paradigm shifts, e.g. network centric warfare?
- Is our ongoing investment justifiable and explainable to independent assessors?

It was observed that Assessments are pro-active (e.g. at process gates) or re-active, often triggered by some (perceived) problem. Related to the trigger assessments can be planned, avoiding (big) project conflicts, or disruptive. One of the challenges of assessment is to ensure that the assessment is real and to avoid that participants only go through the motions because some external force asks for an assessment.

Interestingly, the announcement of an assessment triggers the creation of documentation before the assessment. In other words, the assessment already has impact before it actually takes place. A side effect of assessments is that overview and awareness of cross-cutting concerns is created. Often the need for overview and awareness is an implicit, unspoken, need.

Scope

Architecture assessments are performed at different levels, from components up to an entire portfolio. The scope depends mostly on the initial need that triggered the assessment. In general the scope is relatively broad, e.g.:

- Do we achieve the appropriate level of re-usability across the product line?
- Does the system align with the enterprise?

Scoping of the assessment might be done in two steps, e.g. zoom in on a subset of issues after a global overview. The heavy focus on requirements triggered by Systems Engineering processes narrows the focus of architects and other invloved stakeholders. An assessment should look broad enough.

Principle 8.1 Architecture assessments must be broad enough and not be limited to requirements.

Who are the assessors?

Quite often internal people, architects, managers, designers or engineers form the assessment team. External reviewers are used only in larger organizations with more established architecting processes. For example, in one organization Vice-President Engineering and Program Managers are typical part of the assessment team.

During the discussion it was stated that architecture should be assessed by architects. What could be the role of non-architects? The participants supported the importance of having architects review architecture. In fact requirement for the assessment team is that it should contain sufficient "system thinkers" or "big picture people": people how are able to relate specific detailed issues to the much broader context. We tend to call these people architects. That does not exclude non architects, such as managers or experts as member of the assessment team. In some cases the presence of the right expert or manager as assessment team member might even be crucial. However, we consider the main task of the assessment team to assess the architecture as a whole, the big picture, with attention for (threatening)

details. Note that the assessment result is often reported to non-architects, for instance the business owner

Principle 8.2 Architecture assessors have to be system thinkers with eye for detail

It was pointed out that stakeholders can also contribute significantly to an assessment, especially customers can make a significant contribution to the assessment. Ownership of the assessment and the assessment results is important. Ownership helps to achieve stakeholder involvement. A question that popped-up in the same discussion is: do we need to speak the same language?

Principle 8.3 Architecture assessments mitigate the risk of inbreeding by involving independents.

The who questions (who assesses, for who is the assessment, and for who are the architecture descriptions) triggered lots of discussions. There is a tension between:

- architects facilitate communication and reasoning across stakeholders; this requires understandability and accessibility
- contemporary systems have so many concepts and technologies that the descriptions cannot be simplified to be accessible and understandable for everyone.

Principle 8.4 Every part of the description of an Architecture should be understandable by directly related stakeholders. The high level description of an architecture should be understandable by non-architects.

What is done with the assessment outcome?

Most common is that the outcome of the assessment is consolidated in a presentation of limited size, e.g. 20 slides. The outcome is communicated upward, e.g. management team, as well as downward, e.g. the engineering team itself. Quite often the follow-up is delegated to the team that has been reviewed. One of the companies used as rule-of-thumb that 90% of the findings are handled by the reviewed team, for the most severe 10% of issues follow-up is ensured by entering them in the appropriate tracking systems. In exceptional cases the outcome of an assessment caused the abortion of the ongoing tendering process.

Forward Architecting

Architecting is primarily a forward oriented activity, where by pro-active analysis and synthesis a solution is shaped. Assessments are reactive, architecture assessments tend to detect issues that have not been covered sufficiently by the architecting effort. All processes, tools, checklists that are proposed for architecture assessments are presumably also beneficial for the forward architecting activity. Ideally an assessment is only a formality, since the forward architecting activity did cope with all architectural challenges pro-actively.

3. Elaborating a hypothetical case

The course *System Architecture and Design* from Stevens Institute uses a submarine case in the assessment topic. We divided the participants in two teams and asked them to make an architecture assessment proposal for that case for a 3-day assessment. The proposal addressed:

- the process or method to be used
- the format of the assessments
- the participants
- the content to be discussed/assessed

Figures 1 and 2 show the results of the two teams.

Team 1 produced a three day agenda. The agenda alternates review team meetings, plenary sessions and smaller working sessions. Team 1 let the review team meeting start at 12pm, the actual review itself starts at 3pm the first day. The morning is reserved for traveling, assuming that not all reviewers and participants are on the same site. Two hours are reserved for the team to meet each other and to prepare for the actual review. One hour is used plenary to explain the assessment process itself.

Day I	
AM	travel
12-2pm	Review Team Meeting
	Reconnect
	General context vs skills, domain
2-3pm	Process Overview *all*
3-3:30	Break
3:30-5:30	Business/mission overview
	done by customer or program
	manager or eng.domain expert
5:30-...	Review Team Meeting

Day II	
8:30-Noon	technical arch overview
(with break)	done by: chief architect
	Present tradeoff decisions
	Key artifacts, key arch drivers
noon-3pm	Review team meeting
(with break)	to define way forward
	checklist tailoring
	team member tasking
	identify SME's for interview
3pm-5:30	Interviews, Research
	data gathering

Day III	
8:30-9	Review Team Meeting
9-noon	continue interview
(with break)	
noon-2pm	Build outbrief
2-3pm	Review outbrief
	with chief arch; tailor
3-4pm	formal outbrief *all*
4pm-...	travel

Figure 1. Agenda proposal for architecture assessment by team 1.

The review starts with a business/mission review. This is followed, the next day, by a technical architecture overview. The chief architect is the main presenter who presents trade-off decisions, key artifacts (tangible byproducts produced during architecting) and key architecture drivers. The whole morning is reserved for this technical architecture overview. The early afternoon is used by the review team to reflect on the first part of the assessment and to define the way forward. For example, based on the information obtained so far, the checklists may be tailored, more specific tasks may be allocated to team members, and Subject Matter Experts (SMEs) to be interviewed are identified.

The remainder of the afternoon and the following morning are used for data gathering by interviewing and delving into artifacts. At noon the third day the assessment team starts to build the presentation with findings and recommendations: the outbrief. The outbrief is reviewed and tailored with the chief architect. From 3 to 4pm the outbrief is presented plenary.

Team 2 created a coarse agenda, but added additional viewpoints on people, the way-of-working, the output, and the tools: see Figure 2. The session of team 2 elaborated the idea that the assessment team itself makes high level models during the second day. Day 1 is used to get into the problem, to find artifacts and SMEs. The high level model is the means to discuss the architecture, and to identify potential gaps and risks.

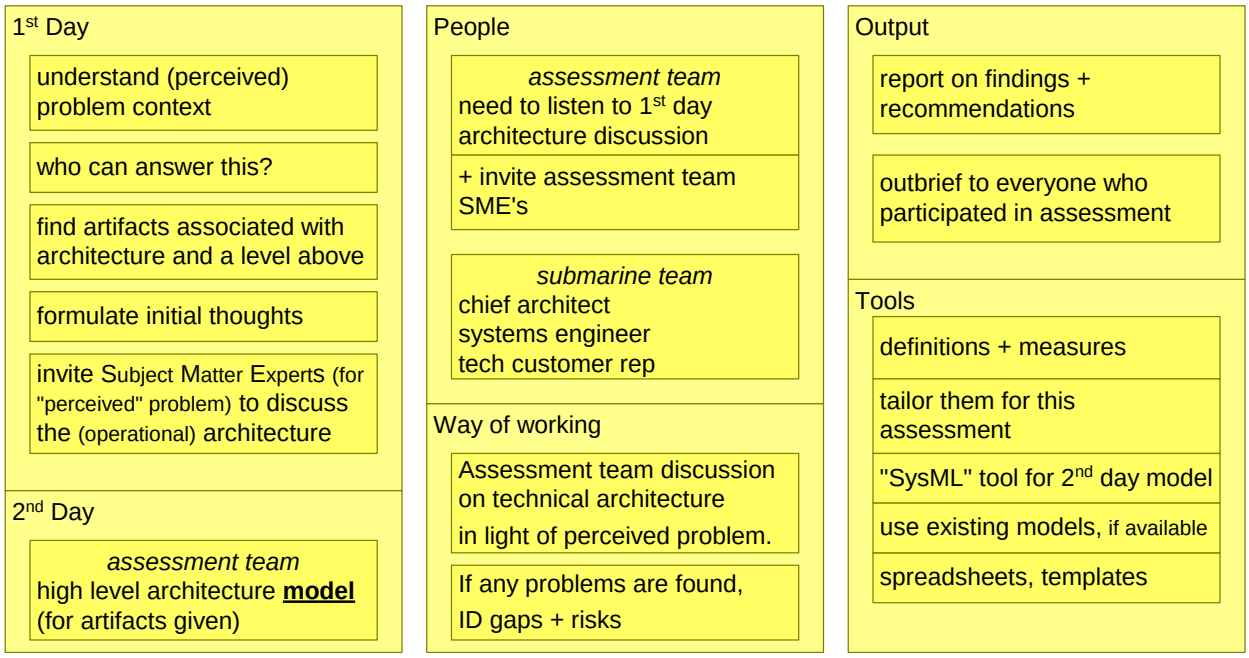

Figure 2. assessment approach by team 2.

Day 3 is used to finish the model and discussions, to create a report, and to do a plenary outbrief.

Reflection on case results.

The forum explicitly reflected on the case results as presented by both teams.

A major issue that popped up is the amount of time that should/can be invested in architecture assessments, as one participant remarked: “We invented Cadillacs”. Three days is perceived as a huge investment that is only warranted for large programs. The major cost of investment is the time of critical resources both from the project/program itself as well as from the assessors. In practice it is hard to line-up all these resources at the same time. On the other hand, tens of person-days of assessment investment might save tens of person-years of development and engineering work when new risks are uncovered. From noon to noon was proposed as alternative assessment duration. Several member have good experiences with

that format, where one afternoon, one evening and one morning is available for the assessment.

We also looked at our original questions:

1. What Process, Method, or Techniques do you propose? E.g. TOGAF, ATAM, ARID, …
2. What are you looking **at**?
3. What are you looking **for**?
4. What is the assessment result?

What Process, Method, or Techniques do you propose?

In general the mood during the forum meeting was that having some assessment processes, procedures, and guidelines to do assessments is beneficial. The assessment proposals from the teams did not follow one of initially mentioned methods explicitly. Although both teams used elements from TOGAF and ATAM® , looking at qualities, expecting certain artifacts and using checklists. The question popped up if there are other methods or techniques that could be used for assessments. Examples mentioned were fault tree analysis, simulations, and FMEA-like techniques for reliability, safety, and security. These specific examples were seen as techniques that should be done by the project or program team itself; the assessment team might assess the outcome of such analysis.

The team 2 presentation triggered an extensive discussion about tools and modeling. Does architecture assessment require any other tools than architecting? Can any assessment tool also be used for forward architecting, e.g. checklists? The team 2 presentation also raised questions about what the assessment team can or may do and what the responsibility is of the project or program team. Making high level models definitely is a responsibility of the project or program team. However, when these models are lacking or inadequate the assessment team gains lots of insight by making the models on the spot.

What are you looking at?

The consensus is that you look **at** architecture related *artifacts* of the system and its context, and at *people*. Examples of artifacts are Concept of Operations (ConOps), requirements, architecture description, trade-off decisions. Quantification and metrics are seen as important to look **at**. In case of people the assessment team looks at competencies of involved people, but also at behavior, needs, and emotions.

Scenarios provide specific examples and a means to look in more depth.

What are you looking for?

This can be checklist based, for example a checklist with issues the assessors should look for:

- gaps and risks
- concerns of the assessment owner
- the critical parts of an architecture (e.g. internal and external interfaces, key performance parameters)
- the most relevant issues to be assessed, e.g.:
    - how well does architecture address requirements
    - how adaptable/extendable is the architecture
    - how well do requirements address needs
    - concordance (coupling, dependencies)

These items are quite generic, so an assessor needs to be open-minded: what you look **at** and **for** might be highly situational.

What is the assessment result?

The assessment result is a limited size presentation that is presented and shared with a broad set of stakeholders. The identified issues are mostly provided to the project or program team. It is the responsibility of the project or program team to address these issues, or to ignore them based on their own judgment.

4. What questions to ask during an assessment

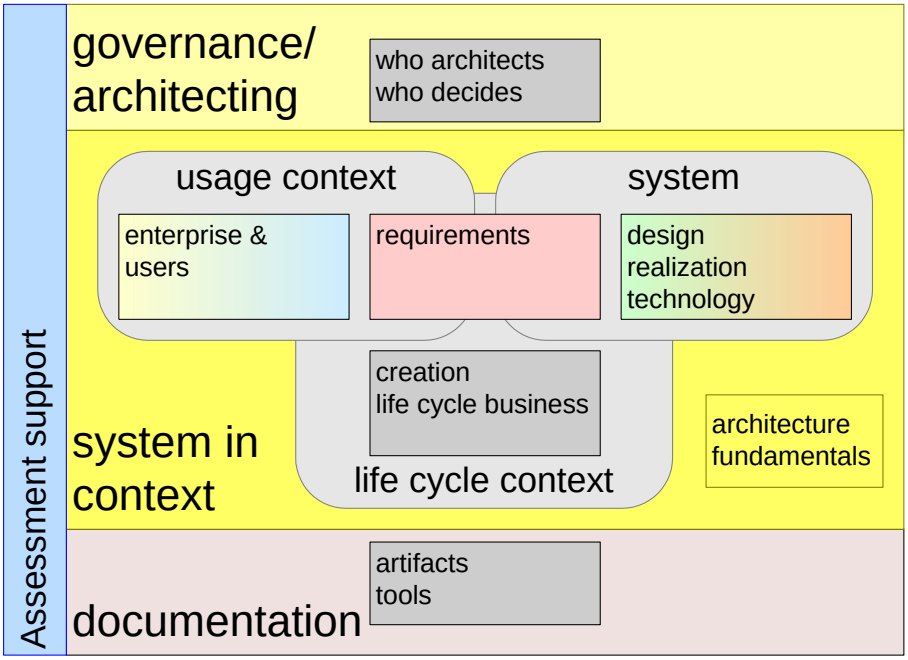

Figure 3. Questions to ask during an assessment can be classified in the categories Assessment support, Governance, System in context, and Documentation.

The last step in the assessment discussion was a brainstorm to identify what questions to ask during an assessment. The idea behind this list is that it can be transformed into a checklist for architecture assessments. Figure 3 shows a classification of these questions. This classification has been introduced after the brainstorm. Note that architects in the defense industry are quite used to DoDAF and frequently refer to the view number, rather than descriptive label. The used OV-n (Operational View) and AV-n (All View) numbers are defined in the section abbreviations at the end.

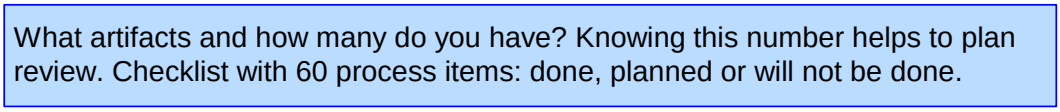

Figure 4. Assessment Support question.

Figure 4 shows that the brainstorm resulted in one question that helps the assessment team in planning the assessment itself. This question can be posed before the actual assessment workshop.

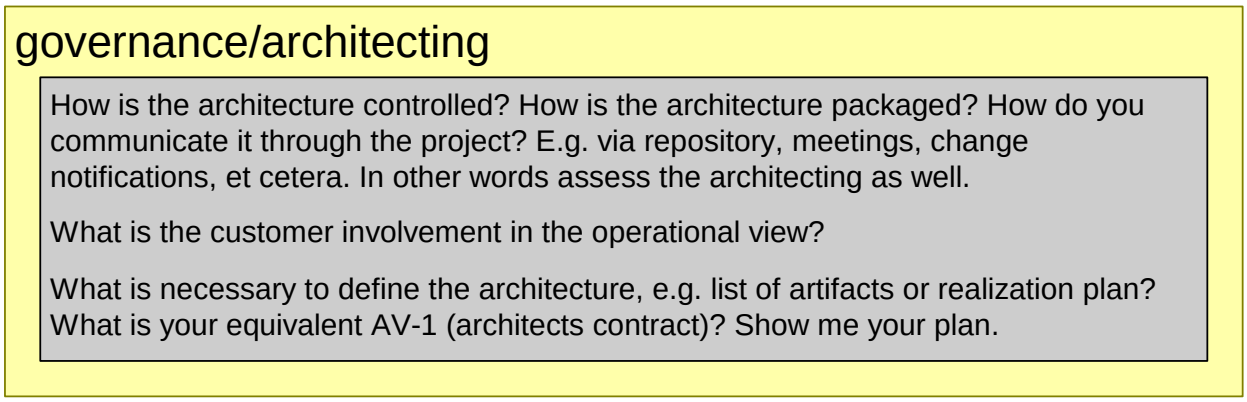

Figure 5. Governance and Architecting questions.

The assessment of an architecture most often also touches the organizational context of the architecture: how is the architecture created, who is responsible and many more governance questions, see Figure 5. Many process, people and governance related issues often pop-up as side effect of the architecture assessment.

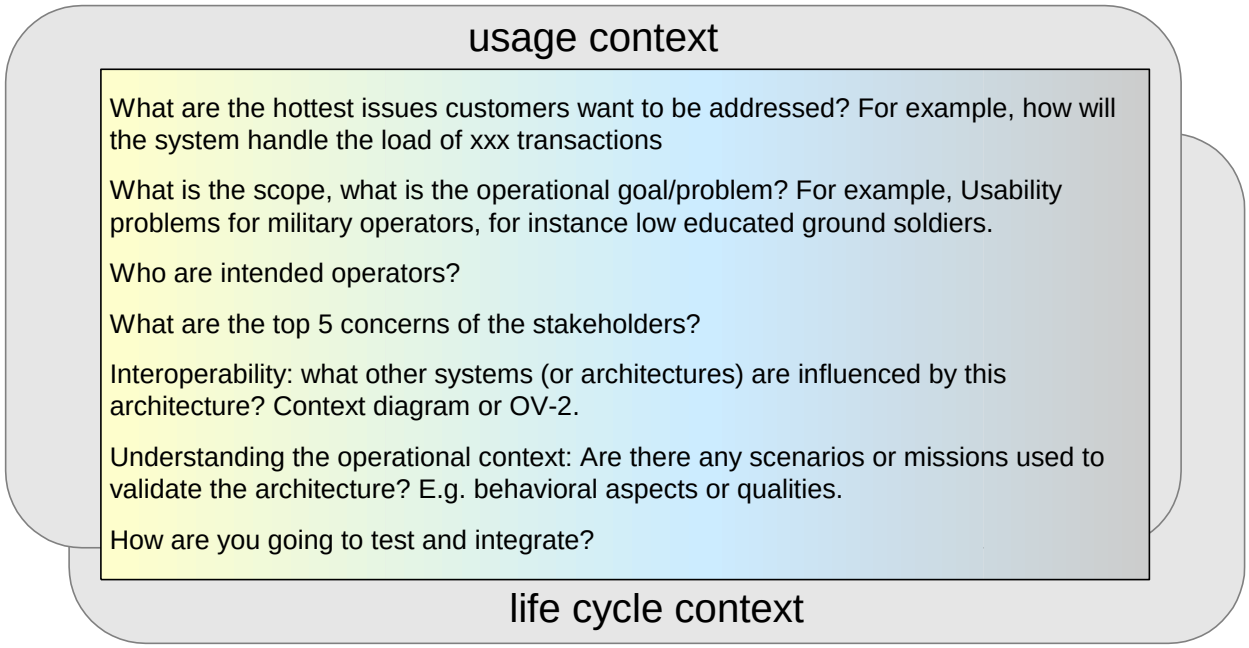

Figure 6. Questions from the context of the system

Many architecture assessment related questions are targeted towards the understanding of the context of the system: see Figure 6. The fit of the system in the context is one of the primary yardsticks of an architecture.

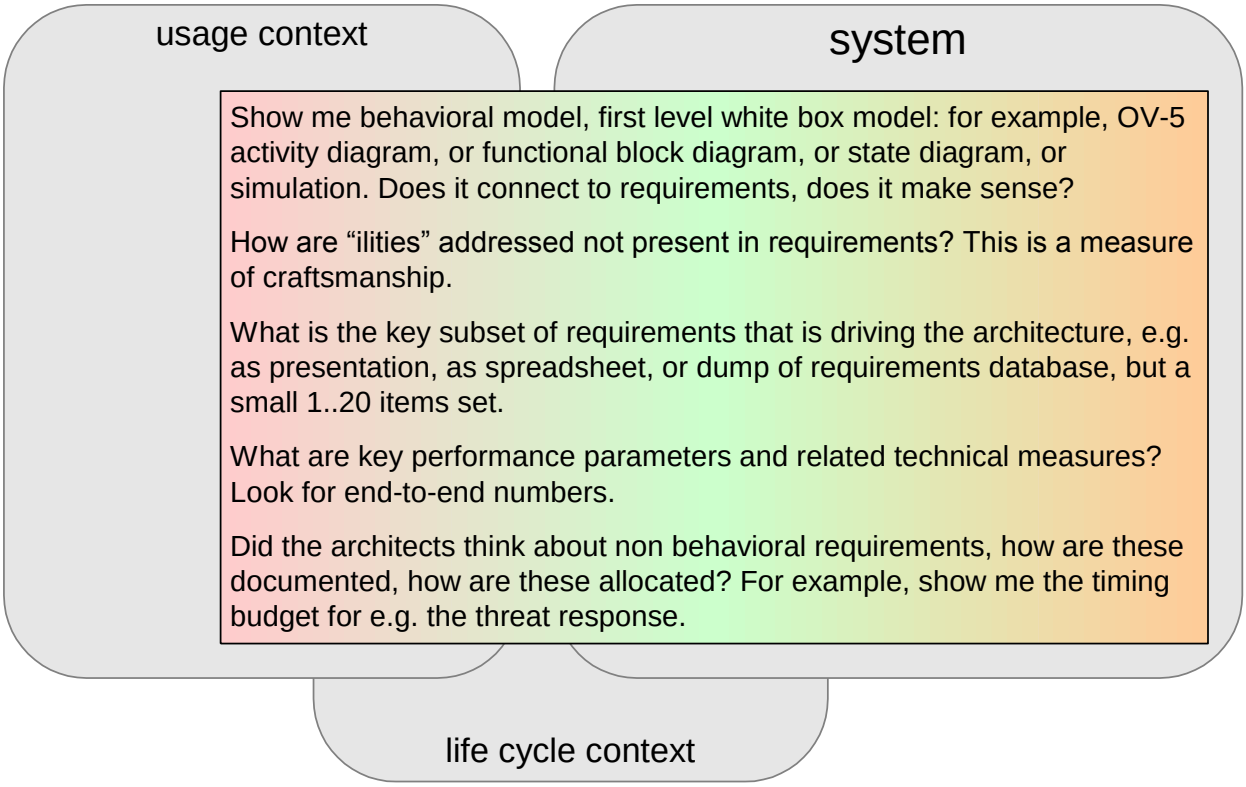

Figure 7. Questions about the system and its design and realization.

Another major set of questions is targeted at the system itself, its requirements and how these requirements are addressed by the design and realization, see Figure 7.

What are the (5 to 10) architecture principles? How do you address security? E.g. physical before virtual, do not harm, et cetera.

What are the main architectural trade-offs, what approach, criteria, or strategy is used?

Figure 8. Architecture questions.

Figure 8 shows a number of questions that are directly related to the architecture and are more overarching than the questions in Figures 5 and 6.

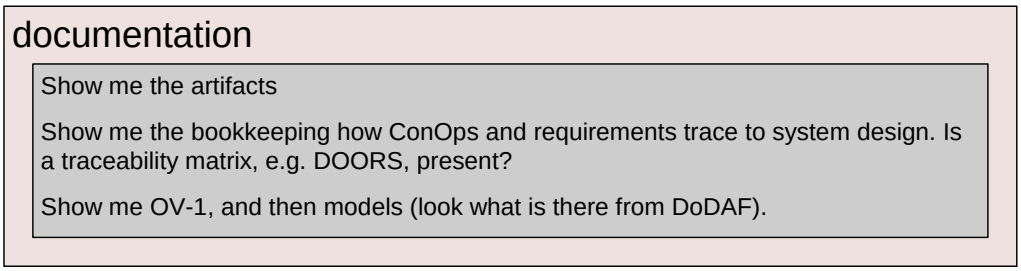

Figure 9. Documentation questions.

Figure 9 shows the documentation related questions. These questions are more focused on the availability of artifacts.

5. Conclusions

Many organizations have a need for architecture assessments. Some organizations have the assessments embedded and schedule assessments pro-actively, for example at one of the process gates. In other organizations some trigger is needed to ask for an assessment. The scope of such assessments can range from small, e.g. component level, to large, e.g. enterprise level. We concluded that architecture assessments ought to be done by architects complemented with stakeholders, especially customers.

The use of assessment methods and techniques, such as checklists, is seen as beneficial. It was observed that all methods and techniques developed for assessments are also applicable for forward architecting.

The assessment team looks primarily at artifacts and people, while looking for assessment owner concerns, vulnerabilities, gaps, risks, and understanding how the most relevant architectural issues.

The assessment result is shared with a broad group of people, upward with management teams, downward with engineering teams, and where appropriate with external stakeholders.

We made an initial list of questions that can grow and be transformed into an architecture assessment checklist. These questions address assessment support, governance and

architecting, the context of the system, the system and design and realization, overarching architecture, and the documentation.

Acronyms and Abbreviations

ARID	Active Reviews for Intermediate Designs
ATAM	Architecture Trade off Analysis Method®
AV	All Views
AV-1	Overview and Summary Information
ConOps	Concept of Operations
DoDAF	Department of Defense Architecture Framework
FMEA	Failure Mode and Effects Analysis
OV	Operational View
OV-1	High-Level Operational Concept Graphic
OV-2	Operational Node Connectivity Description
OV-5	Operational Activity Model
SysML	Systems Modeling Language
TOGAF	The Open Group Architecture Framework

Acknowledgements

The initial presentation by Jim Williams from the FAA stimulated our discussions.

Literature

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