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"Adapting C2 to the 21st Century"

COAT: Communications Systems Assessment for the Swedish Defence

Suggested topics:
C2 Metrics and Assessment, C2 Technologies and Systems

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Abstract

The transformation of the Swedish Defence has substantially increased and changed the demands on the communication systems needed to support its future missions. Sweden's focus on international missions and its role as framework nation for the Nordic Battle group further emphasize this. Increasing demands for interoperability, fast response, unknown mission areas and heterogeneous operating environments make the assessment of communications systems hard and complex. Our conclusion is that our traditional assessment methods no longer are satisfactory.

The COAT project aims to develop a user-centric, well-structured and traceable methodology for the assessment of communications systems. The development is focused on capabilities related to the technical parameters of the communications system, but the goal is to provide a method to express how these contribute to higher-level C2 capabilities and, ultimately, to tactical effects.

The methodology should, ideally, be applicable at any point in the life cycle of communications systems, from the study of evolving technologies, R&D, acquisition, operational use, to replacement and decommissioning.

This paper will discuss the ideas behind the project, our methodological approach and some thoughts on assessment of complex systems.

1. Introduction

This paper describes the current status of a project aimed at improving our current methods for the assessment of communications systems in a tactical and operational context. The project is called COAT, which stands for, loosely and unsurprisingly, Communications Assessment. The work is carried out by the Swedish Defence Research Agency, on a research contract from the Swedish Armed Forces. The competencies within the project team include basic radio science, wireless and network technology, information security, systems analysis and scenario techniques. The project is now in it's third and final year.

The aim of the work is to develop, test and implement an improved method that is both well-structured and manageable in practical use. For the method to deliver results of high quality and relevance, it must combine best practice in a number of fields of analysis. Since all assessments necessarily contain an element of subjective judgement, two absolute requirements are transparency and traceability, so conclusions can be linked to individual assumptions.

The most important goal is to provide a bridge between technological and military capabilities. The critical challenge is to assess how a specific communications system contributes to higher system levels effects. The method should ideally go both ways: from technical performance to military effects and the other way round.

It should be applicable at any stage in the life cycle of a communications system. Examples of uses may be:

- Assessment of system concepts
- Assessment of alternative system
- Assessment of complementary systems
- System under development
- New functions or services in existing systems
- Consequences of phasing out of existing system s

Purpose of this paper

Our intention here is not to give a formal description of a complete method for assessment of communications systems. The purpose is rather to discuss our perception of the general problem and our approach to a solution. The immediate goal for our presentation at this symposium to initiate a dialogue with other interested partners.

2. The problem

Many available methods are well suited for analysing the performance of individual radio links or entire communication systems at an infrastructure level. For (mobile) radio networks and systems of systems, where the complexity is higher, no reliable assessment method exists. The link from this to higher-level measures such as force effectiveness is even more tenuous.

The NATO Code of Best Practice for C2 Assessment is one of our main starting points. We consider this to be an excellent framework for the general problem of assessing C2 effectiveness. It is however too coarse for our specific needs. On the other hand, one measure of success for our project is whether it can be applied within the COBP framework.

COAT and C2 Assessment

According to various sources, "assessment" means:

"The classification of someone or something with respect to its worth"[1]
"The act or result of judging the worth or value of something or someone"[2]

The operative words here are "judging" and "value". Common synonyms of assessment are "appraisal", "estimate", "evaluation", and "valuation" and most significantly, "judgement". All these examples connote some element of subjectivity. So it is with assessment in our meaning: It is fundamentally subjective. There is no way around that, and what the customer pays for is the best possible, unbiased judgement. The proper way to handle it is through judicious documentation of all facts, assumptions and reasoning behind the conclusions given.

Value is also clearly context-dependent. What is valuable in one situation may be totally worthless in another. The lesson here is that the context must be specified before an assessment can deliver any meaningful result.

If the COBP Assessment framework is too wide, what is the scope of COAT? And what sets it apart from other types of studies? Introducing the acronym CA for the application of the COAT method, it is designed primarily when these

- Independence: the task has the character of outside review
- Operational relevance (not only technical analysis)
- Timely results (early assessment of new technology or neartime assessment of existing systems)

[1] http://www.thefreedictionary.com/assessment

[2] "assessment." The New Dictionary of Cultural Literacy, Third Edition. Houghton Mifflin Company, 2002.

Current practice

Assessments of various C2 elements are conducted on a regular basis, and the body of methodological knowledge and experience to build upon is indeed extensive. In fact, given the enormous literature and ongoing research activities, the reader may well ask, what more is there actually to do?

It is our firm belief, after having participated in many earlier studies, that the current practice is falling behind changing demands. The critical insufficiency is the apparent disconnect between analysis of technical performance and tactical effects. Too often, there is also a lack of analytical rigour and transparency.

These shortcomings are well known to seasoned practitioner in this field, though rarely openly admitted to. At the risk of stating the obvious, let us enumerate just a few sore points: imprecise formulation of the problem, inaccurate data, hidden assumptions, poor quality of analysis, lack of clear documentation, obscure reporting and unsubstantiated conclusions.

Bad assessments waste time and money for the people involved, and, if a bad decision is eventually made based on the result, entail enormous costs for the taxpayer. There are of course a number of reasons why reality fails to live up to the ideal: lack of competence, impossible timelines, vested interests and hidden agendas, pressure from industry and political considerations.

No method can entirely make up for these real-world facts, and least we forget in our analytical fervour, good decisions can sometimes actually be made on rather shaky grounds. Hoping for pure luck is however hardly a valid method. As analysts we have an ethical obligation to continually improve our work.

New challenges

The demands of interoperability, fast response and heterogeneous operating environments, with large number of actors, makes the both object of study, as well as the overall assessment task increasingly hard and complex.
(To be expanded)

Requirements for an ideal assessment method

- Provide the customer with an unbiased, relevant and timely result
- Report results on a conceptual level and in a language suiting the customer
- Provide transparency by linking results to all assumptions and data
- Make the conclusions more independent of personal or organisational bias
- Always support, never burden, the assessment team
- Be adaptable to different scope and depth of studies
- Handle contingencies, such as new directives or change in team composition

Supporting tools

In the software development field, there exists a number of standardised methods and tools, to handle a range of tasks, from user requirements to system design and change management. Some examples are the Rational Unified Process (RUP), Architecture Tradeoff Analysis Method (ATAM) and Common Criteria (CC). These methods or combinations thereof are also gaining increasing support and use also within military Systems Engineering and Capability Development.

As with any successful product, there is a temptation to use them far outside the area they were designed for. The temptation may be even stronger in fields that are relatively less mature or unstructured. C2 Assessment certainly falls in this category.
In our view, tools follow methods and methods follow tasks. CA is not the same as requirements management or systems engineering.

This does not absolutely preclude their use also in CA. When the assesment task is very large, the benefit may outweigh the investment in time to adapt them to the task.

3. The COAT approach

This section gives an overview of the approach we have taken. The description should be understood as an ideal process. In actual practice, it is hard to follow any set of simple rules as can be put down in writing. Indeed, one of the most important things may be to indicate what "shortcuts" can be taken, without forsaking quality.

In the following exposé, all the usual remarks apply: boundaries between steps are inherently fuzzy, and although it is depicted as a simple chain of activities, it is of course an iterative process, where earlier steps must often be revisited.

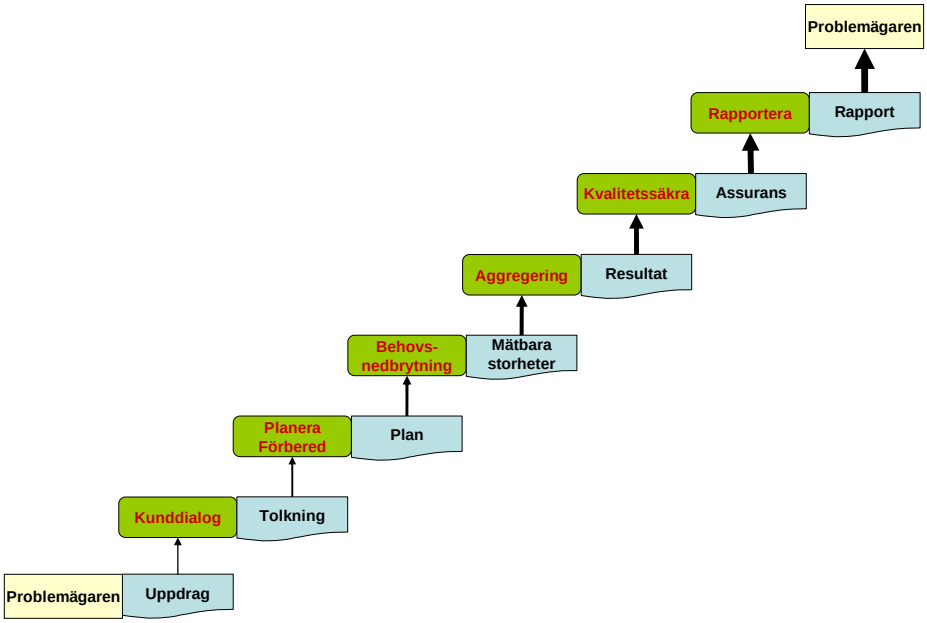

Figure 1 Main elements in the COAT approach (NEEDS TRANSLATION)

The COBP lists a number of roles that are involved in assessment work. For us, "customer" is the person or organisation that gives the task and to whom the assessment team reports back.

Customer dialogue

A necessary condition for any kind of study is of course that the right question is answered. This may seem tremendously obvious but this is probably the most common point of failure. In all but the most trivial cases, the system in focus is complicated in itself, and putting it into a relevant context further increase the complexities.

Therefore, a constructive customer dialogue is of decisive importance. This is discussed at some length in the COBP, so we do not have to dwell upon it here. We only wish to point out the problem is so general that good methods and tools can be found in many places. The best starting point is to use some variant of semi-structured interviews. One example is the practice of "User Requirements Elicitation" that is common in many larger system development projects.

In the analytical community, the received wisdom says that people often do not know what they want: ”First find out what the question is – then find out what the real question is.” From the customers point of view, this is not seldom perceived as arrogant and not terribly useful: “Ask an analyst a question, get a question in return“. Still, the analyst has a special role and an obligation to look into the issue from an outside perspective. Framing the question in a particular way, the customer can bias the analysis towards any desired result.

There is actually a corollary to the above statement: ” - then find out what part of that question can actually be answered”. Even if we can formulate the ”real” question, it may prove too hard within the constraints of available time and money.

The customer dialogue must produce two results:
In a narrow sense, it must make clear the purpose of assessment. The assessment team leader must have a clear understanding of why the task is given and and in what context the result will be used. This will guide the team leader in defining the scope and depth of the study, but equally important, the form of the reporting back.

In a more general sense, the customer dialogue should help the team to understand the operational context of the communications system in focus. To do this normally requires the participation of several subject matter experts.

The customer dialogue frequently will require a number of iterations, but sooner rather than later, the assessment team must take over full responsibility for the work. Further interaction with the customer should ideally be limited to predetermined decision gates. In practice, the team will have to turn to the customer or his representatives to get data or information from various subject matter experts.

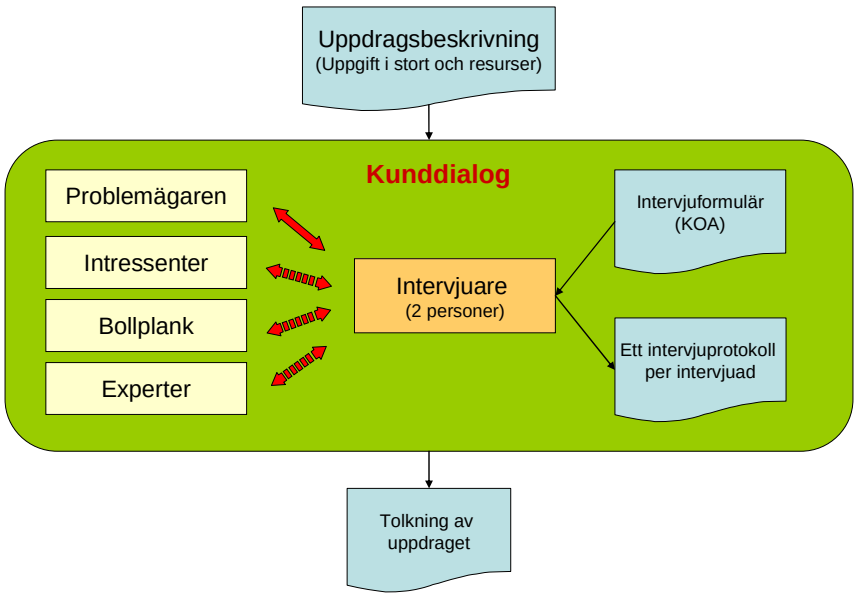

Figure 1: Parties involved in the customer dialogue (NEEDS TRANSLATION).

Interviews with different persons should be documented separately, in order to be able to trace what assumptions come from where. The final interpretation of the task should be checked with the customer before proceeding.

Planning and preparation

Once there is agreement on the problem formulation, planning and preparation for the actual assessment work can proceed. This is not really different from any other kind of study, but the documentation plan is of special importance, since it is the primary vehicle to deliver the necessary transparency.

Modelling

When the problem formulation is nailed down, the next thing to do is to define the system in focus: the elements of the communications system that should be assessed. This must be done in considerable detail to make it amenable to analysis. It is of course very different to assess a future system based on emerging technologies or evolving standards, than existing system. In the former case a lot of assumptions about implementation must be made.

The next step is to define a relevant operational context within which the communications system can be analysed. In our experience, the best method to do this is using scenarios. Constructing a scenario from scratch is a time-consuming activity. It is generally far better to start from some existing scenario. In some cases, the customer may actually demand that a set of standard scenarios should be used.

Regardless of where the scenarios come from, the main work for the assessment team is to formulate a number of smaller use cases or vignettes, within the framework of the overall scenario. These will set the scene for communications-related activities. To be useful, such a vignette must define a situation or specific event, a military task, the units and other actors involved and the C2 system.

This is a time-consuming part of the work, and therefore it is tempting (or plain necessary) to limit the number of vignettes. The consequence is that it will be much harder, if not impossible, to draw more general conclusions from the analysis.

Analysis

(To be completed)

Synthesis

(To be completed)

Quality control

(To be completed)

Reporting

(To be completed)

4. Further work

Further testing, analysis and documentation

The main activity in the last part of our work is a test of all parts of the method in a realistic situation. The final parts of the description will have to await this test and subsequent analysis.

Validation and measuring improvements

Validation of the method is hard to do. The best we can achieve is to have the result evaluated by prospective customers, not involved in the test. The analytical work and documentation can be controlled by peer review.

An interesting question is how we can measure improvement. What is the baseline? It is not practical to make any controlled experiment, performing the same task with and without the COAT method. One radical suggestion is to compare the test results with a quick-and-dirty "gut-level," professional assessment by a subject matter expert with extensive experience.

Implementation issues

A method that cannot be transferred cannot pretend to be scientific. On the other hand, as pointed out, all assessments contain an element of professional judgement, which is not possible to pass on.
(To be completed)

Bibliography

(To be completed)