TORA - Three Level Ordered Requirements Analysis

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Abstract

The paper proposes a three level schema to order the results of requirements analysis: social, socio-technical, and technical models. The proposal is derived and evolved from a methodology used in several interdisciplinary requirements analysis projects for various requirements areas, e.g. German Constitution, or social security goals in consideration of high damage potential. The three level schema maps to other current requirements engineering methods. From that perspective the three levels seem to be a very useful scheme to order requirements analysis results and give some hints for integration of non-functional requirements, analysis steps, and improvement of completeness.

Keywords: *requirements engineering, non-functional requirements, normative requirements analysis, social model, socio-technical criteria, ordering schema.*

1 Three Levels for Requirements Analysis?

Requirements analysis is an evolving area, getting input from various approaches. It would be helpful to have a schema in which the relationship between the results of several analysis methods could be brought together.

1.1 Some Questions

A lot of current time software projects try to reach a higher integration of information technology systems. This integration is often not only technical but also needs to meet more requirements of their operational environment (e.g. [1]) or lead to more impact on social systems. Up to date examples are standardisation of PKI issues and integration of digital signatures for legally binding transactions with government agencies [2]. In such complex requirements engineering processes the project managers and project team increasingly face some of the following questions:

- Which non-functional requirements are to be considered?
- How to derive technical requirements from social goals? Often there is a wide "description gap" between very generalised social goals and technical specification. How to overcome this description gap?
- We find very different types of sources for requirements. How are they related and how should they be ordered?
- Is sufficient completeness reached, e.g. for non-functional requirements?

Beside the answers for a single requirements engineering process this are questions of general interest. An answer may - for example - improve the chance for re-use of requirements analysis results.

1.2 Towards an Answer

A piece of an answer to all this questions is given by ordering requirements in a three level schema:

- The Top Level identifies all the **social goals** relevant for the application.
- The High Level describes requirements in a **socio-technical manner**.

[1] In October 2015 the author wanted to ensure better availability of the paper. The paper was republished at the University and State Library Darmstadt (ULB). The text of the document is unchanged to the previous version as of June 2002. The differences concern the URN for provisioning the document, usage licence added, page breaks, hints on new links of references and contact address.

- The Low Level collects and specifies requirements in form of **technical models**.

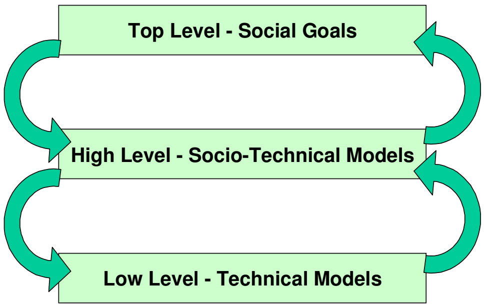

Figure 1: Three levels for ordering requirements used in an iterative analysis process

On every level we find a set of requirements written in the "language" of the level. Every single requirement can be seen as a node. To reach completeness for the technical models the nodes of the upper level are linked by traces to lower level nodes. A trace expresses that an upper level node "loads" to a lower level node, i.e. aspects of the upper level requirements are to be satisfied by the lower level node. An upper level node is covered fully by a lower level if all relevant aspects are "loaded" to lower level nodes. The relationship between nodes is expressed by links or traces.

The three levels as a general ordering schema and the traces give four obvious benefits:

- Social requirements are often formulated as a "general clause" (e.g. in law). With the levels "social", "socio-technical", and "technical" we find an obvious structure for *breaking up the description gap* between general clauses and technical specification. This points to a method for dealing with some types of social requirements.
- We often find lots of different types of requirements in a requirements engineering project, e.g. standards, law, business cases, use cases, etc. The three levels give a *basic structure to order* and handle these various fragments.
- On each level we should be able to describe requirements in level specific terms, i.e. social, socio-technical or technical "languages". Therefore it can be expected that on the higher levels we get types of requirements which are relatively independent from implementation details, e.g. the current programming paradigm. The *chance of re-use* of upper level requirements can be improved.
- Using traces to make the relationships between nodes explicit *gives rationales* of decisions and better understanding of complex results. Each level address specific types of decisions. By checking nodes and traces for the *completeness* and consistency, the overall requirements analysis can be improved.

The levels and traces between them have been used successfully: from constitution as non-functional anchor some requirements for PABX systems were derived (see Figure 2). Each of the three levels may contain different types of nodes. These different types result from use of different methods to overcome the description gap of the specific level. To order the nodes within a level various

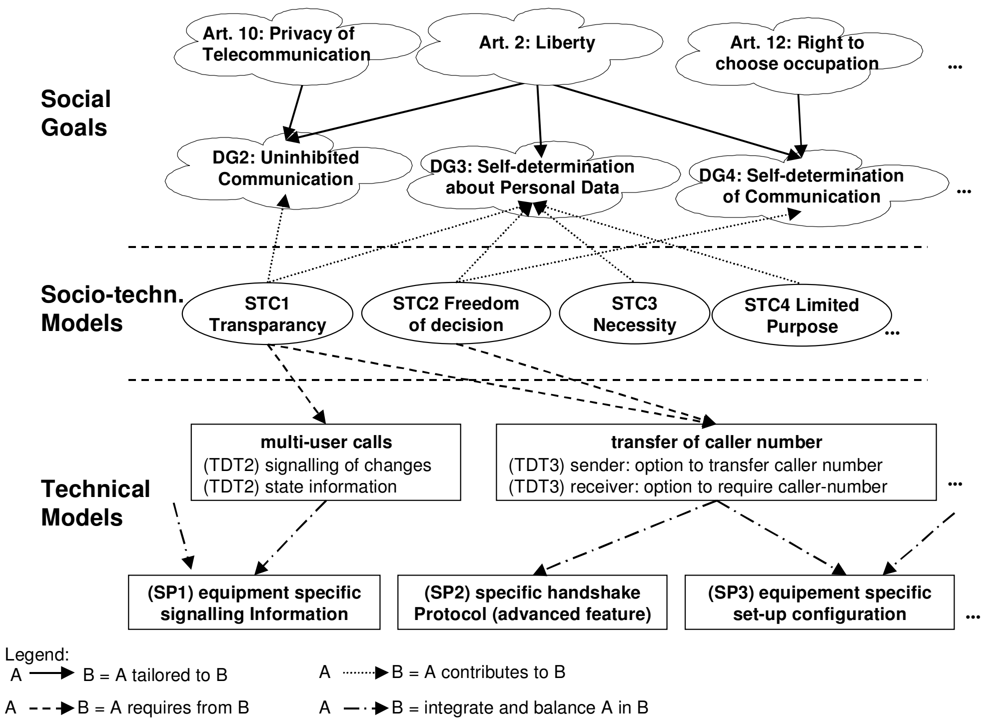

Figure 2: Segment of the NORA criteria-system for enterprise PABX systems derived from law. Note that the arrows express the methodical relationship but not the traces in an requirements analysis.

sub-layers can be used (examples see below).

1.3 Roots of the Three Level Schema

The three level ordering schema was originally developed and successfully used in an interdisciplinary requirements engineering project dealing with non-functional requirements. In the late eighties lawyers and computer scientists where asked to find criteria from law and co-determination of employees for selection of a big private automated branch exchange system (PABX) for some organisations. The project developed a system of criteria and requirements for technical functions derived from the German Constitution. It was ordered in the three levels (see [3] for details). The methodology for deriving legal requirements was reused for several additional fields of technology, e.g. directory systems and digital signatures.[1]

With the successful adoption of the approach to three more requirements areas, the methodology of Normative Requirements Analysis (NORA, [4]) was developed. One project dealt with *socio-psychological impacts* of applications of digital signatures in work environments of lawyers and judges.[2] IT security focuses often on preventing faults and attacks. But social preference tends towards limitation or *reduction of damage*. Directed to this target generic criteria where derived and applied to public key infrastructures and applications [4]. Currently the methodology is applied to the *requirements area of education* to identify design criteria for environments for electronic education [6].

When looking with some distance to the three levels and the ideas behind the transitions the Three Level Ordered Requirements Analysis (TORA) might be applied to more requirements areas. Section 2 explains the three levels based on an example from NORA. Section 3 shows that other methods also fit into the three level ordering schema. Section 4 gives a conclusion and points out to further work.

2 The Three Analysis Levels

When looking at the description gap between social level requirements and technical specification at the beginning of a requirements analysis we find the following situation:

- Several areas from which technical requirements may derive can be identified, e.g. purpose of the system, law, security, usability, operations and monitoring, performance and scalability, or rollout process. From the perspective of a requirements engineering process every of these **requirements areas** can be understood as an anchor for further work. The list of requirements areas has primarily the function of a checklist and some areas will usually overlap in some aspects.[3]
- Especially in projects which address new technologies we have little knowledge of these technologies, e.g. public key infrastructures and digital signatures. The **field of technology** must be understood in the requirements engineering process.
- The third group of questions derives from the environment in which the technical system should be used. The **field of application** includes the specific local conditions, e.g. from the perspective of a workplace[4], culture of an organisation, or separation of duties within an organisation.

This list gives three "corners" for the requirements analysis. From a very general view the following questions must be understood and answered related to these corners:

- Which relevance do the requirements areas have to the fields of technology and application?
- Has the field of technology impact on the requirements areas as well as on the field of application, e.g. digital signed documents for lawsuits in general as well as for control of a form of evidence by a customer?
- To fulfil the requirements of the field of application: what specific aspects of the requirements area must be detailed as well as which specific adoptions of the technical system are required?

These questions show that each of the corners of the requirements analysis is related in both directions to the other two. E.g.: A requirements engineer may try to reduce the set of top level security aspects to be considered for the requirements analysis very early. He can do this in a substantiated way by checking out the security relevant aspects of the fields of application and technology.[5] The example shows that often low level aspects are highly relevant for reducing requirements and design space. The interdependencies of all the three corners must be in the requirements engineers view. During requirements analysis a more precise understanding (and description) of the requirements areas, the fields of application and technology is developed. This can be understood as *stepwise accumulation* of knowledge.[6] It is performed during iterations passing the three levels down and up.

1 References to the results of these projects are documented in [4], pp. 338.

2 This requirements area was called "Anwendergerechtheit" (socio-psychological suitability for users). While usability concentrates on the work environment of an individual user "Anwendergerechtheit" looks for impacts of technology to individual (psychological) development and development of social relationships in co-operation based on IT systems (see [5]).

3 Depending on how the aspects are separated over several anchors the number of identified requirements areas may vary in a range between 10 and 20.

4 Often workplaces may be generalised by classes, e.g. "unexperienced customer", "experienced customer", and "trained vendor".

5 Other example e.g. [11], pp 367.

6 We prefer "stepwise accumulation" instead of "going from abstract to detailed" or "refinement" because the understanding and documentation of *each of the three levels is extended* with details related to the three "edges" during the iterations of the analysis.

The idea behind TORA is to integrate or at least to coordinate several requirements engineering approaches including the analysis of non-functional requirements. If this can be achieved in a very early stage of development processes, hopefully some social impacts can be anticipated. In this case the design and specification of the technology should be directed in a way by which negative social impacts are avoided and potential benefits improved.

The further discussion of this section assumes that it is one of the harder tasks of a requirements analysis to operationalise non-functional requirements like from the constitution. Therefore, the three levels of TORA are introduced by an example in terms of a NORA project. With respect to the extend the of a conference paper a lot of details must be omitted and the example must be restricted to a very small excerpt of one requirements area. Given these restrictions the best choice are privacy aspects of PABX systems: they don't require specific background knowledge and are easiest to understand. Even if some of the technical requirements seem to be obvious today they were not in 1988 and may be not in new fields of technology, as for automated communication managers, voice over IP, or use of pseudonyms with digital signatures. Please note that the example is based on German law. More details of this example as well as more examples are available in references [3], [4], [5], and [6].

2.1 Top Level Analysis: Social Goals

The purpose of the top level analysis is to collect the social goals relevant for the fields of technology and application, e.g. business rules, constitution and law, security goals, or input parameters for a mass model. In the understanding of TORA these goals are determined from a social perspective or by social setting. For the PABX system we need to search e.g. for purposes of telecommunication, law related to telecommunications in enterprises, special security issues and so on.

The social goals can be understood as the anchors for the requirements analysis. In the social description, the technical systems are often absent (e.g. in most articles of a constitution) or only in a role to support or give potential impact to social functions. From the perspective of the requirements engineer the social goals are usually relatively fixed. The social goals often need to be focussed on the planned system.

Top Level Analysis with NORA

For social goals in some areas of non-functional requirements a high social consensus can be assumed. For democracies this assumption should be valid e.g. for law and especially the constitution. Accepting a constitution as the leading ideas for organisation and development of a society, these rules should somehow be normative for technical development. Even if such an consensus does not exist in a written form (as for law) similar anchors can be identified for the three additional requirements areas listed above.[7] From the perspective of technology developers these anchors are social norms which should be accepted by most stakeholders. A more specific form of TORA dealing with such requirements areas was called Normative Requirements Analysis (NORA, [4]).

The social determined or preferred rules of the specific requirements area (normative social goals) are the anchor for NORA. The **first step of NORA** is to collect all relevant normative social goals of the requirements area under analysis. Relevance is to be examined in relationship to the fields of technology and application.

Example: Relevant articles of the German Constitution [7] (Grundgesetz, GG) are in the area of PABX systems for the area of enterprises e.g.:

- *(Article 10) Privacy of letters, posts and telecommunications:* Addresses (besides others) the confidentiality of communication using telecommunication systems.
- *(Article 2) Liberty:* Contains (beside others) the freedom to perform or to omit from actions.
- *(Article 12) Freedom to choose an occupation:* Allows free choice of occupation as well as balance of rights between employer and employee.

Note, that the articles do not only give constraints but contain also positive visions which may be supported by the technical system. In the worst case the technical system must be reconcilable with the goals of the constitution. In the best case the system will open up beneficial effects for the social goal.

Unfortunately the articles of the constitution (as well as the normative social goals of other areas) are usually given in terms of general clauses. They are not directed to applications of technical systems and therefore not very helpful for a developer. The **second step of NORA** deals with that problem. It "tailors" the normative social goals, but stays on the social level. The task is to identify the aspects of the general clauses which are relevant for the fields of technology and application. The identified aspects are reformulated with focus on the fields of technology and application, i.e. introduce appropriate terms and their definitions. These definitions separate the specific aspects related to the fields of technology and application, concentrate on them, and omit other aspects of the normative social goals. New objectives for the normative goals may arise by checking application scenarios for impacts. They can lead to a specific new interpretation of the normative goals. The resulting terms are called *Derived Social Goals* (DG). In a graphical representation we can use a sub-layer to depict the derivation (see Figure 2). The relationship between the nodes of the normative and the derived social

7 It may be subject to discussion if a "normative" basis of requirements can be identified for a requirements area. E.g. this was the starting point of the discussions with an expert in the field of pedagoic.

goals may be n:m. The graph builds the first part of a NORA criteria system.

Example: From the above listed constitution articles are tailored e.g. to the following derived goals:

- *(DG2) Free communication:* This goal is contained in (Article 2) and (Article 10). It requires that people can communicate without being afraid that they might be controlled by a third party. The goal concerns the content as well as the relationship between the participants of the communication.
- *(DG3) Self-determination of personal data:* This goal was derived by the Federal Constitutional Court (Bundesverfassungsgericht [BVerfGE 65, (43)]). It bases e.g. on (Article 2). Basically it permits the processing of person-related data only under two conditions: permission by law or consent of the person. The latter can be given in several forms or assumed under some circumstances. The goal is the general basis for the German privacy rules and is also to be applied to PAPX systems.
- *(DG4) Self-determination of communication:* DG3 addresses only privacy-aspects which are related to telecommunication. Features of modern PABX-systems may have also impact on the communication workplace of the users, e.g. automatic callback functions. Therefore, a specific DG for the field of technology was derived from (Article 2) and (Article 12). It requires that the user may decide to communicate or to reject.

2.2 High Level Analysis: Socio-Technical Models

The level of socio-technical models build the middle of the bridge spanning the description gap. The purpose of the high level is to make decisions about the relationship between the (planned) social and technical system. In the understanding of TORA the interactions and dependencies are described in terms of socio-technical models. These models separate "roles" and tasks between the social actors, e.g. people or organisations, and the technical systems. The requirements engineer develop implicit or explicit scenarios for the future socio-technical processes. Description types can be e.g. business processes, user goals (see below), or real world object's life cycle transactions relevant to the system. Usually the top level functional requirements of a project can be solved by different compositions of technical measures, organisational rules, legal regulation (e.g. by contract) and qualification of stakeholders. If we find alternative socio-technical solutions, decisions on where to go are required.

High Level Analysis with NORA

To make socio-technical and technical design decisions we need criteria, especially at the beginning of an upcoming new technology. The **third step of NORA** focuses on the conditions required in socio-technical solutions regarding the functional requirements. These solutions should fulfil the derived social goals. In the top down perspective the DGs are divided into objectives of socio-technical solutions related to the fields of technology and application. Looking bottom up from the socio-technical level the task is to identify generic aspects contributing to the DGs (see Figure 2). This can be done by diverting (post-)conditions which must be met by socio-technical processes, e.g. use cases, or technical artefacts.

The resulting terms are called *Socio-Technical Criterias* (STC). Each criteria may contribute to several DGs, as well as every DG may load to several criteria. The alternative socio-technical solutions may have different impact on the DGs. The solutions are assessed and selected by using the criteria. The criteria can also be used to search for solutions and give directions for technical alternatives. Through selection and guidance the criteria have influence on the technical system's functions and properties.

Example: The following socio-technical criteria can be derived for the running PABX example beside others:

- *(STC1) Transparency:* To know about privacy related objectives the user must be able to recognise the relevant states and processing of PABX equipment and system features (DG2, DG3, also as a precondition for (STC2)).
- *(STC2) Freedom of decision:* If not permitted by other regulation the user him- or herself must be able to decide if his personal data are processed or transferred by the technical systems (DG3). The user must be able to decide if he wants to communicate or not (DG4).
- *(STC3) Necessity of data:* It is only permitted to process, transfer, or store personal data which is required for the purpose which was granted by regulation or consent of the user. The record must be minimised. This implies beside others that personal data within the PABX system must be deleted if it is no longer required (DG3).
- *(STC4) Limited Purpose of data:* If processing of personal data is permitted for a purpose it is not permitted to use the data for other purposes not included in the permission (DG3).

Such socio-technical criteria are applied to several design objects in a crosscutting sense.

2.3 Low Level Analysis: Technical Models

The purpose of technical level of analysis is to focus on the aspects relevant to the technical implementation. In the technical models the technical artefacts get precedence, i.e. to switch to the inside view of the planned technical system. The social parts are omitted as far as they are not build into these artefacts. From the perspective of the requirements engineer the users appear only as "outside" actors giving inputs or recognising outputs. Types of descriptions in that level are e.g. design models, collaboration diagrams, interaction diagrams, specifications of user interfaces, data formats and so on. The low level may contain several sub-layers related to different granularity and degree of detail of the models.

Low Level Analysis with NORA

With the socio-technical solution in mind the criteria can be applied to technical design objects. For the chance of better re-use this should be done in two steps: The first sub-layer omits the realisation details, e.g. implementation details of formats or protocols. It can also omit detailed workplace conditions, e.g. a standard ISDN desk telephone in contrast to a call centre equipment. The layer describes Technical Design Targets (TDT) for design objects. The fifth step completes the missing technical and context of use details and gives specification proposals (SP). **Note:** In parallel to the TDTs it does make sense to document the related organisational rules, legal regulations, and so on. But this is out of scope of the technical requirements analysis.

Step 4 of NORA consists of two tasks. The first is the *identification of relevant design objects*. A relevant design object is any technical artefact which may have positive or negative impact on the normative requirements area. Therefore, design objects are selected specific to the requirements area. The design objects may be derived from other activities of the requirements analysis as well as by considerations driven by NORA. As the design objects are "abstract" they may also be separated into some kind of elementary features.

Examples of NORA design objects**:**

- For the area of privacy law are relevant: The defined data structures containing personal data, the features using such data, and the controls applied to them, including protection mechanisms like access control. Elementary features of ISDN-PABX systems are e.g. the features "transfer of caller number" and "multi-user calls" including conference calls, to cut in a call by operator, or tapping a call. A design object with personal data is the log of processed calls with the numbers of the participants, time, and duration.
- For security related criteria every artefact which may contribute to high damage is selected as a design object. These are not only processes and data formats, but can also be e.g. system architecture or abstract "structures", like in public key infrastructures.

The second task is to *apply the socio-technical criteria* to the identified objects. I.e. to search for the best variant or modification of a design object to support all of the criteria (if applicable). This gives the Technical Design Targets (TDT) for the abstract design objects. The description of the targets is bound to the design objects.

Example: Some selected TDTs contained in the NORA criteria system for PABX-systems are:

- (TDT1): Status information of a call should give appropriate information. This TDT is only applicable for equipment with displays. Therefore, the next item gets high weight for analogue phones.
- (TDT2): Informational controls for multi-user calls by signalling to all participants of a call.
- (TDT3): The initiator of a call must have the control to send or to suppress sending of his number. The controls should be supported by several alternatives in parallel: e.g. pre-selection per call, configured per line, and suppressed for the whole PABX-System. Analogue phones should not transfer a caller-number per default. The permission to change this in special cases might be granted to system administration.
- (TDT4): The receiver of a call may require the transfer of caller-number. The controls should be supported by several alternatives in parallel: e.g. configure auto-reject for unidentified calls, and require caller number for current incoming call. The latter leads to a handshake-protocol between initiator and receiver.

The fifth and **last step of NORA** is to transfer the TDTs into specifications. They specifiy how the TDTs are to be implemented in components considering the details of the underlying technology and workplace conditions. The elements of the sub-layer in NORA research projects are called "specification proposals" (SP) and used to evaluate technical feasibility of TDTs. Implementation objects composed from several elementary features need to collect all relevant TDTs for the elementary features contained in that implementation object.

Examples: For the PABX system the parts of the above TDTs for elementary features can be fulfilled by following specification proposals:

- (SP1) Signalling during establishment of a call (TDT1) and status information (TDT2) on "real" ISDN-phones can be given via display while analogue phones need a signal tone or a spoken announcement.
- (SP2) Specification of the handshake using the protocols supported within the specific PABX-system
- (SP3) The set-up configuration of a PABX-system may support different default-values for the feature "transfer of caller-number": for ISDN-phones and for other equipment. The separation allows for different automatic set-up for newly installed phones: e.g. per call selection for ISDN-phones and omitted transfer for others.

Note, that conflicting goals respectively criteria or targets are carried along with the stepwise accumulation. The balancing decisions are made as late as possible, typically in the "specification proposals" sub-layer. Like that the chance of re-use of NORA results increases because the design space is kept open.

3 Ordering other Methodologies with Levels

Functional requirements as well as other requirements areas are not covered by NORA, e.g. main purpose of a system, performance aspects, maintainability, and so on. Even if the three levels were identified when developing NORA, similarities to some of today's requirements analysis methods can be found, e.g. the Common Criteria, the ISO standard for usability, TROPOS, and use case based requirements analysis. As a promising parallel we can map the results of these analysis and design approaches to the three levels, even if not explicitly stated. If the three levels give a common ground between several methodologies we get good preconditions to proceed in a co-ordinated way and combine the analysis results.

This section checks for a possible mappings of other approaches. Of course, many other types of models appear in other methodologies. Similar to NORA they may be seen as own classes of analysis results which build separate sub-layers but be ordered within the levels. Identification of clearly separated sub-layers is shifted to further work.

3.1 Common Crieria

Several national organisations for IT-security agreed with feedback of the IT-security community to a common framework for security specifications and evaluation called Common Criteria (CC) [8]. The CC contain a general framework for comparable security, guidelines for security specification documents, pre-formulated functional requirements grouped by security measures categories, and grouped requirements for security-evaluation. The documentation guidelines require besides others the following content:

- *in the Target of Evaluation (TOE) security environment section:* assumptions about the security environment, all threats to the assets of the system environment, organisational security policies. This section can be mapped to a social setting, i.e. top level analysis.
- *in the Security objectives section:* security objectives for the TOE and security objectives for the environment. Both together with the organisational security policies must cover all threats identified as relevant. This section can be mapped to the socio-technical model.
- *in the IT security requirements section:* technical IT security requirements that must be satisfied by the IT system under evaluation or its IT-environment. The section fit into the technical level.

The pre-formulated requirements in part 2 of the CC can be mapped to technical level. As they have to be completed by application and implementation details they are similar to the TDT sub-layer.

3.2 Usability

ISO 9241 part 10 [9] describes seven high level principles on user interface design considering usability. These are independent of a specific system. The principles are suitability for the task, self descriptiveness, controllability, conformity with user expectations, error tolerance, suitability for customisation, and suitability for learning. They should be respected in the requirements analysis with respect to the context of use of the system. The context of use can be different per class of users, work conditions, equipment and tasks to be solved with the system. The principles can be applied for specifying as well as for evaluating the user dialogues of an IT-system.

The use of the principles requires the analysis of technical and social factors and gives guidelines for technical design targets in the sense of NORA. Therefore, the usability principles are similar to socio-technical criteria.

3.3 TROPOS

The authors of TROPOS [1] propose a "requirements-driven development methodology". During the early requirements analysis the intentions of the stakeholders and their dependencies should be modelled in a first *i* model*. It contains goals for the required system features in terms of a social perspective as well as soft-goals, like increaing the market share. From the perspective of the three analysis levels this model seems to be located on the top level beside other social models.

The further tasks of the methodology elaborate a means-ends analysis, a strategic dependency model, and a strategic rationale model. In this stage of the analysis human and technical actors are part of the models, as well as soft goals. This implies that these models take a socio-technical view, as TORA high level analysis does. While some parts of soft-goals may be solved during the previous tasks TROPOS recommends to keep the unsolved aspects as soft-goals in this phase of the analysis. The remaining soft goals, e.g. security or usability, should be decomposed into sub-goals. The sub-goals are used for assessment of alternatives in the architectural design. From this perspective the sub-goals seem to be roughly comparable to socio-technical criteria while the architectural models and further detailed technical models are naturally part of the technical level.

With TORA more requirements areas, e.g. security, usability and law, are used as "anchors" besides the purpose of the system (i.e. the first i* model in the example). While in the TROPOS example security requirements arise "only" during the requirements engineering process, TORA proposes to check all known anchors for relevance. The probability for missing important aspects should be reduced. Looking to requirements areas as a checklist it is suggested to re-use existing requirements knowledge in early stages, e.g. as documented in the Common Criteria.

3.4 Use Case Based Requirements Analysis

Use cases are introduced as the user's view on the system functionality. Even if examples in literature cover a wide range from general process description to models containing only technical actors, use cases focus mainly on a system process initiated by an actor. "Three named goal levels" are introduced in [10], i.e. user goals, summary level, and sub-functions. Summary level groups user goals. The summary level describes the "why" while the sub-functions level specifies the (technical) "how". It is also proposed to derive use cases from business models ([11]). From use cases several models of the technical system can be developed.

Nodes on the summary level appear as anchors and abstract to a social view. Therefore, from the perspective of TORA these should fit into the top level. Business process models ([11]) or user goals (in terms of [10]) focussing on the user interactions are to be ordered to the socio-technical level. while interaction diagrams, design model, sub-functions, etc. are low level nodes. As stated above, specific sub-layers may be used within the levels for better ordering. Business process models have a tendency towards the upper border of the socio-technical level while "classical" use cases towards the lower. (Note, that NORA not only leads to criteria but may derive additional or load to existing use cases. E.g. in the area of privacy the privacy officer is introduced as a stakeholder. He as well as the user may require privacy related use cases, e.g. for offering information to give transparency (STC2)).

4 Conclusions and Further Work

The three levels "social goals", "socio-technical models", and "technical models" is obvious structure for breaking up the description gap in requirements engineering. Several methodologies seem to fit into the schema. This proposes a good chance to connect functional and non-functional requirements analysis - by using traces as well as by co-ordinated analysis steps. Keeping the three levels in mind eases orientation in requirements analysis.

Integration of approaches like NORA draw the attention to potential social impact and possible solutions in a very early phase of requirements analysis for new fields of technology or application. I.e. for some aspects at least one "round" of try and error can be avoided and a higher acceptance in the public is reachable.

Traces between social anchors, socio-technical criteria and models, and technical design objects transfer the "loads" and rationals from upper to lower levels. Even if top down analysis is preferred, as depicted in Figure 1 a full analysis needs several iterations. The upward direction considers impacts and interdependencies between technical feasibility and social goals. Checks improve completeness and consistency of the requirements analysis.

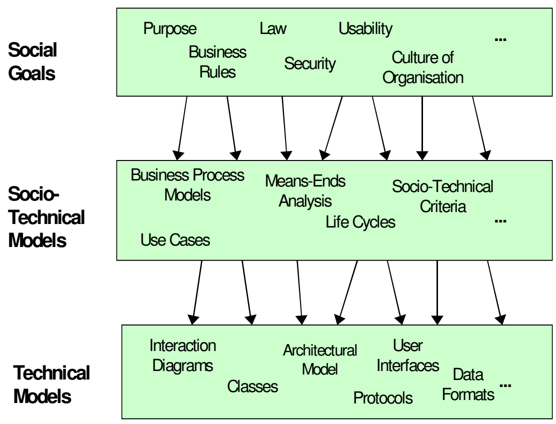

Figure 3: Some requirements areas (Top Level) and types of nodes in TORA. Arrows symbolise traces between all types of nodes.

Further work will look for more methodical aspects, i.e. how to combine the different requirements analysis approaches on the three levels. This includes the definition of more sub-layers related to types of models as well as strategies for linking nodes by typed traces.

Experience from NORA projects showed that similar results appear in different requirements areas and fields of technology and application. They seem to have the characteristics of layer specific requirements patterns. Therefore, a second task is the search for stable requirements patterns. Even the relationship between such requirements patterns and reusable fragments of code seems to be interesting, especially if derived from non-functional requirements areas.

At last more requirements engineering approaches should be checked for their mapping to the three level ordering scheme of TORA, to Multi-Dimensional Separation of Concerns [12] or requirements identification leading to crosscutting in Aspect Oriented Programming [13].

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