Legal Requirements Analysis and Modeling with the Measured Compliance Profile for the Goal-oriented Requirement Language

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***Abstract*—As demonstrated by a benchmark HIPPA case study, the Measured Compliance Profile for the Goal-oriented Requirement Language (GRL) is used to formalize legal text with GRL in order to make it amenable to compliance analysis. This formalization is based on guidelines yielding a goal model that can be analyzed for compliance with the jUCMNav tool with the help of real-world measurements captured by indicators in the goal model. For usability reasons, the legal text may also be specified in a tabular representation and subsequently transformed into a goal model by jUCMNav.**

***Index Terms*—legal requirements, Goal-oriented Requirement Language, compliance, indicator, jUCMNav.**

I. Users of the Approach

The users of the Measured Compliance Profile for the Goal-oriented Requirement Language (GRL) [2] are varied as the GRL model of the legal text is meant to be a focal point for all involved parties. The users can be grouped into those who create the GRL model in the first place, those who review the GRL model to detect omissions and inconsistencies or simply need to read the model to understand the legal text, and those who use the goal model to assess compliance with the legal text. Typically, the first group is comprised of policy analysts, regulatory experts, and subject matter experts, and the second group consists of lawyers, regulated parties, and possibly the general public. Compliance officers, inspectors, policy makers, regulators, and regulated parties are in the third group as they are interested in detailed outcomes of compliance inspections.

While there are nuances in terms of the required pre-requisite knowledge and training needed for the three groups, all users must have knowledge of the GRL concepts required for the legal model, i.e., goal, decomposition, contribution, condition, and indicator. A foundation in basic logic is also useful.

The entry barrier of learning a new modeling language is alleviated by the use of a tabular representation of the legal text that is as formal as the graphical GRL representation of the legal text, but only requires a rudimentary understanding of spreadsheet features. Knowledge of the guidelines [3] for the formalization is nevertheless required for the users in the first group – as is, obviously, deep knowledge of the legal text itself. More advanced features such as analysis of the legal text performed by the third group necessitate familiarity with the open-source, Eclipse-based GRL modeling tool jUCMNav [1]

II. Steps of Approach

In this section, an overview of the required steps for creating a model of a legal text based on the Measured Compliance Profile is given. In a first step, the hierarchical structure of the regulations including decompositions, the relative importance of regulations, conditions, as well as exception clauses are made explicit. Then, if possible, the resulting model hierarchy is simplified. In addition, compliance measurements are derived from the legal text, modeled with indicators, and associated/linked with the legal text.

A regulation at any level of granularity (i.e., representing a clause, individual rule, section, chapter, or the whole legal text) is modeled with a *goal* (⬭). The hierarchical structure of regulations is captured with AND/OR/XOR-*decomposition links* (┼). A condition or exception clause is represented with a *resource* (□) stereotyped as «condition» and connected to a regulation with a *dependency link* (-◗-). An indicator (⬡) describes how compliance with a regulation is to be measured and is connected to the applicable regulation using a *contribution link* (→) with a quantitative weight ([0..+100]). Contributions links may also be used instead of decomposition links to connect sub-regulations to parent-regulations, especially if the importance of each sub-regulation varies.

The resulting model for the case study (§ 164.512(f) of the U.S. Health Insurance Portability and Accountability (HIPAA) Privacy regulations) is shown in Figures 1 to 4. Each root goal in the figures represents one of the sub-regulations § 164.512(f)(1-6). What is not shown due to space constraints, is that the main goal "(Disclosures for law enforcement purposes) A covered entity may disclose protected health information for a law enforcement purpose to a law enforcement official" corresponding to § 164.512(f) is AND-decomposed into these six sub-regulations, because a regulated party must comply with each of the sub-regulations – otherwise the complete model is shown.

A tabular representation may also be used to formalize the legal text. In this tabular representation, the modeler fills in for

each element in the legal text the detailed ID of the element (e.g., § 164.512(f)(1)(ii)(A)), the text of the element, decomposition information (e.g., § 164.512(f)(1)(i) is an OR-decomposition of its parent element § 164.512(f)(1)), the relative importance of the element compared to its siblings in the hierarchy (i.e., this is translated into a contribution weight), the indicator used to measure compliance with the element (e.g., "Is a description of distinguishing physical characteristics disclosed?" for § 164.512(f)(2)(i)(H)), and any conditions or exception clauses applicable to the element.

Conditions and exception clauses are typically distinguishable by key words like *if, except,* etc. For example, the exception clause "except for laws subject to paragraph (b)(1)(ii) or (c)(1)(i) of this section" in § 164.512(f)(1)(i) is modeled with a resource stereotyped as «condition» and labeled "not laws subject to paragraph (b)(1)(ii) or (c)(1)(i) of this section". Similarly, the condition "if the covered entity has a suspicion that such death may have resulted from criminal conduct" in § 164.512(f)(4) is also modeled with the stereotyped resource and labeled "the covered entity has a suspicion that such death may have resulted from criminal conduct".

Finally, the phrase "as applicable" in § 164.512(f) results in an "applicability" condition for each sub-regulation. These conditions are necessary for this regulation because otherwise measurements that demonstrate compliance would have to exist for all sub-regulations. For example, in Figure 1, if the current situation does not involve a grand jury subpoena etc., then all of the indicators in Figure 1 will be 0 (i.e., the model value corresponding to "No"). Consequently, the compliance value of the sub-regulation in Figure 1 would also be 0, i.e. non-compliant. However, this is not the case as the sub-regulation simply does not apply in this situation. Hence, the applicability conditions are needed. Note that an OR-decomposition of the regulation into six sub-regulations is not possible, because in this case non-compliance with one sub-regulation could be masked by compliance with another sub-regulation.

In addition, a conversion function that translates a real-world measurement value into a model value is specified for each indicator. For the case study, two different types of conversions are needed as shown in TABLE I. One type of indicator (e.g., "Are name and address disclosed?") represents a simple yes/no question for which the answers are mapped to the indicator's goal model value of 100 or 0, respectively. The second type represents a four point Likert-scale with respective mappings to model values. Note that it is also possible to indicate that the real-world value exceeds expectations. The second type of conversion applies, e.g., to the indicator "Is the information relevant enough to law inquiry?". However, as these conversions must be done in cooperation with domain experts, the conversions used for this case study are simply demonstrations of what is possible.

Any information mentioned in this section that is not shown in the figures is captured in the model either through element properties or metadata – in any case, the information is available for compliance analysis of the legal text.

TABLE I. TABULAR REPRESENTATION OF INDICATOR CONVERSIONS

Real-World Label	Model Value	Exceeds
No	0	false
Somehow	40	false
Yes	100	false
Yes and also exceeds	100	true
Real-World Label	**Model Value**	**Exceeds**
No	0	false
Yes	100	false

Once the legal text has been modeled with GRL, compliance with the legal text can be analyzed based on measurements collected for a regulated party as defined by the indicators. The result of the analysis is a compliance value between 0 and 100 for each element of the legal text, from an individual clause to the whole act. Compliance is given if the value is 100, while the range from 0 to 99 indicates levels of non-compliance.

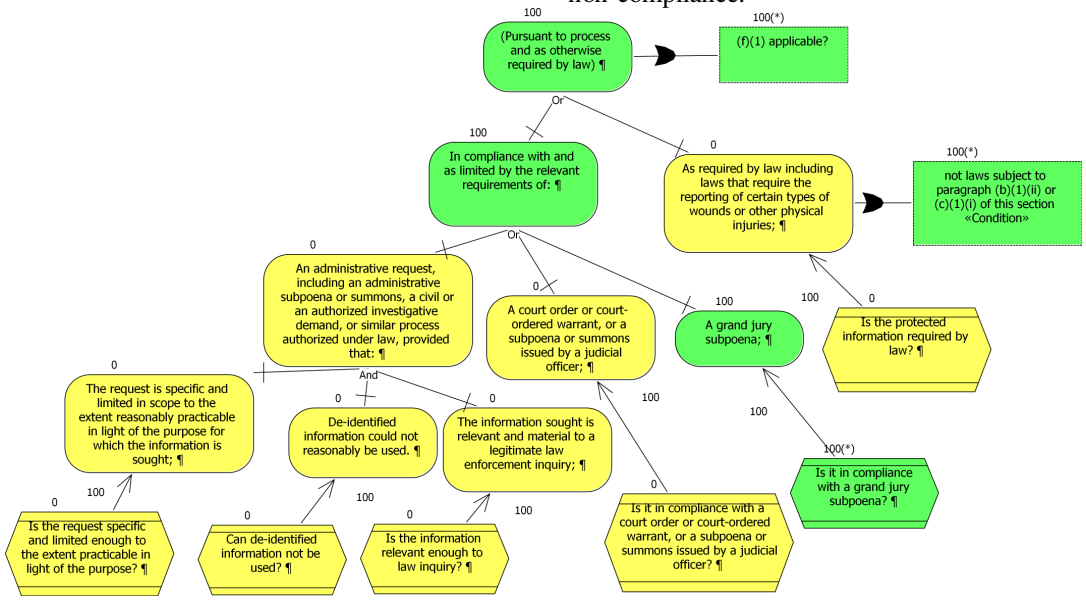

Fig. 1. GRL Goal Model for § 164.512(f)(1)

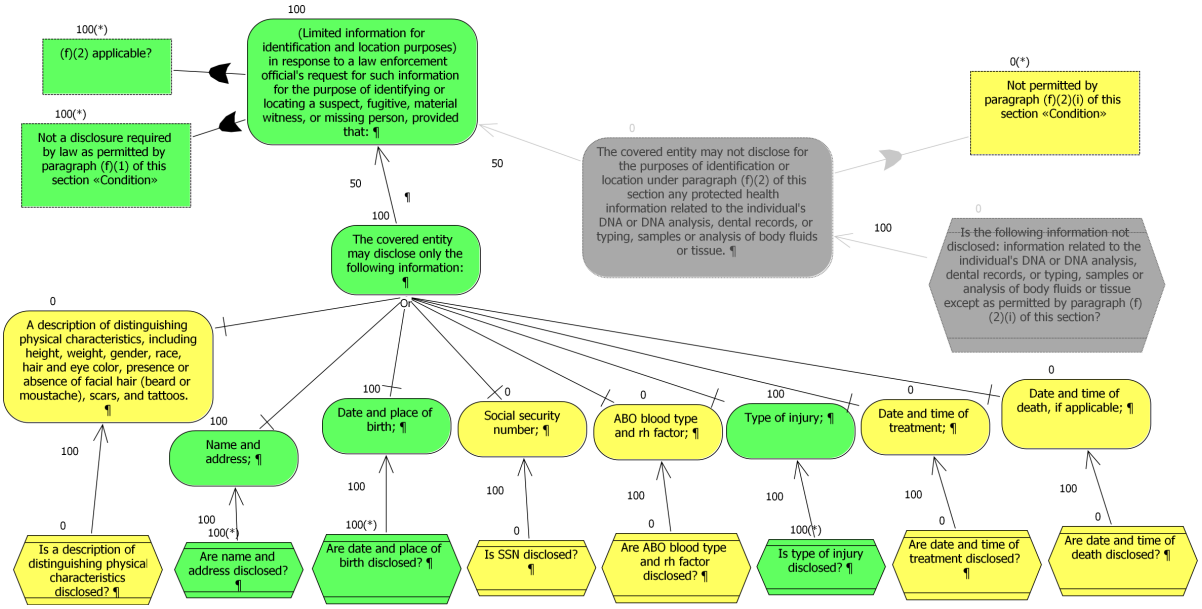

Fig. 2. GRL Goal Model for § 164.512(f)(2)

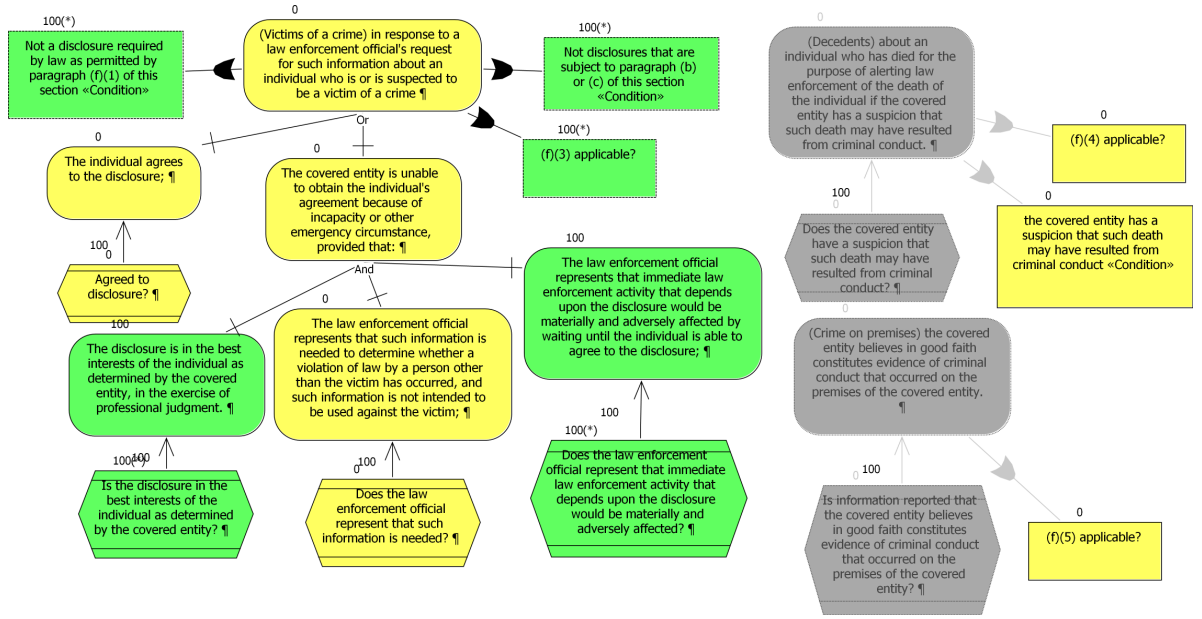

Fig. 3. GRL Goal Model for § 164.512(f)(3-5)

In Figure 2, e.g., a regulated party discloses the address, name, date and place of birth, as well as type of injury in a situation where paragraph (f)(2) does and paragraph (f)(1) does not apply (hence, both conditions on the left are true, i.e., 100). In this case, the indicator "Are name and address disclosed?" is, e.g., set to 100, because the answer to the corresponding question is "Yes" and hence mapped to model value 100 according to the specified conversion. Furthermore, since the disclosed information is permitted under (f)(2)(i) (hence, the condition on the right is *false*, i.e., 0), the corresponding parts of the regulation hierarchy are not applicable. Therefore, they are not to be considered for analysis and grayed out.

As a second example, consider Figure 1, which shows the analysis results for a regulated party that discloses protected health information because of a grand jury subpoena in a situation where paragraphs (b)(1)(ii) or (c)(1)(i) are not applicable but paragraph (f)(1) is applicable (hence, both conditions are true).

The third analysis example depicted in Figure 3 illustrates a situation where the regulated party is not in compliance with the legal text, because the individual does not agree with disclosure of health information and the law enforcement official does not represent that such information is needed. Since (f)(3) is applicable, the left hand side is active. On the other hand, since (f)(4) and (f)(5) are not applicable, the right hand side is grayed out.

Last but not least, Figure 4 shows how a goal model is visualized that is not currently analyzed.

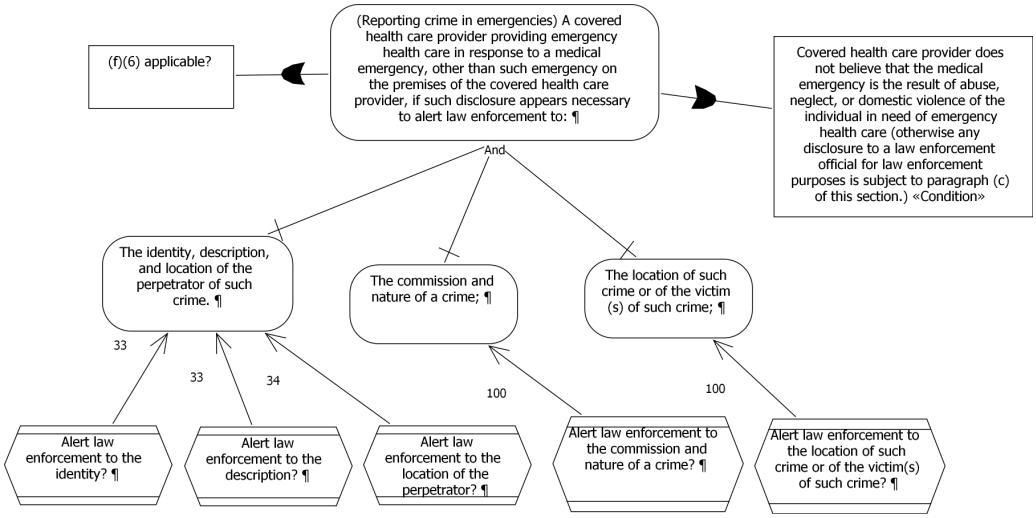

Fig. 4. GRL Goal Model for § 164.512(f)(6)

III. Discussion

A. What are the research challenges that are addressed by your approach?

The Measured Compliance Profile for GRL addresses how to assess compliance with legal texts based on concrete measurements captured by indicators in the GRL model. The profile is particularly useful for outcome-based regulations as well as regulations that need to be evolved over time as detailed assessments of each regulation element are supported. It is possible to assess the impact of regulations.

The creation of the GRL goal model is semi-automated with the help of a tabular representation. Furthermore, the tabular representation can often more easily be pre-populated with data about the regulations stored in a database. This improves the usability of the approach and simplifies the mechanics of model creation.

B. Are there benefits of your approach that could not be demonstrated with this excerpt?

The case study does not lend itself very well to demonstrate the relative weights (importance) of regulations and their impact. Relative importance tends to manifest itself between regulations that cover different subject areas, while the case study deals with one subject matter in detail (i.e., disclosures for law enforcement purposes). Moreover, relative weights require domain experts to be involved.

Regulations targeting different types or classes of organizations can also be captured in one model with goal families [3].

C. What are the limitations, and what are the unaddressed research challenges that you would like to address in the future?

Regulations change from time to time. A challenge is to determine what measurements of a previous version of the regulation still apply to the new version and how to represent an aggregated view of compliance with changed regulations over time.

D. What evaluation and validation exists to date? For example, what laws have this approach been applied to, was this done in prior case studies or experiments, and so on.

The Measured Compliance Profile for GRL has been applied to the security and safety compliance domain as well as the financial domain. However, due to confidentiality issues, we cannot disclose the name of the regulatory entities involved or the specifics of their regulations and compliance procedures.

E. Briefly describe any tool support, if it exists?

Tool support for the Measured Compliance Profile for GRL is provided by jUCMNav [1]. This mature tool provides a complete editing environment for goal models of legal text as well as the analysis of the legal text with an evaluation mechanism tailored to the profile. In addition, the tool allows trends to be visualized based on a series of compliance results.

Furthermore, the transformation of the tabular representation of legal text into GRL goal models is also supported, including automatic layout features of the resulting goal model (with reasonable success rates). Last but not least, the jUCMNav tool offers the ability to dynamically explore the generated goal model. E.g., a sub-regulation can be selected and expanded over a specified number of hierarchical levels.

References

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