Learn the rules so you know how to break them properly*

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***Abstract*—Commitment-based protocols are receiving increasing attention as tools for the representation of business interaction in open MAS. As recent proposals, like 2CL, show when the reality to be modeled is characterized by a high degree of regulation, traditional commitment-based protocols, which account only for the constitutive specification of actions, are to be enriched with a regulative specification. This is the case of the measures foreseen by the Markets in Financial Instruments Directive, aimed at fostering the creation of an integrated financial market within the European Union. This work shows the usefulness of adopting a declarative commitment-based approach by applying it to the MiFID case study. We developed an extension of Winikoff et al.'s enhanced commitment machine, that accounts of 2CL temporal regulations. It allows the analysis of business protocols and, in particular, of the possible violations.**

I. Introduction

Business processes often involve autonomous partners with heterogeneous software designs and implementations. In this context, there is the need of identifying high-level abstractions that allow modeling them in a natural way. Moreover, in many practical contexts (like banking) there is the need to integrate in such processes specific regulations that constrain the interaction. In order to minimize the effort needed to define proper interfaces and to minimize the altering of internal implementations, Telang and Singh [1] propose that such abstractions should capture the *contractual relationships* among the partners. Existing approaches (e.g. BPEL, WS-CDL) rely on the specification of control and business flows, imposing unnecessarily restrictive orderings of the message exchanges but do not supply the means for capturing the business relationships nor the business intent. This limitation is highlighted also by authors like Pesic and van der Aalst [2], [3], who, in particular, show the advantages of adopting a declarative rather than a procedural representation. In other words, existing approaches are characterized by high rigidity and are not suitable to naturally represent decisional processes and responsibilities, which are two key elements in the definition of business activities. Rigidity is counter-productive when tackling unexpected or exceptional situations, while the lack in accounting of responsibilities does not support the identification of causes to failures and possible violations.

One possible alternative is to rely on commitment-based approaches [4], that are well-known in the Multi-Agent Systems research area for modeling interaction. Commitments, abstracting from operational details, allow a flexible specification of business intents and relationships that involve autonomous and heterogeneous parties. This alternative is, for instance, investigated in [1], which proposes a commitment-based approach to the representation of cross-organizational business models by identifying a set of reusable and composable patterns. Such patterns are designed so as to be employed by business analysts in the development of business models for desired scenarios.

Recent proposals, like [5], [6], enrich commitment protocols with temporal regulations. In particular, [5] proposes a decoupled approach that separates a constitutive and a regulative specification [7]. A clear separation brings about many advantages, mostly as a consequence of the obtained modularity: easier re-use of actions, easier customization, easier composition. Roughly speaking, constitutive rules, by identifying certain behaviors as foundational of a certain type of activity, create that activity. They do so by specifying the semantics of actions. Regulative rules contingently constrain a previously constituted activity. In other words, they rule the "flow of activity", by capturing some important characteristics of how things should be carried on in *specific contexts* of interaction [8].

This work shows how to use the proposal in [5] to represent and analyze business protocols. We implemented an extension of Winikoff et al.'s commitment machine [9] that can be used to identify potential risks and violations of temporal regulations and of commitments, to foresee the impact on the business protocols of changes in the regulations, and decide about possible regimentation/enforcement policies. Moreover, we applied this tool to a real world case study, the MiFID directive by the European Union, which regulates the interaction of banks, clients, and financial intermediaries in the task of buying/selling financial products. Such parties are characterized by autonomy and heterogeneity, and it is fundamental to define each party's responsibilities in the interaction.

Section II introduces the case study. Section II-A explains the challenges involved by it. Section III presents the formal model. Section III-A discusses violations. Section IV presents the MiFID model and analyses execution graphs. Conclusions end the paper.

II. The MiFID case study

The Markets in Financial Instruments Directive (MiFID for short) is the directive number 2004/39/EC [10], issued by the European Commission within the Financial Services

(*) Apparently attributed to Tenzin Gyatso, 14th Dalai Lama, *The 18 Rules For Living*, Rule #5.

Action Plan, and represents a fundamental step in the creation of an integrated and harmonized financial market within the European Union. Specifically, MiFID specifies values and principles that all the countries will have to follow as well as corresponding implementative measures. One of the main concerns of the directive is the protection of the clients of financial service agencies, thereby it introduces new regulations that financial services must follow so as to guarantee the position of the investor. Three categories of clients are identified, with increasing knowledge about financial products. For each of them, it specifies *informative and protective obligations* to which the financial operator is bound. For instance, intermediaries are expected to collect information about his/her clients, with the help of detailed tests. Each country in the European Union implements European directives in ways that are customized to its specific structures and organization. In Italy, the adjustment of the market regulation to the MiFID principles and implementative measures is up to two actors: *Consob* (Commissione Nazionale per le Società e la Borsa) and *Banca d'Italia*.

One of the main characteristics of MiFID is a great attention to clients. At any moment, the intermediary must guarantee the investor the control of the contractual relation for all aspects ranging from the proposed financial products to the strategies that will be enacted to obtain the most beneficial results for the client. Therefore, MiFID imposes *strong constraints* to investment companies, and gives investors the tools for legally acting against those intermediaries who *do not comply* to them. The case study we use in this proposal concerns the regulation that applies to the offer of investment services off-site. This case study is already used in the literature [11] and, in particular, by the ICT4LAW project (http://www.ict4law.org). This is, for instance, the case when a bank promotes and sells financial products with the help of external collaborators (called "tied agents" or intermediaries). The proposal of products and the definition of a contract must comply to a set of constraints:

- **Identification**: the client must be identified by an identity card or equivalent document;
- **Qualification**: the intermediary supplies all the foreseen documentation about his/her professional qualification and the rules that he/she must stick to;
- **Profiling**: the intermediary must profile the client, gathering information about the balance sheet, knowledge about financial subjects, investment aims. This phase requires the filling the MiFID form, which explicitly specifies the resulting category of client and which is to be signed also by the client;
- **Selection**: the proposed financial products must agree with the client's profile. This requires that financial products are classified w.r.t. the different client profiles;
- **Evaluation**: the proposal is evaluated through a simulation: if it is adequate an order is filled and signed both by the client and by the intermediary, otherwise the product is discarded;
- **Verification**: the documentation is sent to the investment trust, which must check that there are no errors or missing data. In this case, the documentation is corrected and sent back to the intermediary, otherwise the contract is stamped and sent to the client.
- **Withdrawal**: The client can decide to cancel an order.

Due to the high degree of regulation imposed by the directive, an intermediary can incur into many forms of violations. For instance, when the mandate contract is stipulated, the client should receive a signed copy of it. By this contract the client commissions the intermediary to use some financial holdings so as to achieve some investment goals. One common violation, that occurs in this phase, is that the intermediary *does not give to the client copy of the documentation foreseen by the qualification phase*. Another common violation is that often intermediaries do not ask their clients *to sign the MiFID form for the definition of the client's profile*. The motivation behind both these behaviors is that intermediaries believe that a great amount of documents to sign will refrain clients from stipulating contracts and will even compel them to consult some competitor. Indeed, investors tend to be unwilling to study in depth the proposed products, and often prefer to have just an overall idea. A third kind of violation, with similar motivations, amounts to the proposal of a financial products that does not agree with the client's profile, without an explicit and formalized agreement with the client.

A. Challenges

What happens if, despite these violations, an intermediary buys a financial product for the client? Even though, standing to MiFID, the intermediary did not fulfill all of his/her obligations, *the sale is valid*, the client results to be the owner of the product. This happens because MiFID does not define *sales* (sales are defined by a different regulation) but dictates how the interaction with the client should be carried on by adding a new layer of regulations on top of existing ones. So, the violation of some constraint does not affect the sale directly but creates both a *risk of sanction* and an *exposure risk* for the intermediary. This is witnessed by a sentence by the Italian Supreme Court (*Cassazione civile a sezioni unite*, num. 26724 and 26725 [12]) which decided that in case of violations, like the above, if the client was economically damaged he/she can ask for a compensation and, in the most serious cases, for the cancellation of the contract between the client and the intermediary. So, if the investment turns out to be a bad investment, the client can arraign the intermediary before the court.

These observations show the importance of putting the business analyst in condition to study the possible violations, in the context of a regulation, with the aim of identifying the risks the interaction could encounter. The evaluation of such risks will allow the definition of operational strategies which can, alternatively, prevent the occurrence of violations (*regimentation*) or implement alerting mechanisms (*enforcement*) [13]. The choice depends on various factors, tied to the nature of violations and to the context. As explained by Sergot [13], it is impossible to realize a complete regimentation that

prevents all possible violations. Even when regimentation were applicable its implementation could be expensive, also in the sense that it may require a long time to be realized.

In particular, the MiFID case study underlines the need of adopting a representation model that accommodates both a *constitutive* and a *regulative* specification. MiFID is designed for regulating interactions of clients, intermediaries, and financial trusts (regulative specification) that involve the exertion of powers, like that of sale or of profiling, which constitute the reality in which the three parties interact (constitutive specification). Part of these powers (like profiling a client) are defined inside the directive itself, part (like sale) are recognized but pre-exist the regulation. The latter are particularly delicate because, since they already exist before the new regulation is defined, it is not possible to constrain their execution, e.g., by adding preconditions of executability. As the sentence by the Supreme Court that we cited shows, the violation of a constraint, posed by MiFID, does not invalidate a sale. Depending on the kind of violation that occurred, the ownership of the financial product will remain of the client or it will be transfered to the intermediary, but this will be transparent to the seller, who will not be involved in the quarrel and will have no consequences (specifically he/she will not have to give money back). These observations underline the need of adopting a *modular representation* that accounts for both specifications.

Another important remark is that in many practical contexts, the MiFID case is one of them, the business relationship captured by a regulation should be kept as *flexible* as possible, in order to allow the interacting parties, who are heterogeneous, autonomous, and basically self-interested entities, to find the way of interacting that better suits their characteristics and needs. In other words, any interaction that does not violate the constraints should be allowed. Flexibility is important to allow the business partners to profit of opportunities or to make the most efficient use of their time that is possible. As an intuitive example, let us consider the case of financial products classification. What MiFID requires is that financial products are classified according to the types of client profiles. It does not say when this classification should be done. A business process that imposes that classification must be done in the evaluation phase surely respects the directive, however, it precludes the possibility to classify products in those moments when the intermediary is free and have them ready when a client arrives.

Most of the approaches specify business processes as procedures, that implement a selection of some of the possible execution paths. Even though in this way the resulting business process will comply to the directive, it will also implement further restrictions to the interaction that the directive does not impose. Commitment-based representations, instead, offer the degree of flexibility requested in these cases because they can capture the intent of a business relationship [1], avoiding the imposition of unnecessary constraints. What we additionally need to represent in a regulation like MiFID is the capability to express temporal relations (e.g. that the execution of a purchase must occur only after the client was profiled) in a way that is as flexible as basic commitment protocols are. Last but not the least, the commitments that the interacting parties have towards the others are objectively inferable from their observable behavior, thanks to the social semantics of the commitment approach.

III. Modular business protocols

In this work we adopt a representation of the *business protocol*, i.e. of the specification of how the business interaction should be carried out, based on commitments. In particular, we adopt the approach discussed in [5], that features an explicit distinction between a *constitutive* and a *regulative* specification. The former defines the protocol actions, while the latter encodes a set of temporal constraints. Both specifications are defined based on *commitments*. Commitments are directed from a debtor to a creditor. The notation $C(x, y, r, p)$ denotes that agent x commits to an agent y to bring about consequent condition p when the antecedent condition r holds. When r equals $true$, we use the short notation $C(x, y, p)$. The business partners share a social state that contains commitments and other literals that are relevant to their interaction. Every partner can affect the social state by executing actions, whose definition is given in terms of operations onto the social state, see [14]. The partners' behavior is affected by commitments, which have a *regulative* nature, in that debtors should act in accordance with the commitments they have taken.

Definition 1 (Business protocol): A business protocol *P* is a tuple $\langle Ro, F, A, C\rangle$, where Ro is a set of roles, identifying the interacting parties, F is a set of literals (including commitments) that can occur in the social state, A is a set of actions, and C is a set of constraints.

The set of social actions A, defined on F and on Ro, forms the *constitutive specification* of the protocol, while the set of constraints C, defined on F and on Ro too, forms the *regulative specification* of the protocol. We assume that facts persist in the social state, they denote observations about events that occurred.

Constitutive specification. The *constitutive specification* of actions is given by defining their meaning in terms of how they affect the social state. The specification follows the grammar below, where the *means* construct amounts to a *counts-as* relation [7]:

$$
\begin{aligned}
&A \rightarrow (Action \textbf{ means } Operation \textbf{ if } Cond)^{+}\\
&Action \rightarrow protocolAction\\
&Operation \rightarrow Op(commitment) \mid fact \mid\\
&\quad Operation \wedge Operation\\
&Op \rightarrow \textsc{create} \mid \textsc{delete} \mid \textsc{release} \mid \textsc{delegate} \mid\\
&\quad \textsc{assign} \mid \ldots\\
&Cond \rightarrow literal \mid Cond \ \wedge \ Cond \mid Cond \ \vee \ Cond \mid\\
&\quad Cond \ \textsc{xor} \ Cond
\end{aligned}
$$

where *protocolAction* is the name of an action of the protocol; *Cond* specifies the context in which the counts-as relation holds; *Op* is one of the operations on commitments; *commitment* is a commitment of form $C(x, y, r, p)$ (see [15, page

Relation	*Type*	*Operator*	*Meaning*
Response	pos.	$A \bullet\!\!\rightarrow B$	If A occurs, B must hold at least once afterwards (or in the same state). It does not matter if B already held before A.
	neg.	$A \bullet\!\!\not\rightarrow B$	If A holds, B cannot hold in the same state or after.
Before	pos.	$A \rightarrow\!\!\bullet B$	B cannot hold until A becomes true. Afterwards, it is not necessary that B becomes true.
	neg.	$A \not\rightarrow\!\!\bullet B$	In case B becomes true, A cannot hold beforehand.
Cause	pos.	$A \bullet\!\!\rightarrow\!\!\bullet B$	It is the conjunction of the base *response* and base *before* relations: $A \bullet\!\!\rightarrow B$ and $A \rightarrow\!\!\bullet B$.
	neg.	$A \bullet\!\!\not\rightarrow\!\!\bullet B$	It is the conjunction of the base *response* and base *before* negative relations: $A \bullet\!\!\not\rightarrow B$ and $A \not\rightarrow\!\!\bullet B$.

TABLE I
2CL OPERATORS AND THEIR MEANING.

49]), where x and y are roles in Ro and r and p are formulas in disjunctive normal form of propositional literals in F; *fact* is a positive or negative proposition that does not concern commitments and which contributes to the social state (they are the conditions that are brought about); and *literal* can be either a commitment or a positive or negative proposition (where negation means that a certain literal does not hold in the social state)

Regulative specification. The *regulative specification* is expressed in 2CL [16], [5]. This language allows the designer to express many kinds of constraints describing the legal evolutions of the social state. As underlined in [2], [17], [18], constraint-based declarative representations provide abstractions which allow to explicitly capture what is mandatory and what is forbidden, without the need to express the set of possible executions extensionally. For this reason, protocols remain compact improving flexibility: they specify what is desired and undesired, leaving all that remains unconstrained. This is an advantage with respect to procedural approaches, characterized by a prescriptive nature which requires the specification of *all* the allowed evolutions. It also accommodates naturally to the commitment-based approach, where a central issue is the respect of the agents' autonomy. 2CL follows the grammar:

$$C \rightarrow (Cond\ op\ Cond)^*$$

C, see Def. 1, is a set of constraints of the form $A\ op\ B$, where A and B are formulas of literals and op is one of the operators supplied by the language. The complete list of possible operators is fully described in [16], [5]. Table I reports only those that are used in the case study. 2CL allows the expression of temporal constraints on execution paths. Since commitment machines express legal execution paths, temporal constraints can be used to restrict this set. A natural choice for formalizing such constraints is *Linear Temporal Logic* (LTL) [19]. This kind of logic allows the identification of those executions which satisfy the constraints of interest. The work in [5] introduces a LTL semantics for the 2CL operators, that formalizes the intuitive semantics that we reported in Table I.

A. Detecting violations

The interaction of a set of parties will be compliant to a business protocol when all the commitments they have towards the others, and that are objectively inferable from their observable behavior, are satisfied (as usual in the social approach), *and* the overall execution respects all the constraints. Intuitively, the addition of a regulative specification by means of 2CL constraints restricts the set of acceptable executions.

Some approaches to commitment protocols propose an operational semantics that relies on commitment machines to specify and execute protocols [14], [20], [9], [21], [15], some others, like [22], use interaction diagrams, operationally specifying commitments as an abstract data type, and analyzing the commitment's life cycle as a trajectory in a suitable space. Other approaches rely on temporal logics to give a formal semantics to commitments and to the protocols defined upon them. Among these, [23] uses DLTL, while [24], [25] adopt extensions of CTL*. Given the specification of a set of social actions, all these approaches allow the inference of those executions, which are legal with respect to the protocol.

In particular, commitment machines [14] (later refined in [9]) specify the possible states of an execution, the actions that are used for doing the transitions, and the possible final states of the protocol. The meaning associated with each state specifies which commitments are active in that state, and the meaning associated with each action defines how the commitments are affected by the action, leading to a state change. Intuitively, commitment machines allow the formalization of legal executions by taking into account only the *constitutive* specification of the social actions.

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A *legal execution* of a commitment-based protocol, enriched by means of 2CL regulative specifications, is an execution that is accepted by the commitment machine built upon the constitutive specification of the protocol, and that, when interpreted as a linear temporal model, satisfies the LTL formulas corresponding to the regulative specification of the protocol. Based on this characterization, it is possible to provide mechanisms for verifying that an agent is behaving in respectance to the protocol. When this does not happen, we can say that a *violation* has occurred. So, if in a commitment-based protocol, made only of the constitutive specification of actions, violations are detected only when a commitment remains unsatisfied in a final state, in our proposal, we also

detect violations *during the execution*, violation amounting to the fact that a constraint is not respected.

We implemented an extension of Winikoff et al.'s enhanced commitment machine [9] by introducing an automated verification of constraints. This extended commitment machine allows exploring all the possible executions of a business protocol, showing the regulative violations, i.e. both those states in which some constraint is violated and those states that contain unsatisfied commitments. The implementation is done in *tuProlog*[1] and the software interprets a 2CL business process specification by means of a parser written in Java. The implementation is available at the URL http://www.di.unito.it/~alice/2CL.

The output of the commitment machine will be an annotated and colored graph of all the possible interactions (it is a reachability graph). The graph includes all the interactions that are possible, considering only the constitutive specification of the actions. The annotation, highlighted by graphical conventions, accounts for all the regulative aspects, concerning both commitments and constraints. So the graph will include both legal states and states in which violations occur. Part of violations related to a state are, actually, just potential, depending on future behavior. Tendentiously they become violations if the interaction stops in that state. As usual in commitment protocols interaction can, in fact, start/end in any state. In this case, highlighting the possible violations, therefore, amounts to alerting the user about a risk. More generally, the obtained graph is a tool that supports the analysis of a business protocol, by helping the identification of situations where it maybe necessary to perform some regimentation or enforcement.

IV. Modeling MiFID

Let us begin this section by introducing the business protocol of the sales of financial products as they used to be before the MiFID directive. The specification will include just a set of constitutive rules defining the necessary actions. No particular constrain is imposed to regulate the interaction. Afterwards, we will see how it is possible to introduce the MiFID specification, in a way that is modular w.r.t. the pre-MiFID one. The resulting business protocol will include new constitutive rules, aimed at specifying those activities that were introduced by the directive (like the profiling), and a set of regulative rules. Such rules tie the activities of a basic sale to those foreseen by the directive. In particular, that an intermediary, who committed to take care of an investment supplies the necessary documentation, and that this as well as the classification of the possible products happen before the proposal of an adequate solution. The regulative constraints will implement this connection without the need of modifying the specification of the sales actions.

Pre-MiFID sale business protocol. This business protocol foresees an initial state containing a commitment, $\mathsf{C}(fp, inv, invested)$, from the intermediary to the investor to find a good investment. The actions involve three parties: an investor (inv), an intermediary (the financial promoter fp), and a bank ($bank$). The action *propose_solution* presents a selected financial product to the investor. The proposal is characterized by a risk level, and can be rejected (*reject_proposal*) or accepted (*sign_order*). In the first case, the commitment of the intermediary is released. When the order is signed, the investor commits to the bank to respect the purchase contract ($\mathsf{C}(inv, bank, contract\_ended)$). The bank is expected to send a copy of the contract to the investor by the action $send\_contract$, which creates a commitment $\mathsf{C}(bank, inv, executed\_order)$ from the bank to the investor to actually execute the order. When the bank sends copy of the contract to the investor, the initial commitment of the intermediary is discharged. The natural end of the contract is captured by the action *end* which causes the discharge of the pending commitments of the investor and of the bank.

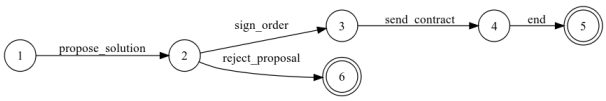

Fig. 1. Execution graph of the pre-MiFID sale regulation.

(a) *propose_solution* **means** *proposed_RiskL*
if $\neg$*proposed_RiskL* $\wedge$ $\neg$*rejected_proposal*.
(b) *reject_proposal* **means** *rejected_proposal*,
RELEASE(C(*fp*, *inv*, *invested*))
if $\neg$*accepted_proposal* $\wedge$ *proposed_RiskL* $\wedge$ $\neg$*rejected_proposal*.
(c) *sign_order* **means** CREATE(C(*inv*, *bank*, *contract_ended*)),
accepted_proposal, *order_signed*
if $\neg$*order_signed* $\wedge$ *proposed_RiskL* $\wedge$ $\neg$*rejected_proposal*.
(d) *send_contract* **means** CREATE(C(*bank*, *inv*, *executed_order*)),
invested, *contract_sent*
if $\neg$*contract_sent* $\wedge$ *order_signed*.
(e) *end* **means** *executed_order*, *contract_ended*
if *contract_sent* $\wedge$ $\neg$*contract_ended* $\wedge$ $\neg$*contract_abort*.

Figure 1 shows the graph of the possible executions for this protocol. For reducing the complexity of the graph and make it readable we added a few preconditions to avoid the depiction of those paths where a same action is repeated. The same is done also with the graphs for MiFID.

Introduction of MiFID. This directive introduces new regulations that financial services must follow in their interaction with the client, so as to protect the investor. Its application requires the enrichment of the business protocol with new, specific actions, aimed at: identifying the investor and supplying the foreseen documentation (*interview*), profiling the investor (*profile*) and assigning him/her a risk category (*investor_classified*), classifying the financial products according to the possible risk levels ($classify$). In the profiling process, the intermediary commits to evaluate, with the help of a simulation, financial products in order to identify one that suits the client ($\mathsf{C}(fp, inv, evaluation)$). Such evaluation (*fi_evaluation*) commits the intermediary to propose a product with an risk level, that is adequate to the investor's profile ($\mathsf{C}(fp, inv, proposed\_RiskL)$). This commitment is crucial to satisfy the MiFID's requirements. A solution that is not adequate can be discarded (*fi_discard*). In this case the in-

[1] http://www.alice.unibo.it/xwiki/bin/view/Tuprolog/

termediary's commitments will be canceled. The withdrawal phase of MiFID is implemented by the action *withdraw*, which concludes a contract by aborting it and by releasing the commitment from the bank to execute the order. The selection and evaluation of a new proposal are modeled as a new interaction.

(f) *interview* **means** *investor_identified*, *document_supplied*
if $\neg$*investor_identified* $\wedge$ $\neg$*contract_abort* $\wedge$ $\neg$*contract_ended* $\wedge$ $\neg$*rejected_proposal* $\wedge$ $\neg$*fi_discarded*.
(g) *profile* **means** CREATE(C(*fp*, *inv*, *evaluation*)), *investor_classified*
if $\neg$*investor_classified* $\wedge$ *investor_identified* $\wedge$ $\neg$*contract_ended* $\wedge$ $\neg$*contract_abort* $\wedge$ $\neg$*rejected_proposal* $\wedge$ $\neg$*fi_discarded*.
(h) *classify* **means** *classified*
if $\neg$*classified* $\wedge$ $\neg$*contract_abort* $\wedge$ $\neg$*contract_ended* $\wedge$ $\neg$*rejected_proposal* $\wedge$ $\neg$*fi_discarded* $\wedge$ $\neg$*proposed_RiskL*.
(i) *fi_evaluation* **means** CREATE(C(*fp*, *inv*, *proposed_RiskL*)), *evaluation*
if *classified* $\wedge$ *investor_identified* $\wedge$ $\neg$*evaluation* $\wedge$ $\neg$*contract_abort* $\wedge$ $\neg$*contract_ended* $\wedge$ $\neg$*rejected_proposal* $\wedge$ $\neg$*fi_discarded*.
(j) *fi_discard* **means** *fi_discarded*, CANCEL(C(*fp*, *inv*, *invested*)), CANCEL(C(*fp*, *inv*, *proposed_RiskL*))
if *evaluation* $\wedge$ $\neg$*proposed_RiskL* $\wedge$ $\neg$*contract_abort* $\wedge$ $\neg$*contract_ended* $\wedge$ $\neg$*fi_discarded*.
(k) *order_verification* **means** *order_verified*, CREATE(C(*bank*, *inv*, *executed_order*))
if $\neg$*order_verified* $\wedge$ *order_signed*.
(l) *withdraw* **means** *contract_abort*, RELEASE(C(*bank*, *inv*, *executed_order*)), CANCEL(C(*inv*, *bank*, *contract_ended*))
if *contract_sent* $\wedge$ $\neg$*contract_ended* $\wedge$ $\neg$*contract_abort*.

Adding only the specific MiFID actions, and the commitment (produced by *fi_evaluation*) by the intermediary to propose a product with a risk level that corresponds to that of the investor are not enough to implement the directive. Actions *(f–j)* should be executed before the actual sale occurs, while *(k)* and *(l)* complete the sales process (see Section II). This could be done by modifying the action that implement a sale but this is not in the powers of the MiFID regulation, as we have explained. This directive, in fact, is to be composed with the definition of sale. In this setting, in order to analyze the violations that could take place in real intermediation contexts, the business protocol must show the same degree of flexibility that intermediaries and banks have when dealing with their clients. The integration of the new directive with the previous regulation is, therefore, done by means of a set of 2CL constraints, which relate facts and commitments which can appear in the social state and, in particular, those pertaining MiFID and those pertaining sales. Hereafter are reported the 2CL constraints that capture the most relevant dictates of the MiFID regulation:

(c1) $\mathsf{C}(fp, inv, invested) \bullet\!\!\rightarrow\!\triangleright\ investor\_identified \wedge document\_supplied$
(c2) $investor\_classified \rightarrow\!\!\triangleright\bullet\ \mathsf{C}(fp, inv, propose\_riskL)$
(c3) $evaluation \wedge \neg fi\_discarded \rightarrow\!\!\triangleright\bullet\ proposed\_RiskL$
(c4) $order\_verified \rightarrow\!\!\triangleright\bullet\ contract\_sent$

(c1) states that once the intermediary took the commitment to serve the investor, he/she must have the investor identified and must supply the necessary documentation to him/her. (c2) expresses the fact that before committing to propose a solution with a certain degree of risk, the investor must have been classified. (c3) states that before proposing a financial product it is necessary to have it positively evaluated by the simulation.

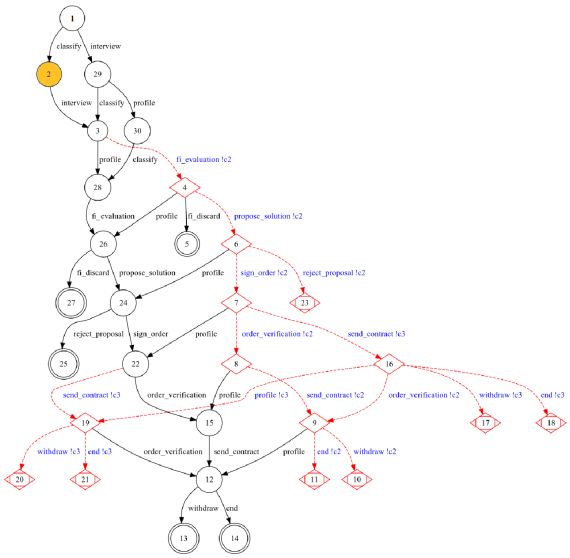

Fig. 3. MiFID with regimented *propose_solution*.

Finally, before the contract is sent to the client the data of the order must have been verified by the bank. Figure 2 gives an idea of the embedding of MiFID inside the sales protocol: the pink part corresponds to the old sales protocol, the green and gray parts altogether correspond to the legal execution of the enriched protocol.

Analysis of the MiFID business protocol. The MiFID business protocol produces the graph in Figure 2. Each state in the graph represents a possible configuration of the social state. Arrows correspond to actions and are directed. The source is a state where the "if" condition of the action labeling the arc holds. The target is, instead, the state obtained by applying the meaning of the executed action to the source state. States that are drawn as diamonds with an incoming red arrow represent the fact that a *before* constraint has been violated. Some states are yellow, the meaning (independently from the shape) is that some *response* constraints are not fulfilled yet. White states (independently from the shape) mean that there are some active commitments (not discharged, released or canceled). Final acceptable states are white and are denoted by double circles.

Figure 2 shows most of the possible executions of the MiFID business protocol. Among them, it is, first of all, worthwhile to notice the part highlighted in pink. This part corresponds to the pre-MiFID interaction but the colors show that in presence of the new directive, this kind of interaction is totally illegal. The other parts that are worthwhile to notice are the ones respectively highlighted in gray and in green. The green part corresponds again to the pre-MiFID interaction but now immersed in the additional activities foreseen by MiFID. The gray part at the beginning amounts to the identification, qualification, profiling and evaluation phases. The little gray parts in the bottom correspond to the new MiFID activities of verification (by the bank) and withdrawal, that the client can

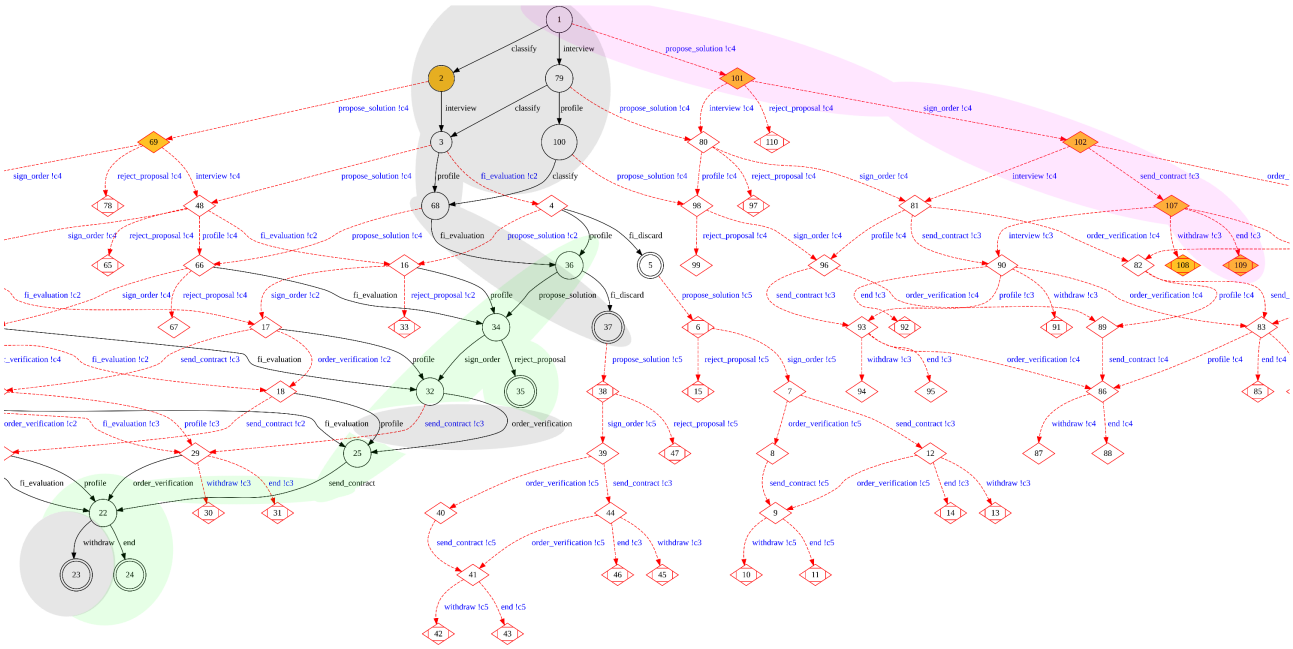

Fig. 2. Excerpt of the execution paths of MiFID.

execute. These two activities naturally find their correct place inside the sales interaction. The colors also help to highlight the modular composition of the regulations. All other paths amount to possible violations, as expected since we aggregated actions that have no mutual preconditions. The designer, by analyzing the graph, can identify the points where it could be helpful to intervene to reduce the possible violations, for instance, by applying enforcement policies or by regimenting some steps. For example, in Figure 2, one action on which it would make sense to intervene is *propose_solution* by adding the condition $\neg$*fi_discarded* $\wedge$ *evaluation*, obtaining the graph in Figure 3. Of course, this choice depends on many factors (e.g. the cost of the implementation of the prospected solution, or the time needed to update the financial services office's software) that are out of the scope of the directive.

V. Conclusion and Related Works

We have proposed a declarative approach to business protocol specification that extends [1] by explicitly including 2CL temporal regulations. We implemented a tuProlog extended commitment machine which was applied to the MiFID case study, whose output allows the analysis of the business protocol and of possible violations. The protocols that we tackle are typical of contexts, like MAS, where norms are seen as soft constraints, i.e. as standards that can be violated [13], [26] – as the Dalai Lama sentence in the title suggests. Indeed, in these contexts it is important to define mechanisms for detecting possible violations and decide about possible regimentations/enforcements. One of the main advantages of the declarative approach, that we have proposed for the representation of business protocol, is that it supports a modular composition of such protocols, as hoped for in [27]. This

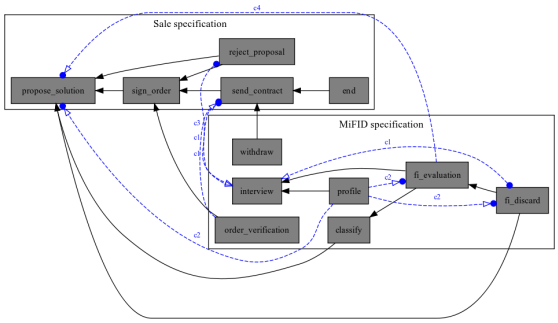

Fig. 4. Sale and MiFID dependency graph.

achievement is obtained thanks to an explicit separation of the constitutive and of the regulative aspects, the regulative ones (represented by dashed arrows in Figure 4) playing as "zippers" that tie stratified specifications.

Telang and Singh [1] proposed the first commitment-based approach to representing business models and identified a set of common patterns of interaction, that can be used by the business analyst. Our proposal extends the one in [1] by enriching the representation of the constitutive rules with the representation of expressive regulative rules. The achieved modularity is an added value in the modeling of business interactions governed by regulations that stratify along time. This is, indeed, often the case in the real world, as the MiFID case study witnesses. Moreover, we supply an analysis tool that supports the business analyst in performing task like: understanding the impact of new regulations on the business model or deciding about enforcement policies or regimentation.

Recently, many works, like [11], [26], focused on the problem of verifying the compliance of a business process to a body of norms. This issue is related to the one we have faced because it concerns business processes that are subject to regulations. However, it is different in that the business process is rigidly modeled as a (YAWL or BPM) workflow, and the verification aims at checking if this process strictly respects the norms, providing, in some cases, a yes or no answer and, in some others, a degree of compliance. In contrast, our commitment-based approach allows a declarative definition of business models that reduces the gap between the specification of the regulation itself (normative level, what is allowed or forbidden) and the one of how achieving the business goals (business process level). The aim is to support the business analyst in the analysis of the possible interactions and of the possible violations, to help him/her in performing strategical decisions.

Another work that it is worthwhile to mention, even though it does not directly tackle business processes and regulations, is [28] by Sergot. This work discusses the relationship between the norms that govern a single agent with those that express a designer's view on what overall system behaviors are deemed to be legal. Also in this case the focus is posed on a compliance of the resulting interactions with the norms. As for the previously cited works, this proposal foresees two models that are to be compared, and to this aim a colored labeled transition system is used. The main difference w.r.t. our proposal is that while in Sergot's approach the focus is on verifying the behavior of a single agent against a global model, in our case the focus is on supplying agents a tool for verifying the behavior of the others w.r.t. a global model, that is based only on the observational behavior and on a shared meaning of actions. It would be interesting to study how to combine the two approaches in order to supply a complete toolkit to the business analyst.

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