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Generating Procedural Controls to Facilitate Trade: The Role of Control in the Absence of Trust

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Abstract

Over the years, Trust has been recognized in the Bled community as a key enabling factor to stimulate Electronic Commerce. Authors have discussed formal aspects of trust, the role trust plays in the adoption of both B2B and B2C Electronic Commerce, as well as mechanisms to build trust and/or overcome the lack of it. This article first provides a brief overview of the Trust-related articles in the Bled eConference. It then focuses on one specific aspect of the facilitation of trade in absence of trust: the development of procedural controls that enable Electronic Commerce at arms' length, summarizing the contributions of the authors on this theme at the Bled Conference since the early 1990s. The paper concludes with the authors' current view on developing procedural controls, focusing on the design process itself, which is often a rather lengthy process consisting of trial-and-error. Here a more analytical approach is proposed to the identification of control requirements for inter-organizational procedures. The approach involves abstracting the process to identify its basic deontic elements. A model checking approach is then applied to identify needed controls.

Keywords: Trust, control, inter-organizational procedure, trade facilitation, deontic process, electronic contracting

Dedication: In memory of our colleague, co-author, dear friend, and long time contributor to the Bled Conferences, the late René W. Wagenaar.

1 Introduction: Trust at the Bled Conference

The topic of "Trust" started to appear in 1994 in the Bled community, when Allan Gillman discussed the "socio political dimensions of EDI trading relationships" (Gillman, 1994). He draws (tentative) conclusions that a properly functioning EDI link will increase the level of trust among trading-partners. However, while many articles until that time had discussed factors of EDI adoption, the concept of "trust" had not really been addressed. In retrospect, this might be due to the fact that EDI was (and is) seen as something between existing trading partners who either have a pre-existing business partnership (valuable enough to bear the high investments in the EDI link) or have an asymmetric power relationship where one can force the other to comply.

This changed when, within and outside the Bled community, the topic of "EDI" was more and more being encompassed by the wider definitions of electronic business, electronic commerce, and e-marketplaces. From a strictly business-to-business setting, the consumer came into the picture, leading to a whole new range of topics and researchers, including the most recent inclusion of social media. The factor "trust" became increasingly more in the focus of Bled researchers, be it as a variable in e-commerce adoption studies for SMEs and/or consumers, but also more fundamentally looking at enabling factors, including legal conditions, technological challenges, risk management approaches as well as socio-political considerations.

Since 1994, about 60 papers have been published in Bled with "trust" as an important factor in the research presented. Some have addressed the constructs that constitute trust, while others have focused on the role trust plays in the adoption of e-Business / e-Commerce solutions and e-Marketplaces in the consumer and SME world. Another group of authors has focused on how to overcome a lack of trust and propose solutions in technical, legal, organizational/institutional and/or procedural dimensions. Table 1 shows an overview of the papers we identified, from the early 1990's until today, using three main categories: Trust Fundamentals, Trust as a factor in Adoption of e-Business/e-Commerce/Social Media, and Trust Enablers. We fully realize that this will not do full justice to the original work we have thus categorized and we could not avoid making some somewhat arbitrary choices, but we do hope that by showing the impressive body of work we can underpin the importance the Bled conference has had on this important topic and each individual contribution in it.

In the "Trust Fundamentals" category, we have clustered those articles that investigate the phenomenon "trust" itself, in terms of definitions and measurement. The definition of the term depends on the view of the respective authors and the context in which it is placed.

When we view "trust" in the context of risk management, it can be seen as an estimated (subjective) probability that the counterparty will act in a predictable and agreed-upon way, or in other words, belief in the absence of opportunistic intentions from the counterparty. In the context of e-Business, trust, or rather lack of trust, becomes an inhibitor for parties (consumers, businesses and governments alike) to adopt new ways of doing business. Following this reasoning, the confidence in a good turn of events can be achieved at the level of the partnership itself (one trusts the good intentions of the other party).

Alternatively, the presence of opportunistic intentions can be addressed by controlling their actual activities through the involvement of trusted third parties or institutions. Finally, specifically in the context of e-business, the medium in which the activities takes place is

based on technology. The additional risks associated with the use of this technology forms an additional factor in the overall risk assessment of the actors in the e-Business theatre.

Trust Fundamentals	**Trust as a factor for Adoption**	**Trust Enablers**
Partnership trust: Gillmann, 1994 Riemer, 2004	*B2B/B2G Context:* Tan et al., 1998a, Castleman et al., 2001, Tung et al., 2001, Christensen et al., 2002, Icasati-Johanson et al., 2003, Koch et al., 2004, Pucihar et al., 2005, Lawson et al., 2005&2007, Vatanasakdakul, 2008	*Institutional / Organizational:* Lee et al., 1995, Bons et al., 1996&1997, Ganzaroli et al., 1997&1999, Lee, 2001a, Gregor et al., 2000, Rao et al., 2001, Gordijn et al., 2003, Kartseva et al., 2004
Institutional trust: Ratnasingam et al., 2003, Hulstijn et al., 2005, Verhagen et al., 2005 *System trust:* Gogan et al., 2009	*B2C/G2C/C2C context:* Schubert, 1997, Klein et al., 1998, Sieber, 1999, Schubert et al., 1999, Farrell et al., 2000, Loebbecke et al., 2001, Ang et al., 2001, Bouwman et al., 2003, Jarvelainen, 2003, Head et al., 2003, Lui et al., 2003, Hassanein et al., 2004, Meents et al., 2004, Verhagen et al., 2004	*Legal / Privacy:* Gisler et al., 1997, Hudoklin et al., 1997, Smith, 1999, Tan et al., 2002, Di Biagi, 2003, Jutla et al., 2003, Dinev et al., 2005, Polanski, 2005&2006, Clarke, 2006, Ong et al., 2009,
General theory and measurement: Tan et al., 1999, Van Buuren et al., 2004, Burgermeestre et al., 2010, Schryen et al., 2010, Soelnner et al., 2010	*Social media context:* Ten Kate et al., 2010, Mantymaki et al., 2010, Riemer et al., 2010	*Technology:* Clarke, 2002, Ratnasingam et al., 2002

Table 1: Overview of Trust related articles in Bled 1994-2011.

Given these considerations, many authors have studied the impact of one or more of these components of trust on the adoption of e-business and more recently social media. We have classified the contributions into B2B/B2G versus B2C/G2B/C2C, which is a common way to study the e-Business / e-Commerce /e-Government fields. At the end of the day, "trust" always comes down to the estimation of one or more human beings and their resulting intentions to engage (or not). However, there is a difference between the role that trust plays if the individual acts in a role as "consumer" (or "patient" or "citizen"), representing him/herself (and/or family) versus a role as an employee or representative of an organization. In recent years, "social media" have been added to the equation, with their own set of dynamics due to the critical role that user-generated content plays in these media and the often anonymous nature of the individuals generating it.

The final category of papers deal with "trust" in a constructive manner, finding ways to overcome a lack of trust by addressing institutional and/or organizational solutions, legal solutions and technological solutions. The first two categories seek solutions that can improve the institutional trust between parties, while the latter contributes to system trust. Institutional and organizational solutions introduce ways for actors to secure their activities, typically via

the intermediating role of trusted third parties. These parties may simply be agents that act on behalf of one of the actors. However, they also include (governmental) institutions that regulate interactions and whose only interest is the facilitation of the transaction itself, for instance, through electronic marketplaces. In principle, these kind of solutions are preventative from a risk management perspective: they try to avoid damage occurring in the first place. Solutions in the legal field are usually more of a reactive nature. They will ensure that parties have sufficient ways to repair any damages via the legal system. Removing uncertainties about the position of parties after the fact is an important way to increase the level of confidence that, even if something goes wrong, not everything is lost. It also provides a negative incentive to those planning opportunistic behavior. In a social media context, but also in other contexts involving private individuals, a separate concern is privacy, which we have clustered in this domain as well. The identity of a person in combination with certain attributes (i.e., knowledge about one's preferences, whereabouts, financial data etc.) is a valuable asset in its own right that needs to be protected. Finally, studies in the technology domain look at how technical solutions can help to contribute to trust as well. Often, they are a consequence of solutions in the other two areas. For instance, legal solutions will typically require that stated intentions must be documented in such a way that courts can rule on them. In an electronic world, the concept of a signature was (and is) therefore an intensively investigated research area. With credit card fraud and identity theft on the rise, lack of technological solutions, their implementation and use is still a major threat to all e-Initiatives in scope of the Bled Conference for years to come.

Figure 1 shows the number of articles on Trust over the years, divided into the three main categories.

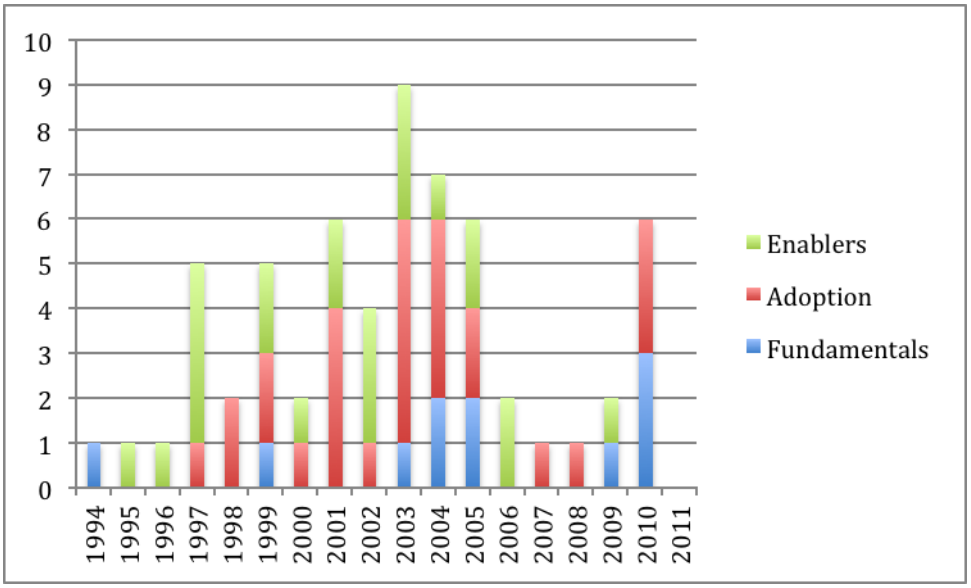

Figure 1: History of trust related articles in Bled 1994-2011

2 Inter-organizational procedures for trade

In the remainder of this paper, we will discuss how our work on procedural controls has contributed to the Trust discussion, at Bled, and in other venues. This section positions our work in the overall context of Trust and discusses the fundamental concepts we have based our research on. The next section will discuss the focus of our current research and provides

an outlook towards what we believe to be the next step in designing procedural controls for trade, particularly international trade.

In 1994, we introduced the concept of "Open-edi" in Bled, looking at taking away the barriers for establishing an EDI link by reducing the set-up costs (Bons et al., 1994). We were convinced that the Internet would offer opportunities to engage in electronic business at a much wider scale, and with new trading partners with whom no prior trading relationship existed and trading would start at "arm's length". The reduction of set-up costs was (and is) an important factor in this, and understanding and agreeing about the context in which messages are sent is a vital element therein. In fact, several international bodies such as the International Chamber of Commerce (ICC), United Nations Conference on Trade and Development (UNCTAD), the World Customs Organization (WCO) and the International Maritime Organization (IMO) have been working on the simplification, standardization, and harmonization of trade rules, conventions, and procedures. Although few scientific articles specifically addressed trade facilitation, the theme has been discussed frequently at the Bled Conferences, where practitioners, scientists and regulators from the EU and the UN have met over the years.

Our initial contribution to the simplification of trade procedures was to introduce a modeling technique, "Documentary Petri Nets" (Lee & Bons, 1995), to model the inter-organizational exchange of goods, funds and information. At the time, other researchers were looking into the modeling of inter-organizational business processes, often adopting a "Business Process Redesign" approach (Hammer, 1990). The research by Van Hee and Van der Aalst at the Eindhoven University of Technology was also looking at the use of (colored) Petri nets to model such processes, and was quantitative in nature (Van der Aalst & van Hee, 1996). Our focus was less on the computational aspects of messaging or the operational efficiency of the resulting processes, and more on the context in which the messages where exchanged.

When reasoning about these "messaging contexts" (a.k.a. "Open-edi scenarios"), we started to realize that the function of many documents in international1 trade is not an operational one but is related to controlling the execution of the underlying contract. The contract specifies an exchange of actions, such as delivering certain goods or performing certain services (or sometimes refraining from taking punitive action, such as licenses, or easements) against a payment from the counterparty. In other words, each party does something to get something. We refer to these actions done for others as 'doing' tasks.

When the principal parties do not have established trading relationships (i.e., insufficient trust at the partnership level) and cannot directly observe the proper execution of these 'doing' tasks by the other parties in the contract, they will want confirmation from an agent that they do trust that the other parties have in fact acted according to their contractual obligations (i.e., sufficient trust at the institutional level). The activities relating to contract monitoring we call 'control' tasks. These control activities usually involve other parties such as banks, carriers and inspection agencies and require documents as evidence of contractual relations (e.g. sales contracts, credit contracts, insurance contracts, and transport contracts), regulatory relations (e.g. import licenses, export licenses, and duty exemptions), and various kinds of performance or operational evidence relating to these contractual and regulatory relations (e.g. shipment of goods, payment of goods, and payment of tax). We use a similar distinction of the concepts

1 The theory developed can also be applied to trade within a single legal jurisdiction, but the amount of uncertainty due to lack of common legal frameworks, cultural differences and physical distance make the international domain more challenging.

"trust" and "control" as defined by (Das & Teng, 1998). While they both contribute to the same goal ("confidence in partner cooperation"), they have an "open-ended supplementary" relationship. If it is possible to fully trust a partner (meaning: have full confidence that the partner has only the best of intentions), controls are not necessary. Vice versa, if one can fully control the other party's actions, the intentions of the party no longer play a role. While Das & Teng focus on the long-term effects of trust and control and their interdependence, we focus on the early stages of the relationship when there is (still) absence of trust and a single transaction has to be completed in a safe and secure way.

The obligations of all these various parties could be incorporated into a single, complex multi-party contract. However, if things go wrong and one or more parties defaults, the question arises as to the residual obligations among the remaining parties (imagine a contract between A,B,C; A defaults; must B and C still fulfill their obligations?). For this reason, most multi-party contracts are divided into two party contracts. Thus, the full transaction may actually involve a number of different sub-contracts. The trade procedure weaves all of these various sub-contracts together. It consists of essential activities that realize the exchange of goods, services, and funds between the parties, as well as other control activities that aim to limit the risk of fraud. The trade procedure also contains any necessary control steps to ensure that the contract is self-enforcing. Therefore, a large part of trade procedures involves creating and transferring documents -- either in paper or in digital form.

With the Internet on the rise and Electronic Commerce becoming a reality, we asked ourselves the question how "electronic documents" could make international trade more efficient, eliminating the limitations of their paper-based equivalents. Furthermore, the Internet made it possible to find new business partners in a globally connected world, and we envisioned the need for safeguards in these starting relationships to increase. Finally, with the digitization of certain industries and the introduction of "micro-payments", we felt that there would be the need for new control mechanisms, because the known and trusted methods may be too expensive to operate in these settings.

As a consequence, our research evolved into the notion of "designing trustworthy trade procedures", where we added the concept of control and risk management in situations with insufficient trust into the reasoning why EDI adoption was limited to "closed relationships" or "electronic hierarchies" (Bons et al., 1997). We introduced the notion of a "trustworthy trade procedure", defined as "a trade procedure that governs a transaction in which the risk of opportunistic behavior by one or more parties is present but which provides sufficient inter-organizational controls to limit this risk." (Bons et al., 1997). Based on a set of control principles, derived from a combination of legal and accountancy literature, reasoning about the "control quality" of the trade procedure and the principles were translated into control patterns. Finally, we set out to automate this reasoning process. The aforementioned "Documentary Petri Net" formalism was used to model the dynamic aspects of the trade procedures. The obligations between parties were specified using a -predicate logic – at that stage a basic one. A pattern-matching approach was used to identify potential control weaknesses in a proposed procedure. A prototype implementation called "InterProcs" translated these patterns into audit daemons (Lee, 1998), which, when applied to example trade procedures, was able to show the control weaknesses and to support the design of procedural controls for trade procedures.

Our research accordingly fits best into the institutional/organizational category discussed earlier, although there is a strong legalistic component to it, because the starting point for our

analysis was the obligations of parties and the contracts in which they are formalized. By the late 1990s, the EURIDIS institute at the Erasmus University Rotterdam, where this research was done, was intensively looking at the various aspects of trust and control under the leadership of Ronald Lee. Its researchers have had a significant mark on the Bled community, most notably Yao-Hua Tan, who co-authored over 12 publications in Bled involving trust from 1998 onwards, and René W. Wagenaar.

3 Design stages for procedures driven by deontic structure

The research we described in the previous section provided a way to automatically analyze the extent to which a given trade procedure had sufficient controls to remove the relevant risks for the parties involved. However, the creativity to derive new or improved procedures in changing circumstances was left up to the stakeholders or their representatives.

In the meantime, re-engineering of trade procedures has become in urgent need and has attracted a great deal of interest from the international community. One key issue is the increased concern for security since 9/11. Traders are now subject to many more government controls, which increase administrative costs for trade. Studies show that trade procedures cost from 2 to 10% of traded value. Meanwhile, globalization makes the world economy depend on trade more than ever before. Since the year 2000, the world trade volume has grown twice as fast as the world output and has grown consistently with the exception of crisis year 2009. In 2011, world merchandise export exceeded $18 trillion (WTO, 2012). It is estimated that reducing the administrative costs of trade procedures could save around €300 billion a year (Grainger, 2007). Thus, among governments and traders, there is a strong interest in the redesign of controls in international trade, especially given the aforementioned new possibilities offered by technologies such as (mobile) Internet, RFID tagging and so on. In 2005, the European Union committed to spend €1 billion every year on "aid for trade", of which improving trade procedure is a major component. In the world, about $3 billion was spent on trade facilitation in 2004 (Grainger, 2007).

A problem with technology motivated re-design is that there is a bias towards imitating the procedures used with the previous technology, for instance by simply replacing paper documents by their electronic equivalents. This may overlook the possibility that some controls are no longer needed in an electronic scheme. For instance, at the time when transferring funds between countries took several days, the seller often required a remittance certificate issued by the remitting bank to verify payment before delivering goods. Now, electronic fund transfers can be done within seconds. Instead of verifying payment from the remitting bank, the seller can check his own account. Consequently, getting a remittance certificate before delivery of goods is no longer required. Simultaneously, given the instant execution of the payment, the buyer has less opportunity to stop a payment if he discovers foul play along the way.

Another factor is that some control requirements can be satisfied in several ways. Each way of enforcing controls may be appropriate to a specific situational context. If the designer only examines control solutions without considering the underlying control requirements, opportunities for improvement may be missed.

Finally, most of the controls involve the exchange of "documents" in one way or another. As a consequence, the communication of those documents becomes a target in need of protection. In (Bons et al., 1997), the link was made between the performative function of a document and the technical requirement(s) of the communication, such as non-repudiation,

confidentiality, integrity and in special cases, uniqueness (or impossibility to copy). These requirements can be met using both procedural and technical measures, such as watermarks, stamps and holograms in case of paper, or public key infrastructure based encryption in case of electronic documents. Changing to e-business technologies, the issue is therefore not to exactly duplicate behaviors of paper documents by electronic means, but rather to capture the underlying functionality of the documents, which is about contracts, promises, licenses, rights, duties, privileges, etc. These concepts, together with their properties (e.g. negotiability and revocability), relations (e.g. conditional promises and mutual promises), and lifecycles (e.g. creation, transfer and discharge), define what technical control requirements are needed.

We believe that the solution to this problem can be found by focusing at the underlying control targets, regardless of the technology and mechanisms chosen to implement the controls. Our focus is on the resulting procedural aspects and the role of information in the execution of trade transactions. Other researchers, like Gordijn and Tan, while departing from similar starting points, have a, in our view complementary, focus on the (quantitative) effects of the value exchange itself and the impact on the underlying business models (see for instance Gordijn & Tan, 2003).

The notions of permissions, rights, obligations, prohibitions, waivers, etc. are collectively known as deontic concepts (Von Wright, 1951, 1968; Hilpinen 1971). These mark the contractual interest of each party in the behaviors of the other contracting parties. An obligation is what one party is expected to do, presumably for the benefit of another party. A prohibition (for instance, a confidentiality agreement), indicates how one party constrains the behavior of another. A waiver is a release from some obligation (for instance, diplomatic immunity from parking tickets). A permission (such as a license) allows a party to do something that would otherwise be prohibited.

The focus here is thus on the adequacy of deontic controls in contracting (trade) procedures. These may involve the design of new procedures in some new problem domain, such as government contracting, or it may involve the re-design of existing procedures, for instance to incorporate electronic technologies. Our current challenge is to be able to generate new trade procedures based on a set of conditions in which the procedure is to operate (i.e., technical capabilities of parties involved, government regulations requiring or forbidding certain ways of working, etc.). While a documentary procedure changes with implemented contexts, its underlying "deontic" functionality – the way it changes the formal relationship among parties – does not. Any new procedure, regardless of its form, needs to provide controls for the same set of underlying deontic functions. In order to develop computational methods for this purpose, a formal representation of the deontic functions in the procedure is needed, as well as methods to systematically analyze the representation to identify control requirements.

There are two ways to approach the deontic analysis of inter-organizational procedures. One way is to analyze the deontic effects at the level of an existing procedure, which already has various documentary and other kinds of controls embedded in it. Using this approach, one does a kind of reverse engineering, identifying the deontic relations, e.g. rights, duties, privileges, prohibitions, liabilities, etc. of the involved parties that are implicit in the various documentary exchanges and other actions (e.g. delivery of goods), for each of the steps in the procedure under analysis. The dissertation of Dewitz (1992) follows this approach. An alternative approach might be called 'start from basics'. In this approach, one designs the procedure first in terms of the basic 'doing' tasks that are to be accomplished, and adds the 'control tasks' later, based on the risks encountered.

The former case is perhaps better for analyzing procedures that have evolved over a long time. The latter is more useful in contexts where the situations are novel and/or urgent – such as for military conflict situations and humanitarian disaster response. Furthermore, the advantage of the 'start from basics' approach is greater generality. The same deontic procedure may have various documentary procedure implementations, depending on the available technology. For instance, one version of the procedure may involve paper documents. Another version of the documentary procedure may utilize digital documents sent over a secure private network. Still another version of the procedure may utilize wireless infrastructure and mobile phones.

The 'start from basics' approach, as we envision it, consists of 5 distinct stages which we will describe and illustrate with a simple example.

3.1 Stage 1: Specify basic terms and conditions of the contract

The first step is to compile a declarative specification of the basic terms and conditions of the contract as formal logic specifications, independent of temporal ordering. The field of deontic modeling offers several alternative formalisms that can be used to model this (for instance, Tan & Thoen, 1998b, Tan et al. 2004). The purpose of this specification is to indicate the basic operational tasks that each of the parties is to perform in the contract, as well as constraints on the sequence in which they are to take place. These tasks may be physical, e.g. manufacture or transport, or they may also be deontic, for instance a particular activity is obligated, or an activity is specifically permitted, as with a license.

To illustrate this we use a simple contract involving two parties, Seller and Buyer, who make two promises: one is the Buyer making a promise to the Seller to pay. The other is the Seller promising to the Buyer to make delivery once the seller has paid. (This tiny example obviously omits relevant details such as the price, the items to be delivered, and the deadlines for the actions.)

> [Buyer, Seller]: prepay_contract(Goods, Price) ==>
>
> A::Buyer to Seller: promise(Buyer to Seller: pay(Price));
>
> B::Seller to Buyer: promise(Seller: delivery(location(Buyer), Goods) / done(A)).
>
> READING: a prepay_contract between Buyer and Seller is made when (A) Buyer promises to Seller to pay a pre-agreed price and (B) when Seller promises to Buyer to deliver Goods to location of Buyer, conditional on Buyer having done (A). Seller commits to deliver the Goods to Buyer at his/her location.

3.2 Stage 2: Derive deontic process model

We introduced the "Documentary Petri Net formalism" in Lee & Bons (1995), to capture the exchange of goods, funds and information. The more explicit emphasis on deontic aspects has led us to adopt this formalism to facilitate these specifications, and to rename it "deontic petri nets". The contract process model for this example is quite simple, as indicated by Figure 2. Essentially, there are two concurrent illocutionary actions in which each party makes its respective promise. These are followed by the sequence of the contract performance, where Buyer makes payment, followed by Seller doing delivery.

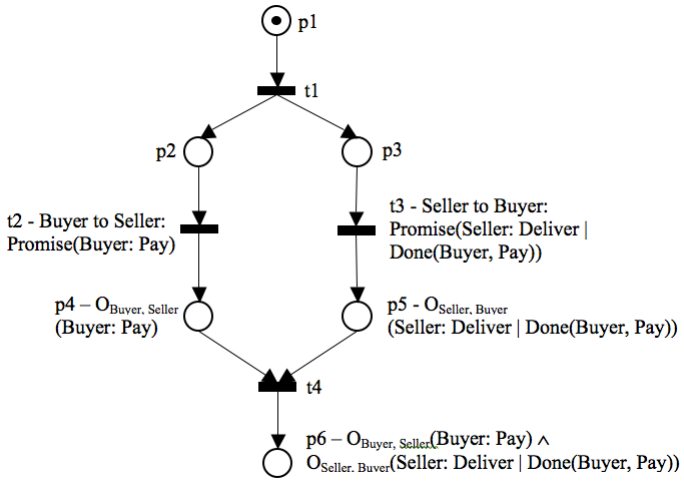

Figure 2: Process Model for Advance Payment Contract.

3.3 Stage 3: Deriving control requirements from deontic proc. model

Once the deontic process has been specified as a deontic petri net, the next stage of analysis is to identify control requirements, which indicate control objectives to be achieved by the documentary trade procedure. Deriving control requirements requires the examination of all possible deontic changes in the process and the effects of such changes on the parties involved. Besides information provided by the deontic process model, this task may need additional information about the problem domain. Examples of such information are whether a party trusts the other, or whether parties are able to directly observe task performance by the other parties.

This framework focuses on two fundamental aspects of a deontic procedure: deontic relations and deontic changes. In developing the rule base to identify control requirements, a taxonomy was established of all categories of deontic change of an obligation. This taxonomy includes the creation and termination of an obligation, as well as changes that take place in any constituents of the obligation. Analogously, a taxonomy of deontic relations was also created. This taxonomy includes unilateral obligations as well as the various contractual relationships between two parties. For each deontic change, a catalogue was made of all possible fraud potentials available to each party involved in the deontic relation, and the corresponding control requirements to limit these fraud potentials was identified (Nguyen, 2008).

The various control requirements are classified into three categories: checking control, evidentiary control, and deontic control. Checking controls are checking activities performed by a party to make sure that a certain event has actually occurred. For example, in a documentary credit transaction, the confirming bank only checks the shipping documents against the specifications in the "Letter of Credit" to make sure that the goods were shipped before making payment2. Evidentiary controls involve the creation, exchange or cancellation of a document as evidence of an event. For example, when the seller delivers the goods to the carrier, the carrier issues a bill of lading to the seller as evidence of the delivery. Finally, the

2 In this procedure, the bank does not physically verify the shipment of goods but relies on documentary evidence only. For that reason, it is called a documentary credit; the credit part of the transaction being that the confirming bank pays the seller prior to receiving the money from the buyer.

kind of deontic control considered in this research involves a secondary promise from a trusted third party such as the promise from the issuing bank to the beneficiary of a documentary credit.

Table 2 paraphrases the requirements generated from this analysis, paraphrased for readability. Control requirements are indicated by the keyword 'should' in the paraphrase. Note that, even for this simple contract, eleven control requirements were found! However, when control solutions are selected, multiple control requirements can often be combined in a single control solution, which will simplify the final trade procedure.

3.4 Stage 4: Select control solutions

A given control requirement may be satisfied by various control solutions. For instance, verification of a person's identity might be accomplished by presentation of a photo ID, such as a driver's license or passport, or it might be done by a more sophisticated biometric scan of the person's fingerprint or iris. The choice of control solution is based on an analysis of the risk of a control failure (either by willful deception or by accident) versus some estimate of the potential damage due to the failure (e.g. unauthorized admission to a concert vs. unauthorized admission to a nuclear reactor's control room). These aspects fall under the category of security engineering, of which there is a large literature. See for instance Anderson (2001), various works by Schneier (2003, 2008) and Lee et al. (2008) which discusses control solutions for transferable rights.

Thus far, the focus has been on the generation of control requirements. We now briefly consider how these control requirements become satisfied by application of selected control solutions. In order to map from control requirements to control solutions, we utilize a rule format common in logic programming:

P if Q1 and Q2 and ... Qn.

	List of control requirements resulting from the analysis
1&2	Verify that after buyer promises to seller that buyer will pay, seller **should** check legal capacity of buyer and, seller **should** check buyer's compliance with applicable regulations re. payments
3&4	After seller promises to buyer that seller will make delivery contingent on buyer's payment, buyer **should** check legal capacity of seller and, buyer **should** check compliance with applicable regulations re. delivery, before buyer pays
5	After seller promises to buyer that seller will deliver on condition that buyer has paid buyer **should** receive evidence from seller stating this promise
6	After buyer has promised seller that buyer will pay seller **should** receive evidence from buyer stating this promise
7	After buyer does pay buyer **should** receive evidence from seller that buyer has paid
8	After seller does deliver seller **should** receive evidence that seller has delivered
9	Before seller does deliver seller **should** verify that buyer has paid
10	After seller has delivered buyer **should** verify that seller has delivered
11	After buyer has paid seller **should** verify that buyer has done payment

Table 2: Control Requirements for Advance Payment Contract.

For example, in the two instances of Control Rules 5 and 6 from Table 2, the control requirement is that each party should receive evidence of the promise of the other. For many routine transactions, this is done by means of a purchase order document followed by some kind of order confirmation. In legal terms, the purchase order is a contractual offer, and the confirmation is an acceptance. But note that even in this simple case, two documentary steps are required for the creation of the promise. For instance, the control requirement for the seller is the following

seller from buyer:

receive_evidence(done(buyer to seller: promise(buyer : pay))))

That is, the seller needs to receive evidence from the buyer about the buyer's promise to pay. Rules used to derive a documentary control solution rule might look like the following:

has_evidence(X, PromisedAction) if

has_evidence(X, Contract) and

implies(Contract, PromisedAction).

has_evidence(Z, contract(X,Y, ContractTerms) if

has_evidence(Z, (X to Y: offer(ContractTerms)) and

has_evidence(Z, (Y to X: accept(ContractTerms)) and
(X to Y: offer(ContractTerms)) < (Y to X: accept(ContractTerms)).

has_evidence(Z, (X to Y: offer(ContractTerms)) if
X to Y: purchase_order(ContractTerms).

has_evidence(Z, (Y to X: accept(ContractTerms)) if
Y to X: confirm_order(ContractTerms).

Thus, according to the first rule, one way to get evidence for a promised action is to get evidence for a contract, which includes ('implies') the promised action. The second rule says that a way to have evidence for a contract is to have evidence for an offer followed by an acceptance. The final two rules say that a purchase order is evidence of an offer, and an order confirmation is evidence for an acceptance. Note that there may be other ways to evidence a promise or a contact, which would require additional rules. It should be emphasized that this step, selection of control solutions, is the stage that is most dependent on the contracting domain and is further most likely to change as new technologies become available. Thus, the rules presented here are only illustrative.

3.5 Integrate control solutions to generate role procedures

Various control requirements involve the transfer of evidence that a certain action has been done, e.g. signing a receipt for delivery. Such evidentiary control requirements can usually be inserted as a single localized step in the procedure. More challenging are control requirements that require a check or comparison to some state created earlier in the procedure. For instance, a claim to refill one's prescription at the pharmacy requires a prior registration of a prescription order from an authorized doctor. The various selected control solutions create a set of additional (control) tasks that add to, or in some cases replace, the original set of contractual (doing) tasks. The final step is to assemble this augmented set of tasks into an integrated procedure.

The approach we take to analysis of procedures is an adaptation of model checking. Model checking is used to determine if and how a program might arrive at a certain critical state that can cause the system to crash. The system and the specified state are formulated using a form of temporal logic. One popular representation is computational tree logic (CTL), which is the representation used here. The essence of the problem is to determine if the specified condition is satisfiable within the axioms that describe the system.

As with other kinds of modal logic theorem provers, a problem for model checkers is a combinatorial explosion of the state space. However, recent developments in model checking have made these techniques computationally more tractable (Clarke et al., 1999). In the approach described in this paper, a logic programming based CTL model checker is used, which is adapted from the version presented in Leuschel and Massart (2000). Essentially, the technique involves converting the petri net form to a state-transition graph, and then matching the control patterns to this transition graph. In our case, this involves an application of AI planning techniques called procedure constraint grammar (Lee, 2001b), which essentially

resolves the ordering constraints on the combined set of doing and control tasks. As explained in (Lee, 1999), the procedures are divided by role, and all coordination is performed by communication of documents. It is important to note that the architecture needs to permit the downloading and autonomous execution of each role procedure by the respective parties.

4 Concluding remarks and future research directions

Trust has been recognized as a key factor in the adoption of e-Business solutions by the Bled Conference over the years. Over 60 contributions have been published between 1994 and 2011, which we categorized into the fundamentals of trust, the role trust plays in the adoption of business-to-business, business-to-consumer and currently Social Media applications and, finally, ways to overcome a lack of trust by implementing controls. While the peak of publications appears to have taken place in the beginning of the 2000s and attention seems to have since shifted to other areas, "Trust" deserves a continuous point on the agenda, especially at conferences such as Bled where the scientific community, the business community and governmental agencies, especially the EU, meet to discuss new ways of working in commerce, healthcare and government. With cybercrime at an all time high, Social Media being increasingly confronted with serious incidents involving (anonymous) participants and a general increase of fear, uncertainty and doubt in traditional (financial) institutions, "trustworthiness" is a topic in need of continual re-evaluation.

Over the years we have been proud members of the Bled community and have contributed to one specific area of "Trust": enabling electronic commerce in situations where the level of partner trust is (still) not high enough and alternative control procedures need to be implemented. In the paper we discussed our key contributions to Bled in the 1990s, focusing on the ability to automatically analyze whether or not a trade procedure provides sufficient controls to the parties involved, based on a set of general design principles.

We have concluded this paper with the next step and focus on the design and generation process of secure procedures and consequently the generation of control requirements. Starting from the core of the trade procedure, the set of obligations that parties have towards each other, a modeling perspective called deontic process modeling was introduced to represent the entire life cycle of deontic relations. A formal representation, "deontic petri nets", has been developed to support the modeling and analysis of practical applications. This formalism comprises two components: (1) a logic component, which combines aspects of deontic logic, temporal logic, action logic, and institutionalized power logic for modeling deontic states and deontic changes, and (2) a Petri net component for graphical representation, analysis and simulation. These two components are integrated in a single semantic framework based on state transition systems.

With this effort, we have hoped to show that the issue of trust and control is as vivid as it has been and that with the help of AI based tools we can facilitate the continuous adoption of business practices ("trade procedures") to accommodate new circumstances, most particularly the evolution of EDI into e- and now m-commerce and social media. We believe that two topics are of specific interest for future research: responsive controls, and harmonizing controls.

Responsive controls are control procedures that are able to actively respond to changes in business and legal environment. Inter-organizational transactions typically span many countries, and may involve different trade alliances. Countries and trade alliances impose various regulatory control requirements on trade procedures. These requirements involve a

wide range of issues, including tax collection, environmental protection, health protection, human right protection, fair trade protection, and security protection. Regulatory control requirements are frequently changed, since a country or a trade alliance may adjust its regulations for political and economic purposes. Moreover, a country may enter or withdraw from a trade alliance. Changes in regulatory controls could affect trading products, trading countries, trading parties, etc. A challenge for future research is to design control procedures that would enable straightforward and rapid adaptation to such changes.

Issues for harmonization of controls in trade procedures have been discussed by Lee and Dominguez (2004). The harmonization problem arises due to differences in regulatory control requirements among administrations governing a transaction. Different countries have different requirements on particular kinds of transactions. Given that the countries are willing to harmonize their differences in their respective trade procedures, how to should one go about designing a system that could facilitate this process? Ideally, such a system would provide features for detecting control weaknesses and possible conflicting requirements, providing negotiation support to resolve control deficiencies and, if there are and conflicts, providing decision support in identifying control solutions that provide inter-operability among the parties, and helping to incorporate these control solutions into a the final procedure. Given a transaction scenario, the process of harmonization could start with gathering regulatory control requirements of all involved governmental administrations and other parties. A system would need to be developed to detect conflicting requirements. These conflicts could be resource conflicts (e.g. a party unable to comply with two different requirements within a certain limitation of resource) or procedural conflicts (one administration requires step A before step B, while another administration requires step B before step A). All detected conflicting requirements would be identified as issues for negotiation, for instance to be resolved by UN trade committees.

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