The Essential Dynamics of Information Infrastructures

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Completed Research Paper

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Abstract

This paper inquires into the complexities of contemporary IT solutions based on a case study of the EU's eCustoms initiatives using Manuel DeLanda's Assemblage Theory. Technological innovations have enabled information infrastructures with dramatically increased number and heterogeneity of included components, and their dynamic and unexpected interactions. Unfortunately, lack of understanding of how the increasing complexity influences development initiatives is hampering effective information infrastructure development. Assemblage Theory can be seen as holistic synthesis of previous research streams seeking to explain how information infrastructures evolve in social contexts. Accordingly, in this paper it helps us getting a holistic grasp of the complexity of contemporary IT solutions and the "essence" of their dynamics. Through Assemblage Theory we explain how the European eCustoms information infrastructure has through a dialectic between stabilizing and destabilizing processes assumed its current shape - a result of decisions taken decades ago, path dependency, complexity, and accumulated emergence.

Keywords: Information Infrastructures, Assemblage Theory, eCustoms, Complexity, Emergence.

Introduction

Increased processing power and higher transmission and storage capacity have made it possible to build increasingly integrated and versatile Information Technology (IT) solutions whose complexity has grown dramatically (BCS/RAE 2004; Hanseth and Ciborra 2007; Kallinikos 2007). Complexity can be defined here as the dramatic increase in the number and heterogeneity of included components, relations, and their dynamic and unexpected interactions in IT solutions. Unfortunately, software engineering principles and design methodologies have not scaled up sufficiently, thereby creating a demand for new approaches that are better suited to cope with this increased complexity. As a starting point a more thorough understanding of this growing complexity is in great demand (BCS/RAE 2004).

In this paper we will inquire into the "essence" of the complexity of contemporary IT solutions through a case study of the European Union's (EU) efforts aimed at developing integrated IT solutions for all traders within the union and the member states' Customs organizations. We consider complexity a crucial aspect of this case, making the case an illustration of the emerging complexity of future IT solutions.

There is a general belief that Information Systems (IS) holds the capacity for strengthening efficiency, providing tools for security, and furthermore being an instrument for streamlining eGovernment procedures (Irani et al. 2007; Lenk 2002). Consequently, national and supra-national bodies, such as the EU and the World Trade Organization (WTO), has taken on a keen interest in IT solutions for electronic submission on data for customs purposes, henceforth referred to as eCustoms (an elaborated discussion of eCustoms is found later in this paper). A transition from paper-based to electronic customs processes is a possible strategic move to increase control in international trade and at the same time increase the competitive power of national traders (Rukanova et al. 2010; Tan et al. 2006) by harnessing the potential of IT to improve intra-organizational processes and decrease the administrative burden put on the traders (McKay and Marshall 2004; Melville et al. 2004). However, the transition to eCustoms requires activation and orchestration of a complex mix of stakeholders from national governments, international trade organizations, regulatory bodies, and businesses. To further complicate matters, the technology dimension has to accommodate the needs for both interoperability and security.

The growth in complexity of contemporary IT solutions has brought to researchers' attention novel mechanisms to cope with it, such as architectures, modularity or standards (Baldwin and Clark 2000; Parnas 1972; Schmidt and Werle 1998). Another, more recent stream of research, has adopted a more holistic, socio-technical and evolutionary approach putting the growth in the combined social and technical complexity at the center of an empirical scrutiny (Gal et al. 2008; Hanseth and Lyytinen 2010; Star and Ruhleder 1996; Turner et al. 2006). These scholars view these complex systems as new types of IT artifacts and denote them with the generic label of Information Infrastructures (IIs). The research presented in this paper forms part of this stream of research.

We define II as a specific type of IT artefact that is characterized by the number and heterogeneity of included socio-technical components, relations, and their dynamic and unexpected interactions (Gal et al. 2008; Hanseth and Lyytinen 2010; Monteiro and Hanseth 1996; Star and Ruhleder 1996; Turner et al. 2006). IIs are IT solutions that frequently are the shared responsibility of several organizational entities (Janssen and Joha 2010; Northrop et al. 2006). Furthermore, IIs are not static entities, but evolving as technological innovations are introduced or the social practice is changed (Ciborra and Hanseth 2000).

So far, empirical studies have garnered significant insights into the evolution of IIs of varying scale, functionality and scope including the Internet (Abbate 1999; Tuomi 2002), electronic market places and EDI networks (Damsgaard and Lyytinen 2001; Markus et al. 2006), wireless service infrastructures (Funk 2002), or ERP systems (Ciborra et al. 2000). Other examples include movement of people, health sector, scientific collaboration networks (e.g. Star & Bowker 1999). Some research within this stream (Ciborra et al. 2000; Hanseth and Ciborra 2007; Hanseth et al. 2006) has explicitly addressed complexity drawing upon theories like Actor-Network Theory (Latour 1992), Complexity Science (David 1986), Reflexive Modernization (Beck 1992; Beck et al. 1994). In this paper we will draw upon another theory of complexity: Manuel DeLanda's (2006) Assemblage Theory. We see this theory as a more holistic theory compare to the three just mentioned. To a large extent in can be seen as a synthesis of these. Accordingly, we believe it will help us getting a more holistic grasp of the complexity of contemporary IT solutions and the "essence" of their dynamics in initiatives to shape them towards specific ends. The formal research

question guiding this research is: *how is complexity influencing initiatives to shape the development of large IIs*. To present such a holistic view of the role of complexity as and indentifying this "essence" of dynamic interaction is our research contribution.

Assemblage theory

Manuel DeLanda (2006) presents his theory as a contrast to most social theories which he argues are "organic theories," which are based on what he calls "relations of interiority" as their basic concept. This means the component parts of a larger totality are constituted by the very relations they have to other parts of the whole like the organs of an organism or the different parts of a mechanical watch. DeLanda views Giddens' structuration theory (1984) as one recent example of such. In contrast to organic theories, DeLanda's theory distinguishes the properties defining a given entity from its *capacities to interact* with other entities. While its properties are given and may be denumerable as a closed list, its capacities are not given – they may go unexercized if no entity suitable for interaction is around – a form a potentially open list, since there is no way to tell in advance in what way a given entity may affect or be affected by innumerable other entities.

DeLanda sees the main theoretical alternative to organic totalities in what the philosopher Gilles Deleuze (Deleuze and Guattari 1994; Deleuze and Guattari 2004) calls assemblages, wholes characterized by *relations of exteriority*. These relations imply, first of all, that a component part of an assemblage may be detached from it and plugged into a different assemblage in which its interactions are different. Relations of exteriority also imply that the properties of the component parts can never explain the relations which constitute the whole. That is, 'relations do not have as their causes the properties of the [component parts] between which they are established…' although they may be cause by the exercise of the component's capacities. These capacities do depend on the component's properties, but cannot be reduced to them since they involve reference to other interacting entities.

In addition to the relations of exteriority, the concept of assemblage is defined along two dimensions: one defines the variable role an assemblage's components may play, the other dimension defines variable processes in which these components become involved. The roles components may play range from a purely material role at one extreme to a purely expressive at the other extreme. This means that assemblages are heterogeneous entities, just like actor-networks. Material components may include individuals, organizations, physical structures such as buildings or roads, and various artefacts. On the other side of the continuum are found linguistic and non-linguistic expressional components. A written code of conduct may bring together an assemblage, but the act of following that code of conduct may also be a strong expressional component. In between are components that serve as both material and expressional components. A supreme court is clearly material, but also expressional in a state assemblage. Similarly, a t-shirt is a material component, but it may also serve as an expressional component, indicating association with a subculture, organization, religion or other types of assemblages.

Importantly, assemblages are not static entities, but constantly evolving in a dialectic of stabilizing and destabilizing processes. The processes in which the material and expressive components become involved either stabilize the assemblage, by increasing its degree of internal homogeneity or the degree of sharpness of its boundaries, or destabilize it. The former are referred to as processes of *territorialization* and the latter as processes of *deterritorialization*. Sharpening of boundaries take place when additional expressive components are introduced, or the stabilizing capacities of existing expressive components are extended. Rooted in the work by Deleuze and Guattari (1994), DeLanda identify increased formalization or more rigid rules for how the assemblage work (also known as coding) as one stabilizing process. An organization with formal membership have clearer boundaries than an informal group of people that meet up at the local pub to watch away-games of the favourite team. Conversely, a component can destabilize an assemblage by refuting or offer alternatives to the stabilizing expressions, thus increasing heterogeneity. Drawing on Hume (1969), DeLanda (2006) identifies repetition as another important stabilizing process, arguing that any relational construct in practice ceases to exist (destabilized) if the relations are not regularly activated.

Assemblages always exist in populations. Synthesis of larger assemblages is frequently achieved as the *collective unintended consequence* of intentional action. What components that adhere to an assemblage is especially complex where several layers of assemblages exists. The problem of inclusion is not unique to

assemblages, but is a classical problem in social theory that has been discussed extensively in prior literature (Downs 1967; Haberstroh 1965; March and Simon 1958). Weick (1969) argues that this is partly due to the fact that it is activities, not people, who are organized. Any individual is only partly included in the organization. Consequently, individuals can be both part of an assemblage and its environment. The problem is accentuated in an assemblage, such as an II assemblage, where most of the individuals work in more than one set of coordinated activities. Pfeffer and Salancik (1978) argue that the problem of where an organization begins and ends disappears when approaching it as a set of coordinated activities. A similar reasoning can be applied to social assemblages where DeLanda argues that the components of an assemblage, both social and technical, are defined by the components' contribution to stabilizing or destabilizing processes.

Method

The empirical part of this paper presents the case of how the II supporting European trade evolved from a paper-based solution to a computerized II.

Research context, approach and empirical limitations

Among existing alternatives for approaching the research question in this article, we considered the need for rich and contextually embedded information best being met by an interpretative approach based on qualitative data. Thus the choice of the structured case study approach, which is especially developed for this research approach and in addition has a primary strength in dealing with complexity in research settings (Carroll and Swatman 2000)– a key characteristic of IIs (Hanseth and Lyytinen 2010).

The essence of the structured case study approach (Carroll and Swatman 2000) is that it forms an iterative research cycle within a formal theoretical framework. The framework creates a structure that permits collection of relevant field data and, in later stages, enables traceability of conclusions and theoretical generalizations (c.f. Yin 1994). In the initial stages a broad theoretical frame can be used, whereas in later stages the object of study and the theoretical concepts are narrowed down and precisely defined. Following the guidelines of Carroll and Swatman (2000), we began the study presented in this paper as widely as possible, and then attempted to narrow down in several study designs, including Assemblage Theory, which addressed the general themes and processes of complexity and dynamic interactions encountered in earlier stages.

The reported study was part of a project on eCustoms implementation throughout Europe, involving multiple stakeholders from government, businesses, a standardization body (UN), and academia. The project, initiated in January 2006 and terminated in December 2010, was built around the concept of Living-Labs (LLs). LL is a concept that has been used in various occurrences to depict a research setting that emphasizes the use of real world environments instead of isolated labs as the setting for research (Klein and Higgins 2010). It is frequently used in a common sense meaning, but has also been used more specifically as a research approach in various research fields (e.g. McNeese 2004).

Based on collaboration in the LLs, issues were identified and further explored among the involved partners. The present study reports the specific experiences gained in the project's third LL situated in Denmark. The Danish LL, named 'Food LL,' focused on export of dairy products and involved the dairy producer Arla, Danish Customs, the Danish software provider Resultmaker, as well as researchers from national and international institutions. Denmark is a suitable context for studying eCustoms since Danish authorities are relatively advanced in their IT use and are frequently show-cased as role model for other countries. Studying customs and trade in Denmark is also particularly suitable due to Denmark's position among the world leaders in logistics and economy based on foreign trade.

The II of interest in this study is the European eCustoms II, which refers to the integrated IT solutions for traders within the EU and the member states' Customs organizations. Empirically, to limit our approach in a way that enabled further understanding, the study in this paper took its starting point in Arla's export of dairy products from Denmark to Russia, and from Sweden to Oman. We then limited empirical investigations to the parts of the II that affected Arla's export processes and the actors that were identified as major influencers of these parts of the II (see below for a complete listing).

Data collection and analysis

In a first research cycle general workshops and project meetings in the Food LL of the eCustoms project were used. In the first data collection phase, 10 meetings were attended, recorded and analyzed for information on the II and its evolution. The project workshops and meetings brought together traders, governmental agencies, standardization bodies and IT providers that discussed how the current II could be reshaped to improve and facilitate trade. The combined view of these stakeholders and the explicit outset to discuss how to work with and build on the existing infrastructure was ideal for creating a broad view of the current infrastructure and the major stakeholder in its transformation. In a 2-day workshop, 29 participants from the stakeholder organizations collectively synthesized a report on barriers on drivers for future eCustoms initiatives in Europe. Another outcome was a technical description (data models, security measures, connection form, etc.) of the export systems of all 27 EU member countries. These documents, recordings, transcriptions, notes, and reflections were structured in a research folder. Data was coded in general themes, representing for example major issues, involved stakeholders, processes, events and objectives. The extensive and broad, rather than narrow and focused, empirical material made the structured case-study approach suitable (Carroll and Swatman 2000).

The first research phase was broad and focused on creating a relatively neutral story with events, processes, actors and outcomes. We used the concept of II to focus data collection, but were not explicit in which theoretical approach to use to explain the transition. Reflecting on the findings we searched for theories that could help us explain why the infrastructure evolved the way it did. From the empirical material complexity and dynamic interactions emerged as highly relevant issues. At an early stage, national and supra-national authorities expressed frustration over complexity, path dependency, emergence and unintended consequences. In a second phase of data collection, 12 semi-structured interviews were made in a second data collection phase with the case company Arla (Business relationship manager, IT manager, Responsible for Danish export), Danish Customs (Head of Customs unit, Manager eCustoms project, Developer e-Export project), the EU's unit for eCustoms (Head of unit, Head of infrastructure, Developer), WCO (Head of IT unit), the IT provider of Arla (IBM: Developer of Arla's IT infrastructure), and Arla's logistics provider (Maersk: Supply chain systems designer). The interviews were recorded and key sections transcribed. Our interpretations, findings and data were continuously shared with the contributing organizations to ensure correct interpretations and avoid disclosure of potentially sensitive information. It should be recognized that the development of the European eCustoms II is a political and potentially sensitive process. Our intentions were to enforce the process, not to harm it with disclosure of sensitive information.

In line with the structured case method approach several theoretical perspectives were used to code and analyze the empirical data. Although Assemblage Theory is presented as one single theoretical lens in this paper, in accordance with the structured case approach, variations and differences corresponding to different lenses related to various theories of complexity were part of the iterations.

eCustoms in Europe

In terms of DeLanda's Assemblage Theory, the integrated IT solutions for all traders within the union and the member states' in Europe have evolved through changes in a number of interconnected assemblages and sub-assemblages related to international trade and eCustoms. This section tells the story of the development of eCustoms in Europe using DeLanda's concepts of assemblage theory. We first describe the principal components (positioned at various places along the material-expressive dimension) of the different assemblages and their sub-assemblages. We then use Assemblage Theory to account for how the assemblages have evolved through the dialectics of stabilizing and destabilizing processes.

Assemblage of Assemblages

The overall customs assemblage can be described as a number of layered, interconnected assemblages: the trade assemblage (traders, transporters and transport technologies, etc.), the regulatory assemblage (international treaties, national and EU legislations, national and international standards, regulatory intuitions, etc.), and, finally, the II assemblage. The overall customs assemblage could also be split into national ones which would, then, consist of the national IIs, national legislation, national authorities

involved in customs declaration, etc. The national assemblages are then connected to each other and to an assemblage representing the EU level and one representing the global one (international treaties, standards and institutions).

Trade assemblage

The trade assemblage that ships goods around the world has roots going back in historical times. Initially with the establishment of silk and amber trade routes Europe achieved relatively stable connections to remote parts of the world, representing an infrastructure that could be used to trade goods between different locations. Today the world trade assemblage includes components of traders (importers and exporters), shipping agents, logistic providers, trading processes, and a physical transportation infrastructure that includes harbours, airports, road and rail networks, warehouses, and routing terminals. A comprehensive set of expressive components is found in the organisation of how trade and shipping is carried out. This includes processes for navigating ships and airplanes, international codes for airports, standardised hierarchical structures for commanding ships, and implicit standards for how to design shipping containers. Taken together, trade qualify as an assemblage whose properties as a whole cannot be reduced to the individual components, enabling international trade.

Legal assemblage

Trade is deeply embedded into multiple layers of legislation. Customs law that affects European traders exists as international treaties, EU law, and national law in a hierarchical structure of sub-assemblages where the latters, in theory, are supposed to incorporate the prior. Assemblage components range from material components of individuals and institutions towards more expressive components such as legal text and memberships.

International organizations such as the World Customs Organization (WCO) works through Conventions, such as the "International Convention on the simplification and harmonization of Customs procedures" (Kyoto Convention), which are voluntarily accepted by the member countries. WCO has developed the WCO Framework of Standards to Secure and Facilitate Global Trade that sets forth principles and standards as the minimum level of what should be adopted by WCO members. Part of the framework is the WCO Data Model that in a hierarchical structure defines common customs data requirements.

Another key player on the international level is UN, that act through UN Centre for Trade Facilitation and Electronic Business (UN/CEFACT)(UNECE 2009). The relevant work of UN/CEFACT is mainly carried out in the Trade and Business Process Group (TBG). TBG in turn is divided into subsections with distinct areas of responsibility (see Figure 1). The work within TBG2 on UNeDocs published in the United Nations Trade Data Elements Directory is particularly interesting for eCustoms. The objective of the UNeDocs project is to develop and maintain aligned digital cross-border supply chain documents to provide a global standard for paper or electronic formats and thereby open a migration path from paper-based information exchange to paperless trade (UNECE 2009).

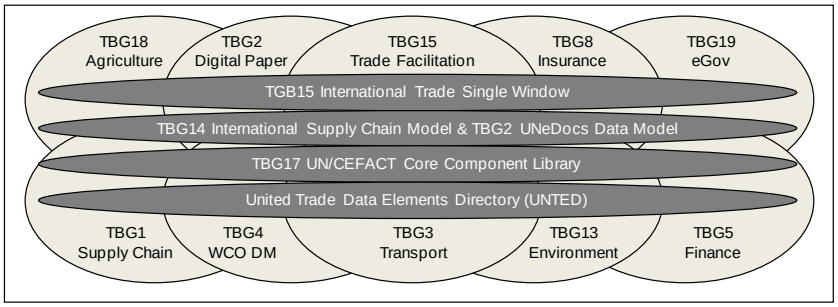

Figure 1. UN/CEFACT International Trade and Business Processes Group (TBG) and key relationships between these working groups. Redrawn from (Dill 2007).

At the regional level, different trade unions and other forms of collaboration act trough more or less voluntarily agreements. The EU acts through the EC by issuing Communications, Decisions, and Regulations that conveys to what standards eCustoms in Europe should conform. Relevant EU law regulates through the "Modernized Customs Code" in general terms how EU Member Countries' legislation should enable eCustoms. Similar arrangement exist throughout the world, including various socio-political and economic organisations such as the Association of Southeast Asian Nations (ASEAN), the East African Community (EAC), the Andean Community (CAM), and the North American Free Trade Agreement (NAFTA).

Despite the comprehensive international and regional regulative context, customs and customs declaration are still primarily national issues. National legislation regulates in detail how customs declaration should take place through laws directly related to export and import of goods. But it also includes a series of laws related to accounting, tax, agriculture, health, pesticides, and many other areas. Some of these laws describe whether a kind of goods is allowed to be exported or imported and the amount of tax payable. But most important, these laws specifies detailed procedures related to the control of export and import of various kinds of goods such as chemicals, drugs, food, living animals, weapons, etc.

How regulated trade is manifested by more than 40 paper documents, each in four copies, that have to accompany a container shipped by vessel (Tan et al. 2006). Each of the documents represents a specific trade-related procedure that the trader and/or shipping company has to go through. This means that companies like Arla, when exporting, has to deal with a number of agencies that operates outside what normally is considered the trade domain (Figure 2). Not infrequently, the processes and demands of the agencies are not synchronized, meaning that a number of agencies can have different requirements to ensure that Arla's exported dairy products meets food safety standards.

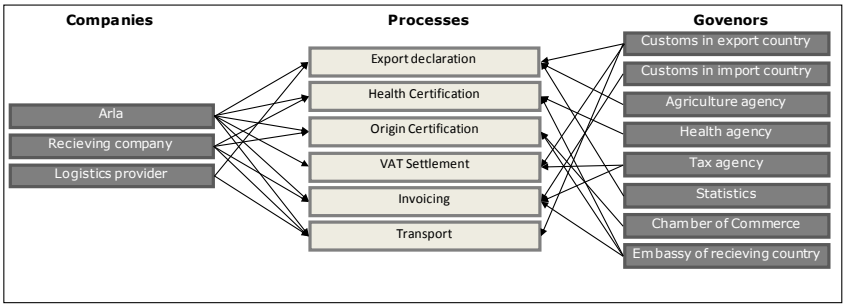

Figure 2. Trade companies, governance agencies, and their interaction in regulated processes.

Information infrastructure assemblage

Some of the material components of the II assemblages form part of a larger globe-spanning digital network, but the expressive components binding the assemblage that affects the European traders together and the customs-related IS are found at regional, national, and also corporate level.

In 2010 about all customs-related processes in Europe are supported by electronic IIs. The assemblage is a mix between completely national systems, national systems fulfilling requirements stipulated by the EU, and common EU-wide systems. Figure 3 shows the European part of the II assemblage as of 2010.

The 2010 eCustoms II can be divided into three areas depending on which business process the systems are supposed to control: import, export, transiting goods. Some of the systems (e.g. the EMCS in Figure 3) are developed and operated centrally in the EU. The systems for controlling transit goods is developed centrally, but implemented and operated nationally, much as a standard package of business software. Other systems were developed after a common EU-wide template. These include the principal systems for export and import declaration, the ECS and the ICS. In addition to these common systems, most European countries have additional systems that have been developed to meet national needs. For example, the EU subsidy export of agricultural products and many countries have a specific system keeping track of the rules and data for claiming subvention (ASS).

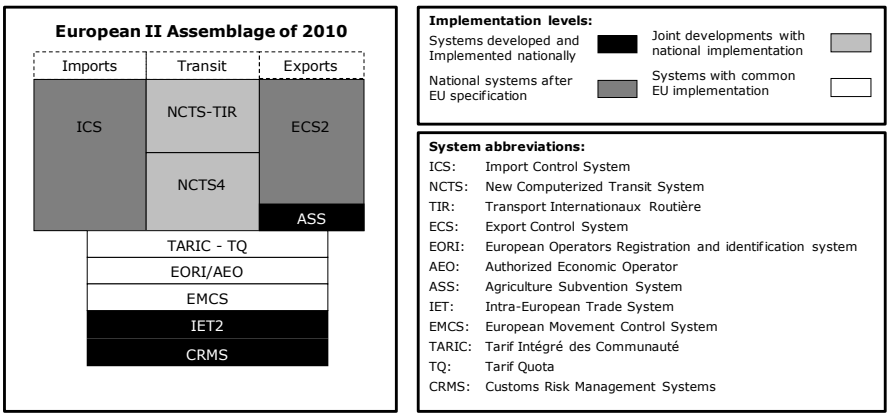

Figure 3. The European eCustoms II of 2010

Concretely, this implies a multilevel information flow as depicted in Figure 4. In the current infrastructural setup an exporting company has to submit data to national ECS2 and ASS when exporting goods. In the simplest form of export, information in the ECS2 is then combined with data from the EORI system and processed by the CRMS. If no risks are found export permission is granted and in relation to that data is fed to the EMCS in Brussels. The EMCS also communicate release information and identifier to the national ECS2. Finally, the exporting company is notified about the outcome of the export declaration. Depending on different variables, such as type of goods exported, destination country, exporting company, etc., different ties to other systems in the II are activated. The cases are similar for import process and transiting goods.

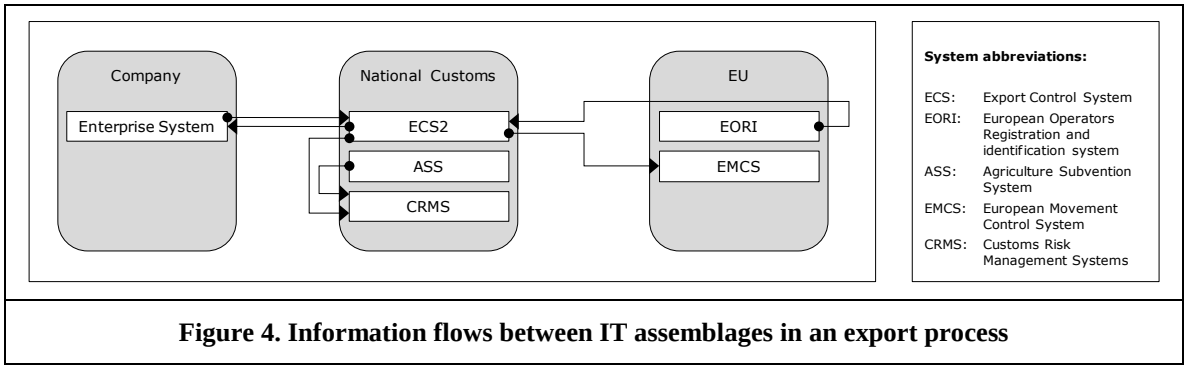

Figure 4. Information flows between IT assemblages in an export process

Taken together, all IT components involved in trade process form a highly integrated, multilevel II where each individual system has ties to many systems at corporate, national, and regional level. On a corporate level there are about 2 million traders (exporters and/or importers in the EU), many with complex corporate II that are connected to the national authorities, and to other companies in respective supply chain. Note, as a trader you need to integrate your systems to authorities in all countries from where you are trading. There are 27 member states with differences in the national solutions as depicted in Figure 3. These national authorities are integrated with other national authorities in their countries, with the traders corporate II, and with the European level solutions within their respective Directorate Generale (DG). On EU level, there are several DGs with responsibilities for different trade-related domains (e.g. TAXUD: taxation and customs, SANCO: health and consumer affaires, TRADE: trade, and AGRI: agriculture). Generally, no integration exists between the DG's different IT solutions, that operates in "silo"-mode. However, as showed in Figure 3, the DG's are tightly integrated with the national authorities in their respective domain.

Stabilization and Destabilization

Now, given the brief account for the different assemblages of relevance and their constituents it should be clear that the setting is too spacious and complex for any developmental account to be exhaustive and complete. That said, the following text explains developments from the perspective assemblage theory. That is how the activation of capacities to interact stabilizes and destabilizes the different assemblages.

Pre- and early eCustoms initiatives

In the 1980's, a company that was an active exporter or importer in the European market had to deal with more than 200 different forms to cover different customs procedures, in different countries and modes of transport. As a response to the call for a reduction of the administrative burden for traders the single administrative document (SAD) was introduced in the EU. The SAD was introduced in January 1988 as an EU-driven initiative to facilitate trade primarily between EU countries, and became the centre of a non-electronic customs II assemblage. By 1990 the assemblage geographically covered a territory of 18 European countries[1] using the document as standard for their customs declaration. The "Convention on the simplification of formalities in trade in goods"[2] acted as an expressional component stabilizing the assemblage.

The SAD document was in fact a set of eight copies of the same document printed on carbon paper. The copies were handed out to the different authorities during the journey of the goods. The first copy was for the country where export formalities were carried out, the second for statistics in the export country, the third copy was returned to the exporter, etc. The SAD standardized data was submitted to national customs and with one and the same operation a company could do export clearance, issue the transport document (customs), and prepare the clearance in the country of destination. Some fields of the SAD were mandatory to collect for all countries, while some fields were optional. Note, this is an inactivated capacity of the SAD to interact that would have implications on developments 20 years later.

As suggested by DeLanda, technological innovations started to destabilize the SAD-based assemblage. As demanded by traders that had experienced efficiency gains by digitalization, during the 1990's many European countries developed different types of eCustoms solutions. By 2000 most European countries had systems that enabled traders to declare export goods electronically. Some of the Eastern European countries were lagging behind in adoption. With a few exceptions these systems were developed separately from each other, thus destabilizing the assemblage by introducing heterogeneous IT components leading to different work processes. In fact, this can be seen as the creation of a large set of individual assemblages created upon individual eCustoms solutions. The national eCustoms stabilized the national assemblages by formal coding, but at the same time destabilized the European SAD-based assemblage. For a pan-European trader this meant that the company had to deal with customs authorities in each EU country in a separate way, using separate systems to declare goods. This was by some customs authorities noted as a problem since it led to European companies paying comparably high expenses for administration of customs processes, compared to their American and Asian peers.

The European eCustoms initiatives

Facilitating trade was a main driver when establishing the EU, and still remains a key EU responsibility. Accordingly, assuring smooth and efficient customs declaration and control procedures is an important objective. In 2001 the European Commission launched the first customs development programme, named Customs 2002, as an area were national customs authorities and the European Commission could cooperate. This was one of a number of initiatives to improve the efficiency of the public sector and to strengthen coordination collaboration among public agencies across national borders by means of Pan-European IT infrastructures. Customs 2002 was an act with the potential to strengthen the European

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[1] Members of EEC (later EU) and EFTA (Austria, Finland, Iceland, Norway, Sweden)

[2] http://ec.europa.eu/taxation_customs/resources/documents/SAD-convention_on_simplification_of_formalities-en.pdf

assemblage by increasing homogeneity in the assemblage. The objective of the programme was to support participating countries in carrying out customs controls. IT development, under the name eCustoms, was the major area of the programme.

Then, around year 2000 a series of events began to destabilize the European trade assemblage. Several pandemic diseases related to food production, such as the mad cow disease, struck the world. So did a number of terrorist attacks. And the cross border trade of counterfeit products increased significantly, to in 2000 being estimated to equate more than 1 billion Euro of legitimate products. Urgently countries worldwide begun to look into ways of tighten their control of traded goods. New restrictions on trade of living animals and food were implemented in most EU countries. And so were also new regulations related to how to control containers to discover hidden weapons and related to counterfeit products.

Consequently, the when the EU launched its Customs 2007 programme it was designed "to help to facilitate trade and to combat fraud so as to safeguard the financial and security interests of the Community and its citizens". The Customs 2007 also had a second purpose in improving the conditions for European traders: "The EU has to be a strong economic and trade partner in the world economy. Customs have an important role to play to ensure the competitiveness of the European trade environment. The programme contributes to this broad objective by minimising the burden placed on trade in relation to customs legislation and procedures".

In 2006, the EC established the legally binding goal of reducing the cost of regulations for European companies by 25% in 2012. It has been estimated that administrative costs could amount to about 3.5% of GDP in the EU (EC 2006). Reducing the administrative burden by 25% would eventually lead to an increase in EU GDP of 1.6% (EC 2006). This cost reduction would require substantial efficiency improvements in all administrative processes, and the current customs processes are no exception. When the Customs 2013 programme was launched in 2008, risk management was still a prominent part of the eCustoms strategy, but compared to previous programmes the cost reduction initiative was intensified.

How the European eCustoms strategy has evolved over time can be followed in the yearly revised Multi-Annual Strategic Plan (MASP) (first issued in 2004). In the near future the EC wants to allow goods to be declared at the country where the economic operator is established, regardless of where goods are physically located or from which EU country it is clearing customs – so called centralized clearance. The desired developments also includes the establishment of a Single Electronic Access Point (SEAP) to allow a trader to lodge all his declarations to customs electronically via one single interface of his choice which connects his system with all EU's member states' customs systems. One step further than the SEAP (which only focuses on data explicitly for customs organizations) is the *Single Window* approach that allows traders to lodge all information required under both customs and non-customs legislation for cross border trade of goods in one place and at one time only. This "is anticipated to be established by the Member States and the Community after 2012" (TAXAUD 2008, p. 17).

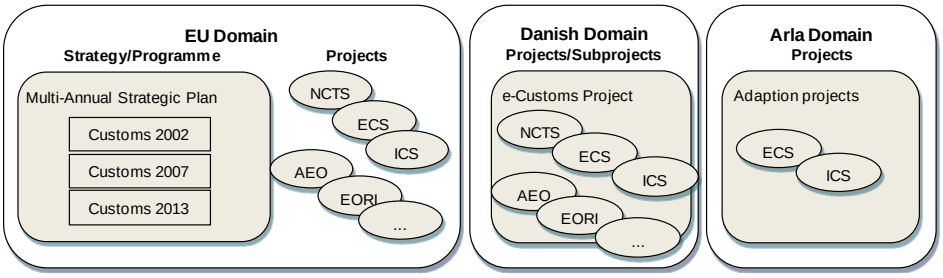

Figure 5. Organization of eCustoms projects at EU, national, and trader level.

During the last decades, a large number of eCustoms-related projects have been launched to achieve the above described strategic ambitions. In the next sections we will account for a few concrete examples to illustrate the complexity of implementing these projects and how developments activate capacities to interact amongst the components of assemblages.

The European transit system

Due to improvements in communication and transport technology, free trade agreements and globalization more broadly, cross border trade has increased 250 times globally since the 1970's (WTO 2009). At the same time as this change has been stimulated by new transport technologies, it has also fuelled this change. Now almost all goods are transported in containers. Related to this a complex assemblage consisting of container producers, specialized trucks for moving and transporting containers, etc. has emerged. More significantly, it has changed the transport routs as the standardization has allowed for scale advantages in goods handling. Almost all extra-European shipment has been concentrated to a few, large harbours that have been seeing growth rates far above the average. The result was congestion in routing harbours, traffic reaching levels that would lead to an infarct in the customs systems.

As a response to the events destabilizing several of the customs-related assemblages, one EU-driven initiative was the New Computerized Transit System (NCTS), which was first launched in 2001 and then re-launched three times during the first decade of its existence. Transit goods are goods that only transit a country on their way to a final destination. The NCTS was to lower the burden for customs organizations and traders by digitalizing and automating transit processes.

How transit goods are defined and should be treated by national customs organizations is defined by the 200-page long TIR (Transports Internationaux Routiers) Convention stemming back to 1975 as UN-driven prolongation of the Kyoto Convention from 1920. All goods that are transited through one or more countries on their way to the final destination are since 1975 followed by a TIR Carnet, a physical paper document, that allows transiting without payment of local tax or being affected by local legislation. Since changing the TIR Convention is a monumental task, when implementing the NCTS, the new system had to comply with the process inscribed into the existing TIR.

With the NCTS the EU member states jointly developed a common system to ensure that the transit process was carried out similarly in each country. The NCTS was comparable to a standard package of business software that is locally customized and implemented. In the end, the NCTS was a pale compromise that did not really fit the needs of any customs organization. The national customs authorities had to spend more resources than expected customizing and refining the standard package to fit into the national context. First of all, it had to fit into the national legislative context. Although the TIR convention specified transit goods regulation, customs systems are interrelated to many other legislative bodies, as explained earlier. The second aspect that influenced the customization need of the NCTS were the, in many countries existing, legacy systems that were integrated with the national systems. These "other systems" includes for example systems that compile statistics based on the export declarations, deals with agricultural control, VAT control, and control of hazardous goods. Rather than adapting all these systems, Customs organizations generally customized their NCTS implementations to work with interfacing systems, interpreting the artefact differently. It was however, not a straightforward task to do so. Only when implementing the new NCTS it became apparent exactly which other systems and organizations that were affected by the changes. This resulted in several adaptation iterations in both NCTS and surrounding systems.

> "Especially the countries with advanced e-Government solutions in place had an extensive job in understanding how the new eCustoms component would have to interface to other systems, and how other systems would be affected by the new component." (DG/TAXUD).

Figure 6 depicts how components of the different assemblages influenced each other during the NCTS implementation. The NCTS project is the story of how destabilization through globalisation in the trade assemblage requires adaptation in the II assemblage. However, what can be done in the II assemblage at an international and regional level is tightly constrained by the highly stabilizing TIR convention (originally the Kyoto convention of 1920) in the legal assemblage, and on a national level by both the national legal assemblages and the national II assemblages. This reveals new capacities to interact in both the TIR convention and the national eGovernment solutions. That the Kyoto convention and how it was formed in 1920 would have consequences for eCustoms almost a century later would certainly come as a suprise for people involved in the pre-1920 discussion. Also that the pioneering eCustoms initiatives of the 1990'ies would possess capacities to interact that hampered trade facilitation (the opposite to the main objectives behind the projects) was also a surprise to NCTS developers. In consequence, the desirable

changes in the European II assemblages become very complex and costly to make. But eventually after a decade of developments, an NCTS that met the European requirements was in place.

Harmonized export systems

When the next phase of the European eCustoms initiative was about to start the actors had learnt some lessons from the NCTS development. Instead of developing a common export control system (ECS) the countries who already had export systems decided to modify their existing systems to fit the ECS specifications. Countries without already existing systems started their developments from scratch. Even though the 27 member states in this way developed 27 different systems doing basically the same thing this was still estimated to be less painful than seeking a joint solution with local customization. Compared to the transit system, the national export systems were even more integrated with national systems and with national legislation. For the NCTS the TIR convention regulated national legislation and had led to an international harmonization in this area. For export legislation no similar international convention existed. The EU realized this potential problem and tried with the 'Modernized Customs Code' to harmonize and enable electronic submission of customs data in all member countries. The initiative was, however, only partly successful. Success was reached in the sense that customs law was harmonized. The limiting part was that customs systems are embedded into more legislative areas than customs law. These other areas were not harmonized.

> "A common solution would not have been realistic. If we would have used the common solution everything that relates to the export needed to be changed, including national legislation and all the national systems that already are linked to the national export systems." (eCustoms Developer, Danish Customs)

As explained earlier, these "national systems" includes for example systems that compile statistics based on the export declarations, deals with agricultural control, VAT control, and control of hazardous goods – a national eGovernment assemblage. A concrete example of the influence can be taken from the Swedish development project. The Swedish Customs collects export data on behalf of the Swedish Agricultural Agency. This data is not addressed by the European e-Export solution. Consequently, an European implementation would had required the Swedish Agricultural Agency to find another way of collecting their data, potentially by asking companies to resubmit the same export data also to their agency. However, the deceive factor behind choosing the strategy of national implementations was the foreseen hardship of changing national legislation to accommodate a common European solution. Related national legislation included, for example, who is responsible for an export declaration being correct (in Sweden it is the individual who makes the declaration, in Denmark the company as a juridical body), the physical storage of export data (Sweden requires this data to be stored in Sweden), special declaration requirements for specific goods (hazardous goods, weapons, agriculture products, etc.), and many other areas.

The ECS implementation was part of the Customs 2013 that had a clear objective in the reduction of administrative burden. However, it seems like the wish for reduction of burden was ruled out by the urge for increased security.

> "What happened in the transition was that many customs organizations saw the opportunity to ask for more data than previously. Customs wanted this data also before, but realized the impossibility when it was all paper based and the SAD was the undisputed standard. Therefore they added new data elements, which ones added was a bit different from country to country, but most countries added data to the requirements." (Customs expert)

Now, this is then activating a capacity to interact of the SAD. The SAD and associated treaties were designed so that there is a minimum data set and some voluntarily elements. Since the SAD is implemented as a physical form, there is no way of adding elements to the form. Digitizing the form revealing an unforeseen capacity to interact that leads to destabilization of the customs assemblage by introduction of increased heterogeneity.

The current versions of ECS, ECS2, had a deadline of September 2009. Although many countries were struggling severely with the update in principle this deadline was met. The countries that had most difficult to meet the deadline turned out to be the ones with already advanced eCustoms solutions in place.

> "When developing the new ECS we had to understand how all other systems interfaced to our e-Export system were affected. Then we had to take measures to ensure that these other systems were not affected. If we made changes in one part of the systems this could have effects in another system that we didn't think of. We basically had to use iterations until we didn't encounter any more unwanted side-effects." (eCustoms Developer, Denmark)

> "We are shuffling data to a lot of other systems. We couldn't use just the minimum standard data model and messages. Besides that we already had a lot of companies doing eCustoms in Sweden. Of course we also had to include them in the transition to make sure that we developed systems that they could fairly easy interact with." (eCustoms Developer, Sweden)

On a corporate level, the increased heterogeneity has implications for the European traders. A company like Arla need to integrated their IT solutions with the export and import control systems in all countries from which they export.

> "It was much easier in the good old SAD-days… back then with the SAD we could use the same document in all countries and clear most of the processes with one single form. Now we have to figure out how the process works and set up specific integrations solutions for each country." (Arla Business Relationship Manager)

Risk management

Another example of EU's strategic eCustoms ambitions was the work with risk management. With the formation of an inner European market the protection of the border between the inside and outside of the EU became more important. Fuelled by issues mentioned above like the mad cow disease, terror and growth in trade of counterfeit articles (counter fait articles were in 2000 estimated to equate more than 1 billion Euro of legitimate products), risk management was identified as a problem area by the European Court of Auditors and as a priority area by the European Parliament. Once inside the EU any malicious goods could be distributed to any location in the EU. As a response, risk management became the core focus of the first joint customs initiative in the EU. Rapidly, guidelines for how to handle risk were expressed in a Risk Framework (RF).

However, as this framework could be differently interpreted at national or even customs office level, it was not considered enough to ensure harmonized risk levels. The electronic Risk Information Form (RIF) system was launched in April 2005. The system was implemented for disseminating and exchanging risk information to all customs control points of the EU. The purpose of the RIF is to exchange risk information dealing with routine control concerns. A RIF should raise the awareness of the offices concerned with regard to a potential irregularity. A RIF can be prepared following a finding of an irregularity (for example a faulty declaration or finding of counterfeit or undeclared goods). The RIF could give information on the technique used to find the irregularity, for example the result of a physical examination or a classification decision. The RIF system is implemented centrally in the EU and customs officers interact with the system using a web interface.

The next step to improve risk management in the EU was the construction of a Customs Risk Management System (CRMS). Although the official documents from the EU speak about the CRMS as one system, it is actually 27 individual systems developed by the member states. These systems contain two parts, one common and one individual. The common part is functionally specified by the EC. The description includes which data elements should be submitted to the customs for risk management purposes in relation to an import or export declaration. The common instructions do, however, not say anything on how the risk data elements should be analysed and what the premises are for something being categorized as a high-risk item. The individual part is the national preference of what is needed for risk management in each respective country. This can be due to that a country has had problems with specific types of goods or specific exporters.

The growth of the II assemblage and its consequences

Since Customs authorities started to approach eCustoms solutions in the 1990's some processes related to export have been affected while others have remained intact. Figure 6 depicts how the European eCustoms II has emerged. The result is a highly complex environment that has significant implications to its users.

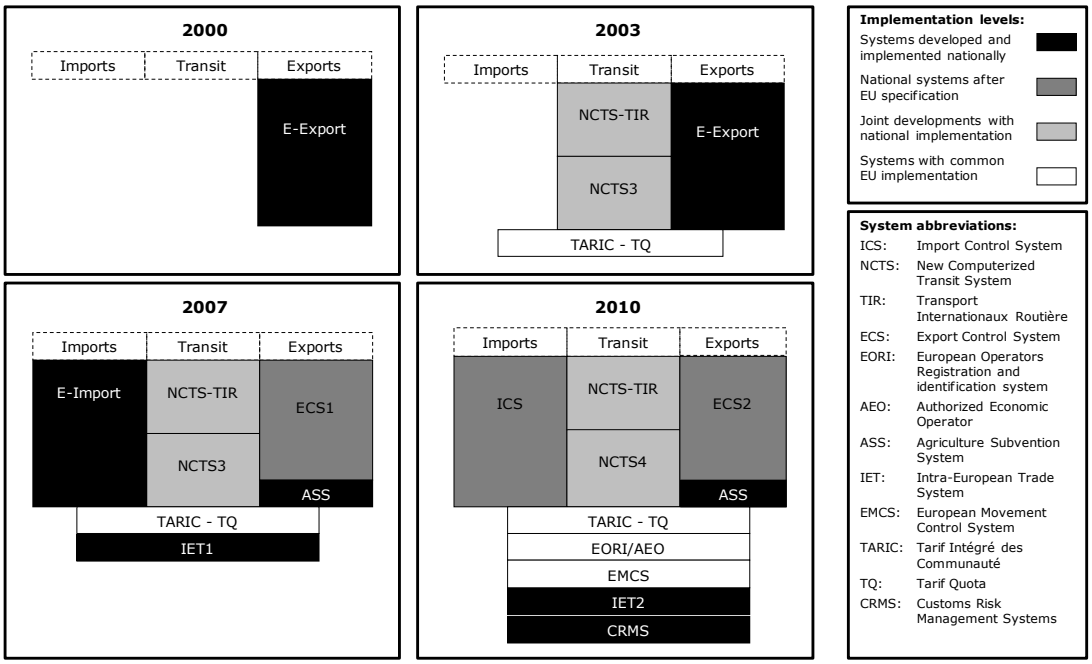

Figure 6. Development of the European eCustoms information infrastructure 2000-2010

Two principal outsets have driven the European eCustoms initiative; the call for increased security and control of international trade, and the ambition to lower the administrative burden associated to export and import. This far the success has been only partial. Regarding decreased administrative burden the British shippers' interest organization, SITPRO, found that 88% of traders are experiencing increased business burdens due to the proliferation of security measures and the transition to eCustoms (SITPRO 2008).

The increased burden is echoed in the specific example of Arla and its export processes. Previously Arla used the standard SAD when exporting, regardless of country. Now, for each country where from Arla exports, it has to develop a specific eCustoms interface for the national eCustoms solution. Arla investigated the cost of developing such a module for Sweden and had an offer of about € 100,000.

> "Based on that offer, which we by the way think is a too low estimation – the real cost will be much higher, we decided to postpone eCustoms in Sweden as long as possible. Eventually the Swedish customs will probably force us, but there are at least at the moment no economic incitement to go down that road […] In addition, we will have extra maintenance and upgrading costs in the future." (Arla).

The effects of the European eCustoms II are, this far, that almost every country that earlier used the very same standardized SAD for customs clearance, now have developed individual eCustoms solutions that enforce companies to set up individual export processes for each country where the company is exporting from.

> "If we would like to do eCustoms in Poland that would also require investments above 100,000 Euro. If we would like have eCustoms in France that means yet another investment of the same size, and so on… I don't think there are any two countries where we could use the same interface" (Arla).

This consequence was clearly not foreseen in the development. Rather, the European eCustoms initiative had an outspoken objective of reducing the administrative burden by 25%. What is also interesting is that this cost is directly countering the EU's ambition of creating one common European market:

> "If we would like to business in another European country we will have to develop and maintain another eCustoms interface. Everything else being equal, this adds to the likelihood that we continue to do business in the countries where we already are present." (Arla Business Relationship Manager)

The EU's long term ambition to create one single point of interaction ("Single window") for traders has this far not been very successful. As a matter of fact, the SAD-based infrastructure worked as a paper-based Singel window, but has been replaced by 27 different electronic windows.

Regarding increased security a vast number of measures have been taken to increase security and control of international trade. Examples include:

- Companies now have to advice customs about an export 24 hours before goods are shipped, compared to only one hour before. This is to give more time for the risk analysis.
- More data about the receiving customer and the exported goods has to be submitted to customs.
- An additional number of products have to be accompanied with certificates proving their origin, production quality, or absence of dangerous diseases.

One important security flaw that still exists, however, is the lack of encryption of data transfers in the European eCustoms solution. Companies and customs organizations both go to great extents to protect their internal data partly to decrease process transparency and limit risks, but the transfers between the two are not encrypted and without other security measures. This is a newly discovered problem.

Discussion

We will now look more closely at how the dynamics of the eCustoms II unfolded as an integrated part of the trade, customs and customs control assemblages, and then zoom in on stabilizing and destabilizing processes and in particular on their interactions.

The case presentation illustrates a quite dramatic change of the overall trade assemblage as well as the customs control and II assemblages. The presentation may give the impression that change, i.e. destabilizing processes dominates. The assemblages change in terms of growth, driven by improved transport and communication technologies, free trade agreements, etc. Increased trade again creates demands for even more efficient transport technologies and systems and so on. The trade assemblage has also changed significantly in the sense that most goods transported over longer distances are going through major hubs like the Rotterdam harbour. Increased volume of goods being transported across national borders, changes in transport technologies like the use of containers, plus the fact that most goods are going through huge hubs have destabilized the customs control assemblage. In addition to this, increased trade generates more unpredictable side-effects, partly in interaction with other processes, as illustrated by risks related to phenomena like the mad-cow disease, increased trade of counterfeit products, and terror. This has also contributed to the destabilization of existing customs control assemblages and generated needs for new control procedures which include risk management.

These demands have been tried satisfied by a whole series of measures: efforts aiming at controlling traders rather that the goods traded through the development of certification systems, by harmonizing customs declaration and control processes internationally through EU directives and international agreements, by replacing paper based systems and practices with computer based ones, by streamlining and simplifying process and support them by new computer based systems, by integrating computer based systems within EU, etc. This means that the eCustoms II has been quite dynamic. Lots of new systems have been developed and implemented. The II has also changed in the sense that all new systems have become tightly integrated with existing ones. In addition to this, computerization of systems supporting the core customs declaration processes stimulates more change. This has in particular happened in the domains related to the control of trade of various goods (like chemicals, food, animals, weapons, etc.). This has triggered several kinds of change. When data is reported electronically rather than on paper, it is easier to report additional data based on computer technology's capacities to interact with control institutions. Authorities controlling trade have used this opportunity and they have demanded more data to be reported by traders. This demand has, in most cases at least, been satisfied, and the amounts of data that have been reported have increased significantly. In addition, when data is reported electronically, it is easier (compared to when they are reported on paper) to build new systems for extended control of trade. Lots of such systems have been developed, implemented, and integrated with the already existing custom systems.

All this means that increased international trade is a destabilizing process in the sense that it continuously generates demands for and triggers changes in virtually all components involved in the trade processes. This is also partly a self-reinforcing process in the sense that increased trade generates a demand for more efficient transport and communications systems which again stimulates even more trade and so on. And when a new computer or information system is introduced, it also presents new capacities for interaction, capacities which may easily be extended by adding new data elements to its database and which may be reported to various authorities. But there are also important stabilizing processes involved. This is related to the fact that the installed base of IS, national legislation, international treaties, etc. represents a strong stabilizing force. In the case presentation above we described EU's aims of simplifying and streamlining customs declaration. The ideas about how to design a best possible solution were continuously confronted with challenges related to existing international treaties like the Kyoto convention from 1920, international standards, national legislation, national legacy systems, etc. All of these were considered too deeply embedded into an installed base of various other international agreements, national legislation, information systems, and practices of various kinds – i.e. various assemblages – to be changed. Accordingly, at every junction point, it was decided to adapt the new systems to the installed base rather than trying to change this. So, every new system was adapted to and integrated into the installed base. This increased the complexity of the installed base and made it even harder to change in the future, i.e. stabilized it. At the same time, however, as the installed base became larger and more stable, its capacities to interact with other components was extended and opened up new spaces for new add-ons, and so on. That means that that the stabilization of the installed base also stimulated and led to its continued growth, i.e. destabilized it.

A large part of the installed base that new systems had to adapt to was made up of national legislation and national systems. For this reason, the development and implementation of the various new systems being a part of EU's eCustoms initiatives did not succeed in developing common European systems, but rather building up larger and more complex IIs within each member state and making the overall European eCustoms II more fragmented. At the same time this fragmentation is becoming increasingly more frozen as the overall eCustoms II is growing and becoming more complex. The complexity and fragmentation of this infrastructure makes customs declaration more difficult and time consuming for traders which makes many of them wish they could return to the happy days of the SAD document.

This means that the destabilizing processes generating more and more IS, and integrating new and old systems more and more, is at the same time a stabilizing process generating a larger and larger installed base which becomes increasingly harder to change. And when this installed base becomes larger and more stable, its capacities to interact with other components are extended and open up new spaces for new add-ons and more integration with other systems - the more it is becoming a powerful infrastructure which may support new and more powerful control systems. This means the stabilizing processes also generate destabilizing processes.

The individual components, or assemblages, mentioned above do all have certain properties. For instance, the IS developed, the international treaties and national legislation settled, all have certain properties carefully crafted by their "designers." However, the central dynamics described above, the stabilizing and destabilizing processes described and the increased irreversibility and fragmentation of the installed base and the burden this put on traders, are definitively not properties the designers intentionally have given the components they have created. These aspects of the assemblages emerge when the various components are brought together and the capacities they have to interact. These features of the overall eCustoms infrastructure assemblage are produced as a synthesis achieved as the *collective unintended consequence* of intentional action.

The overall objective of the eCustoms program is to improve security related to trade and reduce the traders' costs related to customs declaration by 25% by implementing the Single Window concept. We are not in a position to make strong judgements about whether the existing eCustoms II has contributed to increased security. However, as illustrated by Arla's experience reported above, the traders' costs related to customs declaration have certainly not been achieved. As the national installed bases are becoming increasingly more stable and complex, it is becoming increasingly difficult to start moving towards the 25% cost reduction target. It seams clear that reaching that target, or even to start moving towards it, require different strategies and approaches from those pursued. To make any detailed suggestion about how that can be achieved requires knowledge about the domain beyond ours. However, based on the

analysis and concepts presented here we can conclude that one need to focus on how to destabilize the national IIs, i.e. make them more flexible and easier to change and then harmonize them. The general strategy for achieving that is modularization and loose couplings.

The analysis above also reveals that there is a tension between control and efficiency related to customs declaration. Control may be supported more data and tighter integration. So to be able to destabilize national II assemblages, or at least avoid stabilizing them in the way that has happened, one need to be extremely careful in keeping the amount of data that the traders need to report for control purposes at a minimum, and the same when it comes do data transferred between the various systems.

Conclusion

In this paper we have inquired into the complexities of contemporary IT solutions based on a case study of the EU's eCustoms initiatives drawing upon DeLandas Assemblage Theory. This paper has illustrated how Assemblage Theory gives a vehicle to describe and explain how large scale II develops through complex and in many cases unforeseeable paths. The multi-layered assemblage structure of the European eCustoms II assemblage is a show-case of unintended consequences and "drifting" IIs without managerial control. While the aim of the eCustoms initiative was to reduce traders' costs related to customs declaration by 25% through the implementation of the Single Window concept, the outcome, so far at least, has been rather the opposite. Traders need, to declare their imports or exports electronically across EU, to integrate their ERP systems with up to 27 different national customs declaration IIs. Similar outcomes from other II implementation efforts are well documented in the literature. The unintended outcomes have been explained, like in our case, by the IIs complexity. By drawing upon theories like Actor Network Theory, Complexity Science, and Reflexive modernization, the unintended outcomes have been explained by the creation and propagation of side-effects, and, further, that propagation of side-effects creates self-reinforcing or self-destructive processes (Ciborra et al. 2000; Hanseth and Ciborra 2007). In this paper, we have aimed at moving one step further along a route towards a theory of how IIs are evolving and how their evolution may be influenced by demonstrating how II evolution can be seen as dialectic between stabilizing and destabilizing processes. Based on this we can say that the eCustoms initiative have failed because they stabilized what should have be destabilized (the exiting national IIs) and destabilized what should have been stabilized (i.e. limit the growth and integration of additional systems). However, *how* to generate a dialectic of stabilizing and destabilizing processes that makes an II evolve in the desired direction is a major research issue.

References

Abbate, J. 1999. *Inventing the Internet*. Cambridge, Ma.: MIT Press.

Baldwin, C., and Clark, K. 2000. *Design Rules*. Cambridge, Ma.: MIT Press.

BCS/RAE. 2004. "The Challenges of Complex It Projects," British Computer Society and Royal Academy Engineering Project.

Beck, U. 1992. *Risk Society: Towards a New Modernity* New Delhi: Sage.

Beck, U., Giddens, A., and Lash, S. 1994. *Reflexive Modernization. Politics, Tradition and Aesthetics in the Modern Social Order*. Stanford, CA.: Stanford University Press.

Carroll, J.M., and Swatman, P.A. 2000. "Structured-Case: A Methodological Framework for Building Theory in Information Systems Research," *European Journal of Information Systems* (9:4), pp. 235-242.

Ciborra, C., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E., and Simon, K.A. 2000. *From Control to Drift: The Dynamics of Corporate Information Infastructures*. Oxford University Press, USA.

Ciborra, C., and Hanseth, O. 2000. "Introduction: From Control to Drift," in *From Control to Drift,* C. Ciborra (ed.). Oxford, UK: Oxford University Press, pp. 1-12.

Damsgaard, J., and Lyytinen, K. 2001. "The Role of Intermediating Institutions in the Diffusion of Electronic Data Interchange (Edi): How Industry Associations Intervened in Denmark, Finland, and Hong Kong," *Information Society* (17:3), pp. 195-210.

David, P.A. 1986. "Understanding the Economics of Qwerty: The Necessity of History," in *Economic History and the Modern Economist,* N. Parker (ed.). Oxford, UK: Basil Blackwell, pp. 30-49.

DeLanda, M. 2006. *A New Philosophy of Society: Assemblage Theory and Social Complexity*. New York, NJ: Continuum.
Deleuze, G., and Guattari, F. 1994. *What Is Philosophy?* New York, NJ: Columbia University Press.
Deleuze, G., and Guattari, F. 2004. *Anti-Œdipus*. New York, NJ: Continuum.
Dill, M. 2007. "Edocument Standards State-of-the-Art Watch," European Commission, ITAIDE project (027829) Deliverable 1.2a, Brussels.
Downs, A. 1967. *Inside Bureaucracy*. Boston: Little, Brown.
EC. 2006. "Report from the Commission to the Council, the European Parliament and the European Economic and Social Committee Concerning the Need to Develop a Co-Ordinated Strategy to Improve the Fight against Fiscal Fraud," EC, Brussels.
Funk, J.L. 2002. *Global Competition between and within Standards: The Case of Mobile Phones*. New York, NJ: Palgrave.
Gal, U., Lyytinen, K., and Youngjin, Y. 2008. "The Dynamics of It Boundary Objects, Information Infrastructures, and Organisational Identities : The Introduction of 3d Modelling Technologies into the Architecture, Engineering, and Construction Industry.," *European Journal of Information Systems* (17:3), pp. 290-304.
Giddens, A. 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Univ of California Press.
Haberstroh, C.J. 1965. "Organization Design and System Analysis," in *Handbook of Organizations,* J.G. March (ed.). Chicago: Rand McNally.
Hanseth, O., and Ciborra, C. 2007. *Risk, Complexity and Ict*. Edward Elgar Publishing.
Hanseth, O., Jacucci, E., Grisot, M., and Aanestad, M. 2006. "Reflexive Standardization: Side Effects and Complexity in Standard Making," *MIS Quarterly* (30), pp. 563-581.
Hanseth, O., and Lyytinen, K. 2010. "Design Theory for Dynamic Complexity in Information Infrastructures: The Case of Building Internet," *Journal of Information Technology* (25:1), pp. 1-19.
Hume, D. 1969. *A Treatise of Human Nature*. London: Penguin.
Irani, Z., Elliman, T., and Jackson, P. 2007. "Electronic Transformation of Government in the Uk: A Research Agenda," *European Journal of Information Systems* (16), pp. 327-335.
Janssen, M., and Joha, A. 2010. "Connecting Cloud Infrastructures with Shared Services," in: *Proceedings of the 11th Annual International Digital Government Research Conference on Public Administration Online: Challenges and Opportunities*. Puebla, Mexico: Digital Government Society of North America, pp. 225-226.
Kallinikos, J. 2007. "Technology, Contingency and Risk: The Vagaries of Large-Scale Information Systems," in *Risk, Complexity and Ict,* O. Hanseth and C. Ciborra (eds.). Edward Elgar Publishing, pp. pp. 46-74.
Klein, S., and Higgins, A. 2010. "The Concept of Living Labs," in *Accelarating Global Supply Chains with It-Innovation: Itaide Methods and Tools,* Y.H. Tan, N. Bjorn-Andersen, S. Klein and B. Rukanova (eds.). Springer.
Latour, B. 1992. "Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts," in *Shaping Technology/Building Society,* W. Bijker and J. Law (eds.). Cambridge, Ma: MIT Press, pp. 225-258.
Lenk, K. 2002. "Electronic Service Delivery - a Driver of Public Sector Modernisation," *Info. Pol.* (7:2,3), pp. 87-96.
March, J.G., and Simon, H.A. 1958. *Organizations*. New York: Wiley.
Markus, M.L., Steinfield, C.W., Wigand, R.T., and Minton, G. 2006. "Industry-Wide Information Systems Standardization as Collective Action: The Case of the U.S. Residential Mortgage Industry " *MIS Quarterly* (30:5), pp. 439-465.
McKay, J., and Marshall, P. 2004. *Strategic Management of Ebusiness*. New York: John Wiley & Sons.
McNeese, M.D. 2004. "How Video Informs Cognitive Systems Engineering: Making Experience Count," *Cognition, Technology & Work* (6:3), pp. 186-196.
Melville, N., Kraemer, K., and Gurbaxani, V. 2004. "Information Technology and Organizational Performance: An Integrative Model of It Business Value," *MIS Quarterly* (28:2), pp. 283-322.
Monteiro, E., and Hanseth, O. 1996. " Social Shaping of Information Infrastructure: On Being Specific About the Technology," in *Information Technology and Changes in Organisational Work,* W. Orlikowski, G. Walsham, M.R. Jones and J. Degross (eds.). Chapman & Hall, pp. 325-343.
Northrop, L., Feiler, P., Gabriel, R.P., Goodenough, J., Linger, R., Longstaff, T., Kazman, R., Klein, M., Schmidt, D., Sullivan, K., and Wallnau, K. 2006. "Ultra-Large-Scale Systems: The Software Challenge of the Future," Carnegie Mellon Software Engineering Institute.

Parnas, D.L. 1972. "On the Criteria to Be Used in Decomposing Systems into Modules," *Communications of the ACM* (15:12), pp. 1053-1058.
Pfeffer, J., and Salancik, G.R. 1978. *The External Control of Organizations: A Resource Dependence Perspective*. New York: Harper and Row.
Rukanova, B., van Stijn, E., Zinner-Henriksen, H., Baida, Z., and Tan, Y.H. 2010. "Understanding the Influence of Multiple Levels of Governments on the Development of Inter-Organizational Systems," *European Journal of Information Systems* (18:5), pp. 387-408.
Schmidt, S.K., and Werle, R. 1998. *Coordinating Technology*. Cambridge, Ma.: MIT Press.
SITPRO. 2008. "The Cost of Paper in the Supply Chain: "Project Hermes" Perishable Foods Sector Research Report," SITPRO, London.
Star, S.L., and Ruhleder, K. 1996. "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Space," *Information Systems Research* (7:1), pp. 111-134.
Tan, Y.-H., Klein, S., Rukanova, B., Higgins, A., and Baida, Z. 2006. "E-Customs Innovation and Transformation: A Research Approach," *Bled eCommerce Conference*, Slovenia.
TAXAUD. 2008. "Electronic Customs Multi-Annual Strategic Plan - Taxud/477/2004 - Rev. 8 - En," European Commission, Brussels, Belgium.
Tuomi, I. 2002. *Networks of Innovation. Change and Meaning in the Age of the Internet*. Oxford, UK: Oxford University Press.
Turner, W., Bowker, G., Gasser, L., and Zackland, M. 2006. "Information Infrastructures for Distributed Collective Practices," *Computer Supported Co-operative Work* (15), pp. 93–110.
UNECE. 2009. "Un/Cefact." Retrieved 11th November 2009, from http://www.unece.org/cefact/about.htm
Weick, K.E. 1969. *The Social Psychology of Organizing*. Reading, MA: Addison-Wesley.
WTO, W.T.O. 2009. "International Trade Statistics 2009," World Trade Organization, Lausanne, Geneva.
Yin, R.K. 1994. *Case Study Research*. Thousand Oaks: Sage Publications.