Liability and automation: issues and challenges for socio-technical systems

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***Abstract*— Who is responsible for accidents in highly automated systems? How do we apportion liability among the various participants in complex socio-technical organisations? How can different liability regulations at different levels (supranational, national, local) be harmonized? How do we provide for accountability, while promoting safety? These and other questions are being addressed by the ALIAS (Addressing Liability in Automated Systems) project, which is co-financed by EUROCONTROL on behalf of the SESAR Joint Undertaking as part of Work Package E. The project focuses on the legal implications of automation – exploring the wide spectrum of relations between automation and liability, focusing on Air Traffic Management (ATM), but also considering various domains that face similar issues, such as HealthCare, ICT, Train Transport, Navy, automotive industry, etc. The paper presents the outline framework of the project, its objectives, and the initial steps being taken to create an online multidisciplinary "community of practice" around the relationships between liability and automation in socio-technical systems.**

***Foreword*— This paper describes a project that is part of SESAR Workpackage E, which is addressing long-term and innovative research. The project was started early 2011 so this description is limited to an outline of the project objectives augmented by some early findings.**

Keywords-component; liability; automation; socio-technical systems; legal issues

I. INTRODUCTION

In the time horizon of SESAR, that is over the next 30 years, a new generation of air traffic management systems will be developed. Such systems will be capable of augmenting today's capacity, while at the same time making traffic safer and more fluid, efficient and sustainable. To achieve this objective, new technologies will be developed with increasing automation levels. Some of these innovations are likely to raise new legal issues related to liability for accidents.

In particular, highly automated systems will make choices and engage in actions with – usually with some level of human supervision, or even without any such supervision. For instance, aircraft will autonomously separate from each other, and some of them will fly unmanned. In general, rather than directly governing flight operations, pilots and controllers will supervise automated systems doing the job. As operational tasks are increasingly delegated to automatic systems, the actual human contribution needs to be reconsidered, and human-machine interaction reengineered. This will require a critical revision of the allocation of tasks, roles and responsibilities in the context of complex socio-technical systems.

In the context of a socio-technical system the allocation of functions, responsibilities, and liabilities may be viewed as a governance mechanism enabling the enhancement of the functioning of ATM. A socio-technical system (STS), is a system that involves a complex interaction between technical, social and organisational factors, as well as human factors. In STSs, both the technical and the social aspects (the latter including humans, institutions and norms) are crucial to their design and functioning: at the core of such systems is a technical infrastructure, designed to serve a specific purpose, coupled with human operators that continuously monitor and modify its state during the operational process.

The ALIAS project argues that in order to ensure a safe and responsible use of automated technologies, an appropriate regulation and allocation of liability is crucial. In particular, the following questions are central for the project.

The first question refers to how automation changes the tasks and responsibilities of human operators, organisations, and technology providers, i.e., manufacturers and system developers. This requires addressing different issues: e.g., (a) how different degrees of autonomy of agents and machines, in a complex organisational framework, shape the responsibilities of the different actors (operators, controller, managers, manufacturers, designers), (b) how forthcoming operational concepts and procedures (e.g. business trajectories, self separations, variable separation minima depending on aircraft performance) provide specific challenges in the involvement of the different actors and their consequent responsibilities.

The second question concerns how existing laws and regulations (national and international, public and private) regulate the allocation of liabilities in ATM, and the assessment of whether such laws and regulations provide an adequate normative framework. We will also consider whether current regulations, case law and internal practice contribute to fostering the development of a safety culture within organizations. For instance currently, the allocation of liability is focused almost exclusively on the action (or inaction) of pilots and controllers. We would argue that automated devices

implemented in ATM in recent years have reduced some captain's (and controller's) tasks, or have transformed them from operational into supervisory tasks. This change must be reflected in the allocation of responsibilities and ensuing liabilities for failures.

The third question concerns how to optimally allocate responsibilities in present and future highly-automated socio-technical systems. This implies viewing the allocation of responsibilities, not only as a way to distribute risks and sanctions, but also as a means to prevent accidents and to increase levels of safety and performance in ATM. Thus, it will be essential to do the following: 1) identify tasks and roles of operators (managers, ATCOs, pilots, etc) and automated tools; 2) identify the expected level of performance for each task; 3) consider different kinds of errors (unintentional rule violations, reckless behaviours, intentional violations); and 4) define the appropriate legal and disciplinary sanctions and/or safety incentives in relation to different errors, risks and accidents. On the basis of this analysis, we shall suggest how to adapt existing normative frameworks and practices to forthcoming pervasive automation scenarios.

In order to answer the above questions, ALIAS proposes a research plan that will combine theoretical investigation with an on-going online discussion with stakeholders, who can share their experience and thoughts and benefit from a collaborative effort on the project's themes.

Two main outcomes are expected from the project:

- The development of the "Legal Case", a methodological tool including recommendations and guidelines to ensure that relevant legal aspects are taken into consideration at the right stage of the design, development and deployment process.
- The creation of a network of legal research in socio-technical systems with the purpose of creating a multidisciplinary community that will support knowledge construction and distribution, sharing of cases and best practices, discussion on the topics of interest, archiving of documents and references useful to develop this research area.

II. THE "LEGAL CASE"

The Legal Case is a methodological tool, to systematically manage the identification and treatment of legal issues as early as possible in a project/product's lifecycle, with particular reference to automation. It is meant to complement the EUROCONTROL Safety Case and the Human Factors Case currently being used in ATM.

The Legal Case will provide guidelines and recommendations and will include a graphical tool to model organisational structure and regulations, and to examine the allocation of responsibilities and liabilities.

The development of the Legal Case will start with the collection, analysis and modelling of factual incidents illustrating occurrences of liability in highly automated scenarios. These stories will cover ATM, and, in particular, relevant concepts and devices proposed or developed by SESAR (such as SWIM) will be taken into account. However, we shall also consider different complex systems (health care, railways, automotive, etc.). The stories will be mapped onto a taxonomy of scenarios and classified according to the their relevant features, such as the degree of automation they involve and the legal issues they raise.

Furthermore, relevant civil and criminal judicial decisions will considered, to establish how courts deal with liability in automation, and in particular how they balance personal and corporate/organisational responsibilities, and identify immediate and systemic causes for incidents as emerging from technical investigations.

As well as theses stories and judicial decisions, regulations and academic literature will also be collected concerning liability in air traffic management and in related areas. We will consider some of the main theoretical issues concerning liability: the distinction between state actors and private actors, the distinction between individual actors and institutional ones (internationally and at the European level, such as EUROCONTROL), the role of insurance companies, the different applicable standards of liability (e.g., negligence, or strict liability). We shall take into account international law, EU legislation, and legislation in the member states. Differences with the US, and other legal systems, will also be considered.

On the basis of all these elements, we shall develop a framework for addressing the legally-relevant issues occurring in the various stages of the design, development and deployment of new technologies in socio-technical systems. The framework is expected to facilitate capturing issues which may give rise to legal liabilities, and to propose solutions – legal, technical, social, or organisational – to mitigate them. A comparison will be made with regard to stories and regulation concerning liability in different technological areas involving automation and human - machine interaction (automotive industry, train transportation, product liability, medical liability, etc.), in different European and extra-European countries. On the basis of this comparison we will assess the applicability of different models of liability (fault liability, organisational liability, design liability) to the ATM domain. We will also consider how different forms of liability are able to cope with the increasing delegation of tasks to automatic systems or to hybrid human - machine systems. For this purpose, literature on risk management, trust and human machine interaction will be analysed.

Examples of concrete topics that will be addressed include:

- how to proceed when agency does not pertain only to humans or to machines, but rather to hybrid man - machine systems;

- how to deal with cases where, as in the Uberlingen accident, conflicting information is provided to the pilots, by humans (controllers) or automated systems;
- what kind of priorities should be given to different signals, and under what conditions may humans override automatic devices (and the consequences for liability);
- how to relate the allocation of liabilities and the allocation of trust towards humans and machines;
- whether liabilities may be linked to the failure to adopt methods for optimal apportionment of tasks between humans and machines, i.e., whether a better allocation would have enabled an informed human intervention to prevent the failure, or whether automated control should have stopped mistaken human interference;
- how to allocate liability in the case of problematic interoperability of devices;
- what duties of information exist with regard to automated systems, and how such duties affect industrial secrets and intellectual property;
- possible liabilities resulting from wrong information being provided to automated systems by other automated systems (e.g., GPS);
- how automation interferes with data protection.

We shall devote particular attention to liability for software mistakes. As is well known, no complex software is immune to bugs. Not all errors can be detected during the development and validation phases, even though good development methods and skilful programing can reduce them to a minimum. Thus, the users of a software-based system must be ready to mitigate the consequences of software malfunctioning, and be capable of manually handling high-priority tasks when there is a software failure. Competent effort in both preventing malfunctioning and mitigating its impact is particularly important when software is the core component of a safety-critical system, whose failure could result in death, injury or illness, major economic loss, mission failure, environmental damage, or property damage. The regulation of liabilities related to software failure must contribute to assisting developers and users in their efforts to minimise damage. Such a regulation takes place at different levels: binding legal rules govern liabilities towards third parties, while mainly default rules govern the content of software contracts, so that contracts act as the main source for the apportionment of liabilities between software providers and users (such as airlines and airports). In fact software development contracts and use licenses often include strong liability limitations or even exemptions for the developers/providers for damages caused by their products. There is currently much discussion as to whether strict (no-fault) liability should be imposed upon the producer/manufacturer of software, with regard to damages caused by the software. Those in favour claim that producers are in the best position to prevent defects in the products, and to absorb or spread losses in cases where damage was caused, even though no negligent action was performed. Usually, to mitigate this approach, the concept of misuse (or contributory negligence) is introduced, so that a user might be held partially or fully responsible whenever he uses the software in an incorrect or improper way, and as a consequence of a negligent action. Others claim, on the contrary, that by making software producers liable for all damages caused by their software, we would put many producers out of the market (in particular those who are delivering free or open-source software), and reduce the creativity of the software industry, thus stifling technological progress. Moreover, insuring risks for software liabilities is very difficult, since such risks are very difficult to assess and quantify.

Of particular interest in this context are the “aeronautical charts” cases (Aetna Casualty and Surety Co. v. Jeppesen & Co; Saloomey v. Jeppesen & Co; Brocklesby v. United States; Fluor Corp. v. Jeppesen & Co) where the courts categorized information provided in a chart as a product, assuming that a nautical chart or an airline chart is similar to other instruments of navigation such as a compass or radar finder which, when defective, can prove to be dangerous. Since the charts were considered to be a product, the judges held their producer liable under a strict liability rule. Thus the judges considered charts to be different from books, newspapers or other sources of information, as well as from consultancy services, to which judges usually do not apply strict liability standards (they do not consider authors, publishers or consultants to be liable for providing, without any fault, wrong information, the reliance on which leads people to harmful consequences). The chart cases, by analogy, support the view that software too may be viewed as a product (rather than as a service) and may be subject to strict liability. However, the debate on the matter is still open, as case law is uncertain, even more so when addressing new subject matter, such as the liability of providers of GPS services for mistaken information provided to their users.

III. ALIAS NETWORK

The second main outcome of the ALIAS project is the development of a Network of Legal Research in socio-technical systems. The Network provides a structured way to establish a body of knowledge, competence and capability that will serve the operational scenario in the long term. The Network will comprise participants from academia, research centres, industry/SMEs etc. that share knowledge and interest in legal issues concerning socio-technical systems, in particular ATM. As a meeting place for professionals, the network draws on the collective experience of its members to foster discussion and collaboration across disciplinary lines. The network is envisaged as a Web 2.0 community, providing social network services and a variety of additional services such as: a document archive, a forum to launch and discuss relevant topics, a shared calendar for relevant events, and visualisation tools to monitor the activity of the network.

The creation of this Network is considered a fundamental milestone for the implementation of the Legal Case. In fact the Legal Case is intended to be a methodological tool to introduce technology in complex systems, ensuring that all the relevant legal aspects are taken into consideration at the appropriate stage of the design, development and deployment process. Its adoption implies a cultural change, in which liability is not only a criterion of investigation, but also a design principle. In this cultural change the creation of this Network of Legal Research plays a key role, for three reasons:

- It supports the identification of relevant incidents and accounts and their analysis
- It identifies a set of issues to be taken into consideration in the development of the Legal Case
- It lays the foundation for the cultural change mentioned above, and the adoption of the legal case.

The Network will welcome members, not only from the ATM domain, but potentially from domains sharing similar issues and characteristics. The plan is to discuss the relation between automation and liability, to stimulate the international debate on the topic, to exchange information, and learn from each other. It will also be configured as a self-empowering community, whose areas of discussion include the theme of the project, but may also extend to related themes and topics. In this respect the Network may be useful in the SESAR framework, where a Network of Research on Legal Aspects has not yet been established.

The first activity of the Network will be the publication of a position paper that is intended to "seed" the discussion forum, leading hopefully to a collaborative effort from the network community in developing a rich community corpus of stories arguments, and interpretations.

A. Position paper "Framing the problem"

The purpose of the position paper is to set the scene for ensuing debates and discussions within the network of academics, experts and users on regulation of advanced automation in socio-technical systems, in particular with regard to legal liabilities. As such, the document does not attempt to provide a formal, fixed definition of the central themes to be considered, but rather provides an overview of the landscape of issues covering ATM, as well as similar domains. The intent is to "seed" the discussion on these and other issues which will be addressed by the ALIAS network, during the lifetime of the ALIAS project.

The position paper is thus not seen by us as a closed document, but rather an open one, setting out an initial position on some of the key issues, with the intent that it should be amended, and extended, as a result of discussions over the course of the project. Indeed, the extent to which this takes place will be a key to the success of the network that we aim to develop. We believe that this evolving approach to enriching our concepts, scenarios and evaluations is the best way to ensure a lively interaction among the participants, and a way to foster critical debate and discussion. We expect to continually revise this core document over the lifetime of the project, as the central concepts become further enriched and developed as a result of the network debates.

The process of people recruiting for the ALIAS Network will start during the SESAR Innovation Days 2011 in Toulouse (France) and will continue for the whole project duration.

A dissemination event will be organized in June 2012 at the European University Institute in Florence (Italy) for the official Launch of the ALIAS Network.

B. Launch of the Network

The event will offer an important occasion for project members and Network members and interested observers to physically meet each other and to start building the community.

It has the threefold purpose to:

- officially Launch the Network, showing its basic structure and initial membership along with its purposes and interests;
- present the ALIAS project activity carried out to date, particularly on the position paper, and to profit by the event to enrich the discussion on it;
- foster the expansion of the Network activity highlighting research themes to be explored, topics to be addressed, stories of interest, and other communities with whom it might be useful to interact.

The ALIAS Network will be accessible from the project web site www.aliasnetwork.eu. People interested in joining the Network can express their interest to the authors of this paper. They will be contacted as soon as site registration is open.

REFERENCES

There is a large literature of relevance to the ALIAS project, since our research is at the intersection of various disciplines. Here we outline some initial references, listed by different areas.

Law.

[1] J., Bing, G. Sartor (eds), The law of electronic agents, Unipubskriftserier, Oslo, 2003.

[2] G. Calabresi, The costs of accidents: A legal and economic analysis.Yale Univ Press, 1970.

[3] V. M. Brannigan, R. E. Dayhoff, "Liability for Personal Injuries Caused by Defective Medical Computer Programs," American Journal of Law & Medicine, vol. 7(2), 1981; pp. 123-144.

[4] M. Chatzipanagiotis, "Liability aspects of air traffic services provision," in Air and Space Law, 32, 2007, pp. 326–357.

[5] I. Diederiks-Verschoor, M. Butler. M., An introduction to air law. Kluwer Law International, Alphen aan den Rijn, 2006.

[6] S. Lanoue, "Computer Software and Strict Products Liability," in San Diego Law Review vol. 20(2), 1983, pp. 439-456.

[7] D.B. Lawrence, "Strict Liability, Computer Software and Medicine: Public Policy at the Crossroads," in Torts & Insurance Law Journal, vol. 23(1), 1987, pp. 1-18.

[8] G. Leloudas, G. Risk and Liability in Air Law. Informa Maritime and Transport, London, 2009.

[9] R. Morrow, R, "Technology issues and product liability," in Product liability and innovation: managing risk in an uncertain environment, 1994, pp 23 – 29.

[10] G. Sartor, C. Cevenini, M. Laukyte, G. Contissa, R. Rubino, "Legal Issues of Software Agents," in P. e M. Cunningham (eds.), Exploiting the Knowledge Economy: Issues, Applications, Case Studies, IOS Press, Amsterdam, 2006.

[11] G. Sartor, "Cognitive automata and the law: electronic contracting and the intentionality of software agents," in Artificial Intelligence and Law, vol. 17(4), 2009, pp. 253-290.

[12] F.E. Zollers, A. McMullin, S. Hurd, and P. Shears P, "No more soft landings for software: Liability for defects in an industry that has come of age," in Santa Clara Computer and High Technology Law Journal, vol 21, 2004, pp. 745-782.

[13] G. Teubner, "Rights of Non-humans? Electronic Agents and Animals as New Actors in Politics and Law," in Journal of Law and Society, vol. 33, 2006, pp. 497-521.

[14] N. Van Antwerpen, "Cross-border provision of air navigation services with specific reference to Europe: safeguarding transparent lines of responsibility and liability," in Kluwer Law International, Alphen aan den Rijn, 2008.

Argumentation, logic and computer science.

[15] H. Prakken, G. Sartor, "A logical analysis of burdens of proof," in Legal Evidence and Proof: Statistics, Stories, Logic, 2009, pp. 223–53.

[16] N. D. Walton, C. Reed, F. Macagno F. Argumentation Schemes. Cambridge University Press, Cambridge, 2008.

[17] M. Wooldridge, An Introduction to MultiAgent Systems, John Wiley & Sons Ltd, 2002.

[18] D.C. Dennett, The Intentional Stance. MIT Press, Cambridge, Mass., 1987.

Safety and socio-technical systems.

[19] P. Kroes, M. Franssen, I. Van de Poel, M. Ottens, "Treating socio-technical systems as engineering systems: some conceptual problems," in Systems Research and Behavioral Science, vol 23(6), 2006, pp. 803–814.

[20] G. Baxter, I. Sommerville, "Socio-technical systems: From design methods to systems engineering," in Interacting with Computers, vol. 23(1), 2011, pp. 4–17.

[21] J. Reason, "Achieving a safe culture: theory and practice," in Work & Stress, vol 12(3), 1998, pp. 293-306.

[22] S. Bennett, "The 1st July 2002 mid-air collision over Überlingen, Germany: a holistic analysis," in Risk Management, 2004, pp 31–49.