Cape Town Convention Journal

ISSN: 2049-761X (Print) 2049-7628 (Online) Journal homepage: https://www.tandfonline.com/loi/rcap20

The Cape Town Convention's International Registry: decoding the secrets of success in global electronic commerce

Jane K Winn

To cite this article: Jane K Winn (2012) The Cape Town Convention's International Registry: decoding the secrets of success in global electronic commerce, Cape Town Convention Journal, 1:1, 25-51

To link to this article: https://doi.org/10.5235/CTC.2012.25

The Cape Town Convention's International Registry: decoding the secrets of success in global electronic commerce

Jane K Winn*

The International Registry, established pursuant to the Cape Town Convention on International Interests in Mobile Equipment, is a new global electronic commerce system for recording and establishing the relative priority of interests in aircraft equipment. Other examples of global electronic commerce systems include the airline computer reservation system, the SWIFT financial network, and payment card networks. The International Registry may be the most successful global electronic commerce system ever built in terms of the speed with which it was implemented, its adoption rate, and the dearth of controversy surrounding its operation. The real 'driver' of its success is demand for a more efficient aircraft financing regime, while its design is an 'enabler' of the realization of that goal. This paper also will identify some other factors that have contributed to its remarkable success, and will note how the relative absence of such factors may have limited the success of other global electronic commerce systems.

1. Introduction

The International Registry, established pursuant to the Cape Town Convention on International Interests in Mobile Equipment and the Aircraft Protocol (the 'International Registry', 'Convention' and 'Aircraft Protocol', respectively), is a new global electronic commerce system for recording international security interests in aircraft equipment.[1] 'Electronic commerce' in this context refers to commercial transactions executed by means of information and communication technology ('ICT', also referred to as information technology or 'IT' especially in the US) rather than paper-based administrative systems. The first global electronic commerce system was the international electronic fund transfer system based on 'key tested telex' that was operating on a global basis in the 1950s; it is still occasionally used today. The computer reservation system ('CRS') built by airlines in the 1960s is another example of a global electronic commerce system. In the 1970s, this was followed by the creation of the Society for Worldwide Interbank Financial Telecommunications ('SWIFT') network designed to replace tested telexes with the same kind of electronic data interchange technology that global production networks were beginning to use at the same time. By the 1980s, credit card and ATM payment card networks were operating on a global scale, and dotcom start-ups, including eBay and Amazon, used the Internet to build global electronic commerce systems during the 1990s. By the 2000s, dozens of public and private electronic commerce

* Charles I. Stone Professor, University of Washington School of Law, Seattle Washington. Thanks to Rob Cowan, Jay Simmons and Jeffrey Wool for helpful insights, and to Laura Powell and Victoria Parker for research assistance. All errors remain mine alone.

[1] Cape Town Convention on International Interests in Mobile Equipment; Protocol to the Convention on International Interests in Mobile Equipment on Matters Specific to Aircraft Equipment.

doi:10.5235/CTC.2012.25

systems were operating around the world with varying degrees of success.[2]

The International Registry may be the most successful global electronic commerce network ever built in terms of the speed with which it was developed and implemented, and the dearth of controversy surrounding its operation. This paper will provide an overview of how the International Registry works, including the legal, management, and technological elements of its design and operation. It will also highlight the factors that have contributed to its success. Although many efforts in recent decades to launch markets based on 'digital signature' systems within 'public key infrastructures' have failed, the International Registry stands out as a major success for the commercial use of that technology.

It is now proverbial in management circles that technology should be understood as an 'enabler' of economic change, rather than a 'driver'.[3] The International Registry's success exemplifies this principle. The most important factor contributing to its success is the basic economic 'driver' of the Convention: increasing the efficiency of aircraft financing markets, and thereby increasing the availability and lowering the cost of aviation credit. The information technology used in the International Registry is merely an important 'enabler' of the strategic goal of reducing the cost of aircraft financing. Another factor contributing to its success is the tight integration of the International Registry into the Convention's framework, which makes its use mandatory for any party subject to the requirements of the Convention. The drafters of the Convention wanted the International Registry to be built on the foundation of current electronic commerce best practices. As a result, the use of information technology has evolved organically within the Convention's framework. The development of large-scale, cross-border markets that rely on information technology generally faces formidable 'collective action problems' in the search for consensus among stakeholders, but the relatively small number of global aircraft manufacturers and financiers, working together in an organized manner with representatives of the world's airlines, reduced the scope of such coordination problems when this scheme was being developed. Since it was established, the International Registry's governance institutions have proven to be flexible and dynamic in responding to market conditions. A comparison between the development of the International Registry and the development of some other major global electronic commerce systems suggests that these factors contributed to the success of the International Registry. Many of these factors were lacking when other global electronic commerce systems were developed, causing their development and progress toward widespread adoption to be much slower.

2. Mapping the terrain of global electronic commerce

When the foundations were laid for the first global electronic commerce system, airline CRSs, merely the idea of migrating paper-based reservation systems to automated systems was seen as a radical new undertaking. The integration of separate enterprise-based reservation systems into a global network took decades to complete. The system of 'key tested telexes' for cross-border funds transfers was designed to solve a problem that arose in international

[2] Some other examples of successful global electronic commerce systems include the ARC (formerly Airline Reporting Corporation) that provides a clearing and settlement mechanism for airline ticket payments; Universal Air Travel Plan, a travel payment network owned by a consortium of airlines; the UPU Clearing system operated by the Universal Postal Union for the clearing and settlement of terminal dues for cross-border delivery of postal mail; the Alibaba trading platform based in China; the TradeCard cross-border trade finance platform; the Bolero cross-border trade finance platform; the PayPal payment network; various global retail platform providers including Apple iTunes, and Walmart.com; and social commerce networks including Google+ and Facebook.

[3] See, eg, Jørgen Rosted and others, *New Nature of Innovation* (2009) www.newnatureofinnovation.org/full_report.pdf, accessed 15 July 2012.

financial markets, but it relied on mechanical telex machines, not computers. Similarly, charges on bank-issued credit cards were first processed at the retail level using paper administrative systems, although they soon migrated to more sophisticated computer technology. SWIFT was 'born digital' in that it was always based on computer networks. The main goal in building SWIFT was to replace mechanical tested telex systems with computerized systems, just as automated teller machines were developed to make greater use of computers in retail banking.

Each of these systems grew in response to business demands for more computerization in order to increase the efficiency of business administration systems.[4] They also faced considerable 'business process reengineering' barriers to adoption because many participants had to upgrade their 'legacy' administrative systems in order to make use of them.[5] Once an electronic commerce system has gained a critical mass of users, then positive 'network effects' provide incentives for others to join. 'Network effects' exist whenever the value of the network to individual users increases as a function of the number of other users on the network.[6] Network effects not only benefit individual users of networks, they also increase the market power of the network operator, which easily tends to suppress competition.[7] These older global electronic commerce networks each achieved widespread adoption much more slowly than the Convention International Registry has, but with time, each has evolved into an equivalent form of critical infrastructure for their respective industry sectors.

By contrast, the digital signature 'public key infrastructure' ('PKI') created by the SAFE BioPharma industry association developed in response to a technology-specific government mandate regarding the migration from paper to electronic records in the US pharmaceutical industry.[8] Network effects can be negative as well as positive, however, resulting in barriers to the adoption of new network technology until a critical mass of users has been recruited. Law reforms around the world designed to promote the adoption of digital signatures have failed to achieve widespread private-sector adoption, and ultimately create barriers to the adoption of electronic commerce. Just as European government mandates to use digital signatures for value-added tax invoices have failed to trigger widespread private sector adoption of that technology,[9] the US Food and Drug Administration 21 CFR Part 11 has failed to provide a path for the American pharmaceutical industry to embrace electronic commerce.

[4] Peter F Drucker, 'Coming of the New Organization' (1989) 66(1) *Harvard Business Review* 45.

[5] Michael Hammer, *Reengineering the Corporation: A Manifesto for Business Revolution* (Harper Business 1993).

[6] Carl Shapiro and Hal R Varian, *Information Rules: A Strategic Guide to the Network Economy* (Harvard Business Press 1999).

[7] Mark A Lemley and David McGowan, 'Legal Implications of Network Economic Effects' (1998) 86 *California Law Review* 479.

[8] Public key infrastructure refers to an information security system that uses 'asymmetric key' cryptography to authenticate users.

[9] When the 2001 e-Invoicing Directive (Council Directive 2001/115/EC of 20 December 2001 [2002] OJ L15/24) was revised by the Council Directive 2010/45/EU of 13 July 2010 [2010] OJ L 189/1, Article 233 was revised so that member states could no longer require taxpayers to use 'advanced electronic signatures' on e-invoices. Instead, Article 233 now provides in part that 'Each taxable person shall determine the way to ensure the authenticity of the origin, the integrity of the content and the legibility of the invoice. This may be achieved by any business controls which create a reliable audit trail between an invoice and a supply of goods or services.' Council Directive 2010/45/EU, 'Explanatory Notes: VAT Invoicing Rules', http://ec.europa.eu/taxation_customs/resources/documents/taxation/vat/traders/invoicing_rules/explanatory_notes_en.pdf. EU policy in this regard is now equivalent to the policy adopted by the US Internal Revenue Service in 1991. See generally, Jane K Winn and Angela Zhang, 'China's Golden Tax Project: A Technological Strategy for Reducing Vat Fraud' (2010) http://ssrn.com/abstract=1641379.

(a) Airline computer reservation systems

In 2012, there were several major 'global distribution systems' ('GDS') for travel reservations in operation: SABRE, developed by American Airlines; Travelport, created by the takeover of the Worldspan CRS by Galileo, which was developed by a consortium of European airlines; Amadeus, developed by a second consortium of European airlines; and Abacus, developed by a consortium of Asian airlines working with Sabre Holdings. These GDSs are the contemporary successors to the original CRSs. They provide integrated systems for reserving various types of travel services including airplane and rail tickets, hotel reservations and car rentals. Aviation industry data is carried over a secure network provided by the *Société Internationale de Télécommunication Aéronautique* ('SITA').[10]

The origins of the contemporary GDSs are found in American Airlines' decision in the late 1940s to try building the first large-scale computer system to manage its reservation system.[11] American Airlines management recognized that manual paper-based reservations were creating an administrative bottleneck that would interfere with its ability to put jet aircraft into service, so work was begun on developing an automated reservation system.[12] In the early 1950s, it launched its 'Reservoir' system, and in the late 1950s, began work on what became its SABRE system.[13] United Airlines responded by developing Apollo; Northwest, TWA and Delta developed competing systems that became Worldspan; European airlines responded by developing the Amadeus and Galileo systems.

When CRSs were first developed, airlines saw them as systems for increasing the efficiency of their internal operations. Employees of the airline that owned the CRS generally did their own booking and inventory management using the system hardware and software provided by the vendor.[14] In addition to creating CRSs, airlines began investing to upgrade their computer systems in order to provide airline managers with detailed information about the market for air travel.[15] The International Air Transport Association ('IATA'), an international trade association that works with the International Civil Aviation Organization ('ICAO'), the international body with responsibility for international civil aviation, developed technical standards for airport and passenger data records to regulate the international aviation industry.[16] Early attempts by travel agent trade associations to create national CRSs floundered, however, due to technical problems, insufficient funding, lack of participation by some airlines, and antitrust concerns.[17] 'Airlines that invested in CRSs made their systems publicly available; and in the regulated era, when route entry and fares were tightly controlled, these airlines did not see any particular market power advantages from

[10] SITA is an information and communications technology trade association founded in 1949 by a group of European airlines; in 2012 it had over 500 active members representing over 90% of the world airline business including airlines, airports, air freight carriers and GDS providers. It sponsored the creation of the .aero generic top-level domain in 2002. See generally, SITA, www.sita.aero/.

[11] Martin Campbell-Kelly and NetLibrary, Inc, *From Airline Reservations to Sonic the Hedgehog: A History of the Software Industry* (MIT Press 2003) 42.

[12] James McKenney et al, *Waves of Change: Business Evolution through Information Technology* (Harvard Business Press 1995) 149.

[13] The system was originally named SABER by IBM for 'Semi-Automatic Business Environment Research,' but in 1959 was changed to SABRE after the Buick automobile. Timothy M Ravich, 'Deregulation of the Airline Computer Reservation System (CRS) Industry' (2004) 69 *Journal of Air Law and Commerce* 387, 390.

[14] Michael E Levine, 'Airline Competition in Deregulated Markets: Theory, Firm Strategy, and Public Policy' (1987) 4 *Yale Journal on Regulation* 393, 459.

[15] US Department of Transportation, 'Study of Airline Computer Reservation Systems' (May 1988) 8.

[16] For example, IATA developed the three-letter codes that identify airports around the world, and standards for the new mobile boarding pass technology. See generally, www.iata.org/workgroups/Pages/padis.aspx.

[17] US Department of Transportation (n 15) 89 n 2.

CRSs. All that changed with deregulation.'[18] A decade after the Airline Deregulation Act of 1978, ninety-five percent of all American travel agents were using CRSs to manage customer air travel reservations rather than telephone and paper communications.[19]

With deregulation, airlines soon learned that CRSs could be used to distort information received by travel agents and consumers about the service offerings of rival airlines.[20] In particular, the computer display of flight information could easily be ordered to place flights of the CRS owner's airline in a privileged position on the first screen of information displayed, and to relegate flights by other airlines to second or third screens. Airlines without CRSs claimed that the terms and conditions under which they were allowed to display their flights were discriminatory and oppressive, including delays in uploading information about other airlines' flights into the CRS. In addition, airlines that owned CRSs had unfair access to information about competitors' business plans because they could analyze all the data held in the CRS, not just information about their own operations.[21] The Civil Aeronautics Board ('CAB') responded by issuing rules in 1984 to govern airline-owned CRSs.[22]

There was strong demand for CRS services from both travel agents and other airlines because of the positive 'network effects' produced by the creation of national CRS networks. 'During the 1980s, airlines that owned CRSs had market power that they could use to charge booking fees to other airlines and impose onerous terms and conditions on travel agents using their terminals.'[23] However, by the 2000s, technological innovations, such as consumers' ability to use the Internet to access CRSs directly, were transforming the travel industry, fueling real competition among CRSs and between airlines and CRSs. As a result, the US Department of Transportation finally ended the regulation of CRSs in 2004.[24]

(b) Society for Worldwide Interbank Financial Telecommunications

The arrival of the telegraph in the 19th century gave banks access to a fast, inexpensive mechanism for authorizing funds transfers. In order to use telegraphy for funds transfer instructions, however, banks needed a good system for insuring that they only acted on instructions given with the authority of the account holder whose funds were to be transferred. In the early 20th century, banks solved this problem by creating a system for authenticating account users that depended on manual cryptographic functions. In order to set up a secure channel for cable communications between two banks, the banks would exchange code books that were regularly updated. Bank employees would encrypt funds transfer cables using the values in the code book provided by the receiving bank. This system solved two business problems at once for the banks: the cable messages would not be comprehensible to anyone who intercepted them in transit, and successful decryption of the message demonstrated to the receiving bank that the sender was in possession of its code book. Of course, there was always a risk of a bank executing fraudulent funds transfer messages if any of the encryption code books fell into the wrong hands.

[18] JP Hanlon, *Global Airlines: Competition in a Transnational Industry* (Butterworth-Heinemann 1996) 54.

[19] US Department of Transportation (n 15) 10.

[20] Michael E Levine (n 14) 415.

[21] US Department of Transportation (n 15) 10.

[22] Final Rule, Carrier-Owned Computer Reservations Systems, 49 Fed Reg 32,540 (15 August 1984) (revised and reissued by the Department of Transportation in 1992; see 57 Fed Reg 43,780 (22 September 1992)).

[23] David McGowan, 'Networks and Intention in Antitrust and Intellectual Property' (1999) 24 *Journal of Corporation Law* 485.

[24] Final Rule, Computer Reservations System (CRS) Regulations; 69 Fed Reg 976 (January 7, 2004); see generally, Cindy R Alexander and Alex Yoon-ho Lee, 'Economics of Regulatory Reform: Termination of Airline Computer Reservation System Rules' (2004) 21 *Yale Journal on Regulation* 369; Ravich (n 13).

In the second half of the 20th century, a global network of teleprinters connected to the telegraph system came into use, allowing businesses that used cable regularly to send and receive messages within their own organization instead of going to an outside intermediary. These teleprinter services later evolved into a network for automatically routing telegraphic messages known as 'telex' (for 'TELegraph EXchange').[25] The system of using code books to manually encrypt and decrypt funds transfer messages migrated to the new telex environment. The 'keys' (ie, code numbers) used to secure tested telex messages were 'symmetric' keys, meaning that the sending and receiving banks used exactly the same key to encrypt and decrypt the message.[26] Access to the codes was highly restricted, and only designated employees within the bank were given access to them in order to perform the function of encoding outbound messages and 'testing' inbound messages.[27] Bank employees were eventually given access to encryption software to perform the cryptographic functions, although the code books did not immediately disappear. During the 1990s, different telephone operators around the world dismantled the global telex network, forcing the remaining vestiges of the 'tested telex' system to migrate to a 'pseudo-telex' format using regular telephone lines to access a data network. In 2012, it remains possible to send 'tested telexes' using this vestige of the old system, but the volume of transactions is negligible.

The tested telex system was only a 'virtual' network built up from many bilateral relationships between banks; it was not a network *per se*. Communications were bilateral between banks that had previously exchanged matching cryptographic keys.[28] The migration from tested telexes to the SWIFT network created a multi-lateral global network under the supervision of SWIFT. By the 1970s, the international banks providing the majority of cross-border payment services realized:

> … that if they were to be able to automate effectively, they had to come up with a universal standard for inter-bank communications irrespective of where all banks resided. Until this time, all inter-bank payments had to be made manually by tested telex as this was the only communication medium with worldwide coverage and standards. Telex was designed for communication of free-format text and so could not be adapted for computer-to-computer communication. It was therefore apparent to the banks that they would have to develop their own secure payments communication network if they were to stand any chance of automating payment processing across

[25] 'Telegraphy' (Wikipedia) http://en.wikipedia.org/wiki/Telegraphy, accessed 15 July 2012.

[26] Although using the same key on both ends of the transaction simplifies the technology, it creates an administrative problem with regard to the initial distribution of the cryptographic keys. Digital signatures are based on asymmetric cryptography, which is a more sophisticated cryptographic process than symmetric cryptography, but it simplifies the key distribution process because the individual being identified is the only one in possession of the private key, while the corresponding public key can be widely distributed without fear of compromising the security of the private key.

[27] When an electronic funds transfer message needed to be sent, the sending bank used its cryptographic key to produce a unique 10 digit number related to only three data elements from the message: the date, the amount and the sending bank's identification number. When the receiving bank received a funds transfer instruction together with a 10-digit test number, then an employee in the 'cipher room' would run the 10-digit number and the cryptographic key of the sending bank through the cryptographic engine. If the 10-digit number corresponding to the date, amount and ID number matched the date, amount and ID number contained in clear text in the body of the telex, then the telex had passed the 'test' and the funds would be transferred. (This discussion is based on a telephone interview with Jay Simmons, chairman, Board Advisory Services, Inc., 10 July 2012.)

[28] The keys were numbers, not mechanical keys. Thus, a secure key distribution method might include dividing the key into two parts, sending one part by postal mail and sending the other part by telex so that only the intended recipient would be able to put them together.

> globally distributed organizations. The result was the formation of the Society for Worldwide Inter-bank Financial Telecommunications, (SWIFT) in 1973, a market cooperative owned by the member banks, and the transmission of the first payment instructions in 1977.[29]

SWIFT was started by 239 banks from 15 countries, and now has nearly 10,000 users in more than 200 countries.[30] SWIFT mandates the use of sophisticated security technology for messages sent over its network. 'Numerous features such as passwords, authentication of the message content and the sender, encryption, audit tracing and intrusion detection ensure data confidentiality and integrity. Messages leaving a customer site are encrypted before their transmission over SWIFT's network.'[31] SWIFT provides only a communication network and not a settlement facility, so the transfer of funds based on SWIFT messages takes place in the accounting systems of the banks processing the SWIFT messages.[32] Participation by banks in SWIFT is optional, however, unless mandated by a national bank regulator. As a result of the large variations in the technological sophistication of bank operations around the world, many banks continued to use tested telex technology for cross-border funds transfers for decades after the launch of SWIFT.[33]

In addition to providing a highly secure network for the exchange of messages related to funds transfers, SWIFT is also a leader in setting global standards for electronic financial transactions. In the early years of SWIFT's operations, it required its members to use its own proprietary Message Transfer ('MT') standards based on 'electronic data interchange' ('EDI') technology. SWIFT later changed its orientation from closed, proprietary technology to an open, standards-based approach. It also contributed the content of its proprietary MT standards to the International Organization for Standardization ('ISO') for use as EDI financial transaction message standards. Its standards-based approach was an important factor contributing to broader banking industry efforts to achieve 'straight-through-processing' (ie, end-to-end automation from the sending bank's computer system to the receiving bank's computer) of financial transactions. With the emergence of 'eXtensible Markup Language('XML') as a successor to EDI as a method for standardizing machine-executable business communications,[34] SWIFT emerged as one of a handful of competing standard-setting organizations capable of contributing to the development of new global XML standards for financial transactions. In 2004, ISO designated SWIFT as the 'registration authority' (ie, administrative lead) for ISO 20022 (also known as the 'Universal Financial Industry Message Scheme' or UNIFI) for XML financial transaction standards. The ISO 20022 family of standards is within the scope of the ISO Technical Committee 68 ('TC 68') for financial services standards.[35]

(c) Digital signatures

In the 1990s, many observers expected 'digital signature' technology deployed within PKIs to emerge as a ubiquitous system for authenticating

[29] Graeme Biggs and David Loader, *Managing Technology in the Operations Function* (Butterworth-Heinemann 2002) 14-15.

[30] SWIFT Press Office, 'Facts about SWIFT for the Media' (July 2010) 2, 6, www.swift.com/about_swift/press_room/SWIFT_for_media_July_2010.pdf.

[31] Ibid.

[32] Robert C Effros, *Current Legal Issues Affecting Central Banks* (5th vol, International Monetary Fund 1997).

[33] John Bryant, 'Fighting Tested Telex Fraud, SWIFTWorld' (1996) Thales e-Security White Paper, http://electronics.bluestarindia.com/DataCom/WhitePapers/Banking/fighting_tested_telex_fraud3.pdf, accessed 15 July 2012.

[34] See generally, Jane Winn, 'Making XML Pay: The Regulation of XML Standards for Internet Payments' (2000) 53 *SMU L Rev* 1477.

[35] John Sandman, 'New Standards Panel Faces Old Problems' (2006) 18 Securities Industry News 8; see also ISO 20022, www.iso20022.org.

computer users.[36] Utah led the way by adopting its Digital Signature Law in 1995,[37] Germany enacted a similar law in 1997,[38] the EU issued a directive on 'electronic signatures' in 1999,[39] and UNCITRAL issued a model law on electronic signatures in 2001.[40] This approach to cross-border electronic commerce was radically different than the approach adopted by SWIFT. SWIFT first developed the technology for secure messaging based on proprietary standards, and then gradually migrated toward open standards and expanded its activities in global standard-setting arenas. Digital signature laws were intended to be technology neutral, but in reality describe a particular technology. As a result, they converted that particular technology into a technology-specific mandate before there was any concrete evidence of market demand for it. The FDA jumped on the digital signature regulation bandwagon, and issued an electronic records and signatures rule that took effect in 1997.[41] This rule, known generally as '21 CFR Part 11,' was intended to encourage technological innovation, while also protecting public health during the process of reviewing new medical products, conducting efficient audits of required laboratory testing records, and, if necessary, taking enforcement action.

Although the Part 11 rule was developed in concert with industry over a period of six years and efforts were made to ensure that it was consistent with commercial practice, it has been a source of much frustration for regulated entities that struggle to comply with its terms. For example, older information systems not in compliance in 1997 when the rule took effect were not grandfathered under Part 11; the FDA expects regulated entities operating such 'legacy systems' to bring them into compliance.[42] In 2003, the FDA noted in guidance it provided on the implementation of 21 CFR Part 11, that '…[private-sector] concerns have been raised that some interpretations of the part 11 requirements would (1) unnecessarily restrict the use of electronic technology in a manner that is inconsistent with FDA's stated intent in issuing the rule, (2) significantly increase the costs of compliance to an extent that was not contemplated at the time the rule was drafted, and (3) discourage innovation and technological advances without providing a significant public health benefit.'[43]

In retrospect, it is easy to see how the FDA made the mistake of inadvertently enacting a restrictive 'technology-specific' regulation promoting the use of digital signatures when it meant to enact an empowering 'technology-neutral' regulation. In the mid-1990s, it seemed clear to many subject-matter experts around the world that digital signatures deployed within a PKI were on the threshold of becoming a 'dominant design' for electronic commerce.

The notion of dominant design was first defined by William Abernathy and James Utterback's analysis of the automobile industry in its formative stage and the impact of the all-metal body, rear-wheel drive and the dramatic changes in the car. These changes standardized design and competition, which shifted to

[36] See generally, Jane Winn, 'Open Systems, Free Markets and the Regulation of Internet Commerce' (1998) 72 *Tulane Law Review* 1179.

[37] It was repealed in 2006 because it was not being used.

[38] 1997 Information and Communication Services Act (*Informations- und Kommunikationsdienste-Gesetz – luKDG)*, www.epractice.eu/files/media/media_939.pdf.

[39] Council Directive 1999/93/EC of 13 December 1999 creating a Community framework for electronic signatures (1999) OJ L013/12.

[40] UN Commission on International Trade Law, 'Model Law on Electronic Signatures with Guide to Enactment' (5 July 2001), www.uncitral.org/uncitral/uncitral_texts/electronic_commerce/2001Model_signatures.html.

[41] Electronic Records; Electronic Signatures, 62 Fed Reg 13,430 (20 March 1997) (codified at 21 CFR pt 11).

[42] Jane K Winn and Benjamin Wright, *The Law of Electronic Commerce* (4th edn, Aspen 2012) § 5.04 [D] [2].

[43] Guidance for Industry Part 11, 'Electronic Records; Electronic Signatures Scope and Application' (2003), www.fda.gov/regulatoryinformation/guidances/ucm125067.htm.

execution, styling and marketing, and IT firms developed efficient technology and complementary assets to produce it. Once defined, the dominant design of information processing in an industry becomes obvious, and most firms move quickly either to adopt it or shift to an atypical strategy that reduces their reliance on IT. The rate of adoption depends on the ability of competitors to manage the change to a new mode of information processing. The overwhelming evidence from Harvard Business School case studies is that firms without much experience find making the change a painful and costly effort, requiring several attempts over a number of years.[44]

With the benefit of hindsight, it is now equally obvious that digital signatures did not become a dominant design for electronic commerce.[45] Since it is difficult and expensive to integrate PKIs into functioning electronic commerce systems, PKIs *per se* rarely correspond to the requirements of parties engaged in commercial transactions. Furthermore, there are alternatives to PKIs that are cheaper and easier to use with existing information systems, and that can produce similar results.[46] The FDA has not repealed 21 CFR Part 11, however, so the US pharmaceutical industry had no choice but to try to lower the cost of compliance with it in order to migrate its paper-based systems to electronic systems.

In 2004, a consortium of US pharmaceutical companies and related organizations launched the SAFE BioPharma Association in order to develop and promote the Secure Access for Everyone (SAFE) digital signature standard for the US pharmaceutical industry. FDA approval of new medical products requires the submission of an enormous number of individual laboratory test results signed by the individual scientist who conducted the test. Research scientists at the companies that formed SAFE BioPharma wanted to migrate these mandatory record management processes to electronic lab notebooks where a 21 CFR Part 11 complaint digital signature could be affixed directly to the electronic record. The standards that SAFE BioPharma developed are designed to make it possible to comply with both US and EU regulations. Its certificate authority service has been cross-certified with the Federal PKI authority.[47]

But by 2012, it remained unclear what the future would hold for the SAFE BioPharma initiative. Several major pharmaceutical firms had implemented its standards, but it had not yet achieved the widespread adoption hoped for by its sponsors. As with the airline CRSs and the replacement of tested telexes with secure SWIFT messages, the business case for migrating from paper-based to electronic processes was clear. Both SWIFT and SAFE BioPharma were organized as collaborative, private self-regulatory organizations designed to serve an entire industry, and both attracted strong support from leading players in those industries. One major obstacle to the widespread adoption of SAFE BioPharma standards has been the US FDA's decision not to provide

[44] McKenney et al (n 12), 36.

[45] See generally, Jane Winn, 'The Emperor's New Clothes: The Shocking Truth About Digital Signatures and Internet Commerce' (2001) 37 *Idaho Law Review* 353; Jane Winn, 'US and EU Regulatory Competition and Authentication Standards in Electronic Commerce' (2006) 5[1] *International Journal of IT Standards and Standardization Research* 84; Jane Winn and Yuping Song, 'Can China Promote Electronic Commerce Through Law Reform? Some Preliminary Case Study Evidence' (2007) 20 *Columbia Journal of Asian Law* 415; Jane Winn, 'Globalization and Standards: The Logic of Two-Level Games' (2009) 5 *Journal of Law and Policy for the Information Society* 185.

[46] Eg, in the US, the credit card system provides a *de facto* identity management system for retail Internet commerce.

[47] Rich Furr and Viky Manaila, 'The Use of EU qualified eSignatures in the BioPharmaceutical Industry' (ETSI ESI Workshop 2012), http://docbox.etsi.org/workshop/2012/201202_ESIWORKSHOP/SAFE-BioPharma.pdf, accessed 15 July 2012; Zack Martin, 'Trusted Identity Plan Unleashed' (*Secure ID News*, 9 June 2011), www.secureidnews.com/2011/06/09/trusted-identity-plan-unleashed, accessed 15 July 2012.

it any official support.[48] While disappointing to the sponsors of SAFE BioPharma, this decision is completely consistent with American standards policy generally: both US government and American business managers generally believe that the costs of government interference in standards markets will normally outweigh the benefits.[49] In the absence of any formal government support, SAFE BioPharma is left trying to build private-sector support for technology on the basis of its own assertion that its technology complies with 21 CFR Part 11. It is possible that growing use of electronic health records outside the context of new product reviews may provide a new market for SAFE BioPharma technology.[50] It also may evolve from an industry-based electronic signature standard-setting organization into a cloud computing service provider for the healthcare industry.[51] However, it seems unlikely that SAFE BioPharma will ever achieve its original goal of making electronic lab notebooks used in clinical trials and running on its technology ubiquitous in the American pharmaceutical industry.

(d) Payment cards

The move from paper to electronic administration of bank payment systems began in the 1950s when it became clear that traditional paper-based systems could not sustain the increasing scale of the banking industry. One commentator described the problem in these terms:

> The early 1950s found the banking industry on the brink of a crisis. Check use in the United States had doubled between 1943 and 1952, from four billion to eight billion checks per year, and bankers were projecting continuing increases of one billion checks per year by 1955. Banks were at a standstill, unable to expand, or, in some cases, even to keep pace with the increasing flow of paper. The immediate culprit was the check clearing process.[52]

The immediate technological solution to the problem was the invention and national deployment of the 'magnetic ink character recognition' system and computerization of check clearing. A longer-term strategic response was the development of payment cards. A third-party charge card that could be used at many different points of sale was not a new idea when Bank of America began developing such a system in the late 1950s. However, earlier efforts to launch such systems only operated within a limited geographic region or had failed due to prohibitive operating costs and credit losses.[53] BankAmericard was launched in 1958, and Bank of America made it into the first truly national credit card scheme by licens-

[48] The European Payment Council is a collaborative, private, self-regulatory organization organized by European banks to lower the cost of operating the Single Euro Payment Area. It faced a similar challenge of low industry adoption rates for its standards, but unlike SAFE BioPharma, was able to secure an EU legislative mandate for European banks to make the transition to its standards by an 'end date' of 2014. Council Regulation 260/2012 of 14 March 2012 establishing technical and business requirements for credit transfers and direct debits in euro and amending Council Regulation (EC) 924/2009 of 16 September 2009 [2012] OJ L94/22.

[49] US Congress, Office of Technology Assessment, *Global Standards: Building Blocks for the Future* (US Government Printing Office 1992). However, the FDA has taken a different approach with regard to the use of public or public standards to establish the safety of medical devices. US Food and Drug Administration, 'Guidance for Industry and FDA Staff – Recognition and Use of Consensus Standards' (17 September 2007), www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm077274.htm.

[50] John D Halamka, 'Trustworthy Information Systems for Healthcare', *Geek Doctor*, 19 May 2010, http://geekdoctor.blogspot.com/2010/05/trustworth-information-systems-for.html, accessed 15 July 2012.

[51] Nicholas Basta, 'Pharma IT is Going to the Clouds', *Pharmaceutical Commerce*, 14 November 2011, http://pharmaceuticalcommerce.com/information_technology?articleid=2605, accessed 15 July 2012.

[52] A Weaver Fisher and JL McKenney, 'The Development of the ERMA Banking System: Lessons from History' (1993) 15(1) *IEEE Annals of the History of Computing* 44, quoted in McKenney et al (n 12) 41.

[53] McKenney et al (n 12) 67.

ing other banks across the country to offer it to their customers. In response to the Bank of America credit card scheme's success, in 1966, a group of banks formed the competing MasterCharge program, and announced its decision to license its credit cards to banks across the country. As a result of the competitive pressure created by MasterCharge's more inclusive governance system, Bank of America turned over control of the BankAmericard system to an independent entity, National BankAmericard Inc. that was run by a consortium of banks. This entity changed its name and the name of the card to Visa in 1977.

Until the late 1970s, credit card systems required manual entry of information on paper charge slips to post charges to accounts. Rapid growth combined with weak credit analysis and inefficient back-office processing systems quickly produced a crisis in the fledgling credit card industry.[54]

> Stories of the banking madness of the time are legendary. In the beginning, there was no magnetic strip on the card and no electronic readers at point of sale. Cards were placed in the bed of a manual imprinter, a four-part sales draft placed on top and a lever pulled or pressed to create an impression. They were dubbed 'zip-zap' machines. … The system for clearing sales drafts between banks was primitive, cumbersome, and impossible to fully describe. …There were no electronic data entry or clearing systems. … When the clearing draft reached the issuing bank, it was posted to a suspense ledger while waiting for the merchant bank to keypunch the sales drafts and send them through the US mail … there were no electronic systems for authorizing transactions.[55]

The crisis was partly resolved by creating national networks that allowed merchants to obtain authorizations without making telephone calls and also to capture the transaction data. The point-of-sale technology was also standardized for magnetic stripe cards.

At the same time that Bank of America was reinventing the way American consumers borrowed money to finance consumption, Citibank was exploring the idea of giving consumers direct access to bank computer systems through automated teller machines.[56] Walter Wriston, the CEO of Citibank, was a technology visionary, famously noting, 'Information about money has become almost as important as money itself.'[57] In 1968, Citibank formed a separate subsidiary to develop and market new products based on technological innovations. By 1972, consensus had emerged to target check-cashing services in Citibank branches together with point-of-sale authorization for credit card transactions. The technical staff charged with developing new products opposed the use of magnetic stripe cards for these new services because of their weak security characteristics. These objections were eventually overridden because magnetic-stripe cards could operate in both on-line and off-line environments, while a stronger security architecture could operate only in an on-line environment.[58] Market research indicated strong customer demand for access to their funds outside of limited banking hours and access from more locations than the current branch network. The product development team concluded that 'automated teller machines' were feasible given the current state of technology at that time, and could also meet consumer demand for wider access to banking services outside of normal bank hours and away from bank branches. In 1976, Citibank began deploying ATM machines throughout its New York branch network, and soon experienced rapid growth in its share of the New

[54] Dee Hock, *One From Many: VISA and the Rise of Chaordic Organization* (Berrett-Koehler 2005) 80.

[55] Ibid 76–78.

[56] Paul F Glaser, 'Using Technology for Competitive Advantage: The ATM Experience at Citicorp' (1988) *Managing Innovation: Cases from the Services Industries* 108.

[57] Thomas A Bass, 'The Future of Money', *Wired Magazine* October 1996, www.wired.com/wired/archive/4.10/wriston.html, accessed 15 July 2012.

[58] Glaser (n 56) 110.

York retail banking market.[59] As banks around the country added ATM services, they began to form 'shared networks' to give cardholders access to ATM machines owned by other banks.[60]

Although the leadership of managers at individual banks played a decisive role in the growth of the payment card industry, voluntary consensus standard-setting activities made the ubiquitous deployment of payment cards possible. In 1974, the American Bankers Association formed the X9 Standards Committee to develop banking operation standards. In 1976, the X9 Standards Committee opened its membership to representatives of vendors, insurance companies, trade associations, retailers, regulators and others, and expanded its scope of work to include operational standards in financial services generally.[61] In 1984, X9 was accredited by ANSI. In 2002, ASC X9 split from its original sponsor, the American Bankers Association, in recognition of the growth of non-bank financial services. ASC X9 was instrumental in standardizing the encryption used to secure ATM transactions, as well as standardizing the security and interoperability of debit and credit card transactions.[62] The export of American payment card industry standards to global markets is facilitated by ASC X9's leadership of the Technical Committee on Financial Services (TC68) at ISO.

By the early 1990s, the card networks had ventured into debit cards: Visa by acquiring the Interlink network and MasterCard by acquiring Maestro. The card networks also developed a 'signature debit' function that allowed retail merchants to accept debit card payments authenticated with the consumer's signature rather than a PIN number and to process those transactions using the credit card networks instead of bank ATM card networks. These signature debit cards are sometimes referred to as 'offline' debit cards to distinguish them from the 'online' PIN-debit cards issued by banks as ATM cards. Offline debit cards achieved more rapid acceptance for retail payments than online debit cards because they could be used with existing point-of-sale credit card reader technology. Offline debit cards also encountered resistance from merchants, because their fees were set at the same (high) level as credit card fees. These fees were normally higher than the fees paid by merchants for online debit or check processing. Merchant frustration with high offline debit card fees erupted in antitrust litigation against the card networks. In Brussels, DG Competition also found that credit card fees violated European competition law.[63] Settlement of these lawsuits produced major reforms in the card networks during the 2000s. However, merchant frustration with high fees again boiled over in the late 2000s, resulting in price caps on debit card fees mandated by the Durbin Amendment to the Dodd-Frank Act in 2010.

Unlike the airline CRSs – which were deregulated after it became clear that competition among CRSs had emerged as a result of innovations in technology and business models – the global payment card networks currently face severe criticism for their allegedly anti-competitive and unfair pricing policies.[64] Pricing for payment card services

[59] Ibid 113.

[60] Fumiko Hayashi and others, *A Guide to the ATM and Debit Card Industry* (Federal Reserve Bank of Kansas City 2003), www.kc.frb.org/publicat/PSR/BksJournArticles/ATMPaper.pdf.

[61] 'History of ASC X9' (*X9*), https://www.x9.org/about/, accessed 15 July 2012.

[62] ATM & Debit News, 'The X9 Transaction Standards Group Bids A Farewell to its ABA Sponsor' (2002) 3[35] *Standards Watch* 1.

[63] EU, 'Antitrust: Commission prohibits MasterCard's intra-EEA Multilateral Interchange Fees' IP/07/1959 (Brussels, 19 December 2007) http://europa.eu/rapid/pressReleasesAction.do?reference=IP/07/1959, accessed 15 July 2012.

[64] See, eg, Ben Protess and Jessica Silver-Greenberg, New Rules for Prepaid Debit Cards, *New York Times*, 23 May 2012, http://dealbook.nytimes.com/2012/05/23/new-rules-for-prepaid-debit-cards/, accessed 16 July 2012; Jessica Silver-Greenberg, MasterCard and Visa Will Pay Billions to Settle Antitrust Suit, *New York Times*, 13 July 2012, www.nytimes.com/2012/07/14/

can be analyzed in terms of the economic theory of 'two-sided' or 'platform markets.'[65] To promote the development of two-sided markets, platform operators must develop unique pricing models for different groups based on their level of interest in participating in the market. A classic example is newspaper publishers charging high prices to advertisers in order to subsidize the cost of providing papers to readers. The economic theory of two-sided markets predicts that the card networks will engage in whatever form of price discrimination among their different stakeholder groups maximizes the growth of the platform itself. While such a strategy might be economically rational, it is clear from recent anti-credit card network legislation and enforcement action in the United States, Europe, Australia and other countries around the world that such pricing strategies are politically unpopular, and that national regulators are prepared to take action to block them.

3. Cape Town Convention International Registry Framework

The Convention establishes a system for registering creditors' interests in aircraft as part of an international legal regime established to protect the interests of secured creditors, conditional sellers, and lessors of aircraft.[66] It covers 'international interests' in mobile equipment, including security interests, the lessor's interest under a lease agreement, and the seller's interest under a title reservation agreement.[67] The Convention was drafted under the auspices of the International Institute for the Unification of Private Law ('UNIDROIT') and the ICAO, and was intended to overcome what many perceived as the shortcomings of the Geneva Convention.[68] The Convention embodies many innovations in international commercial law, including its 'hub and spokes' structure of a base treaty with different protocols for different categories of mobile equipment including aircraft, railway rolling stock, and space assets.[69]

The Geneva Convention relied on national systems for registering lenders' interests in aircraft and mutual recognition of different national regimes for security interests in moveable property. The United States, some other common law countries including Canada, and some developing and transition economies[70], had enacted modern personal property security laws that established a central registry and permitted non-possessory interests. Meanwhile, many civil law countries lacked such registries and provided little or no recognition of non-possessory security interests. In addition, the actual enforcement of creditors' rights under the Geneva Convention had been undermined in some countries by interpretations that favored

business/mastercard-and-visa-settle-antitrust-suit.html, accessed 16 July 2012.

[65] See Jean-Charles Rochet and Jean Tirole, 'Platform Competition in Two-Sided Markets' (2003) 1 *Journal of European Economics Association* 990 (2003); David S Evans and others, *Invisible Engines: How Software Platforms Drive Innovation and Transform Industries* (MIT Press 2006).

[66] Roy Goode, *Official Commentary on the Convention on International Interests in Mobile Equipment and Protocol Thereto on Matters Specific to Aircraft Equipment* (revised edn, UNIDROIT 2008) 1.

[67] Article 2(2).

[68] Convention on the International Recognition of Rights in Aircraft (signed at Geneva on 19 June 1948); Ludwig Weber, 'Rights in Aircraft' in Elmar M Giemulla and Ludwig Weber (eds), *International and EU Aviation Law: Selected Issues* (Kluwer Law International 2011) 196–197.

[69] Mark Sundahl, 'The "Cape Town Approach": A New Method of Making International Law' (2006) 44 *Columbia Journal of Transnational Law* 339, 341. Professor Richard Speidel, the reporter for the attempt to revise UCC Article 2 during the 1990s, initially proposed to convert Article 2 to a 'hub and spokes' structure with a general part as the hub and spokes for sale of goods, leasing and licensing transactions, but his proposal was not accepted by the drafting committee.

[70] That development was often inspired by the 1994 EBRD's 1994 Model Law on Secured Transactions, which was particularly influential in former CIS countries. See generally, www.ebrd.com/pages/research/publications/guides/model.shtml.

local parties at the expense of foreign lenders.[71] While some of the Convention's substantive provisions have engendered some controversy, there has been virtually no controversy about the operation of the International Registry.

(a) Governance framework

The 'Supervisory Authority' established pursuant to the Convention formally governs the International Registry. Article 17 of the Convention provides that each protocol to the Convention shall establish a Supervisory Authority, which in turn will be charged with establishing an International Registry. The Supervisory Authority is responsible for appointing, supervising, and dismissing the Registrar, and promulgating regulations for the International Registry's operation.[72] In addition, the Supervisory Authority is charged with doing 'all things necessary to ensure that an efficient notice-based electronic registration system exists to implement the objectives' of the Convention and the Aircraft Protocol.[73]

After the Convention and the Aircraft Protocol were adopted in Cape Town in 2001, the ICAO authorized the creation of a Preparatory Commission for the International Registry.[74] The Preparatory Commission set the terms and conditions, including the technical specifications, for a global public tender for the International Registry.[75] The Preparatory Commission reviewed the bids received, and in 2004, awarded a five-year contract to Aviareto Ltd, a joint venture of SITA and the Irish government to be established in Dublin.[76] The Preparatory Commission issued regulations and administrative procedures for the International Registry as provided in Convention.[77] From June 2004 to November 2005, the International Registry was progressively developed and tested on behalf of the Preparatory Commission. On March 1, 2006, the International Registry was officially opened for business on the same day that the Convention and Aircraft Protocol entered into force.[78] The mandate of the Preparatory Commission lapsed, and the ICAO Council took over the functions of the Supervisory Authority. In this capacity, the ICAO Council is advised by a Commission of Experts for the Supervisory Authority of the International Registry ('CESAIR') made up of not more than fifteen members nominated by signatory and contracting states of the Convention and Aircraft Protocol.[79]

During the drafting of the Convention, UNIDROIT took a very pragmatic approach by permitting private industry to play a central role in the process.[80] IATA, which represents 240 airlines that account for over 80% of global air traffic, was one industry association that was actively involved in the drafting.[81] Another private industry association, the *ad hoc* Aviation Working Group ('AWG'), was created specifically to support the process of drafting the Convention:

> In 1994, the International Institute for the Unification of Private Law (UNIDROIT), requested the formation, by Airbus and Boeing, of an ad hoc international industry group to provide detailed, coordinated input

[71] Jeffrey Wool, 'The Next Generation of International Aviation Finance Law: An Overview of the Proposed UNIDROIT Convention on International Interests in Mobile Equipment as Applied to Aircraft Equipment' (1999) 20 *University of Pennsylvania Journal of International Economic Law* 499, 502.

[72] Convention, Article 17.2(d); in 2012, the relevant regulations were ICAO Regulations and Procedures for the International Registry (4th edn, 2010) doc 9864, www.icao.int/publications/Documents/9864_4ed.pdf, accessed 15 July 2012.

[73] Article 17.2(i).

[74] Weber (n 68) 198.

[75] Ibid 208.

[76] Ibid 209. The contract was renewed in 2011 for another five years.

[77] Article 17(2)(d) and (e).

[78] Weber (n 68) 209.

[79] Rob Cowan, 'Overview of the International Registry Established by the Cape Town Convention', www.awg.aero/assets/docs/OverviewIR.pdf, accessed 15 July 2012.

[80] Sundahl (n 69) 349-50.

[81] IATA, 'Membership' (2012), www.iata.org/membership/Pages/airlines.aspx, accessed 15 July 2012.

> to assist UNIDROIT in the development of an international treaty on the financing and leasing of mobile equipment that would come to be known as the Cape Town Convention. In response to that request, Airbus and Boeing agreed to form AWG. They jointly invited others into this grouping. The initial and subsequent invitees were a number of major manufacturers, financial institutions, and leasing companies. Since that time, AWG's scope of activity and membership has expanded significantly. It now addresses a wide range of topics affecting international aviation financing and leasing.[82]

The degree of industry involvement in drafting the treaty might have raised concerns in some quarters regarding the neutrality of the results. AWG and IATA commissioned an Economic Impact Assessment in order to spell out the economic benefits of the Convention to industry, governments, and consumers.[83] After the International Registry was launched, an International Registry Advisory Board ('IRAB') was established to provide a channel of communication between the International Registry and its stakeholders, and is chaired by a representative of the AWG.[84] The ICAO also formed CESAIR to assist in its execution of its duties as the Supervisory Authority.

The authority to make or approve and to ensure the publication of regulations governing the operation of the International Registry is vested by the Convention in the Supervisory Authority.[85] The first edition of the Regulations and Procedures for the International Registry ('Regulations') was published in 2006. ICAO takes advice on these matters from CESAIR, a group of government experts which meets regularly to review proposed changes in the Regulations. CESAIR recommends changes proposed to address practical issues and the needs of the user community, and the Regulations are updated as needed. In the first meeting in 2006, CESAIR established a distinction between changes in the International Registry's operations that require revisions to the Regulations, and thus require ICAO approval, and mere 'facilitatory changes' related to the technical operations of the system, which do not require ICAO approval. It was agreed, however, that the International Registry would notify CESAIR in advance of making any technical changes to the operation of the International Registry, such as by redesigning user interfaces. The recommendations of CESAIR became effective when they were approved in an ICAO Council meeting.[86] At each subsequent annual meeting, the changes to the Regulations proposed by the International Registry management were approved by CESAIR, and then subsequently approved by the ICAO Council.[87]

---

[82] 'History of AWG' (*Aviation Working Group*, 2011), www.awg.aero/inside/history/, accessed 15 July 2012.

[83] Ludwig Weber and Silverio Espinola, 'The Development of a New Convention Relating to International Interests in Mobile Equipment, in Particular Aircraft Equipment: A Joint ICAO–UNIDROIT Project' (1999) 4 *Uniform Law Review* 463.

[84] 'The International Registry Advisory Board' (*Aviareto*), www.aviareto.aero/irab.htm, accessed 15 July 2012.

[85] Article 17(2)(d). Jeffrey Wool, the secretary general of AWG, chair of IRAB, and observer to CESAIR noted, 'Governments, industry, and the registrar are uniformly impressed with ICAO's speed and skill in acquiring the expertise to regulate a complex commercial system. Confidence in ICAO has been an important element of ratification process.' Email from Jeffrey Wool to author (22 July 2012).

[86] Registrar of the International Registry of International Interests in Aircraft Equipment, 'First Annual Report to the Supervisory Authority' (July 2007) (covering the period 1 February 2006 to 31 December 2006).

[87] Registrar of the International Registry of International Interests in Aircraft Equipment, 'Second Annual Report to the Supervisory Authority' (November 2008) (covering the period 1 January 2007 to 31 December 2007); Registrar of the International Registry of International Interests in Aircraft Equipment 'Third Annual Report to the Supervisory Authority' (December 2008) (covering the period 1 January 2008 to 31 December 2009); Registrar of the International Registry of International Interests in Aircraft Equipment 'Fourth Annual Report to the Supervisory Authority' (January 2011) (covering the period 1 January 2009 to 31 December 2009).

(b) Organization

The Regulations provide that the International Registry is a facility for effecting and searching registrations under the Convention.[88] It must be accessible, and technical support for its use made available, seven days a week on a twenty-four hour basis, unless it is unavailable due to maintenance or unforeseen circumstances.[89] Ronald Cuming analyzed the limited scope of the registrar's duties in the following terms:

> While, no doubt, the registrar is required to manage the international registry, it is necessary to determine whether he or she has any responsibility to ensure that the information submitted for registration is accurate or that it has been submitted by the appropriate person. For the most part, the structure of an international registry provides an answer to this question. If the purpose of the registry is to provide a notice of the possible or potential existence of an international interest and not to be a system through which property rights are established, the registrar's role must be largely managerial. While the registrar has the obligation to ensure that the registry regulations are followed, he or she should have no obligation to verify registration information submitted by a registrant or confirm the source of that information. In any event, when the international registry provides for electronic remote access facilities…there is no opportunity for human intervention between the submission of registration data and their entry in the registry database.[90]

In other words, because the International Registry is notice-based, the Registrar is not expected to review filings to assess their legal adequacy, or investigate who is making the submission beyond the technological function of authenticating the digital signature certificate used.[91]

The International Registry is a non-profit organization that operates on a cost-recovery basis. ICAO sets and reviews its fees, taking into account the recommendations of CESAIR and representatives of the user community. In setting its fees, the Registrar must consider not only its operating costs, but also its potential liability. The Registrar is liable for loss suffered as a result of an error or omission of the Registrar or from a malfunction of its system, except where the malfunction is due to a *force majeure* event or could not have been prevented by using the current best practices related to back-up, systems security, and networking.[92] The Registrar is therefore required to maintain errors and omission insurance in an amount not less than the value of an aircraft object.[93] During its first five years of operation, the International Registry was able to increase the amount of liability insurance for progressively lower premium cost per million of coverage as its carrier became familiar with its business model and it established a track record of no losses.[94]

Under the Convention, a Contracting State may designate an 'entry point' within its territory through which registrations may be submitted to the International Registry.[95] These are referred to in the Regulations as a 'Direct Entry Point' ('DEP').[96] An 'Authorizing

[88] Regulations and Procedures for the International Registry (4th edn, 2010) Article 3.1.

[89] Ibid Articles 3.4 and 3.5.

[90] Ronald Cuming, 'Considerations in the Design of an International Registry for Interests in Mobile Equipment' (1999) 4 *Uniform Law Review* 275, 280; Regulations and Procedures for the International Registry (4th edn, 2010) Article 3.2

[91] Ibid 280.

[92] Convention, Article 28.1.

[93] Aircraft Protocol, Article XX(5); Regulations and Procedures for the International Registry (4th edn, 2010) Regs 14.1 and 14.4. Liability is excluded for losses suffered as a result of loss of access while the International Registry is closed for maintenance performed outside of peak periods, or technical or security problems as provided for in the Procedures. Reg 3.4.

[94] Rob Cowan and Donal Gallagher, 'International Registry' draft 25 May 2012.

[95] Article 18.

[96] Regulations and Procedures for the International Registry (4th edn, 2010) Reg 12.1.

Entry Point' ('AEP') is one that authorizes the transmission of information to the International Registry. The United States, Mexico, Albania, China and Brazil have all established AEPs.[97] In 2008, the United Arab Emirates became the first Contracting State to establish a DEP, but in 2012, this was converted to an AEP. For countries that have established an AEP, an AEP code provided by the AEP must be entered at the time of the registration. In the US, the Federal Aviation Administration Aircraft Registry ('FAA Registry') is designated as the US AEP. For US civil aircraft or aircraft assigned a US identification number, filing with the FAA is required for registrations in the International Registry to be valid.[98] Most Contracting States do not have an entry point, permitting registrations directly with the International Registry.

(c) Technology infrastructure

In essence, the International Registry is a technology service organization managing the database of registrations under the Convention and the PKI that secures access to the database. The Regulations recognize three categories of parties that may access the International Registry:

- Transacting user entity ('TUE') is a legal entity or natural person named in a registration or intending to be named;
- Professional user entity ('PUE') is a firm or other group of persons (such as the legal department of a company) providing professional services to transacting user entities in connection with the International Registry; and
- DEP.

Registry user entity ('RUE') means either a TUE or a PUE or a DEP. A RUE must appoint an 'administrator' to act on its behalf when dealing with the International Registry.[99] A RUE is responsible for the actions of its administrator, as well as the accuracy of information it submits to the International Registry.[100]

In order to register an interest, each party to the interest must first establish an account with the International Registry as a TUE or as a PUE.[101] The administrator must submit the account application, which is normally processed by the staff of the International Registry within 24 hours.[102] The Registrar will verify that the entity exists and its contact details are accurate, and confirm that the Registrar's 'Certificate of Entitlement to Act' form used by a party to nominate an administrator is in order.[103] During the account application process, the Registrar generates a public and private key pair, and the private key is placed in a 'keystore' on the hard drive of the computer that the administrator will use to make filings with the International Registry. Once the Registrar has completed its review of the application, the administrator will be issued a digital signature certificate containing the public key issued to the administrator which is stored together with the private key on the hard drive of the administrator's computer. Access to the administrator's keystore containing the private key required to authenticate

[97] Scott D McCreary, 'The Cape Town Treaty and International Registry Outline and Suggested Best Practice Checklist' (NBAA Annual Meeting & Convention Presentation, October 2011), www.nbaa.org/events/amc/2011/news/presentations/1011-Tue/NBAA2011-1011-1300-Cape-Town-Treaty-IR-Update-Handout-1.pdf.

[98] Cape Town Treaty Implementation Act of 2004, Pub Law No 108-297, codified at 14 CFR pt 47; 70 Fed Reg 240 (3 January 2005).

[99] Regulations and Procedures for the International Registry (4th edn, 2010) Reg 5.1.

[100] Ibid Reg 4.

[101] The Legal Advisory Panel of the Aviation Working Group, 'Practitioners' Guide to the Cape Town Convention and the Aircraft Protocol' (*Aviation Working Group* 2011) 51, www.awg.aero/assets/docs/Practitioner's%20Guide%20FINAL%20_4V_.pdf, accessed 15 July 2012.

[102] Email from Rob Cowan, Managing Director of Aviareto Limited, to author (19 July 2012).

[103] The Legal Advisory Panel of the Aviation Working Group, 'Practitioners' Guide to the Cape Town Convention and the Aircraft Protocol' (*Aviation Working Group* 2011) 53, www.awg.aero/assets/docs/Practitioner's%20Guide%20FINAL%20_4V_.pdf.

any submissions to the International Registry is password protected. Generally, transferring the administrator's private key to another computer requires technical support from the International Registry staff. Thus, before a party opens an account at the International Registry, thought should be given as to where the administrator's private key will be stored to insure accessibility. Since there is no password recovery feature, a completely new account application must be submitted if a password is lost.[104] While participants in the aircraft finance industry may consider it burdensome to register as users of the International Registry, it is nevertheless much less burdensome than gaining access to the SWIFT network.[105]

After setting up an account, a TUE may make registrations in the International Registry, either by working with its administrator or a PUE. After the required information has been entered on the International Registry's website and the applicable fees paid, then all other parties to that interest will be given 36 hours within which to consent. Once all the parties have consented, the registration is complete and the Registrar provides electronic notice to all parties. The registering party should then search its own registration to insure that all is in order.[106] In 2012 the charge for a priority search fee was US$35, while an informational search was free. A priority search following registration is recommended because as a practical matter, that is the only proof of a valid registration—not even a copy of the registration confirmation email from the Registrar can take its place.[107]

(d) Experience from 2006 to 2012

By the end of 2011, the International Registry had accepted over 313,000 registrations and 245,000 searches had been performed.[108] There was a great deal of activity during the first years of its operation followed by a decline during the Global Financial Crisis and then gradual recovery. Since the International Registry went live in 2006, four significant updates to its software have been made. With each update, the International Registry worked with its users in developing technical specifications and then obtained the necessary changes to the Regulations from the ICAO. Many of the updates were made in response to user feedback, including permitting fractional registrations, transferrable rights to discharge, and replacement registrations by way of an amendment. The technological infrastructure has also been evolving continuously, with major changes in the hardware in 2012.[109]

Since its inception, Aviareto as Registrar has worked continuously to maintain close contacts with its user community and elicit their views on the International Registry's development.[110] The International Registry has provided information and training sessions at aviation finance industry events around the world, and in 2012, launched a series of multi-lingual online training webinars for users. The International Registry has also hired

[104] Scott Wilson, 'Beginner's Guide to the International Registry' (2006) *Airfinance Journal*, available in Lexis News, accessed 16 July 2012.

[105] Although SWIFT does not provide a settlement mechanism for cross-border funds transfers, SWIFT messages govern payment transactions, which are generally a much more attractive target for criminals than security interests in aircraft would be.

[106] The Legal Advisory Panel of the Aviation Working Group, 'Practitioners' Guide to the Cape Town Convention and the Aircraft Protocol' (*Aviation Working Group* 2011) 56–57, www.awg.aero/assets/docs/Practitioner's%20Guide%20FINAL%20_4V_.pdf.

[107] The Legal Advisory Panel of the Aviation Working Group, 'Practitioners' Guide to the Cape Town Convention and the Aircraft Protocol' (*Aviation Working Group* 2011) 61, www.awg.aero/assets/docs/Practitioner's%20Guide%20FINAL%20_4V_.pdf.

[108] Rob Cowan and Donal Gallagher, 'International Registry' draft 25 May 2012.

[109] Ibid.

[110] Registrar of the International Registry of International Interests in Aircraft Equipment, 'First Annual Report to the Supervisory Authority' (July 2007) (covering the period 1 February 2006–31 December 2006) 7.

an independent consulting firm to conduct annual customer satisfaction surveys and published the results on its website.[111] According to these surveys, the overall weighted registry experience rating has improved from 5.68 out of 10 in 2007 to 7.78 in 2011.[112] The survey tracks user satisfaction with a variety of factors, including the speed of approvals for new users, the technical knowledge of Registry officials, the level of fees charged, the efficiency with which staff at the help desk respond to queries, and the speed of the International Registry during use. The results of the annual surveys are analyzed by Aviareto management and used to develop proposals for technical improvements to the Registry and amendments to the regulations. These proposals are discussed with the IRAB before being submitted to CESAIR. In addition, the International Registry has sought independent review of the technical dimensions of its operation of the Registry, and was successful in obtaining ISO 27001 information security management and ISO 9001 quality management certifications.[113]

4. Decoding the secrets of the International Registry's success

A great deal of the success of the International Registry is due to characteristics of the international market for aircraft as well as its legal and technical design. These characteristics include: the creation of a mandatory, hard law regime that defines the consequences of using the International Registry; concrete, immediate economic rewards to nations that ratify the Convention; a small number of global aircraft manufacturers reduces collective action problems; efficiency gains from the targeted use of a mature technology; and an effective self-regulatory governance system. Together, these favorable institutional factors greatly reduce the scope of the technical requirements that the Internal Registry system must address.

(a) Concrete 'value proposition'

The AWG, IATA and ICAO commissioned a study to determine what the economic benefits of the Convention would be.[114] The study concluded that economic gains from the Convention should be several billion US dollars on an annual basis. IATA also estimates that the total savings from the Convention could be billions of dollars.[115]

The Convention value proposition is equivalent to those that triggered the development of airline CRSs, SWIFT, and the payment card networks. Stakeholders in the airline industry, and wholesale and retail payment industries were motivated to computerize their administrative processes by the promise of huge efficiency gains. Although there may have been some detours along the way, each of these industries has continued to reap the benefits of those investments in information technology. By contrast, the slow adoption rate for SAFE BioPharma standards suggests that many in the industry believe that its adoption would offer only modest efficiency gains.

(b) Mandatory, formal regime

Under the Convention, registering an international interest in an aircraft in the International Registry is mandatory for any party seeking

[111] 'Aviareto Customer Surveys' (*Aviareto*), www.aviareto.aero/surveys.htm, accessed 15 July 2012.

[112] Ian McShane, 'International Registry of Mobile Assets User Survey 2011', *Behaviour & Attitudes*, December 2011, www.aviareto.aero/index_htm_files/Customer%20Survey%20Results%202011.pdf, accessed 15 July 2012.

[113] Cowan and Gallagher (n 108).

[114] Sunders and Walters, 'Proposed UNIDROIT Convention on International Interests in Mobile Equipment as Applicable to Aircraft Equipment - Economic Impact Assessment' (September 1998), www.awg.aero/assets/docs/economicbenefitsofCapeTown.pdf.

[115] 'Special Report – Opportunities in Aircraft Leasing, International Airlines' *Airlines International* (August 2010), www.iata.org/pressroom/airlines-international/august-2010/pages/07a.aspx, accessed 15 July 2012.

priority over other claimants in the event of the debtor's bankruptcy or a dispute with another lender.[116] In a Contracting State, the priority of competing claims to aircraft in that state are determined with reference to the framework established by the Convention, not with reference to any domestic framework for perfecting security interests. As Ronald Cuming has explained:

> The Registry is the only relevant registry for registrable interests in aircraft objects when competing interests in those interests arise. While there is nothing in the Convention or Protocol to prevent a Contracting State from providing under its domestic law for the registration of these interests in a national registry, the only way a holder of such an interest can protect it from defeat under the priority rules of the Convention and Protocol is to effect a registration relating to that interest in the Registry.[117]

The requirement to register interests in the International Registry in order to secure priority over competing claims is 'hard law.' Kenneth Abbott and Duncan Snidal have suggested that in international governance, 'hard law' embodies binding obligations that are stated with precision and for which interpretation and enforcement have been delegated to adjudicative institutions.[118] By contrast, international law may be 'soft law' if the obligations it embodies lack one or more of the dimensions of obligation, precision, and delegation. For example, most provisions of the Convention on the International Sale of Goods are mere default rules that parties can opt out of, and many describe general principles of contract law rather than detailed rules. Thus, the CISG could be characterized as 'soft law,' because the obligations it establishes are weak and are described in imprecise terms.

Although Contracting States are permitted to establish DEP, the Convention has granted the International Registry a monopoly over the provision of the primary registry services. The flip side of this legislative monopoly is that the International Registry must operate on a cost-recovery basis only and the Supervisory Authority determines the level of its fees. No government or treaty has ever given SWIFT a monopoly over the processing of cross-border funds transfer messages; rather, it has achieved monopoly status as a result of strong positive network effects. As a result, both SWIFT and the International Registry consult with their stakeholders before making significant changes in their business models or technology. By contrast, there is intense competition and limited government oversight in global markets for airline CRSs and payment card networks. Pricing models and technology upgrades in those global electronic commerce systems are largely market-driven.

(c) Collective action problems

Creation of the International Registry required cooperation among a wide range of stakeholders in global aviation markets. Collective action problems arise when large groups of individuals need to work together to solve a problem, but cannot because some individuals will try to 'free ride' on the efforts of others.[119] Some features of the International Registry and the global aviation market have contributed to overcoming collective action problems that might have been associated with the Convention.

[116] 'Article 29(1) of the Convention provides that a registered interest has priority over any other interest subsequently registered and over an unregistered interest. Article 29(3) provides that a buyer of an object acquires its interest subject to a prior registered interest and free from a prior unregistered interest.' Ronald Cuming, 'The International Registry for Interests in Aircraft: An Overview of its Structure' (2006) 11 *Uniform Law Review* 18, 22 n 9.

[117] Ibid 22.

[118] Kenneth W Abbott and Duncan Snidal, 'Hard and Soft Law in International Governance' (2000) 54 *International Organization* 421

[119] Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Harvard University Press 1965).

A classic collective action problem arises in relation to the production of 'public goods.' A public good is defined as one for which each individual's consumption of such a good leads to no subtraction from any other individual's consumption of that good, and for which there is no feasible mechanism to exclude any individuals from consuming it.[120] Some classic examples of public goods include national defense and ideas. Public goods tend to be under-produced in competitive markets because their producers cannot recapture their production costs. However, if consumption of a good is non-rivalrous, but exclusion is feasible, then it can be described as a 'club good.'[121] The International Registry can be considered as a 'club good' because, although it is non-rivalrous and non-exclusive for any normal volume of use, fees paid by registered entities help defray the cost of maintaining it. While it might have been technologically feasible to limit access to the International Registry, the decision was made to provide open access to it and that decision was enshrined in the language of the Convention.[122] That applies not only to parties making registrations but to those searching the system. Operating the International Registry as a club good helps overcome the collective action problems normally associated with the production of public goods.

Solving collective action problems related to the operation of the International Registry does not explain how such a large reform in aviation lending was achieved, however. International law reforms that affect significant domestic economic interests require voluntary agreement by the nations involved, which can be very difficult to secure even though there is consensus that some agreement would benefit everyone involved.[123] The negotiations that led to the Convention can be therefore thought of as another collective action problem. Groups with many members, each having only a low level of interest in the collective undertaking, are particularly likely to suffer from collective action problems. Meanwhile, small groups with intensely held mutual interests are less likely to suffer from collective action problems.

The system for the creation and enforcement of security interests in aircraft before the Convention exhibited many characteristics of a collective action problem: the cost of financing acquisition of aircraft was increased for all borrowers because lenders' rights were uncertain, but those rights could not be made certain without the cooperation of a critical mass of interested parties. This collective action problem was addressed by a relatively small number of global aircraft manufacturers and financiers, working together with the world's airlines. The effort was led initially by the two largest aircraft manufacturers in the world: Airbus and Boeing. By comparison, more diffuse industries—such as the international maritime and road transportation industries—have been unable to overcome collective action problems more acute than those facing the aviation industry.

(d) Mature technology

Although many governments around the world have tried to promote the adoption of digital signatures by enacting electronic signature laws, almost none have succeeded in fueling

[120] Paul A Samuelson, 'The Pure Theory of Public Expenditure' (1954) 36(4) *Review of Economics and Statistics* 387; Jora R Minasian, 'Television Pricing and the Theory of Public Goods' (1964) 7 *Journal of Law and Economics* 71.

[121] James M Buchanan 'An Economic Theory of Clubs' (1965) 32 *Economica* 1.

[122] Cape Town Convention Article 22 provides 'Any person may, in the manner prescribed by the Protocol and regulations, make or request a search of the International Registry by electronic means concerning interests or prospective international interests registered therein.'

[123] See generally Roy Goode, Herbert Kronke, Ewan McKendrick, and Jeffrey Wool, *Transnational Commercial Law – International Instruments and Commentary* (OUP 2012) (including the number of ratifications for the major conventions in this field). Other than the Vienna Sales Convention and certain transport of goods conventions and dispute resolution instruments, the numbers of ratifications are small.

the growth of private commercial use of digital signatures. By contrast, the use of digital signature technology in the International Registry has been one of the factors contributing to its success. Digital signatures came into commercial use in the late 1980s. Thus, when the International Registry was launched in 2006, the technology had been in use for nearly twenty years.[124] As a result, knowledge about digital signature technologies is widespread among information technology professionals in both developed and developing countries. As a mature authentication technology for which the core patents had already expired, it was less expensive to implement than a cutting-edge technology might have been.

In order to access the International Registry, parties are issued digital signatures as part of the process of opening an account.[125] Parties with accounts are required to take whatever steps are appropriate to keep them safe. Mandating this level of security could cause electronic commerce systems dealing with less valuable or more varied assets to fail, but 'aircraft objects' in the International Registry may be worth millions of dollars. The enormous value of the assets being registered in the International registry dwarfs the cost to interested parties of securing their digital signature credentials. In the context of global aircraft finance, operating a traditional PKI is relatively inexpensive, even though in other contexts, operating a PKI might be so expensive as to create barriers to the growth of new markets.[126]

(e) Organic development

The principles of 'technology neutrality' and 'functional equivalence' were adopted to guide the drafting of the UNCITRAL Model Law on Electronic Commerce:

> The principle of technological neutrality mandates the adoption of provisions that are neutral with respect to technology used. In light of rapid technological advances, neutral rules aim at accommodating any future development without further legislative work. The functional equivalence principle lays out criteria under which electronic communications may be considered equivalent to paper-based communications.[127]

These principles apply when the law reform objective is to remove legal barriers to the adoption of new technologies. However, the drafters of the Convention faced a slightly different problem than the drafters of the UNCITRAL Model Law on Electronic Commerce because their objective was to establish a wholly new institution. Under the Geneva Convention, registration of security interests in aircraft was accomplished within national systems, and no international registry was ever established. The drafters of the Convention thus had the luxury of not worrying about 'reengineering' an exist-

[124] EldoS Corp, 'Basics of PAdES (PDF Advanced Electronic Signatures)', www.eldos.com/security/articles/6963.php, accessed 15 June 2012 ('First attempts to provide mechanism of digitally signed documents was made in early 80s, but the first commercial software package to offer digital signature was Lotus Notes 1.0, released in 1989, which used the RSA algorithm.').

[125] See Section 3(c) above for a more detailed discussion of how accounts are established with the International Registry.

[126] The relatively high cost of using PKI and digital signatures to authenticate value-added tax receipts drove the EU Commission Directorate General Taxation to prohibit member states from mandating their use for VAT e-invoicing schemes. PricewaterhouseCoopers, 'A study on the Invoicing Directive (2001/115/EC) now incorporated into the VAT Directive (2006/112/EC)' Final Report TAXUD/2007/Ao-009 (2008) 13-14 ('The provision requiring an electronic invoice to be signed is a burden for businesses. Additionally, in some Member States, the advanced electronic signature requires to be based on a qualified certificate and be created by a secure-signature creation device…We recommend abolishing article 233 of the VAT Directive which requires to guarantee the authenticity of origin and the integrity of content in the case of e-invoicing by means of a pre-defined technology solutions.').

[127] UNCITRAL Model Law on Electronic Commerce with Guide to Enactment (1996) with additional Article 5 as adopted in 1998, www.uncitral.org/uncitral/uncitral_texts/electronic_commerce/1996Model.html.

ing paper-based system, but could focus simply on current best practices.[128]

The Convention's objective is to create a 'low-cost electronic system in which all registration applications, checking of applications entries, searches and the issue of search certificates are effected by a computer without the need for human intervention.'[129] However, the failure of digital signature laws around the world to promote the growth of new Internet business models demonstrates that drafting enabling legislation for new institutions may not be any easier than drafting legislation to remove existing barriers.[130] The drafters of the Convention wanted to mandate the creation of a wholly electronic, Internet-based registry while avoiding any 'technology specific' legislation.[131]

This legislative drafting problem is equivalent to the trade law notion of drafting technical standards based on the performance to be achieved, rather than mandating the design to be used.[132] Examples of performance standards in the Aircraft Protocol include the obligation of the Supervisory Authority to establish an efficient notice-based electronic registration system; the requirement that anyone be able to make a search of the International Registry by electronic means; and the Registrar's liability for damages suffered as a result of its errors and omissions that could have been prevented by following 'best practices in current use in the field of electronic registry design and operation, including those related to back-up and systems security and networking.'[133] By the time the text of a preliminary draft of the Convention was presented to the Governing Council of UNIDROIT in 1998, knowledge of PKIs and digital signatures was already widespread. Yet none of the provisions of the Convention, the Protocol, or the Regulations create a requirement that digital signatures be used.

Even when working with a mature technology, however, it is still possible to 'snatch defeat from the jaws of victory.'[134] One of the fundamental challenges in the successful design and deployment of electronic commerce system is identifying the optimal division of labor between machines and people. The managing director of Aviareto noted the importance of achieving this balance:

[128] After UCC Article 9 governing security interests in personal property was revised in 2001, there have been problems both with upgrading legacy computer systems and the interpretation of the revised filing office provisions. See, eg, Lynn M LoPucki, 'The Spearing Tool Filing System Disaster' (2007) 68 *Ohio State Law Journal* 281.

[129] Goode (n 66) 187.

[130] See above 2(c), discussion of digital signatures.

[131] Cuming (n 90) 278 ('It is the view of the author that it would be inconceivable to create a document filing system under the Convention or Protocol. A document filing system would effectively preclude the use of a computerized registry database. Given the need for efficiency and accessibility, an international registry will have to employ a computerized database.').

[132] WTO Agreement on Technical Barriers to Trade (1994), Article 2.2 prohibits creating unnecessary obstacles to trade in the drafting of 'technical regulations.' The US National Institute of Standards and Technology explains the distinction this way:

Another distinction among standards is the manner in which [standards] specify requirements.

- Performance standards describe how a product is supposed to function. A performance standard for water pipe might set requirements for the pressure per square inch that a pipe must withstand, along with a test method to determine if a specimen meets the requirement.
- Design standards define characteristics or how the product is to be built. The specification that a pipe be made of a given gage of copper would characterize a design standard.

Government agencies are encouraged to write technical regulations and standards in terms of performance, rather than design characteristics. National Insitute of Standards and Technology, 'What Are Standards?' (2012), http://standards.gov/standards.cfm, accessed 15 July 2012.

[133] Convention, Articles 17(2)(i), 22(1) and 28(1).

[134] See, eg, 'The 11 Greatest Supply Chain Disasters', *Supply Chain Digest* (January 2006), www2.isye.gatech.edu/~jjb/wh/tidbits/top-sc-disasters.pdf, accessed 15 July 2012; Dan Gilmore, 'The Top Supply Chain Disasters of All Time', *Supply Chain Digest* (7 May 2009), www.scdigest.com/assets/FirstThoughts/09-05-07.php, accessed 15 July 2012.

> When I joined Aviareto in 2006 as Head of Operations, my initial assessment was that this was a simple system. It was a list of registrations, all digitally signed. That naive view has changed over time. Now, as the Managing Director, when I consider the IR, I am aware that I need to stand in several positions, simultaneously. In fact, the development and operations of the IR requires a blend of Engineering, Legal, Financial, and IT Security skills. The job of the Registrar has become one of facilitation and co-ordination between these diverse skills.[135]

An essential step in identifying that optimal division of labor is the 'requirements elicitation' process undertaken during the development of computer systems. It is notoriously difficult to do well:

> Being able to sift through the myriad of differing views to identify the set of necessary conditions, rather than a set of symptoms that actual problems may manifest, is critical to the success of the project. To accomplish this end, analysts are charged with the task of producing a set of requirements that are measurable, testable, actionable, and in sufficient detail such that system design can occur with the delivery of a system that truly does solve business needs. Mistakes made at this investigatory level and propagated through to the project conclusion result in very expensive corrections.[136]

The task of requirements elicitation for the International Registry is made more feasible because the Convention limits the scope of the Registrar's responsibilities.

In addition, the Registrar's duties are largely formal, which limits the scope of what the International Registry computers are required to analyze. Limiting the scope of what computers are expected to contribute to an electronic commerce system is important because, notwithstanding spectacular recent progress in information technology, computers remain 'stupid.' A software developer explained why the basic structural limitations of computer systems make them 'stupid' in the following terms:

> If you tell a computer to do something, it does exactly that – no more, no less. There's no 'intelligence' behind it. Software can be written with algorithms that allow flexibility, but it's still all deterministic with predefined rules and patterns that were manually specified by a programmer in a cubicle somewhere. When an unforeseen condition arises, a human can always use judgment to figure out a good possible solution. Computers are restricted to a finite set of predetermined patterns. Hardware can get faster than we could have ever imagined a decade ago, but we'll still never conquer that limit.[137]

The International Registry's success is due in part to its successful allocation of labor between its staff and its computer systems.

The fact that the Registrar's role is formal and limited, and the range of functions its computer system performs are similarly formal and limited, does not suggest that management of the International Registry as a whole is a simple matter. The environment in which the International Registry operates is continuously evolving. As a result, the management of Aviareto must be continually vigilant in monitoring the division of labor between humans and computers in order to consistently fulfill its

[135] Email from Rob Cowan, Managing Director of Aviareto Limited, to author (8 February 2012).

[136] William J Tastle and others, 'A New Approach in Requirements Elicitation Analysis' (2010) 2(3) *Journal of Emerging Technologies in Web Intelligence* 221; Nilofar Mulla and Sheetal Girase, 'A New Approach to Requirement Elicitation Based on Stakeholder Recommendation and Collaborative Filtering' (2010) 3(3) *International Journal of Software Engineering & Applications* 51 ('The most important activity in software project development is the requirements engineering.').

[137] Marco Arment, 'Computers are Stupid' (20 November 2005), http://articles.marco.org/166, accessed 15 July 2012.

mandate under the Convention. The managing director of Aviareto provided the following illustration of the kind of vigilance that is required:

> I should start by explaining the issue. A WS is a space or spaces or a tab which, when printed, is invisible. However, it is not invisible to a computer as all IT systems store the space as a character. Therefore a piece of text, for instance 'BOEING', is different to one with a leading WS such as ' BOEING' or a trailing WS such as 'BOEING '.
>
> The IR is based on the identification of the aircraft object not the entity or person. So you can search by object identification which, in the case of an aircraft object, is the manufacturer name, the generic model designator and the serial number. The IR is supplied these data in the form of lists from manufacturers. However, not all manufacturers provide a list and in those cases the user has the option of typing in the identification information. We have found that some users typed that data with a leading or trailing space either by mistake or because they thought that it was not important. This can cause confusion to other users and relying parties.
>
> The IR no longer allows the entry of such leading and trailing WS but, for a handful of early registrations, that data was entered and signed by users. The IR has designed its searching system (SearchPath) to ensure that searching parties see the object in which they are interested and any similarly named objects (such as ones with WS issues) before they finalise their search. However, the handful of registrations with WS are a difficulty and have to be taken into account every time new software changes are being designed. From a simple IT stand point this is a data cleaning issue. Just run a script to remove all unintended WS. However, from an IR point of view, we cannot change in any way the data entered by IR users. To the uninitiated (I am thinking of a senior technical person we hired) the fix is obvious, just delete the space. To a seasoned registry person (that same technical person after six months) the problem is clearer than the solution.
>
> It is therefore important to allow new technical people to explore, learn and suggest change but it is critical to deny them real power or access until the penny drops. When I see them bringing their copies of the Regulations to meetings I begin to gain confidence.[138]

(f) Responsive governance

In *Responsive Regulation*, Ian Ayres and John Braithwaite proposed a new model for economic regulation in which formal laws incorporate the best commercial practice and in turn serve as models for the refinement and development of that practice through collaboration among business, national governments and non-profit organizations.[139] Political economists and legal academics studying the emergence of global markets have further elaborated on this idea.[140] One of the hallmarks of globalization is the rise of private standard-setting organizations that may be able to regulate some global markets with an authority approaching that of regulatory agencies within national economies.[141]

---

[138] Email from Rob Cowan, Managing Director of Aviareto Limited, to author (8 February 2012).

[139] Ian Ayres and John Braithwaite, *Responsive Regulation: Transcending the Deregulation Debate* (OUP 1992) 3, 54.

[140] See generally, Lester Salamon (ed), *Tools of Government: a Guide to the New Governance* (OUP 2002).

[141] Kenneth W Abbott and Duncan Snidal, 'The Governance Triangle: Regulatory Standards Institutions and the Shadow of the State' in Walter Mattli and Ngaire Woods (eds) *The Politics of Global Regulation* (Princeton UP 2009); Craig Murphy and Joanne Yates, *The International Organization for Standardization (ISO): Global Governance Through Voluntary Vonsensus* (Routledge 2009).

Accountability is a fundamental governance challenge when self-regulatory organizations are used to regulate economic activity in lieu of formal international and national bodies.[142] The International Registry operates under an express delegation of authority under the Convention, and thus is formally accountable to the ICAO as the Supervisory Authority. In practice, the International Registry's accountability to ICAO is maintained through its dialogue with CESAIR and the ICAO practice of granting five-year renewable contracts. In addition, Aviareto is accountable to its shareholders, SITA and the Irish Government, whose goals are not profits, but reputational gain and low risk.[143] However, its governance processes also mimic those of private self-regulatory organizations and non-governmental organizations committed to maintaining accountability to more diffuse bodies of stakeholders. Such bodies must use processes such as making their deliberations as open as possible because universal participation by stakeholders in their governance processes is simply not feasible.[144] The International Registry has kept its deliberative processes open through continuous dialogue with the IRAB and outreach to industry through other mechanisms such as conferences and training programs. The management of Aviareto has also made extensive use of independent third-party assessments such as customer surveys and certification to industry standards to demonstrate to ICAO, its shareholders and its stakeholders its commitment to customer service and best practices.

One governance challenge that has arisen in the airline CRSs and payment card networks is pricing. The operators of these networks use pricing models that are perceived by some users as unfair because the operators use users on one side of a 'two-sided market' to subsidize users on the other side. At different times and with varying degrees of success, critics of airline CRSs and payment card networks pricing policies have enjoyed some success in getting national regulations passed to regulate their prices. The CRS and GDS travel services and card networks impose significant fees on merchants to subsidize consumer access to the market. Although the International Registry can also be seen as a 'two-sided market' with aircraft producers and financiers on one side and airlines on the other side, it seems unlikely that pricing policies of the International Registry will generate much controversy. This is because the ICAO must approve any changes in its fees, and in any event, its fees are very low relative to the value of the interests being registered.

5. Conclusion

A few lessons for the development of global electronic commerce can be gleaned from the experience of the International Registry. Many of the factors that contributed to its success are simply not reproducible in other contexts, such as the concentration and coordination of industry that minimized collective action problems, or the small cost of participation in the International Registry relative to the value of commercial aircraft. While these lessons may have relatively little relevance to the design of new electronic commerce systems designed to serve specific markets with different characteristics, they may be very relevant to the development of heuristics that can be used to predict the likely success or failure of a new system proposal. If a critical mass of the six success factors discussed above are absent, then it is not difficult to predict a new system is not likely to succeed, at least in the short term.

[142] Anne Peters, Till Förster, and Lucy Koechlin, 'Toward non-state actors as effective, legitimate and accountable standard-setters,' in Anne Peters, Lucy Koechlin, Till Förster, and Gretta Fenner Zinkernagel, eds, *Non-State Actors as Standard Setters* (Cambridge University Press 2009) at 527.

[143] Email from Rob Cowan, Managing Director of Aviareto Limited, to author (19 July 2012).

[144] Robert G Dixon and National Fire Protection Association, *Standards Development in the Private Sector: Thoughts on Interest Representation and Procedural Fairness: A Report to the National Fire Protection Association* (National Fire Protection Association 1978).

While the value proposition of electronic commerce technology for the airline CRSs, SWIFT, and card networks was always clear, each of those systems took decades to achieve widespread success because of competition with systems based on older technologies. The scale of these three global electronic commerce networks is also vastly larger than the International Registry: SWIFT transmits tens of millions of messages a day,[145] and the payment card networks have issued over 600 million credit cards in the US alone.[146]

Viewed from one angle, the success of the International Registry is absolutely remarkable. A truly global system was built and deployed in record time, and there have been no disputes regarding its operation since its inception. Viewed from another angle (and with the benefit of hindsight), its success is entirely predictable, given the disparity in the price of access to the International Registry and the value of the interests recorded in it. According to the 2011 full retail price list posted by Boeing on its website, the price of its jets range from $59 million to $339 million.[147] By contrast, the fees for setting up an account and performing searches in the International Registry range from $35 to $300.[148] The International Registry also benefits from being part of a strong tradition of effective, transparent cooperation among public and private actors in the international aviation industry. The Convention provided clearly written, feasible, and appropriate goals for the International Registry, and Aviareto has been very successful in achieving them.

The International Registry's success also helps to highlight the significance of the barriers that other global electronic commerce systems had to overcome to achieve widespread adoption. Most have millions of users rather than thousands, and require users to engage in the difficult and expensive task of business process reengineering. Many electronic commerce systems required significant innovation in information technology before they could achieve their target. While competition among different technological solutions may produce better results for everyone in the long term, it can create confusion and slow the adoption of new technology in the short term. Some, like digital signatures, were a solution in search of a problem without a clear value proposition for end users. As a result, the other successful global electronic commerce systems described above—airline CRSs, SWIFT and payment card networks—worked long and hard for decades to build acceptance for their services. The experience of the International Registry shows that when all the relevant business, technical and legal factors are aligned, then a brand-new global electronic commerce system can be successfully deployed in Internet time. ■

[145] SWIFT, 'Annual Review: The New Normal' (*SWIFT* 2011), www.swift.com/resources/documents/Annual_Review_2011.pdf, accessed 15 July 2012.

[146] Kevin Foster and others, 'The 2008 Survey of Consumer Payment Choice' (No 09-10, Federal Reserve Bank of Boston 2010), www.bos.frb.org/economic/ppdp/2009/ppdp0910.pdf, accessed 15 July 2012.

[147] Boeing, 'Commercial Airplanes', www.boeing.com/commercial/prices/, accessed 15 July 2012. On the practice of discounting catalog prices, see Daniel Michaels, The Secret Price of a Jet Airliner, *Wall Street Journal* (9 July 2012), online.wsj.com/article/SB10001424052702303649504577494862829051078.html, accessed 15 July 2012.

[148] Some services, such as informational searches, are free. International Registry of Mobile Assets, www.internationalregistry.aero, accessed 15 July 2012.