Lighthill Risk Network

Automating (Re)insurance through Computable Contracting

(Version 1.1)

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1. Introduction

It is said that for every pound spent on premiums on the Lloyd's insurance market, only 60p remains to cover claims. In other words, the cost of doing business represents 40% of gross income.

The consequences of the reinsurance industry failing to innovate have been highlighted several times in recent commentary: *"It is often said that Lloyd's of London is the most expensive place to do business, and while the attraction for companies seeking to operate there is typically the access to specialty insurance or reinsurance underwriting business, it has to be questioned whether that will always be the case if Lloyd's remains more expensive than competitors."* [1]

Thus, in May 2019, John Neal, Chief Executive of Lloyd's of London, unveiled plans to drastically cut the costs of doing business, from 40p in the pound to just 20 or 25p. This would be achieved by arranging standard contracts on a new online system, and for complex, bespoke policies to have more efficient back-office systems [2].

This report outlines a transformative approach that will help achieve this ambitious goal in reinsurance i.e. for those policies that lie at the more complex end of the insurance spectrum.

The main idea is to turn traditional (re)insurance policies into 'computable contracts', so that rather than remain a 'dumb document' while data is entered (and reentered) into various systems across the insurance value chain, reinsurance contracts can become rich data objects, readable by humans and computers, that constantly feed (and are fed by) the whole value chain from the moment of creation right through to their expiry.

A key issue in the insurance sector stems from its organisation into quasi functional silos: it is as if the main activity groups of pricing, negotiation and binding; payments and policy administration; portfolio management and risk modelling; and claims management all have trouble talking to one another. There has to be a greater emphasis on workflow for the full, horizontal lifecycle of contracts, and where the contract itself acts as the thread throughout the whole process.

There is a constant call for better standards, data integration and structured data capture, all of which is fine, and indeed vital. But the lethargic progress on this front points to the need for a unifying idea that urges the various components to work together to move things forward.

Beyond the potential for significant reductions in the costs of doing business, computable contracts may also facilitate the emergence of new business models. As the 2016 Nobel Prize for Economics serves to remind us, the theory and practice of contracting is pivotal in helping to shape the nature of the commercial landscape [3]. To this end, this report also offers some insights into how this landscape for (re)insurance contracts could play out.

The City of London has a unique collection of world-leading skills and expertise in the (re)insurance sector, and so much so that, for example, a significant portion of business in the US comes to the UK. Hence, given its reputation and history in an area where the UK can truly claim to be a global leader, as well as the important contribution it makes to the UK economy, it would be a great shame if the London (re)insurance market were to shrivel because of a failure to innovate, especially as the skills are on tap to make it happen.

In various places in this report, the term '(re)insurance' is used, simply because the argument proposed may well have just as much validity for insurance as it does for reinsurance. Indeed, many technologies that might be used for insuring large and complex risks would be identical to those used for reinsurance. The main difference between the two is that reinsurance tends to deal with larger, (usually) more complex, and more aggregated risk portfolios, and is therefore more likely to be syndicated.

In order to bring the current and future technological landscape for the (re)insurance sector alive in this report, with meaningful examples and well-known reference points, a number of market players are mentioned. While the core activities, products or services of these players may be discussed in a positive light (or indeed less positively), these comments should not be taken as endorsements (or criticisms) relative to similar products or services of other companies that have not been mentioned. If anything, their mentioning is more a reflection of their interest in being involved in an exciting and innovative time in London's insurance market.

The research work leading to this report has been generously funded by the Lighthill Risk Network. The work itself has been expertly steered by Dickie Whitaker, CEO of the Oasis Loss Management Framework, under whose guidance John Cummins of Innovation Partners Ltd completed the programme of work in the latter half of 2019.

John is an innovator, and seeks to press forward with new ideas. He was one of the founders of the Legal Technology Laboratory in the US [4], and in addition to managing his own innovation practice, he has also been an Innovator in Residence at UCL focussing on computable contracting.

However, without the help of many folks, all of whom have generously given their time and shared their knowledge and wisdom throughout the full course of this project, this report could not have emerged in its current form. Both Dickie and John would therefore like to thank those who contributed, most of whom are listed in the Appendices to this document.

John Cummins, April 2020

2. Executive Summary

Briefly Setting the Scene

By serving to clarify agreement between multiple parties, contracts are an essential and fundamental component of commerce and society. Insurance is also essential - it is the ‘invisible pillar’ that enables people and organisations to go about their lives and business without the threat of significant loss. However, the business of (re)insurance and the contracting operations within it are, for the most part, still entrenched in the traditional, paper-centric practices of yesteryear. Hence, in light of their importance, it is time for a foundational change.

The past three decades have seen profound changes relating to the digitisation of information. And while digital technologies have helped to transform and automate many activities associated with contracting, the contracts themselves continue, in the main, to be in the form of unstructured, natural-language text, even though they may be stored in a digital format. There are of course good reasons for retaining this natural language form: the complex modes of expressivity that it provides, as well as the simple fact that the written word has underpinned human communication for thousands of years.

The heart of the issue here concerns one of ***informational structure***: the more structure information has, the easier it is for computers to process it. And if computers struggle to process it because of a lack of structure, then more human intervention is necessary, thereby driving up the costs of doing business.

In May 2019, John Neal, CEO of Lloyd’s stressed his commitment to halving the costs of doing business at Lloyd’s. This would be achieved through electronic exchanges for more standard insurance products, and by reducing back-office costs for more bespoke (re)insurance.

The Vision

To meet this challenge of driving down the costs of doing business in (re)insurance industry, this report explores three bold propositions:

1. (Re)insurance contracts, even at the more complex end of the insurance spectrum, can be fundamentally reengineered to become ‘computable contracts’.

2. These computable contracts will be ‘rich’ data objects that are readable by humans <u>and</u> computers. They will have inbuilt structure and logic, be aligned with commonly used standards and have full digital connectivity.

3. Computable contracting will have a transformative effect throughout the (re)insurance value chain (as shown in Figure 1), and may well provide the basis for emerging business models, or at the very least increased business volumes.

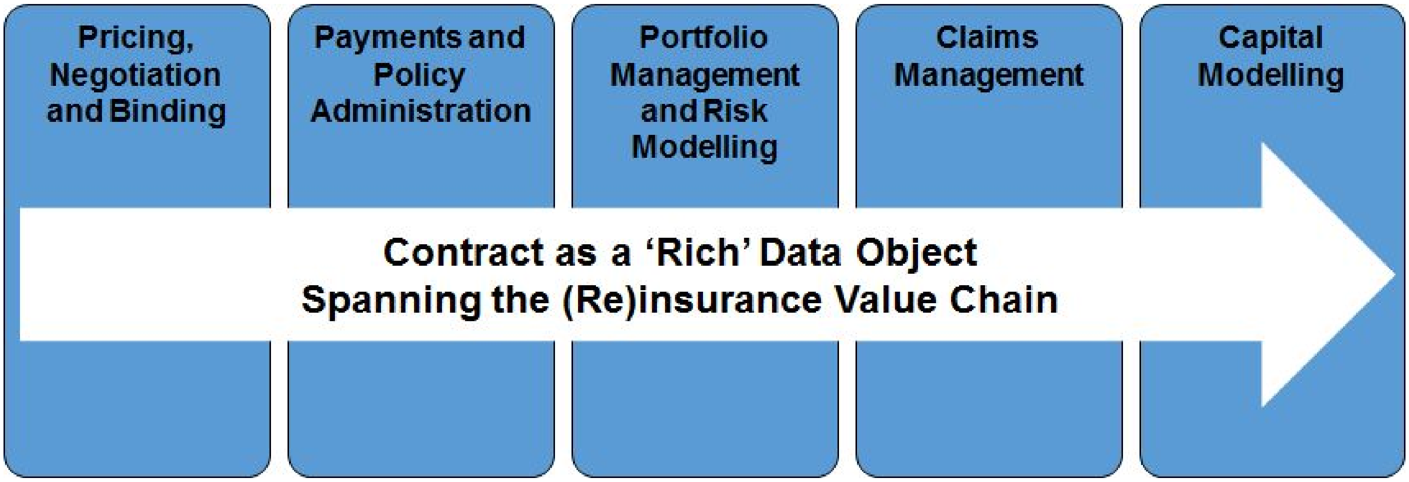

Figure 1: Contracts as Rich and Open Data Objects Spanning the Complete Value Chain

The Impact

Although it might be unrealistic to claim that halving the cost of doing business is possible through computable contracting approaches alone, the approaches outlined in this report will make a vital and significant contribution towards doing so. And perhaps more importantly, they will also establish the foundations for the industry for a long time to come.

At this stage, concrete figures are at best 'guestimates', but if computable contracting could make a dent of between 10% and 25% in the cost of doing business for the whole London market, this would be worth between £2.5 billion and £6.5 billion annually.

Innovation in (Re)insurance Contracting to Date

With contracts retaining their natural language form, we have nevertheless tried to make our lives easier by following two main courses of action to make contracting more efficient:

- The first is to 'simplify' contracts through standardisation and modularisation. And even here, digital technologies have come to our assistance with so-called automated document assembly systems, in essence, a 'lego-style' word processing kit.
- The second is to 'automate around the contract' by writing computer code to enact parts of contracts such as automated payments e.g. with so-called 'smart contracts'. The essential point here is that the contract remains in its basic, natural language form, while code is created separately to bring it to life. Thus the text of the contract and the code are different entities, often with little or no linkage between the two.

In (re)insurance, the industry has made progress on both these fronts: electronic placement systems help at the 'trading end' of the value chain, and various initiatives have sought to streamline claims handling for more standard types of business. There are also companies that provide software to help with the "management of contracts throughout their complete lifecycle".

Commonly known as contract lifecycle management systems, they suffer from several shortcomings: the first is that the contract remains largely unchanged, with no structural reengineering; the second is that these systems can require the manual transfer of data; and the third is that the underpinning structure and logic remains closed and hidden within the system.

Blueprint One, Lloyd's strategy for the next three years had been fully initiated by the beginning of 2020. In particular, it is suggested that this report on computable contracting will contribute to the key activities in Blueprint One of 'creating a data framework' and building a 'complex risk platform'.

Computable Contracting and its Future in (Re)insurance - In a Nutshell

The heart of computable contracting is to be able to create contracts that are:

- Easy for humans to understand and generate; and
- Expressible using formal (i.e. readable by computers), user-friendly high-level languages that are directly compilable ('translatable') into lower-level languages.

This idea can be made real for the (re)insurance sector by bringing together the components of the 'technology stack', shown below in Figure 2.

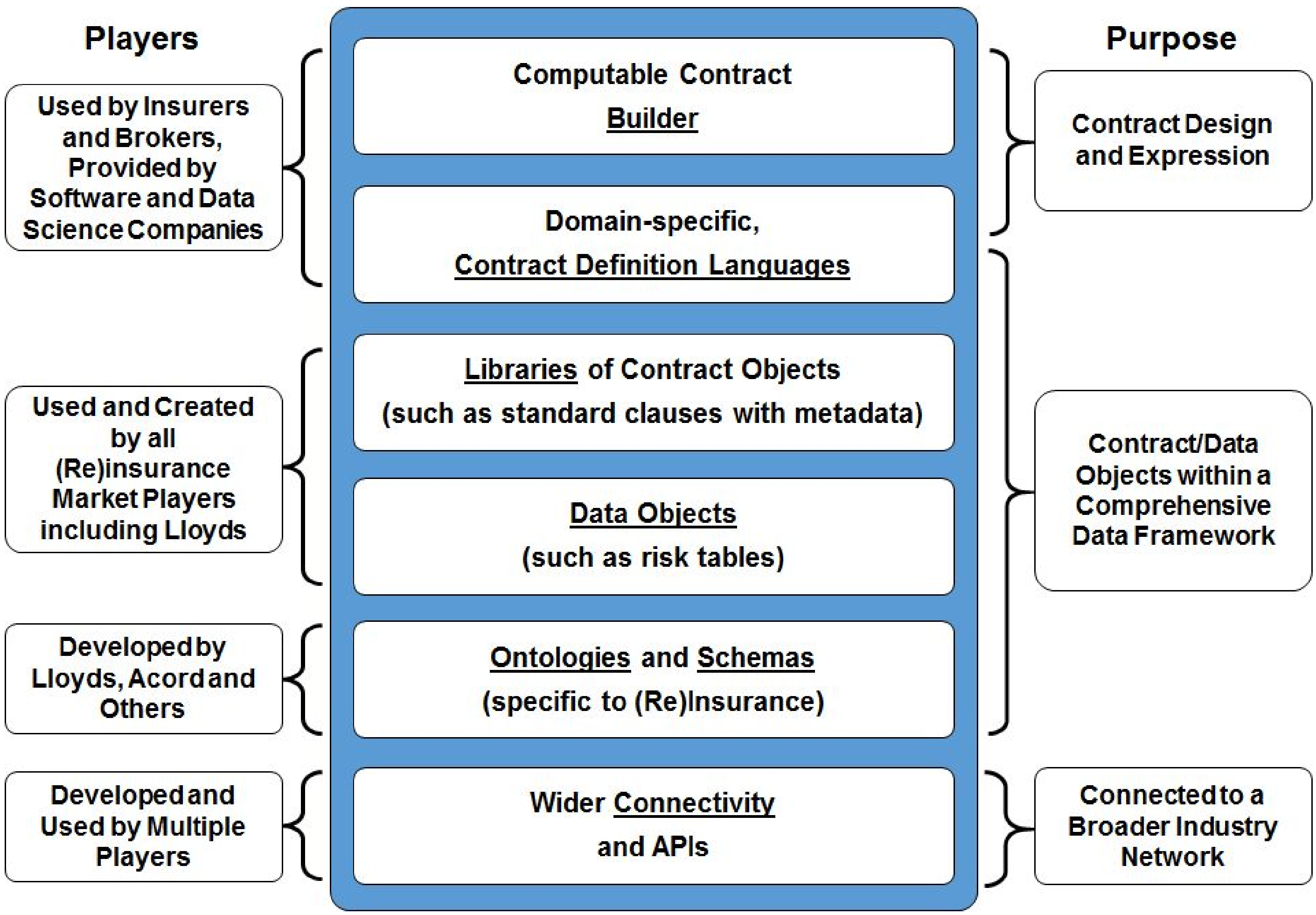

Figure 2: Technology Stack for (Re)insurance Sector

The technology stack shown in Figure 2 combines three essential elements:

- **Contract building** - the tools to put together computable contracts with sufficient expressivity in a straightforward way, much like web sites are built. One central component of this is the idea of domain-specific languages - high-level, user-friendly 'coding', using graphical interfacing where possible, and that has been engineered specifically for the (re)insurance sector.
- **Data framework** - all of the elements to enable data (and the processing of it) to be undertaken in the most efficient way possible. This embodies the ideas of open and modular data structures, libraries of contract objects, and industry-wide schemas (data maps).
- **Wider connectivity** - that spans the (re)insurance value chain, but which also extends beyond it to whichever functionality may be required (e.g. data sensing, dynamic regulation).

The Route to Implementation

Blueprint One emphasises prototyping, and that is the best way to get computable contracting approaches to take off, perhaps by focussing initially on one or two lines of business. This report outlines five pragmatic steps towards building working prototypes that collectively address all of the components shown in the technology stack shown in Figure 2 including:

- Building an industry-wide 'data map' (for specific lines of business) to better understand data types, structures, flows and volumes;
- Developing mock-ups of computable reinsurance contracts to provide a shared vision of what they could look like;
- Identifying and focusing on key areas to close gaps in key standards that support interoperability across the (re)insurance value chain;
- Developing a prototype of a computable contract builder - a kind of 'Dreamweaver for (re)insurance contracts'; and 'piggy back' existing systems for simultaneous operation, and
- Analysing and assessing business impact and the emergence of new business models in much greater detail.

Finally, it is recognised that this report outlines approaches that are innovative and that represent a fundamental 'replumbing' of the (re)insurance industry - new approaches that put the contract, and not just the trade, at the heart of business operations. Indeed, by elevating the contract to reflect its pivotal role, rather than an afterthought, we are laying the groundwork for genuine market change.

Some might say that these ideas are too ambitious, and that smaller incremental steps are what we need. There is both truth and pragmatism in this, but without a bigger, well-founded vision that gives us direction, any steps that are taken may not serve us so well in the longer term. Furthermore, the tradition and excellence of the UK's (re)insurance industry warrants nothing less than ideas that will continue to enable it to retain its position as ***the*** global leader.

3. Contracting and Computable Contracts - A General Overview

Contracts are the bedrock of commerce: through helping to build a common understanding between multiple parties, contracts help to orchestrate the global exchange of tens of billions of dollars of goods and services around the world every single day [5]. However, despite the ever increasing levels of digital connectivity, the drafting, reviewing, execution and monitoring of contracts remains relatively unchanged and has not kept pace with the levels of innovation seen in other areas of business.

3.1 The Innovation Landscape for Contracting Technologies

Figure 3 presents an innovation landscape for contracting technologies with two key dimensions: one that indicates the ease with which contracts can be understood and used by humans, and a second that indicates the degree to which contracts can be understood or processed by computers.

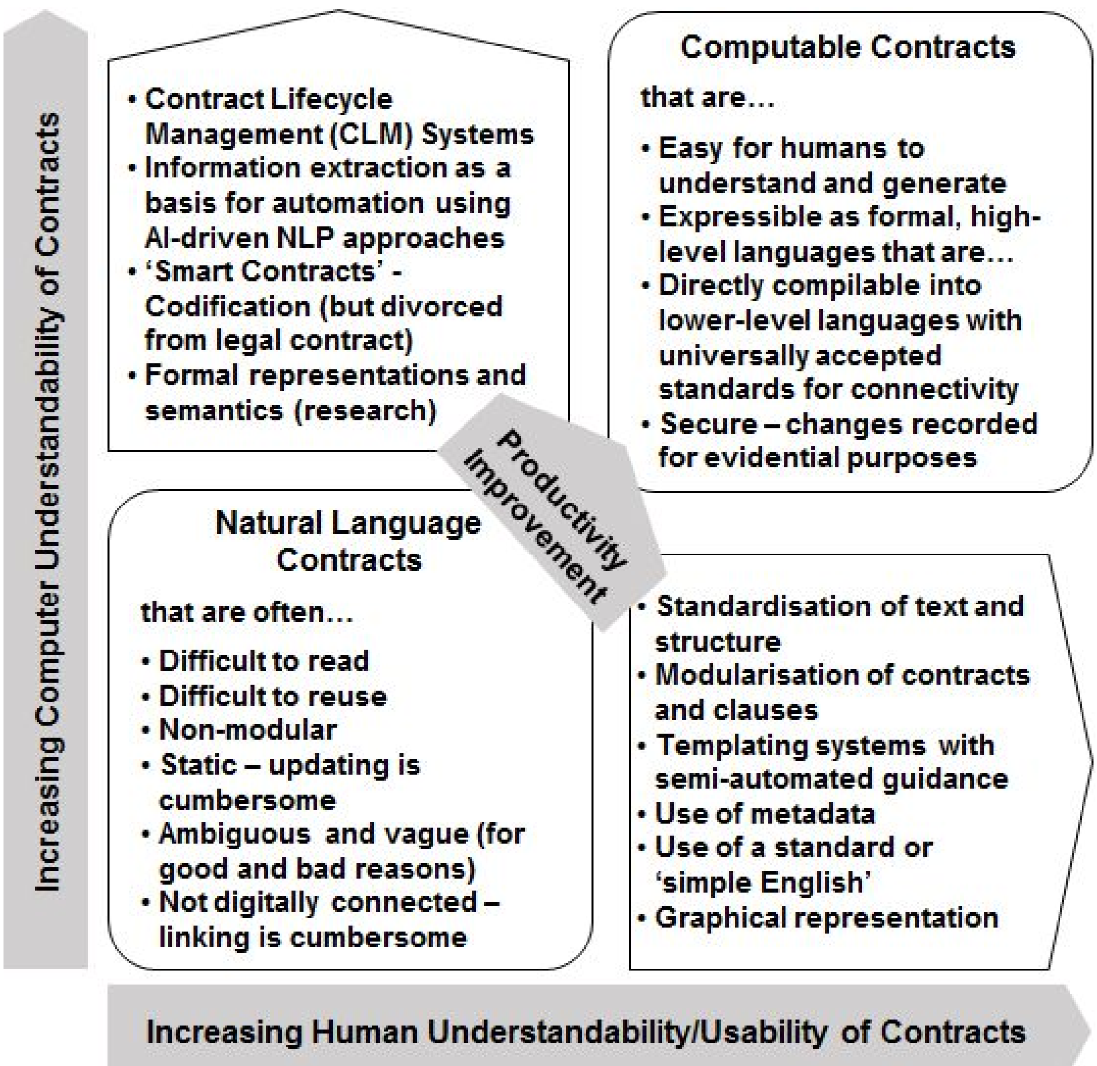

Figure 3: Innovation Landscape for Contracting Technologies

The term 'computable contracting' was first used and discussed extensively by Harry Surden in 2012 [6]. Here, Surden indicates that 'computable' means that the legal result is "*able to be automatically generated by a rules-based process*". But being rules-driven is just one aspect; as described in the top-right quadrant of Figure 3, computable contracts embody the following characteristics:

- Easy for humans to understand and generate;
- Expressible as a formal, high-level language that is directly compilable ('translatable') into lower-level languages;
- Adopt universally accepted standards for connectivity (and interoperability);
- Secure – changes recorded for evidential purposes.

While the vision of computable contracting is to take commerce to the top-right quadrant, the realities of contracting for many organisations are more accurately described by the bottom left. In short, many contracts of today are created as monolithic, non-modular documents in natural language form. They are often difficult to read and to modify, and when they are modified, the process of doing so is clumsy, sometimes with unintended consequences such as inconsistencies and time delays. While 'vagueness' in contracts is sometimes a practical necessity, all too often it reflects the limited resources available for drafting, again with the possibility of costly dispute resolution actions further down the line. Finally, and for the most part, contracts are isolated documents (either in hard or soft copy formats) with little connectivity to the business systems to which they refer.

3.2 Moving Towards Computable Contracting

This transformative vision of computable contracting will facilitate productivity improvements and lower costs through reducing contract drafting times and negotiations; increasing the scope for the automation of contract execution; and speeding up (or even avoiding) dispute resolution. Furthermore, making contracts computable should not only bring about a profound and fundamental shift in the way that contracting is undertaken, but should also pave the way for the emergence of new business models. In an analogous sense, it could do for contracting what computer aided design, knowledge management systems, and production control systems have done for the automation of manufacturing.

Most innovation in contracting has tended to fall into two main areas, either by moving horizontally or vertically from the bottom-left quadrant shown in Figure 3. As we shall see, there are many contracting technologies but they generally fall short of closing the 'contract innovation gap'. These innovations, specifically for the (re)insurance sector, are explored in more detail in Section 4.

By moving horizontally and towards the right from this quadrant, we are enabling humans to read and use contracts more easily. Typically, this might involve the creation of standards for contracts, such the Lloyd's Wordings Repository. Further innovations along the horizontal dimension might include the modularisation of contracts and the use of templating systems that can help to semi-automate the drafting of contracts. Based on AI-driven analytics, contracts might also be annotated with metadata - information about the text in the contract. And, even the English used might be standardised in some way so as to avoid unintended ambiguities. Finally, and as the old adage suggests, ‘a picture is worth a thousand words’: the judicious use of carefully constructed graphics might actually make the act of reading contracts a more inviting experience, e.g. Lemonade contracts for insurance [7], who claim to transform the customer experience by paring down the contract to its bare essentials and presenting them in a customer-friendly way.

A vertical transition upwards from the bottom-left quadrant represents innovations that permit contracts to be understood by computers in some way. Broadly speaking, it usually involves ***‘automating around the contract’***. The most commonly deployed of these are contract lifecycle management (CLM) systems, essentially using document management approaches to underpin increased automation. The electronic placement platforms that we see in the (re)insurance market today are, in a way, mini CLM systems. Pushing forward on another front, and sometimes referred to as ‘contract analytics’, AI-based approaches are currently being deployed to help speed up the process of searching for, retrieving and analysing information from large bodies of text-based contracts (or ‘large, unstructured datasets’). And finally, and perhaps the most fashionable at the moment, there are ‘smart contracting’ approaches: this involves the creation of pieces of computer code to enact specific aspects of a contract (e.g. payments), and in some cases, mainly in fintech, are starting to muddy the distinction between computer code and legal contracts [8].

Achieving further productivity gains in (re)insurance through computable contracting, and moving to the top-right quadrant, requires a blend of innovation and discipline, as well as an integrated approach that supports comprehensive coverage of the full (re)insurance value chain. The way in which contracts are structured and expressed needs a fundamental rethink. Encouragingly, it would appear as if industry appetite is there, which, if coupled with the available talent, and an awareness of the many somewhat fragmented solutions bubbling away, would suggest that there is significant hope for unleashing a transformative approach to contracting onto the London market, and inevitably globally.

And if there is one other factor that might spur on industry practitioners in the (re)insurance sector to embrace innovation in a substantial way, it is the threat of new and powerful players muscling in. The Economist reported in July 2019 [9] that *“rumours are growing that Big Tech is gearing up to enter insurance. Amazon, Apple and Google have troves of data and idle capital; they lack underwriting skills but can easily lure talent.”* While the likes of Amazon are likely to start at the commoditised end of the insurance spectrum, once a foothold is established, there will be little to hold them back from entering other parts of the (re)insurance market.

4. The Current Landscape for Contracting in (Re)insurance

This section seeks to describe the key initiatives and technologies related to contracting that currently exist in the (re)insurance space. It starts off with e-placement platforms, and then moves on to describing a number of contracting technologies specific to (re)insurance. These include:

- AI-driven analysis of natural language contracts;
- Automated document assembly systems;
- Contract lifecycle management systems;
- Smart contracts (and distributed ledger technologies - DLTs);
- Standards for contracting.

It should be emphasised again, that this report is addressing the reinsurance market, which is at the more complex end of the insurance spectrum. Many, more vanilla, insurance products (such as home or car insurance) have already felt the full force of technological change. And given that reinsurance is often associated with very specialised types of insurance, any future contracting technology seeking to increase levels of automation will have to address this level of complexity.

4.1 Digital Platforms - Currently a Strong Emphasis in the (Re)insurance Space

In 2019, and as something of a call to action, Sheila Cameron, CEO of the Lloyd's Market Association, emphasised the importance of establishing a seamless, digital (re)insurance marketplace in London [10]. At the Insurance Network's TINtech Conference, Cameron called for a *"digital marketplace where processing tasks are linked seamlessly, which in turn would provide market experts with more time to concentrate on adding real market value."*

In 2017, Mckinsey produced a report entitled: 'Global Reinsurance: Fit for the Future' [11]. In the report, the following question was posed: 'Does a more efficient, digital-based operating platform provide an upside?' The response starts by suggesting that *"many mid-sized reinsurance companies already see themselves as being relatively lean and cost efficient"*. It goes on to say that *"reinsurance companies also recognise that underwriting performance, much more than cost, is the key underlying driver of success."* These comments seem to echo the general sentiment that the London Reinsurance market is resting on its laurels, or sees no alternative to the status quo.

In McKinsey's view, this mindset has resulted in a low impetus to modernise: *"the industry has lots of bricks-and-mortar and low-grade technology (e.g., Excel-based models hosted on local desktops, prevalence of case-by-case underwriting, including for small-ticket items)."*

As a concluding statement in addressing the question on the need for a 'digital platform', the Mckinsey report suggests that *"there may be an upside from building a more efficient, digitally enabled, analytically driven operating platform. Aside from the obvious cost benefits, such a platform might also provide the tools to support more mobile, data-driven, technology-based* *underwriting, which could improve results even further"* as well as to *"potentially enable new risk transfer models."*

As things stand, and when it comes to platforms, the main focus appears to be on electronic placement i.e. securing quotations from prospective (re)insurers and supporting the interim negotiations with brokers before binding. The Lloyd's electronic placement platform (PPL) requests a fairly limited set of information[1] and appears to be used as little more than a repository for documents, sometimes with information being added after binding. In short, it is a very 'document-centric', rather than a 'data-centric' solution. In 2018, a number of proprietary e-placement systems (i.e. managed by brokers, insurers or third-party organisations) were recognised by Lloyd's [12]. There are now 16 different electronic placement systems.

It is also interesting to observe that between the two actions of 'building a platform' and 'engineering the content (and its structure) to put on a platform', it is the former that appears hitherto to have had the most attention and resourcing. Maybe, this is because building a platform is considered a much more tangible initiative, with data reengineering just a little too abstract to demonstrate progress. This is starting to change, and from various quarters in the (re)insurance industry, the awareness of the importance of data models and structures is increasing.

Relative to London's FinTech community, the InsurTech community is somewhat smaller, less effervescent, and has perhaps somewhat fewer technology solutions within its overall portfolio. In part, this may be because speed in finance (where milliseconds really do count, and where digital technology can provide a strong and immediate competitive edge) is much more of a key driver of success than it is for insurance. However, after having racked up successes in the finance space, there is a tendency for FinTech providers to view the (re)insurance space as the next opportunity.

4.2 Artificial Intelligence - Hugely Important, Less So for Contracts

Artificial intelligence (AI) is, without doubt, having a massive impact on our lives and the world of commerce. By seeing patterns in complexity and masses of data, AI systems can help us to understand things and make decisions that, until relatively recently, were considered intractable.

The (re)insurance sector is no different: both risk assessment and claims management will benefit from the application of AI. In their report on 'The Impact of AI on the (Re)insurance Sector' from 2018 [13], SCOR suggests that:

"As a result of the application of AI, (re)insurers will know their customers and risks more thoroughly, price and underwrite more accurately, better identify fraudulent claims, and detect and monitor evolving risks. They will be able to tailor products and services to the exact needs of their customers, when and as those needs appear and evolve."

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[1] The main pieces of information submitted by brokers to the PPL are: UMR, insured client name, programme name, type of business, contract type, class of business, region, period, layering detail, markets added, messages

So, yes, AI is important for the (re)insurance sector, but what about AI in the activity of contracting? In his collaborative whitepaper with Stanford [14], Oliver Goodenough, one of the thought leaders in computable contracting, makes the following observation:

"There are several activities seeking to mine natural language contracts and use machine learning approaches to construct typologies, analyse contractual holdings, and even begin to create executable options. In academia, one major ongoing project is the MIREL project [15]. Startups such as Kira Systems [16] and Luminance [17] are commercial examples. While often quite useful in dealing with legacy, word-based contract libraries, these approaches will have limited use for defining a legal specification protocol", such as that required for a computable contract.

And this is precisely the situation we find ourselves in with AI and computable contracting, both in the insurance sector and elsewhere. ***Essentially, the use of AI to analyse current contracts involves looking for patterns in <u>unstructured</u> data***, and then establishing an observation, usually with a degree of statistical significance, about the pattern. For example, from a large body of contracts, it might be asserted that a particular phrase occurs with a specific frequency. The point is that if contracts had a greater degree of inbuilt structure from the outset, assertions based on contract aggregation would also be known from the outset, thereby rendering this particular application of AI redundant.

Nevertheless, because so many contracts still exist in the form of unstructured data, there are many companies that exist to assist with AI-driven contracts analysis. Another example of such a company is Eigen Technologies [18], a London-based startup whose machine learning engine helps banks and other businesses in the financial services sector to extract information and insights from large and complex documents like contracts. And, as the insurance sector has to deal with massive amounts of legacy data in an unstructured form, these organisations will provide part of the overall solution towards working with more structured data.

Lloyd's also has its own tool for contract analytics: Contract Confidence. According to Lloyd's it *"uses advanced search techniques to scan contracts and check for errors and discrepancies, which significantly reduces the time underwriters, management and risk/compliance teams spend manually checking contracts."*

Launched in 2019, this is a worthwhile endeavour, because whichever way contracts change in their balance between structured and unstructured data, there will always be a benefit in having checks for validity and consistency. This requirement is also touched upon in Section 5.

4.3 Automated Document Assembly Systems

Clearly, it makes little sense to draft each (re)insurance contract anew; most companies have a large library of pre-existing contracts and clauses that can be drawn upon, rejigged, tweaked and then used for a particular situation. Making this process easier is where the so-called 'automated document assembly systems' come in.

These systems range in their degree of sophistication from the simplest: those that offer a set of fixed templates that require gap-filling; to the more advanced: those that automatically create a bespoke contract based on answers to a set of questions. The latter is an example of a rule-based system.

One of the first, and now leading, providers of automated document assembly systems is Hotdocs [19]. The Hotdocs document assembly system sits at the more advanced end within its field and serves the insurance sector.

Closer to home, and within the reinsurance sector, Swiss Re have a system called 'Blockfinder', which has a 'contract drafting wizard' that offers the following functionalities [20]:

- *Creation of compliance-proof contracts;*
- *Allows production from templates, precedents or expiring contracts;*
- *Enables a broad range of stakeholders to provide support in drafting documents;*
- *Enables access to and insertion of approved clauses from a database.*

The main advantage of an automated document assembly system is the time saved in putting together a high-quality document. The output, however, is still in the form of unstructured natural language data object with little scope for computability.

4.4 Contract Lifecycle Management Systems

Once a contract has been created and agreed between the parties, it comes to life and sits at the heart of the business operation(s) and system(s) to which it refers, either directly or indirectly. However, despite the obvious importance of contracts, and once active, it is quite typical for them to remain in a filing cabinet somewhere or on a database i.e. inactive. It is curious that, for something so pivotal as a commercial contract, it pretty much goes to sleep as soon as it is born.

The aim of contract lifecycle management (CLM) systems is to change this and to manage the evolution of a contract from its inception, including any amendments, or possible renewals and ultimately, through to its cancellation or expiry. It does so by storing key information about the contract on a CLM system.

In essence, a CLM system concerns the management of a set of data fields (that are referred to in a contract), and whose values can be used or modified by the various automated or semi-automated business operations to which the fields have connectivity. More advanced CLM systems might facilitate the set up of contracts as templates with embedded, predefined fields, and with the information being drawn automatically from these fields, or fed to them in order to modify their existing status or value. These templates may even have been designed with an automated document assembly system (Section 4.3) with a data tagging facility to create the fields.

However, despite the relative simplicity of this technology, it is still quite common for information contained in a contract to be rekeyed manually into other systems.

There are many CLM systems on the commercial market (at least 200), but there appears to be less diversity in the (re)insurance space. Ed Broking has been using the Exari CLM (now Coupa) [21], which is well known across all industry sectors. Swiss Re uses SICS (DXC.technology) as do more than 80 reinsurance and insurance customers globally [22].

In their marketing materials, SICS claim an end-to-end support capability for reinsurance: *“SICS supports all aspects of a reinsurer’s processing needs, from acquiring new business, through renewals management and accounting, to retrocession. Insurers’ outwards cession administration is equally supported, and claims processing and recoveries capabilities meet the needs of insurers and reinsurers across the whole reinsurance value chain.”*

While all of this may be true, the information for the reinsurance contract itself needs to be entered into the system (in many instances, manually) and becomes divorced from the contract document itself. ***As is the case with many CLM systems, this system uses its own data structures and ‘automates around the contract’, rather than the contract itself remaining at the centre of operations as an ‘open data object’ with inbuilt structure and intelligence.*** In Section 5, the meanings of ‘open data object’, ‘structure’ and ‘intelligence’ in this context are explored in greater detail.

4.5 Smart Contracts - Much Excitement, Less Relevance for (Re)insurance

Smart Contracts are concerned with helping to automate the performance (of part) of a contract and are perhaps the area most talked about in contract innovation. Although the term ‘smart contract’ has been used for over two decades, coined initially by Szabo [23] in the 1990’s, the rapid increase in its current usage has been driven largely by the cryptocurrency community, and it is usually associated with ‘Blockchain’ or distributed ledger technologies (DLTs).

From an insurance perspective, maybe a good place to start is the report (published in 2019) based on a collaboration between Lloyd's and the Centre for Commercial Law Studies (CCLS) at Queen Mary University London (QMUL) [24]. Entitled ‘Triggering innovation: how smart contracts bring policies to life’, the report seeks to explore how smart contracts might disrupt the (re)insurance sector. The report provides a useful definition as a starting point:

"A smart contract is a computer protocol intended to digitally facilitate, verify or enforce the negotiation or performance of a contract. Smart contracts are pieces of computer code that are designed to carry out tasks automatically in response to external triggers, such as receiving storm or flood data. They are used to carry out contractual obligations in whole or in part. A simple contract might be coded in its entirety; a more complex contract would use smart contracts to carry out only some of its obligations."

This definition (which is typical) raises a very fundamental question: are all pieces of code that are used to carry out contractual obligations, in whole or in part, considered to be smart contracts? If this is indeed the case, then surely, the countless instances of where pieces of code have been doing such tasks for decades are also smart contracts.

In a report by Clyde and Co. on 'Connected contracting: smart parametric insurance' [25], a clear and useful description of how parametric insurance works using smart contracts is provided. A smart contract template is set up that has a number of defined data fields, much like those described in Section 4.4. The values in these data fields are referenced by other connected systems, that may have a sensing or payment functionality, and based on the reading of a sensor (for e.g. flooding levels) an automated payment may be initiated.

This is an example of how greater levels of automation may be achieved, which is fine, but the template and the associated code that help to facilitate this process do not necessarily have to be thought of as a 'smart contract'. From an innovation perspective, we have not really moved forward that much. ***And crucially, the code is still quite separate from the contract.***

One insightful point from the Lloyd's/QMUL report (referred to above) concerns the act of 'translating' natural language contracts to code. Making contracts readable by a computer, to whatever extent possible, means that "*a combination of computer and legal skills are needed to create a smart contract as it involves coding legal obligations*. *One challenge is to ensure the nature of the contracted relationship is not lost in translation."*

This idea of not being 'lost in translation' is fundamental to computable contracting; whatever code is used, it must be faithful to the contract [26]. In Section 5, this basic requirement, and how one may go about addressing it, is explored in greater depth.

Now, let us look at an initiative that is bringing blockchain and smart contracting technologies together for reinsurance. Based in Zurich, and with an overall team of around 40 people, B3i is a joint venture between 20 insurance market participants from around the world. Altogether, B3i has "*more than 40 companies are involved in B3i as shareholders, customers, and community members"*. Their objective was to have launched their first application to the reinsurance market in the form of a catastrophe excess of loss product by 2019.

The B3i smart contracts seem to be similar in nature to those described earlier in this section, although example contracts have not been analysed. In conversations with B3i, the contracts are described as “*being able to undertake relatively simple calculations*”.

A key part of B3i’s mission is to “*create a DLT based network through the adoption of standardised systems and protocols*” [28], which is very much pointing in the right direction regarding the standards. However, the DLT (distributed ledger technology) part is less convincing. It lies beyond the scope of this report to address the extent to which, and also, which variation of DLT may be appropriate, if indeed a DLT-based solution is required at all for (re)insurance, but it does underline one general observation: there is perhaps still too much emphasis on technology/software solutions without fundamentally rethinking the data models in the (re)insurance space. Indeed, it is the data science that will most help to unlock the further development of industry-wide standards.

4.6 Contracting Standards

There are many different types of standards for contracts, but possibly the one that most people would think of first for contracting concerns standard clauses. Here, Lloyd’s has its own database for standard wordings, essentially a repository of paragraphs or full sections of contracts. A good example is LMA3092 - an insurance contract for physical loss or physical damage riots, strikes, civil commotion, malicious damage, terrorism and sabotage insurance. The texts are in a wholly natural language form, and the only metadata that appears to be used is that which is necessary for retrieval i.e. a kind of library classification.

Beyond Lloyd’s, the organisation most commonly recognised with regard to standards in (re)insurance is Acord [28]. While its coverage is very broad in terms of its development and upholding of standards, Acord is primarily recognised for its support in two areas:

- Data exchange for post-binding activities via the Rusclikon initiative (e.g. settlement for premiums and claims): 9 million messages annually, and
- The use of standard forms: 3 million downloads over 10 years.

Another organisation operating in the area of insurance standards is Polaris. Their main mission is to facilitate the managed exchange of electronic data in insurance, specifically for the UK market for more standard commercial (e.g. for SMEs) and personal lines of insurance. Their e-trading platform is underpinned by the development of e-trading standards, as well as the provision of a tool called ‘ProductWriter’ [29] that:

- *enables insurers, brokers, software houses and data solution providers to specify products in an electronic format and rapidly deliver them to market, and*
- *references market developed data definition dictionaries that are maintained and updated monthly.*

The Productwriter has a similar functionality to that which is required by the proposed Lloyd's Risk Exchange for more standard types of risks. This is outlined in the Lloyd's strategy, Blueprint One, discussed in Section 5.

While Acord and Polaris have established standards for post-binding administration and electronic trading, there are organisations that have developed data standards for risk modelling, two of which are:

- **Oasis:** Loss Modelling Framework [30] and their Open Data Standards (ODS), providing an ecosystem as well as data models for risk modelling. This incorporates the Open Exposure Data schema from Simplitium [31];
- **RMS:** Risk Data Open Standard [32].

In addition to establishing open data standards for risk modelling, RMS has developed a domain-specific, contract definition language (CDL) that calculates the final payout value for a specific loss scenario, based on a range of variables for e.g. limits, deductions etc. The idea and importance of a domain-specific language is explored further in Section 5, but in essence, it boils down to describing contract functionality in a way that can be read by a computer, but where the language is very familiar to an industry practitioner.

Another data analytics firm, QOMPLX [33], has a domain-specific language that similarly allows contracts to be described formally. Like RMS, it enables the calculation of a final payout for a loss scenario. However, unlike RMS, the QOMPLX approach captures sufficient contractual details to enable the automation of the entire pre-bind, underwriting workflow. This workflow is sequenced in various stages, e.g. risk-pricing models, reference-portfolio-pricing models and rules-based decision-making based on those models. Submissions that are successfully bound are added to this reference portfolio, which itself is a contract of contracts.

In addition to their CDLs, RMS and QOMPLX have developed a number of 'entity relationship diagrams' or 'schemas' (also discussed further in Section 5). One interesting observation in the RMS documentation is that the contract is defined as ***"the central component of the data model, as a binding agreement between the insurance provider and insured customer."*** This idea of the contract being at the centre of an open data model is fundamental to computable contracting and is not properly recognised in many of the contract lifecycle management systems such as SICS.

Possibly more than any of the other technologies outlined in this section, the data modelling approaches undertaken by these three organisations (Oasis, RMS and QOMPLX) in the area of risk modelling and workflow-driven data modelling are those that will shape the future of computable contracting in the (re)insurance space.

A more detailed review of these open data standards for risk modelling lies beyond the scope of this report, but it would appear that some form of integration between the risk modelling standards (of Oasis and RMS) and the data exchange/management standards (Acord and Polaris) would help with the general advancement of standards in (re)insurance.

Finally, and to end this section with a quote, the idea of integrating horizontally across the value chain is supported by the following IMRI article from 2012 entitled ‘Underwriting and claims clauses in insurance agreements’ [34]. For claims control clauses:

“one of the biggest problems with underwriting and claims handling clauses is the lack of communication between those negotiating and drafting the reinsurance agreement and those who handle the day-to-day underwriting and claims handling duties. Most line underwriters and claims handlers have little familiarity with the company's reinsurance agreements. When disputes arise, it is not uncommon for underwriting and claims witnesses to testify that they never saw the reinsurance agreement and had only a summary (if lucky) of the requirements that affected their duties. This problem becomes exacerbated when a reinsurance contract is in place for a long time and personnel change with frequency.”

In short, through data-driven, value-chain integration, and with a strong focus on the workflow using common data objects, fundamental mismatches, such as the example above between claims and underwriting, can be avoided.

5. The Art of the Possible - The Future of Contracting in (Re)insurance

Moving on from the current state-of-the-art in Section 4, this section seeks to provide a glimpse of the future for contracting in reinsurance. It leads with the most relevant parts of Blueprint One, and then describes the main components of an architecture for computable contracting in (re)insurance.

Subsequently, a suite of examples in the (re)insurance space helps to provide a context for these components, and in Section 5.8, all of the ideas from Sections 5.2 to 5.7 are brought together in the form of a computable contracting technology stack for (re)insurance. The section concludes by briefly looking at some of the work of ISDA (the International Swaps and Derivative Association).

5.1 Blueprint One Leading the Way

Blueprint One [35] lays out an ambitious programme for the future of Lloyd's. As a strategy, it is well articulated, comprehensive and bold. And while many implementation details still remain to be defined, the strategy sensibly avoids advocating specific (and often over-hyped) technology solutions. Having completed a number of baselining activities towards the end of 2019, a three-phase programme over three years was initiated at the beginning of 2020.

In brief, the future Lloyd's ecosystem comprises six 'integrated solutions'[2], all of which are underpinned by data, technology and culture. For reinsurance contracts specifically, the definition of a 'data framework' is particularly relevant. For 2020, the objectives regarding the data framework are to:

- Finalise the overall data framework,
- Define and publish data standards, and
- Support the technology builds to develop solutions in line with data requirements.

According to Blueprint One (see page 98), Lloyd's are currently in the transition phase and should be in the midst of "*defining the structure and approach to the data framework, including data types and classifications to differentiate clearly between the core data that enables efficient automated transactions, and the proprietary data that enables differentiated decision-making and enhanced insights*". On the same page, it then goes on to add that "*the logical data structure for selected risk classes will be developed*".

The data framework will be a key enabling factor for establishing the complex risk platform as a data-first solution, the roll-out of which is envisaged in 2022. In the shorter term (for 2020), the objective is to have completed an early-build of the document-plus-data solution and a prototype of the data-first capability.

[2] The six integrated solutions comprise: complex risk platform, Lloyd's risk exchange, claims solution, capital solution, syndicate in a box, and services hub

5.2 Building the Data Framework - Data Structures and Algorithms 101

The future of contracting across multiple industry sectors rests upon the idea of establishing contracts as ***data structures <u>and</u> algorithms***. This section provides a general description of these two key terms in the context of building a data framework for computable contracting with references to (re)insurance. Indeed, without crystal clarity as to what these terms mean, it is hard to imagine what an architecture (or 'data framework') for an entire industry might look like.

A table that describes a range of property characteristics for different geographical regions is a form of data structure. Other data structure forms include hierarchies and graphs. More generally, ***a data structure is a collection of data values, the relationships among them, and the functions or operations that can be applied to the data*** [36]. A data structure, therefore, goes beyond the idea of simply grouping and categorising data; it also includes the links between the data as well as a description of the nature of these links.

In Blueprint One, therefore, the phrase "*logical data structures for selected risk classes*" may, for example, be referring to different classes of catastrophe risk as well as their respective subclasses. And, in this specific case, the data structures will take the form of hierarchies.

A risk assessment model that determines the probability of loss occurrence over a specific period of time is a type of algorithm. More generally, ***an algorithm is a set of clearly defined steps that undertake a specific task***. In computing, these tasks are driven by coded instructions and usually involve a series of operations (e.g. calculations) on data structures.

As indicated in Section 4, many of the electronic placement technologies that typify the current state-of-the-art for reinsurance only go as far as grouping and categorising data and presenting these data in the form of a 'digital slip'. Any interdependencies between the data contained on the slip (and data elsewhere) are often not formally defined in a convenient way. This is because these interdependencies may be buried in wads of documentation, coded in quite separate IT systems, or simply hidden away in the minds of individuals.

A central idea of computable contracts is that ***data structures <u>and</u> algorithms are an integral part of (or are <u>directly</u> referenceable by) the contracts***. This means that contracts of the future will move away from relatively static documents, with little (or no) in-built intelligence, towards multi-faceted, dynamic objects with integrated (or transparently referenceable and easily accessible) data structures and algorithms. While the importance of data structures is emphasised in Blueprint One, the close association with algorithms does not come across so strongly.

5.3 An Architecture for Computable Contracts in R(e)insurance

In this subsection, we look more closely at an architecture for future computable contracts, and within this context provide some examples that are specific to reinsurance.

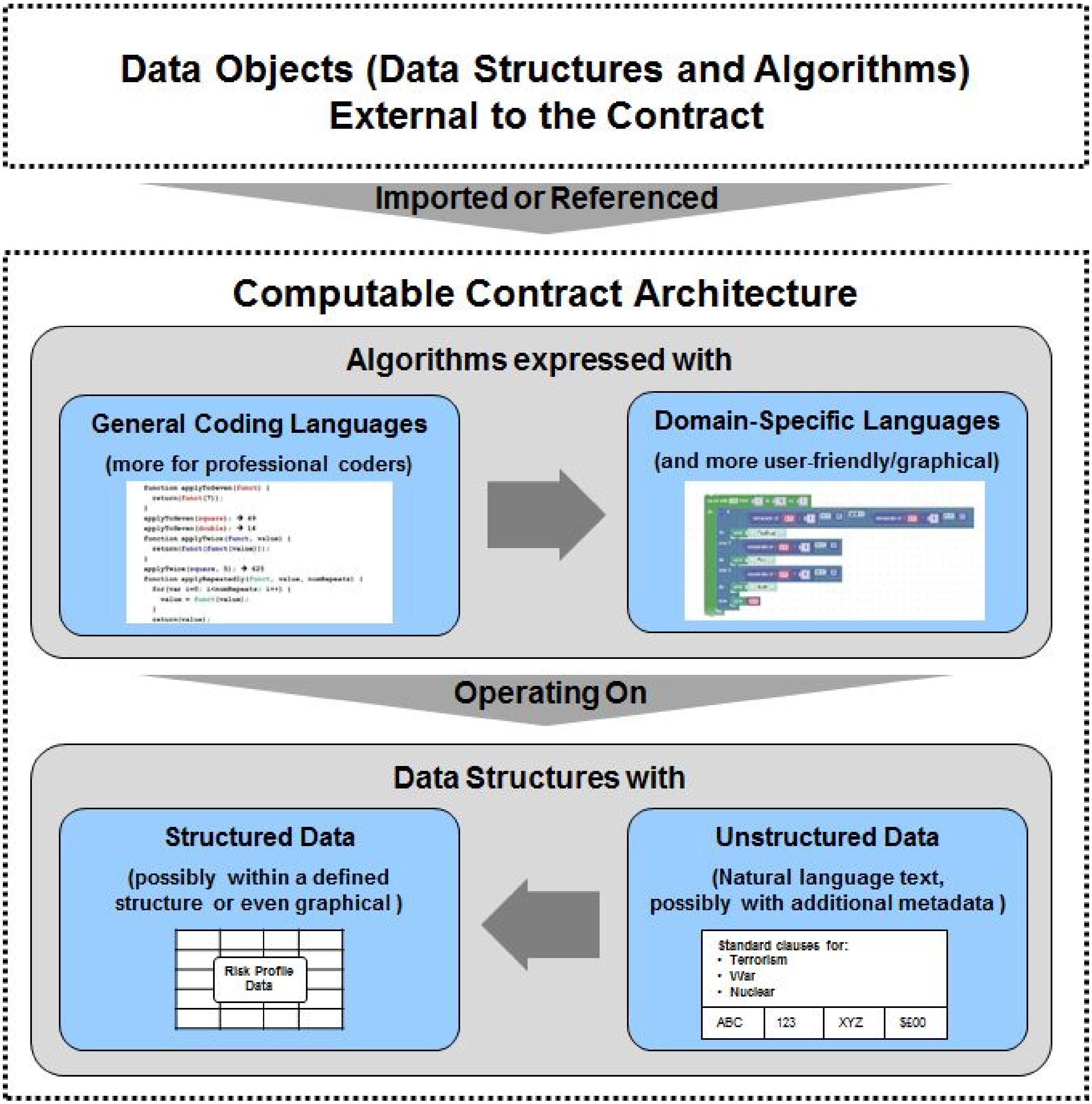

Figure 4: Contract Architecture for (Re)insurance Contracts

Data is often classified as either ‘structured’ and ‘unstructured’. A typical reinsurance policy document is largely unstructured, even though, with section headings and paragraphing, it may appear to be structured. As far as it is pragmatic to do so, ***the aim is to engineer as much of the unstructured data as structured*** (represented above by the arrow pointing to the left).

However, (re)insurance contracts will always contain a combination of:

- **Structured data** e.g. risk profile data within a defined structure (e.g. a table). Structured data may also be presented in a graphical way; and
- **Unstructured data**, mainly natural language text (e.g. standard provisions for terrorism, war and nuclear), but may be augmented with metadata (information about the natural language text) that may well be structured.

As described in the previous subsection, these data structures are then operated upon by algorithms. These are expressed in some form of computer code, which can be classified into:

- **General coding languages** such as C++, Java and Python, which are used by professional coders; and
- **Domain-specific languages**, which tend to be more user friendly and may not need such a high level of coding expertise, particularly if they employ graphical interfacing.

Again, and as far as it is pragmatic to do so, ***the aim is to be able to express the algorithmic aspects of (re)insurance contracts using a domain-specific language*** (represented by the arrow pointing to the right in the upper part of Figure 4).

5.4 Data Structure Example for R(e)insurance

A simple reinsurance-related example may serve to contextualise the description of data structures. A section from the 'definition of loss occurrence' for a property catastrophe ('prop cat') reinsurance contract has been used to create the data table below in Figure 5. This table shows a range of perils (some of which have been grouped), together with the duration limits, and some further details, including exclusions (terrorism, war, nuclear).

Group	Loss Occurrence	Duration Limit (hrs)	Further Details
1	Hurricane, Typhoon, Windstorm, Rainstorm, Hailstorm, Tornado	120	
2	Earthquake, Seaquake, Tidal Wave, Volcanic Eruption	72	
3	Riot, Civil Commotion, Malicious Damage	72	Within limits of one country
4	Flooding	504	Whatever the cause
5	Fire	168	Caused by 1, 2, 3 or 4
6	Collapse caused by weight of snow or water damage from burst pipes or melted snow	504	
7	Other of whatsoever nature	168	Excluding 1, 2, 3 or 4
8	Terrorism, War, Nuclear	N/A	Excluded

Figure 5: Data Structure for Definitions of Loss Occurrence

Several clauses in the 'definitions of loss occurrence' concern ***the duration limits for combinations of the groups of loss occurrences defined in the table***. The figure below shows a graphical representation of the following provision for duration limits: *"120 consecutive hours as regards any 'Loss Occurrence' which includes individual loss or losses from a combination of any of the insured perils mentioned in groups 1, 2 or 3. However, it is understood that within the period of consecutive hours the Reinsured shall treat as constituting a Loss Occurrence all individual losses occurring during a period of: 120 consecutive hours as regards the insured perils referred to in group 1; and 72 hours as regards the insured perils referred to in groups 2 and 3."*

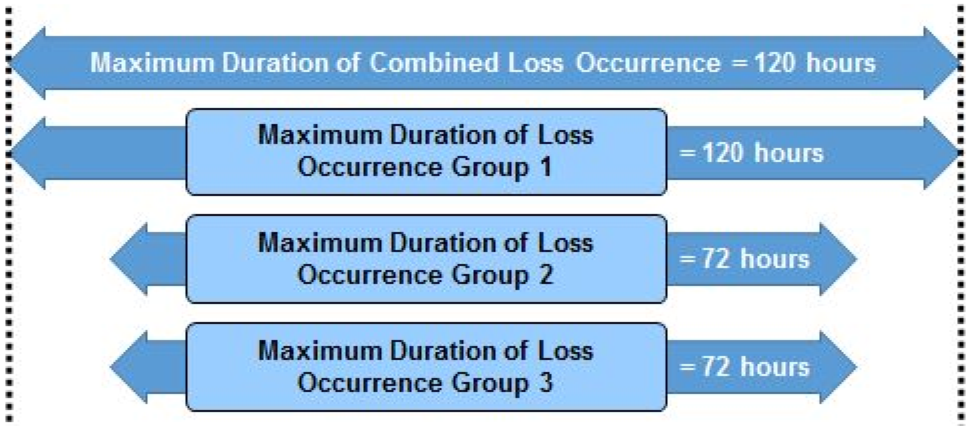

Figure 6: Visualised Data Structure for Definitions of Loss Occurrence

The above example serves to show how elements of a reinsurance contract can be represented in a computable form with two basic data structure types, the first of which is a standard table and the second of which is a more graphical representation of limits. It might be said, however, that this example is oversimplified and that there are many contracts in which, for example, the 'type' of flooding[3] may need to be defined in a greater level of detail. From a data structure perspective, this poses no issue at all: it simply means adding one or more levels to the data structure.

It might also be said that "the risk modelling community is doing this already", which is a correct assertion. It might also be that risk assessment models are not sufficiently aligned as the level of detail increases, and this would be an important area to address in establishing standard data structures. Ultimately, however (and until this alignment does exist), it may well be that details are added to contracts that serve mainly to keep the client happy, rather than having any impact on operational processes such as risk assessment or claims management.

Just as a traditional paper contract might make reference to other documents, a computable contract may reference data structures and use algorithms that lie outside of the notional boundary of a computable contract (mentioned in Section 5.6). This will be determined by factors such as data storage, processing requirements and ownership.

[3] Flooding types may include: pluvial, fluvial, river, inundation, flash floods, coastal, tidal, high tide, high seas, rising water table, surface, dam failure, drains backwater

5.5 Domain-Specific Languages Example for (Re)insurance

One area that is likely to see significant innovation in the insurance sector going forward is the development of domain-specific languages. In simple terms, a domain-specific language provides a user with the vocabulary and grammar, specific to a particular application domain (such as (re)insurance), to enable data structures to be processed or modified in a desired way. The basic idea is to enable the user of the language to feel at home by adopting familiar concepts and frameworks, thereby ensuring a steep learning curve.

In 2012, a paper was presented by the Bank of England on the need to move “towards a common financial language” [37]. Maybe in part spurred on by this paper (and maybe also by the financial crisis), the past ten years or so have seen a mushrooming of domain-specific languages for financial systems [38]. A closer analysis of these languages for financial contracts lies beyond the scope of this report, but it is often suggested that technological innovations in the finance sector manifest themselves in the insurance sector after something of a time delay.

Indeed, domain-specific languages are starting to emerge in the (re)insurance space. RMS has recently unveiled its CDL (contract definition language) [32]. At this stage, its functionality is limited to enabling the determination of how much a contract pays out given a set of discrete loss scenarios. Nevertheless, it provides a clear indication of what we might expect in terms of a domain-specific language for the (re)insurance industry going forward.

Another organisation in the data analytics space, QOMPLX, has also developed a contract definition language for (re)insurance. It is broader in its functional scope than the RMS CDL and encompasses aspects related to automating data-and-analytics-intensive workflows for pre-bind underwriting, claims and portfolio analysis.

Beyond domain-specific languages, other examples of where the finance sector has moved more quickly than the insurance sector include ontology/schema development (see section 5.6), electronic trading systems and distributed ledger technologies (DLT). Now, even though it may be justifiably countered that electronic trading and DLT will be different for (re)insurance, and in some instances, just not appropriate, the quicker pace of innovation in the finance sector, relative to that of insurance sector, is particularly noticeable in the underlying ‘plumbing’ i.e. the data models and structures, the algorithms, and the standards that underpin them.

5.6 A Broader ‘Web of Data’ Requiring Standards and APIs

Individual (re)insurance contracts do not exist in isolation: they refer explicitly or implicitly to entities, events and legislation across the insurance industry as a whole, and for which much of the data lies beyond the scope of the data objects contained in a computable contract. it is vital, therefore that these ‘internal’ and ‘external’ data objects are able to ‘talk’ to one another.

This concept of a web of data objects (i.e. data structures and algorithms) for the (re)insurance industry may be thought of as a localised or industry-specific form of the Internet, or perhaps more accurately, an industry-specific form of the Semantic Web[4] for (re)insurance. And, In order for this web of data objects to operate in unison, there are two fundamental requirements:

- First, a common set of standards that define the form of data structures (with their component parts) *and* the function of some algorithms (and potentially the domain-specific languages that express them); and,
- Second, the 'glue' to enable these data objects to actually work together in some useful way, generally referred to as APIs (application programming interfaces). These APIs will also have their own data structures and algorithms, and for which adherence to standards may well be necessary.

As indicated in Section 4, data standards do exist for the (re)insurance industry (e.g. Acord), but they appear not to be widely used for all stages of the (re)insurance value chain e.g. the Acord standards are generally used for data messaging, but not for risk modelling. Going forward, and as emphasised in the Blueprint One strategy, it is paramount that these (and other) data standards are not only more widely adopted but aligned across the industry. It is not so much a case of starting from scratch, but more an exercise in leveraging and expanding of what is already there.

With the aim of accelerating the adoption of standards, creating an overview of the 'web of data objects' for (re)insurance could be an important enabling factor. Such a 'data map' would be similar to the RMS Entity Diagram [32] for risk modelling and will help to set priorities through encouraging a shared and holistic understanding of the structure and flow of data (or indeed lack of) for the insurance industry at a broader level, as well as serving to clarify some of the dynamics in specific areas e.g. data exchange between brokers and underwriters.

This idea of a 'data map' is sometimes referred to as an ontology[5] or schema[6]. And, both of these terms may be applied to the representation of a reinsurance contract (at a more granular level), or more broadly, for a 'web of data objects' for the insurance industry as a whole. Although at a relatively early stage, work is being undertaken by a 'collaborative community' to establish the Financial Industry Business Ontology (FIBO) [39]. At the moment, FIBO still does not have insurance specific content [40], but its work in other areas of the financial services industry serves as an indication of what will be required for Lloyd's to build a comprehensive data framework for the insurance industry[7].

[4] 'Semantic Web' - a proposed development of the World Wide Web in which data in web pages is structured and tagged in such a way that it can be read directly by computers
[5] 'Ontology' - a set of concepts and categories in a subject area or domain that shows their properties and the relations between them (Google)
[6] 'Schema' - an outline, diagram, or model. In computing, schemas are often used to describe the structure of different types of data (Tech Terms Computer Dictionary)
[7] This comprehensive data framework is likely to require data management approaches that build upon some of the ideas in the area of 'ontology-based data integration'

As standards for a range of data objects become more entrenched, the competition to establish the most powerful APIs at the more complex end of the (re)insurance sector will also intensify. The drive by different organisations to control the flow of, and to add value to, connected data structures should also help to push forward the adoption of standards. Typical examples here might include:

- Data enhancement to improve the quality, augmentation, and contextualisation of specific datasets;
- A single-point-of-access, risk assessment platform that has connectivity to a number of risk modelling entities (something similar to which is being pioneered by Oasis Loss Modelling Framework).

5.7 A Computable Contract Designer - A Website Builder Analogy

As outlined in Section 4, there are many document assembly systems currently available (e.g. Hotdocs or Contracts Express) that enable documents (such as contracts) to be created with ease and efficiency. Furthermore, some (more advanced) systems offer automated clause selection based on responses the user gives to a set of guided questions. In the course of undertaking this industry research, and based on general observations, it appears that the (re)insurance industry has not adopted this technology as widely as other sectors: contracts are usually in the form of straightforward Word documents, and are modified in accordance with needs.

It is important to remember here that document assembly systems are essentially text manipulators; the contract is not in the form of a computable data object. At best, the form of the data structure in this case is a simple tree, but with non-computable elements.

Websites, on the other hand, are rich, multi-facetted, computable data objects. Nowadays, a plethora of website building software equips the relative novice with the tools to create their own website, sometimes with relatively advanced functionalities. Using simple pull-down menus, drag-and-drop techniques, and a variety of other user-friendly experience design approaches, what was once the domain of the computer programmer is now the domain of the designer. In fact, it might be ventured that, rather than encourage the so-called ‘lawyers of the future’ to think like programmers, it may well be more apt for lawyers to adopt a ‘design mindset’.

Work undertaken by Helena Haapio (Lexpert Ltd / University of Vaasa) and Margaret Hagan (Stanford University) [41] has made a significant impact on establishing the concept of design in the legal space. In 2016, Helena spoke at a SwissRe conference on the subject of simplifying (or reengineering) complex contracts, such as those for reinsurance. Helena suggested three approaches for tackling the complexity of (re)insurance contracts:
i) Leave contracts ‘as is’, but hide the complexity – provide a better (graphical) user interface or guidance: examples, references, visualisation about contracts.

ii) Change contracts to make them less complex – optimization: plain language, plain design, clear typography – transformation: abstraction, visualisation in contracts, visualisation as contracts.
iii) Provide different ways to present the content – contracts as code (smart / computable / algorithmic contracts): tailor styles or dashboards based on user needs.

Simplifying and hiding complexity through redesign and visualisation, as well as providing dashboards for coded data objects may all be adopted in reinsurance contracts of the future. ***Indeed, it is suggested that the drafting of computable reinsurance contracts will use collaborative tools that are a hybrid form of automated document assembly systems and website building software.*** With their specific combination of structured and unstructured data, the form and complexity of reinsurance contracts is very much suited to this hybrid approach.

It is anticipated, therefore, that in the not-too-distant future, several start-ups (or even more established technology companies) will emerge that ***successfully integrate the concepts associated with website building with those of automated document assembly systems to create a wholly new concept: automated computable contract builders for more complex forms of (re)insurance.***

These computable contract builders will have access to libraries of data objects e.g. clauses with metadata or maybe a ‘dispute resolution object’ that could be used for certain dispute types. Just as a website can have an embedded e-commerce functionality, computable contracts may have one or more embedded dispute resolution functionalities.

Some data objects may be expressed using a controlled natural language - a language that looks like natural language, but is in fact a high-level coding language. A good example here is the Lexon digital contracts language, an initiative led by Henning Diedrichs [42]. While the current language is of a general nature, it is wholly plausible that a derivative approach could be developed, suited specifically for the (re)insurance industry.

5.8 The Computable Contracting Stack for (Re)insurance

In this section, a technology stack for computable contracting in reinsurance is explored. This brings together the components described in Sections 5.2 to 5.7 and may help industry professionals to imagine how the future for contracting in reinsurance could evolve, where they may play a role and how the respective components might fit together.

The computable contract builder will be something like a cross between a collaborative website building tool (such as Dreamweaver) and an automated document assembly tool. It will use domain-specific, contract definition languages (as coding algorithms) and have access to libraries of contract-specific data objects with defined functionalities. There will be in-built validation and consistency checking mechanisms to ensure that contracts are error-free.

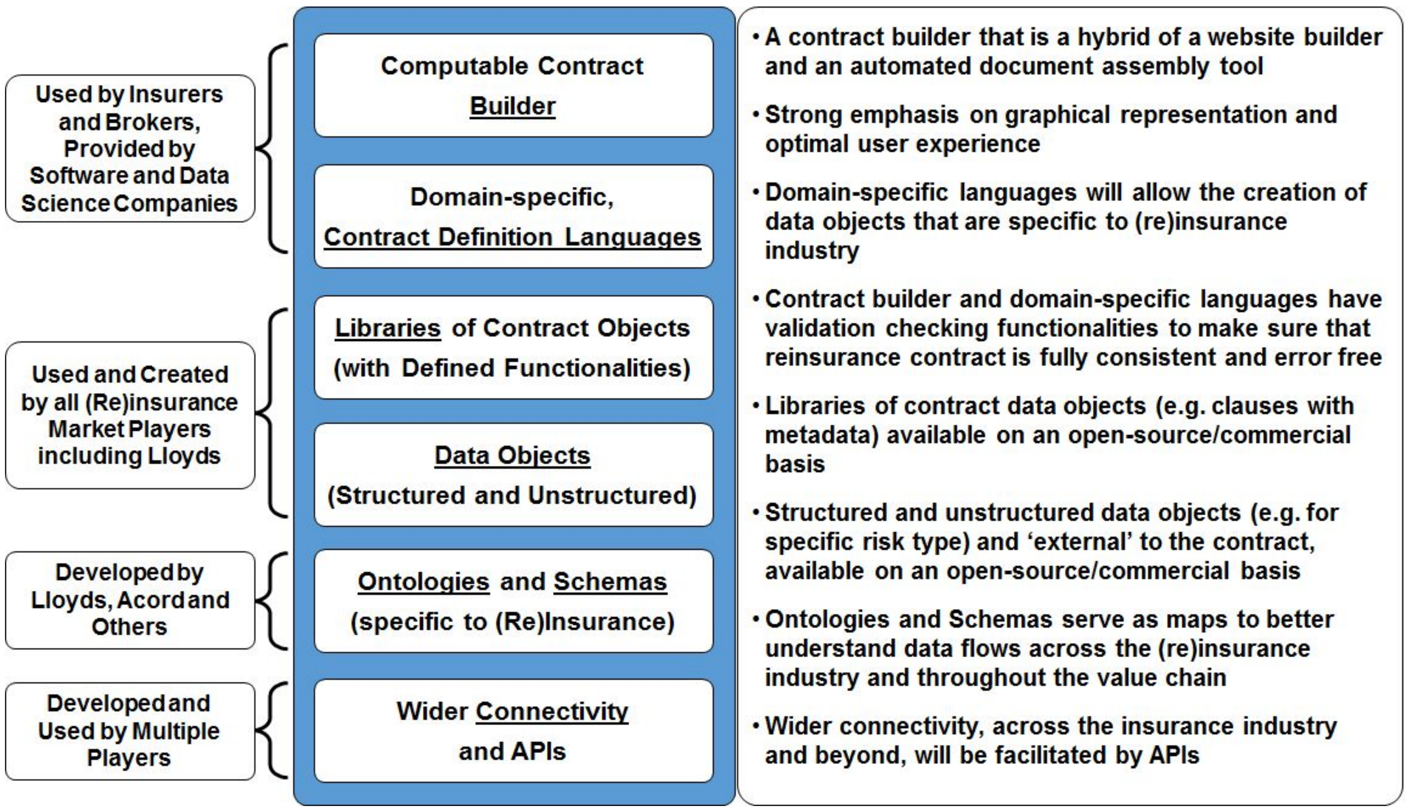

Figure 7: Technology Stack for (Re)insurance

Different parts of this technology stack will involve different players in different ways. For example, computable contract builders and domain-specific languages will be used by insurers and brokers and will be provided by software and data science organisations. Libraries of contract objects and data objects will be used and created by a variety of players in the (re)insurance market, as will APIs and systems to promote wider connectivity.

Industry ontologies and schemas that define the overall data landscape for (re)insurance will be guided and developed, as they are today, by Lloyds and the likes of Acord.

5.9 A Closer Look at Computable Contracting Approaches in Financial Services

Now that a future technology stack has been sketched out for the future of (re)insurance, it is always useful to look at what other sectors are doing. To this end, the International Swaps and Derivatives Association (ISDA) may offer some useful pointers.

Observation 1: In conversations with ISDA, it emerged that there is an interest in changing some documents in natural language text (or parts thereof) into a more standardised form of English. This would in essence create documents that are understandable by humans, easily translatable into multiple languages, and readily computable. Although at an early stage, there is a serious commitment to this initiative.

Observation 2: ISDA have developed a Common Domain Model [43], which sets standards for how derivatives are managed across the trade lifecycle. This includes, capturing the trade, risk analysis, core financial data, reporting, settlement and collateral. If we compare this to the (re)insurance sector, it appears as if they have done the equivalent of combining the electronic product placement and risk modelling into a single data model. *"The ISDA CDM enables a consistent hierarchical representation across trades, portfolios and events, providing enhanced risk management and trade processing capabilities."* In the (re)insurance sector, and as many market insiders have commented, it appears that much of the innovation "*is focussed on the trade*". Here, for example, Ed Broking has been leveraging the financial trading expertise of BGC partners (its owners) to develop early-stage prototypes of a (re)insurance trading platform. The message here is that innovation often has to start with where the action is, and work outwards.

It is worthwhile mentioning MLFi, Lexify's [44] domain-specific language for defining financial contracts, both in terms of their product composition as well as their workflow. Their approach builds on the groundbreaking work of Simon Peyton Jones and Marc Eber [45][46] to use functional programming approaches for specifying financial products.

Observation 3: ISDA have developed a new platform called 'Create' [47] that "allows firms to produce, deliver, negotiate and execute derivatives documents completely online. The system captures, processes and stores data from these documents, providing users with a complete digital record." Of particular interest here is the fact ISDA Create combines the two aspects of automated document creation and digital functionality: *"online functionality makes the negotiation process more efficient and less time consuming from start to finish."*

Clearly, derivatives trading is a different business to (re)insurance, but as indicated elsewhere in this document, if the financial sector is a technology leader, the insurance sector is a follower. However, while the ISDA CDM and Create tools and the MLFi language should not be copied, a closer inspection would undoubtedly help the (re)insurance sector to progress in developing computable contracting approaches.

6. Impact and Prototyping

After having looked at what is out there (Section 4), as well as what might be (Section 5), this section will take a look at the two practical considerations of:

- What the expected benefits might be; and
- What the next steps would be in terms of making computable contracting a reality.

6.1 Estimating the Impact

Computable contracting approaches will contribute to significant reductions in the cost of doing business, and will pave the way for the emergence of new business models. Of course, for innovations of this nature, estimating the impact quantitatively, or describing the exact nature of new business models represents something of a challenge.

As a start, and as stated in the section on measuring success of the Blueprint One strategy, it is *"believed that digitisation, automation and simplification could reduce the cost of doing business from 40% to 30%."* [ref: Page 12 of Blueprint One]. This represents a full 25% reduction of the operating costs for Lloyd's (or 10% of gross income), which are around £3.6 billion[8] annually.

As something of a precursor to Blueprint One, the London Market Target Operating Model sought to achieve more modest cost savings of £350 million over the five-year period (from 2015 to 2019). These cost savings were to be achieved through straight-through processing for underwriting, claims and delegated authority. However, as an overview document for TOM suggests [48], *"these quantified benefits do not include other expected benefits, including new business generated due to increased ease of doing business, international services, improved customer experience, broker benefits due to faster claims processing and greater ability to track claims, savings through better risk management and better fund management to delegated authority."*

Hence, the Blueprint One strategy indicates financial benefits that are roughly an order of magnitude bigger than the Target Operating Model: £3.6 billion versus £0.35 billion (with TOM's figures stretching over five years but with some efficiencies not included).

In 2011/2012, research undertaken by the International Association for Contract and Commercial Management (IACCM) [49] concluded that: "good contract development and management could improve profitability by the equivalent of a massive 9% of annual revenue. This value is not industry specific, but, as a general rule, it indicates that improved contracting can lead to cost reductions of at least several percentage points.

[8] Lloyd's gross premiums were £36 billion in 2018, and for which there was a loss of £1 billion. The gross income for the overall London Market is around £65 billion.

Combining the thinking above and with a little guestimation, the financial benefit of computable contracting for (re)insurance therefore is likely to fall somewhere in between 1% and 10% of overall premiums (or a reduction in the costs of doing business of between 2.5% and 25%).

Given that there are many initiatives in Blueprint One that account for this overall 25% reduction in the costs of doing business (and not just computable contracting), a somewhat **conservative** estimate might suggest that ***computable contracting could unlock a reduction of approximately 5% in the costs of doing business in (re)insurance at Lloyd's, or somewhere in the range of £0.5 to 1 billion per annum.*** Furthermore, this figure would be doubled if one were considering the whole London market, or quadrupled if less conservative.

Beyond the Numbers

With cost savings, however, we are just starting to scratch the surface of the potential impact. As already indicated, computable contracting approaches will unlock a number of efficiencies that go well beyond the preparation and negotiation of contracts: it will also reform the downstream activities of compliance checking, subjectivity monitoring and claims management.

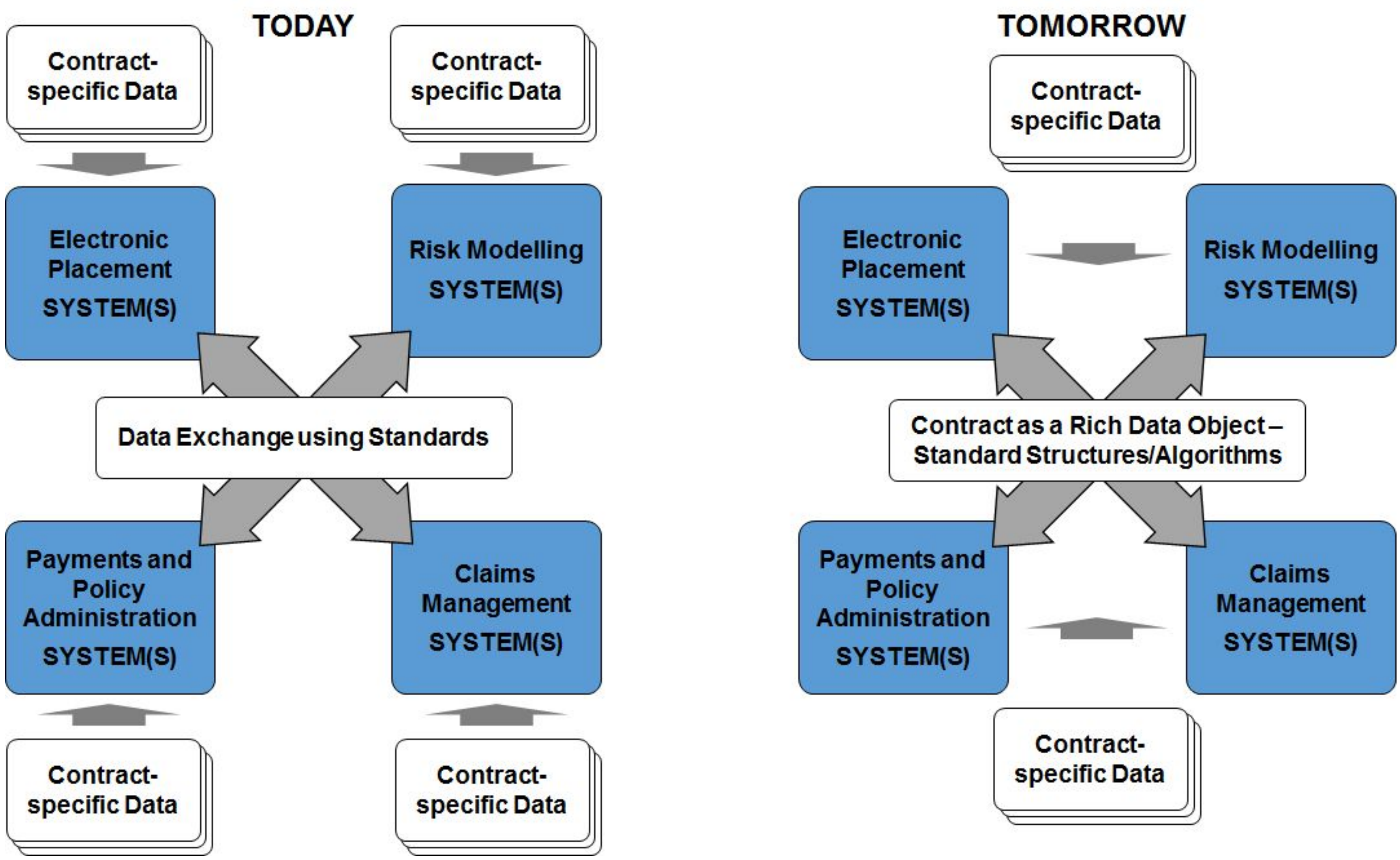

Figure 8. Contracting Paradigms for Today and Tomorrow in (Re)insurance

Figure 8 above shows the transition from the traditional contracting processes of today to the new computable contracting paradigm of tomorrow. Basically, the approach today involves entering contract-related details into separate systems (often multiple times) and then adopting standards to achieve interoperability between the systems. Tomorrow will herald an approach whereby the contract sits at the heart of operations and feeds (and is fed by) multiple systems simultaneously. As a rich data object, the contract will adopt standards for data content, structure and processing.

WIth regard to the emergence of new business models for (re)insurance, this new architecture will underpin a much greater product/service flexibility and may help to usher in a number of innovations such as: weekly insurance policies; seasonal peril purchasing; coverage suspension; and usage based pricing. In addition to unlocking product innovations, the new computable contracting paradigm will underpin easier transfer of complex risks, which, in turn, should help to increase capital availability (one of the key pillars of the Blueprint One strategy).

The User Experience

As already described, the contract drafter of the future for (re)insurance will have an experience somewhere between website (or rich data object) building and automated document assembly. The insured will feed into this process by providing detailed (and structured) information on risk types, geographical coverage, and other factors. The buyer will follow a guided process augmented by technology and people.

6.2 Pathway to Prototyping

Implementation should combine ambition for the sector, best practices and pragmatic approaches. In particular, the development of prototypes (as practised in Blueprint One) should be a central idea towards the full implementation of computable contracts. This section outlines five main actions for prototyping.

It is suggested that one of two lines of business are selected for implementation of the following prototyping actions. This would help to ensure that sufficient progress is made so that industry players can develop a sense of what computable contracting approaches actually look like. Early suggestions have included terrorism, or possibly cyber insurance, which is a relatively young area in the market, and may be open to some innovative thinking.

With regard to a vehicle for getting things done, there are three options that could be considered:

- **Led by Lloyd's** through integration with the Blueprint One programme of activities;
- **Integration with existing consortium** (e.g. B3i) to minimise incubation time and to better leverage activities undertaken to date; or/and
- **Establishing a new consortium/entity** with selected industry players (and with all participants as co-sponsors/funders).

Action 1 - The Data Map

Develop a comprehensive industry data map (ontologies or schemas) to facilitate a shared and more holistic understanding of data types, structures, flows and volumes among main stakeholders. The RMS Entity Diagram [32] and the Oasis Open Data Standards (ODS) both serve as an example here as to how it might look. Building upon Acord's existing schemas would be a good place to start.

Action 2 - Mock-Ups of Computable (Re)insurance Contracts

Reengineer/Redesign a suite of complex reinsurance contracts so that they are expressed in a way that is potentially computable: mock-up computable contracts for reinsurance with data structures and algorithms. This should draw from some of the ideas currently being advanced to develop domain-specific, contract definition languages, including the finance sector (e.g. ISDA).

Action 3 - Identify and Focus on Key Areas to Close Gaps in Key Standards

Using the data map (Action 1) and the mock-up contracts (Action 2), both of which are essentially 'paper-based exercises', identify those data objects that are most in need of development of standards, and particularly where interoperability is required. This may include the LMA standard wordings so that they have a greater level of inbuilt structure and broader applicability. It may also involve an exploration of how to map one set of standards to another set (e.g risk modelling standards and data exchange standards for the post-binding phase) in order to establish a greater integration of standards across the value chain.

Action 4 - A Prototype Computable Contract Builder

Use an app prototyping tool (such as Just in Mind [50]) to develop a prototype of a Computable Contract Builder so that industry participants can get a better understanding of what the drafting process for computable contracting might look like in the future. One key aspect here will be to involve the website building community (or at least the designers of tools for building websites) as well as innovators from the automated document assembly community.

Action 5 - Analysing and Assessing Business Impact and New Business Models

By building structure and intelligence into (re)insurance contracts, many parts of the (re)insurance value chain will be impacted. These detailed impacts should be mapped to provide a stronger basis for the estimates in Section 5.10. It should also allow a more detailed understanding of the form of new business models that are likely to emerge.

7. Conclusions

There is a palpable sense of urgency in London's (re)insurance market that, unless costs are slashed, the future of Lloyds as a global centre for reinsurance is under threat.

The launch of Blueprint One by Lloyd's in late 2019 as a comprehensive strategy towards digitising the market seems serious and well thought out. On the data framework side, it is a little light on detail, and it is here that maybe this report can make a contribution on how to address these aspects.

Originally developed as a concept by the University of Stanford, computable contracting approaches are set to change many aspects of contracting through making contracts simultaneously understandable by humans and computers. Not only will these approaches lead to significant cost reductions, but they will also facilitate the emergence of new business models. The (re)insurance sector is particularly amenable to adopting these approaches.

Within the (re)insurance sector, there are several contracting technologies, but they all 'automate around the contract', essentially leaving the contract as a 'dumb', unstructured document while data is lifted out by various systems (often manually) and inserted into the (often different) data structures of various systems across the value chain.

The future lies in putting contracts back where they belong: at the core of operations. To do this, contracts will be rich data objects containing both structured and unstructured data and algorithms expressed in a human-friendly, domain-specific language. It is here that some inspiration might be found in the work of ISDA in the financial sector.

More broadly, creating these computable contracts will be something like a cross between using a sophisticated automated document assembly system and a website building tool in a collaborative fashion. And in some respects, the science of design will be just as important as the science of data.

By putting contracts right at the heart of digital operations, it will help to establish data and algorithmic standards across the (re)insurance value chain: pricing/negotiation/binding; payments and policy administration; portfolio management and risk modelling; claims management; and capital modelling. As a unifying concept, computable contracts will provide a single thread throughout the contracts lifecycle.

Initial impact analyses suggest that computable contracting approaches will make a significant contribution towards halving the costs of doing business, seen as essential by Lloyd's CEO, John Neal.

Finally, making it happen will emphasise the building of prototypes, an approach that seems very much in line with the Blueprint One Strategy. These prototypes will enable the next generation of reinsurance contracts to be built as rich data objects, whose connectivity spans the complete value chain.

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Appendices

A.1 Industry Experts Involved in Research

The success of this project is due in large part to a number of people at different organisations.

In particular, Alastair Speare-Cole, Anant Borole and their colleagues from QOMPLX, who have worked with John throughout the course of the project. In addition to explaining aspects relating to data analytics, portfolio management and underwriting in the (re)insurance sector, they also shared details on the functionality, goals and workings of their contract definition language and their MGA underwriting systems workflow.

From the Lloyd’s Market Association, Sheila Cameron and Peta Kilian have helped to open the door to Lloyd’s and their plans, particularly in the area of developing a data framework.

David Hilson, Andrew Arram and Christopher Butten from Aon helped John to delve into reinsurance contracts and to start to take them apart.

Alastair Burns form the Hartford has provided invaluable insights and wisdom by giving John a full, behind-the-scenes tour of Lloyd’s, as well as several meetings to discuss many of the fundamental dynamics of the (re)insurance industry.

Jonathan Prinn from BCG has been very helpful in enabling John to glimpse some aspects of the future of (re)insurance, particularly concerning electronic placement and trading systems.

From Swiss Re, Richard Phipps and Rory Unsworth (now left) were extremely helpful in sharing their ideas on the future of contracting in reinsurance. Rory’s help in explaining Swiss Re’s Blockfinder tool (which he architectured) was particularly valuable.

Marcus Broome (CEO Whitespace) kindly spent an afternoon with John describing the functionality of the Whitespace system.

Antonio Dimarzo, Fabrizio Faraone and Ken Marke from B3i helped John to understand B3i’s objectives from a contracting perspective.

Other extremely useful dialogues have been led with Alex Thomas (Beazley), Walid Saqqaf from Insure Blocks, and Gary Bass (Consultant in Claims Handling).

A.2 Details of Key Activities for the Research Project

The following schedule of activities will be undertaken for the research phase. This schedule has two levels: ‘key project activities’ at a higher level (essentially groups of tasks), and then the tasks themselves

1. Analysis of Existing Natural Language Reinsurance Contracts
Objective: To better understand the scope for computable representation and automation. This will help to identify where and how to automate contracts and supporting processes.

- Identifying contract types
- Identify and build ontologies (to assist domain-specific interpretation AND automation-technologies) and reusable modules to support templating, standardisation and automation

2. Analysis of State-of-the-Art Approaches to Contract Automation in Reinsurance
Objective: To better understand the most promising solutions currently available to support contract automation in the (re)insurance sector.

- ‘Smart’ Contracting in insurance - see Accord Project and Clyde & Co
- Contract lifecycle management solutions for insurance - see e.g. Exari
- Explore proposals for electronic systems for ePlacement in (re)insurance

3. Process and Systems Mapping for Reinsurance
Objective: To create a clear understanding of the activities undertaken, the people (organisations) involved, and the systems used for (re)insurance. By identifying weaknesses in the current system, this will a) help to identify where contract automation can help, and b) how it will help in terms of the impact.

- Mapping the current view - also indicating areas for potential improvement
- Mapping future alternatives - also indicating impact
- Linking features within QOMPLX’s Contract Definition Language that accomplish any/all the above
- Linking in features from Oasis LMF approach to standardisation of event types (with open access)
- Linking with proposals for integration with ePlacement initiatives
- Building the case for change (the ‘business case’) including a clear impact/benefits analysis

4. Benchmarking with the Finance Sector
Objective: To identify the best practices regarding contract automation in the finance sector.

- Lexify / Haskell approaches (Peyton Jones)
- Learning from computable derivatives-contracts under the ISDA Master Agreement
- Designs neutral to/assisted by ‘smart’ contracting (and supported by DLT/blockchain)

5. Identifying and Engaging Champions

Objective: To identify key people that might play an important role in helping to effect changes to the current mode of doing business.

- Identify people and roles
- Estimate funding requirements for potential involvement
- Identify conflicts of interest

6. Mapping out the Next Phase

Objective: To produce a plan of action for a defined consortium to implement a working prototype. This should also include the identification of funding.

- Produce a plan for definition and development of a working prototype
- Confirm consortium partners
- Identify potential funding sources and funding application processes

A.3 Key Questions to be Addressed In Interviews

Through undertaking the tasks outlined in the Section A.3, the following questions will be addressed:

1. What are the issues/challenges with the current way of contracting (and doing business more generally) in reinsurance?

2. Which approaches are currently used to support the automation of contracting (and related activities) in reinsurance? This will cover ‘smart contracting’ and ‘contract lifecycle management’ approaches.

3. How could contracts be re-engineered to demonstrate the following:
    - Greater levels of standardisation, including the structure of the language (and not just the terms)?
    - Greater levels of modularity (for which standardisation is a prerequisite), which then provides a platform for creating new contracts?
    - Use of rules-based ‘wizards’ or expert systems for contract/clause/phrase selection?

4. Which parts of contracts can be automated, or are worth automating?

5. How might things be done differently in the form of alternative solutions?

6. How would these alternatives:
    - Allow seamless risk transfer throughout a reinsurance network?
    - Link to ePlacement initiatives?
    - Align with existing approaches for electronic specification of reinsurance cover?
    - Link with databases for standard definitions and descriptions of events (Oasis LMF)?
    - Facilitate greater securitisation of reinsurance risk?

7. In view of the above, what would be the impact/benefits of these alternative approaches?

8. What can we learn from other sectors e.g. finance?
    - Functional specifications e.g. Lexify
    - ISDA Agreements