LONG FINANCE

From Slips To Smart Contracts

Intelligent Technology
In The London Wholesale Insurance Market

A Long Finance report prepared by Z/Yen Group
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Sponsored by the London Market Group

LMG

Contents

Foreword

The London Market Group is pleased to sponsor this study into the potential applications of 'smart contracts' in the London wholesale insurance market. An abundance of new technologies and new technology interactions has created the buzz surrounding 'InsurTech', the emerging combination of insurance and technology.

Smart contracts are "the implementation of contract terms as executable computer code". Their popularity has grown as people realise that the computer code can be embedded in distributed ledger technology, thus increasing their reliability and robustness.

Smart contracts have the potential to streamline much London wholesale market processing, realising the straight-through-processing potential. They also have the potential to reduce costs markedly, improve the client experience, reduce risk, and deliver new products. A tall offering.

We are delighted to have been involved in commissioning this report which we hope demystifies Smart Contracts and goes some way towards pointing to the opportunities for their adoption in the commercial insurance world. We feel that this is a material technological advance that will eventually lead towards significantly greater efficiency and more client facing solutions in our marketplace.

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1. Executive Summary

Background

The London Market for wholesale insurance provides bespoke cover for specialist risks to large clients. At a processing level, this involves data-heavy interactions between multiple participants in a one-to-many value chain, in addition to large-scale processing within individual firms. Brokers, underwriters, and reinsurers cooperate and compete, creating a complex environment for agreeing cross-market structures.

Since the 1970s, a series of digital technologies has allowed steady improvements in both inter-firm and intra-firm processing. The London Market is a widespread user of data standards, computerisation, workflow, databases, and electronic data communication such as messaging, document repositories and websites. Applications have been implemented both within and among firms. Although none of the individual improvements may have appeared revolutionary at the time, the cumulative effect has been a step change in working practices and capacity, with the market today handling hugely more data with greater efficiency, speed, and control than would have been conceivable forty years ago.

Continuing technology development means that the steady improvements of the last forty years are likely to continue. The London Market Group TOM (Target Operating Model) initiative aims to continue to make market processes more effective and efficient. Yet newer digital technologies offer the prospect of accelerating change and transforming ways of doing business. Smart contracts, in conjunction with a confluence of new technologies and networks, provide a vision of more efficient and accurate processing with improved control to underlying legal agreements, particularly attuned to the complexity of wholesale insurance.

Objectives & Scope

The London Market Group, representing brokers, insurers, and reinsurers in London, is committed to improving "the ease of doing business in the London Market, locally and globally"[1] and sponsors initiatives such as the TOM towards

[1] LMG, "Blueprint Enterprise Architecture", August 2016 - http://isupporttom.london/media/8816/lm-tom-enterprise-architecture-market-v1-0.pdf

this goal. The London Market Group believes that effective use of established and emerging technologies over the next few years will enable its members to continue to increase efficiency, to innovate products, and to improve competitiveness relative to other markets. The London Market Group commissioned this report to explore the use of smart contracts in improving cross-market processes, and understand the potential use of smart contracts with associated technologies in wider contexts that involve insurance. The time horizon of interest is roughly the next seven years.

Mark Twain offers an aphorism on making predictions: "Prophesy is a good line of business, but it is full of risks." Conscious of this, we have tried to adopt appropriate humility; we concentrate on documenting and analysing current technologies and trends and we explain the rationale and the limitations behind such predictions as we risk. Firms need a framework in order to understand the possibilities and risks inherent in new technologies, and to consider these appropriately in their strategic thinking. To balance Mark Twain with Dwight D. Eisenhower: "Plans are nothing; planning is everything."

Smart Contract Opportunity

Smart contracts translate legal contract terms directly into executable computer code within a business process. This creates a rigorous link between the legal contract and business processes, increasing efficiency and effectiveness, and reducing errors.

A prerequisite for using smart contracts in a process is to have sources of agreed data to trigger all subsequent actions without manual intervention. Smart contracts therefore provide a further layer in a 'Straight-Through-Processing' (STP) environment. The power of the smart contract approach is to bring the end-to-end client relationship into the control and processing framework, ensuring structured communication between business, legal, and back-office staff. This rigour can eliminate errors both in drafting the original contact and in translating the contract terms into the operational process.

As with all technologies, there are areas where smart contracts will be the appropriate solution and other areas where they will not work so well. For example, reinsurance treaties can be largely standardised and smart contracts could add rigour and efficiency to the process, but in facultative reinsurance, where each risk underwritten has to be separately defined, every agreement is largely different and the overhead of using smart contracts may be too high.

The research identified five broad areas within the London Market where smart contracts could be applied: Process, Product, Portal, Performance, and Privacy. These are reviewed briefly here, with an indication of the opportunities for the use of smart contracts within each.

Process

This refers to the cross-market processes in the London Market, such as subscription and claims settlement. Even after TOM, the overall architecture of the processing will consist of brokers and underwriters communicating extensive and iterative versions of risk and contract data through messaging.

For multiple firms to use smart contracts in their processing there would need to be further inter-firm systems integration, so that data could flow directly between broker systems at one end and underwriter systems at the other without manual intervention. Integration could be expanded on the front to the client and on the back to reinsurers and capital markets, so that the scope for STP is greater than simply within the Market itself. Such inter-firm cooperation could be entwined with other technologies designed to share data, for example mutual distributed ledgers. There are huge potential gains in cost savings, accuracy, and speed, from implementing STP across market processes, but there are also major institutional barriers.

One area where TOM is overcoming these barriers and creating the environment for STP is in enforcing that premiums are allocated fully at the time of contract binding; this is currently not a requirement. Once the full information is available at binding, it will be possible to implement STP to automate the process from receipt of premium to payment to all relevant parties. Whether or not this involved smart contracts, it would be a proof-of-concept for STP in cross-market processes.

A separate area where firms could consider smart contracts in their processing would be managing wordings. Legal contracts, especially those applying across jurisdictions, can have complex requirements for wordings, and the control capability offered by smart contracts could be useful in managing this with greater efficiency and effectiveness.

Product

Smart contracts, in conjunction with other digital technologies, allow development of new insurance products or of new capabilities for existing products.

A new product idea is insurance for reputational risk where the measure of reputation is a complex formula based on social media traffic. Smart contracts could provide a mechanism to define, track, and measure potential loss events, and to manage the claims process. For insurance of other intangibles, such as intellectual property or brands, smart contracts may similarly enable efficient and effective management of complex definitions of loss specified in a legal contract.

As an example of improved capabilities, if an insurer can access the insured's data directly, it becomes practical to structure an insurance contract so that the insurer can mitigate risks in real time, thus preventing some loss events or reducing the quantum of loss. Other possibilities include adjusting the premium automatically as the insured's circumstances change and initiating some types of claim automatically, thus reducing the costs to the insured.

Portal

Distribution costs are high in the London Market as most transactions are mediated by personal contract between the broker and the insured (and, for deals going through subscription, also between the broker and multiple underwriters). If some transactions, particularly for SME customers, can be signed up through a web portal with subsequent automatic processing mediated by smart contracts, then distribution costs for these deals can be radically lower. Portals, *per se*, already exist and are fairly generic in functionality. Smart contracts provide the potential to automate more complex administration that should be largely invisible to clients. For example, notifications when limits are approaching triggers, or allocations of cover, or inspection reporting. This has the potential to reduce costs and to attract business from new clients who would otherwise be too small to deal directly with the London Market.

Performance

There are two main categories for performance improvement, risk analysis and risk mitigation. Risk analysis can potentially be improved using techniques from Artificial Intelligence (AI) and resources from big data, but the deeper need is for larger and more complete cross-industry datasets of policies and claims. Brokers and underwriters appear reluctant to share such data, as they believe they are more valuable to their customers if they hold proprietary information. Smart contracts allow a 'half-way house' in data sharing, where granular data could be summarised for sharing and there could be a deliberate delay in transmission of days or months. Structured delay might lower objections to sharing some private market information that in aggregate would allow all firms to improve their risk analysis, without individual firms feeling that they were giving up too much competitive advantage.

It is but a small step from releasing data to a central area to creating indices. Indices permit certain types of insurance-linked securities and other means for smart contracts to interact with the capital markets. One example might be a set of smart contracts that poll thousands of computers in a geographical area to determine whether they are functioning correctly. If a threshold of non-functioning computers were reached, for example, more than 2,500 out of 10,000 not available for more than four hours, then an event would be declared, triggering payment under an insurance policy or insurance-linked security.

Smart contracts can enable a firm to write detailed mitigation clauses in the legal contract and to implement them automatically. Thus the insurer of a marine risk might have the right to demand that if the telemetry from a ship's engine showed emerging problems, then the ship should go to the nearest equipped port for repairs or the policy changes dynamically. This could have the effect of reducing the overall number and size of claims. Claims prevention is also perceived as a benefit by clients, who typically will have costs beyond the insured amount arising from any loss.

Privacy

The trend is for statutory requirements for the control of sensitive data to become ever more stringent, for example with the forthcoming full implementation of the EU's General Data Protection Regulation (GDPR) in 2018. Smart contracts could offer an improved control framework for

managing sensitive data within statutory requirements. This control framework could ensure better communication and cooperation between business, compliance, operations, and systems staff in implementing requirements and create a clear audit trail from the policy to its implementation. A key benefit would be improved control over process changes as statutory requirements change.

The following table summarises the potential benefits of each of these five areas, both to Market firms and to clients. The benefits of cost, accuracy, and speed accrue directly to the Market, although the net effects should include at least some reduction of premium costs to the client. Oversight of the market should also be simpler and more effective with better information. 'Risk management' refers particularly to preventing losses or mitigating the impact of losses which do occur; it should be a direct benefit both to the firms and to the client. 'Client facility' means that the client has the ability to purchase a policy with capabilities or at a price that was not previously available.

	Cost	Accuracy	Speed	Oversight	Risk management	Client facility
Process	✓	✓	✓			
Product	✓	✓	✓			✓
Portal	✓	✓	✓			✓
Performance	✓			✓	✓	✓
Privacy		✓		✓		

Findings

The large number of use cases in different areas which we found for STP and smart contracts indicates that these are technologies which could have a strong impact on the London Market over the next few years, and they should be part of the strategic debate within firms and at Market level. We suggest further development of the ideas surrounding:

- 'follower syndicate' proposal for applying smart contracts;
- opportunity for smart contracts in implementing STP for settling payments;
- smart contracts for contract wordings;
- governance structure for sharing data that feeds smart contracts;
- geolocation information feeding smart contracts.

There is no simple way to progress smart contracts, given the multi-party nature of the Market, and this report recognises that a core recommendation

is that smart contracts remain on the strategic agenda for the Market as a whole and for individual firms for the foreseeable future. Smart contracts will be important for wholesale insurance and need to be part of future discussions and gain the attention needed to be built appropriately into future Market processing architecture.

2. Background to the Study

This study was commissioned by the London Market Group in October 2016 as a review of the impact of smart contracts and other new digital technologies on the London Market for wholesale insurance. The context for the review was the London Market Group's goal to promote efficiency and innovation in the London Market, coupled with the strategic pressures on the Market from costs and competition.

The study was conducted over seven weeks from end October by a team from Z/Yen. The aims were to identify the scope for improving efficiency and generating new products and capabilities through adoption of smart contracts in conjunction with the new technologies, and to suggest how the London Market Group and its members could best incorporate this into their strategies and into tactical initiatives.

Methodology

The work started with a review of published material on smart contracts and on current activity in the utilisation of digital technologies in insurance. This allowed development of a model of different areas of impact and of barriers to implementation. The second phase of work was to interview some 60 market participants and other stakeholders to validate and develop the initial model.

The interviewees fell broadly into two classes: direct stakeholders in the London Market, including brokers, underwriters, global insurers, and central processors, and experts from outside the London Market who had involvement in technology or insurance. In addition, we spoke with a handful of sophisticated clients.

The initial findings were presented to a group of industry professionals for review and challenge at a project workshop; this led to a final retuning of the model and the completion of this report.

The report is organised around the following goals:

- to define and describe smart contracts and other relevant new technologies;
- to document the potential benefits of smart contracts to the London Market;
- to describe the current activity in the Market regarding smart contracts;

- to identify specific use cases for smart contracts;
- to recommend next steps the London Market might take in this area.

Technologies

A note about the title of this report. Forty years ago – much as was the practice three centuries earlier – subscription business in the London Market was conducted exclusively through paper slips. A broker would walk around the underwriters with a document summarising the proposed insurance, and would get offers to cover some or all of the risk, possibly with changes to the proposed terms. When the broker had the full risk covered and could get terms agreed by all parties, the insurance would be signed. Since the early 2000s, slips have been replaced with the Market Reform Contract (MRC), incorporating terms and contract conditions within one document. More recently, some brokers have used the MRC contract in PDF form as the basis of an electronic subscription process. The move away from paper submissions should be completed by the PPL (Placing Platform Limited) system currently being implemented under TOM. The journey from slips to computers shows the progress the Market has made; the next stage is to take more advantage of the power of intelligent digital technologies – hence the report title.

The wholesale insurance industry's self-image is of being behind the times in using digital technology. Despite this perception, over the last forty years firms have invested hugely in their digital infrastructure. Through the use of computerisation, databases, workflow, and electronic communication, the market today handles vastly more data, at greater speed and accuracy, than would have been conceivable in the 1970s.

The London Market comprises some 390 brokers and underwriters, each with its internal systems and processing. There is also a central 'Bureau' which performs back-office roles as required for certain parties in the market. The market technical infrastructure is underpinned by an electronic messaging system often using ACORD data standards where these exist.

The London Market Group is driving improvements in the market technical infrastructure through its TOM (Target Operating Model) initiative. This is a multi-year programme to improve standardisation of messaging and to implement cross market processes such as PPL (Placing Platform Limited) and CSRP (Central Services Refresh Programme). The former will create inter-firm workflow to manage the subscription process of a broker obtaining

underwriting for a proposed cover, while the latter will upgrade Bureau processes to use EBOT and ECOT messaging, so as to make them operate as any other non-Bureau insurer.

The gold standard of processing is straight-through-processing (STP), where once data is validated on the system all further processes are automatic. This is the paradigm used in banking, where it has achieved massive efficiency gains, as well as increasing speed and accuracy. STP is also achieved in certain Bureau processes such as settlement.

In the complex institutional environment of the London Market it has proven hard to achieve the completeness and timeliness of data exchange and validation to act as a basis for STP for end-to-end processes such as subscription or claims settlement which span brokers, loss adjusters, underwriters, and reinsurers.

Market participants continue to improve the processing infrastructure through developing use of established technologies. Beyond this, new digital technologies have become or are becoming mature, and many of these appear to have potential for use in wholesale insurance. The focus of this study is 'smart contracts', which are defined and discussed in Section 3 below, but many of the potential uses of these comes from the confluence of maturing technologies such as:

- artificial intelligence (AI);
- Big Data;
- cryptography;
- digital registries (public and private);
- Internet-of-Things (IoT);
- geolocation;
- remote sensing (for example, drones and satellites).

These are discussed in Appendix A below.

3. The London Market For Wholesale Insurance

Insurance is a key enabler of business and trade globally. The OECD expresses this as: "The insurance industry is a major component of the [global] economy by virtue of the amount of premiums it collects, the scale of its investment and, more fundamentally, the essential social and economic role it plays by covering personal and business risks."[2]

'Wholesale Insurance' generally refers to insurance transactions which are individually large or complex or are for large organisations. The aggregation of retail insurance policies such as house or car cover creates portfolios of risk which are also insured or reinsured on the wholesale market.

The London Market is defined as specialty commercial insurance and reinsurance business backed by London capital, plus business controlled by, but not written by, London Market participants. In 2013, business backed by London capital totalled £45bn of gross written premium (GWP) according to the 2014 'London Matters' report [3], This was 10.6% of the total global GWP of £307bn for insurance plus £117bn for reinsurance. In addition £15bn of business was controlled by London Market participants but not underwritten by them. This volume of business makes London the largest hub for wholesale insurance worldwide.

There are some 390 brokers and underwriters in the London Market; this includes members of Lloyd's Market, UK firms who are not members of Lloyd's, and overseas firms with a presence in London. This depth of expertise and resilience creates a genuine marketplace where the buyer of insurance can benefit from competition among the sellers. This competition stimulates product innovation in order to maintain volume and margins.

Despite this competition, the London Market has a high cost base relative to competitor hubs. According to 'London Matters', in 2013 London's expense ratio was some 9% higher than its most efficient competitors. At an Xchanging Conference in November 2016, Lloyd's Market's Director of Operations quoted a 41% expense ratio for Lloyd's firms as opposed to about 30% for efficient overseas hubs. This highlights the cost challenge facing the Market.

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[2] OECD website: http://www.oecd.org/daf/fin/insurance/globalinsurancemarkettrends.htm
[3] Boston Consulting Group, "London Matters", 2014 - http://www.lmalloyds.com/lma/market_processes/London_Matters.aspx

The sponsor of this study, the London Market Group, is a market-wide body, bringing together the specialist commercial (re)insurance broking and underwriting communities in London. It is supported by the International Underwriting Association of London (IUA), Lloyd's of London, the Lloyd's Market Association (LMA) and the London & International Insurance Brokers' Association (LIIBA).

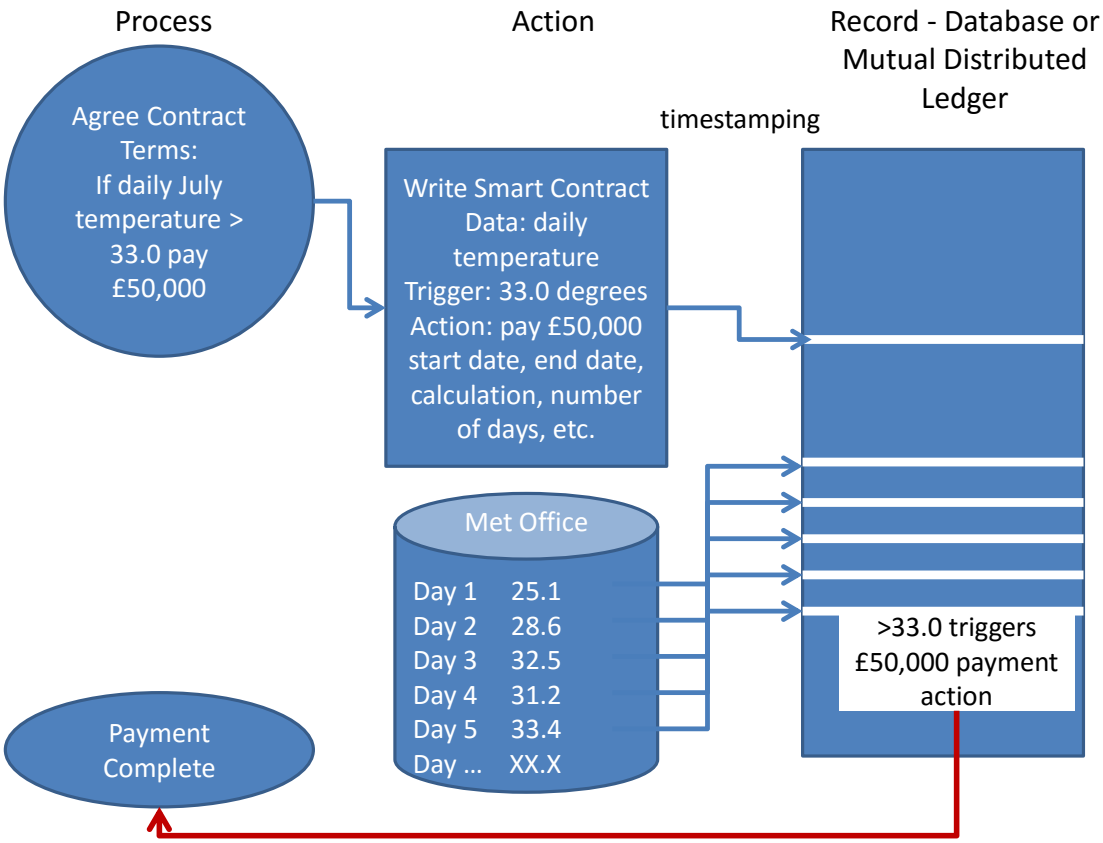
The London Market Group speaks collectively for market practitioners on growth and modernisation issues, and its aim is to build on London's position and reputation as the global centre of insurance excellence.[4]

[4] LMG website https://www.londonmarketgroup.co.uk/lmg-overview.

4. Smart Contracts

For the purposes of this report, a smart contract is "the implementation of contract terms as executable computer code". Another term for this is a 'smart legal contract', as defined in a useful paper by Clack et al[5]. A related but different concept defined in that paper is 'smart contract code', which is explained further below.

A simple example of a smart contract is an insurance contract which pays $50,000 on every day in July when the temperature recorded by a given field on the Met Office website is above 33 °C.



A smart contract is neither smart nor a contract. Rather, it is a code element containing two basic components:

- conditions which trigger action(s);
- actions to execute.

[5] Clack et al, "Smart Contract Templates: Foundations, Design Landscape And Research Directions", August 2016 - http://www0.cs.ucl.ac.uk/staff/C.Clack/SCT2016.pdf

The smart contract should mirror actual contract terms between the parties and execute specific contract requirements. A memorable way of explaining this is 'time, test, trigger'. Parties agree on timings, the tests or conditions they will apply, and the action or trigger to be taken.

It is important to emphasise that smart contracts can be implemented within a conventional single-company computer system. Much of the literature around smart contracts relates to their implementation on mutual distributed ledgers such as blockchain, but this is not a necessary condition for their use. The underlying assumption of this report is that in the context of wholesale insurance, processing and the use of smart contracts will continue to be done mainly in an environment of single-company computing and databases, while mutual distributed ledgers may provide multi-company data sharing with a rigorous audit trail. Smart contracts executed across companies can form so-called 'smart distributed ledgers'.

Smart contracts appear to have five separate areas of application within the London Market: process, product, portals, performance and privacy. Within these areas, smart contracts can perform many different types of functions, such as

- control process flow – for example, instigate workflow actions;
- agree subscription or claim – for example, on completion of all internal workflow steps confirm a subscription or claim on the internal system and send confirmation messages to counterparts;
- set liabilities or commitment - for example, update a contract premium;
- control data - for example, transmit data after a delay to preserve commercial confidentiality;
- interrogate data - for example, aggregate data without revealing detail;
- move money - for example, pay a claim on a contract trigger when all internal workflow is completed.

The range of tasks which smart contracts can undertake shows their power as a business tool.

Smart Contract Code

As noted above, there is an alternative concept of 'smart contract code', where the code itself defines the relationship between the parties. This comes in two flavours, with or without a legal contract.

From Slips To Smart Contracts

The idea in 'smart contract code with a legal contract' is that the contract states that certain terms are implemented as defined in specific computer code. This would reduce the risk of divergence between contract and code, but at the cost of making any error in the code binding on the parties. A further issue is that as machines, networks, operating systems, and applications are replaced or updated, it may be become difficult or impossible to prove details of how the smart contracts are meant to act - for example rounding calculations or the order in which a complex list of items is sorted. This may make contract enforcement more difficult.

A more extreme model is 'smart contract code without a legal contract', where the relation between the parties is defined purely by the execution of code; typically this involves applications using distributed ledgers. This is the underlying structure of bitcoin, which has run successfully for seven years. There have been well-publicised incidents of fraud or error on bitcoin exchanges such as Mt Gox, but not on the core distributed ledger, blockchain application.

However, a recent high-profile implementation of more general functionality using smart contract code demonstrated the risk of the 'code is king' approach.

The full story is given in Appendix C, but in brief, 'The DAO' was a project based on smart contracts on the Ethereum blockchain infrastructure with no underlying contractual structure; it suffered a catastrophic attack for which there appeared to be no legal remedy.

The DAO was launched in April 2016 as an investment fund. It raised about US$150 million from investors in 'ether', the currency unit of the Ethereum blockchain. On 17 June an unknown attacker succeeded in transferring about a third of this to accounts within its own control. The majority of the Ethereum community agreed to rewrite the blockchain to restore the funds to the original owners – this was possible because the blockchain code imposed a month's delay on further transfers so that Ethereum had time to act. (A minority disagreed with the rewrite on the basis that the blockchain should follow its own defined rules with no rewriting; the result has been a 'hard fork' of Ethereum into two parallel versions with the majority using the rewritten version.)

In the absence of an underlying contract, the users had no obvious redress beyond the code; had Ethereum not intervened it seems they would have had

no way to recover their funds. Because of the legal and practical issues surrounding smart contract code, the underlying assumption of this report is that the smart contracts to be considered for use in the London Market are smart legal contracts.

Straight-Through-Processing (STP)

As mentioned above, the well-developed concept of STP is a necessary precursor to the use of smart contracts. In STP, the parties to a contract validate the underlying data between them and thereafter all processing is automatic, minimising costs and errors and maximising speed. This can be represented as a simplified layer model:

Function	Process
Business rules & operations	approvals & confirmations
Control flow	sequencing & reporting
Data management	sharing & storing
Messaging	synchronising

Smart contracts provide another layer to this process, sitting above the business rules & operations to carry out the actual execution of code and providing a rigorous link to the legal contract itself:

Function	Process
Client	risk management
Insurance policy	risk transfer
Smart contracts	legally compliant actions
Business rules & operations	approvals & confirmations
Control flow	sequencing & reporting
Data management	sharing & storing
Messaging	synchronising

The discipline of linking the legal contract directly to the execution of the automated process via a smart contract creates benefits over and above STP.

Improving Contract Setting And Execution Through Smart Contracts

In process terms, the business rules & operations layer can do almost everything that a smart contracts layer can do. However, by having a rigorous

process to translate the legal contract into executable code, control can be improved – reducing errors and creating a more efficient process. Smart contracts provide a mechanism for extraordinarily high volumes of rules and operations, for example, handling the claims processing of a variable electricity contract claim as discussed in the box below.

Box – Variable Electricity Contract Claim Handling

Insurers are exploring how to handle energy companies that offer reduced electricity rates to clients who allow the companies to balance their load by turning appliances such as freezers on-and-off through the Internet-of-Things. Freezers can hold substantial and valuable quantities of foodstuffs. Imagine, for example, coming home to find your freezer off and formerly valuable food now defrosted mush. You ring your home and contents insurer, which notes you have one of those new-fangled electricity contracts. The fault was probably the electricity company's - go claim from them. You ring the electricity company - it denies it had anything to do with turning off your machine; if anything, it was probably the freezer manufacturer that is at fault. The freezer manufacturer knows for a fact there is nothing wrong because the freezer is talking across the Internet-of-Things.

Of course, it might have been your error. Perhaps you unplugged the freezer temporarily and forgot to reconnect things, at least that's what the vacuum cleaner says. Or, perhaps you were a bit tight on funds at the end of the month and thought you could turn frozen foods into liquid assets.

The analysis of the electricity company control signals that led to the situation could be embedded in a smart contract leading to a direct claim and payment in the majority of cases, all based on analysis of the Internet-of-Things signals traffic.

Smart contracts will require improved communication between business, legal, and operations staff. The need to engage operations at an early stage should ensure that there is better negotiation and clarification of terms by the business and lawyers, and the engagement with the business and lawyers should improve the quality of operations staff implementing contracts as process steps.

Moreover, the one-to-one relation between legal contract terms and smart contracts in processing will simplify changing the process to match any

subsequent renegotiation of the legal contract. It will also provide an audit trail for any future disputes. The audit trail can be implemented as data fields attached to the code as comment to show how it relates to the source document and to the change history; this could be interrogated by automated tools to support control and governance. The audit trail might well also be contained in various timestamps and hashes of the code on a mutual distributed ledger.

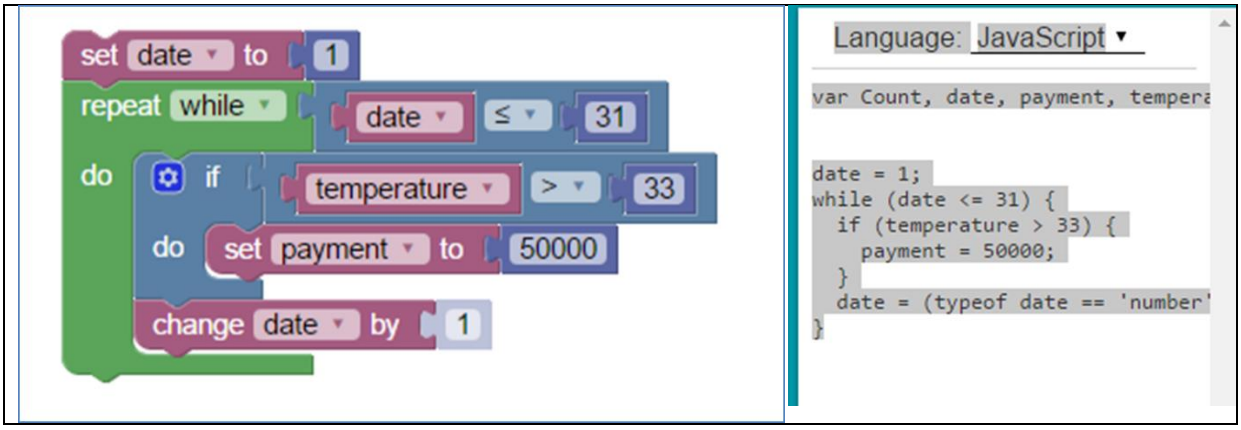
A further advantage of a smart contract process is that the pressure of ensuring rigour about the contract process for coding purposes should help drive standardisation of legal contracts across the London Market, since firms will wish to avoid duplicating work. Standardisation of contracts should create costs savings for all firms.

There are different proposals on how to implement smart contracts. At one extreme, the suggestion is that the relevant operational terms of the legal contract will be separately identified and written in structured English which can be transferred unambiguously into code. There are various academic initiatives around this. A perhaps more mainstream idea is that the starting point should be legal contracts as they exist today, with the translation process providing the rigour to ensure effective implementation of smart contract code mirroring the legal contract's intention.

The two approaches are not necessarily exclusive, as structured English could be used in some circumstances but normal legal English in others. The viewpoint of this report is that there will always be some ambiguity in how a legal contract is to be executed; even if the operational terms are effectively arithmetic, there will still be context which could change in the real world and which could lead to a dispute on the correct implementation. There are therefore limited gains in putting effort into creating an unambiguous structured English for operational contract terms – but there may be circumstances in which it is worthwhile to the parties involved.

An example of what structured English might look like is shown here. This uses a Google application called 'Blockly'[6] to create diagrammatic structured English, and then automatically translates it on the right into code. The example here is for the weather contract above.

[6] Blockly at https://developers.google.com/blockly/.



Legal And Other Risks

The definition of smart contracts here ensures that they are used as a processing tool to execute obligations in a conventional legal contract. Therefore, the basic legal risks should not change.[7]

Any STP can create process errors making payments which have to be corrected retrospectively. This raises the risk that the counterparty cannot repay or that legal redress is impractical – or that there would be a reputational risk in demanding repayment. Other types of process error such as setting premiums wrongly could similarly carry risk. Analysing these possibilities should be part of the cost/benefit analysis in setting up STP for any process.

One new area of risk arising from smart contracts is taking decisions based on erroneous external data sources, further taking into account that the error may arise from cybercrime. This risk can be mitigated by comparing more than one source or using AI techniques to identify potential errors. A further mitigation would be to introduce a delay of several days from trigger to payment, to allow review and identification of likely errors.

[7] Norton Rose Fulbright discusses the legal implications in detail: "Smart Contracts: Coding The Fine Print", March 2016 - http://www.nortonrosefulbright.com/knowledge/publications/137955/smart-contracts-coding-the-fine-print

5. Survey Responses

This section summaries responses from interviews and from the project workshop.

Strategic Context

Respondents expressed scepticism about whether participants in the London Market genuinely accepted the need to achieve processing efficiency. While respondents were well aware of London's cost disadvantage relative to other insurance hubs, there was a recognition that many firms (always excluding the respondent's own) saw London's advantage in specialty insurance putting it above mere cost competition.

However, the overwhelming consensus was that the London Market did need to achieve a more competitive cost position in order to maintain business and margins. Many respondents observed that there had been a long-term trends of commoditisation – whereby products which were once speciality were now generally available, and localisation – whereby overseas hubs such as Malaysia which once referred business to London developed local expertise and capacity to provide their own insurance. London did not have an automatic right to business, and needed to keep reinventing itself. Innovation was important, as was depth of capital, but this could not completely offset cost pressures.

Clients were aware that the claims ratio was not far above 50% - this meant that for every £100 they paid for insurance they would receive back in the long run only around £55. This was perceived as very poor value relative to other financial products and was a major incentive to find other methods for mitigating risk, whether by doing more self-insurance, insuring outside London, establishing industry mutuals, finding cheaper quasi-insurance products, or doing more to reduce claims in the first place.

Another respondent pointed out that the processing requirements for claims could be very different in different sectors. For property claims, especially after a catastrophe, the need was for speedy settlement of a large volume of claims. For casualty there might be a small volume of large claims, with legal process being the limiting factor.

"Brokers are paid a bonus for new business, not for settling claims."
Client risk manager

Another major trend was the creation of products such as Insurance Linked Securities (ILSs) which gave an alternative route for capital to be provided for insurance or quasi-insurance products. This could be attractive for investors and also as part of a risk management strategy for clients. Other existing products such as Industry Loss Warrants (ILWs) perform a similar function, and also provide an alternative risk management tool for reinsurance.

The summary of respondents' views is that London cannot be complacent about costs – it not only has to reduce its cost base closer to competitor levels but it also has to be aware that it is competing with developing non-conventional insurance products and risk management techniques.

"If London doesn't reduce its cost base, clients will find insurers elsewhere who will."
Attendee at project workshop

Client View

Most of the respondents were from the insurance industry or were professional or technical suppliers, but we also spoke to a small number of risk professionals in client organisations to ask them about their requirements from wholesale insurance. We received comments about cost, speed, and transparency.

The perception about cost was generally expressed as the claims amount paid as a percentage of premium. Figures around 55% were quoted. This was regarded as low enough to drive a search for risk management techniques other than conventional insurance. Transparency was about the failure of insurance prices to be quoted publically in the way that other financial market prices and rates were published. It was also suggested that publication of other information would be useful in allowing clients to compare insurers. Speed related to the claims process, with the suspicion that the insurers dragged their feet and could be more efficient and innovative in making payments earlier.

Disruption

There was much discussion of the possibility of disruption of the London Market from market entrants finding innovative ways to use the new technologies.

The underlying protection of the London Market is threefold:

- sales are complex and managed through relationships
- risk analysis needs to be sophisticated as contracts are complex and historic data is limited
- risk needs to be transferred by the Market so that each firm can optimise its own risk profile relative to its capital.

As noted above, all of these are under slow attack from long-term market trends, but there has been no sign of a technological challenger offering a business model which would bypass a major part of the end-to-end functionality of the Market.

Digital technologies offer the possibility of new entrants with cheaper and more efficient processing. The 'follower syndicate' discussed in Section 6 (B) below would be such a lower-cost competitor. However, lower cost will not in itself enable the new entrant to distribute business or to calculate or lay off complex risks in a more efficient way than incumbents.

We did not identify any current use of new technologies such as AI in risk analysis. The consensus seemed to be that improving risk analysis relied more on obtaining bigger and fuller data sets on claims than on improving the analysis techniques themselves. Such large data sets – should they become available – could be used by all firms, and therefore are unlikely to disrupt the market overall although they could certainly change the balance of the value chain between client, broker, and underwriter.

"The disruptor London needs to fear is not Google; it's ILSs."
CFO, Global Insurer

As discussed above, there is increasing use of alternative capital structures such as ILSs and ILWs as a substitute for conventional insurance. These have the capacity to replace some aspects of conventional insurance, but because of their lack of direct linkage to clients' risks, they seem more appropriate as substitutes for reinsurance or as asset classes for investors outside insurance.

A different threat to the London Market is irrelevance. According to the quote below, conventional insurance is losing its relevance for large corporations, whose risks are more and more related to intangibles such as brands, intellectual property, and reputation. If a new entrant is able to provide a risk management solution for these intangibles – whether through conventional insurance or otherwise – then it could potentially have a major impact on the London Market, although this seems likely to involve adding capacity rather than re-engineering existing business. Section 6 (B) below discusses the use of smart contracts as a technology to support the writing of policies for intangibles.

"The proportion of the corporate risk map covered by insurance has shrunk to perhaps as little as 10%."
Chief Executive, Risk Management Association (quoted in 'London Matters' report)

On the basis of this analysis, change in wholesale insurance seems likely to be evolutionary rather than revolutionary, without the capacity to give an overwhelming advantage to new entrants. We emphasises that this is a medium-term forecast – and is subject to Mark Twain's observation quoted above.

We note that retail insurance does not enjoy any of the three lines of protection described above. Its products are standardised, its risk analysis is commodified, and reinsurance is readily available. Its market is also highly price sensitive. Therefore, it is much more likely that a new entrant with a clever business model can take a large market share in retail insurance – as indeed happened with Direct Line in 1985.

The above comments relate to the market a as a whole. Specific market segments may be amendable to new business models. For example, improvements in the process of reinsurance might enable the largest insurers and reinsurers to deal amongst themselves without the participation of brokers.

Technological Awareness

Many respondents were using or looking at using the new technologies, and there seemed to be a good awareness in particular of the Internet-of-Things,

geolocation, and remote sensing as technologies with applications in insurance. More than one firm was involved in product initiatives involving these.

On AI and big data, most respondents had a good understanding but the general view was that these technologies were more appropriate for retail insurance, where large homogeneous data sets gave an arena for sophisticated statistical analysis.

There was a good understanding of STP, with various respondents referring to it by name or by function as an approach they were using to improve efficiency, speed, and accuracy within their own processing.

There was much less awareness of smart contracts as a technology, and we did not identify firms with plans to use it. There was a lack of understanding of the breadth of ways in which smart contracts could be implemented, for example the fact that they could work within a conventional computing structure rather than just within mutual distributed ledgers. There was also little appreciation of the potential benefits from the discipline which smart contracts could impose on the process of negotiating legal contracts and on improving communication amongst business, legal, and operations staff. Respondents were, however, interested in understanding and discussing these ideas.

Value Chain: Client - Broker - Underwriter - Reinsurer - Capital Market

A question raised by various respondents in different contexts was how implementation of new applications using smart contracts would impact the value chain from client to broker to underwriter to reinsurer.

For example, if an underwriter had direct access to an insured's data as proposed on various product ideas, would that change the various participants' power in the chain? In particular, if the access to data improved risk mitigation and hence reduced claims, who would receive the benefit of lower premium or higher margin?

Similarly, if smart contracts were used to share aggregated data from brokers to create (delayed release) industry data sets for claims and prices, would that change the relative power of brokers, underwriters, and reinsurers?

Although there is no clear answer to the shift in the value chain in the various scenarios, it seems clear that the fear of loss will be a factor in the behaviour of firms in any attempt to change the status quo.

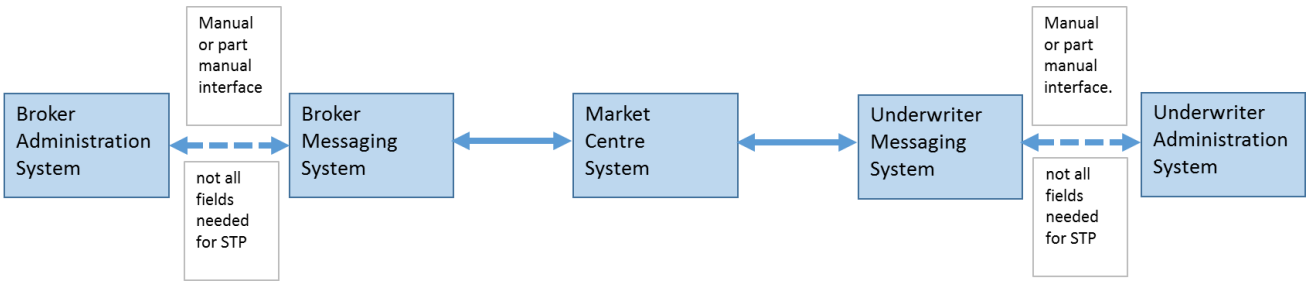
The rest of this section summarises the responses to the five potential areas for application which we identified: process, product, portals, performance, and privacy.

Process

There was a consistent perception among respondents that processing across the London Market was inefficient, although less agreement on the detail of the problems or of the route to resolution. A common theme was that the interests of the market participants differed from the interests of the market as a whole, and that the governance of the market needed to address this in order to be able to optimise the processing architecture.

A general comment on processing was that there was often a disconnect between the people who ran the firms and the processing; it simply wasn't on their radar.

As shown in the diagram below, even after TOM, brokers and underwriters will communicate through messaging, directly or through central functions, without automated processing linking back into their internal systems.



This results in a large amount of rekeying to transfer messages between the centre and broker and underwriter back-office systems (although the largest firms have implemented automated interfaces in some areas). The effect is that processes are slow and subject to error, and carry the costs of the manual interventions. The diagram could be expanded on one side to show the client and on the other to show reinsurers, so that the scope for improved processing – and the current gap – is even greater than shown.

"The Bureau reads PDFs with Optical Character Recognition (OCR) to extract data fields which already exist in the broker's database"
CIO, underwriter

Respondents agreed that in principle creating automated STP end-to-end would improve efficiency across the market and also increase speed and accuracy of processing. This would require each firm to implement automated interfaces into its back-office systems. There was no consensus on the practicality of this, especially for smaller firms, or on the governance structure necessary to achieve it. There are potential huge gains in cost, accuracy, and speed in implementing STP across market processes, but there are also major institutional barriers.

Most of the direct input from respondents in interviews was effectively about Straight-Through-Processing, with the interviewer having to raise the subject of whether smart contracts could improve processing further. Respondents expressed various levels of enthusiasm towards using smart contracts to link the back-office process to the legal contract. There was a general understanding of the potential benefits, but seemingly little desire to treat this as a priority for investigation.

"To improve Market processes, we need to be honest about the vested interests and the blockers - and unblock them."
Participant at workshop

Several respondents identified that one area where TOM is creating the environment for STP is in ensuring that premiums are allocated fully at the time of contract binding. Currently this is not a requirement until later in the process. Once the full information is available at binding, it will be possible to implement STP to automate the end-to-end settlement. Although this might not necessarily involve smart contracts, it would be a proof-of-concept for STP in cross-market processes and would demonstrate potential benefits as an input to the discussion on strategy.

It was noted that no process would ever be 100% accurate. There would always be a need for subsequent review and correction. The point at which it made sense to switch a particular process to STP and smart contracts would depend largely on the economics of the cost of such subsequent correction.

It was also noted that even an automated process could have steps which called for manual intervention. Effectively the automated process would trigger a workflow action and then periodically chase a response. This would be necessary in say the claims management process, where the STP could trigger a workflow request for a loss adjustor's report, chase periodically, and then start up again when the details of the report had been entered.

There were other suggestions for use of smart contracts within individual firms' back-office processes. For example, regulatory reporting might be driven by smart contracts analysing existing data; this could replace extensive manual processing currently expended in analysis such as identifying all instances of claims.

It was observed that in order to improve inter-firm processes there is a need to standardise higher level aggregations of data. For example, loss adjustors typically report in their own format and consolidation of multiple loss reports is currently a time-consuming manual task. All such standardisation should ultimately save money across the market.

Products

Respondents gave examples of products or product features which they were working on which could benefit from smart contracts. These included for example:

- marine hull insurance with access to geolocation and telemetry (Internet-of-Things);
- marine cargo insurance with access to client data driving volume and value cover;
- commercial vehicle fleet insurance with access to client data driving pricing and risk mitigation;
- insurance of reputational risk;
- Industry Loss Warrants (ILWs).

Some clients observed that paying out on claims on an STP or smart contract basis could attract fraud. One mitigation could be imposing a 'risk adjusted' delay on payments; for example, payments on a marine policy might be made immediately on receipt of a notice from a cargo agent in New York, but a week after notification from a cargo agent in a jurisdiction with poorer governance. This would give an opportunity for a manual review before payment.

There were also ideas suggested for products which the respondents were not themselves currently progressing; the most popular of these involved geolocation of shipping containers. There was interest in creating products linked to insurance price indices if these became readily available. One product feature suggested was automatic triggering of claims from data triggers from the Internet-of-Things. However, it was pointed out that currently insureds do not claim 100% of the time; making claims automatic could change the economics of some underwriting. It could also challenge the relationships between the broker and the client and the broker and the insurers.

Where smart contracts were driven by external data sources, there would need to be independent validation of the source. This might involve trusted third parties (so called 'oracles'), or it could involve comparing different sources using some techniques from AI - this could also provide an application for smart contracts in the processing. Another issue was being able to prove after the event that the correct external data was accessed, perhaps in the context of a dispute. This could give a role for mutual distributed ledgers in creating a tamperproof record of the source to prove that the correct value was accessed.

Some of the product ideas assumed that clients would give underwriters direct access to their data. Respondents pointed out the clients might have difficulties with agreeing to this, and there would be further difficulty in agreeing the relationship between the client, broker, and underwriter over the data.

Portals

Some respondents saw portals as a strategic issue for the London Market. London's competitive advantage lay in speciality products, and portals would allow expansion of this market to SMEs globally. The same respondents tended to see the subscription market reducing in size relative to single-underwriter placements independently of portals, so that they are predicting a change in the balance of the London Market over time.

Several underwriters were actively engaged in developing portals. These generally supported brokers to enable efficient take on of delegated-authority business, but there was also investigation of portals direct to clients. Where

smart contracts could make a difference is in the active administration of terms, conditions, triggers, and notifications. The smart contract should reflect the terms of business and then execute via the portal in the manner that the insured and insurer have agreed.

These respondents were not planning on using smart contracts for portals, but could see their advantage especially as a way of controlling processes as changes were introduced over time.

Performance

On risk analysis, underwriters were typically keen to see larger datasets, which they believed would give better insights, regardless of the technology used. No one claimed to be using AI techniques in analysis. Even within individual firms there were difficulties in getting the 'data plumbing' right to allow automatic consolidation of all available risk information. Smart contracts used to analyse existing data could potentially help with this.

The new technologies were seen as having a high potential impact on risk mitigation. For example, geolocation on ships or containers could allow identification of concentration risk in real time, leading to more effective use of reinsurance. There were concerns about the change in the value chain from client to broker to underwriter which products involving enhanced risk mitigation would cause.

Several participants at the workshop expressed enthusiasm for better processing and better risk management as a way to reduce capital requirements. For example, by improving control over claims it should be possible to reduce the risk which feeds into the regulatory calculation. Such use of smart contracts could enable contract administration to be much more effective, for example, notification and administration of additional and returned premiums, notices of cancellation, etc.

Privacy

Respondents were generally interested in the idea of using smart contracts as part of the control process around implementing privacy legislation. The consensus seemed to be that the advantages of improving two-way communication, rigour, auditability, and support for future changes were

worth investigating. However, no one was currently looking directly at this area.

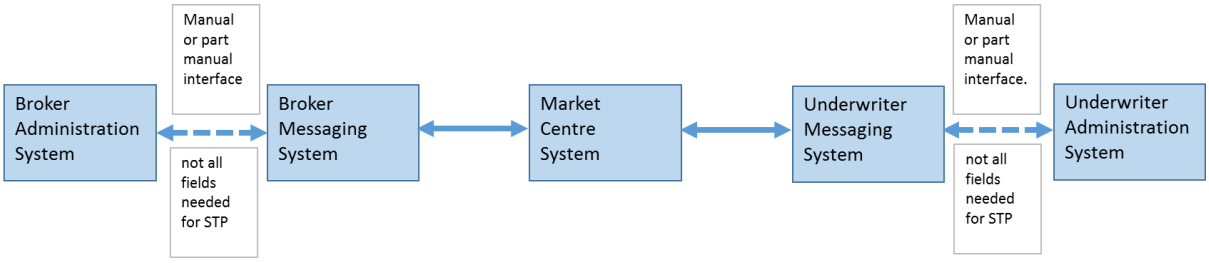
As regards sharing data, there was a general recognition that this was a difficult subject in the Market, even if the power of cryptography and smart contracts would allow the protection of data at a granular level. In particular, brokers were perceived in having a vested data in holding their own data as proprietary. It was also noted that in some instances clients would object to their data being made widely available. On the other hand, various respondents were keen to create products based on market indices or industry loss statistics from shared data should this become available, and there was a strong desire to see shared claims and loss data to enable better risk analysis and risk management. One respondent said that indices was a business opportunity for London; there were already ILSs and unless London developed its own indices and products it would be outflanked by other providers.

The next section discusses each of these five areas in more detail.

6. Applications For Smart Contracts

A. Process

The analysis above shows that the current architecture for cross market processing does not support STP from the brokers' back-office systems to the underwriters' back-office system. The schematic diagram showing the gaps is repeated here:



As noted, although TOM will improve various aspects of processing, it will leave the fundamental architecture as above, with the gaps as shown.

This results in a large amount of rekeying to transfer messages between the centre and broker and underwriter back-office systems (although the largest firms have implemented automated interfaces in some areas). The effect is that processes are slow and subject to error, and carry the costs of the manual interventions. The diagram could be expanded on one side to show the client and on the other to show reinsurers, so that the scope for improved processing – and the current gap – is even greater than shown. As discussed above, smart contracts would enable firms to reap further benefits from such an STP environment.

In principle creating an automated Straight Through Process end to end would improve efficiency across the market and also increase speed and accuracy of processing. This would require each firm to implement automated interfaces into its back-office systems. There are major institutional barriers to this in the London Market, where individual firms have to manage their own strategy and costs. On the other hand, there are potentially huge gains in cost, accuracy, and speed in implementing STP across market processes, and it would potentially have a material effect on London's expense ratio.

There is no simple way to progress this issue, given the multi-party nature of the market, so the recommendation of this report is that it is put on the strategic agenda for the Market as a whole and for individual firms, so that it is

considered as part of future discussions and so that it can get more attention if evidence builds that it is an appropriate goal for the Market processing architecture.

One area where TOM is creating the environment for STP is in ensuring that premiums are allocated fully at the time of contract binding. Currently this is not a requirement. Once the full information is available at binding, it will be possible to implement STP to automate the end-to-end settlement. Although this would not involve smart contracts, it would be a proof-of-concept for STP in cross-market processes and could give important evidence for developing future strategy for Market processing.

It should be noted that no process will be 100% accurate. The point at which it makes sense to switch a particular process to STP and smart contracts will depend largely on the economics of the cost of retrospective correction of process errors versus the costs in current processing.

Also, even an automated process could have steps which call for manual intervention. Effectively the automated process would trigger a workflow action and then periodically chase a response. This would be necessary in say the claims management process, where the STP could trigger a workflow request for a loss adjustor's report, chase periodically, and then start up again when the details of the report had been entered.

There are other areas in which smart contracts could be within individual firms' back-office processes. For example, regulatory reporting might be driven by smart contracts analysing existing data; this could replace extensive manual processing currently expended in analysis such as identifying all instances of claims.

The market has moved to ACORD standards for data, but in order to improve inter-firm processes (and enable future STP) there is also a need to standardise higher level aggregations of data. For example, loss adjustors typically report in their own format and consolidation of multiple loss reports is currently a time-consuming manual task. All such standardisation should ultimately save money across the market.

A completely separate area for smart contracts in cross-market processing is wordings. Contract wording is often varied for specific client or underwriter requirements. A further layer of complication comes from certain jurisdictions

demanding or forbidding certain contract terms. In addition, some jurisdictions require contracts to be in the local language, rather than in English.

Further standardisation of contract wording and the use of smart contracts count potentially provide a more effective and efficient solution for varying wordings as necessary. A “market wording directory” could in future actually be more of a smart contract clause repository.

B. Products

This section gives some illustrations of the type of new product or capability which could be implemented using smart contracts, possibly alongside other new technologies. The general structure is that the product would be managed through STP; this would be achieved by distributing through dedicated channels, possibly through delegated authority to brokers, or through a portal to deal with the brokers or indeed to deal directly with clients. It is also possible that some of these products would be driven by the broker assessing customer need and bringing the idea to an underwriter. Where the product involves use of granular client data, it is difficult to see how more than one underwriter could be involved.

Insurer Having Access To The Insured's Data

The illustration is the insurance of a fleet of commercial vehicles. The principle of the insurer having access to the insured's database carries across to other sectors. [8]

The legal contract of insurance can be set up to give the insurer the right to access the insured's database and to take action in specified circumstances; smart contracts can be used to implement this. For example, the insurer could interrogate information such as loads, journeys, maintenance, and telemetry of individual drivers. This would give the insurer better risk analysis as it would be able, for example, to correlate accidents with previous driver behaviour, maintenance, geography, or time of day, and would have finer grained information on which to predict losses going forward. It could use the same information to mitigate risk, for example identifying drivers whose telemetry indicated they were high risk and recommending that they be sent on remedial training. In return for better risk management and reducing claims, the underwriter should be able to offer a lower premium.

Commercial vehicle fleet insurance with access to client data

[8] See for example item 7 in http://www.insurancejournal.com/news/national/2016/10/17/429441.htm?utm_content=buffer43d0c&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer

The insured would also have a lower administration costs for the policy if it allowed automatic updating of the premium as its circumstances changes, for example through acquiring or disposing of vehicles. Similarly, in certain circumstances the policy could require the insurer to automate Notification Of Loss (NOL) thus removing the need for the insured to claim.

A cybersecurity policy could also benefit from the insurer having direct access to the client's data and systems. The insurer could combine data from the client's own security monitoring with raw data from its systems infrastructure to provide an additional layer of threat detection and mitigation. The same dataset could be used to define insurable events, such as non availability of servers or applications for extended periods, with smart contracts being used to align the monitoring and actions with the underlying legal agreement.

Cybersecurity policy with access to client systems

Internet-of-Things – Marine Hull Insurance

The idea is that a policy for hull insurance gives the insurer access to the geolocation of the ship and telemetry from the engines and from other IoT devices. The insurance contract could be written to reset the premium in real time according to the location and activity of the ship. For example, if the ship were stationary for a long period then the premium might be reduced, while if it were in certain dangerous areas it might be increased. The policy could also give the insurer the right to take mitigating action in some circumstances; for example, if the telemetry from an engine showed a chance of imminent failure the insurer might have the right to insist that the ship put in for repairs rather than continue to the next port.

Hull insurance with access to telemetry

The insurer would benefit from better information and better risk mitigation. Beyond its direct rights in the policy, it could also use the geolocation to identify when it had concentration risk from too many of its insured ships being in the same small area, or in extremis it could track a ship captured by pirates. It could share some of the benefit with the insured through a lower premium. The insured would also benefit from any reduction in claims and from knowing any premium adjustments in real time.

Geolocation Of Shipping Containers

On 12 August 2015 a series of explosions and a subsequent fire destroyed a container storage depot in the Chinese port of Tianjin, causing over 170 deaths and massive destruction – and a huge insurance loss. At the time of writing, the total insured loss is still not known, since it has not been possible to track in full the containers and cargoes in the depot.

There would clearly be a benefit to insurers if all shipping containers carried geolocation transmitters. Smart contracts would be a natural framework for managing the process to support the complex analysis envisaged.

Sample applications allowing better risk management would include:

- identification of theft or errors;
- finding lost containers;
- knowledge of location for catastrophes such as explosions in ports;
- realtime information on concentration risk to allow for dynamic reinsurance.

A shortfall for insurers is that the transmitter would not identify damage to the container, which is a major source of claims.

Assuming that the benefits were material and that the infrastructure was in place to give them the information in close to real time, underwriters might offer some reduction on premium for covering containers with geolocation.

Geolocation of shipping containers

In practice, much of the physical infrastructure is in place. However, the system set up for one company does not necessarily identify containers from a second company, and even if it does the two companies may use different data standards or have no way of relying on the integrity of the reporting from the other. Similarly, systems designed for ships may differ from those designed for trains. The challenge is to build on the physical infrastructure to create consistent performance, communication, data, and trust so that users can rely on the information they want being available and accurate.

It seems unlikely that a single insurer, or even the industry as a whole, could progress this. However, other stakeholders could also benefit from installing the infrastructure for geolocation; for example, shippers, container owners, and law enforcement agencies should all have an interest.

Stakeholders should consider examining as a group the costs and benefits of developing the global infrastructure to provide standardised trusted exchange of geolocation information on shipping containers. The goal would be to identify the business case and in due course a roll-out plan for implementing such an infrastructure. The London Market, as the premier global insurance hub, is well placed to progress such an initiative and to use it as the base for introducing new insurance products and capabilities.

Follower Syndicate

A potential application of smart contracts would be to give underwriters and syndicates an option to simplify and automate part of the subscription process. This could potentially reduce costs and expand overall market capacity.

The current process is that the broker shows the terms of a proposal to many underwriters. These individually ask questions and decide how much (if anything) they are prepared to underwrite and at what price. Typically, once a lead underwriter is in place, follower underwriters tend to follow the leader's terms and to do less detailed investigation.

Underwriters who were prepared, under strictly specified conditions, to follow major insurers without further due diligence could express their preferences through smart contracts recorded on a central system. For example, an underwriter might agree for a particular insurance type to underwrite 3% of the total amount underwritten by named insurers A, B, C, D, and E, up to a maximum of £Z, provided at least 2 of the insurers took at least 7% each., The premium would be defined by "best terms available", a market standard condition meaning the highest premium per £100 paid to any underwriter.

It would be important that the participants could easily adjust the smart contract terms over time as their circumstances changed. Advantages would include:

- reduced administration cost to the underwriter and broker;
- faster subscription;
- a route for new capital to be raised in the market for 'follower syndicates'.

A proposal based on this idea is to create a dedicated 'Follower Syndicate' which would carry out all of its underwriting by following through smart contracts as

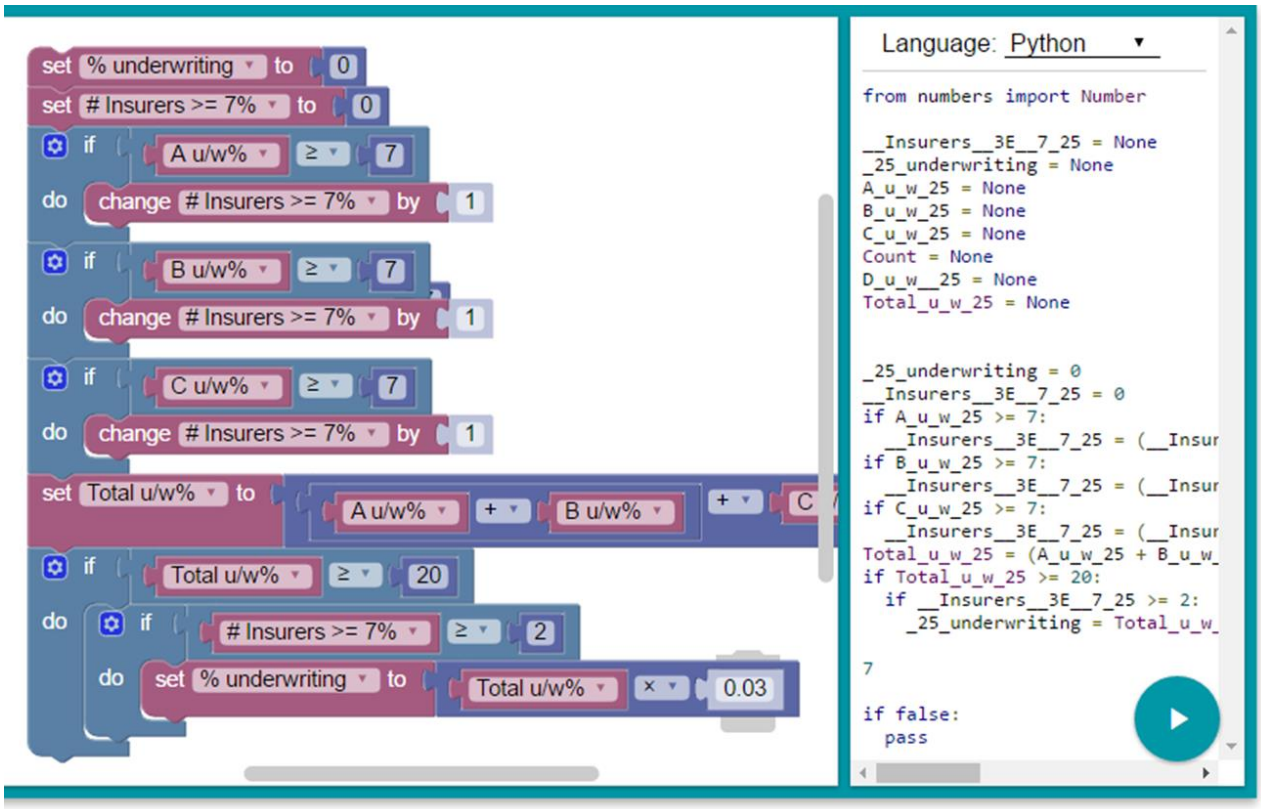
Follower Syndicate

above. If the syndicate also followed on all claims, it could achieve a reduced cost base while arguably maintaining a competitive risk profile. It might therefore represent a good investment for new capital in the market.

There are practical, regulatory, and legal questions to answer to make such a structure work, but the underlying economics and the alignment with the reality of market practice makes it an attractive subject for further investigation.

The diagram below shows how a part of the smart contract for a Follower Syndicate might look, both as structured English and as code. This uses Blockly as in Section 3 above, except that, to demonstrate the versatility of the tool, this time the English is translated to Python rather than to Java.

An unrealistically simple formula is shown to minimise the size of the text and code. The rules are that the Syndicate will underwrite 3% of the total underwritten by insurers A, B, and C, provided that at least 2 of them underwrite 7% and the three together underwrite 20%.



Parametric Insurance

Parametric insurance is a type of risk management product which does not indemnify the loss suffered directly by the insured party but instead makes a payment upon the occurrence of a triggering event. The trigger can be a catastrophic natural event, such as an earthquake measured in a particular location above a particular force, which would ordinarily precipitate an insurable loss. The trigger does not have to relate to a catastrophe; for example where agricultural output correlates with particular weather conditions, weather insurance is a type of parametric insurance. Conceivably a more complex correlation between parameters could be used, for example having some formula based on both weather and commodity prices.

Parametric insurance

Smart contracts would be a natural mechanism for implementing complex parametric insurance contracts. They would facilitate a process to track the underlying events which would typically be published on public data sources. Thus for earthquakes they could track all quakes in a defined zone and provide data for risk analysis, as well as signalling when a trigger event has happened and calculating and paying the loss.

ILWs

Another type of parametric is Industry Loss Warrants (ILWs). Here the parameter is the total insured loss paid out by all insurers for a catastrophic event, typically hurricanes in a particular state or region. ILWs are used largely for reinsurance, where their characteristics, especially speed of execution, are complementary to conventional reinsurance contracts. Some ILWs pay out according to a complex formula based on a number of catastrophic events, and smart contracts could again have a role in implementing a process to track the formula and identify when a trigger event has happened and to calculate the payout.

If there were definitive industry loss datasets across sectors, it would be possible to create more ILW products which might provide a useful alternative both for reinsurance and for conventional insurance. However, as noted in Section 6 (E) below, there is a reluctance in the London Market for firms to share the relevant data.

It is also worth noting the paradox that if ILWs became a popular risk management tool to substitute for conventional insurance, the total amount of

conventional insurance would decrease and presumably the industry loss figures would also decrease, thus impacting the value of the ILWs.

The last two examples in this section use the capabilities of smart contracts to support insurance using more complex pay-off criteria and processes which have to be implemented automatically.

Intangibles

As noted above, many risks, particularly those arising from intangibles, are not covered by conventional insurance. New technologies such as big data offer the possibility of aggregating data which could identify the crystallisation of intangible risk. For example, reputational risk could be measured by trends on social media. At least one underwriter has written a policy on reputational risk on this basis.

Insuring intangibles with loss defined from Big Data

Smart contracts offer a methodology to control the integration of a legal insurance contract with a complex definition driven by statistics from public data. For example, one aspect of brand value could be measured by the difference between positive and negative references on social media combined with some measure of volume of references and volume of sales, with a policy paying out if the valuation changed beyond a trigger point. The underlying process for creating the valuation would need to be defined in a legal contract. Smart contracts would be a useful methodology to ensure that the legal contract was correctly implemented in the back-office processes used to create a regular valuation for risk management and to pay out if the valuation breached a trigger.

Insurance On Demand

Insurance when you need it – for example, for using photography equipment on location – is an area being explored by startups in retail insurance. However, there are also applications in wholesale insurance, where the use of smart contracts would help support more complex contractual arrangements needing automated execution between the client and the underwriter.

War risk on demand

For example, war risk on ships could be underwritten on a demand basis, with standardised cover terms and a quick turnaround from application to being 'on risk'.

Generator cover on demand

A similar structure would be a gas power generator providing surge generation capacity to the national electricity grid. It could be insured for a baseline number of hours of operation per year with an 'on demand' policy available if it needs to run additional hours.

Individualised insurance for car hire

Another application would be allowing a car hire company to offer insurance tailored to the individual driver. Making this work would require the underwriter to give a quote for each driver quickly enough to fit within the process of hiring the car. The benefit to the hire company and the ultimate retail customer could be generally lower premiums since the underwriter could match the individual premium to the risk.

C. Portals

An important distribution channel for underwriters is through 'delegated authorities' to 'coverholders'. A coverholder is a broker in London or elsewhere and the delegated authority gives it the right to take on insurance business within tightly defined parameters which the underwriter will underwrite in full. This mechanism is typically used to allow an underwriter to take on a portfolio of standardised risk, aggregating many small transactions at a low administrative cost. A large underwriter can have hundreds of coverholders.

The use of an internet portal allows the underwriter to automate this process further, using STP directly from input. Either the portal can be used by the broker to automate fully the taking on board of business, or it can bypass the broker completely and be used directly by the client. In either case, the use of smart contracts in the process can allow both improved control and the opportunity for customising some classes of policy or of introducing policy changes in a more controlled way. Much of this could be done in existing portals, but smart contracts, particularly those based on mutual distributed ledgers, could enhance the multi-organisational organisation, automation, and reporting of administration processes.

The development of portals in this way could attract substantial global speciality insurance business to London, particularly from SMEs whose smaller size means they are too expensive for brokers to deal with direct. This is potentially a major strategic opportunity for the London Market.

D. Performance

Risk Analysis

The most obvious step towards improving risk analysis is to assemble industry-wide datasets of claims, but as discussed elsewhere in this report there is reluctance among firms to share such data. Section 6 (E) below discusses how smart contracts might help tackle this reluctance by supporting the sharing of aggregated and time-delayed data which might be seen as less commercially sensitive.

The discussion on insurance of intangibles in Section 6 (B) above suggests that the formula for measuring the level of risk for such contracts is likely to be complex. This would give a natural role for smart contracts together with other technologies such as AI in managing the process to calculate the risk so as to improve accuracy.

Risk Mitigation

Different parts of Section 6 (B) above discuss giving the insurer the contractual right to call for mitigating action in defined circumstances, whether triggered by information from the Internet-of-Things or by information from the insured's own data. Again, smart contracts provide a natural framework for implementing such contract terms operationally, to ensure accuracy, speed, and efficiency of execution.

E. Privacy

Privacy Legislation

The advantages of smart contracts have been described in the context of implementing legal contracts. However, smart contracts can also be a useful mechanism in implementing the requirements imposed by complex legislation.

A particular example is privacy legislation, where the trend for increasingly onerous requirements on organisation seems set to continue, notably with the implementation of the EU's GDPR legislation in May 2018. Generally, an organisation will implement such legislation by creating or updating a policy document at Board or Risk Committee level, and then giving this to business and support units to achieve compliance.

By using the policy document (rather than a legal contract with a third party) as the starting point, smart contracts would provide a natural framework for implementing the requirements in operational processes and systems. As discussed above, the rigorous use of smart contracts is likely to increase accuracy of the implementation. Beyond this there would be a clear audit trail of the rigour with which the organisation has complied with the legislation, thus simplifying the dialogue with the regulator. A further advantage is that as laws and regulation change, the audit trail will assist in changing the control structure efficiently This is in contrast to the typical circumstances today, where new controls are layered over old ones, since there is no clear understanding of what controls are implemented in the system and how they actually work.

Suppose, for example, that the policy says: "Since each jurisdiction can have its own laws on privacy, each piece of sensitive information must have a recorded jurisdiction of origin and the management of that sensitive information must conform to the laws of that jurisdiction."

The original smart contract might contain an instruction to be executed before allowing a particular action on a particular element of sensitive information:

IF NOT JURISDICTION_PERMISSION(JURISDICTION, ACTION_TYPE) THEN EXCEPTION(JURISDICTION, ACTION_TYPE)

This checks if the given jurisdiction allows the given action; if not then the code instead executes the appropriate exception routine.

Suppose that the UK leaves the EU but agrees to follow any requirements of EU law on sensitive information, in addition to UK law. The policy and process will need to be changed, but this can now be implemented by adding a single line to the code:

```
IF JURSIDICTION = "UNITED KINGDOM" THEN
        IF NOT JURISDICTION_PERMISSION("EUROPEAN UNION", ACTION_TYPE)
        THEN EXCEPTION("EUROPEAN UNION", ACTION_TYPE)
```

This has clear advantages in terms of clarity and audit trail compared with editing a table of business rules. The code can include specific audit comments linking it to the source document and to the change history.

Data Sharing

Brokers and underwriters have historically been averse to sharing data on prices and claims, on the basis that keeping their information private gives them a competitive advantage. Smart contracts in conjunction with cryptography offer a route to sharing data in anonymised form at an aggregated rather than a detailed level, as well as introducing a delay of several months into the process. This could be set up to be auditable by a regulator, while leaving individual firms to have privacy over their own data in all other regards. Sharing data in this way might reduce commercial sensitivity and make way for new applications

A sample application within wholesale insurance using shared data would be to construct industry datasets on claims and losses. As discussed above, this could be used by underwriters to improve their risk analysis and risk management, leading to lower losses and thus lower premiums.

Another application would be constructing indices of insurance prices; these could be proprietary to the London Market and thus act as a revenue stream. They would also increase transparency to clients, potentially attracting more business to London.

Different cuts of loss data could be used as the basis for parametric insurance such as ILWs, as described in Section 6 (B) above. Again these could be proprietary and thus bring revenue to the London Market.

As well as smart contracts being used to aggregate the underlying data, they could have a role in managing the administration of these applications, all of which involve accurate and timely execution of complex calculations.

7. Findings

The large number of use cases in different areas which we found for STP and smart contracts indicates that these are technologies which could have a strong impact on the London Market over the next few years, and they should be part of the strategic debate within firms and at Market level.

The technologies are not just about revolutionary change. There are many promising use cases for simple cost savings and income growth, as well as for increasing speed and accuracy of processes. If the Market is to flourish, firms must take advantage of incremental *and* revolutionary improvements. Smart contracts appear to offer both kinds of opportunity.

This report suggests several areas of potential change, affecting both processing and business strategy. These can affect the Market as a whole, smaller groups of firms, or individual firms. We would hope that individual firms consider their product development and distribution in the light of the various ideas and examples given in this report to see if these suggest actions they can take themselves.

Groups of firms – or indeed outside investors - could look at introducing the **'follower syndicate' proposal for applying smart contracts**. By offering an alternative cost and risk structure to investors this could attract more capital to the London Market and increase its overall capacity, although there is clearly a possibility that it would take business away from existing underwriters.

At the Market level, the most direct initiative seems to be for TOM to see if, once the binding process involves fully allocating premiums, there will be an **opportunity for smart contracts in implementing STP for settling payments** immediately from binding. Although this might not involve smart contracts directly it could generate a material cost saving for the market and would be a test bed for STP in cross-market processing. This would be an important piece of evidence for the Market in evaluating whether the goal of implementing STP is appropriate.

In principle end-to-end STP would improve efficiency across the market and also increase speed and accuracy of processing. This would require each firm to implement automated interfaces into its back-office systems. There are major institutional barriers to this in the London Market, where individual

firms have to manage their own strategy and costs. On the other hand, there are potentially huge gains in cost, accuracy, and speed in implementing STP across market processes, and it would potentially create a material improvement in London's expense ratio.

Another area for smart contracts in cross-market processing is wordings. Contract wording is often varied for specific client or underwriter requirements. A further layer of complication comes from certain jurisdictions demanding or forbidding certain contract terms. In addition, some jurisdictions require contracts to be in the local language, rather than in English. Further standardisation and the use of **smart contracts for contract wordings** could potentially provide a more effective and efficient solution for managing wording variance.

Another Market-level initiative could examine the opportunities which the emergence of social media and big data give for measuring risk and loss around intangibles. The London Market Group is well placed to coordinate investigation of ideas in this area and to encourage design and marketing of new products, perhaps using social media feeds for smart contract 'oracles' to create reputational risk products. The proposals for data sharing discussed above will not be popular with everybody, but the Market should at least consider what would constitute a **governance structure for sharing data that feeds smart contracts**. If it is possible to share at least some data, that might allow the development of new products in the London Market.

A further initiative at the Market level might be to examine the costs and benefits of more active and constant use of **geolocation information feeding smart contracts**, perhaps via a common 'oracle', such as wider shared use of transmitters on shipping containers or aircraft. This would include stakeholders from areas such as shipping, container owners, and law enforcement, as well as insurance, and the goal would be to identify the business case and in due course a roll-out plan for such an infrastructure. The London Market, as the premier global insurance hub, is well placed to progress such an initiative and to use it as the base for introducing new insurance products and capabilities.

There is no simple way to progress smart contracts, given the multi-party nature of the Market, and this report recognises that a core recommendation is that smart contracts remain on the strategic agenda for the Market as a whole and for individual firms for the foreseeable future. Smart contracts will

be important for wholesale insurance and need to be part of future discussions and gain the attention needed to be built appropriately into future Market processing architecture.

Appendix A – Wider Technologies

The following matured or maturing technologies are relevant when considering the applications of smart contracts:

- artificial intelligence (AI);
- Big Data;
- cryptography;
- digital registries (public and private);
- Internet-of-Things (IoT);
- geolocation;
- remote sensing (for example, drones and satellites);
- standards.

'Standards' may not seem like a technology, but it is included because it is the vital underpinning for digital data exchange. A brief description of each technology is given below, with a focus on how it can be useful in the context of wholesale insurance and smart contracts.

Artificial Intelligence (AI)

AI gives new ways of analysing large datasets, going beyond traditional statistical techniques. For example, 'neural networks' are computer models based on a how the human brain is believed to process information. A neural net is set up for a particular domain by 'training'. An example could be inputting to a neural net real-life datasets, each showing a company's risk profile together with its actual insurance claims. This would train the neural net to recognise patterns, and allow it predict the claims expected from a new company when it is given the equivalent dataset. There are many recent academic articles giving examples of neural nets making predictions in retail insurance, and many ideas for wholesale insurance. Neural nets are actively used in live applications such as fraud detection for credit card transactions.

Deep structured learning (also known as hierarchical learning or deep machine learning) is the leading edge research on machine intelligence. Large claims are being made, with some substantial evidence to back them up, ranging from automated medical diagnoses to simulating human operators in a variety of situations. There have been some high-profile publicity events, for example, IBM's Watson's success on the US game show 'Jeopardy' in 2011. In addition, there are a wide range of statistical classification techniques, for example, support vector machines, that make decisions based on mathematically proven

probability methods; often these can show the logic of their decision making with more clarity than advanced AI models.

Big Data

Extremely large datasets are now available both from public sources and from internal systems; these may be analysed computationally to reveal patterns, trends, and associations. The analytical capabilities of software have been increasing to cope with the demand for insight from ever-accumulating sources of data. In the context of insurance these can most obviously drive risk models, but they can also be used in many other applications such checking identity and prevention of fraud. Typically, various types of AI are used in the analysis.

It should be noted that retail insurance is a major user of big data and AI, since typically it has access to very large industry datasets on different products such as home and car insurance, and therefore it has a good basis for statistical analysis and for the other analytic approaches of AI. However, large-scale risk analysis in wholesale insurance can also be advanced: for example, catastrophe modelling.

Cryptography

Cryptography goes beyond just encrypting text and data using keys distributed through secure channels. Cryptography offers a range of mathematical techniques for managing and controlling data even on insecure channels – i.e. those susceptible to eavesdropping. These techniques are already in widespread use, for example, they underpin all e-commerce on the internet. In the context of wholesale insurance, cryptography offers capabilities such as:

- encrypting sensitive information in databases in physical and logical locations separate from information on keys, in order to give greater protection from cybercrime;
- recording a 'hash' for files as a code number generated by a formula involving every single byte in the file. The arithmetic of the formula means that a single change of a 1 to 0 or vice versa anywhere in the file will result in a major change in the hash. Storing the hash separately from the file can provide proof that the file has not been tampered with;
- the use of 'digital signatures' to prove that a particular message was sent by a particular person/organisation; digital signatures cannot be repudiated;

- homomorphic encryption and zero-knowledge proofs that permit interrogation of encrypted information without decrypting everything; for example, "Has this person ever made a claim?", or "Is the total value of the insurance above £1m?"

Digital Registries

Much authoritative information which used to have to be sourced manually is now available digitally through remote electronic inquiry. This includes state information such as land registries, vehicle licensing, and passports, public agency information such as weather, and industry aggregated data such as exchange rates. Insurance clients will also have extensive information about their own business activities and assets, which can be accessed subject to the client's granting of permission.

The massive availability of data gives scope for automating processes within insurance which historically have required manual intervention.

Geolocation

GPS and associated technologies allow a device to record and timestamp its own position. By connecting to the device through the internet, this information can be used by third parties such as insurers. For example, an insurer could track individual shipping containers over a multi-modal journey

Internet-of-Things (IoT)

Devices other than computers or mobile phones connected to the internet and broadcasting information and/or receiving instructions. These are now numbered in the billions, and Gartner forecast that there will be 21 billion such connected devices by 2020[9].

Mutual Distributed Ledgers (MDLs)

MDLs – also known as blockchains - are currently being proposed as a solution to many issues in processing, particularly within financial services. They use techniques from cryptography to create tamperproof records. The applications suggested in this study are to create a 'gold standard' for data

[9] http://www.gartner.com/newsroom/id/3165317

sources used to trigger smart contracts and to create a tamperproof record of the data sources actually used.

Standards

The use of common data standards underpins the ability to reuse data across different platforms and users. ACORD standards are the most widely used standards in insurance globally and are continually being developed to cover new areas.

As new technology is adopted, its utility can generally be increased if common data standards are adopted across the industry, since there is less need for firms to translate data from one format to another or to set up duplicate processes to deal with different counterparts.

Appendix B – Sample Smart Contract Related Companies

Sample companies we encountered advertising services around smart contracts.

Company	Website	Advertised proposition
Adjoint	http://www.adjoint.io/	Smart contract solutions for finance.
Aesthetic Integration	https://www.imandra.ai/	Formal proof tools to analyse smart contracts or code to prove integrity of algorithms and boundaries of potential outcomes.
Codius	https://www.codius.org/	Smart contract hosting services.
Concordata	http://www.concordata.co.uk/	Codeless smart contracts coordinated across companies without using MDLs.
Cover Genius	http://www.covergenius.biz/	Marketplace that optimizes the frontend, price, product and risk for OTAs, airlines, travel operators and their underwriting partners.
Doorda	https://doorda.com/	Big data tools: Aggregate government open data into usable formats, and provide tools to do the same with private datasets.
Oraclize	http://www.oraclize.it/	Providing data feed and carrier services to smart contracts.
RightIndem	https://rightindem.com/	Automated claims handling.
Sparkl	http://sparkl.com/	In-house smart contract language to connect different systems – also works between companies.

Appendix C – The Attack On 'The DAO'

The DAO (Decentralized Autonomous Organization) was a project based on smart contracts on a blockchain infrastructure with no underlying contractual structure.

It was launched on the Ethereum blockchain platform on 30 April 2016 with a 28-day 'crowdsale' to fund the organisation. By 21 May it had raised capital of more than US$150 million from more than 11,000 investors. On 17 June an unknown attacker 'stole' around 3.6M 'ether', Ethereum's online currency similar to bitcoin, from The DAO. At the time the currency valuation of 3.6M ether was about $55 million dollars and represented around a third of The DAO's assets.

The DAO was intended to operate as a hub that dispersed funds in ether to suitable projects. Investors received voting rights by means of a digital share token and voted on proposals that were submitted by 'contractors' while a group of volunteers called 'curators' checked the identity of people submitting proposals and made sure the projects were legal before 'whitelisting' them. The profits from the investments would then be given back to its stakeholders.

The DAO was controlled by the votes of its members (anyone who transferred ether to it) and transactions occurred automatically once enough members voted for them. A vulnerability in the code was exploited by the attacker, who used a 'Recursive Call attack', to appropriate ether.

The immediate loss to DAO investors was compounded by a loss of confidence in Ethereum as a whole. Complex legal questions remain over whether the attack was really 'theft'. In effect, the Ethereum project was set up to "let the code decide", and the code decided to transfer 3.6M ether to an account. Although the hackers could claim that their actions were legitimate as they were simply using options available under the smart contracts, Ethereum management succeeded in getting the approval of the majority of the Ethereum community and in returning the funds to their original owners. The eventual solution, a 'hard fork' that changed the Ethereum blockchain to move the 'stolen' ether back to its original owners, in effect replaced 'tyranny of the code' with 'tyranny of the majority'.

A minority disagreed, and the result has been a split of Ethereum into two platforms, with the majority being 'Ethereum' and the minority 'Ethereum

Classic'. At the time of writing, the ether was worth US$7.98, while the rival classic currency unit was worth US$1.07.

In the absence of an underlying contract, the users have no redress beyond the code; had Ethereum not intervened it seems they would have had no way to recover their funds.

Glossary

ACORD	Standards organisation which creates and owns the standards most widely used across global insurance.
Bureau	The central processing utility in the London Market.
Facultative insurance	Reinsurance for a single risk or a defined package of risks. The insurer submits a package of its risks to the reinsurer, who can accept all, some, or none of those submitted.
GDPR	General Data Protection Regulation – a data protection regime introduced by the EU in 2016 for application from 2018 with heightened requirements on organisations to implement measures to protect sensitive data, and giving citizens the 'right to be forgotten'.
ILS	Insurance-Linked Security – a bond whose payment will be reduced if an insurance event happens. For example, an earthquake bond.
ILW	Industry Loss Warranty – type of reinsurance or derivative in which one party will buys protection based on the total loss arising from an event to the entire insurance industry rather than their own losses.
MDL	Mutual Distributed Ledger - a tamperproof record (achieved through cryptographic techniques) which can be co-owned by multiple users with no central point of control.
MRC	Market Reform Contract – standard London Market contract for subscription process.
Slip	Historically, a paper document created by a broker summarising a proposed insurance contract, presented to selected underwriters for quotation, and signed by underwriters to evidence terms and amounts when the contract is agreed.

Smart contract	A contract clause translated into computer code through a rigorous process and embedded in a database or MDL, which executes automatically when its trigger conditions are met.
STP	Straight-Through–Processing - automated processing where data once validated is used without further checks.
TOM	Target Operating Model – an initiative sponsored by the London Market Group to improving messaging and processing of cross-market activities such as subscription.
Treaty reinsurance	Reinsurance for a particular class of risk. The reinsurer agrees cover up front on all future transactions within a specified class of risk and a specified time period. The cover is typically to pay all or a percentage of losses within a tranche, for example, 80% of losses up to a total of $125m losses ($100m paid) above the first $150m of losses for that class of insurance.

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