The Second R3 Smart Contract Templates Summit

16 November 2016
London and New York
Agenda
<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
<th>Presenter(s)</th>
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</thead>
<tbody>
<tr>
<td>08.00</td>
<td>Arrival and breakfast / light lunch</td>
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<tr>
<td>08.30</td>
<td>Welcome. Agenda and goals for the summit</td>
<td>Todd McDonald, Co-Founder, R3</td>
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<tr>
<td>08.40</td>
<td>Smart contract templates: progress</td>
<td>Dr. Lee Braine, Investment Bank CTO, Office, Barclays</td>
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<tr>
<td>08.55</td>
<td>Smart contract templates: requirements and abstract specification</td>
<td>Dr. Chris Clack, Senior Lecturer, University College London</td>
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<tr>
<td>09.15</td>
<td>ISDA: distributed ledger technology and smart contracts – the future of derivatives processing?</td>
<td>Clive Ansell, Head of Market Infrastructure and Technology, ISDA</td>
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<td>09.35</td>
<td>Smart contracts for cleared derivatives</td>
<td>Simon Puleston Jones, Head of Europe, FIA</td>
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<td>09.55</td>
<td>Experimental oracle for Corda</td>
<td>Mark Raynes, Blockchain Developer, Thomson Reuters</td>
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<td>10.15</td>
<td>Coffee break</td>
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<tr>
<td>10.30</td>
<td>Languages and abstraction layers to support the adoption of smart contracts</td>
<td>Sofus Mortensen, Chief Quantitative Analyst, Nordea Markets</td>
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<td>10.40</td>
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<td>Robin Green, Executive Director, Digital Markets Innovation, CIBC Capital Markets</td>
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<td>Matt Britton, Consultant, R3</td>
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<td>11.00</td>
<td>Dispute resolution for smart contracts</td>
<td>Isabelle Corbett, Senior Counsel, R3</td>
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<td>Matt Britton, Consultant, R3</td>
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<td>Ian Grigg, Consultant, R3</td>
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<td>11.25</td>
<td>Conceptualizing smart contracts</td>
<td>Aaron Wright, Cardozo Law School</td>
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<td>Sean Murphy, Partner, Norton Rose Fulbright</td>
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<td>Gavin Thomas, Tech COO, R3</td>
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<td>11.50</td>
<td>Can smart contracts be legally binding contracts?</td>
<td>Dr. Lee Braine, Investment Bank CTO, Office, Barclays</td>
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<tr>
<td>12.15</td>
<td>Summary of key points from the summit</td>
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<td>12.20</td>
<td>Next steps</td>
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<tr>
<td>17.30</td>
<td>Networking and drinks (London only)</td>
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Summit goals

Todd McDonald
Co-Founder, R3
Summit goals

- Elicit views and opinions on standards for representing smart legal agreements
- Share leading edge thinking on smart contract languages and future implementations
- Engage with a broad spectrum of financial industry participants
- Drive open innovation through collaboration
Smart contract templates: progress

Dr. Lee Braine
Investment Bank CTO Office, Barclays
Smart contract templates: progress

Lee Braine, Investment Bank CTO Office

16 November 2016
Presentation at The Second R3 Smart Contract Templates Summit
London and New York
Contents

1. Internal Team in Barclays Accelerator
2. First summit
3. First research paper
4. Second summit
5. Second research paper
6. Publicly available materials
7. Questions
1. Internal Team in Barclays Accelerator – January to April 2016

Introduction

Complex challenge – each bank maintains its own separate ledgers and systems, huge duplication of effort and cost

Solution – shared ledgers and smart contracts

Piece in jigsaw puzzle – smart contract templates

Our focus – legal document templates to facilitate smart contracts
  • connect legal text to business logic, simplify legal documentation processes
  • drive standards adoption via reusable templates
  • mutualise costs via common components

General benefits – cost reductions, efficiency improvements, risk reductions

Demo Day

Aim – showcase a vision of the future: the lifecycle of a “smart” standardised financial product

Software demo – prototype web application to edit templates, edit agreements, enter trades, affirm trades, and view trades

History in the making – first public demo of prototype application on R3’s prototype Corda platform

Venue – The O2 in London, audience of 800, largest FinTech demo day ever anywhere

Collaboration – Barclays Investment bank, R3, University College London, ISDA, Société Générale, Techstars
Internal Team in Barclays Accelerator – software demo

**Master Agreement 1992 - England and Wales**

<table>
<thead>
<tr>
<th>Field</th>
<th>Data</th>
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<tbody>
<tr>
<td>Name</td>
<td>Party A</td>
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<td>Type</td>
<td>ISDA®</td>
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<tr>
<td>Value</td>
<td>9x-March 2016</td>
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**Credit Support Annex 1995 - England and Wales**

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<th>Field</th>
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<tr>
<td>Name</td>
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<td>Type</td>
<td>ISDA®</td>
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<tr>
<td>Value</td>
<td>9x-March 2016</td>
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**2002 MASTER AGREEMENT**

**Table 1:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time (GMT)</th>
<th>Currency</th>
<th>Amount</th>
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<td>2016-04-05</td>
<td>23:59</td>
<td>USD</td>
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</table>

Reproduced with permission of ISDA.
2. First summit

The R3 Smart Contract Templates Summit

- held in London and New York in June 2016
- presentations by R3, Barclays, ISDA, University College London and Norton Rose Fulbright
- over 60 participants from over 20 organisations
3. First research paper

Smart Contract Templates: foundations, design landscape and research directions

• position paper presenting vision

• foundations (terminology, automation, enforceability, semantics), e.g.:

  “A smart contract is an agreement whose execution is both automatable and enforceable. Automatable by computer, although some parts may require human input and control. Enforceable by either legal enforcement of rights and obligations or tamper-proof execution.”

• design landscape (parameter sophistication, code commonality, long-term research)

• joint Barclays-UCL authorship

• publicly released in August 2016
Design landscape

Evolution of legal prose and parameters
- PDF/Word documents
- Prose linked to base type parameters
- Prose linked to higher order parameters
- All contract business logic as higher order parameters

Evolution of code sharing
- Different across banks
- Standardisation
- Common utility functions
- Standardisation
- Common business logic

Long-term research
- Code
- Legal Prose
- Computer Science and Law
- Source Language
- Code
- Legal Prose
- Admissible Source Language
- Code
4. Second summit

The Second R3 Smart Contract Templates Summit

- held in London and New York in November 2016
- presentations by R3, Barclays, CIBC, Nordea, ISDA, FIA, Norton Rose Fulbright, University College London and Cardozo Law School
5. Second research paper

Smart Contract Templates: requirements and abstract specification

- explores initial requirements, basic agreements, and extended agreements
- focuses on key data structures to support smart legal agreements
- joint Barclays-UCL authorship
- to be publicly released in December 2016

Consider the Ricardian Contract triple:

\[
\text{ricardian-contract} \rightarrow \text{prose parameter}^* \text{ code}
\]
\[
\text{prose} \rightarrow \text{prose-element}^*
\]
\[
\text{prose-element} \rightarrow \text{markup} | \text{text}
\]
\[
\text{parameter} \rightarrow \text{name type value}
\]

* = zero or more
## 6. Publicly available materials

<table>
<thead>
<tr>
<th>Smart Contract Templates at Barclays Accelerator Demo Day</th>
<th>Video</th>
<th><a href="https://vimeo.com/168844103">https://vimeo.com/168844103</a></th>
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<td></td>
<td>Press article</td>
<td><a href="http://www.coindesk.com/barclays-smart-contracts-templates-demo-r3-corda/">http://www.coindesk.com/barclays-smart-contracts-templates-demo-r3-corda/</a></td>
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<td>The R3 Smart Contract Templates Summit</td>
<td>Slide deck</td>
<td><a href="http://r3cev.com/s/R3-Smart-Contract-Templates-Summit-_FINAL.pdf">http://r3cev.com/s/R3-Smart-Contract-Templates-Summit-_FINAL.pdf</a></td>
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<td>Press interview</td>
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<td>Legally-Enforceable Smart Contracts</td>
<td>Video</td>
<td><a href="https://www.youtube.com/watch?v=IHAT7zCzlhM">https://www.youtube.com/watch?v=IHAT7zCzlhM</a></td>
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<td>Press article</td>
<td><a href="http://www.ibtimes.co.uk/legally-enforceable-smart-contracts-debated-london-fintech-week-2016-1572084">http://www.ibtimes.co.uk/legally-enforceable-smart-contracts-debated-london-fintech-week-2016-1572084</a></td>
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<td><em>To be made publicly available in November 2016</em></td>
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<tr>
<td>Smart Contract Templates: requirements and abstract specification</td>
<td>Research paper</td>
<td><em>To be made publicly available in December 2016</em></td>
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7. Questions

“It will take time to build, but the potential benefits are enormous”

“Further collaboration is required; it needs industry behind it”
Smart contract templates: requirements and abstract syntax

Dr. Chris Clack
Senior Lecturer, University College London
Smart Contract Templates: requirements and abstract specification

Dr. Christopher D. Clack
The Centre for Blockchain Technologies
Department of Computer Science
University College London
Consultant to Barclays

The Second R3 Smart Contract Templates Summit
16 November 2016
Contents

- Smart legal agreements
- Requirements *sine qua non*
- Defining formats for storage and exchange
- Smart legal agreement – basic and extended
- Complex smart legal agreements
- Discussion points
- Next steps
Smart legal agreements

- The legal contract includes both prose and parameters
- Parameters provide the link from prose to code
- Parameters are embedded in the prose – they must be identified and passed to the code

- Key question: what are the requirements for supporting smart legal agreements?
Requirements *sine qua non*

- Methods for **creating** and **editing** smart legal agreements
- Standard formats for **storing**, **exchanging**, and **retrieving** smart legal agreements
- Methods to add **signatures** to smart legal agreements
- Methods to **link** the legal prose and the smart contract code
- Methods for making smart legal agreements available to **dispute resolution processes**
Defining formats for storage and exchange

- Used for:
  - storage and retrieval
  - exchange between counterparties

- **Standard** formats will facilitate common semantics, automated procedures, and development of tools by technology vendors

- There could potentially be different standard formats for different categories of financial products (derivatives, trade finance, etc.)

- Key question: can communities define abstract specifications that capture the core requirements, from which concrete standards could be derived?
A smart legal agreement – basic

- “basic” = a single document
- Digital representation of legal prose
  - simple formatting (bold, italic, …)
  - simple way to identify embedded parameters (with name, type & value)
- Extended with a header for administrative convenience
  - contains data not in prose (e.g. document identifier, hash)
Illustrative example abstract syntax:

```
smartLegalAgreement : header  prose

header : Date*  Signature*  InstantiatedSmartContractID?  DocHash?  DocID

prose : proseSection+

proseSection : presentationalMarkup?  parameter?  Text

presentationalMarkup : PresentationalStyle*

parameter : ParameterName ParameterType ParameterValue
```
A smart legal agreement – extended

- Structured semantic markup
  - bidirectional references (active links)
  - clause semantics (for analysis)
  - clause hashing (for standard clauses)

- Structured prose
  - names, lists, tables, optional clauses

- Extended parameters
  - execution, nonexecution, analytic
  - arrays, expressions
Complex smart legal agreements

- Grouping of multiple documents (parts of legal agreement, plus other documents)
- Bidirectional references between documents
- Distributed binding
  - define parameter “X” in Document A
  - give parameter a value in Document B
  - refer to the name/value in Document C
- Extended header
  - edit history, versions
  - document status, group status
  - parent-child hierarchies
Discussion points

• Should the abstract syntax be accompanied with an abstract semantics, to facilitate automated checking and analysis?

• Should there be a generic abstract syntax (and semantics?) that is applicable across the whole of law?
  - or focused on just financial agreements?
  - or focused just for one business area?

• What are the constraints for development of common abstract syntaxes?

• Any preferences for academic research directions?
Next steps

• Develop a “straw-man” abstract syntax
• Publish the second academic research paper
• Explore different concrete implementations
• Develop an abstract semantics, to facilitate automated checking and analysis
• Explore the genericity of the abstract specification
• Explore the use of semantic markup to assist workflow
Distributed ledger technology and smart contracts – the future of derivatives processing?

Clive Ansell
Head of Market Infrastructure and Technology, ISDA
Distributed Ledger Technology and Smart Contracts – The Future of Derivatives Processing?

Clive Ansell
Head of Market Infrastructure and Technology
ISDA
ISDA Whitepaper

• The Future of Derivatives Processing and Market Infrastructure
  https://www2.isda.org/functional-areas/infrastructure-management/market-infrastructure-and-technology/

• Current infrastructure challenges

• The need for change

• Opportunities for Technology and Standardisation
Primary Challenge – Complexity

- Reduces efficiency
- Increases cost
- Creates operational risk
- Challenges for regulatory compliance
A High Level Generic Process Flow
An Extract of Reality
Opportunities for Technology and Standardisation

- **Standardisation**
  - Process – operating models and interactions
  - Data – identifiers and formats
  - Documentation – umbrella/master and product

- **Collaboration**
  - Counterparties, Infrastructures, Vendors, Regulators
  - Solicit views to ensure end state is suitable for all

- **Technology**
  - FinTech
  - RegTech
  - Smart Contracts
ISDA – A Trade Associations Role

- Member reach – facilitate participation and dissemination:
  - Across multiple market segments
  - Globally
- Provide access to expertise - leveraging existing working group structures:
  - Asset class – credit, rates, equity
  - Functions – trading, reporting, confirmation, settlement
  - Discipline – business, legal, operations and technology
- Connect thought leaders
- Facilitate integration of legacy and next generation environments
- A standards body
Other Considerations

• FpML as a basis for financial derivatives Smart Contracts

• The relationship between Smart Contracts and Distributed Ledger Technology

• What is the goal – agreeing primary objectives and limitations

• How do we get there – a plan for adoption
Since 1985, ISDA has worked to make the global derivatives markets safer and more efficient. Today, ISDA has over 850 member institutions from 67 countries. These members comprise a broad range of derivatives market participants, including corporations, investment managers, government and supranational entities, insurance companies, energy and commodities firms, and international and regional banks. In addition to market participants, members also include key components of the derivatives market infrastructure, such as exchanges, intermediaries, clearing houses and repositories, as well as law firms, accounting firms and other service providers. Information about ISDA and its activities is available on the Association's web site: www.isda.org.
Smart contracts for cleared derivatives

Simon Puleston Jones
Head of Europe, FIA
Smart Contracts for Cleared Derivatives

Simon Puleston Jones, Head of Europe
Overview

• The punchline

• The context: what are “Cleared Derivatives”?

• Industry standard legal documentation for Cleared Derivatives

• The challenges of implementing Smart Contracts for Cleared Derivatives
Conclusion

• Smart contracts are an important technical innovation that will increasingly be employed for both relationship documentation and trades in OTC markets

• Smart contracts are a viable tool for contract creation when using the FIA Terms of Business to document a clearing broker’s relationship with its client

• The platforms used to build such contracts can be integrated into other enterprise systems, to assist with the capture, analysis and monitoring of such contracts

• Self-executing contracts are not yet viable for client cleared derivatives, due to the level of discretion afforded to the client, the clearing broker, the clearing house and regulatory authorities in the context of a cleared derivatives transaction

• We encourage the industry and vendors alike to consider further whether the current challenges in applying smart contracts to cleared derivatives are surmountable in a scalable way and, if so, how
What are “Cleared Derivatives”?
What is clearing and why is it important?

• We run a day-long seminar called “Clearing in a Day” that answers these two questions in detail. It is aimed primarily at those coming into the cleared derivatives industry for the first time.

• Clearing is the process of a clearing house intermediating a buyer and a seller, with the aim of protecting each of the buyer and the seller from the other’s default and ensuring settlement of their financial obligations to one another.

• Clearing replaces direct counterparty credit risk with CCP credit risk and mutualised clearing member risk, which is mitigated by regulator independent initial and variation margin calls.

• Clearing involves risk margining, reporting, the netting of trades into single positions, tax handling, failure handling and, for many clearing houses, compression - it also provides for standardised expiry and delivery processes.

• From a product perspective, “Cleared derivatives” covers futures, exchange traded options, swaps, certain commodities, repos and other derivatives that are intermediated by a clearing house.
Pittsburgh G20 Leaders Summit 2009 communiqué:

“All standardised OTC derivative contracts should be traded on exchanges or electronic trading platforms, where appropriate, and cleared through central counterparties by end-2012 at the latest.

OTC derivative contracts should be reported to trade repositories. Non-centrally cleared contracts should be subject to higher capital requirements.”
Clearing of OTC derivatives in Europe
Executing/Clearing an OTC interest rate swap

THE ORIGINAL OTC TRADE

Party A (Buyer) | Fixed Rate | ISDA Master Agreement + Schedule (+CSA?) | Party B (Seller)

Floating Rate

Fixed Rate

BECOMES CLEARED AS FOLLOWS

CCP Rulebook

Fixed Rate

Party A (Buyer) | CCP | Fixed Rate

CCP Rulebook

Floating Rate

Fixed Rate

CCP Rulebook

Floating Rate

Party B (Seller)
Executing/Clearing an OTC interest rate swap

OR, IF PARTY A IS NOT A MEMBER OF THE CCP BUT PARTY B IS A CLEARING MEMBER: THE ORIGINAL OTC TRADE

BECOMES CLEARED AS FOLLOWS

Party A (Buyer) → Fixed Rate → ISDA Master Agreement + Schedule (+CSA?) → Floating Rate → Party B (Seller)

Party A (Buyer) → Fixed Rate → FIA ToBs + Clearing Module → Floating Rate → Clearing Broker

Fixed Rate → Clearing Broker → Floating Rate → CCP → Floating Rate → Party B (Seller)
Margining of a cleared interest rate swap

**IF BOTH PARTIES ARE A MEMBER OF THE CCP AND PARTY A IS IN-THE-MONEY**
Margining of a cleared interest rate swap

OR, IF PARTY A IS **NOT** A MEMBER OF THE CCP, AND PARTY A IS IN-THE-MONEY
Who can default under a cleared interest rate swap

- Party A
- Clearing Broker
- Clearing Broker’s settlement banks/custodians
- CCP
- CCP’s settlement banks/custodians
- Party B
The clearing of Exchange Traded Derivatives
Executing an exchange traded derivative (e.g. a futures contract) for a client

- **Party A (Buyer)**
- **Executing Broker**
- **Trading Venue**
- **Party B (Seller)**

Back to back arrangement between clearing broker and its client (Party A), governed by FIA Terms of Business, incorporating any rules mandatorily required by TV / CCP rulebook.
Clearing an exchange traded derivative (e.g. a futures contract) for a client

Back to back arrangement between clearing broker and its client (Party A), governed by FIA Terms of Business, incorporating any rules mandatorily required by TV / CCP rulebook.
Industry standard documentation for Cleared Derivatives
Industry standard documentation?

No industry standard

• Exchange contract specifications for exchange traded derivatives
• Clearing House rules for cleared derivatives
• Documentation for indirect client relationship

Industry standard documentation exists

• FIA Terms of Business and ancillary modules for clearing broker’s relationship with direct client (although most firms currently diverge from the FIA template)
• Documentation for direct client relationship
• Bilateral trading and clearing terms for OTC derivatives: ISDA Master Agreement and ancillary modules
• Regulatory disclosures and annexes
Industry Standard Documentation?

- Indirect Client(s)
- Direct Client’s Terms and regulatory disclosure
- Clearing Member’s terms and regulatory disclosures
- Clearing House’s Rulebook
- Clearing House
FIA Terms of Business + Numerous modules to the FIA Terms of Business +?

FIA Clearing Module or ISDA / FIA Client Clearing Addendum

ISDA Master Agreement + Numerous modules to the ISDA Master Agreement +

ISDA / FIA Client Clearing Addendum
FIA Terms of Business

+ 

Numerous modules to the FIA Terms of Business
The challenges of implementing smart contracts for cleared derivatives
The promise of Smart Contracts

- Simplify / electronify the process of contract creation
- Increased standardisation of trading terms
- Electronic execution
- Immediate integration of legally binding contracts into documentation storage platforms and of the terms of those contracts into wider IT infrastructure that capture, analyse and monitor trade terms
- Self-execution of contracts
The challenges of Smart Contract implementation

Simplify / electronify the process of contract creation

• Two different things to solve for contractually:
  o The wider relationship between clearing broker and direct client (governed by the clearing broker’s Terms of Business); and
  o The terms of the trade being cleared (governed by a combination of such Terms of Business and the exchange/clearing house rules relating to the applicable derivative contract).

• So, it’s not just a single, bilateral, relationship with a single set of terms

• How do you capture the clearing house rules that are required to be incorporated into the Terms of Business between the clearing broker and the direct client? What should the effect of subsequent rule changes be and how do you incorporate those into the contract?

• Regulations from around the globe form the bedrock of the legal agreements - after the date of entry into of the contract, how does a Smart Contract cater for changes in regulation that require changes to the contract?
Increased standardisation of trading terms

- The modular architecture of the FIA Terms of Business lends itself to standardisation of terms
- Smart Contracts can be used to select the appropriate modules and then “fill in the blanks” within the clauses of the relevant module
- If clients are willing to accept a more standardised offering, this can significantly decrease the time it takes to on-board a new client
Electronic execution

• In a global business, the ability to sign documents electronically may further reduce client on-boarding times

• You still need to be comfortable that:
  
  o electronic execution is legally binding in all applicable jurisdictions; and
  
  o that the person purporting to execute the contract has power, capacity and authority to do so
Immediate integration of legally binding contracts into documentation storage platforms and of the terms of those contracts into wider IT infrastructure that capture, analyse and monitor trade terms

• This is an enormously useful feature of Smart Contracts: some clearing brokers will have hundreds of contracts with their client base, possibly thousands. This is an efficient way of establishing:
  o What contracts have you entered into?
  o When?
  o With whom?
  o On what terms?
  o To what extent do those terms deviate from the house template?
  o How many of those agreements contain a specific provision?
The challenges of Smart Contract implementation

Self-execution of contracts

**Discretion is the enemy of smart contracts. Clearing relies on discretion - a lot:**

- Clearing broker has discretion in how much margin to call the client for, and when
- Default of the client: clearing broker has discretion in how, whether and when to close out the client, and what to do with the posted collateral
- Default of the clearing broker: client has discretion as to whether to port their positions to a back up broker or close them out
- Default of the clearing house: the clearing house management and regulators have significant discretion, that may impact the client/clearing broker relationship
- The clearing broker can exercise discretion to change the terms of the trade in light of the actions of markets or regulators

Further, unlike OTC derivatives, **the relationship is not bilateral** – what happens to the contract and trades under it are impacted by exchange rules and clearing house rules.
Self-execution of contracts

How do you:

• Address the margining of the position, given the contract typically says, effectively, “you, the client, will pay much whatever margin I ask for, whenever I ask for it”?
• Deal with the default of the client?
• Deal with the default of the clearing broker, given the default management procedures of the clearing house will have a direct impact on what happens to the trade between the clearing broker and the client?
• Ensure that your automated margin call mechanisms integrate into your client money/client asset compliance regime?
• Document and operate margin transformation services?
• Address cross-product margining?
• Deal with set-off and indemnities?
• Address post-trade regulatory change, to the extent it impacts on the derivatives entered into under the agreement?
Other considerations

• If a trade association establishes industry standard terms, does the entire industry have to use the same vendor?

• What IT platform should be used? What if the two parties use different smart contract systems?

• ETD markets are often accessed via a number of brokers and “long chains” are a common feature of ETD markets – how may smart contracts work harmoniously along the entire chain?

• Some of these contracts (e.g. inflation swaps) might last 50 years – technology changes a lot in 50 years...

• In the absence of a single industry standard language or platform for Smart Contracts, is it too early to standardise using Smart Contracts?
Conclusion

• Smart contracts are an important technical innovation that will increasingly be employed for both relationship documentation and trades in OTC markets

• Smart contracts are a viable tool for contract creation when using the FIA Terms of Business to document a clearing broker’s relationship with its client

• The platforms used to build such contracts can be integrated into other enterprise systems, to assist with the capture, analysis and monitoring of such contracts

• Self-executing contracts are not yet viable for client cleared derivatives, due to the level of discretion afforded to the client, the clearing broker, the clearing house and regulatory authorities in the context of a cleared derivatives transaction

• We encourage the industry and vendors alike to consider further whether the current challenges in applying smart contracts to cleared derivatives are surmountable in a scalable way and, if so, how
Experimental oracle for Corda

Mark Raynes
Blockchain Developer, Thomson Reuters
Experimental oracle for Corda

The Second R3 Smart Contract Templates Summit
16 November 2016

Mark Raynes
Blockchain Developer
Introduction

• What is Thomson Reuters Applied Innovation?
  - Responsible for the exploration of emerging technologies
  - Currently looking at Blockchain, Cognitive Computing, IoT, Cloud, AR/VR and more
  - Also responsible for mobile application development for internal and external clients

• What are we doing in this space?
  - Public/Blockchain Initiatives – BlockOne ID
  - Private/DLT Initiatives – Oracles, Corda (and others)

• This presentation:
  - Provide an overview of oracles and how they relate to legal agreements
  - Provide an example of how an oracle takes part in a smart legal agreement
  - Propose a high level oracle architecture
  - Discuss key considerations and future work
Oracles

• Why do we need oracles?
  - All parties to an agreement must be able to independently arrive at the same result for a given transaction
  - We cannot ensure that external services will always return the same answer
  - We need trusted agents that can attest to certain facts by signing transactions that contain them

• What can oracles do?
  - Act as a trusted source of data
  - Respond to defined queries
  - Sign data within a transaction
  - Act as a definitive model / valuation service
  - Act as a scheduler or notification service
Oracles and Legal Agreements

• Automatically establish key facts of agreement
  - Holiday dates
  - Current market prices

• Automation of lifecycle events
  - Rate fixings
  - Maturity events

• Ability to specify data sources up-front
  - Future interest rates will be provided by “ProviderX:RatesOracle”

• Traceability
  - Results are signed and permanently committed to ledger
Example – Floating Rate Loan Agreement

- Governs a floating rate loan agreement between two parties

- “LoanAgreement” object represents deal:
  - Payment terms – Immutable
  - Payment schedule – Mutable (via transactions)

- Interest rate oracle is specified up-front
  - Would be possible to specify backup(s)

- Utilises Corda’s in-built “TwoPartyDealProtocol”
  - Orchestrates rate fixings

- Utilises Prototype Rate Fix Oracle
  - Provides interest rates and signs transactions
Example – Floating Rate Loan Agreement

- Agreement is mutated throughout its lifecycle via transactions
- Corda platform ensures transactions are signed by the required parties
Potential Architecture

• Service Integration Layer
  - Abstracts communication with external data service
  - Manages sessions

• Oracles
  - Support different use cases / workflows
  - Support different subscription patterns (e.g. request / response, publish / subscribe)
  - Provide appropriate behavior (e.g. caching/persistence, interpolation)

• Protocols
  - Standard (e.g. interest rate fix, end-of-day pricing)
  - Proprietary (e.g. complex valuations)
Potential Oracles

- **Market Pricing**
  - Intraday / End-of-Day

- **Corporate Actions**
  - Dividends
  - Earnings
  - Capital changes

- **Valuations**
  - Evaluated pricing
  - Models / Analytics

- **Reference Data**
  - Symbols / Identifiers
  - Industry classifications
  - Descriptive data
  - Calendars
Key Considerations

• Standardisation
  - Identifiers / Symbology
  - Protocols / Workflows - Encourage data providers to adhere to common interfaces
  - Terminology

• Testing
  - TestNet presence
  - Simulators – Must be able to test against realistic data

• Commercial Models
  - Must adhere to incoming license agreements
Future Work

• Establish and understand requirements
  - Engage with market participants
  - Engage with standards bodies

• Continue to experiment with Corda and other emerging platforms
Questions?
Coffee break
Simpler OTC smart contracts

Sofus Mortensen
Chief Quantitative Analyst, Nordea Markets
Simpler OTC Smart Contracts

*The Second R3 Smart Contract Templates Summit*

Sofus Mortensen
16 November 2016
Motivation

• Reduce complexity of writing a new type of contract
  – Specification
  – Testing

• Making OTC Smart Contracts accessible by business
  – Reading
  – Reasoning
  – Writing?

• Reduce complexity of manual validation transactions
The shoulders of giants:

“Composing Contracts: an adventure in financial engineering”

Simon Peyton Jones, Jean-Marc Eber, Julian Seward
Smart Contracts – Corda’s approach

- Actor proposes transaction
- Transaction is validated against contract by network
- Upon consensus transaction is final

*Smart contract* refers to the code that verifies transactions
Smart Contracts – refining Corda’s approach

Contract state *is* the contract

Readable by both machines and humans

Implementation details for Corda:
- Validation of transaction is still done in a “Super Smart Contract” that can interpret the state
- The *light weight contract* found in the state is called *Arrangement* to avoid confusion
Contract Examples

Basics
Debt

Indicates beginning of light weight contract

```
arrange {
  highStreetBank.owes(acmeCorp, 100.K, GBP)
}
```

“highStreetBank” and “acmeCorp” are references to involved parties and are defined elsewhere.
Zero coupon bond

ACME Corp has the right to exercise after specified date

```
arrange {
  actions {
    acmeCorp.may {
      "execute".givenThat(after("2018-06-01")) {
        highStreetBank.owes(acmeCorp, 100.K, GBP)
      }
    }
  }
}
```
Contract examples

IR Caplet
IR Caplet

arrange {
  actions {
    (acmeCorp or highStreetBank).may {
      "exercise".anytime {
        val floating = interest(notional, "act/365",
                                fix("LIBOR", "2016-04-01", Tenor("6M")),
                                "2016-04-01", "2016-10-01")

        val fixed = interest(notional, "act/365",
                             0.5,
                             "2016-04-01", "2016-10-01")

        highStreetBank.owes(acmeCorp, floating - fixed, GBP)
      }
    }
  }
}

placeholder for future LIBOR fixing

calculation of interest on notional

Note that debt obligation must be of positive amount. Hence exercise is only valid if floating leg is larger than fixed leg.
IR Caplet

Following transaction applying fixing from oracle

arrange {
    actions {
        (acmeCorp or highStreetBank).may {
            "exercise".anytime {
                val floating = interest(notional, "act/365", 
                0.67, 
                "2016-04-01", "2016-10-01")

                val fixed = interest(notional, "act/365", 
                0.5, 
                "2016-04-01", "2016-10-01")

                highStreetBank.owes(acmeCorp, floating - fixed, GBP)
            }
        }
    }
}
IR Caplet

Resulting state following exercise

```scala
arrange {

  val floating = interest(notional, "act/365",
                         0.67,
                         "2016-04-01", "2016-10-01")

  val fixed = interest(notional, "act/365",
                       0.5,
                       "2016-04-01", "2016-10-01")

  highStreetBank.owes(acmeCorp, floating - fixed, GBP)
}
```

Reduces to obligation
Contract examples

IR Swap
IR “Swaplet”

Calculation of interest of floating and fixed leg. Floating leg uses placeholder for LIBOR fixing.

Choice of exercise depends on which is larger, fixed or floating leg

```scala
arrange {
  val floating = interest(notional, "act/365",
                          fix("LIBOR", "2016-04-01", Tenor("6M")),
                          "2016-04-01", "2016-10-01")
  val fixed = interest(notional, "act/365",
                       0.5,
                       "2016-04-01", "2016-10-01")

  actions {
    (acmeCorp or highSteeetBank).may {
      "exercise floating".anytime {
        highStreetBank.owes(acmeCorp, floating - fixed, GBP)
      }
      "exercise fixed".anytime {
        acmeCorp.owes(highStreetBank, fixed - floating, GBP)
      }
    }
  }
}
```
IR Swap

Rollout of date sequence from September 2016 to 2017 with semi-annual frequency

```scala
arrange {
  rollOut("2016-09-01", "2017-09-01", Frequency.SemiAnnual) {
    val floating = interest(notional, "act/365",
      fix("LIBOR", start, Tenor("6M")),
      start, end)
    val fixed = interest(notional, "act/365",
      0.5,
      start, end)
    actions {
      (acmeCorp or highStreetBank).may {
        "exercise floating".anytime {
          highStreetBank.owes(acmeCorp, floating - fixed, GBP)
          next()
        }
        "exercise fixed".anytime {
          acmeCorp.owes(highStreetBank, fixed - floating, GBP)
          next()
        }
      }
    }
  }
}
```

Note placeholders for start and end date for interval

Links to next interval in date sequence
IR Cancelable Swap

```java
arrange {
  rollOut("2016-09-01", "2017-09-01", Frequency.SemiAnnual) {
    val floating = interest(notional, "act/365", fix("LIBOR", start, Tenor("6M")), start, end)
    val fixed = interest(notional, "act/365", 0.5, start, end)
    actions {
      (acmeCorp or highSteetBank).may {
        "exercise floating".anytime {
          highStreetBank.owes(acmeCorp, floating - fixed, GBP)
          next()
        }
        "exercise fixed".anytime {
          acmeCorp.owes(highStreetBank, fixed - floating, GBP)
          next()
        }
      }
      acmeCorp.may {
        "cancel".anytime {
          acmeCorp.owes(highStreetBank, 10.K, GBP)
        }
      }
    }
  }
}
```

ACME Corp can cancel the swap, paying a fee. Note absence of “Next”. Contract ends here.
Thank you!

Sofus Mortensen
sofus.mortensen@nordea.com
Languages and abstraction layers to support the adoption of smart contracts

Robin Green
Executive Director, Digital Markets Innovation, CIBC Capital Markets
The Second R3 Smart Contract Templates Summit

Languages and abstraction layers to support the adoption of smart contracts

Robin Green
Executive Director, Digital Markets Innovation, CIBC Capital Markets

16 November 2016
Introduction

Question - Can we create a means to clearly define the business intent of a smart contract?

Similar things have been done in other areas, for example:

Web Page Design - HTML

Create a table with one row and two cells. In the first cell put the word ‘hello’ and in the second put the word ‘world’

```
<table><tr><td>hello</td><td>world</td></tr></table>
```

This piece of HTML is fully defined by the W3C web standard group, and any modern web browser will display the table that this code defines in exactly the same way.

Asking questions of a Relation Database - SQL

Select all records from the table called ‘employees’:

```
Select * from employees
```

This SQL is fully defined by the ANSI standard group, and will return the same results set on any of the major databases that supports SQL.

Benefits

• The person writing the definition does not worry about the technology implementation
• The meaning of the business definition is well defined and non-ambiguous
• Minimised vendor lock-in – the definition can run on / interpreted by a number of platforms with the same result
Abstracting Business operations

Can we do the same for smart contracts?

Would it be possible to have a platform independent, legally binding means of defining the operation of smart contracts. For example, would it be possible to have a Delivery vs Payment (DVP) contract defined by the following tag:

```
<DVP (refToAssetA, refToAssetB, identityOfPartyOne, identityOfPartyTwo)>
```

The rights and obligations of all parties entering into this DVP contract, along with the operation of the contract would be defined in legally enforceable language.

**Why would this be useful?**

1. It would allow parties to enter into a fully defined legal contract, without having to worry about the code implementation.

2. The legal definition would only need to be made once when the Tag is initially created/defined.

3. Developers would have a very clear business definition that describes exactly how the contract should operate and what they should code, leaving no room for misinterpretation.

4. Operation across ledgers, while complex, would become a purely technical problem. Both parties will be agreeing to identical versions of the legal agreement, tags and parameters; this will not (if correctly coded) be affected by the underlying ledger technology.
Breaking the problem down - into layers

When thinking about how we might put this approach into practice, it can be helpful to think of Smart Contracts that run on a distributed ledger as a layered model as in the table below.

Each layer would be agnostic to the implementation in the layers above and below, but each layer would expose a set of distinct methods or properties that can be called by layers above.

<table>
<thead>
<tr>
<th>Smart Contract Layers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Tags</td>
</tr>
<tr>
<td>4</td>
<td>Choreography / Orchestration</td>
</tr>
<tr>
<td>3</td>
<td>Actions</td>
</tr>
<tr>
<td>2</td>
<td>Data</td>
</tr>
<tr>
<td>1</td>
<td>Ledger Services</td>
</tr>
<tr>
<td>0</td>
<td>Ledger</td>
</tr>
</tbody>
</table>
Breaking the problem down - into layers

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<td>Ledger</td>
</tr>
</tbody>
</table>

Layer 0 – Ledger

An off-the-shelf unmodified ledger implementation. Could be Etherium, Corda etc...

Technically, this does not need to be a ledger, but merely a networked data store; the Ledger Services layer would then have to implement all missing 'Ledger-like’ functionality.
Breaking the problem down - into layers

Layer 1 - Ledger Services

The smart contract code will require some base functionality to operate - this could either be provided natively by the ledger, or by trusted third parties that provide services on the ledger (the specific service provider could be specified as an input parameter in the contract definition). This functionality would likely include:

1. The ability to enforce a guaranteed and provable state across multiple participants
2. Operations to support transactions between autonomous actors, e.g., ‘only do x when condition y has been met’. (Consensus, Notary & Semaphoring operations)
3. Escrow services
4. Content agnostic messaging service
5. Identity services
Breaking the problem down - into layers

Layer 2 – Data

Instruments, Cash, etc... In finance, these are likely to be existing FPML or FIX-based definitions.

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</tr>
<tr>
<td></td>
<td>0</td>
<td>Ledger</td>
</tr>
</tbody>
</table>
Breaking the problem down - into layers

Layer 3 - Actions

Actions are the base level building blocks from which contacts are built. A common set of well defined actions will be supported by all nodes on the ledger.

A defined protocol to describe inter-action communication

If we assume that two parties are running the ‘Exchange’ action, then at some point in the process, the code running at Party 1 and at Party 2 will need to communicate – messages might include ‘Does Party 1 have the Assets’ and ‘What is the value of the asset being provided by Party 2.

It is suggested that the messages and the wire format that represents the messages should be fully defined. Having a formal definition will:

1. Allow interoperability between different concrete implementations of code for a given action, i.e., the action is the same, but the underlying code is different.

2. Enable the long term goal of having different parties sitting on separate ledgers or other transactional systems, i.e., same as above; the action is the same, but the underlying code is different.

3. Help to decouple the underlying message protocol / fabric from business logic.
Breaking the problem down - into layers

Layer 4 Orchestration & Choreography – linking things together

It should be possible to build up more complex operations by combining actions and tags. Before the DVP can take place, assets need to be loaded onto the ledger, and the identity of the actors needs to be confirmed. The following pseudo-code outlines the type of concept being considered:

```plaintext
var refToAssetA = <LoadAsset(A)>
var refToAssetB= <LoadAsset(B)>
var identityOfPartyOne = <ValidateIdentity(PartyOne)>
var identityOfPartyTwo = <ValidateIdentity(PartyTwo)>
<DVP (refToAssetA, refToAssetB, identityOfPartyOne, identityOfPartyTwo)>
```

It would also be useful to investigate properties of variables, e.g.,

- refToAssetA.getValue(USD)
- refToAssetA.getOwner.getName()

Control structures and conditional execution will also be required.
Breaking the problem down - into layers

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<tr>
<td>1</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

Layer 5 – Tags

This is what the end user would see, agree to, and would be enforceable in a court of law. An agreement could be as simple as ‘send party A some cash’, but could obviously become much more complex. A simplified tag may look as follows:

\[<\text{DVP} \left( \text{refToAssetA, refToAssetB, identityOfPartyOne, identityOfPartyTwo} \right)>\]

The Choreography layer could be used to wrap / combine a number of tags and actions together to create a new tag with inherited or extended functionality.
Putting theory into practice

Can we develop these ideas and solve a real world problem?

Project Banff is looking at the Canadian Banker’s Acceptance market. Would it be possible to:

1. Define a set of tags that represent the legally binding transactions and obligations that make up the Banker’s Acceptance issuance process

2. Implement these tags using a layered approach, and thus begin to abstract the business/legal definition from the underlying technology

3. Represent the smart contract agreement in a form that is more understandable to a non-technical reader
Dispute resolution for smart contracts

Isabelle Corbett, Senior Counsel, R3
Matt Britton, Consultant, R3
Ian Grigg, Consultant, R3
Dispute Resolution for Smart Contracts

Isabelle Corbett, Senior Counsel, R3
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Ian Grigg, Consultant, R3

The Second R3 Smart Contract Templates Summit

16 November 2016
R3 AWG. Legal & Dispute Resolution Frameworks SWG

As part of the wider R3 AWG\(^1\), the Legal & Dispute Resolution Frameworks SWG\(^2\) looked at the following areas, predominantly on the architectural aspects:

- User agreements
- Legal enforceability of smart contracts
- Dispute resolution
- Handling of dispute resolution

\(^1\) AWG = Architecture Working Group  
\(^2\) SWG = Sub-Working Group
User Agreements. How much change is needed to accommodate DLT?

- Agreements governing parties’ behavior and obligations to one another still must exist

- Contracts with automated elements are still contracts and, therefore, subject to contract law

- Contract law will likely not change as quickly as technology advances, so agreements must adapt
User Agreements. Types of Agreements Required

• Agreements must be in place that address the following questions:
  • What determines who is allowed to participate on a ledger?
  • What governs behavior on the ledger?
  • What governs transactions in a particular assets?
  • What sets forth the terms of transactions that parties agree to?
  • Who else is providing services to facilitate transactions and what are the obligations that attach to provision of those services?
User Agreements. Next steps

• Look at the agreements that exist today and determine how much those agreements need to change to accommodate the technology

• Learn from currently existing electronic trading agreements

• Explore the identity question as it relates to signatures

• Continue dialogue with regulators

• These must be done in parallel with the analysis of enforceability of smart contracts and the suitability of contracts for conversion into “smart contracts”
Assumption. Disputes will happen
Assumption. Disputes will happen
Assumption. Disputes will happen

- More or less frequently
- More or less expensive

**Goal:** to create certainty *and* confidence
Handling disputes. How do we deal with them?
Handling disputes. How do we deal with them?

- initiateDisputeResolution()
- pause()
Handling disputes. How do we deal with them?

Dispute Resolution

Exhibit A

initiateDisputeResolution()
pause()
Handling disputes. How do we deal with them?

Exhibit A

Dispute Resolution

initiateDisputeResolution()
pause()

Ruling

restart()

or terminate()
Dispute Resolution. What are the options?

- **Negotiation**: Between parties only.
- **Mediation**: Between parties with independent, non-decision-making mediator.
- **Arbitration**: Between parties with independent, decision-making arbitrator.
- **Courts**: Between parties within legal system.
Dispute Resolution. What are the options?

- Negotiation: Between parties only
- Mediation: Between parties with independent, non-decision-making mediator
- Arbitration: Between parties with independent, decision-making arbitrator
- Courts: Between parties within legal system

- Expert knowledge
- Cross-border jurisdiction
Dispute Resolution. What are the options?

- Negotiation: Between parties only
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- Expert knowledge
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Arbitration. How would this work?

Could be a natural fit for the challenges around expert knowledge and cross-border jurisdiction. Examples: SWIFT, CME, ISDA, EDI & LCH
**Arbitration. How would this work?**

Could be a natural fit for the challenges around expert knowledge and cross-border jurisdiction. Examples: SWIFT, CME, ISDA, EDI & LCH

What would we need?

- Arbitration clause in the legal prose of the Smart Contract
- Administration
- Policy / set of rules
- List of arbitrators and mechanism for selection
Arbitration. The challenges

1. Being able to find the experts
Arbitration. The challenges

1. Being able to find the experts

2. Scope of disputes

Or
Arbitration. The challenges

1. Being able to find the experts

2. Scope of disputes

3. Volume of disputes
Conceptualizing smart contracts

Aaron Wright
Clinical Professor, Cardozo Law School
Conceptualizing Smart Contracts

Aaron Wright
Clinical Professor, Cardozo Law School
November 16, 2016
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WHAT IS A SMART CONTRACT

• A condition facilitated via a blockchain with a high probability of execution
• Enables code to operate autonomously from any one party
• Not simply an automated legal agreement
• Smart contracts have a range of potential applications
Universe of Smart Contracts

Legal Contracts

Group Rules

Machine-to-Machine Interactions
SMART CONTRACTS AS LEGAL CONTRACTS

• Like any code, smart contracts can be used to memorialize or effectuate conditions (promises)

• Such a use is a subset of “computable contracts” or data-oriented contracts

• However, promises memorialized using a smart contract can be designed such that they are more difficult to terminate and breach, if relying on a public and permissionless blockchain (i.e., “immutable” promises)

• Because smart contracts can be designed in such a way that makes it difficult to halt the execution of code, they decrease the risk of non-performance and thus decrease monitoring costs
• Agreements can accept input from outside world, via “oracles” to create dynamic agreements that change economic terms based on real world events

• Over a longer time horizon, smart contracts could help facilitate decentralized arbitration systems
• Code → potentially **less ambiguous** than words for verifiable facts

• Code is modular, making it possible to break agreements into chunks which can be assembled by lawyers (or perhaps even AI systems)
ENFORCEABILITY OF “SMART” LEGAL CONTRACTS

• “Smart” legal contracts are not the first contracts to rely on data and promises memorialized in an electronic format.

• In the early 1960’s Ed Guilbert develops an electronic message format for sending information about cargo between Du Pont and Chemical Leahman Tank Lines.

• 1965, the Holland- America steamship line begins sending trans-Atlantic shipping manifests using telex messages and converting the messages into tape that could be loaded into their computers.

• Today, over one hundred thousand companies in the United States use an EDI solution to communicate with their business partners.
• Any electronic message is defined to be a “writing” or “in writing”.

• Agreements expressly provide that the conduct of the parties pursuant to its terms shall evidence a course of dealing and a course of performance which has been accepted by the parties.

• Agreements bar parties from asserting estoppel in order to bar reliance upon the statute of frauds.

• Severability clause to provide courts with flexibility if asked to interpret an agreement.

• Courts have considered cases involving Master EDI agreements; none (based on my research) have been challenged on the basis of invalidity.
ENFORCEABILITY OF AGREEMENTS ENTIRELY WRITTEN IN CODE

• Answer in New York is largely “yes”; due to the E-Sign Act and New York Electronic Signatures and Records Act (ESRA)

• E-Sign:
  • “a contract relating to such transaction may not be denied legal effect, validity, or enforceability solely because an electronic signature or electronic record was used in its formation.” 15 U.S.C. § 7001.
  • Electronic signature defined as “symbol[] or process, attached to or logically associated with a contract or other record . . . executed or adopted by a person with the intent to sign the record.” 15 U.S.C. § 7006.
ESRA:

“An agreement, promise, undertaking or contract, which is valid in other respects and is otherwise enforceable, is not void for lack of a note, memorandum or other writing and is enforceable by way of action or defense provided that such agreement, promise, undertaking or contract is a qualified financial contract” and (a) “there is . . . sufficient evidence to indicate that a contract has been made” or (b) “the parties thereto, by means of a prior or subsequent written contract, have agreed to be bound by the terms of such qualified financial contract from the time they reach agreement (by telephone, by exchange of electronic messages, or otherwise) on those terms.” N.Y. GOL § 5-701(b)(1).

Qualified financial contracts include: “a currency option, currency swap or cross-currency rate swap”; “a commodity swap or a commodity option (other than an option contract traded on, or subject to the rules of a contract market or board of trade)”; “a rate swap, basis swap, forward rate transaction, or an interest rate option”; “a security-index swap or option or a security (or securities) price swap or option.” N.Y. GOL § 5-701(b)(2).
ENFORCEABILITY OF AGREEMENTS ENTIRELY WRITTEN IN CODE (CON’T)

• ESRA:

  • Sufficient evidence, includes: (1) “evidence of electronic communication (including, without limitation, the recording of a telephone call or the tangible written text produced by computer retrieval), admissible in evidence under the laws of this state, sufficient to indicate that in such communication a contract was made between the parties”; or (2) a confirmation (communicated electronically) that isn’t objected to by the party sending the confirmation within a certain defined timetable (even if confirmation omits material terms of agreement). See N.Y. GOL § 5-701(b)(3).

  • Qualified financial contracts include: “a currency option, currency swap or cross-currency rate swap”; “a commodity swap or a commodity option (other than an option contract traded on, or subject to the rules of a contract market or board of trade)” ; “a rate swap, basis swap, forward rate transaction, or an interest rate option”; “a security-index swap or option or a security (or securities) price swap or option.” N.Y. GOL § 5-701(b)(2).

Court held that “E–SIGN's requirement that an *electronically memorialized and subscribed contract be given the same legal effect as a contract memorialized and subscribed on paper* is part of New York law.”

Broad language of E-Sign should be given effect at least in the First Department.
IMMUTABILITY

• Are immutable contracts valid? Probably not.


• Contractual provision that purports to limit the enforceability of a subsequent modification generally deemed unenforceable.

• Restatement (Second) of Contracts § 311 cmt. a (1979) (“The parties to a contract cannot by agreement preclude themselves from varying their duties to each other by subsequent agreement.”).
IMMUTABILITY (CON’T)

• By default, smart contracts arguably have an implied anti-modification provision, which may place the validity of certain smart legal contracts at risk.

• Courts and law undergird all computable contracts, including smart contracts used to model legal agreements. Just because promises are memorialized in “code”; the law does not evaporate.

• Courts have the authority to determine whether a party breached an agreement and remediate harm after the fact
OTHER LIMITATIONS

• Do we want entirely code-bases smart contracts?

• In certain instances, there is value in keeping contracts open-ended or ambiguous, because it can provide flexibility to the parties while also cutting down on the time and expense of negotiation.

• Even if smart contracts make it easier for parties to specify a greater number of possible states of the world, the cost of specifying these contingencies could surpass any gains that may result from such an exercise.

• In many cases, it may be more cost-effective to address remote contingencies after the fact—and renegotiate or make further adjustments to an economic arrangement at that point in time—rather than negotiate them up front.
Can smart contracts be legally binding contracts?

Sean Murphy
Partner, Norton Rose Fulbright
Can smart contracts be legally binding contracts?

Sean Murphy, Partner
16 November 2016
Will the answer involve new law?

Smart “contract” suggests a contract – is that correct?

Will normal contractual principles apply?

Smart contracts raise issues the law has already addressed:

- In the EDI context
- Contractual impact of new methods of communicating (e.g. email / the Internet)
- Electronic signatures
Key questions:

- Can a smart contract give rise to a legally binding contract?
- Does “follow-on” contracting give rise to a legally binding contract?

The answers may sometimes depend on the model of smart contract used, the factual matrix and the applicable law.
Smart contracts: models

Smart contracts lie on a spectrum

- **Contract entirely in code**
- **Contract in code with duplicated natural language version**
- **“Split” natural language contract with encoded performance of non-human aspects**
- **Natural language contract with encoded payment mechanism**

- **100% Code is Contract**
- **Automated Performance**
### Key findings of our research

<table>
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<tr>
<th><strong>Electronic status</strong></th>
<th>Electronic nature not problematic for many (but not all) jurisdictions in establishing contractual formation</th>
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<tbody>
<tr>
<td><strong>Certainty of terms</strong></td>
<td>Certainty as to contractual terms often a critical factor: can the code be understood by a party?</td>
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<td>Smart contracts that merely automate a particular process but do not include (or operate in conjunction with) contractual terms may not satisfy such requirements</td>
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<tr>
<td><strong>Follow-on contracting</strong></td>
<td>Follow-on contracting (by which a later, separate contract is brought about by performance of an earlier smart contract) may not give rise to a legally enforceable contact in some jurisdictions</td>
</tr>
<tr>
<td><strong>Other technical requirements</strong></td>
<td>Other technical requirements of the applicable jurisdiction’s law (typically prescribed by legislation) may, in a few jurisdictions, be a potential impediment to legally binding contractual effect</td>
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Some country-specific observations

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<tr>
<th>Country</th>
<th>Observations</th>
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| USA     | - Current legislative proposals to clarify the position  
          - Key issues: (1) how the parties give assent to the terms; (2) what steps need to be taken to ensure courts are satisfied parties have sufficient notice of the terms (usual rules will apply)  
          - Current precedent indicates US courts may be open to the possibility of follow-on contracting |
| UK      | - No legislation dealing with the issue specifically, but EU directive requires contracts can be concluded electronically. Electronic nature unlikely to be relevant  
          - Usual rules concerning contract formation likely to apply  
          - Limited authority to suggest follow-on contracting may be possible |
| Australia | - Electronic Transactions Act 1999 facilitates electronic contracting and contemplates follow-on contracting  
           - In other respects usual common law principles relating to formation apply |
| Germany | - Currently a machine/software cannot declare intent (a requirement for contract formation) - human behaviour is required. But is it possible that machine/software actions might be attributed to the person responsible  
          - The more independently a smart contract acts, the less likely the necessary attribution would be |
### Some country-specific observations

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| **France**  | - There are both enabling and limiting factors in French law in relation to smart contracts. French Civil Code envisages possibility of contracting electronically.  
             - But essential terms would need to be accessible and understandable by each party, and a technical mechanism must be available to express consent. |
| **China**   | - China’s Electronic Signature Law facilitates electronic contracting. Also relevant will be China’s Contract Law.  
             - Where parties form contract by data messaging, either party may request option to sign letter of conformation before conclusion of the contract. Such requirement could impact upon the efficacy of smart contracts in China.  
             - A smart contract may be considered a standard form contract, to which additional controls apply. |
| **South Africa** | - The Electronic Communications and Transactions Act 2002 gives communications via data messages the same effect as non-electronic documents. Although the Act provides for formation of an contract by an electronic agent (which might include a smart contract), if the terms are not capable of being reviewed by a natural person prior to the contract forming, a party interacting with an electronic agent is not bound.  
             - This means there must be an option to review the terms by a natural person, and to correct errors, before a contract is formed. |
| **Canada**  | - Uniform Electronic Commerce Act 1999 facilitates electronic contracting, but silent in a number of respects in relation to smart contracts. Such aspects are determined by common law.  
             - Among other things, establishing the requirement of reasonable notice in respect of computer code could be challenging.  
             - Also unclear whether follow-on contracts initiated by a smart contract could have binding legal effect. |
The problem of enforceability

If legally binding, the technology (especially in permissionless systems) may raise enforceability issues

Reasons for this:

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<th>No central administering authority</th>
<th>Evidence and proof</th>
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<td>• Absence of administrator in permissionless systems</td>
<td>• No obvious defendant (e.g. defective program logic or data corruption)</td>
</tr>
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<td>• Lack of administrator decision could force parties to court</td>
<td>• Pseudonymous nature of some transactions</td>
</tr>
<tr>
<td></td>
<td>• Proof of existence or content of entirely electronic smart contract</td>
</tr>
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<td></td>
<td>• Problems enforcing court judgment or arbitration award in relation to blockchain</td>
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</table>
Is a dispute resolution (DR) mechanism the solution?

- Blockchain permissioned or permissionless?
- A central administering authority with power to amend the blockchain?
- Scope for parties to agree procedure in smart contract or blockchain entry terms?
- Administering authority needs protection from dispute resolution liability?
- Is the relevant blockchain immutable?
- Does the mechanism need to be different for different parties?
## What characteristics would a DR mechanism need?

| Delegation to arbitrator | - Provision in smart contract itself allowing delegation to arbitrator  
| - Could be triggered by both parties nominating the arbitrating entity |
| Submission to arbitration | - Provision in the underlying contract (say, the natural language contract in a “split” model) agreeing to submit disputes to arbitration  
| - It should match delegation mechanism in smart contract |
| Choice of arbitrator | - A pool of possible arbitrators  
| - Administered centrally or via relevant blockchain  
| - Could include low level expert determination, or higher value arbitrators for complex disputes |
Contact

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Summary of key points from the summit

Gavin Thomas
Tech COO, R3
Next steps

Dr. Lee Braine
Investment Bank CTO Office, Barclays
Networking and drinks (London only)