

# On Counterparty Networks

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## Measuring Counterparty Networks

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## Contract as Automaton:

### The computational representation of financial agreements

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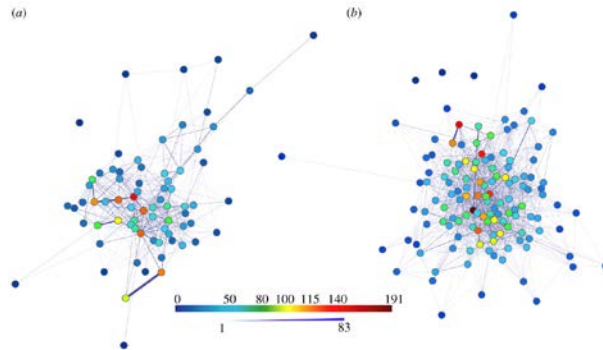
Oliver Goodenough

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## Modeling organisms - cribbing from biology

- **Population characteristics**



Interaction networks in harvester ants

Image source : Pinter-Wollman, et al. (2011)

- **Genotyping**

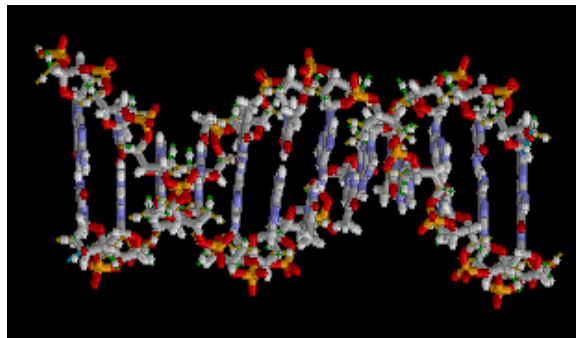


Image source : Wikipedia

- **Phenotyping**



Image source : Wikipedia

## Reifying Relationships – and bipartizing the graph

### Example: Guaranteed loan

- Borrower (B)
- Lender (L)
- Guarantor (G)

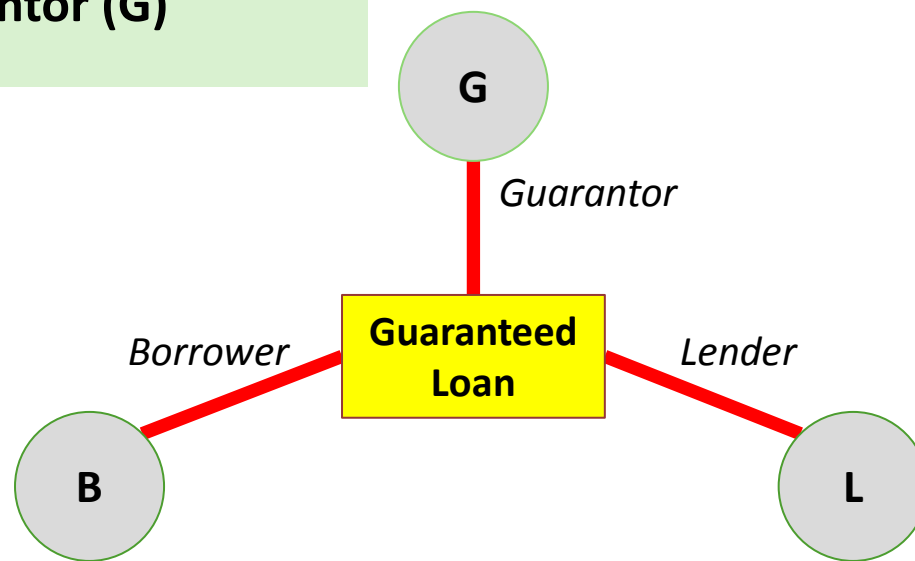
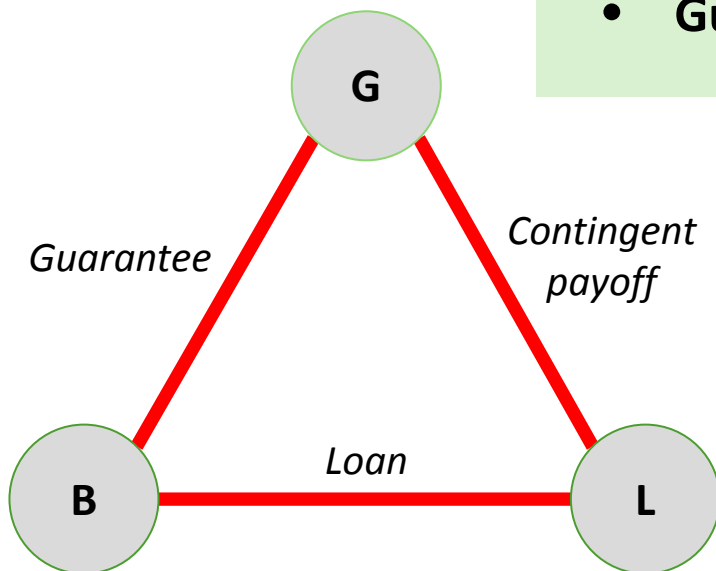


Image source : OFR analysis



## Bipartization in practice

### 2a-7 Money fund holdings on SEC Form N-MFP

- Holdings of short-term, highly rated, financial debt
- Not core-periphery
- Monthly snapshots on N-MFP
- Edge-width proportional to end-of-period position market value
- Color indicates change in position market value:

 Decrease, Jul-Aug

 Increase, Jul-Aug

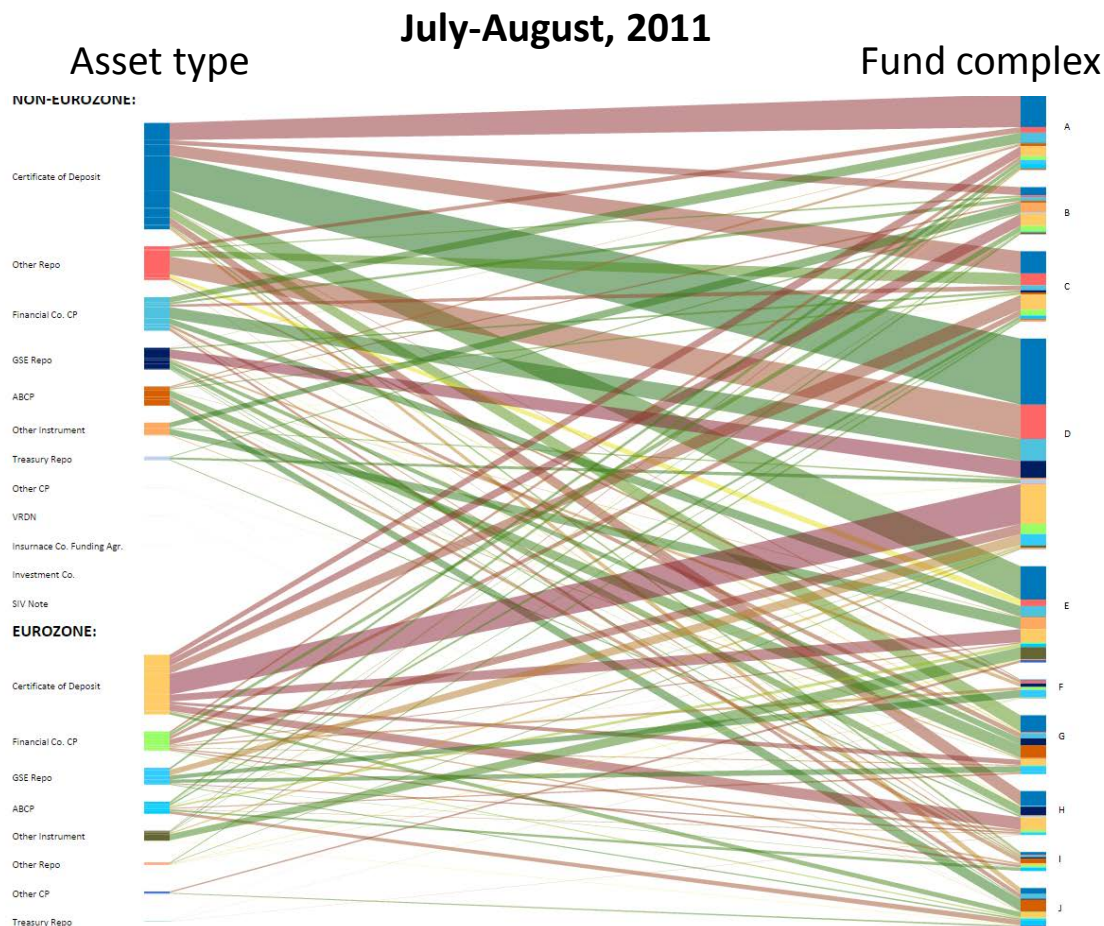


Image source : SEC N-MFP, OFR analysis

## Trees

### Holding Company Hierarchies

- Directed acyclic graph (DAG; again, not core-periphery)
- Evolving over time
- Wells Fargo BHC (pruned), between 2006 and 2010:
  - New since 2006
  - Gone since 2006
  - Always present

### Transient nodes and persistent edges

- Defeasance trusts are a large proportion of the nodes

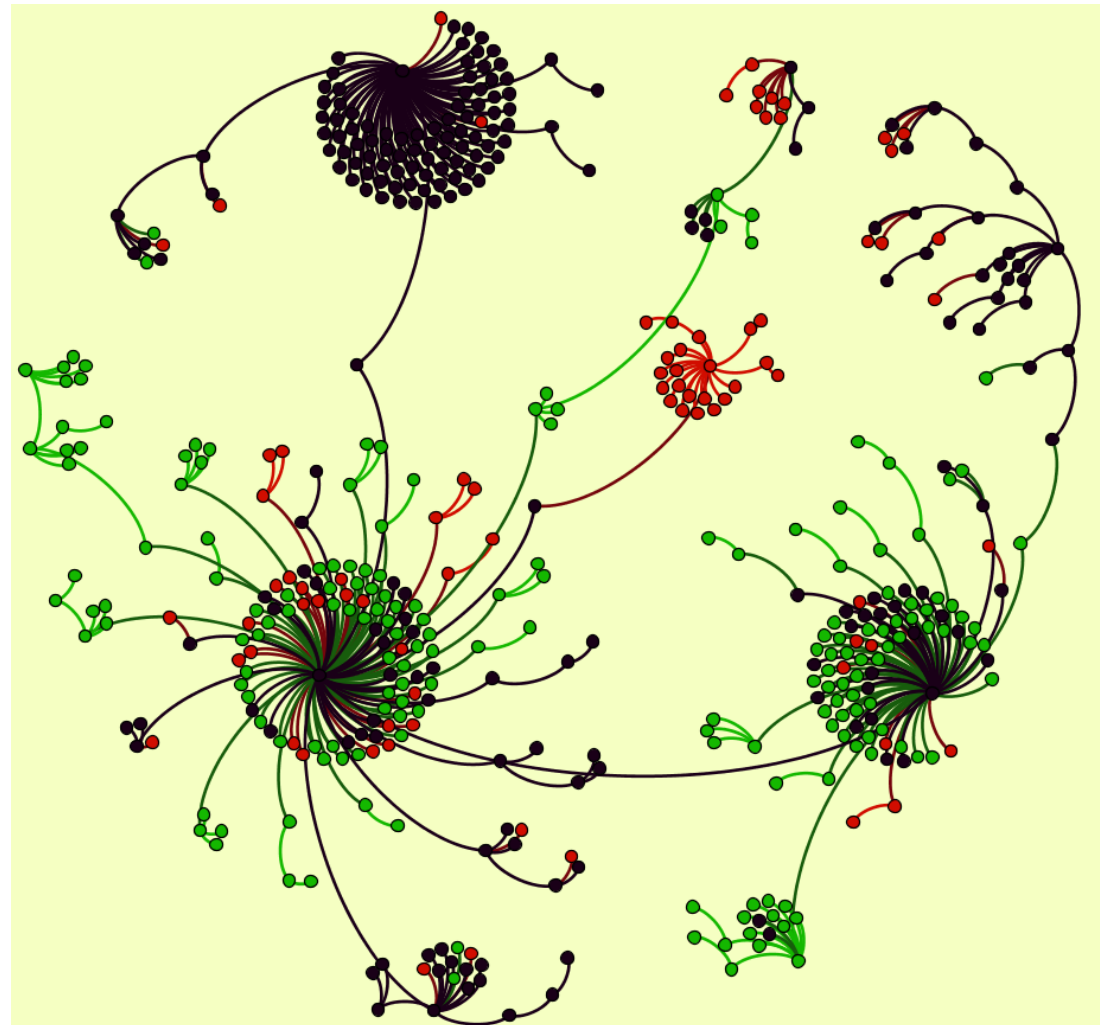


Image source : FFIEC (2015), OFR analysis



## Proposed Rule – Qualified Financial Contracts (QFC)

- Maintain detailed data on qualified financial contracts
  - Deliverable to primary regulator within 24 hours of a request
- QFCs have special treatment under FDIC receivership

## Defining a QFC:

- Securities, commodities, forwards, repos, swaps
- 102 attributes at contract or counterparty level
  - Position-level terms and conditions
  - Master agreement
  - Collateral details

## Defining a Records Entity – If a party to a QFC, and:

- Party to an open QFC, and:
  - Could threaten the financial stability of the U.S.,
  - Designated systemically important financial market utility, or
  - Total assets exceeding \$50 billion; or
  - Affiliated with a firm that matches the above

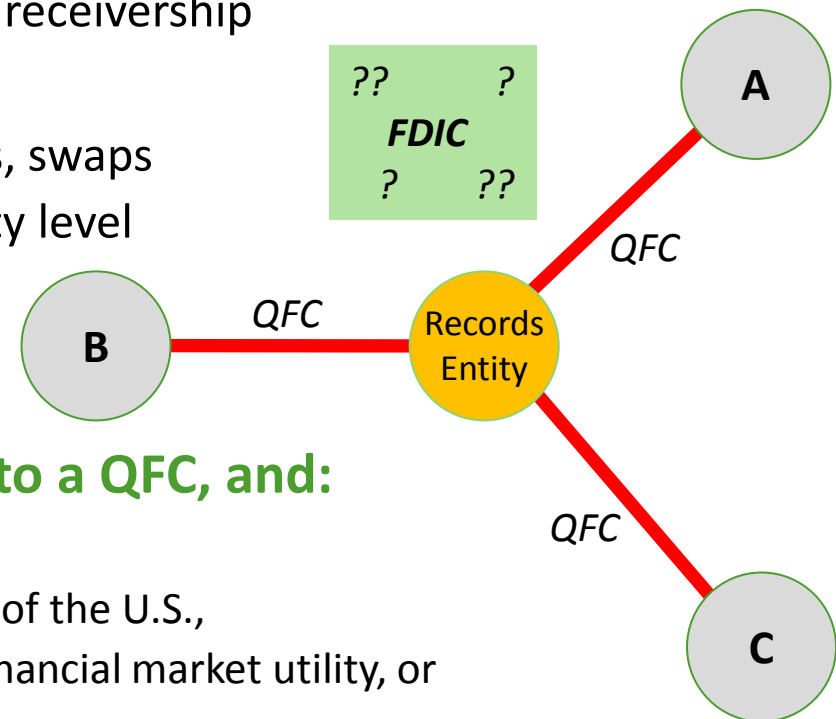


Image source : OFR analysis



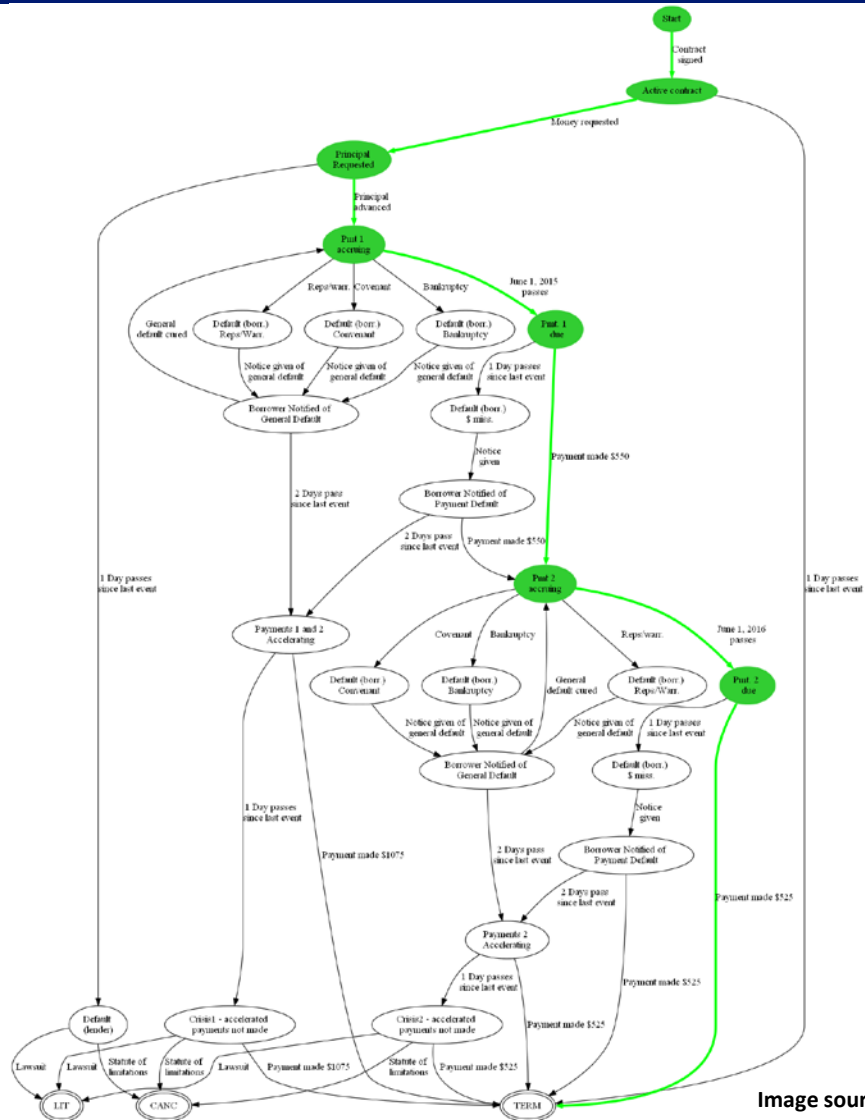


Image source: OFR analysis

## Deterministic Finite Automaton

Simple computational formalism for state-transition systems

- Start state at the top
- Terminal states (3) at bottom
  - Litigation
  - Cancellation
  - Termination
- “Happy” path traced in green
- “Interesting” ramifications in black
  - Defaults and cures
  - Payment acceleration

# Representation II: Tabular



State	Label	Natural Language Consequences and Correlates (A)	Sec
start <sup>o</sup>	Start	Contract is fully specified; key information (payment dates, notice addresses and procedures, choice of law and dispute process) delivered	7, 9, 11
q0 <sup>v</sup>	Active contract	Contract is fully signed/executed	
q1 <sup>v</sup>	Principal Requested	Borrower's has requested and awaits \$1,000	1
P1 <sup>v</sup>	Pmt 1 accruing		
P1d <sup>v</sup>	Pmt. 1 due		
P2 <sup>v</sup>	Pmt 2 accruing		
P2d <sup>v</sup>	Pmt. 2 due		
DI	Default (lender)	Lender has failed to deliver principal	5
Acc1	Payments 1 and 2 Accelerating	Accelerated payment due is \$1075	6
Acc2	Payments 2 Accelerating	Accelerated payment due is \$525	6
Db0_1	Default (borr.) payment missed	Borrower has failed to make first payment in a timely fashion, and should be notified	5
Dbcv_1	Default (borr.) Covenant	Borrower violates covenant(s), and should be notified	5
Dbrw_1	Default (borr.) Reps/Warr.	Borrower breaches reps. and/or warranties; should be notified	5
Dbbkr_1	Default (borr.) Bankruptcy	Borrower files for bankruptcy or insolvency; should be notified	5
Nb0_1 <sup>v</sup>	Borr. notified of payment default	Borrower has 2 days to pay, or all payments accelerate	5
Nbnpd_1 <sup>v</sup>	Borr. notified of general default	Borrower has 2 days to pay, or all payments accelerate	5
Db0_2	Default (borr.) payment missed	Borrower has failed to make first payment in a timely fashion, and should be notified	5
Dbcv_2	Default (borr.) Covenant	Borrower violates covenant(s), and should be notified	5
Dbrw_2	Default (borr.) Reps/Warr.	Borrower breaches reps. and/or warranties; should be notified	5
Dbbkr_2	Default (borr.) Bankruptcy	Borrower files for bankruptcy or insolvency; should be notified	5
Nb0_2 <sup>v</sup>	Borr. notified of payment default	Borrower has 2 days to pay, or all payments accelerate	5
Nbnpd_2 <sup>v</sup>	Borr. notified of general default	Borrower has 2 days to pay, or all payments accelerate	5
xT <sup>v</sup>	TERM	Contract is fulfilled in accordance with its terms	
xL <sup>v</sup>	LIT	A legal action is brought to enforce, interpret or otherwise deal with the agreement in the state courts of the State of New York located in New York County and that the results of this action will replace the computation of the contract	9
xC <sup>v</sup>	CANC	Contract is canceled due to the passing of time beyond the statute of limitations or canceled because of modification or termination by mutual agreement of the parties	8
Crisis1	Crisis1—accel. payments not made	Payments accelerated, but borrower has not responded	6
Crisis2	Crisis2—accel. payments not made	Payments accelerated, but borrower has not responded	6

<sup>o</sup> States on the "happy" path of the contract lifecycle  
<sup>v</sup> Default states  
<sup>\*</sup> Terminal states

ID	Label	Natural Language Event Specification	Section
A	Contract signed	Contract is signed to bind all parties	
B	1 Day passes since last event	June 1, 2014 passes	1
C	Money requested	Borrower gives request for loan of \$1,000	1
D	Lawsuit	A legal action is brought to enforce, interpret or otherwise deal with the agreement in the state courts of the State of New York located in New York County.	
E	Statute of limitations	June 1, 2020 passes—the Statute of Limitations on debt obligations in New York is six years	
F	Principal advanced	Lender advances \$1,000 no later than June 2, 2014	1
G	June 1, 2015 passes	Payment 1 due on June 1, 2015	2(a)
H	Reps/Warr.	The Borrower's assets exceed its liabilities as determined under an application of the FASB rules of accounting	3, 5(b)
I	Covenant	The Borrower fails to make a timely payment of an amount of state or federal tax	4, 5(c)
J	Bankruptcy	The Borrower files for bankruptcy or insolvency under any applicable federal or state law	
K	Notice given	Notice given to Borrower of a failure to make timely payment of an amount due to Lender under this agreement	5
L	Notice given of general default	Notice given to Borrower of an event of default other than a failure to make timely payment of an amount due	5
M	Payment default cured	A payment-related event of default is cured	5
N	General default cured	A non-payment related event of default is cured	5
O	2 Days pass since last event	Two days elapse since last event/notice	5
P	June 1, 2016 passes	Payment 2 is due on June 1, 2016	2(b)
Q	Payment made \$550		
R	Payment made \$525		
S	Payment made \$1075		
T	Cancel or modify	Contract in this form is canceled because of modification or termination by mutual agreement of the parties	8

Initial State	Event	Resulting State
start <sup>v</sup>	A	q0
q0	B	xT
q0 <sup>v</sup>	C	q1
q1	B	DI
DI	D	xL
DI	E	xC
q1 <sup>v</sup>	F	P1
P1 <sup>v</sup>	G	P1d
P1d	B	Db0_1
P1	H	Dbrw_1
P1	I	Dbcv_1
P1	J	Dbbkr_1
Db0_1	K	Nb0_1
Dbcv_1	L	Nbnpd_1
Dbbkr_1	L	Nbnpd_1
Dbrw_1	L	Nbnpd_1
Nb0_1	Q	P2
Nbnpd_1	N	P1
Nb0_1	O	Acc1
Nbnpd_1	O	Acc1
Acc1	B	Crisis2
Acc1	S	xT
Crisis1	E	xC
Crisis1	D	xL
Crisis1	S	xL
P1d <sup>v</sup>	Q	P2

Initial State	Event	Resulting State
P2 <sup>v</sup>	P	P2d
P2d	B	Db0_2
P2	H	Dbrw_2
P2	I	Dbcv_2
P2	J	Dbbkr_2
P2d <sup>v</sup>	R	xT
Db0_2	K	Nb0_2
Dbcv_2	L	Nbnpd_2
Dbbkr_2	L	Nbnpd_2
Dbrw_2	L	Nbnpd_2
Nb0_2	R	xT
Nbnpd_2	N	P2
Nb0_2	O	Acc2
Nbnpd_2	O	Acc2
Acc2	B	Crisis2
Acc2	R	xT
Crisis2	E	xC
Crisis2	D	xL
Crisis2	R	xT

<sup>o</sup> Transitions along the "happy" path of the contract lifecycle  
As noted above, only the transitions that result in a change of states are noted here; all un-noted transitions result in the state being unchanged.

State Space (27)

Q

Event Alphabet (20)

Σ

Transitions (45)

δ

Image source : OFR analysis

Regular expressions list the “acceptable” event sequences under the DFA

- Uses a compact shorthand notation
- Equivalent (without labels) to the tabular and graphical representations
- Natural measure of complexity (i.e., length of the regex)

$A(B | CB[ED]) |$

*Rapid demise*

$ACF(G(BK)?)QPR |$

*Happy path*

$ACF([HIJ]LN)^*(GBK | [HIJ]L)O(S | B[DES]) |$

*Unhappy 1*

$ACF(G(BK)?)Q([HIJ]LN)^*(PBK | [HIJ]L)O(R | B[RED])$  *Unhappy 2*

**Thanks!**