

Engineering Foreign Exchange Processes

An Application of Commitment Protocols

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Outline

Foreign Exchange Overview

Ambiguities in Price Discovery Protocols

Commitments in Price Discovery

- What are Commitments?

- Commitments in Bilateral Price Discovery

Engineering Challenges in TWIST

- Managing a Large Set of Scenarios

- Discovering new Business Scenarios

- Enabling Verification

Conclusions

Foreign Exchange Overview

- ▶ \$2.3 Trillion per day
- ▶ SWIFT standards: closed—just big banks
- ▶ Newer standards: opening to big companies and others
 - ▶ RFQ, credit checks, deals, . . .
 - ▶ Data exchange
- ▶ Important business protocols, but informal
 - ▶ We study the TWIST specification, section 7.2 (price discovery protocols)

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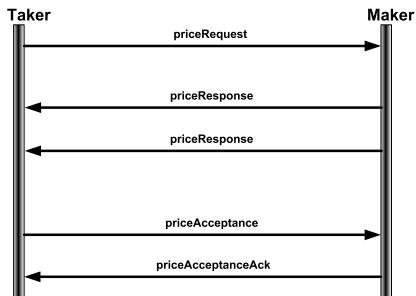
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Problem: Message Semantics

- ▶ Which messages are to be taken seriously?
 - ▶ Asking for prices?
 - ▶ Paying for an item?
- ▶ Which messages can be skipped?
 - ▶ No receipts needed, thank you
- ▶ What is special about the “serious” messages?
 - ▶ Without semantics, all messages are equally important!

Bilateral Price Discovery (*BPD*)

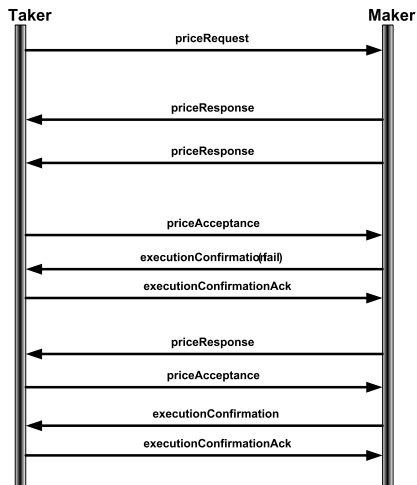


What do these messages mean?

- ▶ Must the *Maker* trade at the quoted price if the *Taker* accepts the price?
- ▶ Must the *Taker* trade at an accepted price even without confirmation?
- ▶ Why is it that multiple RFQs are OK but multiple accepts are not?

Bilateral Price Discovery (*BPD*)

With Execution Confirmation



Ambiguities

- ▶ What if the *Maker* confirms execution but the *Taker* does not acknowledge it?
- ▶ Can two price responses have different execution confirmation requirements?
- ▶ Can the acknowledgments be skipped?

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Commitments

- ▶ $CC(x, y, q, p)$: x is committed to y to bring about p if q
 - ▶ Debtor x
 - ▶ Creditor y
 - ▶ Precondition q
 - ▶ Condition p
- ▶ Unlike obligations
 - ▶ Manipulable: create, delegate, assign, ...

Example

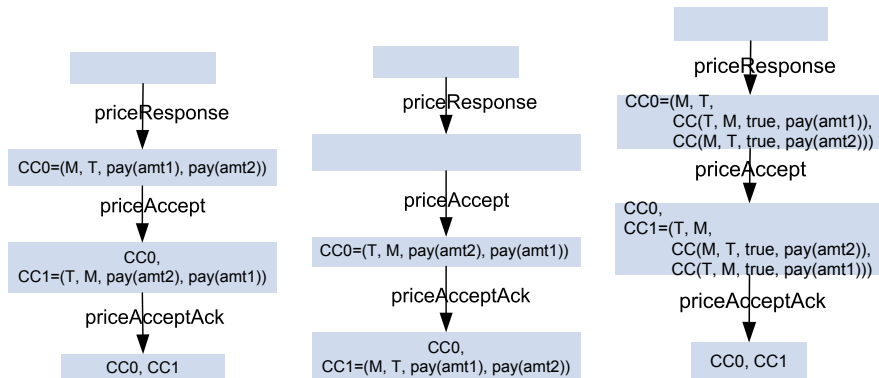
$CC(\text{Buyer}, \text{Seller}, \text{goods}, \text{pay})$

- ▶ If $\text{goods} \wedge CC(\text{Buyer}, \text{Seller}, \text{goods}, \text{pay})$ Then $CC(\text{Buyer}, \text{Seller}, T, \text{pay})$
- ▶ If $\text{pay} \wedge CC(\text{Buyer}, \text{Seller}, \text{goods}, \text{pay})$ Then fulfilled
- ▶ If $\text{pay} \wedge CC(\text{Buyer}, \text{Seller}, T, \text{pay})$ Then fulfilled

Can be nested:

$CC(\text{Seller}, \text{Buyer}, \text{pay}, CC(\text{Shipper}, \text{Buyer}, \text{deliverGoods}))$

Commitments in *BPD*



- ▶ When are the commitments created?
 - ▶ Force the designer to resolve the ambiguities

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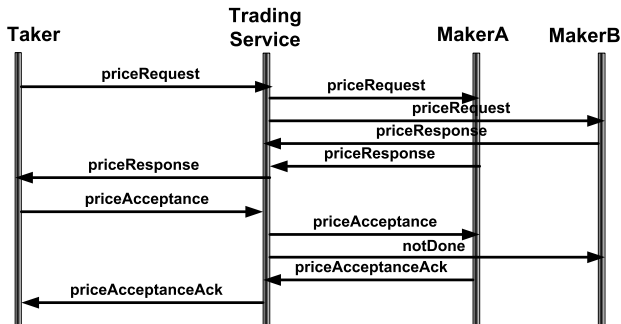
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Engineering Challenges

- ▶ Many dimensions of variations
 - ▶ With or without credit checks
 - ▶ With or without a trading service
- ▶ Each combination is treated separately: set of possibilities explode
- ▶ Verification of various properties

Multilateral Price Discovery

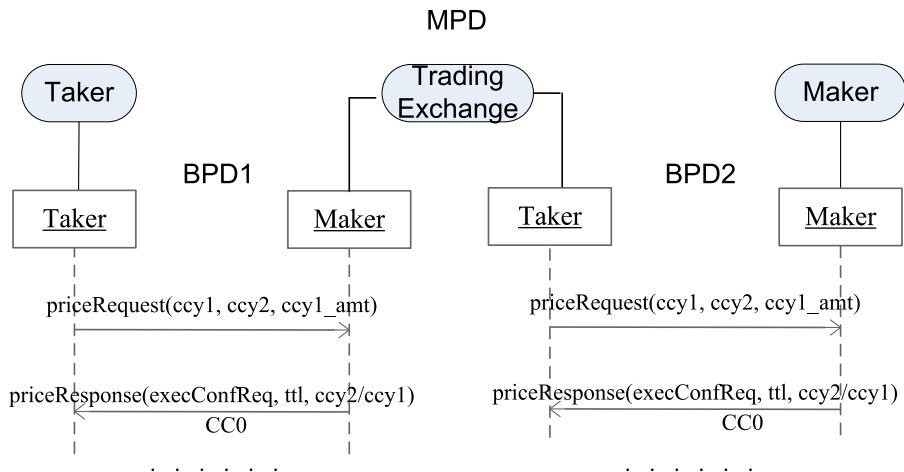


- ▶ Do we really need to capture this as a separate protocol?

Protocols Methodology

- ▶ Model each variant as a *commitment protocol*
- ▶ Store protocols in a repository
- ▶ To construct a combination
 - ▶ Select one protocol per variation from the repository
 - ▶ Put the selected protocols together with *protocol composition* by specifying appropriate composition axioms

Example: Multilateral as Composition of Bilateral



Composing Simple Protocols

Fewer protocols; more combinations

TWIST specification	Protocols needed
7.2.1	BPD
7.2.2	BPD
7.2.3	BPD \oplus BPD
7.2.4 (order)	Order
7.2.5 (order, cancel)	Order
7.2.6 (credit check)	BPD \oplus Credit
7.2.7 (credit check–multi)	BPD \oplus BPD \oplus Credit
7.2.8 (price stream)	ESP
7.2.9 (price stream–multi)	ESP \oplus ESP

\oplus means composition

ESP: Executable Streaming Prices

New Protocols

- ▶ Domain experts document several scenarios, say $A \oplus B \oplus C$, $A \oplus B$, $A \oplus C$
- ▶ We break them down as protocols A , B , and C
- ▶ How many ways can A , B , and C be composed?
 - ▶ $B \oplus C$ is discovered
 - ▶ May or may not make business sense

New Configuration of Existing Compositions

- ▶ Domain experts document a scenario say $A \oplus B \oplus C$
- ▶ We break it down as protocols A , B , and C
 - ▶ We specify the set of composition axioms to achieve the documented scenario
- ▶ What if we add new axioms? What if we remove some?
 - ▶ Unnecessary constraints may be lifted
 - ▶ Additional constraints may be imposed
- ▶ New configurations of $A \oplus B \oplus C$ are discovered

Querying the Protocols

- ▶ Protocols are specified in action description language $C+$
- ▶ Such specifications can be queried with a tool
 - ▶ Does the protocol always end in a state wherein all commitment are fulfilled?
 - ▶ In *MPD*, is it possible for the trading exchange to quote different prices on both sides?
- ▶ Undesired behaviors are uncovered by such queries

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- ▶ Commitments capture the essence of business interactions
 - ▶ Replace any amount of UML and natural language documentation
 - ▶ Force ambiguities out
- ▶ Protocol composition is essential for engineering business processes
 - ▶ 28 scenarios of TWIST 7.2 with only 12 protocols
 - ▶ Tells us how the various scenarios are related
 - ▶ New scenarios and configurations are discovered