Enacting Protocols by Commitment Concession

Pınar Yolum[a] and Munindar P. Singh[b]

pinar.yolum@boun.edu.tr[a], singh@ncsu.edu[b]

Boğaziçi University[a]

North Carolina State University[b]

Outline

- Motivation
- Commitments for negotiation
- Costs and valuations
- Concession rules
- Properties of commitment concession
- Discussion

Motivation

- A commitment creates a risk for its debtor
- Consider a purchase protocol
  - Customer will pay; merchant will deliver
  - Who should act first?
  - What should each commit to do?
- Possible strategies for commitments
  - Cautious creation: Prevent progress
  - Incautious creation: No matching payback
- Desirable to reduce risk yet enable progress

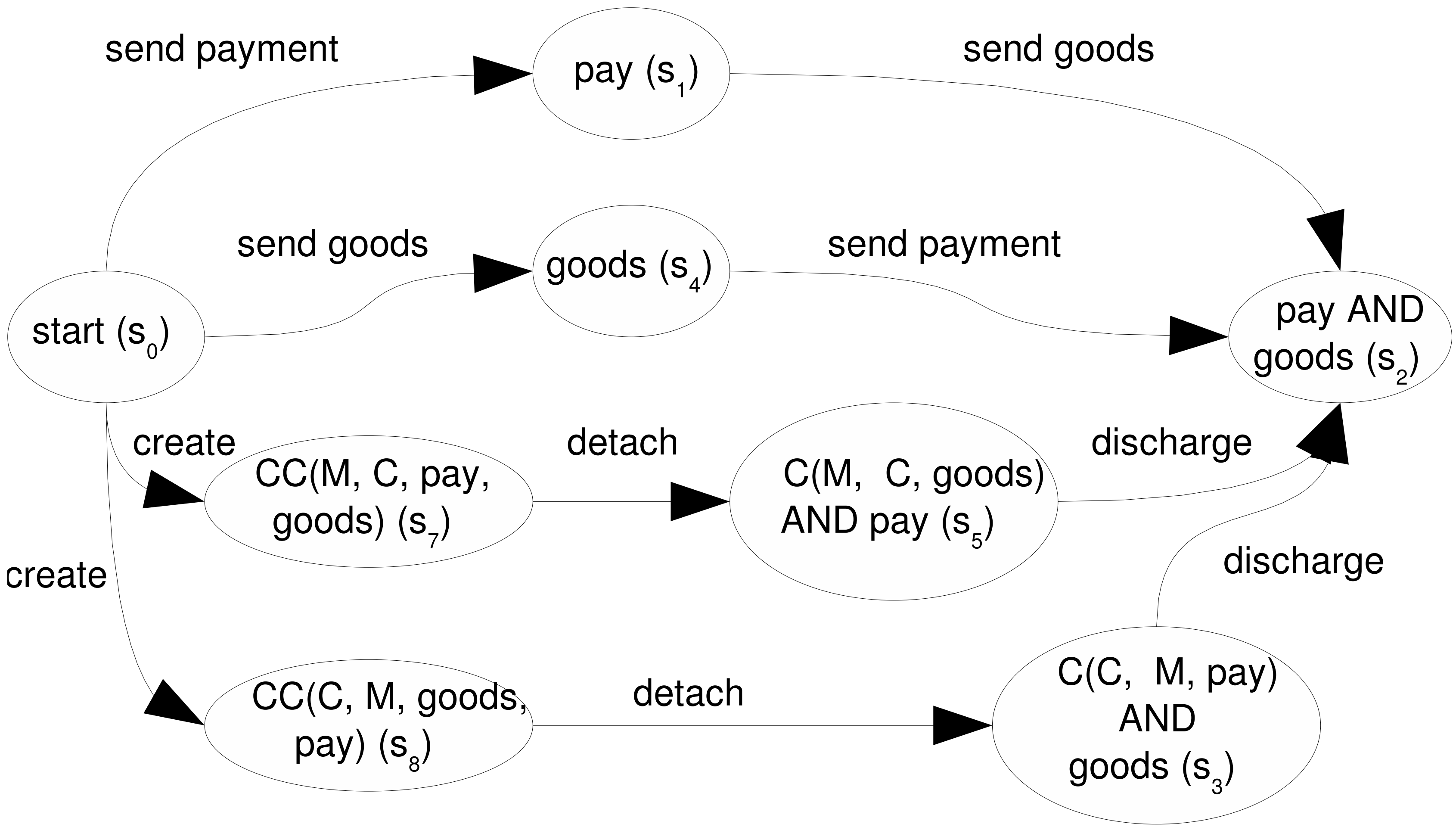
Commitment Concession

- Begin with weak commitments
- Incrementally strengthen commitments at each round
  - Calculate the consequences of a move
  - Increase the risk taken
  - Expect others to increase their risk
- Continue if others increase their risk sufficiently

Review of Commitments

- A base-level commitment
  - c(x, y, p): x commits to y to bring about p
  - c(customer, merchant, pay)
- A conditional commitment
  - cc(x, y, p, q) is a conditional commitment: x commits to y to bring about q if p is brought out first.
  - cc(customer, provider, deliver, pay)
- Commitments provide meaning to protocol messages

Example Purchasing Enactments



Benefits and Risks

- Benefit of a commitment: What the agent will gain by creating the commitment
- Risk of a commitment: What the agent may lose by creating the commitment

Commitment made	C's risk	C's benefit
CC(C, M, goods, pay)	C(C, M, pay)	goods
CC(C, M, C(M, C, goods), pay)	C(C, M, pay)	C(M, C, goods)
C(C, M, pay)	pay	None

Commitment Concession Rules: 1

- Start with a weak commitment (e.g., conditional rather than base-level)

$$\frac{\mathsf{G}(x,p)}{\mathsf{CC}(x,y,p,q)} \quad (\text{create-CC})$$

- Discharge a commitment after guaranteeing a benefit from other agents

$$\frac{\mathsf{C}(x,y,q) \qquad \mathsf{C}(y,x,p) \qquad \mathsf{G}(x,p)}{q} \quad (\text{discharge-C})$$

Commitment Concession Rules: 2

- Cooperate by increasing risk when other (trustworthy) agents make commitments

$$\frac{\mathsf{CC}(y, x, q, p) \qquad \mathsf{G}(x, p)}{\mathsf{C}(x, y, q)} \quad (\text{accept})$$

- Create a counter conditional commitment: in essence, request further commitment from other agents if they are not immediately trusted

$$\frac{\mathsf{CC}(y, x, q, p) \qquad \mathsf{G}(x, p)}{\mathsf{CC}(x, y, p, q)} \quad (\text{challenge})$$

Commitment Concession Rules: 3

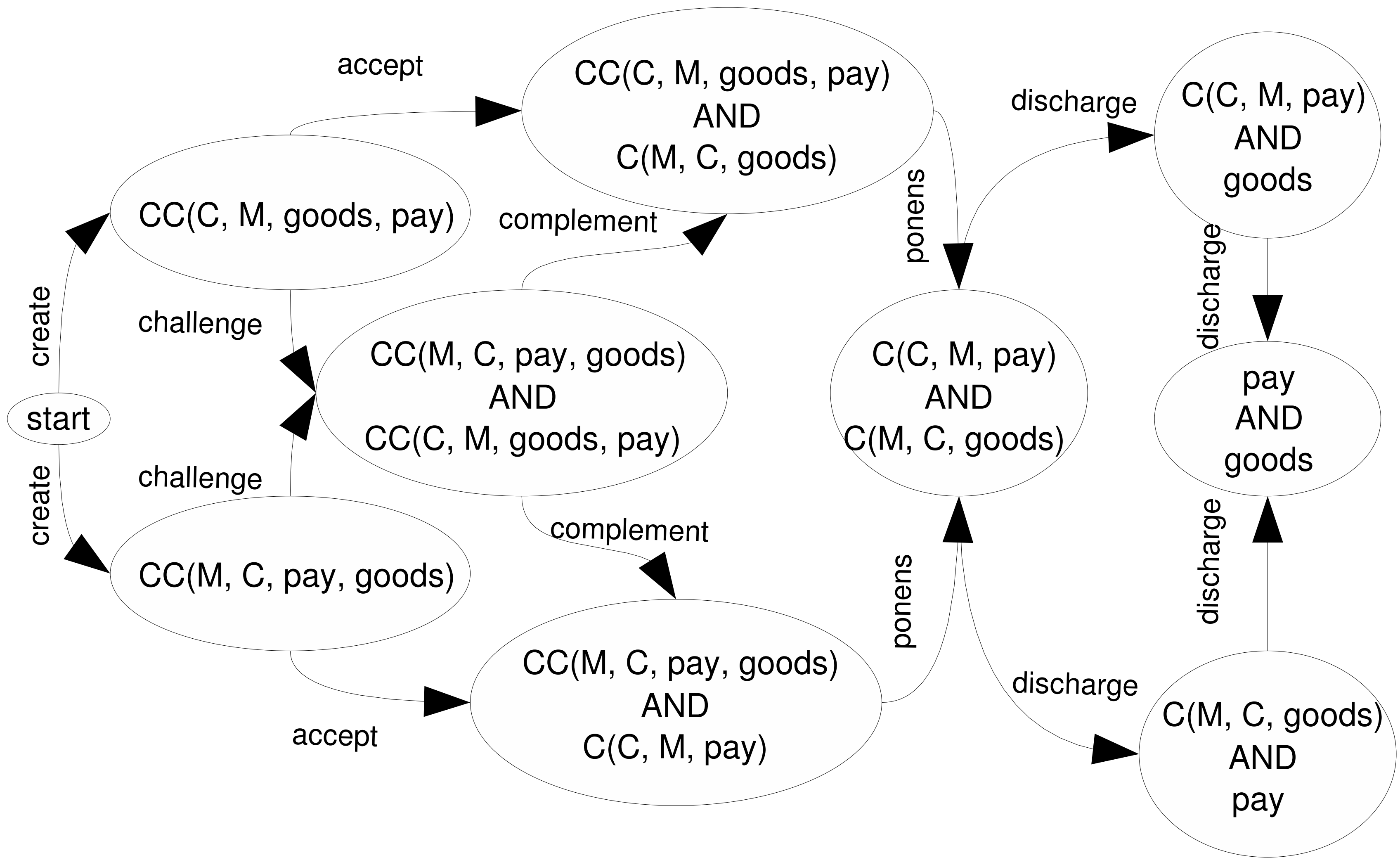
- If all agents have taken some risk, take some more risk

$$\frac{\mathsf{cc}(x,y,p,q) \qquad \mathsf{cc}(y,x,q,p)}{\mathsf{c}(x,y,q) \qquad \neg\mathsf{cc}(x,y,p,q)} \qquad (\text{complement})$$

- When other agents are apparently at greater risk, commit more

$$\frac{\mathsf{c}(x,y,q) \qquad \mathsf{cc}(y,x,q,p)}{\mathsf{c}(y,x,p) \qquad \neg\mathsf{cc}(y,x,q,p)} \qquad (\text{ponens})$$

Applying the Concession Rules



Private Valuations of Propositions

- Valuation is negative for the agent's actions and positive for others' actions
- In either case, a proposition itself can't have a lower magnitude than a commitment for it: $|v_x(p)| \geq |v_x(C(\cdot, \cdot, p))|$
  - As creditor, a proposition is valued above a commitment
  - As debtor, the other way around
- A base-level commitment can't have a lower magnitude if conditionalized: $|v_x(C(x, y, p))| \geq |v_x(CC(x, y, q, p))|$

Coherent Valuations of States: 1

- Null. Valuation of an empty set is zero: $v_x(\{\ \}) = 0$
- Separability. Valuation of a union of two sets is the sum of their valuations: $v_x(S_1 \cup S_2) = v_x(S_1) + v_x(S_2)$
- As creditor. Commitment for goal is worth less than the deed: $v_x(p) > 0$ implies $0 \leq v_x(\mathsf{C}(y, x, p)) \leq v_x(p)$
- As debtor. Commitment for task is worth more than the deed: $v_x(p) < 0$ implies $0 \geq v_x(\mathsf{C}(x, y, p)) \geq v_x(p)$

Coherent Valuations of States: 2

- As creditor of conditional commitment: $v_x(\mathsf{C}(y, x, p)) \geq v_x(\mathsf{CC}(y, x, q, p)) \geq v_x(q) + v_x(\mathsf{C}(y, x, p))$
- As debtor of conditional commitment: $v_x(\mathsf{C}(x, y, q)) \leq v_x(\mathsf{CC}(x, y, p, q)) \leq v_x(p) + v_x(\mathsf{C}(x, y, q))$

Valuations in Protocol Enactment

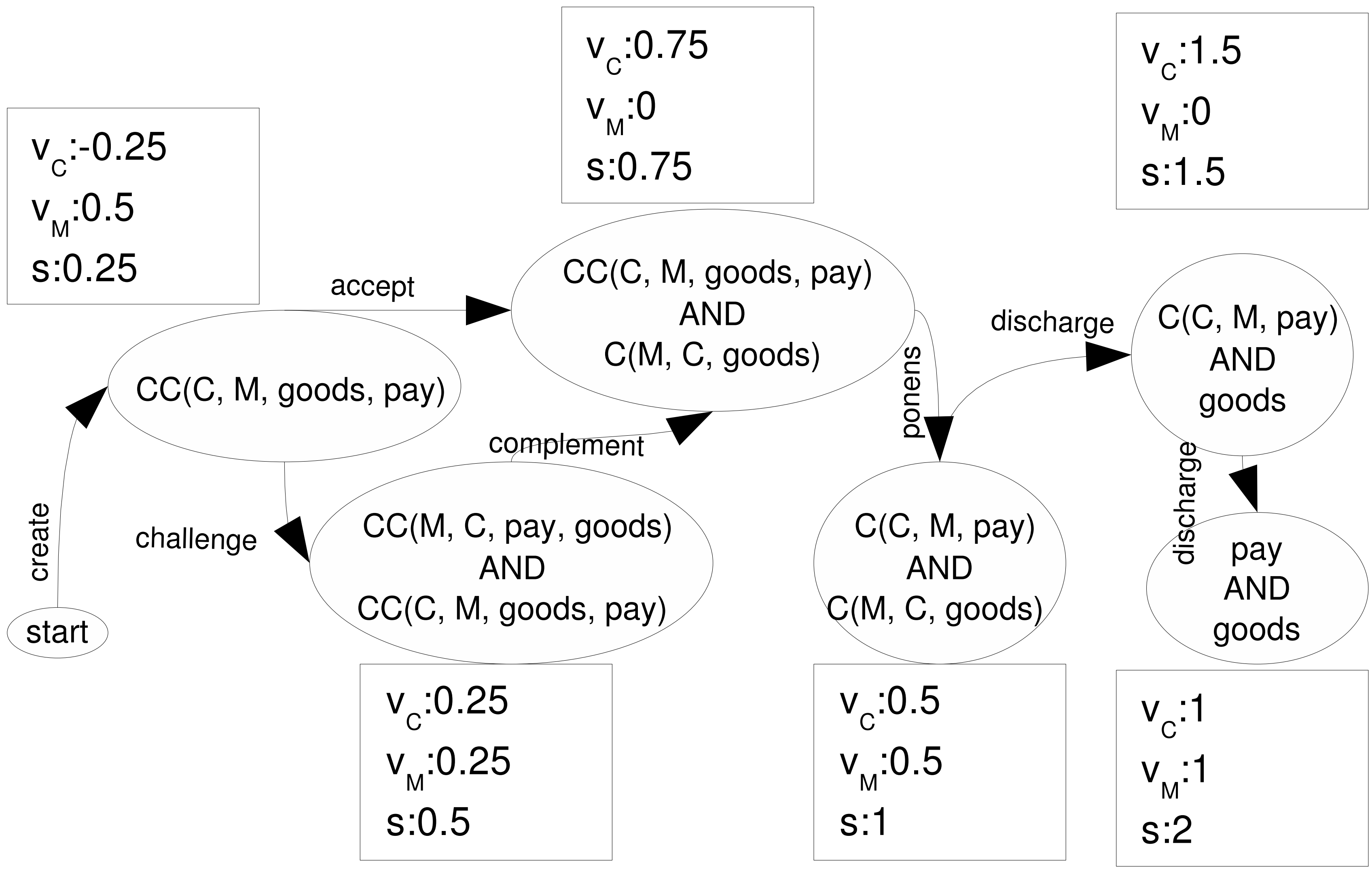
- Goal states: valued higher by all than nongoal states
  - $v_C(pay) + v_C(goods) > 0$
  - $v_M(pay) + v_M(goods) > 0$
- Goal states have compatible incentives
- Social welfare of a state: sum of the valuations for all agents
- Inference rules to help agents reach such states while enacting a protocol

Example Valuations

Condition	C's valuation
goods	2.00
C(M, C, goods)	1.00
CC(M, C, pay, goods)	0.50
pay	−1.00
C, M, pay)	−0.50
CC(C, M, goods, pay)	−0.25

M's valuations are the additive inverses of these

Example Enactment with Valuations



Quasidistance between States

Measure of progress based on social welfare

From	To	Quasidistance (qd)
$\{\ \}$	$\{p\}$	$w(p)$
$\{\ \}$	$\{c\}$	$w(c)$
$\{\ \}$	$\{cc\}$	$w(cc)$
$\{q\}$	$\{p\}$	$w(p) - w(q)$
$\{c\}$	$\{p\}$	$w(p) - w(c)$
$\{cc\}$	$\{p\}$	$w(p) - w(cc)$
F_1	$T_1 \cup T_2$	$qd(F_1, T_1) + qd(F_1, T_2)$
$F_1 \cup F_2$	T_1	$\min(qd(F_1, T_1), qd(F_2, T_1))$

Commitment Concession Properties

- Each rule decreases the valuation of whoever applies it and increases the valuations of others
- Final states have positive social welfare
- Concession rules increase social welfare
- Concession rules guarantee termination in a final state

Discussion

- Application of monotonic concession to commitment protocols
- Concession moves may be
  - Independent of the domain protocol
  - Embedded into the domain protocol
- Directions
  - Study of valuation functions with different characteristics
  - Improved treatment of risk and rationality