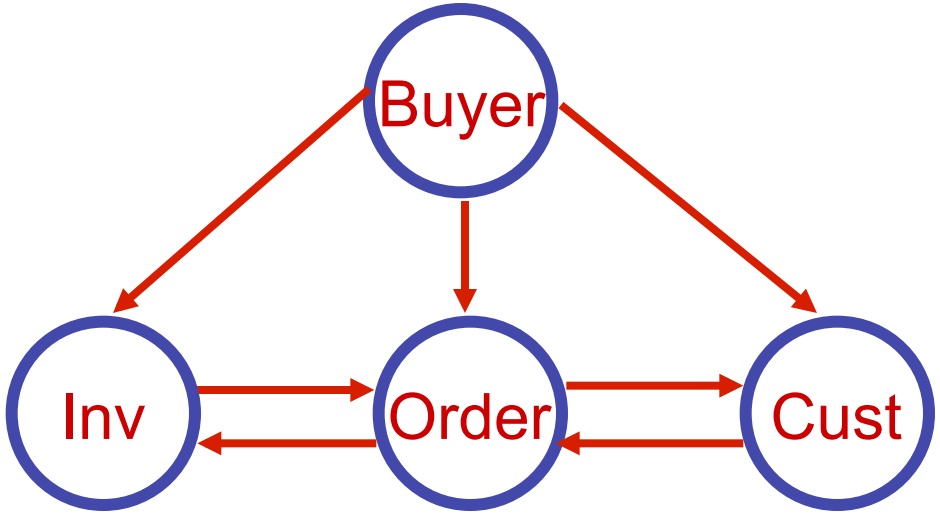
Trans in Distributed Systems

- A distributed transaction involves
  - updates at multiple nodes
  - and the messages between those nodes
- For example, buying widgets



Distributed Atomic Commit Requirements

1. All workers that reach a decision reach the same one
2. Workers cannot change their decisions on commit or abort once a decision is made
3. To commit all workers must vote commit
4. If all workers vote commit and there are no failures the transaction will commit
5. If all failures are repaired and there are no more failures each worker will eventually reach a decision (In fact it will be the same decision)

2PC and communication topologies

- We have previously focused on centralized 2PC
  - Why funnel messages through the coordinator?
  - + None of the worker nodes can influence one another
  - + Failure of a worker node independent
  - - Put trust in coordinator
  - - Hope coordinator does not fail
- Nothing stopping us from considering alternative communication topologies for 2PC!
- Why? Because other topologies may reduce time or message complexity for the basic 2PC protocol

2PC in other topologies

- Two extremes: linear and decentralized
- Linear 2PC: coordinator, and all workers in a single line/chain
  * Build a protocol that has fewer messages (but more rounds!) than 2PC
- Decentralized 2PC: all workers can communicate with one another
  * Build a protocol that has fewer rounds (but more messages!) than 2PC

Linear 2PC

- Alternative communication topologies in 2PC context
  - Why channel messages through the coordinator?
- Decentralized 2PC: all workers can communicate with one another
  - Build a protocol that has fewer rounds (but more messages!) than 2PC
- Linear 2PC: coordinator, and all workers in a single line/chain
  - C, W1, W2, W3, … Wn
  - Build a protocol that has fewer messages (but more rounds!) than 2PC
  - C sends request + its vote to W1, W1 decided commit/abort, forward decision to W2. W2, determines outcome with its own decision, forward to W3, and so on.
  - Wn receives commit and decided commit → tx commit! Forward this decision back to front of chain
  - Wn receives abort/decides abort -> tx abort! Forward this decision back
- Note: linear 2PC bundles node/site failure with communication failure.

Linear 2PC

- Important note: linear 2PC bundles node/site failure with communication failure.
- Why is this important?

- Analysis for linear 2PC:
  - 2n rounds
  - 2n messages

Decentralized 2PC

- Alternative communication topologies in 2PC context
  - Why channel messages through the coordinator?
- Decentralized 2PC: all workers can communicate with one another
  - Build a protocol that has fewer rounds (but more messages!) than 2PC
  - Complete graph communication topology
  - Coordinate votes and sends it's decision (commit/abort) along with prepareToCommit to workers
  - Workers broadcast their choice to all other workers (n^2 messages!)
  - Workers collect votes, and figure out the final transaction outcome
- 2 rounds -- Can we do better than 2 rounds?
- Approx: n+(n+1)^2 messages (n=number of nodes)

Comparison in one slide

	Messages	Rounds
Centralized 2PC	3n	3
Linear 2PC	2n	2n
Decentralized 2PC	n^2 + n	2