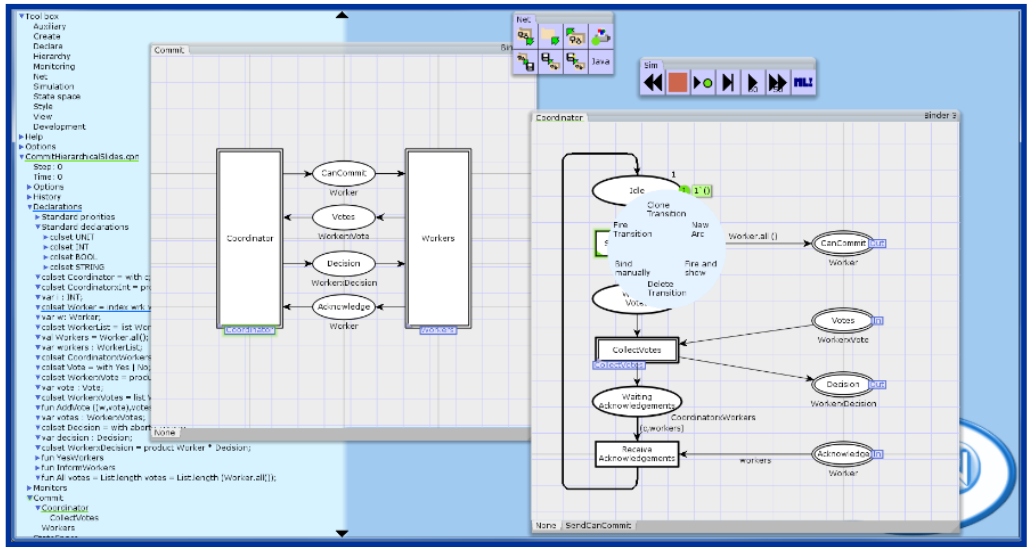
Lecture 2

Modelling with Place/Transition Nets



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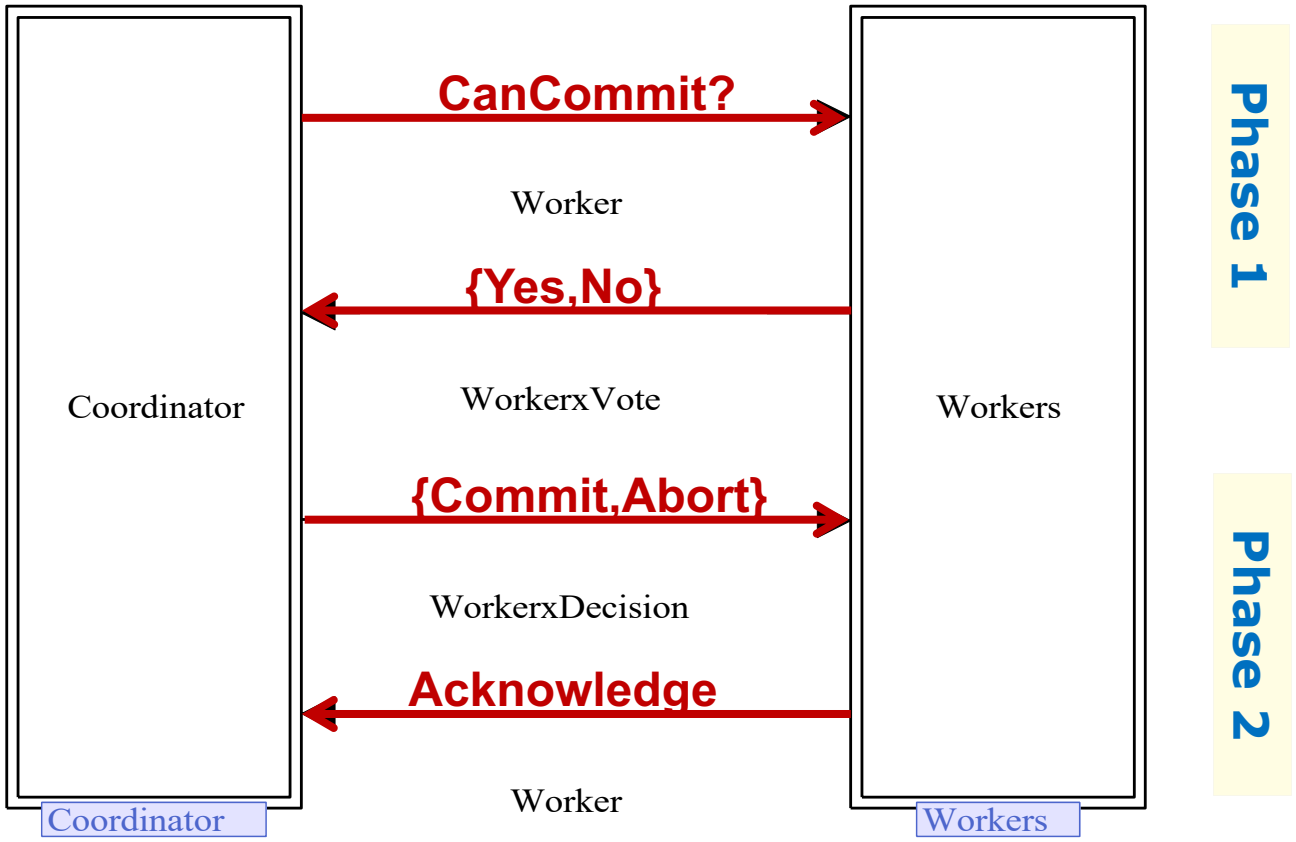
Overview

- **Syntactical elements – model structure**
  - Places and transitions
  - Arcs and arc weights
  - Initial marking
- **Semantical concepts - dynamics/execution**
  - Tokens and current marking
  - Transition enabling and occurrence
  - Concurrency, conflict and non-determinism

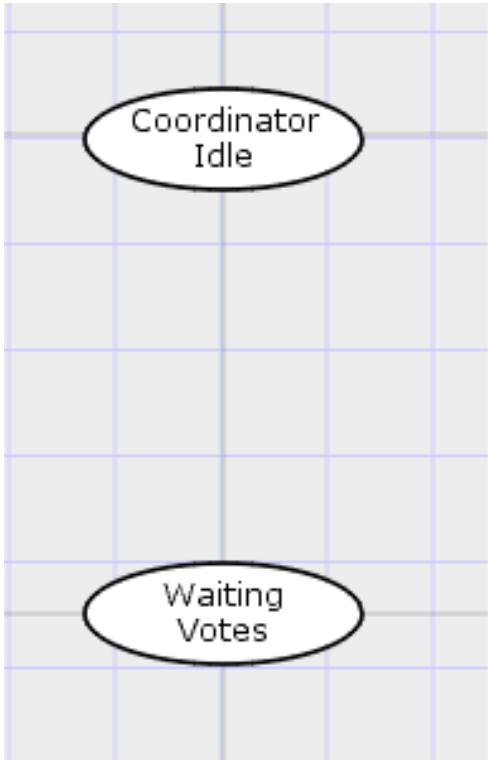
Two-phase Commit Transaction Protocol

- **We will focus on modelling the first phase**



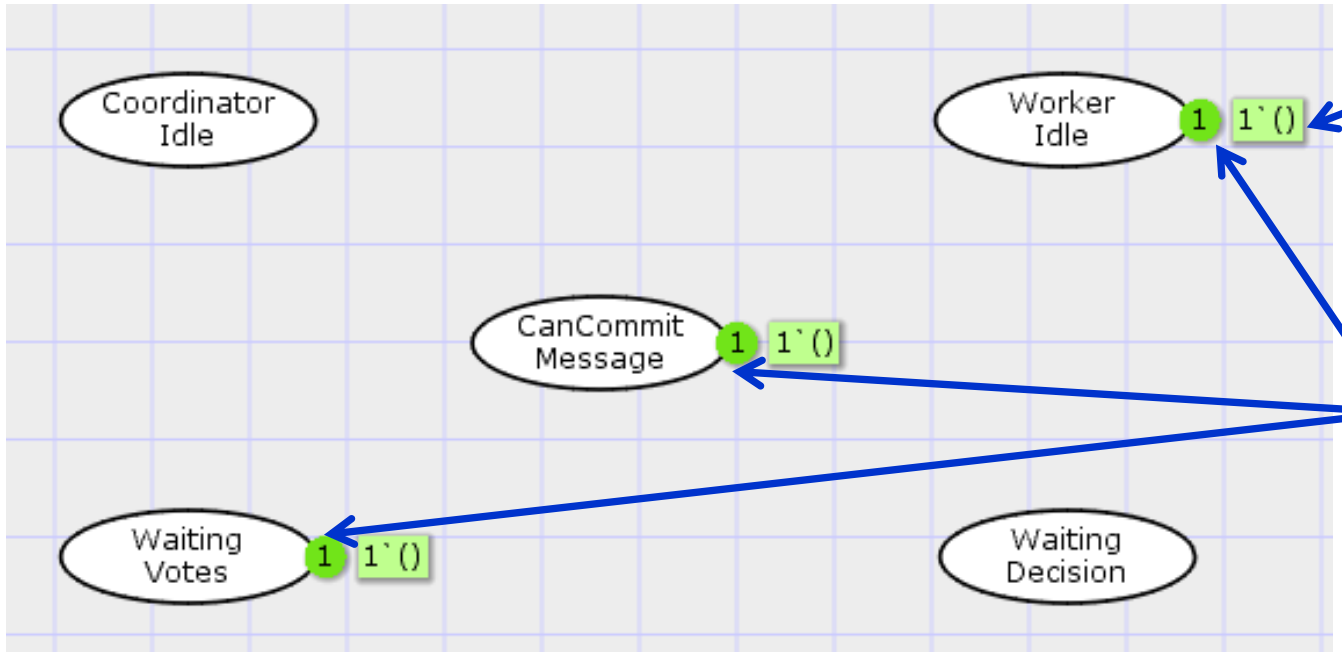
Places

- **Used to model the state of the system - drawn as ellipses**



Tokens and markings

- A place can contain a number of tokens



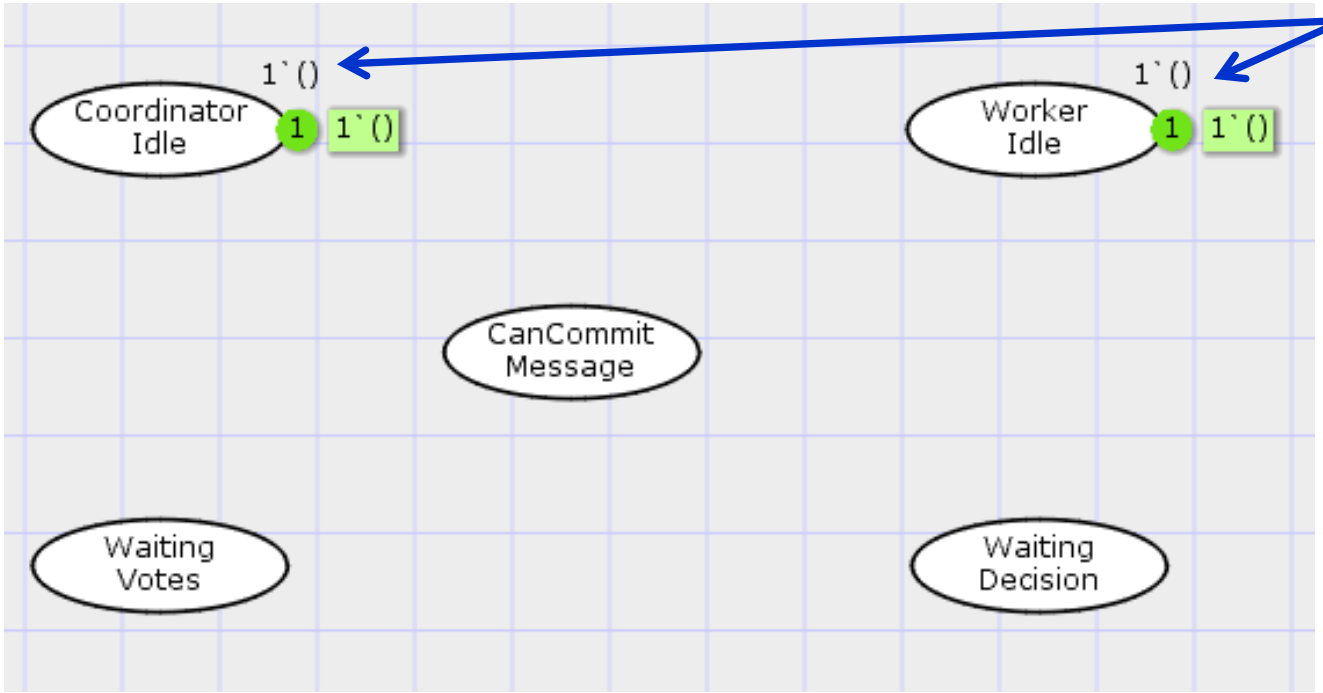
() is the unit value representing an anonymous token

Number of tokens on the place

- A marking is a distribution of tokens on the places
  - represents a system state

Initial marking

- The **initial marking** (token distribution) represents the **initial system state**
- Specified by giving the number of tokens that are initially present on a place



Initial marking is by convention specified above the place

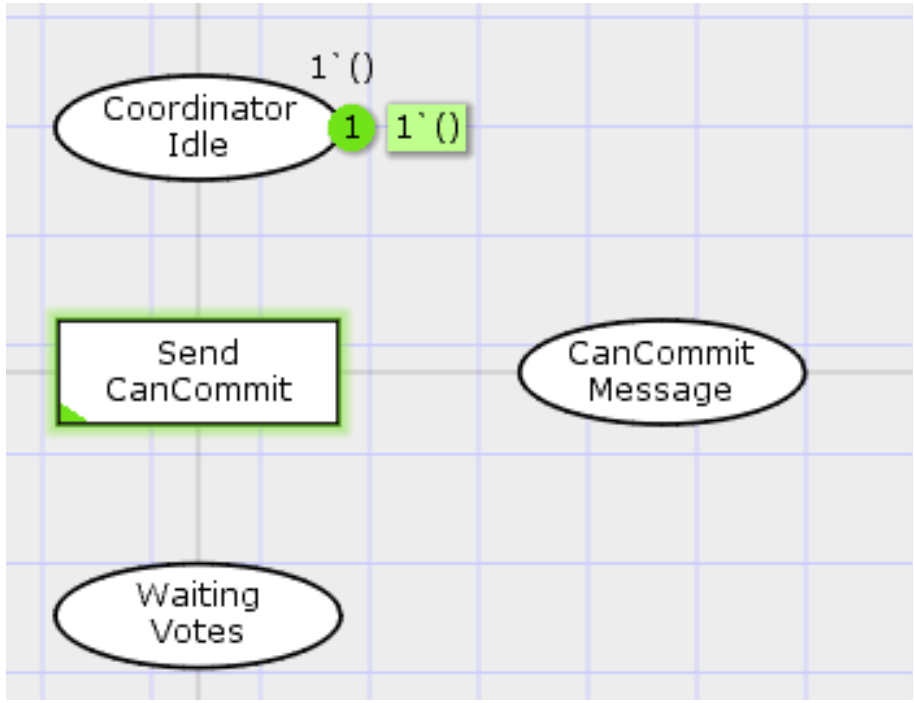
Current marking

- **The current marking is representing the state that the system is currently in**

- **Starts out by being equal to the initial marking - changes when the model is executed**

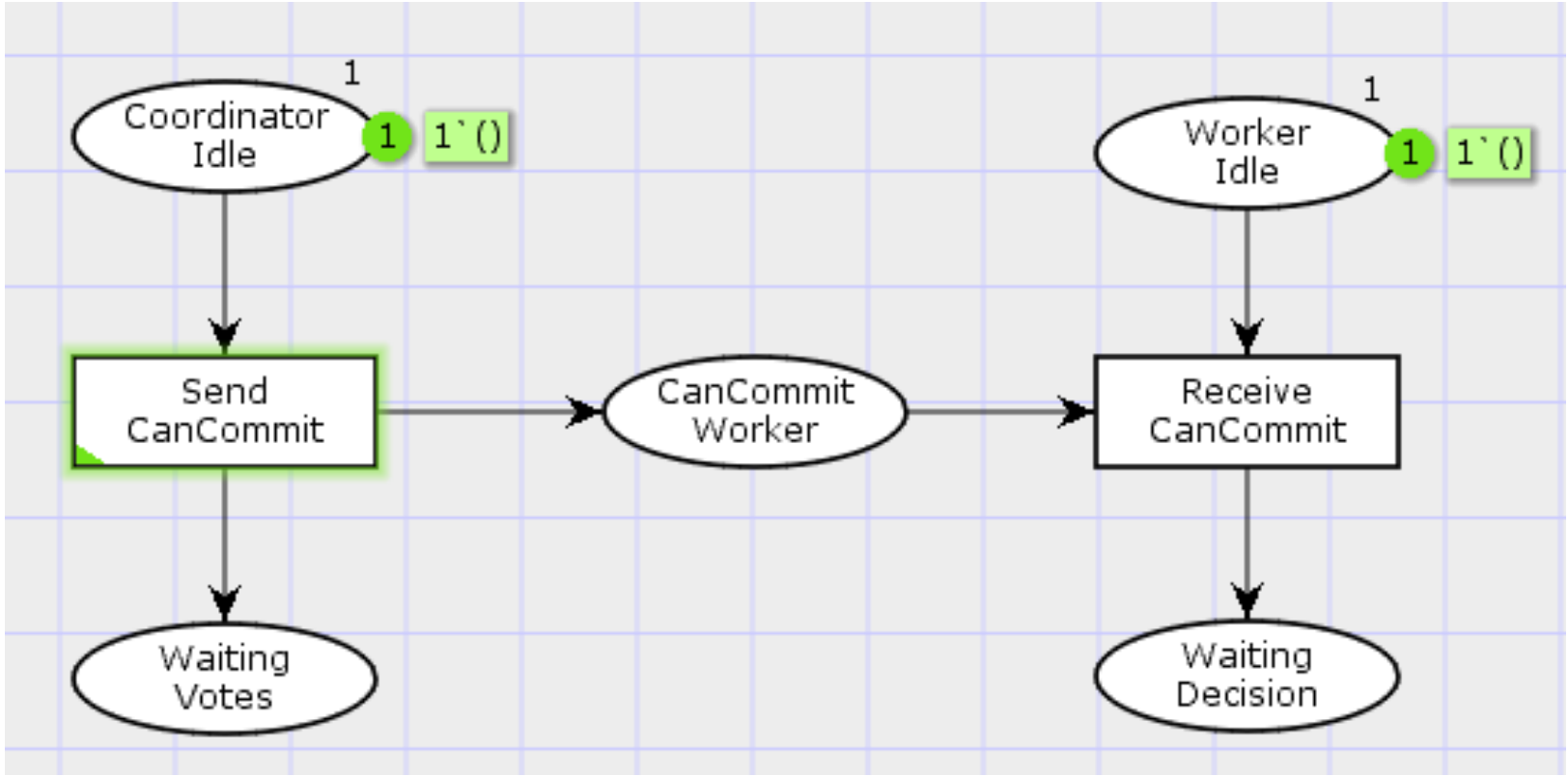
Transitions

- **Used to model the actions/events in the system - drawn as rectangles**



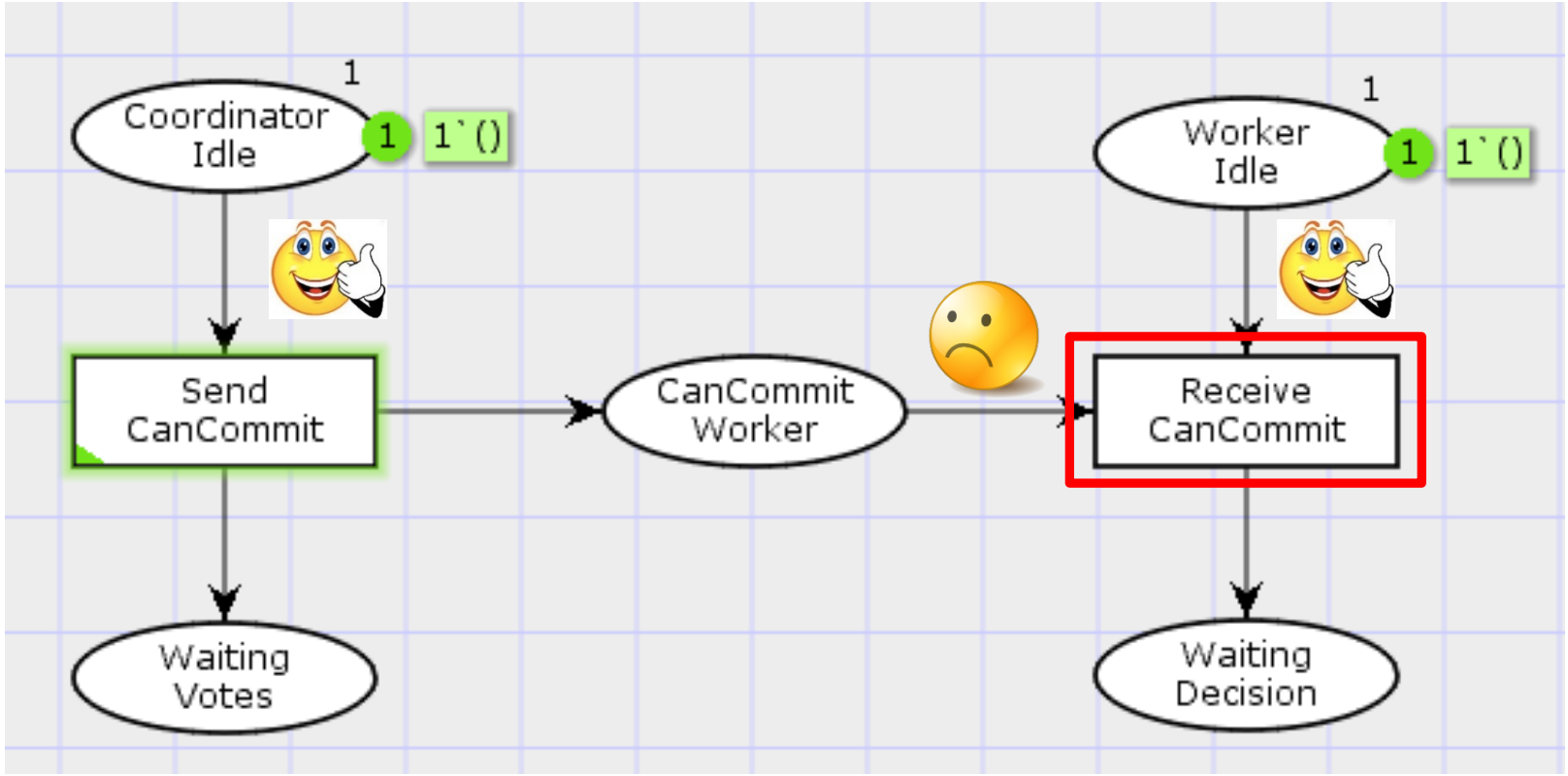
Arcs

- **Connect places and transitions and determine transition enabling and occurrence (firing)**



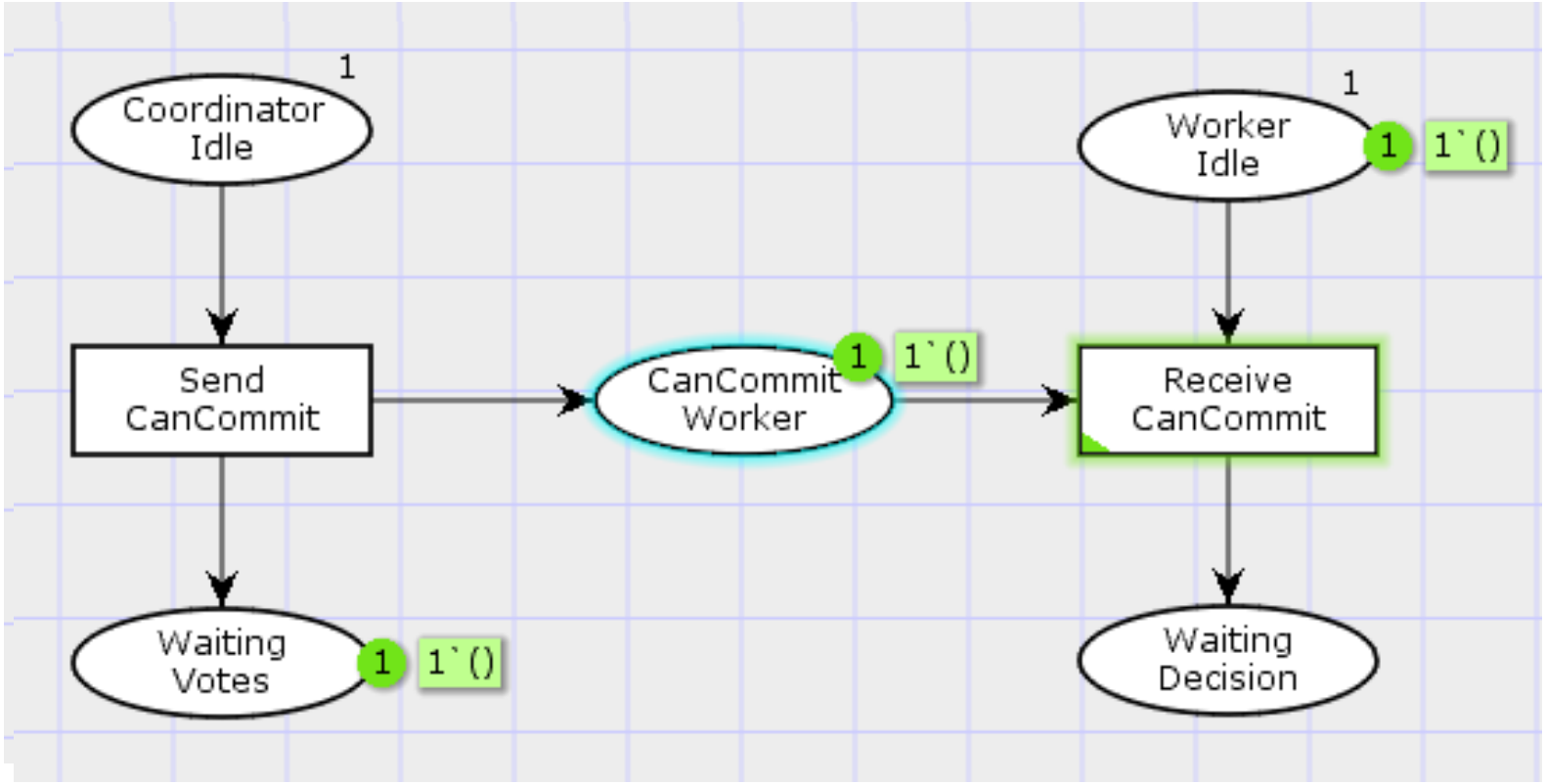
Transition enabling

- **A transition is enabled if there is at least one token on each of its input places**



Transition occurrence

- **An enabled transition may occur (fire)**
  - Removes one token from each input place
  - Adds one token to each output place

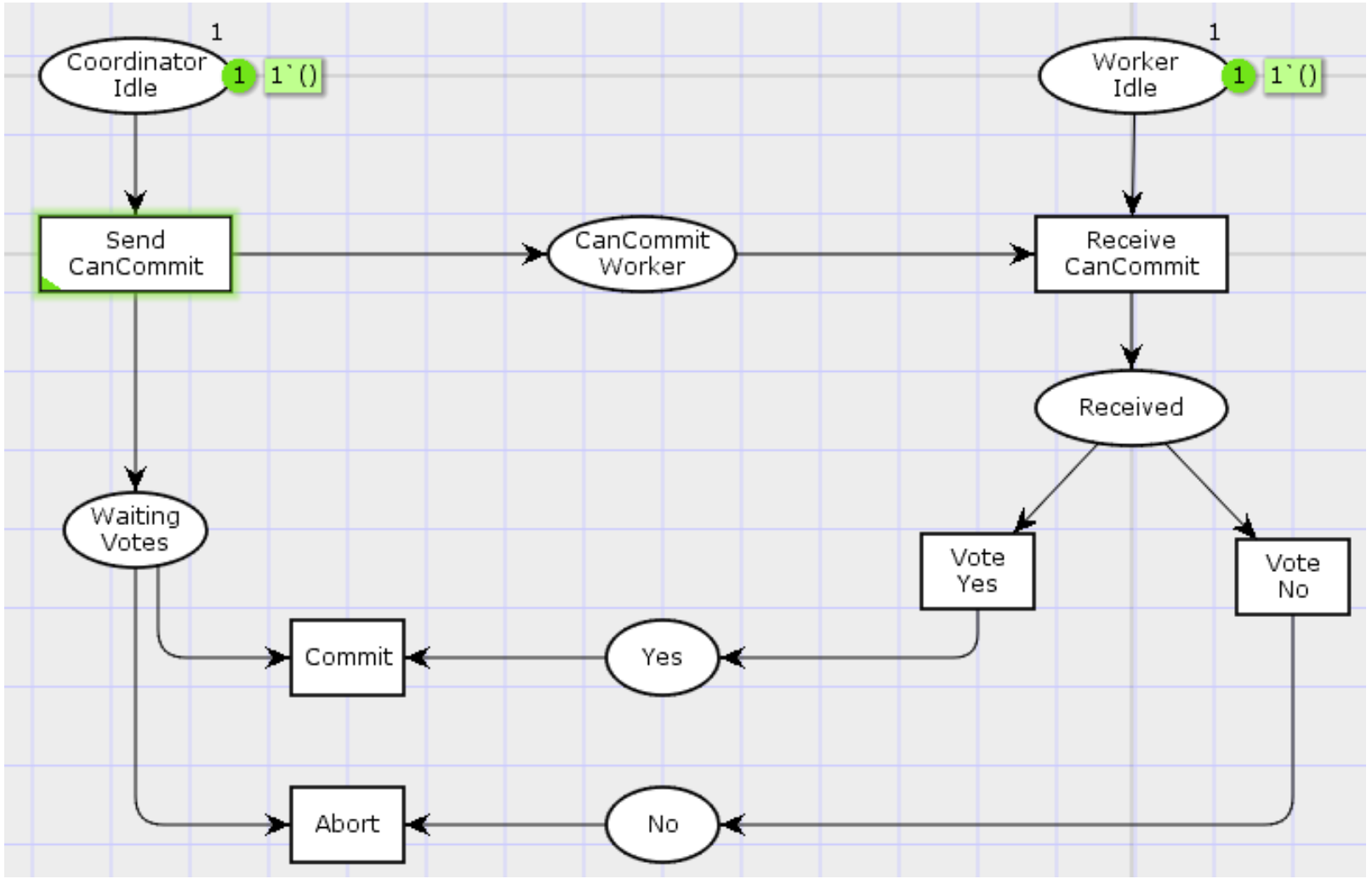


CPN Tools demo

- **Simulation of CPN models**
- **Extensions to the Place/Transition-net model**
  - Modelling votes – conflict and non-determinism
  - Modelling multiple workers - concurrency
  - Collecting votes - arc weights
  - Modelling the protocol as a reactive system

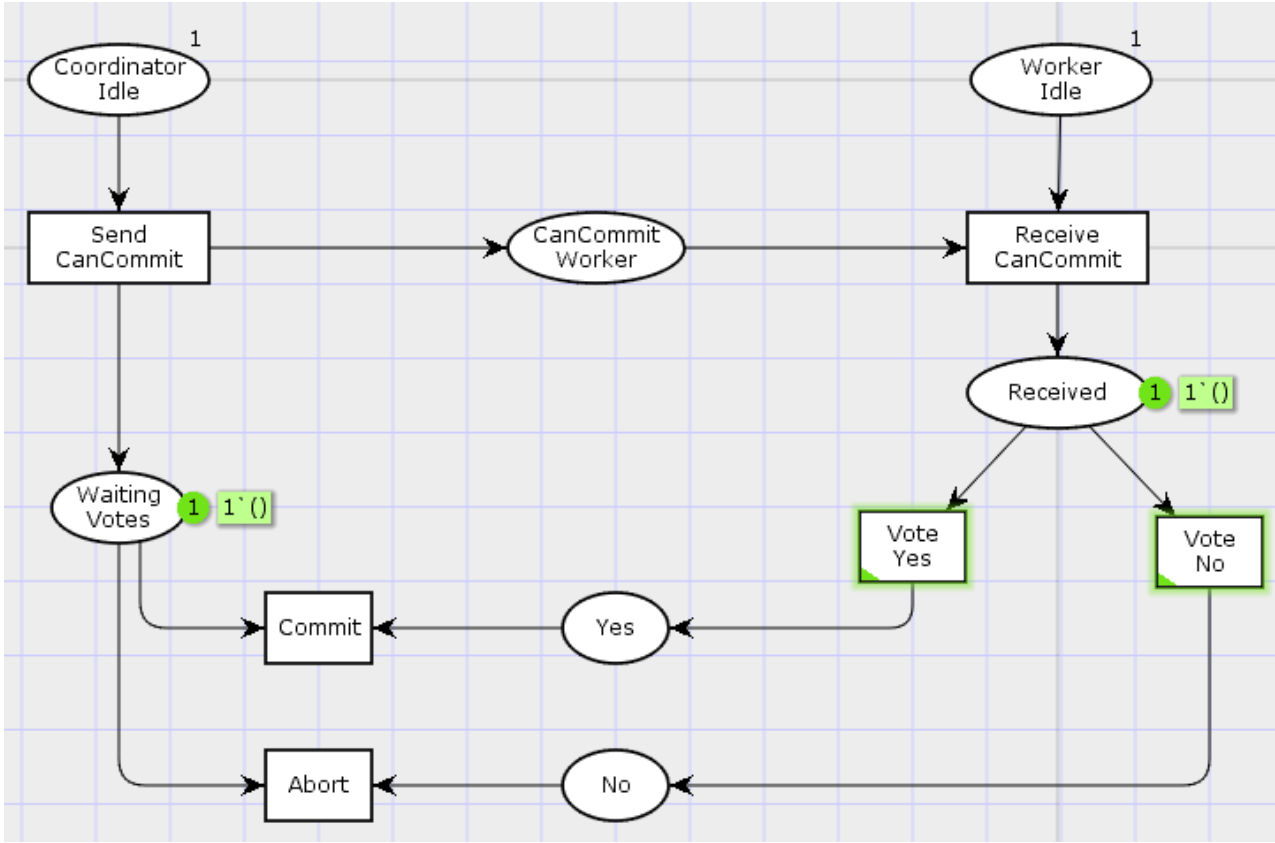
`lecture2-ptnets-tpc-firstpart.cpn`

Modelling votes



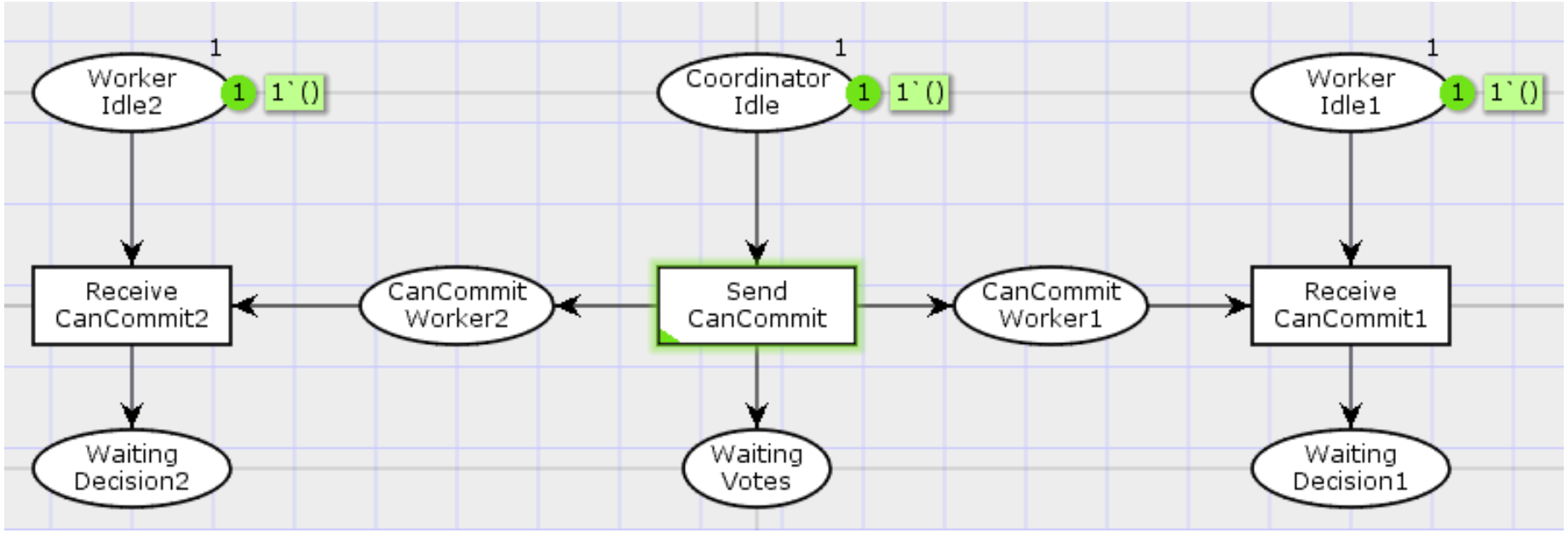
Conflict

- **Transitions are in conflict if they compete for tokens with other enabled transitions**



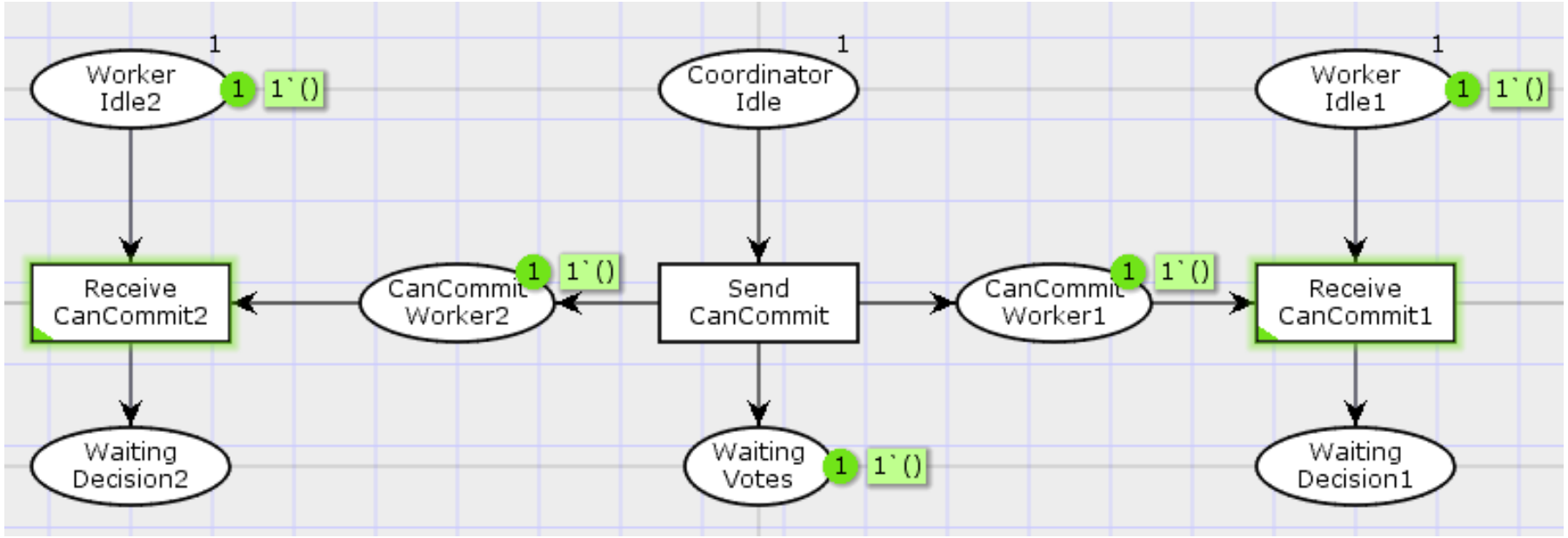
Multiple workers

- **Extending the model to multiple workers**



Concurrency

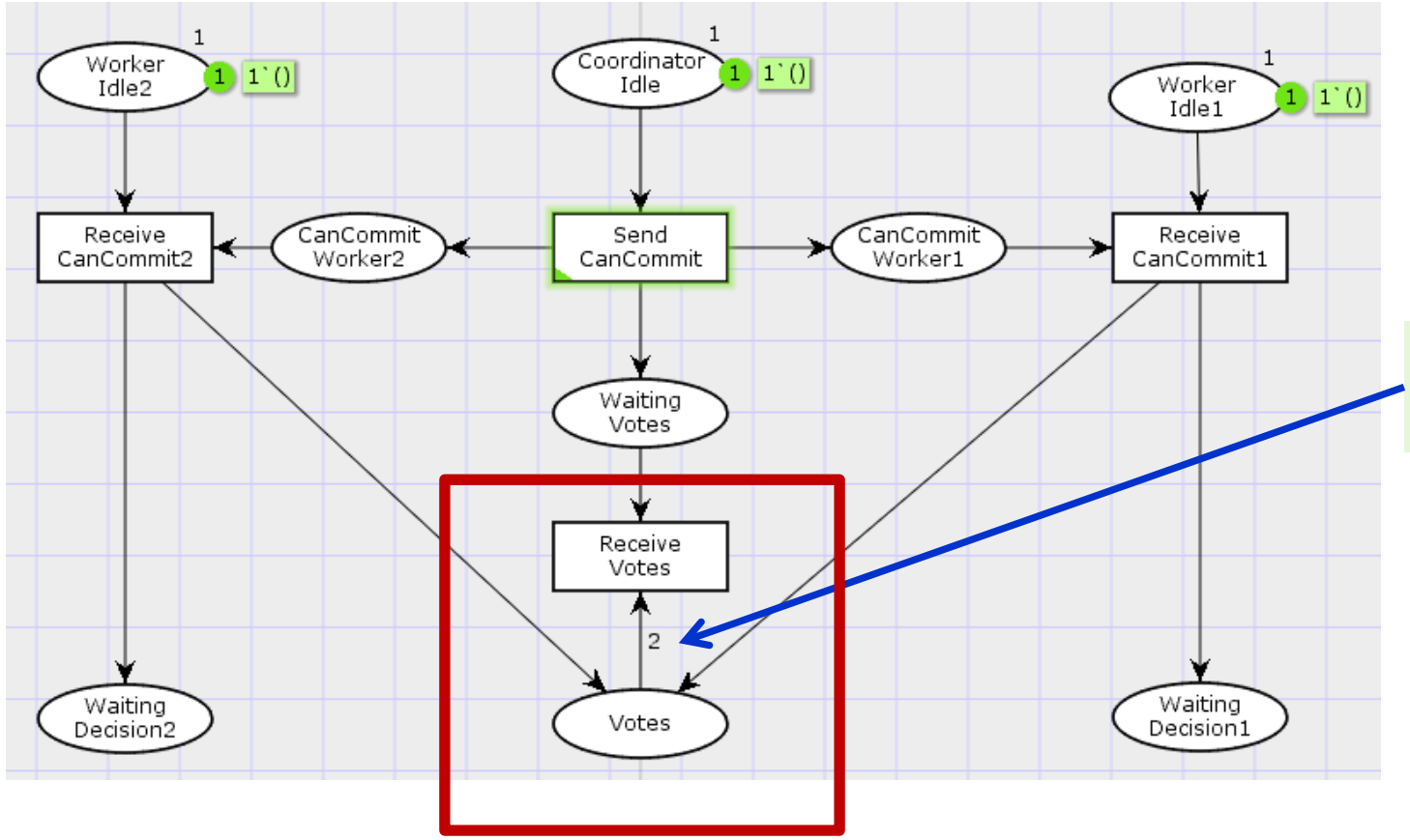
- **Transitions may be concurrently enabled in the same simulation step**



- **ReceiveCanCommit transitions can get the tokens required without sharing**

Arc weights

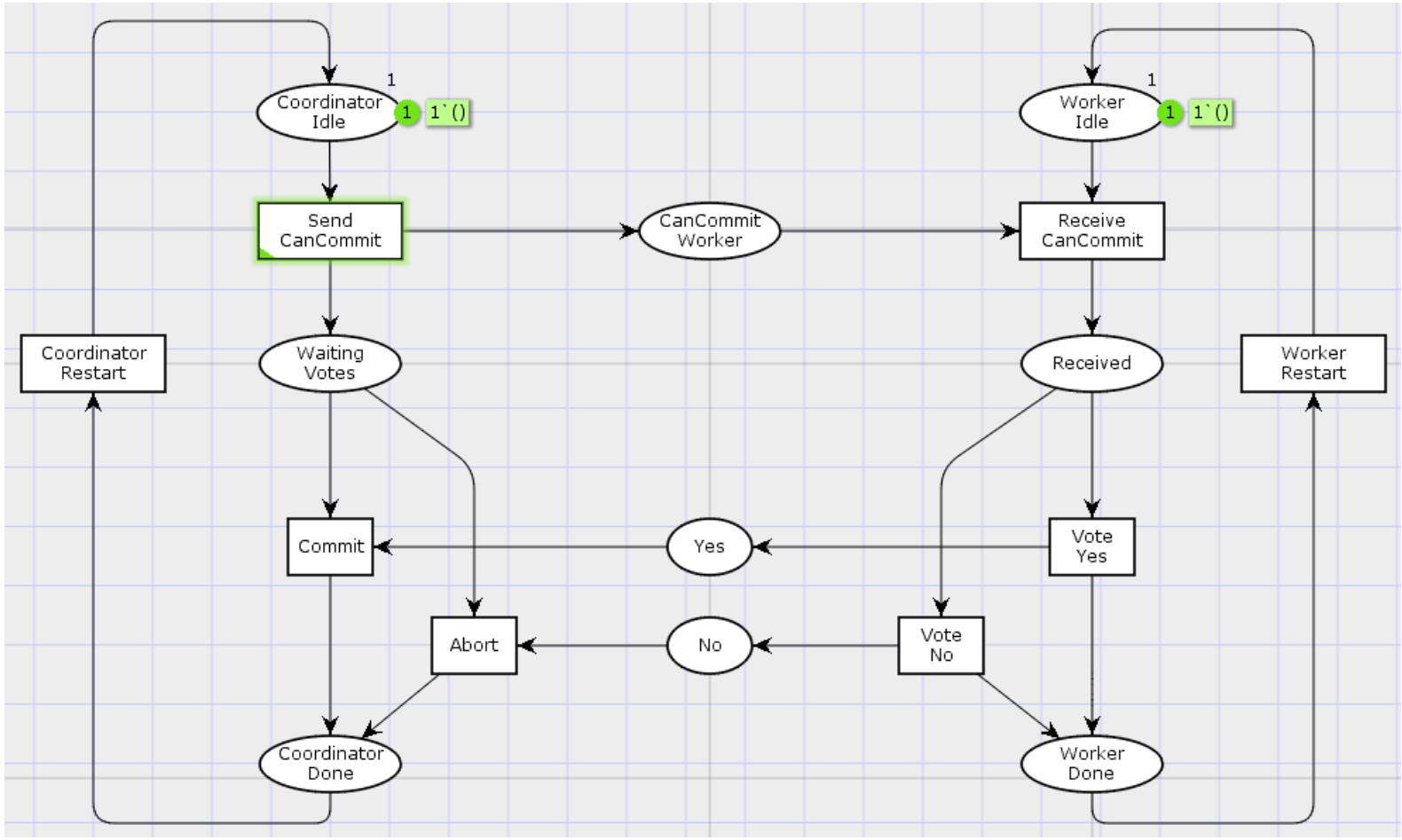
- **Number of tokens required for enabling, consumed and produced (occurrence)**



Both workers must have sent a reply

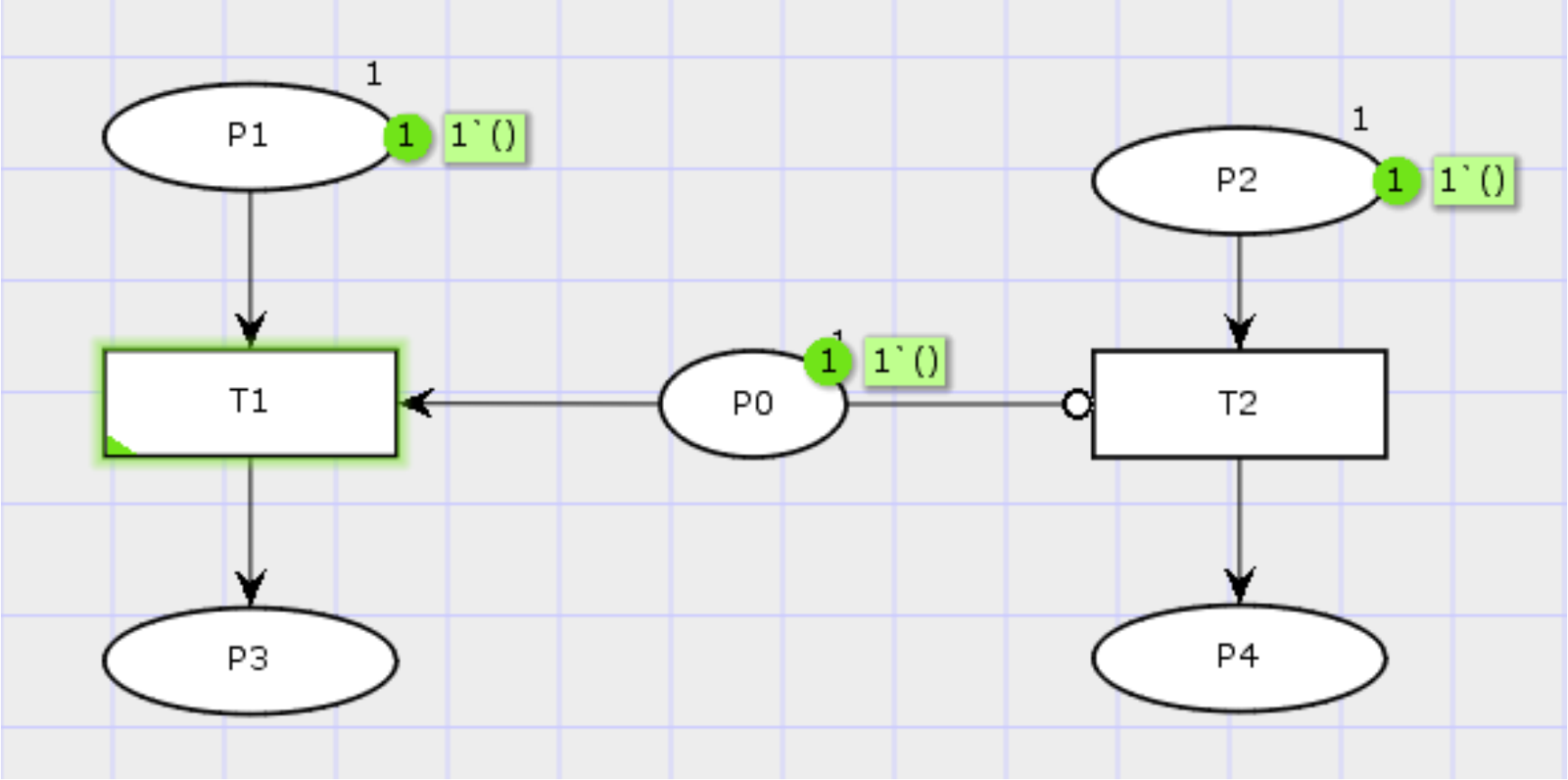
Reactive systems

- **Many concurrency systems are intended to be continuously operating**



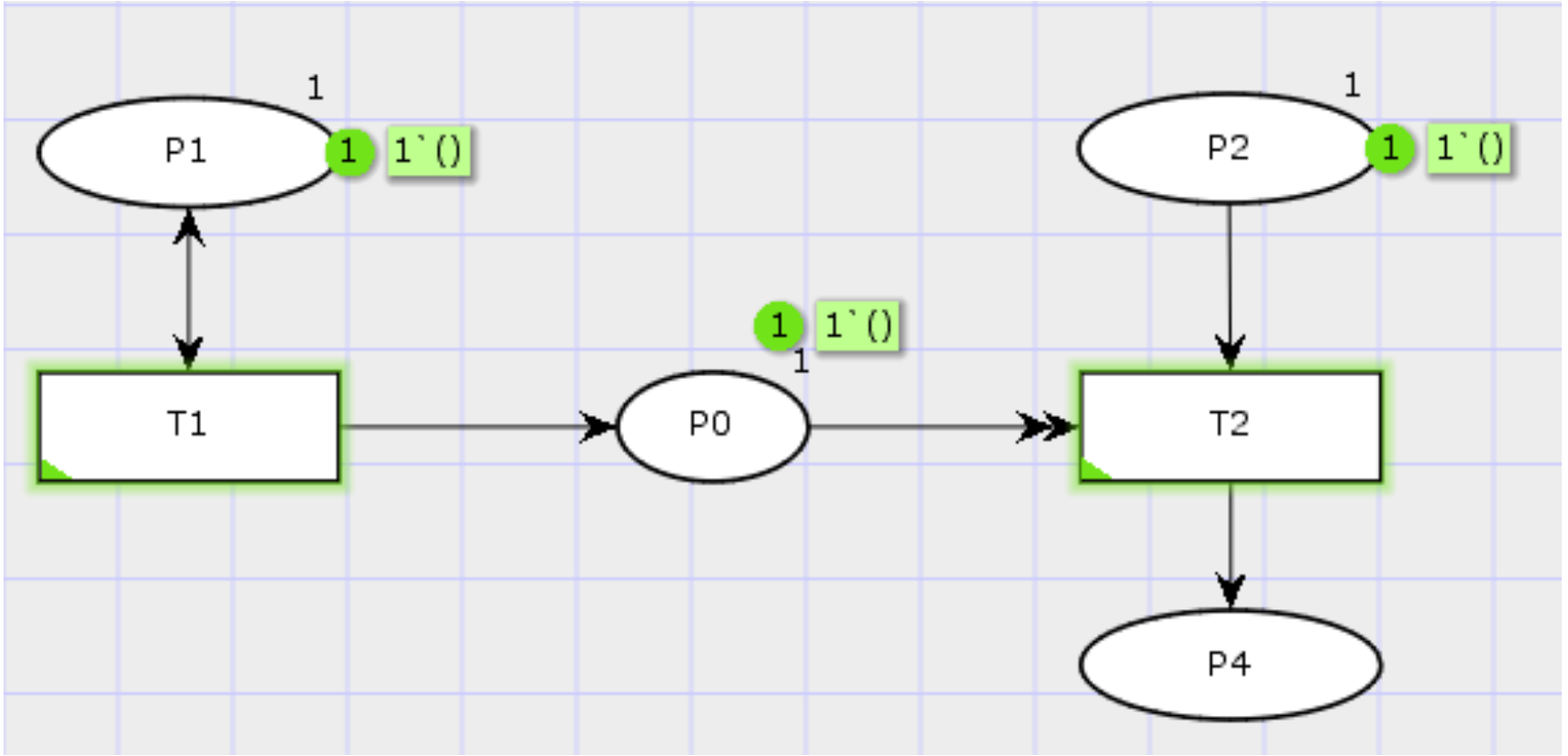
Inhibitor arcs

- Can be used to test for the absence of tokens on a place



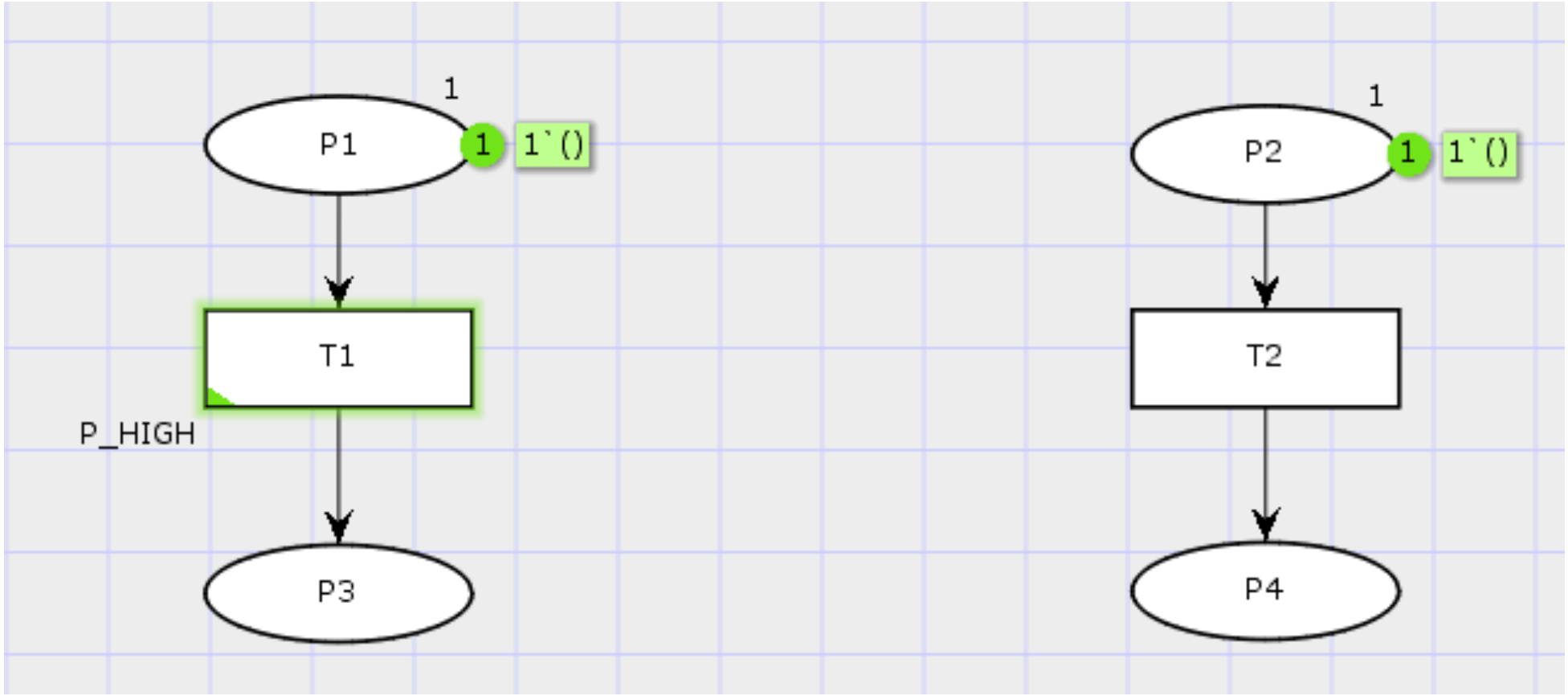
Reset arcs

- **Removes all tokens that are currently present on a place**



Transition priorities

- **Transitions can be given a priority level**



Summary

- **Basic syntactical and semantical concepts of Place/Transition Nets introduced**
- **Additional language constructs**
  - Inhibitor arcs and reset arcs
  - Transition priorities
- **A main limitation of Place/Transitions Nets is scalability to large (real) software systems**
  - Modelling of data is inconvenient
  - Does not allow models to be split into modules
  - Does not support parametric systems in an elegant way