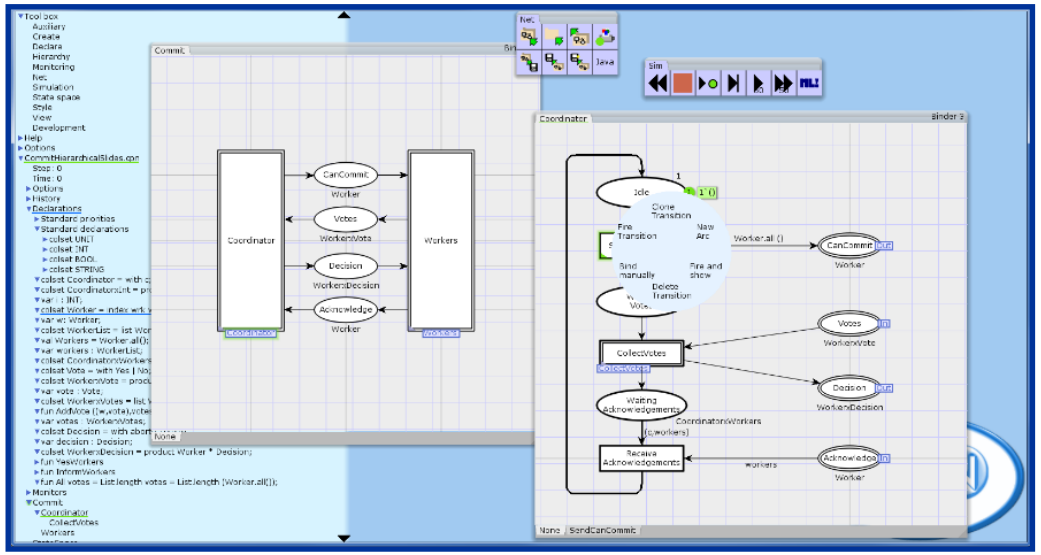
Theory and Tool | Part 1d

Hierarchical Coloured Petri Nets with Modules



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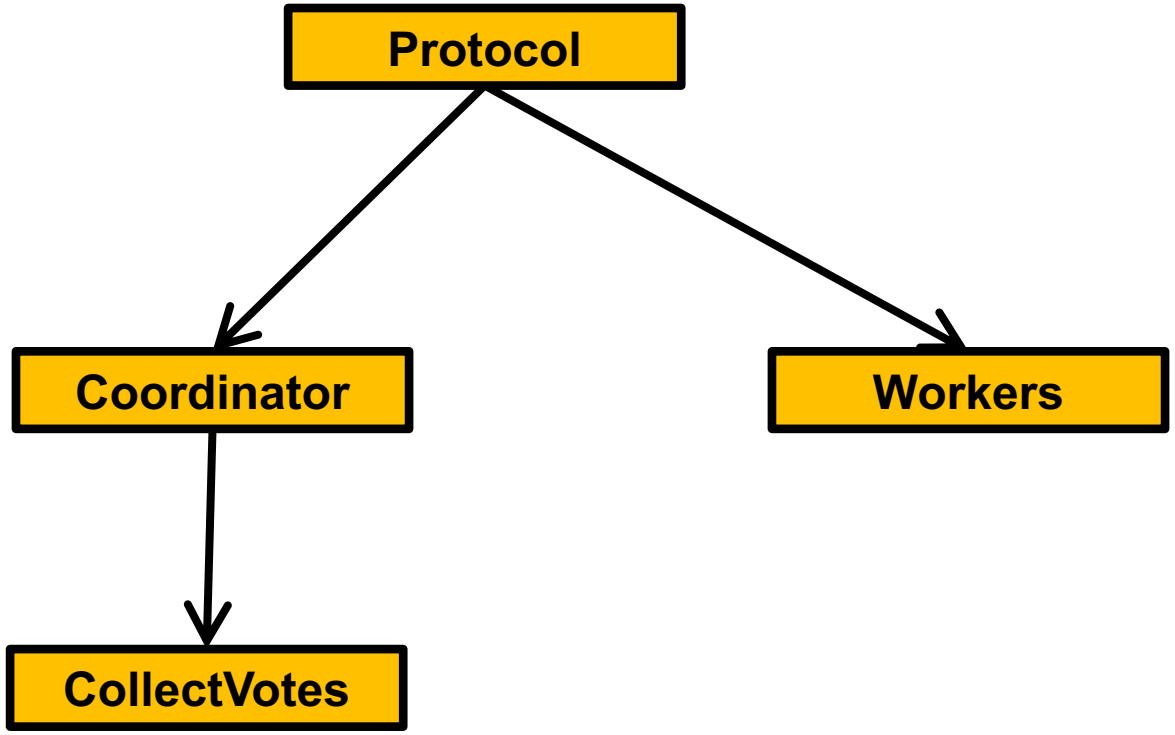
Motivation and concepts

- **Important to be able to split a large CPN models into a set of modules with interfaces**
  - To support construction of large CPN models
  - To support reuse of modules and maintainability
  - To support abstraction and management of details

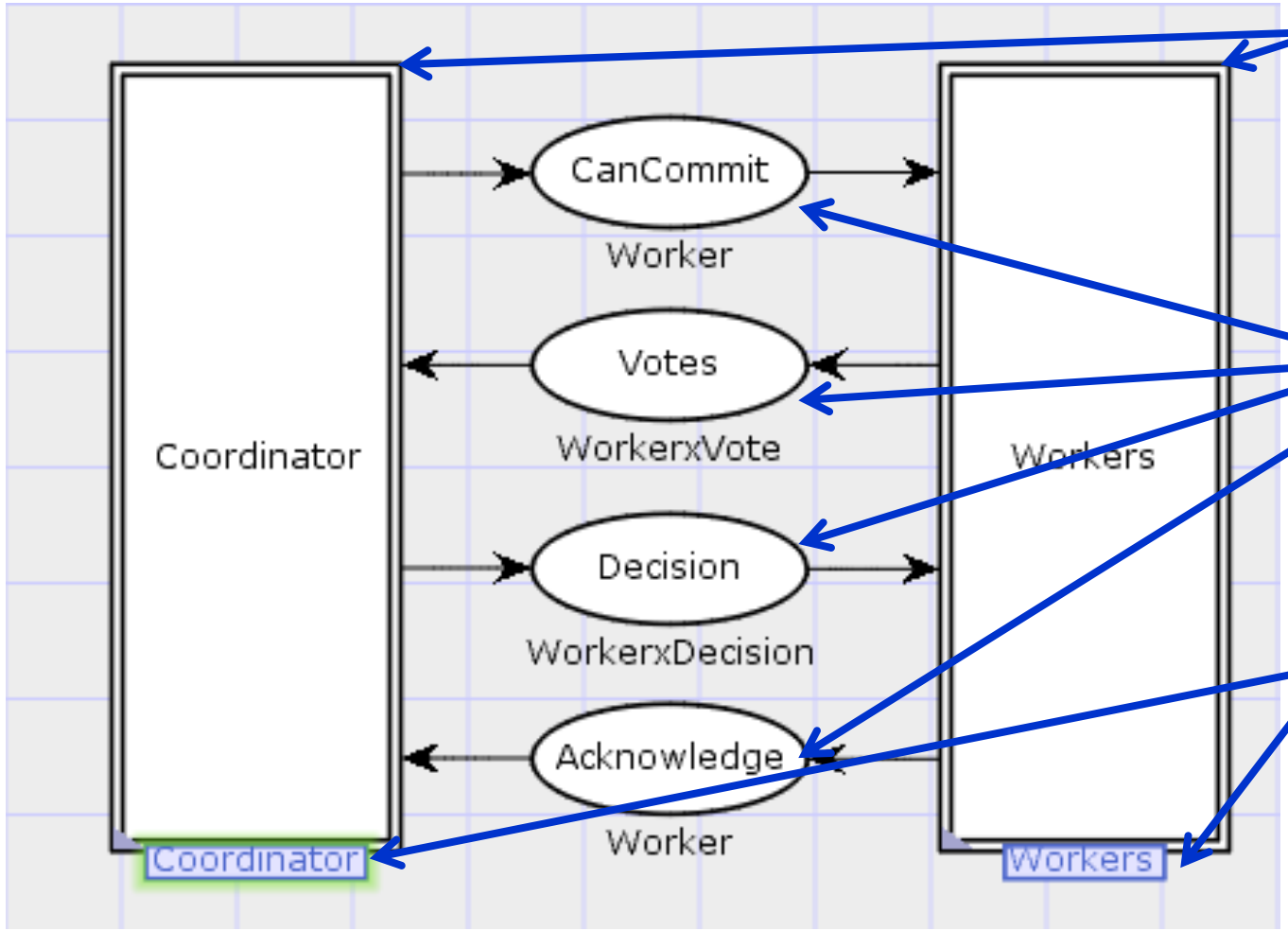
- **Key concepts of hierarchical CPN modules**
  - A module exchange tokens with its environment using input/output port places
  - Substitution transitions have associated submodules
  - Port-socket relation associates socket places of substitution transitions with the port places in the associated submodule

Hierarchical modules

- **Model is comprised of a collection of modules that are hierarchically organised into levels**
- **Example: the two-phase commit protocol**



Top-level: Protocol module

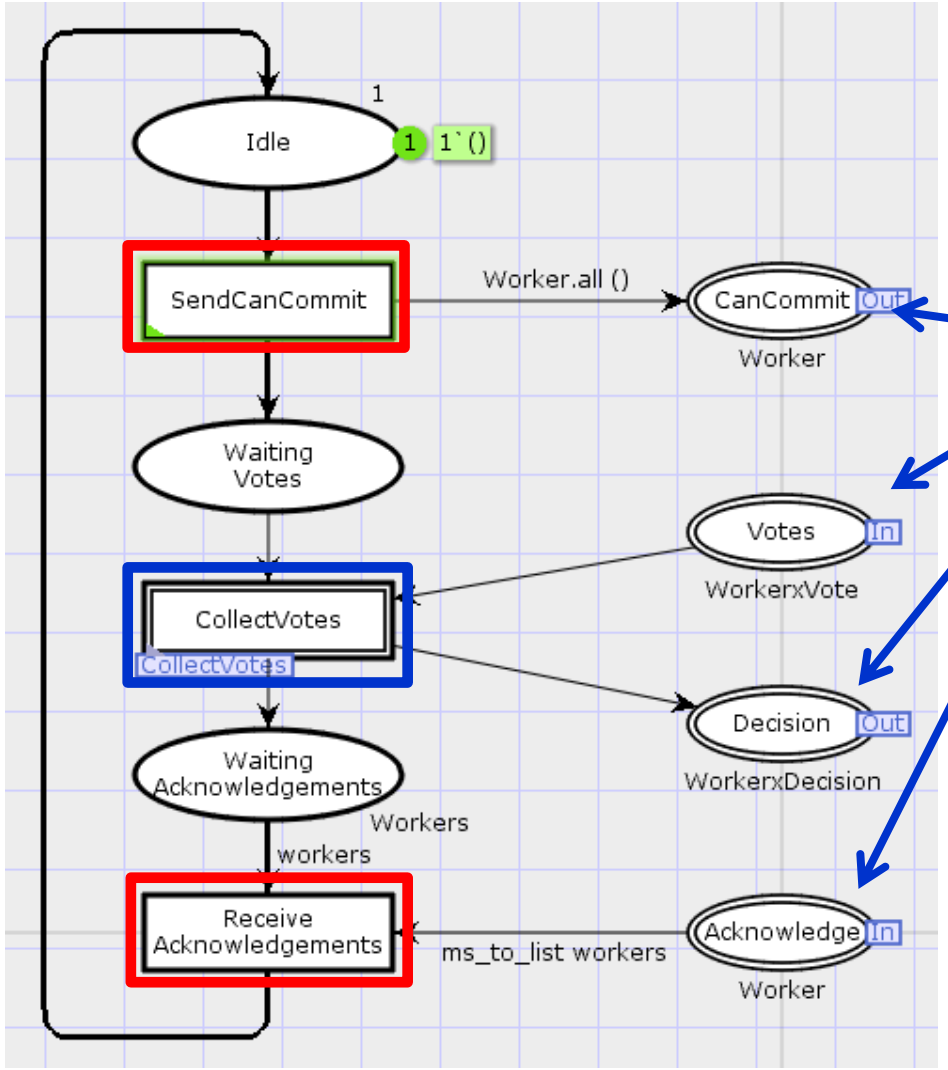


Substitution transitions (double-lined border)

Socket places – places connected to substitution transitions

Substitution tags – name of submodule associated with substitution transition

Coordinator module



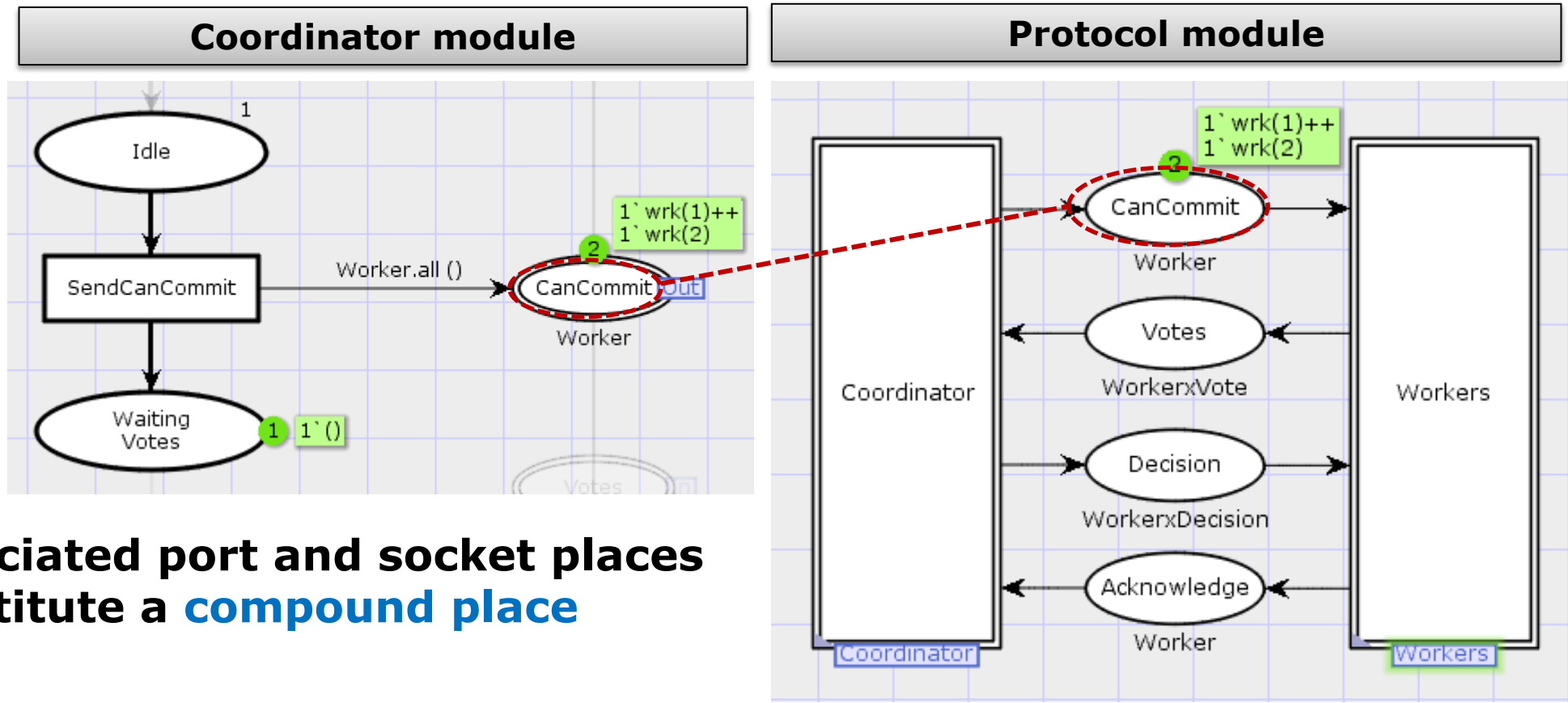
Port place - used for exchanging tokens with the upper-level module (IN,OUT,IN/OUT)

SendCanCommit and ReceiveAcknowledgement are ordinary transitions

CollectVotes is a substitution transition

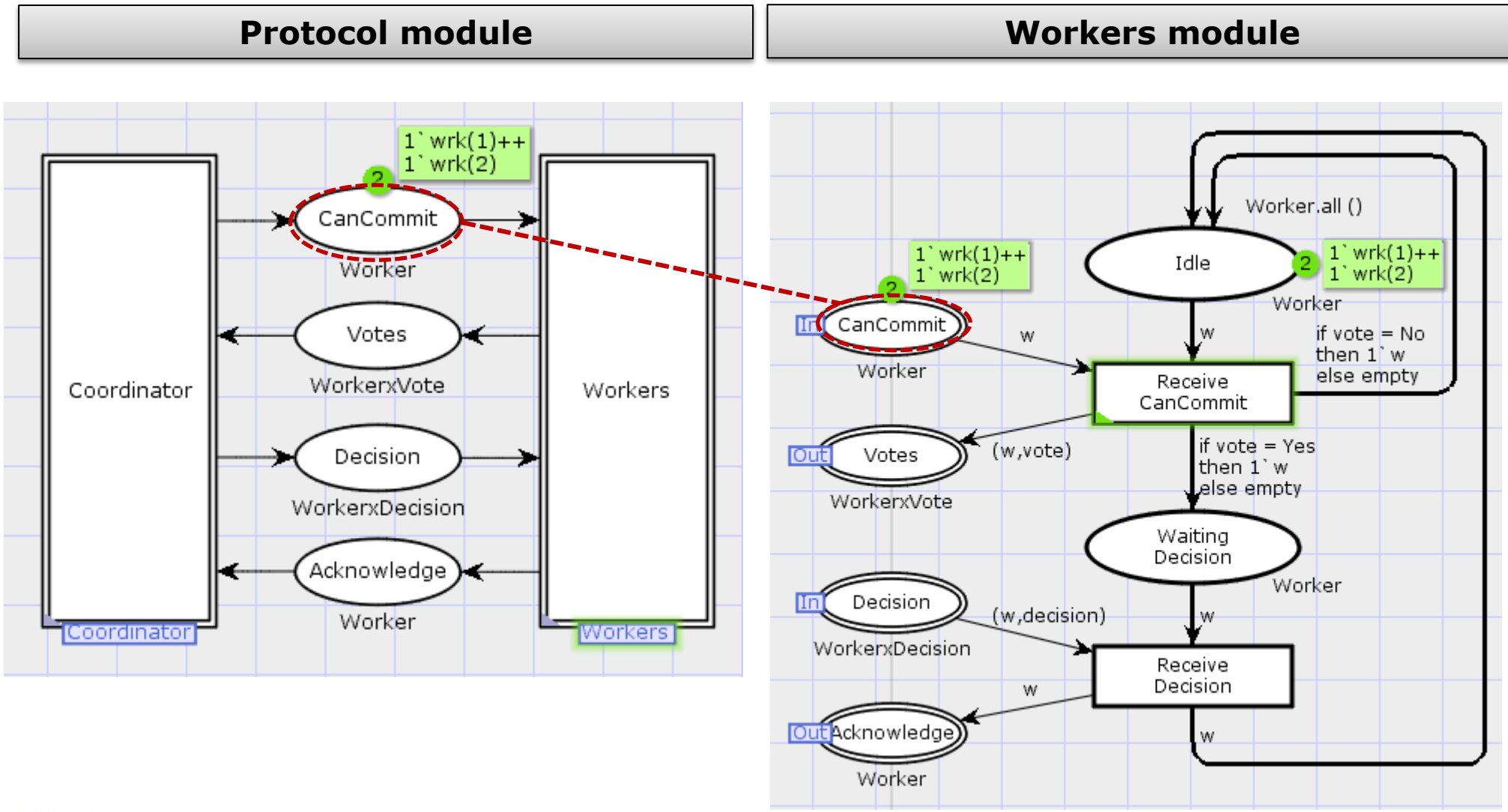
Port-socket place relation

- **Tokens added (removed) on a port place are added (removed) on the associated socket place**



- **Associated port and socket places constitute a compound place**

Workers module



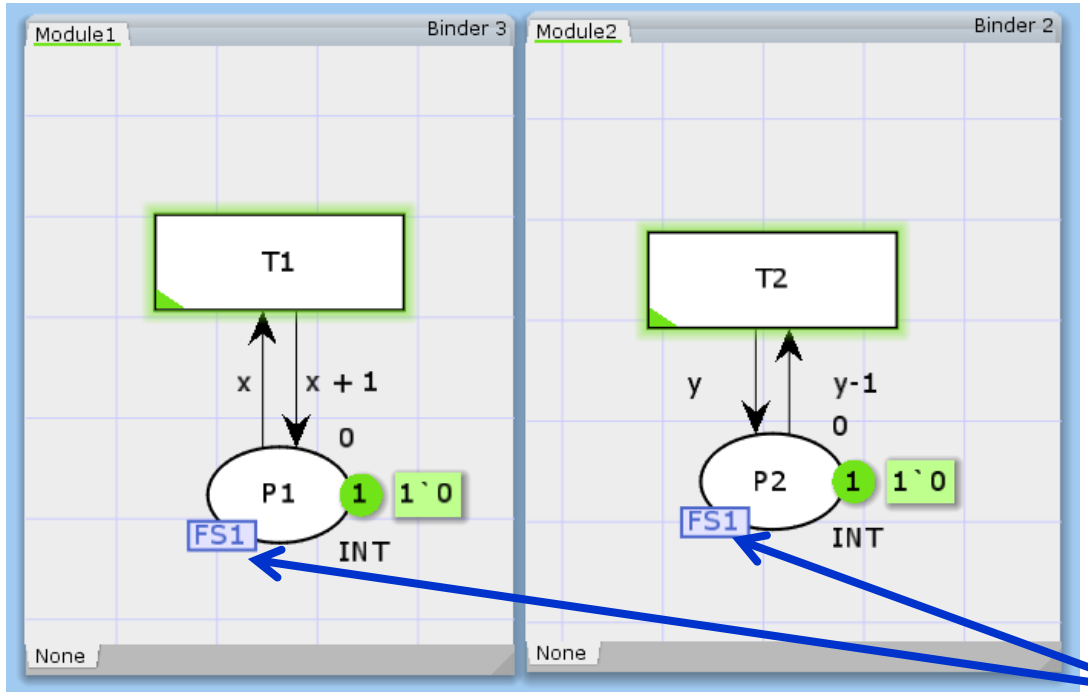
CPN Tools demo

`part1d-cpnmodules.cpn`

- **Hierarchical CPN models**
  - Navigating hierarchical models
  - Simulation of hierarchical models
  - Editing of modules: top-down and bottom-up development

Place Fusion Sets

- **Group of places to be treated as one compound (global) place**



Any change in the marking of P1 will be reflected on P2 (and vice versa)

Similar to global variables - should be used with care

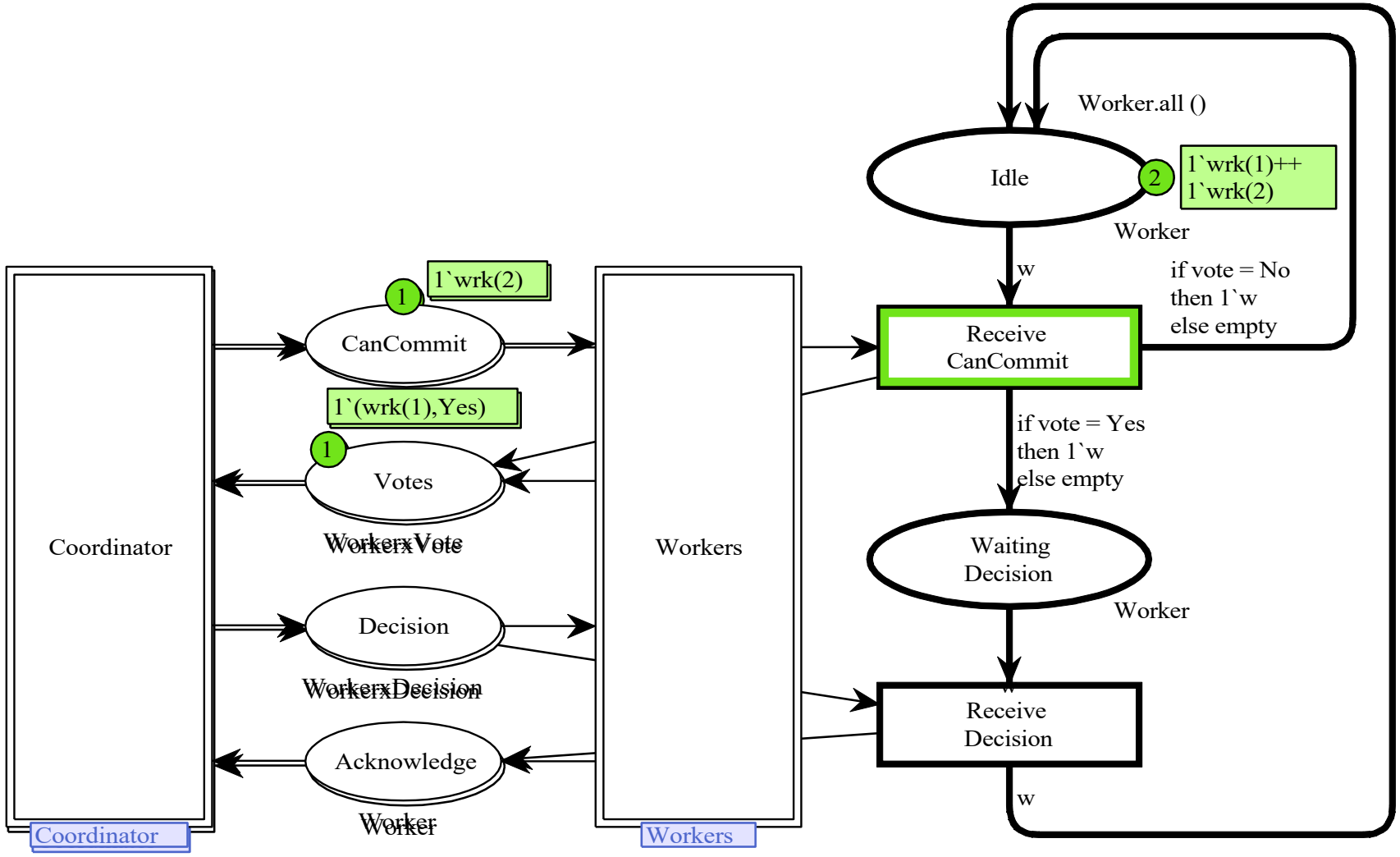
P1 and P2 are fusion places belonging to fusion set FS1

Unfolding Coloured Petri Nets to Place/Transition Nets

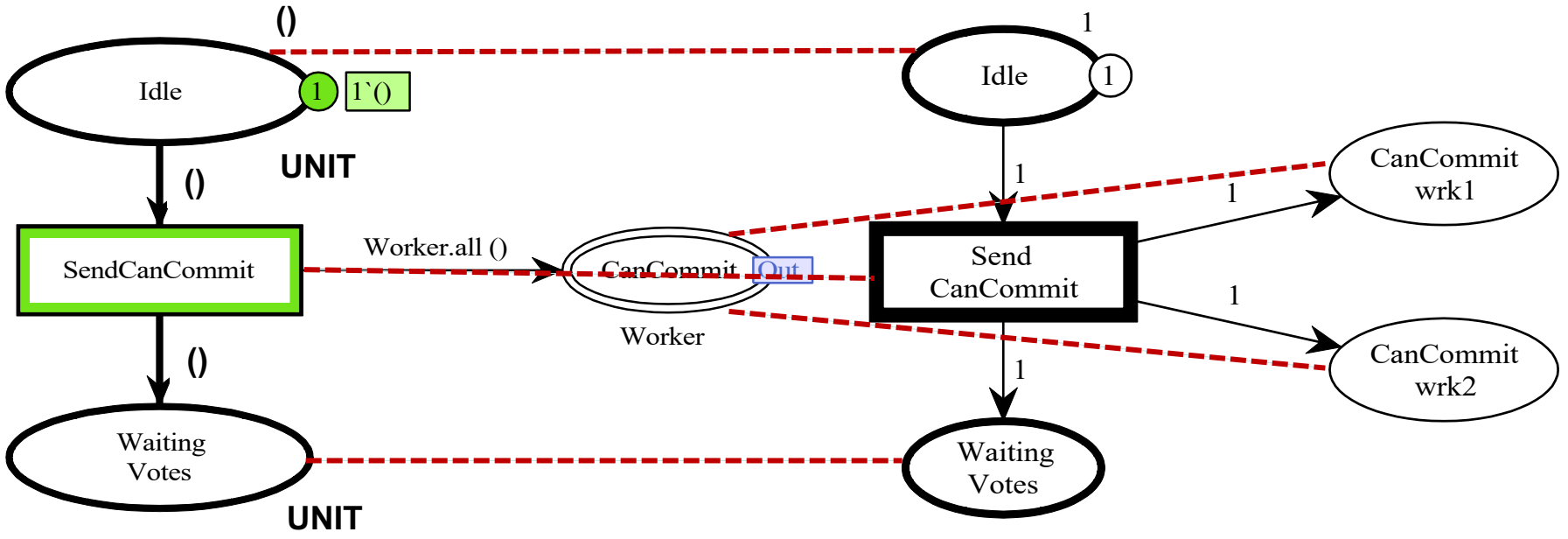
Unfolding Coloured Petri Nets

- **A hierarchical CPN model can be unfolded to a non-hierarchical Coloured Petri Net**
  - Recursively replace each substitution transition with its associated submodule
  - Associated port and socket places are merged into a single place
- **A non-hierarchical Coloured Petri Net can be unfolded into a Place/Transition Net (PTN)**
  - Replace each CPN place with one PTN place for each colour in the colour set of the CPN place
  - Replace each CPN transition with one PTN transition for each possible binding of the CPN transition

Unfolding hierarchical CPNs



Unfolding CPN places



Unfolding CPN transitions