

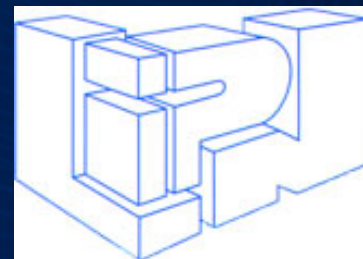


Towards a coloured Petri nets semantics for a chronicle language

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r e t u r n o n i n n o v a t i o n

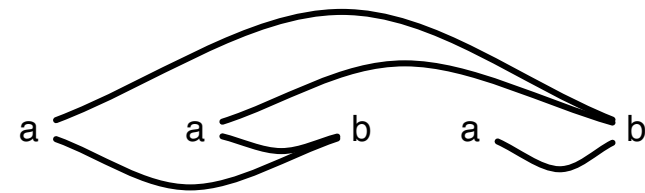


Context

- Behaviour analysis of HLA distributed simulation
 - HLA : High Level Architecture : IEEE interoperability standard
- Using activities recognition techniques
- Activities are denoted by chronicles

Chronicle and their recognition

- Chronicles
 - Describe an event pattern
 - Events relationships :
 - Logical
 - Temporal
- Chronicle recognition :
 - Identify the chronicle patterns that are searched for in the observed event flow
 - Characteristic :
 - Find all instances of a searched chronicle
 -
 - Store events that contributed to the recognition



occurrences of
a followed by b

Chronicle language

- Logical operators
 - And : $A \& B$
 - Or : $A \parallel B$
- Temporal operators
 - Sequence : $A B$
 - Absence : $(A B)-[C]$
 - Absence and Sequence can be used to represent timed constraint
 - Minimum delay : $A \text{ } 5 \text{ } B$
 - Maximum delay $(A B)-[5]$
- Operator composition
 - $(A \parallel B) (C \parallel D)$

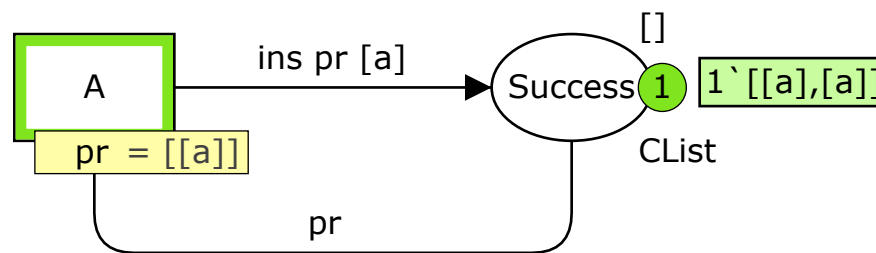
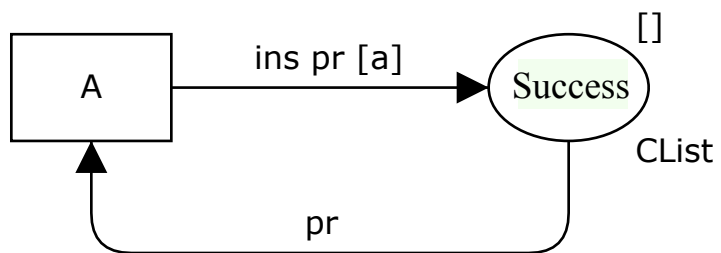
Chronicle modelling

- Using coloured Petri Nets
- Each chronicle event is represented by a transition
- Event occurrence is associated with firing the corresponding transitions

- We use specific nets (modelled with CPN tools):
 - One token per place (type CList or Boolean)
 - Complex list functions
 - colset Event with a|b|c|d;
 - colset ChronInst= list Event;
 - colset CList= list ChronInst;

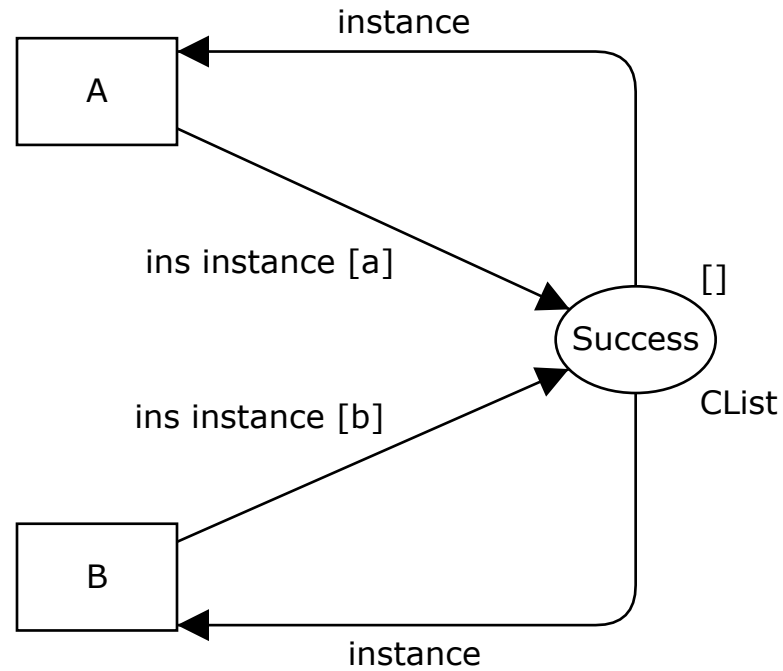
Basic operators

- Basic event recognition



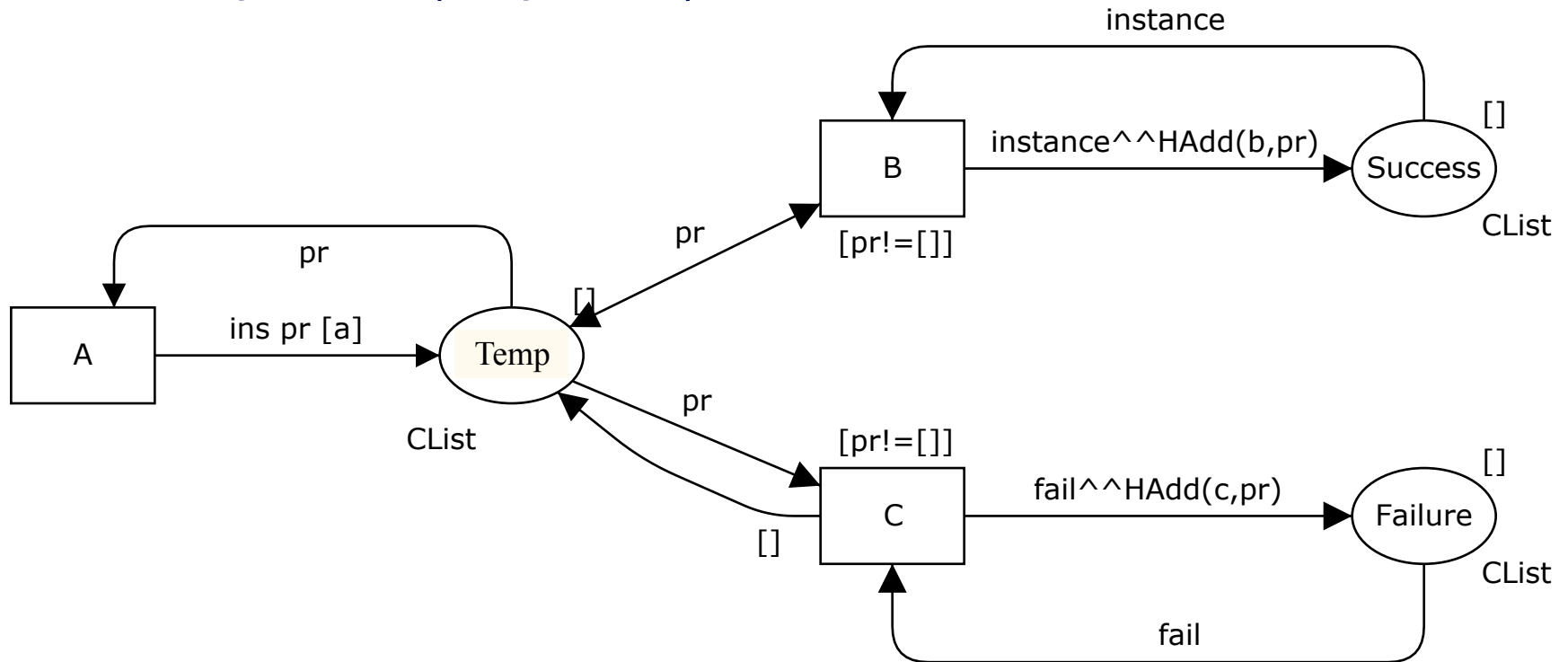
Event flow : a a

Basic operator : or



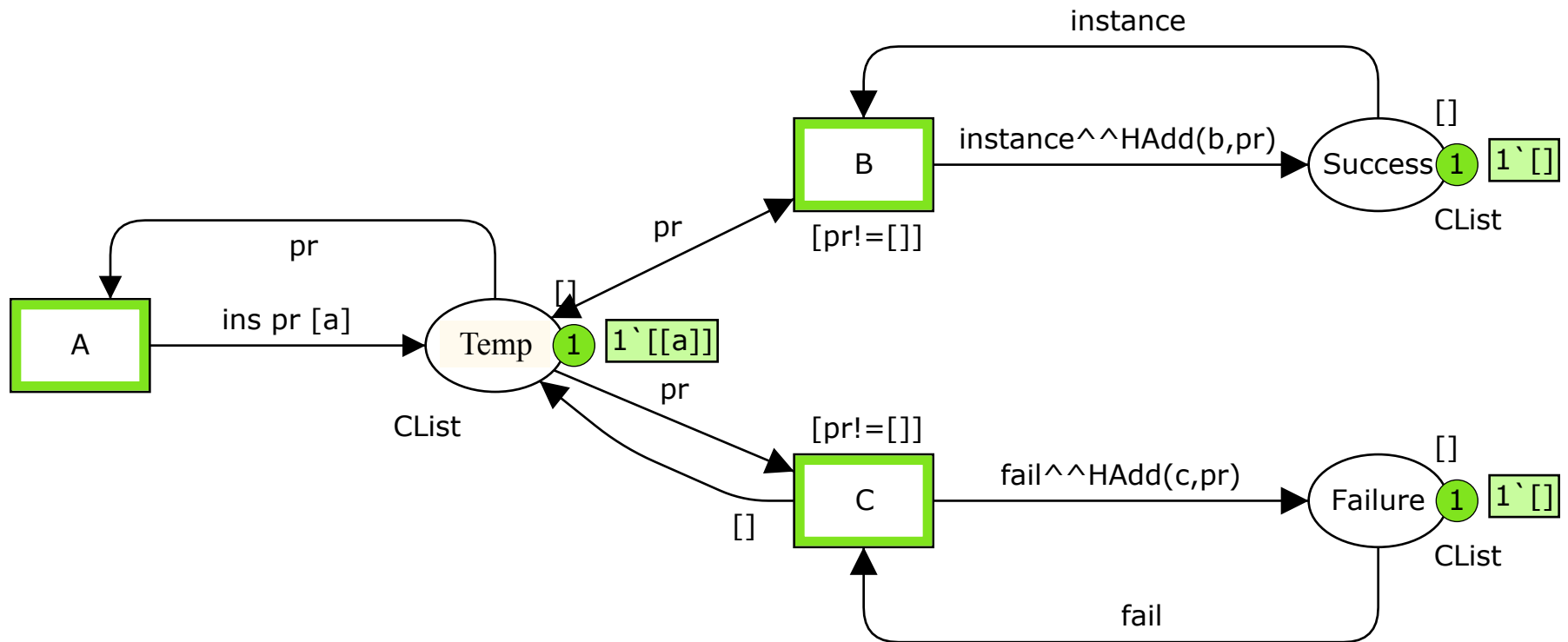
Basic operators (A B) -[C]

- Absence operator (sequence)



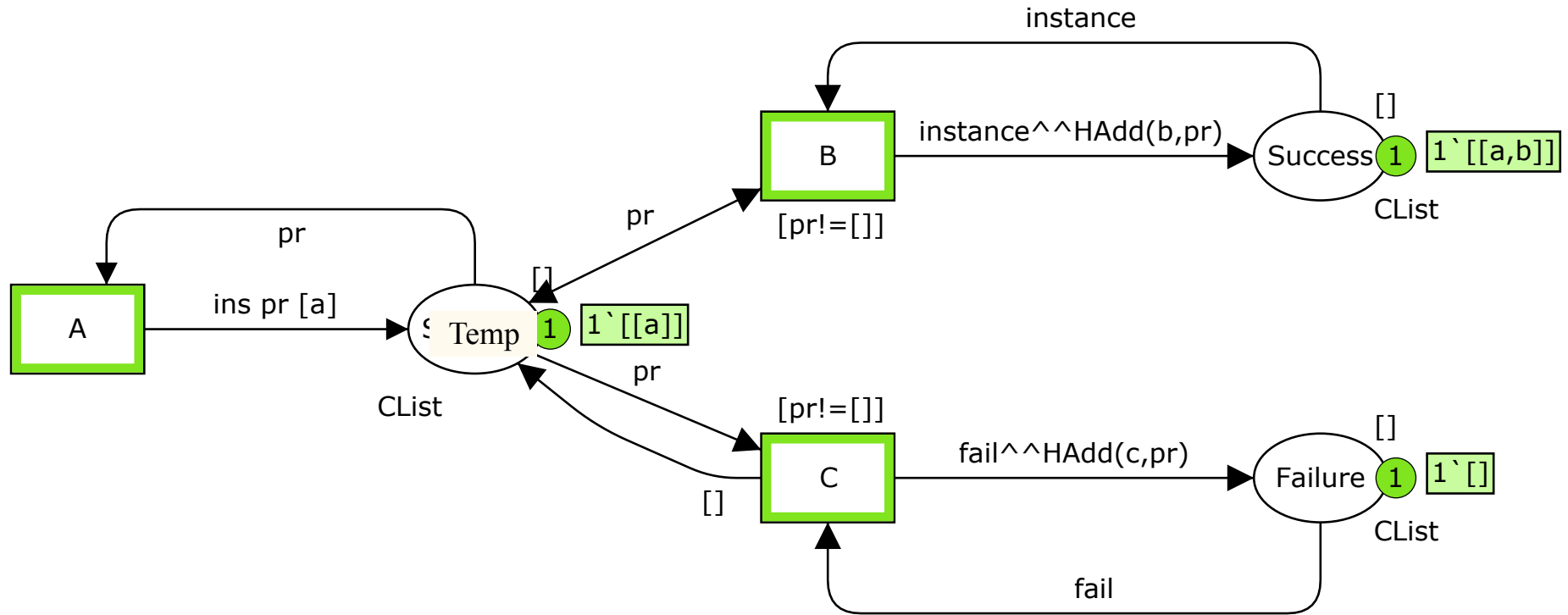
Basic operators (A B) -[C]

Event flow : "a b b c b"



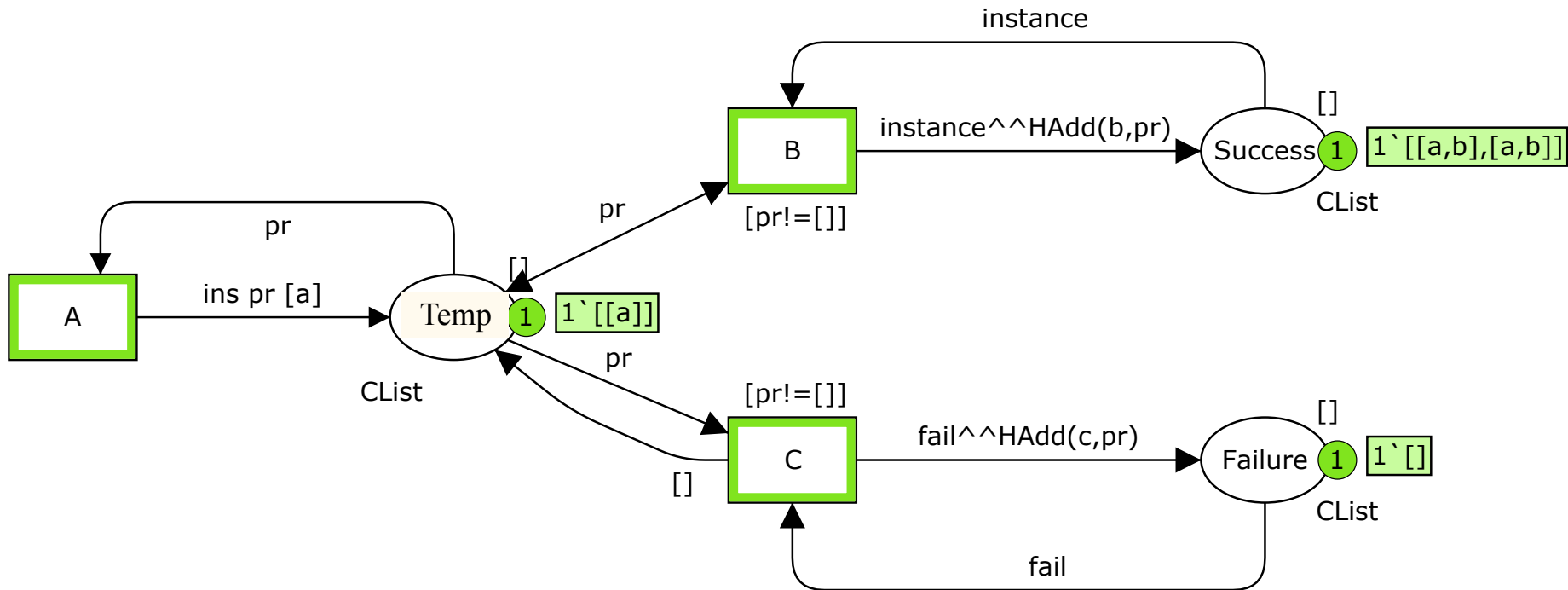
Basic operators (A B) -[C]

Event flow : "a b b c b"



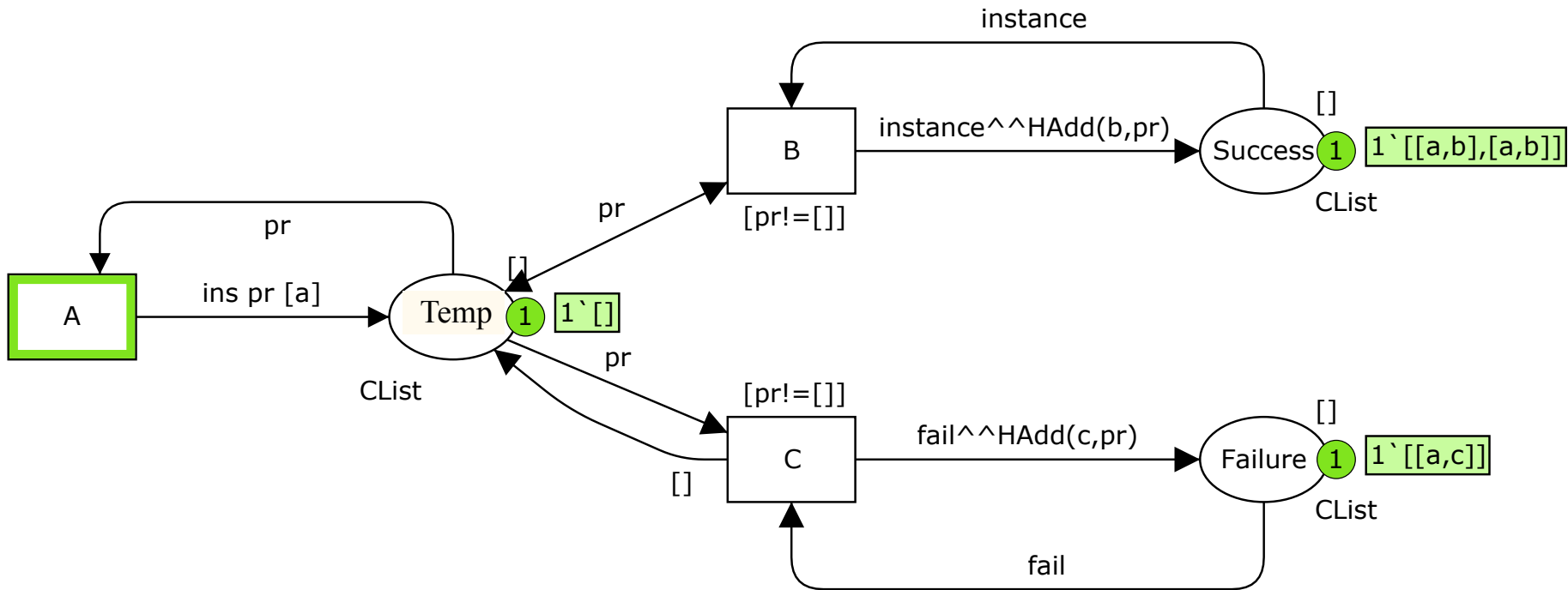
Basic operators (A B) -[C]

Event flow : "a b b c b"



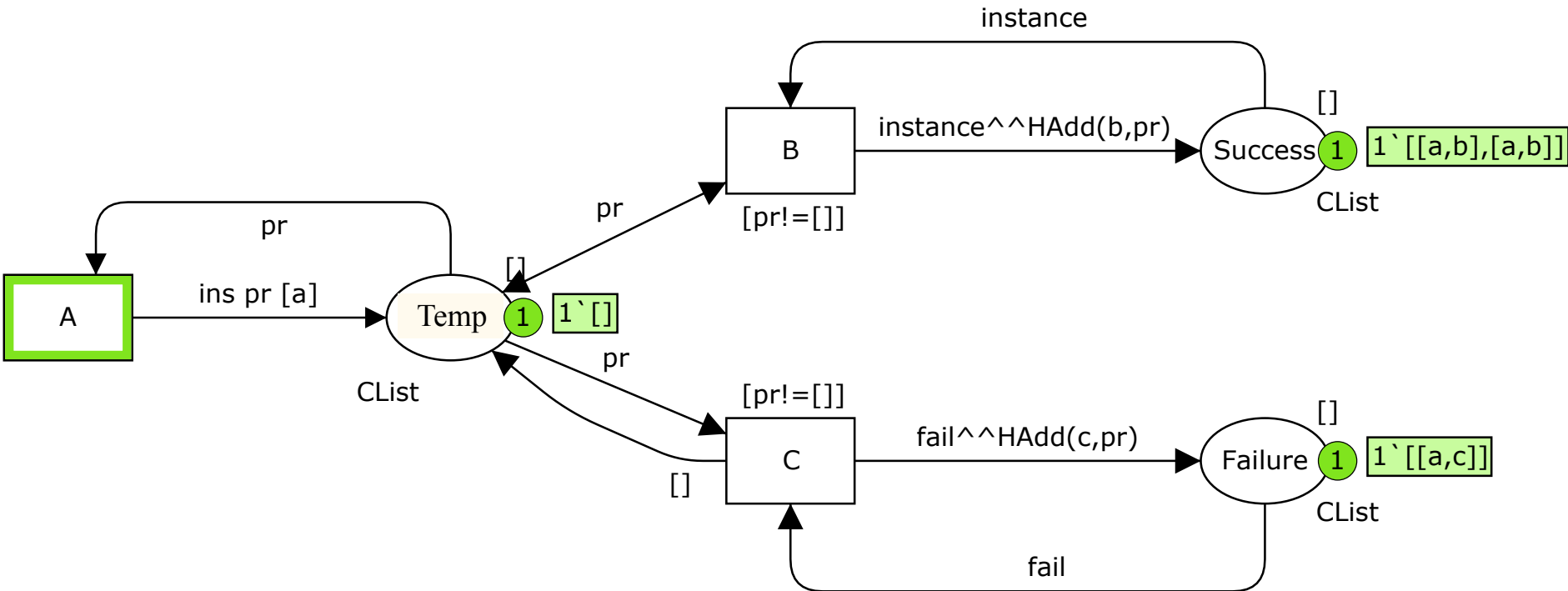
Basic operators (A B) -[C]

Event flow : "a|b|b|c|b"



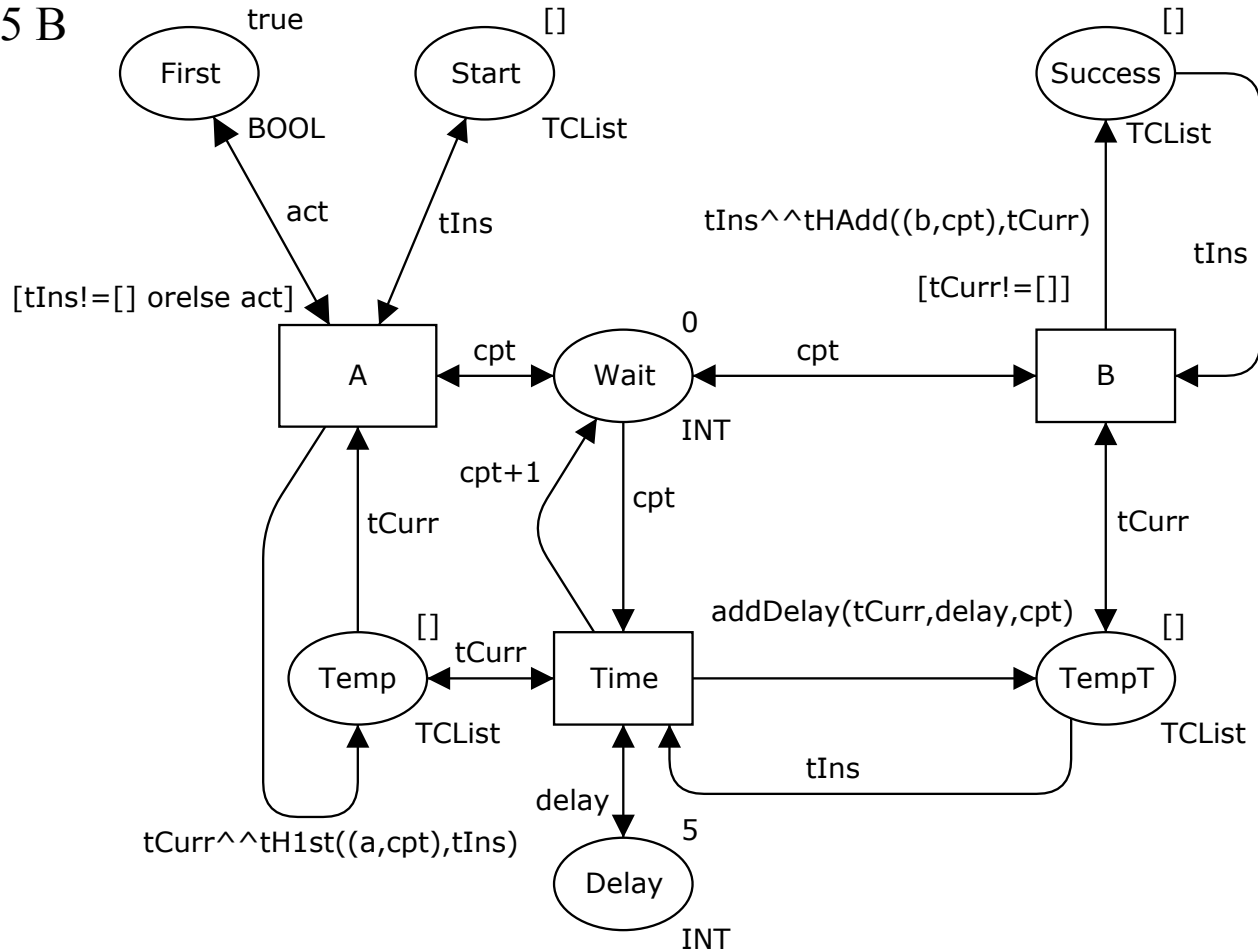
Basic operators (A B) -[C]

Event flow : "a|b|b|c|b"



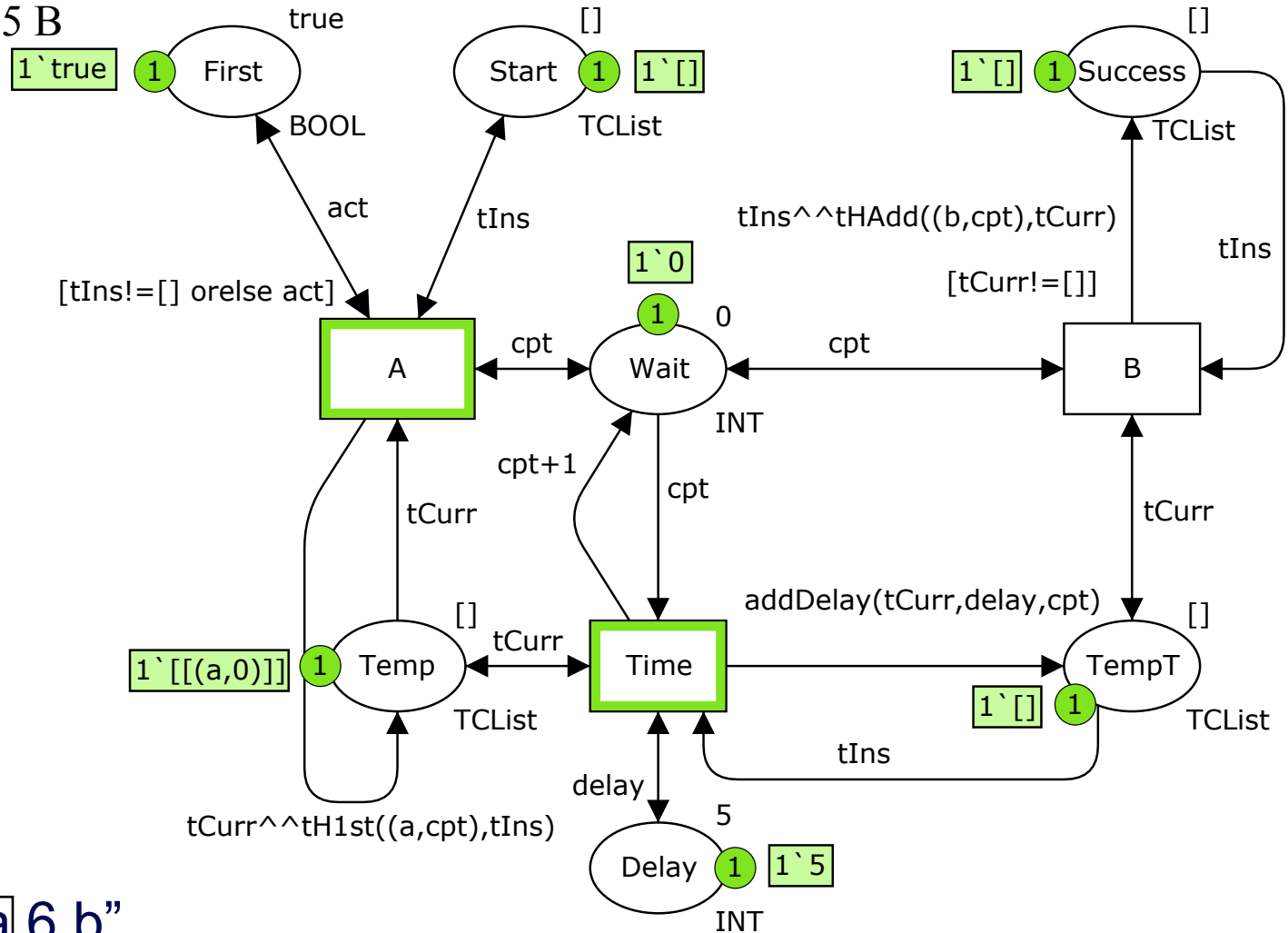
Basic net : time constraint

Minimum delay : A 5 B



Basic net : time constraint

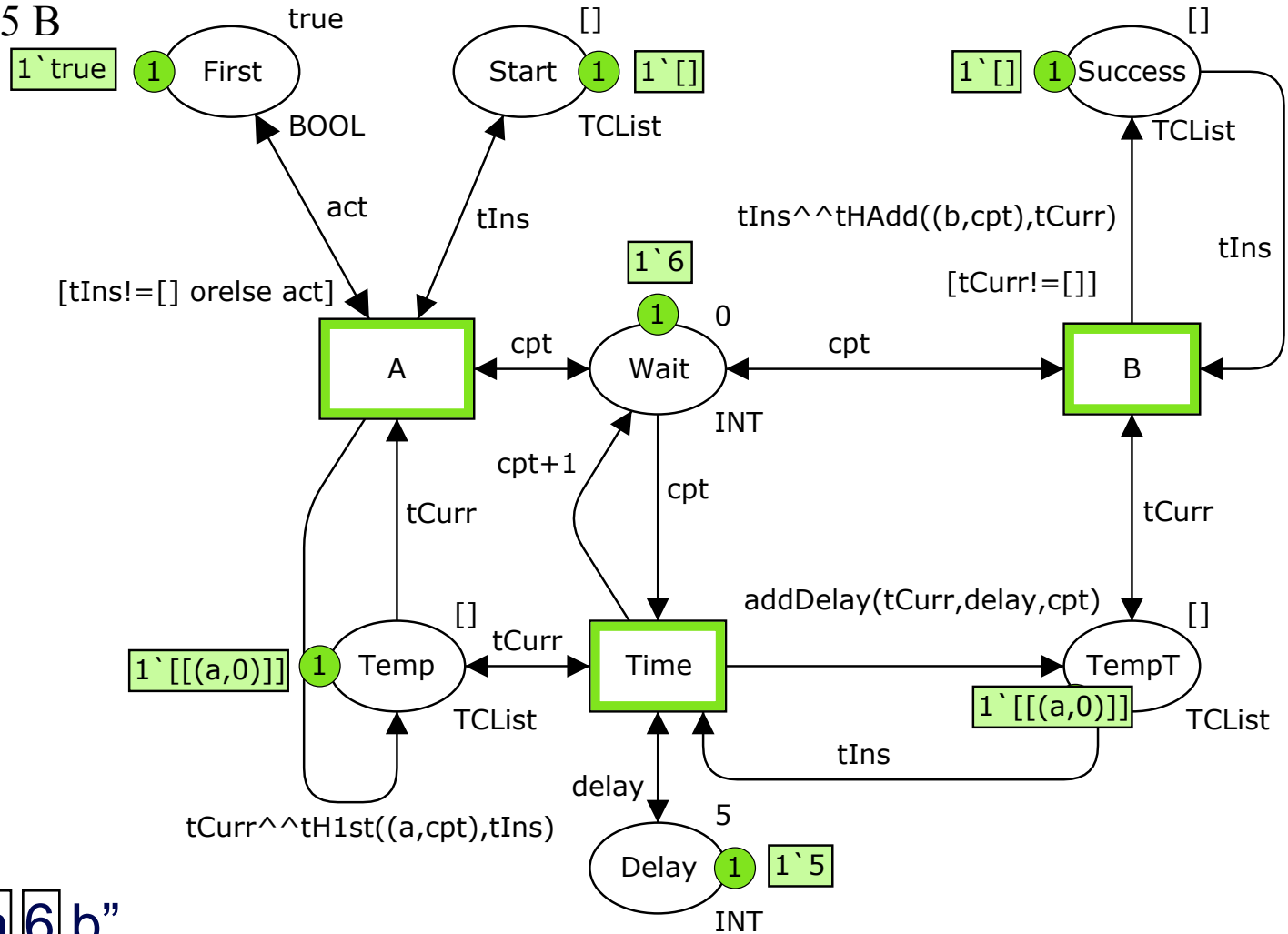
Minimum delay : A 5 B



Event flow : "a 6 b"

Basic net : time constraint

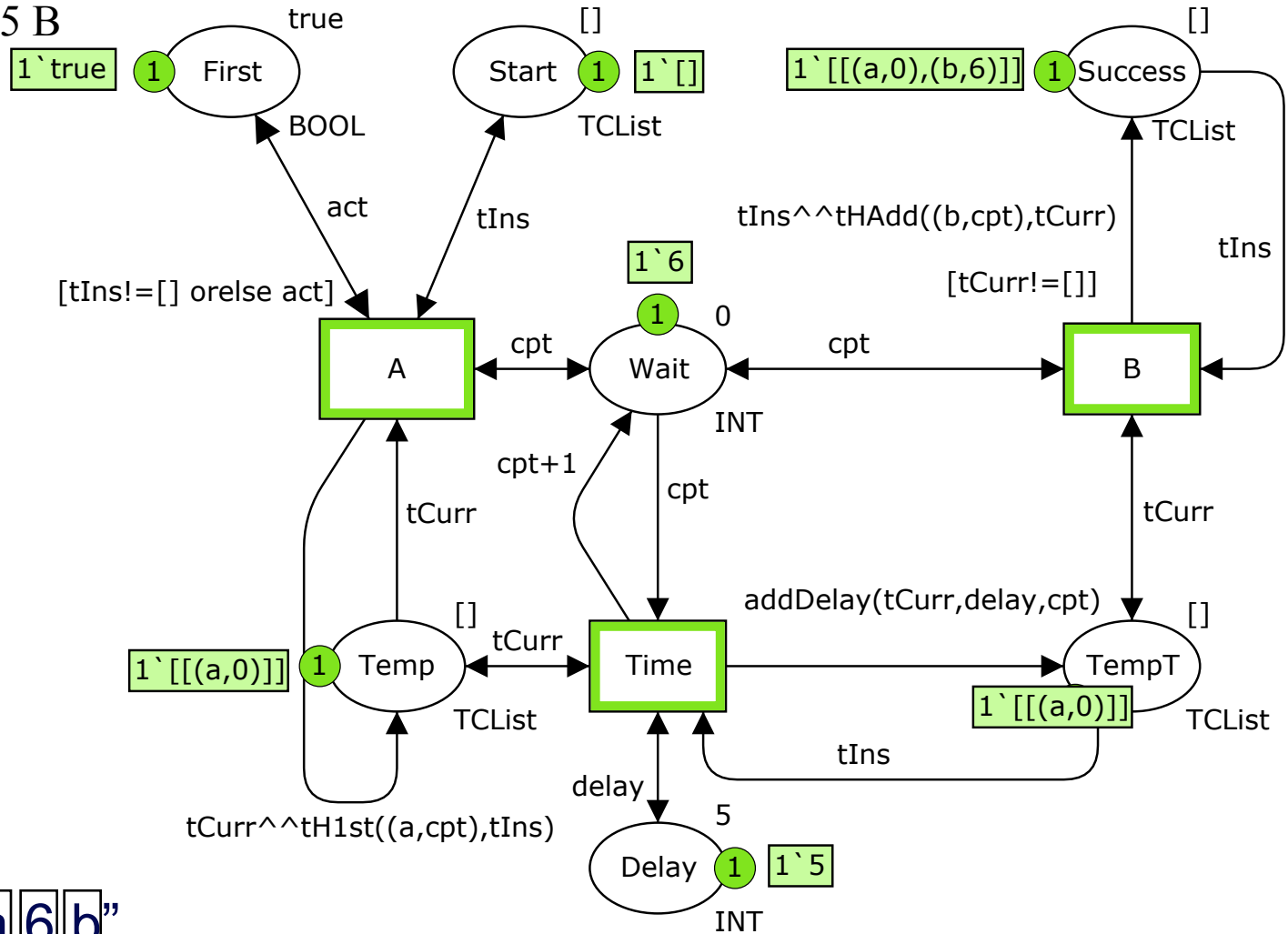
Minimum delay : A 5 B



Event flow : "a 6 b"

Basic net : time constraint

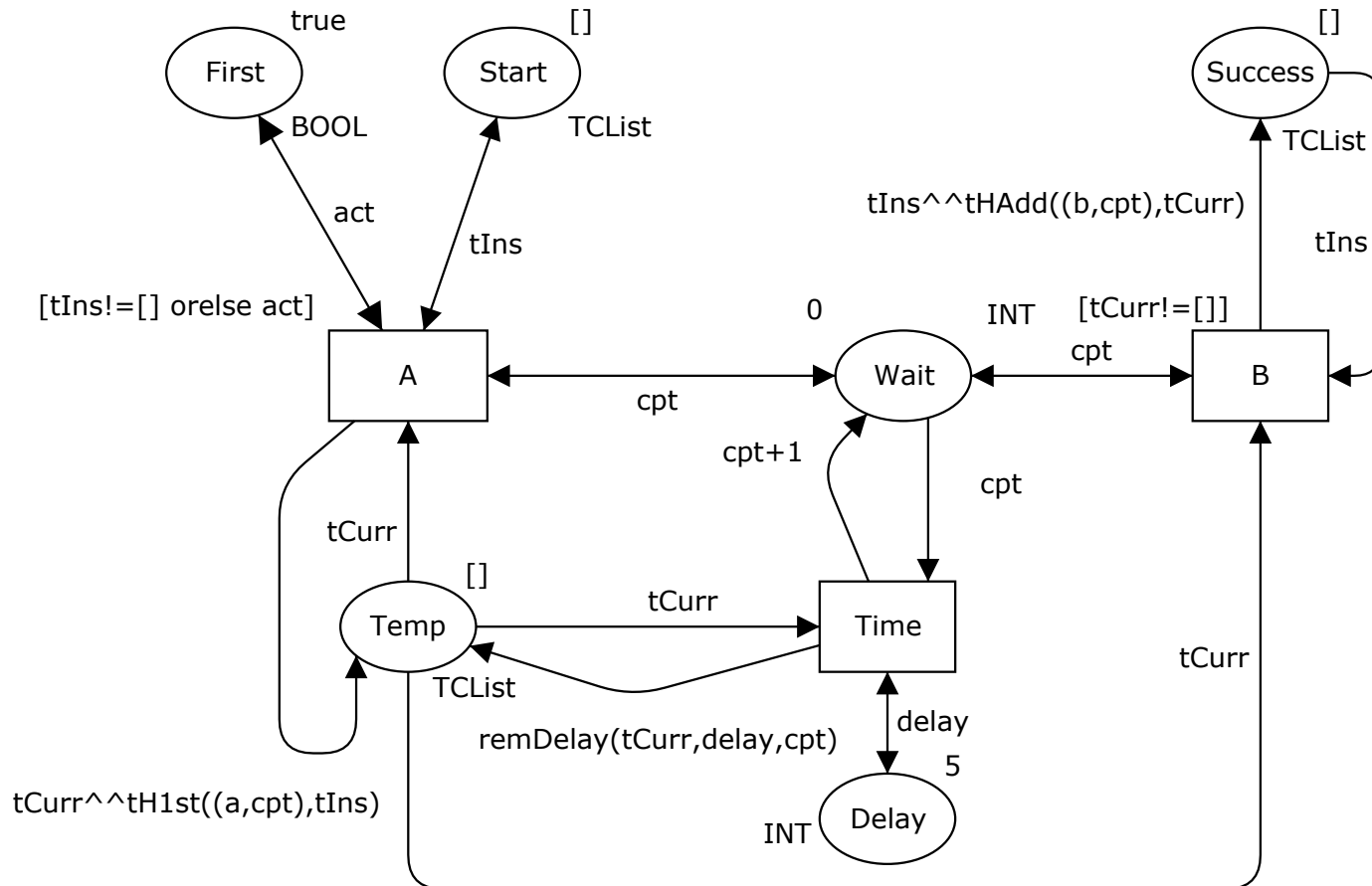
Minimum delay : A 5 B



Event flow : "a 6 b"

Basic net : time constraint

Maximum delay : (A B)-[5]

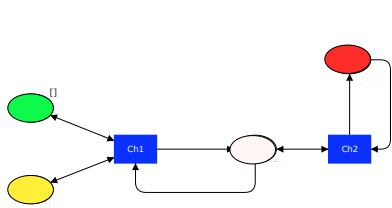


Chronicles composition

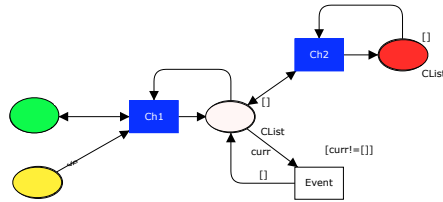
- Goal : modelling the chronicle algebra
- We must model operators composition
- 2 ways :
 - Transition substitution
 - Places fusion

Transition Substitution

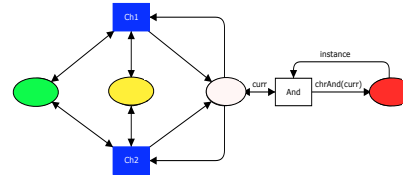
- Operators nets :



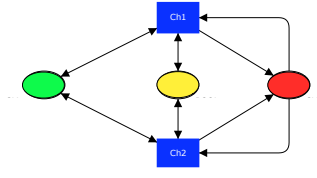
Sequence



Absence

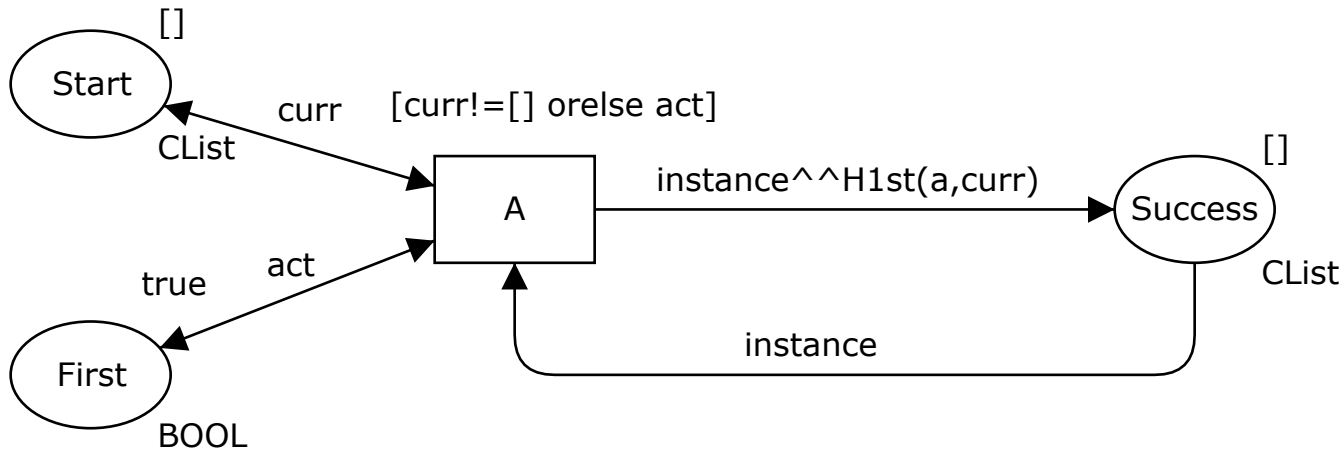


Conjunction

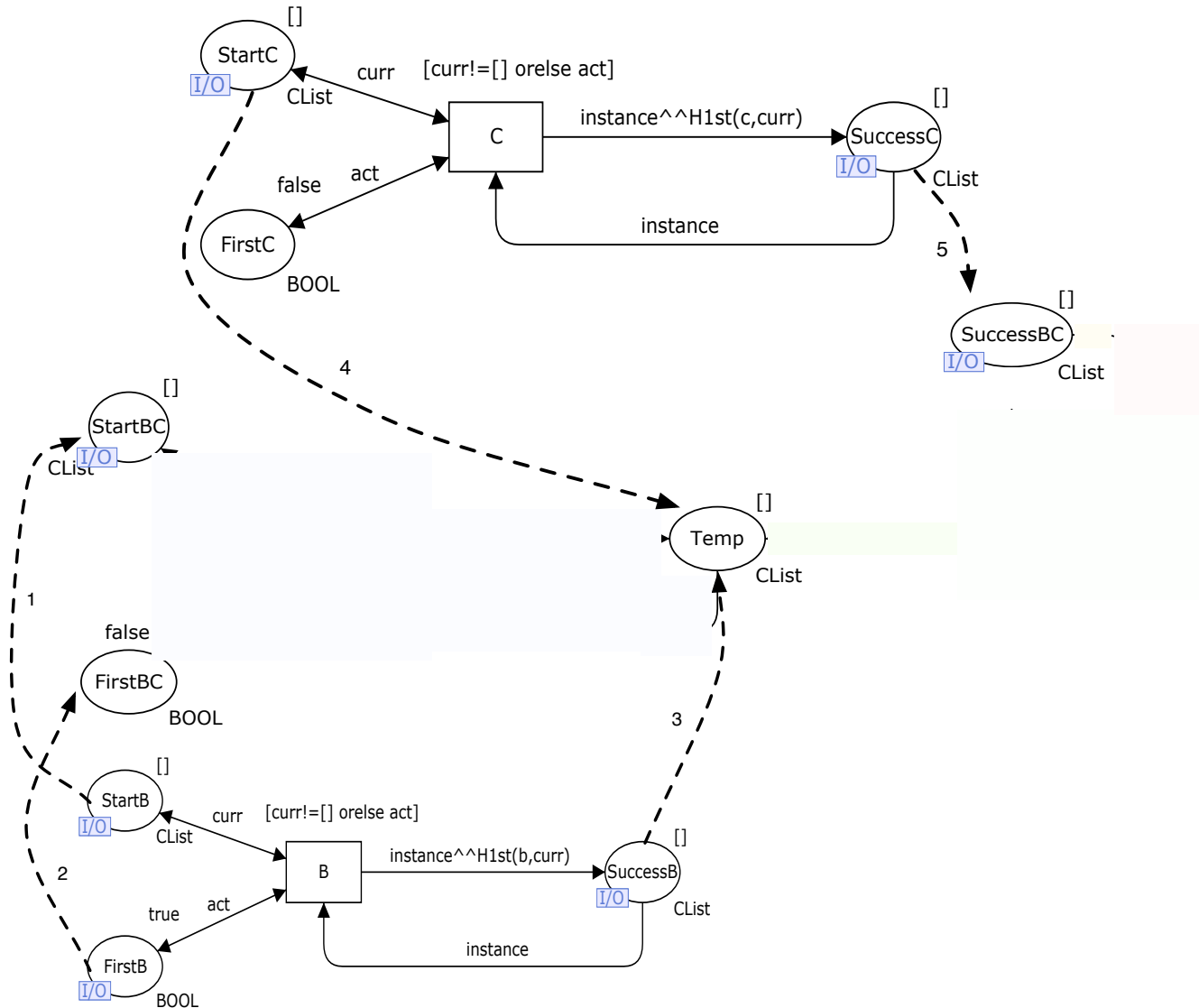


Disjunction

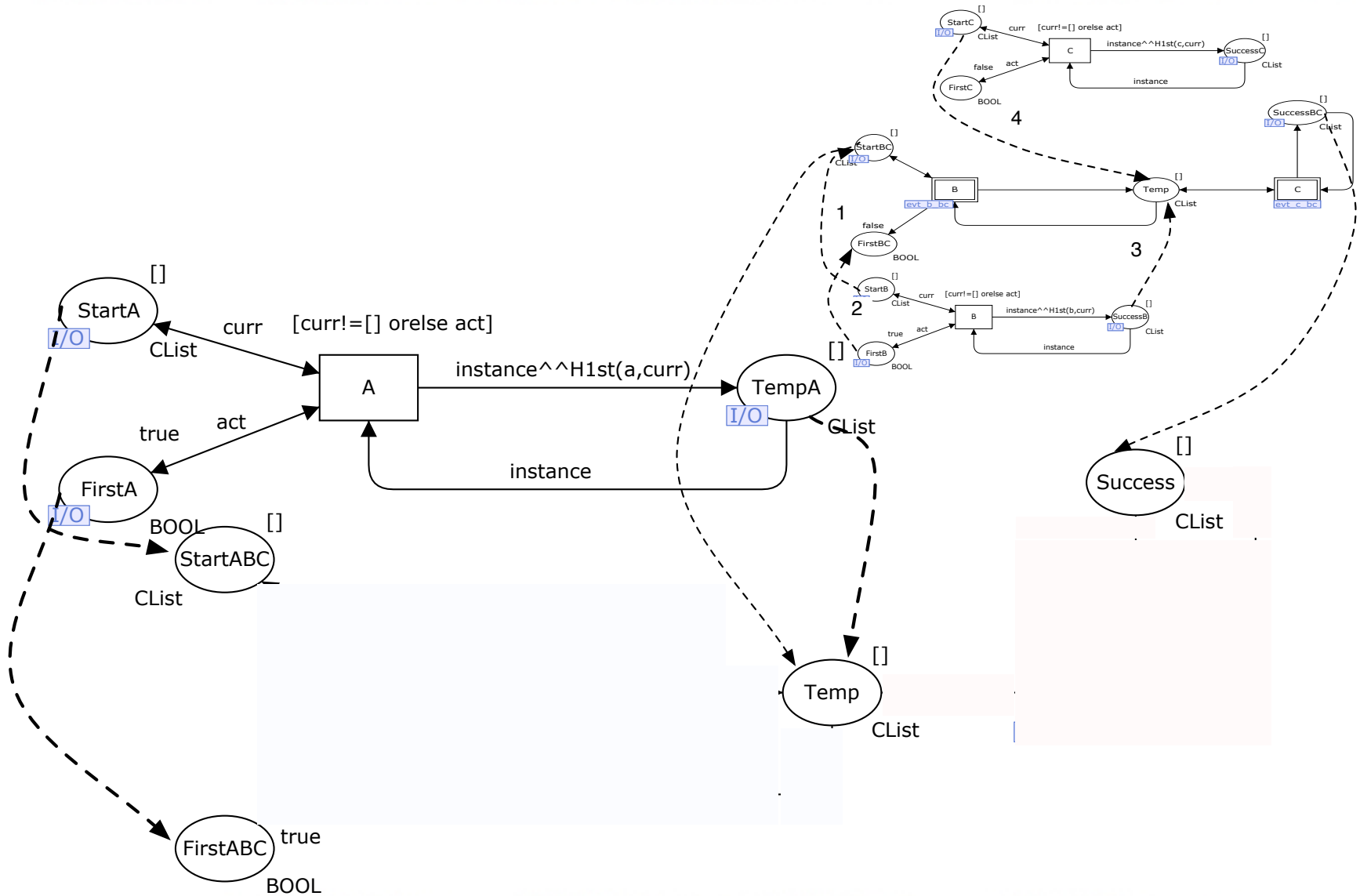
- Event recognition :



Transition substitution : the chronicle A (B C)

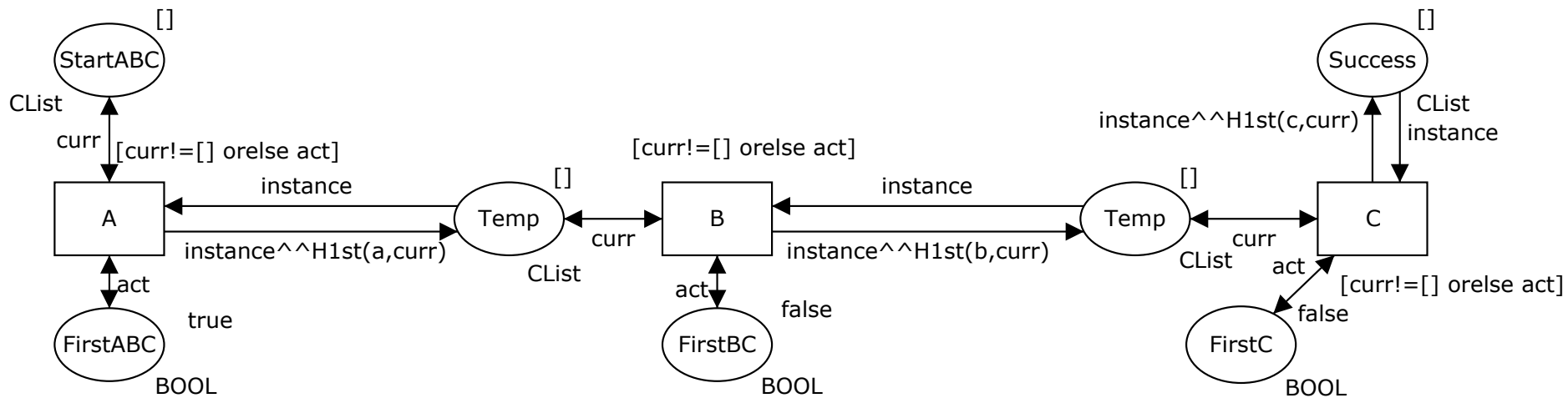


Transition substitution : the chronicle A (B C)



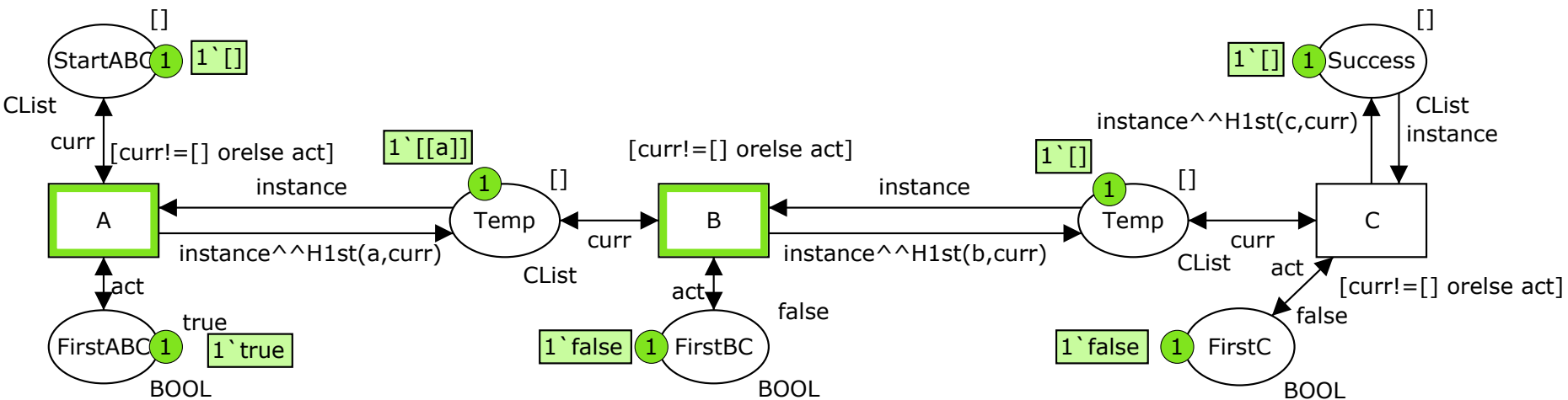
Recognition of A (B C)

Event flow : "a b b c"



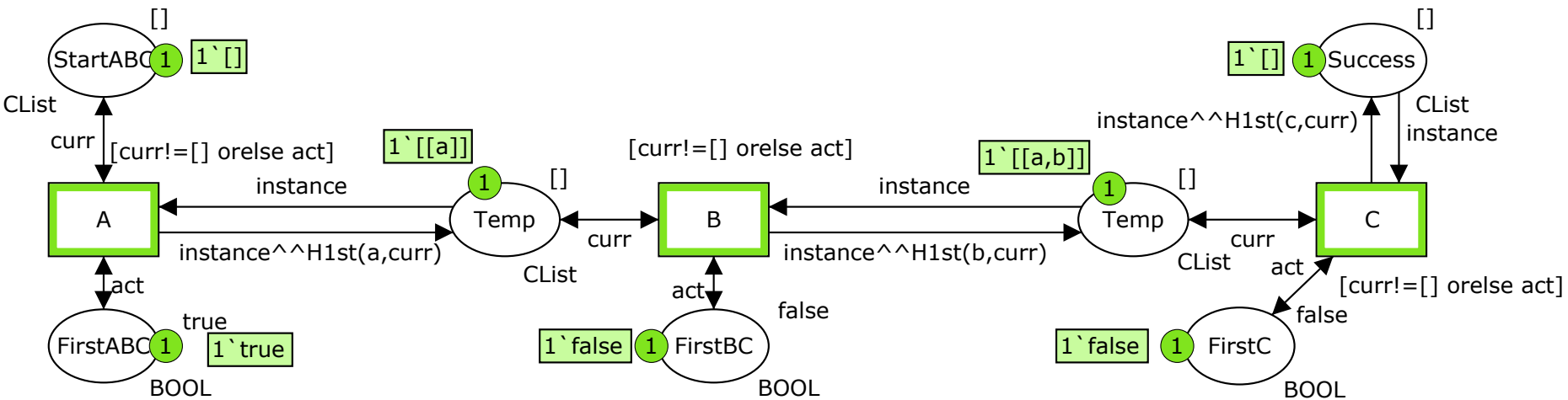
Recognition of A (B C)

Event flow : "a b b c"



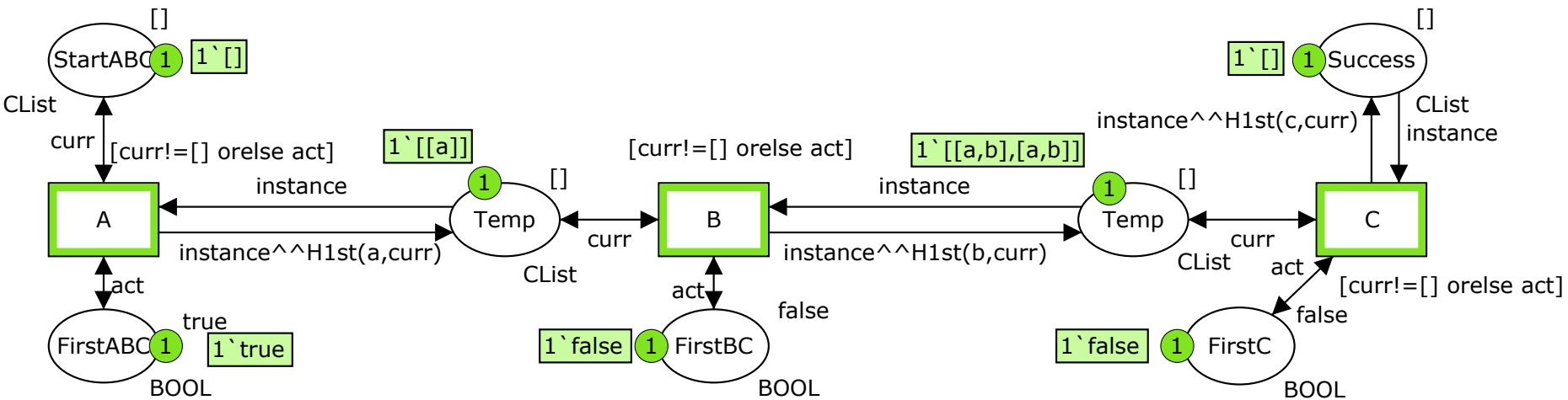
Recognition of A (B C)

Event flow : "a b b c"



Recognition of A (B C)

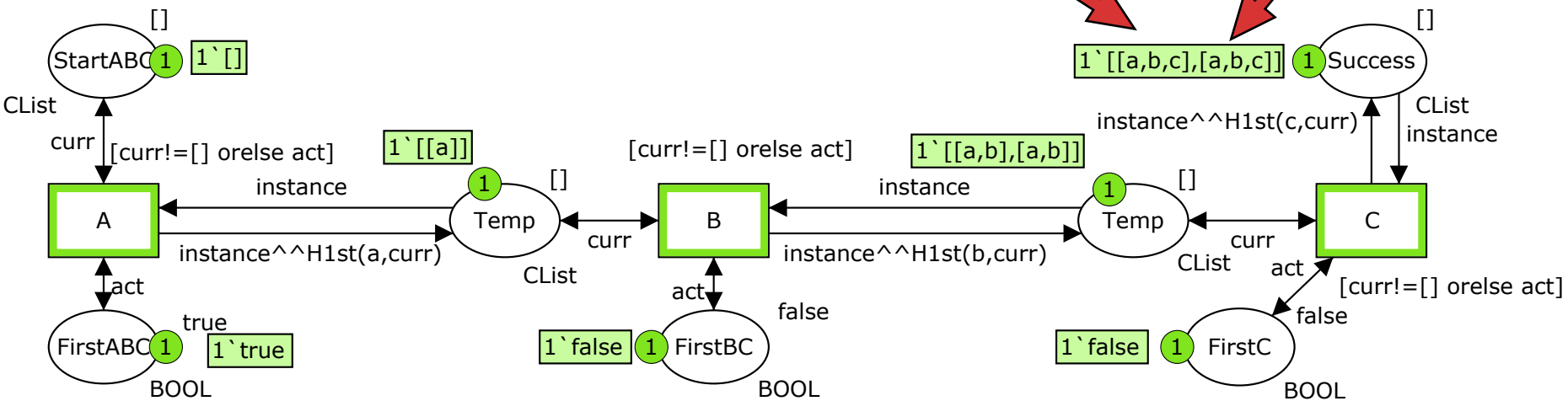
Event flow : "a b b c"



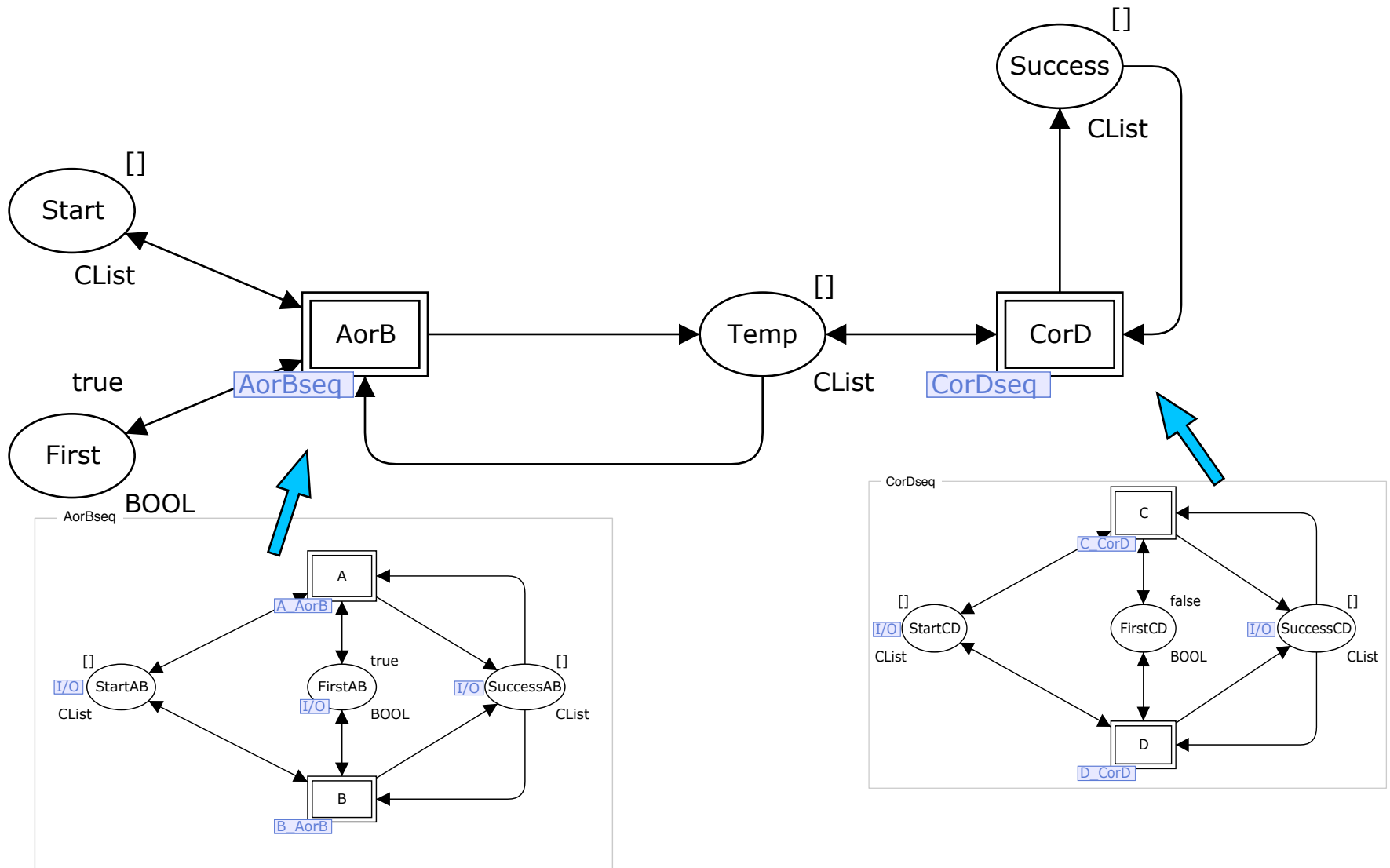
Recognition of A (B C)

Event flow : "a b b c"

2 recognition of A (B C)



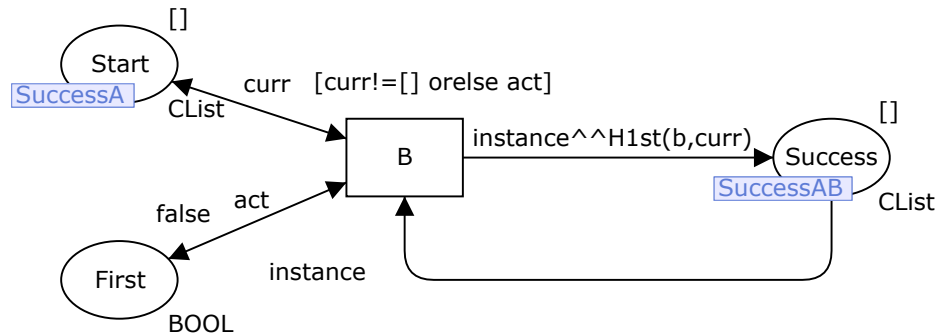
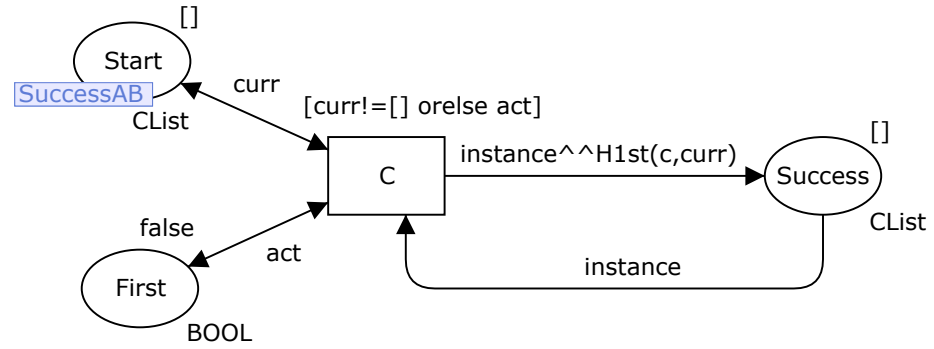
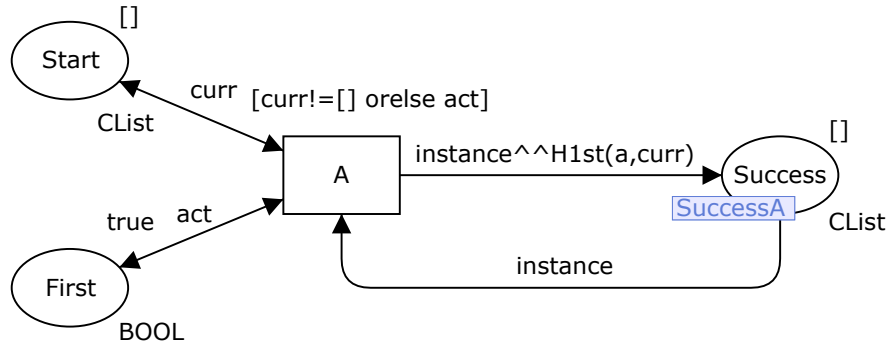
(A || B) (C || D) with transition substitution



Composition with place fusion

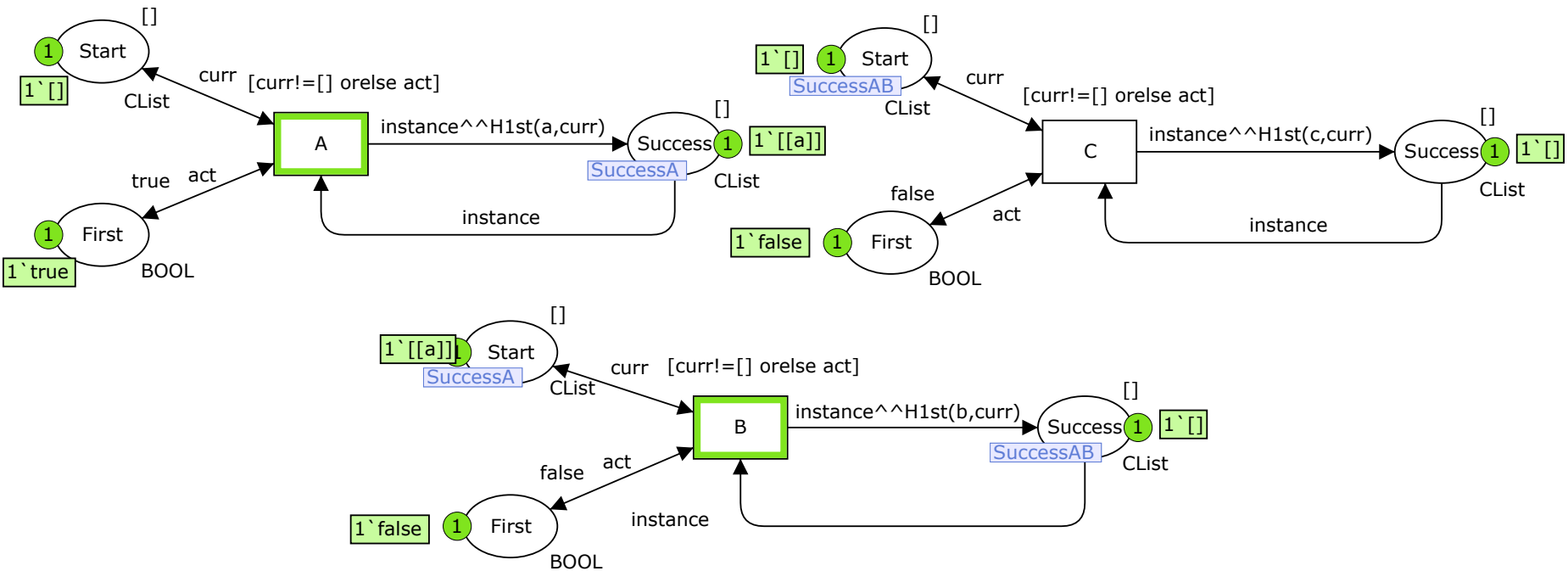
- Introducing another method to compose nets
- Motivations :
 - Easier than transition substitution
 - Visual correspondence with algebra operator composition

Chronicle A (B C) with place fusion



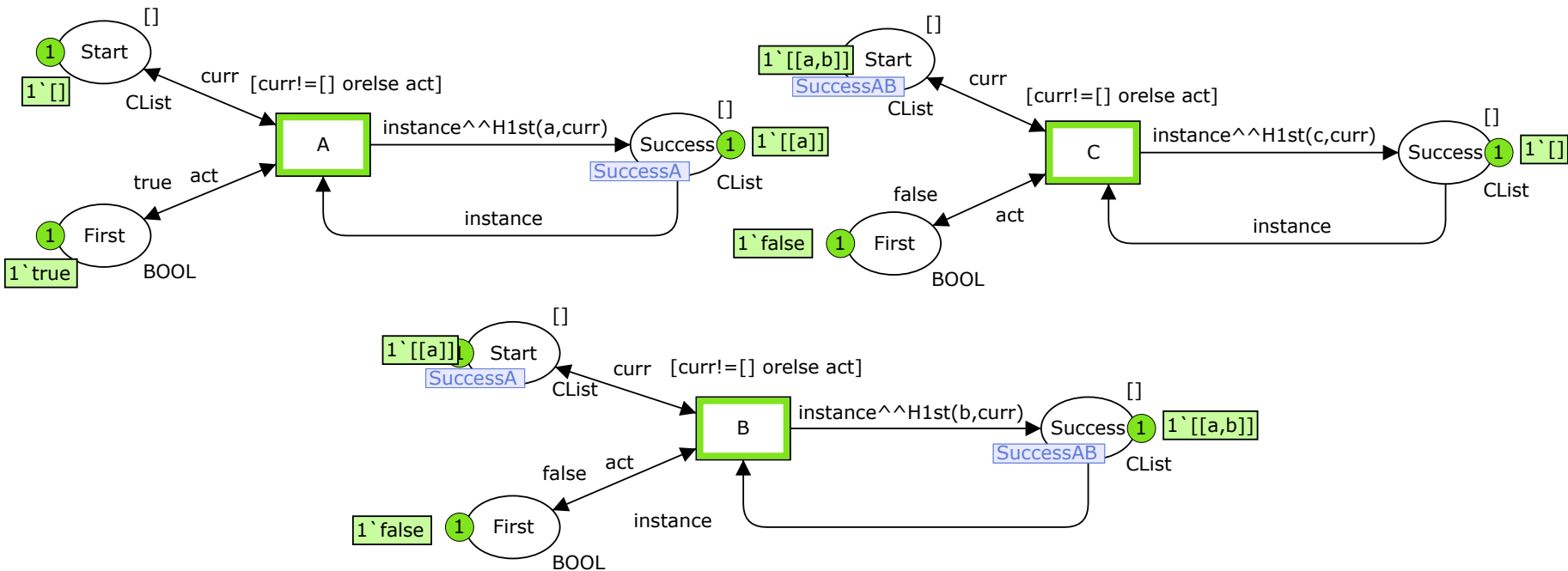
Chronicle A (B C) with place fusion

Event flow : "a b b c"



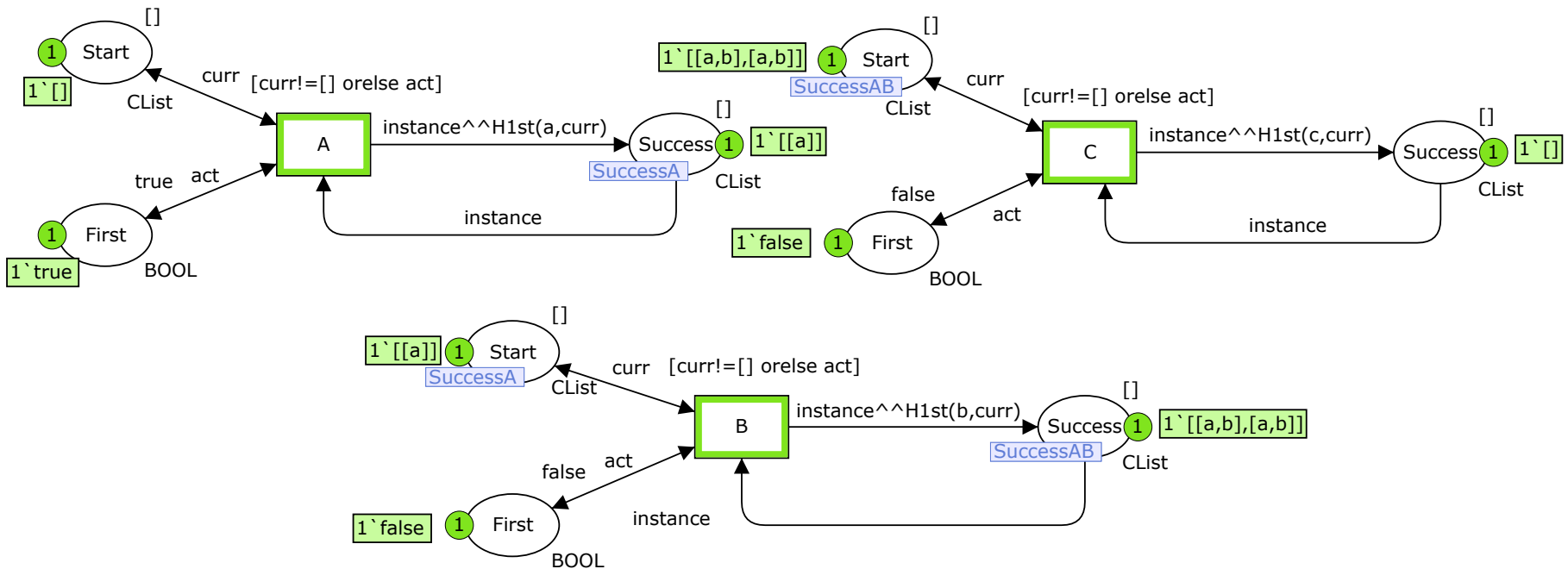
Chronicle A (B C) with place fusion

Event flow : "a|b b c"



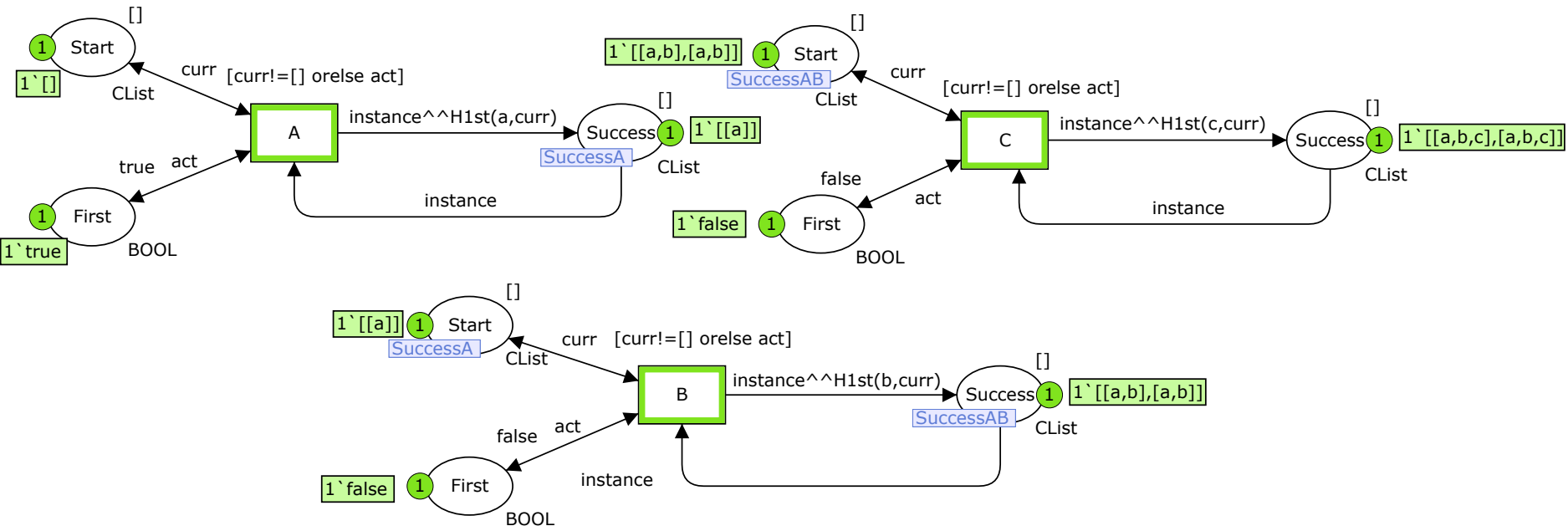
Chronicle A (B C) with place fusion

Event flow : “**a** **b** **b** c”

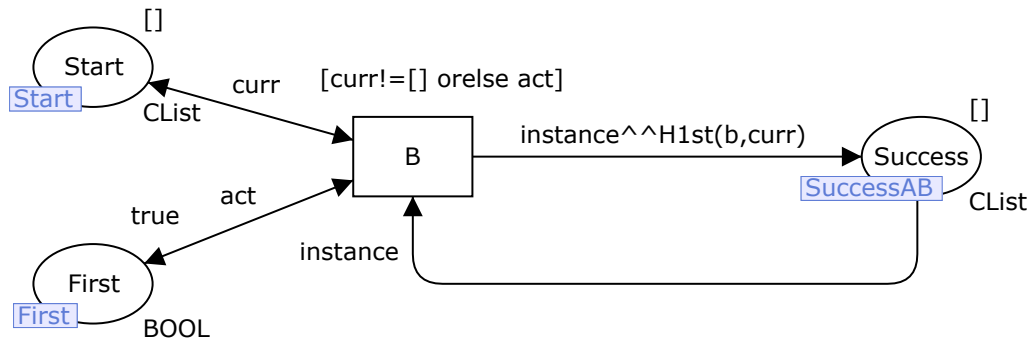
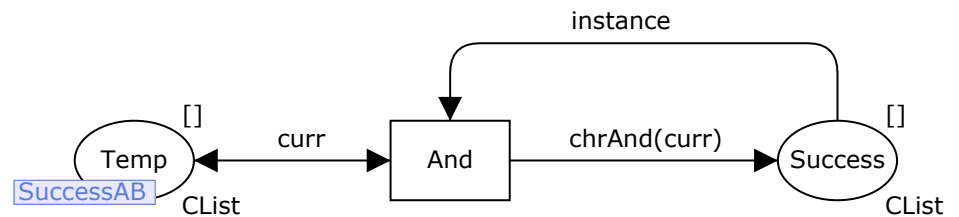
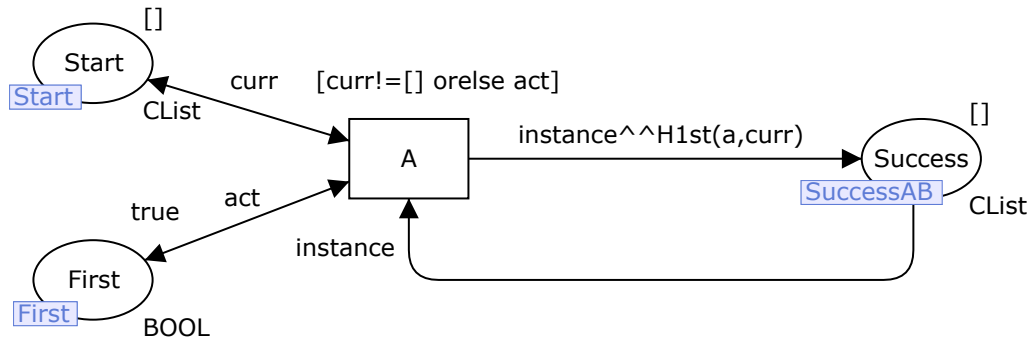


Chronicle A (B C) with place fusion

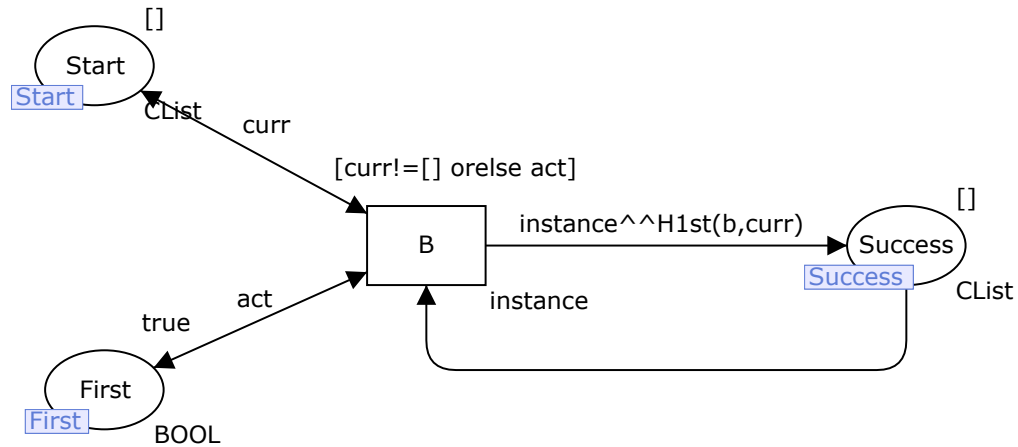
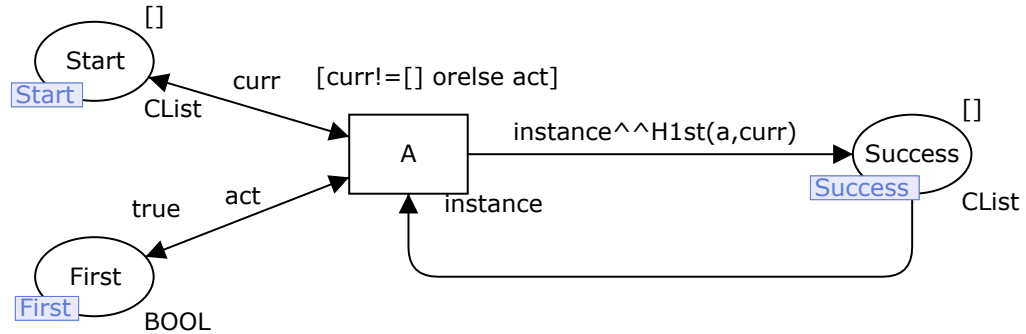
Event flow : "a b b c"



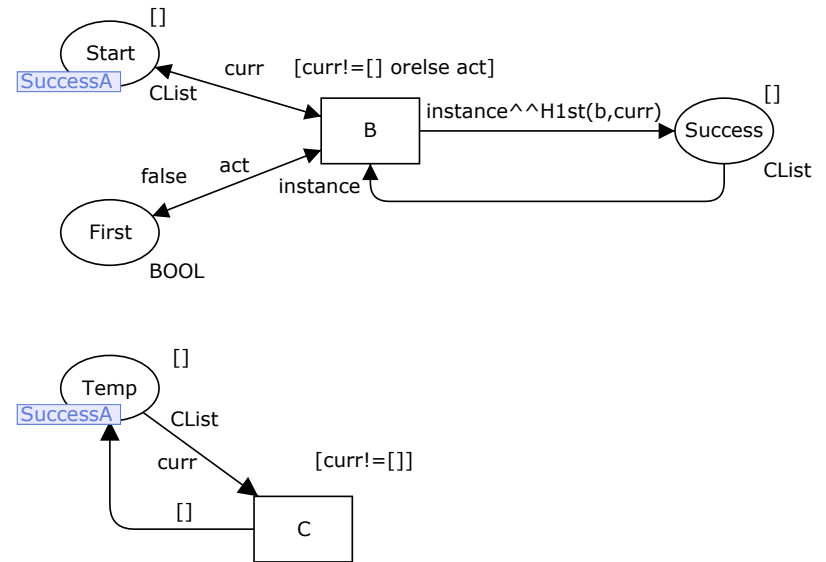
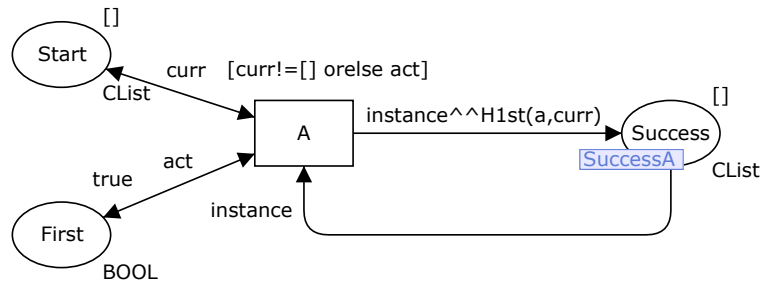
And operator with place fusion



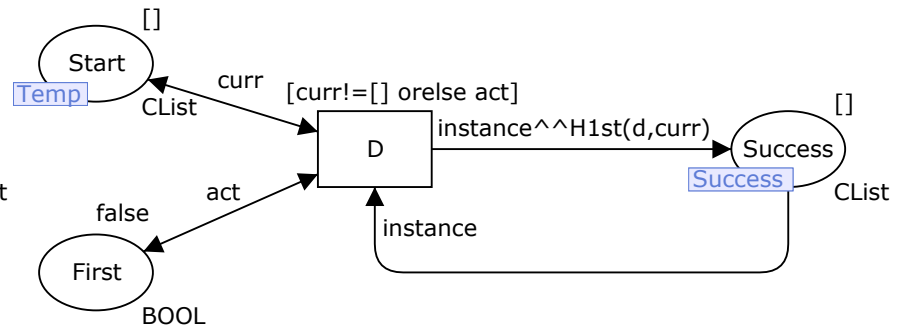
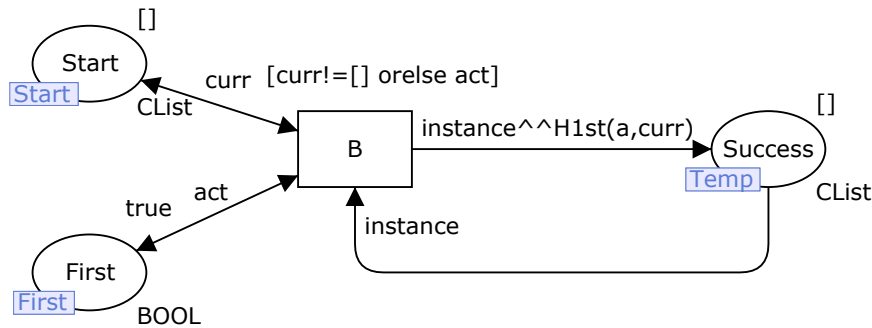
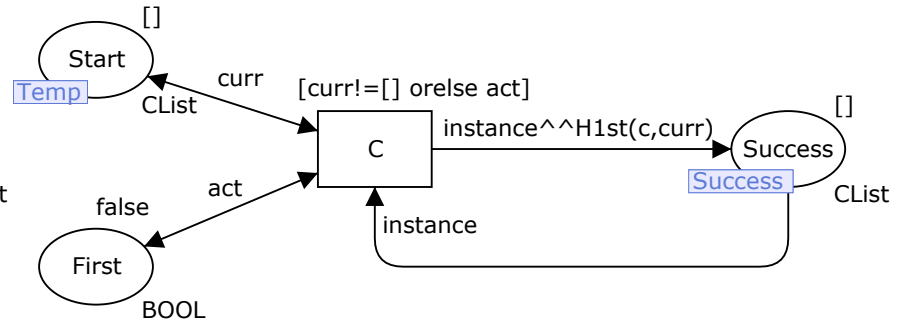
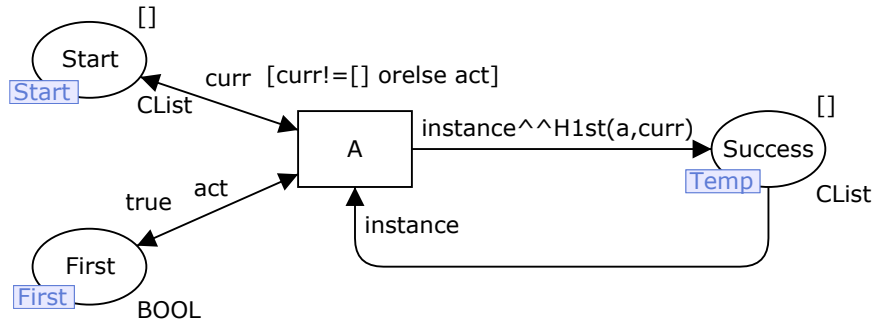
Or operator with place fusion



Absence operator with place fusion



Chronicle (A || B) (C || D)



Comparison

- Both methods produce the same results
 - Example with the A (B C) chronicle
- Both methods have the same expressiveness
- Place fusion nets are easier to read
- And easier to model with CPN tools

Conclusion

- We have nets for
 - Event recognition
 - Each operator
 - Formalise the composition
 - Two ways for the composition
- CRS/Onera works with HLA simulation
- Future works :
 - Integrating time representation in composition
 - Formalise the net subset
 - Extend the models with sub-chronicle and their absence

Application example

The screenshot displays three overlapping windows from a simulation application:

- Blagnac Airport Simulation:** Shows a 3D aerial view of the airport with a yellow aircraft on the runway. The top status bar includes "Start", "Stop", "One Step", "Refresh rate", and "Traffic Simulator Time".
- bertrand@blizzard2: ~/genesis_ADF/ADF_CPP/CompiledFiles/BinGNU:** A terminal window displaying a log of flight events. The log includes messages such as "Flight A6103 is cleared for PUSHBACK", "Flight A768 requesting PUSHBACK", and "Flight D1002 landing".
- VIRTUAL PILOT FEDERATE:** A smaller terminal window showing a list of times from 07:04:07 to 07:04:18.

At the bottom left, the text "Running" is visible, and at the bottom center, there is a "Quit" button.

Chronicle detection