Concurrent Grammar

Concurrent Grammar

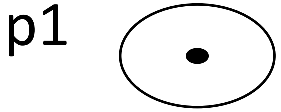
- The Concurrent grammar is a kind of grammar which contains the production rules that can be defined at the same instance without depending on any other production rule.
- The concurrent grammar can be simulated by using Petri Nets.

Petri Nets

- First introduced by Carl Adam Petri in 1962.
- A diagrammatic tool to model concurrency and synchronization in distributed systems.
- Very similar to State Transition Diagrams.
- Used as a visual communication aid to model the system behavior.
- Based on strong mathematical foundation
- More popularly used for distributed systems and systems with resource sharing.

A Petri Net Specification

- consists of three types of components: *places* (circles), *transitions* (rectangles) and *arcs* (arrows):



  - Places represent possible states of the system;

  - Transitions are events or actions which cause the change of state;

  - Every arc simply connects a place with a transition or a transition with a place

A Change of State

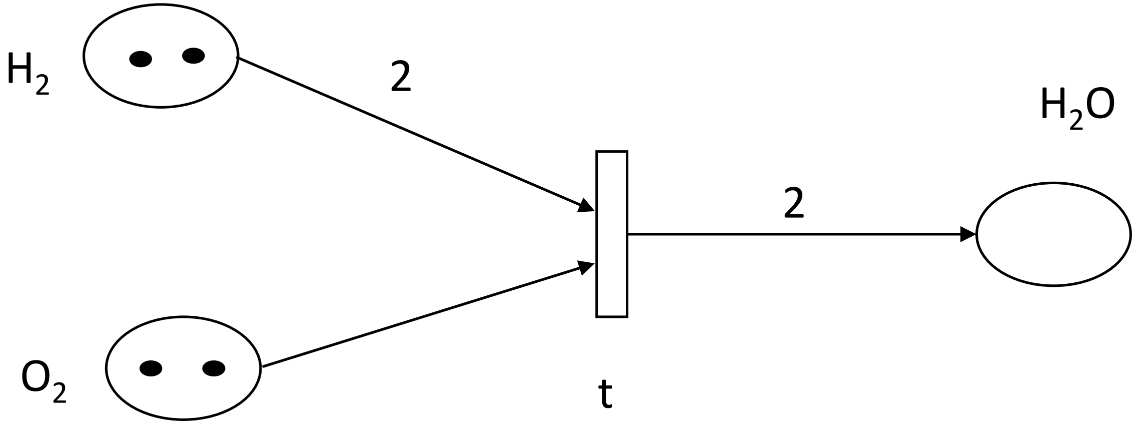
- is denoted by a movement of *token(s)* (black dots) from place(s) to place(s); and is caused by the *firing* of a transition.
- The firing represents an occurrence of the event or an action taken.
- The firing is subject to the input conditions, denoted by token availability.

Defination

- A Petri net is formally defined as a 5-tuple $N = (P, T, I, O, M_0)$, where
- (1) $P = \{p_1, p_2, \ldots, p_m\}$ is a finite set of places;
- (2) $T = \{t_1, t_2, \ldots, t_n\}$ is a finite set of transitions, $P \cup T \neq \emptyset$, and $P \cap T = \emptyset$;
- (3) I: $P \times T \rightarrow N$ is an *input function* that defines directed arcs from places to transitions, where N is a set of nonnegative integers;
- (4) O: $T \times P \rightarrow N$ is an *output function* that defines directed arcs from transitions to places; and
- (5) M_0: $P \rightarrow N$ is the *initial marking*.

Example

- Petri net to represent chemical reaction $2H_2+O_2$ ->$2H_2O$

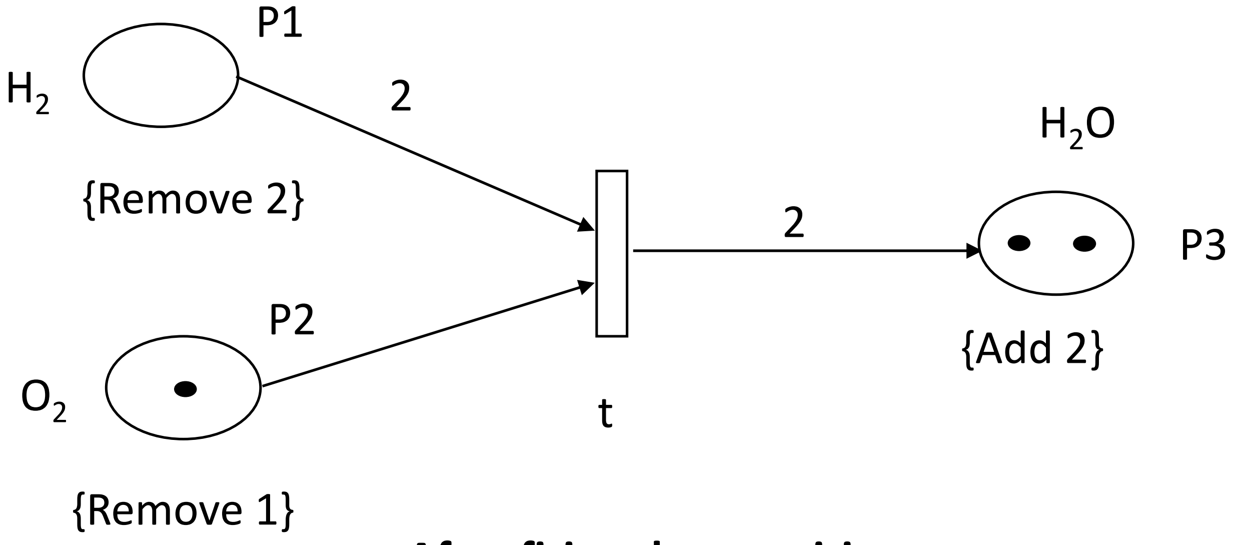


Initial State diagram

Marking M=(2,2,0)

Example

- Petri net to represent chemical reaction $2H_2+O_2$ ->$2H_2O$

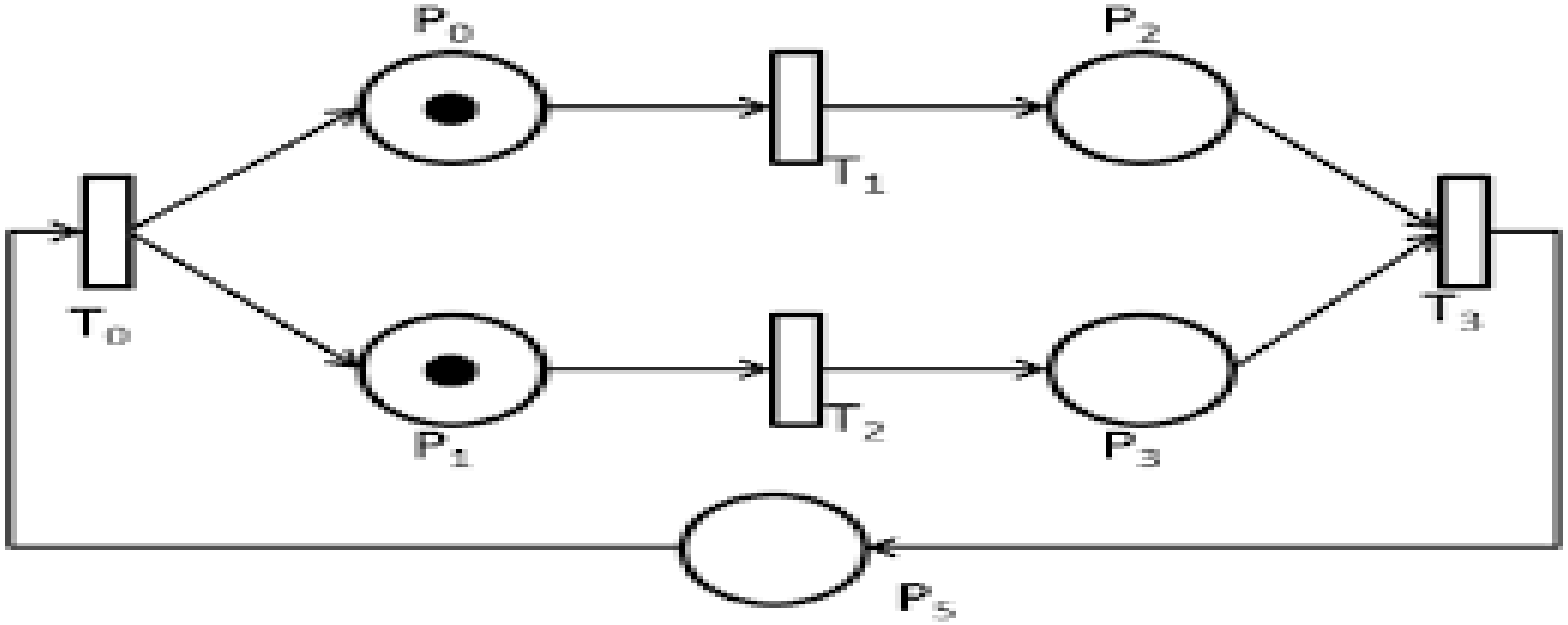


After firing the transition t

Marking M=(0,1,2)

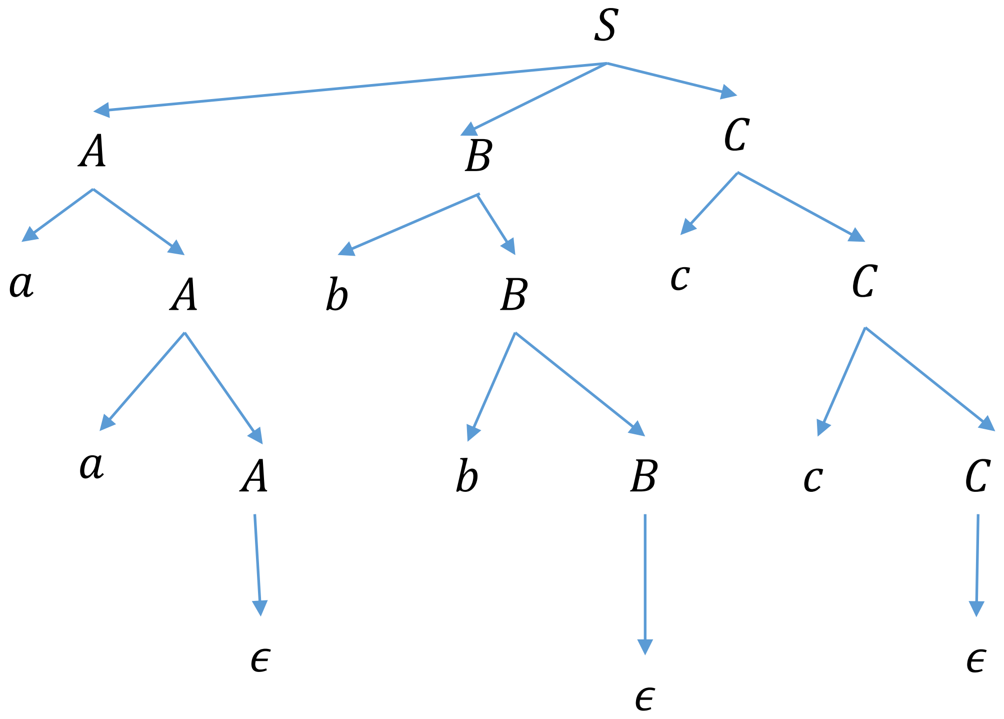
Concurrency using petri nets

- Parallelism or concurrency can be easily represented by Petrinets

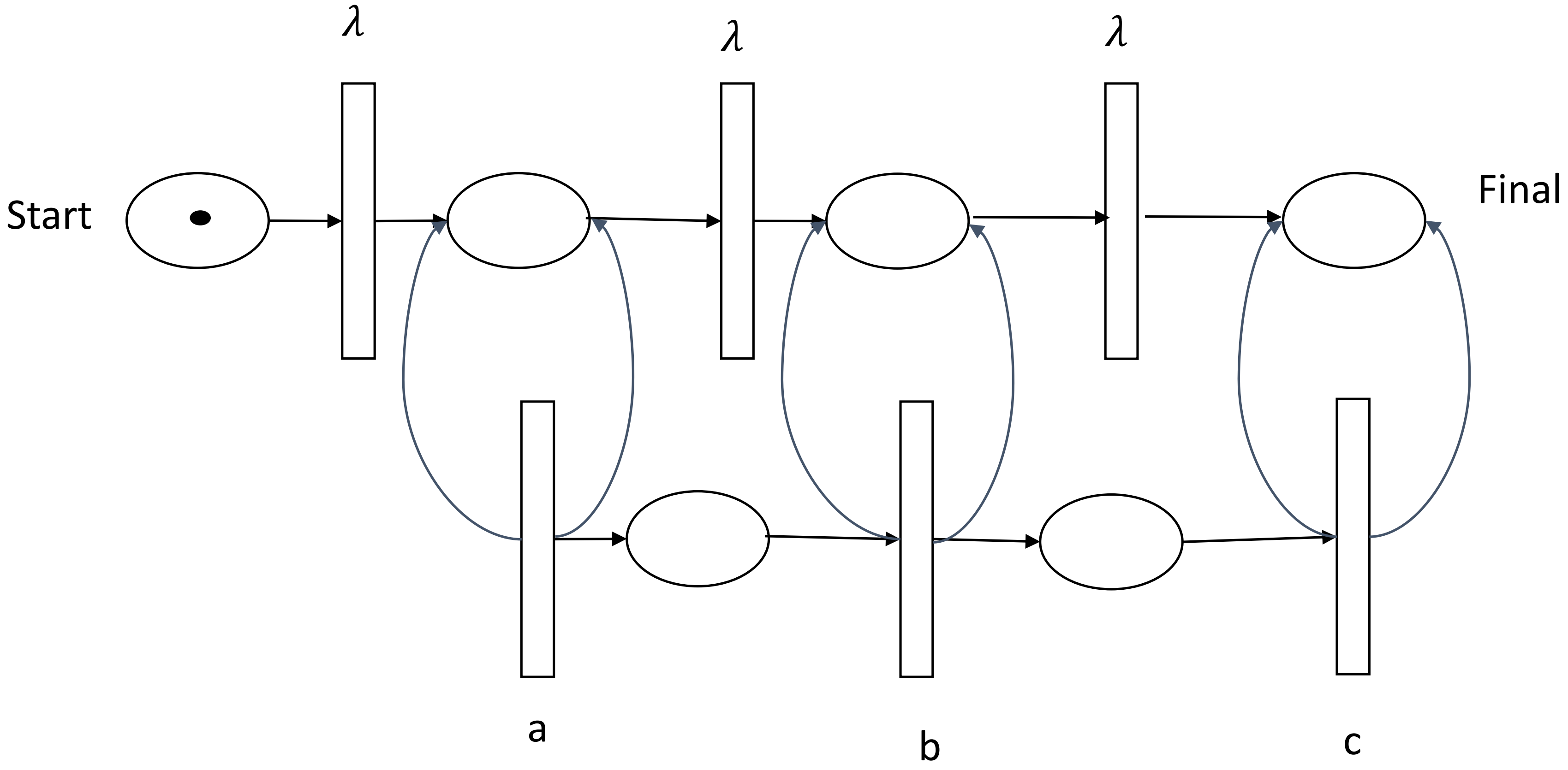


Example of Concurrent Grammar using Petri nets for $a^nb^nc^n$

- S ->ABC|ϵ
- A->aA|ϵ
- B->bB|ϵ
- C->cC|ϵ
- In this case all the alternats for S are processed concurrently
- i.e. S generates ABC and ϵ
- Nonterminal ABC also expanded simultaneously as follows
- String generated by below parse tree is aabbcc


S
A
B
C
a
A
b
B
c
C
a
A
b
B
c
C
ϵ
ϵ
ϵ

Example of Concurrent Grammar using Petri nets for $a^n b^n c^n$



Example

- Consider the language ww i.e. first half of string is equal to second half ex: abaaabaa where w ϵ {a,b}+
- Solve using pteri net