

Previously

- Sliding Window Protocols
- Protocol using Go-Back-N
- Protocol using Selective Repeat

Protocol Verification

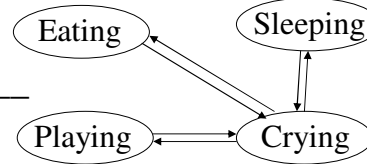
Finite State
Petri Net

- Formal mathematical techniques
- Finite State Machine Models
- Petri Net Models

Finite State Machines (1)

Finite State
Petri Net

- Protocol Machines: _____
- State
 - Includes all _____
 - 2^n possible states
 - This is very large so states are _____
 - Generally chosen from _____
 - as all other states can be regarded as _____
- Transitions: From each state there are _____
 - These are caused by _____
- One state must be designated as _____



Finite State Machines (2)

Finite State
Petri Net

- Given a full description of a FSM it should be possible to draw a graph
 - Nodes _____
 - Directed arcs _____
- Reachability Analysis allows to _____ such as
 - Incompleteness: _____
 - Deadlock: _____
 - ...

Example.

■ Protocol for a Noisy Channel

■ States

- 3 variables

- S _____
- R _____
- C _____

■ Initial State 000

■ Normal transmission

- 000 → 01A → 111 → 10A _____

■ Lost data frame

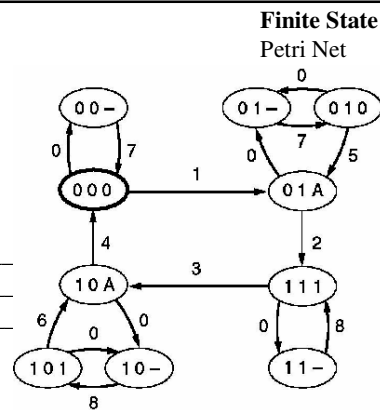
- 000 → 00- → 000 _____

- 111 → 11- → 111 _____

■ Lost acknowledgement

- 01A → 01- → 010 → 01A _____

- 10A → 10- → 101 → 10A _____



Checking for problems

■ Alternating frames

- Never 11 _____
- Or 33 _____
- Check FSM...

| Transition | Who runs? | Frame accepted | Frame emitted | To network layer |
|------------|-----------|----------------|---------------|------------------|
| 0 | – | (frame lost) | | – |
| 1 | R | 0 | A | Yes |
| 2 | S | A | 1 | – |
| 3 | R | 1 | A | Yes |
| 4 | S | A | 0 | – |
| 5 | R | 0 | A | No |
| 6 | R | 1 | A | No |
| 7 | S | (timeout) | 0 | – |
| 8 | S | (timeout) | 1 | – |

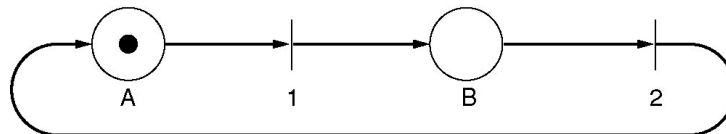
■ Deadlock

- No way out _____
- No forward progress _____
- Check FSM...

Petri Net Models

Finite State
Petri Net

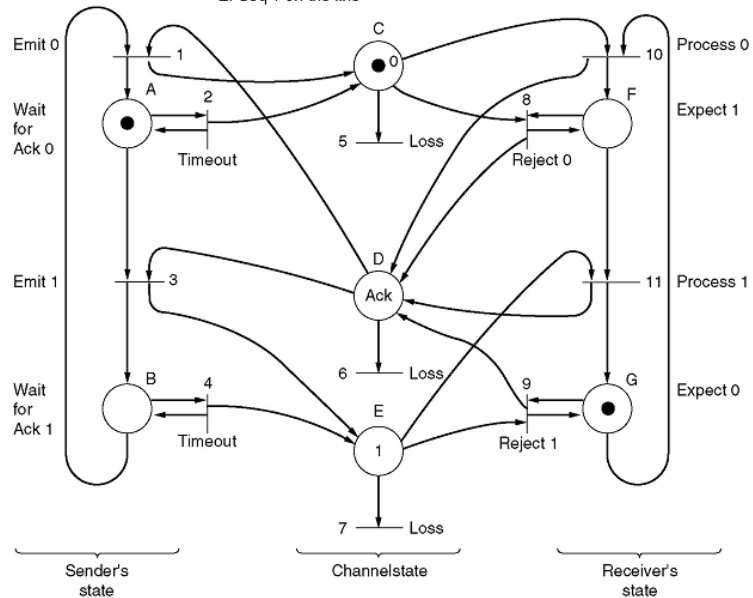
- Places: _____
- Tokens: _____
- Transitions: _____
 - Input Arcs: _____
 - Output Arcs: _____
 - Enabled: _____
 - Fire: _____
 - Effect: _____
 - When? _____



Example

Finite State
Petri Net

C: Seq 0 on the line
D: Ack on the line
E: Seq 1 on the line



Example illustrated

■ Starting

- A _____
- C _____
- G _____

■ Transitions

- 2 _____
- 5 _____
- 10 _____
- 2 _____
- 3 _____
- 8 _____
- 11 _____

■ What went wrong? _____

■ How can it be fixed? _____