VHDL Simulation algorithm
Demo of
Create / Apply Transactions Loop

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(for EE-214 – 2018-19 , IIT Bombay)

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As promised during yesterday's lecture

- Got this illustrations ready. Wish I'd time to got them ready before yesterday's lecture.
- The main takeaway yesterday was the notion of **process**, **drivers, events** , **transactions** and creation/application of these transactions are central to VHDL simulation algorithm
- With this illustration, you will get to see little more vividly the "under-the-hood" book-keeping activities of a vhdl-simulator
  - Disclaimer : Ever-possible errors / discrepancies in the following should only provide you opportunity to figure out things on your own … ultimate mode of learning …. You would get a feeling of ownership of ideas that way

The example code fragment from lab-lecture (5/3/2019)

```
architecture  pqr of xyz is
   signal  a,b,c : std_logic := '0' ;
   …….
begin
    aproc : process ( a )  begin a <= not a   after 5 ns ; end process ;
    bproc : process ( a )  begin b <= not a   after 1 ns ; end process ;
    cproc : process begin c <= a or b  after 1 ns ;  wait on a , b ; end process ;
    ……
    ……
end pqr  ;
```

Simulation Loop

- Create transactions
  - **Evaluate** drivers of all (internal) statements of “resumed” processes until their “suspension” due to explicit or implicit “wait”
    - during evaluation of “driver”, use “present” values of signals and variables (note : variables get updated instantaneously)
  - For each target signal, **create transaction** (i.e. < futureTime, futureValue > pairs using the values of the evaluated drivers and the explicit/implicit delays specified)
    - In our simple demo, we are not illustrating the complicated aspects of contentions between transactions etc.
- Apply transactions
  - Advance Simulation time (by delta or “tangible” time of next transaction)
  - Find which transactions would become event (i.e. cause change in value of signal) …. Update such signals and “resume” processes that are suspended “waiting on” events on such signals
    - more complicated scenarios not illustrated here

Delta-Cycle : when simulation time is “advanced” by DELTA

Simulation-Cycle : when simulation time is “advanced” to a “tangible” future time

a

b

c

Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 0

Transaction Queues

a : 0

b : 0

c : 0

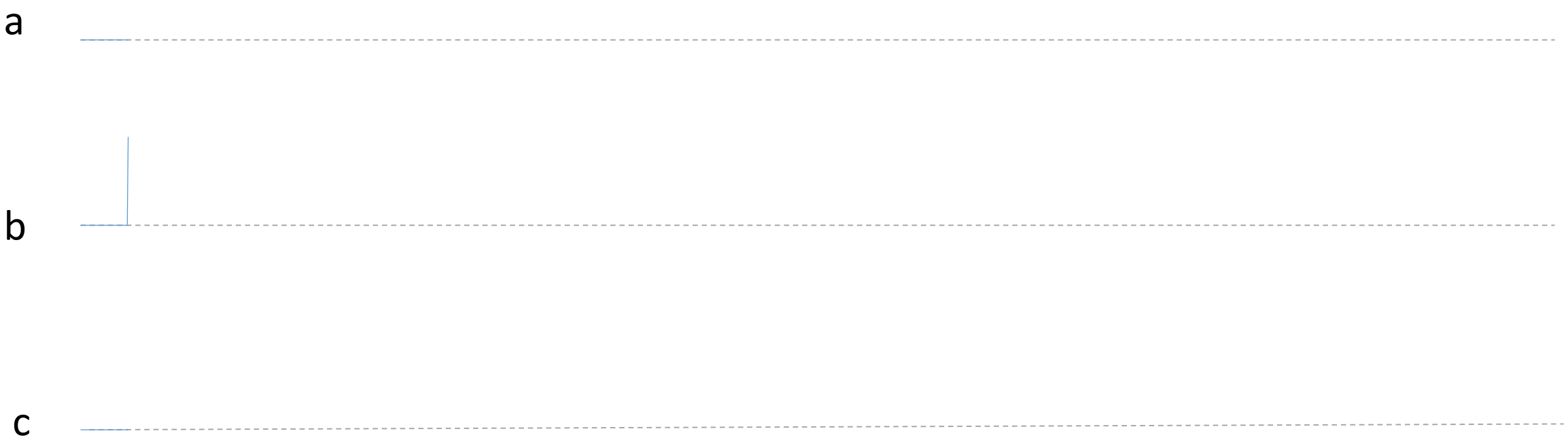
Transaction Queues after “create transactions”

a : 0 < 0+5, ‘1’>

b : 0 < 0+1, not ‘0’>

c : 0 < 0+1, ‘0’ or ‘0’>

Next transaction at T=1



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 1

Transaction Queues

a : 0 <5,’1’>

b : 1

c : 0

Transaction Queues after “create transactions”

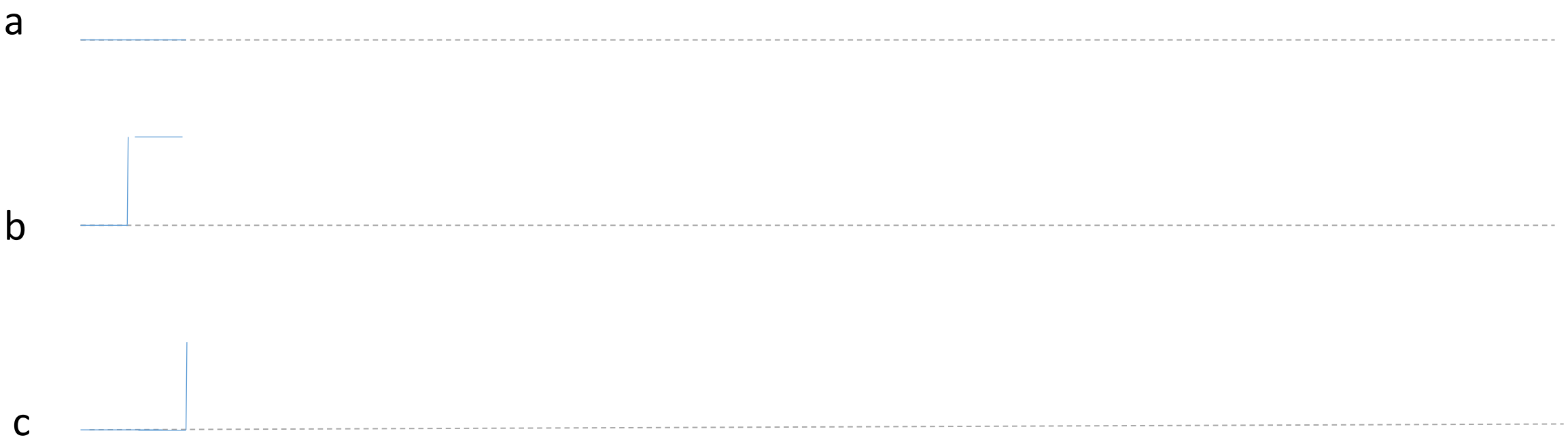
a : 0 <5,’1’>

b : 1

c : 0 <1+1, ‘0’ or ‘1’>

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 2

Transaction Queues

a : 0 <5,’1’>

b : 1

c : 1

Transaction Queues after “create transactions”

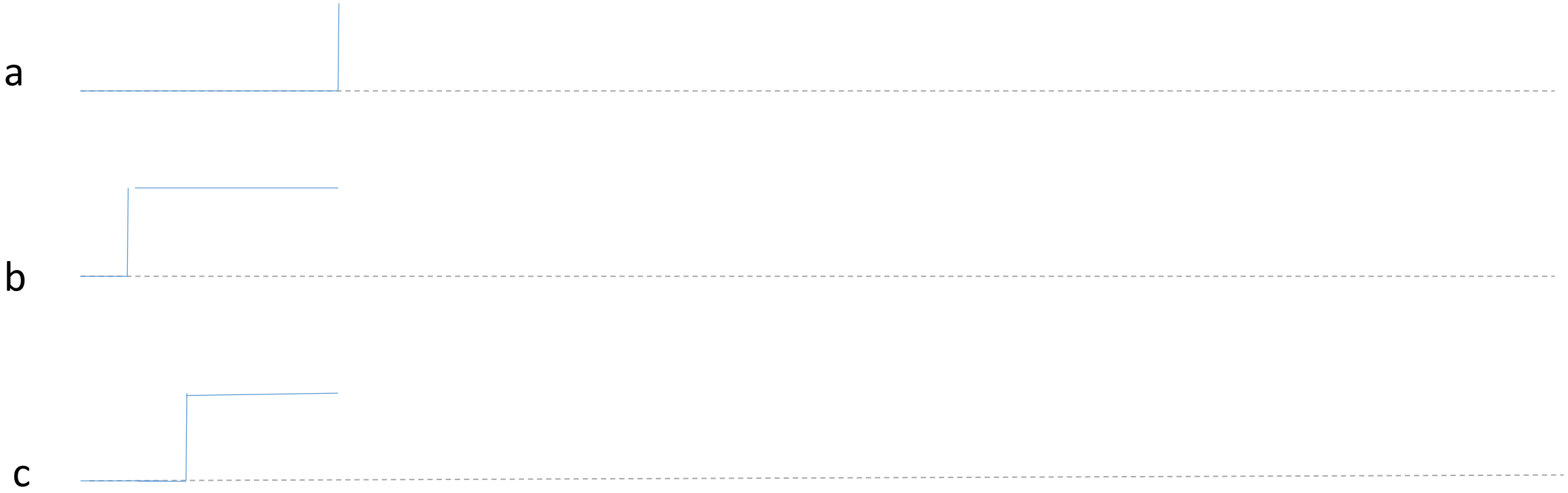
a : 0 <5,’1’>

b : 1

c : 1

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 5

Transaction Queues

a : 1

b : 1

c : 1

Transaction Queues after “create transactions”

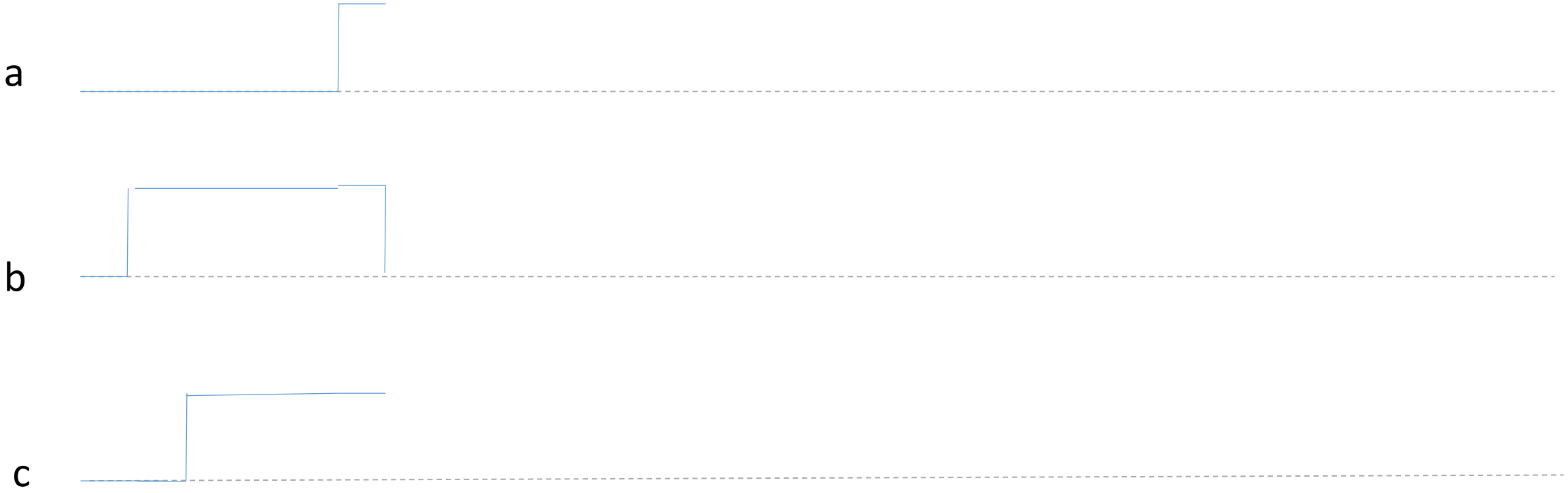
a : 1 <5+5, not ’1’>

b : 1 <5+1, not ’1’>

c : 1 <5+1, ’1’ or ‘1’>

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 6

Transaction Queues

a : 1 < 10, ‘0’ >

b : 0

c : 1

Transaction Queues after “create transactions”

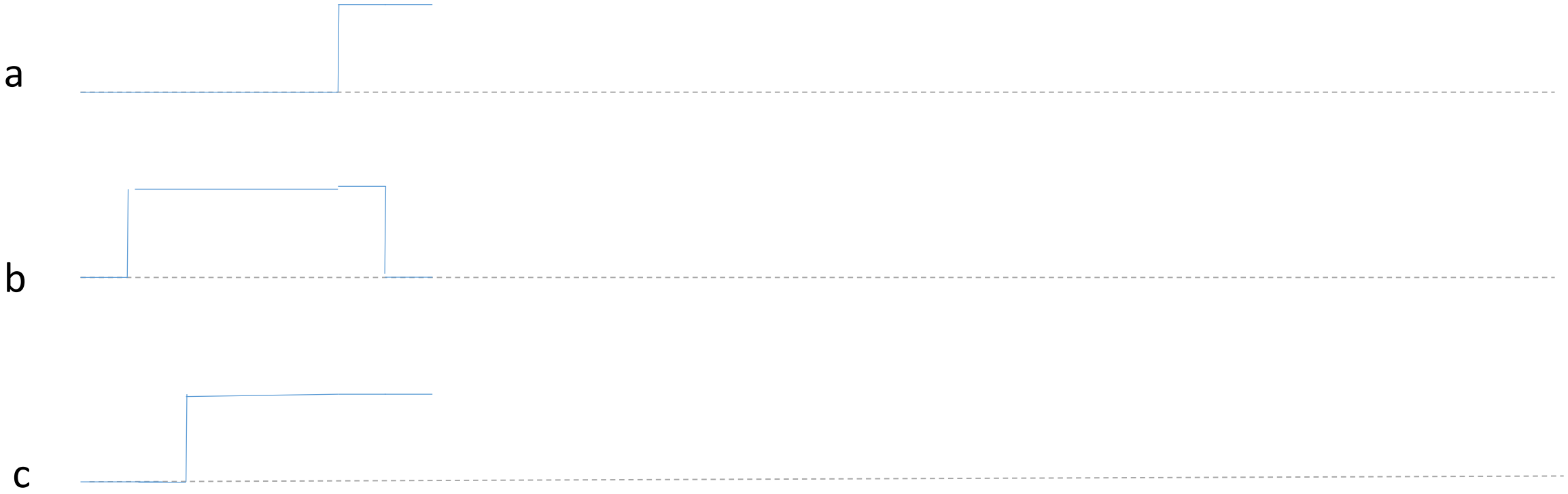
a : 1 < 10, ‘0’ >

b : 0

c : 1 < 6+1, ‘1’ or ‘0’ >

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 7

Transaction Queues

a : 1 < 10, ‘0’ >

b : 0

c : 1

Transaction Queues after “create transactions”

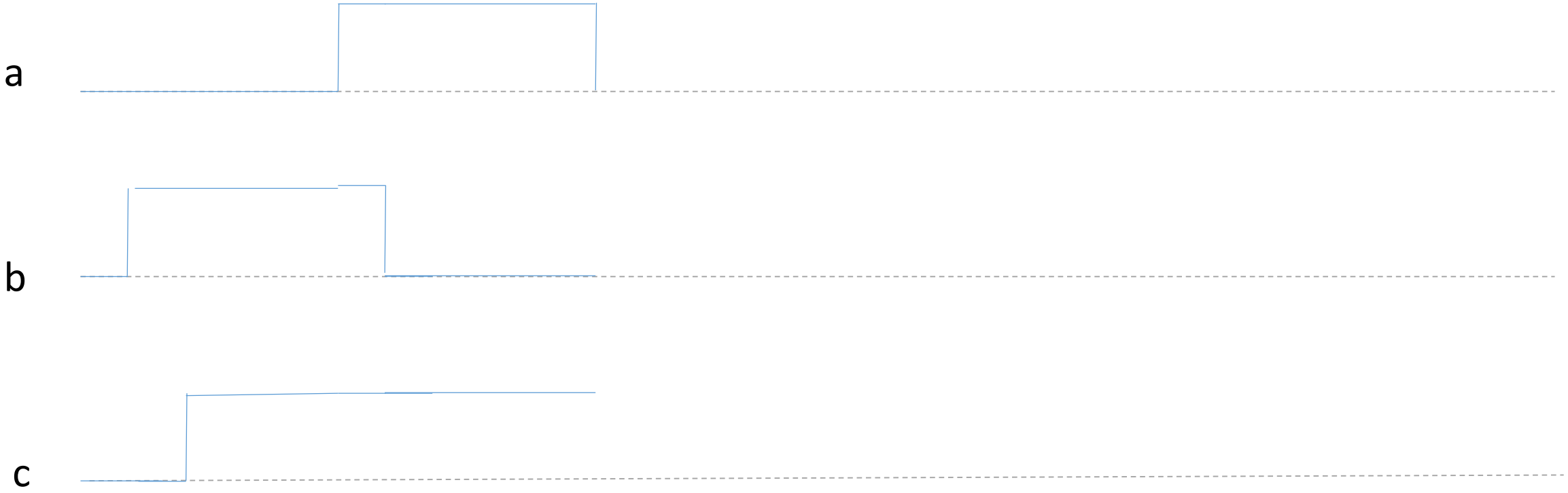
a : 1 < 10, ‘0’ >

b : 0

c : 1

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 10

Transaction Queues

a : 0

b : 0

c : 1

Transaction Queues after “create transactions”

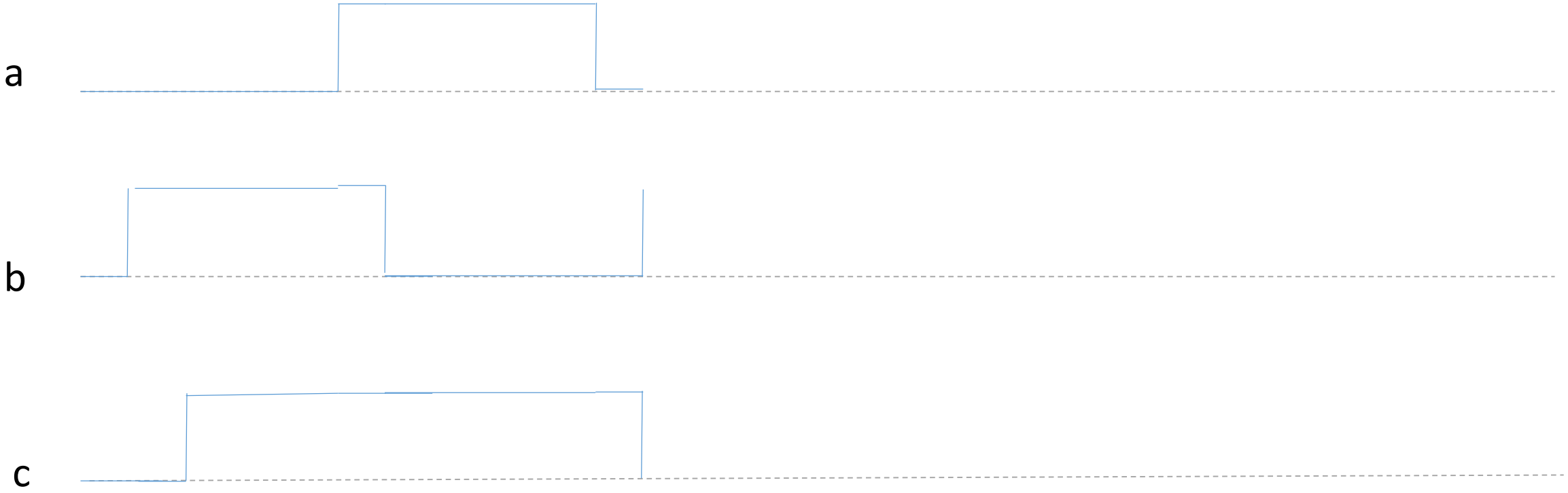
a : 0 < 10+5, not ‘0’ >

b : 0 < 10+1 , not ‘0’ >

c : 1 < 10+1, ‘0’ or ‘0’ >

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 11

Transaction Queues

a : 0 < 15, ‘1’ >

b : 1

c : 0

Transaction Queues after “create transactions”

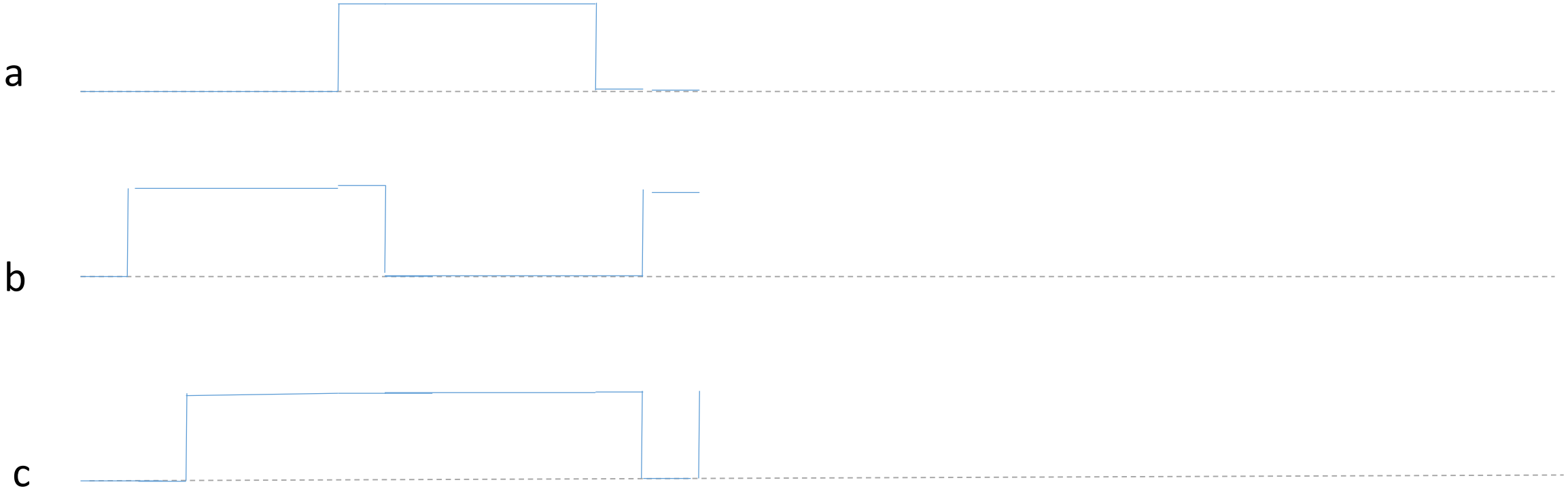
a : 0 < 15, ‘1’ >

b : 1

c : 0 < 11+1, ‘0’ or ‘1’ >

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 12

Transaction Queues

a : 0 < 15, ‘1’ >

b : 1

c : 1

Transaction Queues after “create transactions”

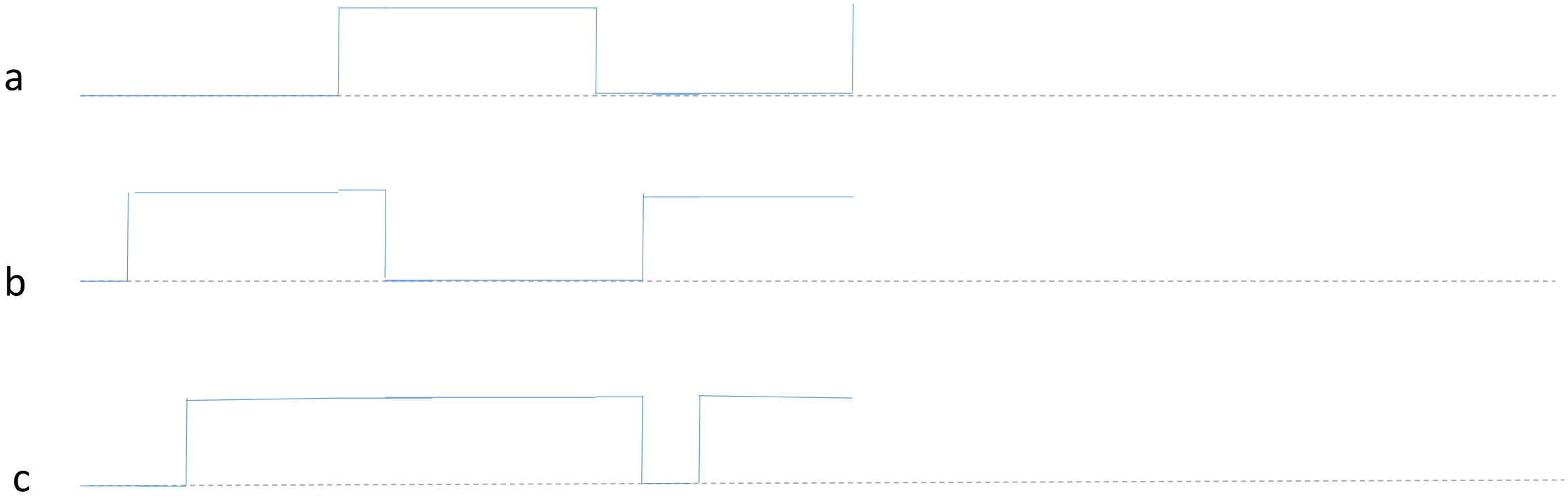
a : 0 < 15, ‘1’ >

b : 1

c : 1

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 15

Transaction Queues

a : 1

b : 1

c : 1

Transaction Queues after “create transactions”

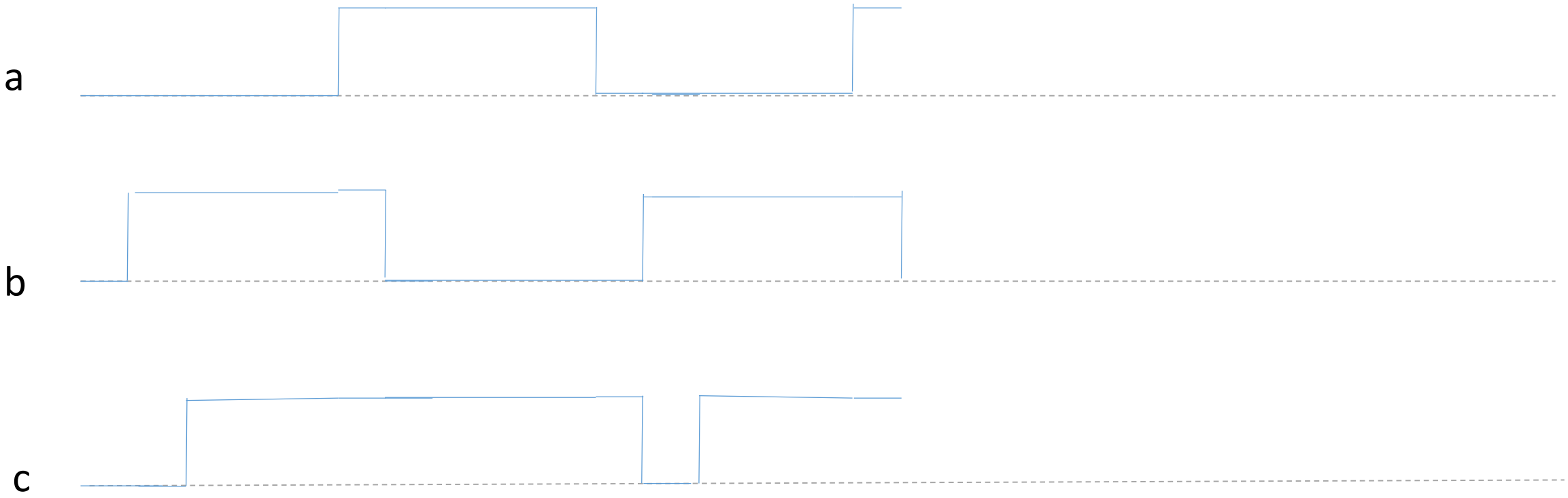
a : 1 < 15+5, not ‘1’ >

b : 1 < 15+1, not ‘1’ >

c : 1 < 15+1, ‘1’ or ‘1’ >

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 16

Transaction Queues

a : 1 < 20, ‘0’ >

b : 0

c : 1

Transaction Queues after “create transactions”

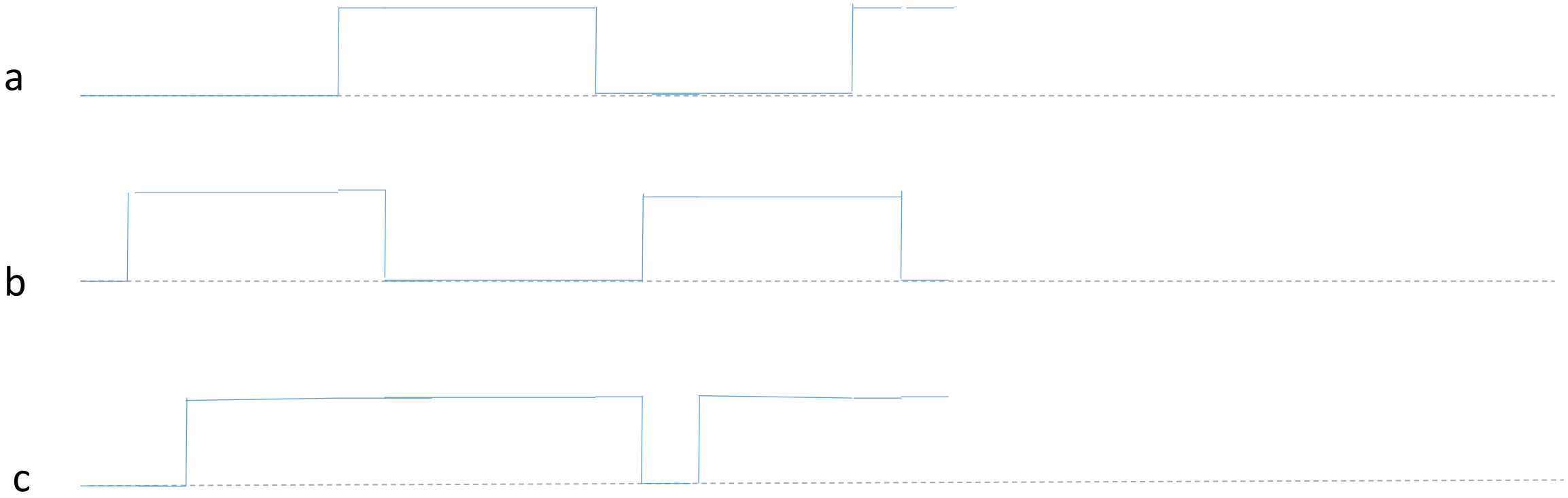
a : 1 < 20 , ‘0’ >

b : 0

c : 1 < 16+1, ‘1’ or ‘0’ >

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 17

Transaction Queues

a : 1 < 20, ‘0’ >

b : 0

c : 1

Transaction Queues after “create transactions”

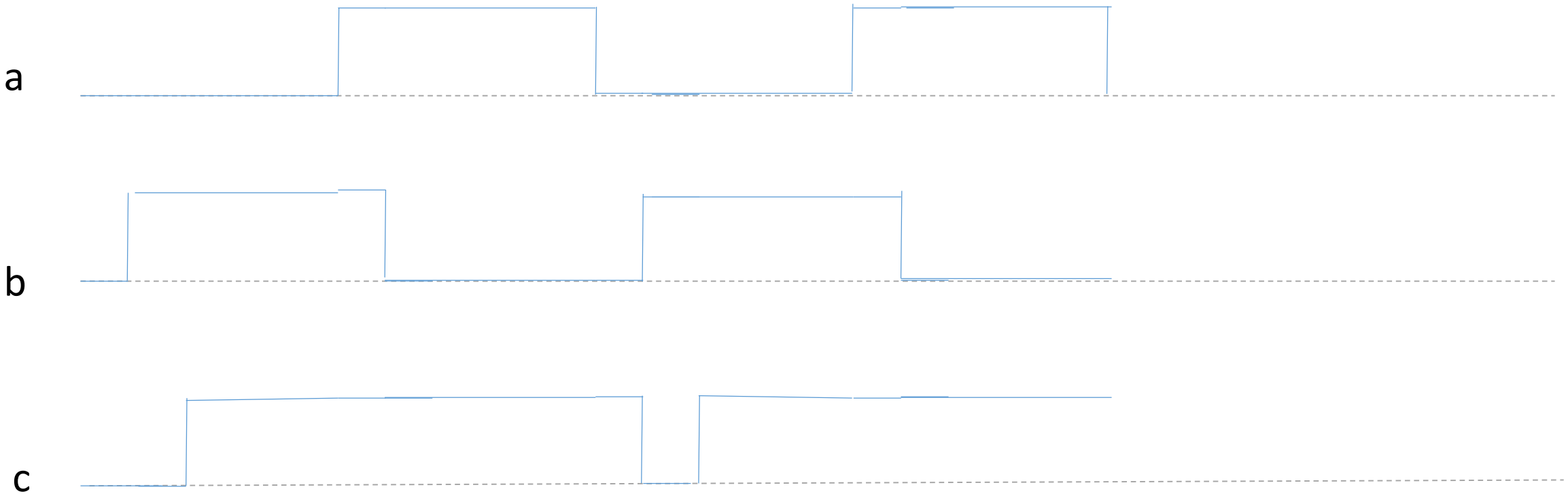
a : 1 < 20 , ‘0’ >

b : 0

c : 1

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 20

Transaction Queues

a : 0

b : 0

c : 1

Transaction Queues after “create transactions”

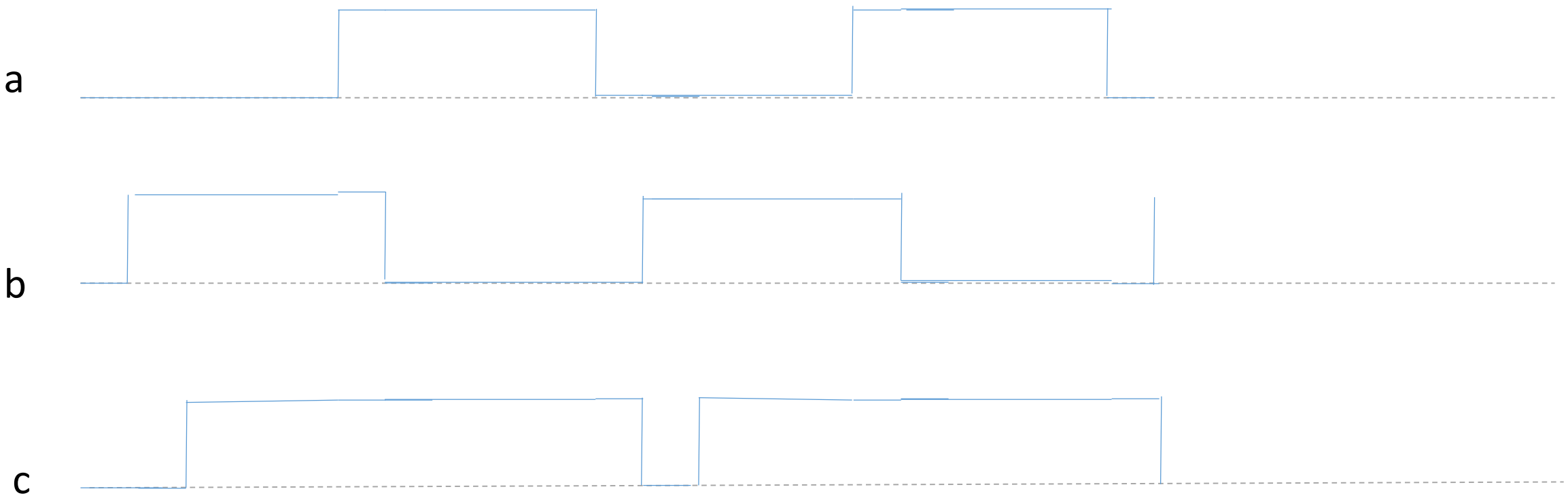
a : 0 < 20+5 , not ‘0’ >

b : 0 < 20+1 , not ‘0’ >

c : 1 < 20+1 , ‘0’ or ‘0’ >

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 21

Transaction Queues

a : 0 < 25 ,‘1’ >

b : 1

c : 0

Transaction Queues after “create transactions”

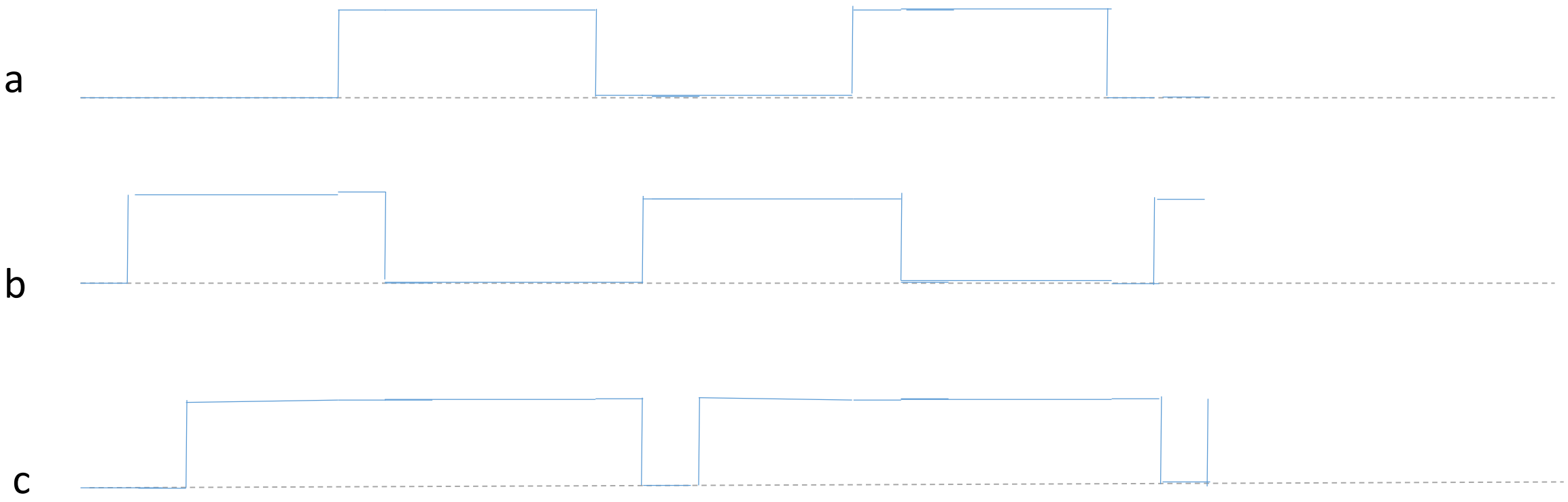
a : 0 < 25 , ‘1’ >

b : 1

c : 0 < 21+1 , ‘0’ or ‘1’ >

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 22

Transaction Queues

a : 0 < 25 ,‘1’ >

b : 1

c : 1

Transaction Queues after “create transactions”

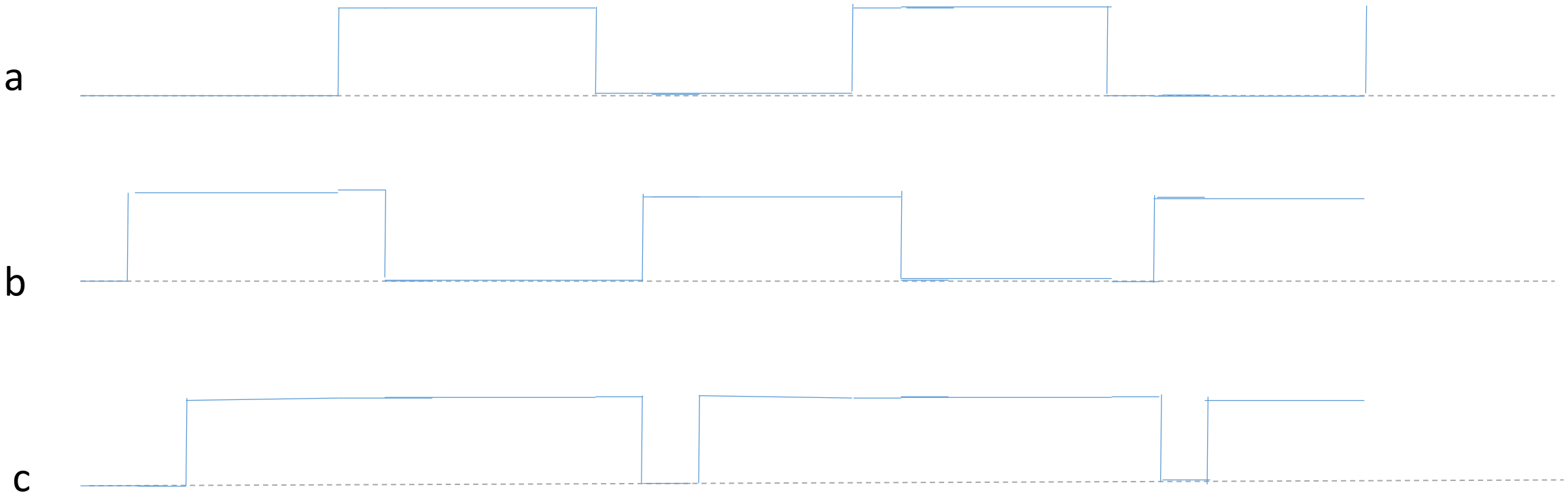
a : 0 < 25 , ‘1’ >

b : 1

c : 1

Applied transactions = ?

Next transaction at T= ?



Event on which signals ? Which processes are “sensitive” to these “events ?

Simulation
Time T = 25

Transaction Queues

a : 1

b : 1

c : 1

Transaction Queues after “create transactions”

a : 1 < 25+5, not ‘1’ >

b : 1 < 25+1, not ‘1’ >

c : 1 < 25+1, ‘1’ or ‘1’ >

Applied transactions = ?

Next transaction at T= ?