Lecture 02: A SingleServer Queue

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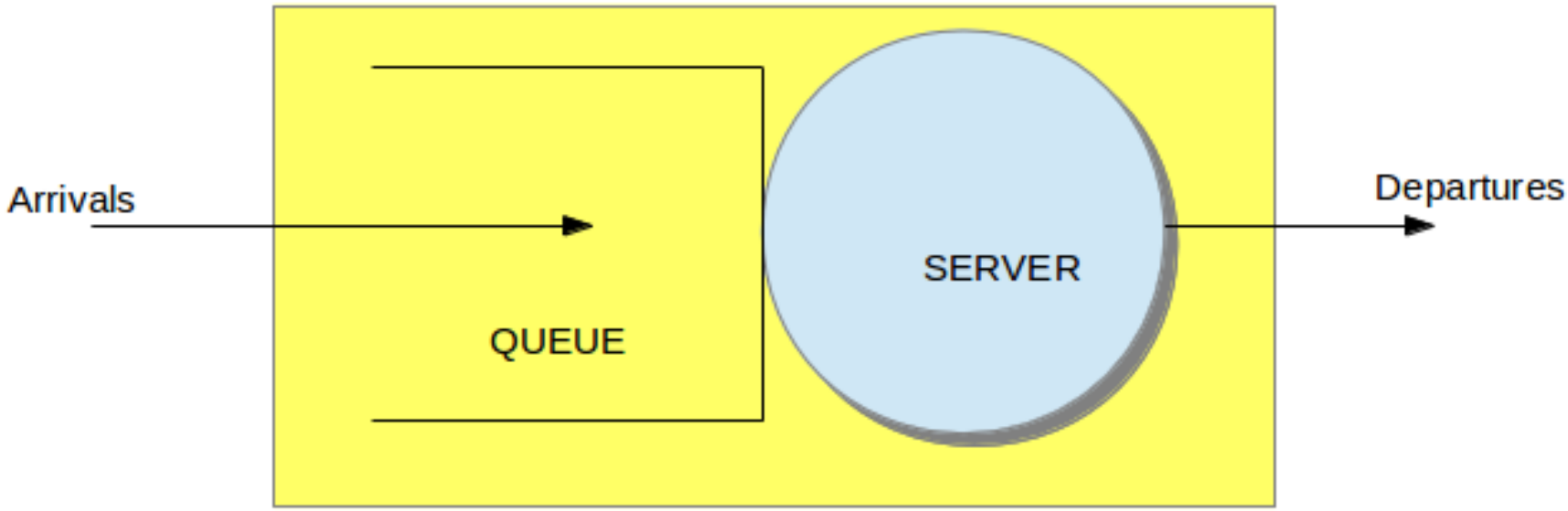
A SingleServer Queue



- A single-sever service node consists of a server plus its queue
- Example: ATM booth.

Queue Discipline

Queue Discipline: the algorithm used when a job is selected from the queue to enter service

- FIFO - first in first out
- LIFO - last in first out
- SIRO - serve in random order
- Priority - shortest job first / other schemes

Queue Assumptions

- FIFO is also known as first come, first serve (FCFS)
  - The order of arrival and departure are the same
  - Unless otherwise specified, assume FIFO with infinite queue capacity.
- Service is non-preemptive
  - Once initiated, service of a job will continue until completion
- Service is conservative
  - Server will never remain idle if there is one or more jobs in the service node

The problem model

Initial Conditions

- Queue empty
- Server idle

Events

- Arrival
- Departure

Variables

Two input variables

- Arrival times, A_i
- Service times, S_i
- IID (Independent and identically distributed) random variables

Performance measures

- Delay
- Customers in Queue
- Utilization of the server

Delay

Expected average delay in queue

$$\hat{d}(n) = \frac{\sum_{i=1}^{i=n} D_i}{n}$$

D_i is the delay for the customer i

Gives the system performance from customer's point of view.

Customers in Queue

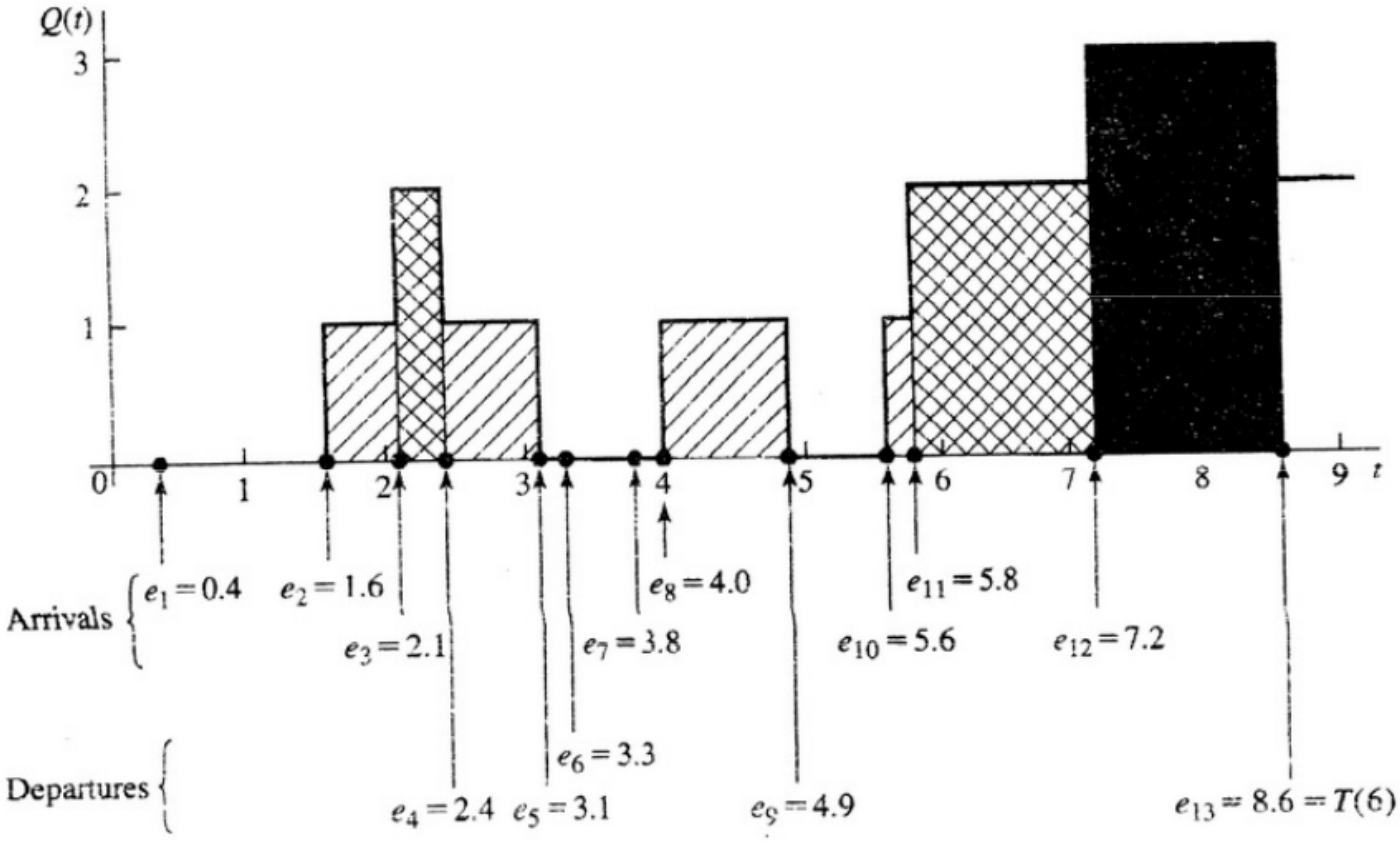
Expected number of customers in Queue

$$\hat{q}(n) = \frac{\sum_{i=1}^{\infty} iT_i}{T(n)}$$

T_i is the total time of simulation that number of customers in the queue is i

Who wants this information? customer/service provider?

Customers in Queue



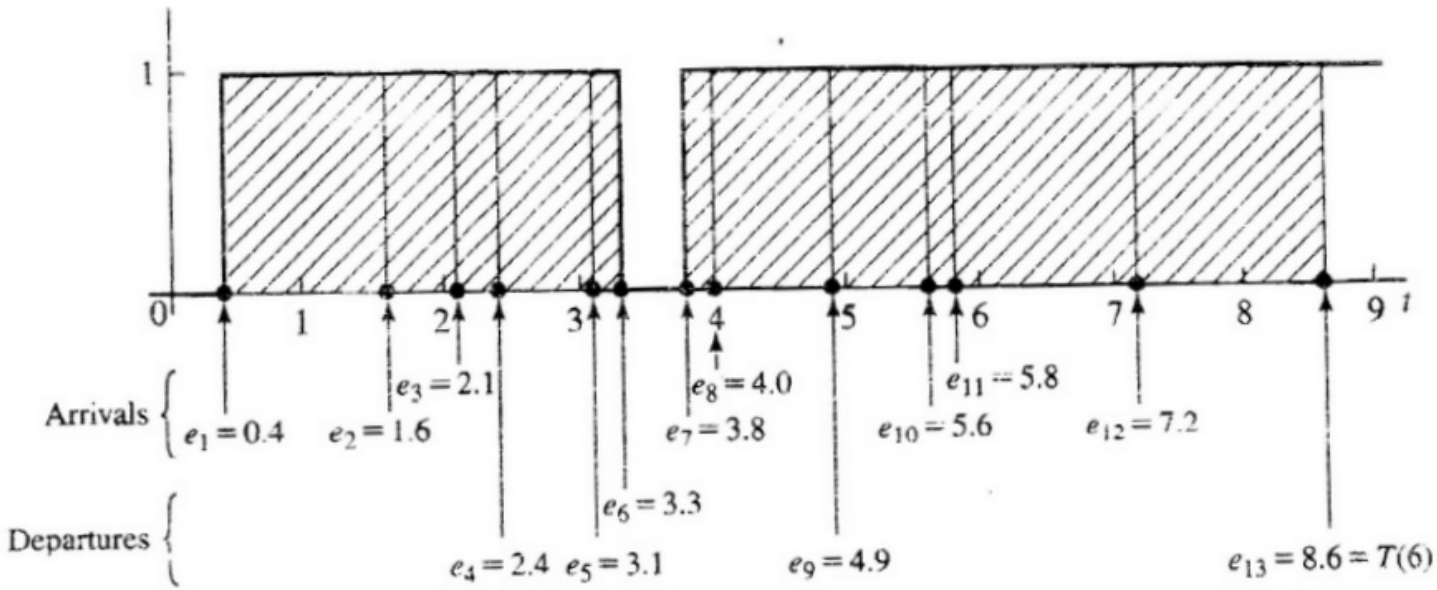
Utilization of the server

Expected utilization of the server

$$\hat{u}(n) = \frac{\int_0^{T(n)} B(t)dt}{T(n)}$$

$B(t) = 1$, if the server is busy at time t
$B(t) = 0$, if the server is idle at time t

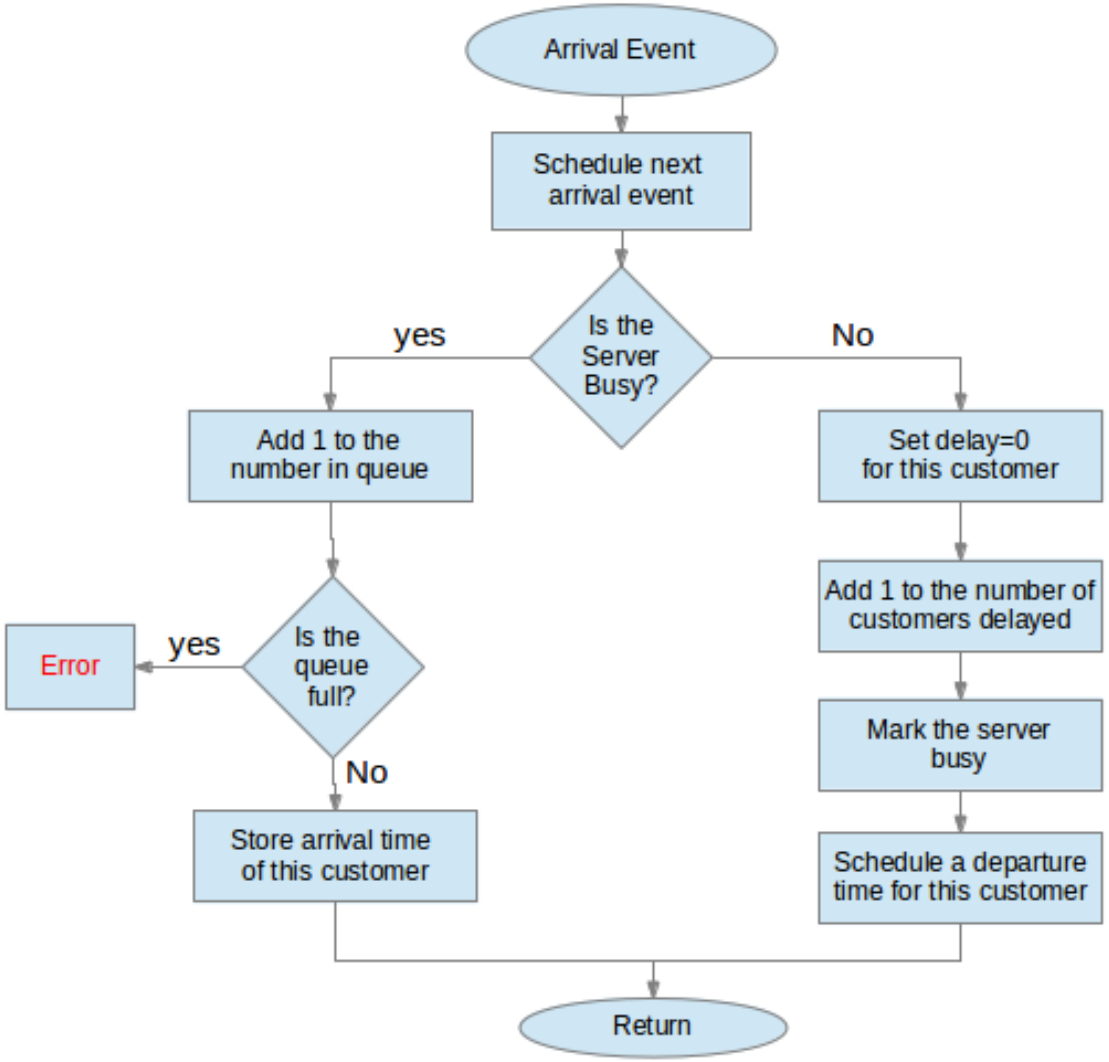
Utilization of the server



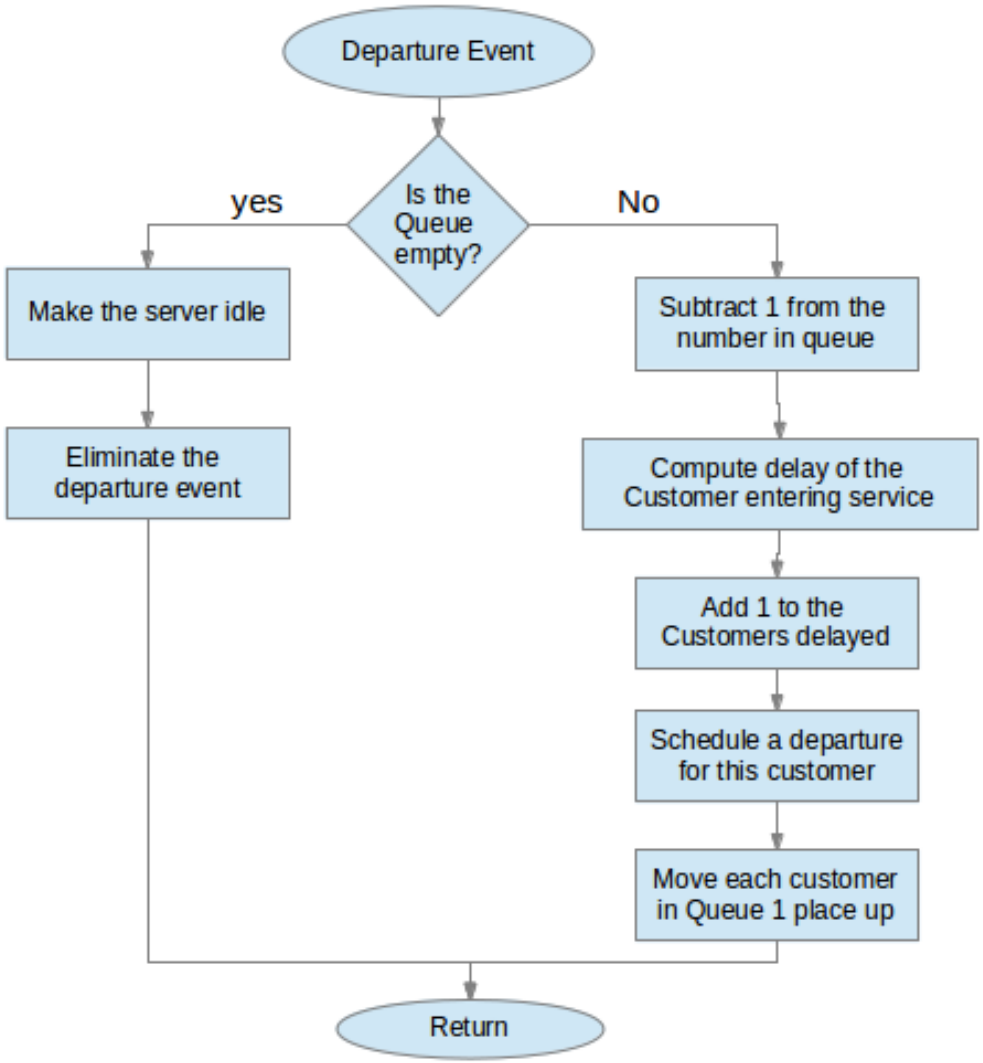
An Example Simulation

Suppose inter-arrival times are $A_1 = 0.4, A_2 = 1.2, A_3 = 0.5, A_4 = 1.7, A_5 = 0.2, A_6 = 1.6, A_7 = 0.2, A_8 = 1.4, A_9 = 1.9, \cdots$
Service times are
$S_1 = 2.0, S_2 = 0.7, S_3 = 0.2, S_4 = 1.1, S_5 = 3.7, S_6 = 0.6, \cdots$
Next event time advance mechanism.

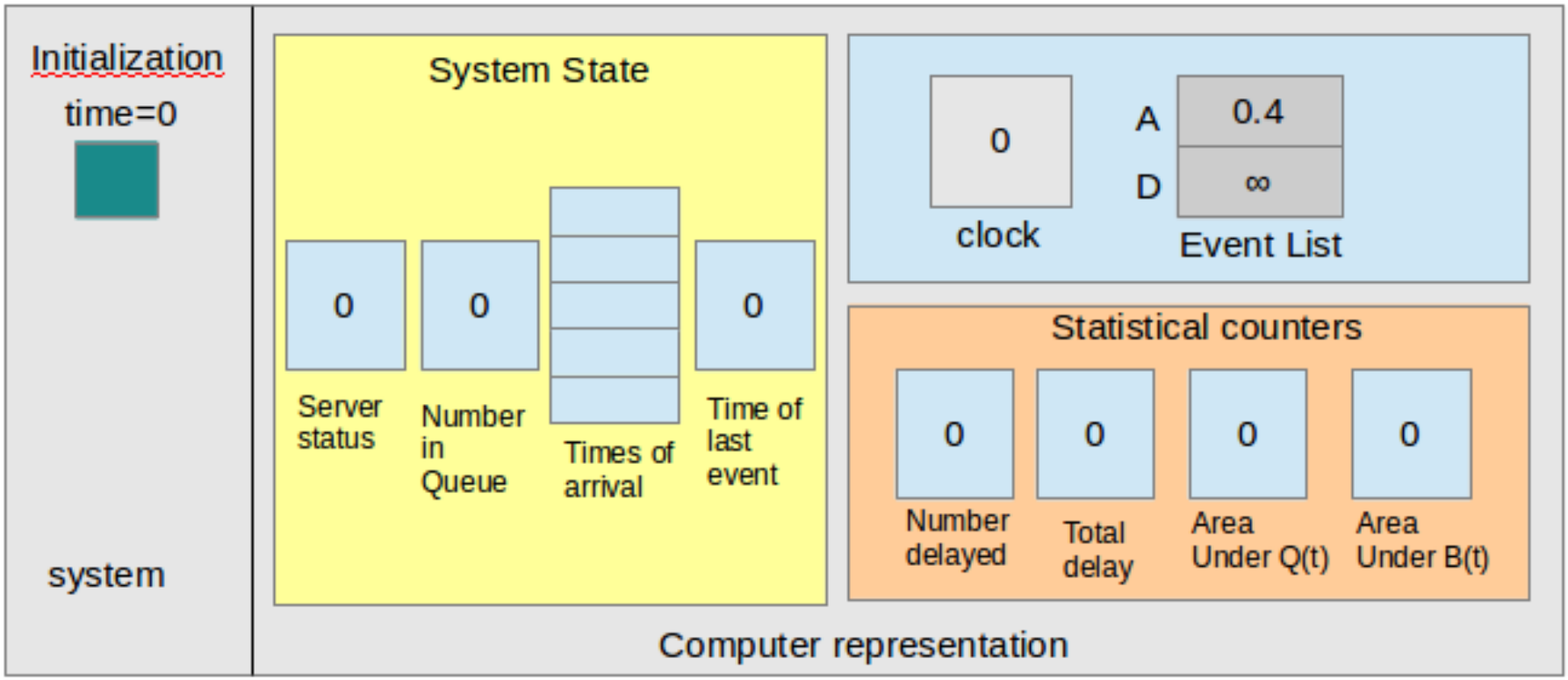
An Arrival Event



A Departure Event



An Example Simulation



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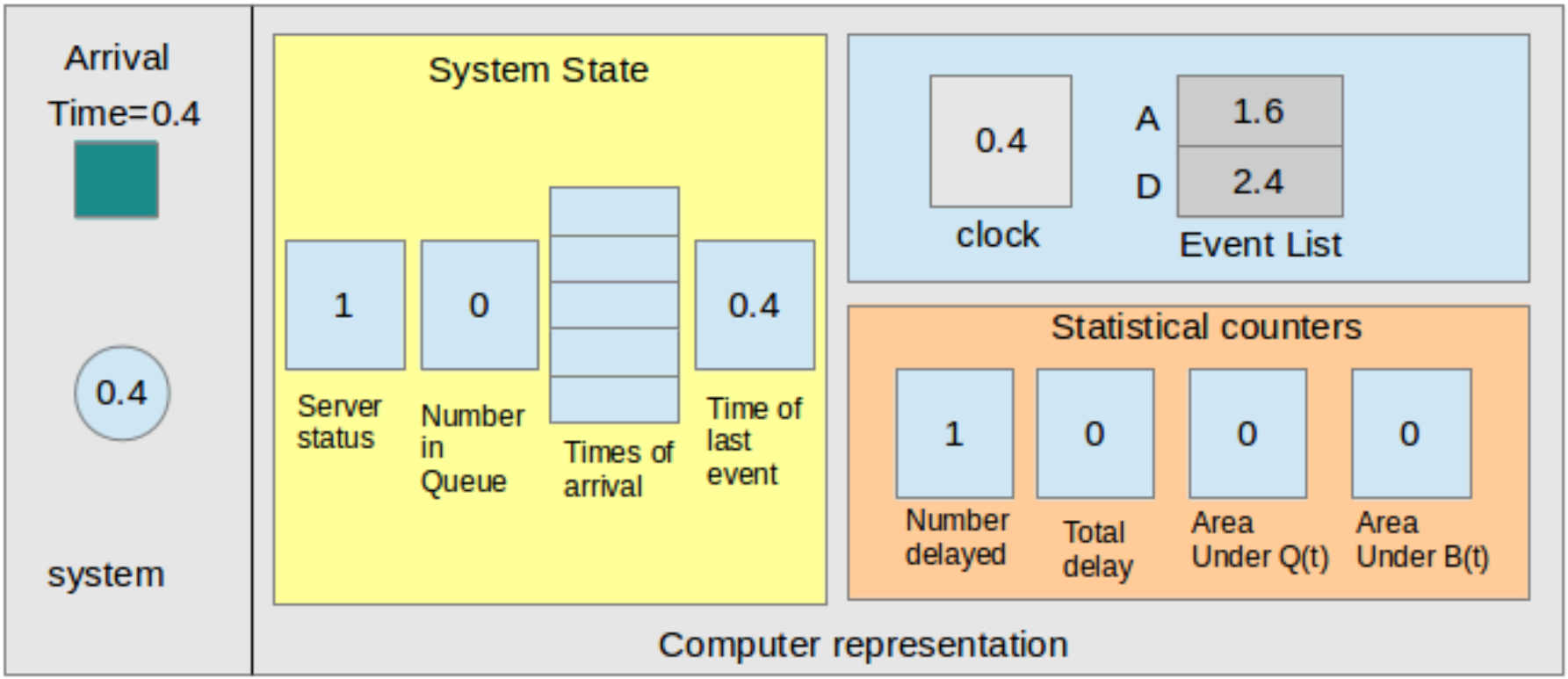

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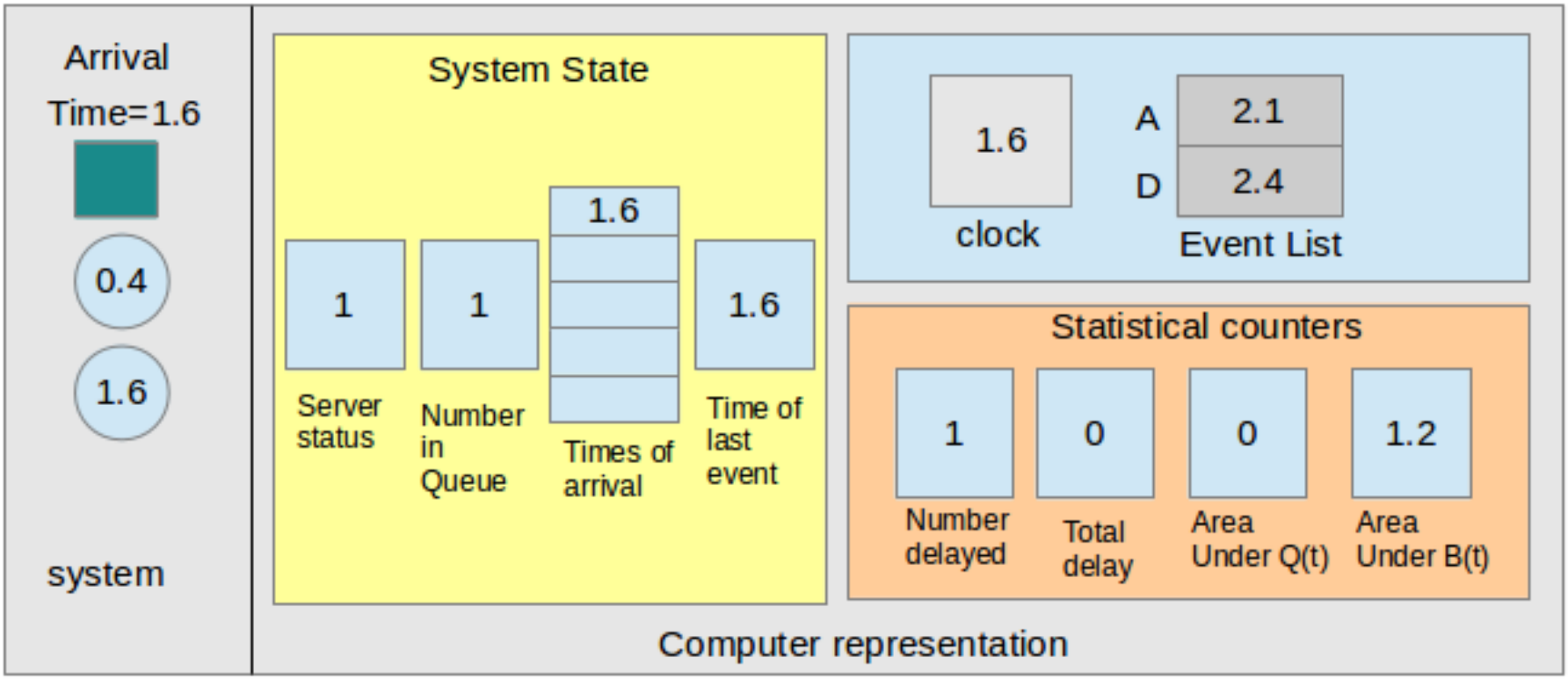

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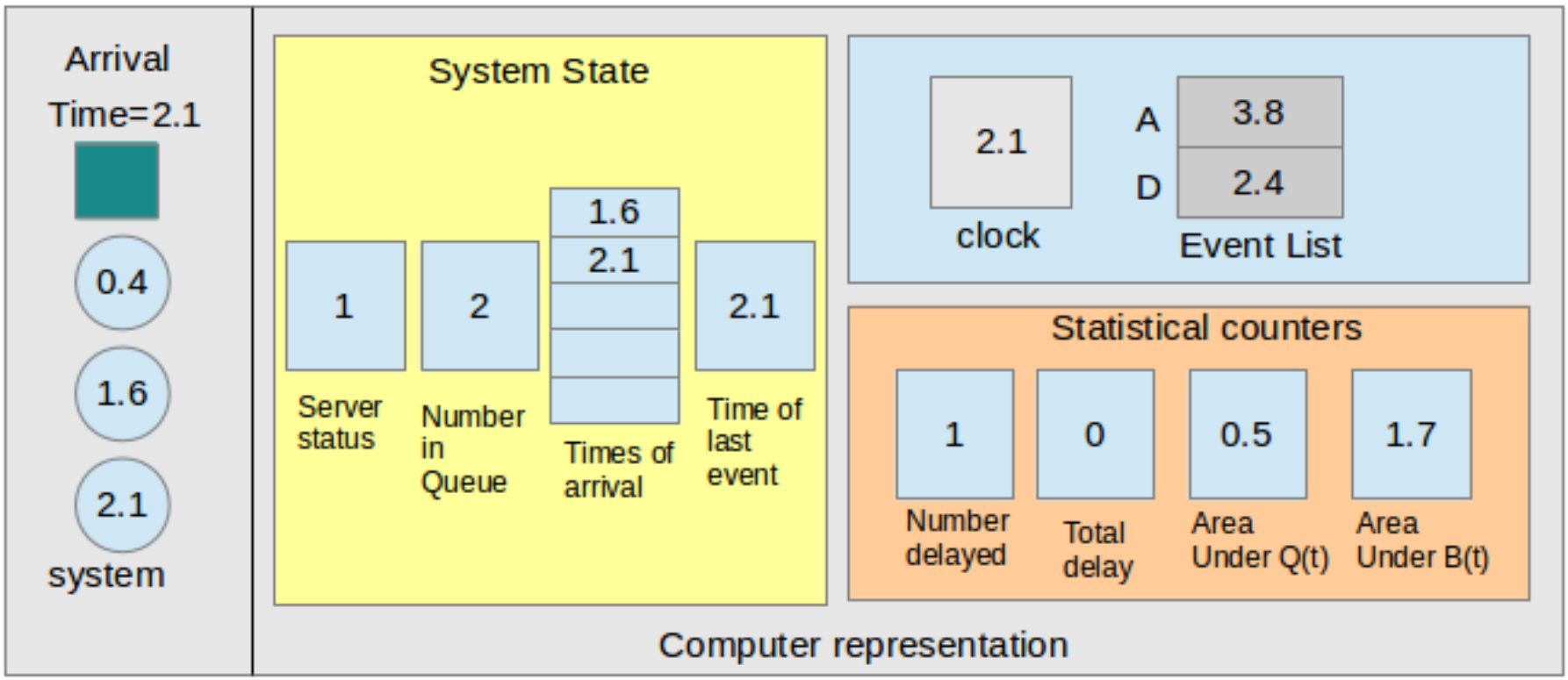

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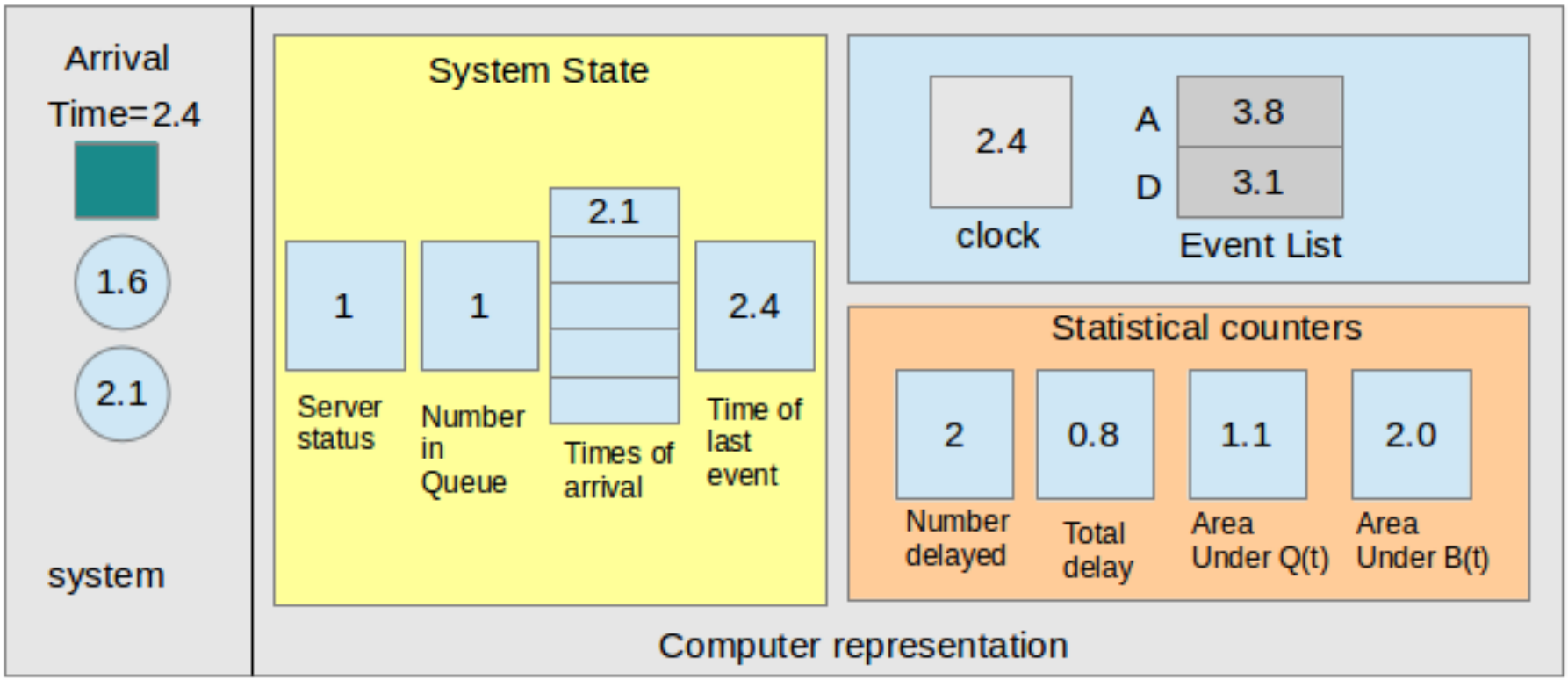

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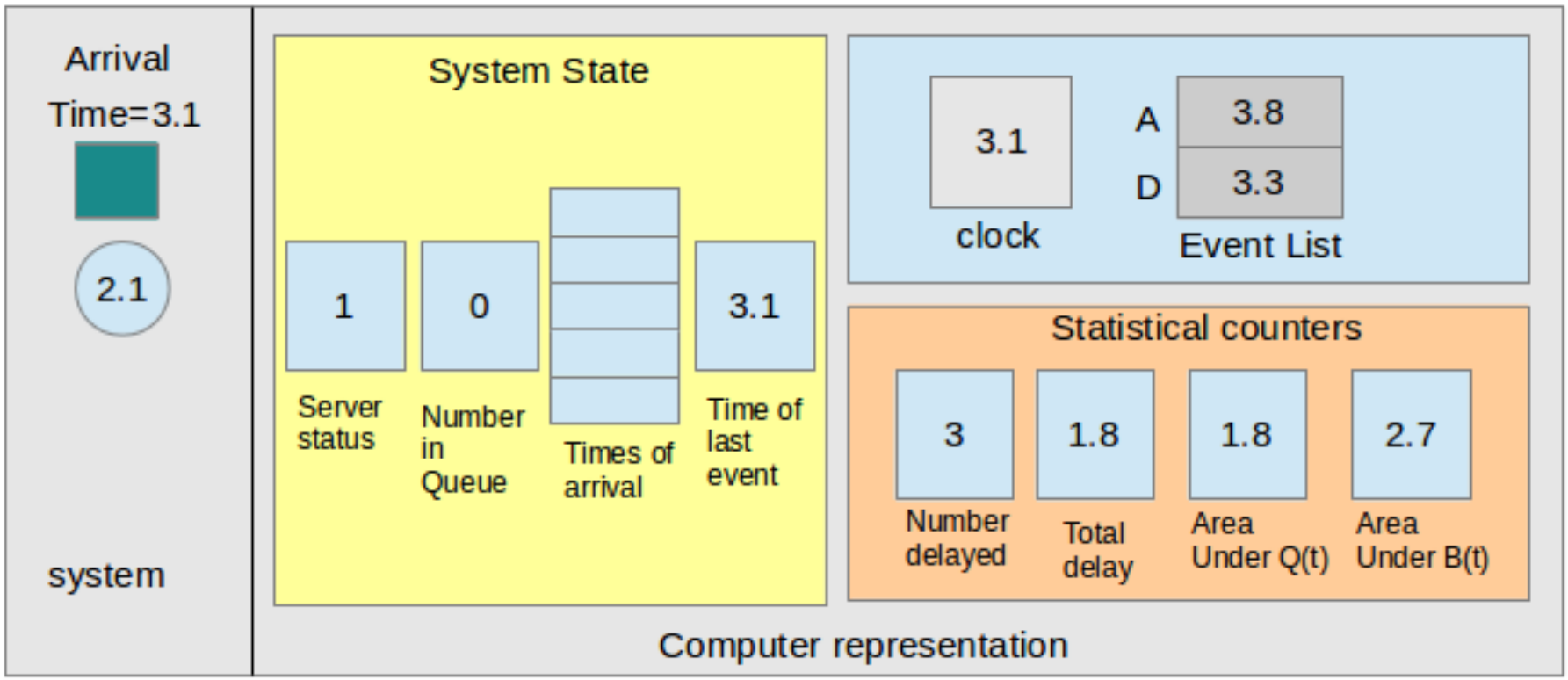

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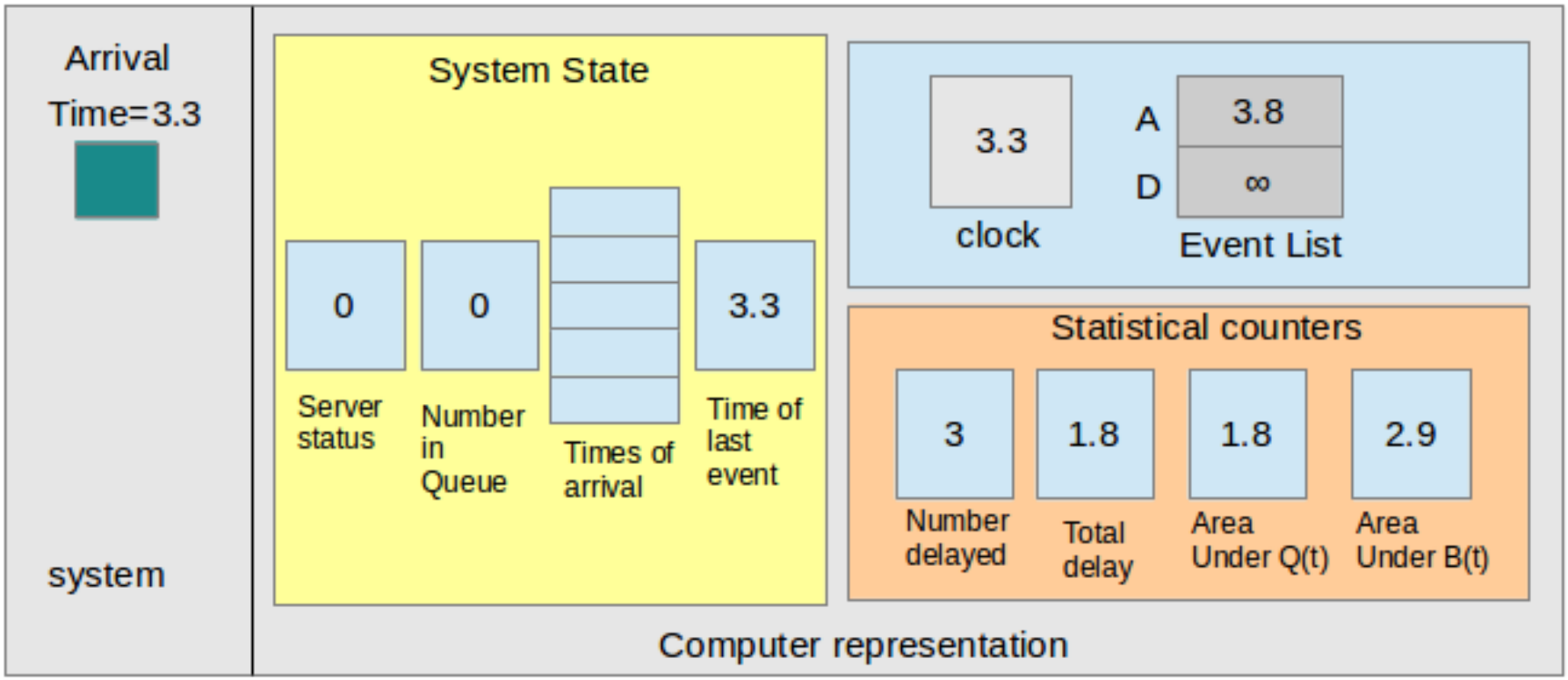

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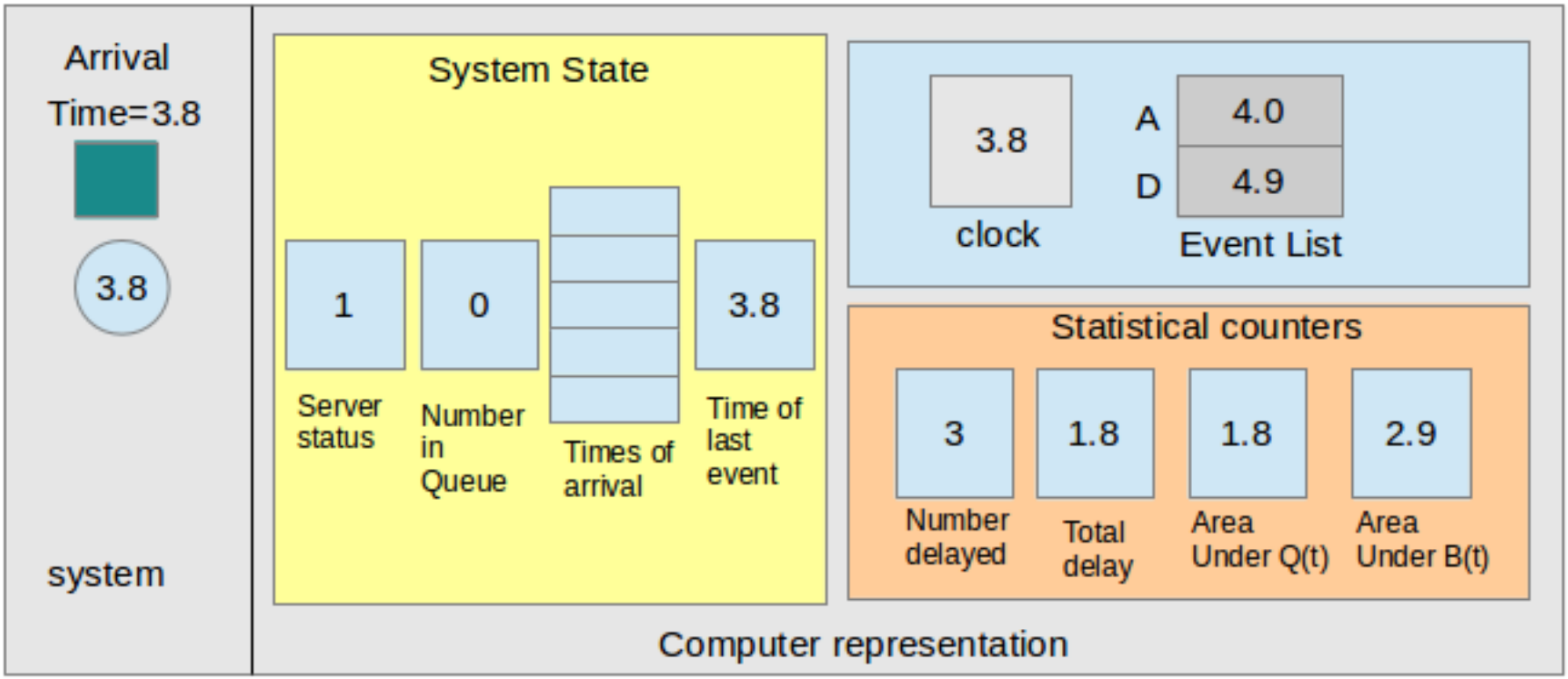

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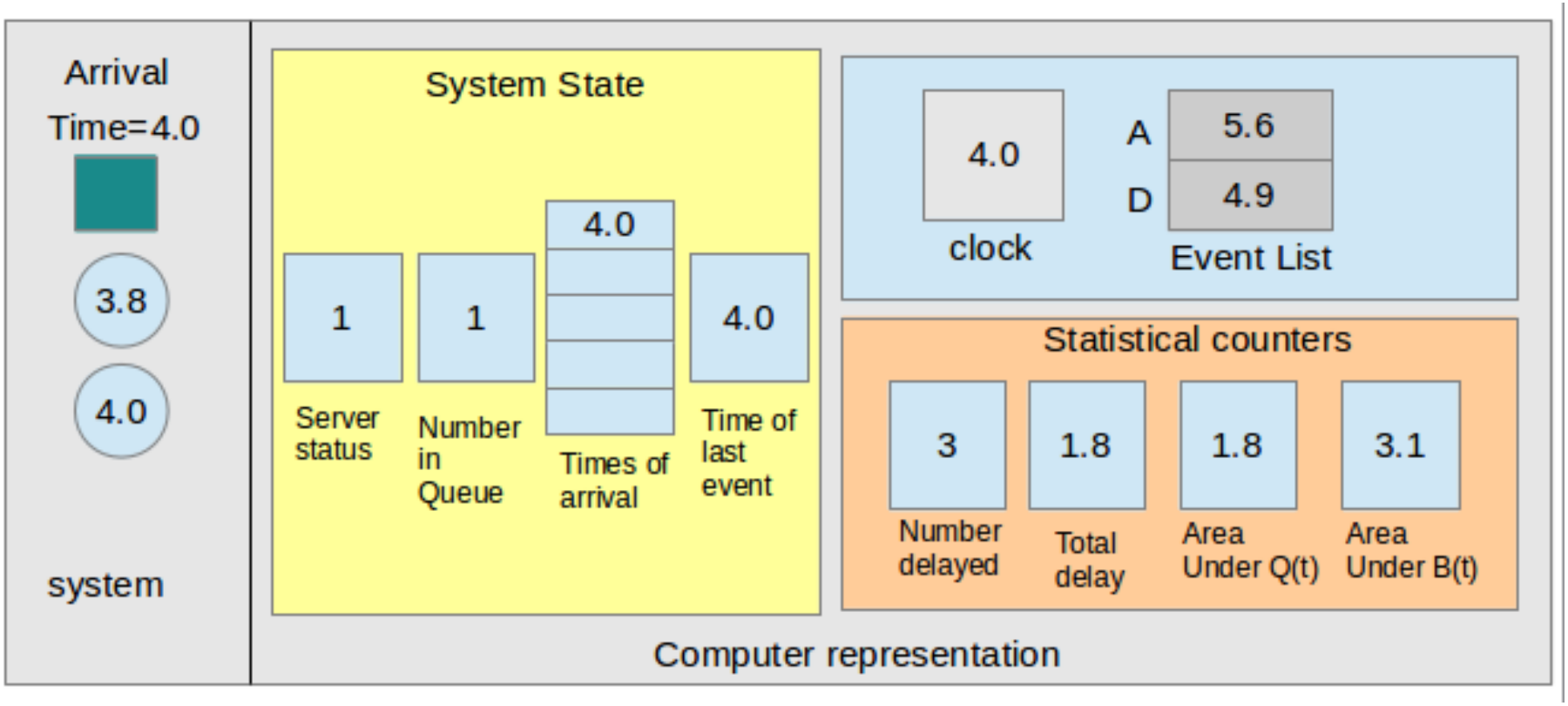

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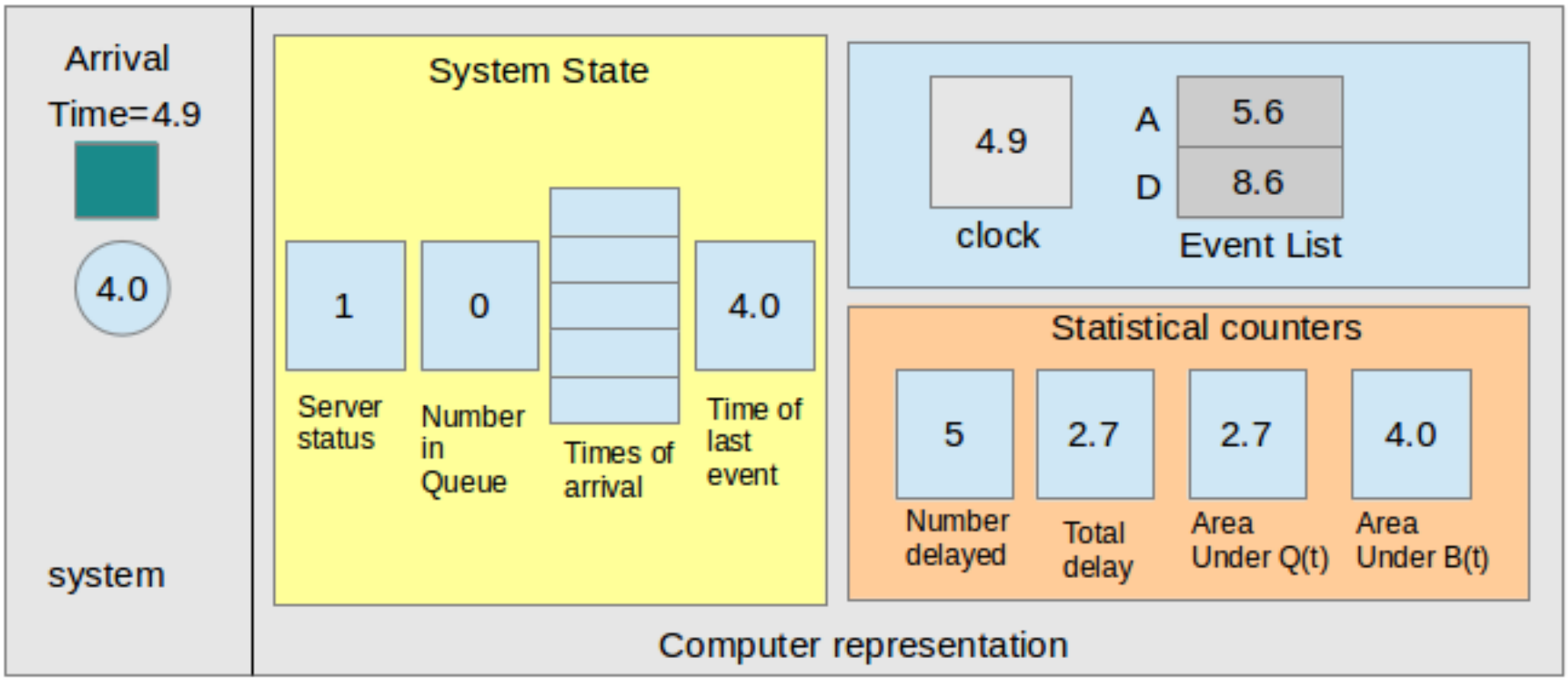

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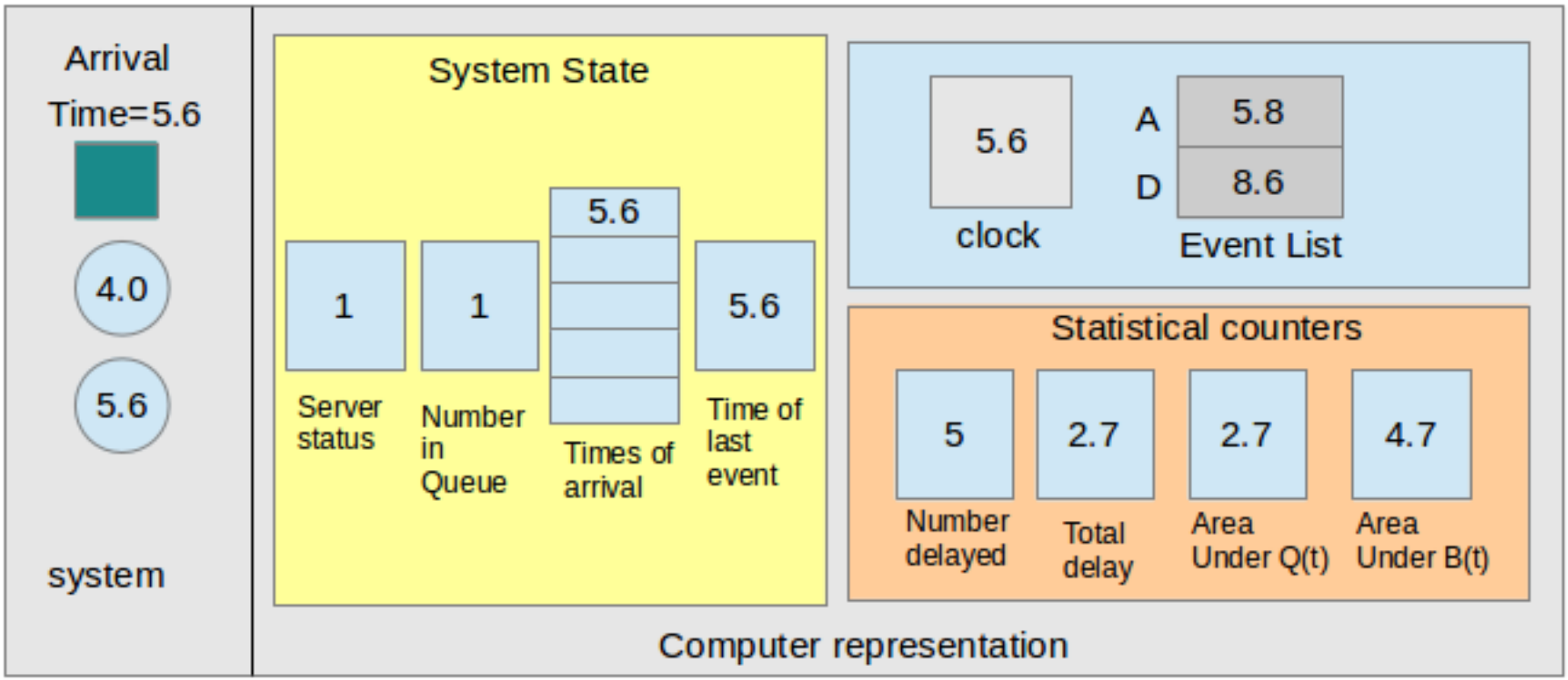

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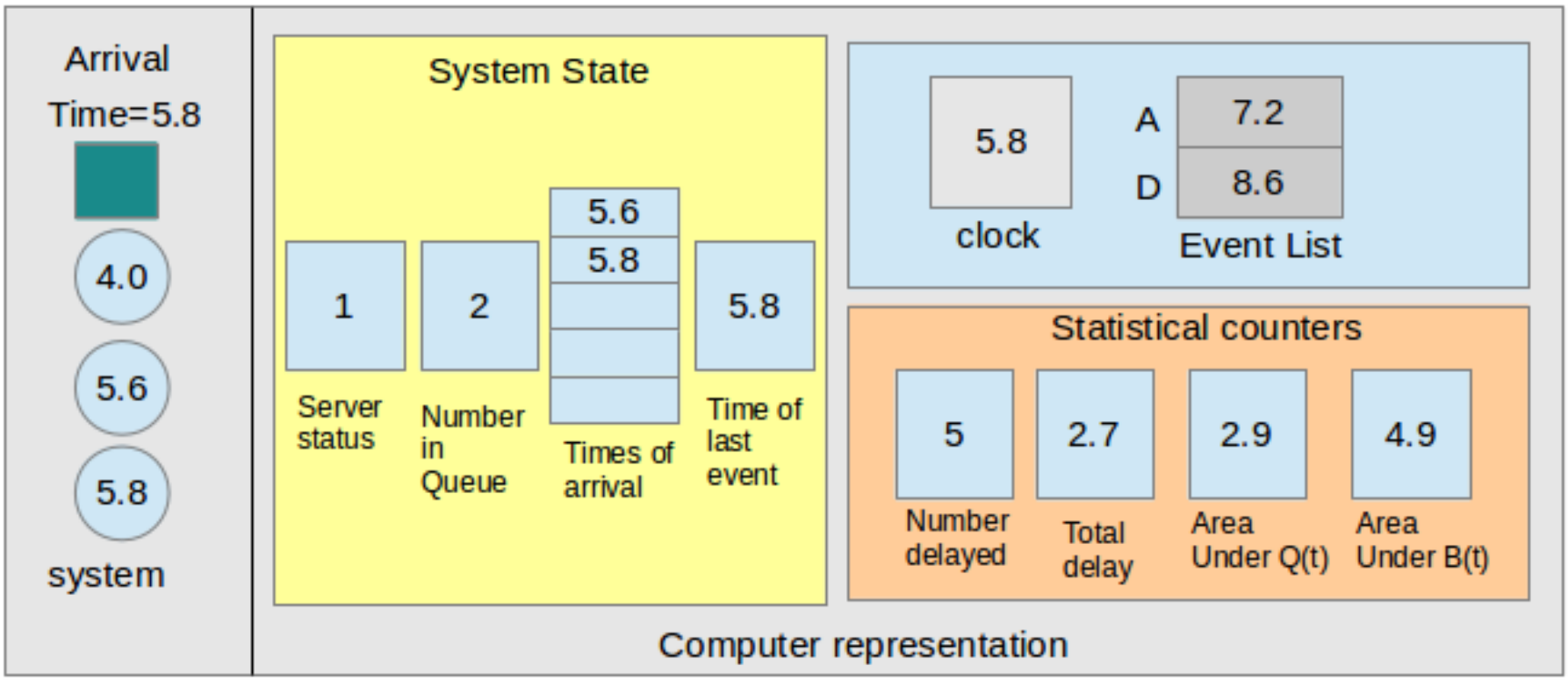

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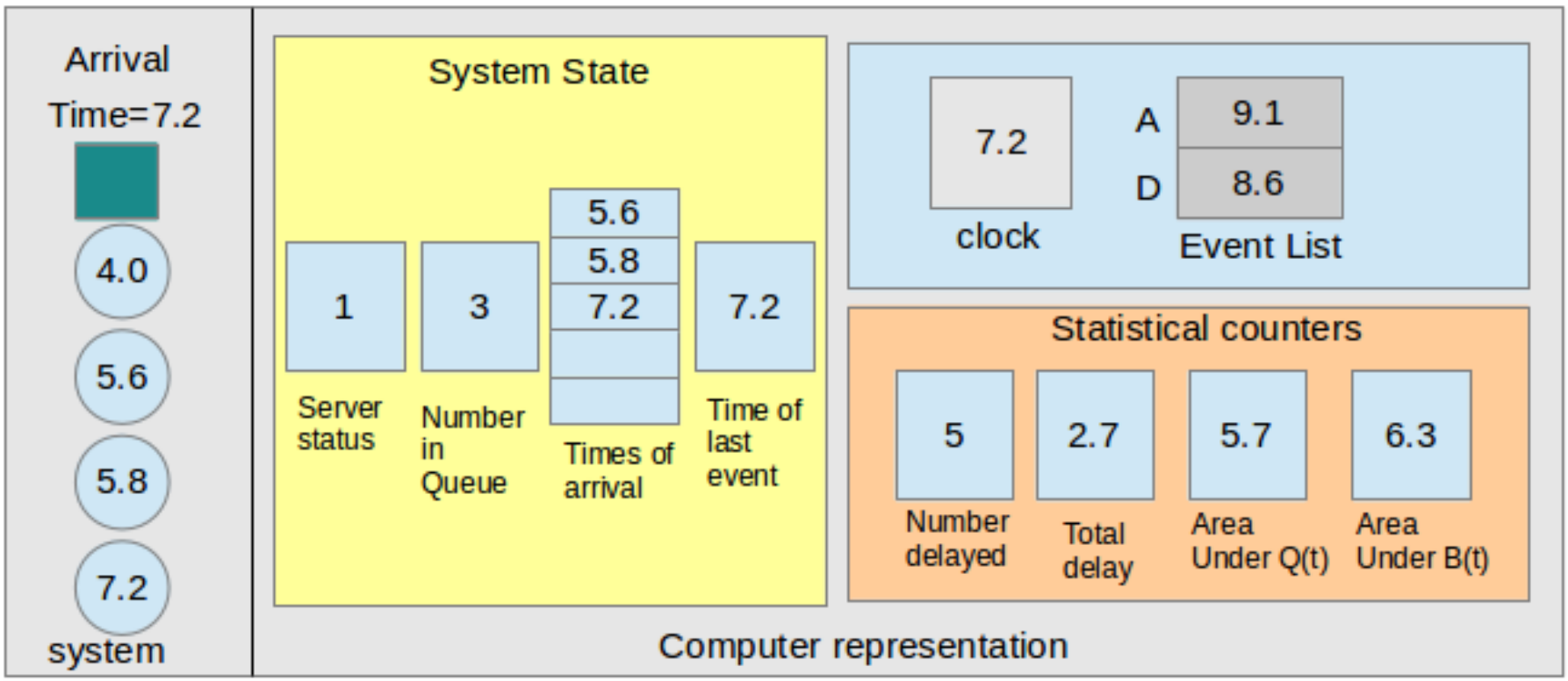

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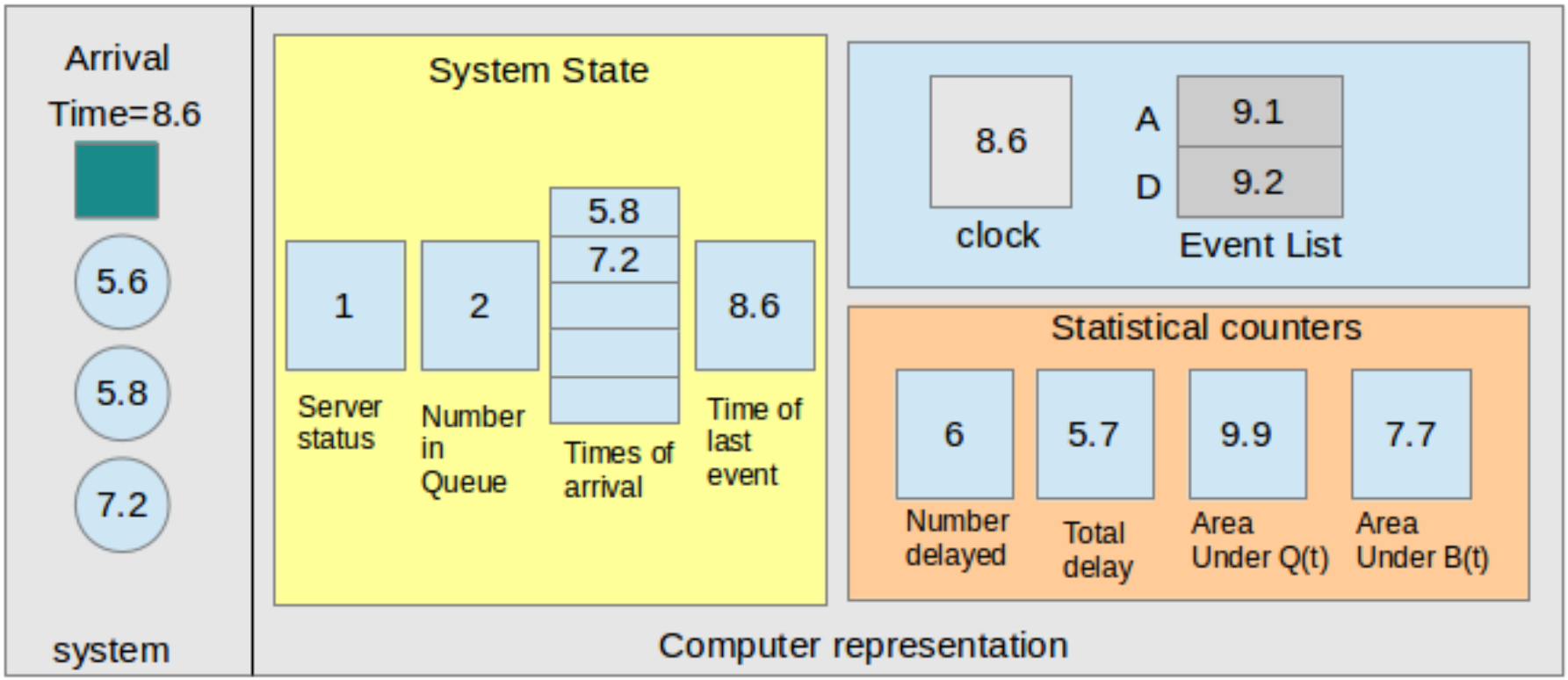

Thats it!

Thank you