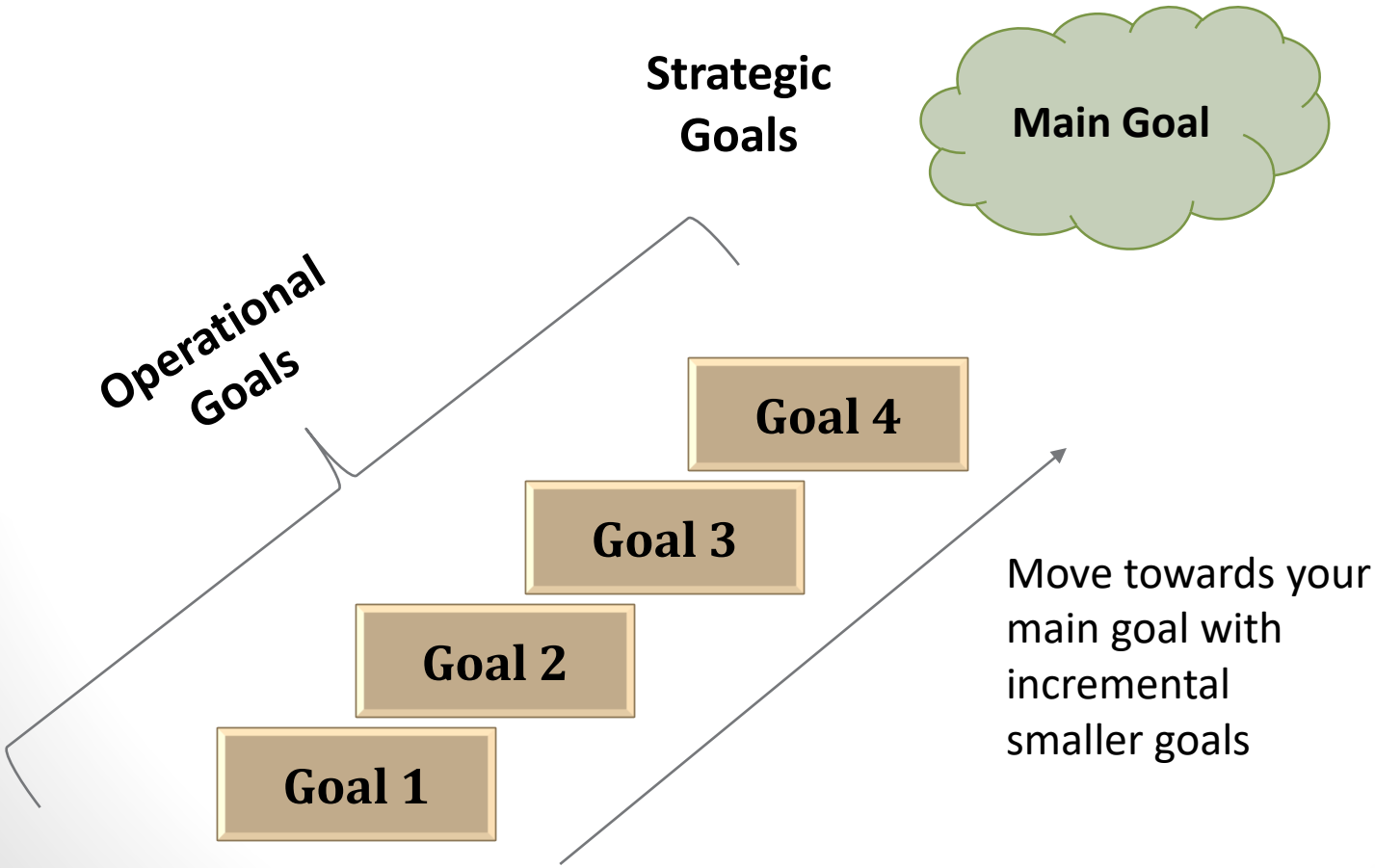
Extracting Key Performance Indicators from Process Execution Logs

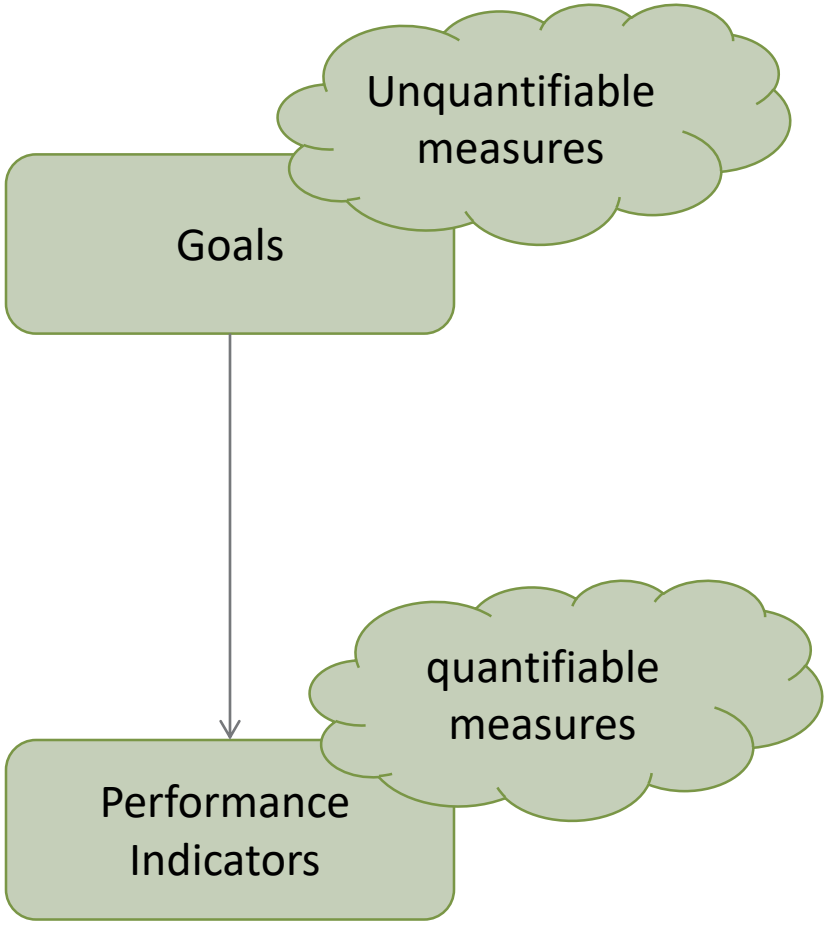
Introduction

- Organizations need to define their strategic goals to guide their work efforts.



Organizational Goals

Introduction



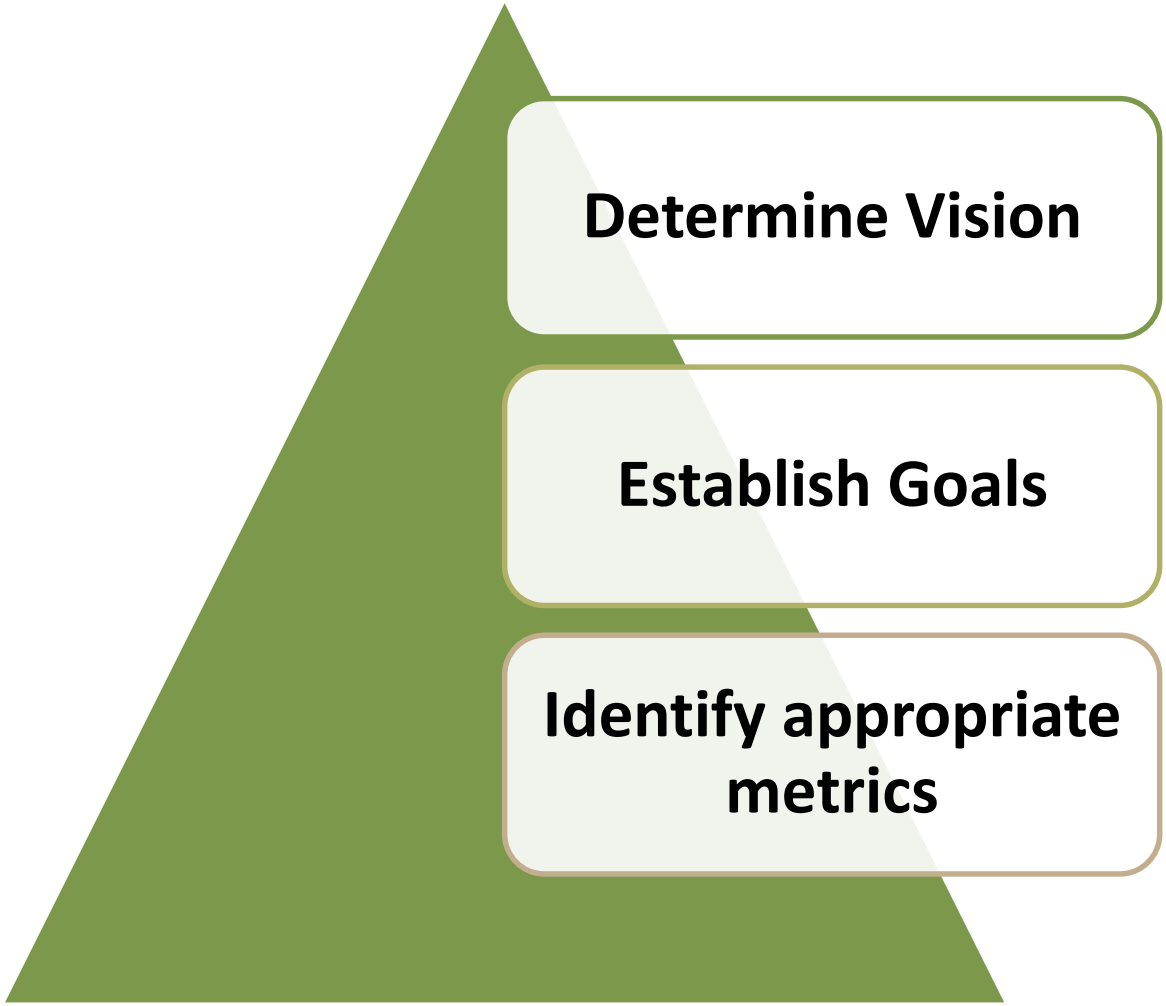
Performance Indicators

- **Performance Indicators:** are quantifiable metrics that help organizations measure performance towards achieving goals.

- **Example:**
  - **Goal:** increase site traffic 50 % in the next year
  - **Indicator:** number of unique visitors the site receives daily.

- **Examples:**
  - Workload of employees
    - what are the tasks that the employee take?
  - How much did the employee spend in the task ?

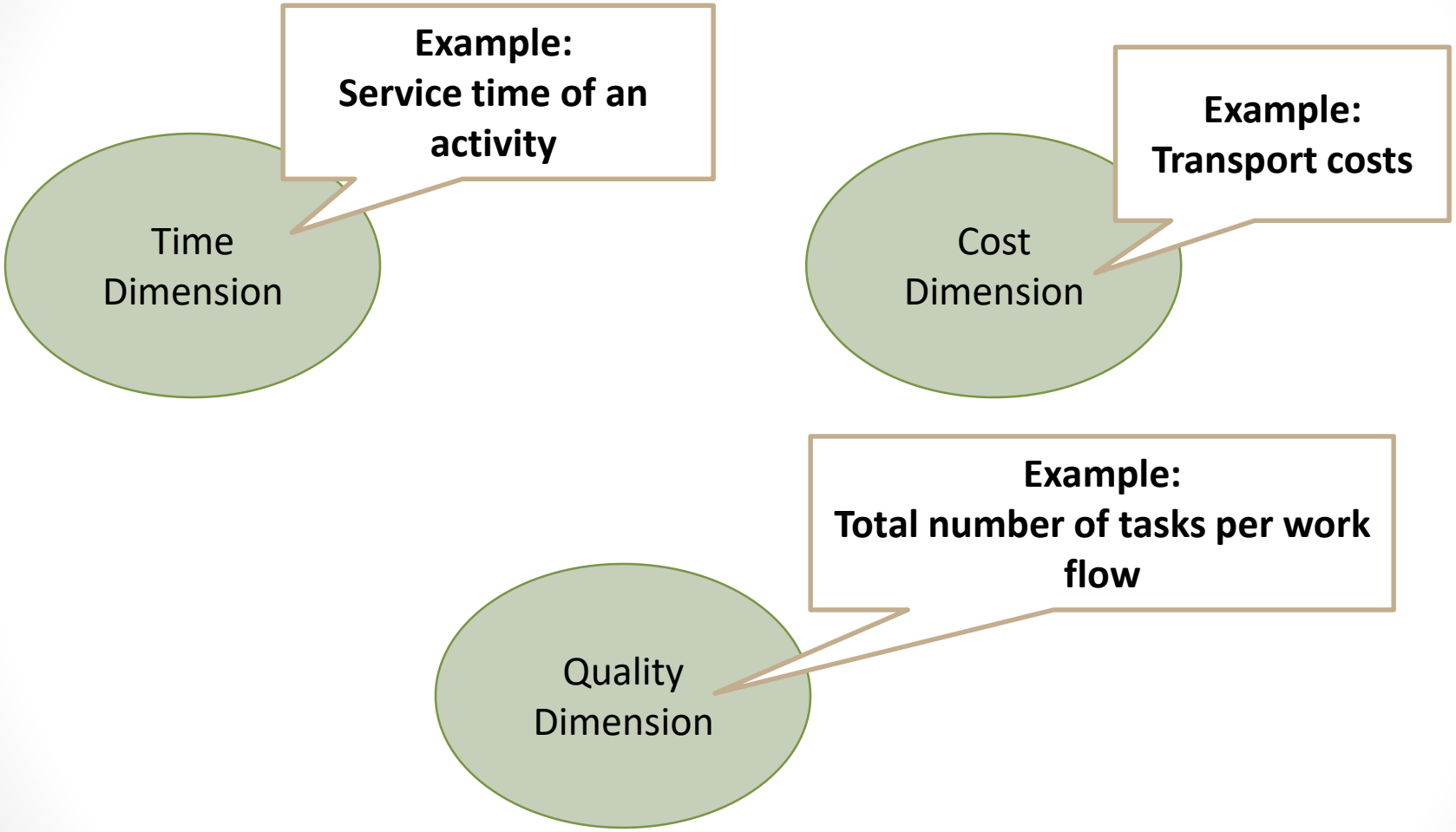
Developing Key Performance Indicators



Performance Indicators (cont')

- **Benefits of Performance Indicators:**
  - Providing a clear picture about weakness and strength points.
  - Monitor Performance.
  - Help organizations make better decision toward their success.

Dimensions of Performance Indicators



Performance Indicators

- **Time Related-Performance Indicators:**
  - Effective Time:
    - Actual time of an object. Object can be activity, human resource.
  - Service Time:
    - Total time of an object.
  - Waiting Time:
    - Idle time of an object.
  - Sojourn time:
    - Time when the activity offered in the system till it terminated.

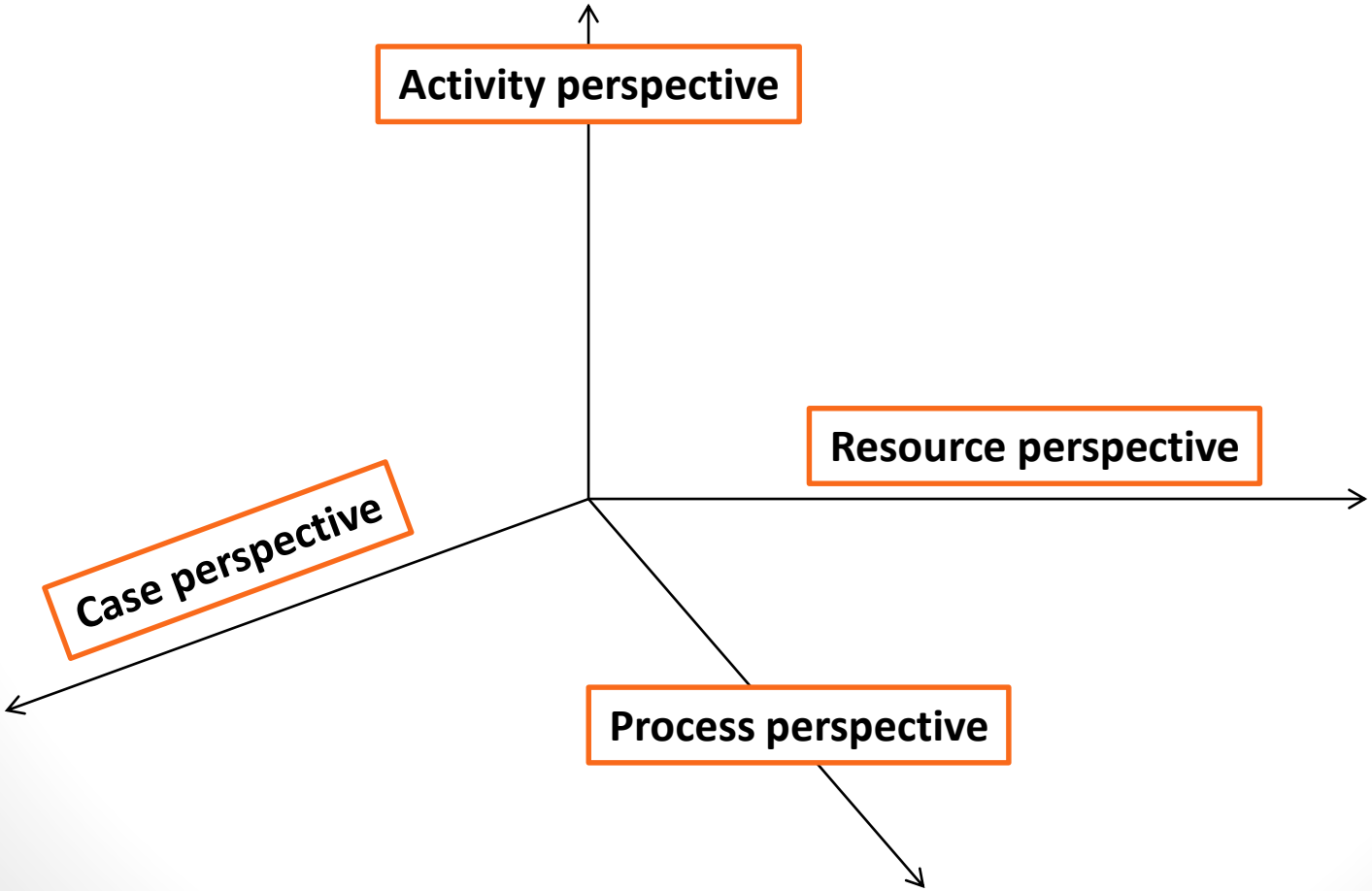
Process Execution logs

- **Process Execution logs** are logs that contain information about the activities, their timestamps and the resources who participated to their execution.

Event ID	Case	Activity	Resource	Event type	Timestamps
⋮	⋮	⋮	⋮	⋮	⋮
26	1	S.P.	Kareem	Offered	18-03-2015 06:28
27	1	S.P.	Kareem	Allocated	18-03-2015 07:28
28	1	S.P.	Kareem	Started	18-03-2015 09:28
29	1	S.P.	Kareem	Suspended	18-03-2015 15:28
30	1	S.P.	Kareem	Started	18-03-2015 17:28
31	1	S.P.	Galal	Offered	18-03-2015 18:28
32	1	S.P.	Galal	Allocated	18-03-2015 19:28
33	1	S.P.	Galal	Started	19-03-2015 10:28
⋮	⋮	⋮	⋮	⋮	⋮
54	2	G.R.M.2	Ramy	Offered	14-03-2015 11:46
55	2	G.R.M.2	Ramy	Allocated	14-03-2015 12:46
56	2	G.R.M.2	Ramy	Started	14-03-2015 14:46

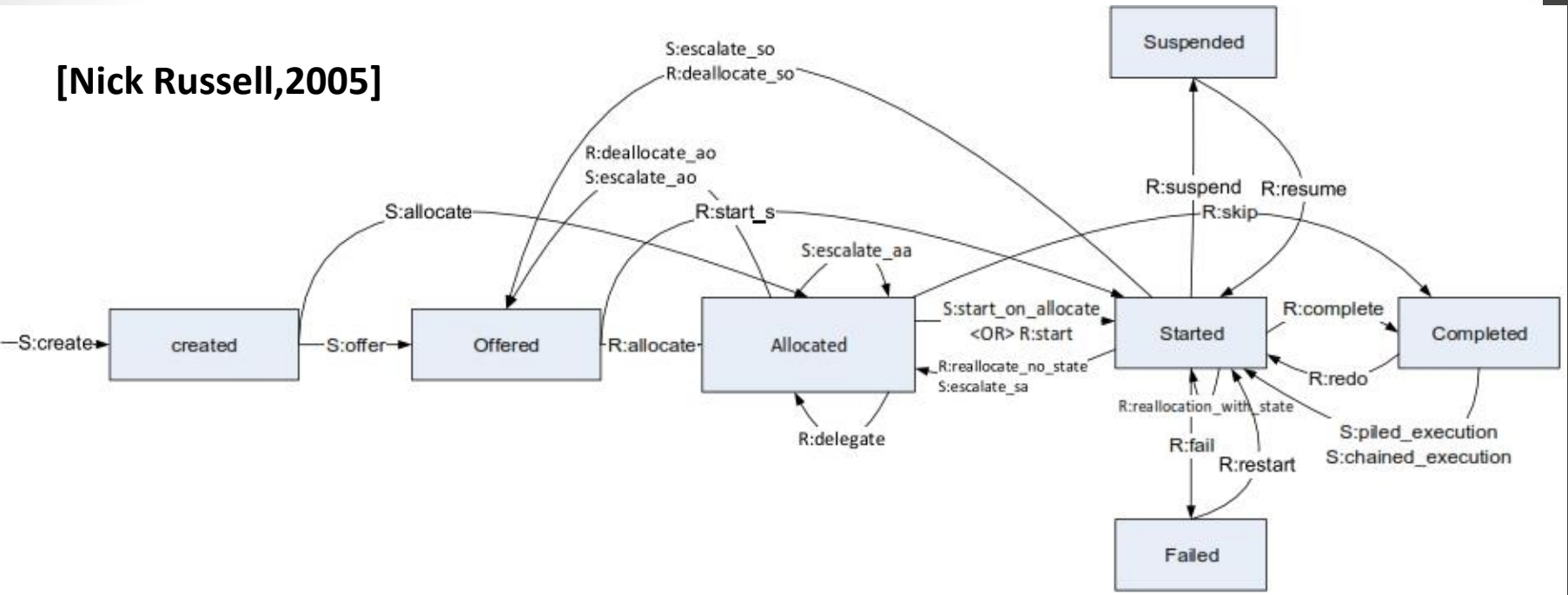
Introduction

- Performance indicators are measured according to four perspectives:



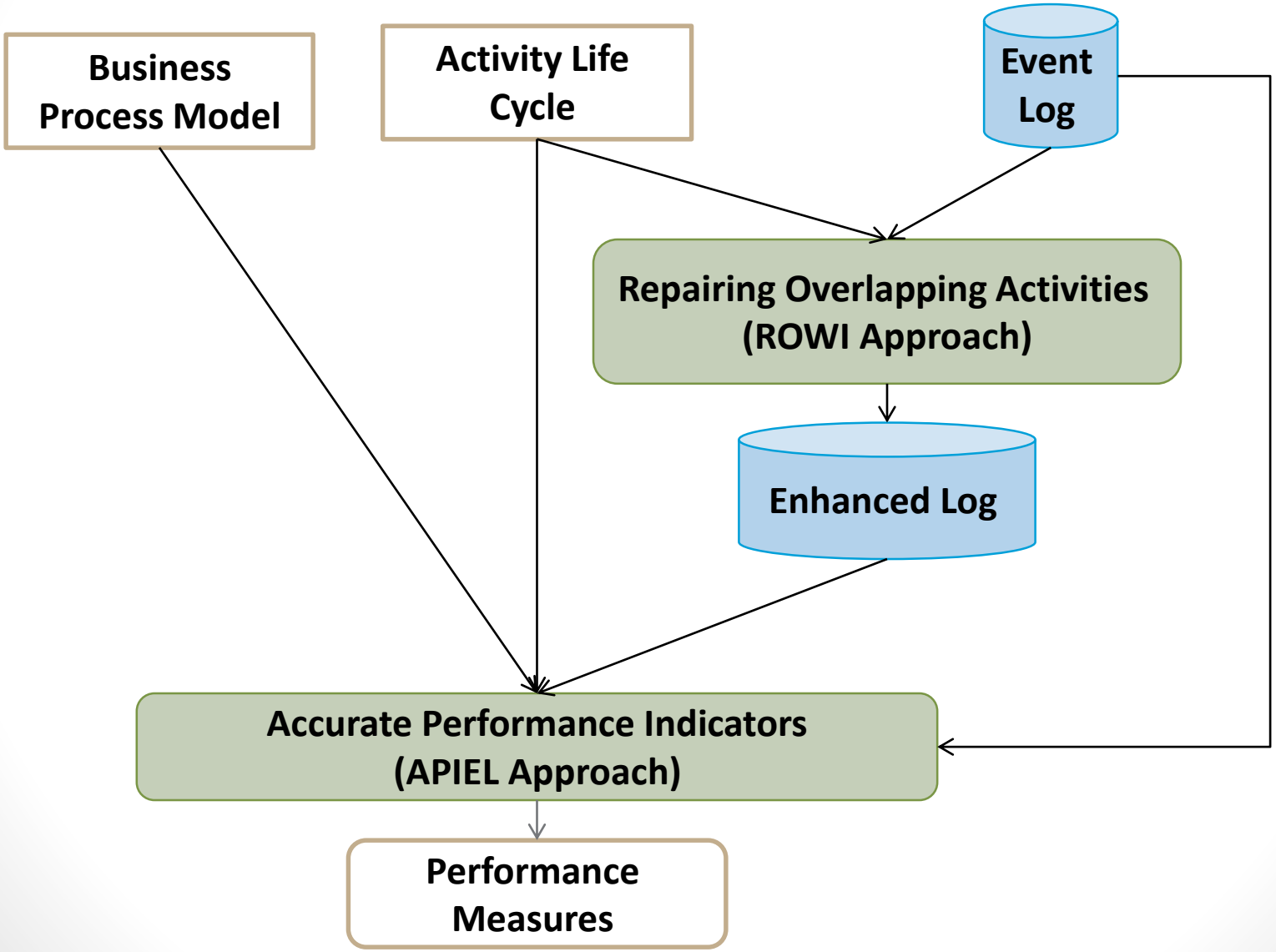
Activity Life Cycle

[Nick Russell,2005]

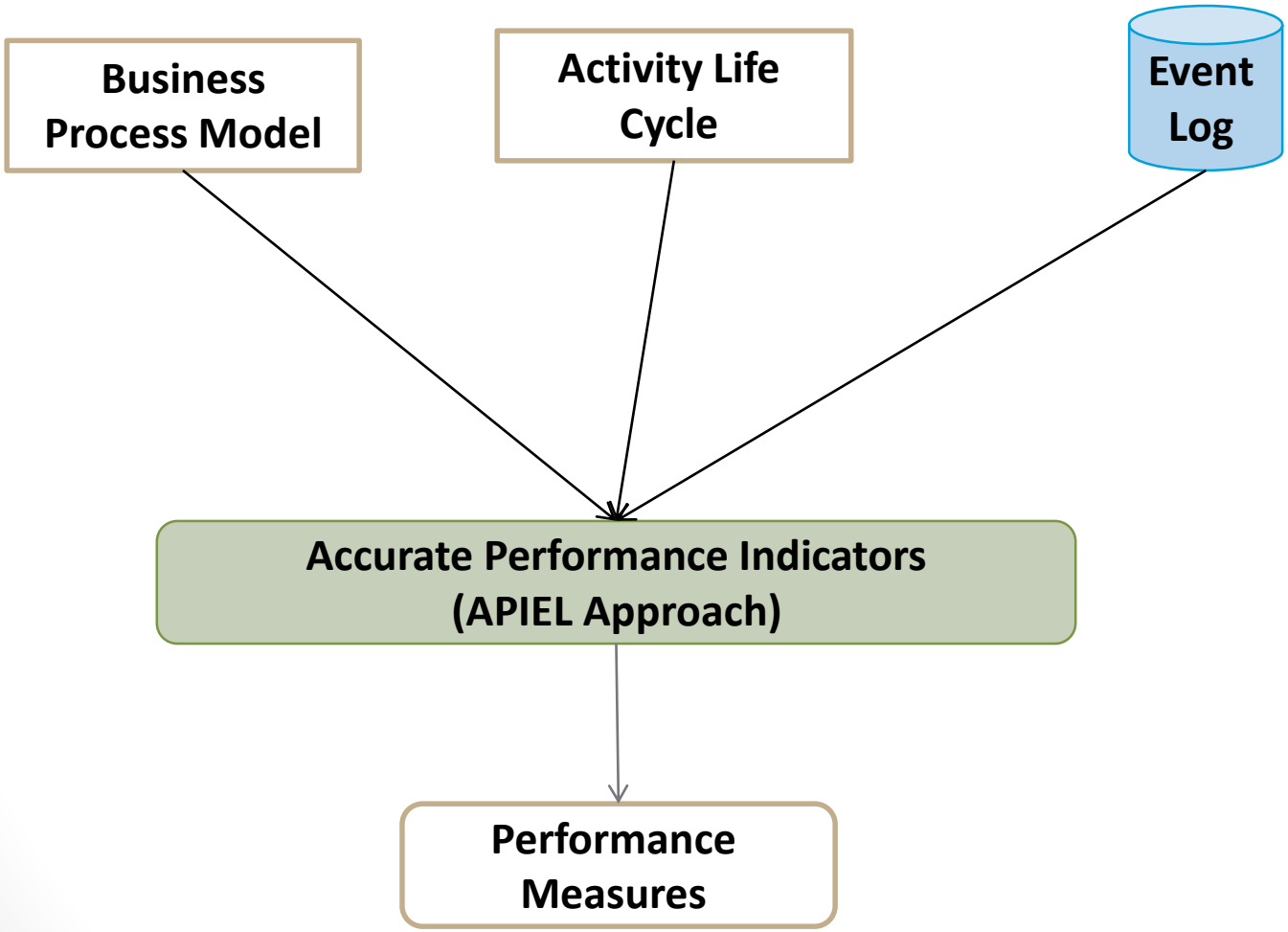


Case ID	Activity	Resource	Event type	TimeStamp
1	A	R1	Offered	1/1/2014 01:00
1	A	R1	Allocated	2/1/2014 02:00
1	A	R1	Started	2/1/2014 04:00
1	A	R1	Completed	4/1/2014 03:00

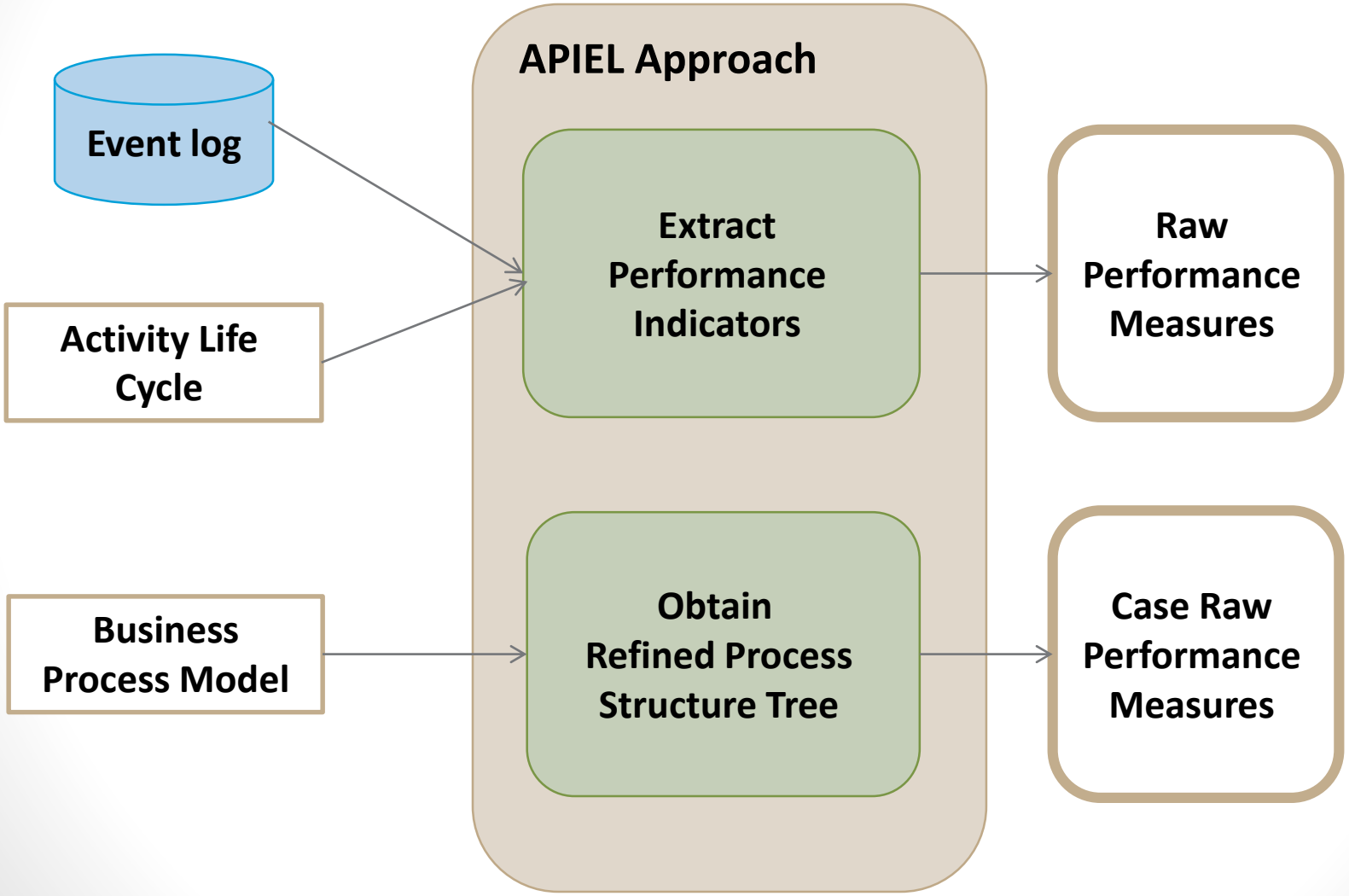
APIEL & ROWI Approaches



APIEL approach

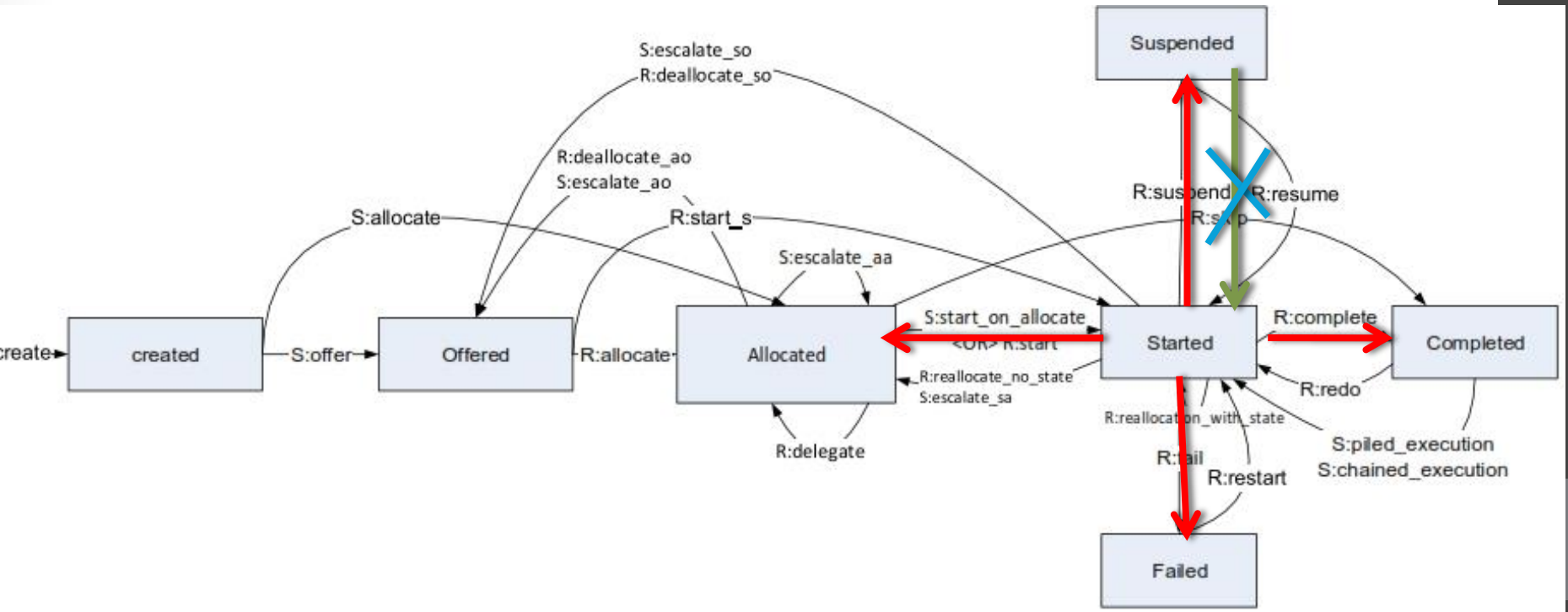


APIEL Approach



Effective Time

- **Effective time** is the actual time that the resource work on the activity without idle time.



Effective Time

- Calculate Effective time of two resources “Kareem” and “Galal” according to activity Ship Product within case 1.

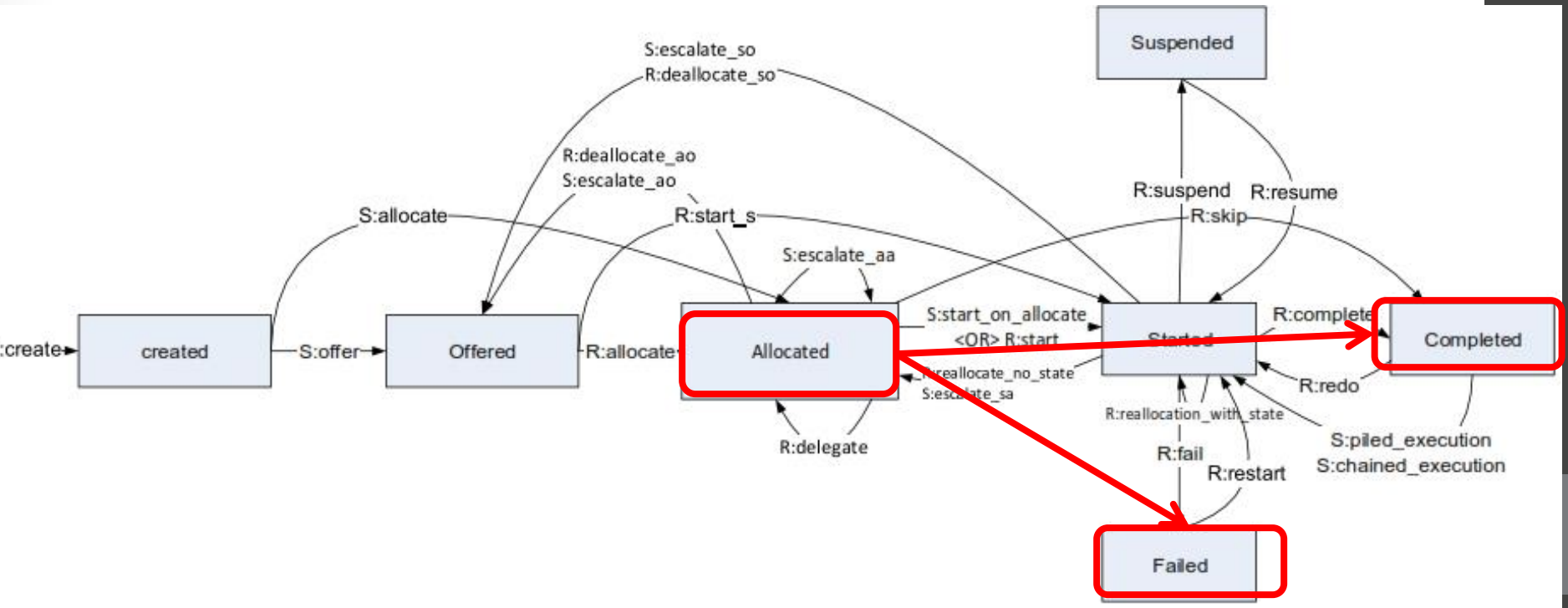
Case	Activity	Resource	Event type	Timestamps
⋮	⋮	⋮	⋮	⋮
1	S.P.	Kareem	Offered	18-03-2015 06:28
1	S.P.	Kareem	Allocated	18-03-2015 07:28
1	S.P.	Kareem	Started	18-03-2015 09:28
1	S.P.	Kareem	Suspended	18-03-2015 15:28
1	S.P.	Kareem	Started	18-03-2015 17:28
1	S.P.	Galal	Offered	18-03-2015 18:28
1	S.P.	Galal	Allocated	18-03-2015 19:28
1	S.P.	Galal	Started	19-03-2015 10:28
1	S.P.	Galal	Completed	19-03-2015 15:28
⋮	⋮	⋮	⋮	⋮

Effective time of Resource “Kareem” according to Activity “S.P.” within case 1 is **“7 hours”**

Effective time of Resource “Galal” according to Activity “S.P.” within case 1 is **“5 hours”**

Service Time

- Is the total time that the resource worked on the activity. The time elapsed between the started time of the activity until it terminated.



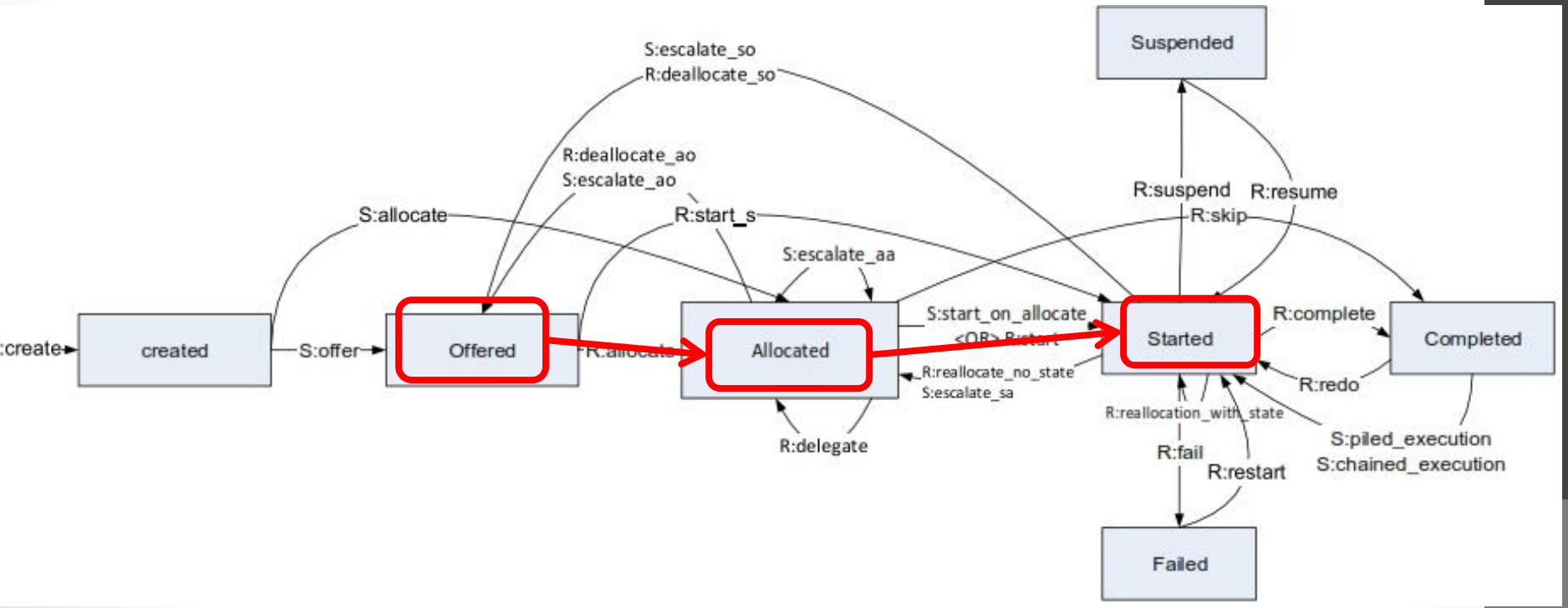
Service Time

- **Example:**
  - Service time for Ramy in G.R.M.2 in case 2 is 20 hours

Event ID	Case	Activity	Resource	Event type	Timestamps
⋮	⋮	⋮	⋮	⋮	⋮
54	2	G.R.M.2	Ramy	Offered	14-03-2015 11:46
55	2	G.R.M.2	Ramy	Allocated	14-03-2015 12:46
56	2	G.R.M.2	Ramy	Started	14-03-2015 14:46
57	2	G.R.M.2	Ramy	Suspended	14-03-2015 17:46
58	2	G.R.M.2	Ramy	Started	14-03-2015 18:46
59	2	G.R.M.2	Marwan	Allocated	15-03-2015 08:46
60	2	G.R.M.2	Marwan	Started	15-03-2015 09:46
61	2	G.R.M.2	Marwan	Completed	15-03-2015 11:46

Waiting Time

- Time between offered/allocated and started events.



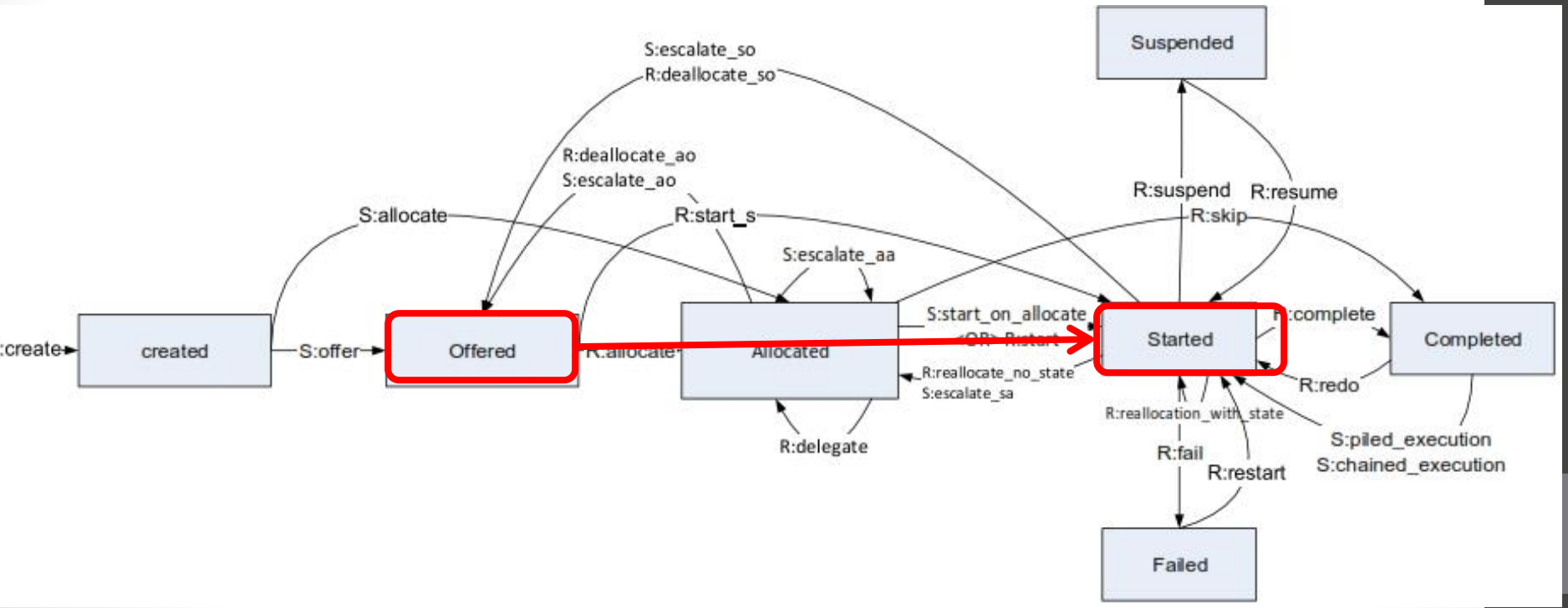
Waiting Time

- **Example:**
  - Waiting time of Kareem in S.P. within case 1 is 3 hours

Event ID	Case	Activity	Resource	Event type	Timestamps
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
26	1	S.P.	Kareem	Offered	18-03-2015 06:28
27	1	S.P.	Kareem	Allocated	18-03-2015 07:28
28	1	S.P.	Kareem	Started	18-03-2015 09:28
29	1	S.P.	Kareem	Suspended	18-03-2015 15:28
30	1	S.P.	Kareem	Started	18-03-2015 17:28
31	1	S.P.	Galal	Offered	18-03-2015 18:28
32	1	S.P.	Galal	Allocated	18-03-2015 19:28
33	1	S.P.	Galal	Started	19-03-2015 10:28
34	1	S.P.	Galal	Completed	19-03-2015 15:28

Sojourn Time

- Time between very first allocated/offered and last completed events.
- This measure applied only for activity dimension.



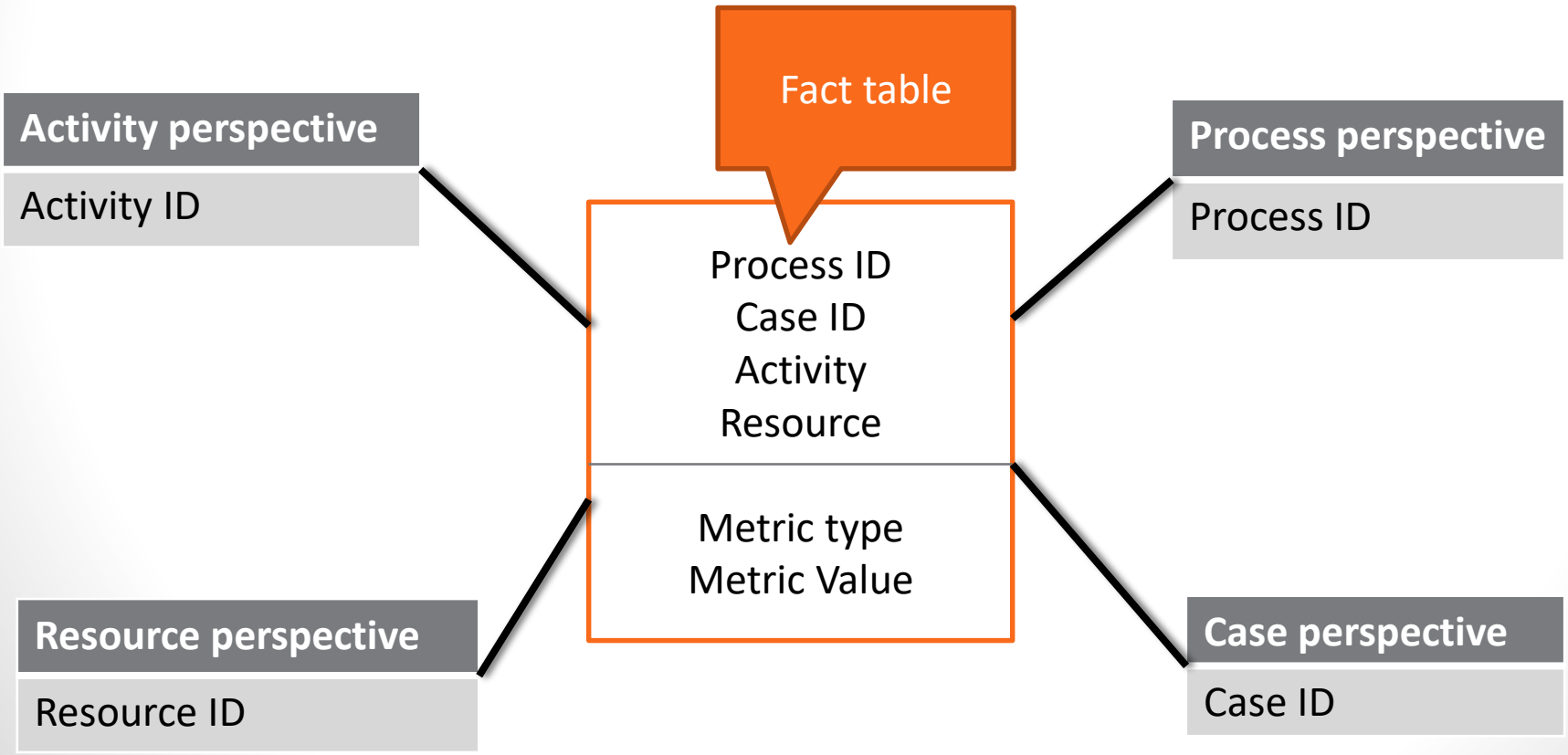
Sojourn Time

- **Example:**
  - Sojourn time for “Ship Product” in Case 1 is 33 hours

Event ID	Case	Activity	Resource	Event type	Timestamps
:	:	:	:	:	:
26	1	S.P.	Kareem	Offered	18-03-2015 06:28
27	1	S.P.	Kareem	Allocated	18-03-2015 07:28
28	1	S.P.	Kareem	Started	18-03-2015 09:28
29	1	S.P.	Kareem	Suspended	18-03-2015 15:28
30	1	S.P.	Kareem	Started	18-03-2015 17:28
31	1	S.P.	Galal	Offered	18-03-2015 18:28
32	1	S.P.	Galal	Allocated	18-03-2015 19:28
33	1	S.P.	Galal	Started	19-03-2015 10:28
34	1	S.P.	Galal	Completed	19-03-2015 15:28

Raw Performance Measures

- is a tuple on the form
  - (Process id, Case id, Activity, Resource, Occurrence, Type, Start, End, Value)



Raw Performance Measures

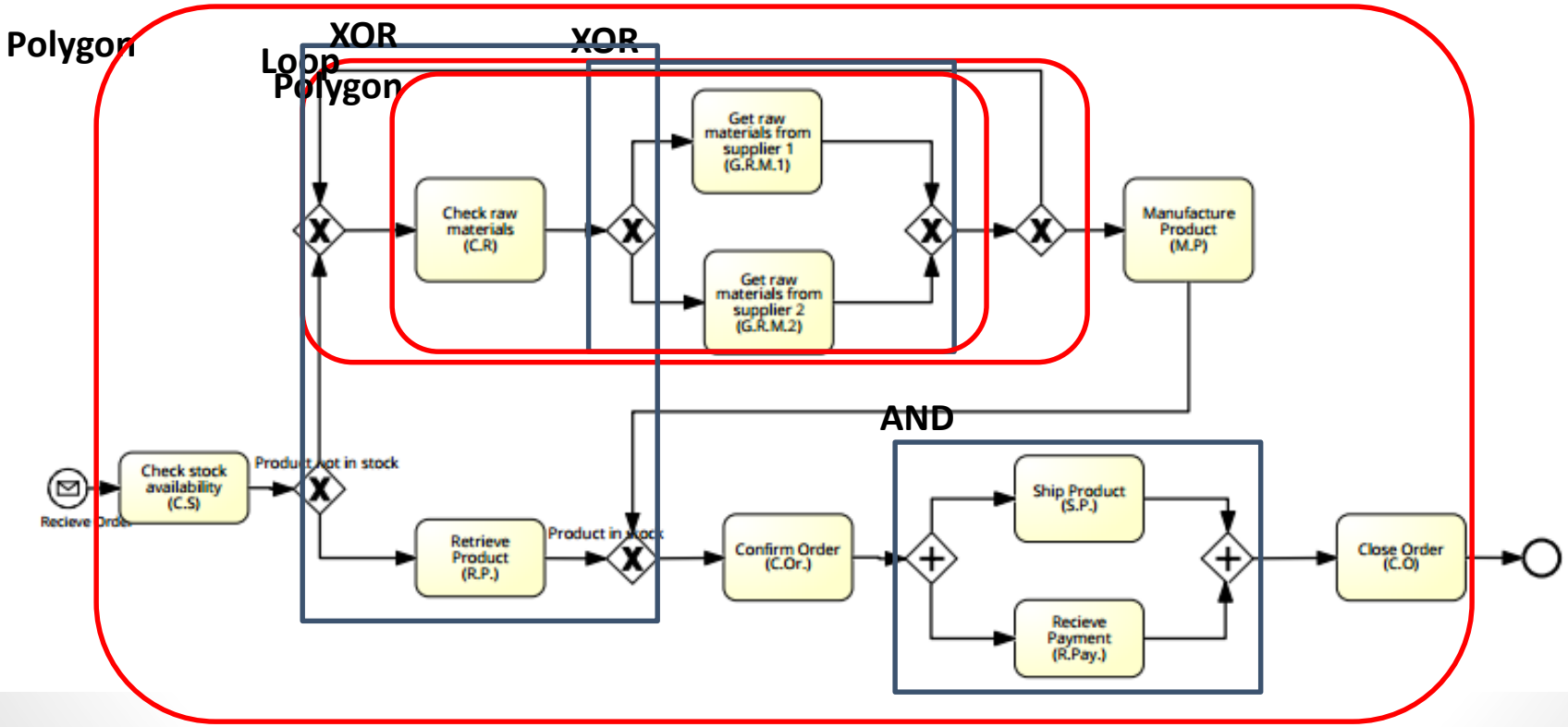
- Example: Obtain Effective time for ship product.

Effective time for S.P. is 12 hours

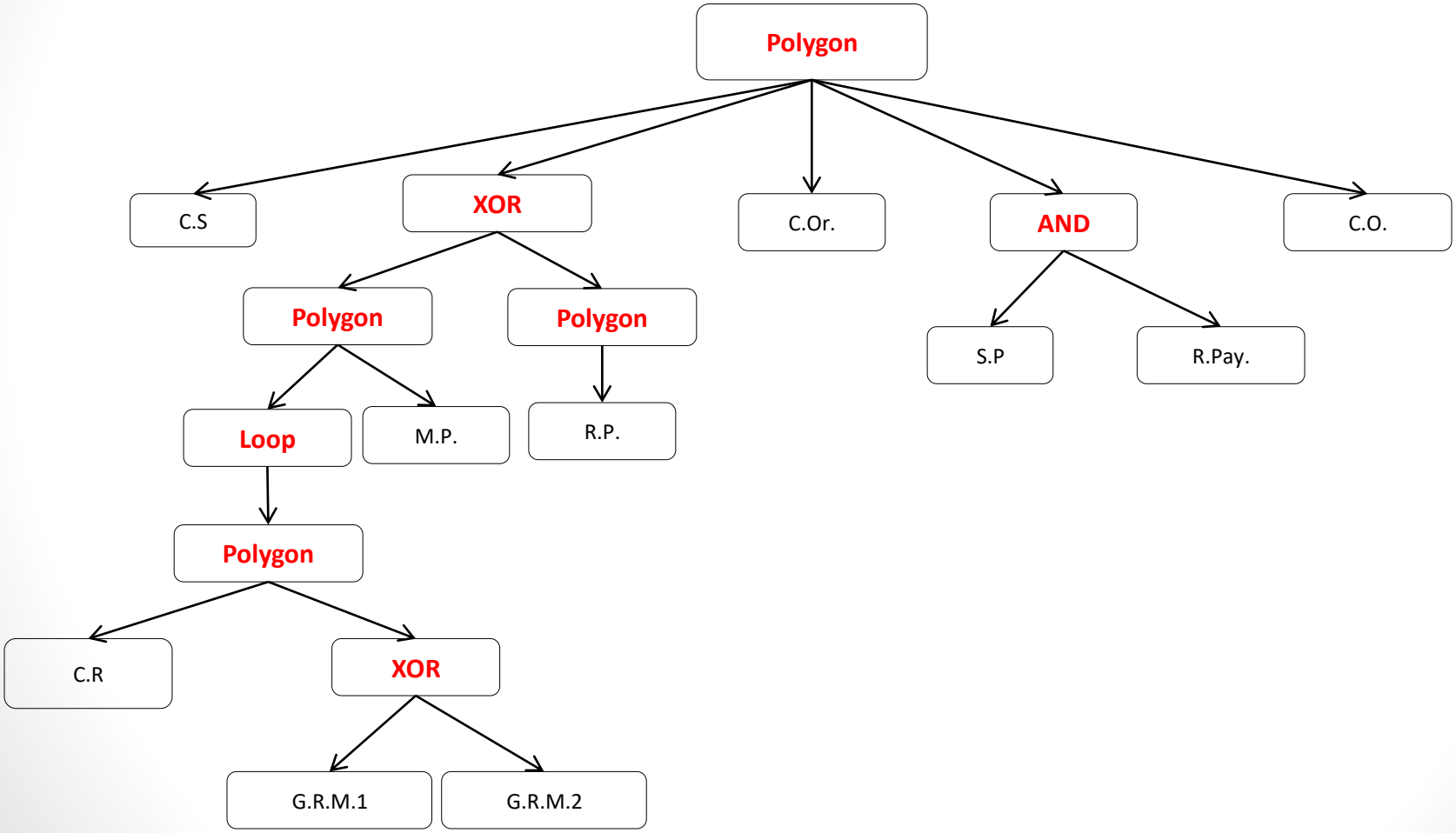
#	P.ID	C.ID	Activity	Resource	Occurrence	type	start	end	value
1	1	1	S.P.	Galal	1	Effective	07-03-2015 6:28	22-03-2015 9:28	5
2	1	1	S.P.	Kareem	1	Effective	07-03-2015 6:28	22-03-2015 9:28	7
3	1	1	S.P.	Kareem	1	Service	07-03-2015 6:28	22-03-2015 9:28	12
4	1	2	G.R.M.2	Ramy	1	Waiting	07-03-2015 11:46	30-03-2015 11:46	3
5	1	2	G.R.M.2	Marwan	1	Waiting	07-03-2015 11:46	30-03-2015 11:46	1
6	1	14	G.R.M.2	Marwan	1	Service	24-03-2015 2:41	02-05-2015 2:41	23
7	1	14	G.R.M.2	Ahmed	2	Service	24-03-2015 2:41	02-05-2015 2:41	14
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

Refined Process Structure Tree

- RPST is based on the unique decomposition of a process model into fragments. Fragments, which are the decomposition result, are organized into a hierarchy according to the nesting relation.

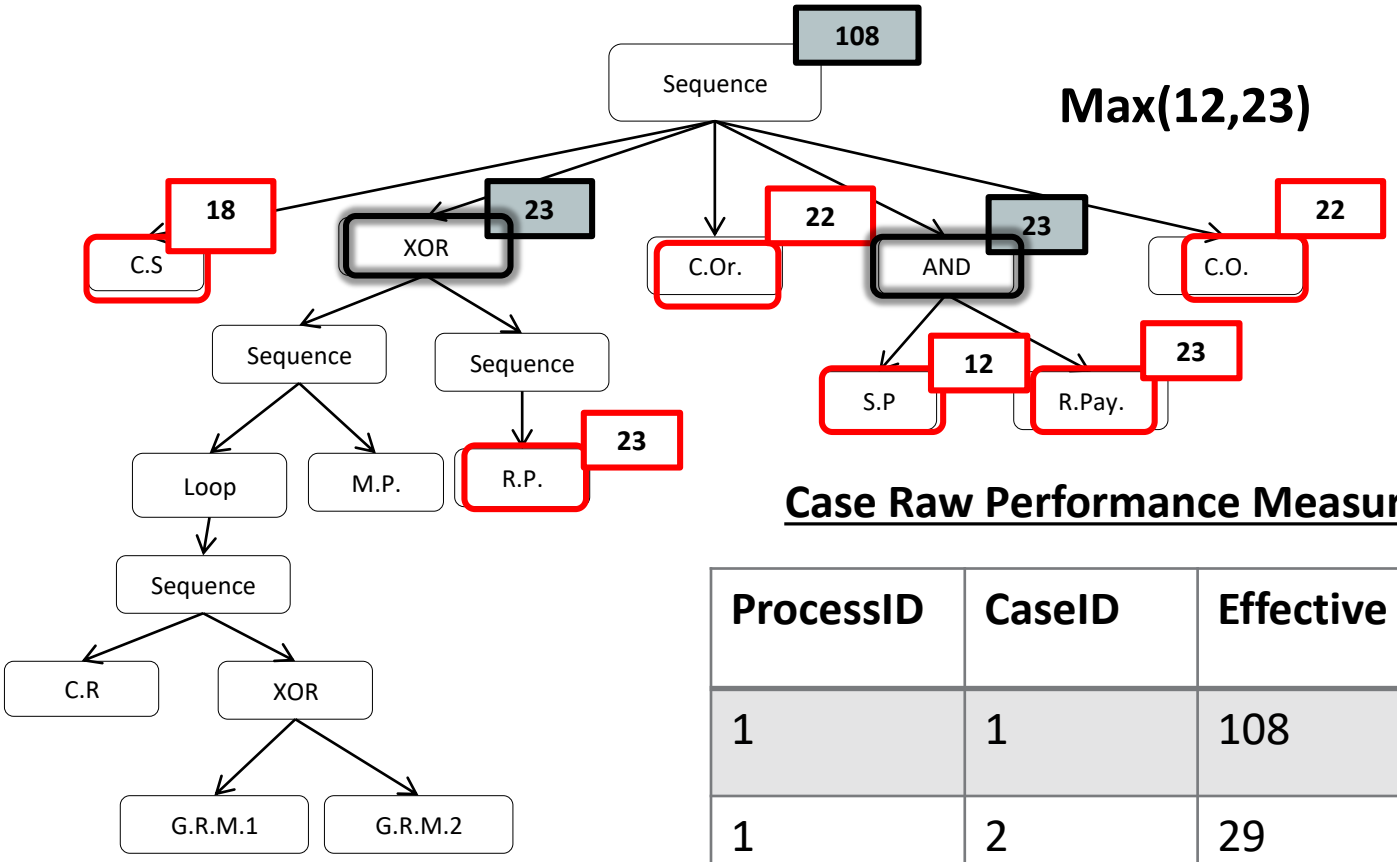


Refined Process Structure Tree



Example of Case Effective time

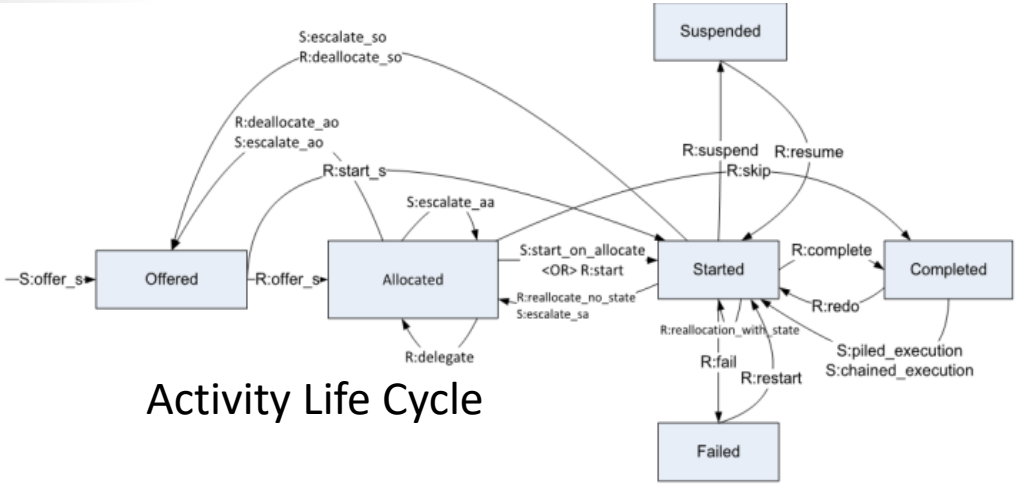
- Calculate Effective Time of Case 1 in process execution log:



Case Raw Performance Measures

ProcessID	CaseID	Effective time
1	1	108
1	2	29
1	6	19

ROWI Approach



Activity Life Cycle

Log contains overlapping activities

Event log

ROWI Approach

Log contains sequential activities

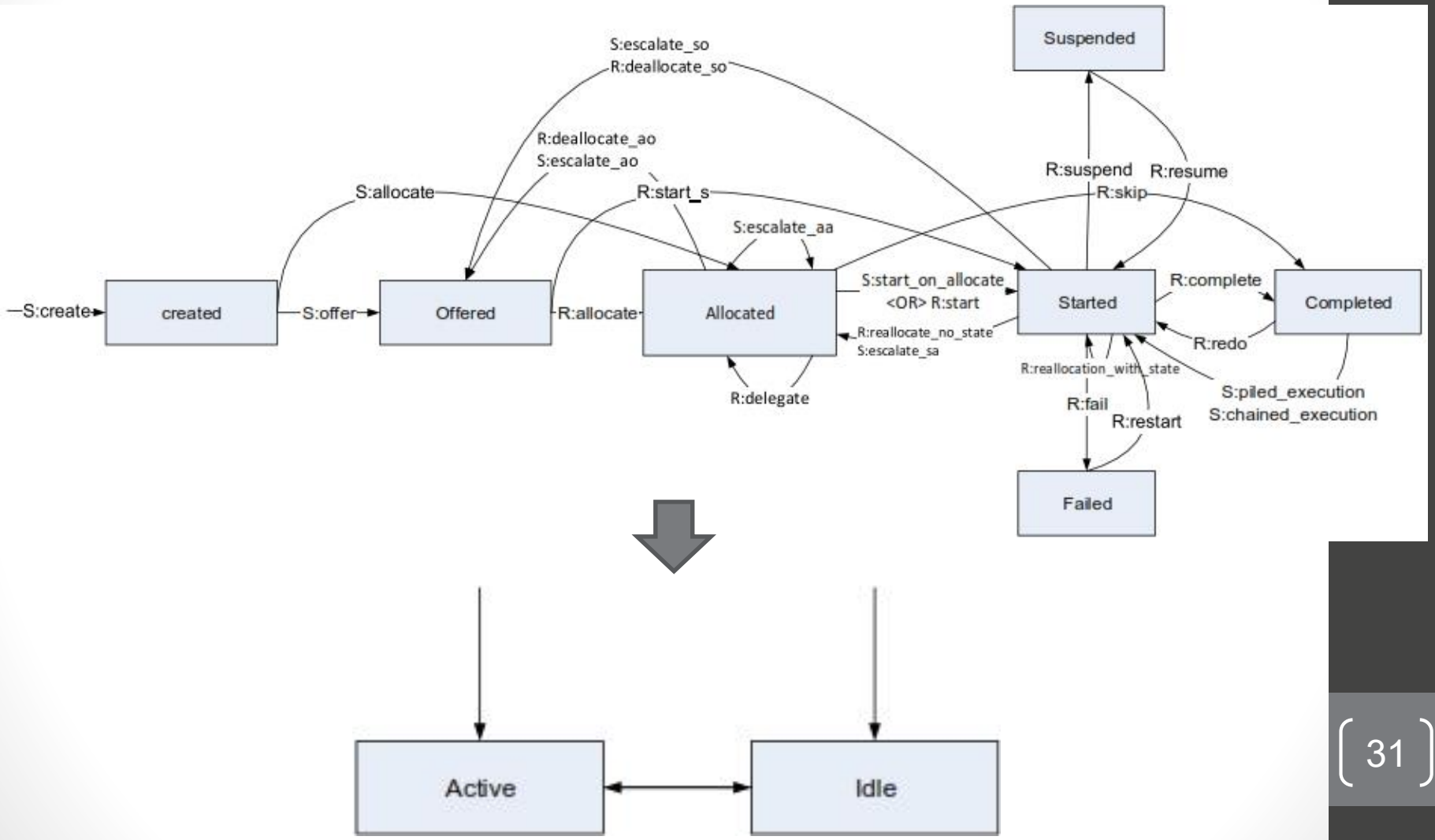
Enhanced log

ROWI Approach

- In real logs, it often happens that some human resources appear to have more than one task active concurrently, thus resulting in human multitasking.

CID	Task	Resource	Event type	Timestamp
1	A	R1	Start	T1
2	B	R1	Start	T2
1	C	R1	Start	T3
1	A	R1	Complete	T4
2	B	R1	Complete	T5
1	C	R1	Complete	T6

Mapping event states into abstract states



Abstract Life Cycle

Event log with abstract states

Active(A,t1)

CID	Task	Resource	Event type	Abstract states	Timestamp
1	A	R1	Start	Active	T1
1	B	R1	Start	Active	T2
1	C	R1	Start	Active	T3
1	A	R1	Complete	Idle	T4
1	B	R1	Complete	Idle	T5
1	C	R1	Complete	Idle	T6

Expected Results without overlapping activities

CID	Task	Resource	Event type	Abstract states	Timestamp
1	A	R1	Start	Active	T1
1	B	R1	Allocate	Idle	T2
1	C	R1	Allocate	Idle	T3
1	A	R1	Complete	Idle	T4
1	B	R1	Start	Active	T4 + θ
1	B	R1	Suspend	Idle	T4 + θ
1	C	R1	Start	Active	T4 + θ
1	C	R1	Complete	Idle	T5
1	B	R1	Start	Active	T5 + θ
1	B	R1	Complete	Idle	T6

Resolution Strategies

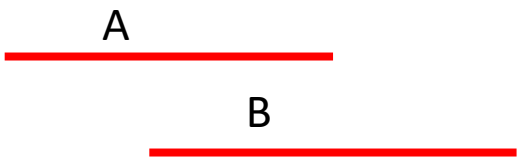
- When overlap is observed, there are three situations:
  - The human performer just forgot to assign the old activity as an idle before activation of the new activity.

Close Old Item First (COF)

  - The new activity was activated by the resource can be a ***lower priority or a higher priority***
    - In case of **lower priority**: he kept the new activity as waiting until the activity that is in his hand has finished. This situation called "Queuing Pattern". The queuing pattern is equal to **overlap (o)** relationship.

Defer Low Priority Item (DL)

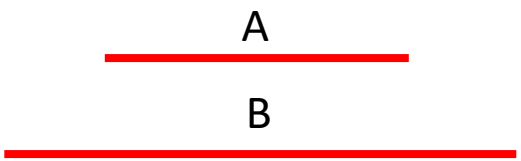
    - **Example**: A overlaps B (A o B)



Resolution Strategies

- In case of **higher priority:** old activity that is in his hand was set to be idle until the higher priority activity is finished. This situation called “Stacking Pattern” The stacking pattern is equal to **inverse during (di)** relationship.
- **Example**: A during B (B di A)

Suspend Low Priority Item (SL)



Close Order Item First (COF)

- In this technique, the log is changed so that the first activity is closed before the second activity is started.

Before applying COF pattern

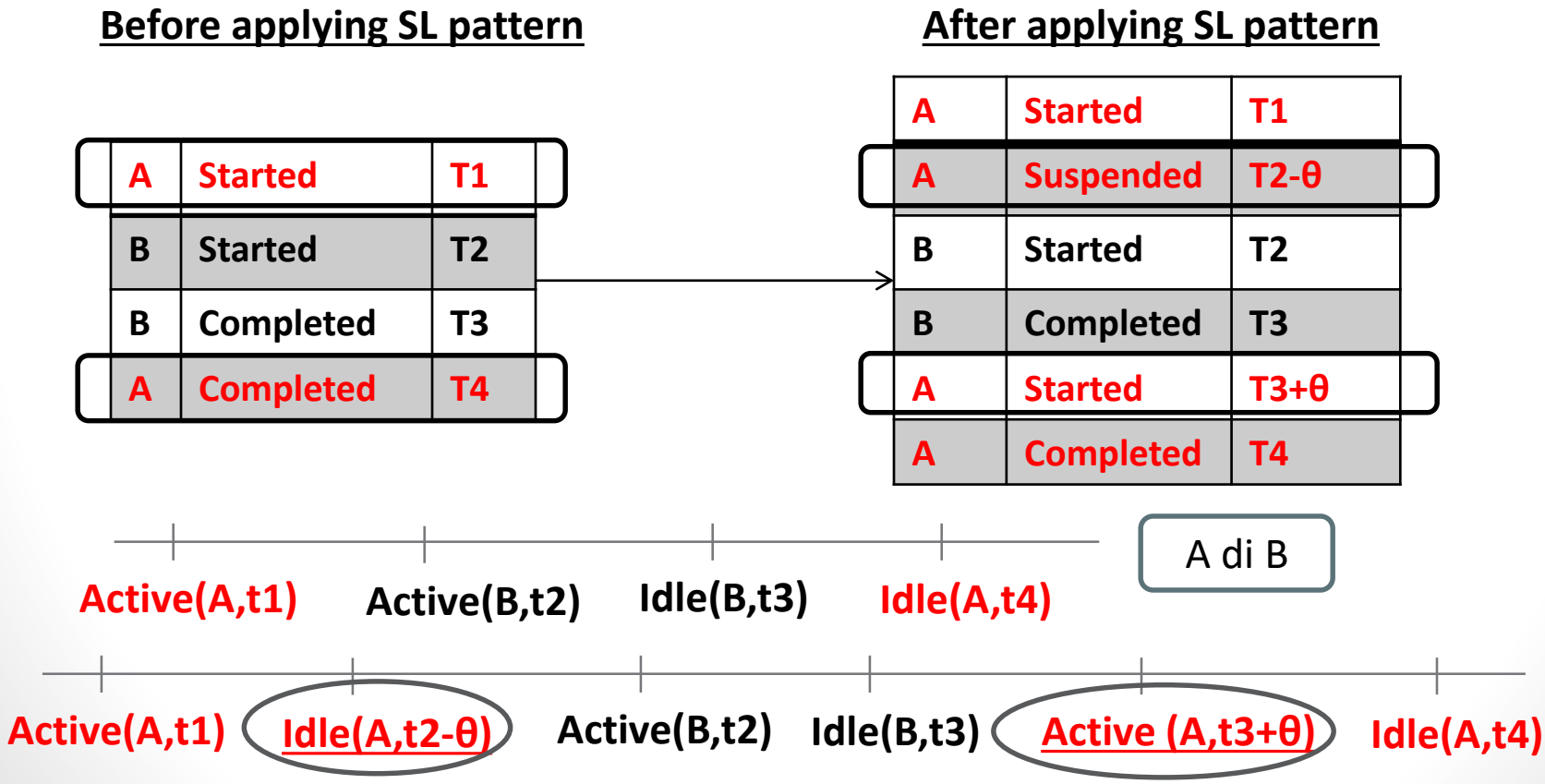
A	Started	T1
B	Started	T2
B	Completed	T3
A	Completed	T4

After applying COF pattern

A	Started	T1
A	Completed	T2
B	Started	T2
B	Completed	T3

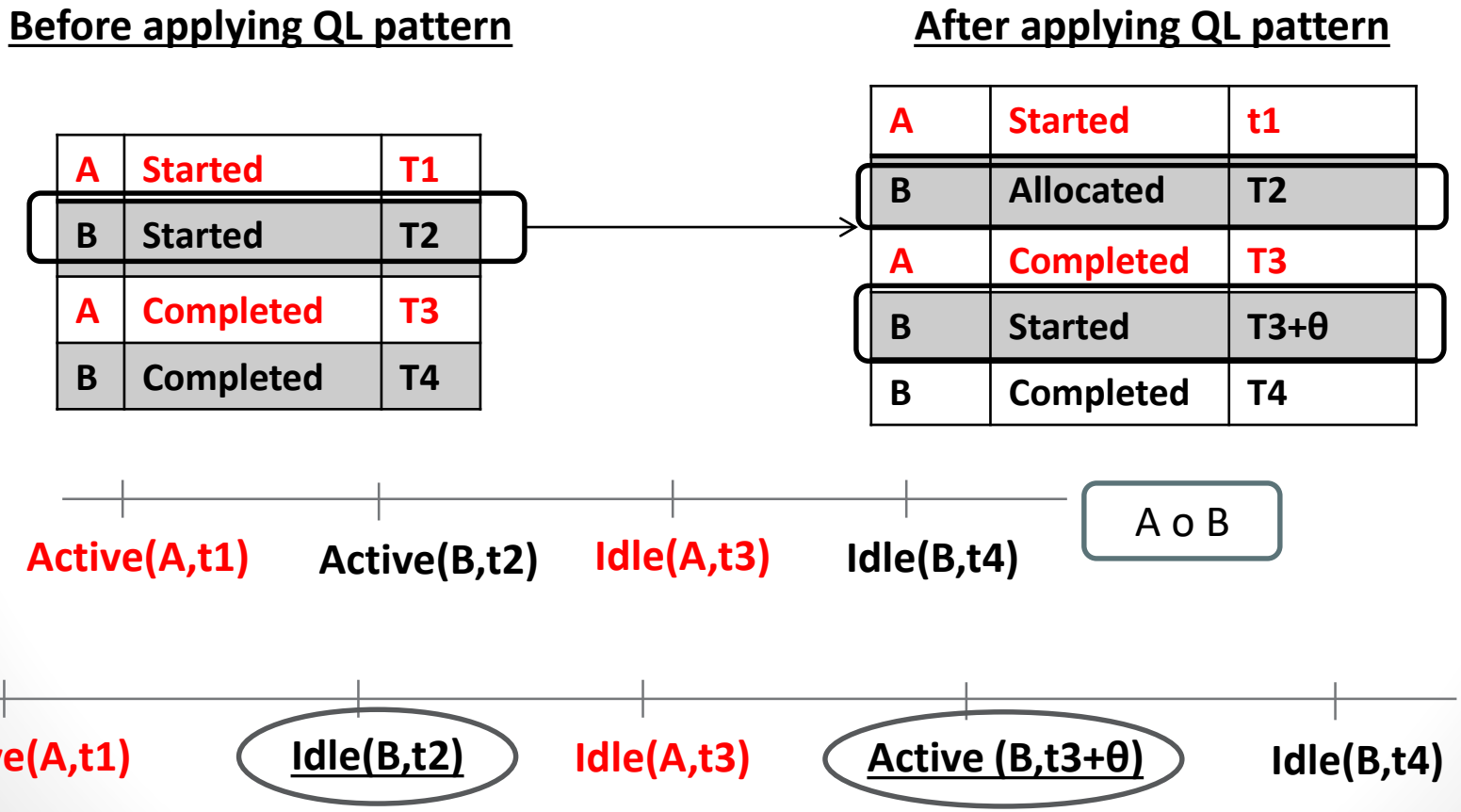
Suspend Low Priority Item (SL)

- In this technique, the current activity is **paused** until the new item is **addressed** and then **resumed** again

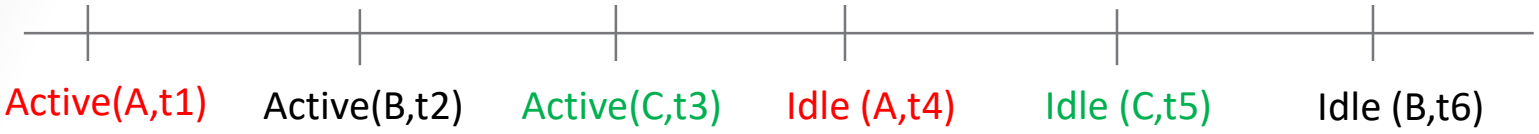


Defer Low Priority Item (DL)

- In this technique, the new activated item will be postponed until the currently active item is finished.

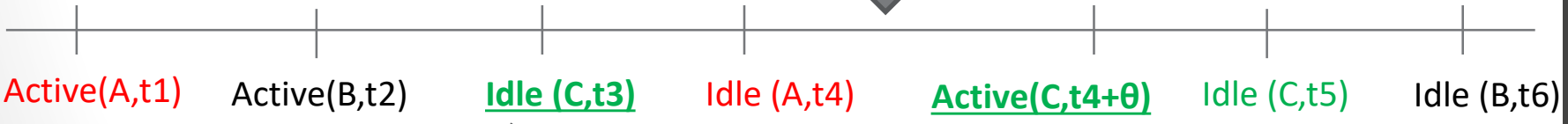


Compound Overlap



Relationship	Time
A o B	T2
A o C	T3
B di C	T3

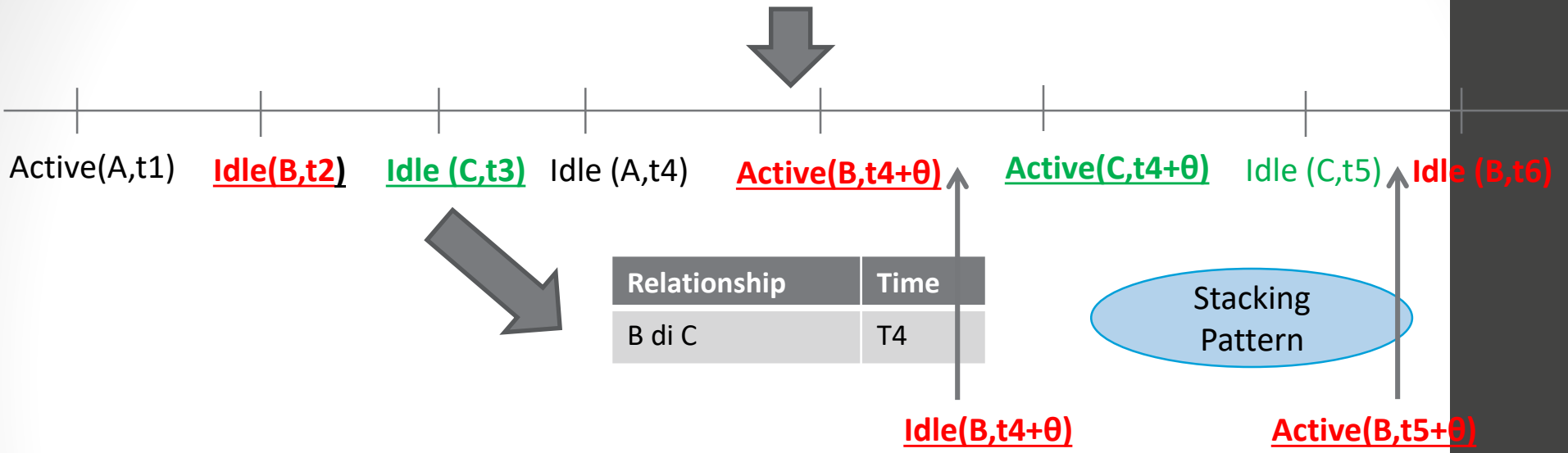
Queuing Pattern



Relationship	Time
A o B	T2
B di C	T4

Queuing Pattern

Compound Overlap



Thank You