



**Technische Universität München**  
**Lehrstuhl für Kommunikationsnetze**

Techno-Economic Analysis of Telecommunication Networks  
Project report

**FAILURE REPARATION OF IP**  
**NETWORK ROUTING SERVER**  
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## **INTRODUCTION**

### **SCENARIO**

Network operator provides 3G mobile data service. These services are handled by various servers.

### **EVENTS THAT TRIGGER THE PROCESS**

The Network Operator receives complaints from the customers regarding the degradation of the 3G mobile data service. Using this, technicians of the Network Operator Centre detected failure in one of the IP network routing components server. The server was mainly used to assign IP and IP-MSISDN mapping to other platforms in the network. This bug in the server resulted in the reduction in the number of unallocated IP address in the pool, as a result, when there was a new attempt of IP allocation from 3G mobile data users, no IP address was available for allocation to the users.

The event was handled by the Network Operator, who provides 3G mobile data services to the customers.

## **PROCESS MODEL**

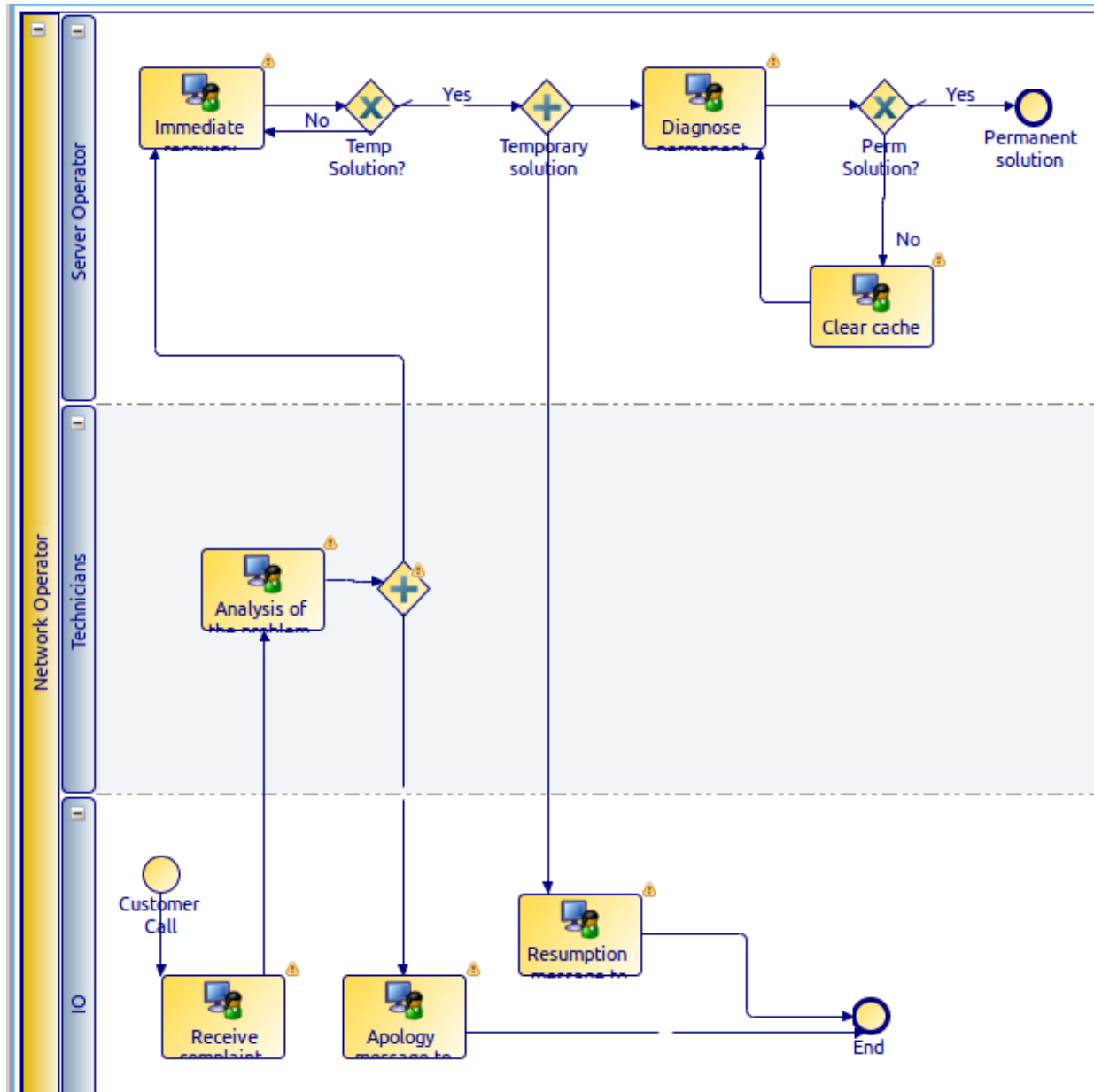


Fig 1: BPMN Process model

## **DESCRIPTION OF THE MODEL**

- ◆ Network operator of 3G mobile data service receives Customer call regarding the degradation of the data service.
- ◆ The customer complaint is noted by the Information Operation team and transferred to the Technicians.
- ◆ The organization group of technicians analyze the cause for the service degradation, and find out the bug in the IP network routing component server.

- ◆ The technicians group informs Information Officer, and an apology message is sent to all the customers, regarding the service degradation, by the Information Operation team.
- ◆ The technicians group informs the Server Operator Desk regarding the bug in the server.
- ◆ The group of technicians in Server Operation Desk tries to find the temporary fix to the bug. In reality, this task takes minimum 1-hour duration.
- ◆ On fixing the server temporarily, the Information officer is informed about the service resumption. The service resumption message is sent to all the customers.
- ◆ The technicians group of Server Operator Desk further has to find the permanent fix to the server bug.
- ◆ The group gets 4 weeks of duration to fix the bug permanently, otherwise the cache of server is cleared every 4 weeks.

(In the process modelling, the duration to find the permanent fix to the bug is reduced to 2-hours, in order to get the simulation results.)

## **DEFAULT SCENARIO**

### **ACTIVITIES**

**START EVENT:** Customer call

- ◆ No. Of cases = 100
- ◆ Distribution: Exponential
- ◆ Value: Mean = 5 minutes.

### **PARTICIPANTS**

Participant Name	Number of participants	Salary in € / hour
<b>CCO (Customer Care Operator)</b>	3	8
<b>OU1 (Organizational Unit 1)</b>	5	15
<b>IO (Information Operator)</b>	2	8
<b>OU2 (Organizational Unit 2)</b>	3	18
<b>OU3 (Organizational Unit 3)</b>	2	20
<b>CC1 (Clear Cache 1)</b>	1	10

### **ACTIVITIES**

All the activities are User tasks

Activity	Distribution	Value	Participants
<b>Receive the complaint</b>	Exponential	Mean = 5 mins	CCO
<b>Analysis of problem</b>	Normal	Mean = 30 mins, SD = 1	OU1
<b>Apology to customers</b>	Constant	Value = 30 mins	IO

<b>Resumption message</b>	Constant	Value = 10 mins	IO
<b>Immediate recovery solution</b>	Normal	Mean = 30 mins, SD = 2	OU2
<b>Diagnose for permanent solution</b>	Normal	Mean = 1 hour, SD = 1	OU3
<b>Clear cache</b>	Constant	Value = 30 mins	CC1

## GATEWAYS

Name	Yes (%)	No (%)
<b>Temporary solution</b>	25	75
<b>Permanent solution</b>	50	50

## SIMULATION RESULTS

- ♦ Time analysis:
  - ♦ Minimum event time – 1081.4902 mins
  - ♦ Maximum event time – 5190.9705 mins
  - ♦ Average event time – 2986.0454 mins

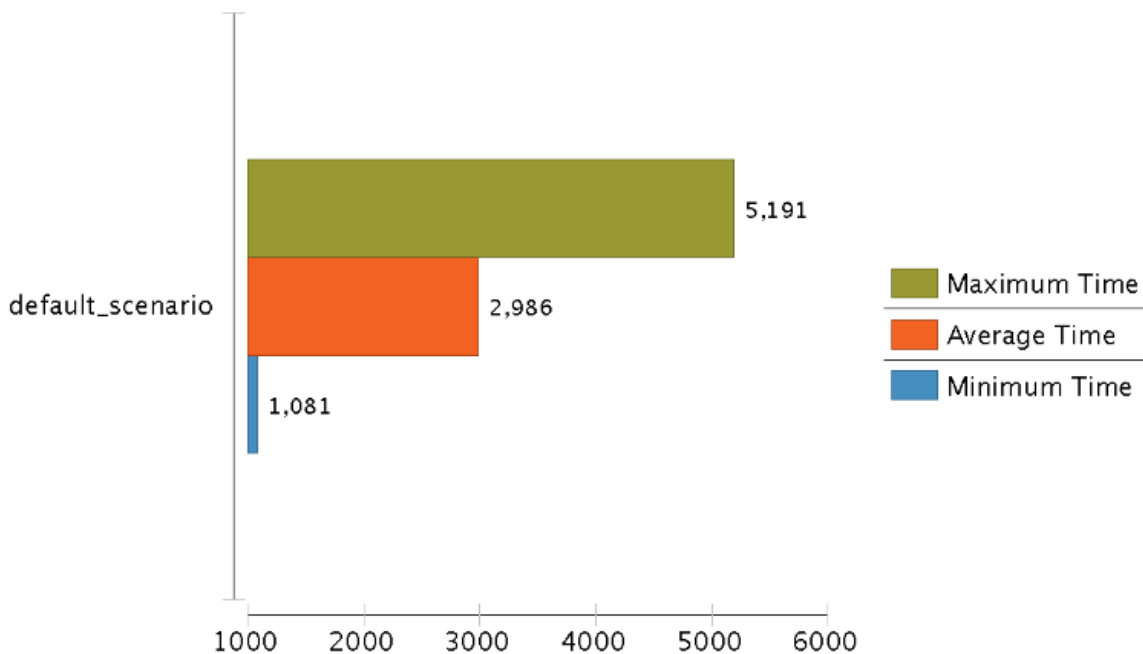


Fig 2: Case Cycle Times

The figure above shows the minimum, average and maximum case times for each experiment. All time measurements are displayed in minute and all costs are in (EUR).

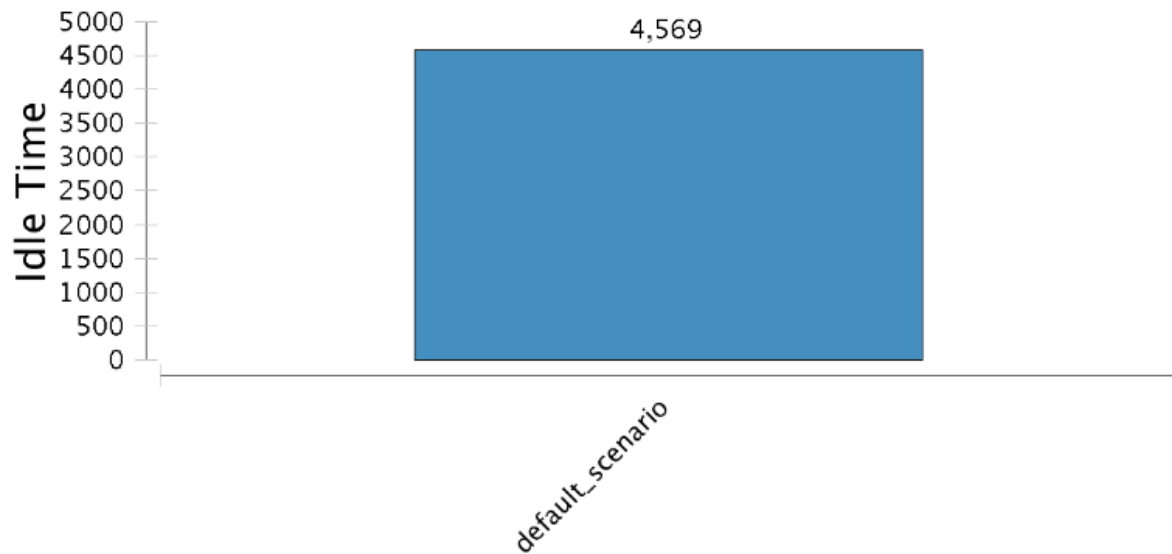
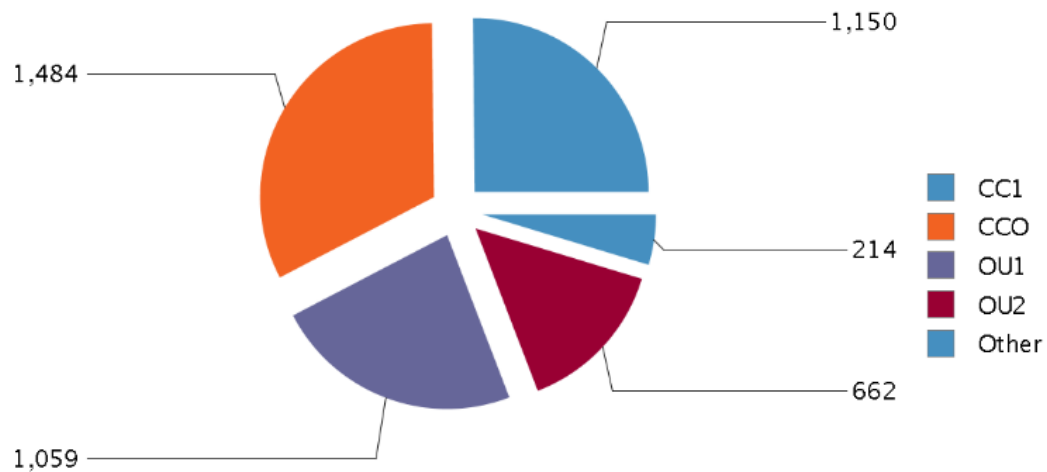


Fig 3: Total Resource Idle Time

The figure above shows the totals of the average resource idle times for each experiment. All time measurements are displayed in (minute).



Name	Instances	Average Idle Time	Average Busy Time	Utilization %
CCO	3	1484	176	10.
OU3	2	179	1481	89.2
CC1	1	1150	510	30.7
OU2	3	662	998	60.1
IO	2	35	1625	97.8
OU1	5	1059	601	36.

Fig 4: Participant Idle Time

The figure above shows the comparison of Idle time of different participants in percentage. The table shows the percentage of Participant Utilization. The time values of Average Idle Time and Average Busy Time are in minutes.

## **ANALYSIS OF THE RESULTS**

- ◆ For the default scenario, the weight of 'Temporary solution' gateway is Yes-25% and No-75%. This is chosen based on the fact that in real scenario, the time taken to find a temporary fix to the service is more, and there are many chances of failure. To give this effect, the task 'Immediate solution recovery' runs for 1-hour and checks whether the solution is obtained.
- ◆ Due to the above situation, the 'Diagnose for permanent solution' does not encounter many events to handle and so does the 'Clear cache'. Hence the participant 'CC1' of 'Clear cache activity' experiences very high Idle time.
- ◆ Since all the events do not reach the 'Diagnosis for permanent solution' task, the overall Idle time is high and the average event time is low.
- ◆ 'CCO' does not have any task after receiving the customer call, hence the Idle time is high. 'OU1' has more participants in order to analyze the bug quickly, hence the Idle time is high. 'IO', the number of participants is less and they handle two tasks, hence they have maximum utilization. The number of participants is kept low for 'Diagnosis for permanent solution' task because it is a technical job, the technicians have high salary and also more time to allotted for the diagnose.
- ◆ From the simulation results, it was observed that, 'Immediate solution recovery' and 'Diagnose for permanent solution' have a huge average waiting time. The waiting time of 'Immediate solution recovery' affects the events entering the task 'Diagnose for permanent solution'. The waiting time also increases the time required for the temporary fix. Hence two case scenarios were modelled based on these results.

## **CASE STUDY**

### **CASE STUDY I**

#### **GOAL**

It was observed that, 'Immediate solution recovery' and 'Diagnose for permanent solution' have a huge average waiting time. The waiting time of 'Immediate solution recovery' affects the events entering the task 'Diagnose for permanent solution'. The waiting time also increases the time required for the temporary fix. The goal is to reduce the time required to provide a temporary fix and permanent solution (average waiting time) and to increase the number of tasks handled by 'Diagnose for permanent solution' task.

#### **CHANGES IN THE PARAMETERS**

Two changes were made in the number of participants 'OU2' and 'OU3'. The number of participants were increased to see the desired output. For 'OU2' the number of participants were increased from 3 to 5. For 'OU3' the number of participants were increased from 2 to 4.

## SIMULATION RESULTS

### ACTIVITY: IMMEDIATE RECOVERY SOLUTION PARTICIPANT: OU2

	No. of participants	Average waiting time	Events handled
<b>Default scenario</b>	3	659.7016 mins	100
<b>Case 1</b>	5	62.5386 mins	100

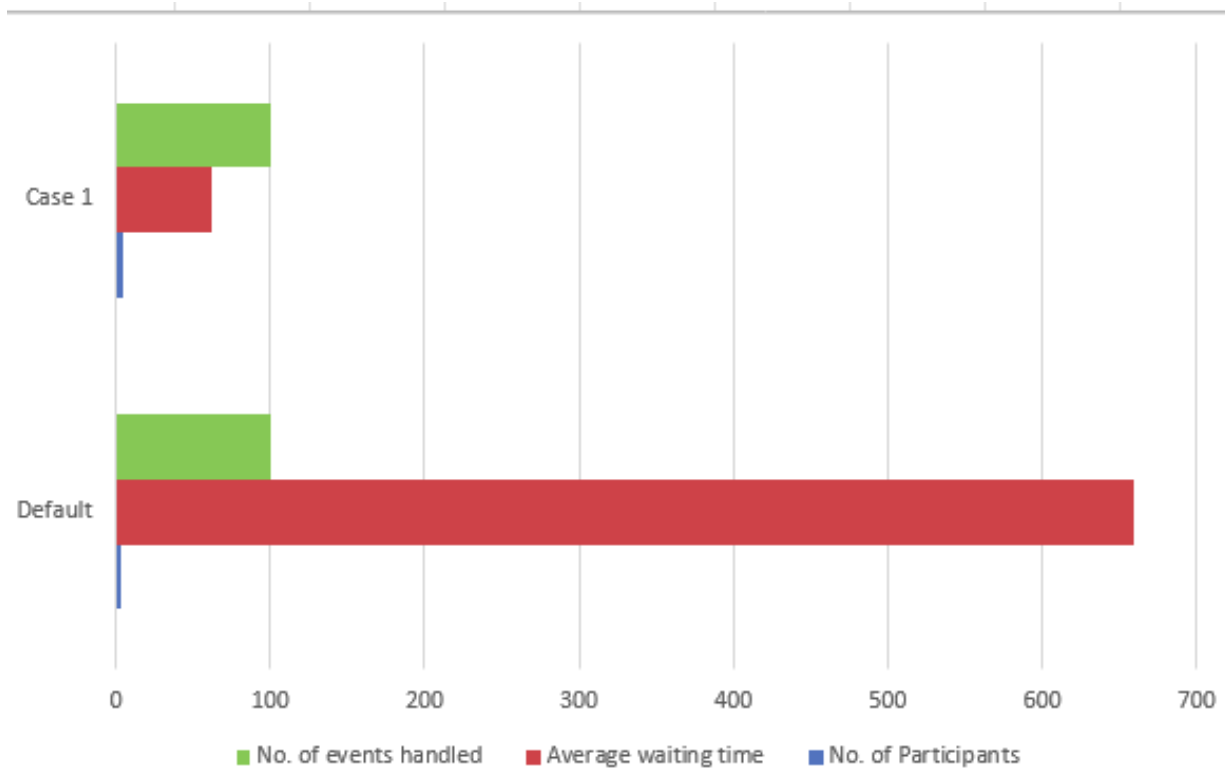


Fig 5: Comparison of Average Waiting Time

The figure above shows the comparison of Average waiting time in minutes for the activity 'Immediate solution recovery' when the number of participants is increased.

### ACTIVITY: DIAGNOSE FOR PERMANENT SOLUTION PARTICIPANT: OU3

	No. of participants	Average waiting time	Events handled
<b>Default scenario</b>	2	572.1357 mins	41
<b>Case 1</b>	4	189.4657 mins	56



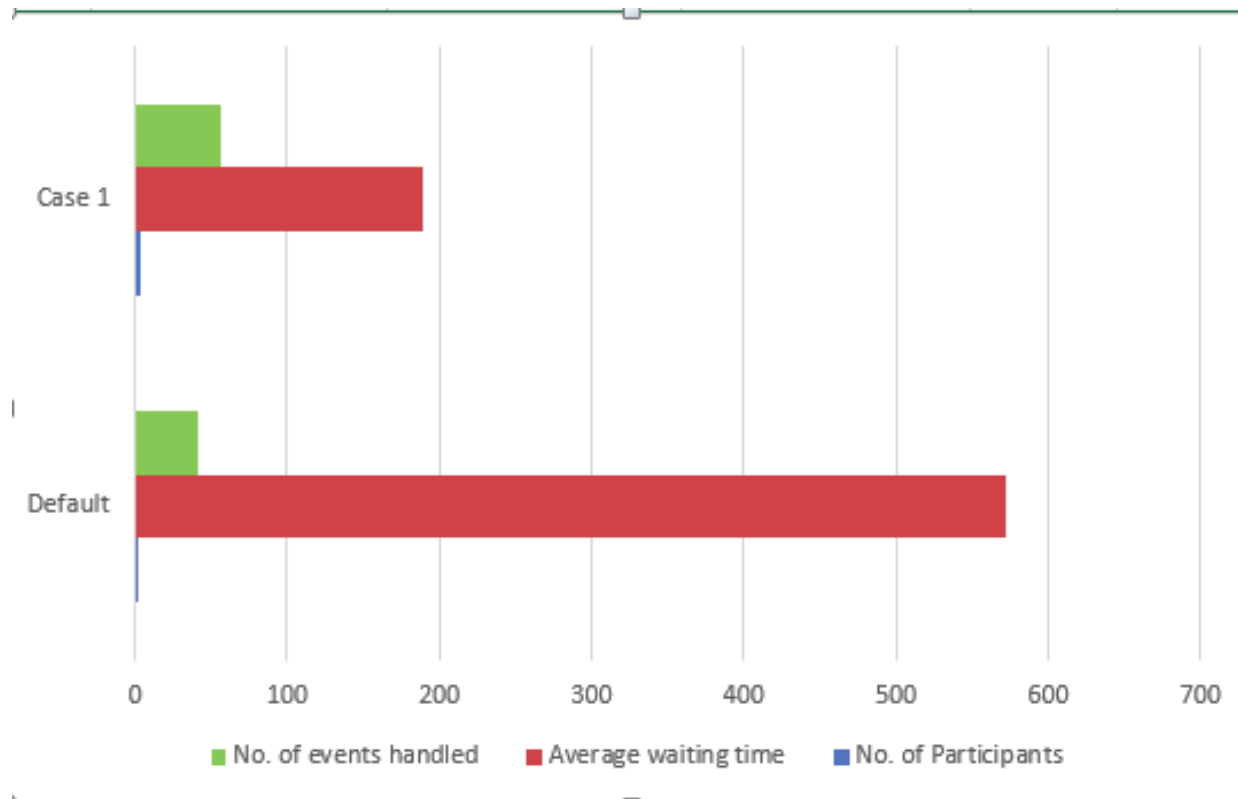


Fig 6: Comparison of Average Waiting Time and the no. of events handled

The figure above shows the comparison of Average waiting time in minutes for the activity 'Diagnose for permanent solution' when the number of participants is increased.

### ANALYSIS

From the above simulation results, we can see that the average waiting time for the task 'Immediate solution recovery' is reduced, hence the time taken for the service resumption is reduced from the default scenario. The number of events handled by the task 'Diagnose for permanent solution' is increased by increasing the number of participants. But these benefits are at the cost of increase in the overall cost of the event, when compared to the default scenario.

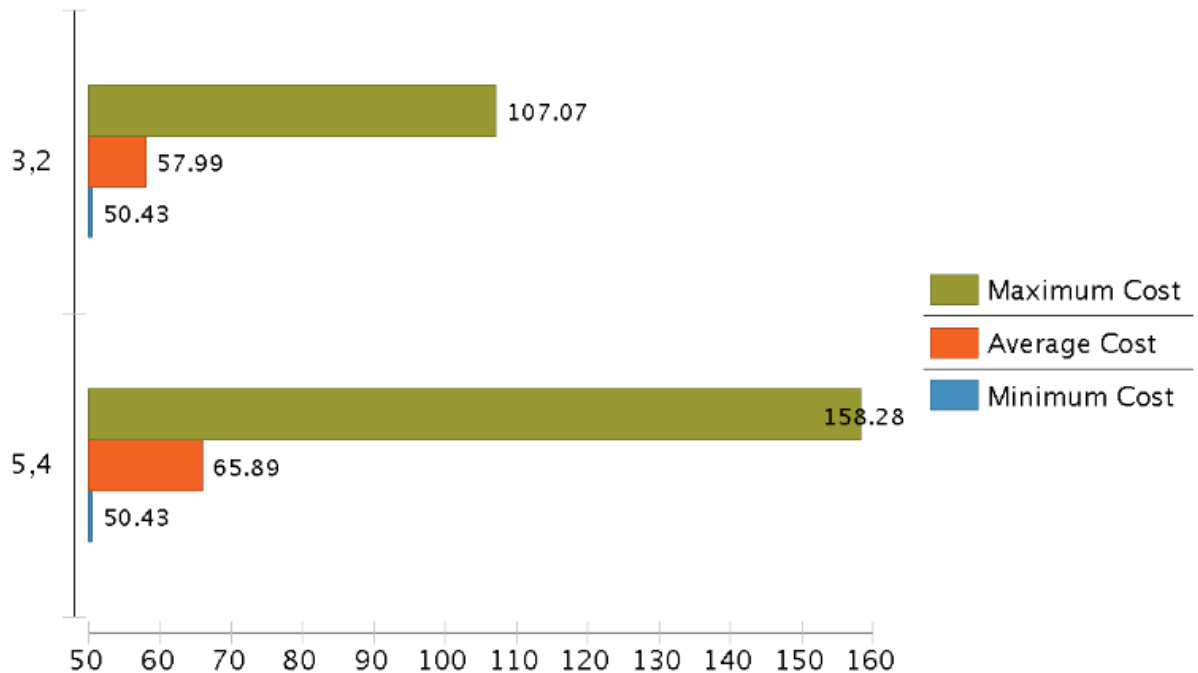


Fig 7: Average case costs

The figure above shows the minimum, average and maximum case cost for each case, where '3,2' is Default scenario and '5,4' is Case I.

## **CASE STUDY II**

### **GOAL**

For the default scenario, the weight of 'Temporary solution' gateway is Yes-25% and No-75%. This is chosen based on the fact that in real scenario, the time taken to find a temporary fix to the service is more, and there are many chances of failure. The goal is see the effect on the average event time on increasing the percentage of success.

### **CHANGES IN THE PARAMETERS**

#### **LOOP: TEMPORARY SOLUTION**

	Yes (%)	No (%)
<b>Default scenario</b>	25	75
<b>Case 2(i)</b>	50	50
<b>Case 2(ii)</b>	75	25

### **SIMULATION RESULTS**

	Min event time (mins)	Avg event time (mins)	Max event time (mins)
<b>Default scenario</b>	1081	2986	5191
<b>Case 2(i)</b>	1081	3087	5304
<b>Case 2(ii)</b>	1081	3193	6361

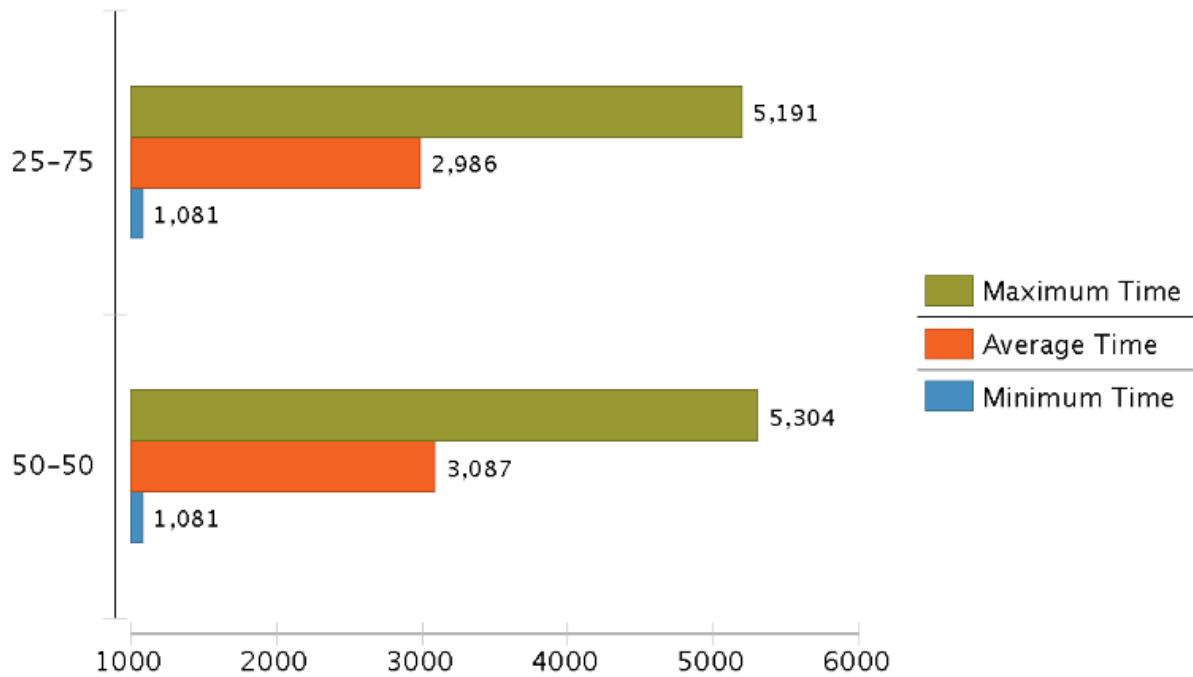


Fig 8: Case Cycle Times

The figure above shows the minimum, average and maximum case times for each '25-75'-Default scenario and '50-50'-Case 2(i). All time measurements are displayed in minute.

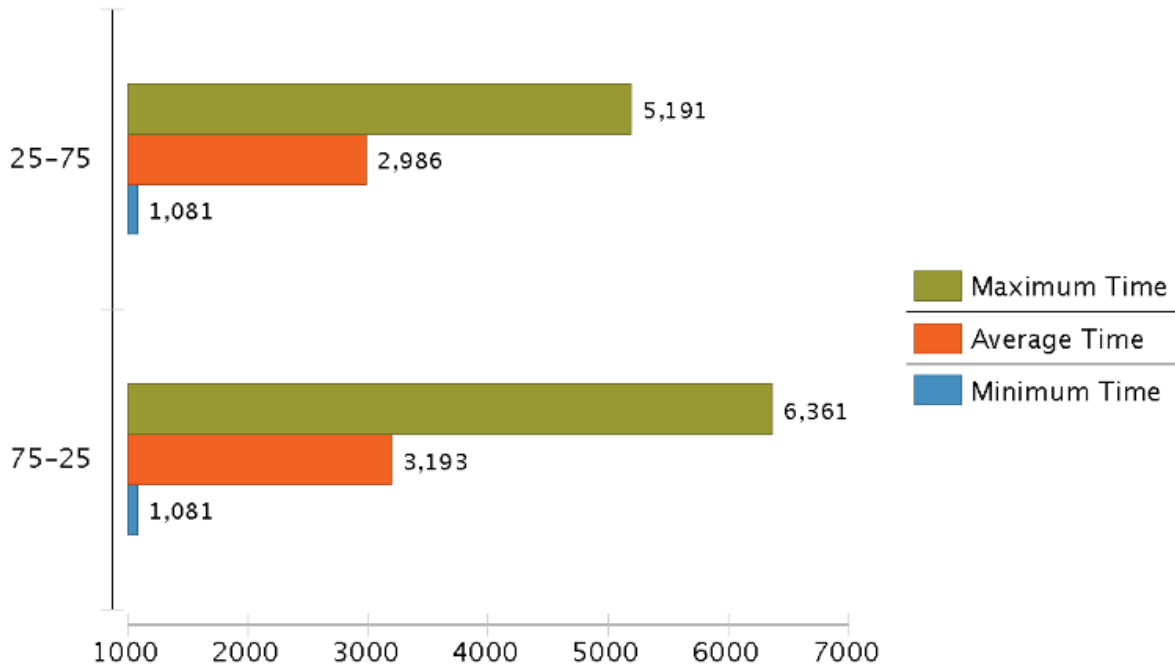


Fig 8: Case Cycle Times

The figure above shows the minimum, average and maximum case times for each '25-75'-Default scenario and '50-50'-Case 2(i). All time measurements are displayed in minute.

## ANALYSIS

From the above simulation results, we can see that when the percentage of success of the loop 'Temporary solution' increases, the average time per event also increases. This means that, more number of the events are temporarily fixed and hence tried to fix permanently i.e. for the task 'Diagnose for permanent solution. The task 'Diagnose for permanent solution' is time consuming. When more number of events are handled are handled by this task, the time per event is increased and hence the average event time is also increased.

## CONCLUSIONS

From the simulations performed so far, the major conclusions are

- ◆ The time taken for the temporary fix can be reduced by adding more participants to that particular task.
- ◆ Increasing the success rate of temporary fix, leads to more number of events to be diagnosed for the permanent fix. This increases the average event time.

Further studies

- ◆ The effect of the changes on cost can be further analyzed and changes can be made to lower the cost of the event.

- ◆ The distribution of the tasks can be changed to see the effect on the temporary solution output and the end results.

Time is a constraint during the failure reparation. The more time the process takes to repair a failure, the company experiences loss in the business along with the expenses of the failure. Here in this simulation, even though the problem was fixed temporarily, the time taken for the permanent fix was huge, hence resulting in the lower average event time and increased expenses of the event.

## **REFERENCES**

1. Incident report by Hutchison Telephone Company Limited to the Office of the Communications Authority on an incident relating to a temporary 3G mobile data service degradation occurred on 29 June 2012.
2. <https://docs.tibco.com>
3. <https://camunda.com/bpmn/>