Additional File for Reference

TABLE 2: Simulation results: values on Server1 and Server2 without any assumption on . Results satisfy the condition 

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Server Cost | Server Load |  |  |  |
| 50 | 10 | 0.611749 | 0.389197 | 4.288795 |
| 50 | 3 | 0.567333 | 0.434660 | 4.286146 |
| 5 | 80 | 0.719920 | 0.281966 | 4.288413 |
| 10 | 40 | 0.685039 | 0.315826 | 4.288273 |
| 40 | 25 | 0.640219 | 0.360577 | 4.289915 |
| 30 | 6 | 0.605103 | 0.397328 | 4.286653 |
| 10 | 20 | 0.670304 | 0.331262 | 4.286881 |

Table 3: Server Configuration

|  |  |  |
| --- | --- | --- |
| Server | Load | Fixed Unit Cost |
| 1 | 40 | 50 |
| 2 | 10 | 50 |

Table 4: Simulation Results: Allocation, Cost and Utility

|  |  |  |
| --- | --- | --- |
| User 1  Allocation | User 2  Allocation | Utility |
| (2,0) | (2,0) | (-0.5,-0.5) |
| (2,0) | (1,1) | (-0.6851, -0.3149) |
| (2,0) | (0,2) | (-0.7901, -0.2099) |
| (1,1) | (2,0) | (-0.3149, -0.6851) |
| (1,1) | (1,1) | (-0.5,-0.5) |
| (1,1) | (0,2) | (-0.6337, -0.3663) |
| (0,2) | (2,0) | (-0.2099, -0.7901) |
| (0,2) | (1,1) | (-0.3663, -0.6337) |
| (0,2) | (0,2) | (-0.5,-0.5) |

Table 5: Simulation Results: Allocation of Resources and Load Factor, with  and 

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Serv1 Cost | Serv2 Cost | Serv1 Load | Serv2 Load | user1 | user2 | Load Factor |
| 50 | 50 | 10 | 10 | (3,3) | (5,6) | 0.05 |
| 50 | 50 | 10 | 3 | (1,5) | (3,8) | 0.005 |
| 10 | 50 | 10 | 10 | (4,2) | (6,5) | 0.15 |
| 50 | 5 | 10 | 80 | (5,1) | (10,1) | 0.05 |
| 50 | 10 | 10 | 40 | (5,1) | (9,2) | 0.1 |
| 5 | 30 | 25 | 6 | (1,5) | (2,9) | 0.045 |

Table 6: Simulation Results: Allocation of Resources and Load Factor, with  and 

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Serv1 Cost | Serv2 Cost | Serv1 Load | Serv2 Load | user1 | user2 | Load Factor |
| 50 | 50 | 10 | 10 | (3,3) | (5,6) | 0.05 |
| 50 | 50 | 10 | 3 | (1,5) | (3,8) | 0.005 |
| 10 | 50 | 10 | 10 | (3,3) | (6,5) | 0.05 |
| 50 | 5 | 10 | 80 | (5,1) | (10,1) | 0.05 |
| 50 | 10 | 10 | 40 | (5,1) | (9,2) | 0.1 |
| 5 | 30 | 25 | 6 | (1,5) | (2,9) | 0.045 |

Table 7: Simulation Results: Unit Cost per user and system, with 

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Serv1 Cost | Serv2 Cost | Serv1 Load | Serv2 Load | Avg.Ser Cost User1 | Avg.Ser Cost User2 | System Cost |
| 50 | 50 | 10 | 10 | 50 | 50 | 50 |
| 50 | 50 | 10 | 3 | 50 | 50 | 50 |
| 10 | 50 | 10 | 10 | 23.33 | 28.18 | 26.47 |
| 50 | 5 | 10 | 80 | 42.5 | 45.9 | 44.7 |
| 50 | 10 | 10 | 40 | 43.3 | 42.72 | 42.94 |
| 5 | 30 | 25 | 6 | 25.83 | 25.45 | 25.58 |

Table 8: Simulation results: Unit Cost per user and system, with  and 

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Serv1 Cost | Serv2 Cost | Serv1 Load | Serv2 Load | Avg.Ser Cost User1 | Avg.Ser Cost User2 | System Cost |
| 50 | 50 | 10 | 10 | 50 | 50 | 50 |
| 50 | 50 | 10 | 3 | 50 | 50 | 50 |
| 10 | 50 | 10 | 10 | 30 | 28.18 | 28.82 |
| 50 | 5 | 10 | 80 | 42.5 | 45.9 | 44.7 |
| 50 | 10 | 10 | 40 | 43.3 | 42.72 | 42.94 |
| 5 | 30 | 25 | 6 | 25.83 | 25.45 | 25.58 |

Algorithm:

9.1. Algorithm to compute  using Gradient Descent method:



9.2. Algorithm to find Optimum Allocation Combination at Equilibrium (Algorithm1)



In the above algorithm, function FINDALLALLOCATIONCOMBIS() finds all possible allocation combinations for each user based on user demand and available servers. The function GENERATECOMBINATIONS(), finds all combinations of allocations possible for all users together on available servers.

9.3. Algorithm to compute cost incurred by a given combination (Algorithm 2)

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 9.4. Algorithm to compute utility of the selected combination(Algorithm 3) | |  |