### **General Linear Model**

## **Between-Subjects Factors**

|                        |   | Value Label | N   |
|------------------------|---|-------------|-----|
| Router Type   Protocol | 1 | ecmp-mptcp  | 160 |
|                        | 2 | ps-mptcp    | 160 |
|                        | 3 | ps-tcp      | 160 |
|                        | 4 | static-tcp  | 160 |
| Juggler Enabled        | 1 | false       | 320 |
|                        | 2 | true        | 320 |

|            | Router Type   Protocol | Juggler Enabled | Mean        | Std. Deviation |
|------------|------------------------|-----------------|-------------|----------------|
| Goodput    | ecmp-mptcp             | false           | 1833533.179 | 99210.65194    |
|            |                        | true            | 1751989.144 | 115824.6920    |
|            |                        | Total           | 1792761.162 | 115016.2168    |
|            | ps-mptcp               | false           | 1863812.664 | 89767.98534    |
|            |                        | true            | 1708404.239 | 182712.6659    |
|            |                        | Total           | 1786108.451 | 163299.4259    |
|            | ps-tcp                 | false           | 1932588.567 | 85813.62838    |
|            |                        | true            | 1816330.780 | 109532.3572    |
|            |                        | Total           | 1874459.674 | 114105.1841    |
|            | static-tcp             | false           | 1918004.342 | 69955.07756    |
|            |                        | true            | 1841696.585 | 40814.74214    |
|            |                        | Total           | 1879850.463 | 68731.53862    |
|            | Total                  | false           | 1886984.688 | 95303.75970    |
|            |                        | true            | 1779605.187 | 133196.0716    |
|            |                        | Total           | 1833294.937 | 127585.7022    |
| Throughput | ecmp-mptcp             | false           | 2079808.270 | 103632.0127    |
|            |                        | true            | 2039500.381 | 270268.5682    |
|            |                        | Total           | 2059654.325 | 205030.7507    |
|            | ps-mptcp               | false           | 2113147.860 | 95442.96974    |
|            |                        | true            | 2011535.361 | 155473.9054    |
|            |                        | Total           | 2062341.610 | 138324.2513    |
|            | ps-tcp                 | false           | 2114764.051 | 91626.36450    |
|            |                        | true            | 2076009.658 | 238698.2646    |
|            |                        | Total           | 2095386.855 | 181268.8341    |

|            | Router Type   Protocol | Juggler Enabled | N   |
|------------|------------------------|-----------------|-----|
| Goodput    | ecmp-mptcp             | false           | 80  |
|            |                        | true            | 80  |
|            |                        | Total           | 160 |
|            | ps-mptcp               | false           | 80  |
|            |                        | true            | 80  |
|            |                        | Total           | 160 |
|            | ps-tcp                 | false           | 80  |
|            |                        | true            | 80  |
|            |                        | Total           | 160 |
|            | static-tcp             | false           | 80  |
|            |                        | true            | 80  |
|            |                        | Total           | 160 |
|            | Total                  | false           | 320 |
|            |                        | true            | 320 |
|            |                        | Total           | 640 |
| Throughput | ecmp-mptcp             | false           | 80  |
|            |                        | true            | 80  |
|            |                        | Total           | 160 |
|            | ps-mptcp               | false           | 80  |
|            |                        | true            | 80  |
|            |                        | Total           | 160 |
|            | ps-tcp                 | false           | 80  |
|            |                        | true            | 80  |
|            |                        | Total           | 160 |

|                          | Router Type   Protocol | Juggler Enabled | Mean        | Std. Deviation |
|--------------------------|------------------------|-----------------|-------------|----------------|
|                          | static-tcp             | false           | 2115429.763 | 225213.9854    |
|                          |                        | true            | 2015471.290 | 44801.65520    |
|                          |                        | Total           | 2065450.526 | 169446.4077    |
|                          | Total                  | false           | 2105787.486 | 140648.9753    |
|                          |                        | true            | 2035629.172 | 198351.3174    |
|                          |                        | Total           | 2070708.329 | 175353.6389    |
| Flow Completion Time     | ecmp-mptcp             | false           | .071708     | .0041731       |
|                          |                        | true            | .075141     | .0050568       |
|                          |                        | Total           | .073424     | .0049319       |
|                          | ps-mptcp               | false           | .070491     | .0035242       |
|                          |                        | true            | .077876     | .0110814       |
|                          |                        | Total           | .074184     | .0089947       |
|                          | ps-tcp                 | false           | .067955     | .0030471       |
|                          |                        | true            | .072457     | .0049591       |
|                          |                        | Total           | .070206     | .0046832       |
|                          | static-tcp             | false           | .068422     | .0023561       |
|                          |                        | true            | .071207     | .0017541       |
|                          |                        | Total           | .069815     | .0024976       |
|                          | Total                  | false           | .069644     | .0036606       |
|                          |                        | true            | .074171     | .0070862       |
|                          |                        | Total           | .071907     | .0060735       |
| Mean Network Utilization | ecmp-mptcp             | false           | .6382726030 | .1706914209    |
|                          |                        | true            | .6262924461 | .1824041499    |
|                          |                        | Total           | .6322825246 | .1761910223    |
|                          | ps-mptcp               | false           | .8431981733 | .0898778198    |
|                          |                        | true            | .8679701861 | .0637913731    |
|                          |                        | Total           | .8555841797 | .0786756611    |
|                          | ps-tcp                 | false           | .8526838522 | .0925775683    |
|                          |                        | true            | .8342996730 | .0650965844    |
|                          |                        | Total           | .8434917626 | .0803046349    |
|                          | static-tcp             | false           | .3512362692 | .2467786249    |
|                          |                        | true            | .2588225371 | .0042663251    |
|                          |                        | Total           | .3050294032 | .1800441128    |

|                          | Router Type   Protocol | Juggler Enabled | N   |
|--------------------------|------------------------|-----------------|-----|
|                          | static-tcp             | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |
|                          | Total                  | false           | 320 |
|                          |                        | true            | 320 |
|                          |                        | Total           | 640 |
| Flow Completion Time     | ecmp-mptcp             | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |
|                          | ps-mptcp               | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |
|                          | ps-tcp                 | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |
|                          | static-tcp             | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |
|                          | Total                  | false           | 320 |
|                          |                        | true            | 320 |
|                          |                        | Total           | 640 |
| Mean Network Utilization | ecmp-mptcp             | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |
|                          | ps-mptcp               | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |
|                          | ps-tcp                 | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |
|                          | static-tcp             | false           | 80  |
|                          |                        | true            | 80  |
|                          |                        | Total           | 160 |

| Ro | outer Type   Protocol | Juggler Enabled | Mean        | Std. Deviation |
|----|-----------------------|-----------------|-------------|----------------|
| To | otal                  | false           | .6713477244 | .2608551197    |
|    |                       | true            | .6468462106 | .2631355977    |
|    |                       | Total           | .6590969675 | .2620796858    |

#### **Descriptive Statistics**

| Router Type   Protocol | Juggler Enabled | N   |
|------------------------|-----------------|-----|
| Total                  | false           | 320 |
|                        | true            | 320 |
|                        | Total           | 640 |

#### Box's Test of Equality of Covariance Matrices<sup>a</sup>

| Box's M | 4526.750   |
|---------|------------|
| F       | 63.340     |
| df1     | 70         |
| df2     | 546844.039 |
| Sig.    | .000       |

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + router\_proto + juggler\_enabled + router\_proto \* juggler\_enabled

## **Multivariate Tests**<sup>a</sup>

| Effect          |                    | Value     | F                       | Hypothesis df |
|-----------------|--------------------|-----------|-------------------------|---------------|
| Intercept       | Pillai's Trace     | 1,000     | 3119633.81 <sup>b</sup> | 4.000         |
| ппетсері        |                    | 1.000     |                         | 4.000         |
|                 | Wilks' Lambda      | .000      | 3119633.81 <sup>b</sup> | 4.000         |
|                 | Hotelling's Trace  | 19838.689 | 3119633.81 <sup>b</sup> | 4.000         |
|                 | Roy's Largest Root | 19838.689 | 3119633.81 <sup>b</sup> | 4.000         |
| router_proto    | Pillai's Trace     | .951      | 73.189                  | 12.000        |
|                 | Wilks' Lambda      | .169      | 132.865                 | 12.000        |
|                 | Hotelling's Trace  | 4.213     | 220.372                 | 12.000        |
|                 | Roy's Largest Root | 4.041     | 637.513 <sup>c</sup>    | 4.000         |
| juggler_enabled | Pillai's Trace     | .267      | 57.139 <sup>b</sup>     | 4.000         |
|                 | Wilks' Lambda      | .733      | 57.139 <sup>b</sup>     | 4.000         |
|                 | Hotelling's Trace  | .363      | 57.139 <sup>b</sup>     | 4.000         |
|                 | Roy's Largest Root | .363      | 57.139 <sup>b</sup>     | 4.000         |
| router_proto *  | Pillai's Trace     | .089      | 4.824                   | 12.000        |
| juggler_enabled | Wilks' Lambda      | .913      | 4.871                   | 12.000        |
|                 | Hotelling's Trace  | .094      | 4.901                   | 12.000        |
|                 | Roy's Largest Root | .067      | 10.583 <sup>c</sup>     | 4.000         |

# **Multivariate Tests**<sup>a</sup>

| Effect          |                    | Error df | Sig. | Partial Eta<br>Squared |
|-----------------|--------------------|----------|------|------------------------|
| Intercept       | Pillai's Trace     | 629.000  | .000 | 1.000                  |
|                 | Wilks' Lambda      | 629.000  | .000 | 1.000                  |
|                 | Hotelling's Trace  | 629.000  | .000 | 1.000                  |
|                 | Roy's Largest Root | 629.000  | .000 | 1.000                  |
| router_proto    | Pillai's Trace     | 1893.000 | .000 | .317                   |
|                 | Wilks' Lambda      | 1664.469 | .000 | .447                   |
|                 | Hotelling's Trace  | 1883.000 | .000 | .584                   |
|                 | Roy's Largest Root | 631.000  | .000 | .802                   |
| juggler_enabled | Pillai's Trace     | 629.000  | .000 | .267                   |
|                 | Wilks' Lambda      | 629.000  | .000 | .267                   |
|                 | Hotelling's Trace  | 629.000  | .000 | .267                   |
|                 | Roy's Largest Root | 629.000  | .000 | .267                   |
| router_proto *  | Pillai's Trace     | 1893.000 | .000 | .030                   |
| juggler_enabled | Wilks' Lambda      | 1664.469 | .000 | .030                   |
|                 | Hotelling's Trace  | 1883.000 | .000 | .030                   |
|                 | Roy's Largest Root | 631.000  | .000 | .063                   |

a. Design: Intercept + router\_proto + juggler\_enabled + router\_proto \* juggler\_enabled

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

# Levene's Test of Equality of Error Variances<sup>a</sup>

|                          |                                      | Levene Statistic | df1 | df2     | Sig. |
|--------------------------|--------------------------------------|------------------|-----|---------|------|
| Goodput                  | Based on Mean                        | 12.033           | 7   | 632     | .000 |
|                          | Based on Median                      | 5.716            | 7   | 632     | .000 |
|                          | Based on Median and with adjusted df | 5.716            | 7   | 333.418 | .000 |
|                          | Based on trimmed mean                | 8.877            | 7   | 632     | .000 |
| Throughput               | Based on Mean                        | 3.148            | 7   | 632     | .003 |
|                          | Based on Median                      | 2.571            | 7   | 632     | .013 |
|                          | Based on Median and with adjusted df | 2.571            | 7   | 336.999 | .014 |
|                          | Based on trimmed mean                | 2.591            | 7   | 632     | .012 |
| Flow Completion Time     | Based on Mean                        | 19.102           | 7   | 632     | .000 |
|                          | Based on Median                      | 7.174            | 7   | 632     | .000 |
|                          | Based on Median and with adjusted df | 7.174            | 7   | 188.898 | .000 |
|                          | Based on trimmed mean                | 12.164           | 7   | 632     | .000 |
| Mean Network Utilization | Based on Mean                        | 28.472           | 7   | 632     | .000 |
|                          | Based on Median                      | 14.019           | 7   | 632     | .000 |
|                          | Based on Median and with adjusted df | 14.019           | 7   | 174.796 | .000 |
|                          | Based on trimmed mean                | 21.614           | 7   | 632     | .000 |

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + router\_proto + juggler\_enabled + router\_proto \* juggler\_enabled

## **Tests of Between-Subjects Effects**

|                 |                          | Type III Sum of        | 16  |             |
|-----------------|--------------------------|------------------------|-----|-------------|
| Source          | Dependent Variable       | Squares                | df  | Mean Square |
| Corrected Model | Goodput                  | 3.243E+12 <sup>a</sup> | 7   | 4.632E+11   |
|                 | Throughput               | 1.070E+12 <sup>b</sup> | 7   | 1.529E+11   |
|                 | Flow Completion Time     | .006 <sup>c</sup>      | 7   | .001        |
|                 | Mean Network Utilization | 32.176 <sup>d</sup>    | 7   | 4.597       |
| Intercept       | Goodput                  | 2.151E+15              | 1   | 2.151E+15   |
|                 | Throughput               | 2.744E+15              | 1   | 2.744E+15   |
|                 | Flow Completion Time     | 3.309                  | 1   | 3.309       |
|                 | Mean Network Utilization | 278.022                | 1   | 278.022     |
| router_proto    | Goodput                  | 1.237E+12              | 3   | 4.123E+11   |
|                 | Throughput               | 1.326E+11              | 3   | 4.421E+10   |
|                 | Flow Completion Time     | .002                   | 3   | .001        |
|                 | Mean Network Utilization | 31.791                 | 3   | 10.597      |
| juggler_enabled | Goodput                  | 1.845E+12              | 1   | 1.845E+12   |
|                 | Throughput               | 7.876E+11              | 1   | 7.876E+11   |
|                 | Flow Completion Time     | .003                   | 1   | .003        |
|                 | Mean Network Utilization | .096                   | 1   | .096        |
| router_proto *  | Goodput                  | 1.607E+11              | 3   | 5.358E+10   |
| juggler_enabled | Throughput               | 1.502E+11              | 3   | 5.006E+10   |
|                 | Flow Completion Time     | .000                   | 3   | .000        |
|                 | Mean Network Utilization | .289                   | 3   | .096        |
| Error           | Goodput                  | 7.159E+12              | 632 | 1.133E+10   |
|                 | Throughput               | 1.858E+13              | 632 | 2.940E+10   |
|                 | Flow Completion Time     | .017                   | 632 | 2.759E-5    |
|                 | Mean Network Utilization | 11.714                 | 632 | .019        |
| Total           | Goodput                  | 2.161E+15              | 640 |             |
|                 | Throughput               | 2.764E+15              | 640 |             |
|                 | Flow Completion Time     | 3.333                  | 640 |             |
|                 | Mean Network Utilization | 321.912                | 640 |             |
| Corrected Total | Goodput                  | 1.040E+13              | 639 |             |
|                 | Throughput               | 1.965E+13              | 639 |             |
|                 | Flow Completion Time     | .024                   | 639 |             |
|                 | Mean Network Utilization | 43.890                 | 639 |             |

# Tests of Between-Subjects Effects

| Source          | Dependent Variable       | F          | Sig. | Partial Eta<br>Squared |
|-----------------|--------------------------|------------|------|------------------------|
| Corrected Model | Goodput                  | 40.894     | .000 | .312                   |
|                 | Throughput               | 5.202      | .000 | .054                   |
|                 | Flow Completion Time     | 31.768     | .000 | .260                   |
|                 | Mean Network Utilization | 247.994    | .000 | .733                   |
| Intercept       | Goodput                  | 189891.208 | .000 | .997                   |
|                 | Throughput               | 93353.693  | .000 | .993                   |
|                 | Flow Completion Time     | 119948.694 | .000 | .995                   |
|                 | Mean Network Utilization | 14999.792  | .000 | .960                   |
| router_proto    | Goodput                  | 36.402     | .000 | .147                   |
|                 | Throughput               | 1.504      | .212 | .007                   |
|                 | Flow Completion Time     | 28.524     | .000 | .119                   |
|                 | Mean Network Utilization | 571.722    | .000 | .731                   |
| juggler_enabled | Goodput                  | 162.863    | .000 | .205                   |
|                 | Throughput               | 26.791     | .000 | .041                   |
|                 | Flow Completion Time     | 118.830    | .000 | .158                   |
|                 | Mean Network Utilization | 5.182      | .023 | .008                   |
| router_proto *  | Goodput                  | 4.730      | .003 | .022                   |
| juggler_enabled | Throughput               | 1.703      | .165 | .008                   |
|                 | Flow Completion Time     | 5.992      | .000 | .028                   |
|                 | Mean Network Utilization | 5.204      | .001 | .024                   |
| Error           | Goodput                  |            |      |                        |
|                 | Throughput               |            |      |                        |
|                 | Flow Completion Time     |            |      |                        |
|                 | Mean Network Utilization |            |      |                        |
| Total           | Goodput                  |            |      |                        |
|                 | Throughput               |            |      |                        |
|                 | Flow Completion Time     |            |      |                        |
|                 | Mean Network Utilization |            |      |                        |
| Corrected Total | Goodput                  |            |      |                        |
|                 | Throughput               |            |      |                        |
|                 | Flow Completion Time     |            |      |                        |
|                 | Mean Network Utilization |            |      |                        |

a. R Squared = .312 (Adjusted R Squared = .304)

b. R Squared = .054 (Adjusted R Squared = .044)

- c. R Squared = .260 (Adjusted R Squared = .252)
- d. R Squared = .733 (Adjusted R Squared = .730)

## **Post Hoc Tests**

# **Router Type | Protocol**

### **Multiple Comparisons**

| Dependent Variable | (I) Router Type   Protocol | (J) Router Type   Protocol | Mean<br>Difference (I-J) |
|--------------------|----------------------------|----------------------------|--------------------------|
| Goodput            | ecmp-mptcp                 | ps-mptcp                   | 6652.710604              |
|                    |                            | ps-tcp                     | -81698.5121 <sup>*</sup> |
|                    |                            | static-tcp                 | -87089.3013 <sup>*</sup> |
|                    | ps-mptcp                   | ecmp-mptcp                 | -6652.71060              |
|                    |                            | ps-tcp                     | -88351.2227 <sup>*</sup> |
|                    |                            | static-tcp                 | -93742.0119 <sup>*</sup> |
|                    | ps-tcp                     | ecmp-mptcp                 | 81698.5121 <sup>*</sup>  |
|                    |                            | ps-mptcp                   | 88351.2227 <sup>*</sup>  |
|                    |                            | static-tcp                 | -5390.78923              |
|                    | static-tcp                 | ecmp-mptcp                 | 87089.3013 <sup>*</sup>  |
|                    |                            | ps-mptcp                   | 93742.0119*              |
|                    |                            | ps-tcp                     | 5390.789225              |
| Throughput         | ecmp-mptcp                 | ps-mptcp                   | -2687.28469              |
|                    |                            | ps-tcp                     | -35732.5291              |
|                    |                            | static-tcp                 | -5796.20094              |
|                    | ps-mptcp                   | ecmp-mptcp                 | 2687.284693              |
|                    |                            | ps-tcp                     | -33045.2445              |
|                    |                            | static-tcp                 | -3108.91625              |
|                    | ps-tcp                     | ecmp-mptcp                 | 35732.52914              |
|                    |                            | ps-mptcp                   | 33045.24445              |
|                    |                            | static-tcp                 | 29936.32820              |
|                    | static-tcp                 | ecmp-mptcp                 | 5796.200942              |
|                    |                            | ps-mptcp                   | 3108.916249              |
|                    |                            | ps-tcp                     | -29936.3282              |

| Dependent Variable | (I) Router Type   Protocol | (J) Router Type   Protocol | Std. Error  |
|--------------------|----------------------------|----------------------------|-------------|
| Goodput            | ecmp-mptcp                 | ps-mptcp                   | 11899.39562 |
|                    |                            | ps-tcp                     | 11899.39562 |
|                    |                            | static-tcp                 | 11899.39562 |
|                    | ps-mptcp                   | ecmp-mptcp                 | 11899.39562 |
|                    |                            | ps-tcp                     | 11899.39562 |
|                    |                            | static-tcp                 | 11899.39562 |
|                    | ps-tcp                     | ecmp-mptcp                 | 11899.39562 |
|                    |                            | ps-mptcp                   | 11899.39562 |
|                    |                            | static-tcp                 | 11899.39562 |
|                    | static-tcp                 | ecmp-mptcp                 | 11899.39562 |
|                    |                            | ps-mptcp                   | 11899.39562 |
|                    |                            | ps-tcp                     | 11899.39562 |
| Throughput         | ecmp-mptcp                 | ps-mptcp                   | 19168.94333 |
|                    |                            | ps-tcp                     | 19168.94333 |
|                    |                            | static-tcp                 | 19168.94333 |
|                    | ps-mptcp                   | ecmp-mptcp                 | 19168.94333 |
|                    |                            | ps-tcp                     | 19168.94333 |
|                    |                            | static-tcp                 | 19168.94333 |
|                    | ps-tcp                     | ecmp-mptcp                 | 19168.94333 |
|                    |                            | ps-mptcp                   | 19168.94333 |
|                    |                            | static-tcp                 | 19168.94333 |
|                    | static-tcp                 | ecmp-mptcp                 | 19168.94333 |
|                    |                            | ps-mptcp                   | 19168.94333 |
|                    |                            | ps-tcp                     | 19168.94333 |

| railey 1102        |                            |                            |      |
|--------------------|----------------------------|----------------------------|------|
| Dependent Variable | (I) Router Type   Protocol | (J) Router Type   Protocol | Sig. |
| Goodput            | ecmp-mptcp                 | ps-mptcp                   | .944 |
|                    |                            | ps-tcp                     | .000 |
|                    |                            | static-tcp                 | .000 |
|                    | ps-mptcp                   | ecmp-mptcp                 | .944 |
|                    |                            | ps-tcp                     | .000 |
|                    |                            | static-tcp                 | .000 |
|                    | ps-tcp                     | ecmp-mptcp                 | .000 |
|                    |                            | ps-mptcp                   | .000 |
|                    |                            | static-tcp                 | .969 |
|                    | static-tcp                 | ecmp-mptcp                 | .000 |
|                    |                            | ps-mptcp                   | .000 |
|                    |                            | ps-tcp                     | .969 |
| Throughput         | ecmp-mptcp                 | ps-mptcp                   | .999 |
|                    |                            | ps-tcp                     | .245 |
|                    |                            | static-tcp                 | .990 |
|                    | ps-mptcp                   | ecmp-mptcp                 | .999 |
|                    |                            | ps-tcp                     | .312 |
|                    |                            | static-tcp                 | .998 |
|                    | ps-tcp                     | ecmp-mptcp                 | .245 |
|                    |                            | ps-mptcp                   | .312 |
|                    |                            | static-tcp                 | .401 |
|                    | static-tcp                 | ecmp-mptcp                 | .990 |
|                    |                            | ps-mptcp                   | .998 |
|                    |                            | ps-tcp                     | .401 |

| Tukey HSD          |                                       |                            | 95%         |
|--------------------|---------------------------------------|----------------------------|-------------|
| Dependent Variable | (I) Pouter Type I Protocol            | (J) Router Type   Protocol | Lower Bound |
| Goodput            | (I) Router Type   Protocol ecmp-mptcp | ps-mptcp                   | -23998.6944 |
| Goodput            | естр-трюр                             | ps-tcp                     | -112349.917 |
|                    |                                       | static-tcp                 | -117740.706 |
|                    |                                       | ·                          |             |
|                    | ps-mptcp                              | ecmp-mptcp                 | -37304.1156 |
|                    |                                       | ps-tcp                     | -119002.628 |
|                    |                                       | static-tcp                 | -124393.417 |
|                    | ps-tcp                                | ecmp-mptcp                 | 51047.10706 |
|                    |                                       | ps-mptcp                   | 57699.81767 |
|                    |                                       | static-tcp                 | -36042.1943 |
|                    | static-tcp                            | ecmp-mptcp                 | 56437.89629 |
|                    |                                       | ps-mptcp                   | 63090.60689 |
|                    |                                       | ps-tcp                     | -25260.6158 |
| Throughput         | ecmp-mptcp                            | ps-mptcp                   | -52064.1661 |
|                    |                                       | ps-tcp                     | -85109.4105 |
|                    |                                       | static-tcp                 | -55173.0823 |
|                    | ps-mptcp                              | ecmp-mptcp                 | -46689.5967 |
|                    |                                       | ps-tcp                     | -82422.1258 |
|                    |                                       | static-tcp                 | -52485.7976 |
|                    | ps-tcp                                | ecmp-mptcp                 | -13644.3522 |
|                    |                                       | ps-mptcp                   | -16331.6369 |
|                    |                                       | static-tcp                 | -19440.5532 |
|                    | static-tcp                            | ecmp-mptcp                 | -43580.6804 |
|                    |                                       | ps-mptcp                   | -46267.9651 |
|                    |                                       | ps-tcp                     | -79313.2096 |

#### Tukey HSD

95% Confidence ..

| Dependent Variable | (I) Router Type   Protocol | (J) Router Type   Protocol | Upper Bound |
|--------------------|----------------------------|----------------------------|-------------|
| Goodput            | ecmp-mptcp                 | ps-mptcp                   | 37304.11564 |
|                    |                            | ps-tcp                     | -51047.1071 |
|                    |                            | static-tcp                 | -56437.8963 |
|                    | ps-mptcp                   | ecmp-mptcp                 | 23998.69443 |
|                    |                            | ps-tcp                     | -57699.8177 |
|                    |                            | static-tcp                 | -63090.6069 |
|                    | ps-tcp                     | ecmp-mptcp                 | 112349.9171 |
|                    |                            | ps-mptcp                   | 119002.6277 |
|                    |                            | static-tcp                 | 25260.61581 |
|                    | static-tcp                 | ecmp-mptcp                 | 117740.7064 |
|                    |                            | ps-mptcp                   | 124393.4170 |
|                    |                            | ps-tcp                     | 36042.19426 |
| Throughput         | ecmp-mptcp                 | ps-mptcp                   | 46689.59668 |
|                    |                            | ps-tcp                     | 13644.35223 |
|                    |                            | static-tcp                 | 43580.68043 |
|                    | ps-mptcp                   | ecmp-mptcp                 | 52064.16606 |
|                    |                            | ps-tcp                     | 16331.63692 |
|                    |                            | static-tcp                 | 46267.96512 |
|                    | ps-tcp                     | ecmp-mptcp                 | 85109.41051 |
|                    |                            | ps-mptcp                   | 82422.12582 |
|                    |                            | static-tcp                 | 79313.20957 |
|                    | static-tcp                 | ecmp-mptcp                 | 55173.08231 |
|                    |                            | ps-mptcp                   | 52485.79762 |
|                    |                            | ps-tcp                     | 19440.55317 |

| Dependent Variable       | (I) Router Type   Protocol | (J) Router Type   Protocol | Mean<br>Difference (I-J) |
|--------------------------|----------------------------|----------------------------|--------------------------|
| Flow Completion Time     | ecmp-mptcp                 | ps-mptcp                   | 000759                   |
|                          |                            | ps-tcp                     | .003218*                 |
|                          |                            | static-tcp                 | .003609*                 |
|                          | ps-mptcp                   | ecmp-mptcp                 | .000759                  |
|                          |                            | ps-tcp                     | .003977*                 |
|                          |                            | static-tcp                 | .004369*                 |
|                          | ps-tcp                     | ecmp-mptcp                 | 003218 <sup>*</sup>      |
|                          |                            | ps-mptcp                   | 003977*                  |
|                          |                            | static-tcp                 | .000391                  |
|                          | static-tcp                 | ecmp-mptcp                 | 003609 <sup>*</sup>      |
|                          |                            | ps-mptcp                   | 004369 <sup>*</sup>      |
|                          |                            | ps-tcp                     | 000391                   |
| Mean Network Utilization | ecmp-mptcp                 | ps-mptcp                   | 223301655 <sup>*</sup>   |
|                          |                            | ps-tcp                     | 211209238 <sup>*</sup>   |
|                          |                            | static-tcp                 | .327253121*              |
|                          | ps-mptcp                   | ecmp-mptcp                 | .223301655 <sup>*</sup>  |
|                          |                            | ps-tcp                     | .0120924171              |
|                          |                            | static-tcp                 | .550554776 <sup>*</sup>  |
|                          | ps-tcp                     | ecmp-mptcp                 | .211209238 <sup>*</sup>  |
|                          |                            | ps-mptcp                   | 012092417                |
|                          |                            | static-tcp                 | .538462359 <sup>*</sup>  |
|                          | static-tcp                 | ecmp-mptcp                 | 327253121 <sup>*</sup>   |
|                          |                            | ps-mptcp                   | 550554776 <sup>*</sup>   |
|                          |                            | ps-tcp                     | 538462359 <sup>*</sup>   |

| Dependent Variable       | (I) Router Type   Protocol | (J) Router Type   Protocol | Std. Error  |
|--------------------------|----------------------------|----------------------------|-------------|
| Flow Completion Time     | ecmp-mptcp                 | ps-mptcp                   | .0005872    |
|                          |                            | ps-tcp                     | .0005872    |
|                          |                            | static-tcp                 | .0005872    |
|                          | ps-mptcp                   | ecmp-mptcp                 | .0005872    |
|                          |                            | ps-tcp                     | .0005872    |
|                          |                            | static-tcp                 | .0005872    |
|                          | ps-tcp                     | ecmp-mptcp                 | .0005872    |
|                          |                            | ps-mptcp                   | .0005872    |
|                          |                            | static-tcp                 | .0005872    |
|                          | static-tcp                 | ecmp-mptcp                 | .0005872    |
|                          |                            | ps-mptcp                   | .0005872    |
|                          |                            | ps-tcp                     | .0005872    |
| Mean Network Utilization | ecmp-mptcp                 | ps-mptcp                   | .0152212978 |
|                          |                            | ps-tcp                     | .0152212978 |
|                          |                            | static-tcp                 | .0152212978 |
|                          | ps-mptcp                   | ecmp-mptcp                 | .0152212978 |
|                          |                            | ps-tcp                     | .0152212978 |
|                          |                            | static-tcp                 | .0152212978 |
|                          | ps-tcp                     | ecmp-mptcp                 | .0152212978 |
|                          |                            | ps-mptcp                   | .0152212978 |
|                          |                            | static-tcp                 | .0152212978 |
|                          | static-tcp                 | ecmp-mptcp                 | .0152212978 |
|                          |                            | ps-mptcp                   | .0152212978 |
|                          |                            | ps-tcp                     | .0152212978 |

| randy 1102                            |                            |                            |      |
|---------------------------------------|----------------------------|----------------------------|------|
| Dependent Variable                    | (I) Router Type   Protocol | (J) Router Type   Protocol | Sig. |
| Flow Completion Time                  | ecmp-mptcp                 | ps-mptcp                   | .568 |
| , , , , , , , , , , , , , , , , , , , |                            | ps-tcp                     | .000 |
|                                       |                            | static-tcp                 | .000 |
|                                       | ps-mptcp                   | ecmp-mptcp                 | .568 |
|                                       |                            | ps-tcp                     | .000 |
|                                       |                            | static-tcp                 | .000 |
|                                       | ps-tcp                     | ecmp-mptcp                 | .000 |
|                                       |                            | ps-mptcp                   | .000 |
|                                       |                            | static-tcp                 | .910 |
|                                       | static-tcp                 | ecmp-mptcp                 | .000 |
|                                       |                            | ps-mptcp                   | .000 |
|                                       |                            | ps-tcp                     | .910 |
| Mean Network Utilization              | ecmp-mptcp                 | ps-mptcp                   | .000 |
|                                       |                            | ps-tcp                     | .000 |
|                                       |                            | static-tcp                 | .000 |
|                                       | ps-mptcp                   | ecmp-mptcp                 | .000 |
|                                       |                            | ps-tcp                     | .857 |
|                                       |                            | static-tcp                 | .000 |
|                                       | ps-tcp                     | ecmp-mptcp                 | .000 |
|                                       |                            | ps-mptcp                   | .857 |
|                                       |                            | static-tcp                 | .000 |
|                                       | static-tcp                 | ecmp-mptcp                 | .000 |
|                                       |                            | ps-mptcp                   | .000 |
|                                       |                            | ps-tcp                     | .000 |

| Tukey 113D               |                            |                            | 95%         |
|--------------------------|----------------------------|----------------------------|-------------|
| Dependent Variable       | (I) Router Type   Protocol | (J) Router Type   Protocol | Lower Bound |
| Flow Completion Time     | ecmp-mptcp                 | ps-mptcp                   | 002272      |
|                          |                            | ps-tcp                     | .001705     |
|                          |                            | static-tcp                 | .002097     |
|                          | ps-mptcp                   | ecmp-mptcp                 | 000753      |
|                          |                            | ps-tcp                     | .002465     |
|                          |                            | static-tcp                 | .002856     |
|                          | ps-tcp                     | ecmp-mptcp                 | 004731      |
|                          |                            | ps-mptcp                   | 005490      |
|                          |                            | static-tcp                 | 001121      |
|                          | static-tcp                 | ecmp-mptcp                 | 005122      |
|                          |                            | ps-mptcp                   | 005881      |
|                          |                            | ps-tcp                     | 001904      |
| Mean Network Utilization | ecmp-mptcp                 | ps-mptcp                   | 262509879   |
|                          |                            | ps-tcp                     | 250417462   |
|                          |                            | static-tcp                 | .2880448979 |
|                          | ps-mptcp                   | ecmp-mptcp                 | .1840934316 |
|                          |                            | ps-tcp                     | 027115806   |
|                          |                            | static-tcp                 | .5113465530 |
|                          | ps-tcp                     | ecmp-mptcp                 | .1720010145 |
|                          |                            | ps-mptcp                   | 051300641   |
|                          |                            | static-tcp                 | .4992541359 |
|                          | static-tcp                 | ecmp-mptcp                 | 366461345   |
|                          |                            | ps-mptcp                   | 589763000   |
|                          |                            | ps-tcp                     | 577670583   |

Tukey HSD

95% Confidence ..

| Dependent Variable       | (I) Router Type   Protocol | (J) Router Type   Protocol | Upper Bound |
|--------------------------|----------------------------|----------------------------|-------------|
| Flow Completion Time     | ecmp-mptcp                 | ps-mptcp                   | .000753     |
|                          |                            | ps-tcp                     | .004731     |
|                          |                            | static-tcp                 | .005122     |
|                          | ps-mptcp                   | ecmp-mptcp                 | .002272     |
|                          |                            | ps-tcp                     | .005490     |
|                          |                            | static-tcp                 | .005881     |
|                          | ps-tcp                     | ecmp-mptcp                 | 001705      |
|                          |                            | ps-mptcp                   | 002465      |
|                          |                            | static-tcp                 | .001904     |
|                          | static-tcp                 | ecmp-mptcp                 | 002097      |
|                          |                            | ps-mptcp                   | 002856      |
|                          |                            | ps-tcp                     | .001121     |
| Mean Network Utilization | ecmp-mptcp                 | ps-mptcp                   | 184093432   |
|                          |                            | ps-tcp                     | 172001015   |
|                          |                            | static-tcp                 | .3664613449 |
|                          | ps-mptcp                   | ecmp-mptcp                 | .2625098786 |
|                          |                            | ps-tcp                     | .0513006406 |
|                          |                            | static-tcp                 | .5897630000 |
|                          | ps-tcp                     | ecmp-mptcp                 | .2504174615 |
|                          |                            | ps-mptcp                   | .0271158064 |
|                          |                            | static-tcp                 | .5776705829 |
|                          | static-tcp                 | ecmp-mptcp                 | 288044898   |
|                          |                            | ps-mptcp                   | 511346553   |
|                          |                            | ps-tcp                     | 499254136   |

Based on observed means.

The error term is Mean Square(Error) = .019.

# **Homogeneous Subsets**

<sup>\*.</sup> The mean difference is significant at the .05 level.

#### Goodput

Tukey HSD<sup>a,b</sup>

|                        |     | Subset      |             |
|------------------------|-----|-------------|-------------|
| Router Type   Protocol | N   | 1           | 2           |
| ps-mptcp               | 160 | 1786108.451 |             |
| ecmp-mptcp             | 160 | 1792761.162 |             |
| ps-tcp                 | 160 |             | 1874459.674 |
| static-tcp             | 160 |             | 1879850.463 |
| Sig.                   |     | .944        | .969        |

Means for groups in homogeneous subsets are displayed. Based on observed means.

The error term is Mean Square(Error) = 11327649295.306.

- a. Uses Harmonic Mean Sample Size = 160.000.
- b. Alpha = .05.

#### **Throughput**

Tukey  ${\sf HSD}^{{\sf a},{\sf b}}$ 

|                        |     | Subset      |
|------------------------|-----|-------------|
| Router Type   Protocol | N   | 1           |
| ecmp-mptcp             | 160 | 2059654.325 |
| ps-mptcp               | 160 | 2062341.610 |
| static-tcp             | 160 | 2065450.526 |
| ps-tcp                 | 160 | 2095386.855 |
| Sig.                   |     | .245        |

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 29395871063.708.

- a. Uses Harmonic Mean Sample Size = 160.000.
- b. Alpha = .05.

#### **Flow Completion Time**

Tukey HSD<sup>a,b</sup>

|                        |     | Subset  |         |
|------------------------|-----|---------|---------|
| Router Type   Protocol | N   | 1       | 2       |
| static-tcp             | 160 | .069815 |         |
| ps-tcp                 | 160 | .070206 |         |
| ecmp-mptcp             | 160 |         | .073424 |
| ps-mptcp               | 160 |         | .074184 |
| Sig.                   |     | .910    | .568    |

Means for groups in homogeneous subsets are displayed. Based on observed means.

The error term is Mean Square(Error) = 2.759E-5.

- a. Uses Harmonic Mean Sample Size = 160.000.
- b. Alpha = .05.

#### **Mean Network Utilization**

Tukey HSD<sup>a,b</sup>

|                        |     | Subset      |             |             |
|------------------------|-----|-------------|-------------|-------------|
| Router Type   Protocol | N   | 1           | 2           | 3           |
| static-tcp             | 160 | .3050294032 |             |             |
| ecmp-mptcp             | 160 |             | .6322825246 |             |
| ps-tcp                 | 160 |             |             | .8434917626 |
| ps-mptcp               | 160 |             |             | .8555841797 |
| Sig.                   |     | 1.000       | 1.000       | .857        |

Means for groups in homogeneous subsets are displayed.

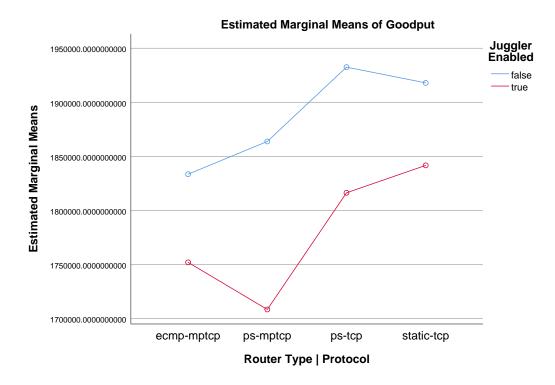
Based on observed means.

The error term is Mean Square(Error) = .019.

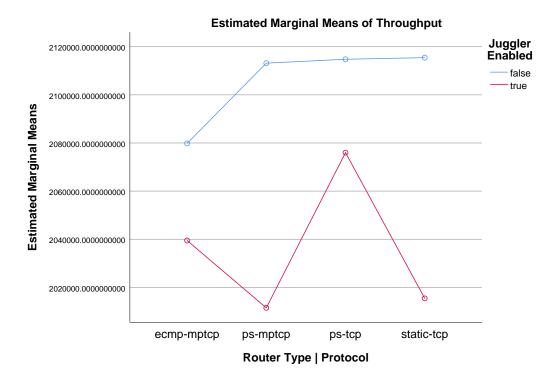
- a. Uses Harmonic Mean Sample Size = 160.000.
- b. Alpha = .05.

#### **Profile Plots**

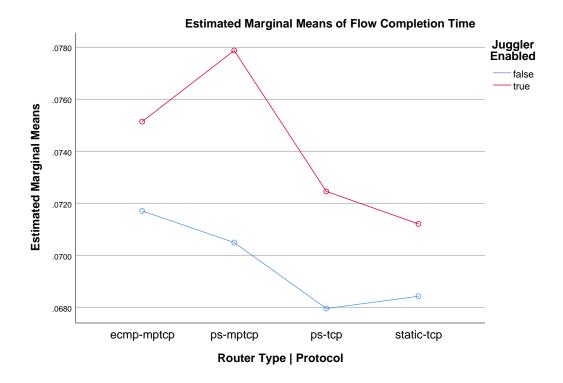
### Goodput



## **Throughput**



# **Flow Completion Time**



### **Mean Network Utilization**

