Trends and patterns of broadband Internet access speed in a Nigerian university campus: A robust data exploration

Aderemi A. Atayero a, Segun I. Popoola a,*, Oluwaseun J. Adeyemi b, David G. Afolayan b, Matthew B. Akanle b, Victor Adetola b, Emmanuel Adetiba a, b, c

a IoT-enabled Smart and Connected Communities (SmartCU) Research Cluster, Department of Electrical and Information Engineering, Covenant University, Ota, Nigeria
b Center for Systems and Information Services, Covenant University, Ota, Nigeria
c HRA, Institute for Systems Science, Durban University of Technology, Durban, South Africa

A R T I C L E   I N F O

Article history:
Received 19 March 2018
Received in revised form 7 January 2019
Accepted 22 January 2019

Keywords:
Smart campus
Broadband internet access
Data bit rate
Mobile communication
Knowledge management

A B S T R A C T

Efficient broadband Internet access is required for optimal productivity in smart campuses. Besides access to broadband Internet, delivery of high speed and good Quality of Service (QoS) are pivotal to achieving a sustainable development in the area of education. In this data article, trends and patterns of the speed of broadband Internet provided in a Nigerian private university campus are largely explored. Data transmission speed and data reception speed were monitored and recorded on daily basis at Covenant University, Nigeria for a period of twelve months (January–December, 2017). The continuous data collection and logging were performed at the Network Operating Center (NOC) of the university using SolarWinds Orion software. Descriptive statistics, correlation and regression analyses, Probability Density Functions (PDFs), Cumulative Distribution Functions (CDFs), Analysis of Variance (ANOVA) test, and multiple comparison post-hoc test are performed using MATLAB 2016a. Extensive statistical visualizations of the results obtained are presented in tables, graphs, and plots. Availability of these data will help network administrators to determine optimal network latency towards efficient deployment.
of high-speed broadband communication networks in smart campuses.

© 2019 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Specifications table

| Subject area          | Engineering                                      |
|-----------------------|--------------------------------------------------|
| More specific subject area | Internet Engineering                          |
| Type of data          | Tables, graphs, figures, and Microsoft Excel spreadsheet file |
| How data was acquired | The continuous data collection and logging were performed at the Network Operating Center (NOC) of the university using SolarWinds Orion software. |
| Data format           | Raw, analyzed                                    |
| Experimental factors  | All statistical computations were performed using MATLAB 2016a |
| Experimental features | Various statistical visualizations such as boxplots, time series plots, frequency distributions, correlation and regression analyses, Probability Density Functions (PDFs), Cumulative Distribution Functions (CDFs), Analysis of Variance (ANOVA) test, and multiple post-hoc test performed on the dataset are presented. MATLAB 2016a software was used for the statistical computations. |
| Data source location  | The dataset on broadband Internet access speed presented in this article were collected at Covenant University, Ota, Nigeria (Latitude 6.6718°N, Longitude 3.1581°E) |
| Data accessibility    | Data is with this data article as supplementary material to aid reproducible research. This data is hosted in Mendeley data repository: https://data.mendeley.com/datasets/c9kcbf4s6t/1 https://doi.org/10.17632/c9kcbf4s6t.1 |
| Related research article | S. N. John, C. Ndujuiba, R. Okonigene, and N. Kenechukwu, "Simulation and Monitoring of a University Network for Bandwidth Efficiency Utilization," in Proceedings of the International Conference on Modeling, Simulation and Visualization Methods (MSV), 2013, p. 1. |

Value of the data

- The data provided in this data article include both peak and off-peak periods and these are valuable to the development of prediction or forecasting models for broadband communication networks in a smart campus environment [1,2].
- Robust data exploration presented in this data article will facilitate effective bandwidth distribution and allocation based on need, priority, and desired Quality of Service [3–5].
- Open access publication of these empirical data has an inherent ability to spur further evidence-based research on efficient bandwidth allocation and usage in computer networking [6–8].
- Availability of these data will help network administrators to determine optimal network latency towards efficient deployment of high-speed broadband communication networks in smart campuses [9–11].

1. Data

Quantitative data on broadband Internet access speed in Covenant University are presented in a reusable format. The data presented are further explored to reveal useful insights that are needed for
productive decision making based on statistical parameters used in [13–18]. Datasets on Internet transmission and reception speeds are extensively described by their statistical mean, median, mode, standard deviation, variance, kurtosis, skewness, range, minimum, maximum, and sum as shown in Table 1 and Table 2 respectively. Fig. 1 and Fig. 2 show the quartiles, minimum, maximum, and outliers in the transmission data and the reception data using boxplots. Trends of broadband Internet access speed in the university were analyzed monthly and the resulting graphs for each quarter of the year 2017 are shown in Figs. 3–6. Similarly, the frequency distributions of the data are shown in Figs. 7–10.

The scatter plot shown in Fig. 11 illustrates the relationship between the data transmission speed and the data reception speed that were monitored and logged daily for a period of twelve months. A regression line, linear regression equation, and regression coefficient are made available on the scatter plot. In addition, probability distributions of the transmission speed and the reception speed were computed and the results are presented in Fig. 12 and Fig. 13 respectively. In like manner, the cumulative densities of the datasets are shown in Fig. 14 and Fig. 15. The Distribution fitting parameters for data transmission speed and data reception speed are presented in Table 3 and Table 4 respectively. The estimates and standard errors of the two datasets are given in Table 5 and Table 6.

The datasets were tested for statistical difference across the months of the year based on Analysis of Variance (ANOVA) and multiple post-hoc comparison tests. The results of the ANOVA and multiple post-hoc comparison tests for data transmission speed are presented in Table 7 and Table 8 respectively. Similarly, the results of the ANOVA and multiple post-hoc comparison tests for data reception

| Table 1 | Descriptive statistics of data transmission speed in Gigabit per second (Gbps). |
|---------|----------------------------------|
|         | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  |
| Mean    | 0.08 | 0.20 | 0.27 | 0.14 | 0.13 | 0.14 | 0.12 | 0.08 | 0.19 | 0.18 | 0.18 | 0.06 |
| Median  | 0.09 | 0.15 | 0.32 | 0.14 | 0.13 | 0.14 | 0.11 | 0.07 | 0.18 | 0.18 | 0.17 | 0.03 |
| Mode    | 0.00 | 0.04 | 0.32 | 0.00 | 0.06 | 0.14 | 0.04 | 0.02 | 0.13 | 0.13 | 0.12 | 0.00 |
| Standard Deviation | 0.04 | 0.12 | 0.15 | 0.04 | 0.05 | 0.04 | 0.05 | 0.04 | 0.03 | 0.04 | 0.07 |
| Variance | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Kurtosis | 2.37 | 1.48 | 7.60 | 8.12 | 2.44 | 2.78 | 2.85 | 5.20 | 1.92 | 1.98 | 2.49 | 5.19 |
| Skewness | -0.68 | 0.30 | 0.32 | -1.61 | 0.26 | 0.42 | 0.64 | 1.49 | 0.28 | 0.06 | 0.50 | 1.50 |
| Range | 0.16 | 0.33 | 0.77 | 0.20 | 0.18 | 0.15 | 0.19 | 0.21 | 0.13 | 0.11 | 0.14 | 0.28 |
| Minimum | 0.00 | 0.04 | 0.08 | 0.00 | 0.06 | 0.08 | 0.04 | 0.02 | 0.13 | 0.13 | 0.12 | 0.00 |
| Maximum | 0.16 | 0.37 | 0.86 | 0.20 | 0.23 | 0.23 | 0.23 | 0.26 | 0.24 | 0.27 | 0.28 |
| Sum    | 2.47 | 5.66 | 8.37 | 4.36 | 4.15 | 4.18 | 3.57 | 2.46 | 5.57 | 5.59 | 5.35 | 1.67 |

| Table 2 | Descriptive statistics of data reception speed in Gigabit per second (Gbps). |
|---------|----------------------------------|
|         | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  |
| Mean    | 0.50 | 0.64 | 0.72 | 0.71 | 0.63 | 0.66 | 0.58 | 0.41 | 0.97 | 0.94 | 0.89 | 0.28 |
| Median  | 0.66 | 0.68 | 0.75 | 0.71 | 0.60 | 0.69 | 0.63 | 0.32 | 0.91 | 0.95 | 0.90 | 0.14 |
| Mode    | 0.00 | 0.15 | 0.32 | 0.00 | 0.34 | 0.32 | 0.16 | 0.13 | 0.67 | 0.53 | 0.53 | 0.00 |
| Standard Deviation | 0.28 | 0.18 | 0.13 | 0.17 | 0.20 | 0.17 | 0.19 | 0.28 | 0.18 | 0.20 | 0.19 | 0.36 |
| Variance | 0.08 | 0.03 | 0.02 | 0.03 | 0.04 | 0.03 | 0.04 | 0.08 | 0.03 | 0.04 | 0.04 | 0.13 |
| Kurtosis | 2.22 | 3.87 | 4.82 | 10.05 | 3.22 | 2.74 | 2.27 | 4.92 | 1.73 | 2.87 | 2.95 | 4.16 |
| Skewness | -0.93 | -1.14 | -1.13 | -2.06 | -0.87 | -0.49 | -0.28 | 1.67 | 0.17 | -0.11 | 0.52 | 1.39 |
| Range | 0.75 | 0.70 | 0.68 | 0.96 | 0.75 | 0.62 | 0.78 | 1.09 | 0.57 | 0.81 | 0.82 | 1.29 |
| Minimum | 0.00 | 0.15 | 0.32 | 0.00 | 0.34 | 0.32 | 0.16 | 0.13 | 0.67 | 0.53 | 0.53 | 0.00 |
| Maximum | 0.75 | 0.85 | 1.00 | 0.96 | 1.10 | 0.94 | 0.94 | 1.22 | 1.25 | 1.34 | 1.35 | 1.29 |
| Sum    | 15.55 | 17.88 | 22.46 | 21.92 | 19.68 | 19.93 | 17.93 | 12.76 | 29.07 | 29.22 | 26.68 | 8.38 |
speed are presented in Table 9 and Table 10 respectively. Graphical representations of the results showing statistical difference in data transmission speed and data reception speed are shown in Fig. 16 and Fig. 17.
2. Experimental design, materials, and methods

A smart campus relies on robust and efficient broadband internet access for optimal functionality [12]. A case in point is Covenant University, Nigeria which currently has a subscription of seven Synchronous Transport Module level one (STM-1) from three Internet Service Providers (ISPs). For this massive investment to be justifiably utilized, precise knowledge of internet speed trend and pattern on both the uplink and downlink is essential. Besides access to broadband Internet, delivery of high speed and good Quality of Service (QoS) are pivotal to achieving a sustainable development in the area of education. In this data article, trends and patterns of the speed of broadband Internet provided in a Nigerian private university campus are largely explored. The data presented in this article will help in network planning towards guaranteeing desired QoS.

Fig. 3. Trends of Internet speed in (a) January (b) February and (c) March 2017.
Covenant University, an ICT-driven private university located in Nigeria, is serviced with high-speed broadband Internet by three ISPs through fiber optic communication links. Two of the ISPs utilize STM-1 with an equivalent maximum Internet speed of 310 Megabit per second (Mbps) while the third ISP provides three STM-1 with an equivalent maximum Internet speed of 465 Mbps. All fiber optic communication links terminated at the Network Operating Center (NOC), which distributes available broadband Internet access to all academic, administrative, and residential buildings in the university campus. The data transmission speed and the data reception speed were monitored and recorded on daily basis for a period of twelve months (January – December, 2017). The continuous data collection and logging were performed with the use of SolarWinds Orion software. The network monitoring tool was installed on the bare metal server in the NOC to ensure sufficient computing resources. To facilitate easy data reuse for reproducible research, empirical data obtained from the experimental process were properly sorted and preprocessed using Microsoft Excel (MS-Excel) 2013 version.

![Fig. 4. Trends of Internet speed in (a) April (b) May and (c) June 2017.](image-url)
Fig. 5. Trends of Internet speed in (a) July (b) August and (c) September 2017.
Fig. 6. Trends of Internet speed in (a) October (b) November and (c) December 2017.
Fig. 7. (a)–(f). Frequency distributions of Internet speed in the first quarter of 2017.

Fig. 8. (a)–(f). Frequency distributions of Internet speed in the second quarter of 2017.
Fig. 9. (a)–(f). Frequency distributions of Internet speed in the third quarter of 2017.

Fig. 10. (a)–(f). Frequency distributions of Internet speed in the fourth quarter of 2017.
Fig. 11. Scatter plot of broadband Internet access speed.

Fig. 12. Probability distributions of data transmission speed.
Fig. 13. Probability distributions of data reception speed.

Fig. 14. Cumulative probability distributions of data transmission speed.
Table 3
Distribution fitting parameters for data transmission speed (Gbps).

|            | Normal          | Logistic        |
|------------|-----------------|-----------------|
| Log Likelihood | 365.399        | 394.714         |
| Domain     | $-\infty < y < \infty$ | $-\infty < y < \infty$ |
| Mean       | 0.1463          | 0.1394          |
| Variance   | 0.0079          | 0.0066          |

Table 4
Distribution fitting parameters for data reception speed (Gbps).

|            | Normal          | Logistic        |
|------------|-----------------|-----------------|
| Log Likelihood | $-68.1229$     | $-68.5258$     |
| Domain     | $-\infty < y < \infty$ | $-\infty < y < \infty$ |
| Mean       | 0.6615          | 0.6763          |
| Variance   | 0.0853          | 0.0878          |

Table 5
Estimates and standard errors of data transmission speed (Gbps).

| Parameter | Normal | Logistic |
|-----------|--------|----------|
|           | Approx | Std Err  | Approx | Std Err |
| $\mu$     | 0.1463 | 0.0047   | 0.1394 | 0.0040 |
| $\Sigma$  | 0.0890 | 0.0033   | 0.0449 | 0.0020 |

Fig. 15. Cumulative probability distributions of data reception speed.
Table 6
Estimates and standard errors of data reception speed (Gbps).

| Parameter | Normal | Logistic |
|-----------|--------|----------|
|           | Approx | Std Err  | Approx | Std Err |
| $m$       | 0.6615 | 0.0153   | 0.6763 | 0.0148  |
| $\Sigma$  | 0.2920 | 0.0108   | 0.1633 | 0.0072  |

Table 7
ANOVA test results for data transmission speed (Gbps).

| Source of Variation | Sum of Squares | Degree of Freedom | Mean Squares | F Statistic | Prob > F |
|---------------------|----------------|-------------------|--------------|-------------|----------|
| Columns             | 1.2348         | 11                | 0.1123       | 24          | 9.41 x 10^{-37} |
| Error               | 1.6511         | 353               | 0.0047       |             |          |
| Total               | 2.8859         | 364               |              |             |          |

Table 8
Multiple comparison post-hoc test results for data transmission speed (Gbps).

| Groups Compared | Lower limits for 95% confidence intervals | Mean Difference | Upper limits for 95% confidence intervals | p-value |
|-----------------|-------------------------------------------|-----------------|-------------------------------------------|---------|
| Jan             | – 0.1805                                  | – 0.1223        | – 0.0640                                  | 0.0000  |
| Jan             | – 0.2471                                  | – 0.1903        | – 0.1336                                  | 0.0000  |
| Jan             | – 0.1177                                  | – 0.0610        | – 0.0042                                  | 0.0228  |
| Jan             | – 0.1109                                  | – 0.0542        | 0.0026                                    | 0.0782  |
| Jan             | – 0.1167                                  | – 0.0595        | – 0.0022                                  | 0.0333  |
| Jan             | – 0.0922                                  | – 0.0354        | 0.0214                                    | 0.6678  |
| Jan             | – 0.0563                                  | 0.0005          | 0.0573                                    | 1.0000  |
| Jan             | – 0.1630                                  | – 0.1058        | – 0.0485                                  | 0.0000  |
| Jan             | – 0.1574                                  | – 0.1006        | – 0.0438                                  | 0.0000  |
| Jan             | – 0.1557                                  | – 0.0985        | – 0.0412                                  | 0.0000  |
| Jan             | – 0.0332                                  | 0.0240          | 0.0813                                    | 0.9688  |
| Feb             | – 0.1264                                  | – 0.0681        | – 0.0098                                  | 0.0075  |
| Feb             | 0.0030                                    | 0.0613          | 0.1196                                    | 0.0291  |
| Feb             | 0.0098                                    | 0.0681          | 0.1264                                    | 0.0074  |
| Feb             | 0.0040                                    | 0.0628          | 0.1215                                    | 0.0241  |
| Feb             | 0.0286                                    | 0.0869          | 0.1451                                    | 0.0001  |
| Feb             | 0.0645                                    | 0.1228          | 0.1810                                    | 0.0000  |
| Feb             | – 0.0422                                  | 0.0165          | 0.0752                                    | 0.9990  |
| Feb             | – 0.0366                                  | 0.0217          | 0.0799                                    | 0.9879  |
| Feb             | – 0.0350                                  | 0.0238          | 0.0825                                    | 0.9764  |
| Feb             | 0.0876                                    | 0.1463          | 0.2050                                    | 0.0000  |
| Mar             | 0.0726                                    | 0.1294          | 0.1861                                    | 0.0000  |
| Mar             | 0.0794                                    | 0.1362          | 0.1930                                    | 0.0000  |
| Mar             | 0.0736                                    | 0.1309          | 0.1881                                    | 0.0000  |
| Mar             | 0.0982                                    | 0.1550          | 0.2117                                    | 0.0000  |
| Mar             | 0.1341                                    | 0.1909          | 0.2476                                    | 0.0000  |
| Mar             | 0.0273                                    | 0.0846          | 0.1418                                    | 0.0001  |
| Mar             | 0.0330                                    | 0.0897          | 0.1465                                    | 0.0000  |
| Mar             | 0.0346                                    | 0.0919          | 0.1491                                    | 0.0000  |
| Mar             | 0.1571                                    | 0.2144          | 0.2716                                    | 0.0000  |
| Apr             | – 0.0500                                  | 0.0068          | 0.0636                                    | 1.0000  |
| Apr             | – 0.0558                                  | 0.0015          | 0.0587                                    | 1.0000  |
| Apr             | – 0.0312                                  | 0.0256          | 0.0823                                    | 0.9482  |
| Apr             | 0.0047                                    | 0.0615          | 0.1182                                    | 0.0206  |
| Apr             | – 0.1020                                  | – 0.0448        | 0.0124                                    | 0.3039  |
Table 8 (continued)

| Groups Compared | Lower limits for 95% confidence intervals | Mean Difference | Upper limits for 95% confidence intervals | p-value |
|-----------------|------------------------------------------|----------------|------------------------------------------|---------|
| Apr Oct         | 0.0964                                   | 0.0396         | 0.0171                                   | 0.4899  |
| Apr Nov         | 0.0948                                   | 0.0375         | 0.0197                                   | 0.5920  |
| Apr Dec         | 0.0278                                   | 0.0547         | 0.1422                                   | 0.0001  |
| May Jun         | 0.0626                                   | -0.0053        | 0.0519                                   | 1.0000  |
| May Jul         | 0.0380                                   | 0.0188         | 0.0755                                   | 0.9955  |
| May Aug         | 0.0021                                   | -0.0516        | 0.0056                                   | 0.1248  |
| May Sep         | 0.1089                                   | -0.0464        | 0.0103                                   | 0.2395  |
| May Oct         | 0.1032                                   | -0.0443        | 0.0129                                   | 0.3204  |
| May Nov         | 0.1016                                   | 0.0782         | 0.1354                                   | 0.0005  |
| May Dec         | 0.0210                                   | 0.0241         | 0.0813                                   | 0.9683  |
| Jun Jul         | 0.0331                                   | 0.0600         | 0.1172                                   | 0.0030  |
| Jun Aug         | 0.0027                                   | -0.0463        | 0.0114                                   | 0.2674  |
| Jun Sep         | 0.1040                                   | -0.0411        | 0.0161                                   | 0.4425  |
| Jun Oct         | 0.0984                                   | -0.0390        | 0.0187                                   | 0.5430  |
| Jun Nov         | 0.0967                                   | 0.0835         | 0.1412                                   | 0.0001  |
| Jun Dec         | 0.0258                                   | 0.0359         | 0.0927                                   | 0.6470  |
| Jul Aug         | 0.1276                                   | -0.0652        | -0.0084                                  | 0.0095  |
| Jul Sep         | 0.1230                                   | -0.0631        | -0.0059                                  | 0.0165  |
| Jul Oct         | 0.1203                                   | 0.0594         | 0.1167                                   | 0.0337  |
| Jul Nov         | 0.1635                                   | -0.1063        | -0.0490                                  | 0.0000  |
| Jul Dec         | 0.0129                                   | 0.1011         | -0.0443                                  | 0.0000  |
| Aug Sep         | 0.1562                                   | -0.0990        | -0.0418                                  | 0.0000  |
| Aug Oct         | 0.0337                                   | 0.0052         | 0.0624                                   | 1.0000  |
| Aug Nov         | 0.0504                                   | 0.0073         | 0.0650                                   | 1.0000  |
| Aug Dec         | 0.0721                                   | 0.1298         | 0.1875                                   | 0.0000  |
| Sep Oct         | 0.0551                                   | 0.0021         | 0.0594                                   | 1.0000  |
| Sep Nov         | 0.0674                                   | 0.1246         | 0.1819                                   | 0.0000  |
| Nov Dec         | 0.0648                                   | 0.1225         | 0.1802                                   | 0.0000  |

Table 9
ANOVA test results for data reception speed (Gbps).

| Source of Variation | Sum of Squares | Degree of Freedom | Mean Squares | F Statistic | Prob > F |
|---------------------|----------------|-------------------|--------------|-------------|----------|
| Columns             | 14.3882        | 11                | 1.3080       | 27.73       | 1.57 × 10^{-41} |
| Error               | 16.6523        | 353               | 0.0472       |             |          |
| Total               | 31.0405        | 364               |              |             |          |
### Table 10
Multiple comparison post-hoc test results for data reception speed (Gbps).

| Groups Compared | Lower limits for 95% confidence intervals | Mean Difference | Upper limits for 95% confidence intervals | p-value |
|-----------------|------------------------------------------|----------------|------------------------------------------|---------|
| Jan Feb         | −0.3220                                  | −0.1369        | 0.0481                                   | 0.3938  |
| Jan Mar         | −0.4033                                  | −0.2231        | −0.0428                                  | 0.0031  |
| Jan Apr         | −0.3858                                  | −0.2055        | −0.0253                                  | 0.0106  |
| Jan May         | −0.3136                                  | −0.1332        | 0.0470                                   | 0.3948  |
| Jan Jun         | −0.3444                                  | −0.1627        | 0.0191                                   | 0.1323  |
| Jan Jul         | −0.2570                                  | −0.0767        | 0.1036                                   | 0.9655  |
| Jan Aug         | −0.0903                                  | 0.0900         | 0.2703                                   | 0.8980  |
| Jan Sep         | −0.6492                                  | −0.4674        | −0.2856                                  | 0.0000  |
| Jan Oct         | −0.6212                                  | −0.4409        | −0.2606                                  | 0.0000  |
| Jan Nov         | −0.5696                                  | −0.3878        | −0.2060                                  | 0.0000  |
| JanDec          | 0.0403                                  | 0.2221         | 0.4038                                   | 0.0038  |
| Feb Mar         | −0.2712                                  | −0.0862        | 0.0989                                   | 0.9350  |
| Feb Apr         | −0.2537                                  | −0.0686        | 0.1164                                   | 0.9882  |
| Feb May         | −0.1814                                  | 0.0036         | 0.1887                                   | 1.0000  |
| Feb Jun         | −0.2123                                  | −0.0257        | 0.1608                                   | 1.0000  |
| Feb Jul         | −0.1249                                  | 0.0602         | 0.2452                                   | 0.9961  |
| FebAug          | 0.0418                                  | 0.2269         | 0.4119                                   | 0.0036  |
| Feb Sep         | −0.5170                                  | −0.3305        | −0.1440                                  | 0.0000  |
| Feb Oct         | −0.4891                                  | −0.3040        | −0.1900                                  | 0.0000  |
| Feb Nov         | −0.4374                                  | −0.2509        | −0.0644                                  | 0.0007  |
| Feb Dec         | 0.1725                                  | 0.3590         | 0.5455                                   | 0.0000  |
| Mar Apr         | −0.1628                                  | 0.0175         | 0.1978                                   | 1.0000  |
| Mar May         | −0.0905                                  | 0.0898         | 0.2700                                   | 0.8995  |
| Mar Jun         | −0.1214                                  | 0.0604         | 0.2422                                   | 0.9953  |
| Mar Jul         | −0.0340                                  | 0.1463         | 0.3266                                   | 2.5005  |
| MarAug          | 0.1327                                  | 0.3130         | 0.4933                                   | 0.0000  |
| Mar Sep         | −0.4262                                  | −0.2444        | −0.0626                                  | 0.0007  |
| Mar Oct         | −0.3982                                  | −0.2179        | −0.0376                                  | 0.0045  |
| Mar Nov         | −0.3465                                  | −0.1647        | 0.0171                                   | 0.1201  |
| MarDec          | 0.2633                                  | 0.4451         | 0.6269                                   | 0.0000  |
| Apr May         | −0.1080                                  | 0.0722         | 0.2525                                   | 0.9781  |
| Apr Jun         | −0.1389                                  | 0.0429         | 0.2247                                   | 0.9998  |
| Apr Jul         | −0.0515                                  | 0.1288         | 0.3091                                   | 0.4514  |
| AprAug          | 0.1152                                  | 0.2955         | 0.4758                                   | 0.0000  |
| Apr Sep         | −0.4437                                  | −0.2619        | −0.0801                                  | 0.0002  |
| Apr Oct         | −0.4157                                  | −0.2354        | −0.0551                                  | 0.0012  |
| Apr Nov         | −0.3640                                  | −0.1822        | −0.0005                                  | 0.0487  |
| AprDec          | 0.2458                                  | 0.4276         | 0.6094                                   | 0.0000  |
| May Jun         | −0.2111                                  | −0.0294        | 0.1524                                   | 1.0000  |
| May Jul         | −0.1237                                  | 0.0566         | 0.2369                                   | 0.9972  |
| MayAug          | 0.0430                                  | 0.2233         | 0.4036                                   | 0.0030  |
| May Sep         | −0.5159                                  | −0.3341        | −0.1524                                  | 0.0000  |
| May Oct         | −0.4879                                  | −0.3076        | −0.1274                                  | 0.0000  |
| MayNov          | −0.4363                                  | −0.2545        | −0.0727                                  | 0.0003  |
| MayDec          | 0.1736                                  | 0.3554         | 0.5371                                   | 0.0000  |
| Jun Jul         | −0.0959                                  | 0.0859         | 0.2677                                   | 0.9281  |
| JunAug          | 0.0708                                  | 0.2526         | 0.4344                                   | 0.0003  |
| Jun Sep         | −0.4880                                  | −0.3048        | −0.1215                                  | 0.0000  |
| Jun Oct         | −0.4601                                  | −0.2783        | −0.0656                                  | 0.0000  |
| Jun Nov         | −0.4084                                  | −0.2251        | −0.0419                                  | 0.0035  |
| JunDec          | 0.2014                                  | 0.3847         | 0.5680                                   | 0.0000  |
| Jul Aug         | −0.0136                                  | 0.1667         | 0.3470                                   | 0.1022  |
| Jul Sep         | −0.5725                                  | −0.3907        | −0.2089                                  | 0.0000  |
| Jul Oct         | −0.5445                                  | −0.3642        | −0.1839                                  | 0.0000  |
| Jul Nov         | −0.4928                                  | −0.3111        | −0.1293                                  | 0.0000  |
| JulDec          | 0.1170                                  | 0.2988         | 0.4806                                   | 0.0000  |
| Aug Sep         | −0.7392                                  | −0.5574        | −0.3756                                  | 0.0000  |
| Aug Oct         | −0.7112                                  | −0.5309        | −0.3506                                  | 0.0000  |
### Table 10 (continued)

| Groups Compared | Lower limits for 95% confidence intervals | Mean Difference | Upper limits for 95% confidence intervals | p-value |
|-----------------|-------------------------------------------|-----------------|-------------------------------------------|---------|
| Aug Nov         | − 0.6595                                  | − 0.4778        | − 0.2960                                  | 0.0000  |
| Aug Dec         | − 0.0497                                  | 0.1321          | 0.3139                                    | 0.4234  |
| Sep Oct         | − 0.1553                                  | 0.0265          | 0.2083                                    | 1.0000  |
| Sep Nov         | − 0.1036                                  | 0.0796          | 0.2629                                    | 0.9599  |
| Sep Dec         | 0.5062                                    | 0.6895          | 0.8728                                    | 0.0000  |
| Oct Nov         | − 0.1286                                  | 0.0532          | 0.2349                                    | 0.9985  |
| Oct Dec         | 0.4812                                    | 0.6630          | 0.8448                                    | 0.0000  |
| Nov Dec         | 0.4266                                    | 0.6098          | 0.7931                                    | 0.0000  |

**Fig. 16.** Graphical representation of monthly mean data transmission speed (Gbps).

**Fig. 17.** Graphical representation of monthly mean data reception speed (Gbps).
Acknowledgments

This work is carried out under the IoT-Enabled Smart and Connected Communities (SmartCU) research cluster in collaboration with the Center for Systems and Information Services (CSIS), Covenant University, Ota, Nigeria. This research is fully sponsored by Covenant University Centre for Research, Innovation and Development (CUCRID), Covenant University, Ota, Nigeria.

Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2019.103705.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2019.103705.

References

[1] N. Nkordeh, A. Atayero, F. Idachaba, O. Oni, LTE network planning using the Hata-Okumura and the COST-231 Hata pathloss models, in: Proceedings of the Lecture Notes in Computer Science and Engineering, World Congress on Engineering, London, UK, 2014, pp. 705–709.
[2] T. Takpor, A.A. Atayero, Integrating internet of things and ehealth solutions for students’ healthcare, Proc. World Congr. Eng. (2015) 265–268.
[3] S.I. Popoola, S. Misra, A.A. Atayero, Outdoor path loss predictions based on extreme learning machine, Wirel. Personal. Commun. 99 (2018) 441–460.
[4] O.B. Idowu-Bismark, A.E. Ibhave, A. Atayero, Mimo optimization techniques and their application in maximizing throughput for 3GPP HSPA+, J. Wirel. Netw. Commun. 7 (2017) 1–8.
[5] S.I. Popoola, E. Adetiba, A.A. Atayero, N. Faruk, C.T. Calafate, Optimal model for path loss predictions using feed-forward neural networks, Cogent Eng. 5 (2018) 1444345.
[6] A. Atayero, Distributed Denial of Service (DDoS) Network Attacks: Impact On The Virtual Learning Environment, 2014.
[7] S.I. Popoola, N. Faruk, A.A. Atayero, M.A. Oshin, O.W. Belo, M. Adigun, 5G radio access network technologies: research advances, in: Proceedings of the World Congress on Engineering and Computer Science, San Francisco, 2017, pp. 101–105.
[8] S.I. Popoola, N. Faruk, A.A. Atayero, M.A. Oshin, O.W. Belo, E. Mutafungwa, Radio Access Technologies for Sustainable Deployment of 5G networks in emerging markets, Int. J. Appl. Eng. Res. 12 (2017) 14154–14172.
[9] A.A. Atayero, O.A. Ilori, M.O. Adedokun, Cloud security and the internet of things: impact on the virtual learning environment, Covenant Univ. (2017).
[10] M.K. Luka, A.A. Atayero, O.I. Oshin, Call admission control techniques for 3GPP LTE: a survey, in: Proceedings of the SAI Computing Conference (SAI), 2016, pp. 691–700.
[11] A.A. Atayero, Y.A. Ivanov, Modeling of packet streaming services in information communication networks, Integr. Model. Inf. Commun. Syst. Netw.: Des. Dev.: Des. Dev. (2013) 166.
[12] S.N. John, C. Ndujuiba, R. Okonigene, N. Kenechukwu, Simulation and monitoring of a university network for bandwidth efficiency utilization, in: Proceedings of the International Conference on Modeling, Simulation and Visualization Methods (MSV), 2013, p. 1.
[13] S.I. Popoola, A.A. Atayero, N. Faruk, Received signal strength and local terrain profile data for radio network planning and optimization at GSM frequency bands, Data Brief. 16 (2018) 972–981.
[14] S.I. Popoola, A.A. Atayero, N. Faruk, J.A. Badejo, Data on the key performance indicators for quality of service of GSM networks in Nigeria, Data Brief. 16 (2018) 914–928.
[15] S.I. Popoola, A.A. Atayero, T.T. Okanlawon, B.I. Omopariola, O.A. Takpor, Smart campus: data on energy consumption in an ICT-driven university, Data Brief. 16 (2018) 780–793.
[16] S.I. Popoola, A.A. Atayero, O.A. Popoola, Comparative assessment of data obtained using empirical models for path loss predictions in a university campus environment, Data Brief. (2018).
[17] S.I. Popoola, A.A. Atayero, O.D. Arausi, V.O. Matthews, Path loss dataset for modeling radio wave propagation in smart campus environment, Data Brief. 17 (2018) 1062–1073.
[18] J.O. Okeniyi, A.A. Atayero, S.I. Popoola, E.T. Okeniyi, G.M. Alalade, Smart campus: data on energy generation costs from distributed generation systems of electrical energy in a Nigerian University, Data Brief. 17 (2018) 1082–1090.