Oak Hammock Internet Service Upgrade: Report 1 - Residents' Speeds Version 1.1

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1. Introduction:

Oak Hammock (OH) at the University of Florida (UF) is a continuing care retirement community (CCRC) in Gainesville, FL.[2] The monthly fee for residents in the main building apartments and in homes on the streets include internet access contracted with the Gainesville Regional Utility (GRU). The utility is owned by the Gainesville city government. A speed upgrade implemented in 2018 and 2019 and Wi-Fi was extended throughout the main building.

Before the upgrade, the maximum speed announced by the GRU internet service was 100, though – as can be seen below – at least nine OH residents had speeds over 100. The upgrade was to give all OH users access to a shared 1 gigabit "pipe" to the internet world. This was to accommodate the fast growing number of devices sharing the link for microcomputer chip based and streaming devices.

There was no history of residents' access to the internet on microcomputers. A resident volunteer group, Hammock Electronic Assistance Team (HEAT), gives free assistance to residents needing help with micros and other stand-alone electronic devices using internet bandwidth. The author, a member of HEAT, proposed a before and after upgrade study of residents' internet micro speeds; it was accepted by two OH residents' committees.

The primary objective of the study was to create a history of residents' use of micros on the internet. This will give HEAT members a basis for recommending changes being considered by existing and new OH residents. This, Report 1, gives the results of the before and after upgrade speeds. Report 2 will present recommendations for existing and new Oak Hammock residents to improve their internet speeds if they wish to do so.[3]

2. Oak Hammock

This CCRC is now in its 16th year. Residents are in five types of residences: 212 independent living apartments, 57 independent living houses, 46 assisted living units, 73 skilled nursing units, and 24 memory units.[4] On 10/12/19 there were 441 unique names on the OH resident listing; the listing also has 338 unique email addresses. Excluding those in memory units, almost all residents have email addresses included in the resident listing or share an address with a spouse. Those without email addresses included in the resident listing (a) share an address, (b) do not have one, or (c) prefer to not have their address on the listing. Many residents have multiple email addresses.

All residential units, excluding the memory units, have RJ45 outlets in one room. Skilled nursing has ceiling-mounted wireless access points as do 9 rooms in assisted living. To use the internet, residents must supply their own hardware, software, and connection. Prior to the access upgrade, residents had to connect their micros with cables to the RJ45 outlets. Many had micro – switch – router or micro – wireless router hardware configurations.

Part of the OH internet upgrade was installing a Ruckus Wireless H510 router where the existing RJ45 outlet was located on the residence wall using a CAT 5e or CAT 6 cable (See http://support.ruckuswireless.com/documents/. Search on "H510"). The H510 delivers high-speed 802.11ac WiFi and has four RJ45 outlets. The two buildings with the 212 apartments had major equipment upgrades and cable upgrades, such as replacing CAT R5 cables with CAT R5e or CAT R6 cables. A number of OH residents refused the direct, micro – H510 wireless configurations. They had their personal wireless routers connected with R5e or R6 cables to the H510's. Some connected their micros to the H510's with R5e or R6 cables. And, some had 10-100 switches upgraded to 10-100-1000.

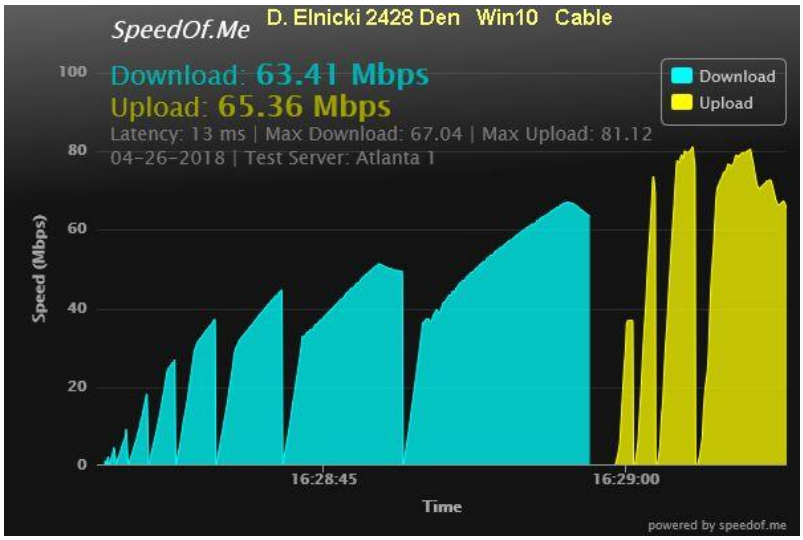
A special thank you to Bill Castine, Norm Cooney, Doug Merrey, John Paul and Bill Zegel for their detailed "red-pen" reviews of Version 1.0.

3. Why Speedof.Me?

OH residents' common use of their micros to access internet sites includes sending and receiving email, reviewing personal financial transactions and status, shopping at on-line stores, and general browsing. Most sites accessed are in the U.S.A., though many residents access sites throughout the world. It follows that a speed test should reflect residents' use rather than speeds to and from the UF, the closest non-GRU site that has a speed test that can be used by an internet user (Enter "speedtest.ufl.edu" from a browser). Little of OH residents' traffic is to and from the UF. For example on the OH resident listing 10/24/16, 18 OH residents (5%) have email addresses ending with "ufl.edu" and 187 residents (55%) have gmail.com addresses[5] The 10/24/19 resident listing included 18 unique email addresses ending in "com", "edu" or "net".

A review of a large number of internet speed tests led the author to conclude speedof.me would provide the most information on a resident's test while being relatively easy for the resident to use and relatively easy for the resident to send the author the results of a test. GRAPH 1 has the author's pre-upgrade test results. The author added

GRAPH 1



"D.Elnicki 2428 Den Win10 Cable" to the image for GRAPH 1. Each participant in the Before case was sent back a copy of their equivalent of the image in GRAPH 1 their name, windows or apple, and their reported connectivity, cable or wireless.

The factors that influenced the choice include the following.

1. Each download test uses files starting with 128 KB, 256KB, 512KB, 1, 2, 4, 8, 16, 32, 64, 128MB, up to 11 files, and reports the last requiring more than 8 seconds as the average speed and also reports the maximum speed of all the files tested. Each upload does the same, giving average and maximum speeds.

2. It is a HTML5 test run on the user's browser without any Flash or Java needed.

3. The latency of the tests is given in milliseconds. (Dictionary.com "…the period of delay when one component of a hardware system is waiting for an action to be executed by another component." © 2019 Dictionary.com, LLC)

4. The time of day of the tests and the day, month, and year are included for documentation.

5. Small, full instruction set: Start test, Test Again, Share.

6. Using "Share", it opens an email on the user's installed email client to forward the test results to a recipient, the author in this case.

7. All tests could be run on speedof.me's Atlanta 1 super server site (See https://speedof.me/howItworks.html" for details. Atlanta 1 is one of 116 world-wide super server POPs as of December 20, 2019).

8. The advertisements are not intrusive.

9. No personal information is collected on users.

10. Simple directions for use, stating "Stop all internet activities and click 'Start Test'.

It is not known the extent to which participants did "Stop all internet activities…" It is well known that other devices using an internet connection can slow down traffic on any given bandwidth. A typical set of devices in an OH residence included 2 microcomputers, 2 cell phones, 2 TV's with streaming capabilities, multiple speakers and a voice-command controller or virtual assistant, e.g., an Alexa by Amazon LAB126.

4. Study Sample

The author met with two OH residents' committees to get approvals: the Communications Committee and the Information Technology Committee. The study was also reviewed with the OH Chief Executive Officer, the Chief Financial Officer (3 IT staff residents report to this officer), and the Information Technology staff residents. The latter support OH's administrative, security, food services, and operations IT services. The IT staff members are available to help OH residents with problems on a time-available basis, though residents' IT support is not in their job descriptions.

The usual sampling method was NOT followed for these tests, i.e., a random sample of the population under observation/being tested. Prior to the start of this study, the author had helped many OH residents having problems with their Windows microcomputers. This led to the conclusion that a majority, if not most, OH residents sampled randomly would not be comfortable doing the test and sending an email with results or just not want to bother doing so. Two other HEAT residents, one an Apple guru and one a Windows guru, and the author met to pick OH residents that would be comfortable participating in a before- and an after-upgrade speed test and would volunteer to do so. No rewards or remuneration were given to participants. At the time, the other two residents each had 5 years of experience helping OH residents while the author had 2.5 years.

The three HEAT residents met to identify likely OH participants. Each had a paper copy of the then current OH private name, residence, and email address listing. At the time, there were 437 unique resident names in the list. Fifty five residents were chosen since 5 HEAT residents' first tests were available to get the desired 60 total tests. The sixty participants were 13.7 percent of the OH resident population when the sampling was started.

The before-upgrade sampling started April 24, 2018 and was completed July 22, 2018. The upgrade was expected to take 5 to 6 months; it took 15 months and one week. The after-upgrade sampling started August 29, 2019 and was completed October 30, 2019.[6] The months between individual participants' tests ranged from 13 to 16.

Requests for participation were printed and put in individuals' cubby mailboxes in the building or delivered by hand and placed on front-door clips on houses. Copies of the before- and after-upgrade requests are shown in Exhibits 1 and 2 below. Reminders on these forms were placed in the participants' cubbies or on front-door clips as needed. In a few cases, individuals were phoned and asked to do the test.

The Before participation form included the internet URL "speedof.me". The After form included "speedof.me/old" because the testing site changed the report format. This resulted in the same After report format the participants experienced 13 through 16 months earlier, the image shown above in GRAPH 1. The Before results were made available on one of the author's Web pages: individual participants received blind complimentary copy emails that identified the line number in the Web page with their individual results. No participants were identified by name or unit number.

Sixty participants completed the before-upgrade test. Forty nine completed the after-upgrade test. So, 11 participants in the before-upgrade sample did not complete the after-upgrade sample for a variety of reasons. The evaluation structure – discussed in the next section – requires matched pairs. The 49 paired tests are shown in Exhibits 1 and 2 with speed means and standard deviations for the reported download average, download maximum, upload average, and upload maximum.

5. Comparison Problems

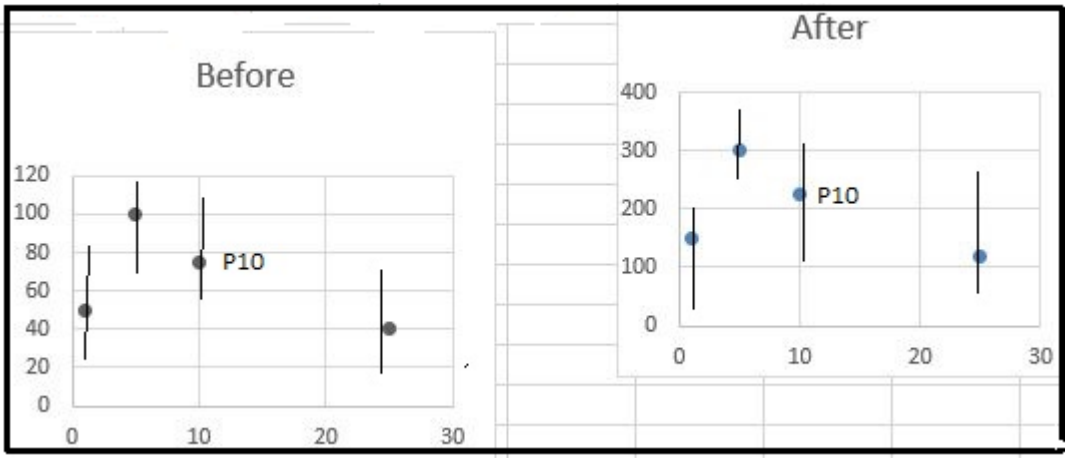
A problem with this kind of before and after sampling of times is the inherent variation of speeds on the internet. There is variation across time. And, there is variation by individuals with continuous tests. For example, the author did five speedof.me tests in the middle of a Monday that were one minute apart. They started at 2:27 p.m. and ended 2:31 p.m. The download average speeds were as follows:[7]

221.2 310.5 195.5 205.5 232.3 [1]

A larger sampling continuously for a user will give a representative range with a maximum and a minimum, such as 195.5 and 310.5 in the above 5 tests. This range will vary for many reasons including the speeds in the user's micro, the communication paths from the micro to the local internet connection, the traffic on/capacity of the GRU path of the internet connection, routers' traffic on the internet "pipes", and the processor at the other end functioning as a server. The test server for the above sample of 5 is located at the speedof.me Atlanta1 site, as shown in GRAPH 1 above in the Section 3.

Perfect sampling of OH residents' speeds before and after the upgrade should include a representative sampling of each resident's tests. This was not feasible. Rather, a single sampling from the participating residents' ranges was available for the before and after upgrade. This is depicted in GRAPH 2 where the manually inserted vertical lines depict possible ranges and the bullets depict possible single million bit per second samples for each participant:

GRAPH 2



In GRAPH 2, "P10" is a speed point in that hypothetical resident's range in the Before state and a second point in the After state. The time separation between a resident's Before and After tests was from the two Speedof.Me samples permit three relatively simple statistical tests of whether the After results are significantly different from the Before results.[8]

1. Difference between means tests of the After and Before tests.
2. Absolute differences between each participant's After and Before tests.
3. Percentage difference between each participant's After test Before test.

What was tested? The objective was to determine the differences in speeds of a part of the internet path due to changes in the GRU.com component of the path. The full path described above – purposefully simplified - is segmented next:

A. Participants' Component -- Speeds in the user's micro, the paths from the micro to the local internet connection.

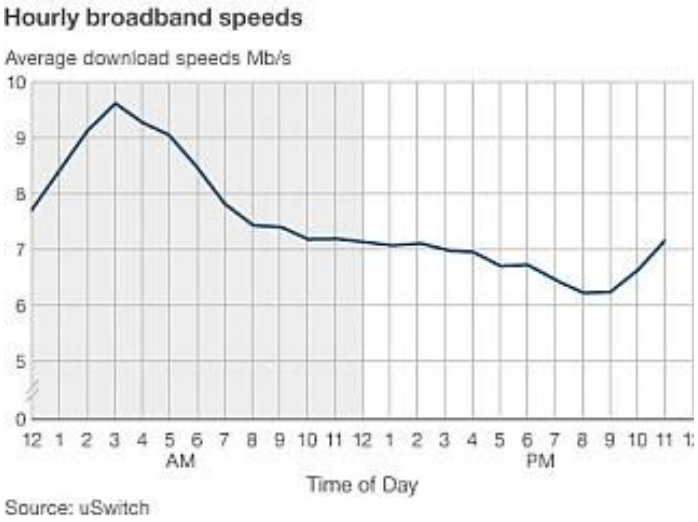
B. GRU.com Component -- The GRU path of the internet connection.

C. Internet Component -- Routers' traffic on the internet "pipes", and the processor functioning as a server.

The Participant's components, A., include a very large number of hardware parts, software, and cables. The author picked but three. Street or building (s/b) because of differences in fiber and cable connections. Windows or Apple

operating systems (appl/win) because of their inherent differences. And, cable or wireless communication media because of well documented differences between the two.[9]

The participants were also asked to run their After speed tests on the same day of the week and about the same time of day as their Before speed tests. While it is impossible for all practical purposes to run tests at exactly the same time, it was hoped by asking for tests at about the same time would help account for the inherent variability of internet traffic by time of day. This variability is depicted in Graph 3 from Steve Smarthom's "eGuide" published November, 2019:[10]



The IDEAL test is from the start of B. GRU.com Component to the end of B only as it affects residents' responses. The Speedof.Me upload tests are from the start of A. Participant's Component to the end of C. Internet Component. The download tests are from the end of C. to the start of A. The statistical analysis in the next section assumes the A. Participants' Components in the Before tests are the same as these components in the After tests with random, insignificant variations. Similarly, it is assumed the C. Internet Components in the Before tests are the same as these components in the After tests with random, insignificant variations.

6. Test Results:

The sampled values for the Before tests are in Exhibit 1 for 49 participants. The sampled values for the After tests are in Exhibit 2 for those 49 participants. All reported speeds were read from graphic results similar to those shown in Graph 1 above and entered manually by the author into the two Excel spreadsheet pages. The manual entries were usually completed within 2 days from the date each participant completed the tests and mailed results to the author.

As noted in Section 3 above, Item 1, each download test uses files starting with 128 KB, 256KB, 512KB, 1, 2, 4, 8, 16, 32, 64, 128MB, up to 11 files, and reports the last requiring more than 8 seconds as the average speed. It also reports the maximum speed of all the files tested. Each upload is similar giving average and maximum speeds. Averages for these 4 speeds plus latency and the standard deviations are at the top of Exhibits 1 and 2.

6.1 Difference between means tests of the After and Before tests. The Before means and standard deviations are on lines 2 and 3 of Exhibit 1, as are the After tests on Exhibit 2. All AFTER averages and standard deviations are greater than the BEFORE case as shown in Table 1 next.

Table 1

BEFORE	Std Dev	28.3	40.1	30.5	34.4	6.6
	Mean	37.3	46.8	58.0	66.1	16.9
		DownAv	DownMax	UpAv	UpMax	Latency
AFTER	Std Dev	92.9	94.6	135.1	144.7	3.6
	Mean	133.3	152.4	168.5	179.6	16.9
	T Tests	6.92	7.19	5.58	5.34	0.04

All averages for the 49 After speed tests are significantly higher than the before tests at the .005 level (where the t-test value is 2.576). The latency averages are the same, though the After case has variation about half the Before case. So, given the assumptions about random, insignificant variations in A. Participant's Components and in C. Internet Components, it is concluded the B. GRU.com Component is giving significantly faster aggregate internet service.

The four mean values of the After case are 2.7 to 3.6 greater than the Before case. Another major change is variability where the standard deviation ratios are 2.4 to 4.4 greaterer in the After case.

Table 2

Ratios After/Before:	Down Avg	Down Max	Up Avg	Up Max
Means	3.6	3.3	2.7	2.7
Std. Dev.	3.3	2.4	4.4	4.2

These ratios imply that some OH participants had much better upgrade results than others. This implication is demonstrated by the next subsection, 6.2.

6. 2. **Absolute differences** between each participant's After and Before tests.

Exhibit 3 shows the difference between each participant's four speed values and latency in the before and after cases. The cell entries were all calculated using the Cell entries shown in Exhibits 1 and 2. The following example is for Participant 1's two Download Averages (Exhibit 2 Cell F5 minus Exhibit 1 Cell F5):

After - Before = Difference

160 - 52 = +108

Exhibit 3 starts with "t" tests showing significant differences in agreement with those shown in 6.1 above. The maximum upload individual speed increase was +401 by Participant 24, the highest for all 49 participants' four difference values. Participant 28 had the lowest change with a Download difference of -54. There are 49 x 4 = 196 speed value differences shown on Exhibit 3 for all participants. The following, Table 3, is a tabulation in Exhibit 3 of all 196 speed values by 7 Megabit classes:

Table 3

	N	Percent
-71 - 0	30	15.3%
1 - 50	54	27.6%
51 - 100	24	12.2%
101 - 150	30	15.3%
151 - 200	20	10.2%
201 - 300	23	11.7%
301 - 401	15	7.7%
	196	100.0%

This tabulation of all 196 speed value changes shows 15.3 percent were decreases or zero. One could infer from this, similarly, that 15.3 percent of all OH internet users have speed changes that were negative or zero doing internet activities. Three of the values in the 196 are zero, but this is, in part, because the actual measures reported are rounded to millions. In the last two classes, 19.4 percent, almost one-fifth are increases of 201 megabits or more: this is about four times the averages found in the Before tests, the latter shown in 6.1 above and on Exhibit 1. In keeping with the first inference made here, about one fifth of all OH users are experiencing speed increases of 201 or more megabits per second with 7.7 percent over 300.

6.3. **Percentage difference** between each participant's After and Before tests.

In Section 6.1, it is shown the internet upgrade has led to statistically significant increases in OH participants' megabit speeds in aggregate, a.k.a. "on the average": the four mean values of the After case are 2.7 to 3.6 greater than the Before case. Section 6.2 shows what the author considers very large differences in changes in participants' megabit speeds. Here, the percentage change experienced by participants is evaluated.

The percentage change is defined as a participant's speed change on each of the four speed tests divided by the Before speed on each of the four tests. The ratio is multiplied by 100 to give percentages. For Participant 1, the percent increase in the download average was (Exhibit 3 Cell G6 divided by Exhibit 1 Cell F5):

108/52 = 207.7%

The percentage change for each of the 49 participants' four speed tests are in Exhibit 4. The means for the four speed tests (with respect to zero) are all significant at the .005 level. The latency mean percentage difference was not significantly different from zero at conventional testing levels.

Table 4

t=	6.46	6.59	5.46	5.41	1.76
Std Dev	444.9%	429.0%	306.3%	270.2%	27.6%
Mean	410.6%	404.1%	239.0%	208.8%	6.9%
	DownAv	DownMax	UpAv	UpMax	Latency

These average After-Before percentage changes are consistent with the absolute value means tests above at the end of Section 6.1.

A major, unexpected result indicated in the above tabulation was that all standard deviations are greater than the respective means. The inference of this is a large variation in the participants' Before and After change results. Regression tests using binary explanatory variables for street (s = 1) versus building (b=0), and for Apple (apl=1) versus Windows (win=0) did not give significant results at conventional testing levels (Exhinbit 4, Columns P to S).
A number of attempts to explain the increase in speed variances, from 270% to 360% as indicated at the end of Section 6.1 for the four test speeds of each participant, and, aggregate results in the tabulation directly above where for all four tests the standard deviations exceed the means.

Various sorts of the percentage changes for each participant with the Before numeric speeds showed that

(a) participants with the slowest Before speeds had the largest percentage changes and

(b) participants with the highest Before speeds had the lowest percentage changes.

These relationships were opposite the writer's expectations and require explanation. In addition, 9 participants experienced 1 to 4 negative or zero percentage changes in their four percentage changes. Their participant numbers are

1. Negative/Zero Change List: 3, 17, 22, 28, 31, 41, 42, 43, 46 [Total 9]

These participants' results could be due to equipment and/or software constraints as compared to the other 40 participants. These constraints could have led to After potential ranges that overlapped the Before potential range per Graph 2. above. For hypothetical P10 on that graph, the Before sample could be at the top of the range while the After sample is at the bottom of the range resulting in a negative change in speed. This is a major limitation of the Graph 2 model where only one Before and one After test was done by each participant. It follows that participants in the Negative/Zero Change List should be asked for permission to evaluate their equipment and/or software to determine if potential constraints can be removed. Or, whether the negative or zero change was due to random sampling outcomes.

Participants in the Negative/Zero Change List were excluded for additional analysis of the percentage change results. All participants with percent changes greater than zero also had large variations. The four tests by each

participant were sorted by Before speed with their corresponding percentage changes and participant numbers: Exhibit 5, Page 1-2.

Visual inspection showed the pattern stated in the second paragraph above. So, the lowest 10 Before speeds and corresponding percent changes were compared to the fastest 10 Before speeds and corresponding percent changes. The results for the 10 fastest and 10 slowest are in Table 5

Table 5.

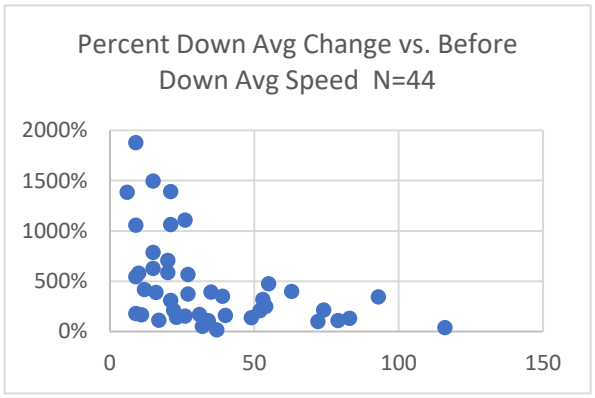
Average Percent Speed Changes by Before Speeds

Download Average	Download Maximum	Upload Average	Upload Maximum	Test Types
761%	817%	529%	459%	10 Slowest Before Speeds
237%	113%	198%	218%	10 Fastest Before Speeds
3.2	7.3	2.7	2.1	Ratios: Slowest/Fastest

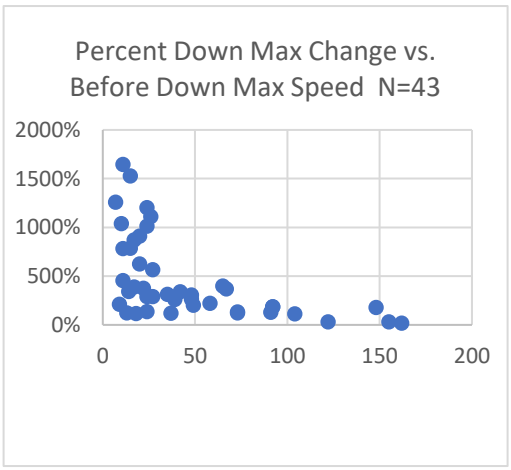
These counter intuitive – to the author – results, two-fold to seven-fold differences, were followed by four regression estimates. One for each of the four types of tests for participants with positive percentage changes between the Before and After tests at Speedof.Me. All four estimates gave significant negative values with increasing Before speeds (Downloads: Exhibit 5, Page 1, Lines 2 to 9 and Uploads: Exhibit 5, Page 2, Lines 2 to 9)

This, in turn, led to plots of the tests with speed change percentages greater than zero. They are shown next.

PLOT 1



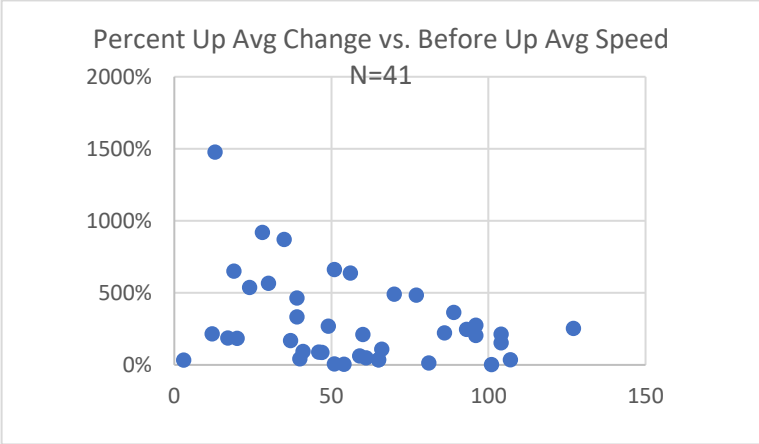
PLOT 2



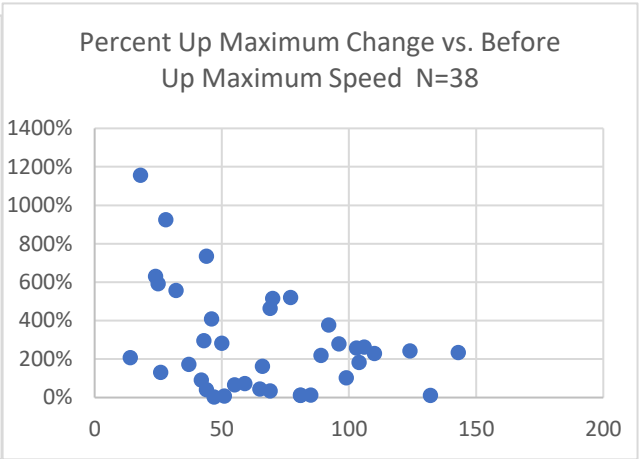
These download plots show a distribution that is like 1Erlang. But, the shape is not important. The important part of the plots is that most Before download speed tests are associated with a very wide range of percentage changes: 16% to 1,878% of the download averages and 19% to 1,527% of the download maximums with some clustering.

The upload plots also exhibit very wide percentage changes (The are like 2-Erlang.[13]). The upload average percentage changes ranged from 3% to 1,477%; the upload maximum percentage changes ranged from 2% to 1,156%.

PLOT 3



PLOT 4



These plots permit the identification of groups of participants that can be compared to develop profiles of the users' path components. OH sample participants identified in the groups could be asked to further participate in getting inventories of their path components, i.e., microcomputer make and age, operating system make and age, personal router make, age, and cable (5, 5E, 6) if in use, micro location relative to Ruckus routers, and signal barriers in users' residences. Other and/or different path components could be considered.

PLOT 1 with download averages for 44 participants has the highest variation in the positive speed change percents, viz., 1,878 – 16% = 1,862, almost two-fold. So, it is used to identify potential sample participants in three groups:

2. Before Speed < 50 & Speed Change < 200%: 22, 44, 38, 43, 17, 10, 30, 20, 15, 26, 35, 36 [Total = 12]

3. Before Speed < 50 & Speed Change > 500%: 13, 39, 6, 37, 18, 24, 14, 16, 9, 7, 23, 40, 33, 27 [Total = 14]

6.4 Fastest After Results

A fourth group of participants should also be considered for inventories of their user component of the full test path. It is **A**. in the simplified full test path shown in **Section 5**. Shown above:

A. Participants' Component -- Speeds in the user's micro, the paths from the micro to the local internet connection.
B. GRU.com Component -- The GRU path of the internet connection.
C. Internet Component -- Routers' traffic on the internet "pipes", and the processor functioning as a server.

They illustrate the largest absolute megabit increases in the Before vs. After speed tests on Speedof.Me by OH users. Again, the download average speeds are used. Included are participants with After download average speeds of 200 megabits or greater. The largest was 412 megabits, larger than the average for all 49 participants by a factor of three (412/133).

Fastest Nine:	#1	#2	#3	#4	#5	#6	#7	#8	#9	Means	Std. Devs.
Before Mbps	93	55	63	26	21	21	15	74	53	46.8	27.43
After Mbps	412	316	314	314	313	244	239	232	221	289.4	61.32
Participant	52	49	2	7	40	9	33	21	4		
Mbps Increase	319	261	251	288	292	223	224	158	168	242.7	33.9
Ratios										6.2	2.2

This group, also, illustrates the wide variation in results among the OH participants change in speeds. Participant 52, #1 in the above listing, had an absolute megabit increase twice that experienced by Participant 21, #8 above (319/158).

7. Inherent Problems & Considerations

The testing model, represented by Graph 2, should have been implemented by having each participant do multiple Speedof.Me tests continuously (to minimize time-oriented full path changes) for the Before case and again for the After case. This may have given a robust sampling result. This was judged to not be feasible with the OH's internet users.

The default sampling was one Before and one After test. The result was 60 Before participants and 49 After participants, a reduction of about 1/5th. While the statistical results for the 49 participants likely are reasonably valid for the OH internet user population, results for each user are not robust. And, regression models with available explanatory variables did not give significant measures.

For about one month, various searches on the Web were attempted to find prior studies of the imact of an internet upgrade on users speeds. A variety of search terms, e.g., including the words speed, test, changes, impacts, upgrades, links, cables, wireless, WiFi, communication, path and so on in various permutations and combinations, did not give sites even somewhat similar to what was attempted for this study. Many very interesting and educational sites were found, some of which are referred to in the footnotes below.[15] To any reader of this: if you know of studies similar to this attempt or remotely similar, please send links to the sources to the author at dicke@ufl.edu.

Questions have been raised about the uniformity of cables connecting and running to the main server in a basement machine room and through the 2 residential buildings with 4 L-shaped floors each to the individual residences and access points. This included a number of switches and patch panels. There was no way this study could address the question and conclude that this part of **B**. GRU.com Component was the same for all during the Before case and the After case where the latter incudes the upgrade to a shared 1 gigabit path. The OH-GRU.com contract specified that the GRU part of the link ends at the RJ45 link on each residence wall PLUS the new Ruckus Wireless H510 router (described above in Section 2).

Regarding **C**. Internet Component -- Routers' traffic on the internet "pipes", and the processor functioning as a server, where the Atlanta 1 server was used for all tests, the "Submit a request" site, https://speedofme.zendesk.com/hc/en-us/requests/new, was used to send an email. After a brief 3 sentence introduction about this study, the email asked if there a MAJOR change in the service speeds of the four tests between the end of Before case date and the beginning of the After-case date. This request has been outstanding for about 11 weeks as of the date of this writing: February 12, 2020.

The searches noted above in this section did not include information on whether other parts of **C**. Internet components connecting GRU.com with the Speedof.me Atlanta site had changes in speed. From long before the start of this study though this writing, the Windows-based traceroute command, "tracert site" has been used for various reasons. While it may not, in fact, be possible to use this to observer major speed changes, none were observed by the writer.

8. **Summary**

The primary objective of the study was to create a history of residents' use of micros on the internet. This will give HEAT residents a basis for recommending changes being considered by existing and new OH residents. This, Report 1, gives the results of the Before and After upgrade speeds:

• The average speeds after the upgrade were significantly higher by factors from 2.7 to 3.6 times higher (Table 2 in Section 6.1). Given classical statistics assumptions on such tests, all internet OH residents, the population in question, have had these gains on the average.

• The average change in megabits per second ranged from 96.0 to 113.4 for the four kinds of tests results given for each sample participant. They are all significantly different from zero at the .005 testing level. See Section 6.2.

• The average percent change in megabits per second ranged from 208.8% to 410.6% for the four kinds of tests. All significantly different from zero at the .005 level. See Section 6.3. In addition, participants with relatively low Before times had much larger percentage increases than those with higher Before times.

• Detailed analysis of changes in speeds on the 4 types of tests versus Before speeds enabled the identification of participant users to create profiles of outcomes for groups:

1. Negative/Zero Change List: 3, 17, 22, 28, 31, 41, 42, 43, 46 [Total = 9]
2. Before Speed < 50 & Speed Change < 200%: 22, 44, 38, 43, 17, 10, 30, 20, 15, 26, 35, 36 [Total = 12]
3. Before Speed < 50 & Speed Change > 500%: 13, 39, 6, 37, 18, 24, 14, 16, 9, 7, 23, 40, 33, 27 [Total = 14]
4. Fastest After Results: 52, 49, 2, 7, 40, 9, 33, 21, 4 [Total = 9]

• Initial expectations that the Before and After sample data would, in multivariate formulations, give significant findings about variables affecting OH users' internet speeds. None were found.

Inventory profiles on residents of these groups should[14] give information on how the OH HEAT, IT employees, and/or GRU support employees can recommend changes to present and future OH residents to speed up their internet connectivity **if** they wish to do so. The changes could be small at no or low cost or large at major or much higher cost to the individual OH residents. It is expected that if the recommendations for the second part of this study are undertaken, a number of the individual OH residents identified by number in the 1. To 4. list directly above will not continue as participants for a variety of reasons. The Before case to After case participant drop rate was about 1/5.

The next step in this study is to distribute this version, 1.1, to the 49 participants in both tests. Since the author had to manually type 883 (60 x 9 + 49 * 7) entries in Excel pages included here as Exhibits 1 and 2: there are likely some data entry errors. Each participant will be asked to review the values included for them in Exhibits 1 and 2. Each received from the author a copy of the Before test image; the After-test images are still available at the Speedof.Me test site. They will be asked if they will permit the author to meet in their units to do an inventory of their internet access, including all devices that utilize network capacity. And, they will be asked for their comments on this study and internet services in general at OH.

Results from this next step will result in Version 2.0 of this study. It will, hopefully, include profile recommendations for any OH resident wanting to change their internet connectivity.

Footnotes:

1. No part of this or all of this may be reproduced in any medium or form without the written consent of the author.
2. OH's web page https://www.oakhammock.org. Oak Hammock Life Care Residency Contract, "The University of Florida is not responsible for the financial or contractual obligations of Oak Hammock." LCRC-02-15-14, Page 1.
3. While "more speed" seems to be the mantra of most promoting the internet for various purposes, residents of the OH HEAT group have learned that many OH residents are essentially comfortable with the way they can use the internet for email and browsing. Some – the author has no guess as to the proportion users – would not want to incur the cost and bother of changing their microcomputer equipment.
4. "The Oak Leaf," Oak Hammock at the University of Florida, (16,8), August, 2018, page 15.
5. The other email addresses by frequency: 52 aol.com, 18 yahoo.com, 8 bellsouth.net, 8 cox.net and 1 – 3 addresses ending in com, edu or net at/on case, outlook, tampabay.rr, embarqmail, kennesaw, acm, Windstream, fastmail, grahamcos, earthlink, yale, Hotmail,vqme, wvmiq, icloud, me, shorstein. The Trace Route command, "tracert address'" in a Windows DOS command box shows these email servers are distributed throughout the U.S.A.
6. There were some units in the building where additional routers had to be installed following the beginning of the after-upgrade sampling. No sample participants were involved in these fixes. A number of times after the start of the after-upgrade sampling, major replacements were made to the infrastructure cabling and equipment.
7. Download speeds for these tests are shown because they are usually faster than upload speeds. David Salway, "Lifewire, Understanding Broadband Internet Speeds," https://www.lifewire.com/broadband-internet-speeds-explained-437202, Updated November 15, 2019.
8. The standard "t" tests of significance are used here along with the assumption the sampling error terms are normally distributed per the Central Limit Theorem (Freund & Williams, "Modern Business Statistics", '…when n is large [greater than 30], the theoretical distribution of the mean will be close to a normal curve regardless of the shape of the population.' Page 179) . The test value for significance at the .005 level is 2.576 for sample sizes of 30 or greater. Most published research report significance at the .05 or .01 level with corresponding "t" statistics of 1.960 and 2.326.
9. Shaun Anderson, "Hobo: UK SEO Services, How Fast Should a Website Load in 2019?", Last Updated October 31st, 2019.

10. Steve Smarthorm, "Steve's Smart Home Guide: Internet Speeds Explained, Time of Day", https://stevessmarthomeguide.com, Updated November 1, 2019.
11. Test formula where B=before, A= After: t = (MeanA – Mean B)/SQRT(StdvA**2/49 +StdvB**2/49)

12.The location of routers in residences makes significant differences in WiFi signal strength. The Ruckus routers with WiFi and RJ45 connection ports were placed 2 feet above the floor in all residences (per the OH – GRU upgrade contract). In some building residences this resulted in zero signal strength in other parts of these residences. At the University of Florida, WiFi access point installs are always within 6 inches of or are on the ceiling. The IT online advice on router locations suggest locations avoiding potential obstructions. For example, a PC Magazine article states, "Finding an open space toward the center of your residence is the best way to ensure optimal coverage. Be aware that walls and floors will impede Wi-Fi signals, so the more obstructions you have between your devices and your router, the weaker (and potentially slower) the signal will be." R. Pacchiano and W. Van Winkle, Oct. 11, 2019, https://www.pcmag.com/article/258865/how-to-set-up-and-optimize-your-wireless-router.

13. See https://en.wikipedia.org/wiki/Erlang distribution. Last updated 30 November 2019.

14. At the author's first class in Business Policy at the Harvard Business School, Professor Merriam walked into the room where we 26 new Doctor of Business Administration students assembled for our new class. Professor Merriam, gritting his teeth, somehow talked through them, asked the following question: "What is a business policy?" He then pointed to 3 students in his class – fortunately not including me – and said "Mr. Aaaaa"? Dismissing all responses, all of which I then thought were well done, he said. "A business policy is a statement with should in it. It requires detailed operational procedures in any organization to be anything other than useless verbal noise."

15. For example, Category 5, 5e, and 6 cables are concisely discussed in “Network Cabling Directory: Cat5 vs. Cat5e vs. Cat6 – Which should you use,” https://networkcablingdirectory.com/articles/structured-network-cabling-id_1151.htm The copyright by Invenio is dated 2020.