

Report for: Wifi Capacity Test



Thu Jun 03 14:19:29 PDT 2021

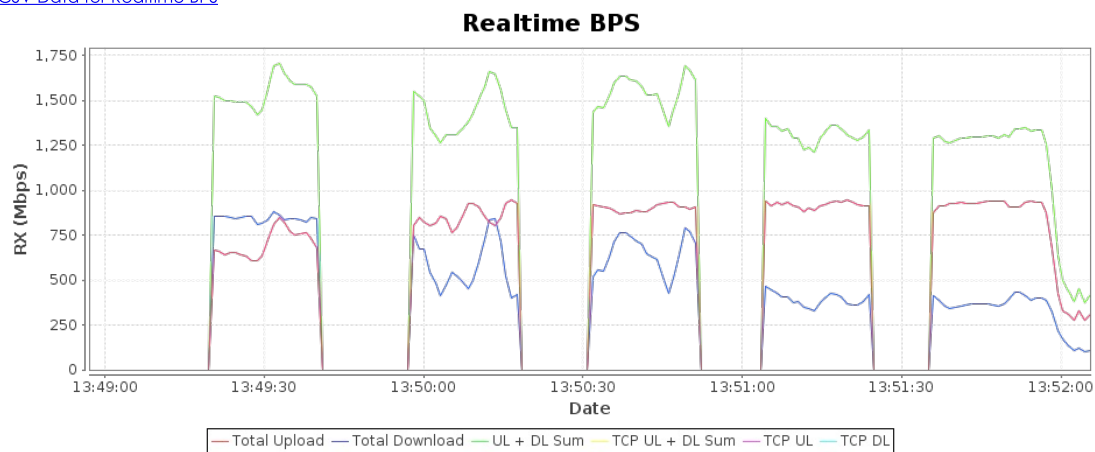
Objective

The Candela WiFi Capacity test is designed to measure performance of an Access Point when handling different amounts of WiFi Stations. The test allows the user to increase the number of stations in user defined steps for each test iteration and measure the per station and the overall throughput for each trial. Along with throughput other measurements made are client connection times, Fairness, % packet loss, DHCP times and more. The expected behavior is for the AP to be able to handle several stations (within the limitations of the AP specs) and make sure all stations get a fair amount of airtime both in the upstream and downstream. An AP that scales well will not show a significant over-all throughput decrease as more stations are added.

Capacity test with 19 virtual stations on 4x4 AX card, connected to MTK AX chipset AP.
OTA about 1m distance.

Realtime Graph shows summary download and upload RX bps of connections created by this test.

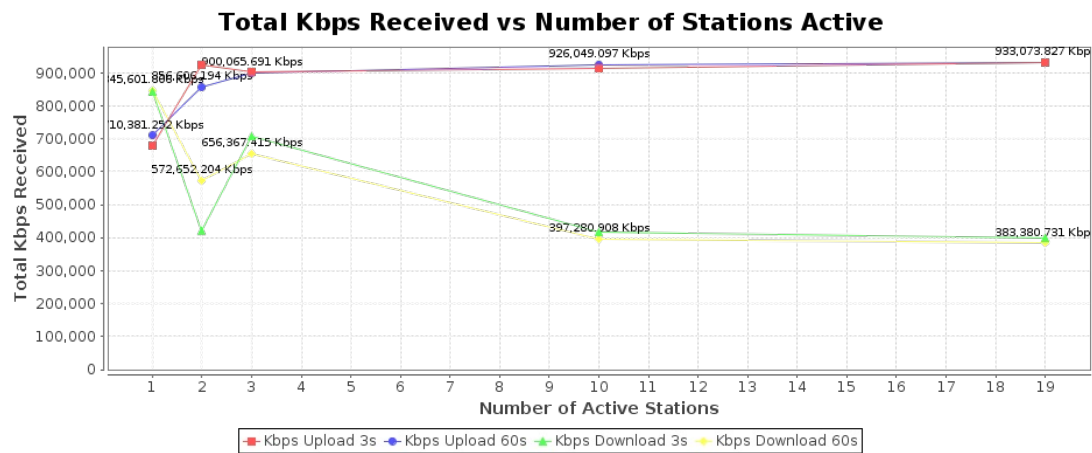
[CSV Data for Realtime BPS](#)



Total bits-per-second transferred. This only counts the protocol payload, so it will not count the Ethernet, IP, UDP, TCP or other header overhead. A well behaving system will show about the same rate as stations increase. If the rate decreases significantly as stations increase, then it is not scaling well.

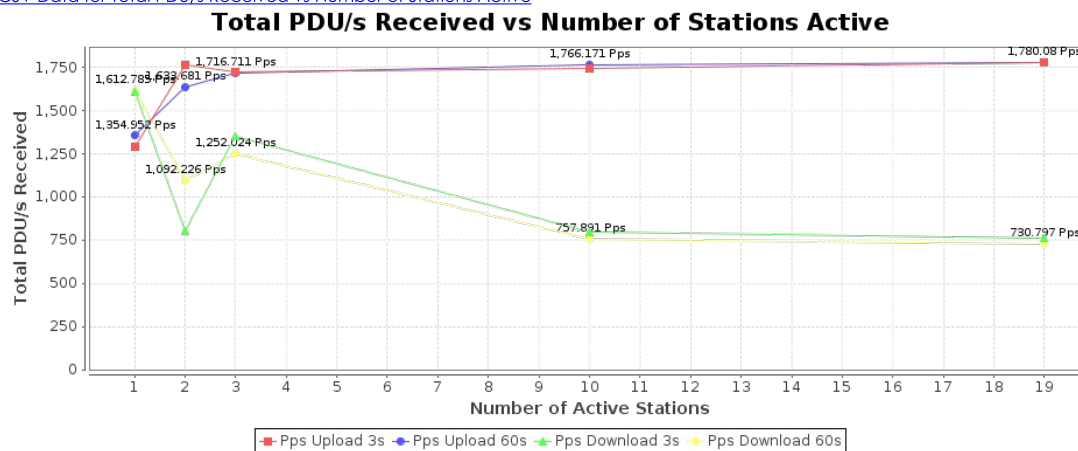
If selected, the Golden AP comparison graphs will be added. These tests were done in an isolation chamber, open encryption, conductive connection, with LANforge CT525 wave-1 3x3 NIC as the stations.

[CSV Data for Total Kbps Received vs Number of Stations Active](#)



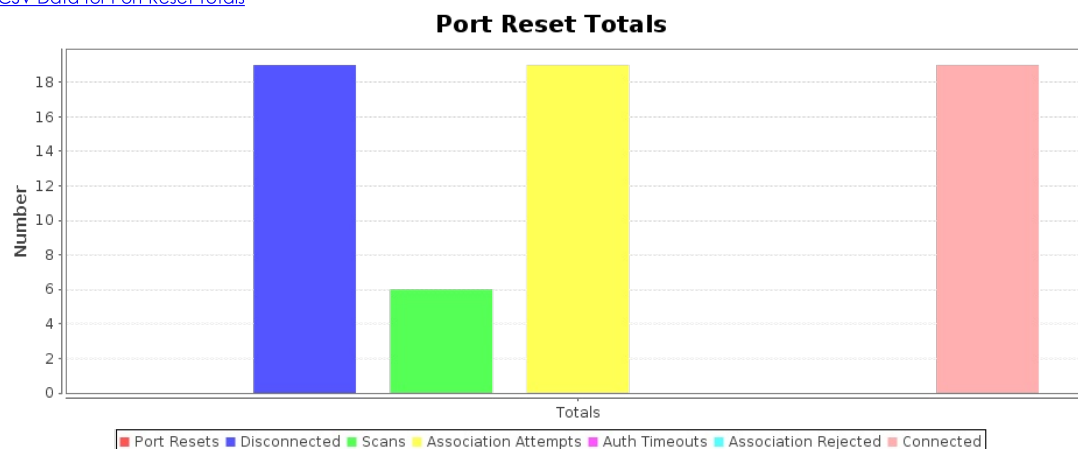
Protocol-Data-Units received. For TCP, this does not mean much, but for UDP connections, this correlates to packet size. If the PDU size is larger than what fits into a single frame, then the network stack will segment it accordingly. A well behaving system will show about the same rate as stations increase. If the rate decreases significantly as stations increase, then it is not scaling well.

[CSV Data for Total PDU/s Received vs Number of Stations Active](#)



Station disconnect stats. These will be only for the last iteration. If the 'Clear Reset Counters' option is selected, the stats are cleared after the initial association. Any re-connects reported indicate a potential stability issue. Can be used for long-term stability testing in cases where you bring up all stations in one iteration and then run the test for a longer duration.

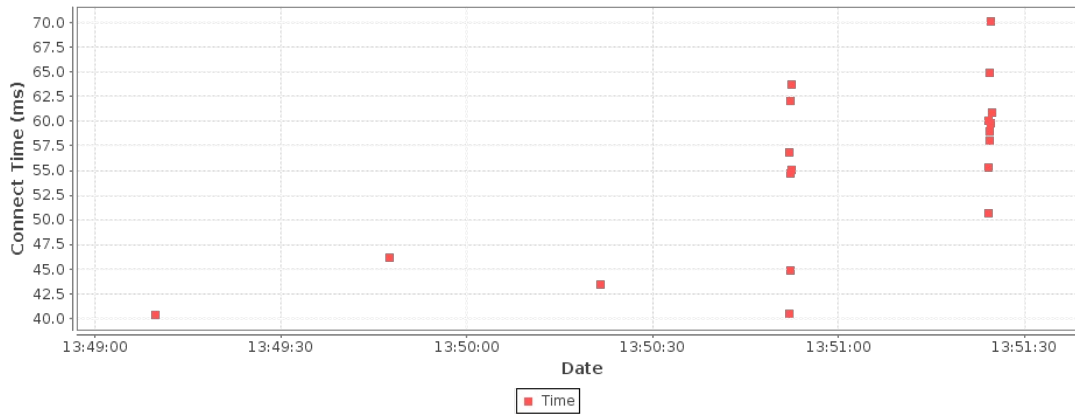
[CSV Data for Port Reset Totals](#)



Station connect time is calculated from the initial Authenticate message through the completion of Open or RSN association/authentication.

[CSV Data for Station Connect Times](#)

Station Connect Times



Wifi-Capacity Test requested values	
Station Increment:	1,2,3,10,19
Loop Iterations:	Single (1)
Duration:	20 sec (20 s)
Protocol:	TCP-IPv4
Layer 4-7 Endpoint:	NONE
Payload Size:	AUTO
MSS	AUTO
Total Download Rate:	1G (1 Gbps)
Total Upload Rate:	1G (1 Gbps)
Percentage TCP Rate:	10% (10%)
Set Bursty Minimum Speed:	Burst Mode Disabled (-1)
Randomize Rates	true
Leave Ports Up	false
Socket buffer size:	OS Default
Settle Time:	5 sec (5 s)
Rpt Timer:	fast (1 s)
IP ToS:	Best Effort (0)
Multi-Conn:	AUTO
Show-Per-Iteration-Charts	true
Show-Per-Loop-Totals	true
Hunt-Lower-Rates	false
Show Events	true
Clear Reset Counters	false
CSV Reporting Dir	- not selected -

Build Date	Thu 03 Jun 2021 05:56:03 AM PDT
Build Version	5.4.3
Git Version	310507e3a26d2bcd1bbfad6c104640a9f89693c6
Ports	1.1.eth1 1.1.sta03500 1.1.sta03501 1.1.sta03502 1.1.sta03503 1.1.sta03504 1.1.sta03505 1.1.sta03506 1.1.sta03507 1.1.sta03508 1.1.sta03509 1.1.sta03510 1.1.sta03511 1.1.sta03512 1.1.sta03513 1.1.sta03514 1.1.sta03515 1.1.sta03516 1.1.sta03517 1.1.sta03518
Firmware	0.6-1 DEV_000000-20201105222323
Machines	ct523c-0b29

Requested Parameters:

Download Rate: Per station: 1000000000 (1 Gbps) All: 1000000000 (1 Gbps)
 Upload Rate: Per station: 1000000000 (1 Gbps) All: 1000000000 (1 Gbps)
 Total: 2000000000 (2 Gbps)
 Station count: 1 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

Observed Rate:

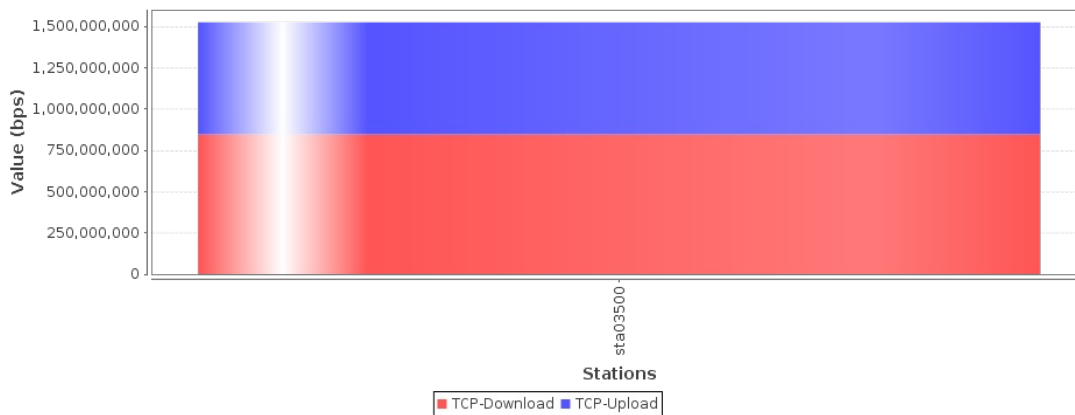
Download Rate: Cx Min: 845.602 Mbps Cx Ave: 845.602 Mbps Cx Max: 845.602 Mbps All Cx: 845.602 Mbps
 Upload Rate: Cx Min: 678.116 Mbps Cx Ave: 678.116 Mbps Cx Max: 678.116 Mbps All Cx: 678.116 Mbps
 Total: 1.524 Gbps

Aggregated Rate: Min: 1.524 Gbps Avg: 1.524 Gbps Max: 1.524 Gbps

This graph shows fairness. On a fair system, each station should get about the same throughput.
 In the download direction, it is mostly the device-under-test that is responsible for this behavior,
 but in the upload direction, LANforge itself would be the source of most fairness issues
 unless the device-under-test takes specific actions to ensure fairness.

[CSV Data for Combined bps, 60 second running average](#)

Combined bps, 60 second running average



Requested Parameters:

Download Rate: Per station: 1000000000 (1 Gbps) All: 1000000000 (1 Gbps)
 Upload Rate: Per station: 1000000000 (1 Gbps) All: 1000000000 (1 Gbps)
 Total: 2000000000 (2 Gbps)
 Station count: 1 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

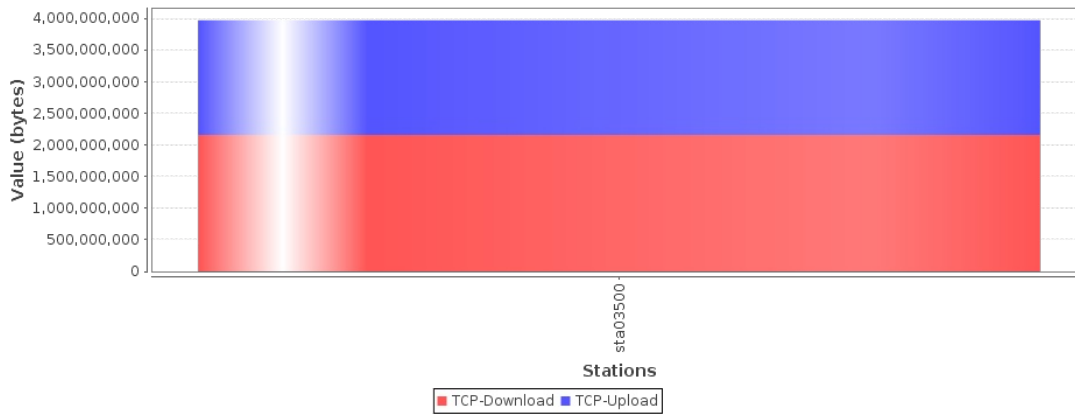
Observed Amount:

Download Amount: Cx Min: 2.01 GB Cx Ave: 2.01 GB Cx Max: 2.01 GB All Cx: 2.01 GB
 Upload Amount: Cx Min: 1.689 GB Cx Ave: 1.689 GB Cx Max: 1.689 GB All Cx: 1.689 GB
 Total: 3.699 GB

This graph shows fairness. On a fair system, each station should get about the same throughput.
 In the download direction, it is mostly the device-under-test that is responsible for this behavior,
 but in the upload direction, LANforge itself would be the source of most fairness issues
 unless the device-under-test takes specific actions to ensure fairness.

[CSV Data for Combined Received bytes, for entire 20 s run](#)

Combined Received bytes, for entire 20 s run



Requested Parameters:

Download Rate: Per station: 500000000 (500 Mbps) All: 1000000000 (1 Gbps)
 Upload Rate: Per station: 500000000 (500 Mbps) All: 1000000000 (1 Gbps)
 Total: 2000000000 (2 Gbps)

Station count: 2 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

Observed Rate:

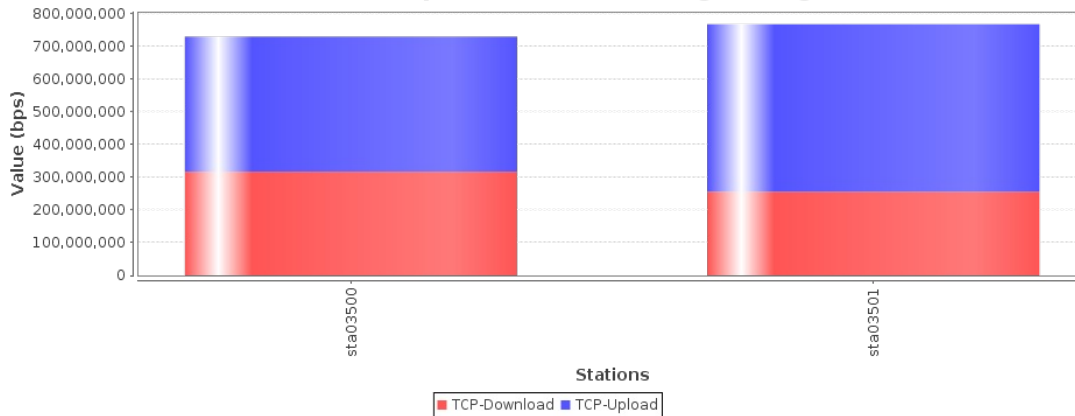
Download Rate: Cx Min: 255.72 Mbps Cx Ave: 286.326 Mbps Cx Max: 316.932 Mbps All Cx: 572.652 Mbps
 Upload Rate: Cx Min: 412.543 Mbps Cx Ave: 461.978 Mbps Cx Max: 511.413 Mbps All Cx: 923.956 Mbps
 Total: 1.497 Gbps

Aggregated Rate: Min: 668.263 Mbps Avg: 748.304 Mbps Max: 828.345 Mbps

This graph shows fairness. On a fair system, each station should get about the same throughput. In the download direction, it is mostly the device-under-test that is responsible for this behavior, but in the upload direction, LANforge itself would be the source of most fairness issues unless the device-under-test takes specific actions to ensure fairness.

CSV Data for Combined bps, 60 second running average

Combined bps, 60 second running average



Requested Parameters:

Download Rate: Per station: 500000000 (500 Mbps) All: 1000000000 (1 Gbps)
 Upload Rate: Per station: 500000000 (500 Mbps) All: 1000000000 (1 Gbps)
 Total: 2000000000 (2 Gbps)

Station count: 2 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

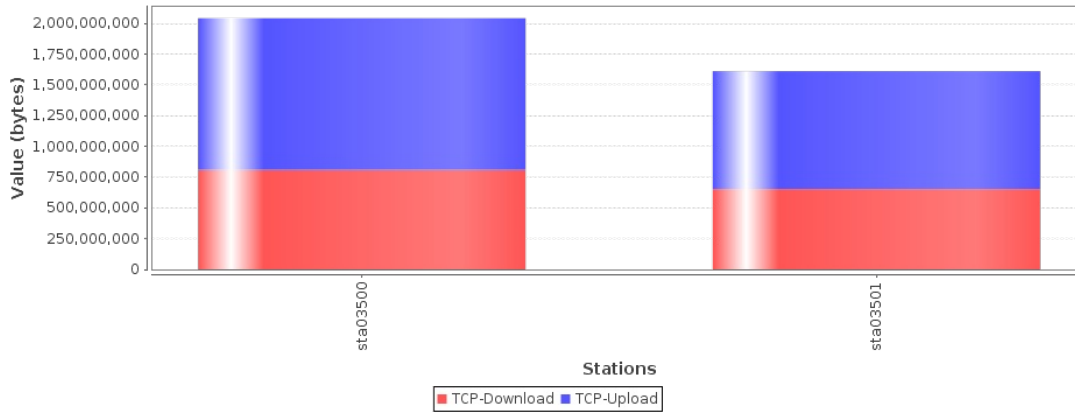
Observed Amount:

Download Amount: Cx Min: 622.985 MB Cx Ave: 697.548 MB Cx Max: 772.111 MB All Cx: 1.362 GB
 Upload Amount: Cx Min: 912.648 MB Cx Ave: 1.019 GB Cx Max: 1.147 GB All Cx: 2.038 GB
 Total: 3.4 GB

This graph shows fairness. On a fair system, each station should get about the same throughput. In the download direction, it is mostly the device-under-test that is responsible for this behavior, but in the upload direction, LANforge itself would be the source of most fairness issues unless the device-under-test takes specific actions to ensure fairness.

CSV Data for Combined Received bytes, for entire 20 s run

Combined Received bytes, for entire 20 s run



Requested Parameters:

Download Rate: Per station: 333333333 (333.333 Mbps) All: 1000000000 (1 Gbps)
 Upload Rate: Per station: 333333333 (333.333 Mbps) All: 1000000000 (1 Gbps)
 Total: 2000000000 (2 Gbps)
 Station count: 3 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

Observed Rate:

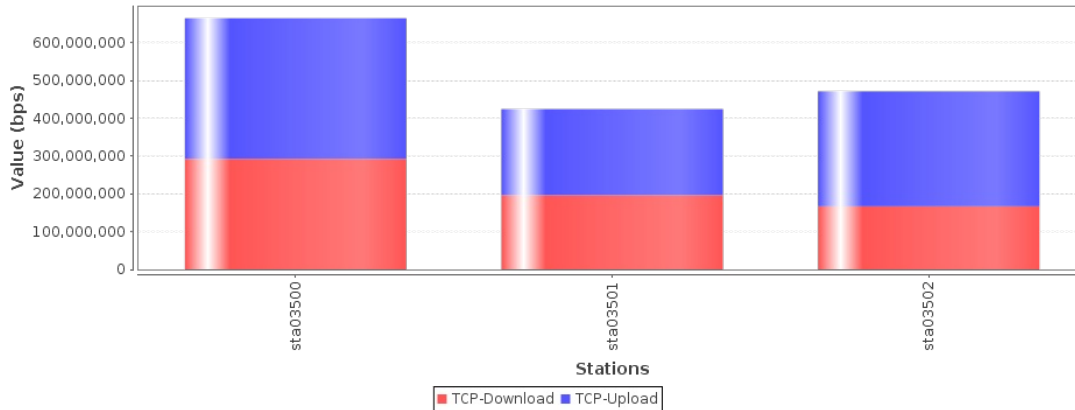
Download Rate: Cx Min: 167.096 Mbps Cx Ave: 218.789 Mbps Cx Max: 292.826 Mbps All Cx: 656.367 Mbps
 Upload Rate: Cx Min: 227.999 Mbps Cx Ave: 301.543 Mbps Cx Max: 372.071 Mbps All Cx: 904.628 Mbps
 Total: 1.561 Gbps

Aggregated Rate: Min: 395.095 Mbps Avg: 520.332 Mbps Max: 664.896 Mbps

This graph shows fairness. On a fair system, each station should get about the same throughput. In the download direction, it is mostly the device-under-test that is responsible for this behavior, but in the upload direction, LANforge itself would be the source of most fairness issues unless the device-under-test takes specific actions to ensure fairness.

[CSV Data for Combined bps, 60 second running average](#)

Combined bps, 60 second running average



Requested Parameters:

Download Rate: Per station: 333333333 (333.333 Mbps) All: 1000000000 (1 Gbps)
 Upload Rate: Per station: 333333333 (333.333 Mbps) All: 1000000000 (1 Gbps)
 Total: 2000000000 (2 Gbps)
 Station count: 3 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

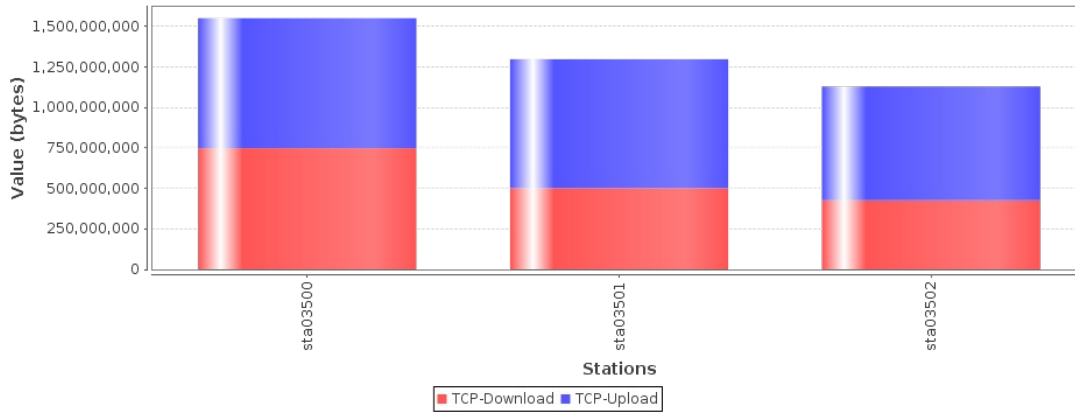
Observed Amount:

Download Amount: Cx Min: 407.434 MB Cx Ave: 533.479 MB Cx Max: 714.004 MB All Cx: 1.563 GB
 Upload Amount: Cx Min: 669.816 MB Cx Ave: 731.569 MB Cx Max: 765.66 MB All Cx: 2.143 GB
 Total: 3.706 GB

This graph shows fairness. On a fair system, each station should get about the same throughput. In the download direction, it is mostly the device-under-test that is responsible for this behavior, but in the upload direction, LANforge itself would be the source of most fairness issues unless the device-under-test takes specific actions to ensure fairness.

[CSV Data for Combined Received bytes, for entire 20 s run](#)

Combined Received bytes, for entire 20 s run



Requested Parameters:

Download Rate: Per station: 100000000 (100 Mbps) All: 1000000000 (1 Gbps)

Upload Rate: Per station: 100000000 (100 Mbps) All: 1000000000 (1 Gbps)

Total: 2000000000 (2 Gbps)

Station count: 10 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

Observed Rate:

Download Rate: Cx Min: 11.063 Mbps Cx Ave: 39.728 Mbps Cx Max: 93.871 Mbps All Cx: 397.281 Mbps

Upload Rate: Cx Min: 69.067 Mbps Cx Ave: 91.559 Mbps Cx Max: 102.129 Mbps All Cx: 915.589 Mbps

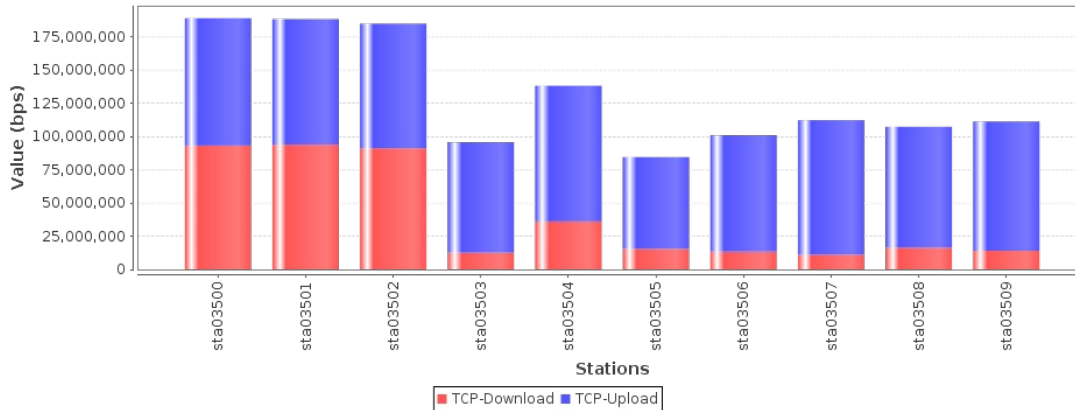
Total: 1.313 Gbps

Aggregated Rate: Min: 80.13 Mbps Avg: 131.287 Mbps Max: 196 Mbps

This graph shows fairness. On a fair system, each station should get about the same throughput. In the download direction, it is mostly the device-under-test that is responsible for this behavior, but in the upload direction, LANforge itself would be the source of most fairness issues unless the device-under-test takes specific actions to ensure fairness.

[CSV Data for Combined bps, 60 second running average](#)

Combined bps, 60 second running average



Requested Parameters:

Download Rate: Per station: 100000000 (100 Mbps) All: 1000000000 (1 Gbps)

Upload Rate: Per station: 100000000 (100 Mbps) All: 1000000000 (1 Gbps)

Total: 2000000000 (2 Gbps)

Station count: 10 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

Observed Amount:

Download Amount: Cx Min: 26.829 MB Cx Ave: 96.335 MB Cx Max: 227.628 MB All Cx: 963.353 MB

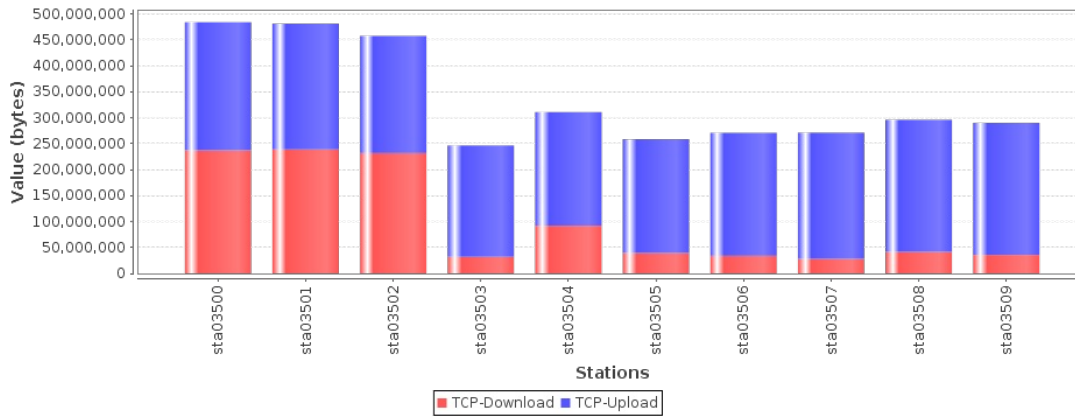
Upload Amount: Cx Min: 204.326 MB Cx Ave: 224.569 MB Cx Max: 242.427 MB All Cx: 2.193 GB

Total: 3.134 GB

This graph shows fairness. On a fair system, each station should get about the same throughput. In the download direction, it is mostly the device-under-test that is responsible for this behavior, but in the upload direction, LANforge itself would be the source of most fairness issues unless the device-under-test takes specific actions to ensure fairness.

[CSV Data for Combined Received bytes, for entire 20 s run](#)

Combined Received bytes, for entire 20 s run



Requested Parameters:

Download Rate: Per station: 52631578 (52.632 Mbps) All: 1000000000 (1 Gbps)

Upload Rate: Per station: 52631578 (52.632 Mbps) All: 1000000000 (1 Gbps)

Total: 2000000000 (2 Gbps)

Station count: 19 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

Observed Rate:

Download Rate: Cx Min: 7.835 Mbps Cx Ave: 20.178 Mbps Cx Max: 55.73 Mbps All Cx: 383.381 Mbps

Upload Rate: Cx Min: 28.287 Mbps Cx Ave: 49.079 Mbps Cx Max: 66.732 Mbps All Cx: 932.5 Mbps

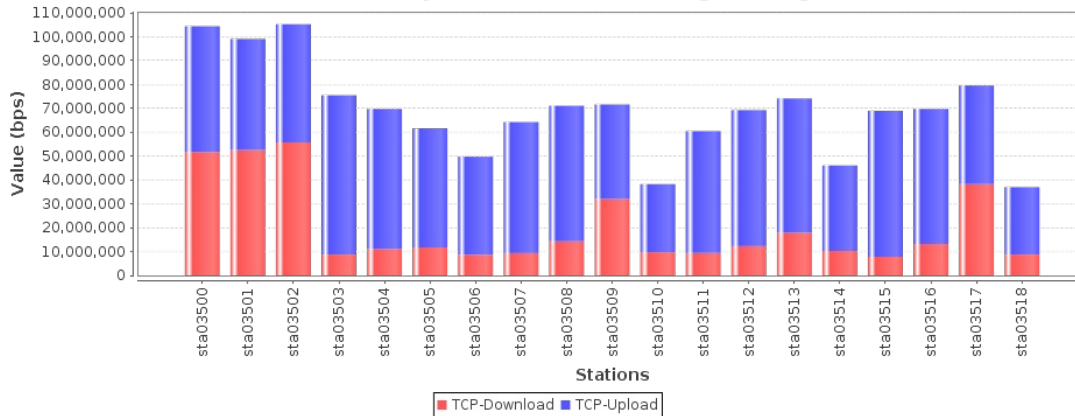
Total: 1.316 Gbps

Aggregated Rate: Min: 36.122 Mbps Avg: 69.257 Mbps Max: 122.462 Mbps

This graph shows fairness. On a fair system, each station should get about the same throughput. In the download direction, it is mostly the device-under-test that is responsible for this behavior, but in the upload direction, LANforge itself would be the source of most fairness issues unless the device-under-test takes specific actions to ensure fairness.

CSV Data for Combined bps, 60 second running average

Combined bps, 60 second running average



Requested Parameters:

Download Rate: Per station: 52631578 (52.632 Mbps) All: 1000000000 (1 Gbps)

Upload Rate: Per station: 52631578 (52.632 Mbps) All: 1000000000 (1 Gbps)

Total: 2000000000 (2 Gbps)

Station count: 19 Connections per station: 1 Payload (PDU) sizes: AUTO (AUTO)

Observed Amount:

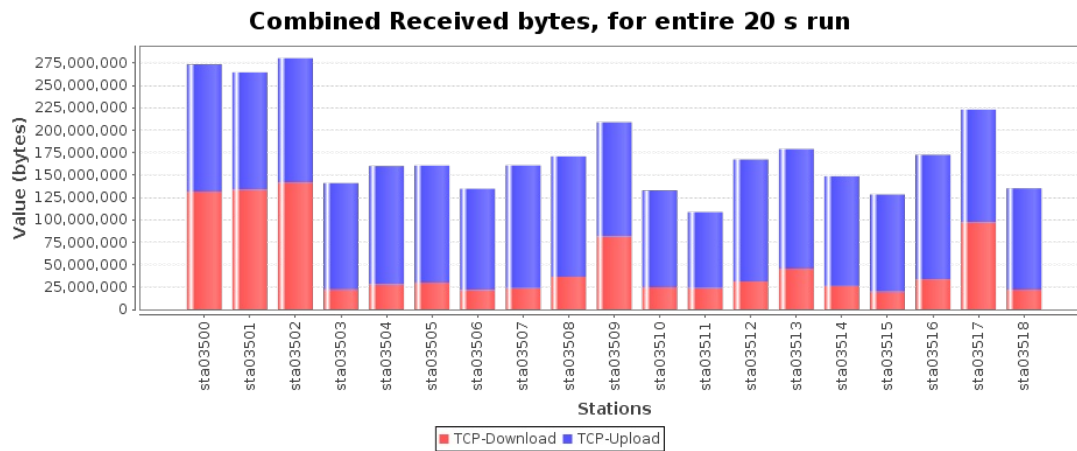
Download Amount: Cx Min: 19.027 MB Cx Ave: 49.001 MB Cx Max: 135.339 MB All Cx: 931.013 MB

Upload Amount: Cx Min: 80.792 MB Cx Ave: 119.262 MB Cx Max: 135.369 MB All Cx: 2.213 GB

Total: 3.122 GB

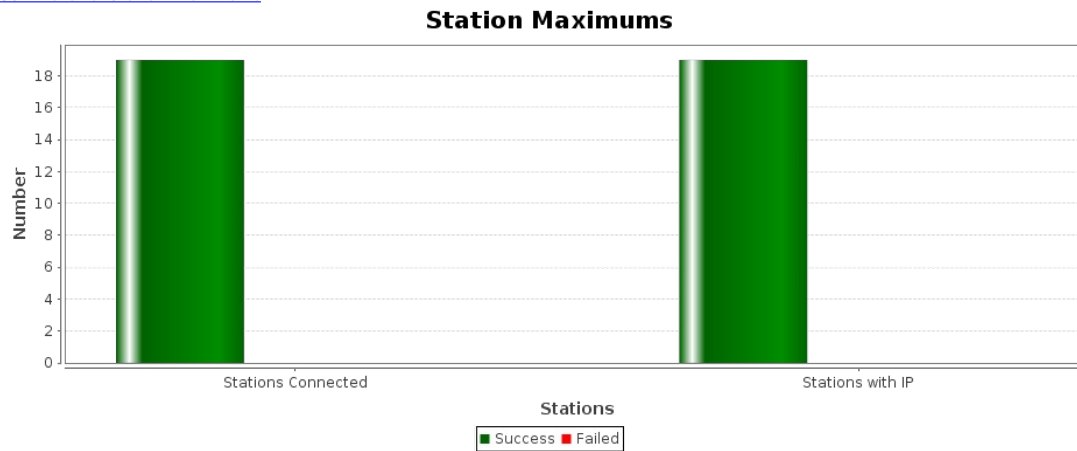
This graph shows fairness. On a fair system, each station should get about the same throughput. In the download direction, it is mostly the device-under-test that is responsible for this behavior, but in the upload direction, LANforge itself would be the source of most fairness issues unless the device-under-test takes specific actions to ensure fairness.

CSV Data for Combined Received bytes, for entire 20 s run



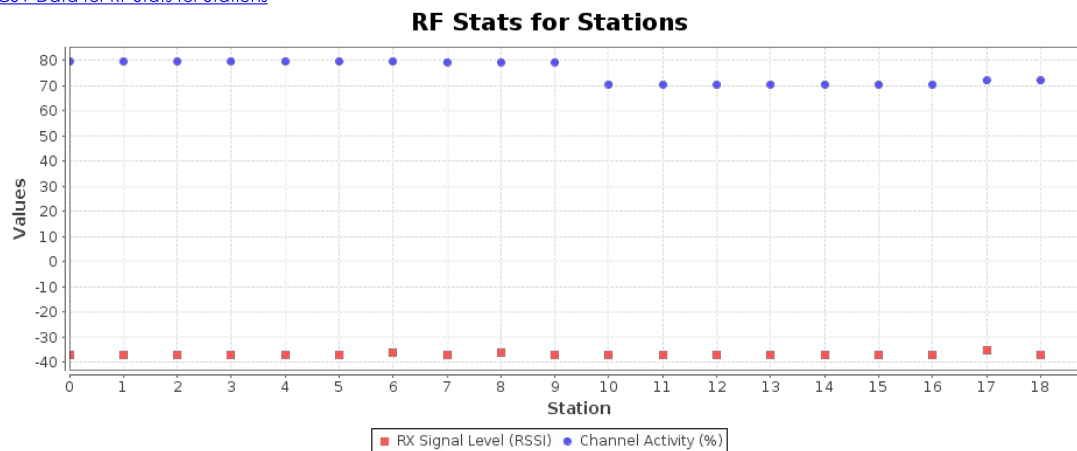
Maximum Stations Connected: 19
 Stations NOT connected at this time: 0
 Maximum Stations with IP Address: 19
 Stations without IP at this time: 0

[CSV Data for Station Maximums](#)



RF stats give an indication of how well how congested is the RF environment. Channel activity is what the wifi radio reports as the busy-time for the RF environment. It is expected that this be near 100% when LANforge is running at max speed, but at lower speeds, this should be a lower percentage unless the RF environment is busy with other systems.

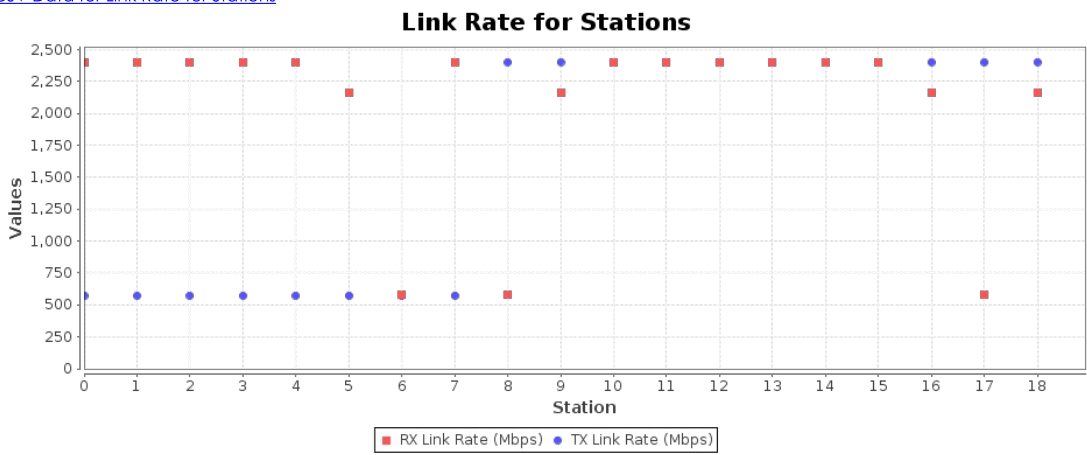
[CSV Data for RF Stats for Stations](#)



Link rate stats give an indication of how well the rate-control is working. For rate-control, the 'RX' link rate corresponds to what the device-

under-test is transmitting. If all of the stations are on the same radio, then the TX and RX encoding rates should be similar for all stations. If there is a definite pattern where some stations do not get good RX rate, then probably the device-under-test has rate-control problems. The TX rate is what LANforge is transmitting at.

[CSV Data for Link Rate for Stations](#)



[Key Performance Indicators CSV](#)

Scan Results for SSIDs used in this test.

```
BSS c4:41:1e:f5:2d:11(on sta03512)
  TSF: 28296244011 usec (0d, 07:51:36)
  freq: 5180
  beacon interval: 100 TUs
  capability: ESS Privacy RadioMeasure (0x1011)
  signal: -39.00 dBm
  last seen: 28 ms ago
  Information elements from Probe Response frame:
  SSID: test-linksys-5g
  Supported rates: 6.0* 9.0 12.0* 18.0 24.0* 36.0 48.0 54.0
  DS Parameter set: channel 36
  Country: US      Environment: Indoor/Outdoor
    Channels [36 - 64] @ 23 dBm
    Channels [100 - 144] @ 23 dBm
    Channels [149 - 165] @ 30 dBm
  RSN:
    * Version: 1
    * Group cipher: CCMP
    * Pairwise ciphers: CCMP
    * Authentication suites: PSK PSK/SHA-256
    * Capabilities: 16-PTKSA-RC 1-GTKSA-RC MFP-capable (0x008c)
  BSS Load:
    * station count: 11
    * channel utilisation: 231/255
    * available admission capacity: 0 [*32us]
  RM enabled capabilities:
    Capabilities: 0x72 0x00 0x00 0x00 0x00
      Neighbor Report
      Beacon Passive Measurement
      Beacon Active Measurement
      Beacon Table Measurement
    Nonoperating Channel Max Measurement Duration: 0
    Measurement Pilot Capability: 0
  Supported operating classes:
    * current operating class: 128
  HT capabilities:
    Capabilities: 0x9ef
      RX LDPC
      HT20/HT40
      SM Power Save disabled
      RX HT20 SGI
      RX HT40 SGI
      TX STBC
      RX STBC 1-stream
      Max AMSDU length: 7935 bytes
      No DSSS/CCK HT40
    Maximum RX AMPDU length 65535 bytes (exponent: 0x003)
    Minimum RX AMPDU time spacing: No restriction (0x00)
    HT TX/RX MCS rate indexes supported: 0-31
  HT operation:
    * primary channel: 36
    * secondary channel offset: above
    * STA channel width: any
    * RIFS: 0
    * HT protection: no
    * non-GF present: 1
    * OBSS non-GF present: 0
    * dual beacon: 0
    * dual CTS protection: 0
    * STBC beacon: 0
```

```

* L-SIG TXOP Prot: 0
* PCO active: 0
* PCO phase: 0
Extended capabilities:
* Extended Channel Switching
* BSS Transition
* SSID List
* UTF-8 SSID
* Operating Mode Notification
* 6
* Max Number Of MSDUs In A-MSDU is unlimited
VHT capabilities:
VHT Capabilities (0x338819f9):
Max MPDU length: 7991
Supported Channel Width: 160 MHz, 80+80 MHz
RX LDPC
short GI (80 MHz)
short GI (160/80+80 MHz)
TX STBC
SU Beamformer
SU Beamformee
MU Beamformer
RX antenna pattern consistency
TX antenna pattern consistency
VHT RX MCS set:
1 streams: MCS 0-9
2 streams: MCS 0-9
3 streams: MCS 0-9
4 streams: MCS 0-9
5 streams: not supported
6 streams: not supported
7 streams: not supported
8 streams: not supported
VHT RX highest supported: 0 Mbps
VHT TX MCS set:
1 streams: MCS 0-9
2 streams: MCS 0-9
3 streams: MCS 0-9
4 streams: MCS 0-9
5 streams: not supported
6 streams: not supported
7 streams: not supported
8 streams: not supported
VHT TX highest supported: 0 Mbps
VHT operation:
* channel width: 1 (80 MHz)
* center freq segment 1: 42
* center freq segment 2: 0
* VHT basic MCS set: 0xfffc
Transmit Power Envelope:
* Local Maximum Transmit Power For 20 MHz: 23 dBm
* Local Maximum Transmit Power For 40 MHz: 23 dBm
* Local Maximum Transmit Power For 80 MHz: 23 dBm
HE capabilities:
HE MAC Capabilities (0x00051a081044):
+HTC HE Supported
TWT Responder
BSR
OM Control
Maximum A-MPDU Length Exponent: 3
BQR
A-MSDU in A-MPDU
OM Control UL MU Data Disable RX
HE PHY Capabilities: (0x0420ce126c538f10000000):
HE40/HE80/5GHz
LDPC Coding in Payload
NDP with 4x HE-LTF and 3.2us GI
STBC Tx <= 80MHz
STBC Rx <= 80MHz
Full Bandwidth UL MU-MIMO
Partial Bandwidth UL MU-MIMO
DCM Max Constellation: 2
DCM Max Constellation Rx: 2
Beamformee STS <= 80Mhz: 3
Beamformee STS > 80Mhz: 3
Sounding Dimensions <= 80Mhz: 3
Sounding Dimensions > 80Mhz: 2
Ng = 16 SU Feedback
Codebook Size SU Feedback
Codebook Size MU Feedback
Triggered SU Beamforming Feedback
Triggered MU Beamforming Feedback
PPE Threshold Present
Max NC: 2
HE RX MCS and NSS set <= 80 MHz
1 streams: MCS 0-11
2 streams: MCS 0-11
3 streams: MCS 0-11
4 streams: MCS 0-11
5 streams: not supported
6 streams: not supported
7 streams: not supported
8 streams: not supported
HE TX MCS and NSS set <= 80 MHz
1 streams: MCS 0-11
2 streams: MCS 0-11
3 streams: MCS 0-11
4 streams: MCS 0-11
5 streams: not supported
6 streams: not supported
7 streams: not supported
8 streams: not supported

```

PPE Threshold 0x3b 0x1c 0xc7 0x71 0x1c 0xc7 0x71 0x1c 0xc7 0x71

WMM:

- * Parameter version 1
- * BE: CW 15-1023, AIFSN 3
- * BK: CW 15-1023, AIFSN 7
- * VI: CW 7-15, AIFSN 2, TXOP 3008 usec
- * VO: CW 3-7, AIFSN 2, TXOP 1504 usec