**Fremont School District**
**Wireless Upgrade Bids - FY20-21**

| Bidder | Wireless | Specifications | Amount |
|---|---|---|---|
| | | | |
| | | | |
| ***New England Communications*** | *Ruckus* | (39) CLOUD Wi-Fi License 1 AP-3 year | $6,669.39 |
| 480 Riverside Street | | (39) R650 dual band indoor AP 4 2strm/Wi-Fi 6 | $20,498.40 |
| Portland, ME 04103 | | AP installation | $1,990.00 |
| Tom Morini | | ICX7150 Switch 24X10/100/1000 PoE+po vel | $672.00 |
| | | Essential remote support ICX 7150 24 - 3yr | $209.44 |
| | | Cable custom labor* | $3,490.00 |
| **Total** | | | **$33,529.23** |
| | | | |
| | | | |
| ***Omada Technologies*** | *Aruba* | (39) Aruba CM AP-515 (us) Unified AP | $16,594.50 |
| ***36 Maplewood Ave*** | | (4) AP-MNT-MP10-AP mount bracket 10 pack A | $303.40 |
| ***Portsmouth, NH 03801*** | | (39)Aruba central device management/cloud services - 2 tokens- 5yr subscription | $4,826.25 |
| ***Matt Keane*** | | (39) Aruba 1Y FC NBD Exch AP-515 SVC | $1,684.80 |
| | | HPE 1Y FC NBD Exch Aruba 2930F 24G P SVC | $148.50 |
| | | (2) days of Omada professional services | $4,000.00 |
| | | cabling services detailed in March 4th SOW | $11,400.00 |
| ***Total*** | | | **$38,957.45** |
| ***Optional*** | | | |
| | | Aruba 2930F 24G PoE+ 4SF Switch | $1,284.75 |
| | | Aruba 1G SFP LC SX 500m MMF transceiver | $153.00 |
| ***Total optional*** | | | **$1,437.75** |
| **Total with optional items** | | | **$40,395.20** |
| | | | |
| | | | |
| | | | |

**Fremont School District**
**Wireless Upgrade Bids - FY20-21**

| | | | |
|---|---|---|---|
| ***RMT Communications*** | *Extreme* | (39) Wi Fi access points with Extreme IQ | $5,343.00 |
| 360 Route 101 | | (39) 3 year license includes hive management/cloud IQ management | $9,477.00 |
| | | Extreme Networks X4440-G2-24p-10GE4 Ethernet switch-24 Ports-manageable-3 layer supported-Modular-Twisted Pair, Optical Fiber-1U high-rack mountable - Lifetime limited warranty | $1,335.00 |
| #9 Pine Street | | | |
| Bedford, NH 03110 | | Extreme Networks Standard power cord -110 V AC/10 A | $15.00 |
| Susan Bancroft | | Extreme Networks Standard power cord -13 A | $20.00 |
| | | Cabling - see vendor proposal for specific details and assumptions | $6,949.00 |
| | | Estimated project NPEDU: Configure, Install, Knowledge transfer | $2,400.00 |
| **Total** | | | **$25,539.00** |
| *some exclustions see specific vendor quote | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

New England Communications
480 Riverside Street
Portland, ME 04103
Phone: 1-800-464-7585 Fax: (207) 878-8273

# Quote

No. **21994**
Date: 2/10/2020
Quoted By: Tom Morini
tmorini@necomm.com

Prepared for:
Carla Smith
SAU #83 - Fremont School District
432 Main St
Freemont, NH 03044 U.S.A.

Customer Phone: (603) 895-6903
Customer Fax: (603) 895-6905

| Qty. | Description | Price | Ext. Price |
|---|---|---|---|
| | Scope of Work: Install 39 Ruckus AP's, pull cable for 15 new cables and move 18 AP's.<br>Quote includes 3 year Cloud license fof the Ruckus application, and 3 year software support on the included 24 Port data switch.<br>Form 470 APP #: 200015411<br>SPIN #: 143012046 | | |
| 39 | CLOUD WiFi License 1AP - 3yr | $171.01 | $6,669.39 |
| 39 | R650 WW dual band indoor AP 4 2strm/Wi-Fi 6 | $525.60 | $20,498.40 |
| 1.00 | AP INSTALLATION | $1,990.00 | $1,990.00 |
| 1 | ICX7150 Switch 24x10/100/1000 PoE+po vel | $672.00 | $672.00 |
| 1 | ESSENTIAL REMOTE SUPPORT ICX 7150 24 // 3 year | $209.44 | $209.44 |
| 1.00 | CABLE CUSTOM LABOR | $3,490.00 | $3,490.00 |

This quote does not include a patch panel or patch cords. We can add those if they are needed.
This quote assumes that the existing ethernet switches in the MDF are configured to provide needed power for new AP's.
Quote assumes system will be installed at existing system location.

Unless stated, all work will be done within the normal hours of business operation: 8am- 5pm, Monday - Friday.

Any work, materials or cabling outside the scope of this quote will be billable at the prevailing rate.

Shipping Charges May Apply

A 50% deposit or appropriate finance agreement is required upon contract signature. When the equipment is delivered to the site or after 45 days from contract signing (which ever comes first) 40% of the contracted price is due.
The final 10% will be due within 30 days of project completion.

New England Communications, Inc. will impose a late fee of 1.5 % per month (compounded monthly) on any unpaid balances (more than 30 days old), which include accrued late fees.
Furthermore, New England Communications, Inc. is entitled to recover attorney's fees and costs relating to its efforts to collect such unpaid balances.

Provider Tax: $0.00

**Total: $33,529.23**

New England Communications
480 Riverside Street
Portland, ME 04103
Phone: 1-800-464-7585 Fax: (207) 878-8273

# Quote

No. **21994**
Date: 2/10/2020
Quoted By: Tom Morini
tmorini@necomm.com

Prepared for:
Carla Smith
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432 Main St
Freemont, NH 03044 U.S.A.

Customer Phone: (603) 895-6903
Customer Fax: (603) 895-6905

| Qty. | Description | Price | Ext. Price |
|---|---|---|---|

**Accepted by:**_____ Date: _____

**Signature:**_____ Prices are firm until: 3/11/2020

**FREMONT SCHOOL DISTRICT**

**WIRELESS UPGRADE BID**

**Company Name:** NEW ENGLAND COMMUNICATIONS

**Company Address:** 480 RIVERSIDE ST. / PORTLAND, ME 04103

**Phone Number:** 207 523-1826

**Cell Number:** 603 490-0745

**Federal ID #:** 01-045-3005

**Bid Amount:** $ 33529.23

TJD.

**Authorized Signature**

3-3-2020

**Date**

New England Communications

March 6, 2020

Fremont School District
Attn: Susan Penny
432 Main St
Fremont, NH 03044

Dear Susan,

Thank you for the opportunity to recommend a new Ruckus wireless (wi-fi) network solution for the Ellis School in Fremont, NH. We have chosen Ruckus, as they represent the best in wi-fi technology and have a deep portfolio of access points, data switches, and have a highly regarded support organization. They are also now a part of Commscope Corporation, an $8B company.

New England Communications is celebrating its 31th year in business this year. We are a VAR or value added reseller of voice solutions, wired and wireless data networks, firewall applications, and offer managed services to different market verticals. We have dedicated deployment teams that have worked together for multiple years, that know each others strengths, and help to make our implementations complete and comprehensive.

New England Communications enjoys a very positive reputation for customer service in Maine, New Hampshire, Vermont, and Northern Massachusetts. Our work ethic, quality engineering, customer satisfaction, coupled with very fair and reasonable labor rates help us stand out among our competition. We have numerous customer references available to you upon request.

We appreciate the opportunity to participate in this significant IT project with you for the Fremont School District. We look forward to working with you. Please reach out to me with any questions that you may have regarding our recommendations.

Sincerely,

Thomas Morini
New England Communications
480 Riverside St. / Portland, ME 04103
14 Park Ave. / Derry, NH 03038
207 523 1826

**SECTION 2 - Submittal Requirements**

Qualifications/Costs

The vendor may be the direct servicing entity or designate its authorized dealer(s) to provide services.

Equipment will be purchased utilizing USAC E-Rate Category 2 monies and alt bids must qualify for such support. The following must be included in the proposal:

A A company profile of manufacturer, authorized dealer, and service entity.

***Ruckus Wireless (formerly a $450M company), is now part of CommScope Holding Company an $8B business. Ruckus is a very popular wi-fi vendor that holds numerous patents and was the first wireless company to deploy beam forming, which concentrates the power of the AP toward weak clients in a given space. Ruckus designed an adaptive directional antenna technology called BeamFlex. The company first sold the technology to other manufacturers to enable them to include it in their products. Ruckus also came out with a Customer Premises Equipment (CPE) device that was sold to service providers.***

***Ruckus offers indoor and outdoor access points in several price ranges. BeamFlex is at the core of Ruckus' ZoneFlex APs with its directional antenna technology. This technology automatically adjusts to changes in the Radio Frequency (RF) environment providing stronger signals. Beamforming has now been integrated into the latest version of the 802.11 standard and 802.11ac. Other products that Ruckus offers include controllers, software, and smart wireless services.***

***New England Communications is a 30-year-old company that is comprised of about 40 professionals. We are a VAR (value added reseller) of telephony, wired and wi-fi networks, firewall applications, storage and virtualization solutions, managed services applications and cable infrastructures. Our HQ is in Portland, ME.***

B qualifications statement describing projects and installations of similar scope and size.

***In calendar year 2019 we deployed approx 16 different wi-fi projects. (over 1000 AP's) Mostly K-12 education customers in the State of Maine. With some exception, most of these projects utilized Ruckus AP's.***

C The ability to supply, install, train users, maintain, service, and support proposed equipment.

***New England Communications has in house design engineering, seasoned implementation teams, and expert cable installers which make us a good fit for this particular wi-fi project that the Fremont School district is doing.***

D Proof of insurance including workers compensation naming Fremont School District as an additionally insured.

***Included separately along with the worker's compensation amounts. They are both on the same form.***

E The problem resolution process for service of equipment and technical/connectivity problems.

***Support is included with the Ruckus Cloud solution for the duration of the Cloud license term. If for any reason the Ruckus support team needs on site support, NEComm would engage on T&M if requested.***

F The ability to respond to service issues within 2 hours.

***Ruckus support would be immediate, or the time it takes to get an engineer on the help line. NEComm has on call techs that live in NH and Southern ME.***

G Name of companies/organizations that have been customers for a minimum of 18 months and have used services with comparable proposed equipment in similar projects/installations.

***-Wells & Ogunquit ME School District/ Elementary / JR High/ High School / Michael Richards / 207 646 8331 / Mrichards@wocsd.org***

***-Brunswick, ME School District / Elementary/Middle/High School/ Dr. Sue Woodhams / 207 319 1900 / swoodhams@brunswick.k12.me.us***

***-Auburn ME School District / multiple different schools in this district / David Strome 207 576 5445 / dstrome@auburnschl.edu***

H A proposal covering all equipment costs by site location.

***See included quotation for line item pricing.***

I Bids are for new equipment only, we will not accept refurbished or remanufactured.

***Agree***

J All contract terms must be agreeable to Fremont School District.

***Agree***

K A proposal with timelines covering:

***o Installation: can commence on any schedule the school chooses. NEComm would typically wait for the first payment to be received; at which time we would order the hardware. Install can commence at that time.***

***o Training: admin will be provided as a small separate session by the on-site techs at the conclusion of the project.***

***NEComm complies with all of the remaining terms cited in Section 2 of the RFP.***

NEWENGL-19 SNASON

# CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY) 2/25/2020

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Clark Insurance
1945 Congress Street, Bldg A
PO Box 3543
Portland, ME 04104-3543

CONTACT NAME: Mary Labrecque, AAI, AINS, MLIS
PHONE (A/C, No, Ext): (207) 523-2268 FAX (A/C, No): (207) 774-2994
E-MAIL ADDRESS: mlabrecque@clarkinsurance.com

| INSURER(S) AFFORDING COVERAGE | NAIC # |
|---|---|
| INSURER A : The Hanover Insurance Company | 22292 |
| INSURER B : Allmerica Financial Benefit | 41840 |
| INSURER C : Maine Employers Mutual Ins Co | 11149 |
| INSURER D : Axis Insurance Co | 37273 |
| INSURER E : | |
| INSURER F : | |

INSURED
New England Communications
480 Riverside Street
Portland, ME 04103

**COVERAGES** **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

| INSR LTR | TYPE OF INSURANCE | ADDL INSD | SUBR WVD | POLICY NUMBER | POLICY EFF (MM/DD/YYYY) | POLICY EXP (MM/DD/YYYY) | LIMITS | |
|---|---|---|---|---|---|---|---|---|
| A | X COMMERCIAL GENERAL LIABILITY | | | | | | | |
| | CLAIMS-MADE X OCCUR | | | ZHP9040460 | 2/12/2020 | 2/12/2021 | EACH OCCURRENCE | $ 1,000,000 |
| | | | | | | | DAMAGE TO RENTED PREMISES (Ea occurrence) | $ 100,000 |
| | | | | | | | MED EXP (Any one person) | $ 10,000 |
| | GEN'L AGGREGATE LIMIT APPLIES PER: | | | | | | PERSONAL & ADV INJURY | $ 1,000,000 |
| | X POLICY PRO-JECT LOC | | | | | | GENERAL AGGREGATE | $ 2,000,000 |
| | OTHER: | | | | | | PRODUCTS - COMP/OP AGG | $ 2,000,000 |
| | | | | | | | | $ |
| B | AUTOMOBILE LIABILITY | | | | | | | |
| | ANY AUTO | | | | | | COMBINED SINGLE LIMIT (Ea accident) | $ 1,000,000 |
| | OWNED AUTOS ONLY X SCHEDULED AUTOS | | | AWP9041380 | 2/12/2020 | 2/12/2021 | BODILY INJURY (Per person) | $ |
| | X HIRED AUTOS ONLY X NON-OWNED AUTOS ONLY | | | | | | BODILY INJURY (Per accident) | $ |
| | | | | | | | PROPERTY DAMAGE (Per accident) | $ |
| | | | | | | | | $ |
| A | X UMBRELLA LIAB X OCCUR | | | | | | | |
| | EXCESS LIAB CLAIMS-MADE | | | UHP9040463 | 2/12/2020 | 2/12/2021 | EACH OCCURRENCE | $ 3,000,000 |
| | DED RETENTION $ | | | | | | AGGREGATE | $ 3,000,000 |
| | | | | | | | | $ |
| C | WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y/N | | | | | | X PER STATUTE OTH-ER | |
| | ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) | N/A | | 5101800072 | 2/12/2020 | 2/12/2021 | E.L. EACH ACCIDENT | $ 500,000 |
| | If yes, describe under DESCRIPTION OF OPERATIONS below | | | | | | E.L. DISEASE - EA EMPLOYEE | $ 500,000 |
| | | | | | | | E.L. DISEASE - POLICY LIMIT | $ 500,000 |
| D | Professional Liab. | | | P-001-000023827-02 | 7/19/2019 | 7/19/2020 | Limit - Each Claim | 2,000,000 |
| D | Deductible $15,000 | | | P-001-000023827-02 | 7/19/2019 | 7/19/2020 | Aggregate Limit | 2,000,000 |

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

**CERTIFICATE HOLDER**

Fremont School Board
432 Main Street
Fremont, NH 03044

**CANCELLATION**

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

New England Communications

# About Us


## Our Services

- Voice Over IP
- Telephone Systems
- Video Conferencing
- Wireless Networks (WiFi)
- Paging & Intercom Solutions
- Video Streaming
- Cat 5/Cat 6, Fiber, RGB
- Switches, Routers, Servers
- Appointment Reminder Systems
- Call Recording Solutions
- Voicemail Solutions
- Music on Hold
- Networking Assessments
- Virtual Private Networks
- Network Solutions
- Firewall Solutions
- Security Cameras

Founded in 1990, New England Communications has been providing specialized voice and data products and services for both small and large businesses. From structured cabling through IP Telephony, we cover the entire New England geography with our home base in the state of Maine. We can engineer and integrate hardware, software and network systems to meet the increasingly complex operational needs of our customers. With dedicated Account Managers to understand your business needs and over 30 highly skilled engineers and technicians, we can help develop your unique technology solutions with professional expertise. Since 1990, we have been working with businesses, government agencies, school systems, and colleges providing solutions in the most cost effective way. Our reputation has been built on commitment to quality, service, and excellence using premier manufacturers such as Avaya, IBM, and Cisco. Whether you are adding to your existing infrastructure or looking for a new system, let our professionals make the difference your business deserves!

480 Riverside Street, Portland, ME 04103
800.464.7585 Fax: 207.878.8273
www.necomm.com


# New England Communications
# Portland, Maine

## NEC Overview

For 30 years, New England Communications has been dedicated to providing specialized communication products and services to organizations throughout New England. With an innovative use of technology, NEC will engineer, install and service your critical voice and data network, and support your organization with a commitment to quality and service excellence that is the driving force behind our company.

Founded in 1990, New England Communications has been providing specialized voice and data products and services for both small and large businesses. From structured cabling through IP Telephony, we cover the entire New England geography with our home base in the state of Maine. Since 1990, we have been working with businesses, government agencies, school systems and colleges providing solutions in the most cost effective way. Our reputation has been built on commitment to quality, service and excellence using Premier manufacturers.

Our strategic partnerships include leading global solutions from Avaya Inc., Commscope, Hubbell, Ortronics, and SYSTIMAX, IBM, HP, Microsoft, Juniper Networks, Mitel, Polycom, and others. From structured cabling to IP networking, NEC seasoned professionals will deliver your solution in a professional and thoughtful manner. Through careful planning and design, we will work closely with you to deliver a solution that meets your exact criteria. Certified technicians who are intimately familiar with our products provide the vital skills, tools, and resources necessary to complete your implementation on time and on budget. We are certified on the Hubbell Structured Cable and can offer the full Hubbell warranty.

## The NEC Team

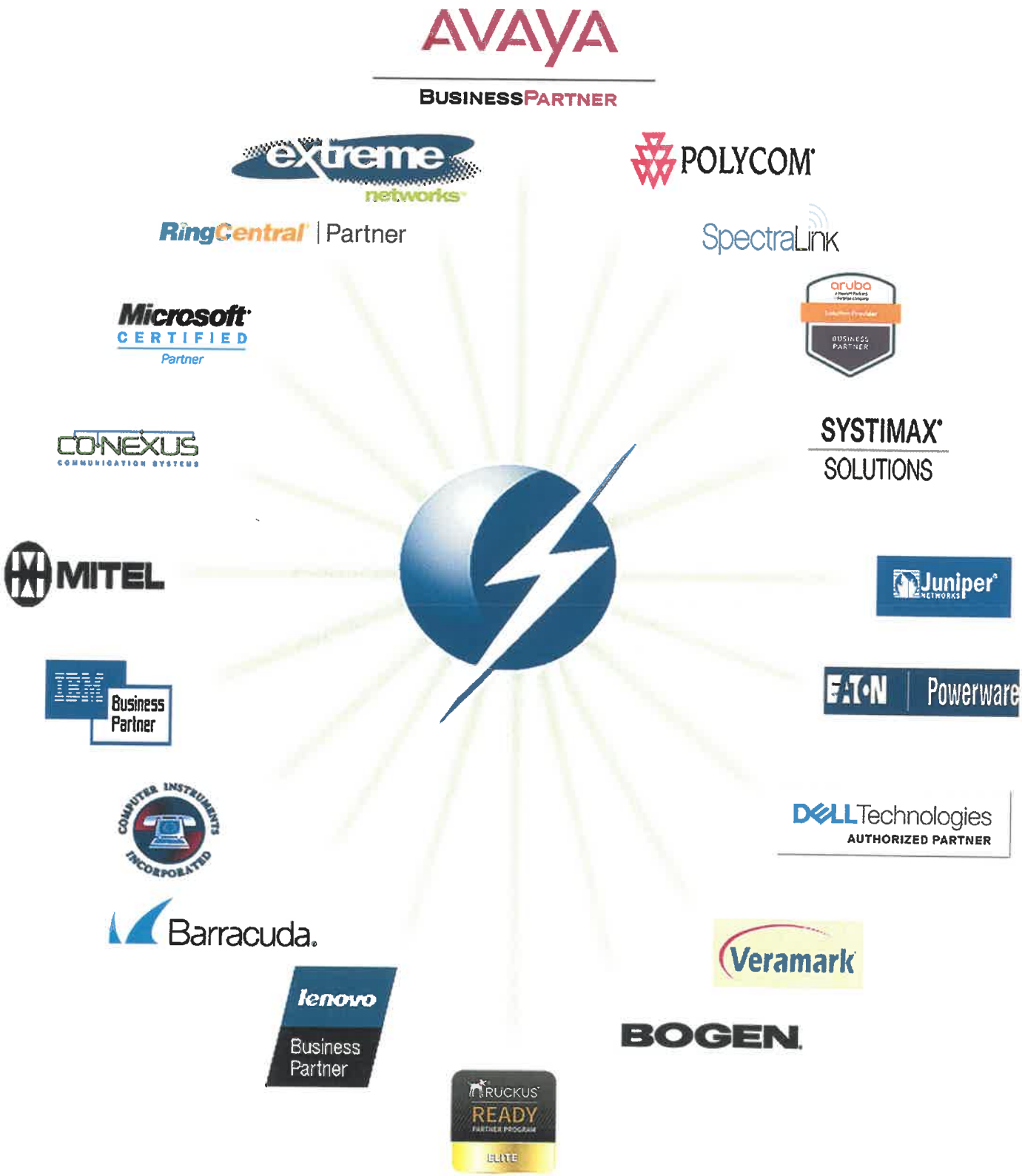
The NEC team consists of 32 employees dedicated to providing excellence in customer service. This includes 20 trained technicians that support cable, IP Telephony installation and maintenance and desktop and network services. The NEC Management Team includes:

Eric Nason, Owner and President
Barbara Nason, Vice President and Treasurer
Linda Ollen, Director of Operations

Joel Bicknell, Sales Manager
As owner and President of NEC, Eric Nason is an active participant involved in guiding our company's overall operations and performance. The NEC Design-Build team is headed by Linda Ollen who oversees all aspects of our day-to-day Operations.

**Management Approach**

Our management approach at NEC ensures your project will be handled in a professional manner to exceed expectations. Our talented engineers and technicians in the field are trained to deliver a quality solution with you, our customer, in the forefront of our concerns. Regular project status updates are communicated to management on a daily basis, and if management involvement is needed, our executives will help guide the project to ensure complete customer satisfaction.




www.necomm.com

800-464-7585

# R650

Indoor Wi-Fi 6 (802.11ax) 4x4:4 Wi-Fi Access Point with 2.5Gbps backhaul and 6 spatial streams

RUCKUS an ARRIS company

DATA SHEET

## BENEFITS

### STUNNING WI-FI PERFORMANCE

Mitigate interference and extend coverage with patented BeamFlex+™ adaptive antenna technology utilizing several directional antenna patterns.

### SERVE MORE DEVICES

Connect more devices simultaneously with six MU-MIMO spatial streams and concurrent dual-band 2.4/5GHz radios while enhancing device performance.

### CONVERGED ACCESS POINT

Allow customers to eliminate siloed networks and unify WiFi and non-WiFi wireless technologies into one single network by using built-in BLE and Zigbee, and also expanding to any future wireless technologies.

### AUTOMATE OPTIMAL THROUGHPUT

ChannelFly dynamic channel technology uses machine learning to automatically find the least congested channels. You always get the highest throughput the band can support.

### MULTIPLE MANAGEMENT OPTIONS

Manage the R650 from the cloud, with on-premises physical/virtual appliances, or without a controller.

### BETTER MESH NETWORKING

Reduce expensive cabling, and complex mesh configurations by checking a box with SmartMesh wireless meshing technology to dynamically create self-forming, self-healing mesh networks.

### MORE THAN WI-FI

Support services beyond Wi-Fi with Ruckus IoT Suite, Cloudpath security and onboarding software, SPoT Wi-Fi locationing engine, and SCI network analytics.

Wi-Fi capacity requirements in office buildings, classrooms, and retail venues are rapidly raising due to increase in Wi-Fi connected devices, non-Wi-Fi IoT devices and bandwidth-hungry applications.

The R650 access point (AP) with the latest Wi-Fi 6 (802.11 ax) technology delivers increased capacity, improved coverage and performance in dense environments. The R650 is our mid-range dual-band, dual-concurrent AP that supports six spatial streams (4x4:4 in 5GHz, 2x2:2 in 2.4GHz). The R650 supports peak data rates of up to 2974 Mbps and efficiently manages up to 512 clients connections. Furthermore, 2.5GbE Ethernet ensures the backhaul will not be a bottleneck for full use of available Wi-Fi capacity.

Also, wireless requirements within enterprises are expanding beyond Wi-Fi with BLE, Zigbee and many other non-Wi-Fi wireless technologies resulting in creation of network silos. Enterprises need a unified platform to eliminate network silos. The Ruckus AP portfolio is equipped to solve these challenges.

The R650 has built-in IoT radios with onboard BLE and Zigbee capabilities. In addition, the R650 is a converged access point that allows customers to seamlessly integrate any new wireless technologies with the pluggable IoT module.

The R650 is packed with ruckus patented technologies in addition to Wi-Fi 6 features such as OFDMA, MU-MIMO and TWT. The R650 is ideal for medium-density deployments such as office buildings, K-12 classrooms, libraries and retail venues.

The R650 Wi-Fi 6 AP incorporates patented technologies found only in the Ruckus Wi-Fi portfolio.

- **BeamFlex+ Antennas**: Extended coverage and optimized throughput with patented multi-directional antennas and radio patterns
- **ChannelFly**: Improved throughput with dynamically changing the channels to use least congested channel
- **Ruckus Ultra-High-Density Technology Suite**: Dramatically improved network performance with technologies such as Airtime Decongestion, Transient Client Management etc.

Whether you are deploying ten or ten thousand APs, the R650 is also easy to manage through Ruckus' physical and virtual management options.


Front view


Weight: 1.88 lbs (0.854 kg)

## ACCESS POINT ANTENNA PATTERN

Ruckus' BeamFlex+ adaptive antennas allow the R650 AP to dynamically choose among a host of antenna patterns in real-time to establish the best possible connection with every device. This leads to:

- Better Wi-Fi coverage
- Reduced RF interference

Traditional omni-directional antennas, found in generic access points, oversaturate the environment by needlessly radiating RF signals in all directions. In contrast, the Ruckus BeamFlex+ adaptive antenna directs the radio signals per-device on a packet by-packet basis to optimize Wi-Fi coverage and capacity in real-time to support high device density environments. BeamFlex+ operates without the need for device feedback and hence can benefit even devices using legacy standards.

Figure 1. Example of BeamFlex+ pattern

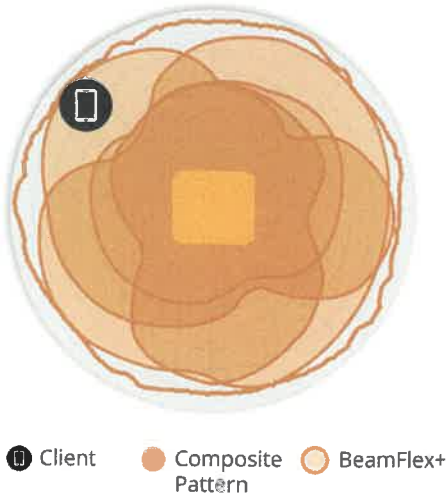



Figure 2. R650 2.4GHz Azimuth Antenna Patterns

Figure 3. R650 5GHz Azimuth Antenna Patterns

Figure 4. R650 2.4GHz Elevation Antenna Patterns

Figure 5. R650 5GHz Elevation Antenna Patterns

Note: The outer trace represents the composite RF footprint of all possible BeamFlex+ antenna patterns, while the inner trace represents one BeamFlex+ antenna pattern within the composite outer trace.

# R650

Indoor Wi-Fi 6 (802.11ax) 4x4:4 Wi-Fi Access Point with 2.5Gbps backhaul and 6 spatial streams

DATA SHEET

| WI-FI | |
|---|---|
| **Wi-Fi Standards** | • IEEE 802/11a/b/g/n/ac/ax |
| **Supported Rates** | • 802.11ax: 4 to 2400 Mbps<br>• 802.11ac: 6.5 to 1732 Mbps<br>• 802.11n: 6.5 to 600 Mbps<br>• 802.11a/g: 6 to 54 Mbps<br>• 802.11b: 1 to 11 Mbps |
| **Supported Channels** | • 2.4GHz: 1-13<br>• 5GHz: 36-64, 100-144, 149-165 |
| **MIMO** | • 4x4 SU-MIMO<br>• 4x4 MU-MIMO |
| **Spatial Streams** | • 4 streams SU/MU MIMO 5GHz<br>• 2 streams SU/MU MIMO 2.4GHz |
| **Radio Chains and Streams** | • 4x4:4 (5GHz)<br>• 2x2:2 (2.4GHz) |
| **Channelization** | • 20, 40, 80, 160/80+80MHz |
| **Security** | • WPA-PSK, WPA-TKIP, WPA2 AES, WPA3, 802.11i, Dynamic PSK, OWE<br>• WIPS/WIDS |
| **Other Wi-Fi Features** | • WMM, Power Save, Tx Beamforming, LDPC, STBC, 802.11r/k/v<br>• Hotspot<br>• Hotspot 2.0<br>• Captive Portal<br>• WISPr |

| RF | |
|---|---|
| **Antenna Type** | • BeamFlex+ adaptive antennas with polarization diversity<br>• Adaptive antenna that provides unique antenna patterns per band |
| **Antenna Gain (max)** | • Up to 3dBi |
| **Peak Transmit Power (Tx port/chain + Combining gain)** | • 2.4GHz: 26dBm<br>• 5GHz: 28 dBm |
| **Frequency Bands** | • ISM (2.4-2.484GHz)<br>• U-NII-1 (5.15-5.25GHz)<br>• U-NII-2A (5.25-5.35GHz)<br>• U-NII-2C (5.47-5.725GHz)<br>• U-NII-3 (5.725-5.85GHz) |

| 2.4GHZ RECEIVE SENSITIVITY (dBm) | | | | | | | |
|---|---|---|---|---|---|---|---|
| HT20 | | HT40 | | VHT20 | | VHT40 | |
| **MCS0** | **MCS7** | **MCS0** | **MCS7** | **MCS0** | **MCS7** | **MCS0** | **MCS7** |
| -93 | -75 | -90 | -72 | -93 | -75 | -90 | -72 |
| HE 20 | | | | HE40 | | | |
| **MCS0** | **MCS7** | **MCS9** | **MCS11** | **MCS0** | **MCS7** | **MCS9** | **MCS11** |
| -93 | -75 | -70 | -64 | -90 | -72 | -67 | -61 |

| 5GHZ RECEIVE SENSITIVITY (dBm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VHT20 | | | | VHT40 | | | | VHT80 | | | |
| **MCS0** | **MCS7** | **MCS8** | **MCS9** | **MCS0** | **MCS7** | **MCS8** | **MCS9** | **MCS0** | **MCS7** | **MCS8** | **MCS9** |
| -98 | -80 | -77 | - | -95 | -77 | - | -72 | -92 | -74 | - | -69 |
| HE20 | | | | HE40 | | | | HE80 | | | |
| **MCS0** | **MCS7** | **MCS9** | **MCS11** | **MCS0** | **MCS7** | **MCS9** | **MCS11** | **MCS0** | **MCS7** | **MCS9** | **MCS11** |
| -98 | -80 | -75 | -70 | -95 | -77 | -72 | -67 | -92 | -74 | -69 | -64 |

| 2.4GHZ TX POWER TARGET (PER CHAIN) | |
|---|---|
| **Rate** | **Pout (dBm)** |
| **MCS0 HT20** | 22 |
| **MCS7 HT20** | 19 |
| **MCS8 VHT20** | 18 |
| **MCS9 VHT40** | 17 |
| **MCS11 HE40** | 15 |

| 5GHZ TX POWER TARGET (PER CHAIN) | |
|---|---|
| **Rate** | **Pout (dBm)** |
| **MCS0, VHT20** | 22 |
| **MCS7, VHT40, VHT80** | 16.5 |
| **MCS9, VHT40, VHT80** | 15 |
| **MCS11, HE20, HE40, HE80** | 12.5 |

| PERFORMANCE AND CAPACITY | |
|---|---|
| **Peak PHY Rates** | • 2.4GHz: 574 Mbps<br>• 5GHz: 2400 Mbps |
| **Client Capacity** | • Up to 512 clients per AP |
| **SSID** | • Up to 31 per AP |

| RUCKUS RADIO MANAGEMENT | |
|---|---|
| **Antenna Optimization** | • BeamFlex+<br>• Polarization Diversity with Maximal Ratio Combining (PD-MRC) |
| **Wi-Fi Channel Management** | • ChannelFly<br>• Background Scan Based |
| **Client Density Management** | • Adaptive Band Balancing<br>• Client Load Balancing<br>• Airtime Fairness<br>• Airtime-based WLAN Prioritization |
| **SmartCast Quality of Service** | • QoS-based scheduling<br>• Directed Multicast<br>• L2/L3/L4 ACLs |
| **Mobility** | • SmartRoam |
| **Diagnostic Tools** | • Spectrum Analysis<br>• SpeedFlex |

# R650

Indoor Wi-Fi 6 (802.11ax) 4x4:4 Wi-Fi Access Point with 2.5Gbps backhaul and 6 spatial streams

DATA SHEET

| NETWORKING | |
|---|---|
| **Controller Platform Support** | • SmartZone<br>• ZoneDirector<br>• Unleashed[1]<br>• Standalone |
| **Mesh** | • SmartMesh™ wireless meshing technology. Self-healing Mesh |
| **IP** | • IPv4, IPv6, dual-stack |
| **VLAN** | • 802.1Q (1 per BSSID or dynamic per user based on RADIUS)<br>• VLAN Pooling<br>• Port-based |
| **802.1x** | • Authenticator & Supplicant |
| **Tunnel** | • L2TP, GRE, Soft-GRE |
| **Policy Management Tools** | • Application Recognition and Control<br>• Access Control Lists<br>• Device Fingerprinting<br>• Rate Limiting |
| **IoT Capbale** | • Yes |

| PHYSICAL INTERFACES | |
|---|---|
| **Ethernet** | • One 2.5Gbps Ethernet port and one 1Gbps Ethernet port<br>• Power over Ethernet (802.3af/at) with Category 5/5e/6 cable<br>• LLDP |
| **USB** | • 1 USB 2.0 port, Type A |

| PHYSICAL CHARACTERISTICS | |
|---|---|
| **Physical Size** | • 22.4cm (L), 19.4cm (W), 4.7cm (H)<br>• 8.8in (L) x 7.6in (W) x 1.9in (H) |
| **Weight** | • 0.854 kg<br>• 1.88 lbs |
| **Mounting** | • Wall, acoustic ceiling, desk<br>• Secure bracket (sold separately) |
| **Physical Security** | • Hidden latching mechanism<br>• T-bar Torx<br>• Bracket (902-0120-0000) Torx screw & padlock (sold separately) |
| **Operating Temperature** | • 0°C (32°F) - 40°C (104°F) |
| **Operating Humidity** | • Up to 95%, non-condensing |

**POWER[2]**

| Power Supply | Operating Characteristics | Max Power Consumption |
|---|---|---|
| **802.3af PoE** | • 2.4GHz radio: 2x2, 19dBm per chain<br>• 5GHz radio: 2x4, 20dBm per chain<br>• 2nd Ethernet port, onboard IoT & USB disabled | 12.25W |
| **802.3at PoE+** | • Full Functionality<br>• 2.4GHz radio: 2x2, 23 dBm per chain<br>• 5GHz radio: 4x4, 22 dBm per chain<br>• 2nd Ethernet Port, onboard IoT & USB Enabled (3W) | PoE+ : 21.59W<br>DC Power: 21.46W |

| CERTIFICATIONS AND COMPLIANCE | |
|---|---|
| **Wi-Fi Alliance[3]** | • Wi-Fi CERTIFIED™ a, b, g, n, ac, ax<br>• Passpoint®, Vantage |
| **Standards Compliance[4]** | • EN 60950-1 Safety<br>• EN 60601-1-2 Medical<br>• EN 61000-4-2/3/5 Immunity<br>• EN 50121-1 Railway EMC<br>• EN 50121-4 Railway Immunity<br>• IEC 61373 Railway Shock & Vibration<br>• UL 2043 Plenum<br>• EN 62311 Human Safety/RF Exposure<br>• WEEE & RoHS<br>• ISTA 2A Transportation |

| SOFTWARE AND SERVICES | |
|---|---|
| **Location Based Services** | • SPoT |
| **Network Analytics** | • SmartCell Insight (SCI) |
| **Security and Policy** | • Cloudpath |

| ORDERING INFORMATION | |
|---|---|
| **901-R650-XX00** | • R650 dual-band (5GHz and 2.4GHz concurrent) 802.11ax wireless access point, 4x4:4 + 2x2:2 streams, adaptive antennas, dual ports, onboard BLE and Zigbee, PoE support. Includes adjustable acoustic drop ceiling bracket. One Ethernet port is 2.5GbE. Does not include power adaptor. |

See Ruckus price list for country-specific ordering information.
Warranty: Sold with a limited lifetime warranty.
For details see: http://support.ruckuswireless.com/warranty.

[1] Refer to Unleashed datasheets for SKU ordering information.
[2] Max power varies by country setting, band, and MCS rate.
[3] For complete list of WFA certifications, please see Wi-Fi Alliance website.
[4] For current certification status, please see price list.

| OPTIONAL ACCESSORIES | |
|---|---|
| **902-0180-XX00** | • PoE Injector (60W) |
| **902-1170-XX00** | • Power Supply (48V, 0.75A, 36W) |
| **902-0120-0000** | • Spare, Accessory Mounting Bracket |
| **902-0195-0000** | • Spare, T-bar ceiling mount kit for mounting to flush frame ceiling |

PLEASE NOTE: When ordering Indoor APs, you must specify the destination region by indicating -US, -WW, or -Z2 instead of XX. When ordering PoE injectors or power supplies, you must specify the destination region by indicating -US, -EU, -AU, -BR, -CN, -IN, -JP, -KR, -SA, -UK, or -UN instead of -XX.
For access points, -Z2 applies to the following countries: Algeria, Egypt, Israel, Morocco, Tunisia, and Vietnam.





RUCKUS
an ARRIS company

# Ruckus ICX 7150

Enterprise-Class Stackable Access Switch

Ruckus
Simply Better Wireless.

## PRODUCT BROCHURE

## BENEFITS

### STACKABILITY SIMPLIFIES MANAGEMENT

- Class-leading stacking scalability with up to 12 switches per stack[1]
- Long-distance stacking up to 10 km using standard optics or cables

### 10 GBE PORTS OPTIMIZE NETWORK PERFORMANCE

- Up to 8×10 GbE SFP+ ports for stacking or uplinks

### DUAL POWER SUPPLIES FOR HIGH AVAILABILITY

- Dual load-sharing, hot-swappable power supplies available on the Z-Series switch

### MULTIGIGABIT SUPPORT ENABLES NEXT GENERATION WIRELESS DEPLOYMENT

- Up to 16x 2.5 GbE ports optimized for 802.11ac Wave 2 wireless deployment

### CLASS LEADING POE BUDGET TO POWER ADVANCED EDGE DEVICES

- PoE+/PoH budget (up to 1,480 watts)
- Supports advanced wireless APs and video surveillance equipment

### SILENT OPERATION FOR DEPLOYMENT IN THE WORK ENVIRONMENT

- Fanless design or silent mode enables non-disruptive deployment

### ADVANCED L3 MAXIMIZES FLEXIBLITY

- RIP, OSPF, VRRP, PIM, PBR L3 features[1]

### CAMPUS FABRIC REDUCES COST OF OPERATIONS, INCREASES FLEXIBILITY

- Ruckus Campus Fabric[1] delivers the benefits of a chassis with the flexibility of stackables
- Scales to over 1800 ports

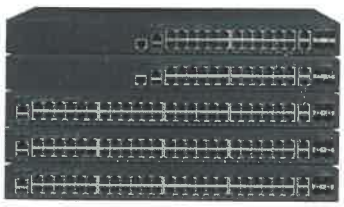
[1] Feature to be supported in a future software release.

## ENTRY-LEVEL ACCESS SWITCH FAMILY DELIVERS UNPRECEDENTED PERFORMANCE AND FEATURES IN ITS CLASS

The Ruckus® ICX® 7150 family of stackable switches delivers the performance, flexibility, and scalability required for enterprise access deployment, raising the bar with non-blocking performance and up to 8x10 GbE ports for uplinks or stacking. It offers seamless interoperability with Ruckus wireless products to deliver unified wired and wireless network access. In addition, Ruckus Multigigabit Ethernet technology offers bandwidth speeds needed to optimize performance of the latest generation high performance wireless access points and edge devices, over standard Ethernet cables.

The Ruckus ICX 7150 family of switches are available in three formats:

### RUCKUS ICX 7150 SWITCHES



The standard Ruckus ICX 7150 switches are available in 24-, and 48-port 10/100/1000 Mbps models with four 1/10 GbE dual-purpose uplink/stacking ports. These switches are available with or without PoE+ power. Silent operation is available for out-of-closet environments.

### RUCKUS ICX 7150 Z-SERIES SWITCHES

The Ruckus ICX 7150-48ZP 48-port switch adds higher performance, greater resiliency and increased PoE power. The switch offers Multigigabit technology (IEEE 802.3bz) to match the highest performing 802.11ac Wave 2 wireless access points available, with dual redundant, hot-swappable power supplies and fans, and up to 8x10 GbE uplink/stacking ports.

The switch offers 16 Multigigabit (100Mbps/1Gbps/2.5Gbps) ports, each with Power-over-HDBaseT (PoH) up to 90 watts, plus 32 10/100/1000 Mbps ports with PoE+. With a maximum PoE budget of 1480 watts, this switch delivers the power, and performance, to drive PoE+ power to all 48 ports.

### RUCKUS ICX 7150 COMPACT SWITCHES

The Ruckus ICX 7150-C12P compact 12-port stackable switch features a fanless design to operate silently in out-of-closet environments such as offices, classrooms, and retail spaces. It offers PoE+ on all 12 ports to drive devices such as wireless APs, VoIP phones, lighting fixtures or surveillance cameras. With 2x1/10 GbE uplink/stacking ports, the ICX 7150-C12 delivers high performance in a small package.


## STACKING ACROSS THE ICX 7150 FAMILY

Ruckus stacking technology[2] makes it possible to stack up to twelve Ruckus ICX 7150 switches into a single logical switch. This allows the Ruckus ICX 7150 to deliver a class-leading 480 Gbps of aggregated stacking bandwidth and offer simple and robust expandability for future growth. Stacking is supported across the ICX 7150 family and all ICX 7150 models including the ICX 7150 compact switch and the ICX 7150-48ZP can be mixed within the same stack. This stacked switch has only a single IP address that simplifies management and offers transparent forwarding across up to 600×1 GbE ports or up to 192×2.5 GbE ports, and up to 96×10 GbE ports. When new switches join the stack, they automatically inherit the stack's existing configuration file, enabling a plug-and-play network expansion.

Because the ICX 7150-48ZP switch has twice as many uplink ports, when it is added to a stack of other ICX 7150 switch models, the effective bandwidth of all the switches is doubled. By designing the stack this way, all four of the 10GbE ports on the ICX 7150 switches can be used for stacking (rather than having to split the four ports between stacking and uplinks), and leveraging four of the 10GbE ports on the ICX 7150-48ZP for stacking and the other four 10GbE ports can be used for uplinks.

## ENTERPRISE-CLASS AVAILABILITY

The Ruckus ICX 7150 Switches help deliver continuous availability to optimize the user experience. Ruckus stacking technology provides high availability by performing real-time state synchronization across the stack and transferring switch management control from the master stack controller to the standby controller if the master stack controller experiences a failure. When hot-inserting or hot-removing a stack member to increase capacity or perform service upgrade, traffic flows will not experience interruption.

In addition to stack-level high availability, Ruckus ICX 7150 Switches also support stack level ISSU (In Service Software Upgrade), a unique capability that allows the user to perform software upgrades to a Ruckus ICX 7150 stack without service interruption. Taking high-availability and reliability even further, the Ruckus ICX 7150 Z-Series switch offers redundant hot swappable load sharing power supplies and up to 2 hot swappable fans.

## SILENT OPERATION

The Ruckus ICX 7150-C12P compact switch, along with the Ruckus ICX 7150-24 and the ICX 7150-48 switches, feature a fanless design that enables it to operate silently.

The Ruckus ICX 7150-24P and the ICX 7150-48P offer a "silent mode" configuration option, enabling these switches to operate with the fan disabled while providing a PoE budget of 150 watts. This Ruckus-exclusive feature enables users in hospitality, education, healthcare, and retail industries to deploy these switches outside of the wiring closet without disrupting the work environment.

## MULTIGIGABIT ETHERNET SUPPORT

The Ruckus ICX® 7150-48ZP Switch raises the bar for entry-level switches even further with 16x IEEE 802.3bz compliant 2.5 GbE ports, up to 8×10 GbE uplink ports, dual redundant load sharing power supplies and class-leading stacking density with up to 12 switches per stack. It stacks with all other members of the ICX 7150 family allowing organizations to buy what they need now and easily scale as the need for Multigigabit support emerges. It is designed to work seamlessly with Ruckus wireless access points to deliver unified wired and wireless network access.

## POWER NEXT-GENERATION EDGE DEVICES

All ICX 7150 family members offer PoE options. The compact 12 port switch delivers PoE+ on all ports with a 124W PoE budget. The 24- and 48-port ICX 7150 switches offer up to 740W of PoE+ power and the ICX 7150 Z-Series offers an industry leading 1480W PoE budget when equipped with 2 power supplies. In addition to supporting PoE and PoE+, the Ruckus ICX 7150 Z-Series also offers Power over HDBaseT (PoH). This new, high power HDBT standard delivers up to 90 watts per port through a standard Ethernet cable, simplifying the wiring of next-generation Ethernet-connected devices such as high-performance wireless APs, large HD displays, video surveillance equipment, and VDI thin terminals, enabling data and power to be carried by a single Ethernet wire. The PoE, PoE+ and PoH capabilities reduce the number of required power receptacles and power adapters while increasing reliability and wiring flexibility.

With a 1,480-watt power budget per switch (with two power supplies), the Ruckus ICX 7150 48ZP model can supply Class 4 PoE+ power (30 watts) to every port and PoH power (90 watts) on 16 dedicated Multigigabit ports.

[2] Feature to be supported in a future software release.

## RUCKUS ICX 7150 PRODUCT FAMILY

### RUCKUS ICX 7150

These Ruckus ICX 7150 models offer a single integrated power supply, one RJ-45 Ethernet port for out-of-band network management, one USB Type-C port for console management, one RJ-45 port for serial console management, and one USB port for external file storage.

| | |
|---|---|
|  | **Ruckus ICX 7150-24 Switch**<br>24× 10/100/1000 Mbps RJ-45 ports<br>2× 10/100/1000 Mbps uplink RJ-45 ports<br>4× 1/10 GbE uplink/stacking SFP/SFP+ ports |
|  | **Ruckus ICX 7150-24P Switch**<br>24× 10/100/1000 Mbps RJ-45 PoE+ ports<br>370 W PoE budget<br>2× 10/100/1000 Mbps uplink RJ-45 ports<br>4× 1/10 GbE uplink/stacking SFP/SFP+ ports |
|  | **Ruckus ICX 7150-48 Switch**<br>48× 10/100/1000 Mbps RJ-45 ports<br>2× 10/100/1000 Mbps uplink RJ-45 ports<br>4× 1/10 GbE uplink/stacking SFP/SFP+ ports |
|  | **Ruckus ICX 7150-48P Switch**<br>48× 10/100/1000 Mbps RJ-45 PoE+ ports<br>370 W PoE budget<br>2× 10/100/1000 Mbps uplink RJ-45 ports<br>4× 1/10 GbE uplink/stacking SFP/SFP+ ports |
|  | **Ruckus ICX 7150-48PF Switch**<br>48×10/100/1000 Mbps RJ-45 PoE+ ports<br>740 W PoE budget<br>2×10/100/1000 Mbps uplink RJ-45 ports<br>4×1/10 GbE uplink/stacking SFP/SFP+ ports |

### RUCKUS ICX 7150 Z-SERIES

The Ruckus ICX 7150 Z-Series Switch offers redundant hot swappable load sharing power supplies, up to 2 hot swappable fans, one RJ-45 Ethernet port for out-of-band network management, one USB Type-C port for console management, one RJ-45 port for serial console management, and one USB port for external file storage.

| | |
|---|---|
|  | **Ruckus ICX 7150-48ZP**<br>16x 100/1000 Mbps/2.5 Gbps RJ-45 PoH ports<br>32× 10/100/1000 Mbps RJ-45 PoE+ ports<br>1,480 W PoE budget (with two power supplies)<br>8× 1/10 GbE uplink/stacking SFP/SFP+ ports |

### RUCKUS ICX 7150 COMPACT SWITCH

The Ruckus ICX 7150 compact switch offer a single integrated power supply, one RJ-45 Ethernet port for out-of-band network management, one USB Type-C port for console management, one RJ-45 port for serial console management, and one USB port for external file storage.

| | |
|---|---|
|  | **Ruckus ICX 7150-C12P Compact Switch**<br>12× 10/100/1000 Mbps POE+ RJ-45 ports<br>124 W power budget<br>2× 10/100/1000 Mbps uplink RJ-45 ports<br>2× 1/10 GbE uplink/stacking SFP/SFP+ ports |

## ENTERPRISE-CLASS FEATURES ACROSS ALL RUCKUS ICX SWITCHES

The Ruckus ICX 7150 is one of the ICX switch families delivering the enterprise class features for flexibility, scalability and simplified management.

- Ruckus Campus Fabric technology delivers unmatched flexibility, scalability and simplified management for campus network deployments. Incorporating all of the ICX 7000 switch families with up to 1800 ports in a single logical domain, Campus Fabric allows customers the benefits of a traditional chassis, with the flexibility of stackable switches at a dramatically reduced Total Cost of Ownership (TCO).
- Advanced stacking goes beyond traditional stacking with capabilities that take flexibility, ease of management and cost effectiveness to then next level, including:
  - Stacking on standard Ethernet ports
  - Long-distance stacking
  - No hardware module require for stacking
  - In Service Software Upgrade (ISSU) to minimize downtime
  - Superior scalability with the industry-leading number of switches per stack
  - Stacking at the access, aggregation and core layers
- Enterprise-Class Availability to improve resiliency and minimize downtime, including:
  - Hitless stack failover
  - Hot-insertion/removal of stack members
  - Redundant power supplies
  - In Service Software Upgrades for switch stacks
- On-boarding and security policies across ICX switches and wireless networks.
- OpenFlow 1.3 protocol support in hybrid mode allows user to deploy traditional Layer 2/3 forwarding with OpenFlow on the same port for Software Defined Network (SDN) enabled programmatic control of the network
- Open Standards based management, monitoring and authentication
  - sFlow-based network monitoring to help analyze traffic statistics and trends on every link and overcome unexpected network congestion
  - Open-standards management includes Command Line Interface (CLI), Secure Shell (SSHv2), Secure Copy (SCP), and SNMPv3
  - Support for Access Controller Access Control System (TACACS/TACACS+) and RADIUS authentication helps ensure secure operator access
  - LLDP and LLDP-MED protocol support for configuring, discovering, and managing network infrastructure such as QoS, security policies, VLAN assignments, PoE power levels, and service priorities

## RUCKUS ICX 7150 SWITCH FEATURE/MODEL COMPARISON

| | 24 or 48 RJ-45 Ports | | 12 RJ45 PoE+ Ports | 24 or 48 RJ45 PoE+ Ports | | | Z-Series |
|---|---|---|---|---|---|---|---|
| FEATURE | Ruckus ICX 7150-24 | Ruckus ICX 7150-48 | Ruckus ICX 7150-C12P | Ruckus ICX 7150-24P | Ruckus ICX 7150-48P | Ruckus ICX 7150-48PF | Ruckus ICX 7150-48ZP |
| Switching capacity (data rate, full duplex) | 132 Gbps | 180 Gbps | 68 Gbps | 132 Gbps | 180 Gbps | 180 Gbps | 304 Gbps |
| Forwarding capacity (data rate, full duplex) | 98 Mpps | 134 Mpps | 51 Mpps | 98 Mpps | 134 Mpps | 134 Mpps | 226 Mbps |
| 10/100/1000 Mbps RJ45 downlinks | 24 | 48 | 12 | 24 | 48 | 48 | 32 |
| 100/1000 Mbps/2.5 Gbps RJ45 downlinks (full duplex only) | | | | | | | 16 |
| 10/100/1000 Mbps RJ45 uplinks (full duplex only, no PoE) | 2 | 2 | 2 | 2 | 2 | 2 | |
| 1/10 Gbps SFP/SFP+ uplinks | 4 | 4 | 2 | 4 | 4 | 4 | 8 |
| PoE/PoE+ ports | | | 12 | 24 | 48 | 48 | 32 |
| PoH / PoE / PoE+ ports | | | | | | | 16 |
| Dual hot-swap power supplies | | | | | | | Yes |
| Maximum PoE Class 3 ports (15.4 W per port) | | | 8 | 24 | 24 | 48 | 48 |
| Maximum PoE+ Class 4 ports (30 W per port) | | | 4 | 12 | 12 | 24 | 48 (2 PSU) |
| Base IPv4/v6 Layer 3 routing[3] (static routing, RIP) | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Advanced IPv4/v6 Layer 3 routing[3] (OSPF, VRRP, PIM, PBR features) | With license | With license | With license | With license | With license | With license | With license |
| Aggregated stacking bandwidth[3] (data rate, full duplex) | 480 Gbps | 480 Gbps | 240 Gbps | 480 Gbps | 480 Gbps | 480 Gbps | 480 Gbps |
| Stacking density[3] (maximum switches in a stack) | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Stacking ports[3] (maximum ports[4] usable for stacking) | Up to 4×10 GbE SFP+ | | Up to 2×10 GbE SFP+ | Up to 4×10 GbE SFP+ | | | Up to 4x10 GbE SFP+ |
| Maximum stacking distance[3] (distance between stacked switches) | 10 km | 10 km | 10 km | 10 km | 10 km | 10 km | 10 km |

[3] Feature to be supported in a future release.
[4] 10 Gbps SFP+ ports are required for stacking.

## RUCKUS ICX 7150 SWITCH FEATURE/MODEL COMPARISON

| | 24 or 48 RJ-45 Ports | | 12 RJ45 PoE+ Ports | 24 or 48 RJ45 PoE+ Ports | | | Z-Series |
|---|---|---|---|---|---|---|---|
| | Ruckus ICX 7150-24 | Ruckus ICX 7150-48 | Ruckus ICX 7150-C12P | Ruckus ICX 7150-24P | Ruckus ICX 7150-48P | Ruckus ICX 7150-48PF | Ruckus ICX 7150-48ZP |
| FEATURE | POWER | | | | | | |
| Power inlet (AC) | C14 | | | | | | |
| Input voltage/frequency | AC: 100 to 240 VAC @ 50 to 60 Hz | | | | | | |
| Power supply rated maximum (AC) | 36 W | 65 W | 150 W | 525 W | 525W | 880 W | 2x 920 W |
| PoE power budget (AC) | | | 124 W | 370 W | 370 W | 740 W | 1480 W (2 PSU) |
| Airflow | Fanless | Fanless | Fanless | Side-to-back | Side-to-back | Side-to-back | Front-to-back |
| FEATURE | ENVIRONMENT | | | | | | |
| Net Weight (Kg) | 3.8 | 4.82 | 2.58 | 4.93 | 6.17 | 6.28 | TBD |
| Dimensions (mm) | 440 (W) 280 (D) 43.65 (H) | 440 (W) 370 (D) 43.65 (H) | 269 (W) 213 (D) 43.4 (H) | 440 (W) 280 (D) 43.65 (H) | 440 (W) 370 (D) 43.65 (H) | 440 (W) 370 (D) 43.65 (H) | TBD |
| Acoustics (25°C, min fan speed) | Fanless | Fanless | Fanless | 41.4 dBA | 41.8 dBA | 47.7 dBA | TBD |
| MTBF (25°C) | 871,931 hours | 714,420 hours | 562,889 hours | 397,428 hours | 335,853 hours | 312,241 hours | TBD |

## RUCKUS ICX 7150 SWITCH SPECIFICATIONS

| FEATURES | SPECIFICATIONS |
|---|---|
| Connector options | • 10/100/1000 Mbps RJ-45<br>• 1 Gbps SFP ports<br>• 1/10 Gbps SFP+ ports<br>• Out-of-band Ethernet management: 10/100/1000 Mbps RJ-45<br>• Console management: RJ45 serial port and USB Type-C port with serial communication device class support<br>• File transfer: USB port, standard-A plug<br>• For the latest information about supported optics, please visit http://brocade.com/optics. |
| DRAM<br>NVRAM (Flash)<br>Packet buffer size | • 1 GB<br>• 2 GB<br>• 12/24 port: 2 MB, 48 port: 4 MB |
| Maximum MAC addresses | • 16,384 |
| Maximum VLANs<br>Maximum PVLANs | • 4,095<br>• 32 |
| Maximum STP (spanning trees instances) | • 254 |
| Maximum VEs | • 128 |
| Maximum ARP entries | • 4,094 |
| Maximum routes (in hardware)[3] | • 1,000 (IPv4), 1,000 (IPv6)<br>• Next hop address: 4,094 |
| Trunking | • Maximum ports per trunk: 16<br>• Maximum trunk groups: 128 |
| Maximum jumbo frame size | • 9,216 bytes |
| QoS priority queues | • 8 per port |
| Multicast groups | • 3,072 (Layer 2)<br>• 2,048 (Layer 3) |
| Quality of Service (QoS) | • ACL Mapping and Marking of ToS/DSCP (CoS)<br>• ACL Mapping and Marking of 802.1p<br>• ACL Mapping to Priority Queue<br>• Classifying and Limiting Flows Based on TCP Flags<br>• DiffServ Support<br>• Honoring DSCP and 802.1p (CoS)<br>• MAC Address Mapping to Priority Queue<br>• Priority Queue Management using Weighted Round Robin (WRR), Strict Priority (SP), and a combination of WRR and SP |
| Traffic management | • ACL-based inbound rate limiting and traffic policies<br>• Broadcast, multicast, and unknown unicast rate limiting<br>• Inbound rate limiting per port<br>• Outbound rate limiting per port and per queue |

[3] Feature to be supported in a future release.

## RUCKUS ICX 7150 SWITCH SPECIFICATIONS

| | |
|---|---|
| Security | • 802.1X authentication<br>• MAC authentication<br>• Flexible authentication<br>• Web authentication<br>• DHCP snooping<br>• Dynamic ARP inspection<br>• Neighbor Discovery (ND) Inspection<br>• Bi-level Access Mode (Standard and EXEC Level)<br>• EAP pass-through support<br>• IEEE 802.1X username export in sFlow<br>• Protection against Denial of Service (DoS) attacks<br>• Authentication, Authorization, and Accounting (AAA)<br>• MAC Address Locking MAC Port Security<br>• Advanced Encryption Standard (AES) with SSHv2<br>• RADIUS/TACACS/TACACS+<br>• Secure Copy (SCP)<br>• Secure Shell (SSHv2)<br>• Local Username/Password<br>• Change of Authorization (CoA) RFC 5176<br>• Trusted Platform Module |
| SDN features[3] | • OpenFlow v1.0 and v1.3<br>• OpenFlow with hybrid port mode<br>• Operates with an OpenDayLight Controller |
| High availability | • Layer 3 VRRP/VRRP-E protocol redundancy[3]<br>• Real-time state synchronization across the stack[3]<br>• Hitless failover and switchover from master to standby stack controller[3]<br>• Hot insertion and removal of stacked units[3]<br>• Layer 2 VSRP switch redundancy[3]<br>• In Service Software Update (ISSU)[3] |

| FEATURES | FEATURE SETS |
|---|---|
| Layer 2 feature set | • 802.1s Multiple Spanning Tree<br>• 802.1x Authentication<br>• Auto MDI/MDIX<br>• BPDU Guard, Root Guard<br>• Dual-Mode VLANs<br>• MAC-based VLANs, Dynamic MAC-based VLAN activation<br>• Dynamic VLAN Assignment<br>• Dynamic Voice VLAN Assignment<br>• Fast Port Span<br>• GVRP: GARP VLAN Registration Protocol<br>• IGMP Snooping (v1/v2/v3)<br>• IGMP Proxy for Static Groups<br>• IGMP v2/v3 Fast Leave<br>• Inter-Packet Gap (IPG) adjustment<br>• Link Fault Signaling (LFS)<br>• MAC Address Filtering<br>• MAC Learning Disable<br>• MLD Snooping (v1/v2)<br>• Multi-device Authentication<br>• Per-VLAN Spanning Tree (PVST/PVST+/PRST)<br>• Mirroring: Port-based, ACL-based, MAC Filter-based, and VLAN-based<br>• PIM-SM v2 Snooping<br>• Port Loop Detection<br>• Private VLAN<br>• Remote Fault Notification (RFN)<br>• Single-instance Spanning Tree<br>• Trunk Groups (static, LACP)<br>• Uni-Directional Link Detection (UDLD)<br>• Metro-Ring Protocol (MRP) (v1, v2)<br>• Virtual Switch Redundancy Protocol (VSRP)[3]<br>• Q-in-Q<br>• Topology Groups |
| Base Layer 3 IP routing[3] feature set | • IPv4 and IPv6 static routes<br>• RIP v1/v2, RIPng<br>• ECMP<br>• Port-based Access Control Lists<br>• Layer 3/Layer 4 ACLs<br>• Host routes<br>• Virtual Interfaces<br>• Routed Interfaces<br>• Route-only Support<br>• Routing Between Directly Connected Subnets |
| Premium Layer 3 IP routing[3] feature set with software license | • IPv4 and IPv6 dynamic routes<br>• OSPF v2, v3<br>• PIM-SM, PIM-SSM, PIM-DM, PIM passive (IPv4, IPv6)<br>• PBR<br>• Virtual Route Redundancy Protocol VRRP (IPv4)<br>• VRRP v3 (IPv6)<br>• VRRP-E (IPv4/IPv6) |

[3] Feature to be supported in a future release.

## RUCKUS ICX 7150 SWITCH SPECIFICATIONS

| FEATURES | STANDARD COMPLIANCE |
|---|---|
| IEEE standards compliance | • 802.1AB LLDP/ LLDP-MED<br>• 802.1D MAC Bridging<br>• 802.1p Mapping to Priority Queue<br>• 802.1s Multiple Spanning Tree (MST)<br>• 802.1w Rapid Reconfiguration of Spanning Tree (RSTP)<br>• 802.1x Port-based Network Access Control (PNAC)<br>• 802.3 Carrier Sense Multiple Access/Collision Detection (CSMA/CD)<br>• 802.3ab 1000BASE-T<br>• 802.3 10Base-T<br>• 802.3ad Link Aggregation (Dynamic and Static)<br>• 802.1 AX-2008 Link Aggregation<br>• 802.3ae 10 Gigabit Ethernet<br>• 802.3af Power over Ethernet<br>• 802.3at Power over Ethernet Plus<br>• 802.3bz Multigigabit Ethernet<br>• 802.3u 100Base-TX<br>• 802.3x Flow Control<br>• 802.3z 1000Base-SX/LX<br>• 802.3 MAU MIB (RFC 2239)<br>• 802.1Q VLAN Tagging<br>• 802.1BR Bridge Port Extension[3] |
| RFC standards compliance | For a complete list of RFCs supported by the ICX 7000 product family, please visit www.brocade.com/fastironrfc. |

| FEATURES | NETWORK AND DEVICE MANAGEMENT |
|---|---|
| Management | • DHCP Auto Configuration<br>• Configuration Logging<br>• Digital Optical Monitoring<br>• Display Log Messages on Multiple Terminals<br>• Embedded Web Management (HTTP/HTTPS)<br>• Embedded DHCP Server<br>• Industry-standard Command Line Interface (CLI)<br>• Brocade Network Advisor (sold separately)<br>• CLI activation of optional software features<br>• Integration with HP OpenView<br>• USB file management and storage<br>• Macro for batch execution<br>• Out-of-band Ethernet Management<br>• TFTP<br>• TELNET Client and Server<br>• SSH / SSH V2<br>• Bootp<br>• SNMPv1/v2c<br>• DHCP Server and DHCP Relay<br>• SNMPv3 Intro to Framework<br>• Architecture for Describing SNMP Framework<br>• SNMP Message Processing and Dispatching<br>• SNMPv3 Applications<br>• SNMPv3 User-based Security Model<br>• SNMP View-based Access Control Model SNMP<br>• sFlow<br>• Network Time Protocol (NTP)<br>• Multiple Syslog Servers<br>• SCP<br>• Virtual Cable Tester (VCT)[3]<br>• For management MIB, please visit www.brocade.com |
| Ruckus Campus Fabric technology[3] | • The Ruckus ICX 7150 can operate in fabric Port Extender (PE) mode<br>• Up to 36 PEs per fabric (up to 1800 ports)<br>• PE cascade depth up to 6 units |

| FEATURES | ENVIRONMENT |
|---|---|
| Temperature | Operating temperature: -5°C to 45°C<br>Storage temperature: -25°C to 70°C |
| Humidity | Operating relative humidity: 5% to 95% at 45°C, non-condensing<br>Non-operating relative humidity: 0% to 95% at 70°C, non-condensing |
| Altitude | Operating altitude: 10,000 ft (3,000 m) maximum<br>Storage altitude: 39,000 ft (12,000 m) maximum |

[3] Feature to be supported in a future release.

## RUCKUS ICX 7150 SWITCH SPECIFICATIONS

| FEATURES | COMPLIANCE/CERTIFICATION |
|---|---|
| Electromagnetic emissions | FCC Class A (Part 15); EN 55022/CISPR-22 Class A; VCCI Class A; ICES-003 Electromagnetic Emission; AS/NZS 55022; EN 61000-3-2 Power Line Harmonics; EN 61000-3-3 Voltage Fluctuation and Flicker; EN 61000-6-3 Emission Standard (supersedes: EN 50081-1) |
| Safety | CAN/CSA-C22.2 NO. 60950-1-07; UL 60950-1 Second Edition; IEC 60950-1 Second Edition; EN 60950-1:2006 Safety of Information Technology Equipment; EN 60825-1 Safety of Laser Products—Part 1: Equipment Classification, Requirements and User's Guide; EN 60825-2 Safety of Laser Products—Part 2: Safety of Optical Fibre Communication Systems |
| Immunity | EN 61000-6-1 Generic Immunity and Susceptibility (supersedes EN 50082-1); EN 55024 Immunity Characteristics (supersedes EN 61000-4-2 ESD); EN 61000-4-3 Radiated, Radio Frequency, Electromagnetic Field; EN 61000-4-4 Electrical Fast Transient; EN 61000-4-5 Surge; EN 61000-4-6 Conducted Disturbances Induced by Radio-Frequency Fields; EN 61000-4-8 Power Frequency Magnetic Field; EN 61000-4-11 Voltage Dips and Sags |
| Environmental regulatory compliance | RoHS-compliant (6 of 6); WEEE-compliant |
| Vibration | IEC 68-2-36, IEC 68-2-6 |
| Shock and drop | IEC 68-2-27, IEC 68-2-32 |

## RUCKUS ICX 7150 SWITCH ORDERING INFORMATION

| PART NUMBER | RUCKUS ICX 7150 SWITCHES WITH 1 GBE UPLINKS |
|---|---|
| ICX7150-C12P-2X1G | Ruckus ICX 7150 Compact Switch, 12×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 2×1 GbE SFP uplink-ports upgradable to 2×10 GbE SFP+ with license, 124 W PoE budget, basic Layer 3 (static routing and RIP). |
| ICX7150-24-4X1G | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 4×1 GbE SFP uplink-ports upgradable to up to 4×10 GbE SFP+ with license, basic Layer 3 (static routing and RIP). |
| ICX7150-24P-4X1G | Ruckus ICX 7150 Switch 24×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×1 GbE SFP uplink ports upgradable to up to 4×10 GbE SFP+ with license, 370 W PoE budget, basic Layer 3 (static routing and RIP). |
| ICX7150-48-4X1G | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 4×1 GbE SFP uplink-ports upgradable to up to 4×10 GbE SFP+ with license, basic Layer 3 (static routing and RIP). |
| ICX7150-48P-4X1G | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×1 GbE SFP uplink ports upgradable to up to 4×10 GbE SFP+ with license, 370 W PoE budget, basic Layer 3 (static routing and RIP). |
| ICX7150-48PF-4X1G | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×1 GbE SFP uplink ports upgradable to up to 4×10 GbE SFP+ with license, 740 W PoE budget, basic Layer 3 (static routing and RIP). |

| PART NUMBER | RUCKUS ICX 7150 SWITCHES WITH 2×10 GBE UPLINKS |
|---|---|
| ICX7150-C12P-2X10GR | Ruckus ICX 7150 Compact Switch, 12×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45, 2×10 GbE SFP+ stacking/uplink-ports, 124 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR). |
| ICX7150-24-2X10G | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 2×1 GbE SFP and 2×10 GbE SFP+ stacking/uplink-ports upgradable to 4×10 GbE SFP+ with license, basic Layer 3 (static routing and RIP). |
| ICX7150-24P-2X10G | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 2×1 GbE SFP and 2×10 GbE SFP+ stacking/uplink-ports upgradable to 4×10 GbE SFP+ with license, 370 W PoE budget, basic Layer 3 (static routing and RIP). |
| ICX7150-48-2X10G | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 2×1 GbE SFP and 2×10 GbE SFP+ stacking/uplink-ports upgradable to 4×10 GbE SFP+ with license, basic Layer 3 (static routing and RIP). |

## RUCKUS ICX 7150 SWITCH ORDERING INFORMATION

| | |
|---|---|
| ICX7150-48P-2X10G | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 2×1 GbE SFP and 2×10 GbE SFP+ stacking/uplink-ports upgradable to 4×10 GbE SFP+ with license, 370 W PoE budget, basic Layer 3 (static routing and RIP). |
| ICX7150-48PF-2X10G | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 2×1 GbE SFP and 2×10 GbE SFP+ stacking/uplink-ports upgradable to 4×10 GbE SFP+ with license, 740 W PoE budget, basic Layer 3 (static routing and RIP). |
| ICX7150-48ZP-E2X10G | Ruckus ICX 7150 Z-Series Switch, 16×100/1000 Mbps/2.5 Gbps PoH ports, 32x10/100/1000 PoE+ ports, 6x1 GbE SFP uplink ports and 2×10 GbE SFP+ stacking/uplink-ports upgradable to up to 8x10 GbE SFP+ with license, 1x 920 W AC power supply, 1 fan, 740 W PoE budget, base L3 (static routing and RIP). |

| PART NUMBER | RUCKUS ICX 7150 SWITCHES WITH UP 4 OR 8×10 GBE UPLINKS AND LAYER 3 FEATURES |
|---|---|
| ICX7150-24-4X10GR | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, Layer 3 features (OSPF, VRRP, PIM, PBR). |
| ICX7150-24P-4X10GR | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 370 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR). |
| ICX7150-48-4X10GR | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, Layer 3 features (OSPF, VRRP, PIM, PBR). |
| ICX7150-48P-4X10GR | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 370 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR). |
| ICX7150-48PF-4X10GR | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports , 740 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR). |
| ICX7150-48ZP-E8X10GR | Ruckus ICX 7150 Z-Series switch, 16×100/1000 Mbps/2.5 Gbps PoH ports, 32x10/100/1000 PoE+ ports, 8×10 GbE SFP+ stacking/uplink-ports (max 4 for stacking), 1x920 W AC power supply, 1 fan, 740 W PoE budget, L3 features (OSPF, VRRP, PIM, PBR). |

| PART NUMBER | RUCKUS ICX 7150 SWITCHES WITH THREE-YEAR REMOTE SUPPORT<br>Please note that three-year remote support can be ordered separately to cover any Ruckus ICX 7150 model. |
|---|---|
| ICX7150-C12P-2X10GR-RMT3 | Ruckus ICX 7150 Compact Switch, 12×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 2×10 GbE SFP+ stacking/uplink-ports, 124 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), three-year remote support. |
| ICX7150-24-4X10GR-RMT3 | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, Layer 3 features (OSPF, VRRP, PIM, PBR), three-year remote support. |
| ICX7150-24P-4X10GR-RMT3 | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps PoE+ ports, 2×1G RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 370 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), three-year remote support. |
| ICX7150-48-4X10GR-RMT3 | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, Layer 3 features (OSPF, VRRP, PIM, PBR), three-year remote support. |
| ICX7150-48P-4X10GR-RMT3 | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 370 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), three-year remote support. |
| ICX7150-48PF-4X10GR-RMT3 | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 740 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), three-year remote support. |
| ICX7150-48ZP-E8X10GR-RMT3 | Ruckus ICX 7150 Z-Series switch, 16×100/1000 Mbps/2.5 Gbps PoH ports, 32x10/100/1000 PoE+ ports, 8×10 GbE SFP+ stacking/uplink-ports (max 4 for stacking), 1x 920 W AC power supply, 1 fan, 740 W PoE budget, L3 features (OSPF, VRRP, PIM, PBR). Three-year remote support. |

## RUCKUS ICX 7150 SWITCH ORDERING INFORMATION

| PART NUMBER | TAA-COMPLIANT RUCKUS ICX 7150 SWITCHES<br>The Ruckus ICX 7150 models with the SKUs below meet the requirements of the Trade Agreements Act (TAA). |
|---|---|
| ICX7150-C12P-2X10GR-A | Ruckus ICX 7150 Compact Switch, 12×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 2×10 GbE SFP+ stacking/uplink-ports, 124 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), TAA-compliant. |
| ICX7150-24-4X10GR-A | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, Layer 3 features (OSPF, VRRP, PIM, PBR), TAA-compliant. |
| ICX7150-24P-4X10GR-A | Ruckus ICX 7150 Switch, 24×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 370 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), TAA-compliant. |
| ICX7150-48-4X10GR-A | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, Layer 3 features (OSPF, VRRP, PIM, PBR), TAA-compliant. |
| ICX7150-48P-4X10GR-A | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 370 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), TAA-compliant. |
| ICX7150-48PF-4X10GR-A | Ruckus ICX 7150 Switch, 48×10/100/1000 Mbps PoE+ ports, 2×1 GbE RJ45 uplink-ports, 4×10 GbE SFP+ stacking/uplink-ports, 740 W PoE budget, Layer 3 features (OSPF, VRRP, PIM, PBR), TAA-compliant. |
| ICX7150-48ZP-E8X10GR2-A | Ruckus ICX 7150 Z-Series switch, 16×100/1000 Mbps/2.5 Gbps PoH ports, 32x10/100/1000 PoE+ ports, 8×10 GbE SFP+ stacking/uplink-ports (max 4 for stacking), 2x920 W AC power supply, 2 fans, 1480 W PoE budget, L3 features (OSPF, VRRP, PIM, PBR). TAA compliant. |

| PART NUMBER | UPGRADE LICENSES<br>All Ruckus ICX 7150 switch models with 1 GbE SFP uplink ports can be upgraded to 10 GbE SFP+ ports with a license. |
|---|---|
| BR-ICX-7150C-21U210R-P-01 | License to upgrade the Ruckus ICX 7150 compact switch from 2×1 GbE SFP to 2×10 GbE SFP+ stacking/uplink-ports. Also includes Layer 3 features (OSPF, VRRP, PIM, PBR). |
| BR-ICX-7150-41U210-P-01 | License to upgrade any Ruckus ICX 7150 24/48 ports except the Z-Series from 4×1 GbE SFP to 2×1 GbE SFP and 2×10 GbE SFP+ stacking/uplink-ports. |
| BR-ICX-7150-41U410R-P-01 | License to upgrade any Ruckus ICX 7150 24/48 ports except the Z-Series from 4×1 GbE SFP to 4×10 GbE SFP+ stacking/uplink-ports. Also includes Layer 3 features (OSPF, VRRP, PIM, PBR). |
| BR-ICX-7150-210U410R-P-01 | License to upgrade any Ruckus ICX 7150 24/48 ports except the Z-Series from 2×1 GbE SFP and 2×10 GbE SFP+ to 4×10 GbE SFP+ stacking/uplink-ports. Also includes Layer 3 features (OSPF, VRRP, PIM, PBR). |
| BR-ICX-7150Z210U810R-P-01 | License to upgrade ICX 7150 Z-Series model from 6x1 GbE SFP and 2x10 GbE SFP+ to 8x10 GbE SFP+ stacking/uplink-ports (max 4 for stacking). Also includes L3 features (OSPF, VRRP, PIM, PBR). |

| PART NUMBER | FRUS AND ACCESSORIES |
|---|---|
| RPS20-E | Ruckus ICX 7150-48ZP 920 W AC hot-swap PoE power supply, front to back airflow (up to 2 per switch). Only applicable to the Z-Series |
| ICX-FAN11 | Ruckus ICX 7150-48ZP hot-swap fan tray (up to 2 per switch). Only applicable to the Z-Series. |
| ICX6400-C12-MGNT | Magnet Mount Kit for Ruckus ICX 7150/6450/6430 12 Port Compact Switch |
| CC-RJ45-DB9 | Console cable RJ45-RJ45 With RJ-45-DB9 Adapter (for RJ-45 console port on ICX 7150) |
| CC-USBC-USBA | USB 2.0 Cable, Type-C to Type-A, 1 meter (for USB Type-C console port on ICX 7150) |
| ICX7000-C12-RMK | ICX7150-C12P Compact Switch Rack Mount Kit |
| ICX7000-C12-WMK | ICX7150-C12P Compact Switch Wall Mount & Under Desk Mount Kit |
| XBR-R000295 | Universal Rack Mount Kit, 4 post FRU |
| ICX7000-RMK | Rack Mount Kit, 2-post FRU for ICX 7000 series 24/48 port models |
| RMK-LRM-ADP | Rack Mount Kit for LRM adapters. This 1RU shelf can accommodate up to 8 LRM adapters. |

## RUCKUS ICX 7150 SWITCH ORDERING INFORMATION

| PART NUMBER | OPTICS |
|---|---|
| E1MG-TX | 1000BASE-TX SFP copper, RJ-45 connector |
| E1MG-SX-OM | 1000BASE-SX SFP optic, MMF, LC connector, optical monitoring-capable |
| E1MG-LX-OM | 1000BASE-LX SFP optic, SMF, LC connector, optical monitoring-capable |
| E1MG-LX-A | 1000BASE-LX SFP optic, SMF, LC connector, optical monitoring-capable, TAA-compliant |
| E1MG-LHA-OM-T | 1000BASE-LHA SFP optic, SMF, LC connector, optical monitoring-capable |
| E1MG-BXU | 1000BASE-BXU SFP optic SMF, transmits at 1,310 nm and receives at 1,490 nm, LC connector, single-strand SMF fiber |
| E1MG-BXD | 1000BASE-BXD SFP optic SMF, transmits at 1,490 nm and receives at 1,310 nm, LC connector, single-strand SMF fiber |
| 10G-SFPP-USR | 10GE USR SFP+ optic (LC), target range 100 m over MMF, 1-pack |
| 10G-SFPP-USR-SA | 10GE USR SFP+ optic (LC), target range 100 m over MMF, 1-pack, standard temperature, TAA-compliant |
| 10G-SFPP-SR | 10GBASE-SR, SFP+ optic (LC), target range 300 m over MMF |
| 10G-SFPP-SR-SA | 10GBASE-SR, SFP+ optic (LC), target range 300 m over MMF, standard temperature, TAA-compliant |
| 10G-SFPP-SR-S | 10GBASE-SR, SFP+ optic (LC), target range 300 m over MMF, standard temperature |
| 10G-SFPP-LR | 10GBASE-LR, SFP+ optic (LC), for up to 10 km over SMF |
| 10G-SFPP-LR-SA | 10GBASE-LR, SFP+ optic (LC), for up to 10 km over SMF, standard temperature, TAA-compliant |
| 10G-SFPP-LR-S | 10GBASE-LR, SFP+ optic (LC), for up to 10 km over SMF, standard temperature |
| 10G-SFPP-ER | 10GBASE-ER SFP+ optic (LC), for up to 40 km over SMF |
| 10G-SFPP-ZR | 10GBASE-ZR SFP+ optic (LC), for up to 80 km over SMF |

| PART NUMBER | OPTICS WITH EXTERNAL LRM SFP+ ADAPTER |
|---|---|
| 10G-SFPP-LRM-1-ADP | 10GBASE-LRM SFP+ optic (LC), for up to 220 m over MMF, 1-pack. Includes one LRM adapter device |
| 10G-SFPP-LRM-2-ADP | 10GBASE-LRM SFP+ optic (LC), for up to 220 m over MMF, 2-pack. Includes one LRM adapter device |

| PART NUMBER | DIRECT-ATTACHED CABLES |
|---|---|
| 1G-SFP-C-0x01 | Direct-attached SFP copper cable, 1 m, 1-pack, passive |
| 10G-SFPP-TWX-0101 | Direct-attached SFP+ copper cable, 1 m, 1-pack, active |
| 10G-SFPP-TWX-0301 | Direct-attached SFP+ copper cable, 3 m, 1-pack, active |
| 10G-SFPP-TWX-0501 | Direct-attached SFP+ copper cable, 5 m, 1-pack, active |
| 10G-SFPP-TWX-P-0101 | Passive Direct-attached SFP+ copper cable, 1 m, 1-pack, active |
| 10G-SFPP-TWX-P-0301 | Passive Direct-attached SFP+ copper cable, 3 m, 1-pack, active |
| 10G-SFPP-TWX-P-0501 | Passive Direct-attached SFP+ copper cable, 5 m, 1-pack, active |

## ORDERING NOTES

All Ruckus ICX 7150 switches come with an accessory kit that includes a rubber foot kit, power cord clip, rack mount kit (for 24/48 ports model), RJ-45 console cable and US AC power cord. Stacking cables, USB console cables, compact switch rack mount kit, and optics need to be ordered separately.

All Ruckus ICX 7150 switch models with 1 GbE SFP uplink ports can be upgraded to 10 GbE SFP+ ports with a license.

Standard Ruckus ICX 7150 1 RU Switch models can be ordered configured with either 4×1 GbE SFP, 2×1 GbE SFP, and 2×10 GbE SFP+, or 4×10 GbE SFP+ uplinks.

The Ruckus ICX 7150 compact switch can be ordered configured with either 2×1 GbE SFP or 2×10 GbE SFP+ uplinks.

The Ruckus ICX Z-Series switch can be ordered configured with 2×10 GbE SFP+ uplinks and 6×1 GbE SFP, or 8×10 GbE SFP+ uplinks.

Upgrade licenses are available to upgrade standard Ruckus ICX 7150 1 RU switches to either 2×1 GbE SFP and 2×10 GbE SFP+ or to 4×10 GbE SFP+, the Ruckus ICX 7150 compact switch to 2×10 GbE SFP+, and the Ruckus Z-Series switch to 8×10 GbE SFP+.

Ruckus ICX 7150 Switches with 4×10 GbE SFP+ and 8×10 GbE SFP+ (2×10 GbE SFP+ for the compact switch) include a license to enable Layer 3 features (OSPF, VRRP, PIM, PBR).

Special SKUs have been created to enable customers to order specific Ruckus ICX 7150 models with three-year remote support included. Please note that additional years of remote support can always be ordered separately to cover any Ruckus ICX 7150 model. Contact Ruckus or channel partner representative for details about Ruckus support options and support part numbers.

For your convenience, a fully loaded ICX 7150-48ZP model with dual power supplies and 8x 10 GbE ports bundle has been created. It comes with factory installed power supplies, fans and 8x 10 GbE port licenses.

## WARRANTY

Ruckus ICX 7150 Switches are covered by the Brocade Assurance Limited Lifetime Warranty. For details, visit www.brocade.com/warranty.

## BEST-IN-CLASS SUPPORT

Ruckus ICX 7150 switches are supported by next-business-day advance replacement where available, as well as software defect repairs and maintenance updates. 90 days remote support is included with the product purchase. Many on-site and remote support options are available and can be purchased bundled with the product or separately.

## LEGAL DISCLAIMER

Product features, functionality and specifications may change or be discontinued without notice. Nothing in this document shall be deemed to create a warranty of any kind, either express or implied, statutory or otherwise, including but not limited to, any implied warranties of merchantability, fitness for a particular purpose, non-infringement of third-party rights or availability with respect to any products and services.

Refer to www.ruckuswireless.com for the latest version of this document.

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Notice: This document is for informational purposes only and does not set forth any warranty, expressed or implied, concerning any equipment, equipment feature, or service offered or to be offered by Brocade. Brocade reserves the right to make changes to this document at any time, without notice, and assumes no responsibility for its use. This informational document describes features that may not be currently available. Contact a Ruckus sales office for information on feature and product availability. Export of technical data contained in this document may require an export license from the United States government.



Ruckus Wireless, Inc. | 350 West Java Drive | Sunnyvale, CA 94089 USA | T: (650) 265-4200 | F: (408) 738-2065
ruckuswireless.com

Ruckus Simply Better Wireless | BROCADE

Omada Technologies, LLC
36 Maplewood Avenue
Portsmouth, NH 03801
P: 603-610-8282
F: 603-610-8116

**Customer**

Account Name: Ellis School - Fremont School District- SAU#83
Contact: Carla Smith
Phone: (603) 895-2511 ext. 202
E-Mail: carla_smith@sau83.org

Date: 3/6/2020
Expiration: 4/5/2020
Quote No.: OMD-ESF-030620
Terms: Net 30
FOB: Origin

**Address Information**

Bill To Name: Ellis School - Fremont School District- SAU#83
Address: 432 Main Street
Fremont, NH 03044-3416

Ship to Name: Ellis School - Fremont School District- SAU#83
Address: 432 Main Street
Fremont, NH 03044-3416

**Omada Contact**

Name: Matthew Keane
Phone: 603-682-2290
E-Mail: mkeane@omadatechnologies.com

**Quote Detail**

| Line# | QTY | Part # | Description | List Price | Unit Price | Extended |
|---|---|---|---|---|---|---|
| | | | **Aruba/HPE Hardware** | | | |
| 1 | 39 | Q9H63ACM | Aruba CM AP-515 (US) Unified AP | $ 1,150.00 | $ 425.50 | $ 16,594.50 |
| 2 | 4 | JZ370A | AP-MNT-MP10-A AP mount bracket 10-pack A | $ 205.00 | $ 75.85 | $ 303.40 |
| | | | **Aruba/HPE (3YR) Subscription** | | | |
| 3 | 39 | JZ017AAE | Aruba Central Device Management/Cloud Services 2 Tokens 5yr Subscription E-rate Bundle E-STU | $ 275.00 | $ 123.75 | $ 4,826.25 |
| | | | **Aruba/HPE (1YR) Support** | | | |
| 4 | 39 | HC4J8E | Aruba 1Y FC NBD Exch AP-515 SVC [for Q9H63A] | $ 48.00 | $ 43.20 | $ 1,684.80 |
| 5 | 1 | H1YC9E | HPE 1Y FC NBD Exch Aruba 2930F 24G P SVC [for JL261A] | $ 165.00 | $ 148.50 | $ 148.50 |
| | | | **Omada Professional Services** | | | |
| 6 | 2 | OMADA-SVC | 2 Days of Omada Professional Services | | $ 2,000.00 | $ 4,000.00 |
| | | | **TNT Professional Services** | | | |
| 7 | 1 | TNT-SVC | Cabling Services Detailed in March 4, 2020 SOW | | $ 11,400.00 | $ 11,400.00 |
| | | | **Optional** | | | |
| | | | **Aruba/HPE Hardware** | | | |
| 8 | 1 | JL261A | Aruba 2930F 24G PoE+ 4SFP Switch | $ 2,855.00 | $ 1,284.75 | $ 1,284.75 |
| 9 | 1 | JL261A ABA | INCLUDED: Power Cord - U.S. localization | | | |
| 10 | 1 | J4858D | Aruba 1G SFP LC SX 500m MMF Transceiver | $ 340.00 | $ 153.00 | $ 153.00 |
| | | | | | **Subtotal:** | **$ 1,437.75** |
| | | | **Omada Technologies, LLC - SPIN: 143050357** | | | |
| | | | **Form 470 Application Number: 200015411** | | | |
| | | | | | **TOTAL:** | **$ 38,957.45** |
| | | | | | **TOTAL w/ Switch:** | **$ 40,395.20** |

**Expected Lead Time** _____

Estimated Shipping: $ -
Estimated Tax: $ -

**GRAND TOTAL:** $ -

**Signature - Required if Purchase Order will not be issued.**

**Printed Name** _____
**Signature** _____
**Title** _____
**Date** _____
**Purchase Order #** _____

# REQUEST FOR PROPOSAL

## Wireless Upgrade Bid

## Fremont School District

## Response by Omada Technologies LLC.

## SPIN: 143050357

3-6-2020

### Executive Summary:

Omada Technologies LLC (Omada) is responding to Fremont School District's proposal to provide a bid for WIFI services for on campus faculty, staff, students, and guests. This is a joint response between Omada (VAR) and Aruba Networks (Manufacturer).

Omada Technologies is a Portsmouth, NH based reseller of enterprise IT solutions in the areas of modern network and datacenter infrastructure and information security. Founded in 2017, Omada is an agile company made up of highly qualified team members who all have over 10 years of industry experience. We take great pride in the long-lasting client relationships we've formed, and during a project we foster a collaborative atmosphere that's built on clear and continuous communication. At the start of any new undertaking, we make sure that all our extended team members (vendors, etc.) understand the client's business, technology environment, and long- and short-term goals.

Aruba, a Hewlett Packard enterprise company, is redefining the intelligent edge with reliable mobility and IoT solutions for organizations of all sizes. The company delivers solutions that empower organizations to serve mobile savvy users who rely on internal and cloud-based apps for every aspect of their work and personal lives. With services offered as software from the public or private cloud, Aruba also delivers secure connectivity for mobile and IoT. An open architecture allows IT professionals to

build networks that keep up with changing technology and user behavior by migrating away from expensive-to-operate and proprietary infrastructures which were originally designed for fixed network connections within physical locations.

## Proposed Solution

We are proposing an Aruba wireless solution that we believe addresses all your requirements and even exceeds your requirements in several areas. Aruba offers several deployment models based on their Instant AP platform that gives customers the option to deploy a complete on-premise solution or a Cloud Solution based on Aruba's Central Cloud platform. Based on our understanding of your needs, our recommendation is to deploy an on-premise controller-based solution managed by Aruba's Airwave network management tool. As an alternative, we have included an option for Aruba's Central Cloud management solution as well.

**Compatibility with existing network equipment:** All proposed solutions are fully compatible with existing network equipment on the PEA network without any third-party modifications or additional licensing from the manufacturer. Aruba prides itself on offering several platform independent tools and interoperating with all major network vendors.

**References:**

Aruba solutions are present in over 50 local school districts, private schools, and Higher Education Institutions in the area. We are happy to share additional local references beyond what is provided upon request.

**Insurance:** Omada Technologies has the necessary coverage and is happy to share this information if chosen and required.

**Installation:** Omada & Aruba will work with Carla and the School to schedule the installation and all physical installation and configuration needed is completed on schedule.

## VENDOR BACKGROUND

**Omada Technologies LLC**

36 Maplewood Ave, Portsmouth, NH 03801

603.610.8282

**SPIN NUMBER: 143050357**

**Primary Contact:**
Matthew Keane (Founder, Principal)
603.682.2290
mkeane@omadatechnologies.com

REFRENCE #1:

NAME OF REFERENCE: SAU31 (Newmarket School District)

CONTACT: Jason Carey

PHONE NUMBER: 603-659-3271

EMAIL ADDRESS: careyj@newmarket.k12.nh.us

REFRENCE #2:

NAME OF REFERENCE: SAU28 (Pelham School District)

CONTACT: Chris Curtin

PHONE NUMBER: 603-635-1145 x5016

EMAIL ADDRESS: ccurtin@pelhamsd.org

REFRENCE #3:

NAME OF REFERENCE: Brewster Academy

CONTACT: Eric Burns-White

PHONE NUMBER: 603-569-1600

EMAIL ADDRESS: eric_burns-white@brewsteracademy.org

REFRENCE #4:

NAME OF REFERENCE: Oyster River School District

CONTACT: Joshua Olstad

PHONE NUMBER: 603-868-5100

EMAIL ADDRESS: jolstad@orcsd.org

**BID SUBMISSION FORM**

COMPANY NAME Omada Technologies LLC

COMPANY ADDRESS 36 Maplewood Ave
Portsmouth, NH 03801

PHONE NUMBER 603-610-8282

CELL NUMBER 603-682-2290

FEDERAL ID # 82-1609324

E-RATE SPIN NUMBER SPIN Number: **143050357**

BID AMOUNT **$38,957.45 ($40,395.20 w/ Switch)**

RESPONSIBLE PERSON'S NAME AND AUTHORIZED SIGNATURE*

NAME Matthew Keane (Principal)

SIGNATURE

DATE: March 5, 2020

CONTACT TELEPHONE: 603-610-8282

CONTACT EMAIL: mkeane@omadatechnologies.com

*Signature certifies that the proposed solution and services meet all requirements outlined in the bid and that the vendor will comply with all specified requirements.

*March 4, 2020*

***Carla Smith***
***Ellis School – Fremont School District – SAU#83***
***432 Main Street***
***Fremont, NH 03044***

*Attention: Carla*

***Re: Fremont School (Ellis)***

***Telephone & Network Technologies is proposing the following cabling solution for the above referenced project based on the following:***

## *Cabling:*

- *Provide and install (30) cat 6 riser rated cables to replace (30) cat 5 existing cables for wifi AP's. There are some existing locations with cat 6 cable in place at the moment, that we will utilize. Exact count is unknown at the moment. These cables are terminated onto existing cat 5e panels and will need to move to a cat 6 panel (if possible.) We will try to accommodate for this. 7600+625+150+500+*
- *Provide labor to install (38) new AP's.*
- *Some locations include moving AP's, but will still require a new cat 6 cable.*
- *Scope to include:*
  - ***(19 cables) MDF:***
    - ✓ *(19) cat 6 riser rated cables*
    - ✓ *(1) Hubbell 48 port cat 6 patch panel*
    - ✓ *(2) PoE injectors*
  - ***(16 cables) IDF:***
    - ✓ *(16) cat 6 riser rated cables*
    - ✓ *(1) Hubbell 48 port cat 6 patch panel*
    - ✓ *(1) 2U wall mount bracket*
  - ***(1 cable) West side portable:***
    - ✓ *(1) cat 6 riser rated cable*
    - ✓ *(1) Hubbell 1 port SM box with cat 6 jack*
  - ***(2 cables) East side portable:***
    - ✓ *(2) cat 6 riser rated cables*
    - ✓ *(1) Hubbell 2 port SM box with cat 6 jack*
  - ***(2 cables) Gym:***
    - ✓ *(2) cat 6 riser rated cables*
    - ✓ *(2) AP protective cages*
  - ***All field end locations:***
    - ✓ *(1) cat 6 Rj-45 mod end*

- *Price includes hanging physical AP's. AP's are to be supplied by others, on site and ready to install at time of project start date.*
- *Price is for normal business hours only. 7 AM to 3:30 PM.*
- *Provide and install J-hook pathways where needed.*
- *All cables passing through firewalls will be fire stopped and will meet all local and national codes.*
- *Install EMT conduit sleeves and bushings where needed.*
- *Provide testing on all new cabling.*
- *Test results will be submitted upon completion of work in PDF format.*

## *Total investment: $11,400*

## *Exclusions:*

- *Cost for wiring permit not included. (if required)*
- *No demo of existing cables is included in quote.*
- *No price for scissor lift included. We are to assume the school has a lift we can use for the gym locations.*

## *General Information*

- *Work to be completed during normal business hours. 7:00am – 3:30pm*
- *TNT will require access to the facility during these hours.*
- *All cable ends will be marked with a mechanical label maker.*
- *All permits are to be obtained by others before the start of the project.*
- *All cabling will comply with BICSI standards.*
- *Additional work not included in this proposal can be requested at any time with our onsite project manager.*
- *TNT will not perform any additional work requests or change orders without written confirmation and authorized signature from electrical contractor personnel.*
- *TNT does not supply any hardware or electronic devices.*
- *TNT requires a signed purchase order referring to this proposal before the start date.*
- *All prices are valid for a period of 30 days after date of proposal.*
- *Any tax or other government charge upon the sale, shipment or use of the products that are included with proposal which TNT is required to pay or collect, shall be paid by Buyer.*

## *Certification and Warranty*

- *Telephone Network Technologies employees are BICSI certified technicians.*
- *Telephone Network Technologies provides a standard 1-year warranty on all parts and labor.*
- **A 25-year warranty comes standard with the manufacturer.* ****(on qualifying jobs)***

- *Telephone Network Technologies follows the guidelines of the BICSI Telecommunications Distribution Methods Manual for all of our installations.*
- *This installation shall comply with all current EIA/TIA 568B and 569 BICSI cabling specifications unless otherwise requested by the customer.*
- *All cabling will comply with BICSI standards.*

*Thank you for giving us this opportunity to be of service to you and we look forward to working with you on this project in the near future.*

*Sincerely,*

***Matt Keane***
***Omada Technologies, LLC***
***(603) 682-2290 Cell***
***mkeane@omadatechnologies.com***

***Doyle Barnes***
***Project Manager***
***Telephone Network Technologies***
***(603) 957-0477 Cell***
***Doyle@telnettec.com***

# Wireless Network Planning Report

## For Fremont School District


**March 5, 2020**

Omada Technologies, LLC

## *Requirements - Coverage and Performance*

Requirement criteria for **Voice + Data**

| | | | |
|---|---|---|---|
| ? | Signal Strength Min | -67.0 dBm | |
| ? | Secondary Signal Strength Min | -75.0 dBm | |
| ? | Signal-to-noise Ratio Min | 20.0 dB | |
| ? | Data rate Min | 20 Mbps | |
| ? | Channel Interference Max | 2 | at min. -85.0 dBm |
| ? | Round Trip Time (RTT) Max | 200 ms | |
| ? | Packet Loss Max | 2.0 % | |

# Total AP Count for Ellis School: 39

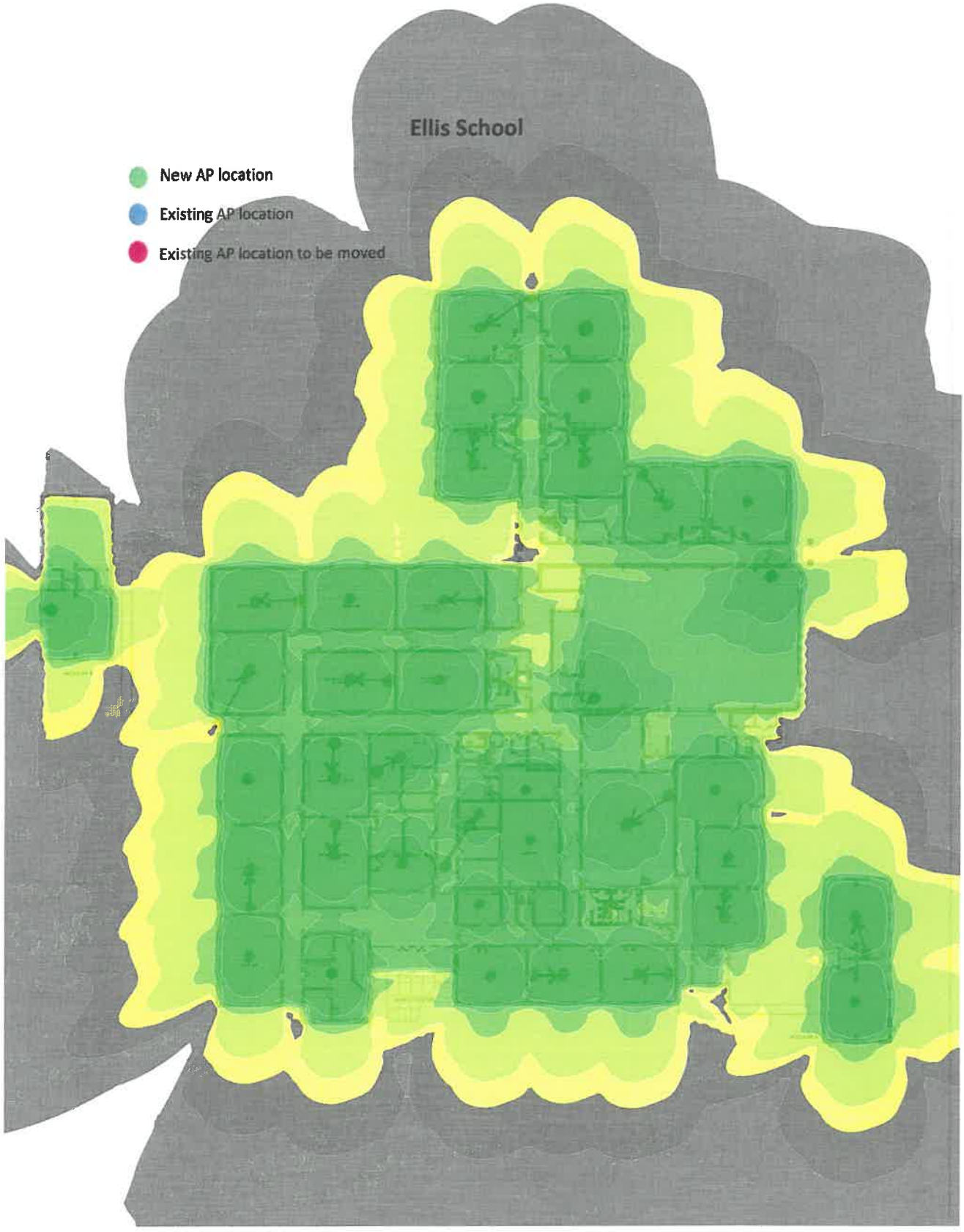
## Ellis_School_Floorplan

### AP Count for Ellis_School_Floorplan: 39

## Access Point Locations

Wireless Network Planning Report

## Heat Map / Signal Strength



**FREMONT SCHOOL DISTRICT**

**WIRELESS UPGRADE BID**

**Company Name:** RTM COMMUNICATIONS INC

**Company Address:** 360 ROUTE 101 #9 PINE TREE, BEDFORD NH 03110

**Phone Number:** 603-420-1203

**Cell Number:** 603- 494-6563

**Federal ID #:** 02-0505931

**Bid Amount:** $ 25,539.00

Susan E. Bean

**Authorized Signature**

3/6/2020.

**Date**

Secure Your IT Assets
www.solutionsbyrtm.com

**Quote #:** RTMQ17266
**Date:** 03/05/20
**Sales Rep:** Susan Bancroft

**Quote To:**
SAU #83 - Fremont
Carla Smith
432 Main St.
Fremont, NH 03044-9999

**Ship To:**
SAU #83 - Fremont
Carla Smith
432 Main St.
Fremont, NH 03044-9999

**Terms:**
Ship Via: Best Way
Terms : Net 20 Days
FOB: Bedford

**Quote Name:** Wireless and Cabling **Agreement Start Date:**

| Qty. | Vendor | Description | Price Each | Extended |
|---|---|---|---|---|
| | | **SPIN 38013795** | | |
| 39 | Extreme Networks | Wi Fi 6 Access Points with Extreme IQ | $137.00 | $5,343.00 |
| 39 | Extreme Networks | 3 Year License includes Hive Manager/Cloud IQ Management | $243.00 | $9,477.00 |
| 1 | Extreme Networks, Inc | Extreme Networks X440-G2-24p-10GE4 Ethernet Switch - 24 Ports - Manageable - 3 Layer Supported - Modular - Twisted Pair, Optical Fiber - 1U High - Rack-mountable - Lifetime Limited Warranty | $1,335.00 | $1,335.00 |
| 1 | Extreme Networks, Inc | Extreme Networks Standard Power Cord - 110 V AC / 10 A | $15.00 | $15.00 |
| 1 | Extreme Networks, Inc | Extreme Networks Standard Power Cord - 13 A | $20.00 | $20.00 |
| 1 | RTM | Cabling<br>Scope of Work<br>1. Install, terminate and test (16) new CAT6 runs for new AP locations, hang customer<br>supplied AP's.<br>2. New cables to be terminated onto the existing patch panels.<br>3. Replace AP's at (5) existing locations, customer to supply AP's.<br>4. Move existing cable and replace existing AP's at (18) existing locations, customer to<br>supply AP's.<br>5. Total of (39) AP locations.<br><br>Assumptions<br>All work can take place during normal business hours Monday through Friday between<br>the hours of 7AM and 5PM.<br>Testing<br>?4-pair CAT 6 Cables: RTM intends to test all CAT 6 station cables with a Fluke Networks<br>DSX Series Cable Analyzer selecting the Category 6 test based on the EIA/TIA Standard.<br>Warranty<br>RTM. warrants the installation for the period of three (3) years against<br>any cable-related failure due to improper installation or termination. Any failure during this<br>period is repaired at no charge.<br>Excluded under warranty is repair for damage to the cable from accident, negligence, misuse,<br>unauthorized repairs, failure of electrical power, sprinkler or humidity control or vandalism, fire,<br>storm, water damage or other casualties not relating to the installation and beyond the control of<br>RTM | $6,949.00 | $6,949.00 |



RTM - #9 Pine Tree Place, 360 Route 101, Bedford, NH 03110
Local: (603) 420-1200 - Toll Free: (866) 786-9990 - Fax: (603) 420-1240
www.solutionsbyrtm.com

| Qty. | Vendor | Description | Price Each | Extended |
|---|---|---|---|---|
| 1 | RTM | Estimated Project NPEDU:Configure, Install and Knowledge Transfer | $2,400.00 | $2,400.00 |
| | | | **Quote Total** | **$25,539.00** |

**Quote Notes:** Thank you for your quote request.

All quotes from RTM Communications, Inc. are valid for 30 days following the date of transmission. Pricing assumes purchase of all line items. All delivery, training, consulting and services are to be billed at the published rates for each activity involved. Shipping costs and taxes will be applied at time of invoice. Delivery of products and services are dependent upon availability at the time of order. A minimum 15% restocking fee may be assessed on returns with original unopened packaging. The information and pricing in this document is confidential and proprietary and shall not be disclosed or duplicated in whole or part..



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Local: (603) 420-1200 - Toll Free: (866) 786-9990 - Fax: (603) 420-1240
www.solutionsbyrtm.com

Secure Your IT Assets

**Response to E-Rate RFP for Ellis-Fremont School District Form 470 200015411 RTM SPIN is 143034241 and we have a current SPAC.**

RTM was founded in February 1999 with the unique goal to "Remove the Mystery" relative to voice, video and data communications for schools and businesses, celebrating our 21-year anniversary last month. We offer our Helpdesk and remote, as well as on-site, technical support. We are currently working with the several NH School District on several different initiatives including switching, wireless and security. We have a Help Desk and several project-based or support contracts. We offer cabling as well as testing along with other items. We will be happy to discuss an ongoing support that is customized to your needs.

Per our walk through with you on February 11 we are recommending an Extreme Aerohive Cloud network utilizing Wi-Fi 6 Access Points (802.11AX) to take advantage of the latest technology, allowing higher density and faster speeds for your wireless users. For the switch we are recommending a 440 which gives you the option to enable 10 Gig on the backbone without an upgrade, just a Uplink module. The switch comes with a limited lifetime warranty.

Extreme Networks was established in 1996 with a corporate HQ in San Jose, CA. Since then it has been pushing the boundaries of networking technology, driven by a vision of making it simpler and faster as well as more agile and secure. Their higher purpose has been helping their customers connect beyond the network to strengthen your relationships to your students and teachers, and admin. Extreme has its Eastern US HQ in Salem NH, which also houses the technical support team that will back up RTM and allow Ellis-Fremont School to have local NH-Based phone support. They have been named as leaders and visionaries by analysts for their ability to execute and completeness of vision.



**RTM** • #9 Pine Tree Place, 360 Route 101, Bedford, NH 03110
Local: (603) 420-1230 • Toll Free: (866) 786-9990 • Fax: (603) 420-1240 • www.removethemystery.com

Secure Your IT Assets

70%
of schools are moving to digital textbooks.

43%
of schools can still not customize each student's network access.

20%
of kindergartners have Internet-connected phones.

---

Why Extreme Networks for Primary/Secondary Education:

With digital transformation and the massive shift to smart schools, the need for hyper-reliable, easily managed network infrastructure has never been greater in K-12 education. Extreme Networks builds open, software-driven educational networking solutions with the elements necessary for K-12 schools to remain agile, adaptive and secure while improving learning outcomes.
Whether it's online testing, virtual and augmented reality, STEM and robotics, or flipped classroom initiatives, more than 17,000 school and 4,500 campuses worldwide rely on autonomous networks from Extreme.

We have included a list of references from local schools where we have worked with them of projects and installations of similar scope and size. RTM's engineers and cable installers have certifications and experience in a broad range of networking technologies such as wired, and we are an Extreme partner. Extreme has local engineers who are available to us as well.
RTM has the ability to procure, install, train, maintain, service and support the prosed equipment in the bid.

We have included proof of insurance as required.

Your agreement license through Extreme allows you to call directly through their support TAC to the Salem NH office where they have live answer and assist you to diagnose and solve your issue very quickly meeting your 2-hour response.



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Optionally we can have a PSA agreement through RTM to give you on site from our Bedford NH office If you have a support agreement with RTM, we have a help desk that can be accessed either through a portal we give you access to or via email, or by phone (most of our phone calls are answered by live people who will create a ticket and triage your request.) Once a ticket is created it is assigned to an engineer who will work with you to either resolve your request remotely or come on site if needed. We work with third parties as needed (your WAN provider for example if there is an external connectivity issue.) We will respond and we have SLA's as needed. Typically, our support agreements start at $5000 for approx. 30 hours with a 10% discount for schools off our standard rates. These are optional and not currently included in this bid.

RTM will work with Freemont School District to create a timeline for installation and training once we receive approval to move forward, there will be a kick-off meeting scheduled to create a schedule that is mutually agreeable to everyone. We are assuming a summer project once the approvals from USAC are received. Susan Bancroft will be your designated Project Manager and will co-ordinate delivery and install. The only caveat is given the ongoing Coronavirus which may impact deliveries so we will work with you ahead of that to create a timeline that works with that.

This bid is for new equipment as required.



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Our References include:

SAU# 40 Milford School District Milford NH – we have supported them for over 6 years with complete networking technologies including switch, wireless, voice etc. Jerry Stajduhar Director of Computing Technology (603) 249-0708 jstajduhar@milfordk12.org.

SAU#53 Pembroke School District Pembroke NH – we have supported them for over 13 years with various networking technologies including routing, firewalls and cabling. Josh Berube Director of IT 603-485-5187 jberube@sau53.org

SAU #95 Windham School District- we have supported them for over 3 years with a complete voice, wireless, switching refresh as well as services. Sean Harnett Network Manager 603-425-1574 shartnett@windhamsd.org

We have worked with Crotched Mountain Foundation on firewalls, switching servers and voice as well as wireless. Other customers include Merrimack, Nashua and many other NH School Districts on previous E-rate opportunities as well as supporting them year-round, we have been registered with USAC since 2010.

RTM is happy to offer a complete spectrum of services and products to support the K-12 market including security assessments for HB1612.

As your account manager I have been at RTM for 15 years and many of our employees are similarly long-term.

Susan Bancroft 603-420-1203 sbancroft@removethemystery.com

RTM Communications Inc 360 Route 101, 9 Pine Tree Place Bedford NH 03110

https://www.solutionsbyrtm.com



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Extreme™
Customer-Driven Networking

White Paper

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# Considering Wi-Fi 6

## Making the Case for 802.11ax

While there are many innovative technologies and solutions being introduced at the network edge, few garners as much interest as the next-generation of Wi-Fi. With over 9 billion devices globally, and 3 billion more being added each year, Wi-Fi is engrained in every area of our lives: home, work, and leisure. Many now view Wi-Fi as a utility – right up there with electricity and water. The thought of having a school, hospital, or stadium without Wi-Fi nowadays is on par with them having no teachers, beds or athletes.

### Wi-Fi: Where the Human Experience and 24/7 Connectivity Converge

Today, people tend to value memorable experiences over material goods. This is due in part to the rise of the experience economy: the paradigm of selling goods or services by emphasizing their positive impact on people's lives.[1] When attending a sporting event, staying at a hotel, shopping in a store, or studying through college, consumers have high expectations when it comes to the experience of their personal journey. Every little detail counts, from look and feel to the features and benefits – Wi-Fi included.

The demand for 24/7 connectivity is only getting greater as digital transformation pervades every industry. The internet has shifted from a useful tool to a necessary, integrated component of work and life. In the office, mobile devices, tablets, laptops, and more have been adopted by the masses and employees expect to be able to work anytime, anywhere. At home, if we want to order a pizza or can't find time to go grocery shopping, the solution is a few finger swipes away.

[1] Localist. (2016, November 14). What is the Experience Economy? Retrieved June 11, 2019, from https://www.localist.com/blog/experience-economy/

### Bringing Humanity into Wi-Fi Across Industries

Technological ingenuity has brought us a myriad of futuristic capabilities, such as artificial intelligence, machine learning, robotics, big data, IoT, and more, which once seemed dream-like. Today, technology isn't just a component of business—it is the business. Reliance on technology is evident everywhere we go, whether to increase availability of information, convenience, or speed. People, applications, and experiences all depend on their ability to connect. Though our always-on digital culture is dominated by technology and connectivity, the goal is to change and deliver new human experiences across industries.

### As Digital Transformation Abounds, Wi-Fi 6 is Within Reach

It's clear that Wi-Fi today plays a critical role in our lives. Though the challenges vary slightly among industries, the outcome is the same: **Wi-Fi has reached a pinnacle of critical importance**—and the next iteration of Wi-Fi technology is here. The time to get ahead of wireless to accelerate digital transformation is now.

Wi-Fi 6, or 802.11ax, is High-Efficiency Wireless, the latest generation of Wi-Fi. Where previous generations of Wi-Fi focused on a single device throughput, High-Efficiency Wireless is designed to get more out of the entire system, rather than a single client. The timing couldn't be better, because most of the problems network OEMs and enterprises are running into with Wi-Fi deployments are efficiency-related; a drawback to relying on Wi-Fi 5, or 802.11ac.

> *"What we would like to see for efficiency purposes is multiple transmissions at a time on a channel, whether it be uplinkor downlink. Wi-Fi 6 is clearly a step in the right direction. High efficiency is what's needed at this point."*
>
> **– Perry Correll, Director of Product Marketing, Extreme Networks**

## What You Need to Know About Wi-Fi 6

The hype cycle begins with the initiation of any advancement in technology. Promises of a cure-all for a given tech problem pervade the media, and naturally, people get excited. Wi-Fi 6 is well-positioned to meet the wireless demands of the enterprise, but it's worth noting that most of the technology is already used in other wireless services; it's not new.

### The Current Status of Wi-Fi 6

As enterprises evaluate Wi-Fi 6, it's important to understand which components are useful and which are hype. If implemented properly, 11ax has very real potential to positively impact not just high-density networks, but all networks and organizations. However, technology decision makers shouldn't assume the technology will instantly catapult their business years into the future. It is an incremental technology that will improve protocol efficiency, leading to better handling of high client density and application performance.

> *"11ax is an evolutionary technology, not a revolutionary technology. It gives us another piece of the puzzle with respect to efficiency gains."*
>
> **– Perry Correll, Director of Product Marketing, Extreme Networks**

### The 802.11ax Standard

Ratification of the 802.11ax standard is expected in early 2020. However, the exact timing is still uncertain. It's important to note that most significant changes take place in the early drafts of an amendment. As the standard develops, changes decrease in size and scope, thus major modifications to the 802.11ax standard are unlikely to be introduced. Realistically, any changes moving forward will be minor, likely requiring only software updates.

Enterprises should still exercise caution in purchasing early 802.11ax solutions to ensure investments are protected. Networking products being produced currently are based on what manufacturers believe will reflect the ratified standard. It's best to ensure products state "Wi-Fi 6 or Certified." If you see "compliant" or "compatible," you should be concerned that the products may not be certifiable by the Wi-Fi Alliance. Several infrastructure quick-to-market vendors lack a primary Wi-Fi 6 requirement, OFDMA-uplink capability.

Historically, infrastructure vendors tend to go to market first to surpass their competition. On the other hand, client vendors are slower to implement the technology as Wi-Fi 6 is only one component of the new generation of the product, and not the primary reason for a new generation

of phone or other type of device. Despite the official status of the 802.11ax standard, multiple infrastructure vendors already offer 11ax access points, but there are as yet very few clients.

### Wi-Fi Alliance Certification

The Wi-Fi certification process is of critical importance because it verifies that a new product has been tested using a diverse sampling of devices to confirm interoperability with Wi-Fi certified equipment. Even though ratification of the IEEE 802.11ax standard is targeted for early 2020, the Wi-Fi Alliance will launch Wi-Fi 6 certification prior to final standard ratification as the standard's technical requirements are firmly established at this point.

The most important features of the 802.11ax standard will be selected to measure against all vendor products to ensure connectivity in a standard fashion. After the certification is officially prepared for issuance, vendors will undergo interoperability testing through the Wi-Fi Alliance's Authorized Test Laboratories. When a vendor's product passes testing, they are granted certification and the right to use the Wi-Fi certified logo.

> *"Wi-Fi CERTIFIED™ is an internationally-recognized seal of approval for products indicating that they have met industry-agreed standards for interoperability, security, and a range of application specific protocols."*
>
> **– Wi-Fi Alliance[4]**

To be clear, the IEEE writes the standards; the Wi-Fi Alliance does not. The Wi-Fi Alliance is not a group of people, but a group of vendors who facilitate task groups of industry experts to make decisions and validate interoperability. The Alliance identifies the key components of the IEEE standard that new 11ax vendor products should interoperate with.

## 11ax Versus 11ac

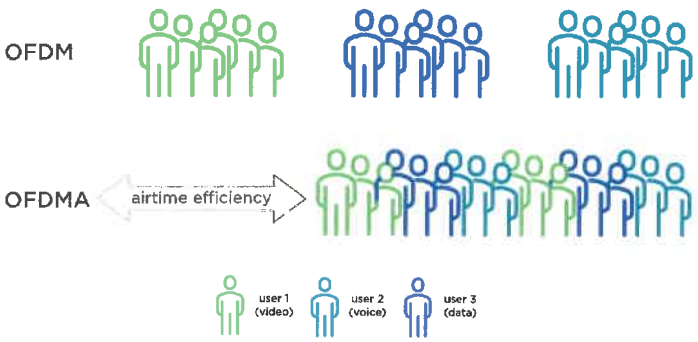
802.11ac is a solid Wi-Fi standard that has done its job well since its inception. The next evolution of Wi-Fi, 802.11ax, is built on this technology, but with several variations, enhancements, and new features. 802.11ac certainly achieved performance improvements, with a theoretical maximum rate of 1.3Gbps.[5]

Fast forward to today, an exponentially increasing demand has called for a new round of efficiency gains. 802.11ax is designed to alleviate congestion, even in highest-density environments, but will also bring numerous other supportive benefits to the enterprise - from optimizing IoT deployments to increasing capacity for videoconferencing.

### OFDMA

The pervasive use of mobile devices and data-hungry applications has created an insatiable appetite for Wi-Fi capacity. This is exacerbated in dense user environments such as lecture halls, auditoriums, and dormitories where many Wi-Fi devices contend for the same airwaves. 802.11ax introduces several new technology building blocks to address these challenging environments. The most important of these is OFDMA, an uplink/downlink resource scheduler, designed to manage airtime utilization and improve spectral efficiency.

Orthogonal Frequency Division Multiple Access (OFDMA) is a methodology to allows an RF channel to be dynamically divided multiple ways. For example, it's possible to carve 20 MHz channel nine different ways, leveraging a new capability called resource units, this allows up to nine clients to communicate simultaneously, either uplink or downlink.




OFDMA, has been used in other wireless technologies since at least 2007, is an extension of Orthogonal Frequency Division Multiplexing (OFDM), which takes an RF channel, such as 20 MHz, and rather than using a single carrier-frequency to support a single client, it subdivides the channel to support multiple users simultaneously.[6]

In theory, utilizing OFDMA allows up to 74 clients to share each channel rather than switching between broadcasting and listening on each. In actual use, the number of

Wi-Fi Alliance. (n.d.). Certification. Retrieved June 11, 2019, from https://www.wi-fi.org/certification
Weinberg, N. & Network World from IDG. (2018, February 27). What is 802.11ax Wi-Fi, and what will it mean for 802.11ac. Retrieved from https://www.networkworld.com/article/3258807/what-is-802-11ax-wi-fi-and-what-will-it-mean-for-802-11ac.html
Network World from IDG, & Thornycroft, P. (2018, October 18). Why is OFDMA a Magical Feature in the 802.11ax Standard? Retrieved June 11, 2019, from https://www.networkworld.com/article/3315056/why-is-ofdma-a-magical-feature-in-the-802-11ax-standard.html

simultaneous communications will be far less, actual totals still TBD. From the standpoint of an end user, the network will seem significantly less congested than with 802.11ac.

The ability to take many small transmissions and send them in parallel using OFDMA is a major driver of efficiency. Further, it can be applied to wider channels, such as 40 or 80 MHz. At present, the industry is mainly focused on the 20 MHz channel and subdividing it to drive system-wide capacity, as well as per plot throughout. As is frequently publicized throughout the media, the long-term goal is 4x faster, but this increase will occur progressively over time.

### Changes in POE Requirements

With the onset of 802.11ax comes the need for higher power levels with respect to access points. Since 802.11ax access points are higher performing, they have more antenna elements, handle more devices and greater traffic loads. As a result, power consumption increases. In addition, Wi-Fi 6 will affect campus edge connectivity.

Most WLAN vendors with 4x4 architectures will recommend 802.3at (POE+), with limited support at 802.3af (POE). Several vendors supporting 8x8 architecture or other services will require 802.3bt, and some even require dual POE power to the AP.

Increased bandwidth demands generated by 11ax access points has the potential to saturate the current wired edge and require port speed upgrades. The best path forward is to perform due diligence when selecting access points and verify power requirements as your selection of APs may require a significant, and costly upgrade of existing edge switches.

### MU-MIMO and Antennas: Comparing 4x4 vs. 8x8 Designs

As the 802.11ax standard nears release, multi-user, multiple input, multiple output (MU-MIMO) is likely to become more popular. MU-MIMO is wireless technology first offered in 802.11ac that is supported by endpoint devices and routers. It's an extension of MIMO, originally designed to increase the number of antennas on wireless routers for receiving and transmitting, as well as improving capacity for wireless connections.[7]

Bandwidth is divided into separate, single streams which share the connection equally. MU-MIMO routers come in 2x2, 3x3, 4x4, and now, 8x8 variations.

Vendors have taken divergent paths in selecting 11ax chipsets, and antenna architecture is one of the significant differences. Some chips support a 4x4 architecture, while others have embraced an 8x8 architecture. There is no real difference in potential network performance or even capacity limits; rather, the only difference will apply to operation in MU-MIMO networks, with 8x8 offering double the number of spatial channels over 4x4. However, full 8x8 MU-MIMO support is not expected on any clients and the full MU-MIMO certification is not scheduled until 11ax Wave 2. In the meantime, 8x8 APs will be more expensive and require significantly greater power at PoE+ or higher and not offer any real performance improvements.

### Increased Capacity and Efficiency

While prior generations of Wi-Fi addressed greater performance, 802.11ax addresses greater capacity. It supports more devices simultaneously and makes better use of available spectrum with increased efficiencies. 802.11ax allows different types of traffic (e.g., high bandwidth video, voice, low bandwidth IoT traffic) to be bundled together for more efficient transport.

To use a simple postal analogy: instead of sending separate parcels for each traffic type – often with empty space in each parcel – all the traffic is packaged into one parcel for more efficiency.

### Optimized IoT Support

802.11ax supports flexible channel sizes and resource units that allow operators to offer more efficient IoT support and better scale to address the thousands of IoT devices that will connect to Wi-Fi networks around the globe. In addition, IoT devices that require lower data rates can use narrow dedicated channels to save power.

802.11ax also includes support for Target Wake Time (TWT) that will be very useful for IoT devices to improve Client Battery Life. The TWT has first proposed under 802.11h. TWT uses negotiated policies based on expected traffic activity between 802.11ax clients and an 802.11ax AP to specify a scheduled wake time for each client. 802.1ax IoT, as well as other clients could potentially 'sleep' for longer periods of time, providing extended battery life.

### Dual 5 GHz Capability

Dual 5Ghz capability in an AP, also called software-configurable radios offers the ability to allow both radios in an AP to operate simultaneously on the 5GHz band. This

Network World from IDG & Shaw K. (2018, January 26). What is MU-MIMO and why you need it in your wireless routers. Retrieved June 13, 2019, from https://www.networkworld.com/article/3250268/what-is-mu-mimo-and-why-you-need-it-in-your-wireless-routers.html

allows the AP to take advantage of the additional spectrum available in 5GHz over the 2.4Ghz band. It also allows Wi-Fi infrastructure to optimize the network by more closely match the 5GHz/2.4GHz client mix which is typically in the 80/20% range.

When applied to use in a Wi-Fi 6 environment, the ability to have two radios operating in the 5 GHz band on a single radio means that 'client steering' can segregate clients based on their technology. As a result, all Wi-Fi 6 clients can be grouped on one radio with the other radio supporting non-WiFi-6 clients, optimizing the operation of both environments. Additionally, if MU-MIMO is used the performance of two radios operating on 5GHz with a 4x4 architecture exceeds the capability of a single 5GHz radio operating in 8x8 due to spatial separation requirements of clients.

While dual 5 GHz is not a component of Wi-Fi 6, it will optimize network performance.

## How 802.11ax Alleviates Wi-Fi Pains

802.11ax certainly brings new features and capabilities to the table, but how does it alleviate the Wi-Fi pains of the enterprise?

Around the world, throughout schools, stadiums, homes, hotels, and airports, people are connecting to the network with multiple devices per person, and in some cases, they're wondering why the wireless is slow. We live in a hyper-connected world, and our reliance on technology, and consequently, Wi-Fi, continues to increase. Here are the primary Wi-Fi challenges that 802.11ax can effectively eliminate.

### Wi-Fi Contention

If a network environment has high contention, many clients will be forced to wait for access. Faster Wi-Fi speeds, enabled by the progression from 11n to 11ac, do not reduce contention on their own. Wi-Fi 6 is built to resolve contention through OFDMA. As mentioned, multiple simultaneous transmissions on a channel, whether uplink or downlink, increase efficiency significantly.

### Application Performance

Improved application performance is another benefit of Wi-Fi 6 as a result of OFDMA. Real-time voice and multimedia services are enhanced significantly.

Subdividing the channel enables applications that use small framesto be transmitted to multiple endpoints at the same time. This reduces overhead and congestion at layer two and effectively improves application performance.

### Improved Network Efficiency – Speed Over Capacity

The assumption that the primary benefit of Wi-Fi 6 is about speed is inaccurate. Rather, Wi-Fi 6 encompasses numerous features designed to increase capacity and lower latency in dense network deployments (Wi-Fi Alliance).[8] The potential for faster speeds is a natural positive result.

## 5G Won't Displace Wi-Fi

Wi-Fi is a staple for enterprise connectivity, or as Claus Hetting of Wi-Fi NOW stated so well, "it is the Swiss Army knife of wireless communication, able to support almost any type of device, deployment, market or use case." [9]

It's the default wireless technology in almost any device, and it's not going to change any time soon.

In many ways, Wi-Fi is like Ethernet technology in the 90s; it just works. In the mid-nineties and through the early part of the century, new wired technologies came along to challenge it with advanced features. Frankly, Token Ring, FDDI, and ATM all had technical advantages they positioned against Ethernet, but those technologies never were able to displace Ethernet.

> *"For more than 20 years, Wi-Fi has been the staple of enterprise connectivity, and it remains so today. Its ubiquity will ensure that even as the wireless ecosystem continues to expand, Wi-Fi will be a core, irreplaceable infrastructure coexisting with the likes of 5G, CBRS, and other next-generation wireless innovations, to connect people, technology and communities."*
>
> **– Perry Correll, Director of Product Marketing, Extreme Networks**

White paper: High-performance next-generation Wi-Fi. Wi-Fi Alliance. 2018. Retrieved June 11, 2019 from https://www.wi-fi.org/downloads-registered-guest/Wi-Fi_6_White_Paper_20181003.pdf/35680

Hetting, C. (2017, November 23). Our take: The future role of Wi-Fi vs. anything '5G' | Wi-Fi NOW Events. Retrieved June 10, 2019, from https://wifinowevents.com/news-and-blog/take-role-wi-fi-vs-anything-5g/

Similarly, 5G and CBRS wireless technologies are not going to fade away like legacy wired technologies. Contrarily, these wireless technologies will play significant roles in operating alongside, or even in cooperation with Wi-Fi.

### Compounding Costs of 5G

Different jobs require different tools, and there are multiple areas where both Wi-Fi and 5G excel. One of the best use cases for Wi-Fi is connecting the ever-growing number of Wi-Fi only devices. In a high-density network environment, equipping every single device with cellular technology wouldn't make sense. If any organization has bandwidth-intensive needs such as streaming video or transferring large files, then Wi-Fi is a faster, more reliable option. Achieving the same thing over 5G would lead to an astronomically high bill. 5G simply isn't cost effective for this kind of use case.

### Enterprise vs. Carrier Ownership

Other benefits of Wi-Fi don't necessarily come from the technology itself, but the ownership of it. An organization that provides Wi-Fi can garner real-time, analytic insights from their own network. This is beneficial from an IT perspective because it helps identify and solve any network issues that arise, but it can also add real business value.

A retailer providing free Wi-Fi to customers can use an analysis of the data generated to engage with shoppers and optimize services. This wouldn't be the case if the retailer was using a mobile carrier, who would own that data, making analysis difficult. The evolution of Wi-Fi allows those deploying networks to enhance their security posture, and new standards like WPA3, a prerequisite for Wi-Fi 6, are bringing new capabilities to keep networks safe.

### Limitations of CBRS and 5G

As far as 5G is concerned, no other technology offers as much mobility and reach as cellular technology. It's available in homes, businesses, cars or simply walking down the street. Cellular technology is almost always there, and with additional advancements offered by 5th generation technology, its value will extend beyond basic connectivity.

Its shortcoming is a significant lack of services beyond the phone, such as with laptops and tablets. Additionally, trying to use 5G as a replacement for enterprise Wi-Fi would result in data traffic transiting the carrier network even if the destination is a local server, which is not an optimal solution.

Then there's CBRS; not a competitor to 5G, as CBRS is expected to become a Radio Area Network (RAN) for 5G services. With respect to Wi-Fi, the implications are similar to those of 5G. CBRS is essentially indoor, small cell operation on a shared license spectrum.

As a result of the above, 5G will continue to dominate the realm of outdoor mobility, with CBRS offering a more reliable cellular service for challenging indoor environments. Wi-Fi has, and will continue to dominate the enterprise and hotspot wireless market due to its simplicity and economical deployment capabilities. Further, with more spectrum expected in the future (6GHz), there is no slowdown in sight. All technologies will co-exist for the foreseeable future.

Wi-Fi, 5G, and CBRS each have individual value propositions and advantages unique to their technology and capabilities that cannot be 100% emulated by alternatives. However, in some cases, another technology can offer a reasonably acceptable level of service, allowing it to support all use cases. All three technologies may be leveraged in the future to design a single wireless infrastructure.

## Wi-Fi 6 Buying Tips

In your Wi-Fi 6 evaluation process, consider the long-term, as well as your current upgrade cycle—most networks last five to seven years. When the time comes for an upgrade, you'll have two choices: 11ac or 11ax.

11ac is a proven technology that's been around for several years and will continue to provide the same level of service for the life of a new network. Conversely, 11ax clients are just cropping up. However, in 12-18 months, large quantities of 11ax devices will be commonplace on the network. At that juncture, supporting and taking advantage of greater network efficiency and performance offered by the infrastructure will be viable.

If you're in a very specific vertical industry with a high number of 11ax clients coming in, you should consider making the upgrade. For example, if you're a primary/secondary school system planning to upgrade to new Chromebooks and your product of choice is 11ax, it's best to evaluate 11ax infrastructure because you'll be able to reap the benefits as soon as you onboard the clients.

If your upgrade cycle isn't nearing its end, it won't be cost effective or immediately beneficial to rip and replace all APs because a new 11ax is being released. Altering your purchasing methodology should have a major purpose behind it, otherwise, you're unlikely to reap the benefits.

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*"Our customers are testing the limits of today's Wi-Fi standards daily at football games, eSports tournaments, emergency rooms, retail shops, college campuses and more. And if there is a failure – if they get it wrong – it won't just be providing a poor experience, they'll lose customers.*

**– Mike Leibovitz, Senior Director of Product Management and Strategy, Extreme Networks**

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Don't forget, regardless of the status of the standard and certification, the technology is set. If your organization is considering moving forward with Wi-Fi 6, vendors with certifiable products are safe to purchase from. Be advised that "certifiable" is the key word to look for. Some vendors have rushed to market with 802.11ax products and selected a chipset produced too early in the design cycle; these products will never meet Wi-Fi 6 certification requirements because of an unalterable hardware issue, not a software issue.

## Wi-Fi Usage and Challenges Across Industries

### Retail

More than **60%** of C-level executives agree that an effective digital/mobile strategy is essential to improve the customer experience[10].

**Future-forward initiatives**

- Creating a personalized shopping experience
- Making it possible for shoppers to get what they want, even if it's out of stock
- Providing next-level customer service

Digital technologies have significantly altered the way retail consumers shop. With the rise of the internet, social media, and mobility, consumers have particular expectations related to their shopping experience, as well as their access to information to guide them along their path to purchase. To complement the service and convenience of online retailers, brick and mortar stores must attract customers with a superior, value-driven experience.

By leveraging Wi-Fi, brick and mortar retailers can exceed the expectations of today's connected shopper, optimize their in-house operations, and build a powerful business asset to leverage in today's digital society.

### Healthcare

**90%** of healthcare organizations agree that investments in new tools and technology are required to transform healthcare.[2]

**Future-forward initiatives**

- Connecting a life flight to doctors on a helipad
- Monitoring the IV pumps keeping a patient alive
- Metering pill distribution and tracking volume to compare with other hospitals and clinics

Technology innovations in healthcare are evolving, aimed at improving the patient and clinician experience while bettering the bottom line. With technologies like AR/VR, robotics, and IoMT becoming an everyday part of the modern intelligent hospital, investing in tools and technologies on an ongoing basis is key to healthcare transformation. As a result, healthcare organizations are facilitating engagement in a transparent, accessible fashion, using patient portals, self-scheduling, online lab result delivery, and email and chat sessions with physicians. It's up to the hospital IT staff to ensure that services are optimally delivered.

In many ways, reliable Wi-Fi means better health outcomes for patients. From ensuring clinical applications stay online to facilitating clinician communications, Wi-Fi plays an essential role.

Internet of Things (IoT) Healthcare Market by Component (Implantable Sensor Devices, Wearable Sensor Devices, System and Software), Application (Patient Monitoring, Clinical Operation and Workflow Optimization, Clinical Imaging, Fitness and Wellness Measurement) - Global Opportunity Analysis and Industry Forecast, 2014 - 2021. (2016, February) Allied Market Research. Retrieved June 11, 2019, from https://www.alliedmarketresearch.com/iot-healthcare-market

PlanetRetail RNG. Personalization Opportunities in Retail Stores. 6 December 2017. Miya Knights. https://www.extremenetworks.com/resources/white-paper/personalisation-opportunities-in-retail-stores-enhancing-customer-experiences-through-location-analytics/

## Education

70% of schools are moving to digital textbooks.

**Future-forward initiatives**

- Supporting software to help overcome learning challenges
- Powering next-level robotics programs
- Keeping at-risk kids engaged in education

Technology is shaping the primary/secondary education experience for teachers, students, and districts as a whole. From BYOD, to 1:1 computing to cutting-edge tools like smartboards and augmented reality, the way the curriculum is delivered today is vastly different from the past. As EdTech evolves, K-12 school districts must be prepared to adopt new technology that enhances the learning experience.

Higher education institutions face their own challenges. Today's college students are demanding and digital savvy; they want to communicate through social channels wherever they are, and expect access to video lectures, class discussion forums, and assignments from anywhere, at any time. Higher education has to ensure consistent connectivity to students and teachers, provide great sports events experiences, and stay ahead of advances in tech like A/R and V/R, robotics, and more.

Both primary/secondary and higher education campuses increasingly rely on Wi-Fi to enable digital transformation, improve learning outcomes, and meet student needs.

## Hospitality and Venues

72% of travelers with smartphones look for the most relevant information, regardless of the travel company providing the information.[3]

**Future-forward capabilities**

- Reacting to key events on the property or in-venue in real-time
- Engaging with guests related to their location
- Enabling contextual and personalized marketing

With digital transformation in full swing, the volume of users, devices, and applications businesses need to support today has increased significantly. The demand is taxing Wi-Fi networks and heightening the pressure on hospitality organizations to meet the mobile expectations of guests, in addition to supporting business requirements.

When it comes to hospitality and public venues, Wi-Fi is an expected amenity for guests. It's also a valuable tool for business; a strong Wi-Fi solution establishes a quality guest experience, bolsters guest loyalty, creates mobile engagement opportunities, and overall strengthens the relationship between the guest and the brand. Whether it's a hotel property, retail store, sports venue or casino, Wi-Fi is the key to unlocking a personalized guest experience. A flexible, secure, smart network infrastructure that delivers on Wi-Fi allows businesses to humanize the guest experience and meet connectivity demands.

*As a Wi-Fi solutions provider for 28 NFL stadiums, as well as numerous collegiate and pro sports venues, Extreme is an expert in solving the challenging issues of dense, outdoor networking. In fact, we were the first to offer 802.11ax access points that are purpose-built for stadium environments, and we've applied those learnings across our 802.11ax family to empower businesses of all kinds to get ahead of the Wi-Fi curve and support more users, and more devices, more efficiently."*

**– Mike Leibovitz, Senior Director of Product Management and Strategy, Extreme Networks**

White paper, Digital Transformation of the Guest Experience. Sabre, Atmosfera, 2018. Retrieved June 11, 2019 from http://www2.sabrehospitality.com/digital-transformation?utm_source=PressRelease&utm_campaign=DigitalTransformation

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http://www.extremenetworks.com/contact