Law Office of
Richard A. Finnigan
2112 Black Lake Blvd. SW
Olympia, Washington 98512

Richard A. Finnigan
(360) 956-7001
rickfinn@localaccess.com

Candace Shofstall
Legal Assistant
(360) 753-7012
candaces@localaccess.com

March 23, 2015

VIA EFILING AND OVERNIGHT DELIVERY

Public Utility Commission of Oregon
3930 Fairview Industrial Drive SE
PO Box 1088
Salem OR 97308-1088

Re: UM 1721 - Exhibit 3 - Douglas Services, Inc. d/b/a Douglas FastNet - ERRATA

Dear Sir/Madam:

On March 20, 2015, Douglas Services, Inc. d/b/a Douglas FastNet filed an Application for designation as an eligible telecommunications carrier, designation as an eligible telecommunications provider and request for waiver.

Exhibit 3, page 42 is marked as confidential and it is not confidential. A replacement Exhibit 3 is attached.

Sincerely,

Richard A. Finnigan

RAF/cs

cc: Client (via email)

EXHIBIT 3

EXHIBIT 3
REDACTED

DFN
DOUGLAS FAST NET

December 31, 2014

Douglas Services Inc.,
2350 NW Aviation Dr.
Roseburg, OR 97470
(541) 673-4242

Commission's Secretary, Office of the Secretary,
Federal Communications Commission.
445 12th Street, SW,
Washington, DC 20554

DOUGLAS SERVICES, INC.

AUDIT REPORT

Years Ended December 31, 2011, and 2010

KENNETH KUHNS & CO.
Certified Public Accountants
570 Liberty Street S.E., Suite 210
Salem, Oregon 97301-3594

Telephone: (503) 585-2550

TABLE OF CONTENTS

DOUGLAS SERVICES, INC.

December 31, 2011

Directors

Terry Nelson	President
Robert Poage	Vice President
Shirley Cairns	Secretary
Dick McHaffie	Treasurer
Roy Ellis	Director
Larry Shipley	Director
Carey Weatherly	Director

EXHIBIT 3
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KENNETH KUHNS & CO.
CERTIFIED PUBLIC ACCOUNTANTS
570 LIBERTY STREET S.E., SUITE 210
SALEM OREGON 97301-3594

TELEPHONE (503) 585-2550

INDEPENDENT AUDITOR'S REPORT

March 13, 2012

Board of Directors
Douglas Services, Inc.

EXHIBIT 3
REDACTED

DOUGLAS SERVICES, INC.

Balance Sheet

Assets

Current assets:
- Cash (Note 1)
- Accounts receivable (less provision for doubtful accounts of $988 in 2011 and $5,264 in 2010)
- Prepayments
- Inventory (Note 1)

Total current assets

Other assets:
- Investments in associated organizations (Note 2)
- Investment in Eastern Oregon Telecomm
- Organization costs

Total other assets

Utility plant: (Note 1)
- In service
- Construction in progress

Total utility plant

Less: accumulated provision for depreciation

Net utility plant

Total assets

Liabilities and Equity

Current liabilities:
- Current maturities of note payable
- Accounts payable ✓
- Accrued paid time off ✓
- Deferred tax liability (Note 4) ✓
- Other current liabilities - 24,805 -

Total current liabilities

Long-term liabilities:
- Note payable, less current maturities
- Deferred tax liability (Note 4)

Total long-term liabilities

Total liabilities

Equity:
- Retained earnings-(deficit)

Total liabilities and equity

The accompanying notes are an integral part of this statement.

EXHIBIT 3
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DOUGLAS SERVICES, INC.

Statement of Revenue and Retained Earnings

Operating revenues:
Sales

Operating expenses:
Cost of sales
Labor and benefits
Materials and services
Depreciation

Total operating expenses

Net income from operations

Other income-(expenses):
Investment income
Loss on disposal of plant
Interest expense

Net income before provision for income taxes

Provision for income taxes

Net income

Retained earnings-(deficit) - beginning of year

Retained earnings-(deficit) - end of year

The accompanying notes are an integral part of this statement.

EXHIBIT 3
REDACTED

DOUGLAS SERVICES, INC.

Statement of Cash Flows

Cash flows from operating activities:
- Cash received from customers
- Cash received from interest
- Cash payments to employees and other suppliers of goods and services
- Cash payments for interest
- Cash payments for income taxes

Net cash provided by operating activities

Cash flows from investing activities:
- Capital expenditures
- Proceeds from sale of plant
- Payment received for capital credits

Net cash used in investing activities

Cash flows from financing activities:
- Decrease in line of credit payable
- Principal payments on note payable

Net cash used in financing activities

Net increase-(decrease) in cash and cash equivalents for year

Cash - beginning of year

Cash - end of year

Reconciliation of net income to net cash provided by operating activities:
- Net income
- Adjustments to reconcile net income to net cash provided by operating activities:
  - Depreciation
  - Loss on disposal of plant
  - Noncash investment income
  - Decrease-(increase) in:
    - Accounts receivable
    - Prepayments
    - Inventory
  - Increase-(decrease) in:
    - Accounts payable
    - Accrued paid time off
    - Accrued interest
    - Deferred tax liability
    - Other current liabilities

Total adjustments

Net cash provided by operating activities

The accompanying notes are an integral part of this statement.

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Notes to Financial Statements
December 31, 2011 and 2010

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Notes to Financial Statements
December 31, 2011 and 2010

DOUGLAS SERVICES, INC.

AUDIT REPORT

Years Ended December 31, 2012, and 2011

KENNETH KUHNS & CO.
Certified Public Accountants
570 Liberty Street S.E., Suite 210
Salem, Oregon 97301-3594

Telephone: (503) 585-2550

TABLE OF CONTENTS

DOUGLAS SERVICES, INC.

December 31, 2012

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Carey Weatherly	Director

EXHIBIT 3

REDACTED

KENNETH KUHNS & CO.
CERTIFIED PUBLIC ACCOUNTANTS
570 LIBERTY STREET S.E., SUITE 210
SALEM OREGON 97301-3594

TELEPHONE (503) 585-2550

INDEPENDENT AUDITOR'S REPORT

April 2, 2013

Board of Directors
Douglas Services, Inc.

Opinion

EXHIBIT 3
REDACTED

DOUGLAS SERVICES, INC.

Balance Sheet

Assets

Current assets:
- Cash (Note 1)
- Accounts receivable (less provision for doubtful accounts of $320 in 2012 and $988 in 2011)
- Prepayments
- Inventory (Note 1)

Total current assets

Other assets:
- Investments in associated organizations (Note 2)
- Investment in Eastern Oregon Telecomm
- Organization costs

Total other assets

Utility plant: (Note 1)
- In service
- Construction in progress

Total utility plant

Less: accumulated provision for depreciation

Net utility plant

Total assets

Liabilities and Equity

Current liabilities:
- Current maturities of note payable
- Line of credit payable (Note 5)
- Accounts payable
- Accrued paid time off
- Deferred tax liability (Note 4)
- Other current liabilities

Total current liabilities

Long-term liabilities:
- Note payable, less current maturities (Note 3)
- Deferred tax liability (Note 4)

Total long-term liabilities

Total liabilities

Equity:
- Retained earnings

Total liabilities and equity

The accompanying notes are an integral part of this statement.

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Statement of Revenue and Retained Earnings

Operating revenues:
Sales

Operating expenses:
Cost of sales
Administration and operations
Depreciation

Total operating expenses

Net income from operations

Other income-(expenses):
Investment income
Loss on disposal of plant
Interest expense

Net income before provision for income taxes

Provision for income taxes

Net income

Retained earnings-(deficit) - beginning of year

Retained earnings - end of year

The accompanying notes are an integral part of this statement.

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Statement of Cash Flows

Cash flows from operating activities:
- Cash received from customers
- Cash received from interest
- Cash payments to employees and other suppliers of goods and services
- Cash payments for interest
- Cash payments for income taxes

Net cash provided by operating activities

Cash flows from investing activities:
- Capital expenditures
- Proceeds from sale of plant
- Payment received for capital credits

Net cash used in investing activities

Cash flows from financing activities:
- Line of credit advances
- Principal payments on note payable

Net cash used in financing activities

Net decrease in cash and cash equivalents for year

Cash - beginning of year

Cash - end of year

Reconciliation of net income to net cash provided by operating activities:
- Net income
- Adjustments to reconcile net income to net cash provided by operating activities:
  - Depreciation
  - Loss on disposal of plant
  - Noncash investment income
  - Decrease-(increase) in:
    - Accounts receivable
    - Prepayments
    - Inventory
  - Increase-(decrease) in:
    - Accounts payable
    - Accrued paid time off
    - Deferred tax liability
    - Other current liabilities

Total adjustments

Net cash provided by operating activities

The accompanying notes are an integral part of this statement.

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Notes to Financial Statements
December 31, 2012 and 2011

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Notes to Financial Statements
December 31, 2012 and 2011

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Notes to Financial Statements
December 31, 2012 and 2011

DOUGLAS SERVICES, INC.

AUDIT REPORT

Years Ended December 31, 2013, and 2012

KENNETH KUHNS & CO.
Certified Public Accountants
570 Liberty Street S.E., Suite 210
Salem, Oregon 97301-3594

Telephone: (503) 585-2550

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EXHIBIT 3

REDACTED

KENNETH KUHNS & CO.
CERTIFIED PUBLIC ACCOUNTANTS
570 LIBERTY STREET S.E., SUITE 210
SALEM OREGON 97301-3594
TELEPHONE (503) 585-2550

INDEPENDENT AUDITOR'S REPORT

March 12, 2014

Board of Directors
Douglas Services, Inc.

Opinion

EXHIBIT 3
REDACTED

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Balance Sheet

Assets

Current assets:
- Cash (Note 1)
- Accounts receivable (less provision for doubtful accounts of $1,500 in 2013 and $320 in 2012)
- Prepayments
- Inventory (Note 1)

Total current assets

Other assets:
- Investments in associated organizations (Note 2)
- Organization costs

Total other assets

Utility plant: (Note 1)
- In service
- Construction in progress

Total utility plant

Less: accumulated provision for depreciation

Net utility plant

Total assets

Liabilities and Equity

Current liabilities:
- Current maturities of loans and note payable
- Line of credit payable (Note 5)
- Accounts payable
- Accrued paid time off
- Deferred tax liability (Note 4)
- Other current liabilities

Total current liabilities

Long-term liabilities:
- Loans payable, less current maturities (Note 6)
- Note payable, less current maturities (Note 3)
- Deferred tax liability (Note 4)

Total long-term liabilities

Total liabilities

Equity:
- Retained earnings

Total liabilities and equity

The accompanying notes are an integral part of this statement.

EXHIBIT 3

REDACTED

DOUGLAS SERVICES, INC.

Statement of Revenue and Retained Earnings

Operating revenues:
  Sales

Operating expenses:
  Administration and operations
  Depreciation

    Total operating expenses

    Net income from operations

Other income-(expenses):
  Investment income
  Loss on disposal of plant
  Interest expense

    Net income before provision for income taxes

Provision for income taxes

    Net income

Retained earnings - beginning of year

Retained earnings - end of year

The accompanying notes are an integral part of this statement.

EXHIBIT 3
REDACTED

DOUGLAS SERVICES, INC.

Statement of Cash Flows

Cash flows from operating activities:
- Cash received from customers
- Cash received from interest
- Cash payments to employees and other suppliers of goods and services
- Cash payments for interest
- Cash payments for income taxes

Net cash provided by operating activities

Cash flows from investing activities:
- Capital expenditures
- Proceeds from sale of plant
- Payment received for capital credits

Net cash used in investing activities

Cash flows from financing activities:
- Loans payable advances
- Line of credit advances
- Principal payments on loans and note payable
- Principal payments on line of credit

Net cash provided by-(used in) financing activities

Net increase-(decrease) in cash and cash equivalents for year

Cash - beginning of year

Cash - end of year

Reconciliation of net income to net cash provided by operating activities:
- Net income
- Adjustments to reconcile net income to net cash provided by operating activities:
  - Depreciation
  - Loss on disposal of plant
  - Noncash investment income
  - Decrease-(increase) in:
    - Accounts receivable
    - Prepayments
    - Inventory
  - Increase-(decrease) in:
    - Accounts payable
    - Accrued paid time off
    - Deferred tax liability
    - Other current liabilities

Total adjustments

Net cash provided by operating activities

The accompanying notes are an integral part of this statement.

EXHIBIT 3
REDACTED

DOUGLAS SERVICES, INC.

Notes to Financial Statements
December 31, 2013 and 2012

DOUGLAS SERVICES, INC. REDACTED

Notes to Financial Statements
December 31, 2013 and 2012

EXHIBIT 3

DOUGLAS SERVICES, INC.

REDACTED

Notes to Financial Statements
December 31, 2013 and 2012

EXHIBIT 3

DOUGLAS SERVICES, INC.

REDACTED

Notes to Financial Statements
December 31, 2013 and 2012

EXHIBIT 3
REDACTED

DOUGLAS FAST NET

Income Statement for December 2014

RUS Form 479

Item		Year to Date	Current Month
1. Local Network Services Revenue			
0 5000.01	Local Services - Transport (Ethernet)		
0 5000.02	Local Services - DSL		
0 5000.03	Local Services - Voice		
0 5000.05	Local Services - Co-Location		
	Total for Line 1:		
2. Network Access Services Revenue			
0 5080.0	Network Access Revenue		
	Total for Line 2:		
3. Long Distance Network Services Revenues			
0 5000.04	Local Services - Voice Long Distance		
	Total for Line 3:		
5. Miscellaneous Revenues			
0 5010.0	LAN Services (Local Area Network)		
0 5200.01	NRR Installation		
0 5250.00	Other / Misc. Income		
	Total for Line 5:		
7. Net Operating Revenues (1 thru 5 less 6)			
8. Plant Specific Operations Expense			
0 6112.0	Motor Vehicle Expense		
0 6121.0	Land and Building Expense		
	Total for Line 8:		
9. Plant Nonspecific Operations Expense			
0 6530.0	Network Operation - Electronic Plant		
0 6531.0	Power Expense		
0 6534.0	Plant Operations - Outside Plant		
0 6540.0	Access Expense		
	Total for Line 9:		
10. Depreciation Expense			
0 6561.0	Depreciation Expense - Plant in Service		
	Total for Line 10:		
12. Customer Operations Expense			
0 6612.0	Sales		
0 6613.0	Product Advertising		
0 6623.0	Customer Service		
	Total for Line 12:		

EXHIBIT 3

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13. Corporate Operations Expense

0	6711.0	Executive
0	6720.0	General and Administrative
0	6721.0	Accounting and Finance
0	6723.0	Human Resources
0	6725.0	Legal
0	6726.0	Procurement
0	6728.0	Other General and Administrative

Total for Line 13:

14. Total Operating Expenses (8 thru 13)

15. Operating Income or Margins (7 less 14)

16. Other Operating Income and Expenses

0	7300	Interest Expense
0	7400.0	Gain/Loss - Disposal of Assets
0	7500.0	Interest Income

Total for Line 16:

17. State and Local Taxes / Other

0	6750.01	Taxes - Federal
0	6750.02	Taxes - State
0	6750.03	Taxes - Other

Total for Line 17:

20. Total Operating Taxes (17 + 18 + 19)

21. Net Operating Income or Margins

EXHIBIT 3

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DOUGLAS FAST NET

Balance Sheet for December 2014

RUS Form 479

		Year to Date
ASSETS		
Current Assets		
1. Cash and Equivalents		
0 1120.01	Cash - Checking Account	
0 1120.03	Petty Cash	
0 1120.04	Cash Drawer	
0 1120.05	Cash - Checking - Umpqua Bank	
0 1120.051	Cash - Money Market - Umpqua Bank	
	Total for Line 1:	
3. Affiliates:		
a. Telecom, Accounts Receivable		
0 1180.01	Accounts Receivable - Customers	
0 1180.02	Allowance for Bad Debt - Customers	
0 1181.01	Accounts Receivable - Prof. Services	
	Total for Line 3A:	
b. Other Accounts Receivable		
0 1182.01	Accounts Receivable - Other Receivable	
0 1182.02	Allowance for Bad Debt - Other Rec.	
	Total for Line 3B:	
5. Interest and Dividends Receivable		
0 1210.00	Interest / Dividends Receivable	
	Total for Line 5:	
6. Material-Regulated		
0 1220.01	Materials and Supplies/Inventory	
	Total for Line 6:	
8. Prepayments		
0 1280.01	Pre-Paid - Rent / Lease	
0 1280.02	Pre-Paid - Taxes	
0 1280.03	Pre-Paid - Insurance	
0 1280.04	Pre-Paid - Regulatory Charges	
0 1280.05	Pre-Paid - Other	
	Total for Line 8:	
10. Total Current Assets (1 thru 9)		

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Noncurrent Assets

11. Investments in Affiliated Companies

b. Nonrural Development

0 1401.0	Investments - Affiliated Companies

Total for Line 11B:

17. Total Noncurrent Assets (11 thru 16)

Plant, Property, and Equipment

18. Telecom, Plant-in-Service

0 2112.0	Motor Vehicles
0 2116.0	Tools and Equipment
0 2121.0	Building
0 2122.0	Furniture and Fixtures
0 2124.0	General Purpose - Computers / Software
0 2402.0	Outside Plant
0 2403.0	Electronic Plant

Total for Line 18:

20. Plant Under Construction

0 2002.01	Construction in Progress - Plant
0 2002.02	Construction in Progress - Billable

Total for Line 20

22. Less Accumulated Depreciation

0 3112.0	Accum. Depr. - Motor Vehicles
0 3116.0	Accum. Depr. - Tools and Equipment
0 3116.0	Accum. Depr. - Building
0 3122.0	Accum. Depr. - Furniture and Fixtures
0 3124.0	Accum. Depr. - General Purpose
0 3402.0	Accum. Depr. - Outside Plant
0 3403.0	Accum. Depr. - Electronic Plant

Total for Line 2

23. Net Plant (18 thru 21 less 22)

24. Total Assets (10 + 17 + 23)

LIABILITIES AND STOCKHOLDERS' EQUITY

Current Liabilities

25. Accounts Payable

0 4010.01	Accounts Payable
0 4010.02	Accounts Payable - Other
0 4020.01	Employee Deduction - Medical

EXHIBIT 3
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0 4020.02	Employee Deduction - Dental
0 4020.03	Employee Deduction - Vision
0 4020.04	Employee Deduction - 401(k)
0 4020.05	Employee Deduction - Life
0 4020.06	Employee Deduction - Child Support
0 4020.07	Employee Deduction - Section 125
0 4020.08	Employee Deduction - Other
0 4020.1	Employee Deduction - Garnishment
0 4025.04	Employer 401(k) Match
0 4030.01	Federal Payroll Taxes Payable
0 4030.02	FUTA Tax Payable
0 4030.03	State Payroll Taxes Payable
0 4030.04	SUTA Payable
0 4030.05	Worker's Comp. - State

Total for Line 25: -

29. Current Maturity - L/T Debt

0 4155.00	Current Portion - Long Term Debt

Total for Line 29: -

32. Income Taxes Accrued

0 4070.00	Accrued Income Taxes
0 4190.00	Deferred Income Taxes

Total for Line 32: -

33. Other Taxes Accrued

0 4100.01	Franchise Fees - Myrtle Creek
0 4100.02	Franchise Fees - Riddle
0 4100.03	Franchise Fees - Winston
0 4100.04	Franchise Fees - Canyonville
0 4100.05	Franchise Fees - Eugene
0 4100.06	Franchise Fees - Sutherlin
0 4100.07	Franchise Fees - Roseburg
0 4100.08	Franchise Fees - Oakland
0 4100.09	Franchise Fees - Drain
0 4100.10	Franchise Fees - Glendale
0 4100.11	Franchise Fees - Yoncalla
0 4160.01	Federal Universal Service Fee
0 4160.02	Oregon Universal Service Fee
0 4160.03	PUC Fees

Total for Line 33:

34. Other Current Liabilities

0 4040.00	Accrued Paid Time Off
0 4050.00	Accrued Payroll

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4130.00	Other Current Liability	
4150.01	Line of Credit - NCSC	
4220.01	Accrued Interest - N/P - Restructure	
4220.02	Accrued Interest - N/P - Capital Needs	
0 4220.03	Accrued Interest - N/P - Aviation Drive	
		Total for Line 34:

35. Total Current Liabilities (25 thru 34)

Long-Term Debt

39. Funded Debt - Other

0 4215.01	Notes Payable - NCSC - Debt Restructure	
0 4215.02	Notes Payable - NCSC - Capital Needs	
0 4215.03	Notes Payable - NCSC - Aviation Drive	
		Total for Line 39:

46. Total Long-Term Debt (36 thru 45)

Other Liability and Deferred Credits

57. Retained Earnings or Margins

0 4560.00	Retained Earnings	
	Current Fiscal Margins	
		Total for Line 57:

58. Total Equity (51 thru 57)

59. Total Liabilities and Equity (35 + 46 + 50 + 58)

EXHIBIT 3
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DOUGLAS FAST NET

Cash Flow for December 2014

OPERATING ACTIVITIES
Net Income
Depreciation Expense
Amortization Expense
Loss/Gain from Disposal of Assets
Total Funds from Operations

Accounts Receivable
Materials and Supplies
Prepayments and Deferred Charges
(Increase)/Decrease in Operating Assets

Accounts Payable
Other Current Liabilities
Increase/(Decrease) in Operating Liabilities

CASH FROM OPERATING ACTIVITIES

INVESTMENT ACTIVITIES
Net Capital Expenditures
Other Long-Term Investments
CASH FROM INVESTMENT ACTIVITIES

FINANCING ACTIVITIES
Long-Term Debt
Other Liabilities and Deferred Credits
CASH FROM FINANCING ACTIVITIES

CASH FROM ALL ACTIVITIES

TOTAL CASH BEGINNING OF PERIOD

TOTAL CASH END OF PERIOD

structured
bridging people, business & technology

December 31, 2014

Douglas Services (dba Douglas Fast Net)
Jon Vradenburg, Director of Network Operations
2350 NW Aviation Drive
Roseburg, Oregon 97470

RE: Certification of Network Diagram

Dear Mr. Vradenburg,

As requested, members of the Structured Communication Systems, Inc. ("Structured") network engineering team have reviewed the attached network diagram (Exhibit A) and associated technology descriptions for purposes of determining whether the network is capable of delivering voice and broadband service up to 100 Mbps.

Based upon our review of the information provided, Structured certifies that the Douglas Services (dba Douglas Fast Net) network drawing contained in Exhibit A demonstrates a network design capable of delivering voice and broadband services up to 100 Mbps.

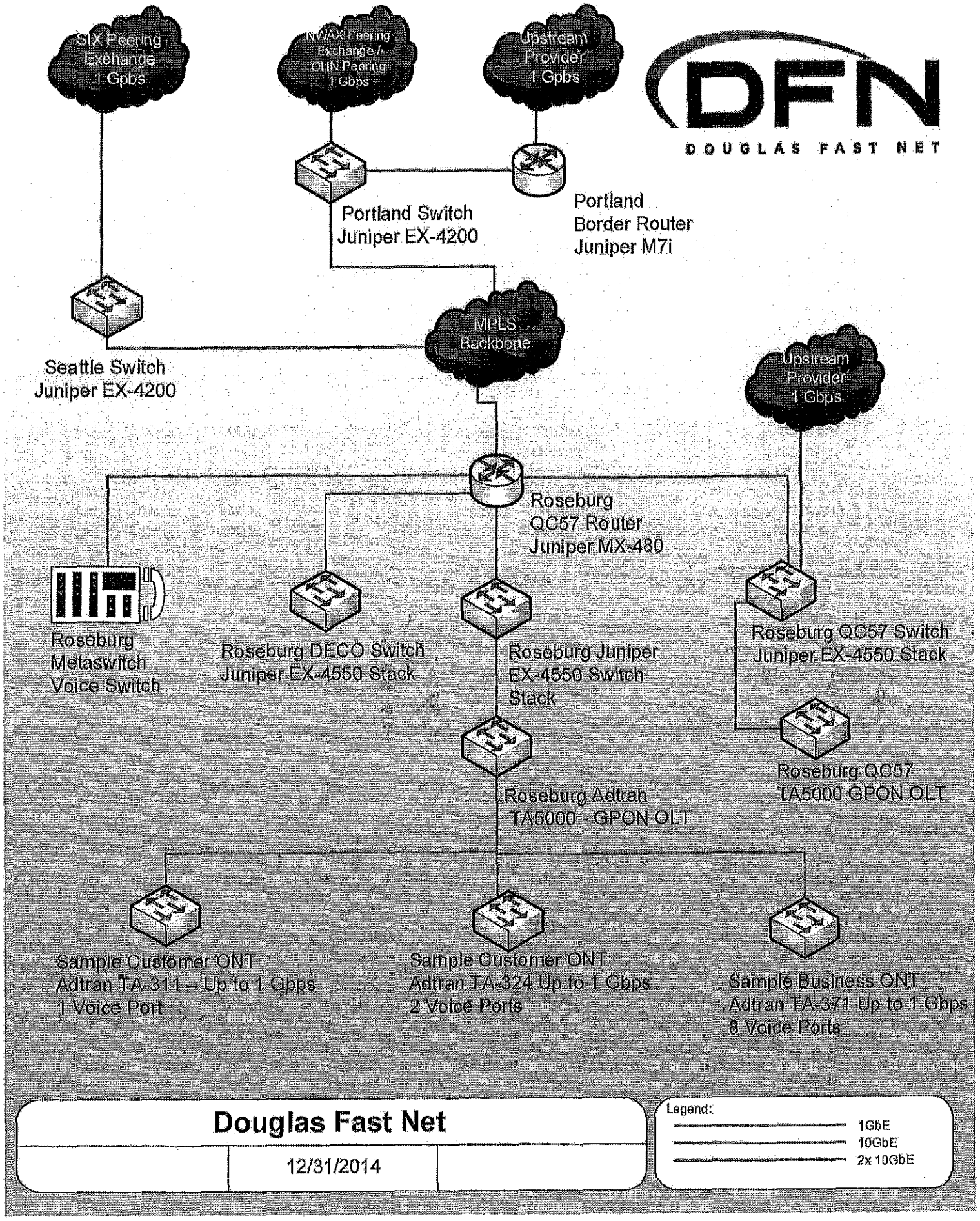
Structured is a leading information technology consultancy and systems integrator that has partnered with hundreds of clients throughout the U.S. to maximize the value of IT. For two decades, Structured consultants have collaborated with CIOs and IT departments to develop and implement technology strategies that drive measureable improvements throughout the organization.

Founded in 1992 and headquartered in Portland Oregon, Structured has offices throughout the US and represents a global clientele. For more information, visit http://www.structured.com.

Regards,

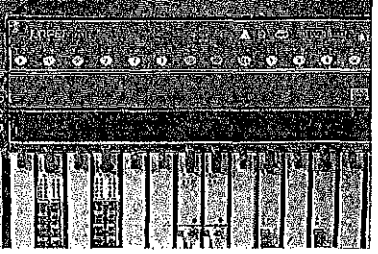
Casey Richmond, General Counsel
Structured Communication Systems, Inc.
12901 S.E. 97th Avenue, Suite 400
Clackamas, Oregon 97015

EXHIBIT 3


SIX Peering Exchange 1 Gpbs
NWAX Peering Exchange / OHIN Peering 1 Gbps
Upstream Provider 1 Gpbs
DFN
DOUGLAS FAST NET
Portland Switch Juniper EX-4200
Portland Border Router Juniper M7i
Seattle Switch Juniper EX-4200
MPLS Backbone
Upstream Provider 1 Gbps
Roseburg QC57 Router Juniper MX-480
Roseburg Metaswitch Voice Switch
Roseburg DECO Switch Juniper EX-4550 Stack
Roseburg Juniper EX-4550 Switch Stack
Roseburg QC57 Switch Juniper EX-4550 Stack
Roseburg QC57 TA5000 GPON OLT
Roseburg Adtran TA5000 - GPON OLT
Sample Customer ONT Adtran TA-311 – Up to 1 Gbps 1 Voice Port
Sample Customer ONT Adtran TA-324 Up to 1 Gbps 2 Voice Ports
Sample Business ONT Adtran TA-371 Up to 1 Gbps 8 Voice Ports
Douglas Fast Net
12/31/2014
Legend:
1GbE
10GbE
2x 10GbE

Data Sheet

MX240, MX480 and MX960 3D Universal Edge Routers



Product Overview

Businesses and cloud builders of all types—from telecom service providers to enterprises—are under pressure to increase network scale, performance, and reliability while containing capital spending and streamlining operations. Achieving these goals is difficult due to double-digit growth rates, driven mainly by cloud adoption, online video, and mass adoption of mobile devices.

Powered by the Junos operating system and Junos Trio chipset, the SDN-ready MX Series Universal Edge Router portfolio helps enterprises, cloud operators, service providers, and cable operators increase network scale, performance, and reliability. The MX Series delivers the capital efficiency, service agility, and operational scale needed for next-generation carrier, cloud and enterprise applications.

Product Description

Juniper Networks® MX Series 3D Universal Edge Routers are a portfolio of high-performance, software-centric physical and virtual routers that support a broad set of applications in service provider, enterprise and cloud networks. With powerful routing, switching, and services capabilities, the MX Series delivers unmatched flexibility and investment protection.

Powered by Juniper Networks Junos® operating system, the MX Series streamlines network operations and improves the availability, performance, and security of all types of services. It offers the most complete, advanced features in the industry, including traffic segmentation and virtualization with MPLS, subscriber management, sophisticated virtualization techniques such as Virtual Chassis technology and virtual CPE, low-latency multicast, as well as comprehensive security and QoS implementations that ensure the quality delivery of time-sensitive applications and services.

With the MX Series, all major components are field replaceable, increasing system availability and decreasing mean time to repair (MTTR). Carrier-class reliability and high availability features on the MX Series include graceful restart, nonstop active routing (NSR), MPLS fast reroute, unified in-service software upgrade (unified ISSU), a comprehensive OAM toolkit, and service-level resiliency with features such as virtual private LAN service (VPLS) multihoming.

MX Series 3D Universal Edge Routers provide the 3D scale, bandwidth, services, and subscribers that cloud builders, enterprises and service providers need to command a competitive advantage in today's rapidly changing environment. The MX Series portfolio offers a broad range of physical and virtual platforms that deliver routing capacity from 1 Gbps through 80 Tbps. The MX Series portfolio includes the vMX virtual router; highly compact routers such as the MX5, MX10, MX40, and MX80; an aggregation optimized router, the MX104; modular edge routers including the MX240, MX480, and MX960; and ultra-high capacity edge and converged edge/core platforms such as the MX2010 and MX2020. This datasheet specifically addresses the Juniper Networks MX240, MX480, and MX960 3D Universal Edge Routers.

- The MX240 offers high-interface density and performance in a space-efficient package that is practical for enterprise WAN, data center, and campus deployments as well as several service provider applications in small and medium points of presence (POPs).
- The MX480 provides a dense, highly redundant platform primarily targeted for medium to large enterprise campuses and data centers, and service provider edge applications in medium and large PoPs.
- The MX960 is a high-density, high-capacity platform designed for the service provider edge and data center cores.

Architecture and Key Components

Table 1: MX Series Key Components

Description	MX240	MX480	MX960
System capacity[1]	1.92 Tbps	5.12 Tbps	9.92 Tbps
Switch fabric capacity per slot[2]	480 Gbps	480 Gbps	480 Gbps
MPCs and DPCs per chassis	3	6	12
Chassis per rack	9	6	3

Switch Control Board (SCB)

The SCB powers on and powers off cards, controls clocking, resets, boots, monitors and controls system functions, including fan speed, board power status, inline power distribution module (PDM) status and control, and the system front panel. The switch fabric is integrated into the SCB, providing a non-blocking architecture that connects to all within the chassis, and the Routing Engine installs directly into the SCB. Three SCBs are available for the MX960, MX480, and MX240 routers—the SCB, the SCBE, and the SCBE2.

Table 2: SCB Comparison

Model Number	Description	Switch Fabric Capacity (Tbps)		
		MX240	MX480	MX960
SCBE2-MX-BB	Enhanced MX Switch Control Board (SCBE2)	1.92	5.12	9.92
SCBE-MX-BB	Enhanced Switch Control Board (SCBE)	.96	2.72	5.12
SCB-MX960-BB	Switch Control Board (SCB)	.48	1.44	2.64

Routing Engine (RE)

The Routing Engine handles all routing protocol processes, the software processes that control the router's interfaces, the chassis components, system management, and user access to the router. These routing and software processes run on top of a kernel that interacts with the Packet Forwarding Engine (PFE). The Routing Engine also provides control plane functions and runs Junos OS. Software processes that run on the Routing Engine maintain the routing tables, manage the routing protocols used on the router, control the router interfaces, control some chassis components, and provide the interface for system management and user access to the router. Routing Engines communicate with DPCs and MPCs via dedicated out-of-band management channels, providing a clear distinction between the control and forwarding planes.

Modular Port Concentrator (MPC)

MPCs leverage the Junos Trio chipset to deliver high density 1, 10, 40 and 100 Gigabit Ethernet, as well as ATM/SONET and inline services across the entire MX Series portfolio. These advanced capabilities allow you to flexibly mix and match interfaces to create service-specific and "pay-as-you-grow" configurations. The MPC houses the PFEs to deliver comprehensive Layer 3 routing (IPv4 and IPv6), MPLS, and Layer 2 switching and advanced Hierarchical quality-of-service (HQoS).

For more details on MPCs, please visit www.juniper.net/us/en/local/pdf/datasheets/1000294-en.pdf.

Dense Port Concentrator (DPC)

DPCs provide multiple physical interfaces and PFEs on a single board that installs in a slot in the MX Series routers. A DPC receives incoming packets from the network and sends outgoing packets to the network. The PFEs on a DPC are equipped with purpose-built ASICs that perform packet processing and forwarding. Each PFE consists of one I-Chip for Layer 3 processing and one Layer 2 network processor.

For more details on the DPC, please visit www.juniper.net/us/en/local/pdf/datasheets/1000209-en.pdf.

Junos OS

Junos OS is a single, modular OS with a single release cycle that is supported across all Juniper Networks routers, switches, and security devices in a unique approach that extends significant operational and economic benefits. Junos OS streamlines network operations and improves the availability, performance, and security of all types of services supported by the MX Series 3D Universal Edge Routers, including L2/L3 VPNs, traffic segmentation, low-latency multicast, and comprehensive QoS features that accelerate the delivery of time-sensitive applications.

Junos OS also offers advanced virtualized network services such as Virtual Chassis technology, cloud-based CPE, and network edge services such as network address translation (NAT) and carrier-grade NAT (CGNAT), IPsec, flow monitoring, and stateful firewall—allowing the seamless and operationally efficient integration of these advanced service capabilities directly on the MX Series. Unlike other network operating systems that are fragmented into many different release images joined under a common "brand," our unified approach to OS development and deployment reduces the cost, complexity, and time to implement and maintain network infrastructure.

MX Series Features and Benefits

Unmatched Network Availability

The MX Series 3D is a true carrier-grade platform that ensures nonstop network availability with layered physical, logical, and protocol-level resiliency options. Chassis redundancy is based on advanced Virtual Chassis technology. Link aggregation group (LAG) technology supports stateful card and port redundancy, as well as subscriber and session persistence in the case of switchover.

On the software side, Junos OS has a modular architecture that runs each program independently with its own memory space to ensure that processes do not interfere with one another. A full set of high availability (HA) features, including unified in-service software upgrade (ISSU); a comprehensive OAM toolkit, Junos XML management protocol commit script capabilities and service-level resiliency with features such as virtual private LAN service (VPLS) multihoming.

Advanced Virtualized Network Services

Junos OS-based virtualized network services enable cost-effective router integrated service scale without impacting forwarding performance or requiring operators to use third-party appliances. The MX Series can efficiently support services that include the following:

- Junos Video Focus for proactive video quality assurance
- Junos Address Aware, which helps you conserve your IPv4 address pool, ensure IPv4/IPv6 coexistence, and transition to IPv6
- Junos Network Secure, which provides stateful firewall services for network protection and managed security offers
- Junos VPN Site Secure, which uses standard encryption modes to secure communication between the customer premises and the network edge, and for added security over L3 VPNs
- Junos Traffic Vision, which monitors traffic flows and generates detailed flow records

The Service Control Gateway, an open platform that enables the creation and delivery of subscriber- and application-aware services and service chaining.

Comprehensive Broadband Edge Capabilities

The MX Series provides a powerful broadband network gateway (BNG) that lets operators provision broadband services for today and tomorrow with support for Point-to-Point Protocol (PPP) subscriber termination, Dynamic Host Configuration Protocol (DHCP), IPv4/IPv6 local server, and relay proxy for subscribers' migration to DHCP access models. Juniper's solution also supports RADIUS and Diameter back-end servers to facilitate authentication, policy control, and accounting, and it offers flexible L2/L3 wholesale models. The MX Series BNG also delivers advanced features such as hierarchical queuing, granular QoS, and dynamic multilayer service activation.

Broad Business Edge Capabilities

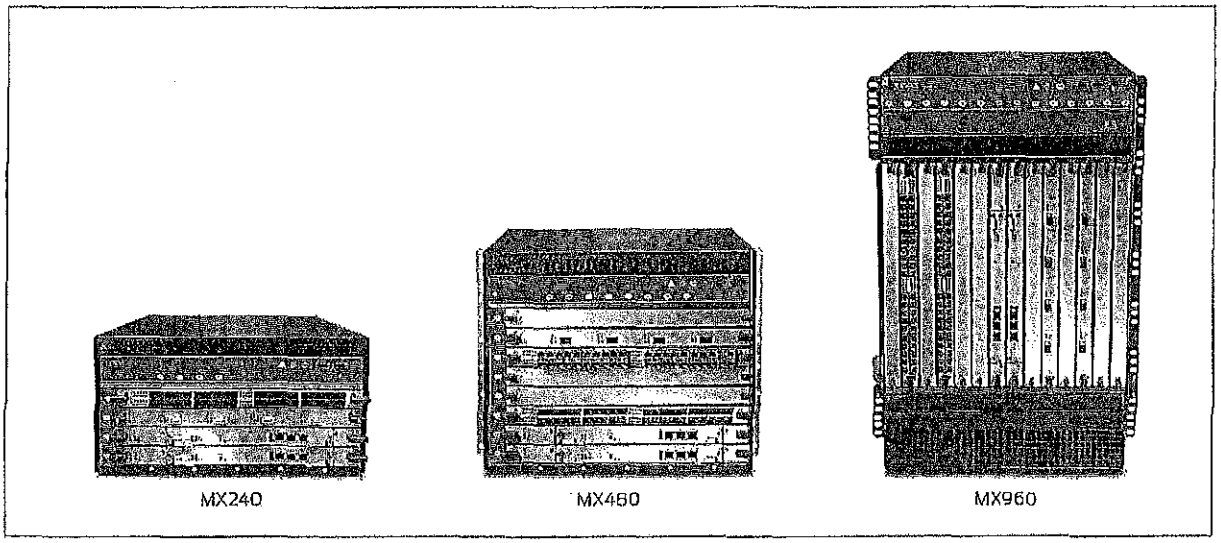
The MX Series provides a comprehensive VPN toolkit that enables feature-rich, standards-based, secure interworking and streamlined operations needed to help you reduce expenses and enable innovative business services. In addition to basic L3 VPN, L2 VPN, and VPLS, enhanced VPN service support includes QoS prioritized VPN traffic for voice and video, VPN-aware multicast and firewall services that leverage technologies such as LDP-BGP VPLS interworking, point-to-multipoint label-switched paths (P2MP LSPs), BGP-based multicast L3VPN, L2 VPN interworking to connect dissimilar L2 access networks, MPLS plug-and-play, and IPsec/GRE VPNs.

Metro Ethernet Capabilities

The MX Series is Carrier Ethernet 2.0 certified and supports metro Ethernet and aggregation solutions with a full suite of routing and switching features, allowing you to choose the deployment model that best fits your business and technical needs. The MX Series can be flexibly deployed as an IP/IP VPN edge router, VPLS provider edge router (VPLS-PE), MPLS label-switching router (LSR), L2 switch, or L3 router in mobile, fixed, and cable networks.

Universal SDN Gateway Capabilities

Supporting a wide range of SDN and encapsulation protocols, the MX Series is ideal as an SDN universal gateway to bridge between physical and virtual networks—even networks running different encapsulation or overlay technologies. Examples of supported protocols include Multiprotocol BGP (MBGP), dynamic tunnels using MPLS-over-GRE or VXLAN encapsulation, virtual routing tables and forwarding (VRF) and EVI (E-VPNs), mechanisms to send traffic between VRF and global routing table based on configuration and policy, and support for NETCONF.



Specifications and Approvals

This section lists basic specifications by platform. For further details, please refer to the hardware installation manuals at www.juniper.net/techpubs/hardware.

Specification	MX240	MX480	MX960
Dimensions and Power			
Physical dimensions (W x H x D)	17.5 x 8.7 x 23.8 in (44.5 x 22.1 x 60.5 cm)	17.5 x 14 x 23.8 in (44.5 x 35.6 x 60.5 cm)	17.5 x 27.8 x 23.5 in (44.5 x 70.5 (16 RU) x 59.7 cm)
Weight (lb/kg) fully configured	130 lb/59 kg	180 lb/81.7 kg	334 lb/151.6 kg
Mounting	Front or center	Front or center	Front or center
Power (DC/AC)	-40 to -72 V DC 100 to 240 V AC	-40 to -72 V DC 100 to 240 V AC	-40 to -72 V DC 200 to 240 V AC

Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit www.juniper.net/us/en/products-services.

Ordering Information

Model Number	Description		
Base Unit	MX240	MX480	MX960
DC Chassis	MX240BASE-DC, MX240BASE3-DC	MX480BASE-DC, MX480BASE3-DC	MX960BASE3-DC; MX960BASE-DC
AC Chassis	MX240BASE-AC, MX240BASE3-ACH, MX240BASE3-ACL	MX480BASE-AC, MX480BASE3-AC	MX960BASE3-AC; MX960BASE-AC
MPC			
MX-MPC1-3D	1xTrio Chipset MPC, port queuing; includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC1-3D-Q	1xTrio Chipset MPC, per-IFL HQoS, 128,000 queues (maximum 64000 egress); includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC1-3D-Q-R-B	MX-MPC1-3D-Q line card bundle; includes full scale L3, L2, and L2.5 features		
MX-MPC1-3D-R-B	MX-MPC1-3D line card bundle; includes full scale L3, L2, and L2.5 features		
MX-MPC1E-3D	1xTrio Chipset Enhanced MPC, port queuing; includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC1E-3D-Q	1xTrio Chipset Enhanced MPC, per-IFL HQoS, 128,000 queues (max 64,000 egress); includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC1E-3D-Q-R-B	MX-MPC1E-3D-Q line card bundle; includes full scale L3, L2, and L2.5 features		
MX-MPC1E-3D-R-B	MX-MPC1E-3D line card bundle;includes full scale L3, L2, and L2.5 features		
MX-MPC2-3D	2xTrio Chipset MPC, port queuing; includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC2-3D-EQ	2xTrio Chipset MPC, per-IFL HQoS, 512,000 queues; includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC2-3D-EQ-R-B	MX-MPC2-3D-EQ line card bundle, includes full scale L3, L2 and L2.5 features		
MX-MPC2-3D-Q	2xTrio Chipset MPC, per-IFL HQoS, 256,000 queues (max 128,000 egress): includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC2-3D-Q-R-B	MX-MPC2-3D-Q line card bundle; includes full scale L3, L2, and L2.5 features		
MX-MPC2-3D-R-B	MX-MPC2-3D line card bundle; includes full scale L3, L2, and L2.5 features		
MX-MPC2E-3D	2xTrio Chipset Enhanced MPC, port queuing; includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC2E-3D-EQ	2xTrio Chipset Enhanced MPC, per-IFL HQoS, 512,000 queues; includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC2E-3D-EQ-R-B	MX-MPC2E-3D-EQ line card bundle; includes full scale L3, L2, and L2.5 features		
MX-MPC2E-3D-P	2xTrio Chipset Enhanced MPC, 1588v2, port queuing; includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC2E-3D-P-Q-B	MX-MPC2E-3D-P line card bundle; includes 1588v2, per-IFL HQoS, 256,000 queues (maximum 128,000 egress), full scale L2/L2.5 and reduced scale L3 features		
MX-MPC2E-3D-P-Q-R-B	MX-MPC2E-3D-P line card bundle; includes 1588v2, per-IFL HQoS, 256,000 queues (maximum 128,000 egress), full scale L3, L2, and L2.5 features		
MX-MPC2E-3D-P-R-B	MX-MPC2E-3D-P line card bundle; includes 1588v2, full scale L3, L2, and L2.5 features		
MX-MPC2E-3D-Q	2xTrio Chipset Enhanced MPC, per-IFL HQoS, 256,000 queues (maximum 128,000 egress); includes full scale L2/L2.5 and reduced scale L3 features		
MX-MPC2E-3D-Q-R-B	MX-MPC2E-3D-Q line card bundle; includes full scale L3, L2, and L2.5 features		
MX-MPC2E-3D-R-B	MX-MPC2E-3D line card bundle; includes full scale L3, L2, and L2.5 features		
MX-MPC3E-3D	MPC3 with support for 100GbE, 40GbE, and 10GbE interfaces, L2.5 features, optics sold separately		
MX-MPC3E-3D-R-B	MPC3E with support for 100GbE, 40GbE, and 10GbE interfaces, includes full scale L2, L3, L3VPN features, optics sold separately		
MPC-3D-16XGE-SFPP	16x10GbE ports with L2.5 features, optics sold separately		
MPC-3D-16XGE-SFPP-R-B	16x10GbE ports with full scale L3, L2, and L2.5 features, optics sold separately		
MPC4E-3D-2CGE	2x100GbE and 8x10GbE ports, full scale L2/L2.5 and reduced scale L3 features		
MPC4E-3D-32XGE-SFPP	32x10GbE, full scale L2/L2.5 and reduced scale L3 features		
MPC4E-3D-2CGE-8XGE-IRB	2x100GbE and 8x10GbE ports, full scale L2/L2.5, L3 features, up to 16 L3VPNs per MPC		

Model Number	Description
MPC4E-3D-32XGE-IRB	32x10GbE SFPP ports, full scale L2/L2.5, L3 features, up to 16 L3VPNs per MPC
MPC4E-3D-2CGE8XGE-RB	2x100GbE and 8x10GbE ports, full scale L2/L2.5, L3 and L3VPN features
MPC4E-3D-32XGE-RB	32XGbE SFPP ports, full scale L2/L2.5, L3 and L3VPN features
MPC5E-100G10G	2-port 100GbE and 4-port 10GbE; includes full scale L2/L2.5 and reduced scale L3 features, optional license permits up to 32,000 queues with HQoS.
MPC5E-100G10G-IRB	2-port 100GbE and 4-port 10GbE; includes full scale L2/L2.5, L3 features and up to 16 L3VPN instances, optional license permits up to 32,000 queues with HQoS.
MPC5E-100G10G-RB	2-port 100GbE and 4-port 10GbE; includes full scale L2/L2.5, L3 and L3VPN features, optional license permits up to 32,000 queues with HQoS.
MPC5E-40G10G	6-port 40GbE or 24-port 10GbE; includes full scale L2/L2.5 and reduced scale L3 features, optional license permits up to 32,000 queues with HQoS.
MPC5E-40G10G-IRB	6-port 40GbE or 24-port 10GbE; includes full scale L2/L2.5, L3 features and up to 16 L3VPN instances, optional license permits up to 32,000 queues with HQoS.
MPC5E-40G10G-RB	6-port 40GbE or 24-port 10GbE; includes full scale L2/L2.5, L3 and L3VPN features, optional license permits up to 32,000 queues with HQoS.
MPC5EQ-100G10G	2-port 100GbE and 4-port 10GbE with HQoS; supports 1 million queues and 128,000 sessions; includes full scale L2/L2.5 and reduced scale L3 features.
MPC5EQ-100G10G-IRB	2-port 100GbE and 4-port 10GbE with HQoS; supports 1 million queues and 128,000 sessions; includes full scale L2/L2.5, L3 features and up to 16 L3VPN instances.
MPC5EQ-100G10G-RB	2-port 100GbE and 4-port 10GbE with HQoS; supports 1 million queues and 128,000 sessions; includes full scale L2/L2.5, L3 and L3VPN features.
MPC5EQ-40G10G	6-port 40GbE or 24-port 10GbE with HQoS; supports 1 million queues and 128,000 sessions; includes full scale L2/L2.5 and reduced scale L3 features.
MPC5EQ-40G10G-IRB	6-port 40GbE or 24-port 10GbE with HQoS; supports 1 million queues and 128,000 sessions, includes full scale L2/L2.5, L3 features and up to 16 L3VPN instances.
MPC5EQ-40G10G-RB	6-port 40GbE or 24-port 10GbE with HQoS; supports 1 million queues and 128,000 sessions, includes full scale L2/L2.5, L3 and L3VPN features.
MS-MPC-128	Multiservices MPC supports a variety of licensed applications including Stateful firewall, Carrier-Grade NAT (CGN), and deep-packet inspection (DPI); each purchased separately. MS-MPC occupies a single slot in MX2020, MX2010, MX960, MX480, and MX240.
MIC	
MIC3-3D-10XGE-SFPP	MIC with 10x10GbE SFP+ interface
MIC-3D-20GE-SFP	20 ports of 10/100/1000 Ethernet with small form-factor pluggable transceiver (SFP) interfaces
MIC-3D-20GE-SFP-E	20 ports of 10/100/1000 Ethernet with enhanced small form-factor pluggable transceiver (SFP) interfaces
MIC-3D-20GE-SFP-EH	20 ports of 10/100/1000 Ethernet with enhanced and temperature hardened small form-factor pluggable transceiver (SFP) interfaces
MIC-3D-2XGE-XFP	2 10GbE modular interface cards with XFP interfaces
MIC-3D-4XGE-XFP	4 10GbE modular interface cards with XFP interfaces
MIC-3D-40GE-TX	40 ports of 10/100/1000 Ethernet with TX interfaces
MIC3-3D-1X100GE-CFP	MIC with 1x100GbE C form-factor pluggable transceiver (CFP) interface
MIC3-3D-1X100GE-CXP	MIC with 1x100GbE CXP interface
MIC3-3D-2X40GE-QSFPP	MIC with 2x40GbE QSFP+ interfaces
MS-MIC-16	Multiservices MIC supports a variety of licensed applications including Stateful firewall, Carrier-Grade NAT (CGN), and deep-packet inspection (DPI); each purchased separately.

Model Number	Description
DPC	
DPCE-R-20GE-2XGE	20-port GbE + 2-port 10GbE DPC with L2+L3 features
DPCE-R-Q-20GE-2XGE	20-port GbE + 2-port 10GbE enhanced queuing DPC with L2+L3 features
DPCE-R-Q-20GE-SFP	20x1GbE L2/L3 capable with enhanced queuing
DPCE-R-2XGE-XFP	2x10GbE Enhanced DPC for MX Series
DPCE-R-40GE-SFP	40x1GbE L2/L3 capable
DPCE-R-Q-40GE-SFP	40x1GbE enhanced queuing DPC for MX Series with L2/L3 features and VLAN-HQoS
DPCE-R-40GE-TX	40-port 10/100/1000 RJ-45 DPC with L2+L3 features
DPCE-X-40GE-SFP	40x1GbE L2+ capable
DPCE-X-Q-40GE-SFP	40x10/100/1000 Ethernet L2/L3 capable with RJ45
DPCE-X-4XGE-XFP	4x10GbE L2+ capable
DPCE-R-4XGE-XFP	4x10GbE Enhanced DPC with L2+L3 features
DPCE-R-Q-4XGE-XFP	4x10GbE queuing DPC with L2/L3 features and VLAN-HQoS
DPCE-X-Q-4XGE-XFP	4x10GbE L2+ capable board with enhanced queuing
MX-FPC2	DPC with 2 slots for type 2 PICs
MS-DPC	Multiservices DPC provides 20 Gbps of service throughput
Routing Engines	
RE-S-1300-2048-BB	1.3 GHz CPU and 2 GB memory, base bundle
RE-S-2000-4096-UPG-BB	2 GHz CPU and 4 GB memory, base bundle
RE-S-1300-2048-R	1.3 GHz CPU and 2 GB memory, redundant
RE-S-2000-4096-R	2 GHz CPU and 4 GB memory, redundant
RE-S-1800X2-8G-R	Dual-core 1.8 GHz CPU and 8 GB memory, redundant
RE-S-1800X2-16G-R	Dual-core 1.8 GHz CPU and 16 GB memory, redundant
RE-S-1800X4-8G-R	Quad-core 1.8 GHz CPU and 8 GB memory, redundant
RE-S-1800X4-16G-R	Quad-core 1.8 GHz CPU and 16 GB memory, redundant
RE-S-1800X2-8G-UPG-BB	Dual-core 1.8 GHz CPU and 8 GB memory, upgrade for base bundle
RE-S-1800X2-16G-UPG-BB	Dual-core 1.8 GHz CPU and 16 GB memory, upgrade for base bundle
RE-S-1800X4-8G-UPG-BB	Quad-core 1.8 GHz CPU and 8 GB memory, upgrade for base bundle
RE-S-1800X4-16G-UPG-BB	Quad-core 1.8 GHz CPU and 16 GB memory, upgrade for base bundle
RE-S-1800X4-32G-BB	Quad Core 1.8GHz CPU with 32 GB memory, base bundle
RE-S-1800X4-32G-R	Quad Core 1.8GHz CPU with 32 GB memory, redundant
RE-S-1800X4-32G-S	Quad Core 1.8GHz CPU with 32 GB memory, spare
RE-S-1800X4-32G-UB	Quad Core 1.8GHz CPU with 32 GB memory, upgrade for base bundle
RE-S-1800X4-32G-WS	Quad Core 1.8GHz CPU with 32 GB memory, worldwide version
Switch Board Control	
SCB-MX960-BB	SCB for MX240, MX480, and MX960
SCBE-MX-BB	Enhanced Switch Control Board for MX240, MX480, and MX960
SCBE2-MX-BB	Enhanced MX Switch Control Board for MX240, MX480, and MX960
Junos OS	
USA	Junos OS
Worldwide	Junos-WW

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net.

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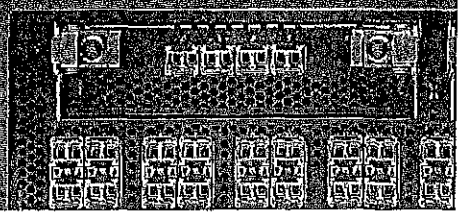
Data Sheet

EX4500 Ethernet Switch

with Virtual Chassis Technology



Product Overview

The Juniper Networks EX4500 line of Ethernet switches delivers a scalable, high-performance platform for supporting high-density 1 gigabit per second (Gpbs) and 10 Gbps data center top-of-rack as well as data center, campus, and service provider aggregation deployments.

Product Description

Featuring up to 48 wire-speed 10-Gigabit Ethernet (10GbE) ports in a two rack unit (2U) platform, the Juniper Networks® EX4500 Ethernet Switch delivers Layer 2 and Layer 3 connectivity to networked devices such as servers and other switches. The EX4500 base switch provides 40 fixed 10GbE pluggable ports that can also support GbE connectors for added flexibility. Two optional high-speed uplink modules offer four additional 10GbE small form-factor pluggable transceiver (SFP+) ports each for connecting to upstream devices.

By targeting high-density 10GbE top-of-rack and aggregation deployments in the data center, campus, and service provider environments, EX4500 switches perfectly complement the Juniper Networks EX Series Ethernet Switch product family: the Juniper Networks EX2200 line and EX3200 line designed for low-density access deployments; the EX4200 line designed for data center and campus GbE access and aggregation deployments; and the EX8200 line of Ethernet switches designed for data center and campus core and aggregation environments.

Virtual Chassis Technology

The EX4500 supports Juniper Networks' unique Virtual Chassis technology, which enables up to 10 interconnected switches to operate as a single, logical device with a single IP address. When deployed in a Virtual Chassis configuration, the EX4500 switches are connected over a 128 Gbps backplane using Virtual Chassis interconnect cables. EX4500 switches can also be interconnected using a link aggregation (LAG) of up to eight SFP+ 10 GbE line-rate links, allowing switches to reside in different locations. Interconnected switches are monitored and managed as a single device, enabling enterprises to separate physical topology from logical groupings of endpoints and allowing more efficient resource utilization.

In the data center, using Virtual Chassis technology at the top of rack or end of row to aggregate servers provides flexibility in the deployment of uplinks. Rather than requiring redundant links for each physical switch to ensure high availability, redundant links are only needed for each Virtual Chassis group. EX4500 and EX4200 switches may be combined within a single Virtual Chassis configuration to support environments where both GbE and 10GbE servers are present.

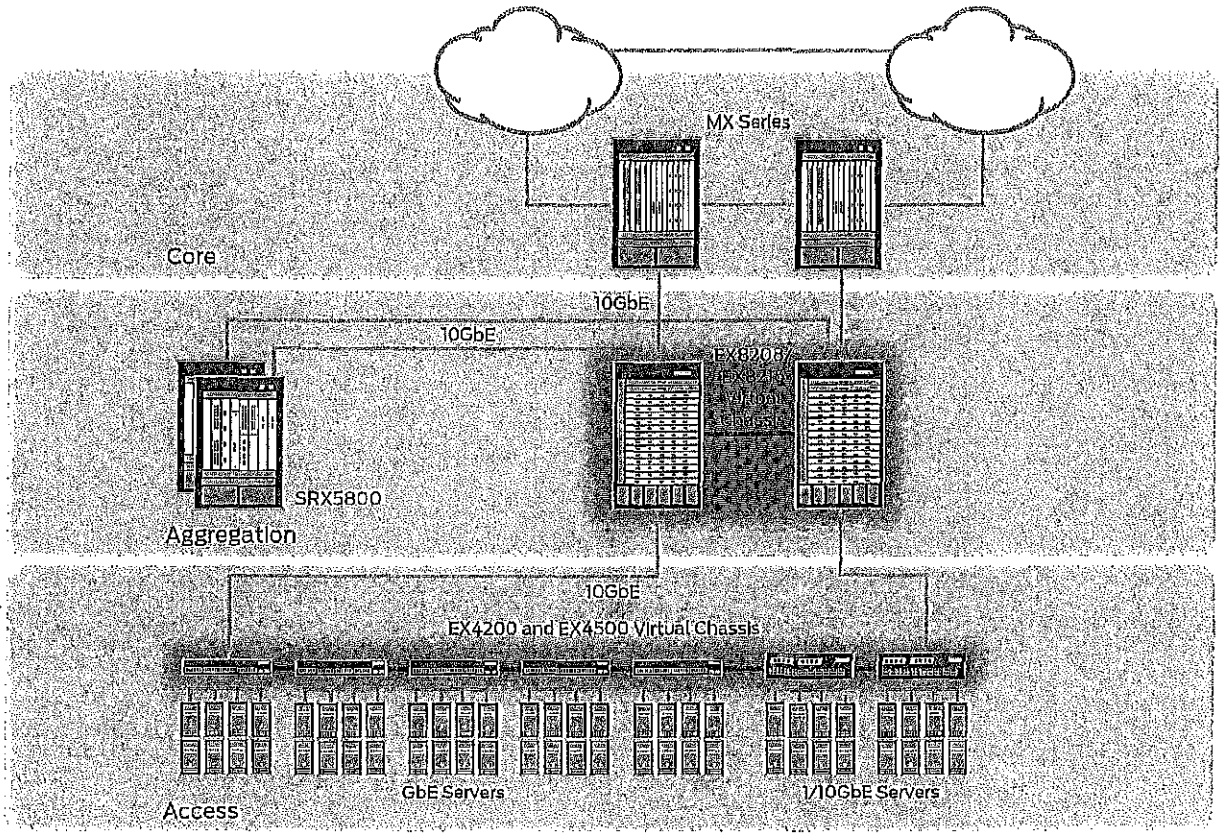


Figure 1: The EX4500 provides 10GbE server access in the data center.

Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit www.juniper.net/us/en/products-services.

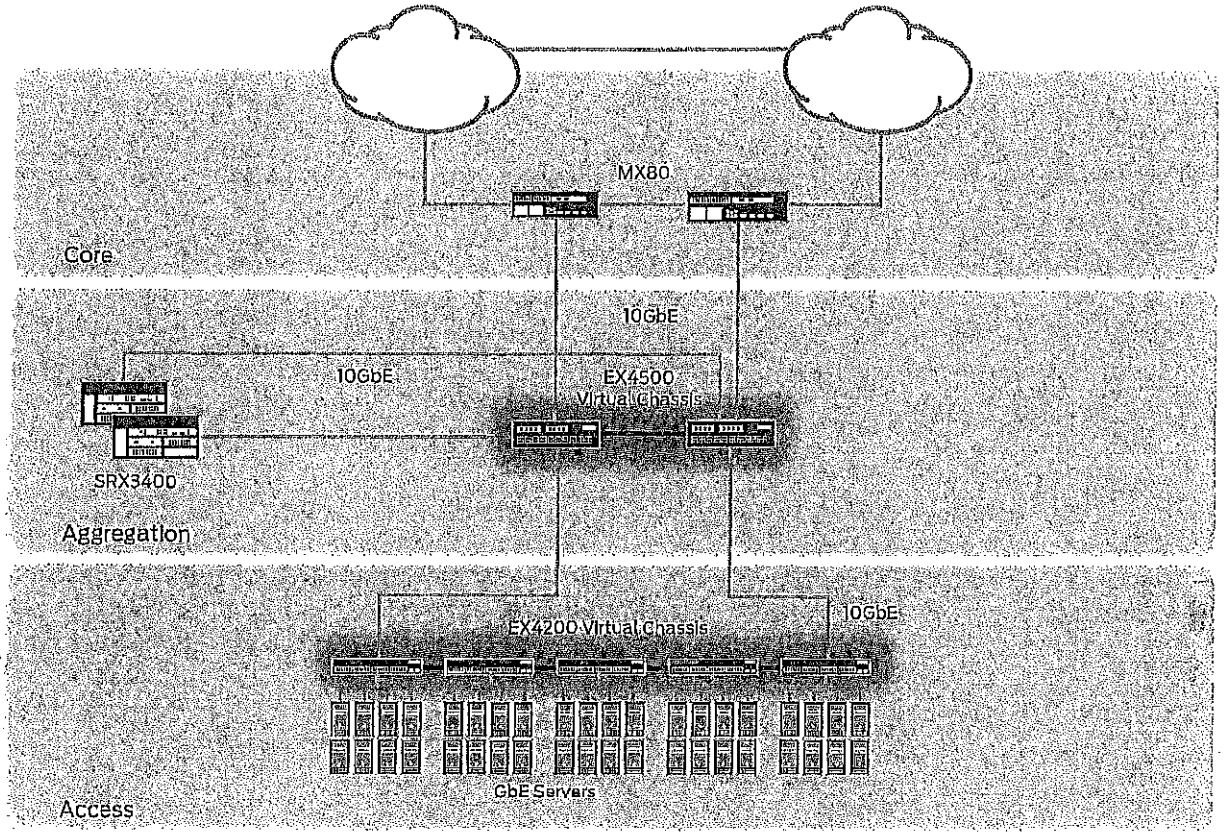


Figure 2: The EX4500 10GbE switch is ideal for small data center core deployments.

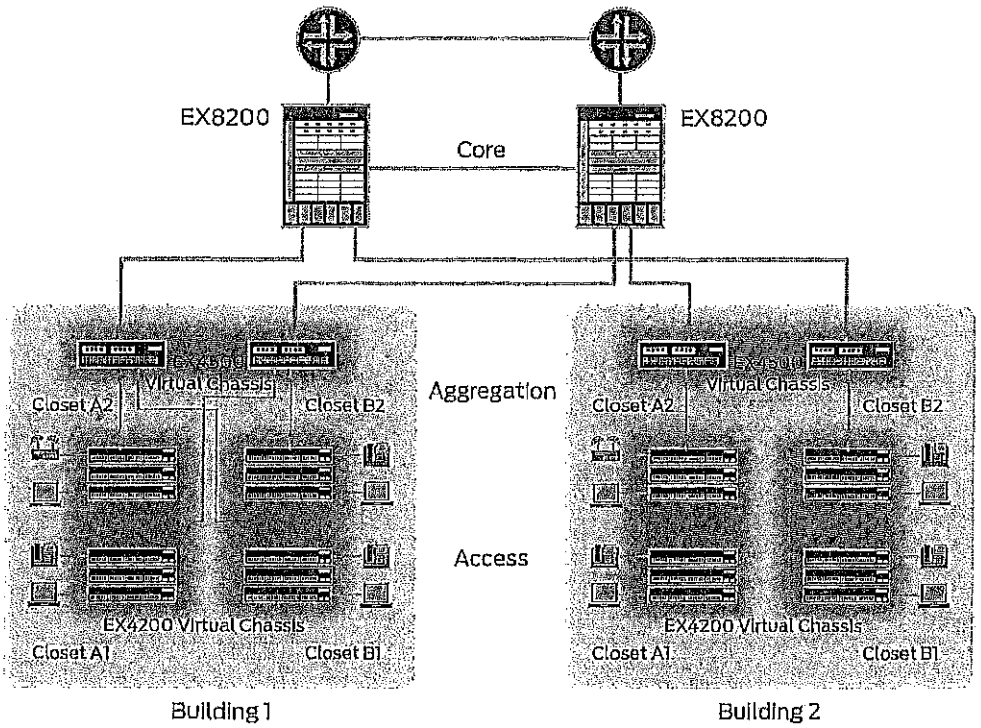


Figure 3: The EX4500 switch offers an economical, power-efficient, compact solution for campus aggregation deployments.

Campus Deployments

The EX4500 also offers an economical, power efficient and compact solution for aggregating 10GbE uplinks from access devices in building and campus deployments (see Figure 3). The switch's dual-speed interfaces also support environments transitioning from GbE to 10GbE.

The EX4500 easily meets enterprise core switch requirements, delivering wire-speed performance on every port, full device redundancy, support for Layer 3 dynamic routing protocols such as RIP and OSPF, and a comprehensive security and quality-of-service (QoS) feature set.

Data Center Deployments

The EX4500 Ethernet Switch is designed for demanding data center applications where high performance, high availability, and energy efficiency are key requirements (see Figure 1). Operating at wire speed, the EX4500 switches deliver 714 Mpps throughput and a data rate of 960 Gbps (full duplex) for both Layer 2 and Layer 3 protocols. An industry first and only, EX4500s can be interconnected in a Virtual Chassis configuration that also includes EX4200s, creating a single logical switch that offers a variety of port and density options for mixed server environments.

Flexible deployment options enable the EX4500 to support back-to-front and front-to-back cooling, which ensures consistency with server designs for hot and cold aisle deployments. Front- and rear-facing configuration options ensure closer proximity to server ports, optimizing performance and keeping cable lengths short and manageable. The EX4500 is also very environmentally conscious, drawing less than eight watts per port under maximum load.

For small data centers, the EX4500, in a Virtual Chassis configuration, is ideally deployed as the aggregation/core switch, aggregating 10GbE uplinks from EX4200 Virtual Chassis configurations in the access layer (see Figure 2).

Customers introducing 10GbE into their racks will be able to use the EX4500 to add 10GbE-attached servers, iSCSI, and network-attached storage (NAS) with minimal impact to the current switching infrastructure.

The EX4500 also includes hardware support for the Data Center Bridging (DCB) feature set, also referred to as Converged Enhanced Ethernet (CEE). DCB is a collection of individual IEEE standards that allow for Ethernet-based I/O and network convergence, including support for FCoE.

10GbE DCB and I/O Convergence Deployments

The EX4500 is a full IEEE DCB- and T11 FC-BB-5-based FCoE Transit Switch, delivering a high-performance solution for converged server edge access environments. As an FCoE Transit Switch, the EX4500 provides a pure IEEE DCB-converged access layer between FCoE-enabled servers and an FCoE-enabled Fibre Channel SAN (see Figure 4).

The EX4500 also supports FC Initiation Protocol (FIP) snooping, which provides perimeter protection to ensure that the presence of an Ethernet layer does not impact existing SAN security policies. The FCoE Transit Switch functionality, along with Priority-based Flow Control (PFC) and Data Center Bridging Exchange (DCBX), are included as part of the default software; no additional licenses are required.

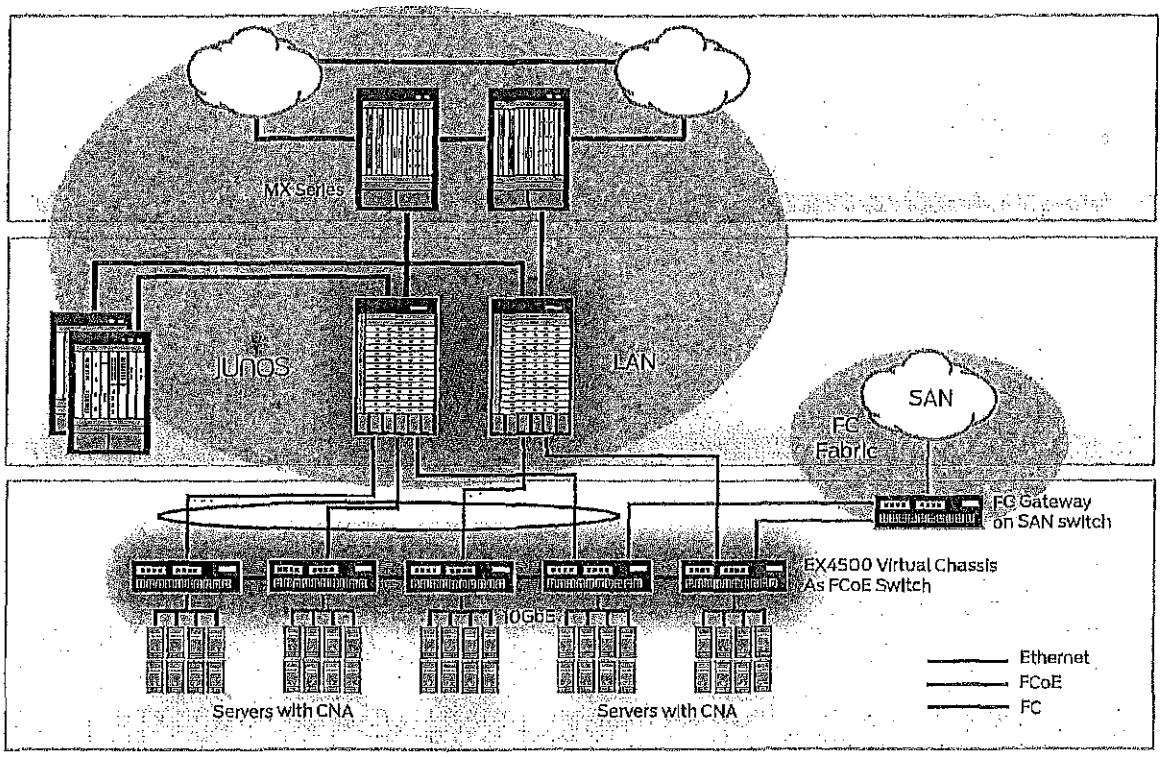


Figure 4: The EX4500 deployed as a data center FCoE Transit Switch in a top-of-rack Virtual Chassis configuration.

Junos Operating System

The EX4500 runs the same Juniper Networks Junos operating system that is used by other EX Series Ethernet Switches, as well as all Juniper Networks routers and Juniper Networks SRX Series Services Gateways. By utilizing a common operating system, Juniper Networks delivers a consistent implementation and operation of control plane features across all products. To maintain that consistency, Junos OS adheres to a highly disciplined development process that uses a single source code, follows a single quarterly release train, and employs a highly available modular architecture that prevents isolated failures from bringing down an entire system.

These attributes are fundamental to the core value of the software, enabling all Junos OS-powered products to be updated simultaneously with the same software release. All features are fully regression tested, making each new release a true superset of the previous version; customers can deploy the software with complete confidence that all existing capabilities will be maintained and operate in the same way.

Management Options

Up to four different system management options are available for the EX4500 Ethernet switches.

The standard Junos OS command-line interface (CLI) offers the same granular management capabilities and scripting parameters found in any router powered by the Junos OS.

1. The EX4500 also includes the integrated Juniper Networks J-Web Software, an embedded web-based device manager that allows users to configure, monitor, troubleshoot, and perform system maintenance on individual switches via a browser-based graphical interface.
2. EX4500 performance, configuration, and fault data can also be exported to leading third-party management systems such as HP OpenView, IBM Tivoli, and Computer Associates Unicenter software, providing a complete, consolidated view of network operations.
3. The EX4500 is also supported by Juniper Networks Junos® Space*, an open, programmable application platform for hosting a comprehensive suite of network operational application tools that provide a smart, simple, and open approach for automating the deployment and operation of a Juniper infrastructure.
4. Explicitly designed to allow partners and customers to build and deploy smart, simple, and easy-to-use applications, Junos Space provides multiple management and infrastructure applications for managing Juniper resources and assets, including inventory management, device and interface configuration, automated software management and deployment, and event-driven fault management. These Junos Space applications offer predefined automation schemes and best practice templates to enable rapid and accurate deployments.

*Roadmap

Features and Benefits

The EX4500 Ethernet switches include the following key features and benefits.

High Performance

Each EX4500 supports 480 Gbps of bandwidth with 48 line-rate 10 Gbps ports at all packet sizes or 14.88 Mpps per port at the minimum Ethernet frame size.

High Availability

The EX4500 switches offer dual internal load sharing AC power supplies, and redundant variable-speed fans as standard features, protecting the switch from a single power supply or fan failure. DC power options will be available in the future.

Energy Efficient

Consuming less than eight watts per 10GbE interface, the EX4500 offers a low power solution for 10GbE top-of-rack, end-of-row, and aggregation deployments. The EX4500 switches also improve cooling efficiency with redundant variable-speed fans that automatically adjust their speed based on existing conditions to reduce power consumption.

Small Footprint

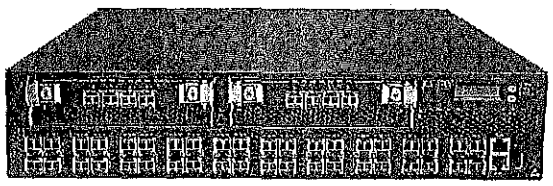
The EX4500 supports up to 48 wire-speed 10GbE ports in a single 2U platform.

Additional Features

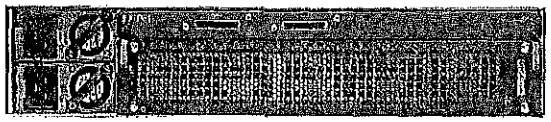
- System status LEDs
- LCD status display
- Versatile two- and four-post rack mounting options
- Front-to-back and back-to-front airflow options
- AC and DC power supply options
- Support for Jumbo frames (9,000)
- Quality of service (IEEE 802.1p marking)
- Multicast (IGMP v1/v2/v3 snooping)
- Layer 2 features including support for 4,096 VLAN IDs, Spanning Tree (802.1s and 802.1w), bridge protocol data unit (BPDU) guard, 802.3as Link Aggregation
- Management features including Telnet and SSH v1/v2, SNMP v1-v3, RADIUS, TACACS+, and RMON

Table 1: EX4500 Power Consumption

Configuration	Power Consumption
No uplinks installed; 40 USR ports in base, all ports forwarding (line rate)	328 W
One uplink module (4 x 10GbE SFP+ ports) installed; 40 USR ports in base, all ports forwarding (line rate)	346 W
Two uplink modules (8 x 10GbE SFP+ ports) installed; 40 USR ports in base, all ports forwarding (line rate)	364 W



EX4500 with two uplink modules
(4 x 10GbE SFP+ ports)



EX4500 with Virtual Chassis module and
dual redundant power supplies

EX4500 10GbE Ethernet Switch Specifications

Hardware

Interface Options

- 40 GbE/10GbE small form-factor pluggable transceiver (SFP/SFP+) fiber connectors
- Eight 10GbE SFP+ uplink ports (via two optional four-port uplink modules)
- 1 x 10/100/1000 Ethernet RJ-45 ports for management
- Console port for management
- 128 Gbps Virtual Chassis module with 2 x 64 Gbps ports

Supported Optics

- 10GbE SFP+ LC connector type: short reach (SR) (multimode), long reach (LR) (single mode), ultra short reach (USR) (multimode), extended reach (ER) (single mode)
- 10GbE SFP+ copper: Direct-attached copper (1/3/5/7 m)
- 1 GbE SFP LC connector type: LX (single mode), SX (multi mode), 1000BASE-T (only 1,000 M supported)

Dimensions

- Height: 3.5 in (8.9 cm); 2U
- Width: 17.25 in (43.8 cm)
- Depth: 21.1 in (53.6 cm)
- Weight: 37 lb (17 kg) with one AC and DC power supply

Rack Installation Kit

- Versatile two- and four-post mounting options for 19-in server rack or datacom rack

LEDs

- System LEDs that indicate status

Airflow

- Front-to-back or back-to-front cooling
- Redundant variable-speed fans reduce power draw

CPU

- 1.5 GHz PowerPC

Memory

- DRAM: 1 GB
- Flash: 2 GB

Power

- Dual hot-swappable load sharing AC and DC power supplies

Software

Security

- RADIUS
- TACACS+
- Access control lists (ACLs): Allow and deny
- SSH v1, v2
- Secure interface login and password
- Local proxy Address Resolution Protocol (ARP)
- Static ARP support

Layer 2 Switching

- Maximum number of MAC addresses in hardware: 32,000*
- Jumbo frames: 9,216 bytes
- Number of VLANs: 4,096
- Port-based VLAN
- 4,096 VLAN IDs supported
- Routed VLAN Interface (RVI)

Link Aggregation

- 802.3ad support
  - Number of Link Aggregation Groups (LAGs) supported: 64
  - Maximum number of ports per LAG: 8
- LAG load-sharing algorithm—bridged or routed (unicast or multicast) traffic:
  - IP: S/D IP
  - TCP/UDP: S/D IP, S/D Port
  - Non-IP: S/D MAC
  - Tagged ports support in LAG

Spanning Tree

- RSTP and VSTP running concurrently
- Spanning Tree Protocol (802.1D)
- Multiple Spanning Tree Protocol (MSTP) (802.1s)
- Rapid Spanning Tree Protocol (RSTP) (802.1w)
- VSTP - VLAN Spanning Tree
- BPDU protect
- Loop protect
- Root protect

Quality of Service (QoS)

- EZQoS
- CoS on L3 VLAN
- Per interface rewrite
- Per interface classification
- Policer mark down action
- Remarking of bridged packets
- Layer 2 QoS
- Layer 3 QoS
- Rate Limiting:

* MAC address table uses a hash-based scheme to program entries; therefore, some entries may not be programmed due to hash index collision.

- Ingress policing: 1 rate 2 color
- Egress shaping: per-queue, per-port
- Eight hardware queues per port
- Scheduling methods (egress): Strict priority (SP), shaped deficit weighted round-robin (SDWRR)
- 802.1p remarking
- Layer 2-4 classification criteria: Interface, MAC address, Ethertype, 802.1p, VLAN, IP address, DSCP/IP precedence, TCP/UDP port numbers, etc.
- Congestion avoidance capabilities: Weighted tail drop eight queues

Layer 3 Features: IPv4

- VRF-lite (ISIS, RIP, OSPF, BGP, BGP, ISIS)
- IP directed broadcast traffic forwarding
- Routing protocols: RIPv1/v2, OSPF, BGP, ISIS
- Max number of IPv4 unicast routes in hardware: 14,000**
- Max number of IPv4 multicast routes in hardware: 4,000
- Static routing
- Routing policy
- Virtual Router Redundancy Protocol (VRRP)
- Bidirectional Forwarding Detection (BFD) protocol

Layer 3 Features: IPv6

- Max number of Neighbor Discovery (ND) entries: 1,000
- Max number of IPv6 unicast routes in hardware: 3,400**
- Max number of IPv6 multicast routes in hardware: 1,000
- Routing protocols: RIPng, OSPFv3, IPv6, BGP, MLDv2
- Static routing

Multicast

- VRF-lite (PIM, IGMP)
- IGMP static
- Internet Group Management Protocol (IGMP): v1, v2, v3
- IGMP snooping
- PIM-SM, PIM-SSM
- Multicast Source Directory Protocol (MSDP)

Access Control Lists (ACLs) (Junos OS firewall filters)

- Port-based ACL (PACL)—ingress and egress
- VLAN-based ACL (VACL)—ingress and egress
- Router-based ACL (RACL)—ingress and egress
- ACL entries (ACE) in hardware per system: 1,500
- ACL counter for denied packets
- ACL counter for permitted packets
- Ability to add/remove/change ACL entries in middle of list (ACL editing)
- Layer 2-L4 ACL
- Trusted Network Connect (TNC) certified
- MAC authentication (RADIUS)
- Control plane denial-of-service (DoS) protection

** Uni-dimensional scale (shared table between v4 and v6)

Virtual Chassis Capabilities

- Maximum number of members: 10
- Virtual Chassis Ports (VCPs):
  - Two dedicated 64 Gbps ports with 128 Gbps Virtual Chassis module
  - Any base or uplink port can act as VCPs
- Maximum Virtual Chassis interconnect capacity:
  - 128 Gbps with Virtual Chassis module
  - Up to 48 x 10 Gbps using base or uplink ports (subject to a maximum of 8 members per LAG group per destination, 64 LAG groups per system)
- Maximum Virtual Chassis distance:
  - Virtual Chassis module ports: Up to 5m with VCP cable
  - Base or uplink ports: Up to maximum distance supported by optics

Data Center Bridging (DCB)

- Priority-based Flow Control (PFC) – IEEE 802.1Qbb
- Data Center Bridging Exchange Protocol (DCBX)

Fibre Channel over Ethernet (FCoE)

- FCoE Transit Switch (FIP snooping)
- iSCSI SAN
- iSCSI TLV support

High Availability

- Non-Stop Routing (NSR): OSPF v2, RIP v1/v2, BGP, ISIS, IGMP v1, v2, v3
- Redundant, hot-swappable power supplies
- Redundant, field-replaceable, hot-swappable fans
- Graceful Route Engine Switchover (GRES) for Layer 2 hitless forwarding and Layer 3 protocols on Routing Engine failover
- Graceful Protocol Restart: OSPF, BGP, IGMP v1/v2/v3 snooping
- Non-stop Bridging (NSB) for xSTP, LACP, LLDP/LLDP-MED
- Non-stop Switch Upgrade (NSSU) for EX4500-VC or EX4200-EX4500-VC
- Virtual Chassis Fast Convergence (as low as sub-50ms)

Supported RFCs

- RFC 2925 MIB for Remote Ping, Trace
- RFC 1122 Host Requirements
- RFC 768 UDP
- RFC 791 IP
- RFC 783 Trivial File Transfer Protocol (TFTP)
- RFC 792 ICMP
- RFC 793 TCP
- RFC 826 ARP
- RFC 894 IP over Ethernet
- RFC 903 RARP
- RFC 906 TFTP Bootstrap
- RFC 1027 Proxy ARP
- RFC 2068 HTTP server

- RFC 1812 Requirements for IP Version 4 Routers
- RFC 1519 Classless Interdomain Routing (CIDR)
- RFC 1256 IPv4 ICMP Router Discovery (IRDP)
- RFC 1058 RIP v1
- RFC 2453 RIP v2
- RFC 1112 IGMP v1
- RFC 2236 IGMP v2
- RFC 3618 MSDP
- RFC 4915 MT-OSPF
- RFC 3376 IGMP v3
- RFC 1492 TACACS+
- RFC 2138 RADIUS Authentication
- RFC 2139 RADIUS Accounting
- RFC 3579 RADIUS EAP support for 802.1x
- RFC 5176 Dynamic Authorization Extensions to RADIUS
- RFC 2267 Network Ingress Filtering
- RFC 2030 SNTP, Simple Network Time Protocol
- RFC 854 Telnet client and server
- RFC 951, 1542 BootP
- RFC 2131 BOOTP/DHCP relay agent and Dynamic Host Configuration Protocol (DHCP) server
- RFC 1591 Domain Name System (DNS)
- RFC 2338 VRRP
- RFC 2328 OSPF v2 (edge mode)
- RFC 1587 OSPF not-so-stubby area (NSSA) Option
- RFC 2154 OSPF w/Digital Signatures (Password, MD-5)
- RFC 2370 OSPF Opaque link-state advertisement (LSA) Option
- RFC 3623 OSPF Graceful Restart
- RFC 2362 PIM-SM (edge mode)
- RFC 3569 draft-ietf-ssm-arch-06.txt PIM-SSM PIM Source Specific Multicast
- RFC 2474 DiffServ Precedence, including 8 queues/port
- RFC 2598 DiffServ Expedited Forwarding (EF)
- RFC 2597 DiffServ Assured Forwarding (AF)
- RFC 2475 DiffServ Core and Edge Router Functions
- LLDP Media Endpoint Discovery (LLDP-MED), ANSI/TIA-1057, draft 08
- PIM-DM Draft IETF PIM Dense Mode draft-ietf-idmr-pim-dm-05.txt, draft-ietf-pim-dm-new-v2-04.txt
- Draft-ietf-bfd-base-05.txt Bidirectional Forwarding Detection

Supported MIBs*

- RFC 1155 SMI
- RFC 1157 SNMPv1
- RFC 1905 RFC 1907 SNMP v2c, SMIv2 and Revised MIB-II
- RFC 2570 – 2575 SNMPv3, user based security, encryption and authentication
- RFC 2576 Coexistence between SNMP Version 1, Version 2, and Version 3
- RFC 1212, RFC 1213, RFC 1215 MIB-II, Ethernet-Like MIB and TRAPs
- RFC 2578 SNMP Structure of Management Information MIB
- RFC 2579 SNMP Textual Conventions for SMIv2
- RFC 2925 Ping/Traceroute MIB
- RFC 2665 Ethernet-like Interface MIB
- RFC 1643 Ethernet MIB
- RFC 1493 Bridge MIB
- RFC 2096 IPv4 Forwarding Table MIB
- RFC 2011 SNMPv2 for Internet protocol using SMIv2
- RFC 2012 SNMPv2 for transmission control protocol using SMIv2
- RFC 2013 SNMPv2 for user datagram protocol using SMIv2
- RFC 2863 Interface MIB
- RFC 3413 SNMP Application MIB
- RFC 3414 User-based Security Model for SNMPv3
- RFC 3415 View-based Access Control Model for SNMP
- RFC 1724 RIPv2 MIB
- RFC 2863 Interface Group MIB
- RFC 2932 IPv4 Multicast MIB
- RFC 2787 VRRP MIB
- RFC 1850 OSPFv2 MIB
- RFC 2819 RMON MIB
- RFC 2287 System Application Packages MIB
- RFC 4188 STP and Extensions MIB
- RFC 4363 Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and VLAN extensions
- RFC 2922 LLDP MIB
- Draft – blumenthal – aes – usm - 08
- Draft – reeder - snmpv3 – usm - 3desede -00
- Draft – ietf-idmr-igmp-mib-13
- Draft – ietf-idmr-pim-mib-09
- Draft – ietf-bfd-mib-02.txt

Troubleshooting

- Debugging: CLI via console, Telnet, or SSH
- Diagnostics: Show and debug command, statistics
- Traffic monitoring/mirroring (port, VLAN)
- IP tools: Extended ping and trace
- Junos OS commit and rollback

Traffic Mirroring

- Port-based
- VLAN-based
- ACL-based mirroring
- Mirroring destination ports per system: 1
- LAG port monitoring
- Multiple destination ports monitored to 1 mirror (N:1)
- Maximum number of mirroring sessions: 1
- Mirroring to remote destination (over L2): 1 destination VLAN

*Unless explicitly specified for any particular MIB table or variables, Junos OS does not support SNMP set operations.

Safety and Compliance

Safety Certifications

- UL-UL60950-1 (First Edition)
- C-UL to CAN/CSA 22.2 No.60950-1 (First Edition)
- TUV/GS to EN 60950-1, Amendment A1-A4, A11
- CB-IEC60950-1, all country deviations

Electromagnetic Compatibility Certifications

- FCC 47CFR Part 15 Class A
- EN 55022 Class A
- ICES-003 Class A
- VCCI Class A
- AS/NZS CISPR 22 Class A
- CISPR 22 Class A
- EN 55024
- EN 300386
- CE

Environmental

- Reduction of Hazardous Substances (ROHS) 5
- Telco
- CLEI code
- Environmental Ranges
- Operating temperature: 32° to 113° F (0° to 45° C)
- Storage temperature: -40° to 158° F (-40° to 70° C)
- Operating altitude: up to 10,000 ft (3,048 m)
- Non-operating altitude: up to 16,000 ft (4,877 m)
- Relative humidity operating: 10% to 85% (noncondensing)
- Relative humidity non-operating: 0% to 95% (noncondensing)

Telecom Quality Management

- TL9000

Mean Time Between Failures (MTBF)

Part Number	Description	Predicted MTBF (khrs)	FIT Rate
EX4500-40F-BF/FB-C	EX4500 40-port GbE/10GbE SFP/SFP+ with back-to-front/front-to-back airflow	110	9,094
EX4500-40F-VC1-BF/FB	EX4500 40-port GbE/10GbE SFP/SFP+ with back-to-front/front-to-back airflow and 128 Gbps Virtual Chassis Interconnect module	96	10,389
EX4500-UM-4XSFP	EX4500 four-port 10GbE SFP+ uplink module	626	1,598

Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit www.juniper.net/us/en/products-services.

Ordering Information

Model Number	Description
Base Unit*	
EX4500-40F-FB-C	40-port GbE/10GbE SFP/SFP+ front-to-back airflow, hardware support for Data Center Bridging, and support for eight PFC (802.1Qbb) queues
EX4500-40F-BF-C	40-port GbE/10GbE SFP/SFP+ back-to-front airflow, hardware support for Data Center Bridging, and support for eight PFC (802.1Qbb) queues
EX4500-40F-DC-C	40-port GbE/10GbE SFP/SFP+ front-to-back airflow, 1200W DC, hardware support for Data Center Bridging, and support for eight PFC (802.1Qbb) queues
EX4500-40F-VC1-BF	40-port GbE/10GbE SFP/SFP+ back-to-front airflow, 128 Gbps Virtual Chassis Interconnect module, hardware support for Data Center Bridging, and support for eight PFC (802.1Qbb) queues
EX4500-40F-VC1-FB	40-port GbE/10GbE SFP/SFP+ front-to-back airflow, 128 Gbps Virtual Chassis Interconnect module, hardware support for Data Center Bridging, and support for eight PFC (802.1Qbb) queues
EX4500-40F-VC1-DC	40-port GbE/10GbE SFP/SFP+ front-to-back airflow, 128 Gbps Virtual Chassis Interconnect module, 1200W DC power supply, hardware support for Data Center Bridging, and support for eight PFC (802.1Qbb) queues
Advanced Feature Licenses	
EX-48-AFL	Advanced Feature License for IS-IS, BGP, MPLS and IPv6 routing
Accessories	
EX4500-PWR1-AC-FB	EX4500 1200 W AC (1000 W at 110 V) power supply – front-to-back airflow
EX4500-PWR1-AC-BF	EX4500 1200 W AC (1000 W at 110 V) power supply – back-to-front airflow
EX4500-UM-4XSFP	EX4500 4-Port 10GbE SFP+ uplink module (optics sold separately)
EX4500-PWR1-DC	EX4500 1200 W DC power supply - front to back airflow (power cord needs to be ordered separately)
EX4500-VC1-128G	128 Gbps Virtual Chassis module
EX-CBL-VCP-50CM	Virtual Chassis Port cable 0.5 M length
EX-CBL-VCP-1M	Virtual Chassis Port cable 1 M length
EX-CBL-VCP-3M	Virtual Chassis Port cable 3 M length
EX-CBL-VCP-5M	Virtual Chassis Port cable 5 M length

* EX4500 base unit includes chassis, fan tray, interconnect module, AC power supply, power cord, power supply cover panel, and two uplink module cover panels

Model Number	Description
Pluggable Optics	
EX-SFP-1GE-T	SFP 1000BASE-T copper; RJ-45 connector; 100 m reach on UTP
EX-SFP-1GE-SX	SFP 1000BASE-SX; LC connector; 850 nm; 550 m reach on multimode fiber
EX-SFP-1GE-LX	SFP 1000BASE-LX; LC connector; 1310 nm; 10 km reach on single mode fiber
EX-SFP-10GE-SR	SFP+ 10GBASE-SR; LC connector; 850 nm; 300 m reach on 50 microns multimode fiber; 33 m on 62.5 microns multimode fiber
EX-SFP-10GE-LR	SFP+ 10GBASE-LR; LC connector; 1310 nm; 10 km reach on single mode fiber
EX-SFP-10GE-LRM	SFP+ 10GBASE-LRM; LC connector; 1310 nm; 220 m reach on multimode fiber
EX-SFP-10GE-ER	SFP+ 10GBASE-ER 10 Gigabit Ethernet Optics, 1550 nm for 40 km transmission on single-mode fiber
EX-SFP-10GE-DAC-1M	SFP+ 10GbE Direct Attach Copper (twinax copper cable) 1 m
EX-SFP-10GE-DAC-3M	SFP+ 10GbE Direct Attach Copper (twinax copper cable) 3 m
EX-SFP-10GE-DAC-5M	SFP+ 10GbE Direct Attach Copper (twinax copper cable) 5 m
EX-SFP-10GE-DAC-7M	SFP+ 10GbE (twinax copper cable) 7 m
EX-SFP-10GE-USR	10GbE Ultra Short Reach; 850 nm; 10 m on OM1, 30 m on OM2, 100 m on OM3 multimode fiber

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net.

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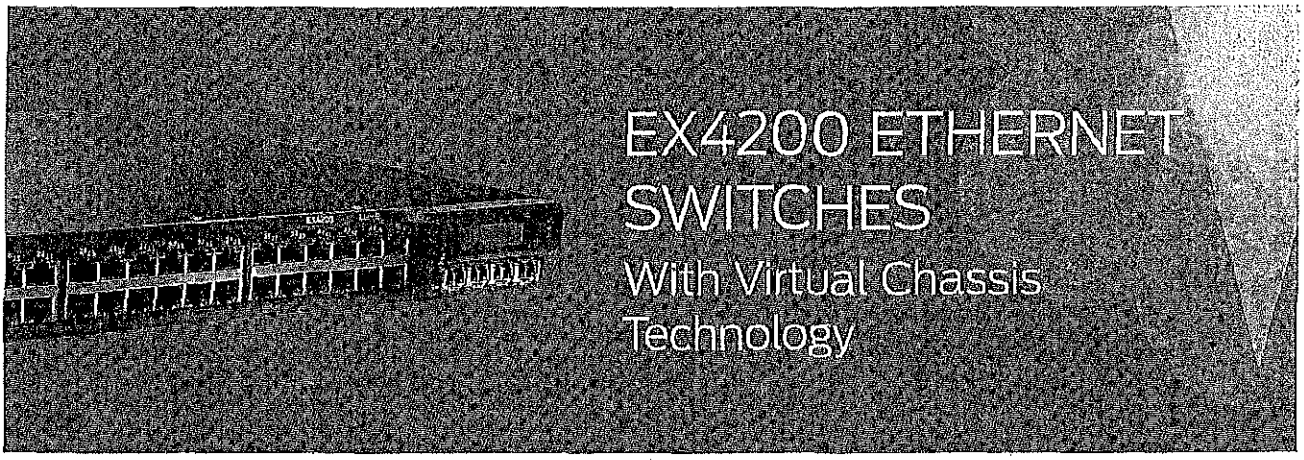
JUNIPER NETWORKS

DATASHEET



Product Overview

High-performance businesses demand high-performance networking solutions. These solutions include a new class of secure, scalable and always-on enterprise switch that advances the economics of networking by enabling businesses to deploy innovative new technologies that increase revenue and improve productivity. The Juniper Networks EX4200 line of Ethernet switches with Virtual Chassis technology combine the compact, pay-as-you-grow economics and low power and cooling requirements of stackable switches with the performance, availability, operational ease and port densities of chassis-based platforms to meet the demands of today's high-performance enterprises.

Product Description

The Juniper Networks® EX4200 line of Ethernet switches with Virtual Chassis technology combine the high availability (HA) and carrier-class reliability of modular systems with the economics and flexibility of stackable platforms, delivering a high-performance, scalable solution for data center, campus and branch office environments.

Offering a full suite of Layer 2 and Layer 3 switching capabilities as part of the base software, the EX4200 satisfies a variety of high-performance applications, including branch, campus and data center access deployments as well as Gigabit Ethernet (GbE) aggregation deployments. A single 24-port or 48-port switch can be deployed initially; as requirements grow, Juniper Networks Virtual Chassis technology allows up to 10 EX4200 switches to be interconnected over a 128 gigabit-per-second (Gbps) backplane and managed as a single device, delivering a scalable, pay-as-you-grow solution for expanding network environments. Flexible Gigabit Ethernet (GbE) and 10-Gigabit Ethernet (10GbE) uplink options enable high-speed connectivity to aggregation- or core-layer switches which connect multiple floors or buildings.

All EX4200 switches include HA features such as redundant, hot-swappable internal power supplies and field-replaceable, multi-blower fan trays to ensure maximum uptime. In addition, the base EX4200 partial PoE switch models offer Class 3 Power over Ethernet (PoE), delivering up to 18.6 watts on the first eight ports to support networked devices such as telephones, video cameras and wireless LAN (WLAN) access points for low-density converged networks. Full PoE options delivering up to 18.6 watts on all 24 or 48 ports are also available, making them ideal for high-density IP telephony deployments. Furthermore, PoE+ models deliver up to 30 watts of standards-based 802.3at PoE+ on 24 or 48 ports making them ideal for all PoE applications including campus deployments with 802.11n wireless access points.

Juniper Networks Virtual Chassis Technology: Chassis-like Switch Features in a Stackable Form Factor

- Redundant, internal hot-swappable power supplies
- Hot-swappable fan tray with redundant blowers
- Consistent modular Juniper Networks Junos® operating system control plane feature implementation
- Dual Route Engines with Graceful Routing Engine Switchover (GRES)
- Single management interface
- Easy, centralized software upgrades
- Scales from 24 to 480 ports with up to 20 10GbE uplinks
- Limited lifetime switch hardware warranty

Each EX4200 switch includes an integrated application-specific integrated circuit (ASIC)-based Packet Forwarding Engine, the EX-PFE, while an integrated Routing Engine (RE) delivers all control plane functionality. Based on field-proven Juniper Networks technology, the Route Engine brings the same level of carrier-class performance and reliability to the EX4200 line of Ethernet switches that Juniper Networks routers bring to the world's largest service provider networks.

The EX4200 also leverages the same modular Juniper Networks Junos OS as Juniper Networks router products, ensuring a consistent implementation and operation of each control plane feature across an entire Juniper Networks infrastructure.

Architecture and Key Components

The EX4200 switches are single rack-unit devices that deliver a compact solution for crowded wiring closets and access switch locations where space and power are at a premium. Each EX4200 supports optional front-panel uplink modules offering either four GbE ports or two 10GbE ports for high-speed backbone or link-aggregation connections between wiring closets and upstream aggregation switches. Uplink modules can be installed without powering down the switch, enabling users to add high-speed connectivity at any time or migrate from one uplink type to the other to deliver the ultimate in flexible, high-performance interconnectivity.

The EX4200 also features a front-panel LCD that offers a flexible interface for performing device bring-up and configuration rollbacks, reporting switch alarm and LED status, or restoring the switch to its default settings. The LCD also displays a Virtual Chassis member switch's chassis "slot number" and Route Engine status for rapid identification and problem resolution.

Dual rear-panel Virtual Chassis ports enable EX4200 switches to be interconnected over the 128 Gbps virtual backplane. Switches deployed in close proximity, such as wiring closets or top-of-rack data center applications, can be securely connected using a Virtual Chassis cable and cable lock supplied by Juniper Networks.

In addition, a dedicated rear-panel RJ-45 port is available for out-of-band management, while a rear-panel USB port can be used to easily upload Junos OS and configuration files.

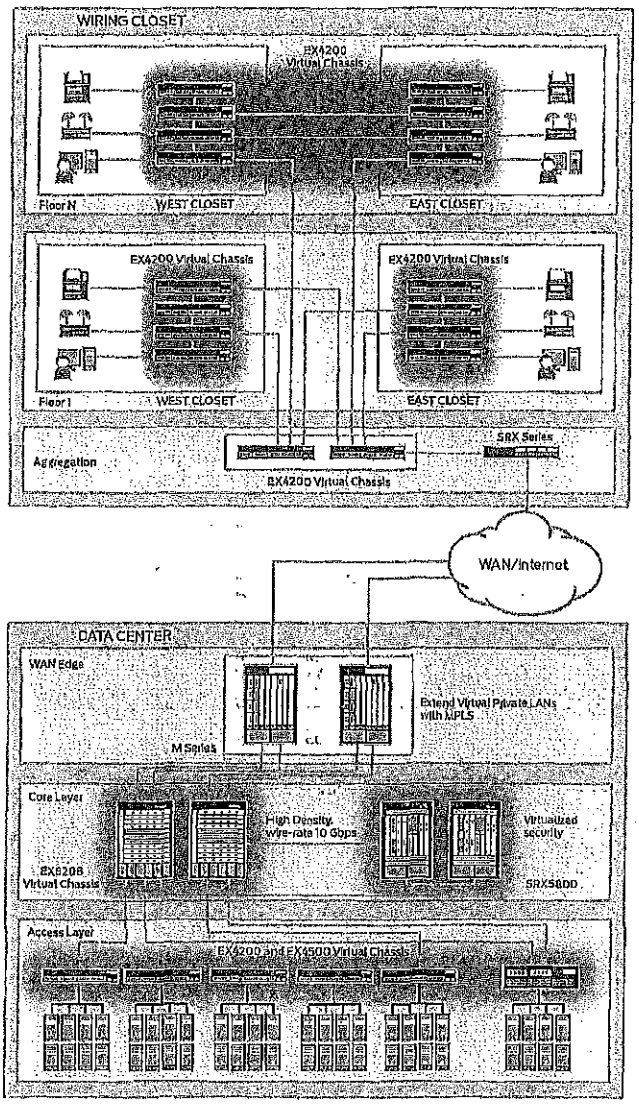


Figure 1: The EX4200 Ethernet switch with Virtual Chassis technology delivers a high-performance, scalable and highly reliable solution for data center, branch and campus environments.

Virtual Chassis Technology

Up to 10 EX4200 switches can be interconnected using Virtual Chassis technology to create a single logical device supporting up to 480 10/100/1000BASE-T ports or 240 100/1000BASE-X ports, plus an additional 40 GbE or 20 10GbE uplink ports. Additionally, EX4200s can be interconnected in a Virtual Chassis configuration that also includes EX4500s, creating a single logical switch that offers a variety of port and density options for mixed server environments.

In a Virtual Chassis configuration, all switches are monitored and managed as a single device, enabling enterprises to separate physical topology from logical groupings of endpoints and allowing more efficient resource utilization. Highly resilient topologies can also be created using the GbE or 10GbE uplink ports to extend the Virtual Chassis configuration across long distances spanning multiple wiring closets, floors or even buildings.

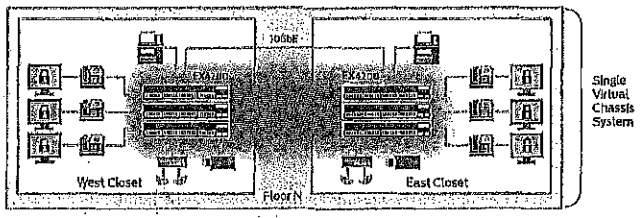


Figure 2: Using Virtual Chassis technology, up to 10 EX4200 switches can be interconnected to create a single logical device spanning multiple wiring closets, floors or even buildings.

Features and Benefits

Chassis-Class Availability

The EX4200 line of Ethernet switches deliver the same HA functionality and support many of the same failover capabilities as other Juniper chassis-based systems.

Each EX4200 switch is capable of functioning as a Route Engine. When two or more EX4200 switches are interconnected, they share a single control plane among all Virtual Chassis member switches. When two EX4200 switches are interconnected, Junos OS automatically initiates an election process to assign a master (active) and backup (hot-standby) Route Engine. An integrated Layer 2 and Layer 3 Graceful Route Engine Switchover (GRES) feature maintains uninterrupted access to applications, services and IP communications in the unlikely event of a primary RE failure.

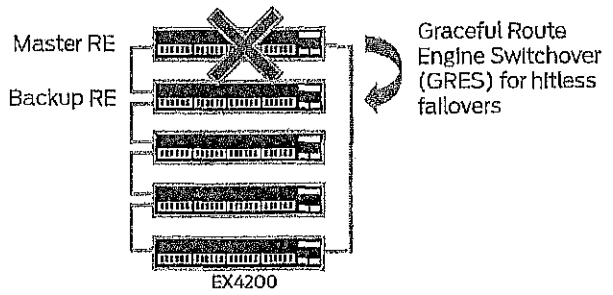


Figure 3: Support for Graceful Route Engine Switchover (GRES) ensures a smooth and seamless transfer of control plane functions following a master Route Engine failure.

When more than two switches are interconnected in a Virtual Chassis configuration, the remaining switch elements act as line cards and are available to assume the backup RE position should the designated master fail. Master, backup and line card priority status can be assigned by the network operations team to dictate the order of ascension; this N+1 RE redundancy, coupled with the GRES, nonstop routing (NSR) and nonstop bridging (NSB) capabilities of the Junos OS, assures a smooth transfer of control plane functions following unexpected failures.

The EX4200 implements the same slot/module/port numbering schema as other Juniper Networks chassis-based products when numbering Virtual Chassis ports, providing true chassis-like operations. By utilizing a consistent operating system and a single configuration file, all switches in a Virtual Chassis configuration are treated as a single device, simplifying overall system maintenance and management.

Individually, the EX4200 offers a number of HA features that are typically associated with modular chassis-based switches. When combined with the field-proven Junos OS and L2/L3 failover capabilities, these features provide the EX4200 with true carrier-class reliability.

- **Redundant power supplies:** The EX4200 line of Ethernet switches support internal redundant, load-sharing, hot-swappable and field-replaceable AC and DC power supplies to maintain uninterrupted operations. Thanks to their compact footprint, the EX4200 requires significantly less power than chassis-based switches delivering equivalent port densities.
- **Hot-swappable fan tray with multiple blowers:** The EX4200 includes a hot-swappable, field-replaceable fan tray with three blowers, providing sufficient cooling even if one of the blowers were to fail.
- **Redundant Trunk Group (RTG):** To avoid the complexities of the Spanning Tree Protocol (STP) without sacrificing network resiliency, the EX4200 employs redundant trunk groups to provide the necessary port redundancy and simplify switch configuration.
- **Cross-member link aggregation:** Cross-member link aggregation allows redundant link aggregation connections between devices in a single Virtual Chassis configuration, providing an additional level of reliability and availability.
- **Carrier-class hardware:** The EX4200 leverages a purpose-built packet forwarding engine ASIC, the EX-PFE, which integrates much of the same intellectual property used in Juniper Networks carrier routers. As a result, the EX4200 delivers the same predictable, scalable functionality found in the world's largest networks.
- **Non-Stop Bridging (NSB) and Non-Stop Routing (NSR):** NSB and NSR on the EX4200 ensure control plane protocols, states and tables are synchronized between Master and Standby REs to prevent protocol flaps or convergence issues following a Routing Engine failover.
- **Non-Stop Software Upgrade (NSSU):** With NSSU, all members of a Virtual Chassis system can be upgraded with a single command. Mission-critical traffic can be configured as a link aggregate across multiple Virtual Chassis switch members, ensuring minimal disruption during the upgrade process.
- **IPv4 and IPv6 routing support:** IPv4 and IPv6 Layer 3 routing (OSPF and PIM) is available in the base license, enabling highly resilient networks.

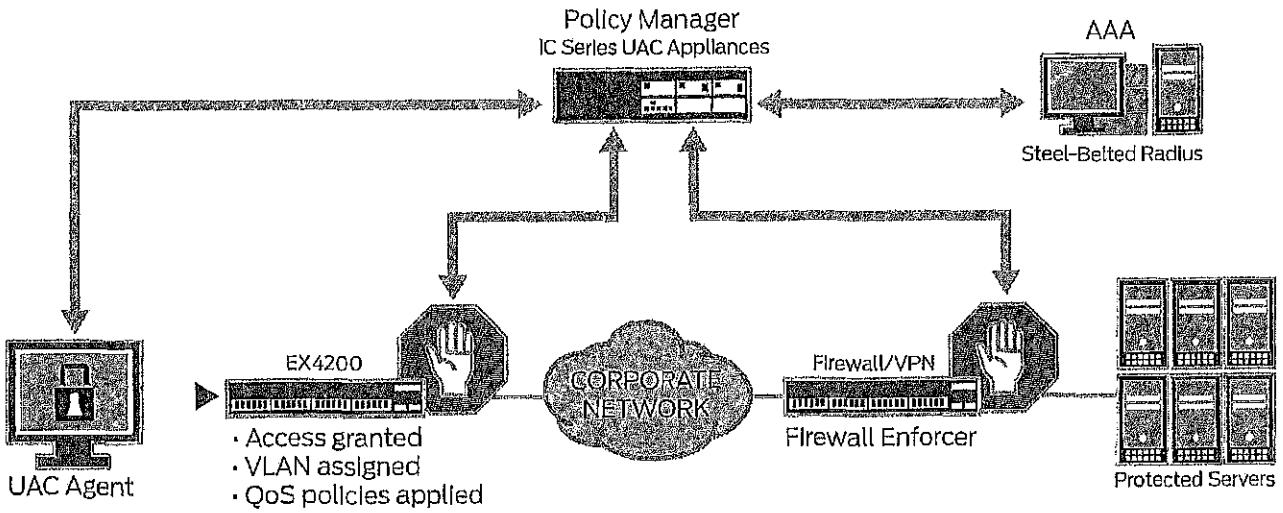


Figure 4: The EX4200 works with the Juniper Networks UAC to enforce access control down to the individual port level.

Carrier-Class Operating System

The EX4200 runs on Junos OS, the same operating system software used by Juniper Networks routers to power the world's largest and most complex networks.

By utilizing a common operating system, Juniper delivers a consistent implementation and operation of control-plane features across all products. To maintain that consistency, Junos OS adheres to a highly disciplined development process that utilizes a single source code, follows a single quarterly release train, and employs a highly available modular architecture that prevents isolated failures from bringing an entire system down.

These attributes are fundamental to the core value of the software, enabling all products powered by Junos OS to be updated simultaneously with the same software release. All features are fully regression-tested, making each new release a true superset of the previous version; customers can deploy the software with complete confidence that all existing capabilities will be maintained and operate in the same way.

Converged Networks

The EX4200 line of Ethernet switches provide the highest levels of availability for the most demanding converged data, voice and video environments, delivering the most reliable platform for unifying enterprise communications.

By providing Class 3 PoE with 15.4 watts on some or all ports to power voice over IP (VoIP) telephones, closed-circuit security cameras, wireless access points, and other IP-enabled devices, the EX4200 delivers a future-proofed solution for converging disparate networks onto a single IP infrastructure. Furthermore, any PoE port can provide up to 18.6 watts to power wireless access points and other PoE powered devices requiring more than Class 3, 15.4 watts of PoE. EX4200 PoE+ switches also support 802.3at standards-based PoE+ for powering networked devices like multiple radio IEEE 802.11n wireless access points, and video phones that may require more power than available with IEEE 802.3af.

LLDP-MED-based granular PoE management allows the EX4200 to negotiate PoE usage down to a fraction of a watt on powered devices, enabling more efficient PoE utilization across the switch.

To ease deployment, the EX4200 supports the industry-standard Link Layer Discovery Protocol (LLDP) and LLDP-Media Endpoint Discovery (LLDP-MED), which enable the switches to automatically discover Ethernet-enabled devices, determine their power requirements and assign virtual LAN (VLAN) parameters.

In addition, the EX4200 supports rich quality of service (QoS) functionality for prioritizing data, voice and video traffic. The switches support eight QoS queues on every port, enabling them to maintain multi-level, end-to-end traffic prioritizations. The EX4200 also supports a wide range of policy options, including priority and shaped deficit weighted round-robin (SDWRR) queuing.

Security

The EX4200 line of Ethernet switches fully integrate with the Juniper Networks Unified Access Control (UAC), which consolidates all aspects of a user's identity, device and location, enabling administrators to enforce access control and security down to the individual port or user levels.

Policy orchestration, enabled via Juniper UAC Enhancement Protocol (JUEP), enables the EX4200 to construct dynamic ACLs on a port-by-port basis by associating role/resource access policies with authorization table entries. This allows the switch to dynamically create thousands of ACLs or role-based access policies in a scaled environment.

Additionally, a captive portal redirection feature redirects URLs from the EX4200 to the Infranet Controller (IC) for user authentication and authorization, making the IC a "single source of truth" for user and device authentication and for enforcing role-based security policies.

Working as an enforcement point within the UAC, the EX4200 provides both standards-based 802.1X port-level access control as well as Layer 2–4 policy enforcement based on user identity, location and/or device. A user's identity, device type, machine posture check and location can be used to determine whether access should be granted and for how long. If access is granted, the switch assigns the user to a specific VLAN based on authorization levels. The switch can also apply QoS policies or mirror user traffic to a central location for logging, monitoring or threat detection by intrusion prevention systems.

The EX4200 also provides a full complement of port security features including DHCP (Dynamic Host Configuration Protocol) snooping, DAI (dynamic ARP inspection) and MAC limiting (per port and per VLAN) to defend against internal and external spoofing, man-in-the-middle and denial-of-service (DoS) attacks.

MACsec on the EX4200

A MACsec software license enables the EX4200 to provide near line-rate hardware-based encryption of user traffic on a dual-speed 2x10GbE or 4x1GbE SFP+ MACsec uplink module.

Defined by IEEE 802.1AE, MACsec provides secure, encrypted communication at the link layer that is capable of identifying and preventing threats from denial of service (DoS) and intrusion attacks, as well as man-in-the-middle, masquerading, passive wiretapping and playback attacks launched from behind the firewall. When MACsec is deployed on switch ports, all traffic is encrypted on the wire but traffic inside the switch is not. This allows the switch to apply all network policies such as Quality of Service (QoS), deep packet inspection and sFlow to each packet without compromising the security of packets on the wire.

Hop-by-hop encryption enables MACsec to secure communications while maintaining network intelligence. In addition, Ethernet-based WAN networks can use MACsec to provide link security over long-haul connections. MACsec is transparent to Layer 3 and higher-layer protocols and is not limited to IP traffic; it works with any type of traffic carried over Ethernet links.

Simplified Management and Operations

When employing Virtual Chassis technology, the EX4200 dramatically simplifies network management. Up to 10 interconnected EX4200 switches can be managed as a single device. Each Virtual Chassis group utilizes a single Junos OS image file and a single configuration file, reducing the overall number of units to monitor and manage. When Junos OS is upgraded on the master switch in a Virtual Chassis configuration, the software is automatically upgraded on all other member switches at the same time.

The EX4200 also includes port profiles that allow network administrators to automatically configure ports with security, QoS and other parameters based on the type of device connected to the port. Six preconfigured profiles are available, including default, desktop, desktop plus IP phone, wireless access point, routed uplink and Layer 2 uplink. Users can select from the existing profiles or create their own and apply them through the command line interface (CLI), Junos Web interface or management system.

An EZ touchless provisioning feature allows a DHCP server to push configuration details and software images to multiple switches at bootup.

Four system management options are available for the EX4200. The standard Junos OS CLI management interface offers the same granular capabilities and scripting parameters found in any device powered by Junos OS. The EX4200 also includes the integrated Junos Web management tool, an embedded device manager that allows users to configure, monitor, troubleshoot and perform system maintenance on individual switches via a browser-based graphical interface.

When managing a group of EX4200 switches, the Juniper Networks Network and Security Manager (NSM) provides system-level management across all Juniper switches in the network, from a single console.

Finally, the EX4200 switch system, performance and fault data can be exported to leading third-party management systems such as HP OpenView, IBM Tivoli and Computer Associates Unicenter software, to provide a complete, consolidated view of network operations.

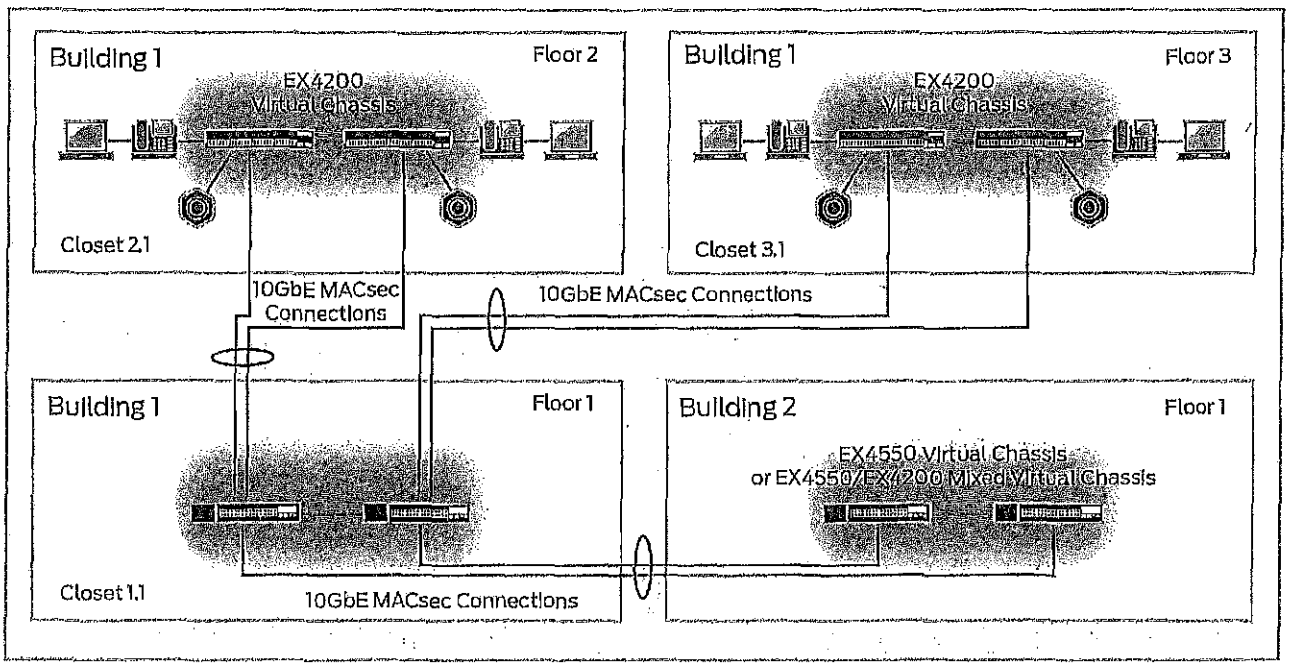


Figure 5: MACsec deployment with EX4200 and EX4550 switches.

Limited Lifetime Warranty

The EX4200 includes a limited lifetime hardware warranty that provides return-to-factory switch replacement for as long as the original purchaser owns the product. The warranty includes lifetime software updates, advanced shipping of spares within one business day, and 24x7 JTAC support for 90 days after the purchase date. Power supplies and fan trays are covered for a period of five years. For complete details please visit www.juniper.net/support/warranty.

Junos SDK

Juniper offers a Junos Software Developer's Kit (SDK) that enables users to create, deploy and validate innovative custom applications that run on top of the Junos operating system on EX Series switches, confirming the company's commitment to software innovation through network programmability. Junos SDK simplifies the development and reuse of components for collaboration while the underlying Junos OS provides security, robustness and resiliency, creating a widespread platform for running network applications.

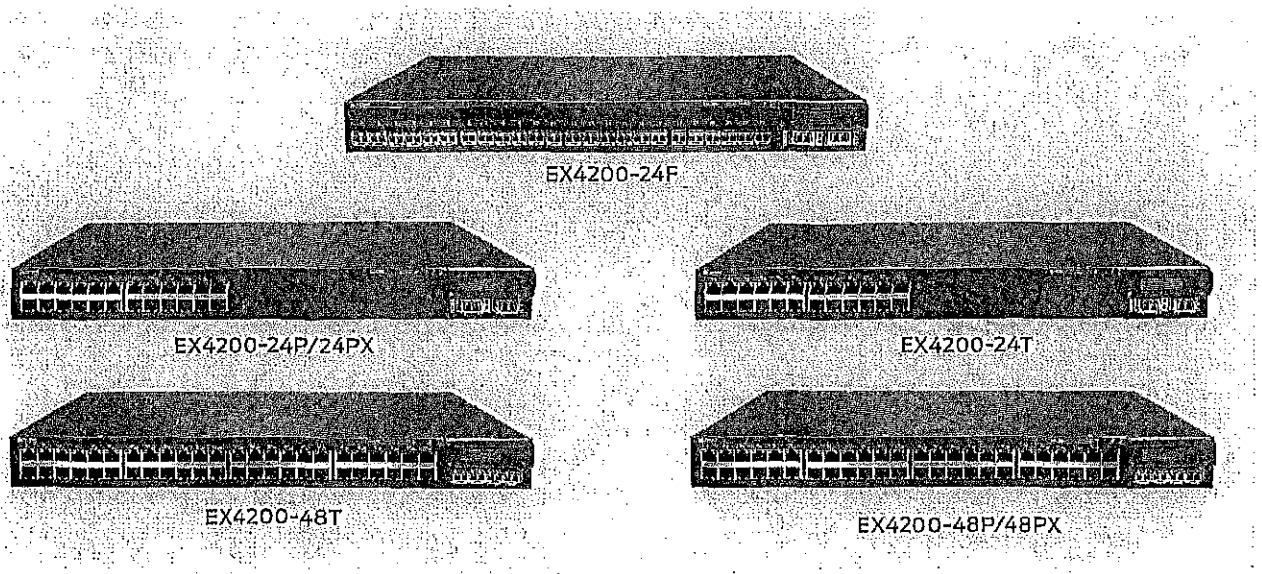
Product Options

Eight EX4200 switch models are available (see Table 1 below).

Table 1: EX4200 Line of Ethernet Switches

Model	Access Port Configuration	PoE Ports*	Height	PoE Budget	Power Supply Rating
EX4200-24T**	24-port 10/100/1000BASE-T	8 PoE	1 RU	130 W	320 W AC
EX4200-24PX	24-port 10/100/1000BASE-T	24 PoE+	1 RU	740 W	930 W AC
EX4200-48T**	48-port 10/100/1000BASE-T	8 PoE	1 RU	130 W	320 W AC
EX4200-48PX	48-port 10/100/1000BASE-T	48 PoE+	1 RU	740 W	930 W AC
EX4200-24P**	24-port 100/1000BASE-X (SFP)	N/A	1 RU	N/A	320 W AC
EX4200-24T-DC**	24-port 10/100/1000BASE-T	0	1 RU	N/A	190 W DC
EX4200-48T-DC**	48-port 10/100/1000BASE-T	0	1 RU	N/A	190 W DC
EX4200-24F-DC**	24-port 100/1000BASE-X (SFP)	N/A	1 RU	N/A	190 W DC

* All PoE ports 802.3af-compliant @ 15.4W. All PoE+ ports on EX4200-24PX/48PX models 802.3af compliant @ 30 W subject to maximum PoE budget.
** NEBS certified



EX4200 Specifications

Physical Specifications

- Backplane: 128 Gbps Virtual Chassis interconnect to combine up to 10 units as a single logical device
- Uplink module options:
  - 4-port GbE module with pluggable SFP optics
  - 2-port 10GbE module with pluggable XFP optics
  - Dual-mode 2-port 10GbE SFP+ / 4-port GbE SFP module with pluggable SFP+/SFP optics
  - Dual-mode 2-port 10GbE SFP+ / 4-port GbE SFP module with pluggable SFP+/SFP optics and MACsec support

Power Options

- Power supplies: Autosensing; 100-120 V / 200-240 V; AC 320 W, 600 W and 930 W dual load-sharing hot-swappable internal redundant power supplies
- Maximum current inrush: 50 amps
- DC power supply: 190 W DC, input voltage range 36 V - 72 V, dual input feed, dual load-sharing hot-swappable internal redundant power supplies
- Minimum number of PSUs required for fully loaded chassis: 1 per switch

Dimensions (W x H x D)

- 17.41 x 1.72 x 16.43 in (44.21 x 4.32 x 41.73 cm)
- [1]Desktop installation width noted above, rack-mount width is 17.5 in (44.5 cm)
- [2]Height: 1 RU
- [3]Depth with 320 W AC PSU and 190 W DC PSU noted above, 18.8 in (47.8 cm) with 600/930 W AC PSU

System Weight

- EX4200-24T with 320 W AC PSU: 16.5 lb (7.5 kg)
- EX4200-24P with 600 W AC PSU: 17.2 lb (7.8 kg)
- EX4200-24PX with 930 W AC PSU: 18 lb (8.16 kg)
- EX4200-48T with 320 W AC PSU: 17.1 lb (7.8 kg)
- EX4200-48P with 930 W AC PSU: 18.2 lb (8.3 kg)
- EX4200-48PX with 930 W AC PSU: 19 lb (8.61 kg)
- EX4200-24F with 320 W AC PSU: 16.1 lb (7.3 kg)
- EX4200-24T-DC with 190 W DC PSU: 16.5 lb (7.5 kg)
- EX4200-48T-DC with 190 W DC PSU: 17.1 lb (7.8 kg)
- EX4200-24F-DC with 190 W DC PSU: 16.1 lb (7.3 kg)

Environmental Ranges

- Operating temperature: 32° to 113° F (0° to 45° C)
- Storage temperature: -40° to 158° F (-40° to 70° C)
- Operating altitude: up to 10,000 ft (3,049 m)
- Non-operating altitude: up to 16,000 ft (4,877 m)
- Relative humidity operating: 10% to 85% (noncondensing)
- Relative humidity non-operating: 0% to 95% (noncondensing)

Cooling

- Field-replaceable fan tray with multiple blowers (3)
- Switch remains operational even if one blower fails
- Airflow: 20.3 cfm

Hardware Specifications

- Switching Engine Model: Store and forward
- DRAM – 1 GB with ECC
- Flash – 1 GB
- CPU – 1 GHz PowerPC CPU
- GbE port density per system:
  - 24P/24T/24F: 28 (24 host ports + four-port GbE uplink module)
  - 48P/48T: 52 (48 host ports + four-port GbE uplink module)
- 10GbE port density per system (all models): 2 (uplink module)

Optics

- 100 Mbps optic/connector type: LC SFP fiber supporting 100BASE-FX SFP (multimode), LX (single-mode) and BX (single-strand)
- 10/100/1000BASE-T connector type: RJ-45
- GbE SFP optic/connector type: RJ-45 or LC SFP fiber supporting 1000BASE-T SFP, SX (multimode), LX (single-mode), LH/ZX (single-mode) and BX (single strand)
- 10GbE XFP optic/connector type: 10GE XFP LC connector, SR (multimode), LR (single-mode), ER (single-mode) or ZR (single-mode)
- 10GbE SFP+ optic/connector type: 10GE SFP+ LC connector, SR (multimode), USR (multimode), LR (single-mode), ER (single-mode), LRM (multimode) and DAC (direct-attach copper)

Physical Layer

- Time Domain Reflectometry (TDR) for detecting cable breaks and shorts: 24P/24T and 48P/48T only
- Auto MDI/MDIX support: 24P/24T and 48P/48T only (all ports)
- Port speed downshift/setting max advertised speed on 10/100/1000BASE-T ports: 24P/24T and 48P/48T only, on all ports
- Digital optical monitoring for optical ports

Packet Switching Capacities (Maximum with 64 Byte Packets)

- 24P/24T: 88 Gbps
- 48P/48T: 136 Gbps
- 24F: 88 Gbps

Aggregate Switch Capacities (Maximum with 64 Byte Packets)

- 24P/24T/24F: 216 Gbps
- 48P/48T: 264 Gbps

Layer 2/Layer 3 Throughput (Mpps) (Maximum with 64 Byte Packets)

- 24P/24T: 65 Mpps (wire speed)
- 48P/48T: 101 Mpps (wire speed)
- 24F: 65 Mpps (wire speed)

Layer 2 Switching

- Max MAC addresses per system: 32,000
- Jumbo frames: 9216 Bytes
- Number of VLANs: 4,096
- VST instances: 253
- Port-based VLAN
- MAC-based VLAN
- GVRP
- Voice VLAN

EX4200 Specifications (continued)

Layer 2 Switching (continued)

- Physical port redundancy: Redundant trunk group (RTG)
- Compatible with PVST+
- RVI (Routed VLAN Interface)
- IEEE 802.1AB: Link Layer Discovery Protocol (LLDP)
- LLDP-MED with VoIP Integration
- IEEE 802.1D: Spanning Tree Protocol
- IEEE 802.1p: CoS prioritization
- IEEE 802.1Q: VLAN tagging
- IEEE 802.1s: Multiple Instances of Spanning Tree Protocol (MSTP)
- Number of MST Instances supported: 64
- Number of VSTP Instances supported: 253
- IEEE 802.1w: Rapid reconfiguration of Spanning Tree Protocol
- IEEE 802.1X: Port Access Control
- IEEE 802.1ak: Multiple Registration Protocol
- IEEE 802.3: 10BASE-T
- IEEE 802.3u: 100BASE-T
- IEEE 802.3ab: 1000BASE-T
- IEEE 802.3z: 1000BASE-X
- IEEE 802.3ae: 10 Gigabit Ethernet
- IEEE 802.3af: Power over Ethernet
- IEEE 802.3x: Pause Frames/Flow Control
- IEEE 802.3ad: Link Aggregation Control Protocol
- IEEE 802.3ah: Ethernet in the First Mile
- Metro
  - PVLAN support
  - IEEE 802.1ag connectivity fault management
  - ITU-T G8032
  - ITU-T Y.1731
  - IEEE 802.1ad Q-in-Q
  - Multicast VLAN routing

Layer 3 Features: IPv4

- Max number of ARP entries: 16,000
- Max number of IPv4 unicast routes in hardware: 16,000
- Max number of IPv4 multicast routes in hardware: 8,000
- Routing protocols: RIPv1/v2, OSPF, BGP, IS-IS
- Static routing
- Routing policy
- Bidirectional Forwarding Detection
- Layer 3 redundancy: VRRP
- IPv4/v6 GRE tunneling

Layer 3 Features: IPv6

- Max number of Neighbor Discovery (ND) entries: 16,000 (shared with IPv4)
- Max number of IPv6 unicast routes in hardware: 4,000
- Max number of IPv6 multicast routes in hardware: 2,000
- Routing protocols: RIPng, OSPFv3, IPv6, ISIS, BGP4+, PIM, MLD, MLDv2
- Static routing

MPLS

- Circuit Cross Connect (CCC)
- Multicast snooping MLD v1/v2
- VRF-Lite

Supported RFCs

- RFC 768 UDP
- RFC 783 TFTP
- RFC 791 IP
- RFC 792 ICMP
- RFC 793 TCP
- RFC 826 ARP
- RFC 854 Telnet client and server
- RFC 894 IP over Ethernet
- RFC 903 RARP
- RFC 906 TFTP Bootstrap
- RFC 951, 1542 BootP
- RFC 1027 Proxy ARP
- RFC 1058 RIP v1
- RFC 1112 IGMP v1
- RFC 1122 Host Requirements
- RFC 1195 Use of OSI IS-IS for Routing in TCP/IP and Dual Environments (TCP/IP transport only)
- RFC 1256 IPv4 ICMP Router Discovery (IRDP)
- RFC 1492 TACACS+
- RFC 1519 CIDR
- RFC 1587 OSPF NSSA Option
- RFC 1591 DNS
- RFC 1745 BGP4/IDRP for IP-OSPF Interaction
- RFC 1771 Border Gateway Protocol 4
- RFC 1812 Requirements for IP Version 4 Routers
- RFC 1965 Autonomous System Confederations for BGP
- RFC 1981 Path MTU Discovery for IPv6
- RFC 1997 BGP Communities Attribute
- RFC 2030 SNTP, Simple Network Time Protocol
- RFC 2068 HTTP server
- RFC 2080 RIPng for IPv6
- RFC 2131 BOOTP/DHCP relay agent and DHCP server
- RFC 2138 RADIUS Authentication
- RFC 2139 RADIUS Accounting
- RFC 2154 OSPF w/Digital Signatures (Password, MD-5)
- RFC 2236 IGMP v2
- RFC 2267 Network Ingress Filtering
- RFC 2283 Multiprotocol Extensions for BGP-4
- RFC 2328 OSPF v2 (Edge-mode)
- RFC 2338 VRRP
- RFC 2362 PIM-SM (Edge-mode)
- RFC 2370 OSPF Opaque LSA Option
- RFC 2385 TCP MD5 Authentication for BGPv4
- RFC 2439 BGP Route Flap Damping
- RFC 2453 RIP v2
- RFC 2460 Internet Protocol, Version 6 (IPv6) Specification
- RFC 2461 Neighbor Discovery for IP Version 6 (IPv6)
- RFC 2463 Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification
- RFC 2464 Transmission of IPv6 Packets over Ethernet Networks
- RFC 2474 DiffServ Precedence, including 8 queues/port
- RFC 2475 DiffServ Core and Edge Router Functions
- RFC 2526 Reserved IPv6 Subnet Anycast Addresses
- RFC 2545 Use of BGP-4 Multiprotocol Extensions for IPv6 Inter-Domain Routing

EX4200 Specifications (continued)

Supported RFCs (continued)

- RFC 2597 DiffServ Assured Forwarding (AF)
- RFC 2598 DiffServ Expedited Forwarding (EF)
- RFC 2740 OSPF for IPv6
- RFC 2784 Generic Routing Encapsulation (GRE)
- RFC 2796 BGP Route Reflection (supersedes RFC 1966)
- RFC 2796 Route Reflection
- RFC 2918 Route Refresh Capability for BGP-4
- RFC 2925 MIB for Remote Ping, Trace
- RFC 3176 sFlow
- RFC 3376 IGMP v3
- RFC 3392 Capabilities Advertisement with BGP-4
- RFC 3484 Default Address Selection for Internet Protocol Version 6 (IPv6)
- RFC 3513 Internet Protocol Version 6 (IPv6) Addressing Architecture
- RFC 3569 draft-ietf-ssm-arch-06.txt PIM-SSM PIM Source Specific Multicast
- RFC 3579 RADIUS EAP support for 802.1x
- RFC 3618 MSDP
- RFC 3623 OSPF Graceful Restart
- RFC 4213 Basic Transition Mechanisms for IPv6 Hosts and Routers
- RFC 4291 IP Version 6 Addressing Architecture
- RFC 4360 BGP Extended Communities Attribute
- RFC 4443 ICMPv6 for the IPv6 Specification
- RFC 4486 Subcodes for BGP Cease Notification message
- RFC 4541 IBMP and MLD snooping services
- RFC 4861 Neighbor Discovery for IPv6
- RFC 4862 IPv6 Stateless Address Autoconfiguration
- RFC 4915 MT-OSPF
- RFC 5176 Dynamic Authorization Extensions to RADIUS
- RFC 5798 VRRPv3 for IPv6
- Draft-ietf-bfd-base-05.txt Bidirectional Forwarding Detection
- Draft-ietf-idr-restart-10.txt Graceful Restart Mechanism for BGP
- Draft-ietf-isis-restart-02 Restart Signaling for IS-IS
- Draft-ietf-isis-wg-multi-topology-11 Multi Topology (MT) Routing in IS-IS
- Internet draft-ietf-isis-ipv6-06.txt, Routing IPv6 with IS-IS
- ITU-T Y.1731
- LLDP Media Endpoint Discovery (LLDP-MED), ANSI/TIA-1057, draft 08
- PIM-DM Draft IETF PIM Dense Mode draft-ietf-idmr-pim-dm-05.txt, draft-ietf-pim-dm-new-v2-04.txt

Security

- MAC limiting (per port and per VLAN)
- Allowed MAC addresses -- configurable per port
- Dynamic ARP inspection (DAI)
- IP source guard
- Local proxy ARP
- Static ARP support
- DHCP snooping
- Captive Portal
- Persistent MAC address configurations
- DDoS protection (CPU control path flooding protection)

Access Control Lists (ACLs) (Junos OS firewall filters)

- Port-based ACL (PACL) – Ingress and Egress
- VLAN-based ACL (VACL) – Ingress and Egress
- Router-based ACL (RACL) -- Ingress and Egress
- ACL entries (ACE) in hardware per system: 7,000
- ACL counter for denied packets
- ACL counter for permitted packets
- Ability to add/remove/change ACL entries in middle of list (ACL editing)
- Layer 2 – L4 ACL
- 802.1X port-based
- 802.1X multiple supplicants
- 802.1X with VLAN assignment
- 802.1X with authentication bypass access (based on host MAC address)
- 802.1X with VoIP VLAN support
- 802.1X dynamic ACL based on RADIUS attributes
- 802.1X Supported EAP types: MD5, TLS, TTLS, PEAP
- TNC certified
- MAC Authentication (RADIUS)
- Control Plane DoS protection

High Availability

- Non-Stop Routing (NSR) - PIM, OSPF v2 and v3, RIP v2, RIPnG, BGP, BGPv6, ISIS, IGMP v1, v2, v3
- Non-Stop Software Upgrade (NSSU)
- Redundant, hot-swappable power supplies
- Redundant, field-replaceable, hot-swappable fans
- Graceful Route Engine Switchover (GRES) for Layer 2 hitless forwarding and Layer 3 protocols on RE failover
- Graceful protocol restart -- OSPF, BGP
- Layer 2 hitless forwarding on RE failover
- Online insertion and removal (OIR) uplink module
- Non-Stop Bridging (NSB) - LACP

Link Aggregation

- 802.3ad (LACP) support:
- Number of LAGs supported: 64
- Max number of ports per LAG: 8
- LAG load-sharing algorithm -- Bridged or Routed (Unicast or Multicast) Traffic:
- IP: S/D IP
- TCP/UDP: S/D IP, S/D Port
- Non-IP: S/D MAC
- Tagged ports support in LAG

QoS

- Layer 2 QoS
- Layer 3 QoS
- Ingress policing: 1 rate 2 color
- Hardware queues per port: 8
- Scheduling methods (egress): Strict priority (SP), Shaped Deficit Weighted Round-Robin (SDWRR)
- 802.1p, DSCP/IP Precedence trust and marking
- Layer 2-4 classification criteria: Interface, MAC address, Ethertype, 802.1p, VLAN, IP address, DSCP/IP Precedence, TCP/UDP port numbers, etc.
- Congestion avoidance capabilities: Tail Drop

*Unless explicitly specified for any particular MIB table or variables, Junos OS does not support SNMP set operations.

EX4200 Specifications (continued)

Multicast

- IGMP: v1, v2, v3
- IGMP snooping
- PIM-SM, PIM-SSM, PIM-DM

Services and Manageability

- Junos OS CLI
- Web interface
- Out-of-band management: Serial; 10/100/1000BASE-T Ethernet
- ASCII configuration
- Rescue configuration
- Configuration rollback
- Image rollback
- LCD management
- Element management tools: Network and Security Manager (NSM)
- Remote performance monitoring
- Junos SDK
- Proactive services support via Advanced Insight Solutions (AIS)
- SNMP: v1, v2c, v3
- RMON (RFC 2819) Groups 1, 2, 3, 9
- NTP
- DHCP server
- DHCP client and DHCP proxy
- DHCP relay and helper
- DHCP local server support
- RADIUS
- Service Now for automated fault detection, simplified trouble ticket management and streamlined operations
- TACACS+
- SSHv2
- Secure copy
- HTTP/HTTPs
- DNS resolver
- Syslog logging
- Temperature sensor
- Config-backup via FTP / secure copy
- Interface range specification
- Port profile associations

Supported MIBs*

- RFC 1155 SMI
- RFC 1157 SNMPv1
- RFC 1212, RFC 1213, RFC 1215 MIB-II, Ethernet-Like MIB & TRAPs
- RFC 1493 Bridge MIB
- RFC 1643 Ethernet MIB
- RFC 1657 BGP-4 MIB
- RFC 1724 RIPv2 MIB
- RFC 1850 OSPFv2 MIB
- RFC 1905 RFC 1907 SNMP v2c, SMIv2 and Revised MIB-II
- RFC 2011 SNMPv2 for Internet protocol using SMIv2
- RFC 2012 SNMPv2 for transmission control protocol using SMIv2
- RFC 2013 SNMPv2 for user datagram protocol suing SMIv2
- RFC 2096 IPv4 Forwarding Table MIB
- RFC 2287 System Application Packages MIB
- RFC 2570 – 2575 SNMPv3, user based security, encryption and authentication
- RFC 2576 Coexistence between SNMP Version 1, Version 2 and Version 3
- RFC 2578 SNMP Structure of Management Information MIB
- RFC 2579 SNMP Textual Conventions for SMIv2
- RFC 2665 Ethernet-like Interface MIB
- RFC 2787 VRRP MIB
- RFC 2819 RMON MIB
- RFC 2863 Interface Group MIB
- RFC 2863 Interface MIB
- RFC 2922 LLDP MIB
- RFC 2925 Ping/Traceroute MIB
- RFC 2932 IPv4 Multicast MIB
- RFC 3413 SNMP Application MIB
- RFC 3414 User-based Security model for SNMPv3
- RFC 3415 View-based Access Control Model for SNMP
- RFC 3621 PoE-MIB (PoE switches only)
- RFC 4188 STP & Extensions MIB
- RFC 4363 Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and VLAN extensions
- RFC 5643 OSPF v3 MIB support
- Draft – blumenthal – aes – usm - 08
- Draft – reeder - snmpv3 – usm - 3desede -00
- Draft-ietf-bfd-mib-02.txt
- Draft-ietf-idmr-igmp-mib-13
- Draft-ietf-idmr-pim-mib-09
- Draft-ietf-idr-bgp4-mibv2-02.txt – Enhanced BGP-4 MIB
- Draft-ietf-isis-wg-mib-07

Troubleshooting

- Debugging: CLI via console, Telnet or SSH
- Diagnostics: Show and debug cmd, statistics
- Traffic mirroring (port)
- Traffic mirroring (VLAN)
- ACL-based mirroring
- Mirroring destination ports per system: 1
- LAG port monitoring
- Multiple destination ports monitored to 1 mirror (N:1)
- Max number of mirroring sessions: 1
- Mirroring to remote destination (over L2): 1 destination VLAN
- IP tools: Extended ping & trace
- Juniper Networks commit and rollback

Warranty

- Limited lifetime switch hardware warranty

Safety and Compliance

Safety Certifications

- UL-UL60950-1(First Edition)
- C-UL to CAN/CSA 22.2 No. 60950-1 (First Edition)
- TUV/GS to EN 60950-1, Amendment A1-A4, A11
- CB-IEC60950-1, all country deviations

Electromagnetic Compatibility Certifications

- FCC 47CFR Part 15 Class A
- EN 55022 Class A
- ICES-003 Class A
- VCCI Class A
- AS/NZS CISPR 22 Class A
- CISPR 22 Class A
- EN 55024
- EN 300386
- CE

NEBS
- GR-63-Core: NEBS, Physical Protection
- GR-1089-Core: EMC and Electrical Safety for Network Telecommunications Equipment
- All models except EX4200-24P and EX4200-48P

Environmental
- Reduction of Hazardous Substances (ROHS) 5

Telco
- CLEI code

Joint Interoperability Test Command (JITC)
- Department of Defense (DoD) Unified Capabilities (UC) Approved Products List (APL)

Common Criteria
- CC-EAL3

Metro Ethernet Forum
- MEF 9

Telecom Quality Management
- TL9000

Trusted Network Connect
- TNC IF-PEP

FIPS
- FIPS 140-2 Level 1

Noise Specifications

Noise measurements based on operational tests taken from bystander position (front) and performed at 23° C in compliance with ISO 7779.

Model	Power Supply Rating	Acoustic Noise in dBA
EX4200-24T	320 W AC	51.6
EX4200-24P	600 W AC	53.2
EX4200-24PX	930 W AC	39.9
EX4200-24F	320 W AC	50.8
EX4200-48T	320 W AC	51.6
EX4200-48P	930 W AC	54.0
EX4200-48PX	930 W AC	45.6
EX4200-24T-DC	190 W DC	48.0
EX4200-48T-DC	190 W DC	48.3
EX4200-24F-DC	190 W DC	46.7

Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit www.juniper.net/us/en/products-services.

Ordering Information

Model Number	Description
Switches*	
EX4200-24T	24-port 10/100/1000BASE-T (8 PoE ports) + 320 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-24P	24-port 10/100/1000BASE-T (24 PoE ports) + 600 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-24PX	24-port 10/100/1000BASE-T (24 PoE+ ports) + 930 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-48T	48-port 10/100/1000BASE-T (8 PoE ports) + 320 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-48P	48-port 10/100/1000BASE-T (48 PoE ports) + 930 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-48PX	48-port 10/100/1000BASE-T (48 PoE+ ports) + 930 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-24F	24-port 100/1000BASE-X SFP + 320 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-24T-DC	24-port 10/100/1000BASE-T + 190 W DC PSU. Includes 50cm Virtual Chassis cable.
EX4200-48T-DC	48-port 10/100/1000BASE-T + 190 W DC PSU. Includes 50cm Virtual Chassis cable.
EX4200-24F-DC	24-port 100/1000BASE-X SFP + 190 W DC PSU. Includes 50cm Virtual Chassis cable.
EX4200-24T-TAA	Trade Agreement Act-compliant 24-port 10/100/1000BASE-T (8 PoE ports) + 320 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-24P-TAA	Trade Agreement Act-compliant 24-port 10/100/1000BASE-T (24 PoE ports) + 600 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-48T-TAA	Trade Agreement Act-compliant 48-port 10/100/1000BASE-T (8 PoE ports) + 320 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-48P-TAA	Trade Agreement Act-compliant 48-port 10/100/1000BASE-T (48 PoE ports) + 930 W AC PSU. Includes 50cm Virtual Chassis cable.
EX4200-24F-TAA	Trade Agreement Act-compliant 24-port 100BASE-FX/1000BASE-X SFP + 320 W AC PSU. Includes 50cm Virtual Chassis cable.
Accessories	
EX-CBL-VCP-50CM	Virtual Chassis Port cable 0.5 M length
EX-CBL-VCP-1M	Virtual Chassis Port cable 1 M length
EX-CBL-VCP-3M	Virtual Chassis Port cable 3 M length
EX-CBL-VCP-5M	Virtual Chassis Port cable 5 M length
Mounting Options	
EX-4PST-RMK	Adjustable 4-post rack-mount kit for EX4200 and EX3200
EX-RMK	Rack-mount kit for EX2200, EX3200, EX4200 and EX4550
EX-WMK	EX4200 and EX3200 wall-mount kit
EX4200 Feature Licenses**	
EX-24-AFL	Advanced Feature License for EX4200-24T, EX4200-24T-DC, EX4200-24P, EX4200-24F and EX4200-24F-DC switches
EX-48-AFL	Advanced Feature License for EX4200-48T, EX4200-48T-DC and EX4200-48P switches
EX-QFX-MACSEC-ACC†	MACsec Software License for EX4200 access switches

* Each switch comes with one power supply, RJ-45 cable, RJ-45-to-DB-9 serial port adapter, 19" rack-mount kit, and Virtual Chassis cable and connector retainer. Each system also ships with a power cord for the country to which it is being shipped. The EX4200-24F also comes with fiber port dust covers.

** AFL includes licenses for IS-IS, BGP and MPLS.

† Not available in Russia and CIS countries.

Ordering Information (continued)

Model Number	Description
Uplink Modules	
EX-UM-2XFP	2-port 10GbE XFP Uplink Module
EX-UM-4SFP	4-port GbE SFP Uplink Module
EX-UM-2X4SFP	2-port 10GbE SFP+ / 4-port GbE SFP Uplink Module
EX-UM-2X4SFP-M*	2-port 10GbE SFP+ / 4-port GbE SFP Uplink Module with MACsec Support
Power Supplies	
EX-PWR-320-AC	320 W AC Power Supply Unit (PSU)
EX-PWR-600-AC	600 W AC Power Supply Unit (PSU)
EX-PWR3-930-AC	930 W PoE+ AC Power Supply Unit (PSU)
EX-PWR-190-DC	190 W DC Power Supply Unit (PSU)
Pluggable Optics	
EX-SFP-1FE-FX	SFP 100BASE-FX; LC connector; 1310nm; 2km reach on multimode fiber
EX-SFP-1FE-LX	SFP 100BASE-LX; LC connector; 1310nm; 10km reach on single-mode fiber
EX-SFP-1FE-LX40K	SFP 100BASE-LX; LC connector; 1310nm; 40km reach on single-mode fiber
EX-SFP-1FE-LH	SFP 100BASE-LX; LC connector; 1310nm; 80km reach on single-mode fiber
EX-SFP-FE20KT13R15	SFP 100BASE-BX; LC connector; TX 1310nm/ RX 1550nm; 20km reach on single-strand, single-mode fiber
EX-SFP-FE20KT15R13	SFP 100BASE-BX; LC connector; TX 1550nm/ RX 1310nm; 20km reach on single-strand, single-mode fiber
EX-SFP-1GE-T	SFP 10/100/1000BASE-T copper; RJ-45 connector; 100m reach on UTP
EX-SFP-1GE-SX	SFP 1000BASE-SX; LC connector; 850nm; 550m reach on multimode fiber
EX-SFP-1GE-LX	SFP 1000BASE-LX; LC connector; 1310nm; 10km reach on single-mode fiber
EX-SFP-GE10KT13R14	SFP 1000BASE-BX; Tx 1310nm/Rx 1490nm for 10km transmission on single-strand, single-mode fiber
EX-SFP-GE10KT13R15	SFP 1000BASE-BX; Tx 1310nm/Rx 1550nm for 10km transmission on single-strand, single-mode fiber
EX-SFP-GE10KT14R13	SFP 1000BASE-BX; Tx 1490nm/Rx 1310nm for 10km transmission on single-strand, single-mode fiber
EX-SFP-GE10KT15R13	SFP 1000BASE-BX; Tx 1550nm/Rx 1310nm for 10km transmission on single-strand, single-mode fiber
EX-SFP-1GE-LX40K	SFP 1000BASE-LX; LC connector; 1310nm; 40km reach on single-mode fiber

Model Number	Description
EX-SFP-GE40KT13R15	SFP 1000BASE-BX; Tx 1310nm/Rx 1550nm for 40km transmission on single-strand, single-mode fiber
EX-SFP-GE40KT15R13	SFP 1000BASE-BX; Tx 1550nm/Rx 1310nm for 40km transmission on single-strand, single-mode fiber
EX-SFP-1GE-LH	SFP 1000BASE-LH; LC connector; 1550nm; 70km reach on single-mode fiber
EX-XFP-10GE-SR	XFP 10GBASE-SR; LC connector; 850nm; 300m reach on 50 microns multimode fiber; 33m on 62.5 microns multimode fiber
EX-XFP-10GE-LR	XFP 10GBASE-LR; LC connector; 1310nm; 10km reach on single-mode fiber
EX-XFP-10GE-ER	XFP 10GBASE-ER; LC connector; 1550nm; 40km reach on single-mode fiber
EX-XFP-10GE-ZR	XFP 10GBASE-ZR; LC connector; 1550nm; 80km reach on single-mode fiber
EX-SFP-10GE-SR	SFP+ 10GBASE-SR; LC connector; 850nm; 300m reach on 50 microns multimode fiber; 33m on 62.5 microns multimode fiber
EX-SFP-10GE-LRM	SFP+ 10GBASE-LRM; LC connector; 1310nm; 220m reach on multimode fiber
EX-SFP-10GE-LR	SFP+ 10GBASE-LR; LC connector; 1310nm; 10km reach on single-mode fiber
EX-SFP-10GE-DAC-xM	SFP+ 10 Gigabit Ethernet Direct Attach Copper (twinax copper cable), where "x" denotes 1, 3, 5 or 7 meter lengths
EX-SFP-10GE-ER	SFP+ 10GBASE-ER 10 Gigabit Ethernet Optics, 1550nm for 40km transmission on single-mode fiber
EX-SFP-10GE-USR	SFP+ 10 Gigabit Ethernet Ultra Short Reach Optics, 850 nm for 10m on OM1, 20m on OM2, 100m on OM3 multimode fiber
EX-XFP-10GE80KDWDM	XFP 10GBASE DWDM, LC connector, tunable across C-band 50 GHz channel spacing (compliant with ITU-T G.698.1); 80km reach on single-mode fiber
EX-SFP-GE80KCWxxxx	SFP Gigabit Ethernet CWDM, LC connector; xxxx nm where xxxx represents 1470, 1490, 1510, 1530, 1550, 1570, 1590 or 1610; 80km reach on single-mode fiber

*Not available in Russia and CIS countries.

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net.

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To purchase Juniper Networks solutions, please contact your Juniper Networks representative at 1-866-298-6428 or authorized reseller.

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Total Access 5000 Octal OLT

8-port GPON Optical Line Terminal Access Module

Product Features

- Supports Gigabit and Committed Information Rate (CIR) services
- Supports an extensive and growing family of ONTs
- Supports both IPTV and RF overlay video service
- Supports Dynamic Bandwidth Allocation (DBA) enabling committed rate business services
- Supports service-aware provisioning and troubleshooting
- Allows both CO and RT deployments
- Scalable to 64 ONTs per GPON
- Supports native Ethernet transport over GPON

Today, carriers are dealing with increasing competition, operating costs and demand for bandwidth. As a result, many are turning to fiber deployment as a solution. For many carriers, GPON is the means to compete in an environment where high bandwidth is required. GPON provides the flexibility, reliability, and bandwidth to give carriers a competitive advantage in today's Fiber-to-the-Home (FTTH) market.

ADTRAN® provides an ultra-flexible, high-capacity, deep fiber solution allowing over 8,700 subscribers to be served from a single FTTH platform. The Total Access® 5000 is a carrier class Multi-service Access and Aggregation platform (MSAP) that bridges the gap between existing and the nextgeneration networks—like GPON. With a pure Ethernet core, the Total Access 5000 system supports services over copper and fiber, easily scaling to support even the most bandwidth-intensive applications. As a GPON Optical Line Terminal (OLT), the Total Access 5000 provides the bandwidth and Ethernet switching capabilities needed to deliver a highly profitable service offering and meet a variety of legacy and emerging service requirements.

The SFP-based GPON OLT allows operators to increase their serving area by utilizing optical capabilities to reach up to 60 km on a single PON.

The ADTRAN GPON solution utilizes GPON Encapsulation Mode (GEM) to exclusively carry Ethernet traffic. ADTRAN has made a complete commitment to Ethernet in the access network with the Total Access 5000, and the GPON OLT Access Module is furthering this commitment.

With the ADTRAN solution, data traffic is carried natively as Ethernet, which is a very efficient means of transporting high bandwidth data connections.

Video options with the Total Access 5000 GPON OLT include both IPTV and RF video. IPTV functions in the Total Access 5000 and the GPON OLT Access Module provide Internet Group Management Protocol (IGMP) signaling and multicast replication functions. RF video overlay at 54–1,004 MHz is supported on GPON as a third wavelength at 1550 nm using outboard amplifiers and wavelength combiners.

Environmentally hardened, the Total Access 5000 GPON OLT Access Module can be installed in both Central Office (CO) and Remote Terminal (RT) environments. This allows carriers to deploy GPON from whatever infrastructure is available or desired rather than limiting GPON to just CO deployments.

ADTRAN®

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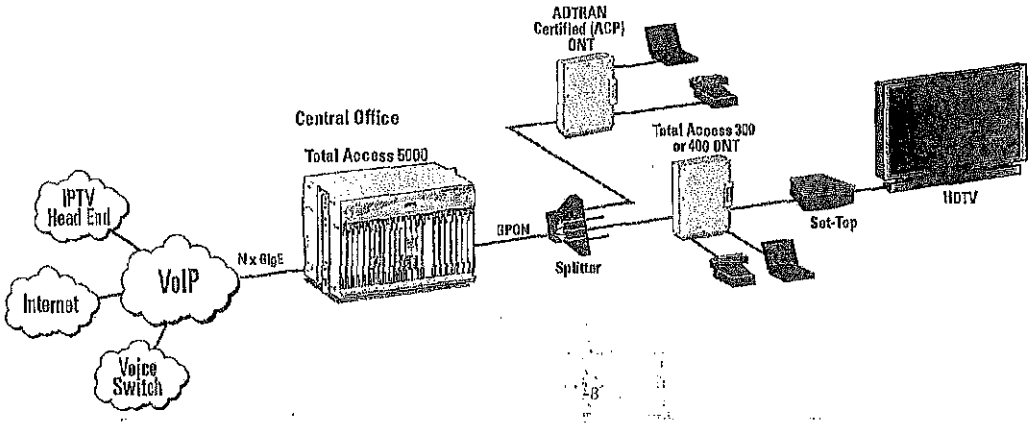
Total Access 5000 Octal OLT

8-port GPON Optical Line Terminal Access Module



Product Specifications

Mechanical

- **Dimensions:** 9.25 in. x 0.8 in. x 9.25 in. (235 mm x 20 mm x 235 mm) (H x W x D)

Interfaces

- 8-SFP Single-mode fiber Interfaces on Faceplate

Capacities

- Capable of up to 64 ONTs per GPON Interface
- 21 GPON OLT Access Modules per 23-inch Total Access 5000 chassis
- 10752 Subscribers per 23-inch Total Access 5000 Chassis utilizing 1:64 Split

Regulatory Standards

- ETSI EN 300 019
- ETS 300 753
- ETSI EN 300 386
- ETS ES 201 468
- ETSI EN 60950
- ITU-T K.20/21/27/31/35/45

Management

- AOE
- Remote Management Through SNMP and TL1
- Ethernet Interface on SCM for Web, SNMP and Telnet Access
- Craft Interface on SCM
- OMCI to ONTs

Environmental

- **Operating Temperature:** -40° F to 158° F (-40° C to +65° C)
- **Storage Temperature:** -40° F to 185° F (-40° C to +85° C)
- **Relative Humidity:** Up to 95%, at 122° F (50° C), Non-condensing

Optics

- Class B+ Compliant as Specified in G.984.2 Amendment 1
- 20 km Reach with 64x Split
- 30 km Reach with 32x Split
- 37 km Reach with 16x Split

Ordering Information

Equipment	Part No.
Total Access 5000 GPON Octal OLT	1187503F1
SFP GPON 2.5G, 1.25G 30km	1442530G1

TL9000 TL.19.1270

ADTRAN is an ISO 9001, ISO 14001, and a TL 9000 certified supplier.

61187503F1-8D January

Total Access 311

SFU GPON Indoor ONT

Product Features

- Cost-effective delivery of triple-play services
- Supports symmetric gigabit services
- G.984 compliant 2.5 Gbps downstream and 1.25 Gbps upstream
- Small form factor packaging designed for indoor deployments
- Auto-negotiating/sensing 10/100/1000Base-T Ethernet port
- Built-in layer-2 switch
- Native Ethernet transport over the GPON (GEM Based)
- VoIP using SIP or MGCP
- Native POTS RJ-11 port with full suite of voice quality features
- IPTV video support including IGMP snooping feature set
- Traffic management through priority queuing, scheduling, policing and traffic shaping
- VLAN Stacking (Q-in-Q), VLAN tagging/untagging
- QoS with four traffic classes as per IEEE 802.1p
- Full IEEE 802.1Q VLAN ID processing per port
- Full OMCI integration

Carriers today are dealing with increasing competition, operational costs, and demand for bandwidth. To address these concerns, ADTRAN® offers a complete suite of fiber access solutions that are enabling carriers to compete more cost-effectively while expanding broadband services to un-served and underserved areas, like those targeted by national broadband initiatives.

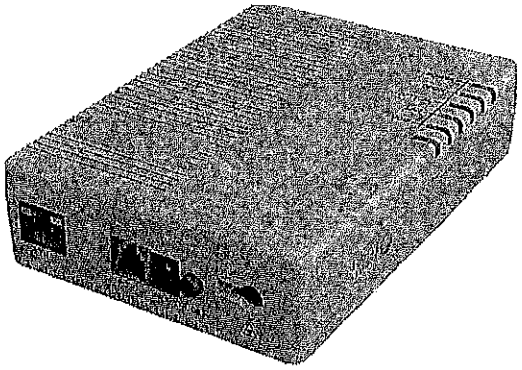
With fiber access solutions like Gigabit Passive Optical Networking (GPON) carriers have a new means to compete in an environment where bandwidth is king. GPON provides the flexibility, reliability, and bandwidth to give carriers a competitive advantage in today's market. As part of the ADTRAN FTTx strategy, ADTRAN offers a range of differentiated GPON Optical Network Terminal (ONT) solutions to address residential, business, and cell site applications.

The Total Access® 300 and 400 ONTs are designed to address the market with industry leading voice, data, and video capabilities. These ONTs include both indoor and outdoor models for residential and business applications. With Total Access GPON ONTs, carriers can benefit from high data rates of fiber optic transmission and the flexibility offered by ADTRAN's portfolio of Ethernet-based systems that can be easily configured for new, customized service offerings.

Total Access 300 and 400 ONTs work seamlessly with ADTRAN's widely deployed Total Access 5000 Series Multiservice Access and Aggregation Platform. Functioning as a highly capable GPON OLT and flexible carrier class access platform, the Total Access 5000 bridges the gap between existing and next-generation network architectures like GPON. It makes a carrier's access network capable of meeting a variety of legacy and emerging system requirements. Its Ethernet architecture allows carriers to increase bandwidth while offering differentiated capabilities. Coupled with Total Access 300 and 400 ONTs, this provides an end-to-end GPON deployment strategy that is supported by a common management solution.

The Total Access 300 and 400 ONTs leverage the industry-leading converged voice and data functionality widely deployed in ADTRAN integrated access, IP gateway, and Voice over IP (VoIP) platforms, with millions of ports currently deployed. Based on the ADTRAN Operating System (AOS), each ONT provides unmatched SIP and MGCP interoperability with a host of major softswitch vendors, as well as integrated statistics and tools that allow carriers to quickly and easily troubleshoot network configuration issues, as well as monitor performance.

Features of the Total Access 300 and 400 outdoor ONTs include box-in-box, weatherproof and access controlled construction with entry ports for fiber, power, ground, Ethernet, telephone, RFoG (specific models), and HPNA (specific models). Each device supports 2.5 Gbps GPON applications per the ITU-T G.984.2 specification. Data services are delivered over 10/100/1000Base-T Ethernet interfaces.



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TL9000 TL9-1270

ADTRAN is an ISO 9001, ISO 14001, and a TL 9000 certified supplier.

61267565G1-9A January

Total Access 311

SFU GPON Indoor ONT

Product Specifications

Ethernet Interfaces

- 10/100/1000Base-T interface with RJ-45 connectors
- Ethernet port auto negotiation or manual configuration
- MDI/MDIX automatically sense
- Hardware priority queues on the downstream direction in support of CoS

Ethernet Services

- Committed symmetric 1Gbps throughput
- 802.1D bridging
- 802.1x Authentication
- Virtual switch based on 802.1q VLAN
- VLAN tagging/detagging per Ethernet port
- VLAN stacking (Q-in-Q) and VLAN translation
- IP ToS/DSCP to 802.1p mapping
- Class of Service based on VLAN-ID, 802.1p bit, ToS/DSCP
- Marking/remarking of 802.1p
- IGMP v2/v3 snooping
- Broadcast/multicast rate limiting

POTS Interface

- RJ-11 interface
- 3-REN, 55V RMS
- VoIP Voice: Both SIP and MGCP
- TDM Voice: Both GR.303 and TR-08
- Full CLASS feature set
- Both ANSI and ETSI POTS
- T.38 Facsimile
- Configurable dial plan
- Configurable country specific ring-back tones (frequency and cadence)
- DHCP Client or static IP configuration
- Optionally Metallic Loop Testing

Dimensions

- 1.4 in. x 3.9 in. x 5.5 in. (35 mm x 100 mm x 140 mm) (H x W x D)

Power Supply

- +12V (feed via external AC/DC adapter)
- Dying Gasp support
- Power switch
- Power Consumption: Less than 4W

Working Environment

- Temperature: 32° F – 104° F (0° C – 40° C)
- Humidity: 5% – 95% relative humidity

Safety and EMI

- CE certificate
- FCC/UL compliant

Environmental Directive

- RoHS 6 of 6

Installation

- Wall mounting & desktop mounting

GPON Interface

- Compliant with ITU-T G.984 GPON standards
- Compliant with ITU-T G.984.2 Amd1, Class B+
- Support G.984.5 blocking filter
- Multiple T-CONTs per device
- Multiple GEM Ports per device
- DBA reporting by piggyback reports in the DBRu (mode 0 and mode 1)
- 802.1p mapper service profile on U/S
- Mapping of GEM Ports into a T-CONT with priority queues based scheduling
- Support multicast GEM port and incidental broadcast GEM port

LEDs

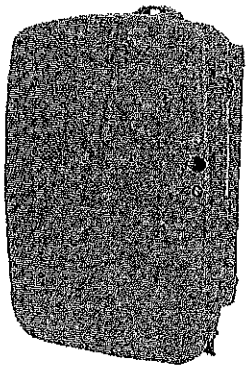
- Power
- GPON
- Optical
- LAN
- VoIP

OAM

- Standard compliant OMCI (the embedded operations channel) interface as defined by ITU-T G.988
- Provisioning all kinds of services including Ethernet, VoIP etc.
- Alarming and performance monitoring
- Remote software image download over OMCI, as well as activation and rebooting
- Hold two software sets with software image integrity checking and automatic rollback

Ordering Information

Equipment	Part No.
Total Access 311 SFU GPON Indoor ONT	1287565G1



Total Access 300 Series

Total Access 300 Series GPON SFU ONTs

Carriers today are dealing with increasing competition, operational costs, and demand for bandwidth. To address these concerns, ADTRAN® offers a complete suite of fiber access solutions that are enabling carriers to compete more cost-effectively while expanding broadband services to un-served and underserved areas, like those targeted by the American Recovery and Reinvestment Act and Connect American Fund.

With fiber access solutions like Gigabit Passive Optical Networking (GPON) carriers have a new means to compete in an environment where bandwidth is king. GPON provides the flexibility, reliability, and bandwidth to give carriers a competitive advantage in today's market. As part of the ADTRAN FTTx strategy, ADTRAN offers a range of differentiated GPON Optical Network Terminal (ONT) solutions to address residential, business, and cell site applications.

The Total Access® 300 Series is a line of GPON ONTs designed to address the residential market with industry-leading voice, data, and video capabilities. This series includes the Total Access 351, 352, 352H, 361, 362, 362H, 362R Outdoor ONTs and Total Access 324 and 334 Indoor ONTs. With Total Access GPON ONTs, carriers can benefit from high data rates of fiber optic transmission and the flexibility offered by ADTRAN's portfolio of Ethernet-based systems that can be easily configured for new, customized service offerings.

Total Access 300 Series ONTs work seamlessly with ADTRAN's widely deployed Total Access 5000 Series Multiservice Access and Aggregation Platform. Functioning as a highly capable GPON OLT and flexible carrier-class access platform, the Total Access 5000 bridges the gap between existing and next-generation network architectures like GPON. It makes a carrier's access network capable of meeting a variety of legacy and emerging system requirements. Its Ethernet architecture allows carriers to increase bandwidth while offering differentiated capabilities. Coupled with Total Access 300 Series ONTs, this provides an end-to-end GPON deployment strategy that is supported by a common management solution.

The Total Access 300 series ONTs leverage the industry-leading converged voice and data functionality widely deployed in ADTRAN integrated access, IP gateway, and Voice over IP (VoIP) platforms, with millions of ports currently deployed. Based on the ADTRAN Operating System (AOS), each ONT provides unmatched SIP and MGCP interoperability with a host of major soft-switch vendors, as well as integrated statistics and tools that allow carriers to quickly and easily troubleshoot network configuration issues, as well as monitor performance.

Features of the Total Access 300 Series Outdoor ONTs include box-in-box, weatherproof and access controlled construction with entry ports for fiber, power, ground, Ethernet, telephone, RFoG (specific models), and HPNA (specific models). Each device supports 2.5 Gbps GPON applications per the ITU-T G.984.2 specification. Data services are delivered over 10/100/1000Base-T Ethernet interfaces. Telephone service is supported by POTS interfaces.

The POTS ports use in-band signaling tones and currents to determine call status. GPON Encapsulation Mode (GEM) is used to carry Ethernet traffic. SIP, MGCP, GR-303, TR-008, and TR-57 are all available to support a wide variety of network models. Voice traffic is carried as VoIP packets to either the Total Access 5000 integrated Voice Gateway Module for access to legacy TDM interfaces, or as SIP or MGCP to an external soft-switch to support voice services. A full suite of Quality of Service (QoS) features are available with support for 802.1Q VLANs and 802.1p for prioritization.

The Total Access 300 Series Outdoor ONTs are powered by an external UPS. The AC-powered UPS provides a nominal 12 VDC to the ONT. Total Access 300 Series Indoor ONTs are optionally powered by an external UPS or directly connected to a 120 VAC power source. Management of the Total Access 300 Series ONTs is performed over OMCI as specified in G.984.4. The Total Access 300 Series Outdoor ONTs are environmentally hardened for installation inside or outside a residence as a particular installation demands. The ONTs are accepted by Rural Utilities Service (RUS) and provide a wealth of benefits for carriers of all types, deploying broadband solutions including voice, data, video, and HDTV. An industry-leading warranty and best-in-class technical support make ADTRAN Total Access GPON solutions the best value on the market today.

Product Features

- G.984 compliant
- Environmentally hardened for indoor and outdoor deployments
- Full Class B+ Optics, capable of 30 km reach
- Optional Internal Opti-Fit mounting
- 10/100/1000 Base-T Ethernet Port(s)
- RF Over Glass Support (ONT specific)
- HPNA Support (ONT specific)
- Fiber cable management
- Native Ethernet transport over the GPON (GEM Based)
- VoIP using SIP or MGCP
- Traditional voice using GR-303, TR-008, or TR-57
- IPTV video support
- Traffic management through priority queuing, scheduling, policing and traffic shaping
- VLAN Stacking (Q-in-Q), VLAN tagging/untagging
- QoS with four traffic classes as per IEEE 802.1p
- Full IEEE 802.1Q VLAN ID processing per port
- Full OMCI integration

ADTRAN

Total Access 300 Series

Total Access 300 Series GPON SFU ONTs

Product Specifications

Voice Support

VoIP Protocol

- SIP
- MGCP

Traditional Voice

- GR-303
- TR-008
- TR-57

LEDs

- Power
- Network Status
- POTS
- ETH

Mechanical Outdoor Units

- 9.75" W x 12" H x 4" D
- 3 lbs., 0.5 oz. weight

Mechanical Indoor Units

- 9.3" W x 2.1" H x 6.7" D
- 1.25 lbs. weight

Compliance

- FCC PART 15 Class B
- UL/CSA 60950
- RoHS 5 of 6 Compliant

Interfaces

Voice Interfaces

- 2 POTS lines
- RJ-11 and screw-down terminals
- 5 REN per line
- 10 REN per unit
- 1,000 ft. drop length

Data Interfaces

- RJ-45 10/100/1000Base-T Ethernet ports
- Auto-sensing
- Auto MDI/MDIX

RF Video Interfaces (ONT specific)

- F-Type connector
- 1610nm RF return path

Video PON Optical Output (ONT specific)

- Output wavelength 1610+ 10nm
- Optical output Power 1 dBm min.

Video—RF Output (ONT specific)

- **Impedence:** 75-ohms
- **Connector Type:** F-Type
- **Bandwidth:** 54MHz to 1GHz
- **RF Output Power:** 15dBmV/ch to 24.5dBmV/ch
- **RF Output Tilt:** 2dB to 7dB from 54 to 870MHz
- **Channel Loading:** up to 82 (Analog), up to 200 (Digital)
- **CNR:** 46dB min
- **CSO:** -56dBc max
- **CTB:** -56dBc max

HPNA Interface (ONT specific)

- HPNA 3.1 compliant

Power Connections Battery Backup

- 12 VDC (nominal) from external battery backup/power supply
- 5-wire battery backup/power supply status signals
- Screw-down terminal

Power Connections Indoor AC

- 12 VDC external power supply connects to 120 VAC source
- External power supply provided with appropriate Indoor ONT models

Management

- Remote management through SNMP and TL1 to Total Access 5000 GPON OLT
- Ethernet interface on Total Access 5000 for IP management access
- Craft interface on Total Access 5000 for VT100 management access
- OMCI between ONT and OLT
- AOS statistics and debug capabilities

Environmental Outdoor

- **Operating Temperature:** -40°C to +65°C
- **Storage Temperature:** -40°C to +85°C
- **Relative Humidity:** Up to 95%, non-condensing

Environmental Indoor

- **Operating Temperature:** 0°C to 40°C
- **Storage Temperature:** -20°C to +70°C
- **Relative Humidity:** Up to 95%, non-condensing

Optics

- Class B+ compliant as specified in G.984.2
- Up to 30km reach with 32x split
- SC/APC for GPON uplink

Enclosures for Outdoor Units

- Corning OptiTap™ mounting for pre-terminated fiber cable
- Slack storage tray
- Wind-driven rain protection

Packet-based Voice Resources

- **CODECs**
  - G.711-64k PCM
  - G.729a-8k CS-ACELP
- G.168 Echo Cancellation

Media Stream

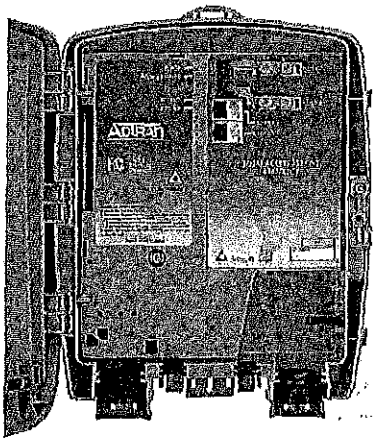
- RTP/UDP/IP (RFC 3550)
- RTP payload for DTMF digits (RFC 2833)
- SDP (RFC 2327)

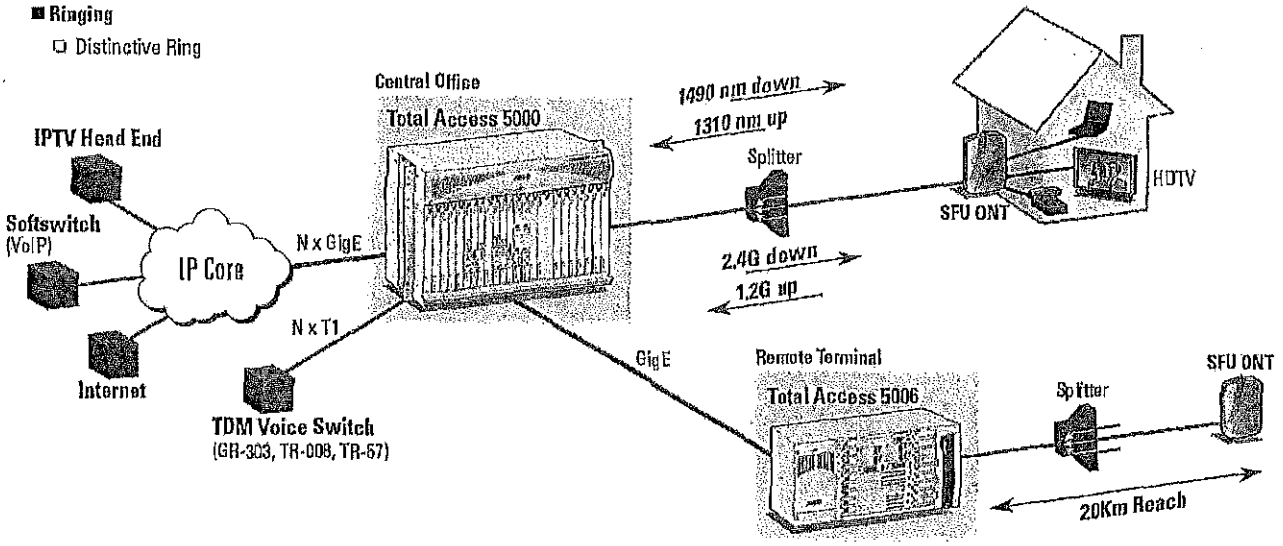
Tone Services

- **Local DTMF Detection**
- **Local Tone Generation**
  - Dialtone
  - Busy
  - Call Waiting
  - Alternate Call Waiting
  - Receiver Off Hook
- **Ringing**
  - Distinctive Ring

Calling Feature Support (varies with feature server/gateway)

- **Caller ID**
  - Name and Number (MDMF, SDMF)
  - Call Waiting IAD
- **Voice Mail**
  - Stutter dialtone
  - Visual Message Waiting Indicator (VMWI)
- **Call Hold**
- **Call Forward**
  - Busy Line
  - No Answer
- **Call Transfer**
  - Blind, Attended
- **Call Waiting**
- **Distinctive Ring**
- **Do Not Disturb**
- **Three-way Calling**
- **Call Return**
- **Speed Dial**
- **3-way Conferencing (3WC)**





Fiber To The Premises (FTTP)

ADTRAN Total Access 5000 Multiservice Access and Aggregation Platform enables multiplay service delivery over an all Ethernet access platform capable of delivering FSAN-compliant GPON. OLT modules can be installed in any access slot in the Total Access 5000 enabling FTTP service delivery. Services are delivered over a single fiber up to 30km from a central office or remote terminal, providing 2.4Gb of bandwidth over the PON. The ADTRAN OLT is completely ITU-T G.984 standards-compliant and offers unprecedented bandwidth per subscriber.

The Total Access Series ONTs work seamlessly with ADTRAN Total Access 5000 Series Multiservice Access and Aggregation Platform. With its Ethernet architecture, the Total Access 5000 allows carriers to increase bandwidth while offering differentiated capabilities. Coupled with Total Access Series ONTs, this provides an end-to-end GPON deployment strategy that is supported by a common management solution.

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TL9000

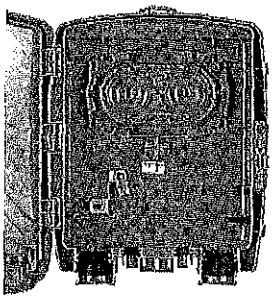
TL19,1270

ADTRAN is an ISO 9001, ISO 14001, and a TL 9000 certified supplier.

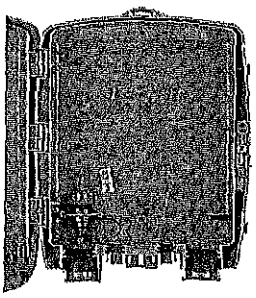
6128770G1-8D April

Total Access 300 Series

Total Access 300 Series GPON SFU ONTs



Splice Tray Enclosure



Corning OptiTap™ Enclosure

Ordering Information

Indoor ONTs

ONT Model	Part number	Application	POTS	GigE Ports	HPNA	RF Video	Battery Backup/UPS
Total Access 324	1287735G1	SFU/Indoor	2	4	—	—	No, AC only
Total Access 324 w/UPS Connector	1287735G2	SFU/Indoor	2	4	—	—	Yes
Total Access 334	1287736G1	SFU/Indoor	2	4	—	1	No, AC only
Total Access 334 w/UPS Connector	1287736G2	SFU/Indoor	2	4	—	1	Yes

Outdoor ONTs

ONT Model	Housing	Part number	Application	POTS	GigE Ports	HPNA	RF Video
Total Access 351	Splice	4287701G2	SFU	2	1	—	—
Total Access 352	Splice	4287702G2	SFU	2	2	—	—
Total Access 352	Opti-tap	4287702G3	SFU	2	2	—	—
Total Access 352H	Splice	4287702G4	SFU	2	4	1	—
Total Access 362	Splice	4287712G12	SFU	2	2	—	1
Total Access 362	Opti-tap	4287712G13	SFU	2	2	—	1
Total Access 362H	Splice	4287712G14	SFU	2	4	1	1
Total Access 362R	Splice	4287715G12	SFU	2	2	—	1 (w/RF return)

ONT Cartridge Only (No Housing)

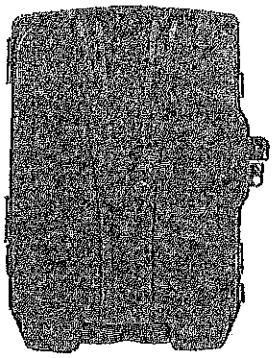
Total Access 351, 2ND GEN	1287701G1
Total Access 352, 2ND GEN	1287702G1
Total Access 352H, 2ND GEN	1287702G3
Total Access 362, 2ND GEN	1287712G1
Total Access 362H, 2ND GEN	1287712G3
Total Access 362R 2ND GEN	1287715G1
Total Access 324	1287735G1
Total Access 324 W/UPS CONN	1287735G2
Total Access 334	1287736G1
Total Access 334 W/UPS CONN	1287736G2

SFU Housing and Spare Kits

Total Access 350 ONT NID HSG SPLICE	1187770G1
Total Access 350 ONT NID HSG OPTITAP	1187771G1
Total Access 350 ONT Slack Storage Unit	1187772G1
Total Access 300 SFU Spares Kit, Qty 5	1187700G1
ONT UPS, GPON	1187731G1
GPON UPS Cable, 50 FT	1187732G1

MDU Housing Details

MDU UPS, GPON	1187733G1
GPON MDU SPLITTER	1187734G1
ONT INSTALLATION ACC KIT	1187735G1
Total Access 380 MDU, SPLICE	1187773G1



Total Access 372 GPON SBU Series

GPON SBU Optical Network Terminal (ONT)

Product Features

- 8 POTS and 4 DS1/E1 for PWE Transport through Total Access 5000
- 10/100/1000 Base-T Ethernet Port(s)
- G.984 compliant
- Environmentally hardened for indoor and outdoor deployments
- Full Class B+ Optics, capable of 30 km reach
- Optional Internal Opti-Fit mounting
- RF over Glass (RFoG) Support (ONT specific)
- Fiber cable management
- Native Ethernet transport over the GPON (GEMBased)
- VoIP using SIP or MGCP
- Traditional voice using GR-303, TR-008, or TR-57
- IPTV video support
- Traffic management through priority queuing, scheduling, policing and traffic shaping
- VLAN Stacking (Q-in-Q), VLAN tagging/untagging
- QoS with four traffic classes as per IEEE 802.1p
- Full IEEE 802.1Q VLAN ID processing per port
- Full OMCI integration

Carriers today are dealing with increasing competition, operational costs, and demand for bandwidth. To address these concerns, ADTRAN® offers a complete suite of fiber access solutions that are enabling carriers to compete more cost-effectively while expanding broadband services to unserved and underserved areas, like those targeted by the American Recovery and Reinvestment Act and Connect American Fund.

With fiber access solutions like Gigabit Passive Optical Networking (GPON) carriers have a new means to compete in an environment where bandwidth is king. GPON provides the flexibility, reliability, and bandwidth to give carriers a competitive advantage in today's market. As part of the ADTRAN FTTx strategy, ADTRAN offers a range of differentiated GPON ONT solutions to address residential, business, and cell site applications.

The Total Access® 300 Series Small Business Units (SBU) GPON ONTs are designed to address the small business market with industry-leading voice, data, and video capabilities. This series includes the Total Access 372 and 372R. With Total Access GPON SBU ONTs, carriers can benefit from high data rates of fiber optic transmission, multiple DS1 hand-offs, and the flexibility offered by ADTRAN's portfolio of Ethernet-based systems that can be easily configured for new, customized service offerings.

Total Access 300 Series SBU ONTs work seamlessly with ADTRAN's widely deployed Total Access 5000 Series Multiservice Access and Aggregation Platform. Functioning as a highly capable GPON OLT and flexible carrier-class access platform, the Total Access 5000 bridges the gap between existing and next-generation network architectures like GPON. It makes a carrier's access network capable of meeting a variety of legacy and emerging system requirements. Its Ethernet architecture allows carriers to increase bandwidth while offering differentiated capabilities. Coupled with Total Access 300 Series SBU ONTs, it provides an end-to-end GPON deployment strategy that is supported by a common management solution.

The Total Access 300 Series SBU ONTs leverage the industry-leading converged voice and data functionality widely deployed in ADTRAN integrated access, IP gateway, and Voice over IP (VoIP) platforms, with millions of ports currently deployed. Based on the ADTRAN Operating System (AOS), each ONT provides unmatched SIP and MGCP interoperability with a host of major soft-switch vendors, as well as integrated statistics and tools that allow carriers to quickly and easily troubleshoot network configuration issues, as well as monitor performance.

Features of the Total Access 300 Series Outdoor ONTs include box-in-box, weatherproof and access controlled construction with entry ports for fiber, power, ground, Ethernet, telephone, RFoG (specific models), and DS1 (pseudowire) business circuits. Each device supports 2.5 Gbps GPON applications per the ITU-T G.984.2 specification. Data services are delivered over 10/100/1000Base-T Ethernet interfaces. Telephone service is supported by POTS interfaces and DS1 delivery is achieved by leveraging SAToP PWE3 services through the Total Access 5000 platform.

The POTS ports use in-band signaling tones and currents to determine call status. GPON Encapsulation Mode (GEM) is used to carry Ethernet traffic. SIP, MGCP, GR-303, TR-008, and TR-57 are all available to support a wide variety of network models. Voice traffic is carried as VoIP packets to either the Total Access 5000 integrated Voice Gateway Module for access to legacy TDM interfaces, or as SIP or MGCP to an external soft-switch to support voice services. A full suite of Quality of Service (QoS) features are available with support for 802.1Q VLANs and 802.1p for prioritization.

The Total Access 300 Series SBU ONTs are powered by an external UPS. The AC-powered UPS provides a nominal 12 VDC to the ONT. Management of the Total Access 300 Series SBU ONTs is performed over OMCI as specified in G.984.4. The Total Access 300 Series SBU ONTs are environmentally hardened for installation inside or outside a residence as such a particular installation demands. The ONTs are accepted by Rural Utilities Service (RUS) and provide a wealth of benefits for carriers of all types, deploying broadband solutions including voice, data, video, and HDTV. An industry-leading warranty and best-in-class technical support make ADTRAN Total Access GPON solutions the best value on the market today.

ADTRAN

Total Access 372 GPON SBU Series

GPON SBU ONT

Product Specifications

Voice Support

VoIP Protocol

- SIP
- MGCP

Traditional Voice

- GR-303
- TR-008
- TR-57

LEDs

- Power
- Network Status
- Voice
- ETH
- DS1

Mechanical

- 9.75" W x 12" H x 4" D
- 3 lbs., 0.5 oz. weight

Compliance

- FCC PART 15 Class B
- UL/CSA 60950

Interfaces

Voice

- 8 POTS Lines
- RJ-11

Data

- RJ-45 10/100/1000Base-T Ethernet ports
- Auto-sensing
- Auto MDI/MDIX

RF Video Interfaces (ONT specific)

- F-Type connector
- 1610nm RF return path

DS1/E1, PWE

- RJ-45
- SAToP structured in conjunction with PWE Modules in Total Access 5000

Video PON Optical Output (ONT specific)

- **Output Wavelength:** 1610+ 10nm
- **Optical Output Power:** 1 dBm min.

Video—RF Output (ONT specific)

- **Impedence:** 75-ohms
- **Connector Type:** F-Type
- **Bandwidth:** 54MHz to 1GHz
- **RF Output Power:** 15dBmV/ch to 24.5dBmV/ch
- **RF Output Tilt:** 2dB to 6dB from 54 to 870MHz
- **Channel Loading:** up to 82 (Analog), up to 200 (Digital)
- **CNR:** 46dB min
- **CSO:** -56dBc max
- **CTB:** -56dBc max

Power Connections Battery Backup

- 12 VDC (nominal) from external battery backup/power supply
- 5-wire battery backup/power supply status signals

Management

- Remote management through SNMP and TL1 to Total Access 5000 GPON OLT
- Ethernet interface on Total Access 5000 for IP management access
- Craft interface on Total Access 5000 for VT100 management access
- OMCI between ONT and OLT
- AOS statistics and debug capabilities

Environmental Outdoor

- **Operating Temperature:** -40°C to +65°C
- **Storage Temperature:** -40°C to +85°C
- **Relative Humidity:** Up to 95%, non-condensing

Optics

- Class B+ compliant as specified in G.984.2
- 30 km reach with 32x split
- SC/APC for GPON uplink

ONT Model	Application	POTS	GigE Ports	T1/E1	RF Video
Total Access 372	SBU	8	2	4	—
Total Access 372R	SBU	8	2	4	1

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TL9000
TL19.1270

ADTRAN is an ISO 9001, ISO 14001, and a TL 9000 certified supplier.

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Total Access 372 GPON SBU Series

GPON SBU ONT

Ordering Information

ONT Model	Housing	Part number	Application	POTS	GigE Ports	T1/E1	RF Video
Total Access 372	Splice	4287722G2	SBU	8	2	4	—
Total Access 372R	Splice	4287722G4	SBU	8	2	4	1

Equipment	Part #
ONT Cartridge Only (No Housing)	
Total Access 372 SBU, 2ND GEN	1287722G1
Total Access 372R SBU, 2ND GEN	1287722G2
Housings and Spare Kits	
NID, SBU STND	1187774G1
NID, SBU OPTITAP	1187775G1
Total Access 300 SBU Spares Kit, Qty 5	1187700G2
GPON UPS CABLE, 50 FT	1187732G1
SBU UPS, GPON	1187735G1

Enclosures for Outdoor Units

- Corning OptiTap™ mounting for pre-terminated fiber cable
- Slack storage tray
- Wind-driven rain protection

Packet-based Voice Resources

- **CODECs**
  - G.711-64k PCM ☐ G.729a-8k CS-ACELP
- G.168 Echo Cancellation

Media Stream

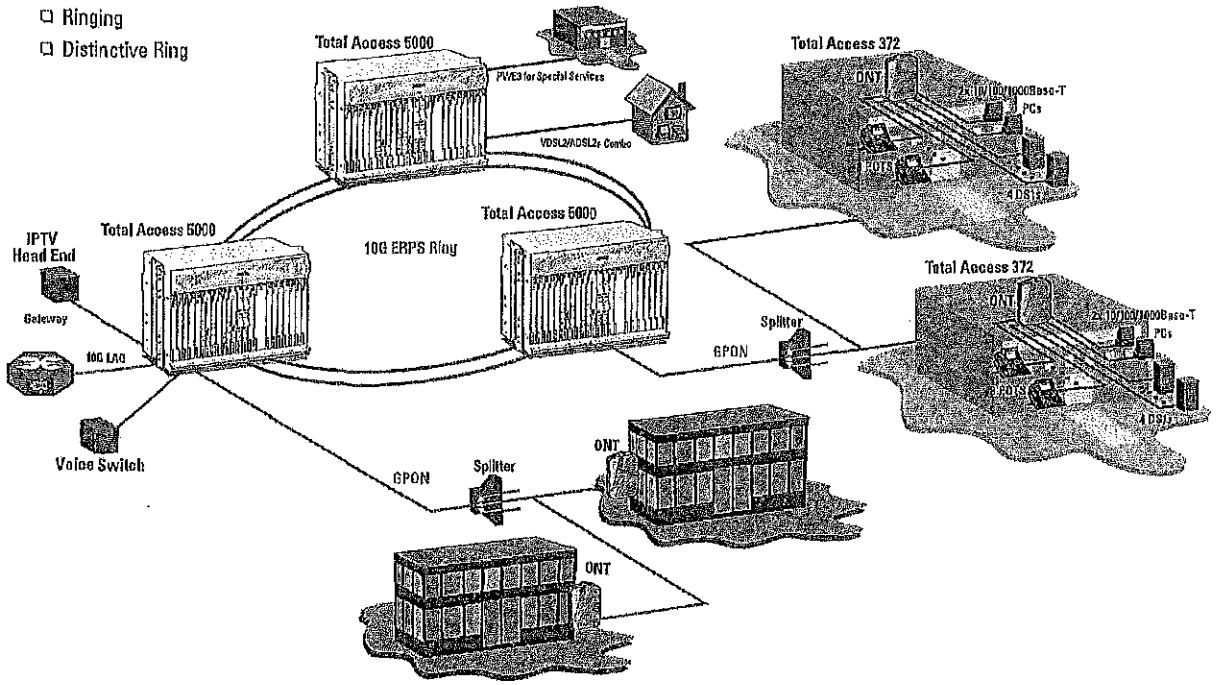
- RTP/UDP/IP (RFC 3550)
- RTP payload for DTMF digits (RFC 2833)
- SDP (RFC 2327)

Tone Services

- **Local DTMF Detection**
- **Local Tone Generation**
  - Dialtone
  - Busy
  - Call Waiting
  - Alternate Call Waiting
  - Receiver Off Hook
  - Ringing
  - Distinctive Ring

Calling Feature Support (varies with feature server/gateway)

- **Caller ID**
  - Name and Number (MDMF, SDMF)
  - Call Waiting IAD
- **Voice Mail**
  - Stutter dialtone
  - Visual Message Waiting Indicator (VMWI)
- **Call Hold**
- **Call Forward**
  - Busy Line ☐ No Answer
- **Call Transfer**
  - Blind, Attended
- **Call Waiting**
- **Distinctive Ring**
- **Do Not Disturb**
- **Three-way Calling**
- **Call Return**
- **Speed Dial**
- **3-way Conferencing (3WC)**



Total Access® System