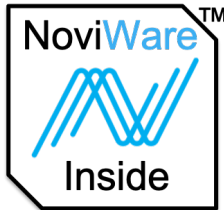


NoviWare™ 500.2 for NPU

HIGH PERFORMANCE OPENFLOW SWITCH OS SOFTWARE



NoviFlow's NoviWare 500.2 is the SDN industry's highest throughput and most complete implementation of the SDN OpenFlow 1.3/1.4/1.5 standard for use in switches, WAN IP/MPLS routers, network appliances and other high-performance forwarding planes. It is

deployed around the world in NoviFlow's NoviSwitch products, and is also offered via software license to OEM and ODM switching platform suppliers.

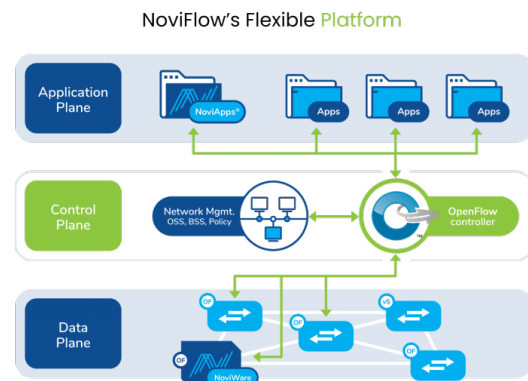
NoviWare 500.2 consists of all the software necessary for a pure-play OpenFlow switch, and currently supports the Mellanox NP-4 and NP-5 network processors with host CPU's from Intel. (See *NoviWare 500.2 for Tofino datasheet* for support of Barefoot's Tofino processor.) Today's major network operators demand flexible, scalable switching and routing solutions that deliver wire-speed performance. NoviWare was designed from the ground up to be a reliable, scalable platform for OpenFlow, combining a fully programmable L2-L7 packet forwarding data plane with high throughput performance.

NoviFlow Inc.™ aims to change the traditional approach to networking by making switching and routing smarter. The company was founded to deliver upon the promise of OpenFlow and SDN by delivering solutions that can handle complex flow processing and be field upgradable via software updates, making it possible for data centers and WANs to keep up with today's exponentially growing networking demand. By licensing NoviWare, NoviFlow is enabling leading OEMs and ODMs to bring to market tried and tested OpenFlow 1.3/1.4/1.5 solutions in months, not years.

NOVIWARE 500.2 FOR NPU KEY FEATURES:

- Implements all required and optional OpenFlow 1.3/1.4 match fields (41 of 41) and instructions (6 of 6) as well as 59 out of 60 actions and basic support of OF 1.5 (Copy-Fields action), including group chaining.
- Supports Mellanox NP-4 and NP-5 networking hardware.
- Fully programmable OpenFlow 1.3/1.4/1.5 pipeline with up to 60 wildcard plus 60 exact match flow tables.
- External TCAM for wire-speed wildcard matching in very large flow tables (up to a million flows).
- OpenFlow queues and up to 1 Million meters.

- Exact-match flow table entries in DRAM (up to 6 Million flows).
- Supports Virtual Machine installation on top of NoviWare
- Simplifies installation of NoviWare through ONIE
- Host processor software optimized for maximum flow-mods/second performance on Intel hosts.
- Hardware abstraction layer to facilitate porting to other platforms.
- Extensive O&M features optimized for large scale deployments including Plug-and-Play features such as gRPC remote automated provisioning and Switch IP address default set via DHCP.
- License key support (NS-1000 and NS-2000 series)



OpenFlow Experimenter-based extensions for ODL/ONOS/Ryu controllers:

- L2-L7 matching, packet processing and flow management.
- Hash on user defined ordered list of OpenFlow fields and Symmetric Hash of Fields
- Copy-Field action based on OF1.5 also supported on OF1.3 to 1.5 through OpenFlow Experimenter action
- VLAN and MPLS payload matching
- Additional tunnel encapsulation/decapsulation (VxLAN, L2MPLS, L2GRE, GTP, PPPoE, L2TP, STT)
- Timestamping
- Swap fields
- Traffic Shaping and Hierarchical Quality-of-Service (H-QoS) Optional Feature – (for more info, consult the [NoviWare FlowShaper Option Data Sheet](#))

Looking to transition to the powerful P4 technology and the Barefoot Tofino 6.5Tbps programmable forwarding plane? Consult our [NoviWare NOS for Barefoot Tofino Data Sheet](#).

NOVIWARE FOR NPU 500.2 FEATURES SUMMARY*

- Multiple Controllers and Controller role-change
- OpenFlow version negotiation (1.3, 1.4 and 1.5)
- All OpenFlow 1.3/1.4 required and optional match fields (41 of 41): IN_PORT, IN_PHY_PORT, METADATA, ETH_DST, ETH_SRC, ETH_TYPE, VLAN_VID, VLAN_PCP, IP_DSCP, IP_ECN, IP_PROTO, IPv4_SRC, IPv4_DST, TCP_SRC, TCP_DST, UDP_SRC, UDP_DST, SCTP_SRC, SCTP_DST, ICMPv4_TYPE, ICMPv4_CODE, ARP_OP, ARP_SPA, ARP_TPA, ARP_SHA, ARP_THA, IPv6_SRC, IPv6_DST, IPv6_FLABEL, ICMPv6_TYPE, ICMPv6_CODE, IPv6_ND_TARGET, IPv6_ND_SLL, IPv6_ND_TTL, MPLS_LABEL, MPLS_TC, MPLS_BOS, PBB_ISID, TUNNEL_ID, IPv6_EXTHDR, PBB_UCA
- All OpenFlow 1.3/1.4 instructions (6 of 6): Meter, Apply-Actions, Clear-Actions, Write-Actions, Write-Metadata, Goto-Table
- 59 of 60 OpenFlow 1.3/1.4 actions: Output {physical port, logical port, ALL, LOCAL, CONTROLLER, TABLE, IN_PORT, FLOOD}, Set-Queue, Drop, Group, Push VLAN, Pop VLAN, Push MPLS, Pop MPLS, Push PBB, Pop PBB, Set Field {ETH_DST, ETH_SRC, VLAN_VID, VLAN_PCP, IP_DSCP, IP_ECN, IPv4_SRC, IPv4_DST, TCP_SRC, TCP_DST, UDP_SRC, UDP_DST, SCTP_SRC, SCTP_DST, ICMPv4_TYPE, ICMPv4_CODE, ARP_OP, ARP_SPA, ARP_TPA, ARP_SHA, ARP_THA, IPv6_SRC, IPv6_DST, IPv6_FLABEL, ICMPv6_TYPE, ICMPv6_CODE, IPv6_ND_TARGET, IPv6_ND_SLL, IPv6_ND_TTL, MPLS_LABEL, MPLS_TC, MPLS_BOS, PBB_ISID, TUNNEL_ID, IPv6_EXTHDR, PBB_UCA}, Set MPLS TTL, Decrement MPLS TTL, Set IP TTL, Decrement IP TTL, Copy TTL outwards, Copy TTL Inwards, Unsupported action: Output NORMAL,(OpenFlow-hybrid switch only)
- TAGS: Push/Pop MPLS, multiple MPLS, VLAN (802.1Q), multiple VLAN (802.1ad "QinQ") and Provider Backbone Bridging (802.1ah) tags to/from packets
- Flexible flow entry width (10B, 20B, 40B or 80B) for wild card matching in TCAM based flow tables
- 48-byte flow table entry width for exact matching in DRAM
- Multiple tables support (OpenFlow pipeline processing). Any match field or combination of match fields, any instruction and any action may be used in any table
- Group Table supporting all OpenFlow 1.3/1.4 required and optional Group types (ALL, SELECT, INDIRECT, FAST FAILOVER) for complex forwarding such as multicasting
- Up to 8 queues per port (port slicing) with priorities
- Up to 1 million Meters (Drop, DSCP Remark) compliant with RFC2697 srTCM and RFC2698/ MEF 5 trTCM
- Bundles, Eviction, Vacancy Events, Role Status Events, Group and Meter change notifications
- Support for fan-out cables (for 40 Gbps ports)
- Link Aggregation Group (LAG) with dynamic port provisioning
- Supports Virtual Machine installation on top of NoviWare
- Simplifies installation of NoviWare through ONIE
- Push/pop PPPoE and match
- Up to 32-byte wide user defined (width and offset) IP and UDP payload exact or wild card match fields and maskable set fields actions through experimenter match field and actions
- L2MPLS for layer 2 PTP or PTMP MPLS services
- Persistent flows
- GPRS Tunneling Protocol (GTP) for 2G/3G/4G mobile network services

- VxLAN/L2GRE/L2MPLS/GTP Encapsulation / Decapsulation through experimenter push/pop actions
- Tunnel Metadata for GRE, MPLS and VxLAN
- Per port Rx dropped counter on table-miss with action drop
- BFD Link Monitoring as liveness mechanism for Fast Failover group entry type with multiple BFD sessions
- Packet timestamping with stats
- Time sync in a NTP or PTP
- Linux port bonding-OF port redundancy
- Additional stats counters and logs:
 - Packets received, dropped and transmitted per flow
 - Per port counters
 - Logs: errors, table entries
 - Matching entries per protocol
 - Multipart message support
 - Queues support
 - Per-flow meters

O&M FEATURES:

- TACACS+ for AAA services with AAA timeout
- RADIUS for CLI access control and accounting
- Access Control Lists (allowed IP addresses) for switch management ports
- VLAN on OpenFlow and CLI ports
- CLI command log file with accessing IP address for configuration change traceability
- CLI command log file export to external server
- CLI command for H-QoS to show and configure the QoS hierarchy, shaping, burst size, and priority for flows
- Command to initiate the sending of a dummy Packet-out on a specific port
- Load new/rollback to previous switch software revision
- Set port configuration, tables, user names, passwords, traces on/off for monitoring of OpenFlow messages to/from the controller, OF port status logging – messages log
- Show configuration for switch, controller, transceiver, OFChannel, tables, users
- Show switch stats, logs, software revision, OFChannel status
- Manual and automatic (remote server based) switch configuration
- Possibility to use the option 'monitoring' with 'show status port' and 'show status platform' through gRPC
- Switch configuration file export/import to remote server in binary and text formats
- TLS CA certificates
- Commands for adding and deleting flow entries
- Redundant physical OFChannel ports
- SNMP v2/v3 protocol
- Support gNMI, gNOI and the OpenFlow model for OpenConfig over gNMI
- Key-based user authentication
- NETCONF support
- Firmware upgrade including BIOS
- Introduction of SmartCTL
- TLS for Remotelog Server
- gRPC Support for CA Chain
- Watchdog to Restart IPMI Modules if IPMI Service down

*Please consult www.noviflow.com/noviswitch for details on the features and characteristics of NoviSwitch products, and www.noviflow.com/noviware for NoviWare release details as well NP and Tofino specific NoviWare features

FOR MORE INFORMATION



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