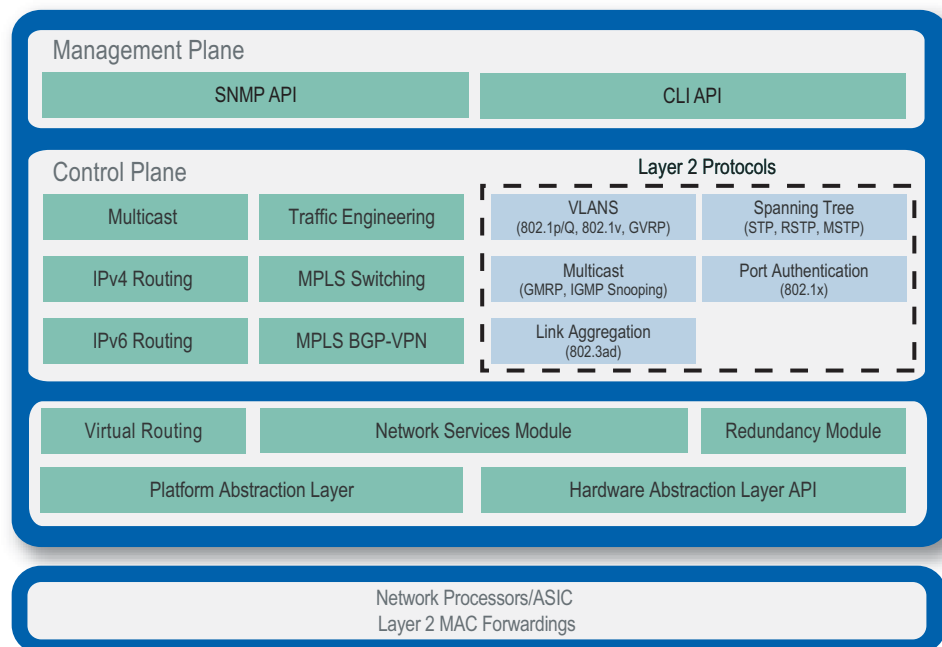


# Layer 2 Protocol Modules

## Overview

The ZebOS® Advanced Routing Suite (ARS) Layer 2 Protocol Modules are a family of Ethernet bridging, Spanning Tree, multicast and VLAN software packages that provide advanced Layer 2 functionality for vendors building routing and switching equipment. The ZebOS Layer 2 Protocol Modules leverage the command line interface and the kernel management of the ZebOS Network Services Module (NSM). In addition, the ZebOS Layer 2 Protocol Modules support IP Infusion's Network Processor API (NPapi), providing portability to a variety of network processors and ASICs. Because of their seamless integration with the leading operating system and other ZebOS ARS protocols, the ZebOS Layer 2 Protocol Modules offer the ideal Layer 2 framework for both new and existing IP Infusion customers.

The following architecture diagram illustrates the functional components of the ZebOS Layer 2 solution.



## ZebOS Layer 2 Protocol Modules

The ZebOS Layer 2 family includes Ethernet MAC bridging, Spanning Tree Protocol (STP), Rapid Spanning Tree Protocol (RSTP), Multiple Spanning Tree Protocol (MSTP), VLAN and hardware forwarding APIs, IGMP Snooping, GARP Multicast Registration Protocol (GMRP), GARP VLAN Registration protocol (GVRP), Port and Protocol VLAN classification (802.1v), VLAN Stacking, 802.1x Port Authentication, and Link Aggregation (802.3ad). In addition to the individual protocol modules, the ZebOS Layer 2 family offers Core, Advanced, and Advanced VLAN bundled options. In addition, ZebOS offers the Hybrid Switching Routing module that establishes a hierarchical relationship between the L2 and L3 protocols. This enables the design of advanced L2 switching and L3 routing hybrid switching and routing systems that can behave as a L2 switch, L3 router or a combined L2 and L3 hybrid switch router that to take advantage of the fast path forwarding provided by today's advanced network processors.

**802.1d MAC Bridging** – 802.1d provides MAC (Media Access Control) Bridging which allows multiple Local Area Networks (LANs) to be connected together. MAC bridging filters data sent between LAN segments, reduces network congestion and allows networks to be partitioned for administrative purposes.

**Spanning Tree** – The Spanning-Tree Protocol (STP) enables devices to avoid bridge loops by exchanging BPDU (bridge protocol data unit) messages and includes standard MIB support for RFC 1493 and RFC 2674. The Spanning Tree Algorithm calculates the best path and prevents multiple paths between network segments. Also it supports 802.3x flow control, Broadcast storm recovery, and port mirroring.

**802.1w Rapid Spanning Tree** – In addition to Spanning Tree, ZebOS supports Rapid Spanning Tree Protocol (RSTP) which accelerates the reconfiguration and restoration of a Spanning Tree after a link failure. Also it supports 802.3x flow control, Broadcast storm recovery, and port mirroring.

**802.1s Multiple Spanning Tree** – The Multiple Spanning Tree Protocol (MSTP) is a supplement to 802.1Q. It allows VLAN bridges to use multiple spanning trees by providing the ability for traffic belonging to different VLANs to flow over potentially different paths within the virtual bridged LAN. Also it supports 802.3x flow control, Broadcast storm recovery, and port mirroring.

**802.1p and Q VLANs** – The ZebOS Layer 2 Modules provide 802.1Q Virtual LAN (VLAN) bridging. VLAN bridging allows network devices to be segmented into virtual LANs regardless of their physical location. The ZebOS Layer 2 Core Module also includes 802.1p priority signaling for prioritization of traffic at the data-link layer.

**802.1v Port and Protocol Classification** – Port and Protocol Classification is an amendment to 802.1Q that describes enhancements to allow for classification of incoming packets by methods other than source port. Specifically, it defines rules for classification based on data-link layer protocol identification.

**GVRP - GARP VLAN Registration Protocol** – The GARP VLAN Registration Protocol (GVRP) provides 802.1Q VLAN pruning and dynamic VLAN creation. A switch can exchange VLAN configuration information with other GVRP switches, prune unnecessary broadcast and unknown unicast traffic, and dynamically create and manage VLANs.

**GMRP - GARP Multicast Registration Protocol** – The GARP Multicast Registration Protocol (GMRP) provides multicast pruning and dynamic group membership for multicast. A switch can exchange multicast group information with other GMRP switches, prune unnecessary broadcast traffic, and dynamically create and manage multicast groups.

**Internet Group Multicast Protocol (IGMP) Snooping** – A switch supporting IGMP snooping can passively snoop on IGMP packets to learn the IP Multicast group membership. With IGMP snooping multicast traffic of a group is only forwarded to ports that have members of that group. IGMP snooping generates no additional network traffic.

**802.3ad Link Aggregation** – Link Aggregation allows one or more links to be aggregated together to form a Link Aggregation Group (LAG), such that a MAC Client can treat the Link Aggregation Group as if it were a single link.

**802.1x Port Authentication** – The ZebOS Layer 2 802.1x Module provides port-based network access control for LAN devices. The IEEE 802.1x standard offers centralized control of user authentication and access.

**Network Processor Application Program Interface (NPapi)** – The ZebOS Layer 2 Protocol Modules include an NPapi with interface definitions. Using the NPapi, hardware manufacturers can easily develop a communication interface between their network processors or ASICs and the Layer 2 protocols

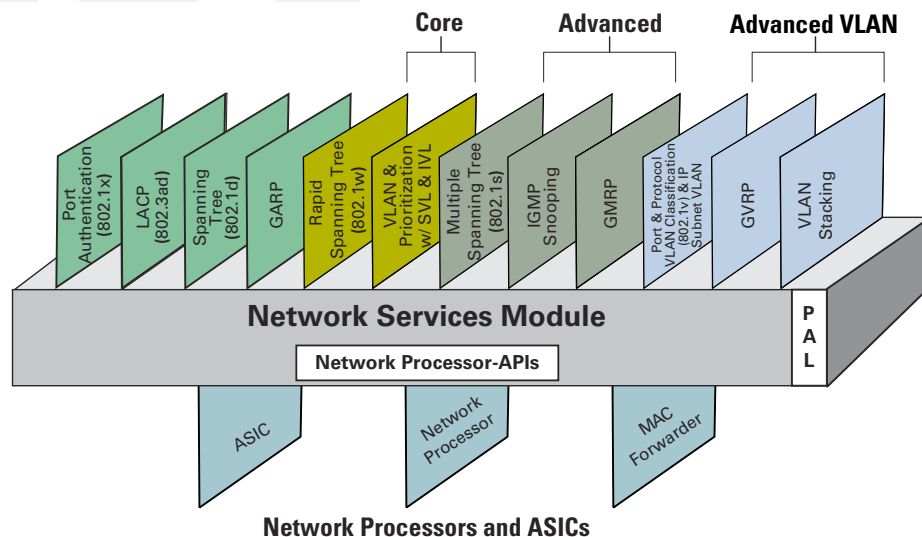


Figure 1 ZebOS Layer 2 Switching Modules

## ZebOS Layer 2 Protocol Features

- Robust and reliable implementation of Layer 2 protocols
- Conformance to IEEE standards and tested interoperability with leading Layer 2 vendors
- Industry-standard Command Line Interface (CLI) management
- Software-based MAC forwarding engines for Linux that handle exception packets for network processors or ASICs or forward traffic for CPU-based systems

## ZebOS Layer 2 Protocol Benefits

- Complements the ZebOS ARS Layer 3 routing protocols
- Includes hardware APIs to streamline integration with ASICs and network processors
- Provides flexible, modular Layer 2 software custom designed for Linux operating systems
- Reduces the time and associated costs of developing Layer 2 applications

## Standards and Protocols

STANDARD/PROTOCOL	FUNCTION
IEEE.802.1d	Bridging
IEEE.802.1p	Spanning Tree
IEEE.802.1Q	Priority Signaling
IEEE.802.1w	VLAN Bridging
IEEE.802.1s	RSTP
IEEE.802.1x	MSTP
IEEE.802.3ad	Port Authentication
IEEE.802.3x	Link Aggregation
IEEE.802.1v	Flow Control
RFC 1493	VLAN Classification
RFC 2674	Port and Protocol VLAN Classification
GARP	Definitions of Managed Objects for Bridges
GVRP	Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and Virtual LAN Extensions
GMRP	Generic Attribute Registration Protocol
	GARP VLAN Registration Protocol
	GARP Multicast Registration Protocol

ADVANCED LAYER 2 FUNCTION
IGMP Snooping
Independent VLAN Learning (IVL) Support
Broadcast Storm Recovery
Port Mirroring

## Supported Operating Systems

- Linux
- Monta Vista Professional Edition
- VxWorks

## Special Considerations

The ZebOS Layer 2 Modules require either software or hardware based forwarding for Layer 2 data plane support.

## Standard Deliverables

- Source Code (written in ANSI compliant C)
- Installation and Configuration Guide
- Command References

## ZebOS Layer 2 Protocol Modules Part Numbers

MODULES	SKU	REQUIREMENTS
Spanning Tree Protocol Module	ZOS-L2-STP	Network Services Module
GARP Module	ZOS-L2-GARP	
LACP Module	ZOS-L2-LACP	
Port Authentication Module	ZOS-L2-802.1x	
Rapid Spanning Tree Module	ZOS-L2-RSTP	Network Services Module
VLAN & Prioritization with SVL & IVL Module	ZOS-L2-VLAN	Spanning Tree Protocol Module or Rapid Spanning Tree Protocol Module or Multiple Spanning Tree Module
Multiple Spanning Tree Module	ZOS-L2-MSTP	Network Services Module and VLAN & Prioritization with SVL & IVL Module
IGMP Snooping Module	ZOS-L2-SNOOP	Spanning Tree Protocol Module or Rapid Spanning Tree Protocol Module or Multiple Spanning Tree Module
GMRP Module	ZOS-L2-GMRP	GARP Module
Port & Protocol VLAN Classification Module	ZOS-L2-VCLASS	Spanning Tree Protocol Module or Rapid Spanning Tree Protocol Module or Multiple Spanning Tree Module and VLAN & Prioritization with SVL & IVL Module
GARP VLAN Registration Protocol Module	ZOS-L2-GVRP	GARP Module
VLAN Stacking Module	ZOS-L2-VLANS	Spanning Tree Protocol Module or Rapid Spanning Tree Protocol Module or Multiple Spanning Tree Module and VLAN & Prioritization with SVL & IVL Module
BUNDLES	SKU	REQUIREMENTS
Core Bundle (Includes ZOS-L2-RSTP & ZOS-L2-VLAN)	ZOS-L2-CORE	Network Services Module
Advanced Bundle(Includes ZOS-L2-MSTP, ZOS-L2-SNOOP, & ZOS-L2-GMRP)	ZOS-L2-ADV	Network Services Module, VLAN & Prioritization with SVL & IVL Module, and GARP Module
Advanced VLAN Bundle (Includes ZOS-L2-VCLASS, ZOS-L2-GVRP & ZOS-L2-VLANS)	ZOS-L2-AVLN	Spanning Tree Protocol Module or Rapid Spanning Tree Protocol Module or Multiple Spanning Tree Module and VLAN & Prioritization with SVL & IVL Module and GARP Module



**IP Infusion Inc.**  
**125 South Market Street**  
**9th Floor**  
**San Jose, CA 95113**  
**tel: 408.794.1500**  
**fax: 408.278.0521**  
**sales@ipinfusion.com**  
**www.ipinfusion.com**

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