Cisco ASR 1000 Series Routers Embedded Services Processors

The Cisco ASR 1000 Series embedded services processors are based on the Cisco QuantumFlow Processor (QFP) for next-generation forwarding and queuing. These embedded service processors provide centralized forwarding-engine options for the Cisco ASR 1000 Series Aggregation Services Routers.

Additionally, the Cisco ASR 1002 Fixed Router includes a nonmodular, fixed embedded services processor with a throughput of 2.5 Gbps and the Cisco ASR 1001 Router has a nonmodular, fixed embedded services processor with a throughput of 2.5 Gbps, which is upgradable with a software activated performance upgrade license to 5 Gbps.

The Cisco ASR 1000 Series embedded service processors:

- Provide the centralized embedded forwarding services responsible for the bulk of the data plane processing tasks. All network traffic through the Cisco ASR 1000 Series system flows through the Cisco ASR 1000 Series Embedded Services Processors.

- Are responsible for the data-plane processing tasks and all network traffic flows through them.

- Support Forwarding Engine Control Processor which provide hardware abstraction layer between the QFP-based forwarding engine and other system components, allowing datapath and management functions to be independent.

- Support Cisco QuantumFlow Processor (QFP) forwarding engines.

- Support QFP provisioned with two TCAM4 devices for ACL lookup and other software features.

- Perform all baseline packet routing operations, including MAC classification, Layer 2 and Layer 3 forwarding, quality-of-service (QoS) classification, policing and shaping, security access control lists (ACLs), VPNs, load balancing, NetFlow.

- Are responsible for features such as firewalls, intrusion prevention, Network Based Application Recognition (NBAR), Network Address Translation (NAT), and flexible pattern matching.

- Incorporates a security encryption coprocessor to assist encryption processing common to all embedded services processors. The security processor operates in coprocessor mode and only processes packets sent to it by the Cisco QFP.

- Provide hardware abstraction layer between the packet processing-based forwarding engine and other system components.

The Cisco ASR1000-ESP5, Cisco ASR1000-ESP10, Cisco ASR1000-ESP10-N, Cisco ASR1000-ESP20, Cisco ASR1000-ESP40, Cisco ASR1000-ESP100, and Cisco ASR1000-ESP200 provide centralized forwarding-engine options for the Cisco ASR 1000 Series Aggregation Services Routers. The Cisco ASR 1002-F Router includes a nonmodular, integrated embedded services processor with a forwarding bandwidth (throughput) of 2.5 Gbps. The integrated embedded services processor of the Cisco ASR 1002-X Router can provide a forwarding bandwidth of 5 Gbps, 10 Gbps, 20 Gbps, or 36 Gbps.

The Cisco ASR1000-ESP10-N is the nonencryption version of the Cisco ASR1000-ESP10. The Cisco ASR1000-ESP10-N can only support noncrypto Cisco IOS software images. It does not support encryption capabilities such as IPsec.

Note The embedded services processor can be upgraded only on redundant embedded services processor systems (Cisco ASR 1006 Router and Cisco ASR 1013 Router). The Cisco ASR 1002 router supports only one Cisco ASR1000-ESP5 or ASR1000-ESP10. The Cisco ASR 1006 Router and Cisco ASR 1004 Router do not support the Cisco ASR1000-ESP5. When performing upgrades, the Cisco ASR1000-ESP10, Cisco ASR1000-ESP20, and any future ESPs can be upgraded.

Note Do not have different embedded services processors operating in the same chassis. The only time this condition occurs is when you are performing an upgrade.

The Cisco ASR1000-ESP100-X and Cisco ASR1000-ESP200-X are QFP-based embedded services processor for the Cisco ASR1000 Series Routers and are based on third generation QFP ASIC.

The Cisco ASR 1000 Series Routers support the following Cisco ASR 1000 Series Embedded Services Processors:

Cisco ASR 1000-ESP5

The Cisco ASR1000-ESP5 forwarding performance will vary depending on features configured. Up to 4 Mpps for the combination of the following commonly-used features: IPv4 forwarding, IP Multicast, ACL, QoS, Reverse Path Forwarding (RPF), load balancing, and Sampled NetFlow.

Cisco ASR 1000-ESP10

The encryption capability of the 10 Gbps ESP is rated for 4 Gbps whereas the 5 Gbps ESP is rated for 1.8 Gbps and the 2.5 Gbps ESP is rated for 1.0 Gbps. The ASR1000-ESP10-N has the same performance characteristics as the ASR1000-ESP10 but does not support encryption services.

The Cisco ASR1000-ESP10 supports the following forwarding engines:

- Cisco ASR1002-ESP-F
- Cisco ASR1000-ESP10
- Cisco ASR1000-ESP10-N—The Cisco ASR1000 Embedded Services Processor 10G Non Crypto Capable board provides an ASR 1000 series router solution for customers who are under export restrictions and not qualified to implement products that support strong encryption services. The Cisco ASR1000 Embedded Services Processor 10G Non Crypto Capable feature support is the same as the Cisco ASR100-ESP10 except that SSH, SSL and IPSec VPN services are not supported. For detailed information about this feature, see Cisco ASR 1000 Series Aggregation Services Routers Software Configuration Guide and Cisco ASR 1000 Embedded Services Processor 10G Non Crypto Capable Feature Guide.

The ASR1000-ESP10-N has the same performance characteristics as the ASR1000-ESP10 but does not support encryption services.

Cisco ASR 1000-ESP20

Cisco ASR 1000-ESP20 supports the Cisco ASR 1006 Router and ASR 1004 Router. Performance highlights of the Cisco ASR1000-ESP20 include hardware-assisted policing, encryption capability of 8 Gbps, and special jitter- and latency-minimizing multicast packet replication.

Cisco ASR 1000-ESP20 supports 1Gb Cisco QuantumFlow Processor, 4Gb DRAM, 40Mb TCAM, and 256Mb packet buffer memory and high availability 1 + 1 redundancy in dual ESP configuration in combination with the Cisco ASR 1006 Router.

Cisco ASR 1000-ESP40

Cisco ASR1000-ESP40 is a field-replaceable unit (FRU) capable of supporting online insertion and removal (OIR) operation in conjunction with one or two route processors, a secondary forwarding processor, and up to six SPA carrier cards.

Cisco ASR 1000-ESP40 is a CPP-based forwarding processor for the Cisco ASR1000 Series Routers. Cisco ASR 1000-ESP40 is supported on the following routers:

- Cisco ASR 1006
- Cisco ASR 1004
- Cisco ASR 101
- Cisco ASR 1006-X
- Cisco ASR 1009-X

The Cisco ASR1000-ESP40G supports:

- ESI (enhanced serial interface) punt path support for dual redundant ASR 1000 route processors with a bandwidth of 11 Gbps

- ESI state path support for redundant ASR 1000 forward processors
- Dual ESI support for four carrier cards (in slots 0 though 3) and single ESI support for two carrier cards (in slots 4 and 5).
- Total bandwidth or throughput of 40 Gbps

It provides 40 Gbps bandwidth per system and at least 10 Gbps aggregated security traffic.

All initial Cisco ASR 1000 Series Embedded Services Processors are based on a common highly-programmable network Cisco QuantumFlow Processor (packet processing). The Cisco ASR 1013 Router slots are keyed using rotated guide pins so that plug-in cards can only be fully inserted in slots where they are intended to operate. This keying prevents cards from making midplane contact in slots the cards are not allowed.

Cisco ASR 1000-ESP100

Cisco ASR1000-ESP100 is a CPP-based embedded services processor for the Cisco ASR1000 Series Routers. It is a field-replaceable unit (FRU), and it is capable of supporting online insertion and removal (OIR) operations in conjunction with one or two route processors, a secondary embedded services processor, and up to six SPA carrier cards.

Cisco ASR 1000-ESP100 is supported on the following routers:

- Cisco ASR 1006
- Cisco ASR 1013
- Cisco ASR 1006-X
- Cisco ASR 1009-X

Cisco ASR1000-ESP100 provides the following features:

- 24 configurable ESI links for SPA Carrier Card and native Line Card support:

  - ESI links support with a bandwidth of up to 46 Gbps for the Cisco ASR 1013 Router on Sip slots 0,1,4, and 5.
  - ESI links support with a bandwidth of up to 110 Gbps for the Cisco ASR 1013 Router on Sip slots 2 and 3.

- ESI punt path support for dual redundant ASR 1000 route processors with a bandwidth of 11 Gbps
- ESI state path support for redundant ASR 1000 forward processors

It can support at least 20 Gbps of aggregated security traffic.

All Cisco ASR 1000 Series embedded services processors are based on a common highly-programmable network Cisco QuantumFlow Processor (packet processing). The Cisco ASR 1013 Router slots are keyed using rotated guide pins so that plug-in cards can only be fully inserted in slots where they are intended to operate. This keying prevents cards from making midplane contact in slots the cards are not allowed.

Cisco ASR 1000-ESP200

Cisco ASR1000-ESP200 is a CPP-based embedded services processor for the Cisco ASR1000 Series Routers. It is a field-replaceable unit (FRU), and it is capable of supporting online insertion and removal (OIR) operations in conjunction with one or two route processors, a secondary embedded services processor, and up to six SPA carrier cards.

Cisco ASR 1000-ESP200 is supported on the Cisco ASR 1013 Router and Cisco ASR 1009-X router.

Cisco ASR1000-ESP200 provides the following features:

- 24 configurable ESI links for SPA Carrier Card and native Line Card support:
  - ESI links support with a bandwidth of up to 46 Gbps for the Cisco ASR 1013 Router on Sip slots 0,1,4, and 5.
  - ESI links support with a bandwidth of up to 110 Gbps for the Cisco ASR 1013 Router on Sip slots 2 and 3.

It can support at least 40 Gbps of aggregated security traffic.

All Cisco ASR 1000 Series embedded services processors are based on a common highly-programmable network Cisco QuantumFlow Processor (packet processing). The Cisco ASR 1013 Router slots are keyed using rotated guide pins so that plug-in cards can only be fully inserted in slots where they are intended to operate. This keying prevents cards from making midplane contact in slots the cards are not allowed.

Cisco ASR 1000-ESP200 and Second Generation Cisco QFP

Each Cisco ASR 1000-ESP200 uses 4 third generation Cisco QFPs (QFP-2nd-Gen) Application Specific Integrated Circuits (ASICs) to achieve maximum performance. Each QFP-2nd-Gen ASIC is mapped with a subset of SPA bays and interfaces (SIP). Through this mapping, the Cisco ASR 1000-ESP200 can perform all baseline packet routing operations such as Quality of Service (QoS) classification and IP multicasting. They can also perform Network Address Translation (NAT) tasks.

1	Egress queueing for interfaces handled by QFP-2nd-Gen 3	3	Egress queueing for interfaces handled by QFP-2nd-Gen 1
2	Egress queueing for interfaces handled by QFP-2nd-Gen 2	4	Egress queueing for interfaces handled by QFP-2nd-Gen 0

Implications of SIP and SPA Slot Mapping

Interfaces and sessions that have an egress QoS have their schedules and queues present in the QFP-3rd-Gen ASIC that services the particular slot. Since there is a limitation of 29000 schedules and 116000 queues per QFP-3rd-Gen ASIC, multiple QFP-3rd-Gen ASICs should be targeted by placing the SIP and SPA in the correct order, in order to achieve full system scalability for schedules and queues.

For example, A 5xGE SPA supports more than 32000 point-to-point protocol (PPP) sessions depending on the ESP. However, if QoS is applied to these sessions, the QFP-3rd-Gen ASIC that supports the SIP and SPA slot can support only 29000 schedules, and these sessions share the 116000 queue limit. To support PPP sessions with QoS that are greater than 29000, a different SIP and SPA should be used to map to a different QFP-3rd-Gen ASIC. This will enable additional schedules and queues.

Cisco ASR1000-ESP100-X

Cisco ASR1000-ESP100-X is a QFP-based embedded services processor for the Cisco ASR1000 Series Routers. This ESP is based on third generation QFP ASIC. The ASR1000-ESP100X contains one, third generation QFP ASIC, built-in crypto module providing improved, higher bandwidth and crypto support. Additionally it also supports smart licensing and soft enforcement.

Cisco ASR1000-ESP100-X is supported on the following routers:

- Cisco ASR 1013 Router

- Cisco ASR 1006-X and

- Cisco ASR 1009-X

The following table describes the ESI capacity for each of the SIP slots:

Table 1: ESI capacity for SIP slots on ASR1000-ESP100-X

	0	1	2	3	4	5
ASR 1006-X	1x100G	1x100G	-	-	-	-
ASR 1009-X	1x100G	1x100G	1x100G	-	-	-
ASR 1013	1x40G	1x40G	1x100G	1x100G	1x40G	1x40G

Cisco ASR1000-ESP100-X provides the following features.

- ESI punt path support for dual redundant ASR 1000 route processors with a bandwidth of 11 Gbps.

- ESI state path support for redundant ASR 1000 forward processors

Cisco ASR1000-ESP200-X

Cisco ASR1000-ESP200-X is a QFP-based embedded services processor for the Cisco ASR1000 Series Routers. This ESP is based on third generation QFP ASIC. The ASR1000-ESP200-X contains two, third generation QFP ASIC that provides 64-bit resource memory, built-in crypto module providing improved, higher bandwidth crypto support therefore leading to improved throughput and scalability. Additionally this ESP also supports smart licensing and soft enforcement.

Cisco ASR1000-ESP200-X is supported on the following routers:

- Cisco ASR 1006-X and

- Cisco ASR 1009-X

Figure 1: Cisco ASR1000-ESP200-X Faceplate

The following table describes the ESI capacity for each of the SIP slots:

Table 2: ESI capacity for SIP slots on ESP-100X

	0	1	2	3	4	5
ASR 1006-X	1x100G	1x100G	-	-	-	-
ASR 1009-X	1x100G	1x100G	1x100G	-	-	-

Features of the Cisco ASR 1000 Series Embedded Services Processors

The following table summarizes the features of the embedded services processors.

Table 3: Differences in Cisco ASR 1000 Series Embedded Services Processors

Embedded Services Processor	Memory	Performance	Bandwidth	Security Traffic Performance
Cisco ASR1000-ESP5	256MB Cisco QuantumFlow Processor, 5Mb TCAM, 64 MB packet buffer, and 1 GB FECP DRAM	4 Mpps for the combination of the following commonly-used features: IPv4 forwarding, IP Multicast, ACL, QoS, Reverse Path Forwarding (RPF), load balancing, and Sampled NetFlow	5 Gbps	1 Gbps
Cisco ASR1000-ESP10	512MB Cisco QuantumFlow Processor, 10Mb TCAM, and 128MB packet buffer, and 2 GB FECP DRAM	8 Mpps forwarding for the combination of the following commonly-used features: IPv4 forwarding, IP Multicast, ACL, QoS, Reverse Path Forwarding (RPF), load balancing, and Sampled NetFlow	10 Gbps	3 Gbps
Cisco ASR1000-ESP20	1 GB Cisco QuantumFlow Processor, 40Mb TCAM, 256 MB packet buffer, 4 GB FECP DRAM	16 Mpps forwarding for the combination of the following commonly-used features: IPv4 forwarding, IP Multicast, ACL, QoS, Reverse Path Forwarding (RPF), load balancing, and Sampled NetFlow	20 Gbps	8 Gbps
Cisco ASR1002-ESP-F	Same as Cisco ASR 1002 Router	Same as the Cisco ASR 1002 router except where limited by constrained throughput of 2.5G	Limited to 2.5 Gbps	1 Gbps

Embedded Services Processor	Memory	Performance	Bandwidth	Security Traffic Performance
Cisco ASR1000-ESP40[1]	• 1 GB Cisco QuantumFlow Processor, 40Mb TCAM, 256MB packet buffer, 4 GB FECP DRAM • 8 GB of registered DDR2 SDRAM memory within two DIMM connectors (4 GB DIMMs)	ASR1000-ESP40 performance**	40 Gbps	12.9 Gb of aggregate security traffic

Cisco ASR1000-ESP100	• Dual Quantum Flow packet processor complex:
	    • 1 GB total packet buffer
	    • 4 GB total resource memory
	• Single 80MB TCAM4 feature lookup memory
	• 16 GB of 1066 MHz DDR3 SDRAM:
	    • Two 8GB, 2-rank registered DIMMs
			100 Gbps	20 Gbps

Cisco ASR1000-ESP200	• Quad Quantum Flow packet processor complex:
	    • 2 GB total packet buffer
	    • 8 GB total resource memory
	• Dual 80MB TCAM4 feature lookup memory
	• 32GB of 1066MHz DDR3 SDRAM:
	    • Four 8GB, 2-rank registered DIMMs
			200 Gbps	40 Gbps

[1] While both the Cisco ASR1000-ESP40 and ASR1000-ESP20 exceed the 16 Mpps forwarding rate, the ESP40 packets per second rate is slightly less than ESP20 when sending continuous stream of small, 64-byte packets. However, at 92 bytes and larger, the ASR1000-ESP40 outperforms ESP20. The difference at small packet sizes is a side-effect of optimizations made to achieve 40 Gbps for medium to large packets.

Note For unsupported hardware component configuration combinations, see xref Table 2-4.
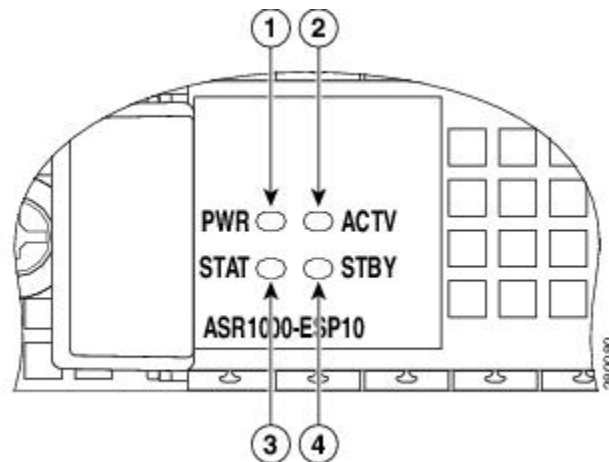
The embedded services processor consists of a front panel label for indicator and control functions. The Cisco ASR 1000 Series Embedded Services Processor model number labeling is located next to the left card module handle. The module also contains card handles to assist in insertion or removal of the module. There are no front panel interfaces on the Cisco ASR1000-ESP modules.

The following figure displays the Cisco ASR 1000 Series Embedded Services Processor LEDS on the front panel.

Note The Cisco ASR 1000 Series embedded services processors have the same faceplate and status information except for the name label, such as Cisco ASR1000-ESP40, Cisco ASR1000-ESP20, Cisco ASR1000-ESP10, Cisco ASR1000-ESP10-N, Cisco ASR1000-ESP5, Cisco ASR1000-ESP100X and Cisco ASR1000-ESP200X.

Figure 2: Cisco ASR1000-ESP Faceplate LEDs

| 1 | PWR—Power LED | 3 | STAT—Status LED |
| 2 | ACTV—Active LED | 4 | STBY—Standby LED |

The following table describes the LEDs on the embedded services processors.

Table 4: LEDs on the Embedded Services Processors

LED Label	LED	Color	Behavior Description
PWR	Power	Solid green	All power requirements are within specification
		Off	The embedded services processor is not powered on.
STAT	System status	Solid green	Cisco IOS has successfully booted.

LED Label	LED	Color	Behavior Description
		Amber	ROMmon is running or when the Process Manager declares that a critical route processor process is not running.
		Red	System failure or powering up.
ACTV	Active	Green	The ACTV LED indicates (in a redundant system) the embedded services processor board that is actively forwarding packets. On the active embedded services processor board, the ACTV LED is green and the STBY LED is off. On the standby embedded services processor board, the STBY LED is yellow and the ACTV LED is off. On Cisco ASR 1002 Router, Cisco ASR 1004 Router, and Cisco ASR 1002-F Router, the embedded services processor board is always active because these routers do not support redundancy. The Cisco ASR1000-ESP5 does not support redundancy. Therefore, it is always active.
STBY	Standby	Yellow	On a redundant system, the STBY LED indicates which embedded services processor is in the standby state and is waiting to take over packet forwarding in the event that the active embedded services processor experiences a failure. The STBY LED is in the off state while the active embedded services processor is in the on state.