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Integrating the PSM in Enterprise Operations: Strategy and Benefits

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Pensando Policy and Services Manager Overview

This document describes the features of the Pensando Policy and Services Manager (PSM) that offer value and insights into the operation of enterprise data centers.

The Pensando **Distributed Services Platform** is built around the Distributed Services Card (DSC): a PCIe adapter that provides services and network I/O for the host. The DSC provides services that would otherwise be implemented either in software on the host CPU, or in appliances within the network. The Policy and Services Manager (PSM) delivers network, security, and telemetry policy to Pensando DSCs at scale, thus offering a single point of management and monitoring for the distributed services running on the DSCs. Moreover, the PSM offers lifecycle management of DSCs.

For fault tolerance and scale, the PSM runs as a quorum-based cluster of three VMs that execute on separate servers.

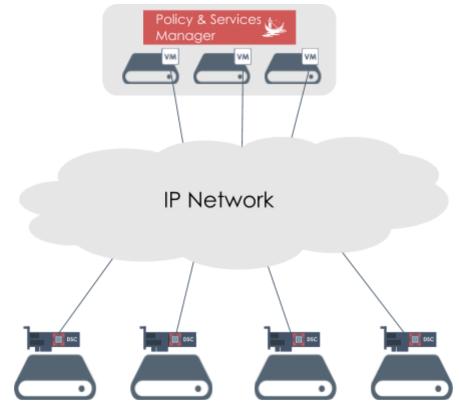


Figure 1. PSM and DSCs

The PSM is accessible through both a web browser-based Graphical User Interface (GUI), and a secure RESTful API.

All inter-cluster communication (PSM's REST API, and PSM-to-DSC communication via gRPC) is encrypted to ensure security. The PSM is intent-based: it does not require that policies are propagated and accepted at the same time by all the DSCs, as in a transactional model, but instead continuously works to reconcile the policies on the DSCs with the intent specified on the PSM.

Policies are user-configurable and intent-based. Labels can be associated to groups of objects and can be used within policies, making "administration at scale" simple and extremely effective, as a single policy can be applied to a potentially large number of objects with the same label.

This document focuses first on features related to distributed services and applications running in the data center, and then those related to the Pensando platform itself.

For detailed information on managing the PSM, including installation instructions and a description of its complete feature set, refer to the Pensando PSM Enterprise User Guide.

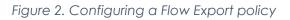
Distributed Services and Applications

All services running on the Pensando platform are designed with data center operations in mind, and thus can be monitored via the PSM or through third party tools. The PSM also provides visibility into applications running on DSC-equipped hosts and the traffic they generate.

Flow export

DSCs can collect statistics on any network flows that transit the DSC. An administrator can use the PSM to set policies that specify which flows should be monitored. Figure 2 illustrates that each flow is identified through a 5-tuple: source and destination IP address, transport protocol, source and destination transport port.

low Export				
	Interval	Template Refresh Rate	* Export Packet: (specify one or more)	
* Unique Policy Name	10s	5m		
EXPORT CONFIGURATION			Source	
Format ipfix			IP Addresses	MAC Addresses
TARGET:			Target	
* Destination	* Transport	+ ADD	1 IP Addresses	MAC Addresses
			Protocol	
			Protocols Ports	



The PSM administrator can then specify the collector (or target) that should receive the flow information and the transport that should be used (e.g. "udp/2055"). The flow information is sent in IPFIX format.

The PSM administrator does not have to specify which exact DSCs should be configured for flow monitoring and exporting. The Pensando platform ensures that the DSCs subscribe to all collection and export policies. Those DSCs that are involved in the flow will then collect and export any relevant information. If the workload generating a flow is moved to a different DSC (e.g. a VM is moved through vMotion to a different server), the platform continues to seamlessly monitor and collect flow information without requiring administrator intervention.

Metrics

Each DSC collects a large set of metrics ("Fields" in Figure 3) organized by various categories ("Measurement" in Figure 3).

Measurement:
O Prop Statistics O Asic Egress Drop Statistics O CPS Statistics O Session Summary Statistics O
O Port Packet Statistics O Mgmt Port Packet Statistics O Lif Packet Statistics O Cluster
Fields:
Malformed Packet Drops RDMA ICRC Errors Packet Length Errors Hardware Errors
Input Mapping Table Drops Input Mapping Deja-vu Drops Multi-dest-not-pinned-uplink Drops
Drop-flow-hit Drops Flow-miss Drops Drop-NACL-hit Drops Drop-IPSG Drops IP-Normalization Drops
TCP-Normalization Drops TCP-RST-Invalid-ACK Drops TCP-RST-Invalid-ACK Drops ICMP-Normalization Drops
Input-properties-miss Drops TCP-out-of-window Drops TCP-split-handshake Drops TCP-zero-window Drops
TCP-data-after-FIN Drops TCP-non-RST-after-RST Drops TCP-responder-first-packet Drops
TCP-unexpected-packet Drops Source-LIF-mismatch Drops VF-IP-Label-mismatch Drops
VF-Bad-RR-Destination-IP Drops ICMP/ICMPv6-Fragment Drops

Figure 3. Selecting metrics

A subset of these metrics can be selected to create custom graphs on the PSM such as the one shown in Figure 4. Graphs can be saved by name, showing the latest metric values, hence offering a dashboard of the health and performance of the hosts, applications, and the platform itself.

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Netrics									SAVE CH	ART	CANCEL
Metrics											Past da
s_graph											
800											
600 -		/	~		\checkmark		/	_	-		~
		-					\sim			\sim	
auge)											
(eause) 400											
											1
200											
										/	
0 21:00 05/11	23:00 01:00 05/12 CPS - venkv-sr		05:00 CPS - venk		09:00 CPS	11:00	13:00	15:00 CPS -	17:00	19:00	21:00
21:00 05/11	05/12 CPS - venky-sr		CPS - venk	07:00 y-srv1-oob CPS - 00	CPS	- 00ae.cd(01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11	05/12	v2-oob	CPS - venk	y-srv1-oob	CPS	- 00ae.cd(01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11	05/12 CPS - venky-sr	v2-oob	CPS - venk	y-srv1-oob	CPS	- 00ae.cd(01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11 braph Title: C	05/12 CPS - venky-sr	v2-oob	CPS - venk	y-srv1-oob	CPS	- 00ae.cd(01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11 Graph Title: C ADD QUERY Measurement:	05/12 CPS - venky-sr	v2-oob	CPS - venk	y-siv1-oob	CPS Dae.cd01.07	; - 00ae.cd(01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11 Graph Title: C ADD QUERY Measurement:	05/12 CPS - venky-sr ps_graph	v2-oob	CPS - venk	y-srv1-oob	CPS Dae.cd01.07	; - 00ae.cd(01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11 Graph Title: C ADD QUERY Measurement: O ASIC Egres © CPS Statist	05/12 CPS - venky-sr ps_graph	v2-oob CPS - 00ae.cr	CPS - venk dol.05c0	y-srv1-oob	CPS Dae.cd01.07	e - 00ae.cd(01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11 Graph Title: C ADD QUERY Measurement: O ASIC Egres O CPS Statist O Logical Inte	05/12 CPS - venky-sr ps_graph ss Drop Statistic	v2-oob CPS - 00ae.cr S	CPS - venk J01.05c0 O ASIC In O Cluster O Manag	y-siv1-oob	CPS Dae.cd01.07 Do Statistic	cs - 00ae.cd	01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11 iraph Title: C ADD QUERY Measurement: O ASIC Egres © CPS Statist O Logical Inte O Session Su Fields:	05/12 CPS - venky-sr ps_graph cs Drop Statistic tics erface Statistics	v2-oob CPS - 00ae.cr S	CPS - venk J01.05c0 O ASIC In O Cluster O Manag	ngress Drop	CPS Dae.cd01.07 Do Statistic	cs - 00ae.cd	01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11 Graph Title: C ADD QUERY Measurement: O ASIC Egres O CPS Statist O Logical Inte O Session Su	05/12 CPS - venky-sr ps_graph cs Drop Statistic tics erface Statistics	v2-oob CPS - 00ae.cr S	CPS - venk J01.05c0 O ASIC In O Cluster O Manag	ngress Drop	CPS Dae.cd01.07 Do Statistic	cs - 00ae.cd	01.0458	CPS -	- 00ae.cd01.0		21:00
21:00 05/11 iraph Title: C ADD QUERY Measurement: O ASIC Egres © CPS Statist O Logical Inte O Session Su Fields:	05/12 CPS - venky-sr ps_graph cs Drop Statistic tics erface Statistics	v2-oob CPS - 00ae.cr S	CPS - venk J01.05c0 O ASIC In O Cluster O Manag	ngress Drop	CPS Dae.cd01.07 Do Statistic	cs - 00ae.cd	01.0458	CPS -	- 00ae.cd01.0		21:00

Figure 4. Creating a PSM chart

Administrators can use this powerful distributed monitoring capability to constantly observe the state of the network, identify potential performance bottlenecks, and remediate issues before they impact applications and services.

Mirror sessions

The Pensando Distributed Services Platform has the unique ability to mirror bi-directional traffic generated or received by any application or workload hosted on servers equipped with a DSC. A DSC can make a copy of each packet conforming to a given mirroring policy and send (a portion of) the packets to a collector using ERSPAN (Encapsulated Remote Switched Port Analyzer) encapsulation.

The administrator can choose whether to send all traffic that is transiting one DSC interface (called *interface-based mirroring or bidirectional ERSPAN*¹), or only packets that match mirroring policies configured on the PSM. As shown Figure 5, mirroring policies can have flow-level granularity identified by a 5-tuple: source and destination IP address, transport protocol, source and destination transport port.

Mirror Sessions			CREATE MIRROR SESSION	CANCEL
► Mirror Sessions				
	* Unique Name	Schedule (UTC)		A
	Packet Size			- 1
	Collectors (specify one or more) Type ERSPAN Type 3 + ERSPAN Type 2 ERSPAN Type 3	Gateway		
		nk Interfaces		
	Source IP Addresses Protocol / Ports	Target IP Addresses		
	+ RULE			

Figure 5. Configuring mirror sessions

With the Pensando platform, administrators have the visibility needed to troubleshoot traffic issues as they arise, without an expensive parallel tap and traffic-brokering infrastructure.

¹ If ERSPAN were instead enabled via the Top-of-Rack switch, only one of the traffic directions would be captured and mirrored, whereas the DSC has the unique ability to capture and mirror in *both* directions while maintaining the temporal relationship between captured packets.

Distributed stateful firewall logs

The Pensando platform offers a distributed stateful firewall to protect data center East-West traffic, which traditional firewall appliances are not well-positioned to analyze. The network administrator gains full visibility of firewall operations by exporting the firewall logs from the DSCs enforcing the firewall policies directly to "syslog" collectors.

The administrator can specify a single collector for all logs, or distribute the logs to different collectors based on the action being logged (allow, deny, reject, etc.).

PSM Administration

Operation of the Platform itself is simplified by its built-in features, including logging events and alerts related to system state and configuration, saving and restoring global configurations, and managing upgrades in a completely automated way.

AAA

The PSM offers a complete solution for Authentication, Authorization, and Accounting (AAA).

Authentication

The PSM supports several authentication policies, as shown in Figure 6.

	Dashboard		Au	th Policy	Refresh	New Authorization	Token
្នា	System	~	20	Authentication Policy			
ð	Workload		Au	thenticators			
*	Network			Jser credentials will be tested against the following authentication methods until one of the	m returns succe	ssfully.	
Ð	Security	~					
ş	Monitoring	~					
٩	Troubleshoot	~		Local			1
G	Orchestrator	~					
20	Admin	^					
• 🐴	Auth Policy						
*	User Management	i.		LDAP	CREA	TE LDAP AUTHENTICATO	DR
♠	System Upgrade						
20	Tech Support						
Ð	Snapshots			Radius	CREATE	RADIUS AUTHENTICATO	DR
	Server Certificate						
e	API Capture						
						[Programma

Figure 6. Authorization Policy screen

Authentication Policy should be established early in the system setup process with Authentication Policies that can be reordered dynamically.

Local users

Local users can be created via the User Management menu, clicking on the Add User button, and filling out the form shown in Figure 7:

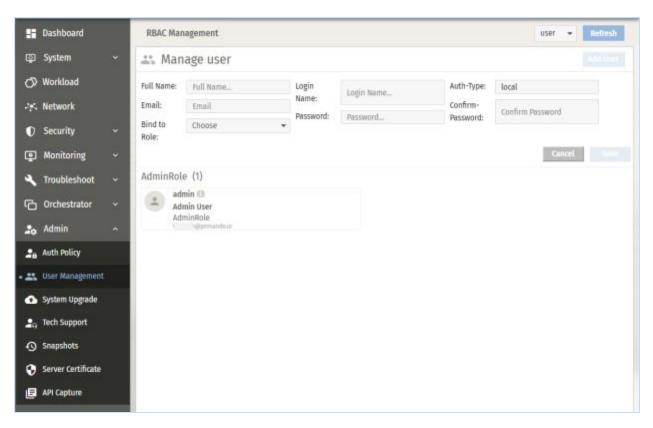


Figure 7. Creating a local user

LDAP and Active Directory (AD)

To create an LDAP (Lightweight Directory Access Protocol) Authorization Policy, click the "CREATE LDAP AUTHENTICATOR" button in the Admin view, shown in <u>Figure 6</u> above. Active Directory (AD) and OpenLDAP providers are supported.

Configure the **Credentials**, **Scope**, and **Attribute** Mapping as appropriate, ensuring all required (*) fields are properly filled, as in Figure 8:

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Aut	Policy								Refresh	New Authoriza	ition Token
20	Authenticatio	n Policy									
	nenticators er credentials will be	tested against the following authentic	ation methods until one o	of them returns successfu	lly.						
	LDAP									SAVE	CANCEL
	CREDENTIALS * Bind DN: Bind Password:	cn=admin user,ou=u: Test Bind password	SCOPE * Base DN: * User Object Class: * Group Object Class:	dc=pensando,dc=io inetOrgPerson posixGroup	ATTRIBUTE * User: * Group: Tenant:	uid ou	Full name: Email:	cn mail			
	SERVER CONFIGU	RATION 192.168.71.153.389	Use TLS Verify Server Certificate openIdapvm01	BAYTALhYMRUwEwY Q29tcGFueSBMdGQ MDdaFw0yMDEwMD	AgIJAMInL/d3 DVQQHDAxEZ xFTATBgNVBA NwOTMyMDda	yxAhMAOGCSqGSlb3Di WZhdWx0IENpdHkxHD MMG69XWS2GFwdm IMFkxCZaJBgNVBAYTAL ORIZmF1bHQgQ29tcGFi	AaBgNVBAoMEORI 10wMTAeFw0xOTEv hYMRUwEwYDVQQ	ZmF1bHQg wMDMwOTMy HDAxEZWZh	+ ADD		
									Test Connections	5	

Figure 8. Authentication fields

Once saved, the values should be visible, as in Figure 9:

Aut	h Policy								Refresh	New Authorization Token
20	Authenticatior	n Policy								
Aut	henticators									
U	ser credentials will be t	ested against the following	authentication method	ds until one of them returns	successfu	lly.				
	LDAP									
	CREDENTIALS		SCOPE		ATTRIBU	TE MAPPING				
	* Bind DN:	cn=admin user,ou=users,dc =pensando,dc=io	* Base DN:	dc=pensando,dc=io	* User:	uid	Full name:	cn		
	* Bind Password:	******	* User Object Class:	inetOrgPerson	* Group:	ou	Email:	mail		1
			* Group Object Class:	posixGroup	Tenant:					
	SERVERS:	192.168.71.153:389								\checkmark
										\mathbf{T}
	Local									2
	Locut									2

Figure 9. LDAP settings

Create or Update the RoleBinding with the "User Groups" string as below. This string is the "Group" attribute value configured in the LDAP policy "Credentials" section, taken from the LDAP server configuration for the corresponding LDAP user(s).

🚓 Manage	rolebin	ding		
Name:	AdminRoleBi	nding		
Role:	AdminRole	e 🔻		
User Groups:	cn=admi	in,ou=gi	roups,dc=pensando,dc	=io ×
Users:				
Available			Selected	
Search by name	۹		Search by name	۹
		> >>		admin
		~ <		
		«		

Figure 10. Rolebinding

User Management

User Management, Roles, Role Bindings and Authentication Policy settings can be configured in PSM in User Management under the Admin Menu.

The recommended sequence for User Management is to first create one or more Roles, followed by one or more Users. The Role, Rolebinding and User objects can all be created from the dropdown User Management Menu:

DOCS	(99
user 👻	Refresh
user role	Add User
rolebinding	

Figure 11. User Management menu

Role / Rolebinding

Create a Role to control access classes for users. Roles can have scope over various "Groups" (i.e. management aspects) including:

- Auth
- Cluster
- Diagnostics
- Monitoring
- Network

- Objstore
- Rollout
- Security
- Staging
- Workload

Read

For a given Group, Action Access can be further granted or limited to:

- Create
- Delete
 Update

Once a Role is created, a corresponding "Role Binding" is created implicitly.

User Creation

Creating a User will allow you to bind the User to any previously created Rolebinding.

Audit logs

The PSM collects Audit Events that, as shown in Figure 12, log configuration changes to the platform and the distributed services running on it.

Audit E	vents							
🔍 Au	dit Events							
🗰 Au	lit Events (154) Sy	stem has (232)) records		9 Column	s 🔹 Last Updated:	2020-04-28 22:5	7:30 UTC Ċ 🕻
	S	earch				0 Q	~	
Who	Time ↓	Action	Act On (kind)	Act On (name)	Outcome	Client	Service Node	Service Name
admin	2020-04-28 22:56:08 U	TC Delete	Buffer	b3fd7c90	success	192.168.32.3	localhost.loca	pen-apiserver
idmin	2020-04-28 22:56:08 U	TC commit	Buffer	b3fd7c90	success	192.168.32.3	localhost.loca	pen-apiserver
admin	2020-04-28 22:56:08 U	TC update	Distribu	00ae.cd01.090	success	192.168.32.3	localhost.loca	pen-apiserver
"meta": "name"; "tenant" "genera	"378d70de-5eb1-49e4-ac ": "default", :ion-id": "", "255539fa-4f24-465d-b0	-	7".					
}, "creatio "mod-tio	on-time": "2020-04-28T2 ne": "2020-04-28T22:56: ink": "/audit/v1/events	08.453486933Z",		8e9ee14f8f"				
}, "creatio "mod-tio	ne": "2020-04-28T22:56:	08.453486933Z", /255539fa-4f24-46	5d-b059-7e	8e9ee14f8f" b3fd7c90	success	192.168.32.3	localhost.loca	pen-apiserver

Figure 12. Audit configuration

System logging

The PSM collects events and alerts related to the platform. The administrator can define policies to specify which such events should be logged and whether they should be sent to an external "syslog" collector.

Alerts &	Events						EVENT POLICIES
ALE	RTS	EVENTS					
Ever	nts (Past 1,0	00)			18	152 830 Show Debug Ev	vents Past day
		Search				Ø Q 🗸	
Severity	Туре	Message		Object Ref	Count	Source Node & Component	Time↓
🌲 info	COLLECTOR.	DSC 00ae.cd01.15e0	20.0.0.141 reachable from DS	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	2020-04-28 22:51:3
🌲 info	COLLECTOR	DSC 00ae.cd01.15e0	20.0.0.122 not reachable fron	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	2020-04-28 22:51:1
🌲 info	COLLECTOR	DSC 00ae.cd01.15e0	20.0.0.141 not reachable fron	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	2020-04-28 22:50:3
🌲 info	COLLECTOR	DSC 00ae.cd01.15e0	20.0.0.122 reachable from DS	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	t 2020-04-28 22:50:1:
🕕 warn	SYSTEM_RE	pen-citadel disk usage	e is high (84.37%)	Node : 20.0.0.2(1	20.0.0.204 : pen-citadel	2020-04-28 22:50:1
🌲 info	COLLECTOR.	DSC 00ae.cd01.15e0	20.0.0.122 not reachable fron	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	1 2020-04-28 22:49:1
🌲 info	COLLECTOR.	DSC 00ae.cd01.15e0	20.0.0.141 reachable from DS	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	t 2020-04-28 22:48:2 ⁻
🌲 info	COLLECTOR.	DSC 00ae.cd01.15e0	20.0.0.143 reachable from DS	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	t 2020-04-28 22:48:2·
🌲 info	COLLECTOR.	DSC 00ae.cd01.15e0	20.0.0.141 not reachable fron	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	2020-04-28 22:47:3
🌲 info	COLLECTOR	DSC 00ae.cd01.15e0	20.0.0.143 not reachable fron	DistributedServi	1	HP-srividhya-1.pensando.io : pen-netagent	2020-04-28 22:47:2
infa		D00 0000 ad01 1500	00 0 0 140 masshable from DC	DistributedCarui	1	11D acividhus 1 nanaanda is , nan nataaant	0000 04 00 00.46.1

Figure 13. Logged Events

Figure 13 above shows a sample display of events, classified as informational, warning or errors. Typical events include PSM level information (such as a disk getting full or a user logging onto the PSM), DSC lifecycle events (such as a DSC being admitted to the PSM), or a "syslog" collector not being reachable.

The administrator also has the capability to select a subset of alerts and events to be collected into a downloadable archive.

	ALERTS	EVENTS							
Ļ	Alerts (139)			-		Acknowled	ged 🔽 Oper	Resolved Past week	
	Modification Time Λ	Creation Time	Severity	Me	START:		END:		
	2020-05-08 21:34:49 UTC	2020-05-08 21:34:49 UTC	critical	Flo	end - 1w	(iii)	now	iii	
כ	2020-05-08 21:34:49 UTC	2020-05-08 21:34:49 UTC	Critical	Flo	Past hour	Past 6 hour		Past 12 hour	
	2020-05-08 21:34:59 UTC	2020-05-08 21:34:59 UTC	critical	Flo	Past day	Past week		Past month	
	2020-05-08 21:34:59 UTC	2020-05-08 21:34:59 UTC	critical	Flo	Previous day	Previous wee	k	Previous month	
	2020-05-08 21:35:19 UTC	2020-05-08 21:35:19 UTC	Critical	Flow	w logs rate-limited for DSC 00ae.cd00.06ai Open 20.0.1.62 : pen-spyglass				
	2020-05-08 21:35:19 UTC	2020-05-08 21:35:19 UTC	critical	Flow	logs rate-limited for DSC 00ae.cd00.093I Open 20.0.1.62 : pen-spyglass				
	2020-05-08 21:35:19 UTC	2020-05-08 21:35:19 UTC	critical	Flow	w logs rate-limited for DSC 00ae.cd00.3a91 Open 20.0.1.62 : pen-spyglass				

Figure 14. Selecting specific events

The screenshot in Figure 14 above shows sample alerts that are classified as critical. Administrators can filter based on disposition ("Acknowledged", "Open", "Resolved"), and limit the search to a specific time period.

Configuration Snapshots

The PSM can capture a snapshot of its configuration, which includes the feature sets activated and policies installed on each DSC. Snapshots are stored on the PSM and can be restored when necessary.

This lets the administrator save configurations that are known to work properly, and experiment with changes knowing that the entire platform can be easily rolled back to a known, working state.

Upgrades

The PSM provides a centralized, simplified system for managing DSC software and firmware upgrades. The PSM also provides easy, reliable management for upgrading the Virtual Machines (VMs) that compose the PSM cluster itself.

Once a new software release is selected and the upgrade is started, the PSM is upgraded first, one VM at a time. Then each DSC is upgraded.

Upgrading a 3-node PSM cluster takes about 15 minutes, while the upgrade of each DSC takes about 3 minutes. During the upgrade, services are not disrupted; packet forwarding is halted for a short time on each DSC, but no state information is lost and after a brief pause, packets resume flowing normally. The overall time required to complete the upgrade of an entire platform depends on the upgrade strategy adopted and the maximum number of DSCs that are allowed to be upgraded in parallel. For example, it is possible to schedule the upgrade to be performed at a future time and to specify that DSCs are upgraded only the next time their host is rebooted. The PSM provides a view of the status of the upgrade process.

Third-party Integration

The Pensando Distributed Services Platform is designed to integrate with third party tools and systems to simplify the role of the network administrator, facilitate the deployment of the Pensando platform in pre-existing environments, and leverage functionality not directly provided by the Pensando solution. Some examples are given below:

Custom Orchestrators and Automation

In addition to the Graphical User Interface (GUI) as seen in examples abovet, the PSM offers a REST (REpresentational State Transfer) API (Application Programming Interface), allowing for programmatic access to all the features offered by the Pensando platform. This API enables sophisticated integration of the network and visibility services offered by the Pensando platform with existing data center environments, such as an orchestrator used by an enterprise for the automation of their data center. Since the API design and documentation is based on <u>Swagger</u>, it is particularly easy to create Python and Ansible scripts to automate PSM operations.

Custom Controllers

If an enterprise has developed their own controller for their services and prefers to use it instead of the PSM, this is easy to do as all communication between the PSM and DSCs takes place via a well-defined interface based on gRPC (gRPC Remote Procedure Call). Since the protobuf (Protocol Buffer) message definition understood by the DSC is documented, DSCs can be controlled directly from a custom enterprise controller.

Telemetry Collectors and Analytics

As previously discussed, DSCs offer a wide array of telemetry data and even the capability of exporting captured packets. Since standard formats and protocols such as IPFIX, syslogs, and ERSPAN are used for this purpose, various third-party tools and platforms can be used to collect and analyze this data. For example, interoperability has been verified with solutions such as Wireshark, Corvil, Extrahop, Splunk, and ELK.

About Pensando

Founded in 2017, Pensando Systems is the company pioneering distributed computing designed for the New Edge, powering software-defined cloud, compute, networking, storage and security services to transform existing architectures into the secure, ultra-fast environments demanded by next generation applications. The Pensando platform, a first of its kind, was developed in collaboration with the world's largest cloud, enterprise, storage, and telecommunications leaders and is supported by partnerships with HPE, NetApp, Oracle, IBM, Equinix, and multiple Fortune 500 customers. Pensando is led by Silicon Valley's legendary "MPLS" team – Mario Mazzola, Prem Jain, Luca Cafiero, Soni Jiandani and Randy Pond – holding an unmatched track record of disruptive innovation having already built \$8Bn/year businesses across storage, switching, routing, wireless, voice/video/data, & software-defined networking. The company is backed by investors that include Goldman Sachs and JC2 Ventures. For more information, please visit <u>www.pensando.io</u>

DOCUMENT REVISIONS

Pub Date	Exp/Review Date	Description
31-Nov-2020	1-Dec-2021	Initial release.