LAYER SEVEN SECURITY

SIEM INTEGRATION FOR SAP©

SAP-SIEM INTEGRATION FOR ADVANCED THREAT DETECTION

WHITE PAPER

Version 1.0
January 2020

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SIEM INTEGRATION FOR SAP

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SECTION 1 SUMMARY

Security Information and Event Management (SIEM) platforms combine the ability to collect log data from applications, hosts, routers, switches, firewalls and other endpoints with the ability to analyze events to support threat detection, event correlation and incident response.

SIEM platforms require complete coverage for maximum yield. In other words, organizations reap the full benefits of SIEM platforms when monitoring logs throughout the technological infrastructure. This includes SAP application logs for organizations with SAP systems.

However, there are several challenges with integrating SAP application logs with SIEM systems. The first challenge is complexity. SAP systems typically contain multiple logs that capture security-relevant events. The SAP NetWeaver Application Server ABAP (AS ABAP) alone has at least seven such logs including the Security Audit Log, Gateway Server Log, HTTP Log, System Log, Transaction Log, Change Document Log, and the Read Access Log. The logs do not have a standardized format or structure. Some are captured at the file level and others are stored in SAP tables. The complexities involved in integrating multiple and distinct logs from each SAP system should not be underestimated, especially for large SAP landscapes.

The second challenge is log volume. Raw event logs can grow to gigabytes and even terabytes within a relatively short period of time in SAP systems that often support thousands of end users and hundreds of cross-system connections. Transmitting large volumes of log data from SAP systems to SIEM platforms could consume high levels of network bandwidth. The need to store such data for analysis could also increase resource requirements and licensing costs for SIEM systems.

The third challenge with directly integrating SAP logs is maintenance. Monitoring and supporting the numerous integration points between SAP systems and SIEM platforms, as well as regular archiving to deal with the accumulation of log data, could lead to high maintenance costs.

Finally, many SAP logs do not natively include information to support cross-platform correlation using SIEM tools. This includes source and destination IPs for security events. Values for sources and destinations in SAP logs are often terminal names and SAP System IDs (SIDs) rather than IP addresses. Therefore, Security Operations Centers (SOCs) are not able to easily correlate SAP events with non-SAP events in SIEM platforms.

The challenges of log complexity, volume, maintenance and correlation can be overcome by monitoring SAP event logs with Solution Manager. SAP Solution Manager is a management platform installed in SAP landscapes. Licensing for Solution Manager is bundled with SAP Support agreements. Therefore, most SAP customers have usage rights for the software.

The monitoring and alerting infrastructure in Solution Manager connects directly to event logs in SAP systems to detect indicators of compromise (IOCs) and trigger alerts for security events. Alerts are written to text files in real-time by Solution Manager before they are ingested by SIEM platforms. This approach supports log filtering, normalization and enrichment, and therefore provides a simpler, easier and faster method for integrating SAP event logs with SIEM platforms.

SECTION 2 SAP LOGS

SECURITY AUDIT LOG

The Security Audit Log is the main source of security-related event information in the SAP NetWeaver Application Server ABAP (AS ABAP). Events captured by the log are assigned a unique message ID. Each message ID is categorized in an audit and event class. Audit classes include dialog logons, RFC/ CPIC logons, RFC calls, transaction starts, report starts, user master changes, and system events. Event classes include critical, severe and non-critical. Supported message IDs can vary between systems based on the version of AS ABAP. Report RSAU_INFO_SYAG displays available message IDs in each system.

Figure 2.1 Report RSAU_INFO_SYAG

Information System for Message Definitions

Cancel More

Report Environment:
Release / System ID / Client: 740 / AS2 / 001
Executed On: 10.12.2019/12:34:35

Message ID	Message text	Category name	Event Weighting
AU0	Audit - Test. Text: &A	Other	Non-Critical
AU1	Logon successful (type=&A, method=&C)	Logon	Severe
AU2	Logon failed (reason=&B, type=&A, method=&C)	Logon	Critical
AU3	Transaction &A Started	Transaction Start	Non-Critical
AU4	Start of transaction &A failed (Reason=&B)	Transaction Start	Critical
AU5	RFC/CPIC logon successful (type=&A, method=&C)	RFC Login	Non-Critical
AU6	RFC/CPIC logon failed, reason=&B, type=&A, method=&C	RFC Login	Critical
AU7	User &A Created	User Master Record Change	Critical
AU8	User &A Deleted	User Master Record Change	Severe
AU9	User &A Locked	User Master Record Change	Severe
AUA	User &A Unlocked	User Master Record Change	Severe
AUB	Authorizations for User &A Changed	User Master Record Change	Severe
AUC	User Logoff	Logon	Non-Critical
AUD	User Master Record &A Changed	User Master Record Change	Severe
AUE	Audit Configuration Changed	System	Critical
AUF	Audit: Slot &A: Class &B, Severity &C, User &D, Client &E, &F	System	Critical
AUG	Application Server Started	System	Critical
AUH	Application Server Stopped	System	Critical
AUI	Audit: Slot &A Inactive	System	Critical

Audit classes, event classes and message IDs are selected for auditing using filters maintained in transaction SM19. Recommended settings include all actions covering all audit classes and events in every client for standard users such as SAP* (see 2.2), severe and critical events, and the specific non-critical events specified in fig. 2.3.

Figure 2.2 Filter Settings for Auditing Actions Performed by SAP* User

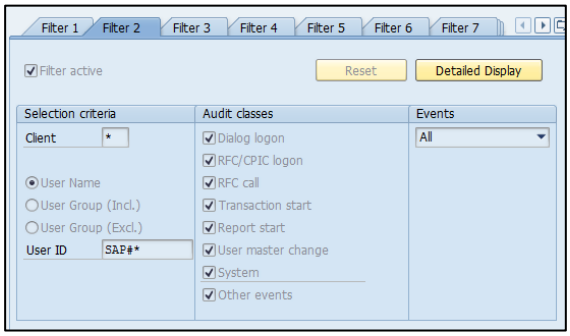


Figure 2.3 Recommended Non-Critical Events for Auditing

MESSAGE ID	EVENT
BU4	Dynamic ABAP Code
CUY	Debugging Users
DU9	Generic Table Access
DUI	RFC Callback Executions
FU1	RFC Calls with Dynamic Destinations
AU5	RFC/CPIC Logon
AUK	RFC Function Call
AUW	Report Start
EUF	Failed RFC Function module Call
EUG	Failed RFC Function module Call
EU5	Deletion of Audit Log Data
BU2	Password Change

The security audit log is not activated by default and should be enabled using the setting 1 for profile parameter rsau/enable. The maximum size of the audit log should be adjusted to higher than the default value of 1,000,000 bytes using parameter rsau/max_diskspace_local. The log is stored as a UTF-16LE encoded file stored in the directory specified by the rsau/local/file parameter. Log events can be read and backed up using transaction SM20 and deleted using transaction SM18.

SYSTEM LOG

System-related errors and warnings in AS ABAP are logged in the System Log. This includes events such as debugging, user locks/ unlocks, logon attempts for locked users, and changes to audit settings. Unique message IDs are used for each event. The System Log can be displayed using transaction SM21.

Figure 2.4 System Log

Syslog messages

Cancel More

Syslog of instance layer7as2_AS2_00

Date	TIME	Instance	Type	Process No	CL.	Priority	Message ID	Message Text	TCode
11.12.2019	09:02:03	layer7as2_AS2_00	DIA	008	001	●	BY2	Database error 10 at CON	
11.12.2019	09:02:03	layer7as2_AS2_00	DIA	008	001	○	BY0	> authentication failed	
11.12.2019	09:02:03	layer7as2_AS2_00	DIA	008	001	●	BY2	Database error 10 at CON	
11.12.2019	09:02:03	layer7as2_AS2_00	DIA	008	001	○	BY0	> authentication failed	
11.12.2019	09:06:28	layer7as2_AS2_00	DIA	005	001	▲	A23	Goto ABAP Debugger: Source:(7)->(34) | ByteCode:iclr(420	SE24
11.12.2019	09:06:28	layer7as2_AS2_00	DIA	005	001	○	A14	> in program /L7S/CL_CCDB_EXTRACTOR========CM00K , line 0034, event CONSTRUCTOR	SE24
11.12.2019	09:06:38	layer7as2_AS2_00	DIA	005	001	●	A19	Field contents changed: MV_UPDATE_INTERVAL_MINUTES -> 60	SE24
11.12.2019	09:06:38	layer7as2_AS2_00	DIA	005	001	○	A14	> in program /L7S/CL_CCDB_EXTRACTOR========CM00K , line 0034, event CONSTRUCTOR	SE24
11.12.2019	09:07:03	layer7as2_AS2_00	DIA	015	001	●	BY2	Database error 10 at CON	
11.12.2019	09:07:03	layer7as2_AS2_00	DIA	015	001	○	BY0	> authentication failed	
11.12.2019	09:07:03	layer7as2_AS2_00	DIA	015	001	●	BY2	Database error 10 at CON	
11.12.2019	09:07:03	layer7as2_AS2_00	DIA	015	001	○	BY0	> authentication failed	
11.12.2019	09:09:07	layer7as2_AS2_00	WRK	000		○	Q0Q	Start Workp. 39, Pid 59264	
11.12.2019	09:09:08	layer7as2_AS2_00	DIA	005	001	▲	A23	Goto ABAP Debugger: Source:(123)->(123) | ByteCode:cmpb(	SE24
11.12.2019	09:09:08	layer7as2_AS2_00	DIA	005	001	○	A14	> in program /L7S/CL_CCDB_EXTRACTOR========CM00E , line 0123, event GET_GATEWAY	SE24
11.12.2019	09:09:44	layer7as2_AS2_00	DIA	005	001	▲	A23	Goto ABAP Debugger: Source:(118)->(119) | ByteCode:cmpb(	SE24
11.12.2019	09:09:44	layer7as2_AS2_00	DIA	005	001	○	A14	> in program /L7S/CL_CCDB_EXTRACTOR========CM00E , line 0119, event GET_GATEWAY	SE24
11.12.2019	09:11:55	layer7as2_AS2_00	DIA	005	001	●	GEO	Lock entry deleted manually: SEOCLSENQ X	SM12
11.12.2019	09:11:56	layer7as2_AS2_00	DIA	005	001	●	GEO	Lock entry deleted manually: SEOCLSENQ X	SM12

The System Log is enabled by default and does not require any specific maintenance tasks since the log is a ring buffer that automatically overwrites the oldest data. The maximum size of the system log is specified by the parameter rslg/max_diskspace/local. The default value of the parameter is 500,000 bytes. Central system logs can be configured for Linux platforms. Application servers send local logs to the central server. The central log is comprised of an active and inactive file. The current log is stored in the active file. A log switch is performed when the maximum size of the active file is reached, and a new inactive log file is automatically created. The switch occurs when the size of the active log file is half the value as specified in the rslg/max_diskspace_central parameter. The default value for the parameter is 2,000,000 bytes. The location of the local log is specified in the rslg/local/file profile parameter. The location of the active file for the central System log is specified in the rslg/central/file profile parameter and the location of the inactive file is specified in rslg/central/old_file.

ICM LOG

Web-based communication including HTTP(S) and SMTP calls to AS ABAP are captured in the log for the Internet Communication Manager (ICM). The profile parameter icm/HTTP/logging_<xx> controls the logging for inbound requests and icm/HTTP/logging_client_<xx> regulates logging for outbound requests. <xx> specifies the port reference for the supported protocols. For example, the relevant parameter for HTTP logging would be icm/HTTP/logging_0 if icm/server_port_0 = PROT=HTTP. The syntax for the ICM logging parameters includes options for the log file format. The CLF format is recommended since this option supports logging of URLs in log entries. The ICM will log access to dangerous URLs including URLs for ICF services with known security vulnerabilities. This includes IDOC MXL, SOAP RFC and WEBRFC. Client and server ICM logs can be displayed using transaction SMICM or directly in the work directory of each instance.

Figure 2.5 ICM Log

ICM Monitor of Server layer7as2_AS2_00

HTTP Log File

```
10.8.91.9 - - [11/Dec/2019:10:54:47 -0500] "GET /sap/public/bc/ur/nw7/js/classes/LayeredControl.js?4EFA9C11A645 HTTP/1.1" 304 0
10.8.91.9 - - [11/Dec/2019:10:54:49 -0500] "GET /sap/public/bc/ur/nw5/themes/~cache-20190201101416/UR/baseLib/sap_goldreflection/img/loading/lsloading_ani.gif HTTP/1.1"
10.8.91.9 - - [11/Dec/2019:10:54:51 -0500] "POST /sap/bc/webdynpro/sap/diag_app_starter?sap-contextid=.....................................................................
10.8.91.9 - - [11/Dec/2019:10:54:51 -0500] "GET /sap/public/bc/ur/nw5/themes/~cache-20190201101416/Base/baseLib/sap_corbu/img/libs/Icon/Help.png?version=UR.ls:10.30.7.30
10.8.91.9 - - [11/Dec/2019:10:54:51 -0500] "GET /sap/public/bc/ur/nw5/themes/~cache-20190201101416/Base/baseLib/sap_corbu/img/libs/Icon/GreenLed.png?version=UR.ls:10.30.
10.8.91.9 - - [11/Dec/2019:10:54:52 -0500] "GET /sap/public/bc/ur/nw5/themes/~cache-20190201101416/Base/baseLib/sap_corbu/img/libs/Icon/YellowLed.png?version=UR.ls:10.30
10.8.91.9 - - [11/Dec/2019:10:54:52 -0500] "GET /sap/public/bc/icons/s_B_EXEC.gif HTTP/1.1" 200 127
10.8.91.9 - - [11/Dec/2019:10:54:52 -0500] "GET /sap/public/bc/icons/s_B_CALC.gif HTTP/1.1" 200 125
10.8.91.9 - - [11/Dec/2019:10:54:52 -0500] "GET /sap/public/bc/ur/nw5/themes/~cache-20190201101416/Base/baseLib/sap_corbu/img/libs/Icon/RedLed.png?version=UR.ls:10.30.7.
10.8.91.9 - - [11/Dec/2019:10:54:52 -0500] "GET /sap/public/bc/ur/nw5/themes/~cache-20190201101416/Base/baseLib/sap_corbu/img/libs/Icon/UnknownStatus.png?version=UR.ls:1
10.8.91.9 - - [11/Dec/2019:10:54:52 -0500] "GET /sap/public/bc/ur/nw7/js/classes/TabStrip_standards.js?4EFA9C11A645 HTTP/1.1" 200 5885
10.8.91.9 - - [11/Dec/2019:10:54:52 -0500] "GET /sap/public/bc/ur/nw7/js/classes/TabStrip.js?4EFA9C11A645 HTTP/1.1" 200 1247
10.8.91.9 - - [11/Dec/2019:10:54:53 -0500] "GET /sap/public/bc/ur/nw7/js/classes/ItemNavigation.js?4EFA9C11A645 HTTP/1.1" 200 1069
10.8.91.9 - - [11/Dec/2019:10:54:53 -0500] "GET /sap/public/bc/ur/nw7/js/classes/TabStripItem_standards.js?4EFA9C11A645 HTTP/1.1" 200 1690
10.8.91.9 - - [11/Dec/2019:10:54:53 -0500] "GET /sap/public/bc/ur/nw7/js/classes/TabStripItem.js?4EFA9C11A645 HTTP/1.1" 200 818
10.8.91.9 - - [11/Dec/2019:10:54:54 -0500] "GET /sap/public/bc/ur/nw7/js/classes/TabstripDelegate_standards.js?4EFA9C11A645 HTTP/1.1" 200 783
10.8.91.9 - - [11/Dec/2019:10:54:54 -0500] "GET /sap/public/bc/ur/nw7/js/classes/ResizeEventHelper.js?4EFA9C11A645 HTTP/1.1" 200 743
10.8.91.9 - - [11/Dec/2019:10:54:54 -0500] "GET /sap/public/bc/ur/nw7/js/classes/Image.js?4EFA9C11A645 HTTP/1.1" 200 3403
10.8.91.9 - - [11/Dec/2019:10:54:55 -0500] "GET /sap/public/bc/ur/nw7/js/classes/Panel.js?4EFA9C11A645 HTTP/1.1" 304 0
10.8.91.9 - - [11/Dec/2019:10:54:55 -0500] "GET /sap/public/bc/ur/nw7/js/classes/PanelBase.js?4EFA9C11A645 HTTP/1.1" 304 0
10.8.91.9 - - [11/Dec/2019:10:54:55 -0500] "GET /sap/public/bc/ur/nw7/js/classes/Animation.js?4EFA9C11A645 HTTP/1.1" 304 0
10.8.91.9 - - [11/Dec/2019:10:54:55 -0500] "GET /sap/public/bc/ur/nw7/js/classes/Animator.js?4EFA9C11A645 HTTP/1.1" 304 0
```

BUSINESS TRANSACTION ANALYSIS

Statistical records can be monitored to identify calls for dangerous transactions and programs including areas such as system administration, user maintenance, transports, and RFC administration. The records can be viewed using transaction STAD. Statistical records are stored chronologically in a buffer in each application server. The buffer is flushed to a statistics file when it is full. A new file is created each hour. The oldest file in the directory is automatically deleted every hour. The default directory for the files is /usr/sap/<SysID>/<Instance Directory>/DATA. The maximum number of statistic files is determined by the value of the profile parameter stat/max-_files. The default value for the parameter is 48. Therefore, STAD data is only available for 48 hours. The maximum value for the parameter is 99. This would retain STAD data for 4 days.

Figure 2.6 STAD

SAP Workload: Single Statistical Records - Overview

Download | Disp. mode | Sel. fields | Server ID | Cancel

System: AS2 Number of RFCs which responded (without errors): 1 (1)
Analysed time: 18.12.2019 / 12:12:00 - 18.12.2019 / 12:22:00
Display mode: All statistic records, sorted by time Application statistic is included

Started	Server	Transaction	Program / Function	T	Scr.	Wp	User
		*	*		*		*
12:12:20	layer7as2_AS2_00		<AUTO TASKHANDLER PROCESSING>	G		18	SAPSYS
12:12:29	layer7as2_AS2_00		RFC	R	3004	19	SMDAGENT_AS2
12:12:33	layer7as2_AS2_00		SIW=======E2E_DPC_PUSH	9	0010	19	SM_EXTERN_WS
12:12:34	layer7as2_AS2_00		SAPMHTTP /sap/public/ping	H		5	UNKNOWN
12:12:35	layer7as2_AS2_00		RFC	R		19	SAPJSF
12:12:35	layer7as2_AS2_00		RFC	R		19	SAPJSF
12:12:35	layer7as2_AS2_00		RFC	R		19	SAPJSF
12:12:35	layer7as2_AS2_00		RFC	R		19	SAPJSF
12:12:35	layer7as2_AS2_00		RFC	R		19	SAPJSF
12:12:35	layer7as2_AS2_00		SIW=======E2E_DPC_PUSH	9	0010	19	SM_EXTERN_WS
12:12:38	layer7as2_AS2_00		RFC	R	3004	0	SOLMAN_BTC
12:12:38	layer7as2_AS2_00		<AUTO SECURITY PROCESSING>	G		4	SAPSYS
12:12:38	layer7as2_AS2_00		(BATCH)	B		6	SAPSYS
12:12:38	layer7as2_AS2_00		Buf.Sync	Y		6	SAPSYS
12:12:38	layer7as2_AS2_00		RFC	R	3004	14	SOLMAN_BTC
12:12:38	layer7as2_AS2_00		<DDLOC CLEANUP>	K		17	SAPSYS
12:12:38	layer7as2_AS2_00		<AUTO CCMS PROCESSING>	3		17	SAPSYS
12:12:38	layer7as2_AS2_00		(BATCH)	B		17	SAPSYS
12:12:38	layer7as2_AS2_00		RFC	R	3004	18	SOLMAN_BTC
12:12:38	layer7as2_AS2_00		E2E_EFWK_RESOURCE_MGR	B		23	SM_EFWK
12:12:38	layer7as2_AS2_00		RSBTCRTE	B		23	SM_EFWK
12:12:38	layer7as2_AS2_00		ACE_CALCULATION_CONTROLLER	B		29	SOLMAN_BTC
12:12:38	layer7as2_AS2_00		RSBTCRTE	B		29	SOLMAN_BTC
12:12:38	layer7as2_AS2_00		RSBTCRTE	B		30	SM_EFWK

GATEWAY LOG

The gateway log supports monitoring for RFC communications. This includes actions such as opening and closing of network connections, monitor commands, registration and deregistration of servers, and launching of external programs. Logging for gateway actions is configured by maintaining the relevant indicators for each action using the ACTION option in the profile parameter gw/logging. The default setting for the parameter only logs changes to security settings and rejected actions. The gateway log is stored in a file located in the work directory of each SAP instance. The prefix for each entry in the log denotes the gateway action.

Figure 2.7 Gateway Log

```
S Sun Dec 18 2016 11:11:16:442  P USER=* USER-HOST=local HOST=internal TP=*
S Sun Dec 18 2019 11:11:16:442  P USER=* USER-HOST=internal HOST=local TP=*
S Sun Dec 18 2019 11:11:16:442 (re)load reginfo file C:\usr\sap\AS2\SYS\global\reginfo.DAT, version=2 (3 lines, mode=1)
S Sun Dec 18 2019 11:11:16:442  P TP=* HOST=local
S Sun Dec 18 2019 11:11:16:442  P TP=* HOST=internal
S Sun Dec 18 2019 11:11:16:442 prxyinfo file C:\usr\sap\AS2\DVEBMGS00\data\prxyinfo.DAT not found
X Sun Dec 18 2019 11:24:06:969 gateway stopped, pid=2628
P Sun Dec 18 2019 11:24:06:969 log file closed
P Sun Dec 18 2019 11:24:22:483 log file reopened
P Sun Dec 18 2019 11:24:22:483 initial gw/logging ACTION=Ss LOGFILE=gw_log-%y-%m-%d SWITCHTF=day MAXSIZEKB=100
X Sun Dec 18 2019 11:24:22:483 gateway started, pid=4120
P Sun Dec 18 2019 11:24:22:483 gw/logging = ACTION=Ss LOGFILE=gw_log-%y-%m-%d SWITCHTF=day MAXSIZEKB=100
S Sun Dec 18 2019 11:24:22:483 simulation mode deactivated
S Sun Dec 18 2019 11:24:22:483 gw/reg_no_conn_info: 1
S Sun Dec 18 2019 11:24:22:487 (re)load secinfo file C:\usr\sap\AS2\SYS\global\secinfo.DAT, version=2 (5 lines, mode=1)
S Sun Dec 18 2019 11:24:22:487  P USER=* USER-HOST=local HOST=local TP=*
S Sun Dec 18 2019 11:24:22:487  P USER=* USER-HOST=local HOST=internal TP=*
S Sun Dec 18 2019 11:24:22:487  P USER=* USER-HOST=internal HOST=local TP=*
S Sun Dec 18 2019 11:24:22:487 (re)load reginfo file C:\usr\sap\AS2\SYS\global\reginfo.DAT, version=2 (3 lines, mode=1)
S Sun Dec 18 2019 11:24:22:487  P TP=* HOST=local
S Sun Dec 18 2019 11:24:22:487  P TP=* HOST=internal
S Sun Dec 18 2019 11:24:22:487 prxyinfo file C:\usr\sap\AS2\DVEBMGS00\data\prxyinfo.DAT not found
X Sun Dec 18 2019 16:05:46:083 gateway stopped, pid=4120
P Sun Dec 18 2019 16:05:46:083 log file closed
P Sun Dec 18 2019 16:17:23:719 log file reopened
P Sun Dec 18 2019 16:17:23:719 initial gw/logging ACTION=Ss LOGFILE=gw_log-%y-%m-%d SWITCHTF=day MAXSIZEKB=100
X Sun Dec 18 2019 16:17:23:719 gateway started, pid=3636
P Sun Dec 18 2019 16:17:23:719 gw/logging = ACTION=Ss LOGFILE=gw_log-%y-%m-%d SWITCHTF=day MAXSIZEKB=100
```

CHANGE DOCUMENTS

Change documents support auditing for changes to critical objects. Objects consist of one or more table. User-related changes are logged in change documents within the IDENTITY and PFCG object class. This includes adding/ removing users and profiles. The change document header in table CDHDR logs changes for all objects and classes. However, the complete details of change documents can be viewed in table CDPOS. This includes old and new values. Each row in CDPOS includes a change flag. This field will include the value U for updates, I for insert, and D for delete.

READ ACCESS LOGGING

Read Access Logging (RAL) monitors access to sensitive data based on customer-specific scenarios configured with SRALMANAGER. This can include Personally Identifiable Information (PII) such as social security numbers, credit card numbers, and banking information. RAL supports monitoring for RFC, dynpro, web dynpro and web service channels. It can log access to sensitive data at both the field and table level. RAL entries can be viewed using transaction SRALMONITOR or in table SRAL_LOG. RAL is archived using archiving object SRAL with transaction SARA.

Figure 2.8 Read Access Log

Created At (Local Ti...	User Name	System ID	Channel	Direction	Logging Purpose	Client IP Address
05.08.2019 06:26:15,00	ATTACKER	AS2	Dynpro	Output	SE16_USR02	10.8.91.4
05.08.2019 06:26:15,00	ATTACKER	AS2	Dynpro	Output	TABLE_USER02_ACCESS	10.8.91.4
05.08.2019 02:45:27,00	ATTACKER	AS2	Dynpro	Output	SE16_USR02	10.8.91.4
05.08.2019 02:45:27,00	ATTACKER	AS2	Dynpro	Output	TABLE_USER02_ACCESS	10.8.91.4
05.08.2019 02:45:24,00	ATTACKER	AS2	Dynpro	Output	SE16_USR02	10.8.91.4
05.08.2019 02:45:24,00	ATTACKER	AS2	Dynpro	Output	TABLE_USER02_ACCESS	10.8.91.4
23.07.2019 13:23:11,00	ATTACKER	AS2	Dynpro	Output	SE16_USR02	10.8.91.4
23.07.2019 13:23:11,00	ATTACKER	AS2	Dynpro	Output	TABLE_USER02_ACCESS	10.8.91.4
23.07.2019 12:06:07,00	ATTACKER	AS2	Dynpro	Output	TABLE_USH02_ACCESS	10.8.91.4
23.07.2019 11:53:44,00	ATTACKER	AS2	Dynpro	Output	SE16_USR02	10.8.91.4
23.07.2019 11:53:44,00	ATTACKER	AS2	Dynpro	Output	TABLE_USER02_ACCESS	10.8.91.4

JAVA SECURITY LOG

The security audit log is enabled by default in the SAP NetWeaver Application Server (AS) Java. It logs security-relevant events in Java platforms including successful and unsuccessful logons, user creation, and changes to users, role, groups, and audit or UME properties. The log is stored in the file system within the directory \usr \sap \ <SID> \ <instance_number> \j2ee \cluster \server <n> \log \system. Logs are written to five files. The maximum size of each file is 10 MB. When the fifth file reaches the maximum permitted size, the contents of the oldest file is overwritten. If you enable the archiving process, the set of files is converted into a single ZIP file and stored as an archive on the file system.

Entries in the log follow the format below.
[Timestamp] | [Event Name] | [Event Type] | [ObjectID] | [ObjectName] | [Details]
The UME properties ume.secaudit.log_actor, ume.secaudit.get_object_name, and ume.logon.security_policy.log_client_hostaddress should be set to true in order to log usernames, objects names and IP addresses in audit entries.

Figure 2.9 Java Security Log

```
#2.0#2019 12 18 13:05:31:868#+00#Info#/System/Security/Audit/PrincipalModification#
#BC-JAS-SEC-UME#com.sap.security.core.sda#C000AC1F01BF00210000009000011B8#5334650000001859#sap.
User created    | USER.CREATE   | USER.PRIVATE_DATASOURCE.un:cup_app    |       | SET_ATTRIBUTE:

#2.0#2019 12 18 13:05:31:868#+00#Info#/System/Security/Audit/PrincipalModification#
#BC-JAS-SEC-UME#com.sap.security.core.sda#C000AC1F01BF00210000000A000011B8#5334650000001859#sap.
User account created    | USERACCOUNT.CREATE    | UACC.PRIVATE_DATASOURCE.un:cup_app    |

#2.0#2019 12 18 13:05:31:953#+00#Info#/System/Security/Audit/PrincipalModification#
#BC-JAS-SEC-UME#com.sap.security.core.sda#C000AC1F01BF00210000000B000011B8#5334650000001859#sap.
Role modified   | ROLE.MODIFY   | ROLE.UME_ROLE_PERSISTENCE.un:Administrator    |       | ADD_VA

#2.0#2019 12 18 13:05:44:617#+00#Info#/System/Security/Audit/PrincipalModification#
#BC-JAS-SEC-UME#com.sap.security.core.sda#C000AC1F01BF00120000001200011B8#5334650000000613##com
Role created    | ROLE.CREATE   | ROLE.UME_ROLE_PERSISTENCE.un:view-creator.CTCView     |

#2.0#2019 12 18 13:05:45:356#+00#Info#/System/Security/Audit/PrincipalModification#
#BC-JAS-SEC-UME#com.sap.security.core.sda#C000AC1F01BF00250000000F000011B8#5334650000003106#sap.
Role modified   | ROLE.MODIFY   | ROLE.UME_ROLE_PERSISTENCE.un:SAP_XI_ADMINISTRATOR_J2EE
```

HANA AUDIT LOG

Auditing in the HANA database is enabled by setting the value of the system property global_auditing_state to true. The default value is false. Therefore, auditing is not enabled in the default configuration of SAP HANA databases. The audit log can be written to a table, syslog and/or csv files. Table and syslog are recommended. Hence, the property default_audit_trail_type should include the values SYSLOGPROTOCOL and CSTABLE. For logging to csv files, the value of default_audit_trail_type should include CSVTEXTFILE and the file location can be set using the property default_audit_trail_path. The default file path is /usr/sap/<sid>/<instance>/<host>/trace. The property audit_statement_length should be set to -1 to log complete statements for audit events.

Audited actions are defined in audit policies. Each action corresponds to one or more SQL statement. Policies can be defined for the successful or unsuccessful execution of SQL statements and applied globally for all users or targeted for specific users. Policies can also be targeted for specific objects such as tables, schemas, views or procedures. Audit policies should be configured to log the actions in the table below using the HANA Cockpit or Studio. This includes all actions performed by the standard SYSTEM user, system, role and user changes, and failed logon attempts. The audit level should be set to ALERT or CRITICAL for all actions.

Figure 2.10 Recommended Audit Policy for SAP HANA

ACTION	AUDITED ACTION STATUS	AUDIT LEVEL	USERS
ACTIVATE REPOSITORY CONTENT	SUCCESSFUL	ALERT	
ALL ACTIONS	ALL	CRITICAL	SYSTEM
ALTER PERSISTENCE ENCRYPTION ROOT KEY	SUCCESSFUL	ALERT	
ALTER PERSISTENCE ENCRYPTION	SUCCESSFUL	ALERT	
ALTER PSE	SUCCESSFUL	ALERT	
ALTER STRUCTURED PRIVILEGE	SUCCESSFUL	ALERT	
ALTER USER	SUCCESSFUL	ALERT	
CONNECT	UNSUCCESSFUL	ALERT	
CREATE CERTIFICATE	SUCCESSFUL	ALERT	
CREATE PSE	SUCCESSFUL	ALERT	
CREATE ROLE	SUCCESSFUL	ALERT	
CREATE STRUCTURED PRIVILEGE	SUCCESSFUL	ALERT	
CREATE USER	SUCCESSFUL	ALERT	
DROP CERTIFICATE	SUCCESSFUL	ALERT	
DROP PSE	SUCCESSFUL	ALERT	
DROP ROLE	SUCCESSFUL	ALERT	
DROP STRUCTURED PRIVILEGE	SUCCESSFUL	ALERT	
DROP TABLE	SUCCESSFUL	ALERT	
DROP USER	SUCCESSFUL	ALERT	
EXPORT REPOSITORY CONTENT	SUCCESSFUL	ALERT	
GRANT ANY	SUCCESSFUL	ALERT	
IMPORT REPOSITORY CONTENT	SUCCESSFUL	ALERT	
REVOKE ANY	SUCCESSFUL	ALERT	
SET LICENSE (HANA 1.0) OR SET SYSTEM LICENSE (HANA 2.0)	SUCCESSFUL	ALERT	
SYSTEM CONFIGURATION CHANGE	SUCCESSFUL	CRITICAL	
UNSET LICENSE (HANA 1.0) OR UNSET SYSTEM LICENSE (HANA 2.0)	SUCCESSFUL	ALERT	

Database audit trails can be viewed through the system view AUDIT_LOG using the AUDIT OPERATOR or AUDIT ADMIN system privilege. Results can be exported for offline analysis and storage. Once archived, audit logs can be truncated to manage the size of the AUDIT_LOG table.

Figure 2.11 HANA Audit Log

APPLICATION_NAME	APPLICATION_USER_NAME	XS_APPLICATION_USER_NAME	AUDIT_POLICY_NAME	EVENT_STATUS	EVENT_LEVEL	EVENT_ACTION
HDBStudio	Administrator	SYSTEM	MandatoryAuditPolicy	SUCCESSFUL	CRITICAL	CLEAR AUDIT LOG
HDBStudio	Administrator	SYSTEM	DROP USER	SUCCESSFUL	ALERT	DROP USER
HDBStudio	Administrator	SYSTEM	CREATE ROLE	SUCCESSFUL	ALERT	CREATE ROLE
HDBStudio	Administrator	SYSTEM	GRANT ANY	SUCCESSFUL	ALERT	GRANT ROLE
HDBStudio	Administrator	SYSTEM	CREATE USER	SUCCESSFUL	ALERT	CREATE USER
HDBStudio	Administrator	SYSTEM	GRANT ANY	SUCCESSFUL	ALERT	GRANT ROLE
HDBStudio	Administrator	SYSTEM	ALTER USER	SUCCESSFUL	ALERT	ALTER USER
HDBStudio	Administrator	SYSTEM	GRANT ANY	SUCCESSFUL	ALERT	GRANT PRIVILEGE

SAPROUTER LOG

The SAProuter is a network proxy that filters traffic between SAP systems and external networks. It performs a pivotal role in SAP landscapes by filtering SAP traffic using a more granular approach than is possible with conventional network-level firewalls. Logging for the SAProuter is enabled and configured using option -G. The log will capture connections rejected by the SAProuter based on the route permission table configured in the saprouttab. It will also log connections and disconnections between clients and hosts including IP addresses and hostnames.

Figure 2.12 SAPRouter Log

```
Wed Dec  4 13:13:59 2019 INIT LOGFILE
Wed Dec  4 13:13:59 2019 READ ROUTTAB ./saprouttab o.k.
Wed Dec  4 13:14:05 2019 CONNECT FROM C1/- host 10.21.72.60/1245 (ldp007.wdf.sap.corp)
Wed Dec  4 13:14:05 2019 CONNECT TO   S1/2 host 10.21.82.77/sapmsBIN (binmain)
Wed Dec  4 13:14:05 2019 DISCONNECT   C1/2 host 10.21.72.60/1245 (ldp007.wdf.sap.corp)
Wed Dec  4 13:14:13 2019 CONNECT FROM C2/- host 127.0.0.1/44997 (localhost)
Wed Dec  4 13:14:13 2019 SEND INFO TO C2/-
Wed Dec  4 13:14:13 2019 DISCONNECT   C2/- host 127.0.0.1/44997 (localhost)
Wed Dec  4 13:14:23 2019 CONNECT FROM C2/- host 10.21.72.60/1276 (ldp007.wdf.sap.corp)
Wed Dec  4 13:14:23 2019 CONNECT TO   S2/1 host 10.21.72.60/3298 (ldp007)
Wed Dec  4 13:14:24 2019 DISCONNECT   S2/1 host 10.21.72.60/3298 (ldp007)
Wed Dec  4 13:14:31 2019 CONNECT FROM C2/- host 10.21.72.60/1352 (ldp007.wdf.sap.corp)
Wed Dec  4 13:14:31 2019 PERM DENIED  C2/- host 10.21.72.60 (ldp007.wdf.sap.corp) to ldp007/23
Wed Dec  4 13:14:31 2019 DISCONNECT   C2/- host 10.21.72.60/1352 (ldp007.wdf.sap.corp)
```

SECTION 3

SIEM INTEGRATION WITH SAP SOLUTION MANAGER

The challenges of directly integrating logs from each system in SAP landscapes with SIEM platforms are summarized below. The complexities of integrating multiple logs from numerous systems and managing the various integration points, not to mention the volume of SAP data in SIEM platforms, can lead to long, drawn-out deployments and push up maintenance costs. It may also fail to deliver the desired benefits since SAP event logs often lack the necessary data to support event correlation.

High Complexity
There are multiple event logs in SAP applications. The logs do not have a standard structure

High Volume
Each SAP system can generate hundreds of events per second and logs can grow to several gigabytes

High Maintenance
Monitoring of multiple integration points and regular archiving of event logs

Poor Correlation
Many SAP logs do not include source and destination IP addresses for correlation

The challenges can be overcome by monitoring SAP event logs indirectly using SAP Solution Manager. Solution Manager will filter, normalize and enrich security event data from SAP logs before forwarding alerts to SIEM systems. The Monitoring and Alerting Infrastructure (MAI) in Solution Manager can be used to monitor logs at source without extracting and replicating event logs to external repositories. This reduces both bandwidth and storage requirements. MAI data providers support monitoring for all SAP logs including file and table logs in ABAP, HANA, and Java systems, and standalone components such as the SAProuter. MAI periodically parses event logs using attack detection patterns configured in metrics. The frequency of metric checks is customizable and can range from every 60 seconds to several minutes apart.

A pattern match triggers the MAI to generate alerts and email or SMS notifications for security events. Security alerts generated by Solution Manager are managed using applications such as Monitor Systems, System Monitoring and the Alert Inbox. Alerts can also be written to an external file by Solution Manager. Solution Manager enriches event data by including source and destination IP addresses for each alert written to the file. This is intended to support correlation once the data is ingested by SIEM platforms. Event data is also normalized using a standardized structure for all log sources. The fields and separators for event details within each file are customizable and include values for alert name, description, date, time, system, system type, and event details. The event details can include information such as the event ID, username, source and destination IP addresses, and objects accessed by the user such as transactions, reports, function modules or URLs. The example below includes <DATE>::<TIME>::<SYSTEM>::<MANAGED OBJECT TYPE>::<ALERT TYPE>::<PRIORITY>::<ALERT NAME>::<ALERT DESCRIPTION>::<ALERT DETAILS>.
Each value is separated by ::

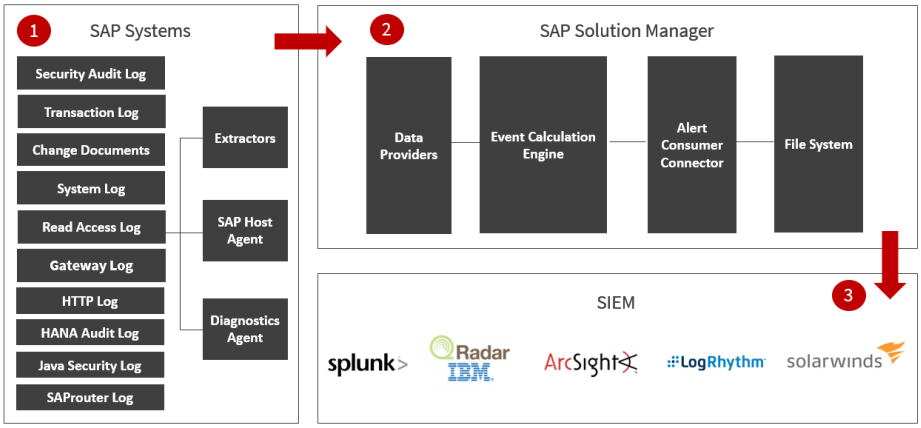
Figure 3.1 Event Structure

```
AlertDetails <DATE>::<TIME>::<SYSTEM>::<MANAGED OBJECT TYPE>::<ALERT
TYPE>::<PRIORITY>::<ALERT NAME>::<ALERT DESCRIPTION>::<ALERT DETAILS>
```

```
AlertDetails 20191120::132643::AS2~ABAP::T_SYSTEM::EXCEPTION::8::Generic Table
Access::A generic table access tool such as transaction SE16, SE16N, SE17, SM30,
SM31, SM34 or SQVI was used to successfully or unsuccessfully access the named
table with the executed activity. Select the Guided Procedure for Table
Access::SOLMAN_BTC/DU9/184/|DATE:2019-11 20/TIME:08:05:40/
SOURCE_IP:layer7as2.aws.layer7/TARGET_IP:192.168.30.211/CLIENT:001/MSG_TXT:
Generic table access call to /SSF/BTAB with activity 03 (auth. check: passed)
/TCODE:/REPNA:SAPMSSY1/PRIORITY:Low/PARAM1:/SSF/BTAB/PARAM2:03/PARA
```

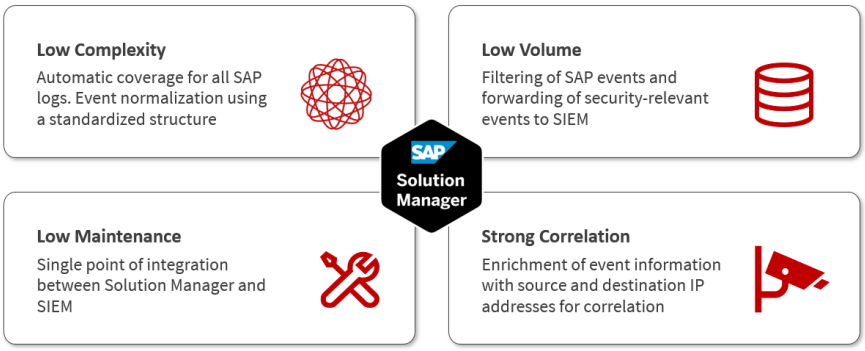
Event files can be stored on the Solution Manager host or an external host or file server. A new event file is created by Solution Manager for each day. The contents of the newest file can be periodically pushed to SIEM platforms or pulled by SIEM systems directly from relevant directories. There is a single point of integration for event data between SAP and SIEM systems. Hence, maintenance efforts are relatively low.

Figure 3.2 System Architecture

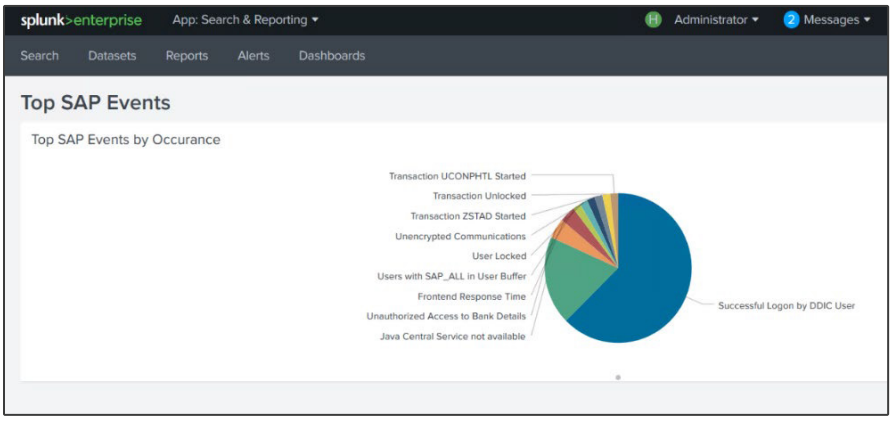


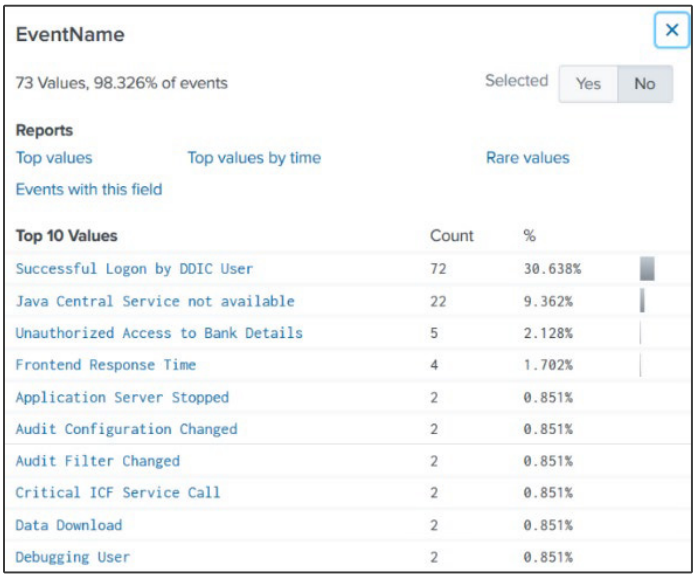
Since event details are written to and stored within alerts in Solution Manager, attackers will not be able to remove all traces of malicious actions by modifying event logs alone. They will also need to delete alerts and stop the triggering of email/ SMS notifications of alerts in Solution Manager. This would be challenging since alerts cannot be deleted in Solution Manager. They can only be confirmed. All alerts are retained and only removed by periodic housekeeping jobs designed to delete aged alerts.

The benefits of SAP-SIEM Integration with SAP Solution Manager are summarized below.



The following illustrates the integration between Solution Manager and Splunk Enterprise.





Top 10 Values	Count	%
Successful Logon by DDIC User	72	30.638%
Java Central Service not available	22	9.362%
Unauthorized Access to Bank Details	5	2.128%
Frontend Response Time	4	1.702%
Application Server Stopped	2	0.851%
Audit Configuration Changed	2	0.851%
Audit Filter Changed	2	0.851%
Critical ICF Service Call	2	0.851%
Data Download	2	0.851%
Debugging User	2	0.851%

SECTION 4 SIEM INTEGRATOR FOR SAP

This whitepaper discusses the benefits of integrating security event data from SAP applications with SIEM platforms using SAP Solution Manager. The benefits include lower complexity, rapid deployment, reduced costs, ease of maintenance, and the enrichment of event data to support cross-platform correlation.

The SIEM Integrator for SAP is a software add-on for Solution Manager that delivers automated threat detection for SAP systems. The add-on supports integration with SIEM platforms including Splunk, QRadar, ArcSight, LogRhythm and SolarWinds. The Integrator includes 300+ attack detection patterns for SAP platforms and logs.

To learn more or schedule a demo, contact Layer Seven Security at info@layersevensecurity.com

LAYER SEVEN SECURITY

Layer Seven Security secure, patch and monitor SAP systems against cyber threats using SAP Solution Manager. Layer Seven's Cybersecurity Extension for Solution Manager extends the capabilities of Solution Manager for advanced vulnerability management, threat detection and incident response.

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