Configurazione delle notifiche e-mail con script per gli avvisi IDS tramite CiscoWorks Monitoring Center for Security

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Introduzione

Monitor di protezione consente di inviare notifiche tramite posta elettronica quando viene attivata una regola di evento. Le variabili incorporate che possono essere utilizzate nella notifica e-mail per ogni evento non includono elementi quali il Signature ID, l'origine e la destinazione dell'avviso e così via. In questo documento vengono fornite istruzioni che consentono di configurare Monitor di protezione in modo da includere queste variabili e molte altre nel messaggio di notifica tramite posta elettronica.

Prerequisiti

Requisiti

Nessun requisito specifico previsto per questo documento.

Componenti usati

Il documento può essere consultato per tutte le versioni software o hardware. Tuttavia, assicurarsi di utilizzare lo script Perl appropriato in base alle versioni dei sensori eseguite nell'ambiente.

Convenzioni

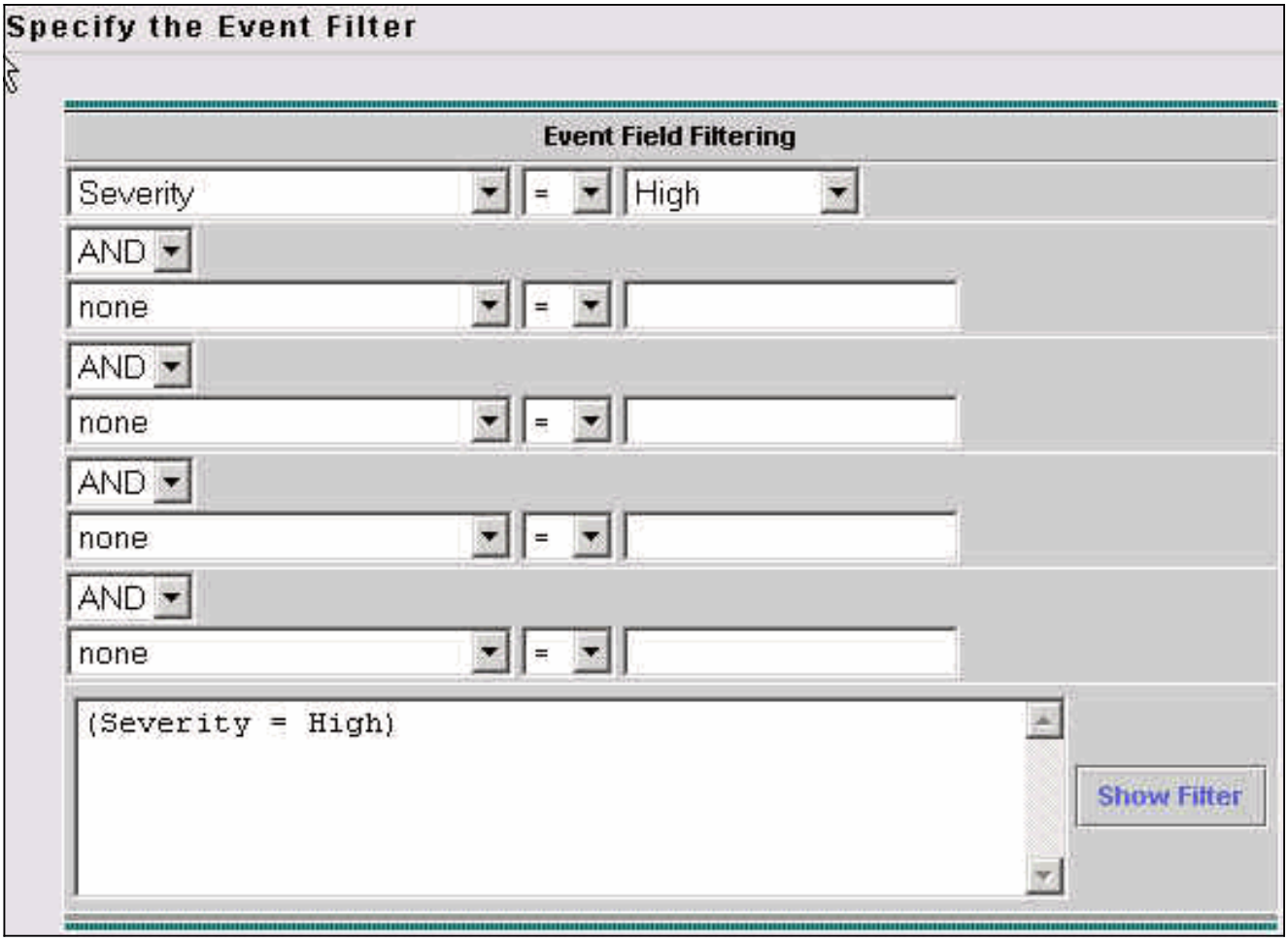
Fare riferimento a Cisco Technical Tips Conventions per ulteriori informazioni sulle convenzioni dei documenti.

Procedura di configurazione notifica e-mail

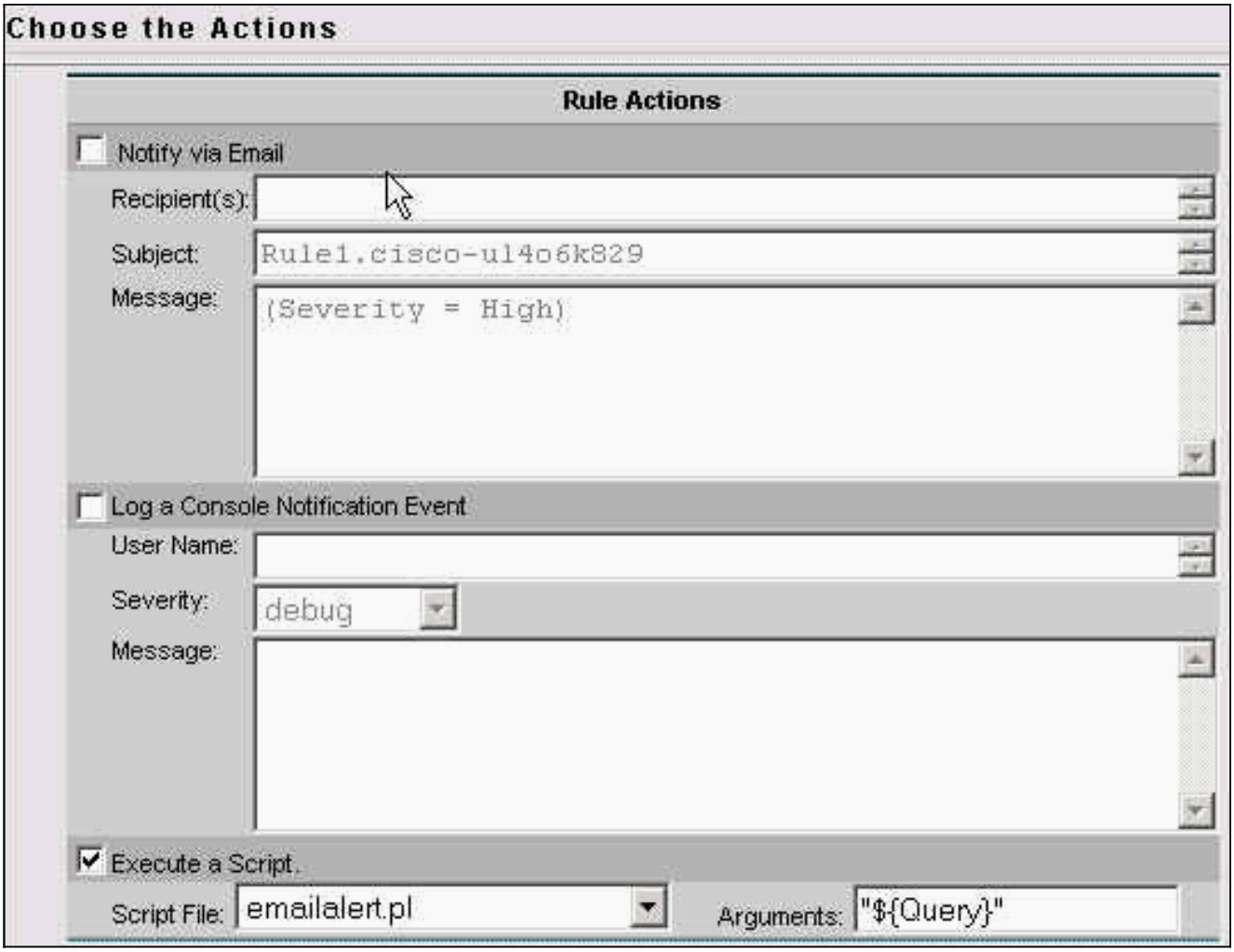
Utilizzare questa procedura per configurare le notifiche tramite posta elettronica.

Nota: Per inviare il messaggio all'indirizzo corretto, assicurarsi di modificare l'indirizzo nello script.

1. Copiare uno di questi script nella directory $BASE\CSCOpx\MDC\etc\ids\scripts sul server VPN/Security Management Solution (VMS). Ciò consente di selezionarla in un secondo momento durante il processo quando si definisce una regola di evento. Salvare lo script come **emailalert.pl**.**Nota:** Se si utilizza un nome diverso, assicurarsi di fare riferimento a tale nome nella regola di evento definita in questi passaggi.Per i sensori versione 3.x, usare lo script Sensori 3.xPer la versione 4.x Sensori, usare lo script Sensori 4.xPer la versione 5.x Sensori, usare lo script Sensori 5.xSe si dispone di una combinazione di versioni dei sensori, Cisco consiglia di effettuare l'aggiornamento in modo che tutte le versioni abbiano lo stesso livello. Questo perché è possibile eseguire solo uno di questi script alla volta.
2. Lo script contiene commenti che spiegano ciascuna parte e l'eventuale input richiesto. In particolare, modificare la variabile `$EmailRcpt` (nella parte superiore del file) come indirizzo di posta elettronica della persona che deve ricevere gli avvisi.
3. Definire una regola di evento in Monitor di sicurezza per chiamare un nuovo script Perl. Dalla pagina principale di Security Monitor, scegliere **Admin > Regole di evento** e aggiungere un nuovo evento.
4. Nella finestra Specificare il filtro eventi aggiungere i filtri che si desidera attivino l'avviso tramite posta elettronica. Nell'esempio riportato viene inviato un messaggio di posta elettronica per ogni avviso con livello di gravità
elevato.



5. Nella finestra Scegliere l'azione, selezionare la casella per eseguire uno script e selezionare il nome dello script dall'elenco a discesa.
6. Nella sezione Argomenti immettere **"${Query}"** come illustrato di seguito.**Nota:** deve essere inserito esattamente come indicato qui, comprese le virgolette doppie. Inoltre, fa distinzione tra maiuscole e
minuscole.



7. Quando viene ricevuto un avviso, come definito nei filtri eventi (in questo esempio, un avviso di severità elevata), lo script denominato emailalert.pl viene chiamato con un argomento di `${Query}`. Contiene informazioni aggiuntive sull'avviso. Lo script analizza tutti i campi separati e utilizza un programma chiamato "blat" per inviare un messaggio di posta elettronica all'utente finale.
8. Blat è un programma di posta elettronica freeware utilizzato sui sistemi Windows per inviare e-mail da file batch o script Perl. È incluso come parte dell'installazione di VMS nella directory $BASE\CSCOpx\bin. Per verificare le impostazioni del percorso, aprire una finestra del prompt dei comandi sul server VMS e digitare **blat**.Se viene visualizzato l'errore `File non trovato`, copiare il file blat.exe nella directory winnt\system32 oppure trovarlo e aprirlo dalla directory in cui si trova. Per installarlo, eseguire:

```
blat -install
```

Al termine dell'installazione del programma.

Script

Questi sono gli script a cui si fa riferimento nel passo 1 della procedura di configurazione:

- Script sensore 3.x
- Script sensore 4.x
- Script sensore 5.x

Script sensore 3.x

Utilizzare questo script per la versione 3.x Sensori.

Sensori 3.x

```
#!/usr/bin/perl
#*****************************************************
***************
#
# FILE NAME : emailalert.pl
#
# DESCRIPTION : This file is a perl script that will be
executed as an
# action when an IDS-MC Event Rule triggers, and will
send an
# email to $EmailRcpt with additional alert parameters
(similar to
# the functionality available with CSPM notifications)
#
# NOTE:   this script only works with 3.x sensors,
alarms from 4.0
#         sensors are stored differently and cannot be
represented
#         in a similar format.
#
# NOTE:   check the "system" command in the script for
the correct
#         format depending on whether you're using
IDSMC/SecMon
#         v1.0 or v1.1, you may need the "-on" command-
line option.
#
# NOTE :  This script takes the ${Query} keyword from
the
#         triggered rule, extracts the set of alarms
that caused
#         the rule to trigger. It then reads the last
alarm of
#         this set, parses the individual alarm fields,
and
#         calls the legacy script with the same set of
command
#         line arguments as CSPM.
#
# The calling sequence of this script must be of the
form:
#
#         emailalert.pl "${Query}"
#
# Where:
#
#         "${Query}" - this is the query keyword
dynamically
#         output by the rule when it triggers.
#         It MUST be wrapped in double quotes when
```

```
specifying it in the Arguments
#         box on the Rule Actions panel.
#
#
#*****************************************************
***************
##
## The following are the only two variables that need
changing. $TempIDSFile can be any
## filename (doesn't have to exist), just make sure the
directory that you specify
## exists. Make sure to use 2 backslashes for each
directory, the first backslash is
## so the Perl interpretor doesn't error on the
pathname.
##
## $EmailRcpt is the person that is going to receive the
email notifications. Also
## make sure you escape the @ symbol by putting a
backslash in front of it, otherwise
## you'll get a Perl syntax error.
##
$TempIDSFile = "c:\\temp\\idsalert.txt";
$EmailRcpt = "nobody\@cisco.com";

##
## pull out command line arg
##

$whereClause = $ARGV[0];

##
## extract all the alarms matching search expression
##

$tmpFile = "alarms.out";

## The following line will extract alarms from 1.0
IDSMC/SecMon database, if
## using 1.1 comment out the line below and un-comment
the other system line
## below it.

## V1.0 IDSMC/SecMon version
system("IdsAlarms -s\"$whereClause\" -f\"$tmpFile\"");

## V1.1 IDSMC/SecMon version.
## system("IdsAlarms -on -s\"$whereClause\" -
f\"$tmpFile\"");
##

# open matching alarm output

if (!open(ALARM_FILE, $tmpFile)) {
    print "Could not open ", $tmpFile, "\n";
    exit -1;
}

# read to last line

while (<ALARM_FILE>) {
    $line = $_;
}
```

```
# clean up

close(ALARM_FILE);
unlink($tmpFile);

##
## split last line into fields
##

@fields = split(/,/, $line);

$eventType = @fields[0];
$recordId = @fields[1];
$gmtTimestamp = 0; # need gmt time_t
$localTimestamp = 0; # need local time_t
$localDate = @fields[4];
$localTime = @fields[5];
$appId = @fields[6];
$hostId = @fields[7];
$orgId = @fields[8];
$srcDirection = @fields[9];
$destDirection = @fields[10];
$severity = @fields[11];
$sigId = @fields[12];
$subSigId = @fields[13];
$protocol = "TCP/IP";
$srcAddr = @fields[15];
$destAddr = @fields[16];
$srcPort = @fields[17];
$destPort = @fields[18];
$routerAddr = @fields[19];
$contextString = @fields[20];


## Open temp file to write alert data into,

open(OUT,">$TempIDSFile") || warn "Unable to open output
file!\n";

## Now write your email notification message. You're
writing the following into
## the temporary file for the moment, but this will then
be emailed. Use the format:
##
## print (OUT "Your text with any variable name from the
list above \n");
##
## Again, make sure you escape special characters with a
backslash (note the : in between $sigId
## and $subSigId has a backslash in front of it)

print(OUT "\n");
print(OUT "Received severity $severity alert at
$localDate $localTime\n");
print(OUT "Signature ID $sigId\:$subSigId from $srcAddr
to $destAddr\n");
print(OUT "$contextString");
close(OUT);

## then call "blat" to send contents of that file in the
body of an email message.
## Blat is a freeware email program for WinNT/95, it
comes with VMS in the
## $BASE\CSCOpx\bin directory, make sure you install it
```

```
first by running:
##
## blat -install <SMTP server address> <source email
address>
##
## For more help on blat, just type "blat" at the
command prompt on your VMS system (make
## sure it's in your path (feel free to move the
executable to c:\winnt\system32 BEFORE
## you run the install, that'll make sure your system
can always find it).

system ("blat \"$TempIDSFile\" -t \"$EmailRcpt\" -s
\"Received IDS alert\"");
```

Script sensore 4.x

Utilizzare questo script per la versione 4.x Sensori.

Sensori 4.x

```
#!/usr/bin/perluse
Time::Local;#*****************************************
****************************
#
# FILE NAME : emailalert.pl
#
# DESCRIPTION : This file is a perl script that will be
executed as an
# action when an IDS-MC Event Rule triggers, and will
send an
# email to $EmailRcpt with additional alert parameters
(similar to
# the functionality available with CSPM notifications)
#
# NOTE: this script only works with 4.x sensors. It will
# not work with 3.x sensors.
#
# NOTES : This script takes the ${Query} keyword from
the
# triggered rule, extracts the set of alarms that caused
# the rule to trigger. It then reads the last alarm of
# this set, parses the individual alarm fields, and
# calls the legacy script with the same set of command
# line arguments as CSPM.
#
# The calling sequence of this script must be of the
form:
#
# emailalert.pl "${Query}"
#
# Where:
#
# "${Query}" - this is the query keyword dynamically
# output by the rule when it triggers.
# It MUST be wrapped in double quotes
# when specifying it in the Arguments
# box on the Rule Actions panel.
#
#
#*****************************************************
```

```
****************
##
## The following are the only two variables that need
changing. $TempIDSFile can be any
## filename (doesn't have to exist), just make sure the
directory that you specify
## exists. Make sure to use 2 backslashes for each
directory, the first backslash is
## so the Perl interpretor doesn't error on the
pathname.
##
## $EmailRcpt is the person that is going to receive the
email notifications. Also
## make sure you escape the @ symbol by putting a
backslash in front of it, otherwise
## you'll get a Perl syntax error.
##

$TempIDSFile = "c:\\temp\\idsalert.txt";
$EmailRcpt = "yourname\@yourcompany.com";

# subroutine to add leading 0's to any date variable
that's less than 10.
sub add_zero {
my ($var) = @_;
if ($var < 10) {
$var = "0" .$var
}
return $var;
}

# subroutine to find one or more IP addresses within an
XML tag (we can have multiple
# victims and/or attackers in one alert now).
sub find_addresses {
my ($var) = @_;
my @addresses = ();
if (m/$var/) {
$raw = $&;
while ($raw =~ m/(\d{1,3}\.){3}\d{1,3}/) {
push @addresses,$&;
$raw = $';
}
$var = join(', ',@addresses);
return $var;
}
}

# pull out command line arg

$whereClause = $ARGV[0];

# extract all the alarms matching search expression

$tmpFile = "alarms.out";

# Extract the XML alert/event out of the database.

system("IdsAlarms -s\"$whereClause\" -f\"$tmpFile\"");

# open matching alarm output

if (!open(ALARM_FILE, $tmpFile)) {
print "Could not open $tmpFile\n";
```

```
exit -1;
}

# read to last line

while (<ALARM_FILE>) {
chomp $_;
push @logfile,$_;
}

# clean up

close(ALARM_FILE);
unlink($tmpFile);

# Open temp file to write alert data into,

open(OUT,">$TempIDSFile");

# split XML output into fields

$oneline = join('',@logfile);
$oneline =~ s/\<\/events\>//g;
$oneline =~ s/\<\/evAlert\>/\<\/evAlert\>,/g;
@items = split(/,/,$oneline);

# If you want to see the actual database query result in
the email, un-comment out the
# line below (useful for troubleshooting):
# print(OUT "$oneline\n");

# Loop until there's no more alerts

foreach (@items) {

if (m/\<hostId\>(.*)\<\/hostId\>/) {
$hostid = $1;
}

if (m/severity="(.*?)"/) {
$sev = $1;
}

if (m/Zone\=".*"\>(.*)\<\/time\>/) {
$t = $1;
if ($t =~ m/(.*)(\d{9})/) {
($sec,$min,$hour,$mday,$mon,$year,$wday,$yday,$isdst) =
localtime($1);

# Year is reported from 1900 onwards (eg. 2003 is 103).
$year = $year + 1900;

# Months start at 0 (January = 0, February = 1, etc), so
add 1.
$mon = $mon + 1;

$mon = add_zero ($mon);
$mday = add_zero ($mday);
$hour = add_zero ($hour);
$min = add_zero ($min);
$sec = add_zero ($sec);
}
}
```

```
if (m/sigName="(.*?)"/) {
$SigName = $1;
}

if (m/sigId="(.*?)"/) {
$SigID = $1;
}

if (m/subSigId="(.*?)"/) {
$SubSig = $1;
}

$attackerstring = "\<attacker.*\<\/attacker";
if ($attackerstring = find_addresses ($attackerstring))
{
}

$victimstring = "\<victim.*\<\/victim";
if ($victimstring = find_addresses ($victimstring)) {
}

if (m/\<alertDetails\>(.*)\<\/alertDetails\>/) {
$AlertDetails = $1;
}

@actions = ();
if (m/\<actions\>(.*)\<\/actions\>/) {
$rawaction = $1;
while ($rawaction =~ m/\<(\w*?)\>(.*?)\</) {
$rawaction = $';
if ($2 eq "true") {
push @actions,$1;
}
}
if (@actions) {
$actiontaken = join(', ',@actions);
}
}
else {
$actiontaken = "None";
}

## Now write your email notification message. You're
writing the following into
## the temporary file for the moment, but this will then
be emailed.
##
## Again, make sure you escape special characters with a
backslash (note the : between
## the SigID and the SubSig).
##
## Put your VMS servers IP address in the NSDB: line
below to get a direct link
## to the signature details within the email.

print(OUT "\n$hostid reported a $sev severity alert at
$hour:$min:$sec on $mon/$mday/$year\n");
print(OUT "Signature: $SigName \($SigID\:$SubSig\)\n");
print(OUT "Attacker: $attackerstring ---> Victim:
$victimstring\n");
print(OUT "Alert details: $AlertDetails \n");
print(OUT "Actions taken: $actiontaken \n");
print(OUT "NSDB: https\://<your VMS server IP
address>/vms/nsdb/html/expsig_$SigID.html\n\n");
```

```
print(OUT "-----------------------------------------
-------\n");

}

close(OUT);

## Now call "blat" to send contents of the file in the
body of an email message.
## Blat is a freeware email program for WinNT/95, it
comes with VMS in the
## $BASE\CSCOpx\bin directory, make sure you install it
first by running:
##
## blat -install <SMTP server address> <source email
address>
##
## For more help on blat, just type "blat" at the
command prompt on your VMS system (make
## sure it's in your path (feel free to move the
executable to c:\winnt\system32 BEFORE
## you run the install, that'll make sure your system
can always find it).

system ("blat \"$TempIDSFile\" -t \"$EmailRcpt\" -s
\"Received IDS alert\"");
```

Script sensore 5.x

Utilizzare questo script per la versione 5.x Sensori.

Sensori 5.x

```
#!/usr/bin/perl
use Time::Local;

#*****************************************************
***************
#
#  FILE NAME   : emailalertv5.pl
#
#  DESCRIPTION : This file is a perl script that will be
executed as an
#                action when an IDS-MC Event Rule
triggers, and will send an
#                email to $EmailRcpt with additional
alert parameters (similar to
#                the functionality available with CSPM
notifications)
#
#                NOTE: this script only works with 5.x
sensors.
#
#  NOTES       : This script takes the ${Query} keyword
from the
#                triggered rule, extracts the set of
alarms that caused
#                the rule to trigger.  It then reads the
last alarm of
#                this set, parses the individual alarm
fields, and
```

```
#                calls the legacy script with the same
set of command
#                line arguments as CSPM.
#
#                The calling sequence of this script
must be of the form:
#
#                emailalert.pl "${Query}"
#
#                Where:
#
#                   "${Query}"  - this is the query
keyword dynamically
#                                 output by the rule
when it triggers.
#                                 It MUST be wrapped in
double quotes
#                                 when specifying it in
the Arguments
#                                 box on the Rule
Actions panel.
#
#
#*****************************************************
***************
##
## The following are the only two variables that need
changing.  $TempIDSFile can be any
## filename (doesn't have to exist), just make sure the
directory that you specify
## exists.  Make sure to use 2 backslashes for each
directory, the first backslash is
## so the Perl interpretor doesn't error on the
pathname.
##
## $EmailRcpt is the person that is going to receive the
email notifications.  Also
## make sure you escape the @ symbol by putting a
backslash in front of it, otherwise
## you'll get a Perl syntax error.
##

$TempIDSFile = "c:\\temp\\idsalert.txt";
$EmailRcpt = "gfullage\@cisco.com";

# subroutine to add leading 0's to any date variable
that's less than 10.
sub add_zero {
  my ($var) = @_;
  if ($var < 10) {
      $var = "0" .$var
  }
  return $var;
}

# subroutine to find one or more IP addresses within an
XML tag (we can have multiple
# victims and/or attackers in one alert now).
sub find_addresses {
  my ($var) = @_;
  my @addresses = ();
  if (m/$var/) {
      $raw = $&;
      while ($raw =~ m/(\d{1,3}\.){3}\d{1,3}/) {
```

```
          push @addresses,$&;
          $raw = $';
      }
      $var = join(', ',@addresses);
      return $var;
  }
}

# pull out command line arg

$whereClause = $ARGV[0];

# extract all the alarms matching search expression

$tmpFile = "alarms.out";

# Extract the XML alert/event  out of the database.

system("IdsAlarms -os -s\"$whereClause\" -
f\"$tmpFile\"");

# open matching alarm output

if (!open(ALARM_FILE, $tmpFile)) {
  print "Could not open $tmpFile\n";
  exit -1;
}

# read to last line

while (<ALARM_FILE>) {
   chomp $_;
   push @logfile,$_;
}

# clean up

close(ALARM_FILE);
unlink($tmpFile);

# Open temp file to write alert data into,

open(OUT,">$TempIDSFile");

# split XML output into fields

$oneline = join('',@logfile);
$oneline =~ s/\<\/sd\:events\>//g;
$oneline =~
s/\<\/sd\:evIdsAlert\>/\<\/sd\:evIdsAlert\>,/g;
@items = split(/,/,$oneline);

# If you want to see the actual database query result in
the email, un-comment out the
# line below (useful for troubleshooting):
# print(OUT "$oneline\n");

# Loop until there's no more alerts

foreach (@items) {
  unless ($_ =~ /\<\/env\:Body\>/) {

    if (m/\<sd\:hostId\>(.*)\<\/sd\:hostId\>/) {
      $hostid = $1;
```

```
    }

    if (m/severity="(.*?)"/) {
      $sev = $1;
    }

    if (m/Zone\=".*"\>(.*)\<\/sd\:time\>/) {
      $t = $1;
      if ($t =~ m/(.*)(\d{9})/) {

($sec,$min,$hour,$mday,$mon,$year,$wday,$yday,$isdst) =
localtime($1);

        # Year is reported from 1900 onwards (eg. 2003
is 103).
        $year = $year + 1900;

        # Months start at 0 (January = 0, February = 1,
etc), so add 1.
        $mon = $mon + 1;

        $mon = add_zero ($mon);
  $mday = add_zero ($mday);
  $hour = add_zero ($hour);
  $min = add_zero ($min);
  $sec = add_zero ($sec);
      }
    }

    if (m/description="(.*?)"/) {
      $SigName = $1;
    }

    if (m/\ id="(.*?)"/) {
      $SigID = $1;
    }

    if (m/\<cid\:subsigId\>(.*)\<\/cid\:subsigId\>/) {
      $SubSig = $1;
    }

    if
(m/\<cid\:riskRatingValue\>(.*)\<\/cid\:riskRatingValue\
>/) {
      $RR = $1;
    }

    if (m/\<cid\:interface\>(.*)\<\/cid\:interface\>/) {
      $Intf = $1;
    }

    $attackerstring =
"\<sd\:attacker.*\<\/sd\:attacker";
    if ($attackerstring = find_addresses
($attackerstring)) {
    }

    $victimstring = "\<sd\:target.*\<\/sd\:target";
    if ($victimstring = find_addresses ($victimstring))
{
    }

    if
(m/\<cid\:alertDetails\>(.*)\<\/cid\:alertDetails\>/) {
```

```
      $AlertDetails = $1;
    }

    @actions = ();
    if (m/\<sd\:actions\>(.*)\<\/sd\:actions\>/) {
      $rawaction = $1;
      while ($rawaction =~ m/\<\w*?:(\w*?)\>(.*?)\</) {
         $rawaction = $';

         if ($2 eq "true") {
            push @actions,$1;
         }
      }
      if (@actions) {
        $actiontaken = join(', ',@actions);
      }
    }
    else {
        $actiontaken = "None";
      }

## Now write your email notification message. You're
writing the following into
## the temporary file for the moment, but this will then
be emailed.
##
## Again, make sure you escape special characters with a
backslash (note the : between
## the SigID and the SubSig).
##
## Put your VMS servers IP address in the NSDB: line
below to get a direct link
## to the signature details within the email.

    print(OUT "\n$hostid reported a $sev severity alert
at $hour:$min:$sec on $mon/$mday/$year\n");
    print(OUT "Signature: $SigName
\($SigID\:$SubSig\)\n");
    print(OUT "Attacker: $attackerstring  --->  Victim:
$victimstring\n");
    print(OUT "Alert details: $AlertDetails \n");
    print(OUT "Risk Rating: $RR,  Interface: $Intf \n");
    print(OUT "Actions taken: $actiontaken \n");
    print(OUT "NSDB: https\://sec-
srv/vms/nsdb/html/expsig_$SigID.html\n\n");
    print(OUT "-----------------------------------------
-----------\n");

   }
}

close(OUT);

## Now call "blat" to send contents of the file in the
body of an email message.
## Blat is a freeware email program for WinNT/95, it
comes with VMS in the
## $BASE\CSCOpx\bin directory, make sure you install it
first by running:
##
##     blat -install <SMTP server address> <source email
address>
##
## For more help on blat, just type "blat" at the
```

```
command prompt on your VMS system (make
## sure it's in your path (feel free to move the
executable to c:\winnt\system32 BEFORE
## you run the install, that'll make sure your system
can always find it).

system ("blat \"$TempIDSFile\" -t \"$EmailRcpt\" -s
\"Received IDS alert\"");
```

Verifica

Attualmente non è disponibile una procedura di verifica per questa configurazione.

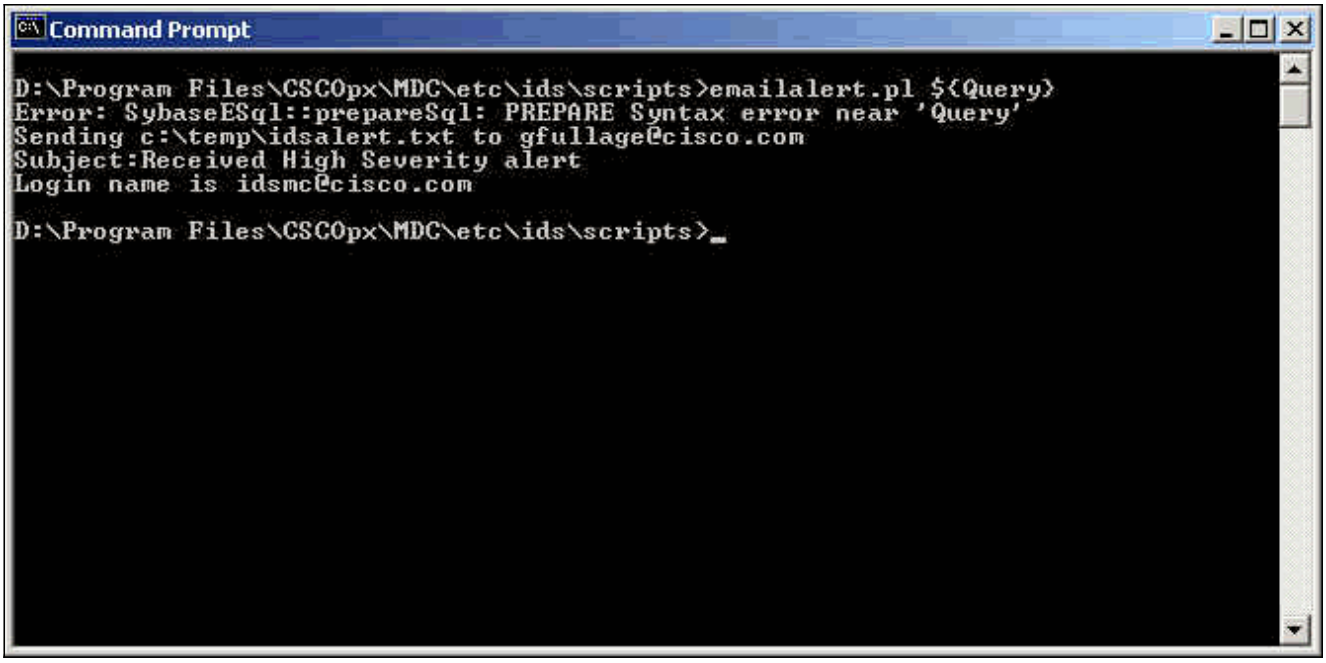
Risoluzione dei problemi

Seguire queste istruzioni per risolvere i problemi relativi alla configurazione.

1. Per verificare che il comando blat funzioni correttamente, eseguire questo comando dal prompt dei comandi:

   blat

   <nomefile> è il percorso completo di qualsiasi file di testo presente nel sistema VMS. Se l'utente a cui è indirizzato lo script di posta elettronica riceve questo file nel corpo di un messaggio di posta elettronica, allora si sa che blat funziona.
2. Se non viene ricevuta alcuna e-mail dopo l'attivazione di un avviso, provare a eseguire lo script Perl da una finestra del prompt dei comandi.In questo modo vengono evidenziati tutti i problemi relativi ai perl o ai tipi di tracciato. A tale scopo, aprire un prompt dei comandi e immettere:
   >cd Program Files/CSCOpx/MDC/etc/ids/scripts
   >emailalert.pl ${Query}
   Èpossibile che venga visualizzato un errore di Sybase, simile a questo esempio. Ciò è dovuto al fatto che il parametro ${Query} passato non contiene effettivamente informazioni, a differenza di quando viene passato da Monitor di
   protezione.



Oltre a visualizzare questo errore, lo script viene eseguito correttamente e invia un messaggio di posta elettronica. Tutti i parametri di avviso all'interno del corpo del messaggio di posta elettronica sono vuoti. Se si ricevono errori Perl o di percorso, è necessario correggerli prima di inviare un messaggio di posta elettronica.

Informazioni correlate

- Pagina di supporto per Cisco Secure Intrusion Prevention
- Documentazione e supporto tecnico – Cisco Systems