XKEYSCORE
Appids & Fingerprints

xkeyscore@nsa

Basic Syntax

- Syntax is similar to C:

function('name', level, <optional info>) = 'search terms and patterns';

- Two main functions -- *appid* and *fingerprint*:

```
appid('chat/icq', 8.5, wireshark='icq', chatproc='ICQ') =
        /[^o]icq/c and $icq;

fingerprint('fingerprint/phone/nokia/generic') =
      'user-agent: nokia' or
      'profile: http://nds.nokia.com/uaprof/n';
```

Naming Conventions

Appids are named using a pseudo directory convention:

/application_type/sub_type/name

Levels

Levels are 1.0 – 9.9 with lower numbers meaning higher priority.

This allows multiple signatures to match a piece of traffic, but only the most specific appid will be applied. For example:

```
appid('chat', 9.9) = ...
appid('chat/yahoo', 9.8) = ...
appid('chat/yahoo/incoming', 9.7 = ...
```

If a session matches all three signatures, the appid will be 'chat/yahoo/incoming' since that has the best priority.

Application Type

Third parameter is the *application type*; if missing, we use the appid name up to the first slash as the type

```
appid('http/response', 9.2, 'web') = ...

appid('chat/yahoo/incoming', 9.1) = ...
```

Basic Search Patterns

XKEYSCORE supports Boolean operations and regular expressions

Raw text must be encapsulated between single quotes

- *'search term'*

Terms can be combined with Boolean logic

- *'search term' and 'another term' and not 'defeat term'*
- *'search term' or 'another term'*

Exampie

```
appid('voip/sip/IMS', 6.0, wireshark='sip') =
              ('via: sip' or 'v: sip') and 'cseq:' and (
                'p-access-network-info:' or
                'p-called-party-id:' or
                'p-charging-vector:' or
                'p-charging-vector-addresses:' or
                'p-media-authorization:' or
                'security-verify:' or
                'proxy-authorization:' and 'scscf' or
                'path:' and 'pcscf' or
                'path:' and 'scscf'
              );
```

Binary and Regex Patterns

Binary patterns can be represented by putting a \x in front of each value:

```
'\xff\xff\x00\x02'
```

Or use the hex function:

```
hex('ff:ff:00:02')
```

Use slashes to enclose regular expressions:

```
/[^a-zA-Z0-9]BTE/
```

Case sensitivity

Keywords and regular expressions are NOT case sensitive by default.

Append a 'c' to request case-sensitive evaluation:

```
'keyword'c
/regex/c
```

Keyword Length

Keywords must be at least 3 characters or they will never hit. This minimum is increased to 4 at some sites for performance reasons.

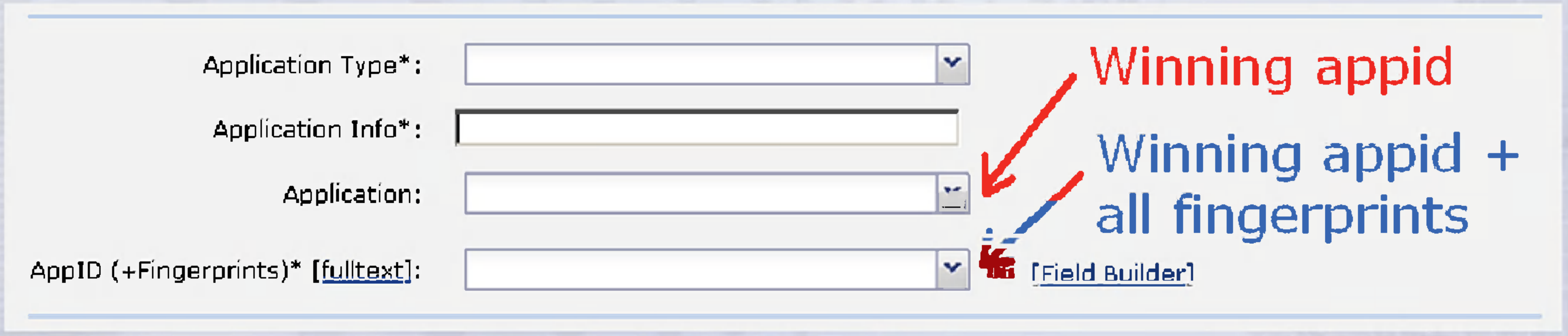
Regular expressions must include a fixed "anchor" meeting the minimum keyword length.

```
Bad: /[A-Z]{3}-[0-9]{3,5}/
OK: /ABC-[0-9]{3,5}/
```

Appid vs Fingerprint

Each session gets *one* appid -- lowest level wins. It gets databased in the 'application' field.

All matching fingerprints are stored in the 'fingerprint' field. Level is ignored and can be omitted from fingerprint definitions.



Application Type*:	
Application Info*:	
Application:	
AppID (+Fingerprints)* [fulltext]:	[Field Builder]

Example

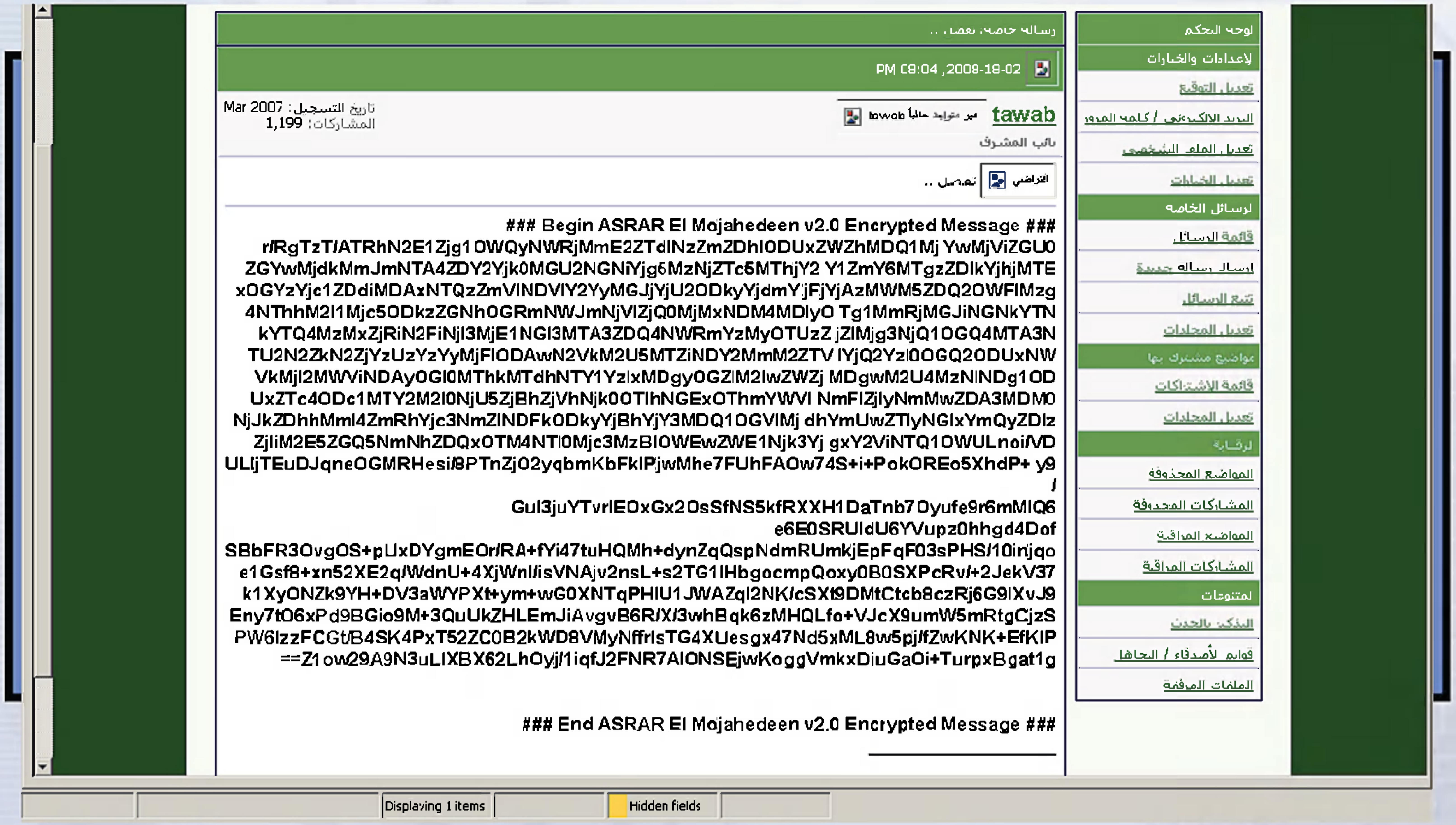
```
appid('mail/yahoo', 9.0) = 'Host: mail.yahoo';
appid('mail/yahoo/login, 8.0) = 'Host: mail.yahoo' and '/login';

fingerprint('mail/arabic') = 'mail' and /language[:=] ?ar/;
fingerprint('mail/yahoo/ymbm') = 'Host: mail.yahoo' and 'YMBM='c;
```

```
GET /login.html HTTP/1.1
Referer: http://us.f359.mail.yahoo.com/ym/ShowLetter
Accept-Language: ar
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1; SV1)
Host: mail.yahoo.com
Connection: Keep-Alive
Cookie: B=fn50ehd2612o2&b=3&s=rp; YMBM=d=&v=1;
```

Application: mail/yahoo/login
Fingerprint: mail/yahoo/login mail/arabic mail/yahoo/ymbm

Real world example



رسالة خاصة: نعمد ..

PM 08:04 ,2008-10-02

tawab غير متواجد حاليا tawab
نائب المشرف

تاريخ التسجيل: Mar 2007
المشاركات: 1,199

الافتراضي تفصيل ..

```
### Begin ASRAR El Mojahedeen v2.0 Encrypted Message ###
r/RgTzT/ATRhN2E1Zjg1OWQyNWRjMmE2ZTdlNzZmZDhlODUxZWZhMDQ1Mj YwMjViZGU0
ZGYwMjdkMmJmNTA4ZDY2Yjk0MGU2NGNiYjg5MzNjZTc5MThjY2 Y1ZmY6MTgzZDlkYjhjMTE
xOGYzYjc1ZDdiMDAxNTQzZmVlNDVlY2YyMGJjYjU2ODkyYjdmYjFjYjAzMWM5ZDQ2OWFlMzg
4NThhM2I1Mjc5ODkzZGNhOGRmNWJmNjVlZjQ0MjMxNDM4MDlyO Tg1MmRjMGJiNGNkYTN
kYTQ4MzMxZjRiN2FiNjI3MjE1NGI3MTA3ZDQ4NWRmYzMyOTUzZjZlMjg3NjQ1OGQ4MTA3N
TU2N2ZkN2ZjYzUzYzYyMjFlODAwN2VkM2U5MTZiNDY2MmM2ZTV lYjQ2YzI0OGQ2ODUxNW
VkMjI2MWViNDAyOGI0MThkMTdhNTY1YzlxMDgy0GZlM2IwZWZj MDgwM2U4MzNlNDg1OD
UxZTc4ODc1MTY2M2I0NjU5ZjBhZjVhNjk0OTlhNGExOThmYWVl NmFlZjlyNmMwZDA3MDM0
NjJkZDhhMml4ZmRhYjc3NmZlNDFkODkyYjBhYjY3MDQ1OGVlMj dhYmUwZTlyNGIxYmQyZDIz
ZjliM2E5ZGQ5NmNhZDQxOTM4NTI0Mjc3MzBlOWEwZWE1Njk3Yj gxY2ViNTQ1OWULnoi/VD
ULljTEuDJqneOGMRHesi/8PTnZj02yqbmKbFklPjwMhe7FUhFAOw74S+i+PokOREo5XhdP+ y9
/
GuI3juYTvrlEOxGx2OsSfNS5kfRXXH1DaTnb7Oyufe9r6mMIQ6
e6E0SRUldU6YVupz0hhgd4Dof
SBbFR3OvgOS+pUxDYgmEOr/RA+fYi47tuHQMh+dynZqQspNdmRUmkjEpFqF03sPHS/10injqo
e1Gsf8+xn52XE2q/WdnU+4XjWnl/isVNAjv2nsL+s2TG1lHbgocmpQoxy0B0SXPcRv/+2JekV37
k1XyONZk9YH+DV3aWYPXt+ym+wG0XNTqPHIU1JWAZql2NK/cSXt9DMtCtcb8czRj6G9lXvJ9
Eny7t06xPd9BGio9M+3QuUkZHLEmJiAvgvB6R/X/3whBqk6zMHQLfo+VJcX9umW5mRtgCjzS
PW6lzzFCGt/B4SK4PxT52ZC0B2kWD8VMyNffrlsTG4XUesgx47Nd5xML8w5pj/fZwKNK+EfKIP
==Z1ow29A9N3uLIXBX62LhOyj/1iqfJ2FNR7AlONSEjwKoggVmkxDiuGaOi+TurpxBgat1g

### End ASRAR El Mojahedeen v2.0 Encrypted Message ###
```

Distribution

- Appids and fingerprints are distributed across the XKEYSCORE network every hour
- Changes will take effect within 2 hours of check-in
- Current definitions are available on the website:

  http://xkeyscore.r1.r.nsa/documents/appid.html

Intermediate Syntax

Append Option

You can append derived metadata fields onto the end of an appid:

```
appid('p2p/kazaa', 7.7, append='mime_type') =
        lpos('x-kazaa') and not $http;
```

This will result in an appid like 'p2p/kazaa/image/jpeg'.

Built in functions

ip(expr)	Matches against an IP Address looks in to address and from address in the session headere • ip('10.10.10.1');
toport(expr)	Matches against the Destination/To port. Note this must be a numeric representation of a port. • toport(1920);
fromport(expr)	Matches against the Source/From port. Note this must be a numeric representation of a port. • fromport(80);
port(expr)	Matches against the either port. Note this must be a numeric representation of a port. •port(6667);
next_protocol(expr)	Matches against the integer version of the next protocol. • next_protocol(250);
protocol ('text')	Will only work for IP next protocol names as defined in the IANA next protocol numbers document • protocol('tcp');

Built in functions

email_address(sel)	permutes just like strong_selector (just like DECODEORDAIN
mac_address(addr)	Tasks a mac address
smac(addr)	
dmac(addr)	
ip(addr)	tasks this IP address (either to or from)
from_ip(addr)	tasks this IP address only when it is the originator
to_ip(addr)	tasks this IP address only when it is the destination

More built in functions

first(expr)	Matches against a pattern at the beginning of the session
lpos(expr)	Matches against a pattern at the beginning of each line (\n)
pos(expr)	expression occurs at offset X in the session • pos('Hello') == 5, • pos(/Good.*Grief/) <= 10
between(expr)	• between('Hello', 'World', 10, 100) Separation between 'Hello' and 'World' is greater than or equal to 10 bytes and less than or equal to 100 bytes This is the same as using the following regular expression: • /Hello.{10,100}World/
'term'c	Does a case sensitive match of the term
'term'u	Treats the term as UTF-16

Example

```
appid('voip/skinny(port2000)', 9.9, wireshark='skinny') =
    port(2000);

appid('voip/skinny/keep-alive', 3.0, wireshark='skinny') =
    toport(2000) and
    first('\x04\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00');

appid('voip/skinny/keep-alive-ack', 3.0, wireshark='skinny') =
    fromport(2000) and
    first('\x04\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00');
```

Example

```
appid('mail/smtp/to_server', 8.5, direction=$from_server,
    wireshark='smtp') =
          toport(25) and
          ( first('helo') or
            first('ehlo') or
            first('data') or
            (lpos('To: 'c) and lpos('From:'c)) or
            lpos('QUIT'c) or
            lpos('mail from:') or
            lpos('rcpt to:') );
```

CHAINWORDs

You can assign a pattern to a variable (CHAINWORD) and reuse the variable in many patterns.

```
$sip = 'via: sip' and 'cseq:' and 'SIP/2'c;
```

Now we can use this variable in future definitions:

```
appid('voip/sip', 7.2 ) = $sip;

appid('voip/sip/invite', 6.9) = $sip and 'INVITE';
```

Predefined Chainwords

There are a number of chainwords predefined for convenience:

- $tcp
- $udp
- $icmp
- $sctp
- $rpc
- $arp
- $ssl
- $http_cmd
- $http
- $http_get
- $http_put
- $http_post
- $http_delete
- $http_trace
- $http_head
- $http_options
- $http_partial
- $vbulletin
- $mime_type
- $user_agent

Example

```
$icq = 'ICQ'c and $http and not (port(80) or $html_body or
    $http_cmd);

appid('chat/icq', 8.5, wireshark='icq', chatproc='ICQ') =
            /[^o]icq/c and $icq;


appid('chat/icq', 9.0, wireshark='icq', chatproc='ICQ') =
            first('icq') and not port(25);
```

Context sensitivity

Expressions are evaluated only with a certain context instead of across the session as a whole.

html_title('Yahoo! Mail' or 'Yahoo! Address Book')

... only hits if those keywords are seen within the title of a web page

http_host('maps.google.com')

... only hits within the "Host:" HTTP header

Context sensitivity

Why use context-sensitive scanning?

- More intuitive - you can say what you mean
- More accurate - if 'maps.google.com' is mentioned in a blog post, you don't want to try processing it as a Google Maps session
- Better performance for XKEYSCORE

Context sensitivity

Sample contexts:

html_title
url
http_host
http_referer
http_cookie
http_server
user_agent
web_search
to_cc
from_cc

filename
file_ext
doc_title
doc_subject
doc_author
doc_org
doc_hash
doc_body
email_body
chat_body

Example

```
appid('finance/currency_conversion/generic', 8.0) =
        html_title('currency' and ('exchange' or 'conver')) or
        http_server('currency' or 'x-rates.com');

appid('finance/currency_conversion/xe', 8.0) =
        http_host('xe.com') or
        html_title(/^XE -/c or 'XE.com'c);
```

Appid utility

```
appid options:
  --help                  this help message
  --list-all              list all the application/fingerprint names and
                          levels
  --list-appids           list all the application names (no fingerprints)
  --list-fingerprints     list all the application names (no appids)
  --list-types            list all the application types
  --list-levels           list all the application levels
  --unit-test             perform unit tests with data in the heirachy
                          'datadir', with files matching 'filespec'
  --quiet                 don't print any load messages
  --appid_fname arg       location of appid.cfg
  --input-file arg        input file to test
  --datadir arg           The test data directory. Defaults to
                          $(XSCORE_TEST_DATA_DIR)/appids
  --filespec arg (=.*\.u124) A regular expression to match against files to
                          check
  --noexit arg (=0)       do not stop on the first error
```

Appid Validation

```
appid sample.u124
Loading appids
->Loading : /home/oper/xkeyscore/config/dictionaries/appid/appid_definitions.cfg
->Loading : /home/oper/xkeyscore/config/dictionaries/appid/anonymizer.appid
->Loading : /home/oper/xkeyscore/config/dictionaries/appid/bulletin_board.appid
->Loading : /home/oper/xkeyscore/config/dictionaries/appid/tao_vpn.appid
->Loading : /home/oper/xkeyscore/config/dictionaries/appid/tdmoip.appid
->Loading : /home/oper/xkeyscore/config/dictionaries/appid/terminal.appid
->Loading : /home/oper/xkeyscore/config/dictionaries/appid/voip.appid
->Loading : /home/oper/xkeyscore/config/dictionaries/appid/appid_definitions.cfg
Finished loading appids
Filename: sample.u124

Appid: encryption/https

Total Size: 19.36Kbits
Total Time: 0.01secs
Rate: 1.936Mbits/s
Overall performance:
Total Time: 0.01secs
Total Bits: 0.01936Mbits
Overall Rate: 1.936Mbits/s
```

Advanced Syntax

Code-based appids

Keywords and regular expressions don't work for everything

- Looking down columns in packet data
- Checksums
- Decoding (urlencoding, base64, gzip, etc.)

Code-based appids

Basic idea:

1. Preliminary "trigger" using standard keywords and regular expressions

2. Secondary test using a snippet of C++ code

Code-based appids

Example -- verifying a length field:

```
appid('netmanagement/ospf', 2, wireshark='ospf') =
  protocol('ospf')
  : c++ {{

    if (size() < 4)
      return false;

    const uint8_t *data = begin();
    return (data[3]==size());
  }};
```

Code-based appids

Example -- packet data:

```
fingerprint('vpn/xxp_example') =
  'Next Protocol 250'
    : c++ {{
    packet_t pkt;
    int count = 0;
    while ((pkt = get_packet()) && count < 20) {
      ++count;
      if (pkt.size < 16)
        return false;

      if (pkt.data[4]  != 0xCC ||
          pkt.data[5]  != 0x45 ||
          pkt.data[15] != 0x72)
        return false;
    }
    return (count > 0);
  }};
```

Context-sensitive code

Example -- code-based check on certain extracted files:

```
fingerprint('crazy/office') =
   extracted_file('doc' or 'xls' or 'ppt' : c++ {{
     return xks::filename().find("crazy") != std::string::npos;
    }});
```

Extractors

Simplified regex-based metadata extraction

```
fingerprint('maps/google/example') =
  http_host('.google.') and url('/maps?')
  : c++
  extractors : {{
    ka = /Keep-Alive: (\d+)/;
    accept[] = /Accept-([^:]+): ([\w-]+)/;
  }}
  main : {{
    if(ka && ka[0] == "300") {
      for(size_t i = 0; i < accept.size(); ++i)
        if(accept[i][0] == "Encoding" && accept[i][1] == "gzip")
          return true;
    }
    return false;
  }};
```

Flex

Support for flex-based pattern matching

```
fingerprint('maps/google/firefox') =
  http_host('.google.') and url('/maps?')
  : c++
  flex : {{
    USER_AGENT_CHAR [^\n\r]
    %%
    "User-Agent: "{USER_AGENT_CHAR}+  {
      std::string agent(yytext);
      if(agent.find("Firefox") != std::string::npos)
        return true;
    }
  }};
```

Microplugins

The next step: giving code-based appids (limited) access to the XKS core

- Accessing top-level session metadata
- Throwing common events
- Contributing metadata for databasing

The goal: higher level of agility with lower learning curve

Microplugins

Example: accessing session metadata

```
fingerprint('maps/google/server1') =
  http_host('.google.') and url('/maps?')
  : c++
  main : {{
    return (SESSION["to_ip"] == "123.45.67.1");
  }};
```

Microplugins

Example: throwing a document_metadata event

```
fingerprint('maps/google/contrived') =
  http_host('.google.') and url('/maps?')
  : c++
  main : {{
    xks::doc_meta_t dm;
    dm.filename = "google.txt";
    dm.author = "Google, Inc.";
    xks::document_metadata(dm);
  }};
```

Microplugins

Example: contributing metadata to HTTP Activity

```
fingerprint('maps/google/search') =
  http_host('.google.') and url('/maps?')
  : c++
  extractors : {{
    q = /[&?]q=([^&]+)/;
  }}
  main : {{
    if(q) {
      DB["http_parser"]["search_terms"] = xks::urldecode(q[0]);
      DB.apply();
      return true;
    }
  }};
```