BIND 9

(Part 1 - Event based BIND 9 log- and system analysis)

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Welcome

Welcome to part one of our BIND 9 webinar series

In this Webinar

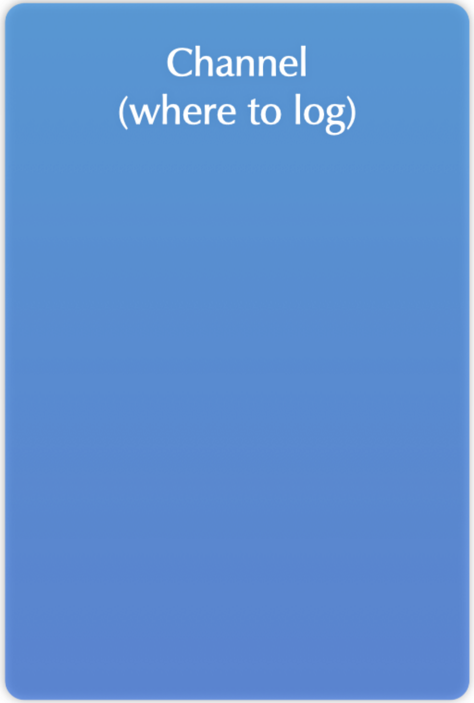
- best practice BIND 9 log template for authoritative server
- best practice BIND 9 log template for DNS resolver
- file system best practices for BIND 9 log files, transparent online compression
- searching through log-files with modern 'grep': ugrep, ripgrep, sack, sift …
- BIND 9 Log-Analysis with Linux Systemd-Journal
- Identifying hot-spots in BIND 9 logfiles with histograms
- Condensing information from large BIND 9 logfiles with the "logeater" tools
- Monitoring BIND 9 run-time information with `atop`
- Incident based DNSTAP and TCPDUMP traffic capture

BIND 9 logging

BIND 9 logging

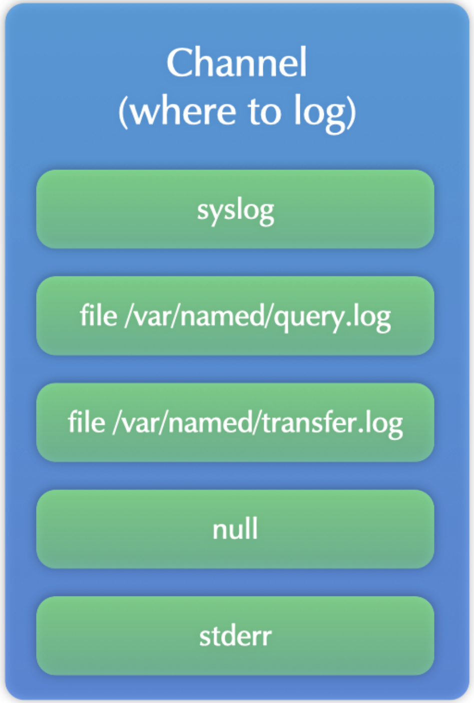
- BIND 9 has one of the most flexible logging framework found in Unix/Linux server products
- `categories` define *what* should be written to the logs
- `channel` define *where* the log data should be written
- multiple `categories` can be written into the same channel
- one `category` can be written to multiple channels

BIND 9 logging

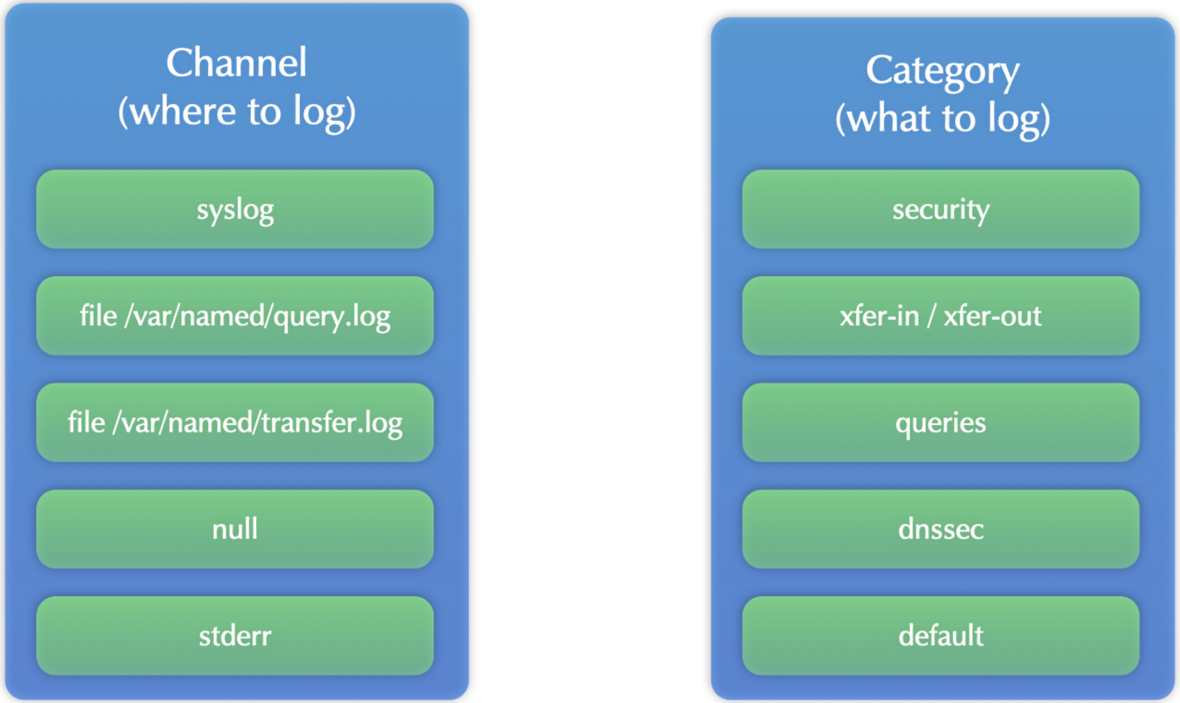


Channel
(where to log)

BIND 9 logging



BIND 9 logging



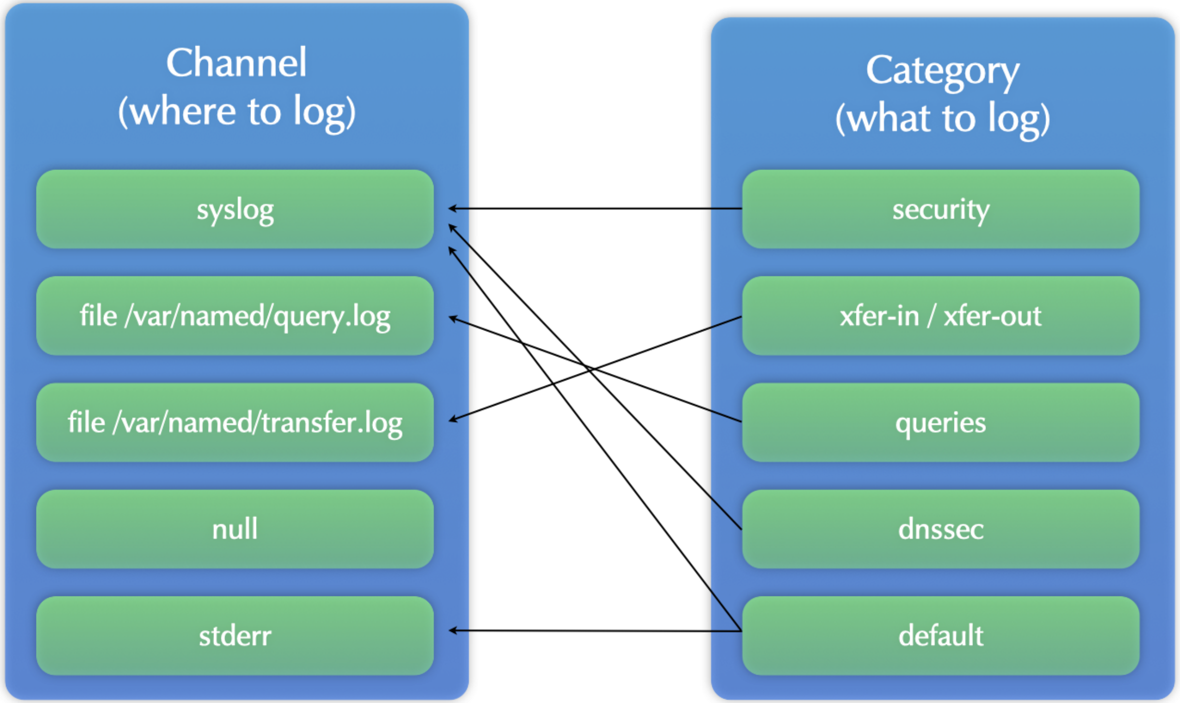
Channel
(where to log)

- syslog
- file /var/named/query.log
- file /var/named/transfer.log
- null
- stderr

Category
(what to log)

- security
- xfer-in / xfer-out
- queries
- dnssec
- default

BIND 9 logging



Logging configuration

- separate log categories with many entries per day from categories with only a few entries a day
  - else it will be hard to spot the few entries and react on them
- combine categories with related information into the same channel
  - for example: `xfer-in`, `xfer-out`, `notify` or `update` and `update-security`
  - use the logging configuration statement `print-category yes;` to be able to filter for the categories in combined log files

Logging severity

- BIND 9 supports the syslog *priorities* (debug, info, warning, error …) also when writing to a log-file
  - a lower priority for a channel will include all messages of the selected priority/severity and higher
- Using the logging statement `print-severity yes;` BIND 9 will print the logging severity in the log file
  - this allows for later filtering of the log file based on the severity

```
2021-02-17T11:27:36.593 general: info: reloading configuration succeeded
2021-02-17T11:27:36.600 general: info: reloading zones succeeded
2021-02-17T11:27:37.006 general: notice: all zones loaded
2021-02-17T11:27:37.100 general: notice: running
2021-02-17T11:27:43.929 query-errors: info: client @0x5dbab4d4 ::1#63099 (fail05.dnssec.works): query f
2021-02-17T11:27:49.962 query-errors: info: client @0x5dbab4d4 ::1#59273 (fail05.dnssec.works): query f
2021-02-17T11:27:50.073 general: info: zone fail05.dnssec.works/IN: refresh: unexpected rcode (SERVFAIL
```

RPZ Logging

- The RPZ logging category gives information about the response policy zone activity on the server:

```
17-Feb-2021 11:56:55.311 client @0x7f4fb5f3cd40 2001:db8:ff:1a00:95e8:d30:c8a9:6ced#62678 (31b4bd31fg1x
17-Feb-2021 11:57:24.663 client @0x7f4fcd2379b0 2001:db8:561:5:7935:d587:336b:436e#17126 (malware.com):
17-Feb-2021 11:57:24.840 client @0x7f4fc5a66560 2001:db8:4212:0:11da:b4a5:b77e:31dc#45577 (trojan.biz):
17-Feb-2021 11:57:41.814 client @0x7f4f51668910 1002:db8:1121:5:7935:d587:336b:436e#4460 (badstuff.com)
```

Logging configuration template

- Please find a logging configuration template for BIND 9.16 in this document linked below:

BIND 9 Logging templates

Query-Logging

- The BIND 9 log system allows to write a log entry for every incoming query
  - the log entries will list the IP address of the sender, the domain name of the query, the record type and information on the flags (DNSSEC OK, EDNS, Recursion Desired etc) of the query sender

```
2021-01-18T15:13:01.438 client @0x413ce4d4 192.0.2.4#13700 (blog.defaultroutes.de): \
                        query: blog.defaultroutes.de IN AAAA - (5.45.109.212)
```

Performance issues with query logging

- Converting the query log information from binary data into human readable text format is CPU intensive
    - enabling query logging on an busy DNS server (> 500 Queries/Second) can reduce the performance of the DNS server and increase the latency of DNS answers
- Query-Logging should be disabled on (re-)start of the BIND 9 process and should only be enabled for a short period of time during troubleshooting:

```
options {
        directory "/var/named";
        querylog no;
        [...]
};
```

Alternatives to BIND 9 query logging

- BIND 9 query logging only gives information on the query, but not on the answer send out
- alternatives to query logging exist that capture queries and responses and have less impact on the DNS servers performance:
  - DNSTAP: Using DNSTAP with BIND https://kb.isc.org/docs/aa-01342
  - PCAP/tcpdump based *passive* DNS data collection: for example DNSmezzo from AFNIC https://github.com/AFNIC/DNSwitness

File-System and logging best practices

Partitions

- Modern Unix and Linux systems sometimes propose a single partition install
  - While this is usually good for Desktop/Laptop installs, it increases the risk of the operating system (root) partition running full
  - Bad things will happen once the root partition runs out of storage space
  - Recommendation: create a dedicated (large enough) partition for the log files (mount to `/var/log` or the place where your BIND 9 server writes the log files)

Log-file compression

- Tools like `logrotate` can compress logfiles to save space
    - However, disk space is seldom a problem today
    - Working with compressed log files is more difficult then with plain text files
    - Some file systems (BTRFS, ZFS) offer transparent `online` compression which can speed up I/O performance of logfile operations

Logging with Linux systemd-journald

Systemd Journal

- Modern Linux systems come with the *systemd* process management system
  - systemd includes a database of log information called *the journal*
  - the Systemd-Journal can be stored locally (on the same machine the service runs) or remote (on a central Journal-Server)

Benefits of the systemd journal

- Automatically correlates log entries from different sources (systemd process start up, network stack, BIND 9 server)
- Allows easy filtering of log information by time, service, keyword
- Output log entries as text (different flavors), JSON or binary
- On a central journal host, can merge log information from multiple hosts
- Can log remotely via push or pull configurations
- Support online compression
- Supports *Forward Secure Sealing* to detect tampering with written log data

Using the Systemd Journal with BIND 9

- BIND 9 needs to be started from a systemd service unit
- Systemd will capture all information written to the `stdout` and `stderr` channels of the BIND 9 process and store that information into the Journal
  - in the BIND 9 logging configuration, you need to configure the relevant log information to be send to `stdout` or `stderr`

Live Demo Systemd-Journal

Searching/filtering of logfiles

Modern Tools

- Traditional tools to search and filter through log-files are `grep`, `awk` and `perl`
- A few years ago, a number of new tools appeared that have pros compared with the traditional tools:
  - Multi-CPU core scalability
  - Faster regular expression engines
  - Interactive filter capabilities
  - Work transparently on compressed files

Modern "grep" alternatives

- Sack - https://github.com/sampson-chen/sack
- uGrep - https://github.com/Genivia/ugrep
- RipGrep - https://github.com/BurntSushi/ripgrep
- sift - https://sift-tool.org/

Live Demo - ugrep

Condensing information from large logfiles

Logeater

- from time to time I'm tasked with finding the root cause of an BIND 9 incident in large (> 1 GB) BIND 9 logfiles
- I've written the logeater tools to help with that task
- The source code (golang) can be found at https://github.com/cstrotm/logeater
- be careful: the logeater tools distribute the work on all available CPU cores, don't run the tools on a productions DNS server, the tools can *starve* the DNS server process

Logeater-queries

- logeater-queries will read a BIND 9 (9.10+) style query log file and will output statistics and aggregated information from the file:

```
$ ./logeater-queries -h
Usage of ./logeater-queries:
  -c    list query network classes
  -d    list domain names
  -i    list query IP addresses
  -n    no reverse IP lookup
  -s    list statistics
  -t    list query type
```

Example use of logeater-queries

- logeater-queries Example - printing network classes and query types of queries:

```
$ cat query.log | ./logeater-queries -c -t | column -t

Query-Network-Classes
21379                  :  IN
6                      :  CH

Query-Network-Types
8514                   :  A
4060                   :  AAAA
3079                   :  SOA
2372                   :  DNSKEY
927                    :  PTR
658                    :  MX
543                    :  NS
312                    :  DS
286                    :  TXT
186                    :  NSEC
129                    :  ANY
115                    :  CNAME
[…]
```

Example use of logeater-queries

- `logeater-queries` Example - printing the top ten query IP addresses with reverse name resolution:

```
$ cat query.log | ./logeater-queries -i | head | column -t
Query-IP-Addresses
1571                :  212.114.206.217                   [muc.example.de.]
821                 :  2620:74:13:4400::41               [dnsviz-db.verisignlabs.com.]
794                 :  72.13.58.112                      [dnsviz-db.verisignlabs.com.]
704                 :  54.234.42.241                     [241.compute-1.amazonaws.com.]
682                 :  2001:19f0:5001:df:76d7:5703:ba0a:e220  []
565                 :  185.92.221.212                    [185.92.221.212.vultr.com.]
467                 :  185.22.143.29                     [b9168f1d.cgn.dg-w.de.]
314                 :  91.51.184.46                      [3b82e.dip0.t-ipconnect.de.]
```

Logeater-DNSSEC

- `logeater-dnssec` analyses the a log file with messages from the *DNSSEC* category and groups the error messages :

```
$ cat dnssec.log | ./logeater-dnssec | head
8727 : 0C9F6LGOE6NADAS8KG1CLIK9UO9G7EIG.ad/NSEC3: no valid signature found
6953 : ad/SOA: no valid signature found
3976 : sat-tv.com/A: got insecure response; parent indicates it should be secure
1730 : mozilla.com/SOA: no valid signature found
1586 : stream.bestvideostreaming.is/A: no valid signature found
1577 : 8FC1DQ3C2Q3ERFD4UO40ENDBTSFME5JO5.ad/NSEC3: no valid signature found
1576 : sat-tv.com/SOA: got insecure response; parent indicates it should be secure
1576 : cdws.eu-west-1.amazonaws.com.Cisco/AAAA: bad cache hit (amazonaws.com.Cisco/DS)
1483 : 0c9f6lgoe6n13ad9iu1clik9uo9g7eig.ad/NSEC3: no valid signature found
968 : cbr.de/NSEC: no valid signature found
```

Logeater-Resolver

- `logeater-resolver` analyses the a log file with messages from the *resolver* category and groups the error messages :

```
$ cat resolvers.log | ./logeater-resolvers | head
42908 : s-cnc1.qq.com/AAAA: Name qq.com (SOA) not subdomain of zone ns-cnc1.qq.com -- invalid response
42713 : s-tel1.qq.com/AAAA: Name qq.com (SOA) not subdomain of zone ns-tel1.qq.com -- invalid response
42484 : s-os1.qq.com/AAAA: Name qq.com (SOA) not subdomain of zone ns-os1.qq.com -- invalid response
42297 : s-cmn1.qq.com/AAAA: Name qq.com (SOA) not subdomain of zone ns-cmn1.qq.com -- invalid response
20346 : mails.sonymusicfans.com/DS: invalid response
10920 : tp1.glb.nist.gov/DS: invalid response
9693 : media.netd.com.tr/AAAA for client 192.0.2.165#3347: Name netd.com.tr (SOA) not subdomain of zone
7932 : service.superc.net/AAAA for client 192.0.2.11#3073: Name superc.net (SOA) not subdomain of zone
4597 : brickleonavon.com/NS for client 192.0.2.46#3073: Name . (SOA) not subdomain of zone brickleonavo
4474 : promo.mobile.de/AAAA for client 2001:db8:1800:88:78f9:ba4:45fe:d438#48296: Name mobile.de (SOA)
```

Live-Demo Logeater Tools

Logfile histograms

Finding hot-spots or outliers

- When working with large BIND 9 log files (or `tcpdump` pcap files), I often generate histograms over the logfiles to find hot-spots or outliers
- Logfile Histograms can be created from any field in the logfile
    - Time based
    - Query name based
    - Query IP address based
    - Error message based
- Histogram creation is done with classic Unix tools in a shell pipeline

Time based histogram

- Example of a time based histogram from BIND 9 log files with DNSSEC issues

```
cat dnssec.log | grep "2021-02-17" | awk '{print substr($0,0,16)}' \
 | uniq -c | awk '{printf("\n%s ",$0) ; for (i = 0; i<$1/100 ; i++) \
 {printf("*")};}' | less
```

Time based histogram output

- This histogram shows an incident around 18:17 UTC on 27th April 2020:

```
 178 27-Apr-2020 18:09 **
 159 27-Apr-2020 18:10 **
 160 27-Apr-2020 18:11 **
 169 27-Apr-2020 18:12 **
 175 27-Apr-2020 18:13 **
 166 27-Apr-2020 18:14 **
 183 27-Apr-2020 18:15 **
 224 27-Apr-2020 18:16 ***
4082 27-Apr-2020 18:17 *****************************************
4439 27-Apr-2020 18:18 *********************************************
3476 27-Apr-2020 18:19 ***********************************
3212 27-Apr-2020 18:20 *********************************
2484 27-Apr-2020 18:21 *************************
2201 27-Apr-2020 18:22 ***********************
2036 27-Apr-2020 18:23 *********************
2032 27-Apr-2020 18:24 *********************
2059 27-Apr-2020 18:25 *********************
1679 27-Apr-2020 18:26 *****************
 943 27-Apr-2020 18:27 **********
 639 27-Apr-2020 18:28 *******
 500 27-Apr-2020 18:29 *****
 414 27-Apr-2020 18:30 *****
```

Example: Histogram by log messages

- This pipeline prints the log messages from `security.log` based on the number of recurring messages

```
cat security.log | grep "2021-02-14" | awk -F : '{print substr($4,0,60)}' | \
  uniq -c | sort -nr | \
  awk '{printf("\n%s ",$0) ; for (i = 0; i<$1/10 ; i++) {printf("*")};}'
```

Example: Histogram by log messages output

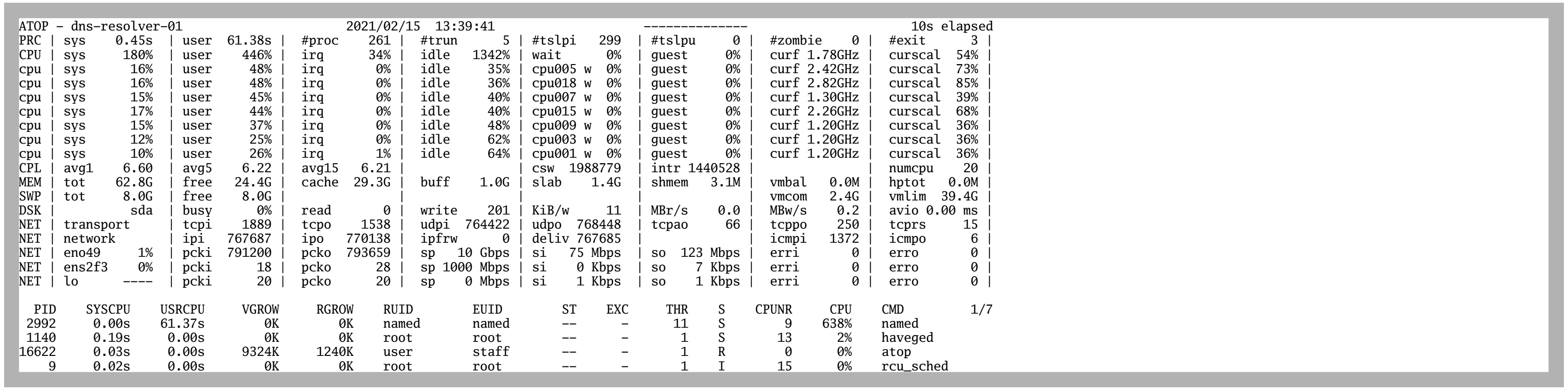
```
100  query (cache) 'www.google.com/A/IN' denied **********
 10  query (cache) 'peacecorps.gov/ANY/IN' denied *
  2  query (cache) 'com/ANY/IN' denied *
  2  query (cache) '67b.org/AAAA/IN' denied *
  1  query (cache) 'www.qq.com/A/IN' denied *
  1  query (cache) 'www.qq.com/A/IN' denied *
  1  query (cache) 'researchscan541.eecs.umich.edu/A/IN' denied *
  1  query (cache) 'pizzaseo.com/RRSIG/IN' denied *
  1  query (cache) 'invalid.parrotdns.com/A/IN' denied *
  1  query (cache) 'dnsscan.shadowserver.org/A/IN' denied *
  1  query (cache) 'cpsc.gov/ANY/IN' denied *
  1  query (cache) 'c.afekv.com/A/IN' denied *
  1  query (cache) 'amazon.com/A/IN' denied *
  1  query (cache) '5-45-109-212-60287611.spiderprobe.com/A/IN'  *
  1  query (cache) '37-120-183-122-60287611.spiderprobe.com/A/IN *
  1  query (cache) '212.109.45.5.in-addr.arpa/PTR/IN' denied *
  1  query (cache) '122.183.120.37.in-addr.arpa/PTR/IN' denied *
```

System-Monitoring with atop

atop - a top alternative of 'steroids'

- `atop` is an real-time system monitor. It is an alternative to the original Unix/Linux `top` tool
- Advantages
  - Shows resource usage of ALL processes, even those that are closed/completed.
  - Monitors threads within processes & ignores processes that are unused.
  - Accumulates resource usage for all processes and users with the same name.
  - Highlights critical resources using colors (red).
  - Will add or remove columns as the size of the display window changes.
  - Includes disk I/O and network utilization.
  - Shows interrupt utilization per CPU and CPU frequencies
  - Uses netatop kernel module to monitor TCP & UDP and network bandwidth.

Atop Example



```
ATOP - dns-resolver-01                      2021/02/15  13:39:41                    --------------                      10s elapsed
PRC | sys    0.45s  | user  61.38s |  #proc    261 |  #trun      5 | #tslpi   299  | #tslpu     0 |  #zombie    0 |  #exit      3 |
CPU | sys     180%  | user    446% |  irq      34% |  idle   1342% | wait      0%  | guest     0% |  curf 1.78GHz |  curscal  54% |
cpu | sys      16%  | user     48% |  irq       0% |  idle     35% | cpu005 w  0%  | guest     0% |  curf 2.42GHz |  curscal  73% |
cpu | sys      16%  | user     48% |  irq       0% |  idle     36% | cpu018 w  0%  | guest     0% |  curf 2.82GHz |  curscal  85% |
cpu | sys      15%  | user     45% |  irq       0% |  idle     40% | cpu007 w  0%  | guest     0% |  curf 1.30GHz |  curscal  39% |
cpu | sys      17%  | user     44% |  irq       0% |  idle     40% | cpu015 w  0%  | guest     0% |  curf 2.26GHz |  curscal  68% |
cpu | sys      15%  | user     37% |  irq       0% |  idle     48% | cpu009 w  0%  | guest     0% |  curf 1.20GHz |  curscal  36% |
cpu | sys      12%  | user     25% |  irq       0% |  idle     62% | cpu003 w  0%  | guest     0% |  curf 1.20GHz |  curscal  36% |
cpu | sys      10%  | user     26% |  irq       1% |  idle     64% | cpu001 w  0%  | guest     0% |  curf 1.20GHz |  curscal  36% |
CPL | avg1    6.60  | avg5    6.22 |  avg15   6.21 |               | csw  1988779  | intr 1440528 |               |  numcpu    20 |
MEM | tot    62.8G  | free   24.4G |  cache  29.3G |  buff    1.0G | slab    1.4G  | shmem   3.1M |  vmbal   0.0M |  hptot   0.0M |
SWP | tot     8.0G  | free    8.0G |               |               |               |              |  vmcom   2.4G |  vmlim  39.4G |
DSK |          sda  | busy      0% |  read       0 |  write    201 | KiB/w     11  | MBr/s    0.0 |  MBw/s    0.2 |  avio 0.00 ms |
NET | transport     | tcpi    1889 |  tcpo    1538 |  udpi  764422 | udpo  768448  | tcpao     66 |  tcppo    250 |  tcprs     15 |
NET | network       | ipi   767687 |  ipo   770138 |  ipfrw      0 | deliv 767685  |              |  icmpi   1372 |  icmpo      6 |
NET | eno49     1%  | pcki  791200 |  pcko  793659 |  sp   10 Gbps | si   75 Mbps  | so  123 Mbps |  erri       0 |  erro       0 |
NET | ens2f3    0%  | pcki      18 |  pcko      28 |  sp 1000 Mbps | si    0 Kbps  | so    7 Kbps |  erri       0 |  erro       0 |
NET | lo      ----  | pcki      20 |  pcko      20 |  sp    0 Mbps | si    1 Kbps  | so    1 Kbps |  erri       0 |  erro       0 |

  PID    SYSCPU    USRCPU     VGROW     RGROW    RUID        EUID        ST    EXC     THR    S    CPUNR     CPU    CMD         1/7
 2992     0.00s    61.37s        0K        0K    named       named       --      -      11    S        9    638%    named
 1140     0.19s     0.00s        0K        0K    root        root        --      -       1    S       13      2%    haveged
16622     0.03s     0.00s     9324K     1240K    user        staff       --      -       1    R        0      0%    atop
    9     0.02s     0.00s        0K        0K    root        root        --      -       1    I       15      0%    rcu_sched
```

Atop background monitoring

- atop can be run as a daemon process in the background
  - in this example, atop collects the system information every 60 seconds into the (binary) file /var/log/atop/atop_20210215 (rotated daily)

```
# systemctl status atop
● atop.service - Atop advanced performance monitor
   Loaded: loaded (/lib/systemd/system/atop.service; enabled; vendor preset: enabled)
   Active: active (running) since Mon 2021-02-15 00:00:02 CET; 13h ago
     Docs: man:atop(1)
 Main PID: 10509 (atop)
    Tasks: 1 (limit: 4915)
   CGroup: /system.slice/atop.service
           └─10509 /usr/bin/atop -R -w /var/log/atop/atop_20210215 60

Feb 15 00:00:02 dns-resolver-12 systemd[1]: Started Atop advanced performance monitor.
```

Replay historical atop data

- `atop` can read the (binary) historical data
  - the tools then allows to move back and forth in the time to investigate past system events

```
atop -r /var/log/atop/atop_20210215
```

Live Demo of atop

Incident based traffic capture

DNS incidents and available data

- As it is hard to predict when a DNS or network incident will strike, often valuable detail data from the incident is missing
- Next we show an example of a system that measures critical system parameter (CPU load, UDP and TCP query volume) and will start a network capture with `tcpdump` once a threshold is reached
  - can be adapted to do other data collection (DNSTAP, wireshark/tshark, dnscap etc)
  - scripts should test the amount of free storage space before starting the data collection
  - the scripts should also raise a alarm, so that someone knows there is data to be examined

Systemd Timer Unit

- file `/etc/systemd/system/tcpdump-starter.timer`: this systemd unit starts the `tcpdump-starter` service every 60 seconds *after* the last termination of the same service

```
[Unit]
Description=TCPDUMP Starter Timer

[Timer]
OnUnitInactiveSec=60s

[Install]
WantedBy=timers.target
```

Systemd service unit

- the unit file in `/etc/systemd/system/tcpdump-starter.service` starts the `tcpdump-starter` script on the timer event
  - parameter `-c 12`: start collecting detail information when the CPU load is > 12
  - parameter `-u 32000`: start collecting detail information if the number of queries over UDP > 32.000
  - parameter `-t 1000`: start collecting detail information if the number of queries over TCP > 1.000

```
[Unit]
Description=TCPDUMP Starter Service

[Service]
Type=oneshot
ExecStart=/usr/local/sbin/tcpdump-starter  -c 12 -u 32000 -t 1000

[Install]
WantedBy=multi-user.target
```

Tcpdump-starter Script (1/4)

- The script sets some default values and processes the parameter to the script

```
#!/bin/sh
set -o nounset

cputhreshold=12
udpthreshold=32000
tcpthreshold=1000
diskthreshold=10000000
interface=eth0

while getopts ':t:u:c:' optname
do
    case $optname in
        c) cputhreshold=$OPTARG;;
        t) tcpthreshold=$OPTARG;;
        u) udpthreshold=$OPTARG;;
        :)
            echo "$(basename $0): Argument missing for option ${OPTARG}" >&2
            exit 2;;
        \?)
            echo "$(basename $0): Unknown option ${OPTARG}" >&2
            exit 2;;
        *)
            echo "$(basename $0): Internal error, unexpected option ${optname}" >&2
            exit 3;;
    esac
done
shift $((OPTIND-1))
[...]
```

Tcpdump-starter Script (2/4)

- the 2nd part checks the CPU load

```
[...]
# test for high CPU load
avg=$(cat /proc/loadavg | cut -d '.' -f 1)

if [ $cputhreshold -le $avg ]; then
    echo "High CPU Load ${cputhreshold}"
    logger -t tcpdump "High CPU Load ${avg} - starting TCPDUMP"
    diskfree=$(df --output=avail / | tail -1)
    if [ $diskthreshold -ge $diskfree ]; then
        logger -t tcpdump "Not enough free disk space to start TCPDUMP."
    else
        tcpdump-run 5 $interface
    fi
fi
[...]
```

Tcpdump-starter Script (3/4)

- the 3rd part checks for the volume of UDP queries

```
[...]
# test for high DNS UDP request rate
udpqr=$(/usr/sbin/rndc status | grep "recursive clients" | cut -d ':' -f 2 | cut -d '/' -f 1)
if [ $udpthreshold -le $udpqr ]; then
    echo "High UDP DNS Load ${udpqr}"
    logger -t tcpdump "High UDP DNS Load ${udpqr} - starting TCPDUMP"
    if [ $diskthreshold -ge $diskfree ]; then
        logger -t tcpdump "Not enough free disk space to start TCPDUMP."
    else
        tcpdump-run 5 $interface
    fi

fi
[...]
```

Tcpdump-starter Script (4/4)

- the last part checks for the volume of TCP queries

```
[...]
# test for high DNS TCP request rate
tcpqr=$(/opt/local/bind/sbin/rndc status | grep "tcp clients" |  cut -d ':' -f 2 | cut -d '/' -f 1)
if [ $tcpthreshold -le $tcpqr ]; then
    echo "High TCP DNS Load ${tcpqr}"
    logger -t tcpdump "High TCP DNS Load ${tcpqr} - starting TCPDUMP"
    if [ $diskthreshold -ge $diskfree ]; then
        logger -t tcpdump "Not enough free disk space to start TCPDUMP."
    else
        tcpdump-run 5 $interface
    fi
fi
```

Script tcpdump-run

- The script `tcpdump-run` collects network traffic for some time (5 minutes in this case)

```
#!/bin/sh
tcpdump -q -W $1 -G 60 -w /pcap/packettrace-%F-%T.pcap -i $2
```

References:

- BIND 9 Logging configuration templates: https://webinar.defaultroutes.de/webinar/bind9-logging-
- BIND 9 ARM - Logging: https://downloads.isc.org/isc/bind9/9.16.5/doc/arm/htm statement-definition-and-usage

DNS data collection

- DNS-OARC software tools https://www.dns-oarc.net/oarc/software
- DNS witness https://github.com/AFNIC/DNSwitness
- DNS Parse https://github.com/pflarr/dns_parse
- Capture DNS - A simple program to capture and show DNS queries https://github.com/lilydjwg/capture-dns

Systemd Journal

- Log Management with the Systemd Journal https://materials.rangeforce.com/tutorial/2020/04/16/Sys Journal/
- Forward secure sealing https://lwn.net/Articles/512895/

Atop

- `atop` home page https://www.atoptool.nl/
- atop – For Linux server performance analysis https://haydenjames.io/use-atop-linux-server-performance-analysis/

Upcoming Webinars

- March 17: Session 2. Long-term statistics monitoring and log analysis
- April 21: Session 3. Load balancing with DNSdist
- May 19: Session 4. Dynamic zones, pt1 - Basics
- June 16: Session 5. Dynamic zones, pt 2 - Advanced topics

Questions and Answers