Raspberry Pi as Black Box

Raspberry Pi “Black Box”
Download Test and Logging Tool

Ian E. Gorman

Ottawa Canada Linux Users Group
July 7, 2016

National Capital Freenet

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- Test data may indicate that, notwithstanding low speeds, a user has a good and properly functioning DSL connection
- Speeds experienced by the user are influenced by factors other than the quality of the DSL connection
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NCF Connection to WWW

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Digital
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High
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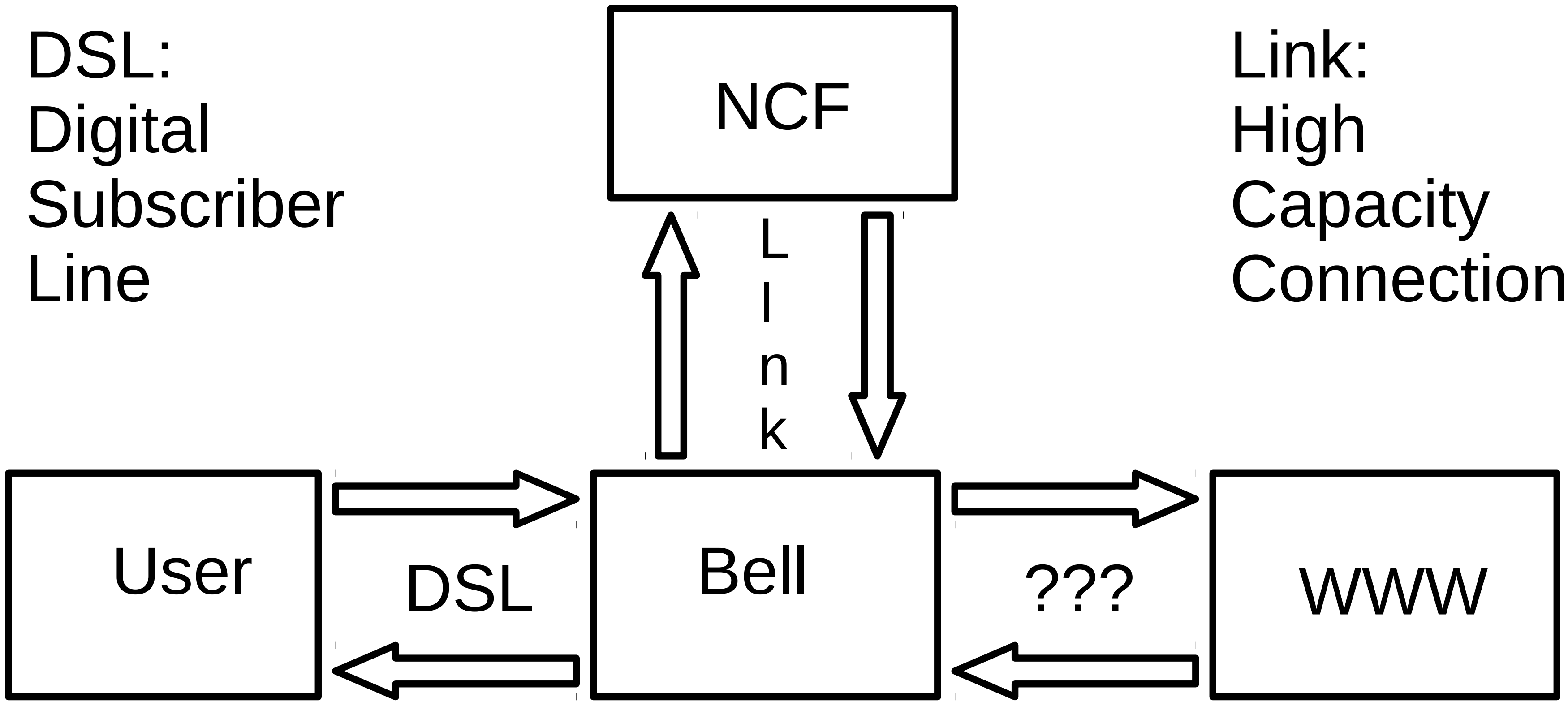

Scope of Bell DSL Test Data

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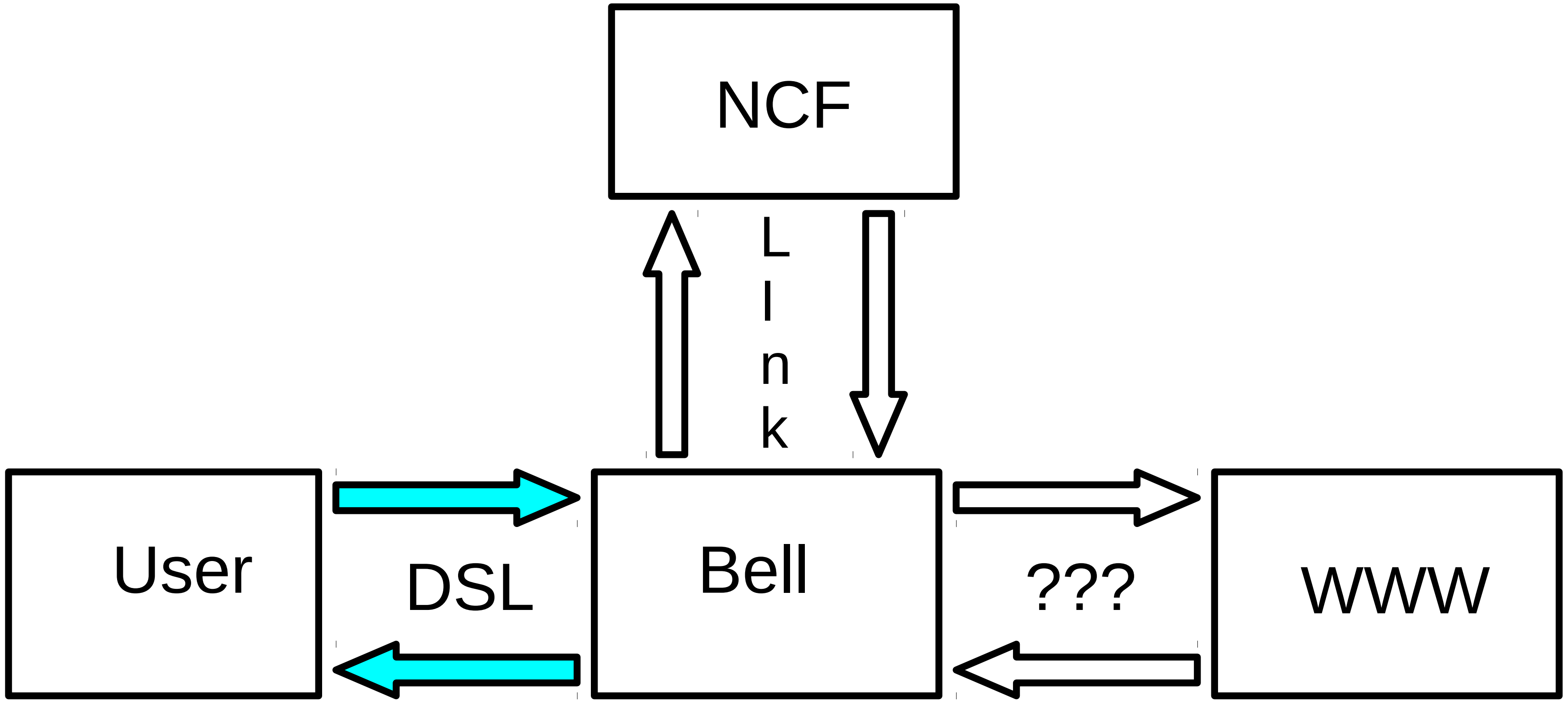

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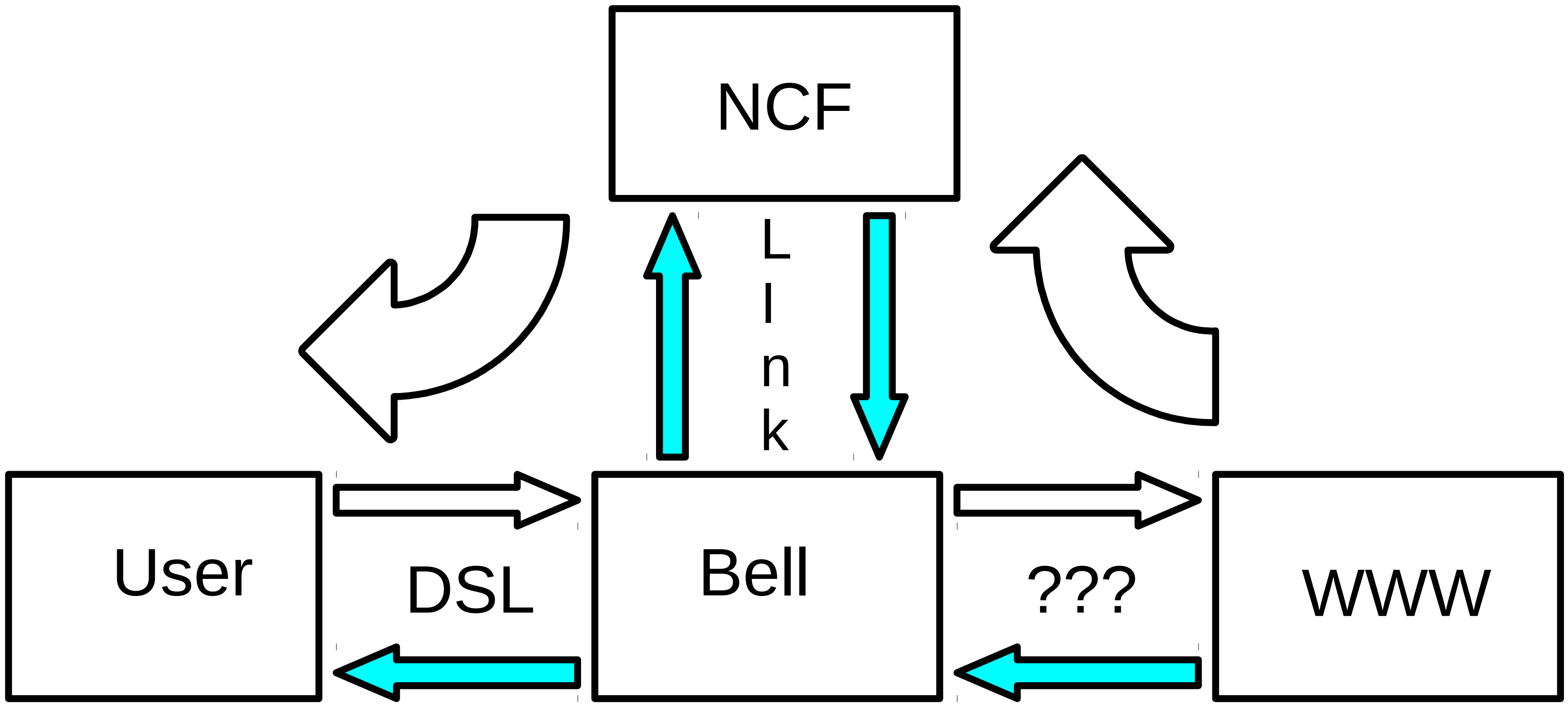

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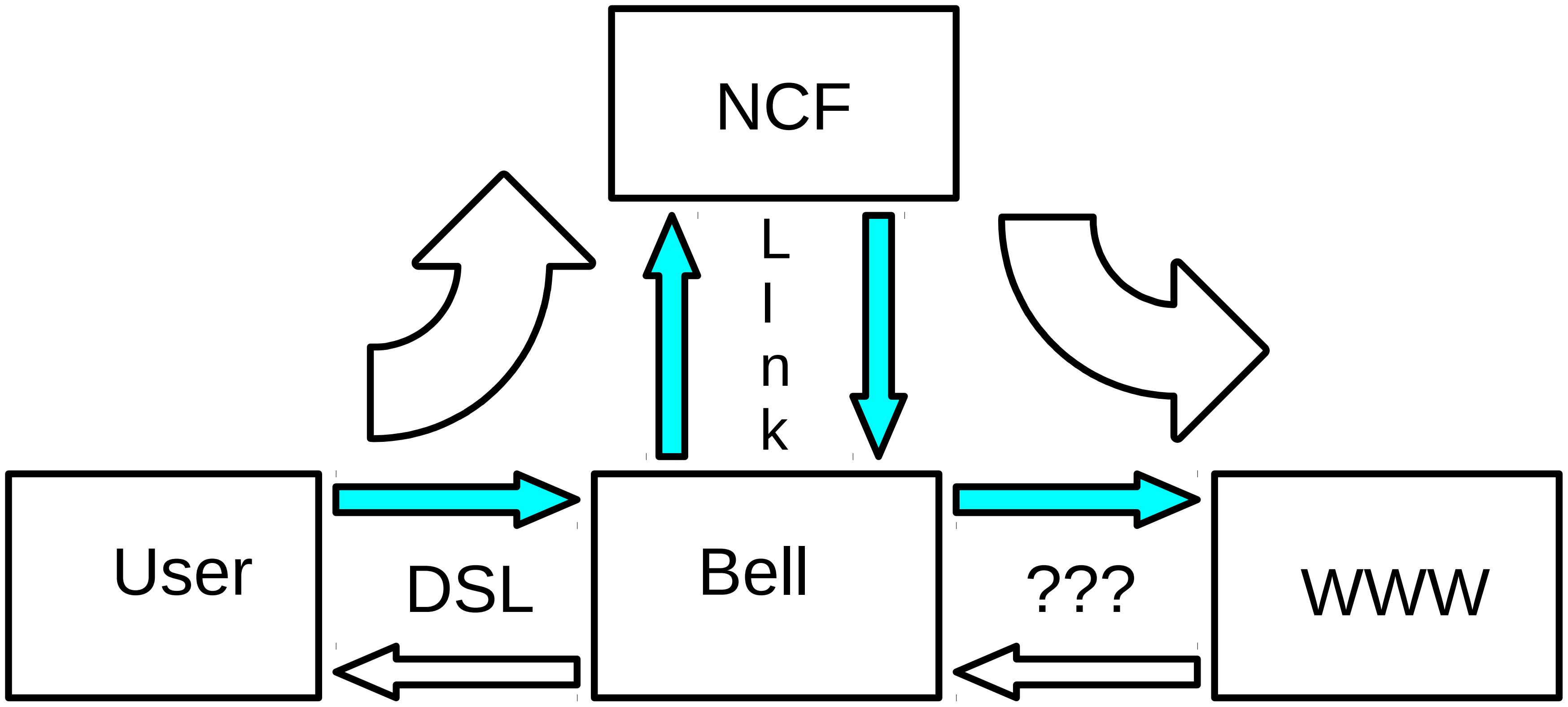

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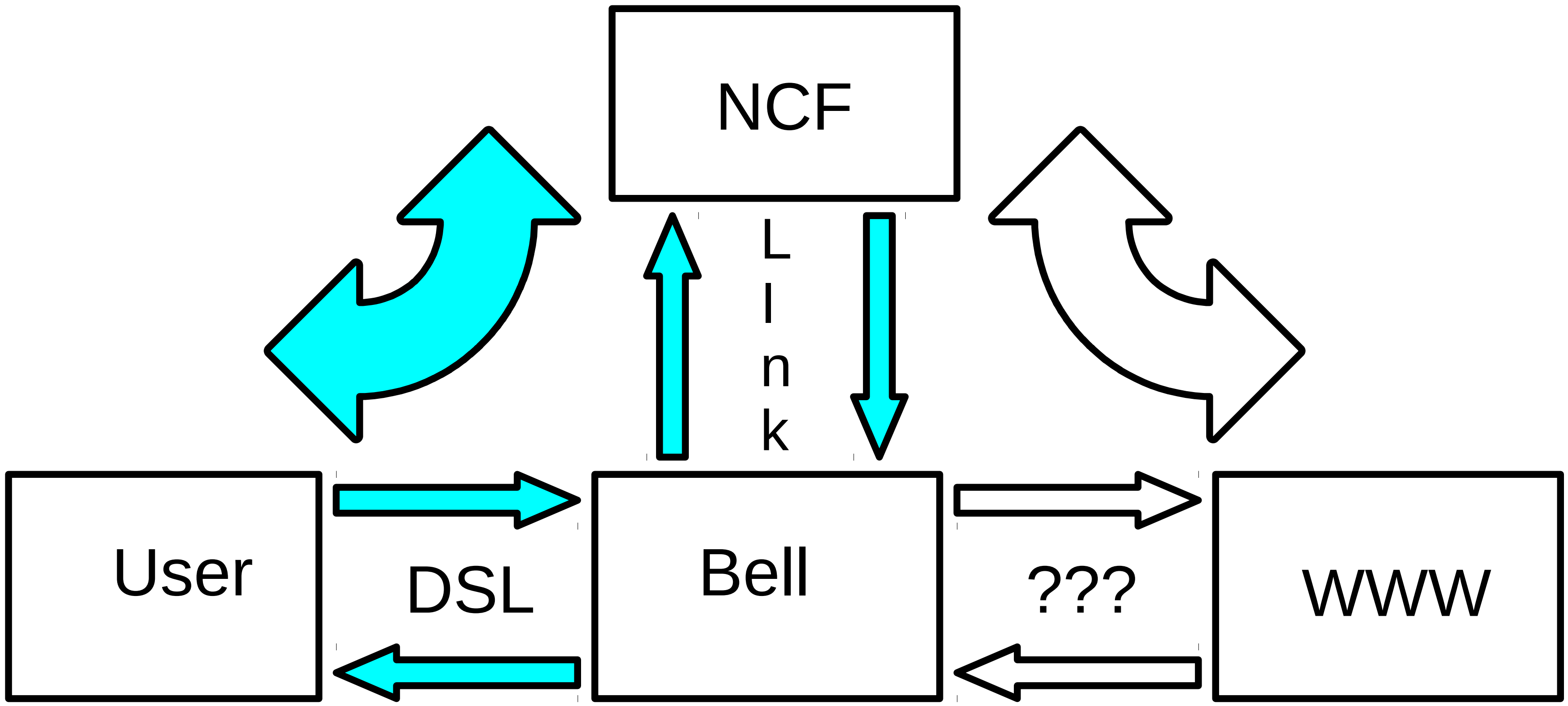

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Black Box Operation

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  - One Raspberry Pi (in a black case!)
    - Test software installed in the Raspberry Pi
  - One 5 volt power block for Raspberry Pi
  - One Ethernet cable
- Testing
  - User plugs black box into router (with Ethernet cable) and wall (with power block), watches the lights go on.
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Black Box Test Software

- Test runs
  - Shell script to run and log one test
  - Shell script to repeat the tests
  - Shell script to act as hook for crontab entry
  - Crontab entry
- Processing
  - Awk script to translate log to one line per download
  - R script to produce report
- Setup
  - Python script to generate test files for download

Progressive Test Strategy

- Link (from Bell data)
- DSL (from Bell data)
- User Equipment + DSL
  - User modem is tested, user takes black box home
  - Black box records downloads from Bell
- User Equipment + DSL + Link + NCF
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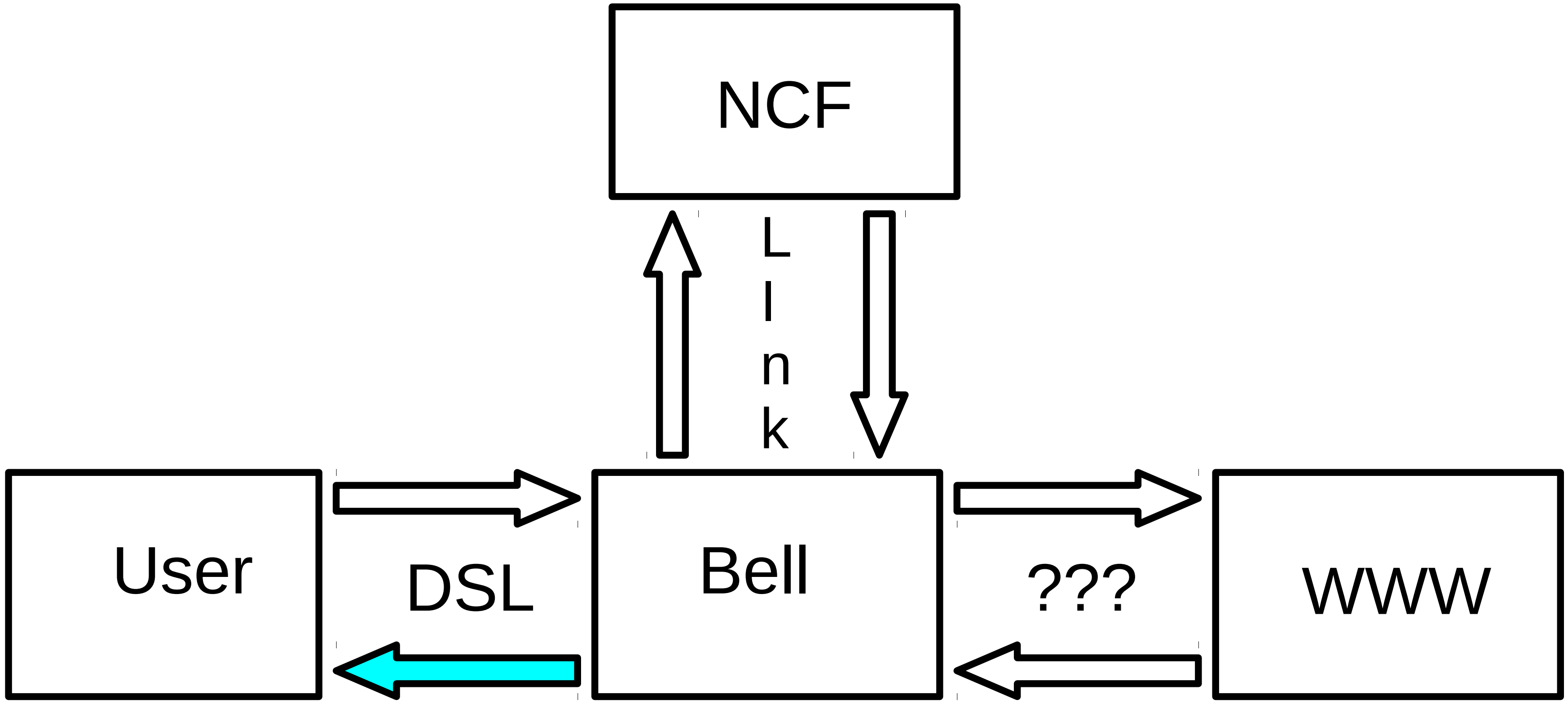
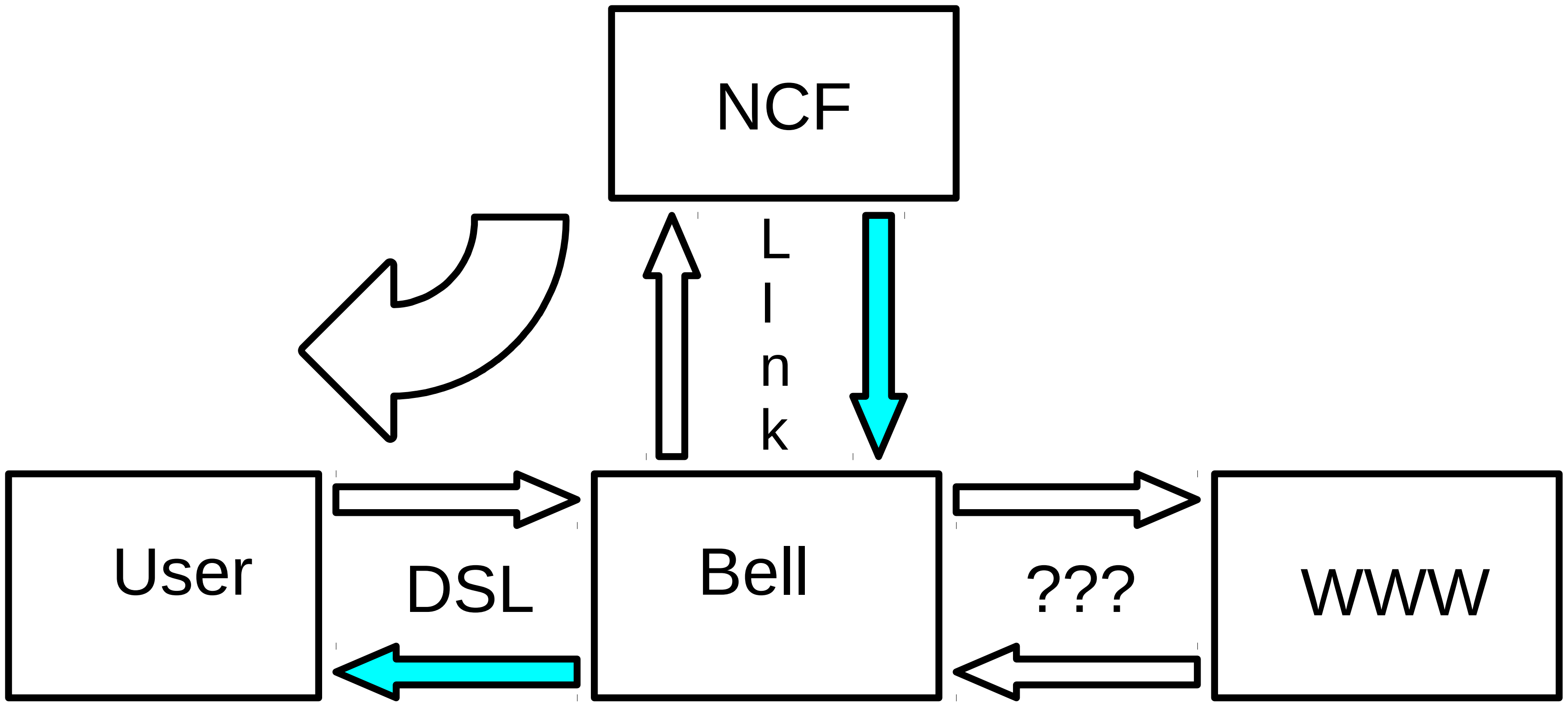
Download Test from Bell

User equipment and DSL path can be tested by downloading data from the Bell system



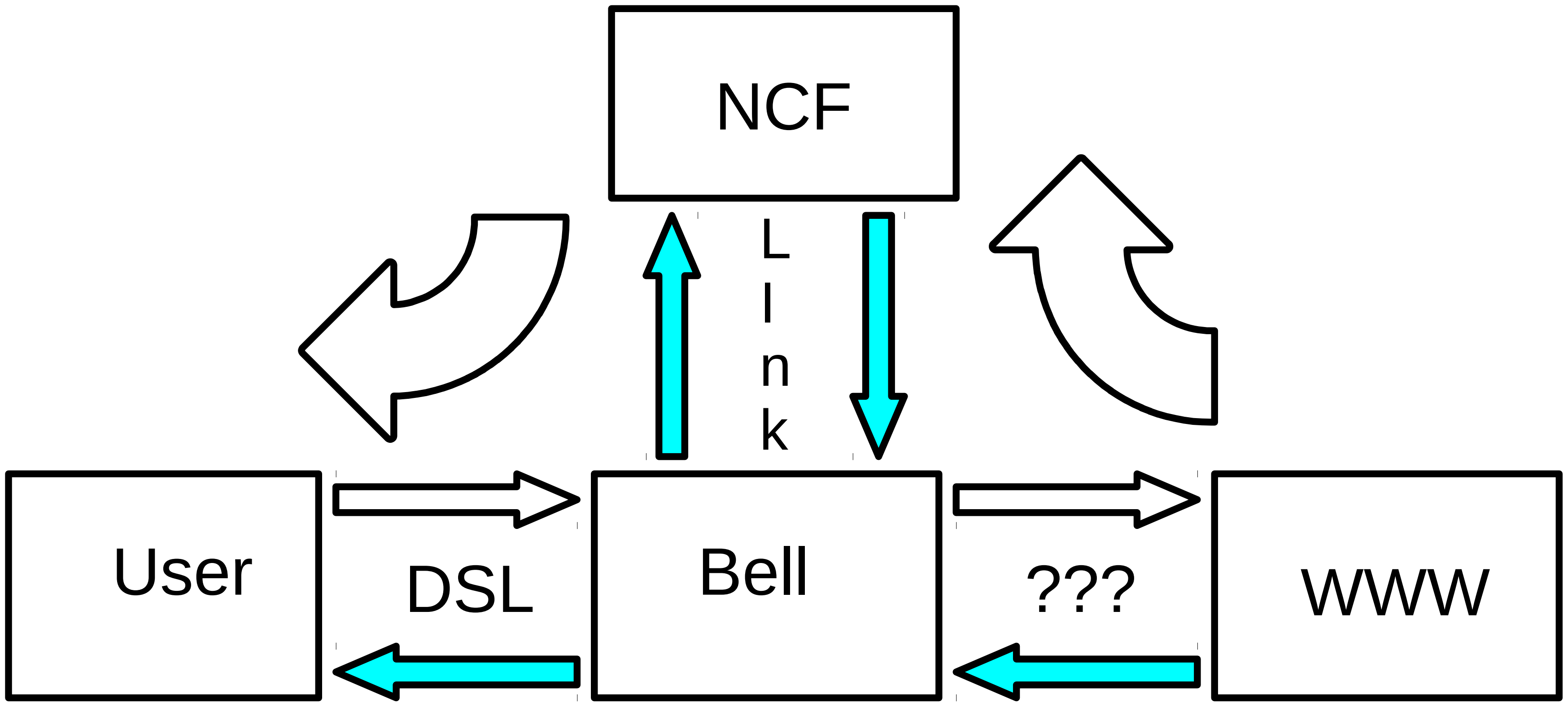
Download Test from NCF

User equipment, DSL path, and Link path can be tested by downloading data from the NCF system



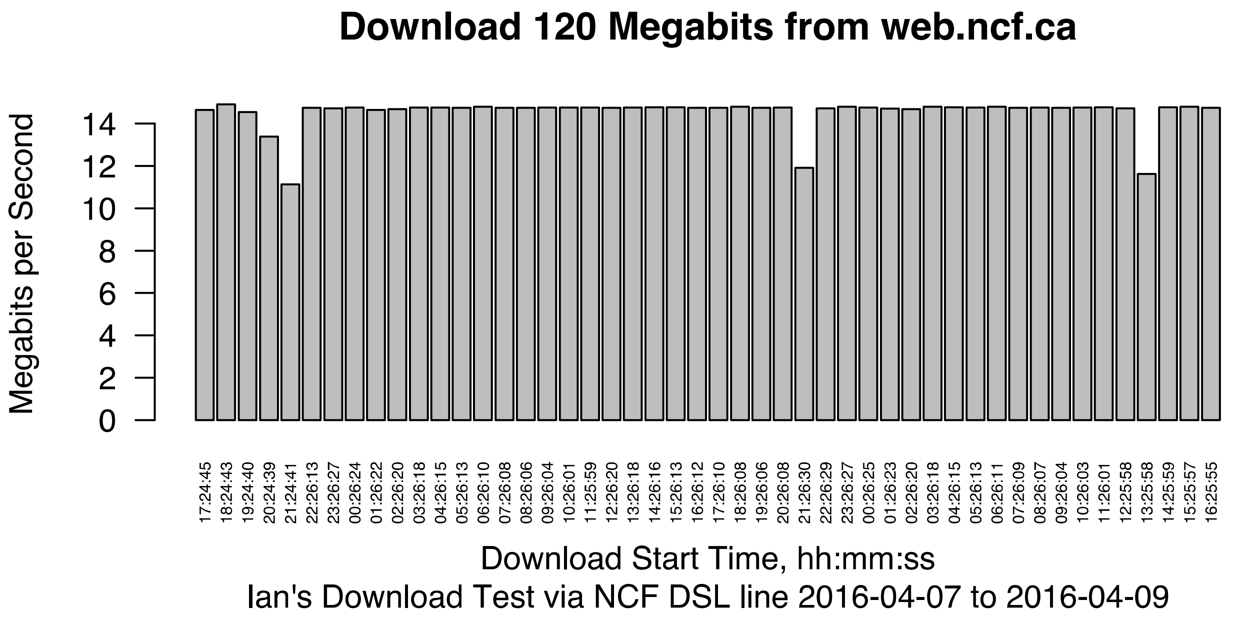
Download Test from WWW

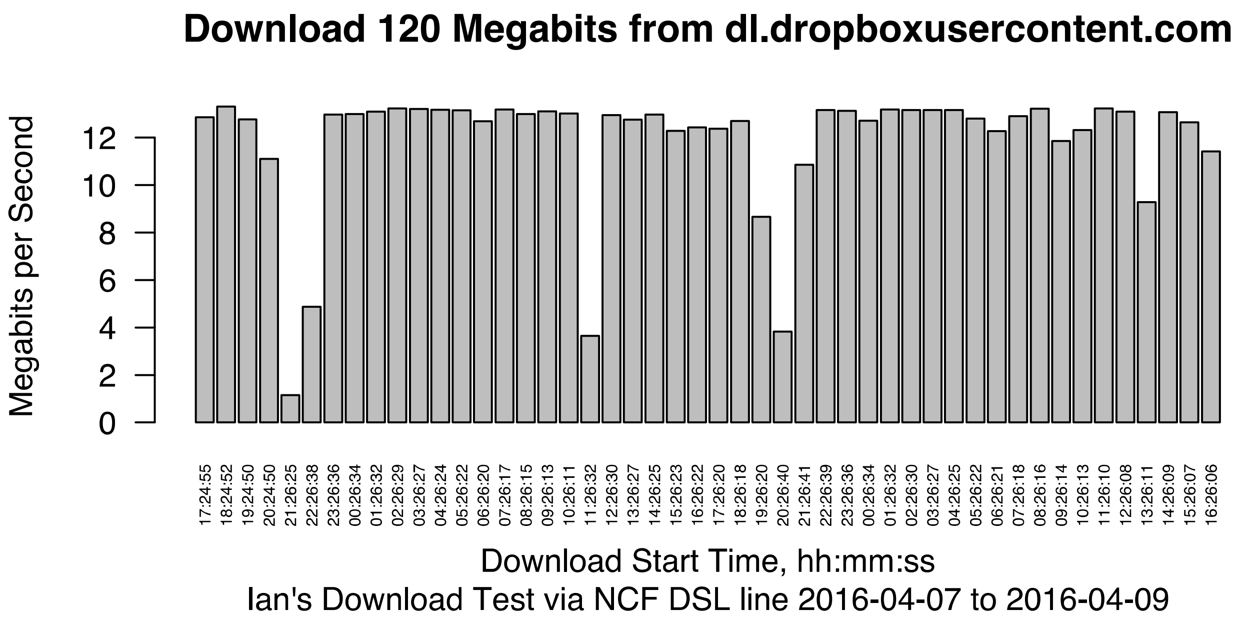
User equipment plus entire path can be tested by downloading data from the WWW



Bar Chart

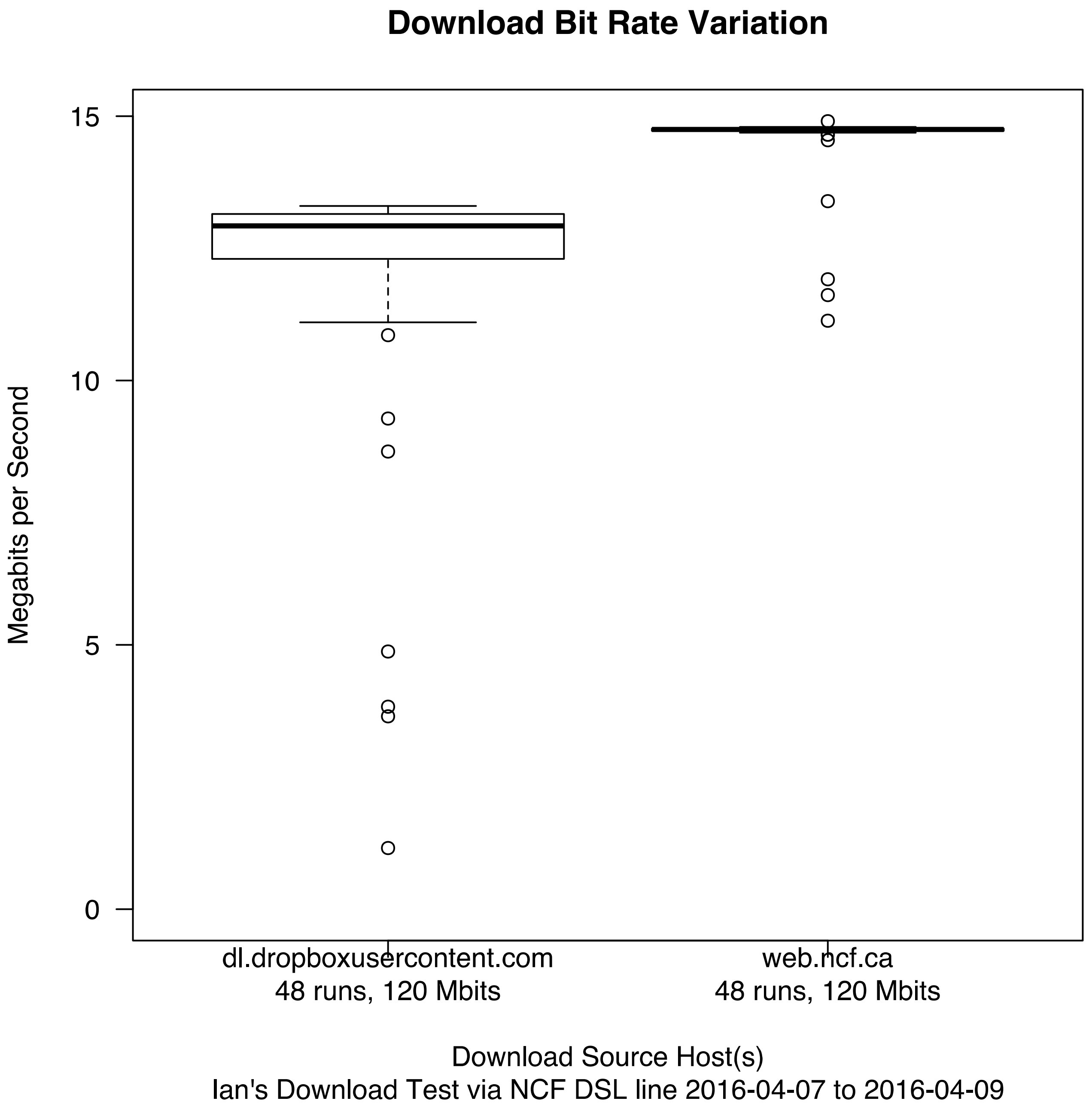
Compare speeds from up to three download sources





Scatter Chart

Compare variation from up to three download sources



Test Software in Raspberry Pi

- User plugs Raspberry Pi in to modem and power, without keyboard or mouse
- Crontab starts a control script in $HOME (~pi) and redirects output to a file in $HOME
- Control script takes no parameters but has internal parameters that can be set to run the desired tests
- Control script runs a test script as specified by the internal parameters, to append data to a log file
- Test script script exits to the control script
- Control script shuts the Raspberry Pi down

Test Analysis with Raspberry Pi

- Technician starts Raspberry Pi with keyboard and mouse, but no network connection
- Technician logs in before test failure shuts Raspberry Pi down, and stops current test run
- Awk program converts test log to report file with one line per download.
- R program produces graphs and a summary from the report file
- Raspberry Pi can be connected to network to transfer graphs and reports

crontab Entry

```
# crontab entry to run download speed test and then shut
down
# scripts require 'bash' and will fail in default Raspbian
shell
# see crontab(5) for default shell
SHELL=/bin/bash
#
# redirection must be done within the crontab command
line, see cron(8)
# see crontab(5) for comand line format
@reboot~/speedtest/speedtest.cron.sh >>
~/speedtest.log 2>&1
```

Control Script (excerpt 1)

```
# wait for system startup and DHCP to complete
sleep 120

# Run the test script with the parameters,
environment, and termination options
# created by this script
"${SCRIPTNAME%/*}"/speedtest.sh "$URL_1"
"$URL_2"  "$URL_3" "$INTERVAL" "$COUNT"
```

Control Script (excerpt 2)

Shutdown and error management:

```
# In normal operation, shutdown occurs 2 minutes after other script returns
# Shutdown can be avoided by deleting the file ${SHUTDOWNFLAGFILE}
#
SHUTDOWNFLAGFILE=~/".shutdown.after.speedtest"
:>"${SHUTDOWNFLAGFILE}"
echo "Delete file \"${SHUTDOWNFLAGFILE}\" to abort shutdown after speed test"
trap 'sleep 120; if [ -f "${SHUTDOWNFLAGFILE}" ]; then rm -f "$
{SHUTDOWNFLAGFILE}"; sudo shutdown now; fi' EXIT

trap 'echo Error "$?" al line ${LINENO} in script ${SCRIPTNAME} ; exit 1' \
    ERR

trap 'echo Terminated al line ${LINENO} in script ${SCRIPTNAME} ; exit 2' \
    HUP INT ABRT KILL
```

Test Script (1)

Main control loop:

```
# execute a sequence of test runs until end or a series of consecutive failures
while [[ "${COUNT}" -gt 0 ]]
do
    # Execute a sequence of downloads until one fails or all succeed
    if download "${URL_1}" && download "${URL_2}" && download "${URL_3}"
    then
        # send any cached data to disk
        sync
        # reset error flag
        ERRORCOUNT=0
    else
        # report download errors
```

Test Script (2)

Principal part of the download function:

```
    else
        # next command is used to provide a timestamp and url in case wget fails
        # wrap the command in a test so that script will not stop on failure
        if echo "TimeStamp $(date '+%Y-%m-%d %H:%M:%S') URL=$URL"; then
true; fi
        # now get the download
        time -p {
            # keep time stamp, url, download size, but discard progress report
            wget ${WGET_OPTIONS} -nv -O /dev/null ${1}
            WGETCODE=$?
        }
        TIMECODE=$?     # should be same as WGETCODE, see time(1)
        sync
```

Test Script (3)

Error Management:

```
# Information for figuring out what went wrong (if anything did)
echo "Script \"${SCRIPTNAME}\" running as USER=\"${USER=}\" with
PATH=\"${PATH=}\""

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Download File and Report File

Log Entry (5 lines per download - TimeStamp/URL:/real/user/sys)

```
TimeStamp 2016-04-07 17:24:37
URL=http://web.ncf.ca/am125/speedtest/random15megabytes
2016-04-07 17:24:45
URL:http://web.ncf.ca/am125/speedtest/random15megabytes
[15000000/15000000] -> "/dev/null" [1]
real 8.19
user 0.48
sys 1.94
```

Report Input File (one line per download)

```
date      time      source  bytes    bits seconds      bps host
2016-04-07 17:24:45
http://web.ncf.ca/am125/speedtest/random15megabytes 15000000
120000000  8.19      1.4652e+07 web.ncf.ca
```

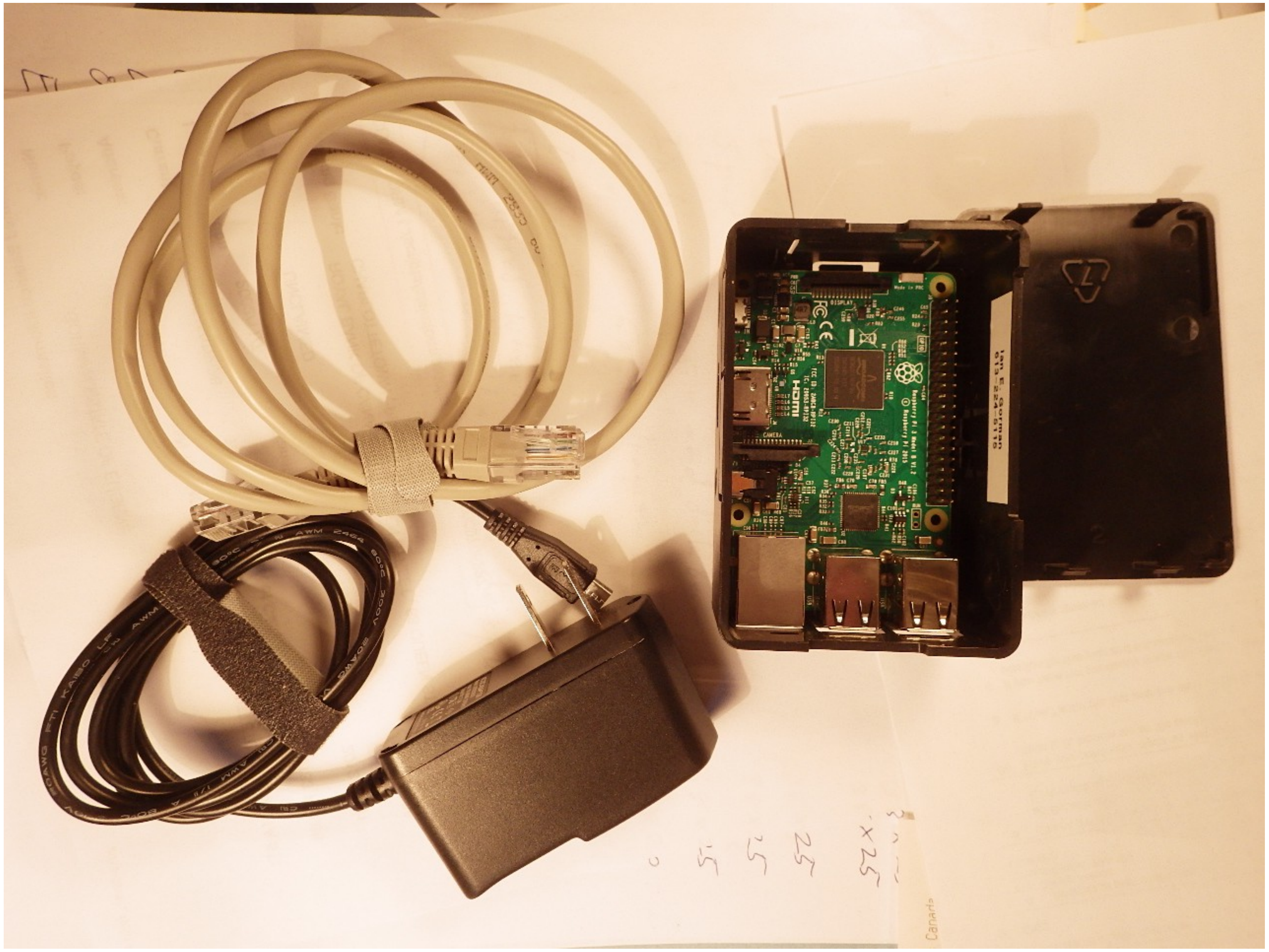
AWK Program to Convert Log File

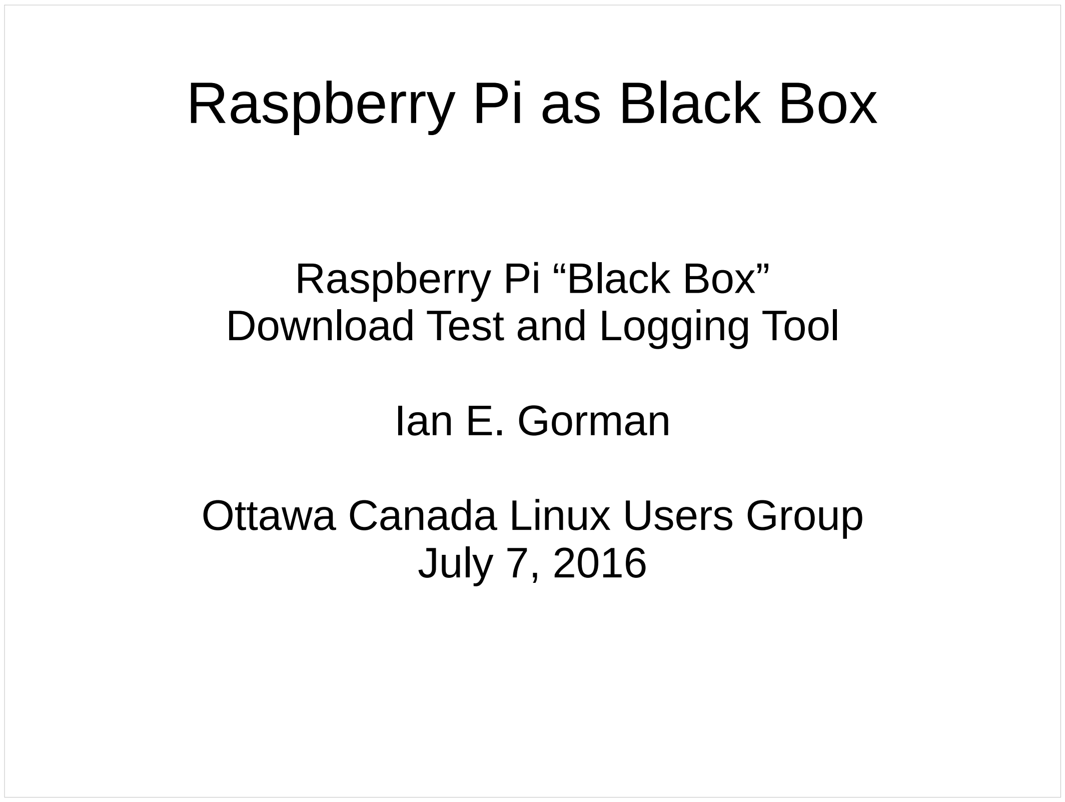
```
# timestamp and URL should be given by 'wget'
# Get the secondary timestamp, url and host to be used when wget fails
/^TimeStamp/    {
    stamp_date = $2
    stamp_time = $3
    sub(/^.*URL=/, "")
    stamp_url = $0
    stamp_host = stamp_url
    sub(/^.*:\/\//, "", stamp_host)   # trim all before hostname
    sub(/\/.*$/, "", stamp_host)      # trim all after hostname
}

# get data from the output of 'wget' and clear the previous time report
/^2[0-9]/  {    # Pick up the year, but with a Y3K problem  ;)
    …
}

# get data from the following 'time' report and print a one-line test summary
/^ *real/  {   # pick up the "wall clock" line from the 'time' report
    …
}
```

The Black Box Test Kit





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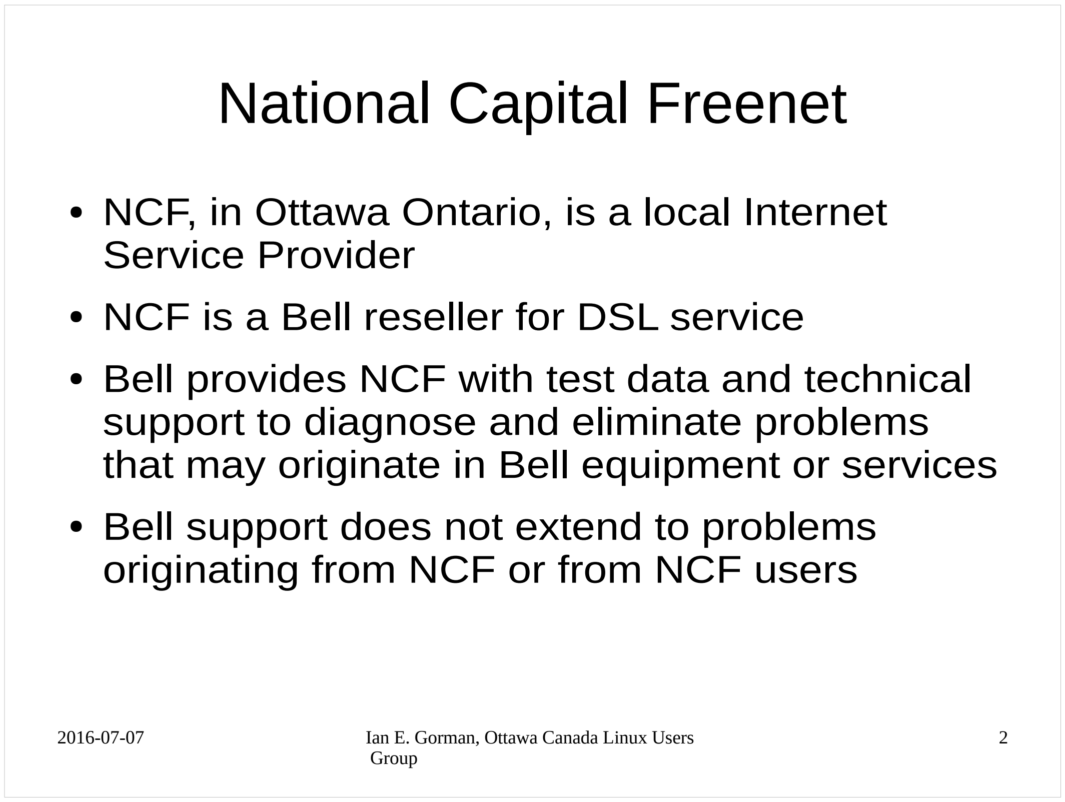

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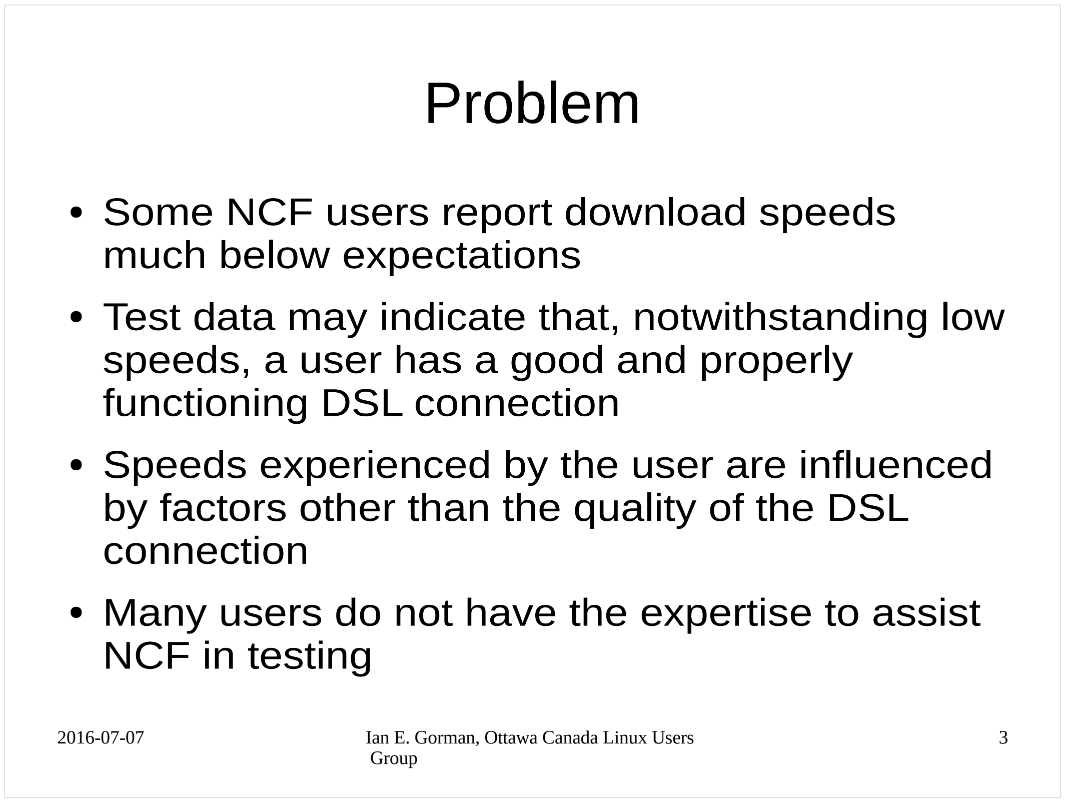

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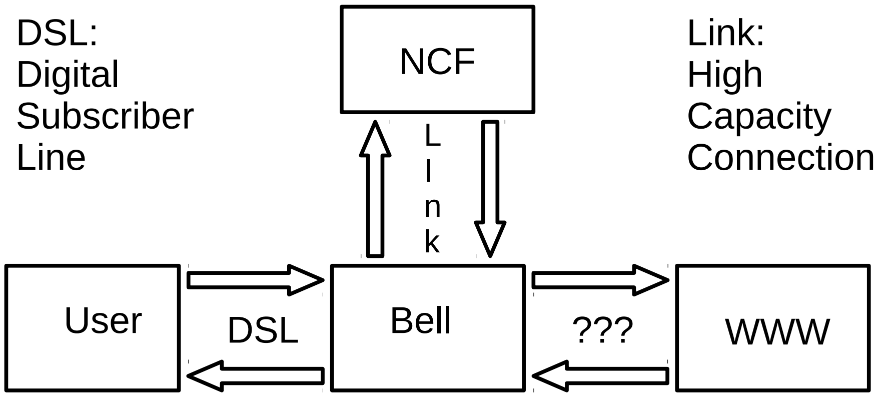

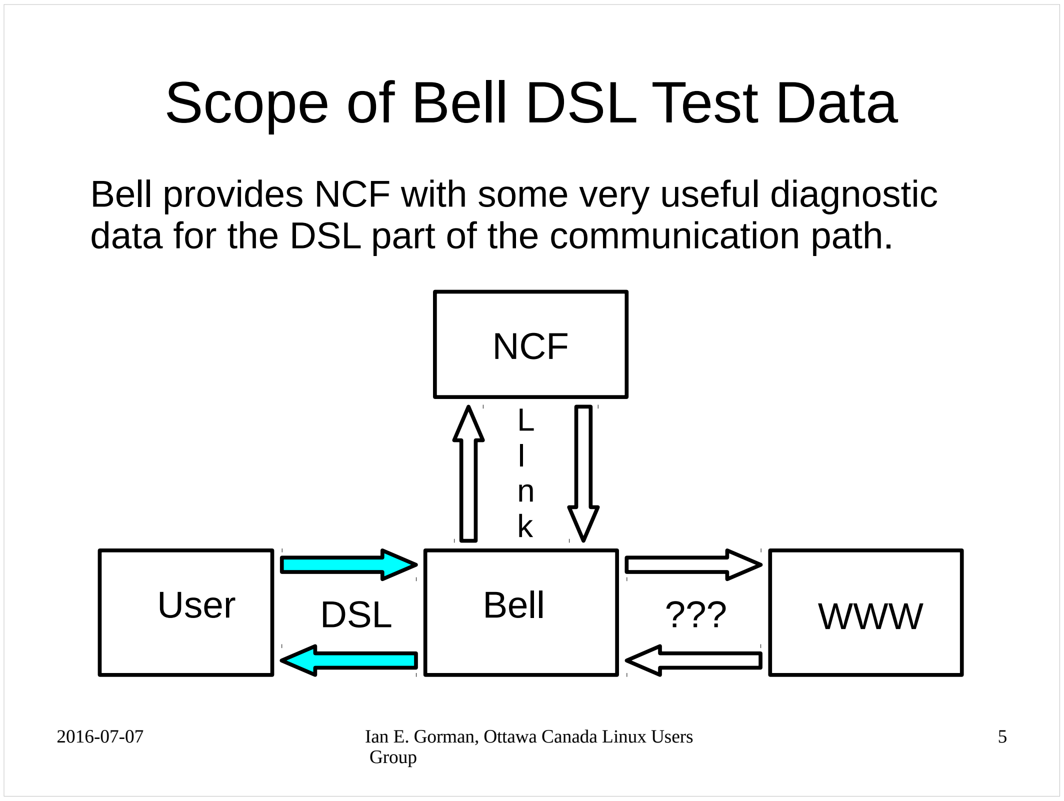

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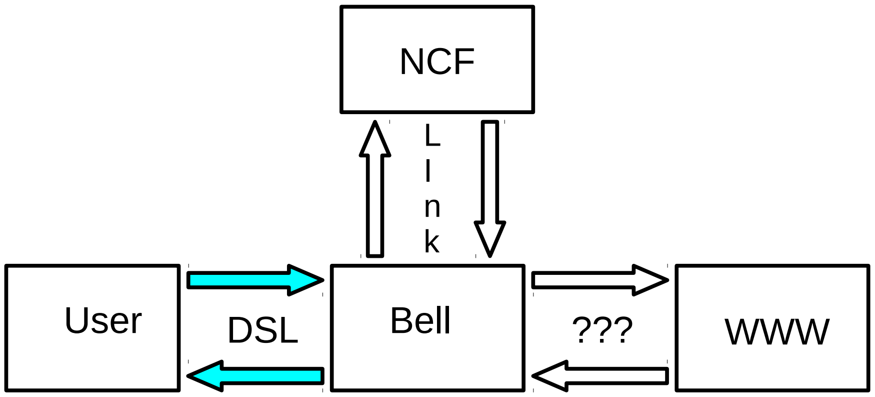

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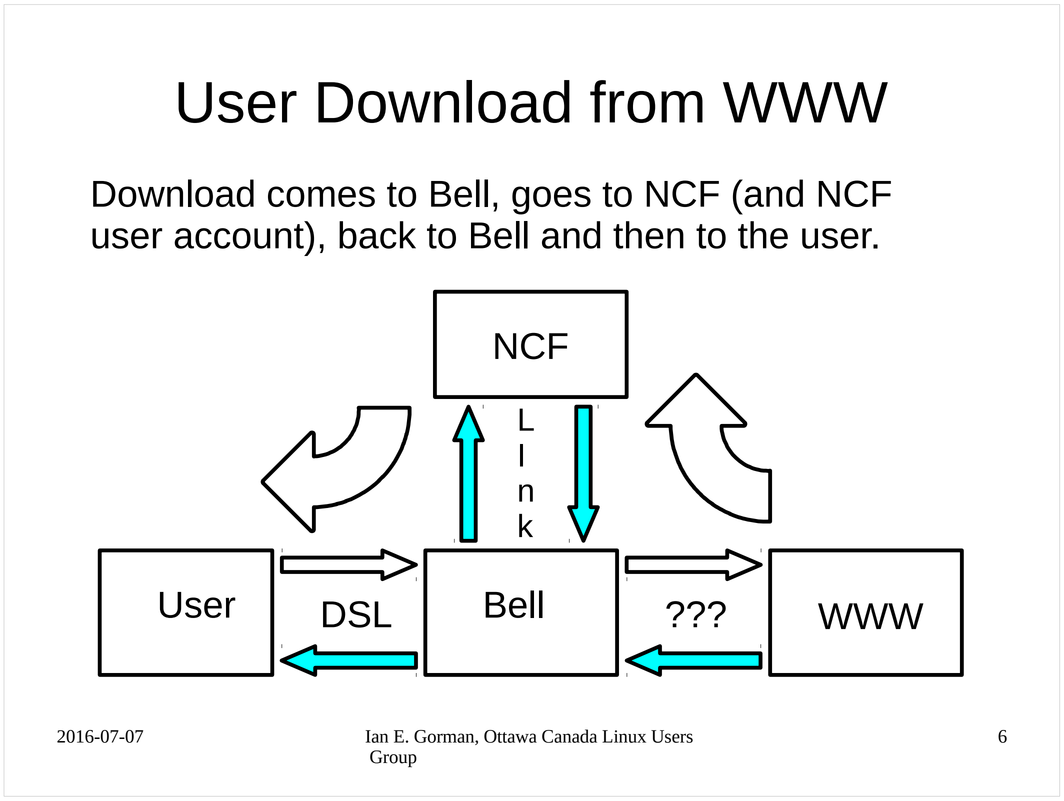

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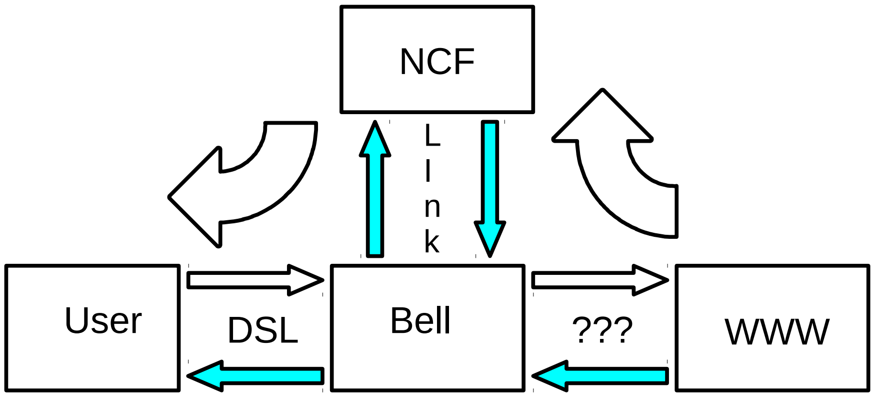

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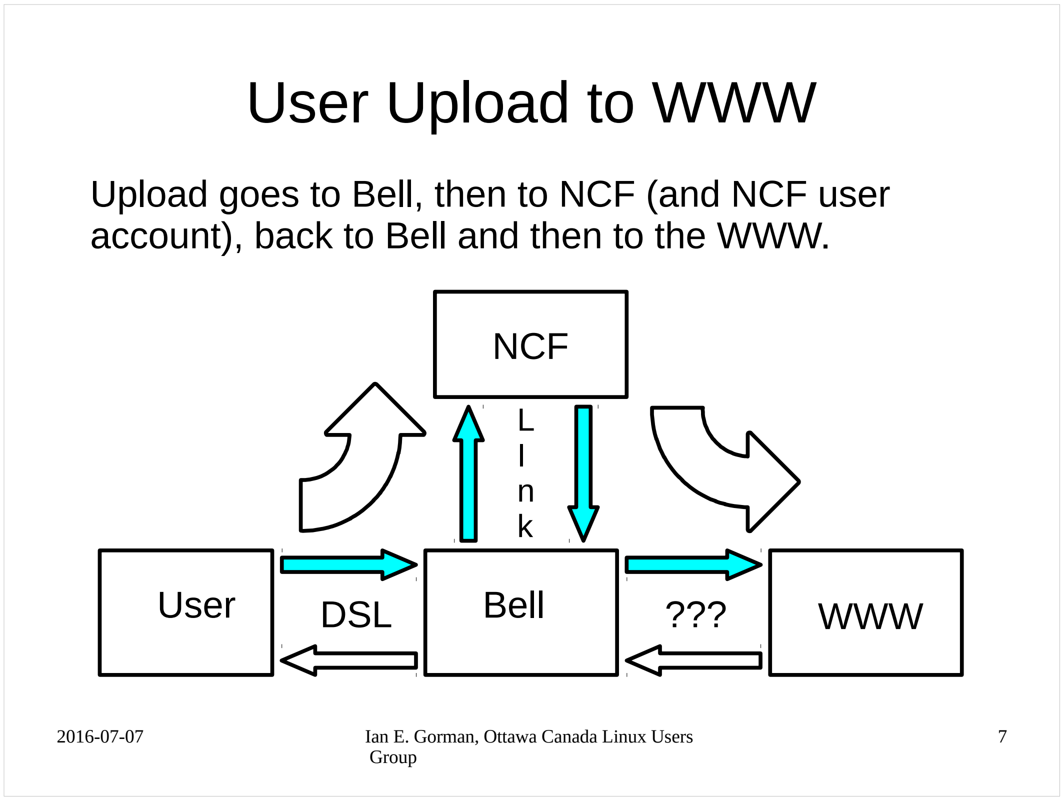

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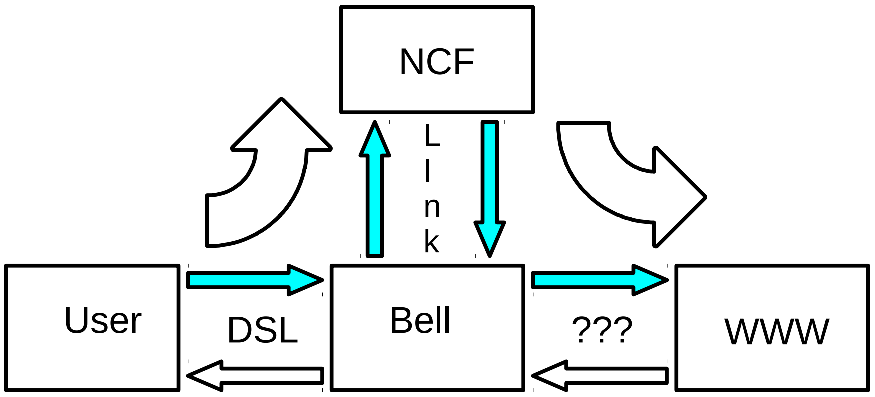

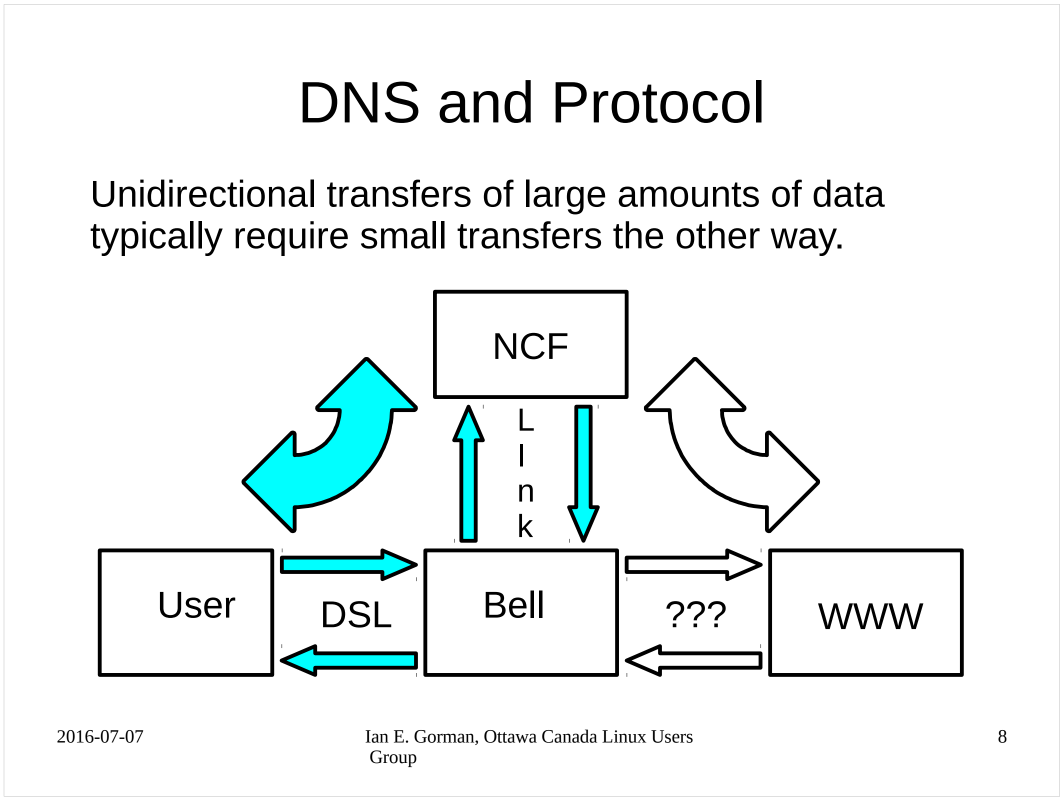

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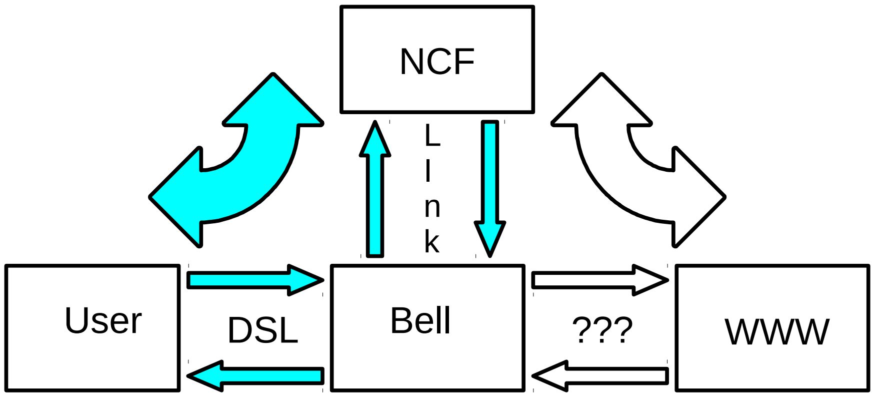

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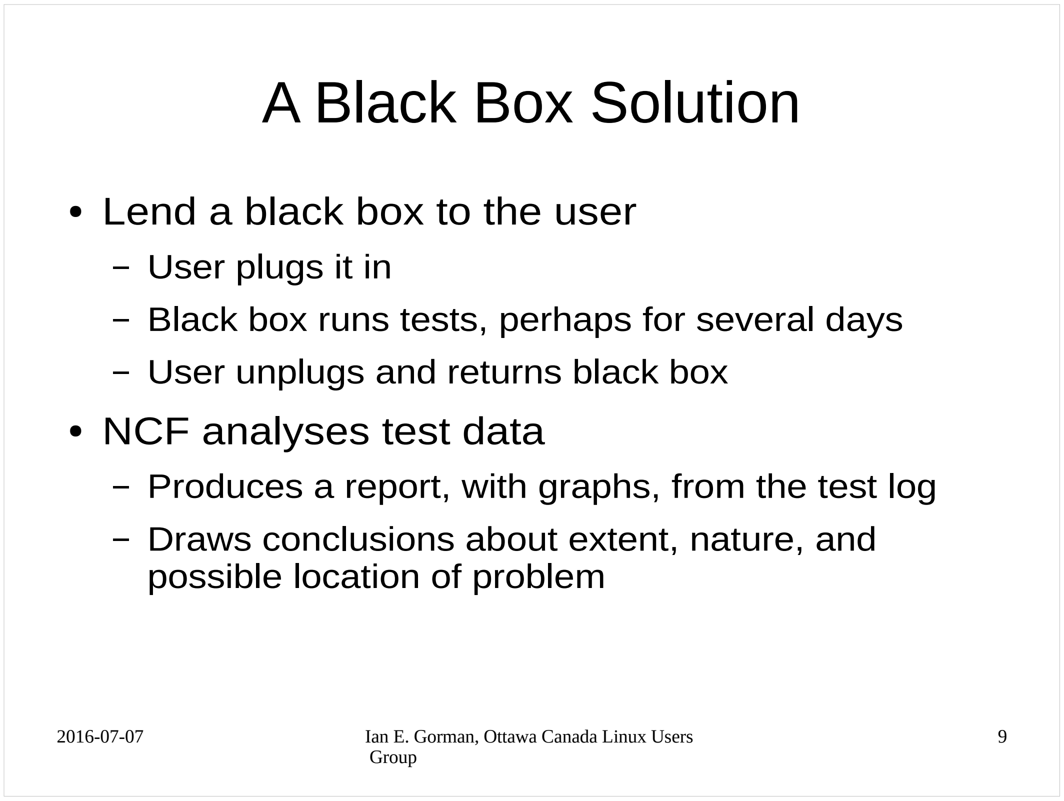

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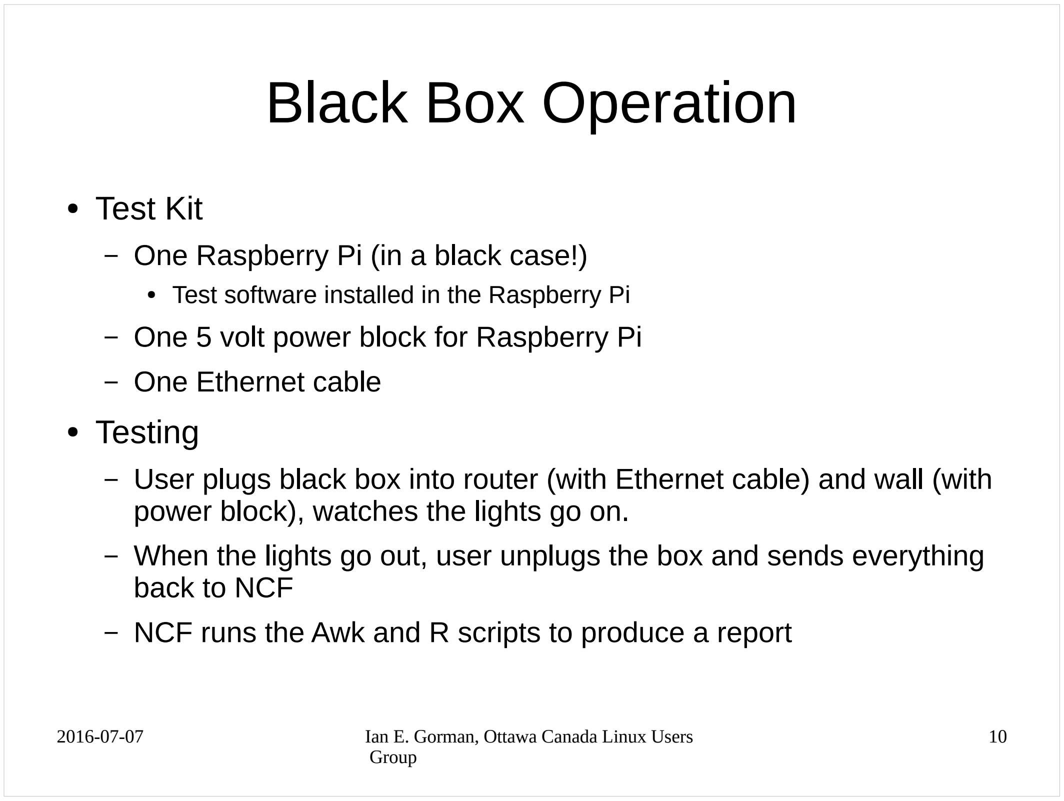

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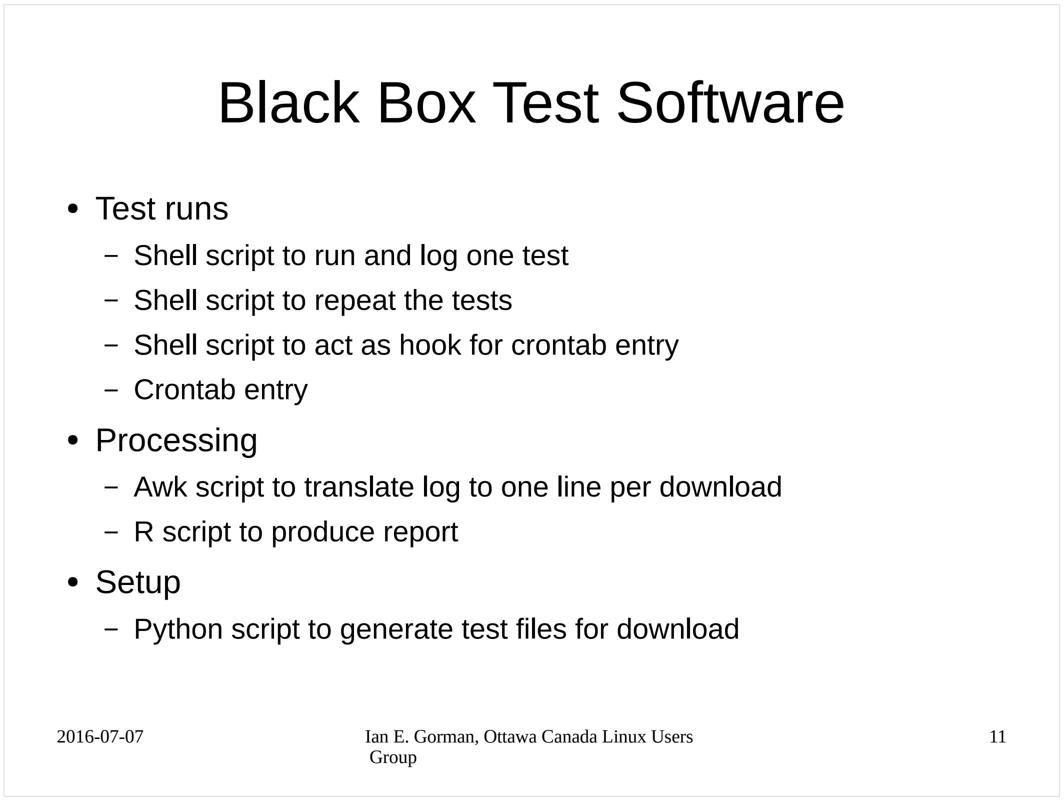

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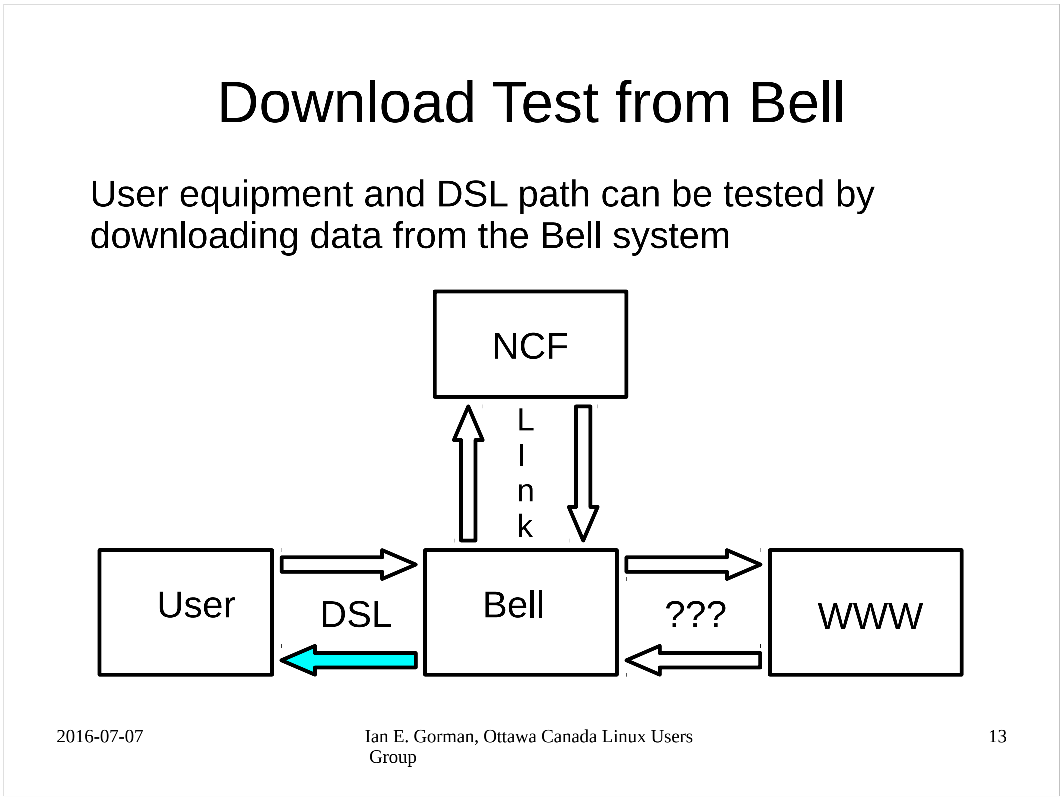

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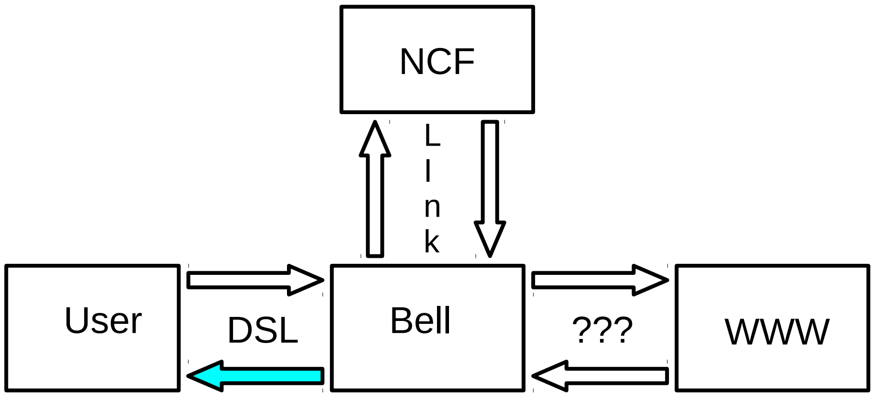

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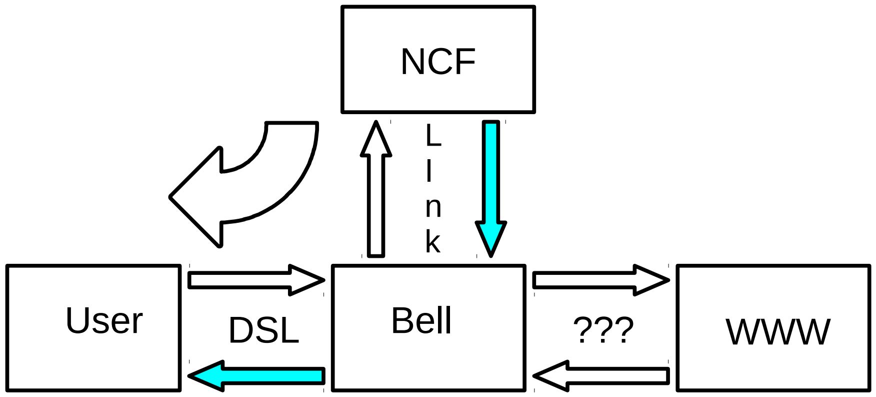
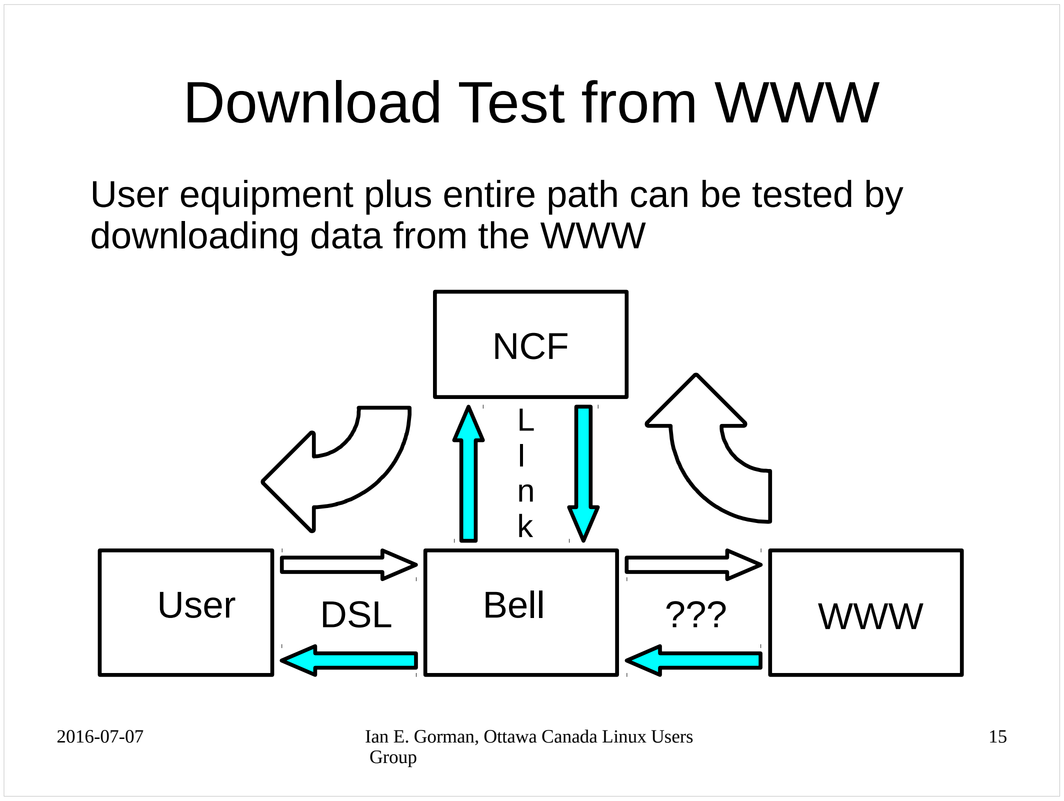
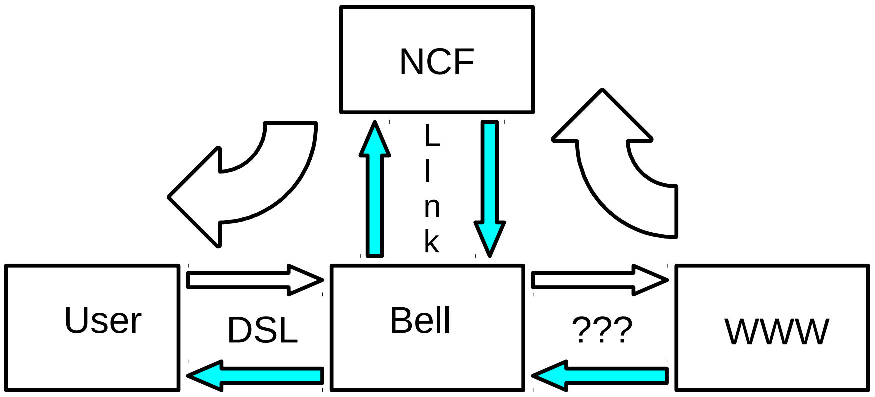




Download Test from WWW

User equipment plus entire path can be tested by downloading data from the WWW



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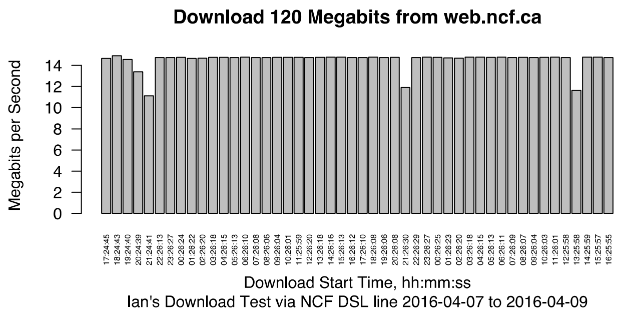

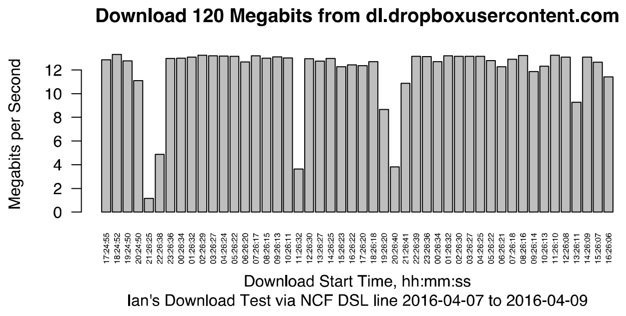

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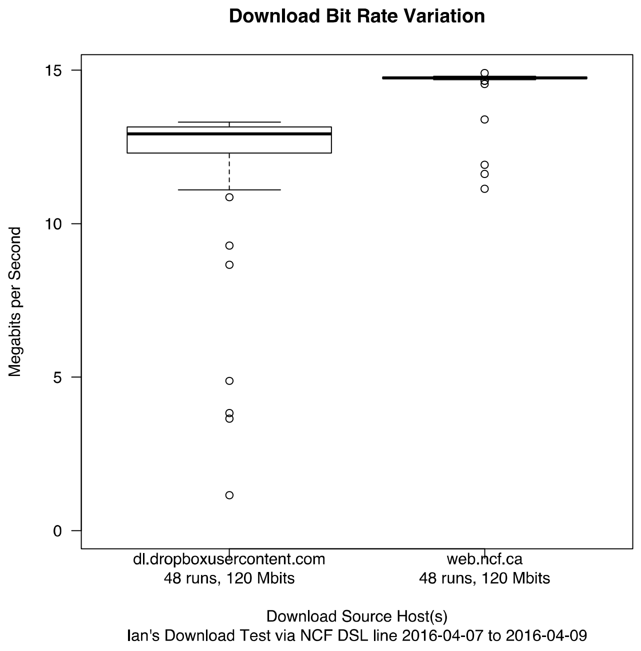

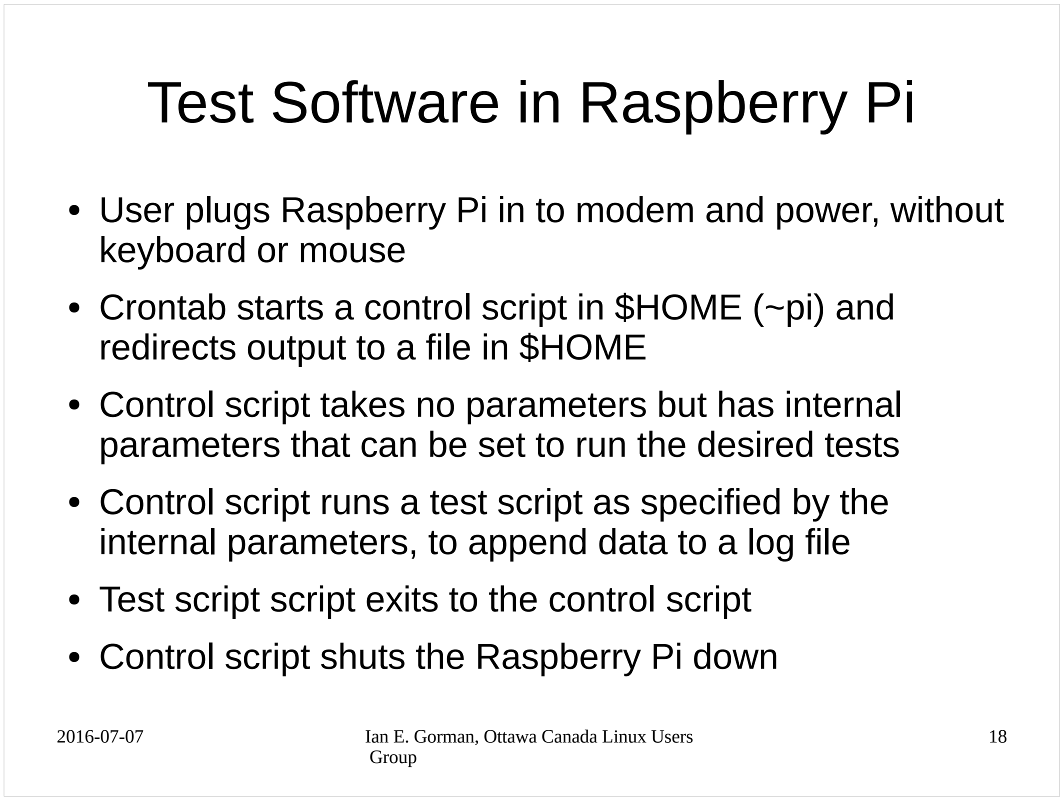

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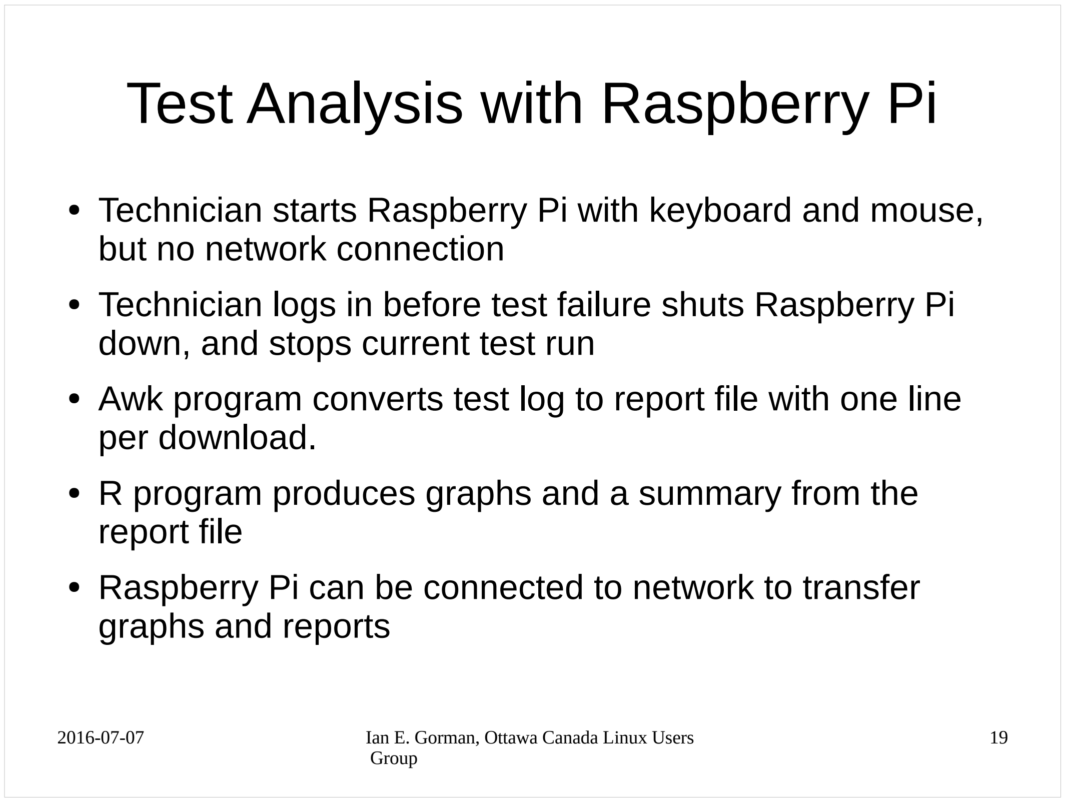

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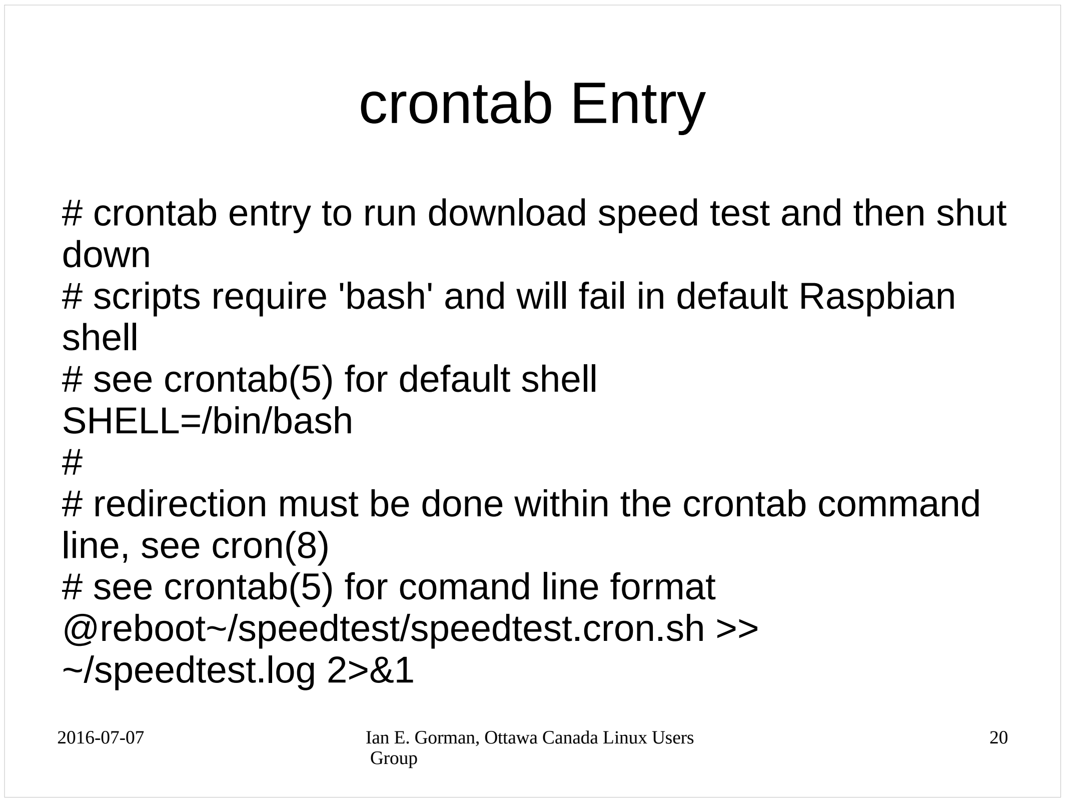

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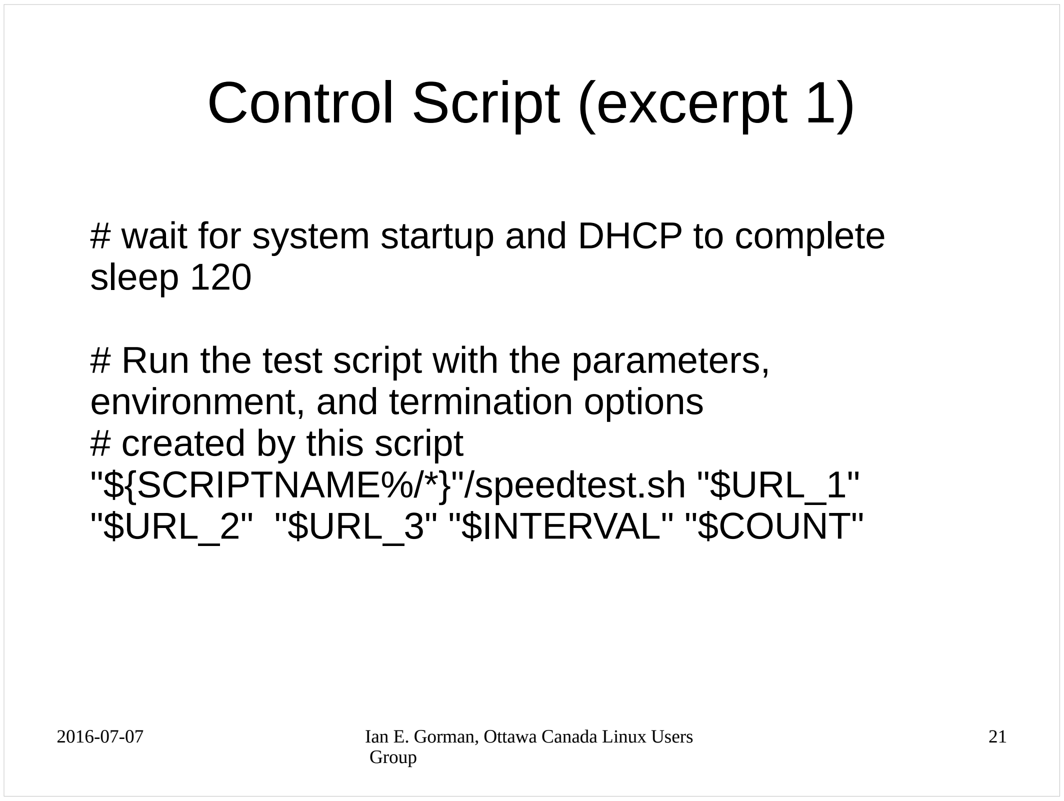

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# created by this script
"${SCRIPTNAME%/*}"/speedtest.sh "$URL_1"
"$URL_2"  "$URL_3" "$INTERVAL" "$COUNT"
```

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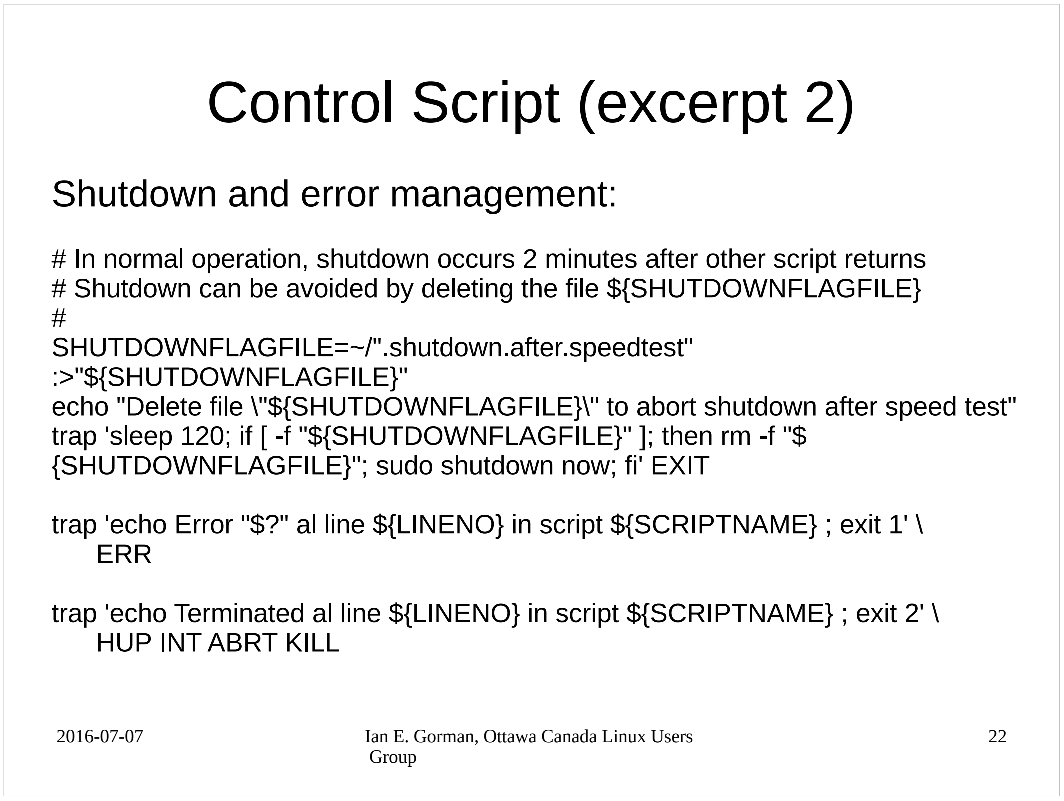
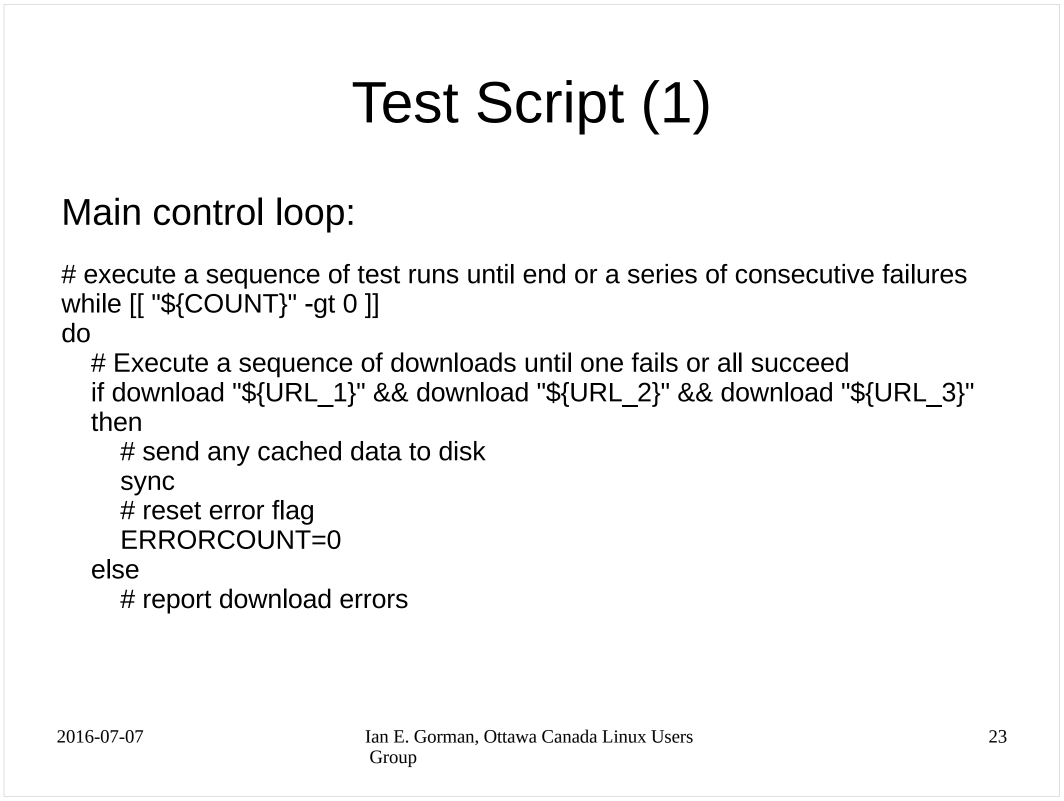


Control Script (excerpt 2)

Shutdown and error management:

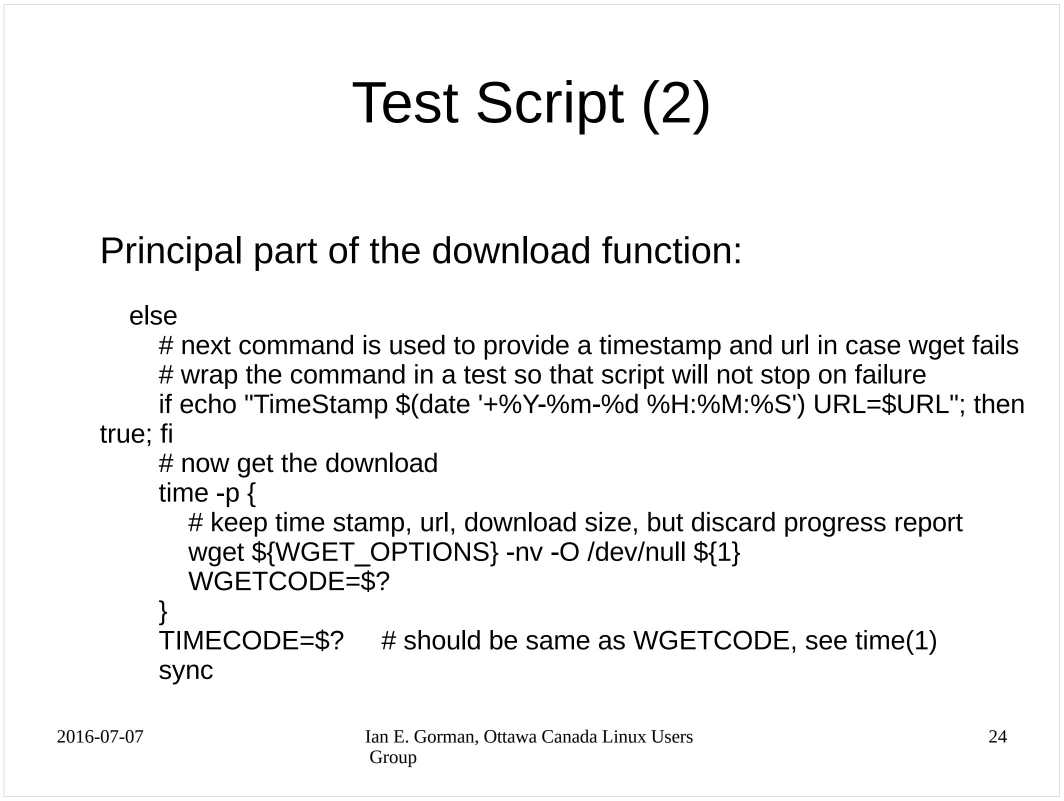
```
# In normal operation, shutdown occurs 2 minutes after other script returns
# Shutdown can be avoided by deleting the file ${SHUTDOWNFLAGFILE}
#
SHUTDOWNFLAGFILE=~/".shutdown.after.speedtest"
:>"${SHUTDOWNFLAGFILE}"
echo "Delete file \"${SHUTDOWNFLAGFILE}\" to abort shutdown after speed test"
trap 'sleep 120; if [ -f "${SHUTDOWNFLAGFILE}" ]; then rm -f "$
{SHUTDOWNFLAGFILE}"; sudo shutdown now; fi' EXIT

trap 'echo Error "$?" al line ${LINENO} in script ${SCRIPTNAME} ; exit 1' \
    ERR

trap 'echo Terminated al line ${LINENO} in script ${SCRIPTNAME} ; exit 2' \
    HUP INT ABRT KILL
```



Test Script (1)

Main control loop:

```
# execute a sequence of test runs until end or a series of consecutive failures
while [[ "${COUNT}" -gt 0 ]]
do
    # Execute a sequence of downloads until one fails or all succeed
    if download "${URL_1}" && download "${URL_2}" && download "${URL_3}"
    then
        # send any cached data to disk
        sync
        # reset error flag
        ERRORCOUNT=0
    else
        # report download errors
```



Test Script (2)

Principal part of the download function:

```
  else
      # next command is used to provide a timestamp and url in case wget fails
      # wrap the command in a test so that script will not stop on failure
      if echo "TimeStamp $(date '+%Y-%m-%d %H:%M:%S') URL=$URL"; then true; fi
      # now get the download
      time -p {
          # keep time stamp, url, download size, but discard progress report
          wget ${WGET_OPTIONS} -nv -O /dev/null ${1}
          WGETCODE=$?
      }
      TIMECODE=$?     # should be same as WGETCODE, see time(1)
      sync
```

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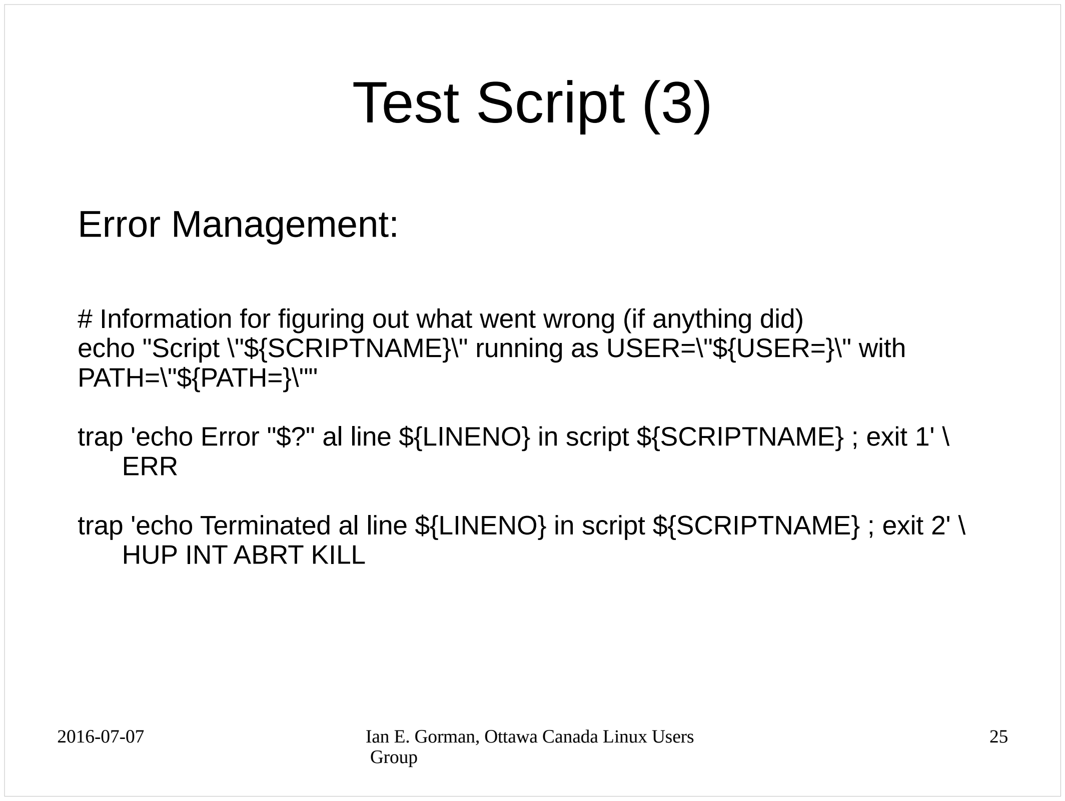

Test Script (3)

Error Management:

```
# Information for figuring out what went wrong (if anything did)
echo "Script \"${SCRIPTNAME}\" running as USER=\"${USER=}\" with
PATH=\"${PATH=}\""

trap 'echo Error "$?" al line ${LINENO} in script ${SCRIPTNAME} ; exit 1' \
      ERR

trap 'echo Terminated al line ${LINENO} in script ${SCRIPTNAME} ; exit 2' \
      HUP INT ABRT KILL
```

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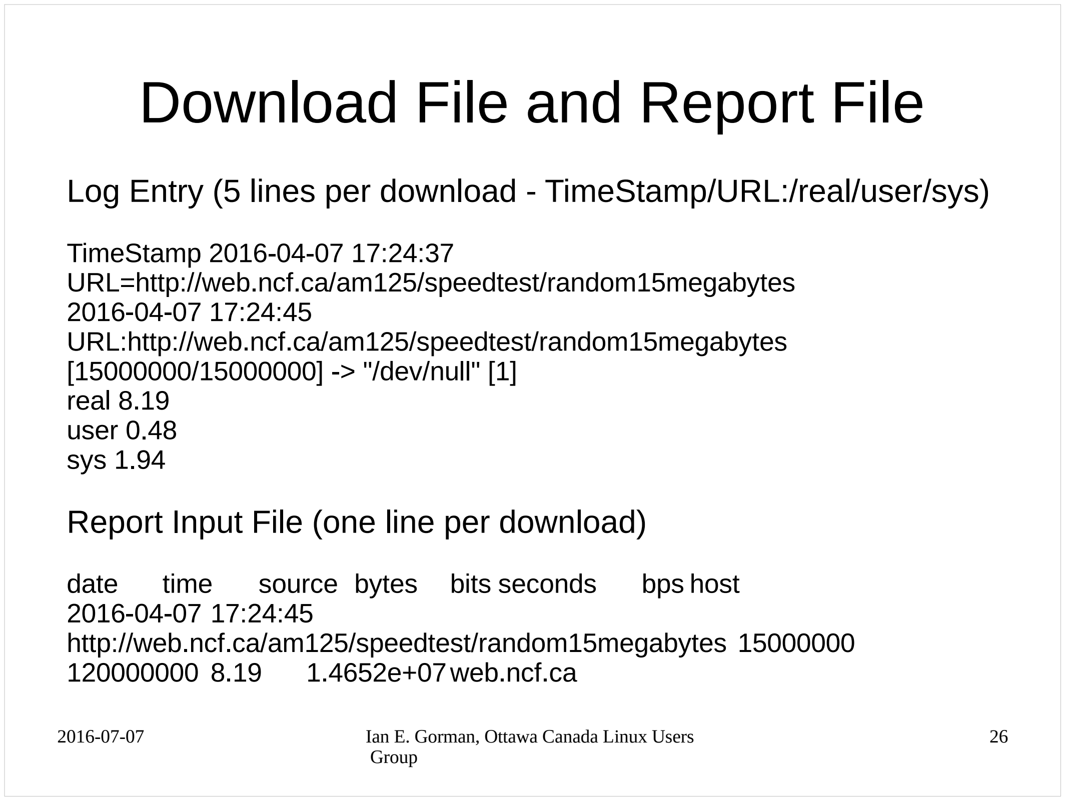

Download File and Report File

Log Entry (5 lines per download - TimeStamp/URL:/real/user/sys)

```
TimeStamp 2016-04-07 17:24:37
URL=http://web.ncf.ca/am125/speedtest/random15megabytes
2016-04-07 17:24:45
URL:http://web.ncf.ca/am125/speedtest/random15megabytes
[15000000/15000000] -> "/dev/null" [1]
real 8.19
user 0.48
sys 1.94
```

Report Input File (one line per download)

```
date      time      source  bytes     bits seconds      bps host
2016-04-07 17:24:45
http://web.ncf.ca/am125/speedtest/random15megabytes  15000000
120000000  8.19      1.4652e+07 web.ncf.ca
```

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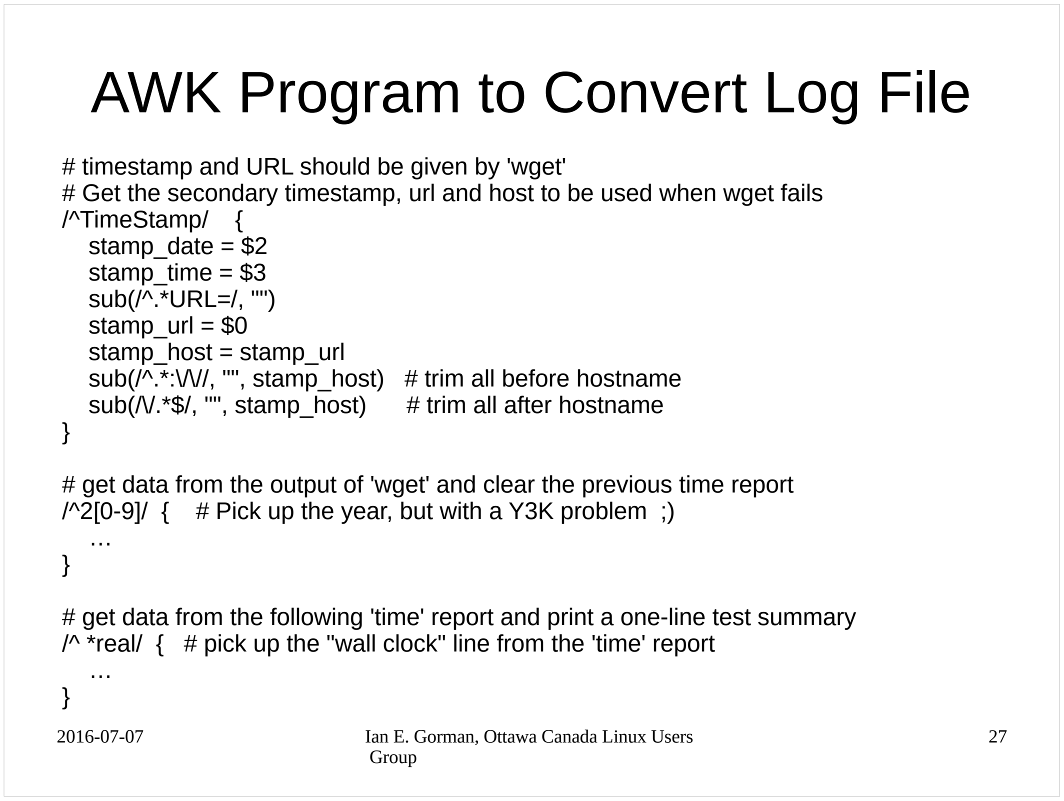

AWK Program to Convert Log File

```
# timestamp and URL should be given by 'wget'
# Get the secondary timestamp, url and host to be used when wget fails
/^TimeStamp/    {
    stamp_date = $2
    stamp_time = $3
    sub(/^.*URL=/, "")
    stamp_url = $0
    stamp_host = stamp_url
    sub(/^.*:\/\//, "", stamp_host)   # trim all before hostname
    sub(/\/.*$/, "", stamp_host)      # trim all after hostname
}

# get data from the output of 'wget' and clear the previous time report
/^2[0-9]/  {    # Pick up the year, but with a Y3K problem  ;)
    …
}

# get data from the following 'time' report and print a one-line test summary
/^ *real/  {   # pick up the "wall clock" line from the 'time' report
    …
}
```

The Black Box Test Kit