Test

August 26, 2022

1 Behavior Tests

This notebook is used to test the behavior (not the performance) of the prototype. I.e. we are interested in the user's experience. We use the following tests: * iperf3 to determine the SSH's tunnel link's speed (VM to VM); * iperf3 to determine the Docker's virtual network link's speed (container to container on the same VM); * netcat to determine a baseline for file sharing between VMs (via the SSH tunnel); * a baseline of our crypto implementation (i.e. just the crypto, without transfering the test files); * file sharing via IPFS on the same VM (node to node); * file sharing via IPFS using two VMs (node to node); * and file sharing via IPFS using two VMs via a (v1/Bitswap) relay.

We store the results in .csv files, which we will then plot.

1.1 Generate test files containing random data

[1]:
```
print('Generating...')
!head -c 1048576 </dev/urandom >testfile_1_MiB.bin
!head -c 10485760 </dev/urandom >testfile_10_MiB.bin
!head -c 104857600 </dev/urandom >testfile_100_MiB.bin
!head -c 524288000 </dev/urandom >testfile_500_MiB.bin
!head -c 1073741824 </dev/urandom >testfile_1_GiB.bin
#!head -c 5368709120 </dev/urandom >testfile_5_GiB.bin
!sha256sum testfile_1_MiB.bin|cut -d' ' -f1 > testfile_1_MiB.bin.sha256sum
!sha256sum testfile_10_MiB.bin|cut -d' ' -f1 > testfile_10_MiB.bin.sha256sum
!sha256sum testfile_100_MiB.bin|cut -d' ' -f1 > testfile_100_MiB.bin.sha256sum
!sha256sum testfile_500_MiB.bin|cut -d' ' -f1 > testfile_500_MiB.bin.sha256sum
!sha256sum testfile_1_GiB.bin|cut -d' ' -f1 > testfile_1_GiB.bin.sha256sum
#!sha256sum testfile_5_GiB.bin|cut -d' ' -f1 > testfile_5_GiB.bin.sha256sum
print('Done!')
```

```
Generating…
Done!
```

1.2 Obtain the link speed

1.2.1 SSH tunnel

We can obtain an SSH tunnel's link speed as follows:

`(run this command from the VM itself, so not from within this JupyterLab container)`

```
ssh <user>@<dockerhost> -L 127.0.0.1:4444:127.0.0.1:4444 "iperf3 -s -B 127.0.0.1 -p 4444"
(launch a new terminal window)
iperf3 -c 127.0.0.1 -p 4444
```

1.2.2 Docker virtual network

We can obtain the link speed between two containers on the same VM as follows:

```
(run this command from the VM itself, so not from within this JupyterLab container)
docker run -it --name iperfserver --rm --network jovian-colab_demo-net alpine sh -c "apk add i
(launch a new terminal window)
docker run -it --name iperfclient --rm --network jovian-colab_demo-net alpine sh -c "apk add i
```

1.3 Generate netcat results

Using the generated test files above (which are available on our VM via a bind mount), we can measure the transfer time via netcat (over an SSH tunnel) using our script:

```
(run this command from the VM itself, so not from within this JupyterLab container)
./baseline_nc.sh VM-B 127.0.0.1 4445
```

Either copy the test files to the script's directory (*'./src/ipfs'*) or vice versa. Note that the script creates multiple SSH connections, so make sure credentials are set up correctly (i.e. public-key authentication is configured in ~/.ssh/config). Once the script it finished, copy/move the resulted .csv file to this JupyterLab container.

1.4 Generate baseline crypto results

This test will encrypt/decrypt the various test files using multiple ciphers via the IPFS client Python module (without any transfer, encrypt/decrypt only). This gives us a baseline to compare the IPFS results against.

[1]:
```python
import jcipfsclient as ipfs
import time

# Test configuration
files = ['testfile_1_MiB.bin','testfile_10_MiB.bin','testfile_100_MiB.
 ↪bin','testfile_500_MiB.bin','testfile_1_GiB.bin']
ciphers = ['plain','ChaCha20','Salsa20','AES_256_CTR']
rounds = 20

print('Processing crypto baseline...')

with open('baseline_crypto_duration_results.csv', 'w') as results:
  # .csv header
  delimiter = ';'
```

```
results.write('File;SHA256;Cipher;Round;Time_Encrypt_Wall_Start;
↪Time_Encrypt_Wall_Stop;Time_Decrypt_Wall_Start;Time_Decrypt_Wall_Stop;
↪Time_Encrypt_Duration_Wall;Time_Decrypt_Duration_Wall;
↪Time_Encrypt_Duration_Cpu;Time_Decrypt_Duration_Cpu;Time_Total_Duration_Wall;
↪Time_Total_Duration_Cpu;Match\n')

# Run the test
for cipherMode in ciphers:
  for file in files:
    for round in range(0, rounds):
      print('Round ' + str(round+1) + '/' + str(rounds) + ' for file ' +␣
↪str(file) + ' using cipher ' + str(cipherMode))
      chunkSize = 1024*1024*10
      base64Key = ipfs.genKey(cipherMode)

      # Encrypt file
      filenameEncrypted = file + '.encrypted'
      with open(file, 'rb') as fileOriginal:
        with open(filenameEncrypted, 'wb') as fileEncrypted:
          timestampEncryptWallStart = time.time()
          timestampEncryptCpuStart = time.process_time()
          for chunk in ipfs.encrypt(fileOriginal, base64Key, chunkSize,␣
↪cipherMode):
            fileEncrypted.write(chunk)
          timestampEncryptCpuStop = time.process_time()
          timestampEncryptWallStop = time.time()
          timestampEncryptCpuDuration = timestampEncryptCpuStop -␣
↪timestampEncryptCpuStart
          timestampEncryptWallDuration = timestampEncryptWallStop -␣
↪timestampEncryptWallStart

      # Decrypt file
      filenameDecrypted = file + '.decrypted'
      with open(filenameEncrypted, 'rb') as fileEncrypted:
        with open(filenameDecrypted, 'wb') as fileDecrypted:
          timestampDecryptWallStart = time.time()
          timestampDecryptCpuStart = time.process_time()
          for chunk in ipfs.decrypt_from_file(fileEncrypted, base64Key,␣
↪chunkSize, cipherMode):
            fileDecrypted.write(chunk)
          timestampDecryptCpuStop = time.process_time()
          timestampDecryptWallStop = time.time()
          timestampDecryptCpuDuration = timestampDecryptCpuStop -␣
↪timestampDecryptCpuStart
          timestampDecryptWallDuration = timestampDecryptWallStop -␣
↪timestampDecryptWallStart
```

```
        # Compare decrypted file to original (hash has to be the same)
        same = '?'
        hashFileDecrypted = !sha256sum $filenameDecrypted|cut -d' ' -f1
        hashFileDecrypted = hashFileDecrypted.nlstr.rstrip()
        with open(file + '.sha256sum', 'r') as fileOriginalHash:
          hashOriginal = fileOriginalHash.readlines()
          hashOriginal = hashOriginal[0].rstrip()
          if hashFileDecrypted == hashOriginal:
            same = 'yes'
          else:
            same = 'no'
            print('Warning: hash mismatch between original and decrypted (file:␣
↪\'' + file + '\', cipher: ' + cipherMode + ')!')

        # Write results to .csv file and clean up test files / storage
        results.write(file + delimiter + hashOriginal + delimiter + cipherMode␣
↪+ delimiter + str(round) + delimiter + str(timestampEncryptWallStart) +␣
↪delimiter + str(timestampEncryptWallStop) + delimiter +␣
↪str(timestampDecryptWallStart) + delimiter + str(timestampDecryptWallStop) +␣
↪delimiter + str(timestampEncryptWallDuration) + delimiter +␣
↪str(timestampDecryptWallDuration) + delimiter +␣
↪str(timestampEncryptCpuDuration) + delimiter +␣
↪str(timestampDecryptCpuDuration) + delimiter +␣
↪str(timestampEncryptWallDuration + timestampDecryptWallDuration) + delimiter␣
↪+ str(timestampEncryptCpuDuration + timestampDecryptCpuDuration) + delimiter␣
↪+ same + '\n')
        !rm $filenameEncrypted $filenameDecrypted

print('Done!')
```

```
Processing crypto baseline…
Round 1/20 for file testfile_1_MiB.bin using cipher plain
Round 2/20 for file testfile_1_MiB.bin using cipher plain
Round 3/20 for file testfile_1_MiB.bin using cipher plain
Round 4/20 for file testfile_1_MiB.bin using cipher plain
Round 5/20 for file testfile_1_MiB.bin using cipher plain
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Round 7/20 for file testfile_1_MiB.bin using cipher plain
Round 8/20 for file testfile_1_MiB.bin using cipher plain
Round 9/20 for file testfile_1_MiB.bin using cipher plain
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Round 11/20 for file testfile_1_MiB.bin using cipher plain
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Round 20/20 for file testfile_500_MiB.bin using cipher plain
Round 1/20 for file testfile_1_GiB.bin using cipher plain
Round 2/20 for file testfile_1_GiB.bin using cipher plain
Round 3/20 for file testfile_1_GiB.bin using cipher plain
Round 4/20 for file testfile_1_GiB.bin using cipher plain
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Round 9/20 for file testfile_500_MiB.bin using cipher Salsa20
Round 10/20 for file testfile_500_MiB.bin using cipher Salsa20
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Round 17/20 for file testfile_500_MiB.bin using cipher Salsa20
Round 18/20 for file testfile_500_MiB.bin using cipher Salsa20
Round 19/20 for file testfile_500_MiB.bin using cipher Salsa20
Round 20/20 for file testfile_500_MiB.bin using cipher Salsa20
Round 1/20 for file testfile_1_GiB.bin using cipher Salsa20
Round 2/20 for file testfile_1_GiB.bin using cipher Salsa20
Round 3/20 for file testfile_1_GiB.bin using cipher Salsa20
Round 4/20 for file testfile_1_GiB.bin using cipher Salsa20
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Round 18/20 for file testfile_1_GiB.bin using cipher Salsa20
Round 19/20 for file testfile_1_GiB.bin using cipher Salsa20
Round 20/20 for file testfile_1_GiB.bin using cipher Salsa20
Round 1/20 for file testfile_1_MiB.bin using cipher AES_256_CTR
Round 2/20 for file testfile_1_MiB.bin using cipher AES_256_CTR
Round 3/20 for file testfile_1_MiB.bin using cipher AES_256_CTR
Round 4/20 for file testfile_1_MiB.bin using cipher AES_256_CTR
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Round 19/20 for file testfile_1_MiB.bin using cipher AES_256_CTR
Round 20/20 for file testfile_1_MiB.bin using cipher AES_256_CTR
Round 1/20 for file testfile_10_MiB.bin using cipher AES_256_CTR
Round 2/20 for file testfile_10_MiB.bin using cipher AES_256_CTR
Round 3/20 for file testfile_10_MiB.bin using cipher AES_256_CTR
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Round 20/20 for file testfile_100_MiB.bin using cipher AES_256_CTR
Round 1/20 for file testfile_500_MiB.bin using cipher AES_256_CTR
Round 2/20 for file testfile_500_MiB.bin using cipher AES_256_CTR
Round 3/20 for file testfile_500_MiB.bin using cipher AES_256_CTR
Round 4/20 for file testfile_500_MiB.bin using cipher AES_256_CTR
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Round 20/20 for file testfile_500_MiB.bin using cipher AES_256_CTR
Round 1/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 2/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 3/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 4/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 5/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 6/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 7/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
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Round 14/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 15/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 16/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 17/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 18/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 19/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 20/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Done!
```

1.5 Generate inter-notebook results

This test will exchange the various test files between two JupyterLab instances using IPFS (and encryption/decryption) via the IPFS client Python module. We will launch a web server on a second JupyterLab instance that allows for automated testing (i.e. remote control of the second instance / IPFS peer node). Note that we first have to join our IPFS nodes to the same IPFS private network. **SECURITY WARNING:** Do not expose this web server directly to the Internet (i.e. use a secure network / tunnel / VPN)!

1.5.1 Second JupyterLab instance (web server)

[ ]:
```python
from http.server import BaseHTTPRequestHandler, HTTPServer
from socket import getfqdn
from os import getenv
import jcipfsclient as ipfs
import json as JSON
import time

address = '0.0.0.0'
port = 4000
chunkSize = 1024*1024*10

# Local IPFS peer node address
node = getenv('IPFS_NODE')
nodeApiUrl = 'http://' + node + ':5001'

# Web server endpoints
class RequestHandler(BaseHTTPRequestHandler):
  def do_GET(self):
    self.send_response(200,)
    self.send_header("Content-type", "application/json")
    self.end_headers()
    if self.path == "/" or self.path == "/hello":
      response = {'Hello': str(getfqdn())}
    if self.path == "/hash":
      hashFileDownloaded = !sha256sum testfile.download|cut -d' ' -f1
      hashFileDownloaded = hashFileDownloaded.nlstr.rstrip()
      response = {'hashFileDownloaded': hashFileDownloaded}
    if self.path == "/garbagecollect":
      !rm testfile.download
      ipfs.collectGarbage(nodeApiUrl)
      response = {'collectGarbage': 'complete'}
    self.wfile.write(bytes(JSON.dumps(response), 'utf-8'))

  def do_POST(self):
    self.send_response(200)
    self.send_header('Content-Type', 'application/json')
    self.end_headers()
    length = int(self.headers.get('Content-Length'))
    body = self.rfile.read(length)
    body = body.decode("utf-8")
    if self.path == "/download":
      metadata = JSON.loads(body)
      timestampDownloadWallStart = time.time()
      ipfs.getFile(nodeApiUrl, metadata['cid'], 'testfile.download',␣
↪metadata['base64Key'], chunkSize, metadata['cipherMode'])
      timestampDownloadWallStop = time.time()
      timestampDownloadWallDuration = timestampDownloadWallStop -␣
↪timestampDownloadWallStart
      response = {'timestampDownloadWallStart':␣
↪str(timestampDownloadWallStart), 'timestampDownloadWallStop':␣
↪str(timestampDownloadWallStop), 'timestampDownloadWallDuration':␣
↪str(timestampDownloadWallDuration)}
    self.wfile.write(bytes(JSON.dumps(response), 'utf-8'))

# Launch the web server
server = HTTPServer((address, port), RequestHandler)
print('Web server started at http://' + address + ':' + str(port))
try:
  server.serve_forever()
except KeyboardInterrupt:
  pass
finally:
  server.server_close()

print('Web server stopped')
```

1.5.2 First JupyterLab instance (test)

```
[1]: import jcipfsclient as ipfs
import time
from os import getenv
import requests

# Test configuration
files = ['testfile_1_MiB.bin','testfile_10_MiB.bin','testfile_100_MiB.
↪bin','testfile_500_MiB.bin','testfile_1_GiB.bin']
ciphers = ['plain','ChaCha20','Salsa20','AES_256_CTR']
rounds = 20
chunkSize = 1024*1024*10
#remoteHostUrl = 'http://notebook.jupyter-2.localhost:4000'
```

```
remoteHostUrl = 'http://notebook.jupyter-ext.localhost:4000'

# Local IPFS peer node address
#ipfsnode = getenv('IPFS_NODE')
ipfsnode = 'peer0.pnet0.orga.ipfs.localhost'
nodeApiUrl = 'http://' + ipfsnode + ':5001'

print('Processing IPFS file sharing...')

with open('inter_notebook_file_sharing_duration_results.csv', 'w') as results:
  # .csv header
  delimiter = ';'
  results.write('File;SHA256;Cipher;Round;Time_Upload_Wall_Start;
 ↪Time_Upload_Wall_Stop;Time_Download_Wall_Start;Time_Download_Wall_Stop;
 ↪Time_Upload_Duration_Wall;Time_Download_Duration_Wall;
 ↪Time_Total_Duration_Wall;Match\n')

  # Run the test
  for cipherMode in ciphers:
    for file in files:
      for round in range(0, rounds):
        print('Round ' + str(round+1) + '/' + str(rounds) + ' for file ' +␣
 ↪str(file) + ' using cipher ' + str(cipherMode))

        # Upload (and encrypt) file to local IPFS node
        timestampUploadWallStart = time.time()
        metadata = ipfs.addFile(nodeApiUrl=nodeApiUrl, file=file,␣
 ↪base64Key=None, chunkSize=chunkSize, cipherMode=cipherMode)
        timestampUploadWallStop = time.time()

        # Instruct remote host to download (and decrypt) file from private IPFS␣
 ↪network
        response = requests.post(remoteHostUrl + '/download', json = metadata,␣
 ↪timeout=None)
        response = response.json()
        timestampDownloadWallStart = response['timestampDownloadWallStart']
        timestampDownloadWallStop = response['timestampDownloadWallStop']
        timestampDownloadWallDuration =␣
 ↪response['timestampDownloadWallDuration']

        # Compare downloaded (plaintext) file to original (hash has to be the␣
 ↪same)
        same = '?'
        response = requests.get(remoteHostUrl + '/hash', timeout=None)
        response = response.json()
        hashFileDownloaded = response['hashFileDownloaded']
        with open(file + '.sha256sum', 'r') as fileOriginalHash:
          hashOriginal = fileOriginalHash.readlines()
          hashOriginal = hashOriginal[0].rstrip()
          if hashFileDownloaded == hashOriginal:
            same = 'yes'
          else:
            same = 'no'
            print('Warning: hash mismatch between original and downloaded (file:
 ↪ \'' + file + '\', cipher: ' + cipherMode + ')!')

        # Write results to .csv file and clean up test files / storage
        results.write(file + delimiter + hashOriginal + delimiter + cipherMode␣
 ↪+ delimiter + str(round) + delimiter + str(timestampUploadWallStart) +␣
 ↪delimiter + str(timestampUploadWallStop) + delimiter +␣
 ↪timestampDownloadWallStart + delimiter + timestampDownloadWallStop  +␣
 ↪delimiter + str(timestampUploadWallStop - timestampUploadWallStart) +␣
 ↪delimiter + timestampDownloadWallDuration + delimiter +␣
 ↪str(float(timestampUploadWallStop - timestampUploadWallStart) +␣
 ↪float(timestampDownloadWallDuration)) + delimiter + same + '\n')
        ipfs.rmPin(nodeApiUrl, metadata['cid'])
        ipfs.collectGarbage(nodeApiUrl)
        requests.get(remoteHostUrl + '/garbagecollect', timeout=None)

print('Done!')
```

```
Processing IPFS file sharing…
Round 1/20 for file testfile_1_MiB.bin using cipher plain
Round 2/20 for file testfile_1_MiB.bin using cipher plain
Round 3/20 for file testfile_1_MiB.bin using cipher plain
Round 4/20 for file testfile_1_MiB.bin using cipher plain
Round 5/20 for file testfile_1_MiB.bin using cipher plain
Round 6/20 for file testfile_1_MiB.bin using cipher plain
Round 7/20 for file testfile_1_MiB.bin using cipher plain
Round 8/20 for file testfile_1_MiB.bin using cipher plain
Round 9/20 for file testfile_1_MiB.bin using cipher plain
Round 10/20 for file testfile_1_MiB.bin using cipher plain
Round 11/20 for file testfile_1_MiB.bin using cipher plain
Round 12/20 for file testfile_1_MiB.bin using cipher plain
Round 13/20 for file testfile_1_MiB.bin using cipher plain
Round 14/20 for file testfile_1_MiB.bin using cipher plain
Round 15/20 for file testfile_1_MiB.bin using cipher plain
Round 16/20 for file testfile_1_MiB.bin using cipher plain
Round 17/20 for file testfile_1_MiB.bin using cipher plain
Round 18/20 for file testfile_1_MiB.bin using cipher plain
Round 19/20 for file testfile_1_MiB.bin using cipher plain
Round 20/20 for file testfile_1_MiB.bin using cipher plain
Round 1/20 for file testfile_10_MiB.bin using cipher plain
Round 2/20 for file testfile_10_MiB.bin using cipher plain
Round 3/20 for file testfile_10_MiB.bin using cipher plain
Round 4/20 for file testfile_10_MiB.bin using cipher plain
Round 5/20 for file testfile_10_MiB.bin using cipher plain
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Round 11/20 for file testfile_10_MiB.bin using cipher plain
Round 12/20 for file testfile_10_MiB.bin using cipher plain
Round 13/20 for file testfile_10_MiB.bin using cipher plain
Round 14/20 for file testfile_10_MiB.bin using cipher plain
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Round 1/20 for file testfile_100_MiB.bin using cipher plain
Round 2/20 for file testfile_100_MiB.bin using cipher plain
Round 3/20 for file testfile_100_MiB.bin using cipher plain
Round 4/20 for file testfile_100_MiB.bin using cipher plain
Round 5/20 for file testfile_100_MiB.bin using cipher plain
Round 6/20 for file testfile_100_MiB.bin using cipher plain
Round 7/20 for file testfile_100_MiB.bin using cipher plain
Round 8/20 for file testfile_100_MiB.bin using cipher plain
Round 9/20 for file testfile_100_MiB.bin using cipher plain
Round 10/20 for file testfile_100_MiB.bin using cipher plain
Round 11/20 for file testfile_100_MiB.bin using cipher plain
Round 12/20 for file testfile_100_MiB.bin using cipher plain
Round 13/20 for file testfile_100_MiB.bin using cipher plain
Round 14/20 for file testfile_100_MiB.bin using cipher plain
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Round 16/20 for file testfile_100_MiB.bin using cipher plain
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Round 18/20 for file testfile_100_MiB.bin using cipher plain
Round 19/20 for file testfile_100_MiB.bin using cipher plain
Round 20/20 for file testfile_100_MiB.bin using cipher plain
Round 1/20 for file testfile_500_MiB.bin using cipher plain
Round 2/20 for file testfile_500_MiB.bin using cipher plain
Round 3/20 for file testfile_500_MiB.bin using cipher plain
Round 4/20 for file testfile_500_MiB.bin using cipher plain
Round 5/20 for file testfile_500_MiB.bin using cipher plain
Round 6/20 for file testfile_500_MiB.bin using cipher plain
Round 7/20 for file testfile_500_MiB.bin using cipher plain
Round 8/20 for file testfile_500_MiB.bin using cipher plain
Round 9/20 for file testfile_500_MiB.bin using cipher plain
Round 10/20 for file testfile_500_MiB.bin using cipher plain
Round 11/20 for file testfile_500_MiB.bin using cipher plain
Round 12/20 for file testfile_500_MiB.bin using cipher plain
Round 13/20 for file testfile_500_MiB.bin using cipher plain
Round 14/20 for file testfile_500_MiB.bin using cipher plain
Round 15/20 for file testfile_500_MiB.bin using cipher plain
Round 16/20 for file testfile_500_MiB.bin using cipher plain
Round 17/20 for file testfile_500_MiB.bin using cipher plain
Round 18/20 for file testfile_500_MiB.bin using cipher plain
Round 19/20 for file testfile_500_MiB.bin using cipher plain
Round 20/20 for file testfile_500_MiB.bin using cipher plain
Round 1/20 for file testfile_1_GiB.bin using cipher plain
Round 2/20 for file testfile_1_GiB.bin using cipher plain
Round 3/20 for file testfile_1_GiB.bin using cipher plain
Round 4/20 for file testfile_1_GiB.bin using cipher plain
Round 5/20 for file testfile_1_GiB.bin using cipher plain
Round 6/20 for file testfile_1_GiB.bin using cipher plain
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Round 16/20 for file testfile_1_GiB.bin using cipher plain
Round 17/20 for file testfile_1_GiB.bin using cipher plain
Round 18/20 for file testfile_1_GiB.bin using cipher plain
Round 19/20 for file testfile_1_GiB.bin using cipher plain
Round 20/20 for file testfile_1_GiB.bin using cipher plain
Round 1/20 for file testfile_1_MiB.bin using cipher ChaCha20
Round 2/20 for file testfile_1_MiB.bin using cipher ChaCha20
Round 3/20 for file testfile_1_MiB.bin using cipher ChaCha20
Round 4/20 for file testfile_1_MiB.bin using cipher ChaCha20
Round 5/20 for file testfile_1_MiB.bin using cipher ChaCha20
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Round 19/20 for file testfile_1_MiB.bin using cipher ChaCha20
Round 20/20 for file testfile_1_MiB.bin using cipher ChaCha20
Round 1/20 for file testfile_10_MiB.bin using cipher ChaCha20
Round 2/20 for file testfile_10_MiB.bin using cipher ChaCha20
Round 3/20 for file testfile_10_MiB.bin using cipher ChaCha20
Round 4/20 for file testfile_10_MiB.bin using cipher ChaCha20
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Round 19/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Round 20/20 for file testfile_1_GiB.bin using cipher AES_256_CTR
Done!
```

1.6 Generate plots from generated .csv files

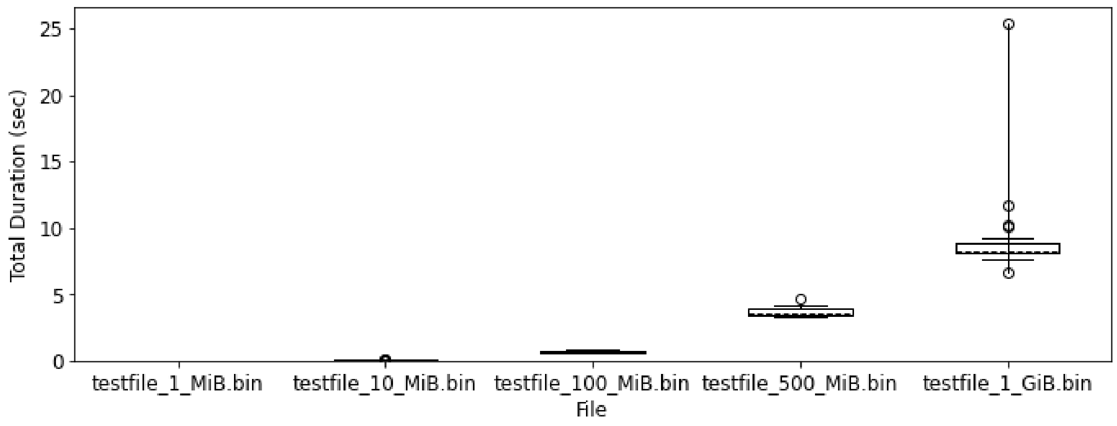
We will use the pandas and matplotlib Python libraries to visualize our measurements (both are pre-installed in our JupyterLab Docker image). The plots will be saved as .svg files.

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
!mkdir plots

# Read results into memory
netcat = pd.read_csv('baseline_netcat_duration_results.csv', sep=';')
crypto = pd.read_csv('baseline_crypto_duration_results.csv', sep=';')
ipfs_same_vm = pd.read_csv('inter_notebook_file_sharing_duration_results-sameVM.
 ↪csv', sep=';')
ipfs_vm_to_vm = pd.
 ↪read_csv('inter_notebook_file_sharing_duration_results-vm-to-vm.csv', sep=';
 ↪')
ipfs_relay = pd.
 ↪read_csv('inter_notebook_file_sharing_duration_results-via-relay-between-VMs.
 ↪csv', sep=';')

# Configure boxplot
x_label_order_file = ['testfile_1_MiB.bin','testfile_10_MiB.
 ↪bin','testfile_100_MiB.bin','testfile_500_MiB.bin', 'testfile_1_GiB.bin']
x_label_order_cipher = ['plain','ChaCha20','Salsa20','AES_256_CTR']
figsizeFile = (11,4)
figsizeCipher = (8,4)
config = {
  'x_label_order': x_label_order_cipher,
  'fontsize': 12,
  'figsize': figsizeCipher,
  'grid': False,
  'boxprops': {
    "linestyle": "-",
    "linewidth": "1",
    "color":"black"
  },
  'whiskerprops': {
    "linestyle": "-",
    "linewidth": "1",
    "color":"black"
  },
  'medianprops': {
    "linestyle": "--",
    "linewidth": "1",
    "color":"black"
  },
  'capprops': {
    "linestyle": "-",
    "linewidth": "1",
    "color":"black"
  },
  'flierprops': {
    "linestyle": "-",
    "linewidth": "1",
    "color":"black"
  }
}

# Plot <column> per file
def create_boxplots_file(testname, df, column, config):
  print(testname + ': ' + column)
  #max = df[column].max() * 1.05
  df['File'] = pd.Categorical(df['File'], config['x_label_order'])
  plot = df.boxplot(column=column, by='File', grid=config['grid'],␣
 ↪fontsize=config['fontsize'], figsize=config['figsize'],␣
 ↪boxprops=config['boxprops'], whiskerprops=config['whiskerprops'],␣
 ↪medianprops=config['medianprops'], capprops=config['capprops'],␣
 ↪flierprops=config['flierprops'])
  plot.set_title('')
  plot.get_figure().suptitle('')
  plot.set_xlabel('File', fontsize=config['fontsize'])
  plot.set_ylabel('Total Duration (sec)', fontsize=config['fontsize'])
  plot.set_ylim(ymin=0)
  plot.get_figure().savefig('./plots/' + str(testname) + '-' + column + '.svg')
  plt.show()

# Plot <column> per cipher per file
def create_boxplots_cipher(testname, df, column, config):
  print(testname + ': ' + column)
  #max = df[column].max() * 1.05
  for file in df['File'].groupby(df['File']).unique():
    df['Cipher'] = pd.Categorical(df['Cipher'], config['x_label_order'])
    plot = df.loc[df['File'] == str(file[0])][['Cipher', column]].
 ↪boxplot(column=column, by='Cipher', grid=config['grid'],␣
 ↪fontsize=config['fontsize'], figsize=config['figsize'],␣
 ↪boxprops=config['boxprops'], whiskerprops=config['whiskerprops'],␣
 ↪medianprops=config['medianprops'], capprops=config['capprops'],␣
 ↪flierprops=config['flierprops'])
    plot.set_title(str(file[0]), fontsize=config['fontsize'])
    plot.get_figure().suptitle('')
    plot.set_xlabel('Cipher', fontsize=config['fontsize'])
    plot.set_ylabel('Total Duration (sec)', fontsize=config['fontsize'])
    plot.set_ylim(ymin=0)
    plot.get_figure().savefig('./plots/' + str(testname) + '-' + column + '-' +␣
↪str(file[0]) + '.svg')
    plt.show()

#netcat.head()
#crypto.head()
#ipfs_same_vm.head()
#ipfs_vm_to_vm.head()
#ipfs_relay.head()
```

1.6.1 Plot netcat results per file

[2]:
```
# Plot Time_Total_Duration_Wall
config['figsize'] = figsizeFile
config['x_label_order'] = x_label_order_file
create_boxplots_file('netcat-file', netcat, 'Time_Total_Duration_Wall', config)
```

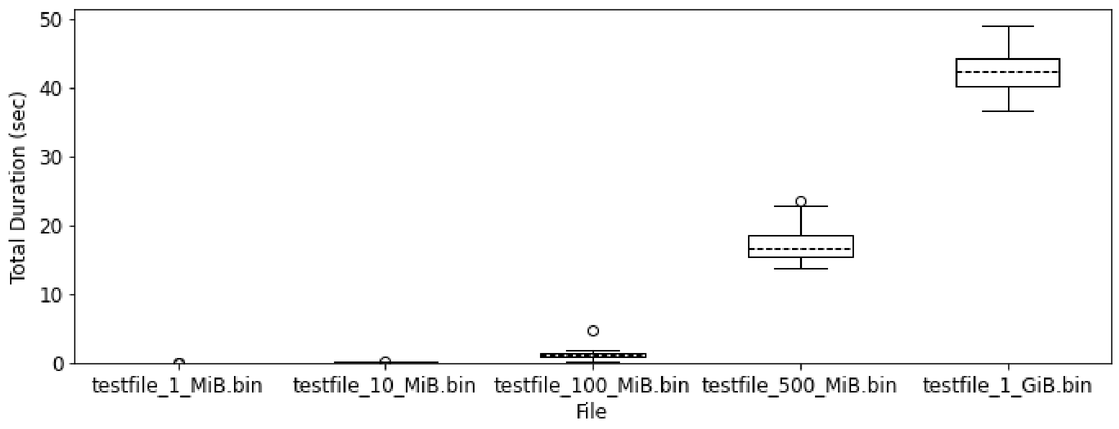
```
netcat-file: Time_Total_Duration_Wall
```



1.6.2 Plot baseline crypto results per file

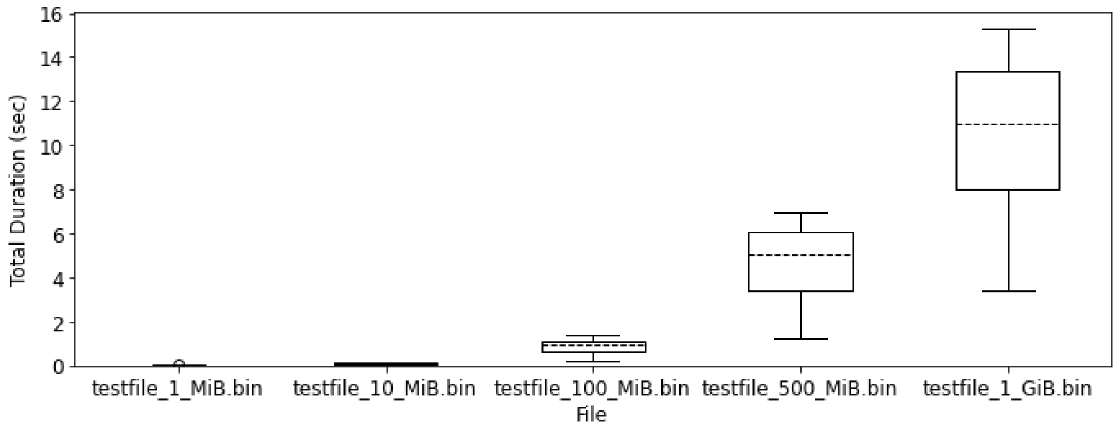
[3]:
```
# Plot Time_Total_Duration_Wall
config['figsize'] = figsizeFile
config['x_label_order'] = x_label_order_file
create_boxplots_file('crypto-file', crypto, 'Time_Total_Duration_Wall', config)
```

```
crypto-file: Time_Total_Duration_Wall
```



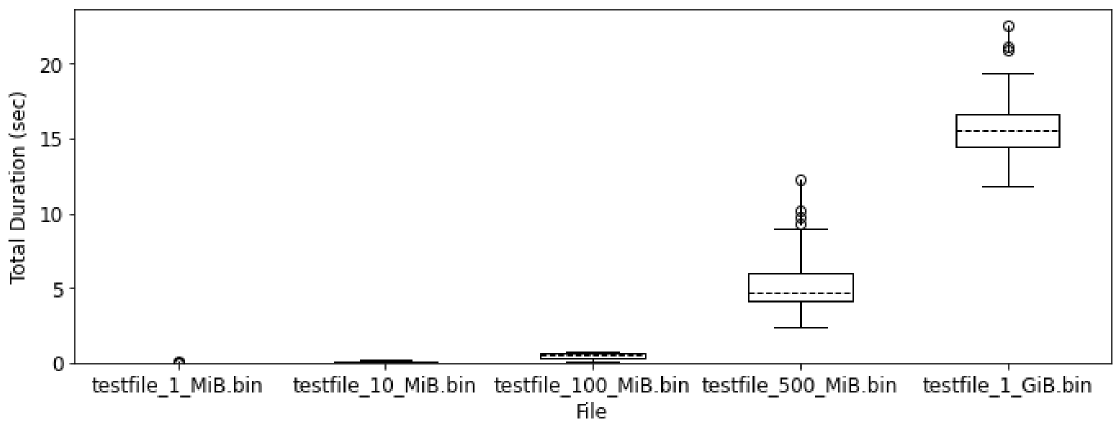
```
[4]: # Plot Time_Total_Duration_Cpu
     create_boxplots_file('crypto-file', crypto, 'Time_Total_Duration_Cpu', config)
```

```
crypto-file: Time_Total_Duration_Cpu
```



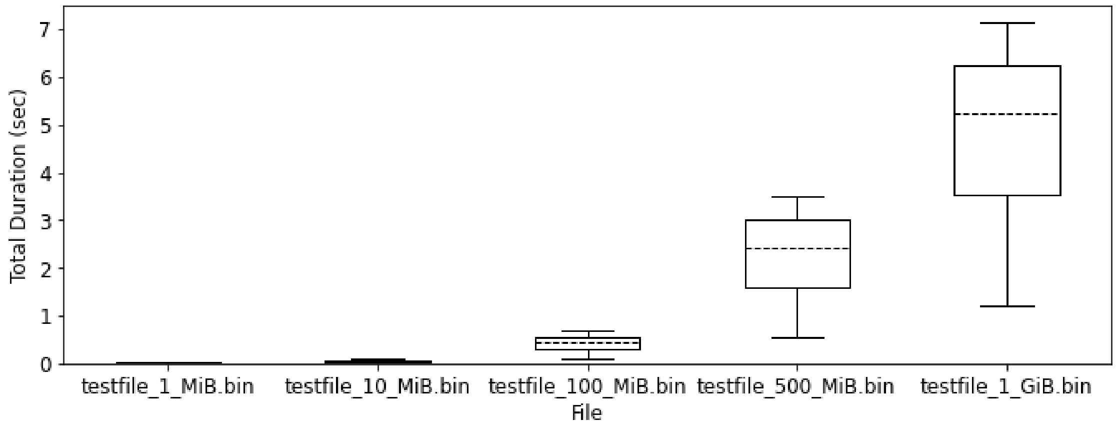
```
[5]: # Plot Time_Encrypt_Duration_Wall
     create_boxplots_file('crypto-file', crypto, 'Time_Encrypt_Duration_Wall',␣
      ↪config)
```

```
crypto-file: Time_Encrypt_Duration_Wall
```



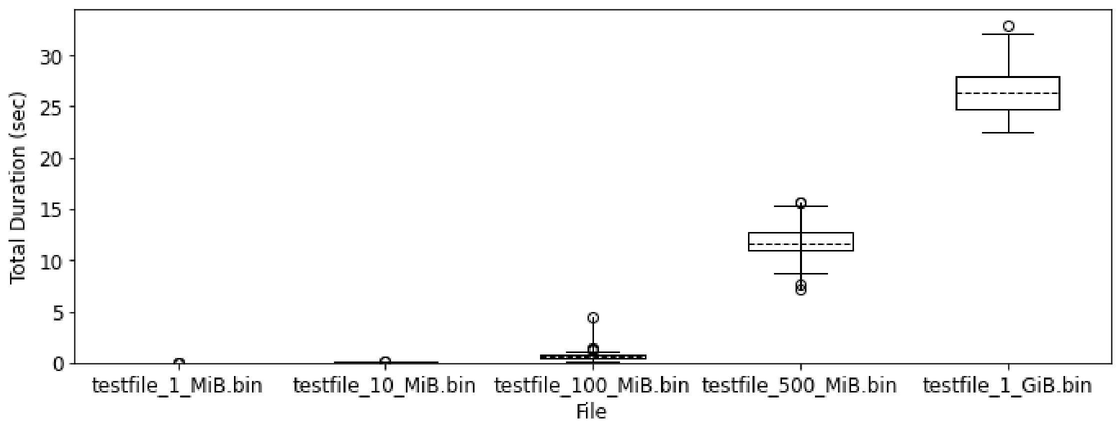
```
[6]: # Plot Time_Encrypt_Duration_Cpu
     create_boxplots_file('crypto-file', crypto, 'Time_Encrypt_Duration_Cpu', config)
```

```
crypto-file: Time_Encrypt_Duration_Cpu
```



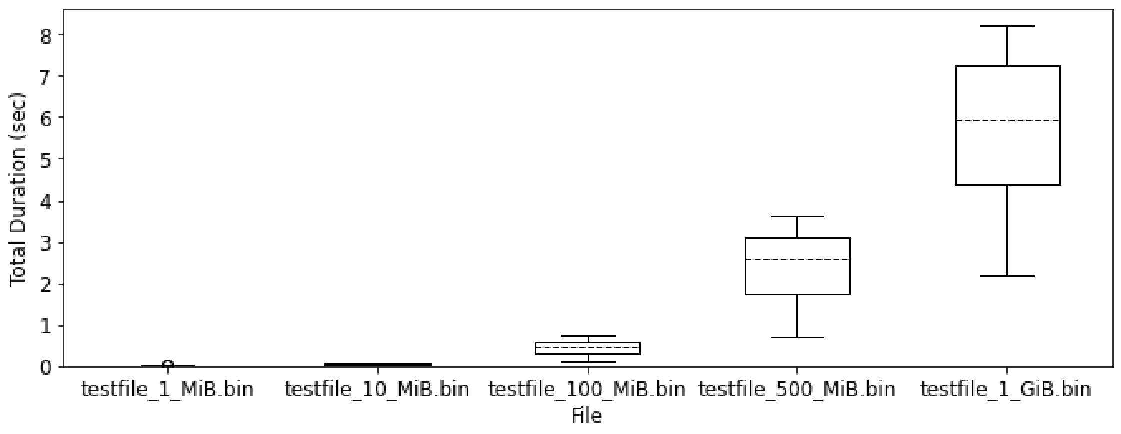
```
[7]: # Plot Time_Decrypt_Duration_Wall
     create_boxplots_file('crypto-file', crypto, 'Time_Decrypt_Duration_Wall',␣
      ↪config)
```

```
crypto-file: Time_Decrypt_Duration_Wall
```



```
[8]: # Plot Time_Decrypt_Duration_Cpu
     create_boxplots_file('crypto-file', crypto, 'Time_Decrypt_Duration_Cpu', config)
```

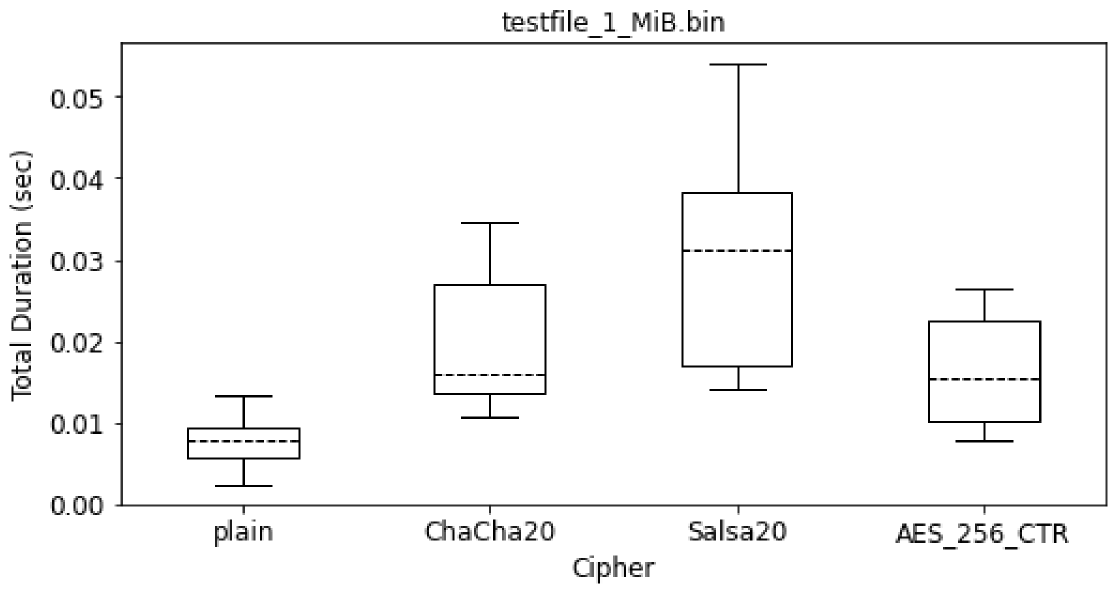
```
crypto-file: Time_Decrypt_Duration_Cpu
```

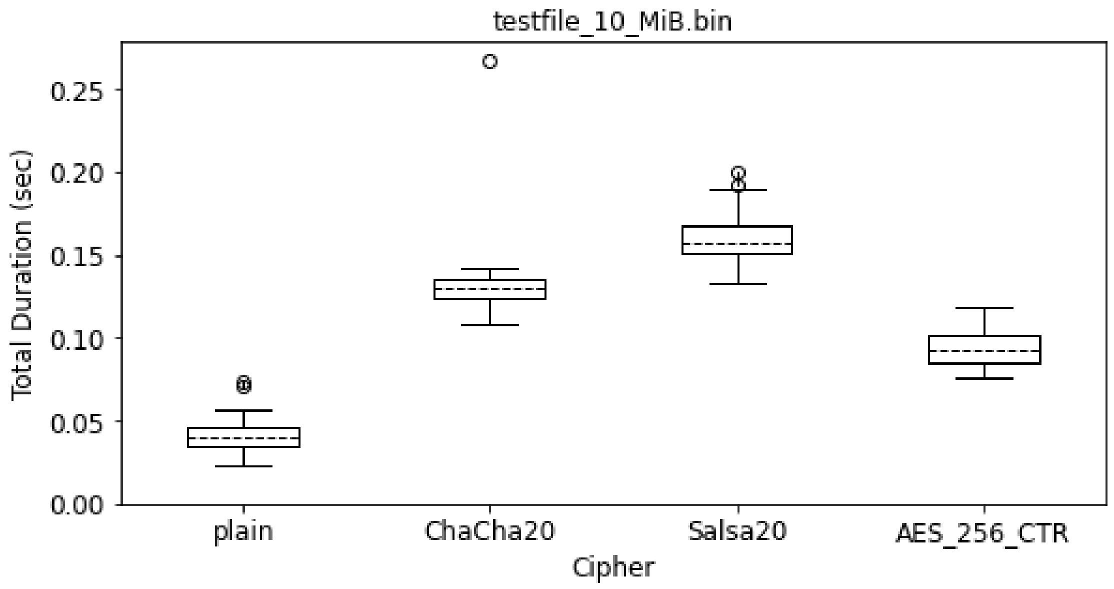


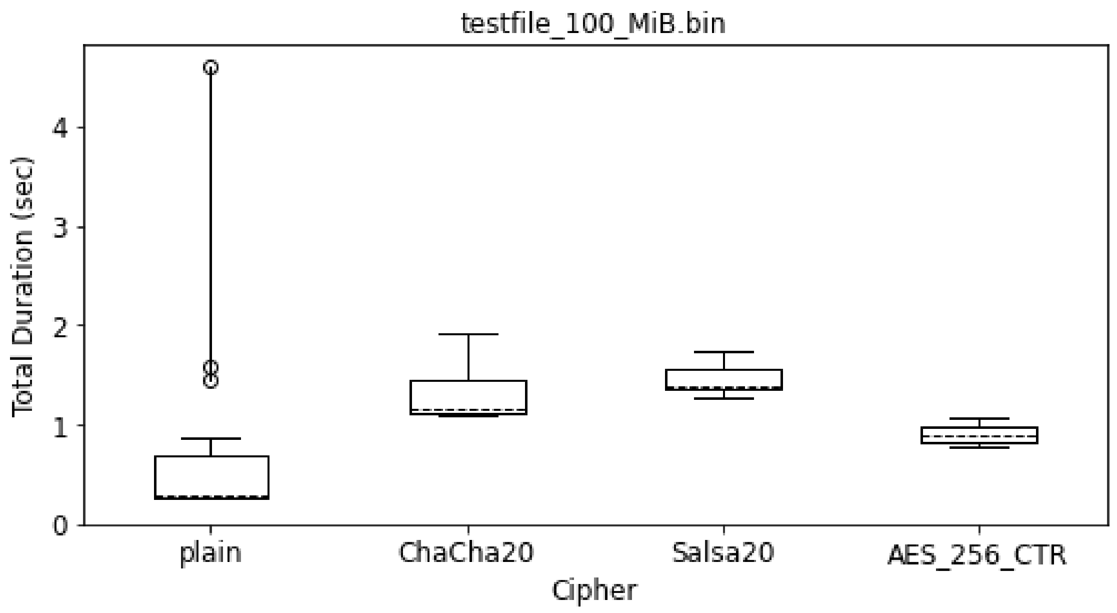
1.6.3 Plot baseline crypto results per cipher

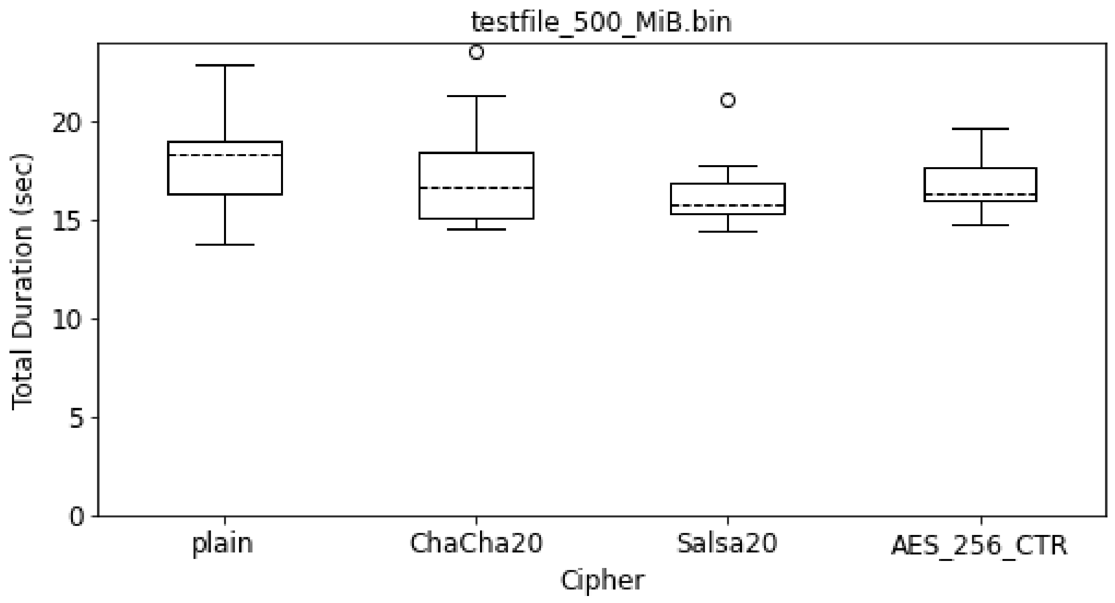
```
[9]: # Plot Time_Total_Duration_Wall
     config['figsize'] = figsizeCipher
     config['x_label_order'] = x_label_order_cipher
     create_boxplots_cipher('crypto-cipher', crypto, 'Time_Total_Duration_Wall',␣
      ↪config)
```

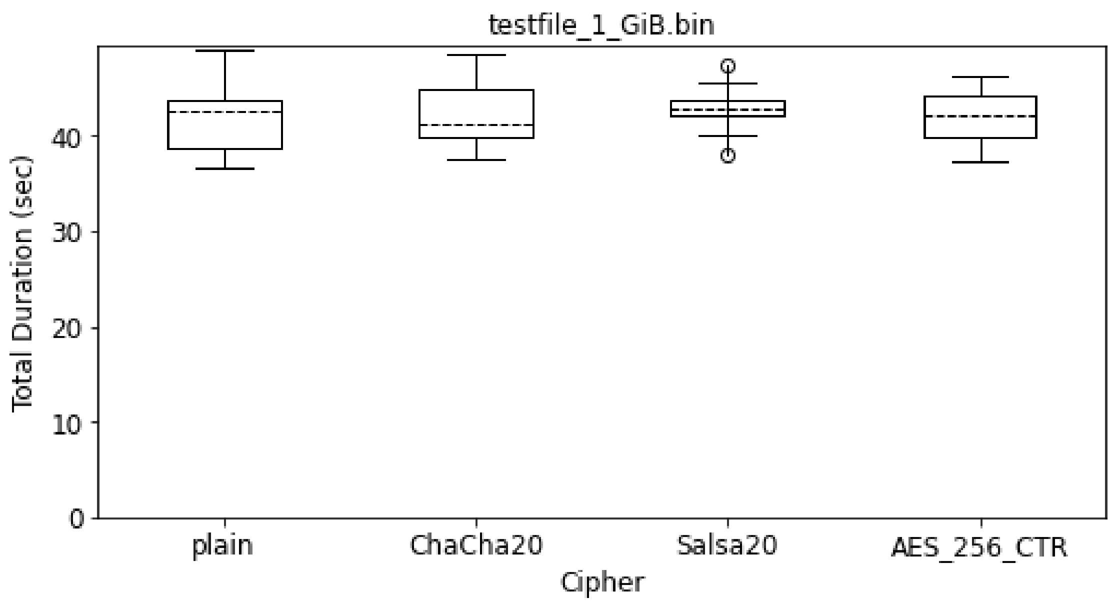
```
crypto-cipher: Time_Total_Duration_Wall
```


testfile_1_MiB.bin
Total Duration (sec)
0.00
0.01
0.02
0.03
0.04
0.05
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_10_MiB.bin
Total Duration (sec)
0.00
0.05
0.10
0.15
0.20
0.25
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

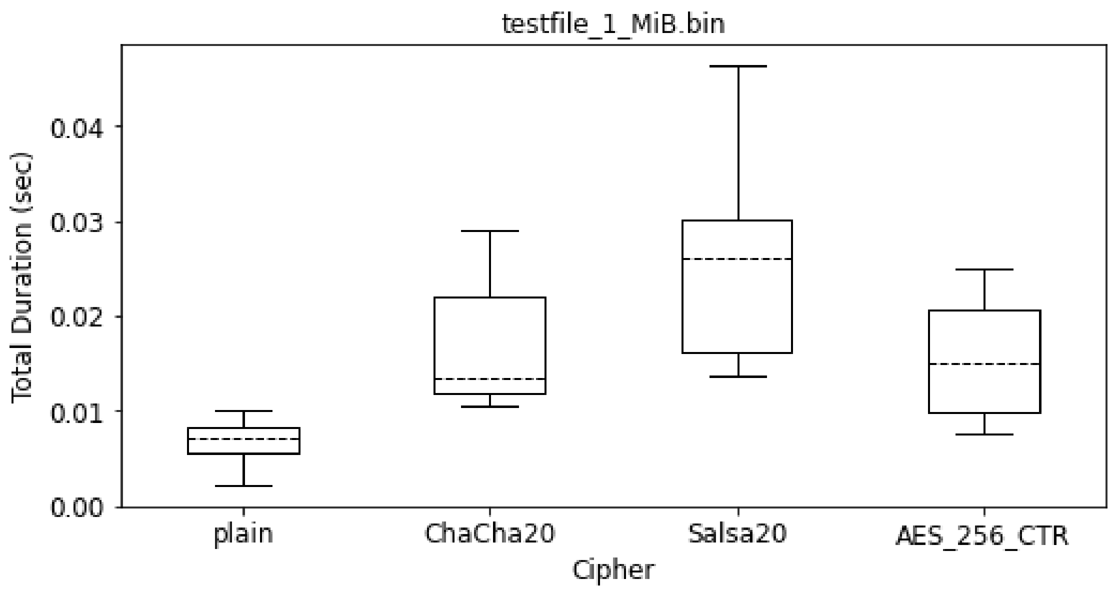

testfile_100_MiB.bin
Total Duration (sec)
0
1
2
3
4
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

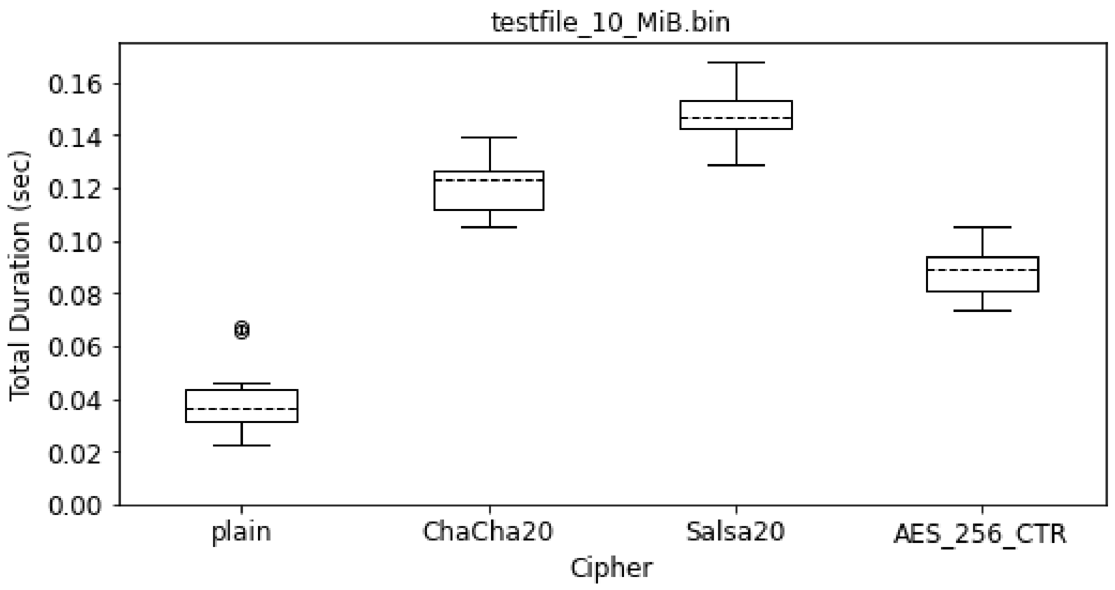

testfile_500_MiB.bin
Total Duration (sec)
0
5
10
15
20
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

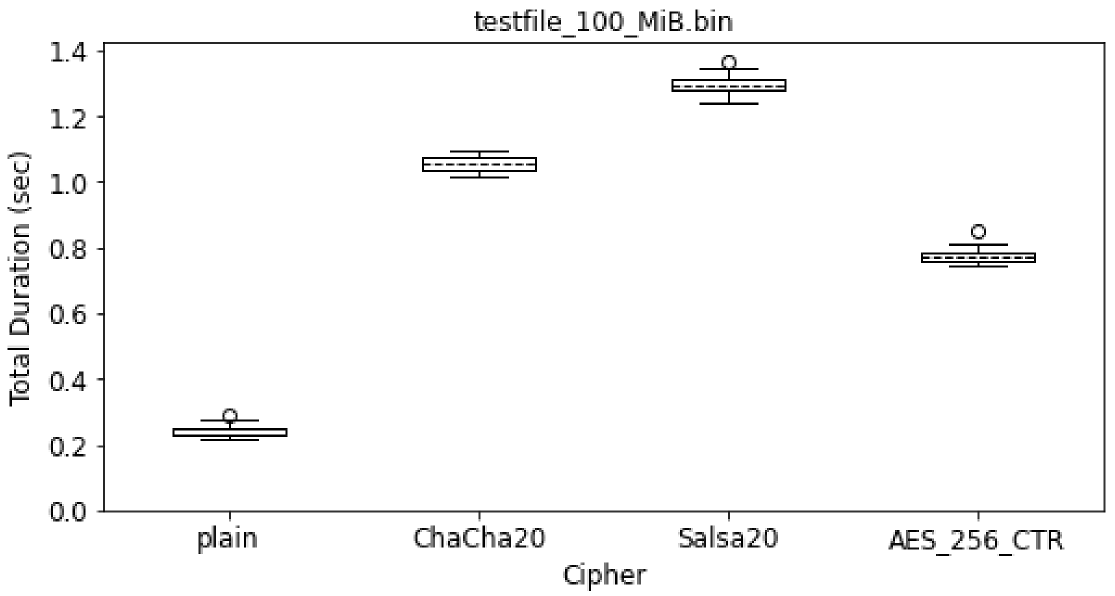


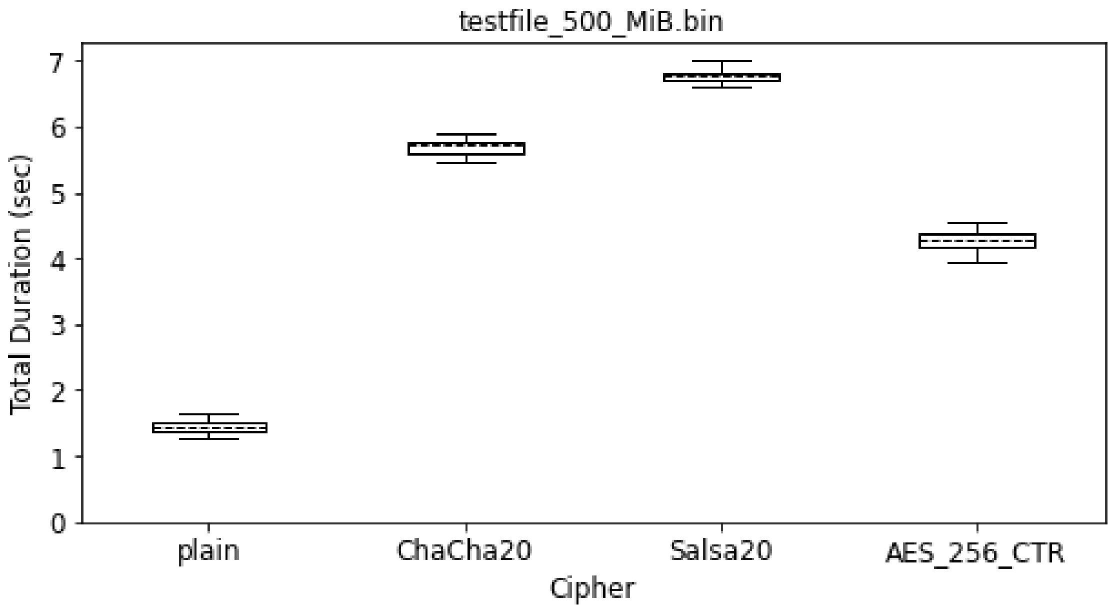
```
[10]: # Plot Time_Total_Duration_Cpu
      create_boxplots_cipher('crypto-cipher', crypto, 'Time_Total_Duration_Cpu',␣
       ↪config)
```

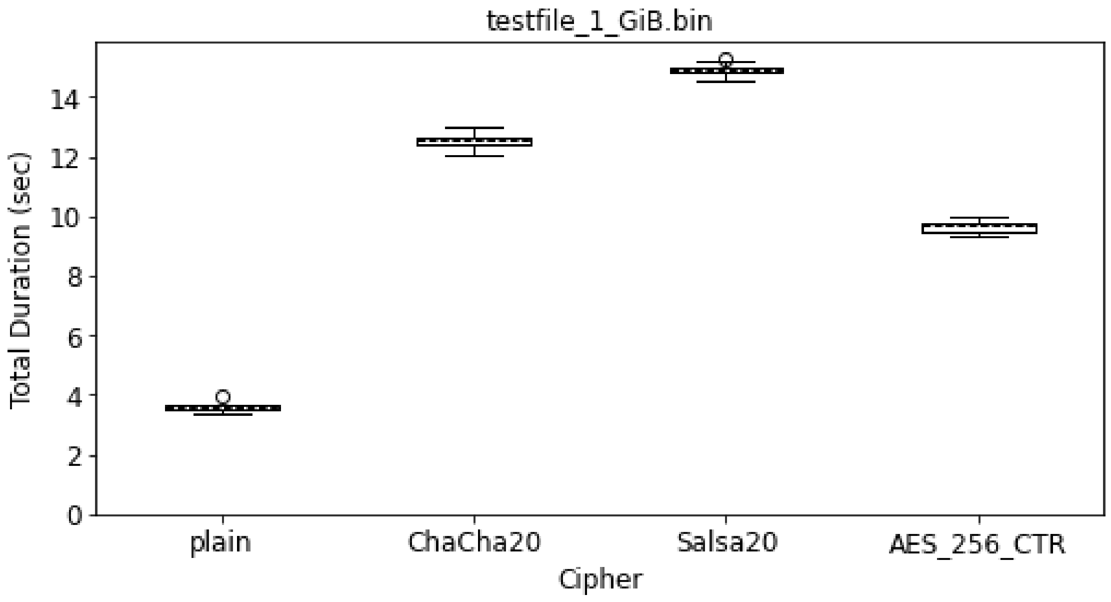
```
crypto-cipher: Time_Total_Duration_Cpu
```




testfile_10_MiB.bin
Total Duration (sec)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

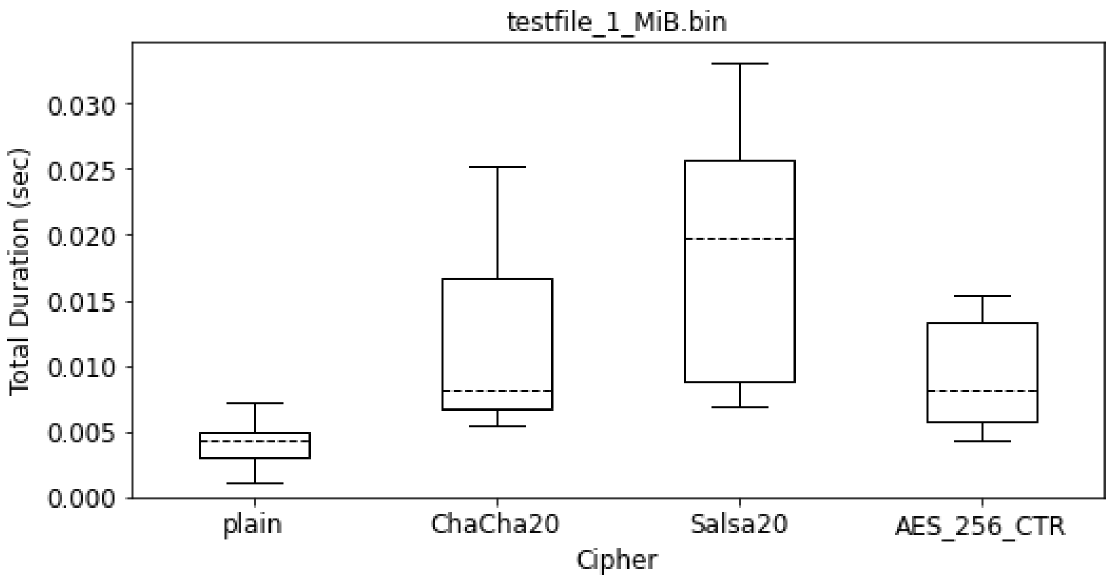

testfile_100_MiB.bin
Total Duration (sec)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

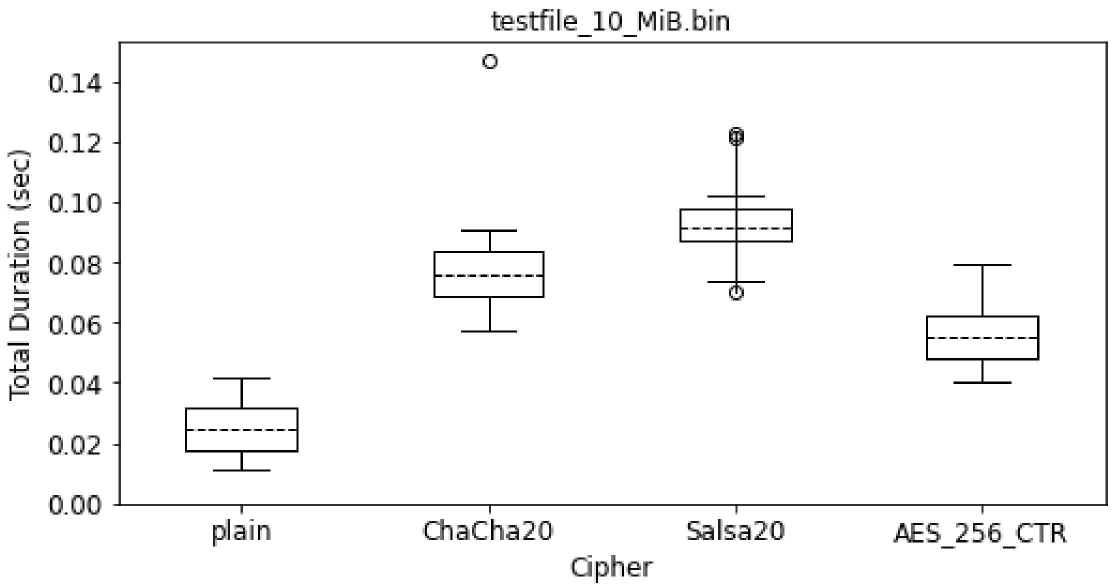


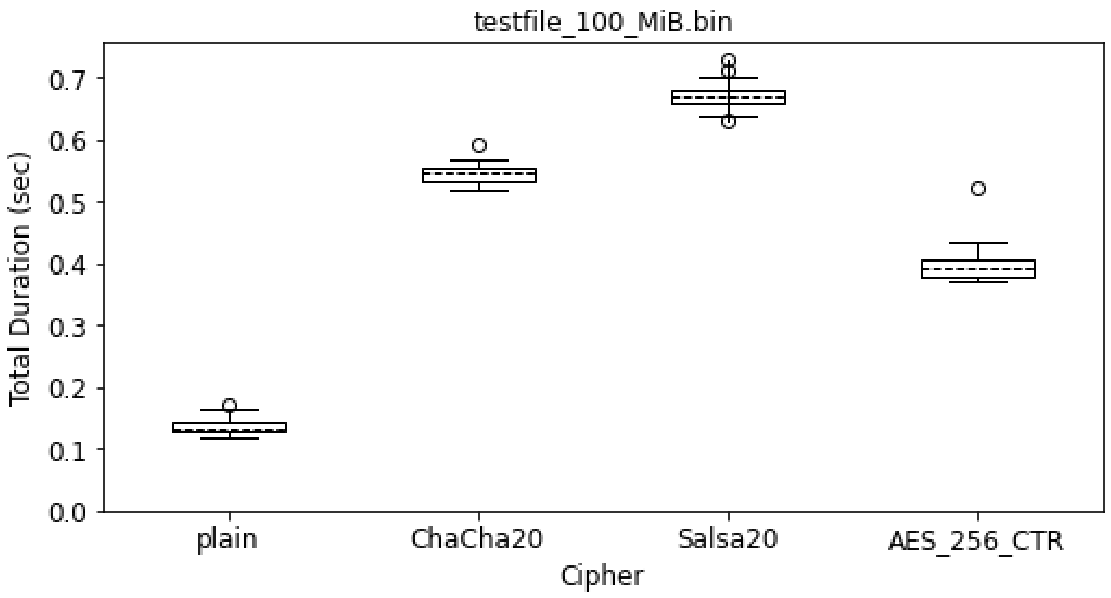


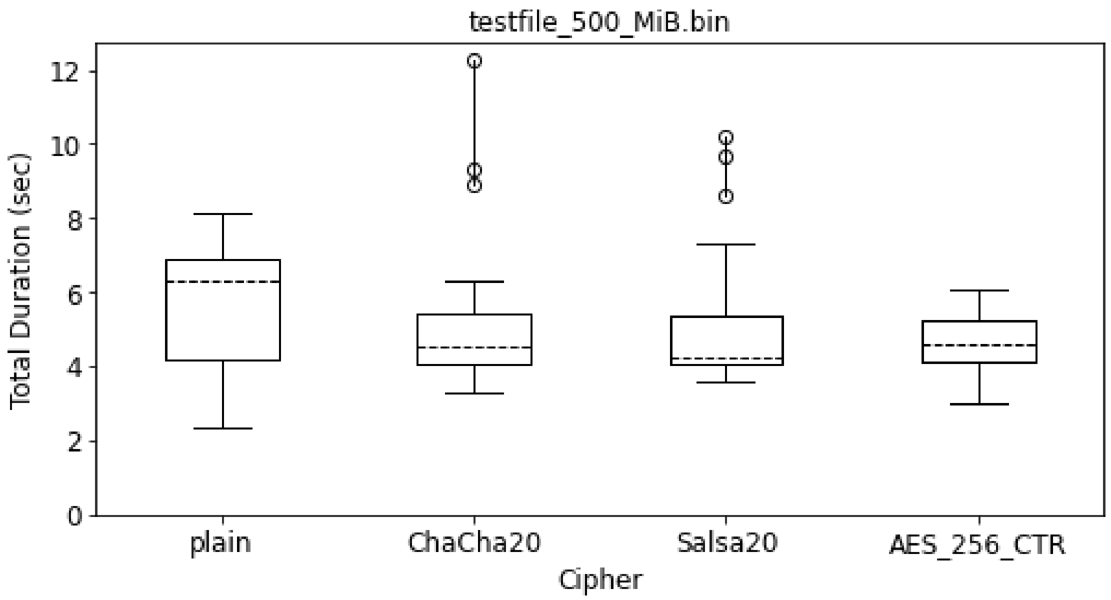
```
[11]: # Plot Time_Encrypt_Duration_Wall
      create_boxplots_cipher('crypto-cipher', crypto, 'Time_Encrypt_Duration_Wall',␣
       ↪config)
```

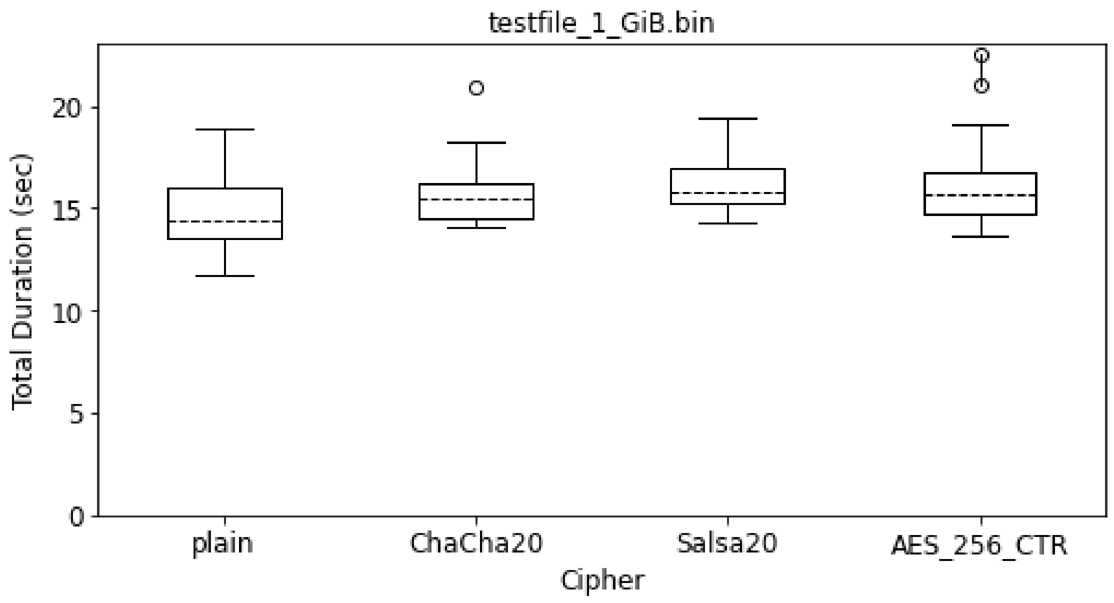
```
crypto-cipher: Time_Encrypt_Duration_Wall
```


testfile_1_MiB.bin
Total Duration (sec)
0.000
0.005
0.010
0.015
0.020
0.025
0.030
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_10_MiB.bin
Total Duration (sec)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

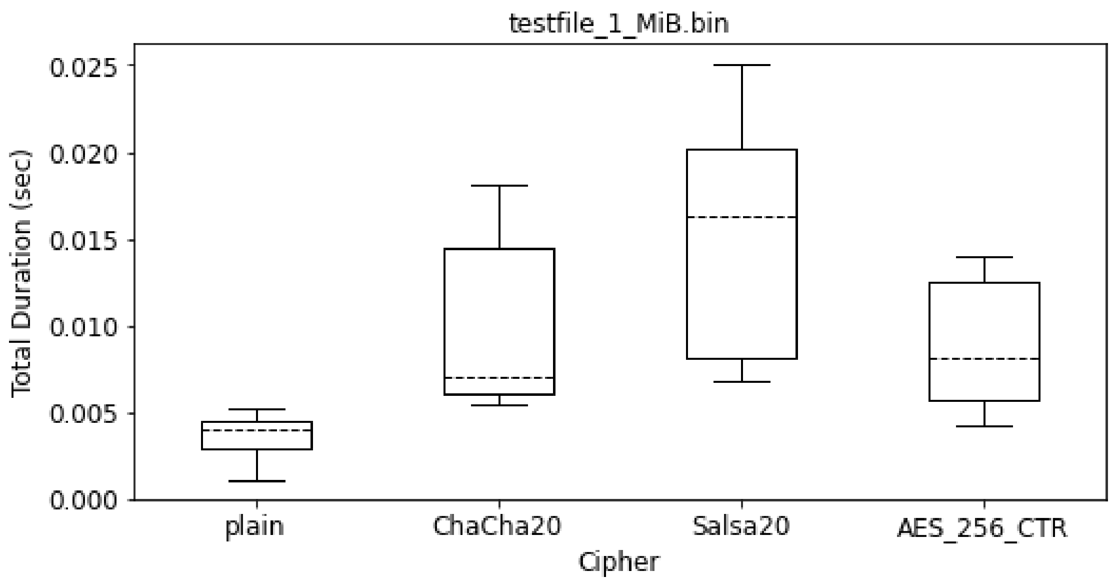

testfile_100_MiB.bin
Total Duration (sec)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

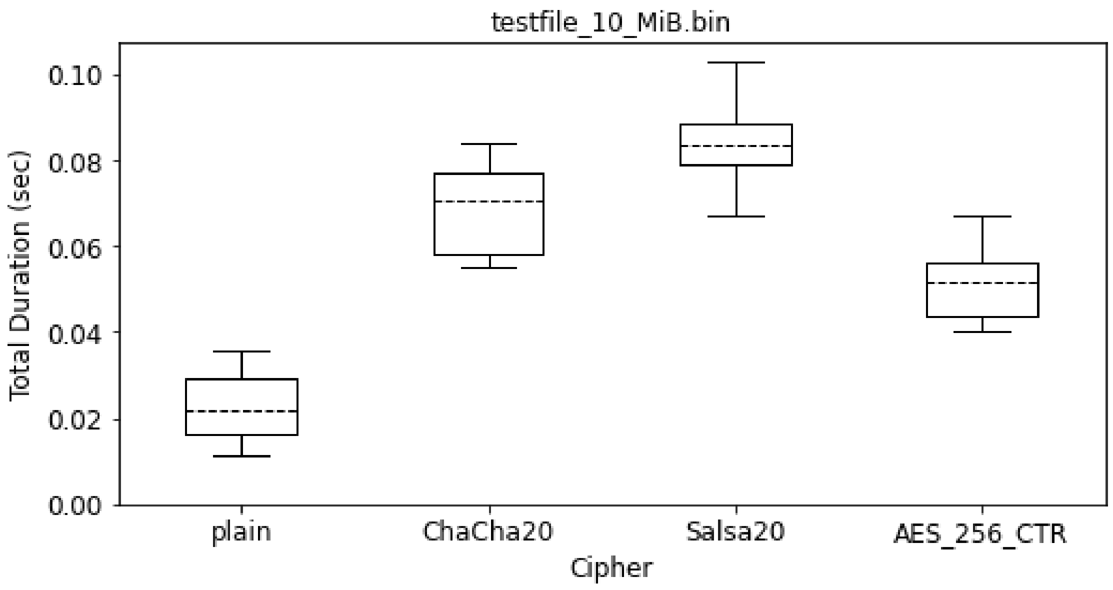

testfile_500_MiB.bin
Total Duration (sec)
0
2
4
6
8
10
12
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

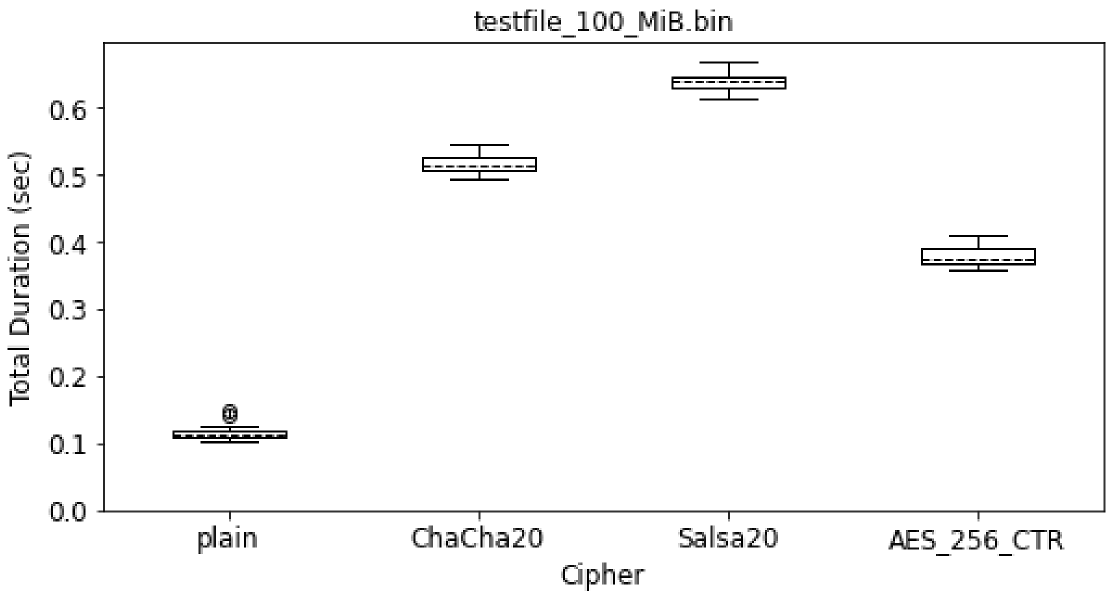


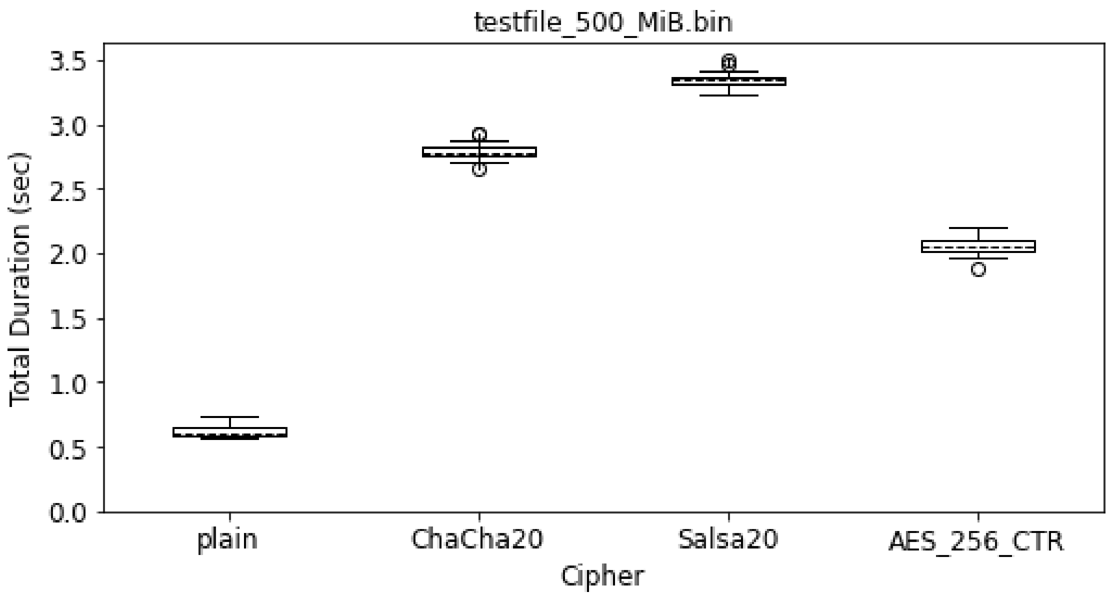
```
[12]: # Plot Time_Encrypt_Duration_Cpu
      create_boxplots_cipher('crypto-cipher', crypto, 'Time_Encrypt_Duration_Cpu',␣
       ↪config)
```

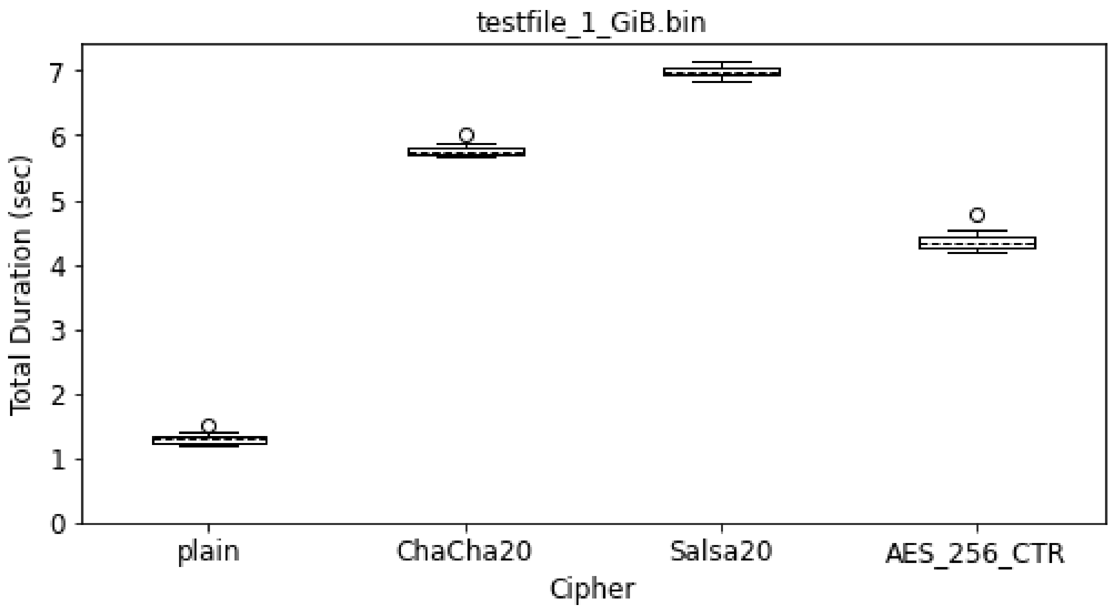
```
crypto-cipher: Time_Encrypt_Duration_Cpu
```




testfile_10_MiB.bin
Total Duration (sec)
0.00
0.02
0.04
0.06
0.08
0.10
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

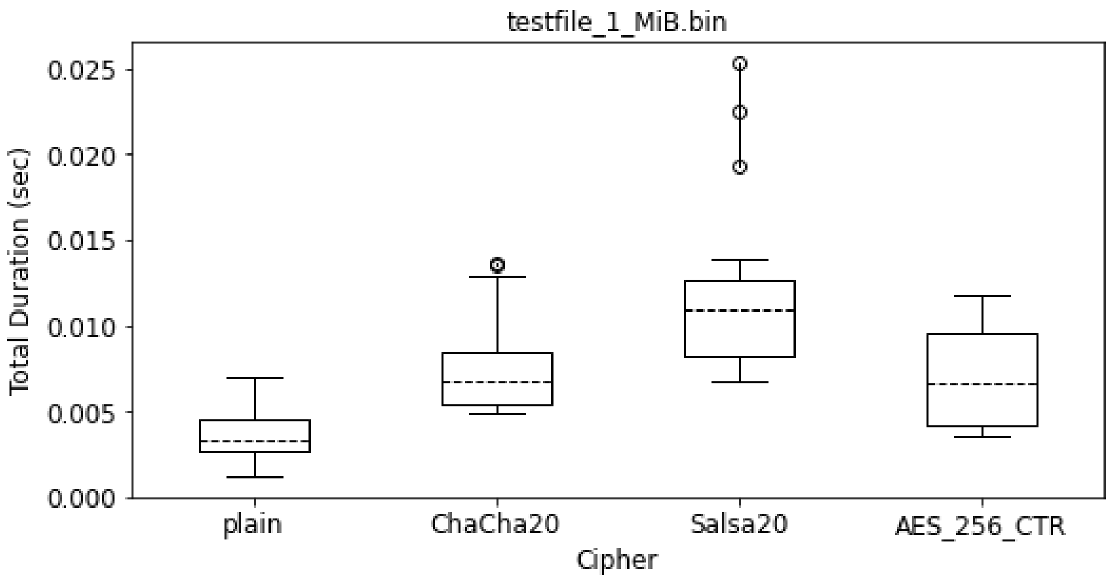

testfile_100_MiB.bin
Total Duration (sec)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

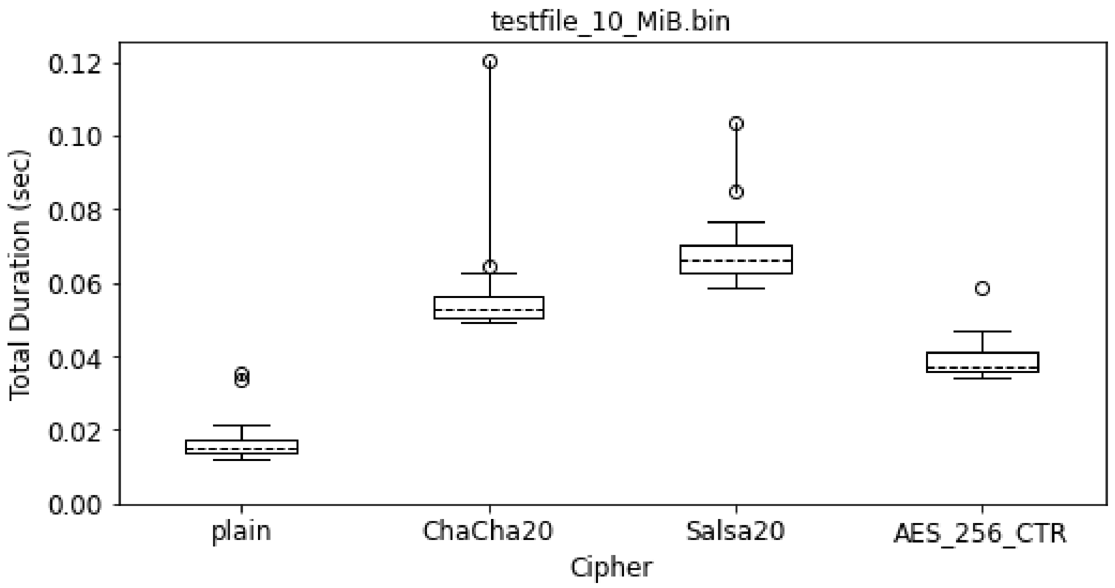


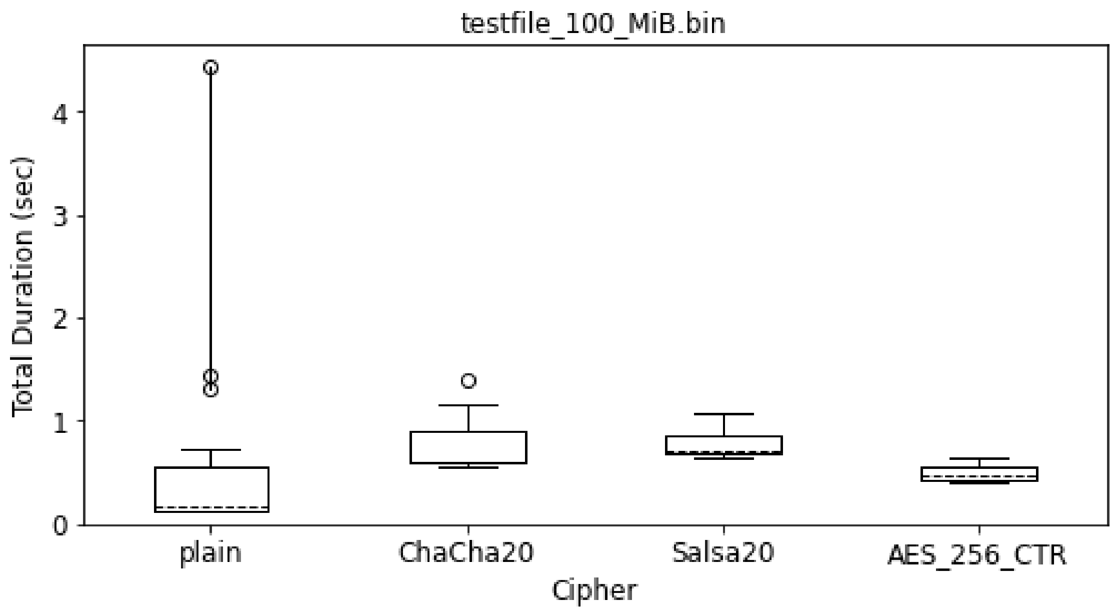


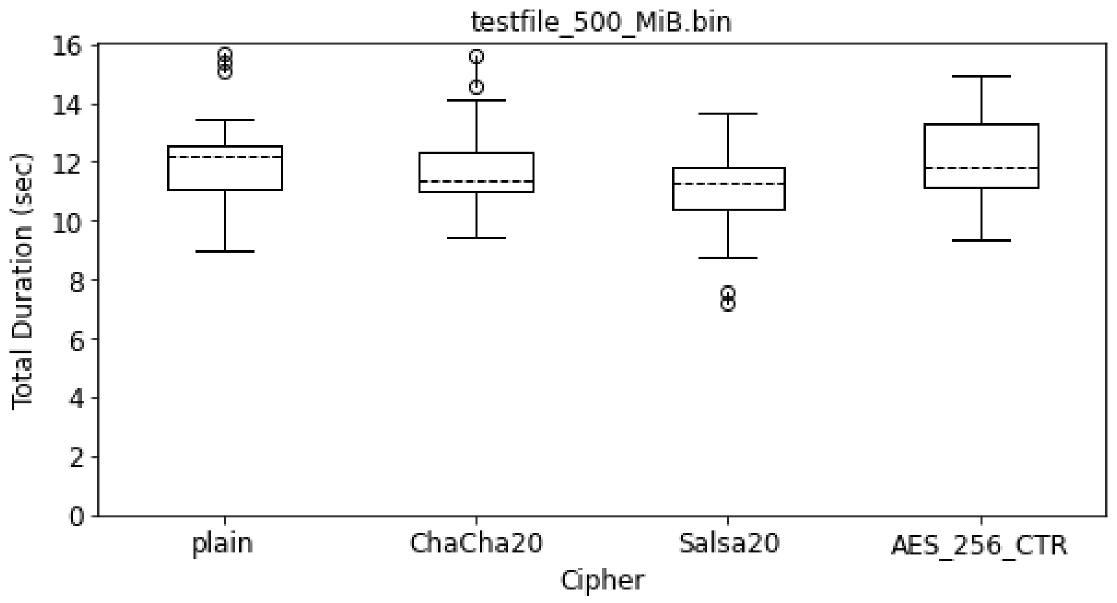
[13]:
```
# Plot Time_Decrypt_Duration_Wall
create_boxplots_cipher('crypto-cipher', crypto, 'Time_Decrypt_Duration_Wall',␣
↪config)
```

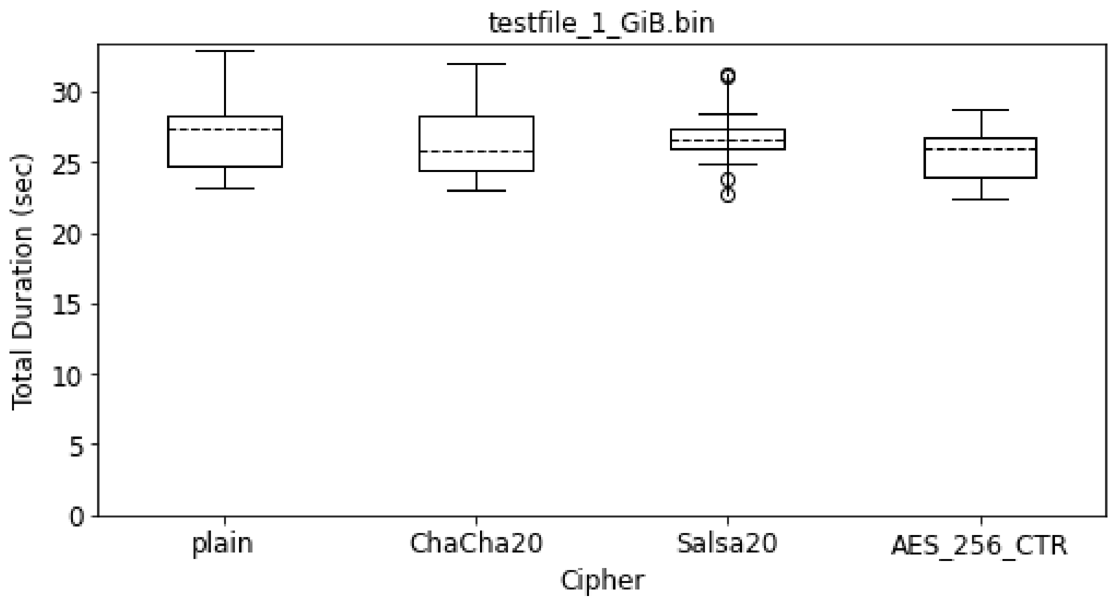
```
crypto-cipher: Time_Decrypt_Duration_Wall
```


testfile_1_MiB.bin
Total Duration (sec)
0.025
0.020
0.015
0.010
0.005
0.000
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_10_MiB.bin
Total Duration (sec)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

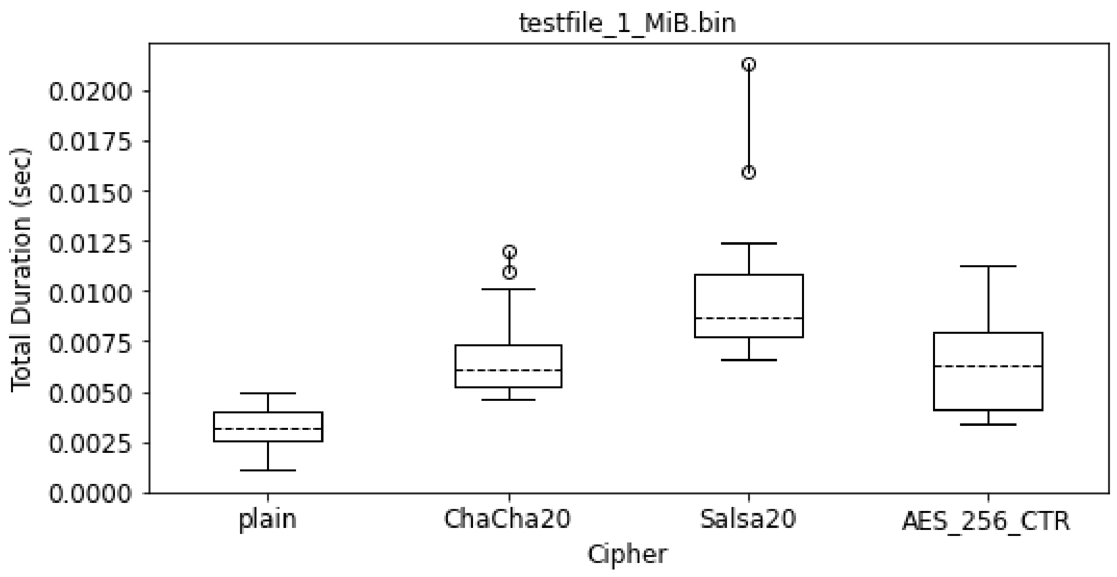

testfile_100_MiB.bin
Total Duration (sec)
0
1
2
3
4
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

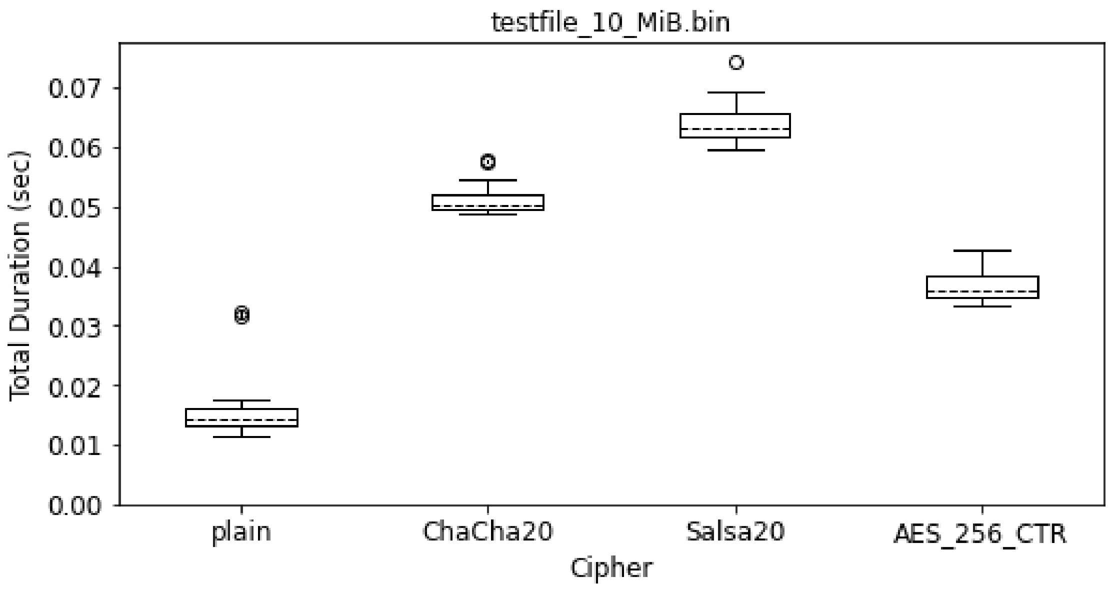

testfile_500_MiB.bin
Total Duration (sec)
0
2
4
6
8
10
12
14
16
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

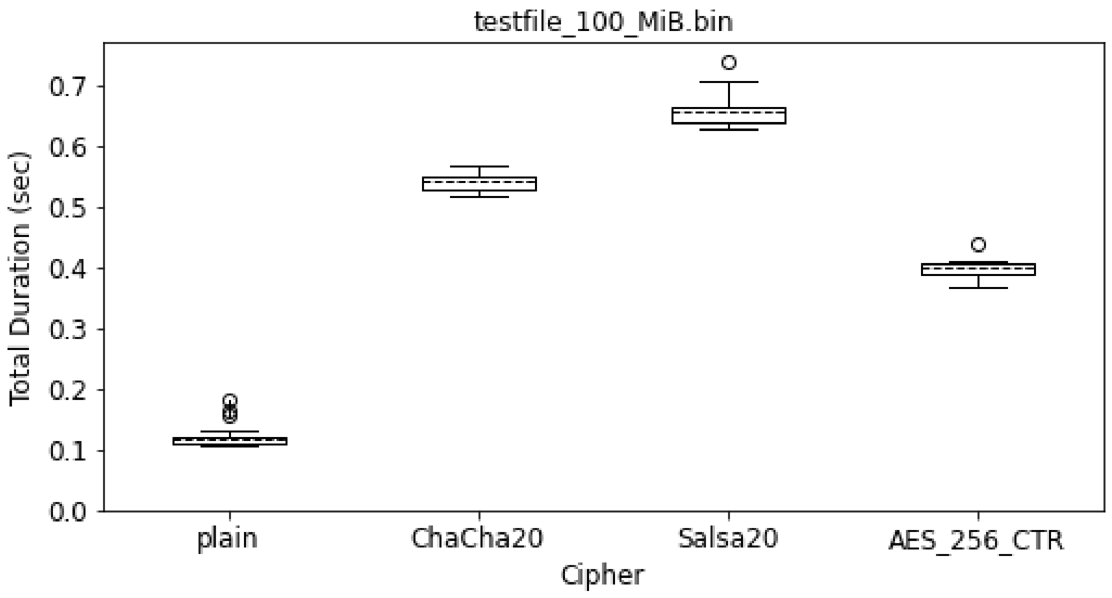


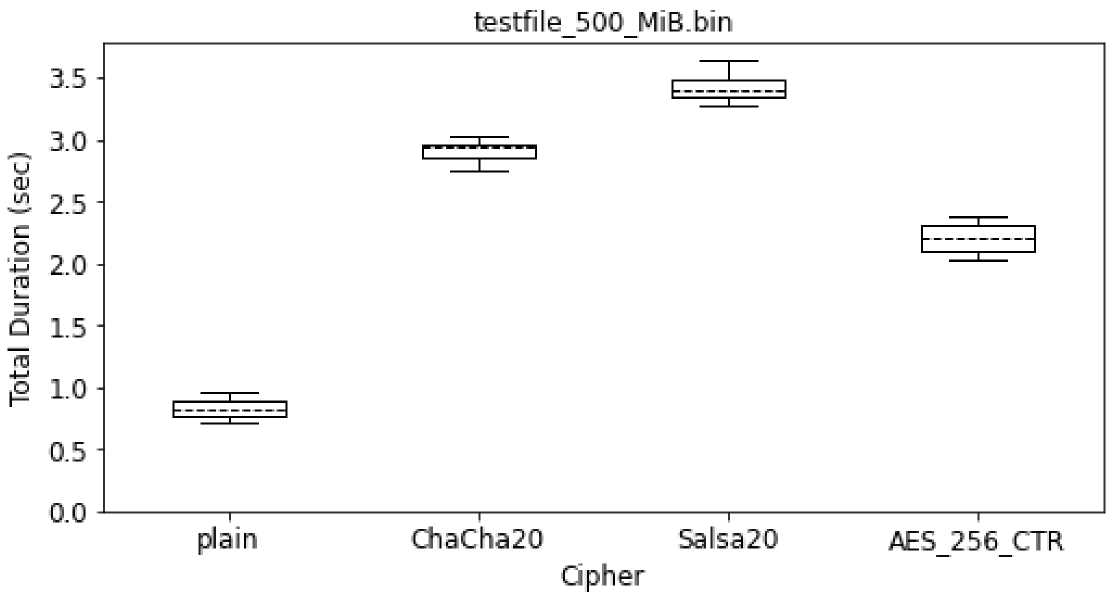
```
[14]: # Plot Time_Decrypt_Duration_Cpu
      create_boxplots_cipher('crypto-cipher', crypto, 'Time_Decrypt_Duration_Cpu',␣
       ↪config)
```

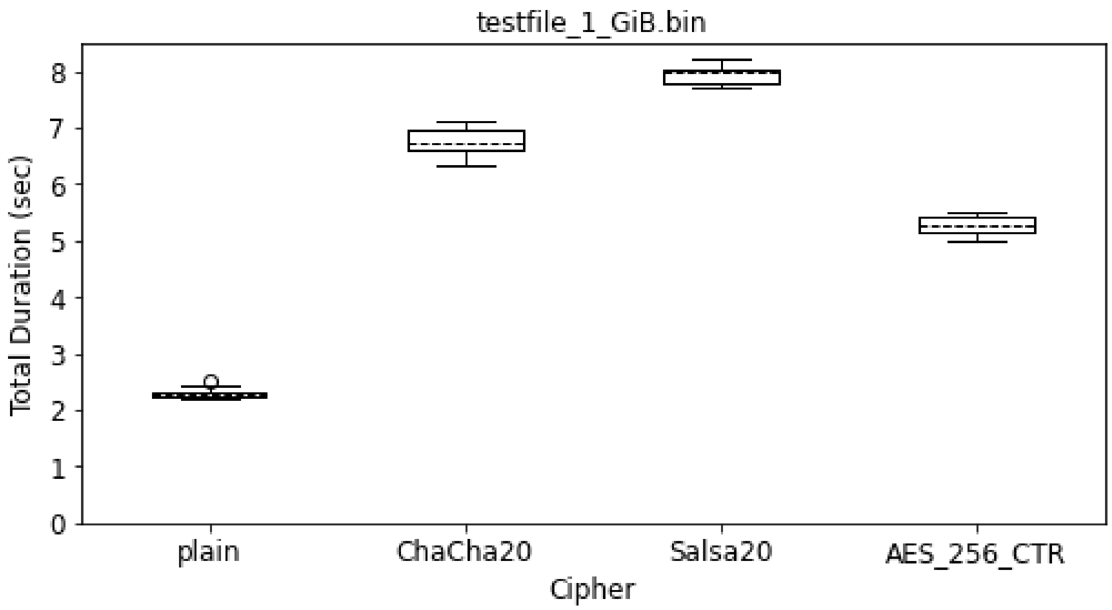
```
crypto-cipher: Time_Decrypt_Duration_Cpu
```




testfile_10_MiB.bin
Total Duration (sec)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_100_MiB.bin
Total Duration (sec)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher



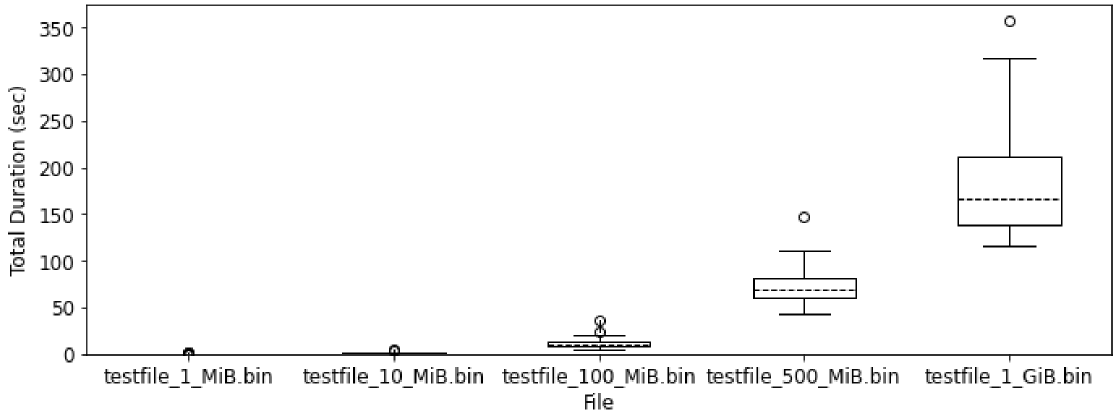


1.6.4 Plot IPFS results per file for peer to peer on the same VM

[15]:
```
# Plot Time_Total_Duration_Wall
config['figsize'] = figsizeFile
config['x_label_order'] = x_label_order_file
```

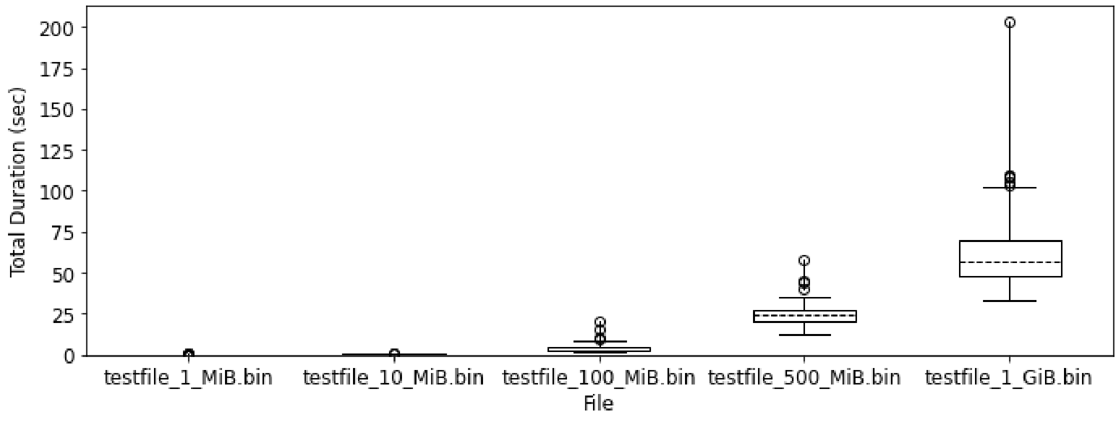
```
create_boxplots_file('ipfs-file-sameVM', ipfs_same_vm,␣
↪'Time_Total_Duration_Wall', config)
```

```
ipfs-file-sameVM: Time_Total_Duration_Wall
```



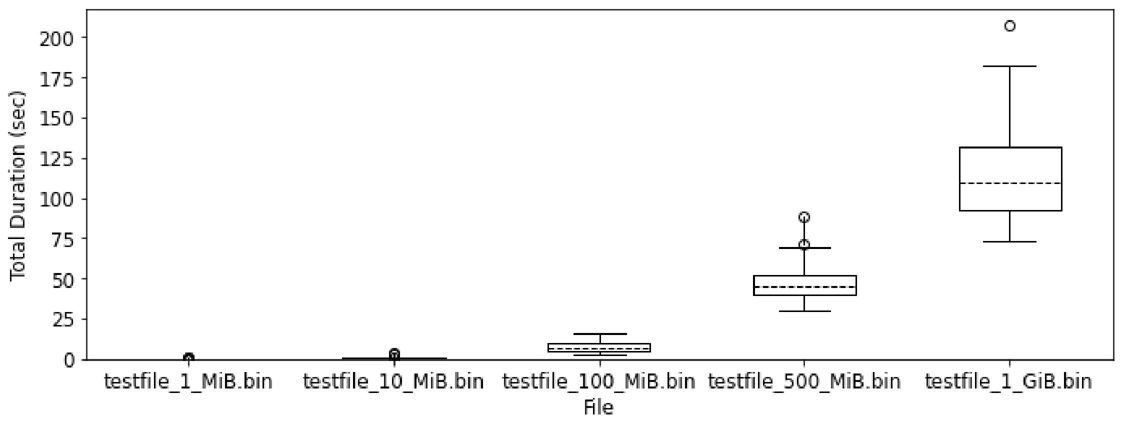
[16]:
```
# Plot Time_Upload_Duration_Wall
create_boxplots_file('ipfs-file-sameVM', ipfs_same_vm,␣
↪'Time_Upload_Duration_Wall', config)
```

```
ipfs-file-sameVM: Time_Upload_Duration_Wall
```



[17]:
```
# Plot Time_Download_Duration_Wall
create_boxplots_file('ipfs-file-sameVM', ipfs_same_vm,␣
↪'Time_Download_Duration_Wall', config)
```

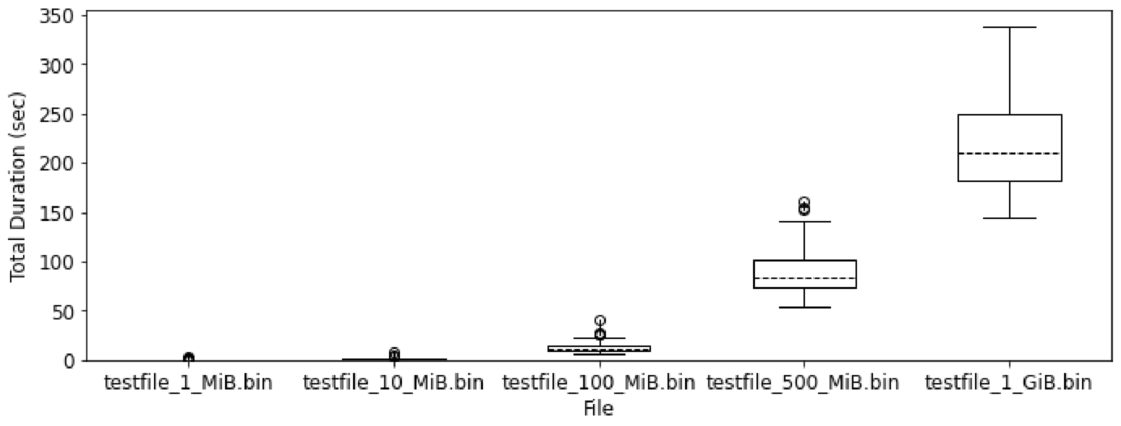
```
ipfs-file-sameVM: Time_Download_Duration_Wall
```



1.6.5 Plot IPFS results per file for peer to peer on different VMs

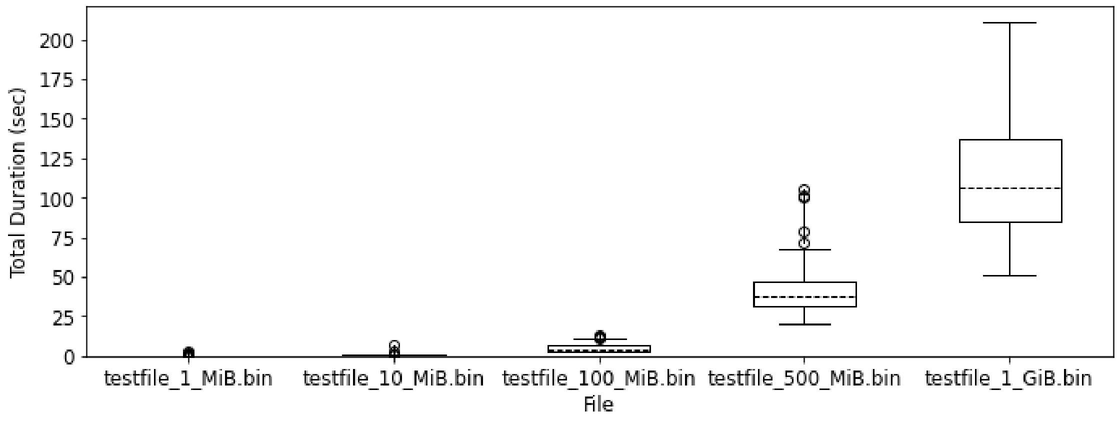
```
[18]: # Plot Time_Total_Duration_Wall
config['figsize'] = figsizeFile
config['x_label_order'] = x_label_order_file
create_boxplots_file('ipfs-file-diffVM', ipfs_vm_to_vm,␣
 ↪'Time_Total_Duration_Wall', config)
```

```
ipfs-file-diffVM: Time_Total_Duration_Wall
```



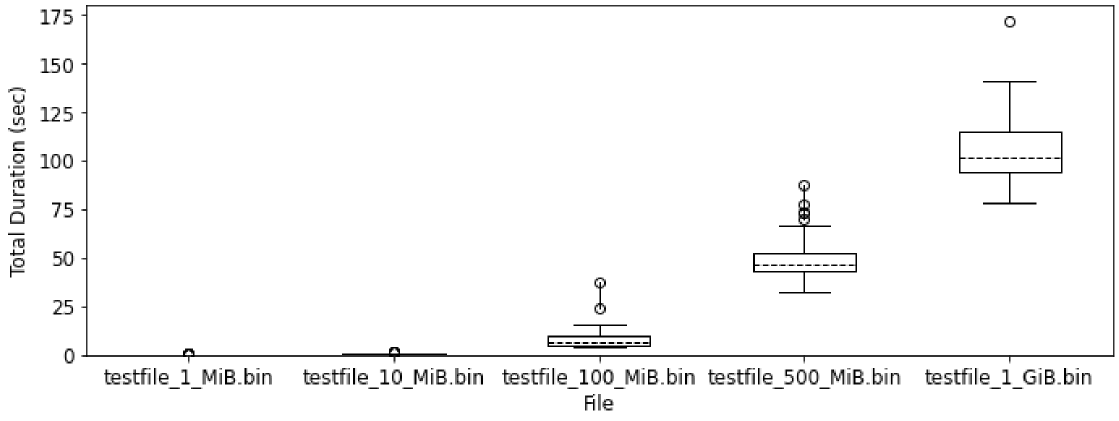
```
[19]: # Plot Time_Upload_Duration_Wall
create_boxplots_file('ipfs-file-diffVM', ipfs_vm_to_vm,␣
 ↪'Time_Upload_Duration_Wall', config)
```

```
ipfs-file-diffVM: Time_Upload_Duration_Wall
```



```
[20]: # Plot Time_Download_Duration_Wall
      create_boxplots_file('ipfs-file-diffVM', ipfs_vm_to_vm,␣
       ↪'Time_Download_Duration_Wall', config)
```

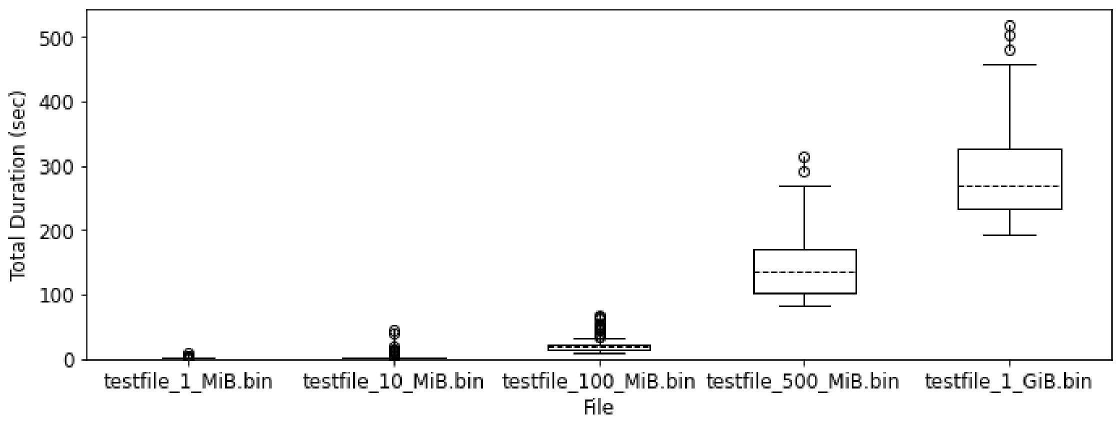
```
ipfs-file-diffVM: Time_Download_Duration_Wall
```



1.6.6 Plot IPFS results per file for peer to peer on different VMs via (bitswap) relay

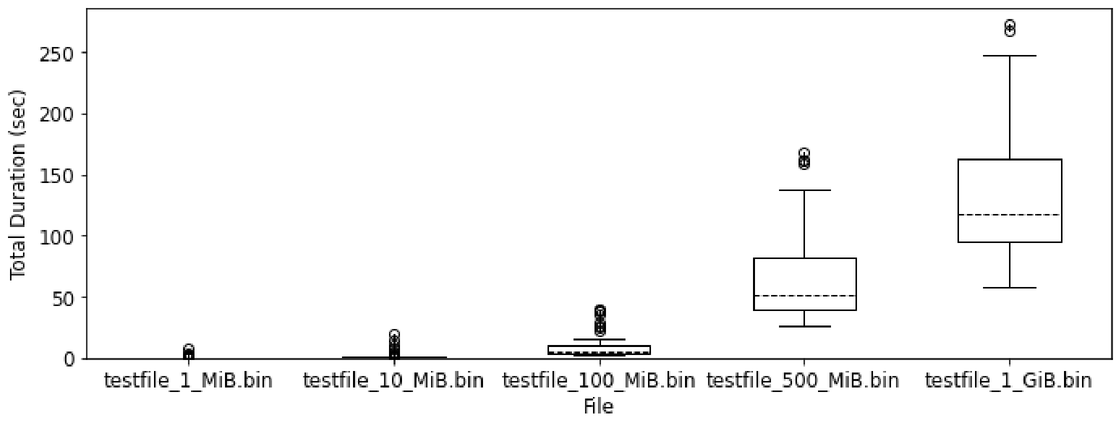
```
[21]: # Plot Time_Total_Duration_Wall
      config['figsize'] = figsizeFile
      config['x_label_order'] = x_label_order_file
      create_boxplots_file('ipfs-file-relay', ipfs_relay, 'Time_Total_Duration_Wall',␣
       ↪config)
```

```
ipfs-file-relay: Time_Total_Duration_Wall
```



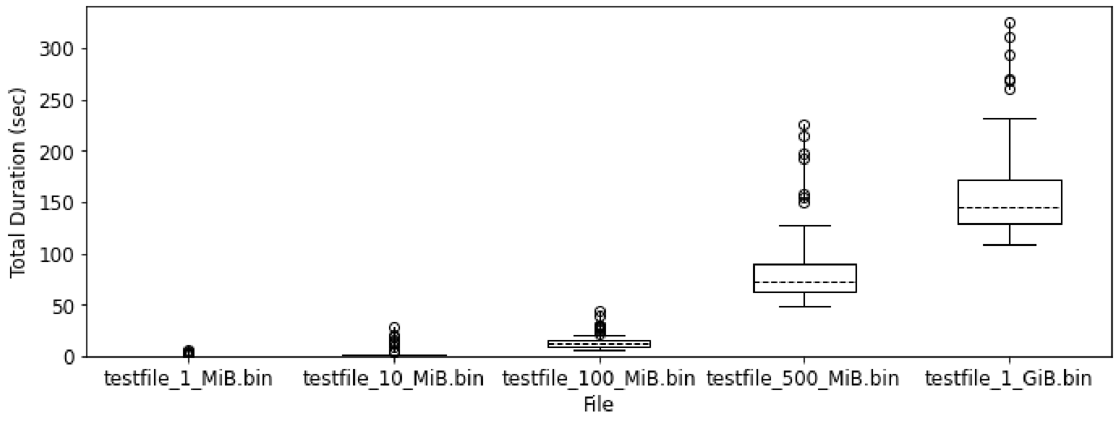
[22]:
```
# Plot Time_Upload_Duration_Wall
create_boxplots_file('ipfs-file-relay', ipfs_relay,␣
↪'Time_Upload_Duration_Wall', config)
```

```
ipfs-file-relay: Time_Upload_Duration_Wall
```



[23]:
```
# Plot Time_Download_Duration_Wall
create_boxplots_file('ipfs-file-relay', ipfs_relay,␣
↪'Time_Download_Duration_Wall', config)
```

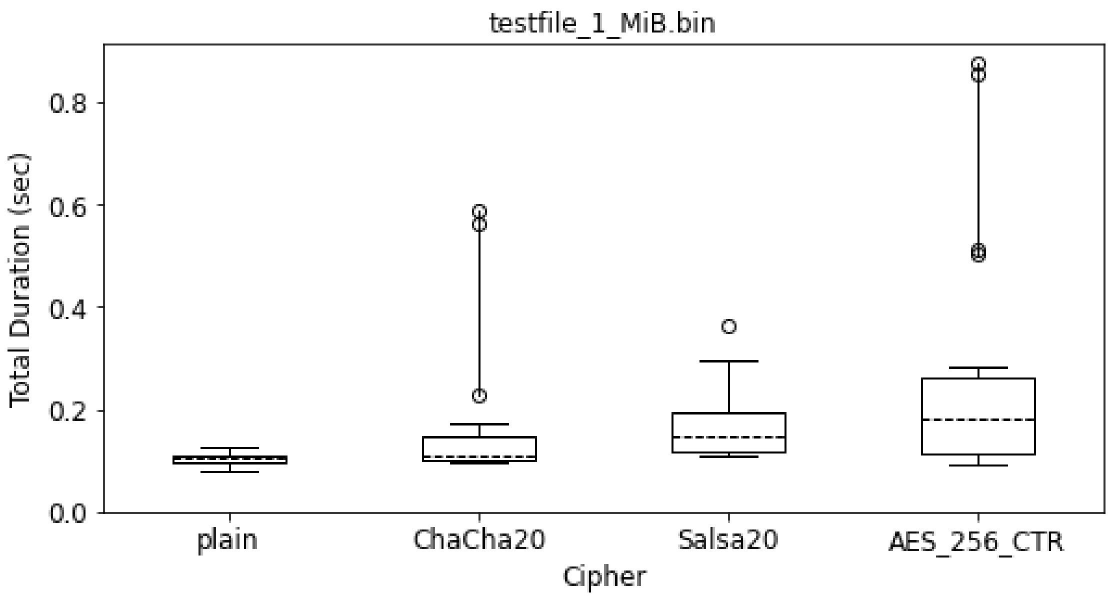
```
ipfs-file-relay: Time_Download_Duration_Wall
```

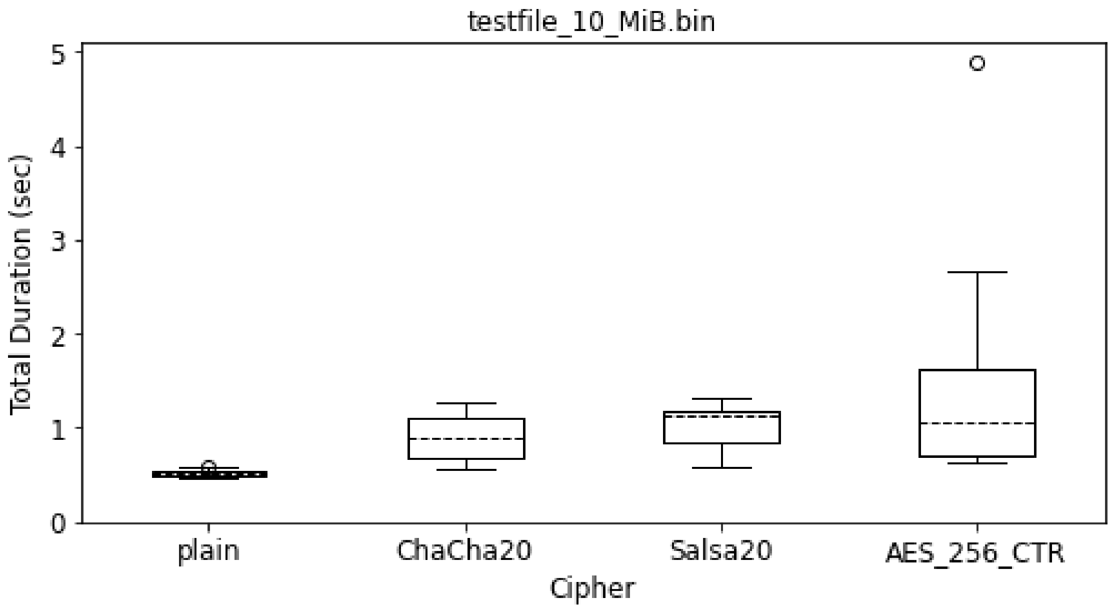


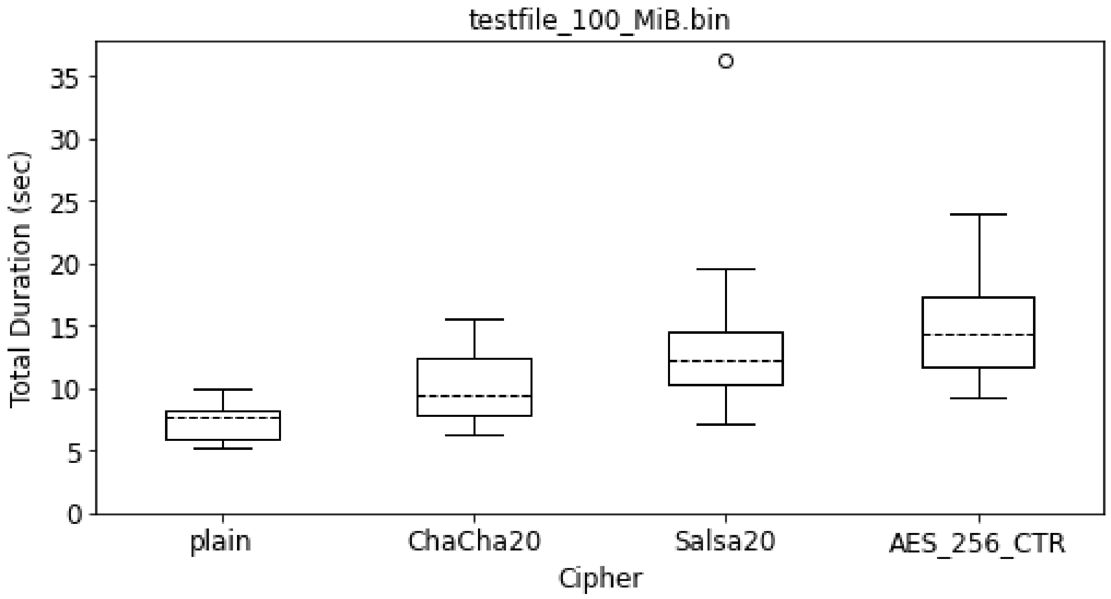
1.6.7 Plot IPFS results per cipher for peer to peer on the same VM

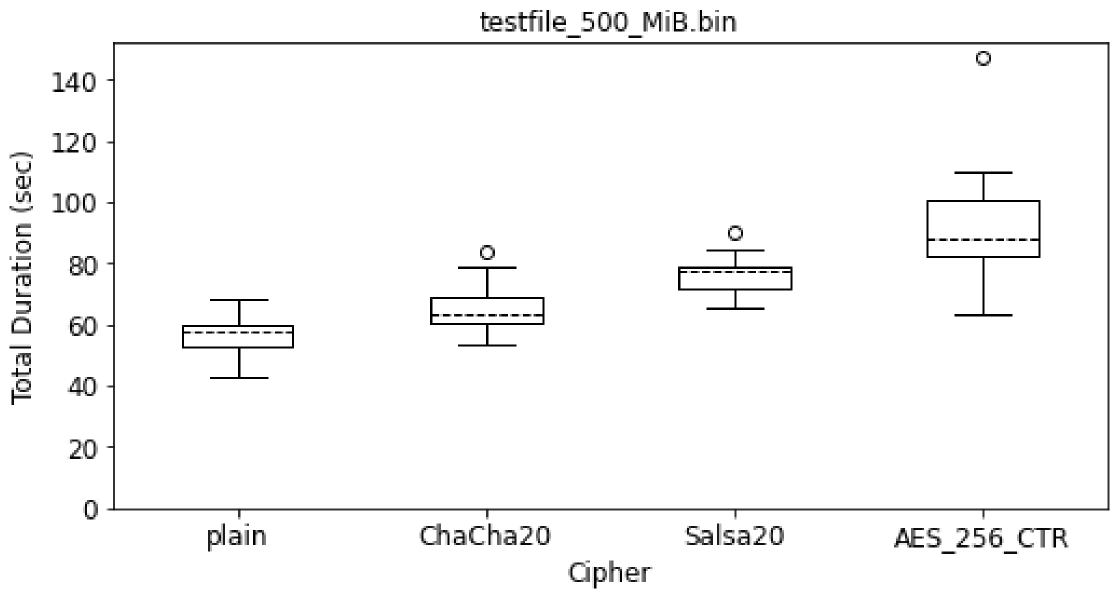
```
[24]: # Plot Time_Total_Duration_Wall
config['figsize'] = figsizeCipher
config['x_label_order'] = x_label_order_cipher
create_boxplots_cipher('ipfs-cipher-sameVM', ipfs_same_vm,␣
 ↪'Time_Total_Duration_Wall', config)
```

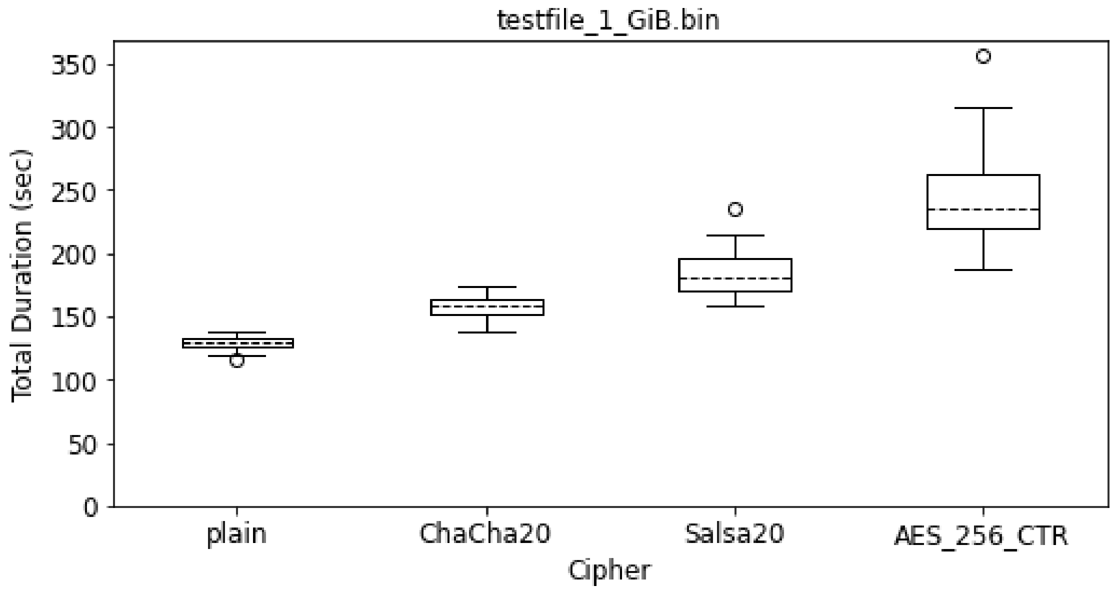
```
ipfs-cipher-sameVM: Time_Total_Duration_Wall
```




testfile_10_MiB.bin
Total Duration (sec)
0
1
2
3
4
5
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

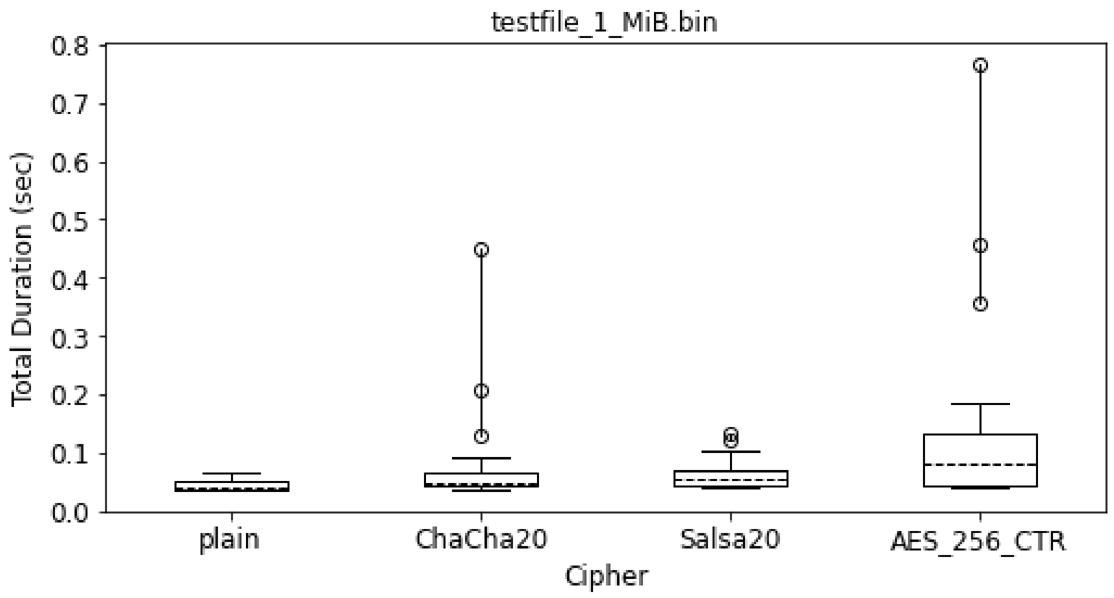

testfile_100_MiB.bin
Total Duration (sec)
0
5
10
15
20
25
30
35
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

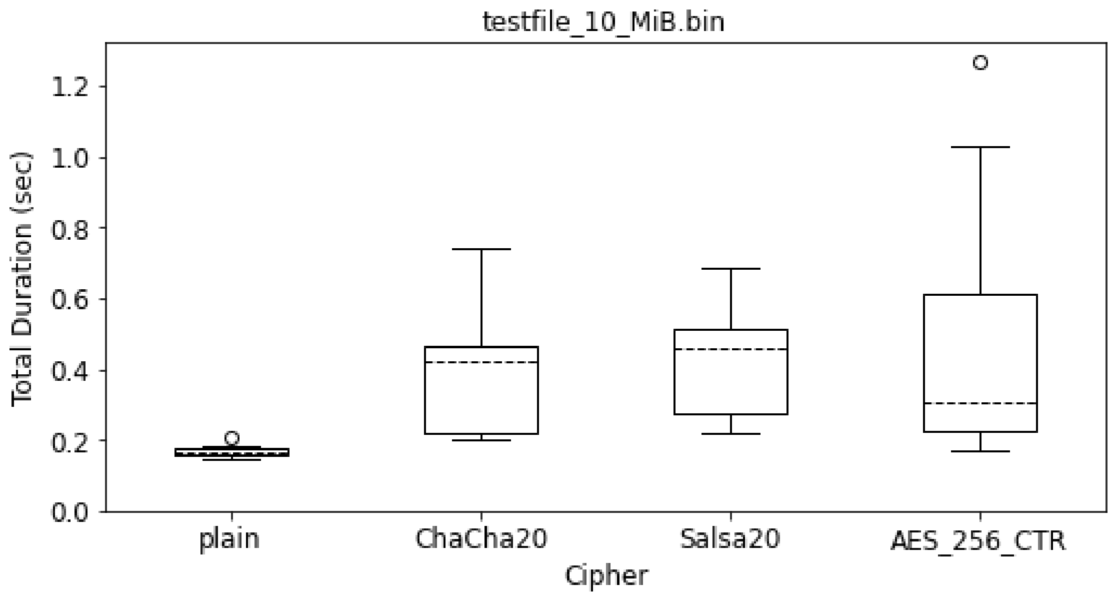


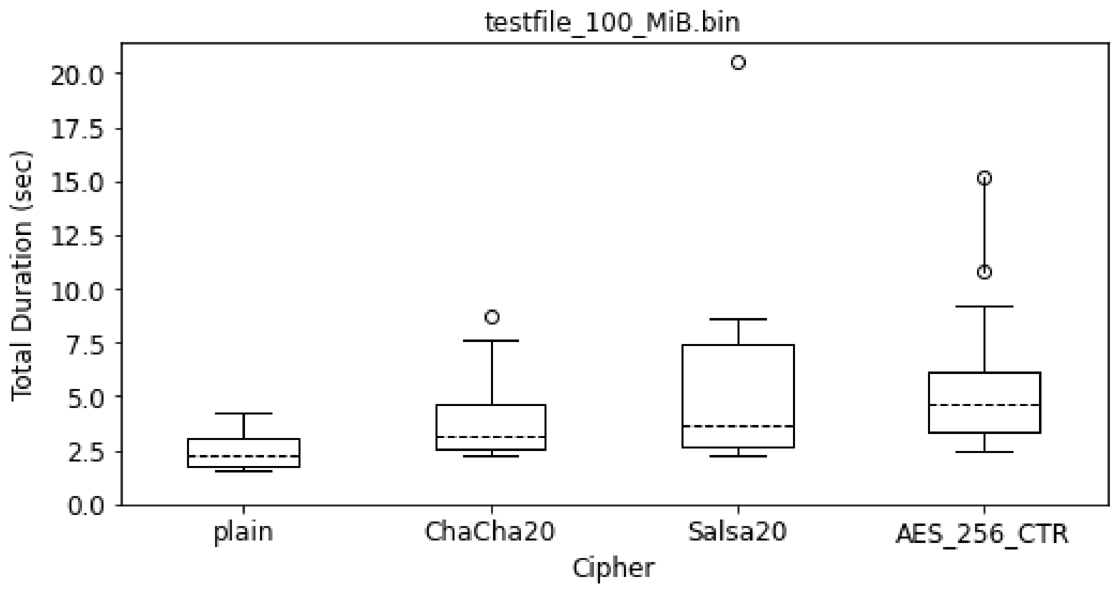


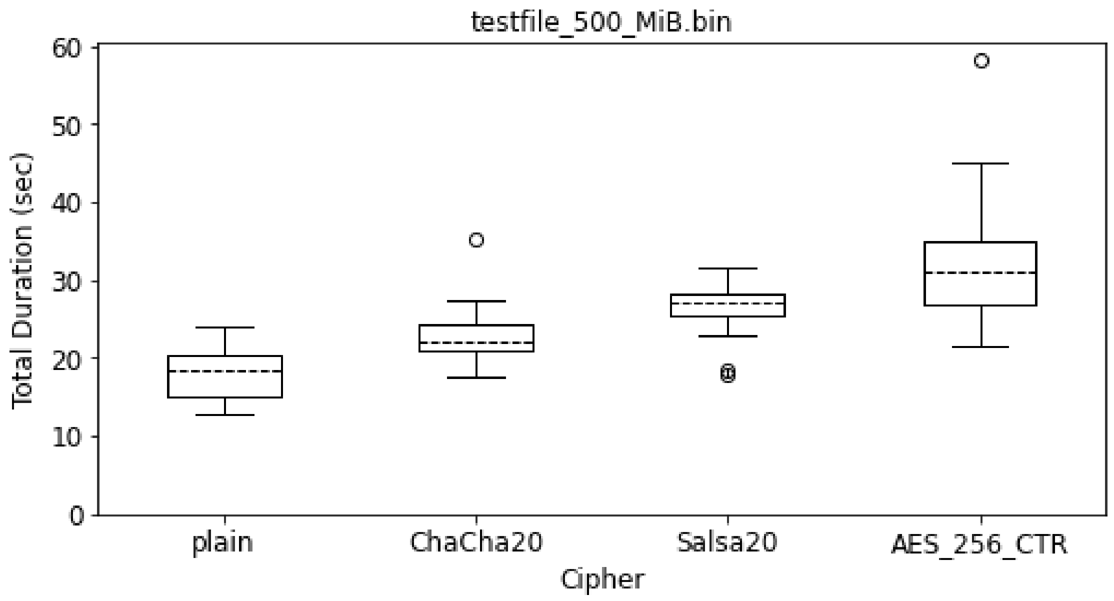
[25]:
```
# Plot Time_Upload_Duration_Wall
create_boxplots_cipher('ipfs-cipher-sameVM', ipfs_same_vm,␣
 ↪'Time_Upload_Duration_Wall', config)
```

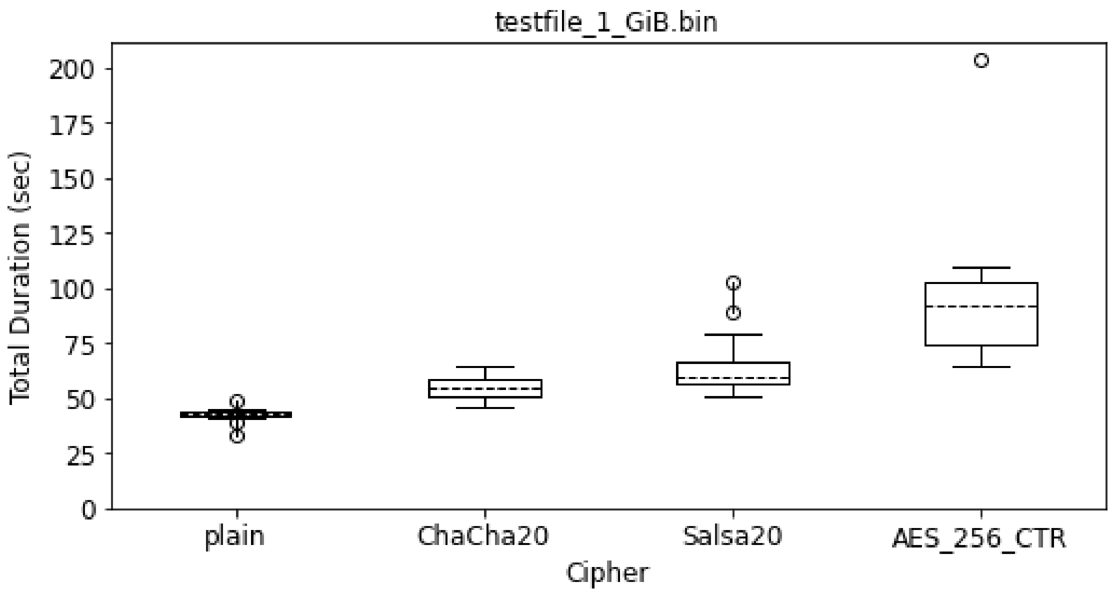
```
ipfs-cipher-sameVM: Time_Upload_Duration_Wall
```


testfile_1_MiB.bin
Total Duration (sec)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_10_MiB.bin
Total Duration (sec)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

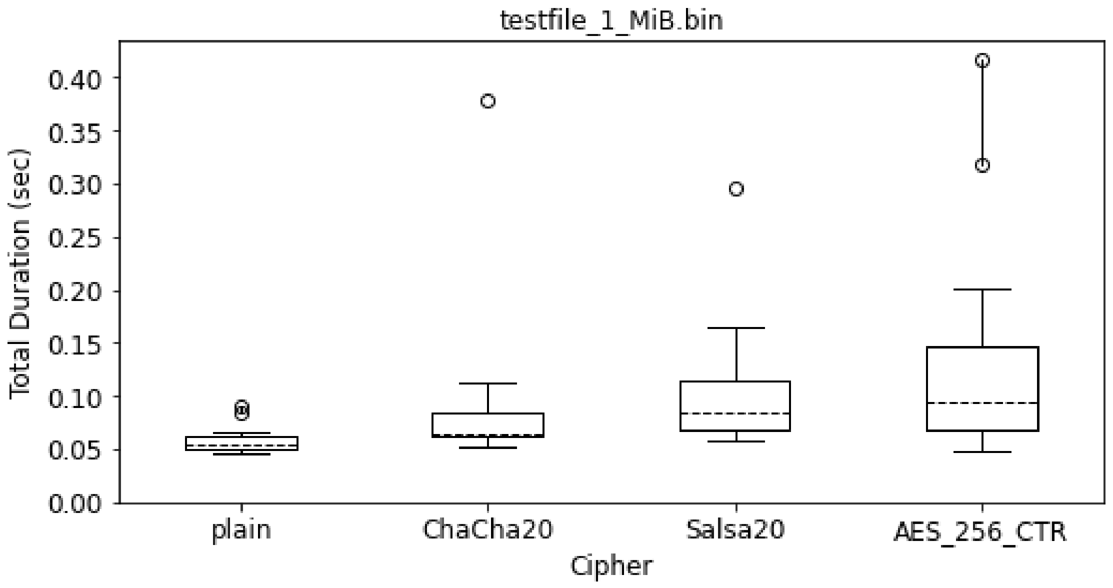

testfile_100_MiB.bin
Total Duration (sec)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

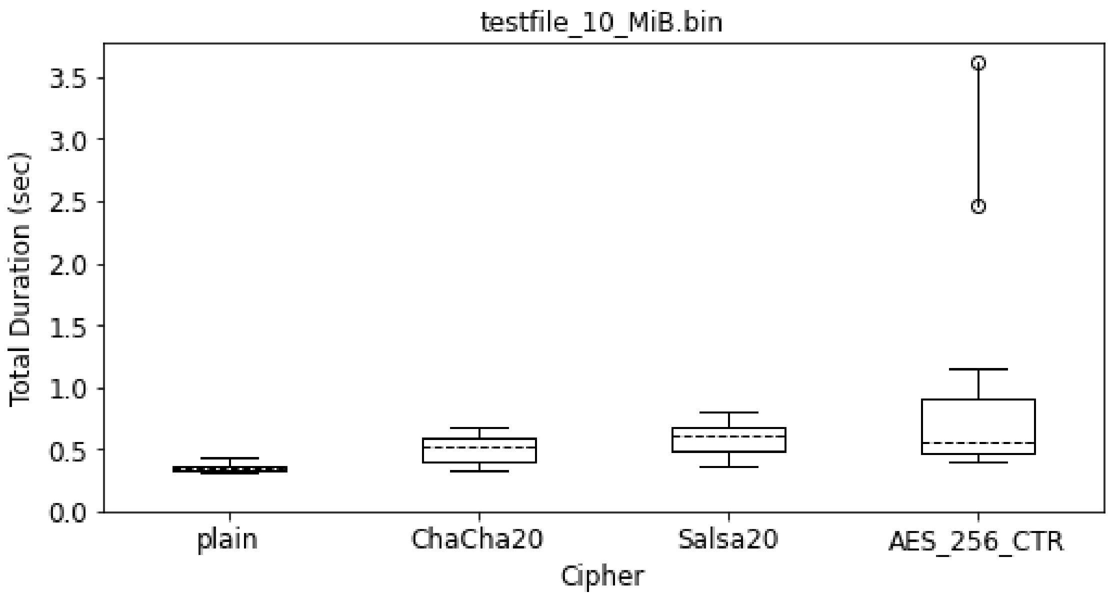

testfile_500_MiB.bin
Total Duration (sec)
60
50
40
30
20
10
0
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

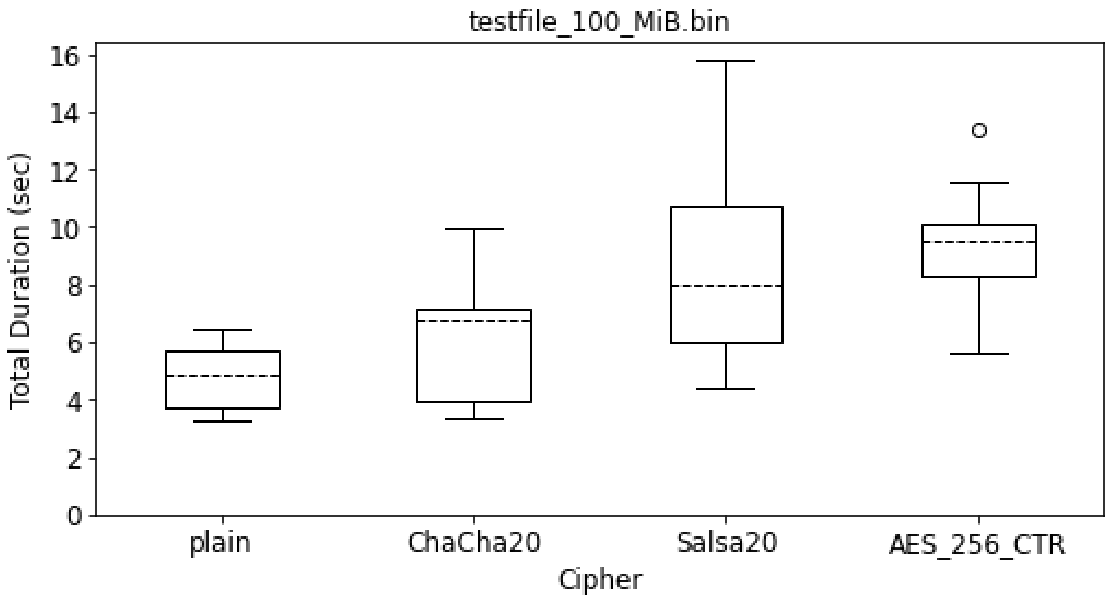


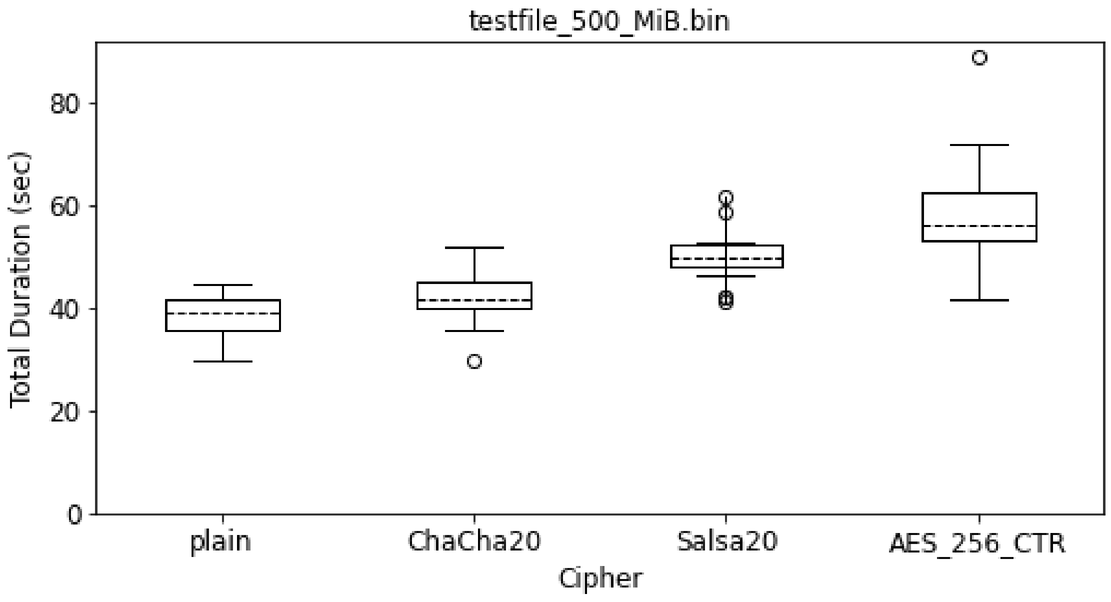
[26]:
```
# Plot Time_Download_Duration_Wall
create_boxplots_cipher('ipfs-cipher-sameVM', ipfs_same_vm,␣
↪'Time_Download_Duration_Wall', config)
```

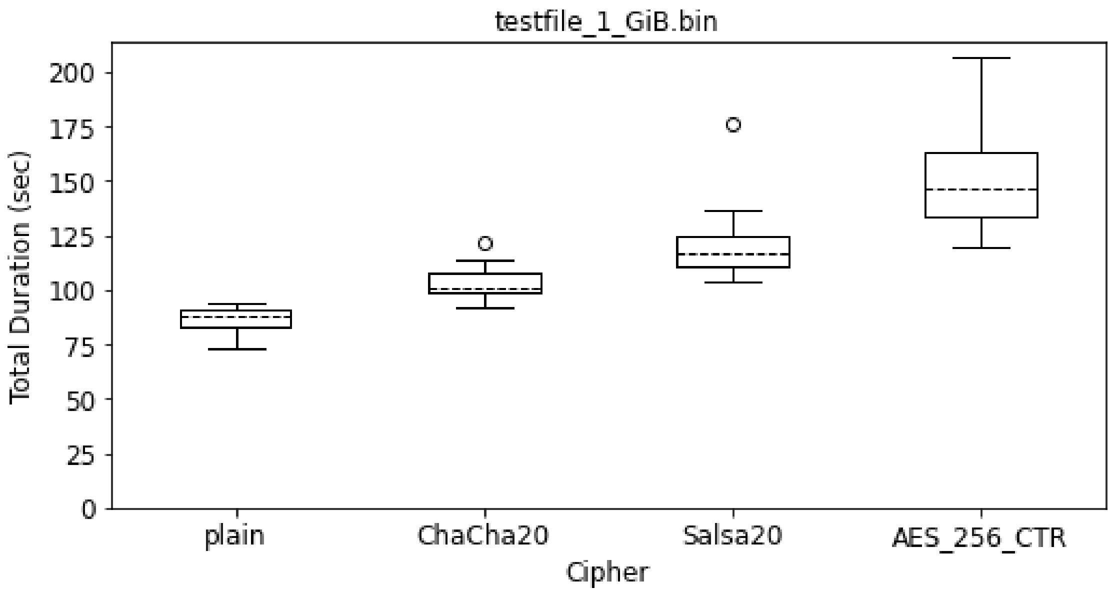
```
ipfs-cipher-sameVM: Time_Download_Duration_Wall
```




testfile_10_MiB.bin
Total Duration (sec)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_100_MiB.bin
Total Duration (sec)
0
2
4
6
8
10
12
14
16
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

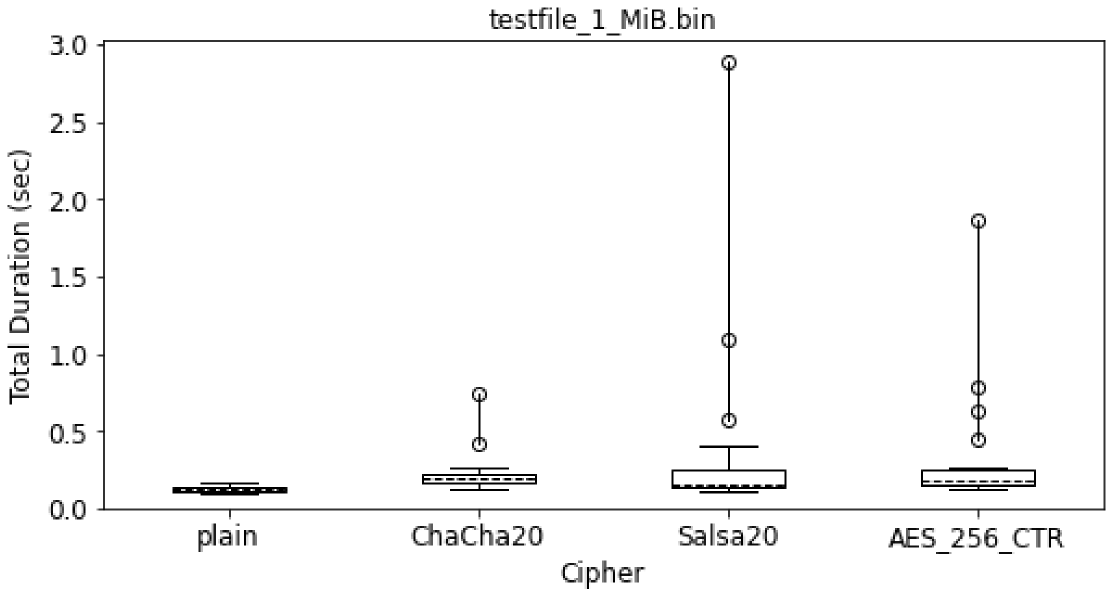


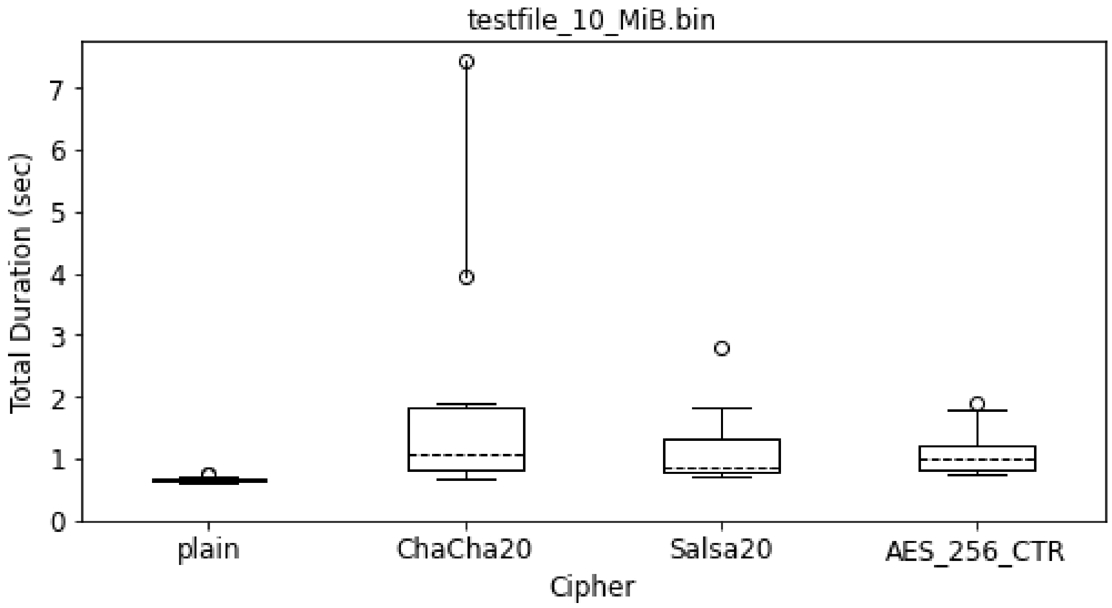


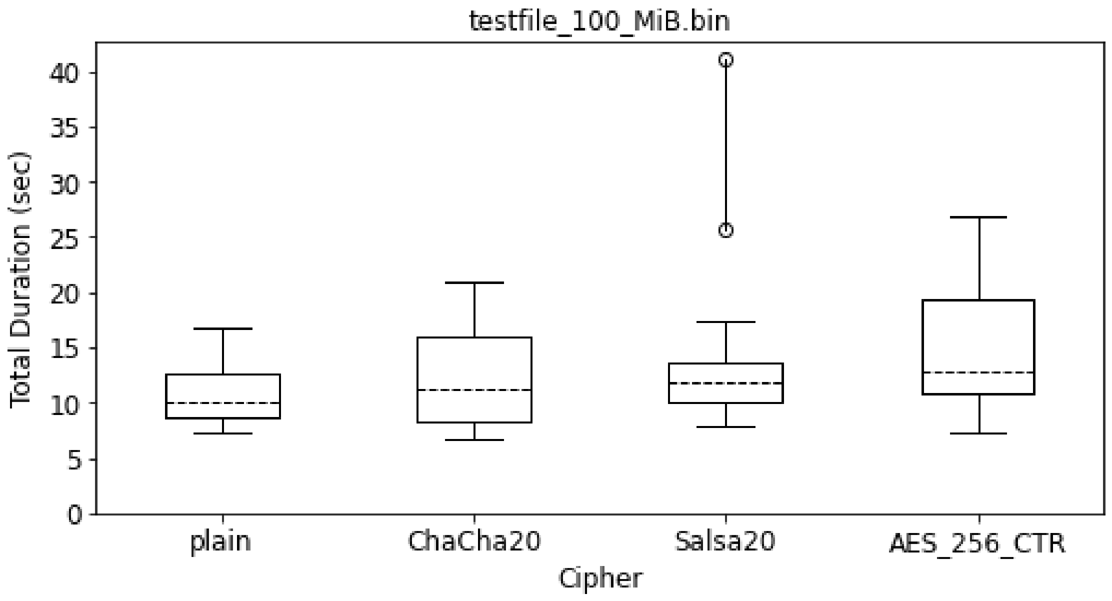
1.6.8 Plot IPFS results per cipher for peer to peer on different VMs

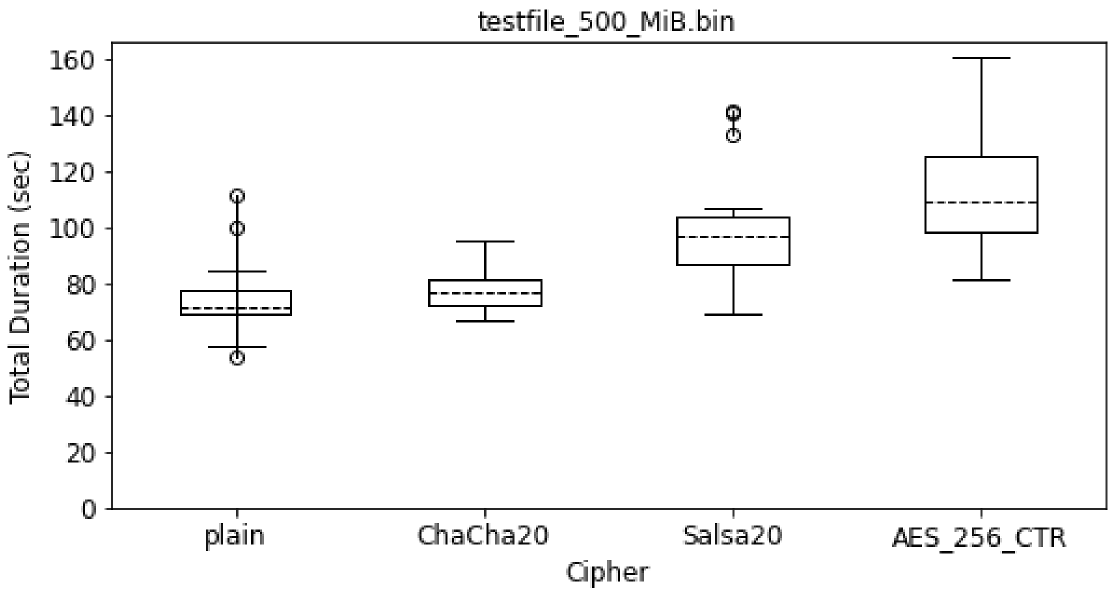
```
[27]: # Plot Time_Total_Duration_Wall
config['figsize'] = figsizeCipher
config['x_label_order'] = x_label_order_cipher
create_boxplots_cipher('ipfs-cipher-diffVM', ipfs_vm_to_vm,␣
 ↪'Time_Total_Duration_Wall', config)
```

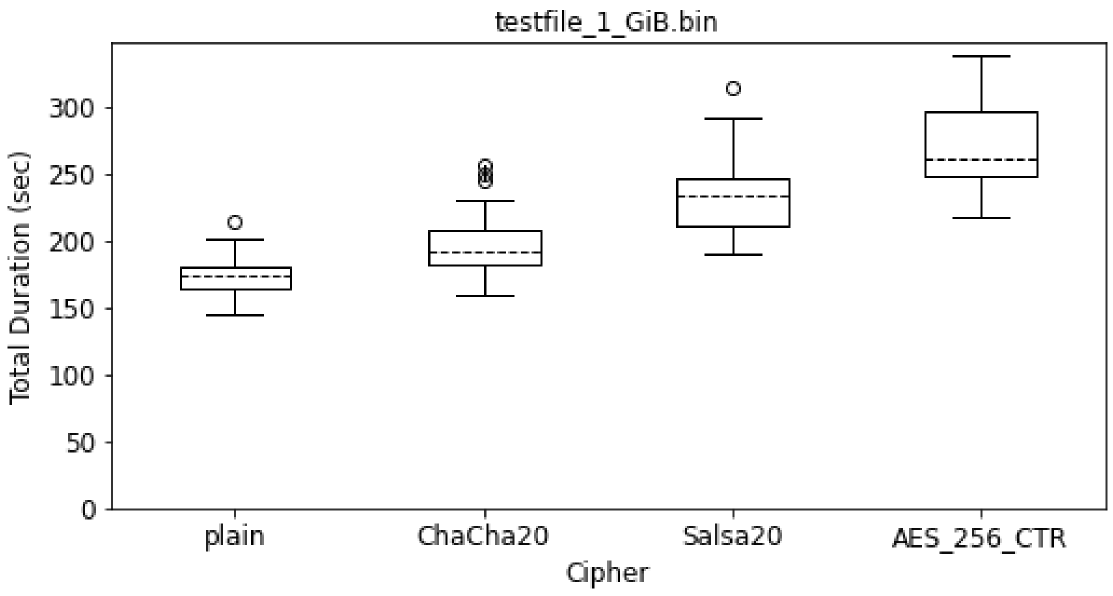
```
ipfs-cipher-diffVM: Time_Total_Duration_Wall
```





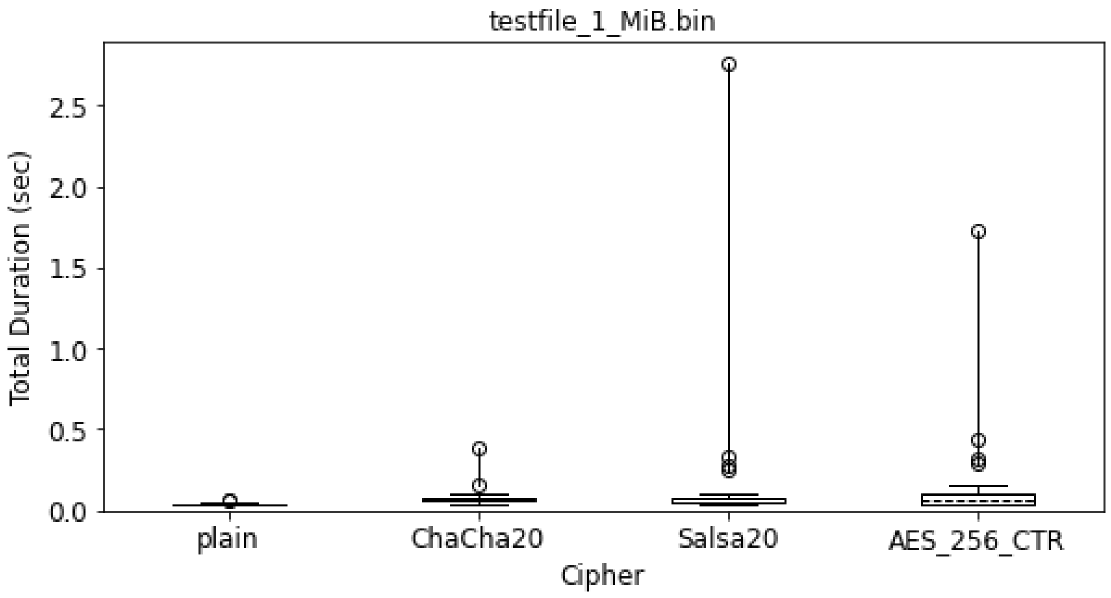

testfile_100_MiB.bin
Total Duration (sec)
0
5
10
15
20
25
30
35
40
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

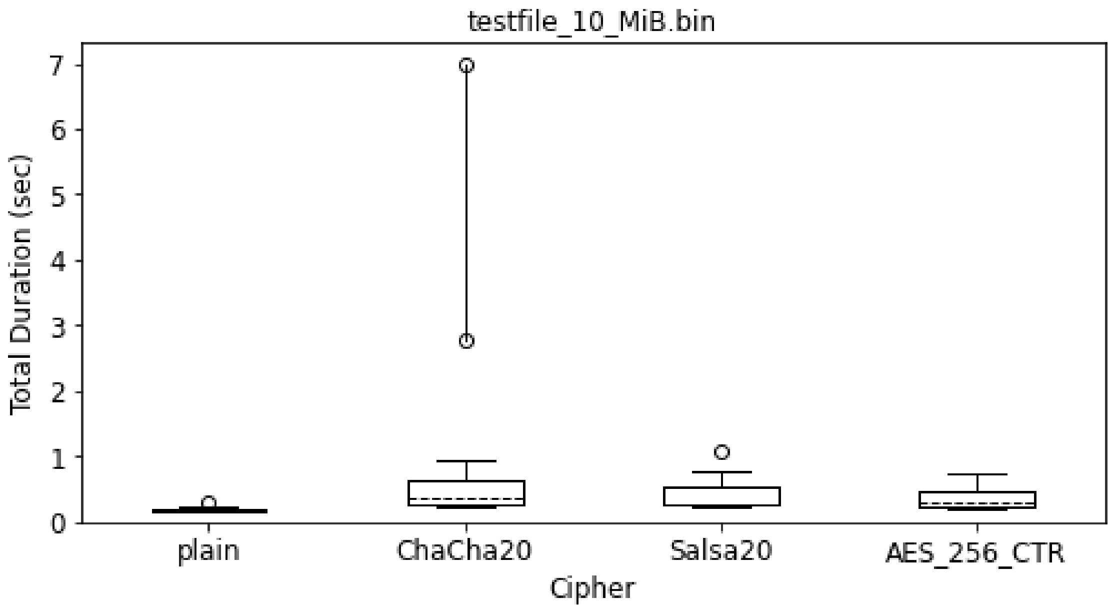

testfile_500_MiB.bin
Total Duration (sec)
0
20
40
60
80
100
120
140
160
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

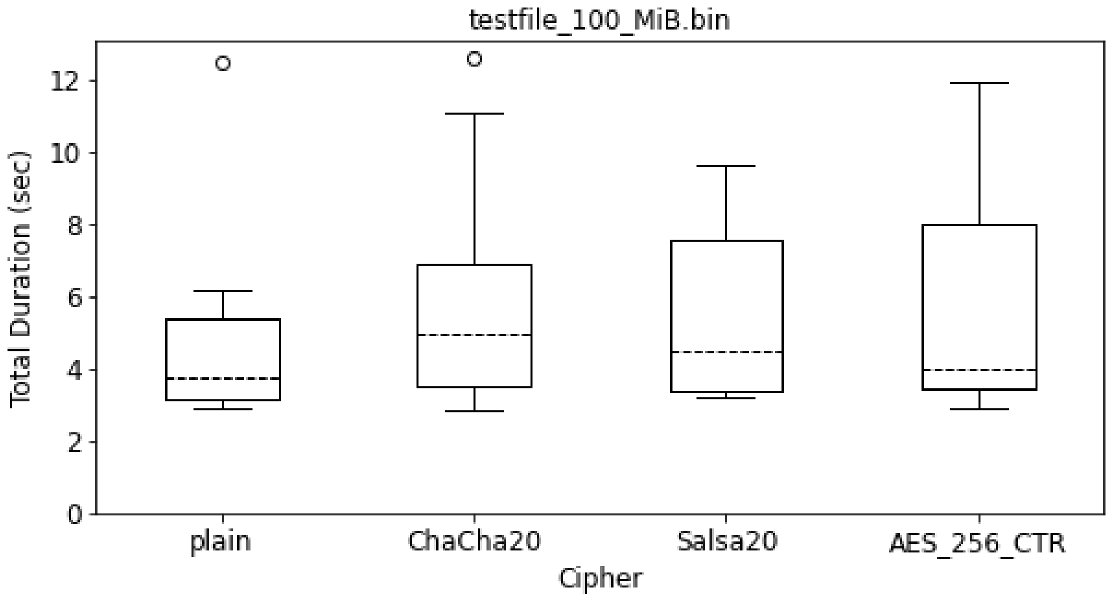


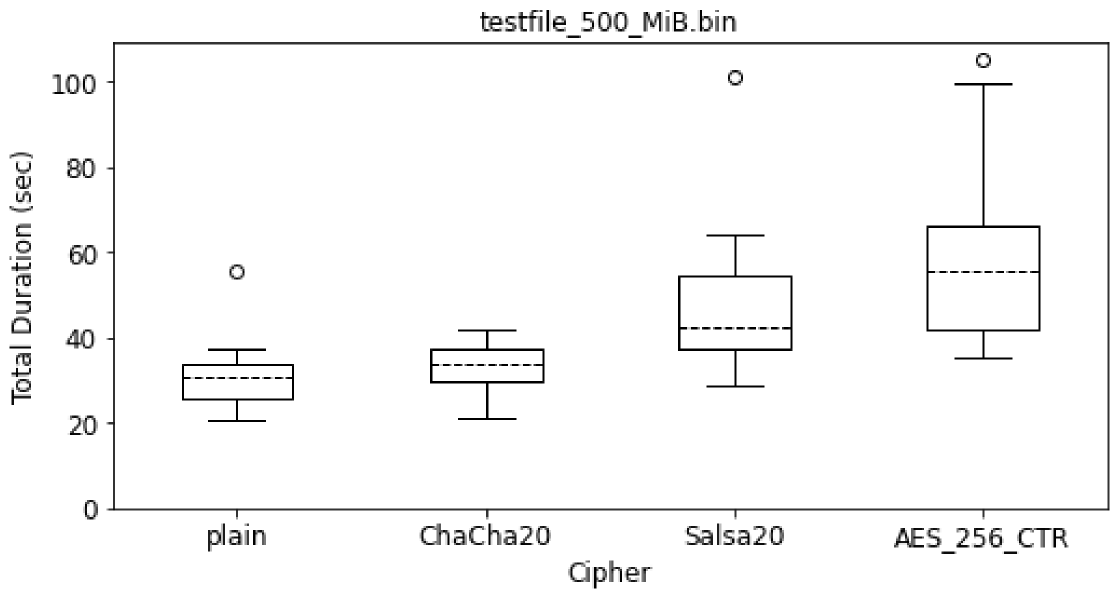
```
[28]: # Plot Time_Upload_Duration_Wall
      create_boxplots_cipher('ipfs-cipher-diffVM', ipfs_vm_to_vm,␣
       ↪'Time_Upload_Duration_Wall', config)
```

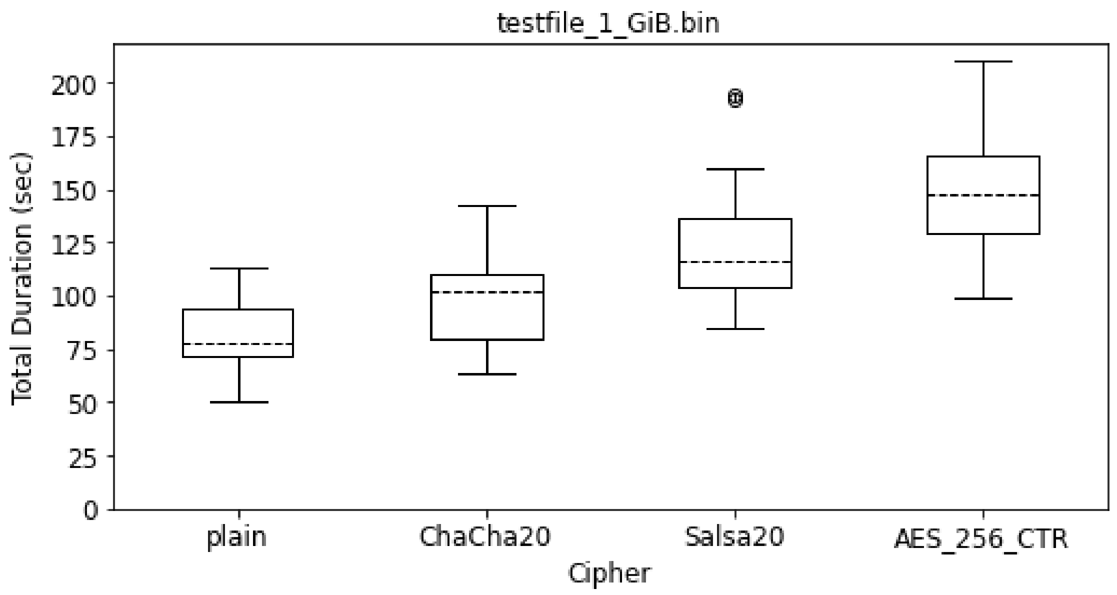
```
ipfs-cipher-diffVM: Time_Upload_Duration_Wall
```




testfile_10_MiB.bin
Total Duration (sec)
0
1
2
3
4
5
6
7
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

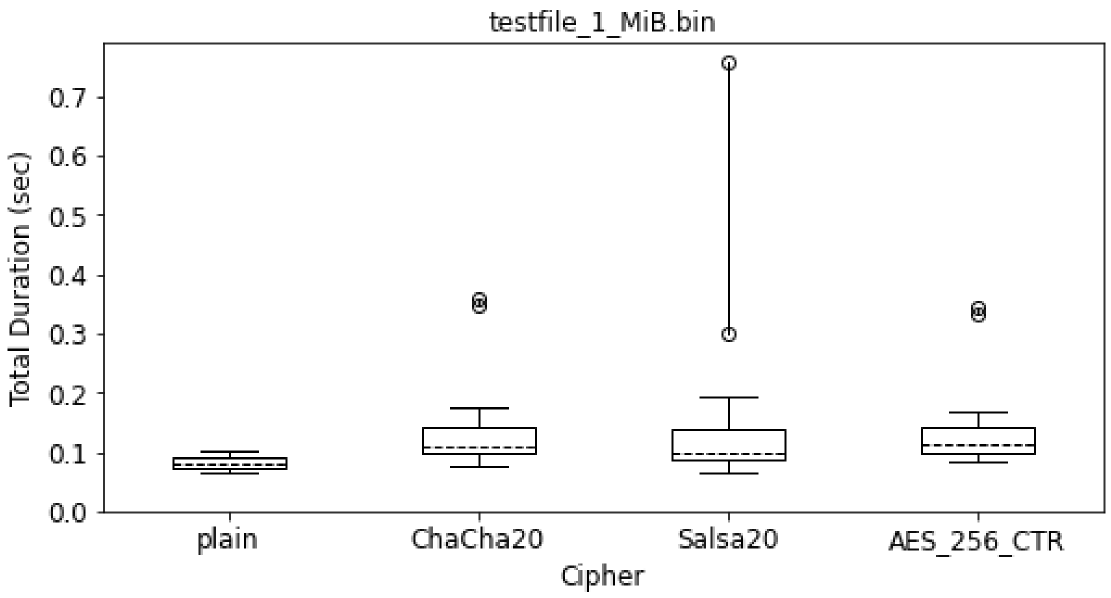

testfile_100_MiB.bin
Total Duration (sec)
0
2
4
6
8
10
12
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

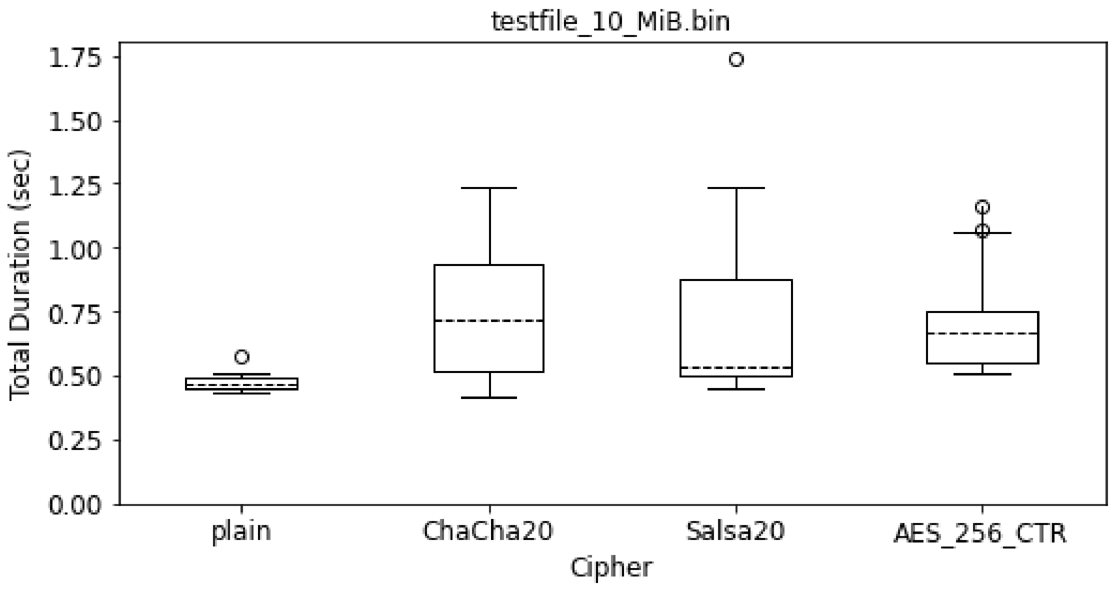


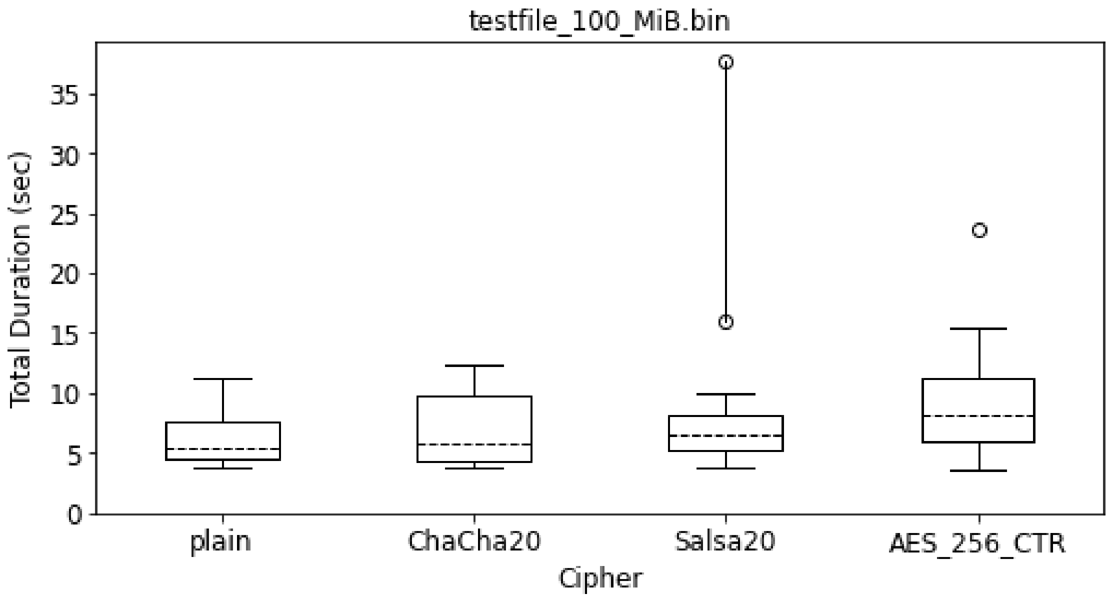


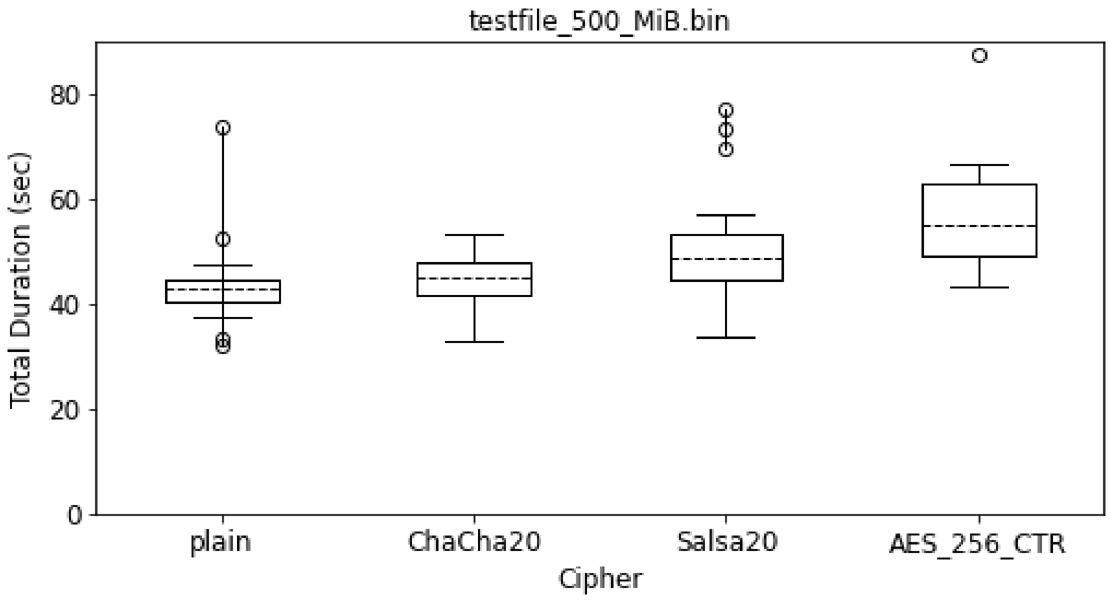
[29]:
```
# Plot Time_Download_Duration_Wall
create_boxplots_cipher('ipfs-cipher-diffVM', ipfs_vm_to_vm,␣
 ↪'Time_Download_Duration_Wall', config)
```

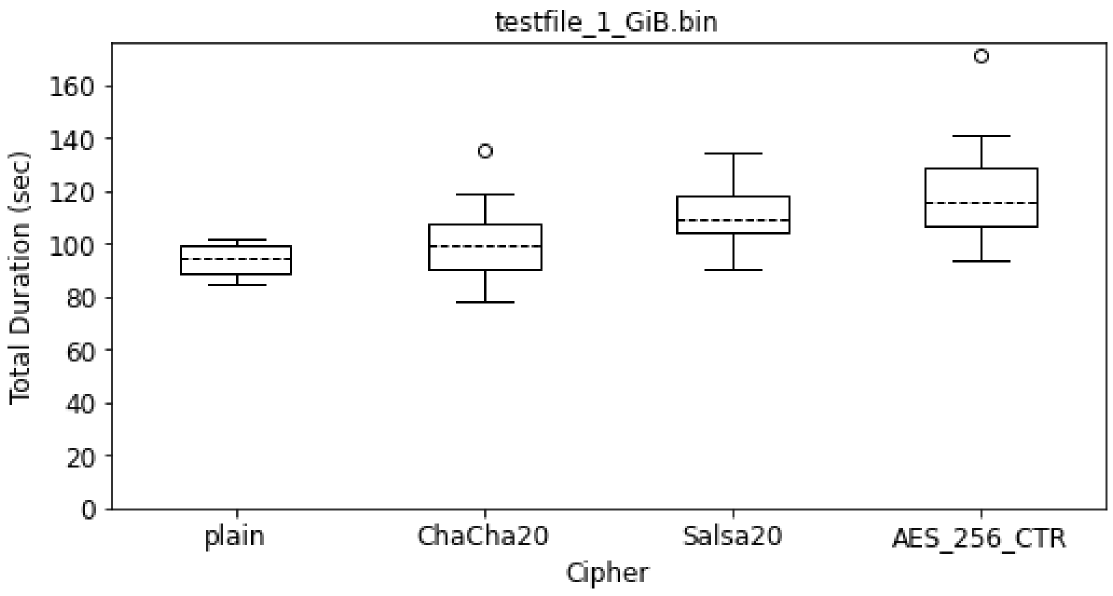
```
ipfs-cipher-diffVM: Time_Download_Duration_Wall
```


testfile_1_MiB.bin
Total Duration (sec)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_10_MiB.bin
Total Duration (sec)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_100_MiB.bin
Total Duration (sec)
0
5
10
15
20
25
30
35
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

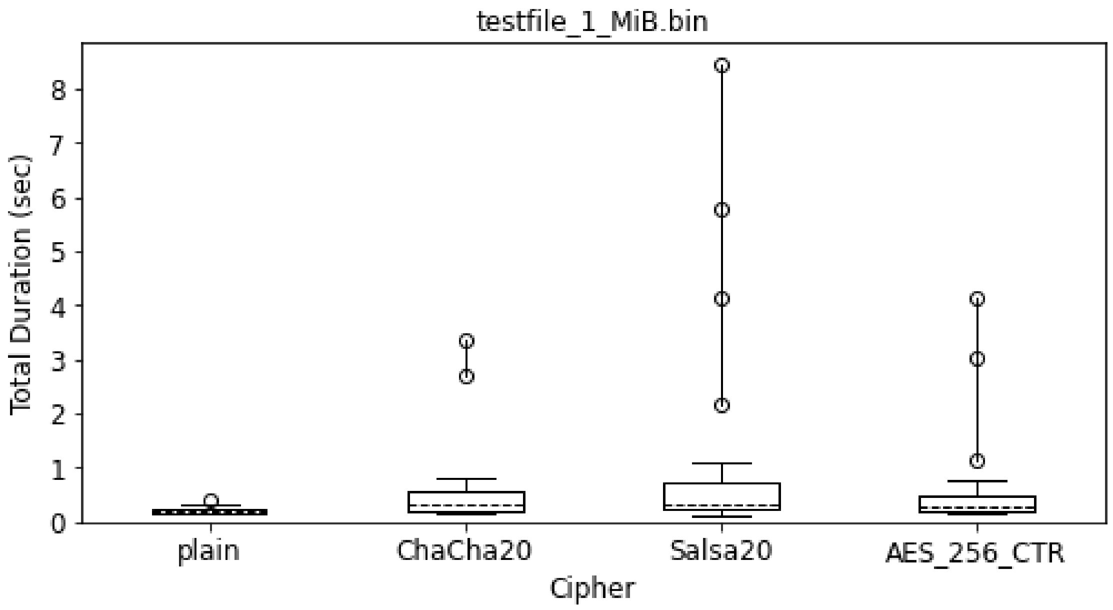

testfile_500_MiB.bin
Total Duration (sec)
0
20
40
60
80
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

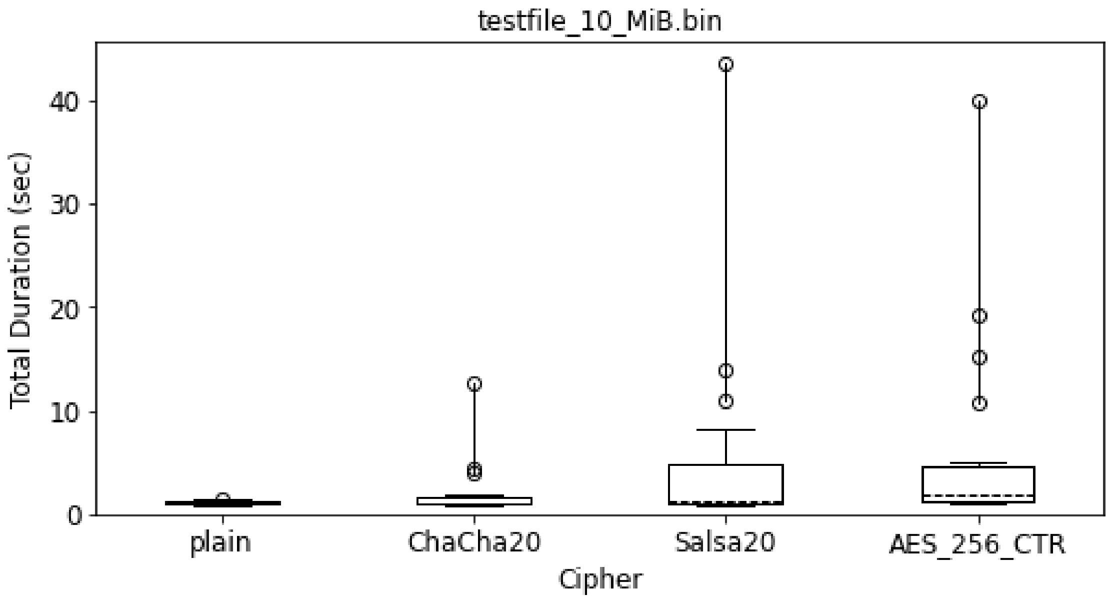


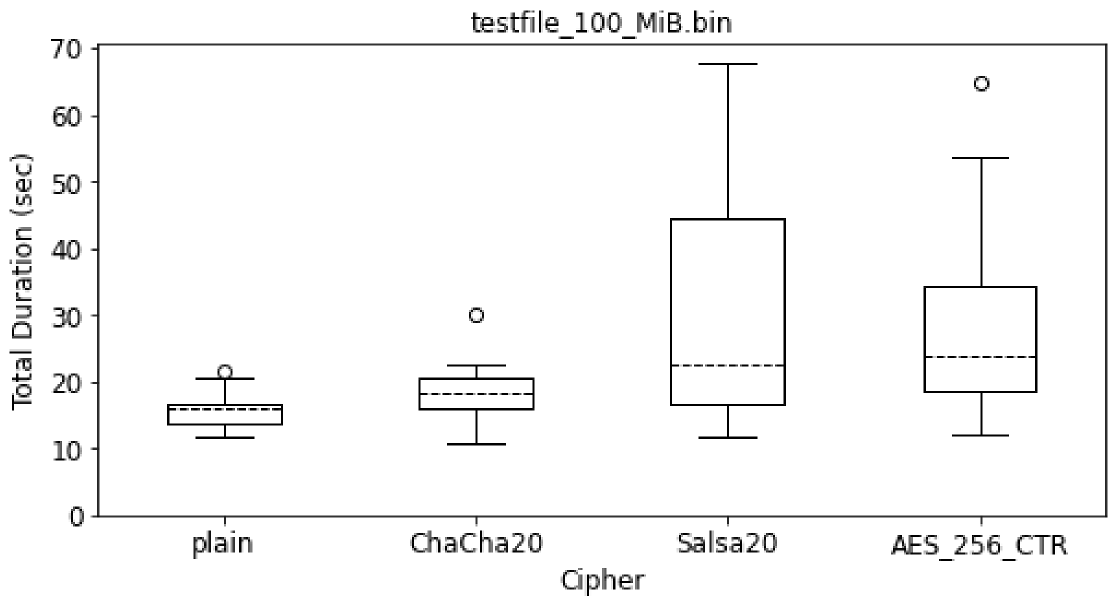
1.6.9 Plot IPFS results per cipher for peer to peer on different VMs via (bitswap) relay

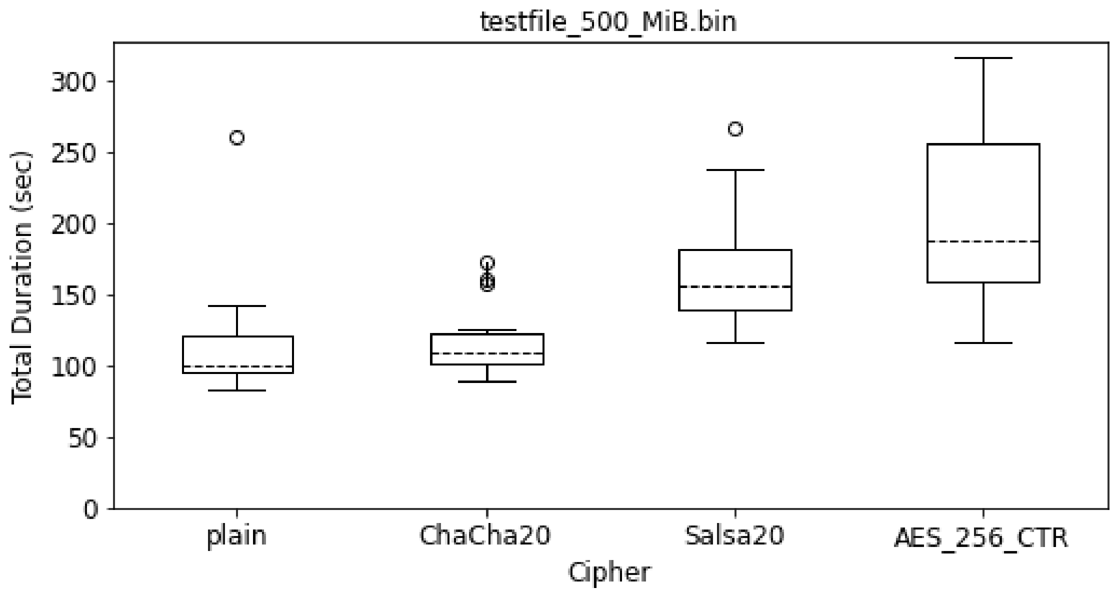
[30]:
```
# Plot Time_Total_Duration_Wall
config['figsize'] = figsizeCipher
config['x_label_order'] = x_label_order_cipher
create_boxplots_cipher('ipfs-cipher-relay', ipfs_relay,␣
 ↪'Time_Total_Duration_Wall', config)
```

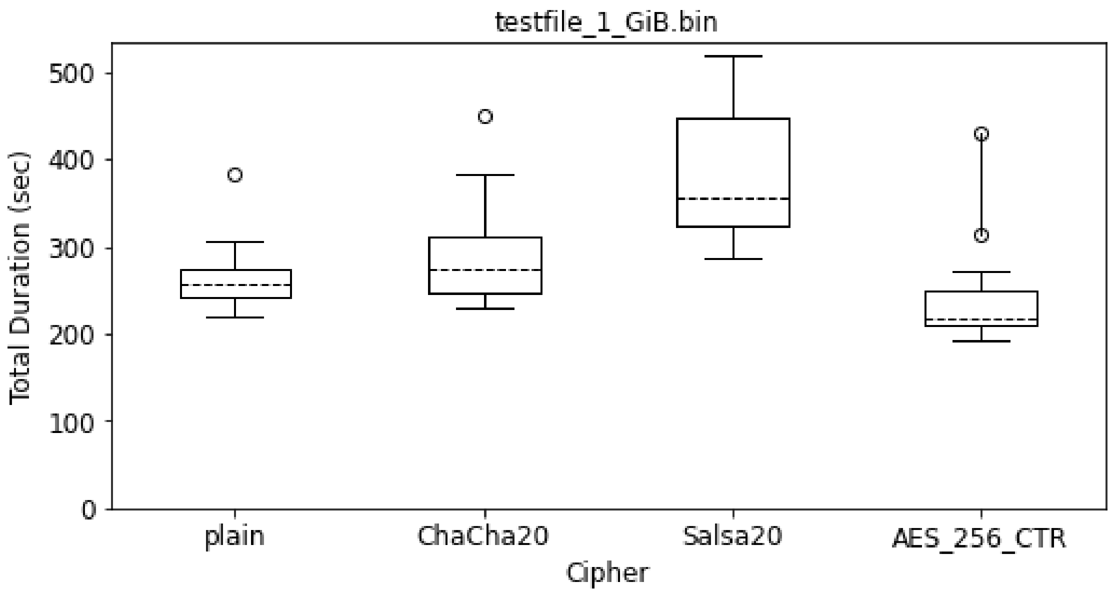
```
ipfs-cipher-relay: Time_Total_Duration_Wall
```


testfile_1_MiB.bin
Total Duration (sec)
0
1
2
3
4
5
6
7
8
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_10_MiB.bin
Total Duration (sec)
0
10
20
30
40
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

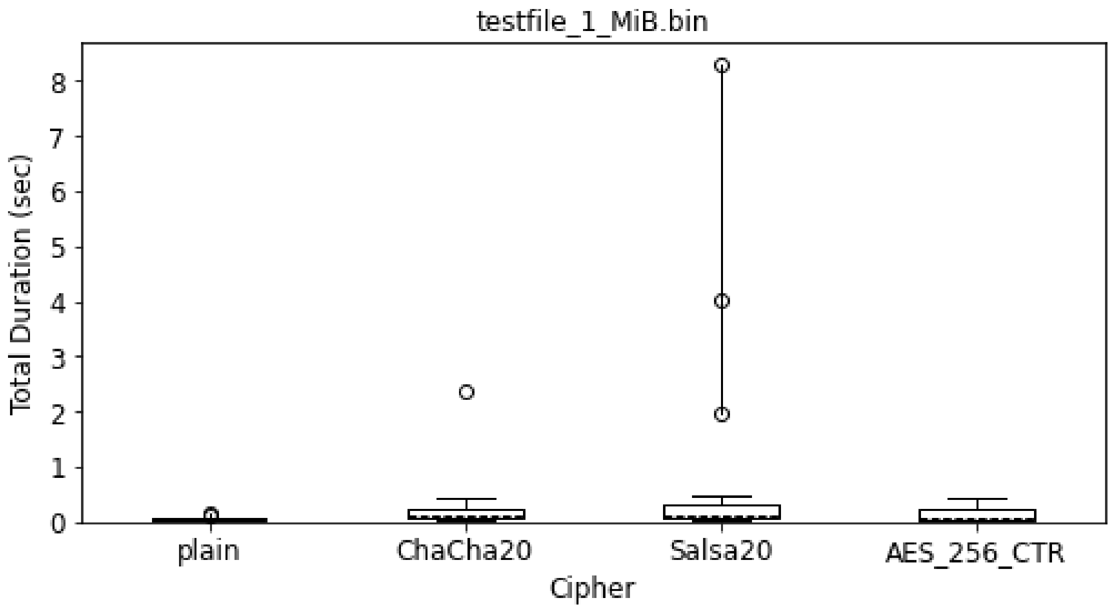

testfile_100_MiB.bin
Total Duration (sec)
0
10
20
30
40
50
60
70
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

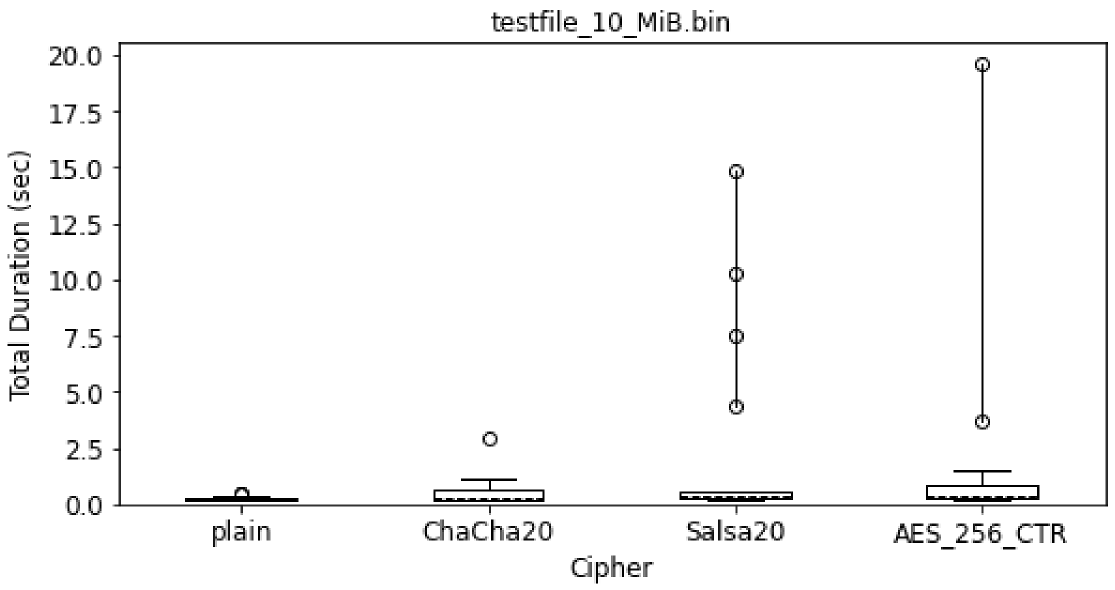

testfile_500_MiB.bin
Total Duration (sec)
0
50
100
150
200
250
300
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

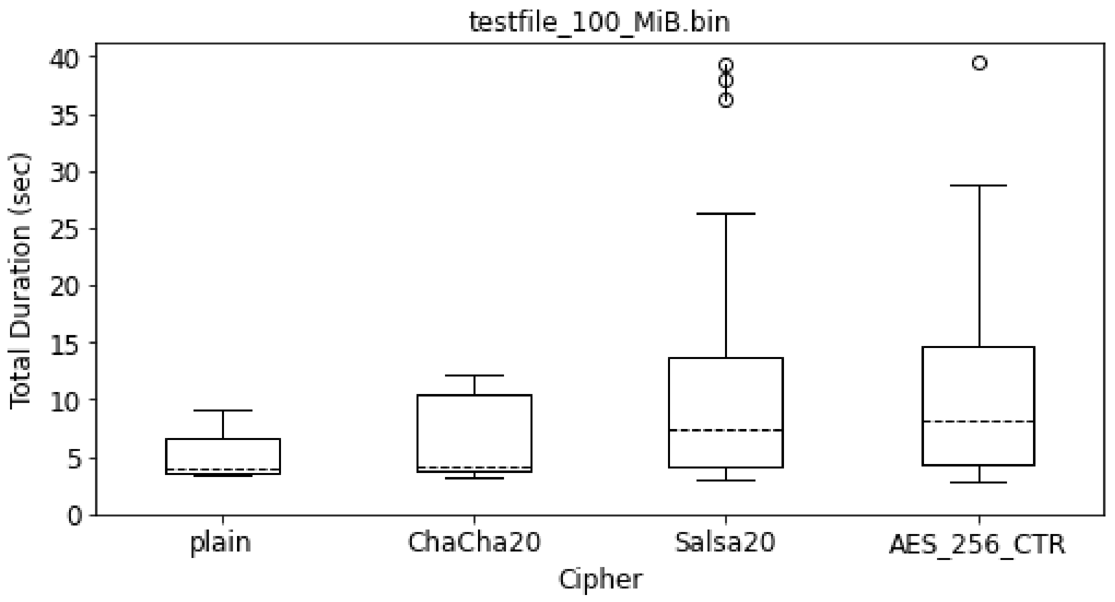


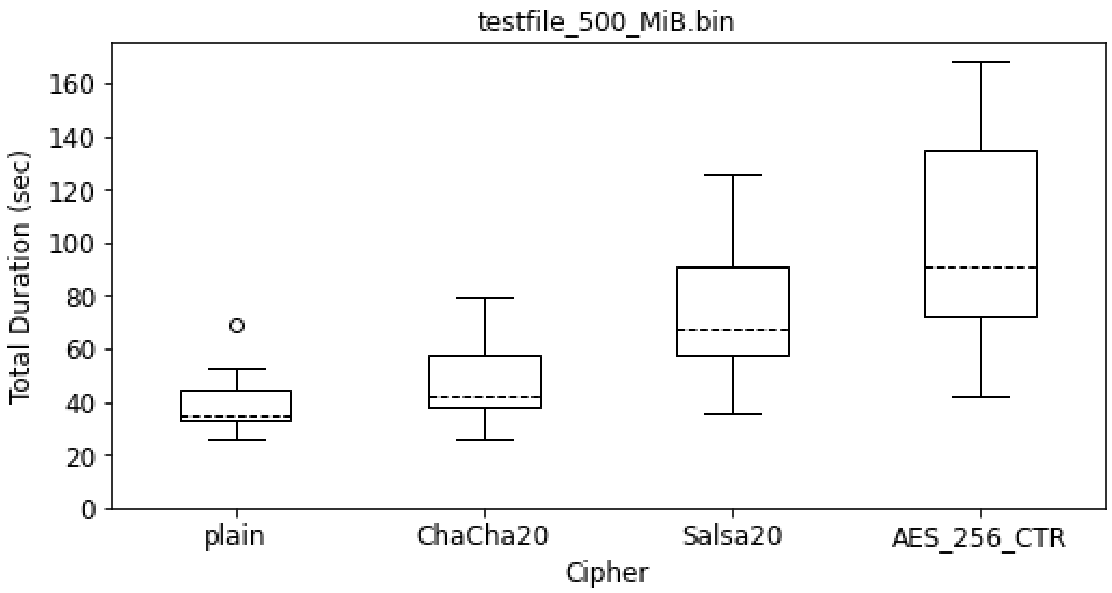
```
[31]: # Plot Time_Upload_Duration_Wall
create_boxplots_cipher('ipfs-cipher-relay', ipfs_relay,␣
 ↪'Time_Upload_Duration_Wall', config)
```

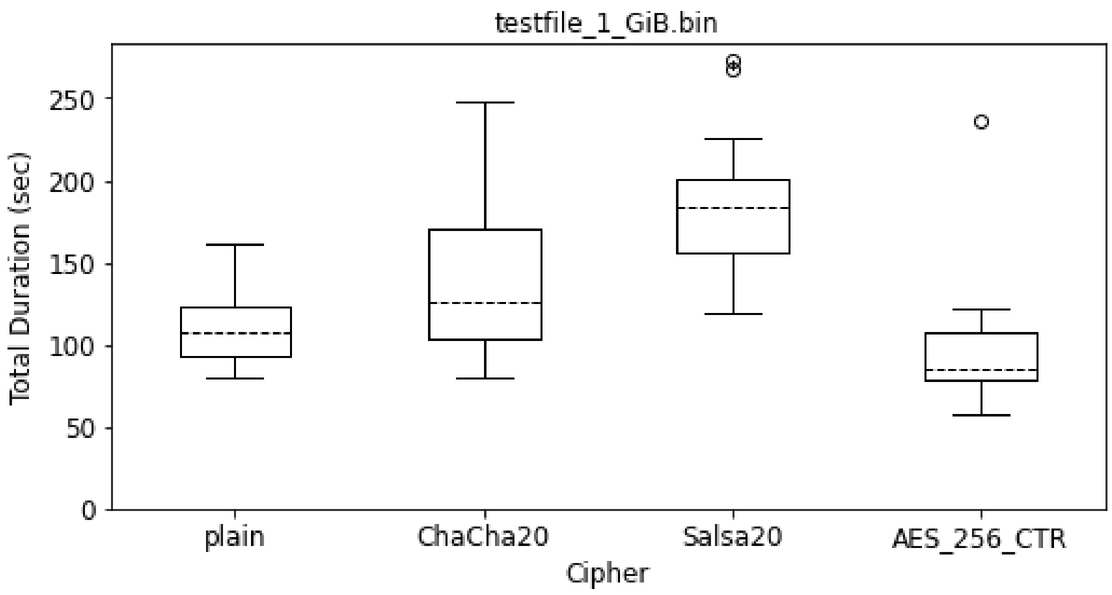
```
ipfs-cipher-relay: Time_Upload_Duration_Wall
```




testfile_10_MiB.bin
Total Duration (sec)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

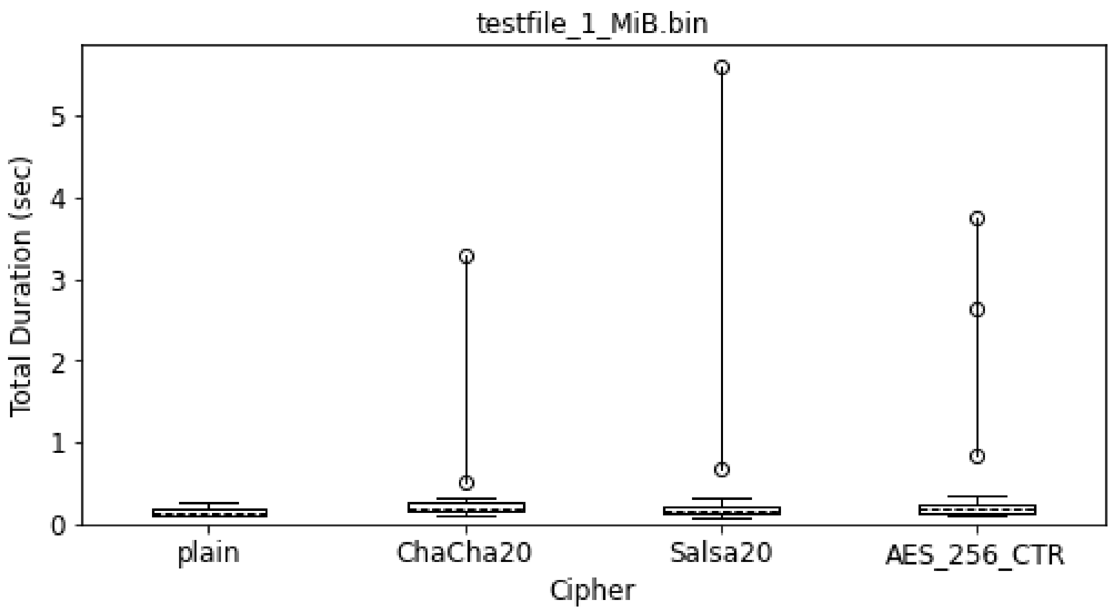

testfile_100_MiB.bin
Total Duration (sec)
40
35
30
25
20
15
10
5
0
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

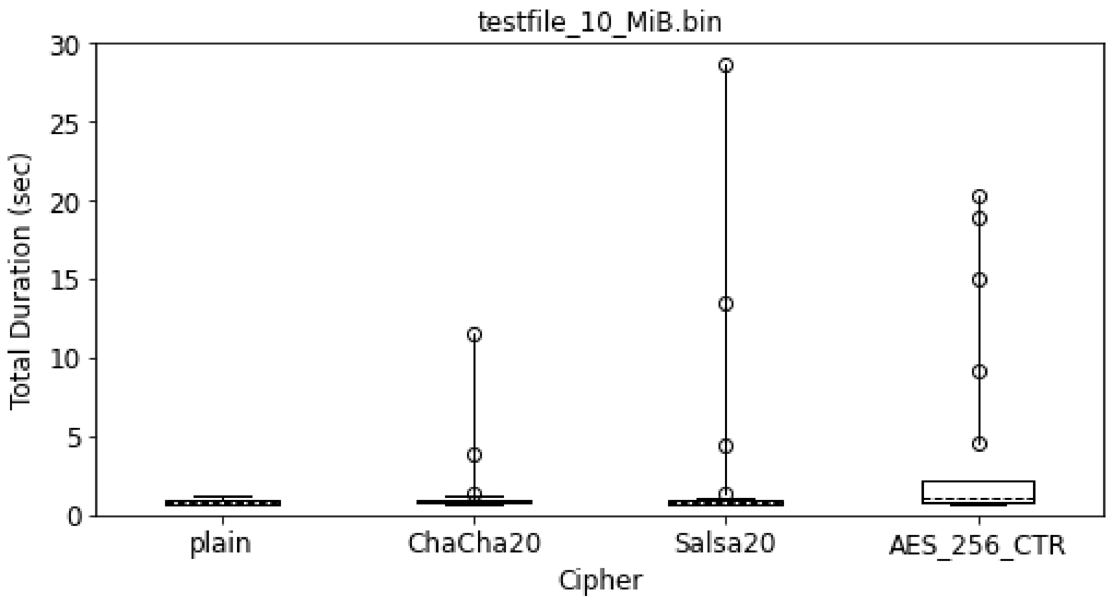


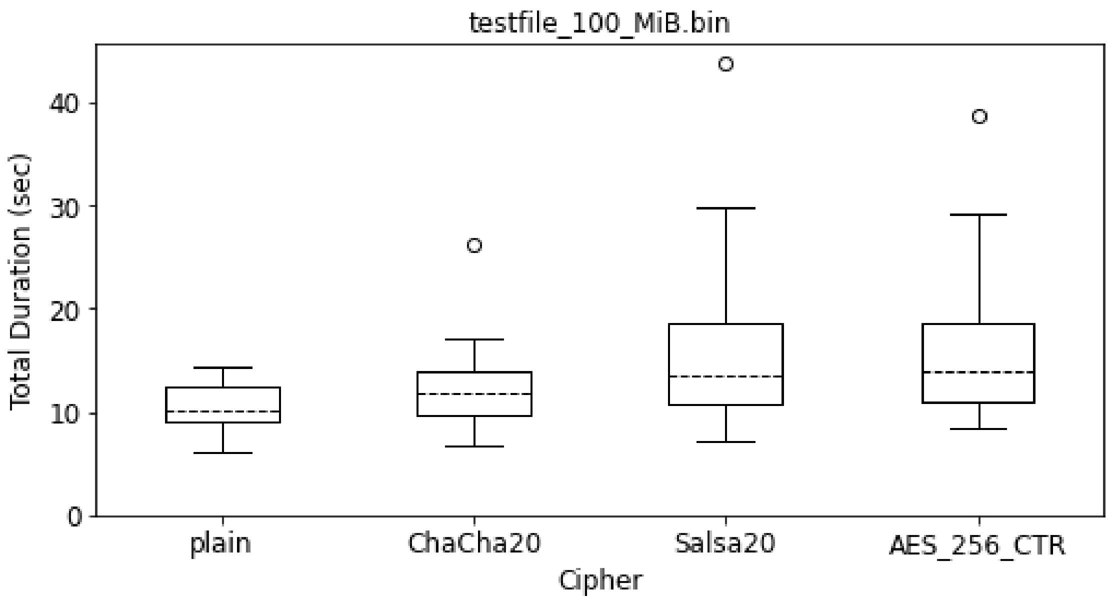


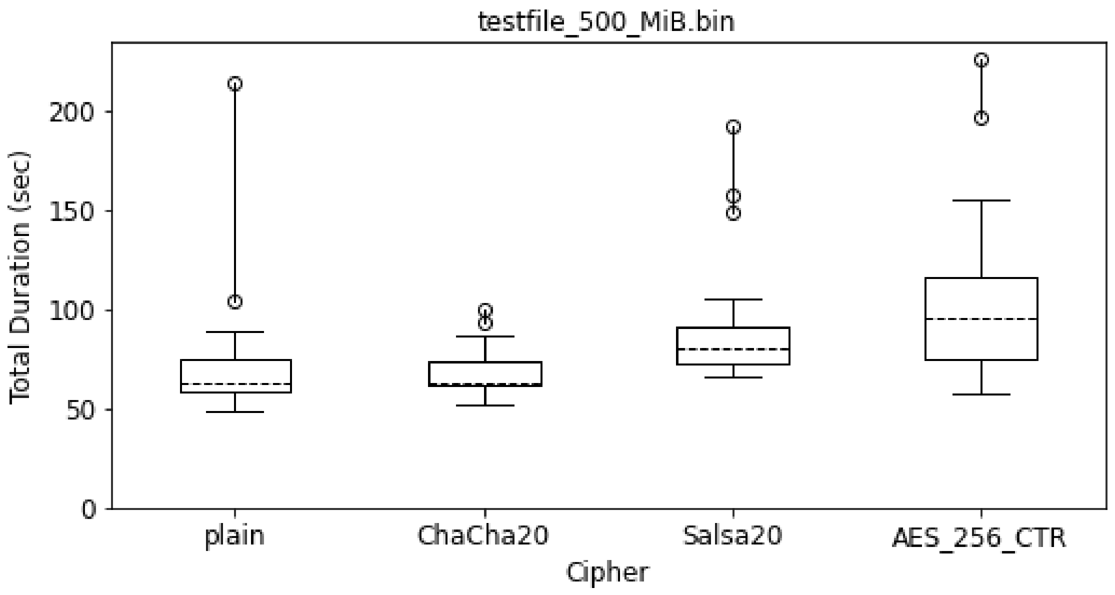
```
[32]: # Plot Time_Download_Duration_Wall
      create_boxplots_cipher('ipfs-cipher-relay', ipfs_relay,␣
       ↪'Time_Download_Duration_Wall', config)
```

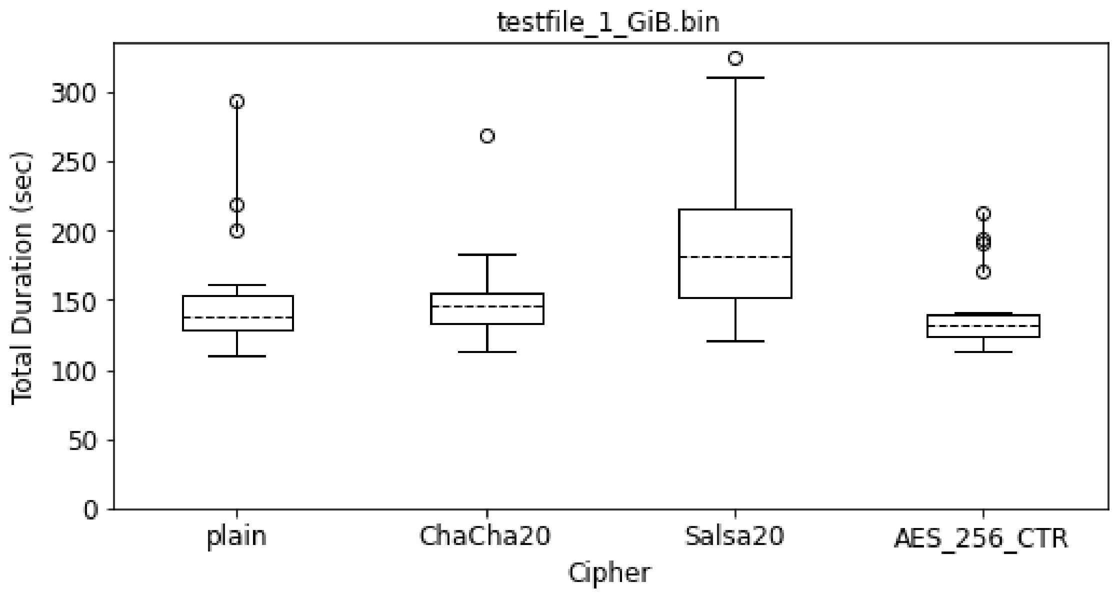
```
ipfs-cipher-relay: Time_Download_Duration_Wall
```


testfile_1_MiB.bin
Total Duration (sec)
0
1
2
3
4
5
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_10_MiB.bin
Total Duration (sec)
0
5
10
15
20
25
30
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_100_MiB.bin
Total Duration (sec)
0
10
20
30
40
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_500_MiB.bin
Total Duration (sec)
0
50
100
150
200
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher


testfile_1_GiB.bin
Total Duration (sec)
0
50
100
150
200
250
300
plain
ChaCha20
Salsa20
AES_256_CTR
Cipher

```
[ ]:
```