JMeter Analysis

September 20, 2022

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from IPython.display import Image
```

[2]:
```
def load_dataset(results):
    df = pd.read_csv(results,␣
 ↪usecols=['timeStamp','elapsed','success','bytes','Latency',␣
 ↪'IdleTime','Connect'])
    df['totalElapsed'] = df.elapsed.cumsum()
    df['throughput'] = ((df.index+1)/(df.totalElapsed/(df.index+1))*60000)
    return df
```

[3]:
```
def load_summary(summary):
    df = pd.read_csv(summary)
    return pd.read_csv(summary)
```

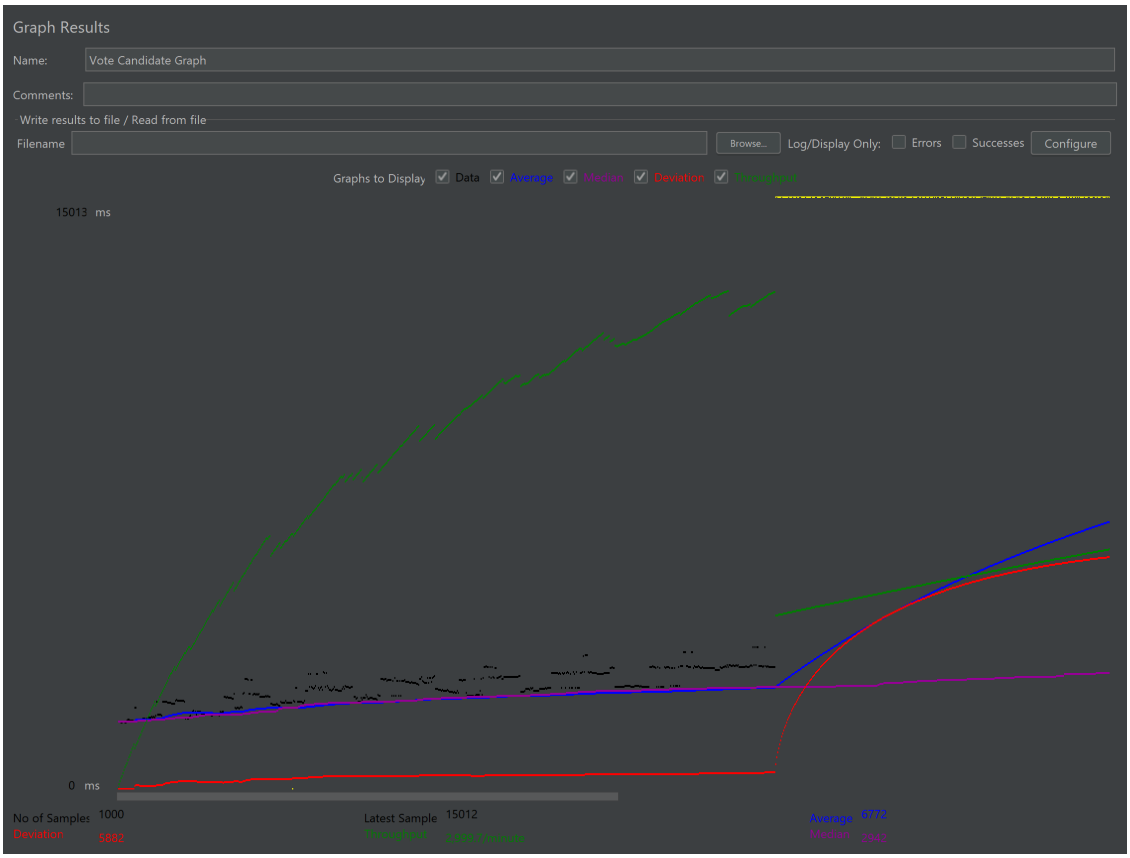
[4]:
```
add500 = load_dataset('Add/Add_500T.csv')
addSum500 = load_summary('Add/Add_500T_Summary.csv')

add1000 = load_dataset('Add/Add_1000T.csv')
addSum1000 = load_summary('Add/Add_1000T_Summary.csv')
```

[5]:
```
vote500 = load_dataset('Vote/Vote_500T.csv')
voteSum500 = load_summary('Vote/Vote_500T_Summary.csv')

vote1000 = load_dataset('Vote/Vote_1000T.csv')
voteSum1000 = load_summary('Vote/Vote_1000T_Summary.csv')
```

0.0.1 JMeter Graph Showing voteCandidate API Results: 1000 Threads

[6]:
```
Image(filename='Vote/Vote_1000T.png')
```

[6]:



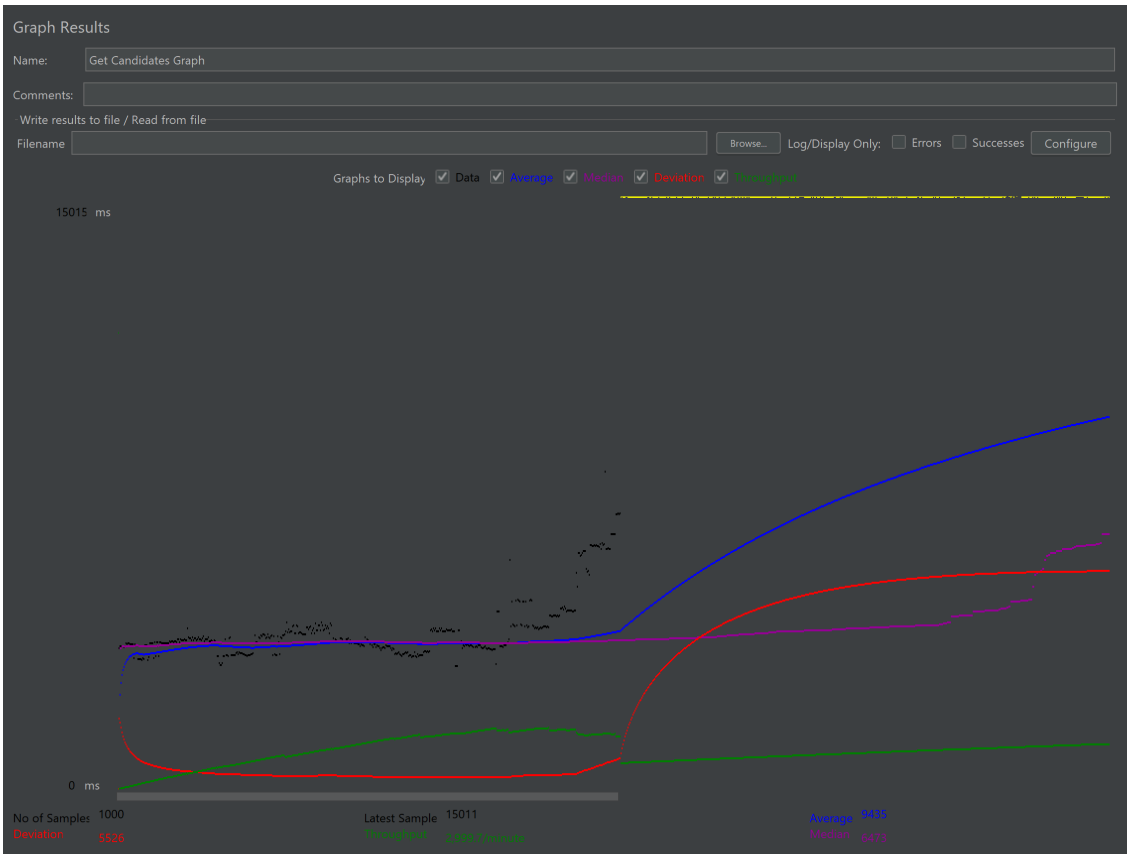
[7]:
```
get500b = load_dataset('Get/Get_500T_50c.csv')
getSum500b = load_summary('Get/Get_500T_50c_Summary.csv')

get500_250c = load_dataset('Get/Get_500T_250c.csv')
getSum500_250c = load_summary('Get/Get_500T_250c_Summary.csv')
```

[8]:
```
get1000b = load_dataset('Get/Get_1000T_50c.csv')
getSum1000b = load_summary('Get/Get_1000T_50c_Summary.csv')

get1000_250c = load_dataset('Get/Get_1000T_250c.csv')
getSum1000_250c = load_summary('Get/Get_1000T_250c_Summary.csv')
```

0.0.2 JMeter Graph Showing getCandidates API Results: 1000 Threads 50 Candidates per pull

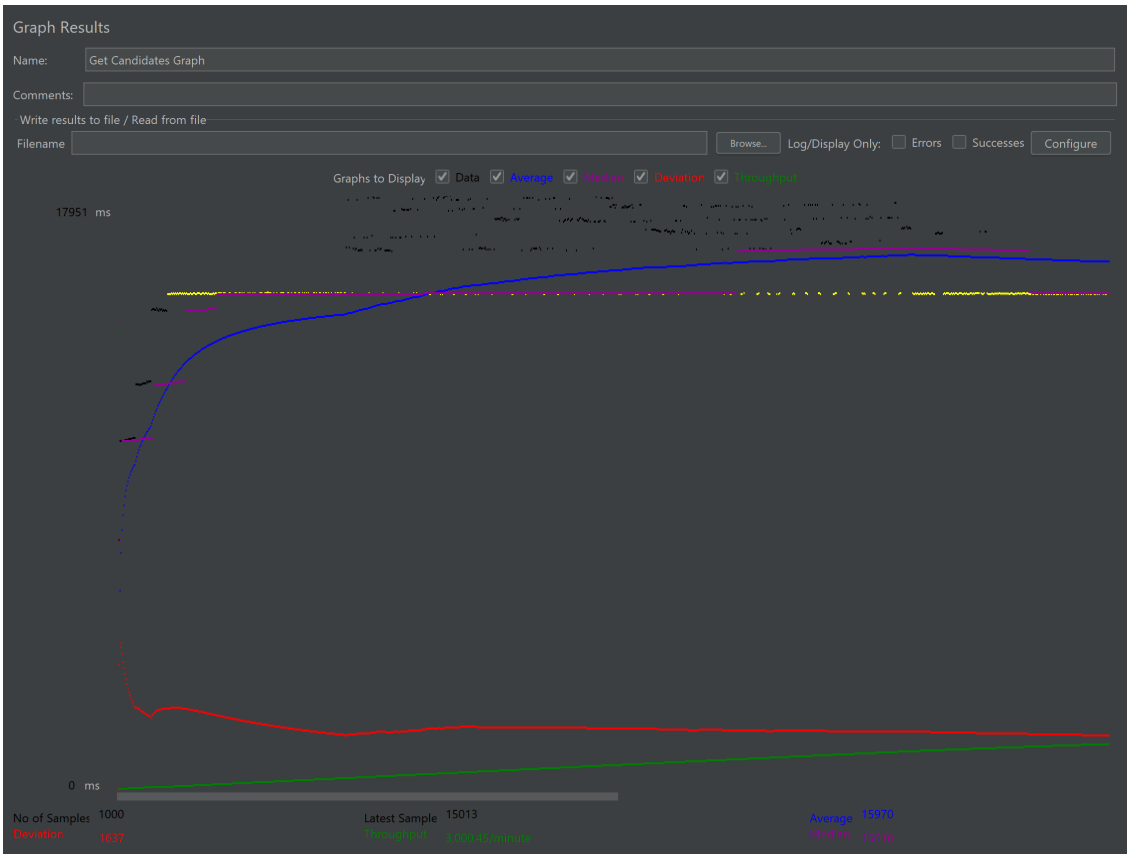
[9]:
```
Image(filename='Get/Get_1000T_50c.png')
```

[9]:



[10]:
```
Image(filename='Get/Get_1000T_250c.png')
```

[10]:



0.0.3 JMeter Graph Showing getCandidates API Results: 1000 Threads 250 Candidates per pull

[11]:
```
get1000b
```

[11]:

	timeStamp	elapsed	success	bytes	Latency	IdleTime	Connect	\
0	1663641500060	1753	False	2080	0	0	0	
1	1663641497543	3580	True	1703	3580	0	1	
2	1663641497549	3630	True	1703	3630	0	1	
3	1663641497548	3632	True	1703	3632	0	1	
4	1663641497555	3625	True	1703	3625	0	1	
..	…	…	…	…	…	…	…	
995	1663641502505	15015	False	2441	0	0	1	
996	1663641502516	15004	False	2441	0	0	0	
997	1663641502510	15010	False	2441	0	0	1	
998	1663641502521	15015	False	2441	0	0	0	
999	1663641502525	15011	False	2441	0	0	0	

	totalElapsed	throughput
0	1753	34.227039

```
1            5333    45.002813
2            8963    60.247685
3           12595    76.220723
4           16220    92.478422
..            …          …
995       9377415  6347.267344
996       9392419  6349.859392
997       9407429  6352.451876
998       9422444  6355.045464
999       9437455  6357.646209

[1000 rows x 9 columns]
```

[12]:
```
get1000_250c
```

[12]:
```
          timeStamp  elapsed  success  bytes  Latency  IdleTime  Connect  \
0    1663640344006     1753    False   2080        0         0        0
1    1663640341471     7549     True   7654     7549         0        1
2    1663640341476    10537     True   7654    10536         0        0
3    1663640341476    10541     True   7654    10541         0        0
4    1663640341481    10554     True   7654    10554         0        0
..             …        …      …     …        …        …      …
995  1663640346450    15002    False   2441        0         0        1
996  1663640346445    15007    False   2441        0         0        1
997  1663640346440    15012    False   2441        0         0        1
998  1663640346436    15016    False   2441        0         0        1
999  1663640346455    15013    False   2441        0         0        1

     totalElapsed   throughput
0            1753    34.227039
1            9302    25.800903
2           19839    27.219114
3           30380    31.599737
4           40934    36.644354
..            …          …
995      15912570  3740.499492
996      15927577  3744.482918
997      15942589  3748.465196
998      15957605  3752.446561
999      15972618  3756.428658

[1000 rows x 9 columns]
```

[13]:
```
add1000
```

[13]:
```
          timeStamp  elapsed  success  bytes  Latency  IdleTime  Connect  \
0    1663634113661     1753     True    261     1753         0        1
```

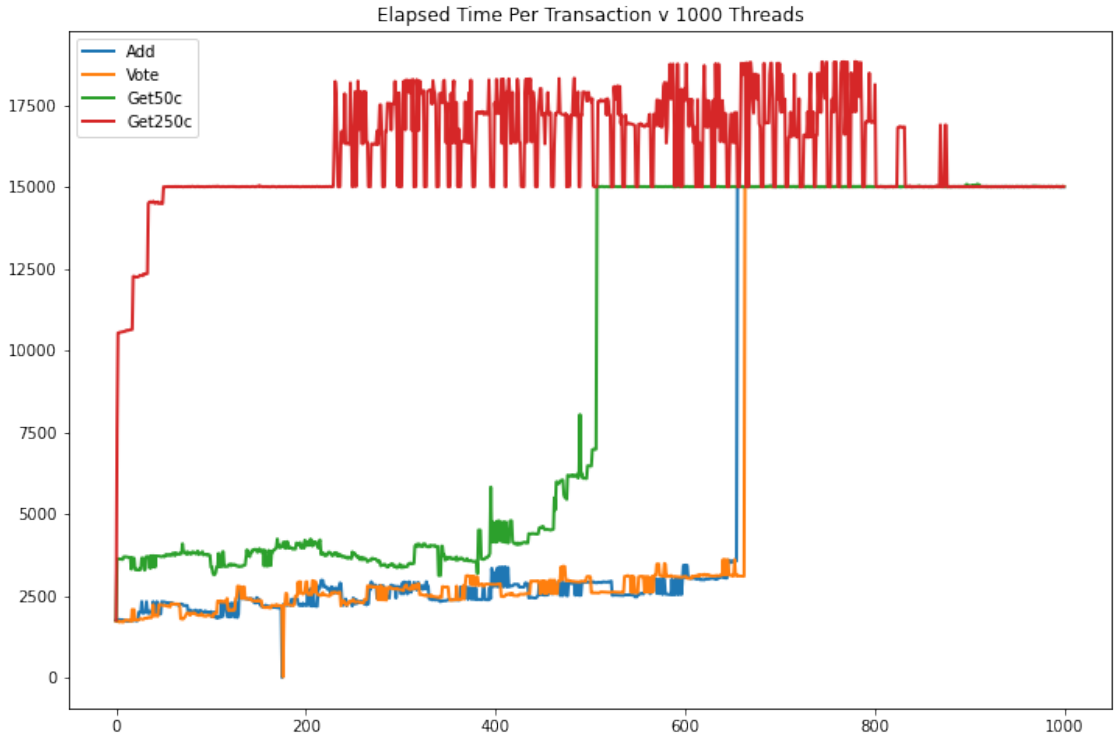
```
1    1663634113680     1735     True    261     1735         0         1
2    1663634113651     1766     True    261     1766         0         1
3    1663634113642     1775     True    261     1775         0         0
4    1663634113640     1777     True    261     1777         0         1
..             …      …      …    …       …        …      …
995  1663634118554    15000    False   2441        0         0         0
996  1663634118554    15000    False   2441        0         0         0
997  1663634118554    15000    False   2441        0         0         1
998  1663634118554    15000    False   2441        0         0         1
999  1663634118554    15000    False   2441        0         0         1

     totalElapsed   throughput
0            1753    34.227039
1            3488    68.807339
2            5254   102.778835
3            7029   136.577038
4            8806   170.338406
..            …          …
995       6775454  8784.792871
996       6790454  8782.997426
997       6805454  8781.227527
998       6820454  8779.483008
999       6835454  8777.763701

[1000 rows x 9 columns]
```

0.0.4 Elapsed Time per Transcation across 500 and 1000 Threads

In this section we plot the elapsed time of the add, vote, and get transactions across 500 and 1000 threads respectively. We can see that in the 500 thread plot, there is not a dramatic increase in elapsed time because the backend server does not hang. When we look at the 1000 thread plot we can see a near vertical line in the elapsed time, showing the number of threads that cause a hang in the backend server.

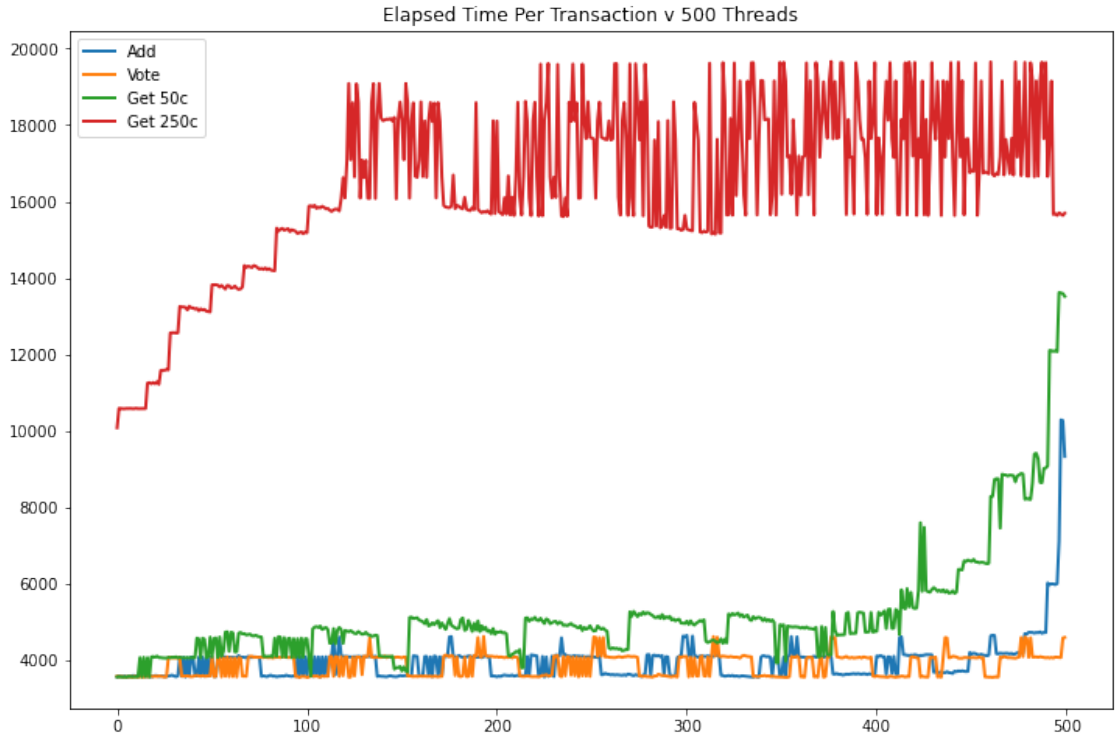
[14]:
```
fig, ax = plt.subplots()
fig.set_figheight(8)
fig.set_figwidth(12)
ax.plot(range(0,1000), add1000.elapsed, linewidth=2.0, label="Add")
ax.plot(range(0,1000), vote1000.elapsed, linewidth=2.0, label="Vote")
ax.plot(range(0,1000), get1000b.elapsed, linewidth=2.0, label="Get50c")
ax.plot(range(0,1000), get1000_250c.elapsed, linewidth=2.0, label="Get250c")
ax.title.set_text('Elapsed Time Per Transaction v 1000 Threads')
ax.legend(loc="upper left")
```

[14]:
```
<matplotlib.legend.Legend at 0x24fc9de68e0>
```



[15]:
```
fig, ax = plt.subplots()
fig.set_figheight(8)
fig.set_figwidth(12)
ax.plot(range(0,500), add500.elapsed, linewidth=2.0, label="Add")
ax.plot(range(0,500), vote500.elapsed, linewidth=2.0, label="Vote")
ax.plot(range(0,500), get500b.elapsed, linewidth=2.0, label="Get 50c")
ax.plot(range(0,500), get500_250c.elapsed, linewidth=2.0, label="Get 250c")
ax.title.set_text('Elapsed Time Per Transaction v 500 Threads')
ax.legend(loc="upper left")
```

[15]:
```
<matplotlib.legend.Legend at 0x24fc9e85340>
```

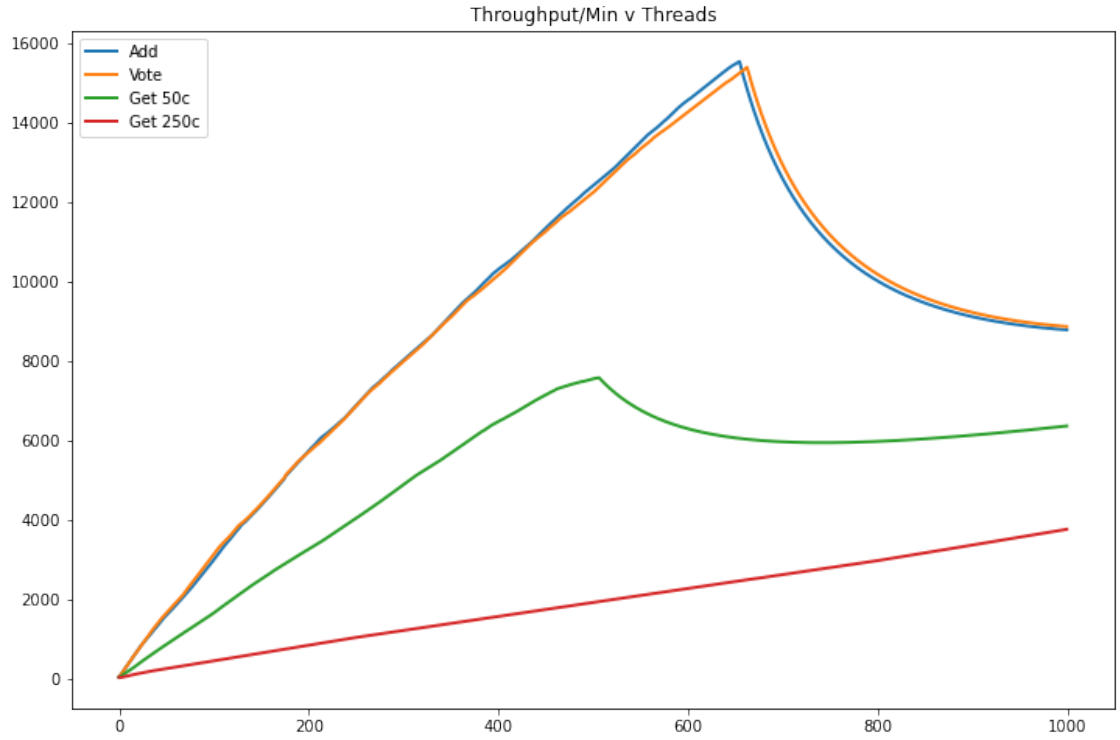


0.0.5 Throughput Per Minute over 1000 Threads

In the following section we calculate the average throughput per minute of each transaction across each the add, vote, and get function. We test the getfunction while retrieving 50 candidates as opposed to 250 candidates. Throughput is calculated as (number of requests)/(total elapsed time). Similar to the plot of elapsed time for 1000 threads we can see a dip in throughput for the add, vote, and get 50 candidates functions when the backend hangs. In comparison we do not see a throughput dip for retrieval of 250 candidates, since the throughput was much slower in growth.

[16]:
```
fig, ax = plt.subplots()
fig.set_figheight(8)
fig.set_figwidth(12)
ax.plot(range(0,1000), add1000.throughput, linewidth=2.0, label="Add")
ax.plot(range(0,1000), vote1000.throughput, linewidth=2.0, label="Vote")
ax.plot(range(0,1000), get1000b.throughput, linewidth=2.0, label="Get 50c")
ax.plot(range(0,1000), get1000_250c.throughput, linewidth=2.0, label="Get 250c")
ax.title.set_text('Throughput/Min v Threads')
ax.legend(loc="upper left")
```

[16]:
```
<matplotlib.legend.Legend at 0x24fca38bca0>
```



[17]:
```
addSum1000
```

[17]:
```
           Label  # Samples  Average  Min    Max  Std. Dev.  Error %  \
0  HTTP Request       1000     6835    3  15028    5941.17  34.600%
1          TOTAL       1000     6835    3  15028    5941.17  34.600%

   Throughput  Received KB/sec  Sent KB/sec  Avg. Bytes
0    49.77601            49.33         7.34      1014.9
1    49.77601            49.33         7.34      1014.9
```

[18]:
```
voteSum1000
```

[18]:
```
           Label  # Samples  Average  Min    Max  Std. Dev.  Error %  \
0  HTTP Request       1000     6772   20  15019    5882.95  33.800%
1          TOTAL       1000     6772   20  15019    5882.95  33.800%

   Throughput  Received KB/sec  Sent KB/sec  Avg. Bytes
0      49.995             48.7         7.27       997.5
1      49.995             48.7         7.27       997.5
```

[19]:
```
getSum1000b
```

[19]:
```
          Label  # Samples  Average  Min    Max  Std. Dev.  Error %  \
0  HTTP Request       1000     9737    3  15028    5212.69  49.500%
1         TOTAL       1000     9737    3  15028    5212.69  49.500%

   Throughput  Received KB/sec  Sent KB/sec  Avg. Bytes
0     49.9975           100.95          5.2      2067.6
1     49.9975           100.95          5.2      2067.6
```

[20]:
```
getSum1000_250c
```

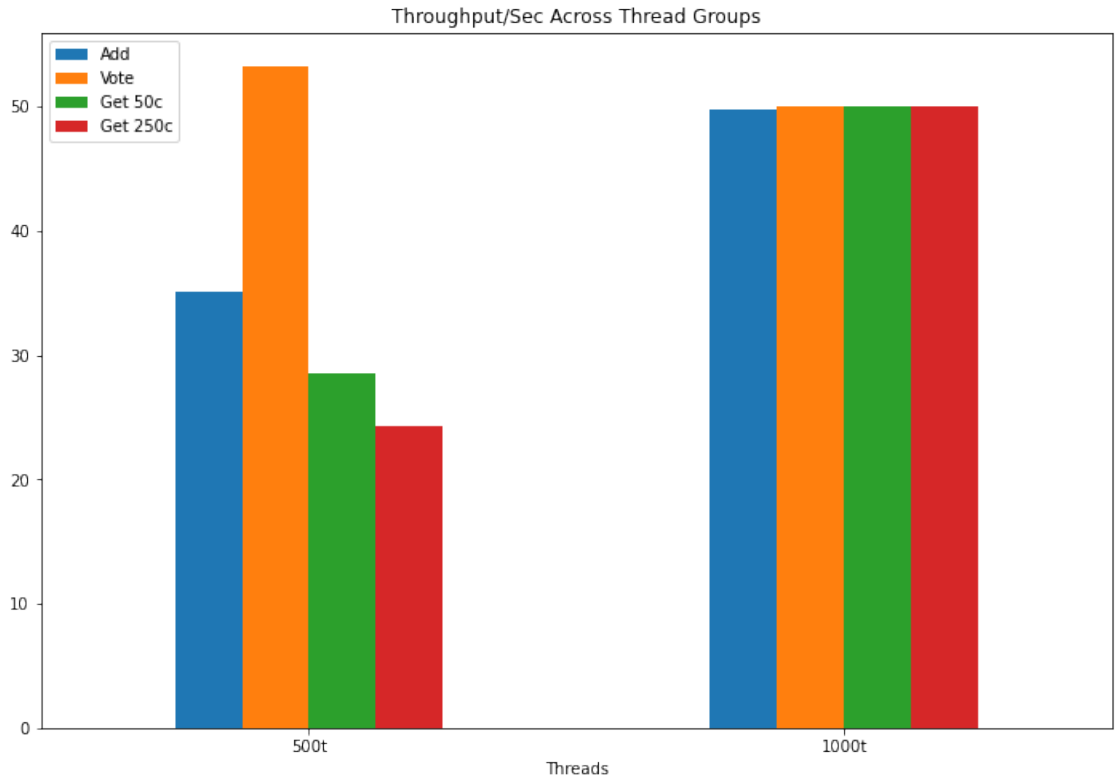
[20]:
```
          Label  # Samples  Average  Min    Max  Std. Dev.  Error %  \
0  HTTP Request       1000    15970    2  18835    1637.37  49.100%
1         TOTAL       1000    15970    2  18835    1637.37  49.100%

   Throughput  Received KB/sec  Sent KB/sec  Avg. Bytes
0     50.0075           248.77         5.24      5094.1
1     50.0075           248.77         5.24      5094.1
```

0.0.6 Throughput per Second

In the following segement we plot throughput per second of each function in both the 500 thread and 1000 thread groups respectively. In this we actually see that when testing on our local machine that there is an upper limit of approximately 50 throughput per second. This also tells us that on the 500 thread group the upper limit on the throughput is actually bottlenecked by the number of threads being called instead of any problems related to function or server.

[21]:
```
r1 = ['500t', addSum500.Throughput[1], voteSum500.Throughput[1], getSum500b.
 ↪Throughput[1], getSum500_250c.Throughput[1]]
r2 = ['1000t', addSum1000.Throughput[1], voteSum1000.Throughput[1], getSum1000b.
 ↪Throughput[1], getSum1000_250c.Throughput[1]]

df = pd.DataFrame([r1, r2], columns=['Threads', 'Add', 'Vote', 'Get 50c', 'Get␣
 ↪250c'])

df.plot(x='Threads',
        kind='bar',
        stacked=False,
        title='Throughput/Sec Across Thread Groups',
        figsize=(12, 8),
        rot=0)
```

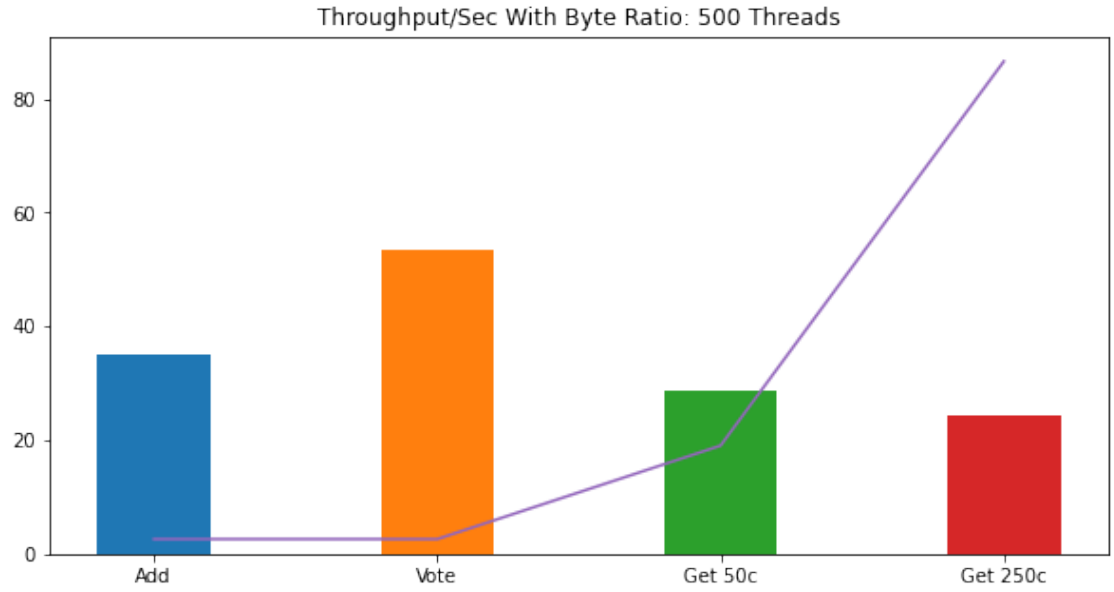
[21]:
```
<AxesSubplot:title={'center':'Throughput/Sec Across Thread Groups'},
xlabel='Threads'>
```



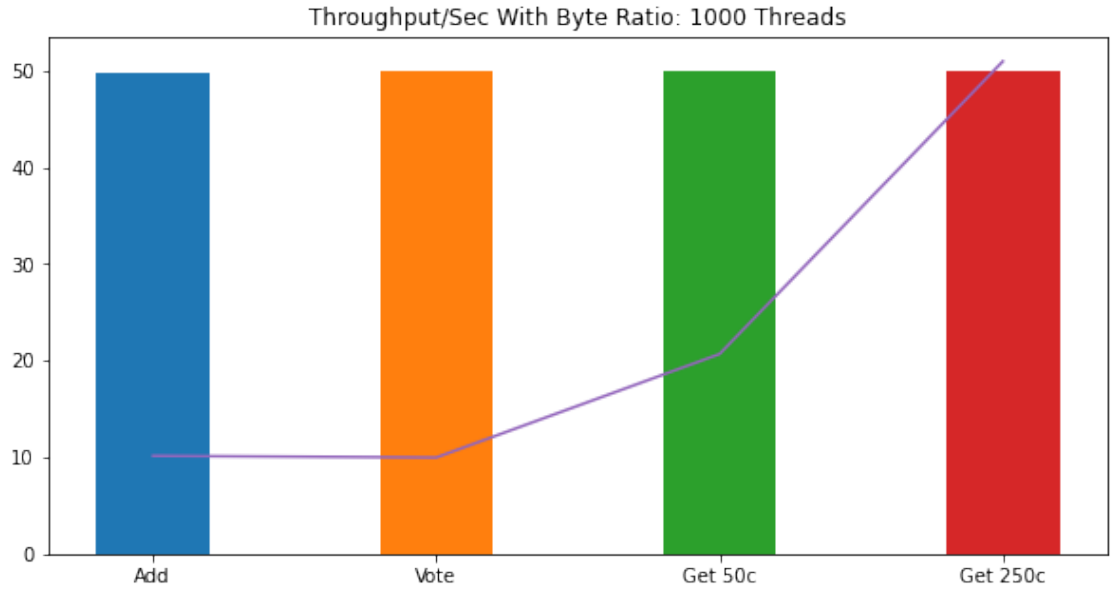
0.0.7 Throughput vs Bytes

When comparing the results of the functions for 500 threads to 1000 threads, we can see that the number of bytes play a less significant role on throughput per second when there is a hang in the backend server. When the server is running optimally we can see that the increase in number of bytes can lead to lower throughput, however, when factoring in a server hang the number of bytes do not have a significant affect on overall throughput. This is also indicated by the plots in throughput per second where we see that the limiting factor on throughput is actually the number of threads being called.

[22]:
```
Bytes = [addSum500['Avg. Bytes'][1], voteSum500['Avg. Bytes'][1],␣
 ↪getSum500b['Avg. Bytes'][1], getSum500_250c['Avg. Bytes'][1]]
Throughput = [addSum500.Throughput[1], voteSum500.Throughput[1], getSum500b.
 ↪Throughput[1], getSum500_250c.Throughput[1]]
labels = ['Add', 'Vote', 'Get 50c', 'Get 250c']
colors= ['tab:blue', 'tab:orange', 'tab:green', 'tab:red']
ScaledBytes=[x/100 for x in Bytes]
fig = plt.figure(figsize = (10, 5))
plt.bar(labels, Throughput, width=0.4, color = colors)
plt.plot(labels, ScaledBytes, color = 'tab:purple')
plt.title("Throughput/Sec With Byte Ratio: 500 Threads")
plt.show()
```



[23]:
```
Bytes = [addSum1000['Avg. Bytes'][1], voteSum1000['Avg. Bytes'][1],␣
 ↪getSum1000b['Avg. Bytes'][1], getSum1000_250c['Avg. Bytes'][1]]
Throughput = [addSum1000.Throughput[1], voteSum1000.Throughput[1], getSum1000b.
 ↪Throughput[1], getSum1000_250c.Throughput[1]]
labels = ['Add', 'Vote', 'Get 50c', 'Get 250c']
colors= ['tab:blue', 'tab:orange', 'tab:green', 'tab:red']
ScaledBytes=[x/100 for x in Bytes]
fig = plt.figure(figsize = (10, 5))
plt.bar(labels, Throughput, width=0.4, color = colors)
plt.plot(labels, ScaledBytes, color = 'tab:purple')
plt.title("Throughput/Sec With Byte Ratio: 1000 Threads")
plt.show()
```



0.0.8 Comparison of Failed Transactions Per Function with Byte Ratio

After seeing that the average throughput for each of the functions is about the same when running the 1000 thread group we need to consider the number of transactions that failed. In this case we can see that the increase in bytes may lead to earlier cases where we cannot connect to the server. For this segment we can also refer to the previous graph of elapsed time per transaction, increasing the number of return bytes per transaction increases the elapsed time per transaction, which eventually leads to a bottleneck in network transaction time.

[30]:
```
def calcFailed(df, summary):
    failed = df.success.value_counts()[0]
    summary['Failed'] = failed
    return summary
```

[34]:
```
addSum1000 = calcFailed(add1000, addSum1000)
voteSum1000 = calcFailed(vote1000, voteSum1000)
getSum1000b = calcFailed(get1000b, getSum1000b)
getSum1000_250c = calcFailed(get1000_250c, getSum1000_250c)
```

[42]:
```
FailedTrans = [addSum1000['Failed'][1],
               voteSum1000['Failed'][1],
               getSum1000b['Failed'][1],
               getSum1000_250c['Failed'][1]]
Bytes = [addSum1000['Avg. Bytes'][1], voteSum1000['Avg. Bytes'][1],␣
 ↪getSum1000b['Avg. Bytes'][1], getSum1000_250c['Avg. Bytes'][1]]
ScaledBytes=[x/10 for x in Bytes]
```

```
labels = ['Add', 'Vote', 'Get 50c', 'Get 250c']
colors= ['tab:blue', 'tab:orange', 'tab:green', 'tab:red']

fig = plt.figure(figsize = (10, 5))
plt.bar(labels, FailedTrans, width=0.4, color = colors)
plt.plot(labels, ScaledBytes, color = 'tab:purple')

plt.title("Failed Transactions With Byte Ratio: 1000 Threads")
plt.show()
```