2.3 Top500 Showing Signs of Stagnation (10 points)

Since 2008, experts claim that there is a slowing of the pace of performance improvement.

1. Can you estimate this slowdown or demonstrate it by developing a graph that represents the annual performance increase of top500 versus the annual growth predicted by Moore's law? Hint: For Moore's law, you can calculate last_year_transistor /current_year_transistors ; For top500, you can calculate last_year_performance/ current_year_performance , and feel free to use the supplementary file provided with this prompt.
2. Why do you think supercomputers are not getting faster like they used to?
3. The speed limit for modern computers is now set by power consumption. If all other factors are held constant, the electricity needed to run a processor chip goes up as the cube of the clock rate: doubling the speed brings an eightfold increase in power demand. Since 2005 the main strategy for boosting performance has been to gang together multiple processor "cores" on each chip. The clock rate remains roughly constant, but the total number of operations per second increases if the separate cores can be put to work simultaneously on different parts of the same task. Large systems are assembled from vast numbers of these multicore processors. Can you source evidence to support this phenomenon?.

By Jiahui Tang

Question 1.

In [15]:
```
## data used
import pandas as pd
%matplotlib inline
import matplotlib.pyplot as plt


df = pd.read_csv("linpack_dat_small.csv", names= ['year','SUM','T1','T500'], ski
df
```

Out[15]:

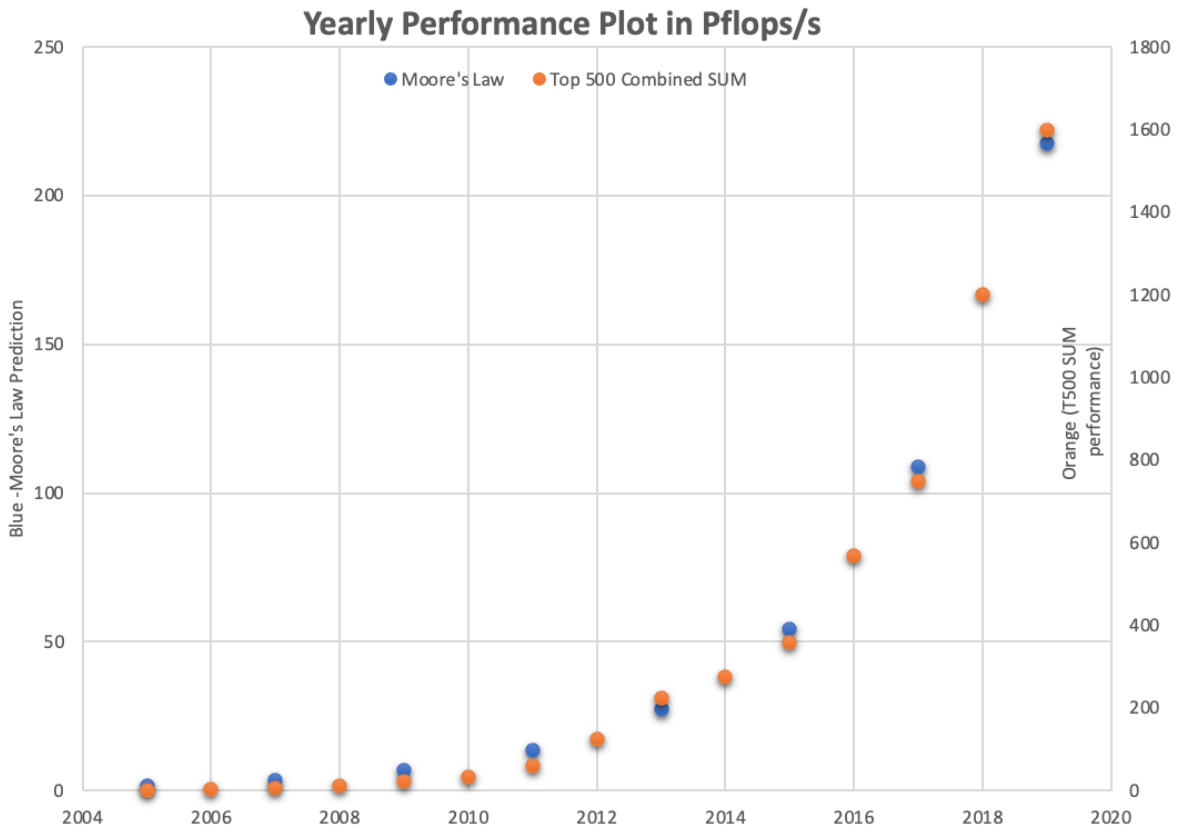
	year	SUM	T1	T500
0	2005	1.7 Pflop/s	136.8 Tflop/s	1.2 Tflop/s
1	2006	2.8 Pflop/s	280.6 Tflop/s	2.0 Tflop/s
2	2007	5.0 Pflop/s	280.6 Tflop/s	4.0 Tflop/s
3	2008	12.2 Pflop/s	1.0 Pflop/s	9.0 Tflop/s
4	2009	22.6 Pflop/s	1.1 Pflop/s	17.1 Tflop/s
5	2010	32.4 Pflop/s	1.8 Pflop/s	24.7 Tflop/s
6	2011	58.9 Pflop/s	8.2 Pflop/s	40.2 Tflop/s
7	2012	123.4 Pflop/s	16.3 Pflop/s	60.8 Tflop/s
8	2013	223.7 Pflop/s	33.9 Pflop/s	96.6 Tflop/s
9	2014	273.8 Pflop/s	33.9 Pflop/s	133.7 Tflop/s
10	2015	359.3 Pflop/s	33.9 Pflop/s	164.6 Tflop/s
11	2016	567.4 Pflop/s	93.0 Pflop/s	286.1 Tflop/s

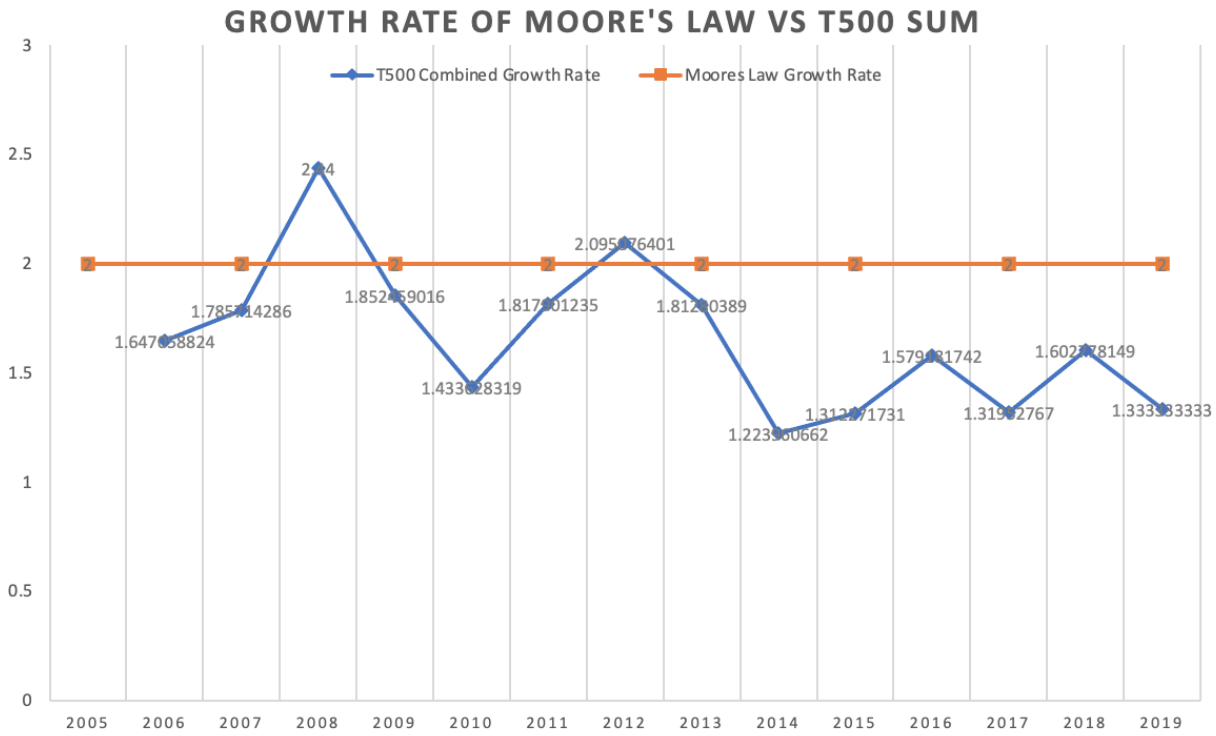
	year	SUM	T1	T500
12	2017	748.7 Pflop/s	93.0 Pflop/s	432.2 Tflop/s
13	2018	1.2 Eflop/s	122.3 Pflop/s	715.6 Tflop/s
14	2019	1.6 Eflop/s	148.6 Pflop/s	1.0 Pflop/s

Used Excel To calculate and draw, plots as Below

Note: Moore's Law Prediction used 2005's SUM in Pflops which is 1.7 Pflop/s as a benchmark, and then double for every 2 years.

Below are the performance trend and growth rate comparison, we could see that there's a slightly slow down in T500 combined comparing to Moore's Law. The growth rate graph demostrate this clearer, where sometimes the growth rate of T500 combined is higher than 2, most of the time it's below 2.





Question 2.

Supercomputer are not getting faster like they used to because there is physical constraints like power wall and quantum tunneling to transistors. Single core CPU performance thus has its bottonneck, while for multi-core we could only increase the number of cores, which causing increasing overhead from data communication, efficiency and storage. Thus, it is not getting faster as it is expected to be or as prediction of Moore's Law, but shows a slow down in trend.

Question 3.

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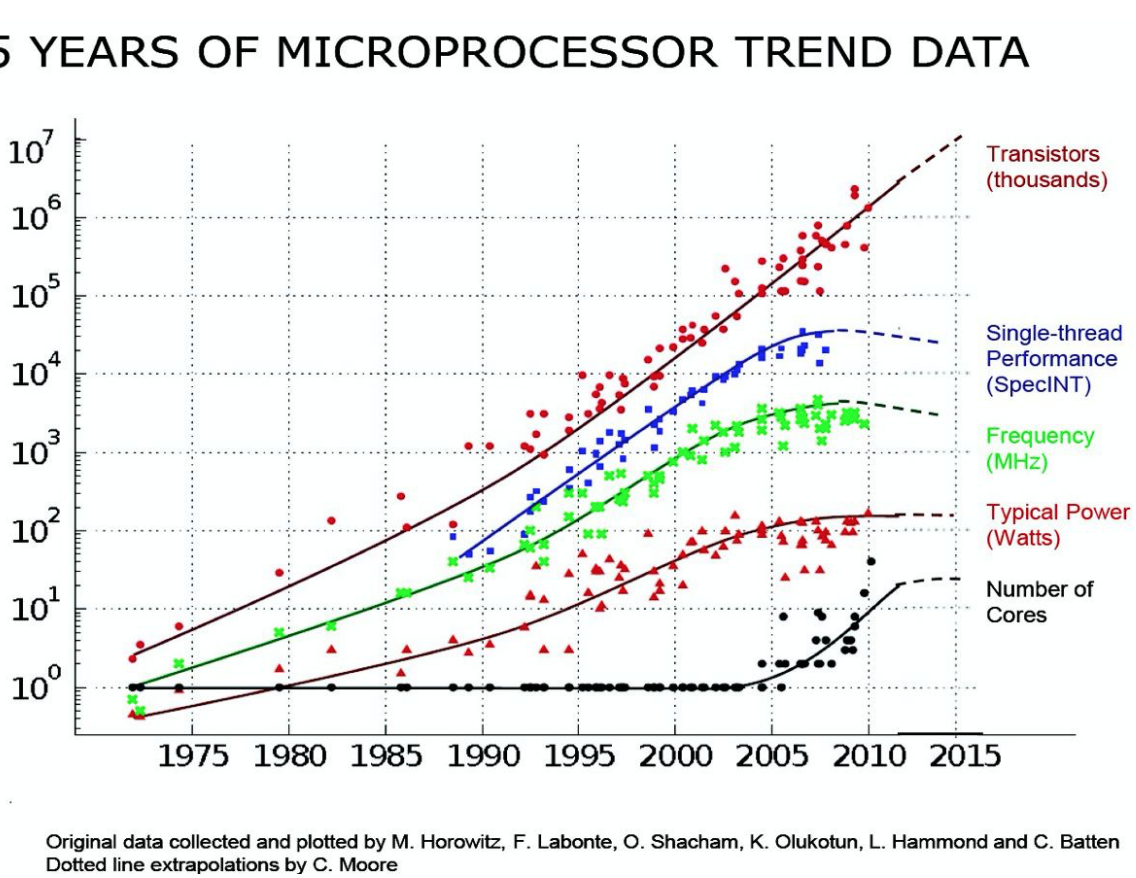

I found this graph as evidence from M.Horowitz, F.Labonte, O.Shacham, K.Olukotun, L.Hammond and C.Batten

As measured by number of transistors, Moore's Law still hold. However, single thread CPU performance has been showing slow down in increment since 2005. Thus, we can also see that Number of Cores has been increasing since 2005, as separate cores are put to work simultaneously on different parts of the same task. Large systems are assembled from vast numbers of these multicore processors. We could clearly see from this graph, the clock rate remains roughly constant, but the total number of operations per second still increases.

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