2020 State of the VITA Technology Industry

April 2020

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State of the VITA Technology Industry April 2020

by: Ray Alderman, Chairman of the Board, VITA

This report provides the reader with updates on the state of the VITA Technology industry in particular and of the board and system industry in general, from the perspective of Ray Alderman, the Chairman of the Board of VITA. VITA is the trade association dedicated to fostering American National Standards Institute (ANSI) accredited, open system architectures in critical embedded system applications. The complete series of reports can be found at Market Reports. (www.VITA.com/MarketReports)

Introduction

The world auto industry is being destroyed by Greta Thunberg, technology, world economic conditions, and the coronavirus. The commercial aircraft business is being destroyed by bad engineering, graft and corruption, and the coronavirus. Europeans are trying to figure-out what to build instead of automobiles as that industry declines. Tanks and warships and warplanes look promising. EU authorities are scrambling for something else to tax now that England is gone from the Union. Turkey has entered the wars in Iraq, Syria, and Libya while Iran is being attacked by UFOs. I'm not making this stuff up!

Economic Conditions

U.S. GDP growth came in at 2.1% for Q4-2019, and 2.3% for the year.[1] EU GDP grew at 0.1% in Q-4-2019.[2] Italy's GDP shrank by 0.3% and France's GDP grew 0.2% in the final quarter. Germany's economy grew at 0.5%. The EU is fidgeting with the numbers, so they haven't released the final figures yet. They were anticipating 1.5% growth for 2019.

The big shocker was Japan: their GDP shrank by 6.3% in Q-4, thanks to a massive increase in sales taxes that stifled consumer spending in that country.[3]

1 Lucia Mutikani, "*U.S. economy grows steadily in fourth-quarter, but coronavirus looms large*", Reuters, February 27, 2020, https://www.reuters.com/article/us-usa-economy/u-s-fourth-quarter-gdp-unrevised-weakness-in-business-spending-persists-idUSKCN20L22O?il=0

2 Graeme Wearden, "*Eurozone growth slows sharply as French and Italian economies shrink – as it happened*", the Guardian, January 31, 2020, https://www.theguardian.com/business/live/2020/jan/31/french-gdp-shrinks-eurozone-gdp-economy-italy-business-live

3 "*Japan's economy shrinks at fastest pace in 6 years, virus clouds outlook*", CNBC, February 16, 2020, https://www.cnbc.com/2020/02/17/japans-economy-shrinks-at-fastest-pace-in-6-years-virus-clouds-outlook.html

Contents

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Things don't look good for them going forward either. World GDP growth is expected to decline from 3.3% to 2.8% due to the coronavirus supply chain disruptions, factory closings, and lower demand in 2020.[4] That could be an overly optimistic forecast.

"That could be an overly optimistic forecast."

China is taking a big hit too. They grew at 6% in Q4 and 6.1% for 2019.[5] But forecasters say they will drop to 2% growth in Q1-2020. Some analysts say China could see 0% growth in Q1.[6] None of this historical data means anything about what we can expect in 2020. The COVID-19 virus crisis is expected to have a severely negative effect, especially on Q1 and Q2 U.S. GDP numbers. They range from a 1% contraction in Q1 to a 30% contraction in Q2, with unemployment going up to as much as 32%.[7] Declines in China and EU GDP could be even worse.

Let's look at some markets at the micro-level. Before Covid-19 ever showed up, there were a lot of companies in marginal condition. Look at the airline industry. They have one of the worst business models in the entire history of capitalism. They endure high fixed costs, high variable costs, and intense regulation. In March, the fourth UK airline (Flybe) filed for bankruptcy. The others were Monarch in 2017, Flybmi in 2019, and Thomas Cook in 2019. Add to this the 737 MAX issues at Boeing and the bribery scandal surrounding Airbus.[8] Thousands of commercial flights have been canceled globally in the past few months, cutting deeply into the airline's Q1 revenue and putting their employee's jobs in jeopardy.[9]

"They have one of the worst business models in the entire history of capitalism"

The next example is the auto industry. They have the second worst business model in the history of capitalism and have been taking a beating worldwide for 3 years. 95.2 million vehicles were sold in 2017 and 94.4 million in 2018. Global auto sales in 2019 were down 4% to 90.3 million units, and the trend is sharply lower for 2020. The auto industry is in turmoil as new emission regulations and climate change rhetoric have forced them to design and build electric vehicles (EVs) before they were ready. Additionally, China, the world's largest market for vehicles, dropped their tax incentives to buy EVs in 2019. India's economy recently declined significantly forcing consumers to delay auto purchases.[10]

To put things in perspective, out of the 90 million vehicles sold in 2019, 2.2 million were EVs. Tesla sold 368,000 of those for a 17% market share worldwide. Ford, Chrysler, and GM were not in the top 10 EV makers in 2019.[11] GM leads the U.S. manufacturers with about 16,500 EVs sold in 2019. Ford and Chrysler only sold a few thousand units each, so you can see that none of them have any economies of scale at this point.

This financial, environmental, legal, technological, political, and competitive disorder is driving a wave of mergers and alliances. Volkswagen, already suffering from the fallout of the diesel emissions scandal, has an alliance with Ford

4 "*Bank of America: World Economy Weakest Since 2009 Amid Virus*", Newsmax Media, February 27, 2020, https://www.newsmax.com/finance/streettalk/bank-of-america-world-economy-weakest/2020/02/27/id/956043/

5 "*Instant View: China's economic growth slows to 6.1% in 2019, near 30-year low*", Reuters, January 16, 2020, https://www.reuters.com/article/us-china-economy-gdp-instantview/instant-view-chinas-economic-growth-slows-to-6-1-in-2019-near-30-year-low-idUSKBN1ZG092

6 Gordon Watts, "*China's GDP growth in Q1 could plunge to zero*", Asia Times, February 27, 2020, https://asiatimes.com/2020/02/chinas-gdp-growth-in-q1-could-plunge-to-zero/

7 Jeff Cox, "*Coronavirus job losses could total 47 million, unemployment rate may hit 32%, Fed estimates*", CNBC, March 30, 2020, https://www.cnbc.com/2020/03/30/coronavirus-job-losses-could-total-47-million-unemployment-rate-of-32percent-fed-says.html

8 Simon Calder, "F*lybe Collapses as Coronovirus Outbreak Takes Toll*", Independent, March 4, 2020, https://www.independent.co.uk/travel/news-and-advice/flybe-news-flights-administration-collapse-coronavirus-outbreak-bust-latest-news-a9376421.html

9 Anurag Kotoky, "*The Airlines Most in Danger of Going Under During the Crisis*", Bloomberg, March 26, 2020, https://www.bloomberg.com/news/articles/2020-03-26/the-airlines-most-in-danger-as-virus-inflicts-252-billion-blow

10 Charles Riley, "*The recession in global car sales shows no sign of ending*", CNN Business, January 20, 2020, https://www.cnn.com/2020/01/20/business/global-auto-recession/index.html

11 Mark Kane, "*Global EV Sales For 2019 Now In: Tesla Model 3 Totally Dominated*", Inside EVs, February 2, 2020, https://insideevs.com/news/396177/global-ev-sales-december-2019/

to develop EVs. Chrysler-Fiat is merging with Peugeot if the deal goes through. BMW and Daimler are co-developing ride-sharing and driverless technology. The Nissan-Renault alliance is falling apart after the Carlos Goshn scandal.[12]

After this industry stabilizes a little, things will get even worse. Auto sales constitute 5.7% of the world GDP and 8% of world trade (imports and exports). Over 9 million people work in the auto industry worldwide. That's 5% of world's manufacturing employment. A car contains about 20,000 parts made by millions of people, so the supply chain for conventional vehicles is wide and deep. Automotive companies don't make cars: they assemble cars-kits, from all the parts made by the people in other companies around the globe. The auto industry is the second largest consumer of steel and aluminum. The auto industry business model is about to experience what the newspaper and magazine industry went through several years ago.

"The auto industry business model is about to experience what the newspaper and magazine industry went through several years ago."

Many countries and cities have already passed legislation mandating EVs and eliminating gas and diesel vehicles starting in 10 years. Electric cars and trucks are much more expensive than combustion engine vehicles. They contain only a few thousand parts, so their supply chain is narrow and shallow. Also, EVs require substantially fewer workers to build and maintain them. It's hard to estimate, but it looks like the electric vehicle industry only needs about 50% of the people presently working in the auto industry. Don't forget about all the people who work at car dealerships too. You can buy a car today on your cell phone and pick it up at a building that looks like a large vending machine (Carvana).

How many people could lose their jobs in this environmentally forced transition to EVs? Millions and millions. Germany has horribly misallocated their capital and labor to the auto industry for decades, to keep about 850,000 people working in industrial-age factories. Auto sales and exports are 5% of the German economy and 13% of their exports. They have not made investments in software, semiconductors, computers, or technology as they perpetuated their industrial-age manufacturing business model.[13] In a few years, the city of Dingolfing (in Bavaria) could look like Detroit.[14] Ford, Daimler, Opel, BMW, Audi, Continental, Volkswagen, Nissan, Land Rover, Jaguar, Bosch, GM, and Honda announced layoffs before the virus hit. Could we see a new tax on EVs, to pay benefits to all those laid-off auto workers? You can bet on it.

For comparison, the U.S. auto industry employs 1.7 million people, contributes 3.5% to U.S. GDP, and autos are about 10% of U.S. exports. Ford announced last year that they would close their engine plant in Michigan and sell six of its European plants. GM is closing four plants in the U.S. and one in Canada, but one of those may be retooled for EV production.

In March, the EU leadership revealed their new climate law. It says that the EU will be carbon-neutral by 2050 instead of 2030. That upset the climate activists who want fossil fuel vehicles outlawed by tomorrow afternoon. But maybe the EU leadership can see what is about to happen to their auto industry in the next few years, so they delayed killing-off all the gas and diesel vehicles.

Brexit is done and the EU needs money badly, to replace what England was paying into the kitty. At this point, they realize they will need much more money to pay out benefits to future laid-off manufacturing workers.[15] Now, you can

12 Lionel Laurent, "*The Not-So-Irreversible Renault-Nissan Allliance*", Bloomberg, January 13, 2020, https://www.bloomberg.com/opinion/articles/2020-01-13/renault-nissan-alliance-problems-run-deeper-than-carlos-ghosn

13 Jeff Dorsch, "*Can Germany's Auto Industry Keep Pace?*", Semiconductor Engineer, January 9, 2020, https://semiengineering.com/can-germanys-auto-industry-keep-pace/

14 Michael Neinaber, "*Shades of Detroit? Germany's auto heartlands in peril as 'golden age' fades*", Reuters, February 18, 2020, https://www.reuters.com/article/us-germany-economy-autos-insight/shades-of-detroit-germanys-auto-heartlands-in-peril-as-golden-age-fades-idUSKBN20C0MO

15 Associated Press, "*EU leaders seek economic strategy for life after coronavirus*", MarketWatch, March 26, 2020, https://www.marketwatch.com/story/eu-leaders-seek-economic-strategy-for-life-after-coronavirus-2020-03-26?mod=home-page

better understand why the EU wants to tax the big U.S. technology companies (the digital tax), financial transactions (banks and the investment industry), and carbon content in products imported from the U.S. and other countries.[16]

There are two countries that have already initiated their national cryptocurrencies: UAE (Emcash) and Venezuela (Petro). Venezuela did it to get around U.S. sanctions. Estonia (Estcoin), Russia (Cryptoruble), Sweden (E-Krona), and Japan (J-coin) are close to announcing their digital money.[17] Additionally, the EU is looking into issuing their own cryptocurrency before their member countries do it, to gain another source of potential tax revenue on transactions.[18] The recent coronavirus relief bill in Congress used the words "digital dollars" as the method to pay people's benefits. That wording was the precursor to the Federal Reserve creating a national cryptocurrency (FedCoin) in the U.S.. But that wording was removed before the bill moved forward.[19]

I could go on and on about the deteriorating financial environment. Read Klaus Schwab's book, "The Fourth Industrial Revolution", you won't sleep for a week. He lists all the jobs that will disappear in the next 10 years, eliminated by computers, global warming, bad government policy, misallocated R&D investment, bad corporate management, and artificial intelligence. Note that this book was written before Covid-19 emerged.

Just remember what Warren Buffet said: "Only when the tide goes out, do you discover who's been swimming naked." A lot of countries and companies have been swimming naked, concealed by government subsidies, protectionism, bad laws, outdated business models, huge debt loads, and deflated currencies. Covid-19 and the Q-1 financial results will show us who they are. Pay attention to countries that depend on exporting their natural resources to survive, like the Middle East, Russia, Canada, and Australia.

"A lot of countries and companies have been swimming naked, concealed by government subsidies, protectionism, bad laws, outdated business models, huge debt loads, and deflated currencies."

Companies that have been borrowing heavily at low interest rates (leveraging) are most vulnerable to the economic effects of the virus and the changes in technology.[20] Tax cuts and low interest rates could help minimize the economic harm.[21] The industries and companies getting bailed-out in the Covid-19 relief package are unknown, but bankruptcies, mergers, and asset sales will probably be commonplace in 2020.

Then, there's the cruise industry: if you pay for a one-week cruise, they'll give you another two weeks for free! But you'll be anchored offshore under quarantine for those extra weeks. All the cruise lines are suffering badly due to the virus. Some of these boats could be re-staffed and anchored offshore as makeshift hospital facilities if the number of virus infections goes up dramatically.

While the U.S. economy showed some strength last year, Italy, China, Germany, and Japan were all economically weak going into 2020. The effects of COVID-19 could throw them into a deep recession. Making any predictions about the economic outlook for 2020 is a fool's errand. So, we'll have to wait and see what happens in Q2 and beyond.

16 Francesco Guarascio, "*In blow to U.S., EU pledges quick move on tax for polluting firms*", Reuters, October 3, 2019, https://www.reuters.com/article/us-eu-commission-gentiloni/in-blow-to-u-s-eu-pledges-quick-move-on-tax-for-polluting-firms-idUSKBN1WI0K1

17 "*List Of Countries That Have Plans To Roll Out Their Own Cryptocurrencies*", CoinSutra, September 6, 2019, https://coinsutra.com/national-cryptocurrencies/

18 Yessi Bello Perez, "*EU proposes issuing its own digital currency to counteract the Libra effect*", TNW, November 5, 2019, https://thenextweb.com/hardfork/2019/11/05/eu-proposes-issuing-its-own-digital-currency-to-counteract-the-libra-effect/

19 Nikhilesh De, "*'Digital Dollar' Stripped From Latest US Coronavirus Relief Bill*", Coindesk, March 24, 2020, https://www.coindesk.com/digital-dollar-stripped-from-latest-us-coronavirus-relief-bill

20 Rich Miller and Claire Boston, "*Coronavirus Exposes the Danger of Corporate America's Debt Binge*", Bloomberg, March 10 , 2020, https://www.bloomberg.com/news/articles/2020-03-10/coronavirus-exposes-the-danger-of-corporate-america-s-debt-binge?srnd=premium

21 Milton Ezrati, "*Why Interest Rate and Tax Cuts Won't Stop an Economic Meltdown if Coronavirus Sticks Around*", The National Interest, " March 11, 2020, https://nationalinterest.org/feature/why-interest-rate-and-tax-cuts-wont-stop-economic-meltdown-if-coronavirus-sticks-around

Technology

In the October 2019 report, I discussed new exaFLOPS supercomputers under construction. Recent developments require an update. In March, Honeywell announced that they have built the world's most powerful quantum computer.[22] They once got out of the computer business in 1991, when they merged their computer division with Campagnie des Machines Bull (France) and NEC (Japan). Honeywell's announcement must really irritate Google. They announced in October 2019 that they had achieved "quantum supremacy", when their 54-Qubit Sycamore machine did a calculation in 200 seconds that would take the world's most powerful supercomputer (the Summit computer at Oak Ridge) 10,000 years to accomplish.[23] We'll have to wait and see what the performance levels of the Honeywell machine are in the future.

In early March, AMD announced that the new El Capitan exaFLOPS computer being built for Lawrence Livermore Labs will use their Epyc CPUs and Radeon GPUs as the processing elements.[24] Hewlett Packard Enterprises (HPE), who bought Cray in 2019, will build the machine. HP has had a close relationship with Intel over years, so I suspect they will use Intel's new Compute Express Link (CXL) fabric for the interconnect. According to some analysts, the AMD chips significantly outperform the Intel Xeon CPUs and Intel GPUs used in the Aurora supercomputer being built for Argonne National Labs. This decision by HPE, to use AMD chips for El Capitan, must hurt Intel's big push into the supercomputer market segment.

In February, the Department of Defense bought a 6 petaFLOPS supercomputer in a cargo container, made by IBM.[25] The machine contains 300 IBM Power9 CPUs and 688 Nvidia GPUs. The interconnects are implemented in a 100Gb InfiniBand network, along with dual 10Gb Ethernet networks.

In February, the DoD bought a 12.8 petaFLOPS HP-Cray Shasta supercomputer for the U.S. Navy.[26] This machine contains 4,536 AMD Epyc CPUs and 112 Nvidia GPUs, connected with the Cray 200Gb Slingshot fabric. Last August, the Air Force bought a similar HP-Cray Shasta supercomputer, and the Army Research Lab (ARL) and the Army Engineer Research and Development Center (ERDC) both bought HP-Cray CS500 machines. All these machines use AMD Epyc CPUs and Radeon GPUs, a triple-punch in the nose to Intel's supercomputer program. At the end of 2019, the DoD had 53 petaFLOPS of supercomputing power from the machines they already owned. Once the new machines are up and running, they will have over 100 petaFLOPS of computing power.

As you can imagine, China is also working on exaFLOPS supercomputers. About a year ago, they made a presentation about exaFLOPS design prototypes being made by Sugon, Tianhe, and Sunway. They all use home-made x-86 CPUs, hooked together with a proprietary interconnect, in architectures that look like 3D Torus machines and 6D hypercubes.[27]

Back in 2018, the EU announced their supercomputer project (EuroHPC) to build several petaFLOPS machines. They will probably hook them together somehow to create an exaFLOPS machine.[28] However, the EU wants to design and build their own CPUs and accelerators, instead of buying U.S.-made CPUs and GPUs. They will probably start with the RISC-V core as the basis for their processor chip. Hard to guess what they will come up with for the GPU-type accelerators. Their efforts are very far behind the U.S. and China in supercomputer technology, since they have

22 Igor Bonifacic, "*Honeywell says it built the world's most powerful quantum computer*", Engadget, March 3, 2020, https://www.engadget.com/2020-03-03-honeywell-quantum-computer.html

23 Jon Porter, "*Google confirms 'quantum supremacy' breakthrough*", The Verge, October 23, 2019, https://www.theverge.com/2019/10/23/20928294/google-quantum-supremacy-sycamore-computer-qubit-milestone

24 Patrick Seitz, "*Supercomputer Deal Called Huge Win For Chipmaker AMD*", Investor's Business Daily, March 5, 2020, https://www.investors.com/news/technology/amd-stock-could-benefit-huge-supercomputer-deal/?src=A00220&yptr=yahoo

25 Sebastian Moss, "*US Army buys $12m IBM supercomputer in a shipping container, will test for tactical edge deployments*", Data Centre Dynamics, August 2, 2019, https://www.datacenterdynamics.com/en/news/us-army-buys-12m-ibm-supercomputer-shipping-container-will-test-tactical-edge-deployments/

26 Alex Alley, "*US Navy to deploy Cray Shasta supercomputer with AMD and Nvidia chips*", Data Centre Dynamics, February 18, 2020, https://www.datacenterdynamics.com/en/news/us-navy-install-new-cray-shasta-supercomputer-amd-and-nvidia-chips/

27 Christina Wong, "*Details of China's Three Prototypes of Exaflop Supercomputer Architectures*", Next Big Future, March 5, 2019, https://www.nextbigfuture.com/2019/03/details-of-chinas-three-prototypes-of-exaflop-supercomputer-architectures.html

28 Éanna Kelly, "*EU launches €1B project to build world's fastest supercomputer*", Science/Business, October 2, 2018, https://sciencebusiness.net/news/eu-launches-eu1b-project-build-worlds-fastest-supercomputer

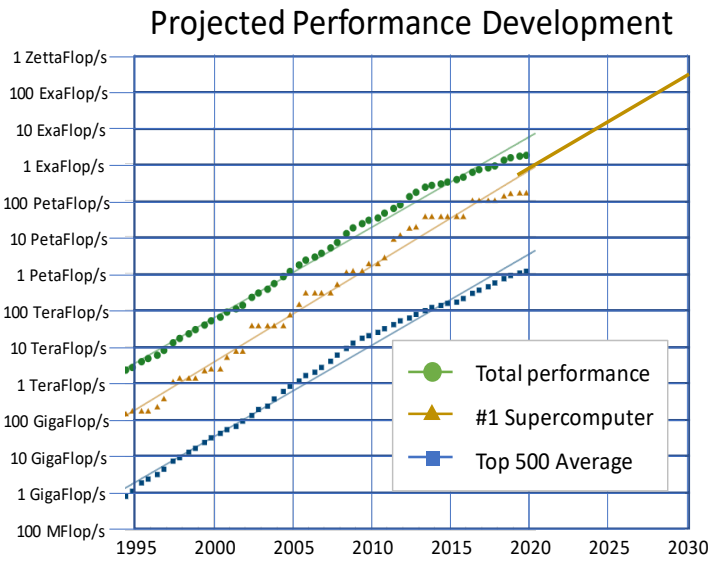
misdirected their investment money and intellectual energy into industrial-age plants and technologies. The ongoing virus-driven economic crisis might push them further backward as government money is diverted to bailing-out their fading industrial corporations and banks.

Now that Brexit is done, the UK has been ostracized from the EuroHPC project. Consequently, they announced the "UK Exascale Project" in late 2019. They plan to use ARM-based CPUs for the computing elements. Three universities (Edinburg, Leicester, and Bristol) are working with HPE, ARM, and SUSE (an open-source Linux-based software company) on the architecture. What they may do is build large petaFLOPS machines for the three universities and then hook them together through optical cables to reach the exaFLOPS level. This project may also be pushed back depending upon the economic effects of the virus on UK budgets. The first question this group is trying to answer is whether the UK needs an exaFLOPS machine and for what purposes.

Japan doesn't want to be left out of the exascale race, so they announced their Fugaku Project back in 2018.[29] Their previous supercomputer, the K-machine at 10.5 petaFLOPS and made by Fujitsu, contains 88,128 SPARC CPUs. This is the largest number of computing elements in any supercomputer. For Fugaku, they will use a modified ARM processor designed and made in Japan. Preliminary design specs say that the chip will have about 50 cores and the machine will contain 150,000 of those processors, connected with the TofuD interconnect Their goal is to get 1.3 exaFLOPS at much lower power consumption and heat generation than present petaFLOPS machines. But Japan could also run out of government money for this project as Covid-19 takes their economy down further.

When you look at the list of petaFLOPS machines mentioned in the October 2019 report, they all have thousands of CPUs and GPUs, not to mention hundreds of thousands of memory and I/O chips. The planned exaFLOPS machines will contain even more chips, and they will produce a lot more heat. All these machines are using exotic liquid cooling techniques to keep the heat from killing the chips. One article I read said that some of the older petaFLOPS machines have an MTBF (mean time between failure) of about an hour. When something fails, you must continue computing without those nodes (reducing overall performance), or stop everything, find the bad chip (or node board), replace it, and start-up again. Redundancy just adds more chips that produce more heat, so that's not the answer. Japan's 10.5 petaFLOPS K-Machine has 88,128 CPUs, and the 93 petaFLOPS Chinese Taihulight machine contains 40,690 CPUs. The fastest machine today, the Summit 148 petaFLOPS supercomputer at Oak Ridge, contains 36,864 CPUs and GPUs. The second fastest machine, the Sierra 125 petaFLOPS machine at Lawrence Livermore, contains 25,920 CPUs and GPUs. The planned Japan Fugaku machine has 150,000 CPU chips. We don't know how many computing elements will be included in the three exaFLOPS machines under construction in the U.S. (Aurora, Frontier, and El Capitan). What is evident from these numbers is that U.S.-designed machines produce more performance with fewer processors and interconnects.

TOP500.org maintains a very current list of the 500 most powerful commercially available computer systems known to the public. Their November 2019 report helps us understand the performance/power ratio trends of the exaFLOPS machines being constructed (Aurora, Frontier, and El Capitan). A recent technical report on the efficiency ratings of supercomputers, written in 2019 by Koomey Analytics and completed in collaboration with Advanced Micro Devices, Inc., goes into great detail on supercomputing performance and efficiency.[30]



Source: Top500.org

29 Joel Hruska, "*Japan Tests Silicon for Exascale Computing in 2021*", Extreme Tech, June 29, 2018, https://www.extremetech.com/computing/272558-japan-tests-silicon-for-exascale-computing-in-2021

30 Supercomputing Performance and Efficiency, December 2019, https://www.amd.com/en/system/files?file=documents/Supercomputing-Performance-Efficiency.pdf

In late March, medical scientists announced that they used the Summit supercomputer at Oak Ridge to model how over 8,000 pharmaceutical compounds might be effective in treating the Covid-19 virus. Calculations showed that 77 of them had promise.[31] A few days later, the two supercomputers at Argonne National Labs modeled how over 250 million known small molecules might affect the virus. The machines used were the 10 petaFLOPS MIRA supercomputer, an IBM-built Blue Gene machine and the 11.69 petaFLOPS Theta machine built by Intel and Cray. A supercomputing consortium was also announced that will use 16 U.S.-based supercomputers with a combined computing power of 330 petaFLOPS, to run bioinformatics, epidemiology, and molecular modeling simulations in search of a potential cure for Covid-19.[32]

All of these supercomputers mentioned above are using traditional von Neumann load-store register-based sequential-processing architectures. However, they are probably running some AI algorithms in software and doing parallel processing to a degree. We have a few nascent neural network chips in the market, but they are primitive. As AI algorithms are refined, polished, and proven, and then put into hardware, those chips might take us to zettaFLOPS (1 followed by 21 zeros) and yottaFLOPS (1 followed by 23 zeros) processing levels. The next scales (unofficial prefixes at this point) are the brontoFLOPS (1 followed by 27 zeros) and the geoFLOPS (1 followed by 30 zeros). Depending on how neural networks progress in hardware, von Neumann exaFLOPS supercomputers (1 followed by 18 zeros) could be considered very slow in a few years. Then there's the quantum machines, but they excel at only few very specialized applications right now. And present quantum computers are very sensitive to noise (quantum decoherence) making them unstable and unreliable.

The supercomputer race, between countries and companies, is driving the CPU, GPU, and interconnect (fabric) technologies. The PC and sever markets only want cheaper CPU cycles, not expensive high-performance processors. They are not doing massive scientific simulations, so they are happy filling-up million-square-foot data centers with 50,000 to 80,000 cheap motherboards. So, the big question is…. how much of the advanced technologies being developed for supercomputers will come down to us in the high-performance embedded computer market? We'll have a better idea about the answer when the exaFLOPS machines (Aurora, Frontier, and El Capitan) are up and running.

"How much of the advanced technologies being developed for supercomputers will come down to us in the high-performance embedded computer market?"

Military

In the Technology Section of this report, I mentioned that the Pentagon bought a 6 petaFLOPS supercomputer in a cargo container. The cargo container packaging implies that the computer will be mobile, capable of being placed near the battlefield.[33] The 6 petaFLOPS performance level says it is capable of processing huge amounts of data from sensors. How will this machine be used in a war? Keep in mind that the DoD issued a Joint Enterprise Defense Infrastructure (JEDI) contract to Microsoft for cloud computing services last October, but Amazon filed a legal challenge against the award in February. Different departments in the DoD already have over 500 cloud computing contracts in place, handling lots of administrative and database chores, and they need to be consolidated.

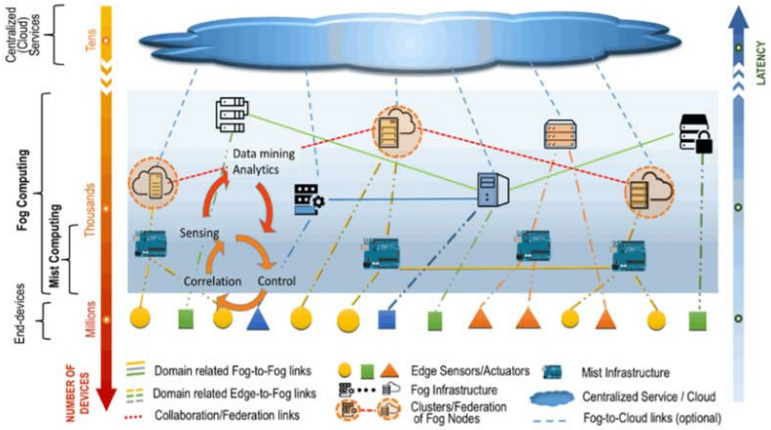
The computer-in-a-cargo-container is taking us into tactical battlefield "cloud" computing, and we need to examine the different levels of cloud computing to understand what the DoD is doing. The basic cloud computing model assumes that you have a big centralized computer center back on the U.S. mainland, and thousands of sensors and little computers on a remote battlefield somewhere will feed data to that central machine. This model assumes that you have reliable high-bandwidth communications links from all the sensors and little computers to the big computer. That's a bad assumption, considering that we will not be running communication cables all over the battlefield,

31 Mike Wehner, "*Supercomputer finds 77 drugs that could halt coronavirus spread*", New York Post, March 23, 2020, https://nypost.com/2020/03/23/supercomputer-finds-77-drugs-that-could-halt-coronavirus-spread/

32 Paul Ausick, "*How Researchers Are Using Massive Computing Power to Stop COVID-19*", 24/7 Wall St., March 25, 2020, https://247wallst.com/technology-3/2020/03/25/how-researchers-are-using-massive-computing-power-to-stop-covid-19/

33 Sebastian Moss, "*US Army buys $12m IBM supercomputer in a shipping container, will test for tactical edge deployments*", Data Centre Dynamics, August 2, 2019, https://www.datacenterdynamics.com/en/news/us-army-buys-12m-ibm-supercomputer-shipping-container-will-test-tactical-edge-deployments/

and the enemy will be trying to jam the RF communications frequencies.



Source: NIST

The next level is called "fog" computing. That's where a smaller but very powerful computer is put "near" the battlefield, between the big cloud computer back in the States and all the sensors and little computers on the battlefield. This is where the new cargo-container computer fits in the picture. This architecture removes the dependence on high-bandwidth communications links from the sensors back to the States, and speeds-up tactical decisions since the sensor data doesn't have to travel as far to be processed. The cargo-container computer will process all the data, send targeting data to the weapons, and then send consolidated reports back to the main cloud computer in the States.

The next level is called "mist" computing. That's where we put an even smaller but still powerful computer "on" the battlefield, between the fog computer and the sensors and little computers on the weapons platforms. The mist computer will process all the data from the sensors and little computers on the battlefield and send some of the data and reports to the fog computer near the battlefield. The fog computer will do further processing and send reports back to the big cloud computer back in the States.

The final level is called "fluid" computing. That's where even smaller but still-powerful computers are located on all the intelligence and weapons platforms and vehicles, next to the sensors on those platforms. They will do all the tactical processing (targeting enemy positions and firing the weapons). That data will also be sent to the mist computer on the battlefield, for further processing. The mist computer will send data and reports to the fog computer near the battlefield. It will do further processing and send strategic reports to the main cloud computer back in the states.

We need to process huge amounts of tactical data from sensors and weapons on the battlefield to make targeting and weapons-firing faster, but basic cloud computing introduces delays. Fog computing, with the cargo-container supercomputer, will somewhat solve that problem. When we have better and faster processor chips, we will put mist supercomputers on the battlefield, to speed things up even more. And eventually, we will have smaller and more powerful fluid computers that can be put on all the weapons platforms and vehicles next to the sensors. Additionally, we need to evaluate all the data from our sensors and weapons, to see how the enemy plans his attacks and how our weapons and sensors perform in a fight. From that, we get strategic concepts to plan the next battles. Basically, processing and analyzing all this data will tell us how our enemies think, and we can anticipate their actions. If we operate faster than our enemy on the battlefield, with foreknowledge of what they are going to do, the war will not last very long. So, the concept of the cargo-container fog computer will make our weapons more accurate and deadly and shorten any war we must fight.

When will we see the first mist supercomputers on the battlefield? Back in August 2017, a 1 teraFLOPS (1 followed by 12 zeros) small supercomputer was launched to the International Space Station.[34] It was called "Spaceborne-1", built by HPE, and it contained off-the-shelf Xeon CPUs, Nvidia GPUs, and memory chips. Those chips were not subjected to extreme stress-testing or radiation-hardening. This computer is the size of a traditional server with PCIe expansion boards and weighed 124 pounds. It survived the shock and vibration of launch, endured the radiation and temperature fluctuations in space, and survived cosmic rays while running benchmark calculations for 615 days. It returned to earth in June 2019 and is now being examined by HPE engineers to evaluate the effects of space on the chips and circuit boards.

34 Oliver Peckham, "*The Spaceborne Computer Returns to Earth, and HPE Eyes an AI-Protected Spaceborne 2*", HPC Wire, June 10, 2019, https://www.hpcwire.com/2019/06/10/spaceborne-computer-returns-to-earth-hpe-eyes-an-ai-protected-spaceborne-2/

Obviously, we are considering putting supercomputers on satellites and positioning those over the battlefield as mist computers. They will be difficult targets for our enemies to hit with their weapons or to jam the satellite communication frequencies. HPE is designing and building Spaceborne-2 now, but we don't know what CPUs and GPUs they will use, or how many teraFLOPS to expect from that machine.

What the DoD is really doing with computers here is creating the "kill web". That's DARPA's idea and here's how it works. As conditions deteriorate and a war becomes inevitable, we will saturate the potential battlefield with SIGINT, IMINT, ELINT, radar, infrared, acoustic, and other types of sensors as well as moving our weapons platforms into position. The sensors will collect data about enemy movement of troops, weapons, communications, and radar scanners, and send that data to mist computers. The mist computers will integrate all that data and send targeting data about the enemy's positions to all the weapons on or near the battlefield in seconds. When the time is right, the weapons will fire at the enemy and destroy his troops and weapons. The sensors will do damage assessment and target any remaining enemy troops and weapons that survived. They will be destroyed, and all the data from the fight is fed-back to the fog computers and the cloud computer for strategic analysis.

That's how the Kill Web works, and it's called the 5F model: Find (identify), Fix (track), FIRE, Finish, and Feedback. Execution of some of the phases takes only seconds (finding targets and identifying them). Others may take minutes (fix and track, FIRE the weapons, finish any remaining threats, and feedback the data from the battle). USAF General John Jumper started this thinking. He said that we must destroy our enemies on the battlefield by executing the 5F model in 10 minutes or less. I have written a series of articles on the kill web in more detail than I can put here. They are at http://mil-embedded.com/topics/kill-web/ if you want to explore this topic further. But for now, you understand what the cargo container supercomputer will do and where the DoD is going as the technology advances.

The next topic of my extensive research, while under stay-at-home orders without adult supervision, might raise some questions about my mental health. Back in 2004, and again in 2015, U.S. Navy pilots chased UAPs (unidentified aerial phenomena) over the Pacific. The Navy does not call them UFOs, or unidentified flying objects. In 2019, three authenticated Navy videos were leaked to the press: "FLIR1", "Gimbal", and "GOFAST". You should watch those before you continue reading.[35]

"The next topic of my extensive research, while under stay-at-home orders without adult supervision, might raise some questions about my mental health."

Unable to identify the aircraft in the videos, the U.S. Navy decided to create a process for pilots to report UAPs to the Navy brass for investigation.[36] Previously, if a Navy pilot reported a UFO, they would probably be grounded and sent off for psychological evaluation and eye exams. Numerous projects have been secretly undertaken to study UFO reports over the years: Project Sign (1947), Project Grudge (1949), Project Blue Book (1952), the COMETA Report (done by the French government in 1999), and the Advanced Aerospace Threat Identification Program (AATIP started in 2007). There have been 38 different studies and reports issued under the AATIP program so far. It's worth reading about each of these studies.[37]

In 2004, the Iranian government claimed that advanced unidentified aircraft (allegedly operated by the CIA) were flying over their nuclear installations collecting data. They could hover over their targets and fly away at Mach-10, emitting a faint blue light. Iranian fighter planes attempted to intercept the aircraft but had their radar and navigation systems disabled by intense magnetic energy beams.[38] Interesting that both the Navy and Iranian encounters with UFOs occurred in the same year, 2004.

35 Jurica Dujmovic, "*Opinion: Here's a believable explanation of those UFO videos released by the Navy*", MarketWatch, October 19, 2019, https://www.marketwatch.com/story/heres-a-believable-explanation-of-those-ufo-videos-released-by-the-navy-2019-10-15

36 J.D. Simkins, "*The Navy is creating guidelines for pilots to report UFO sightings*", Military Times, April 25, 2019, https://www.businessinsider.com/navy-creating-guidelines-for-pilots-to-report-ufo-sightings-2019-4

37 Robert Beckhusen, "*What The U.S. Military Learned From Watching UFOs*", The National Interest, March 12, 2020, https://defensemaven.io/warriormaven/air/what-the-u-s-military-learned-from-watching-ufos-wf6Zag9fJ02zEnfF-9-mhQ

38 https://militarywatchmagazine.com/article/iran-claimed-hypersonic-american-spy-drones-flew-over-its-nuclear-sites-attempted-f-14-interception-failed

Additionally, 2019 was a banner year for UFO sightings worldwide.[39] In March 2020, the Pentagon asked Congress to classify future defense budgets because they will give our enemies insight into what platforms and weapons we are investing in heavily if made public (that's called open-source intelligence).[40] DoD budgets have been unclassified and publicly available since 1989, so maybe the future budgets will reveal the new antigravity-powered UAVs we have been flying over the Pacific and Iran?

For many years, the explanation for UFOs revolved around spaceships from alien galaxies visiting earth (Theory 1). After the development of the F-117 stealth fighter and the SR-71 in total secrecy, two new theories emerged. Theory 2A says that smart engineers secretly working on military programs have developed the technology to build flying saucers, and Theory 2B that says that DoD engineers gained the technology to build flying saucers from alien spaceships that crashed on earth (i.e., from the Roswell, NM crash in 1947). Another theory (call it Theory 2B.1) suggests that Velcro and WD-40 were discovered in crashed space craft and were reverse-engineered after DoD gave samples to industry. Theory 3 says that either the Russians or the Chinese have developed these advanced aircraft, either internally or they got the technology from an alien spacecraft that crashed in their countries (Theories 3A and 3B). Given the level of technology seen in Russian and Chinese weapons platforms today, Theory-3 can be discounted by observation.

Now, there's Theory 4. It says that sometime in the past, a group of very intelligent humans broke away from society and moved underground or created a city under the sea. There, they developed the technologies to make these UFOs fly and defy the laws of physics. That aligns with the reports from the pilots who saw them, saying that they arose from the ocean before they flew away.[41] This theory does not consider how those breakaway people built those cities underground or underwater, how they power them, and how they grow food to stay alive.

While you are thinking about these theories, remember that the U.S. Navy was awarded patents for anti-inertial and anti-gravity engines (US10145532B2 and US2018029864A1). Other patent applications have been filed for antigravity engines in the past by major technology companies (US20120092107A1, WO2001009509A2, WO2001009509A3). According to experts, the DoD and U.S. aerospace companies have been researching antigravity properties for over 70 years now.[42] You can decide which theory about UFOs you like or come up with a new one on your own.

"You can decide which theory about UFOs you like or come up with a new one on your own."

Coming back to reality, how the COVID-19 virus is going to affect our Military/COTS business is unknown at this point. Critical projects will continue to be funded and others will be put on hold as government money is funneled into bail-out programs for the airline industry and small businesses. An additional problem is that the electronic component supply chain could be disrupted by the crisis, and parts could be hard to find. The DoD could issue priority numbers for certain components, and that would give military contractors first access to existing supplies. That happened back in the 1970's. I remember IBM engineers going into Radio Shack back then and buying all the ICs in plastic bags on the hangers, intended for hobbyists.

The virus crisis has put a damper on our enemy's activities in the Middle East and other regions, for now. But, according to a report released in January, 40% of the world's countries will experience some sort of social unrest, limited conflict, or civil war in 2020.[43] That's 75 out of the 195 countries in the world, and this prediction came before the coronavirus emerged. We are already seeing flare-ups in Libya, Greece, Turkey, India, Peru, Iran, China (Hong Kong), and several African nations.

39 Paula Froelich, "*2019 was banner year for credible UFO sightings*", New York Post, December 14, 2020, https://nypost.com/2019/12/14/2019-was-banner-year-for-credible-ufo-sightings/

40 Aaron Mehta, "*Pentagon seeks to classify future year defense spending plans*", Defense News, March 30, 2020, https://www.defensenews.com/pentagon/2020/03/30/pentagon-seeks-to-classify-future-year-defense-spending-plans/

41 Jazz Shaw, "*One Scientist's Alternate Theory If The UFOs Weren't Created By Aliens*", Hot Air, March 28, 2020, https://hotair.com/archives/jazz-shaw/2020/03/28/one-scientists-alternate-theory-ufos-werent-created-aliens/

42 Brooke Crothers, "*US research into anti-gravity goes back 70 years, report says*", Fox News, November 1, 2020, https://www.foxnews.com/tech/us-anti-gravity-research-70-years

43 Paul Joseph Watson, "*40% of Countries in the World to Experience Civil Unrest in 2020*", InfoWars, January 17, 2020, https://www.infowars.com/40-of-countries-in-the-world-to-experience-civil-unrest-in-2020/

Mergers and Acquisitions

Early in 2020, Xerox made a $35 billion hostile takeover bid for HP, Inc (the group that makes PCs and printers). But the virus crisis appeared, and Xerox dropped their bid in late March. We could see another wave of mergers in the telecom industry, as telecommunication companies buy-up cable TV and internet providers. The top two satellite TV companies (Dish TV and Direct TV) could merge as more people move to internet-based streaming.[44] Ford could try to merge with GM to save both companies as conventional car sales decline and EVs take over in many world markets.[45]

Boeing may need to spin-out their military division, to protect it from the ongoing 737 MAX disaster as well as the virus crisis effect on airlines.[46] That would make the spun-out company an acquisition target for other prime contractors. In December 2019, Leidos bought Dynetics, to build hypersonic glide vehicles.[47]

Most likely, we will see large semiconductor companies continuing to buy start-ups in artificial intelligence (AI).

What we see in the Xerox-HP deal, the potential Dish-Direct deal, and the potential Ford-GM deal is purely the consolidation of market share in declining markets. That's a survival strategy. What we see in the possible deal for Boeing's military division, the purchases of AI companies, and the Leidos-Dynetics deal is the purchase of advanced technology in promising markets. That's a growth strategy.

In early April, Woodward (a maker of fluid controls and combustion systems for aircraft engines) and Hexcel (a maker of composition materials for aircraft and spacecraft) cancelled their planned merger. The combined companies would have been worth nearly $14 billion. The COVID-19 virus conditions made forecasting the merged company's future impossible.[48] Other mergers, either under negotiation or ready to be announced, have probably been nixed because of poor future visibility.

Could we see some M&A activity in our market segment? Possibly, later in the year. Small companies with crisis-induced cash flow or debt problems, who have contracts on some programs, could be attractive. I doubt we will see much M&A activity before next year, considering the risk associated with uncertainty.

Summary

As of early April, the International Monetary Fund says that countries have already allocated $8 trillion in relief funds to shore-up businesses and the unemployed.[49] And, we will probably see more government subsidies coming before the end of the year. All that money will create some political problems in the EU, when the fiscally promiscuous southern countries get bailed-out by the more responsible northern countries. Some analysts say that this crisis could deepen the existing divisions and cause more countries to leave the EU.[50]

Where is all the relief money coming from? Countries are manipulating their budgets, taking it away from other programs where they can, and they are issuing huge mountains of new debt (government bonds). Before the coronavirus struck, the U.S. debt-to-GDP ratio was at 102%. Congress has already passed legislation to allocate $2

44 Alex Sherman, "*Why T-Mobile's deal with Sprint could be the warmup to a wild decade of mergers*", CNBC, February 12, 2020, https://www.cnbc.com/2020/02/12/t-mobile-sprint-merger-is-a-warmup-to-more-wireless-cable-mergers.html

45 Douglas A. McIntyre, "*Will GM Buy Ford as Industry Consolidates?*", 24/7 Wall St., October 30, 2019, https://247wallst.com/autos/2019/10/30/will-general-motors-buy-ford-as-industry-consolidates/

46 Douglas A. McIntyre, "*Boeing Could Spin Off Defense Unit to Salvage Stock*", 24/7 Wall St., January 30, 2020, https://247wallst.com/aerospace-defense/2020/01/02/boeing-could-spin-off-defense-unit-to-salvage-stock/

47 Aaron Mehta, "*Leidos' acquisition of Dynetics has a future technology focus*", Defense News, December 18, 2019, https://www.defensenews.com/industry/2019/12/18/leidos-acquisition-of-dynetics-has-a-future-technology-focus/

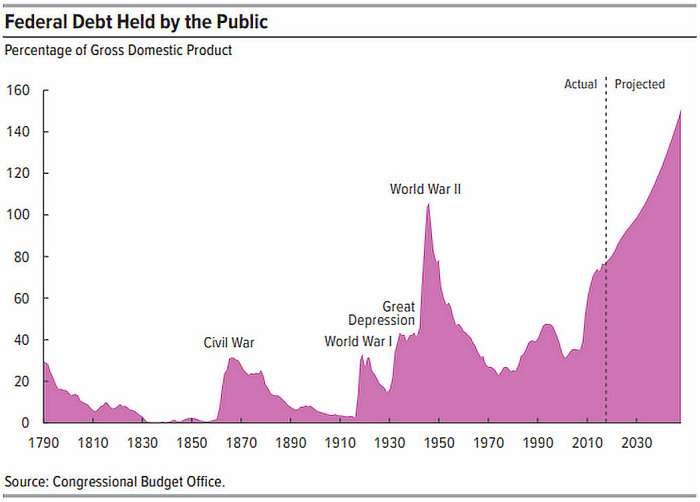
48 Greg Avery, "*Coronavirus pandemic scuttles multibillion-dollar merger for Colorado manufacturer*", Denver Business Journal, April 6, 2020, https://www.bizjournals.com/denver/news/2020/04/06/woodward-hexcel-merger-coronavirus.html?ana=yahoo&yptr=yahoo

49 Newsmax, "*IMF Sees World Economy in Worst Recession Since Great Depression*", Bloomberg, April 9, 2020, https://www.newsmax.com/finance/economy/imf-world-economy-recession/2020/04/09/id/962059/

50 Jennifer Rankin, "*Coronavirus could be final straw for EU, European experts warn*", The Guardian, April 1, 2020, https://www.theguardian.com/world/2020/apr/01/coronavirus-could-be-final-straw-for-eu-european-experts-warn

trillion in virus relief funds, and with more to come, we may see debt-to-GDP go as high as 112% by the end of this year. The highest ratio experienced by the U.S. was in 1946, after the war, when it reached about 122%.

Japan's debt-to-GDP is over 200%. Look at the EU countries today: Greece (178%), Italy (137%), Portugal (120%), Belgium (102%), and France (100%). Most of Europe was still recovering from the 2008 financial crisis, and now they are being hit again. You can expect to see these and other EU countries radically slow or stop their defense spending and NATO funding, just as they were beginning to carry their weight.[51] Europe's ability to meet their NATO commitments, or fund a collective self-defense, is probably impossible now.



On an international scale, we may see the end of globalization. This crisis has exposed vulnerabilities in critical supply chains (pharmaceutical, medical equipment, machinery, automotive components, etc.).[52] Labor-intensive products that were outsourced to cheap-labor countries will be brought back to the developed nations, to create jobs and tax revenue. That will repair the broken supply chains at the same time. These economic changes could usher-in a series of international political changes, terminated alliances, and broken relationships between countries.

We are just now experiencing the primary effects of the virus crisis: lower GDP, high unemployment, lower tax revenues for governments, higher debt levels, disrupted supply chains, and strains on the medical systems. We have not yet seen the secondary effects (business bankruptcies, banks becoming insolvent, defaulted mortgages) and tertiary effects (civil unrest, broken alliances and shattered treaties between countries, nationalism, and isolationism).

What we are experiencing is called a "Black Swan" event. That's a low-probability incident that has extreme consequences. Nobody saw it coming, but many will say that is was clearly evident in hindsight. To better understand Black Swans, what causes them and their effects, go read Nassim Taleb's book "The Black Swan" (2010).

51 Sophia Becker, Christian Mölling, and Torben Schütz, "*The coronavirus threatens NATO. Let's move to protect the alliance.*", Defense News, April 9, 2020, https://www.defensenews.com/opinion/commentary/2020/04/09/the-coronavirus-threatens-nato-lets-move-to-protect-the-alliance/

52 Colin H. Kahl and Ariana Berengaut, "*Aftershocks: The Coronavirus Pandemic and the New World Disorder*", War on the Rocks, April 10, 2020, https://warontherocks.com/2020/04/aftershocks-the-coronavirus-pandemic-and-the-new-world-disorder/

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