



2019 State of the VITA Technology Industry



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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](http://MarketReports). (www.VITA.com/MarketReports)

Introduction

There's a lot going on in our world today. According to the latest forecasts, the economic situation is slowing down. The big guys in the technology sphere are trying to figure-out what the "next big thing" is, since the PC, cellphone, flat-screen TV, and auto markets are all saturated. In the military segment, the latest budget requests are delivering confusing information about future contracts and technologies as military spending shifts from chasing terrorists in deteriorating Middle Eastern countries, to preparing for war against near-peer adversaries like China and Russia. And adding to the confusion, there are many more traditional business models slamming into the ground at terminal velocity besides shopping malls and telecom. There's much more you didn't know about in this report, so I suggest you read it thoroughly.

Economic Conditions

The OECD (Organization for Economic Cooperation and Development) downgraded 2019 world GDP growth to 3.3% in their March report, down from the 3.5% previously forecast.¹ They blame the slowdowns in the U.S., Germany, Italy, France, Turkey, the UK, and Canada in 2018. The UN says world GDP growth will be lucky to hit 3% in 2019.² So, there's the big picture: we're looking at slowing economic activity worldwide.

Despite all the good economic news in the U.S., things are starting to look dicey going forward. U.S. GDP slowed from 3.4% in Q3 to 2.2% in Q4, but we had 2.9% growth for

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2 Tom Miles, "U.N. sees global economy growing 3 percent in 2019 but beset by risk", Reuters, January 21, 2019,

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all of 2018.³ Dark clouds are developing for 2019 though, mostly coming from Europe and China. Both economies are declining and that will affect us here in the U.S. since we are connected by exports. China's growth rate declined to 6.6% in 2018, down from 6.8% in 2017.⁴

Let's consider the political situation. Just count the number of country leaders under investigation, pressured to resign, or did resign recently: Trump in the U.S., Merkel in Germany (resigned from party leadership), Maduro in Venezuela, Macron in France, Netanyahu in Israel, Trudeau in Canada, Nazarbaev in Kazakhstan (resigned), May in the UK (being attacked from all directions), Dukanovic in Montenegro, Bouteflika in Algeria (resigned), Najib Razak in Malaysia (voted out), Faye Al-Serraj in Libya (under attack). The entire government of Finland resigned in March over healthcare reform issues.⁵ Spain's government collapsed in February.⁶ Amazingly, Italy is the pinnacle of stability in government these days (their previous government lasted 8 months). Political instability leads to economic instability, and we have plenty of both.

“Political instability leads to economic instability, and we have plenty of both.”

In the EU, Germany's GDP growth rate fell to 1.5% in 2018, down from 2.2% in 2017.⁷ France turned-in similar numbers. Italy's GDP growth went negative for the last 2 quarters of 2018. Here's a website (<https://countryeconomy.com/gdp>) where you can view numbers of the GDP growth of each country. The ECB (European Central Bank) downgraded GDP growth in the EU to 1.1% for 2019, down from the previously forecast of 1.7%.⁸ Even George Soros says that the EU is sleep-walking into a Soviet-Union-style bankruptcy (the USSR went bankrupt in 1991).⁹

There are several EU policies, along with growing nationalism by each member country, that support Soros' predictions.¹⁰ France and Germany are bickering over which country gets what work (and jobs) on the new 5G Euro-fighter aircraft.¹¹ Italy says they are getting shut-out of the Franco-German fighter project, so they are cozying-up to BAE in the UK, to get a piece of the Tempest project.¹² The EU plan to tax all internet companies 3% of their revenue has many countries claiming their piece of the pie is too small.¹³ The EU tax proposal will fail, so the UK and France are developing their own plans to tax internet companies. Other EU countries will follow suit with different rates, just like they do now with income taxes or revenue taxes on foreign companies.

Italy and France are at odds over who will get what jobs in their joint venture to build naval vessels for the EU military. Italy is also concerned that they will be shut-out on other Franco-German military equipment programs.¹⁴ EU regulators nixed

3 Jeffery Bartash, "U.S. economy grew a slower 2.2% in the fourth quarter, new GDP figures show", Market Watch, March 28, 2019, https://www.marketwatch.com/story/fourth-quarter-gdp-growth-cut-to-22-from-26-2019-03-28?mod=mw_theo_homepage

4 Huileng Tan, "China's economy grew 6.6% in 2018, the lowest pace in 28 years", CNBC, January 20, 2019, <https://www.cnbc.com/2019/01/21/china-2018-gdp-china-reports-economic-growth-for-fourth-quarter-year.html>

5 Anne Kauranen, "Finland's cabinet quits over failure to deliver healthcare reform", Reuters, March 8, 2019, <https://www.reuters.com/article/us-finland-government/finlands-cabinet-quits-over-failure-to-deliver-healthcare-reform-idUSKCN1QP0R6>

6 Chris Tomlinson, "Spanish Snap Election Confirmed After Govt Collapses", Breitbart, February 16, 2019, <https://www.breitbart.com/europe/2019/02/16/spanish-snap-election-confirmed-after-govt-collapses/>

7 Holly Ellyatt, "German economy posts weakest growth in five years", CNBC, January 15, 2019, <https://www.cnbc.com/2019/01/15/germany-2018-gdp-data.html>

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14 Tom Kington, "Italian row with France unsettles naval industry cooperation", Defense News, February 1, 2019, <https://www.defensenews.com/naval/2019/02/01/italian-row-with-france-unsettles-naval-industry-cooperation/>

a merger between railroad equipment makers Siemens (Germany) and Alstom (France) in February.¹⁵ This decision is in line with another EU policy, not allowing bank mergers across country borders. Two of Germany's banks (Deutsche Bank and Commerzbank) have been languishing, so they are exploring a merger inside Germany.¹⁶ The objective of this merger is to prove that if you put two turkeys together, you'll get an eagle.

In March, the U.S. Federal Reserve announced they would not raise interest rates in 2019. The ECB (European Central Bank) announced they would hold interest rates low, and offer low interest loans to EU banks, to inspire borrowing to increase economic activity (another cycle of quantitative easing, or QE). Those are both signs that central banks anticipate slower GDP growth going forward.

Meanwhile, the EU recently fined Google \$1.7 billion for playing games with advertisers online. In the last few years, the EU has fined Google a total of \$9.3 billion for digital transgressions.¹⁷ Google is appealing all those fines, at the General Court of the European Union. In the U.S., some congressional leaders are calling for a break-up of the top U.S. internet companies. While Amazon has only 4% of U.S. retail sales (1% of global retail sales), they are being treated as a monopoly when they just have a different business model than brick-and-mortar stores.¹⁸ The EU is a bunch of shopkeepers, the primary collectors of their massive VAT taxes, and they have been protected by laws and outdated rules for decades. The success of online product sales and services by U.S.-based companies are driving EU lawmakers crazy, so they need to tax any foreign company that creates revenue online. Most of the innovation coming from Europe these days is in tax law, not technology.

The economic malaise in the EU will negatively affect NATO, but we'll cover that in the Military section. Just be aware that general economic conditions seem to be deteriorating in 2019. From my perspective, I'm going with a worldwide economic slow-down, but not a recession. The U.S. economy may get bruised in Q1 2019, and maybe part of Q2, while the EU and China will take a beating. The EU will probably take the worst of it.

“From my perspective, I'm going with a worldwide economic slow-down, but not a recession.”

Military

There's a lot of stuff going on in the military segment, most of it confusing. So, let's explore those elements superficially here:

NATO is a mess, for both political and financial reasons.¹⁹ None of the NATO countries, except the U.S. and the UK, are ready to fight the Russians if they invade the Balkan states through the Suwalki Gap. The coming economic slowdown in the EU, mentioned previously, will make Europe's military position even worse. There are cracks and fissures forming between EU-member countries, over immigration and tax laws, and that also affects NATO's mission and preparedness.

The bulk of NATO's weakness is in Germany.²⁰ Little of their equipment, or their troops, are battle-ready. France is not in much better shape either, and Macron is in a fight with the “yellow vests” over high taxes and the cost of living. Merkel in Germany is on her way out. President Trump is fed-up with the U.S. paying 70% of the cost of NATO, and relationships

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with our European allies are beginning to fray.²¹ There are talks of dissolving NATO, but there are downsides.²² Surely the Russians would become more aggressive, and a U.S. withdrawal could worsen the conflicts between EU members as each country builds-up its own military (as they did before WWI and WWII). Most people don't understand that NATO had two missions: (1) deter the Russians from attacking Europe, and (2) keep Germany, France, Spain, and England from attacking each other, like they have for the previous 2,000 years.

The Germans are protesting that the communications and control for our armed UAVs comes through satellite links at Ramstein Airbase. The Italians are protesting for better wages and hours for their people working at Aviono Airbase. The French protest at U.S./NATO bases in their country, for whatever reason. So, President Trump has suggested that we charge these countries our costs plus 50%, since they don't appreciate the protection U.S. forces provide.²³ That would make our spending on European defense seem more proportionate and appropriate.

Germany, France, Belgium, and Spain would never pay, so it might be time to move our bases to more friendly countries. In March, the U.S. started stockpiling combat vehicles and supplies at a new base in Powidz, Poland.²⁴ Recently, Poland's government has offered to build a "Fort Trump" in their country. Now, there are discussions about building a new airbase in Poland, for our drones and maybe fighter jets and bombers.²⁵

But first, we need to cut the European Defense Initiative funding by 10%. Trump propose that in the 2020 defense budget.²⁶ NATO is not dead yet, but it is in serious trouble. Europe, especially Germany, has become increasingly dependent on Russian gas and oil over the past years. They may not really want to beef-up their military defenses against a Russian invasion and irritate their primary energy supplier. Add that to your thinking about why the NATO alliance is falling apart. If the Russians can control the energy supplies to the EU by turning the pipelines on and off, then they can control the politics in those countries and in NATO.

There's a lot more to the NATO story. I suggest you read Victor Davis Hanson's book, "An Autumn of War".

In late March, India shot-down one of their satellites (Microsat-R) 185 miles up in space with a home-grown missile during Mission Shakti. That makes them the fourth nation to show their anti-satellite weapons capability.²⁷ The U.S. shot-down USA-193, a non-functioning surveillance satellite, in 2008 (Operation Burnt Frost). Since 2016, Russia has been firing ASAT missiles into space, and may have "killer satellites" in orbit. In 2007, China shot-down an old weather satellite (FY-1C) 537 miles above the earth. Space is the new frontier of war, which gives credibility to President Trump's push for the Space Force as the next independent branch of the military.

If certain European countries do start spending money on their military, they want to get that money back through exports and the jobs that create income tax revenue locally. You already know that Germany and France have a project to replace the Eurofighter, called FCAS (Future Combat Air System). England, and maybe Italy, could be working together on their new fighter jet called Tempest. Italy and France have an alliance to build warships. France and Germany are building the new EMBT (European Main Battle Tank). It uses the chassis from a German Leopard 2A7 tank, mated with the turret

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22 Hans Binnendijk, "5 consequences of a life without NATO", Defense News, March 19, 2019, <https://www.defensenews.com/opinion/commentary/2019/03/19/5-consequences-of-a-life-without-nato/>

23 Ryan Pickrell, "Trump reportedly wants America's closest allies to pay all of the cost of hosting US troops — plus 50% for the privilege", Business Insider, March 8, 2019, <https://www.businessinsider.com/trump-wants-to-charge-allies-more-than-ever-to-host-us-troops-2019-3>

24 Sebastian Sprenger, "NATO foots bill for massive US combat depot in Poland", Defense News, March 28, 2019, <https://www.defensenews.com/global/europe/2019/03/28/nato-foots-bill-for-massive-us-combat-depot-in-poland/>

25 Joe Pappalardo, "It Looks Like A U.S. Air Base Is Coming To Poland", Popular Mechanics, March 13, 2019, <https://www.popularmechanics.com/military/aviation/a26814044/poland-us-air-base/>

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from a French Leclerc tank.²⁸ Germany has suggested that the EU needs to build its own aircraft carriers too.²⁹ There are many other EU projects for UAVs and ground combat vehicles, involving a few of their industrialized countries. Their efforts, like their tax laws, are inconsistent and scattered all around.

Speaking of tanks, you should watch the video of Rafael's (Israel) new Advanced Suite for Armored Fighting Vehicles (ASAFV).³⁰ It incorporates many of the features and concepts for the planned next-generation ground combat vehicle in design for the U.S. Army.

One look at the latest SIPRI report on 2017 worldwide weapons sales will give you an idea about why Europe is interested in building military weapons and systems.³¹ Europe has 6 countries on the top-ten military equipment exporters list, but what they sell is relatively low-tech stuff. The U.S. came in first again as the top military exporter, but that's easy to do when an F-35 costs over \$100 million each and about 50% of F-35 production goes to eight of our overseas allies.³² India and Saudi Arabia were the top two importers of weapons.³³ Preliminary data says that U.S. arms sales to others in 2018 reached a new high.³⁴

Another report states that there is a decline in U.S. arm sales to Middle East countries, now that ISIS has been defeated and things are calming down there. Military exports are shifting to European and Pacific countries, to counter Russian and Chinese aggression.³⁵

For those of you interested in future weapons technology, I have written an article, "*Future weapons and the kill web*", that collects many of those concepts in one place, along with animated videos of those imagined platforms in action. (<http://mil-embedded.com/guest-blogs/future-weapons-and-the-kill-web/>)

As the U.S. Army transitions from fighting terrorists in the Middle East, to preparing for war with near-peer enemies (Russia and China), they have adopted the "Big Six" modernization plan (long range precision fires, next generation combat vehicle, future vertical lift, network communications, air and missile defense, and soldier lethality).³⁶ That's where a lot of money will be going for new systems and weapons.

The Air Force is also changing their strategy. They plan to buy 8 new F-15EX fighters in 2020, with more to follow in future years. The stealthy F-35 and F-22 will destroy the enemy air defenses so the more vulnerable F-15's can come into the combat zone without being molested. The F-15 carries a bigger munitions load than the F-35 or F-22. It's a flying

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arsenal.³⁷ Another reason the Air Force is buying F-15's is to maintain the manufacturing base for fighter aircraft: they need companies other than Lockheed with those capabilities.³⁸

Boeing just announced a deal with the Australian Defense Force to develop a “loyal wingman” unmanned fighter jet for the F-35.³⁹ And, the Kratos XQ-58A Valkyrie unmanned fighter jet made its first flight over Arizona in March.⁴⁰ In April, the Air Force released their new concept of an unmanned fighter jet, called “Skyborg”.⁴¹

The Navy is changing their strategy too. The cost and time to build new aircraft carriers and destroyers won't get us to the 355 ship navy we need for decades. So, they are buying smaller unmanned surface vessels in the near future. Those boats are cheaper, and you don't have to recruit and train as many sailors to run them.⁴²

Then, there's the 2020 DoD budget. Trump wanted \$750 billion and the Pentagon wanted \$733 billion. Congress has proposed \$733 billion too.⁴³

There's a lot more going on in the MIL segment, but not enough space to cover it here. Understand that money is flowing like water into new technologies, platforms, and weapon systems. It's just hard to see which ones will go into full scale production and deployment.

Technology

Let's start-off with the announcement about Nvidia's purchase of Mellanox on March 11, for \$6.9 billion.⁴⁴ Back in January, Intel offered to buy Mellanox for \$6 billion, but Mellanox turned them down.⁴⁵ Intel, Mellanox, and Cray have been working together for years on supercomputer designs that used Mellanox' InfiniBand for storage system interconnect and maybe box-to-box connections.⁴⁶

Just hours after Nvidia announced their purchase of Mellanox, Intel announced their new Compute Express Link (CXL) interconnect, a basic replacement for InfiniBand in supercomputer architectures.⁴⁷

37 David Axe, “Boeing's F-15EX: We Have the Air Force's Master Plan for This New Warplane”, The National Interest, March 19, 2019, <https://nationalinterest.org/blog/buzz/boeings-f-15ex-we-have-air-forces-master-plan-new-warplane-48182>

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41 Rachel S. Cohen, “Meet the Future Unmanned Force”, Air Force Magazine, April 4, 2019, <http://www.airforcemag.com/Features/Pages/2019/April%202019/Meet-the-Future-Unmanned-Force.aspx>

42 Sam LaGrone, “Navy to Contract New Class of Unmanned Surface Vehicle by Year's End”, USNI News, March 6, 2019, <https://news.usni.org/2019/03/06/navy-contract-new-class-unmanned-surface-vehicle-years-end>

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45 Tova Cohen, “Intel offered up to \$6 billion for Israel's Mellanox”, Reuters, January 30, 2019, <https://www.reuters.com/article/us-mellanox-m-a-intel/intel-offered-up-to-6-billion-for-israels-mellanox-reports-idUSKCN1P0008>

46 Timothy Prickett Morgan, “Shasta Sets Up Cray For Commercial HPC And Supercomputing Expansion”, The Next Platform, February 13, 2019, <https://www.nextplatform.com/2019/02/13/shasta-sets-up-cray-for-commercial-hpc-and-supercomputing-expansion/>

47 Navin Shenoy, “A Milestone in Moving Data”, Intel, March 11, 2019, <https://newsroom.intel.com/editorials/milestone-moving-data/#gs.2gtepa>

On March 18, seven days later, Intel and Argonne National Labs announced that Intel and Cray would build the next generation exascale supercomputer, named Aurora. Absent from this announcement was any mention of Mellanox.⁴⁸ Informed speculation has it that Intel will use their new CXL interconnect, Intel's Xeon SP (scaleable processor), Intel's Xe GPU cards, and Intel's new Optane memory chips in this advanced computing machine. Intel getting back into the memory business was not welcomed by Wall Street analysts.⁴⁹ These moves will give Nvidia and Mellanox the shut-out in both interconnect technology and GPU processors in the Aurora project.⁵⁰

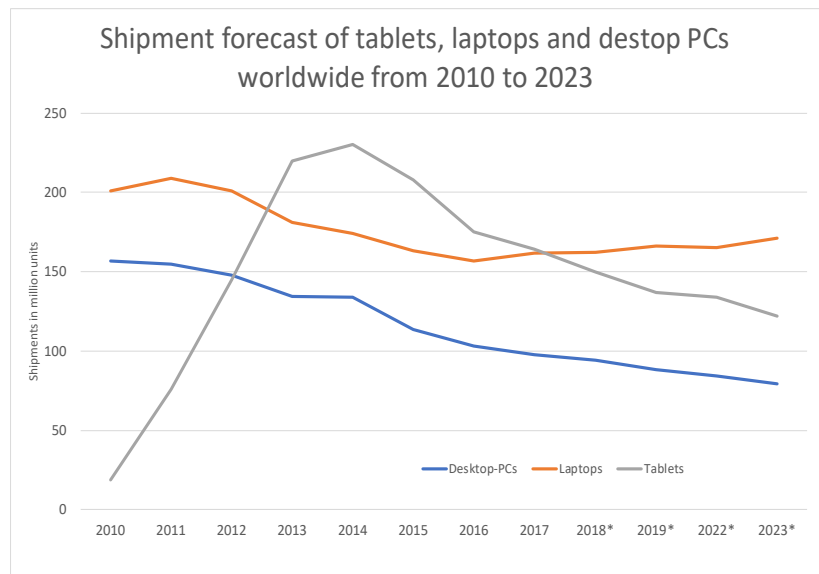
All this happened over 7 days, and Intel is not about to let Nvidia and Mellanox have any components in the world's fastest supercomputer. CXL, Xeon SP, Xe GPU boards, and Optane memory are all targeted at data center servers and networking. Nvidia GPUs have been making inroads as compute engines for AI and servers in the data center, and that's where Intel has circled their wagons. I doubt this series of events were coincidental.

PC sales declined by 1.3% in 2018. The previous 6 years have all seen declining PC shipments too, and that cuts into Intel's revenue. Intel missed the cellphone market altogether, and they are struggling to get a piece of that pie with their 5G modem chip. But Qualcomm sued Apple for modem patent infringement that has started a big legal flap.⁵¹ Additionally, Intel has been slow to create high-performance GPUs for graphics and AI applications, leaving that market to Nvidia, AMD, and some smaller companies. They want a foothold in that market now, with their new Xe GPU cards.

Last year, Intel sold-off their Wind River software group to TPG Capital. It was previously part of Intel's Internet of Things (IoT) group. As it turns out, part of the U.S.'s concerns about Huawei's telecom gear is that

it runs on VxWorks v5.5 software. It was designed for speed, not security. According to a UK cyber security group, that version is going EOL, and Huawei has a service/support contract that runs out in 2020. After that, Huawei has no easy way to fix any security bugs.⁵² The security group report also implied that little old ladies with a Cricket phone can hack into Huawei's gear if they tried. Their software development processes and revision control policies are rumored to be terrible. The U.S. could be sending sensitive intelligence to our allies (the "five eyes": Australia, New Zealand, Canada, UK, and the U.S.), through Huawei-made equipment. That might give you an understanding about why Huawei and ZTE gear are both banned in U.S. government and military contractor networks.

Add to all this the Spectre and Meltdown bugs in Intel's processors in 2018, and their delay on 10nm processor chips. In June 2018, Intel's CEO (Brian Krzanich) resigned over a past consensual relationship with an Intel employee (read hanky-



Source: Statistica 2019

48 B David Zarley, "America's first exascale supercomputer to be built by 2021", The Verge, March 18, 2019, <https://www.theverge.com/2019/3/18/18271328/supercomputer-build-date-exascale-intel-argonne-national-laboratory-energy>

49 Ian King, "Intel's Latest Chip Push Suggests the Company Has a Short Memory", Bloomberg, March 18, 2019, <https://www.bloomberg.com/news/articles/2019-03-18/intel-s-big-push-behind-its-optane-chip-isn-t-inspiring-analysts?srnd=premium>

50 Nicole Hemsoth, "Intel To Take On OpenPower For Exascale Dominance With Aurora", The Next Platform, March 18, 2019, <https://www.nextplatform.com/2019/03/18/intel-to-take-on-openpower-for-exascale-dominance-with-aurora/>

51 Chaim Gartenberg, "Looks like Apple's making its own modem to compete with Qualcomm", The Verge, December 12, 2018, <https://www.theverge.com/circuitbreaker/2018/12/12/18137816/apple-modem-qualcomm-intel-iphone-competition-engineer-hiring>

52 Sean Gallagher, "UK cyber security officials report Huawei's security practices are a mess", ARS Technica, March 28, 2019, <https://arstechnica.com/information-technology/2019/03/uk-cyber-security-officials-report-huaweis-security-practices-are-a-mess/>

panky). In January Intel announced their new CEO, Bob Swan, the previous CFO at Intel. So now, we have a finance guy running a technology company.

Next, let's look at what Nvidia's Chief Scientist, Bill Dally, says about technology and computer architectures. Watch the video of his presentation at DARPA's ERI Summit (2018).⁵³ Moore's Law is dead. Denard Scaling is dead. General purpose processors are dead, since we only get a few percent performance improvement with each new CPU generation now. Moving data is extremely expensive from a power consumption standpoint. Look at the Volta-100 GPU board in the presentation: 21 billion transistors on the die, drawing 400 Amps at 0.8 Volts (320 Watts). Intel's CPUs are right up there with GPUs on power consumption, but nowhere close on performance.

“General purpose processors are dead, since we only get a few percent performance improvement with each new CPU generation now. . .”

Burning 320 Watts on a single GPU is a lot of power. So, the good people at the University of Hawaii released a study that says Bitcoin (crypto-currency) mining, with high-performance GPUs, will raise global temperatures by 2 degrees C by 2033, and contribute more to global warming than all the flatulence from cows, horses, pigs, dogs, cats, camels, donkeys, parakeets, and chickens on the planet.⁵⁴ If you ever wondered how much power Bitcoin mining machines use, and how much money they make, here's your chance to find out. Some of these are real power hogs, and they don't make much money per day. ASICs have replaced CPUs, GPUs, and FPGAs as the processing element of choice for bitcoin mining. The website ASIC Miner Value tracks the realtime live income estimate of all known ASIC miners (<https://www.asicminervalue.com/>).

In February, PCI-SIG rolled-out the PCIe 5.0 (v0.9) specification. In our industry, we hardly see any 4.0-based products. Doing 4.0 is tough but doing 5.0 will be more than challenging. Insertion losses, crosstalk, and signal integrity (SI) problems are much worse with 5.0. Not many companies have the talent, or the money to buy the tools to design, simulate, and test 5.0 products.⁵⁵

To carry the SI issue a bit further, here's an informative article about NRZ signaling vs PAM-4 signaling, “Signal Integrity for 112G”, (https://community.cadence.com/cadence_blogs_8/b/breakfast-bytes/posts/si-for-112g). This will give you an idea about the problems associated with 4-voltage-level signaling in PAM-4. All this information leads me to believe that if you want to do PCIe Gen-4 or Gen-5, or Ethernet at higher frequencies, you might need to use twin-ax flyover cables and not copper backplane traces. That will make the backplane look like a patch-panel, with cables running all over the place.

How fast can you send data on copper wires? The theoretical limit is established by the channel capacity and the real-world data transfer rate is established by Shannon's Limit. Even with the latest Ethernet, InfiniBand, or PCIe silicon, we are nowhere near the channel capacity on copper (despite my lifelong claim that "Copper is Dead!").⁵⁶ Additionally, backplanes are further limited by the crosstalk induced by the connector. Technologies like Kandou Bus (mentioned in previous reports) and Chord Signaling (CRNZ-5) get better data transfer rates than traditional differential signaling or PAM-4 on copper. If you study the data and the graph, and then do some math with the numbers in the article, we are somewhere between 5% and 13% of copper's channel capacity today.

In 1990, the DoD built their own secure semiconductor fab at NSA headquarters, Ft. Meade, MD (micron-level geometries). They made classified crypto chips and other ICs for sensitive military systems. That facility was closed, and DoD outsourced semiconductor manufacturing through the Trusted Fab program to IBM, Cypress, and Global Foundries. Global Foundries dropped their work on 7nm processes, so that leaves Intel, Samsung, and TSMC as 10nm/7nm sources today. But military

53 Christina Wong, “Economic Growth and AI Progress Depends on Better Hardware”, Next Big Future, March 6, 2019, <https://www.nextbigfuture.com/2019/03/economic-growth-and-ai-progress-depends-on-better-hardware.html>

54 Brian Wang, “Bitcoin by itself can generate 2 degree warming by 2033”, Next Big Future, October 30, 2018, <https://www.nextbigfuture.com/2018/10/bitcoin-by-itself-can-generate-2-degree-warming-by-2033.html>

55 Gary Ruggles, “Getting Ready for 32 GT/s PCIe 5.0 Designs”, Semiconductor Engineering, February 14, 2019, <https://semiengineering.com/getting-ready-for-32-gt-s-pcie-5-0-designs/>

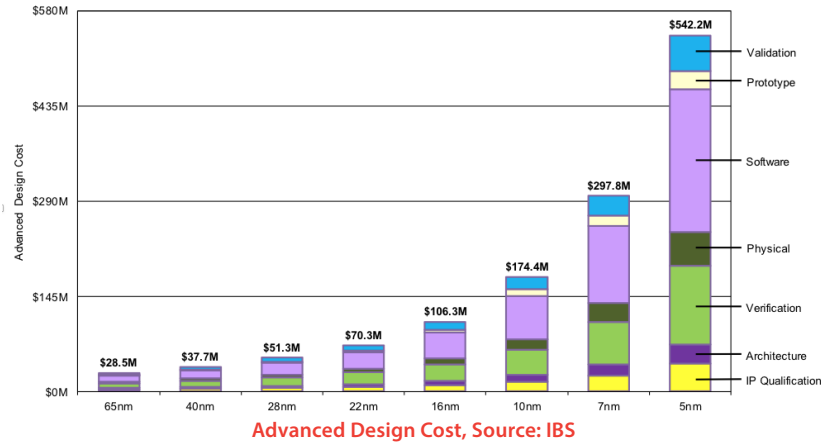
56 Jeff McGuire, “How Much Data Can Be Pushed Through Copper Wires?”, Semiconductor Engineering, October 8, 2018, <https://semiengineering.com/how-much-data-can-be-pushed-through-copper-wires/>

business is low-volume, requires lots of security, and is an administrative nuisance. So, the DoD is trying to figure out what to do about their secure semiconductor needs.⁵⁷

For the curious, you want to see the locations of all the military semiconductor fabs, design, and assembly locations, here's the map (<https://semiengineering.com/wp-content/uploads/2018/10/dod2.png>).

Ever wonder what it cost to design a new processor chip at the different geometries? A study from IBS estimates those costs. It's getting very expensive and that means you must sell lots of chips to justify the up-front costs.⁵⁸

Moore's Law is failing. We used to get 40% performance improvement every 18 months by scaling-down the geometries. Now, we are lucky to get 20% performance improvements (or less) every 2.5 years.⁵⁹ This fact has created a flurry of activity in new processor architecture design.



Intel is experiencing a CPU shortage that will last until late 2019.⁶⁰ There's an ongoing memory glut in the market, affecting NAND and DRAM memory chips.⁶¹ Even some commodity capacitors (depending on footprint) are hard to find these days, primarily due to rare earth mineral shortages. So, we are probably looking at some supply chain issues that are directly associated with the declines in PC, cellphone, flat-screen TV, and data center server demand.

Lara Chamness, a senior market analyst at SEMI, made a presentation at Semicon Europa last November titled "2018: Semiconductor Equipment and Materials Market: Have we Reached an Inflection Point?" that deserves a quick review.⁶² It has some great insight into semiconductor demand and revenue projections. She consolidated the 2018 semiconductor forecasts from all of the major analysts. It shows that the average forecasts, made early in 2018) was revised down from 15% growth to 7.3% with forecasts made in late 2018 or early 2019.

There's an old African proverb that says, "When the elephants fight, it's the ants that take a beating." All the technology we use comes down to us from the high-volume markets, like data centers and cellphones and desktop computers and flat-screen TVs. I have connected a few of the dots for you here. What my insightful analysis proves is that in the embedded markets, we are the ants.

"What my insightful analysis proves is that in the embedded markets, we are the ants."

57 Mark Lapedus, "A Crisis In DoD's Trusted Foundry Program?", Semiconductor Engineering, October 22, 2018, <https://semiengineering.com/a-crisis-in-dods-trusted-foundry-program/>

58 Joel Hruska, "As Chip Design Costs Skyrocket, 3nm Process Node Is in Jeopardy", Extreme Tech, June 22, 2018, <https://www.extremetech.com/computing/272096-3nm-process-node>

59 Mark Lapedus, "What's the Right Path For Scaling?", Semiconductor Engineering, January 2, 2019, <https://semiengineering.com/whats-the-right-path-for-scaling/>

60 "Expect CPU shortages until late 2019", TechAdvisory.org, February 14, 2019, <https://www.techadvisory.org/2019/02/expect-cpu-shortages-until-late-2019/>

61 Max Smolaks, "Memory glut crisis almost over, weeps Micron as Q2 results crank shares up 8%", The A Register, March 21, 2019, https://www.theregister.co.uk/2019/03/21/micron_q2_2019/

62 Lara Chamness, "2018: Semiconductor Equipment and Materials Market: Have we Reached an Inflection Point?", SEMI, November 2018, http://www1.semi.org/eu/sites/semi.org/files/events/presentations/01_Lara%20Chamness_SEMI_0.pdf

Mergers and Acquisitions

Mergers and acquisitions have been active in the past few months, most of it above our embedded market segment:

- *In October 2018, Harris announced their merger with L3 creating the 6th largest defense contractor in the U.S.. This merger looks to be mostly about C4ISR systems in military platforms.*⁶³
- *For those of you of the Linux persuasion, IBM bought Redhat in October, to shore-up their cloud services division.*⁶⁴
- *Also, in October, Esterline was bought by TransDigm Group. Esterline is involved in aerospace and military sales. At one time, they were interested in buying some of the board companies in our space.*⁶⁵
- *In November 2018, Elbit bought IMI (Israeli Military Industries). Both are Israeli military prime contractors.*⁶⁶
- *In March 2019, Nvidia bought Mellanox. The ripples of this acquisition are discussed in the technology section.*⁶⁷

In a recent survey, top executives in the Military/Aerospace industry predicted more mergers and acquisitions in our segment. Increased defense spending and solid economic growth are catalysts for many new deals between military contractors, their suppliers, and their partners.⁶⁸

In our corner of the world, Mercury Systems has been on a buying spree. In January, they bought GECO Avionics. GECO makes electronics and software for the Apache helicopter and the KC-46 tanker, among other things. GECO's estimated sales were \$26.6 million, and Mercury paid \$36.5 million for the company. That's a multiple of 1.38 times sales.⁶⁹ In April, they announced the acquisition of The Athena Group, Inc. and Syntonic Microwave LLC. The all cash purchase price for both transactions was \$46 million. The two acquisitions expand scale and breadth of Mercury Systems's security and RF capabilities.

We will probably see more M&A activity occurring in the military segment as large contractors buy-up some smaller companies who have component contracts in emerging programs. Business is good in the military segment these days.

Summary

In the introduction, I promised to tell you about additional business models that are collapsing, other than the shopping mall, brick-and-mortar retailers, newspapers, magazines, video rental stores, and telecom engineers. So, let's get to it:

The internal combustion engine is going away . . .

This starts with a ban on diesel cars and trucks in certain cities starting as early as 2025. Other countries have set goals to ban gasoline vehicles by 2040 or 2050. There are 17 countries that have established future bans on cars and trucks with internal combustion engines: Denmark, Italy, Norway, Greece, France, Spain, India, Ireland, Israel, Belgium, Netherlands,

⁶³ Jill Aitoro, "A merger of equals, years in the making", Defense News, October 16, 2018,

<https://www.defensenews.com/opinion/2018/10/16/a-merger-of-equals-years-in-the-making/>

⁶⁴ Ron Miller, "IBM acquires Red Hat", Tech Crunch, October 29, 2018, <https://techcrunch.com/story/ibm-acquires-red-hat/>

⁶⁵ Mariana Iriarte, "Esterline to be acquired by TransDigm for approximately \$4 billion", Military Embedded Systems, October 17, 2018, <http://mil-embedded.com/news/esterline-to-be-acquired-by-transdigm/>

⁶⁶ Steve Scheer, "Elbit completes purchase of Israel's IMI after government approval", Reuters, November 25, 2018, <https://www.reuters.com/article/us-elbit-systems-imi/elbit-completes-purchase-of-israels-imi-after-government-approval-idUSKCN1NU0HK>

⁶⁷ Jeremy C. Owens, "Nvidia to make largest acquisition in its history with \$6.9 billion deal for Mellanox", Market Watch, March 11, 2019, https://www.marketwatch.com/story/nvidia-to-make-largest-acquisition-in-its-history-in-7-billion-deal-for-mellanox-2019-03-11?mod=mw_theo_homepage

⁶⁸ Mandy Mayfield, "Survey: More Mergers, Acquisitions to Come", National Defense, April 3, 2019, <http://www.nationaldefensemagazine.org/articles/2019/4/3/survey-more-mergers-acquisitions-to-come>

⁶⁹ Matthew Nelson, "Mercury Acquires GECO Avionics; Mark Aslett Quoted", Govcon Wire, January 30, 2019, <https://www.govconwire.com/2019/01/mercury-acquires-geco-avionics-mark-aslett-quoted/>

England, Taiwan, China, Germany, Canada, and the U.S.. Obviously, the replacements will be electric vehicles.⁷⁰ If you enjoyed sitting in line for gas during the shortages, you'll love standing around while your car is charging-up.

And then, people will stop buying cars . . .

They will use Uber or Lyft. Depending on your travel habits, using these services is cheaper than buying a car, paying the insurance and gas, maintaining the vehicle, and paying for the tags.⁷¹ The taxi business in major cities has already felt the effect of these services. The price of a medallion to operate a taxi in New York City hit over \$1 million in 2013. Today, it's worth about \$200,000 and still falling. You can easily see what this trend will do to auto dealerships and auto repair shops. But, think about the revenue losses to public transportation (city buses and subways). Factor-in the loss of full-time jobs for those government employees and maintenance people.⁷² Also, think about the lost revenue to municipalities from speeding tickets, parking tickets, and drunk driving fines. Then, there are the insurance companies who lose all those premiums when people stop buying cars. All the parking garages in major cities will go out of business, and the valet parking attendants lose their jobs at hotels and restaurants. And don't forget the gas stations too.

The transportation business is turning into the mobility business . . .

For short trips, why use Uber or Lyft? Just grab an electric e-scooter, e-bike, or mini e-vehicle that's painted lime-green or blaze orange, dumped on the sidewalk somewhere. Obviously, this option requires a certain degree of balance, muscle tone, and sobriety so it's not for aging baby boomers with a taste for beer like me.⁷³ Take all this one step further, when we have self-driving vehicles that don't crash into each other regularly. Many large cities are already restricting the use of Uber, Lyft, e-bikes, e-scooters, and other mobility services to protect cab drivers, bus drivers, and subway people from losing their jobs. Local emergency rooms have experienced huge upticks in accidents related to scooters.

While all this is going on, the market for artificial intelligence (AI) chips, just for cars, will be \$10 billion by 2024, according to the latest market report.⁷⁴ This reminds me of the incredibly inflated and fictitious forecasts for boards and systems for telecom in 2000. A lot of companies believed those forecasts, and they are no longer with us.

Beer is going away . . .

With a heavy heart, I must report that beer sales have been declining for the past 5 years.⁷⁵ The younger health-conscious generations are drinking exotic waters, wine, vodka, and tequila, not beer. The sugary soft drink business is also failing. But there is hope for the beer industry. According to a recent study, military personnel drink more alcohol than any other occupation by a wide margin.⁷⁶ What the brewers need to do, to rejuvenate sales, is formulate a military-grade fortified beer, put it in green cans (for the Army and Marines), and blue cans (for the Navy and Air Force), and ship it in a cooler with a small CO2 fire extinguisher. Just open the lid, spray the extinguisher inside, and you have instant cold beer. I learned that trick in my Army days in the 60's.

70 Michael J. Coren, "Nine countries say they'll ban internal combustion engines. So far, it's just words.", Quartz, August 7, 2018, <https://qz.com/1341155/nine-countries-say-they-will-ban-internal-combustion-engines-none-have-a-law-to-do-so/>

71 Kate Samuelson, "The Latest Uber Effect: People Are Ditching Their Cars", Fortune, May 26, 2017, <http://fortune.com/2017/05/26/uber-lyft-people-ditching-cars/>

72 Jim Edwards, "Carpocalypse now: Lyft's founders are right — we're in the endgame for cars", Business Insider, March 3, 2019, <https://www.businessinsider.com/carpocalypse-cars-automobile-sales-data-us-europe-2019-3>

73 Jeff Dorsch, "Micro-Mobility Market Potential Widens", Semiconductor Engineering, March 13, 2019, <https://semiengineering.com/from-e-bikes-to-e-scooters/>

74 Christina Wong, "AI Chips for Self Driving Cars Will a Be \$10 Billion Market by 2024", Next Big Future, March 6, 2019, <https://www.nextbigfuture.com/2019/03/ai-chips-for-self-driving-cars-will-a-be-10-billion-market-by-2024.html>

75 Craig Giammona and Carmen Reinicke, "Pour One Out for the Fading American Beer Industry", Bloomberg, March 1, 2019, <https://www.bloomberg.com/news/features/2019-03-01/are-beer-sales-declining-carbs-push-drinkers-to-wine-tequila>

76 Patricia Kime, "US Military Is America's Heaviest-Drinking Profession, Survey Finds", Military.com, April 11, 2019, <https://www.military.com/daily-news/2019/04/11/us-military-americas-heaviest-drinking-profession-survey-finds.html>

Corporations are going away . . .

Their lifespans are getting shorter. Public companies used to live for 50 years or more. Today, a company stays viable for less than 20 years.⁷⁷ Older companies are being killed-off by advances in technology, as the previous examples point out. They don't invest in new ideas to perpetuate themselves and they are destroyed by new technology-driven companies. Even Jeff Bezos says that Amazon will probably go bankrupt in maybe 15 years or so.⁷⁸ When the AI algorithms are clean, and we have super-powerful neural network processors, successful corporations will probably fail in 10 years or less, on average.

How can this happen to prosperous companies? For that answer, we must go to Ernest Hemingway's book, "The Sun Also Rises". He says: "How do you go bankrupt? Two ways. Gradually, and then suddenly." We saw that happen to a bunch of telecom board companies a few years back

⁷⁷ Michael Sheetz, "Technology killing off corporate America: Average life span of companies under 20 years", CNBC, August 24, 2018, <https://www.cnbc.com/2017/08/24/technology-killing-off-corporations-average-lifespan-of-company-under-20-years.html>

⁷⁸ Eugene Kim, "Jeff Bezos to employees: 'One day, Amazon will fail' but our job is to delay it as long as possible", CNBC, November 15, 2018, <https://www.cnbc.com/2018/11/15/bezos-tells-employees-one-day-amazon-will-fail-and-to-stay-hungry.html>

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